SSRG International Journal of Economics and Management Studies
ISSN: 2393 – 9125 / https://doi.org/10.14445/23939125/IJEMS-V7I6P112

Volume 7 Issue 6, 76-84, June 2020

Original Article

Energy Accounting and Sustainability: Analysis of Energy Performance in a Manufacturing Company

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Received Date: 09 May 2020
Revised Date: 15 June 2020
Accepted Date: 17 June 2020

Abstract *- For manufacturing companies, one way to gain an advantage over competitors is to reduce product costs and thus improve financial efficiency. Considering its rising prices, energy is one of the key factors in reducing operating costs. Introducing energy accounting to a manufacturing company provides a high level of energy awareness. This paper describes the concept and stages of energy accounting and discusses the role of the accounting information system in energy and sustainability analysis in particular. Through the functions of accounting information systems, energy-related issues come increasingly into view of top management. Abnormalities in energy consumption can be detected to evaluate energy-saving opportunities by simply applying energy performance indicators to the plant or its units where detailed information is needed. The study employs accounting techniques that include energy performance analyses, which make energy efficiency gaps clear and visible. Thus, businesses can develop effective and rational strategies to improve their competitive position in the long term by developing an energy-focused perspective. It also plays an important role to draw attention to the high correlation between consumed fossil energy sources and environmental pollution.*

Keywords *- Energy Accounting, Energy Management, Energy Performance Indicators, Sustainability.*

I. INTRODUCTION

The notion of "energy" deriving from the word "Energia" used in ancient Greek to mean "existence or acting something out" was defined as the ability to do work by the first modern physicists[1], [2]. Energy consumption has been increasing rapidly with the development of civilization and population growth since ancient times. Today, energy is of critical importance for all developed or developing economies with its strategic potential that has caused two major wars in the recent past. From an economic point of view, the value of the energy is determined by the relationship between the availability and the need (or demand) for it [3]. When these two factors interact, it is possible to observe how scarce energy is to deliver a clean environment, high living standards, and good health. Nevertheless, considering the growing necessities with the help of technological developments today, an adequate and affordable energy supply is indispensable for the generations to come. The accounting discipline has the potential to contribute to sustainability, and the academic community in this field needs to increase awareness by conducting research [4].

For many of us, accounting is a concept associated with money, and the relationship with energy might not be directly perceived. Energy is a strategic input for enterprises, and the financial consequences of this input increase its magnitude on the management's agenda. At this point, financial events that take place in an enterprise, like energy costs, fall under the scope of the accounting information system. Energy accounting is as valuable as the energy information it provides to reduce the uncertainty when decision making for businesses operating in today's highly competitive environment. With its traditional role to provide relevant information for decision-makers, and accounting information system may be one of the most effective instruments to increase energy efficiency.

Providing an adequate, safe, and environmentally friendly energy system is one of the most important factors affecting the welfare, competitive position and development of an economy. The problem of providing sufficient energy requires close attention in order to obstruct the tendency of uncontrolled energy consumption[5], [6]. Along with the growing awareness and responsibility for governments, entrepreneurs and society as a whole to respond to threatening environmental issues, including diminishing energy sources and their use, sustainable development concept has been emerged to find out successful remedies to these concerns. GRI Standards, ISO50001 and ESID guidelines are some of the comprehensive efforts focusing on sustainable energy management systems. Once they are implemented in a company, it would mean that a baseline survey of energy use has been completed, and continuous improvement of energy performance will be ensured.

Energy accounting enables the determination of measurable energy cost reduction targets as well as efficient transmission of energy data that can be used to improve energy management. Energy accounting, at the same time, contributes to sustainable development by providing control of the use of scarce resources. There are various performance indicators that are used to evaluate why an energy system in operation is not working

properly, why energy costs are higher than they should be in a particular plant and/or reduce large carbon footprints, which are considered good for both the company and society. In addition, businesses use a variety of energy performance measures to create a baseline for comparing existing energy structures and use them in decision-making processes. The most commonly used energy performance indicators include Energy Utilization Index, One-Shot Productivity Measures and Energy Cost Index. They are important accounting tools that contribute to the integrity, comparability and accuracy of energy data that decision-makers need.

