Establishing energy efficiency in SMEs – energy management to enhance energy efficiency in everyday work life

Werner König
REZ – Reutlingen Energy Center for Distributed Energy Systems and Energy Efficiency
Reutlingen University
Alteburgstrasse 150, 72762 Reutlingen
Germany
Werner.Koenig@Reutlingen-University.de

Sabine Löbbe
REZ – Reutlingen Energy Center for Distributed Energy Systems and Energy Efficiency
Reutlingen University
Alteburgstraße 150, 72762 Reutlingen
Germany
Sabine.Loebbe@Reutlingen-University.de

Stefan M. Büttner
EEP – Institute for Energy Efficiency in Production
Universität Stuttgart
Nobelstraße 12
70569 Stuttgart
Germany
Stefan.Buettner@eep.uni-stuttgart.de

Christian Schneider
EEP – Institute for Energy Efficiency in Production
Universität Stuttgart
Nobelstraße 12
70569 Stuttgart
Germany
Christian.Schneider@eep.uni-stuttgart.de

Keywords
energy management, energy efficiency gap, energy efficiency practices, energy efficiency culture

Abstract
Despite strong political efforts across Europe, small and medium-sized enterprises (SMEs) seem to neglect adopting effective measures for energy efficiency. Adopting a cultural perspective and based on a study among industrial SMEs in Southern Germany, we investigate what drives decisions for energy efficiency in SMEs and how energy management contributes to closing the energy efficiency gap. The study follows a mixed-methods approach and combines eleven ethnographic case studies and a quantitative survey among 500 manufacturing SMEs in Southern Germany.

The main contribution of the paper is to offer a perspective on energy efficiency in SMEs beyond the diffusion of energy-efficient technology. By contrast, our results strongly suggest that the diffusion of energy efficiency in industrial companies should not be solely reduced to decisions for technical measures. We shed light on how energy efficiency is established and the importance of energy management in SMEs.

Our study shows that energy efficiency is well established in the investigated SMEs. At the same time, establishment cannot be explained by company size or energy demand. By contrast, the contextual environment of the company and the individual leadership of the company appear to have a more substantial influence. The embedding of energy efficiency in corporate strategy, a broad spectrum of different practices, the involvement of the employees, actions for raising awareness in everyday work life, and distributing attention by organizational measures constitute the driving forces in establishing energy efficiency, and these drivers can be subsumed under the label of energy management.

Introduction
Increased industrial energy efficiency has been a highlighted objective in political agendas in Europe aiming to achieve productivity gains and ecological sustainability since decades (Patterson 1996, Martin et al. 2012). Small and medium-sized enterprises (SMEs) hold a special position in this context. SMEs are often considered as the backbone of the European industrial structure (Trianni et al. 2016). For instance, in 2017, 184,667 SMEs represented about 96.9 % of industrial enterprises in Germany (Destatis 2019). At the same time, studies point to lower rates of increased energy efficiency among SMEs compared with large enterprises, mostly explained by insufficient material and personal resources (EU Commission 2008, Eurochambres 2010). Despite strong political efforts in Europe, SMEs seem to neglect adopting effective measures for energy saving and efficiency. Energy management is often considered as a vital means for enterprises to overcome barriers and improve energy efficiency (Caffal 1995, Thollander et al. 2010). At the same time, according to Thollander and Palm (2013: 140f.) an "energy management gap" is particularly evident in SMEs: in order to tap the energy efficiency potentials, more efforts are needed than the mere implementation of technical measures in industrial organizations.

In practice, energy management is often understood synonymously with the international energy management standard (ISO) 50001. This applies to both corresponding scientific

studies (Christoffersen et al. 2016, Fiedler/Mircea 2012) and the general discourse in industry and politics. In 2017, there were about 23,000 valid certificates according to the international energy management standard ISO 50001 worldwide, about one-third of which exist in Germany, albeit mainly in large companies (FEA 2019). As our results show, this does not mean that SMEs do not engage in energy management. Nevertheless, the institutionalization of energy management and the adoption of energy management practices is therefore nothing less than a necessity to close the energy efficiency gap in industrial SMEs. Based on our study among industrial SMEs in Southern Germany (Löbbe et al. 2020), we elaborate the following research questions:

- What constitutes energy management for SMEs?
- What role does energy management play in the decision-making process?
- How can energy management be institutionalized in SMEs and what recommendations can be made?

The remainder of this study is organized as follows. Section 2 provides a brief overview of the theoretical perspective. The next section sets out the empirical background and the methods used. Section 4 is devoted to the main results of the study, before conclusions are finally drawn in Section 5.

Theoretical perspective

For the data collection and analysis, we followed the theoretical concept developed by König (2020), who introduces a framework addressing the decision-making processes in industrial organizations regarding energy efficiency (Figure 1). The framework combines multidisciplinary concepts and theoretical approaches of organizational theory. It integrates concepts of sociological neo-institutional theory (Scott 2008, Hoffman 1999), the translation perspective on diffusion (Wæraas 2016), the attention-based view of the firm (Ocasio 1997), research on barriers for energy efficiency (Cagno et al. 2013, Sudhakara Reddy 2013), and organizational (Schein 2004) and energy culture research (Stephenson 2015). The framework assumes that decisions and actions on energy efficiency emerge at the intersection between three levels.

1. The Macro level encompasses the institutional issue field of which organizations and actors have emerged around the issue of energy efficiency. This field and its actors exert regulative (e.g., through policies, rules, and laws), economic-financial (e.g., through prizes, grants, subsidies), normative (e.g., work roles, habits, professional, social, and scientific norms), and cognitive-cultural (e.g., constitutive schemes, values, beliefs, and assumptions) influences the organization's decisions.
2. The Meso level encompasses the industrial organization with its material conditions, climate, cultural beliefs and practices. Referring to Fiedler and Mircea (2012) who view energy management as "the sum of all measures and activities which are planned or executed in order to minimize the energy consumption of a company" the energy efficiency practices represent the energy management of an enterprise. In this sense, energy management is understood as the totality of all practices towards energy efficiency and energy conservation by an enterprise and represents an outcome as well as an input to decisions on energy efficiency measures. König (2020) distinguishes six different forms of energy efficiency practices: technology-investment-related practices (e.g. purchase and implementation of energy-efficient technical equipment), technology-organization-related practices (e.g. enhancement and optimization of existing support or process technology), organization-related practices (e.g. corporate energy strategy, implementation of an energy management system), information-related practices (e.g. energy-monitoring, internal technical meetings), competence-related practices (e.g. workshops, trainings) and behavior-related practices (e.g. raising awareness for energy saving by personal encouragement, explicit behavior guidelines). Referring to the attention-based view of the firm (Ocasio 1997) the organization distributes the attention to, structures the situational context of, and shapes the focus of attention on energy efficiency issues. Following Schein (2004) the energy efficiency culture of an industrial organization is defined as the unconsciously-shared assumptions and beliefs that are mutually dependent from the organizational structures, practices, environment and individual members.
3. The micro-level incorporates the decision-makers and members of the organization with their individual characteristics (e.g., attitudes, interests, competencies). These characteristics are mutually dependent of the positioning and socialization of individuals within the organization.

