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Management as a Key Driver of Energy Performance

Summary

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Introduction

Energy consumption and its related issues – safety of energy supply, various types of pollution, and greenhouse gas emissions – are subjects of growing importance and awareness.

The easiest, quickest, and cheapest way to reduce energy consumption is to improve energy efficiency: the invisible fuel. In the context of the Swiss Energy Strategy 2050, energy efficiency is a strategic path towards a sustainable energy system. The core hypothesis of the M_Key research project is that management is a key driver of energy performance; consequently, the project focuses on energy efficiency of large-scale energy consumers (LSEC) in the industry and service sectors. There is considerable untapped energy savings potential in many companies in this regard. However, investments in energy efficiency often remain undiscovered and projects undecided upon, even though they may be highly profitable. A large body of international research has discussed this under-investment in energy efficiency, known as the "energy efficiency gap", and has developed the concept of barriers to energy efficiency to explain it.

The M_Key project tries to better understand how large-scale energy consumers (LSEC) make energy efficiency investments decisions. M_Key specifically aims to investigate the influence of energy management as a way to reduce the energy efficiency gap in companies, and thus increase their energy performance.

Conceptual framework

The mainstream line of thought explains energy efficiency decisions mainly based on energy cost and profitability. To analyse the influence of energy management on energy efficiency investments, Cooremans' (2011, 2012a, 2012b) theoretical framework of investment decision-making was used, which includes alternative energy efficiency research findings and tries to explain companies' investment decisions better than the mainstream theories. According to this framework, investment decisions are the result of a complex process influenced by many different factors.

Among the factors influencing investment decision-making, investment characteristics play a paramount role. Investments can be categorized according to their functional object (research & development, production, etc.) or according to their strategic character. The strategic character of an investment – its "strategicity" – plays a paramount role in decision-making. Strategicity can be defined as an investment's contribution to a firm's competitive advantage. It is more important than profitability in the competition for resources, which exists in any or-

ganisation. In short, competitive advantage is a three-part concept formed of three interrelated constituents: value proposition, cost, and risks. However, the strategic character is not an objective fact: it is perceived, diagnosed and interpreted as such by decision-makers and companies. Therefore, the same investment project can be interpreted and infused with meaning differently by different companies. Individual and organisational filters influence this perception.

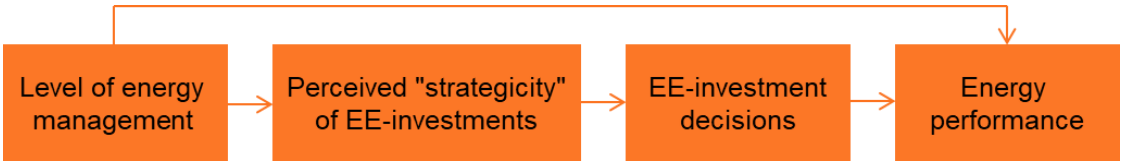
Research model

The objective of M_Key research is to better understand and describe the influence of energy management on a company's energy performance. The underlying core assumption is that energy management acts as an organisational filter which positively influences companies' perception of the strategic character of energy efficiency investments and, in turn, their choices regarding these investments.

M_Key also tries to confirm the relative importance of some other factors which, according to the literature review, appear to play a major fostering or hindering role. As a basis for the empirical work, M_Key took a detailed sounding of large-scale energy consumers in Switzerland and of the level and composition of energy management in Swiss companies. In Swiss cantonal energy regulations, large-scale energy consumers are usually defined as entities consuming more than 0.5 GWh per year of electrical energy and/ or 5 GWh per year of thermal energy.

Based on M_Key's theoretical framework, the influence of energy management on energy performance is hypothesised to happen through an impact chain which breaks down the influence of energy management on energy performance. Figure 1 illustrates the impact chain, which needs to be better understood.

Figure 1: M_Key's research model: The impact chain



Three relationships of influence to be analysed: 1) Influence of a company's energy management level on its perception of energy efficiency (EE) investment strategicity; 2) influence of energy efficiency investments' strategicity on energy efficiency investment decision-making; 3) influence of positive energy efficiency investment decisions on energy performance level.

Figure INFRAS, Université de Neuchâtel and Impact Energy.

