LEED-NC-Certified Projects in Germany

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1. LEED Certification Strategies in Different Countries

Leadership in Energy and Environmental Design (LEED) is one of the most well-known environmental rating systems; developed in the United States, it has been widely adopted around the world. The adoption of LEED in foreign countries is due to the flexibility of this certification system. LEED has five main categories—sustainable sites (SS), water efficiency (WE), energy and atmosphere (EA), materials and resources (MR), and indoor environmental quality (EQ)—and two additional categories—innovation in design (ID) and regional priority (RP). Each category has several prerequisites and credits. Each credit can have a certain number of points. By adding up all these points, LEED projects can achieve one out of four certifications: certified (scores 40–49), silver (scores 50–59), gold (scores 60–79), or platinum (scores 80+).

With such a variety of LEED categories and credits, each country can choose the certification strategy that best reflects its climate, demographics, building technologies, and natural resource availability [1][2]. Thus, it becomes clear that different countries may prefer different LEED certification strategies. For example, in the USA, the highest-priority category was EA, while, in China, the priority categories were SS and WE [3]. A comparison between Northern Europe and Southern Europe showed that Northern Europe outperformed Southern Europe in the EAc1 (optimize energy performance) credit [4]. In Vietnam, SS, WE, and EQ scored highly compared to the other categories [5]. In Turkey, SS and WE were higher priorities than the remaining categories [6]. A comparison of eight U.S. states showed different LEED certification strategies: six states used an EA-high emphasized strategy, while two states used a non-EA-moderate emphasized strategy [7].

Studying LEED-certified projects using inference statistics is a new direction in the science of green construction. In 2017 [8], one of the first studies using inferential statistics aggregated LEED data from six countries: the United States, China, Turkey, Brazil, Chile, and Germany and determined four levels of certification: certified, silver, gold, and platinum. With this research design, the strategies for LEED-certified projects in a single country could not be explored. In a 2018 study [9] on the performance of silver-to-gold cross-certification in LEED projects, the design framework included a comparison of two types of design: (i) four U.S. states were analyzed separately, and (ii) four U.S. states were analyzed as one group. The two different study designs led to different results. The first study design showed the unique properties for each U.S. state. In the second study design, the pooled data showed a result acceptable for only one of the four U.S. states. Therefore, the study of LEED-certified projects in a separate country is an urgent problem. In this context, these studies should use the same study design and the same inference statistics, so that different studies can be compared. These different LEED certification strategies that were revealed for different countries/states can lead to different environmental impacts. However, this problem is understandable, because it is a consequence of the previously noted features of each of the countries.

However, the problem is that, as has recently been shown [10][11][12], different LEED certification strategies in office buildings have been used at the state (California, USA), city (Shanghai, China), and borough (Manhattan, New York City) levels. Therefore, these different LEED certification strategies applied to the same country/state/city result in different life cycle assessments (LCA) of their environmental damage. Therefore, the LCA of LEED-certified projects is a timely issue.

For example, California cities have used two different LEED certification strategies: low location and transportation (LT) and high EA or high LT and low EA [10]. In Shanghai, LEED certification strategies have used either high EA and low EQ achievements or low EA and high EQ achievements [11]. In Manhattan, two different LEED certification strategies have been used: either high EA and low MR achievements or low EA and high MR achievements [12]. In all three cases, different LEED certification strategies led to a different LCA of their environmental damage [10][11][12]. Thus, the use of different LEED certification strategies for office buildings should be explored in other countries.

In this regard, Germany is a country of particular interest, as it has the highest number of LEED New Construction (LEED-NC)-certified office space projects among the other European countries, such as Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Greece, Hungary, Ireland, Italy, the Netherlands, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, and the United Kingdom [13].

It should be noted that, in Germany, the Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB), developed by the German Sustainable Building Council, is the most representative national green rating system [14]. Similar to LEED, DGNB is based on indicators of different environmental area protections, such as responsible procurement and waste management. Unlike LEED, DGNB focuses more on protecting the economic sphere by introducing life cycle cost indicators and social protection, such as access for all and user security [15].

This country is a signatory to the Paris Agreement on climate change and has set itself the goal of becoming carbon-neutral by 2050 [16]. Germany also signed the Montreal Protocol to decrease its ozone depletion potential (ODP) [17]. The country has a mandatory AgBB scheme that requires the measurement of volatile organic compounds (VOCs) contained in building materials [18]. German citizens have a high level of willingness to invest in renewable energy [19]. Germany's current fuels for energy production come from about 50% renewable sources, such as wind, photovoltaic (PV), and bioenergy, and about 50% from fossil fuels, such as coal, natural gas, and oil [20]. This country is making substantial efforts toward the development of hydrogen vehicles and is committed to replacing its electricity system with fully renewable energy sources [21].

