Behavioural change based energy efficiency at Volvo Construction Equipment, Braås, Sweden

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Abstract

Industrial energy efficiency studies have mostly focused on innovative technological approaches and solutions and discussed hindrances to investments oriented measures. However, very little research has been done to understand the challenges of implementing interventions to change employee behavior and the corresponding energy savings potentials. Behaviour may be investment (e.g. decision to buy an expensive machine) or non-investment (e.g. turn of machines when not in operation) in nature, but in this paper behavioral change refers to the transformation in executing everyday non-investment tasks. Volvo Construction Equipment AB in Braås, Sweden (VCE Braås) has recently implemented a behavioral change strategy to improve energy efficiency of the production process. The approach was introduced following the global Volvo CE goal that all production plants of the company would reduce idle electricity use during off-production hours to 15 % (from 25 % to 40 % in different plants) during the period 2013–15. This paper analyzes the factors contributing to the energy efficiency achievements of VCE Braås through the application of behavioral change theories and focus group interviews with production leaders and group leaders. Results showed that a concrete goal, the commitment of the leadership including employment of a fulltime project leader who earlier worked as a production worker at VCE Braås, and the involvement of both the leadership and employees (production leaders, group leaders and floor workers) in project management were key to the success of the project.

Introduction

In the European Union, energy efficiency of the industry sector has improved by 1.4 % per year since 2000. However, the improvement was 1.9 % per year during the period 2000–2007, but 0.9 % during 2007–2013 because of a slower progress in most branches and even no more improvement in some others (e.g. steel, cement, machinery) (ODYSSEE-MURE, 2015). In Sweden, industrial energy efficiency increased by 36 % between 1993 and 2010 and the industry has set a target to further improve the energy efficiency by 50 % by 2050 (IVA, 2013).

Industrial energy efficiency is essential to decoupling of economic growth and environmental impact while improving energy security and industry competitiveness. However, there are several economical, organizational and behavior related hindrances (Thollander and Palm, 2012). The Royal Swedish Academy of Engineering Sciences reported that there exists significant cost-effective energy efficiency potential of the Swedish industry, but there exists four main barriers (IVA, 2013). They are (1) competition for limited resources of a company, in terms of both time and money, and that companies give priority to their core business, (2) knowledge of energy efficiency are insufficient or missing, (3) economic calculations do not take into account the life cycle costs and investment and operating budgets are located in different parts of the financial system, (4) no external demands for increased energy efficiency, whether from customers, owners or authorities.

Industrial energy efficiency studies have mostly focused on innovative solution in the technological domain and discussed hindrances to investments oriented measures, but there is a lack of studies to understand the behavioural aspects and the corresponding energy savings potential. There are several research projects (e.g. Intelligent Energy Europe, FP7) at the

European Union level that focus on energy efficiency of diverse SMEs (small and medium size enterprises). However, almost none of the projects deal with promoting day-to-day energy efficiency behavior of the production workers.

It is very difficult to change human behavior especially, in case of "preventive innovations" (such as energy efficiency) whose benefits or consequences may be unclear and accrue in distance future (Rogers, 2003). Hence, it is a challenge for industries, where energy efficiency does not constitute the core activity, to act in innovative ways to implement a behavioural intervention approach. However, by implementing such an approach, the production plant Volvo Construction Equipment AB at Braås (VCE Braås) in Sweden has been successful to meet the 15 % idle electricity use target set by the parent company. The behavioural change involves engaging the production worker to switch off machines when they are not in operation. The aim of this paper is to investigate the factors contributing to the energy efficiency achievements of VCE Braås.

Volvo CE and its behavioural energy efficiency approach

Volvo Construction Equipment (Volvo CE), which is a part of the global Volvo Group, has it's headquarter in Brussels, Belgium. It has production sites across the globe to manufacture machinery equipment that are used for quarries and aggregates, energy related industries (oil & gas), heavy infrastructure, utilities, road construction, building, demolition, recycling industry, industrial material handling, and forestry industry. At Volvo CE Braås haulers are produced in up to three shifts at several work stations such as paint shop, laser cutting, welding and assembly. Approximately 850 workers are employed.

