Assessment of financial and environmental potential of a real estate energy efficiency investment

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Abstract

Energy consumption reduction in the real estate sector possesses significant possibilities in environmental point of view but also, interestingly, in economic point of view. Emerging interest in energy efficiency improvements is driven by the growing awareness of energy costs, increasing energy prices and recent technical development in means of improving buildings' energy efficiency. In the environmental point of view, energy efficiency improvements have significant potential in reducing energy consumption related greenhouse gas emissions, which continue to dominate the total life cycle emissions of the current building stock.

The study focuses on financial and environmental performance of an energy audit investment in Finland. The study consists of two phases. First, we assess financial and environmental returns of energy efficiency investments in office buildings. Secondly, we compare rate of returns of energy efficiency investment with initial property investment returns. Possibilities of reducing greenhouse gas emissions of the building by energy efficiency improvements compared to the current energy consumption of the same building are assessed as well.

The results of the study indicate that compared to the average property investment returns, investments in energy improvements tend to result in higher returns and simultaneously in reductions of greenhouse gas emissions of the building. Furthermore, energy efficiency investments have short or moderate payback periods in both financial and environmental perspective. Predicted rises in energy tariffs in the future further increase the relevance of this investment option.

The results of the study reveal genuine financial and environmental advantages of energy efficiency investments. Yet, the benefits of energy efficiency investments are currently not easily reached nor realized by investors. This is at least partly due to mechanisms of distributing the potential returns of an investment between stakeholders and in the case of net leases, the mindset, which considers the heating and electricity costs more as passing through cost elements, eventually paid by the tenant, thus not always directly offering greater interest to the property owner. However, by focusing solely on the energy improvement investments and absolute returns that they generate, there appears to be tempting investment opportunities. Consequently, demand for the development in practices in the industry remains.

Keywords: Energy audit, energy efficiency, property returns, greenhouse gas emissions

1. Introduction

1.1 Background of the study

Buildings consume one third of the energy globally and cause the same share of the total greenhouse gas emissions (Huovila *et al.* 2007). According to McKinsey & Company (2009), building and real estate sector has the most economically feasible potential of climate change mitigation. This has sparked political action, for example the European Union has set climate change mitigation targets for 2020 and 2050 with specific goals for built environment (European Commission Climate Action Website). Increasing energy prices together with the increased environmental awareness and political support have led to a situation where energy efficiency actions of the built environment are gaining more and more momentum, due to their large potential for both financial savings and decreased environmental burden.

Use phase, especially energy consumption accounts for significant share of building life cycle GHG emissions even though new energy efficient building types have had a major increase into the share of construction phase emissions (Junnila *et al.* 2006, Gustavsson & Joelsson. 2010). In Nordic countries, heating accounts for as much as two thirds of buildings' energy consumption and GHG emissions (Junnila *et al.* 2006, Kyrö *et al.* 2011). Reducing energy consumption of building stock is thus an effective way of mitigating climate change. Further, energy efficiency improvements are seen as one of the most cost-effective ways to achieve improved energy security, increase industrial profitability, and guarantee greater competitiveness (Hansen *et al.*, 2009). On the other hand, while the large potential for the energy efficiency improvement appears to be widely recognized and accepted, from property owner's point of view the focus is mostly set on the net rental income, not on the cost minimization especially while net lease agreements are used (i.e. the tenant is responsible for the operating expenses).

The European Union directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 defines energy audit as: "'energy audit ': a systematic procedure to obtain adequate

knowledge of the existing energy consumption profile of a building or group of buildings, of an industrial operation and/or installation or of a private or public service, identify and quantify cost effective energy savings opportunities, and report the findings;" According to Khan (2006) the Energy Audit Programme (EAP) in Finland was launched in 1992. Companies and organizations, which carry out energy audits for their buildings, are subsidized by 40 to 50 percent by the Finnish Ministry of Employment and the Economy (MEE) when energy audit process is carried out according to MEE's general guidelines and the model audit guidelines. Saving potentials for energy and water and saving measures are identified in the energy audit and companies and organizations can then decide whether to carry out the activities or not. Motiva is an affiliated Finnish Government agency promoting efficient and sustainable use of energy and materials. According to Motiva energy audits are suitable for properties with standard building technologies including also big or complex buildings e.g. hospitals or large business centers.

