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Barriers to and drivers for energy efficiency in the Swedish foundry industry

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Abstract

Despite the need for increased industrial energy efficiency, studies indicate that cost-efficient energy conservation measures are not always implemented, explained by the existence of barriers to energy efficiency. This paper investigates the existence of different barriers to and driving forces for the implementation of energy efficiency measures in the energy intensive Swedish foundry industry. The overall results from a questionnaire show that limited access to capital constitutes by far the largest barrier to energy efficiency according to the respondents. A comparison between group owned and privately owned foundries shows that, except for limited access to capital, they face different high-ranked barriers. While barriers within group owned companies are more related to organizational problems, barriers within private foundries are more related to information problems. This study also found that energy consultants or other actors working with energy issues in foundries are of major importance in overcoming the largest barriers, as the foundries consider them trustworthy. They may thus help the

foundries overcome organisational problems such as lack of sub-metering and lack of budget funds by quantifying potential energy efficiency investments. The two, by far, most important drivers were found to be people with real ambition and long-term energy strategies.

Keywords: Barriers, Drivers, Energy efficiency, Swedish foundry industry

1. Introduction

The Swedish industry, which historically has enjoyed one of the lowest electricity prices in Europe, is exposed to a competitive disadvantage as the opening of the domestic energy markets has led to increasing electricity prices (EEPO, 2004). Growing concern for global warming resulting from the use of fossil fuels has led to the implementation of a number of policy instruments, e.g. CO₂ tradable emission allowances and green electricity certificates. These instruments may increase energy prices even further, stressing the need for the implementation of cost-efficient energy conservation measures (ECON, 2003; Elcertificat, 2001; IEA, 2004). This is especially vital for the energy intensive foundry industry, where electricity is essential. The Swedish foundry industry, which mainly produces for domestic markets, involves about 130 enterprises and employs some 7,350 people. Annual production in Sweden amounts to 325,000 tons of castings of which 76% is iron, 18% non-ferrous and 6% steel resulting in an aggregated annual energy use of about 1 TWh (Swedish Foundry Association, 2004a). A comparison with the

foundry industry in some European countries shows that the Swedish industry has the largest relative use of electricity (Fig. 1) (Thollander et al., 2005).

Despite the need for increasing industrial energy efficiency, studies indicate that cost-efficient energy conservation measures¹ are not always implemented, implying the existence of an ‘energy-efficiency gap’. The energy-efficiency gap is in turn explained by the existence of barriers to energy efficiency (SPRU, 2000; Hirst and Brown, 1990). These barriers differ depending on sector- and regional-specific conditions (SPRU, 2000) which implies the need for regional and sector-specific studies in order to spot these barriers and adopt effective energy policies (Ramirez et al., 2005). This paper investigates the existence of different barriers to and driving forces for the implementation of energy efficiency measures in the energy intensive Swedish foundry industry and is one part of a larger ongoing research project with the focus of creating opportunities for the Swedish foundry industry to use electricity and energy more efficiently.

2. Method and theory

Due to the nature of the study and the multiple sites investigated, this study was carried out as a case study (Yin, 1994), using a questionnaire (Bryman, 2001). The study began with a workshop, initiated by the Swedish Foundry Association, where seven invited executives from Swedish foundries discussed major barriers to and driving forces for energy efficiency within the sector. Partly based on the results from the workshop and a previous study of the non-energy intensive industry, and

Fig. 1. Foundry sector's average use of electricity in relation to the total energy use [%] and electricity prices for 1-9 GWh and 9-50 GWh enterprises in some European countries. For the Netherlands, too few observations were made in order to state a figure for enterprises using 9-50 GWh annually (based on 0).

partly based on the scientific theory on the subject, a questionnaire was created mostly covering barriers to and driving forces for energy efficiency. It should be noted that the drivers are mainly derived from the workshop, while the barriers (presented in Table 1) are based on scientific literature (Blumstein et al., 1980; DeCanio, 1993; DeCanio, 1998; de Groot et al., 2001; Dias et al., 2004; Hirst and Brown, 1990; Howarth and Andersson, 1993; Jaffe and Stavins, 1994; Ramirez et al., 2005; Sanstad and Howarth, 1994; SPRU, 2000; Stern and Aronsson, 1984; Stern, 1992; Velthuijsen, 1995; Weber, 1997). Furthermore, the classification of barriers is not unambiguous (Weber, 1997).

The questionnaire was sent out by email to 59 members² of the Swedish Foundry Association with 20 or more employees within the foundry, resulting in an answer frequency of 47%,³ which related to similar studies may be considered high; see for example Velthuijsen (1995) and Ramirez et al. (2005). The respondents were all executives.

It should be noted that when quantifying barriers, drivers and information sources, large simplifications are made. The quantified results contain several perspectives of the issue other than receiving a single score on a ranking. This must be kept in mind when drawing conclusions from these types of studies. A respondent's answers must also be added to parameters that must be seen as somewhat uncertain.

Table 1: Classification of barriers to energy efficiency (Based on SPRU, 2000).

