The current issue and full text archive of this journal is available at
www.emeraldinsight.com/0263-2772.htm

Facilities management driving green building certification: a case from Finland

Anna Aaltonen, Eeva Määttänen, Riikka Kyrö and
Anna-Liisa Sarasoja
Aalto University, Espoo, Finland

Abstract

Purpose – The aim of this study is to identify and understand the role of facility services in the environmental performance of existing office buildings.

Design/methodology/approach – The study observes how a facilities management (FM) service provider develops its service processes to meet environmental efficiency objectives. The environmental objectives are adopted from a commonly used green building rating system. The developed processes and services are then analysed and tested against a case facility.

Findings – The results indicate that FM service processes have both direct and indirect influence on the building environmental performance metrics. The results show that, by relatively light changes and modifications to the FM service processes, quite extensive environmental benefits can be achieved.

Research limitations/implications – The study is preliminary and the results are based on the single case study. Only one service provider was assessed. Moreover, the case study represents a situation where all FM services are provided by one service provider.

Practical implications – FM providers readily hold a great portion of the data required for green management. It can be argued that FM services play a central role in the environmental performance of an office building and FM organizations can significantly support client organizations in their efforts to minimize their total environmental impact.

Social implications – The majority of carbon dioxide emissions caused by buildings are created during the operating phase of existing buildings. In other words, the way a building is managed and maintained has a major impact on the environmental performance of the building.

Originality/value – The study contributes to the discussion on the role of FM in climate change.

Keywords Green building, Facilities management, Facility services, Operating phase, Office building, Finland, Buildings, Sustainable development

Paper type Research paper

1. Introduction

It is currently well-known that the built environment is a major contributor to climate change. The built environment (i.e. residential and commercial buildings) accounts for roughly 40 percent of both the total energy consumption and the carbon dioxide emissions in Europe (COD/2008/0223, n.d.; UNEP, 2007) and the USA (USGBC, 2010a). Furthermore, research (Rosenblum *et al.*, 2000) has shown that, even when compared with the industrial sector, the service industry (including the use of commercial buildings) accounts for a surprisingly large portion of all environmental impacts in areas such as energy consumption. Consequently, reducing the environmental impacts

Facilities
Vol. 31 No. 7/8, 2013
pp. 328-342

0263-2772
DOI 10.1108/02632771311317475

The authors wish to thank Tekes (the Finnish Funding Agency for Technology and Innovation) and ISS Palvelut Oy for inspiring and funding the research.

of commercial buildings represents significant potential (Junnila, 2004). An estimated 80-90 percent (Junnila and Horvath, 2003; Junnila, 2004; Junnila *et al.*, 2006; Scheuer, 2003; Suzuki and Oka, 1998) of climate change impacts caused by commercial buildings are created during the operational phase of existing buildings. Moreover, existing commercial buildings will continue to represent the majority of the commercial building stock far into the future. As Miller *et al.* (2010) states:

> We do not have the luxury of replacing all existing buildings with new, green construction overnight, we do have tremendous opportunity to incorporate green practices into management of existing buildings.

Many of the earlier studies of green buildings focus on certificates for new buildings and the construction phase (e.g. Lavy and Fernández-Solis, 2009; von Paumgartten, 2003). These certificates are based widely on simulations instead of actual performance and as such the reality may differ greatly from the certification levels. For example, regarding energy use, it has been found that most new buildings do not perform as well as advertised by their certificate (Gaby, 2011). Efforts have also been made to study and present research results on the impact of green buildings on rents, values and real estate investments (e.g. Miller *et al.*, 2008; Fuerst and McAllister, 2009; Dermisi and McDonald, 2011; Falkenbach *et al.*, 2010; Newell and Lee, 2012). Other studies have focused on the benefits of green buildings relating to worker productivity, health, comfort and satisfaction issues (e.g. Romm and Browning, 1994; Paul and Taylor, 2008; Miller *et al.*, 2009; Kamaruzzaman *et al.*, 2011; Zhang and Altan, 2011), while less attention has been paid to the role of Facilities Management (FM) and facility services in the field of green buildings.

The few studies that have been conducted in the field suggest that FM services could support user organizations in their effort to become more environmentally sound (Hodges, 2005; Roper and Beard, 2006; Wood, 2006; Junnila, 2007). In fact, end-user companies already expect facility managers to be able to provide environment and energy related services (Nousiainen and Junnila, 2008). End-user companies wish to receive comprehensive reporting and recommendations on improving their environmental performance. Also, the barriers to the implementation of sustainable facilities management has been investigated (Elmualim *et al.*, 2010). Furthermore, as Hodges (2005) suggests, facility managers are unique in bearing knowledge of historical, current, and future operations, i.e. the entire life-cycle of a building.

