# Seeing is believing – visualizing helps realize the hidden benefits of energy efficiency

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# Abstract

Most people agree that energy-efficiency measures contribute to several benefits in addition to saving energy and costs. There are several benefits that come with the bargain! However, it is often difficult to calculate the value of these benefits; hence we often neglect their true value. By visualizing the different added values that comes with an energy-efficiency project it is possible to raise awareness, interest and knowledge among all kinds of stakeholders.

Based on the IEA report "Capturing the Value of the Multiple Benefits of Energy Efficiency" a model for visualizing the hidden benefits of energy-efficiency projects, implemented at local and regional level in Sweden, has been developed and tested. Based on interviews with the project managers of eight different projects, estimates of the impact on the 15 benefit categories identified by IEA have been made. The impacts have been estimated at four different levels to indicate whether the effects occur at an individual, local, national or global level. Finally the results have been presented in a pie chart diagram showing the multiple benefits for each project. The goal was to visualize the added benefits, or values, of energy efficiency measures. No attempt to calculate the actual values of these benefits has been made.

The results from the model are presented as a visual picture of the normally hidden benefits of energy efficiency. The model can be used for different purposes for instance:

• In early project planning to assess what added values the project may contribute to, and thus be used as part of a decision-making document.

- Follow-up and evaluate implemented projects.
- Increase knowledge and awareness of the effects of energyefficiency projects.

The model was developed in 2015 and has since been further developed and tested. Today it is a free of charge, easy to usetool readily available for local and regional actors to use. The aim is that the tool should support local actors to accelerate the implementation of energy-efficiency measures.

### Introduction

During recent years there has been an increasing focus on all the additional benefits that are brought about by energy efficiency measures. There are more to it than energy and cost savings, several other benefits come with the bargain. However, it is often difficult to calculate the value of these benefits. This often results in a negligence of the added values true contribution. By visualizing the different benefits that come with energy-efficiency projects it is possible to raise awareness, interest and knowledge among all kinds of stakeholders.

The International Energy Agency's (IEA) report "Capturing the Value of the Multiple Benefits of Energy Efficiency" created a significant milestone for the awareness of multiple benefits (IEA 2014). Through this report IEA created a concentrated highlight of the added values of energy efficiency. A large number of scientists from 60 different organizations in 27 countries, covering numerous different areas of expertise that rarely gets illuminated in a context, participated in the production of the report. A total of 15 different categories of benefits from energy-efficiency measures were identified in the report. The Swedish Energy Agency recognised the potential of IEA's Multiple Benefits Model and initiated a development project to adapt it to the Swedish context. The purpose of the project was to highlight the benefits which often accompany energyefficiency measures. On behalf of the Swedish Energy Agency, WSP Sweden has undertaken the task to develop a visualizing tool for the hidden benefits of energy efficiency.

# Developing the model

# PHASE 1 - PILOT

The work to develop a more visual model adapted to Swedish conditions started during autumn 2015. The model development was focusing on highlighting the added values in local and regional governmental energy-efficiency project. Despite the fact that some of the benefits identified by IEA were considered not to be relevant for these target groups in a current Swedish context it was decided to include all the 15 categories in the visualisation tool. The reason for this was to create possibilities for international comparisons.

### Methodology

The project started with a literature review to establish the state of the art of multiple benefits of energy efficiency. The literature review showed that very little work with a Swedish context was published. A brief summary of the findings was included in WSP's final project report to the Swedish Energy Agency (WSP 2016). Then, in parallel, the project team developed a visualization tool and identified eight suitable projects for testing the model in a pilot project. The visualization-tool development was based on an existing WSP tool called Orbis, which is a kind of pie chart diagram that presents information on several levels.

This new visualization tool was developed as a four-layer diagram including the 15 categories of which were identified in IEA's report. The four different layers aim at indicating whether the impacts occur at an individual, local, national or global level (Figure 2).

