# Potential energy efficiency improvements in Swedish energy intensive industries using an Energy Efficiency Obligation Scheme

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**Abstract**

Energy Efficiency Obligation Schemes (EEOS) as suggested in the Energy Efficiency Directive (EED) could help remove barriers to energy efficiency. However, despite the fact that such schemes have been successfully implemented and proven cost-effective in several Member States, not all countries are convinced of their potential benefits. In this paper, we investigate the policy instruments that Sweden has introduced or is planning to introduce for achieving increased industrial efficiency under the EED's requirements. Our preliminary results show that these instruments are not exploiting the full potential of energy savings, especially in energy intensive industries. We present the design of an EEOS as an alternative policy instrument to alleviate some of the barriers to energy efficiency that the industries face today. The implications of the EED for industries in Sweden are evaluated together with the insights from EEOSs carried out in other Member States and the practices of industrial energy efficiency policies in Sweden. Finally, we identify possible pathways that could engage the industries in energy saving measures including the EEOS for removing non-economic and regulatory barriers to energy efficiency in the industrial sector.

Keywords: energy efficiency obligation scheme (EEOS), Energy Efficiency Directive (EED), Program for Improving Energy Efficiency (PFE), industrial energy efficiency

## 1 Energy efficiency targets and challenges

The impact assessment of the European Commission (EC) on the climate and energy policy framework states that the 2020 goal of 20% reduction of primary energy use in the EU will most likely not be reached, mainly because the energy efficiency targets are not binding (European Commission 2014a).

The Energy Efficiency Directive (EED) can push towards energy efficiency improvements across Member States. Although the EED lacks binding targets, the Directive has a number of binding measures such as the obligation posed at national level for saving 1.5% of the final energy delivered annually, excluding the transport sector (European Parliament 2012).

The costs for leading the European energy system into more sustainable paths imply a major challenge that policymakers have to face. Ultimately, shifting energy system is necessary for achieving the target of 80-95% reduction of greenhouse gases (GHG) emissions by 2050. Policymakers and stakeholders need to find ways to combine economic growth with the required changes of the energy market. This has particular implications within the European industrial sector and its competitiveness can be affected by this situation (Danish Energy Association 2013). This challenge is especially magnified in a period of economic stagnation and low liquidity for the European Union (EU), when lack of investments in the industry also represents a clear threat for the stability and development of European industries (European Commission 2014c).

At the moment, energy prices in the EU cannot compete with energy prices of the United States (US) due to the abundance of shale gas. Thus the European industrial sector needs to either reduce energy consumption or energy prices (European Commission 2014b). The reduction of energy consumption is an attractive option since it can both promote the reduction of GHG emissions as well as reduce the economic burden on industries. Another aspect that enhances the argument in favor of lower energy consumption as a way to achieve a more competitive European industrial sector is the high sensitivity of the sector to fluctuations of energy prices. Meanwhile, forecasts on future energy prices are not certain, particularly because of the unknown linkages between energy prices and economic growth, geopolitical circumstances, and technological innovations in the long run.

Clearly, the potential of energy savings in the industrial sector is large and it is economically viable to be pursued even if carbon emission pricing did not exist (IPCC 2007). However, it seems that the industries and national authorities are hesitant in adopting more aggressive actions related to industrial energy efficiency. The reason for this is the so-called *energy efficiency gap*.

The *energy efficiency gap* is a market failure which occurs when the market fails to overcome the barriers that inhibit the implementation of measures and practices that would lead to cleaner production processes (Jaffe & Stavins 1994). The *energy efficiency gap* includes numerous "barriers" such as lack of information, shortage of trained personnel, and limited access to capital (Sorell et al. 2011). Thus, it is important to have a strong energy efficiency policy that can help remove these barriers and fully exploit energy efficiency potentials.

Sweden has applied a mix of policies to promote energy efficiency, combining fiscal, financial, legislative, information, and voluntary instruments with targets in various sectors of the country's economy both at national and regional levels (European Commission 2013a). Nevertheless, in 2013, the European Commission recommended Sweden to benefit from the accumulated knowledge in the energy efficiency field and introduce new policy initiatives to capture the full potential of energy efficiency in the country. The International Energy Agency (IEA) has also ratified the introduction of new policy instruments for energy efficiency in Sweden (IEA 2013). Finally, the European Commission reports that the EED's transposition by June 2014 would help Sweden create instruments in that direction (European Commission 2013b).

