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The design and structure of effective energy end-use policies and programs towards industrial SMEs

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Abstract

The issue of climate change due to in particular anthropogenic emissions of CO_2 is driving decision-makers to make decisions towards more efficient use of energy. Improved industrial energy efficiency is stated to have a key role in the transition into more carbon-neutral energy systems. In most countries, industrial SMEs represent more than 95 % of the number of companies. Thus, the sector is apart from using energy, a major driver in the Economy in regard to innovations, and GDP growth, investments and export etc. The aim of this paper is to present results of an international study within International Energy Agency Industrial Energy Technologies and Systems) concerning the design and structure of effective energy end-use policies towards industrial SMEs in the countries Belgium, Japan, Spain and Sweden. The major method used was workshops, and literature studies, mainly country-specific reports and documents, mostly written in that countries native language.

Results from this paper states that for medium-sized and energy-intensive industrial SMEs it is emphasized that Energy Conservation Law/Long-Term Agreements (LTA)/Voluntary Agreement (VA) are strong energy end-use policies followed by energy audit programs, preferably but not necessarily located regionally or locally. Energy networks, preferably locally or regionally anchored, are also policies suggested to be considered for medium-sized and energy-intensive industrial SMEs followed by investment subsidies mainly for investments in production-related technologies, benchmarking, and finally sector guidelines.

For small-sized and non-energy-intensive industrial SMEs it is emphasized that energy audit program, preferably locally or regionally anchored, followed by energy networks, preferably locally or regionally anchored, are strong energy end-use policies followed investment subsidies, benchmarking, and finally sector guidelines.

Introduction

The issue of climate change due to in particular anthropogenic emissions of CO_2 is forcing decision-makers to make decisions towards more efficient use of energy. Improved industrial energy efficiency is stated to have a key role in the transition into more carbon-neutral energy systems. While the energy efficiency potential is vast, there are many barriers to energy efficiency which hinder implementation of energy efficient technologies. Moreover, attention, research- and policy-wise, have extensively been raised towards energy-intensive industries, while non-energy-intensive and small- and medium-sized enterprises (SMEs) have received much less attention (Ramires et al., 2005). This holds despite the fact that a larger relative energy efficiency potential is spotted in non-energy-intensive and SME industry, in relation to the energy-intensive sector. In most countries, industrial SMEs represent more than 95 % of the number of companies. Thus, the sector is apart from using energy, a major driver in the Economy in regard to innovations, and GDP growth, investments and export etc. Energy policies towards industrial SME and non-energy-intensive industry have been scarce compared with policies and programs targeting large and energy-intensive industry (Ramires et al., 2005). Normally, energy audit programs are the most common means towards industrial SME and non-energy-intensive industry

while towards large and energy-intensive industry, Long-Term Agreements (LTAs) or Voluntary Agreements (VAs) are more common (Bertoldi, 2001). Most research about industrial SMEs consists of evaluations of national energy audit programs, e.g. Fleiter et al. (2012), Andersson and Newell (2004), and Thollander et al. (2007) while international comparisons are scarce, some exceptions being Price and Lu (2011) and Tanaka (2011). The aim of this paper is to present results of a study concerning the design and structure of effective energy end-use policies towards industrial SMEs. The paper is a result of Task I, energy end-use policies in industrial SMEs, in the international project within the IEA IETS[1] (International Energy Agency Industrial Energy Technologies and Systems), including Japan, Spain, Belgium and Sweden.

