Creative Construction Conference 2016

Performance of LEED Energy Credit Requirements in European Countries

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Abstract

Construction industry influences the environment a great deal by using different resources. Efficient use of resources is important for sustainability considerations. Heavy consumption of energy is one of the reasons causing adverse impacts on the built environment. The interest in sustainable construction is growing worldwide. Green building systems are used to certify the projects as green buildings in different countries. All these systems have similar approaches to build sustainably and they all highlight requirements related to energy consumption with a significant emphasis. One of the most recognized green building certification systems, LEED addresses energy optimization, green power and on-site renewable energy in much detail. The maximum credit points can be achieved from "energy and atmosphere" category in LEED. However, the use of LEED in countries other than the U.S. can be difficult as local conditions and practices are influential in earning credentials. This study aims to review the practices of "energy and atmosphere" category of LEED v3 2009 New Construction in European countries. Analysis of practices in selected countries is made based on credit performances, which can display variations depending on local conditions. It is expected that practitioners in these countries will benefit from the credit patterns, providing improved insights about on-site real applications.

Keywords: LEED; energy and atmosphere; Europe; sustainable construction; credit.

1. Introduction

The buildings are responsible from the consumption of energy throughout their life cycles and reported as consuming 30-40% of all primary energy worldwide [1]. Energy is used in the production and transportation of construction materials, during buildings' operations, and dismantling and demolition in the construction sector [2]. Negative environmental impacts arise from several construction activities, manufacturing of building materials and transportation. All of these are consuming energy, generating emissions linked to global warming, acid rain and smog [3].

Sustainable construction principles refer to minimizing all these negative impacts. The interest in sustainable construction is growing particularly gaining a momentum over the past two decades. Green building certification systems are being frequently used as a means of rating buildings as sustainable. There are several systems developed in different countries. Some countries use their own systems, while some others prefer to adopt them. LEED certification system was first pilot tested in 1998 by United States Green Building Council (USGBC) in the U.S. The system aims to use resources efficiently by using less energy and water, reducing greenhouse gas emissions, and focusing on materials to reduce the effects of their harmful components. According to USGBC project database, 87,216 projects are listed as either registered or certified through LEED as of March 14, 2016.

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LEED is one of the certification systems, which is also widely used in different countries, other than the U.S. There are five rating systems listed in LEED; Building Design and Construction (BD+C), Interior Design and Construction (ID+C), Building Operations and Management (O+M), Neighborhood Development (ND), and Homes. BD+C applies to buildings that are newly constructed or going through a major renovation, including New Construction (NC), Core & Shell, Schools, Retail, Hospitality, Data Centers, Warehouses & Distribution Houses, and Healthcare. Although LEED v4 has been launched in 2013, LEED v3 2009 is still in effect until October 2016. Buildings certified through latest version is rather few when compared with buildings certified using LEED v3 2009.

Sustainable construction practices are frequently addressed and implemented in the the EU. This study aims to review the practices of "energy and atmosphere" category of LEED in European countries for New Construction with LEED v3 2009. Analysis of practices in selected countries is made based on credit performances, which can display variations depending on local conditions. It is expected that practitioners in these countries will benefit from the credit patterns, providing improved insights about on-site real applications.

2. LEED Certification System – New Construction (NC)

LEED Building Design and Construction (BD+C) can be used for eight different types of projects depending on projects' needs, including New Construction (LEED-v3 2009 NC). The system addresses design and construction activities for both new buildings and major renovations of existing buildings. This includes major HVAC improvements, significant building envelope modifications and major interior rehabilitation.

Energy and atmosphere credit category has the largest portion of the maximum achievable points in LEED v3 2009 and accounts for approximately 32% for New Construction rating system of the total points. The credits and corresponding points are given in Table 1. A building can achieve four certification levels, certified (40-49 points), silver (50-59 points), gold (60-79 points), and platinum (80 and up).

