Mef University
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Alternative Architecture Practices

A Critical Study on Sustainability Within Environmental Assessment Methodologies: Evaluating Volu-te in Search of an Alternative Vision in Architecture

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2022

I would like to take the opportunity to thank my supervisor Prof. Dr. Şebnem Yücel for her assistance, advice, and feedback throughout my research project. In addition, I would like to thank our project instructor Oral Göktaş, who made it possible for a team of 10 to design our micro living unit Volu-te. I also want to thank the Passive House Institute that they have provided me with a free PHPP and its manual for my research via Patrick Manott. Lastly, I would like to thank my parents, Meryem and Melih Kaleli for their endless trust and love.

Abstract

This thesis focuses on the evaluation of sustainability in architecture and the environmental assessment methodologies as its tools. These methodologies act as measuring mechanism of sustainability of the architectural product; however, they also work as a wheel of the current capitalist system by labelling and certification requirements. Therefore, this study aims to focus on evaluating ecological impact and financial stress on the project. It shows that BREEAM certification adds a triple amount of project budget and Passive House certification adds double the amount of the total cost of the project. In this evaluation Volu-te has been used as an architectural product to discuss and make the cost effect of these certification systems on micro scale living projects.

Key Words: Sustainability, Environmental Conscious Design, Environmental Assessment Methodology, Ecology, Capitalism, Micro-Living

Source Code: 80107

Özet

Bu araştırma, mimaride sürdürülebilirliğin değerlendirilmesine ve bunun araçları olarak çevresel değerlendirme metodolojilerine odaklanmaktadır. Bu metodolojiler, mimari ürünün sürdürülebilirliğinin ölçüm mekanizması olarak işlev görür; ancak etiketleme ve sertifikasyon gereklilikleri ile mevcut kapitalist sistemin çarkı olarak da çalışırlar. Bu nedenle, bu çalışma proje üzerindeki ekolojik etkiyi ve finansal stresi değerlendirmeye odaklanmayı amaçlamaktadır. BREEAM sertifikasının proje bütçesine ekstra üç kat, Pasif Ev sertifikası ise projenin toplam maliyetine ekstra iki kat daha masraf eklendiği görülmektedir. Bu değerlendirmede Volu-te, bu sertifikasyon sistemlerinin mikro ölçekli yaşam projelerinde maliyet etkisini tartışmak ve maliyet etkisini ortaya koymak için mimari bir ürün olarak kullanılmıştır.

Anahtar Kelimeler: Sürdürülebilirlik, Çevreye Karşı Duyarlı Tasarım, Çevresel Değerlendirme Metodolojisi, Ekoloji, Kapitalizm, Mikro Yaşam

Bilim Dalı Sayısal Kodu: 80107

Table of Contents

List of Figures

Introduction

In recent years, there has been a tremendous growth in the number of words, such as sustainable, ecological, green, energy efficient, carbon-neutral, or resilient, used to describe environmentally conscious approaches for architectural production. Although none of these terms define a quantitative achievement in terms of the holistic consideration of the environment, they represent an either deep or shallow understanding on acting towards a future with the climate crisis. Cultural theorist Raymond Williams[1] links the challenge in defining a quantitative measurement to the difficulty of using the definition of words that keep beliefs and opinions efficiently. Within this pool of words, the certification systems offer quantitative value for the architectural product and its environmental performance to create a clear and fair comparison between the products for the advertisement industry due to legal procedures. As the media is the most important tool of the capitalist system according to Political philosopher Felix Guattari[2], certification becomes a crucial driver to describe the relationship between a product and the environment for marketing. Therefore, there are various environmental assessment methodologies such as BREEAM, LEED, CASBEE, or Green Star, and they aim to compare the buildings via creating an optimised scorecard with credits. However, there is hardly any convincing evidence that these methodologies achieve a positive impact on architecture production towards global targets on impact reduction of climate change.

In this context the research problem arises as if environmental assessment methodologies are just another marker within neoliberalism via their certification systems. The main research question relates to this bigger research problem, which is questioning the need for environmental assessment methodologies and their certification mechanism for buildings to obtain environmentally responsible architectural production if we compare financial aspects and ecological impact. There are also sub-questions to shape this research, which ask the main intention to form these certification systems, the

1. Raymond Williams, "Keywords: a Vocabulary of Culture and Society," in Keywords: a Vocabulary of Culture and Society (New York, NY: Oxford University Press, 1976), p. xxiii-xxxvii.

2. Félix Guattari, The Three Ecologies (London, UK: Bloomsbury Academic, 2014).

evaluation of them within the capitalist system, the human urge to certify, and the financial arguments and considerations to adapt into a certification system.

These research questions come from the urge to examine the environmental assessment methodologies as measuring mechanisms of sustainability in architecture. To investigate these tools, this thesis focuses on the ecological impact of environmental assessment methodologies to obtain sustainable architectural production by comparing financial aspects to examine their compliance within the market system. Because it is valuable to enact the economic burden of these methodologies on the total cost of the architectural projects to question the sustainability of the whole system in general. The aim is to review the most well-known environmental assessment methodologies by application on Volu-te to find ecological impact and extra cost.

Volu-te is a temporary dwelling designed by 10 students of Alternative Architectural Practices (AAP) graduate program under the guidance of Oral Göktaş at MEF University. The 2019-2020 theme[3] of the AAP program was called "Small Scale Decent Change", a title which made a reference to both dwelling and production from the architectural exhibition of MoMA in 2010. It has aimed to address the creation of a housing unit, which would be micro scale, off-grid and prefabricated as an alternative way of both dwelling and production considering the global economic and environmental crisis. There have been one research book and one design guidebook developed during the program, which were for the investigation of design parameters, and the design of micro living unit Volu-te. The first Volu-te research book has focused on developing the background research to create the design principles of the micro living unit and it was formed from 5 sections, which were historical timeline, structural durability, technology, sustainability, and ergonomics.

Afterwards originated by this research, the design guidebook of Volu-te was divided into 8 sections, which were context, body and space, exterior and urban context, cycles, structure, construction technology, site studies, and economic model. Volu-te Design Guidebook[4] explains the social and economic context for the design, the key parameters of design as an alternative to the problems stated, and production details.

This thesis is conducted with the combination of research and study, and the application of the selected methodologies on Volu-te as a case study. Firstly, the evolution of sustainability and environmental assessment meth-

3. Oral Göktaş, "2019-2020," AAP Alternative Architectural Practices (MEF University, 2019), https://aap.mef.edu.tr/copy-of-curriculum.

4. Ahmet Yaymanoğlu et al., "AAP Volu-Te Design Guidebook," ed. Oral Göktaş, Yumpu, 2020.

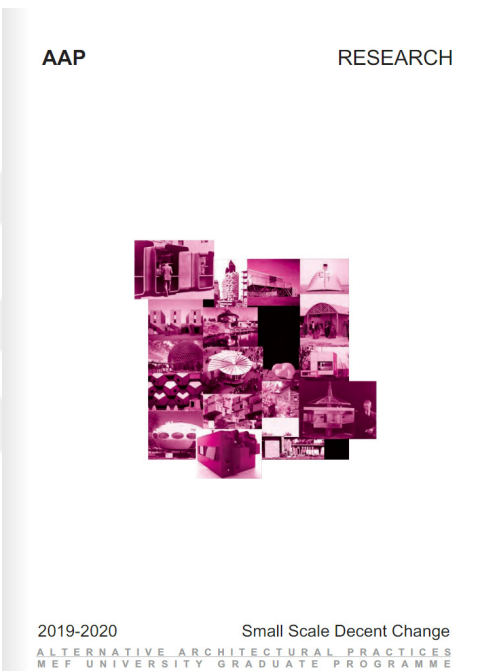
5. Ahmet Yaymanoğlu et al., "AAP Small Scale Decent Change," ed. Oral Göktaş, Yumpu, 2019, https://www.yumpu.com/en/document/read/65263911/aap-smal-scale-decent-change.

6. Ahmet Yaymanoğlu et al., "AAP Volu-Te Design Guidebook," ed. Oral Göktaş, Yumpu, 2020, https://www.yumpu.com/en/document/read/65263933/aap-volute.

odologies is analysed in the literature review via desk-based research from online articles, books, standards, and manuals. This research is refined with selected keywords such as sustainability, environment, development, and capitalism. Afterwards, Volu-te is evaluated with the selected environmental assessment methodologies, which are BREEAM and Passive House. In this way, it becomes possible to evaluate the ecological impact of the methodologies on Volu-te with the comparison from financial aspects. Finally, the results are evaluated and alternative methodologies for a holistic approach for environmentally conscious design practices are discussed. By doing this, it is expected to evaluate both deficiencies and advantages of these methodologies to discuss an alternative ecological vision in architecture.

In this context, the thesis is carried out in three main sections. Literature review focused on sustainability. It comprised the research from the Industrial Revolution to the present via presenting changing human perception on the relationship with nature. The next section discussed the current environmental assessment methodologies in terms of their impacts on sustainability improvements in architectural production. The third section is focused on Volu-te in order to study the ecological impact and financial cost of environmental assessment methodologies. The evaluation of Volu-te has been carried out by using BREEAM and PHPP. Finally, alternative approaches on architecture have been touched to achieve a safer future in terms of the climate crisis.

Figure 1: Small Scale Decent Change[5] research book and Volu-te[6] design guidebook.



On sustainability

01

Sustainability as one of the hot topics of the current headlines, has been involved in ongoing discussions for decades both on climate change and on economic growth. It has served as a cure by numerous researchers, policy makers, professionals to minimise the harm of industrial revolution on Earth and therefore it has changed the working mechanisms of many industries. However, there is a recent argument that sustainability does not fulfil the requirements to obstruct the formation of crises on both climate and financial inequalities. In this section, to evaluate how sustainability became a buzzword, I first focus on the historical background of paradigm shift in human-nature relationship within the Anthropocene. Secondly, I evaluate the creation of the term sustainability and its key parameters of environmental, social, and economic considerations. I then concentrate on the rise of sustainability in architectural production. Finally, I review environmental assessment methodologies such as LEED, BREEAM and Passive House as a tool of sustainable architecture.

Ways of Seeing

John Berger, an artist, critic, and writer, claims in his 1972 television series called "Ways of Seeing[7]" that the process of seeing is a deliberate action more than we would think of as it is managed by habit and convention. Regarding our view of the relation between nature and civilization, the habits and conventions of the 19th century could be very different from those of the 21st century. Even then, a painter's view of this relationship can be very dystopic while other's might be utopic. For example, in 19th century American painter Thomas Cole[8] created a series of paintings called The Course of Empire[9]. According to Cole, the series was depicting the development of nations in history, starting with barbaric settlements, continuing with the rise of civilization, and inevitably reaching a collapse and extinction. Figure 2 shows these 5 paintings that concisely summarises the human-nature relationship and shows the history of the human empire and its catastrophic harm on Earth from his perspective. The first painting is called "Stage One: The Savage

7. John Berger, Ways of Seeing, 1972, https://www.youtube.com/watch?v=0pDE4VX_9Kk&ab_channel=tw19751.

8. Ella M. Foshay, Mr. Luman Reed's Picture Gallery: A Pioneer Collection of American Art. Introduction by Wayne Craven. Catalogue by Timothy Anglin Burgard. New York: Harry N. Abrams, Inc. in association with the New-York Historical Society, 1990 quoted in "About the Series: The Course of Empire," Explore Thomas Cole, 2015, http://www.explorethomascole.org/tour/items/63/series/.

9. *Thomas Cole, New-York Historical Society (New-York Gallery of the Fine Arts, 1858), https://emuseum.nyhistory.org/search/course%20of%20empire?filter=peopleFilter%3A4174#filters.*

State[10]" and it demonstrates the wildlife and hunter-gatherer humans having a survival challenge against nature. Second painting "Stage Two: The Arcadian or Pastoral State[11]" shows the ancient developments of humans with the wooden structures and cultivated gardens. "Stage Three: The Consummation of Empire[12]" depicts a scene of the rise of civilization. Cole expresses the change of perception on human-nature relationship in the 3rd painting by highlighting the size of human made structures dominating the peak of the mountain. Subsequent painting, which is called "Stage Four: Destruction[13]", displays a chaotic view from the fall of the human empire. In the final painting called "Stage Five: Desolation[14]", there are only the ruins of the empire after their extinction, and we see the healing nature in a new springtime after all the destructive damages of human beings on Earth. To sum up Cole lays a simplistic point of view on the destiny of humanity that when it develops against nature then it is condemned to extinction as he presents that nature always wins. However, in the 21st century we may approach these paintings with a different way of seeing.

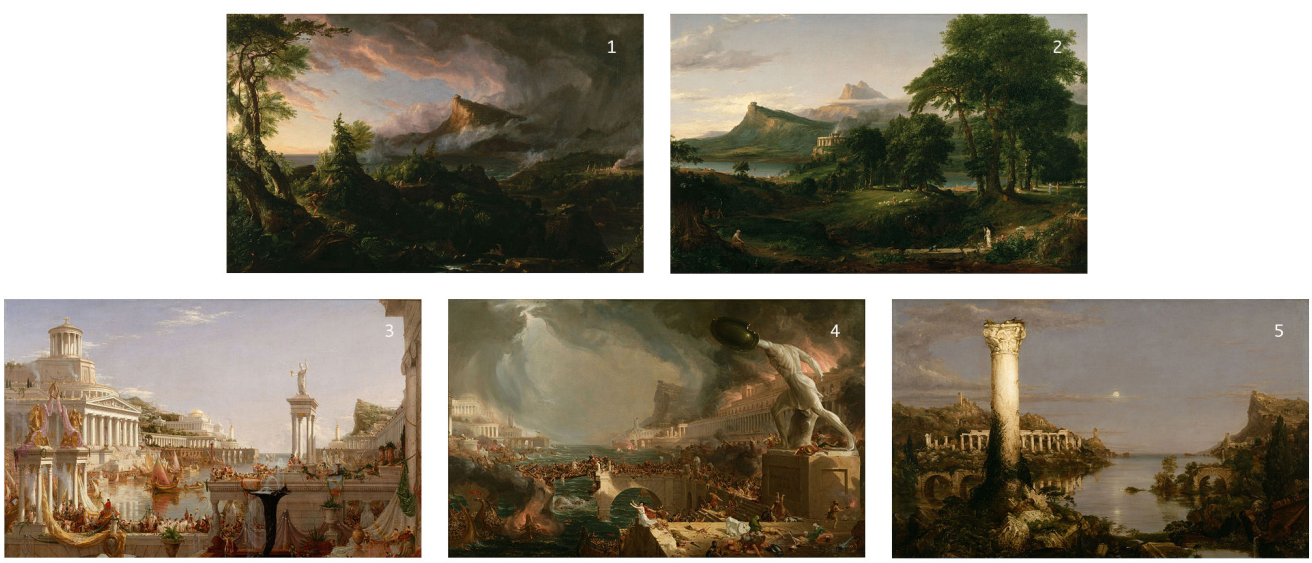


Figure 2: Thomas Cole's "The Course of Empire[15]" series of paintings (1835-1836).

In the timeline of history, we might look at thresholds to question the impulse that pushed Cole to illustrate the rise and fall of civilization. Cole's creation of these paintings take part in the early 19th century, which corresponds with the change in the source of energy used in the steam engines from wood to coal[16]. The use of coal as a resource creates a paradigm shift[17] in the perception of human-nature relationship. In 1977, economic historian John Ulric

10. Anthony Comegna, "Art as Ideas: Thomas Cole's The Course of Empire," Libertarianism, March 25, 2016, https://www.libertarianism.org/columns/art-ideas-thomas-coles-course-empire.

11. Comegna, "Art as Ideas: Thomas Cole's The Course of Empire," Libertarianism, 2016.

12. Ibid.

13. Ibid.

14. Ibid.

15. Thomas Cole, New-York Historical Society (New-York Gallery of the Fine Arts, 1858), https://emuseum.nyhistory.org/search/course%20of%20empire?filter=peopleFilter%3A4174#filters.

16. Eray Çaylı, İklimin Estetiği: Antroposen Sanatı Ve Mimarlığı Üzerine Denemeler. Translated from original. (Istanbul, Bayrampaşa: Everest Yayınları, 2020).

17. Here paradigm shift is used in the Kuhnian sense that a paradigm shift and a scientific revolution occurs respectively when a crisis is caused by unsolved problems because of an increased number of anomalies in scientific research. Therefore, here the use of coal as a source through the Industrial Revolution might be defined as a paradigm shift that provoked a change in the human perception of nature.

Nef[18] stated that the rise in extensive consumption of wood has caused an energy crisis in Europe and it was a force to find other sources of energy. By the end of the 16th century, coal has become the alternative energy source, and it has directly changed history by causing an "economic revolution" that has later been linked to the Industrial Revolution[19]. Although coal was used in small quantities as the source of energy throughout the world since the 12th century, it did not create the same consequences of the Industrial Revolution since the wood crisis has arisen[20]. Nef claimed that the reason behind it is the human attitude against coal before the crisis. He explained that coal mining was thought as an unacceptable act against the Earth until wood prices were too high because of low stock[21]. On the other hand, the use of coal as the source of energy could also be related to James Watt's invention of steam engine and coal to be a more efficient source of energy[22]. Recently cultural anthropologist Eray Çaylı[23] claimed that the change in energy resource from wood to coal is related with the modification of the ways of seeing such as coal becoming the source of energy as well as poor nations becoming the target for colonialism at the end of 18th century. According to Caylı, this was all caused by Watt's steam engine, which made possible the growth of capitalism based on surplus value production at exceptional speeds. In that point of time, a shift has occurred in human perception that has ended with a revolution in the industry while trying to find new methods to use coal as the primary source of energy. To summarise, ecological deprivation due to excessive consumption of wood has caused an economic crisis, which has affected human perception and brought alternative resources to overcome energy scarcity.

According to Nobel prize-winning chemist Paul J. Crutzen, James Watt's steam engine invention overlaps with the start of the rise in carbon dioxide and methane gas levels in the atmosphere, which represents the beginning of an anthropogenic age in 1784[24]. To define human influence on geology and ecology, Crutzen and American biologist Eugene F. Stoermer uses the term Anthropocene[25] first in a newsletter for The International Geosphere–Biosphere Programme in 2000. Crutzen and Stoermer mention in the newsletter[26] that over-increased human population and their actions exploit the resources of the Earth, and it causes the increase in greenhouse gases as well as the rise in extinction rate of the species. Therefore, they propose implementing the term "Anthropocene" to define an epoch where humankind is a geological force. Although it is still not officially recognised by the International Union of Geological Sciences (IUGS) as an epoch[27], a research

18. John U. Nef, "An Early Energy Crisis and Its Consequences," Scientific American, November 1977, pp. 140-150.

19. Nef, "An Early Energy Crisis and Its Consequences," Scientific American, 1977.

20. Ibid.

21. Ibid.

22. Eray Çaylı, İklimin Estetiği: Antroposen Sanatı Ve Mimarlığı Üzerine Denemeler. Translated from original. (Istanbul, Bayrampaşa: Everest Yayınları, 2020).

23. Çaylı, İklimin Estetiği: Antroposen Sanatı Ve Mimarlığı Üzerine Denemeler. (Istanbul, 2020).

