PEER-REVIEWED PAPER

Spreading the word – an online non-energy benefit tool

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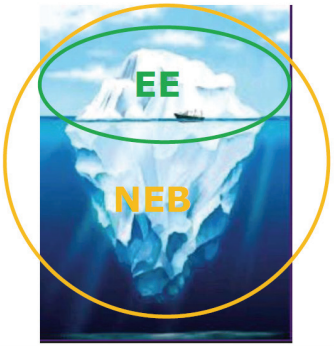
Abstract

Many people around the world have been and are calculating the potential for energy savings both on consumer level and on country level. The result is more or less the same – If the acceptable payback time is up to 4 years then the potential is 10–15 % savings.[1] So why are industrial companies not keen to "harvest their potential"? Have we forgotten something?

When energy consultants and industrial companies discuss energy efficiency (EE) projects the potential energy savings are quite naturally in focus, but frequently the value of secondary effects of these projects is just as high or even higher. Such secondary effects are typically referred to as non-energy benefits – NEBs. Examples are reduced waste, reduced emissions, reduced maintenance costs, a better working environment, and reduced production downtime.

NEBs are traditionally not included in the economics of energy efficiency project implementation since there is no commonly recognised method for calculating their value, nor has the area been prioritised. However, research indicates that if NEBs are included, the true value of the energy efficiency projects might be up to 2.5 times higher than if looking at the energy efficiency improvements alone. Access to information on NEBs and their size might thus lead to higher acceptance and implementation of energy efficiency projects.

This paper presents a method for valuation of NEBs and a web-based tool for collection and visualisation of NEBs of energy efficiency projects. Visualisation of NEBs increases probability that company decision-makers will implement energy efficiency projects. The value of each NEB is rated relative to the perceived value of the energy efficiency improvement as seen by the company decision-maker. The tool is intended to help the company energy manager, sales person, engineer, etc. to put energy efficiency projects on the agenda and thereby – hopefully – increase the numbers of projects implemented.



Introduction

"Energy efficiency is the most promising means to reduce greenhouse gases in the short term," said Yvo de Boer in 2007, then head of the UN Climate Change Secretariat.[2] The message was re-iterated by Maria van der Hoeven, Executive Director, International Energy Agency, in the World Energy Outlook 2013: "Energy efficiency is the only fuel that simultaneously meets economic, energy security and environmental objectives."

Energy efficiency plays a major role in EU efforts to improve productivity, energy security, job creation, and sustainability:

> Energy efficiency is at the heart of the EU's Europe 2020 Strategy for smart, sustainable and inclusive growth and of the transition to a resource efficient economy. Energy ef-

1. Besparelser i erhvervslivet; Viegand & Maagøe for the Danish Energy Agency; February 2010.

2. The Environment in the News, Wednesday, 29 August 2007, UNEP.

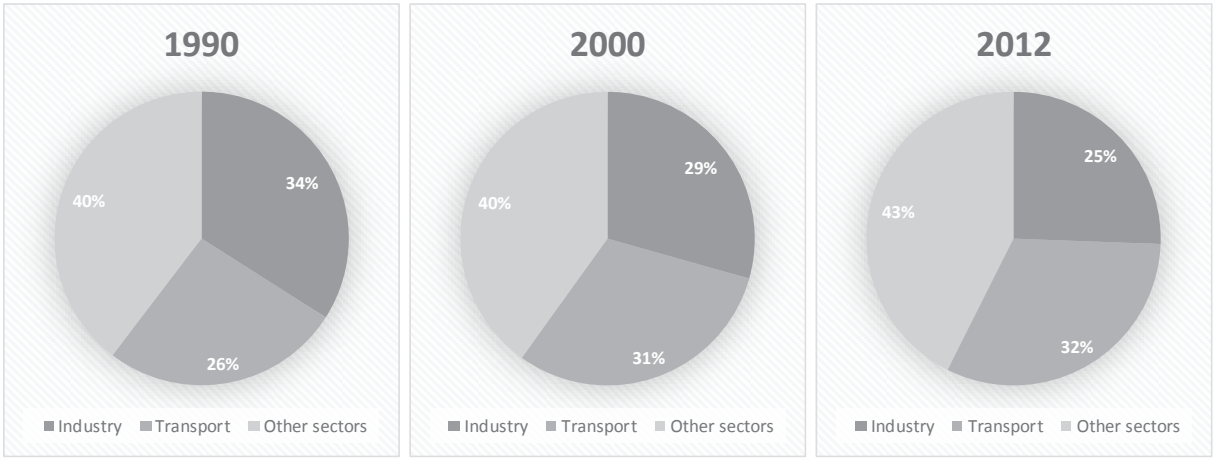


Figure 1. Final energy consumption (TJ) in EU28 [Eurostat Statistical database, nrg_100a, 2014].

