Energy management: a driver to sustainable behavioural change in companies

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Abstract

Improved industrial energy efficiency is a cornerstone in mitigating climate change. One of the foremost means to improve energy efficiency in industry is energy management. A pioneer European policy program including energy management system components was the Swedish PFE, a voluntary long-term agreement programme for improving energy efficiency in energy-intensive industries, which was under operation from 2004 to 2014.

The aim of this paper is to analyse the results of PFE using an interdisciplinary approach combining experience from this program with academic concepts in the field of change management and investment decision-making. Results show how academic conceptual frameworks in the field of change management and investment behaviour in industry can explain PFE results and, more generally, support improved policy evaluation further explaining voluntary agreement programs such as the PFE. Finally, we formulate future research suggestions to improve industrial energy policy conception and evaluation.

Introduction

Improving energy efficiency in organizations requires changes in decision-making processes and in staff behavior, where every part and level of organizations needs to be involved. This means moving from "simply using energy" to "effectively managing energy" (Tunnessen, 2004). The larger the organisation, the more complex its energy use, the more important energy management is.

Research states that there is a large potential for improving energy efficiency, an "energy-efficiency gap", as labelled by Hirst and Brown, 1990[1], even in energy-intensive industries: in the European cement industry (Moya et al.; 2010, 2011), the US economy (DeCanio, 1998; Granade et al., 2009); in several industrial sectors in Brazil (Sola and Xavier, 2007); in the German iron and steel industry (Brunke and Blesl, 2014); in the Swedish pulp and paper industry (Thollander and Ottosson, 2008) and steel industry (Johansson and Söderström, 2011), in the Belgian cement, ceramic and lime industries (Venmans, 2014).

Energy management seems to be an efficient solution to reducing the energy-efficiency gap. When an energy management system is implemented and integrated in the business model of a company, energy end-use and costs decrease continuously and durably, without rising again (Schulze et al., 2015). The International Organization for Standardization (ISO) evaluates that up to 25 % of the energy cost savings entailed by an ISO 50001 certification, without any capital expenditure (Fleury, 2016).

However, the effect of energy management systems on companies' energy and carbon performance has hardly been addressed to date by academia (Böttcher and Müller, 2014) and few literature studies can be found for benchmarking at company or plant level (Bunse et al., 2011; Schulze et al., 2015). On the

1. Hirst and Brown (1990) defined the energy efficiency gap, as a discrepancy between what may be seen as an optimal level of energy efficiency and what is the current state of deployment.

whole, research concludes to a positive contribution of energy management to companies' energy performance (even if the different approaches and measurement tools applied make it difficult to compare evaluation results). Therefore, it is important to include energy management in the design of energy efficiency policy instruments for industry (Backlund et al. 2012), a conclusion which was also acknowledged by Paramonova et al. (2015) and Cooremans (2012b).

This conclusion is shared by the International Energy Agency (IEA): "Government energy management programmes (EnMPs) and associated supporting measures and drivers have been shown to effectively address many of the barriers to energy efficiency and stimulate energy management in industry. Energy management programmes are policies and initiatives that encourage companies to adopt energy management systems. Energy management programmes play an important role in showing that improving energy efficiency is not only compatible with – but can also drive – profitable business development."

But "individual energy management components on their own will not lead to sustained energy management and ongoing improvements" (IEA, Policy pathway, 2012). A systemic, systematic and continuous improvement approach is required, as described in the voluntary standard ISO 50001 Energy Management (issued by ISO in June 2011).

ISO 50001 defines an Energy Management System (EnMS) as a "Set of interrelated or interacting elements to establish an energy policy and energy objectives, and processes and procedures to achieve these objectives" (ISO 50001, June 2011, art. 3.9). It "is based on the management system model of continuous improvement also used for other well-known standards such as ISO 9001 or ISO 14001. This makes it easier for organizations to integrate energy management into their overall efforts to improve quality and environmental management. ISO 50001:2011 provides a framework of requirements for organizations[2] to develop a policy for more efficient use of energy; Fix targets and objectives to meet the policy, to measure and review the results obtained and to continually improve energy management."

In 2004, the Swedish Government launched the Swedish Program for Energy Efficiency (PFE), a public program directed to energy-intensive industrial companies[3] in Sweden. The program lasted to 2014. The core of the program was the implementation by companies of an Energy Management System, a Swedish EnMS standard written prior to the ISO 50001.