24. Paul J. Crutzen, "Geology of Mankind," Nature News (Nature Publishing Group, January 2002), https://www.nature.com/articles/415023a.

25. Sophie Yeo, "Anthropocene: The Journey to a New Geological Epoch," Carbon Brief, October 5, 2016, https://www.carbonbrief.org/anthropocene-journey-to-new-geological-epoch.

26. Paul J. Crutzen and Eugene F. Stoermer, "The Anthropocene," IGBP Newsletter 4 1 (The International Geosphere–Biosphere Programme (IGBP), May 2000), http://www.igbp.net/download/18.316f18321323470177580001401/1376383088452/NL41.pdf.

27. National Geographic Society, "Anthropocene," National Geographic, June 5, 2019, https://www.nationalgeographic.org/encyclopedia/anthropocene/.

28. Colin N. Waters, Jan Zalasiewicz, Colin Summerhayes, Anthony D. Barnosky, Clément Poirier, Agnieszka Galuszka, Alejandro Cearreta, et al. "The Anthropocene Is Functionally and Stratigraphically Distinct from the Holocene." Science 351, no. 6269 (2016): 137–137. http://www.jstor.org/stable/24741581. (Photo credit: J. P. Briner).

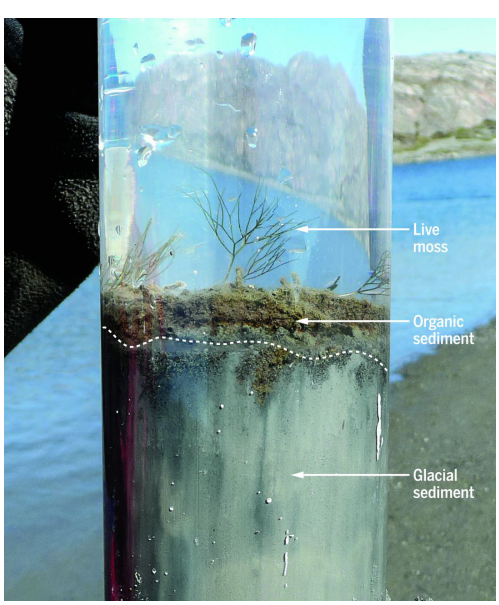


Figure 3: Lake sediments showing differing signatures from glacial sediments of Holocene to non glacial organic matter as a prove of Anthropocene[28].

paper published by scientists Waters[29] et al. in Science Magazine in 2016 has proved how Anthropocene differs from Holocene in lake sediments with the various plastics, metals, and chemicals as the result of increased greenhouse gas emissions.

Although Crutzen and Stoermer thought that the origin of Anthropocene is based on the 18th century related with the invention of steam engine, environmental journalist Sophie Yeo[30] states that there are other scenarios on the topic such as deforestation, like the relocation of species between continents during the Columbian Exchange after Christopher Columbus in 1492, the Industrial Revolution, and the Great Acceleration in 1950. National Geographic Society[31] also claims that atomic bombs represent to be an indicator of destructive human power on Earth and as it is shown in Figure 4 that the mushroom cloud becomes the powerful symbol of it.

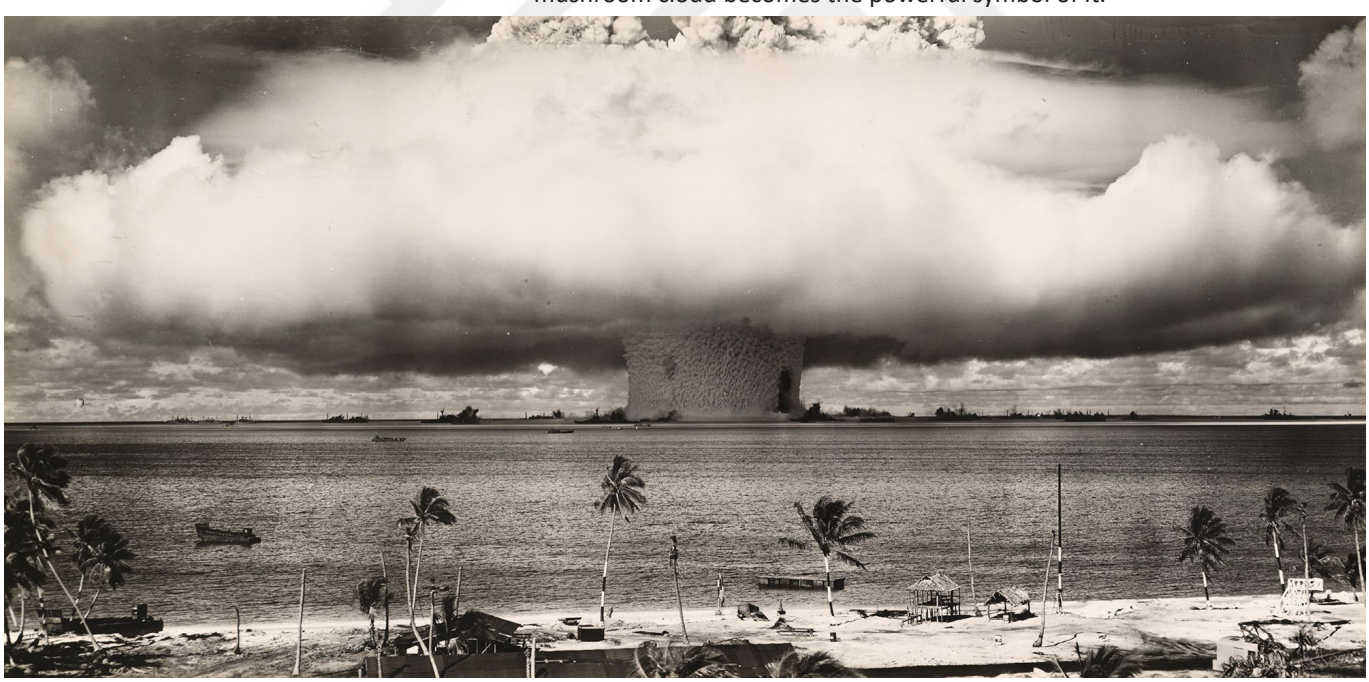


Figure 4: The Mushroom Cloud[32].

To summarise, the use of coal as a source of energy in steam engines in connection with the Industrial Revolution creates a paradigm shift in the way of seeing nature by humans. Humanity turns into a geological force, and it results in irreversible impacts on Earth. Climate crisis is the most catastrophic evidence of these collisions and "sustainability" has been presented as a solution for many years. The next section focuses on the evolution of the concept, sustainability.

29. Colin N. Waters, Jan Zalasiewicz, Colin Summerhayes, Anthony D. Barnosky, Clément Poirier, Agnieszka Galuszka, Alejandro Cearreta, et al. "The Anthropocene Is Functionally and Stratigraphically Distinct from the Holocene." Science 351, no. 6269 (2016): 137–137. http://www.jstor.org/stable/24741581.

30. Sophie Yeo, "Anthropocene: The Journey to a New Geological Epoch," Carbon Brief, October 5, 2016, https://www.carbonbrief.org/anthropocene-journey-to-new-geological-epoch.

31. National Geographic Society, "Anthropocene," National Geographic, June 5, 2019, https://www.nationalgeographic.org/encyclopedia/anthropocene/.

32. National Geographic Society, "Anthropocene," National Geographic, June 5, 2019, https://www.nationalgeographic.org/encyclopedia/anthropocene/. (Photo credit: United States Navy).

Evolution of Sustainability from a Forestry Book to a Buzzword

To start with the origin, sustainability first derives from "sustained yield" in a German forestry handbook (original term was "Nachhaltigkeit") published in 1713, and it has been used to describe the yield that is maintained and protected against the risk of deforestation[33]. Although the origin of the term sustainability was evolved from the critical consideration of extravagant use of wood as a resource material, it contains the fundamental consciousness within its definition when compared to the current scope of the term. Oxford English Dictionary[34] defines it as "the quality of being sustainable by argument" where sustainable[35] is defined as "capable of being endured or borne". Therefore, the term itself holds the meaning of becoming resistant against a crisis. Its usage rises when there is a case of scarcity in terms of resources because of inconsiderate human consumption with economic priorities. The latest perception of sustainability surges in The Club of Rome's 'Limits to Growth' when it was published in 1972[36]. It has suggested in the book that it is important to build up a sustainable foundation with ecological and monetary steadiness for adjusting development patterns based on consumption of limited resources so that every individual on earth would have an equivalent chance to fulfil their own needs. Although the authors of the book highlight later that they refer to sustainability under the discussions on "equilibrium[37]" in Limits to Growth, it still shaped the contemporary scope of the term. Following the success of the book, 1987 Brundtland Report[38] has defined "sustainable development" as one that addresses the current needs for both the environmental and social conditions such as people living in poverty. Therefore, the late twentieth century understanding of sustainability has involved a holistic approach by integrating social, economic, and environmental factors. Linked to the introduction of these three aspects into sustainability, various representations of the term have emerged within the academic studies. The most common diagrammatic representation as shown in Figure 4 includes three intersecting circles, where each circle represents the fundamental parameters of sustainability that are environment, society, and economy. Researchers Feriha Urfalı and Lerzan Aras[39] explain that the environment dimension was popular until the late 1990s; afterwards the economic dimension has come into prominence; and a more equal distribution of three dimensions has gained importance since the 2000s.

33. Jessie Rack, "A Brief History of Sustainability," The World Energy Foundation (World Energy, August 20, 2014), https://theworldenergyfoundation.org/a-brief-history-of-sustainability/.

34. "sustainability, n.". OED Online. March 2022. Oxford University Press. https://ezproxy.mef.edu.tr:2313/view/Entry/299890 (accessed May 07, 2022).

35. "sustainable, adj.". OED Online. March 2022. Oxford University Press. https://ezproxy.mef.edu.tr:2313/view/Entry/195210 (accessed May 07, 2022).

36. Ben Purvis, Yong Mao, and Darren Robinson, "Three Pillars of Sustainability: in Search of Conceptual Origins," Sustainability Science 14 (September 3, 2018): pp. 681-695, https://doi.org/https://doi.org/10.1007/s11625-018-0627-5.

37. Donella H. Meadows et al., The Limits To Growth The 30-Year Update (London: Earthscan, 2004).

38. United Nations, "1987: Brundtland Report," United Nations, 1987, https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf.

39. Feriha Urfalı and Lerzan Aras, "Measuring Social Sustainability with the Developed MCSA Model: Güzelyurt Case," Sustainability 11, no. 9 (April 2019): p. 2503, https://doi.org/10.3390/su11092503.

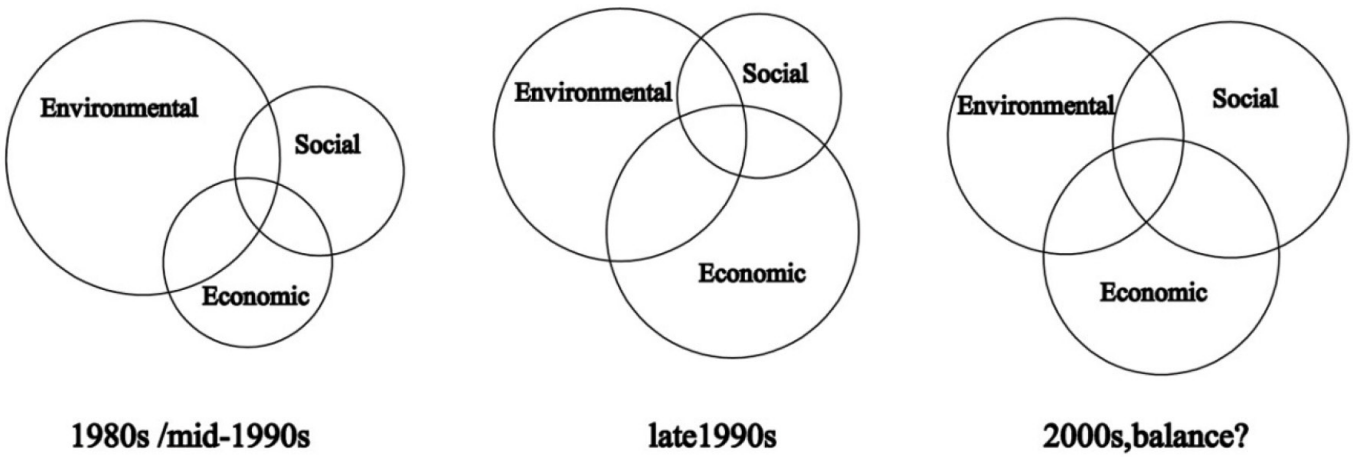


Figure 5: Sustainability diagram[40] with intersecting circles of environmental, social, and economic dimensions.

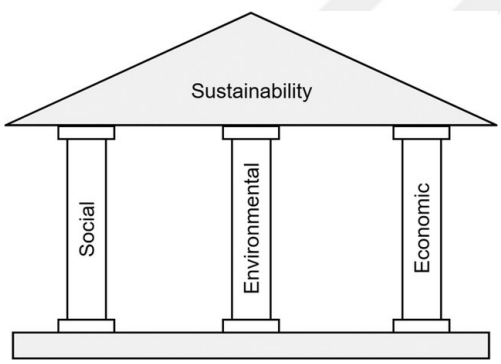


Figure 6: Sustainability diagram[45] with three pillars from environmental, social, and economic dimensions.

Figure 5 shows another common representation that takes the form of a pediment, where sustainability is carried by these three dimensions. Researchers Ben Purvis, Yong Mao and Darren Robinson[41] state in their article this is the most dominant representation of sustainability within the early literature. In fact, this representation originates from Brundtland Report where it is institutionalised with a system approach to encourage "sustainable growth[42]". This representation inserts the objectives of social and economic development as necessary components to sustainability, and it presents these three dimensions with equal priority. Notwithstanding, many of the studies on sustainability do not include all these factors equivalently. Researchers Luanda Lima et al.[43] examines the academic literature on sustainability for 18 years and shows that approximately 65% of the studies and articles do not mention these three dimensions all together and neglect either one or both of the social and economic parameters. Therefore, three intersecting circles of the dimensions of sustainability handle the subject via a more realistic perspective as it shows that there might be common issues of three dimensions as well as they might add up from separate perspectives[44]. It becomes easier to have a flexible consideration of the subject depending on the focal point of either environmental, social, or economic views.

Environmental concerns[46] have been raised since the early 19th century on changing climate. Although global warming concerns had first risen in the end of the 1800s, a quick search through The New York Times archives show that it has steadily increased after the end of WWII. There are approximately 2,500 articles in the New York Times Archive for every 45 years from 1851 to 1945 as Figure 7 shows; however, with the end of WWII the same number of articles are already published in the half of this time. The Figure 6

40. Urfalı and Aras, "Measuring Social Sustainability with the Developed MCSA Model: Güzelyurt Case," Sustainability (2019).

41. Ben Purvis et al., "Three Pillars of Sustainability: in Search of Conceptual Origins,", pp. 682.

42. United Nations, "1987: Brundtland Report," United Nations, 1987, https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf.

43. Luanda Lima et al., "Sustainability in the Construction Industry: A Systematic Review of the Literature," Journal of Cleaner Production 289 (2021): p. 125730, https://doi.org/10.1016/j.jclepro.2020.125730.

44. Lima et al., "Sustainability in the Construction Industry: A Systematic Review of the Literature".

45. Adam Sulich and Tomasz Zema, "Green Jobs, a New Measure of Public Management and Sustainable Development," European Journal of Environmental Sciences 8, no. 1 (2018): pp. 69-75, https://doi.org/10.14712/23361964.2018.10.

also shows another peak at 1970s because of the Environmental Movement[47], where writer Rachel Carson plays a significant role with her famous book Silent Spring.

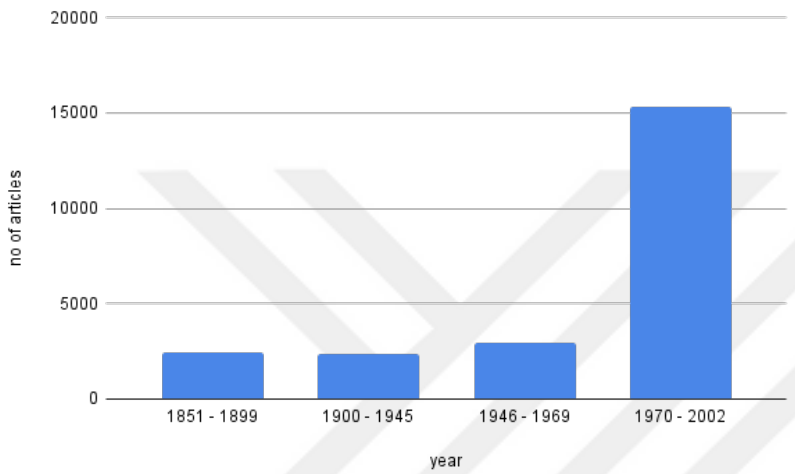


Figure 7: New York Times Archive[48] search results of "climate change" from 1851 to 2002.

The rise in the number of published articles on climate change after the 1970s also coincides with the broadcasting of the first full view of the Earth taken by Apollo 17. Latour[49] claims that seeing the Earth without any borders should provide us a more homogeneous understanding of nature. Furthermore, in 1977 American historian Donald Worster mentioned that ecology has linked human interrelationship with nature, and he states that we might call the time as "Age of Ecology[50]". Although the initial impulse started to rise around the end of 1880s and the full view of the Earth has developed a more holistic understanding of the homogeneity of nature, the first legal action was not constituted until the end of 1980s. In 1988, World Conference on the Changing Atmosphere that is formed by scientist and policy makers from 46 countries set a target to decrease emissions below the levels in 1988 by 2005[51].

Economic concerns arguably contrast with the environmental and social drivers. Justin Rosenstein, former engineer in Facebook and Google, claims in the tv documentary called *The Social Dilemma*[52] that our economy is a system, which is set up on deforestation, mining and killing although it is obviously destroying the planet Earth. He explains his claims with several examples that wood has more of an economic value than a tree, and the whale meat is worth more than when it is alive. Canadian author and activist Naomi Klein[53] imposes that the leaders in the capitalist system consider climate

46. The New York Times article from 1888 captioned as "Global Warming Has Begun, Expert Tells Senate" mentions that Dr. James E. Hansen, who was a space agency scientist, has told a Congressional committee about rising global temperatures due to carbon dioxide and other pollutant gases in the atmosphere. Following this, Swedish scientist Svante Arrhenius also linked this temperature rise to the coal consumption and mentioned in 1896 that there was abnormal warming on Earth. Since then, the subject has become widely known with numerous articles and news reports stating that energy production by fossil fuels increases the risk of climate change to irreversibly damage our living environment.

47. Rex Weyler, "A Brief History of Environmentalism," Greenpeace International, October 26, 2021, https://www.greenpeace.org/international/story/11658/a-brief-history-of-environmentalism/.

48. New York Times Archive, "Climate Change," Timesmachine (The New York Times, 1851), https://timesmachine.nytimes.com/timesmachine/1945/05/08/issue.html.

49. Inside- a Performance Lecture, Inside- a Performance Lecture (zonecritique.org, 2017), http://www.bruno-latour.fr/node/755.html.