> ficiency is one of the most cost effective ways to enhance security of energy supply, and to reduce emissions of greenhouse gases and other pollutants. In many ways, energy efficiency can be seen as Europe's biggest energy resource.[3]

The industry sector still accounts for about a quarter of the final energy consumption in the EU28 in 2012.[4] In absolute terms industrial final energy consumption has decreased from 15.4 million TJ in 1990 to 11.8 million TJ in 2012.

The new EU energy efficiency directive (2012/27/EU) that came into force 4th December 2012 includes a Member State obligation to ensure that large enterprises carry out an energy audit at least every four years plus create incentives for SMEs to undergo energy audits to help them identify the potential for reduced energy consumption. A study conducted by the IEA in 2007[5] concluded "that manufacturing industry can improve its energy efficiency by an impressive 18 to 26 %, while reducing the sector's CO_2 emissions by 19 to 32 %, based on proven technology. Identified improvement options can contribute 7 to 12 % reduction in global energy and process-related CO_2 emissions." Similarly, a study from 2010[6] on the energy savings potential in Danish industries found that with a maximum two year payback time requirement 10 % of the final energy consumption could be saved well proven technologies and energy efficient behaviour. If the payback time requirement is extended to 4 years then the potential savings increased to 15 %.

How come that you in Denmark – after several decades of political focus on energy efficiency – can still can find 10–15 % savings potential with a payback time of less than 4 years? Maybe, part of the reason is that we, the energy consultants, think we have a great product, but the product does not create the same excitement with the management in the industrial companies because our focus is on the energy savings and not the entire portfolio of benefits. Non-energy benefits include among other reduced maintenance cost, better product quality, increased production, better working environment, etc. – all issues that matter to the industrial companies but sometimes are hard to quantify. This paper presents a way forward to overcome this challenge.

The NEB tool

When energy consultants and industrial companies discuss energy efficiency (EE) projects the potential energy savings are quite naturally in focus, but frequently the value of secondary effects of these projects is just as high or even higher. Such secondary effects are typically referred to as non-energy benefits – NEBs. In principle, these secondary effects may also include negative effects. The existence of NEBs is not new to the energy efficiency community and some energy consultants use NEBs to leverage client interest in energy efficiency. However, the value of NEBs is not systematically assessed nor the information compiled on a larger scale.

Lokalenergi (an electricity retail and energy service company), the Danish Technological Institute, and Ea Energy Analyses (a consulting firm) has taken the initiative to develop a NEB tool aimed at Danish energy consultants providing energy efficiency services primarily to the industrial sector but also other business sectors. The research project is partially financed by Elforsk, the research and development program of the Danish Energy Association.

The underlying assumption behind the development of an NEB tool for energy consultants and companies is that easy access to information on NEBs and their size might lead to higher acceptance and implementation of energy efficiency projects.

The NEB tool will be a web-based tool that consists of the following elements:

- Method for assessing NEBs of energy efficiency projects,
- NEB database that allows users to search e.g. by branch and energy efficiency project type,
- Case examples with more detailed description of energy efficiency projects and the associated NEBs,
- Questionnaire for identification and assessment of NEBs, and
- Suggested further reading.

3. Energy Efficiency Plan 2011; COM(2011) 109 final; Brussels, 8th March, 2011.

4. Eurostat statistical database, 2014.

5. Tracking industrial energy efficiency and CO_2 emission, IEA, June 2007, ISBN: 978-92-64-03016-9.

6. Besparelser i erhvervslivet; Viegand & Maagøe for the Danish Energy Agency; February 2010.

The NEB research project consists of two phases. During the first phase, the method for assessing NEBs was developed and tested on 12 specific energy efficiency projects in close dialogue with the involved industrial and tertiary sector companies. In addition, a prototype of the online NEB database was developed. The second phase started in February 2014 and aims to adjust the prototype based on the feedback received from the 12 test cases and expand the database of project cases significantly. A large volume of similar cases may allow the team to derive valid generalisations concerning the expected type and size of NEBs associated with certain types of projects, which can be compared to international experience. An important element of the second phase is also to encourage a wide use of the database.