The organization of this paper will be as follows. First, the conceptual framework covering energy accounting and sustainability is outlined. Second, existing literature about energy management and accounting is reviewed. Third, the methodology of the case study, including energy performance indicators, is described. Fourth, implementation of energy performance measurement to the manufacturing enterprise is carried out to support theoretical background. Finally, the findings are interpreted and summarized in the conclusion and recommendation section.

II. LITERATURE REVIEW: ENERGY ACCOUNTING

Although many published pieces of research are easily available in energy management and carbon accounting, publications on energy accounting are lagging behind in literature. In early studies, Fernandes, Capehart, &Capehart, 1997 explained the energy costs that are ignored by traditional costing methods, with an activity-based costing method. California Energy Commission, 2000 dealt with the use of accounting as a key to managing energy costs and current techniques. In order to allow for more comprehensive and generally accepted energy indicators that contribute to sustainable development, IAEA, 2005 published a set of energy indicators for the use and attention of the interested parties at a national level. In the article called Accounting: Energy Use in Plants published in the encyclopedia of energy engineering and technology, energy monitoring and targeting were discussed by Tripp, 2007 in terms of potential deficiencies in traditional performance indexes or energy density and energy performance analysis.

In some other studies, although energy accounting is not the main focus of research, Karslı et al., 2011 stated that energy accounting is a very important tool in terms of energy management as in other cost accounting applications. Bozkurt&Karataş, 2011 addressed the issues that differ in the accounting standards and tax legislation in the energy sector. Dizkırıcı, 2012; Kavak, 2005; Topallı, 2012; Üçüncü, 2016 in their studies, energy accounting, is mentioned among the measures to be taken in order to increase energy efficiency in the industry. Çakal, 2006 emphasized that energy accounting will guide the well-organized energy management system. In his study on energy saving and consumption reduction Wang, 2013, the theoretical basis of the essence, purpose, and elements of energy accounting was revealed. According to the article named Energy Management and Accounting is written by Kırlı&Kulu, 2016. In the study, it is examined with the hypothetical example that optimum use of energy is important in increasing the profitability and productivity of the enterprises and that energy management applications should be utilized to achieve this goal. It is concluded that necessary measures are taken in energy management practices and energy accounting, which is an important sub-information system, will contribute to the production of new policies. According to Georg &Justesen, 2017, accounting professionals should have a more performative role rather than only informing managers in organizational practices. It is argued in Bebbington&Unerman, 2018 that accounting scholars should be more involved in shaping the policies of Sustainable Development Goals by using their potential for detailed analyses, critiques and advanced understanding.

III. CONCEPT OF SUSTAINABILITY AND ENERGY

Sustainability is to provide and guarantee the conditions in which humanity and the environment can live together in productive harmony to support current and future generations. [20]. The basis of this thought is to focus on solidarity with a global perspective, climatic management, social responsibilities and economic solutions and to give up living predominantly in the form of consumer society [21]. In fact, there is a basic principle behind sustainability: the sources of almost everything we need to sustain our lives lies in nature. This point of view requires avoiding waste, taking future generations into consideration and a more respectful approach to our finite natural resources.

The importance of energy efficiency cannot be ignored in order to achieve sustainable economic development. This is because failure to meet energy efficiency can worsen the environment, deteriorating public health and resources, and lead to energy insecurity causing slow or declining economic growth in the long run. [22, cited in Apergis]. According to the projections, if the use of the energy resources we currently have continues the same as in the past, it seems to be unsustainable in the future. It is therefore argued that the accounting profession can and should contribute to the Sustainable Development Goals at an organisational level [4].

Energy-efficient production processes and related green engineering designs are important elements of sustainable energy management [23]. Increasing awareness for the protection of the environment and energy resources around the world leads to a more systematic approach by business managers to take energy-saving measures. In this respect, energy management has become an obligation to reduce the energy costs of enterprises, comply with the legal regulations and improve the image of the institution [24].

