BEACON Bridging European & Local Climate Action

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ENERGY EFFICIENCY OBLIGATION SCHEME IN DENMARK

Study

On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

European Climate Initiative EUKI

Energy Efficiency Obligation Scheme in Denmark
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Nesen Surmeli-Anac, Sonja Kotin-Förster, Moritz Schäfer (Navigant)

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Contact us at BEACON_HelpDesk@navigant.com

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Abbreviations

BAT	Best Available Technologies
DEA	Danish Energy Agency
DERA	Danish Energy Regulatory Authority
DSO	Distribution System Operator
EED	Energy Efficiency Directive
EEO	Energy efficiency obligation
EPBD	Energy Performance of Buildings Directive
ESCO	Energy Service Company
ETS	Emission Trading System
EU	European Union
EUR	Euro
GHG	Greenhouse gas
KfW	Kreditanstalt für Wiederaufbau
ktoe	kilotonnes of oil equivalent
kWh	Kilowatt hour
MS	Member State
$MtCO_2e$	Million tonnes of carbon dioxide equivalent
NAPE	National Action Plan on Energy Efficiency
SME	Small and Medium Enterprises
STEP up!	German Energy Efficiency Tender Scheme (‘STromEffizienzPotenziale nutzen‘)

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1 Summary

The Energy Efficiency Directive (EED) (2012/27/EU), adopted on 25 October 2012, requires European Union EU Member States (EU MS) to set indicative national energy efficiency targets ensuring that the EU reaches its target of saving 20% of primary and final energy consumption by 2020 compared to business-as-usual projections. Article 7 of the EED obliges Member States to set up an Energy Efficiency Obligation (EEO) scheme to achieve new energy savings of at least 1.5% of annual energy sales to final customers. The EED also allows Member States to opt for alternative policy measures to achieve the same amount of energy savings (Paragraph 9) or the combination of both, EEO scheme and alternative policy measures. Denmark commits to meet its Article 7 obligations exclusively by implementing an EEO scheme (no alternative measures are used).

The obligations of the EEO scheme are part of the so-called "The Energy Savings Agreement" of March 2012 and are laid down up to 2020 through the agreement of 13 November 2012 between the Minister for Climate, Energy and Building and the grid and distribution companies (Denmark NEEAP, 2014). The principle of so-called "forced volunteerism" is applied, building on the country's tradition of dialogue between government and sector organisations. This type of forced volunteerism is accepted to have a high degree of influence for obliged parties compared to a normal legislative process (ENSPOL, 2015). There are three gas companies, six oil companies, 74 electricity companies and 417 district heating companies taking part in the EEO scheme in Denmark. With few exceptions, all technologies are allowed to achieve energy savings. Exclusions may occur because additionality is low for a specific technology or the technology is undesirable. Danish government provides no direct funding for the implementation of the policy. The EEO scheme is financed by end-consumers via their energy bill. Table 1 presents the summary of the main components of the Danish EEO scheme.

Table 1: Summary of Danish EEO scheme characteristics

Period	Since 2006, current phase 2012-2020
Target	Currently 10.1 PJ per year
Obligated parties	500 grid and distribution companies for electricity, gas, district heating and oil
Sector scope	All final consumers (except transport), mainly industry and households
Type of measures	(Almost) all measures are eligible; measures need to be additional; mainly advice and subsidies are provided
Saving calculation	First year, final energy savings; weighting factors are used to promote technologies or measures
Flexibility	Transfer possible between years and between parties
Financing	Through network charge and energy prices

The Danish EEO is praised for its flexibility, and simplicity of administration as well as straightforwardness in technical accounting of energy savings. Denmark also benefited from the long history of energy audits and advice to customers by energy distribution companies dating back to the 1990s, which provided laid out existing methodologies, standard reporting templates and audit routes. As a result, the Danish scheme benefits from

low administrative costs and high acceptance of the scheme amongst the obligated parties and population, for example.

Large overachievements have been observed in Denmark until recent years. The difficulties in achieving targets in 2013 to 2015 are attributed to significant increases in the targets over time, the strengthening of the additionality criteria, or the update of the baseline year to 2006. In 2016, the targets have therefore been adjusted to take into account increases in the costs incurred by the obligated parties. The results of the Danish EEO scheme suggests that EEOs or similar measures may be of special relevance in the industry sector, which has proven difficult in other countries. Despite the successes of the scheme, in June 2018 the Danish government announced that the scheme will not be continued when it expires in 2021. Denmark will continue to invest in energy efficiency measures through a grant fund in combination with an auctioning scheme.

The impact of a German EEO scheme would largely depend on the amount of obligated parties and the overall target. While Germany currently fulfils the EED Article 7 obligations only through alternative policy measures and has a range of energy efficiency policies in place, an EEO scheme could become part of this policy package rather than replace existing policies.

2 National context in Denmark

2.1 National climate policy

According to the Danish Energy Agency (DEA), Danish climate change mitigation policy is guided by both compliance with international climate obligations and achieving national targets for the energy sector. Passed in 2014, the regulatory framework for climate-related policy is outlined in the Danish climate law. The goal of the statute is "to transform the Danish economy into a low-emission society by 2050" (Danish Energy Agency, 2018). This is described as a future "in a resource efficient society where energy supply is based on renewable energy resources, and where the greenhouse gas (GHG) emissions from other sectors is significantly lower, while at the same time leaving room for economic growth and development" (Danish Energy Agency, 2018).

In addition to establishing a council on climate change (with academic experts in the fields of energy, transport, agriculture, environmental protection, nature and economics) and submitting annual energy policy reports to parliament, the government also establishes new national climate targets every year. There are also several climate-related legal frameworks that set out specific work areas and obligations or targets. The 2015 government platform is to completely phase out the use of fossil fuels by 2050 and the Danish climate law, as stated above, seeks a low-emission society by 2050. Denmark also strives to meet the European Union (EU)'s 2020 and 2030 targets and translate them into national law. In 2030 this means, 39% reduction in GHG emissions compared to 2005 in non-ETS sectors and a renewables share of 50% of energy consumption in 2030.