Decisions represent processes of theorization and problematization, linking together the issue-field (1. Macro-level), the organization (2. Meso-level), and the members (3. Micro-level). In this sense, decision makers are not considered as atomistic units. As Andrews and Johnson point out, "individuals in organizations do not act in isolation" (2016: 198), but are members of work groups, professional groups, milieus, or families in the case of family businesses.

Empirical background and methods

The study follows a sequential mixed-methods approach (Creswell 2009) and combines ethnographic case studies with a subsequent quantitative survey. The case studies focus on the general questions of how decisions for energy efficiency are made in SMEs, what driving processes and aspects can be identified and how energy efficiency issues are treated, organized and communicated in everyday work life. The sample (Table 1) comprised ten manufacturing SMEs[1] from different industrial sectors (chemicals, minerals, engineering, and machinery). The cases were selected by theoretical sampling (Glaser/Strauss, 1998). The cases were selected according to the premise of "minimum/maximum contrast", especially with regard to energy intensity, sector and number of employees of the enterprises. The data generation was mainly based on qualitative interviews (Froschauer/Lueger 2003) with members from

1. An SME is intended here as an enterprise according to the 2003 recommendation of the European Council.

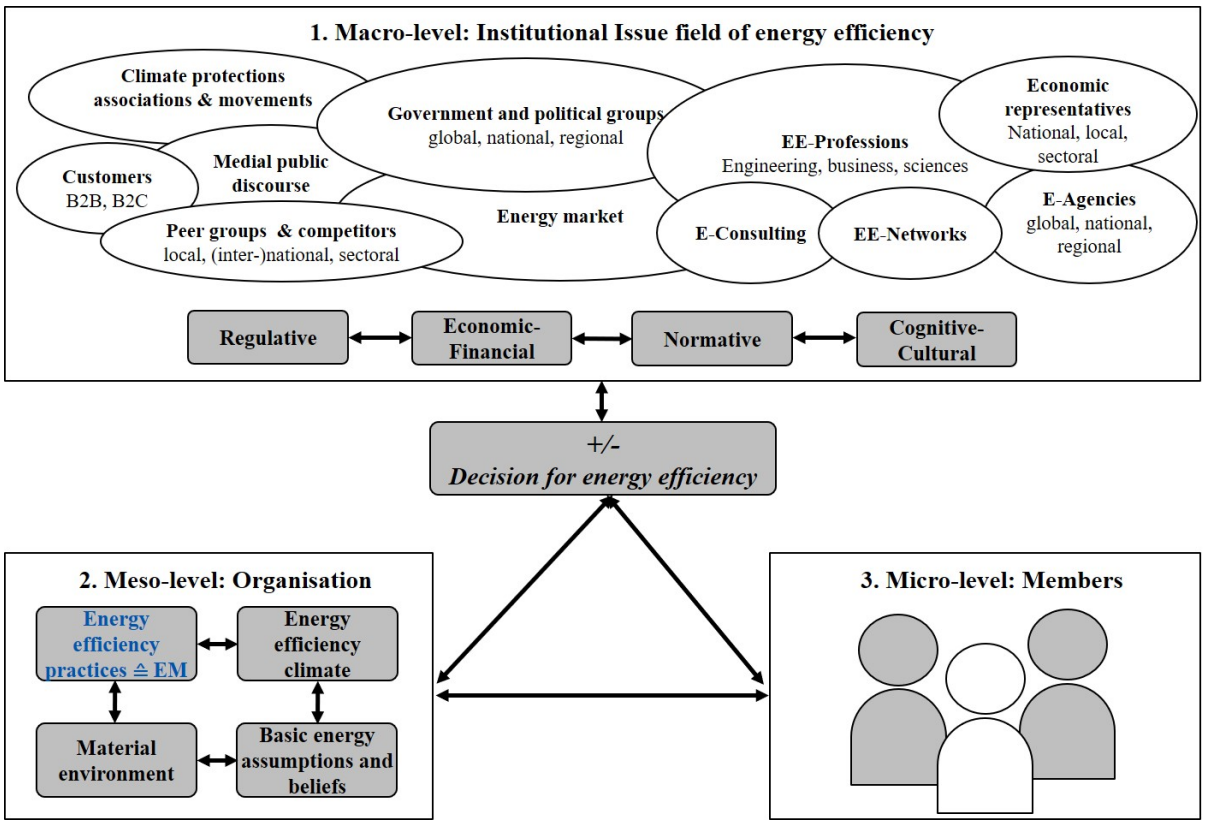

Figure 1. Energy efficiency culture framework following König (2020).

different divisions within the enterprises. Around seven to ten interviews per SME (one on one and multi-person) were conducted in each enterprise. In addition to the interviews, participating observations and artefacts (e.g. company presentations, homepages, work instructions) were included in the analysis. Depending on what was appropriate from the perspective of the enterprises and their members the observations were either performed as fly-on-the-wall (e.g., at meetings of formal or informal energy teams or meetings with external energy efficiency consultants) or following the daily routines throughout the work day. A hermeneutic interpretation procedure in the form of system-analysis (Froschauer/Lueger, 2003, 2009) was used as a means of analysis. The field research was carried out by one person of the University of Reutlingen, taking about one year all together and spending around one work week in each SME.