In this paper, we investigate the policy instruments that Sweden has introduced or is planning to introduce for achieving increased industrial efficiency under the EED's requirements. Our preliminary results show that these instruments are not exploiting the full potential of energy savings, especially in energy intensive industries. We present the design of an Energy Efficiency Obligation Scheme (EEOS) as an alternative policy instrument to alleviate some of the barriers to energy efficiency that the industries face today.

The implications of the EED for industries in Sweden are evaluated together with the insights from EEOSs carried out in other Member States and the practices of industrial energy efficiency policies in Sweden. The objective is to identify pathways that could engage the industrial sector in energy saving measures while using the EEOS to remove non-economic and regulatory barriers to energy efficiency in the industrial sector.

The scope of our analysis is focused on the industrial sector because the Swedish economy is highly dependent on energy intensive industries (Thollander & Ottosson 2010). In fact, energy intensive industries consume nearly 80% of the total energy used by the Swedish industrial sector (Swedish Energy Agency 2012a). Energy costs are pivotal in the overall costs of energy intensive industries and, subsequently, cost increases may affect the sector's international competitiveness (IVA 2013). Swedish industries have enjoyed relatively low energy prices in the past but, in the last ten years, the Swedish electricity prices have increased threefold, putting pressure for industries to revise their energy dependence (Thollander et al. 2013).

Following on this introduction, section two addresses the Swedish industrial context when it comes to energy efficiency. Section three discusses the EEOSs and section four identifies pathways for increasing energy efficiency in Swedish industries.

## 2 The Swedish industrial energy efficiency context

The Swedish government has decided to achieve the cumulative energy savings required by the EED using a combination of new and established instruments but not an energy EEOS. According to Swedish authorities, the EEOS addresses market failures that are already dealt with in other instruments, and does not contribute to address remaining barriers (Ministry of Enterprise Energy and Communications 2013; Swedish Energy Agency 2013).

According to the Swedish Energy Agency (2012b) an EEOS would overlap with the EU Emissions Trading System (ETS) in the country, and thus there is not sufficient motivation to justify an EEOS. Nevertheless, when it comes to the implementation of Article 7 of the EED, the Swedish Energy Agency considers that current policy instruments are not sufficient for achieving the targets, and thus new instruments need to be introduced (Swedish Energy Agency 2013). This shows that there is still a gap to be dealt with particularly because no new policy instruments are proposed to complement or replace the existing ones more effectively.

Sweden has already established a broad range of energy efficiency policy instruments such as carbon taxes and ETS, energy performance requirements and energy labeling for energy-related products and buildings, and actions for increased awareness. In the "Plan for implementation of Article 7 of the Energy Efficiency Directive" communicated to the EC in December, Swedish authorities claimed that the high level of energy and carbon taxes, together with high value added taxes in Sweden have promoted and will continue promoting energy savings, as they motivate changes in consumer behavior and investments in energy savings measures (Ministry of Enterprise Energy and Communications 2013).

The calculations made by the Swedish Energy Agency show that the enterprises participating in the EU ETS will achieve cumulative savings of 11.99 TWh until 2020. Additional 1.37 TWh savings will be achieved in non-EU ETS enterprises (Swedish Energy Agency 2013). The industries included in these calculations basically represent the energy-intensive industries of Sweden (e.g. mining, timber, pulp and paper, chemicals, rubber and plastic, and iron and steel). When the land-based industries (agriculture, forestry etc.) are added to the calculation, the energy savings will amount to 15.36 TWh. According to the Swedish Energy Agency, these savings will occur as a result of the increased taxation on energy and carbon emissions. It should be noted that for enterprises that are included in the EU ETS, different taxation applies based on the fact that these enterprises are exposed to international competition, and thus are more vulnerable to energy price shocks.

The method used by the Energy Agency for the calculation of the energy savings potential has been criticized for overestimating the effect of taxation on the energy use. These views came from energy suppliers and the forest industries (Fortum 2013; Skogsindustrierna 2013). The main criticism is based on the fact that the calculations on potential energy savings in industries were not based on a dynamic econometric model but rather on a simple linear model (Ministry of Enterprise Energy and Communications 2013).