To evaluate the progress made against its climate targets, the DEA (situated under the Danish Ministry of Energy, Utilities and Climate) publishes two reports each year: the Danish Energy Statistics and the Danish Climate and Energy Outlook. According to the Climate and Energy Outlook, Denmark is expected to (over)achieve its goal of reducing GHG emissions from buildings, agriculture and transport, resulting in an overachievement of 14 million tonnes CO2 equivalent (MtCO2e) during the obligation period. The Minister for Energy, Utilities and Climate is to propose national climate targets at least every fifth year, that have ten-year perspectives and a level of ambition that reflects ambitions for 2050.

On 29 June 2018 the Danish government announced that the scheme will not be continued after 15 years of operation when it expires in 2021. But Denmark will continue to invest in energy efficiency measures through a grant fund in combination with an auctioning scheme.

2.2 Sector context

Denmark has ambitious energy and climate targets, requiring substantial reductions in all sectors. Final energy consumption in Denmark is shown in this graph:

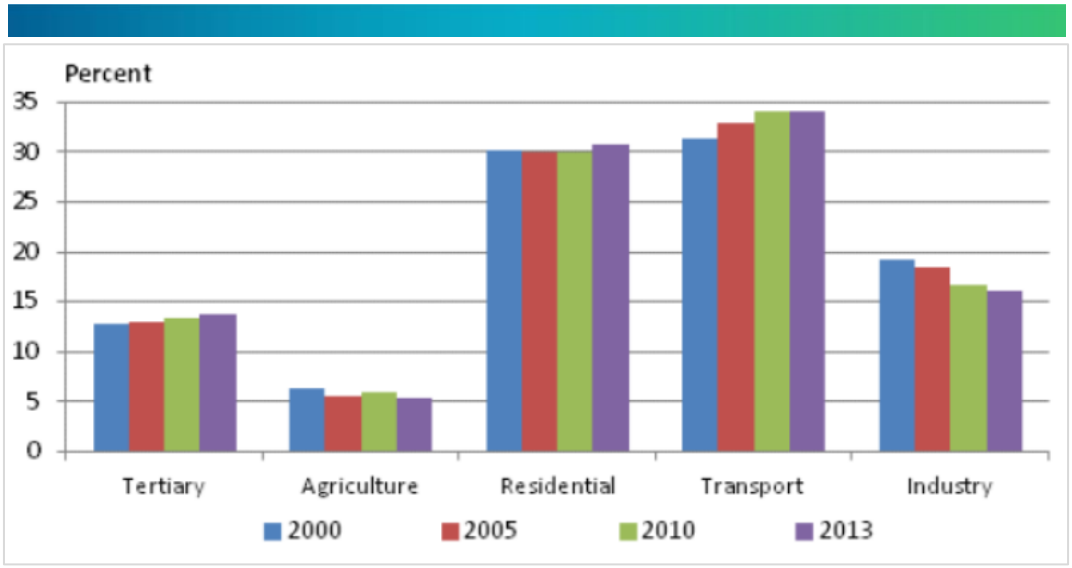

Figure 1: Final energy consumption by sectors, climate corrected for tertiary and residential buildings (Danish Energy Agency, 2016)

An energy saving obligation can be described as an obligation by a party to deliver a defined amount of energy savings within a certain period of time. Such parties are typically final energy suppliers or the distribution network operators (DSO).

The Danish energy efficiency obligation (EEO) scheme is considered very ambitious and complies with the 1.5% target of Article 7 of the Energy Efficiency Directive (EED) without major system changes. The Danish EEO applies to distribution companies rather than energy suppliers. For the accounting process, standard values (referred to as deemed ex-ante savings) as well as individual assessments are possible depending on the type of measure. EEO targets can be met by delivering energy savings from all sectors of the economy and energy end-uses. All energy end-use actors implementing cost-effective measures benefit directly. End-use actors primarily include investor-occupiers, investor-users (appliances), investors (buildings) and users (buildings). Indirectly, many actors may benefit, including property development companies, engineering consultants, construction companies, and system suppliers. All actions that aim to improve energy efficiency in buildings, appliances, industrial equipment and processes, and certain actions in the transport sector are targeted in the EEO scheme (Energy Efficiency Watch, 2016).

According to the DEA's energy statistics, savings in final energy consumption (end use) realised in all sectors may be included in energy savings within the EEO scheme. Reductions of losses in transmission and distribution grids, including losses in transformers, pumps, gas metres/regulators/pumping stations, etc. can be included as well. Furthermore, savings from the establishment of collective solar installations in connection with district heating supply were eligible under the EEO scheme until the end of 2015.

The flexibility of the EEO in achieving energy savings from all sectors and almost all technologies is strongly influenced by the “additionality” requirement of Article 7 of the EED. This requirement establishes that savings achieved by the EEO scheme should be additional to those that are expected to come from existing EU efficiency policies such as those mandated in the Energy Performance of Buildings Directive (EPBD), Ecodesign Directive or other energy related EU policies. Thus, most savings within EEO schemes should come from improvements in

buildings (beyond requirements of EPBD) or industrial processes and their management. Efficiency improvements to products (e.g. lightbulbs, boilers or motors) are largely not applicable as these are delivered via the Ecodesign Directive. Similarly, additional savings from transport sector eligible under the EEO scheme are likely to be limited (Fawcet, Rosenow, & Bertoldi, 2018).

3 General description of the EEO scheme in Denmark

3.1 History

The EEO scheme in Denmark is based on a well-established history as energy efficiency has been a policy objective since the 1990s. As early as 1995, utilities in Denmark were given 'assignment letters' by the DEA that mentioned specific customer areas in which utilities were required to build awareness about energy consumption and thereby realise energy savings. Denmark incentivised these by introducing a CO2-tax in 1992 (see below – Linkages with other policy instruments). In 2004, the obligation to increase awareness was extended to natural gas suppliers, followed by oil companies in 2004 (Artola, Rademaekers, Williams, & Yearwood, 2016). In 2006 the scheme was changed substantially; the focus was shifted from building awareness towards implementation of energy saving measures. With gradual improvement of the scheme, the district heating association joined the agreement in 2009. The current Danish EEO scheme is based on a voluntary agreement of 13 November 2012 known as 'The Energy Savings Agreement'. The current obligation period runs from 2012 to 2020 and is evaluated every three years. The latest scheme agreement was signed in December 2016. Currently, three gas companies, six oil companies, 74 electricity companies and 417 district heating companies are participating (ENSPOL, 2015).