Based on the case study research, we conceptualized a quantitative survey through a questionnaire comprising 28 questions on topics such as the importance of energy efficiency, measures, support measures, the influence of the business environment, the relevance of employee behavior, financing and others. The questionnaire consisted of different types of questions including multiple choice questions; Likert scale questions, matrix questions as well as single choice questions. The survey took place from May to June 2018 and around 500 SMEs from the federal state of Baden-Württemberg, Germany were surveyed. A market research institute was commissioned with the survey itself while the analysis was conducted by the Institute for Energy Efficiency in Production, Universität Stuttgart. On the basis of available data bases and selected by company size (micro-, small-, middle-sized) and sectors (such as mechanical engineering and automotive, which are considered to be very important for German industry) the SMEs were reached by telephone. Naturally, not all companies were open to be interviewed – Therefore, a self-selection bias can be assumed. In addition to descriptive data analysis, we conducted a correlation analysis (using SPSS). The correlation analysis was performed using ordinally scaled variables, with the Spearman-Rho rank correlation coefficient as an indicator of correlation.

Results

The presentation of the results concentrates on those topics we identified as crucial in constituting energy management and the establishment of energy efficiency in SMEs. Referring to the theoretical perspective described in the first section, the results focus on four dimensions containing seven topics (Table 2). To draw a cohesive picture, we merge the results of qualitative and quantitative analysis in our presentation and indicate for the individual topics on which data basis the findings are based on.

ESTABLISHMENT OF ENERGY EFFICIENCY WITHIN SMES

The establishment of energy efficiency represents both the political and social goal as well as the initial question of the present research. Within the scope of our survey, we therefore asked the SMEs how they perceive the establishment of energy efficiency within their organization. Energy efficiency appears to be fairly well established in the surveyed SMEs. Rather surprisingly, the energy demand of the enterprises does not seem to have a particular influence on how energy efficiency is established in the enterprise. On the other hand, the size of the

Table 1. List of enterprises participating in the case studies.

Case	Number of employees	Sector	EMS or audit
Enterprise A	110	Surface engineering	Yes
Enterprise B	90	Mechanical engineering	No
Enterprise C	70	Foundry industry	No
Enterprise D	135	Manufacture of products of wood, synthetics and metal	No
Enterprise E	115	Mineral industry	Yes
Enterprise F	240	Pulp and paper industry	Yes
Enterprise G	85	Mechanical engineering and service	No
Enterprise H	45	Surface engineering	No
Enterprise I	20	Mechanical engineering	No
Enterprise J	85	Manufacture of chemical products	Yes

Table 2. List of enterprises participating in the case studies.

Theoretical dimension	Result topics
1. Energy efficiency climate	1 Establishment of energy efficiency within SMEs
2. Energy efficiency practices	2. Practices constituting energy management
3. Interface between the enterprise and its members	3. Formal and informal energy management in SMEs in every day work life 4. The importance of an energy efficiency strategy 5. Energy management as vital driver in establishing energy efficiency 6. Leadership and empowerment as necessity for energy management
4. Interface between the enterprise and its environment.	7. The importance of energy efficiency for the environment

enterprises appears to have a more significant influence (Figure 2). In the case of micro-enterprises, around 30 % perceive energy efficiency as being strongly to very strongly established, compared with around 50 % for medium-sized enterprises.

PRACTICES CONSTITUTING ENERGY MANAGEMENT

Tapping the energy efficiency potentials adequately usually requires a variety of different measures, ranging from technical investments to raising awareness measures. The case studies showed that the enterprises undertake a variety of measures in different contexts, simultaneously, sequentially and sometimes even unintentionally. The interplay of different practices that may emerge over time can be well illustrated by an example of the case study research.

A medium-sized engineering company draws its attention to its compressed air supply and starts problematizing the technical equipment. The enterprise first turns to compressed air generation, invests in new compressors, and starts monitoring energy consumption. After attending a regional information event, a maintenance employee suggests that the piping system should be checked for leakages and optimized. Top management decides to redesign the compressed air system and commissions a service provider. Although the enterprise can report a significant reduction in energy consumption, the management is not sufficiently satisfied. At a production meeting, the records of savings and energy consumption of the compressed air supply are discussed. The practical use of compressed air becomes a focal point, and the enterprise begins to inform production employees about the sensitive use of compressed air. Half a year later, the results of energy consumption show hardly any differences, and top management wonders why the measures for raising awareness have little effect and what further measures are appropriate. Under the impression that the employees are ignoring the previous measures, the company changes its approach. The quality manager is instructed to formulate working rules for the use of compressed air. At the same time, the technical team is instructed to look for ways to automate the use of air-operated machines.

In some cases, practices can also emerge unintentionally. In one case investigated, top management put particular emphasis on behaviour-related practices. The top management personally invested a lot of time over many months to encourage employees to save energy and to draw attention to this topic. This was achieved primarily through direct daily contact with employees at the shop floor. Rather surprisingly for the top management a pleasant side effect – as an organizational practice – emerged as an informal team formed from within the staff, which now independently took over the task of raising awareness at the shop floor.

The exploitation of energy efficiency potentials by using a broad spectrum of energy efficiency defines successful energy

management in the investigated cases. Within the scope of the survey, we therefore asked the SMEs what type of energy efficiency practices they have implemented in the last three years, what measures they are currently focusing on, what measures they plan for the future (in the following three years) and what ones they do not plan to carry out at all. In the past, the SMEs mostly focused on technical-investment measures and in the future the focus will also be placed on technical measures. Behavior-related practices (e.g., measures for raising awareness for energy saving by personal encouragement or formal/informal behavior guidelines) have had a high priority for SMEs and will also be held as important in the near future. Furthermore, the current focus is mostly drawn to such measures. All other types of measures seem to have considerably less importance for the enterprises (Figure 3).

The relatively low importance of organizational-, information- and competence-related practices becomes even more distinct when considering the size of the enterprises. The smaller the enterprises, the less that they seem to value these measures. Additionally, the percentage of measures not being planned is noticeable higher the smaller the enterprise size. Particularly in micro-enterprises, fewer measures have been implemented and they are not likely to be carried out in the future.

