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**Implementation of Sustainability and Green
Building Standards in the UAE: An analysis of
Relevant Instruments**

تنفيذ معايير الإستدامة ومعايير المباني الخضراء في دولة الإمارات
العربية

المتحدة: تحليل الأدوات ذات الصلة

by

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of the requirements for the degree of
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Abstract

At the time green buildings concept is highly required by the buildings' owners and different authorities and becomes more widespread in order to manage the resources and energy to sustain and reduce the cost of developing and maintaining buildings, and thus save the environment and maximize the economic turnover.

Construction contracts should be formed to protect parties including architects, contractors, and building owners, and to define their liabilities and risks. A successful contract should be well formed in order to achieve the target requested by the owner for completing his investment and development on time, within budget, and in accordance to the scope and standards.

As an example, it is the role of the architect to plan the orientation of the building to maximize the natural ventilation for better heating and cooling, while the role of the contractor to execute the building in accordance to the design, standards and regulations, and to use recycled raw materials considering the origin and location of delivery along with waste management in addition to his role to maintain adequate documentation in order to obtain "LEED" or "BREEAM" certificate. On the other hand, the tenant who occupies the building is responsible for adequate operation and to maintain the space properly.

The aim of this dissertation is to come out with a well formed conditions of contract that manage the owner's expectations by writing specifically what are the obligations and roles of each party, and the ramifications of not fulfilling the obligations related to designing and constructing green buildings in order to reduce disputes among the parties¹.

¹ Robert E. Knoer, Green Buildings: The Intersection of Law and Development, [New York, September 26, 2013]

الملخص:

في الوقت الذي يتطلب فيه مفهوم المباني الخضراء بشكل كبير من قبل أصحاب المباني والسلطات المختلفة ويصبح أكثر انتشاراً من أجل إدارة الموارد والطاقة لخفض تكلفة تطوير وصيانة المباني، وبالتالي الحفاظ على البيئة وتحقيق أقصى قدر من العائد الاقتصادي.

ينبغي إبرام عقود البناء لحماية المتعاقدين بما في ذلك المهندسين المعماريين والمقاولين وأصحاب المباني، وتحديد التزاماتهم ومخاطرهم. يجب أن يكون العقد ناجحاً بشكل جيد من أجل تحقيق الهدف الذي طلبه المالك لاستكمال استثماره وتنميته في الوقت المحدد، في حدود الميزانية، ووفقاً للنطاق والمعايير.

وكمثال على ذلك، فإن دور المهندس المعماري في التصميم يتطلب توجيه المبنى لتحقيق أقصى قدر من التهوية الطبيعية لتحسين التدفئة والتبريد، في حين أن دور المقاول هو تنفيذ المبنى وفقاً للتصميم والمعايير واللوائح، واستخدام المواد الخام المعاد تدويرها بالنظر إلى أصل وموقع تسليم المواد بالإضافة إلى إدارة النفايات ودوره في الحفاظ على الوثائق الكافية من أجل الحصول على شهادة "اليد" أو "بريم". من ناحية أخرى، فإن المستأجر الذي يشغل المبنى مسؤول عن التشغيل الكافي والحفاظ على المساحة بشكل صحيح.

الهدف من هذا البحث هو إيجاد شروط تعاقدية متطورة للوصول إلى إتفاقية تدعم تحقيق توقعات المالك و ذلك من خلال توضيح و تحديد التزامات و مسؤوليات كل طرف في الإتفاقية، وتدابير عدم الوفاء بالالتزامات المتعلقة بتصميم وبناء المباني الخضراء من أجل الحد من النزاعات بين الأطراف.

Dedication

This research paper is dedicated to my father, and my darling wife

Acknowledgment

My Father,

I remember that day when you listened to my explanations about the subject and you encouraged me to go ahead with the project.

At this time, I miss you as I wish to share this moment together, but my condolence that you are at better place and may your soul feel this success.

My Mother,

I am always supported with your pray.

My darling wife,

This research was not going to happen without your continuous support and encouragement. You endured a lot till we got it done. God bless you.

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I would like to thank you for your valuable advises, right directions, and support to complete this research.

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Appendix A

Chapter 1

INTRODUCTION

Buildings influence the surrounding environment during their several stages starting from construction, then occupancy, renovation and repurposing up to demolition. During this life cycle, buildings use raw materials, generate waste, use water and energy, and produce harmful atmospheric emissions. Therefore, standards and sustainable design have been created by several authorities and entities to reduce the impact of buildings on the environment².

The green building governmental authorities and other private entities and agencies aim to reduce greenhouse gas emission, and to construct buildings as Zero Net Energy facilities³. Consumption of water is also targeted to be reduced against the measures taken in 2010. New buildings shall reduce the consumption of energy to the least possible measures which are economically feasible. Thus landlords are encouraged to use alternative techniques to reduce the purchase of different forms of energy. Generating a renewable energy is a method to reduce the consumption of energy. On the other hand, Water conservation measures and alternative sources of water shall be utilized to reduce water consumption.

Buildings shall be commissioned by governmental departments and state agencies to assure the implementation of the regulations and standards for the operation and maintenance of buildings⁴.

Green building certification is a tool to assure the implementation of the green standards by owners, designers, and contractors for promoting sustainable construction process. Owners are encouraged to implement green building standards and rating systems for economical vision to increase the return on investment where occupancy and renting rates increase with the more sustainable buildings. Moreover, the cost of operating the

² S. Vierra, *Green Building Standards and Certification Systems Share* [Vierra Design & Education Services, September 12, 2016]

³ US Government, Green Building Action Plan – For Implementation of Executive Order B-18-12 (Detailed implementation direction and actions that accompany Executive Order B -18-12), [California, April 25, 2012]

⁴ US Government, Green Building Action Plan – For Implementation of Executive Order B-18-12 (Detailed implementation direction and actions that accompany Executive Order B -18-12), [California, April 25, 2012]

green buildings can be reduced. On the other hand, tenants and buyers are also encouraged to occupy green buildings rather than traditional buildings for healthier life style and better indoor environmental quality⁵.

The vision of the Vice President, Prime Minister and Ruler of Dubai for creating a healthy and sustainable environmental development for achieving a balance between the environmental protection and economic development led to the creation of Dubai's green building regulations and specification project⁶. Moreover, Abu Dhabi urban planning Council aims to plan complete sustainable communities through urban strategies, master plans, and policies as it approves key strategic developments and coordinate with projects' stakeholders to monitor and implement these strategies for public and private projects⁷.

Therefore, statutes of Law and regulations must be followed strictly within the construction industry, while conditions of construction contracts shall define the obligations of each party in order to complete the project successfully⁸ in accordance to the specified green building standards in order to achieve the owners' goals and the vision of the Government.

1.1 Research Issue

How could the implementation of the above green buildings standards and regulations by the parties involved in the construction projects including the employer, the engineer, and the contractor be strengthened through the conditions of contracts, industry standards, and enactment of law which formalize the responsibilities and liabilities of each party in additions to the local regulations and fines imposed by the government? The dissertation would attempt to answer this question.

⁵ S. Vierra, *Green Building Standards and Certification Systems Share* [Vierra Design & Education Services, September 12, 2016]

⁶ <http://www.dm.gov.ae/wps/wcm/connect/78ef8aee-02d0-4085-b545-5b1b73f0d433/Green+buildings+in+Dubai+-+website+ENG.pdf?MOD=AJPERES&ContentCache=NONE&CACHEID=78ef8aee-02d0-4085-b545-5b1b73f0d433>

⁷ www.upc.gov.ae

⁸ Charles W. Cook, *Successful Contract Administration For Constructors and Design Professionals*, [Routledge, New york, 2017].

1.2 Aims and objectives

The dissertation will investigate how such standards are adopted in UAE and whether the existing standard construction contracts are formalized to strengthen the implementation of the green standards to resolve the problems and disputes which result from the noncompliance with the green regulations and standards of GBAS? The dissertation will recommend and form clauses to be added to the standard contracts in order to close any gaps in allocating the risks between parties, and to define each party liabilities in cases and disputes such as noncompliance with the designed and proposed savings in consumption of water and energy, claims raised by the employer due to the failure of the engineer or the contractor to fulfill the Employer's requirements to design and execute a sustainable green building, and Claims raised by the subsequent buyers of the property against the employer.

1.3 Research Questions

This dissertation shall address the following research questions:

- (a) Are the green building standards in UAE similar to the standards specified in U.S and UK?
- (b) To what extent are the mandatory green buildings regulations and civil law system in the UAE effective in comparison to the common law system and the mandatory green buildings regulations applied in U.S and U.K?
- (c) How do the existing standard construction contracts allocate the risks between parties, and define each party liability in case of noncompliance with the green building requirements and how to resolve the resulting disputes?

This dissertation is useful for all parties of a construction project. First, projects' owners and investors can find the major green building standards which guide them to decide their requirements and targets. Moreover, this research guides owners to the suitable procurement method and conditions of contract for constructing their sustainable projects.

The dissertation is useful also for contract administrators as they can find the technical requirements, regulations, conditions of contracts, and articles of law which are applicable and useful for constructing green buildings all together in one paper.

Lawyers can get benefit from this dissertation as well, as they can find the technical requirements and know the green building standards as a reference to define the owner's expectations and the role of architects and contractors to achieve these expectations.

The dissertation is useful for the local and governmental authorities in the UAE as well as it provides recommendations that could be applied to strengthen the implementation of green building requirements for achieving the Government's sustainability strategies.

1.4 Research Methodology

The comparative method is used to analyze the effectiveness of green building standards and regulations in the UAE as compared to the same in the U.K and U.S, in addition to comparing the general conditions of the major standard construction contracts used at these countries to find out how these contracts deal with the implementation of green buildings standards and regulations. Moreover, the qualitative method is used by approaching the local Authorities and contractors in the UAE to obtain samples of governmental standard contracts to find out how these contracts deal with the noncompliance with the green buildings requirements.

1.5 Research Scope

The research's scope is to define the major green building technical requirements and measures to find out the strength and weaknesses of green building standards in UAE in comparison to the applicable standards developed and applied in other jurisdictions such as U.S and UK.

The research's scope is to analyze the main mandatory green buildings regulations applied in UAE and its legal powers and effectiveness in comparison to the other mandatory green buildings regulations applied in U.S and UK, and analyzing the existing standard construction contracts to come up with effective contracts with better risk allocation between parties.

1.6 Dissertation structures

The dissertation will be structured as follows: the second chapter will examine the development of green buildings standards in U.S and UK in comparison to the more recent and developing standards in UAE to find out the strength and weaknesses of the

green buildings standards in UAE, then to define the effectiveness and power of green building regulations and law in UAE in comparison to other jurisdictions. Chapter four demonstrates the risk allocation between the parties as formed in standard construction contracts and to collect samples of construction contracts from the local Authorities in UAE in order to find out the strength and weaknesses of the existing instruments including contracts, regulations, and law used for the implementation of green building requirements. Finally, recommendation will be provided on how to strengthen the existing instruments.

Chapter 2

Green building standards in UAE in comparison to other standards

2.1. Green building requirements and certification systems

The sustainable design started to develop since 1990 by creating the first green building rating system which is Building Research Establishment's Environmental Assessment Method "BREEAM" in the United Kingdom, and then followed by the Leadership in Energy and Environmental Design "LEED" rating system in 2000 by the United States Green Building Council aiming to improve the environmental performance of new construction, and sustainability of buildings by developing concepts such as "living and living restorative building" and "net zero energy"⁹. Requirements found in the green building standards are either performance based which specify the end results or perspective which identifies how to achieve the standards.

Green building rating and certification systems determine the level of sustainability which need an integrated design process to construct buildings which are environmentally responsible throughout their life cycle. Some systems focus on water or energy only which are known as "single-attribute" program while others which are known as "multi-attribute" focus also on toxicity, emissions, and the overall performance towards the environment¹⁰.