Besides Belgium (Flanders), France, Italy, and the United Kingdom, Denmark was one of the five countries that implemented EEO schemes before the mechanism became part of the EU EED, thus setting an example for EEO implementation in the EU (European Commission, 2016). Over the various phases of EEO implementation in Denmark, the energy sector accumulated a common understanding of the energy savings, developed standardised methods such as energy audits, and managed a long tradition of dialogue with energy authorities.

3.2 Legal basis

The EED (2012/27/EU) adopted on 25 October 2012, requires EU Member States (MS) to set indicative national energy efficiency targets ensuring that the EU reaches its target of saving 20% of primary and final energy consumption by 2020 compared to business-as-usual projections. Article 7 of the EED is one of the main pillars of EU energy efficiency policy and introduces the EEO schemes. Article 7, paragraph 1 states:

"Each Member State shall set up an energy efficiency obligation scheme. That scheme shall ensure that energy distributors and/or retail energy sales companies that are designated as obligated parties under paragraph 4 operating in each Member State's territory achieve a cumulative end-use energy savings target by 31 December 2020, without prejudice to paragraph 2.

That target shall be at least equivalent to achieving new savings each year from 1 January 2014 to 31 December 2020 of 1.5 % of the annual energy sales to final customers of all energy distributors or all retail energy sales companies by volume, averaged over the most recent three-year period prior to 1 January 2013. The sales of energy, by volume, used in transport may be partially or fully excluded from this calculation […]."

Accordingly, EU countries shall set up an EEO scheme. This scheme requires energy companies to carry out measures that help final consumers improve energy efficiency and achieve additional annual energy savings equal to the amount of 1.5% of annual sales of energy companies to final consumers. The utilities may implement

various energy efficiency measures. The EED also allows MS to opt for alternative policy measures to achieve the same amount of energy savings (paragraph 9) or the combination of both, EEO scheme and alternative policy measures.

Denmark commits to meeting its Article 7 obligations exclusively through the use of the EEO (no alternative measures are used). The obligations are part of the so-called 'The Energy Savings Agreement' of March 2012 and are laid out up to 2020 through the agreement of 13 November 2012 between the Minister for Climate, Energy and Building and the grid and distribution companies (Denmark NEEAP, 2014). The Energy Savings Agreement forms the legal basis of Denmark's EEO scheme.

3.3 Functioning

3.3.1 Governance and design

The current Danish EEO, The Energy Savings Agreement, is formed between the Minister for Climate, Energy and Building and the obliged parties (i.e. grid and distribution companies for electricity, natural gas, district heating and oil). The EEO scheme is set by law but the institutional set up is based on both a voluntary agreement and an Executive Order. The Executive Order will come into play if an obliged party chooses not to be part of the agreement. The so-called 'forced volunteerism' is accepted as a common practice in regulation in different sectors in Denmark, building on the country's tradition of dialogue between government and sector organisations. This type of forced volunteerism is accepted to have a high degree of influence for obliged parties compared to a normal legislative process (ENSPOL, 2015).
The EEO scheme is governed by the 'Technical Working Group'[1] which is formed by two members from the electricity, district heating and gas sectors, respectively, and one member from the oil sector and the DEA. Formally, the voluntary agreement is between the obligated parties and the Minister directly, but there are no representatives from the Ministry. The administrative body of the EEO scheme is the DEA (Energy Efficiency Watch, 2016).

As a first step, the DEA prepares a proposal for the obligation based on the evaluation of the current market situation and technological developments. The overall policy framework and the targets are determined by the government after an agreement on the obligation is reached in the parliament. Targets are determined for both the electricity and gas sectors and are proportional to the average market share of electricity or gas distribution in the three preceding years (Bertoldi, Castellazzi, Oikonomou, & Fawcett, 2015).

The Danish government provides no direct funding for the implementation of the policy. The EEO scheme is financed by end-consumers via their energy bill; in other words, participating companies fund their costs of energy efficiency actions through distribution network tariffs, while oil companies include them in their competitive prices. The Danish Energy Regulatory Authority (DERA) is responsible for checking the costs and allowing their inclusion in distribution network tariffs (BigEE, 2018). On the basis of the reported costs, the DERA

[1] Main tasks of the working group include: Any specification of the guidelines for companies' involvement; follow up on the provisions on market orientation and transparency; clarification of any discrepancies in the use of prioritisation factors; ongoing adjustments to calculation methods, including updates to the deemed savings, and drafting of guidelines for how to calculate the effect of market influence; follow up on requirements for documentation, reporting and quality assurance, including follow up on annual spot checks; discussion of the framework for and the content of the evaluation every three years (ENSPOL, 2015).

prepares an annual benchmark showing the individual company's total costs of meeting the energy saving obligation, as well as costs per kWh reported (Energy Efficiency Watch, 2016).

3.3.2 Energy saving targets

The following energy saving targets are set for the Danish EEO (BigEE, 2018):

- 2006–2009: 2.95 PJ of first-year savings to be achieved in each calendar year,
- 2010–2012: 6.1 PJ/year,
- 2013–2014: 10.7 PJ/year (corresponding to 2.6% of energy end use),
- 2015–2020: initially 12.2 PJ/year (corresponding to 3.0% of energy end use) but the policy agreement of December 2016 revised the annual targets to 10.1 PJ/year.

It is important to note the decrease in the target in 2016. This was due to concerns regarding the increasing costs incurred by the obligated parties to meet their targets. In Denmark, this was mostly due to the combination of large increases in the targets (between 2012 and 2015) and the fact that the cheapest energy savings may have been achieved already (or are no longer eligible, due to the additionality criteria) (ATEE, 2017).

