An-Najah National University
Faculty of Graduate Studies

SUSTAINABLE ENERGY MANAGEMENT IN COMMERCIAL SECTOR IN THE WEST-BANK: CASE STUDY OF A PALTEL COMPANY

By
Ahmad Mahmoud Ahmad Tartir

Supervisor
Dr. Imad H. Ibrik

Submitted In Partial Fulfillment of the Requirements for the Degree of Master Program in Clean Energy and Conservation Strategy Engineering, Faculty of Graduate Studies, An-Najah National University Nablus – Palestine

2010

SUSTAINABLE ENERGY MANAGEMENT IN COMMERCIAL SECTOR IN THE WEST-BANK: CASE STUDY OF A PALTEL COMPANY

By

Eng. Ahmad Mahmoud Ahmad Tartir

This Thesis was defended successfully on 20/5/2010 and approved by:

Committee Members	**Signature**
1 .Dr .Imad Ibrik (Supervisor)	…………………
2 .Dr.Abd Alkareem Daoud (External Examiner)	…………………
3 .Dr.Abd Alraheem Abu Safa (Internal Examiner)	…………………
4 . Dr.Husam Arman (Internal Examiner)	…………………

Dedication

To my parents, my wife, and my children

With love and appreciation.

Acknowledgments

First of all, praise is to Allah for helping me in making this thesis possible. Special thanks are due to my supervisor, Dr. Imad H. Ibrik, for being so generous to me with his time, patience, advice and valuable opinion. Special thanks also to Dr. Abdel Raheem abu Safa for his valuable and helpful suggestions.

Thanks go also to those who helped in providing the data used in this research. Also I am indebted to thank my fellow colleagues at work for the assistance and support they offered in acquiring useful information regarding energy.

My thanks are extended to my parents and all my friends I care to name.

Thank you.

"Engineering is the science of economy, of conserving the energy, kinetic and

Potential provided and stored up by nature for the use of man.

It is the business

of engineering to utilize this energy to the best advantage, so that there may be the least possible waste."

William A. Smith, 1908

الإقــــــرار

انا الموقع ادناه مقدم الرسالة التي تحمل العنوان:

إدارة الطاقة المستدامة في القطاع التجاري في الضفة الغربية:
وأخذ شركة الاتصالات الفلسطينية كحالة دراسية

SUSTAINABLE ENERGY MANAGEMENT IN COMMERCIAL SECTOR IN THE WEST-BANK: CASE STUDY OF A PALTEL COMPANY

اقر بأن ما اشتملت عليه هذه الرسالة إنما هي نتاج جهدي الخاص، باستثناء ما تمت الإشارة إليه حيثما ورد، وان هذه الرسالة ككل، أو أي جزء منها لم يقدم من قبل لنيل أية درجة علمية أو بحث علمي أو بحثي لدى أية مؤسسة تعليمية أو بحثية أخرى.

Declaration

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student's name: **اسم الطالب:**

Signature: **التوقيع:**

Date: **التاريخ:**

Values used

Cost of one kWh = 0.76 NIS

Cost of one liter of diesel = 5.3 NIS/L

Cost of one kg of LPG = 4.6 NIS/kg

Abbreviations

AC	Alternating Ampere
Bcf	Billion Cubic Feet
BG	British Gas Company
BTU/h	British thermal unit per hour of heat
DC	Direct Current
GEDCO	Gaza Electricity Distribution Company Ltd
HEPCO	Hebron Electric Power Company
HPS	High pressure sodium
HVAC	Heating, ventilating, and air conditioning
IEC	Israeli Electric Corporation
JD	Jordanian Dinar
JDECO	Jerusalem Distribution Electric Company
kV	Kilovolt
kVA	Kilovolt Ampere
kW	Kilowatt
kWh	Kilowatt Hour
LPG	Liquefied Petroleum Gas
NEDCO	Northern Electricity Distribution Company
NIS	New Israeli Shekel
O&M	Operation and maintenance
PALTEL	Palestinian telecommunication company
PCBS	Palestinian Central Bureau of Statistics
PT	Palestinian Territories
SELCO	Southern Electric Company
SMPS	Switch Mode Power Supply
SPBP	Simple PayBack Period
Tcf	Trillion Cubic Feet
TJ	Terra Joule
€	Euro
UPS	Uninterrupted power supply
USD	Unitd State Dollar
WB	West Bank

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

SUSTAINABLE ENERGY MANAGEMENT IN COMMERCIAL SECTOR IN THE WEST-BANK: CASE STUDY OF A PALTEL COMPANY

By
Ahmad Mahmoud Ahmad Tartir
Supervisor
Dr. Imad H. Ibrik

Abstract

As a result of several years of Israeli military occupation of the Palestinian Territories, the Palestinian economy suffers from major distortions and under development. The supply of conventional energy electricity and petroleum products is monopolized by the (Israel), which sets unrealistic prices, causing energy shortages and the potential for future energy crises.

For that all the energy management should be considered in different facilities such as commercial sector. In this thesis we concentrate to the Telecommunication sector because it is considered as one of the largest consumer of energy in this sector. It consumed about 9 million Shekel per year for different kinds of energy. To achieve this purpose the detailed energy audits have been carried out for the largest telecom company in Palestine (Paltel) facilities.

We have successfully proved that there a huge potential on energy saving in this company in the most energy consumption equipment's such as lighting, UPS's, rectifiers, air conditioners systems, power factor, and others. We have achieved average total saving of 15.3 % for different facilities with a total annual saving of 1597760 kWh which is equivalent to 1272517 NIS/year, and Equivalent to 1739321 kg/year CO_2 reduction, a simple payback period of 2 years.

Introduction

The present civilization is based on man’s ability to harness energy and use it to his advantages. Fossil fuels and all other conventional energy resources have been identified as the predominant source for low cost energy generation. Nearly 85% of the world's energy consumption is based on fossil fuels [1].

However if prevalent rates of increasing energy consumption are allowed to continue, the world’s total fossil fuel reserves would be completely exhausted within a few generation of a lifetime. And the bad effects of this fuel at the environment, on the other hand Palestine facing more complicated situation due the political situation. Palestine has to import all types of energy from Israelis with high prices and tariff. They also control the quantity and condition of energy, saying nothing that about the arbitrary measures such as continuous threatening to stop pumping fossil fuels and cutting electricity. The outbreak of Al-Aqsa Intifada in September 2000 froze and terminated all energy planes with Israeli sides and Arab neighboring countries.

Energy is an important aspect of human life that has a significant impact on the economy of the country. Saving and using the available resources in a proper manner can help leading a country’s economy out of danger from the serious consequences of various energy related problems. During the past 50 years, global consumption of commercial energy has risen more than fourfold, far outpacing the rise in population. This has resulted in a global concern to use energy more efficiently and to reduce greenhouse gas emissions from power generation.

The awareness towards the need for energy conservation worldwide has helped majority of people to gain knowledge about dwindling reserves of fuels. There is still considerable scope to further reduce the energy consumption in different sectors. Efficient use of energy is important since the reserves of our global energy resources are finite and depleting and adversely affect the environmental as a result of power generation. Among the different energy end-use sectors, the commercial sector is often considered having large potential for substantial energy savings.

Being the commercial sector is one of the main energy consuming sectors in Palestine that suffers from incredible energy consumption and bad management, this study specialized in energy efficiency improvement and cost saving measures in different facilities of Paltel Telecom Company in Palestine.

Objectives of Study

The main purpose of this study is to identify those energy management systems in the commercial sector by taking the biggest telecom company (Paltel) as a case study that can help to attain energy savings. It is expected that the research can draw useful information to develop the energy management in different facility in Palestine to achieve energy efficiency.

The main objectives of this study are as follows:

1. To determine the potential of energy consumption in the Palestinian commercial sector.

2. To determine the potential of energy savings in different energy Consumed equipment through energy audits in main Paltel telecommunication company locations as a case study.

3. Data analysis and determination of energy conservation opportunities in the most energy consumption equipments in telecom sector.

4. Establishing economic evaluation and analysis for those energy conservation opportunities.

5. Study and analyze the restricting barriers for the implementation of energy conservation measures in Palestine.

6. To reduce pollutions and CO_2 emissions.

Projects involving adoption energy conservation measures in the commercial sector satisfy general sustainable development goals and energy priorities of the Palestinian National Authority (PNA) which aims at:

1. Energy efficiency improvements by finding suitable energy management measurements and could be applied with low cost or no cost operations,

2. Reduce imports of electricity, oil and LPG, because of the large energy problems faced by the Palestinian Authority.

3. To take advantage of energy-efficient and clean technology and circulated to the various sectors in order to contribute to solving the problems of energy.

4. To help reduce emissions from burning fossil fuels to be in the ranks of some countries that applies policies of the Organization for this purpose.

In chapter one of this thesis, the energy supply and demand in west bank of Palestine will be discussed, Palestine suffer from up normal situation due to Israel occupation who's makes the energy prices uncontrollable, very high comparing with other countries in region.

Chapter two focus on the importance of energy management in various sectors and review some important results obtained from previous studies in the rationalization of energy consumption and management locally. And prove that this type of research is very important and contribute to solving the energy problem.

Chapter three present the characteristics of the telecom in Palestine, the energy resources and the obstacles in progress the energy management in commercial sector, also the energy consumption for the Paltel telecom company main locations are presented.

Chapter four present the description of audited telecom facilities; the annual electric and fuel consumption in addition to the energy bill analyses for each facility were also discussed, for lighting, telecom equipments, HVAC, and others.

Chapter five presents the energy audit in some different location of Paltel company in west bank and present the mathematical and financial benefit due this valuable audit.

Chapter six presents the software programming of energy management opportunity, most important mathematical models were covered, flow charts for each opportunity measures.

Finally the conclusions and recommendations are illustrated.

CHAPTER ONE

ENERGY SITUATION AND ENERGY SOURCES IN COMMERCIAL SECTOR IN PALESTINE

Chapter One

Energy Situation and Energy Sources in Commercial Sector in Palestine

1.1 Introduction

The aim of this chapter is to explore the current situation of the energy sector as an important part of the Palestinian Territories and, more specifically, the commercial sector.

The lack of an adequate infrastructure for nearly four decades has impeded any real growth on the energy front and created chronic energy problems. The problem is summarizing as the following:

- A high unit price of energy when energy resources are either dwindling or non-existent.
- A clear comprehensive and general energy policy at a national level is still absent. This is due to the continuous Israeli occupation, weak and fragmented institutional framework and the incomplete framework of the Palestinian State.
- Renewable energy has not reached a satisfactory level of utilization and pollution from conventional resources is a potential environmental threat.
- The supply of conventional energy (electricity and petroleum products) is monopolized by the IEC, which sets unrealistic prices, causing energy shortages and the potential for future energy crises.

1.2 Energy Resources in Palestinian Territories

As cleared previously, Palestine is considered as one of the poorest countries in terms of energy sources. Energy resources are either dwindling or non-existent, for quick reviews:

Palestine consider as a country of high solar energy potential since the daily average of solar radiation intensity amount to 5.4kWh/m^2-day. Furthermore, the annual average of total sunshine duration amount to 2850 h. figure 1.1 Illustrates measured daily insolation (Wh/m^2) for each month based on data obtained from energy research center on an-Najah University [3].

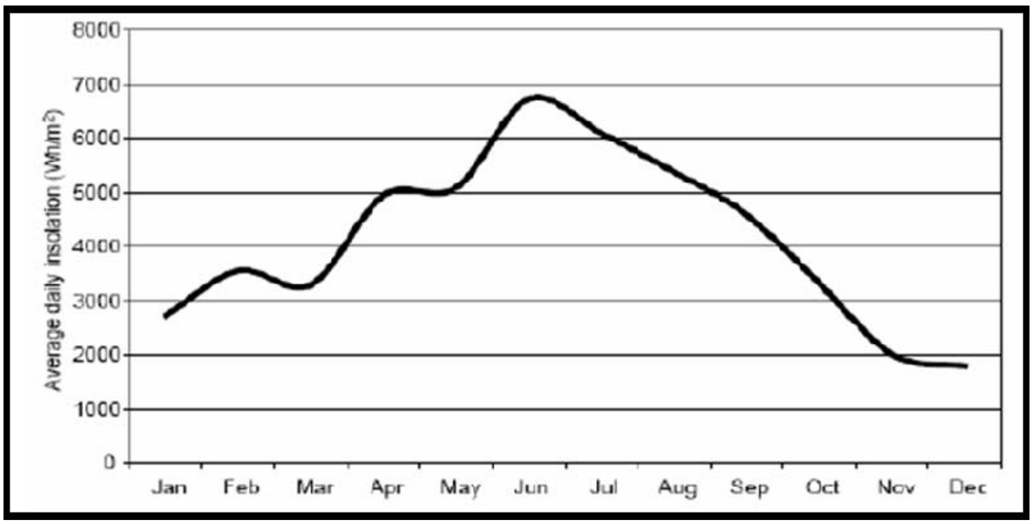


Figure (1.1): Daily average solar insolation throughout the year 2006

The PV in its current statues in not economical and can't compete with electricity supplied with traditional methods. On the other hand, Palestine stands benefit greatly from the utilization of solar water heating. Domestic solar water heating is widely used in Palestine.

- Potential of wind energy is relatively small and not yet utilized in Palestine.
- Biomass (wood and agricultural waste) for cooking and heating in rural areas only decreasing dramatically last ten years.
- Natural gas has been discovered lately by British Gas Company (BG) in December 2000 at Gaza shore. BG has signed a 25-year contract to

explore for gas and to set up a gas network in the Palestinian Authority The gas reserves are estimated to be around 1.4 Tcf, while the needs for gas by the Gaza power station and other industrial, transport and household consumption was estimated at nearly 14.8 Bcf per year. Palestine possesses limited natural resources (minerals and some marine products) [4].

1.3 Energy production and demand in Palestine

With the exception of the latest discovery of the natural gas reserve on the shore of Gaza and some wood supplies, the Palestinian Territories dispose of no energy resources. The available data indicate a very low energy production for the Palestinian Territories (186 Toe) compared to 654 Toe for Israel and 286 Toe and 171 Toe for Jordan and Lebanon. The highest level of energy production in the region could be found in Egypt (with 57,599 Toe) and Syria (with 32,890 Toe) which are the only countries exporting energy in 2007[5].

The West Bank and Gaza Strip imported 44,771.70TJ of energy, including 3,188,271.40 MWh of electricity, 145 million liters of gasoline, 584.370 million liters of diesel, and 5.313 million liters of kerosene. Except for Syria and Egypt, all other countries in the region are net importers, with different energy dependency rates table 1.1[6].

Table (1.1): Energy demands for different types of energy in West Bank and Gaza strip for 2007

Month	Type of Energy							Total Energy
	Charcoal (Ton)	Bitumen (Ton)	LPG (Ton)	Kerosene (1000 liter)	Diesel (1000 Liter)	Gasoline (1000 Liter)	Electricity (MWh)	(Tera Joule)
January	14.2	343.9	15697.0	1444.8	38507.2	10367.4	263029.5	3488.4
February	13.8	0.0	17954.3	900.2	49421.9	12832.6	249521.9	3992.9
March	20.0	35.6	12020.0	256.5	42678.2	9980.4	238108.6	3318.5
April	58.2	71.4	10818.0	73.0	50251.1	11814.7	248753.7	3638.0
May	35.3	70.2	10387.5	320.8	52517.5	12998.8	247838.4	3745.3
June	48.8	231.5	9003.1	86.2	50095.1	11751.0	237578.2	3514.1
July	41.4	357.0	11609.2	137.0	51326.2	12212.1	228582.8	3667.8
August	21.0	873.5	9857.1	94.1	53724.2	13204.0	258261.2	3835.2
Septemb	28.5	585.6	10611.2	70.0	51995.3	13938.8	287823.8	3923.3
October	21.8	649.3	12372.8	263.8	51875.1	13741.7	247654.2	3857.3
Novembe	6.0	846.0	12409.4	824.6	49344.3	11567.5	312082.0	3954.0
Decembe	11.3	701.5	11529.4	842.2	42634.2	10684.1	369037.1	3836.9
Total	320.3	4765.5	144269.0	5313.2	584370.3	145093.1	3188271.4	44771.7

1.4 Energy Balance in Palestine

The energy balance of energy supply and demand for Palestine is frequently up and down every years, it depends usually on the political situation, as cleared in year 2002 which witnessed the events of a serious military by Israel against Palestine. Table 1.2 summarizes this energy balance of Palestine in years 2002 to 2008 in (MWh), its summarize the most recent comprehensive energy balance on energy supply and demand for Palestine. Consumption can be sustained by substantial remittances from abroad that support household incomes and by an increase in non-payments for the supply of commercial energy.

Table (1.2): Summary of energy balance of Palestine from 2002 and 2005-2008 in (MWh) [7, 9].

Year	2002	2005	2006	2007	2008
Total energy requirements	9128877	16493141	14343977	14973914	14285347
Primary production	234474	2666236	2294502	2455068	2337050
Imports	6881358	13827044	12044994	12515807	11985244
Energy conversion	-328563	-980622	-494150	-656263	-648361
Final energy consumption	8692114	9902080	9319697	9980294	9439827
Industrial and construction	567475	715619	710155	531692	539377
Transport	1658172	2686022	2495394	2507393	2497047
Household and other sectors	6466464	6500438	6114147	6941209	6403402

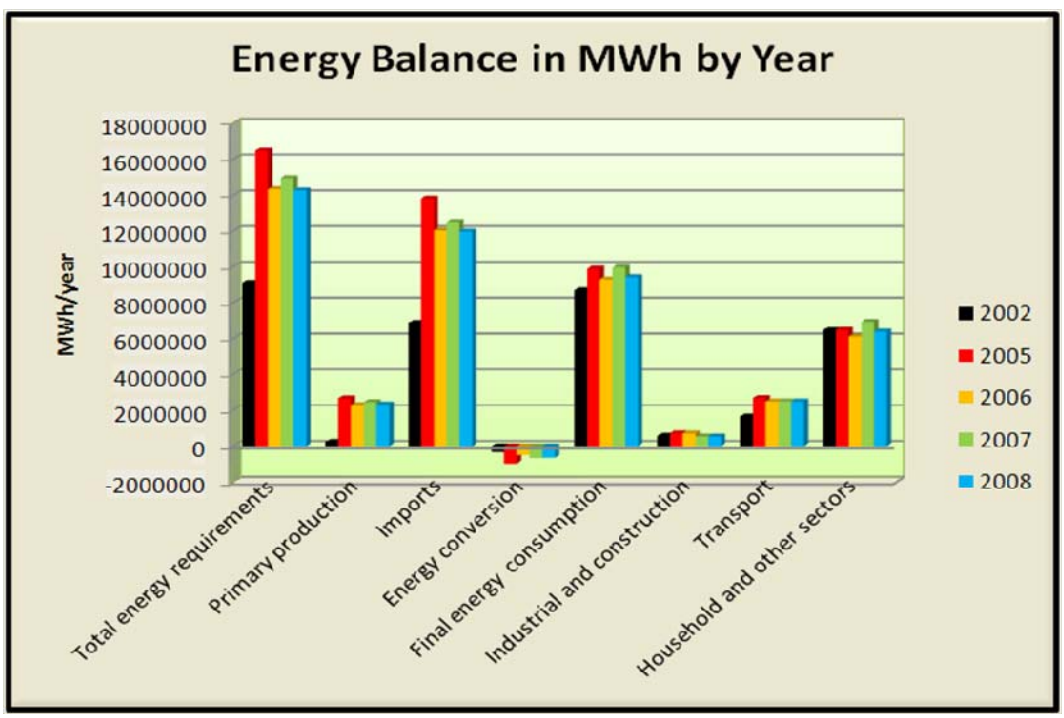


Figure (1.2): Energy balance in MWh for years 2002 and 2005-2008

1.5 The Electric Distribution Companies in WB and GS

Currently, the Palestinian authority is consolidating the structure of power supply and distribution in the West Bank into four power distribution companies to join the Gaza Electricity Distribution Company Ltd (GEDCO) that was set up in 2003 to serve Gaza. Three utilities are being added to the existing utility which serves the central area around Jerusalem -the long-established Jerusalem District Electricity Company (JDECO) it supplies electricity to around 120,000 consumers. Two of the new utilities, the Hebron Electric Power Company (HEPCO) and the Southern Electric Company (SELCO), have recently been established to serve the southern area. The third new utility - the Northern Electricity Distribution Company (NEDCO), is being set up to serve the northern area all of them supplying electricity to around 92,000 consumers [8].

1.6 Energy Consumption by Sector

From Palestinian energy authority for electricity consumption indicate that the residential sector consume 57 % of the total electricity 12% services sector, 6% for internal trading sector. Table 1.3 illustrate the energy consumptions for different sectors for year 2007, figure 1.4 illustrate the electricity consumption by sectors and figure 1.4 illustrate the different energy consumption for year 2007[9].

Table (1.3): Energy consumption for different sectors for year 2007

Utilization	Solar Energy MWh	Electricity MWh	Gasoline MWh	Kerosene MWh
Industrial And Construction	0	206409	9338	15334
Transportation	0	27972	1118583	3586
House Hold	1248320	2072456	0	31452
Agriculture	0	8176	1448	906
Internal Trading	0	228446	0	0
Services	0	415279	3716	422
Other Sectors	0	651901	5165	1328

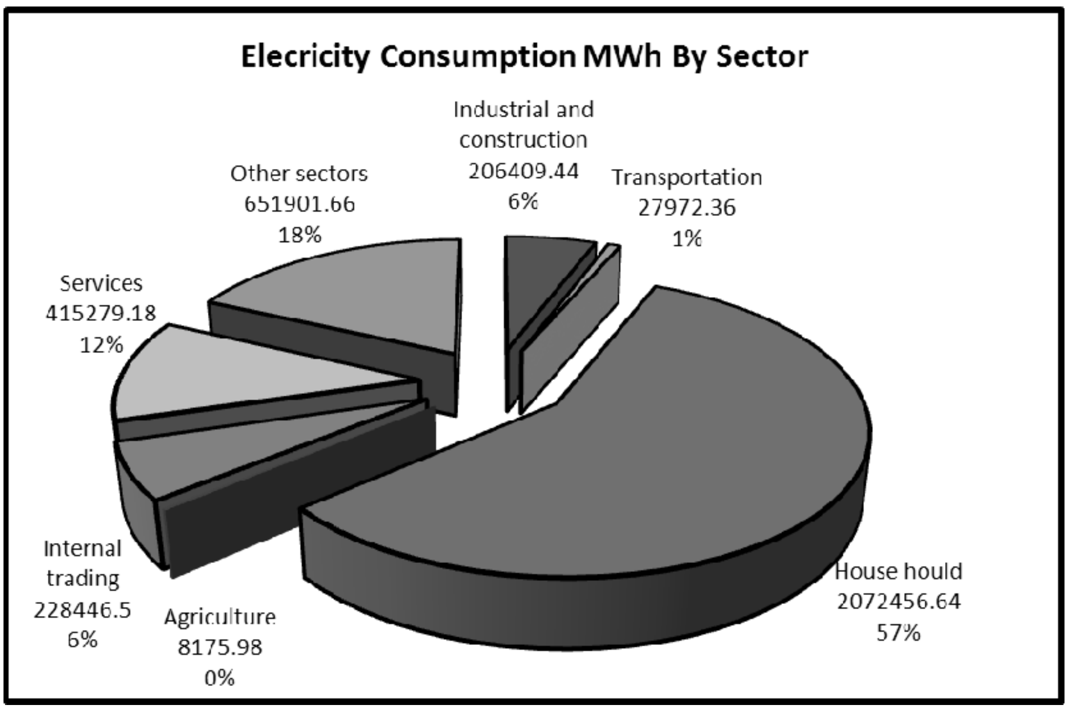


Figure (1.3): Electricity consumption by sectors for 2007

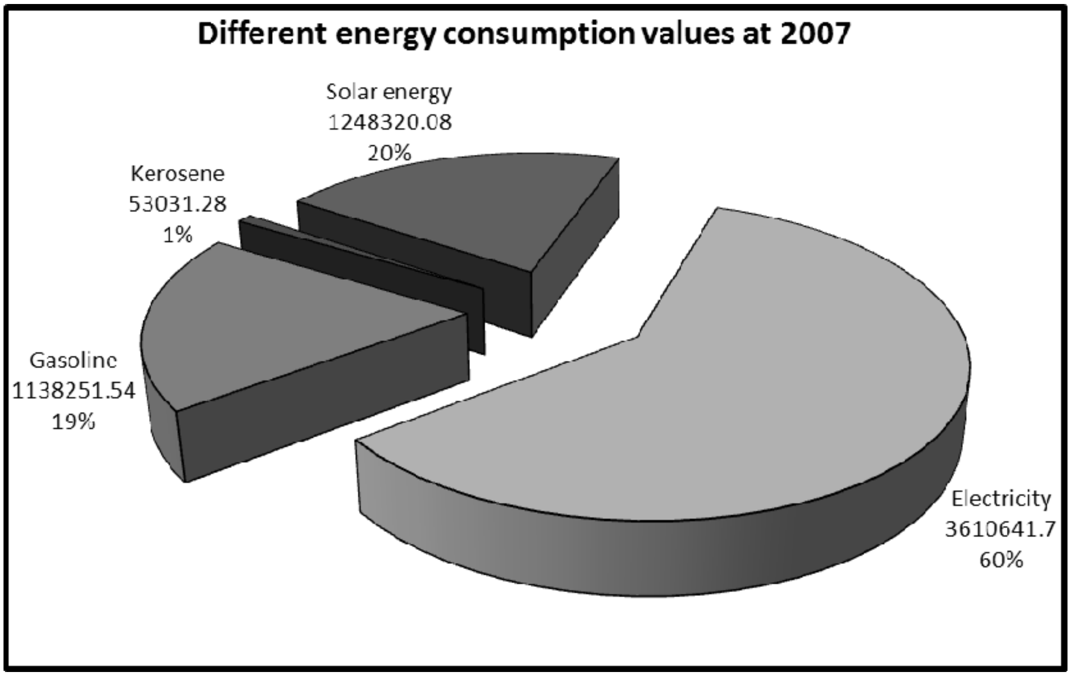


Figure (1.4): Different energy kind's consumption for 2007

1.7 Energy Prices

The electrical energy prices in Palestine are very high; it's about 0.7 NIS/kWh. By comparing with neighboring countries, (Israel) about 0.5 NIS/kWh and Jordan around 0.4 NIS/kWh. The type of tariff using in Palestine is flat rate tariff, each different type of consumers are charged at different uniform per unit rates. The advantage of such a tariff is that it's fairer for different types of consumers and is quite simple in calculations.

Table 1.4 shows the prices of different prices of different energy sources in Palestine and Table 1.5 shows the average electrical tariffs according to the type of consumers and regions.

Table (1.4): Energy prices for consumers, as type of energy, 2007 [9]

Region and Month	Type of Energy					
	Charcoal (NIS/kg)	Oils and Lubricants (NIS/kg)	LPG (NIS/kg)	Kerosene (NIS/L)	Diesel (NIS/L)	Gasoline (NIS/L)
January	5	13.38	3.94	4.49	4.37	5.73
February	5	13.43	4	4.4	4.23	5.53
March	5	13.39	3.94	4.48	4.36	5.79
April	5	14.01	4.26	3.94	4.17	5.83
May	5.67	14.39	4.32	4.07	4.27	6.13
June	5.33	13.78	4.08	4.14	4.33	6.11
July	5.33	14.42	4.28	4.6	4.61	6.22
August	5.5	15.2	4.57	4.73	4.75	6.19
September	5.33	15.15	4.57	4.84	4.85	5.87
October	5.78	15.76	4.74	5.11	5.07	6
November	5.42	16.58	5.06	5.39	5.25	6.18
December	5.86	17.21	5.19	6.05	5.49	6.33
Average	5.35	14.72	4.41	4.69	4.65	5.99

Table (1.5): The average electrical tariffs according to the type of consumers and regions for 2007

	Household Price	Commercial Price	Industrial Price
	NIS/kWh	NIS/kWh	NIS/kWh
Municipality Of Nablus	0.637	0.668	0.562
Municipality Of Jenin	0.578	0.562	0.562
Municipality Of Qalqilya	0.415	0.414	0.404
Municipality Of Hebron	0.498	0.498	0.444
South Electrical Comp.	0.052	0.450	0.410
Jerusalem District EC.	0.471	0.544	0.486
Gaza Electrical Comp.	0.387	0.390	0.389

Energy prices are projected to increase by more than 3 % per year [5].

Summary

The lack of an adequate infrastructure in energy sector for nearly four decades has impeded any real growth on the energy front and created chronic energy problems: there is a high unit price of energy when energy resources are either dwindling or non-existent. The supply of conventional energy (electricity and petroleum products) is monopolized by the (Israel), which sets unrealistic prices, causing energy shortages and the potential for future energy crises. The Palestinian Territories have practically no energy resources, with the exception of wood and the modest natural gas reserve on the shore of the Gaza Strip.

Therefore the energy efficiency improvement in different sectors, by finding suitable energy management measurements are very important for energy sector in Palestine.

CHAPTER TWO

THE IMPORTANCE OF ENERGY MANAGEMENT IN COMMERCIAL SECTOR AND IN THE OTHER DIFFERENT SECTORS

Chapter Two

The Importance of Energy Management in Commercial Sector and in the Other Different Sectors

2.1 Introduction

The use of energy in commercial sector has increased in recent years due to the growing demand in energy used for heating and cooling lighting, and offices equipments. The commercial sector comprises primarily of offices, services companies like telecommunication, shopping malls markets, hotels, restaurants, hospitals, schools, universities and others.

The prime loads in the commercial sector are air-conditioning, electrical equipments, lighting and pumps. The major share of electricity consumption is attributed to by air-conditioning in a full conditioned building followed by lighting, whereas the prime energy consumption in a non-conditioned building is lighting followed by space conditioning (coolers, fans, etc), and then the electrical equipments. The energy conservation and efficiency measures targeted for commercial sector thus should be aimed at enhancing efficiency levels and deploying conservation options. In addition to energy conservation and energy efficiency measures introducing renewable energy would be an advantage to this sector as it will reduce the carbon dioxide emissions.

In this study, we need to analyze the energy conservation opportunities for energy saving in commercial sector especially in telecommunication sector in order to:

- Reduce our dependence on the fossil fuels that are becoming increasingly limited in supply.

- Reduce costs – this is becoming increasingly important as energy costs rise especially in Palestine.

- Reduce risk – the more energy consumes, the greater the risk that energy price increases or supply shortages could seriously affect profitability. With energy management you can reduce this risk by reducing your demand for energy and by controlling it so as to make it more predictable.

Above of that, and even there is a huge potential for energy conservation opportunities, still many barriers are facing the implementation of those measures in the level of management, information, financing and policy.

2.2 Energy Efficiency in Commercial Building

The amount of energy consumed varies depending on the design of the fabric of the building and its systems and how they are operated for example:

a) Since the heating and cooling systems consume the most energy in a commercial building; some building used controls such as programmable thermostats and building energy management systems can significantly reduce the energy use of these systems.

b) Some buildings also use zone heating and cooling systems, which can reduce heating and cooling in the unused areas of a building.

c) Some commercial building used large number of old generation equipments like telecommunication exchange buildings, these equipments needs always to development to increase its efficiency and to reduce the electrical consumption since there is a new generation of equipments which used a new technology, for example the new generation of UPS systems used electronics for transformation but the old conventional used transformer this can reduce the consumption more than 20% due to reduce losses. The replacement of the old equipments cost a lot of money, but when we calculate its conservation for long time we see the large benefit and good money saving.

2.3 The Importance of Energy Managements

The energy management has much already written on this subject. This is not surprising since it's such an important topic today. There is a vast amount of information available in the form of books, articles, and websites dedicated to this subject. Unfortunately, as a vast as the literature on this topic might be, the concept of energy management does not extend very far into the telecommunications facilities. This became evident when the literature study revealed that a direct link between energy management and telecommunications could very seldom be found. This field of exercise has eluded this environment, and has only very recently started to gain popularity, probably as a result of globalization and the high cost of energy. This lack of information provides an excellent opportunity to expand the energy management concept into the telecommunications sector. This forms the basis of this study.

As the previous critical situation on energy sector its cleared the importance of energy management in the various sectors, and because of the commercial sector is consider one of a large consumers of energy, this push us to study this sector and represent the ways of reducing the energy consumption to face the up normal situation which Palestine suffering from. A significant reduction in energy use in commercial buildings can be achieved cost-effectively through a combination of energy management techniques and existing energy efficient technologies.

Paltel as a commercial building include a wide variety of building types such as offices, exchange building, customer services buildings …etc. These different commercial activities all have unique energy needs but, as whole, Paltel buildings are using more than 77% of electrical energy. [10]

2.4 Energy Management in Different Sectors in Palestine

Energy audits can be conducted as a useful way of determining how energy efficient any sector is and what improvements can be made to enhance efficiency. Tests should be undertaken to ensure that the heating, cooling, equipment and lighting all work together effectively and efficiently, lately we will make energy audit for one of the large commercial sector which is Paltel Telecommunication Company.

The industrial sector is one of the main energy consuming sectors in Palestine that also suffers from incredible energy consumption and bad management, the master thesis that submitted to AN-Najah University [4], it's titled in energy efficiency improvement and cost saving measures in different industries in Palestine. Energy demands in Palestinian industries account for approximately 6 to 7 % of the national energy demand. Individual industries and businesses have different demands, which are met from various combinations of on-site heat and power generation from delivered fuels, electricity and gas consumption from mains supplies. Fuel and energy consumption rates and energy processes depend on the type of product produced.

From this master thesis, it was clear that there is huge amount of savings in the industrial facilities could be achieved by implementing no cost and low cost energy conservation measures. It means that we could save a good percentage in energy consumption by just a simple changing in the behavior of energy utilization (no cost) or by a small amount of investment in order to achieve the required goal (low cost). Table 2.1 summarizes the potential savings in electric and fuel energy in each of the four studied factories, the equal amount of money and the reduction in CO_2 emissions.

Table (2.1): Summary of the total energy savings and CO_2 reduction in the four studied factories in WB [4].

Factory name	Electric Energy consumption (kWh/y)	Fuel energy consumption (liter)	Savings in kWh		Savings in fuel		Money savings JD/y	CO2 reductions Tons/y
			kWh/y	%	Liter/y	%		
Al Safa Dairy Factory	626340	109200	54342	8.7	11656	10.7	15263	34
Al Carton Factory	263068	164410	14808	5.6	17998	10.9	10056	24.8
Al Arz Ice Cream Factory	1093780	91190	70959	6.5	15208	16.6	19921	44.35
Al Aqqad Textile Factory		223000			42147	18.9	31669	71.9
		212000			20276	10.9	9327	
Total							**86236**	**175**

There is another valuable master thesis [3], which is concerning on energy management in hospitals sectors in Palestine submitted to AN-Najah University and he get also very important results, table 2.2 summarize it.