Within the context described above, the aim of this paper is to analyse the results of the 2004–2014 PFE using an interdisciplinary approach combining experience from this program with academic concepts in the field of change management and investment decision-making. We show how academic conceptual frameworks in the field of organization behaviour can support improved policy conception and evaluation and further explaining Voluntary Agreement Programs such as the PFE. Based on our analysis of PFE results, we formulate future research suggestions aimed to improve industrial energy policy conception and evaluation.

The authors of this paper emanate from the field of energy efficiency-related research within the field of business and administration and energy systems research, as well as from industrial energy policy program administration and operationalization.

The Swedish Voluntary Agreements Program, PFE

BACKGROUND

The program for energy efficiency, PFE was a voluntary economic policy instrument, implemented in legislation directed to energy-intensive industrial companies[4] in Sweden (SOU 2004:1196). The work to design the PFE program was initiated in 2003 as a result of the EU energy tax directive (2003/96/EG) which changed national legislation on energy taxes. It was preceded by discussions between industry sectors and the government regarding long term agreements (LTAs or sometimes Voluntary Agreements, VAs) including plans for implementation of an EnMS. The directive opened up for national policy measures as an alternative to increased tax provided that the measures would deliver at least the same effect as the tax. The LTA discussions took a new direction resulting in the PFE program.

The core of the program was the implementation of an Energy Management System (EnMS, Swedish Standard SS 6277050) in participating companies. When the ISO 50001 standard was published in June 2011, it replaced the Swedish standard.

When companies were approved for participation[4] they could join the PFE and were eligible for a tax reduction (0,5 Euro/MWh) during the five-year program. The founding idea of PFE was that the program would provide tools to establish a structure for a durable energy management within participating companies.

As shown in Figure 1, PFE participation for companies was based on a five-year cycle. During the first two years a thorough energy audit was carried out including all major energy flows. This meant considering the site as an energy system requiring an analysis that goes beyond the components level. In a second step, the standardized energy management system) was implemented and certified by an independent certification body. The energy agency also cooperated with the certification bodies and SWEDAC (the Swedish Board for Accreditation and Conformity Assessment) in order to verify that the certifications and re-certifications continue according to plans.

In addition to the EnMS, companies had to implement and follow specific procedures (routines) for planning, modifications and renovations, as well as for purchasing high-consumption electrical equipment, based on LCC-methodology (Life Cycle Cost). Companies reported their plan to achieve their individual target regarding their participation in the programme[5]

2. Source: http://www.iso.org/iso/home/standards/management-standards/iso50001.htm.

3. Definition emanates from energy tax directive: 2 criteria are valid: 3 % energy cost related to production value or 0,5 % energy taxes related to added value.

4. Participants must: be energy intensive; 3 % energy cost related to production value or 0,5 % energy taxes related to added value, use electricity in manufacturing process and have an independent budget for investments.

5. Set individually by the participants related to the objective of the PFE act that the measures would deliver at least the same effect as the tax. Nearly all companies interpreted this to equal the cost increase effect of the tax, for example 1 % with electricity price at 50 Euro/MWh.

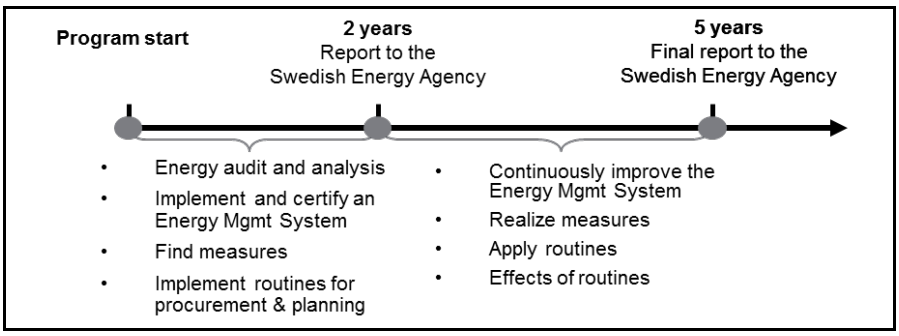

Figure 1. Five year cycle for participating companies.

as well as the energy efficiency measures to be implemented during the five-year cycle.