Therefore, it can be assumed that operational energy (OE) savings for the heating, cooling, and lighting needs of a building; the use of advanced refrigeration equipment to minimize ODP-related emissions such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs); the replacement of fossil fuels with renewable; and the use of low-emission and fuel-efficient vehicles should be a priority for LEED certification in Germany. However, as mentioned earlier, there are countries where LEED certification has been achieved at the same certification level using different certification strategies [10][11][12].

2. LEED Prerequisites and Credits

Table 1 gives a summary of all prerequisites and credits for LEED-NC v3.

Table 1. The LEED-NC v3: prerequisites and credits.

Abbreviation	Prerequisite/Credit Title	Points
	Sustainable Sites (SS) category	26
SSp1	Construction activity pollution prevention	–
SSc1	Site selection	1
SSc2	Development density and community connectivity	5
SSc3	Brownfield redevelopment	1
SSc4.1	Alternative transportation—public transportation access	6
SSc4.2	Alternative transportation—bicycle storage and changing rooms	1
SSc4.3	Alternative transportation—low-emitting and fuel-efficient vehicles	3
SSc4.4	Alternative transportation—parking capacity	2
SSc5.1	Site development—protect or restore habitat	1
SSc5.2	Site development—maximize open space	1
SSc6.1	Stormwater design—quantity control	1
SSc6.2	Stormwater design—quality control	1
SSc7.1	Heat island effect—nonroof	1
SSc7.2	Heat island effect—roof	1
SSc8	Light pollution reduction	1
	Water Efficiency (WE) category	10

Abbreviation	Prerequisite/Credit Title	Points
WEp1	Water use reduction	–
WEc1	Water efficient landscaping	4
Wec2	Innovative wastewater technologies	2
WEc3	Water use reduction	4
	Energy and Atmosphere (EA) category	35
EAp1	Fundamental commissioning of building energy systems	–
EAp2	Minimum energy performance	–
EAp3	Fundamental refrigerant management	–
EAc1	Optimize energy performance	19
EAc2	On-site renewable energy	7
EAc3	Enhanced commissioning	2
EAc4	Enhanced refrigerant management	2
EAc5	Measurement and verification	3
EAc6	Green power	2
	Material and Resources (MR) category	14
MRp1	Storage and collection of recyclables	–
MRc1.1	Building reuse—maintain existing walls, floors, and roof	3
MEc1.2	Building reuse—maintain interior nonstructural elements	1
MRc2	Construction waste management	2
MRc3	Materials reuse	2
MRc4	Recycled content	2
MRc5	Regional materials	2
MRc6	Rapidly renewable materials	1
MRc7	Certified wood	1
	Indoor Environmental Quality (EQ) category	15

Abbreviation	Prerequisite/Credit Title	Points
EQp1	Minimum indoor air quality performance	–
EQp2	Environmental tobacco smoke (ETS) control	–
EQc1	Outdoor air delivery monitoring	1
EQc2	Increased ventilation	1
EQc3.1	Construction IAQ management plan—during construction	1
EQc3.2	Construction IAQ management plan—before occupancy	1
EQc4.1	Low-emitting materials—adhesives and sealants	1
EQc4.2	Low-emitting materials—paints and coatings	1
EQc4.3	Low-emitting materials—flooring systems	1
EQc4.4	Low-emitting materials—composite wood and AgriFiber products	1
EQc5	Indoor chemical and pollutant source control	1
EQc6.1	Controllability of systems—lighting	1
EQc6.2	Controllability of systems—thermal comfort	1
EQc7.1	Thermal comfort—design	1
EQc7.2	Thermal comfort—verification	1
EQc8.1	Daylight and views—daylight	1
EQc8.2	Daylight and views—views	1
	Innovation in Design (ID) category	6
IDc1	Innovation in design	5
IDc2	LEED accredited professional	1
	Regional Priority (RP) category	4
RPc1	Regional priority	4
Total		110

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al impacts
[22] functional
d outputs
of the LCI
life cycle
impact assessment (LCIA) phase. Converting LCI into LCIA becomes possible due to the applied scientific models [22].

A “cradle-to-the-grave” LCA of concrete elements includes (i) the design stage, (ii) the production/execution stage, (iii) the usage stage (operational energy and concrete element maintenance), and (iv) the end-of-life (demolition and recycling) stage [23]. However, depending on the application of the LCA, it is possible to conduct a partial LCA. For example, in order to compare LCAs of building material alternatives, only the production stage needs to be evaluated; to compare the LCAs of fuel sources for operational energy generation, only the usage phase must be assessed; and to compare the LCAs of building materials' recycling options, only the end-of-life stage needs to be considered.

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