The aim of this study is to analyze and understand the potential for positive economic and environmental impacts that energy efficiency improvements of existing buildings can withhold. Moreover, the research compares the estimated returns of the energy efficiency improvement actions to the impacts on overall values of the properties and sets out the potential for decreasing properties' energy consumption along with GHG emissions. Energy efficiency improvement potential is based on actions identified in the energy audit processes. The profitability of the investments is estimated using two factors, through internal rate of return (IRR) and payback period. The environmental performance of energy audit processes is measured in GHG emissions reduction per net area of a property.

1.2 Description of data

The energy audit data set consisted of concluded energy audits of altogether 76 properties in different cities in Finland. For the purposes of this study, all other property types apart from offices were excluded from the data, thus resulting in 29 office properties. The average gross area of the properties was approximately 9,100 m2 and the median 7,800 m2. Average volume was 39,000 m3 and median 37,900 m3. The audits have been done between 2005 and 2012. The amount of suggested actions varied between 4 and 15 and they were related to HVAC/HPAC systems, water systems, lighting and building automation. On average, the identified energy improvement investment measures are approximately 33,800 euros and the average annual savings 15,100 euros. The average lifetime of the savings is 6.4 years, based on the notional savings of each energy improvement measure, following the principles for energy audit savings calculations as set out in the general Finnish guidelines (The Finnish Ministry of Employment and the Economy *et al.* 2012).

For the purposes of the property value calculations property market data was required. The data for operating expenses was received from KTI Property Information Ltd. (KTI). As the energy audit data did not include the addresses nor other identifiable data of the 29 subject properties, each of the property are valuated using rental levels, operating expenses, vacancy rates and

yield levels as close to the given market as possible. The operating expense data includes benchmark data of occurred expenses of office properties in 2012 in the different subject cities in Finland. The operating expenses include administration, upkeep and maintenance, upkeep of outdoor areas, cleaning, heating, water and waste water, electricity and gas, waste management, property insurance, (land) rents, property taxes, other operating expenses, repairs and activations of capital expenses. In addition, existing gross rental levels and vacancy rates for the subject properties' cities were received from KTI (KTI Rental benchmarking 2013) and estimated yield levels (RAKLI-KTI Property Barometer 2013, Catella 2013).

2. Method

2.1 Profitability analysis of energy audit actions

The economic impacts were assessed using three methods. First, the profitability of the actions was modelled by calculating the internal rate of return (IRR) and payback periods for the suggested energy efficiency improvement actions and corresponding annual operating expense savings. Secondly, the impact on the property values was modelled using a Discounted Cash Flow model.

IRR indicates the rate of return when the investments net present value is zero; thus all projects with equal or higher IRR than the investor's required rate of return are profitable. IRRs for the 29 subject properties were calculated based on the identified annual savings, required initial investment and notional lifetimes of the savings.

The economic impact of the energy audit actions on the property value change (i.e. on the returns) was conducted using Discounted Cash Flow valuation method. In the Real Estate and Construction sector, DCF is recognized as the most popular commercial property investment valuation method, both in the literature and in practice (e.g. KTI and IPD 2012; Shapiro *et al.*, 2013). The property value in DCF is the present value of future net rental income and the exit value of the property. These input parameters (i.e. rental income, maintenance costs, repair and replacement costs, vacancy rate, and discount rate) are mainly drawn from market information while using the specifications of the property as a basis for the market information search.

2.2 Greenhouse gas emissions of energy audit actions

The environmental comparisons of energy efficiency improved buildings and average office buildings were conducted with life cycle assessment (LCA). LCA method used in the study is ENVIMAT, an input-output (IO) LCA application, which is presented in more detail later in the chapter. LCA takes all life cycle phases of a product or a service into account in assessments of their environmental effects. According to Hendrickson *et al.* (2006) an example of life cycle phases of a typical product consists of raw material acquisition, material processing,

fabrication, use, disposal and landfill. In the case of reuse or recycle, the life cycle of materials extend into a life cycle of another product. In addition, besides assessing the direct emissions of product manufacturing process LCA also compiles the emissions of indirect emissions of supply chains. Thus LCA provides a holistic perspective of all life cycle phases of a product or service with extensive insight into supply chains of each process in a product life cycle. The details concerning the boundaries of the life cycle assessment are described in the LCA boundary definition according to the characteristics of chosen LCA application.