Green building rating systems are formed for new buildings and existing buildings as well. The former focus on decisions specified in both planning and design stages, and actions taken during the construction stage, while the later focus on the operation and maintenance of the building throughout its life.

⁹ S. Vierra, *Green Building Standards and Certification Systems Share* [Vierra Design & Education Services, September 12, 2016]

¹⁰ S. Vierra, *Green Building Standards and Certification Systems Share* [Vierra Design & Education Services, September 12, 2016]

2.2. Green building standards and GBAS in UK

BREEAM¹¹ is a leading method used for the assessment of sustainability for construction projects during the life cycle of buildings starting from the stage of new construction, then refurbishment and operational stage. The main technical standards and process of BREEAM aim to promote the best practice for all the elements required to develop sustainable properties throughout four stages of the buildings including master planning, new construction, refurbishment and fit-out buildings, and In-use buildings¹².

BREEAM is published by (BRE)¹³ in 1990. A version of BREEAM was published in 2000 for new homes under the name “Eco Homes” then developed by BRE in 2007 for the UK government, than all BREEAM schemes were updated in 2008 followed with a major update in 2011 which is now the reference for rating and certifying all new buildings in UK as this version reclassified and consolidated all the criteria required for the BREEAM process. Another update was launched in May 2014 which is known as BREEAM UK New Construction¹⁴

BREEAM assesses several sustainability elements and categories including management, energy, health and wellbeing, transport, water, materials, waste, land use and ecology, pollution, and innovation. The BREEAM method of assessment rates and certifies the performance on scales of Pass, Good, Very Good, Excellent, and Outstanding against the benchmarks and targets established for the procurement, design, construction, and operation of buildings, in order to achieve more efficient use of natural resources by developers, designers, contractors, and occupiers¹⁵. The total

¹¹ Building Research Establishment Environmental Assessment Methodology

¹² www.breeam.com

¹³ The Building Research Establishment (BRE) which owns and operates the BREEAM rating schemes was formed as UK government organization then became a private organization which participates in the preparation of international and national codes including building regulations in UK.

¹⁴ www.breeam.com

¹⁵ www.breeam.com

number of credits can be awarded when the targets aimed for each category is achieved¹⁶.

Implementation of BREEAM standards includes the reduction of the buildings' running costs and operational cost savings, and increasing the rental values. Moreover, it improves occupant satisfaction and reduces construction waste and material use. Values are surveyed by field research by getting client respondents only, where 71 % of clients reported that implementation of BREEAM was useful and beneficial to their projects as it has been found that social benefits are the most common benefit rather than the environmental and economic researches¹⁷.

BREEAM communities technical standards is formed to support local authorities, developers, and planners at the early design and master planning stages of medium to large scale developments such as regeneration projects and new communities in order to build up sustainable communities. BREEAM communities is used across parts of the Middle East, Africa, and Europe.

Table 1¹⁸ is copied from BREEAM communities 2012 illustrating aims and weighting of five categories including Governance, Social and economic wellbeing, Resource and energy, Land use and ecology, transport and movement. Assessment is based on the value of credits which varies depending on the weighting of forty assessment issues as detailed in the referred tables for each category¹⁹. AL Zahia community in the emirate of Sharjah in the United Arab Emirates is a case study²⁰ of residential development where BREEAM communities' technical standards have been implemented²¹.

¹⁶ www.breeam.com

¹⁷ James Parker, *The Value of BREEAM*, [Joanna Smith, August 2012, UK]

¹⁸ Refer to Appendix A, attached with the dissertation.

¹⁹ Refer to tables 2,3,4,5, and 6 included in Appendix A

²⁰ www.breeam.com

²¹ BREEAM communities helped to deliver the project achieving the following green targets:

1. Ecology; where the project did not cause undue ecological damage. Moreover, the project provided an overall net positive biodiversity contribution to the whole surrounding area.
2. Transport; where BREEAM requirements have been incorporated by rerouting the public bus existing routes to serve the needs of the development.
3. Acoustics; where cost saving solutions has been developed to meet both the mandatory and elective targeted credits in order to ensure that the influence of noise on end users is reduced.

Secondly, BREEAM New construction technical standard 2011 can be applied to assess the environmental life cycle of new non domestic buildings in the United Kingdom. New construction includes development of new standalone structure or new extension to an existing structure which have environmental impacts through their life cycle from the design stage to the construction stage²². Table 7 describes the types of non-domestic buildings for each sector that can be assessed using the guidelines of BREEAM 2011 New construction scheme.

Assessment of buildings measures and evaluates their performance by quantifying a range of environmental forty nine issues for main ten environmental sections as detailed table 8²³. The majority of BREEAM issues can be specified and chosen by the owner by the owner and the design team as a target in order to perform and achieve the desired rating.

The BREEAM rating benchmarks levels are defined in the table 9 to enable owners and stakeholders to evaluate the performance of an individual building against other building which is BREEAM rated and in comparison with typical sustainability performance of new non-domestic buildings in UK

The major assessment issues under the ten sections, which have direct influence on the running operational cost of buildings and rental rates, are highlighted below.

First, the management section which aims to deliver sustainable building in accordance to performance expectation. Assessment criteria of this section is divided in to three parts including project brief and design as first part with four credits, then construction and handover part with two credits, and lastly after care part with two credits²⁴.

One of the issues listed under the first part is to get BREEAM performance targets defined and agreed contractually between the owner, design engineer, and contractor before RIBA stage C²⁵.

-
4. Energy; where the project achieved significant savings in the energy consumption by designing and implementing different sustainability and energy methods such as photovoltaic power generation and shading analysis.

²² BREEAM New construction Non domestic building ,Technical Manual, SD5073-2.0:2011

²³Refer to Appendix-A

²⁴ BREEAM New construction Non domestic building ,Technical Manual, SD5073-2.0:2011

²⁵ Stage C is the outline proposals which begins when the architect's brief has been determined in sufficient detail as defined under Royal Institute of British Architects (RIBA) work stages.

Construction and handover part include the conduction of thermo graphic survey²⁶ after the completion of the construction work to confirm the following points:

- a. Insulation is continuous as detailed in the construction drawings.
- b. Avoidance of excessive thermal bridging.
- c. Avoidance of air leakage paths through the building fabric except through the designed openings.

After care part specifies seasonal commissioning responsibilities that should be carried out and completed through twelve months at least, once the building is occupied by tenants. Such testing and commissioning process aims to collect data from actual annual building water and energy consumption after occupation, and to review occupant's satisfaction towards thermal comfort, lighting, and ventilation²⁷

The following building components have critical impact on the performance of buildings²⁸:

1. The envelope of the building such as roofing, windows, and cladding.
2. Services such as heat source cooling source.
3. Finishes of floors, walls, and ceiling.
4. Alternative hard landscaping and materials used for boundary protection at external spaces.

The aim of the health and wellbeing stage is to ensure the best comfort for building occupants and the best visual performance by complying with five assessment criteria²⁹.

²⁶ Thermo graphic survey is defined as “ a method of producing images of a building using thermal radiation. The images help to identify areas of the building fabric with a higher (or lower in the case of internal fabric) than expected surface temperatures, thus indicating heat loss from, or air infiltration to, the building and therefore highlighting construction defects”.

²⁷ BREEAM New construction Non domestic building ,Technical Manual, SD5073-2.0:2011

²⁸ The selected components results in lowering the consumption of building energy during the operational life time of the building, reducing the maintenance frequency and requirements, extending service lives of building fabric resulting in fewer replacement intervals.

²⁹ The following five assessment criteria:

1. Pre-requisite to ensure that all fluorescent lamps are fitted with high frequency ballasts.
2. Day lighting where relevant buildings shall meet the required day light factor.
3. Glare control to minimize glare to avoid conflict with lighting control systems, in order to avoid higher consumption of energy.
4. View out, where windows area must be bigger than or equal 20% of the area of the surrounding wall to provide adequate view out as an example.

Another assessment criteria including the potential for natural ventilation, and minimizing air pollution are aimed to ensure a healthy internal environment by installing appropriate ventilation, equipment, and finishes. The major assessment issues here are designing the building to provide fresh air with minimum internal pollutants and entry of polluted air from outside to the building³⁰.

Buildings may have sensors to measure the level of Co2 in the building to alert the owner if exceeded the designed set point³¹. Other assessment criteria effecting health and wellbeing of occupants include thermal comfort, quality of water, sound insulation and the buildings' acoustic performance, safety and security³².

The Energy section specifies nine issues³³. The major assessment issues that will be illustrated briefly here are reduction of emissions which aims to minimize the demand and consumption of operational energy and Co2 emission, and low zero carbon technologies which encourage the generation of sufficient local energy form renewable resources to reduce pollution of surrounding atmosphere and carbon emissions.

Calculation of Energy Performance Ratio for New Construction (EPR_{NC})³⁴ is an assessment criterion which takes the following parameters in to account³⁵:

1. The demand of the building's operational energy.
2. The building's primary consumption of energy.
3. The total resulting Co2 emissions.

-
5. Internal and external lighting.

³⁰ Therefore windows should be opened over ten meters from the sources of external polluted air for naturally ventilated buildings. On the other hand, for air conditioned buildings air intakes should be 20 meters apart from sources of external pollution.

³¹ These sensors should be linked with the ventilation system either mechanically or naturally to adjust the quantity of fresh air.

³² BREEAM New construction Non domestic building ,Technical Manual, SD5073-2.0:2011

³³ Including reduction of emissions, energy monitoring which encourage installation of instruments to monitor the operational energy consumption, external lighting, low and zero carbon technologies, energy efficient cold storage, energy efficient transportation systems, energy efficient laboratory systems, energy efficient equipment, and drying space.

³⁴ Refer to table 10

³⁵ BREEAM New construction Non domestic building ,Technical Manual, SD5073-2.0:2011

The assessment criteria of “Low and Zero carbon technologies” is split in to three parts including feasibility study or contract for supply of renewable energy, specification and installation of low or zero carbon technology, and free cooling.

There is credit for having a contract between the developer and energy supplier for the generation of electricity from renewable energy source only where such contract shall be valid for three years at least from the date when the building becomes occupied with tenants. Credit can be obtained also if a feasibility study has been carried out by a specialist in order to set up a local low or zero carbon (LZC) source of energy for the building where such study shall cover minimum requirements³⁶.

Other major assessment criteria under Water section is the water monitoring to ensure that consumption of water is monitored and managed by complying with four requirements³⁷.

The next major assessment criteria is the life cycle impacts of Material which encourage the usage of construction materials which have low impact on the environment over the building's full life cycle³⁸.

Moreover, BREEAM awards credits by assessing the main building elements³⁹ for each building type⁴⁰. Credits should be awarded for achieving specified scores based on the

³⁶

- a. Energy produced annually from LZC source.
- b. Cost of the life cycle for the potential specification to get payment back.
- c. Local planning criteria such as land use and noise.
- d. Quantity of heat and electricity comes out from the system.
- e. Technologies which are suitable for the site and demand of energy.
- f. “Where appropriate to the building type, connecting the proposed building to an existing local community CHP system or source of waste heat or power OR specifying a building/site CHP system or source of waste heat or power with the potential to export excess heat or power via a local community energy scheme”

³⁷ the following requirements:

1. Specifying water meters to be fixed on the main water supply to the building.
2. Areas or plants which consume more than 10 % of the building's total water demand should have water monitoring equipment or sub meters.
3. Main and sub meters should be connected to the Building Management System (BMS) to monitor water consumption.
4. All pulsed water meters should be connected with one BMS managed by the same owner.

³⁸ BREEAM New construction Non domestic building ,Technical Manual, SD5073-2.0:2011

³⁹ These elements include external walls, windows, roof, upper floor slab, internal walls, and floor finishes. All these elements should be assessed for several types of buildings including education, healthcare, courts, and multi residential buildings. Office and retail building types don't require the

Green Guide ratings for the specification that make-up the main building elements. Life cycle Green House Gas emissions (Co₂) for each building element should be reported based on a sixty year life time of the building.