The purpose of this research is to identify the role of FM service processes in the environmental performance of existing office buildings. It is hypothesized that FM service processes play a central role in an office building's environmental performance. More specifically, the working hypothesis has been that FM organizations can significantly support client organizations in their efforts to minimize their total environmental impact.

Following this introduction, Section 2 introduces the research design and subjects of the case study. Section 3 describes the development process of the facility services, and Section 4 presents and analyses the major findings. Section 5 discusses the findings further, while Section 6 draws conclusions, and provides recommendations for the application of the results and future research.

2. Research design

The study was conducted using case study methodology. A single-case design is used in order to retrieve detailed empirical data on the studied phenomenon (Yin, 1994). As the study hypothesizes that FM services can play a significant role in the environmental performance of an office building, it was of importance to find a plausible critical case for the testing of the hypothesis. The selection was based on the principles of theoretical and purposive sampling, in other words, some relevant key characteristics were emphasized in the selection (Yin, 1994; Eisenhardt, 1989). The selected case facility, case organization, and the rating system, along with their respective key characteristics, and the basis for the selection are described in the following subchapters.

2.1 Case building

The subject of this case study is a 16,300 square meter office building housing the Finnish headquarters of an information technology corporation employing ca. 800 staff. The building was first developed in 1984. An extension was built and major renovation carried out in 1991. Some key building characteristics are presented in Table I.

The case building is considered to represent a rather typical Finnish commercial building. According to Statistics Finland (2010), a significant portion (22 percent) of existing commercial buildings in Finland date from the 1980's. Additionally, the building is located in the Helsinki Metropolitan Area in Southern Finland, with the highest density of commercial buildings in the country (KTI Property Information Ltd, 2010).

2.2 Facilities management organization

The case FM service organization is a large, global commercial provider of facility services. The organization provides both facility management services and facility management. The case organization has provided all major facility services for the case building since September 2008. Altogether 20 of the organizations' employees, including a service manager, work on site regularly. The provided services comprise cleaning, waste management, catering, indoor and outdoor property maintenance (i.e. air conditioning, housing automation, plumbing, lighting systems, green areas maintenance, antiskid treatment, etc.), in-house mail delivery, reception of goods, office services, pest management, as well as energy control services.

The main initiative for developing "greener" FM processes came from the FM organization. The organization was tempted to test and analyse their possibilities to influence their clients' environmental efficiency. It was decided that the most effective way to develop and analyse the processes would be to choose a green building indicator system and follow their standards and guidelines for FM processes.

Building parameters	Value
Location	Espoo, Southern Finland (Northern Europe)
Current service life	24 years (1984)
Gross floor area	16,300 m^2 ($\sim$175,451 ft^2)
Gross Volume	70,000 m^3($\sim$2,471,000 ft^3)
Structure	3-storey with basement
Employees	800
Operating energy (2008)	
Heat	124 kWh/m^2/year
Electricity	146 kWh/m^2/year

Table I.
Building parameters

2.3 Green building rating system

Green buildings are buildings or structures that have less impact on the environment than conventional buildings. The environmental aspects to be considered in estimating the impact include, at a minimum, energy and resource use, waste generation, pollution, and indoor air quality (US EPA, 1995). The green building practice ideally considers all of the environmental aspects listed above, and therefore does not equal building energy-efficiency, as sometimes falsely perceived. Furthermore, green building is a practice that extends throughout the entire life-cycle of a building, not just the design and construction phase.

Many green building indicator systems are available globally, the most well-known being the British BREEAM and the US-based LEED®. Others include HK-BEAM (Hong Kong), DGNB (Germany), Green Star (Australia), as well as CASBEE (Japan). While all mentioned indicator systems have similar scopes, the criteria differ, making benchmarking difficult (Reed *et al.*, 2009). However, Lee and Burnett (2007) found that LEED®, BREEAM, and HK-BEAM do not show significant differences when estimating building energy efficiency. The green building indicator system chosen as a reference in the development process was US Green Building Council's LEED® for Existing Buildings: Operations and Maintenance Rating System (LEED EB®). USGBC's LEED® was chosen due to its wide international recognition and popularity: 24,546 registered projects and 10,471 certified projects worldwide in May 2012 (USGBC, 2012). Majority of the LEED® projects are located in the US, but LEED® is also gaining interest in Europe, including Finland. At the time of this study, there were 15 certified and 51 registered LEED® projects in Finland. LEED EB® is a rating system specifically tailored for existing, operational buildings.

LEED® rating systems have been criticized, e.g. for the systems' poor consideration of building materials (Marsh, 2008; Bowyer, 2007) and energy-efficiency (Gifford, 2008). However, the LEED EB® rating system does have a broad approach to different environmental aspects, which is essential in estimating the environmental impact of a building. The rating system comprises altogether seven categories with which the environmental performance of operational buildings is measured. The seven categories have been outlined by the USGBC (2010b), as follows:

1. Sustainable sites (SS).
2. Water efficiency (WE).
3. Energy and atmosphere (EA).
4. Materials and resources (MR).
5. Indoor environmental quality (IEQ).
6. Innovation in operations (IO).
7. Regional priority (RP).