Table (2.2): Total summary of the saving opportunities for hospitals auditing in Nablus city [3]

Opportunity	Energy saved (kWh/year)	Cost reduction (NIS/year)	Opportunity implementation cost (NIS)	Equivalent kg of CO_2 reduction	S.P.B.P
Lighting System	105,108	76729	0	113,516.92	immediate
Cooling System	84,656	61,799	0	91,428.99	immediate
Thermal System	465,240	221,542	35,1145.48	502,459.27	1.585
Power Factor Improvement	221,439	161,650	14,548	239,154.42	0.09
Oxygen System	675830	493355	385383	729896.4	2.2
Total	1,552,274	1015077	751077	1,676,456	-------

This local studies have addressed the issue of energy management and conservation in some sectors, which recent studies and have shown very significant results in the energy conservation subject, which has a great impact on the encouragement to research in energy management in the new sector which is commercial and specialized in a telecommunications sector, this sector is one of the most important sectors, it is one of the most energy-intensive in all its forms, for example the consumption of electricity in Paltel telecommunication sites in the West Bank about 10 million NIS a year, and fuel consumption approximately 2.3 million NIS and this amount is very large and worthy of study and research to improve the energy management.

2.5 Barriers or Energy Management in Commercial Sector

2.5.1 Lack of information

Lack of information or imperfect knowledge on the part of consumers, vendors, manufacturers and policy makers may hamper the introduction of efficiency measures in situations where they make technical and economic sense. Consumers are frequently unaware of practices and technologies available to conserve energy. Developers, architects, and facilities managers often have misconceptions about new or unfamiliar technologies.

2.5.2 Financial barriers

Many consumers will not make investments in energy efficiency because they lack capital to buy new energy-efficient equipment or make the required retrofit in their installations. A certain measure might be very cost effective, with fast payback, but it will not be implemented unless the consumer can meet the up-front capital costs. Also, energy efficiency might not be his priority for investment. An industrial customer may prefer to spend capital on a new line of products rather than consider a retrofit in existing installations. Furthermore, it is often not the person who pays the energy bill who is responsible for the selection and purchase of energy-using equipment. [11]

2.5.3 Technological barriers and infrastructure

Several opportunities to produce and to conserve energy depend on new technologies that might not be available in some countries or regions.

Many new and efficient technologies incorporate electronic components which rely on good quality power to operate. Voltage fluctuations and frequent power failures will shorten the equipment's designed lifetime. Energy prices and rate making: Electricity rates (tariffs) in many instances have been a barrier to attracting consumers to invest in energy efficiency. Very often tariffs do not reflect the marginal costs of producing electricity. Traditional rate making encourages sales of kWh (for an electric utility), and discourages efficiency measures.

2.5.4 Barriers to Provide Energy Efficient Lighting

The energy efficient lighting is often a symbol for energy efficiency in general. However, it is seen that practically there are number of barriers in providing energy efficient lighting.

(i) High capital cost- The energy efficient fixtures such as T5 lamps, Electronic shokes, sensors and dimmers have high capital cost.

(ii) Lacks of awareness – Some of the products which can contribute significantly in improving lighting efficiency are not available in local markets resulting into lack of awareness.

(iii) Availability of Quality products- There are not sufficient guarantees that energy efficient accessories / fixtures will perform satisfactorily in the field for their declared life. It is often seen that life of some of these products is much less as compared to the declared life and it is a common knowledge that electronic shokes do produce humming sound in many cases and requires special setting for individual sets.[11]

Summary

All companies, irrespective of size, number of buildings or sites occupied and total energy spend, can benefit from exercising good energy management. Savings sometimes up to 40% can be realized as we seen previously. Perhaps more importantly, some 'savings can be made without capital investment. For other measures, experience from the demonstration projects repeatedly shows payback times of one year or less.

The key to achieving such savings in telecommunication facilities is to take a strategic approach to managing energy use, combining several separate energy management techniques, as increase energy efficiency in the devices and equipment, managed the energy in the lighting systems and HVAC,.. .ect.

While energy-efficient technologies have a significant role to play in reducing energy use in several sectors, it is just as important to ensure that employees are using energy wisely. This requires the application of management techniques. The diversity of cultures and structures within companies means that no single technique or approach will always work, but a combination of a number of well- known management techniques, appropriate to the particular company.

CHAPTER THREE

ENERGY CONSUMPTION AND ELECTRICAL EQUIPMENTS IN PALTEL MAIN SITES

Chapter Three

Energy Consumption and Electrical Equipments in Paltel Main Sites

3.1 Introduction

Paltel is the national telecommunications provider in Palestine. With the pace of technology rapidly changing, Paltel today leads Palestine into the new era of communications through its state-of-the-art technology and advanced services. Paltel offers a range of services including local and international telephone services, internet, data communications, value-added services, payphones, and next generation services in addition to creating the backbone for other related telecom service.

Paltel building and exchanges of west bank were evaluated, audited and analyzed in this study. The nature of telecom activities were quite varies from each other. They included switches equipments, offices, and one stop shop buildings.

During the initial part of the site investigation, discussions were held with the plants personnel regarding overall annual energy utilization, major energy consuming equipment, and specific and unique energy efficiency opportunities that may not have been explored. There is no problem in visiting and investigating the buildings and all telecommunication facilities with the cooperation of the building's O&M personnel in order to obtain information about the different energy systems of the building.

3.2 Electrical Energy Sources and Equipments

3.2.1 Energy Sources from Electrical Network

Virtually all telecommunications power starts with commercially available AC. Exceptions to this include some sites in west bank that is powered by engine/alternators, like Kufer Kaddom village site. The philosophy behind telecommunications power is that telephone service must be continuous. This philosophy requires a system that is not dependent on any one source of power for the system. Back-up power at each location is dependent on the reliability of the primary commercial AC. Figure 3.1 provides a graphic view of all of the major power plant elements and their relationships.

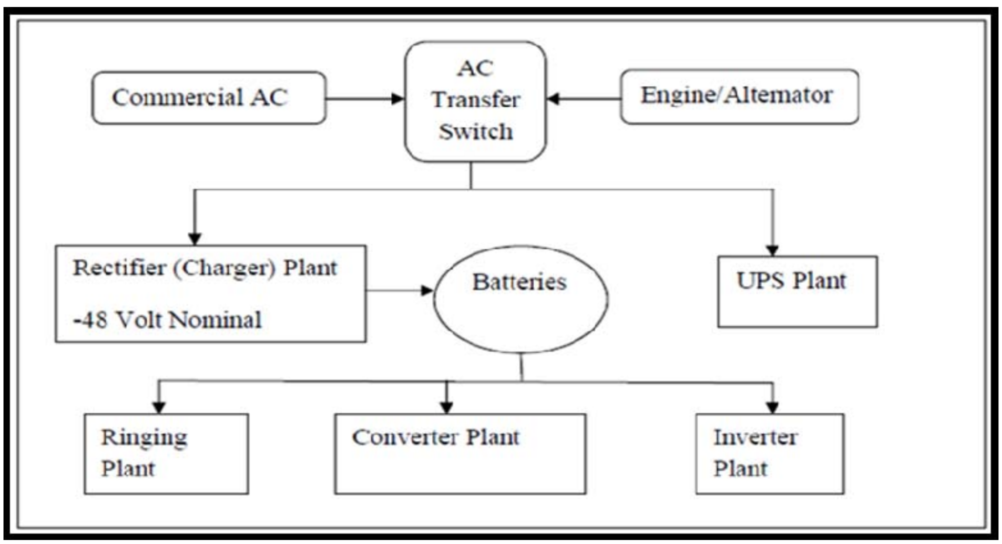


Figure (3.1): Major telecommunications power plant components

3.2.2 Engine/Alternators Energy Sources

Permanent engine/alternators are required to supplement commercial AC in virtually all "critical" telecommunications sites which more than 60 unit in west bank. These include major switching and transport centers, and critical fiber locations. Engine/alternators used for telecommunications are rated as "stand-by" and not "emergency".

3.2.3 Batteries Resources

The reliability of the telecommunications system rests on the batteries. Batteries provide continuous power during momentary and short duration interruptions of commercial AC. The amount of reserve required in a battery system is determined by the reliability of the commercial AC, the placement or lack of an engine/alternator, and the location of the site. Basically a minimum of three hours of battery reserve is required for sites with auto start-auto transfer engine/alternators while a minimum eight hours of reserve (plus travel time) is required for sites without engine/alternators. [12]

3.3 Energy Consumption for Patel Company in West Bank

It's cleared from table 3.1 that the energy consumption for all regions of west bank locations, its cleared the Nablus has the largest consumption due to head quarter, and figure 3.2 cleared this. The consumption of electricity is about 77% and from fuel 23 % as shown in figure 3.3 the fuel used to operate the standby generators and for transportation and also for heating the head quarter in winter.

Table (3.1): The electrical and fuel consumption as total of main regions in west bank, 2008 [10]

Regions	Electricity (kWh)	Electricity (NIS)	Fuel (Liter)	Fuel (NIS)	Fuel (kWh)	Sum of Energy Cost (NIS)
Al-Quds	683389	478372	19787	98936	207767	577309
Jenin	966546	676582	77315	386578	811813	1063160
Tulkarm	727562	509294	48699	243498	511345	752791
Ramallah	2591389	1813973	77315	386578	811813	2200550
Nablus	4244839	2971387	151305	756525	1588702	3727912
Al-Khalil	1402533	981773	34371	171856	360898	1153629
Bethlehem	818494	572946	37914	189570	398097	762516
Jericho	452567	316797	182	911	1913	317708
Sum	11887319	8321124	446890	2234452	4692348	10555575

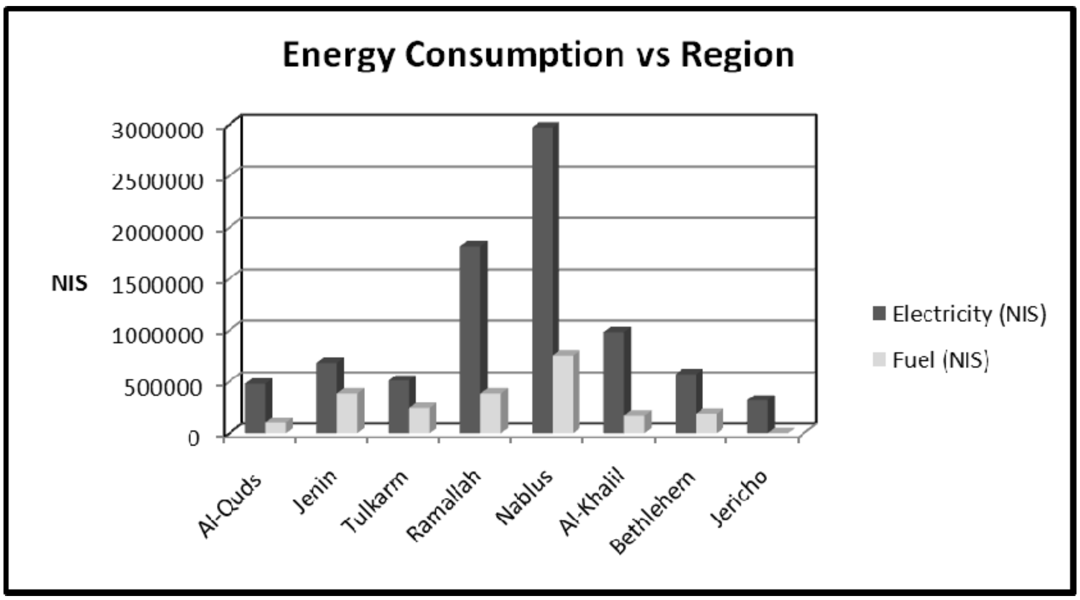


Figure (3.2): Energy consumption for haul Paltel locations in West Bank, 2008

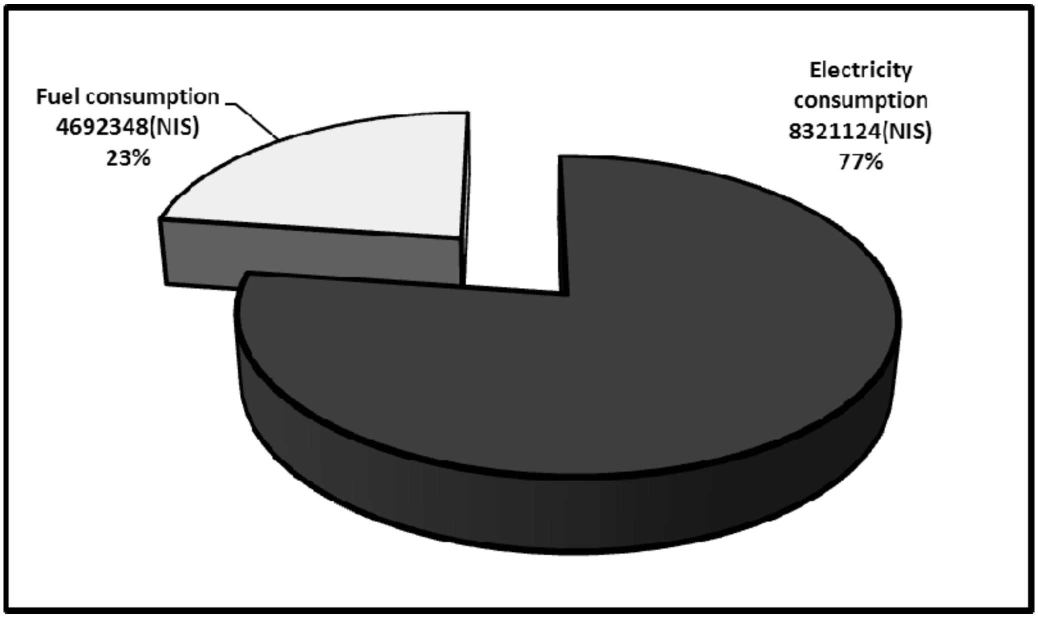


Figure (3.3): Kind of energy consumption percentage for Paltel locations in West Bank, 2008

Figure 3.4 illustrates the distribution map of the main telephone exchange sites in Palestine.

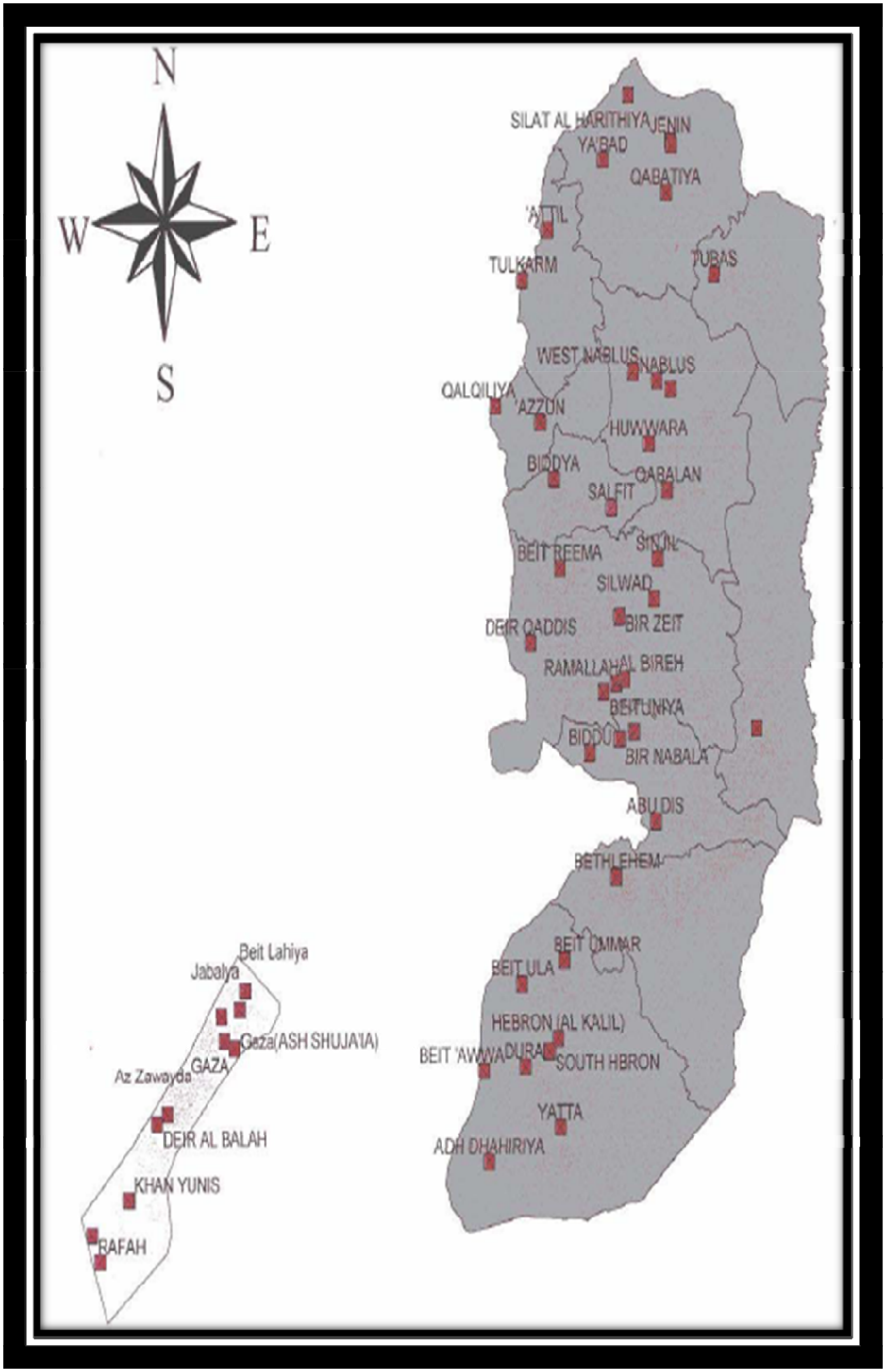


Figure (3.4) Distribution map of the main telephone exchange sites in Palestine [10]

3.4 Building Classification in Paltel Company

Paltel have more than 300 sites including:

1. Office buildings like head quarter, customer services buildings.
2. Main exchange buildings.
3. Sub exchange buildings remote site units (RSU'S).

In this study we will take samples for each kind of building to illustrate the building profiles and the energy information including consumptions and main equipments.

3.4.1 Analysis of Consumption in Offices Building

Paltel head quarter building as sample of this kind of buildings:

Building Profile: The head quarter building of Paltel Company is located in Nablus city. The building is consists of nine floors with total area of 6500 m^2 in the west region of Nablus city, Figure 3.5 shows outside view for the building. It consists of different sections like:

- Financial department, Commercial department, Marketing department, Network services department and Main data centers.[10]

Figure (3.5): Paltel head quarter building photo.

Energy Sources: "Paltel Head Quarter" is supplied by Nablus municipality with main subscription of (3X1000A) that's to cover the needed of electricity, the company has a stand by diesel electricity generator (400 kVA), to cover all loads except central cooling system. [10]

Energy Consumption:

Energy consumed by the building includes electricity and diesel, but consumption is dominated by electricity, in terms of both consumption and cost. Diesel is used as fuel for the two boilers for heating in winter.

Electricity is used to operate all building systems; cooling, data equipments (servers), lighting, office machines like computers printers faxes …etc.

1. Electrical consumption = 1133198 kWh/year
2. Diesel fuel consumption = 10000 liter/year

The energy inputs are electrical energy and Diesel for boiler (heating system). The annual energy consumption for the audit period (2008) is summarized below in figure 3.6 [10].

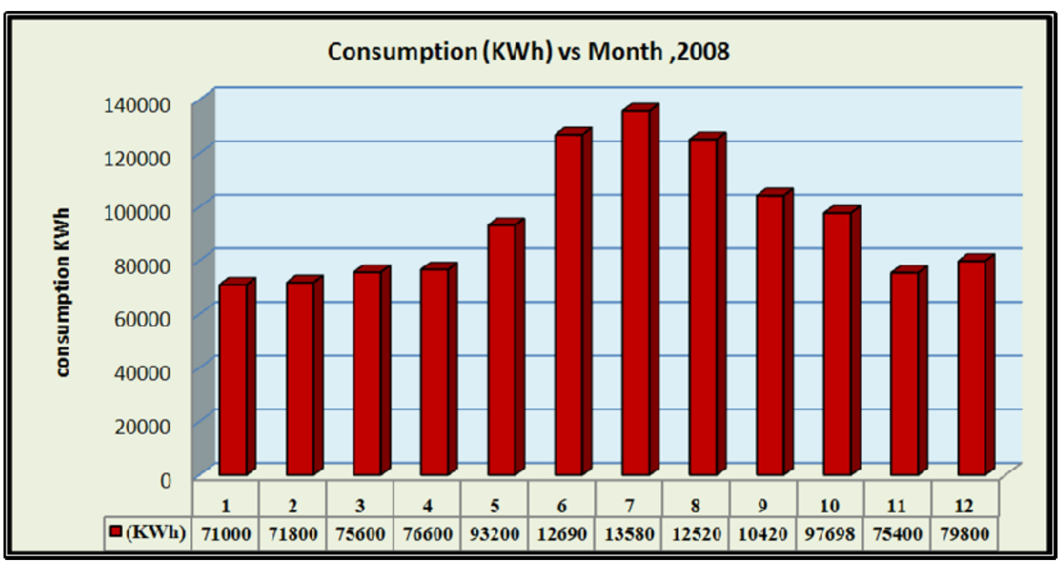


Figure (3.6): Electrical Energy consumption of Paltel head quarter, 2008.

Daily Load Curve:

The daily load curve is a good tool for load management to achieve many benefits, figure 3.7 shows the daily load curve for the period of day 6/1/2008 as cleared in appendix 10.

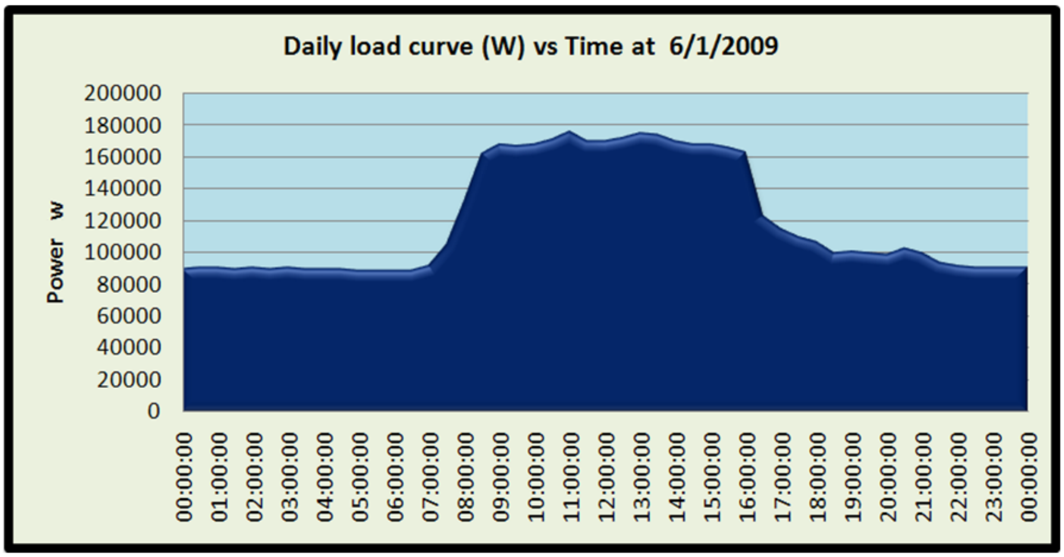


Figure (3.7): daily load curve (W) for H.Q, 2009 [10]

Electrical Equipment:

1) The Head Quarter building is occupied with different equipment including computers, servers, telecommunication machines and systems, printers, scanners, and other electric equipment. Most of the building is used as offices rooms, data centers, labs, mosque first floor in addition to a cafeteria in the ground floor,
2) Data server's lab equipment which are supplied by dual power supply.
3) Big printer to print the monthly consumer telephone bills with full load power = 20 kW and power factor 0.8.
4) Cooling systems are consists of:

a) Central cooling systems. There are two big chillers (70kW) each, which used for cooling hall building in summer.
b) In addition, there are three central cooling systems with (9.6 kW) each one and also ten split units (3 kW) each used for space cooling in the data center. Space cooling is provided 365 days per year.

The Air conditioning systems are the largest load which greater than 59% in summer and the loads are different seasonally as can be seen in figure3 .8, and figure 3.9

5) Heating Systems: Space heating system using diesel is provided in winter (about 850 houre/year). There are two boilers. The diesel consumption for the two working boilers is about 2000 L/month. The outlet hot water temperature is 60 ^{0}C, with heated space temperature of 24 ^{0}C.

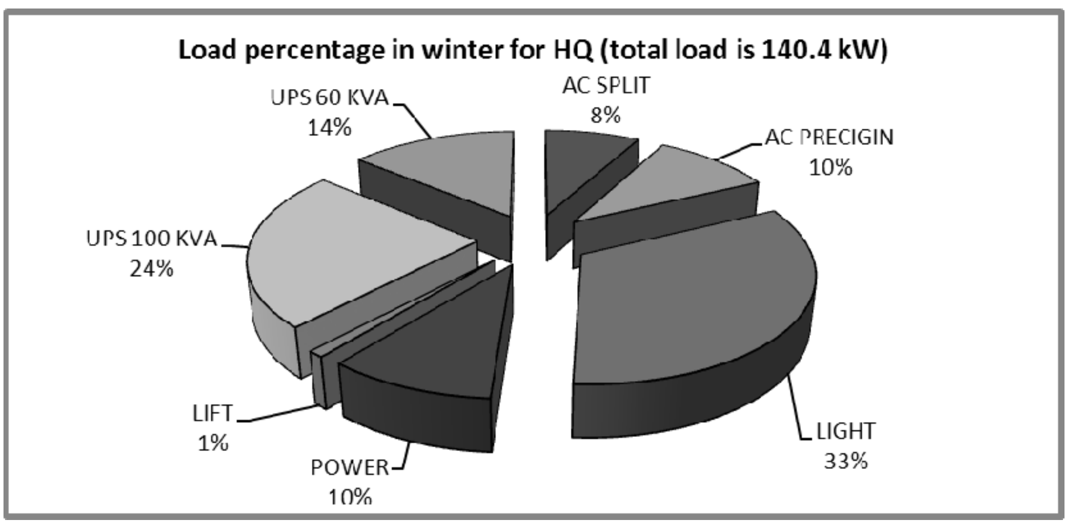


Figure (3.8): Load percentage in winter times for H.Q, 2008

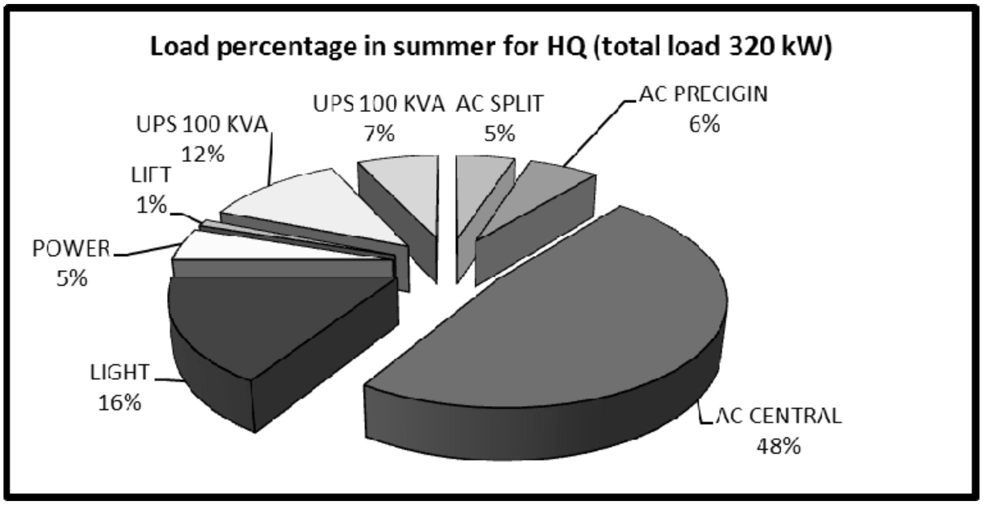


Figure (3.9): Load percentage in summer times for H.Q, 2008

3.4.2 Analysis of Electrical Consumption in Main Exchange Building

Nablus exchange building as sample of this kind of buildings:

Building Profile:

Nablus telecommunication department, this is one of Palestine telecommunication buildings located in Nablus, the total floor area of the building is 5000m^{2}. The building includes:

1) Main telephone switches equipments that consume about 1000 ampere of DC current, about 53kW

2) Its used many chillers to save the equipments in a suitable temperature the building as the following:

a) Chiller (30kW) used for cooling the main international switch, actually it operates (15kW) each 12 h/day,
b) Chiller (38,4kW) used for cooling the H100 switch; actually it operates (19,2kW) each 12 h/day.

c) Chiller (12kW) used for cooling the offices, actually it operates (6KW) each 7 h/day.

d) In addition, there are 6 split units used for space cooling in the building with capacity of 2.4 kW and two split units with capacity 6 kW for each it operates 7h/day .

Energy consumption:

Paltel receives its electric utility service from Municipality of Nablus. The Paltel paid about 646072 NIS for 922960 kWh per year for this section. Also, from the analysis of utility bills data, we can observe the variation in monthly electric energy use. We took the energy consumption for 2008 from the archives as summarize in figure 3.10, and cleared from the energy analyzer results in appendix 9.

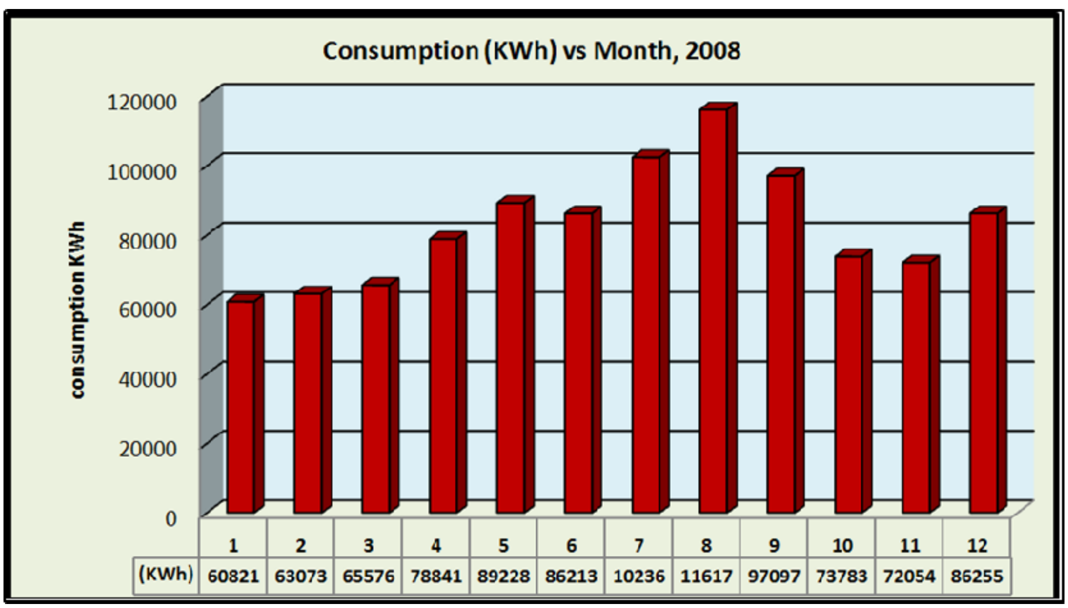


Figure (3.10): Electrical consumption kWh/month for Nablus main exchange, 2008[10]

Figure 3.11 described the Daily load curve, active power consumption at 5/2/2008 for Nablus main exchange.

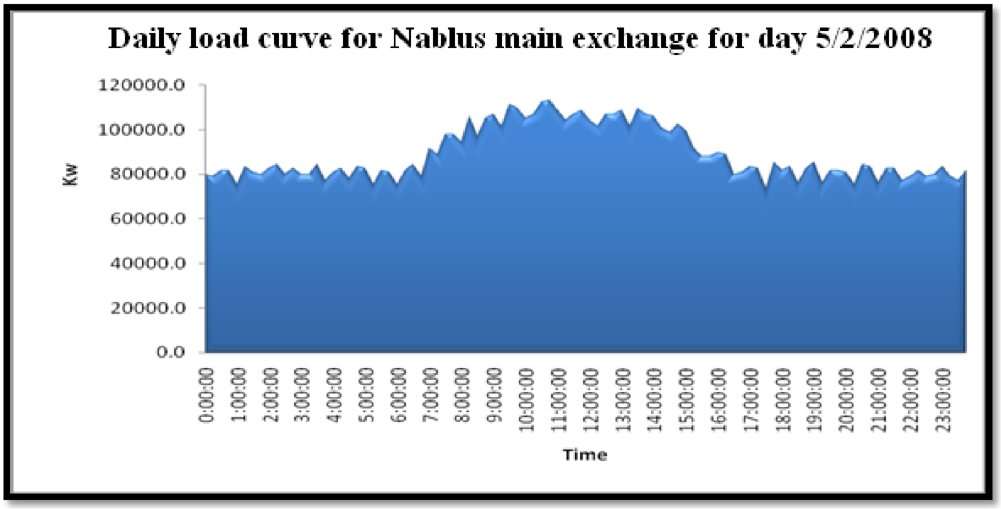


Figure (3.11): Daily load curve for Nablus main exchange, 2008[10]

3.4.3 Analysis of Consumption in Sub Exchanges Buildings Remote Site Units (RSU's)

Borqeen Exchange building as sample of this kind of buildings:

Building Profile:

Borqeen Telecommunication RSU is one of Palestine Telecommunication buildings located in Jenin; the total floor area of the room is 30 m^2, it includes:

1) Small telephone switches equipments that consume about 10 ampere of DC current, about 530 W

2) 2.5 kW air condition unit to save the equipments in a suitable temperature the equipments.

Energy consumption:

The consumption in Borqeen RSU building about 13847 kWh which is corresponding to 9693 NIS/year. Also, from the analysis of utility bills data, we can observe the variation in monthly electric energy use due to air condition operates between summer and winter. We took the energy consumption for 2008 from the archives as summarize in figure 3.12

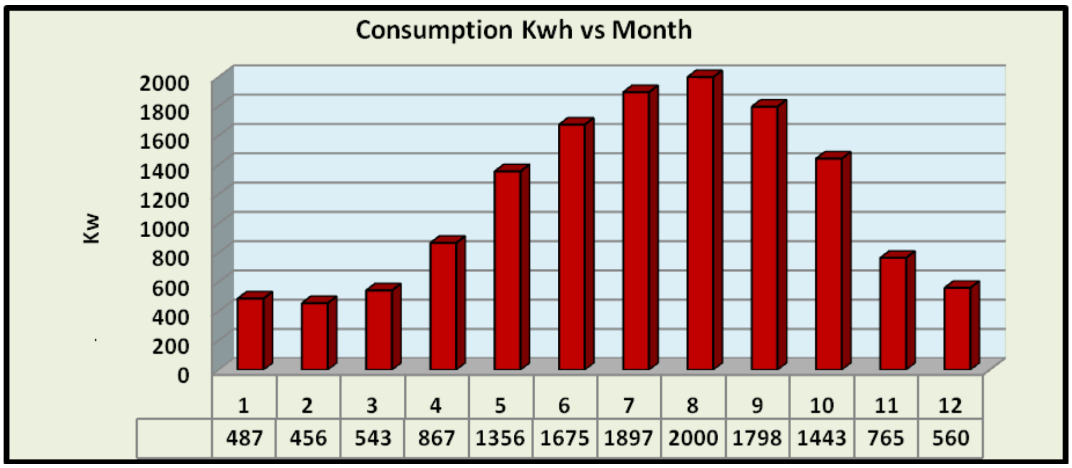


Figure (3.12): Electrical consumption kWh/month for Borqeen RSU, 2008[10]

Summary

From the above analysis and data, the energy consumption in Paltel company is very high; therefore the energy conservation and improving energy efficiency at different facilities in Paltel will be very important and feasible. In next chapters we will determined which measurement necessary to taking into account to reduce the total energy bill of the company.