Theory	Barrier	Comment
Economic	Hidden costs	Overhead costs, cost of collecting and analyzing information, production disruptions, inconvenience etc. are examples of hidden costs (Jaffe and Stavins ,1994)
	Access to capital	This barrier may lead, e.g. to slim budgets which in turn affects the ability to invest in energy efficient technology (Jaffe and Stavins, 1994)
	Risk	The reason why energy efficiency measures are constrained by short pay-back criteria may be explained by risk aversion (Jaffe and Stavins, 1994)
	Heterogeneity	Cost-efficient energy efficiency measures may not always be able to implement because the technique is not adoptable in the company (Jaffe and Stavins, 1994)
	Imperfect information	A large body of research has documented that consumers are often poorly informed about market conditions, technology characteristics and impacts of their own behavior (Howarth and Andersson, 1993)
	Principal-agent relationships	The fact that the principal cannot observe what the agent is doing, may result in strict monitoring and control by the principal and thus result in neglecting of energy efficiency measures (Jaffe and Stavins, 1994)
	Adverse selection	The purchasers may select goods on the basis of visible aspects such as price if suppliers know more about the energy performance of a good than purchasers (Jaffe and Stavins, 1994)
Behavioral	Split incentives	An implementation may become of lower interest if a person or department cannot gain benefits from an energy efficiency investment (Jaffe and Stavins, 1994)
	Bounded rationality	In theory decisions are based on perfect information, in reality it is often rather made by the rule of thumb (Simon, 1957)
	Inertia	Opponents to change within an organization may result in neglecting of energy efficiency measures (Stern, 1984)
	Credibility and trust	The information source should be credible and trustworthy in order to successfully deliver information regarding energy efficiency measures (Stern, 1984)
	Form of information	In order to increase the possibility of becoming accepted, information should be specific, vivid, simple and personal (Stern, 1984)
Organizational	Values	If there are individuals with real ambition, preferably represented by a key individual within top management, efficiency improvements are more likely to be adopted (Stern, 1992)
	Culture	A culture characterized by, for example a group of individuals holding environmental values may encourage energy efficiency investments (SPRU, 2000)
	Power	Lack of power within energy management may lead to lower priority of energy issues within organizations (SPRU, 2000)

3. Major barriers and drivers

Results from this survey show that among the studied foundries only 50 % have been a paying concern for the last 3 years and 69 % have not shown net profits at all in the same period. However, uncertainty regarding the company's future was not considered a major issue among the studied companies (see Fig. 2). Cost-efficient energy efficiency measures were claimed to exist at 93% of the sites according to the respondents, verifying the existence of an energy efficiency gap.

The overall results from the questionnaire show that limited access to capital constitutes by far the largest barrier to energy efficiency. This followed in descending order by: technical risk such as production disruptions, lack of budget funding, cost of obtaining information about energy use of purchased equipment, other priorities for capital investment, possible poor performance of equipment and lack of sub-metering. The barriers of least importance according to the respondents were: department and workers not being accountable for energy costs, energy manager lacking influence, conflicts of interest within the company and cost of staff replacement, retiring and retraining. Barriers related to imperfect information such as cost of obtaining information is of interest as this kind of barrier, according to economic theory, may constitute a market/organisational failure and thus may justify informative activities.

The most powerful drivers for energy efficiency according to the respondents were people with real ambitions and long-term strategies. In fifth place came third

Fig. 2. Ranked results from the questionnaire. The barriers and drivers were rated, 1 point if the respondent considered the question to be of 'major importance', 0.5 points for 'sometimes important' and no points for 'rarely important'. It should be noted that the differences in average response of only a few percent may only represent random statistical variation.

party financing even though this could be a way for the foundries to overcome limited access to capital.

Other studies indicate that larger organisations and companies within a group may face barriers different than the ones faced by smaller, privately owned firms (Rohdin and Thollander, 2005; Velthuisen, 1995). The barriers are also expected to be sector specific (SPRU, 2000). Half of the studied foundries are incorporated in a company group, i.e group owned, while the rest are not, i.e. are privately owned. The average number of employees within group owned companies was 113, and for privately owned companies the average was 65. Thus, the result from a comparison between the two types of ownership (presented in Fig. 3) may also be explained by the size of the companies. It should be noted that the economic difficulties, due to lack of profits, spread evenly between the two types of ownership. The results show that limited access to capital was considered the largest barrier for both types of ownership. The foundries within groups have more strict investment criteria (1-3 years pay-off) than the private companies. For instance, more than 50% of the private companies claim that they do not use any formal investment criteria. The five largest consecutive barriers differ between the two types of ownership except for limited access to capital. The results from the privately owned firms seem to indicate that the economic difficulties create increased risk aversion and lead the companies to prioritise when looking to invest in energy efficiency technologies. The results from the group owned foundries may present similar results. However, these results indicate that the priority is made higher up in the organisation, and is

Fig. 3. Barriers depending on private or group ownership. The barriers were rated, 1 point if the respondent considered the question to be of 'major importance', 0.5 points for 'sometimes important' and no points for 'rarely important'.

not as visible to the staff at the single company as expressed in the privately owned firms. Instead, these foundries claim to experience stricter monitoring and control resulting in barriers like long decision chains, lack of budget funding, and lack of sub-metering. Sub-metering at plants serves to distribute company energy costs among departments in a more individualised way than strictly based on floor area or on number of employees leading to a lack of incentives to make energy efficiency commitments as there is 'nothing in it' for the department. These findings are of importance as some of the barriers may be classified as market/organisational failures and thus justify policy interventions within markets and organisations. In this case barriers found in group owned foundries are related to difficulties within the organisations and are not easily solved through governmental energy policy activities like energy information campaigns. Instead, company or group oriented policies, such as long-term strategies, energy and environmental management systems are more likely to be successful. When comparing driving forces for group owned and privately owned companies, no real differences can be seen.