As a part of the model development a set of questions for each benefit category and level was produced. The set of questions was developed based on IEA's report "Capturing the Value of the Multiple Benefits of Energy Efficiency".

Each question should be possible to answer with: positive effect, neutral, negative effect or not applicable. The different answers have been given the following colours in the diagram:

Positive effect:	Green
Neutral:	Yellow
Negative effect:	Red
Not applicable:	Grey

Several questions were developed for each benefit category, and all answers are weighed together category by category. Examples of questions are:

 Health and wellbeing: How does the project affect noise and sound?



Figure 1. The multiple benefits of energy efficiency improvements. Source: IEA (2014) page 22.



Figure 2. Example of how the results are shown in the visualization tool.

- Health and wellbeing: How does the project affect air quality?
- Resources: How does the project affect resource demand?
- Resources: How does the project affect product/component longevity?

The questions were used during interviews with managers of the eight chosen projects, where the project team asked the project managers to estimate the impacts of their individual projects. The eight projects that were included in the pilot phase of the model development have been carried out by Swedish municipalities or regional governmental agencies. The majority of the projects were co-financed by the Swedish Energy Agency, which means that final reports describing the individual projects' outcomes have been submitted to the agency. The project reports were all focusing on reduced energy demand, cost savings and investments. Only occasional examples of other benefits which can accrue from the energy-efficiency measures that were carried out were mentioned in the project reports, and there was no attempt to estimate values of the benefits in any of the reports.

The eight selected projects in the pilot phase represented a wide variety of projects:

- Transport: Green parking in Umeå (the Municipality of Umeå)
- 2. Transport: Let's meet without travelling (the Regional County of Dalecarlia)

- 3. Residential buildings: In-deep renovation of the Lagersberg area (the Municipality of Eskilstuna)
- 4. Lighting: Outdoor lighting in Jönköping (the Municipality of Jönköping)
- 5. Sustainable city planning: Bicycle focus in Moheda (the Municipality of Alvesta)
- 6. Industry: Modell for energy efficiency in SMEs in Tranås (the Municipality of Tranås)
- 7. Systematic energy-efficiency work: Energy management system in Tyresö (the Municipality of Tyresö)
- 8. Procurement: Routines and capacity building in Karlstad (the Municipality of Karlstad)

The interview results were analysed and presented in the new tool. Finally, the results were presented to the Swedish Energy Agency. The development was carried out in close contacts with the Swedish Energy Agency. During the progress of the development several discussions were held, inter alia, on the design of the chart, formulation of questions and relevant projects for evaluation.

### Phase 1 Results

The goal of the method at this stage was to visualize additional benefits of energy efficiency measures. No attempt to calculate the actual values was made in this phase of the development. The results were presented as visual pictures of the (most often hidden) benefits of energy efficiency.

The model can be used for different purposes for instance:

- In a project's planning phase to assess what added values the project may contribute to, and hence be used as part of a decision-making document.
- · Follow-up and evaluate implemented projects.
- Increase knowledge and awareness of the effects of energyefficiency projects.

The interviews with the project managers indicated that the model is valuable and filled a need. The project managers saw several different and distinct areas of use of the model, and not least, the visualization of added values of energy-efficiency measures provides a basis for discussion between employees in local governmental administration. Several of the interviewed project managers also emphasized that the model delivers a major value in increasing the understanding and knowledge of the multiple benefits that energy-efficiency measures can bring.

A large number of hidden benefits, at individual, local, national as well as international level, were found in all of the eight energy-efficiency projects that were analysed in the first phase of the visualization tool development. Only a few of the categories of additional benefits that were identified by IEA were found irrelevant for the eight projects. A negative impact was found only at an individual level in one of the eight projects, and it concerned disposable incomes in the retrofitting project in Eskilstuna (easily seen in red in the results' visualization of the third project in Figure 3). However, this negative outcome could be debated. It was the renovation as such that caused the decreased individual disposable income, the energy-efficiency part of the renovation actually improved the overall renovation budget.