During the three following years, the mandatory program components where integrated in the management procedures of the enterprise, the EnMS was continuously improved, energy efficiency measures defined were implemented and previously unidentified measures were realized. 103 companies, managing more than 200 Swedish industrial sites, have completed the five-year programme cycle of PFE. All of them, except six, have performed a second program cycle. Their total energy consumption accounted for 25 %, or 110 TWh, of the total Swedish energy consumption, corresponding to 70 % of the energy consumption of the industrial sector. PFE covered 90 % of the energy use among the enterprises eligible for participation but only 10 % of the total number of eligible companies. The number of enterprises eligible to participate in the program was more than 1,000. Two major groups not participating has been defined: 1) Most SMEs did not join due to that the commitment to join was considered too big in relation to the benefit and 2) some large corporations in the metal, refinery and chemistry sectors, which were exempted from the electricity tax in the EU tax directive eliminating or reducing the power of the tax incentive designed to attract companies to participate in the program.

The PFE program was closed to new participants in 2013 because of a change in the European Union state aid guidelines. The tax reduction, which was initially the motivation for companies to join PFE, was no longer in accordance with the new EU guidelines.

RESULTS OF THE PFE

Based on the mandatory self-reporting system provided to the participating companies, the following results were recorded by the Swedish Energy Agency, SEA: 10 years of participation to the Swedish energy-efficiency program resulted in 2,500 measures for electric energy efficiency in the participating energy-intensive companies, totalizing nearly 3 TWh of electricity savings, or 10 % improvement compared to pre-PFE situation[6] (Calculated by the enterprises as bottom-up savings at normal production rate[7]). All data were quality controlled at the SEA and random inspections were made at 15 % of the enterprises. Since nearly all eligible companies using more than 100 GWh per year participated in the PFE program (Stenqvist, Nilsson, 2012) it is difficult to establish what would have happened without PFE. The free-rider and multiplier effects have been studied by Stenqvist et al: "the PFE gross annual impact (i.e. 1,450 GWh/year) as well as the interval of net annual impact (i.e. 689–1,015 GWh/year) greatly exceeds the estimated annual impact of a minimum tax (375 GWh/year) which is interpreted here as the programme's target-level. The evaluation also shows a cost-effectiveness ratio with a relatively low cost per saved amount of energy. Moreover, PFE has caused a multiplier effect of heat and fuel savings that can be as large as 950 GWh/year" (Stenqvist and Nilsson, 2012).

This refers to the first five-year cycle of the program when some of the measures reported were known before entering PFE. For the second program cycle the participants estimated that about 30 % of the measures would have been done without PFE which is coherent with how the measures were reported in the reporting system to have been identified (Mainly energy audit and energy management system, 70 %). Moreover, the multiplier effects of the management system in operation after leaving PFE, sharing good examples in networks with non-PFE participants and implementation of ISO 50001 in sites outside Sweden are not considered.

Apart from energy-efficiency measures, all participants have implemented an energy management system, including the following components:

- One or several persons in each company were officially dedicated to the energy efficiency work.
- Increased amount of targets and follow-up were introduced in sustainability reports.
- Education and training programs were performed for both key competencies and all staff.
- Increased internal and external communication for feedback and customer relations.
- More KPIs were set up and monitored.

A questionnaire[8] of about 60 questions was built up by officers from the Swedish Energy Agency and sent out to the PFE contact persons, which normally was the energy controller. The

6. The sum of 1st program participation (all companies) and a consequent 2nd participation (90 % of the companies.

7. Electricity use the year before the report to SEA. If not representative to normal production rates an alternative base year could be used.

8. STEM inquiry, June 2014. Response rate more than 80 %. Issued to all participants at the end of the second program participation where >90 % of the enterprises participated. In total, 3 inquiries were made. The inquiry consisted of a mix of yes/no-questions, a choice between several alternatives and free text fields for comments.

questionnaire was submitted in 2014 to all 103 participating companies to better document the changes in their internal operation and the benefits they perceived from their participation in the program, i.e. the objective of the questionnaire was to assess the various aspects of the PFE that had not previously been covered extensively. The response rate was more than 80 %. This inquiry showed that, apart from the mandatory organisational changes described above[9], many other results have been obtained by companies as a consequence of their participation to PFE. These results can be grouped in four broad categories: 1) Planning and control; 2) capital budgeting and 3) human resources; 4) energy culture. These impacts are listed in the following paragraphs.