Method and delimitations

This paper have used the definition of an SME in accordance with the EU Commission's definition, i.e. the category of SMEs is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding €50 million, and/or an annual balance sheet total not exceeding €43 million. Small companies are defined as companies with 10–49 employees and medium-sized companies with 50–249 employees. Policies can be categorized as Administrative, Informative, Economic, and R&D (Research & Development) oriented, where many policies often include several of these categories in combination (Linden and Carlsson-Kanyama, 2001). The first three types of policies is the focus in this paper, namely Administrative, Informative, and Economic policies. The paper is an outcome of the research conducted within the IEA Implementing Agreement IETS (Industrial Energy Technologies and Systems). The major method used was expert workshops. Four workshops have been held. One in Linköping, Sweden, 11th of May 2011, yet another one in Linkoping, March 13–14th 2012, and another one in Arnhem, Holland, September 10–11th 2012. Lastly, a final workshop was arranged in Malaga, Spain, 13–14th of May 2013. In addition, a literature study, mainly of country-specific reports and documents, mostly written in that countries native language, was conducted. This paper includes findings from four countries. In the workshops, a larger number of participants from a total of 13 countries have contributed with knowledge and experience from their respective countries in at least one of these workshops, including researchers from Austria, Brazil, Denmark, Finland, France, Germany, Italy, Norway, and Switzerland.

The paper does not directly cover supply side policy instruments like taxes, or energy end-use taxation. The reasons for this are that focus is given on energy-end-use efficiency policies and its outcome, not taxes on the supply and demand of energy. This was an important delimitation in order to try to delimit the paper's aim into focusing on energy end-use efficiency policies for industrial SMEs.

One criticism towards this type of study is that the paper is merely a compilation of national findings. However, it is this very fact that makes a study like this of great interest, because findings from one country may be compared with another nation's energy end-use policies in regard to industrial SMEs, and from that general findings may be drawn. One challenge in policy-related research is that the landscape may change rapidly leading to research which, when published is not up-to-date. This makes a study combining a number of experts simultaneously to evaluate energy policy an important methodological contribution to other studies, e.g. literature studies and surveys.

Energy end-use efficiency policies for industrial SMEs

Tanaka (2011) conducted a review of about 300 industrial energy policy programs in the IEA countries, stating that many of the programs do target SMEs. Tanaka (2011) explicitly outlines the German Special Fund for Energy Efficiency in SME, Japanese, UK and French low interest loans for investment. Energy end-use efficiency policies for industry has traditionally been focused on energy audits and so called long-term or Voluntary Agreements, a policy where an agreement on improved levels of energy efficiency between the government and either a sector organisation or individual companies is set (Bertoldi, 2001). Price (2005) reviewed 23 Voluntary Agreements in 18 countries, and made a categorization of three different type of VAs. She stated that the VAs that are completely voluntary show lower participation and weaker results (Price, 2005). On the contrary, VAs with a regulatory or economic component, showed higher participation rates and improved results (Price, 2005). Price (2005) did not cover explicitly the involvement of industrial SMEs in VA. Rezessy and Bertoldi (2011) made a review of VAs in the EU and stated that VAs, though historically focused on process-industry, now also have started to include medium-sized companies, and outline eight EU Member States that also include industrial SMEs. Even though the Swedish VA in Rezessy and Bertoldi (2011) not explicitly states that industrial SMEs are included, 30 % of the participating companies in the Swedish VA-program are SMEs, mostly medium-sized, energy intensive companies (Bjorkman, 2011). Cornelis (2012) in his evaluation of the Belgium auditing VA in Flanders, comprising medium-sized companies, showed that the economic strength of the company impacted the deployment of measures (Cornelis, 2011). Most VA, like the one in Flanders, includes energy audits as one major component. Linden and Carlsson-Kanyama (2011) evaluated the Swedish VA EKO-Energi and stated that the energy audit within the LTA was one of the most appreciated gains according to the participating companies.

Kimura and Noda (2010a) and Kimura et al. (2011) evaluated the effectiveness of regulation, the Japanese Energy Conservation Law. Johansson et al (2007) in their presentation of industrial energy end-use policies in Sweden, outlined the Swedish Environmental Code, and that the law enforcement from the code is not common. Moreover, that the policy adoption of the Code has been slow (Johansson et al., 2007).