NEB tool will be available online to all interested parties although the primary user group is intended to be energy consultants offering energy efficiency services. New energy efficiency projects and associated NEBs can be added so that the database of cases is continuously expanded.

Experienced NEBs

The NEB tool will contain information on the NEBs of specific energy efficiency projects *as experienced by the project holder*. It is the experiences of the project holders that determine the importance and thus size of the NEBs. The energy consultant that has assisted the client (i.e. project holder) with the energy efficiency project may assist the project holder in identifying and assessing the NEBs but the point of view should be the client's point of view. It is, however, also possible for the project holder to make an assessment of the NEBs on his own since both energy consultants and clients will have access to the NEB tool.

It is also worth mentioning that it is *not* the ambition that all NEBs of a given project should be identified and their size assessed. Rather it is the ambition to capture the *most important* NEBs experienced by the client.

The key NEBs experienced are first identified and classified and then their relative size is assessed. An explanation of how this is done is presented in the following two sections.

CLASSIFICATION OF NEBS

NEBs are traditionally not included in the economic assessment of energy efficiency projects since there is no commonly recognised method for calculating their value, nor has the area been systematically prioritised. However, research indicates that if NEBs are included, the true value of the energy efficiency projects might be up to 2.5 times higher than if looking at the energy efficiency improvements alone[7].

NEBs have been discussed since the 1990's and many research studies have been carried out. Some of the more recent studies, reviewed in relation to the development of the NEB tool, are listed in Appendix 1. The review of these studies had influence on the method setup used for assessing the NEBs in the NEB tool. The majority of the studies have fed into the decision about what categories and sub-categories of NEBs that should be represented in the NEB tool, e.g. the studies "Arbejdsmiljø i et topledderperspektiv" (Working environment from the view of top management), "Energieffektivisering av VA-sektorn" (Energy efficiency in the water sector) and "Non-energy benefits from commercial and industrial energy efficiency programs: Energy efficiency may not be the best story". The study of Andrea Preciado gave inspiration to make comparative valuations, where NEBs are compared to the value of the energy savings. The reviews also had influence on the chosen method regarding interviews and estimation methods.

The review combined with the first hand experiences of the project partners thus formed the basis for the NEB classification used in the web based tool. The classification is presented in the table below. There are four main categories: 1) NEBs influencing productivity, 2) sales and company image, 3) the environment internally in the company, and 4) the external environment and society.

ASSESSMENT METHOD

The NEB values are assessed relative to the achieved energy efficiency improvement. In other words, the achieved energy efficiency improvement is used as index. The value +100 describes the expected benefits of the project in terms of energy efficiency improvement. The NEBs are then rated relative to this index.

If, for example, an industrial company as a result of an energy efficiency project experienced an increased productivity estimated to be twice as valuable as the achieved energy savings, the NEB "productivity" is assigned the value +200. If increased productivity is estimated to have a value of ¼ of the energy savings then the NEB value is +25. It is worth noting that NEBs may have negative values.

Using an index avoids having to translate all NEBs into an exact monetary value and emphasizes that it is the impact as perceived by the client that is in focus. A project may for example have resulted in significantly reduced the noise levels in the factory workshops and the client may judge the reduction just as valuable as energy savings.

The individual NEBs of a given project are in the tool summarised by main category of NEB and presented in a bar chart. Together they may add up to a greater value than the energy efficiency improvements themselves. There are three approaches to assess the size of the NEBs, namely:

1. Calculation – The NEBs are calculated based on more or less detailed documentation and measurements. Typically, this approach can require extensive work and access to multiple types of documentation.
2. Estimation – A person closely associated with the project estimates the value of the NEBs. This method is simpler than a calculation, and is based on subjective ratings.
3. Combination of calculation and estimation.

Choice of approach depends to a large extent on what is actually possible in a given situation. Also, one should keep in mind that the ambition of the online tool is to compile a large amount of case examples and encourage the energy consultants to use the likelihood of NEB as leverage for stimulating the interest of industrial and tertiary sector companies in energy efficiency projects.