The Danish targets under the EEO are still considered significantly higher than the requirements in the EED. Additionally, only final energy savings count towards the target. Energy savings are credited only for the first year of the implementation of the energy efficiency measure, as opposed to lifetime savings. To take the differences in the lifetime of energy efficiency measures and their impacts on primary energy consumption into account, different weighting factors are used for different measures (ATEE, 2017). First-year's savings were chosen in order to avoid uncertain estimations of the lifetime of a given project. Additionally, the experience from the earlier scheme in Denmark indicated that the majority of the gas, district heating and oil savings had a long lifetime whereas, electricity savings had a shorter lifetime. Moreover, the impact on primary energy consumption was estimated larger for electricity savings compared to other energy savings. Because of this it was assumed that the differences in lifetime were balanced out by the differences in impact on primary energy consumption. As a result, it was considered reasonable and simple to count first-year savings (ENSPOL, 2015).

3.3.3 Energy efficiency measures

The Danish EEO gives freedom to obliged parties to choose any energy saving measures as long as they can document the realised energy savings. Energy savings efforts are to be directed towards existing buildings and businesses (industries). Furthermore, the EEO should promote Best Available Technologies (BAT) wherever possible. This is done mainly through deemed savings that set requirements that go beyond the building code, as is the case for windows and insulation material. As mentioned above, the EEO scheme does not restrict particular technologies from being use; however, technologies listed below shall be prioritised. To incentivise the use of prioritised technologies, a factor of 1.5 in the first-year savings in calculations can be applied (ENSPOL, 2015). This factor promotes actions with a lifetime exceeding 15 years and is in line with the national objective of phasing out the use of fossil fuels for space heating (ATEE, 2017). Prioritised technologies include:

- Increased insulation of floors, walls and ceilings/roofs, which reduces space heating consumption in oil and gas-heated buildings;

- New windows and doors marked with energy class A, which reduce space heating consumption in oil and gas-heated buildings;
- Heat recovery from space heating in connection with mechanical ventilation in oil and gas-heated buildings;
- Increased insulation of pipes in connection with space heating in buildings and new tanks for heating of domestic water, when using fuels outside the EU Emissions Trading System (ETS)[2] ;
- New oil and gas boilers in connection with non-ETS oil or gas consumption;
- Connection of oil and gas-heated buildings to district heating;
- Installation of heat pumps replacing non-ETS oil or gas consumption;
- Solar heating in oil and gas-heated buildings.

3.3.4 Reporting and verification mechanism

The obligated companies can only be credited with and report savings which the companies are involved in achieving through specific activities either themselves or based on agreements with other actors. Thus, a direct and clear link between the activity and the savings, such as an agreement concerning involvement of the energy company before the realisation of the saving begins, is the principle requirement. Companies cannot report savings arising without their involvement. There are clear rules stipulating that the obligated parties' activities must have significantly contributed to achieving the energy savings claimed. The obligated parties' involvement may take various forms, such as advice or a grant to the final customer or, a combination of both (Denmark NEEAP, 2014).

Energy savings are reported based either on standard values, referred to as deemed ex-ante savings[3] or specific calculations. Deemed savings are compiled by the Danish Technological Institute and approved by the DEA and used mainly within the scope of household measures. When deemed savings are not available, specific calculations need to be carried out. The larger the project, the greater the requirements for the accuracy of the calculation. Calculations of the energy consumption before and after implementation of the energy savings and thus, the effect of the initiative, must be based on specific measurements, savings on the main metre, invoices from energy companies, and/or technical calculations (ENSPOL, 2015).

Companies must report actual energy savings annually. Monitoring of the energy savings is done jointly by the trade associations of energy companies and the DEA. Trade associations assist their members with interpretation of the agreement as well some administrative tasks such as collecting data on fulfilment of the target, distribution of savings in terms of technology, etc. Once prepared by the companies, trade associations collect the reports on savings achieved from the individual companies and submit the total energy saving data to the DEA. The DEA compiles the main statistical information. A quality assurance system must be implemented by the companies to ensure that energy savings are determined and implemented in accordance with the

[2] District heating for buildings is covered by the ETS in Denmark and hence has a prioritisation factor of 1.

[3] The values are based on the results of previous independently monitored energy improvements in similar installations. The list of deemed ex-ante energy savings are available at http://svk.teknologisk.dk/

framework. There are minimum requirements for the focus of quality assurance system[4] (ENSPOL, 2015). As part of their quality assurance, obligated companies must carry out an audit each year to ensure and demonstrate that the notified savings have been realised and documented in accordance with The Energy Savings Agreement and the Executive Order. Additionally, the DEA contracts independent random control of all involved companies and evaluation of their reports. The independent audit includes desk-based control of the paperwork that has been provided and physical visits to individual projects. The technical audit includes measurement and verification of the overall assessment (Ricardo Energy and Environment, 2016).

3.4 Interlinkages with other policy instruments

The energy saving obligations are one of the most important elements of the Danish energy efficiency policy package. EEO schemes do not operate in isolation and there are other policy instruments in place that support the same energy efficiency improvements. Where this is the case, there is the risk of policy overlaps, meaning two or three policy instruments support the same energy efficiency measures. Overlaps are not necessarily problematic and can either be pre-proportioned among the overlapping policy instruments or attributed only to one of the policy instruments. Regarding its EED requirements, Denmark only counts savings from the EEO scheme and not from other policies that also deliver energy savings (Ricardo Energy and Environment, 2016). The different elements of the Danish energy efficiency policy package are aligned to contribute to the overall political target from different directions as shown in Figure 2.

The EEO scheme is a cross cutting measure covering multiple sectors such as buildings, appliances and industry. By nature, it has synergies with building codes, green taxes and the EU ETS. Several other policy measures have been employed to support the energy efficiency agenda. For example, Denmark introduced a CO2-tax in 1992. For industry, the Ministry of Finance applied the full tax rate as long as energy-intensive processes were not employed. This encouraged companies to invest in monitoring and auditing their specific consumption of different machines and processes and led to an overview of energy consumption by process that did not exist previously. With this information available, profitable investment projects for reducing energy consumption were identified. Given the differentiated data for the various processes, reduced tax rates could be applied to the energy-intensive processes. Triggered by the CO2-tax, this early form of “forced volunteerism” contributed to energy and CO2-savings.

Since the 1970’s, the Danish building code has been a significant normative means of achieving a more energy efficient construction sector both in relation to new builds as well as retrofitting the older building stock. Voluntary near zero energy classes have been introduced and slated to be implemented in 2020 as obligatory energy standards. Furthermore, informative measures and energy labelling of buildings are among central measures to improve energy efficiency (ENSPOL, 2015).