Apart from VAs and law enforcement, industrial energy audit programs in various countries have been studied. Harris et al (2000) presented results from their evaluation of the Australian EEAP, primarily targeting larger companies, and found that 5 out of 6 proposed measures from the energy audits were implemented. Andersson and Newell (2004) and Corbett et al (2009) evaluated the American IAC, the world's largest energy audit program in terms of participating companies, in particular comprising SMEs, and found that about half of the sug-

1. IETS in co-operation with Japan and Spain.

gested measures where implemented, where measures with low investment costs were preferred. Fleiter et al (2012) evaluated the German energy audit program and found that participating SMEs adopted 1.7–2.9 of the measures which would have not been adopted without the audit program. Price and Lu (2011) presented a survey of 22 energy audit programs in 15 countries, and made suggestion on how a successful energy audit program could be structured. In summary, most research related to policy and industrial SMEs consists of evaluations of national energy audit programs, e.g. Fleiter et al. (2012), Andersson and Newell (2004), and Thollander et al. (2007).

Other type of policies are, e.g. investment subsidies, presented in, e.g. in Tanaka (2011), including a number of different countries and in Farla and Blok (1995) including results from the Dutch Energy Bonus. Farla and Blok (1995) found that the policy suffered from free-rider effects. Moreover, Gruber and Brand (1991) found that the a German subsidy was not known to even exist by SMEs, and some that was aware of it, did not know that they were eligible to apply for it. Yet another type of policy is benchmarking schemes, e.g. USEPA has developed plant energy benchmarks known as Energy Star Energy Performance Indicators for more than 10 industrial sectors (Boyd 2013) (though they are directed not only for SMEs). Moreover, energy networks are another form of policy that is now emerging and have proven to be successful in Switzerland and Germany, especially for medium-sized companies (Koewener et al., 2011). Energy networks have proven to double the impact from information programs like an energy audit program (Koewener et al., 2011).

Results

In Table 1, some key figures for industrial SMEs in the studied countries are presented. Table 1 show that industrial SMEs are not using substantial shares of the industrial energy use in the studied countries, but nevertheless contribute with considerable shares of economic output. In Table 2, the major energy end-use policies for SMEs in respective countries are presented.

The findings from this study show that policies directed towards industrial SMEs are limited, with the exception of Japan.

In the following sections the various types of energy end-use policies; administrative, informative and economic are presented. For a more thorough presentation of the various policies in the respective countries, please see Thollander et al. (2014).

ADMINISTRATIVE POLICIES

Administrative policies include laws and regulations, environment quality norms, and prohibitions (Lindén and Carlsson-Kanyama, 2011). Apart from Japan, administrative or regulative policies have not been adopted on a full-scale nationally towards industrial SMEs, or put it differently; such regulations are in place but are not used extensively in practice except for Japan. Based on experience from Japan, it can be concluded that the Energy Conservation Law is a sound policy instruments for medium-sized industrial SMEs and energy-intensive industrial SMEs. Experience from the Japanese Energy Conservation Law for small industrial enterprises is however that it is less suited for such companies. Rather, when these small industrial enterprises are regulated by the law they tend to just do the paper work rather than initiating actual actions in order to comply with the law. They sometimes hire a consultant to fulfil the mandatory requirements from the Energy Conservation Law, but these requirements, mostly, does not result in actions in terms of new investments or change of routines. On the contrary, the law has an important role to motivate medium-sized and energy-intensive industrial enterprises for energy management (Kimura and Noda, 2010a).

In conclusion, administrative policy instruments for medium-sized enterprises may be a sound policy instrument in promoting energy efficiency but may be less effective for small-sized enterprises, both in terms of technology investments and in terms of energy management activities.

A final note in regard to administrative policies are that in the studied countries Belgium, Japan, Spain, and Sweden, the governmental officials conducting the enforcement of the laws, many times are not well experienced in the energy issue, leading to problems of actually enforcing/stressing adoption of BAT (Best Available Technology).