7. Non-energy benefits from commercial and industrial energy efficiency programs: Energy efficiency may not be the best story; Paper presented at the Energy program evaluation conference 2003, Seattle, Nick P. Hall & Johna A. Roth, Tec-Market Works, 2003.

Table 1. The applied NEB classification.

Main category	Sub categories
Productivity (cost per unit)	Consumption of materials Necessary work force Product quality Unscheduled down-time Other
Sales	Sustainability Customer satisfaction/loyalty Publicity Unique selling points (such as sustainability) Other
Work environment/health/safety	Draft Air/dust/vapours Sound/noise Light Employee flux/retention Room temperature Safety Stress Heavy lifts Other
External environment and resources	Waste and waste water (incl. industrial waste, hazardous waste, heat, materials) CO_2 emissions Other GHG emissions Other emissions Security of supply/self sufficiency Other

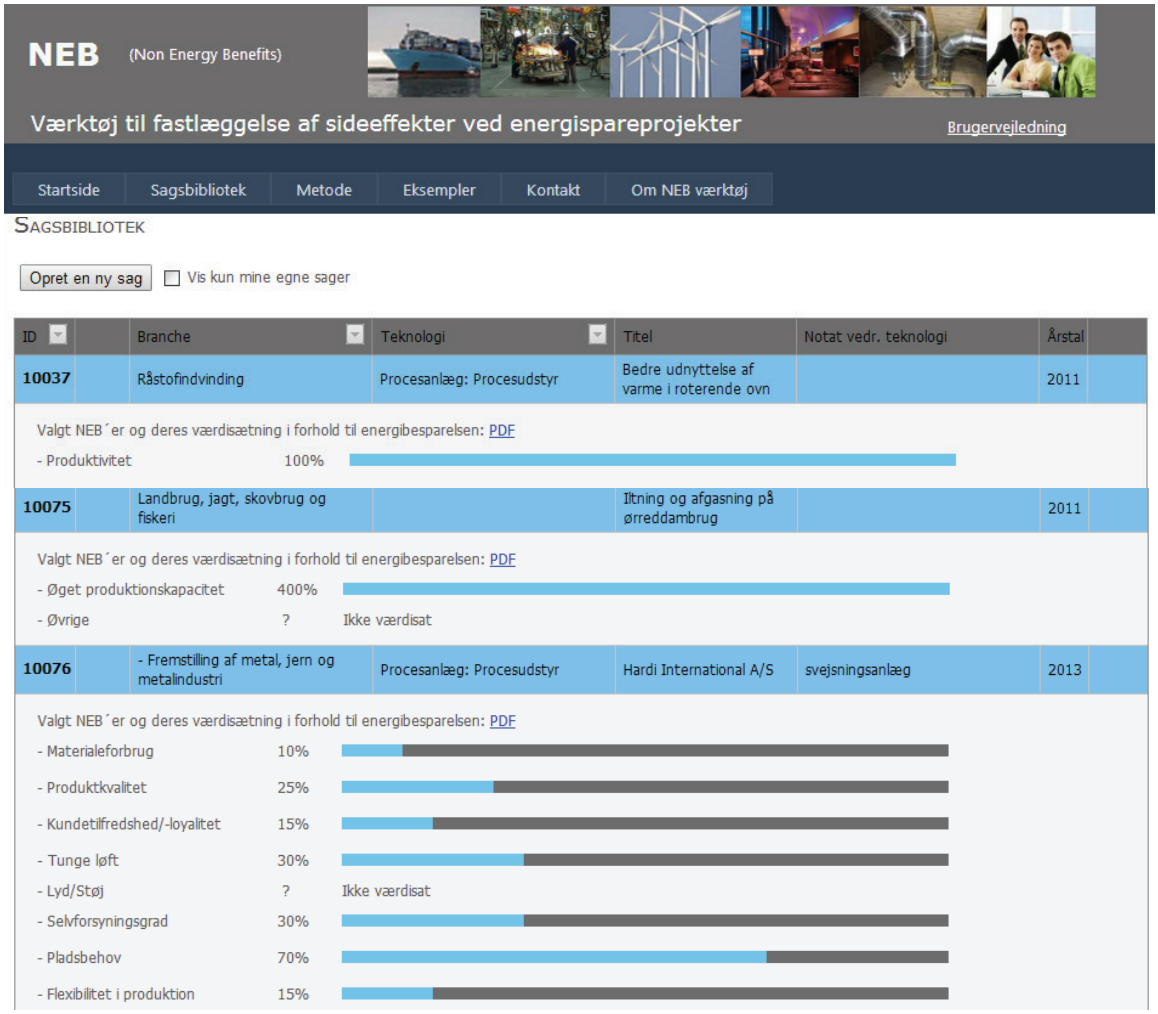


Figure 2. Example of screen shot showing the key NEBs for two different cases [NEB tool prototype].

