Is management a key driver of energy performance?

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Abstract

The Swiss research project "Management as a Key Driver of Energy Performance" (M_Key) aims to assess whether Energy Management (EM) positively influences decisions within companies for energy efficiency investment. The overarching objective of the project is to gain a better understanding of the determinants of energy efficiency investments.

M_Key targets large energy consumer companies in Switzerland with more than 0.5 GWh/a electric energy and/or 5 GWh/a thermal energy consumption in the industrial and services sectors.

The main research hypothesis is that EM significantly raises companies' perception of the strategic character of energy efficiency investments. Thus, EM is expected to induce positive decisions regarding energy efficiency investments and to ultimately increase the energy performance of a company.

The project runs for three years until the end of 2017. A quantitative and qualitative analysis was made during the following three phases:

1. Survey addressing approximately 3000 large energy consumers, with 305 valid responses
2. Interviews with 26 companies who responded to the survey
3. Case studies with 5 companies who were interviewed.

The results of the survey show that the level of EM in Switzerland in most companies is only moderate. The interviews were following up on the survey responses and getting a better understanding on how the EM system of the selected companies is being implemented and how it influences investment decisions. During the interviews, most companies mentioned laws and regulations and the support of the top management as an important determinant for investments into energy efficiency. The case studies focused on getting a detailed understanding of the energy efficiency measures effectively implemented at the companies, including optimization measures of electric motor systems. The evaluation and synthesis of the results of the three phases is still ongoing. This paper presents the findings of the project to date and focuses on the results of the case studies.

The M_Key research project is part of the National Research Programme "Managing Energy Consumption" (NRP 71) of the Swiss National Science Foundation (SNSF). Further information on the National Research Programme can be found at www.nrp71.ch.

Introduction

In many companies there is considerable potential to reduce energy consumption, but investments in energy efficiency often remain undecided, even though they may be highly profitable [4]. This is generally called the "efficiency gap". It is not sufficiently clear why companies are not implementing all the recognized economically feasible energy efficiency measures fully which could save them a considerable amount of money from lower energy cost and avoided CO_2-taxes.

The research project "Management as a Key driver of energy performance" (M_Key) is investigating through a detailed analysis of large companies in Switzerland whether EM significantly increases companies' perception of the strategic character of energy efficiency investments and ultimately increases their energy performance.

M_Key is led by INFRAS, a Swiss consulting company based in Zurich, project partners are the University of Neuchâtel and Impact Energy. M_Key is part of the National Research Programme "Managing Energy Consumption" (NRP 71) of the Swiss National Science Foundation (SNSF). Further information on the National Research Programme can be found at www.nrp71.ch.

The project targets large energy consumer companies in Switzerland in the industrial and services sectors with an annual consumption of more than 0.5 GWh/a electric energy and/or 5 GWh/a thermal energy.

Large energy consumers represent an important fraction of overall national energy consumption and are targeted with several specific policy instruments:

- Federal Act on the Reduction of CO_2 Emissions (2011) with a tax on CO_2 emissions
- National large energy consumer agreements to avoid CO_2 tax
- Reimbursement of electric grid surcharge for companies with high fraction of electric energy consumption in their gross value added (energy-intensive companies)
- Cantonal energy efficiency target agreements for large energy consumers.

The above policy instruments aim to motivate companies for entering into target agreements and committing to reducing their energy consumption. The target agreements are often coupled with financial benefits for the companies.

Theoretical framework

The theoretical framework of the project is based on research by Cooremans [1] [2] [3]. According to this theoretical framework, investments within companies are implemented if they have a link to core business, i.e. if the investments are perceived as strategically important. An investment has a strategic character if it contributes to a durable competitive advantage of the company. A durable competitive advantage is characterized by the three dimensions cost, risk and value. Thus, if through an investment a company can reduce its costs, risks and increase its value proposition, the investment is likely to be perceived as contributing to a durable competitive advantage.

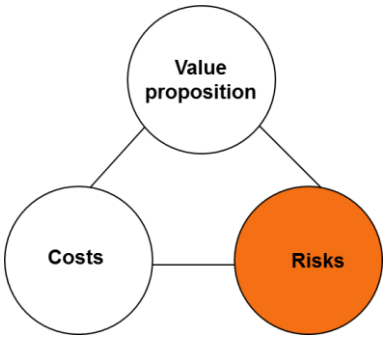

Figure 1 The three dimensions of competitive advantage [3]

The M_Key project builds on the hypothesis that the level of EM[1] has an influence on the perceived strategic character of energy efficiency investments. The higher the level of EM, the higher the perceived strategic character and therefore it is assumed that it is more likely that positive decisions are taken for energy efficiency investments. This leads to a better energy performance of the company (see Figure 2).

