Financial benefits of improved indoor environmental quality

EFFECT4buildings Toolbox:

Multi Service Contracting; Annex 4.1

EFFECT4buildings

The project “Effective Financing Tools for implementing Energy Efficiency in Buildings” (EFFECT4buildings) develops in collaboration with public building managers a comprehensive decision-making support toolbox with a set of financial instruments: **Financial calculation tools**; **Bundling**; **Funding**; **Convincing decision makers**; **Energy Performance Contract**; **Multi Service Contract**; **Green Lease Contract**; **Prosumerism**. The tools and instruments chosen by the project has the biggest potential to help building managers to overcome financial barriers, based on nearly 40 interviews with the target group. The project improves these tools through different real cases.

To make sure building managers invest in the best available solutions, more knowledge on different possibilities is needed as well as confirmation from colleagues that the solutions performs well. EFFECT4buildings mapped **technological solutions** for energy efficiency in buildings with the aim to share knowledge and experiences of energy efficiency solutions among building managers in the Baltic Sea Region.

This document is a part of the Multi Service Contracting (MSC) toolbox within the group of tool 4, “mapping and analysis tools for different services”. It highlights some of the non-energy benefits to consider in relation to energy efficiency measures and serves as an inspiration for objectives to include in an MSC. It introduces calculation tools to use when determining whether investing in non-energy benefits could give financial value.

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EFFECT4buildings project is implemented with the support from the EU funding Programme Interreg Baltic Sea Region (European Regional Development Fund) and Norwegian national funding. The aim of the project is to improve the capacity of public building managers in the Baltic Sea Region by providing them a comprehensive decision-making support toolbox with a set of financial instruments to unlock the investments and lower the risks of implementing energy efficiency measures in buildings owned by public stakeholders. More information: http://www.effect4buildings.se/

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Introduction and context

It is possible to optimise a building's performance, but value is also created by performance of the employees in the building. Studies show that in average 85% of total workplace cost are spent on salaries and benefits, only 10% on rent and less than 1% on energy. Therefore, it makes good sense to secure productivity and get the most value out of salary expenses. Employees' performance can be affected by a lot of different things e.g. work environment, private life and the content of their work. This paper will focus on the physical work environment related to the building and physical surroundings, and not the mental work environment even though they can impact on one another. Studies have shown that improvements in the physical work environment can have a significant impact on productivity e.g. better lighting and ventilation system have shown to improve productivity by respectively 11% and 23% (reference 9).

Focus in the MSC model is to include several services and to be aware on how they are interlinked. Renovation of existing buildings usually emphasise a focus on energy savings, since it can be a way to finance renovation. This paper introduces how to work with financial benefits from non-energy benefits (NEB) such as improved indoor environmental quality (IEQ) and how this can be interlinked with energy efficiency measures. Thereby emphasising how important it is to consider other parameters than energy efficiency in renovation projects.

Why non energy benefits?

Different parameters can affect the indoor environmental quality (IEQ). Pawel Wargocki (reference 1.a) has created an overview of parameters, which gives a good understanding of how many factors can affect IEQ (see figure 1). Furthermore, user behaviour and preferences are also evident for the experience of indoor environment e.g. what temperatures do they prefer, how warm are their clothes and do they move around or sit still.