IO LCA is one of the two primary LCA applications along with the process LCA (Sharrard *et al.* 2008). IO LCAs utilize national IO tables to combine sector-by-sector economic interaction data with sector level environmental effects on resource use data (Bilec *et al.* 2006). According to Hendrickson *et al.* (2006) one of the main advantages of IO LCA applications is that there is no need for boundary definition as the input output tables cover entire economy. Additionally, IO LCA data is often publicly available and IO analyses are faster to conduct compared to more data intensive process LCAs.

ENVIMAT IO LCA application used in the study is based on input output tables of Finnish economy. IO table consists of 151 industries, which is based on 918 domestic and 722 imported products or services (Seppälä *et al.* 2011). ENVIMAT IO application converts monetary costs spent on a sector of an economy into GHG emissions according to the sector intensities. ENVIMAT consists of 159 sectors, which are compiled using Statistics Finland data of years 2002 and 2005. The ENVIMAT tables model the Finnish economy of the year 2005. The ENVIMAT IO tables are publicly available in Internet.

3. Research process

3.1 Profitability analysis of energy audit actions

The profitability analysis was done using a dataset of energy audit information. As the data contained office, retail and warehouse properties, the original dataset was edited to include only office properties (which are in the scope of this study), thus decreasing the number of properties into 29.

The internal rate of returns (IRR) for the energy improvement investments for all of the 29 properties were calculated using the following formula:

$$NPV = CF_0 + \sum_{t=1}^{n} \frac{CF_t}{(1+d)^t} = 0$$

Where CFs denote cash flows in different years NPV is the Net Present Value of the investment and d is equal to IRR, when NPV is zero (Knüpfer & Puttonen, 2004, pp. 85). The payback periods were calculated by dividing the total energy investments by the total annual savings identified in the energy audits.

The simulation of the effects on the property value for the properties was done using spreadsheet software based ten-year-discounted cash flow (DCF) modelling. DCF is based on the formula for Net Present Value where the cash flows are net rental income:

$$NPV = CF_0 + \frac{CF_1}{(1+d)^1} + \cdots + \frac{CF_n}{(1+d)^n} = CF_0 + \sum_{t=1}^{n} \frac{CF_t}{(1+d)^t}$$

, where CF_t denotes the Cash Flow of year t and d is the discount rate (Knüpfer & Puttonen, 2004, pp. 83). In addition, the model included the exit value of the property.

The property market data (i.e. rental data, vacancy rates, yields, operating expenses) for each given property were used in the modelling, using each city's data for the corresponding property value calculations. The lease period was assumed to be 10 years and the properties single tenanted. The used inflation rate was 2.0 percent, which is based on long term average in Finland (OSF 2013).

Two sets of calculations were done for each of the 29 properties, one without the energy improvement investments and one with the investments and corresponding annual savings in operating expenses. The lifetime of savings in the energy audit actions was calculated as weighted average, which was then inserted into the cash flow model's residual value component. In cases where the lifetime of the savings was less than 10 years, the corresponding investments were repeated in the cost component after each period of time. Since the area details in the original energy audit data were reported as gross areas, the data was converted into net rentable area for the DCF purposes. In Finland, the rentable area is the basis for the market rents and thus the transformation was deemed necessary in order to maintain the comparability of the rental income and operating expenses. The gross-net area conversion factor 0.7 is based on the study of Lylykangas *et al.* (2013) and is calculated using the Official statistics Finland data.