[4] As a minimum, quality assurance should focus on: that the size of the energy saving is determined in accordance with the applicable rules and specific calculations being professionally substantiated; that energy savings are implemented within the allowed energy consumption and can be defined as an energy saving within the framework of the agreement; that the company is involved directly, financially or via a third party before the saving is realised; that the company has obtained the right to report; that energy savings are realised and correctly documented; that energy savings are correctly notified; documentation of the entire contractual chain; compliance with the requirements of the agreement by operators acting on the network company's behalf; any errors linked to individual cases or the company's procedures relating to compliance are corrected.

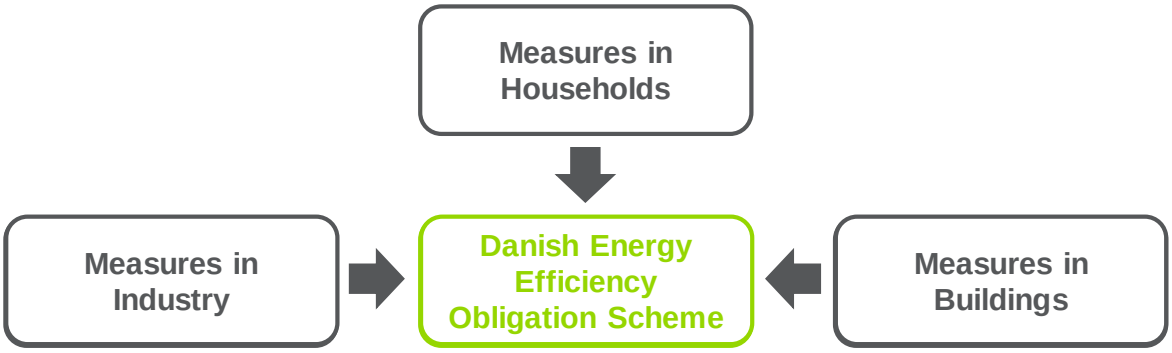

Figure 2: Policy measures in relation to EEO (based on (Enghave, 2016))

4 Impacts of the policy instrument

4.1 Effectiveness

4.1.1 Impacts on sector reductions

The distribution of reported energy savings throughout the EEO implementation periods between sectors can be seen in Figure 3. Large overachievements can be observed in Denmark until 2012. The difficulties in achieving targets in 2013 to 2015 are attributed to significant increases in the targets over time, or stricter additionality criteria. In 2016, the targets have therefore been adjusted to take into account increases in the costs incurred by the obligated parties.

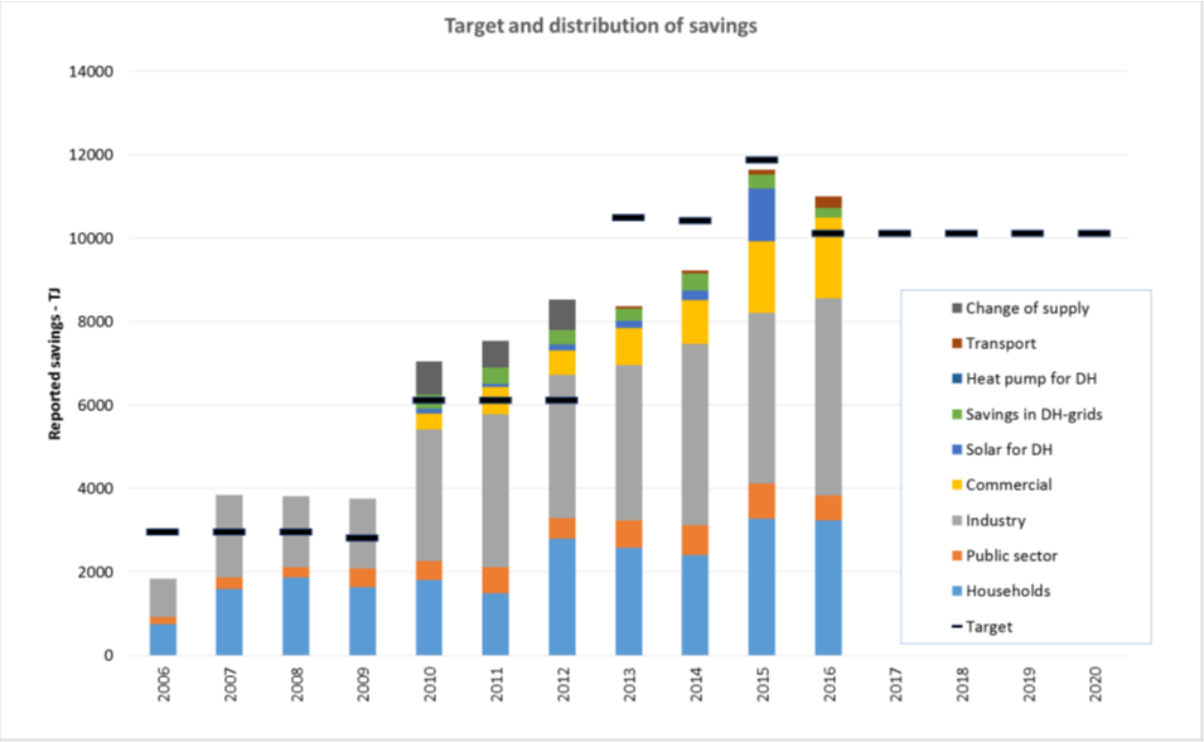

Figure 3: Distribution of energy savings in 2013 between sector for each obligated party (Danish Energy Agency, 2018)

Around 30% of the energy savings are achieved in households — most of these are calculated by one of the 150 standardised actions (deemed savings). Around 45% of the savings are calculated from the industrial sector based on specific calculations (scaled savings). About 20% of the savings are achieved in the services sector (public and private) and 1% in the transport sector (ATEE, 2017). The top five technologies that have been implemented for savings in 2013 were listed as process equipment, building envelope measures, boilers, central heating and ventilation (see section 3.3 for detailed list of applied measures and technologies) (ENSPOL, 2015).

High shares of energy savings in households were observed in Denmark from 2007 to 2009, with savings coming mostly from lighting and appliances. When the energy savings ratios credited to these action types were revised to consider changes in additionality, they became much less attractive or were even de facto excluded from the schemes. This resulted in lower shares of energy savings in households in recent years (ATEE, 2017).