Research questions and hypotheses

Based on the literature review and on M_Key's theoretical framework, the following research questions and hypotheses were formulated at the outset of the project (see Table 1):

Table 1: M_Key's research questions and hypotheses

Research Questions	Hypotheses
1. What is the level of energy management and its determinants in Swiss large-scale energy consumers?	1.1 The level of energy management in Swiss large-scale energy consumers is generally low.
	1.2 The main determinants of the energy management level are company size, company energy intensity and commitment or support of energy management by top management.
2. What is the influence of energy management on the perceived strategicity of energy efficiency investments?	2.1 The higher the companies' level of energy management, the more strategic they perceive energy efficiency investments to be.
3. What is the influence of the perceived strategicity on energy efficiency investment decision-making?	3.1 The more strategic an energy efficiency investment project is perceived by a company, the better the chances for positive decision.
	3.2 The less strategic the investments, the more restrictive the financial criteria in the selection of investment projects.
	3.3 The number of energy efficiency investments positively decided upon and realised depends mainly on the network relations/ knowledge exchange within the sector.
	3.4 Increasing requirements from cantonal energy policies for large consumers and/ or rising energy prices (in particular for electricity) positively influence energy efficiency investment decision-making by companies.
4. How does positive energy efficiency investment decision-making influence energy performance?	4.1 The higher the number of energy efficiency investments implemented, the higher the energy performance of a company (measured in energy intensity terms).

Table INFRAS, Université de Neuchâtel and Impact Energy.

Concept and methodology for empirical studies

M_Key combined quantitative and qualitative empirical research within the following three research methods that were applied sequentially: 1. survey, 2. interviews, 3. case studies.

The starting point was a large survey targeted to gather relevant data from Swiss large energy consumer companies. According to the 2011 Helbling survey (Brunner, *et al.*, 2012) on en-

ergy consumption in the industry and services sectors, there are about 10,000 (private) companies in Switzerland which qualify as LSEC. Those companies may have in total as many as 14,000 establishments (factory, plant, administrative or commercial building, *etc*.). In theory, the survey would have included all companies qualifying as LSEC. In practise—due to restrictions in time and resources—3,670 companies were contacted during the survey. The sample was composed as follows:

- Geographical distribution by language regions and cantons: in total about 13 cantons from the French-speaking part (the four cantons of Geneva, Friboug, Vaud, and Valais); the Italian-speaking part (Ticino), and the German- speaking part (Zurich, Bern, Basel-Stadt, Saint-Gallen, Luzern, Glarus, Graubünden, Solothurn and Aargau).
- Economic activities (two sectors, nine categories): industry with industrial food processing, chemistry, pharmaceutical, metal, instruments including watchmaking, machine and equipment, service with retail and wholesale, hotel, banks and insurance.
- Size of companies: large companies in terms of employment and/ or number of facilities plus a significant proportion of smaller companies.

About 900 companies responded to the online questionnaire, having at least started filling in the questionnaire. A careful process of evaluation resulted in the final selection of 305 valid responses, *i.e.* answers that were qualified as being comprehensive and strong enough for detailed analysis, and also of the correlation between determining factors and the interpretation of results.

Following the survey results, these 305 companies were asked to participate in interviews. The main objective was to gather further information to verify or falsify the hypotheses of the research project. Twenty-six companies were selected for face-to-face interviews, of which 18 companies were located in German-speaking Switzerland and eight were located in French-speaking Switzerland. Apart from the regional criteria, further selection criteria were the sector (two-thirds from the industry sector, one-third from the services sector), the range of energy consumption, and the level of energy management (as scored in the evaluation of the survey).

For the case studies, five out of the 26 interviewed companies were selected. The goal of the case studies was to verify the findings of both the survey and interviews, and to complement them with practical observations concerning the energy consumption, energy performance and energy efficiency measures implemented. Within the M_Key three-part research approach, the five case studies were the first and only time when the companies and their energy-using equipment had to undergo a “walk-through audit”, during which their energy efficiency data were evaluated and their past and future plans of energy efficiency measures were observed in more detail.

Main findings

Level and main determinants of energy management (EM)

The level of energy management of the companies was evaluated for the first time based on a 23-point scale. The energy management of the respondent companies is currently at a rather low level (10.3 points out of the maximum reachable score of 23 points).

The set of main determinants of EM is larger than expected. In most cases, one of the three factors mentioned in the hypotheses (company size, energy intensity, support from top management) is considered to be dominant. Other important factors are the public policy and the energy manager's support. A common result of all empirical studies is that the support from the top management seems to be the most relevant factor.

Influence of energy management on perceived strategicity

In general, no clear impact of the EM on the perceived strategicity of energy efficiency (EE) investments could be observed. The results of the interviews and the case studies indicate that in most companies the direction of the observed influence is the contrary: the more strategic EE investments are perceived, the more important strong EM is considered.

The main contribution of EM is that it informs decision-makers with reliable and solid data[1] regarding energy consumption and cost, energy efficiency projects and the energy savings they have the potential to generate. By providing facts and figures, it tries to make the impacts of EE measures quantifiable.

Strategic relevance of energy efficiency investments

Companies apparently have difficulty assessing energy efficiency investments. They often do not even know exactly how many projects were carried out over recent years, are not able to name the investment characteristics, or even identify which ones would qualify as strategic. In many companies, no specific budget category "investments to reduce energy consumption" exists at all.