Facilities management process development

The FM organization compared their service processes against all the applicable LEED EB® criteria. If the criteria were not met, the processes were developed in order to meet them. Most of the criteria were directly connected to the FM organization's operations allowing for the organization to develop the processes and create the needed performance measures and documentation independently from the customer (e.g. energy monitoring). Some of the criteria were related to the building itself and the processes of the user organization. In these cases, the FM organization developed guidelines and instructions for the client to achieve the sustainability objectives (e.g. instructions for smoking on site). The focus of the development of the FM service processes was especially on cleaning-, property maintenance and building automation-, waste management-, and green areas service processes.

After the process development the FM organization tested their new, "greener" FM services in the case facility. For proper testing it was seen important that the case facility would apply for a green building rating and the third party verification was conducted. The performance period for the LEED EB®: O&M process started 1 December 2009 and ended 31 March 2010, covering four months. Despite the age (first developed in 1984) of the case facility, no major structural or technical refurbishments were needed to achieve the green building certificate. The facility has been appropriately maintained during the FM service partnership since 2008, and many environmental aspects had already been taken into consideration. Most recently, remote real-time energy and automation monitoring of the building was included in the facility services.

As an example of process development, the FM organization's cleaning process was based on minimal chemical use already as standard practice, but during the project the cleaning processes were developed further, so that the eco-labeled chemicals are always preferred, and a site-specific follow-up on the use of the cleaning chemicals, and the follow-up on the proportion of eco-labeled chemicals are in use. Also, the cleaning equipment was selected, and the quality monitoring of cleaning performance was adjusted according to the LEED® criteria. In the case facility, a building specific Green cleaning policy and a program were developed. The established frameworks for sustainable operations confirm the systematic use and surveillance of green cleaning methods and products. Also, in the case facility, the purchased cleaning products, tissue and sanitary paper were ensured to be the most environmentally preferable, i.e. products which have received an eco-label. The cleaning services were evaluated using the APPA audit method.

In property maintenance, there are several requirements in LEED® criteria of implementing general good practices, and much attention is paid especially to the automation optimization and energy monitoring. A handbook for the property maintenance requirements, and more general guidelines to implement best practice in property maintenance were developed in order to receive the LEED®-certification.

Green areas maintenance was developed for example by improving the follow-up of landscape waste recycling and by developing the means to inform building users when chemicals are used in green areas. Also, the organization developed guidelines for environmentally efficient planning of green areas, e.g. by promoting the selection of native or adaptive plants and natural materials that have least impact on the environment. In the case facility, outdoor property maintenance was committed to be performed more manually instead of using machinery. Also the use of antiskid treatment chemicals and other outdoor chemical use was minimized.

Waste management processes were developed for example by implementing an on-line reporting tool, which reports the amounts of waste and recycling rates, making sure that certain waste fractions are always recycled. In the case facility, the waste recycling and monitoring of the waste volumes were already in a moderately high level before the LEED® project. The most significant change was initiating the recycling of energy waste. The energy waste fraction is being utilized in industry as combustible matter, replacing the use of fossil fuels. The building users were given training for recycling during the performance period. The waste volume monitoring was outsourced and the on-line waste monitoring system was taken in use.

The development of the building's operations concentrated on monitoring and optimizing the use of water, heat, and electricity. In order to achieve the required flow rates for water fixtures, the pressure decreasing valve was installed. In addition, the water fixtures were checked for leakages and the flow rates were measured. The indoor temperatures were checked and optimized throughout the building. Ventilation systems were checked, and the temperature of in-blast air was decreased in addition of changing the carbon dioxide steering to adjust the limits. Also the use of recirculated air was intensified and the operating times were optimized. For lighting, the operating times were also optimized. As part of the "greening process" of the building, the purchased electricity was changed to hydropower produced electricity. Although the change was made after the LEED®-performance period and did not impact on the received level of certification, it had a major impact on the overall building's carbon footprint and should be noted here.

In addition to the LEED® criteria, the FM service organization recognized further opportunities to develop its processes to more environmentally sound, and means to inform and educate the building owners and users. The organization produces client-specific information of the buildings' environmental indicators (heat-, water-, and electricity use, waste amounts), and reports them to building users in, e.g. building's info monitors. Also, when significant changes are made, e.g. in building automation or renovations, they are informed to the customer and building users. This helps the building users to understand the work that is done to improve the working conditions and environmental quality, and possibly improve the satisfaction of the employees working on the building. In addition, during the project, the recycling trainings and guidance material (e.g. recycling guidance, environmental tips etc.) were developed further. Also, the FM service organization increased the participation to local and global environmental campaigns by informing and managing the campaigns for the customer.