Planning and control

- 90 % considers that energy efficiency received a substantially higher management attention as a result of the program.
- More than 80 % have improved their way of measuring energy use.
- 86 % considers that PFE has entailed increased focus on new technologies in measurement and analysis, control and operation, motors and motor systems, compressed air systems and ventilation.
- Proactive enterprises integrated their EnMS in their general management system and in their business plan.
- 90 % of the companies integrated EnMS with other management systems such as ISO 9001 and 14001.
- Corporate requirements for energy efficiency have increased as well as cooperation between different sites and support from headquarters.
- Some proactive companies have implemented ISO 50001 in their group of companies worldwide and a certified EnMS is now a corporate requirement in many Swedish and international companies, especially in companies with head offices in countries with a high ISO 50001 certification rate.

Capital budgeting

- 70 % of the enterprises stated that participation in PFE made it easier to get access to internal investment capital, which meant more energy-efficiency investment implemented.
- Investment calculation procedures changed. Procedures for Life-Cycle Cost (LCC) in projects and purchase were implemented and used. As described by a respondent to the survey: "life cycle cost calculations are mandatory in investment and purchase routines". Life cycle calculations were not performed on a regular basis before the PFE program. This means that the investment duration (i.e. the duration taken into account to evaluate the investment cash-flows) was extended, sometimes up to the life time of the equipment considered.
- Participation also substantially lowered the perceived risk to introduce new solutions, an important result since investment risk is claimed to be an important barrier to energy efficiency improvements.

Human resources

- A general increase in human resources skills (technical & managerial).
- Build up skills. Education and training programs have been performed: PFE manager: 87 %, project managers 83 %, Maintenance and purchase 68 %, and finally 42 % of the companies had competence programs for all staff.

Energy culture or energy awareness

- Higher awareness in all the organisation of energy efficiency issues. By working with energy issues continuously and in a structured way, energy efficiency became a part of the daily agenda with increasing awareness of its importance.

It must be noted that, although to a different degree, energy-intensive industries did systematically include routines for energy-efficiency actions in their operations before participating to PFE. Therefore, some of the changes listed above were already in process in proactive enterprises.

The positive role of the Swedish Energy Agency and of PFE was also mentioned by companies in two aspects:

- Supervision of the program by the Swedish Energy Agency sets deadlines to ensure that "things are being done". Specified requirements and clear deadlines are important to ensure that energy efficiency is not put aside for other strategic or more acute issues.
- Working with the PFE participants as a network and bringing forward good practices has substantially lowered the perceived risk to introduce new solutions, an important barrier to energy efficiency improvements.

In addition, companies stated in the 2014 inquiry that they had obtained substantial business benefits from implementing ISO 50001 within the PFE framework. The survey questionnaire asked them to choose in a pre-defined set of benefits (the percentages indicate the proportion of companies which selected the corresponding option):

- energy costs reductions (87 %); other costs reductions (45 %; for example, maintenance, productivity and quality related);
- 59 % of companies participating to PFE were taking into consideration other internal business opportunities than energy cost (multiple energy benefit) when making energy-efficiency investment decisions.
- sustainability report (36 %); this means that the enterprises regard communication on their ISO 50001 certification and on their energy efficiency and climate change action plans as a business benefit;
- matching customer demand (27 %): more and more customers require their energy-intensive suppliers to be ISO 50001

9. Mandatory because essential to become EnMS certified.

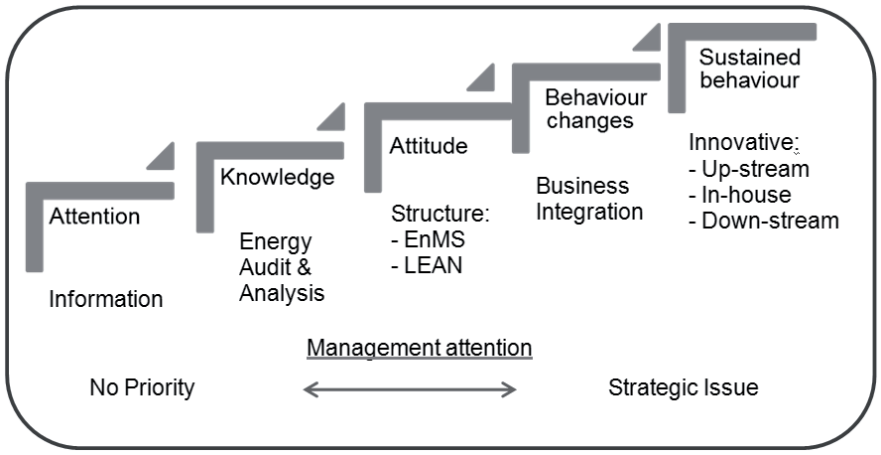

Figure 2. Organisational behaviour changes.

certified. Although this requirement is not frequent yet, it is growing, as well as other requirements (such as, for example, data on products' carbon footprint).