In many countries, the industrial sector represents a challenge for policy makers. Experience from the Danish case suggests that EEOs or similar measures may be of special relevance in such cases. The accompanying instruments used in the Danish EEO for industry are: advice given directly by the obligated parties, advice given by consultants as a third party involved, and subsidies issued per saved kWh. The experience from Denmark shows that when left to the discretion of the obligated parties, the most cost-effective and dominating sector to realise energy savings is the industrial sector. For EU MS that are considering establishing an EEO, it is thus worth considering a design that allows and encourages savings in industry (ENSPOL, 2015). EEO scheme covers industry from both ETS and non-ETS. Prioritisation factors are included in the EEO to promote favourable savings, e.g. with long lifetime or in the non-ETS sectors.

Evaluations have shown that the Danish EEO scheme is making almost full use of the technical and economic potential for energy efficiency in Denmark and is thus regarded as highly effective (BigEE, 2018).

4.2 Cost efficiency

The EEO scheme is financed by end-consumers via their energy bill rather than from the state budget. Enghave (2016) states that the Danish EEO scheme has proven to be a cost-efficient measure to accomplish energy savings. Previous studies provide an analysis of the costs and benefits of the Danish EEO scheme (Rosenow & Bayer, 2018) (ENSPOL, 2015). The costs can be classified as follows:

Programme costs are the costs to the obligated parties required to meet their targets. It includes grant payments to customers to partly (or in some cases fully) fund energy efficiency measures, financial resources on lead generation (finding consumers and businesses willing to receive energy efficiency measures), internal administration of the programme, contracting installers, liaising with third parties promoting energy efficiency measures on their behalf, reporting, and monitoring and verification where required (Rosenow & Bayer, 2018).

Table 2: Programme costs of Danish EEO Scheme

Time period	2015
Energy company costs	EUR 185 million/year
Weighted average EEO costs of lifetime energy savings	EUR 0.5 cent/kWh
Weighted average retail prices of comparable energy supply for relevant sectors	EUR 13 cent/kWh
Cost as share of average energy bill in household sector	2%
Costs as share of average energy bill in industrial sector	5%

Table 2 provides a summary of the programme costs for Denmark in 2015. It shows the costs to the obligated parties in terms of cost per kWh (lifetime) and compares this to the average cost per supplied kWh (weighted average of retail price). The costs to the obligated company per kWh of energy saved in Denmark is EUR 0.5 cents, which is significantly less than the costs of energy supplied to the customer, EUR 13 cents. The EEO costs passed on to consumers by the energy companies through increased energy bills were low, 2% and 5% in the household and industrial sectors, respectively. However, in future deeper energy efficiency improvements will need to be delivered and this will unavoidably increase the costs of EEO schemes over time (Rosenow & Bayer, 2018).

Societal costs include both the costs to the obligated parties and the additional costs incurred by participating customers. However, current data on societal costs are not readily available. An analysis of the Danish EEO scheme uses a leverage factor approach to estimate the societal costs (Rohde, Eyre, Rosenow, & Giraudet, 2016). According to the results, the societal costs of the Danish EEO scheme are three times higher than the programme costs. Given that the average costs of supplied energy are well above the sum of programme and societal costs, the energy savings through EEO proves cost-efficient.

Historical data confirms these results. In 2008, the DEA commissioned an evaluation of all energy savings measures at the time. As part of the evaluation the societal costs of the measures were estimated, including investment cost on the end-user side. The diagram below shows the results by illustrating the ratio between the total societal cost of energy including the cost of CO_2 emissions (the red line) and the costs of energy savings. If a measure is below the red line, there is a socio-economic benefit of the measure. Figure 4 shows that the EEO is the second most cost-efficient policy measure in socio-economic terms at the time, providing 1.6 times more socio-economic value than the total costs of the energy savings being realised. The 2012 evaluation confirms this level of socio-economic benefits (ENSPOL, 2015).

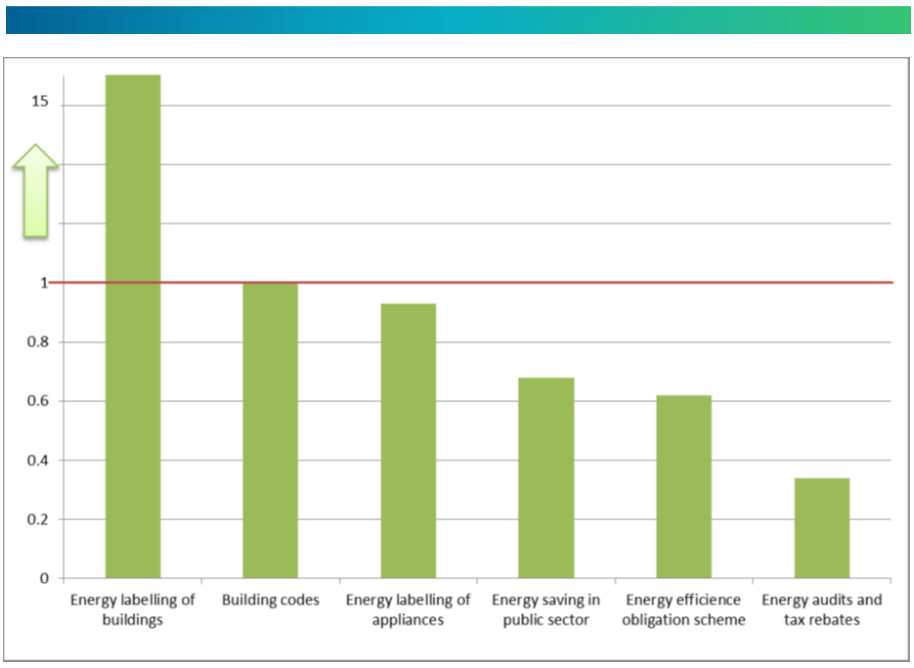

Figure 4: Ratio between societal costs of energy, normalised to 1- versus societal costs of energy saving measures (ENSPOL, 2015)

4.3 Co-benefits and side-effects

EEOs deliver a variety of benefits, of which the most important are described below.