One of the core values of the Volvo CE is to care for environment i.e. a commitment to CO_2 neutral facilities, replace substances that are harmful to the environment and keep resource use to a minimum (Volvo Construction Equipment, 2011). Accordingly, the company has appointed the Global Director of Manufacturing Engineering and Environmental Care to work for environmental and energy issues. In 2013 he initiated a global project (i.e. in all production sites of the company) to reduce its energy consumption through four different approaches (Figure 1). Numbers 1–4 marked in Figure 1 represent the following:

1. Reduce idle energy use during the off-production weekends (Saturday–Sunday).
2. Reduce idle energy use during the off-production hours during weekdays (night time).
3. Increase number of off-production hours during the weekdays, e.g. reduce number and/or duration of production shifts, but keeping the production level constant.
4. Reduce energy use during production hours.

As a first step Volvo CE has set a target to bring down the idle electricity use (approach 1 and 2) to 15 % of the electricity use during production hours at each of the Volvo CE production sites. Each site was free to decide itself how it would reach that goal. Relative idle electricity is used as a key performance indicator (KPI) of energy efficiency and is defined according to the following equation.

$$Relative\ idle\ electicity\ use\ (\%) = \frac{Idle\ electricity\ use\ (kWh\ during\ 10\ idle\ hours)}{Production\ electricity\ use\ (kWh\ during\ 10\ idle\ hours)} * 100$$

The measurement period in Braås for off-production hours is 7 PM Saturday to 5 AM Sunday, compared to 7 AM Monday to 5 PM Monday for production hours.

VCE BRAÅS APPROACH

The idle electricity reduction project was started in 2013. The project in Braås was led by the Environmental Care and Security Manager (here onwards "Env. Manager"), Rickard Alm (co-author of this paper). A concept that would involve the production workers in the project decision making and knowledge sharing was proposed, as well as a fulltime position to drive the project. Accordingly, VCE Braås appointed the Environmental and Safety Technician (Env. Technician) as the fulltime operational project leader. The Env. Technician has previously worked in different production departments at VCE Braås, which allows him for a broad overview of the workers and their activities. Both the Env. Manager and the Env. Technician planned for systematic implementation of the behavioral energy efficiency approach in four steps.

Step 1: With the help of an electrician, four Fluke 1730 energy loggers (Figure 2) were installed to measure energy use of all equipment used in production over a whole week. The three-phase energy loggers measure real-time electricity consumption of all welders, fixtures and equipment to compare multiple data points over time.

Step 2: The Env. Technician approaches the production leaders and group leaders and explain them the project in its

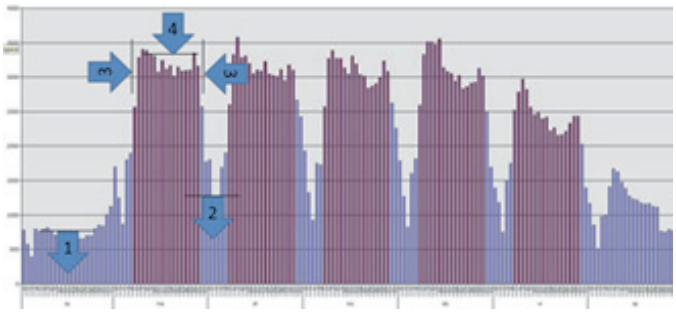

Figure 1. Four ways to reduce energy use at Volvo CE.

Figure 2. Fluke 1730 energy logger.