[1] The term Energy Management is based on ISO 50001:2012. In the project a detailed quantification system is used to assess the level of EM within a company.

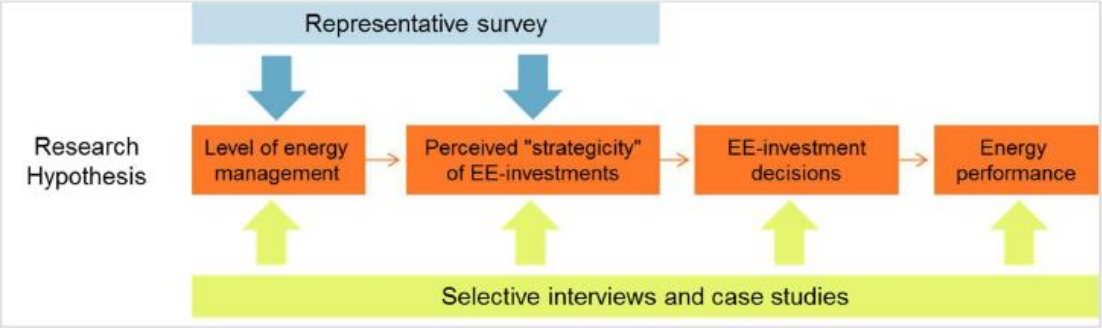

Figure 2: M_Key research model, methods and data collection

Research questions

To analyze the impact of EM, the project aims at answering the following main research questions:

- What are the determinants of EM level in for-profit companies?
- What is the level of EM in large energy consumer companies in Switzerland?
- Does the level of EM influence the perceived strategic character of energy efficiency investments?
- How does the perceived strategic character influence energy efficiency investment decisions?
- Does the level of EM significantly influence positive energy-efficiency investment decisions and therefore ultimately the energy performance of companies?

The project also looks at the effectiveness of the current national and local policy tools and measures in Switzerland and how these could be improved to encourage large energy consumers to implement more energy efficiency measures.

See the detailed research hypotheses in Table 1.

Research question	Research hypotheses
1) level of EM and its determinants	1.1 The level of EM in large energy consumers in Switzerland is generally low.
	1.2 The main determinants of the EM level are the company size, the company energy-intensity and the commitment or support of EM by the top management.
2) influence of EM on the strategic character of energy efficiency investments	2.1 The higher the companies' level of EM, the more strategic they perceive energy-efficiency investments to be.
3) influence of the (perceived) strategic character on 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 and realised depends mainly on the network relations/knowledge exchange within the sector.
	3.4 Increasing requirements from cantonal energy policies for large energy consumers and/or rising energy prices (in particular for electricity) positively influence energy-efficiency investment decision-making by companies.
4) influence of investment decision-making on energy performance, via positive energy-efficiency investment decisions	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 1 M_Key research questions and hypotheses

Methodology

The answers to the research questions are based on quantitative and qualitative data from large energy consumer companies in Switzerland, gathered through a mix of surveys, face-to-face interviews and a small number of case studies.

M_Key runs since 2015 until the end of 2017 in three phases (see Figure 3):

1. A survey among 3000 large energy consumers with 305 valid responses, led by the University of Neuchâtel.
2. Interviews with 26 companies, led by INFRAS.
3. Case studies with 5 companies, led by Impact Energy.

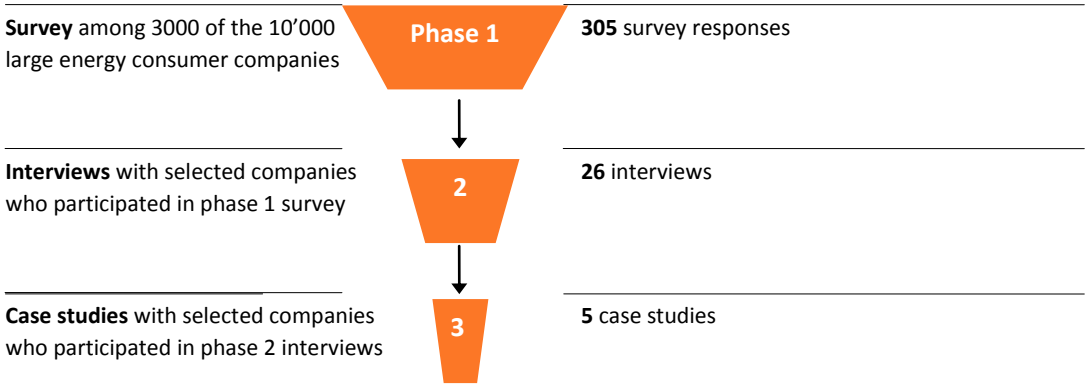

Figure 3: Three empirical work steps designed as focusing funnel

All three project phases have been finished, the project team is currently evaluating the overall results of the three phases.