Table 2. Differences between the assessment methods.

	Calculation	Estimation
Objectivity	High/Medium	Low
Time requirement	High	Low
Complexity	High	Low
Validity	Medium	Medium

Each of the two first methods each have their advantages and disadvantages given the scope of the NEB tool:

- **Objectivity** – In order to be of use to other energy efficiency projects the values should be assessed as uniformly as possible and explicitly as possible. The calculation-based approach appears to be objective, since the values are derived from factual data. However, it is not always possible to measure the causal effects. The calculation-based method will not always be able to unravel the cause and effect objectively.
- **Time requirement** – If the NEB database is to expand and gain a wider use it is important that the time required to assess the NEBs of an energy efficiency project is not too time consuming for the energy consultants. Measuring and documenting NEB effects rigorously can be too cumbersome. Furthermore, it may be perceived as a hassle by the project client in question.
- **Complexity** – The assessment method must be easy to communicate to both energy consultants and their clients, so that is avoids becoming a deterrent if the NEB database is to expand and gain a wider use.
- **Validity** – The user must be able to trust that the NEB values are reliable. Some users will prefer results based on detailed calculation while other will place more weight on results based on client estimates. It is worth emphasising that a calculation is not by definition more accurate as it to some extent is likely to be based on certain assumptions unless very large measurement activities are carried out.

It is our impression that from a client and energy consultant point of view high accuracy is not necessarily the most important issue. Circumstances are very complex. Many parameters change from one company to another – even within the same business field – and this affects the energy saving and the size of the NEBs. What is important is the relative size of the NEB (e.g. very large, larger, equal to the energy efficiency improvements, smaller, much smaller, or negative) rather than the exact value in each case.

Furthermore, it is the benefits as *perceived* by the client that are critical for the clients' future interest in energy efficiency projects – not a scientifically accurate value.

The developed NEB tool therefore permits the user to choose the method of her/his own choice for assessing the NEB values and to specify which method has been used for each NEB in each case. This gives the users of the database the option to distinguish between the NEBs depending on the assessment approach. It is thus possible to choose to only consider projects for which high accuracy measurements have been carried out.

Data collection approach

The NEBs of a specific energy efficiency project are determined using a questionnaire.

The intention is that the NEBs would be determined through an interview carried out by the energy consultant on the project in question and the interviewee would be someone within the company who has a sound knowledge of the energy efficiency project. This approach strengthens the professional ties between the energy consultant and the client but also provides an ideal opportunity for the energy consultant to get feedback on the services rendered in relation to the project. However, the questionnaire may also be used directly by the project client.

In the first phase of the development of the NEB tool, 12 specific energy efficiency projects were reviewed. Each project is included in the NEB database. The case interviews carried out in relation to these 12 projects cases have been used to assess the developed NEB methodology and the interview results will be used to refine the NEB tool in the second phase where also more cases are to be added to the database.

Five of the test cases and the main NEBs recorded by the clients are shown in Table 3.

Some of the key feedback provided from interviews relating to the first 12 cases was as follows:

- The interviewees often found it difficult to identify NEBs on their own accord and to assess their size relative to the energy savings. However, the interviews indicate that it makes sense to try to assess the size of the NEBs since they can greatly influence the decision on whether or not to carry out another energy efficiency project.
- Attempts to calculate the NEBs more accurately for an energy efficiency project in a fish farm that had good measuring conditions still had to resort to some degree of estimation in assessing the size of the NEBs. A "pure" calculation approach was thus not possible.
- The method for assessing the NEBs is based on the size of the energy savings. However, the clients do not always know the size of the energy savings. The second phase of the NEB tool development will therefore aim to make the indexation more intuitive.

Generalisation – from 12 individual cases to rules of thumb

The NEB tool is intended to increase the numbers of energy efficiency projects implemented through easy access to information on NEBs energy efficiency projects. The NEB tool is

Table 3. Five examples of test cases used in the development process.

