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Energy audits in Malta

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By

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Abstract

Energy is the driving force of our society. Industry, economy and the general public, all depend on safe, secure, sustainable and affordable energy. But at the same time, energy related emissions account for almost 80% of the European Union's total green house gas emissions. The European Union has set itself a great challenge and a target was set in 2007 to reduce by 20% of its primary energy consumption, to increase the share of renewable energy by 20% and to reduce the green house gasses by 20% until 2020.

Energy auditing is an effective energy management tool which identifies and implements a means to achieve energy efficiency and savings. In fact, this will not only lead to energy savings, but also to improving life expectancy of system services and to better quality. All these savings in money will improve the productivity. Moreover, the role of energy audits in Malta has greatly expanded since all entities are aware of the benefits, given that a successful way to mange energy is achieved. Organizations still believe that the main idea behind energy audits remains the reduction of utility bills and thus lowering operating costs.

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Table of Contents

List of Figures

List of Tables

Chapter 1 – Introduction and Objectives

1.1 Introduction

Energy is the driving force of our society. Industry, Economy and the general public depend on safe, secure, sustainable and affordable energy. At the same time, energy related emissions by Member State contribute to almost 80% of the European Union's total greenhouse gasses emissions (Energy 2020 Targets, 2010). Thus, energy is one of the greatest challenges which Europe has to face in the forthcoming years and further work needs to be done in order to have more secure and sustainable energy. Hence it is fundamental that the correct decisions are urgently taken, since failing to achieve a well functioning European energy market will only increase the costs for consumers and put Europe's competiveness at risk (Energy 2020 Targets, 2010).

The first step towards a reduction in energy consumption in an organization is an energy audit of the organization. In actual fact, an energy audit is an examination of energy consuming equipment to ensure that the energy used is utilized in an efficient manner. Thus an energy audit is an effective energy management tool, which identifies and implements a means to achieve energy efficiency and savings. Using this management tool, the life time of equipment and systems can be prolonged and quality can be improved. This should produce savings in money. An energy audit can also possibly improve the productivity. Hence based on the principle of "The less energy consumed, the less fossil fuels will be burned", both the buildings and the power generation companies will generate less pollution and by-products (Greenhouse Building Program, 2005). As a result, all those involved shall contribute to conserve the environment and to enhance sustainable development.

1.2 Thesis Objectives

In this dissertation, research was carried out to find out how energy audits are conducted in Malta and to identify procedures that can promote efficiency and conservation. In fact research was conducted on certain European directives and standards, and the savings achieved when implementing these measures.

The objectives were to find out information about entities that are responsible for energy issues, such as the Malta Competition and Consumer Affairs Authority, Malta Enterprise, Ministry for Resources and Rural Affairs, Malta Resource Authority and Enemalta Corporation.

Malta Enterprise is responsible for three schemes. The first one is a European grant scheme of €15 million, which was issued in January 2009. Research was conducted in order to determine the beneficiaries that benefitted from energy audits, what the conditions are in order to be eligible for such grants, what is the amount taken from the grant and when was the grant taken. The second scheme is about energy audits that are specifically for the hospitality sector, while the third scheme is part of the Business Advisory Service Scheme, where organizations can benefit from an energy audit for a reduced price.

The Ministry for Resources and Rural Affairs conducted energy audits in various government places. Thus research was done to determine where the energy audits were implemented, who the energy auditor was, and what the savings were in terms of financial, CO2 emissions and energy.

The main justification for this dissertation was to know exactly what the awareness on energy audits is and how the industry is responding to energy saving measures. Also, research was done to determine whether licenses were required in order to carry out energy audits and if there were uniformity in the methodology used.

1.3 Outline of Dissertation

This dissertation consists of five chapters. The first chapter serves as an introduction to the scope of this dissertation, while the rest of the thesis is organized as follows.

Chapter 2 is a general overview about the history and the existing types of energy audits. This includes a detailed methodology of how an energy audit should be implemented and a comprehensive review regarding European directives and standards that must be followed by all Members States within the European Union. Finally, an energy audit program which had a huge success in Finland is discussed where certain data, figures and savings are presented.

In the third chapter, the incentive schemes that were issued by different governmental and European entities regarding energy audits are discussed. The main governmental entities include the Ministry for Resources and Rural Affairs, Malta Enterprise and the Building Regulation

Office. The conditions for which firms or organizations were eligible, the methodology applied for the conduction of the energy audit, incentive description and evaluation processes are discussed. This section also includes the obligations of and the results obtained by the beneficiaries of the schemes.

In Chapter 4, there is a complete list of energy auditors, who carry out energy audits in the Archipelago of Malta, including the contact details. Also in this section, some energy auditors are reviewed. This includes the number of energy audits conducted, the methodology used when implementing the energy audits, the outcomes from the energy audits such as financial savings, energy savings in kWh/year and CO2 emissions reduction. The general qualifications of the energy auditors are also included in this part.

Finally, the last chapter of this dissertation is the conclusion and some final recommendations. The conclusion includes information on the awareness from industry on energy audits and on reduction of energy consumption. This section also includes information on certain policies on energy audits and how to implement a new policy in the near future. Then the conclusion part proceeds with the subdivision of energy auditors according to their respective expertise and profession. Another conclusion is about the methodology used by the energy auditors, which is mainly of two main types, while finally there is a complete list of recommendations that were given by the energy auditors during their respective work. As regards to recommendations, one is able to note that there is only one proposal, namely regarding education. This advice states that training courses should be organized and a plan is presented accordingly.

Chapter 2 - Literature Review

2.1 Introduction

In this chapter there is an overview about the history and the existent types of energy audits. This chapter also includes a detailed methodology of how an energy audit should be carried out, and a comprehensive analysis regarding the present directives and on the final draft European standard. Finally an energy audit program which was a massive success in Finland is discussed, which provides figures and savings done via energy audits in the industrial, service and energy sectors.

2.2 History of Energy Audits

Energy audits started in the early 1970's when there was the first oil crisis (Krarti M., 2000). In fact in 1973, the value of oil prices quadrupled, which increased the financial spending all over the world (OPEC, 2012). Thus energy audits identified simple energy measures which reduced the expenses, which included; switching off of lighting circuits, turning down heating temperatures, turning up air conditioning temperatures and reducing hot water temperatures. Today, energy auditing is considered an important step to ensure effective building energy management. Therefore, the energy auditor should be aware of key energy issues such as electricity utility rates structures and the latest building energy efficiency technologies together with their applications. Also, nowadays, energy service firms are having a huge success in their contracting projects when conducting energy audits.

2.3 Types of Energy Audits

Energy audit is widely used and may have different interpretations depending on the energy service firms. Energy auditing of buildings can have a wide range of analysis, from a short walk through the facility to a detailed and more complex computer simulation. There are four types of energy audits, which are defined as follows:

1. Walk through audit.
2. Utility cost analysis.
3. Standard energy audit.
4. Detailed energy audit.

2.3.1 Walk through Audit

The walk through audit consists of a short on-site visit to point out and identify simple and inexpensive actions which provide an immediate reduction in energy use and savings in the operating cost. Most of engineering professionals refer to these types of actions as operating and maintenance measures (Krarti M., 2000). Typical examples of operating and maintenance actions include replacing of broken windows, insulating hot water and steam pipes, and setting back heating set point temperatures.

2.3.2 Utility Cost Analysis

The main purpose of utility cost analysis is to analyze carefully the operating costs of the facility. The utility data over several years is evaluated to identify patterns of energy use, peak demand, weather effects and prospective savings of energy. In order to conduct this type of analysis the auditor has to first walk through the plant to collect data and observe certain information on the place and of the energy systems.

During this exercise it is important that the auditor understands clearly the utility rate structure that applies to the facility. The main reasons are that the auditor can check the utility charges and ensure that there are no mistakes in the energy bills. In Malta there is only one tariff at the present moment, but in other countries there are several other electricity rates and tariffs due to the competition in the energy sector. Thus the auditor has to determine the most dominant charges in the utility bills. A case in point is when there are peak demand charges and hence one will recommend reducing the consumption during these times. Also the auditor has to be aware of other utility rates structures in order to identify whether or not the plant can benefit from using such other tariffs to reduce operating costs. This type of analysis can provide a significant reduction in the utility bills especially with implementation of the electrical deregulation and advent of real time pricing rate structures (Krarti M., 2000). Moreover, the energy auditor can determine if the facility is a prime target for energy retrofit projects by analyzing the utility data.

2.3.3 Standard Energy Audit

This type of audit provides a complete energy analysis for the energy systems of the plant. The walk through audit and the utility cost analysis are conducted during this exercise, but the

standard energy audit includes the development of a baseline for energy use for the plant, an evaluation of the energy savings and the cost effectiveness of appropriately selected energy conservation measures. Also a step by step approach in this type of audit is quite similar to the detailed energy audit.

The standard energy audit uses simplified tools to develop baseline energy models and to predict the energy savings of energy conservation measures. Among these tools there are the degree - day methods and linear regression models (Thumann A. and Younger W.J., 2008). Also a simple pay back analysis is developed to determine the cost effectiveness of energy conservation measures.

2.3.4 Detailed Energy Audit

The detailed energy audit is the most comprehensive but it is also the most time consuming type of energy audit. In fact this type of audit uses instruments to measure the energy use for the energy systems within the building or for the building itself. In addition computer simulation programs are used for this type of audit in order to evaluate and recommend energy retrofits for the facility.

There are several techniques that can be performed for the collection of data. Hand-held and clamp - on meters can be used for the collection of indoor air temperature, the luminance level and the electrical energy usage. Sensors are then used when long term measurements are required; these are connected to the data requisition board so that the data is stored remotely and automatically.

The computer simulations used in the detailed energy audits provide the energy usage of every load connected with the system. These types of simulations require a high level of education especially in engineering since they are based on dynamic thermal performance of building energy systems (Krarti M., 2000). In this type of audit, more precise economical estimation of the energy conservation measures is usually performed. Thus the cost effectiveness of energy retrofits may be determined based on the life cycle costs analysis rather than the simple payback period analysis. One has to consider that the life cycle costs analysis takes into account several economic parameters such as interest, inflation and tax rates (Krarti M., 2000).

2.4 Energy Audit Methodology

The energy audit methodology presented in this dissertation combines energy utilization surveys, field measurement and simulation tools which will lead to an accurate assessment of the energy conservation of a particular plant and determines some points for improvement in the energy sector. One should be aware that the steps conducted in an energy audit may vary depending on the size, nature and condition of the plant being audited (Al-Mujahid A.M. and El-Kady M.A., 2008).

2.4.1 Preparation for an Energy Audit

Before the energy auditor visits the facility, some type of preparation should be done. This preparation includes identification of the existing problems and copies of the yearly energy bills of at least the previous two years (Thumann A. and Younger W.J., 2008). This information will be used by the auditor during the energy audit in order to reduce the energy consumption and hence reduce the utility bills.

2.4.2 Energy Auditor Selection

When selecting the energy auditor, one should ensure that the following criteria are met. First, the owner of the plant shall obtain several references and make contact with the energy audit firms. This process may include research on the directories and calls to the business bureaus in order to determine whether there are any complaints against the energy audit firms. Then the energy audit beneficiary shall ensure that the energy auditor uses the appropriate equipment, such as blower door and thermo - graphic inspections, during the energy audit (US Department of Energy, 2012). The blower door tests are used to determine the building air tightness. This will establish any air leakages, will determine moisture condensation problems and make sure that the air quality is not contaminated by indoor air pollution. On the other hand, a thermo - graphic inspection, which is an infrared scanning process, will detect thermal defects and air leakage in building plants. Another method which can be used to determine the air tightness of a building is by the PerFlourocarbon tracer gas (PTF) technique which will also provide adequate information regarding energy losses and air leakages.

2.4.3 Audit Process

The energy auditor starts by gathering and compiling the electricity consumption, energy conservation and the relative information regarding the particular site. At this stage it is important that the data gathered is as accurate as possible to avoid any unnecessary work. An organized approach to carry out this process is to split the procedure into three distinct components, which are the pre - site work, the site visit and the post - site work (Thumann A. and Younger W.J., 2008). By applying this method, it makes it easier to allocate the appropriate time for each section and leads to a more comprehensive energy audit report (Thumann A. and Younger W.J., 2008).

2.4.3.1 Pre - Site Work

In this part of the energy audit it is important that the auditor starts to understand the aspects of the building. This preparation will be effective since the auditor will reduce the time consumption on - site and thus minimizes the disruptions to the personnel in the building. This pre - site review should generate a list of specific questions and certain issues which shall be discussed during the on - site visit at the plant.

The pre - site tasks include collection, review, tabulation and graph plotting of the energy utility data. The auditor should note any seasonal patterns, unusual spikes and accuracy of billing. By this method it would be easier for the auditor to maximize the savings. Also the auditor should have a copy of the mechanical, electrical and architectural original plans for the required remodeling when the complete energy audit is concluded. In this manner all the required audit data forms will be organized and documented with the existing building and equipment facilities (Shapiro I., 2009). The next point is to develop a building profile narrative which includes age, occupancy description, and existing conditions of the electrical, mechanical and architectural systems. The last phase of the pre - site work is to calculate the Energy Use Index (EUI) in Btu/sqft/year (Joules/m^2/year). The EUI is calculated by converting annual consumption of all fuel to Btu (Joules) and then divide by the gross square footage (square meter) of the building. This is a good indicator of the relative potential for energy saving. In fact, energy is saved most when the EUI is large (Thumann A. and Younger W.J., 2008). During this preliminary research the auditor shall develop a list of potential Energy Conservation Measures (ECM) and Operational and Maintenance (O&M) actions.

2.4.3.2 On - site Work

After completing the pre - site preparations, then the energy auditor will have a better idea regarding the building and its system. Thus during the site visit the auditor inspects and observes the actual system in order to come out with the complete answers to the questions which were identified during the previous research.

During this phase of on - site work, the auditor should have all the required equipment and tools for testing purpose. This shall include flash light, calculator, light meter, thermometer and a digital camera. At this stage the auditor uses the drawings of the buildings and notes certain differences from the actual plans. Hence one must note the location of certain facilities such as boilers, chillers, heaters and appliances. Lighting levels and switching, together with room temperatures and other useful information are also noted. During the on - site work, the auditor takes pictures, such as the lighting, mechanical equipment, interior workspaces, common areas and halls, for documentation and recommendation purposes (Thumann A. and Younger W.J., 2008).

2.4.3.3 Post - site Work

This part of the energy audit is one of the most important when carrying out this exercise. Here the auditor needs to evaluate the information collected during the previous phases in order to provide conservation opportunities, organize the audit into a comprehensive report and make recommendations on electrical, mechanical, structural, operational and maintenance improvements.

Immediately after the on - site works the auditor reviews the data collected in order to ensure that all the data is in the appropriate format. At this stage the auditor is in a position to eliminate measures and actions which do not have the potential to reduce utility bills and energy consumption (Thumann A. and Younger W.J., 2008). Since an energy audit can be an ongoing process, the auditor organizes all data and information for future use.

2.4.4 The Audit Report

A typical flow of audit activities is to identify all the energy systems, evaluate the condition of the systems, analyse the impact of improvement of the systems, and write up an energy audit

report (Thumann A. and Younger W.J., 2008). This report should explain the existing conditions of the building in terms of the equipment, lighting, and occupancy, followed by recommendations to improve the efficiency through improvements in operation and maintenance actions and through installation of energy conservation measures.

One important thing that the auditor has to keep in mind is that the audit report will be viewed by different audiences and hence the auditor has to try and customize each section effectively. In fact effectual communication in energy audits has proved to be more successful in implementing the recommendations and hence reducing the energy consumption (Thumann A. and Younger W.J., 2008). The typical audiences include Chief Executive Officer and Chief Financial Officer, plant engineers, operation and maintenance staff, administrators and plant managers.

A well - organized audit report includes an executive summary, which is a straight and to the point explanation of the present situation, recommended improvements and the advantages of implementing the recommended actions. This shall also include an introduction to the building facility, description of the need for an energy audit and finally, an overall conclusion. The next part of the report includes the building information by specifying the building envelope, age, construction history, operating schedules, number of employees and occupancy patterns. In this part it is also useful to include plans, photos of the facility and mechanical systems, a description of energy types used in the plant and a description of the primary mechanical systems and controls. The third section of the report is the utility summary, which includes the energy accounting information of at least the past two years. One uses pictorial representation such as charts and graphs for simplified and understanding purposes. During this section the auditor includes a copy of the utility rates, summary of the overall facility benchmarks, energy use indices and comparisons with industry averages (Thumann A. and Younger W.J., 2008). The fourth section of the audit report is the Energy Conservation Measures, where a list is drawn up in order to meet the financial criteria established by the plant manager. This part of the report includes the name of the measure, estimated cost, estimated savings and simple payback period. Any assumptions taken during the energy audit process are mentioned in this section. The next section is the Operational and Maintenance actions which were observed during the site visit. This part includes specific low cost operational and maintenance items that require attention, items that will reduce the energy consumption and expenses, addressing existing problems and

improve practices that will help to prolong the life of the present equipment. The final section is the Appendices, where the auditor should add the supporting material and technical information which were not included in the report.

2. 5 Directives on Energy Audits

EU directives lay down certain end results that must be achieved in every Member State. National authorities have to adapt their laws in order to meet these goals, but are free to decide how to do so (European Commission, 2012). Directives may concern one or more, or all Member States. Also, directives specify the dates by which national laws must be adapted and hence national authorities are given enough time to implement the required changes to meet the deadlines. Thus, directives are used to bring different national laws into line with each other and are particularly common in matters affecting the operation of the single market (European Commission, 2012).

There are two directives on energy audits which are going to be analyzed in this chapter. The first is Directive 2006/32/EC of the European Parliament and of the Council of 5th April 2006 on Energy End-use Efficiency and Energy Services and repealing Council Directive 93/76/EEC, while the second directive was published on the 13th December 2010, namely, M/479 EN Mandate to CEN, CENELEC and ETSI for Elaboration of Standards regarding Energy Audits.

2.5.1 Directive 2006/32/EC

As this directive is also related to the energy efficiency and energy services, hence not directly related to energy audits, only the relevant points regarding energy audits will be mentioned.

The first important point of the directive is that all Member States in the European Union should ensure the availability of energy audits in order to realize all energy saving potential in all sectors, including households.

The third chapter of this Directive is related to the promotion of energy end use efficiency and energy services, where Article 6 of this chapter specifies certain criteria for energy distributors, distribution system operators and retail energy sales companies. As regards energy audits, this Article states that all Member States distributors, operators or sales companies in the energy

sector shall provide to all final costumers a competitively priced energy audit which is conducted in an independent manner. This Article also mentions energy efficiency improvement measures in accordance with Article 9(2) and 12 (European Union Directive 2006/32/EC, 2006).

Article 6 of the same directive also mentions energy audits where it states that all Member States shall ensure that there are sufficient incentives, equal competition and level playing fields for all markets actors. Hence installers, energy advisors, energy consultants and all those who are involved in the energy audits and energy efficiency measures shall be equally treated.

Article 8 of Directive 2006/32/EC is concerned with the availability of qualification, accreditation and certification schemes. This Article states that all Member States shall ensure, where necessary, the availability of qualification, accreditation and certification schemes of energy audits, energy services and energy efficiency improvements measures as referred to in Article 6, in order to achieve a high level of technical competence, readability and objectivity.