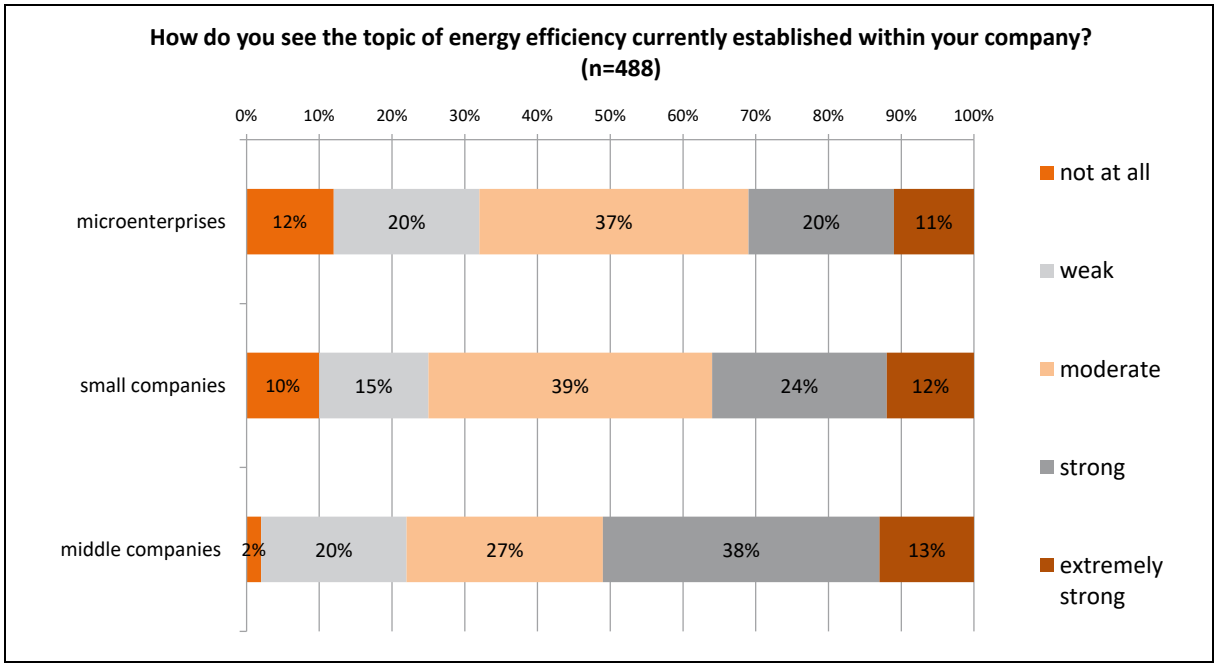

Figure 2. Establishment of energy efficiency in SMEs.

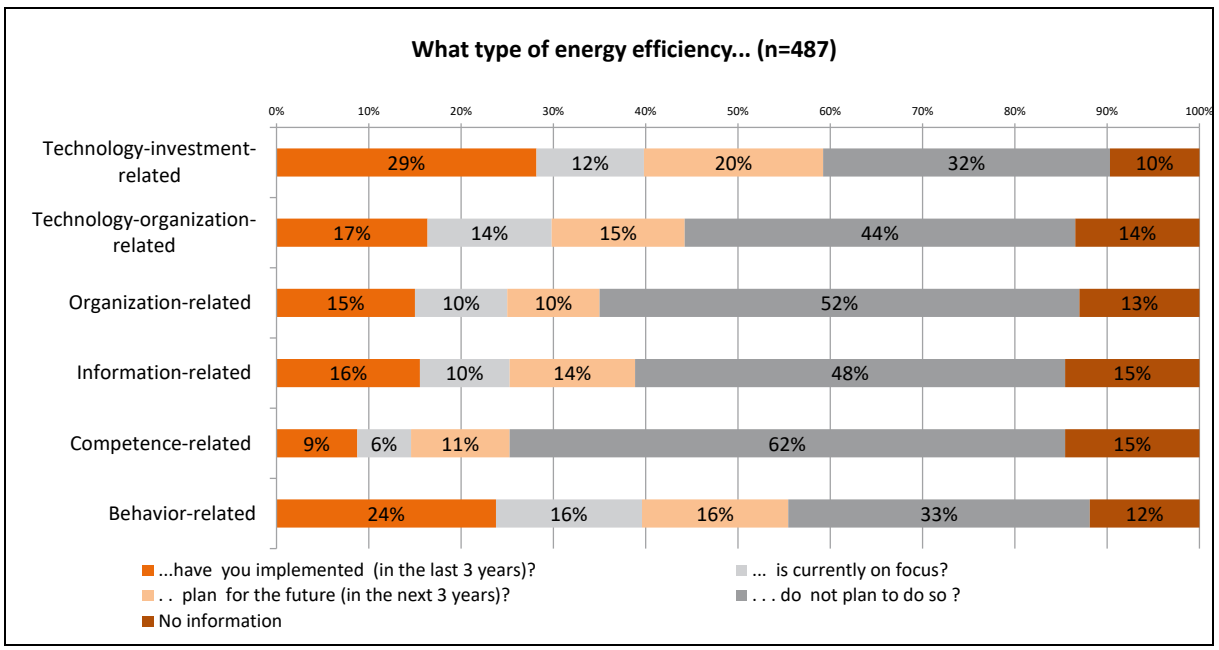

Figure 3. Importance of different types of practices (Energy efficiency practices).

FORMAL AND INFORMAL ENERGY MANAGEMENT IN SMES IN EVERY DAY WORK LIFE

Although five of the eleven enterprises investigated within the case study research operate an energy management system according to the standard ISO 50001, this does not mean that the remaining enterprises do not practice energy management. By contrast, those enterprises successfully conduct energy management without committing themselves to a standardized system, whereby they embed energy efficiency issues in their corporate strategy, set up energy efficiency goals, appoint energy managers, digitize and monitor their energy consumption, plan and implement measures, train their employees, and research possible technical measures and their financing. The difference mainly lies in the formal structure: for instance, in one case a company does not appoint a formal energy team in the enterprise, yet an informal network of people regularly meets to discuss energy efficiency issues. In another case, employees are aware of general premises regarding energy efficiency practices and expected energy-saving behavior, yet no energy policy has ever been documented. It is also noteworthy that those SMEs do not aspire to implement a standard energy management system in the future at all. Due to a lack of personnel resources, administrative and certification costs, an implementation is not a goal or viable option especially for small SMEs.

