GU J Sci, Part B, 8(2): 577-591 (2020)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

https://dergipark.org.tr/tr/pub/gujsb

Evaluation of Mixed-Use Residential Buildings within the Context of Ecological Criteria

İdil AYÇAM[1*], Betül GÜLER[1]

[1]*Department of Architecture, Faculty of Architecture, Gazi University, Ankara, Turkey.*

Article Info

Received:14/04/2020
Accepted: 06/05/2020

Keywords

Mixed-use Residential Buildings, Ecological Criteria, Energy Efficiency, LEED, Residential Certification Guide

Abstract

Mistakes in the way energy is produced and used cause global energy problems and adverse effects on the natural environment. Researches show that a significant part of the energy consumed is used by the construction sector. Designing residential buildings in the context of green criteria is important in terms of decreasing global energy demand. The residences designed in recent years have become more compact with the construction of subsystems that can meet many daily needs. These mixed-use residential buildings lead to collective energy consumption and when they designed in the context of green criteria, they provide savings in great measure. In this study, it is aimed to create a guide in which mixed-use houses can form their own ecosystem in line with green criteria. In this study, for evaluating mixed-use residential designs, one of the existing certification systems, the world-wide, LEED standards created by the USGBC and BEST housing certification guide created by ÇEDBIK Association in Turkey were examined as a criterion. Received at least a gold grade according to LEED certification were evaluated. Results indicated that mixed–use residential buildings designed together with energy-saving strategies and green design criteria examined in the literature review can produce positive results in terms of energy efficiency.

1. INTRODUCTION

Shelter is one of the basic human needs. The United Nations International Standards in the Universal Declaration of Human Rights guarantee the right to adequate living standards, including shelter [1]. The right to adequate living standards requires that everyone enjoy the necessary food, clothing, housing and all essential welfare rights [2]. According to United Nations Population Fund (UNFPA) 2019 data, the world population has reached 7,635 billion. In addition, the world's population continues to grow by about 1.1% annually [3]. In other words, the average population growth is estimated to be 83 million people per year. The increasing population brings some problems. Especially in developing countries, rapid population increase causes insufficient resources, problems in the national economy and social life and causes slowdown in development. The increasing population forms the housing supply and makes the construction of multi-family houses a necessity. Today, "residence" is more than the need for shelter. The residence is changing with the increasing comfort expectations and socio-economic conditions of the people.

Increased housing demand in cities as a result of depletion of resources, climate change and intensive urbanization requires decreasing the energy consumption of residences and making cities more sustainable. For this reason, it is very important to design every residential building in line with green criteria. Green building is one of the measures taken to mitigate the significant impact of building stock on the environment, society and economy [4]. An energy–efficient building, designed with green criteria in mind, provides the comfort of the person while saving energy. Human is always in interaction with the inner environment that surrounds itself, the structure in which it is located and an outer environment that surrounds this structure. In order for a building to be an energy–efficient building, it must have proper values in all these design parameters. Ensuring the comfort conditions of people should be planned with every step in the process from design to construction of the building. Structures should be designed to

contain passive, active or hybrid air conditioning systems. Mixed-use houses built for high socio-economic users are not considered under the green criteria. The factors affecting the energy efficiency of the mixed-use residential buildings will be discussed and examined within the scope of the study.

2. DEFINITION AND DEVELOPMENT PROCESS OF MIXED-USE RESIDENTIAL BUILDINGS

The construction sector uses 40% of global resources, 12% of drinking water reserves, 40% of raw materials and 55% of wood products. It generates 45-65% of the generated wastes and 48% of harmful greenhouse gas emissions and causes air, water pollution, the threat of depletion of natural resources and global warming [5]. The share of the construction sector and buildings in energy and emissions is shown in the graphs in Figure 1. In order to reduce the environmental problems caused by the construction sector, there is a need to develop the construction sector more sustainably. As a result of this need, the concept of green building has gained importance [6]. Today "Sustainable" or "Green" architecture, which provides alternative guidelines to reduce environmental impact, has become a global trend. The principles of sustainable design include providing technically, economically and socially pleasant, healthy environments to users while minimizing environmental damage. On the other hand, green architecture focuses only on creating environmentally friendly environments [5].