Article 12 is specifically related to energy audits and there are three fundamental points. The first is that all Member States shall ensure the availability of high quality energy audit schemes that are designed to identify potential energy efficient improvement measures and which are carried out in an independent manner, to all final costumers irrespective whether they are small domestic or large sized industrial customers. The second point relates to market segments that have higher transaction costs and non-complex facilities which may be reached by other measures, including questionnaires and by computer programs that can be available on the internet. Thus Member States shall ensure that energy audits are available for market segments and where energy audits are not sold commercially as indicated in Article 11(1) (European Union Directive 2006/32/EC, 2006). The final point in Article 12 is in relation to certification in accordance to Article 7 of Directive 2002/91/EC of the European Parliament and of the Council of 16th December 2002 on the energy performance of buildings. Thus energy audits shall meet the requirements that are stated in Article 12 points 1 and 2, while ensuring that audits resulting from schemes based on voluntary agreements between organizations of stakeholders and an appointed body, supervised and followed up by the Member States, are in accordance with Article 6(2)(b) of Directive 2006/32/EC. Hence this final point states that both conditions have to be fulfilled.

Annex VI of this directive lists the eligible energy efficiency public procurement measures and it also instructs all Member States to ensure that the public sector applies certain requirements, including regarding energy audits use and implementation of cost effective recommendations.

2.5.2 Directive M/479 EN

This directive (M/479 EN) is a Mandate to CEN, CENELEC and ETSI for elaboration of standards regarding energy audits, which relates to Directive 2006/32/EC of the European Parliament and of the Council on energy-end use and energy service, for which harmonized standards shall be developed. The main aim of this mandate is to create European standards on energy audits. As already stated, Article 12 of Directive 2006/32/EC provides for the obligation of Member States to ensure high quality energy audit schemes, and hence standards should support European countries in designing energy audit programs.

In this mandate the Commission requests CEN, CENELEC and ETSI to elaborate a reliable, accurate and reproducible European standard, which takes into account the generally recognized state of the art and adopt existing European and International standards for energy audits, laying down common aspects of the auditing processes and the outcome of the process in view of conceiving an energy audit methodology (European Commission Directive M/479 EN, 2010). It is important that the standards cover all forms of energy carrier and conversion, for transportation, processes and buildings.

This mandate also mentions the benefits of a standard on energy audit. In fact this will reduce uncertainties related to expectations, objectives and terminology; thus increasing the confidence of consumers in the outcome of energy audits. Furthermore, standards are an important tool to simulate investments in energy savings and will contribute to a fair competition between auditors in the internal market. This will also be a tool for designing energy audit methodology and energy audit programs.

This mandate lists the standardization tasks which have to be followed. The first part covers general issues, which include several definitions of terminology used with regard to the energy

audit activity and methodology developed. The definitions should be understandable to policy makers and to market actors, while standardization work should address minimum requirements relating to the quality of the auditing process. This general part shall also include the minimum requirements of qualification of the auditor who is going to conduct the energy audit. Moreover, standardization work shall cover general requirements on auditing services, information and disclosure, quality and objectivity of the audit results. Finally, energy audits should deliver cost effective solutions upon which investments can be done. Thus the audit can facilitate the financial decisions to improve energy efficiency, and therefore it shall contribute the financial benefits and the associated risks and risks mitigation strategies.

A reliable and relevant harmonized methodology shall be described in the energy audit standards in order to identify potential energy efficiency improvements for domestic, commercial, public and industrial consumers. This will also define common indicators to get comparable results in order to allow benchmarking of strategies of improvement of energy efficiency.

The second part of this mandate is about the sectoral parts. These sectoral parts are divided into three sectors and this ensures that the standard is of practical use, rather than having only a one general standard used for all sectors. The three sections are subdivided into building, processes and transport.

The building energy audit is carried out in relation to building structure and fabric, heating, cooling, ventilation and air conditioning, hot water, lighting and other building services with associated controls, renewable energies and co-generation, thus covering all forms of energy carriers and conversion (European Commission Directive M/479 EN, 2010). The audit should include individual equipment and more complex systems in order to identify energy efficiency procedures or renewable energy sources. Particular attention shall be given when considering the future use of the building and what type of renovations can be done to the existing building.

As regards the processes energy audits, these shall be carried out in relation to industrial, commercial and public sector processes, which include systems and utilities such as motors, pumps, compressed air and steam systems, boilers and self generation systems.

The last sector is the transport sector, where energy audits would cover all forms of energy carrier and conversion, means of transport, including private vehicles, heavy duty vehicles, busses, trains and airplanes. The audit shall include transport systems such as city public transport systems and taxi services with their respective logistics.

2.6 Standard on Energy Audit

A standard is a published document that contains technical specifications, which is used as a guideline. In fact standards increase the reliability and the effectiveness of many goods and services that the general public uses. The creation of a standard brings together all the interested and expert parties such as producers, sellers, buyers, users and regulators of a particular material, product, process or service (British Standards Institution, 2012). Standards are designed for voluntary use and do not impose any regulations, but laws and regulations may refer to certain standards and make compliance with standards compulsory.

Standards are designed to meet their aim of providing, for common and repeated use, rules, guidelines and characteristics for activities. Hence standards are founded on usability, verifiability and commonality (British Standards Institution, 2012). The duration for a standard to be developed may vary from a matter of months to several years. In fact a European and an International standard can take around three years.

As regards energy audits, there is only one standard which is not yet finalized and at the current moment it is found as a final draft. This final draft European standard, namely EN 16247 – 1, Energy Audits – Part 1: General Requirements was published in March 2012. This draft European standard was submitted to CEN members for a formal vote and it was drawn up by the technical committee of CEN. When the draft becomes a European Standard, CEN and CENELEC members are bound to comply with the regulations which stipulate the conditions for giving the European standard the status of a national standard without any alteration (European Standard Final Draft, EN 16247 – 1, 2012). There are 32 CEN and CENELEC members,

including Malta, who are invited to submit their comments, to notify any relevant patent rights and to provide supporting documentation.

2.6.1 EN 16247 – 1, Energy Audits – Part 1: General Requirements Standard

Part 1 of this final European draft is about the general requirements for an energy audit, but there are an additional three parts of EN 16247 which are currently under development and are on three specific sectors, namely, buildings, processes and transport.

The standard defines the attributes for a good quality energy audit, states the requirements and the obligations within an audit process. Due to the fact that there are differences in approach when conducting an energy audit, this standard recognizes the scope, aims and thoroughness, but seeks to harmonize common aspects of energy audits in order to bring more clarity and transparency to the energy audit services markets. The energy audit process in presented in a simple chronological sequence, but this does not exclude repetitive iterations of steps.

This standard applies to commercial, industrial, residential and public sector organizations, but excludes individual private dwellings (European Standard Final Draft, EN 16247 – 1, 2012). This standard does not deal with energy audit programs properties that include training of energy auditors, program administration, quality control issues and energy auditor's tools.

The scope of the European standard is to specify the requirements, common methodology and deliverables for an energy audit to all forms of establishments and organizations, all forms of energy and uses of energy, but excluding private dwellings. The standard also mentions the quality requirements of the energy auditor. The requirements for an energy auditor are competency, confidentiality, transparency and objectivity. As regards competency, the energy auditor shall be qualified according to local guidelines and recommendations for the type of work that is going to be undertaken for an agreed goal, while for transparency, the auditor has to disclose any conflict of interests in a transparent way where there are business goals and marketing involvement. Also the auditor has to treat as confidential all the information provided

by the organization being audited, while with reference to objectivity, the auditor shall treat the organization's interests as paramount and shall act in an objective manner.

The standard also specifies the energy audit process. The recommended way starts from the appropriate agreed scope, aims and thoroughness, and then follows a defined audited object or organization. The next phase of the energy audit process collects the relevant and reliable data which is subsequently followed by a traceable processing of data. From an analysis of the cost effectiveness of energy saving opportunities, the best options are identified and targets set. The organization can then monitor effectively the achievements of these targets.

The final European draft standard defines the elements of an energy audit process in order to maintain uniformity as much as possible. The first recommendation of the standard is that the preliminary contact with the organization focuses on:

- The aims and expectations concerning the energy audit
- The scope and boundaries, on the degree of thoroughness required
- The time scale to complete the energy audit
- The criteria for evaluating energy efficiency improvement measures
- The time commitments and other resources from the organization
- The requirement for data collection before the energy audit and foreseeable measurement and inspection to be made during the energy audit (European Standard Final Draft, EN 16247 – 1, 2012).

During this phase of plan the auditor requests information about the energy audit context, such as audit related to government schemes, constraints affecting the goals or the aspects of the proposed energy audit, strategic wider programs which include planned projects and outsourcing facilities management, management systems such as environmental, quality and energy management systems. The auditor also requires information about changes that may have a bearing on the energy audit goals, any existing opinions, and ideas relating to potential energy efficiency improvement measures, any expected deliverables and the required format of report and finally whether a final report draft should be presented for comments by the management of the organization. On the other hand the auditor has the responsibility to inform the organization

regarding special facilities and any equipment required to enable the energy audit to be carried out. This also includes commercial and other interests which could influence the auditor's conclusions and recommendations.

Once the preliminary meeting is done, the standard recommends that a start-up meeting is set, where the main objective of this meeting is to brief the interested parties about goals of the energy audit goals, scope, boundaries and depth, hence agreeing on practical arrangements for the energy audit. At this stage the auditor requests the organization:

- To nominate a person who will be responsible for the energy audit
- To nominate a person to liaise with the energy auditor
- To inform the affected personnel and other interested parties about the energy audit
- To ensure that cooperation exists among all parties
- To disclose any individual conditions, maintenance works and other activities that can occur during an energy audit.

The auditor describes the process and schedule which should be carried out for the energy audit and also if there is a possibility for additional metering equipment.

The next phase is to collect data and hence the energy auditor collects the list of systems, processes and equipment that use energy. The auditor should also have detailed characteristics of the audited objects and historic data such as energy consumption, adjustment factors and relevant related measurements. Other important factors required are design, operation and maintenance documents, previous studies related to energy and energy efficiency, other relevant economic data, current and projected tariffs and the status of the energy management system.

The final draft European standard presents the proceedings of the field work, and the first thing that is mentioned is the aim of such field work. In fact the auditor inspects all objects, evaluates the energy use of the audit objects according to the aim and scope of the energy audit, understands the operating routines, user behaviour and their impact on the energy consumption, generates preliminary ideas for energy efficiency improvements opportunities and finally lists areas and processes for which additional quantitative data is needed for later analysis. Then the

standards continues with the conduct of energy audit, where the energy auditor ensures that measurements and observations are reliable and if this is not the case the auditor informs the organization immediately with the encountered difficulties. The next and final form of field work is the site visit, where the energy auditor asks the organization to nominate individuals to act as guides and escort the auditor on site. The organization must ensure that the auditor has access to drawings, manuals and other technical documentation which are relevant in order to carry out the required tests.

The fifth recommendation that the final European draft standard makes is the Analysis, where during this phase the auditor establishes the existing energy performance situation of the audited object. This includes a breakdown of the energy consumption, energy flows and an energy balance of the audited object, pattern of energy demand through time, relationships between energy consumption and adjustment factors, and energy performance indicators suitable to evaluate the audited object (European Standard Final Draft, EN 16247 – 1, 2012). Then the energy auditor identifies opportunities for energy efficiency improvement opportunities. The auditor evaluates the impact of each energy efficiency improvement opportunity on the existing energy performance situation based on financial savings, necessary investments, return of investment, possible non-energy gains, technical interactions between multiple actions and comparison in terms of both cost and energy consumption between alternative energy efficiency improvement measures. Finally in the analysis part the auditor evaluates the reliability of the data provided and highlights abnormalities, uses transparent and technically appropriate calculation methods, documents the methods used and any assumptions made during the process, subjects the results of the analysis to appropriate quality and validity checks and considers any regulatory or other constraints of the potential energy efficiency improvement qualities (European Standard Final Draft, EN 16247 – 1, 2012).

The final draft European standard continues with the Report. This is subdivided into two main parts. The first is the general part, where when the auditor reports the audit results, the auditor ensures that the energy audit requirements agreed with the organization have been met, checks the quality of the report before submission to the organization, summarizes relevant measurements made during the energy audit, states whether the results of analyses were on the

basis of calculations, simulations or estimates and reports the ranking of the energy efficiency improvement opportunities. The second part deals with the content of the report. The exact content of the report should be appropriate for the scope, aim, and thoroughness of the energy audit. In fact the report should have five fundamental points, starting with the executive summary, where the ranking of energy efficiency improvement opportunities and suggested implementation actions are highlighted. Then general information of the audited organization, energy auditor and energy audit methodology are given and the context of the energy audit, description of audited objects and relevant standards are presented. The next stage is to report the energy audit itself, which includes the description of the energy audit, scope, goals, time frame and boundaries, information on the data collected during the process, analyses of the energy consumption and the criteria for ranking energy efficiency improvement measures. After the energy audit, the energy efficiency improvement opportunities follow, where proposed actions, recommendations, plan and implementation schedule are shown. This section also includes appropriate economic analyses, information about applicable grants and schemes, potential interactions with other proposed recommendations and verification together with the measurement methods that will be used in the post-implementation assessment of the recommended opportunities. The final ingredient of the Report is the conclusions.

The last thing that this final European draft standard suggests is the final meeting, where the auditor hands over the energy audit report, presents the results of the audit and explains the results obtained.

2.7 Energy Audit Program in Finland

Finland joined the European Union back in 1995 and the program regarding energy audits in this country is one of the oldest national efficiency energy schemes. This energy audit program started in 1992 as a subsidy policy and was developed into a program level activity in 1993. In January 1994, the energy audit program was launched, and until now it has been a success. This energy audit program is run by a state owned company, Motiva Oy. The Energy Department of the Ministry of Employment and Economy (MEE) is the administrator accountable for all final

and official decisions. There are also consulting companies which form an essential part of the energy auditors, while the clients are industry, services and energy sectors (Motiva, 2012).

This energy audit program in Finland is on a voluntary basis and is promoted by a 40% to 50% subsidy by the Ministry of Employment and Economy. The Ministry has subsidized a total amount of €23.1 million during the period between 1992 and 2007. By the end of 2007 the energy audit program showed that the coverage was approximately 70% of industrial electrical use, while the coverage in heat and fuels is estimated to be a little bit lower. Meanwhile in the service sector almost 40% of the building stock was covered by the energy audit program. A total of 6,800 buildings have been audited since the energy audit program was launched back in 1992.

Studies carried out have shown that by the end of 2007 the Ministry of Employment and Economy saved €23 million annually in water and electricity costs in the service and industry sectors (Motiva, 2012). The corresponding savings in energy use is approximately 0.75TWh per year, while over 75% of the savings come from the industry sector. The cumulative savings are approximately €360 million and over 11TWh in the timeframe from 1992 and till 2007.

The Ministry of Employment and Economy concluded that the average economical saving potentials reported in energy audits in the service sector were 16.4% in heat and fuels, 6.8% in electricity and 7.3% in water consumption. Moreover in the industry sector the average saving potentials were 16.8% in heat and fuels, 6.5% in electricity and 9.9% in water consumption (Motiva, 2012). The report also showed that the realization rate of the proposed measures in the service sector was approximately 70%, whereas in the industry sector the rate was 55%. The energy audit program had all program level elements in place especially the online monitoring system, given that it is a vital tool for such success. In fact without proper monitoring tools the cost effectiveness of the energy audit program would have been very difficult to prove.

Energy audits which are subsidized by the Ministry of Employment and Economy must use the official guidelines. These guidelines are published in an official handbook by Motiva and the Ministry of Employment and Economy. The official handbook provides detailed instructions and

requirements concerning energy auditing and reporting in the service, industrial and energy sector. The amount of auditing support available, from these two entities, for those carrying out energy audits is huge. The handbook for energy auditors presents the general instructions for a practical implementation of audits, background information and means for energy auditors. The energy auditors' handbook is only available for those energy auditors who are qualified and registered.

Qualified energy auditors are approved by Motiva and the Ministry of Employment and Economy, hence these two institutions provide guidelines that state that HVAC and Electrical auditors must be separate, and in both cases in order to qualify for an energy auditor one should follow the training course which is conducted by Motiva. Motiva organizes the training course twice a year, usually in May and November, and the training consists of a basic part for all the participants and two advanced parts of which one is for electrical, while the other is for heating and fuel. These courses started in 1994 and until the present year there were over 1,400 participants (Motiva, 2012). In order to conduct the energy auditor training, certain criteria have to be met. These include at least three years of basic education qualification in energy technology and some working experience in this sector, as well as passing an examination.

The Ministry of Employment and Economy as well as Motiva have also introduced certain tools which help the auditors during the energy audits. These include calculation programs, reporting tools, summary tables, inspection check lists and measurement records. Only authorized energy auditors have the right to use such programs via the internet and this is done by registering as users (Ministry of Employment and Economy of Finland, 2012).

In Finland there are other programs and activities regarding energy audits. In fact as from the early 1990's this country has employed a voluntary agreement scheme in order to promote energy efficiency. Agreements such as energy audits and analyses, which are subsidized by government, are practical measures which boost companies and communities. This is an excellent means of ascertaining the right energy usage and a scope for improving it, as well as integrating improvements in energy efficiency in the daily operation. The energy efficiency agreement has been signed for the period between 2008 and 2016, for industries services,

municipal and energy sectors. Thus this agreement follows on from the energy conservation agreements that were in force in 1997 till 2007 (Motiva, 2012).

Chapter 3 – Presentation of Incentives Schemes involving Energy Audits in Malta

3.1 Introduction

An overview of the incentive schemes that were issued via the various governmental entities involving energy audits in Malta is analyzed in this chapter. The main governmental entities are Malta Enterprise, the Building Regulations Office (BRO) and the Ministry for Resources and Rural Affairs. Hence this section includes the eligibility, the incentive description, evaluation and methodology used when conducting the energy audits, obligations and results for every scheme.

3.2 Malta Enterprise

Malta Enterprise is the first entity that is analyzed in this chapter. Malta Enterprise is the agency responsible for the promotion of foreign investment and industrial development in Malta. Its mission is to sustain Malta's overall competitiveness in order to create the right environment for successful enterprise in Malta. Also this entity offers assistance and advice to businessmen who are seeking to learn more about the business environment and investment opportunities which are available on the island. Similarly, Malta Enterprise offers investors the best possible service before, during and after the investor decides to perform business in Malta (Malta Enterprise, 2012). The principle which Malta Enterprise uses when conducting energy audits is the Green Building Program, which is an energy audit guideline issued by the European Commission's Institute for Environment and Sustainability and its Renewable Energy Unit in September 2005. Thus the following schemes that fall under the responsibility of Malta Enterprise all meet the Green Building Program criteria.

3.2.1 ERDF Energy Grant Scheme

The first scheme that is going to be analyzed is the €15 million ERDF Energy Grant Scheme which was issued on the 15th January 2010. The grant thematic objective was to support enterprise. The regulations had to meet the Legal Notice 70 of 2008, Enterprise Incentive Support Regulations, criteria (Malta Enterprise, 2012).

The main aim of this scheme was to ensure environmental protection in the enterprise via energy efficiency, so that the enterprise can redirect the savings to develop new markets, products and

services. For this scheme an energy audit had to be done in order to identify certain energy efficiency solutions and thus supporting financially the investments required in order to reduce the dependence on fossil fuels and save energy. The ERDF Energy Grant Scheme will remain effective until 31st December 2013 or until all the funds are exhausted. The incentive shall be administered by a series of competitive calls. At the present moment, Malta Enterprise has issued two public calls for interested enterprises, where all applications were reviewed, evaluated and ranked. Grants were given to the top ranking applications in accordance to the available budgets.