The category approaches energy from a holistic perspective, addressing energy use reduction, energy-efficient design strategies, and renewable energy sources. Being worldwide mix of energy resources, oil, coal and natural gas are non-renewable resources [4]. The efficient usage of existing limited resources and construction of environmental-friendly buildings have gained importance [5].

There are several strategies addressed in sustainable buildings to support energy efficiency. Cost-effective systems, tools, means and measures are encouraged. Building orientation, glazing selection, choice of climate-appropriate materials are some examples for design strategies. Employing passive heating and cooling, natural ventilation, and high-efficiency HVAC systems partnered with smart controls further reduce a building's energy use. The generation of renewable energy on the project site or the purchase of green power allows portions of the remaining energy consumption to be met with non–fossil fuel energy, lowering the demand for traditional sources [4]. Commissioning is regarded as a critical process to ensuring high-performing buildings. Early involvement of a commissioning authority helps prevent long-term maintenance issues and wasted energy by verifying that the design meets the owner's project requirements and functions as intended.

Table 1. Credits in LEED v3 2009 New Construction rating system

LEED v3 2009 New Construction	Pts.
Pre1. Fundamental Commissioning of Buildings Energy Systems	-
Pre2. Minimum Energy Performance	-
Pre3. Fundamental Refrigerant Management	-
EAc1. Optimize Energy Performance	1-19
The minimum energy cost savings percentage	
12%	1
14%	2
16%	3
18%	4
20%	5
22%	6
24%	7
26%	8
28%	9
30%	10
32%	11
34%	12
36%	13
38%	14
40%	15
42%	16
44%	17
46%	18
48%	19
EAc2. On-site Renewable Energy	
Percentage renewable energy	
1%	1
3%	2
5%	3
7%	4
9%	5
11%	6
13%	7
EAc3. Enhanced Commissioning	2
EAc4. Enhanced Refrigerant Management	2
EAc5. Measurement and Verification	3
EAc6. Green Power	2
Max. Total	**35**

3. Energy and Atmosphere Credit Achievements in Selected Countries

The adverse impacts of excessive energy consumption forced by many countries make efforts to reduce energy consumption and CO_2 emission [6]. According to Directive 2010/31/EU of the European Parliament and Council, buildings consume 40% of energy in the European Union. It is required to reduce energy consumption and the use of energy from renewable sources [6]. Therefore, a binding legislation named "climate and energy package" is proposed by the European Commission, which was agreed by the European Parliament and Council in 2008 and became law in 2009. This package set an integrated approach to climate and energy policy known as 20-20-20 targets. These are reduction in EU greenhouse gas emissions of at least 20% below 1990 levels, using renewable resources for 20% of EU energy consumption, and 20% reduction in primary energy use with energy efficiency improvement technology by 2020 [6,7,8]. The European Commission also revised the analysis of options to move beyond 20% in 2012 [9].

LEED is originally developed for U.S. construction sector and takes into account local conditions and practices applicable in the U.S. Recognized as a widely used certification system in the world, it has been used in other

countries since its introduction. Since the local conditions, practices, material types, climate conditions, market demands and expert experiences can vary significantly based on locations, achievement in the credits can differ according to the countries. Analyzed LEED v3 2009 New Construction certified buildings in Europe in this study are listed in Table 2. The number of buildings, attained certification levels, and country names can also be seen. The scorecards of these buildings were downloaded from USGBC project web site. The list consists of 20 countries. Figure 1 shows proportion of achievements in Energy and Atmosphere credits of them. Table 3 illustrates the results obtained from Kruskal-Wallis test, which examines the buildings' mean ranks.