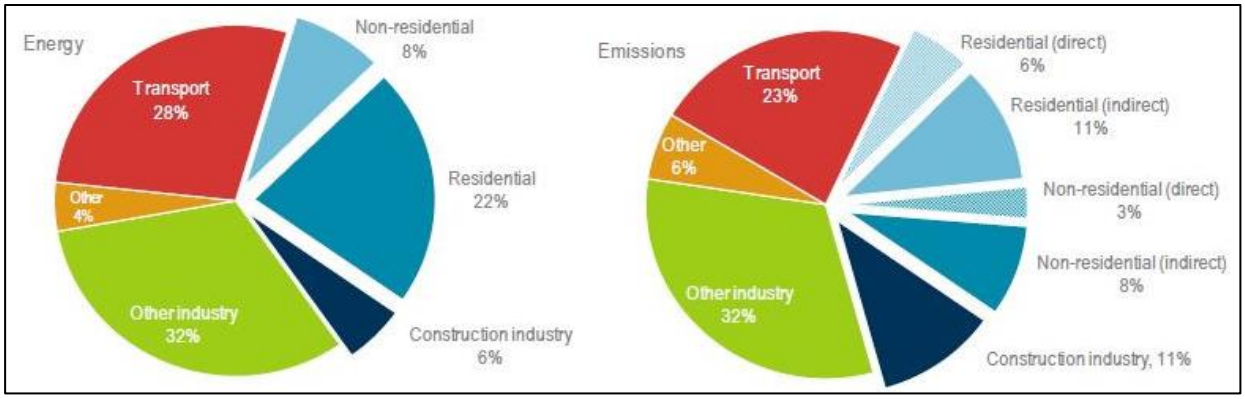

Figure 1. Building sector and buildings share in terms of energy and emissions [7]

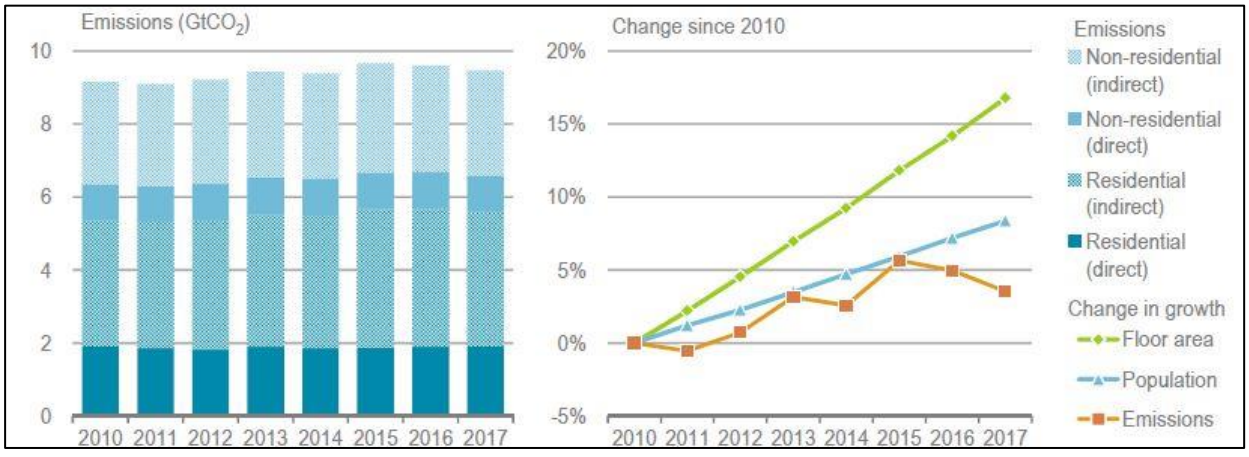

Figure 2. Emissions of global buildings, 2010- 2017 [7]

While the interest in building environmentally friendly buildings has increased, concepts such as green buildings and net zero energy buildings have emerged in the construction sector. Green buildings can use natural resources efficiently, respect the nature, aim to integrate people with nature and protect their health, and reduce energy consumption. Green buildings are part of the global response that is aware of the increasing role of human activity that causes global climate change [8]. Green buildings need to consider water efficiency, resource / material efficiency, indoor air quality and land design [9]. The factors that define a green building are shown in Figure 3.

Figure 3. Green building features [10]

Green building and net zero energy design principles, while minimizing the damage to the environment, technical, social, cultural and aesthetic aspects to satisfy the user, includes providing comfort conditions. In this context, Mixed-Use Residential Structures offer many activities to their users who want to keep up with the fast urban life in a structure and at the same time they are semi-open public spaces, they attract attention with their sustainable approach [11].

Mixed–use residential building not only provides people with living spaces, but also leads to mass–energy consumption. When this situation is evaluated in terms of energy efficiency and correct applications are realized, it is foreseen that it will have positive results by reducing consumption with some measures [12]. Mixed use is advocated by ecological urbanism and is recognized as a path leading to sustainable urban design. In the literature, such settlements are also defined as compact regions [13]. Research generally shows that compact solutions are less polluting to the world. Increasing neighborhood population density also provides improved public transport services and reduces vehicle use. Compared to single-family residence, a compact residential area also reduces the density of infrastructure and contributes to sustainable urbanism [14].