CHAPTER FOUR

ENERGY MANAGEMENT OPPORTUNITY AND AUDIT IN DIFFERENT TELECOM BUILDINGS IN NORTH AND MIDDLE OF WEST BANK-PALESTINE

Chapter Four

Energy Management Opportunity and Audits in Different Telecom Buildings in West Bank-Palestine

4.1 Introduction

Definition of Energy Audit:

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Facilities energy audit is an effective tool in defining and pursuing comprehensive energy management program. Audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption. [13]

Each facility will be separately presented; the potential for saving will be studied from the technical point of view in addition to the calculated method followed in a pointing this potential. The audited facilities were:

- **Paltel Head Quarter,**
- **Nablus Exchanges**
- **Jenin Exchanges**
- **Tulkarm Exchanges**
- **Ramallah Exchanges**

The measurements instruments used for measuring and collecting data were:

- The energy analyzer equipment: it was installed on the main electrical board of the facility for power measurements and energy consumed and for determination of power factor.
- Thermostat: for temperature measurements.
- Lux meter: for lighting illumination measurements.

The auditing mission was focused on the most energy consumed equipment in Paltel telecom facilities as mentioned before.

4.2 Lighting Systems Energy Conservation

Lighting in a typical building constitutes about 25% of the energy bills. There is a considerable scope of reducing energy consumption through energy efficient lighting schemes. However, the experience shows that there are barriers in providing energy efficient lighting schemes due to high capital cost, lack of knowledge and good quality products. Lighting is an element of our home and work environment that affects our life in many different ways. [14]

The specific energy measures included in the lighting energy efficient measure are:

- Extra lamp removal.
- Replace lamps from less efficient types to more efficient types
- Install lighting control equipment to reduce the amount of lighting in vacant spaces where not needed and reducing the length of time that the lights are on.

4.2.1 Extra-Lamps Removal (No Cost Action)

In order to calculate the optimum number of fixtures and reducing the number of excessive lamps equation 4.1 was used:

$$N = \frac{(E \times A)}{(n \times \Phi \times Ku \times Km)} \quad \ldots\ldots\ldots\ldots\ldots\ldots 4.1$$

N: number of units, E: illumination lm/m^2 (lux), A: area in m^2, n: number of lamps in unit, Φ: luminous flux in lumen, Ku: reflectance factor, and Km: maintenance factor [3], we applied extra-lamps removal for many sites like:

a) Lamp removal in Paltel head quarter as a case study:

According to illumination measurements shown in Appendix-1 for Nablus head quarter, it was found that values, which were measured at some places, exceed the standards values. So removing extra- lamps is recommended for the location as shown in appendix-2, Table 4.1 illustrates the expected annual energy saving achieved upon the removal of the lamps.

Ground floor: removal fluorescent 8 lamps 4×18w

The energy saving = N × P × h……………………………4.2

N: total number of removed lamps, P: power of each one, h: total working hours per year.

The energy saving = (8 unit × 0.072 kW) × 2040hr/year = 1175 KWh/year

Saving money = 1175 kWh /year × 0.76 NIS = 893 NIS/year

And by applying this for all floors we got the following results:

❖ The total energy saving by totally lamp removal in HQ building is 24645 kWh/year as cleared in table 4.1.

Table (4.1): Expected annual energy saving achieved upon the removal of the lamps in head quarter

Area #	Area Name	Area m^2	Existing Lamp Type	No. of Fix.	# Removed	kW saved	Saving kWh/year	Money saving
1	Ground floor	900	Fluorescent 60x60 cm^2	33	8	0.576	1175	893
2	First floor	900	Glop 2x13 W	26	8	0.208	424.32	322.5
3	Second floor	900	Glop 2x13 W	17	7	0.182	371.3	282.2
			Fluorescent 2X36 W	11	3	0.216	440.64	334.9
4	Third floor	900	Fluorescent 60x60 cm2	45	15	1.08	2203	1674.3
			PL spot 13 W	38	15	0.195	397.8	302.3
			Fluorescent 2X36 W	14	5	0.36	734.4	558.1
5	Fourth floor	900	Fluorescent 60x60 cm^2	62	20	1.44	2937.6	2232.6
			PL spot 13 W	30	8	0.104	212.16	161.2
6	Fifth floor	900	PL spot 13 W	30	8	0.104	212.16	161.2
7	Sixth floor	900	Fluorescent 60x60 cm^2	62	20	1.44	2937.6	2232.6
			PL spot 13 W	30	8	0.104	212.16	161.2
8	Seventh floor	900	Fluorescent 60x60 cm^2	62	20	1.44	2937.6	2232.6
			PL spot 13w W	30	8	0.104	212.16	161.2
9	Eighth floor	900	Fluorescent 60x60 cm^2	62	20	1.44	2937.6	2232.6
			PL spot 13 W	30	8	0.104	212.16	161.2
10	Ninth floor	900	Fluorescent 60x60 cm^2	62	20	1.44	2937.6	2232.6
			PL spot 13 W	30	8	0.104	212.16	161.2
TOTAL				**674**	**229**	**12.081**	**24645**	**18730**

b) Lamp removal in Nablus main exchange as a second case study:

According to illumination measurements shown in Appendix-5, it was found that values, which were measured at some places, also exceed the standards values. Table 4.2 illustrates the expected annual energy and cost saving respectively achieved upon the removal of the extra lamps specified in Nablus main exchange.

Table (4.2): Expected annual energy saving achieved upon the removal of the lamps in Nablus main exchange

Lamp Type	# Of Lamps	Saved Demand kW	Annual Operation Hours	Saved Energy kWh/ year
Fluorescent 18 W	50	0.9	1930	1737

4.2.2 Replace Lamps from Less Efficient Types to More Efficient Types

Replacement lamps mean substituting one light bulb instead of another to save energy. Manufacturers of lighting equipment now offer a host of efficient lighting products for lamps of all sizes. Figure 4.1 shows the efficacy amount of lighting (in lumens) provided per watt of electricity used. Incandescent lamps have very low efficiencies, while low-pressure sodium lamps provide high levels of lighting per watt of electric power required. Perhaps no area of lighting has seen more innovation than compact fluorescent lamps. These products replace incandescent bulbs in most fixtures. Over the years they have become more reliable and more compact. We applied this for many sites like:

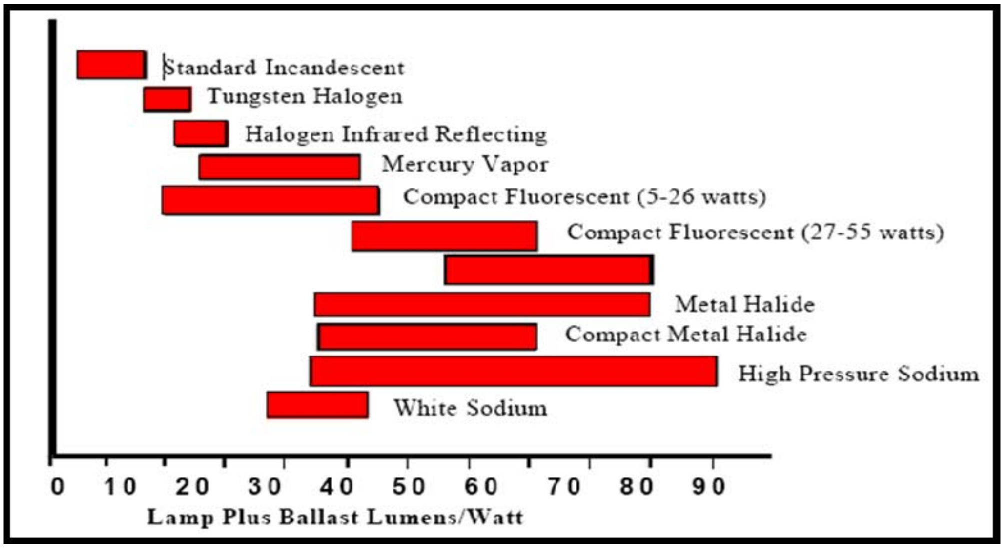


Figure (4.1): Efficacy (Lumens per Watt) for Electric Lamps [15]

a) Replacement of CFL lamps instead of Halogen lamps in Paltel head quarter as first case study

Replace lamps from halogen spot 50 W to PL spot light 1x13 W .The total number of the lamps to replace is 73 lamps as shown in appendix 3, table 4.3 illustrates the expected annual energy and cost saving respectively achieved upon the removal of the lamps specified in Paltel head quarter.

Table (4.3): Annual energy saving achieved upon the replacement of the specified lamps

Replaced Lamp Type	Replace With	# Of Lamps	Saved Demand kW	Annual Operation Hours	Saved Energy (kWh/year)
Halogen 50 W	PL 13 W	73	2701	1930	5213

b) Replacement of HPS 250W instead 400W ML mercury lamps in Nablus main exchange as second case study

Replacement of the ML (400W) external projector lamps with HPS (250W) lamps is recommended. Table 4.4 illustrates the expected annual energy and saving achieved upon the replacement of the specified lamps.

Table (4.4): Annual energy saving achieved upon the replacement of external projector lamps

Replaced Lamp Type	Replace With	# Of Lamps For Manned Locations	Saved Demand KW	Annual Operation Hours	Saved Energy (kWh/year)
ML-400 W	HPS-250W	3	0.45	4380	1971

By applying the previous algorithm to the other main locations leads to the following consequences shown in table 4.5

Table (4.5): Economic analysis of replace lamps to more efficient types at the main Paltel locations

Site	Old Lamp Types	New Lamp Types	# Of Lamps	Operating Hours Per Year	Energy Saving kWh/year
Paltel H.Q	Halogen 50W	CFL 13 W	73	1930	5213
Nablus Exchange	ML 400 W	HPS 250 W	3	4380	1971
Tulkarm Exchange	ML 400 W	HPS 250 W	2	4380	1314
Jenin Exchange	ML 400 W	HPS 250 W	3	4380	1314
Sum					**9812**

4.2.3 Installing High-Efficient Ballasts and T5 Lamps (Medium Cost Measure)

Installing high efficient ballasts can be reduced 4 W for each 36 W fixture, Even though it is established that high frequency electronic glass provides significant savings in power, yet there has been a great amount of reluctance to use the same, due to following reasons.

(i) High cost of good quality electronic

(ii) Generation of harmonics and humming sound by some of these electronic shokes

(iii) Blowing of fuse provided in some of these shokes for protection of electronic circuit. On experimental basis, these shokes have been used in some of the exchanges and departmental complexes, with mixed results.

Electronic ballast offer some advantages such as 20-30% energy reduction compared with conventional ballast, 50% longer service life of lamps, net power factor of 95% -99% , reduction in weight, cool operation, eliminates the annoying problems of light flicker and noise and this lead to an improvement in the quality of lighting.

On the other hand the high efficient fluorescent lamps (HOT5), 24W offer some advantages such as, longer life time 20,000 hours, 10-40% more light output than standard T8 lamps, and 2,700 output lumen [16], then our recommendation is to replace the chocks to electronics type and fluorescent lamps from T8 to T5 type, Table 4.6 and 4.7 illustrates the annual energy savings results due to replacing the ballasts and lamps respectively.

Table (4.6): Annual energy saving by installing high-efficient electronic ballast for studied region locations

Fixture Type	# Of Ballasts	Wattage Reduction/Ballast	Operation houres / year	Energy Saved(kWh/year)
Head Quarter Old And New Buildings				
Fl/36/2	1060	4	1930	8183.2
Nablus Main Exchange				
Fl/36/2	144	4	1930	1111.68
Tulkarm Main Exchange				
Fl/36/2	70	4	1930	540.4
Jenin Main Exchange				
Fl/36/2	60	4	1930	463.2
Ramallah Main Exchange				
Fl/36/2	80	4	1930	617.6
OSS in North and Middle Regions				
Fl/36/2	160	4	1930	1235.2
Remote Sites				
Fl/36/2	480	4	750	1440
Total Energy Saved				13591.28

Table (4.7): Annual energy saving achieved upon the replacement of T8 lamps to T5 type

Old Lamps T8 Type	Suggested T5 lamps	# Of Lamps	Saved Demand kW	Annual Operation Hours	Saved Energy (kWh/year)
Fl 36 W At Manned Locations	Hot5 24W	570	6.84	1930	13201
Fl 36 W At Unmanned Locations	Hot5 24W	960	11.52	750	8640
Total Energy Saved					21841

4.2.4 Installing Occupancy-Linked Systems (Low Cost Measure)

We applied this measure for many sites like:

A) Paltel Data Center as a first case study

In telecom Buildings, they have not used sensors for automatic switching on & off the lightings. The use of these sensors can provide substantial savings, as it is seen occupants of the building normally do not switch off the lighting, even when they are away from their place of work. Similarly in some of the switch rooms, the lightings may be on even when nobody is working in the switch room. The movement sensors, in such cases, can be effectively used to switch off the lighting for energy conservation. Dimmers can also be used effectively to reduce the intensity of the light as the sunlight increases during the day time.

Lighting energy generally reduced from 25% to 50% when properly designed occupancy sensing devices are installed. Air conditioning energy consumption may also be reduced [17].

Table 4.8 illustrates the energy saving results from installing occupancy sensors system in Paltel head quarter data center since its working many times unnecessarily, that's after change the lamps to high efficient types

Table (4.8): Energy saving by installing occupancy-linked systems for HQ data center.

Existing System					Recommended System			
Lamp Type/Watt	# Of Lamp	Oper. Time	Total Watt	Total Energy Used kWh/year	Oper. Time	Total Watt	Total Energy Used kWh/year	Total Energy Saved (kWh/year)
Hot5 24W In Data Center	34	1500	816	1224	500	816	408	816
18 Watt Lamp	30	8760	540	4730.4	4000	540	2160	2570.4
Sum =								3386

b) Nablus main Exchange as second case study

Table 4.8 shows energy saving results from installing occupancy sensors system at main switch room, corridors W.C's, kitchen, offices rooms where one occupancy sensor is to be installed for each one.

Table (4.9): Energy saving by Installing Occupancy-Linked Systems for Nablus switch

Existing System					Recommended System			
Lamp Type/ Watt	# Of Lamps	Oper Time	Total Watt	Total Energy Used kWh/year	Oper. Time	Total Watt	Total Energy Used kWh/year	Total Energy Saved kWh/year
Hot5 24 W	57	1930	1368	2640	975	1368	1334	1306

We need about 30 motion sensor each cost about 4500 NIS, and we needs about 1500 NIS for timers , relays, panels …

4.3 Using Efficient Telecom Equipment Instead of standards

In electronics, efficiency is the ratio of useful power output to total power input. Inevitably, no system is 100% efficient; some energy will always be unavoidably lost, usually as heat produced by the current as it passes through the components. A well-designed system reduces the wasted power to the minimum degree possible, resulting in greater efficiency.

4.3.1 Energy Conservation Opportunities in UPS's Systems:

Paltel still use the old conventional transformer UPS's which suffers from many problems such as:

* Low efficiency compared with new technology UPS's.

* Low reliability, if any electronic card damage, the system will be off.

*High copper losses.

The two main types of UPS's that’s used in Paltel are:

i. Transformers conventional UPS, its inherently low efficient as a result of constant no-load iron losses and load dependent copper losses, most of Paltel location used this type figure 4.3 showing the large transformer which used inside this UPS.

ii. Transformerless UPS systems are more easily scalable because they are smaller and lighter than their transformer-based counterparts and come in modular configureurations. Scalable, modular UPS systems lend themselves to ‘right-sizing’ a UPS system to an anticipated critical load. Furthermore, there is no iron-loss and greatly reduced copper-loss, and consequently less extraneous heat to be removed from the data centre by the air-conditioning infrastructure. Paltel have one system only.

The first modular UPS installed in Paltel head quarter with 100 kVA capacity, that used 10 UPS's each 10 kVA, this type has high efficiency because it used power electronics in the transformation instead of transformers, and it has very high reliability because any damage in any module will not affect on the system and could be replaced as a hot swap. Figure 4.2 showing the efficiency between the UPS's type, and figure 4.3 illustrate the large transformer which used in conventional UPS's.

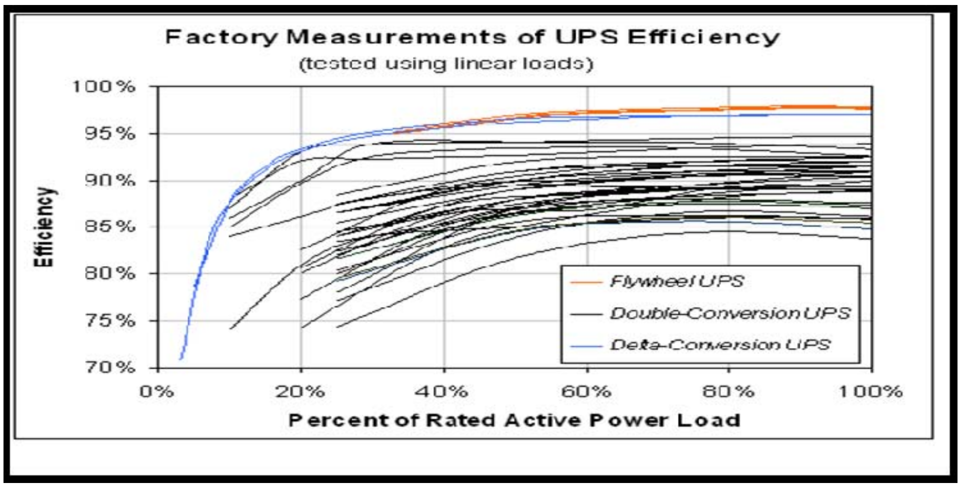


Figure (4.2): Measurement of UPS types efficiency [18]

Figure (4.3): Large transformer used inside the conventional 100kVA UPS

Energy Audit on the Old Conventional UPS 100KVA in Paltel HQ

By installed the power analyzer on the input and output and got all energy specifications as cleared in table 4.10 .Appendix 4 showing the load for each floor of Paltel HQ at this UPS.

Table (4.10): Old Conventional Transformer 100 kVA UPS energy analyzer outputs

Old Conventional Transformer 100kVA UPS						
Output			Input			
Time	Power Consumption (W)	Power Factor	Power Consumption (W)	Power Factor	Losses (W)	Efficiency %
10:08:50	45504	0.948	50867	0.847	5363	89.46
10:09:00	45504	0.948	50867	0.847	5363	89.46
10:09:10	45504	0.948	50257	0.837	4753	90.54
10:09:20	45504	0.948	50257	0.837	4753	90.54
10:09:30	45552	0.949	50196	0.836	4644	90.75
10:09:40	45504	0.948	50135	0.835	4631	90.76
10:09:50	44556	0.948	50135	0.835	5579	88.87
10:10:00	45504	0.948	50135	0.835	4631	90.76
10:10:10	45504	0.948	50135	0.835	4631	90.76
10:10:20	45504	0.948	50196	0.836	4692	90.65
10:10:30	44603	0.949	50196	0.836	5593	88.86
10:10:40	45552	0.949	50196	0.836	4644	90.75
10:10:50	45552	0.949	50196	0.836	4644	90.75
10:11:00	45504	0.948	50135	0.835	4631	90.76
10:11:10	45504	0.948	50135	0.835	4631	90.76
10:11:20	45552	0.949	50135	0.835	4583	90.86
10:11:30	45552	0.949	50135	0.835	4583	90.86
10:11:40	45552	0.949	50074	0.834	4522	90.97
10:11:50	45552	0.949	50135	0.835	4583	90.86
10:12:00	45504	0.948	50135	0.835	4631	90.76
Average	45428.35	0.948	50232.6	0.837	4804.25	90.44

Energy audit on the new modular UPS 100 kVA

By made the same test and power analysis to the other UPS modular type that located in Paltel head quarter and by taking the same load we took the following data in table 4.11.

Table (4.11): New Transformerless Modular UPS 100 kVA energy analyzer outputs

New Transformerless Modular UPS 100 kVA						
	Output		Input			
Time	Power Consumption (W)	Power Factor	Power Consumption (W)	Power Factor	Losses (W)	Efficiency %
10:30:20	45509	0.954	47792	0.988	2283	95.22
10:30:30	45509	0.954	47771	0.988	2262	95.26
10:30:40	45509	0.954	47774	0.988	2265	95.26
10:30:50	45505	0.954	47779	0.988	2274	95.24
10:31:00	45509	0.954	47789	0.988	2280	95.23
10:31:10	45509	0.954	47781	0.988	2272	95.24
10:31:20	45509	0.954	47780	0.988	2271	95.25
10:31:30	45509	0.954	47777	0.988	2268	95.25
10:31:40	45509	0.954	47777	0.988	2268	95.25
10:31:50	45509	0.954	47772	0.988	2263	95.26
10:32:00	45506	0.954	47782	0.988	2276	95.24
10:32:10	45508	0.954	47786	0.988	2278	95.23
10:32:20	45509	0.954	47789	0.988	2280	95.23
10:32:30	45510	0.954	47793	0.988	2283	95.22
10:32:40	45509	0.954	47781	0.988	2272	95.24
10:32:50	45509	0.954	47793	0.988	2284	95.22
10:33:00	45508	0.954	47785	0.988	2277	95.23
10:33:10	45509	0.954	47789	0.988	2280	95.23
10:33:20	45509	0.954	47792	0.988	2283	95.22
Average	45508.58	0.954	47783.263	0.988	2274.68	95.24

As we saw in the previous tables, new modular UPS has higher efficiency about 95.24% and the conventional one about 90.44% and that will affect the losses and the air conditioning consumptions as cleared in table 4.12 .

Table (4.12): Energy consumptions deference between modular and conventional 100 kVA UPS.

	Modular UPS System	Conventional UPS System
AC-AC Efficiency %	95.24	90.44
Power Losses (W)	2274.68	4804.25
Cost Of Energy Losses Over 8760h One Year (kWh/year)	19926.20	42085.23
BTU/h Losses (1 kW=3412 BTU/h)	7745.24	16377.6
Air Conditioning Energy Costs Per Year (kWh/year)	5654.03	11955.65
The Total kWh Saving For One Unit	(42085 kWh-19926 kWh)+(11955.6 kWh-5654 kWh) =28460 kWh/year	

Each 12000 BTU consume about 1 kWh of electrical power

4.3.2 Energy Conservation Opportunities in Rectifiers Systems

Most of Paltel rectifiers are from the old conventional Power plants which consisting of SCR fired rectifiers for conversion from AC to -48 volts DC, that suffer from low efficiency and high copper loses compares with new technology Switch Mode Power Supply (SMPS) power plants using pulse width modulation technology,

Many kinds of electronic switching systems are used by Paltel, because of imports from various countries such as USA, Sweden, Belgium, etc., as well as domestic products. Rectifier systems are also imported along with electronic switching systems. As the demands of telecommunications services increase, more power systems are required to supply power to telecommunications equipment. Therefore, Paltel should be use a new rectifier system to reduce the cost and floor space requirements of the conventional rectifier systems now in use. The new rectifier system is composed of a distribution part, a control unit and rectifier modules in one rack. There are three kinds of modules: 100 A Eltek type; 30 A Benning type; and 16 A Eltek type. The maximum output currents of new rectifier modules are 600 A (100 A), 90 A (30 A), 1600 A (16A) in one rack. The 16 A and 30 A rectifiers are used in remote sites and the 100A unit is operated in local applications.

Now we will see the energy savings when applied to a system with 11 unit x16 A DC rectifiers, a capacity of 176A and an actual load of 110A. With this modular mode, loading the rectifiers 63 percent and providing an operational efficiency above 92 percent. Without this DC modular mode, the old rectifier 300 A capacity it is loaded at 36 percent of its capacity for an approximate efficiency of 89 percent as shown in figure 4.4. This mode saves 146 Watts of dissipated heat. To clear this, we made energy audit for the major types of rectifiers like:

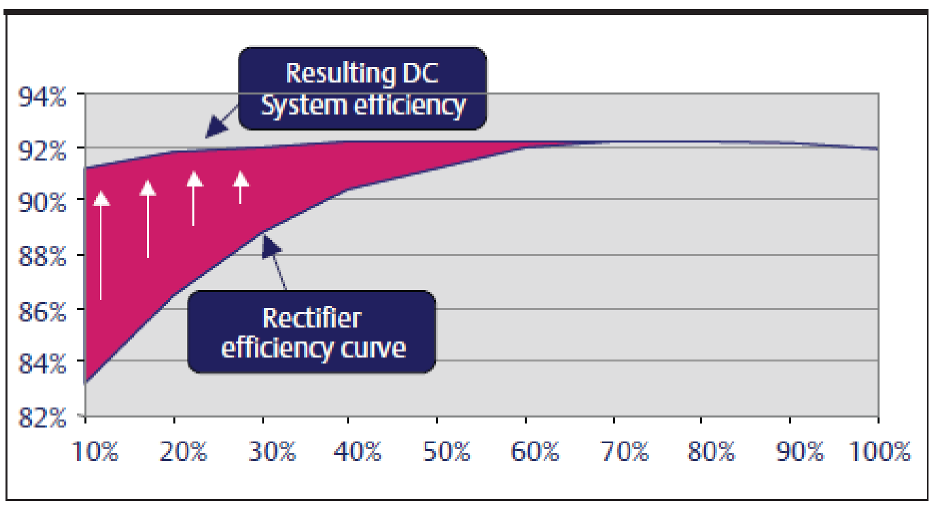


Figure (4.4): Rectifiers efficiency as function of load percentage [20]

a) Energy management for 500A/ 50V DC rectifiers

Energy audit in Conventional Rectifier 380V/50VDC 500A DC

The results of data analyzer are represents in table 4.13

Table (4.13): Energy audit for conventional rectifier (380V/50VDC 500A)

Conventional Rectifier 380V/50V 500A Rating In Nablus Exchange With Load Factor =58%					
	Output	Input			
Time	Power Consumption (W)	Power Consumption (W)	Power Factor	Losses(W)	Efficiency %
08:16:40	15370	17465.9	0.8	2095.9	88
08:16:42	15370	17465.9	0.8	2095.9	88
08:16:44	15370	17465.9	0.8	2095.9	88
08:16:46	15370	17505.7	0.8	2135.7	87.8
08:16:48	15370	17565.7	0.8	2195.7	87.5
08:16:50	15370	17545.7	0.8	2175.7	87.6
08:16:52	15370	17565.7	0.8	2195.7	87.5
08:16:54	15370	17565.7	0.8	2195.7	87.5
08:16:56	15370	17585.8	0.8	2215.8	87.4
08:16:58	15370	17585.8	0.8	2215.8	87.4
08:17:00	15370	17565.7	0.8	2195.7	87.5
08:17:02	15370	17565.7	0.8	2195.7	87.5
08:17:04	15370	17565.7	0.8	2195.7	87.5
08:17:06	15370	17565.7	0.8	2195.7	87.5
08:17:08	15370	17565.7	0.8	2195.7	87.5
08:17:10	15370	17565.7	0.8	2195.7	87.5
08:17:12	15370	17585.8	0.8	2215.8	87.4
08:17:14	15370	17585.8	0.8	2215.8	87.4
08:17:16	15370	17565.7	0.8	2195.7	87.5
08:17:18	15370	17565.7	0.8	2195.7	87.5
Average	15370	17550.8	0.8	2180.8	87.6

Energy audit in Transformerless Modular Rectifier 380V/50V 500A

The result of data analyzer is represents in Table 4.14 this rectifier located in east Nablus main exchange.

Table (4.14): Energy audit for transformerless rectifier 380V/50V 500A

Transformerless Modular Rectifier 380 V/50 V 500A Rating in Nablus Exchange With Load Factor =60%					
	Output	Input			
Time	Power Consumption (W)	Power Consumption (W)	Power Factor	Losses(W)	Efficiency %
08:55:32	15600	16799.5	-0.99	1199.5	92.86
08:55:33	15600	16815.8	-0.99	1215.8	92.77
08:55:34	15600	16797.7	-0.99	1197.7	92.87
08:55:35	15600	16806.7	-0.99	1206.7	92.82
08:55:36	15600	16812.2	-0.99	1212.2	92.79
08:55:37	15600	16815.8	-0.99	1215.8	92.77
08:55:38	15600	16817.6	-0.99	1217.6	92.76
08:55:39	15600	16812.2	-0.99	1212.2	92.79
08:55:40	15600	16810.3	-0.99	1210.3	92.8
08:55:41	15600	16812.2	-0.99	1212.2	92.79
08:55:42	15600	16808.5	-0.99	1208.5	92.81
08:55:43	15600	16812.2	-0.99	1212.2	92.79
08:55:44	15600	16812.2	-0.99	1212.2	92.79
08:55:45	15600	16810.3	-0.99	1210.3	92.8
08:55:46	15600	16810.3	-0.99	1210.3	92.8
08:55:47	15600	16808.5	-0.99	1208.5	92.81
08:55:48	15600	16815.8	-0.99	1215.8	92.77
08:55:49	15600	16815.8	-0.99	1215.8	92.77
08:55:50	15600	16817.6	-0.99	1217.6	92.76
08:55:51	15600	16815.8	-0.99	1215.8	92.77
Average	15600	16811.3	-0.99	1211.3	92.7945

As we saw in the previous tables (4.13) and (4.14), the new modular rectifier 500A has higher efficiency of about 92.8% and the conventional one of about 87.6% and that will affect the losses and the air conditioning consumptions as summarized in table 4.15.

Table (4.15): Energy consumptions deference between modular and conventional 500A DC rectifier System.

	Modular 500A rectifier System	Conventional 500A rectifier System
AC-AC efficiency %	92.8	87.6
Power losses (W)	1211.3	2180.8
The energy losses over 8760h / Year (kWh/year)	= Losses (W) × 8760 hr/year = 10611	19104
BTU/h losses (1kW=3412 BTU/h)	4133	7441
Air conditioning energy consumption / Year (kWh/year)	3017	5432
The total kWh saving for one unit	(19104 kWh-10611 kWh)+(5432 kWh-3017 kWh) =10908 kWh/year	

b) Energy management for 16A /53V rectifier

Paltel still using the conventional rectifiers, this kind has many disadvantages since its used the copper transformer for the transformation, and this cases high copper losses, instead the suggested rectifier is transformerless rectifier which used power electronics for the transformation and this reduce the energy losses, table 4.16 summarized the comparison between the two 16A rectifiers .

Table (4.16): The comparison between the conventional and transformerless 16A DC rectifiers

	Conventional 16A DC rectifier	Transformerless 16A DC rectifier
Size	Large size	Compact size
Cost	High-cost growth	Low-cost growth
Swapped	Not hot-swappable	Hot-swappable modules
Losses	High relatively cupper losses	low cupper and core losses
Efficiency	η= 95%	η= 86%
Noise	50db	23db
Power factor	0.61	0.99
Weight	25 Kg	3 Kg
Dimensions	44 cm x 30cm x 20cm	20 cm x 20 cm x 8cm

Energy audit in conventional rectifier 16A DC

Table 4.17 represents the results of data analyzer on the conventional 16A rectifier. Figure (4.5) showing the transformerless and conventional 53V DC/16A rectifiers.

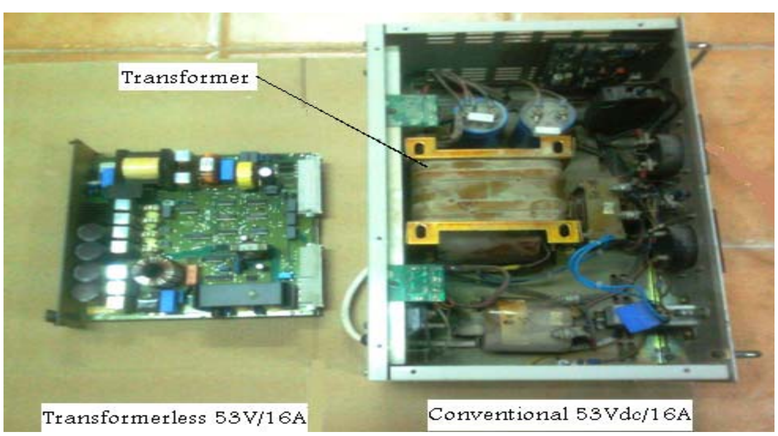


Figure (4.5): Transformerless and conventional 53V/16A rectifiers

Table (4.17): Represents the results of data analyzer on the conventional 16A rectifier

TRANSFORMER CONVENTIONAL RECTIFIER 220V/50VDC 16A DC WITH LOAD FACTOR =100%						
	OUTPUT	INPUT				
Time	Power Consumption (W)	Power Consumption (W)	Power Factor	Losses	Efficiency %	Losses kWh/year
10:33:00	848	986.21	0.62	138.21	85.99	1210.72
10:34:00	848	989.81	0.62	141.81	85.67	1242.26
10:35:00	848	984.14	0.61	136.14	86.17	1192.62
10:36:00	848	984.14	0.61	136.14	86.17	1192.62
10:37:00	848	988.95	0.62	140.95	85.75	1234.74
10:38:00	848	984.14	0.61	136.14	86.17	1192.62
10:39:00	848	984.14	0.61	136.14	86.17	1192.62
10:40:00	848	980.41	0.61	132.41	86.49	1159.92
10:41:00	848	986.31	0.61	138.31	85.98	1211.59
10:42:00	848	986.31	0.61	138.31	85.98	1211.59
10:43:00	848	979.84	0.61	131.84	86.54	1154.93
10:44:00	848	973.97	0.61	125.97	87.07	1103.51
10:45:00	848	977.61	0.6	129.61	86.74	1135.35
10:46:00	848	984.1	0.61	136.1	86.17	1192.25
10:47:00	848	988.97	0.61	140.97	85.75	1234.93
10:48:00	848	988.97	0.61	140.97	85.75	1234.93
Average	848	986.95	0.61	138.93	85.93	1217.21

Energy audit in Transformerless rectifier 16A DC

By apply the same test the other type of 16A/50V DC transformerless rectifier we got a results Table 4.18

Table (4.18): Represents the results of data analyzer on the new transformerless rectifier 16A/50V.