Phase 1: survey

During the survey, answers were collected to a detailed questionnaire concerning the following main issues:

1. Characteristics of the company
2. Energy management within the company
3. Determinants of investments into energy efficiency
4. Evaluation of investments into energy efficiency
5. Public policy
6. Influence of investments into energy efficiency on the energy performance of the company

Out of the approximately 3000 companies who were invited to fill in the online questionnaire, 305 companies provided a valid response.

The level of EM of the companies was assessed based on their answers on a scale where they could reach between 1 to 23 possible points. The average score of respondents was at 10.2 points. Half of the firms have a score of 10 or below (median). This shows that the level of energy management in these companies is only moderate. No difference was observed between the companies in the industrial and services sectors. Approximately half of the respondent companies have designated an energy manager but all of them (except 14) manage energy issues on a part time basis only. Figure 4 and Figure 5 show the most important drivers and barriers for investing into energy efficiency.

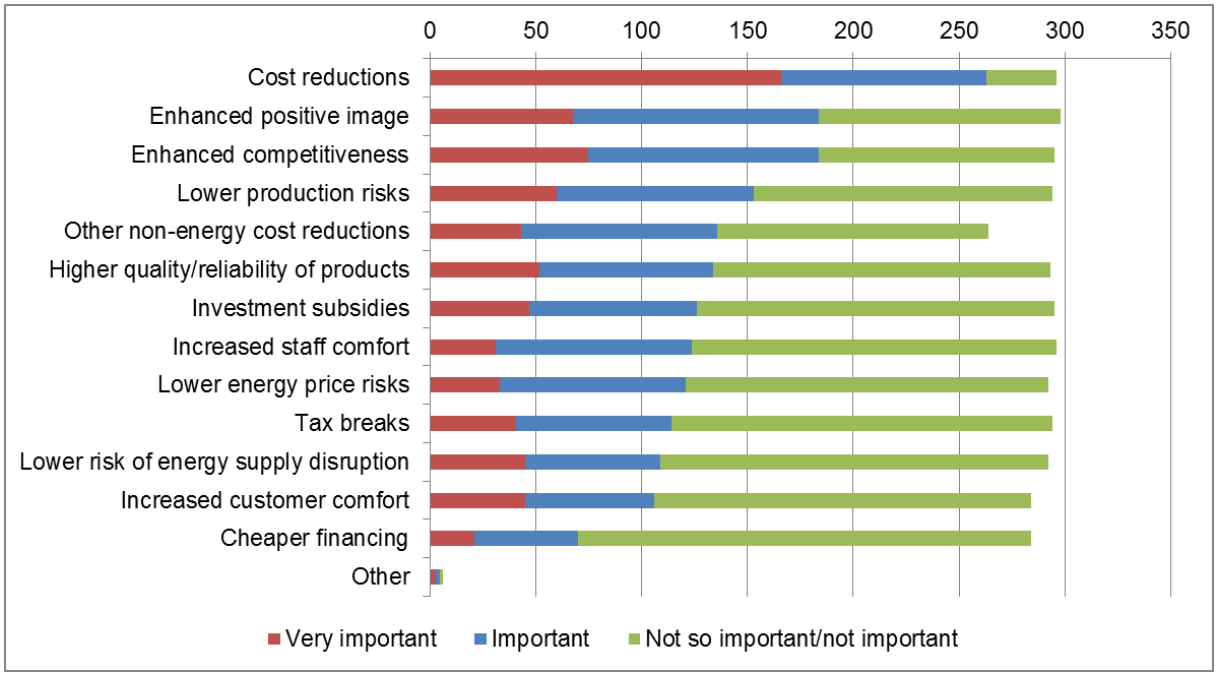

Figure 4 Drivers of energy efficiency investments

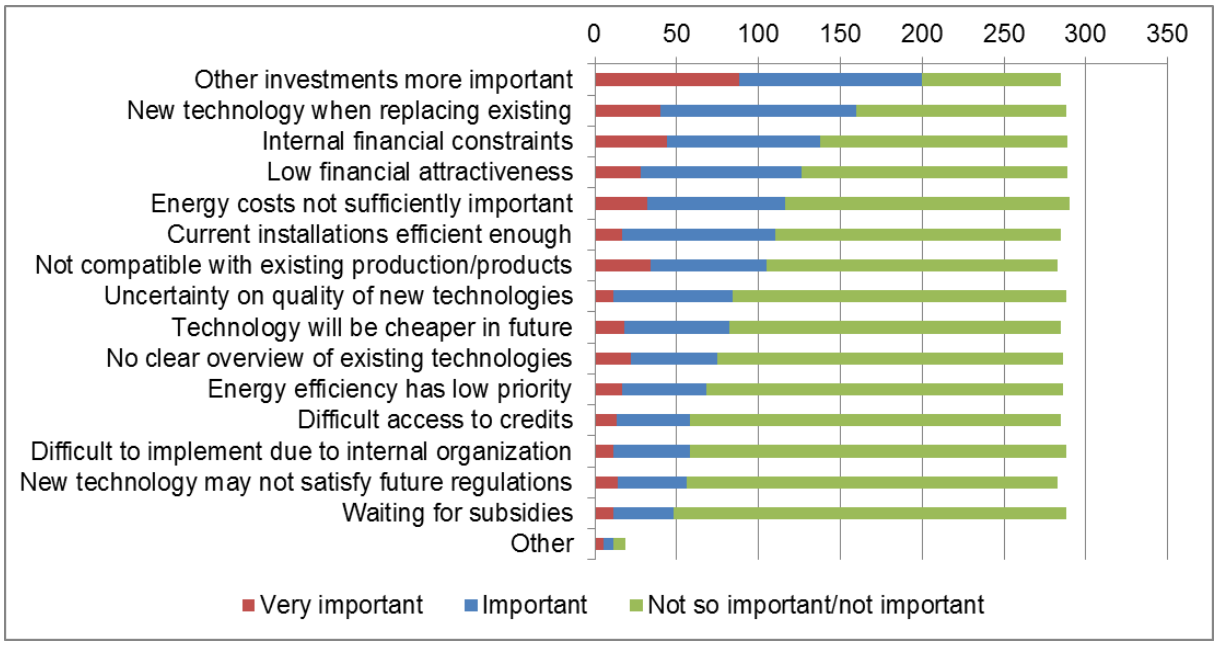

Figure 5 Barriers of energy efficiency investments

Phase 2: interviews

The interviews focused on the following questions:

1. Energy management: relevance, history, how it is organized today
2. Decision making process, including applied criteria
3. Influence of energy management on decision making
4. Impact of energy management on energy performance of the company
5. Potentials for improving energy management

The above questions were elaborated in an interview guide that was sent to the interviewed companies before the interview took place.

The face-to-face interviews were conducted with the energy managers in 26 companies, which have participated in the survey and agreed to be interviewed. Thereof, 18 companies are located in the German part and 8 in the French part of Switzerland. Table 2 summarizes the characteristics of the interviewed companies, including the following information: level of energy management, size, sector.