The analysis of the individual cases indicates, that the implementation of a formal management system does not necessarily guarantee effectiveness. For example, in one case the enterprise has established formal responsibilities and an explicit energy policy, although a lack of authority to take action and employees who are unfamiliar with energy issues constrain the implementation of measures. In addition, the implementation of an energy management system can cause unintended effects. In one case, energy efficiency was mostly perceived by the enterprise and its members as a forced external expectation due to the implementation process of ISO 50001. During the interviews the respondents either directly ("our management/competitors/the customers' expectations forced us to implement …") or rather vaguely ("we had to do it") referred to strong expectations instead of providing hardly any other motivation. This finding allows the interpretation that complying with the paragraphs of the norm and pleasing the auditors became the dominant frame of reference for interpreting energy efficiency issues, despite diametrical intentions of the top management. Additionally, and despite the rational intent of top management to institutionalize energy efficiency within the enterprise another unintended issue became apparent in the same case. When asked about energy efficiency issues or measures almost all interviewed persons referred to the designated energy manager. Whilst the interviewed energy manager complained about the lacking support especially of the production personnel despite the establishment of an energy team consisting of such members. Roughly speaking, energy management became reduced to the face of the energy manager, who in turn got overwhelmed by the responsibility of managing everything by his own. The observations and interviews within the scope of the case study research indicate that those enterprises without formal energy management sometimes take much more effective measures and establish energy management effectively within the organization.

THE IMPORTANCE OF AN ENERGY EFFICIENCY STRATEGY

According to Thollander and Palm, energy management can be defined as the "procedures by which a company works strategically on energy" (2013: 85). The adoption of an energy efficiency strategy is therefore considered as a key driver of energy efficiency (Thollander et al. 2009, Thollander/Ottosson 2008). Assuming that the strong importance of energy efficiency for corporate strategy has a positive effect on further decisions, the enterprises were surveyed (Figure 4). For almost half of the surveyed SMEs, energy efficiency occupies an important or very important position in the corporate strategy. On the other hand, only 6 % of the enterprises surveyed consider energy efficiency as unimportant for their general corporate strategy. The influence of embedding energy efficiency in the corporate strategy is explained in more detail in the following section.

ENERGY MANAGEMENT AS VITAL DRIVER IN ESTABLISHING ENERGY EFFICIENCY

Although energy efficiency seems less established in smaller enterprises (see above), the analysis shows only a minor correlation (Table 3). The size of the enterprise as well as the en-

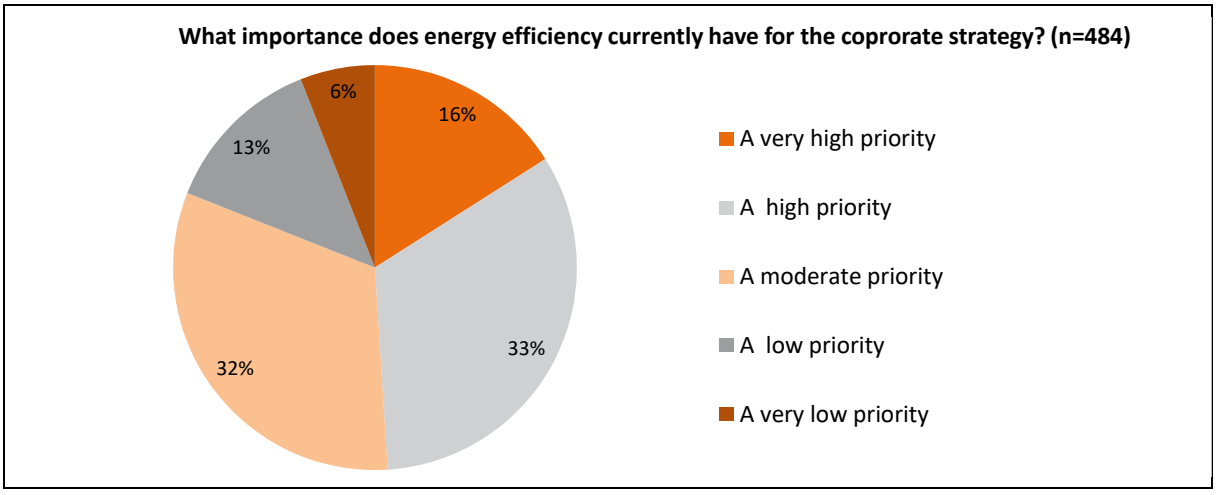

Figure 4. Importance of energy efficiency corporate strategy.

Table 3. Factors correlating with the establishment of energy efficiency within SMEs.

Variables	1	2	3	4	5	6	7
1. Establishment of energy efficiency	1,000						
2. Importance for corporate strategy	,475**	1,000					
3. Variety past energy efficiency practices	,328**	,295**	1,000				
4. Importance of employee behavior for energy savings	,226**	,338**	,124**	1,000			
5. Importance of energy efficiency for the environment	,204**	,223**	,290**	,216**	1,000		
6. Energy demand	,116*	,119**	,218**	,071	,161**	1,000	
7. Firm size	,140**	,094*	,137**	,232	,116	-,140**	1,000

*Note: N=488; Spearman Correlation, * Correlation significant at p < 0.05 (two sided); ** Correlation significant at p < 0.01 (two sided).*