Transformerless Rectifier 220V/50V DC 16A with Load Factor =100%					
	OUTPUT	INPUT			
Time	Power Consumption (W)	Power Consumption (W)	Power Factor	Losses	Efficiency %
10:33:00	848	890.21	-0.99	42.21	95.26
10:34:00	848	893.81	-0.99	45.81	94.87
10:35:00	848	888.14	-0.99	40.14	95.48
10:36:00	848	888.14	-0.99	40.14	95.48
10:37:00	848	892.95	-0.99	44.95	94.97
10:38:00	848	888.14	-0.99	40.14	95.48
10:39:00	848	888.14	-0.99	40.14	95.48
10:40:00	848	884.41	-0.99	36.41	95.88
10:41:00	848	890.31	-0.99	42.31	95.25
10:42:00	848	890.31	-0.99	42.31	95.25
10:43:00	848	883.84	-0.99	35.84	95.94
10:44:00	848	877.97	-0.99	29.97	96.59
10:45:00	848	881.61	-0.99	33.61	96.19
10:46:00	848	888.1	-0.99	40.1	95.48
10:47:00	848	892.97	-0.99	44.97	94.96
10:48:00	848	892.97	-0.99	44.97	94.96
10:49:00	848	906.17	-0.99	58.17	93.58
10:50:00	848	892.46	-0.99	44.46	95.02
10:51:00	848	902.57	-0.99	54.57	93.95
10:52:00	848	905.78	-0.99	57.78	93.62
Average	848	890.95	-0.99	42.95	95.19

Figure 4.6 Shown the power comparison between the two types, transformer and transformerless rectifier 16A/50V, and Figure 4.7 show the power factor at the same period for both types.

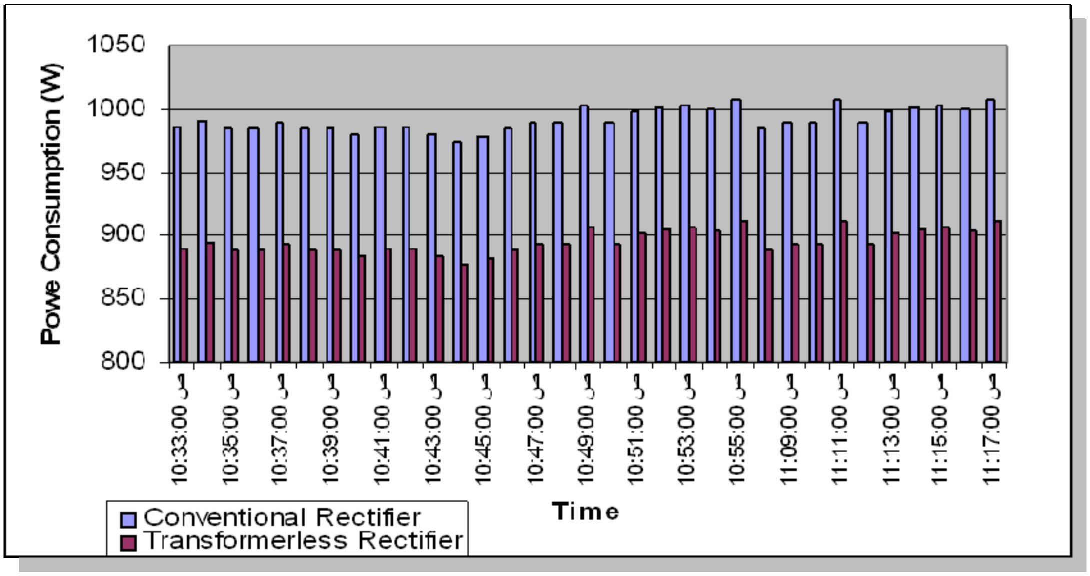


Figure (4.6): Power consumption at the same period of old transformer rectifier and the new one transformerless rectifier.

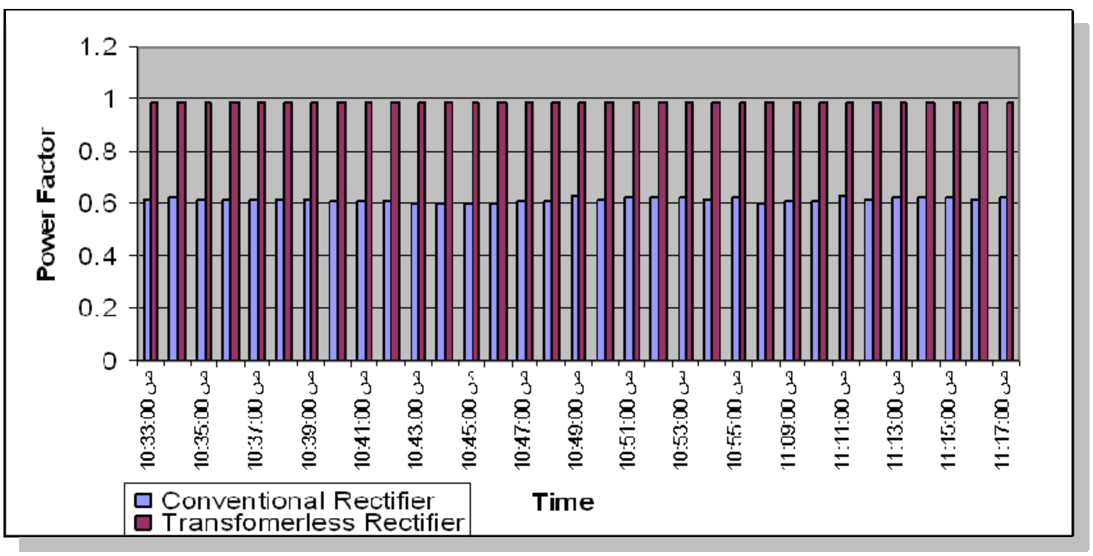


Figure (4.7): Power factor at the same period of old transformer rectifier and the new one transformerless rectifier.

As we saw in the previous tables, the new transformerless rectifier 16ADC has higher efficiency about 95.19 % and the conventional one about 85.93 % and that will affect the losses and the air conditioning consumptions as cleared in table 4.19 .

Table (4.19): Energy consumptions deference between Transformerless and conventional 16A / 53V DC rectifiers.

	Transformerless 16A DC Rectifier System	Conventional 16A DC Rectifier System
AC-AC Efficiency %	95.19	85.93
Power Losses (W)	42.95	138.93
Cost Of Energy Losses Over 8760h One Year (kWh/year)	376.2	1217
BTU/h Losses (1kW=3412 BTU/h)	146.5	474
Air Conditioning Energy Consumption Per Year (kWh/year)	107	346
The Total kWh Saving For One Unit	(1217 kWh-376.2 kWh) + (346 kWh-107 kWh) =1079.8 kWh/year	

Each 12000 BTU cost about 1 kWh of electrical energy

4.4 Energy Conservation Opportunities in Air Conditioning Systems

Energy saving is one of strategic aspects for telecommunication network. As an important content of telecommunication network energy saving technologies, the adaptive constant temperature and humidity control and energy saving technology for air conditioner in telecommunication equipment room is a very useful method. Because the cooling capacity of air conditioning for telecommunication equipment room is designed not only to meet the demand in hot summer but also consider an additional air conditioner as standby, the cooling capacity of air conditioners in the non high temperature season is very rich. Adaptive energy saving technology saves this part of redundant energy so that the average energy saving rate can reach about 20%[19] .

4.4.1 Insulation of Building Envelope Components

The aim of the insulation of building envelope components (walls, roofs, doors and windows) is to reduce the heat transfer from the building envelope which can mainly occur because of convention, conduction and radiation. As regard the components, the walls and the roofs are mainly involved in the heat dissipation; moreover, convention and conduction are the most important dissipative mechanisms. Specifically, the heat transfer by conduction from a homogeneous wall or roof layer.

Most of Paltel locations suffer from weak insulation in windows, doors, walls. For example all exchanges location which are more than 400 sites distributed in Palestine, suffer from bad insulation and that costs Paltel a huge amount of energy each year for cooling, since the temperature in these sites should be about 23 °C.We applied this measures for many sites like:

a) Small site called Tammon as a first case study: Figure 4.8 represents the situation in Tammon site and Figure 4.9 represents the site after built the internal insulated room

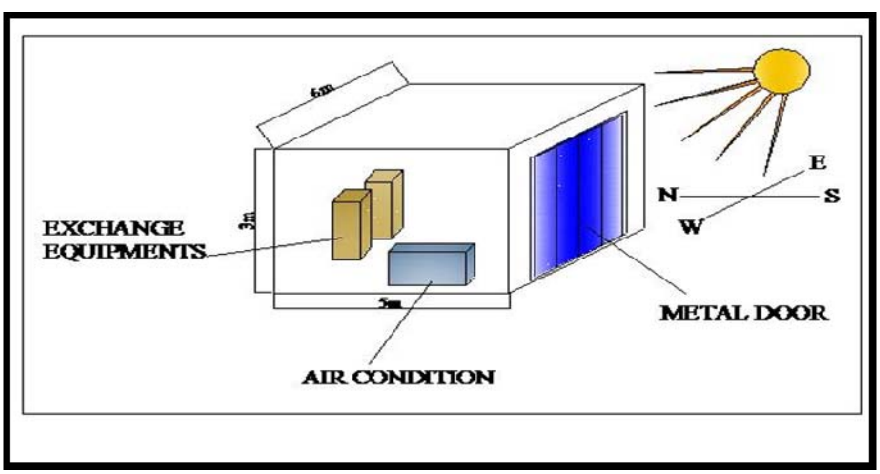


Figure (4.8): The site of Tammon before built the internal insulated room.

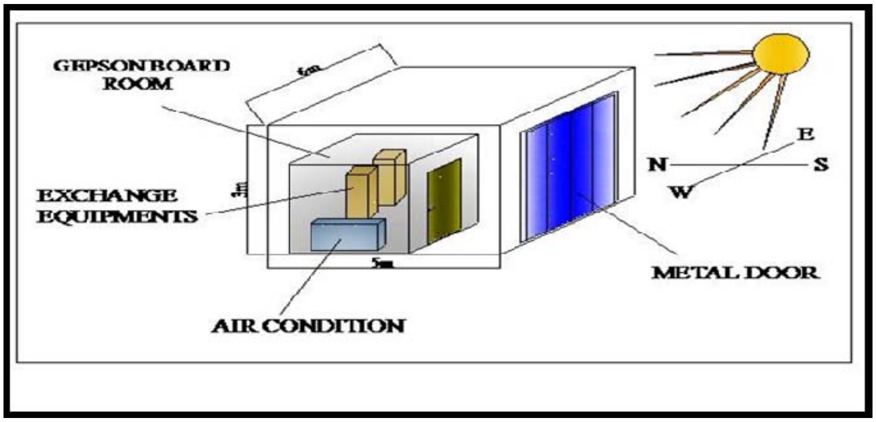


Figure (4.9): The site of Tammon after built the internal insulated room

The idea is to build an inside Gipson room and put all equipment and air condition inside this insulated room to reduce heat transfer by conduction, convection and by reduce the solar radiation transmission to this space, since such sites have large metal door without insulations, the walls are made from bricks without any insulation, the ceiling is made from concrete without any insulation.

After our recommendation, the inside insulated room was built in Tammon site, table 4.20 and figure 4.10 represent the power analysis before and after this room building at the same condition, with temperature of about 30 ^{0}C.

Table (4.20): Tammon site energy consumption before and after internal insulated room

	02/06/2008	05/06/2008
Time	Energy Consumption kWh	Energy Consumption kWh
08:00	0	0
08:10	0.38	0.17
08:20	0.76	0.36
08:30	1.14	0.54
08:40	1.52	0.72
08:50	1.9	0.91
09:00	2.28	1.08
09:10	2.66	1.22
09:20	3.04	1.42
09:30	3.42	1.61
09:40	3.8	1.7
09:50	4.18	2.11
10:00	4.56	2.33
10:10	4.94	2.32
10:20	5.32	2.54
10:30	5.7	2.71
10:40	6.08	3.01
10:50	6.46	3.18
11:00	6.84	3.42
11:10	7.22	3.65
11:20	7.6	3.87
11:30	7.98	3.93

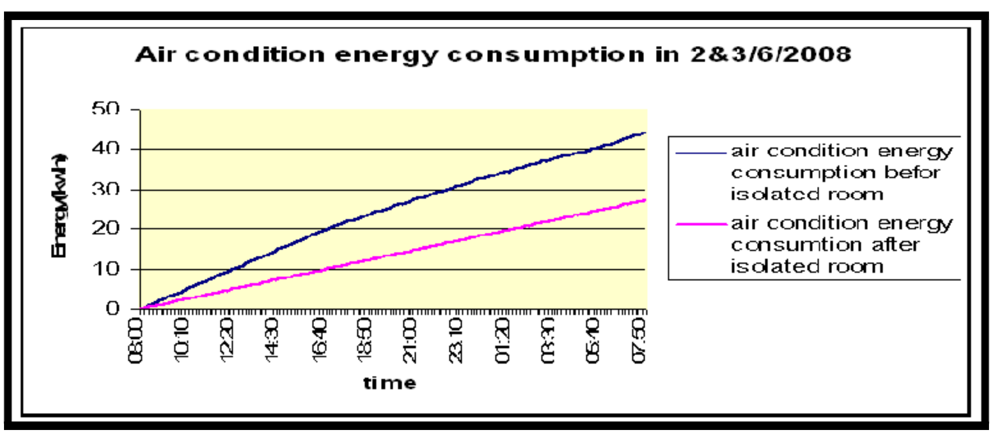


Figure (4.10): The energy consumption diagram before and after built the insulated room in Tammon site.

- The total monthly energy consumption for air conditioning before built the insulated room =960 kWh/ month in summer time.
- The total monthly energy consumption for air conditioning after built the insulated room =588 kWh/ month in summer time.
- The energy saving for Tammon site during summer months
  = 7 months × (970 – 588) kWh / month = 3993 kWh/summer.
- The money saved = 2795 NIS/year.

As cleared previously we could be saved about 38% of the air conditioning. If we applied this idea for all small sites which are old building and suffer from bad isolation, there are about 60 sites at the same condition of Tammon exchange.

b) Paltel main data center in Nablus as a second case study

For analyzing the effect of reducing the heat transfer from the second floor to the third floor as the following

a. The second floor contains the out unit of the data center air condition system, so the temperature is very high especially in summer.

b. Ceiling of the second floor which is the floor of the third floor hasn't special insulation, and it contains from pricks and concrete only.

c. The air conditioning system in the data center is under raised floor. So the cold air touches the warm floor, and that reduce the efficiency of the air cooling system.

By analyzed the average temperature of the second floor in 15/7/2008 is shown in figure 4.11 and figure 4.12 these figures represent the situation at the data center in Paltel HQ.

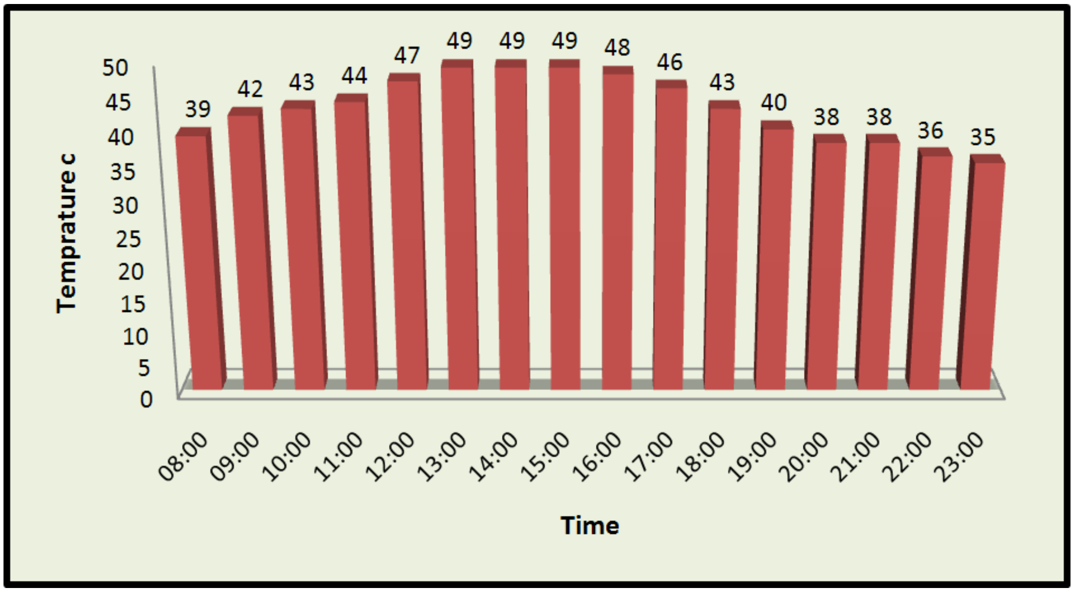


Figure (4.11): Output of the temperature data for the Paltel HQ 2nd floor ceiling

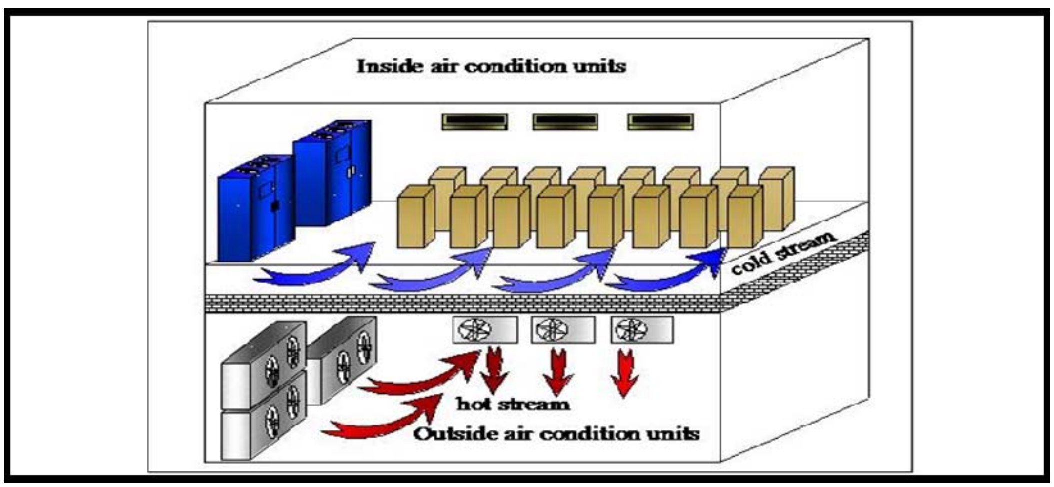


Figure (4.12): Heat transfer to data center throw walls in Paltel HQ.

There is a huge heat transfer from lower floor to data Effect of This High center can be calculated as follows using the Fourier law [21]

$\dot{q} = k/d \times A \times (Ti\text{-}To)$ …………………………4.3

Where:

· A is the area of the layer (m^2)

· T_i is the inside layer surface temperature (°C)

· T_o is the outside wool surface temperature (°C)

· k is the thermal conductive of the wall or roof (W/ m. °C)

· d is the thickness of the wall or roof (m)

$$Rth = \left(\frac{d1}{k1} + \frac{d2}{k2} + \frac{d3}{k3} + \dots\right) \text{.......................} 4.4$$

For our ceiling the ceiling total area A= 280 m^2, because of its construction, it is divided into two areas which are area A1 and area A2.

A1: is the area of ceiling which contains the bricks, and it's about 4/5 of the total ceiling area. A2: is the area of ceiling which don't contain the bricks; and it's about 1/5 of the total ceiling area.

$$A1 = 280\ m^2 \times \frac{4}{5} = 224\ m^2, \qquad A2 = 280\ m^2 \times \frac{1}{5} = 56\ m^2$$

After calculating the conduction thermal losses resistance, the inside and outside thermal resistances, that's by return to heat and air conditioning book [21] page 153 we get the Following:

$Rth1 = 0.439\ \left(\frac{m2.C}{W}\right)$, where $U1 = \frac{1}{Rth1} = 2.278\ \left(\frac{W}{m^2.C}\right)$

Rth2= 0.249$\left(\frac{m2.C}{W}\right)$, where $U2 = \frac{1}{Rth1} = 4\ \left(\frac{W}{m^2.C}\right)$

And by using equation 4.3 the heat transfer Q when the outside A/C units are inside the second floor is

$Q = [(U1 \times A1) + (U2 \times A2)] \times (T_o - T_i)$

$T_o = 40.2\ ^oC$ in average, $T_i = 23$ C.

$Q1 = [(2.278 \times 224) + (4 \times 56)] \times (40.2-23)$

Q1= 12629 W, (1W = 3 .413 BTU/h)

Then the total heat losses = 43104 BTU/h.

For reducing the heat transfer we recommended to transfer the air condition external units to outside the building as shown in figure 4.13

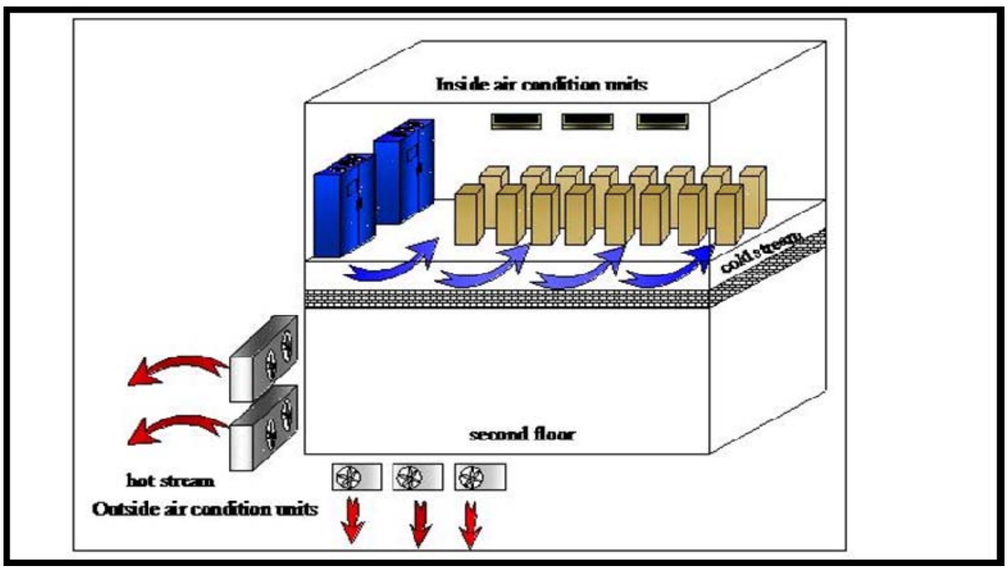


Figure (4.13): Reducing heat transfer by transfer the A/C outside units to outside building in Paltel HQ.

By applying equation 4.3, the heat transfer when the external a/c units outside the building is

$Q2 = [(2.278 \times 224) + (4 \times 56)] \times (24 - 23)$=734 W

Q2 = 2506 BTU/h Then the total heat transfer reduction is about 40598 BTU/ h

From the data sheet of the data center air conditioning system the Energy Efficiency Rating EER =10, where

$$EER = \frac{\left(\frac{BTU}{h}\right)}{(W\ electric)} = 10 \quad \text{..........................4.5}$$

Then W electric saving = 40598 (BTU/h) / 10 = 4.06 kW

The saving energy during summer = 4.06 kW × 5800 h/year

= 23548 kWh.

4.4.2 Energy Saving by Using Inverter A/C System

The inverter tag found on some air conditioners signifies the ability of the unit to continuously regulate its thermal power flow by altering the speed of the compressor in response to cooling demand. Traditional reverse-cycle air-conditioners use a heat pump that is either working at maximum capability or switched off, as the compressor's speed cannot be varied. In order to regulate temperature a thermistor is used to measure the ambient air temperature and switch the compressor on when the ambient air temperature is too far from the desired temperature.

Air-conditioners bearing the inverter tag use a variable-frequency drive to control the speed of the motor and thus the compressor. The variable-frequency drive uses a rectifier to convert the incoming AC current to DC and then uses pulse-width modulation of the DC current within an inverter to produce AC current of a desired frequency. Eliminating stop-start cycles increases efficiency, extends the life of components, and helps eliminate sharp fluctuations in the load the air-conditioner places on the power supply. Ultimately this makes inverter air conditioners less prone to break downs, cheaper to run and the outdoor compressor is generally quieter than a standard air conditioning unit's compressor, its can save more than 30 % as cleared in figure 4.14[22].

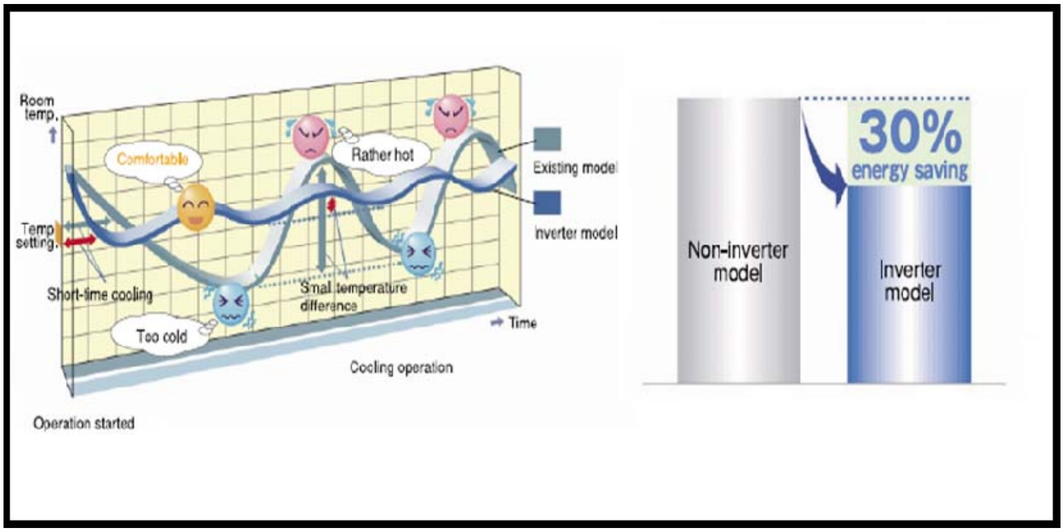


Figure (4.14): Energy saving zone of inverter air conditioner [27]

We have about 100 units of air conditions, the consumption of each one about 2.5 kW each. Table (4.21) illustrates the monthly electrical energy consumption for two selected sites (Alfara and Borqeen).

Table (4.21): Monthly electrical energy consumption for Alfara and Borqeen RSU sites

Site	Jan	Feb	Mar	Apr	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Alfara	494	534	523	971	1429	1757	2013	2076	1893	1523	934	509
Borqeen	487	456	543	867	1356	1675	1897	2000	1798	1443	765	560

From table 4.21, we can calculate the yearly air conditioner consumptions, sine the exchange consumption is fixed and can estimated in winter because the air conditioner is off at that time as represented in table 4.22

Table (4.22): Total energy consumption of the air conditioner for Alfara and Borqeen sites.

Site	The Annual Total Consumption kWh/year	The Exchange Consumption kWh/year Its Fixed1	The A/C Consumption kWh/year
Alfara	14656	5064	9592
Borqeen	13847	5400	8447

Since we have about 100 units work at the same condition in West bank, having the same electric power, and consuming about 9019 kWh/year in each sites.

The total energy saving for each site = 30% × 9019 kWh/year = 2705.7 kWh/year

The total energy saving for 100 sites = 270570 kWh/year.

4.4.3 Increase the Air Conditioner Thermostat Set Point Temperature

Roughly 38% of the power used annually at Paltel telecom consuming for air conditioning and ventilation to keep the racks of equipments from overheating and breaking down. The saving can be achieved in cooling systems by controlling the thermostat at 24 °C.

Percentage of saving in cooling system in summer can be calculated by equation 4.4:

$$\text{Energy saving \%} = \frac{[(T_{existing} - T_{out}) - (T_{suggested} - T_{out})]}{[(T_{existing} - T_{out})]} \quad \text{……4.6}$$

Where

$T_{existing:}$ The temperature inside the mom

$T_{out:}$ Before cooling the space

$T_{suggested:}$ Suggested room temperature [3]

We applied these measures for many sites like:

Data Center in Nablus Head Quarter as Case Study:

The Paltel HQ data center electricity demand about 113.4 kW, for supplying different loads as illustrates in table 4.23

Table (4.23): Loads of the data center of Paltel in the head quarter at Nablus city.

Load name	kW rated
Precigen A/C systems	28.8
Split units A/C	15
Servers and data systems	68.5
Lighting	1.1
Total	113.4 kW

According to the above table, the air conditioning energy consumption equal:

E = 43.8 kW × 6500 hour/year = 284700 kWh/year

The annual energy cost = 284700 kWh/year × 0.76 NIS/kWh = 216372 NIS/year

The number of working hours was taken from the Precigen cooling system saved history

The energy consumption in servers and data centers other equipments = 68.5 kW × 8760 h/y × 0.76 NIS/year = 456045.6 NIS/year. The cooling represents about 32% of the total load of the data center.

The energy saving at readjust the temperature from 22 ºC to 24 ºC can be calculated by equation 4.6

$$\text{Energy saving in summer} = \frac{(28-22)-(28-24)}{(28-24)} \times 100\% = 50\%$$

Where:

T_{out} = 28 ºC Ambient Temperature in summer

T_{ex} = 22 ºC is the Existing Ambient Temperature in the building

T_{sugg} = 24 ºC is the recommended Temperature

Operating hours in summer: 6500 hr/year

The saving energy= 28470 × 50% = 142350 KWh/year of the total air conditioner energy consumption

Table 4.24 summarizes the annual energy and cost savings respectively upon increase the air conditioner thermostat set point temperature for the Paltel main locations.

Table (4.24): Summarize the annual energy saving upon increase the air conditioner thermostat set point temperature for the Paltel main locations central cooling

Facility	T_{out}	T_{ex}	T_{sugg}	total A/C load (kW)	total summer hours	A/C Energy consumption/summer	% saving of the total energy	Energy Saving (kWh/y)
Head Quarter Data Center	28	22	24	43.8	6500	284700	50	142350
Central Cooling System For New H.Q	30	23	24	140	1190	166600	14	23800
Nablus Main Exchange	28	20	24	26.4	5476	144566.4	50	72283.2
Nablus International Switch	30	20	24	34.2	5476	187279.2	40	74911.68
Cooling System For Old H.Q	28	22	24	42	1190	49980	33	16660
Tulkarm Main Exchange	30	22	24	12	5476	65712	25	16428
Jenin Main Exchange	30	22	24	14	5476	76664	25	19166
Ramallah Main Exchange	27	22	24	20	5476	109520	40	43808
Sum								409406.9

4.4.4 Maximize Free Cooling By Using Fresh Air

Telecommunication exchanges consume massive amounts of energy as we said previously, costing companies billions of dollars. These cooling systems are available to slash electricity bills substantially by using fans, allow outside air to complement building cooling systems and provide "free cooling" during colder months, significantly reducing energy usage and wear on some components in the cooling equipment. Savings are achieved because the use of an air-conditioning system's compressor(s) and related electromechanical components are reduced or eliminated.

Whenever ambient dry bulb temperature is in between 16℃ to 21℃ cooling of inside space can be achieved by total displacement of inside air with the fresh air [2], that's could be in some specified locations which don't affected by the contaminants like what we called concentrators switch locations, the ambient air needs to be 100% filtered.

This could be applied except in summer days when the temperature exceed 21 ℃ because it couldn't be able to make good heat transfer to absorb the equipments heat production and its could be at summer nights, table 4.25 represent the monthly average temperature in some cities in Palestine, and figure 4.15 mean monthly temperature (ºC) for Nablus city .

Table (4.25): Summarizing the mean monthly temperature ºC in many sites in Palestine, 2008. [23]

Station	Month											
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Jerusalem	8.7	9.9	12.3	15.6	20	22.5	23.6	23.8	22.8	20.4	15.5	10.6
Nablus	9.6	10.5	13	17.1	20.3	22.6	24.2	24.4	23.4	21	16.1	11.2
Tulkarm	10.9	11.2	13.7	17.6	20.2	23.3	25.5	26.1	24.7	23	17.5	13.2
Jericho	13.2	14.6	17.4	21.7	25.6	28.5	29.9	30	28.6	25.1	19.6	14.7
Hebron	7.1	8.1	10.5	14.7	18.4	20.8	22.1	22.1	20.9	18.6	13.7	8.8
El-Arroub	8.4	8.9	11.4	14.5	19	21.6	22.8	23.1	21.4	18.9	15	10.6
Al-Fara	14.4	14.7	18.2	21.7	26.8	29.1	31.1	31.4	29.8	26.9	22.4	16.7
Gaza	13.4	13.7	15.6	18.7	20.7	23.3	25.4	25.8	24.3	22.9	18.7	15.1

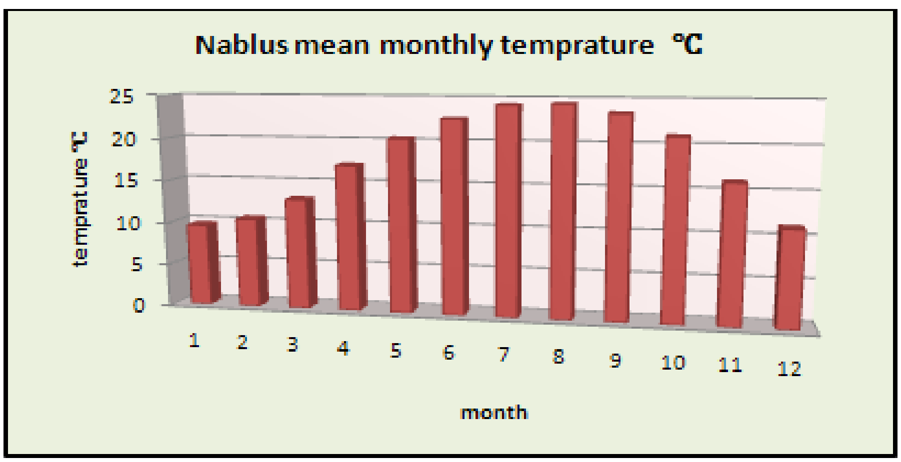


Figure (4.15) : Mean monthly temperature ºC for Nablus city

To clear these measures we applied it to the Concentrator locations as a case study

Paltel has about 39 locations which used concentrators switches type, each of this locations used air conditioner 24000 BTU, we could be used ventilation about 7 months completely without using the conventional cooling.

Each air conditioner operats about 5040 h/year that's because its operate all year except winter time since it's off manually. But at the new suggestion, we can make it off all year except during summer days only, that's because these types of switches can operates in high temperature situation without negative effect to the systems.

- The total energy Consumption if we use the heat ventilation all times except summer days (2520 hours)

= (39 location × 2 kW /loacation × 2520 h) = 196560 kWh/year

- the ventelation consumption in 2520 houre = (0.2 kW × 2520)

  = 504 kWh
- but the old consumption = 393120 kWh/year
- the energy saving = energy consumption before-energy consumption after= (393120 kWh/year) – (196560 kWh/year + 504 kWh)

= 196056 kWh/year

4.5 Economic Uses of Office Equipment

The development, acceptance and increasing usage of technology to create, process and exchange information age over the past decade has had a dramatic impact upon the consumption of electricity by office equipment in commercial buildings. The rapidly accelerating use of the Internet impacts electricity use by computers in both homes and offices, as does the infrastructure supporting the Internet. The heat dissipated by office and telecommunications equipment affects both building cooling and heating loads and its magnitude depends upon the building type and geographical location.