The importance of using energy efficiently to meet the increasing energy demand has become evident. The control of energy use by enterprises will make a significant contribution to less consumption of scarce and valuable resources and thus to sustainability. For this reason, the energy savings achieved may be one of the key factors in reducing operating costs and achieving a competitive advantage.

IV. CONCEPTUAL FRAMEWORK OF ENERGY ACCOUNTING

In recent years, the complexity of managing a different variety of energy resources in large-scale enterprises has increased significantly. Financial, operational and reputation impacts on poor energy management practices may have negative consequences and may be caused by seemingly simple factors. Conversely, considerable prizes can come from effectively understanding and managing energy policy, procurement, contract and accounting issues [25]. In order to optimize the energy consumption of an enterprise, the role of individual variables that increase energy consumption should be known not only in terms of quality but also in quantity. Because the full and accurate energy data required will affect the success of the energy management program, it is critical for decision-makers. The details of obtaining and using energy costs can shade benefits, but when done in a transparent manner, they can provide foresight and assistance in decision-making [26]. In terms of the management of organizations, energy accounting, which is often considered to be outside of its main activity, may have positive effects on the financial structure, operation process and outward-looking image of enterprises. In addition, control of its data through energy accounting can provide freedom for businesses to focus on strategic operations, as they will prevent many potential problems.

The goals of energy accounting stem from the need for information and control about management's energy consumption, losses, efficiency and cost [27]. Energy accounting, whose main objective is to serve the needs of management, should also provide accurate, timely, effective and comprehensive information on the development, use and protection of energy for relevant users of information [17]. Second, the positive impacts of accounting management activities on resources development and utilization processes can simultaneously benefit economic and social recovery. This means a contribution to sustainable development.

The central role of energy accounting in an energy management program requires a clear understanding of how the information will be used, and it is important for the program to achieve its purpose [8]. When integrated into the company's management system, energy accounting is not time-consuming and is an important part of good energy management.

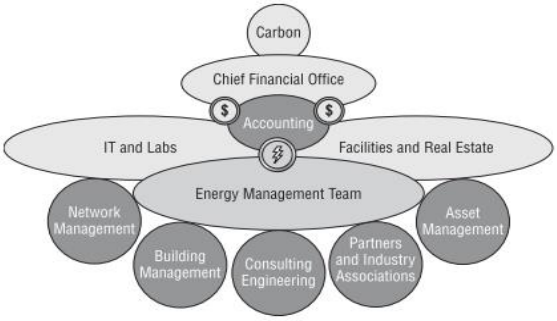

Fig. 1 The Place of Accounting in Energy Management
Source:(Aldrich, Parello, & Aldrich, 2010, p. 17)

Successful enterprise-level energy managers list energy accounting systems behind the commitments of top-level corporate authorities when they rank the cornerstones of an ongoing energy management program [29]. Energy accounting should work in coordination with all units involved in a business while performing the following basic tasks (Alliance, 2017: 1):

- To record and classify energy costs
- Resolve energy problems and billing errors
- Prioritize capital investments that provide more efficient energy use
- To evaluate the success of the energy program and to report the results
- Creating incentives for efficient energy management
- To determine energy budget costs more accurately

Considering energy consumption and emission reductions during the close examination of energy costs and environmental performance of energy-consuming enterprises are among the functions of energy accounting [25]. They can develop effective and rational strategies to improve their competitive positions in the long term by developing an energy-oriented perspective[30]. The fact that enterprises have clear aims and objectives in energy accounting applications will help them to decide on the instruments they need. The following table shows other aims and objectives of energy accounting.

