evaluate energy savings

Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services

Task 8.1: National report from the pilot tests of Case application 18, Energy audits:

Energy audits in Denmark performed by DONG Energy in the period 2006-2008

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DONG Energy, Denmark

evaluate energy savings EU

coordinated by

Wuppertal Institute for Climate, Environment and Energy

supported by

Intelligent Energy Europe

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The Project in brief

The objective of this project is to assist the European Commission in developing harmonised evaluation methods. It aims to design methods to evaluate the measures implemented to achieve the 9% energy savings target set out in the EU Directive (2006/32/EC) (ESD) on energy end-use efficiency and energy services. The assistance by the project and its partners is delivered through practical advice, technical support and results. It includes the development of concrete methods for the evaluation of single programmes, services and measures (mostly bottom-up), as well as schemes for monitoring the overall impact of all measures implemented in a Member State (combination of bottom-up and top-down).

Consortium

The project is co-ordinated by the Wuppertal Institute. The 21 project partners are:

Project Partner	Country
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Task 8.1: National report from the pilot tests of energy audits (EMEEES bottom-up case application 18) in Denmark

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Contents

1 Executive summary

EMEEES Case Application 18: Energy Audits (tertiary and industry sectors) – has been tested in this analysis.

An analysis of DONG Energy's own data from audits at their clients within the public, private services and light industry sectors constitutes the pilot test.

The data is representative of the audits carried out in Denmark. The conclusions of the test should be considered with some reservation as the data material sample is far from statistically significant.

After a brief introduction and presentation of the Danish energy audits and the pilot test to be performed, the report moves on to present the results for step 1 of the Case application methodology. This is followed by a discussion of the steps 2-4 and general and more specific conclusions and recommendations regarding the draft methodology subjected to the test.

Overall, the findings of the pilot test are as follows:

- There does not seem to always be an incentive to more from level 1 to level 2 to level 3 in the evaluation approach. The proposed EMEEES default values do not in all cases provide an incentive for choosing high level (3) approach for electricity. It appears that at least in the Danish case, for heat and fuel savings the incentive is not as intended in the public sector nor in the light industry sector. The data for the private sector were not conclusive regarding heat and fuels.
- The default lifetime of the measures implemented (step 4) can be argued as being short, but since there is an option for national choice, they are acceptable.

Based on the main conclusions of the analysis, our proposals for improvements of the draft methodology include among other the following:

- The appropriate form for communicating the EMEEES methodologies should be considered. It may be relevant to produce an overview pamphlet for decision-makers commissioning evaluations or in charge of evaluation tasks, and provide training and training materials on how to use the EMEEES methodologies.
- Level 1 evaluation should only be recommended for those who have not yet initiated an audit programme. Once initiated there will be data sufficient to allow level 2 or even level 3 assessments.
- Stress the importance of quality assurance of registered audit data. Collecting data with faults is a waste of time and resources.
- Regarding the definition of baselines, maybe insert a comment on how the auditors calculate the difference between *before* and *after* and maybe use the Danish situation as an example. In Denmark, the energy consumption of the previous year is the starting point (level 1 and 2) and for building improvements, the actual existing technology is used as reference relative to the new technology. For appliances, the reference is the market average relative to the new appliance.
- Add a comment in the section on baselines on the fact that – for the sake of simplicity – the natural development is often ignored – i.e. it is assumed that the energy-efficient technology would never have been implemented if no policy was in

place, while in fact it is often only the time of implementation that has been moved to an earlier point in time.

- The draft methodology proposes that if audits contribute more than 10% to the total national ESD target then a level 2 or 3 should be chosen (section 3.4.3.2). We propose that the 10% threshold is used as requirement for moving from level 2 to 3 so that the use of level 3 becomes more frequent (and level 1 almost avoided)
- If audits are part of savings obligations or a white certificate scheme, the impact of free-riders should be assessed. It is our impression that the amount of free-riders has a real risk of being significantly larger than the multiplier effects due to the construction of these systems. We therefore recommend a critical attitude towards the level of free-ridership and that the Danish value of 50% also be listed in the methodology along the Finnish experience, which estimates 10-15% free-ridership.

All suggestions have been written into the original draft methodology and submitted to the project coordinator and MOTIVA who was the primary agent in the writing of the methodology for energy audits.

2 Introduction

DONG Energy has been assisted by staff from the Danish Energy Authority in preparing this report.

Furthermore, two important sources of information have been consulted:

- The road to an increasing number of cheap energy savings – Evaluation of the Danish energy-saving activities; produced by Ea Energy Analysis, Niras, RUC & 4-Fact for the Danish Energy Authority; December 2008.
- Evaluation of the energy distribution companies' non-commercial company audits – Background and description; produced by Kirsten Dyhr-Mikkelsen for AKF; October 2004.

