Energy Efficiency Management in Small and Medium-Sized Enterprises

Subjects: Energy & Fuels

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Energy efficiency is a key factor to meet the ambitious climate targets of the European Union (EU) aligned with the international policy directives. On their own, Small and Medium-sized Enterprises (SMEs) do not consume big amounts of energy, but taking into consideration that they represent about 99% of businesses worldwide, their cumulative energy consumption is remarkable. Even though SMEs experience several barriers in their effort to improve their energy efficiency, their contribution to the EU's energy efficiency improvement targets is crucial through the implementation of measures to improve their energy footprint.

small and medium-sized enterprises SMEs energy efficiency energy footprint energy management energy consumption

1. Energy Management in SMEs

Energy management includes the plans, processes, and operations related to the production, consumption, distribution, and storage of energy within an organization. The main objectives of Energy Management in Small and Medium-sized Enterprises (SMEs) are related to climate protection by optimizing and reducing the consumption of energy, energy costs, and resource conservation, without limiting the access to the amounts of energy required by the user [1]. It is closely associated with environmental management, production management, logistics, and other business operations. Cooremansa and Schönenbergerb [2] highlight that energy management could be a key factor in promoting the required investments to implement energy efficiency policies within SMEs. Several other works tackle different aspects of energy management applied in SMEs [2][3][4][5].

Its economic dimension is specified in the following VDI-Guideline 4602 definition: "Energy management is the proactive, organized and systematic coordination of procurement, conversion, distribution and use of energy to meet the requirements, taking into account environmental and economic objectives". Energy management employs engineering solutions and management techniques in order to systematically optimize the energy efficiency of the organization with respect to specific social, environmental, economic and political objectives [6].

Energy management is defined as the process of tracking and optimizing energy consumption from all business processes (including relevant devices and equipment employed to conserve energy in the company/organization

premises) [7]. The four key steps for the application of effective and successful energy management plans are as follows:

- *Measure energy consumption:* A key component in identifying improvement opportunities is to perform a comprehensive energy analysis. The main parts of such an energy analysis include collecting energy consumption data of the equipment employed within the examined facility, as well as examining the most energy-intensive processes and operations so to be able to identify their energy consumption pattern and demand and evaluate their contribution to total energy usage. In this context, the installation of appropriate energy metering and monitoring equipment is crucial in order to track and set up the energy usage baseline of the examined facility.

- *Fix the basics:* Having carried out an energy audit or a similar energy analysis, organizations usually apply passive measures to improve their energy efficiency, such as implementing high-efficiency technologies and solutions for motors, lighting, and heating, as well as ventilation and air conditioning (HVAC) systems.

- *Automate:* Apart from taking passive energy efficiency measures, organizations should also adopt active energy management policies in order to further improve their energy efficiency performance and promote continuous energy efficiency enhancement and cost savings over time. A typical example of active energy management measures is the implementation of controllers, timers, sensors, etc. HVAC or lighting systems, for instance, are equipped with such automatic equipment in order to maintain room temperature at an optimum level or to turn on the lights of a room during working hours only or whenever the room is occupied.

- *Monitor and control:* In addition to the application of energy efficiency measures that help to manage energy-intensive operations and processes within the facility, employees' awareness through training and information, as well as their commitment to a behavior driven by energy efficiency principles, is a decisive factor in the efforts of organizations to continuously improve their energy efficiency and reduce their operational cost. Policies that could definitely contribute to this direction are the installation of monitoring and control systems and the frequent conduction of energy audits and energy efficiency analysis, as well as the implementation of an appropriate and preferably custom-made Energy Management System (EMS).

According to the United Nations Industrial Development Organization [8], EMS is defined as "a framework for energy consumers, including industrial, commercial, and public sector organizations, to manage their energy use". EMS could be used as an opportunity analysis tool to help organizations and companies to identify opportunities for energy efficiency improvement and guide them to adopt specific technologies, including low capital-intensive ones. Typically, the availability of specialized staff and experts, as well as the training of the company's staff, are required for the successful implementation of EMSs. According to the International Organization for Standardization (ISO) [9], an EMS involves the development of specific energy policies, the definition of measurable and realistic energy consumption targets, the creation of improvement plans to achieve them, and the monitoring of the relevant progress achieved. Measures to improve energy efficiency performance might include the mitigation of

energy losses, the implementation of more energy-efficient technologies, or the redesign of current processes in order to achieve energy consumption and cost reductions.