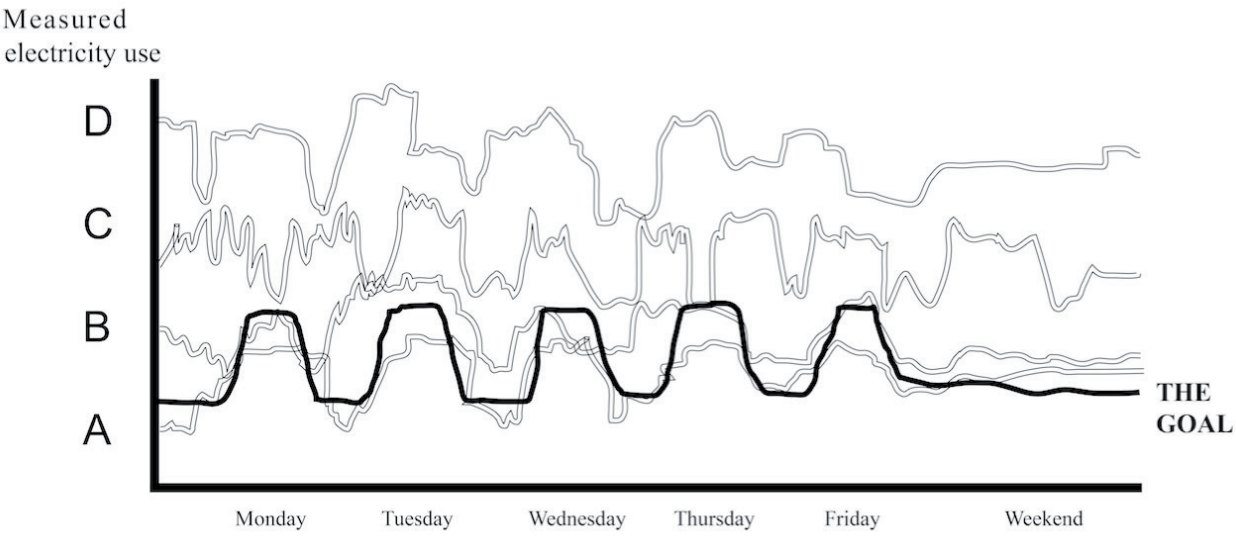

Figure 3. An example of hypothetical electricity use by different machines (A–D) vs. the goals set by VCE Braås.

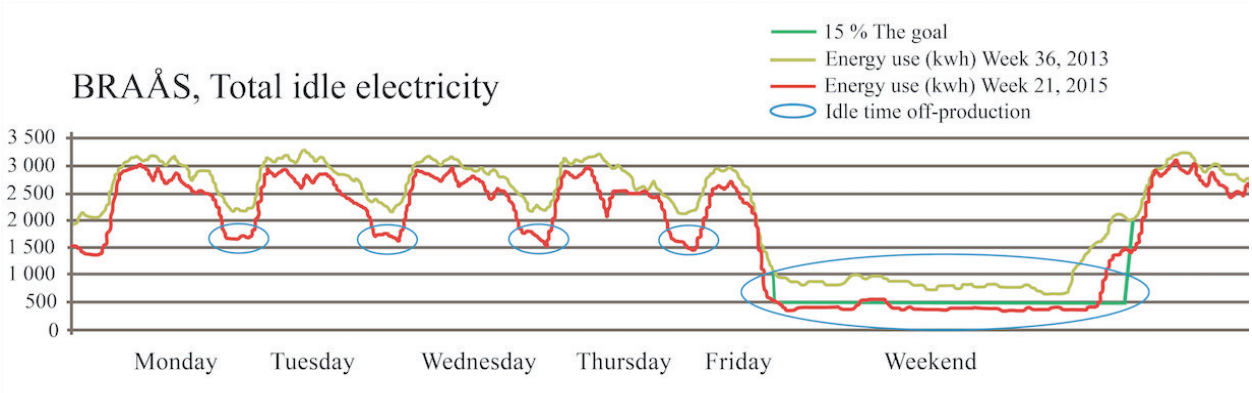

Figure 4. Comparison of energy consumption at VCE Braås between 2013 and 2015.

bigger context and the responsibility of each individual for more environmentally friendly behaviour. The process started by approaching one production group that was most interested in the project. As the Environmental Technician has a good network with other employees and was aware of their reaction to the project, he could identify and reach out to such a production group and other production groups were successively included. The measured electricity use of each equipment, especially during off-production hours, is visualized to the production leaders, group leaders and floor workers. The production groups are challenged to come up with their own goals and approaches to reduce energy use. To keep the production workers updated with project progress, the Env. Technician shares (presentation on an information board) the measured energy use with the group leaders every week. Production leaders get an update of the numbers every month. Figure 3 shows a visual presentation of hypothetical electricity use by different machines versus the goal set by VCE Braås (thick line).

Step 3: The production group develops an action plan (i.e. to turn-off machines when not in use) to reduce the energy waste. Since the production workers have the first-hand experience of different machines, they decide about which machines to be turned off at what time.

Step 4: Upon the implementation of the action plan, verification is conducted to see how far the group has reached the goal. The project results are reported to the top management on a monthly basis. The coordinator to collect reports from all Swedish production sites forwards the report to the global manager responsible for the project.

Through the implementation of the above steps during 2013–15, VCE Braås has been successful in bringing down the idle electricity use to 15 % in 2015 compared to 25 % in 2013 (Figure 4, actual measurements).