Even though the interviewed project managers generally expressed satisfaction with the outcome of their individual projects before the interviews were carried out, several of them were overwhelmed by the results from the analysis with the visualization tool. Some of the values of the energy-efficiency projects, which had not been reflected on before this pilot project was carried out, were:

- Increased property values in the village of Moheda thanks to the new bicycle lanes.
- The ability to participate in travel-free meetings improved information accessibility, knowledge and participation, which are important democratic issues. This is particularly significant in rural municipalities with few citizens and a large geographical coverage, since long distances and limited resources often have restricted people from attending meetings.
- Increased knowledge and level of energy-efficiency awareness in local government as well as companies was an unexpected outcome from several of the projects.
- One of the projects led to an increased demand of photovoltaic on the Swedish market as a whole since the project also inspired investments from other actors. In addition to improved security of supply, the project also created more "green jobs".
- One interviewed project manager said "Reducing greenhouse gas emissions is one of the obtained benefits from the project. The model made us aware that we also contributed to dissemination of information of our project both nationally and to other countries such as Russia, the US and Spain. This could inspire other actors to implement similar measures, with a further reduction of greenhouse gas emissions at a global level."

### Phase 1 Conclusions and recommendations

IEA's Multiple Benefit model helps bring attention to added values that otherwise would have been neglected. The model is clear and illustrative. But in order to obtain comparable results between different projects and different assessors the methodology needs to be developed further. A graphical visualization



Figure 3. Visualization tool results for the eight projects in the development's first phase. The figure indicates that a large number of added values were identified in all of the pilot phase's eight projects, while only one negative effect was identified. Source: WSP Sweden.

can provide transparency to the complex and extensive multiple benefits energy efficiency delivers.

The conducted interviews showed that this new model is useful and that it provides answers to an important issue. The interview results also showed that there is a need to develop the method for assessment of energy-efficiency projects.

This method could be developed to take into account what role the informant has had in an assessed project. It would also be interesting to see how different types of actors view a project's effects. For example, local government officials and citizens may have different views on the outcome of a project.

The following adjustments on the classification of the multiple benefits were suggested after the project's pilot phase:

- The set of questions that were developed and used in the pilot-phase interviews leaves room for different interpretations. Hence the questions should be more stringent and need to be adapted to the particular project under scrutiny.
- There is a need for developing a standardized method to assess the different aspects. The pilot project was carried out during a period of only seven weeks and the interviews were carried out by three different persons. There was no time for extensive quality control with regard to checking if the assessments were consistent between projects and assessors. This can, for example, be seen when it comes to answers regarding GHG emissions at a global level. If a project results in lower GHG emissions on a local or national level, in most cases it would also lead to reduced GHG emissions on a global level. When scrutinizing Figure 3 you will see that the three pilot assessors phase had different views on this.
- The tool is complex. In this assignment WSP has used four assessment levels (individual, local, national and international). Depending on what the tool will be used for, it should be possible to choose to use all of these or fewer levels. For the assessment of projects and evaluation of project proposals, it may be better to use only three levels: individual, locally and nationally.
- Many of the aspects of IEA's model are overlapping. A clarification is necessary in order to avoid double counting of effects.
- Macro-economic effects have proved difficult to identify, and could possibly be removed when using the model for assessing projects.
- In a Swedish context it may be suitable to combine Disposable income and Poverty alleviation. However, there is also a value in keeping all of IEA's categories in order to create opportunity for international comparisons.
- Energy supply and security of supply could be merged to one added value.
- Democracy, increased knowledge and enhanced networks have been identified as additional benefit categories in addition to the 15 categories included in IEA's model.
- Working environment, which is included in the two benefit categories Resource Management and Health and wellbeing in IEA's model could be added as a benefit category of its own. Alternatively, these categories need to be clarified.