Alternative calculations of the energy savings potential in the energy-intensive industrial sector indicate that energy savings attained with increased taxation are likely to be lower than the potential energy savings identified. From our own calculations, we base our estimative on secondary data provided by Fraunhofer ISI (2009) and Eurostat (2013), using a High Policy Intensity (HPI) scenario. This scenario is the most suitable for representing the policy framework required for achieving the EU2020 goals (Wesserlink et al. 2010). We found that the cumulative energy savings potential among the Swedish intensive industries amounts to 16.43 TWh (see Table 1), as opposed to 11.99 TWh in the calculations made by the Swedish Energy Agency. Our numbers indicate that the measures currently planned by the Swedish authorities and aimed at energy savings in the industry result in untapped energy savings potential. Thollander et al. (2013) calculated that the final energy end-use in the industry should cumulatively decrease by at least 17.5 TWh if the Swedish energy efficiency targets are to be achieved by 2020.

| Industrial sector | Cumulative energy savings by 2020 (TWh/year) |
|---|---|
| Iron and Steel | 1.45 |
| Non-ferrous metals | 0.27 |
| Chemicals | 0.57 |
| Non-metallic mineral products | 0.24 |
| Pulp and paper | 13.90 |
| **Total** | **16.43** |

**Table 1:** Total cumulative energy savings potential (TWh) under the HPI scenario for the energy intensive industries of Sweden based on secondary data from Fraunhofer ISI (2009) and Eurostat (2013).

Sweden has previously taken action towards improving industrial energy efficiency. For example, the voluntary agreement PFE (Program for Improving Energy Efficiency) started in 2004 and focused on energy intensive industries. The PFE offered exemption from energy tax on electricity to energy intensive industries in exchange for fulfillment of obligations defined in the program. The companies that participated in the program were obliged to perform an audit, introduce a certified energy management system, and implement electricity saving measures. The participating energy intensive industries implemented energy efficiency measures that added up to a gross annual energy savings of approximately 1.45 TWh (Stenqvist & Nilsson 2011). However, PFE can no longer be continued in its past form as the offered tax exemption violates the EU regulations on government subsidies (Swedish Energy Agency 2012b; Ministry of Enterprise Energy and Communications 2013). Nevertheless, the companies that joined the program until 2012 can stay within PFE until 2017, so PFE will have effects on energy efficiency in the coming years as well (Ministry of Enterprise Energy and Communications 2013).

Despite the fact that participating industries have been strongly in favor of the program, PFE has been criticized for its strong government involvement in regulating the system and for the information asymmetries not captured when determining the baseline of the scheme (Mansikkasalo & Michanek 2011). A recent report by the Swedish National Audit Office evaluating the impacts of Swedish energy efficiency initiatives within industry, particularly PFE, pointed out deficiencies when defining goals and accounting for the energy savings (Swedish National Audit Office 2013).

The Audit Office's report concludes that it is doubtful whether PFE "*…has contributed to significant energy efficiency improvement*". It also doubts whether "*…energy efficiency policy instruments such as the PFE contribute to emissions reductions by 2020 for companies that are part of the EU Emissions Trading System*". Interestingly, the costs of the implemented energy savings measures were more or less the same as the value of the tax exemptions that were offered in the same period. The energy intensive industries benefited in terms of competitiveness not only from the exemptions of electricity tax that PFE offered but also from free emission allowances from the EU ETS and exemptions related to the quota obligation for renewables (Swedish National Audit Office 2013).

The Swedish Energy Agency proposed the reformulation of PFE as an instrument to promote energy efficiency within the EED. The adapted PFE will be structured in three levels targeting different industry sizes, with the third level aiming for the energy intensive industries. For this new version of the program, the Agency widens the scope including more energy carriers than just electricity. The incentives that the industries will have for joining the program have not been clearly defined, though they will be similar to the incentives given in previous periods of PFE (Swedish Energy Agency 2013).

The energy intensive industries have definitely benefited from the Swedish energy and climate policies. PFE has cost 780 million SEK (eq. to approximately 90 million € [1]) and the tax exemptions offered were 705 million SEK (eq. to approximately 81 million €), so the participating industries improved their competitive advantages by increased energy efficiency without any large expenditure. What has been established in the first phase of PFE is a transfer of public resources to these industries (Holmberg 2013). However, the voluntary nature of PFE does not offer a strong incentive for energy efficiency improvement for these industries, and the instrument is strongly government-controlled.