Table 2. Breakdown of analyzed buildings – New Construction

	Certification Level			
Countries	**Platinum**	**Gold**	**Silver**	**Certified**
Austria	3	5	0	0
Belgium	0	2	1	0
Bulgaria	0	1	1	0
Czech Republic	2	1	1	1
Denmark	2	2	0	0
Finland	3	10	3	1
France	5	2	3	0
Germany	5	28	10	0
Greece	0	1	2	0
Hungary	0	2	1	0
Ireland	1	2	1	0
Italy	2	1	1	0
Netherlands	1	0	0	0
Poland	0	8	2	2
Portugal	1	3	1	0
Slovakia	0	1	0	0
Spain	8	14	8	4
Sweden	3	18	2	1
Switzerland	1	2	0	0
United Kingdom	0	1	0	1
	37	**104**	**37**	**10**

Figure 1. Credit achievements of LEED-NC 2009 New Construction certified buildings (189 buildings)

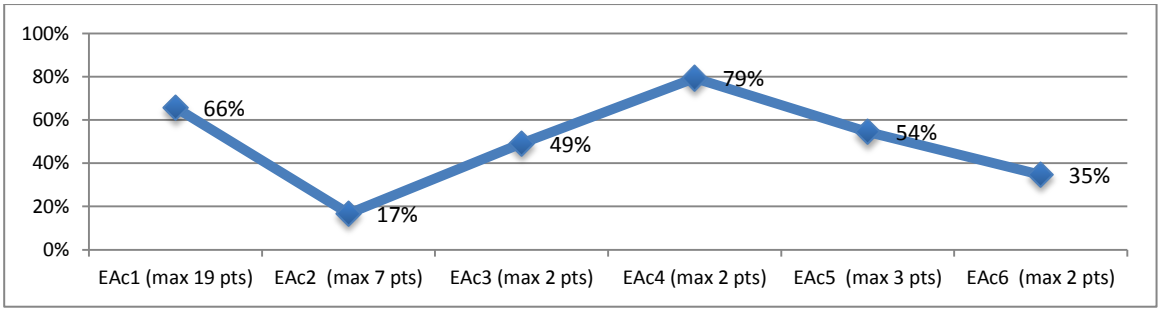

Table 3. Kruskal-Wallis test results of LEED-NC 2009 New Construction certified buildings (189 buildings)

	Certification Level	N	Mean Rank
EAc1	Platinum	37	147.23
	Gold	104	91.83
	Silver	38	66.55
	Certified	10	42.85
EAc2	Platinum	37	137.2
	Gold	104	83.19
	Silver	38	87.93
	Certified	10	88.55
Eac3	Platinum	37	112.35
	Gold	104	95.75
	Silver	38	85.8
	Certified	10	57.95
Eac4	Platinum	37	106.84
	Gold	104	96.33
	Silver	38	82.17
	Certified	10	86.15
EAc5	Platinum	37	115.42
	Gold	104	96.79
	Silver	38	83.07
	Certified	10	46.15
Eac6	Platinum	37	122.73
	Gold	104	91.23
	Silver	38	84.5
	Certified	10	71.5

Table 4. Credit achievements of LEED-NC 2009 New Construction certified buildings

			Maximum Achievable Points						Achievement (%)					
			19	7	2	2	3	2						
Certification Level	**No. of buildings**		**EAc1**	**EAc2**	**EAc3**	**EAc4**	**EAc5**	**EAc6**	**EAc1**	**EAc2**	**EAc3**	**EAc4**	**EAc5**	**EAc6**
Platinum	37	Average	17.7	3.9	1.4	1.8	2.2	1.3	93%	56%	68%	92%	74%	64%
		St.dev.	2.8	3.2	0.9	0.6	1.3	1.0	15%	46%	47%	28%	42%	48%
Gold	37	Average	12.2	0.5	1.0	1.6	1.7	0.6	64%	7%	50%	81%	56%	30%
		St.dev.	5.3	1.5	1.0	0.8	1.4	0.9	28%	22%	50%	39%	48%	46%
Silver	105	Average	9.5	0.6	0.8	1.3	1.3	0.5	50%	8%	38%	65%	43%	24%
		St.dev.	5.7	1.7	1.0	1.0	1.3	0.9	30%	25%	49%	48%	44%	43%
Certified	10	Average	6.9	0.5	0.2	1.4	0.3	0.2	36%	7%	10%	70%	10%	10%
		St.dev.	3.9	1.1	0.6	1.0	0.9	0.6	21%	15%	32%	48%	32%	32%