# PHASE 2 - DEVELOPING AN EASY TO USE-TOOL

The model has been further developed and tested during 2016. The goal of this second phase of the development was to create an easy to use tool for local and regional government administrations which they can use to visualize the added values of implemented or planned energy efficiency measures.

### Methodology

The first step of the development was to create two reference groups, one group with experts from the Swedish Energy Agency and one group with representatives from potential users, including municipality energy coordinators, one regional energy agency and one energy coordinator from a county administrative council. Both reference groups have contributed with constructive and valuable comments and suggestions for improvement during the process.

To make the tool available for the target group, the development initially investigated the possibilities to create a web-based tool. However, due to the projects restriction in time, it was found not to be feasible. Instead, the tool was developed in Excel.

Based on experiences from phase 1 the model has been further developed. The set of questions to identify the additional benefits in the fifteen categories has been revised, new questions have been added and others have been removed. The revised set of questions is more stringent, and is more in line with Swedish conditions with references to e.g. the Swedish Environmental Agency's environmental goals assessment and the Swedish Defense Research Agency<sup>1</sup>.

The questionnaire now consists of 41 questions with a fourlevel answering scale – improved, unchanged, impaired or not applicable. Each question is accompanied by a brief explanation. In addition, descriptions and examples of possible effects for the 15 categories of benefits have been developed in order to support the users to get a better understanding of what the additional benefits may be.

An example of a question from the Industrial productivity category is "How has the project affected productivity costs?" This particular question has the following explanation attached to it "A more stable process can provide reduced costs for maintenance, fewer rejects, fewer work-related injuries, etc., another example is reduced energy demand and reduced travel costs through a change in travel policy where journeys are replaced with travel-free meetings."

One of the comments the development team received from the interviewees in phase 1 was that the model was too extensive and complex. The development team interpreted this as a need to simplify the model for the users, and the following changes to the model have been implemented:

- An adaptation to the needs of the now chosen target group (mainly governmental administration at local and regional level) has resulted in the model being reduced to include only three levels – local, regional and national.
- In a Swedish context two of the benefit categories, macroeconomics and poverty alleviation, were assessed to have no or very low impact on individual projects at local or re-

<sup>1.</sup> Swedish Environmental Agency (accessed January 2017) and The Swedish Defence Research Institute (FOI 2007).

gional level. In the revised visualization tool there are no questions for these benefit categories, and their sectors in the pie chart-diagram have been marked as dimmed (grey).

After this redevelopment of the visualization tool was tested. To check how easy the new model was to use for people in the target group without further assistance, seven project managers were asked to serve as test users of the revised model. The seven test users were asked to run the tool for one project each. The seven test projects in phase 2 were:

- 1. Public buildings: Energy efficiency in municipality owned buildings (Regional Council Skåne)
- Schools: Holistic retrofitting (the Belok Total Project Method)<sup>2</sup> of a kindergarten (Municipality of Eskilstuna)
- 3. Transport: Test bikers in Gothenburg (the Gothenburg Regional County's Energy Office)
- 4. Transport: Coordinated transport of goods in the Södertörn municipalities (Municipality of Huddinge et al)
- Strategic development: Improved competitiveness from energy efficiency in Tranås and Eskilstuna (the municipalities of Tranås and Eskilstuna)
- 6. Lighting: Energy-efficient road lighting in the Örebro County (the Regional County of Örebro)
- Residential buildings: In-deep renovation of the Ålidhem area (the municipality owned property company Bostaden AB)

To make a quality check of the redeveloped tool the WSP project team gathered information about the seven test projects and ran the visualization model on them in parallel to the test users efforts. The model development team also interviewed all the test users after their tests were carried out, to see if they had found the model useful and easy to use. An analysis was made of the correlation between the test users' and the WSP project team's results for each of the seven projects.

# Phase 2 Results

Improvement suggestions were collected from both the Swedish Energy Agency's internal reference group and the external reference group, and adjustments were made accordingly. The adjustments included rephrasing of some of the questions, and redeveloping some of the explanations in order to avoid misunderstandings.