3. Findings

This section presents the main findings of the case study. The results and achieved savings in energy consumption, costs and carbon dioxide emissions are calculated for the year 2010 (12 months). LEED EB® results were achieved during the performance period which was from December 2009 to March 2010.

3.1 Green building certification

Based on thorough analysis of the LEED EB® certification criteria, the following categories were developed, indicating the influence, or "impact potential" of the FM provider on the pursued credits.

- *Fully attainable with FM's internal policies and processes*. FM readily holds the information or documentation required to meet the criteria, or FM has full control over the processes included in the criteria. Meeting the criteria is independent of the site characteristics and occupant. Credit example: green cleaning program.

- *FM has operational impact and can influence the points achieved*. FM plays a central role in meeting the criteria via operating the systems, equipment or processes in question and can produce the required documentation. However, meeting the criteria also depends on the site characteristics and occupant. Credit example: optimize energy efficiency performance.
- *FM has operational impact, but cannot influence the points achieved*. FM has no impact on whether the systems, equipment or processes in question are in place, but can implement the required changes and produce the necessary documentation. Meeting the criteria depends on the site characteristics and occupant. credit example: protect and restore site habitat
- *FM can act as an expert advisor*. FM can perform tasks, such as occupant surveys, required by the green building system, or advice on the best practices. Meeting the criteria depends on the site characteristics and occupant. Credit example: alternative commuting transportation.

LEED EB® entails nine prerequisites that must always be met in order to achieve certification. The prerequisites are grouped according to the respective impact potential of the FM provider in Table II.

Most notably, four out of nine prerequisites are fully attainable through the FM provider. Furthermore, another three can be influenced by the FM, even though dependant on the subject facility. Only two out of the nine prerequisites could not be influenced by the FM. However, with these two prerequisites, the FM was still able to advice on best practice.

Once the prerequisites have been met, the credits to be pursued can be chosen freely, as long as the certification minimum of 40 points is achieved. The case facility received Gold level LEED® certification. The required score for the Gold level is 60 points and it was met precisely. In this case, the points were feasible to attain without major upgrades or alterations. The achieved points fall quite evenly between the different LEED® categories, as can be seen from Table III.

Impact potential	Prerequisite
Fully attainable with FM's internal policies and processes	EA P1 Energy Efficiency Best Management Practices – Planning, Documentation, and Opportunity Assessment EA P3 Fundamental Refrigerant Management MR P2 Solid Waste Management Policy IEQ P3 Green Cleaning Policy
FM has operational impact and can influence the points achieved	WE P1 Minimum Indoor Plumbing Fixture and Fitting Efficiency EA P2 Minimum Energy Efficiency Performance IEQ P1 Minimum Indoor Air Quality Performance
FM has operational impact, but cannot influence the points achieved	–
FM can act as an expert advisor	IEQ P2 Environmental Tobacco Smoke (ETS) Control MR P1 Sustainable Purchasing Policy

Notes: SS = Sustainable sites; WE = Water efficiency; EA = Energy and atmosphere; MR = Materials and resources; IEQ = Indoor environmental quality; IO = Innovation in operations

Table II.
Impact potential of FM – LEED EB® prerequisites

Table III. Impact potential of FM – LEED EB® points

	LEED® Category							
Impact potential	SS	WE	EA	MR	IEQ	IO	Point total	Of point total (%)
Fully attainable with FM's internal policies and processes	1	–	6	1	4	1	13	22
FM has operational impact and can influence the points received	–	10	13	3	7	3	36	60
FM has operational impact, but cannot influence the points achieved	2	–	2	–	–	–	4	7
FM can operate as an expert advisor	6	–	–	1	–	–	7	12
Point total	9	10	21	5	11	4	60	
Of point total (%)	15	17	35	8	18	7		100

Notes: SS = Sustainable sites; WE = Water efficiency; EA = Energy and atmosphere; MR = Materials and resources; IEQ = Indoor environmental quality; IO = Innovation in operations

The 60 points achieved by the case facility are presented in Table III, divided by both the LEED EB® category (horizontally) and the impact potential of the FM provider (vertically).

The results show that the FM had either direct or indirect (operational) impact on 82 percent of the points achieved by the case facility. The vast majority of the points achieved were either readily available due to the FM's existing internal policies and practices (22 percent, 13 points) or indirectly influenced by operations conducted by the FM (60 percent, 36 points). Moreover, the categories with less FM impact potential – FM has operational impact, but cannot influence the points achieved and FM can operate as an expert advisor – represent the minority of the achieved points with the shares of 7 percent (4 points), and 12 percent (7 points), respectively.