	EMEEES Methodologies tested (bottom-up)	**Sector**
1	EMEEES case application 18: Energy Audits	- public sector - private services sector - light industry (industry not included in the EU CO2 quota system)

3 Description of the EEI facilitating measure considered for the pilot test

Title of the EEI measure	*Energy audits in Denmark illustrated by audits performed by DONG Energy in the period 2006-2008. This period has been selected since regulatory changes were made to the energy company activities in 2005 that may make comparison of audits before and after less straight forward. But energy audits have been carried out for many years and are only one of several energy savings services provided by the companies. Although the non-commercial audits are thus now an activity under the energy company obligation system, it is not the characteristics of the obligation systems that has been tested in the pilot test but only the audit activity.*
Category	*Energy audits*
Regional application	*The entire country*
Sector(s) addressed	*Cross sectoral*
Target group	*Public sector, private service sector, and light industry sector* *According to the Danish Economic Council ("Økonomi & Miljø 2009", page 270), the total energy related Danish green house gas emission, which is not regulated by the EU CO2 Emission Trading System, was 23.7 million tonnes CO2 equivalents in 2005. The public sector contributed with 3%, the private service sector with 3% and the light industry with 4% (the remainder is made up by other businesses 18%, households 4%, and transport 57%).*
End-use EEI action targeted	*Identification of energy-saving projects through energy audit of each institution or company.* *The end-uses covered are various including process heat, process electronics, process compression, cooling, pressurised air, motors, ventilation, space heating, lighting, electric appliances, conversion, etc.* *A review carried out in 2004 showed that lighting and cooling were the most frequently suggested measures. But the degree of realisation was highest for pressurized air (46%).The largest savings however, were found in process motors. Since then the context and framework for the auditing have changed and no study made of the tendencies.* *One thing that is apparent is that the size of the required investment cost is not indicative for the customer interest in realising the potential.*
Effectiveness	*Description of how the energy audits will be performed:* *- Visit by adviser* *- Mapping of the found energy-savings* *- Energy-savings follow-up* *- Energy audits can be supplemented by offers to help with funding or help with further advice (tender documents and the like.)* *- Reporting to the Danish Energy Authority* *Audits are typically offered by the energy companies and offered as commercial & non-commercial services. The non-commercial is part of the energy saving obligation of the energy distribution companies.*

If available: expected annual energy savings in 2016 and 2010	*Not available*
Status of implementation and exact timeframe	*EEI measure implemented in another form earlier than 1995 (1991), "regularly reviewed" and still effective in 2010 and 2016, respectively.* The energy saving obligation system introduced in 2006, will continue at least until end 2011 (including), but the obligation level was increased in 2009.

Energy audits were in Denmark introduced in the early 1990's and are still offered. The audits supplement a variety of other energy efficiency programs. Examples of historical programs are the 'Campaign for efficient ventilation' and the 'Energy management scheme for large buildings'.

The audits were originally solely electricity audits and part of the agreement between the electricity distribution companies and the Danish government to offer a certain level of electricity advice to all customers. The electricity auditors were equipped with various tools (models, guidebooks) that helped make the offer uniform across the country and ensure a certain professional quality.

All enterprises with an electricity consumption of more than 20 MWh/year, i.e. about 150.000, were targeted in 2002. The annual budget for electricity audits was in 2002 about 100 million DKK (i.e. about 13 million EUR assuming 1 EUR = 7.5 DKK) and is recovered via the energy tariff. This figure does not include the cost, which the companies themselves incurred due to time spent in relation to the audit and investments made in energy efficiency improvements.

With the introduction of market competition in the energy markets in Europe and in 2005 the new organisation of the Danish energy efficiency activities, the situation changed and the focus on electricity savings was not longer relevant. Instead the auditors are today able to report savings within all types of energy and can focus on meeting the needs and wishes of the customers rather than a small section of the customer's end-use consumption.

Furthermore, together with the introduction of energy saving obligation the energy companies were given more freedom in their pursuit of energy savings. They were given freedom to choose which customers to approach where to find these geographically (before a reasonable mix of customers was required and only within the supply area of the energy company) and which energy forms to address (before they had to limit themselves to the energy type supplied). And now the energy companies also have to show that they caused actual savings as opposed to information about where savings can be found.

Energy audits in a Danish context may consist of either a full energy audit from A to Z (total audit) or an audit of selected parts of the company (partial audit). A full energy audit inspects all end-uses while a partial audit inspects only selected end-uses or end-uses consuming a selected type of energy (e.g. electricity). Partial audits are widely used, as this concept can accommodate the company's interests and has grown to represent about

80%[1] of all energy audits in 2004.

Originally, the Danish energy audit data was reported to a common database handled by the umbrella organisation of the electricity companies. The data was then used to report progress and costs to the authorities. The total number of cases reported to the database was about 17,000 in 2001.

With the introduction of competition among the companies, the common database was abandoned and data is no longer gathered centrally.

Today the auditors typically try to form long-term relationships with the customers and will take contact from time to time either on their own initiative or upon request from the customer to see if already identified saving potentials can be realised or new possibilities identified. After an audit, DONG Energy will thus after an agreed period of time contact the client to hear which projects have been realised and their impression of how many kWh savings have been realised. The data from this process is the basis of the pilot test. All involved in the pilot test has been involved in an energy-saving process with DONG Energy.

[1] "Evaluering af elnetselskabernes ikke-kommercielle erhvervsrådgivning", 2004 page. 8

4 Method 1

4.1 Testing activity description

The energy saving measures, i.e., the energy audits used in the pilot test have been implemented during the period 2006-2009.

The purpose of the presented test has been to assess the following:

- Do the **proposed default value**s provide an incentive for choosing a high level (3) method for both electricity and heat and fuels?
- Do **existing data collection routines** have to be modified and supplemented in order to provide the required data?
- Does the developed methodology to a reasonable degree **reflect the real world** as we see it – in particular in terms of lifetime and realisation degree?
- Can current energy audit **trends** be captured by the methodology?

4.2 Main data sources used for the pilot test

The analyses for level 1, 2 and 3 assessment presented in this report are based on data from DONG Energy's archives.