There is a specific International Standard for Energy Management, namely ISO 50001, that presents an acceptable systematic framework for the design of a successful EMS that can be followed by any organization [10]. ISO 50001 has been developed in order to guide an organization to enhance its energy efficiency performance by improving the management of its energy-intensive activities, assets or processes. ISO 50001 may be implemented globally by any organization regardless of its size. Its benefits could vary from reducing the overall environmental impact and enhancing the organization's reputation up to cutting costs and improving its competitiveness. Finally, an organization following ISO 50001 could verify its legal and internal compliance, identify the assets and/or processes with a higher impact on the overall energy demand, and gain a better perception of its energy use and consumption via internal communication.

Similarly to other ISO management system standards, ISO 50001 is designed following the "Plan-Do-Check-Act" principle for continual improvement [11]. This approach helps organizations integrate energy management policies successfully and, consequently, enhance other operational aspects, such as quality and environmental management. Specifically, ISO 50001 provides a systematic framework of standards that help to create a policy for more energy-efficient operation; define measurable targets to meet the policy; monitor and process the available data in order to understand and manage their energy consumption; implement specific measures and techniques to achieve these targets; measure their results; evaluate the applied action plans and take appropriate decisions based on available measurements; and improve their energy use and costs over time.

2. Energy Consumption for Various SME Sectors

The industrial sector is the most important energy consumer relative to any other end-use economic sector. This is because energy is widely used within an industrial enterprise for the operation of manufacturing equipment, steam production, process heating and cooling, cogeneration applications, lighting, heating, air conditioning in buildings, etc. Additionally, basic chemical feedstocks contribute to the overall energy consumption of the industrial sector. Specifically, the production of agricultural chemicals is based on natural gas feedstocks, while organic chemicals and plastics are manufactured using natural gas liquids and petroleum products [12].

Although the industrial sector is the most energy-intensive, it should be noted that SMEs operating in the tertiary sector, such as transportation or hospitality companies, could have significant energy consumption and consequently the potential for energy savings [13]. For instance, intermediate-sized hotels could have considerable energy demand, not only because of the variety of the services they offer but also because of their continuous operation and the uncontrolled nature of their energy requirements. Thus, they might have the opportunity for significant energy savings, namely in the range of 10–30% [14].

The International Energy Outlook of the U.S. Energy Information Administration [12] suggests three distinct types for categorizing the industrial sector, namely energy-intensive manufacturing, non-energy-intensive manufacturing,

and nonmanufacturing, as shown in **Table 1**.

Table 1. Major groupings and representative industries of the industrial sector; source: U.S. Energy Information Administration (May 2016) [12].

Industry Grouping	Representative Industries
Energy-intensive manufacturing	
Food	Food, beverage, and tobacco manufacturing
Pulp and paper	Paper manufacturing, printing, and related support activities
Basic chemicals	Inorganic chemicals, organic chemicals (e.g., ethylene propylene), resins, and agricultural chemicals; includes chemical feedstocks
Refining	Petroleum refineries and cola products manufacturing, including coal and natural gas used as feedstocks
Iron and steel	Iron and steel manufacturing, including coke ovens
Nonferrous metals	Primarily aluminum and other nonferrous metals, such as copper, zinc, and tin
Nonmetallic minerals	Primarily cement and other nonmetallic minerals such as glass, lime, gypsum, and clay products
Nonenergy-intensive manufacturing	
Other chemicals	Pharmaceuticals (medicinal and botanical), paint and coatings, adhesives, detergents, and other miscellaneous chemical products, including chemical feedstocks
Other industrials	All other industrial manufacturing, including metal-based durables (fabricated metal products, machinery, computer and electronic products, transportation equipment, and electrical equipment)
Nonmanufacturing	
Agriculture, forestry, and fishing	Agriculture, forestry, and fishing
Mining	Coal mining, oil and natural gas extraction, and mining of metallic and nonmetallic minerals
Construction	Construction of buildings (residential and commercial), heavy and civil engineering construction, industrial construction, and specialty trade contractors.

The classification of manufacturing industries to energy-intensive and non-energy-intensive is quite useful because it implicitly identifies the industry sectors that should be prioritized in improving their energy efficiency. The industrial sectors which are considered to be energy-intensive are food, pulp and paper, basic chemicals, refining, iron and steel, nonferrous metals (primarily aluminum), and nonmetallic minerals (primarily cement). The share of these sectors to the overall energy consumption of the industrial sector is about 50%. It should be emphasized that

the above industrial sectors considered are in line with the ones identified by the Department for Economic, Scientific and Quality of Life Policies of the European Parliament [15], which focuses on the industrial sectors that are included in the EU ETS and have the highest share of CO_2 emissions. Specifically, the European Parliament considers the following industries as energy-intensive: iron and steel, aluminum, cement, refineries, petrochemicals, fertilizer, lime and plaster, paper and pulp, hollow glass, and inorganic chemicals.

