GREEN BUILDING AND ENERGY EFFICIENCY APPLICATION DECISIONS IN SUSTAINABLE PROJECT MANAGEMENT

by

Niyazi Mete Saraçoğlu

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ABSTRACT

GREEN BUILDING AND ENERGY EFFICIENCY APPLICATION DECISIONS IN SUSTAINABLE PROJECT MANAGEMENT

Being traditionally one of the main drivers of social and economic development of a country, the construction industry is also a major contributor to the negative impacts on environment especially due to signifcant consumption of energy and resources over the lifecycle of a building and the associated green house gas emissions. Although a lot of efforts are put in place over the last two decades to develop and to promote green building practices and sustainability measures within the industry to minimize negative impacts, the industry is still facing difficulties to adapt to this paradigm shift, especially in emerging markets. Therefore actual steps towards ensuring such shift yet remains as a major challenge.

Within this context, this study aims to identify the critical stage for taking the decision to implement green building practices during the construction of a project while analysing in detail related decisions in order to give more visiblity to the decision makers' with regards to the degree of green building practices achievable over the construction stages depending on the timing of the decision from a sustainable project mangement perspective. In order to collect the necessary data, a survey is conducted with green building professionals and a case study is performed on three hospital projects in Turkey. While preferably such decision should be given as early as possible in the process for new constructions, it was found that the latest stage to give such decisions is early construction stage, beyond which the efforts put in place have little influence on the outcomes.

ÖZET

SÜRDÜRÜLEBİLİR PROJE YÖNETİMİNDE YEŞİL BİNALAR VE ENERJİ VERİMLİLİĞİ UYGULAMA KARARLARI

Bir ülkenin sosyal ve ekonomik kalkınmasının geleneksel ana iticilerinden biri olan inşaat endüstrisi aynı zamanda enerji, kaynak tüketimi ve sera gazi emisyonları bakımından da çevreye en çok zararı veren endüstriler arasındadır. Her ne kadar geçtiğimiz son yirmi yılda bu zararları en aza indirgemek amacıyla yeşil bina ve sürdürülebilirlik uygulamalarini gelistrimek ve on plana çıkarmak için bir çok efor sarfedildiyse de inşaat endüstrisi, özellikle de gelişmekte olan marketlerde bu akıma ayak uydurmakta hala zorlanmaktadır. Bu nedenle akım değişikliği için atılacak adımlar sektörün aşması gereken ana zorluklar arasında yer almaktadır.

Bu bağlamda, bu çalışmanın amacı sürdürülebilir proje yönetimi açısından yeşil bina uygulamalarini hayata geçirme kararının projenin en geç hangi safhasında alınması gerektiğini ortaya çıkarmak ve alınması gereken kararları detaylica analiz ederek karar vericilere bu kararı takiben elde edilebilecek kazanımlar hakkında görünürlük kazandirmaktir. Gerekli veriler yeşil bina profesyonelleriyle yapılan bir anket ve Türkiye'de yer alan 3 adet hastane üzerinde yapılan vaka çalışmasıyla elde edilmiştir. Bu kararın yeni inşaatlar için olabilecek en erken safhada alınması tercihen en uygun olmakla beraber, elde edilecek kazanımlara etkisi bakımından en geç erken inşaat safhasında alınması gerekliliği ortaya çıkarılmıştır.

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LIST OF ACRONYMS/ABBREVIATIONS

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BREEAM	Building Research Establishment Environmental Assessment Method
CASBEE	Comprehensive Assessment System for Built Environment Efficiency
DGNB	Deutsche Gesellschaft fur Nachhaltiges Bauen
EBRD	European Bank of Reconstruction and Development
EUR	Euro
GB	Guobiao Standards
IAQ	Indoor Air Quality
IECC	International Energy Conservation Code
IESNA	Illuminating Engineering Society of North America
IFC	International Finance Corporation
IgCC	International Green Construction Code
kWh	Kilowatt hours
LEED	Leadership in Energy and Environmental Design
LEED-HC	LEED for Healthcare
LCA	Lifecycle Assessment
MEP	Mechanical Electrical Plumbing
MoH	Ministry of Health of Turkey
NPV	Net Present Value
O&M	Operation and Maintenance
PFI	Project Finance Initiative
PPP	Public Private Partnership
m2	square meters
m3	cubic meters

TL	Turkish Lira
TSE	Turkish Standards Institute
UN	United Nations
US	United States
USD	United States Dollars
USGBC	United States Green Building Council

1. INTRODUCTION

Construction industry is a major contributor to social and economic development of a country [1] where its effect is maximum during initial stages of the country's development [2]. This is due to numerous intersectoral linkages that are present between construction industry and other industries that are either backward or forward links [3]. For instance, while a growth in construction industry positively affects labor intensive supply industries and construction material producers such as cement factories as a backward linkage, construction of infrastructure projects will ultimately help the future development of other industries as a forward linkage by better providing critical drivers such as accessibility and energy.

However in conventional development cases, this development is followed by environmental problems as a side product due to increased energy and natural resources consumption and waste generation. Being one of the conventional industries construction industry is a major contributor to environmental detriment partly due to its large consumption of energy [4]. Research done in this area reflect that globally buildings account for 30%-40% of primary energy usage such as fossil fuels, 40%-50% of green house gas emissions, 17% of water usage and 40%-50% of raw materials [5, 6]. Also recent studies forecast global construction industry to grow from 7.2 trillion to over 12 trillion with an increase in global share of GDP from 13% to 15% by 2020 [7]. Being considered as a developing country, Turkey sits above the world average for buildings' share of energy consumption as they have a share of 45% in overall energy consumption and they account for 30% of national greenhouse gas emissions as of 2017 [8]. Concurrently U.S. Energy Information Administration projects world's energy consumption to increase 56% by 2040 [9]. Considering these studies, it is of critical importance for construction industry to adopt sustainability alongside with other industries in order to move towards sustainable development.

1.1. Outlook on Global Developments Around Sustainability

Sustainable development of a country can be described as development of social and economical conditions of that country with having minimal negative impact on the environment such as minimizing green house gas emissions, consumption of energy and natural resources hence allowing future generations to possess enough resources to satisfy their needs. Although the conditions for such development are not achieved yet, since its first usage in Our Common Future (1987) by World Commission on Environment and Development, some important steps on global scale were taken such as Agenda 21 (1992), Kyoto Protocol (1997), UN Millenium Declaration (2000), World Summit (2005), Paris Climate Conference (2015) to promote and to enforce sustainable development.

Following these global scale developments on sustainability, construction industry also faced new building standards, directives, codes, laws and regulations all around the world related to sustainability and energy efficiency. European Union published several directives to enforce energy efficiency measures on buildings such as 93/76/EEC and 2002/91/EC, United States developed ASHRAE 90.1-2007 standards and IgCC, IECC codes, and China developed GB 50411-2007 standards.

A survey conducted by American Institute of Architects in United States [10] revealed various laws and regulations mandated by local authorties to incentivize green building, some being obligation to follow a specific green building assessment system in certain zoning areas, expedited permit processing, green building awards, providing green building dedicated loans or tax abatements. However approach of local authorities might still require a broader perspective towards sustainable construction, as a study based on Swedish green building sector [11] emphasises that main focus during procurement and tender process is on selection of materials that limit the use of resources and waste generation rather than being on energy use during operation which is more critical.

Further support to sustainable development is provided by International Financial Institutions that are granting project finance debt to projects in emerging markets through acceptance of a risk management framework called as Equator Principles since 2010 [12]. Under this framework several financial institutions such as European Bank of Reconstruction and Development (EBRD) and International Finance Corporation (IFC) published and from time to time updated their own performance criteria that needs to be satisfied by the client through due diligence process concerning environmental and social impacts of that specific project as well as to what extent energy efficiency measures are implemented therein before lending any debt to it.

Considering the finance requirements of massive infrastructure projects such as railroads. power plants, pipelines, hospitals and motorways in emerging markets these performance criteria that the clients are obliged to satisfy in order to obtain financing play an important role in securing certain level of care towards environment and society throughout the project life cycle.

All these efforts towards sustainability and energy efficiency ultimately led to emergence of green buildings in construction industry where the term is defined by Office of Federal Environmental Executive as "the practice of: (i) increasing the efficiency with which buildings and their sites use energy, water, and materials and (ii) reducing building impacts of human health and the environment, through better sitting, design, construction, operation, maintenance, and removal throughout complete life cycle [13]. As it can be seen from the definiton, green building correlates with the term sustainability, hence constituting one of the various paths towards sustainable development.

Building up on this new term, many voluntary green building performance assessment and certification systems were developed such as Leadership in Energy and Environmental Design, Building Research Establishment Environmental Assessment Method, Energy Star, Comprehensive Assessment System for Built Environment Efficiency, and Deutsche Gesellschaft fur Nachhaltiges Bauen. Despite having similar purposes, there exist significant differences between the evaluation method of these tools and their outputs which are still subject of comparative studies in the literature which will be discussed further later on in this study. Nevertheless it is widely accepted that these certification systems constitute a reference point for the market on assessing the degree of green in buildings.

Considering the role and the area of influence of construction industry on the social, economical and environmental dynamics towards achieveing sustainable development, as well as all the obligatory and voluntary measures being imposed by various stakeholders, it seems both crutial and inevitable for the construction industry to implement better energy efficiency measures and to eventually build more green. However, even though these facts seem so evident, construction industry still acts reluctant to adapt to this paradigm shift, especially in emerging markets which in fact constitutes the main point of interest for many researches in literature that will be further looked into in the following literature review section of this study.

To the extent that this study is concerned, one of the main reasons behind this reluctancy is that although the decision to build green and energy efficient looks rather straightforward at a broader context, construction industry still has concerns on pros and cons of this decision as well as on how to implement these measures in projects. Going through this process is analogous to solving a problem having multiple unknowns where the equations are rather implicit than explicit. It is therefore of essential importance for academicians to first of all assure to construction industry that this problem is solvable and worth solving, and then to successfully guide the industry both during decision making and implementation processes.

1.2. Outlook on Developments in Turkey Around Sustainability

Considering the high potential of benefit on both the economy and the environment that might come from incremental improvements in the energy consumption, energy efficiency and reduction of emissions became the major driving factors in Turkey's continous steps towards sustainability.

To give examples of major milestones, one of the first steps taken was the creation of TS 825 Thermal Insulation Standard in 2000, which defined the standards for outer shell thermal insulation and set annual heating energy requirement limits for buildings that are newly constructred or renowated after June 14th 2000. In 2004 Turkey became a party to the United Nations Framework Convention on Climate Change. Later on benefiting from 2002/91/EC Framework Directive as part of Turkey's European Union membership process, Law 5627 "Energy Efficiency Law" was passed in 2007 creating the legal basis for regulations on energy efficiency. It was immediately followed by three major regulations. First one being the Regulation for Cost Sharing in Central Heating Systems 26847, April 14, 2008 obligating the use of heating control and measurement tools in buildings. The second one being the Efficient Use of Energy and Energy Sources Regulation 27035 of October 25, 2008 addressing details related to implementation of topics such as energy management, inspection, efficiency improvement and certification. The third one being the Energy Performance of Buildings Regulation 27075 of December 5, 2008, covering the calculation methodology of energy use in building, its classification with respect to primary energy use and greenhouse gas emission, the specification of minimum energy performance requirements for new or substantially renowated buildings, guidelines for the evaluation of the practicability of renewable energy sources, inspection of heating cooling sytems, abatement of greenhouse gas emissions, performance criteria and implementation guidelines.

In 2009, by signing the Kyoto Protocol Turkey became committed amongst various other improvements to limit the green house gas emissions. As per the final undertaking of Turkey during the Paris Climate Conference in 2015, Turkey aims to reduce its greenhouse gas emissions by 21% until 2030. Another milestone in energy efficiency was achieved through Ministry of Environment and Urbanization publishing National Climate Change Action Plan for 2011-2023 in 2012 defining the national path for energy efficiency. Under this agenda Energy Identification Certificate program is launched which obligates buildings to obtain energy certificates that will be registered in an online platform called Energy Efficiency in Buildings categorized under certain criteria where sanctions will be applied to the owners of those buildings exceeding the allowed limits [14].

First green building certificate in Turkey was obtained in 2008 and as of 2017 there were 400 buildings that are either certified or registered to LEED for a number of 300 projects, to BREEAM for a number of 82 projects and to other certification systems for a number of 8 projects with the most frequent one being LEED [15].

Meanwhile Turkey is still trying to develop a national green building certificate system which can better address local context together with the target to export this system to other countries. To achieve this goal three separate attempts were made to develop national certification under the competition between Turkish Standards Institute, Turkish Green Building Council and Mimar Sinan University. Finally, the Regulation for Certification of Sustainable Green Buildings and Sustainable Settlements 29199, December 8, 2014 was issued to set out the framework for certification process, main principles of defined parties like permanent committee, certification institution, assessment experts and sustainability experts and development of a national green building information system.

1.3. Problem Statement

As it can be seen from the developments mentioned above positive steps are being taken both globally and locally towards sustainability and although the necessity to have a paradigm shift from the traditional construction practices to green building practices is accepted globally, actual steps towards ensuring such shift yet remains as a major challenge. It is then the role of the academic studies to shed light on the unknown through combining the field experience and researches to facilitate this transition.

1.4. Purpose of Research

This study aims to identify the critical stage for taking the decision to implement green building practices during the construction of a project while analysing in detail related decisions in order to give more visibility to the decision makers' with regards to the degree of green building practices achievable over the construction stages depending on the timing of the decision from a sustainable project management perspective.

2. METHODOLOGY

To achieve the purpose of the thesis, following methodology is used:

- A literature review is performed in order to set out the key decision making factors for a sustainable project management, to identify key obstacles behind implementation of green building practices together with proposed solutions with the purpose of revealing the impact of time factor on taking the decision to implement green building practices.
- An online survey is created and shared with construction industry professionals having experience with green building practices in order to understand what is the tendency in the industry concerning the methodology and timing of the decision to implement green building practices, whether the outcomes are in line with the expectations depending on when such decision is taken.
- Then a case study is performed to analyse in detail the constraints faced at each stage of the construction in relation with categories under LEED certification system and to identify the critical stage for taking the decision to implement green building practices and to elaborate on the outcomes.
- Following a discussion on the results of the survey and the case study, a conclusion is drawn alongside with suggested areas for further research.

3. LITERATURE REVIEW

According to Cole [16] green buildings are economically viable, reachable by majority of clients and provide added value both in environmental outputs and economic performance. Nevertheless, there is still reluctance on construction industry side towards implementation of green building applications. Having the purpose of aiding the industry's decision making towards green building practices, it is therefore considered as a good starting point for this study to first cover major reasons behind this reluctance through review of the literature.

3.1. Key Success Factors and Obstacles Around Green Building Practices

Decision making is one of the important mechanisms that determines the success of a business. Yeager and Sommer [17] list four key factors for successful decision making in business as follows:

- Clear vision of the business situation.
- Clear and ambitious goals.
- Clear vision of the roles to play in order to achieve these goals
- Cost effectiveness of options for such decision making

As these factors are global, approaching the issue related to implementation of green building practices in construction industry by checking whether these conditions are satisfied in light of current market situation, will definitely provide an insight to the matter at hand.

Amongst various studies that are investigating difficulties encountered with green building practices, Chan *et al.* [18] in their research, listed obstacles for green buildings from green building designers' perspective. The findings of this survey yielded that designers avoid green buildings due to barriers such as higher upfront costs, lack of governmental incentives, lack of awareness and education on green buildings.

In a more recent study, Hwang and Tan [19] compiled a list of obstacles for green buildings through a literature review and tested the frequency and impacts of these obstacles having a survey with construction industry professionals. According to the results of this survey following obstacles were ranked as top five:

- High cost premium of green buildings.
- Lack of communication and interest amongst project team members.
- High costs associated with implementation of green practices.
- Lack of credible research on benefits of green buildings.
- Lack of expressed interest from client and market demand.

Again according to the participants of this survey, the impact of these obstacles were mentioned to be mostly on the project budget, where the impact on schedule and quality ranked below the budget but at similar importance in between.

In addition to these surveys, the smart market report for green buildings published compared the evolution of these challenges between 2008 and 2012 [20], where the results can be seen in the below Figure 3.1.

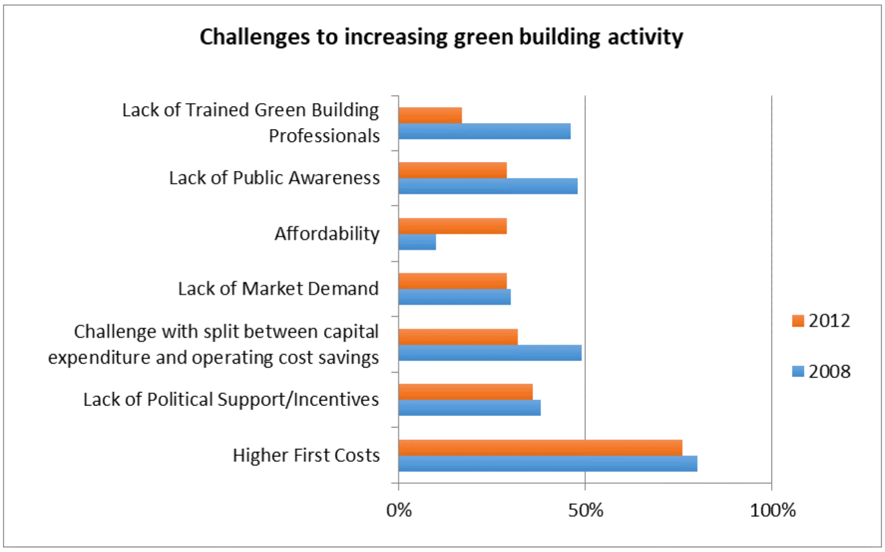

Figure 3.1. Challenges to increasing green building activity.

Looking at these different studies, it is important to note that their results converge on same obstacles. Although it can be seen from the graph that there is an overall reduction in these obstacles since 2008, they still remain to be the main barriers for implementation of green practices in construction.

Going back to the key factors behind successful decision making, these obstacles can be grouped as in below Table 3.1, for better evaluation of the feedback obtained from the industry professionals. This interpretation then clearly shows that in the eyes of the professionals, factors for decision making are not yet matured for green building practices in construction industry and there is a need to remove these obstacles in order to clear the path for decision making.

Table 3.1. List of obstacles in the construction industry.

Key factors	**Obstacles**
Clear vision of the business situation	lack of expressed client interest lack of market demand lack of political incentives lack of public awaraness
Clear set of goals	lack of credible research on benefits of green buildings
Cost effectiveness	high cost premium of green buildings
Clear vision on the action plan	lack of communication lack of interest amongst project team members

Therefore, scope of this study is structured in the following sense, where first literature will be reviewed to reveal studies that are helpful in answering these concerns, then another important factor in decision making, timing, will be introduced and its effect on decision making on green building practices will be investigated with the survey and the case study.

Looking first at business situation for green buildings, the results of comparison of 3 year looking forward trends between 2008 and 2012 worldwide, reflect important findings that addresses this feedback of lack of interest from client and market demand [20].

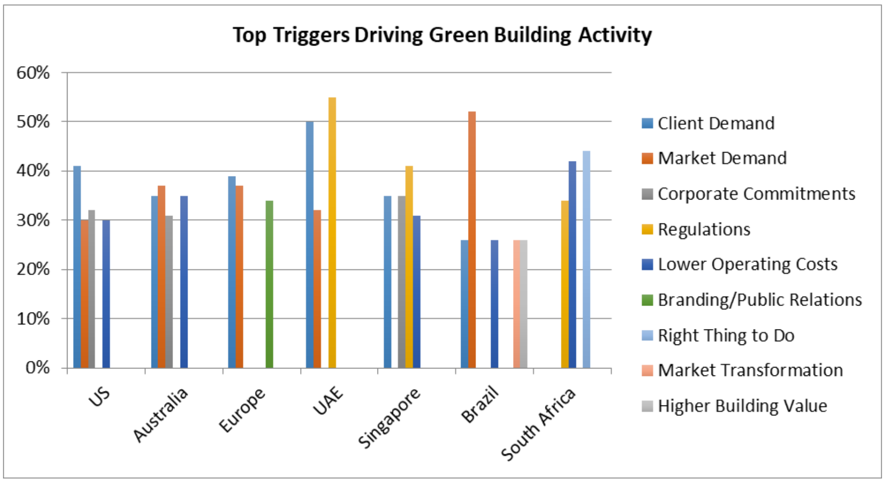

Figure 3.2. Top triggers driving green building activity.

It is possible to interpret from Figure 3.2 that, in places where green building practices are present for a longer time, such as US, Australia, Europe and Brazil, market and client demand itself is pushing the industry towards green buildings and in other regions where these green practices are relatively new, it is seen that transition is stimulated by imposing regulations favoring green building practices as political incentives.

Furthermore, the results obtained from participant professionals to this research indicate that there is an increase in green building involvement of architects, engineers, contractors, consultants and owners which is categorized under the degree of involvement as a percentage of the amount of works they performed during that year in the below Figure 3.3.

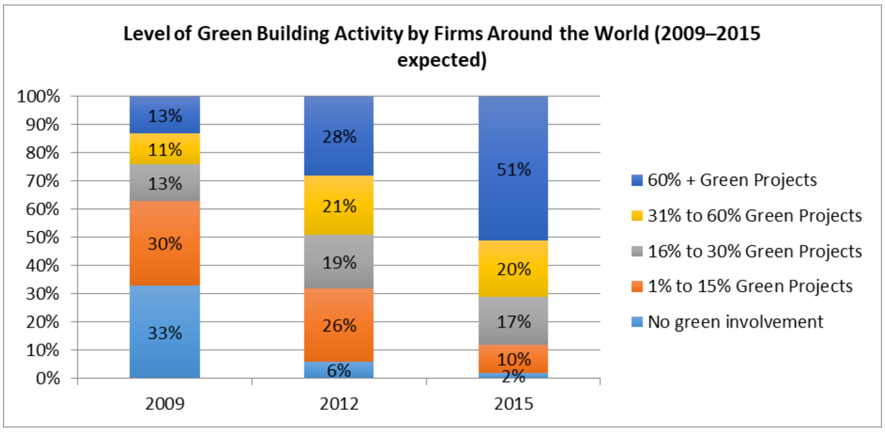

Figure 3.3. Level of Green Building Activity by Firms Around the World (2009–2015 expected).

Even though lack of client, market demand, political incentives and public awareness were expressed to be obstacles to implementation of green building practices, the findings of this report show that there is effort spent globally to stimulate these areas and that the trend is going in favor of green building applications hence the picture on business situation is getting more clear.

The incertitude on benefits of green buildings has an effect on the decision making factor of clear set of goals, since without having a proper view on the outputs of green building practices, that is not knowing what to target for and to achieve, it would not be possible to define precise goals. This topic of benefits is one of the most addressed topics related to green buildings in literature, however as per above surveys, industry raised concerns on lack of credible research on benefits of green buildings. Although this situation looks like a contrast between literature and industry at first glance, nevertheless, a compilation of conclusions of the studies available in literature would set out some principal benefits which in turn would provide insight to decision makers in the industry.

3.2. Green Building Certification Systems and Benefits of Green Buildings

In order to properly address benefits of green building practices, literature makes use of life cycle assessment since there exists both short term and long term benefits. LCA means evaluation of some aspects, mostly environmental, of a product system through all stages of its life cycle covering the techniques and tools that are developed to help in environmental management and sustainable development in the long term [21]. Given this definition, LCA adds more stages to the traditional construction project stages.

Traditional explanation of the construction project life cycle, divides the project into four stages [22] being:

- Feasibility (project formulation, feasibility studies, strategy design and appraisal).
- Planning and design (base design, cost and schedule, contract terms and conditions, detailed planning).
- Construction (manufacturing, delivery, civil works, installation, testing).
- Turnover and Startup (final testing, maintenance).

However, taking green aspects into account in a construction project necessitates a broader scope of vision for better tracking of the impacts of the decisions being made, hence implying a life-cycle approach beyond traditional project stages by including operations and demolition stages.

The benefits associated with green building practices can be grouped under three categories as listed below:

- Economical.
- Environmental.
- Social.

Among these categories, economical benefits are mostly addressed in the literature since they are easy to measure such as increase in rents, occupancy rates, cheaper green building specific financing, cheaper insurance premia or reduction of operating and maintenance costs. Following category, environmental benefits, are explained in terms of reduction in greenhouse gas emissions, energy consumption, waste generation and water consumption where measurements are more difficult because the scope gets larger and complicated since the impacts are spread on entire project life cycle covering all of resources consumed and waste generated from the production of construction materials to the end of demolition of the building. Last category social benefits are more subjective and they are explained in terms of better opportunities and standards for local community around green buildings such as new business opportunities through local procurement, superior indoor air quality, authentic design, fresh spaces making use of natural light, satisfaction obtained from using an environmentally friendly building and prestige.