At least 80% of the materials that make-up any given building element must be responsibly sourced to achieve points for that element. For example, UK government's policy requires that all timber products must be from legal and sustainable sources that can be verified independently or FLEGT⁴¹ licensed timber.

Another major assessment issue is the insulation material which is specified⁴² for use within building elements including external walls, ground floor, roof, and building services⁴³. Thermal insulation material should have a low embodied environmental impact relative to its thermal properties and should be responsibly sourced⁴⁴.

2.3. Green building standards and GBAS in U.S

The LEED Green Building rating systems were nationally developed by USGBC since 1998 to be as an accepted reference to evaluate the design, construction, and operation of buildings. LEED rating system established an acceptance criteria and strategies that should be met by the projects to achieve Silver, Gold, or Platinum level⁴⁵.

LEED green building system is considered as an economic tool for the business owners for developing advanced sustainable buildings and communities, as buildings, schools, warehouses, homes, and infrastructure development which are LEED assessed and

assessment of internal walls while industrial buildings require the assessment of external walls and roof materials only.

⁴⁰ BREEAM New construction Non domestic building ,Technical Manual, SD5073-2.0:2011

⁴¹ In 2003, the EU adopted the Forest Law Enforcement, Governance and Trade (FLEGT) action plan which includes EU timber regulation that prohibits trades and operators from placing illegal harvested timber.

⁴² Location of thermal insulation material, its area and volume, manufacturer technical details including thermal conductivity should be specified and confirmed in design drawings, specification or the contract.

⁴³ BREEAM New construction Non domestic building ,Technical Manual, SD5073-2.0:2011

⁴⁴ The volume weighted thermal resistance for each type of thermal insulation must be calculated to determine the Green Guide rating by dividing the volume of used insulation (m³) by thermal conductivity of the material (W/m.k). So, area of the insulation and its thickness influence the thermal insulation in the relevant building elements. 80% of volume of thermal insulation at least must be responsibly sourced where insulation material should be certified in accordance with the tier levels specified in BREEAM.

⁴⁵ H. Leppo, M. Peot, and B. Schumacher, "LEED PREP BD & C: What you Really Need to Know to Pass the LEED AP Building Design & Construction Exam", [Professionals Publications Incorporated, 2009]

certified consume 25% less energy, and 11% less water with less waste⁴⁶. So, implementing LEED green building requirements results in saving cost over the life of the building in addition to reducing the emission of greenhouse gas and achieving better quality of indoor air and more day light⁴⁷.

U.S government adopts LEED where California, New York, Washington, and Oregon adopt LEED for public buildings. Other countries including India and China have interest in LEED as well as they have high level of new construction⁴⁸. LEED has developed five rating systems⁴⁹ for several market segments and different types of projects. Accordingly, each project type shall follow the related reference guides in order to obtain the required rating systems by fulfilling four LEED Reference Guides⁵⁰.

The third version of LEED was launched in April 2009 which was valid for projects' registration up to 31 October 2016, and then the fourth version was launched in 2013. LEED 2009 changes and revised rating systems were released for LEED New Construction, for Commercial Interiors, for Core and shell, for existing buildings: operations and maintenance, and LEED for schools, where the changes were made to upgrade the application process, and to resolve technical problems such as aligning and

⁴⁶ www.usgbc.org/

⁴⁷ S. Vierra, *Green Building Standards and Certification Systems Share* [Vierra Design & Education Services, September 12, 2016]

⁴⁸ S. Vierra, *Green Building Standards and Certification Systems Share* [Vierra Design & Education Services, September 12, 2016]

⁴⁹ LEED rating systems include the following:

- I. LEED for new construction, LEED for core and shell development, LEED for schools, LEED for health care, and LEED for retail "new construction" has been developed for the design and construction of new buildings.
- II. LEED for commercial interiors and LEED for retail "commercial interiors" has been developed for interior work.
- III. LEED for homes has been developed for residential projects, for low rise buildings only with maximum four floors.
- IV. LEED for neighborhood developments has been established for communities.
- V. LEED for existing buildings has been developed for operation and maintenance of existing buildings, in order to encourage all tenants for sustainable maintenance and operation of the whole building whether the building is LEED certified previously or not.

⁵⁰ The following four Reference Guides:

- I. Green Building Design and Construction Reference Guide
- II. Green Interior Design and Construction Reference Guide.
- III. Green Building Operations and Maintenance Reference Guide.
- IV. LEED for Homes Reference Guide.

harmonizing of perquisites and credits, weighing of credits by human and environmental impact, regionalization, and minimum program requirements⁵¹.

First LEED certification of neighborhood development encourages the involvement of owners, residents, and project team of adjacent community on the planning and design of the new community in order to consider their input before beginning design to come out with decisions how the new community should be changed over time with improvement.

Credit applies to Neighborhood developments which are located within existing cities, encouraging to reduce the consequences of sprawl, and to utilize the existing connectivity in order to conserve the resources required for infrastructure. This can be achieved by locating the project in an area within 800 meters of the existing connectivity. Another credit applies for sites where soil or ground water contamination is found in order to cleanup of contaminated lands⁵².

LEED assessment system encourages development in locations with existing or planned transit in order to reduce air pollution and greenhouse gas emissions. Public transportation is specified to be available within (400 meters) to (800 meters) walking distance from at least 50% of dwelling units and nonresidential use buildings⁵³.

On the other hand, credit applies to communities which have variety of housing types and sizes to achieve a Simpson Diversity Index score greater than 0.5 using the housing categories which are listed table 11.

LEED also promotes the production of fresh local food by dedicating gardens and green houses. Tree-lined and shaded streetscapes are also encouraged to reduce cooling loads in buildings and urban heat island effects and to improve the quality of air and evapotranspiration. Walkways and streets should be boarded with trees to encourage walking and bicycling inside the community to neighborhood schools.

⁵¹ H. Leppo, M. Peot, and B. Schumacher, "LEED PREP BD & C: What you Really Need to Know to Pass the LEED AP Building Design & Construction Exam", [Professionals Publications Incorporated, 2009]

⁵² LEED V4 Neighborhood development, April 5, 2016

⁵³ LEED standards also promote neighborhood development to provide bicycle storage for 90% of all new buildings at least where 2.5% of all visitors should find short-term bicycle storage with minimum four storage spaces at the peak time for each multi-unit residential building. Moreover, long-term bicycle storage should be provided for at least 30% of all regular occupants of the building.

On the other hand, credit applied to neighborhood development if waste water and rain water management is applied in order to reduce pollution from waste water and the runoff volume and to improve quality of water as well. Moreover, LEED promotes proper disposal of hazardous waste encouraging reducing the volume of waste by assessing the solid waste management strategy.

Credit also applies to communities if heat island is reduced by using combination of several strategies⁵⁴ for at least 50% of non-roofed areas such as drive ways, roads, sidewalks, parking structures and lots, and courtyards.

Finally, credits apply to neighborhood development and communities if project is designed in blocks with specified orientation or if buildings⁵⁵ are oriented and designed in a way that one axis of the building to be 1.5 times the other axis where this long axis to be within 15 degrees of geographical east waste⁵⁶.

Second LEED for Building Design and construction is the rating system that applies to New Construction, Core & Shell, Schools, Retail, Data Centers, Warehouses & Distribution Centers, Hospitality, and Health care, in order to come up with cost effective projects through Energy-Related systems⁵⁷ and Water-Related systems⁵⁸ to

⁵⁴

- a. Use plants and trees to provide shade over the paving areas.
- b. Parking structures to be covered with solar thermal collectors or photo voltaic. Also wind turbines can be used to generate energy in place of other nonrenewable resources.
- c. Install shades with three years aged solar reflectance value (SR) of 0.28 or at least 0.33 at installation time.
- d. Install open grid pavement system or use paving materials that have three years aged solar reflectance value of 0.28 or with minimum value 0.33 at installation.

⁵⁵ representing 75% of the total building floor area of the project

⁵⁶ LEED V4 Neighborhood development, April 5, 2016

⁵⁷ The Energy-Related assessment system should be applied on at least two strategies out of the following:

1. Assessing site conditions including adjacent site conditions, landscaping, exterior lighting, and shading.
2. Assess massing and orientation affect HVAC (Heating, Ventilation, and Air Conditioning) sizing, lighting, consumption of energy, and resources of renewable energy.
3. Basic envelope by assessing window to wall ratios, glazing characteristics, insulation values, and shading.
4. Assessing lighting levels in occupied spaces and reflectance values of interior surface.
5. Assessing thermal comfort ranges.
6. Assessing plug and process load needs.
7. Assessing programmatic and operational parameters.

⁵⁸ The Water-Related assessment system includes the following:

1. Assess indoor and outdoor water demand.

achieve sustainability goals and to reduce energy loads and potable water loads in buildings⁵⁹.

All or part of the requirements of Energy-Related systems and Water-Related systems might be planned and designed at the beginning of the project to define the owner's project requirements (OPR) and basis of design and to setup the economic, environmental, and social goals by optimizing the integration of green strategies through design, construction and operations stages. Then project's parties come out with the preliminary rating goals by determining the level of LEED certification (Certified, Silver, Gold, or Platinum), and by selecting the LEED credits that achieve the aimed certification level, and finally by identifying responsibility of parties to ensure the compliance with LEED requirements⁶⁰.

The following paragraphs will summarize LEED major standards for New Construction for the following strategies:

1. Water Efficiency.
2. Energy and Atmosphere.
3. Materials and Resources.
4. Indoor Environment quality.

In regards to Water Efficiency, credit applies to buildings which reduce the consumption of outdoor water through one of either no irrigation option or reduced irrigation option⁶¹. On the other hand, credits apply to buildings which reduce consumption of indoor water by reducing fixture and fitting water use in addition to potable water savings by using alternative sources of water. LEED specifies standards

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2. Process water demand by assessing demand volume for kitchen, laundries, cooling tower, and other equipment.
 3. Assessing volumes of non-potable water supplied by Municipality, site rain water and gray water, and HVAC equipment condensate.

⁵⁹ LEED V4 for Building Design and Construction, April 14,2017

⁶⁰ LEED V4 for Building Design and Construction, April 14,2017

⁶¹ The former option specifies landscape that doesn't need a permanent irrigation system beyond establishment period for two years maximum. The later reduce the projects landscape water requirement (LWR) by at least 50% from the baseline calculation at the peak watering month. Combination of efficiency, alternative water sources, and smart scheduling technologies can be used to achieve additional reduction beyond 30%.

that must be met by installing appliances and equipment⁶² that meet the minimum requirements.

Moreover, credit applies if water used for cooling tower is conserved by conducting a one-time potable water analysis. Credits also apply to buildings which support water management by monitoring the consumption of water through permanent water meters for two or more of the subsystems including irrigation system, indoor plumbing fixtures and fittings, domestic hot water, boilers, reclaimed water system, and other process water such as humidification system and pools. Meter water system shall serve at least 80% of the related water subsystem⁶³.

In regards to assessment of Energy and Atmosphere, fundamental commissioning and verification is required for exterior enclosure design by a qualified member who is not directly responsible for designing the building's envelope. Credits apply to the commissioning of the building's thermal envelope in addition to commissioning of MEP⁶⁴ and renewable energy systems and assemblies⁶⁵. Another path is develop a monitoring-bases commissioning process to assess the performance of water and energy consumption systems.

Credits apply also to buildings which optimize energy performance by setting up a target as KBtu⁶⁶ per square foot-year (KW⁶⁷ per square meter-year) of source energy use through one of the following options:

1. Whole-Building Energy Simulation, by analyzing efficiency measures with focus on load reduction and HVAC-related strategies.
2. Compliance with the applicable standards, design strategies and recommendations by climate zone for the appropriate ASHRAE 50%. Advanced Energy Design Guide and Climate Zone⁶⁸.