50. Donald Worster. Nature's Economy. San Francisco: Sierra Club Books, 1977.

51. Naomi Klein, This Changes Everything: Capitalism vs. the Climate (London: Penguin Books, 2015).

52. The Social Dilemma (Netflix, 2020).

53. Naomi Klein, This Changes Everything: Capitalism vs. the Climate (London: Penguin Books, 2015).

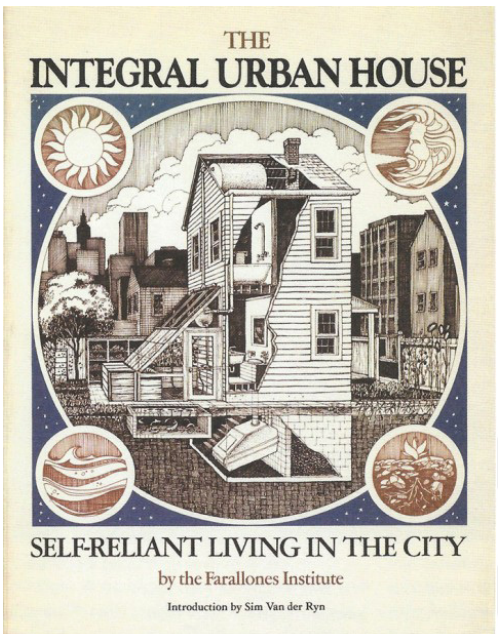


Figure 8: 1974 photos of the Integral Urban House courtesy of the UC Berkeley Environmental Design Archives[57].

change debates as the green trojan horse where a communist manifesto is hidden inside. Researcher Kevin Wehr[54] also explains that environmentalism usually stands for the same meaning of activism in the media as it is the dominant factor of culture.

Political philosopher Felix Guattari[55] states in his work "The Three Ecologies" that "environment, social relations and human subjectivity" are key bonds of ecological interpretation of nature into culture and it is not possible to break the bond between the environment and culture. Therefore, social considerations are extremely important to figure out the roots of the environmental crisis. To incorporate social considerations within sustainability is important as it is related with human perception of space, which could affect the productivity and well-being of users.

At this point Integral Urban House is a great example to explain the importance of human behaviour. Following oil crisis in 1973, there were proliferation of projects to explore energy efficiency within dwellings and Integral Urban House[56] was one of these projects by Farallones Institute in the USA. Although the project aimed to achieve a high level of efficiency by minimising energy needed by passive solar heating and on top of that generating energy, providing food for inhabitants, recycling its wastewater by greywater system and compost toilets; it has failed because of a social response of its inhabitants. Since it has expected a change in daily life and required extra time to run systems within the house, it has not been possible for occupants to fit this routine in their busy urban life.

It is usually challenging to introduce new styles of living for people unless there is popular work or inspiring individuals that are raising awareness on environmental concerns such as Rachel Carson's Silent Spring or publication bodies such as Sierra Club Books and Club of Rome's, which were primary catalysts for climate change awareness in the 20th century.

Although climate change awareness has reached its peak in the 21st century, there are still quite a lot of people who deny the scientific truth. Writer Amitav Ghosh[58] does not totally agree with the term "climate deniers" and offers another phrase of climate "unsayable" because he claims that although these people, such as Donald Trump, knows the truth in climate change (therefore, he still pays money insurance), he lets other less lucky ones to deal with the climate problems not to lose his wealth. Whereas Klein[59] states that climate deniers are not only the ones who ignore the scientific data on climate change and believe that there is nothing wrong with the temperature

54. Kevin Wehr, Green Culture: an A-to-Z Guide (Los Angeles, USA: SAGE, 2011).

55. Félix Guattari, The Three Ecologies (London, UK: Bloomsbury Academic, 2014).

56. Sabrina Richard, "Integral Urban House," Critical Sustainabilities, June 1, 2015, https://critical-sustainabilities.ucsc.edu/integral-urban-house/.

57. Sabrina Richard, "Integral Urban House," Critical Sustainabilities, June 1, 2015, https://critical-sustainabilities.ucsc.edu/integral-urban-house/.

58. David Wallace-Wells, "Amitav Ghosh: 'We Are Living in a Reality That Is Fundamen.Uncanny,'" Intelligencer (New York Magazine, September 30, 2019), https://nymag.com/intelligencer/2019/09/amitav-ghosh-on-our-failure-to-face-up-to-the-climate-crisis.html.

59. Naomi Klein, This Changes Everything: Capitalism vs. the Climate (London: Penguin Books, 2015).

of the Earth. She claims that most of us are somehow fed this anti-climate change belief either directly or indirectly with our unconscious consumption behaviours[60]. Although these people accept the climate change and they are aware of the consequences of it, some still somehow believe that a magical technological improvement will fix the accumulation of greenhouse gases in the atmosphere, or others think that their age is old enough not to see these catastrophic changes, or more pragmatic ones believes that if they have enough money, it will be possible to protect themselves and therefore economic growth is the most important need of the civilization[61].

Within these discussions, it looks like social awareness of environmental issues are in contrast with the economic profit of the majority, although sustainability has claimed to sustain economic growth while developing equal welfare and a healthy environment for individuals. Oxford English Dictionary[62] has described "ecology" as "the science of the economy of animals and plants" until 2008 and ignored the relationship of other living organisms that exist on Earth and the interaction between all of them. Both words of "ecology" and "economy" share the same prefix of "eco-" (oikos in the ancient Greek) meaning home, house, or dwelling, but differentiate with the suffixes where "-logy" (logos) represent the knowledge whereas "-nomy" (nomos) is the management of the household[63]. Through these definitions of etymological roots, activist Satish Kumar[64] claims that ecology should have been the principal factor when compared with economy, because it is the knowledge of the Earth and without this awareness it is impossible to manage it. Whereas Guattari[65] thinks that ecology is primarily about social equality, and inequalities are the key subject to overcome according to Guattari to focus on creating a more sustainable ecology.

Sustainability in Architecture

Jason McLennan[66], who is an architect and a key figure in sustainable construction, describes the evolution of sustainable design in four stages that are respectively "biological, indigenous vernacular, industrial and modern". Although vernacular architecture has passive design solutions to protect the occupants against harsh thermal conditions, industrialization has brought new problems with it that has also caused a paradigm shift in architecture. This shift has been triggered via increase in fossil fuel costs in worldwide eco-

60. Naomi Klein, This Changes Everything: Capitalism vs. the Climate (2015).

61. Ibid.

62. "Ecology," in OED Online (Oxford University Press, December 2020), https://ezproxy.mef.edu.tr:2896/view/Entry/59380?redirectedFrom=ecology#eid.

63. "Economy," in OED Online (Oxford University Press, December 2020), https://ezproxy.mef.edu.tr:2313/view/Entry/59393?redirectedFrom=economy#eid.

64. Satish Kumar, "Ecology and Economy," Pocapoc, August 2018, http://pocapoc.org/wp-content/uploads/2018/08/satish-economy-and-ecology.pdf.

65. Félix Guattari, The Three Ecologies (London, UK: Bloomsbury Academic, 2014).

66. Jason F. McLennan, "The Philosophy of Sustainable Design: The Future of Architecture" (Bainbridge Is. WA: Ecotone Publishing Company, 2004).

nomic crisis conditions during Long Depression between 1873 and 1896; and researcher David Bozsaky[67] states that the invention of thermal insulation materials has been instrumental in decreasing energy consumption in modern buildings via reducing the heat losses. Therefore, it has been the initial attempt to increase energy efficiency in buildings to promote sustainability.

As well as technological progress in building materials, architectural historian Daniel Barber[68] states that passive design principles started to be re-implemented within architectural design in 1928 in iconic examples of modern architecture like Le Corbusier's Villa Savoye or Mies van der Rohe's Villa Tugendhat, and incorporation of these parameters has become at the heart of architectural innovations between two world wars. Following the focus on passive design solutions, the orientation of the building according to position of sun has become important in terms of passive design criteria, and the integration of solar energy systems within architecture has become another alternative to reduce fossil fuel dependency after World War I due to resource scarcity. Barber[69] also states that the American construction industry has approached solar house heating between the 1930s and 1940s as a necessary element because of rising concerns of oil scarcity in relation to increasing energy consumption due to housing shortage in the post war era.

In 1937, MIT received a fund to carry on a 50-year research on exploring solar energy and Solar One[70] has become the first US dwelling project to provide space heating via solar energy when it was completed in 1939. The lessons learnt in Solar One[71]'s heating system's high cost made it impractical despite its effectiveness. There have been five more projects by MIT that have aimed to investigate the integration of solar energy in the heating system of houses and although these projects have failed in some other ways, they have contributed to experience precious lessons on these systems.

Barber[73] claims that there were rising concerns on vanishing resources and increasing energy consumption until the realisation of oil reserves in the Middle East after the late 1950s. However, architect Mirko Zardini[74] proposes in his co-edited book Sorry, Out of Gas that the 1973 Oil Crisis was a breakthrough moment for energy efficiency research in buildings although there were raising awareness starting from the 1960s. McLennan[75] claims that it is possible to link the initial attempt of the green building movement with either Silent Spring or the oil crisis of the 70s; however, the awareness on the subject has fluctuations depending on intensity of severity in scarcity and the firm interest has weakened in the 80s following the fall in the

Figure 9: Solar One[72] by MIT.

67. Dávid Bozsaky. "The Historical Development of Thermal Insulation Materials". Periodica Polytechnica Architecture 41 (2):49-56. https://doi.org/10.3311/pp.ar.2010-2.02.

68. Daniel A. Barber "Tomorrow's House: Solar Housing in 1940s America." Technology and Culture 55, no. 1 (2014): 1–39. http://www.jstor.org/stable/24468396.

69. Barber, "Tomorrow's House: Solar Housing in 1940s America." Technology and Culture (2014).

70. SM '17 Brandon Levy, "The First U.S. House to Go Solar," MIT Technology Review (MIT Technology Review, March 23, 2020), https://www.technologyreview.com/2017/04/25/152254/the-first-us-house-to-go-solar/.

71. Levy, "The First U.S. House to Go Solar," MIT Technology Review.

72. Ibid.

73. Ibid.

74. Mirko Zardini et al., "Think Different," in Sorry, out of Gas: Architecture's Response to the 1973 Oil Crisis, ed. Giovanna Borasi and Mirko Zardini (Canadian Centre for Architecture, 2007), pp. 41-49.

75. Jason F. McLennan, "The Philosophy of Sustainable Design: The Future of Architecture" (Bainbridge Is. WA: Ecotone Publishing Company, 2004).

energy prices. Afterwards, energy conserving buildings from 70s has raised another issue in terms of health and wellbeing, which was called Sick Building Syndrome[76]. Sick Building Syndrome[77] is described as the experience of feeling physical and psychological discomfort by occupants who lived in the 70s energy efficient and air-tight buildings with poor air quality due to inadequate ventilation and contamination from toxic materials such as asbestos. However, sustainability has started to be a rising topic with the start of 90s as concerns on climate change have gathered international organisations together to produce plans to sustain existing resources of Earth[78].

Tools of Sustainability: Environmental Assessment Methodologies

As mentioned above, when the consequences of globalisation on architecture have been affected by the oil crisis and led the industry to focus on energy efficiency, numerous environmental assessment methodologies have emerged since the end of 20th century. In course of time, these methods have evolved into certification systems to classify buildings transparently in terms of sustainability; however, it also created another wheel within the capitalist system. Therefore, to understand the origins and the mechanism behind these systems, I focus on defining the current strategies and principles of selected environmental assessment methodologies for buildings, which are BREEAM, LEED and Passive House. Environmental Assessment Method (BREEAM) by Building Research Establishment (BRE) from the UK is the first methodology to classify buildings in terms of environmental aspects. Therefore, it is crucial to start this research with BREEAM to examine the evolution of an environmental assessment methodology through becoming a certification system. Although BREEAM is the first of its kind, it is only the second commonly used methodology after its US version. According to a study by researchers Luanda Lima[79] et al from Project Development and Management Research Group in Brazil, Leadership in Energy and Environmental Design (LEED) by US Green Building Council (USGBC) is the most accepted certification within approximately 45% of mention in academic literature on sustainability since the 2000s. These two methodologies are the prevailing classification systems around the world for buildings and they claim to provide a holistic approach in environmental design. However, their effectiveness is questionable as they minimise the energy

76. McLennan, "The Philosophy of Sustainable Design: The Future of Architecture" (2004).

77. Sumedha M. Joshi, "The sick building syndrome" Indian journal of occupational and environmental medicine 12, 2 (2008): p. 61-4. doi:10.4103/0019-5278.43262.

78. McLennan, "The Philosophy of Sustainable Design: The Future of Architecture" (2004).

79. Luanda Lima et al., "Sustainability in the Construction Industry: A Systematic Review of the Literature," Journal of Cleaner Production 289 (2021): p. 125730, https://doi.org/10.1016/j.jclepro.2020.125730.

consumption. Aalto University researchers Ali Amiri[80] et al examine 44 articles on effectiveness of LEED in terms of energy consumption and state that especially lower levels of certified buildings does not show a certain proof of energy efficiency savings. This shows that it is not possible to trust the capability of these methodologies in terms of sustainability. Therefore, there are two more methodologies to cover in this section to identify the similarities as well as key different approaches. One of them is Passive House, which steadily becomes more important within the construction industry and policy makers. It only focused on energy efficiency within building fabric, and it provides a visible reduction in energy consumption. Next, I examine three environmental assessment methodologies, i.e. BREEAM, LEED, and Passive House in this section to evaluate their origins.

BREEAM

BREEAM is the oldest methodology used for environmental assessment of buildings, and it has been widely used within Europe either by choice or by city council regulations. Its origins come from BRE (Building Research Establishment) which was founded in 1921 in the UK as a government funded research organisation in chemistry and engineering to search how to improve housing quality for soldiers coming back from World War I[81]. The aim was to explore new methods for the construction industry by research in building materials. Although BRE scientists have mainly focused on the technologies that could be used in World War II, they have returned to their main purpose after the war ended with a serious housing shortage. While BRE scientists refocused on improving construction methods and materials, the authorities were motivated to bring some minimum requirements for new buildings. By the UK government's support, BRE was included in the first building regulations in 1960s[82]. Afterwards in 1985, World Climate Program conference findings have caused BRE to carry on its research on global warming and reducing the UK's carbon emissions. This has led to introduce BREEAM in 1990 to minimise the negative effect of construction industry on environment[83]. In 1997, UK government privatised BRE to become publicly funded body to preserve its independence thus the certification became officially possible for the organisation in 1999, which is followed by globalisation of BRE Certification by 2006[84].

80. Ali Amiri et al., "Are LEED-Certified Buildings Energy-Efficient in Practice?" Sustainability 11 (2019): p. 1672, https://doi:10.3390/su11061672.

81. "History Timeline," BRE Group, February 12, 2019, https://www.bregroup.com/about-us/our-history/timeline/.

82. "History Timeline," BRE Group, February 12, 2019, https://www.bregroup.com/about-us/our-history/timeline/.

83. "History Timeline," BRE Group, February 12, 2019, https://www.bregroup.com/about-us/our-history/timeline/.

In 2021, there are six different BREEAM schemes operated by BRE Global Limited, and these are BREEAM Infrastructure, BREEAM Communities, BREEAM New Construction, Home Quality Mark, BREEAM In-Use, BREEAM Refurbishment. The methodology primarily aims to reduce environmental impact of buildings throughout their life cycle, to add value on sustainable construction and to encourage construction industry by creating a green label[85]. Although the intention of the methodology is to integrate sustainability measures into construction starting from the design stage until the end of the building's life cycle, it also creates a new branch of industry including third party organisations that are specialised to be a BREEAM Assessor and adds extra cost into the construction that is for certification.

LEED

U.S. Green Building Council[86] (USGBC) was founded as a non-profit organisation under American Institute of Architect's (AIA) by firms and individual volunteers from professionals from the building and construction industry in 1993. Rather than implementing the already existing environmental assessment methodology of BREEAM, USGBC committee has decided to create their own customised "building rating system[87]" for the U.S. building industry and published Leadership in Energy and Environmental Design (LEED) in 1998. One of the major differences between BREEAM and LEED was the professions of the members of their founding organisations, unlike BREEAM there were people from various backgrounds such as construction managers, real estate developers, architects, engineers, environmental lawyers, and product manufacturers instead of scientists.

Passive House Institute

Although the Passive House Institute[88] was founded by a German physicist Dr. Wolfgang Feist in 1996 following his pilot project in Darmstadt, Germany, there were numerous early trials within Europe, Canada and the USA since energy efficiency became a hot topic after the 1970s oil embargo. The intention was to provide a living space that does not require any space

84. "Our History," BRE Group, February 12, 2019, https://www.bregroup.com/about-us/our-history/.

85. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016), https://www.breeam.com/BREEAMInt2016SchemeDocument/.

86. Megan Rosa, "Looking Back: LEED History," Sustainable Investment Group, August 11, 2016, https://sigearth.com/leed-history/.

87. Robert Cassidy, ed., "White Paper on Sustainability," White Paper on Sustainability (2003), https://archive.epa.gov/greenbuilding/web/pdf/bdcwhitepaperr2.pdf.

88. Passive House Institute, "About Us," Passivhaus Institut, 2015, https://passivehouse.com/01_passivehouseinstitute/01_passivehouseinstitute.htm.

heating or cooling energy throughout the year like its traditional examples in Chinese architecture[89]. However, Feist[90] explains that the previous zero-energy house trials were unsuccessful because of mainly airtightness problems and insufficient thermal resistance of building elements, and they have tried to overcome these difficulties by constructing a Passive House prototype. Although a similar approach was already existing in Sweden, Feist and his colleagues wanted to produce their own methodology on higher energy efficiency performance with the financial support of the German Government. Therefore, the Passive House is more of an experience-based study of passive design strategies that focuses on energy efficiency performance of a construction when it is compared with BREEAM and LEED.

The methodology is dependent on an Excel spreadsheet called Passive House Planning Package where all measures of a project are entered to calculate total energy consumption of a building. There are training programs that certify architects and engineers to become Passive House Designers, Consultants, Traders, and Certifiers that after support the whole mechanism, which is controlled by the Passive House Institute at the end. There is also a new market of building elements that provide Passive House certified materials to guarantee the performance of the construction. However, this methodology has a narrow perspective that is focused on the energy side of the construction only and ignoring other environmental and sustainability aspects.

89. Wolfgang Feist, "The First Passive House: Interview with Dr. Wolfgang Feist," ed. Katrin Krämer, iPHA Blog, October 9, 2018, https://blog.passivehouse-international.org/first-passive-house-wolfgang-feist/.

90. Feist, "The First Passive House: Interview with Dr. Wolfgang Feist," ed. Katrin Krämer, 2018.

Application of environmental assessment methodologies on Volu-te

02

In this section, I explain the fundamental design decisions and key properties of Volu-te. Afterwards, I evaluate Volu-te from sustainability point of view according to BREEAM as one of the most popular environmental assessment methodologies, and PHPP methodology designed by Passive House Institute to investigate energy efficiency performance. The aim is to analyse Volu-te as an architectural product via two popular methodologies to question the weaknesses and the missing points in terms of the positive ecological impact and negative financial pressure on the project budget. Although LEED is also a common methodology when compared to BREEAM, I use BREEAM International New Construction 2016 Technical Manual[91]. Hence LEED AP architect Gonca Yılmaz stated that it is not possible for Volu-te to comply with LEED, because it does not adhere to the LEED Minimum Program Requirements, which are critical primary factors for a project to be entitled for the certification. One of these rules is that the building should be permanent for its lifetime, whereas Volu-te was designed to be mobile and aimed to be moved when it is necessary to another location. Although BREEAM and PHPP are applicable to be used for Volu-te, there are still many limitations in terms of eligibility of products that are required for the certification and extra financial cost needed to complete the process.