3.2 Greenhouse gas emissions of energy audit actions

The research of greenhouse gas emissions was conducted using the same initial dataset of energy audit information of the properties as in the economical part of the study. The dataset was used to calculate the emissions based on the costs and the future savings of actions recommended as a result of energy audit processes. Another dataset of property operation costs for various office-building types were provided by the KTI Property Information Ltd. (KTI cost benchmarking 2013) and used to enable GHG emission comparisons with the energy audited and the reference properties.

Operation of a reference property that was used as a basis in the analyses was created using the KTI dataset. The dataset consist of average operation costs of office premises for cities of Helsinki, Tampere, Turku, Helsinki metropolitan area and other major cities. GHG emissions of premise operation were assessed using appropriate ENVIMAT sector for each operation activity. The details of the sectors are following:

The GHG emissions of operating the reference premise in each city were assessed in order to create the GHG footprint of the reference building operation in each location. GHG emissions of reference building were then modified with the energy efficiency improvement tasks according to the energy audit recommendations individually for each case. Investments into energy efficiency improvements caused some GHG emissions and operation GHG emissions reduced at the same time. Some improvements had to be renewed according to lifetime of a saving in order to maintain the reduced level of energy or water consumption during the whole analysis period. GHG emissions for these activities were included into the model of the study.

First phase of LCA was to model a GHG emissions caused by the energy efficiency improving actions recommended in the energy audits. Three different sectors of ENVIMAT model were used in the process. First, other construction services sector was used for the actions that included some construction activities. Second, other residential services sector was used for the activities that included tasks done on the property location. Third, business related services sector was used for the minor activities that could be executed remotely. Details of the three ENVIMAT sectors used for modeling the investment GHG emissions are presented in Table 1.

The GHG savings gained as a result of improved energy or water efficiency were modeled by categorizing saved resources for electricity, district heat or water supply according to the system that was enhanced by the energy audit recommendation. Categorized savings were then modeled into avoided GHG emissions using three ENVIMAT sectors. Electricity production and supply sector was used for decreased electricity consumption. Distribution services of hot steam and water sector was used for reduced consumption of district heat. Collected and cleaned water and water distribution services sector was used for reduced water consumption. The details of the ENVIMAT sectors are presented in Table 1.

Table 1: ENVIMAT sectors used in the GHG assessments

Operation activities	***ENVIMAT sector***	***(kg CO2e/€)***
Administration	*Business related services*	*0.23*
Upkeep and maintenance	*Other construction services*	*0.28*
Upkeep of outdoor areas	*Other real estate services*	*0.32*
Cleaning	*Other real estate services*	*0.32*
Heating	*Distribution of hot steam and water*	*5.23*
Water and wastewater	*Collected and cleaned water and water distribution*	*0.4*
Electricity and gas	*Electricity production and supply*	*4.56*
Waste management	*Collected and cleaned water and water distribution*	*3.94*
Property insurance	*Electricity production and supply*	*0.32*
Property tax	*Financing and insurance services*	*0.26*
Other operation expenses	*Business related services*	*0.23*
Repairs	*Residential construction*	*0.43*

Energy audit investments	***ENVIMAT sector***	***(kg CO2e/€)***
Construction related activities	*Other construction services*	*0.28*
Tasks on property location	*Other real estate services*	*0.32*
Minor remote activities	*Business related services*	*0.23*

Energy audit savings	***ENVIMAT sector***	***(kg CO2e/€)***
Electricity	*Electricity production and supply*	*4.56*
Heating and hot water	*Distribution of hot steam and water*	*5.23*
Water consumption	*Collected and cleaned water and water distribution*	*0.4*

These steps enabled assessment of GHG emissions for 10-year analysis period for each energy audited property and the reference properties in each location. GHG emissions analyses of the reference properties consist of constant GHG emissions caused by building operation for each year. GHG emissions of the energy audited properties consist of reduced GHG emissions for building operation according to energy and water savings of the energy audit process. Additionally, GHG emissions caused by the investment and maintenance of the energy audit activities were taken into consideration in the analyses of the energy audited properties.