In addition, we should consider that PFE has been into force for the last 10 years with several large energy intensive industries already participating. Prerequisites of the program, such as the implementation of energy management systems, are already in place. Thus, no substantial energy savings are likely to occur from this measure. Furthermore, a voluntary agreement without binding targets cannot challenge the parties into exceeding the "low-hanging fruit" measures, which most probably have already been achieved. This aspect is also complemented by the fact that it is yet unclear how industries will benefit from participating in the program, although discussions about that are ongoing. Smaller enterprises, which were excluded from previous phases of the program, would benefit from energy savings promoted by the adapted PFE. Yet, energy intensive industries would require a more ambitious and clearly defined instrument.

The Audit Office recommends that the Swedish Energy Agency and government need to reconsider the structure of the policy instruments related to industrial energy efficiency so that actual energy savings can be achieved. Energy savings should be connected to GHG emissions reductions in any case and a clear energy savings target should be set (Swedish National Audit Office 2013). Hence, an EEOS could be an alternative policy instrument for achieving energy efficiency improvement in Sweden. EEOS can lead to a higher stimulation of the energy market actors since it is a market-oriented mechanism of binding nature in contrast with government-controlled voluntary agreements or taxation.

## 3 The Energy Efficiency Obligation Scheme

EEOS is a regulatory mechanism that introduces an obligation for specific actors within energy markets to deliver or procure eligible measures aimed at energy efficiency improvements (Joshi 2012). EEOSs are already in place in some EU Member States. The schemes' characteristics differ from country to country. Lees (2012) and Eyre & Pavan (2009) show that not only EEOSs can remove market barriers to energy efficiency but also they have been cost-effective to implement and effectively stimulate the creation of a market for energy services. Eyre & Pavan (2009) claim that concerns about energy price increase within EEOS are not justified as the price increases are outweighed by the reduction of energy use. Nevertheless, these increases in energy prices are expected to stimulate actors to implement energy savings measures (Fraunhofer ISI et al. 2012).

### *Cost allocation within EEOS*

In line with the subsidiary character of the European energy policies, EED leaves to the Member States the choice of mechanisms to implement the directive. Concomitantly, also in the case of EEOS, it allows the Member State to choose which actors within the energy markets are to have obligations under the scheme. If the energy efficiency obligation is placed upon the suppliers of energy, the larger energy suppliers will benefit disproportionately since they can allocate the added cost among a large base of end-users, and that would lead to an oligopoly on the energy supply side. Furthermore, suppliers could impose unreasonable price increases to recover the costs of the EEOS since energy prices are set in a deregulated market. Therefore, the Swedish Energy Agency (2012b) suggests that if an EEOS was to be implemented, the obligation should be placed on energy distributors since energy distribution is

[1] The currency rate is extracted from the average rate for 2013, where 1 SEK = 0.1156 € .
(Source: www.oanda.com (2014))

regulated in Sweden. Hence, placing the obligation on energy distributors rather than suppliers mitigates the risk of price shocks (Fraunhofer ISI et al. 2012). Figure 1 shows a schematic illustration of the cost allocation among the energy market actors for an EEOS.

There are two financing mechanisms in an EEOS (see Figure 1). One is the cost-recovery mechanism, which transfers the investment costs directly or indirectly to end-users (individuals or organizations). Costs are passed to end-users either by the State through taxation (indirect costs) or by obliged actors through energy price increases (direct costs). The other mechanism is related to the supply of subsidies for investing in energy saving measures for the obligation fulfillment.

The EED recommends obligated actors to achieve their energy savings by including certified energy savings from third parties. The certification of these savings should be transparent and the regulating authority of the scheme must ensure that the certification process has minimal costs. The delivery of energy savings from third parties is quite widespread in EEOSs that already exist in the EU (Bundgaard et al. 2013).

