IMPLEMENTATION OF ENERGY MANAGEMENT IN THE INDUSTRIAL SECTORS

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Abstract: Global climate change, scarce energy resources and the increase in energy consumption make action urgently necessary. [1] For everyday life, suggestions and legal regulations have been created to deal with the scarcity of resources and sustainability. In industry, guidelines and laws regulate the handling of resources such as electrical energy. Controlled energy policy and "voluntary" reduction of energy demand, especially in energy-intensive companies, play a decisive role and offer the approach for a possible resolution of this tension through the application of an energy management system. In order to achieve the goal of efficient energy management, a constant individual review of the systems have to take place, for example with the help of the Plan-Do-Check-Act cycle at short intervals, in order to offer continuous.

Keywords: Energy management, Energy policy, PDCA-Cycle, Renewable energy sources

1 INTRODUCTION

This paper presents the requirements for energy management from the perspective of the International Organisation for Standardisation, European Union and the international and current European legal situation. Based on guidelines, studies, regulations, directives and legal texts, the added value of energy management in connection with the PDCA cycle is analysed. The focus of this work is mainly on the implementation of energy management in the industrial sectors. The strategy and procedure for implementation are exemplified by the PDCA cycle. A large part of society is dependent on resources such as electricity, oil, gas, and water. Without these resources, daily life would be inconceivable. First, energy policy goals oblige and encourage industry to operate an energy management system. In the meantime, European law has developed into a very important source of law, because the primacy of application of European law applies to matters relating to the Union or directly affecting Europe. In this context, regulations and directives are of particular interest within the framework of secondary law. Regulations have direct effect for citizens and member states (Art. 288 TFEU). Directives must be transposed into national, Member State law in conformity with the directive by certain deadlines.

In contrast to a regulation, they only specify the objective, but not the means. They are therefore addressed to the member states, usually with the requirement to transpose them into national law - laws or regulations. Therefore, the objectives of directives are also reflected in concrete form in national laws. The overriding motivation is to raise awareness in dealing with valuable resources; in the industrial environment as well as in private households. A communication-capable compact circuit breaker (Siemens 3VA2) is used as an object in the energy distribution system as an example for the implementation of energy management in the industrial environment. With the help of this switch, it is possible to implement energy management and/or energy monitoring in the field level (Figure 2) and/or the production level (Figure 2).

2 LEGAL FRAMEWORK FOR THE ENFORCEMENT OF ENERGY EFFICIENCY

2.1 CURRENT EUROPEAN LEGAL ACTS

To implement the Paris Climate Agreement of 2015, the European Commission presented its legislative package "Clean Energy for All Europeans" on 31 November 2016 as the so-called "Winter Package" with new climate and energy policy targets for the period after 2020 and the framework for the implementation of the Energy Union until 2030 [2].

The three main objectives of this "winter package" are firstly to reduce greenhouse gas emissions by at least 40 % compared to 1990, secondly to increase the share of renewable energy sources to at least 32 % of final energy consumption, and thirdly to increase energy efficiency by reducing primary energy consumption by at least 32.5 % compared to the reference scenario (1990) [2]. In the meantime, the European Parliament has adopted the amendments to the Renewable Energy Directive (EERL II) [3], the Energy Efficiency Directive (EED) [4], as well as the Regulation on the Governance of the Energy Union[1] [5]. The revised Energy Efficiency Directive, which is of particular interest here, provides for a reduction of primary energy consumption within the European Union by 32.5 % by 2030 compared to an underlying reference development (Art. 1 I EED). The central implementation element, the "final energy savings obligation", was extended and strengthened beyond 2020. For the first time, annual real savings of 0.8 % of energy sales in each Member State were agreed (Art. 7 I EED).

2.2 ENERGY MANAGEMENT ACCORDING TO ISO 50001 IN CONNECTION WITH THE PDCA-CYCLE

Every company can decide how it wants to organize its energy management, but it must adhere to the requirements of ISO 50001 to ensure that subsequent certification is successful. ISO 50001 is a globally valid standard for the implementation of an energy management system and contains measures to increase the energy efficiency of companies. It describes many criteria, the realization of which can lead to high energy savings potentials and thus reduce costs, but also reduce the influence on the environment.

The ISO certification according to ISO 50001:2011-12 is valid for a period of three years but have to be verified by annual audits. The aim is to monitor compliance with the defined indicators, but also the implementation of further energy saving measures, and to ensure a continuous process, which is a strategic task of the management level of a company. If a company decides to be certified according to ISO 50001, it has entered a so-called PDCA cycle. This includes the several areas like Plan, Do, Check and Act and have to be carried out annually. It is derived from ISO 50004 (2014-12): Energy management systems - Guidance for implementing, maintaining, and improving an energy management system. In this way, continuous optimisation and a permanent reduction in energy consumption are to be achieved. After three years, a renewed certification have to take place as a recertification. For the implementation of an energy management system, an energy assessment of the company/organisation has to be first take place. Therefore, a collection of all relevant data must be carried out by the respective persons in charge beforehand. This data includes, among other things, information on past and current energy use and energy consumption and on the factors that influence energy consumption. Facts about current energy efficiency should also be collected. In a three stage analysis, energy consumption and energy use are presented in de-tail, the areas with the highest consumption are identified, and subsequently possibilities for permanent improvement of the energy balance as well as operational goals are determined ("Plan" in PDCA cycle). Once the planning has been completed, the next step is to implement the defined measures ("Do" in the PDCA cycle). In any case, the employees should be involved in the implementation of the measures at this point at the latest. They work in the respective areas on a daily basis and can often provide additional information on further savings opportunities.