3. STANDARDS AND CRITERIA FOR EVALUATION OF ENERGY PERFORMANCE OF MIXED-USE RESIDENTIAL BUILDINGS

In general, it is possible to examine the standards related to the evaluation of energy performance in buildings in two groups as compulsory and voluntary standards. Compulsory standards, countries' own zoning, environment and etc. regulations were prepared by regulations. Ensuring these standards is a requirement. Voluntary standards are based on the certification system. These certification systems, which are determined by environmentally conscious private organizations, are prepared based on certain standards such as ASHRAE, CISBE, EN, ISO and applied on demand. The whole construction process of the building is graded with a certain test and scoring system and a certificate is obtained as a result. Within the scope of this study; LEED and BEST Housing Certification Guide are detailed. In this study, energy performance evaluation criteria for mixed-use dwellings are based on these two certifications.

3.1. LEED (Leadership in Energy and Environmental Design)

LEED is a voluntary standard developed by the US Green Building Council (USGBC). It was launched in 1998 with a pilot version of LEED 1.0. It is used in more than 160 countries and regions. LEED is recognized as the most common rating system [15]. It is graded in nine main areas that address the main aspects of green buildings. These fields are the same for all project types and consist of credit / points [16]. The most achievable score is 100, but 10 additional points can be achieved in the “Innovation” and “Regional priority” categories. Based on the number of points achieved, it is possible to earn one of LEED rating levels [17].

- LEED Platinum (80+ point),
- LEED Gold (60 - 79 point),
- LEED Silver (50 - 59 point)
- LEED Certified (40 - 49 point)

Projects are evaluated in 9 categories in LEED V.4, the most current version if they meet the least program requirements. It must meet the prerequisites under these main headings. Prerequisites are not subject to scoring, projects must also meet the requirements under these headings in order to receive credit. The categories in which the projects are evaluated are as follows [18].

- Integrative Process
- Location and Transportation
- Sustainable Sites
- Water Efficiency
- Materials and Resources
- Energy and Atmosphere
- Indoor Environmental Quality
- Innovation
- Regional Priority

3.2. Ecological and Sustainable Design in Buildings Housing Certification (B.E.S.T)

The second version of the Green Building Association's Guide to Housing Certification published in 2018 is B.E.S.T. The Housing Certification Guide was published in August 2019. With a few differences in the scoring system between versions, improvements are available. Approved consultant clause has been added to the innovation category in order to facilitate the certification process and ensure the necessary design integration. B.E.S.T Housing Certificate evaluates the residential buildings in 9 categories. These categories are defined as follows [19]:

- Integrative Process
- Sustainable Sites
- Water Efficiency
- Energy Efficiency
- Health and Comfort
- Materials and Resources
- Residential Life
- Operation and Maintenance
- Innovation

The assessment systems and criteria are very comprehensive and are based on documentation as well as on the measurement and construction process. It covers all building processes including planning, design, construction, operation and use, transformation. According to B.E.S.T. Housing Certification Guide, the typologies of housing are classified as follows [19]:

- Single family residence
- Standard apartment $\leq$ 2.000 M²
- 2.001 M² $\leq$ Standard apartment $\leq$ 20.00 M²
- 20.001 M² $\leq$ Standard apartment $\leq$ 50.000 M²
- 50.001 M² $\leq$ Standard apartment
- Luxury Residence

The mixed-use residential buildings mentioned in this study are in the scope of Luxury Residence according to the classification of ÇEDBİK. The prerequisites must be complete and score higher than 45%.

In the literature, residential and mixed-use structures containing different functions are discussed separately. Moreover, ecological design criteria are examined and method recommendations for efficient evaluation of energy are developed. However, it is not enough to evaluate the mixed-use residential settlements alone. Environmental factors and technologies to be used in energy efficiency play an important role when examining mixed-use structures. In this study, the factors that contribute to the reduction of energy costs, and the methods and techniques that can be used in mixed-use residential buildings within the framework of energy efficiency have been put forward together with various investigations. The criteria that can be used in the energy performance of mixed-use residential buildings evaluated under the four main headings. The criteria and their subtitles are summarized in Figure 4.

Figure 4. Energy performance evaluation criteria for mixed use residential buildings

4. MIXED USE PROJECT EXAMPLES DESIGNED IN ACCORDANCE WITH GREEN CRITERIA

Eight different mixed-use residential building examples designed according to green criteria were examined. Four of the selected eight projects were selected from Turkey. Four of them were selected from other countries. These projects have LEED certification. The points to be considered when selecting projects are as follows:

- It has at least two other functions besides residence
- Different scales (single building - building complex - neighborhood scale design)
- The USGBC is registered in the system and qualified for the LEED certificate
- To have at least a gold certificate according to LEED certification
- Accessibility of data, scorecards published
- New construction
- Built projects

Table 1. Building identifier (Turkey)