Volu-te: Compact Urban Living

The design aims to create an urban sheltering network with micro living units called Volu-te to provide a temporary accommodation space for young adults. Volu-te claims to offer a minimum space to meet what a human exactly needs to continue daily living activities. It contains adequate space for all basic requirements to sustain daily living activities such as cooking, eating, studying, working, self-cleaning, and sleeping. It provides an accommodation

91. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016), https://www.breeam.com/BREEAMInt2016SchemeDocument/.

53. Juhani Pallasmaa, The Eyes Of The Skin, Chichester: Wiley-Academy, 2005, 40

54. Juhani Pallasmaa, The Eyes Of The Skin, Chichester: Wiley-Academy, 2005, 11.

55. Juhani Pallasmaa, Embodied Image: Imagination and Imagery in Architecture, Chichester: John Wiley and Sons Ltd., 2011, 36.

56. Máire Eithne O'Neill, "Corporeal Experience: A Haptic Way of Knowing," Journal of Architectural Education 55, no:1, March 12: 3-12.

57. Such as Maurice Merleau Ponty, Juhanni Pallasma, Alberto Perez Gomez, Peter Zumthor and Semra Aydınlı

experience for up to 2 people. It can be used hourly, daily, and/or monthly based on the needs of its users. Moreover, it is a compact space and a cylinder-shaped volume, which has 2.5 metre base diameter and 6 metre height. It explores the minimum living area by maximising the efficiency in volume usage and introducing a vertical living experience. It uses the volume with the help of spiral stairs that run by the inner perimeter of the cylinder. As the stairs climb, they create a spot for each action, using the volume vertically in the most effective way with the smallest footprint. Another design consider-

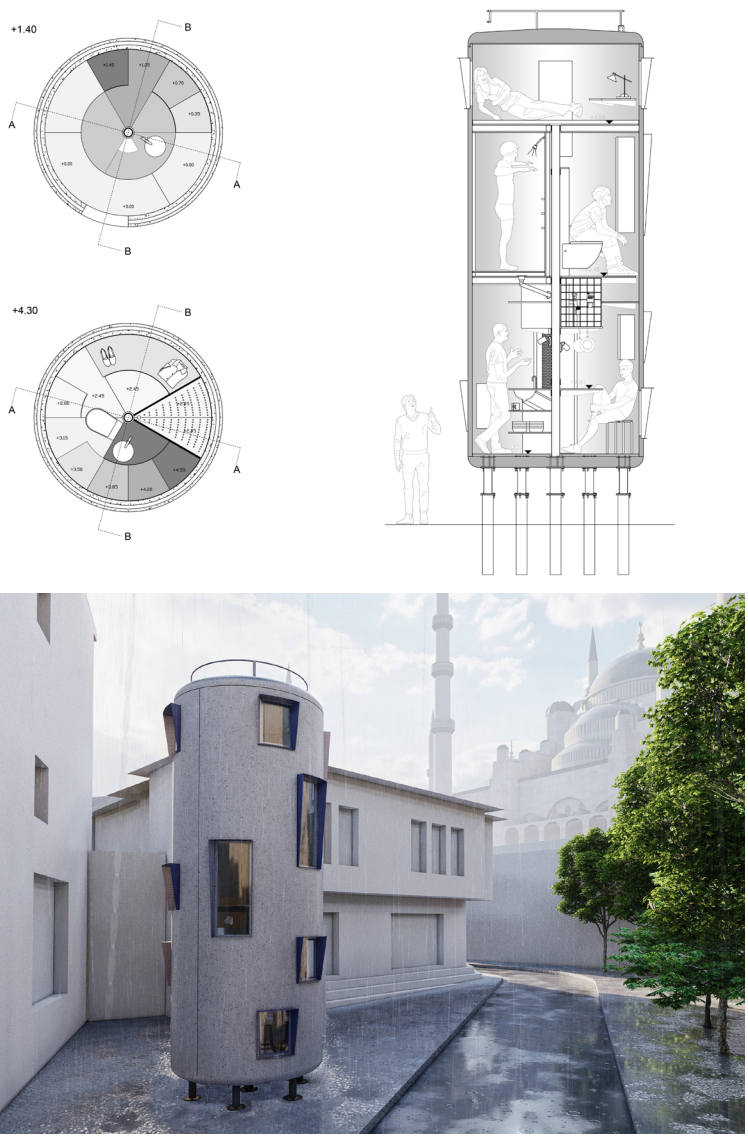


Figure 10: Volu-te section (up-left), plan (up-right), render (down) from outside

ation behind its base diameter is to enable it to transport on motorway and to fit in a container with standard dimensions. With its current dimensions, it can easily fit into a car parking slot on the street or to any other leftover place within the crowded megacities with limited and valuable square metres.

In terms of sustainability, Volu-te has not been designed to meet any environmental assessment methodologies such as BREEAM or LEED; however, it has developed with an environmentally conscious point of view. Social and economic considerations of Volu-te have been to provide an adequate and affordable space to meet their daily needs for young adults such as students, expats, freelancers, and people in transition stage. Environmental consideration has been analysed by evaluating the cycles of the ecosystem around the unit. There have been 4 categories of cycles considered, which were energy, comfort, water, and food. By evaluating four cycles, it has been aimed to evaluate the relationship between Volu-te and its surrounding environment. In addition, the total cost of Volu-te production was aimed to be affordable. To reflect the actual value of the products and services, United States Dollar (USD) has been used and various quotes in Euros or Turkish Lira have been converted from that date to USD for the simplicity of calculations. Below Figure 11 shows the division between cost of building elements, Volu-te has a total cost of $6,000 for its approximately 13 sqm living area.

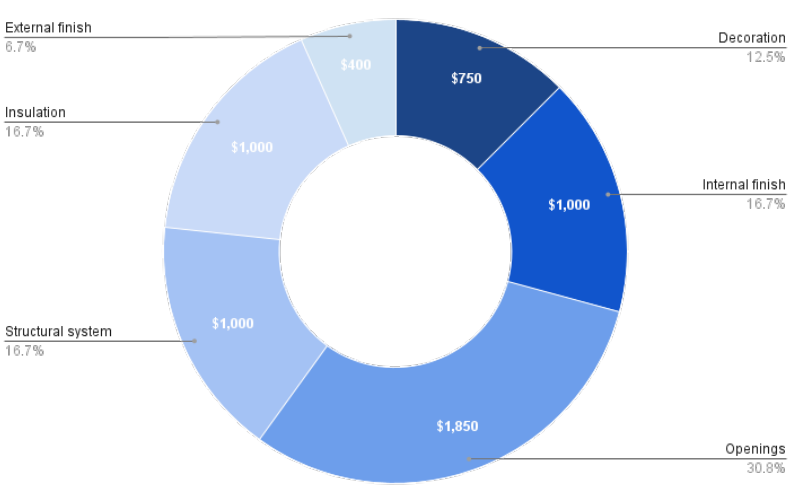


Figure 11: Price division graph of Volu-te.

In addition, the vertical volume of Volu-te allows the flow of natural ventilation through louvres located on the bottom and top levels of the unit.

In winter, fresh air through the bottom louvre is heated via electric heater and warming air rises to the top level. In summer, natural ventilation through open vents provides a cooling effect within the cabin. Two solar panels are located either on top of the unit or near the unit with their own structural elements. The energy generated in summer through sun is potentially much more than the cabin will need; therefore, it can either feed in the grid or could be used as an electric charging spot for electric scooters, bikes, or cars. Whereas, in winter there would be a need for electricity from the grid depending on sunny days. As Figure 12 shows below the estimated amount of energy consumption and generation throughout the year; where light, medium and dark blue bars represent consumption by electrical appliances, water heating and space heating respectively and magenta line stands for energy generation with solar panels.

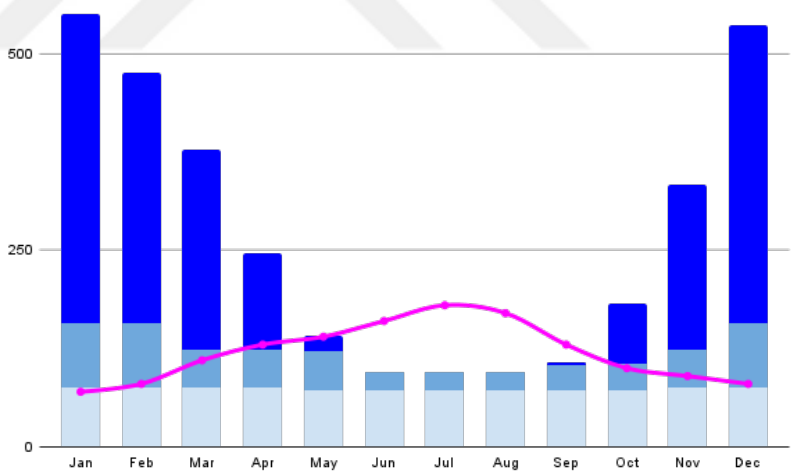


Figure 12: Energy consumption and generation calculations for Volu-te.

The last feature of Volu-te is to be a smart living cabin that is integrated with a mobile application. The occupant has the opportunity to control thermal conditions and lighting appliances, get informed on ventilation and air humidity levels, and even show the energy generated or consumed. Thus, this mobile application interface within the cabin and the application increases its usability. Moreover, it creates a network of shelters within the city; therefore, the user can easily choose which unit to stay depending on its energy backup. Mobile application remembers the data for each user's preferences for next stay in any Volu-te, and it creates the same ambiance.

Assessment #1: BREEAM

BREEAM manual categorises each criterion, which has specified credits for each, under ten sections. These parts are management, health and wellbeing, energy, transport, water, materials, waste, land use and ecology, pollution, and innovation. Energy, health and wellbeing, materials, and land use and ecology sections have the highest weightings; therefore, the most important issues are included in those parts. However, these weightings are different depending on the project type in environmental section weightings. In addition, there are minimum requirements in energy, water, and waste categories to achieve a higher rating level. There are 5 rating levels in total, which are respectively outstanding, excellent, very good, good and pass to qualify for a certification. Minimum requirements to achieve each of these benchmarks are explained under each issue.

Scope of BREEAM Manual includes hotel, residential institutions, and dwellings. At this point, Volu-te is examined as a single dwelling residential unit, which is fully fitted because it includes interior finishes, water fittings, monitoring equipment and all the needed internal items. Therefore, environmental section weightings are as shown in Figure 13, where Health and Wellbeing is the most important section and followed by Energy.

92. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

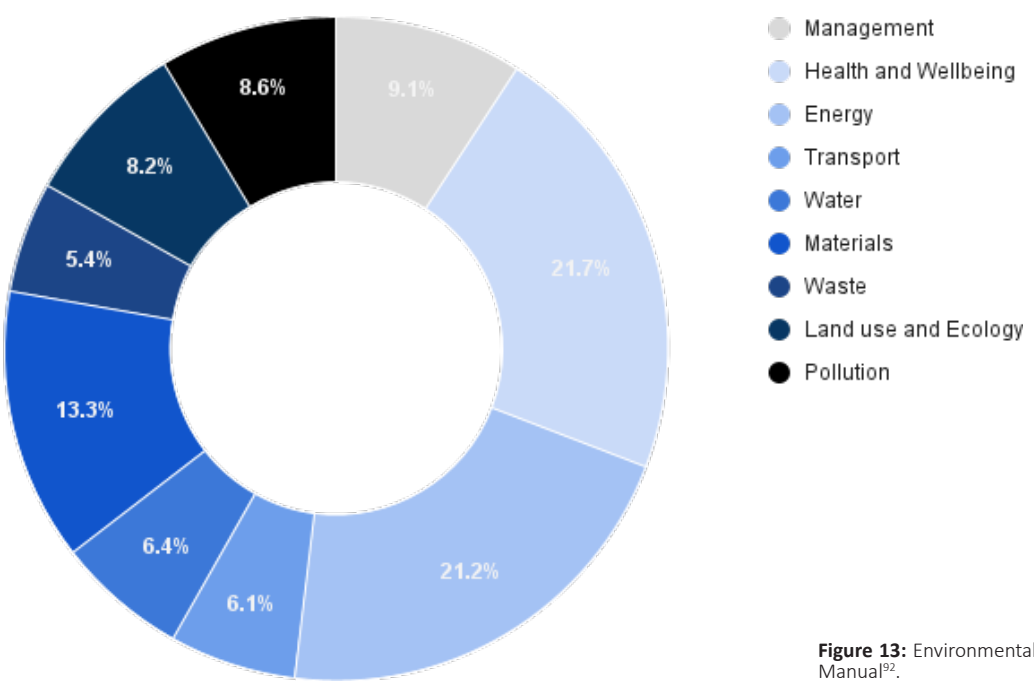


Figure 13: Environmental Section Weightings in BREEAM Manual[92].

Management

Management[93] section includes 5 issues, which are respectively "Project brief and design, Life cycle cost and service life planning, Responsible construction practises, Commissioning and handover, and Aftercare". It focuses on setting milestones to incorporate sustainable management procedures from design stage to after life of the project. There are 3 issues that contain minimum standards. The project must achieve Man03 Responsible construction practices with Health and Safety criterion and must add either 1 or 2 credits on considerate construction to upgrade to excellent or outstanding level respectively. Afterwards, the project must have a building or home user guide under Man04 Commissioning and handover issue to achieve excellent or outstanding as well as Seasonal commissioning credit must be achieved from Man05 Aftercare.

Man 01 Project brief and design is acceptable for all building types including single dwellings. The issue consists of two criteria, which have equal importance, and these are stakeholder consultation and sustainability champion, who could be a BREEAM International New Construction Assessor just for single dwellings. These are both required to act during the concept design stage by including consultants and a BREEAM Assessor into the process. Volu-te has incorporated many people with different backgrounds into the design stage as well as consulted to third parties on various subjects to improve design. However, there was not a BREEAM Assessor involved.

Man 02 Life cycle cost and service life planning is also applicable for all building types, and it consists of setting up a life cycle cost plan from the concept design of the project to provide an economic sustainability. There has been a detailed research stage on building components before the design stage of Volu-te; therefore, this issue is slightly applicable. However, the exact life cycle cost and service life planning would require a more precise background on each material and their life cycle cost analysis.

Man 03 Responsible construction practices[94] is applicable for all building types, it is divided into four parts, which are "Environmental management, Sustainability champion, Considerate, and Monitoring of construction site impacts". In addition, the issue has prerequisite features as all timber and timber-based products must have labels showing that they are legally harvested and traded, and the construction site must fully apply national health and

93. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

94. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

safety legislation and regulations as well. Monitoring site impacts credit is the key one for future in this issue as it collects data such as water and energy consumption and waste monitoring on site during construction for "future BREEAM performance benchmarking"; however, it does not encourage any improvement on these collected data. Therefore, it would mean for the future that future BREEAM performance benchmarking will set the least considered practices as a base line and accordingly it will take a long time to move forward a greener future in construction sites. This criterion would not be suitable for Volu-te as it is produced at the factory and only its final ready-to-use version will be assembled on site.

Man 04 Commissioning and handover is only applicable to single dwellings with one handover credit by developing a home user guide for building occupants. It would be suitable for Volu-te as there will be a responding app for users to improve their interaction with the unit. Although it is extremely important for a building to perform as it is designed in terms of energy efficiency, this issue ignores testing and inspecting building fabric criteria for single dwellings. Man 05 Aftercare has two credits available for single dwellings, one in aftercare support to introduce the building and services to the occupant for an easy acclimatisation time, and one in seasonal commissioning within the first year of occupation to get occupant feedback. This issue as well is suitable for Volu-te as the mobile app will be used for both reasons either to guide users or collect occupant data anonymously.

In summary, Management section would not bring neither any additional cost nor any ecological improvement on Volu-te; however, it would ensure an efficient management of design and construction of the project with the participation of all stakeholders.

Health and Wellbeing

Health and Wellbeing[95] section includes 9 issues, which are "Visual comfort, Indoor air quality, Safe containment in laboratories, Thermal comfort, Acoustic performance, Accessibility, Hazards, Private space, and Water quality". It aims to provide comfortable, healthy, and safe internal conditions for occupants within the design of the proposed project. There are 5 criteria in this section to consider for minimum standards. Hea01, Hea02 and Hea09

95. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

are obligatory parameters for every project to achieve any rating of BREEAM certification. These obligatory parameters are respectively High frequency ballast, No asbestos and Minimise legionellosis risk criteria that each project has to comply with no matter what rating the project is aimed to achieve. In addition, Inclusive and accessible design on Hea06 Accessibility and Private space on Hea08 are criteria that must be achieved for an outstanding level.

Hea 01 Visual comfort is applicable for all building types; and it has a prerequisite that requires all fluorescent and compact fluorescent lamps to have high frequency ballasts. However, this criterion is not applicable for single dwellings as well as glare control and view out criteria. There are only two available criteria for single dwellings within this issue that are daylight, and internal and external lighting levels, zoning, and occupant control. In Daylighting, available credits for residential dwellings could be achieved in the kitchen and/or living room by maintaining average daylight factor levels given by BREEAM. In Volu-te, there are no separation walls; therefore, the volume could be evaluated at once according to assigned tasks on each level and allocated window openings for these spots. Through the design process, these openings are carefully considered to let daylight in for each individual action within the unit; however, no such daylight calculations have been carried out. In addition, there was not a lighting strategy designed by a lighting consultant for internal and external lighting levels, zoning, and control. Although visual comfort parameters have already been examined within the design of the unit because the professional consultation is missing, it is not possible to prove that it works or not. To prove this, the third-party consultancy quote has been gathered and the extra cost needed for daylighting analysis and lighting strategy has been included in the total BREEAM consultancy fee.

Hea 02 Indoor air quality is applicable for all building types and has a prerequisite, which requires all building elements to be free of asbestos. Criteria such as indoor air quality plan and post-construction indoor air quality measurement to check levels of contaminants such as VOCs and formaldehyde are excluded for single dwellings. However, it still pushes for an improved indoor air quality by natural ventilation and encourages designers for detailed consideration of material selection by pollutants such as VOCs emissions. Volu-te has an advantage of its vertical volume that enables natural ventilation. It enables fresh air to enter the unit by louvre and window openings on the bottom level and circulates it out via openable windows that are located through as the unit rises. This provides a flow of fresh air and improves air

quality within the unit. In addition, extra attention on emissions from building elements would improve the design of Volu-te; however, it is challenging to request VOCs or formaldehyde levels of materials from suppliers.