4. Results

4.1 Profitability analysis of energy audit actions

The energy audit improvement investments resulted as internal rate of return of ***40.6 percent*** on average, while the IRR in individual properties ranged from the minimum of -4.6 percent to the maximum of 881.2 per cent (Figure 1). The median IRR was 66.0 percent. In addition to the IRR, the payback periods for the investments were calculated. The average payback period for the projects was ***2.0 years***, the minimum being only 0.1 years and the maximum 8.2 years. The median payback period was 1.4 years.

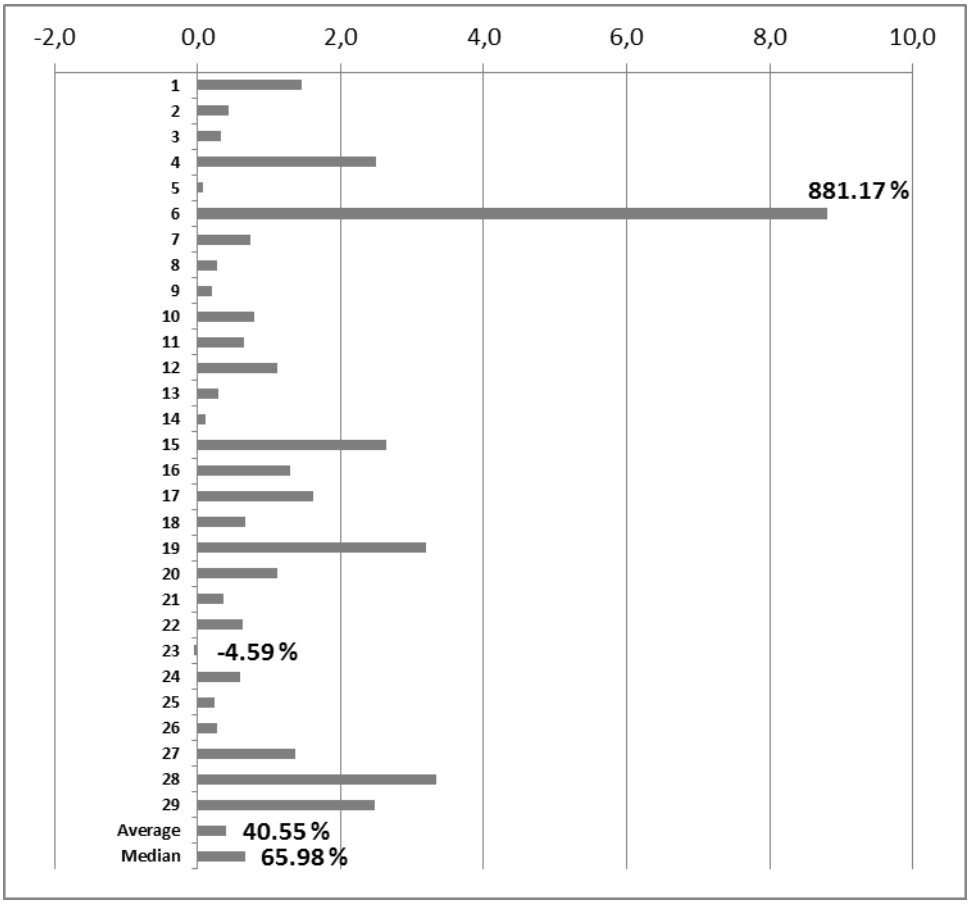

Figure 1: Internal rates of returns of energy improvement actions

Regarding the impacts on the property value, the energy efficiency improvements had some effect. The DCF modelling resulted in an overall average value increase of ***1.72 percent***, the median being ***1.40 percent.*** The value changes of individual properties ranged between the minimum of -0.06 per cent to the maximum of 5.60 per cent (Figure 2). The corresponding euro amounts of value change were approximately -11 400 and 623 900 euros, the average being 147 000 euros.