	AND PASTEL	MİSTRAL İZMİR	PİYALE PAŞA İSTANBUL	KUZU EFFECT
Image of Building				
Architect	HPP International	DNA Mimarlık	İki Design Group	EEA-Emre Arolat Architecture
Location	Kartal/İstanbul	Konak/İzmir	Beyoğlu/İstanbul	Oran/Ankara
Functions	Residential, Office, Commercial Areas, Health center, Education center, Sports areas, Recreation areas, Social areas	Residential, Office, Commercial, Hotel, Sports fields, Social areas	Residential, Commercial, Office, Hotel, Sports, Social Areas	Residential, Office, Commercial Areas, Hotel, Sports fields, Social areas
Type	New Construction	New Construction	New Construction	New Construction
Year	2018	2016	2016	2017
Piece of Block	7 Blocks	2 Blocks	18 Blocks	2 Blocks
Piece of Residences	1243	110	760+190	212
Construction Area	250.000 square meters	112.160 square meters	450.000 square meters	186.000 square meters
Site Area	45.0000 square meters	13.922 square meters	82.000 square meters	30.730 square meters
Certificate	LEED BD+C-New Construction v3 Gold	LEED BD+C-New Construction v3 Gold	LEED ND Neighborhood v3 Gold	LEED BD+C-New Construction v3 Gold

AND Pastel project consists of 7 blocks. The project has a multi-center settlement concept. The project includes a residence tower, detached apartment buildings, buildings opened to the square and areas that can meet different daily needs and areas that provide socialization opportunities for different age groups. Gold level certificate is targeted in 7 different blocks in LEED New Construction category. Orange-1 and Orange-2 blocks received Gold certificates in the LEED BD + C-New Construction category. The other blocks are in the certification process [20].

Figure 5. Images from AND Pastel project [20]

Mistral Izmir, which is designed with residential, office, hotel and bazaar concept, is located in Konak district of Izmir. The project consists of two main towers: 38-storey residence and 48-storey office block. It consists of 110 residences, 153 offices, hotels, 39 shops and sports complexes. The podium, which is thought to be a green roof, connects the residential and office towers. On this podium there is a playground, landscape, pool and terrace [21]. The residential block has been certified Gold level in the LEED BD + C-New Construction category. The office block has been certified Gold level in the LEED BD + C-Core and Shell category. The podium connecting the two blocks is in the process of certification.

Figure 6. Images from Mistral İzmir project [22]

Kuzu Effect, the first LEED Gold certified mixed-use structure in Ankara, describes a complex of shopping districts, residences and offices, while also linking forests to the south and west. A permeable settlement was arranged at ground level by creating access to both vehicle and pedestrian at different levels from environmental roads [23]. Kuzu Effect has been received Gold Certificate in LEED BD + C-New Construction category.

Figure 7. Images from Kuzu Effect project [24]

The scores obtained from the evaluation criteria of And Pastel, Mistral İzmir and Kuzu Effect are given in Table 2.

Table 2. Building identifier (Turkey)

		AND PASTEL						MISTRAL IZMIR			KUZU EFFECT
		Blue	Orange-1	Orange-2	Orange-3	Green 1-2-3	Social Center	Residential	Office	Podium	
Evaluation Criteria	Sustainable Sites	Certification in progress	23/26	23/26	Certification in progress	Certification in progress	Certification in progress	23/26	25/28	Certification in progress	22/26
	Water Efficiency		8/10	8/10				10/10	10/10		8/10
	Energy and Atmosphere		15/35	14/35				12/35	14/37		12/35
	Material and Resources		5/14	5/14				6/14	6/13		6/14
	Indoor Environmental Quality		8/15	8/15				7/15	7/12		12/15
	Innovation		5/6	5/6				5/6	5/6		6/6
	Regional Priority		2/4	2/4				4/4	4/4		3/4
Total score		-	66/110	65/100	-	-		67/110	71/110	-	69/110
Certification level		-	Gold	Gold	-	-	-	Gold	Gold	-	Gold
Last certified on		-	25.12.2018	29.7.2019	-	-	-	07.08.2019	11.09. 2018	-	02.10.2019

Piyalepaşa is an urban transformation project located in Beyoğlu district of Istanbul. It was built on 82 acres of land. It is aimed to revive the multicultural structure of Piyalepaşa district, which extends from the past to the present day with its residences, residences, offices, hotels and shopping streets [25].

Figure 8. Images from Piyalepaşa İstanbul project [25]

Piyalepaşa İstanbul has been received Gold Certificate in LEED ND category for planning stage. The certification process for post-construction is in progress. For each block, LEED was applied in BD + C-New Construction category and its processes are ongoing. The scores obtained from the evaluation criteria of Piyalepaşa are given in Table 3.