Considering the long-term impact sought by PFE, a very important and positive result of the program must be emphasized: all large enterprises and most SMEs declared that they intended to maintain an ISO 50001 certified EnMS in the future. As stated by respondents to the inquiry: "the management system gives a structure to the energy efficiency work that we will continue to use. It is a request from customers and for environmental assessments. It took a lot of resources to implement the system but not a lot to sustain it." "External revisions help us continuously improve our operations."

For the Swedish Energy Authority, the introduction of PFE turned a difficult information task into a successful communication project. Participating companies were willing to take part in national and regional network meetings on energy efficiency. The knowledge gathered from these meetings, including experiences from organizational change and thousands of energy efficiency measures, could be transferred to stakeholders outside the group of participants (Dahlgren, 2014).

One major lesson learnt from the PFE from a program administrator and operator perspectives was that to successfully improve companies' energy performance, an energy management system must be integrated in a durable way in companies' business models, structure and culture, rather than implemented as a stand-alone action. This bottom-up finding of the Swedish Energy Agency (SEA) implementation plan for energy-efficiency policy programs in enterprises is described in Figure 1, i.e. lessons learnt from policy practitioners.

As shown in Figure 2, it is intended that the introduction of an energy management system in a company will achieve the following results: firstly, it raises attention and knowledge regarding the way energy issues are treated in the organization, and about the potential for improvement (thanks to the initial audit); secondly it changes the general "attitude" of the organization towards energy; thirdly it entails behavioural changes regarding organizational procedures (including investment procedures) applied to energy; finally it durably influences the organization in other aspects, internally but also up-stream (relations with suppliers) and down-stream (relations with customers).

On a whole, PFE results look highly positive (even if they don't translate directly into energy savings) and it can be concluded that the organisational learning and change sought by SEA have been achieved.

However, there are conditions making a complete evaluation difficult. The objectives of the PFE program were that the improved energy efficiency of the participants in total must at least equal the increased tax and to maintain the competitiveness of the industry present on a global market. Thus it was difficult to assess the results of the individual participants. There was no calculation of a base-line before starting the program which turned out to be a problem since it was not possible to identify a control group. Therefore it is difficult to establish what the result would have been without PFE. Furthermore, the inquires to the participants were also made from other reasons than evaluation of the program as such.

Analysing PFE results through organization behaviour research lenses

What are the modalities of influence of energy management? What are its long-term effects? On which levels of the organization does it exert its influence and why? These questions have not been extensively addressed by research until now. Thus energy-efficiency public programmes have promoted energy management in organizations in a kind of an "intuitive" way, not knowing exactly the "why" and "how" of the results.

In this section we analyse the results of the 2004–2014 PFE using an interdisciplinary approach combining experience from this program with academic concepts in the field of change management and investment decision-making. These fields are part of the huge research field of organization behaviour[10]. Organization behaviour can be analysed at three levels: the micro-level (individuals); the meso-level (groups, such as departments); the macro-level (the organization itself).

We will tentatively apply two theoretical frameworks to explain energy management influence on companies' behaviour regarding energy issues: 1) Kotter (1996) organizational change

10. A good definition of organizational behaviour field is proposed by Moorhead and Griffin (1995:4): "the study of human behaviour in organizational settings, the interface between human behaviour and the organization, and the organization itself."

theory theoretical framework; 2) Cooremans (2012a) investment decision-making model.

Organisational change is an inherently complex and multidimensional process, theorized by John P. Kotter, the leading scholar in the field, as needing eight successive steps to successfully happen (Kotter, 1996): 1. Establishing a sense of urgency; 2. Creating the guiding coalition; 3. Developing a vision and strategy; 4. Communicating the change vision; 5. Empowering employees for broad-based action; 6. Generating short-term wins; 7. Consolidating gains and producing more change; 8. Anchoring new approaches in the culture.