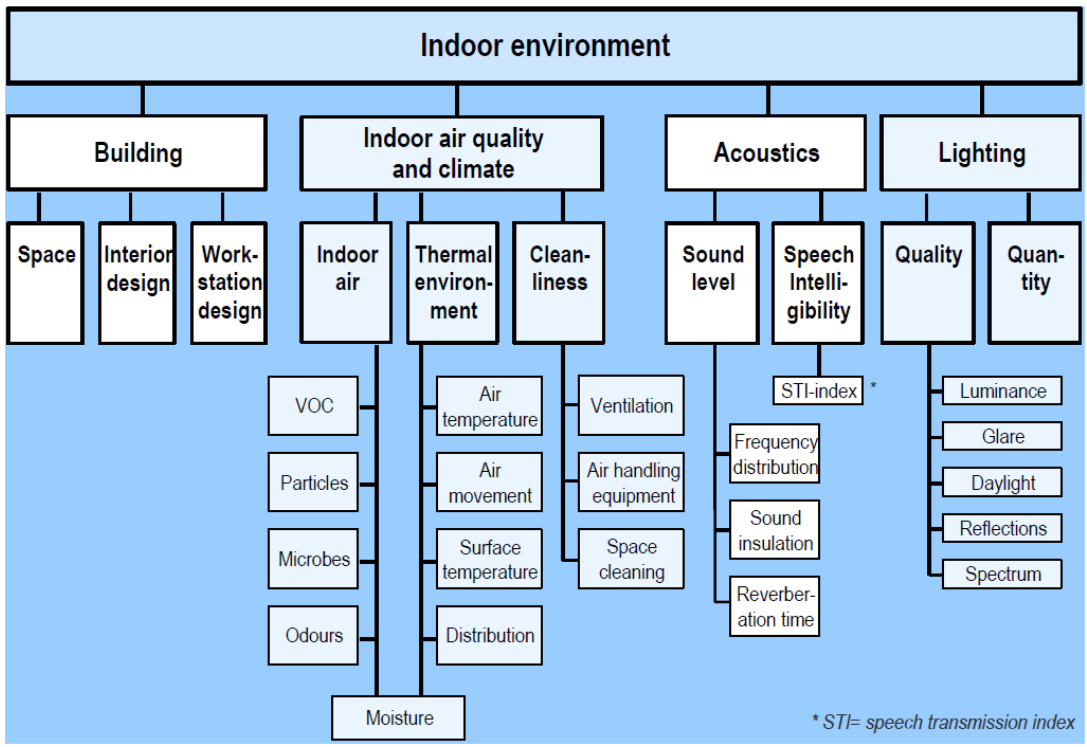


Figure 1 examples of indoor environmental parameters illustrated by Pawel Wargocki in presentation at InnoBYG spring conference 2014 (reference 1.a).

Several studies (references 2, 3, 4, 5, 6) on IEQ have been carried out in the last decade and they indicate that bad IEQ has a negative impact on cognitive functions, sick days and learning environment. If IEQ is improved these areas can also improve and thereby have a positive effect on finances. Figure 2 shows an example of some of the benefits that can be achieved by improved IEQ, and which groups that are affected.

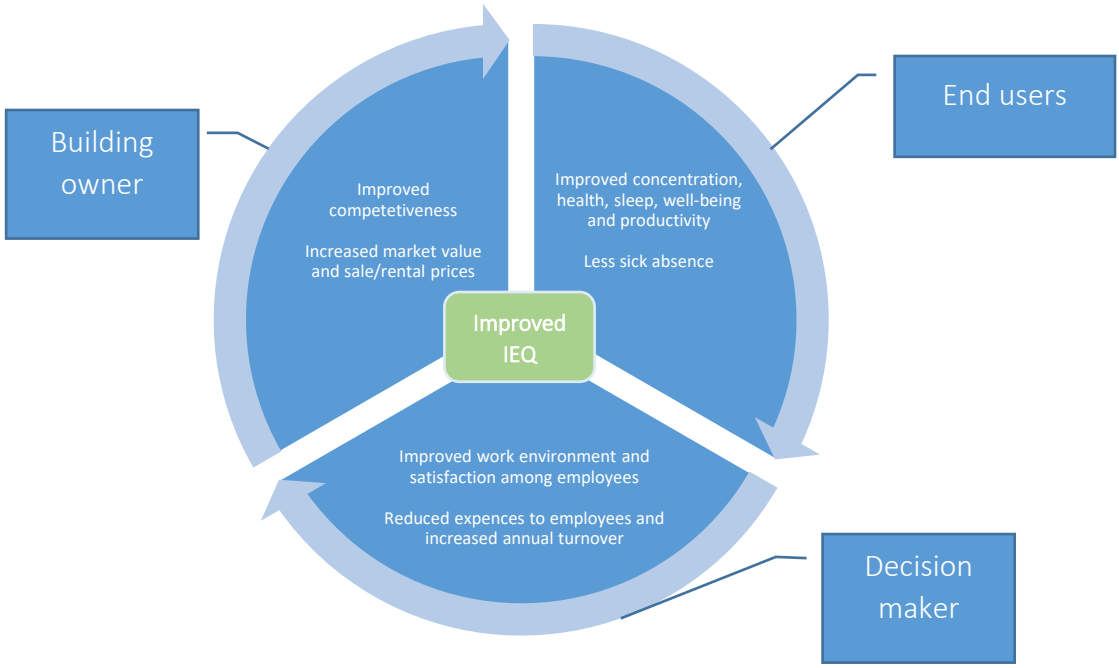


Figure 2 example of benefits from improved indoor environmental quality. Several benefits are interlinked and further they are subdivided into who will gain from the benefit (inspired by reference 8.d)