Table 3. LEED scorecard of Piyalepaşa İstanbul project

		Neighborhood-Plan
Evaluation Criteria	Smart Location and Linkage	20/27
	Neighborhood Pattern and Design	27/44
	Green Infrastructure and Buildings	8/29
	Innovation	5/6
	Regional Priority	2/4
	Integrative Process	0/1
Total score		62/110
Certification level		Gold
Last certified on		27.08.2019

Table 4. Building identifier (Other Countries)

	VIA VERDE	BRIDGE	MACALLEN BUILDING	KAPSARC HOUSING
Image of Building				
Architect	Dattner Architects, Grimshaw	Gluck+	Office dA	HOK
Location	Bronx, New York	Philadelphia, Pensilvanya	Boston, Massachusetts	Riyadh, Suudi Arabistan
Functions	Residential, Commercial, Sports Areas, Health Center, Common Social Areas	Residential, Commercial, Sports Areas, Common Social Areas	Residential, Commercial, Sports, Common Social Areas	Residential, Commercial, Library, Recreation Center, Mosque
Type	New Construction	New Construction	New Construction	New Construction
Year	2012	2017	2007	2014
Piece of Residences	222	146	140	191
Area	294.000 square meters	169.900 feetkare	32.516 square meters	190.240 square meters
Certificate	LEED BD+C-New Construction v2 Gold	LEED BD+C-New Construction v3 Gold	LEED BD+C-New Construction v2.1 Gold	LEED BD+C-New Construction v2.2 Platinum

Via Verde is a mixed-use project with 20 floors, three different building types and 222 apartments. Via Verde, which means 'Green Way' in Spanish, is based on the idea of spiral plant branches growing towards the sun. The structure wraps around the triangular area, focusing on a green area that is accessible to users. The basic principle of the project is to connect people to nature. The mass of the project is graded as amphitheater steps and each of these levels is defined as green roof. Evergreen plants were preferred on the roof. The roof is also used as a socialization area. The project includes an open-air amphitheater, a fitness center, internet access, units where users can work in the home-office, photovoltaic canopies [26]. Via Verde project has been received Gold Certificate in LEED BD + C-New Construction category.

Figure 9. Images from Via Verde project [26]

Located in Philadelphia Old City, the Bridge project is an 18-storey complex with 146 mixed-use residential units. The lower podium of the building adapts to the rhythm and scale of other nearby structures. On the fifth floor, the mass was withdrawn. A central notch creates an outdoor terrace for residents while preserving neighbors' views to the river and bridge [27]. Commercial areas are located along the street. Houses rising on commercial areas are designed as 1 + 1 and 2 + 1 [28]. The Bridge project has received a Gold Certificate in the LEED BD + C-New Construction category. The Bridge project has received a Gold Certificate in the LEED BD + C-New Construction category. The scores obtained from the evaluation criteria are given in Table 5.

Figure 10. Images from Bridge project [28]

The Macallen Building in Boston consists of 140 residences rising above commercial units along the street. There are swimming pool, fitness room, parking, entertainment room and public rest areas for the residents. Macallen Building has been awarded Gold certificate in LEED New Construction category [29].

Figure 11. Images from Macallen Building [29]

KAPSARC (King Abdullah Petroleum Studies and Research Center) is a non-profit community that examines all types of energy, including solar and wind energy. The campus is developed with the designs of different architects. In this study, the multi-family residential area designed by HOK Architecture Office is examined. The examined residential area is a mixed-use complex within its structure and there are retail areas on the ground floor. The library, cafeteria, recreation center, natatorium and supermarket are located in a residential area. A mosque and park are located very close to the residential area [30]. The residential area is within easy reach of the research and office complex. KAPSARC Housing is the first LEED Homes certified project outside North America. KAPSARC Housing received Platinum certification in the LEED New Construction category.

Figure 12. Images from KAPSARC Housing [31]

Table 5. LEED scorecard of Bridge project

		Bridge
Evaluation Criteria	Sustainable Sites	23/26
	Water Efficiency	8/10
	Energy and Atmosphere	11/35
	Material and Resources	5/14
	Indoor Environmental Quality	9/15
	Innovation	6/6
	Regional Priority	2/4
Total score		64/110
Certification level		Gold
Last certified on		13.10.2017

Table 6. Building identifier (Other Countries)

		VIA VERDE	MACALLEN BUILDING	KAPSARC HOUSING
Evaluation Criteria	Sustainable Sites	11/14	10/14	10/14
	Water Efficiency	3/5	3/5	5/5
	Energy and Atmosphere	8/17	4/17	15/17
	Material and Resources	6/13	7/13	5/13
	Indoor Environmental Quality	11/15	13/15	13/15
	Innovation	5/5	4/5	5/5
Total score		44/69	41/69	53/69
Certification level		Gold	Gold	Platinum
Last certified on		21.03.2013	28.03.2008	29.11.2014

5. EVALUATION AND RESULTS

Need for energy supply, depletion of natural resources, and destruction to the natural environment have been increased rapidly with the population growth. Accordingly, this situation has enhanced the importance of sustainable development concept, green building practices, and efficient use of energy in construction sector. Nowadays, the construction process in urban areas should be rearranged with this vision. Ecological point of view should be taken into consideration for planning the new settlements. It should be designed as habitable spaces that are compatible with protected-developed natural resources.

