

Abstract

Many studies, empirical analyses, and energy consultants repeatedly claim that there is a large unexploited economic potential for saving energy. Usually, this potential is estimated to be in the range of 10 to 20 %. This study explores the determinants which influence the management of energy efficiency in companies, especially in small and medium companies, and discusses possibilities how to support the exploitation of energy saving measures. The study focuses on the approach of viewing companies as socio-technical systems.

The theoretical concept is based on the ideas of behavioural decision theory and recent research in the field of organisational development. In this view, energy-related behaviour and decision-making in companies are formed by the ability and the readiness to act of the persons involved, and by the internal organisational structure, corporate routines and values.

Individual knowledge determines the *ability to act*. Cognitive psychology distinguishes between „declarative” and „procedural” knowledge. The first form of knowledge is about facts, is formal, systematic, easily communicated and shared among individuals as information. The second form consists of skills and know-how. It is highly personal, difficult to formalise and hard to communicate to others. Direct transfer of procedural knowledge is possible through imitation and practise, but its externalisation to declarative knowledge and subsequent internalisation requires much greater effort and more time. It is therefore not sufficient to provide only information-based assistance when supporting energy-related decisions. Indeed, it is just as or even more important to also pay attention to practical orientation and analogies with the person’s situation.

A wide range of motives may influence the individual *readiness to act*. Supporting energy efficiency on principle is a rather weak motivation to act, especially at work. Other motives such as relatedness needs (winning high esteem and recognition by colleagues and superiors) or career advancement can be seen as much more important for raising the readiness to act. On the other hand, it is possible to enhance the motivation for a more rational use of energy by combining energy saving measures with motives which are deemed more essential.

At a corporate level, the *organisational structure*, procedures, patterns, and routines which form the basis for the allocation of tasks, and the *organisational culture* with its values and beliefs, have considerable influence on actions and decisions. To promote the rational use of energy within a company, it is advantageous to import energy efficiency as a feature in as many routines as possible. However, routines may also impede energy efficiency. This is the case for time-consuming and costly routines which are difficult to handle, or if the purpose of a routine is not regularly questioned.

The evolvement of organisational structures and values as well as of the individual knowledge base is a complicated and slow task. This is an important explanation for why it is difficult to introduce an ‘energy-efficient’ culture in a company. The question arising here is how and which policies and measures support the development of the individual and organisational knowledge base with respect to improving the energy efficiency of a company.

Energy management is a method which is based on well-known management tasks like planning, controlling, organising and monitoring. Energy management covers a considerable range of aspects which can improve energy-related actions and decision processes. On a company level, this involves assigning responsibilities, introducing structural changes by appointing an energy manager and energy

teams, formulating a corporate energy policy, and demanding the commitment of the upper management. On an operative level, the energy manager and other responsible staff take care of the controlling process, ensure the compliance with the strategic goals and illuminate the energy use and energy costs. Motivation of staff is another important goal of a model implementation.

External help can significantly support the internal process: *energy consultants* mainly provide technical-methodical support or conduct energy audits to prepare for further decisions. Energy consultants provide knowledge which is not available within a company in a fast and direct way and thus help the company to avoid the difficult and time-consuming acquisition of procedural expertise. Focusing attention on energy saving and enhancing motivation are other aspects which can be affected by energy consulting. *Company networks* are another way to provide external help and motivation. Networks support impulses beyond established behavioural patterns and serve as a platform for exchanging know-how. These networks are characterised by informal, trust-based relations which encourage the motivation to act.

Conducting the initial energy audit is a critical hurdle for energy efficiency, regardless whether the audit is integrated in an energy management process or a stand-alone activity. The initial energy audit requires readiness to act, considerable effort and an extensive amount of practical and methodical knowledge and know-how, which companies usually do not possess. Energy consulting may help, but quite often companies are reluctant to make use of it. This is the reason for modelling a *knowledge-based system to support initial energy audits* by providing fast, but clear evidence about possible energy savings. The instrument is intended to serve as a tool for energy consultants and energy managers, and aims at minimising search and information costs. It can help to provide conclusive arguments and to persuade the responsible management to undergo a detailed energy audit.

We do the modelling by using the CommonKADS methodology. As an example, we identify and thoroughly describe energy saving measures within compressed air systems, refrigeration systems, and heat supply systems. In addition, we analyse and describe the application of small combined heat-and-power plants in economic and environmental terms. The instrument is intended to estimate the applicability of measures and the underlying energy saving potential. Taking into account the conditions of initial energy audits, we model the measures in such a way that, apart from basic data no further measurements are required to come to conclusions. The information necessary is acquired using formula, data tables, rules of thumb, and estimations, thus making use of both declarative and procedural knowledge. The theoretical considerations of the study, the debate on policies and measures, and the modelling process illustrate the usefulness of realising and applying such an instrument.