Company	EE project(s)	Main NEBs
Saint Gobain Weber (LECA production)	Oven replacement	• Increased production capacity due to reduced heat losses from the oven
Løjstrup Dambrug (trout farm)	Changes in technology for oxygenation and degassing of a trout fish farm	• Fodder is better exploited which results in higher production without expansion of existing production facilities • Better stability in oxygenation
Stilling Skole (public secondary school)	Energy optimisation including installation of photovoltaic system, lighting timers, replacement of ventilation, automatic control of hot water circulation.	• Better indoor climate and comfort • Has become a landmark in the area • Incorporation of EE experiences in the teaching
Skovby Skole (public secondary school)	Energy optimisation including replacement of windows and doors, installation of fire protection doors, conversion from natural gas to district heating, replacement of ventilation system	• Better indoor climate and comfort • Noise reduction • Better use of space • Reduction of operation & maintenance costs • Reduced absenteeism among teaching staff
Vestermølle (culture house and restaurant)	Energy optimisation including complete building renovation, conversion from oil boiler to district heating	• Has become a landmark in the area • Better use of space • No need for boiler maintenance

therefore designed so that energy consultants and companies can search for relevant projects within relevant branches.

At present, there are only a limited number of projects in the database. The second phase of the tool development will be focused on increasing the number of cases.

If a sufficiently large number of similar projects are assessed and added to the database it might become possible to derive valid generalisations concerning the expected type and size of NEBs associated with certain types of projects. A high number of project cases is therefore perhaps of higher importance than very exact assessment of the NEBs in a given project.

The intention is therefore to review the database near the end of the second phase with the aim to draw more general conclusions and suggest rules of thumb regarding type and size of NEBs.

Conclusion

The aim of the project discussed in this paper is to contribute to a greater awareness of NEBs and thus a greater uptake of energy efficiency projects. The approach chosen for NEB assessment thus focuses on the client perspective rather than the consultant perspective. It also attempts to free NEB assessment from extensive measurements thus allowing for more rapid approaches that are expected to contribute to a higher interest and creation of a larger database. This is in turn expected to create sufficient volume to permit generalisation by type of branch and project.

One challenge remains – Even clients that are satisfied with their energy efficiency project do not necessarily know the size and value of their energy savings. This is an obstacle for using the perceived or measured energy savings as an index for NEBs. This issue will therefore be sought addressed during the second phase of the tool development.

On the other hand, the dialogue between the clients and the energy consultants in the first 12 cases showed that a run through the questionnaire trying to disclose the most important NEBs was to some extent an eye-opener for the clients. It gave them the opportunity and time to reflect on un-expected benefits and see the energy efficiency projects in a new light. This may in turn increase their interest in new projects and perhaps make them ambassadors for projects in other companies.

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Energy Efficiency Plan 2011; COM(2011) 109 final; European Commission, 8 March, 2011.

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Acknowledgements

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Appendix – examples of reviewed NEB research literature

In connection to the project desk research of existing literature on assessment of non-energy benefits was carried out. Some of the key literature is listed below. For each the key content is shown in the right column.

Table 4. Examples of reviewed NEB research literature.