Hea 03 Safe containment in laboratories is not applicable for residential buildings; therefore, it will be avoided in this study. In contrast Hea 04 Thermal comfort is applicable for all building types. It aims to improve thermal comfort by conducting a thermal modelling, foreseeing the future climate change scenarios, and maintaining thermal zoning and controls. Although it is possible to claim that Volu-te has been designed with consideration of improving thermal comfort of its occupants via implementing passive design measures, there is not a thermal comfort modelling to prove it. It also has not been tested for future climate scenarios; however, it has flexible elements such as openable windows and an energy efficient building façade to protect the unit from extreme weather conditions. In addition, temperature of the unit will be available to control via the mobile app so that the occupants can adjust internal conditions according to their preferences. However, there is no attribution and correlation between thermal comfort and visual comfort issues even though they are mingled with contrast that specifications and dimensions of windows are the primary factor in terms of determining both the daylight levels and thermal comfort levels especially in summer.

Hea 05 Acoustic performance is available for single dwellings and requires an acoustic performance testing by an acoustician to improve acoustic performance in habitable living areas. Although it is possible for Volu-te to comply with this issue, the prerequisite makes it difficult as it demands early design advice on external sound levels, and internal acoustic improvements. However, there were not any appointed acousticians during the concept design of Volu-te. The cost of acoustician advice and post-construction acoustic testing requires approximately $1,000 of extra budget.

Hea 06 Accessibility only requires single dwellings to comply with the checklist Lifetime Home criteria for inclusive and accessible design. Unfortunately, this issue is not suitable for Volu-te as its living area is located around a spiral staircase and the usable floor area does not meet the requirements for accessible circulation.

Hea 07 Hazards requires a risk assessment during the design stage of the project for potential natural hazards that could be affected in the future. Volu-te is prepared for this issue as there had been a consultation meeting with structural engineers on the stability of the unit during natural hazards

such as earthquake or fire. All structural calculations of the unit including its foundation have been designed according to this consultation.

Hea 08 Private space aims to provide occupants a private external space such as balcony, patio, terrace, or garden. However, this would be challenging for Volu-te to comply with because of its micro-structure. It only provides a sitting element for two people on the outside of its shelter. In addition, the project is usually designed to be located on communal spaces, public areas, or car parking slots; therefore, it does not have an excessive external space for private use.

Hea 09 Water quality is obligatory for every project that seeks to achieve any BREEAM rating. It aims to secure the source of water to be free of any contamination. Building services water systems criterion requires a considered design of water system within the unit. Volu-te will be connected to the grid; therefore, it will be safe for occupants. Moreover, there will be a filter in the kitchen tap, which will make it possible for drinking. This aspect will also make Volu-te suitable for the second criterion of the issue, which demands fresh drinking water for occupants.

In conclusion, the Health and Wellbeing section in BREEAM would open a discussion on VOCs, accessibility, and private space of Volu-te, and it would provide an opportunity to the project for potential improvements on these subjects. However, they were discussed and already accepted as weak spots of the design. On the contrary, if we would want to prove our sustainability consideration through BREEAM certification, then we would have to appoint a lighting consultant, an indoor air quality specialist, a thermal comfort modelling specialist, a suitably qualified acoustician, and a specialist on hazards, as well as a BREEAM Assessor.

Energy

Energy[96] section includes 9 issues, which are “Reduction of energy use and carbon emissions, Energy monitoring, External lighting, Low carbon design, Energy efficient cold storage, Energy efficient transport systems, Energy efficient laboratory systems, Energy efficient equipment, and Drying space”. It aims to encourage the project for sustainable use of energy.

Ene01 Reduction of energy use and carbon emissions is the most im-

96. “BREEAM International New Construction 2016 Technical Manual,” BREEAM (BRE, 2016).

97. “BREEAM International New Construction 2016 Technical Manual,” BREEAM (BRE, 2016).

portant issue in the whole of the BREEAM methodology as it evaluates energy consumption of a building. However, the minimum standard is only applicable if the project wants to be awarded by excellent or outstanding. In these situations, six or ten credits must be achieved to get excellent or outstanding respectively. In addition, First sub-metering credit from Ene02a Energy monitoring is required to get very good or above.

Ene 01 Reduction of energy use[97] and carbon emissions gives two options to represent energy reductions for the project. These are either calculating energy performance ratio (EPR) by modelling the building's energy demand, primary energy consumption, and CO2 emissions or going through an energy efficient features checklist. The first option requires a suitably qualified energy modelling engineer to conduct all energy calculations for the proposed project. Building's energy model is required to provide three performance indicators of heating and cooling energy demand (MJ/m2), primary energy consumption (kWh/m2), and the total resulting CO2 emissions (kgCO2/m2). Afterwards, energy performance ratio is calculated by comparing the results with the notional building and BREEAM best practice building results. While concluding the results local building regulations create the baseline. In the second option, the energy efficient features checklist includes 6 parts, which are lighting, water heat generator efficiency, low and zero carbon technologies, building fabric, space heat generator efficiency, and cooling and ventilation. The project is considered according to these items in the checklist and collects credits. Although Volu-te's energy consumption has been calculated by Passive House methodology to shape initial concept design, it is not an acceptable method of energy modelling simulation software in terms of BREEAM. Therefore, either an energy modelling had to be completed or a suitably qualified energy modelling engineer must use a BREEAM checklist to examine the building's energy efficient design features. These items would add an extra cost to the total BREEAM consultancy quote as it will be included within the package.

Ene 02 Energy monitoring issue is divided into 2 sections, where Ene 02b is for residential only. It aims to encourage occupants to keep the track of their energy data by monitoring devices. Volu-te's energy will be available to be monitored via the app; therefore, this criterion is already suitable. Ene 03 External lighting is applicable for all building types, and it requires either no need for external lighting by design or energy efficient external lighting for the proposed buildings. This is also a neutral impact on Volu-te as it will only have

an energy efficient external lighting fitted with a motion sensor on its external door to guide occupants when they are entering or exiting the unit.

Ene 04 Low carbon design is applicable for all building types. It is divided into two parts, which are passive design and low or zero carbon technologies. Passive Design requires both passive design analysis on thermal comfort and reduction of energy consumption, and implementation of free cooling strategies via natural ventilation during the concept design stage. There are criteria that passive design analysis should cover such as site location, site weather, microclimate, building layout, building orientation, building form, building fabric, thermal mass, or other fabric thermal storage, building occupancy type, daylighting strategy, ventilation strategy and adaptation to climate change. Majority of these parameters have been discussed during Passive House calculations; therefore, it has a neutral impact on Volu-te. Free cooling strategy is neutral impact as well because of the already implemented natural ventilation strategy within the unit. Low or zero carbon (LZC) feasibility study has been done by simple research by the design team, which has concluded with the use of solar panels as a renewable source of energy. The calculations from these panels are done by engineers working at the solar panel seller company. However, BREEAM[98] requires a feasibility study on the subject to cover at least energy generated from LZC energy source per year, carbon dioxide savings from LZC energy source per year, life cycle cost of the potential specification and accounting for payback, local planning criteria, including land use and noise, feasibility of exporting heat or electricity or both from the system, any available grants, all technologies appropriate to the site and energy demand of the development, reasons for excluding other technologies, and where appropriate to the building type, connecting the proposed building to an existing local community CHP system or source of waste heat or power. Therefore, a feasibility study by an energy specialist would add an extra cost to the total cost of BREEAM consultancy quote at this criterion.

Ene 05 Energy efficient cold storage and Ene 07 Energy efficient laboratory systems are only applicable for non-residential buildings; therefore, it will not be evaluated in this research. In addition, Ene 06 Energy efficient transport systems is applicable for all building types; however, it is not suitable for Volu-te as it will not include any lift, escalator or moving walks. Contrarily, Ene 08 Energy efficient equipment and Ene 09 Drying space are applicable for residential buildings, and they are also suitable for Volu-te. Ene 08[99] requires identification of energy consumption from all domestic-scale appliances and

98. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

99. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

demonstration of a meaningful reduction by using products with high energy efficiency performance according to EU Energy Efficiency Labelling Scheme. Volu-te will only have a micro fit-in fridge, an electric space heater and water heater, single induction hob, iron and hair dryer, and these appliances will have a rating more than A+. Therefore, this criterion is achievable and has no impact on reducing energy consumption for Volu-te. Moreover, Ene 09 requires a minimum of 2m drying line in internal or external space. However, Volu-te will not have any washing machine and as a matter of course there will not be any drying line.

In summary, it is promising for BREEAM to encourage projects to achieve positive carbon via Ene 01; however, it is not an obligatory issue unless the project aims to get an excellent or outstanding labelling by BRE. Therefore, it is not possible to claim that the certification guarantees a reduction on energy consumption of the project. In addition, the whole section requires an energy specialist and an energy modelling engineer to evaluate the proposed design, which would add an extra cost to the project budget while it is uncertain if it will improve the project in terms of sustainability. The rest of the issues have no impact on Volu-te as they were either unapplicable for it or they are already discussed and implemented within the design. However, they have potential to improve an ordinary traditional construction.

Transport

Transport[100] section includes 6 issues, which are "Public transport accessibility, Proximity to amenities, Alternative modes of transport, Maximum car parking capacity, Travel plan, and Home office".

Tra 01 Public transport[101] accessibility is divided into two parts, which are a measure to show density of the public transport network called accessibility index and dedicated bus service. It aims to advocate the use of public transport to reduce carbon emissions via individual vehicles. Accessibility Index (AI) has the primary criterion within the issue as it brings more credits than dedicated bus service criterion. BREEAM Tra 01 Calculator is used to calculate AI, which is dependent the distance in metres from the main building entrance to each compliant public transport node, the public transport types serving the complaint node, and the average number of services stopping per

100. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

101. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

hour at each compliant node during the operating hours of the building for a typical day. Where there is not a strong public transport connection to the proposed site, then dedicated bus service could be used for the issue. However, the current proposal of Volu-te is in Sarıyer, which is at the busy business centre of Istanbul. Therefore, the issue is easily achievable for it, and it does not have a positive ecological impact for the specified project.

Tra 02 Proximity to amenities is also applicable to all building types and this one is about nearby facilities to the proposed development area. For instance, distance to supermarket, cash machine, sports centre, pharmacy, schools, and public spaces affects the score. Volu-te will be located at the front garden at MEF University and within 500 m diameter there is also a shopping centre, which includes restaurants, theatre, ATM, supermarket, and pharmacy. Therefore, this issue is easily achievable for Volu-te. For the alternative sites it can be located in, this issue needs to be evaluated case by case. Tra 03b Alternative modes of transport includes criteria for residential only and aims to lower carbon emissions of occupants on transport by proposing alternative options such as encouraging cycling or public transport or providing electric charging stations. Volu-te will have an outdoor cycle space and an electric charging point on the outside of the unit; therefore, it is already suitable to achieve this issue.

Tra 04 Maximum car parking capacity is only applicable for non-residential and residential institutions such as care homes and dormitories. The issue aims to discourage the use of private cars and Volu-te does not provide any space for parking; therefore, it is still parallel with the idea. Likewise, Tra 05 Travel plan is not applicable for single dwellings. However, it supports the design team to consider the future occupants travel plan from the concept design stage to reduce carbon emissions and encourage low carbon travel options such as walking, cycling, or using public transport. In contrast, Tra 06 Home office is only acceptable for residential, and it aims to create enough space for a study area within dwellings so occupants could reduce the need of travelling for work. The working area must meet the minimum requirements to achieve the issue, these parameters are basic needs to work such as power sockets, adequate daylight, and ventilation. Volu-te has a working area with these minimum features; therefore, it is suitable to comply with the issue.

In summary, these issues in the Transport section would bring a careful consideration within the feasibility studies before concept design and provide a better solution to minimise carbon emission via vehicles for occu-

pants. However, Volu-te is already located in the city centre would not benefit much from the section, indeed it has the potential to be buffer points that will provide higher scores ready on the plate and it might encourage responsible authorities to lose focus on crucial points such as energy, water, and health and wellbeing.

Water

Water[102] section includes 4 issues, which are "Water consumption, Water monitoring, Water leak detection and prevention, and Water efficient equipment". It aims to encourage building occupants to use water sustainably. There are minimum standards in Wat01 and Wat02 issues. Wat01 Water consumption issue must be achieved either with 1 credit to get very good or excellent, or 2 credits to get outstanding. Moreover, Criterion 1 Mains water metre from Wat02 Water monitoring must be included into the project to be awarded good or above.

Wat 01 Water consumption is applicable for all building types. It requires the calculation of daily water consumption in litres per person, and the usage of water recycling systems. Water components are examined according to their consumption levels of water, and in a contrast relationship where components with lower water volume represent the higher performance level. Afterwards it expects the building to show reduction in water consumption depending on the classified zones by BREEAM that correlates with Köppen[103]'s climate classification system. The Köppen Climate Classification System is one of the most widely recognized environment arrangement frameworks, which is utilised to indicate different environment districts on Earth founded on nearby vegetation. According to this classification system, Istanbul is in Zone 2, which is for dry summer and winter seasons. Therefore, Volu-te should achieve a 65% reduction of water consumption over the baseline performance for an exemplary level. This criterion is useful in terms of taking designers' attention to water related components to make decisions by comparing their efficiencies. These appliances are not chosen for Volu-te, yet. However, there will be careful consideration on the subject when choosing the water equipment.

Wat 02 Water monitoring is applicable for all building types, and it

102. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

103. National Geographic Society, "Köppen Climate Classification System," National Geographic Society, September 9, 2019, https://www.nationalgeographic.org/encyclopedia/koppen-climate-classification-system/.

has a minimum requirement of locating a water metre on the mains water supply. Volu-te meets the criterion by its water metre and it also allows users to track their water consumption through the mobile application.

Wat 03 Water leak detection and prevention is applicable for all building types. However, it is less challenging for dwellings as it only requires isolation valves to control water supplies easily. This is already included in Volu-te. In similar, Wat 04 Water efficient equipment is applicable for all building types, and it aims to reduce water consumption by selecting efficient water fittings. Volu-te meets this criterion as all water fittings have been selected carefully to minimise consumption. The issue also requires a specific parameter for single dwellings with gardens to have a water butt located in the garden to harvest rainwater; however, in general it is unknown for Volu-te to have a garden or not, and in the current scenario it is in the university's garden therefore the responsibility is on the university.

In summary, the Water section encourages project instructors to carefully consider water consumption and provide efficient equipment within buildings. There are extra costs of the greywater system and rainwater harvesting; however, these were already considered during the design stage. Therefore, it is beneficial for the project to have encouraging specifications for water appliances.

Materials

Materials[104] section includes 6 issues, which are "Life cycle impacts, Hard landscaping and boundary protection, Responsible sourcing of construction products, Insulation, Designing for durability and resilience, and Material efficiency". It aims to bring attention to the selection of building materials by considering their life cycle. In Mat03 Responsible sourcing of construction products, Criterion 1 Legal timber is mandatory for any BREEAM rating.

Mat 01 Life cycle impacts is applicable for all building types, and it requires projects to measure the impact of materials on the environment during their life cycle via Life Cycle Assessment (LCA) tool and BREEAM Mat 01 calculator. Life Cycle Assessment[105] (LCA) aims to analyse emissions on different material selections and to manage resources of a production efficiently. The issue also requires a minimum of 5 materials to have environmental prod-

104. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

105. Guinée Jeroen B. et al., "Life Cycle Assessment: Past, Present, and Future," Environmental Science & Technology 45, no. 1 (2011): pp. 90-96, https://doi.org/10.1021/es101316v.

uct declarations (EPD) from the design stage to the post-construction. Volu-te does not have LCA done for its building elements or EPDs. Therefore, it would not achieve these criteria and BREEAM would add a positive impact on the project at this point. It also does not require a specialist consultation; however, the calculations need specific information on estimation of quantities of building materials and environmental impact of these materials in terms of kgCO2e. Relatively, paid LCA calculators are getting very popular rather than using BREEAM Mat 01 calculator. In addition, Mat 02 Hard landscaping and boundary protection and Mat 04 Insulation are not standalone issues in this version of BREEAM, and they are included within Mat 01. Therefore, they will be ignored.

Mat 03 Responsible sourcing of construction products is applicable for all building types, and it has a prerequisite of all timber products to be legally harvested and traded. Following compliance with this primary condition the issue contains two criteria, which are sustainable procurement plan and responsible sourcing of construction products. It requires the design team to make initial decisions in favour of materials, which has responsible sourcing and to prepare a procurement requirements plan. In Volu-te, only timber-based products are plywood used for internal finish material and they are labelled as legally harvested and traded. However, there was not any procurement requirements plan at the design stage as well as responsible sourcing of building elements was not the primary decision-making parameter in terms of material selection. Therefore, this issue would have potential to improve design and differentiate material research from the initial design stage.

Mat 05 Designing for durability and resilience is applicable for all building types. It has two parts such as protecting vulnerable parts of the building from possible damages related to vehicles or high pedestrian traffic and protecting exposed parts of the building from material degradation caused by environmental factors. However, only damages from material degradation are applicable to single dwellings as material degradation effects such as corrosion, dimensional change, fading or discolouration, rotting, leaching, blistering, melting, salt crystallisation and abrasion caused by environmental agents, biological agents or pollutants are important as they impact of the building's lifetime in terms of selected elements. Careful consideration of these effects on selected building elements of Volu-te would be very beneficial and they would improve design in a positive way in terms of sustainability.

Mat 06 Material efficiency is also applicable for all building types,

and it aims to show a detailed consideration of material selection starting from the design stage. Therefore, it focuses on the proven efficiency of selected building elements. Volu-te has based its building element selection on detailed research on materials in terms of preferring the most efficient one. Therefore, this issue is already covered during the design stage of it.

In summary, Material section does not add an extra cost to project budget and in contrast it is very useful in terms of increasing sensitivity on lifetime of building elements including their efficiency, responsible sourcing and material degradations caused by environmental factors.

Waste

Waste[106] section includes 6 issues, which are "Construction waste management, Recycled aggregates, Operational waste, Speculative finishes, Adaptation to climate change, and Functional adaptability". There are two issues that are obligatory to achieve outstanding rating, which are Wst 01 Construction waste management and Wst03 Operational waste.

Wst 01 Construction waste management is applicable for all building types. The issue is divided into two parts, which are construction waste reduction and diversion of resources from landfill. It aims to reduce construction waste produced during activities such as demolition or excavation. However, there is not any need for the demolition process for Volu-te as it is located on an empty area and its foundation has been constructed with 6 load bearing pile feet and the area is covered up with the soil extracted first. In addition, the unit is designed to be produced at the factory conditions with minimised waste production through careful arrangement of building elements from the design stage. Wst 02 Recycled aggregates is also about construction waste management, and it is applicable for all building types. The issue aims to maximise the recycling of aggregates. However, it is not suitable for Volu-te as there will not be any aggregate production on construction sites. Volu-te also projects to be easily disassembled to be carried to any other side, wherever it will be needed; therefore, it aims to eliminate leaving any damage or waste behind itself.

Wst 03 Operational waste is covered under two separate issues for non-residential and residential projects. Volu-te will be evaluated as sin-

106. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

gle dwelling; therefore, this section only examines residential parts. The issue aims to provide adequate storage for household waste, and it contains two criteria, which are recycling and composting. In recycling, it requires an external space with the volume of 100L for recyclable, non-recyclable and non-compostable household waste, and an internal space of minimum 7L bins with at least 3 of them are for recycling materials such as paper, cardboard, plastics, glass, metals (tins and cans), textiles (clothes and shoes), vegetable oils (from kitchen), and batteries. In composting, it requires an external space for composable household waste with an informative leaflet that could encourage and guide occupants on how to do it.