3.2 Energy and water savings

During the year 2010 energy and water consumptions were followed. Tables IV-VI show the reductions in energy and water consumption achieved during and after the performance period. A total of 373 MWh was saved in electricity consumption, corresponding 9 percent compared to the previous year. The weather corrected heating energy savings was 680 MWh, i.e. 27 percent. Water consumption savings were 1,046 m^3, i.e. 18 percent.

The electricity consumption was lower in every month throughout the year 2010 compared to the previous year, excluding July, which is the most popular time for holidays in Finland. Therefore in July, the electricity consumption should have been lower due to low utilization rates, but also the month was extraordinarily warm, which may have increased the need for extra cooling and electricity use.

The year 2009 did not have as big chances in the average temperatures as were in the year 2010. In 2009, there were four months with average temperature below zero degrees Celsius, and in 2010 there were five. The year 2009 was warmer and dryer than average Finnish year. The year 2010 had lots of extreme conditions; cold winter and very hot summer. (Finnish Meteorological Institute, 2011) Therefore, the average saved

Table IV.
Electricity consumption

Electricity consumption	Consumption 2009 kWh	Consumption 2010 kWh	Difference kWh	Difference %
January	354,288	317,430[a]	− 36,858	− 10
February	320,957	279,367[a]	− 41,590	− 13
March	355,148	285,241[a]	− 69,906	− 20
April	318,186	315,644	− 2,542	− 1
May	331,986	275,133	− 56,853	− 17
June	337,470	298,500	− 38,970	− 12
July	345,587	369,600	24,013	7
August	339,427	329,200	− 10,227	− 3
September	328,469	299,738	− 28,732	− 9
October	341,292	304,963	− 36,330	− 11
November	314,107	282,600	− 31,507	− 10
December	325,491	281,536	− 43,954	− 14
Total	4,012,407	3,638,952	− 373,455	− 9

Note: [a] LEED EB® performance period

	Heating energy consumption			
	Consumption 2009 MWh	Consumption 2010 MWh	Difference MWh	Difference %
January	330	310[a]	−20	−6
February	354	301[a]	−53	−15
March	331	257[a]	−74	−22
April	205	188	−18	−9
May	190	80	−110	−58
June	94	21	−73	−77
July	58	8	−50	−87
August	58	25	−34	−58
September	96	54	−41	−43
October	239	142	−97	−41
November	302	182	−121	−40
December	250	261	11	4
Total	2,508	1,827	−681	−27

Note: [a] LEED EB® performance period

Table V.
Heating energy consumption

	Water consumption			
	Consumption 2009 m^3	Consumption 2010 m^3	Difference m^3	Difference %
January	522	486[a]	36	7
February	467	521[a]	−54	−10
March	474	583[a]	−109	−19
April	484	491	−8	−2
May	403	519	−117	−22
June	371	496	−125	−25
July	226	374	−148	−40
August	332	374	−42	−11
September	367	517	−150	−29
October	380	534	−155	−29
November	445	451	−6	−1
December	294	462	−168	−36
Total	4,765	5,810	−1,046	−18

Note: [a] LEED EB® performance period

Table VI.
Water consumption

electricity cannot be even partly explained through the weather conditions, on the contrary the savings might have been even higher if the weather conditions would have stayed similar in both years.

The most significant changes in electricity use when comparing the months was in March (20 percent lower electricity use) and May (17 percent lower electricity use). March and May are not the hottest or coldest months, and therefore this might indicate, that the baseline electricity use was diminished after the alterations.

The heating energy consumption decreased by 27 percent in total in the year 2010 compared to the year 2009. Interestingly, the most significant decrease in heating energy was in July (87 percent less heating energy consumption), but similarly the electricity-use increased in July by 7 percent. As outdoor temperature affects the heating need greatly, heating energy is weather corrected. Weather corrected data states the consumption compared to the so called normal year (average in 1971-2000). The equation for weather correction is (RTS, 2005):

$$Q_{norm} = \frac{S_{N\,location}}{S_{actual\,location}} \times Q_{actual} + Q_{warm\,water}$$

Where Q_{norm} = normalized heating energy consumption, Q_{actual} = actual space heating energy consumption, $S_{Nlocation}$ = normal year (1971-2000) heating requirement number at location, $S_{actuallocation}$ = actual heating requirement number at location, $Q_{warmwater}$ = energy for water heating

Weather correction enables a property's heating energy consumption to be compared between years despite the differences in outdoor temperatures. This indicates the change in how the building is operated, and that the most energy-efficient way to use the building automation might not always show an absolute diminishing of energy-use in both heating energy and electricity use.

The water consumption decreased due to the installation of a pressure decreasing valve. The most significant reduction in water use was in July (40 percent decrease compared to year 2009). The installation of the valve did not show to the users in any way, and only the maintenance personnel noticed the lower water flow rate in context of certain tasks.

