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Energy and atmosphere standards for sustainable design and construction in different countries

Ruveyda Komurlu [a,*], David Arditi [b], Asli Pelin Gurgun [c]

[a] Department of Architecture, Kocaeli University, Izmit, Kocaeli, Turkey
[b] Construction Engineering and Management Program, Illinois Institute of Technology, Chicago, IL, USA
[c] Department of Civil Engineering, Yildiz Technical University, Istanbul, Turkey

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ABSTRACT

The "energy and atmosphere" category of LEED accounts for 32% of the total points and heavily depends on U.S. standards such as ANSI/ASHRAE/IESNA. Difficulties arise when LEED is implemented in different countries, because of varying degrees of similarity of local standards to U.S. standards. In some countries, these standards may range from non-existent to locally developed instruments, while U.S. standards are preferred in some. The existing codes, standards, and regulations that are in effect in India, Abu Dhabi, and Turkey, and used in the relevant category of LEED are reviewed relative to their U.S. counterparts. It is found that in India, the ECBC combines local conditions with international standards; in Abu Dhabi, ESMA and ADQCC make sure the geographic conditions prevalent in that part of the world are reflected in the codes and regulations; in Turkey, the new BEP Code constitutes a significant step towards energy conservation. This study shows that the standards that are in effect in the subject countries have adapted U.S. and U.K. standards to local conditions and are in different stages of development. The variety in the quality, substance, and coverage of the standards make it difficult to implement green building certification systems in these countries.

1. Introduction

In order to achieve sustainable buildings, it is necessary to use design principles, construction materials and methods, and operational procedures that minimize negative environmental impacts throughout all the construction project phases of planning, designing, constructing, and operating [1–3]. For the effective management of these efforts, industrialized countries with consistent and well regulated industries have developed their own green building guidelines and certification systems in the last two decades based on established technical standards [4–7]. With the demand of international investors, as well as the demands of sophisticated buyers who are sensitive to sustainability issues, a growing portion of the construction industry in many countries has attempted to adopt the green building guidelines introduced by industrialized countries.

Green building certification systems rely on measurement efforts that involve metrics and processes that allow analysts to assess the level to which sustainability objectives are achieved within the scope defined by the owner and designer. Performance measurement requires the existence of well-defined requirements that address the specific issues of sustainability [8]. Standards play an important role in directing this effort. It should be noted however that standards do not function as solutions to problems, but as guidelines for practitioners to produce solutions to problems [9]. For successful application, standards need to be clear about goals, but comprehensive about scope, flexible for dealing with uncertainty, and supportive of continuous improvement [10]. Also, although government agencies play a critical role in setting up and promoting national standards [11], the success of standards is limited by their acceptance in the industry and by the extent to which they are implemented in practice [12].

Energy regulations and certification are two mechanisms that require quantifying a building's energy consumption and impact. Energy assessment tools are used to quantify energy consumption while energy certification promotes energy performance standards [13].

In LEED 2009 NC, the "energy and atmosphere" category includes three prerequisites (no points assigned) and six credits (a total of 35 points) that are listed in Table 1 with the standards that they use. Despite LEED's expanding global use, it should be noted

* Corresponding author. Tel.: +1 872 2167646/+90 262 3034269; fax: +90 2623034253.
E-mail addresses: ruveydakomurlu@gmail.com, rkomurlu@iit.edu (R. Komurlu).

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Table 1
The "Energy and Atmosphere" category of LEED 2009 new construction.