Before going into the results of literature review on benefits of green buildings, it is seen appropriate to make a side note on green building certifications since most of these studies make use of green building certifications to explain the degree of green in a building and hence the benefits are given against the level and the type of certification obtained. It should also be noted that even though the goal of these certificates are similar, in reality there exists significant differences between each of them which therefore plays an important role in decision making. For instance, Smith *et al.* [23] applied Green Globes and LEED certifications to the same courthouse where it obtained base Certified level from LEED and Two Globes level from Green Globes which was shown to be equivalent of LEED Silver category. The findings of the study of Roderick *et al.* [24] also shows similar differences, where they made a comparison for energy performance and corresponding energy rating of a case study office building between three widely used environmental assessment schemes LEED, BREEAM and Green Star and found out that while having a high energy rating score from Green Star, the building obtained a low score in BREEAM and failed to be certified in LEED scheme, hence pointed out that the ratings are highly dependent on the assessment method used. Nevertheless it is seen appropriate by most of the studies to benefit from these certification criteria while making reference to level of green in buildings as certifications such as LEED and BREEAM are being used worldwide hence bringing certain level of standards that provides a base of comparison for different projects.

Having made this side note, on economical benefits, a research conducted on green office buildings reveals important relationships between certification and energy savings on the value of the building which is compared to nearby buildings. The rent for a commercial building with an Energy Star certification is 3% more per square foot, with an effective difference to be about 7% and an incremental selling price up to 16% when compared to a nearby identical commercial building without certificate. The incremental value of a green building is estimated to be USD5.7 million more than a comparable nearby non green building. Also a 10% decrease in energy consumption leads to 1% increase in the value of the rent of the building [25].

Another important study based on LEED certified buildings for related costs and benefits by Kats [26] reflects that the additional average cost of building green is less than 2% or 3 USD to 5 USD per square foot when compared to conventional designs for the same buildings. The report concludes that the benefits associated with green design are between 50USD to 70USD per square foot in a LEED certified building, more than 10 times the additional cost acquired. It is also mentioned in the report that green building properties result in premia reductions for insurances such as business interruption, property loss prevention, worker health and safety and natural disasters thanks to improved indoor air qualities, self sufficient nature in terms of energy and advanced technologies.

On financial benefits as part of economical benefits, it is shown that the degree to which Real Estate Investment Trusts invest in efficient buildings is positively related to the quality of their credit ratings, and it is also associated with a significantly lower spread. The relation persists at the level of individual buildings and their mortgages: environmentally-certified buildings are financed at significantly lower spread, varying between 30 and 60 basis points, depending on the specification [27].

On environmental benefits, as mentioned at the beginning key parameters are reduction in greenhouse gas emissions, waste production, water and energy consumption. As LCA boundaries cover manufacturing phase, use phase and demolition phase benefits mean in this context an overall reduction in these outputs at all phases. Ramesh *et al.* [28] explains that buildings have a corresponding energy at each of these phases as embodied energy, operating energy and demolition energy. Hence total energy of a building throughout its life cycle is calculated by sum of these energies. They conclude that operating energy accounts for 80%-90% of this life cycle energy where embodied energy has a share of 10%-20% and demolition energy is negligible, pointing out the high potential on energy savings during operation phase. Similarly, same approach is also valid for emissions, waste production and water consumption.

Kats [26] points out that energy consumption in LEED certified green buildings is on average 25%-30% less than energy consumption in conventional buildings during operations phase which in turn reduces the related total emissions by 36% as opposed to conventional buildings. Construction waste generation is found to be reduced between 50% to 75% in projects using LEED certification system. Also it is noted that in case of renovated projects, 75% to 100% of building envelope and shell, 50% of non-shell elements(walls, floor systems etc.) can be used eliminating potential new wastes. For water consumption, LEED envisages over 30% reduction for indoor use and over 50% for landscaping compared to conventional buildings.

Social benefits of green buildings on the other hand are expressed under four categories [29]:

- Healthier building occupants, as less occurrence of sick building syndrome symptoms such as fatigue, dizziness and irritation, allergy and asthma symptoms, transmission of infectious diseases due to ventilation and air conditioning systems used.
- Improved comfort, satisfaction and well-being of building occupants as a result of lighting design incorporating both daylight and electric lighting, individual controls for thermal comfort and better air quality through making use of natural

ventilation

- Increased safety and security of building occupants, as a result of improved control of air distribution systems in cases of emergency or improved use of daylight facilitating evacuation in cases of power outages.
- Community and societal benefits such as aesthetics resulting from architecture principles used in green buildings, minimized strain on local infrastructure or reduction of impact on surroundings both during construction and operation.

When analyzed together, above compilation of studies offer insight on business situation of green buildings, future market trends and related benefits. To further help the decision makers on setting clear targets, below summary of goal categories can be derived from the benefits mentioned above [23]:

- Energy use;
- Water use;
- Pollution (emissions, solid waste, effluents);
- Indoor environment quality and occupant comfort;
- Transport;
- Materials;
- Site ecology;
- Other sustainable systems and processes.

3.3. Cost Premium of Green Buildings

Having set out the list of goals, following step is to adress the third decision making factor, the cost effectiveness of options for achieveing these goals. Now moving further to industry's perception of cost premium, introducing green building practices to a project requires more complex scheme to follow in terms of design, construction and project management which as mentioned in [30] are key factors influencing project cost. However an analysis of these costs should check the difference between net present value of the reduction in long term operational costs and increase in upfront costs before deriving any conclusions on the overall cost of the project.

For this purposes a diagram of this life cycle approach on costs for construction projects is visualized in below Figure 3.4 based on HM Treasury Procurement Guiadance No 35 Life Cycle Costing [31].

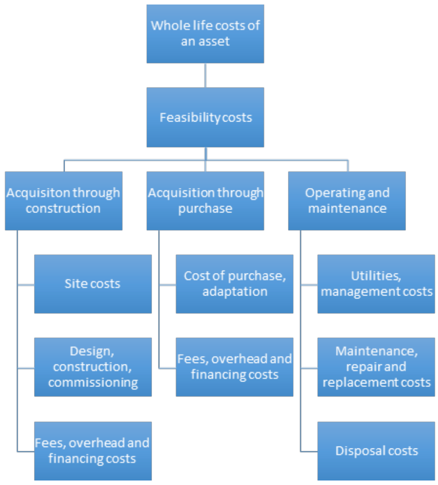

Figure 3.4. Costs across the lifecycle of the project.

Literature review shows higher upfront costs for a project adopting green building practices, which is consistent across numerous studies showing a cost premium range associated with level of certification between 0.66% and 8% [26, 32, 33].

However given the whole life span of the building considered under LCA approach, there is in fact a cost decrease associated with implementation of green features for operating costs varying from 9% to 27% [33]. Furthermore Kats [26] concludes that total 20 year NPV of benefits obtained exceeds the initial premium by 48.87% for LEED Certified and Silver, 67.31% for LEED Gold and Platinum per square foot.

Given these findings, the cost related part of the decision making on green building practices then turns into a matter of perception. Bartlett and Howard [31] tests this point of view across various stakeholders such as tenant, developer, institutional investor and owner-occupier by expressing it in terms of taking measures towards energy savings in a PFI example. Although operating costs are considered to be unlikely to incentivize the tenant towards energy saving, the cost impact of indoor environmental quality on employees appear to be higher than costs associated with measures towards energy saving for the tenant. From developer point of view energy savings is evaluated as important only in terms of marketing the building. Institutional investors are described as to show interest in energy efficiency to keep a low risk investment. Whereas the owner-occupier is stated to be the most interested party towards energy savings due to high relevancy of costs and returns of the building. These differences in point of view across stakeholders are in fact strong indications for communication across stakeholders while setting out the goals and implementing green building practices.

3.4. Decision Making Tools for Green Building Applications

Nevertheless to help decision makers on overcoming the difficulties with upfront costs, there are various decision support tools for green buildings that are offered in literature. National Institute of Building Sciences [34] compiled a list of such decision support tools available for green buildings under 14 categories in below Figure 3.5.

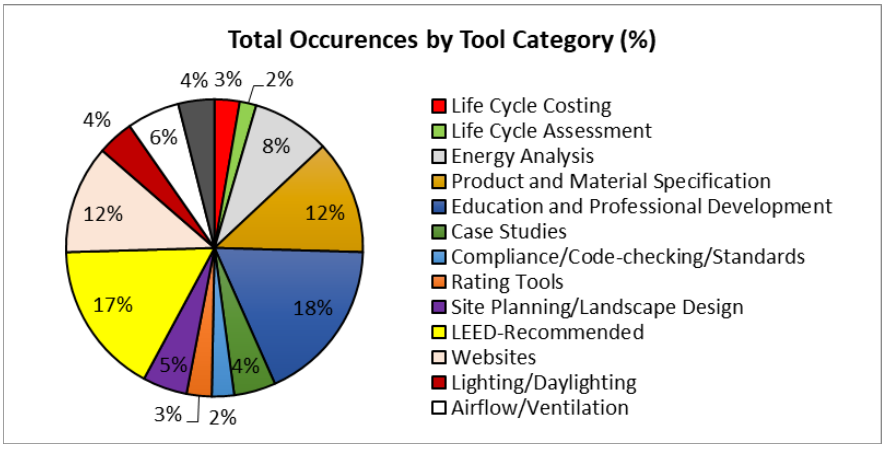

Figure 3.5. Total occurrences by tool category.

These categories are further defined below:

- Life cycle costing: Tools for determining the life cycle costs of the building.

- Life cycle assessment: Tools to make an environmental assessment of buildings based on various design/build options.
- Energy Analysis: Software tools that enable simulation of building energy use, analyze energy and cost savings for different design strategies.
- Product and material specification: Tools that describe products or materials for evaluation of alternatives and identification of sustainable products and suppliers.
- Education/professional development: Tools designed to inform and educate design professionals on sustainability and green building.
- Case studies: Databases containing green building projects.
- Compliance/Code-checking standards: Tools designed to check compliance with building codes and standards.
- Rating tools: Tools to rank the building according to pre-set standards/categories of achievement.
- Site planning/Landscape design: Tools for identifying and evaluating alternate landscape and site planning options.
- LEED-Recommended: Tools specifically addressed to LEED point attainment.
- Websites: Websites designed to assist professionals in meeting green building goals.
- Lightning/Daylighting: Simulation of design options for lighting and other lighting tools; internal and external lighting.
- Air Flow / Ventilation: Simulation of HVAC systems for air flow with various building design options; other tools for Indoor Air Quality.
- Mechanical/Electric/Plumbing Systems: Tools supplying information and/or identifying products for design and specification of M/E/P systems.

As it can be seen from the above chart, there are variety of tools available for optimization towards different set of goals. Amongst such tools, a multi-objective optimization model offered by Wang *et al.* [35] in order to assist green building design at conceptual design stage makes use of life cycle assessment of building to find optimal design, whereas another study made by Tatari *et al.* [36] makes use of neural network approach to reveal relationship between LEED categories and cost premiums. Another study of Castro-Lacouture *et al.* [37] offers a mixed integer optimization model to maximize the LEED rating credits that can be obtained based on material selection. Alternatively an heuristic model which is less sophisticated when compared to mixed integer programming is proposed over forty two energy efficiency measures on a case study for a university campus with a minimal deviation from the exact mixed integer program solution [38]. Again on product selection, Lippiatt [39] offers a tool benefiting from ASTM standard for overall performance measurement and points out the importance of life cycle assessment of product for cost and effect consideration where single attribute environmental claims such as recycling or comparisons made on a single unit of measurement basis might mislead designers.

Given all these methods, current situation shows that the literature is aware of concerns of industry on cost-effectiveness of different options, and these are increasingly being addressed in order to satisfy the third decision making factor.

3.5. Implementation of Green Building Applications

For the last factor on clarity of roles to be played during implementation of green building features, decision makers can benefit from certification system specific implementation guidelines. In one such study Bayraktar and Owens [40] offer a framework in Figure 3.6 for implementation of LEED in new construction projects which lists the actions to be performed during the course of a construction project.

Although this chart is developed for LEED implementation, it contains basic principles that can be discussed for the purpose of this study. As it can be seen from Figure 3.6, the process starts with determining the owner's requirements from the project. These requirements are set out as expectations of sustainability, energy efficiency, system and equipment, building occupants, indoor environmental quality, long term return on investment, budget and paybacks, scheduling and operations of the project and the level of commitment to green building.

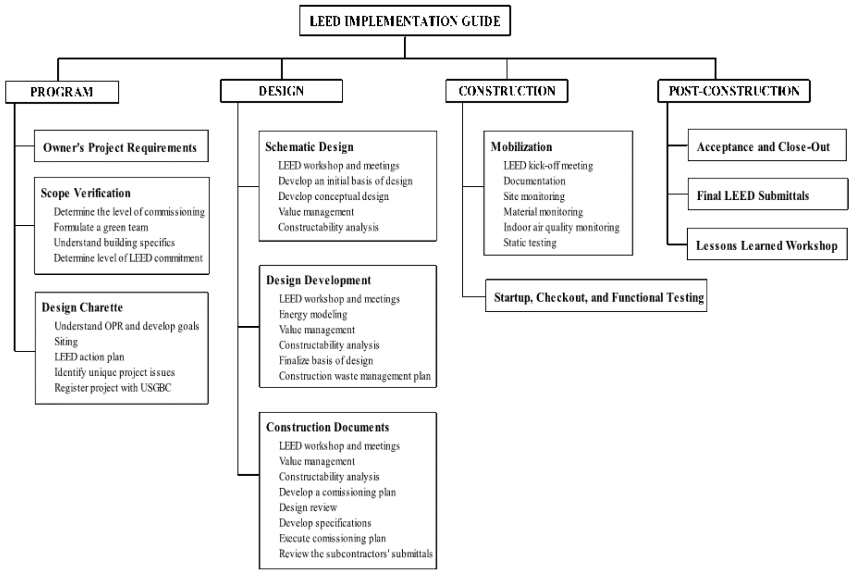

Figure 3.6. LEED implementation guide.

This is followed by creating a dedicated green team that consists of at least owners' representative, contractor, architect and construction manager to properly analyze the requirements of the owner. Further enhancement of the team by inclusion of other stakeholders at early stage such as major subcontractors, consultants or material suppliers would also help obtain more accurate results on the feasibility of the project. Green building features requires detailed feasibility studies, if not the case, the project can easily result in costly and misplaced investments where the budget is exceeded and the desired outcome is not achieved. A proper study would then allow decisions to be taken on which type of certification will the project pursue or whether it is worth pursuing a certification. Another important decision at this early stage is the selection of land, since this decision itself sets the boundaries of project development. Considering all these a certain budget allocation or an offer in case of a tender is made to the project.

Once the set of green goals together with the budget are defined and agreed in this preliminary phase, design is developed accordingly and compliant with project requirements. However this is a rather cyclic process, where studies take place through numerous workshops to assess the costs and benefits of the implementation of green properties associated with the design that aims for the achievement of the predefined goals, hence various decision making methods also noted during literature survey are used for assessing cost effectiveness of different options. These studies include energy modelling, value management and constructability analysis. It is also important to pass this goals from top management to the employees otherwise there would be the so called green baton effect where some part of the green targets are dropped at each stage due to miscommunication hence the outcome of the project goals turns out to be substantially far from the initially aimed target [41].

Meanwhile several action plans such as waste management plan, environmental and social action plan and commissioning plan that will be implemented during construction are prepared. Furthermore a procurement plan is also developed at this stage, where the life cycle effects of the materials and equipment to be used are taken into account assessing the harm done to the environment during production, actual use and whether the product is recyclable at the end of its useful life. Additionally, this stage can be supported by the implementation of green specifications into the main and sub-contracts regulating the procurement to take place in a sustainable manner.

Once the design, budget and schedule is approved, construction period main activities related to green buildings are mainly documenting, monitoring and executing the action plans that were agreed during the planning and design stage. Here main focus is on waste reduction which can be in terms of the construction inputs that are labor, equipment and material [41]. Waste of productivity generated by inadequate planning of the activities in the construction site, such as bad allocation of the work force, inefficient use of the equipment resulting in increased fuel consumption and more pollution, lack of proper storage means for the materials on site leading to weaknesses in material properties, are possible examples that these plans account for.

Following the construction completion, a turnover phase is reached where verification is sought on systems that they operate and perform as required before actual completion certified. A commissioning authority inspects the site for potential defects on the quality of the building, the proper functioning of the systems and whether the utilities are properly provided such as power, water and gas sources. Once the building is approved by the owner, it is important to deliver system manuals and training to the facility management staff for them to be able to properly operate the building.

Adding on this study, during operation and maintenance stage the presence of green aspects takes the form of ensuring the performance of the building in terms of energy and water efficiency, renewal of the malfunctioning parts in compliance with the green specifications, maintaining the green properties throughout the building life and looking for possible improvements in the green industry that can be implemented to the building itself during renovations.

At the end of the project life cycle, the green properties focus on recycling of the building materials where the aim is to minimize the negative effect of waste produced during the dismantling phase on the environment and to be able to reuse the materials of the dismantled building on other projects.

3.6. Outcome of Literature Review

Having discussed the roles to be played during this process finalizes the literature review to point out studies addressing all four decision making factors. However during the review, it is observed that the effect of timing on decision making is not taken into consideration. Although it is obvious that the timing of the decision to implement green building practices should be as early as possible in order to maximize the influence over the project, it is not clear in the literature what is the latest stage to take such decision during the construction of a project.

4. RESEARCH METHODOLOGY

In order to collect the necessary database both a survey and a case study have been performed within the context of this study.

4.1. Survey

The survey is structured to collect relevant information from professionals having experience with green building practices that might pave the way for future research topics alongside with the timing of such decision taken. Survey was prepared online via a web based survey platform named Online Anketler, both in English and in Turkish to eliminate any potential language barrier for local participation. And to be able to maximize the participation, survey was limited to ten questions containing multiple and single choice questions, therefore taking 3 minutes on average as response time. The question form of the survey is provided in the link in Appendix A and the results in Appendix B.

The participants are required to fill out a brief personal information form prior to their access to survey questions. This information form consists of six open ended questions where first two questions are related to participant's personal information such as email address and title in the company, remaining three of the four questions are focused on company details such as number of employees, main activity area, annual turnover in USD currency and final question is about the location of the project. Considering the definition and the importance of confidential information in private sector, these open ended information questions were prepared carefully in order to verify the participant's identity, alongside with the scale of the company that the participant is being employed under and the location of the project for grouping purposes without placing the participant under doubt of potential violation of confidentiality.

First question of the survey asks the type of the project that the decision on going green was made. The purpose of this question is to see on what type of projects green building practices are implemented. The following types of buildings are listed in the answer choices:

- Public Building.
- Residential Building
- Commercial Building
- Industrial Building
- Other

These choices were prepared by making use of common major building classifications available in literature. The other answer choice is also made available to the participants in case the participant does not see the project fitting into any of these common classes.

Second question directly asks at which project phase the decision on implementation of green features was taken. The project is divided into following phases for more sensitivity:

- Pre-design / feasibility / tender phase
- After the pre-design/feasibility/tender phase and before the start of construction (Final Design phase)
- Between the start of construction until the completion of structural works
- After the completion of structural works and before the start of interior works
- After the start of the interior works before the completion of the building
- During the operation phase

As for the third question, the purpose is to find out the targeted level of green features that will be included in the project. Following answer choices were presented to the participant:

- LEED-Platinum or equivalent
- LEED-Gold or equivalent

- LEED-Silver or equivalent
- LEED-Certified or equivalent

As discussed in the previous sections, even though their scope and precision is questioned in literature, green building assessment systems offer a way to gage the level of green properties included in a project. There are many green building assessment systems available and according to literature review each tool has its own focus points for assessment hence applying two different assessment systems to the very same building yield different results. Furthermore these studies also show that it is not possible to declare superiority of one system over the other due to their different characteristics, as well as to equate one level of certain system to another level of other system.

It was also discussed that it is possible to have green features in projects that do not qualify for green building certification. However here, since the purpose is to know whether the targeted level is achieved or not at the end of the project, this level is expressed in terms of one of the most widely used certification systems that is LEED for simplicity. To be able to cover those projects that did not use LEED certification, "or equivalent" is added to these answer choices. This equivalency indicated here is not a direct conversion between LEED levels and other certification systems, but rather a way to express the targeted level such as very high, high, medium, or basic.

Following the idea of the third question, fourth question asks the achieved level of green features in the project. Again the same answer choices were used with the third question, but additionally fifth choice is added which is failure to obtain certification. The answers to this question when evaluated together with the answers to the third question will help visualize the consistency between the targeted level and achieved level.

Fifth question is proposed as a multiple answer question, where it asks the kind of financing used in the project. The main purpose of this question is to see the types of financing used during implementation of green building practices in a project. The following answer choices were presented:

- Project Financing
- Bond Financing
- Private Equity / Venture Capital Investment
- Equity
- Please indicate any green building specific finance instrument used, if applicable

To present the background of this question, as literature review showed, there are green building specific loans available in the finance market of developed countries. There is also effort being paid to make these loans available to developing countries under the leadership of financial institutions and development banks such as EBRD and IFC. Also based on literature review, it is seen that Real Estate Investment Trusts invest in efficient buildings with a significantly lower spread. It might also be the case that a minimum of green level is required prior to receiving certain investment. Furthermore the concept of green bonds are now being used in the U.S. and Europe that are issued to finance environmentally friendly projects.

In the sixth question, the participant is required to compare the outcome of the project to the expectations in terms of financial returns. As seen from literature review, green buildings are generally associated with increased occupancy rates, rental revenues and decreased operational costs therefore it is considered important to collect first hand feedback.

Following the study of Lam *et al.* [42], it is seen that the involvement of the project stakeholders is seen as one of the key factors for successful implementation of green features in a project. Hence seventh question asks the identity and the level of involvement of the project parties in the decision making process for green feature implementation on a scale from 1 to 5 to obtain information related to the overall level of stakeholder participation in green building projects. For the purpose of this question project stakeholders are considered as:

- Client
- Project sponsor

- Project manager
- Designer / architect
- Main contractors
- Subcontractors
- Technical / Financial Service providers
- Consultants
- Material and equipment suppliers
- Site personnel
- End-users / customers
- Finance providing entities
- Other

For the eighth question, level of sensitivity/awareness of end-users towards the green features implemented in the project is asked to the participant. Although public awareness towards green buildings is considered as in an increasing trend globally in the literature, it is important to measure this awareness from the project level. Since the demand has significant effect over the supply in private sector, awareness of the end-users is also expected to be a major motivation on implementation of green features during the project.

The implementation of green features in a project requires far more complex project management, design and delivery systems. As a result of this complexity, there is the possibility that these properties might not be implemented correctly during the process or might carry flaws due to the inexperience of the workers or lack of expertise of quality inspectors. This situation might in turn affect the availability and maintenance of the building during the operation phase such as frequent malfunctioning of automation systems which will mean additional costs. Even without any flaws, green certified materials might be more costly than their conventional alternatives hence during the operation phase, depending on their service life, properties and the performance requirements for the availability of the building, might be more cumbersome to maintain and replace, hence adding burden on the maintenance costs or resulting in some penalties due to not satisfying performance requirements when compared to the maintenance of a conventional building. In light of this discussion, ninth question of this survey asks about the impact of implementation of green features on the maintenance costs and the availability of the building when compared to conventional buildings that the participant had experienced. Since the studies related to energy performance of green buildings show that there is a reduction in operation costs due to increased energy performance, this question was put forward in order to see whether the same applies for the maintenance and availability aspects of the green buildings.

Considering the criticisms raised against LEED system on whether a LEED certified building will continue to perform as promised by the initial certification [43], tenth question is put forward in order to get the opinion of green building professionals on the consistency between the targeted level and the outcome in energy performance.

Companies in Turkey having a track record of green building projects were engaged via electronic mail and phone to identify the project related professionals in these companies. After this identification process, survey link is shared with these participants. As mentioned before in order to prevent any concerns of participants on potential confidentiality issues further explanation to the research is attached to this link together with the full identities and contact details of the surveyor, thesis supervisor and faculty secretary.

Apart from this approach, associations such as Housing Developers and Investors Organization, the Association of Real Estate and Real Estate Investment Companies, Turkish Contractors Association, Center for Strategic Thinking in Real Estate, Istanbul Construction Association and Turkish Green Building Council were contacted and the same information related to this study is shared with the member companies of these associations.