Investments driven by efforts to strengthen the company's core business are generally considered to be more strategic than EE investments. High priorities normally dominating investment decisions are given to safety, continuity of production, and product quality. Many companies take energy efficiency aspects into account as a second step.

Large companies – or companies that are part of a corporate group – often have sustainability strategies and/or EE targets set by the top management or the corporate group. They put higher emphasis on EE and consequently EM. This is different in SMEs, for which the personal motivation and skills of the energy manager often are the main drivers of EM.

[1] When they are available, which is often not the case, as demonstrated by another M_Key project finding.

Financial evaluation of energy efficiency investments

Almost all companies apply at least one of the common methods to the financial evaluation of EE investment projects. More than 80% of them only use the simple payback method, without using the two methods which enables to assess investment projects' profitability[2]: Net Present Value (NPV) and Internal Rate of Return (IRR). Most companies apply the following principle: the more strategic a project or investment is considered to be, the less restrictive the financial criteria applied are.

Influence of network relations/ knowledge exchange within the sector

Although many companies exchange relevant information and experience with other companies and participate in professional networks, most companies claim that decisions to implement EE projects are taken fully independently. The exchange of experience, however, is seen as a pool of ideas and innovation to stimulate the identification of EE potential and new projects.

Impacts of national or cantonal energy policies and/ or of rising energy prices

Public requirements (laws, regulations and incentive programs) appear to have a strong impact with regard to inciting companies to action. First, public policy influences EM positively. Second, public policy impacts EE investments, since it often triggers EE investments and/ or speeds them up. The most relevant public requirements appear to be the CO_2 target agreements, supported by CO_2 levy reimbursement agreements. Companies generally do not anticipate increasing future requirements from federal and cantonal energy policies.

Most companies take their investment decisions based on today's energy prices, which are taken for granted to remain constant in the future. Possible changes in energy prices are rarely considered, except in the case of large companies, whose energy intensities (the ratio of annual energy cost to gross added value) are significant (at greater than 5%).

Influence of energy efficiency investment decisions on energy performance

A majority of companies (60%) that have implemented EE projects over recent years claim to have experienced a reduction in energy consumption. However, these results have to be considered as merely qualitative evaluation, since many companies themselves expressed that they are not able to effectively assess any impact due to of a lack of monitoring tools and capacity. These companies cannot prove direct cause and effect relationships between EE measures implemented and energy consumption of the improved systems (as there are no specific measurements or analyses available).

[2] The payback method only indicates the time necessary to recover the initial investment, i.e. the time necessary to realise an operation without profitability (and without loss), while NPV and IRR evaluate investment profitability.

Main Conclusions

Based on the evaluation and discussion of the survey results, interviews and case studies, the following conclusions can be drawn:

Relevance of energy, in particular energy efficiency

Typically, energy issues are not a priority for companies. Since the share of annual energy costs, compared to the annual gross value added is mostly in the range of 1% to 3%,[3] the energy intensity is generally too small to be an issue of high relevance. The higher the energy intensity of a company, the more likely energy (and particularly EE) is considered to be relevant while deciding on investments. However, there is not a linear relationship between energy intensity and energy management but rather a threshold effect (*i.e.* above a certain level energy intensity becomes a significant decision-making driver and influences the level of energy management. There is virtually no difference between companies from the industry and service sectors.

In most of the five case study companies, the ceiling of possible, feasible and profitable energy efficiency improvement measures is not reached. When visited, in most of these five companies, untapped efficiency potential in thermal and electrical energy was observed: potential which the energy manager was not always aware of. For example, electrical machines like pumps, fans, and compressors for air and cooling were beyond a typical machine age, did not have load control, and seemed to be oversized. These untapped efficiency improvement potentials (Tieben, *et al*, 2015) and additional savings were not analysed in detail by the research team, compared to the planned list of measures.

Investments to strengthen the competitiveness of a company are normally driven by core business. They are rarely driven only by their potential to improve EE and hence reduce energy consumption, even though energy efficiency provides numerous benefits to companies: improvements in worker comfort, product quality, overall flexibility and productivity, as well as reductions in maintenance cost, risk, production time and waste. These benefits are labelled as "non-energy benefits" of energy efficiency. By positively contributing to companies' value proposition, cost reduction and risk reduction, non-energy benefits increase companies' competitiveness. In other words, non-energy benefits have the potential to raise the strategic character of energy efficiency investments (their strategicity). Therefore, non-energy benefits can be more important than energy benefits in convincing the management to invest in energy efficiency.

[3] INFRAS calculations based on Nathani *et al.* (2013) and Iten *et al.* (2015): Average energy intensity = 1.5%, median = value 0.9%.