Wst04 Speculative finishes are only applicable for offices and multiple dwellings only and Wst06 Functional adaptability for non-residential; therefore, these two issues are excluded in this section. Whereas Wst05 Adaptation to climate change is applicable for all building types and it is possibly one of the most important issues to evaluate potential problems that a building could face in the future against extreme weather conditions caused by the current climate crisis. It requires a systematic risk assessment for the project to see if the building can mitigate future risks. It is important for Volu-te to consider this criterion under the risk of drought as Mediterranean region is expected to face dangerously dry seasons due to decreased rainfall in the upcoming future[107].

In summary, the Waste section shows that it will bring awareness to the design especially in terms of providing recycling bins within the interior space and it will encourage occupants for separation of waste and composting. In addition, adaptation to future climate scenarios has a positive impact on the design. Therefore, the issue has key suggestions to the design although it does not add much on top of the total cost of the project.

Land Use and Ecology

Land use and ecology[108] section includes 5 issues, which are “Site selection, Ecological value of site and protection of ecological features, Minimising impact on existing site ecology, Enhancing site ecology, and Long-term impact on biodiversity”.

107. David L. Chandler, “Why the Mediterranean Is a Climate Change Hotspot,” Phys.org (Journal of Climate , June 17, 2020), https://phys.org/news/2020-06-mediterranean-climate-hotspot.html.

108. “BREEAM International New Construction 2016 Technical Manual,” BREEAM (BRE, 2016).

LE01 Site selection is applicable for all project types, and it aims to reduce the use of untouched lands. The issue is divided into two parts: previously occupied land and contaminated land. The project gets awarded according to its ratio of the proposed project area over the previously developed land. In contaminated land, it gets more complicated as the project gets awarded; however, it is also required to prove the remediation of the land. Unfortunately, Volu-te does not comply with this issue because its current site is located in the garden of MEF University due to it being a university project. However, Volu-te is aimed to be placed on leftover spaces in an urban context; therefore, it aims to repurpose the previously developed land.

LE 02 Ecological value of site and protection of ecological features is suitable for all building types. Ecological value of the site requires either the completion of BREEAM checklist or a suitably qualified ecologist report to define the proposed land as 'land of low ecological value'. The BREEAM checklist includes parameters such as if the construction zone is located within 100 metre of any conservation area such as woodland, water courses, wetlands, or grassland. In addition, protection of ecological features requires all stages of construction to protect existing ecological features within the proposed site, and apply recommendations clarified by the ecologist. Although the issue gives opportunity to carry on with the detailed documentation of ecological features done by the design team, it is still challenging to complete it without the ecologist’s examination.

LE03 Minimising impact on existing site ecology is not applicable for this version of BREEAM. Next issue LE 04 Enhancing site ecology is applicable for all building types, and it is a visionary issue in terms of aiming to improve ecological features within the construction site. It is divided into two parts, which are the ecologist's report and recommendations and increase in ecological value. These two criteria must be completed by the ecologist that is appointed to the project. However, it is not possible for Volu-te to comply with these issues as there is not an exact location for the project and ecological surroundings might change in every location.

LE 05 Long term impact on biodiversity is also applicable for all building types. It aims to consider the effect of the proposed building on its surrounding environment in a longer period. It again requires an ecologist to carefully evaluate the site and come up with a habitat management plan. This issue is also important to bear in mind the potential risks that the proposed development could carry on to the site and the whole ecosystem around it.

For instance, the risk of bird-window collisions is extremely important for high rise buildings in the city centre. The article, written by Dezeen's editorial assistant on architecture Lizzie Crook[109], states that approximately 35 million birds die only in the UK due to collision with buildings each year. However, BREEAM does not give an exact instruction on the subject and leaves it to the ecologist. Therefore, it is unknown what else could be important to consider in terms of protecting the current ecosystem.

In summary, Land use and ecology requires an ecologist for site survey, recommendations, ecology report and management plan that would add an extra cost on top of the project budget. These criteria are important to identify and improve the project site's ecological value; however, Volu-te offers flexibility in terms of its location. It is an architectural product, which is not distinct according to its surroundings. Therefore, it is challenging to aim for an on-site ecologist for each location that it will be carried on.

109. Lizzie Crook, "Glass Facades Are 'the Main Culprit' for Billions of Annual Bird Deaths," Dezeen, March 11, 2022, https://www.dezeen.com/2022/03/09/glass-collisions-bird-deaths/.

110. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

Pollution

Pollution[110] section includes 5 issues, which are "Impact of refrigerants, NOx emissions, Surface water run-off, Reduction of nighttime light pollution, and Reduction of noise pollution". It aims to prevent the project site from the pollution caused by the building. Pol 04 Reduction of nighttime light pollution and Pol 05 Reduction of noise pollution are not applicable for single dwellings; therefore, they is not analysed in this section.

Pol 01 Impact of refrigerants is applicable for all building types; and it aims to reduce the leakage from refrigerants used within building heating or cooling systems to accordingly minimise greenhouse gas emissions. The issue has options for buildings with or without refrigerant. Volu-te will only have an electric heater for both space heating and water heating systems; therefore, there will not be any use of refrigerants and all credits will be available. Similarly, Pol 02 NOx emissions is applicable for all building types; however, this time it is for buildings using NOx emitting heat systems such as boilers. Therefore, Volu-te can be awarded with all credits.

Pol 03 Surface water run-off is applicable for all building types. It is divided into three parts, which are flood risk, surface water run-off, and minimising watercourse pollution. Flood resilience requires a site-specific flood risk as-

sessment that evaluates the potential risk of flooding on site. Surface water run-off also requires a consultation report on potential risk of flooding caused by local drainage system failure. In single dwellings it also encourages to increase permeable areas so that it can minimise the risk of flooding. Minimising watercourse pollution includes a drainage plan completed by an appropriate consultant. Volu-te will have feet that raise it above ground level to protect against the risk of flooding. Moreover, it has a micro footprint to minimise the reduction in permeable area. Therefore, this issue does not bring any improvement in design.

Pollution section does not improve Volu-te in terms of sustainability and it also adds up on top of the project budget with flood risk assessment and drainage plan.

Innovation

Innovation[111] section does not include issues like other sections; however, it creates flexible ground for any new technology or methodology to improve sustainability score of the project. It awards projects that go beyond the issues above.

In summary, when Volu-te is evaluated via BREEAM International New Construction 2016 Technical Manual, there is a requirement to include various consultancies into the either design or construction processes. Therefore, on top of the actual BREEAM consultancy and certification cost, there is a reasonable amount of budget needed for consultancies. For such a small project, BREEAM consultancy, certification, daylight analysis and artificial lighting strategy, thermal modelling with future climate scenarios, energy modelling and net zero feasibility study, and consultation on greywater system and rainwater harvesting would be met by a BREEAM Consultancy firm and it would cost approximately $16,000. Other consultancies of acoustic advice and calculations of airborne and impact sound insulation levels, and adaptation to climate change structural and fabric resilience risk assessment would cost an extra of $1,000 for each item and it would increase total cost of BREEAM labelling for Volu-te to $18,000.

111. "BREEAM International New Construction 2016 Technical Manual," BREEAM (BRE, 2016).

Assessment #2: Passive House Planning Package

Passive House (PH) methodology is less comprehensive on environmental aspects when compared to BREEAM and LEED assessments; however, it is more precise on energy reduction as it requires buildings to minimise their heat loss through building fabric with super insulation and strict airtightness. The process of Passive House starts with energy calculations of the very basic design discussion, carries on with construction quality tests, and ends with the final post-construction verification. Therefore, it assures an impressive reduction in energy consumption.

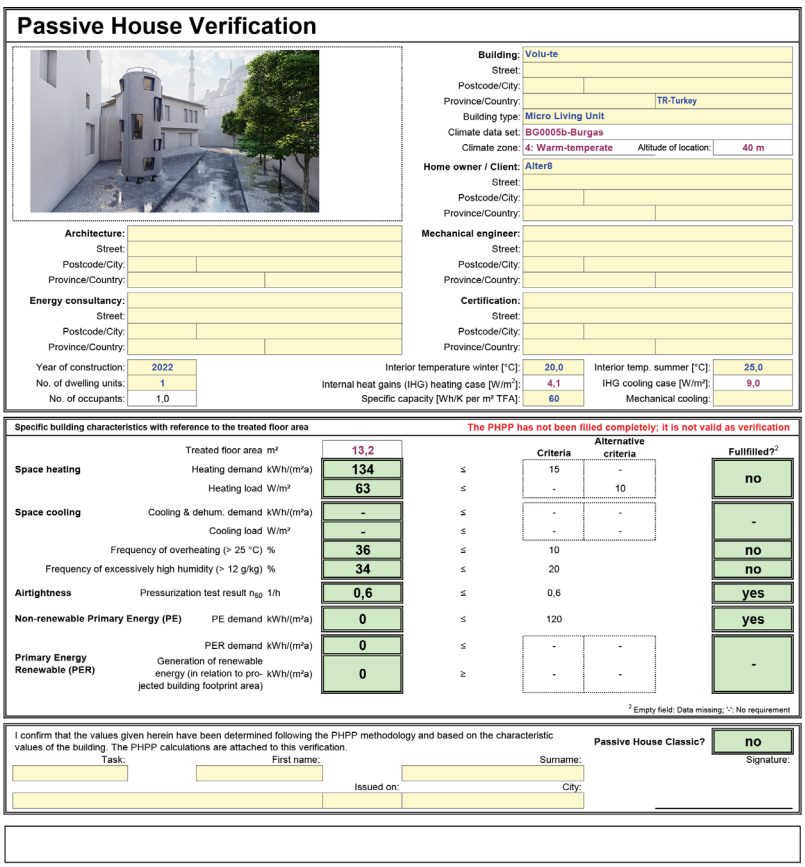
Passive House methodology is based on calculations made on a fill-out Excel document called Passive House Planning Package[112] (PHPP). As a result of these calculations the project is expected to achieve PH minimum requirements, which are challenging space heating, space cooling and air tightness targets. According to these limits, a building must achieve maximum of either 15 kWh/(m^2a) heating demand or 10 W/m^2 heating load; frequency of overheating and frequency of excessively high humidity must be lower than 10 and 20 respectively, and airtightness must be less than 0,6 air change per hour at 50 Pa. According to the manual, these targets could be met by keeping U-values of exterior building elements under 0.15 W/(m^2K) and windows below 0.80 W/(m^2K), providing highly efficient electrical appliances and a mechanical ventilation system with heat recovery.

PHPP document has various tabs in Excel spreadsheets and these tabs include input cells, datasets, calculations, and results to calculate and visualise the energy calculations for selected buildings. It is possible to categorise the main tabs for a project in 6 groups, which are general information, building fabric, building openings, heating system, cooling system and other services. The process in a residential project as Figure 14 shows that it starts with Verification and Climate that include general information on the project. Afterwards, U-values, Areas and Components tabs require building fabric properties, and Windows, Shading and Ventilation tabs require building openings. Finally for building services, Heating and Heating Load tabs are for space heating system specifications; Ventilation, SummVent, Summer and Cooling tabs are for cooling system; DHW+Distribution is for water heating system; and Electricity and Aux Electricity tabs are for electrical appliances used within the building. As a result, PHPP shows the results if the project meets the

112. Wolfgang Feist et al., Passive House Planning Package, vol. Version 9 (Darmstadt, Germany: Passive House Institute, 2015), passiv.de/flipbooks/phpp-9-en.

113. Wolfgang Feist et al., Passive House Planning Package, vol. Version 9 (Darmstadt, Germany: Passive House Institute, 2015), passiv.de/flipbooks/phpp-9-en.

minimum requirements to achieve Passive House criteria.



Passive House Verification

Building:	Volu-te
Street:	
Postcode/City:	
Province/Country:	TR-Turkey
Building type:	Micro Living Unit
Climate data set:	BG0005b-Burgas
Climate zone:	4: Warm-temperate — Altitude of location: 40 m
Home owner / Client:	Alter8
Street:	
Postcode/City:	
Province/Country:	

Architecture:	
Street:	
Postcode/City:	
Province/Country:	
Energy consultancy:	
Street:	
Postcode/City:	
Province/Country:	

Mechanical engineer:	
Street:	
Postcode/City:	
Province/Country:	
Certification:	
Street:	
Postcode/City:	
Province/Country:	

Year of construction:	2022	Interior temperature winter [°C]:	20,0
No. of dwelling units:	1	Internal heat gains (IHG) heating case [W/m²]:	4,1
No. of occupants:	1,0	Specific capacity [Wh/K per m² TFA]:	60
		Interior temp. summer [°C]:	25,0
		IHG cooling case [W/m²]:	9,0
		Mechanical cooling:	

Specific building characteristics with reference to the treated floor area — The PHPP has not been filled completely; it is not valid as verification

					Criteria	Alternative criteria	Fulfilled?[2]
	Treated floor area	m²	13,2				
Space heating	Heating demand	kWh/(m²a)	134	≤	15	-	no
	Heating load	W/m²	63	≤	-	10	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤	-	-	-
	Cooling load	W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C)	%	36	≤	10		no
	Frequency of excessively high humidity (> 12 g/kg)	%	34	≤	20		no
Airtightness	Pressurization test result n_{50}	1/h	0,6	≤	0,6		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	0	≤	120		yes
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	0	≤	-	-	-
	Generation of renewable energy (in relation to projected building footprint area)	kWh/(m²a)	0	≥	-	-	

[2] Empty field: Data missing; '-': No requirement

I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

Passive House Classic? no

Task: First name: Surname: Signature:

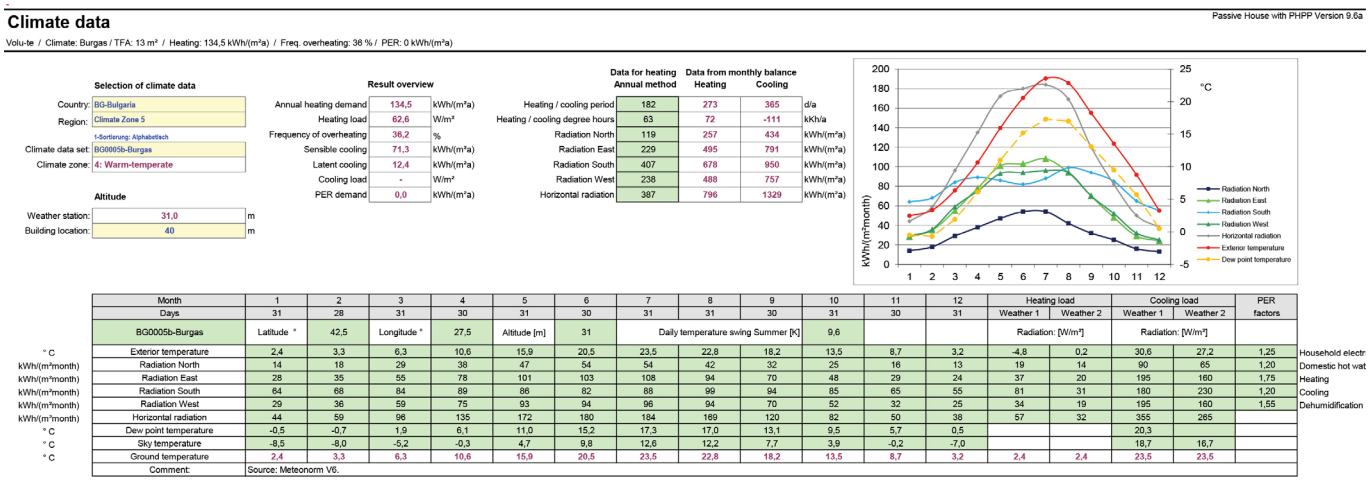
Issued on: City:

Figure 14: PHPP Verification worksheet[113].

General Information: Verification and Climate

The Verification worksheet is the starting point of the Passive House Planning Package (PHPP) calculations. It requires the entry of basic information about the project such as homeowner, architect, project address, building type, and occupancy. For this evaluation Volu-te has been assumed as dwelling in the residential building category because there are only two categories in PHPP; which were residential and non-residential, and as it was the case for the BREEAM assessment. Occupancy number is defined as 1 by the worksheet when number of dwelling units set to 1, and this is acceptable because Volu-te is usually for single occupancy except for extreme conditions where it provides adequate space for a maximum of 2 people. Figure 14 shows the worksheet of Verification with basic information of the project and summary

of energy consumption calculations with treated floor area, space heating demand, space cooling demand and airtightness.



Climate data

Passive House with PHPP Version 9.6a

Volu-te / Climate: Burgas / TFA: 13 m² / Heating: 134,5 kWh/(m²a) / Freq. overheating: 36 % / PER: 0 kWh/(m²a)

Selection of climate data

Country:	BG-Bulgaria
Region:	Climate Zone 5
	1-Sortierung: Alphabetisch
Climate data set:	BG0005b-Burgas
Climate zone:	4: Warm-temperate

Altitude

Weather station:	31,0	m
Building location:	40	m

Result overview

Annual heating demand	134,5	kWh/(m²a)
Heating load	62,6	W/m²
Frequency of overheating	36,2	%
Sensible cooling	71,3	kWh/(m²a)
Latent cooling	12,4	kWh/(m²a)
Cooling load	-	W/m²
PER demand	0,0	kWh/(m²a)

	Data for heating Annual method	Data from monthly balance Heating	Cooling	
Heating / cooling period	182	273	365	d/a
Heating / cooling degree hours	63	72	-111	kKh/a
Radiation North	119	257	434	kWh/(m²a)
Radiation East	229	495	791	kWh/(m²a)
Radiation South	407	678	950	kWh/(m²a)
Radiation West	238	488	757	kWh/(m²a)
Horizontal radiation	387	796	1329	kWh/(m²a)

Month	1	2	3	4	5	6	7	8	9	10	11	12	Heating load		Cooling load		PER factors	
Days	31	28	31	30	31	30	31	31	30	31	30	31	Weather 1	Weather 2	Weather 1	Weather 2		
BG0005b-Burgas	Latitude °	42,5	Longitude °	27,5	Altitude [m]	31	Daily temperature swing Summer [K]			9,6			Radiation: [W/m²]		Radiation: [W/m²]			
°C Exterior temperature	2,4	3,3	6,3	10,6	15,9	20,5	23,5	22,8	18,2	13,5	8,7	3,2	-4,8	0,2	30,6	27,2	1,25	Household electr
kWh/(m²month) Radiation North	14	18	29	38	47	54	54	42	32	25	16	13	19	14	90	65	1,20	Domestic hot wat
kWh/(m²month) Radiation East	28	35	55	78	101	103	108	94	70	48	29	24	37	20	195	160	1,75	Heating
kWh/(m²month) Radiation South	64	68	84	89	86	82	88	99	94	85	65	55	81	31	180	230	1,20	Cooling
kWh/(m²month) Radiation West	29	36	59	75	93	94	96	94	70	52	32	25	34	19	195	160	1,55	Dehumidification
kWh/(m²month) Horizontal radiation	44	59	96	135	172	180	184	169	120	82	50	38	57	32	355	285		
°C Dew point temperature	-0,5	-0,7	1,9	6,1	11,0	15,2	17,3	17,0	13,1	9,5	5,7	0,5			20,3			
°C Sky temperature	-8,5	-8,0	-5,2	-0,3	4,7	9,8	12,6	12,2	7,7	3,9	-0,2	-7,0			18,7	16,7		
°C Ground temperature	2,4	3,3	6,3	10,6	15,9	20,5	23,5	22,8	18,2	13,5	8,7	3,2	2,4	2,4	23,5	23,5		
Comment:	Source: Meteonorm V6.																	