Criteria		German part	French part	Total
Level of Energy Management*	"high" (19-23 points)	3	3	6
	"upper medium" (11–18 points)	9	0	9
	"lower medium" (6–10 points)	6	2	8
	"low" (0–5 points)	0	3	3
Size	> 10 GWh_{el}/a	5	4	9
	3–10 GWh_{el}/a	7	2	9
	0.5–3 GWh_{el}/a	6	2	8
Sector	Industry	11	6	17
	Services	7	2	9
Total		**18**	**8**	**26**

Table 2 Characteristics of the interviewed companies
*The level of energy management was determined based on companies' responses to the survey questionnaire.

Figure 6 shows the most mentioned drivers for energy development by the 26 interviewed companies. Laws and regulations and the support of the top management were mentioned by most of the companies as an important determinant.

Figure 6 Most mentioned reasons and triggers for energy management development by the interviewees
Note: Font size indicates the number of mentions by companies.

Reasons for energy management development	Policy instruments / financial incentives	Sustainability policies / Corporate social responsibility (also SMEs*)	People (motivation and collaboration, involvement of top management)
Role of energy management in the decision-making process	A tool for: data collection / potential analysis / project ideas	Fact based argumentation for project proposals	Monitoring of energy efficiency projects' impact
Investment decision-making criteria	Profitability / Cost reductions	Priority of core business investments	Additional non-energy benefits
What determines the strategicity of energy efficiency investments?	Core business defines strategic relevance of investments	Sustainability policies and market demand (customer expectations, investors) can make energy efficiency more strategic	Finances are strategically relevant for companies. Low energy prices prevent energy efficiency measures from becoming more strategic

Table 3 summarizes the main findings and conclusions of the interviews regarding the research model.