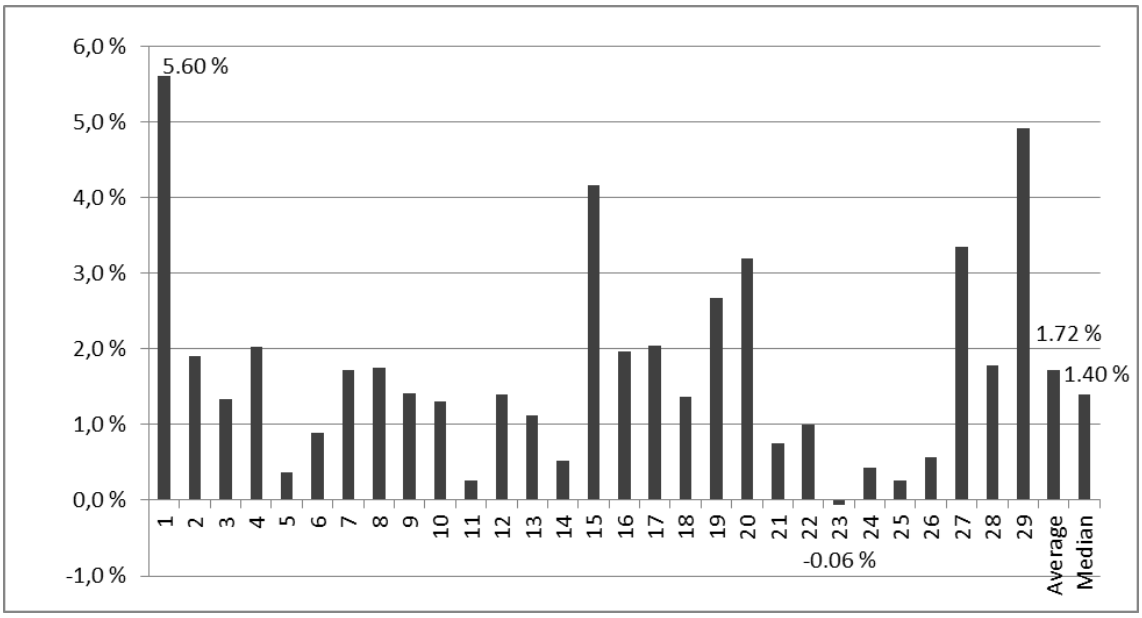

Figure 2: Property value change due to the energy efficiency investments

4.2 Greenhouse gas emissions of energy audit actions

Energy and water consumption activities recommended in the energy audit process had a significant effect on carbon footprint of the property. GHG emission reductions in energy and water consumptions were calculated for 10-year time period, as it is a time frame used in the economical analysis of the energy audit performance. GHG emissions caused by the investments into energy and water consumption reductions and emissions of the maintenance activities that maintain the reduced level of energy and water consumption were then added into the GHG reduction figures.

Based on the average of all 29 cases on the 10-year analysis period, operation of reference property caused approximately 0.89 tons of GHG emissions per net sqm. Operation of energy audited properties caused on average 0.80 tons of GHG emissions. Thus, decrease of emissions is approximately 11 percent. In the case of only including energy and water consumption related GHG emissions of property operation into an account, reference property caused an average GHG emissions of 0.76 tons per net sqm. On average energy audited properties caused GHG emissions of 0.66 tons per net sqm. Energy audit activities reduced water and energy consumption related GHG emission by 13 percent on average of the all assessed case properties

compared to the reference property. Cumulative GHG emissions of an average local reference building and an average energy audited building are presented in Figure 3.