⁶² Equipment includes commercial washing machines, kitchen appliances such as dishwasher, food steamer, combination oven, and food waste disposer, in addition to medical and laboratory equipment and steam systems.

⁶³ LEED V4 for Building Design and Construction, April 14,2017

⁶⁴mechanical, Electrical, Plumbing

⁶⁵ ASHRAE (the American Society of Heating, Refrigerating, and Air-conditioning Engineers) guidelines are a reference for MEP and HVAC systems as they relate to energy, water, durability, and indoor environmental quality.

⁶⁶ Kilo British Thermal Units

⁶⁷ Kilo Watt

Credits apply as well to buildings which save energy by monitoring system-level and building level energy use. This energy management requires installing advanced energy metering for all sources of energy used by the whole building, and any other individual building end uses which exceed 10% of the building's total annual consumption⁶⁹.

LEED standards encourage the generation of renewable energy in place of fossil fuel energy in order to reduce the associated environmental and economic harms⁷⁰. The usage of community renewable energy systems or solar gardens is allowed if the system is owned by the project or a signed lease agreement is in place for minimum 10 years period. So, credit is based on the percentage of use defined in the lease agreement or the percentage of ownership. Credits apply as well to buildings if none-ozone-depleting refrigerants are used for HVAC systems⁷¹.

Finally, LEED standards encourage the reduction of greenhouse gas emissions by specifying the usage of grid-source, renewable energy technologies and carbon mitigation projects. Qualified resources shall be specified in a contract for the provision of at least half or the entire project's energy from green power, carbon offsets, or renewable energy certificates (RECs). The percentage of green power or offsets should be determined based on the quantity of consumed energy regardless the cost.

The third strategy is Materials and Resources, where credits apply to buildings where used materials and products have economic, environmentally, and social life cycle impact with available information about their life cycle. So, selected products should be sourced in a responsible manner with acceptable corporate sustainability reports (CSR) verified by a third party. Moreover, products shall meet the criteria of extended producer responsibility where wood products as an example should be certified by USGBC or the Forest stewardship. For credit achievement calculation, products which

⁶⁸ LEED V4 for Building Design and Construction, April 14,2017

⁶⁹ Such permanent electricity meters shall record the consumption and the demand and must be capable to record the energy use on hourly, daily, monthly, and yearly basis.

⁷⁰ Renewable energy systems should be used to offset building energy costs where the percentage of renewable energy can be calculated by dividing (equivalent cost of usable energy produced by the renewable energy system) by (total building annual energy cost). The local department of energy consumption survey has data base to estimate the annual energy use and cost for the building.

⁷¹ Such refrigerants shall have global warming potential (GWP) less than 50 in order to eliminate or minimize their impact on ozone depletion and climate change. LEED standards specify formulas that should be met by the HVAC and refrigeration which are installed by tenants and building's owner.

are manufactured or purchased from a source within 160 KM of the project's location are valued at 200% of their base contributing cost⁷².

The fourth strategy is Indoor Environmental Quality, where credits apply to buildings with improved indoor air quality aiming the occupant's comfort, productivity and well-being⁷³.

2.4. Green building standards and GBAS in UAE

The Emirates Green Building Council (Emirates GBC) was formed in 2006 and continued to develop as an organization targeting to protect the environment and ensure sustainability in the United Arab Emirates by advancing green building principles⁷⁴.

The standards and codes introduced by EGBC are Estidama which is created by the Urban Planning Council in Abu Dhabi with Pearl Rating System, Dubai AL Sa'fat which is created by the Dubai Municipality in 2016 with mandatory rating system for all new buildings in the Emirate of Dubai, LEED, Energy Star for new home construction, Water Sense, BREEAM, ASHRAE 62.2, and ASHRAE 90.2⁷⁵.

Estidama specified guides and rating system for the following three categories of projects:

1. Pearl Community Rating system.
2. Pearl Building Rating system.
3. Pearl Villa Rating system.

⁷² LEED V4 for Building Design and Construction, April 14, 2017

⁷³ Accordingly, both thermal comfort design and control shall be in place where the design of HVAC system and the building envelope have to comply with the requirements of either ASHRAE standard 55-2010 or the applicable standards ISO 7730:2005 and CEN standards EN 1525:2007.

⁷⁴ <http://emiratesgbc.org/>

⁷⁵ EGBC provides Green Building Tooltips for homes which demonstrate four major tips including Energy, water, Indoor air quality, and Outdoor requirements. Green Building Tooltips for homes list examples of onsite renewable energy which are specified in Estidama Pearl Building Rating, including but not limited to solar thermal systems for heating water, wind energy systems, photovoltaic panels, and "organic and annual waste to energy system", where points can be awarded based on saved power in Kilowatt-hour (Kwh).

The Pearl rating system for Estidama assesses seven main categories through the following sections, where the weighting of each section depends on the number of credit points available:

1. Integrated development process,
2. Natural system,
3. Livable communities,
4. Precious water,
5. Resourceful Energy,
6. Stewarding materials, and
7. Innovating practice.

First, Pearl Community rating System (PCRS) aims to improve quality of life, promoting the development of sustainable communities and encourages minimizing the consumption of water, energy, and waste, in addition to the usage of local sustainable and recycled materials⁷⁶. Pearl rating achieved determines the pearl rating level of the assessed community project, depends on the compliance with the mandatory and optional credit requirements for each section as categorized in table 12.

PCRS is applicable to large scale projects and developments which constitute of multiple plot subdivisions and community facilities with a network for vehicles. Such communities shall be designed to accommodate permanent residential population of 1000 people at least.

PCRS assesses the design stage through Pearl Design Rating which is valid till the construction of the project is completed, then it assesses the Construction Rating to assure that the designed and planned targets are achieved through the construction stage, while the Pearl Operational Rating which is still under development assesses the performance of the building after two years at least from the construction completion and when the project becomes 80% occupied.

⁷⁶ The Pearl Rating System for Estidama, Community Rating System, Design and Construction, version 1.0, April, 2010.

The following paragraphs will summarize the main standards and requirements that shall be met in order to achieve credits while assessing each section with a total credit points 159 excluding innovating practice credit points⁷⁷.

First, credit to be awarded when the life cycle cost analysis takes place during the master planning and design stage of the project is demonstrated. Then, additional credits if the same is updated as a report with final construction costs after completion of construction⁷⁸.

Since the ultimate goal of Abu Dhabi Urban Planning Council is to create a, contemporary, cohesive, and sustainable urban fabric by creating livable communities and sustainable cities supporting the vision of 2030 plan for the Emirate of Abu Dhabi. Therefore, the livable communities section encourages the provision of community facilities within walkable distance with improved outdoor thermal comfort and successful travel plan and neighborhood connectivity.

Outdoor thermal comfort strategy encourages improving the outdoor microclimate in the public spaces, surface car parking, and walkways for the community by implementing shade measures to achieve the minimum shading requirements as specified in table 13⁷⁹, while table 14 demonstrates outdoor thermal comfort requirements⁸⁰.

The livable communities section apply Credits if travel plan is developed, implemented, and updated to guarantee reductions in single-occupancy use of cars by between 5% and 10% during the first three years of operation⁸¹. Moreover, credits apply if there is

⁷⁷ Offered as bonus credit

⁷⁸ Moreover, credits can be awarded if sustainability awareness is implemented to ensure efficient operation of the community by educating residents, visitors, and workers the sustainability strategy and requirements.

⁷⁹ The Pearl Rating System for Estidama, Community Rating System, Design and Construction, version 1.0, April, 2010.

⁸⁰ Refer to Appendix - A

⁸¹ Therefore, credits apply also if transit sheds are established to optimize the use of public transportation along with one pedestrian walkway with minimum 75% shade at least. That is why transit supportive strategy need to define the station types, total area within the transit shed, dwelling units per hectare, and total number of dwellings.

vehicular and pedestrian connection between the community and existing or future surrounding developments⁸².

Provision of an interconnected system of open space by using green ways and trails is also specified by PCRS where open spaces should serve recreation and one function as minimum while 70% of residents at least shall have access to open space within 350 meters walking distance. Moreover, PCRS encourages Accessible Community Facilities which promotes clustering and sharing of community facilities⁸³ including car parking, mosques, schools, and playground and sports areas.

Finally, Livable Communities section of PCRS encourages Housing Diversity as well where credits apply if Housing Diversity Index of 0.6 to 0.7 or bigger than 0.7 is achieved. Mix of residential properties with different options should be identified to support housing diversity. Such options include small and larger apartments, small and larger villa houses, and small and larger town houses. New buildings within communities should be Pearl rated as specified in table 15⁸⁴.

Precious Water section aims to distribute water efficiently through alternative sources and to reduce demand by developing community water strategy to cover public realm items such as district cooling, irrigation, water features and storm water. Therefore, water monitoring and leak detection system should be implemented to reduce consumption and leak of water by providing clearly labeled water meters at every network. Credits also apply when community water consumption required for landscaping is reduced by implementing efficient public realm landscape design⁸⁵.

⁸² Here, Adjacency standards and the minimum average connectivity index of 1.5 shall be met and at 75% of intersections at least shall meet the average through street spacing criteria standard.

⁸³ Credits apply if 25% reduction in facility site size and building footprint through the sharing of facilities is achieved in addition to the compliance with walking distance standards. Shaded resting place should be provided along all primary pedestrian walk ways every 350 meters at least to reduce reliance on automobiles.

⁸⁴ The Pearl Rating System for Estidama, Community Rating System, Design and Construction, version 1.0, April, 2010.

⁸⁵ Such implementation is through selecting plants at public park and streetscape landscaping which doesn't require more than 2-8 liter/square meter/day, and through incorporating efficient irrigation system including sensors, valves, and separate meters connected to central system, and by using recycled water. Recycled water should be used in District Cooling (DC) plants as well where the water cooled DC network in the community should be connected to 35% of the community's buildings at least based on the gross floor area.

Resourceful Energy section specifies community strategies for passive cooling in order to improve the outdoor microclimates, where at least two of six strategies should be incorporated in to the community design and construction⁸⁶.

Resourceful Energy section aims the reduction of energy consumption and emissions of carbon associated with lighting, traffic and signage required for infrastructure in roads and public areas. It also promotes the use of high efficiency District cooling systems within the community⁸⁷.

On the other hand 1-8 credit points can be awarded depending on the percentage of the energy consumption of the community using on site renewable energy in order to reduce curb peak power demand and to replace the usage of power generators which work by fossil fuels⁸⁸. Therefore, credits apply if the total consumption of energy of all community infrastructures is supplied by offsite renewable generation systems such as wind energy systems, solar thermal systems, deep-heat geothermal system, and hydro electric energy system. Such supply of energy from a source outside the community's boundary shall be carried out through direct purchase contract for five years at least, or certified REC⁸⁹. The contracts shall include the annual purchase amount and the source of the renewable energy with confirmation that the annual purchases are sufficient for the community infrastructure energy consumption during the contract period.

Lastly, Stewarding Materials credit section encourages design and development teams to consider the life cycle and the impact of the specified material on the environment as

⁸⁶ The strategies include the following:

1. More than 65% of total streets within the community should be oriented and aligned within 15 degrees of true East-West orientation.
2. Building height, frontage, and mass to be arranged in a staggered way in order to prevent wind flow becoming stagnant.
3. Vegetated corridors or linear parks to be provided in parallel to the prevailing wind direction for ventilating urban areas.
4. Shelter belts to be provided for protecting the community from drifting sand.
5. Wind towers to be placed in order to direct appropriate winds to street level.
6. Green or landscape edge to be provided along 90% of the community's prevailing wind boundary in order to cool the incoming breezes.