Participant benefits are direct benefits to the participating individual households and businesses that install energy efficiency improvements. In 2015 the total final energy savings per year was 291 ktoe which is equivalent to a 4.2% reduction of final energy consumption per year in all sectors covered by the EEO (Rosenow & Bayer, 2018). The energy cost savings are commonly discussed as the main participant benefit but participants often also benefit from increased comfort and increased values of their properties/assets. There is now evidence that suggests that properties with a higher efficiency rating achieve higher sales prices compared to other properties (Fuerst, McAllister, Nanda, & Wyatt, 2015).

Utility system benefits relate to the energy system through reduced costs in providing energy services to end-users. EEOs and other end-use energy efficiency programmes can defer the need for investment in transmission and distribution systems and reduce congestion on existing lines, which reduces line losses and the corresponding need for additional generation to serve consumer demand. A good example are reduced line losses resulting from load reduction within the electricity grid. At the time of writing this study, no studies have been identified for EEOs in Denmark that quantify cost savings due to the avoidance of production, transmission, and distribution capacity (Rosenow & Bayer, 2018).

Societal benefits are the benefits that accrue more broadly to society rather than to a specific energy system. Good examples include carbon emission reductions and air quality improvements. Health benefits related to these are significant societal impacts, thus they are among the main motivators for undertaking energy efficiency improvements. Particularly where homes are under-heated, energy efficiency improvements allow the occupants to increase indoor temperatures at no additional cost. In addition, draught proofing reduces draughts in the buildings making it more comfortable to live in even if indoor temperatures are not changed (Rosenow & Bayer, 2018).

One of the possible side effects of EEOs is their impact on energy prices. Depletion of the relatively cheaper and easier energy saving potentials will give way to move more complex actions, and the costs of energy savings will potentially increase. The energy companies may recover the costs of obligation through energy prices. In theory an increase in energy prices can make energy efficiency actions more attractive, and therefore support achieving energy savings targets. However, increases in energy prices are often very sensitive from a political point of view. Political intervention to prevent increase in energy prices can render energy efficiency measures less attractive, thus may lead to reduction in the energy savings targets. The risk of increase in energy prices becomes more relevant when the cost recovery of energy efficiency actions will impact all sectors while the benefits of the EEOs may be concentrated on a segment (sub-sectors and/or income classes) (ATEE, 2017).

4.4 Success factors and challenges

The following characteristics of Denmark's EEO are acknowledged as success factors of the scheme:

History: Denmark has a history of energy audits and providing advice to customers by energy distribution companies dating back to the 1990s. The CO_2-tax, introduced in 1992, provided a strong incentive driving energy efficiency investments. Reduced rates were linked to monitoring and audits, leading to the identification of profitable saving investments. The EEO scheme could therefore build on existing methodologies for the calculation of savings and standard reporting templates. The combination of setting mandatory targets for the

industry at a far earlier stage than other countries and the innovative element of free choice of measures and the corresponding methodologies, represents the primary success factor of the Danish EEO. There are several further main factors contributing to the success of this policy: the EEO activated those companies that already had regular contact with their consumers. This resulted in very low overall costs and high acceptance among the population. The latter has also been enhanced by the municipal ownership of most DSOs companies in Denmark. Administration costs are also low as documentation procedures are relatively simple and the respective associations of each sector compiles all necessary information at an aggregated level (BigEE, 2018) (ENSPOL, 2015). Cost recovery is crucial to remove economic risks, which supports the choice of energy distribution companies to be the target party of the policy (ENSPOL, 2015). The successful example of the building sector demonstrates that providing permanent consultancy results in more acceptance and confidence within the population while increasing access to financial instruments (ENSPOL, 2015).

Flexibility: The Danish EEO is focused on the realisation of cost efficiency savings and makes use of the market force and freedom of methodology to achieve this goal. The clear focus on one goal results in a system that performs very well on delivering on this particular goal compared to other measures taken in Denmark. This is perhaps the greatest strength of the Danish EEO. The Danish EEO ensures a high degree of flexibility and at the same time takes precautionary measures against speculations (ENSPOL, 2015). To provide due incentives for energy efficiency actions with longer lifetimes, weight factors were introduced to reflect the lifetime of saving solutions. Rebound effects were minimised by focusing on technology-specific solutions and advice. Free-riders are included in the obligation target, which is therefore set relatively high, but the regular adjustment of baselines and standard values also minimise free-rider effects (BigEE, 2018).

Simplicity of administration: The Danish EEO scheme relies on relatively simple documentation procedures. This keeps the administration costs low and required time at a minimum. The agreement states that the level of detail in documentation should be proportional with the size and complexity of the project (ENSPOL, 2015).

The following characteristics of present challenges to the successful implementation of Denmark's EEO:

Additionality: The EEO scheme is found to be the most successful instrument for the industrial sector as significant energy savings have been achieved at low costs (ATEE, 2017) (ENSPOL, 2015). In contrast, the impact of the EEO in the buildings sector has been limited as additionality is low for actions in households and many of the actions carried out under the EEO were found to have been carried ou even if no EEO was in place. Another reason is the typically individual design of refurbishment measures whereas EEO schemes preferably use standardised measures. Furthermore, energy efficiency in buildings is supported by high energy taxes, strong regulations and informational activities. The evaluation of the Danish EEO scheme in 2012 showed that approximately 80% of energy savings in households would have been implemented within three years anyway. This was the case for only 45% of energy savings in businesses (Energy Efficiency Watch, 2016). Consequently, additionality is an important issue within the Danish EEO. The scheme then acts as a tool for measurement and verification of energy saving measures undertaken anyhow but does not lead to significant additional investments. In contrast, capital going into such measures may even be withdrawn from more important investment opportunities. Therefore, the high leverage factors of the Danish scheme must be handled with care.

Depletion of low-hanging fruits: Another issue is the capacity of EEOs to continue to deliver energy savings in an efficient way once the easiest potentials are exploited. One challenge, for example, is to promote actions that require more investments but produce more energy savings in the long term such as the 'deep' retrofitting of buildings. Another challenge is the development of actions in the transport sector, which represents a large share of the final energy consumption (ATEE, 2017).