The standby mode of operation draw high power values as totally, so these machines should off after working days and holidays manually or by using automatic off switch to save energy.

4.5.1 Energy Managements in Personal Computers (PCs)

Personal computers are widely used in Paltel there is more than 1000 pc units with different types between desktops and laptops, the large number of units bosh us to study the energy conservation opportunity. Table 4.26 illustrated the energy consumption as function of mode for each type of PC's [24].

Table (4.26): Power draws measurements for different types of computers

PC	Power Draw, Watts				
PC Type	Active	Standby	Suspend	Off	Unplugged
Desktop	55	N/A	25	1.5	0
Laptop	15	N/A	3	2	0
Pentium II	55	49	32	2	0
486	36	0	22	2	0
Based on 386, 486, and Pentium	55	N/A	20[21]	N/A	N/A
Pentium	51		26	1	0

4.5.2 Energy Managements in Monitors and Display

There are two types of monitors, cathode ray tube (CRT) and liquid crystal displays, or LCDs they also have widely used in Paltel offices, its valuable to study the energy conservation opportunity of this subject, table

4.27 illustrate the monitors power consumption as function of operational mode [24].

Table (4.27): Monitor Usage Pattern Data by Operational Mode

	CRT Power Draw in Operational Mode, Watts				
Type	Active	Standby	Suspend	Off	Unplugged
14-15"	61	53	19	3	0
17-21"	96	86	16	5	0
17"	90	26	9.2	4.3	N/A
19"	104	31	13	4	N/A
21"	135	43	14	4.7	N/A
Monitor (Average, Commercial and Industrial)	85	N/A	5	0.5	N/A
Display Terminal (Average, Commercial and Industrial)	75	N/A	5	0.5	N/A

4.5.3 Energy Managements in Printers and Copier Machines

Printers are also widely used in Paltel there are about 20 printers and copiers machines in Paltel head quarter with different types between small and large, some of these printers are worked on standby mode about 16 hours after working day and 24 hours during off days, the standby mode consumed large number of kWh/years, so that we will study the opportunity of the energy conservation for this subject. Table 4.28 illustrated the energy consumption as function of mode for each type of printers [24]

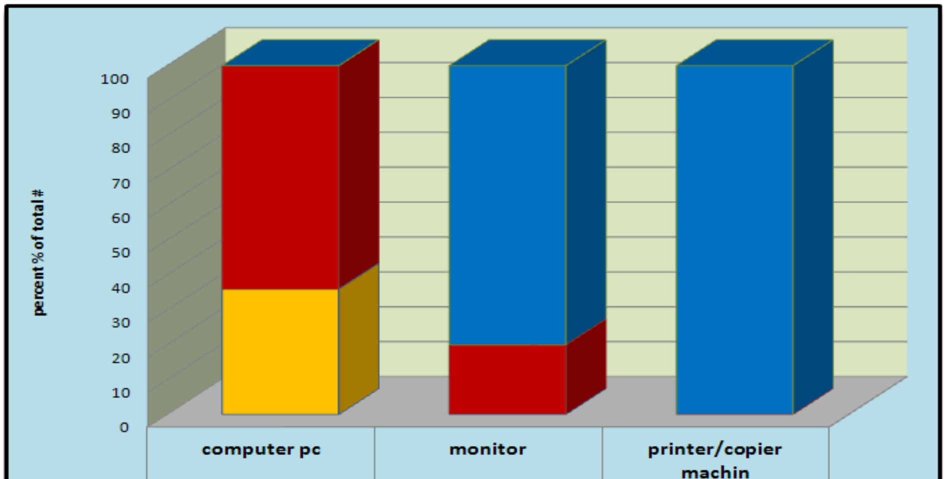
Table (4.28): Laser printer power draws by mode of operation

Type	Active	Standby	Suspend
Laser	231	28	16
Laser	278	27	11
Laser – Small Desktop	130	75	10
Laser – Desktop	215	100	35
Laser – Small Office	320	160	70
Laser – Large Office	550	275	125
Laser	N/A	77.0	25.0

Large numbers of office equipments were left on for 24 hours a day, after we investigated this at Paltel new head quarter we found that 36 percent of 159 computers are on, and 100 percent of 7 printers /copier were on standby mode, and 80 percent of 159 monitors are standby at night as cleared in figure 5.16. The electricity used by common office equipment - computers, monitors, printers, copiers, and fax machines - represents a significant portion of the electricity used in commercial buildings. Reducing the amount of electricity consumed this has important environmental and economic benefits.

We took Paltel head quarter as case study because it has a large number on equipment, but the other locations have little number of equipments and, we have noted a commitment by staff to stop the equipment from working after working times.

As we took the energy analyzer to main feeder that supplied the offices equipments and took the results which are cleared in table 4.29 and figure 4.17.



	computer pc	monitor	printer/copier machin
standby	0	80	100
off	64	20	0
on	36	0	0

Figure (4.16): Percent of office equipments as a function of mode operation during night and holidays at new HQ

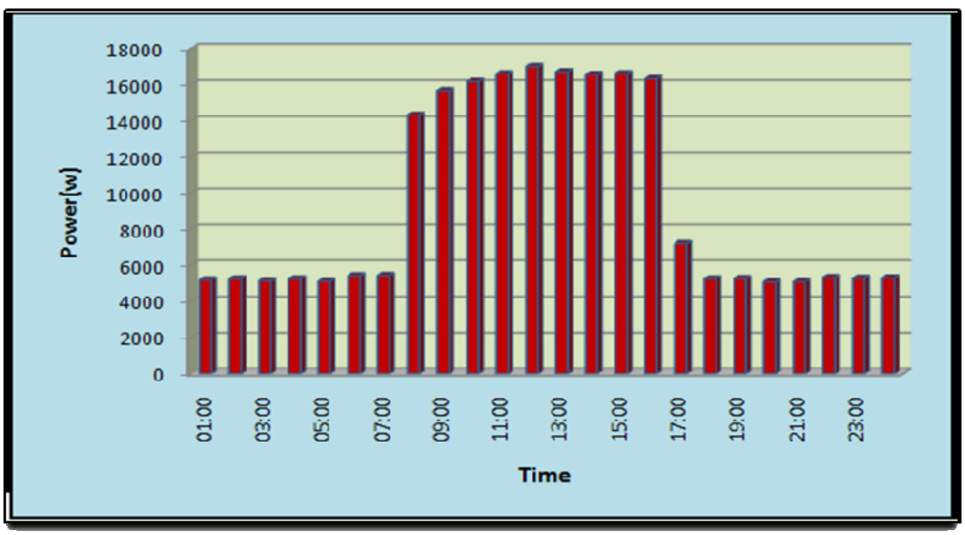


Figure (4.17): Energy analyzer data of offices equipment of new Paltel HQ

Table (4.29): Energy analyzer data of offices equipment of new Paltel HQ

Time	R (A)	S (A)	T (A)	P Avg (W)	P.F
01:00	11.7	9.3	5.2	5190.39	0.92
02:00	11.8	9.6	5.4	5251.55	0.91
03:00	11.7	8.9	5.6	5139.62	0.91
04:00	11.7	9.4	5.3	5241.39	0.92
05:00	11.7	9.5	4.5	5113.48	0.92
06:00	11.8	9.6	5.5	5422.91	0.94
07:00	11.7	9.2	5.9	5439.68	0.94
08:00	25.5	25.2	19.4	14325.03	0.95
09:00	32.8	25.6	20.4	15678.68	0.92
10:00	35.5	24.4	20.9	16181.01	0.93
11:00	36.5	24.3	21.6	16607.88	0.94
12:00	36.5	25.3	22.1	17018.61	0.94
13:00	34.3	25.8	22.6	16721.77	0.94
14:00	32.2	26.2	23.2	16569.64	0.94
15:00	31.9	26.1	24	16615.55	0.94
16:00	32.3	25.2	22.7	16337.17	0.95
17:00	14.5	12.7	8.3	7193.32	0.94
18:00	11.1	9.5	5.3	5253.66	0.94
19:00	10.9	9.8	5.2	5264.81	0.94
20:00	10.9	9.8	4.2	5077.62	0.95
21:00	11.7	8.7	4.8	5089.96	0.94
22:00	11.9	9.2	5.2	5329.13	0.94
23:00	11.3	9.6	5.3	5286.30	0.94
23:30	11.6	9.3	5.3	5303.23	0.94

The average power drawn due these equipments is 5495W during night and holidays, and 16285W during working day hours Paltel have 7152 hours/year off work, then the energy saved according turn off these equipments = 7152 hr/y × 5.495 kW =39300 kWh/year.

4.6 Minimize Electrical Conversion Losses By Reduce the Power Convection AC and DC in Data Centers:

By simple moving the AC/DC conversion outside of the conditioned space of the data center, 20% - 40% of the heat is moved out of the data center where it will not need to be air conditioned away. AC converted to

DC to charge batteries, with much loss. The servers run off batteries. The batteries supply DC, which is converted to AC (5-15% loss of power as heat) to support the AC servers. The power supplies in the servers then convert the AC to DC (as above, with loss of power and generation of heat) .[25]Figure 4.18 illustrates the electricity flow inside the data centers.

What the process above shows, however, that as much as half of the power stored may be lost as heat though the double conversion before it ever gets used for computing.

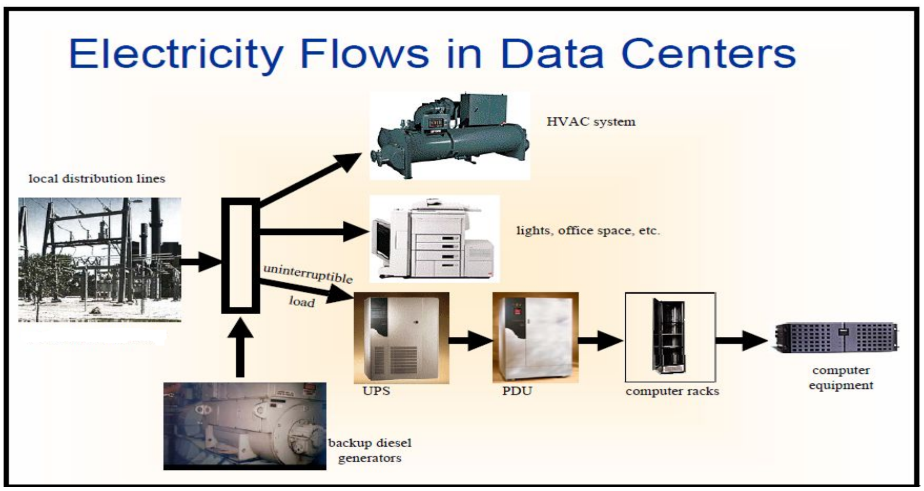


Figure (4.18): Ac power flow in data centers and telecom facility

Then The DC power is converted back to AC for the facility distribution grid and routed to power distribution units (PDUs) for distribution to equipment in racks as cleared in figure 4.19.

Inside the servers and other IT equipment such as storage or networking units, power supplies convert AC (at 220V AC) to DC voltage needed for the digital electronics.

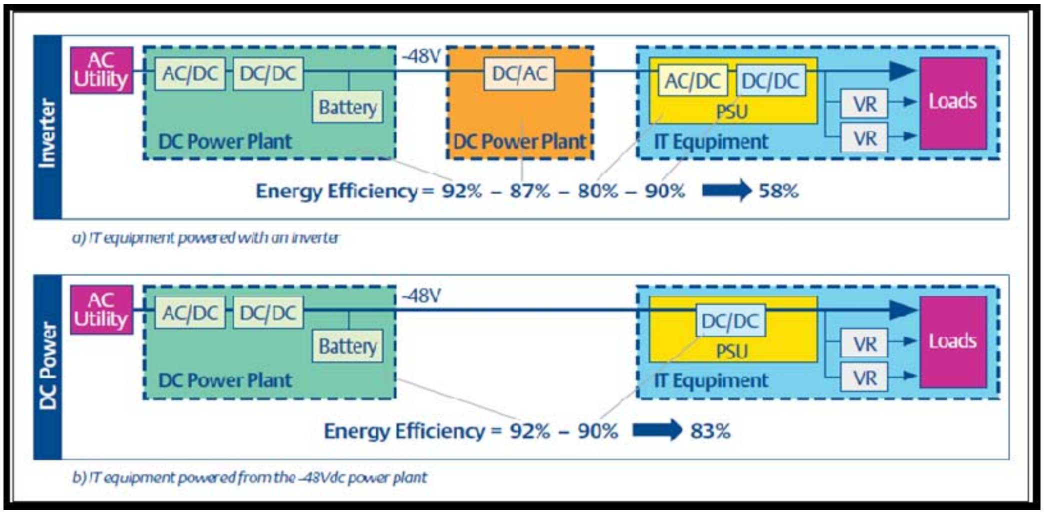


Figure (4.19): Losses percent for AC and DC data centers network.20]]

Table 4.30 represent the deference between ac and dc power systems and the calculation for each 1000W if we use the systems efficiency as shown in table 4.30.

Table (4.30): Deference in efficiency between AC and DC distribution power systems in datacenters

System Efficiency	AC/DC Power Plant Efficiency	DC/AC Power Plant Efficiency	AC/DC In IT Level Equipment Efficiency	DC/DC In IT Level Equipment Efficiency
AC System 220 V	92%	87%	80%	90%
DC System 48 V	92%	100%	100%	90%

Table (4.31): Energy Consumption Improvement Vs Typical AC Distribution for each 1000W in datacenters

Energy Consumption	Compute Load (W)	Input Load (W)	Efficiency Gain
Typical Ac Distribution Efficiency	1000	1724	
Dc Distribution Option (Optimized)	1000	1205	
% Energy Consumption Improvement Vs Typical Ac Distribution			30%

As we see we can save about 30% of the energy consume by using more efficient power distribution which is uses the DC instead of AC for any new projects only, but it's impossible to use this for the exciting data centers because all servers are designed to work on AC voltage and the upgradation of this equipments cost very much and its invisible.

4.7 Energy Conservation Opportunities for PF Correction

The advantages of power factor correction are numerous and could be summarized in the following points:

a) Avoidance of low PF penalty Payment imposed by Electricity Distribution Company.

b) Reduction of power losses in wires and cables (I^2 R) since PF correction decreases value of flowing current in those wires and cables.

c) Improvement of the voltage since it decreases voltage drop in cables and wires.

d) Upgrading transformers and cables capabilities to supply more useful power.

In Palestine, the penalty for power factor supposes to be imposed by the municipality soon according to table 4.32

Table (4.32): Power factor penalty tariff for Nablus Municipality [26]

Power factor value	Penalty
PF≥0.92	None
0.92≥PF≥0.8	1% of the total bill for every 0.01 of power factor less than 0/92
0.8≥PF≥0.7	1.25% of the total bill for every 0.01 of power factor less than 92%
PF<0.7	1.5% of the total bill for every 0.01 of power factor less than 92%

Case study: Improve the Power Factor at Paltel Head Quarter

The building has a damage power factor controller, so its PF value is about 0.88 as shown if Figure 4.20

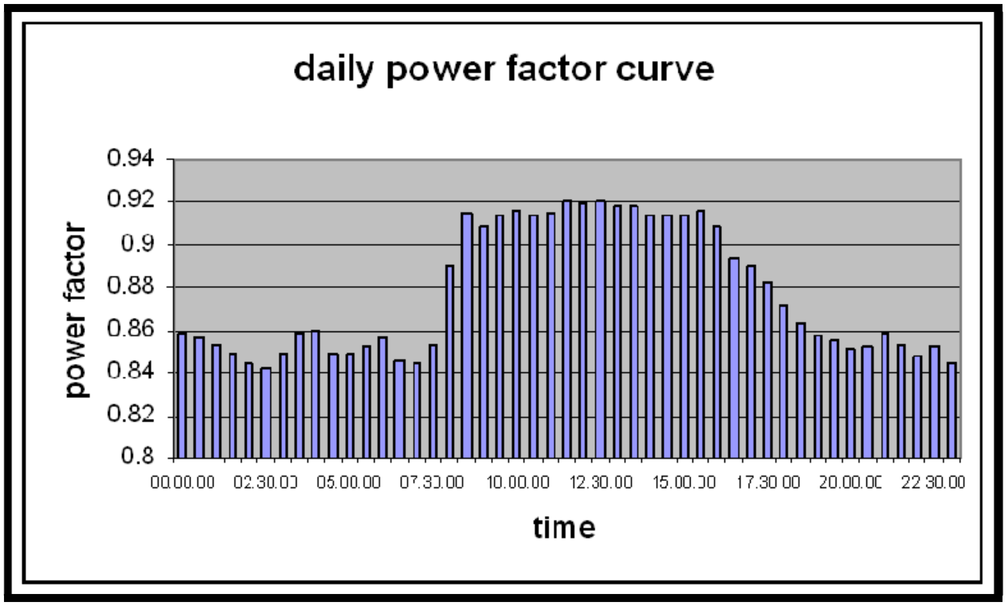


Figure (4.20): PF characteristics for head quarter

- The totally kWh for the month 1/2008 P = 83220 kWh.
- The totally kVARh for the month 1/2008 Q = 43650 kVARh.
- The power factor = Cos (tan-1 Q/P) = 0.88.

The Power Factor value is around 0.88, so it is recommended to replace the power factor controller to improve it to >0.92 (penalty limit). The total electrical bell to the month 1/2008= 86305 NIS, PF= 0.88, table 5.42 illustrate the annual cost saving upon replace the damage power factor controller for Paltel head quarter. All other locations have a high power factor and they don’t need any correction.

4.8 Energy Conservation in Boilers

Replace the Burners of the Two Boilers from Diesel Fuel to LPG Fuel; taking Paltel head quarter boiler as case study.

Paltel head quarter have a diesel boiler used for heating the building during winter. Regular maintenance is doing yearly by a professional company, re-calibrating the efficiency and cleans it from soot's. Table (4.33) shows the boiler flue gas data measured by the combustion flue gas analyzer, the combustion efficiency is about 85% which is the highest efficiency we got by excess air calibration.

The suggestion is by replace the pruners from diesel to LPG fuel, the LPG heating value is higher than the same amount of diesel fuel and the boilers combustion efficiency is higher, that will be reduce the heating cost during winter.

Table (4.33): Paltel Head Quarter boiler flue gas data

Head Quarter Heating Boiler	
Temperature (^oF)	449
O_2%	4.5
CO_2%	13.4
CO%	11.3
Excess air %	25.8
Losses%	10.8
NO_x (ppm)	55
SO_x (ppm)	41
Efficiency %	85

The total fuel consumption of diesel in year 2007 = 10000 liter.

With cost = 10000 × 4.9 NIS =49000 NIS/year.

Then we need to calculate the total thermal load per winter which is

$= \eta c \times \eta ex \times$ diesel hv (kJ/L) $\times$ diesel consumption (L)……… [4.5]

Where;

ηc = the combustion efficiency

ηex = the boiler heat exchange efficiency

Diesel hv = diesel heating value

Total thermal load = $0.85 \times \eta ex \times 37884$ kJ /liter $\times$ 10000 liter/year

= 322014 MJ/y $\times \eta ex$

For the LPG burners the combustion efficiency rise to 0.92 in average [30] and by using equation 4.5 we want to calculate the needed LPG to match the same thermal load

$$0.92 \times \eta ex = \frac{322014\ MJ \times \eta ex}{\left(50\frac{MJ}{Kg} \times \#\ Kg\ of\ LPG\right)}$$

The needed kg of LPG = 7000 kg/y

That's Cost =7000 kg × 4.6 NIS/kg = 32200 NIS/year

The total investment to replace the burners equal 24000 NIS

S.P.B.P = Investment / Saving

$$S.P.B.P = \frac{24000\ NIS}{(49000 - 32200)(NIS/year)} = 17\ Month$$

The CO_2 emissions from diesel = 2.746 kg CO_2 / liter of diesel

The CO_2 emission from LPG = 1.574 kg CO_2/ liter of LPG

= 3.1 kg of CO_2 / kg of LPG

The total CO_2 reduction =

$$\left(2.746\frac{(kg\ CO2)}{L}\times 10000\frac{L}{yr}\right)-\left(7000kg\ \times 3.1\frac{kg\ CO2}{kg}\ LPG\right)$$

$$= 5760\ kg/\text{year}$$

4.9 Energy Conservation Evaluation in Paltel Company

It seems from the previous energy saving analysis that a huge amount of energy savings in Paltel facilities could be achieved as summarized in table 4.34.

Table (4.34): Summary of the total energy savings for Paltel locations

Opportunity		Energy Saved (kWh/year)
Lighting systems	Extra-lamps removal	34355
	Replace spot and outdoor lighting lamps to more efficient types	9812
	Use occupancy sensors	8235
	Use more efficient lamps instead of fluorescent type and also use efficient ballast for haul Paltel locations	35432
More efficient ups systems	Use modular transformerless 100 kVA in HQ	28460.6
More efficient rectifiers systems	Use six modular transformerless 500A/50V DC instead of the conventional	65448
	Use220 modular transformerless 16A/50V DC for haul Paltel locations instead of the conventional	237556
Air conditioning systems	Improve insulation to reduce the heat transfer to 60 remote exchange room	239580
	Heat transfer from outside A/C units to Paltel main data center	23548
	Energy saving according to use inverter A/C system	270570
	No cost temperature calibration	409407
	Disconnect the air condition units most time in year in concentrator locations	196056
Off offices equipments	Turn the offices equipments like computers, monitors, and printers/copier machines after working hours and holidays	39300
Sum		1597760

Summary

It seems from the previous energy analysis that a huge amount of savings in the telecommunication facilities could be achieved by implementing no cost and low cost energy conservation measures. It means that we could save a good percentage in energy consumption by just a simple changing in the behavior of energy utilization (no cost) or by a small amount of investment in order to achieve the required goal (low cost).

Table 5.44 summarizes the potential savings in electric and fuel energy in each of the studied facilities, the equal amount of money and the reduction in CO_2 emissions

CHAPTER FIVE

ECONOMICAL EVALUATION OF ENERGY AUDITS IN COMMERCIAL SECTOR IN PALESTINE

Chapter Five
Economical Evaluation of Energy Audits in Commercial Sector in Palestine

5.1 Introduction

In the previous chapter the technical analysis for each energy conservation opportunity (ECO) on different systems was produced and analyzed. This chapter will be focused on the calculation of the savings in each ECO, the amount of energy saved (electric and fuel) and the equal amount of money, the investment cost required to implement this opportunity in order to achieve this saving and the simple payback period will be the judgment on this investment in order to be feasible.

5.2 Economical Evaluation of Energy Conservation Opportunities for Lighting Systems

5.2.1 Reducing the Number of Lighting Lamps

With refer to table 4.1 and 4.2, the annual energy saving of 34355 KWh upon remove the extra lights to achieve the standard cods of illumination for all studied locations. The corresponding savings are calculated as shown in table 5.1, knowing that lamps removal doesn't incur any costs from Paltel.

Table (5.1): Saving results in removal lighting system for main Paltel locations

Site	Total Lamps (kW) Remove	Operating hours /y	Energy Saving kWh/year	Money Saving NIS/year	CO_2 Saving kg/year	S.P.B.P
Nablus Head Quarter First Building	12.08	1930	24645	18730.2	26828.6	Immediately
Nablus Head Quarter Second Building	1.79	1930	3463	2632	3770.0	Immediately
Nablus Exchange	0.90	1930	1737	1320	1891.0	Immediately
Ramallah Exchange	1.01	1930	1950	1482	2122.8	Immediately
Tulkarm Exchange	0.69	1930	1330	1010.8	1447.8	Immediately
Jenin Exchange	0.64	1930	1230	934.8	1339.0	Immediately
Sum	17.11		34355	26109.8	37399.1	

5.2.2 Install High Efficiency Lighting Fixtures

With refer to table 4.3, 4.4 and 4.5, the annual energy saving of 9812 KWh upon using more efficient lighting fixture like CFL13W and HPS 250W instead of halogen 50W and ML-400 W respectively. The corresponding savings are calculated as shown in table 5.2.

Table (5.2): Economic analysis of replace lamps to more efficient types at the main Paltel locations

Site	Action	Number Of Light Units	Total Operating Hours	Energy Saving kWh/year	Money Saving NIS/year	CO_2 Saving Kg/y	Opportunity Implementation Cost (NIS)	S.P.B.P (Month)
Nablus Head Quarter First Building	Installing Pl 13W Lamps Instead Of Halogen 50W Lamps	73	1930	5213	3962	5675	7300	22
Nablus Exchange	Installing HPS 250 W Lamps Instead Of ML-400 W Lamps For Outside Projector Lighting	3	4380	1971	1497.96	2145.6	750	6
Tulkarm Exchange	Installing HPS 250 W Lamps Instead Of ML-400 W Lamps For Outside Projector Lighting	2	4380	1314	998.64	1430.4	500	6
Jenin Exchange	Installing HPS 250 W Lamps Instead Of Halogen 500 W For Outside Projector Lighting	2	4380	1314	998.64	1430.4	500	6
Sum				9812	7457	10681.5	9050	

5.2.3 Install High Efficiency Ballast and Fluorescent T5 Lamps

With refer to table 4.6 and 4.7; it’s expected to achieve an annual energy saving of 58684 kWh upon installing high-efficiency electronic ballasts, and high efficient lamps. The corresponding savings are calculated as shown in table 5.3.

Table (5.3): Annual cost saving achieved upon installing electronic ballasts, and high efficient lamps

Energy Saving (kWh/year)	Total Saving Nis	Price Difference (Elec. Ballast - Mag.Ballast) NIS	Price Difference (24 W Lamp - 36W Lamp) NIS including T8 to T5 converter adapters	Investment lamps and ballasts (NIS)	S.P.B.P
35432	26928	(80-10)=70	(30-5)=25	210220	5.9 years

The total cost of new ballast = 2054 units × 80 NIS/unit =164320 NIS

The total cost of T524 W lamps = 1530 units × 30 NIS/unit = 45900 NIS

5.2.4 Installing Occupancy Systems

With refer to table 4.8and 4.9, it's expected to achieve an annual energy saving of 8235 kWh/year upon installing occupancy system to operate the lighting by motion detector. The corresponding savings are calculated as shown in table 5.4.

Table (5.4): Economic analysis of occupancy system used at the main locations

Site	Energy Saving kWh/year	Money Saving NIS/year	CO_2 Saving kg/year	Opportunity Implementation Cost (NIS)	S.P.B.P (Month)
Nablus head quarter new Building	3386	2573.36	3686	2300	10.7
Nablus head quarter old Building	2365	1797.4	2574.54	1700	11.3
Nablus exchange	1306	993	1422	1100	13.3
Jenin exchange	1178	895.28	1282.37	870	11.6
Sum	8235	6258	8965	5970	11.4

5.3 Installing High Efficient 100 KVA UPS Instead Of Old One

With refer to energy analyzed at table 4.10 and 4.11, and energy conservation calculation at table 4.12 It's expected to achieve an annual energy saving of 28460.6 KWh upon replace the main UPS 100KVA at Paltel head quarter to the new transformerless type as illustrate in table 5.5.

Table (5.5): Annual cost saving achieved upon change the conventional 100KVA UPS to transformerless type in HQ

Energy Saving from losses and air conditioning (kWh/year)	Total Saving NIS/year	Investment for modular unit (NIS)	S.P.B.P	CO_2 saving (Kg)
28460.6	21630	96000	4.4 years	30982

5.4 Installing High Efficient Rectifiers

5.4.1 Replace 500A Rectifiers from Conventional To Transformerless Type

With refer to energy analyzed at table 4.13 and 4.14, and energy conservation calculation at table 4.15, it's expected to achieve an annual energy saving of 10908 KWh upon replace six units of conventional 500A rectifiers to new transformerless rectifiers as illustrate in table 5.6.

Table (5.6): Annual cost saving achieved upon change 500A old rectifiers to new transformerless type.

Energy Saving from losses and air conditioning (kWh/year)	Total Saving NIS/year	The total saving for 6 units in west bank (NIS)	Investment for 6 modular units (NIS)	S.P.B.P	CO_2 saving (Kg)
10908	8290	49740	612000	12 years	11874

It's not feasible to change the existing conventional rectifiers systems to new transformerless systems because its take very long time to recover the capital cost requires, but the situation is feasible any new projects.

5.4.2 Replace 16A Rectifiers to Transformerless Rectifier

With refer to energy analyzed at table 4.17 and 4.18, and energy conservation calculation at table 4.19, it's expected to achieve an annual energy saving of 237556 kWh upon replace the 220 units of conventional 16A rectifiers to new transformerless rectifiers as illustrate in table 5.7.

Table (5.7): Financial analysis between the conventional and transformerless 16A/50V DC rectifiers for all Paltel devices

Energy Saving from losses and air conditioning (kWh/year)	Total Saving NIS/year	The total saving for 220 units in west bank (NIS)	Investment for 220 modular units (NIS)	S.P.B.P	CO_2 saving (kg)
1079.8	820.6	180542	836000	4.6 years	258603

5.5 Air Condition Systems Energy Conservation

- **Installing Insulation Room Inside Remotely Sites**

With refer to analyzed data at table 4.20 , the calculation which done at the previouse chapter , and by using the same algorithm to the same conditions 60 sites it's expected to achieve an annual energy saving of 239580 kWh upon installing isolation rooms inside remotely sites. Table 5.8 illustrates the conservation by using this technique to the same conditions 60 sites.

Table (5.8): Annual cost saving achieved upon installing the isolation rooms inside remotely sites

Energy Saving for 60 sits (kWh/year)	Total Saving NIS/year	Investment (NIS)	S.P.B.P	CO_2 saving (kg)/year
239580	182080	1800 NIS/room × 60 room =108000 NIS	7 months	260807

- **Energy Conservation Upon transfer the data center outside air conditions out of the building**

With refer to analyzed data that calculated at the previouse chaplter; it's expected to achieve an annual energy saving of 18850 kWh upon transfer the data center outside air conditions out of the building to illuminate the heat transfer due the walls and ceiling. Table 5.9 illustrates the conservation by using this technique

Table (5.9): Annual cost saving achieved upon transfer data center outside air condition out of building

Energy Saving (kWh/year) for	Total Saving NIS	Investment (NIS)	S.P.B.P	CO_2 saving (kg)
23548	17896	3000	2 months	25634

- **Energy Conservation Upon Replace Air Conditioner To Inverter Types**

With refer to analyzed data that summarized at table 4.21 and 4.22; it's expected to achieve an annual energy saving of 270570 KWh/year upon replace air conditioner to inverter types for 100 units. Table 5.10 illustrates the conservation by using this technique.

Table (5.10): Annual cost saving achieved upon replace air conditioner to inverter types

Energy consumed (kWh/year) for 100 units old types	Total Saving NIS	Investment (NIS)	S.P.B.P	CO_2 saving (Kg)
901900	901900 kWh×30% ×0.76 NIS/kWh =205633 NIS	5500 NIS ×100 units =550000 NIS	2 Years	2454521

- **Energy Conservation Upon Increase the Air Conditioner Thermostat Set Point Temperature**

With refer to analyzed data that summarized at table 4.24 and by using equations 4.2; it's expected to achieve an annual energy saving of 394953 kWh/year upon increase the air conditioner thermostat set point temperature. Table 5.11 illustrates the conservation by using this technique.

Table (5.11): Annual cost saving achieved upon increase the air conditioner thermostat set point temperature for the main Paltel locations central cooling

Site	Energy Saving kWh/year	Cost Saving NIS/year	CO_2 Saving kg/year
Head Quarter Data Center	127896	97200	139227
Central Cooling System For New H.Q	23800.0	18088.0	25909
Nablus Main Exchange	72283.2	54935.2	78687
Nablus International Switch	74911.7	56932.9	81549
Cooling System For Old H.Q	16660.0	12661.6	18136
Tulkarm Main Exchange	16428.0	12485.3	17884
Jenin Main Exchange	19166.0	14566.2	20864
Ramallah Main Exchange	43808.0	33294.1	47689
Sum	394953	300164	429946

- **Energy Conservation upon Stopping the A/C Systems for Concentrator Locations.**

With refer to analyzed at the previous chapter; it's expected to achieve an annual energy saving of 196056 kWh upon stopping the A/C systems for concentrator locations. Table 5.12 illustrates the conservation by using this technique.

Table (5.12): Annual cost saving achieved upon stopping the A/C systems for concentrator locations

Energy Saving	Total Saving NIS/year	Investment (NIS)	S.P.B.P	CO_2 saving (kg)/year
196056	149002	800 NIS/room × 39 room =31200 NIS	2.5 months	213426

5.6 Energy Conservation at Offices Equipments

With refer to analyzed at the figure 4.16, 4.17 and table 4.29 we noted that large number of offices equipments continues during off times; we expected to achieve an annual energy saving of 39300 kWh upon stopping the office equipment during off times in head quarter . Table 5.13 illustrates the conservation by using this technique.

The total money saved according this= 39300 kWh/year× 0.76 NIS/kWh

= 29868 NIS/year

The SPBP = immediately, that's if we can compel the employees to stop the equipment after working hours. If not, we can install time automatic on-off controller to turn them off during night and holidays and that cost 1100 NIS between timers and contactors.

The S.P.B.P will = investment /saving

= 1100 NIS ⁄ 29868 NIS/year= 13 days

The total CO_2 saved = 42782 kg/year

Table (5.13): Annual cost saving achieved upon stopping the office equipment during off times in head quarter

Energy Saving	Total Saving NIS/year	Investment (NIS)	S.P.B.P	CO_2 saving (kg)/year
39300	29868	0	Immediate	42782

5.7 Energy Conservation for Power Factor Improvements

With refer to analyzed data at figure 4.20 for the power factor situation in HQ and by using the penalty table 4.32 we noted that the power factor become less than 92% some times and that cost Paltel penalty; we expected to achieve an annual money saving 41424 NIS. Table 5.14 illustrates the conservation by using this technique.

Table (5.14): Annual cost saving achieved upon change the defect power factor controller in head quarter

Power factor penalty	Total Saving NIS/year	Investment (NIS)	S.P.B.P
0.01 × 86305 NIS × (0.92-0.88) = 3452 NIS/month	41424	500	4 days

5.8 Energy Conservation for Increase the Boilers Efficiency

With refer to analyzed at the previous chapter; it's expected to achieve an annual money saving of 16800 NIS upon replace the boilers burners from diesel fuel to propane fuel at Paltel HQ Table 5.15 illustrates the conservation by using this technique.

Table (5.15): Annual cost saving achieved upon replace the boilers burners from diesel fuel to propane fuel

Total Saving NIS	Investment (NIS)	S.P.B.P	CO_2 reduction (kg)
16800	24000	17 months	5760

5.9 Evaluation of Energy Conservation in Paltel Company as a case study of commercial sector in Palestine

It seems from the previous economic analysis that a huge amount of savings in the Paltel facilities could be achieved by implementing no cost and low cost energy conservation measures. It means that we could save a good percentage in energy consumption by just a simple changing in the behavior of energy utilization (no cost) or by a small amount of investment in order to achieve the required goal (low cost).