⁸⁷ DC network is specified to achieve Coefficient Of Performance (COP) weighted average bigger than 4.5 for two credit points or 5.5 for four credit points. Credits also apply if the peak DC system cooling demand is reduced by 25% by using thermal energy storing and if all refrigerants used in the DC plant have a GWP of 10 or less.

⁸⁸ The Pearl Rating System for Estidama, Community Rating System, Design and Construction, version 1.0, April, 2010.

⁸⁹ Renewable Energy Certificates

the usage of materials such as asphalt, timber, and concrete generates direct and indirect consequences beginning with the source of raw materials to how the materials are manufactured, and then delivered and installed⁹⁰. Moreover, the section specifies recycled materials and award credits if 15%-30% of all aggregate used in concrete are recycled as an example⁹¹.

Second, Pearl Building Rating system (PBRS) where maximum credit points can be awarded to buildings is 177 points through seven credit sections as detailed in table 16⁹². Pearl rating levels ranges from 1 pearl to 5 pearl based on the mandatory and optional credit requirements met in each section, where all mandatory credit requirements must be met in addition to the optional credits to achieve higher level. Table 16 demonstrates the maximum number of credit points available for each section.

All sections of PBRS and PCRS are common. Thus, the following paragraphs will demonstrate the credit requirements which are related for the rating of buildings particularly.

The livable indoor section introduces necessary aspects that constitute a comfortable and healthy indoor environment. These aspects include the quality of ventilation and indoor air, selection of materials that reduce harmful emissions, improving thermal comfort, and using natural day light⁹³.

PBRS award credit points if ventilation system met the credit requirements in order to support the wellbeing and comfort of occupants. So, building's mechanical ventilation system should be installed with permanent carbon dioxide monitoring⁹⁴, sensors at all return points, and alert system in order to provide adequate outside air all the times⁹⁵.

⁹⁰ Therefore, credits apply if cost of regional materials used in the construction of infrastructure and public realm equal to 10% to 20% of total material cost, aiming to reduce transport impacts and improve regional economics

⁹¹ The same section encourages the replacement of cement by GGBFS (Ground Granulated Blast Furnace Slag), fly ash, and silica fumes in order to reduce the overall amount of Portland cement used for the project and the associated embodied greenhouse gas emissions. Moreover, Stewarding Materials section specifies credit points if the used timber is legally sourced and if 50%-90% of the timber used (by cost) on the project comply with the credit requirements.

⁹² Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

⁹³ Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

⁹⁴ The level of carbon dioxide must not exceed 1000 Ppm

⁹⁵ Parts per million

Moreover, the use of low emission materials is encouraged by PBRS in order to improve occupant health⁹⁶.

The provision of adequate indoor air is encouraged by PBRS where Livable Building section specifies credit requirements to ensure the quality of indoor air for the occupant's health, starting with ventilation design for car parks which shall meet or exceed the requirements for pollutant concentrations⁹⁷.

The same section aims the indoor thermal comfort and energy efficiency by promoting logical thermal zoning strategies, and controls through thermostatic controller in order to control air speed and temperature⁹⁸.

Precious water section specifies efficiency measures to ensure that interior potable water consumption doesn't exceed the baseline building water consumption. Interior water use depends on building occupancy and water demand of tenants that relates to appliances, fixtures, and fittings. Baseline flow rates and volume are specified in table 17⁹⁹.

Credit points can be awarded if more reductions in the proposed building consumption of potable water are achieved in comparison to the baseline building. The use of recycled water is a method to achieve such reductions in addition to the usage of efficient fixtures and appliances. Credits also apply if metering facilities are installed to monitor the consumption of major individual interior uses, along with installation of a leak detection system.

⁹⁶ Credit points can be awarded if 95% of all adhesives and sealants used in the building interior met the criteria. Moreover, all paints and coatings shall be fungal resistant where 95% of all surface areas shall meet the specified criteria. The use of low emission flooring materials is also encouraged where 100% of all surface areas covered by carpets, carpet cushion, hard flooring and associated finishes shall comply with the credit requirements. Moreover, all suspended ceiling systems used shall comply with the requirements of BS EN 13964:2004 section 4.5 where the contents of formaldehyde and asbestos contents shall meet the minimum requirements.

⁹⁷ Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

⁹⁸ Credit requirements include the design of separate zones and controls for a maximum of 70 square meter of open plan space in the building's internal areas and for a maximum of 35 square meter of open plan space on the perimeter of the building where there is a thermal connection to the outdoors through the façade of the building. Therefore, the building envelope thermal parameters and any associated shading must be reflected while modeling the zones. The depth of perimeter zones must be five meters from the perimeter wall.

⁹⁹ Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

The Resourceful Energy section¹⁰⁰ aims to improve the performance of the building by minimum 12% in comparison to the baseline performance specified by energy simulation model.

Building fabric, HVAC, water heaters, power, lighting and other equipment installed shall meet the minimum acceptable standards within the baseline model¹⁰¹. The standards must be set at either the local code or those given in standard 90.1-2007¹⁰².

Energy monitoring and reporting is specified by PBRS to record and improve the consumption of energy in buildings¹⁰³. Moreover, Resourceful Energy section promotes the selection and installation of fire suspension system and refrigerants to minimize their impact on ozone and the environment, but no credit points specified. Another 1-15 credit points can be awarded based on the percentage reductions in the building's energy consumption and the carbon emission associated with building operation in comparison to the baseline.

On the other hand, cool building strategies shall be defined with effective solutions and passive design to reduce the cooling demand for buildings by reducing the external heat gain. Accordingly, 1-5 credit points can be awarded depending on the percentage reduction in the annual external heat gain of the building in comparison to the baseline building as illustrated in table 19¹⁰⁴:

These passive design measures include the building envelope conductive performance, air tightness, improvement to building fabric, fixing shading devices, and orientation of the building. Both Glazing ratio of skylights and vertical fenestration, and glazing solar heat gain coefficient (SHGC) effect the total reduction in annual external heat gain. All

¹⁰⁰ Refer to table 18 , Appendix-A

¹⁰¹ Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

¹⁰² The Performance Rating Method of ANSI/ASHRAE/IESNA standard 90.1-2007 (Appendix G) provides a methodology for rating the building's energy efficiency. Improvement of performance within the Pearl Rating System are based on the reductions in annual consumption of energy in (Kwh) rather than cost unlike in Appendix G.

The Proposed Building's Performance improvement can be calculated using the following formula:

Percentage Improvement = $100 \times (\text{Baseline Building Performance in Kwh/yr} - \text{Proposed Building Performance}) / \text{Baseline Building Performance in Kwh/yr}$

¹⁰³ Therefore, metering facilities including energy sub meters shall be installed for all tenants' areas and separate meters for all plants exceed load ranges from 10-20 Kilo Watt. Installed energy meters shall monitor a minimum of 90% of the estimated annual energy consumption of the building.

¹⁰⁴ Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

these passive design measures don't require mechanical system and improve the total percentage reduction. Additional credit points can be awarded if reflecting roofing materials with a high (SRI) is used¹⁰⁵.

PBRS demonstrated very useful table¹⁰⁶ which comes out with a result showing 24.7% reduction can be achieved if the above measures are implemented in a ten storey building in comparison to a baseline building, where the annual external heat gain is 45.7 Kwh/square meter for the proposed building and 60.7 Kwh/square meter for the baseline building¹⁰⁷.

Credits also apply if the developer installed energy efficient appliances which are Energy Star accredited or achieve a minimum EU Energy Efficiency labeling scheme¹⁰⁸. Further credits apply if all lifts, and escalators installed within the building are energy efficient. Moreover, 1-8 credits can be awarded if the percentage of the building energy consumption is supplied through on site renewable energy as demonstrated in table 20¹⁰⁹.

Stewarding material credit section aims to eliminate the exposure of tenants and building occupants to hazardous material such as asbestos and to minimize the toxic effect of treated timber used inside the building¹¹⁰. On the other hand, credits apply for the usage of regional and recycled materials such as steel, and aggregates.

Finally, the building durability plan shall be implemented to optimize the integrity of the building envelope, and to protect the building's components and features including foundations, concrete walls, structural elements, ceilings, flooring, roofs, windows and cladding from condensation, water ingress, and improper drainage. Moreover, PBRS award credits if 50% of the building structural skeleton, 75% of the façade, or 90% of the roof is designed to be disassembled and re-used in future. A credit can be awarded if

¹⁰⁵ Solar Reflectance Index (SRI) is specified by PBRS to be greater or equal to 78. Roof area is the upper portion of the building envelope which have slope of less than 60 degree angle to the horizontal.

¹⁰⁶ PBRS, page 163, Cool Building Strategies

¹⁰⁷ Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

¹⁰⁸ Otherwise, guidelines shall be provided for tenants giving examples of the types of energy efficient appliances they may purchase.

¹⁰⁹ Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

¹¹⁰ Moreover, materials which have long term negative impact on human health shall not be selected and installed within the building. For example, all thermal insulation materials used within the building shall have zero ODP (Ozone Depleting Potential) and GWP (Global Warming Potential) less than or equal five, while all other materials installed within the building shall be with low toxicity and free of chlorine

the cost of installed reused materials equal to 3% of the total material cost. Moreover, credits can be awarded if at least 95% of the floor surface area covered with modular flooring products.

Buildings within Masdar city in Abu Dhabi are built with low carbon cement and the aluminum used is 90% manufactured from recycled sources. Each building is designed to reduce consumption of water and energy by 40% in accordance to both LEED and Estidama Pearl Building Rating System¹¹¹.

2.5 Strength and weaknesses of green building standards in UAE

The Emirates Green Building Council (Emirates GBC) provide technical guidelines for retrofitting existing buildings only and no guidelines provided for new construction and communities. EGBS introduced several standards and rating systems for assessing green buildings including but not limited to BREEAM, LEED, and Estidama.

Estidama Pearl rating system has been demonstrated above for both new buildings and communities along with LEED and BREEAM standards and rating systems in US and UK respectively. Accordingly, it is found that Estidama standards including PCRS is similar to LEED for neighborhood developments, while PBRS is similar to LEED for new construction, where they are common for assess four main categories including Water efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environment quality. However, Pearl Rating system is limited only to communities, buildings, and villas only.

Estidama Pearl rating system demonstrates clearly the credit sections, their intent, credit requirements, awarding credit points, credit submission design rating, credit submission construction rating, calculations and methodology, and the needed references.

The clear demonstration of credit sections and the intent of each section guide employers and developers to setup their requirements and targets for the proposed new community or buildings. The proposed targets are mainly planned and designed to save consumption of energy and water to the project's owner and tenants, and to achieve

¹¹¹ <http://masdar.ae/en/masdar-city/detail/About-Masdar-City>

thermal comfort and healthy environment to tenants which encourage tenants to select such green communities and buildings even with higher selling and renting rates.

Credit requirements, credit submission design and construction rating defines clearly the responsibilities of both the architect/engineer and the contractor, while calculations and methodology are guidelines to achieve the targets and to calculate the percentage of performance improvements in saving the consumption of water and energy of the proposed buildings in comparison to the baseline buildings.

Chapter 3

The main mandatory Green Building regulations in different jurisdictions

3.1 The main mandatory green buildings regulations in U.S

Executive order (B-18-12) issued by the government of the state of California in April 2012 established Green Building Action Plan to improve the energy performance of all buildings in the state. The executive order asked all state agencies, entities, and departments under the direct executive authority of the governor to take actions to reduce the greenhouse gas emission by at least 20% by 2020 in comparison to measures of 2010 as baseline.