The eligibility of this scheme was that all the enterprises that wanted to participate had to have projects which lead to an energy efficiency improvement after the recommendations that were identified from the energy audit. The ERDF Energy Grant Scheme clearly excluded four pillars which were:

- The public entities which fall under the definition of ministries, departments, authorities, public commissions, public sector foundations and similar organizations that carry out public or regulatory functions which do not involve economic activity. However public entities that carry out economic activity in direct competition with third parties, and in which the government has a controlling interest, were still eligible for this scheme.
- The steel and coal industries, gambling and betting companies, shipbuilding, financial and insurance activities, the synthetic fiber sectors and the production of the products listed in Annex I to the EC treaty except those listed in the Community guidelines of State Aid in agriculture, fisheries and aquaculture sector (Malta Enterprise, 2012).
- Organizations that were in financial difficulty.
- Projects addressing legal compliance issues.

The incentive aid intensity for the projects presented was set at 50% of the total costs incurred in relation to the items of expenditure. The incentive scheme stated that the projects submitted under this scheme should be completed within 24 months of the issue of the grant from Malta Enterprise (Malta Enterprise, 2012). The scheme also stated that the minimum project value had to be at least €25,000 and not more than €200,000. Thus the resultant grant value per project was €12,500, while the maximum was €100,000. The ERDF Energy Grant Scheme clearly specified the energy saving measures that should be adopted in order to benefit for the grant. Investment for the implementation of energy saving solutions included installation of intelligent lighting

systems, thermal insulation, combined heat and power, and Building Management Systems. Thus the investments had to be done in equipment which had the capability to reduce energy usage. Investments in renewable energy solutions, such as the installation of renewable energy generating and heating solutions based on the use of solar power were also eligible for benefitting from this type of scheme.

The ERDF Energy Grant Scheme included additional provisions that could be applied to any costs that had to be presented through the incentive. The applicant, where required, had to provide proof that any necessary permits had been obtained prior the issue of the letter of approval. The permits required were from the Malta Environment and Planning Authority (MEPA), based on MEPA's policy guidance on planning requirements for renewable and energy efficiency, and the various licenses issued by the Malta Resource Authority (MRA). Also, all the funding was based on reimbursement of eligible costs and had to be on costs incurred by the applicant after the aid was granted. This section also stated that all costs had to be subcontracted and investments in second hand equipment were not eligible. Another fundamental point was that costs related to activities leading to compliance with environmental legislation were not eligible. The final point in this part was that all costs had to be related to additional investments and not the replacement of existing plants, machinery and other infrastructure.

The evaluation and assessment of aid of all the applicants were carried out by Malta Enterprise and had to meet certain criteria of eligibility. The application had to be completed, hence all the fields on the application form had to be filled in with the relevant details and all the requested annexes had to be attached to the application form. The next point was that the application had to fit in one of the focus areas of the aid scheme as defined in the incentive description. Also the applicant had to honor the obligations and conditions which were identified by Malta Enterprise from previous supported grants. This section also stated that the application had to be in accordance with the regulations of the Directive on State Aid. Finally the applicants had to be in compliance with the laws pertaining to the intervention proposed for the funding and had to be in line with the criteria of the eligibility section. One has to note that the applications which did not meet any one of these criteria were not eligible for the grant.

The preliminary evaluation consisted in 35% of the total evaluation and was basically subdivided into three main parts. The first was the risk appraisal where risk was assessed on the number of

years the enterprise has been established, the duration of the project, the value of the project in relation to the financial resources of the applicant, any preparatory work the applicant had to carry out together with the applicant's capability to implement the project. The score was determined according to the risk and hence the riskier the project the lower the score. The second consideration was the extent of need of support, where the applications were assessed in terms of the need for support which was determined on the size of the enterprise and whether it forms part of a network or was a start – up. The smaller the undertaking the higher the score, while additional points were given to start – up undertakings and to those undertakings that form part of relevant networks. The third and final consideration was the holistic nature of the project, where projects comprising more than one eligible cost as mentioned in the incentive description were awarded higher marks.

On the other hand strategic evaluation consisted in 65% of the total evaluation, of which 55% were thematic priorities, which stated how the project would contribute to the national priorities and to the scheme's objective. In fact the projects were evaluated according to certain criteria. Savings in energy or generated in relation to the investment was the first criterion. This had 40% of the 55% and was measured in € per kWh saved per electricity generated from renewable energy sources. The second criterion was fuel switch to cleaner fuels and renewable energy which had 10% of the 55% of the evaluation. The final criterion was the environmental impact which had 5% of the 55% of the evaluation. Reduction in use of water and waste were given additional environmental benefits. The remaining 10% of the 65% of the strategic evaluation was on horizontal priorities which were projects that had to contribute to the attainment of the horizontal priority of environmental sustainability and equal opportunities. For environmental sustainability, the applicants were required to prove that the projects address issues such as carbon neutrality, climate change, water, waste, air quality and nature protection. As regards equal opportunities, applicants had to prove that the projects address issues such as involvement of disadvantaged groups in the project such as participation of females, ensuring accessibility for all and family friendly measures.

Successful applicants were notified in writing of the outcome of their application and if the project was approved, a grant agreement was signed. Some other important points were that Malta Enterprise was responsible for the grant scheme under Malta's Operational Program I

Cohesion Policy 2007 till 2013. In fact these types of funds apply to all member states and are co-financed under the European Regional Development Fund, where the legislative guidelines apply directly according to four points. The first one is Regulation (EC) Number 1083/2006 which lays down the general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund. The second is the National Eligibility rules as per Article 56(4) of Regulation (EC) Number 1083/2006 which lays down the general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund. The third point is the Regulation (EC) Number 1080/2006 on the European Regional Development Fund, while the final point is the Commission Regulation (EC) Number 1828/2006 of 8th December 2006 setting out rules for the implementation of Council Regulation (EC) Number 1083/2006 which lays down the general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund and the Regulation (EC) Number 1080/2006 of the European Parliament and of the Council of the European Regional Development Fund (Malta Enterprise, 2012).

This scheme also imposes the State Aid Rules and Obligations which are in line with the Commission Regulation (EC) Number 1998/2006 of 15th December 2006 on the application of Articles 87 and 88 of Treaty to "de Minimis" aid, Official Journal L379 of 28th December 2006. The State Aid Regulation states that an enterprise can receive a total amount of aid up to €200,000 over a three year fiscal period. The maximum threshold includes all "de Minimis" grants to the beneficiary including that received from other entities other than Malta Enterprise (Malta Enterprise, 2012). The beneficiary should repay with interest any "de Minimis" aid over the €200,000 threshold.

This "de Minimis" rule is governed by regulations and therefore the incentive scheme does not apply to certain fields, such as undertakings active in the fisheries and aquaculture sectors covered by Council Regulation (EC) Number 104/2000 and undertakings active in the primary production in the agriculture sector as listed in Annex 1 of the Treaty. Undertakings in difficulty and aid contingent upon the use of domestic over imported goods are also excluded (Malta Enterprise, 2012). Finally the exclusion list includes aid to export related activities towards third world countries or member states, namely aid directly linked to the quantities exported, to the

establishment and operation of a distribution network or to other expenditure linked to the export activity (Malta Enterprise, 2012).

This aid scheme (i.e. the Malta Enterprise scheme for energy audits) is partly financed by the European Union ERDF, and has co-financing National funds and Private funds; all the results can be seen in Appendix 1. There were two calls for this aid scheme, the first call had the allocation year in 2009 and the payment was done in 2010, while for the second call the year of allocation was the same as the first call but the payment was done in 2011.

When analyzing the results from the first call, there were 55 beneficiaries of which only one firm took the maximum grant of €100,000, which was Hobb Software Ltd, while Care Services Ltd took the minimum grant which was of €12,600.11. The mean amount was of €57,911 and the median was €57,500. The total amount committed to the beneficiaries was €3,185,105.64 and the co-financing rate was of 50%, which implies that this percentage excludes the private financing and hence the amounts committed are public and European funds. Another interesting point is that there were 14 firms which benefitted from an amount above €90,000 as shown in Figure 3.1. On the other hand, Table 3.1 shows the frequency of the beneficiaries from the first call with the range that has a difference of €10,000 each.

Bin	*Range*	*Frequency*
1	0 ≤ € < 10,000	0
2	10,000 ≤ € < 20,000	9
3	20,000 ≤ € < 30,000	7
4	30,000 ≤ € < 40,000	4
5	40,000 ≤ € < 50,000	2
6	50,000 ≤ € < 60,000	9
7	60,000 ≤ € < 70,000	4
8	70,000 ≤ € < 80,000	4
9	80,000 ≤ € < 90,000	2
10	90,000 ≤ € < 100,000	14
More		0

Table 3.1 shows the Frequency of Beneficiaries having a Range Difference of €10,000 each for the First Call.

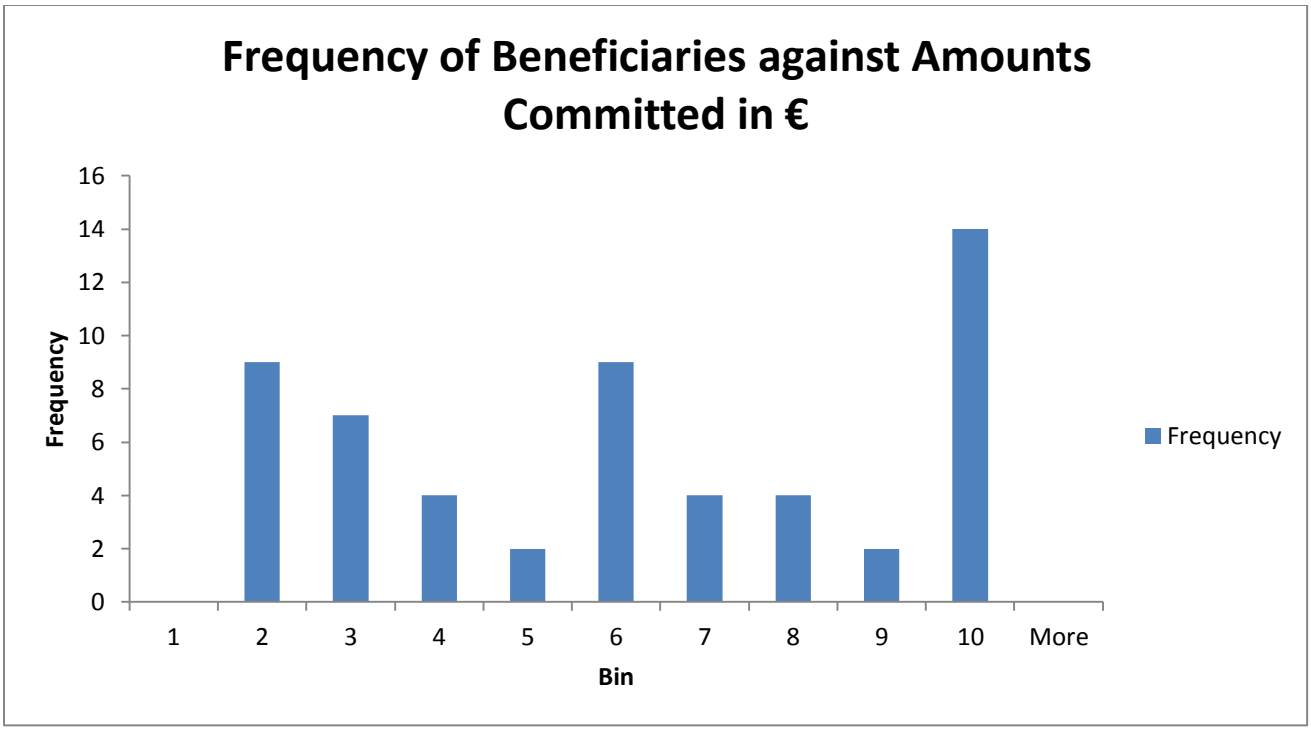

Figure 3.1 shows a Histogram of the Frequency of Beneficiaries against Amounts Committed with a Range Difference of €10,000 for the First Call.

When analyzing the results from the second call, there were 84 beneficiaries of which only one firm took the maximum grant of €100,000, which was Arrow Pharm. (Malta) Ltd, while Childcare Services Ltd took the minimum grant which was of €12,521.5. The mean amount was of €56,610.85 and the median was €50,930.96. The total amount committed to the beneficiaries was €4,755,311.17 and the co-financing rate was of 50%, which implies that this percentage excludes the private financing and hence the amounts committed are public and European funds. Another interesting point is that there were 23 firms which benefitted from an amount above €90,000 as shown in Figure 3.2. On the other hand, Table 3.2 shows the frequency of the beneficiaries from the second call with the range that has a difference of €10,000 each.

Bin	*Range*	*Frequency*
1	0 ≤ € < 10,000	0
2	10,000 ≤ € < 20,000	15
3	20,000 ≤ € < 30,000	8
4	30,000 ≤ € < 40,000	5
5	40,000 ≤ € < 50,000	14
6	50,000 ≤ € < 60,000	6
7	60,000 ≤ € < 70,000	5
8	70,000 ≤ € < 80,000	1
9	80,000 ≤ € < 90,000	7
10	90,000 ≤ € < 100,000	23
More		0

Table 3.2 shows the Frequency of Beneficiaries having a Range Difference of €10,000 each for the Second Call.

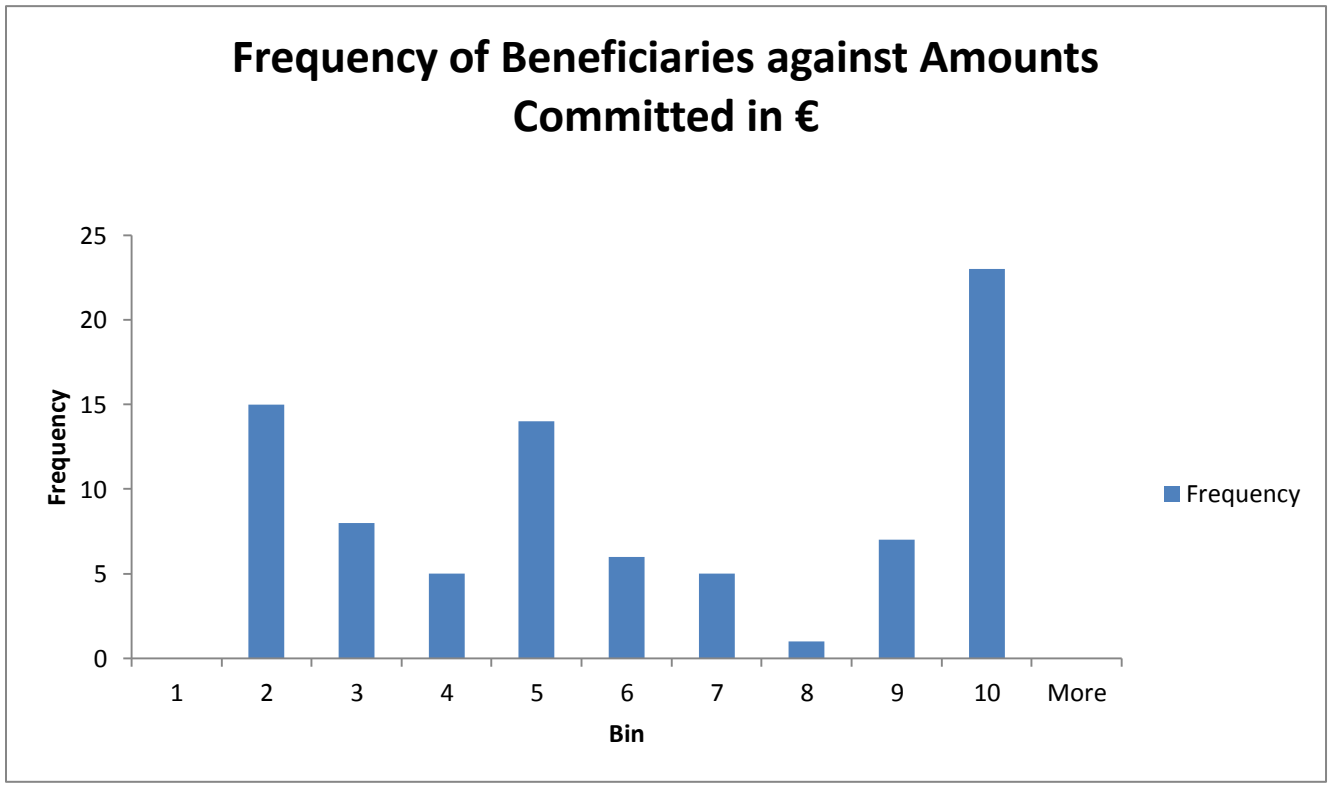

Figure 3.2 shows a Histogram of the Frequency of Beneficiaries against Amounts Committed with a Range Difference of €10,000 for the Second Call.

From the above analysis one can conclude that the total amount of funds taken from this aid scheme was of €3,185,105.64 from the first call and € 4,755,311.17 from the second call, which results to € 7,940,416.81. Thus the remaining amount of funds that can be taken until 2013 from this €15,000,000 incentive scheme is equal to €7,059,583.19.

3.2.2 Energy Efficient Measures for the Hospitality Sector

The second scheme which is going to be analyzed is the Soft loan scheme for hotels, guesthouses, hostels, farm houses, snack bars and restaurants. For this type of scheme an energy audit is a prerequisite in order to benefit from this incentive. This incentive scheme was issued on the 5th of May 2010 and is also under the responsibility of Malta Enterprise.

The scope of this investment, done by entrepreneurs in energy saving solutions and renewable energy sources in the hospitality sector, shall help to promote environment sustainability. This incentive will help businesses in the hospitality sector to reduce their dependence on fossil fuels, reduce costs and attract more "green" customers. Also from the savings, one can reinvest in developing new markets, products, services and address other business growth requirements. This incentive will remain valid until the 31st December 2013 and Malta Enterprise was authorized to issue and publish incentive guidelines in terms of Article 8 (3) (a) of the Malta Enterprise Act, Chapter 463 of the Laws of Malta.

In order to be eligible for this energy saving scheme the applicant should have a valid license issued by the Malta Tourism Authority (MTA) and should be a member stated in the hospitality sector, namely a hotel, hostel, snack bar, restaurant, guest house and farm house. This incentive scheme also mentions the exclusions and hence those which are not eligible to benefit from this scheme. This includes public entities such as ministries, departments, public commissions, authorities, public sector foundations and similar organizations that carry out a public or regulatory function which does not involve an economic activity, whether or not such organizations are established by law and commercial undertakings in which government has a direct or indirect holding of more than 25% are not eligible (Malta Enterprise, 2012). Other exclusions are those firms that are in financial difficulty as defined by the State Aid Regulations and those who are engaged in activities specifically excluded under the applicable State Aid Regulations. Also undertakings that have not honored the obligations from previous grants and

that default the Value Added Tax (VAT), Income Tax, National Insurance and rent or payment to the government are excluded from this scheme. Also excluded are those who work on voluntary basis.

The incentive description states that the projects which are supported under this incentive must result in a reduction of fossil fuels which has to be achieved via an implementation of a holistic investment program for the conservation of energy and the generation of renewable non-fossil energy as determined by an energy audit by an energy business advisor appointed by Malta Enterprise. The applicant shall be eligible for a loan of €400,000, which covers up to 80% of the total costs of the investment. The interest rate shall be of 1.5% over the discount rate charged by local banks, while the loan period will be over 5 years (Malta Enterprise, 2012). Approved projects may also be granted a moratorium covering the initial 12 months from the first withdrawal.