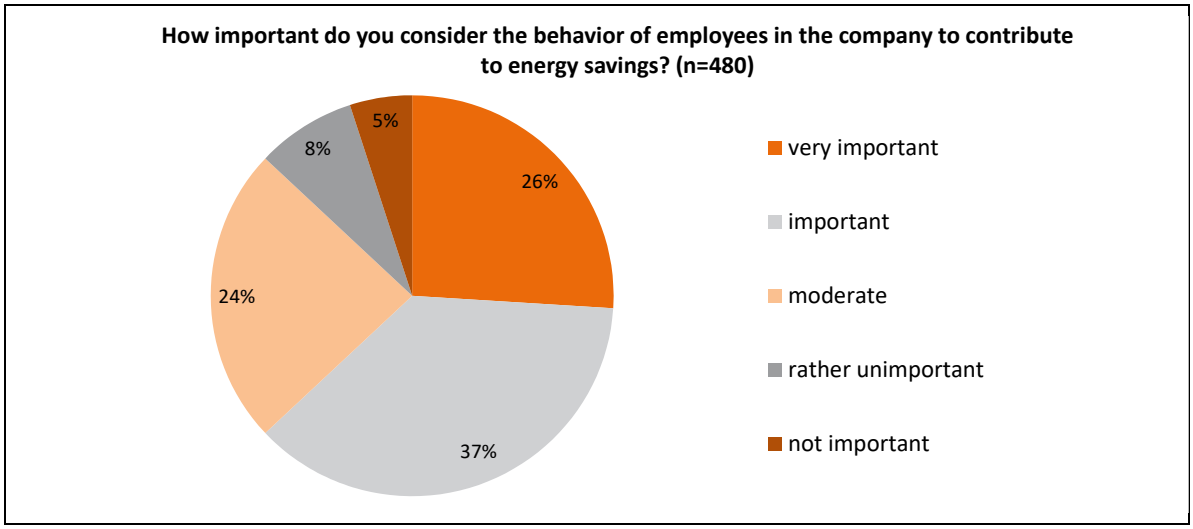

Figure 5. Employee behavior as contribution to energy savings.

ergy demand hardly seem to determine the extent to which energy efficiency is established in the enterprise. By contrast, the embeddedness of energy efficiency in the corporate strategy and the variety of past measures appear to have a significant stronger correlation. According to the analysis, the existence of an energy efficiency strategy is more effective than typical structural characteristics that are identified in other studies as the most important influencing variables. such as the size of an enterprise (Trianni/Cagno 2012, Cagno/Trianni 2013) or the energy demand (Phylipsen et al. 1997).

LEADERSHIP AND EMPOWERMENT AS NECESSITY FOR ENERGY MANAGEMENT

The interviews with top management personnel and the informal or formal members of the energy teams in the context of the case study research showed one thing very clearly: Establishing energy efficiency within the enterprise is by no means a trivial task for SMEs and usually means initiating a permanent change process – a process particularly challenging the responsible personnel. Due to their decisions, actions and interactions they inevitably convey the meanings of energy efficiency for the enterprise, thus providing a frame of reference for the organizational members. If, for instance, energy efficiency is framed by the top management only as the fulfilment of an external and unpleasant requirement, it is highly probable that the employees will also interpret corresponding tasks as an annoying duty. This aspect represents the symbolic aspect of leadership which should not be underestimated. The case studies showed that the everyday behavior of the employees is perceived as an important influencing factor for improving energy efficiency. At the same time, top management often experiences encouraging energy saving among the employees as a daunting task. Actions for raising awareness are sometimes perceived as "Sisyphus work" as one managing director described it graphically. Similarly, many of the interviewed top management personnel or energy managers (formal and informal) complained on the challenging nature of raising awareness for energy saving behaviour. From their point of view those tasks are frequently associated with high affectivity (e.g., incomprehension, frustration, annoyance). Nevertheless, and as the case studies further showed how importantly the everyday efforts of the employees for increasing the energy efficiency in the SMEs is perceived we subsequently asked the SMEs in the survey, how they consider the behavior of the employees in the enterprise to contribute to the success of energy savings (Figure 5). Almost two-thirds of SMEs (63%) consider the importance of energy-saving behavior being important. On the other hand, only 13 % of the SMEs surveyed rate the importance of employee behavior as rather or completely unimportant. No considerable differences regarding enterprise size and energy demand could be observed.

In the context of the case study research, we investigated which strategies the companies pursue in order to promote and enforce energy-saving behaviour within the enterprise. We identified four different strategic approaches: 1. *Raising awareness* (e.g., creation of consciousness by trainings, empowerment or speech), 2. *Motivation* (e.g., promotion of self-interest by sanctions, incentives or job roles), 3. *Regulation* (e.g., establishment of conformity by formal or informal work rules), and *Automation* (e.g., avoidance of human risks by technical measures). It should be stressed that these approaches represent "ideal types" (Weber 1985), which do not occur in pure form in the enterprises. Rather, the enterprises mix and complement, for example, raising awareness measures with formal rules or automation measures.

However, the case studies showed that raising awareness among the employees is the most important strategic approach to foster energy efficiency decisions and energy-saving behavior. As the observations within the enterprises showed, top management and key personnel often devote a lot of time and effort to situating attention on energy issues among the workforce. Occasionally they feel that they become "energy educators" within the enterprise. Through formal speech, discussion and storytelling, they facilitate knowledge, values and beliefs on energy efficiency issues. Drawing attention to energy issues in everyday interactions proves to be particularly important to establish an alert energy efficiency climate. However, not every enterprise or manager is willing or able (e.g. due to a lack of time, competencies or patience) to perform these educational tasks. In defense, the top management personnel of the enterprises often claim the lack of competent personnel as an obstacle to awareness-raising ambitions. Additionally, the extent to which awareness-raising measures might succeed strongly depends on the individual characteristics attributed to the "energy educators" in charge. Interpreting the interviews with top management and production personnel made clear that to succeed, the "educators" not only have to demonstrate sufficient knowledge (e.g. technical, practical, social knowledge), but integrity as well.

Organizational and behavior related practices – empowerment and involvement of the employees, clarification of authorities and responsibilities, creation of communication channels, raising awareness among the personnel – direct and distribute attention on energy efficiency and simultaneously create internal networks. It seems essentially irrelevant whether these networks exist formally or informally. For instance, and with regard to the case study research, informal energy teams can be equally effective as formal energy teams in driving energy efficiency measures or energy saving behavior. Similarly, the empowerment of the production personnel by granting authorities (e.g., for internal trainings) and responsibilities (e.g., for the implementation of measures or monitoring tasks) can sometimes be far more effective than leaving all issues to a single explicit energy manager. From the perspective of investigated the enterprises and their top management, practices to stem energy efficiency issues on broad shoulders are a necessity to make the increasing complexity of energy efficiency manageable. Exploiting energy efficiency potentials will not necessarily become less complex in the long term; for example, due to new technologies, legal frameworks or energy market dynamics. The general complexity of industrial energy efficiency requires a decentralization of attention, responsibility and authority. The involvement of key personnel ("energy efficiency agents") therefore holds particular importance and will become an increasing necessity for SMEs in the long run.