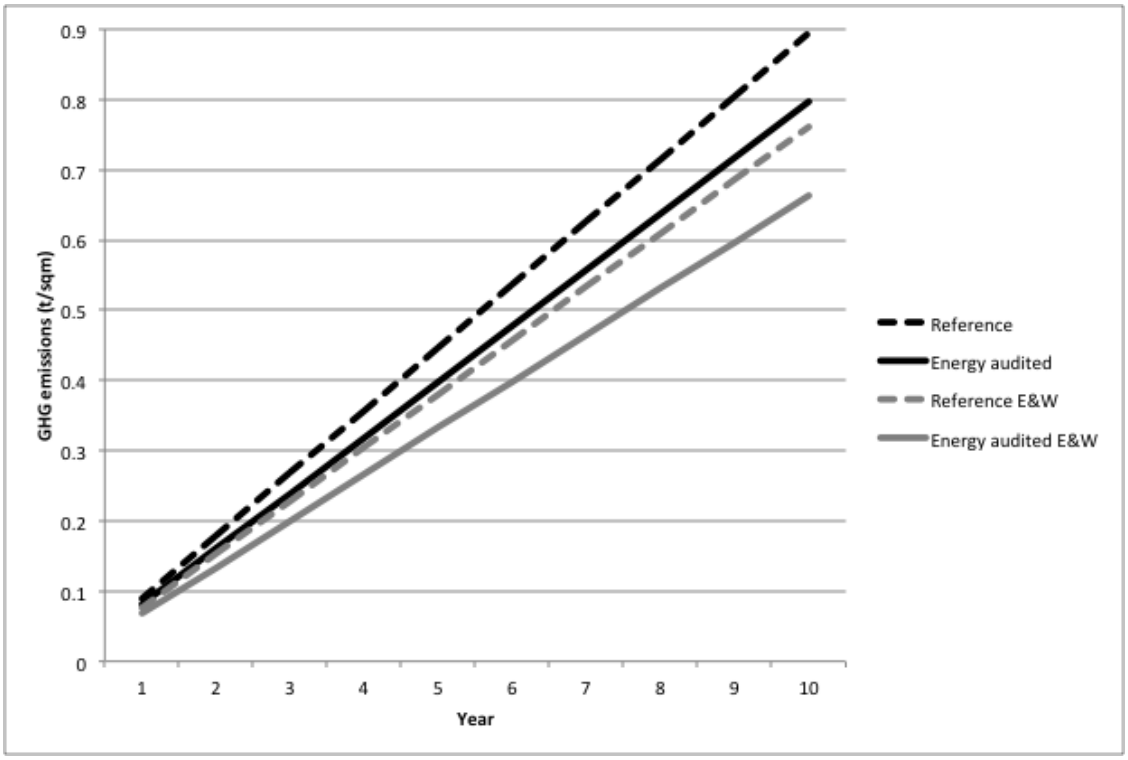

Figure 3 Cumulative GHG emissions of an average reference property and an average energy audited property

Property operation GHG emissions caused by decreased need for electricity, heat and water were also analyzed separately in order to enable comparisons of GHG reductions between different energy types and water. On average energy audit activities reduced GHG emissions caused by electricity consumption by 21 percent. The corresponding figure for district heat was 7 percent. Water consumption focused energy audit activities decreased water consumption related GHG emissions on average by 8 percent.

The activities recommended in energy audit processes had very short GHG payback periods of 1.7 months by average while median GHG payback period of activities was 1.2 months. Accordingly, GHG emissions of activities maintaining the reduced level of energy and water consumption were negligible and hardly visible in cumulative GHG emissions of energy audited properties. The GHG emissions of initial investment and maintenance activities of energy and water consumption reductions were not taken into consideration in GHG emissions payback periods as they occur unevenly during the assessment period.

5. Conclusions and discussion

When the investments were analysed from return perspective, the internal rates of returns were as high as 40.6 percent on average, which could be translated to be a highly profitable investment. On the other hand, the impacts in the overall property returns were 1.7 percent on average, which does not appear to be as tempting at first glance. However, when regarded as absolute value change, the 147,000 euro increase with investment of 34,000 euro is clearly of interest and has significance. Further, it is noteworthy that the positive effects on value change are in line with previous knowledge: e.g. German residential building stock has been reported to yield up to 3.2 percent higher return due to energy efficiency improvements (Cajias and Piazolo 2013).

Indeed, energy efficiency improvement investments could produce tempting returns when analysed *per se*. However, the positive effect on the overall value of the property appears to get diluted, perhaps due to setting too much emphasis on the percentage increase and not on absolute value. Also, depending on the lease structure (net or gross), the operating costs might not even be in the focus of the property owner; in the case of net lease they are considered to be the responsibility of the tenant(s) and in case a net lease is already signed, there is no direct economic benefit. Moreover, since the total project values for the energy efficiency improvement investments are much smaller by scale compared to average property investment values, it could provide another possible reason for regarding the actions so far not always worth conducting.