Table 1. The Aims and Objectives of Energy Accounting

Objectives	***Aims***
• Managing energy costs • Increase energy / environmental awareness • Manage water and other resource costs	• Save energy on energy fortification • Motivate employees to manage energy costs • Identify energy saving targets • Seek energy enhancements opportunities • Eliminating unusual consumption increases • Identify billing errors • Preparing for a bargain because of power cuts

Source: (California Energy Commission, 2000, p. 5)

While energy saving from data obtained through measurement and verification of energy is an important goal, high-performance energy accounting systems increase the level of spatial and temporal data details to conduct comprehensive energy analysis. [31]. Basically, energy accounting should be considered as a function that contributes significantly to good productivity, not as a priority in terms of competitiveness or an extra addition to the business process. When integrated into the company's management system, energy accounting is not time-consuming and is an important part of good energy management.

A. Stages of Energy Accounting

As financial accounting includes the reconciliation of income and expenses, energy accounting can (and must) reconcile energy inputs and outputs. As stated in the First Law of Thermodynamics (as the energy can be created from nothing, it cannot be destroyed, but it can return to another form, and the amount of energy in the universe will remain the same), the principle that all energy can be taken into account because the creation cannot be destroyed allows the energy manager to balance the inputs and outputs. [10].

Before you start tracking energy, you need to be organized and create an energy accounting plan [8]. This step follows energy usage monitoring, energy usage record and performance measurement. Performance measurement may range from a simple Btu / m^2 or Btu / $ production unit index to a complex standard cost system completed with variance reports. In any case, energy accounting requires measurement. Monitoring the energy flow through a cost centre requires the ability to measure incoming and outgoing energy, no matter how large or small. Lack of required meters is probably the biggest deterrent for the widespread use of energy accounting systems [29]. If energy efficiency measures are cost-effective, continuous monitoring and periodic response must be provided to ensure continuity [32].

An important objective of Energy Accounting is to determine the functional relationships between independent variables that direct consumption and consumption. Although it is generally seen as a separate issue from energy accounting, energy monitoring, targeting and reporting is an analysis technique that gives these functional relationships. It is also a basis for energy budgeting, which is part of the accounting process [10]. The key steps required to establish energy accounting can be listed as follows: [33]:

- To prepare proforma tables suitable for the facility,
- To make the necessary arrangements to collect data regularly.
- Prepare for the necessary conversions and calculations.
- To create historical data of previous years.
- To nominate to act on the data by nominating the research.
- Inform all concerns about progress and inefficiency.

As in financial accounting, the complexity or detail of energy accounting systems varies significantly from company to company. A close relationship can be developed between the levels of complexity of financial accounting systems and energy accounting systems [29]. Some technical information is also necessary to adapt the scope of the analysis to the desired purpose. Therefore, it is recommended to start with the evaluation of consumers and their classification according to the type of energy used and the technology used in the creation of an energy accounting system. [34]. The degree to which an energy accounting application is selected is closely related to the size, structure and consumption of the enterprise. It is necessary to take into account the cost-benefit analysis of the information to be obtained.

B. The Measurement and Recording of Energy Consumption

Energy monitoring includes regular collection and analysis of information on energy use. Its aim is to determine when and why energy consumption deviates from a base model and, when necessary, to establish a basis for the management to take action. [29]. Energy monitoring and measurement refer to the collection of operational data that illustrates energy problems or opportunities and the use of appropriate metrics to measure energy project success [35]. There are several factors that determine how to monitor energy data in an organization. Detailed monitoring of energy data plays an important role in the performance of energy accounting. For this reason, accurate data can be obtained by using a combination of several methods, not only by monitoring energy data from a single source. There are many efforts on energy data monitoring technologies in the world, and at this point, there are advanced technologies that can perform very precise measurements, such as smart grids.

If the energy data obtained is not interpreted correctly, they do not make much sense. Therefore, the detailed presentation of the data is important for energy efficiency. Because the information produced by professional accountants and engineers includes analysis techniques, its contribution will also be high [36]. There are different methods used in energy accounting applications, and there is no accepted information about which one is the best choice. The flow of energy that can be tracked by computer, manually or with special software varies according to the expectations of the company. On the other hand, the size of the company, what it wants to monitor and how it plans to transfer the data obtained from energy accounting are the factors that take part in this decision [8].