Title	Author(s)	Year	Key content
Non-Energy Benefits	Andrea Preciado, Enernoc Utility Solutions	August 2012	Valuation of NEBs and methods for valuation
Energieffektivisering av VA-sektorn 110512	Svenskt Vatten, Lene Blad	May 2012	Investigation of NEBs in the water sector
The characteristics of energy-efficiency measures – a neglected dimension	Tobias Fleiter, Simon Hirzel, Fraunhofer Institute for Systems and Innovation, Germany + Ernst Worrell, Copernicus Institute of Sustainable Development, Utrecht University, Netherlands	May 2012	Classification of EE measures in relation to the inclination of the decision-maker to implement the measures, including the importance of NEBs.
Evaluating the multiple benefits of energy efficiency	Workshop at Sustainable Energy Authority of Ireland, seai	March 2012	Extent of NEBs and the importance of their quantification
Energy efficiency & industrial productivity – Gaining through saving	Julia Reinaud, International Energy Agency (IEA)	March 2012	Methods and challenges in valuation of NEBs. Review of studies with the aim to determine a method for quantification of NEBs.
Arbejdsmiljø i et topleder-perspektiv!	Industriens Branchearbejdsmiljøråd	October 2012	The value and importance of a good work environment
Spreading the net: The multiple benefits of energy efficiency improvements	Lisa Ryan and Nina Campbell, International Energy Agency	2012	Social, economic, and environmental benefits of energy efficiency programs. Rebound effects in relation to further energy efficiency improvement.
Quantifying non-energy benefits of a carbon reduction initiative for a glassware company	Sheri Willoughby, World Wildlife Fund, USA Et.al.	eceee, 2011	Calculated NEBs for a fuel conversion project in a glass factory in China
Det grønne virksomhedsindeks	Schneider Electric	March 2011	Investigation of energy efficiency measures and extra benefits in 115 case companies
Green buildings and productivity"	Norm G. Miller et. Al, University of San Diego, USA	August 2009	The value of increased productivity in "green" buildings
Counting good: quantifying the co-benefits of improved efficiency in buildings	Diana Ürge-Vorsatz et. Al., Center for Climate Change and Sustainable Energy Policy	eceee, 2009	Quantification of NEBs associated with energy efficiency improvement of buildings
Retrofitting technology to real homes: assessing the multiple impacts of solar powered ventilation	Louise Sunderland et. Al , Association of the conservation og Energy, Westgate House, UK	eceee, 2009	NEBs of solar powered ventilation in households
Commissioning in public sector building – Non-Energy Benefits (NEBs), not savings, are selling point	Elle McClain et. Al., Skumatz Economic Research Associates, Inc., USA	eceee, 2007	Quantification of NEBs in public buildings
Alternative Methodologies, Special Working Group Project Report Spin 2", including the case studies: Astellas Bulmers Heinz LEO Pharma Molex	Sustainable Energu Authority og Ireland, seai	2008	Alternative method used in energy management systems – methods known from LEAN, quality management, etc. Six Sigma approach Value Stream mapping method Involvement of key staff Kaizen method Six Sigma approach
Economic impacts from energy efficiency programs – Variations in multiplier effects by program type and region	John Gardner + Lisa Skumatz, Skumatz Economic Research Associates, Inc., USA	eceee, 2007	Societal benefits of energy efficiency programs

Table 4 continues on next page. →

Title	Author(s)	Year	Key content
Green Campus: Innovative approaches to energizing the next generation toward energy efficiency and green behaviors	Andy Coghlan, Alliance to Save Energy, Washington DC, USA Lisa Skumatz, Skumatz Economic Research Associates, Inc., USA	eceee, 2007	NEBs of energy efficiency project at the university – campaign to involve students
Attributable effects from information and outreach programs: Net to gross, NEBs and beyond	David Juri Freeman + Lisa Skumatz, Skumatz Economic Research Associates, Inc., USA	eceee, 2007	Opsamling på vurdering af NEB'er på mere end 80 energieffektiviseringstiltag og – programmer
Zero and low energy homes in New Zealand: The value of non-energy benefits and their use in attracting homeowners	Albrecht Stoecklein, BRANZ, New Zealand Lisa Skumatz, Skumatz Economic Research Associates, Inc., USA	eceee, 2007	Quantification of NEBs in zero and low energy homes
En værdisætningsundersøgelse af skovkarakteristika udført vha. metoden Discrete Choice Experiment	Søren Bøye Olsen og Thomas Lundshede	Marts 2005	Method for quantification
Non-energy benefits from commercial and industrial energy efficiency programs: Energy efficiency may not med the best story	Nick P. Hall + Johna A. Roth, TecMarket Works	2003 Energy Program Evaluation Conference, Seattle	Quantification of NEBs in commercial and industrial sectors
Non-energy benefits including productivity, liability, tenant satisfaction, and others – what participant surveys tell us about designing and marketing commercial programs	Dennis Pearson, Seattle City Light Lisa Skumatz, Skumatz Economic Research Associates, Inc., USA	ACEEE 2002	Quantification of NEBs and methods for quantification. Interviews of 130 cases.
Productivity benefits of industrial energy efficiency measures	Ernst Worell + Michael Ruth, Energy Analysis Department, Lawrence Berkeley National Laboratory, USA. John A. Laitner + Hodayah Finman, US Environmental Protection Agency, Washington, USA	December 2001	Review of 70 cases of energy efficiency improvement in industry. Quantification of NEBs and methods for quantification.