Role, significance and influence of energy management

The concept of EM (based on the standard ISO 50001[4]) is not yet widespread in Swiss companies and LSEC. Many companies remain at a low level of resources, capacity and competence, their priority being to collect and compare annual energy consumption data.

The role of the energy manager is certainly a crucial element in the decision-making process and in the subsequent implementation of energy efficiency investments. Being a member of the SME's top management gives an energy manager more authority and opportunity to positively influence decisions and implementation of EE improvements. However, energy managers often lack know-how, time, resources, and influence.

Whenever investments are – at least partly – classified as investments to reduce energy consumption, companies generally consider this investment category as weakly or moderately strategic. The perceived strategic relevance of EE investments is determined by many factors, of which the level of EM is typically not an important one.

The predicted positive influence of (the level of) EM on the perceived strategicity of EE, on investment decisions, and ultimately on energy performance could not be confirmed. Instead, the impact is often the contrary: if energy (efficiency) is perceived as strategic, then companies tend to have a high or higher level of EM.

EM is mostly understood as an instrument for the identification and implementation of energy efficiency investments and has an important role in the EE investment decision-making processes of companies: the better the EM, the better the procedures of collecting and analysing data, and defining project ideas which provide transparent ground for decisions and increase the chances of a project proposal of being accepted and eventually implemented. However, in many cases, energy management can not fulfil this role because of a lack of monitoring and control tools (for instance meters and sub-meters).

Relevance of laws and regulations

Requirements from national or cantonal energy policies have a significant role (in the case of SMEs a key role) in inciting companies to action. While public policy strongly influences EM and indirectly EE investments, it also tends to have a direct positive impact on EE investment decisions, since it often triggers EE investments. However, most companies do not anticipate increasing stringency of these requirements in the near future.

Laws and regulations seem to be particularly effective for companies where the top management is not interested in energy efficiency. The management usually wants to comply with all regulations to avoid compliance issues. The chances of EM of realising EE projects can be increased by the importance given to the project *via* a competent external driver; this increases the chances of creating a commitment towards EE measures from the top management.

[4] ISO 50001:2011 – Energy Management System

Influence of EE investments on energy performance

Although it seems to be logical that the higher the number of EE investments, the higher the company's energy performance, the M_Key project could not provide sufficient data and evidence to prove it.

Sixty percent of the survey responses and almost all interview partners expressed a positive influence of EE investments on energy performance. However, they had to admit that in fact, they could not prove direct cause and effect relations between EE measures implemented and energy consumption of the improved systems, since no specific measurements are available. The case studies confirmed this inability to prove the impact of specific measures since companies generally cannot provide sufficient data for a quantitative *ex-post* analysis.

Policy recommendations

Based on the results and experiences from the three sub-studies, the M_Key project team outlines an approach that is thought to be suitable for promoting EM and EE improvement measures in LSEC. This approach structures the individual recommendation *as per* the headings given below.

Reinforcement of information, education and training; additional technical support

1) The support to LSEC and energy-intensive companies regarding the understanding of the federal and cantonal regulation and incentive mechanisms should be improved (better structured and more specified information).
2) Efforts should be taken to better define the position of an energy manager, including common tasks and duties. Once done, syllabuses of instructions/ reference manuals for EM should be produced and training programmes set up for energy managers.
3) Additional support should be provided to LSEC, through qualified external know-how for initial analysis and identification of potentials as well as the implementation of energy efficiency improvements and follow-up. Particular support should be provided in:
   - intensified specific expertise in the electrical field;
   - illustrative and and easily-understandable information and practical tools regarding the identification, evaluation, and communication of the non-energy benefits of energy efficiency projects;
   - methods or tools regarding systematic and improved monitoring of energy savings.

Expansion and intensification of national and cantonal strategies and regulations

4) The extent of the goals of the target agreements related to the CO_2 levy and the cantonal requirements for large-scale energy consumers should be critically assessed. If there is

room for improvement, options should be explored to set targets at a higher level. Furthermore, potential for strengthening the supervision, monitoring and control of the target agreements should be assessed.

Additional instruments

5) A common obligation for energy audits, as is the case already in the European Union (see Energy Efficiency Directive 2012/27/EU), should be checked. If, despite the fact that the EU system is different from the Swiss system, such a common obligation turned out to be reasonable and realisable, it should be established. It should be further examined if the obligation for energy audits should be combined with a financial incentive system.
6) The empirical results of this study confirm the relevance of energy cost as one of the relevant drivers for the strategic relevance of EE investments. Accordingly, a stepwise and foreseeable increase of prices for conventional energy sources by levies would be an effective measure to promote the implementation of energy efficiency measures in LSEC.