A spreadsheet table can be created to enter sums, comparisons, and graphical information. The table can be prepared showing the energy units and cost information for each fuel type. In-depth analysis of the data allows us to define the relationships between other factors as outdoor temperatures, sales volume, occupancy, and floor area [37].

C. Accounting and Reporting

Reporting involves providing continuous control of energy use, monitoring objectives, and verification of savings through monitoring [10]. There is no common form that can be used for reporting. There are too many variables such as organization size, product, project requirements and already existing procedures. Advanced reporting systems are used by very few companies [38]. Reporting is not always the most interesting part of energy management, but it can be a tool to introduce the program and reveal its effectiveness.

Financial impacts related to energy are part of the financial information of enterprises. Relevant financial statements of these effects can be directly processed in the appropriate financial statements. The purpose of this is to explain energy-related financial conditions and operational performance indicators independently with specific items [17]. On the other hand, energy events that are actually or possibly to be realized and which are difficult to measure directly should be clearly stated in the form of additional information, and, if necessary, the annexed list should be arranged.

Energy expenditure includes the costs of energy maintenance and management, energy savings, new energy research and development, and energy acquisition costs in general. Energy-saving equipment, energy maintenance facilities and investments purchased by enterprises, energy measurement technologies, and energy-efficient equipment can be added to the assets. Expenditure on energy savings can be capitalized if they meet the conditions [17].

Financial information does not need to be similar to the standard information in other organizations. Rather, it is an important criterion that information should be effective for decisions made by managers operating in a particular business environment with a specific strategy [39]. Energy accounting serves the goals of management as a subheading of managerial accounting in internal reporting for decision-making. Thus, more efficient energy efficient applications can be implemented for the enterprises aiming to adopt energy management systems.

The need for energy accounting can be seen more clearly for enterprises that use large energy in response to a number of cost risks and financial statement disclosure requirements. Some of the responsibilities of an energy accountant can be considered as basic services, while others may cover larger areas. Some of these advanced responsibilities are listed below. [25].

Table 2. Responsibilities of the Energy Accountant

Core Energy Accounting	*Advanced Energy Accounting*
• Invoice verification and energy retailer management: • Invoice payment files and financial accruals • Data stewardship • Budgeting and forecasting	• Emission reduction target setting • Energy market analysis and procurement • On-site renewable energy generation • Operational energy monitoring and optimization • Measurement, verification, benchmarking, • Reporting and disclosure

Source:(adapted from Bosnich, 2017)

An energy accountant's skills can contribute to businesses with high-level information provided [25]. In general, most businesses are not able to fully understand the importance of managing energy more effectively. Thanks to the energy accountant, the energy costs can get closer to the top executives' agenda, and their strategic scope can be further expanded. Beyond cost savings and energy, accountants can help identify larger productivity gains and express them with statistical data.

D. Energy Performance Indicators

Energy indicators are useful tools for tracking information and monitoring trends that reflect the various aspects of a business's energy situation over time. [40]. There are various performance indicators used to understand why an energy system is not working properly or why energy costs are higher than what they should be in a particular facility. Some of those;

a) Energy Utilization Index (EUI):

A very basic measure of the energy performance of a plant is known as the Energy Utilization Index. This is an expression of the energy used per square meter per year in terms of Btu. In order to calculate the EUI, it is necessary to define all the energy used in the plant, tabulate the total Btu content and determine the total square meter size of the designated area. The EUI is then found to be the ratio of the total consumed Btu to the square meter level of the total area [29]. The EUI can be used to compare energy consumption with respect to the same building types or to monitor consumption from year to year in the same building [37]. It can be a good indicator of the comparative potential for energy saving. A relatively low EUI indicates less potential for greater energy savings.

b) Energy Cost Index (ECI):

Another useful performance index is the Energy Cost Index or ECI. This is an expression of the energy flow cost used per square meter of the area determined annually. In order to calculate the ECI, all of the energy used in the

plant must be defined, the total cost of this energy and the total square meter of the designated area should be determined. The ECI is then located as the ratio of the total annual energy cost of a plant to the total number of square meters of the facility's conditioned floor area [29].

c) One-Shot Productivity Measures:

One-shot productivity measures uses the energy usage index to determine its course over time and record trends. Significant deviations from the same period of the previous year should be recorded, and explanations should be sought. This measure is often used to verify or at least influence the effects of energy management activities.