It has been decided to use such data mainly because:

- DONG Energy audit data can be considered representative for the national energy audit efforts as DONG Energy accounts for a large part of the effort made in this area. DONG Energy as an energy distribution company accounts for approximately 25% of the non-commercial energy savings (obligations) carried out in Denmark.
- DONG Energy has in the past 15 years conducted energy consultancy in the concerned sectors. The 15 years of experience have resulted in a comprehensive collection of detailed statistical material.
- Using DONG Energy data gives easy access to the full energy audit reports and therefore also the details concerning each audit that are relevant in assessing the appropriateness of the methodology and understanding the mechanisms behind the numbers.
- DONG Energy supplies all types of energy and does therefore not have a bias towards one or the other type of energy.
- Delays in the development of other EMEEES case applications to be tested lead to a delay in testing, which reduced the time available greatly, which made collection of data from other sources difficult.

The data are reported annually to the Danish Energy Authority (electronically) and did therefore not require a special data collection mission. However, extra analyses were carried out in order to establish the details on variations within the different sectors.

The actual resulting energy savings can be difficult to ascertain since the energy consumption depends on several variables. Therefore, conservative estimates of potential energy savings are typically used in the audit reports so as not to risk promising the clients

more than can actually be realised.

The energy audit data used in this analysis is based on "full audits", but the tendency today is to carry out "partial audits", with the exception of very large industrial clients with long-term partnership agreement with the energy distributor. There is, however, a growing interest in ESCO business in certain consumer segments, which may result in a switch back to a greater emphasis upon "full audits".

The data analysed relates to three customer segments:

- Public sector – Buildings in the municipal services sector (residential buildings not included),
- Private enterprises – Buildings in the private services sector (residential buildings not included), and
- Light industry – Industrial consumers excluding energy-intensive process industry.

The presented figures do not necessarily include all of the realised savings generated as a result of the energy audit. Some EEI actions might have been realised after the status date (typically 1 year after the energy audit) and therefore not registered.

EEI action implementation is often postponed due to the following reasons:

- EEI actions are implemented within comprehensive renovation actions.
- Economic considerations.
- Organisational decision-making.

Some savings will therefore not be registered unless DONG Energy has a long-term relationship with the customer.

The applied conversion factors can be found in Appendix II at the back of this report. These factors are generally applied by the Danish energy audit industry and the Danish Energy Authority.

4.3 Test of methodology application step by step

In the following, no attempt has been made to scale up the data to the total volume of energy audits carried out in Denmark (in calculation step 2). Instead, data from the DONG Energy clients is used to raise a number of discussion points. The low number of audits analysed may lead to distortions, which would not occur if a larger number of statistical data had been investigated.

The three tables below show the total annual energy consumption for each customer included in the analysis from the three consumer segments considered, as registered in the audit reports, and the estimated annual energy savings calculated by using the **default EU values for level 1** assessment. The applied conversion factors can be found in Appendix II.

Public sector	Total annual energy consumption registered		Annual energy savings calculated using level 1 default values		
	Electricity [kWh/yr]	Heat and fuels [kWh/yr]	Electricity [kWh/yr] (2%)	Heat and fuels [kWh/yr] (3%)	Total [kWh/yr]
Client 1	530,000	1,048,000	10,600	31,440	**42,040**
Client 2	154,790	2,067,000	3,100	62,010	**65,110**
Client 3	1,095,120	1,061,000	21,900	31,830	**53,730**
Client 4	494,000	425,000	9,880	12,750	**22,630**
Client 5	1,617,310	3,488,100	32,350	104,640	**136,990**
Total	3,891,220	8,089,100	77,830	242,670	**320,497**

Private sector	Total annual energy consumption registered		Annual energy savings calculated using level 1 default values		
	Electricity [kWh/yr]	Heat and fuels [kWh/yr]	Electricity [kWh/yr] (1,5%)	Heat and fuels [kWh/yr] (4%)	Total [kWh/yr]
Client 1	2,025,470	-	30,380	-	**30,380**
Client 2	321,240	-	4,820	-	**4,820**
Client 3	224,790	-	3,370	-	**3,370**
Total	2,571,500	-	38,570	-	**38,570**

Light industry	Total annual energy consumption registered		Annual energy savings calculated using level 1 default values		
	Electricity [kWh/yr]	Heat and fuels [kWh/yr]	Electricity [kWh/yr] (1%)	Heat and fuels [kWh/yr] (2%)	Total [kWh/yr]
Client 1	809,000	-	8,090	-	**8,090**
Client 2	703,500	824,490	7,060	16,490	**23,550**
Client 3	1,200,000	-	12,000	-	**12,000**
Client 4	4600,000	-	46,000	-	**46,000**
Total	7,312,500	824,490	73,150	16,490	**89,640**

In Denmark, a combination of level 2B and level 3 approach is used, since part of the audit service is a follow-up where the auditor asks the client, which of the identified projects have been implemented (level 3) and cursorily whether the client has experienced any great deviations from the expected resulting savings. For smaller customers, national default values (level 2B) based on level 3 experiences are applied for the implementation

rate of energy savings identified in the audits.

No **level 2A** assessment has been carried out for this exercise.

Instead the next three tables below show the total identified annual energy saving potential as registered in the audit reports and the estimated annual savings calculated by using the **default EU values for level 2B** assessment of how much of the potential savings has been implemented.