Various design strategies are introduced to reduce global energy demand. For instance, it has been seen that by means of more compact design solutions and large scale of energy savings can be achieved with mixed-use residential projects where housing, business and social activities are combined. Combining housing needs with daily social needs saves energy and reduces destroyed surface area. Comparisons of mixed-use projects examined were made in the context of green criteria. The comparison criteria consist of data from LEED scorecards are seen in Table 7.

Table 7. Evaluation of the projects examined in terms of process-related criteria

	AND Pastel	Mistral İzmir	Piyale Paşa	Kuzu Effect	Via Verde	Bridge	Macallen Building	KAPSARC Housing
Integrated Project Management Process	●	●	●	●	●	●	●	●
Innovation	●	●	●	●	●	●	●	●
Leading the region in terms of green criteria and design	●	●	●	●	●	●	●	●

● Provides ○ Not Provide (-) Uncertain

It was seen that all the projects examined were realized through an integrated design process. Management of the process is one of the most important criteria for achieving a healthy result. Each of the projects led the regions in terms of green criteria and architectural design. They are sustainable practices that add value to the region and shape their environment. The projects received an innovation score in LEED certification. They are innovative designs with energy–saving solutions and system recommendations.

Table 8. Evaluation of the projects in terms of environmental criteria

	AND Pastel	Mistral İzmir	Piyale Paşa	Kuzu Effect	Via Verde	Bridge	Macallen Building	KAPSARC Housing
Site Selection	●	●	●	●	●	●	●	●
Development density and community connectivity	●	●	●	●	●	●	●	○
Brownfield redevelopment	○	○	○	○	●	○	○	○
Alternative transportation-public transportation access	●	●	●	●	●	●	●	●
Bicycle storage and changing rooms	●	●	○	●	●	●	●	●
Low-emitting and fuel-efficient vehicles	●	●	●	●	○	●	●	●
Parking capacity	●	●	●	●	●	●	●	●
Site development- protect or restore habitat	●	○	●	●	●	○	○	○
Site development-maximize open space	●	●	●	●	●	●	○	●
Storm water design-quantity control	●	●	○	○	○	●	●	●
Storm water design-quality control	●	●	○	○	○	○	○	●
Heat island effect-roof	○	●	●	●	●	●	●	●
Heat island effect-nonroof	●	●	●	●	●	●	●	●
Light pollution reduction	○	○	●	○	●	●	●	○

● Provides ○ Not Provide (-) Uncertain

It is seen that the projects provided the land selection criteria. All the projects examined have easy access to public transportation and it is seen that the parking capacity is kept in sufficient amount in accordance with the standards and minimizes the use of private vehicles. Most projects promote the use of low-emission and fuel-efficient vehicles, and parking on these vehicles has priority. The use of bicycles is also encouraged in the projects, there are bicycle parking spaces. Piyalepaşa project did not get enough points from LEED certification in terms of neighborhood network and storage criteria. They have taken precautions against the heat island effect. In projects other than AND Pastel project, there are heat island effect measures in the roof areas. Although there is rain water quantity control in the projects, there is no rain water quality control system. Rain water is mostly used in irrigation and reservoirs.

Table 9. Evaluation of the projects examined in terms of "water efficiency" and "energy efficiency" in building-related criteria title

		AND Pastel	Mistral İzmir	Piyale Paşa	Kuzu Effect	Via Verde	Bridge	Macallen Building	KAPSARC Housing
WATER EFFICIENCY	Water efficient landscaping	●	●	●	●	●	●	●	●
	No use of potable water in irrigation	●	●	●	●	○	●	●	●
	Innovative wastewater technologies	●	●	○	●	○	○	○	●
	Water use reduction	●	●	●	●	●	●	●	●
ENERGY EFFICIENCY	Optimize energy performance	●	●	●	●	●	●	●	●
	On-site renewable energy	○	○	○	○	●	○	○	●
	Enhanced commissioning	●	○	-	●	●	●	●	●
	Enhanced refrigerant Management	●	●	-	●	○	○	●	○
	Measurement and verification	●	●	-	●	○	●	○	●
	Green power	○	○	○	○	●	●	●	○

● Provides ○Not Provide (-) Uncertain

In the projects reviewed, it was observed that water saving and efficiency were given importance. Optimizing energy performance is a prerequisite for LEED and the projects reviewed meet this criterion. In the projects studied use of renewable energy in Turkey could not get enough points, while the rate was found to be low in the projects studied abroad. The innovative wastewater technologies in projects implemented in Turkey was more common. Measurement and verification systems are more preferred abroad.