However, this classification refers in general to all enterprises without considering their scale. Focusing on SMEs, the main sectors with considerable energy consumption and impact are the following:

- Food, Beverage, and Tobacco [16];
- Chemical and Metal Production [17];
- Construction [18];
- Agriculture and Forestry [19];
- Transport, Storage, and Communication [20].

In the effort to characterize the identified SME sectors in terms of relative levels of energy-use-related key performance indicators, the following aspects were considered [21][22]:

- Number of SMEs in each one of the different sectors considered;
- Size of individual SMEs in the sector;
- Overall energy consumption in the sector;
- Corresponding energy efficiency;
- Potential for energy efficiency improvements in the sector.

The relevant indicators are shown in **Table 2**.

Table 2. Characterization of SME sectors by energy-related indicators.

Sector	Level of Energy Consumption per Enterprise	Level of Energy Efficiency	Energy Efficiency Improvement Potential
Food, Beverage, and Tobacco	Medium	High	Medium

Sector	Level of Energy Consumption per Enterprise	Level of Energy Efficiency	Energy Efficiency Improvement Potential
Chemical and Metal Production	High	High	High
Construction	Low	Medium	High
Agriculture and Forestry	Low	Low	High
Transport, Storage, and Communication	High	Low	High

ir energy uated the final energy consumption levels per number of enterprises using Eurostat's data [23][24]. Corresponding levels are presented graphically in **Figure 1**. It is noteworthy that the values compare favorably with the ones given in [12].

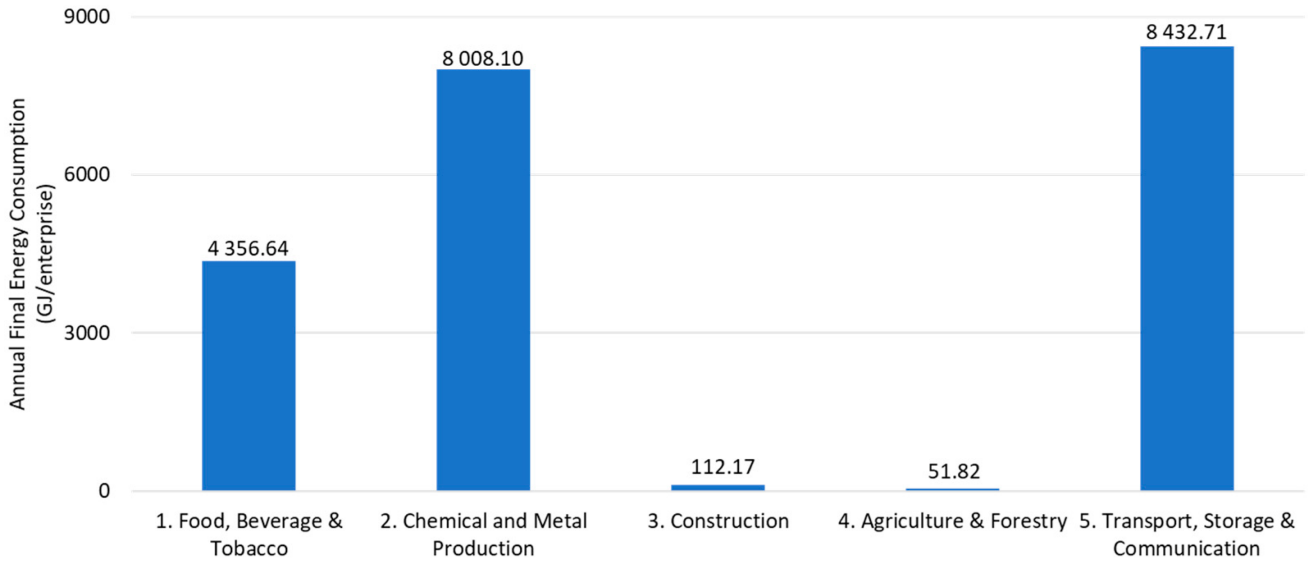

Figure 1. Final energy consumption levels for various SME sectors per number of enterprises.

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