Figure 15: PHPP Climate worksheet[114].

Climate worksheet as shown in Figure 15, include weather data of the proposed project site. It shows monthly exterior, dew point, sky and ground temperatures and monthly radiation data for each orientation. However, it only includes cities where there is a certified Passive House and Istanbul is not currently in this list of cities. Therefore, there is an auxiliary calculation to determine the nearest climate data set. According to latitude and longitude data of Istanbul, the nearest climate data set in PHPP shows Burgas in Bulgaria. Therefore, Burgas has been used in these calculations. In addition, the building location has been set to 40 metres which is the average height of Istanbul above sea level.

Building Fabric: U-Values, Areas, and Components

In the U-values worksheet, material thicknesses and thermal conductivities need to be entered to calculate thermal transmittance of each building element such as walls, roof, and floor. In addition, Components worksheets require data for window specifications such as glass and frame thermal conductivities and thicknesses. Afterwards, all this information is used in the Areas worksheet to specify walls with related values.

As it has been explained in the previous section that Volu-te has an annual heating demand of 134 kWh per sqm. In this scenario, opaque ele-

114. Wolfgang Feist et al., Passive House Planning Package, vol. Version 9 (Darmstadt, Germany: Passive House Institute, 2015), passiv.de/flipbooks/phpp-9-en.

ments of building fabric have an average thermal transmittance (u-value) of 0,246 W/m²K with 120 mm of mineral wool applied to the wall, roof, and floor. This value is already less than the limit value of 0,80 W/m²K as stated in Turkish standard of TS 825 Thermal Insulation Requirements for Buildings[115]; therefore, it is more efficient than traditional dwellings in Turkey. However, it is not adequate to achieve Passive House standards. As a result, the u-value of opaque elements will be improved to 0,152 W/m²K. The insulation material of 120 mm mineral wool will be replaced with internal application of 60 mm of aerogel and 60 mm spray polyurethane foam on top of it. It is expected to increase the cost of insulation by about an extra amount of approximately $5,000.

115. "Thermal Insulation Requirements for Buildings TS 825 ," Thermal Insulation Requirements for Buildings TS 825 (2008), https://sayfam.btu.edu.tr/upload/dosyalar/1458664642TS-825_Standard.pdf.

116. Wolfgang Feist et al., Passive House Planning Package, vol. Version 9 (Darmstadt, Germany: Passive House Institute, 2015), passiv.de/flipbooks/phpp-9-en.

Certified building systems ▶ Exception ▶

Passive House with PHPP Version 9.6a

Areas determination

Volu-te / Climate: Burgas / TFA: 13 m² / Heating: 134,5 kWh/(m²a) / Freq. overheating: 36 % / PER: 0 kWh/(m²a)

Summary

Temp.-zone	Area group	Group no.	Area / Length	Unit	Comment
	Treated floor area	1	13,20	m²	*Treated floor area according to PHPP manual*
A	North windows	2	1,68	m²	Results come from the 'Windows' worksheet. Window areas are subtracted from individual opaque areas. which is displayed in the 'Windows' worksheet.
A	East windows	3	1,68	m²	
A	South windows	4	1,68	m²	
A	West windows	5	2,10	m²	
A	Horizontal windows	6	0,00	m²	
A	Exterior door	7	1,26	m²	*Please subtract area of door from respective building assembly*
A	External wall - Ambient	8	38,46	m²	*Temperature zone "A" is ambient air*
B	External wall - Ground	9	0,00	m²	*Temperature zone "B" is the ground*
A	Roof/Ceiling - Ambient	10	9,20	m²	
B	Floor slab / Basement ceiling	11	0,00	m²	
		12	0,00	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"*
		13	0,00	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"* Factor for X
X		14	0,00	m²	*Temperature zone "X"; Please provide user-defined reduction factor (0 < ft < 1):* 75%
A	Thermal bridges Ambient	15	0,00	m	*Units in m*
P	Perimeter thermal bridges	16	0,00	m	*Units in m; temperature zone "P" is perimeter (see 'Ground' worksheet)*
B	Thermal bridges FS/BC	17	0,00	m	*Units in m*
I	Building element towards neigh	18	0,00	m²	*No heat losses, only considered for the heating load calculation*
Total thermal envelope			56,06	m²	

Building assembly overview	Average U-value [W/(m²K)]	Radiation-gains heating season [kWh/a]	Radiation-load cooling period [kWh/a]
		9 Months	12 Months
North windows	2,272	90	214
East windows	2,214	153	345
South windows	2,272	237	468
West windows	2,307	228	499
Horizontal windows			
Exterior door	0,800		
External wall - Ambient	0,246	43	73
External wall - Ground			
Roof/Ceiling - Ambient	0,246	10	18
Floor slab / Basement ceiling			
Thermal bridges - Overview	Ψ [W/(mK)]		
Thermal bridges Ambient			
Perimeter thermal bridges			
Thermal bridges FS/BC			
Building element towards neighbour			
Average therm. envelope	0,516		

Go to building components list

Area input

2-Sorting: BY ID

Area no.	Building assembly description	To group No.	Assigned to group	Quantity	x (	a [m]	x	b [m]	+	User determined [m²]	-	User subtraction [m²]	) -	Subtraction window areas [m²]	) =	Area [m²]	Selection building assembly / Building system	U-Value [W/(m²K)]	Deviation from North	Angle of inclination from the horizontal	Orientation	Reduction factor shading	Exterior absorptivity	Exterior emissivity
	Projected building footprint	0	Projected building footprint	1	x (		x		+	4,91	-		)		=	4,9									
	Treated floor area	1	Treated floor area	1	x (		x		+	13,20	-		)		=	13,2									
	Exterior door	7	Exterior door	1	x (	2,10	x	0,60	+		-		) -		=	1,3	Exterior door	0,80							
1	Floor	10	Roof/Ceiling - Ambient	1	x (		x		+	4,60	-		) -	0,0	=	4,6	02ud-Floor & Roof	0,246	180	180	Hor	0,40	0,80	0,90
2	Roof	10	Roof/Ceiling - Ambient	1	x (		x		+	4,60	-		) -	0,0	=	4,6	02ud-Floor & Roof	0,246	0	0	Hor	0,40	0,80	0,90
3	Wall 1-N-0	8	External wall - Ambient	1	x (		x		+	3,80	-		) -	0,4	=	3,4	01ud-External wall - mineral wool	0,246	0	90	North	0,40	0,80	0,90
4	Wall 2-N-30	8	External wall - Ambient	1	x (		x		+	3,80	-		) -	1,3	=	2,5	01ud-External wall - mineral wool	0,246	30	90	North	0,40	0,80	0,90
5	Wall 3-E-60	8	External wall - Ambient	1	x (		x		+	3,80	-		) -	0,4	=	3,4	01ud-External wall - mineral wool	0,246	60	90	East	0,40	0,80	0,90
6	Wall 4-E-90	8	External wall - Ambient	1	x (		x		+	3,80	-		) -	0,4	=	3,4	01ud-External wall - mineral wool	0,246	90	90	East	0,40	0,80	0,90
7	Wall 5-E-120	8	External wall - Ambient	1	x (		x		+	3,80	-		) -	0,8	=	3,0	01ud-External wall - mineral wool	0,246	120	90	East	0,40	0,80	0,90
8	Wall 6-S-150	8	External wall - Ambient	1	x (		x		+	3,80	-		) -	0,0	=	3,8	01ud-External wall - mineral wool	0,246	150	90	South	0,40	0,80	0,90
9	Wall 7-S-180	8	External wall - Ambient	1	x (		x		+	3,80	-		) -	0,8	=	3,0	01ud-External wall - mineral wool	0,246	180	90	South	0,40	0,80	0,90
10	Wall 8-S-210	8	External wall - Ambient	1	x (		x		+	3,80	-		) -	0,8	=	3,0	01ud-External wall - mineral wool	0,246	210	90	South	0,40	0,80	0,90
11	Wall 9-W-240	8	External wall - Ambient	1	x (		x		+	3,80	-		) -	1,3	=	2,5	01ud-External wall - mineral wool	0,246	240	90	West	0,40	0,80	0,90
12	Wall 10-W-270	8	External wall - Ambient	1	x (		x		+	3,80	-		) -	0,0	=	3,8	01ud-External wall - mineral wool	0,246	270	90	West	0,40	0,80	0,90
13	Wall 11-W-300	8	External wall - Ambient	1	x (		x		+	3,80	-		) -	0,8	=	3,0	01ud-External wall - mineral wool	0,246	300	90	West	0,40	0,80	0,90
14	Wall 12-N-330	8	External wall - Ambient	1	x (		x		+	3,80	-		) -	0,0	=	3,8	01ud-External wall - mineral wool	0,246	330	90	North	0,40	0,80	0,90
15					x (		x		+		-		) -	0,0	=									
16					x (		x		+		-		) -	0,0	=									
17					x (		x		+		-		) -	0,0	=									
18					x (		x		+		-		) -	0,0	=									
19					x (		x		+		-		) -	0,0	=									
20					x (		x		+		-		) -	0,0	=									
21					x (		x		+		-		) -	0,0	=									
22					x (		x		+		-		) -	0,0	=									

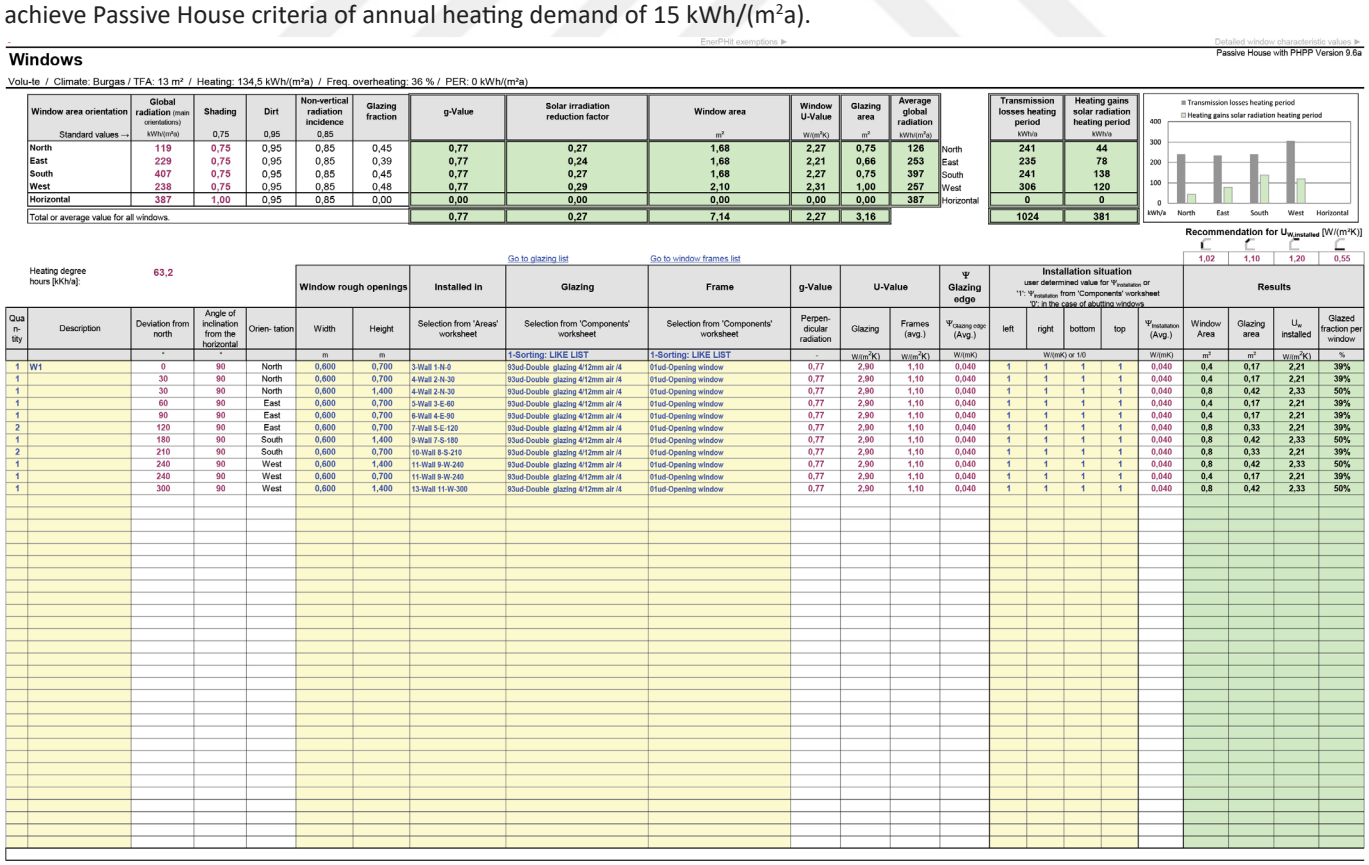
Figure 16: PHPP Areas worksheet[116].

Building Openings: Windows and Shading

In the Windows worksheet each opening on the building fabric is entered by width and length, and they are specified in related walls one by one. Figure 26 shows data entry into Windows for Volu-te with dimensions, related walls, orientation, inclination, and specification information. Shading worksheet works linked to Windows and for each opening a physical obstacle with height and distance away from the related window required to be entered. Therefore, PHPP could calculate the internal solar gains through windows more accurately.

In the current design of Volu-te, the window u-value of the current design is 2,27 W/m^{2}K; which is also thermally weak for Passive House standards. Therefore, the windows will need to be replaced via thermally stronger options to have a u-value of 0,98 W/m^{2}K. This way, it would be possible to achieve Passive House criteria of annual heating demand of 15 kWh/(m^{2}a).

117. Wolfgang Feist et al., Passive House Planning Package, vol. Version 9 (Darmstadt, Germany: Passive House Institute, 2015), passiv.de/flipbooks/phpp-9-en.



Windows

Passive House with PHPP Version 9.6a

Volu-te / Climate: Burgas / TFA: 13 m² / Heating: 134,5 kWh/(m²a) / Freq. overheating: 36 % / PER: 0 kWh/(m²a)

Window area orientation	Global radiation (main orientations)	Shading	Dirt	Non-vertical radiation incidence	Glazing fraction	g-Value	Solar irradiation reduction factor	Window area	Window U-Value	Glazing area	Average global radiation		Transmission losses heating period	Heating gains solar radiation heating period
Standard values →	kWh/(m²a)	0,75	0,95	0,85				m²	W/(m²K)	m²	kWh/(m²a)		kWh/a	kWh/a
North	119	0,75	0,95	0,85	0,45	0,77	0,27	1,68	2,27	0,75	126	North	241	44
East	229	0,75	0,95	0,85	0,39	0,77	0,24	1,68	2,21	0,66	253	East	235	78
South	407	0,75	0,95	0,85	0,45	0,77	0,27	1,68	2,27	0,75	397	South	241	138
West	238	0,75	0,95	0,85	0,48	0,77	0,29	2,10	2,31	1,00	257	West	306	120
Horizontal	387	1,00	0,95	0,85	0,00	0,00	0,00	0,00	0,00	0,00	387	Horizontal	0	0
Total or average value for all windows.						0,77	0,27	7,14	2,27	3,16			1024	381

Transmission losses heating period
Heating gains solar radiation heating period
400 300 200 100 0 kWh/a
North East South West Horizontal

Recommendation for $U_{W,installed}$ [W/(m²K)]
1,02 1,10 1,20 0,55

Heating degree hours [kKh/a]: 63,2

Go to glazing list | Go to window frames list

Qua n-tity	Description	Deviation from north	Angle of inclination from the horizontal	Orien- tation	Window rough openings: Width	Height	Installed in: Selection from 'Areas' worksheet	Glazing: Selection from 'Components' worksheet	Frame: Selection from 'Components' worksheet	g-Value: Perpen- dicular radiation	U-Value: Glazing	Frames (avg.)	Ψ Glazing edge (Avg.)	Installation situation: user determined value for $\Psi_{Installation}$ or '1': $\Psi_{Installation}$ from 'Components' worksheet '0': in the case of abutting windows — left	right	bottom	top	$\Psi_{Installation}$ (Avg.)	Results: Window Area	Glazing area	U_w installed	Glazed fraction per window
		°	°		m	m		1-Sorting: LIKE LIST	1-Sorting: LIKE LIST	-	W/(m²K)	W/(m²K)	W/(mK)		W/(mK) or 1/0				W/(mK)	m²	m²	W/(m²K)	%
1	W1	0	90	North	0,600	0,700	3-Wall 1-N-0	93ud-Double glazing 4/12mm air /4	01ud-Opening window	0,77	2,90	1,10	0,040	1	1	1	1	0,040	0,4	0,17	2,21	39%
1		30	90	North	0,600	0,700	4-Wall 2-N-30	93ud-Double glazing 4/12mm air /4	01ud-Opening window	0,77	2,90	1,10	0,040	1	1	1	1	0,040	0,4	0,17	2,21	39%
1		30	90	North	0,600	1,400	4-Wall 2-N-30	93ud-Double glazing 4/12mm air /4	01ud-Opening window	0,77	2,90	1,10	0,040	1	1	1	1	0,040	0,8	0,42	2,33	50%
1		60	90	East	0,600	0,700	5-Wall 3-E-60	93ud-Double glazing 4/12mm air /4	01ud-Opening window	0,77	2,90	1,10	0,040	1	1	1	1	0,040	0,4	0,17	2,21	39%
1		90	90	East	0,600	0,700	6-Wall 4-E-90	93ud-Double glazing 4/12mm air /4	01ud-Opening window	0,77	2,90	1,10	0,040	1	1	1	1	0,040	0,4	0,17	2,21	39%
2		120	90	East	0,600	0,700	7-Wall 5-E-120	93ud-Double glazing 4/12mm air /4	01ud-Opening window	0,77	2,90	1,10	0,040	1	1	1	1	0,040	0,8	0,33	2,21	39%
1		180	90	South	0,600	1,400	9-Wall 7-S-180	93ud-Double glazing 4/12mm air /4	01ud-Opening window	0,77	2,90	1,10	0,040	1	1	1	1	0,040	0,8	0,42	2,33	50%
2		210	90	South	0,600	0,700	10-Wall 8-S-210	93ud-Double glazing 4/12mm air /4	01ud-Opening window	0,77	2,90	1,10	0,040	1	1	1	1	0,040	0,8	0,33	2,21	39%
1		240	90	West	0,600	1,400	11-Wall 9-W-240	93ud-Double glazing 4/12mm air /4	01ud-Opening window	0,77	2,90	1,10	0,040	1	1	1	1	0,040	0,8	0,42	2,33	50%
1		240	90	West	0,600	0,700	11-Wall 9-W-240	93ud-Double glazing 4/12mm air /4	01ud-Opening window	0,77	2,90	1,10	0,040	1	1	1	1	0,040	0,4	0,17	2,21	39%
1		300	90	West	0,600	1,400	13-Wall 11-W-300	93ud-Double glazing 4/12mm air /4	01ud-Opening window	0,77	2,90	1,10	0,040	1	1	1	1	0,040	0,8	0,42	2,33	50%

Figure 17: PHPP Windows worksheet[117].