Table 10. Evaluation of the projects examined in terms of "indoor health and comfort" and "materials and resources" in building-related criteria title

		AND Pastel	Mistral İzmir	Piyale Paşa	Kuzu Effect	Via Verde	Bridge	Macallen Building	KAPSARC Housing
INDOOR HEALTH AND COMFORT	Environmental Tobacco Smoke (ETS) control	●	●	●	●	●	●	●	●
	Outdoor air delivery monitoring	○	○	-	●	○	○	●	●
	Increased ventilation	○	●	-	○	○	○	●	●
	Construction IAQ Management plan - during construction	●	●	-	●	●	●	●	●
	Construction IAQ Management plan - before occupancy	○	○	-	●	○	○	●	●
	Low-emitting materials - adhesives and sealants	●	●	-	●	●	●	●	●
	Low-emitting materials - paints and coatings	●	●	-	●	●	●	●	○
	Low-emitting materials - flooring systems	○	○	-	●	●	●	●	●
	Low-emitting materials - composite wood and agrifiber products	○	○	-	●	●	○	●	●
	Indoor chemical and pollutant source control	●	●	-	●	○	●	○	●
	Controllability of systems - lighting	●	○	-	●	●	●	●	●
	Controllability of systems - thermal comfort	●	○	-	●	●	●	●	●
	Thermal comfort - design	○	●	●	●	●	●	●	●
	Thermal comfort - verification	○	●	-	●	●	○	●	●
	Daylight and views	●	○	●	○	●	●	●	●
MATERIALS AND RESOURCES	Storage and collection of recyclables	●	●	●	●	●	●	●	●
	Building reuse - maintain existing walls, floors and roof	○	○	-	○	○	○	○	○
	Building reuse - maintain interior nonstructural elements	○	○	-	○	○	○	○	○
	Construction waste Management	●	●	●	●	●	●	●	●
	Materials reuse	○	○	-	○	○	○	○	○
	Recycled content	●	●	-	●	●	●	●	●
	Regional materials	●	●	●	●	●	●	●	●
	Rapidly renewable materials	○	○	-	○	●	○	●	○
	Certified wood	○	○	-	○	○	○	●	○

● Provides ○ Not Provide (-) Uncertain

Environmental smoke control was provided in the projects. The monitoring rate of the outside air input is low. During the construction, the indoor air quality management plan of the building was prepared and many projects have not been implemented before use. Low emission material usage rate is high. In addition, local materials were taken care of and materials were procured from regions close to the project. Recyclable materials were collected and stored and recycling management of wastes generated during construction was ensured. It was seen that the reuse principle could not be achieved in the projects. The utilization rate of daylight and landscape is higher in projects abroad. When evaluated in the projects examined, it is seen that the rate of use of low emission coating materials is higher in abroad projects.

Table 11. Evaluating the projects in terms of user-related criteria

	AND Pastel	Mistral İzmir	Piyale Paşa	Kuzu Effect	Via Verde	Bridge	Macallen Building	KAPSARC Housing
Functionalization based on user attribute	●	●	●	●	●	●	●	●
Regulation of the operation and maintenance of the building	●	●	●	●	●	●	●	●

● Provides ○ Not Provide (-) Uncertain

All of the projects are functional according to the attribute of the users. Apart from the shelter function, it provides areas where it can do activities related to daily social needs. For the usage phase, the users were trained about the green building where they live. In many projects, "Life Guide" was created and presented to users.

Advanced technological verification systems, use of low-emission materials and energy has limited applications in Turkey. Integration of passive strategies with active systems should be ensured to produce more efficient and ecological projects.

As a result, as seen in the evaluation of the projects reviewed, there is a significant reduction in energy consumption and natural resource use in structures designed and implemented in the context of green criteria. Residential areas should be designed with ecological awareness. Thus, the consumption of natural resources and destruction of the natural environment by the built environment will be prevented. The green criteria identified within the content of the study provide guidance for mixed-use housing designs. Each criterion should be seen and applied as a step to make our living space more sustainable.

CONFLICTS OF INTEREST

No conflict of interest was declared by the authors.

REFERENCES

[1] Article 25.1, https://www.unfpa.org/human-rights-based-approach, Last Access Date: 22 December (2019).

[2] Aoul, K. A. T., Ahmed, K. G., Bleibleh., S., "Mass housing: challenges, contemporary paradigms and future potentials", Springer, New York, 31–64, (2016). https://doi.org/10.1007/978-3-319-31967-4_2

[3] UNFP, United Nations Population Fund, https://www.unfpa.org/, Last Access Date: 22 December (2019).