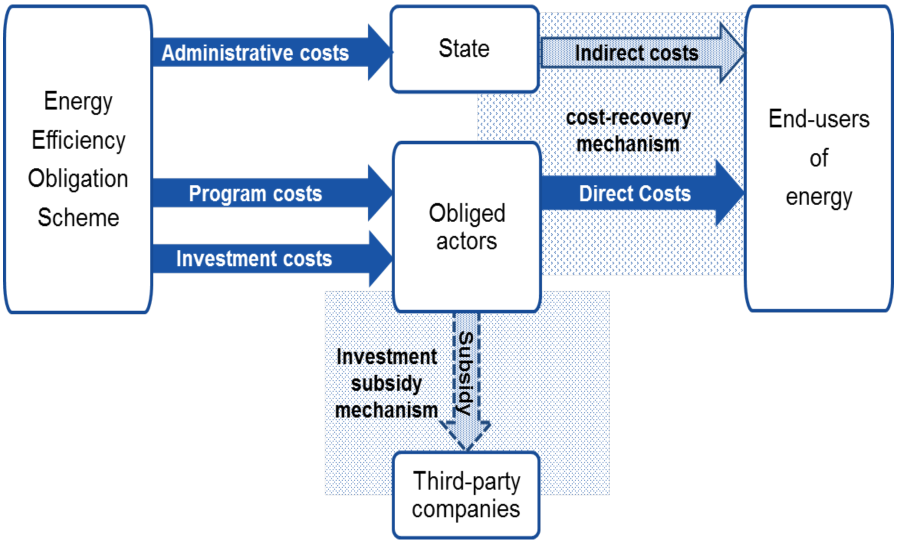


**Figure 1:** Schematic illustration of the cost allocation among the energy market actors for an EEOS (modified from Eichhammer et al. (2012)).

### *Barriers and failures*

Previously published analyses of EEOSs have shown that the scheme is economically efficient, meaning that its benefits in monetary terms exceed the respective costs (Bertoldi et al. 2010; Giraudet et al. 2011; Lees 2012; Joshi 2012). In most of the schemes already implemented, the benefits exceed the costs by a factor of two to six (Lees 2012). The experiences from the EU and the world show that EEOS can overcome barriers to energy efficiency via tailored consultation services, sharing of technical knowledge, finance through subsidies, and lowered administration costs. In addition to that, the EU experience shows that EEOS results in larger energy savings than energy taxes, while the public expenditure on energy efficiency is decreased (Lees 2012).

Rezessy & Bertoldi (2010) have identified several market barriers and failures that are hindering energy efficiency investments. In fact, these can be considered general hindering factors for energy efficiency measures. Table 2 shows how EEOS could help to alleviate these hindering factors specifically for energy efficiency in energy intensive industries.

The Swedish energy-intensive industries are interested in the implementation of energy savings at the systems level, incentivized through a certificate scheme among other services, e.g. for increased use of waste heat for district heating (Swedish Steel Association–Jernkontoret, 2014). In fact, Third-Party

Access (TPA) of industries to the monopolized district heating market is seen as a vital step for Sweden to achieve energy efficiency improvements and reach the EU2020 goals (Thollander et al. 2013).

| Barrier to energy efficiency | Definition | EEOS potential impact |
|---|---|---|
| Lack of information to companies and financing institutions | Companies: Lack of awareness and perceived risks for investments on newer technologies with higher energy savings, mistrust of energy audits and benefits that are initially unclear. Financing Institutions: Lack of experience in financing energy efficiency investments, lack of time and resources to develop specific structures for financing such projects. | Increased awareness among the actors involved and support via consultation for the energy intensive industries that have big energy savings potential. Consultant services and fostered by public entities as well as obligated actors of EEOS. |
| Long marketing cycles of energy efficiency investments | Slow access to commercially viable financing, scarce investment-ready projects. | Sharing of technical knowledge, lower administration costs than other energy efficiency instruments. |
| High upfront costs | Large initial capital requirements for energy savings measures that hinder investments even when the payback times are low and benefits of the measures are clear. | Contractual relationship and risk allocation between public entities and companies, mobilization of funds for energy efficiency, Third Party Access (TPA) allowed in EEOS. Economies of scale effects in EEOS[2]. Long-term payback policies and public and private loans for large investments. |

**Table 2:** Barriers to energy efficiency for energy intensive industries and the potential impact of EEOS in alleviating them (Rezessy & Bertoldi 2010; International Energy Agency 2011; Lees 2012).

### *Member States' experiences*

The experiences of Member States that have implemented EEOSs indicate that investment costs to improve energy efficiency measures have generally short payback periods (Lees 2012; Bundgaard et al. 2013). The Danish EEOS was particularly successful among companies within the industrial sector. Through a recent survey, the Danish Energy Association found out that 45% of the energy savings measures implemented under the scheme had payback time of less than two years (Danish Energy Association 2013).