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Table 3 Summary of main results and conclusions from the interviews
*SMEs: small and medium-sized enterprises

Phase 3: case studies

Goal

Contrary to the interviews that wanted to clarify the level of the strategic character and the level and quality elements of EM, the questions asked in the case studies had three main goals:

1. Analyze and verify the energy efficiency investments
2. Identify who in the company is directly involved in energy efficiency matters
3. What is the effect of policy on energy efficiency and energy performance in the company.

By analyzing the energy consumption and cost data, the list of planned, realized and not-realized improvement measures of the company and with a "walk through audit" by two energy efficiency experts of the case study team, a qualitative analysis of the energy performance of the case study companies can be described [6].

The case studies do not deliver quantifiable nor representative results. They show the individual situation of the five companies with an in-depth qualitative analysis, allowing a closer "reality check" of the effect of all the national and cantonal programs, financial incentives and legal requirements.

Selection of companies

The following criteria were applied to choose the sample of the case study companies:

- Five companies which participated in the preceding survey and interview and agreed to be contacted for the case studies,
- Four companies located in the German speaking part of Switzerland and one located in the French speaking part,
- Different levels of energy management (a contrast with high/low was planned):
    - 2 companies with a high level of energy management
    - 2 companies with a low level of energy management
    - 1 company with a randomly chosen level of energy management,
- Within the case study sample, at least one occurrence of each of the following company sizes (defined by annual electricity consumption):
    - small: 0.5 to 3 GWh/a
    - medium: 3 to 10 GWh/a
    - large: above 10 GWh/a
- 2/3 of companies from the industrial sector, 1/3 of companies from the commercial sector.

In addition to the above criteria, it was aimed to conduct the case study with several people from the company on different hierarchical levels, with different responsibilities:

- One person at management level (decisions / financing)
- One person at technical management level (project planning and implementation)
- One person at operating level (production / energy manager)

For some - especially the smaller - companies, these different levels of responsibility were incorporated in one person.

In the end, as planned, the case studies were conducted with five companies and all of the above criteria could be met. The only difference occurred concerning the share of companies in the industrial and services sector. Instead of three companies from the industrial sector the sample included four such companies. This change was partly due to the fact that some companies who were contacted in the beginning declined to participate in the case studies, because of restricted availability of resources.

Table 1 summarizes the main characteristics of the case study companies and details regarding the contact person(s).

No.	Code	Region	Sector	Size	Level of energy management	Contact person/s
1	A	German	services	medium	4 (low)	1) head of building equipment, unofficial energy manager [T, O]
2	B	German	industry	small	9 (lower medium)	1) head of technology, unofficial energy manager [T, O]
3	C	German	industry	small	15 (upper medium)	1) energy manager, factory manager, member of the board [M, T, O]
4	D	French	industry	large	19 (high)	1) production, energy management, project planning and implementation [T] 2) head of manufacturing unit* [O] 3) energy purchase: gas, electricity, carbon certificates for Europe [O]
5	E	German	industry	large	19 (high)	1) factory manager, highest decision capacity on site [M] 2) head of energy management/electricity supply, head of energy team [T, O] 3) head of energy- and waste management, member of energy team [T, O] 4) head of manufacturing unit* [O]

Table 4 Main characteristics of case study companies and details of contact person(s)

Notes:
[M]: person at management level (decisions / financing)
[T]: person at technical management level (project planning and implementation)
[O]: person at operating level (production / energy manager)
*For both companies, heads of the manufacturing units representing the most significant production processes from an energy point of view took part in the case study.

Procedure

The procedure for conducting the case studies was as follow:

1. Before the on-site visit, each case study company received the case study guide with the questions of the case study which addressed the following issues:

    1. Investment categories and budgets
    2. Investment priorities
    3. Investment decisions and implementation of measures
    4. External and in-house know-how
    5. Influencing factors
    6. Energy efficiency improvements, status of implementation
    7. Monitoring and quantification of energy savings and costs, ex ante and ex post evaluation
    8. Reporting
    9. Equipment maintenance practices
    10. Role of public policy, opportunities and constraints, improvement potentials

    In addition, companies were asked to provide the following information:

    - Annual energy cost and consumption (electrical & thermal energy),
    - List of implemented efficiency measures,
    - Main elements of savings commitments (e.g. target agreement with goals, duration, intermediate results, status of target achievement),
    - Incentivized measures, if any (financial incentives e.g. through federal public tenders, cantons, utilities, etc.).

2. During the visit on site, the case study questions and questions related to the previously supplied data on energy consumption and efficiency improvement measures were discussed. This was followed by a "walk through audit" of the company facilities.

3. After the visit on site, the minutes of the meeting discussion as well as a technical report with observations by the efficiency experts was made and verified by the case study company. The technical report captured the status of energy consumption, measures implemented and potential further savings not yet dealt with.