Public sector	Identified potential annual energy savings in audit report		Annual energy savings calculated using level 2B default values		
	Electricity [kWh/yr]	Heat and fuels [kWh/yr]	Electricity [kWh/yr] (25%)	Heat and fuels [kWh/yr] (25%)	Total [kWh/yr]
Client 1	40,900	17,600	10,230	4,400	**14,630**
Client 2	36,480	140,100	9,120	35,030	**44,150**
Client 3	152,000	-	38,000		**38,000**
Client 4	27,300	-	6,830		**6,830**
Client 5	345,000	-	86,250		**86,250**
Total	601,678	157,700	150,430	39,430	**189,860**

Private sector	Identified potential annual energy savings in audit report		Annual energy savings calculated using level 2B default values		
	Electricity [kWh/yr]	Heat and fuels [kWh/yr]	Electricity [kWh/yr] (25%)	Heat and fuels [kWh/yr] (25%)	Total [kWh/yr]
Client 1	720,400	-	180,100	-	**180,100**
Client 2	19,200	-	4,800	-	**4,800**
Client 3	42,500	-	10,630	-	**10,630**
Total	782,100	-	195,530	-	**195,530**

Light industry	Identified potential annual energy savings in audit report		Annual energy savings calculated using level 2B default values		
	Electricity [kWh/yr]	Heat and fuels [kWh/yr]	Electricity [kWh/yr] (20%)	Heat and fuels [kWh/yr] (15%)	Total [kWh/yr]
Client 1	115,050	-	23,010	-	**23,010**
Client 2	100,000	96,000	20,000	14,400	**34,400**
Client 3	81,000	-	16,200	-	**16,200**
Client 4	1,150,000	-	230,000	-	**230,000**
Total	1,446,050	96,000	289,210	14,400	**303,610**

And finally follow three tables showing the identified potential annual energy savings and the estimated annual savings from realised end-use actions as identified in the audit follow-ups (**level 3** assessments). The numbers shown in red do not solely relate to the potentials identified under the audits but also contain savings from other initiatives. It is far from uncommon that energy efficiency improvement projects suggested in the audit are later adjusted or expanded and therefore the estimated achieved savings may differ from those initially specified.

The numbers marked in red are savings that can be said to be "free-rider" savings. These saving potentials were not identified during the audit but later realised.

Public sector	**Identified potential annual energy savings in audit report**			**Estimated annual energy savings from realised end-use actions**		
	Electricity [kWh/yr]	**Heat and fuels [kWh/yr]**	**Total [kWh/yr]**	**Electricity [kWh/yr]**	**Heat and fuels [kWh/yr]**	**Total [kWh/yr]**
Client 1	40,900	17,600	58,500	21,500 (52.6 %)		**21,500**
Client 2	36,480	140,100	176,580	21,240 (58.2 %)	840 (0.6 %)	**22,080**
Client 3	152,000	-	152,000	79,300 (52.1 %)		**79,200**
Client 4	27,300	-	27,300	27,300 (100 %)		**27,300**
Client 5	345,000	-	345,000	57,400 (29.8 %)	45,500kWh	**102,900**
Total	601,680	157,700	759,380	206,640	46,340	**252,980**

Private sector	**Identified potential annual energy savings in audit report**			**Estimated annual energy savings from realised end-use actions**		
	Electricity [kWh/yr]	**Heat and fuels [kWh/yr]**	**Total [kWh/yr]**	**Electricity [kWh/yr]**	**Heat and fuels [kWh/yr]**	**Total [kWh/yr]**
Client 1	720,400	-	720,400	88,400 (12.3 %)	60,100 kWh	**148,500**
Client 2	19,200	-	19,200	12,645 (65.9 %)		**12,650**
Client 3	42,500		42,500	42,500 (100 %)		**42,500**
Total	782,100	-	782,100	143,550	60,100	**203,650**

Light industry	Identified potential annual energy savings in audit report			Estimated annual energy savings from realised end-use actions		
	Electricity [kWh/yr]	**Heat and fuels [kWh/yr]**	**Total [kWh/yr]**	**Electricity [kWh/yr]**	**Heat and fuels [kWh/yr]**	**Total [kWh/yr]**
Client 1	115,050	-	115,050	58,250 (50.6 %)	%	**58,250**
Client 2	100,000	96,000	196,000	19,000 (19 %)	77,000 (80,2 %)	**96,000**
Client 3	81,000	-	81,000	78,890 (97.4 %)	%	**78,890**
Client 4	1,150,000	-	1,150,000	980,000 (85.2 %)	%	**980,000**
Total	1,446,050	96,000	1,542,050	1,136,140	77,000	**1,213,140**

The aggregated results from **calculation step 1 and 2** for the investigated clients are presented in the table below. The numbers in bold are the highest numbers achieved for that particular level and consumer segment. In the table, two values are specified for heat and fuels in the public sector. This is due the fact that some of the reported savings were not identified during the audit but later realised – the large value is thus including this "free-rider effect".

Segment	Level	Electricity [kWh/yr]		Heat and fuels [kWh/yr]		Total [kWh/yr]	
Public sector (5 clients)	1	77,830	100%	**242,670** **93,450**	100% 100%	**320,497** **171,280**	100%
	2	150,430	193%	39,430	16% 42%	189,860	59% 111%
	3	**206,640**	266%	46,340	19% 50%	252,980	79% 148%
Private sector (3 clients)	1	38,570	100%	-	100%	39,570	100%
	2	**195,530**	507%	-	-	195,530	494%
	3	143,550	372%	**60,100**	-	**203,650**	515%
Light industry (4 clients)	1	73,150	100%	16,490	100%	89,640	100%
	2	289,210	395%	14,400	87%	303,610	339%
	3	**1,136,140**	1,553%	**77,000**	467%	**1,213,140**	1,353%

The intention of the three level approach is to provide Member States with an incentive to increase evaluation efforts. Thus savings calculated using the level 1 approach should ideally provide lower numbers than the level 2 approach and the level 2 approach should provide lower numbers than the level 3 approach. It appears that for heat and fuel savings the incentive is not as intended in the public sector nor in the light industry sector. The data for the private sector were not conclusive regarding heat and fuels and appear not to result in the correct incentive structure for electricity although there is a push away from level 1.