The French and Italian EEOSs include the industrial sectors but the savings are not significant, because the industries are demotivated to invest in energy savings due to the stringent requirements for monitoring and documenting. On the contrary, the Danish scheme shows a high level of contribution of industries in the overall energy savings volume. The reasons for the Danish success are the specific instruments that are used for encouraging energy savings in the industries. These instruments are mainly consultant services offered to industries serving as third parties in the EEOS, and subsidies given per kWh saved for various energy efficiency measures. The Danish actors involved in the EEOS consider industrial energy savings as attractive since they result in large energy efficiency improvements with relatively reduced administration costs (Bundgaard et al. 2013). Furthermore, the general evaluation of the Danish EEOS in 2012 shows that the energy savings in the industrial sector are a cost-effective measure. It also states that the obligated actors are most likely to target industries as potential third

[2] The effect of "economies of scale" has been observed within EEOSs (Lees 2012). This effect helps to overcome the "low-hanging fruit" measures for energy efficiency improvement, as the newer technologies become more widely available and the technical know-how is transferred.

parties for achieving their targets within the obligation as it is the most cost-effective option for improving energy efficiency (Bundgaard et al. 2013).

Bundgaard et al. (2013) specify some problems associated with the EEOS in Denmark, such as subsidies granted to energy savings measures that would be profitable in any case. The certification, categorization, and correct registration of energy savings from each participating industry will help in avoiding such problems.

# 4 Energy efficiency policy pathways for the Swedish industry

In the previous sections we have shown that the current industrial energy efficiency policies in Sweden leave untapped energy savings potential and we have presented how an EEOS could function in order to remove barriers to energy efficiency for the energy intensive industries. However, EEOS cannot be the sole instrument for energy efficiency improvement in the industrial sector. None of the various energy efficiency policy instruments (EEOS, energy efficiency funds, taxation, stricter regulations or information services) can fully exploit the energy efficiency potential independently, meaning that synergies between those instruments should be achieved in order to maximize the potential energy savings and offer a good mix between market-oriented, regulatory and information measures addressing different barriers to energy efficiency.

In this section, we will show the possible options or pathways for developing the future industrial energy efficiency policies of Sweden. Considering the pathways that Schlomann et al. (2012) suggest, we show how an EEOS could be incorporated and function within these pathways in order for the Swedish energy-intensive industries to effectively increase energy savings. The following pathways are identified in that case:

**Path 1: Improved existing instruments.**

This path is representing the current plans of the Swedish authorities regarding energy efficiency policies in the industries, where the existing instruments are improved and expanded to achieve the EU targets.

**Path 2: Improved existing instruments and market-based instruments.**

The existing public-funded subsidy programs (Path 1) are partially replaced by an EEOS that addresses industrial crosscutting technologies, as the EEOS reportedly stimulates effectively the use of Best Available Technologies (BAT) (Schlomann et al. 2012; Lees 2012). Oikonomou et al. (2009) propose such a scheme where an EEOS with certificate trading is combined with voluntary agreements in order to stimulate energy efficiency improvement measures beyond the "low-hanging fruit" measures of voluntary agreements. This scheme is flexible, but needs careful listing of the eligible energy savings and stringent monitoring of the delivery of energy savings, so that overlapping is avoided. Additionally to this scheme, an energy efficiency fund can address energy efficiency improvements for industrial processes (Schlomann et al. 2012).

**Path 3: Regulatory and market-based instruments.**

In this path, public-financed subsidy programs (such as PFE) are completely replaced by the EEOS, in which these companies act as third parties. Removing non-economic and regulatory barriers such as lack of information, high administrative costs etc. should be a first priority among the policy makers. On a second level, the instrument should aim at removing financial barriers for the companies that decide to implement energy savings measures. As in Path 2, defining the baseline of eligible energy savings will minimize "double-counting" of savings and administration and monitoring costs.

**Path 4: Broad energy efficiency instruments implementation.**

This path requires synergies between multiple instruments and addresses both crosscutting and process efficiency improvement. Instruments offering incentives for implementation of advanced energy management systems are combined with the EEOS, efficiency funds and tightened regulation standards, such as ECO-design and labeling. ECO-design aims to regulate minimum standards of industrial equipment and labeling increases awareness on energy efficiency opportunities. These measures aim to remove information barriers and work more effectively at EU level than at national level (Danish Energy Association 2013).