The eligible costs for this incentive scheme include energy saving measures that are defined as costs incurred for the procurement and installation of solutions which lead to more efficient energy solutions when compared to the present situation. This includes measures such as energy saving lighting systems, thermal insulation, double glazing windows and doors, combined heat and power solutions, more efficient electrical equipment and air conditioning, and Building Management System that monitors, records and controls the use of electrical energy. The next eligible cost that is mentioned in the incentive scheme is the use of cleaner fuels, where the loan would be approved when installing equipment that uses bio - fuels or more efficient fuels than those used at the present moment in the premises. Costs incurred in the procurement and the installation of apparatus, such as for energy generated from wind and solar, and heating or cooling solutions that exploit geothermal sources and solar energy may be funded through this loan scheme.

The incentive guidelines state certain additional conditions which are directly related to the project costs. These include that all equipment has to be new, while the costs have to be subcontracted and produced at market prices and rates. Also the replacement of existing solutions is only eligible given that it meets the objectives, which are to reduce the CO2 emissions and the dependence on fossil fuels. Another clause is that the installation costs will only be covered given that they are subcontracted to the supplier providing the equipment for

this project. Also funding will be based on the reimbursement of eligible costs and on costs incurred by the applicant after the aid has been granted.

This scheme also specifies certain ineligible options in order to safeguard the incentive scheme itself. These include costs such as salaries and wages for the employees, investment in second hand equipment, acquisition of land or buildings, costs related to civil engineering and infrastructural works, and cost items assisted through other incentive schemes administered by the Corporation or by any other entity in Malta.

The soft loan scheme also mentions the provisions on approved loans. There are five clauses, the first being that the Corporation may require that the repayment of the principal as well as the payment of interest are secured by a General Hypothec over all the assets, present and future, of the enterprise receiving the loan. The ranking of the soft loan shall be specified in the letter of approval issued by the Corporation. The second clause is regarding the repayment of the loan and specifies the interest shall be paid within a certain period and at installments as specified in the letter of approval sent by the Corporation. But this period shall not exceed five years from the date of first withdrawal of the loan. The third clause is that funds from the loan can only be withdrawn if an actual expenditure equivalent to the percentage of the total value of the cost items that is not covered by the loan, has been paid to or simultaneously with the utilization of the loan (Malta Enterprise, 2012). The fourth clause is that Malta Enterprise can withhold any part of the loan that has not been advanced, without prejudice, to any other remedy given that:

- Any sum of money remains unpaid
- Any parts of the funds were not used in the appropriate manner as stated in the project presented
- The enterprise has gone into liquidation or has assigned property to the benefit of the creditors
- When there is a breech in the conditions for the assigned project.

Finally the fifth clause is that Malta Enterprise can withhold the payment of the loan and also requests to pay back the advanced amounts, if the project has not been implemented after 12

months from the date of issue of the relevant approval documents and if the applicant has implemented the project without the necessary permits.

The application process is also conducted by Malta Enterprise and all applications have to be submitted until the 31st December 2012. The application should include a Review Energy Audit Report which shall be conducted by a Malta Enterprise advisor. The energy audits will be served on first come first served basis and this would provide an overview of the potential energy saving, and hence cost saving that would arise through the implementation of the supported eligible costs identified in this incentive scheme. This service shall be provided in line with the conditions set under the Business Advisory Services Scheme and through this, Malta Enterprise may also provide an advisor to conduct an in depth energy audit. In order to have the application eligible, the energy audit report is mandatory.

For the applicant to be eligible the application has to follow the incentive guidelines and the project has to be in line with the scope of the incentive. If the application does not meet the required criteria, the application will be rejected. The project evaluation consists of two main points, which are; the project results, where the expected revenue generated and cost saving achieved through the implementation of the project will be evaluated, while the second point is the financial risk appraisal, where applicants shall be evaluated on past financial performance. This shall include the requested percentage of soft loan in relation to the project value and value of the project in relation to the financial resources.

This scheme also mentions certain State Aid Obligations. This State Aid shall be in line with Commission Regulation (EC) Number 1998/2006 of 15th December 2006 on the application of Articles 87 and 88 of the Treaty to "de Minimis" aid, Journal L379 of 28th December 2006 (Malta Enterprise, 2012).

Table 3.3 shows the list of the energy auditors that are listed with Malta Enterprise who are capable of conducting an energy audit by following the Green Building Program criteria. In fact Table 3.3 shows the eight energy auditors' names and their respective electronic contact address.

Advisor	e-mail address
Ing. Claude Vella	claudevella@cyanengineering.com
Ing. Ronnie Vella	ronnievella@cyanengineering.com
Ing. Stefan Riolo	sterio@maltanet.net
Ing. Martin Pizzuto	martincpizzuto@maltanet.net
Ing. Valislav Baran	velisbar@msn.com
Ing. Antoine Busuttil	antoinebusuttil@yahoo.com
Ing. Godwin Caruana	godwinca@maltanet.net
Ing. Nicholas Bellizzi	nikibel@onvol.net

Table 3.3 shows the list of Energy Auditors which are listed with the Malta Enterprise.

Until the present moment there were no requests for this scheme, so no soft loans were issued and no beneficiaries were noted. Hence no energy audits were conducted for this scheme. In Appendix II there is the application form which can be filled for an energy audit review, where the energy audit has to be done by one of the stated energy auditors.

3.2.3 Business Advisory Service Scheme

The third and final scheme that falls under the responsibility of Malta Enterprise is the Business Advisory Service Scheme. This scheme was issued on the 10th January 2011 and will close on the 31st December 2013.

The scope of this scheme is to provide business undertakings in Malta with advisory services that suit their specific circumstances. Malta Enterprise issued the incentive guidelines in terms of Article 8 (3) (a) of the Malta Enterprise Act, Chapter 463 of the Laws of Malta. The Legal notice entitled Enterprise Support Regulations, 2008 (LN 70 of 2008), published under the Malta Enterprise Act, provides the legal basis for this incentive (Malta Enterprise, 2012).

In this particular scheme all the enterprises are eligible to apply except public entities such as ministries, departments, public commissions, authorities, public sector foundations and similar organizations that carry out a public or regulatory function which does not involve an economic activity, whether or not such organizations are established by law, and commercial undertakings in which government has a direct or indirect holding of more than 25%.

This incentive scheme shall provide advice to business owners or managers in maintaining the organization competitive and to develop new market and business growth opportunities. In fact, Malta Enterprise is providing businesses with an advisor who will help the entrepreneur to identify opportunities for energy savings. Energy audits are considered as the first step in order to reduce the energy consumption, but other aid can also be related to energy efficiency and renewable energy sources under the ERDF Energy Grant Scheme.

The advisory services provided in energy audits are divided into two main parts. The first is the preliminary investigation of the energy audit, which is a walk through type of energy audit, and is financed by Malta Enterprise as long as this part is completed in less than 10 hours. While in the second phase the consultants and the energy auditors will provide a more detailed analyses and support at €40 per hour. This will include a report with the required recommendations in order to reduce the utility bills. But the levies are discounted according to the size of the enterprise. Thus a large enterprise will have a discount of 30%, a medium size enterprise will have a discount of 40%, while a small enterprise will have a 50% discount. The total amount that Malta Enterprise can finance under this scheme is €2,500 per annum (Malta Enterprise, 2012).

In this incentive scheme, Malta Enterprise made it clear that if the firm feels that the required needs are not being met because the energy auditor is not meeting them or for any other valid reason, then a new auditor shall be assigned to the firm in order to meet expectations.

From the results obtained from Malta Enterprise, there were 269 enterprises that conducted an energy audit in order to reduce the utility bills, where the energy audits were conducted by the eight energy auditors of Table 3.3. Once again the methodology used by the energy auditors is the Green Building Program criteria, when conducting the energy audits. At the current moment there are no factual results that show how much energy was saved in terms of kWh/year, how much CO2 emissions were reduced and what was the actual financial saving from the utility bills, since Malta Enterprise has not yet completed such information given that the actual scheme is still open and will eventually close on the 31st December 2013 (Malta Enterprise, 2012).

3.3 Ministry for Resources and Rural Affairs

The Ministry for Resources and Rural Affairs (MRRA) was responsible for 145 energy audits which were conducted in several governmental buildings around Malta and Gozo. This responsibility falls under this Ministry since in a small island where the sustainable management is crucial and where rural areas enhance the characteristic beauty of the Maltese landscape, this Ministry is an important stake holder in guaranteeing better quality of life to the present and future generations (MRRA, 2012).

The mandate of the Ministry for Resources and Rural Affairs is to provide incentives and to take certain measures in promoting projects for conserving, enriching and upgrading the Maltese situation. Also this ministry will be promoting sustainable and environmentally friendly methods for the generation of energy which include solar and wind renewable energy sources. In fact the government, based on these two mandate points, was committed to reduce the electrical energy consumption from the governmental buildings and in the 2009 budget several energy audits were conducted.

The energy audit project was first published in 2006. Through a framework agreement, the Ministry for Resources and Rural Affairs and the Office of the Prime Minister were the beneficiaries and conducted an energy audit. The Office of the Prime Minister carried out energy audits in the Auberge de Castille and Auberge d'Italie in 2009 through the services of a consultant engineer. Overall there were six energy audits which were conducted in these two government buildings.

Also in April and May 2009, a Call for Expression of Interest from amongst Public Officers and Public Sector Employees was published in order to assign duties as Energy Auditors within the Ministry for Resources and Rural Affairs, but the response was not satisfactory. Even though the response was poor, energy audits started to be performed in a small number of Departments in Ministry of House and Parliamentary Affairs (MJHA) by one engineer who signed the agreement (MRRA, 2012).

Subsequently, in 2010 two Departmental Tenders requesting the services of energy auditor in a number of Government buildings were published by the Ministry for Resources and Rural Affairs on behalf of all Ministries, since the Green Leaders financial vote is administered by this

Ministry. The advert numbers were 101/2010 and 141/2010 on the Malta Government Gazette and are shown in Figures 3.3 and 3.4 respectively.

Avviż Nru. 101/2010. Servizzi ta' *energy auditing consultancy*.

Għandu jitħallas dritt ta' €25 għal kull sett tad-dokument rilevanti tal-offerta.

Dokumenti rilevanti jistgħu jinkisbu, fuq ħlas tad-dritt imsemmi, mill-*Cash Office*, Dipartiment tal-*Financial Management*, Blokk 'A', il-Furjana, f'kull ġurnata tax-xogħol bejn it-8.00 a.m. u nofsinhar. Aktar tagħrif jista' jinkiseb mit-Taqsima tal-Kuntratti u *Procurement* tal-Ministeru għar-Riżorsi u Affarijiet Rurali (Tel. 2299 7567).

Advt. No. 101/2010. Energy auditing consultancy services.

A fee of €25 is to be charged for the procurement of each set of relevant tender documents.

Relevant documents may be obtained, against payment of the indicated fee, from the Cash Office, Department of Financial Management, Block 'A', Floriana, on any working day between 8.00 a.m. and noon. Any further information may be obtained from the Contracts and Procurement Section of the Ministry for Resources and Rural Affairs (Tel. 2299 7567).

Figure 3.3 shows the Advert Number 101/2010 from the Malta Government Gazette.

Sal-10.00 a.m. ta' nhar l-Erbgħa, it-22 ta' Settembru, 2010, fit-Taqsima tal-Kuntratti u l-Akkwisti, Dipartiment tal-*Financial Management*, il-Furjana, jintlaqgħu offerti magħluqin għal:-

Avviż Nru. 141/2010. Servizzi ta' konsulenza dwar verifika ta' *energy auditing*.

Għandu jitħallas dritt ta' €6 għal kull kopja tad-dokumenti tal-offerta.

Sealed tenders will be received at the Contracts and Procurement Section, Department of Financial Management, Floriana up to 10.00 a.m. on Wednesday, 22nd September, 2010, for:-

Advt. No. 141/2010. Energy auditing consultancy services.

A fee of €6 is to be charged for the procurement of each set of relevant documents.

Figure 3.4 shows the Advert Number 141/2010 from the Malta Government Gazette.

The first tender works commenced on the 1st September 2009 and had a deadline after 120 days. This work covered 90 administrative buildings and the cost was €28,911 including VAT.

Engineering Services Ltd won the first tender. As regards the second tender, work started on the 21st October of 2009 and the energy audits were completed within 50 days. During this work, energy audits were carried out on 49 administrative buildings and the cost was €15,000 including VAT. The Ministry of Gozo, (MGOZ) paid €5492.76, of this €15,000 in order to cover buildings that fall under the responsibility of the Ministry of Gozo. Mediterranean Technical Services won the second tender (MRRA, 2012). In fact all the audits were completed by the end of 2009.

Thus a total of €43,911 were spent in energy audits for 139 buildings**.** These were paid from funds from the Green Leaders Initiative Item except for the €5492.76 which was paid by Ministry of Gozo and was administered by the Ministry for Resources and Rural Affairs (MRRA, 2012). The Green Leaders Initiative are funds which are intended to meet the governmental responsibilities regarding the environment. In fact the Prime Minister appointed fourteen Green Leaders, one in each Ministry, who have the duty to create environmental awareness within their respective Ministry (Environmental Corporate Responsibility Office, 2012). The Green Leaders have also their own funds in order to operate and hence these funds were used to conduct the energy audits in the 139 governmental buildings.

The types of energy audits that were carried out in these two tenders which were issued by the Ministry for Resources and Rural affairs were walking through energy audits. This measure was taken so that immediate results of energy saving and utility bills reduction would be obtained (MRRA, 2012). Table 3.4 shows the 134 governmental administrative buildings in which a walk through energy audit was carried out as per budget measure of 2009.

Walk through Energy Audits		
Office of Prime Minister	1	Planning Division, 12 St. Paul's Street, Valletta
	2	Program Implementation Directorate, 13 St. Paul's Street, Valletta
	3	Employment Commission, 46, Archbishop Street, Valletta
	4	Government Printing Press, Factory A29, Industrial Estate, Marsa
	5	Management Efficiency Unit, National Road, B'Bajda
	6	Armed Forces of Malta - Luqa Barracks,

		Luqa
	7	Armed Forces of Malta - Safi Barracks, Safi
	8	Armed Forces of Malta - Lyster Barracks, Hal Far
	9	Electoral Office, Evans Building, St. Elmo Square, Valletta
	10	Tourism - Tourism Information Office, Arcadia, Gozo
	11	Internal Audit and Investigation Directorate, South Street, Valletta
	12	Dept. Of Local Government, 26/28 Archbishop Street, Valletta
	13	Dept. Of Local Government, Chateau de la Ville, Valletta
	14	MCESD/MEUSAC, Republic Street, Valletta
Ministry of Infrastructure	15	Palazzo Verdelin, 111, Archbishop Street, Valletta
	16	Transcontinental House, Zachary Street, Valletta
	17	168, Strait Street, Valletta
	18	Public Registry Building, Merchants Street, Valletta
	19	Passport Office, 1st Floor, Evans Building, Merchants Str. Valletta
	20	TV Licenses Unit, 217, St. Paul's Str. Valletta
	21	Land Registry, West Street, Valletta
Ministry of Foreign Affairs	22	Head Office, Palazzo Parisio, Merchants Str. Valletta
	23	Directorate for Corporate Services, St.Paul's Street, Valletta
	24	Central Visa Unit, Pjazza San Kalcidonju, Floriana
	25	Information Management Unit, 2nd Floor, 280, Republic Str. Valletta
Ministry of Health	26	Ministry of Health and Head Office, 15, Merchant Str. Valletta
	27	Personnel Section, 6, Sqaq Harper, Floriana
	28	24, Triq San Gwann, Valletta

	29	24D, Triq San Gwann, Valletta
	30	12, Health Education Unit, Merchant Street, Valletta
	31	Fafner House Level 2 & 3, Triq Nazzjonali, Hamrun
	32	Emporium, FXB Buildings, Triq San Lwigi, Msida
	33	Blood Transfusion, St. Luke's Hospital, Gwardamangia
	34	Health Information Unit, St. Luke's Hospital, Gwardamangia
	35	181, Melita Street, Valletta
	36	Health Dept, 2, Angelo Street, Zebbug
	37	Health Office, 6,Triq l-iskola, Hamrun
	38	Rodent Section, Vjal l-Avjazzjoni, Luqa
	39	Health Inspector Office, Triq d'Argens, Msida
	40	4, Health Dept, Triq Sant' Ubaldeska, Paola
	41	Health Office, 25/2, Ix-Xatt ta Lascaris, Valletta
	42	12, City Gate, Republic Street, Valletta
Ministry of Finance	43	Maison Demandols, 30, South Street, Valletta
	44	Cavalier House, Old Mint Street, Valletta
	45	Central Districts Office, Floriana
	46	4, Old Mint Street, Valletta
	47	Inland Revenue Dept, Floriana
	48	Capital Gains Dept, 46, Merchants Street, Valletta
	49	Contract Dept, Notre Dame Ravelin, Floriana
	50	Economic Policy Division, St. Calcidonius Square, Floriana
	51	National Statistics Office, Head Office, Lascaris, Valletta
	52	Commerce Division, Lascaris, Valletta
	53	Notary to Government, MA Vassalli Street, Valletta
	54	Government Property Division, St. Sebastian Street, Valletta

	55	Joint Office, 31, Marsamxetto Road, Valletta
	56	Customs Office, Xatt Lascaris, Valletta
	57	Ex Baggage Room, Customs House, Xatt Lascaris, Valletta
	58	Laboratory, Customs House, Xatt Lascaris, Valletta
	59	CICE Licensing Office, Xatt Lascaris, Valletta
	60	CICE, Store Security, Xatt Lascaris, Valletta
Ministry of Resource and Rural Affairs	61	Block B, Francesco Bounamici Street, Floriana
	62	Restoration Unit, Ospizio, Floriana
	63	Construction and Maintenance Dept, Floriana
	64	Offices, Abbatoir, Triq il-Biccerija, Marsa
	65	Offices, Pitkali, Ta Qali, Attard
	66	Plant Health Dept, Annibale Street, Lija
	67	Manufacturing and Services Dept, Triq Troubridge, Marsa
	68	Manufacturing and Services Dept, Kordin Industrial Estate, Kordin
	69	Cleansing Dept, Kordin Industrial Estate, Kordin
	70	Park Dept, National Park, Ta Qali
	71	Block A, Ghammieri, Marsa
	72	Block B, Ghammieri, Marsa
	73	Block C, Ghammieri, Marsa
	74	Block D, Ghammieri, Marsa
	75	Animal Husbandry Block, Ghammieri, Marsa
	76	Ex EU Affairs Block, Ghammieri, Marsa
	77	Applications Block, Ghammieri, Marsa
	78	Dairy Farm Building, Ghammieri, Marsa
	79	Old Farm Building, Ghammieri, Marsa
	80	Laboratories Complex, Ghammieri, Marsa
	81	Casa Leoni, 476, St. Joseph High Str, Sta. Venera