Kotter's theory of organizational change enables to explain PFE results effects on organizations' behaviour regarding energy issues:

1. **Establishing a sense of urgency**. The sense of urgency is not created by the ISO 50001 standard but by PFE itself which provides that companies would have to pay an energy tax if they didn't join PFE. It must be noted, however, that the sense of urgency was strongly connected to size of company and absolute energy use. PFE covered 90 % of the energy use but only 10 % among the eligible companies.

2. **Creating the guiding coalition**. ISO 50001 (art. 4.2.2) prescribes to appoint an energy "management team person(s) responsible for effective implementation of the energy management system activities and for delivering energy performance improvements". This team shall be appointed by top management as a demonstration of its commitment to support the EnMS and to continually improve its effectiveness (art. 4.2.1). Top management support is essential since the coalition has to be powerful, not also in terms of information and expertise, but also in terms of titles and relationships. Thus the coalition should include people from all departments, possibly at a high level.

3. **Developing a vision and strategy.** ISO 50001 prescribes to define an energy policy (art. 4.3) and, based on an energy review and on an energy baseline, to conceive action plan(s) with "documented energy objectives and targets at the relevant functions, levels, processes or facilities within the organization" (art. 4.4.6). However, regarding strategy, previous research of PFE-companies showed that some had a very short and some were even lacking an energy strategy (Thollander and Ottosson, 2010).

4. **Communicating the change vision.** ISO 50001 art. 4.5.2 states that "The organization shall ensure that any person(s) working for or on its behalf are aware of: a) the importance of conformity with the energy policy, procedures and the requirements of the EnMS; b) their roles, responsibilities and authorities in achieving the requirements of the EnMS; c) the benefits of improved energy performance.

5. **Empowering employees for broad-based action**. Art. 4.2.2. states that management representative(s) will have "responsibility and authority" to accomplish their mission and tasks, among which are: "identify person(s), authorized by an appropriate level of management, to work with the management representative in support of energy management activities; … ensure that the planning of energy management activities is designed to support the organization's energy policy; define and communicate responsibilities and authorities in order to facilitate effective energy management".

6. **Generating short-term wins.** We could not find any dispositions of ISO 50001 related to short-term wins. But PFE surveys found out that companies achieved short-term energy benefits (energy costs reductions) as well as non-energy benefits (maintenance, productivity and quality related). A better matching of customers' expectations and participation in regional and national networks could also be considered as short-term wins entailed by participation to PFE.

7. **Consolidating gains and producing more change.** As per ISO 50001 art. 4.7.1 "At planned intervals, top management shall review the organization's EnMS to ensure its continuing suitability, adequacy and effectiveness". Outputs to the management review (art. 4.7.3) shall include any decisions or actions related to: a) changes in the energy performance of the organization; b) changes to the energy policy; c) changes to the EnPIs[11]; d) changes to objectives, targets or other elements of the EnMS, consistent with the organization's commitment to continual improvement; e) changes to allocation of resources.

8. **Anchoring new approaches in the culture.** Several ISO 50001 dispositions relate to this step. According to Art. 4.2.2., the management representative(s) shall promote awareness of the energy policy and objectives at all levels of the organization. Art. 4.3 states that the energy policy will be "communicated at all levels within the organization"; Art. 4.5.2 states that "The organization shall ensure that any person(s) working for or on its behalf are aware of … the impact, actual or potential, with respect to energy use and consumption, of their activities and how their activities and behaviour contribute to the achievement of energy objectives and targets, and the potential consequences of departure from specified procedures".

Based on the above analysis, ISO 50001 certification, together with other PFE features, can be considered not only as a managerial system but as a change agent, durably changing organization behaviour, at all levels (individuals, departments, the whole organization). Most PFE results can be explained by companies' conformity to ISO 50001 prescriptions. However, a more in-depth analysis taking into account companies' individual peculiarities, would certainly highlight huge differences in the way companies have implemented ISO 50001 and, accordingly, in the effects of the certification on their behaviour and activities.