Results

Table 5 gives details on the characteristics of the five case study companies.

General data	A	B	C	D	E
Level of energy management	4 low	9 lower medium	15 upper medium	19 high	19 high
Sector	services	industry	industry	industry	industry
Type of ownership	family-owned	family-owned	several private owners	shareholders (company on stock market)	shareholders (company on stock market)
Product	photos, books, calendars, phone cases	cosmetics	yeast	aluminum sheet metal	pharmaceutical, chemical
Degree of competition in the sector	not so high	not so high	not so high	not so high	very high
Number of employees on site	168	110	30	500	2'700
Location of company top management	on site	on site	on site	USA	Switzerland, different location
Energy intensity (Energy cost/turnover)*	2-3%	1%	1.1%	10%	7-12% **
Energy cost (million USD/a)	0.5	0.2	0.2	12.9	57 to 78 ***
Energy consumption GWh/a (thermal/fossil)	Gas 1	oil 0.4 wood 0.7 total 1.1	gas 2.8	gas 184	gas 466 steam (waste) 86 total 552
Energy consumption GWh/a (electric)	3.3	0.7	2.3	77	492 +48 own production total 540
Trend in production	continuous development of technology, additional products, overall increase	increase of production and shift to specialty products	amount constant in last 10 years, growing share of energy-intensive product	almost doubled since 2012	heavy fluctuation due to market demand
Trend in energy consumption	large fluctuations due to summer temperature and change of cooling technology	heat decreasing, electricity constant	constant in last 10 years	strong increase in the last 10 years, strong increase also in efficiency per production unit	heavy fluctuation
Energy manager	1 part-time	1 part-time	1 part-time	1 energy manager (part-time) plus team	1 energy manager (part-time) and team of 6 people

Table 5 Details of the five case study companies

*The definition of "energy intensity" is not used in the same way by the five companies: energy cost is compared to either total cost, turnover i.e. sales volume or gross value added. These data (total cost, turnover, gross value added) are kept confidential in most companies. Therefore the energy intensity values shown give an indication, however, the values are not directly comparable.

**Range in the last five years.

The results of the case studies are based on the answers of the five case study companies and are presented as "anecdotal evidence" with the main observations, analysis and conclusions of the research team as follow:

Investment categories and budgets, investment priorities

- If the energy-intensity of a company is high, it has an inherent motivation for keeping its energy costs low and invest into energy efficiency. This makes it build up qualified internal staff dealing with energy efficiency issues.

- Energy efficiency does not appear to be a priority when deciding on investments; however, it is considered in all investment types.

- The category "energy efficiency investment" exists in two out of the five case study companies with dedicated budgets. In the other three companies a general budget for all investments is available. The general budgets correspond to the order of magnitude of the energy intensity of the companies (between 3% to 14% of the gross value added). The dedicated energy efficiency budgets are much smaller (0.1% to 0.3% of turnover or gross value added).

Investment decisions and implementation of measures

- The energy manager plays a crucial role, especially in small and medium-sized enterprises (SMEs). If he is supported by top management, he has a much easier task compared to the situation when he is not. All energy managers worked on a part time basis with respect to energy efficiency issues and had other responsibilities on the side.

External and in-house know-how

- SMEs favor to depend on external expertise to complement their scarce internal know-how while larger enterprises are reluctant to engage external specialists, as they claim to know the best their internal processes.

Influencing factors

- The companies pay a relatively low electricity and gas price. This is a disincentive for energy efficiency improvements. The larger enterprises purchase energy from the European market. Their sole decision criteria is low price, it seems that purchasing e.g. certified renewable energy sources is not on their agenda. In addition, in the CO_2 balance of the companies CO_2 emissions stemming from electricity generation and imported electricity are not taken into account.

Energy efficiency improvements, status of implementation

- A focus on fossil energy savings was observed. This can be explained by the Swiss CO_2-emission reduction policy. In Switzerland electricity generation is almost CO_2-neutral (nuclear and hydropower), therefore companies can reduce their CO_2 emissions mainly through decreasing their fossile energy demand (i.e. thermal processes). Energy efficiency measures in the field of electric energy were less present.

- While all five case study companies are located in rural areas, transport issues only entered their energy and environmental rationale in the case of two companies. One company delivered the raw materials for production via railway transport and the other tracked and accounted for the CO_2 emissions for employee transportation.

- While the companies claimed that the low hanging fruits of profitable energy efficiency measures have been implemented and they now have fewer opportunities, the walk through audit showed further savings potentials which could be looked at. This has to do with the setup of the target agreements that the companies enter into. Usually, the savings target and efficiency improvement measures are identified at the beginning of the commitment period. However, throughout the commitment period of 5 to 10 years the list of measures is not being

reassessed. This means that certain equipment is not being looked at or by the time it is, it is often deemed not economically replaceable.