Table 1. Key figures for industrial SMEs in the countries Belgium, Japan, Spain and Sweden.

	Industry share in energy	SME's share in energy	SME's share in economic output
Japan	46%	11% of industrial energy-related CO2 emission in 2010	48% of manufacturing shipments in 2006
Sweden	38%	25% of industrial energy use in 2010	37% of manufacturing value added in 2011
Spain	27%	N.a.	N.a.
Belgium	35%	11% of industrial energy use in 2010	40% of manufacturing value added in 2010

Please note that share of industrial energy use might not be representative, as in 2010, industry still suffered from the global financial crisis. Moreover, 2010 was an exceptional cold year in Europe with a higher energy use for heating.

Table 2. Current industrial energy end-use policies for in the countries Belgium, Japan, Spain and Sweden up until the year 2012.

Energy end-use program	Type of program	Country
Tax deduction for energy-saving investments in businesses	Tax credit	Belgium
Audit agreement	Audit program and VA	Belgium
Benchmark agreement	Audit program and VA	Belgium
Promote good practices (ecodynamic enterprise label)	Audit program and VA	Belgium
Assistance with regard to energy saving investments	Investment subsidy	Belgium
RUE information measures for industry	Informative	Belgium
Subsidies for industry investment (excluding building)	Investment subsidy	Belgium
Volontary Agreements excluding ETS	VA	Belgium
Subsidy for energy efficiency investments in ESCO schemes	Investment subsidy	Japan
Subsidy for energy efficiency investments	Investment subsidy	Japan
Subsidy for energy efficient boilers	Investment subsidy	Japan
Subsidy for oil/coal-to-gas switching	Investment subsidy	Japan
Subsidy for energy efficient refrigerators without CFC	Investment subsidy	Japan
Subsidy for GHG emission reduction investments	Investment subsidy	Japan
Subsidy for enterprises joining voluntary ETS (JVETS)	Investment subsidy	Japan
Tax credit for energy efficiency investments	Tax credit	Japan
Low-interest loan for energy and environmental investments	Investment subsidy	Japan
Low-interest loan for energy efficiency projects with energy audit	Investment subsidy	Japan
Low-interest loan for enterprises with environmental management system certificate	Investment subsidy	Japan
Energy Conservation Law of Japan	Law enforcement	Japan
Energy audit program	Energy audit program	Japan
Energy audit program	Energy audit program	Japan
Energy audit program	Energy audit program	Japan
Energy audit program	Energy audit program	Spain
Investment fund	Investment subsidy	Spain
PFE	VA	Sweden
Swedish Energy Audit Program	Energy audit program	Sweden
The Environmental Code	Law enforcement	Sweden

INFORMATION POLICIES

This study showed that informative policies formed the backbone in the various countries' energy policy mixes towards industrial SMEs. The major informative instruments are information campaigns including seminars, and energy audit programs. The former, information campaigns, has in previous research been shown to lead to increased awareness but less likely, lead to change in actual behaviour, or lead to actual investments (Stern and Aronsson, 1984, Thollander and Palm 2013).

Energy audit programs towards industrial SMEs have often been proven to be very cost-effective: Results from Sweden shows that is about 10–20 times more cost-effective than an LTA- or VA-program towards energy-intensive industry. Even though more research is needed to further exploit these issues, both in Sweden and elsewhere, in order to draw general conclusions from such figures, it may be concluded that an energy audit program does improve energy efficiency in industrial SMEs (Kimura, 2011: Thollander et al., 2007; Thollander and Rohdin, 2010), reduce barriers to energy efficiency (Schleich, 2004), and are very cost-effective compared with other energy-end-use programs (Morgenstern and Al-Jurf, 1999: Fleiter et al., 2012: Vaisanen and Reinikainen, 2002: Khan, 2006: Thollander et al., 2007).