[4] Zuo, J., Zhao, Z. Y., "Green building research–current status and future agenda: A review", Renewable and Sustainable Energy Reviews, 30: 271-281, (2014). https://doi.org/10.1016/j.rser.2013.10.021

[5] Suzer, O., "A comparative review of environmental concern prioritization: LEED vs other major certification systems", Journal of Environmental Management, 154: 266-283, (2015). https://doi.org/10.1016/j.jenvman.2015.02.029

[6] Illankoon, I. C. S., Tam, V. W., Le, K. N., Shen, L., "Key credit criteria among international green building rating tools", Journal of Cleaner Production, 164: 209-220, (2017). https://doi.org/10.1016/j.jclepro.2017.06.206

[7] IEA. (2017), https://www.energypoverty.eu/indicators-data, Last Access Date: 22 December (2019).

[8] Erdede, S. B., Bektaş, S., "Ecologically sustainable development of real estate and certificate systems of green building", Electronic Journal of Map Technologies, 1: 1-12, (2014).

[9] Zhang, C., Cui, C., Zhang, Y., Yuan, J., Luo, Y., Gang, W., "A review of renewable energy assessment methods in green building and green neighborhood rating systems", Energy and Buildings, 195: 68-81, (2019). https://doi.org/10.1016/j.enbuild.2019.04.040

[10] https://www.greencommunities.com/, Last Access Date: 20 December (2019).

[11] Süzer, Ö, "Sustainable design criteria of mixed-use residential high-rise buildings", Master Thesis, Hacettepe University Institute Of Social Science, Ankara, (2012).

[12] Gümüş, Y, "An evaluation of mass housing for the implementation of heating and cooling energy efficiency case study in Istanbul", Master Thesis, Istanbul Technical University, Institute of Science and Technology, Istanbul, (2011).

[13] Zhou, Y., Li, Z., Tao, X., "Urban mixed use and its impact on energy performance of micro gird System", Energy Procedia, 103: 339-344, (2016). https://doi.org/10.1016/j.egypro.2016.11.296

[14] Wilkinson, S.,Hajibandeh, M., Remoy, H., "Sustainable Development", M. Noguchi (Ed.), Springer, New York, 1-29, (2016).

[15] Doan, D. T., Ghaffarianhoseini, A., Naismith, N., Zhang, T., Ghaffarianhoseini, A., and Tookey, J., "A critical comparison of green building rating systems", Building and Environment, 123:243-260, (2017). https://doi.org/10.1016/j.buildenv.2017.07.007

[16] Mattoni, B., Guattari, C., Evangelisti, L., Bisegna, F., Gori, P., and Asdrubali, F., "Critical review and methodological approach to evaluate the differences among international green building rating tools", Renewable and Sustainable Energy Reviews, 82: 950-960, (2018). https://doi.org/10.1016/j.rser.2017.09.105

[17] USGB (United States Green Building), https://www.usgbc.org/, Last Access Date: 11 November (2019).

[18] Ecobuild, https://www.ecobuild.com.tr/, Last Access Date: 11 November (2019).

[19] ÇEDBİK, Turkish Green Building Council, https://cedbik.org/en , Last Access Date: 21 November (2019).

[20] AND Pastel, https://www.andpastel.com/default.aspx, Last Access Date: 02 November (2019).

[21] EKOYAPI, https://www.ekoyapidergisi.org/, Last Access Date: 03 November (2019).

[22] Mistral İzmir, https://www.mistralizmir.com.tr, Last Access Date: 03 November (2019).

[23] Emre Arolat Architecture, https://www.emrearolat.com/, Last Access Date: 03 November (2019).

[24] Kuzu Effect, https://www.kuzueffect.com/, Last Access Date: 03 November (2019).

[25] PiyalePaşa İstanbul, https://www.piyalepasaliolmak.com/piyalepasa-istanbul-cevre-dostu-bir-proje/, Last Access Date: 04 November (2019).

[26] Scott. J., "Working-Class Housing Complex Will Rise as Part of the Greenery", The New York Times, (2007).

[27] https://igsmag.com/features/case-study-bridge-philadelphia-pa-2/, Last Access Date: 25 November (2019).

[28] https://archpaper.com/2014/08/refined-peter-gluck-designed-tower-to-break-ground-in-philly-early-next-year/, Last Access Date: 24 November (2019).

[29] Macallen Building Condominiums, https://www.aiatopten.org/node/130, Last Access Date: 26 November (2019).

[30] KAPSARC Housing, https://www.archdaily.com/614598/kapsarc-housing-hok, Last Access Date: 26 November (2019).

[31] KAPSARC Housing, https://www10.aeccafe.com/blogs/arch-showcase/2017/05/28/king-abdullah-petroleum-studies-and-research-center-residential-community-in-riyadh-saudi-arabia-by-hok/Last, Access Date: 27 November (2019).