The executive order states the following targets for new buildings¹¹²:

1. All new buildings and major renovations in the state beginning design after 2025 shall be constructed as Zero Net Energy facilities where 50% of new facilities beginning design after 2020 are targeted to be Zero Net Energy.
2. New buildings leases shall include sub-meters where economically feasible. Moreover, energy use data shall be provided in to Energy Star's Portfolio Manager.
3. State agencies shall reduce energy purchase for buildings owned by the state at least 20% by 2018 in comparison to 2003 as baseline. Reductions of energy purchase shall include several forms of energy including natural gas, propane, electricity, and other forms of energy, taking in to considerations that renewable energy generated on site counts towards reductions as it is not included in total energy purchase.
4. Any proposed new state building with area larger than 10,000 square feet shall use clean power generation system on site such as wind and solar thermal power generation or photovoltaic, if economically feasible.
5. New state buildings with area larger than 10,000 square feet shall be LEED certified obtaining Silver certificate or higher, while buildings with area less than 10,000 square feet which are authorized to begin design after 1 January

¹¹² US Government, Green Building Action Plan – For Implementation of Executive Order B-18-12 (Detailed implementation direction and actions that accompany Executive Order B -18-12), [California, April 25, 2012]

2013 shall meet Tier 1 measures of the applicable California Green Building Standards.

It is noticed from this target that governmental executive orders and rules refer to LEED although LEED Rating system is not a governmental regulations. So, such referring to LEED by governmental entities may make LEED requirements has legally binding implications¹¹³.

6. New construction of area greater than 5,000 square feet for offices or other energy intensive spaces shall be commissioned.
7. Healthy indoor environments for occupants shall be ensured by state agencies by implementing the relevant voluntary measures of the California Green Building Standard Code.
8. State agencies shall reduce the use of water at the facilities operated by them by 20% by 2020 against the measures taken in 2010.
9. Annual water use shall be monitored and reported by installing sub-meters where appropriate.
10. All new state buildings and landscapes shall use recycled water, gray water, and storm water retention as alternative sources of water.
11. Plants used for landscape shall be selected to be suitable to local climate, and reduced water needs.
12. Electrical vehicle charging stations shall be installed for parking in the new construction owned by the state.
13. State agencies shall use Energy Star rated appliances and products which have less or reduced effect on both environment and human health¹¹⁴.

Title 31 of Los Angeles County Green Building Standards Code adopted and incorporated 2016 California Green Building Standard Code which is published by the California Green Building Standards Commission, aiming to improve public general welfare, health and safety. It also encourages sustainable construction practices in five categories including planning and design, energy efficiency, water efficiency and conservation, material conservation and resource efficiency, and

¹¹³ <http://www.nysba.org/WorkArea/DownloadAsset.aspx?id=43596>

¹¹⁴ https://www.gov.ca.gov/docs/Green_Building_Action_Plan_B.18.12.pdf

environmental air quality through enhanced design and construction of buildings using concepts with positive environment impact¹¹⁵.

The provisions of Title 31 shall apply to planning, design, operation, construction, use, and occupancy of every new structure or building unless indicated otherwise in the code. The code states that structures and buildings shall be designed to incorporate the measures of green buildings as indicated in sections (301.1), (301.2), and (301.3), while the mandatory revisions of chapter 4 shall be applied to all newly constructed high rise and low rise residential structures and buildings up to six stories. New construction of residential buildings higher than six stories shall comply with section (301.3). However, the provisions of this code shall not be deemed to nullify any other provisions of local, state, or federal law¹¹⁶.

The California Green Building Standard Code provides both mandatory and voluntary green building requirements and measures. The provisions of this code allow the use of alternate materials, designs, and construction method provided that such alternatives are approved by the enforcing agencies and found in compliance with the provisions of the code¹¹⁷. The code states that all construction documents shall indicate the nature, location, and scope of the proposed green features clearly to ensure that it will comply with the California Building Standards Code and relevant laws, regulations and rules as determined by the enforcing agency¹¹⁸.

Chapter 4 of the California Green Building Standard Code provides the Residential Mandatory Measures through five divisions including planning and design, energy efficiency, water efficiency and conservation, material conservation and resource efficiency, and environment quality. For example, division 4.3 states the mandatory measures for Indoor and Outdoor water use under section (4.303), and (4.304).

¹¹⁵ Title 31 - GREEN BUILDING STANDARDS CODE

https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT31GRBUS_TCO

¹¹⁶ Title 31 - GREEN BUILDING STANDARDS CODE

https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT31GRBUS_TCO

¹¹⁷ California Code of Regulations. Title 24, part 11 of the 2016 California Green Building Standard Code. January 1, 2017 ERRATA

¹¹⁸ The enforcing agency includes local building department or the department of Housing and community Developments who is responsible to enforce and adopt the provisions of the code, unless otherwise stated.

These sections provide that water conserving plumbing fixtures¹¹⁹ and fittings¹²⁰ shall not exceed the flow rate specified in the code, while outdoor potable water use in landscape areas equal to or greater than 500 square feet shall comply with (MWELO)¹²¹

3.2. The main mandatory green buildings regulations in UK

First UK Green Building Council works closely with government entities aiming to develop new policies, and to support the implementation of the existing standards. UK GBC summarized ten points plan for government as main policy priority aiming zero carbon new build, low energy bills for business and people, and better health results¹²².

Building regulations in UK are made in 1985 and then amended in 2000 under the Building Act 1984 to ensure safe construction of buildings, and health and safety of occupants. The 2000 Building Regulations were made very short and didn't contain any technical details. *"They are drafted in such a way that rigid enforcement is discouraged. The general performance requirements are set out in parts A to P of schedule 1 and each part is supported by an approved document that contains non-binding guidance on how to apply. Although use of the approved document is not mandatory, the document can be relied upon in legal proceedings where breach of the regulations is alleged"*¹²³.

The UK has committed to a 12.5% reduction in emission of carbon dioxide by 2012 in comparison to the levels measured in 1990, being the first country adopting a legally binding framework to reduce carbon emissions. The climate change Act aims to reduce net carbon account for the year 2050 by at least 80% in comparison to 1990 as baseline¹²⁴. Energy efficiency improvements in buildings and industry are effective measures, as controlling Co2 emission from buildings is a main factor to achieve UK commitment. Planning system and standards included in building regulations are the two main routes to implement the targeted reductions.

¹¹⁹ Including water closets and urinals

¹²⁰ Including faucets and shower heads

¹²¹ The Model Water Efficient Landscape Ordinance

¹²² UK Green Building Council, www.ukgbc.org/

¹²³ "Law and the Built environment", chapter 6, Building Regulations.

¹²⁴ D.Wood, P.Chynoweth, J.Adshead, J. Msan, *Law and the Built Environment*, 1st edition, [Blackwell, UK, 2011]

The planning system has role to achieve sustainable development. First, the planning and compulsory purchase Act 2004 made the planners of land use to consider renewable energy provision and greenhouse gas. The Metron Rule¹²⁵ required that some developments to generate portion of their energy using on site source of renewable energy. Moreover, obtaining planning permissions by house holders and land owner is made necessary before starting any development and construction with a condition to certify any new domestic build under the Code for Sustainable Homes.

The Code for sustainable buildings were proposed in 2004 as voluntary code in order to be followed by the government for low carbon buildings, and then the code took place in 2006 and followed by technical guide in April 2007¹²⁶. Then, the Building Regulations 2010 is made to replace the Building Regulations 2000 containing ten parts. Part six provides the regulations related to Energy Efficiency Requirements, and part 7 states those related to Water Efficiency¹²⁷.

The energy efficiency requirements under part 6 of the Building Regulations 2010 applies to buildings which are roofed construction having walls, and those which use energy to condition the indoor climate. Minimum energy performance requirements for new buildings shall be approved in form of targeted emission rates of Co2 which shall be calculated based on the stated methods of calculation of the energy performance of building including asset ratings and operational ratings of buildings. Asset rating is defined in this regulation as “the amount of energy estimated to meet the different needs associated with a standardized use of the building”, while the operational ratings are defined as a “numerical indicator of the amount of energy consumed during the occupation of a building over a period of time”. New constructed buildings shall not exceed the targeted Co2 emission of the approved building.

Regulation 29 under part six provides that the person carrying out the work; the contractor, shall obtain energy performance certificate for the building and give it to the owner, and submit a notice to the local authority with the registration number of the certificate. Energy performance certificate shall be issued by an accredited energy

¹²⁵ By Metron LBC

¹²⁶ D.Wood, P.Chynoweth, J.Adshead, J. Msan, *Law and the Built Environment*, 1st edition, [Blackwell, UK, 2011]

¹²⁷ Statutory Instrument 2010 No. 2214, Building and Buildings, England and Wales, The Building Regulations 2010.

assessor who is authorized to produce energy performance certificates. The energy assessor shall provide a report with recommendations to improve the building's energy performance¹²⁸.

The Energy performance of Buildings (England and Wales) Regulations is made on 17th December 2012 to come in force from 9th January 2013. It contains of eight parts with regulations related to the inspection of Air conditioning system, Energy Performance Certificates, and Energy Assessors¹²⁹.

Approved Document F contains of eight sections where section 4 contains several guidance points including but not limited to “the ventilation strategy adopted in Approved document F”, “Performance-based guidance”, and “ventilation effectiveness”. Section 5 provides regulations for new dwellings while section 6 provides regulations for new buildings other than dwellings. The Approved Document F focuses on the performance-based guidance, providing guides for the sufficient level of ventilation along with the air flow rates required to meet the performance criteria, and the actual performance criteria for acceptable levels of pollutants and moisture¹³⁰.

Moreover, the Approved Document L1A took effect on 6th April 2014 with changes in the energy efficiency requirements under the Building Regulations 2010. This Approved Document includes a note stating that Regulation 25b “Nearly Zero-energy requirements for new buildings” will not come in to force until 2019¹³¹. This document provides criteria that should be complied as demonstrated below:

1. The first criteria provide that the calculated emission rate of Co2 from the dwelling shall not be greater than the targeted emission rate in accordance to regulation 26. Moreover, the calculated Dwelling Fabric Energy Efficiency must not exceed the targeted Fabric Energy Efficiency. It is noted that criteria 1 is a mandatory regulation .
2. The second criteria states that the performance of both the individual fabric elements and the services fixed in the building shall achieve the standards of

¹²⁸ Statutory Instrument 2010 No. 2214, Building and Buildings, England and Wales, The Building Regulations 2010.

¹²⁹ Statutory Instrument 2012 No. 3118, Building and Buildings, England and Wales, The Building Regulations 2010. Energy Performance of Buildings (England and Wales) Regulation 2012.

¹³⁰ Approved Document F, Ventilation, The Building Regulations 2010.

¹³¹ Approved Document L1A “Conservation of fuel and power”, The Building Regulations 2010.

energy efficiency reasonably, giving example to offset the individual building fabric with poor insulation standards by any renewable energy system with uncertain service lives.

3. The third criteria provides that passive control measures shall be followed in the dwellings in order to limit the effect of heat gain in summer on the indoor temperature regardless the use of mechanical cooling in the dwelling. These passive control measures include window sizes and orientation, using shading structures for solar protection, and ventilation and high thermal capacity as provided by the Approved Document.

Guidance point (3.9) under “Thermal Bridges” provides that the building fabric shall be constructed avoiding thermal bridges in the layers of insulation particularly around door and window openings and at joints and edges of elements¹³². DCLG circular 01/2014 issued on 13th March 2014 amended some regulations of The Building Regulations 2010 with guidance applies to buildings and building work in England and to the expected energy buildings in Wales in regards to the performance of flexible thermal linings installed for the insulation of walls in order to achieve a U-Value¹³³ 0.30 W/m².

On the other hand, part 7 “Water Efficiency” of the Building Regulations 2010 provides regulations for water efficiency of new dwellings where regulation No.36 states “*The potential consumption of wholesome water by persons occupying a dwelling to which the regulation applies must not exceed 125 liters per person per day*”. Calculation of wholesome water consumption shall be based on “The Water Efficient Calculator for New Dwellings” which is published by DCLG¹³⁴ in September 2009. Moreover, regulation No. 37 under Part 7 provides that the contractor must submit a notice to the local authority specifying the potential consumption of wholesome water per person per day for the constructed dwelling.