Under this path, there are public subsidies and tax reliefs for supporting the implementation of measures that are not economically efficient but can contribute to substantial energy savings. With this approach, the amount of energy market actors involved in energy efficiency improvement will be maximized. However, the administration costs will be higher because of the complex interactions of the various policy instruments.

These pathways described above show that the implementation of an EEOS has to be a gradual process and the complexity of energy efficiency policy interactions increases when choosing the pathways. The Swedish energy intensive industries are delivering now energy savings under PFE, following Path 1.

A switch to follow Path 2 with a combination of voluntary agreements and EEOS can be facilitated from a policy perspective by the decision to incorporate voluntary agreements by energy companies and households in Sweden's EED implementation plan.

On the basis of these voluntary agreements, a small-scale EEOS can be formed, where the industries can form agreements to deliver energy savings as independent third parties. The opportunities for TPA could be increased even further if these voluntary agreements for energy companies became obligatory, resembling the other Member States' EEOSs, as the Swedish Society for Nature Conservation (2013) suggests for achieving Sweden's energy policy targets. The effects of Path 3 could be evaluated at the checkpoint between the two intermediate periods of the EED's implementation in Sweden. This point is the end of 2016, as specified in the implementation plan for Article 7 of the EED by the Swedish Ministry of Enterprise, Energy and Communications (2013) and the Swedish Energy Agency (2013).

If the result of this evaluation is positive and the energy market actors are now fully acquainted and engaged with the EEOS practices, then Path 3 can be followed, where the EEOS is implemented on full-scale and obligatory basis. The practice of an EEOS targeting non-industrial sectors (i.e. energy distributors as shown in Section 3), is beneficial for industrial sectors as they are further encouraged to implement energy savings measures and overcome regulatory and financial barriers. China for example has advanced its policy instruments for removing such financial barriers to energy efficiency, with performance contracting by energy service companies (ESCOs), demand-side management (DSM) obligations and consulting measures for project financing (Reinaud & Goldberg 2012).

The final pathway, where all available policy instruments for energy efficiency are combined in synergies can be followed at a long-term horizon when the Swedish and European energy efficiency targets will be re-negotiated under more ambitious terms and there will be need for even more stringent measures to be taken in order to match the energy and climate policy frameworks for 2030 and 2050.

The role of the EEOS in these proposed pathways is to tighten the commitment to more ambitious energy savings targets for the companies involved and stimulate the market for energy services. The way the scheme is designed provides a regulatory framework that can reduce the administrative burden and remove key market and non-economic barriers, such as lack of information and access to financing. As we have shown, opportunities exist for the industries to address financial and information barriers to energy efficiency investments and increase their competitiveness via reduced energy costs.

The structure and planning of the existing energy efficiency policies is short-term related to the time that a large investment in a new energy efficiency technology for an industry needs to pay-off. For example, PFE lasted for a few years and the EED does not extend any further than 2020. The framework for EU's energy and climate policies for 2030 does not even decidedly include whether a solid energy efficiency target will be set (European Commission 2014a). In order to achieve large investments in core processes' energy efficiency improvement from the industries, an energy efficiency policy with a long-term horizon needs to be set.

Our concluding remarks show that the key element of any industrial energy efficiency policy design should be the coupling of energy and climate targets to industrial growth targets. In this way, the optimal balance between energy efficiency improvement and global competitiveness can be achieved for the Swedish energy intensive industries. Therefore, the design of energy efficiency policies for the energy intensive industries should take into account the driving forces that decision makers within involved companies take into account. These driving factors are: (i) the financial constraints within the company, (ii) the policy obligations placed on the company, (iii) the knowledge of the potential energy efficiency improvement of the company, (iv) the commitment of the company to energy and climate issues, and (v) the general public and market demands for improved environmental performance (Reinaud & Goldberg 2011).

Future work will focus on analyzing in depth the suggested pathways and evaluate the effect of the EEOS within them. A multiple evaluation criteria approach will be used, with criteria such as the energy-savings and environmental effectiveness, the economic efficiency and technical changes implied from potential energy savings under the EEOS. These effects will be analyzed in conjunction with the legal, financial and social driving factors for energy efficiency investments seen from a Swedish context. Ultimately, the most suitable and effective pathway to increased energy efficiency for the Swedish industry will be proposed.

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