In Belgium, Japan, and Sweden there are also voluntary agreements where some industrial SMEs are able to join. Stenqvist and Nilsson (2011) have evaluated the Swedish VA and Cornelis (2012) the Belgium VA. In Japan these policies has to the authors' awareness not been evaluated.

Networks are present in both Japan and Sweden, though not explicitly directed towards industrial SMEs in the national programs. There are however promising approaches in for example Switzerland and Germany using energy networks (Koewener et al., 2011).

Also, in particular Japan has many regional and local information programs. The importance of regional and locally related programs aiming for improving energy efficiency in industrial SMEs cannot be underscored enough as the industrial SMEs normally puts an information provider, closer to them, as more trustworthy (Stern and Aronsson, 1984). A regionally or locally anchored program, thus increases chances of actually deploying the potential.

A Swedish sector benchmarking scheme showed limited success for industrial SMEs, as only a few firms did participate and fill-in figures in the online platform.

ECONOMIC POLICIES

In both the energy audit programs and the Swedish LTA, informative policies are merged with economic policies, i.e. subsidies are given if joining the program. The level of subsidy has large implications on the policy's cost-effectiveness. However, there is little research on adequate levels of for example how much an industrial energy audit should be subsidized. The Finnish industrial energy audit program one of Europe's most mature audit programs, started with a 50 % subsidy but was reduced to a 40 % subsidy after some years (Vaisenen and Reinikainen, 2002). Applying for funding for industrial SMEs should in any case be extremely easy taken that these firm's management capability is limited, compared with larger companies who often have more structured firms with divisions solely focusing on environmental and energy issues. Results from previous research in Germany revealed for example that many SMEs were not even aware that grants were available (Gruber and Brand, 1994).

Table 3. Some characteristics for industrial SMEs.

	Medium-sized SMEs and energy-intensive industrial SMEs	Small-sized SMEs and non-energy-intensive industrial SMEs
Amount of energy used	Medium	Small
Human resource for energy management	Limited, but they usually have a couple of responsible engineers.	Very limited, often without responsible personnel.
Type of technology	Production and support processes (for example ventilation, compressed air, heating, etc.).	Mainly support processes.

As regards investment funds, these may be seen as relevant, taken that a thorough energy audit has been conducted and available information is at hand for the company. However results from the Dutch Energy Bonus revealed that up to 85 % of the investments funds were given to measures which would have been implemented anyway, i.e. a free-rider effect of up to 85 % (Farla and Blok, 1995). Results from Spain revealed on the contrary that the current economic situation in the country and among individual industrial SMEs makes energy audit without the option of investment subsidy of less relevance. Companies simply do not prioritize investments in improved energy efficiency even with extensive information (coming from an energy audit) on the benefits. This is in line with previous research by, e.g. Sorrell et al. (2000).

Among the studied countries, direct investments subsidies were only offered in Belgium. Distribution grid operators provide subsidies for standard energy saving measures in the framework of their energy efficiency obligation. Examples of such measures are the installation of energy efficient engines and insulation of pipes and devices. Apart from that, companies can apply for an ecology premium. This premium stimulates investments in more environmental equipment. The list of eligible measures for funding contains also energy saving measures. Examples are the installation of absorption chilling, the installation of an advanced control system for multiple compressors, the on-site production of nitrogen or the on-site use of waste heat.

Suggestion for policies directed towards industrial SMEs

In this final part of the paper, a categorizing of successful policies for improved energy end-use efficiency towards industrial SMEs is made[2]. The major perspective addressed when defining the policy as successful is its cost-effectiveness, i.e. high energy efficiency implementation per monetary unit. Industrial SMEs have a large diversity in energy use and energy management, and can be categorized into many segments by size and type of business. Among them, the following category has been concluded to be of particular relevance: i) medium-sized and energy-intensive industrial SMEs, and ii) small-sized and non-energy-intensive industrial SMEs. The differences between the two segments are described in Table 3.

Because the characteristics in the two segments are different, different approaches are needed in improving their energy efficiency.