	82	Malta Qualification Council, 16/18, Dawret it-Torri, Sta. Lucia
	83	EUPA, 36, Old Mint Str, Valletta
	84	NCHE, 4th Floor, Old University Building, Valletta
	85	Educational Directorates, Head Office, Great Siege Road, Floriana
Ministry of House and Parliamentary Affairs	86	Auberge d'Aragon, Pjazza Indipendenza, Valletta
	87	Civil Protection Dept, Marine Unit, Paola
	88	Hal-Far Fire Station, Birzebbuga
	89	Floriana Fire Station, Floriana
	90	Corradino, Fire Station, Paola
	91	Xemxija Fire Station, St. Paul's Bay
	92	Police General Headquarters, Floriana
	93	Justice Unit, 30, Old Treasury Street, Valletta
	94	Office of Notary to Government, 2/3, Triq MA Vassalli, Valletta
	95	Office of Attorney General, St. George Square, Valletta
	96	Corradino, Correctional Facility, Triq Belt Valletta, Paola
	97	Substance Abuse Therapeutic Unit, Mtahleb, Rabat
	98	Forensic Unit, Mount Carmel Hospital, Attard
	99	Court of Justice, Main Building, Republic Str, Valletta
	100	Court of Justice side Annex, Republic Str, Valletta
	101	Family Court, Triq id-Dejqa, Valletta
	102	27, Triq id-Dejqa, Valletta
	103	27A, Triq id-Dejqa, Valletta
	104	Block C, Belt is-Sebh, Valletta
Ministry of Education and Employment	105	DSS, Triq il-Kampanella, Fgura
	106	DSS, Cenrtu Civiku, Mosta
	107	DSS, 1, Triq l-Iskola, Hamrun

	108	DSS, Centru Civiku, Naxxar
	109	DSS, 5, Block A, Centru Civiku, Triq l-Arkata, Paola
	110	DSS, Kumpless Access, Triq il-Frejgatina, Qawra
	111	DSS, 229, Triq il-Vittorja, Qormi
	112	DSS, Centru Civiku, Rabat
	113	DSS, Kumpless Access, Triq Melita, Valletta
	114	DSS, Pjazza San Nikola, Siggiewi
	115	DSS, Kumpless Access, St. Edward Street, Vittoriosa
	116	DSS, Centru Civiku, Zabbar
	117	DSS, Bini tal Gvern, Block 1, Flat 2, Sciortino Str, Zebbug
	118	DSS, 9, Triq il-Madonna tal Hniena, Zejtun
	119	DSS, 8, Triq Santa Katerina, Zurrieq
	120	DFM, Supplies and Services Section, 106/7/8, Melita Str, Valletta
	121	DFM, 19, MA Vassalli Street, Valletta
	122	Palazzo Ferreria, Republic Street, Valletta
	123	Victoria Police Station, Victoria, Gozo
	124	Ministry of Gozo, Administration Centre, Victoria Gozo
	125	Back Office Centre, Triq Hamri, Xewkija, Gozo
	126	IRD Department, Triq Enrico Mizzi, Victoria Gozo
	127	Gozo Law Courts, Cathedral Square, Victoria Gozo
	128	Projects and Development Dept, By the Bastion Str, Victoria Gozo
	129	Cittadella Centre for Culture and Arts, Cittadella, Victoria Gozo
	130	Dept of Information, Pjazza Indipendenza, Victoria Gozo
	131	Gozo Public Library & National Archives, Vajringa Str, , Victoria Gozo
	132	Projects and Development Dept, Imgarr Road, Victoria Gozo

	133	St. Martha Adult Training Centre, Triq tal Far, Victoria Gozo
	134	Gozo Sports Complex, Triq l-Ewropa, Victoria Gozo

Table 3.4 shows the Walk through Energy Audits which were carried out by MRRA.

On the other hand a detailed type of energy audit was carried out in 11 government buildings, where a more in - depth analysis was done in order to identify the potential sources of energy saving and reduce energy consumption and CO2 emissions. Table 3.5 shows the detailed type of energy audits which were conducted under the responsibility of the Ministry for Resources and Rural Affairs.

Detailed Energy Audits		
Ministry for Resources and Rural Affairs	1	Dept. Of Fisheries, Barriera Wharf, Valletta
	2	Projects House, Floriana
	3	Block A, Floriana
Office of Prime Minister	4	Auberge de Castille
	5	3, Castille Palace
	6	Auberge d' Italie
Ministry of House and Parliamentary Affairs	7	House of Catalunya, Valletta
	8	Refugee Commission (Fort St. Elmo), Valletta
	9	Civil Protection Dept, Ta Kandja
	10	Probation Services, 217, St. Ursula Street, Valletta
	11	Data Protection Commission, Sliema

Table 3.5 shows the Detailed Energy Audits which were carried out by MRRA.

The results obtained when carrying the energy audits in the 145 governmental buildings show that the total annual energy consumption is approximately 13GWh, which amounts to an equivalent financial annual energy cost of €3,218,305 and 11,000 tons of Carbon Dioxide emissions. The study shows that the total amount of money that is required to save an annual energy consumption of 3.5GWh is approximately €4.16 million. Until July 2012 a total amount of €3.66 million has been invested in these past three years. The exercise concludes that the total economic value in energy saving is €874k, while the emissions that are being avoided every year amount to 3073 tons. Finally the payback period for the investment is of four years (MRRA,

2012). Table 3.6 shows the summary of figures that were presented by the Ministry for Resources and Rural Affairs after the conduction of the energy audits.

	VALUES
ANNUAL ENERGY CONSUMPTION	12,730,881kWh or 13GWh
ANNUAL CONSUMPTION IN €	€3,218,305
ANNUAL CARBON DIOXIDE EMISSIONS	11,000 tons
TOTAL CAPITAL EXPENDITURE NEEDED	€4,161,611
CAPITAL INVESTMENT BEING SOLICITED	**€3,659,811**
ANNUAL ENERGY SAVINGS	3,458,701kWh or 3.5GWh
ANNUAL SAVINGS IN €	€874k
ANNUAL CARBON DIOXIDE EMISSIONS AVOIDED	3073 tons
PAYBACK PERIOD	4 years

Table 3.6 shows the Summary of Figures that were presented by MRRA after the Energy Audits.

3.4 Building Regulations Office

First of all it is important to mention immediately that this entity does not carry out energy audits but Energy Performance Certificates which are conducted by assessors rather than energy auditors. This form of legislation came into force on the 21st October 2008 under the Legal Notice 261 of 2008, known as the Energy Performance of Buildings Regulations and the scope was to give effect to the provisions of Directive 2002/91/EC of the European Parliament and of the Council of the 19th December 2002 on the Energy Performance of Buildings.

In fact these regulations aim to improve the energy performance of the buildings by setting certain requirements, by means of a technical document, on the application of minimum energy performance for new buildings and for large existing buildings that are subject to major renovation. The goals also include the general framework for a national methodology for the calculation of the energy performance of buildings and a regular inspection of boilers and air conditioning systems as regards to the reduction of energy consumption and limiting carbon dioxide emissions (Legal Notice 261 of 2008, 2008).

The minimum requirements on the energy performance of buildings are specified on Technical Guidance Document F and were notified on the Gazette of the Government, Notice Number 1002 of 2006 which is shown in Figure 3.5. These were to apply to buildings whose development permission applications in terms of Regulation 3(1) of the Development Permission Regulations, 1992, were received by MEPA on and after the 2nd January 2007. For large buildings, an outline or full development application requires a study which takes into consideration the technical, environmental and economic feasibility of alternative energy systems, such as:

- combined heat and power
- block heating and cooling
- decentralized energy supplies systems based on renewable energy
- heat pumps under certain conditions

These requirements have to be carried out by competent people who are academically qualified and made available on the request of the Authority or by the MEPA (Legal Notice 261 of 2008, 2008). On the other hand there are certain institutions were the minimum energy performance criterion does not apply. This takes into account the construction of buildings for the Enemalta Corporation, the Water Services Corporation, Fireworks and Explosives control buildings, buildings classified under Grade One by the Malta Environment and Planning Authority under the Article 46 of the Development Planning Act, glasshouses used for the agriculture sector, temporary buildings used for a maximum period of two years, stand alone buildings which have a maximum total useful area of 40m² and buildings under the responsibility of the Armed Forces of Malta (Legal Notice 261 of 2008, 2008).

Nru. 1002

AWTORITÀ TA' MALTA DWAR IR-RIŻORSI

Avviż għall-Finijiet tar-Regolament 1(3) tar-Regolamenti ta' l-2006 dwar Rekwiżiti Minimi għar-Rendiment tal-Bini fl-Użu ta' l-Enerġija taħt l-Att dwar l-Awtorità ta' Malta dwar ir-Riżorsi (Kap. 423)

L-AWTORITÀ ta' Malta dwar ir-Riżorsi tgħarraf għall-informazzjoni ta' kulħadd illi t-*Technical Guidance Document 'F' – Minimum Requirements for Conservation of Energy in Buildings* maħruġ skond ir-regolament 1(3) tar-Regolamenti ta' l-2006 dwar Rekwiżiti Minimi għar-Rendiment tal-Bini fl-Użu ta' l-Enerġija (Avviż Legali Nru. 238 ta' l-2006), jista' jinkiseb mill-Uffiċċju tar-Regolamenti tal-Bini, Diviżjoni tas-Servizzi, Project House, Floriana, jew jista' jitniżżel elettronikament minn wieħed mill-URLs segwenti:

http://www.mri.gov.mt/downloads/TechGuid_F.pdf
http://www.mra.org.mt/Downloads/Publications/TechGuid_F.pdf
http://www.bicc.gov.mt/bicc/files_folder/Document%20F.pdf

It-28 ta' Novembru, 2006

No. 1002

MALTA RESOURCES AUTHORITY

Notice for the Purposes of Regulation 1(3) of the Minimum Requirements on the Energy Performance of Buildings Regulations, 2006 under the Malta Resources Authority Act (Cap. 423)

THE Malta Resources Authority notifies for general information that the *Technical Guidance Document 'F' – Conservation of Fuel, Energy and Natural Resources (Minimum Requirements on the Energy Performance of Buildings Regulations 2006)* issued in terms of regulation 1 (3) of the Minimum Requirements on the Energy Performance of Building Regulations, 2006, (Legal Notice No. 238 of 2006), is available from the Building Regulations Office, Services Division, Project House, Floriana, or may be downloaded from any of the following URLs:

http://www.mri.gov.mt/downloads/TechGuid_F.pdf
http://www.mra.org.mt/Downloads/Publications/TechGuid_F.pdf
http://www.bicc.gov.mt/bicc/files_folder/Document%20F.pdf

28th November, 2006

Figure 3.5 shows the Notice Number 1002 of 2006 regarding the Minimum Requirements on the Energy Performance of Buildings.

The Energy Performance Certificate can be obtained from an independent energy performance building assessor who is registered with the Building Regulations Office. At the present moment there are 165 assessors and the list can be seen in Appendix 3. Until the 27th June 2012, the assessors conducted 451 affirmative building assessments and thus awarded the same number of Energy Performance Certificates. This certificate shall be valid for a period of ten years, given that no major renovations and alterations occur inside the building. Also the Energy Performance Certificate shall include reference values and shall be accompanied by a recommendation report, which shall indicate the cost effective measures for improving the energy performance of the building.

The Legal Notice also demanded the Energy Performance Certificate of public buildings must be clearly visible in a prominent place to the general public by not later than the 2nd January 2010. These public buildings include commercial banks and post offices which have an area over 100m², large buildings that provide a service for more than 500 people daily, showrooms and

shopping complexes that have a useful area above 1000m² and cinemas, dancehalls and wedding halls which have a useful area of above 1000m².

As per regulations in the LN 261 of 2008, as from the 2nd January 2009, water heating and space heating installations having boilers which are fired by either non renewable or by solid fuel, having a rating of 20kW or higher, shall be inspected and certified by an assessor from the list in Appendix 3. The certificate shall include the boiler efficiency and sizing in the context of heating requirements for the building (Legal Notice 261 of 2008, 2008). The same procedure that is useful in the case of the boilers is applied to air conditioners that are rated at 12kW or higher. Each inspection report shall also include appropriate advice on possible improvements and modifications to the system, replacement of the system and alternatives in order to reduce the energy usage. Finally in order to have a valid Energy Performance Certificate, the report has to be deposited with the Authority by the assessor.

As regards the administration of the Energy Performance Certificates of buildings, the Authority may demand the owner to produce an Energy Performance Certificate of the buildings or the installations as required by the Legal Notice 261 of 2008, and if the owner does not comply within 60 days, an offence is committed. The performance assessments conducted by the certified assessors shall follow certain procedures, including calculations methods and software which are approved by the Authority. In order to be an assessor, the Authority specifies that the prospective assessor shall fill the required form, pay the required fee to the Authority and that the person meets the requirements specified by the Authority. This shall include that the applicant must have the necessary qualifications and shall complete a training course provided by the Authority. One has to note that the assessor can be a registered member of more than one type of certification, given that the assessor has the required standards and ensures that the fees requested by the Authority are met. The assessor has to pay the fees in order to renew the registration when stated by the Authority, while the Authority on the other hand issues a certificate that the assessor is qualified and competent to conduct the work (Legal Notice 261 of 2008, 2008). The Authority has the right to suspend or terminate the registration of a person as an assessor, given that the assessor does not attend the periodic training provided by the Authority, the assessor does not comply with the direction provided under this regulations, the

assessor fails to provide adequate data and documentation when conducting the performance assessment to the Authority and finally if in the opinion of the Authority the assessor ceases to be capable of performing assessor functions under the regulations properly and efficiently. The assessor who has been suspended or has his registration terminated shall be informed in writing with the reasons for the decision and the assessor has the right to appeal from the decision taken within 14 days.

The Authority has the right to appoint authorized persons to enforce these regulations and the officer shall have a warrant of appointment to exercise the power provided by the Legal Notice 261 of 2008. Whether an Energy Performance Certificate data file has been warranted or not, the authorized officer can enter a building to inspect and examine the building in order to form an opinion. A person, who fails to allow an inspection in the building, or refuses to comply with the authorized person or assessor, obstructs or assaults the authorized officer, provides the authorized officer with misleading information, or alters the data files, calculations, any reports and documents, is committing an offence (Legal Notice 261 of 2008, 2008). Hence criminal proceedings for these offences are contemplated under the Court of Magistrates and shall be in accordance with the Criminal Code regulating the procedure before the said courts of criminal judicature.

One fundamental point is that the Energy Performance Certificate was the responsibility of the Malta Resource Authority but nowadays this has shifted to the Building Regulation Office which falls under the responsibility of the Ministry of Resource and Rural Affairs (Building Regulation Office, 2012).

Chapter 4 – Analysis of Energy Auditors and Energy Audits

4.1 Introduction

In this chapter, from the research conducted, one finds the list of energy auditors who carry out energy audits on the island. This list includes the name of the firm or individual, together with the address and the contact number.

During this part of the dissertation some energy auditors shall be reviewed. This chapter contains information such as the number of energy audits that were carried out and the number of organizations that benefitted from the energy audits, the methodology that the energy auditors used, certain outcomes from the energy audits which comprise CO2 emissions reduction, financial and energy (kWh/year) savings, and general qualifications of the energy auditors.

4.2 The Energy Auditors List

In this section all the energy auditors in Malta are presented. Research was done via different mediums. In fact this part of the thesis involved looking up telephone directories, exploration via the internet and public information which was published by government entities. Table 4.1 shows the list obtained from the Yellow Pages directory, while on the other hand, no information was found regarding energy auditors on the Malta Business directory. The same procedure was applied for the GO p.l.c. directory and once again no energy auditors were found. Meanwhile the list of the energy auditors which are published by Malta Enterprise were presented in Chapter 3, Table 3.3.

Energy Auditor Name	Address	Contact Number
Advanced Industrial Systems LTD	BLB 903, Qasam Industrijali, Bulebel, Zejtun. ZTN 3000	21 803 350
Buhagiar Vincent	107, Ta' Gelandri, Triq il- Kbira, Qormi. QRM 1104	21 449 930
Calleja Formosa Energy Saving	Paradise, Triq Fra Bashal, Zebbug	77 015 151
CD Power Saving LTD	Fugi tech Center, Ciancio House, Triq il-Kanun, Qormi. QRM 9030	21 480 500
Chi Consultants	Cauchi Flats, Flat 2, Triq l-Gholjiet, Mellieha. MLH 2105	27 028 452/ 79 324 179

ECO Group LTD	BLB 13, Qasam Industrijali, Bulebel. Zejtun. ZTN 3000	20 998 979
Econing Engineering Consultants LTD	4, Triq il-Katlan, Attard	99 231 231
EES	47, Carmel, Flat 6, Triq Salvu Psialla, B'Kara. BKR 9072	79 056 990
Elextrofix LTD	Triq Valletta, Qormi. QRM 3406	21 675 353
Engineria LTD	43, Villa Eugenie, Triq Mannarino, B'Kara. BKR 9085	22 019 241/ 79 050 754
Fenech Etienne	Tai Ping, Triq E. Bradford, Naxxar. NXR 2213	99 828 484
Med. Technical Services LTD	Central Complex, 2nd Floor, Triq in-Naggar, Mosta. MST 1761	21 442 773
MIEMA	Triq Mikiel Anton Vassalli, Valletta	21 331 505
Renergy LTD	Triq il-Kbira, Balzan. BZN 1259	21 322 999
S. Mizzi Engineering & Automation	Thanks God, Triq Guze Muscat Azzopardi, Qormi. QRM 2666	79 200 714
Sammut and Associates	Manzar, Triq Jean De La Vallette, Naxxar. NXR 1205	21 435 082/ 99 468 228

Table 4.1 shows the list of the Energy Auditors obtained from the Yellow Pages Directory.

As regards the internet search there were the same number of energy auditor firms or individuals' data which can be found on the telephone directory, but another five additional organizations were found which are shown in Table 4.2.

Energy Auditor Name	Address	Contact Number
Engineering Services Limited	76/1, Gorse Street, B'Kara. BKR 4757	21 440 204/ 21 490 472
MICS Limited	53, Triq il- Ortolan, San Gwann.	21 384 723/ 99 497 623
2M Energy Solutions	31, St. Josph Street, Pieta. PTA 1142	2122 8264
Nel Services Limited	Central Court 5, Triq tal - Qroqq, Msida. MSD 1703	21 338 490
ECL Consulting Engineers - Alosio Johan	17, Triq il - Modd, Ibrag, Swieqi. SWQ 2373	99 868 828

Table 4.2 shows the list of additional Energy Auditors obtained from the Internet.

Hence from the information obtained, one can conclude that there are 27 energy auditors around Malta and Gozo.

4.3 Energy Auditor Research

In this section there will be an analyses regarding several energy auditors where details vis-à-vis their energy audit implementation shall be in print. In some cases certain relevant works and projects that were conducted recently shall also be presented.

4.3.1 MIEMA

The Malta Intelligent Energy Management Agency (MIEMA) was set up in 2007 with support of the Intelligent Energy Europe (IEE) Program, with a wide array of public institutions including the Ministry of Tourism and Culture, the Ministry of Resource and Rural Affairs, the Parliamentary Secretariat for Small Business and the Self Employed in the Ministry for the Competitiveness and Communications, Local Councils, the Malta Resource Authority and the University of Malta (MIEMA, 2012).

The main aims of MIEMA are in line with all the IEE supported Energy Agencies. These goals shall lead European countries towards a more intelligent use of energy resources. In fact, these objectives include promoting awareness initiatives, defining specific proposals and policies in order to optimize the use of conventional energy resources and hence to introduce renewable energy.

MIEMA activities are intentionally focused on specific areas and the main spectrum is tourism industry. In fact the case study that is going to be analyzed, which was conducted by the two electrical engineers who work with MIEMA, is related to the hotels in the tourism sector.