Performance measurement can range from a simple Btu / ft2 or Btu / $ production unit index to a complex standard cost system completed with variance reports. In any case, energy accounting requires metering. Monitoring energy flow through a cost centre requires the ability to measure incoming and outgoing energy, no matter how big or small [29].

Energy efficiency performance indicators are not limited to these. Each index that can be used according to the results expected from energy accounting systems of companies provides different information and has various advantages and disadvantages. In an environment where energy prices fluctuate, the best energy index is usually based on Btu measurements. However, when energy prices are stable, indices calculated with currency provide more clear information. On the other hand, more than a limited number of indices shown here can be produced for different purposes and used to measure energy management performances.

Weak energy management practices may have a negative impact on businesses in terms of financial, operational and reputation. As energy accounting approaches the point of view of senior executives, it can be expanded to address these challenges, taking into account strategic, market, operational and compliance requirements. At this point, an energy accountant can play an effective role.

V. ENERGY PERFORMANCE INDEX CALCULATIONS IN A MANUFACTURING PLANT

In this section, energy performance indicators have been calculated and analyzed in a manufacturing company in order to demonstrate the practical application of energy accounting which is explained in the theoretical background. The solid fuel-fired stove production enterprise operating in the province of Konya agreed to provide and participate in the data for these calculations. Stove Company is a medium-sized enterprise that produces a large number of solid-fueled stoves. The energy types used by the company include electricity and coal energy. One of the factors involved in the selection of this company is that the company has started to record the company's energy cost data in detail.

A. Energy Utilization Index (EUI)

The stove firm is established on 11.400 m2 closed area and 44.000 m2 open area. In our application, the open area will not be considered. 1.398.884.76 kWh electric energy and 171.480 kg (7000 kcal/kg) lignite coal were used for 2017.

Conversion Rates in Btu

Electricity	3412 Btu/kWh
Coal	3,9653 Btu/Kcal

Total Energy Use = (1.398.884,76 kWh) x (3412 Btu/kWh) + (171.480 kg) x (7000 Kcal) x (3,9653 Btu/Kcal)

= 9.532.782.309,12.Btu/year

When we divide the total used energy by 11,400 m2, this will give us the EUI.

EUI = (9.532.782.309,12 Btu/year) / (11.400 ft^2)

= 836.208,97 Btu/ft^2/year

The energy utilization index of the enterprise was 836.208.97 Btu / m2 / year. The following are examples of energy utilization indices of some other areas of activity in different countries.

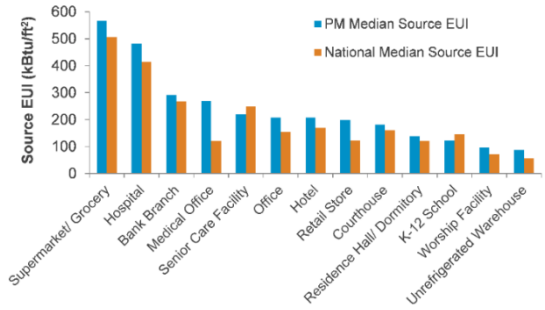

Fig. 2 Different Energy Use Index Rates

Source: www.energystar.gov

When compared to any index. It should not be overlooked that there are many factors that will affect such as weather, production, expansion or contraction of facilities, new technologies, etc. [38]. From the above table, it can be said that the energy consumption of the solid fuel-fired stove production enterprise with the consumption of 836.000 Btu is at normal levels compared to the energy use index of a supermarket operation with an average consumption of 550,000 Btu.