Table 5.16 summarizes the potential savings in electric and fuel energy in each of the Paltel facilities, the equal amount of money and the reduction in CO_2 emissions:

Table (5.16): Summary of the total energy, money savings and CO2 reduction for Paltel locations.

Opportunity		Energy Saved (kWh/year)	Cost Reduction (NIS/year)	Opportunity Implementation Cost (NIS)	Equivalent kg Of CO_2 Reduction	S.P.B.P
Lighting systems	Extra-lamps removal	34355	26109.8	0	37398.853	Immediate
	Replace spot and outdoor lighting lamps to more efficient types	9812	7457	9050	10681.3432	14.6 months
	Use occupancy sensors	8235	6258	5970	8964.621	11.4 months
	Use more efficient lamps instead of fluorescent type and also use efficient ballast for haul Paltel locations	35432	26928	210220	38571	4.9 years
More efficient UPS systems	Use modular transformerless 100kVA in HQ	28460.6	21630	96000	30982	4.4 years
More efficient rectifiers systems	Use modular transformerless 500A/50V DC	65448	49740	612000	11874	12 years
	Use modular transformerless 16A/50V DC for haul Paltel locations	237556	180542	836000	258603	4.6 years

Opportunity		Energy Saved (kWh/year)	Cost Reduction (NIS/year)	Investment Cost (NIS)	Equivalent Kg Of CO_2 Reduction	S.P.B.P
Air conditioning systems	Improve insulation to reduce the heat transfer to remote exchange room	239580	182080	108000	260806.8	7 months
	Heat transfer from outside A/C units to Paltel main data center	23548	17896	3000	25634	3 months
	Energy saving according to use inverter A/C system	270570	205633	550000	294542.5	2 years
	No cost temperature calibration	409407	311149	0	445680	Immediate
	Disconnect the air condition units most time in year in concentrator locations	196056	149002	31200	213426.6	2.5 months
Off offices equipments	Turn the offices equipments like computers, monitors, and printers/copier machines after	39300	29868	0	42782	Immediate
Power factor improvement	Power factor improvement in Paltel head quarter	0	41424	500	0	4 days
Fuel energy conservation	Replace the burners of the two boilers from diesel fuel to propane	0	16800	24000	0	17 months
SUM		1597760	1272517	2461940	1679947	

From the above analyses we could come to a result that the saving percentage by implementing the previous energy conservation measures on the most energy consumed equipment of Paltel telecommunication company could reach up (1597760 kWh) which is equivalent to saving (1272517 NIS/year) and equivalent to reduing about (1739321 kg/year) of CO_2.

The total investment necessary to achieve the above results about 2461940 NIS.

$$\text{The simple bay back period} = \frac{(\text{Total Investment})}{\text{Total annual saved}}$$

$$= \frac{2461940\ \text{NIS}}{1272517\ \frac{\text{NIS}}{\text{year}}} = 2\ \text{years}$$

Its means the saving is about 15.3% of the total consumption of the West Bank locations.

SHAPTER SIX

SOFTWARE PROGRAMMING OF ENERGY MANAGEMENT OPPORTUNITIES

Chapter Six

Software Programming Of Energy Management Opportunities

6.1 Introduction

In the last chapters we discussed in details the main energy conservation opportunities for the commercial sector and concentrated to telecommunication facilities, transforming these ECM'S to mathematical models, that's to finds the energy conservation due each measurements in out studied facility, but as we saw the calculations are not easy and took many time to prepared, since the used data are very large quantity, that Expose us to a lot of mistakes in calculations.

For this we designed a software to convert these ECM's from manual calculations to computerize calculations, printing the outcome in specific tables, these out coming included the saving of gas's emissions besides the energy saving due these opportunities.

6.2 Methodological flow Chart for Energy Management Opportunities

6.2.1 Methodological flow chart for lighting CFL lamps instead of incandescent lamps units

This method is used for the calculation of the energy conservation and the saves gase's emissions by replacing incandescent lamps to CFL types table 6.1 illustrate the CFL equivalent efficacy lamps as compared with incandescent lamps, which are frequently used in commercial buildings. Figure 6.1 cleared the steps of the flow chart to calculate the saving of this ECM.

The input needed for the outside light improvement calculation:

- The rated power of the present incandescent lamp.
- The total number of lamps.
- The total operational hours per year.
- The price of each incandescent lamp.
- The price of each equivalent CFL lamp.
- The electric tariff.

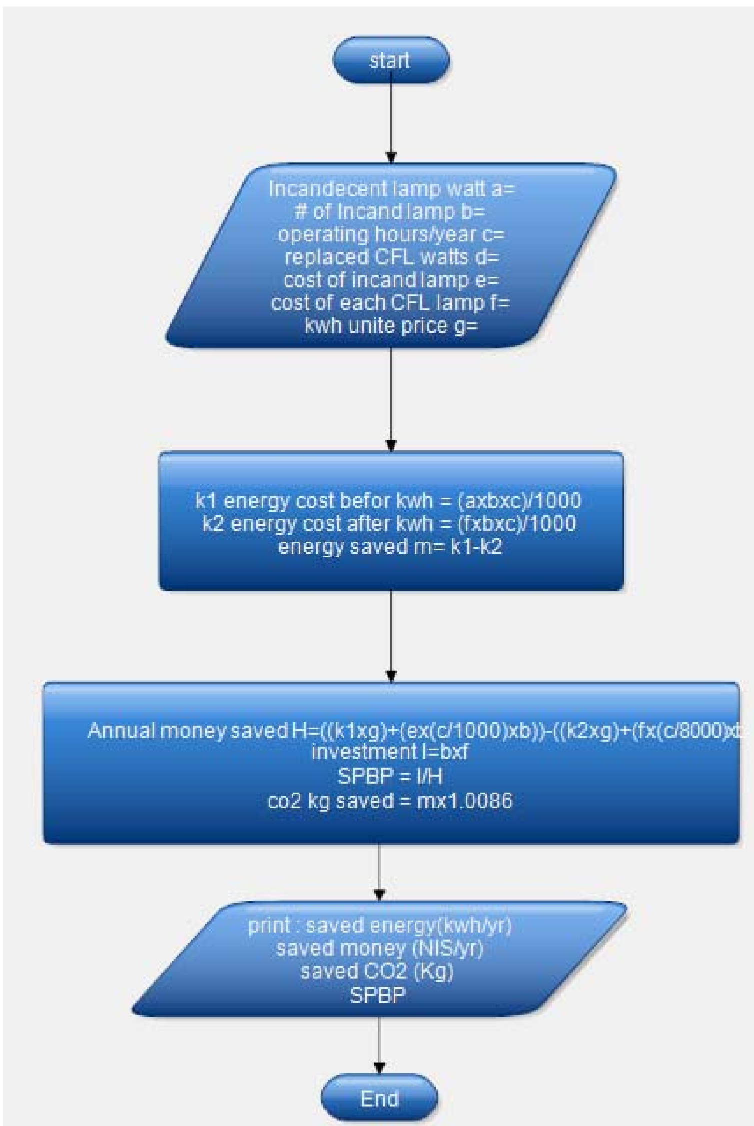


Figure (6.1): Methodological flow chart for calculating the saving of replaced incandescent to CFL lams

6.2.2 Methodological flow chart for Using Efficient Fluorescent and shoke:

This is used to analyze the energy conservation opportunities with Fluorescent Tube lights. Savings are possible by downsizing the wattage and by replacing the conventional Copper/Aluminum shoke by electronic shoke. Figure 6.2 shows the steps of the flow chart to calculate the saving of this ECM.

The input needed for the outside light improvement calculation:

- The rated power of the present fluorescent lamp.
- The total number of lamps.
- The total operational hours per year.
- The price of each fluorescents lamp.
- The price of each electronics shock.
- The suggested lamp rated power.
- Old shock losses (W)
- The new electronics shock losses (W)
- The electric tariff.

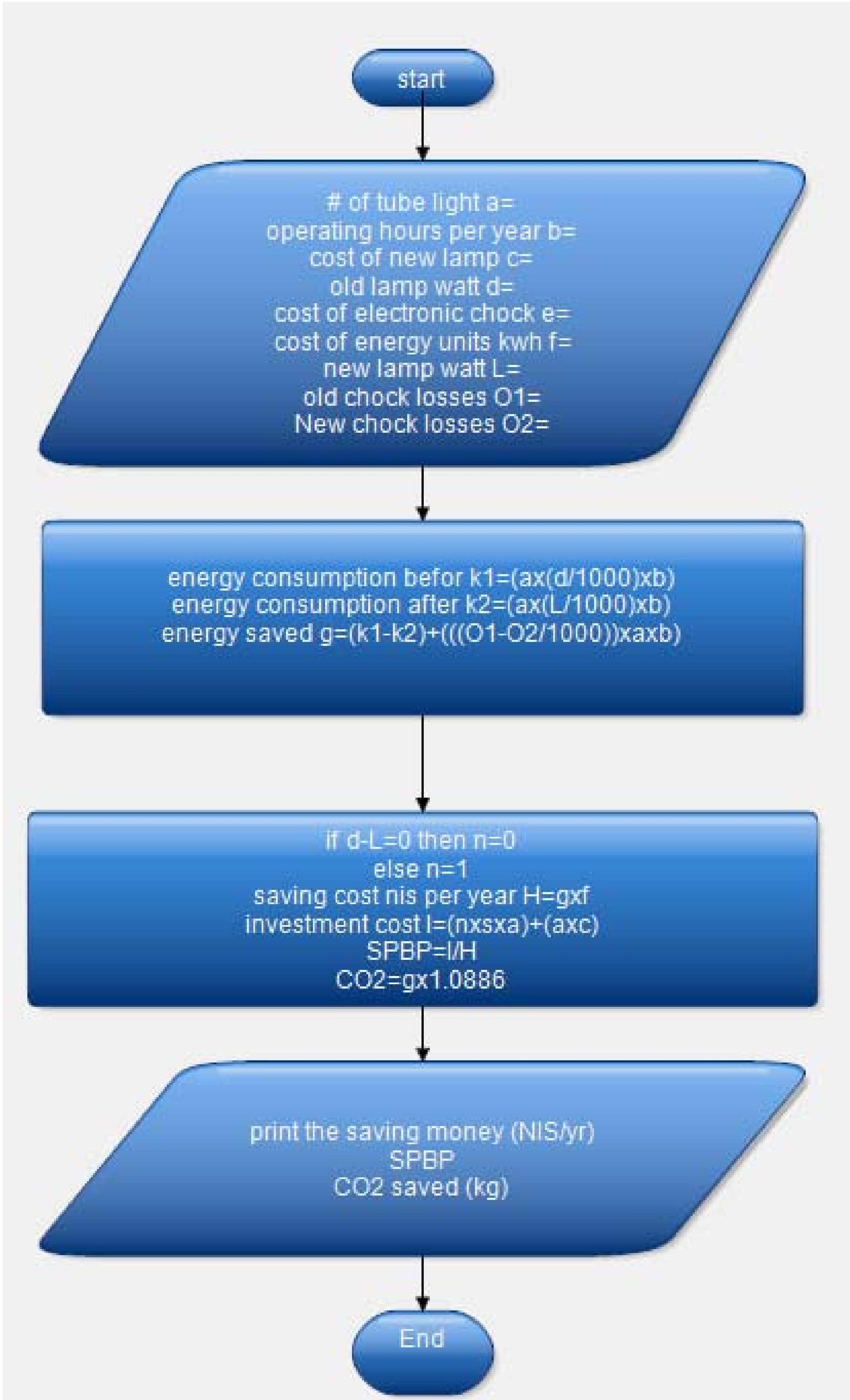


Figure (6.2): Methodological flow chart for calculation the saving among using efficient fluorescent and shoke

6.2.3 Methodological flow chart for using High pressure sodium (HPSV) instead of mercury vapor lamps (HPMV)

This is used to analyze the energy conservation opportunities by replaced the Mercury Vapor lamps (HPMV) to high pressure sodium (HPSV) to reduce the wattage without affect the efficacy level see table 6. .1Figure 6.3 shows the steps of the flow chart to calculate the saving of this ECM.

The input needed for the outside light improvement calculation:

- The rated power of the present HPMV lamp.
- The total number of lamps
- The total operational hours per year
- The electric tariff

Table (6.1): Comparing in wattage between HPSV and HPMV at the same efficacy

Lamp Type	HPSV	HPMV
Wattage	70	125
	100	250
	250	400
	400	1000

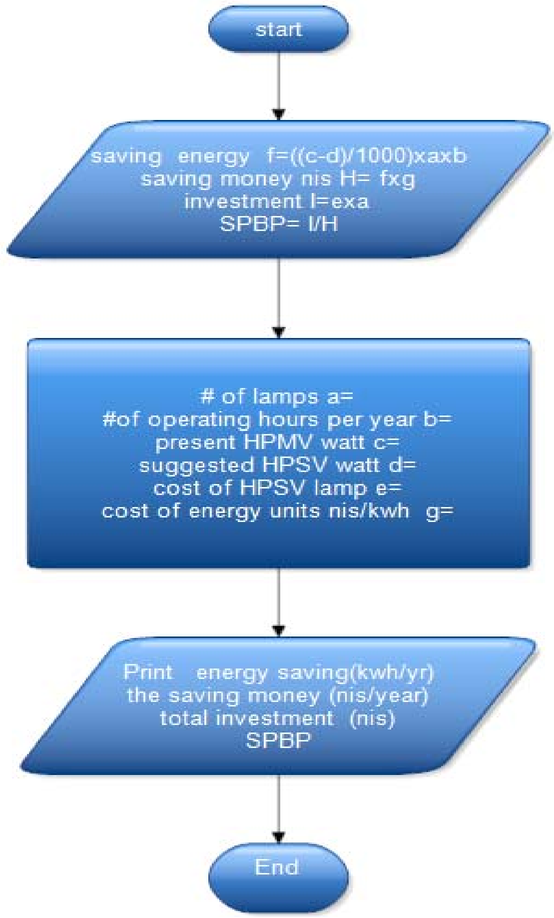


Figure (6.3): Methodological flow chart for calculation the saving among using HPSV instead of HPMV on the outside flood lights.

6.2.4 Methodological Flow Chart for Improving the Power Factor

This software useful to analyze and improvement of power factor on distribution side. This analysis is useful to eliminate the penalty and to sure equal or more than 92%, reduce the maximum demand and system losses by improving the power factor at the load end, these system losses can be reduced by 20-30% depending on the present power factor. Figure 6.4 shows the steps of the flow chart to calculate the saving of this ECM.

The input of the power factor improvement calculation:

- The present power factor

- The present average rated power
- The suggested power factor
- The cost price of one KVAR
- The electric tariff

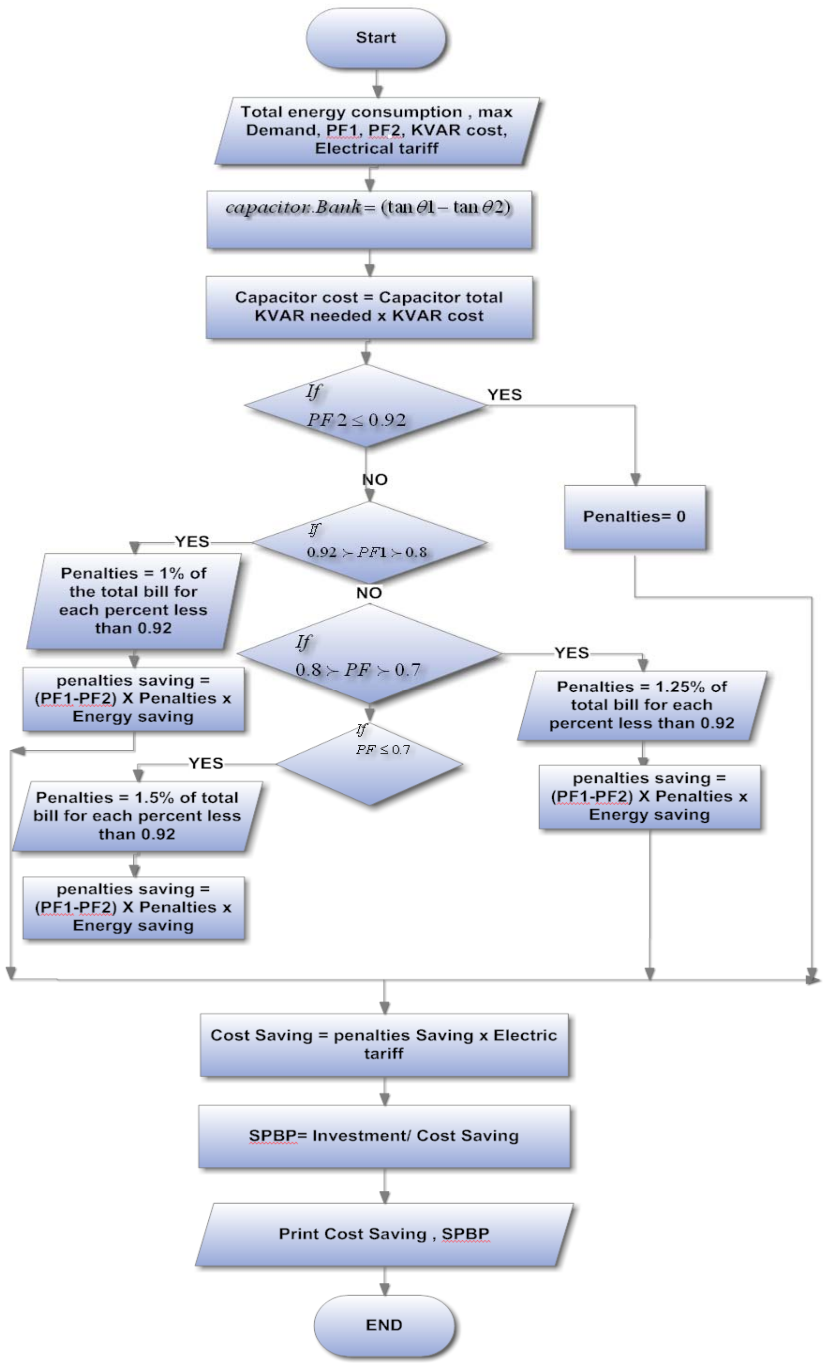


Figure (6.4): Methodological flow chart for calculation the saving among increase the power factor [3]

6.2.5 Methodological flow chart for Cooling Systems

The cooling software are designed to calculate the conservation of energy and money and CO_2 according to increase the temperature of the controller thermostat inside rooms to increase the temperature without exceed the comfort zone and don't affect the equipments.

The input requirements for cooling system calculation:

- The present number of split units and the rated power.
- The present number of chiller units and the rated power.
- The present temperature inside the facility Tin.
- The ambient present temperature.
- The suggested temperature for the facility.
- The operational total hours per year.
- The electrical tariff.

Figure 6.5 illustrates the flow chart of this ECM.

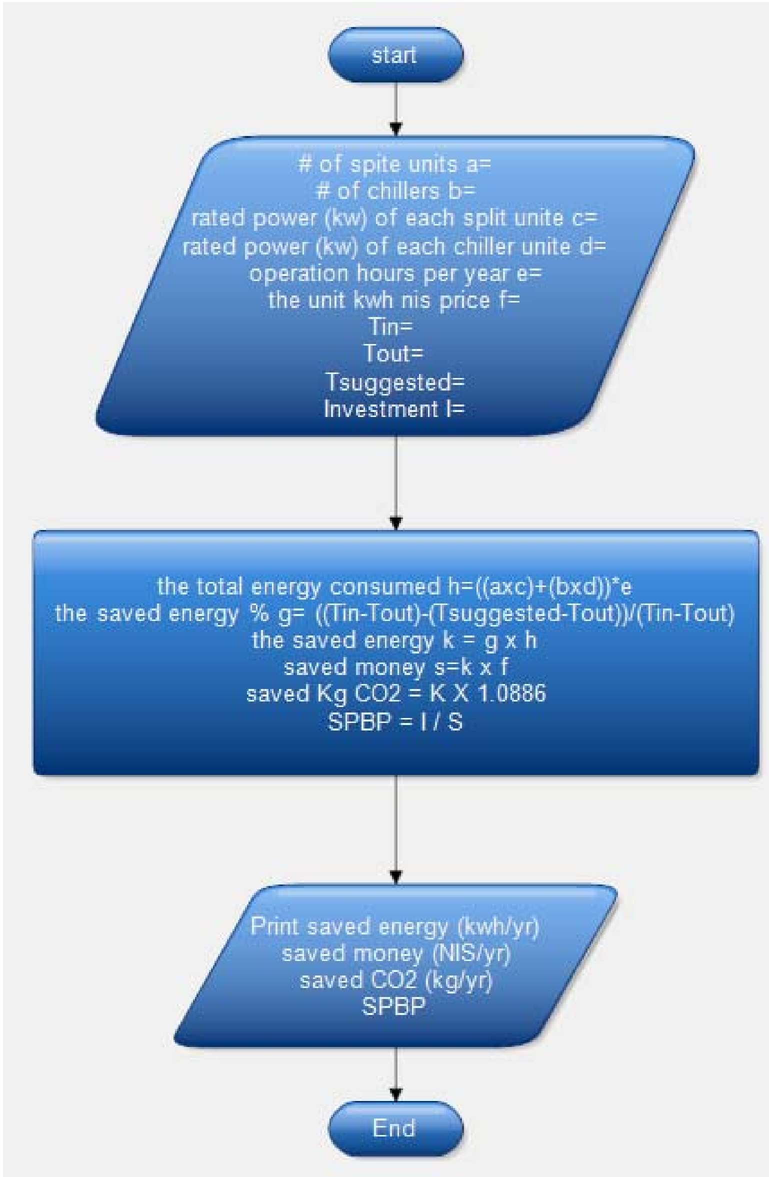


Figure (6.5): Methodological flow chart for calculation the saving among recalibrates the air conditions thermostat.

6.2.6 Methodological flow chart for heating systems

This software is used to determine the energy saved due increased the efficiency of the boilers, and also to calculate the CO_2 saved, SPBP. The measures used is controlling the controlling the excess air which is the most important tool for managing the energy efficiency and atmospheric emissions of a boiler system. Figure 6.6 illustrates the flow chart of this ECM.

The input requirement needed for heating calculation:

- Boiler annual fuel consumption
- Fuel price (NIS/liter)
- The present boiler efficiency
- The new efficiency after controlling the excess air to the burner.
- The investment due this operation, it's generally zero.

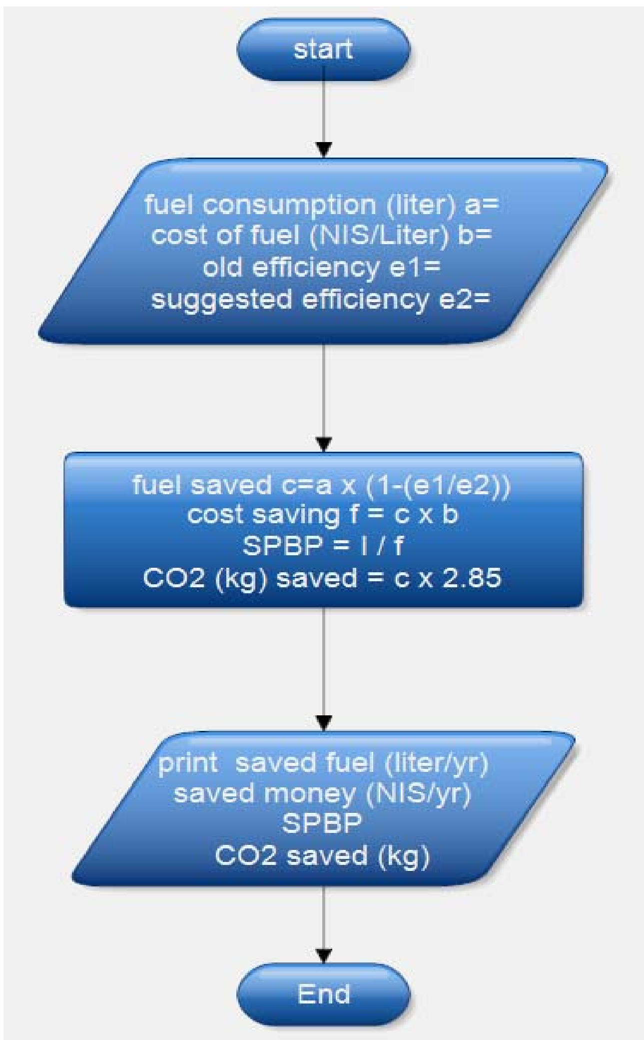


Figure (6.6): Methodological flow chart for calculation the saving among increase the boiler efficiency

6.2.7 Methodological rising UPS and Rectifier Efficiency

This software is used to determine the energy saved due increased the efficiency of the ups and rectifier systems, and also to calculate the CO_2 saved, SPBP. The measures used is replace the old systems from conventional transformer systems to new transformerless systems .Figure 6.7 illustrates the flow chart of this ECM.

The input requirement needed for heating calculation:

- The old system efficiency according the present load
- The new system efficiency according to present load
- The total number of units (ups or rectifier)
- The load rated power (kW)
- The electric tariff (NIS/kWh)
- The total investment of new transformerless system (NIS)

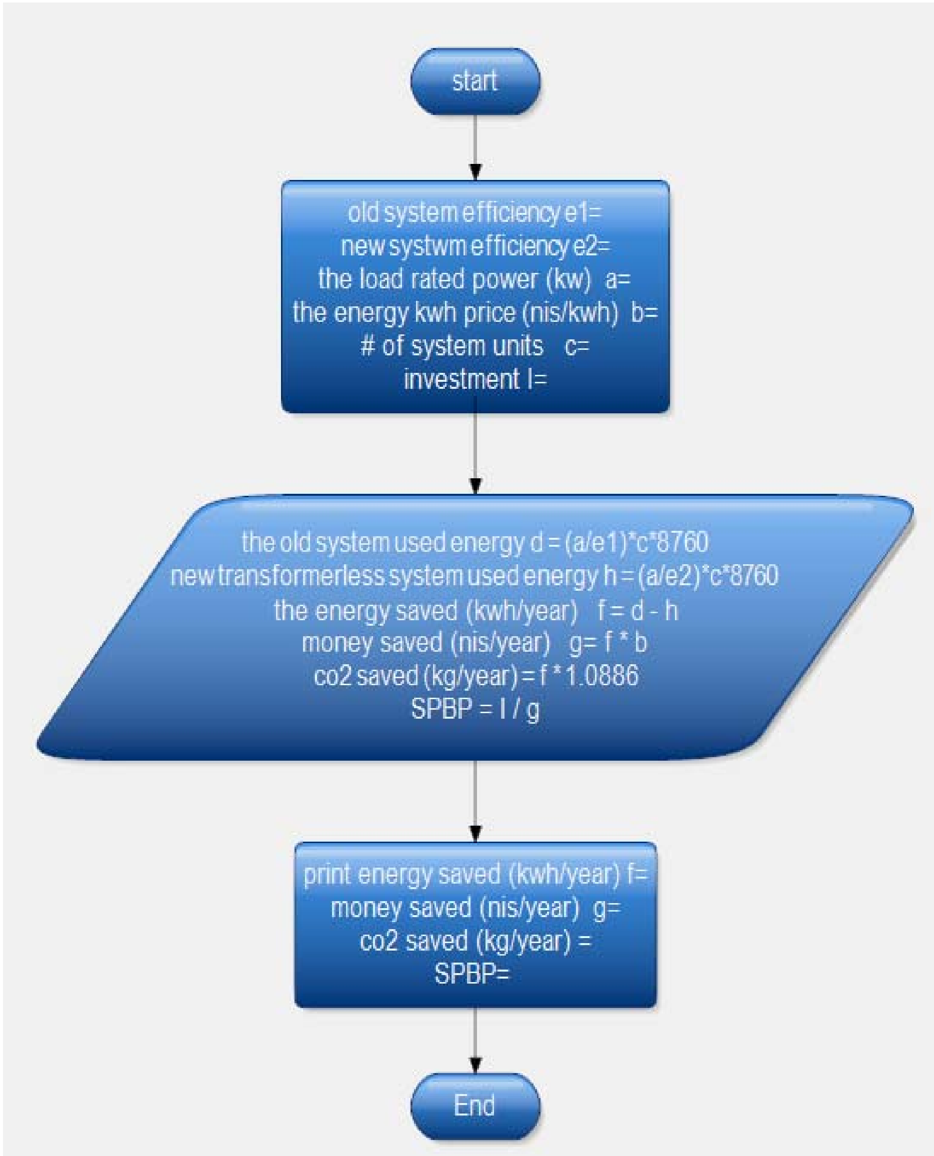


Figure (6.7): Methodological flow chart for calculation the saving among increase the UPS and rectifier efficiency.

6.3 Software Language

We adopted Microsoft excel 2007, this can combined with excel services, a new technology provides significant improvements for sharing data with greater security; we can share sensitive information more broadly with enhanced security with other parameter. By sharing a spreadsheet using office excel 2007 and excel services.

6.3.1 Software Components

As we saw in the previous chapters, we had illustrated the methods employed in energy conservation, transforming them into mathematical models, which used to find the total energy saving from each opportunity in our study, and crowing that in this chapter, by designing a software in which most energy conservation calculation are accomplished on Paltel facilities and that applicable for the commercial sector facilities , printing the outputs in specific tables, in addition to a list of final consequences that all forms of energy saving in our study especially in telecommunication facilities , such as

- Lighting systems by replace the old conventional lamps and shock by new efficient types
- Cooling systems by recalibrate the thermostat to acceptable limit
- Increase the equipment efficiency by replaced the old systems to new more efficient systems
- Increase the efficiency of the heating boilers by adjusts the excess air.
- Increase the power factor by using capacitors bank to avoid the penalty

The list design block diagram of the main data screen display in shown in figure 6, 8 since they are available in the user interface for choosing any process to be implemented. It's needless to say that it is not crucial to process all the cases in each study. On the contrary we could choose any case study independently according to subject matter.

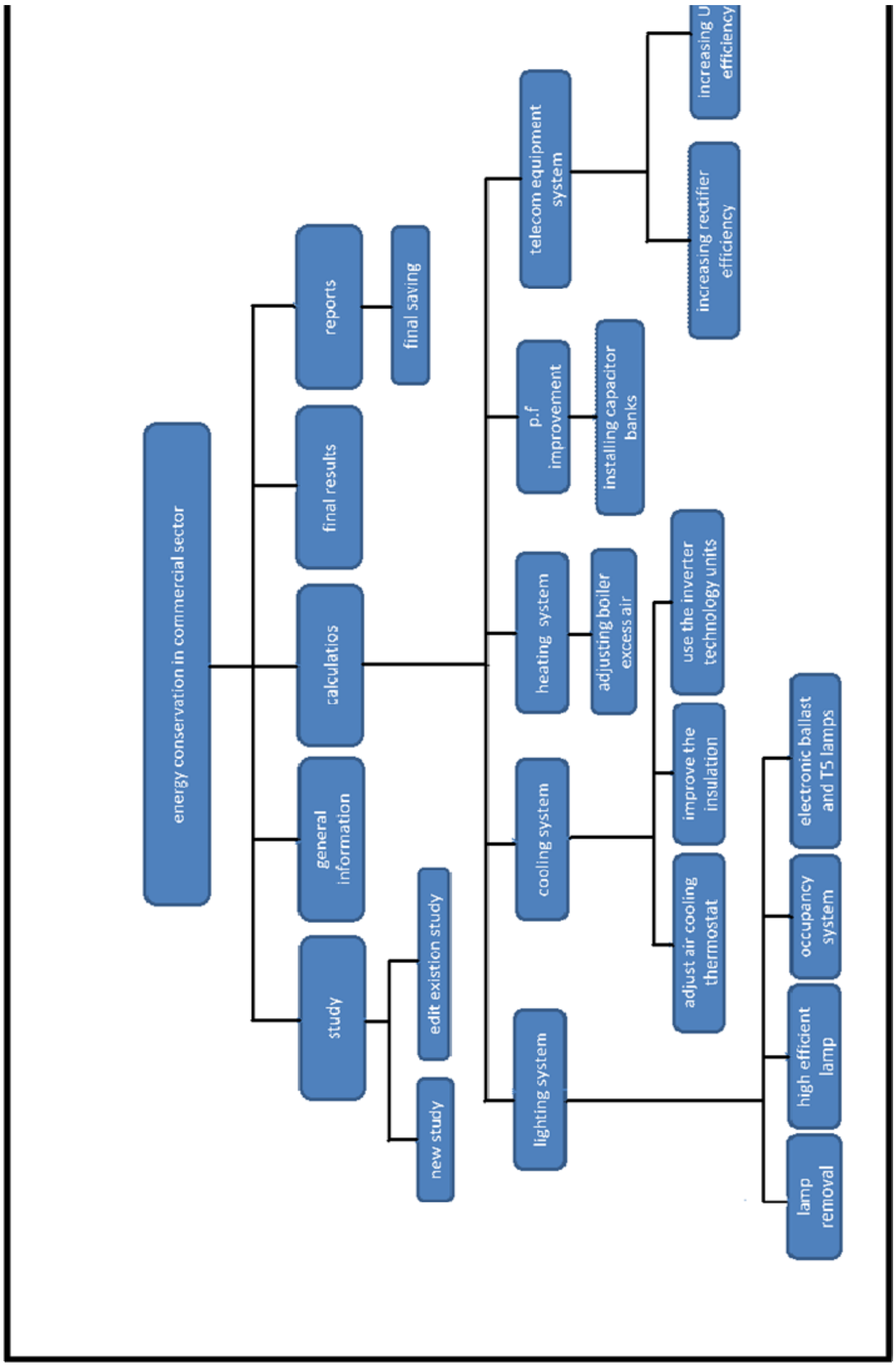


Figure (6.8): block diagram of the main data screen display

Figure 6.9 illustrate the main data screen of our software program of the energy management opportunity in commercial telecommunication sector. The interface illustrates eight energy conservation icons in addition to the final report and the overview.

Figure (6.9): Energy management program main data screen display

1-When pressing efficient CFL instead of incandescent lamps the program moves to lighting calculation windows, as shown in figure 6.10, the windows contains the inputs and the outputs.