Audits: In recent years issues identified regarding audits within the scope of the EEO scheme's monitoring and verification mostly related to low quality of work and incorrect calculation of savings made by some of the independent contractors. The increased error rate detected by the random controls creates some cause for concern in Denmark (ATEE, 2017).

5 Transferability

5.1 General comparability of the context

Since 2006, Denmark has proven that an EEO scheme is a successful tool to achieve energy savings in a cost-efficient and market-based way. With growing experience and trust in the scheme, targets have increased (with a few exceptions) and new sectors for energy savings were included. Besides Denmark, other European countries have introduced similar schemes, yet they differ considerably in their design. This shows the flexibility of the instrument and its adaptability to national preferences and market conditions. The Danish system also represents a good example of accurate quantity control of energy savings. As the instrument is based on the obligation of the final energy suppliers, a high degree of accuracy of the instrument can be assumed with appropriate sanction mechanisms for non-compliance.

In Article 7 the EED requests that EU MS achieve new energy savings each year of 1.5% of the annual energy sales to final customers of all energy distributers or all retail energy sales companies averaged over the most recent three-year period. The MS agreed that EEO schemes, alternative policy measures, or the combination of both shall achieve these savings. Currently, sixteen MS have introduced EEO schemes, of which ten have combined obligation schemes with alternative measures such as support programs or voluntary agreements. 13 countries implement only alternative measures to achieve the Article 7 objective.

Over the course of the EED adoption in 2012, the introduction of such an instrument and various design options was discussed in Germany. The 'Energiekonzept' of 2010 of the German government proposed a pilot project for White Certificates. However, Germany decided to implement alternative policy measures pursuant to Article 7 (9) to fulfil the objective of 1.5% energy savings and introduced a tendering model (STEP up!) as a quantity-controlling instrument under the National Action Plan on Energy Efficiency (NAPE). Numerous other measures have been introduced in Germany, such as the tightening of the Energy Saving Ordinance, an increase in KfW programmes, and the establishment of energy efficiency networks in industry.

While primary energy demand in Germany is slowly decreasing, Germany is not on track to achieve the target of reducing primary energy demand by 20% until 2020 compared to 2008. For this reason, the German government introduced new policy measures in its NAPE. The effects (actual energy savings) of these measures are yet to be demonstrated. The Greenbook on Energy Efficiency (BMWi, 2016) continues the discussion on future energy efficiency policy and raises the question of whether energy saving obligations (White Certificate Scheme) would be a suitable instrument to address the longer-term energy efficiency policy targets of Germany and the EU.

The establishment of an EEO scheme in Germany is therefore possible, including from a legal point of view. It will be key, however, to design the scheme properly and learn from the experience of countries like Denmark.

5.2 Properties of the instrument

A clear advantage of the EEO scheme is the budget-independent design. Regarding the properties of an EEO scheme, a simple and clear design with a primary focus on energy savings is important. Obligated parties and other market actors need to adjust to the new scheme; target setting, obligated parties, and targeted sectors should be limited at first. This can be altered over the commitment periods and extended to achieve higher savings or include further parties (e.g. Energy Saving Companies, so-called ESCOs).

The complexity of the system initially requires a high level of communication with the obligated parties, but also with the general public, in order to raise awareness and explain the functionality, procedures, methods for calculating the savings, etc., of such a new instrument. In selecting the obligated parties, care must be taken to ensure that they have the necessary infrastructure to achieve the savings targets.

In Germany, around 1,260 suppliers of electricity, 960 suppliers of gas, and 550 suppliers of district heating exist (German Statistics, 2017). In the Danish scheme obligated parties, in contrast, include three gas companies, six oil companies, 74 electricity companies and 417 district heating companies. For small obligated parties the administrative effort is higher. This burden could be reduced by setting a threshold (in terms of number of customers or amount of energy sold) or by the possibility of a buyout.

Obligated parties should generally be flexible in the selection and implementation of measures in the sectors. A differentiation by sector can also be made to specifically increase these potentials. However, this restricts the openness to all types of technologies of the system. The aim of the instrument should be to enable energy savings and, hence, reduce GHG emissions in both ETS and non-ETS sectors. However, special design (factoring) can promote increased GHG savings in non-ETS sectors, such as buildings/households and small and medium-sized enterprises (SME).

5.3 Potential impacts

The impact of a German EEO scheme would largely depend on the number of obligated parties and the overall target. While Germany currently fulfils the EED Article 7 obligations only through alternative policy measures and has a range of energy efficiency policies in place, it is clear that an EEO scheme would only become part of this policy package and not replace existing policies.

The Commission's proposal for an amended EED proposes a continuation to deliver new annual savings of 1.5% from 2021 to 2030. This translates into a cumulative savings target of approximately 3,328 PJ for the 2021–2030 period, representing annual savings of 61 PJ.

In Denmark, around 10 PJ are set as yearly energy saving target in the EEO scheme, while Denmark’s final energy consumption is only 615 PJ in 2015 compared to 8,898 PJ in Germany. Potentially, an EEO scheme in Germany could also have large energy saving effects, but, as mentioned, this depends on the design of the scheme and integration into other policy measures. The highest energy saving potentials are expected to be in the industrial and some parts of the buildings sectors (e.g. prefabricated multifamily buildings). An EEO scheme in Germany would need to adapt to national stakeholders, functioning of the market and technical savings potential in different sectors. It can be concluded that an EEO scheme such as the Danish system or as provided as concept in the EED would be suitable to be introduced in Germany and provide additional energy and GHG savings.

5.4 Conclusion

EEO schemes offer a flexible, adaptable, and cost-efficient instrument to achieve high quantities of energy savings with high accuracy. The EU recommends such a scheme in the EED and more and more EU countries introduce similar schemes, which potentially even allows for cross-border trades of White Certificates. Lagging behind on the achievement of energy efficiency targets, it is highly recommended that instruments such as an energy efficiency obligation are considered and introduced in the German context.

The Danish EEO provides inspiration as to how to design and implement an EEO that meets the requirements and target of the EED, encourages cost-efficient savings in industry, effectively includes third parties, and implements a robust measurement and verification system. The Danish EEO highlights the necessity of supplementary instruments to realise the potential savings in existing buildings if public and private buildings are not the only target are of the EEO.

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