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Executive Problems During the Realization of the Investment in Accordance with The LEED Certification Requirements – Case Study

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Abstract. Sustainable Construction (SC) occupies a significant place in the activities aimed at achieving the objectives of Sustainable Development (SD). The construction sector has been identified as one of six markets with high innovation potential and going to meet the challenge of taking a number of initiatives aiming to introduce principles of Sustainable Construction. One of the most dynamically developing SC initiatives is the implementation of international environmental certification of buildings. LEED (*Leadership in Energy and Environmental Design*) is among the most popular ecological certification systems, which is designed to provide building owners and managers with a tool to identify and implement practical and measurable solutions in the field of environmentally friendly building design, their construction, use and maintenance. The authors of the article had the opportunity to cooperate with the contractor during the realization of the facility according to the requirements of LEED, observing the implementation standards processes to be met by a certified building during its construction. A building for office use was erected in the center of one of the cities in Poland and aspired for the highest, platinum level in the LEED classification. During the process of erecting, the authors could observe difficulties in realizing the assumptions that the object should meet. In this article, will be presented selected from the occurred implementation problems that took place in the indicated facility.

1. Introduction

Currently, sustainable development (SD) is an important element of international law, and its presence is visible in many fields of science. SD is a philosophy both in environmental, social and economic terms. In particular, emphasis is visible in the field of construction, which is one of the industries heavily interfering in the environment. Researchers are constantly working on improving building products, biodegradation of waste or reducing emissions and harmful substances. Ecological and passive building is developing dynamically, which aims to reduce energy consumption in buildings. This goal is achieved by applying innovative solutions for heating systems, ventilation, air conditioning, appropriate insulation materials (e.g. nanomaterials) or minimizing water and electricity consumption.



Sustainable construction (SC) has the main goal, which is to limit the negative impact on the natural environment and human health throughout their entire life cycle of a building [1]. Therefore a number of initiatives are taken to make the society aware of the benefits, which represents the idea of green building. The sustainable construction strategy is implemented through a number of initiatives, such as, among others, eco-labels, environmental declarations, ecological statements, numerous thematic conferences, development of standards and regulations aimed at harmonizing the requirements of the SC, requirements for energy efficiency assessment and creating **systems for assessing the sustainability of buildings**. Among the most popular ecological certification systems is LEED (*Leadership in Energy and Environmental Design*), which is designed to provide building owners and managers with a tool to identify and implement practical and measurable solutions in the field of environmentally friendly building design, construction, use and maintenance. So many sustainability actions lead to a change in the existing paradigm, which was time - cost and quality for a new extended additionally: comfort of use, minimization of the use of matter consumption and negative impact on the environment [2].

2. LEED building assessment system

The genesis of LEED certification is connected with the United States Green Building Council, operating since the mid-1990s (USGBC). This organization focuses on activities in accordance with the principles of the SC, promoting the balance between the three main aspects of the SC: environment, society and economics. One of the first USGBC initiatives was the publication of the so-called green LEED building assessment. The essence of this system is **building certification due to the degree of sustainable on subsequent levels** from certified, silver, through gold to platinum for new and refurbishment buildings. The "certified" level is the lowest certificate, and the platinum level is the highest distinction that a building can receive [3].

The LEED building assessment system consists in assigning points (the so-called credits) in the main categories presented in Fig. 1.