Bad IEQ has been proved to have a negative impact on performance if e.g. temperature is too hot or too cold, there is too much or too little light, there is draught, noise or a bad air quality (reference 8). Some studies have quantified the increased performance from improved IEQ as illustrated in figure 3 (reference 9).

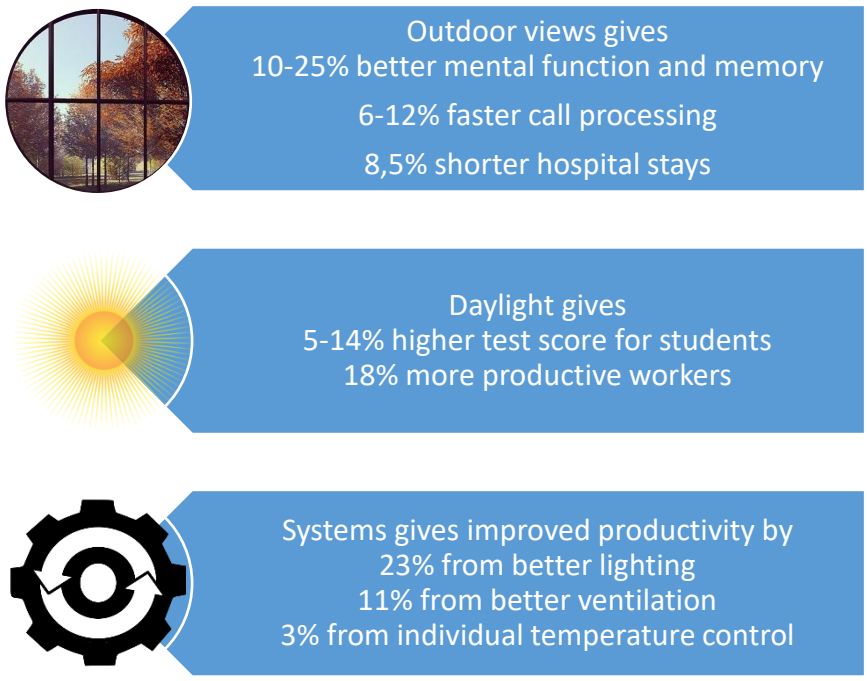


Figure 3 example of benefits from improved IEQ. Inspired by Business case to Green Building p. 67 (reference 9)

So, it is evident that NEBs are very relevant to address, but it can be difficult to include, if they are not quantified into actual financial benefits. In the next section the results from the EU funded COMBI-project will be used as an example of how to quantify NEB from energy efficiency measures and to indicate which measures that are relevant for a given country. The Total Value tool developed by InnoBYG will be used as an example of how to quantify benefits from improved IEQ.