Part of the explanation for the default values not working for heat and fuels could be the following:

- The statistical data used here is very limited.
- In Denmark, only first year savings can be claimed towards the savings obligation. This results in a bias that for example discriminates building insulation. Insulation does not result in a high first year saving but have a long lifetime and therefore a significant saving over time. This problem is also noticed in the recently published report: "En vej til flere og billigere energibesparelser". One way to solve this problem is to favour savings with a significant lifetime but a long investment payback. This can be done by multiplying the kWh savings by an appropriate factor.
- Electricity savings often have a lower payback time than heat savings. The customer and energy adviser often focus on electricity savings because of this fact. Payback times of more than 3-5 years are not attractive.
- Furthermore, savings in electricity often linked to the customer's desire to improve the visual or comfort-related issues in the building. This fact leads to focus on electricity savings. Electricity savings associated with the renovation of lighting is a good example of customer interest in better lighting coincides with the desire for energy savings. Heat and fuel projects are often only driven by the wish for energy savings. Client priority of these energy savings is low, which obviously influences the energy audit focus.
- In the DONG Energy area particularly the public sector primarily consists of buildings in the Copenhagen city centre. Some of these buildings are listed buildings, making it impossible/difficult and costly to implement heat and fuels savings through insulation.

Segment	Electricity	Heat and fuels	Total energy
Public sector (5 clients)	Significant incentive (1-2-3)	Level 2 and 3 very close (2-3-1)	Level 2 highest (2-3-1 / 2-1-3)
Private sector (3 clients)	Level 2 highest (1-3-2)	Not sufficient data	Significant incentive (1-2-3)
Light industry (4 clients)	Greatly significant incentive (1-2-3)	Level 3 highest (2-1-3)	Greatly significant incentive (1-2-3)

The aggregated results also show that in the light industry segment, a default value of 20% is low in relation to a Danish context. Approximately 80% of the 1.446.000 kWh identified electricity savings have been implemented. This corresponds well with the Danish experience that there is a high number of attractive electricity saving projects in the industry. "Companies may have good reason to apply strict profitability requirements (e.g., uncertainty about the future, greater emphasis on its core areas) but it does not alter the fact that private and industry from an economic point of view is an important target group for attractive energy-saving projects"[2]. Therefore, one can generally say that it is a good idea to have ambitious goals for this segment but still in most EU countries the focus is on other segments.

In **calculation step 3** of the methodology, the numbers are to be corrected for double counting, technical interactions, multiplier effect, and free-riders.

Double counting:

- The audit services overlap with several measures and are deliberately coordinated with other offers. During monopoly times, the electricity companies jointly developed campaigns and tools for example for energy efficient motors to be used in conjunction with audits. Also the Electricity Saving Trust will promote efficient pumps and the auditors incorporate this offer in their audits. And the main overlap is with the activities of the Electricity Saving Trust. No guidelines exist for how to deal with this except that the Danish Energy Authority has stated that they will deal with possible overlaps in the national totals.
- Double counting of energy savings between the obliged parties and their agents is not considered a problem since they have to enter an agreement with the client prior to the activity to ensure the energy savings generated is only given to that particular energy company or agent.

Technical interactions:

- The risk of technical interaction not being taken into consideration in the estimates is deemed to be small, since it is compensated by the fact that the auditors make deliberately conservative estimates and since the auditors – in order to ensure customer satisfaction – will have an incentive to make a low estimate rather than a high. A client that cannot realise the "promised" savings is likely to be a dissatisfied customer. Furthermore, the audit report may very well contain a list of possible projects as well as packages of projects that take into account technical interactions.

Multiplier effect:

- This effect is deemed small with the current obligation system imposed on the energy companies. The obligation system provides the auditors with an incentive to record and claim as many of the realised savings as possible. The competitive market provides an incentive for long-term relationship with promising customers and thus gives the auditors an opportunity to discover and claim additional effects. In some cases, the customer may receive a small financial compensation for the transfer of the right to claim the savings.

[2] **"En vej til flere og billigere energibesparelse" 2008, page 20**

Free-riders:

- It is often such that when an energy audit is carried out, the person in charge of energy consumption in the building already has a lot of ideas on various energy-saving projects. These projects often need to be kick-started. This kick-start is often implemented through an energy audit. Energy savings achieved in this way is not considered to be a free-rider effect. In Denmark, it is a requirement that the energy company has been actively involved in the process of the energy saving project for example through an audit.
- Interviews with 105 large consumers suggest that about half of the savings may be considered to be free-rider effects[3]. Contact persons in the companies were asked to describe the extent to which they already knew the projects before the energy companies came into the picture. Similarly, they were asked about the likelihood that the project would be implemented within one and three years, respectively. The replies indicate that within one year 45% would not have occurred without the energy company's involvement and 33% within three years. Allowing for an amount of spill-over, it is estimated that energy company's energy-saving activities can be assumed to have a free-rider effect of about 50%. This means that half of the saving activities reported by energy companies are not additional but would have been realised by the customers on their own. And interestingly enough even with 50% free-riders "the overall economy is both private and socio-economically attractive".