Hotels consume very large amounts of energy and are thus responsible for quite large amounts of carbon dioxide emissions. The study conducted by MIEMA shows that the total annual amount of CO2 emissions are equivalent to 240 Giga tons amongst the 21 hotels that carried out an energy audit. The energy audits that were implemented in several hotels around the island identified certain points in order to reduce the energy usage and hence reduce the utility bills. Figure 4.1 shows the distribution of 240 Giga tons of CO2 amongst the listed hotels (MIEMA Energy Audit Report, 2010).

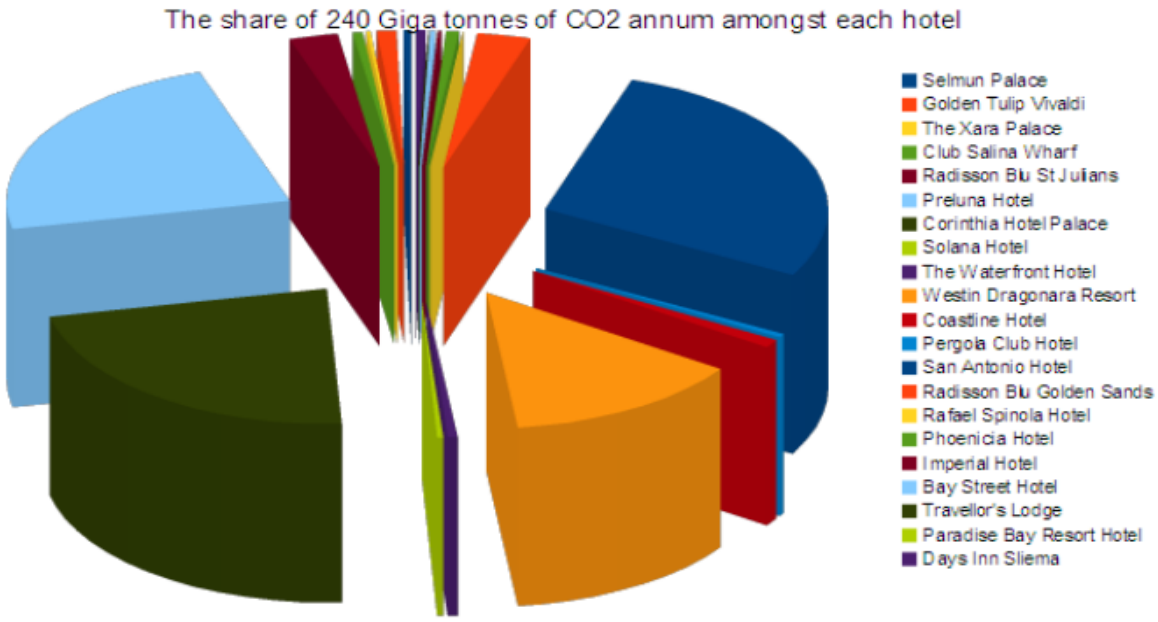

Figure 4.1 shows the distribution of 240 Giga tons of CO2 amongst the listed hotels.

The types of energy audits conducted were walk-through energy audits and these identified that the main contributors to green house gasses were light fittings, machinery, and various appliances for heating and refrigeration purpose. The study revealed that the total annual amount of energy consumption in kWh reached 34 million units (kWh), as shown in Figure 4.2.

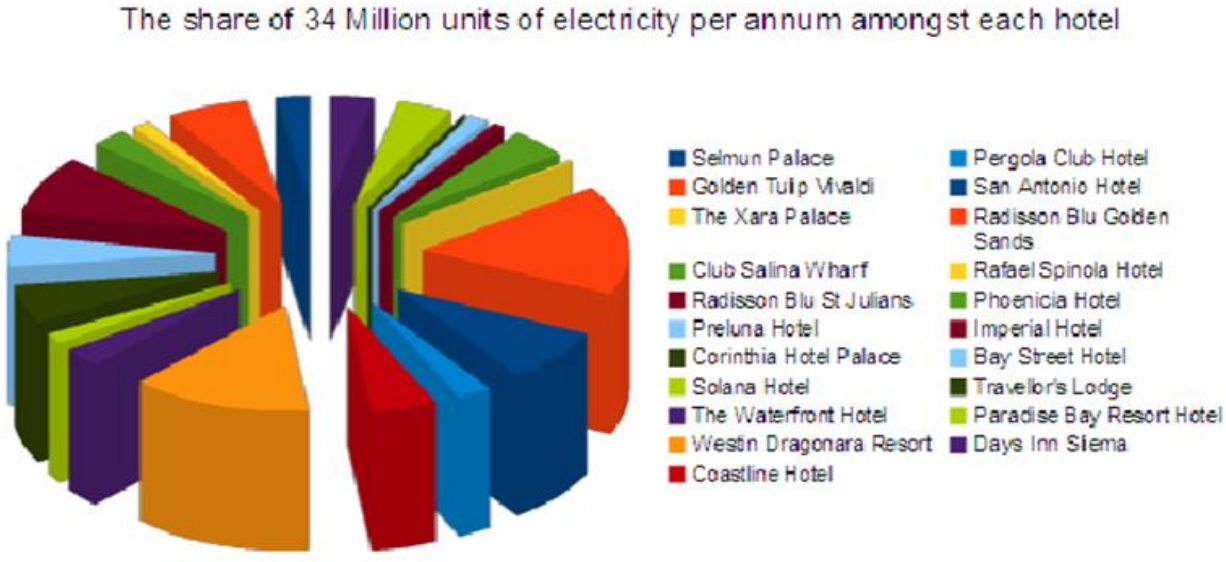

Figure 4.2 shows the distribution of 34 million units of energy consumption among the 21 hotels.

Hotels use a considerable amount of water, the production and distribution of which requires energy. The results show that in 2008, Water Services Corporation produced 18 million cubic meters of water from its reverse osmosis plants. This required 4 units of electricity per unit of water (MIEMA Energy Audit Report, 2010). Another 12 million cubic meters of water were extracted from underground water, using 0.85 units of electricity per unit. Also in order to circulate water to reach our taps, an additional 2 units of electricity were required for each unit of water. But since there were approximately about 25% losses in pipelines, the extraction and delivery of water per unit amounted to an average of 6.67 units of electricity (MIEMA Energy Audit Report, 2010). The energy audit also concluded that the approximate water consumption among the 21 hotels was of 215 thousand cubic meter of water, as shown in Figure 4.3 (MIEMA Energy Audit Report, 2010).

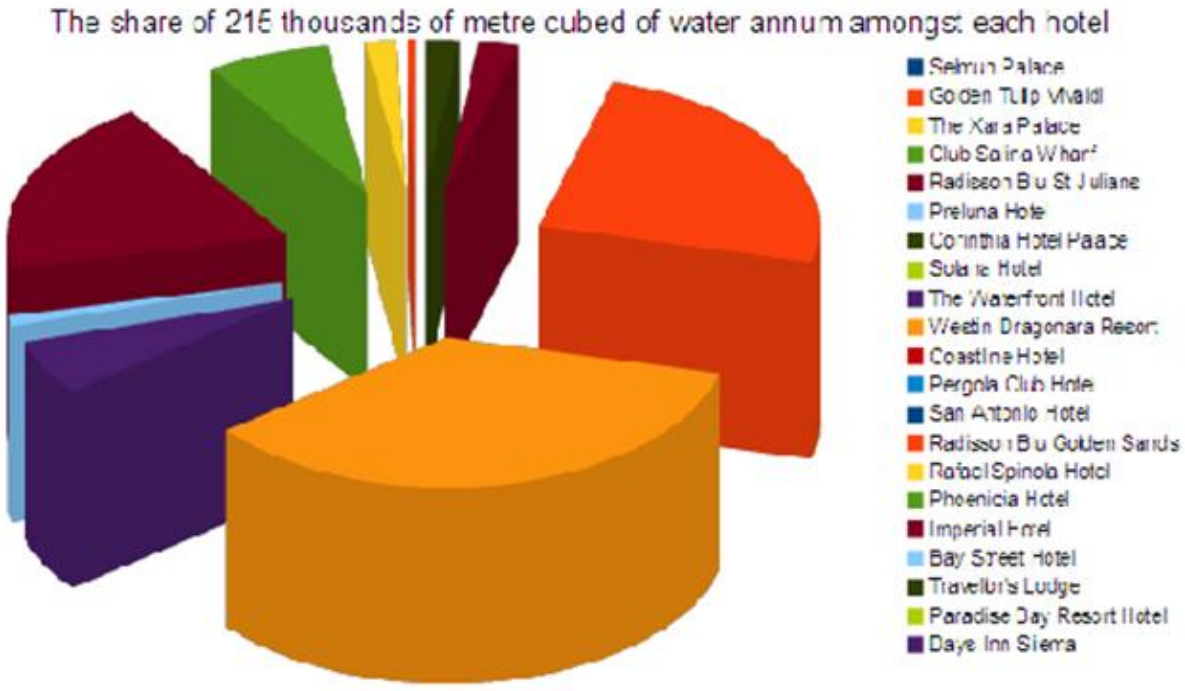

Figure 4.3 shows the distribution of 215 thousand of m^3 of water consumed among the 21 hotels.

The main recommendations that were identified by MIEMA energy auditors were to introduce renewable energy sources in order to generate electricity and hence reduce the utility bills and CO2 emissions. Another recommendation was to shift towards certain higher efficient equipment such as power factor improvement, CHP, high efficiency motors and variable speed drives, space

heating and cooling, office equipment including PCs' standby losses, and door sensors and higher energy efficient lighting. As regards appliances, the main recommendations were to ensure that the appliance energy was the best available in terms of efficiency as indicated by its energy label and to place the refrigerators away from the ovens. Furthermore, refrigerators shall be kept clean in terms of ice or frost since a layer of ice of 5mm would increase the electricity consumption by 30% (MIEMA Energy Audit Report, 2010). With reference to air conditioning it was noted that in certain hotels preventive maintenance was lacking and hence the filters of the air conditions were dirty. Also in certain circumstances the curtains were blocking the air conditioning ducts. Another fundamental point was to set the temperature of hot water to a maximum temperature of 60°C since a variance of 1°C would result in an 8% of energy consumption (MIEMA Energy Audit Report, 2010). Other suggestions were given for the residents' rooms which included the adoption of smart card automation in rooms in order to avoid any unnecessary lighting consumption and to introduce sensors for air conditions so that once the window is opened the air condition would switch off. Moreover in certain hotels, glass tinting was also recommended in order to provide adequate solar illumination and protect costumer privacy. Glass tinting would reduce the humidity of the building irrespective of the season of the year, while on the other hand sun light would be blocked and hence less air conditioning would be required. The final recommendation that was suggested was that where the solar water heating could not be implemented due to various reasons, an instant water heater should be used in order to eliminate storage of hot water. Instant water heaters operate with a 5kW element and warm water instantly (MIEMA Energy Audit Report, 2010).

In the following section a small number of energy audits that were conducted by MIEMA in the 21 different hotels are analyzed. For each energy audit, the idea was to assess and quantify the present system, and with the right investment hotels could save energy and hence in the long run save money. This was possible by identifying the main sources of energy consumption. In fact this was divided into five main parts, which include lighting, method of heating water, heating, cooling and air conditioning (HVAC), electronic data processing and all other power sources.

In our island there are 186 hotels, apartment-hotels, guest houses and hostels, 9 of which are in Gozo. Table 4.3 shows the distribution of the establishments by type and category, and the corresponding number of bedrooms (MIEMA Energy Audit Report, 2010).

Type	Category	No. of Establishments	% of Total	No. of Bedrooms	% of Total
Hotel	Five Star	16	8.60	3547	20.28
	Four Star	41	22.04	6830	39.06
	Three Star	45	24.19	4258	24.35
	Two Star	11	5.91	366	2.09
Apart-hotel	Four Star	7	3.76	547	3.13
	Three Star	10	5.38	756	4.32
	Two Star	11	5.91	473	2.71
Guesthouse	COMFORT	12	6.45	143	0.82
	STANDARD	22	11.83	275	1.57
Hostel	HOSTEL	11	5.91	291	1.66
Totals		**186**	**100.00**	**17486**	**100.00**

Table 4.3 shows the distribution of accommodation by type and category.

From Table 4.3 it is clear that the highest represented categories are the four and three star hotels, with 46.24% of all establishments and 63.41% of the total number of bedrooms. These numbers rise to 55.38% and 70.86% respectively if the apart-hotels are included in the same categories.

4.3.1.1 Coastline Hotel

The Coastline Hotel is a 4-star hotel located in Bahar ic-Caghaq. The hotel has 207 rooms, with an average room area of 34m^2 (MIEMA Energy Audit Report, 2010). Figure 4.4 shows a top view of the Coastline hotel.

Figure 4.4 shows a top view of the Coastline hotel.

From the energy audit that was carried out, it was found that the annual electrical consumption of the building was 1,945MWh, which is equivalent to 2,033 tons of CO2 emissions per annum. There are also CO2 emissions from other sources such as from water supply. The Coastline hotel uses central heating in order to heat the hotel during the cold periods since it is economically viable. In fact boilers are used and the combustion of fossil fuels is employed to heat the large amounts of water which are circulated through all the floors. Such a system is also known as secondary heating system or heat exchanger. The types of fossil fuels which are commonly used are diesel, light heating oil and LPG. Coastline hotel uses light heating oil and LPG and the annual CO2 consumption rate is 329.5 and 32.6 tons respectively (MIEMA Energy Audit Report, 2010). Hence the total amount of CO2 emissions per annum is equivalent to 2,386.2 tons.

The Coastline hotel also has a restaurant, four elevators, an indoor swimming pool, an outdoor swimming pool, a shop, a sauna and twelve administrative offices apart from the residential rooms. Figure 4.5 shows the distribution of the total CO2 emissions per annum which come from different sources of energy as indicated in the tally.

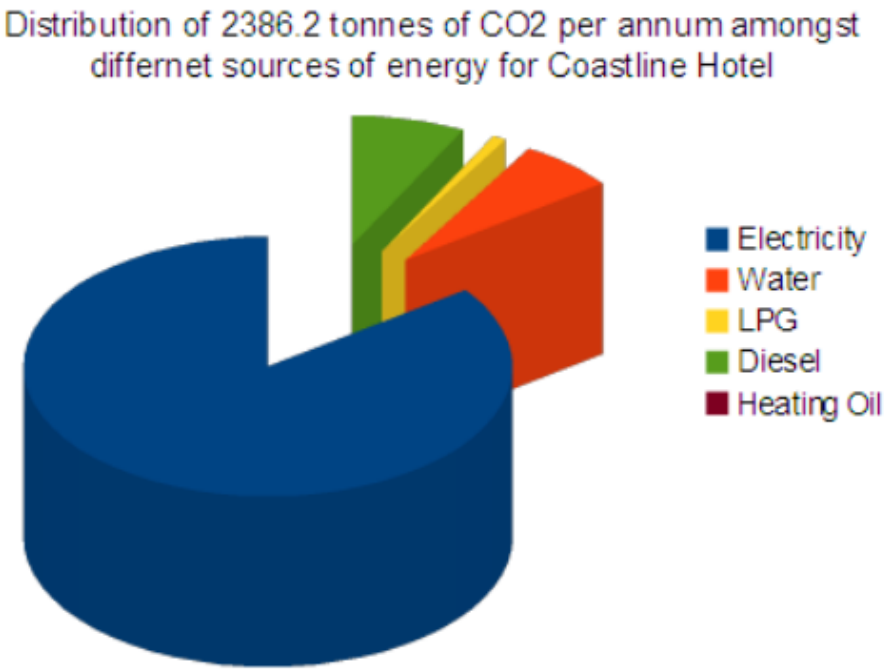

Figure 4.5 shows the annual CO2 emissions from the various sources for the Coastline hotel.

A 480kW chiller is used for the cold water production at 5°C. The hot water temperature was set at 60°C. Coastline hotel makes use of high efficiency lighting and the type of refrigerant used is R22.

4.3.1.2 Corinthia Palace Hotel

Corinthia Palace Hotel is a 5-star hotel located in Attard in the central part of Malta. This hotel has 152 rooms, with an average room area of 21m^2 (MIEMA Energy Audit Report, 2010). A top view of the Corinthia hotel is shown in Figure 4.6.

Figure 4.6 shows a top view of the Corinthia hotel which is situated in Attard.

From the walk-through energy audit which was conducted in this hotel, it was noted that the annual energy consumption was equal to 2,223 MWh which is equivalent to 2,323.7 tons of CO2 emissions per annum. Corinthia Palace hotel also utilizes central heating during the cold periods. The fossil fuel sources used for central heating are diesel and LPG. In fact 230.9 tons of diesel were used, while on the other hand 51,752 tons were used in LPG. Hence the total amounts of CO2 emissions per year were 54,307.6 tons (MIEMA Energy Audit Report, 2010). Figure 4.7 shows the annual distribution of CO2 emissions from the various sources for the Corinthia Palace hotel.

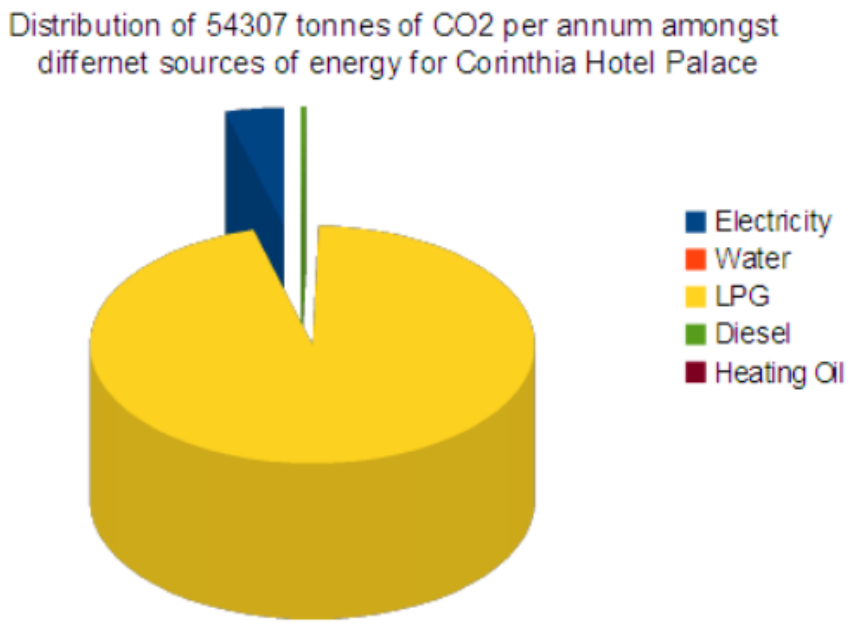

Figure 4.7 shows the annual CO2 emissions from the various sources for the Corinthia Palace hotel.

Apart from the residential rooms, Corinthia Palace hotel has a restaurant, one indoor and one outdoor swimming pool, five elevators, three shops, one sauna and six offices (MIEMA Energy Audit Report, 2010). Cold water production is done by a 500kW chiller at 5°C. The temperature is set at 60°C for hot water. This hotel has already done an investment in solar water heating and the type of refrigerant used is R22.