THE IMPORTANCE OF ENERGY EFFICIENCY FOR THE ENVIRONMENT

According to sociological neo-institutionalism theory, organizations adopt practices and structures that are perceived as "desirable, proper or appropriate within some socially constructed systems of norms, values, beliefs and definitions" (Suchmann 1995, Scott 2008). Hence, organizational decisions are considered legitimate if they appear desirable and appropriate when measured against the social values, norms, and beliefs of their environment. In our questionnaire survey, we therefore asked how the SMEs perceive the significance of energy efficiency for their environment. As Figure 6 shows, customers are most likely attributed as valuing energy efficiency as very important. The significance for the local environment, competitors, owners and professional groups is perceived as considerably lower, albeit at a similar level.

Conclusions

Energy management is a key driver for energy efficiency decisions and a corresponding energy efficiency culture in the SMEs studied. The key principles of energy management to establish energy efficiency within SMEs include the strategic embedding of energy efficiency in the corporate strategy, a broad range of practices, empowering and involving employees, raising awareness in everyday work life and decentralizing attention. In this sense, given that the implementation of an energy management system is often not a viable option or aspiration for SMEs, energy management does not necessarily represent a tool or software for enterprises, but rather the fundamental principles of organizing energy efficiency.

By focusing on the practices of energy management, we showed that the SMEs consider, plan, and carry out a variety of energy-efficiency measures in everyday work life. Although the majority of enterprises concentrate primarily on technical measures, behavioral measures are rated as equally important. In comparison, organizational measures are perceived to be substantially less relevant in our survey, even though the case-study research indicated the driving aspects of organizational measures in establishing energy efficiency within the enterprises. The embedding of energy efficiency in the corporate strategy and the distribution of responsibility and tasks in everyday work life prove effective in establishing long-term attention for energy efficiency

We therefore recommend mediating basic principles (e.g. the importance of embedding energy efficiency into corporate strategy, the benefits and use of a variety of practices, distributing attention by organizational measures) among industrial sectors. As Fresner et al. (2017) have shown regarding engaging SMEs in energy efficiency audits, the support of chambers and industry associations that work directly with SMEs could prove beneficial in spreading ideas about energy management. In order to establish essential knowledge and awareness in the long run, the embedding of energy management in professional education should be supported by policy-makers.

Finally, we showed that if energy efficiency has a high significance for the environment of the enterprises, decisions on

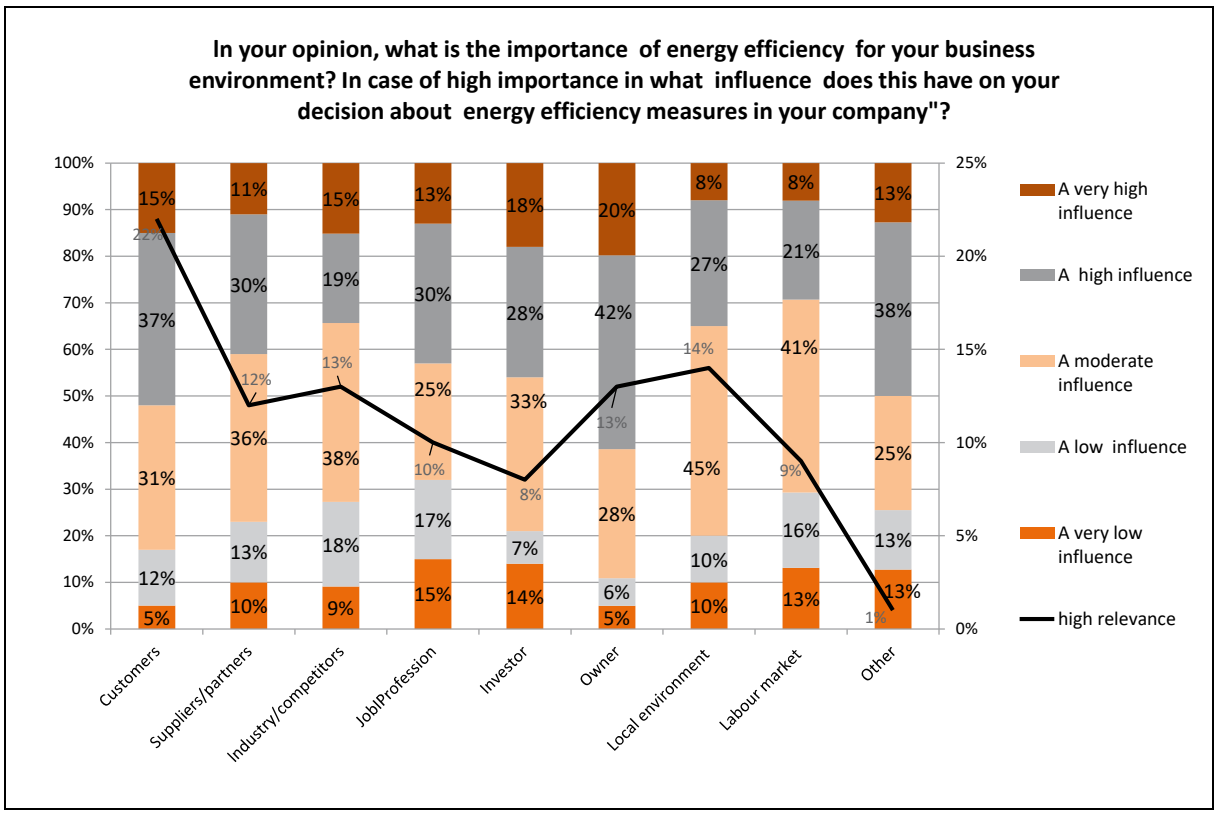

Figure 6. Influence of the environment on decisions about energy efficiency measures.

energy efficiency practices more likely constitute. Considering the meaning of energy efficiency as socially produced by the industrial organizations, its members, and environment, political actions must not be narrowed to industrial organizations. On the contrary, attention for energy efficiency has to be supported throughout the society. We therefore advocate for efforts in strengthening the political and public discourse around energy efficiency. Thus, improving industrial energy efficiency is up to the individual decision makers, the enterprises, and society as a whole.

References

Andrews, R.N.L.; Johnson, E., 2016: Energy use, behavioral change, and business organizations: Reviewing recent findings and proposing a future research agenda. Energy Research & Social Science 11, 195–208.