[1] Governance of the Energy Union (GovEnU)

Then those responsible monitor the measures taken and the achievement of the goals ("Check" in the PDCA cycle). For example, the current energy consumption is measured and this data is aligned with the targets. Realtime data is a profitable means of drawing timely conclusions and making comparisons. In addition, internal audits have to be carried out regularly so that system conformity can be checked and any corrections can be initiated. The documentation of the data should be transparent so that it is available in the desired form for future certification. By monitoring the processes, possible changes are possible, which can or have to be made by those responsible for the process, i.e. the management level ("Act" in PDCA cycle) - **Figure 1** [6]. The management review is also particularly important as a strategic task, because the responsible management is responsible for monitoring all measures introduced so far and for checking their effectiveness. If necessary, this process can be followed by further measures to improve the energy balance or new goals can be decided upon. For this purpose, special action plans are drawn up that build on each other.

2.3 OBJECTIVES OF THE EUROPEAN UNION

Based on the EU's strategic goals up to the year [7]:

- Reduction of greenhouse gas emissions by 40 % compared to 1999.
- Increase the share of renewable energy sources to at least 32 % of final energy consumption.
- Reduction of primary energy consumption by at least 32.5 % compared to 2007.

These targets are an important driving force for technical innovations in energy management.

3 AIM OF IMPLEMENTING AN ENERGY MANAGEMENT SYSTEM

3.1 CREATE INCENTIVES

In order to achieve the goal of efficient energy management, future plants have to be planned according to the requirements and existing plants must be modernised, if necessary from the ground up. Directives, laws, and standards primarily determine the behaviour of society and industry with regard to access to electronic energy and energy consumption. Legal requirements are obligations and must therefore be respected and complied with. At the same time, however, incentives are created that have a motivating influence to possibly invest in a future-oriented manner beyond the legal basis. This means that digital evaluation, visualisation and storage of measurement data should take place in the area of energy management. With the right components, energy savings, cost savings, quality of supply, security of supply and energy efficiency can be guaranteed.

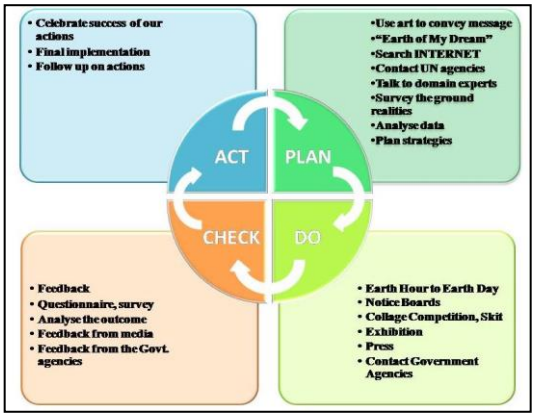

Figure 1: Definition of PDCA-Cycle [6]

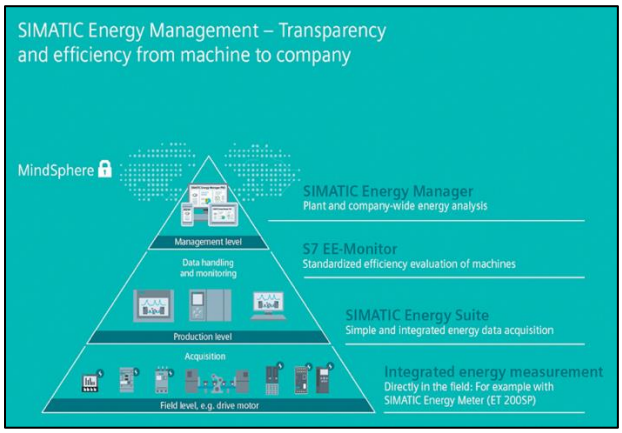

Figure 2: Example for an Energymanagement-System [8]

This illustration from Siemens shows an example of how an energy management system can be implemented (**Figure 2**). All levels from management to field level are brought together in one flow. Data for energy monitoring can be recorded using energy measuring components such as a communication-capable measuring device, a circuit breaker, a soft starter, a frequency converter or a motor. Furthermore, processing and visualisation are possible with the help of a PLC and a human machine interface. Data selection and evaluation can be realised with the help of software at the management level. There are many different application possibilities for implementing energy management, but the management level, the production level and the field level should be taken into account as a guide. As an additional option, the data can be uploaded to a cloud, which allows access from many different locations. The investments should be in the area of communicationcapable measuring devices with a wide range of measuring possibilities, the energy management software as well as the specialised personnel. As a result, energy monitoring is necessary. The continuous evaluation and recording of relevant measurement data helps, for example, to reduce the effort required for the prescribed regulations and logged energy measurement data.