Energy utilization indexes can be carried out in a more detailed approach within the business units. EUIs for seven units were calculated from the cost data obtained from the energy audit performed for the year 2017. The amount of energy consumed by the activities in different units of the enterprise was calculated and converted into Btu type, and the areas of the units were determined as ft^2. Energy usage indices belonging to the units of the business are given below:

Table 3. Energy Utilization Indexes of the Company's Units

Units	Area	Energy Cons.	EUI
	(ft^2)	(Bin Btu)	(Btu/ft2)
Iron Plate	1488	1075392	722710,25
Pressing	1989	2192300	1102212,44
Assembly	1364	869027	637116,65
Enamel Coating	1853	3607519	1946853,44
Foundry	1337	515620	385654,96
Storage	2444	785950	321583,85
Office	925	486970	526454,84

The unit with the highest energy use index was an enamelled area of 1.407.188,04 Btu / ft^2. This is due to the high electrical energy consumption of the tunnel kiln, which must have high temperatures for the enamel coating process. From the following figure, the share of the other units in total consumption can be seen.

Considering the surface areas and activities of the units, the management office has the lowest surface area and the second-highest consumption with 526 thousand Btu energy consumption per square meter.

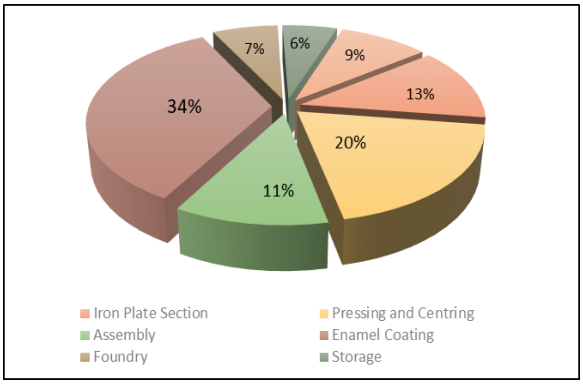

Fig. 3 Energy Utilization Indexes of the Plant's Units

The reasons for this are the low surface area of the management office the fact that the working personnel do not use the equipment efficiently. When the company is closed, there are reasons such as the fact that company employees forget to turn off the electrical equipment regularly and the LED lights are used rarely. As a precaution, the use of sensor lighting in rarely-used areas and the control of electrically operated equipment in the end-of-office may take place. The storage unit is calculated as the area with the lowest energy consumption, which is typical for many storage areas where cooling is not used.

B. Energy Cost Index, (ECI)

The energy cost index is calculated by using the cost data for electricity energy of 395,623.44 TL and 111.675,00 TL for coal energy in the manufacturing company.

Total Energy Cost = (395.623,44 TL) + (111.675,00 TL)
= 507.298,44 TL/year

When we divide the total energy cost by 11,400 ft^2, this will give us the ECI.

ECI = (507.298,44 TL/year) / (11.400 ft^2)
= 44,50 TL/ft^2/year

The cost of annual energy consumed for one square meter in this establishment was 44.50 TL. Periodic sharing of annual average energy consumption costs of plants enables enterprises to compare their energy costs. The energy cost index should be compared with other enterprises in the same sector and data from previous years. Important differences arising here should be taken into account, and the cause should be investigated.

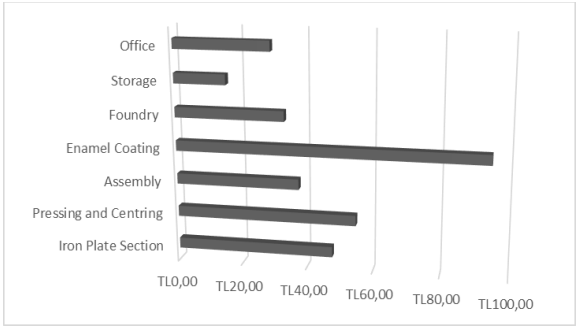

Fig. 4 Energy Costs per Square Meter in Business Units

These performance measures can provide a competitive advantage for the assessment of the energy management program implemented in the enterprise. According to the chart, the most costly unit of the company was enamel coating, spending 94.46 TL per square meter. This is due to the use of tunnel furnaces which must have high temperatures for the enamel coating process in solid fuel-fired stove manufacturing plants.