4. Discussion

This study set out to determine how large a role FM plays in supporting end-user organizations in their efforts to minimize environmental impact. The results show, that by relatively light changes and modifications to the FM service processes, quite extensive environmental benefits can be achieved. By using LEED EB® as indicator for green performance an office building dating from the 1980's, the FM organization had either direct or indirect (operational) influence on 82 percent of the LEED® points achieved by the building. The vast majority of the points earned by the subject facility were either readily available due to the FM organization's existing internal policies and practices (22 percent, 13 points) or substantially but indirectly influenced by operations conducted by the FM organization (60 percent, 36 points). The latter category is of course dependent on both the characteristics of the existing building, and the willingness of the end-user to adopt the points

The electricity and heating energy related LEED EB® points are in the energy and atmosphere (EA) and indoor environmental quality (IEQ)-categories. In both of the categories the FM provider has a significant role in accomplishing the LEED® points. The categories IEQ and EA, which had the most significant impact on the operating costs and CO2-equation of the building, comprised 53 percent of the total LEED®-points received. The FM provider worked relatively independently to accomplish these LEED® points. It was noticed that some of the LEED EB® criteria were met quite easily just based on the Finnish national building code, for example ventilation rates. However, it is the certain verification processes that are needed in addition that differ from the normal maintenance practises in Finland and which have to be implemented to receive the certification.

As presented in previous chapters, the results of the "greening"-project of the building were substantial. During a 12-month period the approximate savings in electricity were 370 MWh, in heating energy 680 MWh, and in water consumption1000 m3. The electricity savings were one-tenth of the electricity use of the previous year, and the heating energy consumption over one-fourth. These values exceed the estimates of an affiliated Government agency, Motiva (2011), according to which Finnish office buildings hold a 6.2 percent savings potential in electricity consumption and 17.7 percent in heating energy consumption. Previous research has shown that for example, building commissioning can reduce whole-building energy by 16 percent for existing buildings (Mills, 2009). Interestingly, the combined energy savings for this case amount to exactly 16 percent.

The reduction in electricity and heating energy-use were significant contributors also to the CO2-eqvivalent savings (254 tons). However, the change to the hydroelectricity since 1st of July 2010 had the most significant impact on the CO2-eqvivalents (558 tons since the change). The CO2-equation of the electricity use was practically non-existent after the change. Therefore, changing to hydroelectricity can contribute to major reduction in the carbon footprint of the building, but will not bring cost savings which is a consequence of the actual reduction of the consumption.

Besides environmental benefits, the "greening" of the service production brought along direct cost benefits. The most significant monetary savings were achieved from electricity and heating energy reductions. Monetary savings from electricity reduction were approximately 32,000 € and from heating energy reduction 35,500 € during 2010 (Energy Market Authority, 2010; Finnish Energy Industries, 2010).

In the case facility, the environmental aspects are now taken in consideration more throughout in the everyday service production and are visible in the value production for the customer, as well as for the building users. For instance, environmental issues are now evaluated systematically when considering renovations. However, the building space use was not the most efficient in the case-building, with 800 building users in 16 300 m^2. This is one example of an environmental indicator, which did not come to the fore in the project. As the "greenest space is no space", this is an indicator that could be part of FM service providers goals to diminish together with the customer.

It should be noted, however, that only one service provider was assessed. Moreover, the case study represents a situation where all FM services are provided by one service provider. Since the case study is conducted in Finland, the results may not be applicable for other countries. It is therefore not possible to make wide generalizations based on the results. Furthermore, the study applied only LEED EB® as a reference, and other rating systems might give different results. It is, however, presumable that as green building rating systems in general all address similar issues, the findings would be similar as well. To conclude, the study exemplifies the impact potential of an active FM organization in a reliable manner.

5. Conclusions

This research demonstrates that, at least in the case of a leading Finnish FM organization, these services partially already exist, as part of the FM organization's internal policies. Additionally, the study indicates that for a FM organization providing a wide range of services it is possible to contribute to several of the green building criteria. It can be argued that FM organizations are well equipped to guide the end-user through a green building certification process, since the required information is already in-house and readily available. However, as there is only a fine line between greener

FM processes and general good practice, it is difficult to analyse which of the improvements can truly be attributed to FM service provider's enhanced processes rather than general good practice. Although it was easiest to prove the environmental gains in diminishing of CO2-emissions by turning into water powered electricity, the most significant gains for good environmental performance can still be argued to be the systematic GreenFM-practices and management adopted in the process, which will lead to, e.g. always considering environmental aspects when making alterations in the building. In the long term this will most probably contribute to more environmentally efficient use of the building. Further research is still needed in order to validate these research results and provide more practical case examples of developing FM services above the green building standards and provide scientific based evidence for practise. This kind of evidence would assist FM organizations, and the entire FM industry to become recognized as a true strategic resource.