In the environmental point of view the energy audit activities lead to significant decreases in property GHG emissions. The energy audit activities produce negligible GHG emissions in the investment phase compared to the GHG emissions reductions caused by reduced electricity, heat and water consumption. The GHG emissions caused in the energy efficiency renewal phase, which extends the lifetime of an energy efficiency improvement, are minor as well. Reasons for this are the low GHG intensities of activities recommended in property energy audits compared to electricity and heat generation. This is due to the fact that majority of the costs of energy audit activities are low GHG intensity staff expenses whereas costs of energy generation include use of high GHG intensity fossil fuels. For example one euro causes 17 to 20 times less GHG emissions when it is invested in energy efficiency improvement activities instead of purchasing electricity or heat with the same amount when modelled with the current IO LCA model. This is also the main reason for the better environmental (GHG wise) performance of energy audits compared to the economic performance where one euro of investment leading to saving of one euro is meaningless.

Majority of the energy audit actions were aimed towards electricity consumption reduction and thus GHG emissions caused by the production of consumed electricity in properties reduced the most. Noteworthy point is also the GHG intensities of the energy or water production sector. Saved euro in electricity or heat consumption reduces GHG emissions by factor ten compared to water consumption. The reasons for this are approximately ten times larger GHG emissions per euro of electricity or heat generation compared to delivery of cold water.

There are some limitations and uncertainties related to the results of the study. First, final dataset of the study consists of a rather small amount of properties. Moreover, as it was not possible to obtain the full details of the subject properties due to confidentiality issues, the exact rent or operating expenses for each property were not obtained for the property value modeling. However, as the study analyses the relative change of the values, using market rent and operating expense levels is justifiable. Further, regarding the property value analysis, the possible impacts of improved energy efficiency actions on the yield or achievable rent levels due to for example possible better rentability and marketability of the premises are not included into the study. Thus, the positive impacts on property values (indicating better returns) are analyzed only from the improved net rental income component.

The GHG emission reductions caused by the activities recommended in the energy audit processes were derived by using the savings measured in euros as the initial data for the IO LCA modeling. The properties are located in various Finnish cities and different cities have dissimilar prices for energy and water. Thus, the monetary savings in energy and water are based on different amounts of energy across the cities as the prices differ, which this study does not take into an account. We suggest this as the next step for the future research of the subject in Finland.

While the economic payback periods of the energy efficiency improvement investments were on average 2.0 years which could be considered rather short, in terms of the GHG the payback periods were even shorter, only 1.7 months on average. One possible interpretation of this is that the environmental burden is more quickly eased albeit the economic payback is still within reasonable limits. Thus, the investments appear attractive from both the economic and environmental perspectives.

By highlighting the rather tempting returns on energy improvement actions the authors of this paper accentuate the large energy efficiency improvement potential that properties can withhold. Especially large property owners' portfolio-wide energy efficiency improvement actions could generate significant outcomes both in terms of value increase and decreased GHG emissions, thus taking advantage of economies of scale. Further, there is a relevant business opportunity for an actor that manages energy efficiency improvements of a large building stock as primary business information technology for managing the technical adjustments of building technology. Using the approximate figures the investment for energy audit activities for the 29 properties analyzed in the study would cost 1.0 million euros. The annual savings achieved by energy consumption reductions would be 0.44 million euros. Thus, the IRR using weighted average of lifetimes of savings for improving energy efficiency of the property stock would be approximately 43 percent considering energy and water savings as revenue.

Further, in order to take full advantage of the energy efficiency improvement potential, it will require the distribution of the benefits between landlord and tenant(s) to be clarified in lease agreements in full detail in order to avoid any disputes. Since the energy prices are likely to increase in the future, the unlocked potential that properties withheld is probable to increase in economic point of view.

Future research possibilities could include e.g. implementation of larger dataset of properties and usage of different property valuation modelling approaches. In addition, analyzing the impacts of improved energy efficiency on the marketing and rentability of the premises could provide another interesting topic: this study only considered the value influence through the decreased operating expenses. The reliability of the findings is considered moderate while the amount of properties was low. Larger dataset could provide further reliability and generalizability through the application of quantitative methods.

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