Monitoring and quantification of energy savings and costs, ex ante and ex post evaluation, reporting

- Monitoring and especially the verification of savings remains a challenge. All companies reported that the results of energy efficiency improvements were as planned. However, it is questionable how they came to this conclusion. Usually for specific measures the engineers make an a priori estimate of the cost and the energy savings. After the implementation of the energy efficiency improvements they can relatively easily check the cost, but not the energy savings. They generally assume that it actually happened according to plan. None of the companies had a strict and systematic savings verification policy for all significant energy efficiency improvements. Some companies were equipped with measuring instruments (the higher the level of energy management, the more likely). Few used measuring equipment before and/or after energy efficiency measures.

- Before / after comparison is challenging. Changing energy prices, changes in production (output volume, product type and quality), weather and climate changes (summer or winter), etc. affect the energy consumption and eventual energy and cost savings. A disproportionate large effort is necessary to recreate the same conditions in two different points in time (before and after implementation) and to determine the influence of these individual factors.

- None of the five companies was able to establish a "Key Performance Indicator" (KPI) to easily compare multi-annual results across all of their products. They mentioned the change of production volume and the characteristics of the individual products (with different energy demand in production) that do not allow a global KPI, comparable over time. If KPIs were established it would be much easier to evaluate progress of energy efficiency improvements.

Role of public policy, opportunities and constraints

- In the case study companies, the Swiss policies have in all cases triggered actions for implementing energy efficiency measures and are therefore an important driver. This was particularly visible in the SMEs. At the same time, the reception by the companies is mixed: many admit that the policies helped in implementing efficiency improvements, however, they were perceived not so enthusiastically, rather as an imposed obligation that comes with an administrative effort. The largest company explicitly expressed strongly favoring market mechanisms freely regulating the market instead of public authorities through policies. All case study companies stressed the importance of keeping administration efforts associated with policies and especially financial incentives at the lowest possible level.

- The goal-setting aspect of the target agreements is helpful to convince company management for energy efficiency improvements. Once the company commits to its goals, there is a certain obligation to fulfil them (instead of postponing or abandoning investments).

- All companies reached their agreed targets easily. None of them complained about severe measures and costly investments.

- While large energy consumers and energy intensive users benefit from financial exemptions/reimbursements, these benefits should be coupled to more stringent energy efficiency improvement requirements.

- The large enterprises benefiting from financial incentives said that they would have implemented the energy efficiency improvements anyway, only stretched during a longer time period (free-rider effect). Incentive programs do not seem to reach SMEs due to a lack of information. A central, coordinated and transparent approach, including a central point of information for such programs is missing.

- SMEs experience the implementation of energy efficiency improvements more challenging than larger companies. They expressed interest for more support concerning the following areas:

- Qualified external know-how for initial analysis and identification of potentials (partially or entirely subsidized) as well as the implementation of energy efficiency improvements and follow up.
- Training of energy managers.
- Information on relevant financial incentives.

Energy efficiency performance in relation to level of energy management

The research team made a qualitative evaluation of the level of energy performance of the five case study companies, based on the "walk through audit". Two independent experts who conducted the audit gave a rating to 13 questions (see Table 6) which forms the basis of the qualitative analysis. This was compared to the level of energy management, as determined during the survey (phase I, based on the answers of the companies).

Level of energy efficiency performance		A	B	C	D	E	all	all		
Nr	Question	average	average	average	average	average	average	min	median	max
1	Are all thermal processes and their energy efficiency potential analyzed?	6.5	6.5	8.5	7.0	8.5	7.4	6.5	7.0	8.5
2	Are all electric processes and their energy efficiency potential analyzed?	5.0	5.0	4.0	3.5	6.5	4.8	3.5	5.0	6.5
3	Is the implementation of the cost effective thermal efficiency measures planned systematically?	6.0	5.0	7.0	4.5	7.0	5.9	4.5	6.0	7.0
4	Is the implementation of the cost effective electric efficiency measures planned systematically?	4.5	4.0	2.5	3.5	4.5	3.8	2.5	4.0	4.5
5	Fraction of thermal measures implemented?	5.0	5.0	7.0	4.5	7.0	5.7	4.5	5.0	7.0
6	Fraction of electric measures implemented?	3.0	4.0	3.0	4.0	5.5	3.9	3.0	4.0	5.5
7	Do they have a good plan* for fossil measures for the next 5 years?	4.5	3.5	5.0	5.5	5.0	4.7	3.5	5.0	5.5
8	Do they have a good plan* for electric measures for the next 5 years?	3.5	3.5	2.0	4.5	5.0	3.7	2.0	3.5	5.0
9	Does the energy manager give the impression of being competent?	5.0	7.5	8.5	7.0	8.0	7.2	5.0	7.5	8.5
10	Did the company use external experts?	7.0	7.5	6.5	4.0	3.0	5.6	3.0	6.5	7.5
11	Did the company take individual measurements before a machine was changed?	3.0	2.5	5.0	5.0	6.5	4.4	2.5	5.0	6.5
12	Did the company take individual measurements after a machine was changed and compared with the outset?	2.5	2.5	4.5	4.5	6.5	4.1	2.5	4.5	6.5
13	Are the calculations for the effect of the energy efficiency measures shown in their plan plausible?	4.0	5.5	2.5	5.5	6.5	4.8	2.5	5.5	6.5
average		**4.6**	**4.8**	**5.1**	**4.8**	**6.1**	**5.1**	**3.5**	**5.3**	**6.5**
percentage		46%	48%	51%	48%	61%	51%	35%	53%	65%