4.3.1.3 Luna Hotel

The Luna Hotel is a 3-star hotel which is located in the northern part of Malta, Mellieha. The hotel comprises of 114 rooms and its facilities are distributed over 6 floors (MIEMA Energy Audit Report, 2010). This hotel conducted an energy audit, since at the moment when this exercise was carried out, it used to open seasonally, but nowadays a refurbishment was completed and is operating all year round. The hotel was built in 1982. However the last adaptation was finished in 2004. Figure 4.8 shows the top view of the Luna hotel. Apart from the residential rooms, the Luna hotel comprises of a restaurant, coffee shop, one kitchen and a chiller for refrigeration purpose, three elevators and a lounge. The chiller is used for cooling purpose only, while hot water is supplied from a boiler. This hotel also invested in solar water heating

which is used in conjunction with the boiler for central heating and hot water purpose. The Luna hotel makes use of Compact Fluorescent Light (CFL's) fittings in the residential rooms. It is also noted that the waste water is discharged into the city water system. Finally the type of refrigerant that is used in this particular hotel is R22 (MIEMA Energy Audit Report, 2010).

Figure 4.8 shows the top view of the Luna hotel which is situated in Mellieha.

The typical yearly electricity consumption of the building under study was of 327,094 kWh. This translates to emissions of 387,985 kg of CO_2 per annum (MIEMA Energy Audit Report, 2010). Table 4.4 shows the list of energy consumption with the load type in kWh/year, together with the assumed load in kWh/year and the actual load percentage for the Luna hotel.

List of Energy Consumers		
Total Fixed load kWh/year	Assumed load kWh/year	% actual
Lighting	10230	3.1
A/C Equipment	44500	13.6
EDP equipment	18220	5.6
Other Power	254144.43	77.7
TOTAL:	327094.43	100

Table 4.4 shows the list of Energy Consumers at the Luna Hotel.

Table 4.5 shows the water consumption for the period between 15th June 2010 and 9th December 2010. The table shows that the average water consumption per day was 19.09m³. Thus within 199 days the water consumption reached 3,799m³.

Inv. Number	*From*	*To*	*No of Days*	*Consumed [m3]*	*Average per Day [m3]*
	15 Jun '10	***9 Dec '10***	***199***	***3799***	***19.1***

Table 4.5 shows the water consumption for the period 15/6/10 and 9/12/10 at the Luna hotel.

Table 4.6 shows the electricity consumption for the period between 15th June 2010 and 9th December 2010. The table shows that the average electrical consumption per day was 1,276.45kWh. Thus within 199 days the electricity consumption reached 254,015kWh.

Inv. Number	*From*	*To*	*No of Days*	*Consumed [kWh]*	*Average per Day [kWh]*
	15 Jun '10	***9 Dec '10***	***199***	***254015***	*1276.46*

Table 4.6 shows the electricity consumption for the period 15/6/10 and 9/12/10 at the Luna hotel.

Hence after analyzing all the information which was collected when inspecting the building the following nine recommendations were noted, as shown in Table 4.7. Given that all the mentioned recommendations were implemented, the total capital investment reached €45,473 while the average payback period would be 2.65 years. On the other hand, the annual saving in kWh would reach 100,947.9 units (MIEMA Energy Audit Report, 2010).

Notes:	Quantity	Savings	Capital	Annual Saving	Payback	Return
		Watts	Euros	kWh	years	%
12 Hour 4x40 replaced with LED tubes utilizing the same fixtures	4	128	384	*2242.6*	1.01	80
24 Hour CFL replaced with LED's utilizing the same fixtures	71	10	1065	6219.6	1.01	90.91
5 Hour CFL replaced with LED's utilizing the same fixtures	750	10	7500	13687.5	3.22	90.91
14 Hour CFL replaced with LED's utilizing the same fixtures	10	10	100	511	1.15	90.91
replacement of existent R22 refrigerator with A+ energy efficient with a star rating of 4 utilize R600 refrigerant	64		28800	35200	4.81	78.57
replacement of existent R22 refrigerator with A+ energy efficient with a star rating of 4 utilize R600 refrigerant	4		1800	2200	4.81	0.5
replacement of existent washing machine with A+ energy efficient with a star rating of 4	2		1920	23126.4	0.49	0.4
replacement of existent tumble dryer with A+ energy efficient with a star rating of 4	2		1952	15768	0.73	0.4
replacement of existent dishwasher with A+ energy efficient with a star rating of 4	2		1952	1992.9	5.76	0.3
			45473	***100947.9***	***2.65***	

Table 4.7 shows the recommendations that were noted after the building inspection at the Luna hotel.

Figure 4.9 shows the payback period for each of the recommended applications. One can note that introducing LED's instead of fluorescent tubes would result in an approximate payback period of one year. Another immediate payback investment would be the replacement of the existent washing machine and tumble dryer by a class A+ energy efficient with a star rating of 4. On the other hand, the replacement of the existent dishwasher with a class A+ energy efficient with a star rating of 4, and the replacement of the R22 refrigerant with a R600 refrigerant would have a payback period of nearly 5 to 6 years (MIEMA Energy Audit Report, 2010).

Figure 4.10 shows the percentage rate of investment for each of the recommended applications. The replacement of CFL's to LED's together with the replacement of R22 by R600 refrigerant would have a high percentage rate of investment which results to over 80%, while as regards to the replacement of the existent dish washer, washing machine and the tumble dryer by a class A+ energy efficient with a star rating of 4 would have a low percentage rate of investment which reaches 3% (MIEMA Energy Audit Report, 2010).

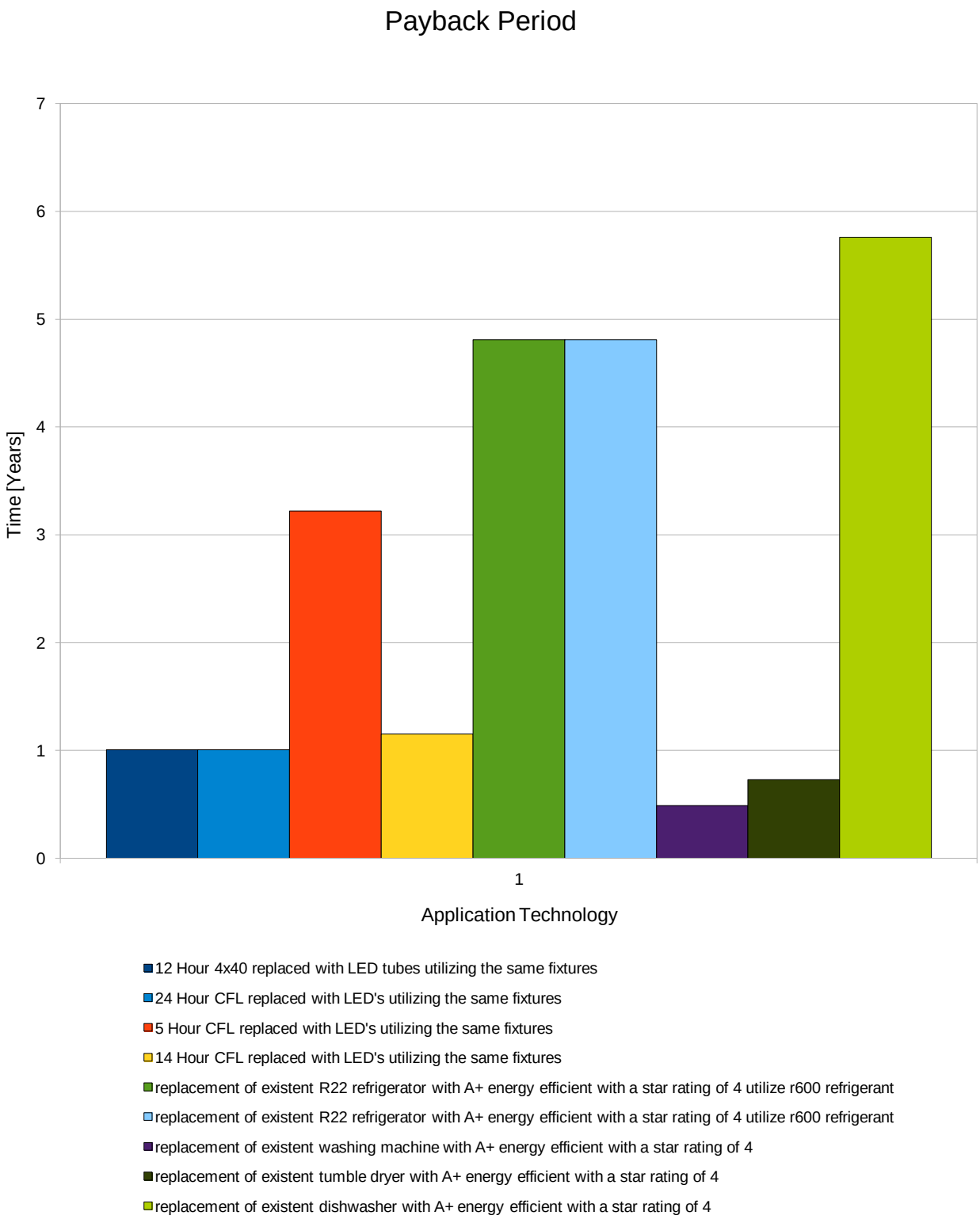

Figure 4.9 the payback period for each of the recommended applications for the Luna hotel.

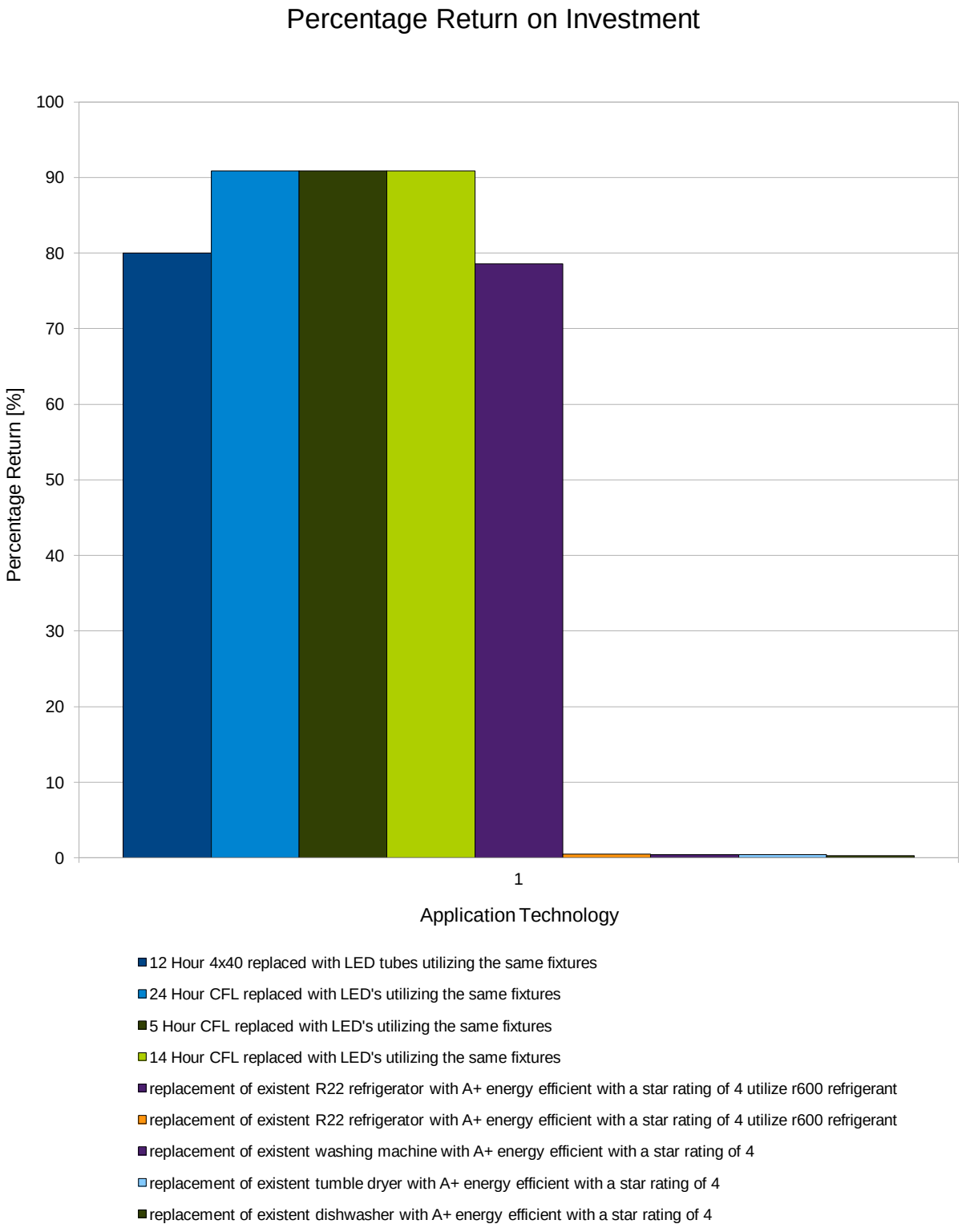

Figure 4.10 shows the percentage rate on investment for each of the recommended applications for the Luna hotel.

Table 4.8 clearly shows that the actual consumption in kWh was 327,094.43 units while with the proposed recommendations the electrical annual consumption would decrease to 226,146.47 units and hence having a difference of 100,947.96 units a reduction of 30.86%.

	Actual	Proposed	Decrease	% Decrease
Annual Consumption (kWh)	327094.43	226146.47	100947.96	30.86%
BEPI (kWh/m²)	69.74	48.22	21.52	30.86%
BEPP (kWh/p)	2869.25	1983.74	885.51	30.86%
BECI (euro/m²)	13.46	9.8	3.66	27.19%
Cost of Energy in 2010	63142.65	45981.5	17161.15	27.18%

Table 4.8 shows the actual consumption in 2010 together with the proposed recommendations as well as the difference between the two.

In Table 4.8 there are three abbreviations which imply the following:

- BEPI: Building Energy Performance Index in (kWh/m²).
- BEPP: Building Energy per Person in (kWh/p).
- BECI: Building Energy Cost Index in (euro/m²)

4.3.1.4 Day and Residential Centers for the Elderly

MIEMA also conducted 25 energy audits in day and residential centers for the elderly around Malta. The decision to select these buildings for carrying out energy audits was based on the importance of these institutions in the life of their communities. Thus by visiting almost half of the 54 municipalities in Malta, MIEMA boosted its visibility and enhanced its relevance for local communities (MIEMA Energy Audit Report, 2010).

The day and residential centers are situated in central locations of their respective villages and occupy a prominent place in the life of their community. These day centers are run by the Ministry of Health, the Elderly and Community Care (MIEMA Energy Audit Report, 2010). The main purpose of these day centers is to prevent social isolation and to reduce social interaction difficulties which older persons tend to encounter.

As regards to the day center buildings, these are usually found at ground floor level and have an average area of 90m². These day centers consist of an office, kitchen, toilets, large dining and common area. The type of energy audit that was carried out in all the day and residential centers was a walk through audit and the energy audits were carried out in the following villages:

- Birzebbuga
- Bormla (Cospicua)
- Birkirkara
- Dingli
- Luqa
- Qormi
- Mosta
- Hamrun
- Attard
- Santa Venera
- Sliema
- Mtarfa
- Zurrieq
- Zejtun
- St. Paul's Bay

The methodology used during these energy audits was based on the set of guidelines that the European Commission offers on energy audits which is the European Green Building Program Energy Audit Guidelines (MIEMA Energy Audit Report, 2010). The energy audits were implemented by an audit team which was made up of graduate engineers under the guidance of experienced engineers.

Results show that the electricity consumption for the day and residential buildings under study were in a range between 1,043kWh and 23,818kWh which translates into 1,090.27kg and 24,879.43kg of CO2 emissions respectively (MIEMA Energy Audit Report, 2010). The main factor of this high consumption was the lighting. In fact the light fittings were T8 light fluorescent tubes and hence these could be easily be replaced by T5 light fluorescent tubes. As

regards to refrigeration, the main recommendation was to replace the existent refrigerant gas which is R22 with a more efficient refrigerant gas, such as R600, R410 and R417A (MIEMA Energy Audit Report, 2010). As in the case of A.C. machines, the efficiency can be improved by introducing soft starters and inverters which reduce the electrical consumption significantly.

One main difficulty that was encountered during the energy audits was that the elderly residents that live permanently in a residential center do not pay the utility bills and hence most of the refrigerators still operate with R22 refrigerant gas, hence consuming more energy.

In view of domestic hot water, which includes also the circulation of hot water for central heating, the best way to reduce the energy consumption is to use solar water heaters. Where solar water heaters cannot be used, present electrical water heaters must have a temperature setting at a maximum of 60°C. The major recommendation regarding electrical appliances was to shift towards Class A equipment which reduces the electrical consumption by 50% (MIEMA Energy Audit Report, 2010).

4.3.2 Malta Enterprise Energy Auditor – Engineer Valislav Baran

Engineer Valislav Baran is one of eight energy auditors appointed by Malta Enterprise to conduct energy audits. Malta Enterprise had a pre - requisite that energy auditors had to be graduates in electrical or mechanical engineering with a number of years of working experience in their field. In fact each auditor had to submit his respective qualification certificates, Curriculum Vitae and had to fill a questionnaire which was issued by the Malta Enterprise.

The type of energy audit that Engineer V. Baran has conducted is a walk through energy audit, where experience and knowledge play an important role when carrying out such an audit. But during the energy audits which were conducted, certain measurements were taken which included power factor readings, unbalancing of three phases, light level, harmonic content and electrical energy measurements. During such audits it was vital that the energy auditor was accompanied by a person who was familiar with the premises in order to provide the necessary data such as number of working hours, maintenance records and occupancy. The methodology used by Engineer V. Baran was the one which conformed to Malta Enterprise standards, which is the Green Building Program, which is an energy audit guideline issued by the European

Commission Institute for Environment and Sustainability Renewable Energy Unit in September 2005 (Malta Enterprise, 2012).

Up to the 20th August 2012, Eng. V. Baran has conducted 17 energy audits with Malta Enterprise and the beneficiaries are shown in Table 4.9.

Beneficiary Number	Beneficiaries Name
1	Barracuda Restaurant
2	BoConcept Urban Design
3	Duraprint Press
4	Engenuity LTD
5	Europrint LTD
6	Golden Harvest Firm - Hamrun Outlet
7	J&A Bonnici LTD packaging industries and printers
8	MCE LTD
9	Melita Cable p.l.c.
10	P. Cutajar Malta 1965
11	Planit Travel Services LTD
12	Rausi Co LTD
13	Ta' Cassia Salina Restaurant
14	The Bakery Shop - Naxxar
15	ULF Furniture
16	Vino Veritas Restaurant
17	Windsor Co. LTD

Table 4.9 shows the Beneficiaries that benefitted from Energy Audits conducted by Eng. V. Baran for Malta Enterprise.

Table 4.10 shows the energy savings in terms of kWh/year, the CO2 emissions in metric tons and the main recommendations that Eng. V. Baran has given for each beneficiary when carrying out an energy audit for Malta Enterprise.