4. Findings and Conclusions

Energy efficiency is important in green buildings and rated by means of several credits in the certification systems. LEED is originally developed for the U.S. construction practices, however its use is common in other areas of the world. Energy and Atmosphere credit category has the largest share of achievable points in LEED-NC 2009 system promoting sustainable practices in the buildings. This study examines achieved points of a group of buildings certified through LEED-NC 2009 for New Construction system for Energy and Atmosphere credits in 20 European countries. The building inventory consists of 189 buildings. Earned credit points are obtained from USGBC's project directory web site. According to the analysis results, following findings can be highlighted:

The proportions of the maximum achievable points in the Energy and Atmosphere credits earned by the LEED v3 2009 certified buildings considered in the study are ranked as "EAc4 - Enhanced refrigerant management" (79%), "EAc1 - Optimize energy performance" (66%), "EAc5 - Measurement and verification" (54%), EAc3 - Enhanced commissioning" (49%), "EAc6 - Green power" (35%), and "EAc2 - On-site renewable energy" (17%) (Figure 1). EAc4 - Enhanced refrigerant management have been employed frequently as a sustainable strategy. This credit aims to reduce stratospheric ozone depletion. It encourages use of new HVAC equipment that usues on CFC-based refrigetants for new buildings and reuse of existing HVAC systems providing a replacement phase-out schedule

for them. The achieved percentages of this credit were determined as 92%, 81%, 65%, and 70% for platinum, gold, silver and certified levels, respectively (Table 4). Mean ranks based on certification levels are provided in Table 3.

EAc1- Optimizing energy efficiency aims cost savings percentage for each point threshold specified in the system. Highly efficient HVAC and lighting systems can be adopted to provide cost savings by redcing comsumption of energy in the buildings. This credit ranked as the second credit. The achieved percentages were identified as 93%, 64%, 50%, and 36 % for platinum, gold, silver, and certified buildings, respectively (Table 4). Platinum buildings achieved significantly higher mean scores (Table 3).

EAc5- Measurement and verification further encourages the prerequisite for the accountability of energy consumption over time. Achivements were recorded as 74%, 56%, 43%, and 10% for platinum, gold, silver, and certified buildings, respectively (Table 4). It was majorly pursued by platinum buildings (Table 3).

EAc3 – Enhanced commissioning credit suggests early involvement of commissioning process and additional activities after systems performance verification is completed. 68%, 50%, 38%, and 10% achievements were determined for platinum, gold, silver, and certified buildings, respectively (Table 4). Additional costs and the lack of experience can affect the use of commissioning services.

EAc6 – Green power encourages the development and use of grid-source, renewable energy technologies on a net zero pollution basis. The low achievement percentage of 35% (Figure 1) indicates that project owners preferred to earn points from other credits. Certification-level based percentages were obtained as 64%, 30%, 24%, and 10% for platinum, gold, silver, and certified buildings, respectively (Table 4).

Use of EAc2- On-site renewable energy options were the least addressed solutions, probably because they are costly and not easy to find. This credit encourages using solar, wind, geothermal, low-impact hydro, biomass and bio-gas strategies to reduce environmental and economic impacts. Platinum, gold, silver, and certified projects scored 56%, 7%, 8%, and 7%, respectively, indicating that only platinum buildings pursued majorly after this credit (Table 4). Table 3 shows the significant difference between platinum and other levels.

The objective of this study was to examine the LEED v3 2009 New Construction practices in the Energy and Atmospehere credits for selected European countries. Achievement percentages points out practitioners' efforts to earn points in this category. Future studies may involve assessment of other credit categories to provide better understanding of employing sustainable solutions required for green building certification systems.

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