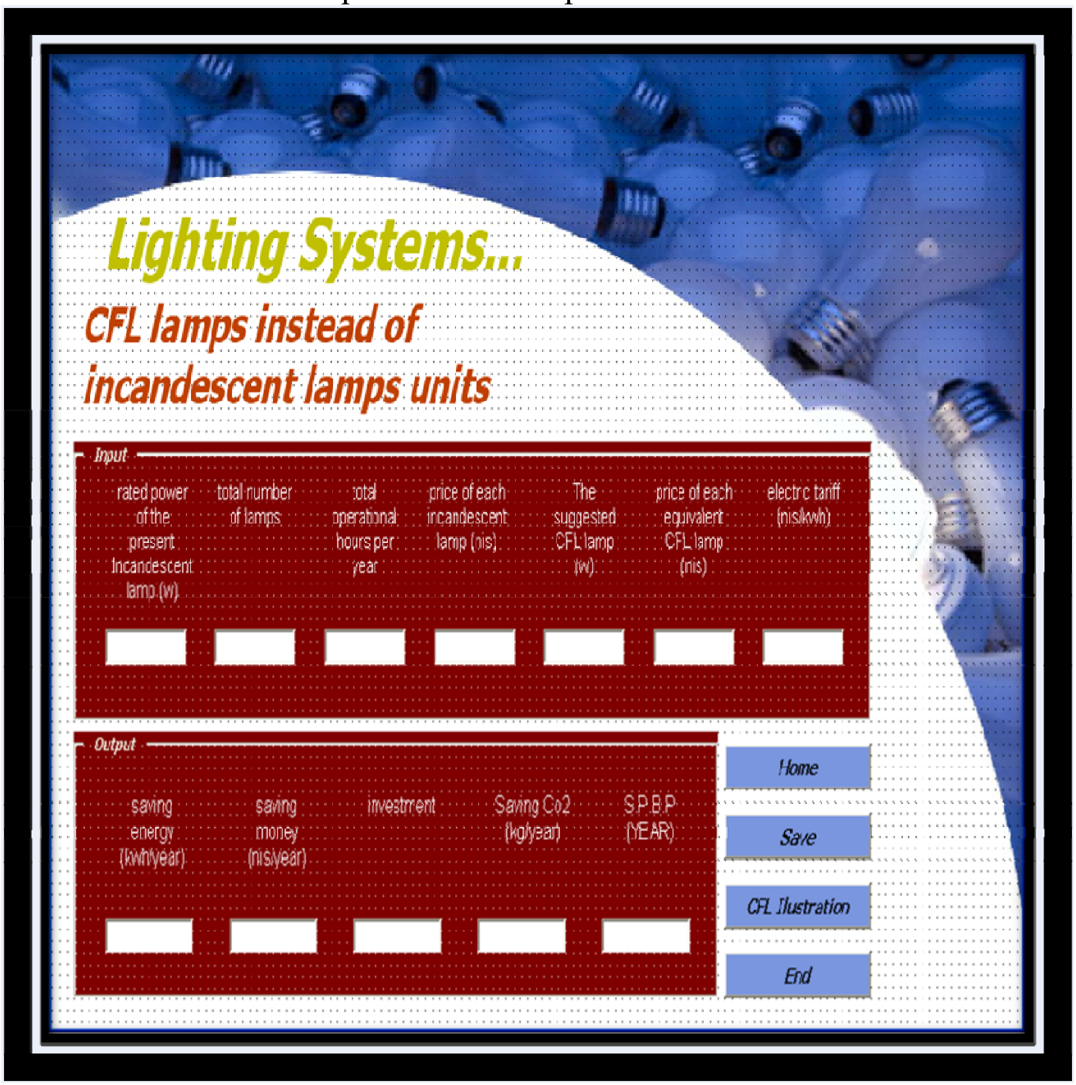


Figure (6.10): the interface windows of replacement CFL instead of incandescent

2-When pressing on efficient electronic chock and efficient fluorescent T5 instead of T8 light lamps the program moves to the calculation windows, as shown in figure 6.11, the windows contains the inputs and the outputs.

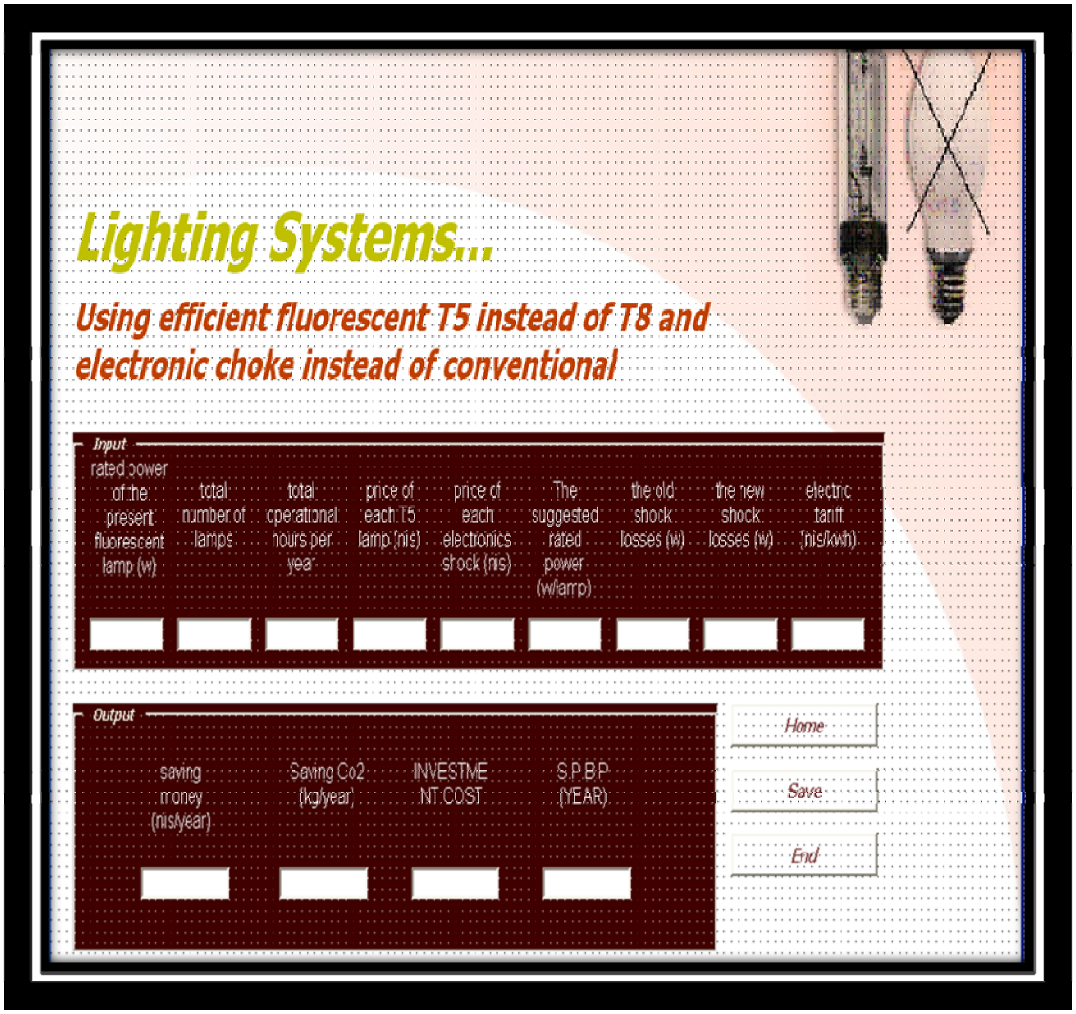


Figure (6.11): The interface windows using efficient Electronic chock and efficient fluorescent lamps

3-When pressing on High Pressure Sodium (HPSV) instead of mercury Vapor Lamps (HPMV) the program moves to the calculation windows, as shown in figure 6.12, the windows contains the inputs and the outputs.

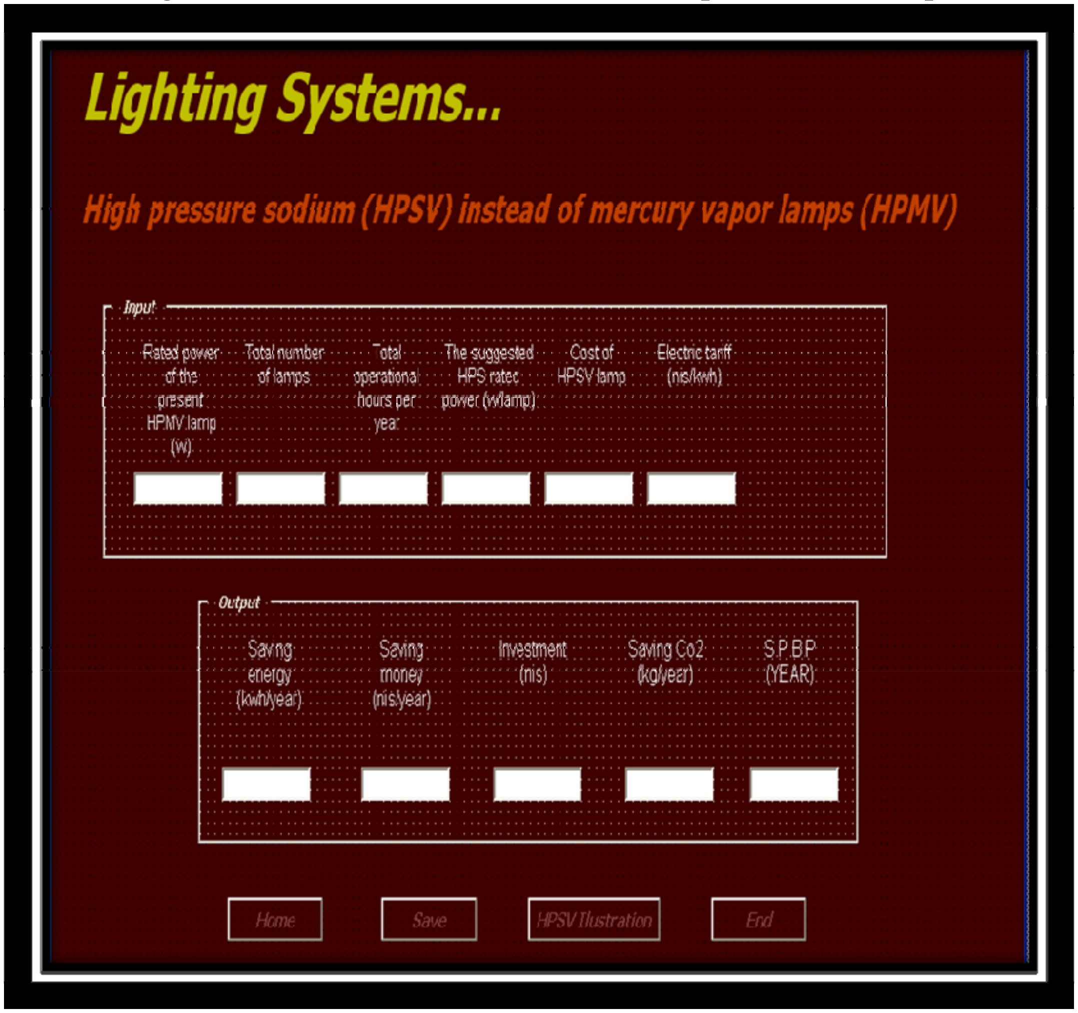


Figure (6.12): The interface windows using efficient HPSV instead of HPMV

4-When pressing on power factor improvement the program moves to the calculation windows, as shown in figure 6.13 , the windows contains the inputs and the outputs.

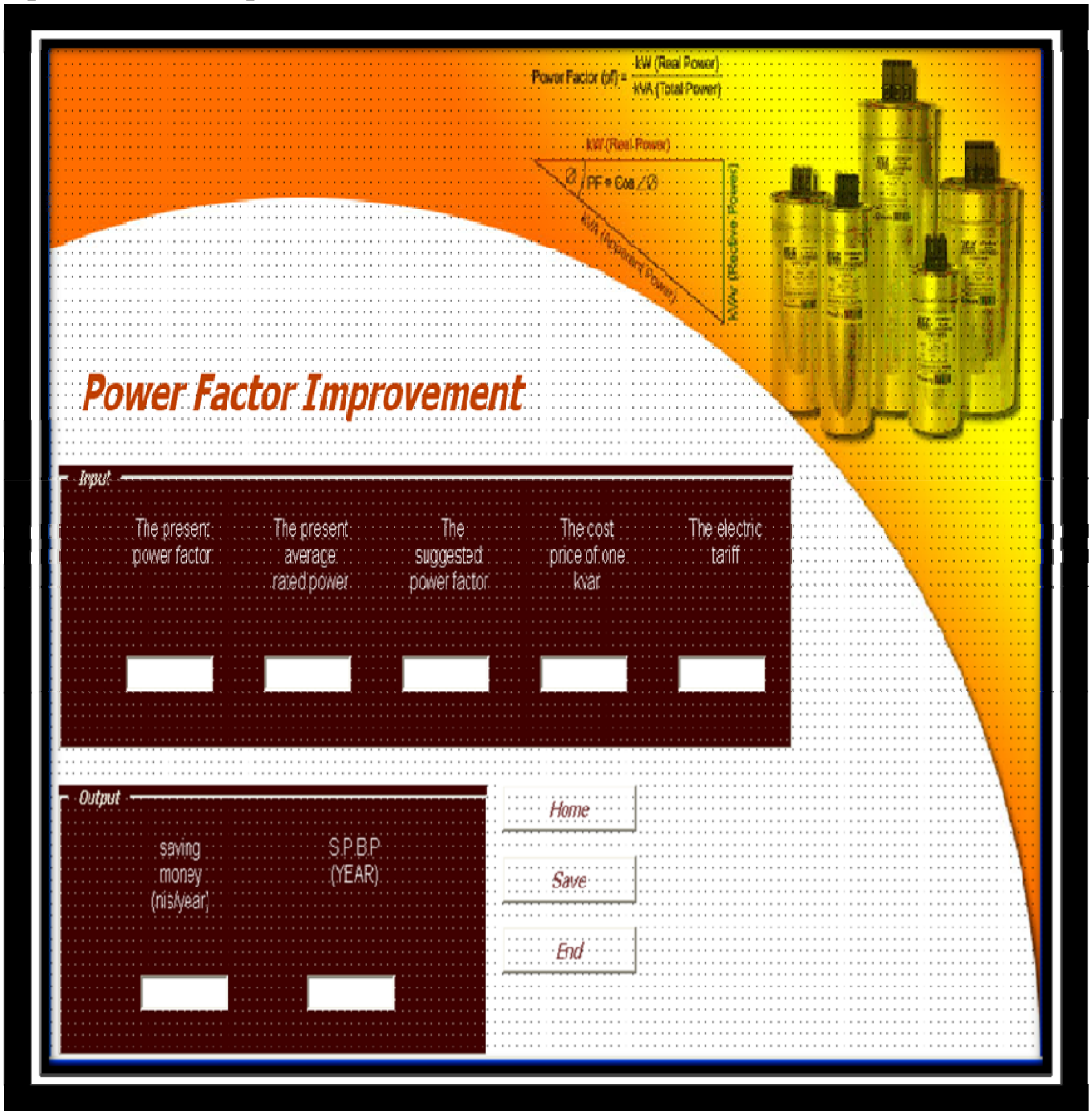


Figure (6.13): The interface windows of power factor improvement

5-When pressing on calibration of thermostat units the program moves to the calculation windows, as shown in figure 6.14 , the windows contains the inputs and the outputs.

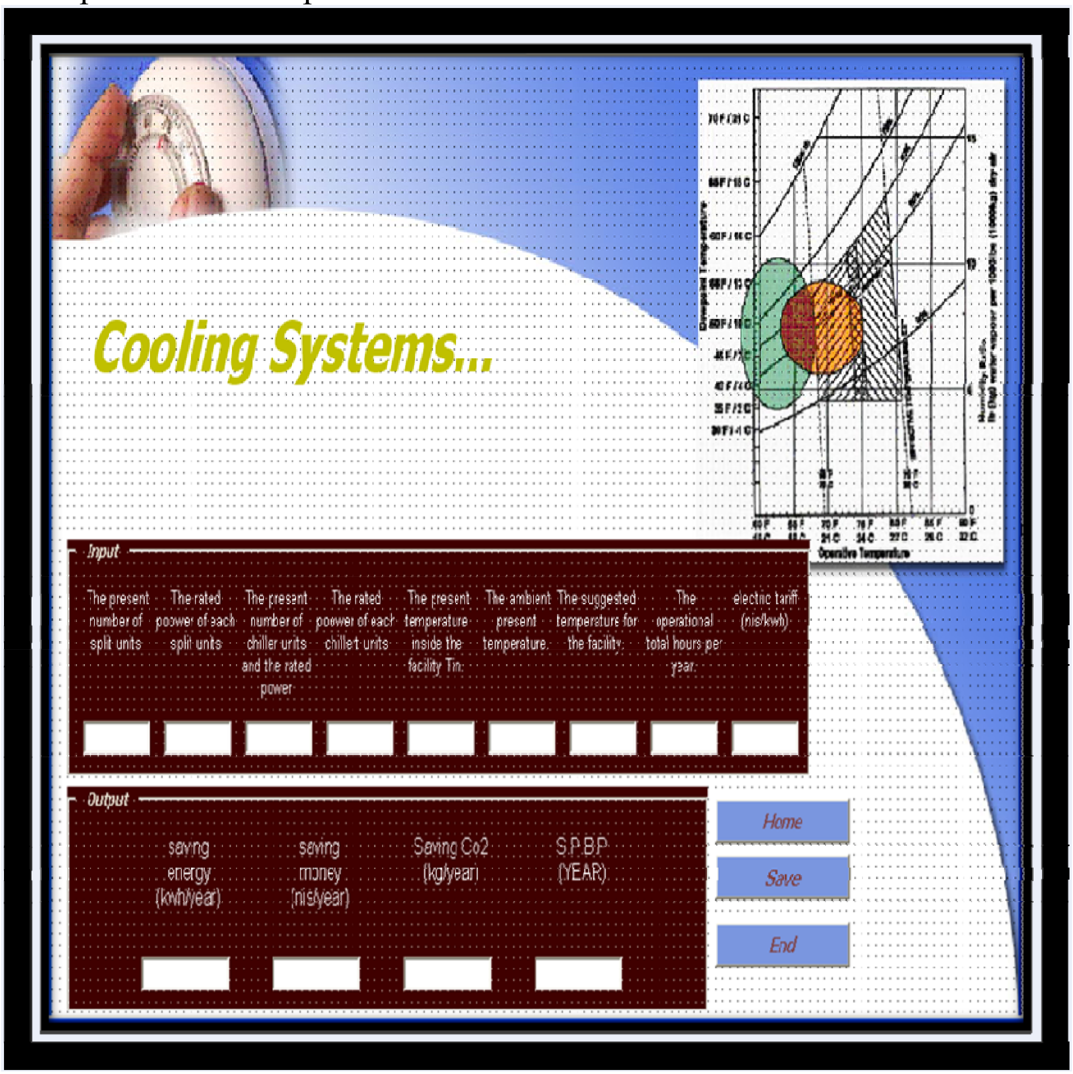


Figure (6.14): The interface windows of thermostat unit recalibration

6-When pressing on rising boilers efficiency the program moves to the calculation windows, as shown in figure 6.15 , the windows contains the inputs and the outputs.

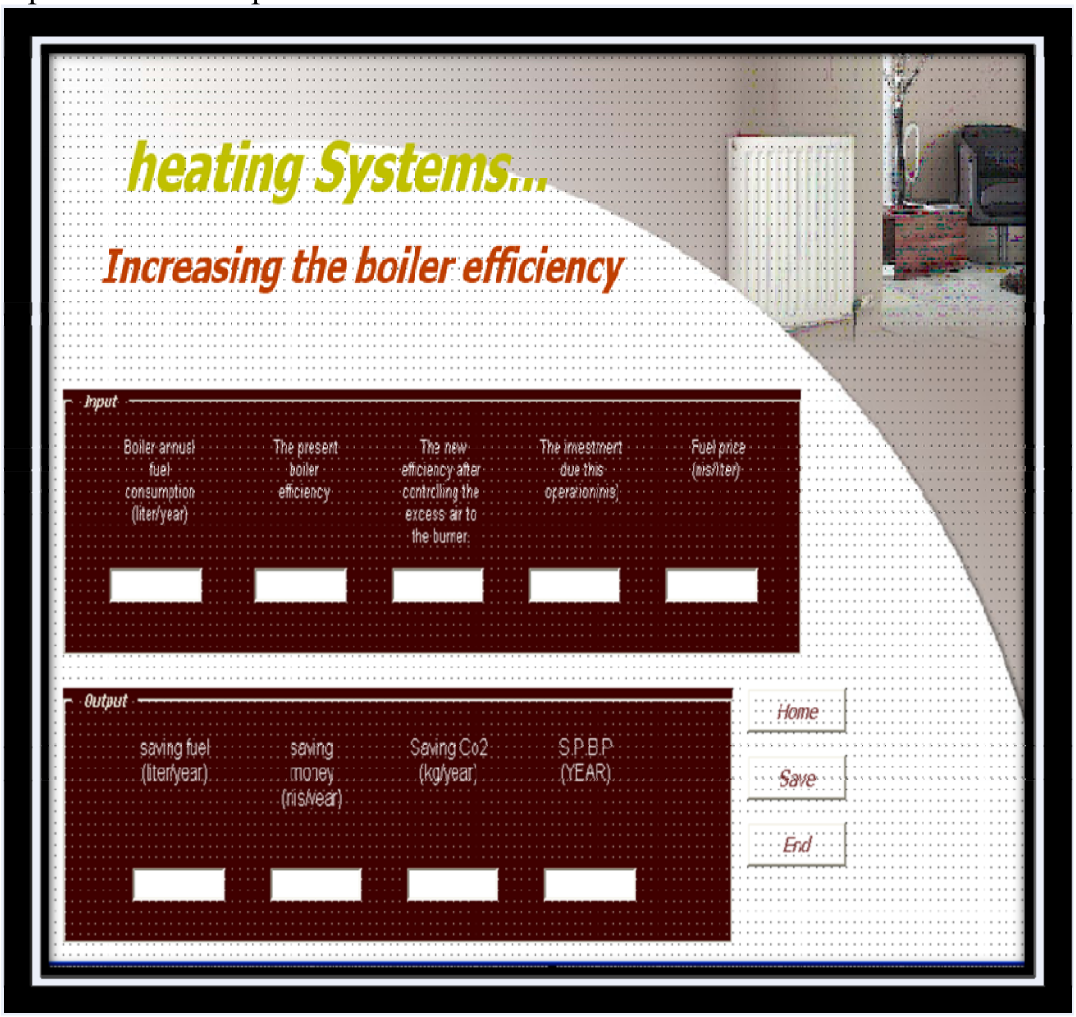


Figure (6.15): The interface windows of boilers efficiency improvement

7-When pressing on using efficient ups and rectifiers systems the program moves to the calculation windows, as shown in figure 6.13 , the windows contains the inputs and the outputs.

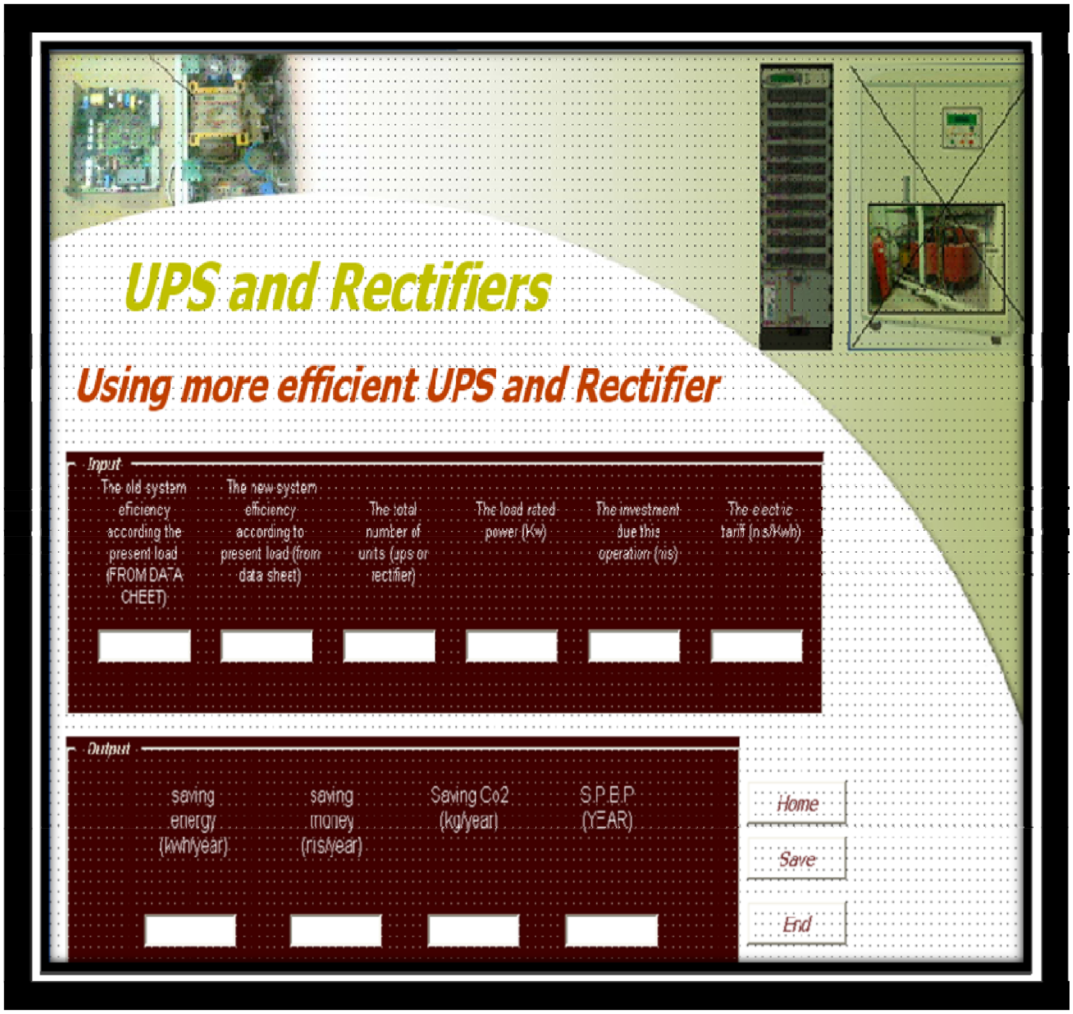


Figure (6.16): The interface windows of use more efficient UPS and rectifiers

Conclusion and Recommendations

Conclusion

As we saw in the previous chapters, the energy situation in Palestine has abnormal conditions, its depend on Israel in fully with a lack of various energy resources, the political situation is miserable as a result Israeli repression and the denial of the Palestinian people their basic rights, and this impacted negatively on the economic situation. Palestine has seen a growth in demand for electricity and energy this has made things complicated. For all that we need great importance of the rationalization of consumption and energy management as a result of all that, we decided to study the energy conservation in one of large sectors which is commercial sector and select Paltel Telecom Company as case study of this sector.

After reviewing the energy bills of Paltel Telecommunication Company it became obvious to us that it is like many commercial buildings and establishments suffer from high consumption with respect to its connected load. by this thesis we proved and presented that there is a great potential for energy savings in the Palestinian commercial sector by implementing energy conservation measures of no and low cost investment. Energy consumption in commercial is huge due to non-awareness and lack of experience of energy management procedures.

We proved that applying the mentioned energy conservation measures would undoubtedly save considerable amounts in the electrical energy bills and fuel. We have achieved a percentage of energy saving 15.3 % from total Paltel consumption of west bank, and that give us a good image for all Paltel locations. Many of our recommendations are specified to other commercial building and many could translate to any facility.

Most telecommunication centres like other old commercial buildings were designed and built many years ago, with the advancement of technology these buildings (and associated equipments) have become large outdated, being over designed, under designed, and/or unreliable. This has compounded inefficiencies in building type, power systems, equipment, and operating schedules. To overcome this problem, we have been proposed the use of electronic equipment with energy-saving technologies like modular transformerless UPS and as well as the modular rectifiers Which is characterized by low power losses compared with the old technology equipments. And also we suggested use a new inverter air conditions, increase the insolation of the telecom sites, using efficient lights equipments, and improve the power factor. We illustrated the advantages of these types and approved that they could save huge amount of the consumed electrical energy.

Recommendations

Our thesis encompasses a multitude of parameters at different spatial levels; several recommendations can be drawn out of this research. The recommendations listed here below are mainly directed to decision makers and for researchers:

1. We suggest and advice that similar energy management researches must be conducted in other commercial facilities, that’s because the suffering of the significant loss of energy as we have shown through

this study for one of the most important commercial facilities, and also, as demonstrated in previous studies in other sectors as mentioned earlier.

2. Strengthen the role of Energy Research Center, and encourage other commercial facilities by encouraging investments in energy conservation programs within the sector.

3. Incentives use of energy efficient products under above categories, by tax rebates to manufacturers, like high efficient offices appliances, air conditioning systems, rectifiers, UPS's system ….ect.

4. Provide technical training for energy conservation practices in schools and vocational colleges and universities and also introduce and develop training and knowledge of energy saving practices to the private sector, especially commercial sector.

5. Support and improve utilization of renewable source especially of solar power as sunshine is abundant and clean source of energy.

References

[1] Colorado River commission of Nevada, March 2002.**World fossil fuel reserves and projected depletion,** (http://crc.nv.gov/docs/world%20fossil%20reserves.pdf)

[2] M., Fasiuddin, master thesis, December, 2005. **HVAC system operation operation strategies in commercial building in Saudi Arabia,** http://eprints.kfupm.edu.sa/10558/1/10558.pdf.

[3] B., Da'as master thesis, 2008. **Energy management procedures and audit results of electrical, thermal and solar applications in hospital sector in Palestine.**

[4] B., Yaseen, Master Thesis, 2008. **Energy efficiency improvement and cost saving measures in some different industries in Palestine.**

[5] A., Abu Alkhair, **The Current Status of the Energy Sector in Palestine, with a Special Focus on the Electricity Sector,** 2006.

[6] PCBS, 2007. **Energy statisties,** http://www.pcbs.gov.ps/Portals /pcbs /Energy/7e1ba6a9-3610-44c0-8133-2b8d355a1e0f.htm

[7] PCBS, 2008. **Energy Balance in the Palestinian Territory,** http://www.pcbs.gov.ps/Portals/_PCBS/Downloads/book1621.pdf

[8] I, Ibrik and Marwan M. Mahmoud. 2003, **Energy efficiency improvement procedures and audit results of electrical, thermal and solar applications in Palestine.** Energy Research Centre, An-Najah National University, Nablus, P.O. Box 7, West Bank, Palestine.

[9] PCBS, 2009. **Energy Balance in the Palestinian Territory,**

http://www.pcbs.gov.ps/portals/_pcbs/downloads/book1532.

[10] PALTEL, 2009. **Technical and financial department data sheets.**

[11] Sepco document library, 2007. **Context and Barriers to Energy Efficienc,** http://www.ises.org/sepconew/Pages/EE_Policy_in_ Germany 1/.html).

[12] J., Godby, **Understanding telecom power components and systems originally,** published at 1994 High Frequency Power Confere.

[13] ANAMA Enertech Solutions PVT Ltd, **What is an energy audit,** http://www.anamaenertech.com/energy%20audits%20thermal%20&% 20 electrical_a.html

[14] Indian telecom company, **Energy efficient lighting and barriers in its implementation,** www.electrical.bsnl.co.in/articles/eel.doc

[15] J., Tiller, **Commercial Sector Strategies,** http://www.p2pays.org/ref/05/04493/chapter_5.pdf

[16] M., Sa'di, master thesis, 2008, **Design of an automatic control system for electric energy management-case study An-Najah national University**.

[17] S., Darragh, **Lighting commissioning,** 2003, http://www.lightingdesignlab.com/ldlnews/lighting_commissioning_sd.pdf

[18] NetworkComputing Magazine, **Efficient UPS systems and the low carbon economy,** Vol 16, Issue 5 - September/October 2007. Chttp://www.networkcomputing.co.uk/articles/reviews.asp?a_id=135

[19] T., Wei, P., Guoping, H., Jiang, and L., Xiyu, China Telecom **Adaptive energy saving monitoring technology for air condition in telecommunication equipment room,** Telecommunications Energy

Conference, 2007. http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=4448758

[20] S., Roy, Global Marketing, **Energy Logic for Telecommunications,** http://www.liebertcanada.ca/sites/Network_Power/fr-CA/Products/GenericProduct/Documents/Energy%20Logic%20for%20Telecommunications/Energy%20Logic%20for%20Telecom%20White%20Paper.pdf

[21] M., Alsaad and M., Hammad, **Heating and air conditioning for residential buildings,** fourth edition, SI version, University of Jordan ,Amman .

[22] Wikipedia free encyclopedia, **Inverter air conditioning systems,** http://en.wikipedia.org/wiki/inverter_(air_conditioning).

[23] PCBS, 2008, **Temperature monthly average in Palestine.**

[24] I., Roth, F., Goldstein, J., Kleinman, **Energy Consumption by Office and Telecommunications Equipment in Commercial Buildings,** Volume I.

[25] Energy star, **Energy star and data centers,** http://www.newdaedalus .com /articles/2007/9/7/energystar-systems-and-data-centers.html, 2007

[26] Nablus municipality, **Power factor penalty schedule,** 2010.