	Beneficiaries	Energy savings (kWh/year)	CO2 emissions (metric tons)	Main recommendations
1	Barracuda restaurant	3300	2.9	1. Replacement of T8 fluorescent tubes with T5 in restaurant and pizzeria kitchen 2. Pizzeria Kitchen installation of Variable Speed Drive (VSD) for exhaust fan
2	BoConcept urban design	9000	7.9	1. Replacement of T12 fluorescent tubes with T5 2. Replacement of 50 W halogen bulbs with 35W metal halide in both showrooms 3. Applying the thermal insulation coat on the walls which are exposed to the sun 4. Installation of double glazed air (argon) filled windows with 6mm air gap 5. Utilization of the roof area for renewable energy generation
3	Duraprint Press	2000	1.75	1. Replacement of present lights of the linear fluorescent tubes T12 technology with T5 technology in manufacturing area 2. Installation of motion sensor in store area Installation of solar panel for hot water domestic use 3. Installation of VSD unit for printing machine 4 kW motor 4. Utilization of the free roof area for renewable energy generation (PV)
4	Engenuity LTD	3150	2.5	1. Replacement of present lights of the linear fluorescent tubes T8 technology with T5 technology in all areas 2. Installation of timers for the lighting 3. Installation of proximity switch for the lights in the store area 4. Applying thermal insulation on the roof 5. Applying tin film filters on the windows 6. Utilization of the free roof area for renewable energy generation (PV)
5	Europrint LTD	7000	6	1. Installation of timers to control the lights during “out of office” hours and weekends. The timers to be installed:

				○ In open production area ○ In offices area 2. Replacement of present lights of the linear fluorescent tubes T12 and T8 technology with T5 technology 3. Applying thermal insulation coat on the roof 4. Installation of centralized air/vacuum compressed system 5. Installation of power factor correction equipment 6. Utilization of the free roof area for renewable energy generation
6	Golden Harvest Firm (Outlet in Hamrun)	700	0.6	1. Regular maintenance of A/C system and refrigeration equipment 2. Replacement of the coffee machine by a smaller one 3. Adequate setting of the fridges temperature set point 4. Adequate setting of hot water heater temperature 5. Replacement of bulbs with filaments by energy saving ones 6. Replacement of present lights of the linear fluorescent tubes of T8 technology with T5 technology in shop area. 7. Elimination of the water pump (if applicable) 8. Redesign of the lighting system
7	J&A Bonnici LTD packaging industries and printers	48000	41	1. Replacement of present lights of the linear fluorescent tubes T12 and T8 technology with T5 technology 2. To increase the size of the compressed air pipes 3. Installation of 5th colour stack for printing machine 4. Replacement of the old paper bag machines with new once 5. Installation of a new air compressor unit for printing machine. Unit should be equipped with a VSD for the motor and with an air dryer.
8	MCE LTD	8500	7.4	1. Installation of motion sensors in Shop's store 2. Installation of motion sensors in Tool shop's store. If the frequent switching on/off operation effects the life time of the tubes, dimmable system to be taken in consideration. 3. To install more motion sensors in Garage 4. Replacement of incandescent bulbs with energy saving ones.

				5. Regular maintenance of A/C system 6. Replacement of present lights of the linear fluorescent tubes T8 technology with T5 technology as per above recommendations. 7. Retrofit of Variable Speed Drive for water pump of A/C system and installation of two way valves for each fan coil units. However, a minimum flow of water has to be provided all the time, when chiller is ON. 8. Applying thermal insulation coat on the walls that are exposed to the sun 9. Utilization of the free roof area for renewable energy generation. As per present technology it can be expected production of approximately 1600 kWh per 1 kWp of installed PV power. Installed PV power of 1 kWp takes about 7m^2. It is expected that investment cost would be roughly €3000/kWp.
9	Melita Cable Public Limted Company	It was difficult to estimate possible energy savings in kWh		1. To continue with replacement of present lights of the linear fluorescent tubes T8 technology with T5 technology 2. HVAC preventive maintenance 3. Foresting the ground around the building 4. Installation of Power factor correction equipment 5. Installation of VSD for cold water pump 6. Installation of SCADA system 7. Utilization of the roof for renewable energy (if feasible)
10	P.Cutajar Malta 1865	47000	41	1. Installation of timers to control the lights during “out of office” hours and weekends. 2. The remote controllers of split type A/C units to be set on 21 deg C and timer to be utilized accordingly. 3. Replacement of present lights of the linear fluorescent tubes T8 technology with T5 technology 4. Installation of motion sensors in the warehouse at basement level. 5. Replacement of the HP mercury and halogen lamps with metal halide ones. 6. Installation of solar panels for the hot water domestic use 7. Installation of double glazed windows’ 8. Applying thermal insulation coat on the walls that are exposed to the sun 9. Installation of power factor correction equipment

				10. Utilization of the free roof area for renewable energy generation
11	Planit Travel Services LTD	3000	2.5	1. Installation of timers for two hot/cold water dispensers in the kitchens 2. Replacement of present lights of the linear fluorescent tubes T8 technology with T5 technology in all offices and corridors 3. Installation of timers for the lights 4. Installation of solar water heater (elimination of two present water heaters) 5. Applying thermal insulation on the roof 6. Replacement of single glazed windows with double glazed 7.Installation of PV system
12	Rausi Co LTD	60000	41	1. Installation of motion sensors in store A, B and C. If the frequent switching on/off operation effects the life time of the tubes, dimmable system to be taken in consideration. 2. Installation of motion sensors in “little people” store 3. The remote controllers of split type A/C units to be set on 21 deg C and timer to be utilized accordingly. 4. Installation of timer for vending machines in the canteen area 5. Utilization of installed power factor equipment 6. Replacement of present lights of the linear fluorescent tubes T8 and T12 technology with T5 technology 7. Replacement of the HP mercury lamps with metal halide ones in old reception area 8. Replacement of 2x55W light fittings with metal halide 70W spot light 9. Applying thermal insulation coat on the walls that are exposed to the sun 10. Utilization of the free roof area for renewable energy generation
13	Ta'Cassia Salina Restaurant	3500	2.5	1. Installation of separate switches for the ceiling fans in outer restaurant 2. Regular maintenance of fridges and freezers 3. Installation of timers in electrical circuits for the kitchen’s equipment 4. Optimising utilisation of the kitchen equipment

				5. Replacement of present lights of the linear fluorescent tubes T8 technology with T5 technology in kitchen 6. Installation of timers for small fridges 7. Installation of control for the exhaust fans 8. Installation of solar water heater 9. To investigate installation of gas water heater instead of electrical one 10.To investigate installation of temperature control for pasta cooker
14	The Bakery Shop (Naxxar)	2000	1.7	1. Regular maintenance of A/C system and refrigeration equipment 2. Replacement of the coffee machine by a smaller one 3. Adequate setting of the fridges temperature set point 4. Adequate setting of the water temperature set point of water heater 5. Replacement of present lights of the linear fluorescent tubes T12 and T8 technology with T5 technology in: • shop-grocery area • shop at basement level • offices 6. Installation of motion detection devices to control the lights in the shop at basement level and offices 7. In case of major refurbishment, to provide exhaust of hot air from fridges and freezers condensers, and divert the flow of this air from the shop area.
15	ULF furniture	6500	5.5	1. Replacement of present lights of the linear fluorescent tubes T8 technology with T5 technology in production areas 2. Installation of timers for the lights in the production areas 3. Replacement of halogen lamps with CFL in the showroom 4. Installation of motion sensors in the showroom 5. Installation of solar panel for the hot water domestic use 6. Applying thermal insulation coating on the roof 7. Installation of power factor correction equipment 8. Installation of variable speed drive unit for exhaust blower 7.5 kW 9. Installation of double glazed windows ‘or applying

				tin film filters 10. Utilization of the free roof area for renewable energy generation (PV)
16	Vino Veritas restaurant	3000	2.5	1. Installation of motion sensor in toilet and replacement of CFL with energy saving halogen 2. Replacement of the 4 incandescent bulbs at entrance 3. Regular maintenance of A/C system 4. Replacement of present lights of the linear fluorescent tubes T8 technology with T5 technology in kitchen 5. Installation of timers for small fridges 6. Installation of control for exhaust fans 7. Installation of gas water heater instead of electrical one 8. To investigate installation of temperature control for pasta cooker 9. In case of major refurbishment, separation of kitchen area from restaurant in order to prevent heat transfer. This will reduce the heat load inside the restaurant and probably reflect on the energy saving, but however a good extraction system has to be installed inside the kitchen.
17	Windsor Co LTD	22000	19	1.To reduce operating compressed air pressure from 8 to 7 bar 2. Installation of soft start/stop unit for the hydro-vane 15kW air compressor 3. Replacement of present lights of linear fluorescent tubes T8 technology with T5 technology 4. Installation of motion sensors in the carpentry area. 5. Installation of light sensor in production area on first floor 6. Replacement of HP mercury with T5 fluorescent tubes 7. Replacement of halogen lamps with metal halide ones, for outside lighting 8. Installation of solar panel for the hot water domestic use 9. Installation of double glazed windows' 10. Applying thermal insulation coating on the wall that are exposed to the sun 11. Installation of power factor correction equipment 12. Utilization of the free roof area for renewable

energy generation

Table 4.10 shows energy savings in terms of kWh/year, the CO2 emissions in metric tons and the main recommendations that Eng. V. Baran has given for each beneficiary.

One can note that the main recommendations were to replace the existent lighting fittings which have a mediocre efficiency to ones which are of higher efficiency. In some cases higher power rating bulbs were changed with bulbs with less power rating in order to reduce the energy consumption and hence reduce the utility bills. Other recommendations included thermal insulation coat on the roof to reduce the temperature inside the rooms and buildings, the introduction of generation of electrical energy via renewable energy such as PV panels which should be installed on the roofs, installation of lighting sensors to reduce unnecessary lighting energy and regular preventive maintenance for the HVAC.

4.3.3 Advanced Industrial Systems LTD

Advanced Industrial Systems LTD (AIS) is an engineering company which is situated in the Bulebel Industrial Estate, Zejtun, with a comprehensive view of design and innovation. This firm was established in 1991 and basically provides solutions offering high quality user experience through holistic technical knowhow, usability and high performance products (Advanced Industrial Systems LTD, 2012). This company has a historical background in process automation and has specialized in time and attendance, access control incorporating biometric technologies, SCADA systems, coding and building management. Advanced Industrial Systems LTD has a strategy to invest in a team of engineers and technicians to deliver high end control systems. It is strategically based in the hub of the Mediterranean and hence this firm provides a comprehensive range of products and services in the region (Advanced Industrial Systems LTD, 2012).

The person responsible for energy audits at Advanced Industrial Systems LTD is Engineer Bernard Brincat and in fact this firm has recorded six audits for industrial facilities and 60 audits for households. Advanced Industrial Systems LTD provides free advice to numerous establishments as part of their sales initiative since this company is related to energy saving solutions. The company does not impose on the client that certain products are bought from

Advanced Industrial Systems LTD and actually none of the six companies that conducted an energy audit with Advanced Industrial Systems LTD purchased any products (Advanced Industrial Systems LTD, 2012). The beneficiary industrial facilities that have conducted an energy audit were a building contractor, two furniture factories, a plastic injection factory and two manufacturing factories. Advanced Industrial Systems LTD did not have a record of the amount of energy saving since the company did not follow whether the recommendations that were given were implemented or not. In fact certain recommendations involved little investment, while others involved certain investment in order to obtain some energy saving. In the latter case, the beneficiaries tended to make gradual adjustments which fit in their yearly budget. Hence since Advanced Industrial Systems LTD did not make a follow up, it was impossible to quote the savings in terms of kWh, economic and CO2 emissions. The methodology used for energy audits by this firm was the Handbook of Energy Audits. The latest version was written by Thumann A. and Younger W.J. in 2008. In fact from the company records, Advanced Industrial Systems LTD conducted the first energy audit in 2008 (Advanced Industrial Systems LTD, 2012).

4.3.4 Energy Efficient Solutions

Energy Efficient Solutions (EES) was founded in 2007 by Engineer Stefan De Marco, who is an engineer by profession and is specialized in energy efficiency (Energy Efficient Solutions, 2012). This company was founded since the topics on global warming, climate change and energy security had become of utmost importance. Energy Efficient Solutions has a multidisciplinary engineering background and hence it acts in a proactive manner to give advice and provide measures as to how to reduce the energy consumption, thus becoming more energy efficient.

Energy Efficient Solutions which is an energy audit firm situated in B'kara was found from the Yellow Pages Directory and Engineer S. De Marco is also a registered assessor for the energy performance rating for dwellings with the Building Regulations Office (Building Regulations Office, 2012). In fact records show that Engineer S. De Marco has conducted 4 domestic and 11 commercial walk through type of energy audits, while on the other hand 8 Energy Performance Certificates were carried out. One can note that all the commercial energy audits that were carried out were all for Middle Sea Valletta Clients (Energy Efficient Solutions, 2012).

The methodology used by Energy Efficient Solutions when carrying out an energy audit was the Handbook for Energy Auditors which was written in 2008 by Thumann A. and Younger W.J. The Technical Guidelines Document F, published in 2006, was also used by Eng. S. De Marco during his energy reduction projects which fall under his responsibility. From the records and the follow ups that were carried out by Energy Efficiency Solutions, one can deduce that the energy savings were between 25 to 43%, but this percentage varied according to the wrong use of electrical energy. Thus in this situation education played an important role since training sessions were organized to highlight the energy saving procedures. Other recommendations included actual changes in the system by making the system more efficient and setting up insulation on the roofs (Energy Efficient Solutions, 2012).

4.3.5 Sammut and Associates

Sammut and Associates was founded in 2009 by the managing director Engineer Christopher Sammut and the company headquarters are situated in Naxxar. This firm has conducted 40 energy audits subdivided into 35 walk through type and 5 detailed types of energy auditors. The methodology used by Sammut and Associates was the Handbook for Energy Audits, which was published in 2008 by Thumann A. and Younger W.J. (Sammut and Associates, 2012).

From the records obtained, the main recommendations that Sammut and Associates provided were to replace the existent systems with higher efficiency equipment in order to reduce the electricity consumption and hence reduce the utility bills. In actual fact the recommendations showed that light fittings of any type should be replaced with LED's and where not applicable T5 fluorescent tubes should be installed. T5 are 20% more efficient and 50% smaller in volume than T8 fluorescent tubes. Also T5 light fittings have a long life up to 24,000 hours (OSRAM, 2012). Other recommendations included temperature settings of approximately 26°C for the air conditioners, shifting from single glazed windows to double glazed windows, introducing tinting on the window where applicable, air conditioners driven by an inverter in order to reduce the electrical consumption and using higher efficient refrigerant for cooling purposes.

Another fundamental point is that Sammut and Associates does not have minutes whether the recommendations that were given in the energy audit report were implemented or not, so it was

extremely difficult to determine the savings in terms of CO2 emissions, electrical energy and economic point of view.

Chapter 5 - Conclusions and Recommendations

During this dissertation regarding energy audits in Malta, research was conducted in order to find out how energy audits are carried out on this Island and to identify schemes that can promote efficiency and conservation. In fact, certain policies including directives and standards on energy audits were analyzed and a successful program on energy audits in Finland was described.

As part of the research work, all entities that are responsible for energy issues were analyzed. Malta Enterprise, Malta Competition and Consumer Affairs Authority (MCCAA), Ministry of Resources and Rural Affairs (MRRA), Malta Resource Authority (MRA) and the Building Regulations Office (BRO), were chosen in order to view their respective contribution towards energy audits and hence reducing the energy consumption in various organizations.

Results showed that there is a sense of awareness from the industry sector regarding energy audits and hence on energy saving. This was shown from the number of firms that benefitted from the various government and European grants which were available in the past years. The main reason for energy saving was to reduce the utility bills, given that the utility tariffs were quite expensive, but this command and control measure in Malta was giving the desired environmental results since less fossil fuel was being burned and less CO2 emissions were being emitted.

Presently in Malta, there are no policies on energy audits and energy auditors. Hence it is the proper time to introduce a policy that guarantees that the energy auditor is licensed and qualified, and that certain procedures must be followed when conducting an energy audit. In solving the policy problem, certain procedures should be followed. First the Agenda needs to be set and thus the problem is identified and defined. Then, policy formulation takes place, where the problem is analyzed in order to understand better the difficulty. The next phase of the policy cycle model is the choice of solution, where some opinion is formulated. Afterwards, the most difficult part of the policy process takes place, where policy design is considered. The next point is the policy implementation, where the policy goal is implemented in order to make the policy real, and finally evaluate the policy to ensure that there are no consequences which could be negative or unintended.

From the data obtained, one can conclude that there are 27 energy auditors in Malta. Three of who are civil engineers, approximately 10% of the energy auditors, while the other 24, roughly 90% of the energy auditors, are electrical or mechanical engineers. As regards the exact amount of electrical and mechanical engineers, it is difficult to determine this information, and hence only an approximation can be taken since there are certain firms that conduct energy audits that employ both type of engineers. But from the results obtained, one is able to predict that 60% of the engineers are electrical, while the remaining 40% are mechanical engineers.

The methodology used by the energy auditors varies and hence one should consider that it is the appropriate time to obtain certain uniformity and hence consistency should be adopted. One can note that, from the results shown, the energy auditors accept two main types of methodologies. The first is the Green Building Program, which is an energy audit guideline and was issued by the European Commission Institute for Environment and Sustainability Renewable Energy Unit in September 2005. In fact, Malta Enterprise stresses the point that the Green Building Program has to be adopted for all energy audits that fall under its responsibility. While on the other hand, the second methodology which is mostly implemented is the Handbook for Energy Auditors which was published in 2008 by Thumann A. and Younger W.J. One can also note that a small minority use the Technical Guideline Document F, which was published in 2006 and deals with the minimum requirements on the energy performance of building regulations.

Another conclusion is regarding the energy auditor's recommendations. Results showed that there are two main types of recommendations. The first was to shift the existent systems to more efficient systems, while the second was to move towards renewable energy rather than using fossil fuels. The latter could be achieved by installing solar water heaters and solar photovoltaic panels on the roof, and where this option cannot be achieved wind turbines were recommended. As regards to the first recommendation, energy auditors listed higher efficiency equipment and certain measures which lead to less energy consumption. These included shifting from filament and compact fluorescent lamps to LED lamps, replacing the existent T8 fluorescent fittings with T5 fluorescent fittings, replacing the induction chokes with high frequency chokes since these types of chokes have a unity power factor, introducing light sensors to avoid unnecessary lighting and using the natural sunlight rather than using artificial lighting. Other measures and recommendations included shifting from existent R22 refrigerant to a more efficient refrigerant

R600, replacement of existent equipment to Class A++ equipment with a star rating of 4, applying thermal insulation coating on roofs and walls which were directly exposed to the sun, replacement of single glazed windows by double glazed windows and installation of power factor correction equipment. Another recommendation was to set the temperature control of air conditioners, fridges, freezers and boilers to the appropriate levels and such equipment had to be cleaned in order to avoid unnecessary electrical consumption. Cases in point were refrigerators where a layer of ice of 5mm would increase the electricity generation by 30% and in the case of hot water from boilers, temperature should be set at a maximum temperature of 60°C, since a variance of 1°C would result in an 8% of energy consumption.

A final recommendation on energy audits in Malta was regarding the education sector. Education had to be specifically provided to graduate professionals in order to cover certain topics since at the current moment energy audits were conducted by using certain experience and practice rather than expertise. In my opinion a short course has to be designed, as in the case of Finland where training courses are organized twice a year. In fact this specific course should include topics such as heat transfer in buildings, air conditioning, heating, ventilation and cooling systems, lighting design systems and electrical power systems. The most important topic is the heating, ventilation and air conditioning (HVAC), where this shall cover over 50% of the overall course.

An energy audit is an effective energy management tool, which identifies and implements a means to achieve energy efficiency and savings. Using this management tool, the life time of equipment and systems can be prolonged and quality can be improved.

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