Credibility and trust in the information provider is of utmost importance if information regarding energy efficiency investments is to be accepted (Stern and Aronsson, 1984). In order for information to be accepted it should also be vivid, personal, simple and specific (Stern and Aronsson, 1984). To investigate the credibility and trust of different sources of information, the respondents were asked to rank nine different sources of information; see Table 2. Ranked highest were colleagues, the Swedish Foundry Association followed by consultants performing

energy audits, while governmental sponsored energy audits, production information from equipment providers and power companies were ranked low.

Table 2: Ranking of different sources of information, 1 p for ‘excellent’, 0.67 p for ‘good’, 0.33 p for ‘fair’ and 0 p for ‘not good’. It should be noted that the differences in average response of only a few percent may only represent random statistical variation.

Source of information	Ranking
Colleagues within the sector	0.57
Staff at the Swedish Foundry Association	0.57
Consultants performing energy audits	0.55
Colleagues within the company	0.53
Conferences and seminars	0.45
Written sources of information, such as journals	0.45
Governmental sponsored energy audits	0.43
Product information from suppliers	0.43
Information from power companies	0.36

The rankings differ somewhat depending on whether the companies were part of a group or were private. The group owned foundries rank colleagues within the company higher than the privately owned companies which perhaps is natural as these companies have fewer ‘energy experts’ to consult within the company compared to companies belonging to larger organisations.

In Table 2 one can distinguish that the top four sources of information are related to more personal relations such as colleagues, staff at the Swedish Foundry Association and consultants.

4. Concluding discussion

The aggregated findings show that limited access to capital was considered the largest barrier, followed by technical risk such as production disruptions and lack of budget funding, indicating a large risk aversion among the foundries. These three largest stated barriers may be difficult to overcome by government energy policies. Instead, company oriented policy instruments like promoting third party financing and striving for long-term energy strategies are more likely to encourage energy efficiency investments. However, third party financing was not considered a major driving force among the respondents. This may seem a bit contradictory as this could help foundries overcome the largest barrier of limited access to capital. However, it appears that respondents and the participants at the workshop had limited knowledge of this possibility, and also that smaller companies have limited access to this type of arrangement. Instead, the driving forces, long-term energy strategy and people with real ambition received top scores.

Of the fourth to ninth consecutive barriers in the ranking, five were more or less related to information problems. When asking the respondents to rank their trust in different information sources, colleagues and the Swedish Foundry Association (which they are working in close relations with) were top ranked, while

information coming from government sponsored energy audits was ranked low. A notable finding (see Table 2) was that the top ranked sources were characterised by long-term and close relations with colleagues, staff at the Swedish Foundry Association and consultants, indicating that personal relations may be an effective catalyst in providing information about energy efficiency opportunities. This is especially true within privately owned firms where information problems proved to be of greater importance while governmental campaigns like sponsored energy audits, at least in the Swedish foundry industry, proved to be of minor importance in stressing the need for increasing industrial energy efficiency.

When making a distinction between group owned and privately owned foundries, it was found that the largest barriers faced among the group owned foundries could be related to organisational problems while the largest barriers faced among the privately owned firms were related to information problems. This was also found by Velthuisen (1995).

When comparing the foundry's trust in different sources of information it was found that group owned foundries in general considered information to be of greater importance than the privately owned firms. So even though the group owned foundries' largest barriers are not related to information problems, they consider information to be of great importance and also rank consultants much higher than the private firms. A conclusion from this may be that energy consultants and other energy actors working with group owned foundries are of major importance in overcoming the largest barriers as they are considered trustworthy by the foundries, and thus may help solve organisational problems such as lack of sub-metering and

lack of budget funds by quantifying potential energy efficiency investments. Also, the lack of confidence in governmental sponsored energy audits together with the high trust in the Swedish Foundry Association seem to indicate that campaigns such as sponsored energy audits are more effective if carried out by other more trusted actors than government associations. Similar results were found in other countries and sectors (de Groot et al., 2001; Gruber and Brand, 1991; Stern and Aronsson, 1984).

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¹ A cost-efficient energy efficiency measure is defined as an investment which lowers the use of energy, and which is considered cost-efficient according to the company's investment criteria.

² The Swedish Foundry Association has 110 members producing about 99 percent of the Swedish annual casting production. The association consists of 29 iron, 12 steel, and 69 non-ferrous metal foundries.

³ The questionnaire was also sent out to members with less than 20 employees. These results are not presented in this paper due to, among other factors, low answer frequency from this segment.