[27]Dikins industrial ltd, **VRV Air conditioning systems,** http//www.dikins.com

Appendices

Appendix-1 Description of the Existing Lighting Fixtures for Paltel head quarter

Area #	*Area Name*	*Area m^2*	*Existing Lamp Type*	*# of lamps /Fixture*	*Rating W/*	*No. of Fix.*	*Annual Operating*	*Consumption kW*	*Consumption kWh/year*	*Measured Lux.*	*Standered lux*
1	Ground floor	900	Fluorescent 60x60 cm^2	4	18	33	2040	2.376	4847.04	550	400
			PL spot 13 W	1	13	16	2040	0.208	424.32		
			Pl spot 26 W	2	13	19	2040	0.494	1007.76		
			Fluorescent 2X36W	2	36	4	2040	0.288	146.88		
			Halogen spot 50 W	1	50	46	2040	2.3	4692		
2	First floor	900	Glop 2x13W	2	13	26	2040	0.676	1379	620	400
			Fluorescent 2X36W	2	36	4	2040	0.288	146.88		
3	Second floor	900	Glop 2x13W	2	13	17	2040	0.442	901.7	600	400
			Fluorescent 2X36W	2	36	11	2040	0.792	1616		
4	Third floor	900	Fluorescent 60x60 cm^2	4	18	45	2040	3.24	6609.6	635	400
			PL spot 13w	1	13	38	2040	0.494	1007.76		
			Fluorescent 2X36W	2	36	14	2040	1	2056		
			Halogen spot 50 W	1	50	9	2040	0.45	918		
5	Fourth floor	900	Fluorescent 60x60 cm^2	4	18	62	2040	4.464	9106.56	590	400
			PL spot 13W	1	13	30	2040	0.39	795.6		
			Halogen spot 50 W	1	50	3	2040	0.15	306		
6	Fifth floor	900	Fluorescent 60x60 cm^2	4	18	62	2040	4.464	9106.56	620	400
			PL spot 13w W	1	13	30	2040	0.39	795.6		

			Halogen spot 50 W	1	50	3	2040	0.15	306		
7	Sixth floor	900	Fluorescent 60x60 cm^2	4	18	62	2040	4.464	9106.56	615	400
			PL spot 13W	1	13	30	2040	0.39	795.6		
			Halogen spot 50w	1	50	3	2040	0.15	306		
8	Seventh floor	900	Fluorescent 60x60 cm^2	4	18	62	2040	4.464	9106.56	500	400
			PL spot 13W	1	13	30	2040	0.39	795.6		
			Halogen spot 50w	1	50	3	2040	0.15	306		
9	*Eighth floor*	*900*	*Fluorescent 60x60 cm^2*	*4*	*18*	*62*	*2040*	*4.464*	*9106.56*	*490*	*400*
			PL spot 13W	*1*	*13*	*30*	*2040*	*0.39*	*795.6*		
			Halogen spot 50 W	*1*	*50*	*3*	*2040*	*0.15*	*306*		
10	*Ninth floor*	*900*	*Fluorescent 60x60 cm^2*	*4*	*18*	*62*	*2040*	*4.464*	*9106.56*	*515*	*400*
			PL spot 13 W	*1*	*13*	*30*	*2040*	*0.39*	*795.6*		
			Halogen spot 50 W	*1*	*50*	*3*	*2040*	*0.15*	*306*		
	TOTAL					*893*		*43.072*	*87001.9*		

Appendix-2 Lamp Removal for Paltel head quarter

Area #	Area Name	Area m^2	Existing Lamp Type	No. of Fix.	# Removed	kW saved	Saving kWh/year
1	Ground floor	900	Fluorescent 60x60 cm^2	33	8	0.576	1175
2	First floor	900	Glop 2x13 W	26	8	0.208	424.32
3	Second floor	900	Glop 2x13 W	17	7	0.182	371.3
			Fluorescent 2X36W	11	3	0.216	440.64
4	Third floor	900	Fluorescent 60x60 cm^2	45	15	1.08	2203
			PL spot 13w	38	15	0.195	397.8
			Fluorescent 2X36W	14	5	0.36	734.4
5	Fourth floor	900	Fluorescent 60x60 cm^2	62	20	1.44	2937.6
			PL spot 13 W	30	8	0.104	212.16
6	Fifth floor		PL spot 13 W	30	8	0.104	212.16
7	Sixth floor	900	Fluorescent 60x60 cm^2	62	20	1.44	2937.6
			PL spot 13w	30	8	0.104	212.16
8	Seventh floor	900	Fluorescent 60x60 cm^2	62	20	1.44	2937.6
			PL spot 13 W	30	8	0.104	212.16
9	Eighth floor	900	Fluorescent 60x60 cm^2	62	20	1.44	2937.6
			PL spot 13 W	30	8	0.104	212.16
10	Ninth floor	900	Fluorescent 60x60 cm^2	62	20	1.44	2937.6
			PL spot 13 W	30	8	0.104	212.16
	TOTAL				229	12.081	24645.02

Appendix-3 Replace lamps for Paltel head quarter

Area #	Area Name	old Lamp Type	new Lamp Type	No. of Fix.	Annual operating	Saving kW	Saving kWh/year
1	*Ground floor*	*Halogen spot 50 W*	*PL spot light 1x13 W*	*46*	*2040*	*1.7*	*3468*
2	*Third floor*	*Halogen spot 50 W*	*PL spot light 1x13 W*	*9*	*2040*	*0.33*	*679.32*
3	*Fourth floor*	*Halogen spot 50 W*	*PL spot light 1x13 W*	*3*	*2040*	*0.111*	*226*
4	*Fifth floor*	*Halogen spot 50 W*	*PL spot light 1x13W*	*3*	*2040*	*0.111*	*226*
5	*Six floor*	*Halogen spot 50 W*	*PL spot light 1x13W*	*3*	*2040*	*0.111*	*226*
6	*Seventh floor*	*Halogen spot 50 W*	*PL spot light 1x13W*	*3*	*2040*	*0.111*	*226*
7	*Eight fool*	*Halogen spot 50 W*	*PL spot light 1x13W*	*3*	*2040*	*0.111*	*226*
8	*Ninth floor*	*Halogen spot 50 W*	*PL spot light 1x13W*	*3*	*2040*	*0.111*	*226*
	TOTAL			*73*		*2.696*	*5503.32*

Appendix-4 The equipment and systems operated from ups 100 kVA and 60 kVA and power

Area	**The Equipment Load (kW) From UPS 100 And 60 kVA**	**The Equipment Load (kW) From Power**
Ground Floor	***1.24 kW***	***0.55***
First Floor	***1.24 kW***	***0.28***
Second Floor	***1.24 kW***	***0.25***
Third Flood	***24.8 kW***	***1.96***
Fourth Floor	***4.96 kW***	***1.82***
Fifth Floor	***4.96 kW***	***1.96***
Six Floor	***4.96 kW***	***1.61***
Seventh Floor	***4.96 kW***	***1.77***
Eighth Floor	***4.96 kW***	***2.11***
Ninth Floor	***4.96 kW***	***1.96***
Total	***58.28 kW***	***14.27 kW***

Appendix-5 Description of the Existing Lighting Fixtures in Nablus exchange

Area #	Area Name	Existing Lamp Type	If Lamps with Reflector	# of lamps /Fixture	Rating W	No. of Fix.	Annual	Consumption kw	Consumption kWh/year	Measured Lux.
1	Generator room	FL	yes	2	36	6	720	0.432	311.04	600
2	kitchen	FL	YES	4	18	2	1500	0.144	216	350
3	W.C	FL	YES	4	18	2	1500	0.144	216	460
4	W.C	PL	YES	1	13	1	1500	.013	19.5	490
5	Yard	FL	YES	2	36	16	2000	1.152	2304	--
6	W.C	pl	YES	1	13	9	1500	0.117	175.5	465
7	Room1	FL	YES	2	18	2	2500	0.072	180	400
8	Room 2	FL	YES	2	36	5	2500	0.36	900	550
9	Room3	PL	YES	2	36	6	2500	0.324	1080	550
10	Romm4	PL	YES	2	36	4	2500	0.288	720	470
11	Outdoor	H.P	NO	1	400	3	4000	1.2	4800	--
12	Kitchen	FL	YES	2	36	1	2500	0.072	180	350
13	Guard Room	FL	YES	2	36	1	5000	0.072	360	300
14	OSS Center	FL	YES	4	18	55	2016	3.96	7983.36	1000
15	OSS Center	FL	YES	4	18	25	2016	1.8	3628.8	800
16	OSS Room1	FL	YES	4	18	3	2016	0.216	435.456	400
17	OSS Room2	FL	YES	4	18	3	2016	0.216	435.456	390
18	Nablus Dep.	FL	YES	4	18	31	2016	2.232	4499.712	800
19	Path room	PL	YES	2	9	5	1000	0.09	90	350
20	Switch	FL	YES	4	18	9	1500	0.648	972	550
21	Switch	FL	YES	2	36	2	1500	0.144	216	300

Area #	Area Name	Existing Lamp Type	If Lamps with Reflector	# of lamps /Fixture	Rating W	No. of Fix.	Annual	Consumption kw	Consumption kWh/year	Measured Lux.
22	Switch	FL	YES	4	18	32	1500	2.304	3456	600
23	Switch	FL	YES	2	36	11	1500	0.792	1188	560
	TOTAL			**61**		**234**		**16.792**	**34366.82**	

Appendix 6: Total Lighting Fixture at North and Middle Region for Paltel Company

LIGHTING						
	TYPE	NUMPER	TOTAL WATT(W)	TOTAL houre /y	ENERGY CNUMPTION kWh/y	MONEY NIS/y
HEAD QUARTER	4X18W	260	18720	1930	36129.6	27458.5
	2X36W	270	19440	1930	37519.2	28514.6
	250 W PROJECTOR	13	3250	4380	14235.0	10818.6
	50 WATT HELOGEN	73	3650	1930	7044.5	5353.8
NABLUS EXCHANGE	4X18W	57	4104	1930	7920.7	6019.7
	2X36W	15	1080	1930	2084.4	1584.1
	400 WATT PROJECTOR	3	1200	4380	5256.0	3994.6
TULKARM MAIN EXCHANGE	4X18W	35	2520	1930	4863.6	3696.3
	400 WATT PROJECTOR	3	1200	4380	5256.0	3994.6
JENIN MAIN EXCHANGE	4X18W	30	2160	1930	4168.8	3168.3
	400 WATT PROJECTOR	3	1200	4380	5256.0	3994.6
RAMALLAH MAIN EXCHANGE	4X18W	40	2880	1930	5558.4	4224.4
	400 WATT PROJECTOR	4	1600	4380	7008.0	5326.1
OSS IN NORTH AND MIDDLE REGIONS	4X18W	80	5760	1930	11116.8	8448.8
REMOT SITES	2X18 WATT	240	17280	750	12960.0	9849.6
SUM					166377.0	126446.5

Appendix 7: data of power analyzer for Jenin main exchange

Date	Time	Avefreq	Aveurms1	Aveurms2	Aveurms3	Aveirms 1	Aveirms 2	Aveirms 3	Aveirms 4	Aveuave	Average	Ave P sum	Ave S sum	Ave Q sum	Ave PFsum	WP-	WQ_LEAD
26/02/2008	00:30:00	49.97	240	244.3	241.6	54	37	27	27	242	40	24000	29000	16000	0.828	877900	592600
26/02/2008	00:45:00	49.98	240.9	245.2	242.6	51	38	28	22	242.9	39	24000	28000	16000	0.836	883800	596500
26/02/2008	01:00:00	50	240.2	244.6	241.7	50	38	34	20	242.1	41	24000	29000	16000	0.834	889900	600500
26/02/2008	01:15:00	49.96	239.5	244.1	242	56	36	26	27	241.9	39	23000	28000	16000	0.825	895800	604600
26/02/2008	01:30:00	49.97	238.8	243.5	241.3	53	36	27	26	241.2	39	23000	28000	16000	0.832	901600	608500
26/02/2008	01:45:00	49.97	239.2	243.8	241.3	49	37	34	19	241.4	40	24000	29000	16000	0.838	907600	612400
26/02/2008	02:00:00	50.02	239.7	244.7	242.3	53	36	27	25	242.2	39	23000	28000	16000	0.83	913400	616300
26/02/2008	02:15:00	49.96	239.6	244.6	242.1	52	36	29	24	242.1	39	24000	28000	16000	0.834	919300	620200
26/02/2008	02:30:00	49.96	240.3	244.9	242.3	47	36	33	18	242.5	39	23000	28000	15000	0.839	925200	624100
26/02/2008	02:45:00	49.93	239.8	244.7	242.4	55	36	27	27	242.3	39	24000	29000	16000	0.828	931100	628100
26/02/2008	03:00:00	49.97	240.2	245.1	242.6	53	36	31	25	242.6	40	24000	29000	16000	0.829	937000	632100
26/02/2008	03:15:00	49.99	240.7	245.5	242.9	47	36	33	17	243	39	24000	28000	15000	0.837	942900	636000
26/02/2008	03:30:00	49.96	240.2	245.2	243	54	36	27	26	242.8	39	23000	28000	16000	0.826	948800	640000
26/02/2008	03:45:00	49.99	240.7	245.6	243.1	52	37	30	23	243.1	40	24000	29000	16000	0.827	954800	644100
26/02/2008	04:00:00	49.97	240.5	245.4	242.7	46	37	33	17	242.9	39	24000	28000	16000	0.837	960700	648000
26/02/2008	04:15:00	49.96	240	244.8	242.4	54	35	27	26	242.4	39	23000	28000	16000	0.828	966500	651900
26/02/2008	04:30:00	49.96	239.4	244.3	241.9	55	37	30	25	241.9	40	24000	29000	16000	0.831	972600	656000
26/02/2008	04:45:00	49.89	238.6	243.2	240.6	44	36	31	15	240.8	37	23000	27000	14000	0.845	978200	659600
26/02/2008	05:00:00	49.92	237.8	242.6	240.2	50	37	27	22	240.2	38	23000	27000	15000	0.84	984000	663300
26/02/2008	05:15:00	49.98	237.6	242.1	240	51	43	32	19	239.9	42	25000	30000	17000	0.836	990200	667400
26/02/2008	05:30:00	49.93	238.8	243	240.7	43	44	32	13	240.8	40	24000	29000	15000	0.845	996300	671300
26/02/2008	05:45:00	50	239.3	243.7	241.3	51	45	28	22	241.4	41	25000	30000	17000	0.83	1002500	675400
26/02/2008	06:00:00	50.03	239	243.2	240.7	49	45	31	18	241	42	25000	30000	17000	0.835	1008800	679600
26/02/2008	06:15:00	50.11	239.8	243.9	241.1	43	41	31	13	241.6	38	23000	28000	15000	0.846	1014600	683300
26/02/2008	06:30:00	49.99	237.6	241.8	239.6	50	43	28	20	239.7	40	24000	29000	16000	0.839	1020700	687300
26/02/2008	06:45:00	49.95	236.1	240	237.7	49	41	32	19	238	40	24000	29000	15000	0.846	1026800	691100
26/02/2008	07:00:00	50.06	234.2	238.2	235.7	42	40	29	14	236	37	22000	26000	13000	0.864	1032400	694400
26/02/2008	07:15:00	49.95	233	237	235	50	45	28	17	235	41	25000	29000	14000	0.866	1038600	698000
26/02/2008	07:30:00	49.97	233.4	237.4	235.2	49	44	33	14	235.3	42	26000	30000	15000	0.859	1045000	701900
26/02/2008	07:45:00	50.01	233	237	234.4	44	41	32	11	234.8	39	23000	28000	14000	0.851	1050900	705500
26/02/2008	08:00:00	50.03	232.2	236.2	234.2	55	41	31	25	234.2	42	25000	30000	16000	0.834	1057100	709600
26/02/2008	10:00:00	50.03	224.2	227.1	223.9	84	51	54	35	225.1	63	38000	42000	19000	0.893	1121300	747100
26/02/2008	12:00:00	49.97	226.9	229.9	226.6	72	46	50	29	227.8	56	33000	38000	19000	0.872	1192200	784900
26/02/2008	14:00:00	49.96	228.7	232	229.6	67	46	49	24	230.1	54	31000	37000	20000	0.839	1253400	823400
26/02/2008	16:00:00	50.09	234.7	238.8	236.5	44	36	29	13	236.7	37	21000	26000	15000	0.805	1302300	858000

Appendix 8: data of power analyzer for Tulkarm main exchange

Date	Time	Ave Freq	AveUrms1	AveUrms2	AveUrms3	AveIrms1	AveIrms2	AveIrms3	AveIrms4	Ave P sum	Ave S sum	Ave Q sum	Ave PF sum	WP+	WQ_LAG
14/08/2009	00:00:00	50.02	234.8	234.1	232.7	103	71	95	23	52000	63000	36000	0.82	789800	472600
14/08/2009	00:30:00	49.96	235.7	235.1	233.5	102	71	95	22	52000	63000	36000	0.82	815500	490400
14/08/2009	01:00:00	50.04	236.7	236.6	235.2	106	71	96	26	53000	64000	37000	0.82	841700	508800
14/08/2009	01:30:00	50.02	236.1	235.5	234.6	103	70	93	24	51000	63000	36000	0.82	867500	527200
14/08/2009	02:00:00	50.02	237.1	236.8	235.8	104	71	94	25	52000	64000	36000	0.82	893200	545300
14/08/2009	02:30:00	50.01	238	237.5	236.7	103	71	94	23	52000	64000	37000	0.81	919000	563800
14/08/2009	03:00:00	50.03	238.2	238.6	237.5	105	68	94	28	52000	64000	37000	0.81	944800	582500
14/08/2009	03:30:00	50.05	239.3	239.1	237.9	102	71	96	23	52000	64000	38000	0.81	970600	601400
14/08/2009	04:00:00	50.04	236.8	237	235.7	105	71	96	26	52000	64000	37000	0.82	996600	620100
14/08/2009	04:30:00	50.02	237.5	237.5	236.1	102	68	96	25	51000	63000	37000	0.81	1022300	638600
14/08/2009	05:00:00	50.05	238.9	240.2	238	105	72	96	25	52000	65000	38000	0.81	1048300	657700
14/08/2009	05:30:00	50.08	239.7	240.7	239.3	102	70	91	23	50000	63000	38000	0.8	1073800	676800
14/08/2009	06:00:00	50.08	239	240.8	239.1	103	66	88	29	51000	62000	35000	0.82	1098900	694700
14/08/2009	06:30:00	50.02	238.7	239.8	238.4	101	68	88	24	50000	62000	36000	0.81	1123900	712600
14/08/2009	07:00:00	50.01	237.9	239.2	237.5	101	69	88	23	50000	61000	35000	0.82	1149000	730500
14/08/2009	07:30:00	49.99	237	238.3	236.5	101	69	91	23	51000	62000	35000	0.82	1174500	748000
14/08/2009	08:00:00	49.98	237.9	239.4	237.5	104	70	91	26	52000	63000	36000	0.82	1200100	765900
14/08/2009	08:30:00	49.99	237	237.9	236.2	100	69	91	22	51000	62000	35000	0.82	1225600	783400
14/08/2009	09:00:00	50	238.2	239.5	237.3	102	70	91	23	51000	63000	36000	0.82	1251300	801200
14/08/2009	09:30:00	49.98	236.8	236.6	235.9	103	81	88	17	53000	64000	36000	0.83	1277700	819300
14/08/2009	10:00:00	49.94	235.7	235.6	234.4	102	79	90	16	53000	64000	35000	0.83	1304400	836900
14/08/2009	10:30:00	49.99	235.8	235.4	233.6	103	82	104	14	57000	68000	37000	0.84	1332300	855100
14/08/2009	11:00:00	50	234.8	234.8	232.5	103	82	103	14	57000	68000	36000	0.85	1361000	873200
14/08/2009	11:30:00	50	236.6	236.4	234.5	102	83	102	15	57000	68000	37000	0.84	1389400	891700
14/08/2009	12:00:00	50	236.5	236.1	235.5	104	83	93	15	55000	66000	37000	0.83	1416700	909900
14/08/2009	12:30:00	50	235.9	236	235.1	105	82	93	17	55000	66000	36000	0.84	1444200	928200
14/08/2009	13:00:00	50	234.7	234.3	233.4	103	82	92	15	54000	65000	35000	0.84	1471600	945900
14/08/2009	13:30:00	50	234.7	233.6	233.1	102	81	90	15	54000	64000	34000	0.84	1498500	963300
14/08/2009	14:00:00	49.83	234.8	234.1	233.1	104	79	90	17	53000	64000	35000	0.84	1525400	980500
14/08/2009	14:30:00	50.01	237.1	236.2	235.6	104	82	90	16	54000	65000	36000	0.83	1552400	998500
14/08/2009	15:00:00	49.96	237.3	236.4	235.5	103	82	92	15	54000	65000	37000	0.83	1579400	1016700
14/08/2009	15:30:00	49.96	237.3	236.7	235.5	103	82	91	16	54000	65000	37000	0.83	1606400	1035000
14/08/2009	16:00:00	49.96	237	236.8	235.8	105	82	92	18	55000	66000	37000	0.83	1633700	1053300
14/08/2009	16:30:00	49.96	236.2	235.7	234.5	103	82	92	15	54000	65000	36000	0.83	1660700	1071300
14/08/2009	17:00:00	49.96	237.1	236.7	235.6	103	82	92	15	54000	65000	37000	0.83	1687700	1089500
14/08/2009	17:30:00	49.96	237.9	237.6	236.3	103	82	89	15	54000	65000	37000	0.82	1714500	1108000
14/08/2009	18:00:00	49.94	237.3	238.9	236.5	104	71	90	24	52000	63000	35000	0.83	1740800	1126000

Appendix 9: data of power analyzer for Nablus main exchange

Date	Time		AveUrms1	AveUrms2	AveUrms3	AveIrms1	AveIrms2	AveIrms3	AveIrms4	Ave P sum	Ave S sum	Ave Q sum	Ave PF sum	WP-	WQ_LEAD
05/02/2008	00:00:00	50.12	232.9	232.7	232.9	117	130	135	260	27000	31395.35	16020.859	.86	470000	1466000
05/02/2008	00:30:00	50.12	231.2	230.9	231.2	124	132	136	266	28000	32558.14	16614.224	.86	484000	1509000
05/02/2008	01:00:00	49.99	232.1	231.6	232.2	114	121	125	244	26000	30232.56	15427.494	.86	497000	1550000
05/02/2008	01:30:00	50.01	229.4	229.2	229.5	129	130	133	263	29000	33720.93	17207.589	.86	511000	1594000
05/02/2008	02:00:00	50.16	229.2	229.2	229.5	133	132	137	267	30000	34883.72	17800.955	.86	526000	1637000
05/02/2008	02:30:00	50.02	230.2	230.3	230.7	127	130	129	258	28000	32558.14	16614.224	.86	540000	1681000
05/02/2008	03:00:00	50.04	230.3	230.3	230.6	127	128	130	258	28000	32558.14	16614.224	.86	554000	1724000
05/02/2008	03:30:00	50.03	230.8	230.8	231.1	133	136	136	273	29000	33720.93	17207.589	.86	568000	1767000
05/02/2008	04:00:00	50.02	230.8	230.8	230.9	125	132	132	262	28000	32558.14	16614.224	.86	582000	1809000
05/02/2008	04:30:00	50.01	230	229.9	230.3	120	129	127	253	26000	30232.56	15427.494	.86	596000	1851000
05/02/2008	05:00:00	49.97	228.4	228.4	228.8	129	137	135	269	28000	32558.14	16614.224	.86	610000	1895000
05/02/2008	05:30:00	49.85	228.6	228.7	229.3	128	135	135	267	28000	32558.14	16614.224	.86	623000	1937000
05/02/2008	06:00:00	49.92	228.4	228.4	229.1	119	127	120	249	24000	27906.98	14240.764	.86	636000	1978000
05/02/2008	06:30:00	50.04	227.4	227.3	228.5	133	143	139	278	28000	32558.14	16614.224	.86	650000	2022000
05/02/2008	07:00:00	50.01	224.8	225.1	226.1	153	157	143	306	30000	34883.72	17800.955	.86	665000	2068000
05/02/2008	07:30:00	50.01	225.5	226.1	226.2	166	163	154	325	34000	39534.88	20174.415	.86	681000	2117000
05/02/2008	08:00:00	50.09	222.4	223.2	222.3	169	153	153	317	37000	43023.26	21954.511	.86	699000	2168000
05/02/2008	08:30:00	50.08	221.3	222	221.6	165	160	160	325	36000	41860.47	21361.146	.86	717000	2221000
05/02/2008	09:00:00	50.06	220.8	221.6	221.3	185	176	175	359	40000	46511.63	23734.606	.86	737000	2276000
05/02/2008	09:30:00	50.03	221.5	221.9	221.5	195	182	181	374	42000	48837.21	24921.336	.86	757000	2332000
05/02/2008	10:00:00	50.03	223.8	224.2	223.8	184	171	169	351	40000	46511.63	23734.606	.86	778000	2388000
05/02/2008	10:30:00	50.03	224.2	224.5	224.3	195	180	181	373	43000	50000	25514.702	.86	799000	2445000
05/02/2008	11:00:00	50.1	223.2	223.4	222.8	192	178	172	364	40000	46511.63	23734.606	.86	820000	2503000
05/02/2008	11:30:00	50.11	225.1	225.2	224.5	180	176	173	354	38000	44186.05	22547.876	.86	838000	2559000

05/02/2008	12:00:00	50.12	225.3	225	224.9	177	176	165	345	36000	41860.47	21361.146	.86	857000	2615000
05/02/2008	12:30:00	50.08	226	225.3	225.2	180	178	170	353	38000	44186.05	22547.876	.86	875000	2670000
05/02/2008	13:00:00	50.1	221.9	222	221.7	191	185	171	373	38000	44186.05	22547.876	.86	895000	2727000
05/02/2008	13:30:00	50.13	223.2	223	222.6	191	181	174	369	40000	46511.63	23734.606	.86	914000	2782000
05/02/2008	14:00:00	50.07	223.2	223	222.9	187	176	166	356	39000	45348.84	23141.241	.86	934000	2838000
05/02/2008	14:30:00	50.06	224.7	224.1	224.2	166	167	159	331	35000	40697.67	20767.78	.86	952000	2891000
05/02/2008	15:00:00	50.04	225.1	224.4	225.5	162	172	160	334	33000	38372.09	19581.05	.86	969000	2945000
05/02/2008	15:30:00	50.04	227	226.2	226.7	148	141	145	287	33000	38372.09	19581.05	.86	986000	2992000
05/02/2008	16:00:00	50.05	228.3	227.6	228.5	149	143	148	290	34000	39534.88	20174.415	.86	1003000	3038000
05/02/2008	16:30:00	50.09	226.7	226.4	227	129	129	134	257	29000	33720.93	17207.589	.86	1018000	3083000
05/02/2008	17:00:00	50.04	226.8	226.6	226.9	135	132	145	270	32000	37209.3	18987.685	.86	1033000	3126000
05/02/2008	17:30:00	50.17	224.1	223.8	224.3	119	113	137	241	31000	36046.51	18394.32	.86	1049000	3167000
05/02/2008	18:00:00	50.07	224.4	224.2	224.6	130	128	148	268	32000	37209.3	18987.685	.86	1065000	3210000
05/02/2008	18:30:00	49.97	224.6	223.9	224.5	121	119	139	250	30000	34883.72	17800.955	.86	1080000	3252000

Appendix 10: data of power analyzer for new Paltel HQ

Date	Time	Min Uunb		AveU rms1	AveUrm s2	AveUrm s3	AveIrm s1	AveIrm s2	AveIrm s3	AveIrm s4	Ave Uave	AveIa ve	AvePsu m	AveSsu m	AveQsum	AvePFsum	WP+	WQ_LA G
06/01/2008	00:00:00	0.1	49.94	228.6	227.7	228.8	178	147	152	30	228.4	159	94000	109000	56000	0.859	6121000	3612000
06/01/2008	00:30:00	0.2	50.04	229.8	228.7	229.8	178	144	155	36	229.4	159	94000	109000	57000	0.856	6168000	3640000
06/01/2008	01:00:00	0.1	50.05	231.4	230.6	231.6	181	146	156	36	231.2	161	95000	112000	58000	0.853	6216000	3669000
06/01/2008	01:30:00	0.1	49.97	233	232.1	233	180	145	156	38	232.7	160	95000	112000	59000	0.849	6263000	3699000
06/01/2008	02:00:00	0.1	49.98	234.5	233.7	234.7	178	144	155	37	234.3	159	94000	112000	60000	0.845	6310000	3729000
06/01/2008	02:30:00	0.2	49.98	235.3	234.5	235.4	177	143	153	35	235.1	158	94000	111000	60000	0.842	6357000	3759000
06/01/2008	03:00:00	0.2	50.02	232.7	231.6	232.6	177	143	153	35	232.3	158	93000	110000	58000	0.849	6404000	3788000
06/01/2008	03:30:00	0.2	49.97	228.5	227.6	228.6	177	148	150	28	228.2	158	93000	108000	56000	0.859	6450000	3816000
06/01/2008	04:00:00	0.2	49.97	228.4	227.5	228.4	178	149	151	28	228.1	159	94000	109000	56000	0.86	6497000	3843000
06/01/2008	04:30:00	0	49.92	232	231	231.9	177	144	152	34	231.6	158	93000	109000	58000	0.849	6544000	3872000
06/01/2008	05:00:00	0.1	50	231.9	231	231.8	178	144	150	33	231.6	157	93000	109000	58000	0.849	6590000	3901000
06/01/2008	05:30:00	0.1	49.92	231.8	230.9	232.1	180	145	154	37	231.6	160	95000	111000	58000	0.852	6637000	3930000
06/01/2008	06:00:00	0.1	50.02	229.8	228.9	230.4	181	147	153	33	229.7	160	94000	110000	57000	0.856	6685000	3959000
06/01/2008	06:30:00	0.3	50	233.8	232.8	234.3	175	148	149	27	233.6	157	93000	110000	59000	0.846	6732000	3988000
06/01/2008	07:00:00	0	49.94	231.5	231	231.7	173	146	145	24	231.4	154	91000	107000	57000	0.845	6777000	4017000
06/01/2008	07:30:00	0	49.99	230.2	229.5	230	174	152	145	17	229.9	157	92000	108000	57000	0.853	6823000	4045000
06/01/2008	08:00:00	0.1	50.01	229.4	228.5	229.4	214	193	192	26	229.1	200	122000	137000	62000	0.89	6884000	4076000
06/01/2008	08:30:00	0.3	49.99	227.1	226	227.6	254	238	242	29	226.9	245	152000	166000	67000	0.915	6961000	4110000
06/01/2008	09:00:00	0.4	49.99	230.3	228.5	230.4	257	244	249	33	229.7	250	157000	172000	72000	0.909	7039000	4146000
06/01/2008	09:30:00	0.5	49.98	228.1	226	228.2	261	246	255	34	227.4	254	159000	173000	70000	0.914	7118000	4181000
06/01/2008	10:00:00	0.4	49.99	228	226.2	228.3	263	245	261	39	227.5	256	160000	175000	70000	0.916	7198000	4216000
06/01/2008	10:30:00	0.4	49.98	227.3	225.8	228.1	262	245	260	37	227.1	256	159000	174000	71000	0.914	7278000	4251000
06/01/2008	11:00:00	0.3	49.98	226.8	225.8	228	263	245	255	33	226.9	254	159000	173000	70000	0.915	7357000	4286000
06/01/2008	11:30:00	0.4	49.99	226.8	225.1	227.6	269	250	262	33	226.5	260	163000	177000	69000	0.92	7438000	4321000

06/01/2008	12:00:00	0.4	49.98	227.4	225.6	227.9	268	253	258	30	227	260	163000	177000	70000	0.919	7520000	4356000
06/01/2008	12:30:00	0.3	49.99	227.1	225.5	227.6	273	253	260	31	226.7	262	164000	178000	69000	0.921	7602000	4390000
06/01/2008	13:00:00	0.3	49.98	227.2	225.7	227.6	273	251	257	30	226.9	260	163000	177000	70000	0.918	7683000	4425000
06/01/2008	13:30:00	0.3	49.98	226.8	225.8	227.7	268	252	254	30	226.7	258	161000	176000	70000	0.918	7764000	4460000
06/01/2008	14:00:00	0.3	49.98	228.7	227.3	229.4	264	252	253	31	228.4	257	161000	176000	71000	0.914	7844000	4496000
06/01/2008	14:30:00	0.3	49.98	228.8	227.3	229.4	267	256	251	31	228.5	258	162000	177000	72000	0.914	7925000	4531000
06/01/2008	15:00:00	0.2	49.97	230.1	228.2	229.8	261	261	260	36	229.3	261	164000	179000	73000	0.914	8007000	4568000
06/01/2008	15:30:00	0.3	49.96	227.7	225.9	228.1	263	253	256	31	227.2	257	161000	175000	70000	0.916	8087000	4603000
06/01/2008	16:00:00	0.3	49.97	229.9	228.7	230.6	264	238	255	32	229.7	252	158000	174000	72000	0.909	8166000	4639000
06/01/2008	16:30:00	0	49.94	229.7	229.1	230.1	213	179	197	38	229.6	196	121000	135000	61000	0.893	8226000	4670000
06/01/2008	17:00:00	0.1	49.95	226.2	225.8	226.9	207	164	190	50	226.3	187	113000	127000	58000	0.89	8283000	4698000
06/01/2008	17:30:00	0.3	49.98	224	223.7	224.9	193	157	177	44	224.2	176	104000	118000	55000	0.883	8335000	4726000
06/01/2008	18:00:00	0.3	49.97	224.3	223.7	225.1	181	149	165	41	224.4	165	97000	111000	54000	0.872	8383000	4753000
06/01/2008	18:30:00	0.2	49.97	226.1	225.7	226.7	178	145	161	42	226.2	162	95000	110000	55000	0.863	8431000	4781000
06/01/2008	19:00:00	0.2	49.99	227.8	227.2	228.3	179	141	161	45	227.8	160	94000	109000	56000	0.858	8478000	4809000
06/01/2008	19:30:00	0.2	49.97	229.2	228.3	229.4	180	142	157	39	229	159	94000	110000	57000	0.855	8524000	4837000
06/01/2008	20:00:00	0.3	49.98	229.8	229.3	230.6	178	141	157	39	229.9	159	93000	109000	57000	0.851	8571000	4866000
06/01/2008	20:30:00	0.2	49.99	229.3	229	230.3	178	141	158	40	229.5	159	93000	109000	57000	0.852	8618000	4895000
06/01/2008	21:00:00	0.2	49.99	226.4	225.9	227.2	179	142	156	38	226.5	159	93000	108000	55000	0.859	8664000	4922000
06/01/2008	21:30:00	0.2	49.99	228.6	228.3	229.4	179	141	153	38	228.8	158	92000	108000	56000	0.853	8710000	4951000
06/01/2008	22:00:00	0	50	230.9	230.3	231.2	178	145	154	32	230.8	159	93000	110000	58000	0.848	8757000	4980000
06/01/2008	22:30:00	0	50	228.7	227.8	228.6	177	145	154	33	228.4	159	93000	109000	57000	0.852	8803000	5008000
06/01/2008	23:00:00	0	50.03	230.9	230.5	230.9	178	143	156	37	230.8	159	93000	110000	59000	0.844	8850000	5038000

جامعة النجاح الوطنية
كلية الدراسات العليا

إدارة الطاقة المستدامة في القطاع التجاري في الضفة الغربية وأخذ شركة الاتصالات الفلسطينية كحالة دراسية

إعداد
أحمد محمود احمد ترتير

إشراف
د. عماد بريك

قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في هندسة الطاقة النظيفة وترشيد الاستهلاك من كلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين.

2010

إدارة الطاقة المستدامة في القطاع التجاري في الضفة الغربية

وأخذ شركة الاتصالات الفلسطينية كحالة دراسية

إعداد

أحمد محمود أحمد ترتير

إشراف

د. عماد بريك

الملخص

يعتبر القطاع التجاري وما يضمه من مباني من أكبر القطاعات استهلاكا للطاقة، والتي يتم استخدامها بطرق كثيرة ومتعددة. لقد برهنا بنجاح في هذه الأطروحة أن هناك كمية ضخمة في توفيرات الطاقة في قطاع الاتصالات الفلسطينية كنموذج من القطاع التجاري وذلك بتطبيق إجراءات ترشيد استهلاك الطاقة (بدون أو باستثمار منخفض) على معظم التجهيزات المستهلكة للطاقة مثل أجهزة ال ups وال rectifiers التي تستخدم بصورة كبيرة جدا في شركة الاتصالات، والأجهزة المكتبية, وأنظمة التبريد، ونظام الإنارة، وتحسين معامل القدرة.

إن فعالية استخدام الطاقة وإدارتها في القطاع التجاري ليست في وضع أفضل من معظم الدول النامية. لذلك حاولنا أن نبدأ بخطوة أولية نحو استعمال فعال للطاقة وإدارتها في هذا القطاع من خلال إجراء عدة مسوحات في مواقع مختلفة من شركة الاتصالات الفلسطينية والعمل على إدارة الطاقة وترشيد الاستهلاك دون المس في كفاءة التشغيل ووسائل الراحة.

لقد حققنا نسبة مئوية يبلغ إجمالي معدل توفيراتها 15.3% في مواقع شركة الاتصالات الفلسطينية في الضفة الغربية، وبتخفيض في الطاقة الكهربائية مقداره 1597760 كيلو واط ساعة أي ما يعادل 1272517 شيكل لكل عام، وتم تخفيض ثاني أكسيد الكربون ما يقارب 1739321 كيلو غرام لكل عام، وبلغت مدة استرداد رأس المال لهذا الاستثمار حوالي عامين.