I) MEDIUM-SIZED AND ENERGY-INTENSIVE INDUSTRIAL SMES

These companies have in general a modest capacity to work on improved energy efficiency, so giving economic and/or regulatory incentives is important. This underscores for example regulation (like the Energy Conservation Law in Japan), or LTA/VA (like in Sweden) as effective policy measures. Yet another reason for those types of support is that these companies also have significant energy use for the production processes and for those measures, more support may be needed, e.g. energy audit programs, networks and investment subsidies.

II) SMALL-SIZED AND NON-ENERGY-INTENSIVE INDUSTRIAL SMES

These companies do not in general have enough capacity to work on improved energy efficiency, and are thus in need of a more supportive approach, e.g. assistance from external experts. Energy audit programs are effective, but should be complemented with networks where an experienced engineer supports the companies within the network.

Concluding discussion

The overall energy use among industrial SMEs in the studied countries is lower than in larger and energy-intensive industry. This might be one major reason why there historically has been a scarcity in relation to energy end-use efficiency policies for industrial SMEs. On the contrary the economic impact from industrial SMEs in Belgium, Japan, Spain and Sweden, is of great relevance for the country's economy. Moreover, the cost-effectiveness of energy-end-use policy measures is often high, compared to large firms that may have already exploited low-cost potentials. Larger and energy-intensive companies have higher energy efficiency potentials in absolute terms, but many of these have implemented low-cost measures because they have sufficient management capability etc. to do so. If only viewing the availability of low-cost potentials of energy efficiency measures in the market, the deployable energy efficiency potential among SMEs might in fact be high. National goals for improved energy end-use efficiency among industrial SMEs may not solely be designed for the purpose of improved energy efficiency. The goal or aim with energy end-use policies may be stated to be an attempt to improve energy end-use efficiency,

2. These suggestions are the ideas of the individual authors alone, and should not be seen as the ideas neither from IEA IETS, nor from the participant's research bodies. Moreover, the presented list is by no means conclusive but may rather be seen as an attempt to try to categorize and structure various policies directed towards industrial SMEs.

but equally or perhaps more importantly support these firms in their long-term survival and success. In these regards, energy end-use efficiency in the longer run is of great importance for the firm's international competitiveness.

The paper is concluded below by presenting a suggestion of relevant policies for industrial SMEs to be considered among policy-makers. These suggestions were derived from the held workshops, and the literature review, and based on the respective researchers outlined country specific policies.

For medium-sized and energy-intensive industrial SMEs it is emphasized that Energy Conservation Law/LTA/VAs are strong energy end-use policies followed by energy audit programs, preferably but not necessarily located regionally or locally. Energy networks, preferably locally or regionally anchored, are also policies suggested to be considered for medium-sized and energy-intensive industrial SMEs followed by investment subsidies, mainly for investments in production-related technologies, benchmarking, and finally sector guidelines.

For small-sized and non-energy-intensive industrial SMEs it is emphasized that energy audit program, preferably locally or regionally anchored, followed by energy networks, preferably locally or regionally anchored, are strong energy end-use policies followed investment subsidies, benchmarking, and finally sector guidelines.

It can also be concluded that there is a demand for guidelines or standard procedures on how to evaluate energy end-use polices for SMEs in the studied countries. The importance of actually metering the outcome must be balanced with the cost for metering. Here lies a great challenge as the number of SMEs are vast compared with evaluating large firms which use large shares of a nation's energy use and are few in numbers. In particular, the importance of guidelines on how to evaluate energy programs is emphasized as the current evaluations in the international literature, e.g. Fleiter et al (2012), Thollander et al. (2007), all use different ways of calculating the effect and cost-effectiveness.

This paper has added a piece to the energy policy puzzle by evaluating, from an expert point of view, the effect of energy end-use policies for industrial SMEs, and contributes with added knowledge to other valuable international comparative studies such as Price and Lu (2011) and Tanaka (2011).

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