The second theoretical framework we use to explain energy management influence on companies' behaviour regarding energy issues is the one proposed by Cooremans (2011, 2012a, 2012b). According to Cooremans model of investment decision-making, positive investment decision-making and access to capital (the first barrier to energy-efficiency spending) are restricted not when an investment is not profitable but when an investment project is perceived by top management as not strategic, i.e. as not contributing to competitive-

11. Energy Performance Indicators.

ness in core business. However "investments are not strategic for objective reasons only: they are interpreted as such by decision-makers and organizations, as are all data and decision events" (Cooremans, 2012a:501). This is done during the issue diagnosis process, at the beginning of the decision-making process. Organizations' internal context influences issue diagnosis and how decision-makers understand and interpret issues. As main elements of organizations' internal context, strategy, structure, culture and control systems are major organizational filters.

Control can be broadly defined as: "a set of rules, formal or even informal, that normalize behaviour.[12]" (De Bodt and Bouquin, 2001). Control systems are at the same time elements of a firm's structure and an emanation of its culture (an artefact as per Schein's, 2004, terminology). As such, they are very powerful organizational filters: they contribute to define the meaning and importance to be attributed to incoming events and information, as well as to new investment project proposals, and they define the procedures to treat them. Organizational culture is another most powerful filter – or interpretative scheme[13] – influencing organizations behaviour.

Energy management (EM) is a control system, focusing on managing energy usages in a company. But energy management can be also considered, based on Schein (2004) and Johnson (1989) as an artefact of organizational culture. According to the conceptual framework described above, energy management system, both as an element of an organization's internal context and as an artefact of its culture, is an organizational filter which positively influences companies' choices regarding energy-efficiency investments and, in turn companies' energy performance. The reality and modalities of this influence are currently being studied by the Swiss research project "M_KEY – Management as a Key Driver of Energy Performance Determinants of energy-efficiency investments"[14].

One hypothesis being tested by M_Key project is that "The less strategic the investments, the more restrictive the financial criteria in the selection of investment projects". If this hypothesis was confirmed as true, this could explain why different financial selection criteria apply to different investment categories and why a different – and apparently unfavourable – treatment (in terms of financial methods and selection criteria)[15] is applied to energy-efficiency investments compared to other investment categories. Figure 6 below illustrates Cooremans (2012a) decision-making model including M_Key research project hypotheses regarding the influence of energy management on the perception of an investment strategic character and, subsequently, on the diagnosis phase.

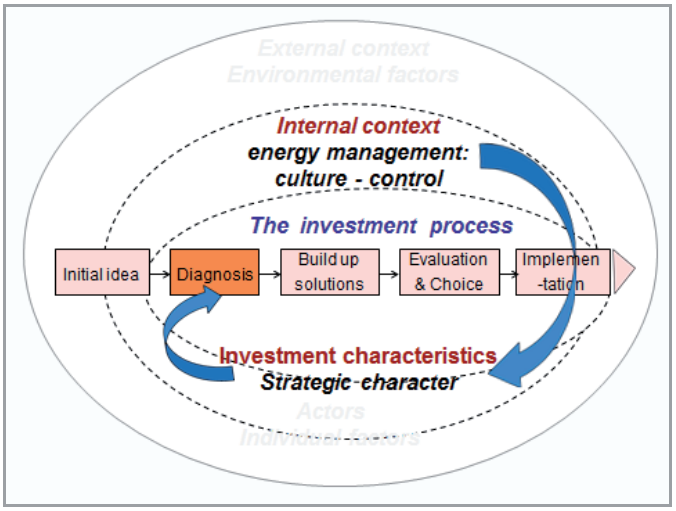

Figure 3. Cooremans investment decision-making model (2012a) showing M_key project hypothesis.

If the links illustrated in Figure 3 were confirmed by M_Key project, Cooremans investment decision-making model would explain why 70 % of the enterprises stated that participation in PFE made it easier to get access to internal investment capital (see Capital Budgeting paragraph of PFE results, p. 6).

Both theoretical frameworks applied in this section to explain energy management influence on companies' behaviour regarding energy issues seem to have a good explanatory power of PFE results and look promising to design and evaluate future public programs.

Discussion

Energy management programs in national energy policy programs and policies can help improve energy efficiency operational skills in enterprises according to the experience from the PFE program. They are working in synergy with price signals and general policies as taxes and the emission trade schemes. Although this paper partly explains how this happens there is still a knowledge gap to cap related to industrial energy policy program evaluation. In the studied program, the PFE, there seems to be an insufficient scope of issues studied during the evaluation. There is a special challenge to find an evaluation method for programs with a 90 % impact as the PFE program when the reasons for not joining are explained by the lack of incentive (tax exemption) or small sized enterprises (to small benefits). There is in practice no self-selection and simply not possible to find a relevant control group. It is even more complicated when major non-participants take part in other knowledge dissemination networks to learn from the good examples

12. Freely translated by us from: "le contrôle, c'est avant tout un ensemble de règles, formelles ou même informelles, qui normalisent les comportements» (De Bodt et Bouquin, 2001: 116).