3.2 GUIDELINES FOR IMPLEMENTATION

To implement these goals, the following important guidelines and laws have been issued or are currently being adapted as you can see in **Table 1**. The table lists the European Union directives that must be transposed into national law. As mentioned above, implementation is mandatory for each member state.

EU
Energy Services Directive (ESD) of 2006 (Directive 2012/27/EU of 25 October 2012) [9]
Eco-design Directive and Energy Using Products Act (EuP Directive) (Directive 2005/35/EC of 6 July 2005) [10]
Emissions allowance trading [11]
Building Efficiency Directive (EU) 2018/ 844 of 30.05.2018 [12]
Energy Efficiency Directive (EED Directive 2018/2001 of 11.12.2018) [4]

Table 1: Basic rules for implementation of energy management

Energy management and the promotion of additional energy storage technologies offer the potential to make optimal use of additional energy sources and to reduce energy demand. The implementation of energy efficiency measures also contributes to independence from energy imports. The introduction of an energy management system should help to determine the exact energy consumption of a company and show possibilities to save resources such as electricity, heating and water. The introduction of an energy management system is not just a one-time assessment and inventory control but must be repeated continuously in cycles. The measures have to be carefully planned - in relation to the respective company/organisation - regularly monitored and the data collected and compared.

3.3 IMPLEMENTATION OF ENERGY MANAGEMENT USING THE EXAMPLE OF THE 3VA2 COMPACT CIRCUIT-BREAKER (SIEMENS)

Compliance with the regulations for valuable energy monitoring of energy data such as current, voltage, power, phase position would be realisable with a commercial measuring device and current transformer. In an existing installation, there may be a lack of space in the energy distribution system, making it impossible to implement a suitable and compliant energy management system on site.

For such challenges, the 3VA2 compact circuit-breaker offers a space-saving and optimal solution. The flexible communication options via Profinet, Profibus, Modbus TCP and Modbus RTU provide a high level of transparency.

By reporting the system statuses and measured values to higher-level management systems, the system utilisation can be optimised, savings potential can be identified and energy efficiency can be increased (transparency of the status of the energy distribution and its energy flows). The 3VA2 compact circuit-breaker can thus support the company's energy management.

The energy operating data, service and maintenance information from the switch are read out and projected on a human machine interface. In addition, the data is stored e.g. via an internal memory of the human machine interface, which, depending on the setting, is evaluated after one working day with the help of a program on the computer and then made available to the person responsible for energy management for further processing. Relevant energy data include, as already mentioned above, current, voltage, active line, apparent power, current frequency, fundamental oscillation power factor; service and maintenance information includes, for example, the number of trips (due to a fault), mechanical clearances and the reason for the last trip.

A circuit breaker is used in almost every industrial building today. If the company is willing to use an energy management system, the communication-capable compact circuit-breaker helps to record all relevant data for an energy management system right from the field level. The recorded data is then evaluated with a programme and compared with the previous measurement data according to the PDCA cycle in order to have reached the target agreement after successful measures. A communication-enabled component such as the compact circuit-breaker is an entry point for companies that are obliged to operate an energy management system or do so voluntarily. An extension with energy-efficient and data-reporting loads or further compact circuit-breakers and PLCs then provides energy management at all levels of the automation pyramid [13].

4 CONCLUSION

Efficiency and savings in the field of energy play a key role today and in the future. With the trend towards renewable energies, the legislative and directive process is being intensified by the European Union in order to save energy. If a company uses the optimal components for an energy monitoring system, a basis is created for operational energy management in accordance with ISO 50001. With maximum plant safety, highest plant availability, short amortisation time of the required equipment, permanent cost reduction (energy savings with plant and cost savings) through e.g. avoidance of financial sanctions such as fines, the company benefits in many ways. However, the optimum can only be achieved with a constantly individually adapted energy management system; this means that a review of the systems takes place at short intervals in order to offer continuous improvement. The implementation of an energy monitoring system is of fundamental importance in the context of the energy audit, but especially in the context of an energy management system. In summary, it can be stated that with EN16247, ISO 50001:2011-12 and its successor ISO 50001:2018, a global standard is available that sustainably supports organisations/companies in driving energy efficiency measures forward. The next work will relate to the international and European standards, examining the relationship between the standards and their impact on energy management. In addition, an investigation of the implementation of the European directives and regulations into national German law will be undertaken in the near future.

ACKNOWLEDGEMENT

This research work has been carried out in the Centre for Research and Utilization of Renewable Energy (CVVOZE). Authors gratefully acknowledge financial support from the Ministry of Education, Youth and Sports of the Czech Republic under Brno University of Technology specific research programme (project No. FEKT-S-20-6449).

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