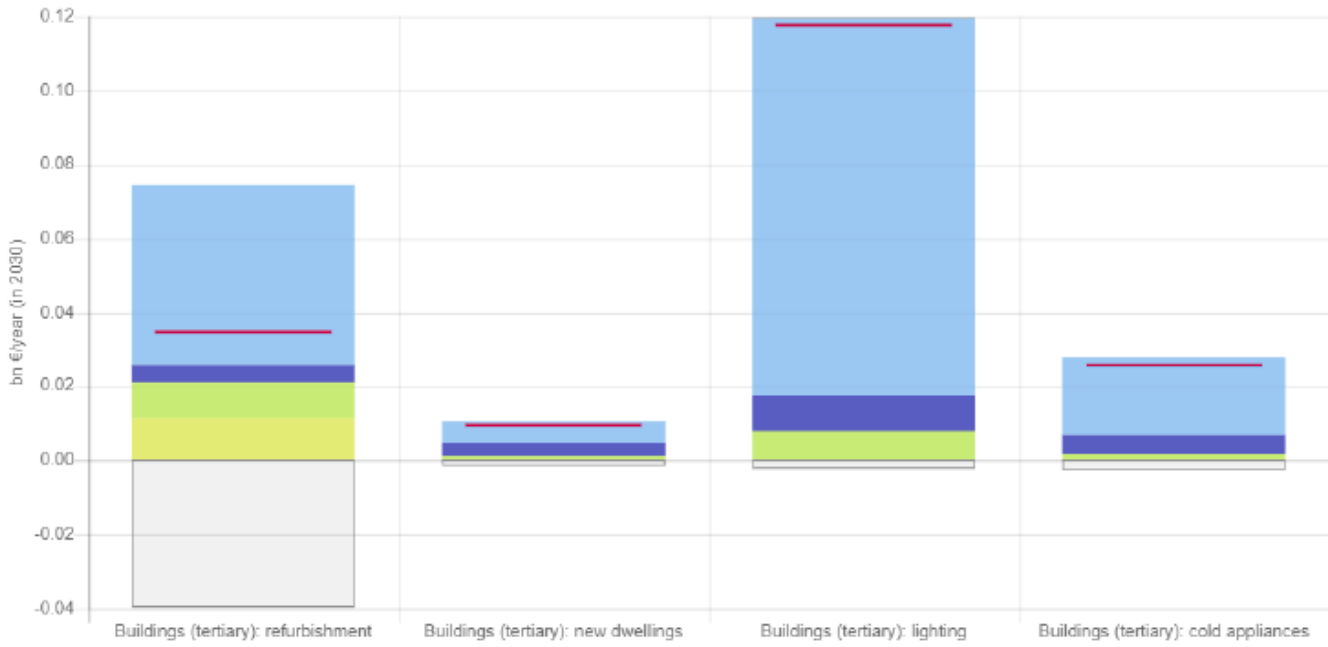
Financial benefits of improved non-energy benefits

COMBI tool

The COMBI-project has developed a calculation tool to use when designing energy efficiency projects, within the 28 EU-member countries. It quantifies the non-energy benefits one can expect when implementing different energy efficiency measures. In this tool non-energy benefits are a broad range of benefits such as; environmental, social, security, productivity, macro-economic etc. IEQ is included but not the only focus. The tool is available online and entails the framework, prerequisites and variables relevant for the chosen EU-country. It is possible to choose different modes with varying complexity of the model.

A simple cost-benefit model from the COMBI tool can be seen in figure 4. Tertiary buildings are chosen, together with some common actions in a renovation project. The country chosen is Denmark and the savings are billion euros pr. Year.

Figure 4 example from the COMBI tool. Cost benefit analysis of tertiary buildings. Actions are refurbishment, new dwellings, lighting and cold appliances. One can see how actions affect labour productivity, health, energy system/security and energy, in billion euros pr. year. Net value indicates the remaining economic benefit after the expected investment. (reference 10.a)



Net value
Investment
Labour productivity
Health
Energy system/security
Energy

Type	Cost-Benefit Analysis
Calculation	Total
User mode	Standard
Impacts	Labour productivity, Health, Energy system/security, Energy
Countries	Denmark
Actions	refurbishment, new dwellings, lighting, cold appliances

As seen in figure 4 there are savings to gain through NEBs when carrying out energy efficiency projects. This tool can serve as an indicator for which measures that would be good to include in an MSC project, what NEBs that are related and the relative size of the business case. This example is of cause an aggregated model and the business case will always depend on the building stock at focus.

For more information visit the website that has several guides for the tool and it is possible to see presumptions for all actions and impacts (reference 10).

Total Value tool

The calculation tool Total Value and Indoor Environmental Quality is developed in the project Total Value and Indoor Environmental Quality [1] carried out by InnoBYG. The tool focuses on financial benefits from improved indoor environmental quality.

Apply IEQ data on CO_2 (ppm), temperature (℃), noise (db) and light (lux) as a percentage of time applied in the different categories of the parameter in the building in focus. Then, the tool calculates the potential to increase performance/productivity as a percentage, if employees worked under perfect conditions for IEQ. Each parameter has 5 categories where category 1 is the perfect condition. For CO2-concentration that would be below 700 ppm (see table 1). The perfect condition is defined based on national regulation as well as studies carried out about the topic. Furthermore, it is possible to apply the data on number of employees and employees' wages and see how much one could possibly save when improving the IEQ as a causality of their improved performance/ productivity.