In **calculation step 4** lifetime, early actions, and uncertainties are dealt with.

The draft methodology proposes to use 6-8 years sliding average for the lifetime of the actions or nationally proven values.

While the energy companies can only claim first year savings towards their saving obligations, the Danish Energy Authority uses 10 years as the lifetime for all electricity actions and 25 years for all other actions in calculating the impact[4] and cost-effectiveness.

At one point in time the electricity companies operated with a large number of lifetimes so that each technology had its own lifetime and phase-out curve. But these have been discarded. A survey made of audits from 1995 suggested that the project implemented will live as long as the equipment or production line to which it is linked.[5]

However, the issue is not just an issue of estimated lifetime but also an issue of earlier introduction of something that would have happened anyway. An example: It is unlikely a house would not be insulated at some point in the relatively near future and an insulation project carried out today may thus only move the savings forward in time by 5 or 10 years, and the achieved "extra" savings should thus only be counted for 5 to 10 years and not 25 years.

Early actions are actions undertaken between 1995 and 2007 that still to some extent are in effect in 2016. Using the default values of the proposed methodology results in no early actions while using the Danish lifetimes some impact would remain and be counted.

[3] **"En vej til flere og billigere energibesparelse" 2008, page 28**

[4] Beregningsteknisk bilag til notat af 8. februar 2007 om samfundsøkonomiske beregninger vedrørende energibesparelser og vedvarende energi, Energipolitisk Udvalg, 22. March 2007,

[5] "Analyse af vederlagsfri energirådgivning med fokus på levetid af konkrete råd", VedKom Kommunkation, 2001.

Denmark would according to the proposed methodology thus have to demonstrate that the lifetimes for Danish audits exceed 6-8 years, which could prove difficult.

The quality of the audit and the audit report are sought guaranteed through certification and templates, guidelines and sample quality control. The greatest uncertainty is estimated to be the actual savings compared to the deemed savings. In very few cases the consumption change is actually monitored and possible to distinguish from changes in other parameters.

There will be errors in data registered but some can be avoided through use of templates and quality control. The errors do not have systematic bias and are thus not considered relevant to the results – it only means that a larger sample has to be picked when evaluating so that after excluding the faulty cases there still remains a sufficient amount for analysis.

Harmonisation of default values

It is as mentioned in the draft methodology difficult to establish common guidelines for EU countries because of the national differences. Some of the barriers making it difficult to apply lessons from Denmark in the setting of default values for the whole EU are:

- Energy audits in a Danish context may consist of either a full energy audit from A to Z (total audit) or an audit of selected parts of the company (partial audit). Partial audits are widely used, as this concept can accommodate the customer's interests and has grown to represent about 80%[6] of all energy audits. This may not be the case in other EU countries. This fact has a consequence for the results of level 1 calculations.
- "Receptiveness toward advice on energy savings depends, among other things, on industry and company size. For example, small businesses are less likely to implement energy-saving activities compared to large firms"7. This may cause problems in the comparison between the situation in Denmark and other EU countries. Denmark is a country with many small and medium sized enterprises, which means that other EU countries with a higher share of larger companies (outside the CO2 quota system) have a better basis to find energy savings.
- The energy saving incentive structure in Denmark has imposed an energy saving obligation on the energy companies who have to save an increasing amount of kWh in enterprises and public institutions. Costs are not shown but can be recovered through the tariff and the savings traded. Thus energy companies have a strong incentive to find and realise savings cost effectively.
- However, in Denmark, the energy savings reported are first-year savings and not life-time savings. This means that there will be a bias that for example discriminates building insulation.
- A different price level leads to different return of investment. For example, a profitable investment in Poland is not necessarily profitable in Denmark. The reason for the variation lies in the energy price level but also in labour and material costs.

[6] "Evaluering af elnetselskabernes ikke-kommercielle erhvervsrådgivning", 2004 page. 8

[7] Evaluering af elnetselskabernes ikke-kommercielle erhvervsrådgivning, 2004 page. 8

- Another challenge is the different energy saving baselines in the EU countries. Since the first oil crisis in 1973 Denmark has worked with energy savings. In 1976, the first Danish energy plan was presented with a focus on increased energy security through the conversion of fuel consumption – less dependency on oil – and energy savings. In 1977, the energy taxes on electricity and oil were introduced and they were increased in 1979. In 1979, building regulations were introduced, which significantly reduced energy consumption in new buildings. In 1984-85, when oil prices fell, significant increases in energy taxes were implemented in order to maintain constant consumer prices of oil[8]. The use of taxes has been an important element in the Danish energy saving policy. The taxes have contributed to a reduction in energy consumption by approx. 10%[9]. In the 1990s, many energy companies started giving energy saving advice. In 1993, CO2 taxes were introduced for business's energy consumption combined with subsidies to energy savings. A total of two billion DKK was given as energy saving subsidies in industries from 1996 to 2001. Law on energy efficiency standards for electric appliances was adopted in 1994 and in 1997 the Electricity Saving Trust was established[10].

The information above taken into consideration, it is difficult to establish general ESD default values based upon Danish and Finnish experiences alone. An analysis of the factors that distinguish the EU countries from each other could be made and the results used to divide the EU countries into groups according to their history in energy savings.

Focus on energy-savings as opposed to electricity savings is also challenged by the EU's CO2 quota. The quota system has increased the incentive for electricity savings in the form of higher electricity prices.