Theory

A schematic diagram of the theoretical framework used in this paper is presented in Figure 5. The goal-framing theory postulates that set goals affect behavior (Evans, 1970). **Goals** influence the functioning of the firm through their influence on firm's internal governance and motivation of the employees, including the top management (Foss and Lindenberg, 2013). To act people need to be aware of the problem their behavior

causes or the benefit a change in behavior can create (Steg, et al., 2013). This means the floor workers must be aware of the effect of their production activities on energy use. Owens and Beevor (2009) suggested that awareness creation can be done through education or making the problem visible and tangible to the people. Also the awareness for a problem depends on the individual's values and the ecological worldview the individual has (Steg, et al., 2013). Such values guide individual's **personal norms** and consequently behaviour. Environmental behavior is also guided by **social norms** and they are rules and standards that are understood by members of a group and that guide the human behavior (Cialdini & Trost, 1998). The **communication set-up** is important because people are more likely to act on information if it is specific, presented in a personal manner, and comes from a person who is related to the receiver (Thollander and Ottoson, 2008; Thollander, et al., 2010).

Employee involvement in a project and the ability to cooperate with others may affect behavioral-based energy reduction (Johansson, 2015). **Cooperation** gives the employees an opportunity to be visible and acknowledged as well the motivation for joint effort (Johansson, 2015). Such cooperation can reflect **local company culture**. When environmental values are anchored to company culture, employees are likely to engage in energy efficiency behaviour (Sorrell, et al., 2000) and take collective responsibility for the action taken towards lowering energy consumption (Nisiforou, et al., 2012).

Real ambition with high commitment is an important driving force for energy efficiency achievements (Rohdin and Thollander, 2006). Therefore, the **leadership** should serve as role model for energy reduction (Johansson, 2015). If they are not involved or do not promote energy saving, employee behavior may not change (Nisiforou, et al., 2012). The leadership can show their commitment to energy efficiency through a project set-up in which a full-time project leader is appointed to fully dedicate his/her time and knowledge to the project (Johansson, 2015). The appointment of such a leader contributes to make the decision chain as short and efficient as possible, which is important for success of a project (Thollander and Ottosson, 2010). However, the influence of the project leader depends very much on the leader's personal characteristics, e.g. ability to motivate others through interpersonal networking (Thollander and Ottosson, 2008).

Method

A group of six Master level students (co-authors of this paper) conducted three focus group interviews at the Volvo CE production site in Braås from February to April 2016. They also conducted individual interviews with the Global Director for Manufacturing Engineering & Environmental Care who is the initiator and the global responsible of the energy efficiency project, the Env. Technician who is the operational project leader in VCE Braås, and eight floor workers. The interviews were recorded in an electronic device. The first two focus group sessions were with three respective four group leaders out of the nine group leaders. The group leaders are responsible to supervise the floor workers and allocated them across machines. Each group leader represented as many as ten floor workers. The third focus group was with three production leaders who are in charge of the group leaders and serve as an interface between the floor workers and the management. All the interviewed group and production leaders were male and between the age of 30–50.