Prerequisites and credits								Points	Referenced standards
Prerequisite 1—fundamental commissioning of building energy systems								–	None
Prerequisite 2—minimum energy performance								–	ANSI/ASHRAE/IESNA Standard 90.1-2007: Energy Standard for Buildings Except Low-Rise Residential ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004 ASHRAE Advanced Energy Design Guide for Small Warehouses and Self Storage Buildings 2008 ASHRAE Advanced Energy Design Guide for K-12 School Buildings New Building Institute, Advanced Buildings Core Performance Guide Energy Star Program, Target Finder Rating Tool
Prerequisite 3—fundamental refrigerant management								–	U.S. EPA Clean Air Act, Title VI, Section 608, Complies with the Section 608 Refrigerant Recycling Rule
Credit 1—optimize energy performance								0–19	ANSI/ASHRAE/IESNA Standard 90.1-2007: Energy Standard for Buildings Except Low-Rise Residential, and Informative Appendix G, Performance Rating Method ASHRAE Advanced Energy Design Guide for Small Office Buildings 2006 ASHRAE Advanced Energy Design Guide for Retail Buildings 2006 ASHRAE Advanced Energy Design Guide for Small Warehouses and Self Storage Buildings 2008 ASHRAE Advanced Energy Design Guide for K-12 School Buildings New Building Institute, Advanced Buildings Core Performance Guide
Imp: New Bldg. (%)	Imp: Existing Bldg. (%)	Pt. (%)	Imp: New Bldg. (%)	Imp: Existing Bldg. (%)	Pt.	Imp: New Bldg. (%)	Imp: Existing Bldg. (%)	Pt.	
12	8	1	26	22	8	38	34	14	
14	10	2	28	24	9	40	36	15	
16	12	3	30	26	10	42	38	16	
18	14	4	32	28	11	44	40	17	
20	16	5	34	30	12	46	42	18	
22	18	6	36	32	13	48	44	19	
24	20	7							
Credit 2—on-site renewable energy								0–7	ANSI/ASHRAE/IESNA Standard 90.1-2007: Energy Standard for Buildings Except Low-Rise Residential
Renewable energy (%)		Pt.	Renewable energy (%)		Pt.	Renewable energy (%)		Pt.	
1		1	7		4	11		6	
3		2	9		5	13		7	
5		3							
Credit 3—enhanced commissioning								2	None
Credit 4—enhanced refrigerant management								2	None
Credit 5—measurement and verification								3	International Performance Measurement and Verification Protocol, Volume III, EVO 30000.1-2006, Concepts and Options for Determining Energy Savings in New Construction
Credit 6—green power								2	Center for Resource Solutions, Green-e Product Certification Requirements
Total								35	

that the energy and atmosphere requirements have been prepared for the U.S. construction environment. LEED refers to U.S. energy codes and standards that do not exist in other countries, resulting in difficulties in the implementation of these credits in other countries even though it accounts for regional priorities.

The objective of this study is to review and discuss the status of local standards used in country-specific systems in India, Abu Dhabi, and Turkey relative to the "energy and atmosphere" category of LEED. Local standards may not exist, may be adopted from U.S. or other advanced countries' standards, or may have been developed based on the particular conditions of a country. A comparison of existing codes, standards, and regulations in India, Abu Dhabi, and Turkey is expected to question the applicability of sustainability principles in the said countries, and shed light on similar situations in other countries. The objective is to investigate the consequences of these different implementations in the hopes that the results will benefit sustainability efforts in these and other countries.

2. Standards used in green building certification

The green building certification systems used in countries interested in sustainability issues are often systems such as LEED and BREAM that have been developed in the U.S. and the U.K., respectively. There are some countries that have developed their own certification systems. There are also some countries where the guidelines in these systems are adaptations of certification systems used in advanced countries.

Regardless of the country where a green building certification system is used, assessments of sustainable practices during design (site selection, selection of materials, energy-efficient design, etc.), construction (project management, resource use, construction methods, etc.), and operation (energy use, water use, indoor environmental quality, etc.) need to be performed, which require adequate standards [14]. For example, as a prominent certification system, LEED heavily depends on codes, standards, and regulations that are in effect in the U.S., such as ANSI, ASHRAE, and IESNA. However, codes, standards, and regulations in some countries may or may not be similar to U.S. standards. Particularly in developing countries, codes, standards and regulations may range from nonexistent to locally developed instruments, while U.S. standards are preferred in some.

The development of standards is a complex process. For example, the development process in Canada involves development of technical content by experts, development of technical details by participants, and reaching consensus between contributing parties. The process follows the steps of request, assignment of a committee, notice of intent, meetings, public review and editions, technical approval, procedural approval and final edition [15]. In the U.S., standards are introduced by professional organizations such as ANSI, ASTM, ACM, AISC, are used in the implementation of local