References

COD/2008/0223 (n.d.), "Proposal for a Directive of the European Parliament and of the Council on the Energy performance of buildings", available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0780:FIN:en:PDF (accessed March 2010).

Dermisi, S. and McDonald, J. (2011), "Effect of 'Green' (LEED and ENERGY STAR) designation on prices/sf and transaction frequency. The Chicago Office Market", *Journal of Real Estate Portfolio Management*, Vol. 17 No. 1, pp. 39-52.

Eisenhardt, K.M. (1989), "Building theories from case study research", *The Academy of Management Review*, Vol. 14 No. 4, pp. 532-550.

Elmualim, A., Shockley, D., Valle, R., Ludlow, G. and Shah, S. (2010), "Barriers and commitment of facilities management profession to the sustainability agenda", *Building and Environment*, Vol. 45 No. 1, pp. 58-64.

Energy Market Authority (2010), "Sähkön hinnan kehitys 1.10.2010" ("Development of the electricity prize 1st October 2010"), available at: www.energiamarkkinavirasto.fi/data.asp?articleid=2084&pgid=67 (accessed October 2010) (in Finnish).

Falkenbach, H., Lindholm, A-L. and Schleich, H. (2010), "Environmental sustainability: drivers for the real estate investor", *Journal of Real Estate Literature*, Vol. 18 No. 2, pp. 203-223.

Finnish Energy Industries (2010), "Kaukolämmön hinta 1.7.2010 alkaen" ("The prize of district heat from 1st July 2010"), available at: www.energia.fi/fi/tilastot/kaukolampotilastot/kaukolammonhinta (accessed October 2010) (in Finnish).

Finnish Meteorological Institute (2011), "Vuositilastot" ("Yearly statistics"), available at: http://ilmatieteenlaitos.fi/vuositilastot (accessed May 2011) (in Finnish).

Fuerst, F. and McAllister, P. (2009), "An investigation of the effect of eco-labeling on office occupancy rates", *Journal of Sustainable Real Estate*, Vol. 1 No. 1, pp. 49-64.

Gaby, J. (2011), "Market implications of operational performance variability in certified green buildings", *Proceedings of the SB11 Helsinki World Sustainable Building Conference, 18-21 October, 2011 Helsinki, Finland.*

Gifford, H. (2008), "A better way to rate green buildings?" available at: www.energysavingscience.com/articles/henrysarticles/BuildingRatingSystems.pdf (accessed February 2010).

Hodges, C.P. (2005), "A facility manager's approach to sustainability", *Journal of Facilities Management*, Vol. 3 No. 4, pp. 312-324.

Junnila, S. (2004), “The environmental significance of facilities in service sector companies”, *Facilities*, Vol. 22 Nos 7/8, pp. 190-198.

Junnila, S. (2007), “The potential effect of end-users on energy conservation in office buildings”, *Facilities*, Vol. 25 Nos 7/2, pp. 329-339.

Junnila, S. and Horvath, A. (2003), “Life-cycle environmental effects of an office building”, *Journal of Infrastructure System*, Vol. 9 No. 4, pp. 157-166.

Junnila, S., Horvath, A. and Guggemos, A.A. (2006), “Life-cycle assessment of office buildings in Europe and the United States”, *Journal of Infrastructure Systems*, Vol. 12 No. 1, pp. 10-17.

Kamaruzzaman, S.N., Egbu, C.O., Zawawi, E.M.A., Ali, A.S. and Che-Ani, A.I. (2011), “The effect of indoor environmental quality on occupants’ perception of performance: a case study of refurbished historic buildings in Malaysia”, *Energy and Buildings*, Vol. 43 Nos 2-3, pp. 407-413.

KTI Property Information Ltd (2010), The Finnish Property Market 2010, available at: www.kti.fi/kti/doc/ajankohtaista/KTI_FMP_Final_net.pdf (accessed May 2010).

Lavy, S. and Fernández-Solis, J.L. (2009), “LEED accredited professionals’ perceptions affecting credit point adoption”, *Facilities*, Vol. 27 Nos 13/14, pp. 531-554.

Lee, W.L. and Burnett, J. (2007), “Benchmarking energy use assessment of HK-BEAM, BREEAM and LEED”, *Building and Environment*, Vol. 43, pp. 1882-1891.

Marsh, A. (2008), “Is green really green?”, *Commercial Property News*, Vol. 22 No. 2, pp. 32-35.

Miller, N., Spivey, J. and Florance, A. (2008), “Does Green Pay Off?”, *Journal of Real Estate Portfolio Management*, Vol. 14 No. 4, pp. 385-401.