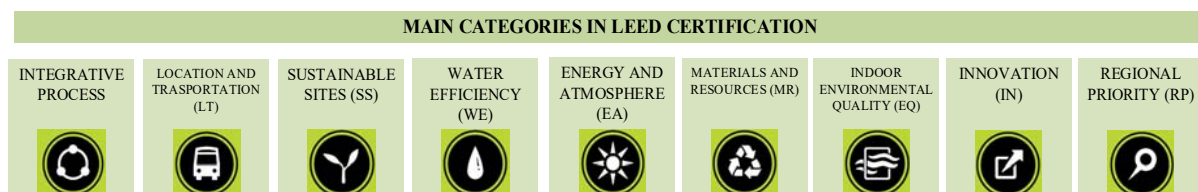


Figure 1. Main categories of sustainable construction in LEED certification
(own elaboration based on [4])

Each of the main categories is characterized by sub-categories that describe in detail the standards that a certified building should meet. Each of the main categories is characterized by sub-categories that describe in detail the standards to be met by a certified building and critical requirements that determine whether the building can be qualified for the certification procedure at all. Critical requirements presented in Table 1 are scored equally in the zero-one system (YES or NO). Failure to comply with even one of the critical requirements results in denial of certification, in turn, their positive assessment allows for further assessment according to the other criteria of a given category and achieving higher levels of certification, depending on the sum of points obtained [5].

Table 1. Mandatory points to be met when applying for LEED certification (own elaboration based on [5])

Nr	Critical requirement	The realization of the requirements	Max. points
1	Sustainable location	reducing the impact of construction activities on the environment by controlling soil erosion and dust emissions	26
2	Effective use of water resources	reduction of water consumption	10
3	Energy and atmosphere	- verification of installing and calibrating energy related systems in accordance with the values included in the project of the building investor, - meeting the minimum requirements for the building energy performance, - meeting the basic requirements for the management of refrigeration systems	35
4	Materials and resources	providing an easily accessible area for collecting and storing materials for recycling	14
5	The quality of the internal environment	- ensuring a minimum indoor air quality indicator according to specific standards, - environmental controls of tobacco smoke	15

LEED certification is such a universal tool that it covers all types of buildings that are both in design, implementation and in use. Therefore, in the certification it is possible to select the type of classification depending on the type of certified object from:

- LEED for New Construction
- LEED for Homes
- LEED for School
- **LEED for Core & Shell (version 2009)**
- LEED for Retail
- LEED for Commercial Interiors
- LEED for Existing Buildings
- LEED for Neighborhood Development.

Regardless of the type of classification for each of them there are four certification levels shown below in Figure 2, for which the total sum of possible points is 110.

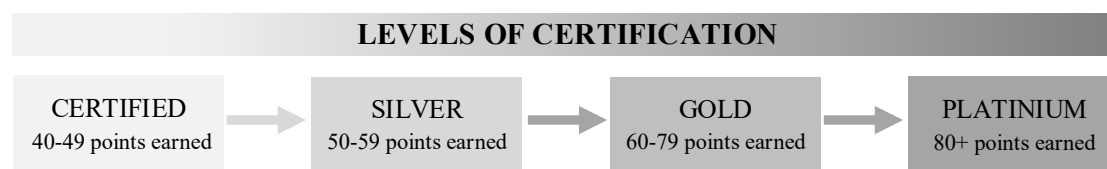


Figure 2. Levels of certification in LEED (own elaboration)

The object presented in the article applies for the highest level - the Platinum.

3. The erecting of a selected object aspiring to obtain the LEED platinum certificate

3.1. Description of the analysed building

The authors had the opportunity to cooperate with the contractor during the implementation of the building located in the center of one of the major cities in Poland. The investment included an office - service building with an underground garage and internal installations i.e. electric with built-in

transformer station, water and sewage installation, mechanical ventilation and air conditioning, Central Heating (CH) including CH station - heat exchanger, low-current, and with terrestrial parking spaces, road and technical infrastructure: storm and sanitary sewage, water supply, heating, electricity, lighting, and small architecture and greenery. The building is a detached object with a reinforced concrete structure, a column-slab construction, located on a foundation slab of 60 cm thickness, has 6 floors, including one underground with a total building area of 1328,88 m². It was designed, in agreement with the conservation office, the modern, rhomboidal form of the building. The building façade was made using systemic façade cladding solutions and glazing taking into account the use of blinds and photovoltaic cells. The object under consideration has been certified for Core & Shell.