Circular No. 01/2015 issued by DCLG on 27th March 2015 to support some requirements of schedule 1 to The Building Regulations 2010 including Part G

¹³² Approved Document L1A “Conservation of fuel and power”, The Building Regulations 2010.

¹³³ U-Value is a measure of the heat transmission through a building part such as a wall or window, or a given thickness of a material such as insulation with lower numbers indicating better insulating properties.

¹³⁴ the Department for Communities and Local Government

“Sanitation, Hot water safety and water efficiency” with amendments to regulation No. 36 for the calculation of Water Efficiency of New Dwellings, where the methodology is included in Appendix A¹³⁵ of Approved Document G. The calculation methodology is useful for assessing the whole consumption of potable water in new dwellings in order to assess the compliance against the targeted water performance specified in regulation No. 36.

In case of failure of project’s parties to comply with the building regulations, sections 35,35A, and 36 of the 1984 Act provides the consequences of the incompliance with the building regulations against the contractor and the building’s owner. Accordingly, in case of contravention with regulations, the local authority covering the area where the building work is carried out has the right to notify the parties informally as first step to achieve compliance with the regulations.

The local authority has the power also to enforce the regulations formally as part of its general duty. If contravention is made by the contractor, then the local authority may approach the Magistrate’s court to impose unlimited fines in accordance to sections 35 and 35A of the Building Act 1984. Prosecution by the local authorities is possible up to two years after the defected work is completed.

On the other hand, the authority may raise an enforcement notice to the owner to remove the building works which are incompliance with the regulations. If no compliance by the owner with such notice, then the local authority can undertake the work on behalf of the owner and recover the cost of rectifying the work from the owner¹³⁶.

¹³⁵This Appendix specifies the flow rate of fittings and sanitary fixtures including WCs, bidets, taps, baths, dish washers, washing machines, and showers.

¹³⁶ Planning portal, Failure to comply with the building regulations
https://www.planningportal.co.uk/info/200128/building_control/38/building_regulations

3.3. The main mandatory green buildings regulations in UAE

The fourth point of the top green building tips by Emirates Green Building Council direct the projects' stakeholders to respect green building standards and regulations, and to be updated and trained with the current changes, stating that the complying with the new regulations in Dubai will impact the projects' operation and will have a long term positive impact on the environment. Moreover, the fifth point provides that complying with the enforced regulations in a specific emirate should be complemented by implementing the specific standards and policies related to health, safety and environment using the global assessment methods such as BREEAM, and ASHRAE, and widely used norms such as ISO¹³⁷.

Abu Dhabi urban planning Council aims to plan complete sustainable communities through urban strategies, master plans, and policies as it approves key strategic developments and coordinate with projects' stakeholders to monitor and implement these strategies for public and private projects¹³⁸.

Abu Dhabi Capital Development Code is a regulatory tool providing urban development regulations within the authorities of Abu Dhabi Municipality. The purpose of this code is to generate development regulations to ensure that all new developments are in line with the Abu Dhabi long-term plan and vision. Abu Dhabi Capital Development Code is not yet published on the website of Abu Dhabi urban planning council but can be obtained by visiting the town planning sector at the Abu Dhabi Municipality.

An executive council order has been issued in May 2010 stating that all new community developments shall meet the requirements of Pearl 1 starting from June 2010 as mandatory requirements. Therefore, PCRS had to be aligned with the Abu Dhabi Development and Building Codes¹³⁹.

On the other hand, the vision of the Vice President, Prime Minister and Ruler of Dubai for creating a healthy and sustainable environmental development for achieving a

¹³⁷ emiratesgbc.org/green-building-tips/

¹³⁸ www.upc.gov.ae

¹³⁹ www.upc.gov.ae

balance between the environmental protection and economic development led to the creation of Dubai's green building regulations and specification project¹⁴⁰. Accordingly the Dubai's government had the first step to implement the created regulations as mandatory requirements for governmental buildings from January 2011. Then after construction of forty four governmental buildings, the green building regulations were made mandatory for all new buildings in Dubai through circular No. 198 effective from March, 1st 2014. This circular¹⁴¹ made the consultant offices responsible to implement the green building regulations and to assure the compliance of drawings with the green requirements listed for building permits with notes why to explain the reasons for non-compliance in case if the proposed building is not complying with the green requirements. The circular contains also the role of Municipality to issue performance certificate (as green building) for all buildings complying with the specifications and regulations.

Dubai Green Building Evaluation system is cited as AL SA'FAT and known as the regulations of Dubai Municipality in the emirate of Dubai, aiming to reduce the consumption of materials, water, and energy for better public health and buildings' performance through enhanced planning, design, construction, operation and maintenance of buildings¹⁴². These regulations are applied to all buildings in the emirate of Dubai where free zone areas are included as well.

AL SA'FAT regulations are additional to the existing regulations of Dubai Municipality particularly the administrative resolution No.125 which approved building regulations and specifications in 2001. These regulations prevails any regulations or articles contained in the following circulars and administrative resolutions in case of any conflicts:

1. The administrative resolution No.66 which approved regulations on technical specifications for thermal insulation systems in 2003.

¹⁴⁰ <http://www.dm.gov.ae/wps/wcm/connect/78ef8aee-02d0-4085-b545-5b1b73f0d433/Green+buildings+in+Dubai+-+website+ENG.pdf?MOD=AJPERES&ContentCache=NONE&CACHEID=78ef8aee-02d0-4085-b545-5b1b73f0d433>

¹⁴¹ Circular No. 198 issued on 13th February 2014 with Ref:812/02/02/1/1402089 by the Dubai Municipality.

¹⁴² AL SA'Fat, Dubai Green Building Evaluation system, version 1.0,2016

2. Circular No. 161 which issued in the emirate of Dubai in 2003 to implement the green building regulations.
3. Circulars No. 171 and 174 which were issued to implement building green facades and roofs in 2007.
4. The administrative resolution No. 30 which was issued in 2007 to promulgate the implementing regulations of the local order No.11 which was issued in the emirate of Dubai in 2003 for public health and safety.

AL SA'AFAT regulations are applied to various types of buildings including villas, residential and commercial buildings, industrial buildings ¹⁴³, and public buildings ¹⁴⁴. These regulations are supported by the 'Green Building Practice Guide', and consider any standards and codes referred to as part of the requirements of these regulations. However, these regulations prevail in case of any conflict between the requirements of standard reference documents and those of the regulations ¹⁴⁵.

Article 102.02 "Energy Compliance Method" defines two compliance routes for energy performance in buildings. The standard route is named as "Elemental Method" where all buildings must comply with each of these regulations, while the alternative route is named as the "Performance Method".

The Performance Method use alternative calculation tool such as dynamic thermal modeling to evaluate the annual consumption of energy of the proposed building in comparison to the base line building which meets all the elemental requirements taking in to considerations that the base line building must be equal in size, shape, and operational patterns to the proposed building. The same methods are defined in Article 102.03 "Water Compliance Method" to evaluate the building's compliance with the elemental requirements for water efficient fixtures by comparing the annual water consumption of the proposed building with the consumption of the base line building.

¹⁴³ Industrial buildings include factories, warehouses, and workshops

¹⁴⁴ Public buildings such as banks, offices and governmental buildings, shopping malls, retail outlets and cinemas, museums and exhibition centers, mosques, and sports complexes.

¹⁴⁵ AL SA'Fat, Dubai Green Building Evaluation system, version 1.0,2016

Section one of AL SA'FAT regulations provides tables demonstrating the general requirements, Bronze Sa'fa requirements, Silver Sa'fa requirements, Gold Sa'fa requirements, and finally the Platinum Sa'fa requirements.

Section four includes seven chapters containing regulations related to ventilation and air quality, thermal comfort, acoustic comfort, hazardous materials, daylight and visual comfort, water quality, and responsible construction. Section five provides regulations for Energy resources effectiveness through four chapters including conservation and efficiency of building fabric, building systems¹⁴⁶, commissioning and management, and onsite generation and renewable energy systems.

Section six provides regulations for water resources effectiveness through three chapters including conservation and efficiency, commissioning and management, and onsite recovery and treatment systems. Finally, section seven provides regulations for materials and waste resource effectiveness through two chapters including materials and resources, and waste management¹⁴⁷.

The following paragraphs demonstrate some of the regulations for resources effectiveness from sections five and six.

First, regulations related to building fabric provides under Article 501.01 that all new air conditions buildings shall have exterior building elements with average thermal transmittance "U Value", and shading coefficients less than the specified values as minimum envelope performance requirements¹⁴⁸. Moreover, Article 501.02 regulates thermal bridging for new air conditioned buildings to reduce the amount of heat transfer from outside to the building through connection points such as those between external walls and columns, and around windows and doors¹⁴⁹.

Article 504.03 provides that solar water heating system shall be installed for all new buildings and labor accommodations to provide 75% of domestic hot water

¹⁴⁶ Building systems include HVAC, demand controlled ventilation, elevators and escalators, interior and exterior lighting power density, and other systems.

¹⁴⁷ AL SA'Fat, Dubai Green Building Evaluation system, version 1.0,2016

¹⁴⁸ The specified U values for Bronze and Silver Sa'fa are 0.3 W/m²k, and 0.57 w/m² for roof, and external walls respectively, while the specified U values for Golden and Platinum Sa'fa are 0.3 W/m²k for roof and 0.42 W/m²k for external walls.

¹⁴⁹ The same article provides that isolated thermal bridges can be avoided for all villas by raising the efficiency of the building envelope through the coefficient of heat transfer which shall not exceed 0.40 W/m²k.

requirements where the system must be designed and installed by a company approved by Dubai Municipality as long as the equipment. Moreover, Article 504.04 provides that renewable energy must be generated on site for all new buildings using solar panels with specified percentages of the actual electrical load of the building which are 5% in case of Bronze and Silver Sa'fa, and 10% for Golden and Platinum Sa'fa.

On the other hand, Article 601.01 provides the maximum flow rates that shall be met by the installed fittings and fixtures for any new building, while Article 602.01 regulates water metering for all new buildings to record and measure the consumption of water. Moreover, Article 603.02 regulates water consumption for heat rejection including cooling towers for all new buildings prohibiting the use of potable water supplied by DEWA¹⁵⁰ for heat rejection purposes, and encouraging the use of treated sewage water or recycled water instead. The same Article provides that “a separate totalizing meter must be fitted on the water supply to individual cooling towers and a daily log of water use must be kept”.

Under section seven, Article 701.05 provides that installation of equipment for HVAC, and refrigeration shall contain zero ozone depletion potential (ODP) refrigerants or with global warming potential less than 100, while Article 701.07 regulates the percentage of the total volume of regional materials used in the construction of all new buildings which are 5% in case of silver requirements, and 10% for Gold and 15% for platinum¹⁵¹.

Finally, it shall be noted that same regulations are contained in the “Manual of Green Building Materials, Products and their Testing Facilities” which was issued as Edition (4) on January, 30th 2017 by Dubai Central Laboratory Department. Moreover, the regulations contained in General requirements of AL SA'FAT as listed in table 21 are mandatory if the equipment is applicable¹⁵².

¹⁵⁰ Dubai Electricity and Water Authority

¹⁵¹ AL SA'Fat, Dubai Green Building Evaluation system, version 1.0, 2016

¹⁵² Refer to Appendix - A

3.4. Effectiveness and power of UAE green building regulations and Law

By comparing ALSA'FAT regulations in the emirate of Dubai with regulations in U.S and U.K, it is found that sections of AL SA'FAT regulations covers all the aspects for constructing green buildings in different ratings, including ecology and planning, building vitality, energy effectiveness, water effectiveness, and materials and waste effectiveness. AL SA'FAT regulations provides the technical requirements with clear demonstration of "Energy Compliance Method", and "Water Compliance Method" which illustrate the calculation of savings in consumption by comparing the annual consumption of the proposed building with the consumption of the baseline building. However, it is recommended to apply federal green building standards and regulations combining all aspects covered by ALSA'FAT in the emirate of Dubai and Estidama Pearl rating system in the emirate of Abu Dhabi. Having federal green building regulations is applicable since climate zone is almost same in the emirates of Abu Dhabi, Dubai, and Sharjah, and will facilitate the applications of standards by both consultant offices and contractors in the UAE, as the same concept is applied in U.S where California Green Building Standard Code is adopted and incorporated in Los Angeles.