Building Services: Heating, Ventilation, Cooling, DHW, Electricity

Building services worksheets such as Heating, Heating Load, Ventilation, SummVent, Summer, Cooling, DHW+Distribution, Electricity and Aux Electricity, work for to calculate energy demand of the proposed building and only required information in those worksheets are the specifications of building services systems. Ventilation is the fundamental category in PHHP as the selection of a highly efficient mechanical ventilation system with heat recovery (MVHR) decreases the heating demand tremendously in half. Therefore, there is a need of MVHR unit for Volu-te's small volume with an efficacy of more than %80, It means that there will be an extra cost of approximately $2,000 with order and transport of the MVHR unit from Germany, which is the closest location according to Passive House Institute Component Database.

In summary, Passive House Planning Package does not require various consultancies like BREEAM, and it does not touch on ecological value of the architectural product, embodied energy of the project, waste production, or water consumption of the building. However, it focuses on the design and aims to reduce the energy consumption sharply. Therefore, the extra cost of the budget becomes visible on building elements and their thermal performance and relatively in the annual heating demand of the building. Thus, extra insulation, MVHR unit, and PH certified windows add an approximate extra cost of $5,000; $2,000 and $4,000 respectively. In addition, PH consultancy, certification and air blower door test add an extra of approximately $2,000 and sums up at a total extra cost of $13,000 for PH certification.

Comparison of BREEAM and Passive House Methodologies

Volu-te has been examined for both BREEAM and Passive House methodology. BREEAM is more comprehensive in terms of ecological consideration such as issues in waste, pollution, construction management and ecology. However, there is not enough quantitative evidence to prove its positive ecological impact. Whereas Passive House is strict with its rule of heating demand and airtightness limits. It focuses on energy consumption as well as water con-

sumption to increase thermal comfort of the proposed building. Figure 18 shows that Passive House methodology guarantees the reduction of annual heating demand of Volu-te from 134 kWh per sqm to less than 15 kWh per sqm, where the pink line represents heating demand in kWh/(m2a) and blue bars show the total project cost. However, BREEAM methodology does not provide such a sharp reduction in any issue.

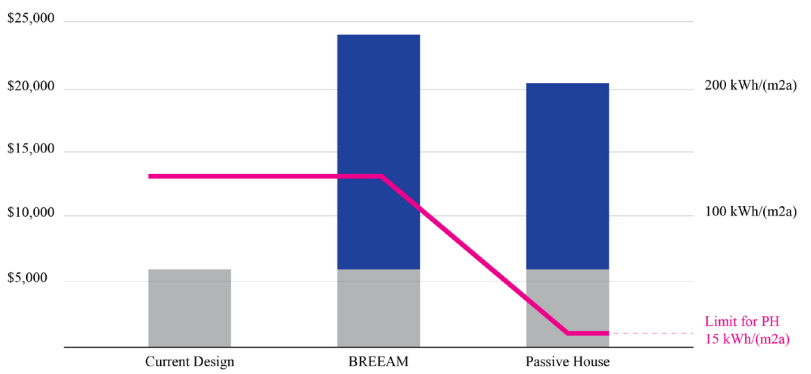


Figure 18: Correlation between Passive House costs and building fabric improvements.

In terms of the financial dimension of these methodologies, Figure 18 also shows that BREEAM consultancy and certification processes triple the total cost of the project from $6,000 to approximately $18,000. This price includes BREEAM consultancy and certification cost as well as various consultancy items such as daylight analysis and artificial lighting strategy, thermal modelling with future climate scenarios, acoustic advice and calculations of airborne and impact sound insulation levels, energy modelling and net zero feasibility study, consultation on greywater system and rainwater harvesting, and adaptation to climate change structural and fabric resilience risk assessment. Although Passive House does not add as much cost as BREEAM, it still increases project budget to approximately $13,000. Passive House consultancy, Passive House certification and air blower door test for air tightness measurement cost approximately $5,000 and the rest of the extra budget from $13,000 is for improving building fabric with PH certified windows and extra insulation as well as a simple mechanical ventilation system with heat recovery.

In Search of an Alternative

03

In the previous section, BREEAM and Passive House Planning Package methodologies have been evaluated via the urban micro living unit Volu-te, which is a product of graduate students at MEF University. Volu-te has been designed to provide living area in minimum volume and relatively has minimised energy consumption. It has shown that BREEAM aims to take a comprehensive approach to a construction project. However, it is hardly possible to prove empirical impact for BREEAM methodology on showing the actual reduction on operational or embodied energy. Although these services have potential to benefit the project; the target in each section is either unclear or non-existing to make a difference. In contrast it has a very noticeable effect on the project budget by tripling it and adding an extra $18,000. In addition, the LEED methodology was not even applicable for Volu-te due to minimum sqm requirements. Therefore, Passive House methodology has been examined for Volu-te as an alternative, although it has more restricted focus the numerical reduction on efficiency. It is more of an energy assessment of a construction project, and it achieves a radical reduction in energy consumption. The results have shown that the Passive House Planning Package would decrease annual heating demand of the project from 134 kWh to 15 kWh per sqm by improving thermal performance of its building fabric and implementing a mechanical ventilation with heat recovery unit for effective ventilation. However, it would cost an extra of $13,000 for the project. Therefore, it brings difficulties into accessibility and opens a discussion on it becoming another wheel within the system.

The evaluation shows that the financial pressure of these methodologies on project budget is not neglectable; therefore, it reduces their applicability. They become a label for better marketing strategies and fall away from their original purpose of improving sustainability parameters. Alternative ideas such as regenerative design approach and non-extractive architecture have potential to make a change unless they refuse to become a wheel in the current system.

It gradually becomes clearer that there are malfunctioning issues on the current mechanisms of sustainable vision in architecture, which supports the need of a paradigm shift. Physicist Fritjof Capra and chemist Pier Luigi

Luisi[118] states in The Systems View of Life: A Unifying Vision that it is crucial to scrutinise each parameter for the paradigm shift as well as deep ecology, which is an Earth-Centred vision locating humans within the natural environment in contrast to anthropocentric shallow ecology. Therefore, the holistic approach to the architecture raises critical questions on environmental assessment methodologies.

First, none of these methodologies question the actual need for the new-build project and feasibility study in existing urban spaces whether there is an adequate space for expected action. Secondly there is not a critical consideration of the project size and its usable building area. Contrary to this critic, there is a minimum project size to practice LEED certification. It is debatable whether the contribution of more dwelling area is required for modern lifestyle. However, senior research associate Katherine Ellsworth-Krebs[119] asserts that floor area per building increases by twice faster globally than the improvement over energy efficiency. Researchers Sylvia Lorek and Joachim Spangenberg[120] delve into the relationship between living area and energy efficiency in housing projects, and they claim that there should be a legal limit to define maximum dwelling size in terms of achieving reduction targets in household energy consumption.

Lastly, neither BREEAM nor LEED methodologies require a design review, which would increase the potential use of the project. Although there is not a limitation in Passive House, the existence of form factor calculations is an effective way for designers to review potential efficiency of building form. Form Factor[119] is the ratio of the external surface area of the building to usable internal floor area to maximise the efficiency in the dedicated volume of the building. As an example, a form factor of less than 3.0[123] is an effective target when designing a small Passive House building. Therefore, it is useful for architects to conduct initial efficiency analyses by the form of the building to understand whether it has the potential to achieve Passive House targets of heating demand and air tightness.

In addition, author, and LEED fellow Jerry Yudelson claims that the major benefit of environmental assessment methodologies is to increase building value as it asserts to become the exclusive method to prove how sustainable the project or the building is. However, researchers Ali Amiri et al. state that environmental assessment methodologies such as LEED does not guarantee a meaningful performance gain in terms of energy efficiency. Therefore, there is a rising concern and increasing research on alternative

118. Fritjof Capra and Pier Luigi Luisi, The Systems View of Life: A Unifying Vision (Cambridge, UK: Cambridge University Press, 2019).

119. Katherine Ellsworth-Krebs, "Average Home Is More Spacious Now than Ever – Here's Why That's a Problem for the Environment," The Conversation (Lancaster University, March 27, 2020), https://theconversation.com/average-home-is-more-spacious-now-than-ever-heres-why-thats-a-problem-for-the-environment-131582.

121. Sylvia Lorek and Joachim H. Spangenberg, "Energy Sufficiency through Social Innovation in Housing," Energy Policy 126 (March 2019): pp. 287-294, https://doi.org/10.1016/j.enpol.2018.11.026.

122. Rob McLeod, Kym Mead, and Mark Standen, "Passivhaus Primer: Designer's Guide: A Guide for the Design Team and Local Authorities," Passive House International (BRE, n.d.), https://passivehouse-international.org/upload/BRE_Passivhaus_Designers_Guide.pdf.

123. Rob McLeod, Kym Mead, and Mark Standen, "Passivhaus Primer: Designer's Guide: A Guide for the Design Team and Local Authorities," Passive House International (BRE, n.d.), https://passivehouse-international.org/upload/BRE_Passivhaus_Designers_Guide.pdf.

holistic approaches in consequence of malfunctioning current environmental assessment methodologies in architecture.

Architect and co-founder of design research studio Space Caviar Joseph Grima states that "cookie-cutter modernism" is a product of capitalism where the same materials and systematic features are applied to buildings regardless of their location and climatic conditions, and this approach should be replaced with an alternative form of architecture that is produced with the current technologies, because it is not sustainable to depend on a system that is based on constant growth on a limited planet. He explains their manifesto called Non-Extractive Architecture: On Designing Without Depletion explains in an interview with Dezeen that it encourages questioning the actual damage of building activities on Earth and look for alternative architectural production methods that would not depend on exploiting or depleting non-renewable resources.

Corresponding with non-extractive architecture arises from a critical judgement on the current sustainability methodologies. Climate consultant Alex Massie explains that it is not sufficient any longer to aim for sustainability because the effort to maintain our current presence on Earth will bring the end of the world therefore it has to be more than sustaining, it should focus on taking actions towards regeneration. Planning consultant and one of the co-founders of the LEED Green Building Rating System Bill Reed claims that the customary methodologies of the sustainability only offer an improvement over the existing approaches; however, it does not incorporate the whole systems and living systems thinking and therefore it is not adequate to overcome the consequences of climate crisis unless the current system that we live in is changed with an alternative human conscious approach with an ecocentric vision. The path and descriptions in Figure 20 show the stages of environmentally responsible design where the most crucial levels are the Reconciliatory and Regenerative and they aim to search on the fundamental focus of sustainability.

Regenerative design considers recovering the harm caused by anthropogenic actions; on the contrary, sustainability only concentrates on maintaining the present ecosystem on Earth as it is. Reed[100] also claims that the "co-learning process", which considers an alternative for the earth and human systems, should be implemented by the corporation of whole design team members from the client to architects in the regenerative approach. Massie[101] categorises regeneration in architecture in 5 stages, which are con-

119. McLeod, Mead, and Standen, "Passivhaus Primer: Designer's Guide: A Guide for the Design Team and Local Authorities," Passive House International (BRE, n.d.).

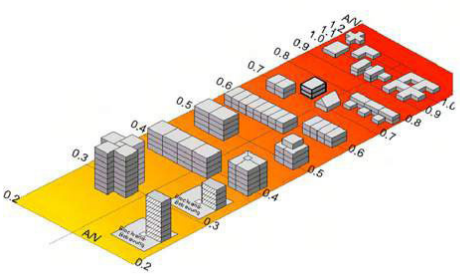


Figure 19: Form factor diagram[123] shows the form factor according to the shape of the building.

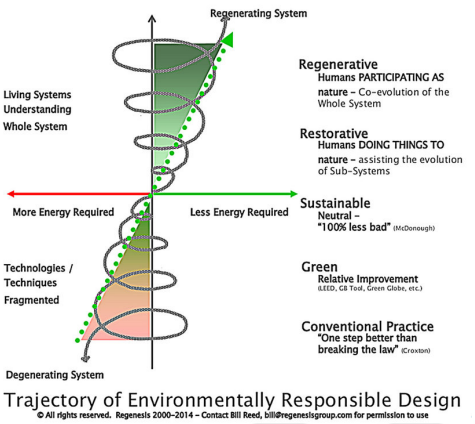


Figure 20: "Trajectory of Environmentally Responsible Design[131]".

sequently decarbonisation, achieving net zero, achieving net carbon, declaring a climate emergency, and declaring an ecological emergency.

In summary, it is recognised that current environmental assessment methodologies are failing to accomplish the targets to achieve a drastic reduction in energy consumption. Therefore, there are rising alternative methodologies to consider the Earth from an ecocentric perspective. The alternatives such as regenerative approach in design and non-extractive architecture carry a potential to offer a more environmentally responsible building environment and perspective. Although they are at the very initial stage of idea formation, they might achieve their holistic whole living system vision if they do not implement under the current system of labelling and certification.

Conclusion

The relationship between environmental assessment methodologies and sustainability is highly interconnected within the construction industry. When sustainability has been discussed for architectural production, environmental assessment methodologies take their place on the table as a must-have criterion for environmentally responsible actions. However, there is not sufficient evidence to prove the link between these methodologies and how they achieve an impact in terms of environment, society, and economy as three dimensions of sustainability. In a world where there is an ongoing climate crisis and resource scarcity, especially the subject of energy efficiency and emissions carry a great importance; therefore, environmental impact stands ahead when it is about requiring robust actions in architectural production.

In this thesis, Volu-te has been evaluated in terms of sustainability as an architectural production. It helped to visualise and materialise the environmental assessment methodologies to carry out a cost comparison and examine ecological impact throughout the design stage to construction as an exemplar project. Volu-te has been designed by questioning the actual requirements of a living space unlike LEED, where even there is a minimum area requirement. Although BREEAM and Passive House Planning Package (PHPP) do not have this kind of obligations, there is an invisible barrier for small projects built by financial aspects. Majority of the experts on these environmental assessment methodologies responded to the enquiry to certify Volu-te from Turkey or neighbouring countries highlighted that the cost of certification would be unaffordable for a micro living project. As it is shown in this thesis that the cost of the project quadruples and triples with BREEAM and Passive House certification processes respectively for Volu-te. Although it would bring prestige to the project via an authorised certification by an international organisation as a proof of quality, it drastically increases the project cost that it either becomes at an unaffordable price for customers or obstructs to gain any profit from the project.

BREEAM could have created an improvement on a typical construction project; however, it does not propose any robust environmental impact for a project like Volu-te because it has already been designed by a consideration to minimise its energy consumption, ecological footprint, and carbon emissions. It adds consultations on lighting strategy, thermal and energy modelling, natural hazard risk assessment, acoustic advice, ecological and flood risk assessments. Although these features of consultation could be extremely important and beneficial for Volu-te, it still would not guarantee a percentage savings or continuation.

Felix Guattari highlights how the current economic system has strong connections with the media to promote itself, BREEAM has a similar relationship with the current available literature. It is extremely difficult to find studies showing that BREEAM has a positive impact on the projects in terms of sustainability unless it is sponsored by the related institutions. As the outcomes from the study of the Aalto University researchers Ali Amiri et al explained previously that there is not a certain proof of energy efficiency savings by certificated buildings. They specifically highlight in their study that there is not a sponsor behind their research, which causes questioning the other studies around showing how effective and useful these methodologies are. However, it is easy to show how these certified buildings value more as it is a source of prestige for the projects. In contrast, Passive House Institution stands alone in this subject as they have provided the PHPP tool and manual for free for this thesis even though they were aware of the critical discussion that will be conducted within this thesis.

From PHPP's point of view, it adds less cost to the project by tripling the price when compared with BREEAM; however, it affects the energy consumption of the proposed project with the help of Passive House criteria and it achieves an approximate 85% reduction in operating costs, which is crucial for the resource scarcity and decreasing the emissions through buildings. Although PHPP has significant benefits in terms of energy efficiency, it does not control other dimensions of sustainability such as impacts on society and economy. In addition, the components that are required for a Passive House certification are extremely expensive or inaccessible. There is a requirement for mechanical ventilation with heat recovery, where it is not extremely affordable for the Volu-te project as it must be imported from Europe. As well as the ventilation system, there is a need for extra insulation and Passive House certified windows. The most difficult

parameter in this methodology for Turkey, is the small number of window producers that have Passive House certified components. In addition, it is difficult for a small project to implement these components, as the companies refuse to produce less than 700 metres of window perimeter projects.

Another point in BREEAM certification processes was the difficulty of reaching out professionals and consultants. The majority of the BREEAM consultants in Turkey, does not prefer an open and flexible approach on cost for the proposed project. These offices ask for the client to phone them for not to provide written information on the estimated cost of their services. Whereas in PHPP certification process, it has been contacted with the certifiers from neighbouring countries as there are none existing certifier in Turkey. Unlike BREEAM consultants, they were able to provide clear fee proposals for their services. However, Passive House consultants from Turkey were unable to even estimate the cost of consultancy as they do not have any work experience on the subject due to no demand in PH certification in Turkey, yet. In summary, the financial aspect is the most troublesome issue on these certifications, as it creates a small system within itself and limits the flow of information to outside professionals.

Within the scope of the research, the question of "Is there any need for environmental assessment methodologies to obtain environmentally responsible architectural production if we compare financial aspects and environmental impact?" has been sought. In this process, an evaluation of Volu-te has been completed via BREEAM and Passive House processes, and a comparison has been made for environmental impact and extra cost of certification. It has shown that certification systems create their own reign with their certified consultants, or certified building elements and materials. Therefore, it adds a crucial financial load on top of the total project cost, although it provides international approval in terms of a few sustainability aspects. Other than these methodologies, there are upcoming alternatives such as regenerative approach and non-extractive architecture. However, these ones do not have a strict methodology to define their process yet. Therefore, they still carry a risk of creating their own system embedded within the capitalist structure just as current environmental assessment methodologies. In addition, it is still a big challenge to implement a holistic approach within the stages of architectural production, as there are crucial concerns like achieving net zero emissions. While materialising an architectural product, there is an enforced use of materials that are already loaded with carbon emissions, ready to be used

in the construction site. Even though the project is carefully designed to apply non-extractive architecture principles, there is still a negative impact of a structure on the living system of the whole ecology. Trying to cover this harm in terms of emissions via renewable energy production, still has dependency on non-renewable resources or they are not fully recyclable after their lifetime. Therefore, it is reasonable to question even the possibility of an environmentally responsible production in architecture regarding new constructions.

There is a certain need for a paradigm shift in environmental consideration, which would then affect the way of seeing architectural production. The similar perspective where the resource of energy has been shifted from wood to coal, or coal to natural gas, is still dominant in that renewable energy tools are still produced with some non-renewable materials and are still not fully recyclable. Therefore, it has the potential to create other problems of resources when these new technologies are widely used within the near future. Alternative environmental assessment methodologies carry the potential to be a wheel in the system, unless they focus on these realities, question the aspects against the neoliberal system and create an open source ecosystem for the benefit of the whole system thinking.

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