For the external projects, Turkish Contractors that are also operating outside Turkey and their foreign partners were contacted with a similar approach for their projects that obtained green building certification in locations such as Russia, Africa, Middle East and Europe. Also informative electronic mails were sent to United States

Green Building Council that are briefly explaining the purpose of the study together with a link to survey, in order to receive the institution's help on distribution of this survey to a wider network.

4.2. Case Study

According to Ministry of Energy of Turkey's reference energy consumption database, the hospitals account for the second highest energy consumption per square meter per year in the buildings category after the shopping malls [44]. The reference value set for shopping malls by the regulation is 750 kWh/m2-year which is followed by the healthcare facilities at a consumption rate of 600 kWh/m2-year. Considering the potential impacts of recently tendered pipeline of health campuses in Turkey which shall be described in detail in the next chapter, it is found relevant to conduct the case study on three of these hospitals that are recently built. All three hospitals were built under the PPP scheme for which the decision to target a LEED certification was given at early construction stage therefore the data collected shall allow further analysis of the degrees of freedom and constraints faced by the projects compared to each LEED criteria. Consequently this study shall derive a decision-making tool showing the degree of green building practices achievable with limited risk at each stage of construction. Furthermore the first year operational results on energy and water consumption are analyzed with the purpose of elaborating on benefits obtained from implementation of such green building practices.

5. ANALYSIS OF FINDINGS

This chapter contains presentation and analysis of the data collected from answers of participants to survey questions and from projects on which case study is performed. Prior to elaborating on the findings, below sections shall give some information on the survey participant profile and on the projects that are subject of the case study.

5.1. Survey Participant Profile

Survey was distributed to a large chain of industry professionals however only 30 of the survey forms were completed by the participants therefore the results will be shared and analyzed over these 30 forms. As the number of completed surveys are too small to form a sample size for statistical analysis with high confidence level, no such analysis was performed.

The feedback collected by the survey mostly represents the feedback of projects in Turkey as they account for 83% of the project locations expressed by the survey participants as shown in below Figure 5.1, whereas remaining of the feedback is distributed equally among Gabon, United Arab Emirates, Russia, United Kingdom and United States as 3%.

Furthermore the distribution in project type as illustrated in Figure 5.2 below shows that more than half of the feedback obtained belongs to commercial buildings at 53% which is followed by residential buildings at 27%, public buildings at 13% and industrial buildings at 7%. As the majority of the feedback is coming from Turkey, this result might suggest that that there is a preference to implement green building practices in commercial buildings in first place rather than other buildings.

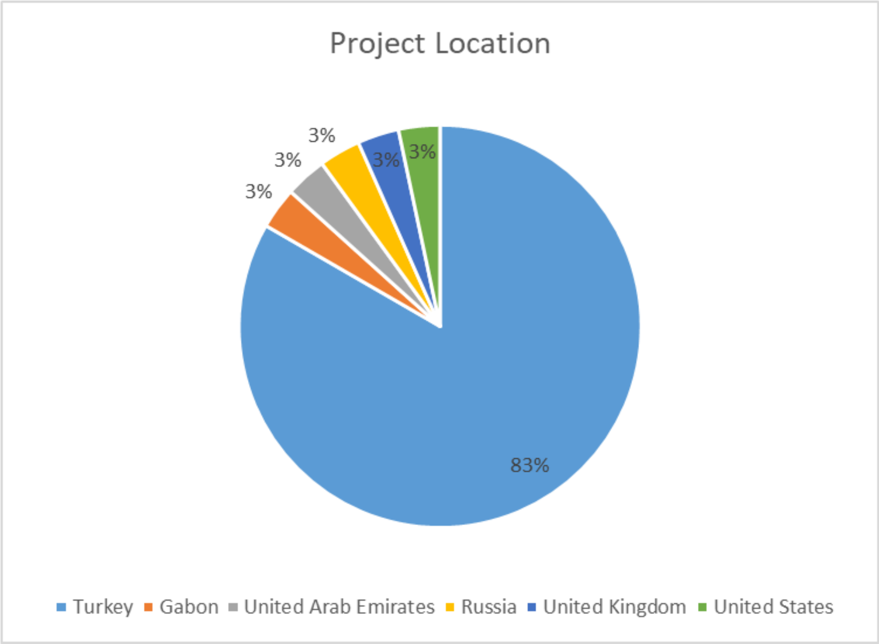

Figure 5.1. Breakdown of project locations.

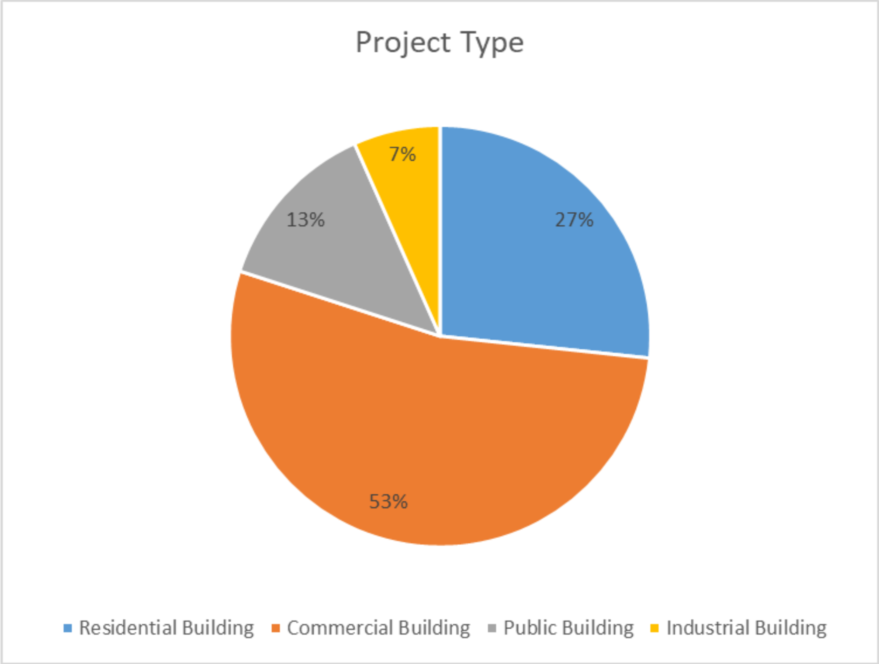

Figure 5.2. Breakdown of project types.

As per Figure 5.3 below, size of the companies of the parcitipants from a number of employee perspective can be grouped under three categories whereby 40% of the feedback is coming from companies having less than 100 employees, 43% of the feedback is coming from companies having between 100 and 1000 employees and 17% of the feedback is coming from companies having more than 1000 employees.

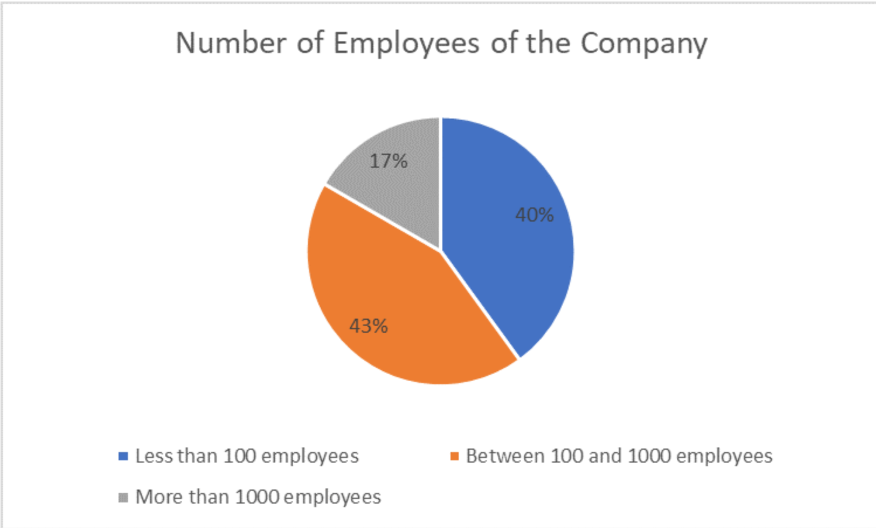

Figure 5.3. Breakdown of company size per number of employees.

Moreover size of the companies of the participants from an annual turnover perspective is grouped in three categories in below Figure 5.4 whereby 47% of companies represent an annual turnover that is less than 10m USD, 27% of the companies represent an annual turnover between 10m USD and 100m USD and the remaining 27% represent an annual turnover that is more than 100m USD.

Main activity area of the companies of the survey participants are shown in below Figure 5.5. While the results represent mainly the feedback of companies whose core business is construction or real estate development, it can also be seen that the results contain feedback from other areas such as project management, consultancy, infrastructure fund, facility manager and industrials.

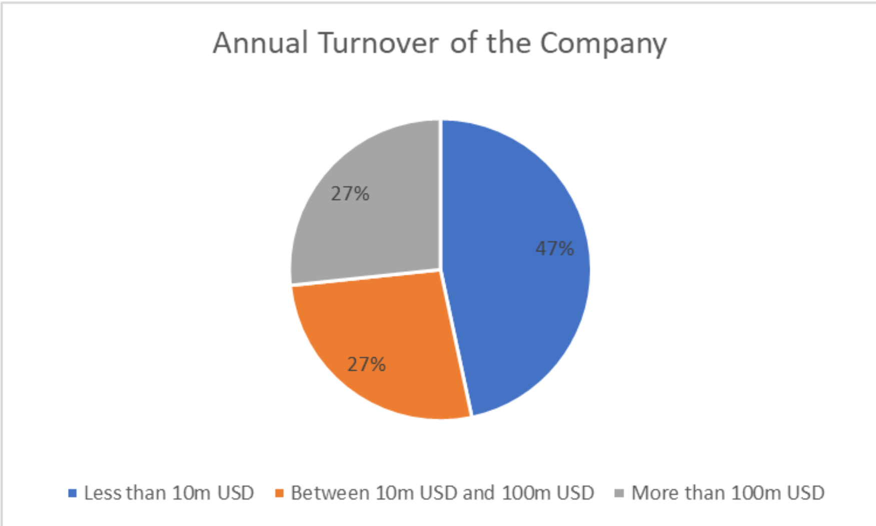

Figure 5.4. Breakdown of company size per annual turnover.

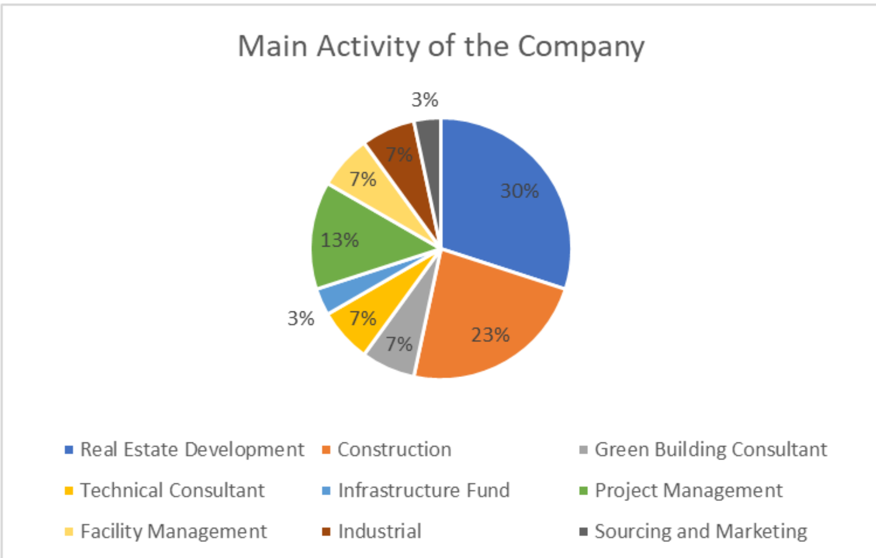

Figure 5.5. Breakdown of main activity area of the companies.

The job titles of survey participants are grouped under major categories to facilitate understanding the profile of survey participants. As it can be observed in below Figure 5.6, the feedback obtained captures the feedback of professionals that are positioned in management level with 43%, in quality control department with 20%, in mechanical and electrical departments with 17%, in design department with 10%, in business development department with 7% and in budget and planning department with 3%.

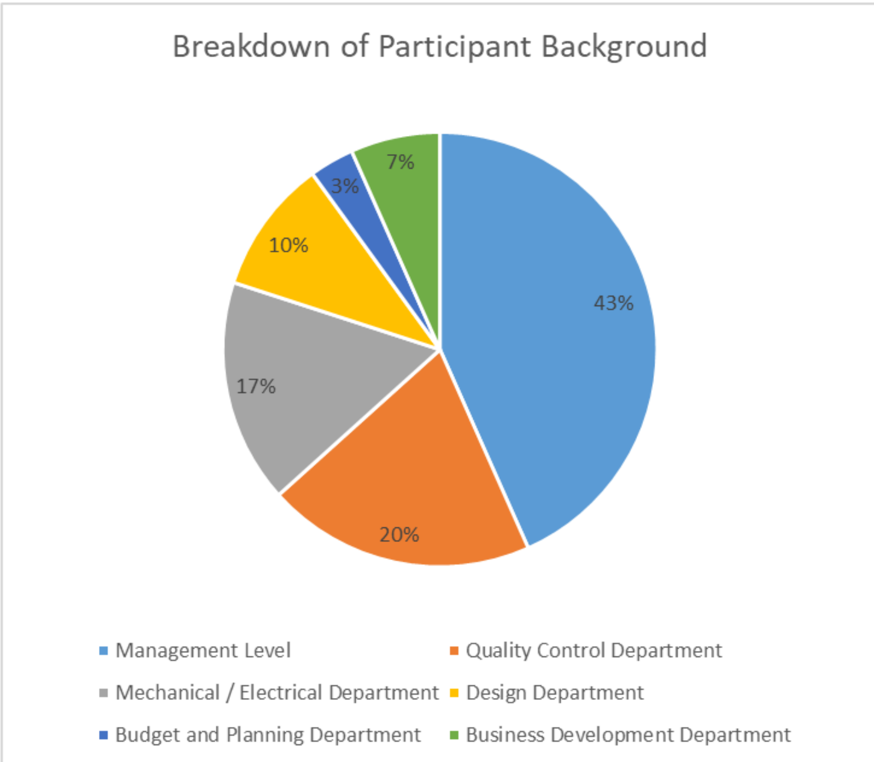

Figure 5.6. Breakdown of survey participant profile.

5.2. Background Information on Case Study Projects

Over the past two decades Ministry of Health of Turkey initiated a series of substantial reforms to restructure the country's healthcare sector.

Prior to 2003 the public healthcare system in Turkey was facing serious problems due to the inadequacy of the system and the facilities to meet the actual demand. The social healthcare coverage system consisted of several fragments each having different scope and covering only a certain part of the population restraining equal access to basic health care services. Furthermore existing public health facilities were in poor shape, limited in terms of scope of treatment offered, had patient restrictions according to the patients' social security coverage and were failing to absorb the demand.

Only a minority of the population who were able to afford private insurance had access to timely and relatively high-quality health care services because of this structural problem. Hence in order to overcome this major problem, Ministry of Health initiated the Health Transformation Program. The purpose of the program was to increase the quality and efficiency of the healthcare system and enhance access to healthcare facilities. Therefore a series of major reforms were made to the system which are explained below:

- All public health facilities were merged under the responsibility of the Ministry of Health in 2005. This was the first step taken to consolidate the provision of public health care services under one authority. This merger resulted in the opening up of all public facilities to the entire population, which was a significant step to allow the population equal access to healthcare services.
- The social security system went through a major restructuring. From 2008, all of the five main social security funds, covering social health insurance, were transferred to the newly created Social Security Institution. This had the impact of aligning the benefits of social security for the population as the previous coverages were offering each different benefits. Therefore the General Health Insurance Scheme, which began operation under the Social Security System in 2008, allowed all of the population to join the social health insurance system for the first time. This change had significant positive impacts on the populations as the insurance coverage for the poorest population groups in Turkey increased from 2.4 million to 10.2 million people in 2011. Healthcare service access increased across the country in particular, access and use of key maternal and child health services improved to help reduce the maternal mortality ratio, and infant and neonatal mortality rate, especially in socioeconomically disadvantaged groups.

- The program increased the administrative and financial autonomy of hospitals. The major development in the hospital sector after 2003 focused on increasing the role of the private sector. Accordingly, a PPP Department under General Directorate of Health Investments of the Ministry of Health was established for the planning of the construction, renovation and management of health facilities in cooperation with the private sector.

As part of the transformation program, the Ministry of Health has considered health campus planning based on four main reasons/requirements:

- Effectiveness of health services across the country
  - (i) Expanding the variety of treatment across the country and provide easy access
  - (ii) Completing regional development in the field of health
  - (iii) Improving the quality of service
  - (iv) Providing cost-effective health services
- Needs of society
  - (i) Sufficient number of beds and suitability of bed quality
  - (ii) Service of specialized team on surrounding area
  - (iii) Application of new treatment technologies
  - (iv) Development of new concepts for treatment services (such as outpatient surgery, day hospital)
- Patients
  - (i) Shortening the length of hospitalisation
  - (ii) Reducing patient transfers
  - (iii) Reducing hospital infections
  - (iv) Enhancing the safety of the patients
  - (v) Increasing patient satisfaction
- Workers
  - (i) Increasing the safety and satisfaction of employees
  - (ii) Increasing workforce and service quality
  - (iii) Improving health service performance

According to the planning health campuses incorporate various types of hospitals with specialized staff, research and development laboratories and centers, social and cultural facilities, hotel, logistic support units, high level of transport and parking facilities, accommodation and open space usage as a whole.

Within the scope of the program, the Ministry of Health also developed a plan to expand and improve its medical education, training and service delivery by creating a new, modern and efficient public healthcare infrastructure. Following the successful examples of similar programs implemented in some European countries, in particular the United Kingdom, the Ministry of Health has decided to procure new healthcare facilities under a Public Private Partnership scheme in order to effectively deliver modern and efficient health infrastructure provision in Turkey.

Thus this model of procurement marked an important milestone in transformation of Turkey's healthcare sector. While facilitating access to healthcare services for a larger part of the population, this model promised to leverage the resources available to the Ministry of Health and to achieve transformation towards high quality and efficient healthcare services in a relatively short time frame whereby the costs of achieving such transformation are spread across the long term.

As a result, 30 health campuses of different sizes and bed capacities within 22 provinces were put in the procurement programme of the Ministry of Health in the format of an international tender. The proposed scheme was a typical design, build, finance, maintain and operate scheme, where the private party undertakes these obligations except provision of medical services which remains the obligation of the Ministry of Health for a period of 28 years in exchange for availability payments and service payments from the Ministry of Health.

As per the tender requirements the bidders' offers were evaluated on technical and financial basis with each criteria being attributed with a score. For the financial part the bidders were expected to submit their total fixed investment amount for the procurement of the facility, the yearly availability payment that the Ministry of

Health will need to pay to the project company created by the successful bidder for the amortization of the total fixed investment amount and their pricing for the provision of hard and soft facility management services as well as medical support services. For the technical part, amongst others the bidders were expected to submit a conceptual design having below main objectives:

- To allow the best possible medical care, examination and treatment for the patient
- To allow the best possible working conditions for the staff
- To allow an economic operation of the hospital
- To optimise investment and running costs
- To design an economic and ecological hospital

The tender documents were not requiring obtention of a certain level of green building certification and no bonus score was attributed to the bidders that were willing to do so. However as per the technical requirements of the tender documents, the design was expected to qualify for at least a B level of energy efficiency in the national energy identity certification system. Furthermore, technical criteria allocated more than half of the points to design improvements which contained amongst others green building practices such as implementation of energy efficiency measures, use of natural light and functionality of areas. The categories under the technical criteria are detailed further in the below Table 5.1.

First hospital (Hospital X) is located in central Anatolia region of Turkey, having a bed capacity of 475, and a gross internal floor area of 141,200m2. The Project was financed under a limited-recourse financing scheme with equity and project finance loan.

Second hospital (Hospital Y) is located in Mediterranean region of Turkey, having a bed capacity of 1,550, and a gross internal floor area of 539,823m2. The Project was financed under a limited-recourse financing scheme with equity and project finance loan.

Table 5.1. Breakdown of Technical Score in tender documents.

Technical Category	**Score**
Vertical and Horizontal Effective Segregation of Flows	6.90
Efficiency Within and Between Adjacent Functional Areas	7.56
Solutions of Unit Designs	9.36
Use of Natural Lights	5.19
Roof lights/ interior garden/ light tubes/ glass classification for natural lighting	1.16
Solar energy panels	0.66
Quantitative and qualitative differences in external light feeling	0.83
Site plan ensuring smooth transition of light	1.68
Recommendations for protection from direct sunlight	0.86
Efficiency of Energy	9.42
Application of thermal insulation to all building	2.75
Frontal materials	1.25
Proposed energy efficiency measures	1.83
Recycling systems	1.92
Landscaping	0.75
Materials for lighting	0.91
Flexibility of Units / Functional Areas	13.01
Modulation Standard in Units/Selected Axle Vulnerabilities	1.83
Demountable Material Selection in Partition	2.72
Outdoor Functions and Flexibility	2.12
Peace of Land Use and Future Status of Development and Flexibility	6.34
Proposed Services	31.97
Technical Quality of Design and Construction Management Proposal	16.60
Total	**100.00**

Third hospital (Hospital Z) is located in Eastern Anatolia region of Turkey, having a bed capacity of 1,038, and a gross internal floor are of 355,752m2. The Project was financed under a limited-recourse financing scheme with equity and privately placed green and social bond.

As a result of the competitive tender process managed by the MoH, these three hospitals were awarded to the consortium comprised of a top-tier Turkish contractor having the target of developing its expertise also in healthcare facility management services together with two well-experienced Turkish medical support service providers respectively on November 2011, August 2012 and September 2012. In 2013, the consortium was joined by an international infrastructure fund as a long-term investor for the financing and financial structuring of the projects.

Following the discussions between the members of the consortium, the decision to go beyond the tender requirements and to target a LEED certification for all three hospitals was taken during Spring 2016 in a context where all three projects were already in construction stage.

The decision was essentially a consequence of the strict environmental and social performance standards of the members of the consortium and their long-term vision in the projects either as investor or as facility manager which necessitated putting in place a sustainable health campus in order to ensure improved indoor and service quality to mitigate potential risks in relation with volume dependent services that are impacted by the number of visitors and to ensure improved efficiency to mitigate potential risks in relation with the operating and maintenance costs over a period of 25 years.

In all three cases, at the time the decision to obtain a LEED-HC v2009 certification was taken by the consortium, the following constraints were already set:

- All three projects were greenfield projects where the project sites were chosen by the MoH without any intention to satisfy related LEED criteria;

- The construction area, duration, price as well as project revenues were fixed as per the Project Agreement that was executed between the respective project companies created by the consortium and the MoH based on the bid of the consortium;
- Both conceptual and detailed design of the facilities were prepared therefore there was very little room for making significant changes to the design. However, the design was prepared as per the local legislations and tender requirements which aimed for energy efficiency such as use of trigeneration or cogeneration systems, optimal use of daylight and functionality of the facilities;
- The construction has been ongoing on the project sites for about a year in form of excavations and preliminary structural works where according to the Law 3194 in Turkey, construction process is governed by two major permits that are issued by the municipalities. The first one being the construction permit which needs to be obtained in order to be able to start the construction (excluding excavation activities which can be performed with excavation permit prior to issuance of construction permit) and the second one being the occupation permit which needs to be obtained in order to allow occupation of the building and use of the utility networks.

Hospital X and Hospital Y reached operations phase respectively on first and third quarters of 2017, followed by Hospital Z reaching operations on third quarter of 2018. All three hospitals acquired LEED gold level certification with respective scores of 60, 62 and 63.

As of the date of this study Hospital X and Hospital Y have completed their first year of operations, whereas Hospital Z is still within its first year of operations.

Annual energy consumption of Hospital X is measured as 58,702,965 kWh consisting of 20,864,493 kWh of electricity and 3,586,585 m3 of natural gas consumption where a conversion factor of 10.55 is used to express m3 of natural gas in kWh. Annual water consumption of Hospital X is measured as 139,206 m3.

Annual energy consumption of Hospital Y is measured as 129,432,967 kWh consisting of 92,924,960 kWh of electricity and 3,460,475 m3 of natural gas consumption, likewise a conversion factor of 10.55 is used to express m3 of natural gas in kWh. Annual water consumption of Hospital Y is measured as 870,918 m3.