C. One-Shot Productivity Measures

As of 2014, the stove company moved from its former place to the organized industrial zone, and the managers played an active role in the construction of a new facility. The management, who experienced the energy losses of the old factory, paid attention to the energy-efficient construction of the new plant. These include roof daylight lighting systems, high insulation with sheathing, low consumption lighting lamps and cooling systems.

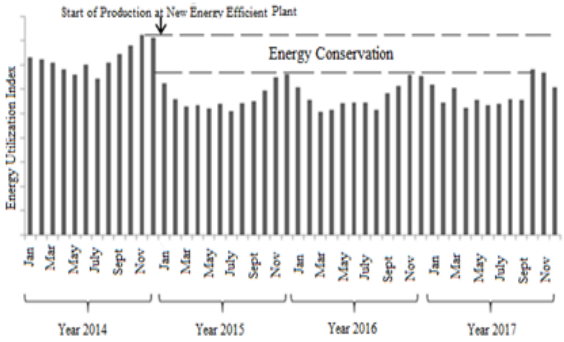

Fig. 5 Energy Utilization Indexes of the Company for the Past Four Years

As can be seen from the graph, the company has achieved great energy savings thanks to the new plant. However, in the following years, energy use rates were almost the same. Continuity and continuous improvement in energy management are necessary. In this respect, it is

deemed appropriate to employ an energy manager in order to demonstrate stability in the energy program.

VI. CONCLUSION AND RECOMMENDATIONS

Monitoring energy data in detail plays an important role in fulfilling the function of energy accounting. If the energy data obtained is not interpreted correctly, they do not make much sense, and therefore, the detailed presentation of the data is important for energy efficiency. Energy indicators are useful tools for tracking information and monitoring trends that reflect the various aspects of a business's energy state over time. As the collection and sharing of energy performance index statistical data becomes more widespread, healthier data can be introduced to reduce the cost-cutting effects of energy consumption of enterprises.

As a result of the energy performance analysis performed in the case study, the energy utilization index of the enterprise was 836.208.97 Btu / ft^2 / year and the energy cost index was found as 44.50 TL / ft^2 / year. It is known that other enterprises using natural gas energy in the same sector save between 25% and 30% in energy costs. The facility, which is not yet accessible to natural gas energy, can evaluate alternative energy sources to meet the electricity needs. Solar energy panels can be a suitable renewable energy investment project by evaluating the criteria such as the open area of the business, the number of sunny days, and the cost of investment. This saving will therefore contribute to the reduction of environmental pollution and sustainable development with the rational use of scarce and valuable energy resources.

According to the energy cost index analysis, the second most cost-effective unit of the enterprise was the management office unit, which spent 53.60 TL per square meter. At this point, awareness should be provided to ensure that all employees develop interest and commitment to the energy management program. On the other hand, the smart grid application in the industry is a new automation technology that collects energy consumption data instantly, matches and intervenes when needed. At this point, the enterprise can evaluate the smart grid implementation as a contribution to long-term sustainability.

The high energy consumption caused by the tunnel furnace used by the enterprise for the enamel coating process greatly increases the energy costs. In order to reduce the cost of this high consumption, energy load reduction contracts can be made between electricity distribution companies and enterprises in need of high energy. It is based on the fact that company operations are carried out outside the busy time for distribution companies and used in return for a lower rate.

Energy accounting continuously provides a high level of energy awareness and allows for the detection of abnormalities in operation very quickly. One way to become a market leader is to reduce product costs and thus improve financial efficiency. On the other hand, the energy savings achieved by sorting out the abnormalities will contribute significantly to the scarce and valuable resources to be consumed and thus to sustainability.

ACKNOWLEDGMENTS

This study was derived from PhD thesis of the author. The author would like to thank Professor Dr.Baki YILMAZ for his great support in the accomplishment of this research.

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