4.4 Methodology test on early actions and additionality issues

Please see section 5.3

4.5 Method comparison and interactions with already existing evaluation methods

As mentioned earlier, the proposed methodology can be applied within the current framework of the Danish energy efficiency activities but whereas earlier the necessary data was easily available, these data now have to be gathered especially and additional information collected. This was last done in 2008.

The philosophy of the current Danish data collection system is pragmatic simplicity. The level of detail has been reduced and is supplemented with sample check of assumptions and effect. This approach might be well suited to a market competition.

Also there is the danger that a large *amount* of data is interpreted as more *accurate* data, which is not necessarily the case. More data does not necessary mean more accuracy – it is has to be the right data. The crux of energy audits is still the realised savings, which are estimated savings (although from an enhanced engineering estimate) and not metered savings, and the additionality of the energy savings identified in an energy audit.

[8] "En vej til flere og billigere energibesparelse" 2008, page 16-17
[9] "En vej til flere og billigere energibesparelse" 2008, page 6
[10] "En vej til flere og billigere energibesparelse" 2008, page 16-17

One problem that very few deal with is that in some instances, when a project is implemented in year x, it does not mean that this would never have happened but only that it happened earlier than it would have if no audit had taken place. This means that the savings achieved are not the savings over the lifetime of the project but the savings achieved in the period until it would have been implemented on its own accord.

4.6 Evaluation of costs related to method application

The data necessary for **Step 1** calculations is automatically collected by each auditor in the audit reports and registered in a company database, as part of the audit service to the customers and documentation of achieved savings that are reported to the Danish Energy Authority as part of the energy saving obligation of the energy company.

Aggregated figures for all energy savings activities under the savings obligation are reported annually to the Danish Energy Authority, but a distinct figure for energy audits is not compiled.

Step 2 and 3 will require special data collecting. Some of this data collection is part of the "routine" evaluations of the Danish Energy Authority but at present the level of detail will not be sufficient to distinguish energy audits from other energy company initiatives.

A few years back, most energy distributors reported their audit data to a central database which allowed benchmarking and analysis. With the introduction of utility savings obligations in 2005 this is no longer the case. The last assessment of the central database information was carried out in 2004.

It will therefore require an extra effort to combine audit data from all those offering energy audits and thus also result in extra costs. Furthermore, extra analyses will have to be carried out in order to establish the details on variations within the different consumer segments.

Since the auditing service has been opened up for market competition due to the fact that the energy distributors with energy saving obligations may offer audits to customers all over Denmark and not just within their own network area, this data is also considered confidential, which complicates matters further.

If one would wish to calculate the impact of energy audits carried out in Denmark, this would as minimum require the collection of aggregated audit data (surveyed end-uses, total energy consumption, identified saving potentials, and realised potentials) and supplementing these with updated expert assessment of current tendencies. Both auditors and independent experts could be consulted.

4.7 Target group perspective

Apart from DONG Energy audit experts and the authors of the evaluations mentioned, it has not been necessary to involve other stakeholders.

4.8 Specific conclusions

Please consult the previous sections.

4.9 General conclusions

With respect to the questions that guided the pilot test (cf. section 4.1 above), the following conclusions can be drawn:

The proposed default values do not in all cases provide an incentive for choosing high level (3) approach for electricity.

It appears that for heat and fuel savings, at least in the Danish case the incentive is not as intended in the public sector nor in the light industry sector. The data for the private sector were not conclusive regarding heat and fuels.

However, the data sample used in the pilot test was very limited and not statistically significant. Further analyses and empirical data might serve to better verify this point.

Other reasons why the default values are not considered to be reliable seen from a Danish perspective are:

- Energy audits may focus on electricity savings instead of heat savings because of issues concerning legislation, history, full energy audit vs. partial audit and the EU's CO2 quota policy.
- Smaller incentive in Denmark with regards to savings in heat and fuels (insulation) than savings in electricity end-uses.
- Trend towards partial audits.

It is therefore the strength of the proposed methodology that values for electricity and heat and fuels are calculated separately. This provides some insight in the possible differences and deviations from the default values.

Regarding the need for an option 2A in level 2 calculations (step 1): In Denmark, the auditing energy company will always collect information about realised savings through follow-up contact (level 3). The latest evaluation of the Danish energy saving efforts complemented this type of data with surveys of customers about their realised savings (level 2, option A). The main difference between the two becomes the "who" has collected the data and "when" (timing) – but both approaches will typically rely on the estimates of the potentials from the audit reports and the customer's statement on degree of realisation. Therefore, option 2A is only applicable in countries that have no detailed database of energy audit report results for the past, as it was recommended in the case application. For the future, the recommendation is to go to level 3 or at least to level 2B with national or measure-specific default values for the share of the identified energy savings that will be realised, based on a sample of level 3 cases.

The default lifetimes of the measures implemented (step 4) can be argued to be short, but since there is an option for national choice, they are acceptable.

In Denmark, existing data collection routines are sufficient in order to provide the required data, but they are not gathered centrally and part of the data is considered confidential. Therefore, it will require an extra effort to collate the necessary data. A possibility could be to select a sample of audits and supplement the audit reports with sample survey among customers and auditors as done in the most recent evaluation.

Depending on the resources at hand the EU Member States can chose the evaluation approach that suit their budgets best. It is however worth mentioning that better

understanding of key factors does not necessarily require expensive data collection efforts – only good and selective investigations.

The current trend in Denmark towards partial audits may not be fully covered by the EMEEES case application, since it provides the same default values irrespective of whether the audits in question are full or partial audits. Partial audits can be expected to give a higher degree of realisation (and better value for the audit money) since they are expected to be more in line with the customer's wishes and means. But again national values can be applied if documented.