An example of CO2 data applied in the tool is illustrated in table 1.

The tool is only available in Danish and can be downloaded for free at InnoBYG's website (reference 8).

Table 1 example from Total Value and Indoor Environmental Quality tool. Time applied in the different categories of CO2-level shows that there is a potential to increase performance by 0,9%. This number is then added to the other three categories when all data has been applied. (reference 8)

CO_2-koncentration	
< 700 ppm	20%
700 - 1000 ppm	50%
1000-1500 ppm	23%
1500-2000 ppm	7%
> 2000 ppm	0%
	100%
0,9%	

[1] Original title: Totalværdi og indeklima

Energy savings and indoor environmental quality are compatible

Improving IEQ can also have a positive effect on energy consumption and thereby provide a financial benefit. Likewise, energy saving measures can also have a positive effect on indoor climate.

For example, if there is already ventilation and the ventilation is changed to a more effective and suitable ventilation system, it is possible to achieve both better indoor climate and energy savings. A case conducted in EFFECT4building concerning Enåbacken, an elderly home in Rättvik, Sweden, exemplifies this. When comparing the energy consumption on ventilation units before and after changing ventilation system (see figure 5), it was found that the energy consumption had dropped by an average of 58% after the conversion. The total savings from three units were estimated to 5.845 euros per year (63.890 SEK/year). The degree of particle separation between outdoor air and supply air also increased for the better by 10% after the conversion of the ventilation units. Thereby achieving both financial savings on energy and a better IEQ.

Energy calculation before and after changing ventilation system
Air flow 1,57m³/s Supply air temp 18C°

Air flow m³/s	Runtime year	kg/m³ °C	kg/m³	kWs/kg year	Efficiency %	Kwh/ year	Energy price Kr	Total cost Kr
1,57	8760	1,2	1	141300	59	109 146	1,00 kr	109 146 kr
1,57	8760	1,2	1	141300	83	45 256	1,00 kr	45 256 kr
						Saving 63 8900kwh år		Saving 63 8900kr år

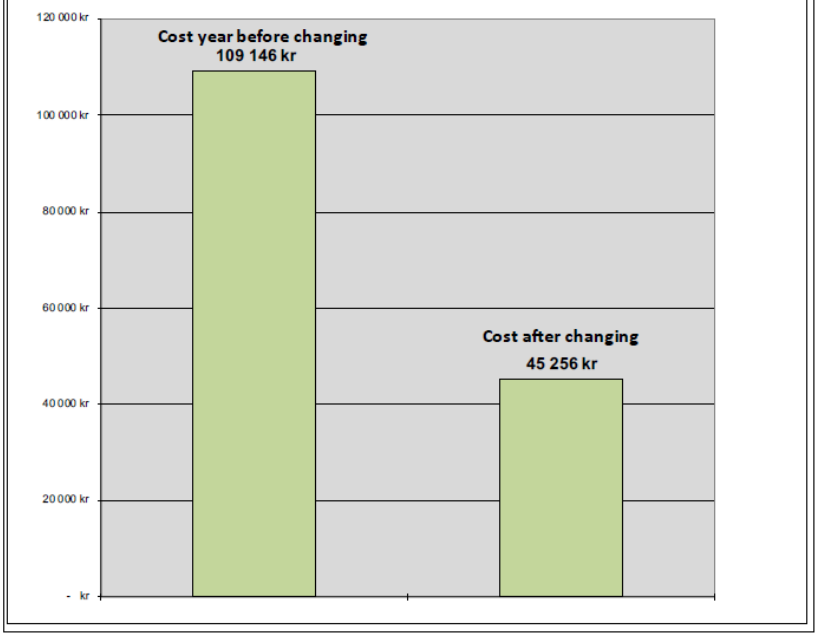


Figure 5 result from 'Enåbacken'. 1 kWh= 1 SEK.

Summary

It is difficult to provide a final answer to the precise financial benefits of measures providing improved indoor environmental quality as other parameters can also affect e.g. sick absence, productivity, and performance. Nevertheless, there is a clear indication that one will gain financial benefits by improving NEB like IEQ and therefore this is a parameter that should be considered when carrying out renovation projects. Furthermore, one should think of how measures for improving IEQ impact on other parameters such as energy savings. A way to do this is by using the exercises described in the MSC tool 2, "Guideline for MSC decision process".

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