3.2. *Criteria to be evaluated in the phase of the selected object*

The processes associated with the phase of erection of buildings are a source of major interference in the natural environment. Currently, contractors are increasingly undertaking to realization investments in accordance with the principles of sustainable development. Usually during the erecting phase of the building, the possibilities of minimizing the damages of the impact of the construction and operation of the object to the natural environment are taken into account. Among the requirements for the presented object related to conducting construction works were:

Table 2. LEED requirements in the field of Core & Shell during building investment implementation

Nr	Category	Undertaken actions
1	Control of erosion and sedimentation	Prevention of soil contamination and erosion
		Prevention of air pollution
		Implementation control
2	Waste management	Waste management
		Implementation control
3	Indoor air quality	Ensuring the quality of air
		Implementation control
4	Construction products and materials	Water equipment
		The use of regional materials
		The use of recycled materials
		Adequate quality paints, glues and adhesives
		Certified windows, doors and curtain walls
		Implementation control

During the erecting phase of the presented object, the certification body assigned the LEED assessor, who was constantly supervising the subsequent stages of the investment. In addition, the General Contractor (GC) of the facility was obliged to establish an inspector performing internal control of compliance with the LEED requirements. The inspector delegated by the GC has been prepared periodic reports that were forwarded for verification to the LEED assessor. Throughout the implementation of the investment, periodic and random inspections were carried out. During the inspections described above, the LEED assessor checked the manner of conducting construction works and the correctness of transmitted reports.

3.3. *Design assumptions in accordance with the requirements of certification*

The investment was already submitted for LEED certification at the design stage. In connection with the above, the design office received guidelines from the certification body regarding the requirements that the facility must meet in order to be able to apply for the LEED Platinum certificate, the highest possible certification level.

The most important design requirements are summarized in Table 3, which also presents solutions applied in the facility that meet these requirements.

Table 3 The most important project requirements during the implementation of the presented investment applying for LEED Platinum certification

Nr	REQUIREMENT	APPLICABLE SOLUTION
1	The use of renewable energy sources	photovoltaic cells have been designed
2	Sunlight control	assembly blinds on glazed facade elements, whose construction, arrangement and shape were dependent on the world's sides
3	The use of so-called "gray water"	collecting so-called "gray water" in a specially designed underground tank that is used for flushing the toilet and urinals
4	The use of energy-saving light sources	energy-efficient light sources controlled by detectors were used to minimize the need to illuminate rooms
5	The use of suitable hydraulic solutions	The appropriate hydraulic solutions were applied, for example, the diameter of sewer pipes, water expenses and water flow control
6	The use of efficient air-conditioning and ventilation systems	Air-conditioning and ventilation systems have been equipped with a modern control system that allows to reduce the consumption of electricity while achieving high comfort of use of the facility

3.4. Selected problems occurring during the construction of the building applying for the LEED Platinum certificate

Obtaining a LEED certificate depends on many aspects. During the implementation phase of the investment project, it is usually divided into works of the raw (shell) state and finishing works.

3.4.1. The works of so-called: shell state

At the stage of the raw state works of the object presented in the article, particular attention was to be paid to maintaining the purity of air, water and soil. Preventive and safety works (Figure 3) consisted of, among others on:

- Properly executed fence construction to prevent water migration out of the investment area - an example of a fence is shown in Figure4,
- Maintaining clean internal roads of construction, departures from the construction site and public roads in the vicinity of the construction being carried out – on the presented object there were used: sweeping and spraying devices; a vehicle washing station was also organized. It is worth noting that the most pollutants were created during the implementation of earthworks,
- Protection of works accompanied by dusting - tools and devices limiting the formation of dusting substances were used,
- Waste segregation,
- Recycling – for example, recovering the concrete mix by means of a filter basket during the washing trough truck mixer – Figure 5,
- Protection of all powdery, prism materials within the area of construction with foil or tarpaulins – an example of security presents a photo on Figure6,
- The use of construction products obtained at a specified (small) distance from the place of incorporation – which allows reducing the impact of transport on environmental degradation,

- Securing sewer manholes against contamination in the immediate vicinity of the construction, e.g. using a geotextile basket - Figure 7.