In order to conclude the presentation of the case study and proceed with the discussions chapter, abovementioned information is summarized in below Table 5.2.

Table 5.2. Summary of key information for Hospital X, Y and Z.

Project Details	**Hospital X**	**Hospital Y**	**Hospital Z**
Project Area (m2)	141,120	539,823	355,752
Bed Capacity	475	1,550	1,038
Project Costs (Euro)	139,000,000	460,000,000	360,000,000
Construction Permit Date	Q2 2015	Q1 2015	Q3 2016
LEED Registration Date	Q2 2016	Q2 2016	Q2 2016
Start of Operations Date	Q1 2017	Q3 2017	Q3 2018
LEED Certificate	LEED-HC v2009	LEED-HC v2009	LEED-HC v2009
LEED Score	60	62	63
Energy Consumption (kWh/year)	58,702,965	129,432,967	-
Water Consumption (m3/year)	139,206	870,918	-

5.3. Findings of the Survey

The findings of the survey are presented hereafter.

Figure 5.7 below shows the feedback obtained on the stage that the decision of implementing green building practices was given and the level of certification achieved after such decision. It can be seen that for nineteen cases out of thirty such decision was given during feasibility stage, for five cases such decision was given during planning and feasibility stage, for 2 cases such decision was given during early construction stage and for 4 cases such decision was given during operation stage whereas no such decision was made during late construction stage.

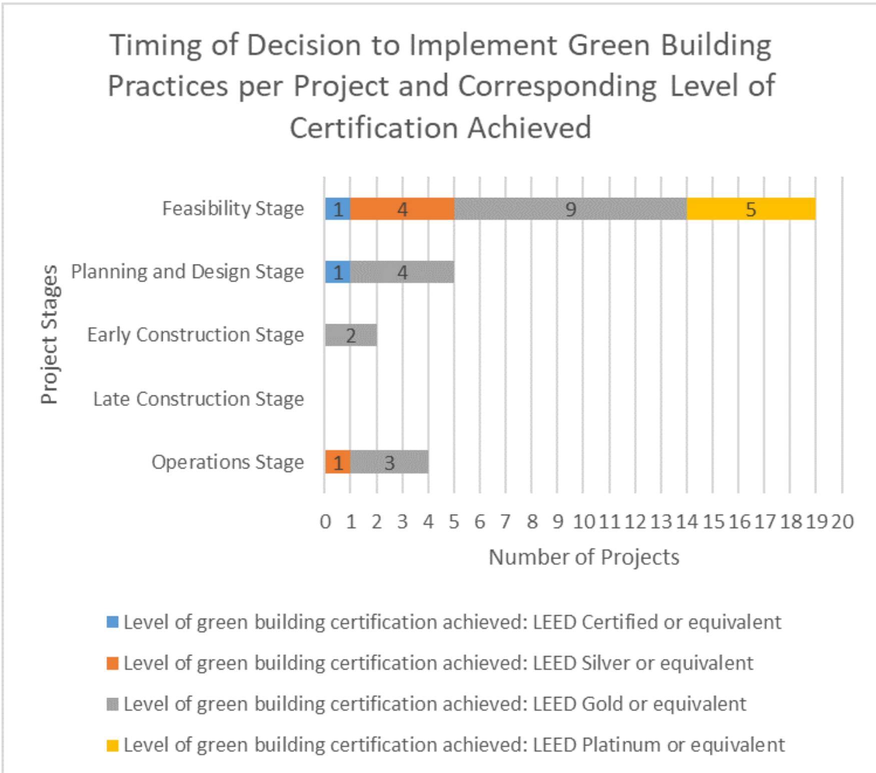

Figure 5.7. Level of green building certification achieved per stage of construction in which the decision to target green building certification is taken.

As per the Figure 5.7 above, none of the decisions expressed by the participants were given during Late Construction stage. Decisions given during Early Construction stage achieved a level of LEED Gold or equivalent indicating that this can be the critical stage to take the decision of implementing green building practices. Furthermore it is observed that majority of the participants gave such decision during the Feasibility stage, which reduced across Planning and Design stage and Early Construction stage. This suggests that the preferred timing in the industry for such decision is the Feasibility stage. The presence of decisions during Operation stage looks promising that effort is spent towards converting existing buildings into green buildings, however it is seen that the preference is to implement green building practices on new buildings.

The results related to project financing structure are shown below in Figure 5.8. 54% of the cases benefited from banks or investors while financing the projects which is a positive indication of liquidity available in the market to finance green building projects. Alongside this liquidity, it is positive to see that in 43% of the cases financing was provided by pure equity which is an indicator that equity providers are also implementing green building practices at their own initiative. The presence of public sector financing in green building projects is also a positive indicator for the green building market.

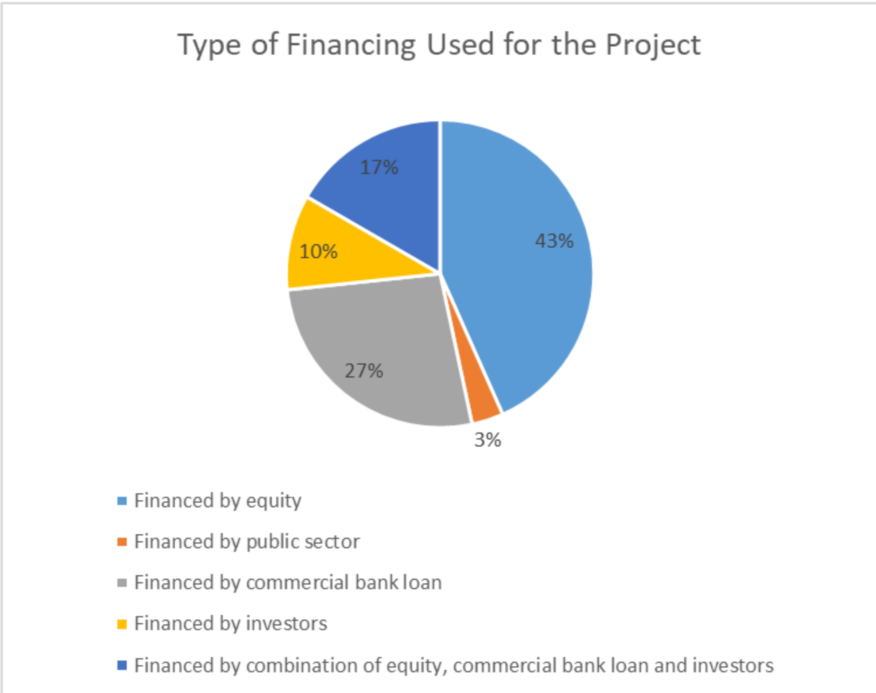

Figure 5.8. Type of financing used for the project.

For the purposes of simplifying the raw data related to stakeholder involvement, the answers are expressed in overall percentages calculated by ratio of sum of participation scale expressed for each stakeholder defined in the question over the sum of maximum scale that can be attributed to each stakeholder defined. Based on this conversion, degree of stakeholder involvement is categorized as Low (1%-25%), Medium (26%-50%), High (51%-75%) and Very High (76%-100%). When the results are then plotted against level of certification obtained as shown in below Figure 5.9, it is seen that for all of the cases that achieved a level of LEED Platinum or equivalent, degree of stakeholder participation in the process is high which is as expected, since targeting the Platinum level requires high level of coordination between stakeholders. For LEED Gold or equivalent level, the degree of stakeholder participation expressed in most of the cases are high with some cases having medium degree of involvement which can be due to the fact that the requirements under LEED Gold still requires high level of coordination but not as much as it is required for LEED Platinum level. For the portion of high degree of stakeholder involvement observed for cases that achieved LEED Silver or equivalent level might indicate that high level coordination of stakeholders was constrained by the targeted LEED Silver level. For the remaining portion of the cases that achieved LEED Silver level, it is seen that such level can still be reached by relatively low involvement of stakeholders, which is also observed in cases with LEED Certified level.

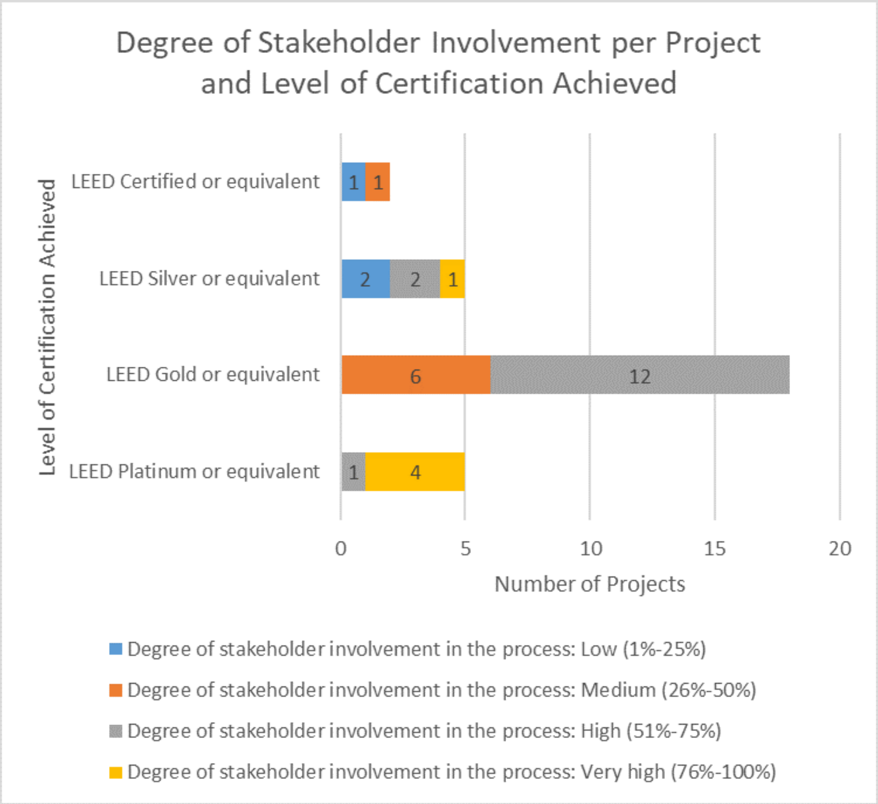

Figure 5.9. Degree of stakeholder involvement per project and level of certification achieved.

By overlapping the data related to targeted green building certification level and achieved green building certification level obtained from the survey below Figure 5.10 is obtained. It is seen that 93% of the cases were able to meet their targets in terms of level of green building achieved. 3% represents the case where LEED Silver was targeted and the project ended up achieving LEED Gold level which can indicate that the performance design of the building was then supported by some strategic points obtained from other LEED criteria leading ultimately to a higher level than expected. Lower case represents the case where LEED Silver was targeted but the achieved level was LEED Certified which can be explained by the green baton effect mentioned in the literature survey section. Overall indication is that the participants had the necessary skills, competence and experience to meeting the targeted green building requirements.

Figure 5.10. Achieved level of green building certification compared to initial target.

The results related to achieved financial returns and expected financial returns are shown in below Figure 5.11. It can be seen that in 90% of the cases the financial returns associated with the certification level of green building achieved are similar or higher than expected which can be considered as an important motivation for decision makers to implement green building practices as they mostly meet their expectations and there is a possibility that the results can end up even higher than their expectations. Considering the fact that most of the feedback is coming from Turkey, such possibility of higher return can also be interpreted as an indication that the market value of green buildings are high in domestic market due to small amount of availability of such buildings. On the other hand one of the 7% of feedback expressed belongs to the case where targeted LEED level was not achieved hence explaining the lower financial return obtained. The other low feedback obtained belongs to a case of public building which can be explained by a possible change in scope to implement green building practices increasing the capital expenditures hence reducing the financial returns of the project.

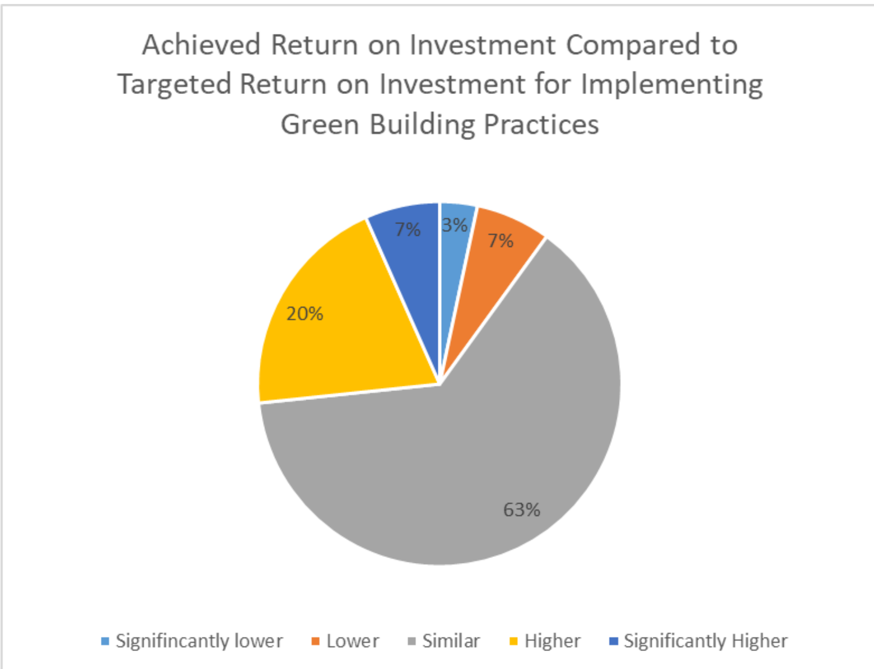

Figure 5.11. Achieved return on investment certification compared to initial target.

Similarly the results obtained for actual energy performance compared to targeted energy performance are shown in below Figure 5.12. It is seen that in 93% of the cases associated with certification level of green building, actual energy performance turned out to be similar to or higher than the targeted energy performance which can be considered again an important motivation factor for decision makers. Again one of the low feedbacks belongs to the case that ended up in a lower certification level than it targeted for hence explaining the reason behind this feedback. The other low feedback obtained belongs to a project that obtained LEED Silver but with low degree of stakeholder involvement in the process which might explain the reason why the project ended up showing less performance than targeted. However these results indicate amongst other reasons a potential need for more improvement in energy performance assessment tools as 50% of the cases resulted different than targeted.

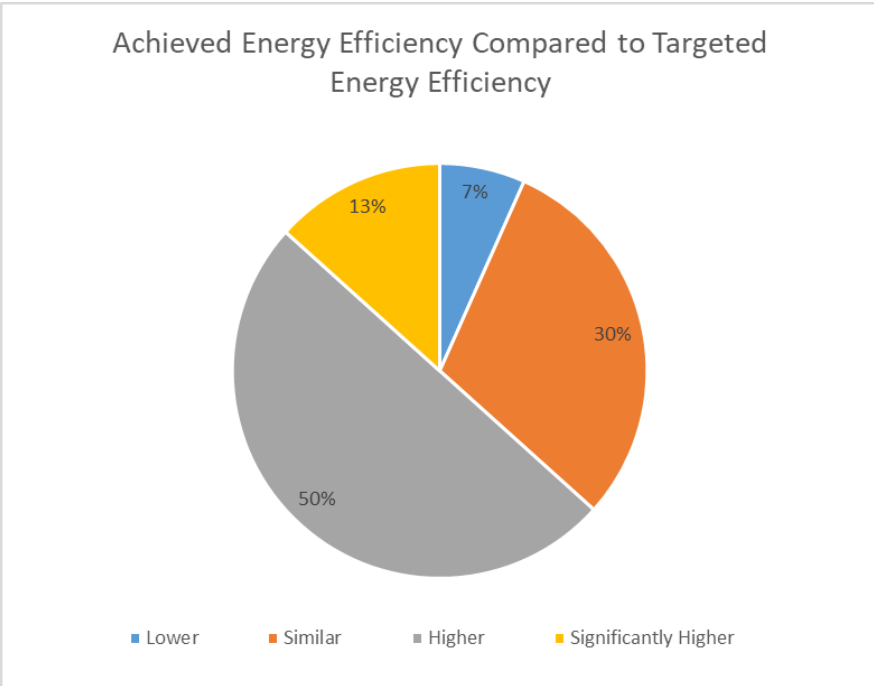

Figure 5.12. Achieved energy efficiency compared to targeted energy efficiency.

Data obtained for awareness of end user towards the green building properties implemented in the building is shown in below Figure 5.13. The result that the amount of cases where awareness of end users are high is greater than the opposite is positive. Nevertheless considering majority of the feedback is coming from Turkey, 43% of the cases showing medium or low awareness indicate a potential need for further effort to promote green building practices nationwide.

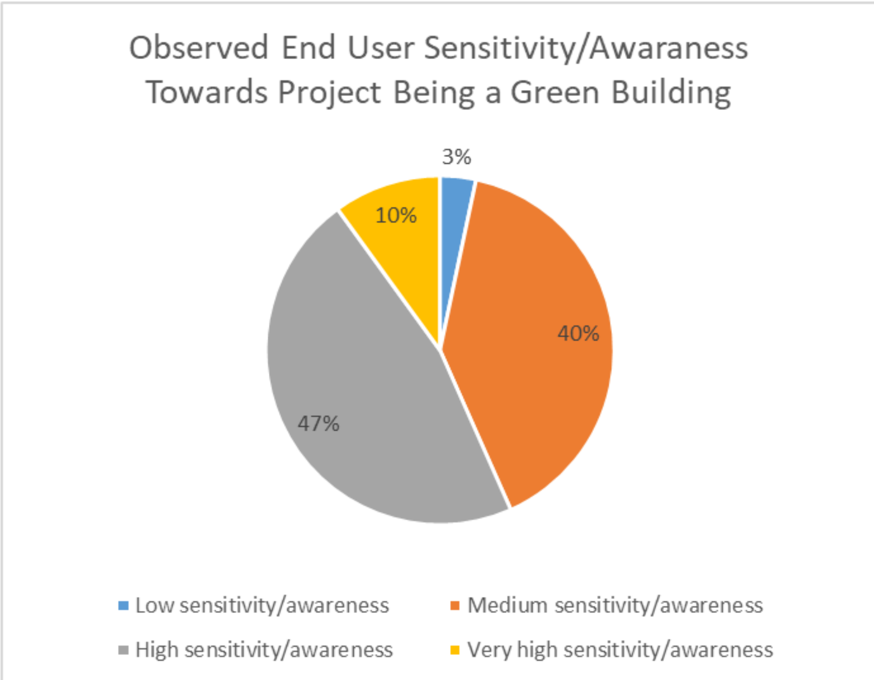

Figure 5.13. Observed end user awareness and sensitivity towards project being a green building.

For the last question, data obtained for impact of green building and energy efficiency applications on occurrence of problems and operations and maintenance costs when compared to those of a conventional building is shown in Figure 5.14 below. In 50% of the cases it is seen that the occurrence of problems and operations and maintenance costs are lower which is consistent with the claimed benefits of the green building practices. One of the higher feedback belongs to the case where the project obtained lower certification than it targeted explaining the result of such feedback. The other higher feedback belongs to the case of an industrial building which might need further analysis on implementation of green building practices on industrial buildings. Also the 43% feedback given as similar is considered worth investigating since one of the benefits associated with green building practices in literature is the reduction in operation and maintenance costs when compared to conventional buildings.

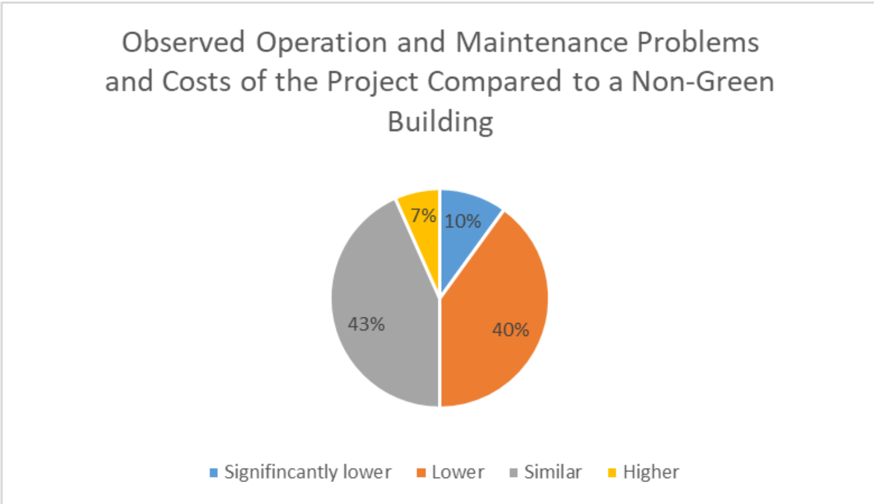

Figure 5.14. Observed operation and maintenance problems and costs of the project compared to a non-green building.

Although the results of the survey yielded much valuable information on the sector tendencies in relation with green building practices and indicated early construction stage as the critical stage for taking the decisions to implement green building and sustainability measures, the survey sample size is not sufficient to get to a statistical conclusion and the question of finding the critical stage to implement green building practices remains unanswered. This study shall therefore proceed with a case study analysis in order to seek answers to the question at hand.

5.4. Findings of the Case Study

5.4.1. Identifying Critical Construction Stage for Decision Making for Green Building Applications

It is important to understand first at which stage the projects were when the decision to target a LEED certification was taken and then to point out the main activities and constraints at each stage of the construction. A derived form of the traditional construction stages [22] is therefore used and accordingly the definitions are provided below:

- Feasibility Stage is assumed to cover the period from the origination of the project idea and until the project site is selected.
- Planning and Design Stage is assumed to cover the period after the site selection until the obtainment of the construction permit.
- Early Construction Stage is assumed to cover the period after the obtainment of construction permit and until the completion of structural works.
- Late Construction Stage is assumed to cover the period after the completion of structural works and until the obtainment of occupation permit.

Within this context the Feasibility Stage of the projects corresponds to the tender phase where the project origination, feasibility analysis and project site selection were performed by the MoH and the design requirements were set accordingly without any obligation to target a green building certification system. Likewise, the consortium had to develop its own conceptual design and feasibility analysis in order to submit a competitive and compliant bid however at that stage a green building certification system was not targeted. If the decision to target a green building certification system had been given at this stage by the MoH, the projects would have had the possibility to fully satisfy the LEED criteria in relation with the project sites. Similarly if the consortium had taken such decision at this stage the projects would theoretically have had the possibility to fully satisfy the remainder of the LEED criteria.

During the Planning and Design Stage, activities amongst others such as, soil analysis, preparation of geotechnical report, design criteria reports, impact assessment reports and necessary management plans (i.e. excavation plan, erosion and sedimentation plan, waste management plan etc.) alongside with detailed design development were performed in order to apply for the construction permit in accordance with local legislation. At this stage mobilisation and preliminary excavation works had already begun and parameters related to the construction price, duration and project revenues were already fixed as per the bid as well as site usage, site layout plan, physical characteristics of the building such as dimensions, total floor area, area distribution, height and orientation were decided based on the detailed design. If the decision to pursue green building practices had been given at this stage, the project would still theoretically have had the opportunity to target full satisfaction of all LEED criteria without necessarily impacting the construction duration, except the ones related to project sites which are beyond the consortium's control, provided that the measures to be implemented either do not exceed the construction price submitted in the bid or are absorbed by either contractor within its margin or by the investor within its return on equity.

During the Early Construction Stage, major activities such as performance of excavation works and structural works, material supply, implementation of management plans and finalization of detailed and implementation design development for all disciplines and preparation of shop drawings for interior finishes were performed. The fact that the decision to target LEED certification was given at this stage hindered the possibility to undergo major alterations to the design in order to satisfy the LEED criteria without significantly impacting the budget and duration. The projects had to rely on the quality of the existing design, therefore the project teams concentrated on adjusting the project management processes, selection of materials, implementation of building systems and usage of spaces to the extent possible to maximize the LEED credits within the existing constraints. A dedicated team for this task was set up supported by a LEED consultant with the target of achieving a gold level certification.

During the Late Construction Stage major activities performed were all works related to façade, exterior cladding, roofing, fit out of the building and associated material selections, commissioning, testing, landscape development, implementation of building mechanical, electrical, sanitary systems as well as all necessary works required in order to prepare the building for occupation and application to occupancy permit. If the decision to pursue a LEED certification had been given at this stage, the possibility of accommodating any LEED criteria within the projects without significantly impacting the budget and construction duration would have been limited to those in relation with commissioning, finishing materials, building systems implementation, landscape development and building use which would have been in addition to any other criteria that could have been satisfied by the existing design and processes put in place.

It is then possible to allocate specific action categories to each stage of construction and hence setting a decision matrix which is presented in the below Table 5.3.