A comparison between the assessments made by the test users and the WSP development team shows only minor differences in the assessment results. The level of conformity between the project owners' and the WSP project team's assessments was high regarding which additional benefits the projects have. However, the judgement for each benefit category varied in some cases regarding to what extent the project had an impact. In some cases the project owner's perceived the impacts larger compared to the WSP team's view and in some cases less. The model development team's interpretation is that this is mainly due to people's different temperament when it comes to how to set grades on a fixed scale, and variations in knowledge of how the additional benefits are defined.

The analysis of the obtained test results indicates that it is important to emphasize for new users that they need to allocate time to understand the definitions of the benefit categories. If a team of employees with different backgrounds answers the set of questions together the individual's impact on the scoring of the benefit will be reduced, and the results will probably be more robust. Hence it can be recommended to use the model at a workshop where people with different skills attend.

The interviews carried out in phase 2 showed that the test users generally are positive to the model. The model was perceived as easy to use and the manual and explanations easy to understand. All the test users said that the model provides a clear view of their project's additional benefits, and that the tool is useful in order to visualize the benefits. All the test users expressed the opinion that the model is easy to use, and that it is a useful tool when presenting the achieved results from a project in a wider perspective. One of the test users who currently is in the planning phase of a new project also pointed out the possibility to use the model to improve the new project to achieve even better project results.

### Phase 2 Conclusions and reflections – seeing is believing

For most of us seeing truly is believing. Visualization of multidisciplinary facts makes it easier to make better informed decisions, and that is valid even if the monetary value of the additional benefits cannot be calculated.

The tests have shown that the model serves to fill an important function in terms of highlighting the many added values and benefits resulting from energy-efficiency measures. Visualizing the multiple benefits adds value in many ways, and the experience from the development of this project with a diagram based tool shows that visualization can be used to highlight otherwise hidden values, support and improve decision documents and processes, help raise awareness and capacity, create focus, and clarify complex connections and inter-reliabilities.

One could argue that the model may be misleading since all benefits are treated equally. Some benefits will be more important than others, depending on which context it is applied in and which perspective one assumes. But decisions will always be subject to discussions based on the current organizational values and conditions.

In an ideal world, all benefits could be estimated in financial terms so that they can be added up and easily compared. However, this is clearly not feasible. For many of the benefits such an assessment is associated with significant efforts and resources, and in many cases the benefits are even impossible to quantify in monetary terms. In other cases the additional benefits are not even identified, which means that any attempt to make a monetary comparison will be misleading or false. A simple visualisation of the multiple benefits of energy efficiency may therefore be of larger value than an incomplete monetary comparison. The major purpose with this visualization model is therefore to provide a basis for a broadened discussion to include the benefits that usually are ignored since they are hard to quantify.

To exemplify the outcomes from the model a diagram from the mobility management project "Test bikers" is used. This project was included in phase 2 of the model development. The project was carried out in the region of Göteborg in western

<sup>2.</sup> www.belok.se (accessed January 2017).



Figure 4. Visualization of the multiple benefits of the Gothenburg Regional County's project "Test bikers".

Sweden. It was implemented in 2014, and aimed to contribute to citizens shifting from using cars to bicycles. The project participants were ordinary citizens who became test bikers for six months during the project. They were able to borrow a bike that was adapted to their personal needs, and were asked to report how many car trips they replaced by the bike. A coach helped the participants to set individual goals and supported and encouraged them during the test period.

The multiple benefits of the "Test biker" project are visualized in Figure 4.

The conclusions of this work are that:

- A visualization model helps create a more complete overview of the benefits from an energy-efficiency project.
- The local and regional project managers who participated in the development found this tool easy to use and valuable for their future work.
- A visualization tool/model like this can be used for knowledge exchange, capacity building and better understanding between different professions.

A remaining challenge for this project is to disseminate knowledge of the tool and its benefits. Decision on how this will be done will be taken in the near future.

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