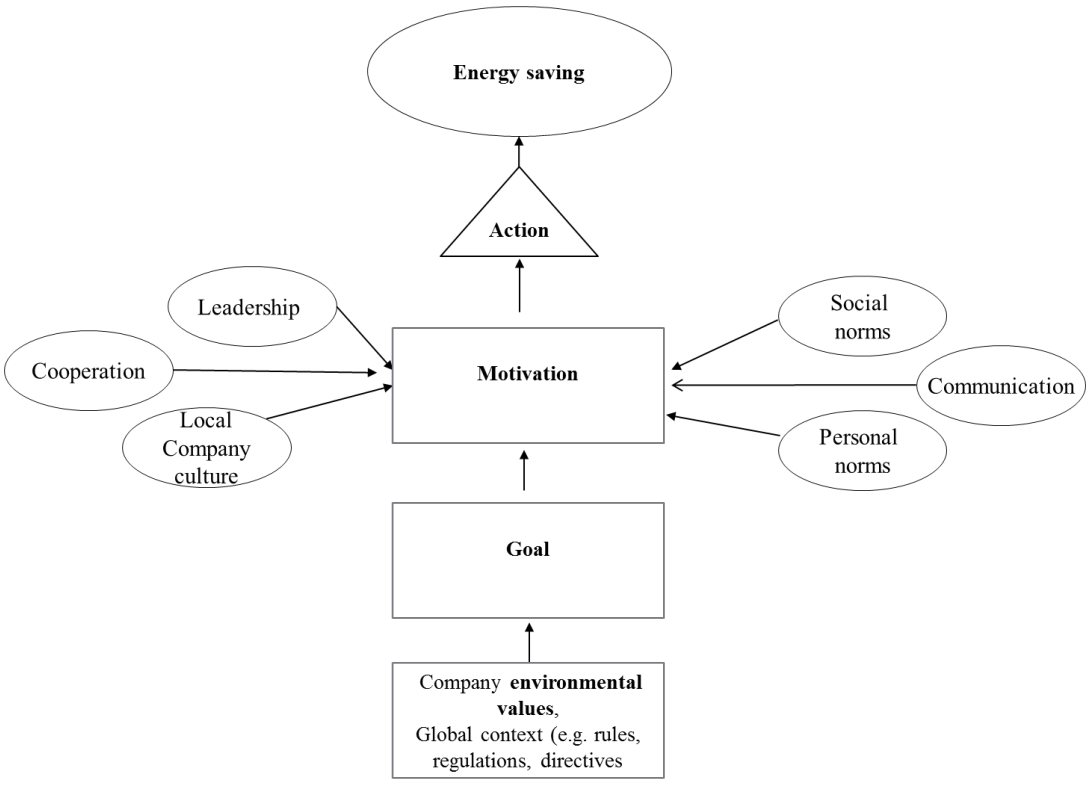

Figure 5. Factors influencing individuals' action to reach the goal.

A semi-structured interview approach was used to get deeper insight into interviewees' reflection regarding the energy efficiency project. Therefore, "how" and "why" questions were paid attention to. The questions were about to understand the usefulness of the goals and feedbacks, how management creates awareness on the energy topic, leadership characteristics, cooperation, project set-up and so on. The interviews with the floor workers were very short to get their overall impression of the project. Due to strong production sound at the working space their interviews could not be recorded in an electronic device. The interviews were mainly conducted in Swedish language by the only native Swedish speaker student in the group with help from another semi-Swedish speaking student. One interview was carried out in English. Immediately after the interviews, the interviewees' responses were summarized as a written text. They were later updated by listening to the recordings (except for floor workers), which also helped scan typical quotes from the production leaders and group leaders. The native Swedish speaker narrated the interview results to be transcribed to English by the semi-Swedish speaker.

Results and Discussion

The interview with the Global responsible for the energy efficiency project of Volvo CE revealed that it too long time and struggle for him to get sufficient attention of the leadership on this topic. However, he set the 15 % idle electricity use goal and actively following the progress. He didn't give any recipe to follow to any plant, because he wanted them to figure out themselves how to achieve the results. This freedom helped VCE Braås to devise its own strategy. However, he mentioned that nothing happens by itself, but needs to be kept on track and followed up. He has weekly meetings to track the progress of the Swedish sites together with a coordinator who is responsible to collect all numbers from the Swedish sites. On a monthly basis they consolidate the results into an A3-reporting-template and send it out to all sites managers, everybody in the top management and environmental care managers (e.g. the Env Manager of VCE Braås). If one site doesn't reach the set goal of energy reduction, they will have individual meetings with the site representative and discussions with the site general manager. They try to understand what the blocking point is and how they could move forward to achieve the goal. He reflected that it was easy for him to get good ideas as there are competent people along the side and they have been contributing with good suggestions for improvements.

Figure 6 presents the key factors (oval shape in Figure 5) contributing to the success of the energy efficiency project and corresponding typical quotes from the focus group interviews with production leaders and group leaders. The quotes are taken from the statements that were agreed to by other members of the focus group.

The analysis of VCE Braås behavioural based energy efficiency project shows that several factors influenced its success. Mainly it is about how the employees (production leaders, group leaders and floor workers) were involved in the project. Being involved in the project right from the beginning means they get an opportunity to share their knowledge and opinion. This gives them a feeling of acknowledgement of their knowledge and themselves as a person. It becomes visible to them that they are an important part in the whole. Positive feedback for their involvement leads to a higher motivation and a greater likelihood of being involved again. However, the acknowledgement and visibility should be directed to a group (instead of an individual standing out as special), which encourage collaborative effort towards a common goal. It increases the motivation among co-workers to help each other to reach the goal and creates a sense of inclusiveness.