Table 5.3. Decision matrix for each construction stage.

Decision Category	**Feasibility Stage**	**Planning and Design Stage**	**Early Cons. Stage**	**Late Cons. Stage**
Site Selection	x			
Conceptual Design Development	x	x		
Management Plan	x	x		
Site Use	x	x		
Site Survey	x	x		
Detailed Design Development	x	x		
Implementation Design Development	x	x	x	
Building Materials	x	x	x	
Commissionning	x	x	x	x
Finishing Materials	x	x	x	x
Building Systems Implementation	x	x	x	x
Landscape Development	x	x	x	x
Building Use	x	x	x	x

Then it is possible to apply this matrix to each of the LEED-HC v2009 certification category in order to find out theoretically the critical construction stage for making the decision to implement each of the LEED criteria at low risk meaning that its achievement from the moment the decision is taken shall be depending only on technical and financial capacity of the project party implementing it. The detailed exercise is presented in Appendix C of this study. The theoretical LEED score achievable at low risk at each construction stage can then be presented in the below Table 5.4.

Table 5.4. LEED Score achievable at low risk per LEED category at each construction stage.

LEED-HC v2009 Category	**Feasibility Stage**	**Planning and Design Stage**	**Early Construction Stage**	**Late Construction Stage**
Sustainable Sites	18	13	6	5
Water Efficiency	9	9	5	5
Energy and Atmosphere	39	39	6	6
Materials and Resources	16	12	11	3
Indoor Environmental Quality	18	18	11	11
Innovation in Design	6	6	6	1
Regional Priority	4	4	4	0
Total LEED Score	**110**	**101**	**49**	**31**

Furthermore it is possible to plot the the theoretical LEED score achievable at low risk at each construction stage as shown in below Figure 5.15.

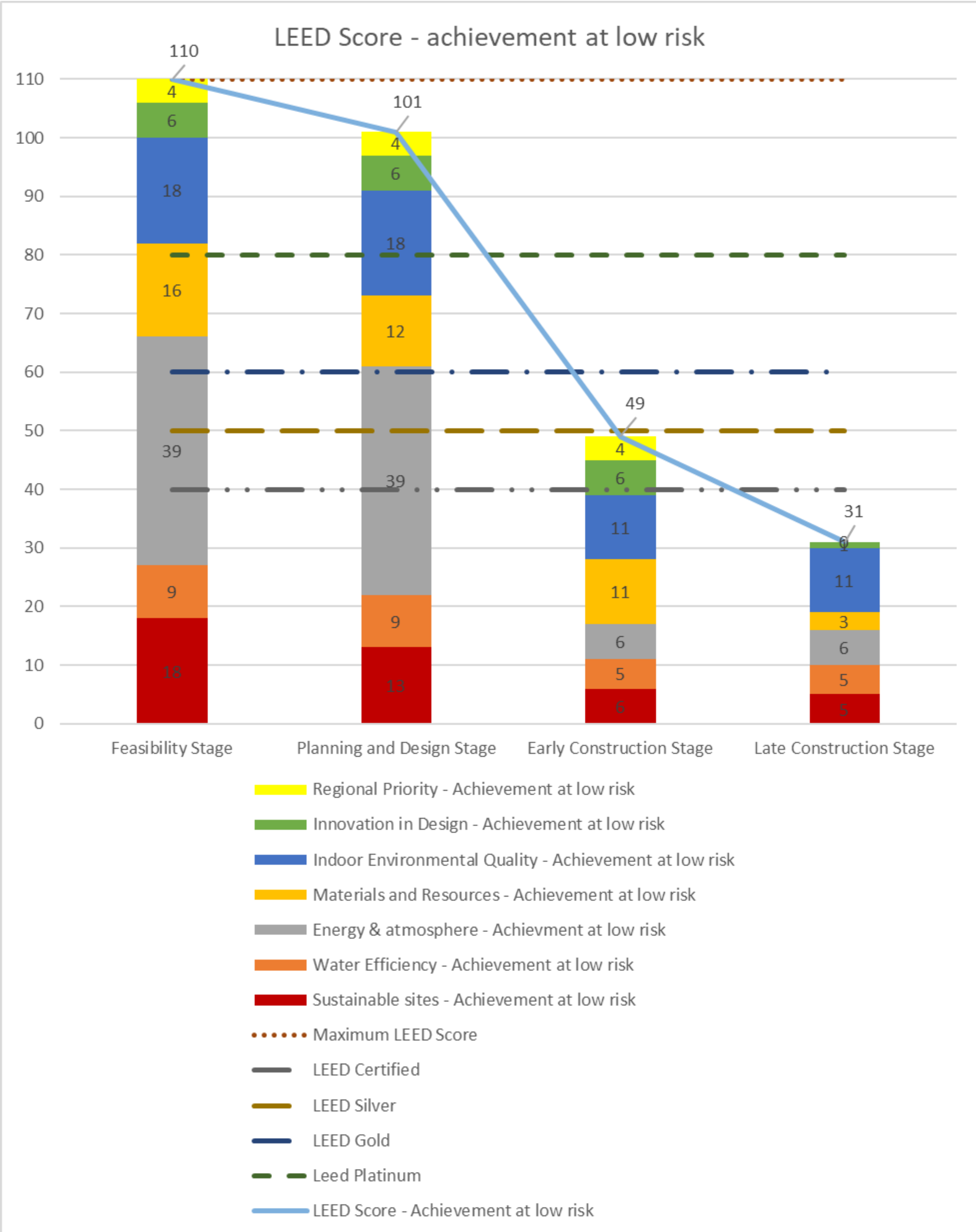

Figure 5.15. LEED score that is achievable at low risk at each construction stage.

As expected, it can be seen that the amount of LEED score that could be achieved at low risk reduces as the project moves forward in construction stages. While the project can target a LEED platinum level at low risk in both feasibility and planning and design stages, this is no longer the case when the project is at Early Construction Stage. When the decision to target a LEED certification is given at this stage, more than half of the possible LEED score will be dependent either on stringency of applicable regulations and compliance of the existing design and construction practices already implemented within the project with the LEED criteria or on the possibility for the projects to deviate from existing conditions to implement the LEED criteria. However despite the fact that more than half of the points will be at risk, available LEED points at low risk still allow the projects to target for at least LEED silver level certification at low risk at Early Construction Stage. Once the project arrives to Late Construction Stage available LEED points at low risk are no longer sufficent for the project to target a LEED certification at low risk.

Hence although it was not possible to demonstrate on the basis of the results of the survey that the Early Construction Stage is the critical stage during construction for implementing green building practices due to limited sample size of the survey not allowing for a statistical analysis, the findings of the case study clearly indicates that the Early Construction Stage is the critical stage during construction for implementing green building practices. Beyond this stage the project is found to be highly dependent on the compatibility of existing project applications with green building applications therefore the decision to implement green building practices comes with a high risk in terms of achievable outcome.

5.4.2. LEED Criteria Satisfied by Existing Conditions of the Projects

Actual LEED score of the three hospitals are then cross-checked against the LEED score at low risk in Early Construction Stage proposed in the previous subsection in order to highlight where the projects already satisfied certain LEED criteria due to tender requirements, industry practices and compliance with local regulations. This is presented in the below Table 5.5.

Table 5.5. Summary of LEED scorecards of Hospital X, Y and Z compared against LEED points achievable at low risk.

LEED-HC v2009 Category	**Total Score**	**Hospital X**	**Hospital Y**	**Hospital Z**	**Score at Low Risk**
Sustainable Sites	**18**	**12**	**10**	**11**	**6**
Construction Activity Pollution Prevention	Req	+	+	+	+
Environmental Site Assessment	Req	+	+	+	+
Site Selection	1	1	1	1	0
Development Density and Community Connectivity	1	0	0	1	0
Brownfield Redevelopment	1	0	0	0	0
Alternative Transportation - Public Transportation Access	3	3	3	3	0
Alternative Transportation - Bicycle Storage and Changing Rooms	1	1	1	1	1
Alternative Transportation - Low Emitting and Fuel Efficient Vehicles	1	1	1	1	1
Alternative Transportation - Parking Capacity	1	1	1	1	1
Site Development - Protect or Restore Habitat	1	0	0	0	0
Site Development - Maximize Open Space	1	1	0	1	0
Stormwater Design - Quantity Control	1	0	0	0	0

Table 5.5. Summary of LEED scorecards of Hospital X, Y and Z compared against LEED points achievable at low risk (cont.).

LEED-HC v2009 Category	**Total Score**	**Hospital X**	**Hospital Y**	**Hospital Z**	**Score at Low Risk**
Stormwater Design - Quality Control	1	0	0	0	0
Heat Island Effect - Non-Roof	1	1	1	1	1
Heat Island Effect - Roof	1	1	1	1	1
Light Pollution Reduction	1	1	0	0	1
Connection to the Natural World - Places of Respite	1	1	1	0	0
Connection to the Natural World - Direct Exterior Access for Patients	1	1	1	0	0
Water Efficiency	**9**	**5**	**7**	**8**	**5**
Water Use Reduction - 20% Reduction	Req	+	+	+	+
Minimize Potable Water Use for Medical Equipment Cooling	Req	+	+	+	+
Water Efficient Landscaping - No Potable Water Use or No Irrigation	1	1	0	1	0
Water Use Reduction: Measurement and Verification	1 to 2	0	2	2	2
Water Use Reduction	1 to 3	1	3	3	0

Table 5.5. Summary of LEED scorecards of Hospital X, Y and Z compared against LEED points achievable at low risk (cont.).

LEED-HC v2009 Category	**Total Score**	**Hospital X**	**Hospital Y**	**Hospital Z**	**Score at Low Risk**
Water Use Reduction - Building Equipment	1	1	1	1	1
Water Use Reduction - Cooling Towers	1	1	1	1	1
Water Use Reduction - Food Waste Systems	1	1	0	0	1
Energy and Atmosphere	**39**	**15**	**23**	**23**	**6**
Fundamental Comissioning of Building Energy Sytems	Req	+	+	+	+
Minimum Energy Performance	Req	+	+	+	+
Fundamental Refrigerant Management	Req	+	+	+	+
Optimize Energy Performance	1 to 24	11	21	18	0
On-Site Renewable Energy	1 to 8	0	0	0	0
Enchanced Commissioning	1 to 2	1	0	2	1
Enhanced Refrigerant Management	1	1	1	1	1
Measurement and Verification	2	2	1	2	2
Green Power	1	0	0	0	1
Community Contaminant Prevention - Airborne Releases	1	0	0	0	0

Table 5.5. Summary of LEED scorecards of Hospital X, Y and Z compared against LEED points achievable at low risk (cont.).

LEED-HC v2009 Category	**Total Score**	**Hospital X**	**Hospital Y**	**Hospital Z**	**Score at Low Risk**
Materials and Resources	**16**	**8**	**8**	**4**	**11**
Storage and Collection of Recyclables	Req	+	+	+	+
PBT Source Reduction - Mercury	Req	+	+	+	+
Building Reuse - Maintain Existing Walls, Floors and Roof	1 to 3	0	0	0	0
Building Reuse - Maintain Interior Non-Structural Elements	1	0	0	0	0
Construction Waste Management	1 to 2	2	2	2	2
Sustainably Sourced Materials and Products	1 to 4	4	4	0	4
PBT Source Reduction - Mercury in Lamps	1	1	1	1	1
PBT Source Reduction - Lead, Cadmium, Copper	0	0	0	0	2
Furniture and Medical Furnishings	1 to 2	0	0	0	2
Resource Use - Design for Flexibility	1	1	1	1	0

Table 5.5. Summary of LEED scorecards of Hospital X, Y and Z compared against LEED points achievable at low risk (cont.).

LEED-HC v2009 Category	**Total Score**	**Hospital X**	**Hospital Y**	**Hospital Z**	**Score at Low Risk**
Indoor Environment Quality	**18**	**11**	**8**	**10**	**11**
Minimum Indoor Air Quality Performance	Req	+	+	+	+
Environmental Tobacco Smoke Control	Req	+	+	+	+
Hazardous Material Removal or Encapsulation	Req	+	+	+	+
Outdoor Air Delivery Monitoring	1	1	0	0	1
Acoustic Environment	1 to 2	0	0	1	0
Construction IAQ Management Plan - During Construction	1	1	1	0	0
Construction IAQ Management Plan - Before Occupancy	1	1	1	1	1
Low Emitting Materials	1 to 4	1	1	0	4
Indoor Chemical Pollutant and Source Control	1	0	0	0	1
Controllability of Systems - Lighting	1	0	0	0	1
Controllability of Systems - Thermal Comfort	1	1	0	1	1
Thermal Comfort - Design and Verification	1	1	1	1	0

Table 5.5. Summary of LEED scorecards of Hospital X, Y and Z compared against LEED points achievable at low risk (cont.).

LEED-HC v2009 Category	**Total Score**	**Hospital X**	**Hospital Y**	**Hospital Z**	**Score at Low Risk**
Daylight and Views - Daylight	2	2	2	2	2
Daylight and Views - Views	1 to 3	3	2	3	0
Designing with Nature, Biophilic Design for Indoor Environment	Req	+	+	+	+
Performance Based IAQ Design and Assessment	Req	+	+	+	+
Innovation in Design	**6**	**6**	**3**	**4**	**6**
Integrated Project Planning and Design	Req	+	+	+	+
Innovation in Design	1 to 4	4	1	2	4
LEED Accredited Professional	1	1	1	1	1
Integrated Project Planning and Design	1	1	1	1	1
Regional Priority Credits	**4**	**3**	**3**	**3**	**4**
Optimize Energy Performance	1	1	1	1	1
On-site Renewable Energy / Stormwater Design Quantity Control	1	0	0	0	0
Thermal Comfort - Design and Verification	1	1	1	1	1
Heat Island Effect - Roof	1	1	1	1	1
Total	**110**	**60**	**62**	**63**	**49**

It can be seen from the Table 5.5 that the projects succeeded in obtaining LEED points from below criteria which are considered at risk since the decision to target LEED certification was given at Early Construction Stage:

- Site Selection: Hospital X, Y and Z
- Development Density and Community Connectivity: Hospital Z
- Alternative Transportation – Public Transportation Access: Hospital X, Y and Z
- Site Development – Maximize Open Space: Hospital X and Z
- Connection to the Natural World – Places of Respite: Hospital X and Y
- Water Efficient Landscaping – No Potable Water Use or No Irrigation: Hospital X, Y and Z
- Water Use Reduction: Hospital X, Y and Z
- Optimize Energy Performance: Hospital X, Y and Z
- Resource Use – Design for Flexibility: Hospital X, Y and Z
- Acoustic Environment: Hospital Z
- Construction IAQ Management Plan – During Construction: Hospital X, Y and Z
- Thermal Comfort – Design and Verification: Hospital X, Y and Z
- Daylight and Views – Views : Hospital X, Y and Z

Within the context of these three projects, the site selection was made by the MoH without any explicit goal of satisfying LEED criteria in Sustainable Sites category. In fact the LEED score obtained by the projects in Site Selection, Development Density and Community Connectivity and Alternative Transportation – Public Transportation Access were beyond the project teams' control as it can be seen that only Hospital Z qualified for Development Density and Community Connectivity.

The difference between the projects with regards to their LEED Score under the Site Development – Maximize Open Space and Connection to the Natural World – Places of Respite categories is consistent with the fact that the site layout were already decided based on the local regulations during the Planning and Design Stage therefore the projects had to rely on the outcome of the existing design. Under the Law No: 3194 Clause 18, the municipalities are granted the right to use up to 40% of the site for public benefit therefore common practice followed by the contractors in Turkey is to leave 40% of the site area as green area.

The projects were able to obtain LEED score in Water Use Reduction, Optimize Energy Performance, Resource Use – Design for Flexibility, Thermal Comfort and Daylight and Views categories which is consistent with the fact that the tender requirements of these projects were already accounting for efficiency and functionality measures. In fact, it is possible to earn points under Optimize Energy Performance criteria by applying the requirements of Regulation for Energy Performance in Buildings, Turkish Standard TS EN 378 "Standard for Refrigerating Systems and Heat Pumps – Safety and Environment Requirements" and "Turkish Standard TS 825 – Thermal Insulation Requirements for Buildings" [45].

It can also be seen from the difference in LEED scores across the three projects in Water Use Reduction, Optimize Energy Performance, Daylight and Views, Acoustic Environment, Water Efficient Landscaping – No Potable Water Use or No Irrigation categories that the capacity of the project teams to deviate from existing design conditions were limited because the decision to target a LEED certification was given at Early Construction Stage.

With regards to the Construction IAQ Management Plan – During Construction criteria, as a consequence of the financing put in place all three projects had to comply with European Bank of Reconstruction and Development's performance requirements which already accounted for an Environmental Quality Management Plan amongst others.

5.4.3. Case Study Findings on Annual Savings

In this final section of the chapter, this study shall analyze the first-year energy and water consumptions of Hospital X and Hospital Y in order to quantify the amount of savings achieved by implementing green building practices.

The tender requirements were asking the projects to qualify for at least a B level energy identity certificate under the Regulation for Energy Performance in Buildings in Turkey which means an energy efficiency between 20% to 60% over the reference values set by the same regulation for healthcare facilities [44]. The reference value set for healthcare facilities by the regulation is 600 kWh/m2-year.

Annual energy consumption of Hospital X is measured as 58,702,965 kWh consisting of 20,864,493 kWh of electricity and 3,586,585 m3 of natural gas consumption where a conversion factor of 10.55 is used to express m3 of natural gas in kWh. When divided by the project area of 141,120m2, it represents an annual energy consumption per square meters of 416 kWh/m2-year which is an improvement of 31% over the reference value set in the Regulation for Energy Performance in Buildings in Turkey.

It can be seen from the LEED Scorecard that Hospital X has obtained 11 points under the Optimize Energy Performance LEED criteria which means 24% improvement in energy consumption compared to the baseline set according to USGBC approved equivalent standard to Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007.

As far as water consumption is concerned, annual water consumption of Hospital X is measured as 139,206 m3. It can be seen from the LEED Scorecard that Hospital X has obtained 1 point under the Water Use Reduction LEED criteria which means 30% savings on building water use and process water use.

For the case of Hospital Y, annual energy consumption is measured as 129,432,967 kWh consisting of 92,924,960 kWh of electricity and 3,460,475 m3 of natural gas consumption, likewise a conversion factor of 10.55 is used to express m3 of natural gas in kWh. Annual water consumption of Hospital Y is measured as 870,918 m3. When divided by the project area of 539,823m2, it represents an annual energy consumption per square meters of 240 kWh/m2-year which is an improvement of 60% over the reference value set in the Regulation for Energy Performance in Buildings in Turkey.

It can be seen from the LEED Scorecard that Hospital Y has obtained 21 points under the Optimize Energy Performance LEED criteria which means 42% improvement in energy consumption compared to the baseline set according to USGBC approved equivalent standard to Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007.

Annual water consumption of Hospital Y is measured as 870,918m3. It can be seen from the LEED Scorecard that Hospital Y has obtained 3 points under the Water Use Reduction LEED criteria which means 40% savings on building water use and process water use. It is then possible to express the savings obtained in terms of hard currency by using the unit electricity, natural gas and water prices which is summarized in the below Table 5.6.

Table 5.6. Summary of annual savings obtained from energy and water efficiency.

	Hospital X	**Hospital Y**
Annual Electricity Consumption (kWh)	20,846,493	92,924,960
Annual Natural Gas Consumption (m3)	3,586,585	3,460,475
Annual Water Consumption (m3)	139,206	870,918
Average Unit Electricity Price (TL/kWh)	0.33	0.35
Average Unit Natural Gas Price (TL/m3)	0.90	0.95
Average Unit Water Price (TL/m3)	4.15	6.66
Annual Savings in Electricty Consumption (kWh)	6,588,787 – 9,373,903	67,290,488 – 139,387,440
Annual Savings in Natural Gas Consumption (m3)	1,132,606 – 1,611,364	2,505,861 – 5,190,172
Annual Savings in Water Consumption (m3)	59,660	580,612
Total Annual Savings (TL)	3,420,901 – 4,762,278	29,454,821 – 56,872,333
Total Project Cost (EUR)	139,000,000	460,000,000
Average Foreign Exchange Rate for Period 2014 - 2017	3.50	3.50
Total Project Cost (TL)	486,500,000	1,610,000,000
Annual Savings as % of Project Cost	0.7% - 1.0%	1.8% - 3.5%
Project Operation Term	25 years	25 years

It is important to note that the lower bound of the range for annual savings is based on energy efficiency measured against the baseline building in LEED system and the upper bound is based on energy efficiency measured against the reference in Regulation for Energy Performance in Buildings in Turkey.

As it can be seen from the calculation, annual savings represent 0.7% - 1.0% of the total project costs for Hospital X and 1.8% - 3.5% of the total project costs for Hospital Y which are consistent with the results of the survey and findings in the literature where cost premium range associated with level of certification is between 0.66% and 8% and that net present value of benefits obtained exceeds the initial premium [26, 32, 46].

6. CONCLUSION AND RECOMMENDATIONS

Being major contributors to the environmental damage, there is an inevitable need for the construction industry to take quick steps towards improving the energy efficiency and reducing the waste generation both for the new and the existing buildings. Hence much focus is paid on sustainability, energy efficiency and green development concepts. Although the problem, the approach and the objectives to be fulfilled are being addressed in the literature, it is evident that further research is needed because the proposed ways to achieve these objectives and the resulting outcome thereafter are yet far from being comprehensive, meaning that they are highly dependent on the project, market, region dynamics and the quality of data available.

In this study, the impact of the timing of the decision to implement green building practices on the level of green building practices achievable at low risk is illustrated during the stages of construction based on the findings of the case study through making use of LEED-HC v2009 scheme. Then relevancy of local legislation and practices to LEED criteria were investigated as the projects were able to obtain certain LEED score without additional efforts. Finally, the annual savings achieved as a result of the efficiency measures used in the projects were quantified and found consistent with both the survey results and literature findings. Hence a set of conclusions derived from the survey and the case study alongside with further recommendations for research are expressed in this section.

During construction the delay in timing of the decision to implement green building practices has negative impact on the level of green building practices that can be achieved hence such decision should preferably be given during the Feasibility stage. It was found that such decision should be taken no later than the Early Construction Stage in order to achieve certification at low risk therefore making the Early Construction Stage as the critical stage.

It is found that it is possible for the projects to satisfy certain LEED criteria with a small effort on top of following the local regulations and practices despite the fact that delay in taking the decision to implement green building practices hinders significantly the achievements possible at low risk. Further research should be made to benchmark the LEED score of a project that does not go beyond the requirements of the local legislation to precisely quantify the amount of effort necessary to implement green building practices.

It was also found that annual savings obtained in the case study represent 0.7% - 3.5% of the total project costs highlighting a long-term benefit far more than the initial premium from a net present value perspective consistent with the results in the literature.

The feedback obtained on project type that green building practices were implemented on showed in majority of the cases commercial buildings were preferred. Further research can be made if there is a general preference in the industry for commercial buildings over other buildings when implementing green building practices and if such is the case then what would be the corresponding reasons behind this preference in order to help promote green building practices for other types of buildings as well.

Results related to financing showed that there is liquidity available in the market for financing of green building projects. Alongside with this liquidity, the presence of projects financed by equity alone shows that equity providers are willing to implement green building practices at their own initiative as well. However no green building specific financing was expressed in the results and considering the availability of finance instruments such as green bonds mentioned in the literature review further research can be made to shed light on application of these instruments.

From degree of stakeholder involvement perspective, it is seen that the cases that achieved high level certification had also high degree of stakeholder involvement in the process which confirms that the implementation of green building practices require coordination between stakeholders.

Results related to actual green building level obtained compared to the targeted level showed that the industry possess the necessary skills, competence and experience to meet the requirements set out by targeted level of green achievement.

The feedback for financial returns also showed an important motivation for decision makers to implement green building practices as they mostly meet their expectations and there is a possibility that the results can end up even higher than their expectations. Considering the fact that most of the feedback is coming from Turkey, such possibility of higher return can also be interpreted as an indication that the market value of green buildings are high in domestic market due to small amount of availability of such buildings.

Actual energy performance achieved turned out to be similar to or higher than the targeted energy performance which can be considered again an important motivation factor for decision makers during decision making process of implementing green building practices. However the results also indicated a potential need for more improvement in energy performance assessment tools due to differences between achieved and targeted level.

Even though in slightly above half of the cases the end users showed high awareness on the green building properties of the building which is positive, the presence of medium or low awareness considering majority of the feedback is coming from Turkey, indicates a potential need for further effort to promote green building practices nationwide.