Figure 3. Prepared fire station [19.01.2017]



Figure 4. Applied fence of the construction site to prevent migration of water [07.11.2016]



Figure 5. Recovering the concrete mix by means of a filter basket during the washing trough truck mixer [19.01.2017]



Figure 6. An example of foil protection for loose powders [23.09.2016]



Figure 7. An example of securing manholes using a geotextile basket [25.09.2016]

Furthermore, the additional advantage of the erected facility was supposed to be the implementation of a deep-well heat pump, which was supposed to be the main source of heating. Unfortunately, geotechnical research carried out aimed at examining the conditions for the implementation of the above installations ruled out the applicability of such a solution. Finally, the building used a traditional solution - the facility was connected to the municipal heating plant.

3.4.2. Finishing works

At the stage of finishing works, special attention should be paid to installation works and mainly to maintain the purity of the ventilation system at every stage, including at the stage of delivery and installation. In the pictures below, the authors presented several ways of using ventilation duct protection at the stage of storage and preliminary prefabrication – Figure 8 and 9.



Figure 8. An example of the applied ventilation ducts at the storage stage [04.04.2017]



Figure 9. Examples of ways to secure installed ventilation ducts [12.02.2018]

The greatest emphasis during the implementation of the investment, in accordance with the LEED certification requirements, was visible during the raw state. Constant controls and the need to maintain security in a proper condition within the construction site was a major obstacle due to the location of the investment, which is located in dense, urban development. Further, the small construction site constituted an impediment to the organization of appropriate storage sites for segregated waste.

Whereas, during the execution of finishing works the greatest difficulty were so-called "dirty works", which, due to the need to maintain tight protection of ventilation systems, lasted much longer and required temporary remedies, in this case, in the form of portable heating devices. By using the above temporary devices, it was possible to speed up the execution of finishing works and providing employees appropriate working conditions. The biggest problem in a stage of finishing works was lack of a functioning ventilation and air conditioning systems occurred during the works related to the installation of walls in the drywall system. Making walls in a drywall system requires adequate humidity and temperature to dry, which during the construction of the office building was possible through heating devices „travelling” behind the workers. These devices ensured appropriate conditions during assembly and maturing of the binder.

4. Conclusions

In the construction industry there is still a belief that the certificates are another invention of generating additional costs for the investor. This approach is partly due to the experience of contractors related to energy certification. However, there is a doubt whether these two things should really be compared. The ideology associated with promoting the idea of sustainable development (SD) is now an important element of the policy of many countries. Activities are undertaken in different areas of the economy, in

particular those that most affect the environment, which, among others belongs the civil engineering. The SD initiative is guided by one common goal - undertaking all activities that will enable sustainable and equitable civilization development of present and future generations. Civil engineering, as one of the industrial branches that most interferes with the environment, should follow new paradigms, among which sustainable development is currently the leader. In addition, the real estate market is changing from year to year. Foreign tenants are constantly demanding higher and higher standards. Following this path, should be taken steps to leading to the realization of construction projects in accordance with the new trends in order to arouse the interest of investors.

Observation of the implementation of the object applying for the LEED certificate has undoubtedly shown that the requirements related to its obtaining increase the investment costs and may affect the time of its implementation. Despite this, according to the authors, one should strive to propagate the idea of SD by introducing the certification of objects as a standard in civil engineering. The question should be asked whether or not to adapt the requirements to specific countries, which, according to the authors, would be much better suited to the realities of the country and would increase the number of interested in certification.

Due to the private investor and copyright of the discussed investment, only selected elements from the realization were presented.

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