The complete project set-up, which includes how the leadership prioritizes the project and how information is shared, has significant influence on the outcome. The decision to establish a full-time position dedicated to the project shows the seriousness of the project to the employees and that their involvement in the project is meaningful. Besides, the project structure encompasses large part of the organization at VCE Braås. Everyone from leadership through production leaders, group leaders and floor workers got involved and had their meaningful places in the project. By setting up an integrative structure, the project becomes a collaborative responsibility instead of a top-down approach with one person telling the others what to do. With the engagement of the Global environmental manager responsible for the project, the Env. Manager and Env. Technician are deeply engaged with the employees as opposed to "dumping" the project execution on the employees and watch them do it. Instead of putting pressure on employees, they try to find a solution together with the employees. When the employees see the leadership act as a role model towards the common goal, the feeling of inclusion is further strengthened. There is a clear correlation between the success of the project and its structure.

As mentioned earlier, a clear goal helps to stay focused and motivated. The interviewees mentioned several times how important it is to them to have a single point of contact to ask questions regarding the project. To know whom to approach to get clarification is important to keep the goal focused and project a float. Hence, the appointment of the Env. Technician as the operational project leader was an important driving force. He comes from the production floor of VCE Braås, which means a lot to the employees. He is considered as "one of them", not as a leader or outsider. His relationship with the employees helps him motivate the employees to engage in the project. He is very passionate about environmental issues. His personal values make him believe that every individual should contribute to a more sustainable way of living and this contributes to his commitment to the project and employees' trust on him. He could identify and reach out the first production group that would be most interested in the project. This is important, since success of any campaign or change management project involves identifying the innovators or early adopters who could act as role models for others to follow (Rogers, 2003). Once the majority of the individuals have changed their personal norms and perception, their behaviour will change. The majority will put social pressure on the remaining individuals with "old" behaviour and trigger further changes.

The communication set-up is also important for the success of the project. To share and provide regular updates about the progress of the project and whether results were reached or not, is an important factor to keep employees involved in the project. If no results or progress is shared with them, then that may lead to decline of commitment. They may feel less responsible