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APPENDIX A: SURVEY QUESTIONS

Survey questions are provided in below Figure A.1.

Participant information: *

Please provide personal/company information

Email adress:

Title of the participant:

Company's annual indorsement (approximate in USD):

Company's main activity area:

Company's number of employees (approximate):

Project location:

Figure A.1. Survey questions.

1) What was the type of the project for which the decision of going green was made? *

- Public Building (hospital, university, government building etc.)
- Residential Building
- Commercial Building (Office, mall, etc.)
- Industrial Building
- Other (Please specify):

Figure A.1. Survey questions (cont.).

2) At which project phase the decision on implementation of green features was taken? *

- ○ Pre-design/feasibility/tender phase
- ○ After the pre-design/feasibility/tender phase and before the the start of construction (Final Design phase)
- ○ Between the start of construction until the completion of structural works
- ○ After the completion of structural works and before the start of interior works
- ○ After the start of the interior works before the completion of the building
- ○ During the operation phase

Figure A.1. Survey questions (cont.).

3) What was the targetted level for the implementation of green features explained in terms of green rating system? *

- ○ LEED-Platinum or equivalent
- ○ LEED-Gold or equivalent
- ○ LEED-Silver or equivalent
- ○ LEED-Certified or equivalent

Figure A.1. Survey questions (cont.).

4) What is the level of the achieved results in terms of implementation of green features when compared to the targeted level? *

- ○ LEED-Platinum or equivalent
- ○ LEED-Gold or equivalent
- ○ LEED-Silver or equivalent
- ○ LEED-Certified or equivalent
- ○ Failure to obtain certification

Figure A.1. Survey questions (cont.).

5) What kind of financing was used in the project? *

You can select multiple answers for this question.

- ☐ Project Financing
- ☐ Bond Financing
- ☐ Private Equity/Venture Capital Investment
- ☐ Equity
- ☐ Please indicate any green building specific finance instrument used, if applicable: ______

Figure A.1. Survey questions (cont.).

6) How close was the outcome of the project compared to targeted/expected finanical returns/profit? *

- ○ Significantly above the targeted/expected returns
- ○ Above the targeted/expected returns
- ○ Same level as the targeted/expected returns
- ○ Below the targeted/expected returns
- ○ Significantly below the targeted/expected returns

Figure A.1. Survey questions (cont.).

7) What is the level of involvement of the project parties in decision making of green feature implementation on a scale of 1 to 5? *

(Range: 1-Very low to 5-Very High)

	1	2	3	4	5	Not applicable
The Client	○	○	○	○	○	○
Project Sponsor	○	○	○	○	○	○
Project Manager	○	○	○	○	○	○
Designer/Architect	○	○	○	○	○	○
Main Contractors	○	○	○	○	○	○
Subcontractors	○	○	○	○	○	○
Technical/Financial Service Providers	○	○	○	○	○	○
Consultants	○	○	○	○	○	○
Material and Equipment Suppliers	○	○	○	○	○	○
Site Personnel	○	○	○	○	○	○
End-users/Customers	○	○	○	○	○	○
Finance Providing Entities	○	○	○	○	○	○
Other (If not applicable please type "not applicable" and mark not applicable box):	○	○	○	○	○	○

Figure A.1. Survey questions (cont.).

8) What level of sensitivity/awareness did the end-users have for the green features of the project? *

- ○ 5 (Very high sensitivity/awareness)
- ○ 4 (High sensitivity/awareness)
- ○ 3 (Medium sensitivity/awareness)
- ○ 2 (Low sensitivity/awareness)
- ○ 1 (Indifferent)

Figure A.1. Survey questions (cont.).

9) What was the impact of implementation of green features on the maintenance costs and the availability of the building when compared to conventional buildings? *

- ○ Significantly higher occurence rate of problems/maintenance costs
- ○ Higher occurence rate of problems/maintenance costs
- ○ Similar occurence rate of problems/maintenance costs
- ○ Lower occurence rate of problems/maintenance costs
- ○ Significantly lower occurence rate of problems/maintenance costs

Figure A.1. Survey questions (cont.).

10) How close does the green building perform during the operational term in terms of energy efficiency when compared to the targeted level? *

- ◯ Significantly higher performance
- ◯ Higher performance
- ◯ Same level of performance
- ◯ Lower performance
- ◯ Significantly lower performance

Figure A.1. Survey questions (cont.).

APPENDIX B: SURVEY ANSWERS

Participant answers to survey questions are provided in below Figure B.1.

Questions	P1	P2	P3
Q0.a - Title of the participant	Business Development Team Leader	design team leader	Electrical Works Team Leader
Q0.b - Project Location	Istanbul	Istanbul	SOHO-ZİNCİRLİKUYU
Q1 - Project Type	Residential Building	Residential Building	Residential Building
Q2 - Decision Timing	Pre-design/feasibility/tender phase	Pre-design/feasibility/tender phase	After the pre-design/feasibility/tender phase and before the start of construction (Final Design phase)
Q3 - Targeted Green Level	LEED-Gold or equivalent	LEED-Silver or equivalent	LEED-Gold or equivalent
Q4- Achieved Green Level	LEED-Gold or equivalent	LEED-Silver or equivalent	LEED-Gold or equivalent
Q5 - Financing Type	Pre-sale	Project financing - Private Equity / Venture Capital Investment	Equity
Q6 - Expected vs Actual Returns	Same level as the targeted/expected returns	Same level as the targeted/expected returns	Same level as the targeted/expected returns
Q7- Degree of Stakeholder Involvement	63%	23%	40%
Q8 - Green Awareness of End Users	3 (Medium sensitivity/awareness)	3 (Medium sensitivity/awareness)	4 (High sensitivity/awareness)
Q9 - Impact of Green on O&M Costs	Similar occurrence rate of problems/maintenance costs	Similar occurrence rate of problems/maintenance costs	Lower occurrence rate of problems/maintenance costs
Q10 - Expected vs Actual Energy Performance	Same level of performance	Higher performance	Same level of performance

Figure B.1. Participant answers to survey questions.

Questions	P4	P5	P6
Q0.a - Title of the participant	CEO	Board Member	Mechanical Works Team Leader
Q0.b - Project Location	izmir	Dubai - UAE	Zincirlikuyu
Q1 - Project Type	Residential Building	Public Building (hospital, university, government building etc.)	Residential Building
Q2 - Decision Timing	After the pre-design/feasibility/tender phase and before the start of construction (Final Design phase)	Pre-design/feasibility/tender phase	After the pre-design/feasibility/tender phase and before the start of construction (Final Design phase)
Q3 - Targeted Green Level	LEED-Gold or equivalent	LEED-Gold or equivalent	LEED-Gold or equivalent
Q4- Achieved Green Level	LEED-Gold or equivalent	LEED-Gold or equivalent	LEED-Gold or equivalent
Q5 - Financing Type	Equity	Project Financing	Equity
Q6 - Expected vs Actual Returns	Significantly below the targeted/expected returns	Above the targeted/expected returns	Above the targeted/expected returns
Q7- Degree of Stakeholder Involvement	33%	43%	62%
Q8 - Green Awareness of End Users	3 (Medium sensitivity/awareness)	4 (High sensitivity/awareness)	3 (Medium sensitivity/awareness)
Q9 - Impact of Green on O&M Costs	Similar occurrence rate of problems/maintenance costs	Lower occurrence rate of problems/maintenance costs	Lower occurrence rate of problems/maintenance costs
Q10 - Expected vs Actual Energy Performance	Same level of performance	Higher performance	Higher performance

Figure B.1. Participant answers to survey questions (cont.)

Questions	P7	P8	P9
Q0.a - Title of the participant	QC manager	architect	Project Manager
Q0.b - Project Location	Domestic	Gabon	Turkey
Q1 - Project Type	Commercial Building (Office, mall, etc.)	Public Building (hospital, university, government building etc.)	Commercial Building (Office, mall, etc.)
Q2 - Decision Timing	Pre-design/feasibility/tender phase	Pre-design/feasibility/tender phase	During the operation phase
Q3 - Targeted Green Level	LEED-Platinum or equivalent	LEED-Gold or equivalent	LEED-Gold or equivalent
Q4- Achieved Green Level	LEED-Platinum or equivalent	LEED-Gold or equivalent	LEED-Gold or equivalent
Q5 - Financing Type	Bond Financing	Financed by government	Equity
Q6 - Expected vs Actual Returns	Significantly above the targeted/expected returns	Same level as the targeted/expected returns	Same level as the targeted/expected returns
Q7- Degree of Stakeholder Involvement	100%	58%	37%
Q8 - Green Awareness of End Users	5 (Very high sensitivity/awareness)	4 (High sensitivity/awareness)	4 (High sensitivity/awareness)
Q9 - Impact of Green on O&M Costs	Lower occurrence rate of problems/maintenance costs	Lower occurrence rate of problems/maintenance costs	Lower occurrence rate of problems/maintenance costs
Q10 - Expected vs Actual Energy Performance	Significantly higher performance	Higher performance	Higher performance

Figure B.1. Participant answers to survey questions (cont.)

Questions	P10	P11	P12
Q0.a - Title of the participant	Project Manager	Construction Supervisor	Technical Office Engineer
Q0.b - Project Location	Moskova - Rusya	Levent İstanbul	Levent
Q1 - Project Type	Commercial Building (Office, mall, etc.)	Commercial Building (Office, mall, etc.)	Commercial Building (Office, mall, etc.)
Q2 - Decision Timing	Pre-design/feasibility/tender phase	Pre-design/feasibility/tender phase	Pre-design/feasibility/tender phase
Q3 - Targeted Green Level	LEED-Silver or equivalent	LEED-Gold or equivalent	LEED-Silver or equivalent
Q4- Achieved Green Level	LEED-Silver or equivalent	LEED-Gold or equivalent	LEED-Silver or equivalent
Q5 - Financing Type	Equity	Project financing - Private Equity / Venture Capital Investment	Equity
Q6 - Expected vs Actual Returns	Above the targeted/expected returns	Significantly below the targeted/expected returns	Same level as the targeted/expected returns
Q7- Degree of Stakeholder Involvement	72%	55%	70%
Q8 - Green Awareness of End Users	3 (Medium sensitivity/awareness)	3 (Medium sensitivity/awareness)	3 (Medium sensitivity/awareness)
Q9 - Impact of Green on O&M Costs	Significantly lower occurrence rate of problems/maintenance costs	Similar occurrence rate of problems/maintenance costs	Lower occurrence rate of problems/maintenance costs
Q10 - Expected vs Actual Energy Performance	Significantly higher performance	Same level of performance	Lower performance

Figure B.1. Participant answers to survey questions (cont.)

Questions	P13	P14	P15
Q0.a - Title of the participant	Finishing Works Supervisor	Executive	Project Manager
Q0.b - Project Location	1.Levent İstanbul	MERSİN	TUZLA
Q1 - Project Type	Commercial Building (Office, mall, etc.)	Commercial Building (Office, mall, etc.)	Public Building (hospital, university, government building etc.)
Q2 - Decision Timing	Pre-design/feasibility/tender phase	Pre-design/feasibility/tender phase	Pre-design/feasibility/tender phase
Q3 - Targeted Green Level	LEED-Platinum or equivalent	LEED-Silver or equivalent	LEED-Gold or equivalent
Q4- Achieved Green Level	LEED-Platinum or equivalent	LEED-Certified or equivalent	LEED-Gold or equivalent
Q5 - Financing Type	Project Financing	Project Financing	Leasing
Q6 - Expected vs Actual Returns	Same level as the targeted/expected returns	Below the targeted/expected returns	Below the targeted/expected returns
Q7- Degree of Stakeholder Involvement	78%	23%	60%
Q8 - Green Awareness of End Users	4 (High sensitivity/awareness)	2 (Low sensitivity/awareness)	3 (Medium sensitivity/awareness)
Q9 - Impact of Green on O&M Costs	Similar occurrence rate of problems/maintenance costs	Higher occurrence rate of problems/maintenance costs	Significantly lower occurrence rate of problems/maintenance costs
Q10 - Expected vs Actual Energy Performance	Higher performance	Lower performance	Same level of performance

Figure B.1. Participant answers to survey questions (cont.)

Questions	P16	P17	P18
Q0.a - Title of the participant	Deputy Operation Manager	Facility Manager	Corporate Services Department Manager
Q0.b - Project Location	Adana	Kanyon AVM	Yenibosna, Bahçelievler, İstanbul
Q1 - Project Type	Commercial Building (Office, mall, etc.)	Commercial Building (Office, mall, etc.)	Commercial Building (Office, mall, etc.)
Q2 - Decision Timing	During the operation phase	During the operation phase	During the operation phase
Q3 - Targeted Green Level	LEED-Silver or equivalent	LEED-Gold or equivalent	LEED-Silver or equivalent
Q4- Achieved Green Level	LEED-Gold or equivalent	LEED-Gold or equivalent	LEED-Silver or equivalent
Q5 - Financing Type	Equity	Equity - Private Equity / Venture Capital Investment	Project Financing
Q6 - Expected vs Actual Returns	Same level as the targeted/expected returns	Above the targeted/expected returns	Same level as the targeted/expected returns
Q7- Degree of Stakeholder Involvement	70%	72%	78%
Q8 - Green Awareness of End Users	5 (Very high sensitivity/awareness)	4 (High sensitivity/awareness)	4 (High sensitivity/awareness)
Q9 - Impact of Green on O&M Costs	Similar occurrence rate of problems/maintenance costs	Similar occurrence rate of problems/maintenance costs	Lower occurrence rate of problems/maintenance costs
Q10 - Expected vs Actual Energy Performance	Higher performance	Higher performance	Higher performance

Figure B.1. Participant answers to survey questions (cont.)

Questions	P19	P20	P21
Q0.a - Title of the participant	Factory Manager	Site Supervisor	Mechanical Engineer
Q0.b - Project Location	Manisa Organize Sanayi Bölgesi	Levent	Kozyatağı
Q1 - Project Type	Industrial	Commercial Building (Office, mall, etc.)	Commercial Building (Office, mall, etc.)
Q2 - Decision Timing	After the pre-design/feasibility/tender phase and before the start of construction (Final Design phase)	Pre-design/feasibility/tender phase	Pre-design/feasibility/tender phase
Q3 - Targeted Green Level	LEED-Certified or equivalent	LEED-Gold or equivalent	LEED-Platinum or equivalent
Q4- Achieved Green Level	LEED-Certified or equivalent	LEED-Gold or equivalent	LEED-Platinum or equivalent
Q5 - Financing Type	Equity	Private Equity / Venture Capital Investment	Project Financing
Q6 - Expected vs Actual Returns	Same level as the targeted/expected returns	Same level as the targeted/expected returns	Above the targeted/expected returns
Q7- Degree of Stakeholder Involvement	35%	63%	92%
Q8 - Green Awareness of End Users	4 (High sensitivity/awareness)	4 (High sensitivity/awareness)	4 (High sensitivity/awareness)
Q9 - Impact of Green on O&M Costs	Higher occurrence rate of problems/maintenance costs	Lower occurrence rate of problems/maintenance costs	Significantly lower occurrence rate of problems/maintenance costs
Q10 - Expected vs Actual Energy Performance	Same level of performance	Higher performance	Significantly higher performance

Figure B.1. Participant answers to survey questions (cont.)

Questions	P22	P23	P24
Q0.a - Title of the participant	Budget and Planning Engineer	Executive	Asset CEO
Q0.b - Project Location	Bomonti	istanbul	United Kingdom
Q1 - Project Type	Residential Building	Industrial	Public Building (hospital, university, government building etc.)
Q2 - Decision Timing	Pre-design/feasibility/tender phase	Pre-design/feasibility/tender phase	Pre-design/feasibility/tender phase
Q3 - Targeted Green Level	LEED-Gold or equivalent	LEED-Gold or equivalent	LEED-Platinum or equivalent
Q4- Achieved Green Level	LEED-Gold or equivalent	LEED-Gold or equivalent	LEED-Platinum or equivalent
Q5 - Financing Type	Project Financing	Equity	Equity - Project Financing - Bond Financing
Q6 - Expected vs Actual Returns	Same level as the targeted/expected returns	Same level as the targeted/expected returns	Same level as the targeted/expected returns
Q7- Degree of Stakeholder Involvement	62%	28%	57%
Q8 - Green Awareness of End Users	4 (High sensitivity/awareness)	4 (High sensitivity/awareness)	4 (High sensitivity/awareness)
Q9 - Impact of Green on O&M Costs	Similar occurrence rate of problems/maintenance costs	Similar occurrence rate of problems/maintenance costs	Similar occurrence rate of problems/maintenance costs
Q10 - Expected vs Actual Energy Performance	Higher performance	Higher performance	Same level of performance

Figure B.1. Participant answers to survey questions (cont.)

Questions	P25	P26	P27
Q0.a - Title of the participant	Project Manager	Business Development Team Leader	design team leader
Q0.b - Project Location	Domestic	İzmir	İzmir
Q1 - Project Type	Commercial Building (Office, mall, etc.)	Residential Building	Residential Building
Q2 - Decision Timing	After the pre-design/feasibility/tender phase and before the start of construction (Final Design phase)	Pre-design/feasibility/tender phase	Pre-design/feasibility/tender phase
Q3 - Targeted Green Level	LEED-Gold or equivalent	LEED-Gold or equivalent	LEED-Silver or equivalent
Q4- Achieved Green Level	LEED-Gold or equivalent	LEED-Gold or equivalent	LEED-Silver or equivalent
Q5 - Financing Type	Project Financing	Pre-sale	Project financing - Private Equity / Venture Capital Investment
Q6 - Expected vs Actual Returns	Same level as the targeted/expected returns	Same level as the targeted/expected returns	Same level as the targeted/expected returns
Q7- Degree of Stakeholder Involvement	52%	63%	23%
Q8 - Green Awareness of End Users	3 (Medium sensitivity/awareness)	3 (Medium sensitivity/awareness)	3 (Medium sensitivity/awareness)
Q9 - Impact of Green on O&M Costs	Similar occurrence rate of problems/maintenance costs	Similar occurrence rate of problems/maintenance costs	Similar occurrence rate of problems/maintenance costs
Q10 - Expected vs Actual Energy Performance	Higher performance	Same level of performance	Higher performance

Figure B.1. Participant answers to survey questions (cont.)

Questions	P28	P29	P30
Q0.a - Title of the participant:	QC manager	Electrical Works Team Leader	Mechanical Works Team Leader
Q0.b - Project Location	International	SOHO-ZİNCİRLİKUYU	Zincirlikuyu
Q1 - Project Type	Commercial Building (Office, mall, etc.)	Commercial Building (Office, mall, etc.)	Commercial Building (Office, mall, etc.)
Q2 - Decision Timing	Pre-design/feasibility/tender phase	After the pre-design/feasibility/tender phase and before the start of construction (Final Design phase)	After the pre-design/feasibility/tender phase and before the start of construction (Final Design phase)
Q3 - Targeted Green Level	LEED-Platinum or equivalent	LEED-Gold or equivalent	LEED-Gold or equivalent
Q4- Achieved Green Level	LEED-Platinum or equivalent	LEED-Gold or equivalent	LEED-Gold or equivalent
Q5 - Financing Type	Bond Financing	Equity	Equity
Q6 - Expected vs Actual Returns	Significantly above the targeted/expected returns	Same level as the targeted/expected returns	Above the targeted/expected returns
Q7- Degree of Stakeholder Involvement	100%	40%	62%
Q8 - Green Awareness of End Users	5 (Very high sensitivity/awareness)	4 (High sensitivity/awareness)	3 (Medium sensitivity/awareness)
Q9 - Impact of Green on O&M Costs	Lower occurrence rate of problems/maintenance costs	Lower occurrence rate of problems/maintenance costs	Lower occurrence rate of problems/maintenance costs
Q10 - Expected vs Actual Energy Performance	Significantly higher performance	Same level of performance	Higher performance

Figure B.1. Participant answers to survey questions (cont.)

APPENDIX C: DECISION MATRIX APPLIED TO LEED CATEGORIES

The decision matrix in Figure 5.3 is applied to LEED-HC v2009 categories for the purposes of this study and following results are obtained shown in Figure C.1

LEED Categories	**Points**	**Action Type**	**Latest Decision Stage**
Sustainable sites	18		
Construction activity pollution prevention	Req		
Create and implement an erosion and sedimentation control plan for all construction activities associated with the project. The plan must conform to the erosion and sedimentation requirements of the 2003 U.S. Environmental Protection Agency (EPA) Construction General Permit (CGP) or local equivalent, whichever is more stringent.	Req	Management Plan	Planning and Design Stage
Environmental Site assessment	Req		
Conduct a Phase I Environmental Site Assessment (as described in ASTM E1527-05) to determine if environmental contamination exists at the site. If contamination is suspected, conduct a Phase II Environmental Site Assessment (as described in ASTM E1903-97, 2002). Projects outside the U.S. may use a local equivalent to ASTM E1527-05 Phase I Environmental Site Assessment and ASTM E 1903-97 Phase II Environmental Site Assessment. AND Sites that are contaminated due to the past existence of a landfill on the site are prohibited. If the site is otherwise contaminated, then it must be remediated to meet local, state or federal EPA region residential (unrestricted) standards, whichever is the most stringent. Documentation from the authority must be provided, such as EPA's Ready for Reuse document, to prove "safe" levels of contamination have been achieved. As the remediation process leads to significant environmental benefit, one point (in SS Credit 3: Brownfield Redevelopment) will be given for successful documented remediation of the site.	Req	Site Survey	Planning and Design Stage
Site selection	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories.