13. One good definition of culture, according to the interpretative perspective on organizations, is proposed by Cossette (2004: 121): "Culture is an organizational scheme, mainly composed of values which are more or less shared, more or less consciously, by organization members. It is a normative system of ideas, ultimately shaped by the actors involved themselves; thus culture is created, maintained and transformed by individuals who, themselves, have schemes, some of those being of a normative nature, i.e. composed of these individuals' personal values. This organizational scheme of culture is in close relationship with other organizational schemes, even if the influence of one scheme on another goes through individuals … The concept of culture almost always refers to values, defined as what is desirable in a given spatio-temporal context."

14. M_Key is a project of the Swiss National Research Project NRP71 "Managing Energy Consumption". NRP71 studies the social, economic and regulatory aspects of the change in energy strategy, thereby examining how private and public actors could be prompted to use energy efficiently. In so doing, NRP71 develops practice-oriented scientific principles for discussion concerning the implementation of the change in energy strategy. The research work will continue until the end of 2018. PNR71 comprises 19 research projects (selected out of 83 project proposals). M_Key research project is part of theme 2: Economy and enterprises.

15. For instance, Qiu et al. (2015) research shows that shorter payback periods are required and higher discount rates are charged for energy efficiency investments to pass compared to for instance ordinary investments in production efficiency.

made by the PFE participants. The evaluation method has to be designed in detail before the start of the program which was not obvious at the time when PFE started. Partly accustomed to the situation (The EU tax directive) and also being somewhat innovative in its approach it was not obvious how the incentive would affect the enterprises to join and how it would change their operations with respect to energy efficiency management. Although both experience from the participating companies and theoretical framework support the explanation that organisational behaviour changes can be initiated and sustained over time as an effect of a Voluntary Agreement Program it remains to be explained how the effect can be fully quantified and "qualitied".

The results in this paper are partly experiential. More thorough studies are required in order for it to be evidential. More specifically, this paper has implicitly shown a deficit in the area of national industrial energy management policy program evaluation. Below follows a list of areas that should also be studied when evaluation program success or failure: evaluations should also include studies on: the effect on reduction or elimination of barriers to energy efficiency; how the strategic character of energy efficiency is changed within participating companies; how non-technical measures are being affected, e.g. energy action plans, in-house energy policy, culture, organization, etc.; What are the most important driving forces for joining and continue in a voluntary long-term agreements program.

Conclusion

The paper concludes that a properly designed national industrial energy management policy program can result in improved organisation skills in enterprises. However, the effect of such has not been properly evaluated up until today.

Academic research did not provide enough information until now on why energy management has such a positive impact and which aspects are especially important in explaining this impact. Therefore, public programs had to launch energy management programs in a "blind way" (i.e. without knowing precisely what to do and why regarding energy management). PFE looks as a precursor in this regard. Academic research could be questioned here, regarding these knowledge gaps. We hope to have started filling these knowledge gaps in this paper.

Still, more thorough studies are required to understand why energy management programmes work (or don't work) and what would happen if they were not performed, as well as to improve our capacity to properly design programs for different companies, working in different sectors with various cultures.

Suggestions for further research include 1) how voluntary agreements between governments and companies (such as the PFE) can provide the extra incentive that makes companies starting to realize the energy-efficiency potential. 2) The impact –or lack of impact as shown by participation of companies to PFE– of tax incentive and of energy costs reduction on increased managerial attention. 3) If energy-related issues have gained or not increased priority, both regarding access to financial and human resources. 4) Lack of time, slim organisations and poor access to capital are some often mentioned barriers for energy efficiency, but to what extent these barriers and others have been reduced by the PFE, is currently unknown. Thus, further research is also needed in the area of barriers to energy efficiency.

Previous research has shown that the largest drivers of energy-efficiency investments are strategic, internal in-house organizational and cultural factors. Understanding energy management principles and VAPs seems to not be possibly achieved by scientific knowledge from one scientific discipline. Thus, further interdisciplinary research is suggested in the field of industrial energy policy program conception and evaluation.

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