Miller, N.G., Pogue, D., Gough, Q.D. and Davis, S.M. (2009), “Green buildings and productivity”, *Journal of Sustainable Real Estate*, Vol. 1 No. 1, pp. 65-89.

Miller, N.G., Pogue, D., Saville, J. and Tu, C. (2010), “The operation and management of green buildings in the United States”, *Journal of Sustainable Real Estate*, Vol. 2 No. 1, pp. 51-66.

Mills, E. (2009), *Building Commissioning - A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions*, Lawrence Berkeley National Laboratory, Berkeley, CA.

Motiva (2011), Saving Potentials by Building Type (in Finnish), Motiva, an affiliated Government agency, Finland, available at: http://motiva.fi/en/areas_of_operation/energy_auditing/mee-supported_energy_auditing/statistical_data_from_energy_audits/saving_potentials_by_building_type/ (accessed September 2012).

Newell, G. and Lee, C.L. (2012), “Influence of the corporate social responsibility factors and financial factors on REIT performance in Australia”, *Journal of Property Investment and Finance*, Vol. 30 No. 4, pp. 389-403.

Nousiainen, M. and Junnila, S. (2008), “End-user requirements for green facility management”, *Journal of Facilities Management*, Vol. 6 No. 4, pp. 266-278.

Paul, W.L. and Taylor, P.A. (2008), “A comparison of occupant comfort and satisfaction between a green building and a conventional building”, *Building and Environment*, Vol. 43 No. 11, pp. 1858-1870.

Reed, R., Bilos, A., Wilkinson, S. and Schulte, K-W. (2009), “International comparison of sustainable rating tools”, *Journal of Sustainable Real Estate*, Vol. 1 No. 1, pp. 1-22.

Romm, J. and Browning, W. (1994), *Greening and the Bottom Line: Increasing Productivity through Energy Efficient Design*, Rocky Mountain Institute, Boulder, CO.

Roper, K.O. and Beard, J.L. (2006), “Justifying sustainable buildings – championing green operations”, *Journal of Corporate Real Estate*, Vol. 8 No. 2, pp. 91-103.

Rosenblum, J., Horvath, A. and Hendrickson, C. (2000), “Environmental implications of service industries”, *Environmental Science & Technology*, Vol. 34 No. 22, pp. 4669-4676.

RTS (2005), “LVI 10-10392 Lämmitystarveluku – Rakenusten energiankulutuksen seuranta” (“HEVAC Building Services Information File”), Rakennustietosäätiö RTS ja LVI-Keskusliitto (The Building Information Foundation), Vol. KH 20- 00373.

Scheuer, C. (2003), “Life cycle energy and environmental performance of a new university building: modeling challenges and design implications”, *Energy and Buildings*, Vol. 35 No. 10, pp. 1049-1064.

Statistics Finland (2010), Statistical Databases, available at: www.stat.fi/tup/tilastotietokannat/index_en.html (accessed May 2010).

Suzuki, M. and Oka, T. (1998), ““Estimation of life cycle energy consumption and CO2 emission of office buildings in Japan”, *Energy and Buildings*, Vol. 28 No. 1, pp. 33-41.

UNEP (2007), Buildings and Climate Change – Status, Challenges and Opportunities, United Nations Environment Programme, available at: www.unep.fr/shared/publications/pdf/DTIx0916xPA-BuildingsClimate.pdf (accessed May 2010).

United States Green Building Council (USGBC) (2010a), Green Building Facts, available at: www.usgbc.org/ShowFile.aspx?DocumentID=5961 (accessed March 2010).

United States Green Building Council (USGBC) (2010b), “What LEED Measures?” available at: www.usgbc.org/DisplayPage.aspx?CMSPageID=1989 (accessed February 2010).

United States Green Building Council (USGBC) (2012), United States Green Building Council (USGBC) LEED Projects & Case Studies Directory, available on: www.usgbc.org/LEED/Project/CertifiedProjectList.aspx (accessed May 2012).

US EPA (1995), Green Buildings Vision and Policy Statement, available at: www.epa.gov/greeningepa/projects/policy.htm (accessed April 2010).

von Paumgartten, P. (2003), “The business case for high performance green buildings: sustainability and its financial impact”, *Journal of Facilities Management*, Vol. 2 No. 1, pp. 26-34.

Wood, B. (2006), “The role of existing buildings in the sustainability agenda”, *Facilities*, Vol. 24 Nos 1/2, pp. 61-67.

Yin, R. (1994), *Case Study Research, Design and Methods*, 2nd ed., Sage Publications, Thousand Oaks, CA.

Zhang, Y. and Altan, H. (2011), “A comparison of the occupant comfort in a conventional high-rise office block and a contemporary environmentally-concerned building”, *Building and Environment*, Vol. 46 No. 2, pp. 535-545.

Corresponding author
Eeva Määttänen can be contacted at: eeva.maattanen@aalto.fi