Do not develop buildings, hardscape, roads or parking areas on portions of sites that meet any of the following criteria: Prime farmland as defined by the U.S. Department of Agriculture in the United States Code of Federal Regulations, Title 7, Volume 6, Parts 400 to 699, Section 657.5 (citation 7CFR657.5). Projects outside the U.S. may use a local equivalent. Previously undeveloped land whose elevation is lower than 5 feet (1.5 meters) above the elevation of the 100-year flood as defined by the Federal Emergency Management Agency (FEMA), an equivalent local regulatory agency, or a professional hydrologist. [Europe ACP: Flood Plains] Land specifically identified as habitat for any species on federal or state threatened or endangered lists. Projects outside the U.S. may use a local equivalent. [Europe ACP: Habitat] Land within 100 feet (30 meters) of any wetlands as defined by the U.S. Code of Federal Regulations 40 CFR, Parts 230-233 and Part 22, or a local equivalent definition outside the U.S., and isolated wetlands or areas of special concern identified by state or local rule, OR within setback distances from wetlands prescribed in state or local regulations, as defined by local or state rule or law, whichever is more stringent. Previously undeveloped land that is within 50 feet (15 meters) of a water body, defined as seas, lakes, rivers, streams and tributaries that support or could support aquatic life, recreation or industrial use, consistent with the terminology of the Clean Water Act. Land that prior to acquisition for the project was public parkland, unless land of equal or greater value as parkland is accepted in trade by the public landowner (park authority projects and projects which are operated by and support the function of the park are exempt).	1	Site Selection	Feasibility Stage
Development density and community connectivity	1		
Option 1: Development density Construct or renovate a building on a previously developed site AND in a community with a minimum density of 60,000 square feet per acre net (13,800 square meters per hectare net). The density calculation is based on a typical two-story downtown development and must include the area of the project being built.	1	Site Selection	Feasibility Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Option 2: Community connectivity Construct or renovate a building on a site that meets the following criteria: · Located on a previously developed site, · Located within 1/2-mile (800 meters) of a residential area or neighborhood with an average density of 10 units per acre net, · Located within 1/2-mile (800 meters) of at least 10 basic services, and · Pedestrian access available between the building and the services. For mixed-use projects, no more than three services within the project boundary may be counted towards the ten basic services, provided it is open to the public. No more than two of the ten services required may be anticipated (i.e., at least eight must be existing and operational). In addition, the anticipated services must demonstrate that they will be operational in the locations indicated within 1 year of occupation of the applicant project. Proximity is determined by drawing a 1/2-mile (800 meter) radius around a main building entrance on a site map and counting the services within that radius.	1	Site Selection	Feasibility Stage
Option 3: Existing rural sites For previously developed existing rural healthcare campus sites, achieve a minimum development density of 30,000 square feet per acre (6,900 square meters per hectare).	1	Site Selection	Feasibility Stage
Brownfield redevelopment	1		
Projects can only obtain this point via SS Prerequisite 2: Environmental Site Assessment, by remediating site contamination.	1	Site Selection	Feasibility Stage
Alternative transportation - public transportation access	3		
Option 1: Rail station, bus rapid transit station & ferry terminal proximity Locate the project within 1/2-mile (800 meter) walking distance (measured from a main building entrance) of an existing or planned and funded commuter rail, light rail, subway station bus rapid transit1 station or commuter ferry terminal. For stations located greater than 1/8 mile (200 meters) from building entrance, provide an on-demand shuttle service with a documented service plan.	3	Site Selection	Feasibility Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Option 2: Bus stop proximity Locate the project within 1/8-mile (200 meters) walking distance (measured from a main building entrance) of one or more stops for two or more public, campus, or private bus lines usable by building occupants.	3	Site Selection	Feasibility Stage
Option 3. Rideshare proximity Projects outside the U.S. may locate the project within 1/4-mile (400 meter) walking distance (measured from a main building entrance) of 1 or more stops for 2 or more existing rideshare options that that meet the definition of public transportation and are authorized by the local transit authority if one exists.	3	Site Selection	Feasibility Stage
Alternative transportation - bicycle storage and changing rooms	1		
Case 1: Commercial or institutional projects Provide secure bicycle racks and/or storage within 200 yards (200 meters) of a building entrance for 5% or more of all Full Time Equivalent (FTE) staff (measured at peak periods) Provide showers and changing facilities in the building, or within 200 yards (200 meters) of a primary staff building entrance, for 0.5% of FTE staff (measured at peak periods). Case 2: Residential projects For residential buildings, provide covered storage facilities for securing bicycles for 15% or more of building occupants, in lieu of changing/shower facilities.	1	Building use	Late Construction Stage
Alternative transportation - low-emitting and fuel-efficient vehicles	1		
Option 1 Provide preferred parking for low-emitting and fuel-efficient vehicles for 5% of the total vehicle parking capacity of the site. Providing a discounted parking rate is an acceptable substitute for preferred parking for low-emitting/fuel-efficient vehicles. To establish a meaningful incentive in all potential markets, the parking rate must be discounted at least 20%. The discounted rate must be available to all customers (i.e., not limited to the number of customers equal to 5% of the vehicle parking capacity), publicly posted at the entrance of the parking area and available for a minimum of 2 years.	1	Building use	Late Construction Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Option 2 Install alternative-fuel fueling stations for 3% of the total vehicle parking capacity of the site. Liquid or gaseous fueling facilities must be separately ventilated or located outdoors.	1	Building use	Late Construction Stage
Option 3 Provide low-emitting and fuel-efficient vehicles for 3% of Full Time Equivalent (FTE) staff measured at peak periods. Provide preferred parking for these vehicles.	1	Building use	Late Construction Stage
Option 4 Provide staff access to a low-emitting or fuel-efficient vehicle-sharing program. The following requirements must be met: One low-emitting or fuel-efficient vehicle must be provided per 3% of FTE staff, assuming that 1 shared vehicle can carry eight persons (i.e., 1 vehicle per 267 FTE occupants). For buildings with fewer than 267 FTE staff, at least 1 low emitting or fuel-efficient vehicle must be provided. A vehicle-sharing contract must be provided that has an agreement of at least two years. The estimated number of customers served per vehicle must be supported by documentation. A narrative explaining the vehicle-sharing program and its administration must be submitted. Parking for low-emitting and fuel-efficient vehicles must be located in the nearest available spaces in the nearest available parking area. Provide a site plan or area map clearly highlighting the walking path from the parking area to the project site and noting the distance.	1	Building use	Late Construction Stage
Alternative transportation - parking capacity	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Case 1 - Non-residential healthcare projects Option 1 Size parking capacity to meet, but not exceed, minimum local zoning requirements OR health department regulatory authority, whichever is the overriding requirement. Provide preferred parking for carpools or vanpools for 5% of the total parking spaces.	1	Building use	Late Construction Stage
Case 1 - Non-residential healthcare projects Option 2 For projects that provide parking for less than 5% of full-time equivalent (FTE) building occupants: Provide preferred parking for carpools or vanpools, marked as such, for 5% of total parking spaces. Providing a discounted parking rate is an acceptable substitute for preferred parking for carpool or vanpool vehicles. To establish a meaningful incentive in all potential markets, the parking rate must be discounted at least 20%. The discounted rate must be available to all customers (i.e. not limited to the number of customers equal to 5% of the vehicle parking capacity), publicly posted at the entrance of the parking area, and available for a minimum of 2 years.	1	Building use	Late Construction Stage
Case 1 - Non-residential healthcare projects Option 3 Provide no new parking.	1	Building use	Late Construction Stage
Case 1 - Non-residential healthcare projects Option 4 For projects that have no minimum local zoning requirements, provide 25% fewer parking spaces than the applicable standard listed in the 2003 Institute of Transportation Engineers (ITE) "Parking Generation" study	1	Building use	Late Construction Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Case 2 - Residential healthcare licensed long term care projects Option 1 Size parking capacity to meet, but not exceed, minimum local zoning requirements or health department regulatory authority, whichever is the overriding requirement. Provide infrastructure and support programs to facilitate shared vehicle use, such as carpool drop-off areas, designated parking for vanpools, car-share services, ride boards and shuttle services to mass transit. Provide preferred parking1 for carpools or vanpools for 5% of the total parking spaces provided for staff OR, for projects that provide parking for less than 5% FTE staff measured at peak periods, provide preferred parking1 for carpools or vanpools, marked as such, for 5% of total provided parking spaces.	1	Building use	Late Construction Stage
Case 2 - Residential healthcare licensed long term care projects Option 2 Provide no new parking.	1	Building use	Late Construction Stage
Case 3 - Mixed use healthcare projects (i.e. including residential, retail, and/or medical office components) Option 1 - Commercial and non-commercial requirements Mixed-use buildings with less than 10% non-residential area must be considered residential and adhere to the residential requirements in Case 2. For mixed-use buildings with more than 10% non-residential area, the non-residential space must adhere to the requirements in Case 1 and the residential component must adhere to residential requirements in Case 2. Note: This option applies only to mixed-use healthcare projects that include residential, retail and/or medical office components.	1	Building use	Late Construction Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Case 3 - Mixed use healthcare projects (i.e. including residential, retail, and/or medical office components) Option 2 Provide no new parking.	1	Building use	Late Construction Stage
Site development - protect or restore habitat	1		
Case 1. Greenfield sites1 Limit all site disturbance to the following parameters: 40 feet (12 meters) beyond the building perimeter and parking garages; 10 feet (3 meters) beyond surface walkways, patios, surface parking and utilities less than 12 inches (30 centimeters) in diameter; 15 feet (4.5 meters) beyond primary roadway curbs and main utility branch trenches; 25 feet (8 meters) beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities and playing fields) that require additional staging areas to limit compaction in the constructed area.	1	Site usage	Planning and Design Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Case 2. Previously developed2 areas or graded sites Restore or protect a minimum of 50% of the site area, excluding the building footprint, or 20% of the total site area, including building footprint, whichever is greater, with native or adapted vegetation.3 Projects earning SS Credit 2, Development Density and Community Connectivity, may include vegetated roof surface in this calculation if the plants are native or adapted, provide habitat, and promote biodiversity. Projects earning SS Credit 9.1, Connection to the Natural World—Outdoor Places of Respite, may apply the planted areas to this calculation, if the plants are native or adapted, provide habitat and promote biodiversity. Projects with limited landscape opportunities may also donate offsite land in perpetuity, equal to 60% of the previously developed area (including the building footprint), to a land trust within the same EPA Level III Ecoregion identified for the project site. The land trust must adhere to the Land Trust Alliance 'Land Trust Standards and Practices' 2004 Revision.	1	Site usage	Planning and Design Stage
Site development - maximize open space	1		
Case 1 Reduce the development footprint1 and/or provide vegetated open space within the project boundary such that the amount of open space exceeds local zoning requirements by 25%.	1	Site usage	Planning and Design Stage
Case 2 For areas with no local zoning requirements (e.g. some university campuses, military bases), provide a vegetated open space area adjacent to the building that is equal in area to the building footprint.	1	Site usage	Planning and Design Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Case 3 Where a zoning ordinance exists, but there is no requirement for open space (zero), provide vegetated open space equal to 20% of the project site area.	1	Site usage	Planning and Design Stage
All cases For projects in urban areas that earn SS Credit 2: Development Density and Community Connectivity, vegetated roof areas can contribute to credit compliance. For projects in urban areas that earn SS Credit 2: Development Density and Community Connectivity, pedestrian-oriented hardscape areas can contribute to credit compliance. For such projects, a minimum of 25% of the open space counted must be vegetated. Wetlands or naturally designed ponds may count as open space and the side slope gradients average 1:4 (vertical: horizontal) or less and are vegetated.	1	Site usage	Planning and Design Stage
Stormwater design - quantity control	1		
Option 1. Design storms Case 1. Sites with existing imperviousness 50% or less Path 1 Implement a stormwater management plan that prevents the post development peak discharge rate and quantity from exceeding the predevelopment peak discharge rate and quantity for the 1- and 2-year 24-hour design storms.	1	Management plan	Planning and Design Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Option 1. Design storms Case 1. Sites with existing imperviousness 50% or less Path 2 Implement a stormwater management plan that protects receiving stream channels from excessive erosion. The stormwater management plan must include stream channel protection and quantity control strategies.	1	Management plan	Planning and Design Stage
Option 1. Design storms Case 2. Sites with existing imperviousness greater than 50% Implement a stormwater management plan that results in a 25% decrease in the volume of stormwater runoff from the 2-year 24-hour design storm.	1	Management plan	Planning and Design Stage
Option 2. Percentile rainfall events Case 1. Non-zero lot line projects In a manner best replicating natural site hydrology processes, manage onsite the runoff from the developed site for the 95th percentile of regional or local rainfall events using Low Impact Development (LID)3 and green infrastructure4. Use daily rainfall data and the methodology in the United States Environmental Protection Agency's Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act to determine the 95th percentile amount.	1	Management plan	Planning and Design Stage
Option 2. Percentile rainfall events CASE 2: zero lot line projects For zero lot line projects located in urban areas with a minimum density of 1.5 FAR (13,800 square meters per hectare net), in a manner best replicating natural site hydrology processes, manage onsite the runoff from the developed site for the 85th percentile of regional or local rainfall events using LID and green infrastructure.	1	Management plan	Planning and Design Stage
Stormwater design - quality control	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Implement a stormwater management plan that reduces impervious cover, promotes infiltration and captures and treats the stormwater runoff from 90% of the average annual rainfall1 using acceptable best management practices (BMPs). BMPs used to treat runoff must be capable of removing 80% of the average annual post development total suspended solids (TSS) load based on existing monitoring reports. BMPs are considered to meet these criteria if: They are designed in accordance with standards and specifications from a state or local program that has adopted these performance standards. OR There exists infield performance monitoring data demonstrating compliance with the criteria. Data must conform to accepted protocol (e.g., Technology Acceptance Reciprocity Partnership [TARP], Washington State Department of Ecology) for BMP monitoring.	1	Management plan	Planning and Design Stage
Heat island effect - nonroof	1		
Option 1 Use any combination of the following strategies for 50% of the site hardscape (including roads, sidewalks, courtyards and parking lots): Provide shade from the existing tree canopy or within 5 years of landscape installation. Landscaping (trees) must be in place at the time of occupancy. Provide shade from structures covered by solar panels that produce energy used to offset some nonrenewable resource use. Provide shade from architectural devices or structures that have a solar reflectance index (SRI) of at least 29. Use hardscape materials with an SRI of at least 29. Use an open-grid pavement system (at least 50% pervious).	1	Building use	Late Construction Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Option 2 Place a minimum of 50% of parking spaces under cover. Any roof used to shade or cover parking must have an SRI of at least 29, be a vegetated green roof or be covered by solar panels that produce energy used to offset some nonrenewable resource use.	1	Building use	Late Construction Stage
Heat island effect - roof	1		
Option 1 Use roofing materials with a solar reflectance index2 (SRI)equal to or greater than the values in the table below for a minimum of 75% of the roof surface. Roofing materials having a lower SRI value than those listed below may be used if the weighted rooftop SRI average meets the following criteria: ((Area Roof Meeting Minimum SRI/Total Roof Area) x (SRI of Installed Roof/Required SRI)) ≥ 75% Low-sloped roof - SRI 78 Steep-sloped roof - SRI 29	1	Building materials	Early Construction Stage
Option 2 Install a vegetated roof that covers at least 50% of the roof area.	1	Building materials	Early Construction Stage
Option 3 Install high-albedo and vegetated roof surfaces that, in combination, meet the following criteria: ((Area Roof Meeting Minimum SRI/0.75) + (Area of Vegetated Roof/0.5))≥ Total Roof Area Low-sloped roof - SRI 78 Steep-sloped roof - SRI 29	1	Building materials	Early Construction Stage
Light pollution reduction	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Option 1 - Interior Lighting Reduce the input power (by automatic device) of all nonemergency interior luminaires with a direct line of sight to any openings in the envelope (translucent or transparent) by at least 50% between 11 p.m. and 5 a.m. An afterhours override may be provided by a manual or occupant-sensing device provided the override lasts no more than 30 minutes. Exterior Lighting Light areas only as required for safety and comfort. Exterior lighting power densities shall not exceed those specified in ANSI/ASHRAE/IESNA Standard 90.1-2007 with Addenda i for the documented lighting zone. Justification shall be provided for the selected lighting zone. Lighting controls for all exterior lighting shall comply with section 9.4.1.3 of ANSI/ASHRAE/IESNA Standard 90.1- 2007, without amendments.	1	Building use	Late Construction Stage
Option 2 - Interior Lighting All openings in the envelope (translucent or transparent) with a direct line of sight to any nonemergency luminaires must have shielding (controlled/closed by automatic device for a resultant transmittance of less than 10% between 11 p.m. and 5 a.m.). Exterior Lighting Light areas only as required for safety and comfort. Exterior lighting power densities shall not exceed those specified in ANSI/ASHRAE/IESNA Standard 90.1-2007 with Addenda i for the documented lighting zone. Justification shall be provided for the selected lighting zone. Lighting controls for all exterior lighting shall comply with section 9.4.1.3 of ANSI/ASHRAE/IESNA Standard 90.1- 2007, without amendments.	1	Building Use	Late Construction Stage
Connection to the natural world - places of respite	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Provide patient and visitor accessible outdoor places of respite equal to 5% of the net usable program area of the building or project. Provide additional dedicated outdoor place(s) of respite for staff equal to 2% of the net usable program area of the building or project.	1	Conceptual Design Development	Planning and Design Stage
Connection to the natural world - direct exterior access for patients	1		
To provide direct access to an exterior courtyard, terrace, garden or balcony with a minimum area of five square feet per patient for 75% of all inpatients AND 75% of qualifying outpatients with clinical Length of Stay (LOS) greater than four hours.	1	Conceptual Design Development	Planning and Design Stage
Water Efficiency	9		
Water use reduction	Req		
Building water use Employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation). The baseline shall meet the requirements of the Energy Policy Act (EPAct) of 1992 and subsequent rulings by the Department of Energy, requirements of the EPAct of 2005, and the plumbing code requirements as stated in the 2006 editions of the Uniform Plumbing Code or International Plumbing Code pertaining to fixture performance. AND Process water use Employ strategies that in aggregate use 20% less water than the process water use baseline calculated for equipment performance requirements	Req	Building Systems Implementation	Late Construction Stage
Minimize potable water use for medical equipment cooling	Req		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

For ALL medical equipment in the project, demonstrate that potable water use will be minimized for equipment cooling. Potable water usage is ONLY acceptable in emergency backup systems or where local requirements mandate. The following is required: · No potable water use for once through cooling for ALL medical equipment that rejects heat. (Note: This credit does not apply to potable water for cooling tower makeup or for other evaporative cooling systems. Refer to WE Credit 4: Process Water Use Reduction for more details.) · Where local requirements mandate limiting the discharge temperature of fluids into the drainage system, a tempering device must be used that runs water only when the equipment discharges hot water. Alternatively, provide a thermal recovery heat exchanger that allows drained discharge water to be cooled below coderequired maximum discharge temperatures while simultaneously preheating inlet makeup water or, if the fluid is steam condensate, return it to the boiler. · An owner may elect to use potable water in an open-loop (once-through) configuration as the emergency backup cooling system only, not as the primary cooling system. The primary cooling system in these critical applications MUST be a closed-loop system requiring no potable water usage. Such emergency back-up systems shall only be used in the event that the primary, closed-loop cooling equipment has failed, and such a failure is visually and audibly indicated at the point-of-use and alarmed at a continuously monitored location.	Req	Implementation Design	Early Construction Stage
Water efficient landscaping - no potable water use or no irrigation	1		
OPTION 1 Use only captured rainwater, recycled wastewater, recycled graywater or water treated and conveyed by a public agency specifically for nonpotable uses for irrigation.	1	Detailed Design Development	Planning and Design Stage
OPTION 2 Install landscaping that does not require permanent irrigation systems. Temporary irrigation systems used for plant establishment are allowed only if removed within a period not to exceed 18 months of installation.	1	Detailed Design Development	Planning and Design Stage
Water use reduction - measurement and verification	2		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Install meters to track the following water uses (as applicable to the project): Cooling tower make-up and blowdown Incoming water to the project Purified water system (reverse osmosis and/or de-ionized) Filter backwash water Water use in dietary department Water use in laundry Outdoor Irrigation systems Steam boiler systems make-up water AND Install meters to track the water use in any two (for one point) or any three (for two points) of the following: Water use in laboratory Water use in central sterile and processing department Water use in physio- and hydrotherapy treatment areas Water use in surgical suite Closed-loop hydronic systems make-up water Cold-water make-up for domestic hot water systems AND The Measurement and Verification (M&V) period shall cover a period of no less than one year of post-construction occupancy. Use the International Performance Measurement and Verification Protocol (IPMVP) Volume 1, Concepts for Determining Energy and Water Savings, March 2002, to provide for long term continuous measurement of potable cold water uses within the facility. [Option D: Calibrated Simulation (Savings Estimation Method 2 - See Volume III, April 2003, for description of Option D, Savings Estimation Method) – for new construction; or Option B: Retrofit Measure Isolation – for renovation].	2	Building Systems Implementation	Late Construction Stage
Water use reduction	3		
Project teams earn points by achieving the following percent reductions for both building water use and process water use. The minimum water savings percentage for each point threshold is as follows: -30% : 1 point -35% : 2 points -40%: 3 points	1-3	Detailed Design Development	Planning and Design Stage
Water use reduction - building equipment	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Install only dry vacuum pumps for central vacuum systems and all other systems except for vacuum systems for sterilizing, which may use oil-lubricated liquid ring pumps. Do not install venturi vacuum systems for sterilizers. For air compressors, install either air cooling or closed-loop cooling, such as a cooling tower or chilled water system. Large frame X-ray processors and/or developers of more than 150 mm (six inches) in length or width shall use film processor water recycling units. Smaller X-ray equipment, such as a dental X-ray film processor, is exempt from this requirement	1	Building Systems Implementation	Late Construction Stage
Water use reduction - cooling towers	1		
Cooling towers and evaporative condensers for air conditioning systems, such as chilled water systems, shall achieve a minimum of five cycles of concentration based on a ratio of the conductivity of the water being discharged (blowdown) divided by the conductivity of the feed (makeup) water(s), or four cycles of concentration, if the makeup water hardness exceeds 200 mg/l expressed as calcium carbonate, or shall achieve a minimum discharge (blowdown) concentration of 1500 mg/L (1500 ppm) expressed as calcium carbonate, or 175 mg/L (175 ppm) of silica measured as silicon dioxide, whichever is met first. ƒCooling towers and evaporative condensers shall be equipped with makeup and blowdown meters, conductivity controllers and overflow alarms and efficient drift eliminators that reduce drift loss to less than, or equal to, 0.001% of recirculating water in a counter-flow tower or 0.005% in a cross-flow tower. ƒƒUse no more potable water than 2.3 gallons per ton hour (2.5 liters per kilowatt hour) for cooling tower or evaporative condenser make-up. Projects without cooling towers or evaporative condensers are ineligible for this credit	1	Building Systems Implementation	Late Construction Stage
Water use reduction - food waste systems	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

When a food waste disposer system is used, the following requirements must be met: Use cold water. (This is a common code requirement.) Equip systems with a load sensing device that regulates the water use to 1 gpm in a no- load situation and 3 to 8 gpm in a full-load situation. Automatic time shutoff that shall have a ten-minute time-out system with a push button to reactivate. When pulpers, extractors, scrap basket or strainer-type systems are used, the following requirements must be met: Mechanical pulpers/extractors and mechanical scrapper systems shall use no more than 2 gpm of potable water, excluding end-of-day, wash-down cycles. Non-mechanical strainer (scrapper) baskets shall not be part of a flowing through collection system connected to potable water at a rate greater than 2 gpm. Automatic time shutoff that shall have a ten-minute time-out system with a push button to reactivate.	1	Building Systems Implementation	Late Construction Stage
Energy & atmosphere	39		
Fundamental commissioning of Building Energy Systems	Req		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