Finally, it is worth mentioning that with the introduction of energy saving obligations or white certificate schemes the level of free-riders is likely to increase, which makes it important to assess the level of free-riders and thereby the level of additionality.

4.10 Needs and potentials for improvement of the method tested

Main conclusions of the analysis regarding the needs and potentials for improvement of the method tested are:

- The method is understandable but it is not easily accessible. The primary problem lies in the terminology to be acquired before the actual test can be performed.
- The three level approach appears logical, although a level 1 situation is hard to imagine.
- The suggested default values do not in all cases provide an incentive to increase the level of evaluation when possible. Also the gap between them may be too large.
- Denmark does not possess data for assessing the validity of the proposed default values for "a" (actions).
- Introduction of the factor "DI" for degree of implementation appears to be an unnecessary complication. At level 3, the potential energy savings from the already implemented, the planned, and the considered end-use actions identified in the audit reports and stored in the database can directly be added together for each participant/customer.
- The term "sliding" average lifetime is not clearly defined.
- Table 3 is incomplete.
- Figure 3 does not hold true for all energy audit schemes.
- The importance of quality assurance of registered audit data is not stressed and our experience is that the quality is often too low if no extra initiative is taken to improve it.
- The definition of baselines may justly vary from country to country. In Denmark we use the energy consumption of the previous year as the starting point (level 1 and 2). For building improvements we use the actual existing technology as reference relative to the new element. For appliances, the reference is the market average relative to the new appliance.
- Another baseline issue is that often the natural development is ignored – i.e. it is assumed that the energy efficient technology would never have been implemented if no policy was in place while in fact it is often only the time of implementation that

has been moved to an earlier point in time.

- At present, there is no specific requirement for when to move from level 2 to 3 (section 3.4.3.2).
- The default values shown in Table 9 do not distinguish between "full audits" and "partial audits". Whether it is one or the other can, however, greatly influence the implementation rate.
- Double counting is an important issue but no recommendations are provided.
- With the introduction of savings obligations and white certificate schemes the tendency is that multiplier effects will be caught and counted by the obliged parties or those that can obtain white certificates. But savings obligations and white certificate schemes in their most common form have a tendency to increase the free-rider problems among counted savings. A recent evaluation shows that the level of free-riders in Denmark is as much as 50%.
- The CEN/CWA27 is not listed in appendix I.

Proposals for improvements of the draft methodology:

- The appropriate form for communicating the EMEEES methodologies should be considered. It may be relevant to produce an overview pamphlet for decision-makers commissioning evaluations or in charge of evaluation tasks, and provide training and training materials on how to use the EMEEES methodologies.
- Level 1 evaluation should only be recommended for those who have not yet initiated an audit programme. Once initiated there will be data sufficient to allow level 2 or even level 3 assessments.
- The default values should be revised or a note added regarding the importance of the type of audits performed on the resulting incentives for the choice of evaluation effort.
- We have no recommendations regarding the proposed default values for "a" (actions).
- Avoid introduction of the factor "DI" for degree of implementation.
- Define the term "sliding" average lifetime.
- Additions to Table 3 have been suggested.
- Add sentence to Figure 3 explaining that the figure represents the Finnish audit system and why the bottom level is expenditure and not audit volumes.
- Stress the importance of quality assurance of registered audit data. Collecting data with faults is a waste of time and resources.
- Regarding the definition of baselines, maybe insert a comment on how the auditors calculate the difference between before and after and maybe use the Danish situation as a case.
- Add a comment in the section on baselines on the fact that – for the sake of simplicity – the natural development is often ignored – i.e. it is assumed that the energy efficient technology would never have been implemented if no policy was in place while in fact it is often only the time of implementation that has been moved to

an earlier point in time.

- We propose that the 10% threshold, suggested in section 3.4.3.2, is used as requirement for moving from level 2 to 3.
- Add a comment to the default values shown in Table 9 underlining the fact that whether the audits in question are "full audits" and "partial audits" can greatly influence the implementation rate.
- Regarding double counting, we recommend that as minimum a list of the overlapping measures is prepared with a brief explanation of the character of the overlaps.
- If energy audits are part of energy savings obligations or a white certificate scheme the impact of free-riders should be assessed. It is our impression that amount of free-riders has a real risk of being significantly larger than the multiplier effects due to the construction of these systems. We therefore recommend a critical attitude towards the level of free-ridership and that the Danish value of 50% also be listed in the methodology along the Finnish experience which estimates 10-15% free-ridership.
- The CEN/CWA27 is not listed in appendix I.
- Furthermore, a number of alterations to the text were suggested.

All suggestions have been written into the original methodology and submitted to the project coordinator and MOTIVA who was the primary agent in the writing of the methodology for energy audits.

References

The road to an increasing number of cheap energy savings – Evaluation of the Danish energy-saving activities. (En vej til flere og billigere energibesparelser. Evaluering af samtlige danske energispareaktiviteter.); produced by Ea Energy Analysis, Niras, RUC & 4-Fact for the Danish Energy Authority; December 2008.

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Appendix I: List of persons involved in the pilot tests

- Kirsten Dyhr-Mikkelsen, Senior Consultant, Ea Energy Analyses
- Tine Florin, Engineer, Energy Advisor DONG Energy
- Søren Vontillius, Cand.techn.soc, Energy Advisor DONG Energy

Appendix II: Applied conversion factors