Table 6 Qualitative rating of the level of energy efficiency performance of the case study companies (10: best; 1: worst)

*a good plan for measures for the next five years is defined as complete, comprehensive, systematic, credible.

Note: Overall, three experts were engaged: one expert evaluated all five companies, one four, one only one company. All experts had only a short briefing for their task and no communication between each other for the individual evaluation and rating. The three experts had a fairly good overall match of their average rating of the five companies and the 13 questions: the result differed by +11% and -18%. The research team did not consider this as major fault of the qualitative analysis.

Figure 7 shows that while the range of the level of energy management of the five case study companies is quite wide (between 4 and 19 points out of 23 points), their level of energy efficiency performance remains in a relatively narrow band (between 4.1 and 6.1 out of 10 points). The comparison shows no clear specific pattern between these two criteria. Also, the sample of the case studies is not large enough to plot any conclusions being representative for a larger group of companies.

Two companies (A and B) clearly started during the case study that they started to analyze their energy consumption and identify efficiency improvement measures in response to their large energy consumer obligations under cantonal law. They did not deal with improving their energy efficiency before. This shows that policies have an effect and can move companies within a short period of few

years to a favorable level of energy efficiency performance, comparable to the level of companies with a high level of energy management, and significantly better compared to the status with no or very little efficiency improvements before.

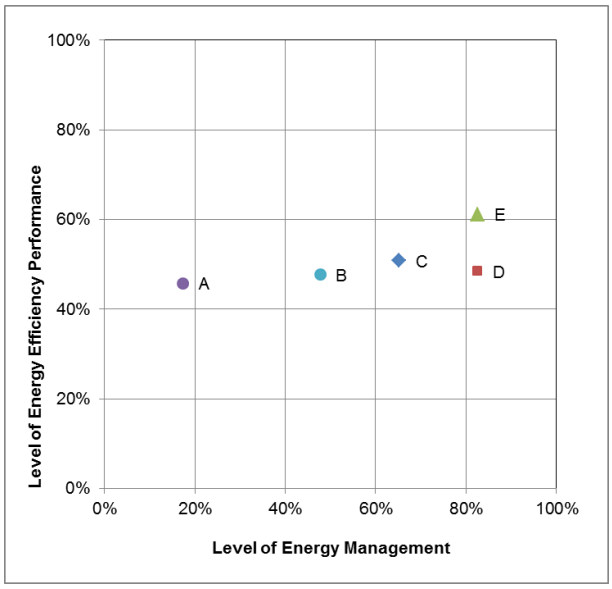

Figure 7 Comparison of level of energy efficiency performance with level of energy management

Main conclusions from the perspective of the case studies

The "efficiency gap" especially observed in large industrial consumers has stimulated research in the decision making process and energy management of companies.

The findings show that several factors play a role in decisions for energy efficiency improvement measures and whether companies perceive energy as strategically important. The main determinants include policies (laws and regulations), role and responsibilities of the energy manager, support by top management, energy intensity and investment priorities.

The case studies have clearly shown that the Swiss policies have a tangible effect and successfully move companies to a considerable level of energy efficiency performance.

The level of energy management seems to be a manifestation of the importance companies attribute to energy issues. Energy management appears to serve as an operational filter, creating more transparency on potential energy efficiency measures, delivering reliable, fact-based data and information as a basis for investment decisions, leading to increased trust and ultimately to increased support for energy efficiency improvements.

The overall evaluation and synthesis of the results from the three project phases is ongoing and will be available until the end of 2017.

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