The following commissioning process activities must be completed by the project team: · Designate an individual as the commissioning authority (CxA) to lead, review and oversee the completion of the commissioning process activities. o The CxA must have documented commissioning authority experience in at least 2 building projects. o The individual serving as the CxA must be independent of the project design and construction management, though the CxA may be an employee of any firm providing those services. The CxA may be a qualified employee or consultant of the owner. o The CxA must report results, findings and recommendations directly to the owner. o For projects smaller than 50,000 gross square feet (4,600 gross square meters), the CxA may be a qualified person on the design or construction team who has the required experience. · The owner must document the owner's project requirements (OPR). The design team must develop the basis of design (BOD). The CxA must review these documents for clarity and completeness. The owner and design team must be responsible for updates to their respective documents. · Develop and incorporate commissioning requirements into the construction documents. · Develop and implement a commissioning plan. · Verify the installation and performance of the systems to be commissioned. · Complete a summary commissioning report.	Req	Implementation Design	Early Construction Stage
Minimum energy performance	Req		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Option 1. Whole-building energy simulation Demonstrate a 10% improvement in the proposed building performance rating for new buildings, or a 5% improvement in the proposed building performance rating for major renovations to existing buildings, compared with the baseline building performance rating. For projects that registered after April 7, 2016 and are subject to the three point mandatory minimum, demonstrate a 16% improvement in the proposed building performance rating for new buildings, or a 12% improvement in the proposed building performance rating for major renovations to existing buildings, compared with the baseline building performance rating. Calculate the baseline building performance rating according to the building performance rating method in Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda1) using a computer simulation model for the whole building project. Projects outside the U.S. may use a USGBC approved equivalent standard OR Option 2. Prescriptive compliance: ASHRAE 50% Advanced Energy Design Guide Comply with the mandatory and prescriptive provisions of ANSI/ASHRAE/IESNA Standard 90.1–2010, with errata (or a USGBC-approved equivalent standard for projects outside the U.S.). Not eligible for projects registered after April 7 2016 OR Option 3. Prescriptive compliance: Advanced BuildingsTM Core PerformanceTM Guide Comply with the mandatory and prescriptive provisions of ANSI/ASHRAE/IESNA Standard 90.1-2010, with errata (or USGBC approved equivalent standard for projects outside the U.S.). Comply with Section 1: Design Process Strategies, Section 2: Core Performance Requirements, and the following three strategies from Section 3: Enhanced Performance Strategies, as applicable. Where standards conflict, follow the more stringent of the two. For projects outside the U.S., consult ANSI/ASHRAE/IESNA Standard 90.1-2010, Appendixes B and D, to determine the appropriate climate zone.	Req	Implementation Design	Early Construction Stage
Fundamental refrigerant management	Req		
Do not use chlorofluorocarbon (CFC)-based refrigerants in new heating, ventilating, air-conditioning, and refrigeration (HVAC&R) systems. When reusing existing HVAC&R equipment, complete a comprehensive CFC phase-out conversion before project completion. Phase-out plans extending beyond the project completion date will be considered on their merits.	Req	Building Systems Implementation	Late Construction Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Optimize energy performance	24		
Whole building energy simulation Demonstrate a percentage improvement in the proposed building performance rating compared with the baseline building performance rating. Calculate the baseline building performance according to Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda26) using a computer simulation model for the whole building project. Projects outside the U.S. may use a USGBC approved equivalent standard - from 12% up to 48% improvement	1-24	Detailed Design Development	Planning and Design Stage
On-site Renewable energy	8		
Use on-site renewable energy systems to offset building energy costs. Calculate project performance by expressing the energy produced by the renewable systems as a percentage of the building's annual energy cost and use the table below to determine the number of points achieved. Use the building annual energy cost calculated in EA Credit 1: Optimize Energy Performance or the U.S. Department of Energy's Commercial Buildings Energy Consumption Survey database to determine the estimated electricity use. -from 1% to 40%	1-8	Implementation Design	Early Construction Stage
Enhanced commissioning	2		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Option 1: 1. Prior to the start of the construction documents phase, designate an independent commissioning authority (CxA) to lead, review and oversee the completion of all commissioning process activities. The CxA shall, at a minimum, perform Tasks 2, 3, and 6. Other team members may perform Tasks 4 and 5. a.The CxA must have documented commissioning authority experience in at least two building projects. b.The individual serving as the CxA: – Must be independent of the work of design and construction. – Must not be an employee of the design firm, though he or she may be contracted through them. – Must not be an employee of, or contracted through, a contractor or construction manager holding construction contracts. – May be a qualified employee or consultant of the owner. c.The CxA must report results, findings and recommendations directly to the owner. d.This requirement has no deviation for project size. 2. The CxA must conduct, at a minimum, one commissioning design review of the owner's project requirements, basis of design, and design documents prior to the mid-construction documents phase and back-check the review comments in the subsequent design submission. 3. The CxA must review contractor submittals applicable to systems being commissioned for compliance with the owner's project requirements and basis of design. This review must be concurrent with the review of the architect or engineer of record and submitted to the design team and the owner. 4. Develop a systems manual that provides future operating staff the information needed to understand and optimally operate the commissioned systems. 5. Verify that the requirements for training operating personnel and building occupants have been completed. 6. The CxA must be involved in reviewing the operation of the building with operations and maintenance (O&M) staff and occupants within 10 months after substantial completion. A plan for resolving outstanding commissioning related issues must be included.	1	Commissioning	Late Construction Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Option 2: Commission the building's thermal envelope systems in accordance with the requirements of Option 1. Commissioning of the building envelope shall be in accordance with ASHRAE Guideline 0-2005, the Commissioning Process, and National Institute of Building Sciences (NIBS) Guideline 3-2006, Exterior Enclosure Technical Requirements for the Commissioning Process. The building thermal envelope entails all exterior wall assemblies separating a building's conditioned spaces from outdoor ambient conditions, including: roof assemblies, vapor barriers, diffusion retarders, air barrier systems, rain-screen layers, flashings, cladding and siding, windows, curtain-wall assemblies, doors, thermal bridges , and utility penetrations, such as piping, electrical conduit, duct-banks and other entry-points made for routing HVAC system components. For major renovations, substantial performance upgrades must be installed on at least 25% of the exterior envelope surface area.	2	Detailed Design Development	Planning and Design Stage
Enhanced refrigerant management	1		
Option 1 : Do not use refrigerants	1	Building Systems Implementation	Late Construction Stage
Option 2: Select refrigerants and heating, ventilation, air conditioning and refrigeration (HVAC&R) equipment that minimize or eliminate the emission of compounds that contribute to ozone depletion and climate change.	1	Building Systems Implementation	Late Construction Stage
Measurement and verification	2		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Case 1: Develop and implement a Measurement and Verification (M&V) plan consistent with Option D: Calibrated Simulation (Savings Estimation Method 2) or Option B: Energy Conservation Measure Isolation, as specified in the International Performance Measurement & Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April 2003. The M&V period must cover at least 1 year of post-construction occupancy. Provide a process for corrective action if the results of the M&V plan indicate that energy savings are not being achieved. In addition, provide evidence of the long-term M&V Plan (minimum two years after the M&V period above). Develop and implement a long-term M&V Plan consistent with Option B, C, or D of Volume 1 of the IPMVP: Concepts and Options for Determining Energy and Water Savings, March, 2002. The application of Volume I methods is contingent upon establishing a stable base year of operation as a result of the initial Volume III M&V period. If a stable base year cannot be established, the Volume III methods shall be continued into the long-term M&V period.	2	Building Systems Implementation	Late Construction Stage
Case 2: Meet MPR 6 through compliance with Option1: Energy and Water Data Release Form. Projects must register an account in ENERGY STAR's Portfolio Manager tool and share the project file with the USGBC master account.	1	Building Systems Implementation	Late Construction Stage
Green power	1		
Engage in at least a 2-year renewable energy contract to provide at least 35% of the building's electricity from renewable sources, as defined by the Center for Resource Solutions' Green-e Energy product certification requirements or an equivalent. All purchases of green power shall be based on the quantity of energy consumed, not the cost. If the green power is not Green-e Energy certified, equivalence must exist for both major Green-e Energy program criteria: 1) current green power performance standards, and 2) independent, third-party verification that those standards are being met by the green power supplier over time. Use the annual electricity consumption from the results of EA Credit 1: Optimize Energy Performance. Use the U.S. Department of Energy's Commercial Buildings Energy Consumption Survey database to determine the estimated electricity use.	1	Building Systems Implementation	Late Construction Stage
Community Contaminant Prevention - Airborne Releases	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Meet California South Coast Air Quality Management District standards for all products of combustion. Do not exceed the emission limits below for products of combustion, as outlined in the California South Coast Air Quality Management District Rules. For engines of 1,000 bhp and greater, install, operate and maintain in calibration a NOX Continuous Emission Monitoring System (CEMS) with data gathering and retrieval capability.	1	Building Systems Implementation	Late Construction Stage
Materials and Resources	16		
Storage and collection of recyclables	Req		
Provide an easily-accessible area or areas for the collection and storage of materials for recycling for the entire building in accordance with Section 2.1-5.4.1.2 (and Appendix) of the 2010 FGI Guidelines for Design and Construction of Health Care Facilities. Establish a collection system and controlled areas serving the portion of the building affected by the project dedicated to the separation, storage and collection of materials for recycling including, at a minimum: paper, corrugated cardboard, glass, plastics, metals, batteries and mercury-containing products and devices.	Req	Building use	Late Construction Stage
PBT Source Reduction - Mercury	Req		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

As part of the recycling collection system developed in compliance with MR Prerequisite 1: Storage and Collection of Recyclables, identify: o types of mercury containing products and devices29 to be collected, o criteria governing how they are to be handled by a recycling program, and o disposal methods for captured mercury. · In facilities delivering dental care, specify and install amalgam separation devices that meet or exceed the standard ISO-11143. · Comply with the mercury elimination requirement outlined in the 2010 FGI Guidelines for Design and Construction of Health Care Facilities (Section A1.3- 4b: Mercury Elimination). o 4.2.1.1 New construction. In new construction, healthcare facilities shall not use mercury-containing equipment, including thermostats, switching devices, and other building system sources. (Lamps are excluded.) o 4.2.1.2 Renovation. For renovation, healthcare facilities shall develop a plan to phase out mercurycontaining products and upgrade current mercury-containing lamps to high efficiency, low mercury or mercury free lamp technology. · Do not specify or install preheat, T-9, T-10, or T-12 fluorescents or mercury vapor type high intensity discharge (HID) lamps in the project. Do not specify probe start metal halide HID lamps in interior spaces in the project. · Only specify and install illuminated exit signs that use Light-Emitting Diode (LED) or Light-Emitting Capacitor (LEC) lamps and use less than 5 watts of electricity.	Req	Finishing Materials	Late Construction Stage
Building Reuse - Maintain Existing Walls, Floors and Roof	3		
Maintain the existing building structure (including structural floor and roof decking) and envelope (the exterior skin and framing, excluding window assemblies and non-structural roofing material).	3	Conceptual Design Development	Planning and Design Stage
Building Reuse - Maintain Existing Interior Nonstructural Elements	1		
Use existing interior nonstructural elements (e.g., interior walls, doors, floor coverings and ceiling systems) in at least 50% (by area) of the completed building, including additions. Hazardous materials that are remediated as a part of the project scope shall be excluded from the calculation of the percentage maintained. If the project includes an addition with square footage more than 2 times the square footage of the existing building, this credit is not applicable.	1	Conceptual Design Development	Planning and Design Stage
Construction Waste Management	2		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Recycle and/or salvage nonhazardous construction and demolition debris. Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or comingled. Excavated soil and land-clearing debris do not contribute to this credit. Calculations can be done by weight or volume, but must be consistent throughout.	2	Building Materials	Early Construction Stage
Sustainability Sourced Materials and Products	4		
One point and up to a maximum of four will be awarded for each 10% of the total value of all building materials and products used in the project (based on cost) that meet the criteria of MR Credit 3. If concrete or steel structural elements are applied toward this credit, the project must include at least two other materials or products from CSI MasterFormat Divisions (other than 03 and 05) to attain the first point. Of the total recycled content, no more than 75% may be steel or concrete.	4	Building Materials	Early Construction Stage
PBT Source Reduction - Mercury in Lamps	1		
In addition to the credit goals outlined in MR Prerequisite 2: PBT Source Reduction—Mercury, specify and install long lasting reduced mercury fluorescent lamps consistent with the following minimum criteria in MR Credit 4.1.	1	Finishing Materials	Late Construction Stage
PBT Source Reduction - Lead, Cadmium and Copper	2		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Specify substitutes for materials manufactured with lead and cadmium, as follow: · Specify and use 100% lead-free solder and flux used to connect plumbing pipe on-site for water intended for human consumption that meets the California AB1953 standard that solder must not contain more than 0.2% lead, and flux not more than a weighted average of 0.25% for wetted surfaces. · Specify and use pipes, pipe fittings, plumbing fittings and faucets for water intended for human consumption that meets the California AB1953 standard of a weighted average lead content of the wetted surface area of not more than 0.25% lead. · Specify and use lead-free roofing and flashing. · Specify and use electrical wire and cable with lead content <300ppm. · Specify no use of interior or exterior paints containing cadmium or lead. Green Seal certified paints or paints meeting Green Seal criteria exclude metals including cadmium, lead, mercury, antimony, and hexavalent chromium. For copper pipe applications, reduce or eliminate joint-related sources of copper corrosion: · use mechanically crimped copper joint system, or · specify that all solder joints are compliant with ASTM B828 and specify and use ASTM B813 flux. For renovation projects, ensure the removal and appropriate disposal of disconnected wires with lead stabilizers, consistent with the 2002 National Electric Code requirements.	2	Building Materials	Early Construction Stage
Furniture and Medical Furnishings	2		
A percentage of the total value of all freestanding furniture and medical furnishings, including mattresses, foams, panel fabrics, cubicle curtains, window coverings, and other textiles, used in the project (based on cost) must meet the criteria in one of the three options of MR Credit 5 in relation to chemical components within, and sustainable sourcing. - from 30% up to 40%	2	Building Systems Implementation	Late Construction Stage
Resource Use - Design for Flexibility	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Increase building flexibility and ease of adaptive reuse over the life of the structure by employing a minimum of three of the following design and/or space planning strategies: · Use of interstitial space33 serving for a minimum 20% of project diagnostic and treatment or other clinical floor area [calculation based on Departmental Gross Square Foot (DGSF)]. Design distribution systems for electrical, information technology, communication, medical gases, and sprinklers with the capability to control multiple zones in clinical spaces. (Inpatient units are included in this calculation.) · Provide programmed soft space34, such as administration/storage, equal to a minimum of 5% of total clinical space. Locate soft space adjacent to clinical departments that anticipate growth. Determine strategy for future accommodation of displaced soft space (calculation based on project DGSF). · Provide shelled space35 equal to a minimum of 5% of total project departmental clinical space; locate where it can be occupied without displacing occupied space (calculation based on project DGSF). · Identify horizontal expansion capacity for diagnostic and treatment or other clinical space equal to a minimum of 30% of existing gross square footage (excluding inpatient units) without demolition of occupied space (other than at the connection point of future expansion). Reconfiguration of additional existing occupied space that has been constructed with demountable partition systems is permitted. Or design for future vertical expansion on a minimum of 75% of the roof, ensuring that existing operations and service systems will be able to operate at or near capacity during the expansion. · Designate location(s) for future above-grade parking structure(s) equal to 50% of existing on-grade parking capacity, with direct access to the main hospital lobby/circulation/vertical transportation pathways. · Use of demountable partitions for 50% of applicable areas as a strategy for future flexibility. · Use movable/modular casework for a minimum of 50% of casework and custom millwork. (Calculation is based upon the combined value of the two elements, as determined by the cost estimator or contractor).	1	Conceptual Design Development	Planning and Design Stage
Indoor Environmental Quality	18		
Minimum indoor air quality performance	Req		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Meet the minimum requirements of Sections 6 through 8 of ASHRAE Standard 170-2008 (with errata but without addenda36). And Case 1: Mechanically ventilated spaces Mechanical ventilation systems must be designed using the ventilation rates in Section 7 of the standard, the requirements of the 2010 FGI Guidelines for Design and Construction of Health Care Facilities (Table 2.1-2) or the applicable local code, whichever is more stringent. Case 2: Naturally Ventilated spaces Naturally ventilated buildings or portions of the buildings must comply with ASHRAE Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality, Paragraph 5.1 (with errata but without addenda1).	Req	Detailed Design Development	Early Construction Stage
Environmental tobacco smoke control	Req		
Option 1. Prohibit smoking in the building Prohibit on-property smoking within 50 feet (16 meters) of entries, outdoor air intakes, bus stops, qualifying places of respite, operable windows, and other locations where occupants could inadvertently come in contact with ETS when occupying, entering or leaving the building. Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property. Option 2. Compartmentalization of Smoking Areas For residential healthcare occupancies only where accommodation for resident smoking is programmatically mandated prohibit smoking in resident rooms and all common areas of the building. Locate any exterior designated smoking areas including balconies where smoking is permitted, at least 50 feet (16 meters) from entries, outdoor air intakes, bus stops, operable windows and other locations where occupants could inadvertently come in contact with ETS when occupying, entering or leaving the building.	Req	Building use	Late Construction Stage
Hazardous Material Removal or Encapsulation (Renovations Only)	Req		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Develop and implement a hazardous material management program for the construction and pre-occupancy phases of the building. Identify the applicable local, state and federal regulatory requirements. Obtain survey records that identify where hazardous materials are located in the building and on the site so that the material(s) present can be addressed appropriately in the ongoing hazardous material management program. If the existing survey records do not cover all areas of the building, conduct a survey to identify where hazardous materials are present in the remaining areas of the building. Include a plan for capture of historical mercury sources in demolition plans, including, but not limited to, piping infrastructure. Collection of any mercury devices shall be designated for recycling and preclude overseas donation/disposal. Contract must include requirements for reporting and investigating suspect mold encountered in demolition. Identify and remedy the source of water and/or moisture to prevent future mold development. Remediate contaminated materials with recognized procedures performed by licensed abatement contractors to protect workers, building occupants and the public. Use lead containment methodologies to prevent release into the air to protect people and prevent soil contamination. Ensure the removal and appropriate disposal of disconnected wires with lead stabilizers. Obtain a letter from the licensed abatement contractor stating that all hazardous materials within the affected demolition or renovation areas have been removed or encapsulated, and that all sources of mold/mildew have been identified and remedied. Provide a certified letter of destruction to the owner for record.	Req	Detailed Design Development	Early Construction Stage
Outdoor Air Delivery Monitoring	1		
Install permanent monitoring systems that provide feedback on ventilation system performance to ensure that ventilation systems maintain design minimum ventilation requirements. Configure all monitoring equipment to generate an alarm when airflow values or carbon dioxide (CO2) levels vary by 10% or more from the design values via either a building automation system alarm to the building operator or a visual or audible alert to the building occupants.	x`	Building Systems Implementation	Late Construction Stage
Acoustic environment	2		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Design the facility to meet or exceed the sound and vibration criteria outlined in the 2010 FGI Guidelines for Design and Construction of Health Care Facilities (2010 FGI Guidelines) and the reference document on which it is based, Sound and Vibration Design Guidelines for Health Care Facilities(2010 SV Guidelines).	2	Detailed Design Development	Planning and Design Stage
Construction indoor air quality management plan - during construction	1		
Develop and implement an Environmental Quality Management Plan (EQMP) for the construction and preoccupancy phases of the building. Minimize air and noise pollution during the construction process as prescribed in IEQ Credit 3.1.	1	Management Plan	Planning and Design Stage
Construction indoor air quality management plan - before occupancy	1		
Develop an IAQ management plan and implement it after all finishes and furnishings have been installed and the building has been completely cleaned before occupancy.	1	Commissioning	Late Construction Stage
Low emitting materials	4		
One point (maximum four) can be achieved for each group of materials that comply with the requirements. Group 1 : Interior Adhesive and Sealants Group 2: Wall and Ceiling Finishes Group 3: Flooring Group 4: Composite Wood Group 5: Exterior Applied Products	4	Finishing Materials	Late Construction Stage
Indoor Chemical and Pollutant Source Control	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Design to minimize and control the entry of pollutants into buildings and later cross-contamination of regularly occupied areas through the following strategies: § Employ permanent entryway systems at least 10 feet (3 meters) long in the primary direction of travel to capture dirt and particulates entering the building at regularly used exterior entrances. Acceptable entryway systems include permanently installed grates, grills and slotted systems that allow for cleaning underneath. Roll-out mats are acceptable only when maintained on a weekly basis by a contracted service organization. § Minimize the entry of contaminants into the building from vehicles, pesticides, herbicides, helipads, diesel generators, designated smoking areas, sources of exhaust air, and other sources of potential contaminant as follows: Provide pressurized entryway vestibules at high-volume building entrances: Ensure, through the results of mathematical modeling [e.g. Computational Fluid Dynamics (CFD), Gaussian Dispersion Analyses] and/or physical modeling (e.g. wind tunnel, tracer gas) that the air contaminant concentrations at outdoor air intakes are less than the thresholds established for the project under worst case meteorological conditions. Demonstrate that outside air intake concentrations pollutants meet the limits in the following table OR demonstrate by calculations that indoor concentrations shall not exceed 2.5% of the exposure limits listed in IEQ Credit 5.	1	Building Systems Implementation	Late Construction Stage
Controllability of Systems - Lighting	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

For all occupants: Provide lighting system controls for all shared multi-occupant spaces to enable adjustments that meet group needs and preferences. For Staff areas: Provide individual lighting controls for 90% (minimum) of the FTE staff (measured at peak periods) to enable adjustments to suit individual task needs and preferences. For Patient Areas: Provide individual lighting controls for 90% (minimum) of patients to enable adjustments to suit individual task needs and preferences. Install lighting controls that are readily accessible from the patient bed. In multi-occupant patient spaces, such as recovery rooms, emergency departments, infusion areas, and similar open areas, provide individual lighting controls. In private rooms, provide occupant controls that are readily accessible from the patient bed for exterior window shades, blinds, and/or curtains. Exempted areas include in-patient critical care, pediatric and psychiatric patient rooms.	1	Building Systems Implementation	Late Construction Stage
Controllability of Systems - Thermal Control	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Provide individual thermal comfort controls for every single occupant patient room. Provide individual thermal comfort controls for 50% (minimum) of the remaining building occupants to enable adjustments to meet individual needs and preferences. Operable windows may be used in lieu of controls for occupants located 20 feet (6 meters) inside and 10 feet (3 meters) to either side of the operable part of a window. The areas of operable window must meet the requirements of ASHRAE Standard 62.1-2007 paragraph 5.1 Natural Ventilation (with errata but without addenda43). Provide comfort system controls for all shared multi-occupant spaces to enable adjustments that meet group needs and preferences. Conditions for thermal comfort are described in IEQ credit 7: Thermal Comfort—Design and Verification, and include the primary factors of air temperature, radiant temperature, air speed and humidity. Comfort system control for the purposes of this credit is defined as the provision of control over at least one of these primary factors in the occupant's local environment.	1	Building Systems Implementation	Late Construction Stage
Thermal Comfort - Design and verification	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Design heating, ventilating and air conditioning (HVAC) systems and the building envelope to meet the requirements of one of the options in IEQ Credit 7, and local codes or current 2010 FGI Guidelines for Design and Construction of Health Care Facilities (Table 2.1-2: Ventilation Requirements for Areas Affecting Patient Care in Hospitals and Outpatient Facilities), where local codes do not apply. Demonstrate design compliance in accordance with the Section 6.1.1 documentation. AND Provide a permanent monitoring system to ensure that the building performs to the desired comfort criteria as determined above. Agree to implement a thermal comfort survey of building occupants45 within a period of six to 18 months after occupancy. The survey shall collect anonymous responses about thermal comfort in the building, including an assessment of overall satisfaction with thermal performance and identification of thermal comfort-related problems. Agree to develop a plan for corrective action if the survey results indicate that more than 20% of occupants are dissatisfied with thermal comfort in the building. The plan shall include measurement of relevant environmental variables in problem areas in accordance with the standard selected above and 2010 FGI Guidelines for Design and Construction of Health Care Facilities.	1	Detailed Design Development	Planning and Design Stage
Daylight and Views - Daylight	2		
Install daylight responsive controls in 100% of the area that meets the daylight quantity thresholds above. Daylight controls must switch or dim electric lights in response to the presence or absence of daylight illumination in the space. For a minimum of 75% or more of the perimeter area used to qualify under IEQ Credit 8.2, achieve daylighting.	2	Building Systems Implementation	Late Construction Stage
Daylight and Views - Views	3		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Inpatient Units: A minimum of 90% of the inpatient units, staff areas, and public areas shall be within 20 feet (6 meters)—or twice the window head height, whichever is smaller—of the perimeter. All such perimeter areas must have windows that provide at least an 11° angle of unobstructed view in the vertical and horizontal direction. Non-inpatient areas In the block planning stage, configure the building floor plates such that the area within 15 feet (4.5 meters) of the perimeter exceeds the perimeter area requirement as determined by the table within IEQ Credit 8.2. Confirm at the conclusion of detailed planning that 90% of the perimeter rooms have windows that provide at least an 11° angle of unobstructed view in the vertical and horizontal direction.	3	Detailed Design Development	Planning and Design Stage
Innovation in Design	6		
Integrated project planning and design	Req		
Use cross discipline design and decision-making, beginning in the programming and pre-design phase.	Req	Detailed Design Development	Early Construction Stage
Innovation in Design	4		
Path 1: Innovation in design Achieve significant, measurable environmental performance using a strategy not addressed in the LEED 2009 for Healthcare Rating System. One point is awarded for each innovation achieved. No more than 4 points under this credit may be earned through PATH 1—Innovation in Design. Identify the following in writing: § The intent of the proposed innovation credit. § The proposed requirement for compliance. § The proposed submittals to demonstrate compliance. § The design approach (strategies) used to meet the requirements.	4	Implementation Design	Early Construction Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Path 2: Exemplary Performance Achieve exemplary performance in an existing LEED 2009 for Healthcare prerequisite or credit that allows exemplary performance as specified in the LEED Reference Guide for Green Building Design & Construction, 2009 Edition Healthcare Supplement. An exemplary performance point may be earned for achieving double the credit requirements and/or achieving the next incremental percentage threshold of an existing credit in LEED. One point is awarded for each exemplary performance achieved. No more than 3 points under this credit may be earned through PATH 2— Exemplary Performance.	3	Implementation Design	Early Construction Stage
Path 3: Pilot Credit Attempt a pilot credit available in the Pilot Credit Library at www.usgbc.org/pilotcreditlibrary. Register as a pilot credit participant and complete the required documentation. Projects may pursue up to 4 Pilot Credits total.	4	Implementation Design	Early Construction Stage
LEED Accredited Professional	1		
At least one principal participant of the project team must be a LEED Accredited Professional (AP) with a specialty appropriate for the project.	1	Commissioning	Late Construction Stage
Integrated project planning and design	1		

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).

Assemble and involve a project team as described in ID Prerequisite 1: Integrated Project Management and Design. Actively involve all team members referenced above in at least three of the following phases of project design and construction process: § Conceptual/schematic design § LEED planning § Preliminary design § Energy/envelope systems analysis or design § Design development § Final design and construction documents § Construction administration Conduct regular meetings with the project team from the end of schematic design until the owner's certificate of occupancy to review project status, introduce new team members to project goals, discuss problems encountered, formulate solutions, review responsibilities and identify next steps. The meetings can be integrated into other required project team meetings. A plan shall be determined for regular integrated team coordination. At a minimum, 12 meetings shall be included with the integrated project team. In these meetings, utilize the framework established by the ANSI Market Transformation to Sustainability Guideline Standard March 2007 revision for distribution Whole System Integration Process (WSIP).	1	Implementation Design	Early Construction Stage
Regional Priority	4		
Regional Priority	4		
Earn up to four of the six Regional Priority credits. These credits have been identified by the USGBC regional councils and chapters as having additional regional importance for the project's region. A database of Regional Priority credits and their geographic applicability is available on the USGBC website, www.usgbc.org/rpc.	4	Implementation Design	Early Construction Stage

Figure C.1. Decision matrix harmonised with LEED-HC v2009 categories (cont.).