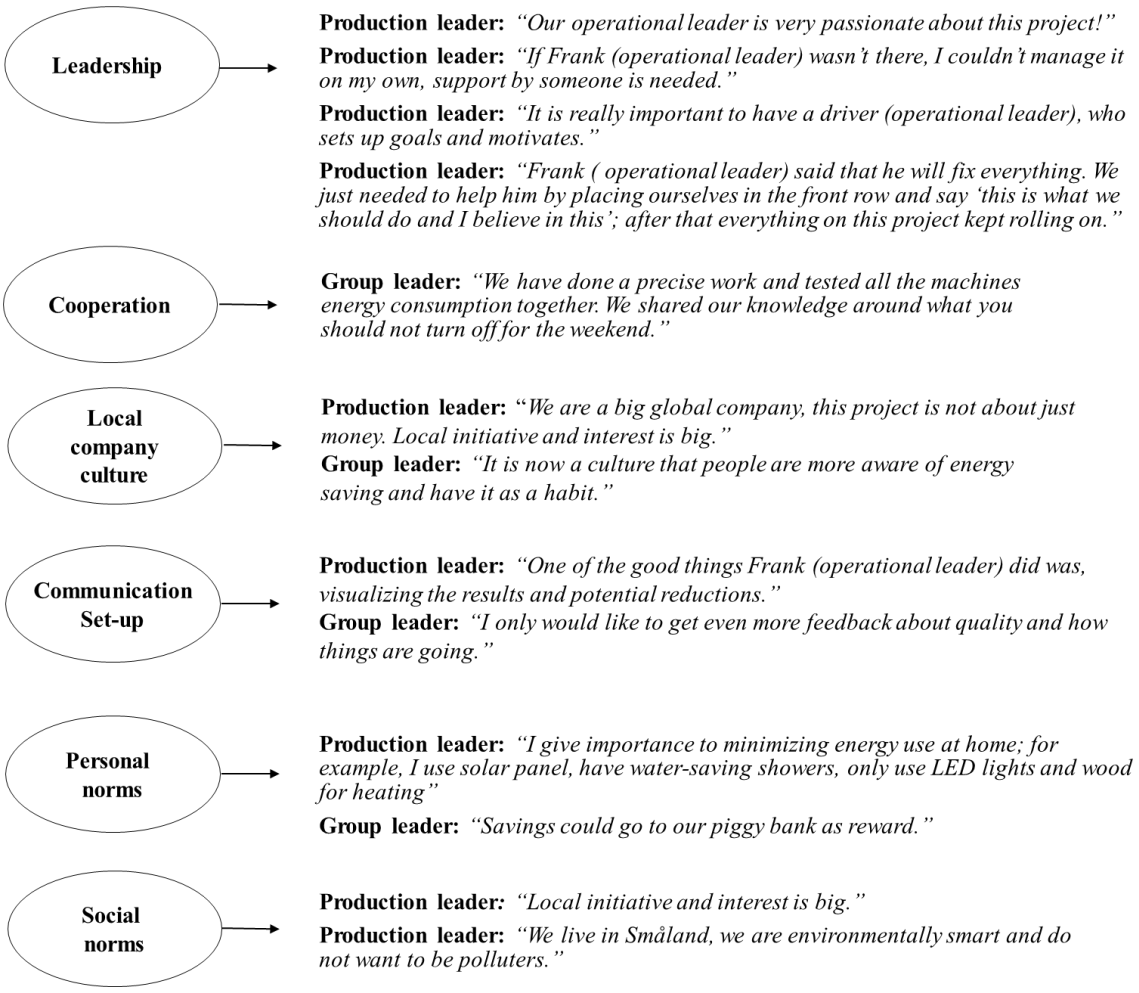

Figure 6. Matching key factors affecting success of the project with typical quotes from focus group interviews.

to reach the common goal as no one is checking up on them and they will feel irrelevant to the project as no one takes the time to share progress on something they have put their time and dedication on. However, it seems there exist improvement possibilities in how the results are communicated. For example, one group leader pointed that "sometimes too many graphs and diagrams on the whiteboard can be confusing". Group leaders can find it confusing which information to share to motivate floor workers. "I only would like to get Feedback about quality and how things are going."

Conclusions

The VCE Braås energy efficiency project shows that it is indeed possible to reduce industrial energy use through non-investment oriented behavioral change. Nevertheless, it is not an easy task to implement and the intervention itself incurred investment. To change habits and behavior requires proper planning and involvement of dedicated project leaders whom the production staff listens to and trusts. They must feel being involved in the decision-making and are acknowledged for their effort. Most of the floor workers indicated that it has become a habit for them to turn-off machines when they are not used. However, there are indications that some floor workers are not entirely convinced of the relevance of the project. They are not sure if the savings are significant, if the project is about environment or saving money and how some activities, e.g. turning of ventilation may affect health.

As part of its energy management plan, VCE Braås has entered the second phase of the project from 2016–2018. In this phase the company will focus on not only idle electricity during off-production hours, but also on energy consumed during production hours. The already changed or newly formed habits from the first phase are assumed to be continued. As long as the motivation of staff is maintained with regular constructive feedbacks, the newly established behavior can be sustained. The success of VCE Braås strategy will be put into test when the Env. Technician will go on parental leave. A new person may replace him and (s)he has to rebuild the commitment and trust with the workers and the leadership.

It is not only about changing the behavior of the floor staff, but also about government policies. For example, currently subsidies are granted to industrial polluters to reduce their greenhouse gas emissions. VCE Braås applied for the subsidy to initiate the behavioral energy efficiency project but did not qualify. This is because it did not make investments in machines to reduce emissions and were already CO_2 neutral when the project was initiated. There needs to be a fundamental rethinking about how pro-environmental behavioral initiatives are promoted through governmental policies.

Energy reduction by behavioral change is a contribution Volvo CE makes towards a more sustainable future. It is an investment for the future as electricity prices are still low in Sweden, but are likely to increase in the future. And after nearly two years, the idle electricity use has been reduced by 10 %, which is equivalent to about 780,000 SEK/year (ca €85,000/year). There might be side benefits of the VCE Braås approach, e.g. the employees might have gained self-empowerment and a sense of meaning through the project. They seem to pay more attentions to self-thinking and are more willing to have discussions with each other, which may lead to a more positive work environment, more efficient machine operations and more skilled employees. However these issues are not investigated in this paper and a potential topic for future research.

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