Caffal, C., 1995: Learning from experiences with energy management in industry. Centre for the Analysis and Dissemination of Demonstrated Energy Technologies. Analysis Series 17, Sittard, Netherlands.

Cagno, E.; Trianni, A., 2013: Exploring drivers for energy efficiency within small- and medium-sized enterprises: First evidences from Italian manufacturing enterprises. Applied Energy 104, 276–85.

Cagno, E., Worrell, E., Trianni, A., Pugliese G., 2013: A novel approach for barriers to industrial energy efficiency. Renewable and Sustainable Energy Reviews 19, 290–308.

Creswell, J.W., 2009: Research design – Qualitative, Quantitative, and Mixed Methods Approaches. 3rd edition. SAGE Publ.: Thousand Oaks, California.

Christoffersen, L.B.; Larsen, A.; Togeby, M., 2006: Empirical analysis of energy management in Danish industry. Journal of Cleaner Production, Vol. 14, 516–526.

FEA 2019 – Federal Environment Agency, data on environmental and energy management systems in Germany. https://www.umweltbundesamt.de/daten/umwelt-wirtschaft/umwelt-energiemanagementsysteme

Fiedler, T.; P.M., Mircea, 2012: Energy management systems according to the ISO 50001 standard – Challenges and benefits. Conference paper: 2012 International Conference on Applied and Theoretical Electricity (ICATE). DOI: 10.1109/ICATE.2012.6403411.

Fresner, J.; Morea, F.; Krenn, C.; Uson, J.A.; Tomasi, F., 2017: Energy efficiency in small and medium enterprises: Lessons learned from 280 energy audits across Europe. Journal of Cleaner Production 142, 1650–1660.

Froschauer, U.; Lueger, M., 2003: Das qualitative Interview. Zur Praxis interpretativer Analyse sozialer Systeme. Facultas Verlags- und Buchhandels AG, Wien.

Froschauer, U.; Lueger, M., 2009: Interpretative Sozialforschung: Der Prozess. Facultas Verlags- und Buchhandelshandels AG: Wien.

Glaser, B.G.; Strauss, A.L., 1998: Grounded Theory. Strategien qualitativer Forschung, H. Huber: Göttingen, S. 51–83.

Hoffman, A., 1999: Institutional evolution and change: Environmentalism and the US chemical industry. Academy of Management Journal 42, 351–371.

Löbbe, S.; König, W.; Büttner, S.M.; Schneider, C., 2020: Establishing energy efficiency – Drivers for implementing energy efficiency in SMEs. Forthcoming.

König, W., 2020: Energy efficiency in industrial organizations – A cultural-institutional framework of decision-making. Energy Research & Social Science 60 (2020) 101314, https://doi.org/10.1016/j.erss.2019.101314

Martin, R.; Muûls, M.; de Preux, L.B.; Wagner, U.J., 2012: Anatomy of a paradox: Management practices, organizational structure and energy efficiency. Journal of Environmental Economics and Management, 63, 208–223.

Ocasio, W., 1997: Towards an attention-based view of the firm. Strategic Management Journal 18, 187–206.

Palm, J.; Thollander, P., 2010: An interdisciplinary perspective on industrial energy efficiency. Applied Energy 87, 3255–3261.

Patterson, M.G., 1996: What is energy efficiency? Concepts, indicators and methodological issues. Energy policy, Vol. 24, No. 5, 377–390.

Schein, E. H., 2004: Organizational culture and leadership. Third edition, Jossey-Bass: San Francisco.

Scott, R.W., 2008: Institutions and Organizations. Ideas and Interests. Third edition, SAGE Publ.: Thousand Oaks California.

Stephenson, J.; Barton, B.; Carrington, G.; Doering, A.; Ford, R.; Hopkins, D.; Lawson, R.; MacCarthy, A.; Rees, D.; Scott, M.; Thorsnes, P.; Walton, S.; Williams, J.; Wooliscroft, B., 2015: The energy cultures framework: Exploring the role of norms, practices and material culture in shaping energy behaviour in New Zealand. Energy Research & Social Science 7, 117–123.

Suchmann, M.C., 1995: Managing legitimacy: Strategic and institutional approaches. Academy of Management Review 20, 571-610.

Sudhakara Reddy, B. (2013), Barriers and drivers to energy efficiency – A new taxonomical approach. Energy Conversion and Management 74, 403–416.

Thollander, P.; Ottosson, M., 2008: An energy efficient Swedish pulp and paper industry: exploring barriers to and driving forces for cost-effective energy efficiency investments. Energy Efficiency 1, 21–34.

Thollander, P.; Solding, P.; Söderström, M., 2009: Energy management in industrial SMEs. Proceedings of the 5th European conference on economics and management of energy in industry (ECEMEI-5), 1–9.

Thollander, P.; Palm, J.; Rohdin, P., 2010: Categorizing Barriers to Energy Efficiency – an Interdisciplinary Perspective, Energy Efficiency, Jenny Palm (Ed.). https://www.intechopen.com/books/energy-efficiency/categorizing-barriers-to-energy-efficiency-an-interdisciplinary-perspective

Thollander, P.; Palm, J., 2013: Improving Energy Efficiency in Industrial Energy Systems. An Interdisciplinary Perspective on Barriers, Energy Audits, Energy Management, Policies, and Programs. Springer Verlag: London.

Trianni, A., Cagno, E., 2012: Dealing with barriers to energy efficiency and SMEs: Some empirical evidences. Energy 37, 494–504.

Urban, D.; Mayerl, J. 2018: Angewandte Regressionsanalyse: Theorie, Technik und Praxis. VS Verlag für Sozialwissenschaften: Wiesbaden.

Wæraas, Arild; Nielsen, Jeppe Agger, 2016: Translation Theory "Translated": Three Perspectives on Translation in Organizational Research. International Journal of Management Reviews, 236–270.

Weber, M., 1985: Gesammelte Aufsätze zur Wissenschaftslehre. Winckelmann, J. (Hrsg.), 6. Aufl., Mohr Verlag: Tübingen.

Acknowledgements

The authors gratefully acknowledge the support of the Ministry of Science, Research and Art Baden-Württemberg (Research program: Innovative projects, 2016) within the scope of the "Decisions for Energy Efficiency" project (project no. 2015.01-Löbbe). All conclusions, errors or oversights are solely the responsibility of the authors.