The Dubai Municipality made the implementation of green building regulations mandatory. The documents provided by the municipality are AL SA'FAT regulations, and circular 198 which made consultant offices responsible to comply with the green building requirements and regulations as demonstrated above. However, Circular No. 198 issued by the Dubai Municipality states that consultant shall mark the issues which are not complying with the green building specifications and regulations and to explain the reasons for non-compliance, but the circular doesn't state the consequences of non-compliance. Therefore, it is recommended here that local authorities in the UAE impose the same power applied by the local authorities in U.K as demonstrated above¹⁵³.

¹⁵³ The local authority in U.K has the power to enforce regulations formally in case of non-compliance with the building regulations by imposing unlimited fines on the contractor in accordance to the Building Act 1984. Moreover, the local authority may raise an enforcement notice to the owner to remove the building works which are not in compliance with the regulations with power to undertake the work on behalf of the owner.

Moreover, Circular No. 220¹⁵⁴ provides that consultant offices have to assure the implementation of fixing “Dubai lamp”¹⁵⁵ by contractors for all new projects as a condition for the issuance of the building completion certificate. This circular indicates that building completion certificate will not be issued by the municipality for new buildings which will not comply with the circular. So, the same concept should be applied in case of non-compliance with the green building standards and regulations in order to strengthen the local regulations in the UAE for implementing the green building requirements. This weakness could be strengthened if the local authorities assigned accredited energy assessor to assess the performance of the building and issue energy performance certificate as mandatory requirements for the issuance of the building completion certificate.

On the other hand, Federal Law No. (24) of 1999 under the UAE Environmental Law provides general principles for the protection and development of the environment including control of all forms of pollution, development of natural resources, protection of society and the health of human beings from any environmentally harmful acts, and compliance with the ratified conventions for the protection of environment and conservation of natural resources¹⁵⁶.

As quoted from Issue 223 by AL Tamimi and company for advocate and legal consultants in UAE “*Law No. 24 and the Executive Order published pursuant to Cabinet Resolution No. (37) of 2001 deals comprehensively with all aspects of environmental protection relating to projects; the marine environment and pollution thereof; liability and compensation for environmental damage; protection of drinking and underground water; air pollution; disposal of hazardous waste; disposal of medical waste, pesticides, agricultural fixers and fertilizers; nature reserves; the protection of wildlife, as well as the penalties imposed for contravention of any provisions of the aforesaid*”. Penalties include fines within the range from AED 1000 to AED 10 Million¹⁵⁷.

¹⁵⁴ Circular Ref: 818/02/02/1/1711779 issued by the Dubai Municipality on 10th August 2017

¹⁵⁵ ‘Dubai lamp’ is advanced project initiated by the municipality in association with international specialist to produce lighting units which reduces energy used for lighting up to 90%.

¹⁵⁶ AL Tamimi company, *LAW UPDATE*, [Issue 223, November 2009]

¹⁵⁷ Clyde & Co LLP, *A guide to environmental regulation in Dubai and the wider UAE*, [May 27, 2013]

<https://www.lexology.com/library/detail.aspx?g=7ad19d42-ea41-4bd9-9c57-08e2142ba10e>

By referring to the appendix¹⁵⁸ provided by Law Update issue 223 by AL Tamimi and company, which listed the Environmental Laws in the UAE including federal and local laws in Abu Dhabi, Dubai, and Sharjah, regional conventions, and international conventions and protocol, it is found that recent Environmental federal Laws are Federal Law No.11 of 2002 and Federal Law No.1 of 2002, while the recent local Environment Laws were issued in 2005. Moreover, the ratified regional and international conventions were concluded in between 1971 and 2001. Accordingly, Environmental Law in UAE should be updated to incorporate the major aspects of green building codes and regulations to strengthen their implementation by imposing fines in case of acts of negligence or non-compliance with the regulations. However, chapter 5 will analyze the related Articles under the Civil Transaction Code to find out the strength and weaknesses of Law for implementation of green building standards and regulations.

Updating Articles of Environmental Law in UAE will strengthen the implementation of mandatory standards of AL SA'FAT in the emirate of Dubai and other green building regulations in the UAE, which will support the achievement of the following governmental targets:

- (i) Applying AL SA'FAT standards for saving electricity consumption by 20%, saving on water consumption by 15%, reducing waste by 50%, and reducing emission of carbon dioxide by 20%.
- (ii) Strategic plan of Dubai Municipality by 2021 for making Dubai the most smart and sustainable city in the world.
- (iii) Dubai Carbon Abatement strategy to reduce carbon emission by 16% by 2021.
- (iv) Abu Dhabi vision and plan for 2030.

¹⁵⁸ Appendix can be found on website <http://altamimi.newsweaver.ie/Newsletter/11dsydcibbf>

Chapter 4

How the standard construction contracts deal with the implementation of green buildings standards and regulations? Parties' liabilities and Allocation of risk

The contract defines the owner's need and the vision of the designer as a base from which project's parties start. Three parties are involved in the construction process including the owner who has to define his requirements and vision, the designer who creates the vision and supervise quality of work, and the contractor who makes the vision reality by constructing the proposed project.

All parties shall respect the contractual relationships and shall comply with the regulations and statutes established by the government and by other associated agencies and municipalities. Therefore, statutory and regulatory laws should be recognized while administering the contract in order to define the obligations of each party and to shift risk from one to another.

There are separate contractual relationships which define the responsibilities and obligations of the three parties of the project. The first one is the relation between the owner and the contractor in case of Design-Bid-Build delivery system, while the second relation comes between the owner and designer. For complex projects, the owner may assign office for the project management with experience in construction management to interfere in the design and construction stages for guaranteed maximum price.

In case of Design-Bid-Build procurement method, the owner assign a designer to prepare the plans and specifications in accordance to his needs, then the owner awards the project to the contractor to build the project either on lump sum value or based on re-measured quantities for itemized unit rates or a cost plus contract. In some cases, the owner use Multi-prime contracting method when he prefers to assign the Mechanical,

Electrical, and Plumbing work separately from the general contractor to save money from his markup¹⁵⁹.

On the other hand, in case of Design-Build procurement method, the owner assigns the contractor as master builder responsible for project management, and works as designer and constructor. Here the contractor is responsible for engineering, procurement, and construction to turn the key to the owner when the project is completed.

The role of the contractor is to execute the project in accordance to the owner's needs, while the role of the owner is the consideration in return. In construction contracts, the owner usually keeps 10% of the value of work done by the contractor to guarantee the completion of the project where he releases 5% when he takes over the project and releases the other 5% after the completion of the defects liability period. Moreover, the contractor provides bank guarantees issued by the bank in the favor of the owner that to be kept with the owner to guarantee the performance of the contractor and to secure the advance payment done by the owner. So, the owner usually retain 10% of the contract value till the successful completion of the project, and keeps performance bond with amount equal to 10% of the contract value until the end of defects liability period.

The question here, are the retained amounts and the encashment of performance bond enough to compensate the owner with the losses resulting from the noncompliance of the contractor with the green requirement and from lower rating? Lower green building rating leads to less selling or renting rates of the property. Moreover, if the actual consumption of energy and water after operating the building exceeded the proposed consumption, then differences in cost are continuous losses to the owner.

Therefore, the contract shall define the "Green Building" certification level and the rating system as needed by the owner, and to define the proposed savings while operating the building. For example, if the owner's requirement is LEED Gold certified building, and then received Silver certification, the contract should be drafted carefully to define the liability of the party who is responsible for the lower rating. Who is responsible and liable to compensate the owner? The designer, the contractor, or joint responsibility?

¹⁵⁹ Charles W. Cook, *Successful Contract Administration For Constructors and Design Professionals*, [Routledge, New york, 2017].

The following paragraphs will demonstrate how the standard construction contracts deal with the implementation of green buildings standards and regulations and allocate risks between project's parties, by comparing the related clauses and articles between AIA, NEC, and FIDIC contracts.

4.1. Prototype contracts for design and construction, produced by the American Institute of Architects (AIA), as most common construction contracts in US.

A101-2017 AIA document is a standard (fixed price) form of contract between the owner and the contractor for large projects. This document should be used in conjunction with Exhibit A "Insurance and Bonds" and AIA document A201-2017 which is the "General Conditions of the contract". The agreement is formed of nine Articles named The contract documents, The work of this contract, Date of commencement and substantial completion, Contract sum, Payments, Dispute Resolution, Termination or Suspension, Miscellaneous provisions, and Enumeration of contract documents.

Article 2 provides that the contractor shall fully execute the work described in the contract documents, while Article 1 defines the contract documents which all form the contract along with the agreement including conditions of contract, drawings, specifications, Addenda issued prior to the execution of agreement, and other documents and modifications issued after the execution of the agreement¹⁶⁰.

Section 4.5 under Article 4 "contract sum" provides the terms and conditions for liquidated damages, while section 5.1.2.6 provides that the amount of each progress payment shall be reduced by the amount previously paid by the owner and the following amounts in cases of defected work by the contractor:

- (a) The amount, if any, for work that remains uncorrected and for which the Architect has previously withheld a certificate for payment.
- (b) Any amount for which the Architect may withhold payment, or nullify a certificate of payment in whole or in part for work performed or defects discovered since the last payment certification.

¹⁶⁰ A101- 2017 Standard Form of Agreement between Owner and Contractor where the basis of payment is a Stipulated Sum. <https://www.aiacontracts.org/contract-documents/69981-standard-form-of-agreement-between-owner-and-contractor>

(c) Retainage with a percentage pursuant to section 5.1.7 “Retainage”.

Article 5.2 “Final payment” provides that final payment shall be made by the owner to the contractor when the contractor has fully performed the contract except for the contractor’s responsibility to correct work as provided in Article 12 of the General condition of contract “AIA document A201-2017”, and to satisfy other requirements, if any, which extend beyond final payments.

Section 8.5.2 under Article 8, provides that the contractor shall provide bonds as set forth in AIA Document A101-2017 Exhibit A, while Article 9 lists the contract documents in the sequence of priority¹⁶¹.

A201-2017 document is an umbrella document for Design-Bid-Build projects which provides the standards General conditions of AIA contract for construction, through fifteen Articles. Article two, three, and four provides the responsibilities of owner, contractor, and Architect respectively. Moreover, Article 11 provides conditions related to “insurance and bonds”, while Article 12 provides those which are related to “Uncovering and correction of work”. Finally, Article 15 provides the conditions for claims and disputes.

The above articles are selected to find out how AIA general conditions of contract defines the responsibilities of the project’s parties for executing the work in accordance to the contract documents to fulfill the needs of the owner’s requirements, and to find if the conditions can be applicable to compensate the owner in case of noncompliance with the green requirements.

Article 3 provides that the contractor is responsible to carefully study and compare the various contract document since they are complementary, as well as the information furnished by the owner, and then to report to the Architect in case of any errors. Section

¹⁶¹ The sequence as follows:

- (i) Standards form of contract between owner and contractor.
- (ii) Exhibit A, Insurance and Bonds.
- (iii) General conditions of contract for construction.
- (iv) Building Information Modeling and Digital Data Exhibit “AIA Document E203-2013”.
- (v) Drawings.
- (vi) Specifications.
- (vii) Addenda.
- (viii) Other Exhibits.
- (ix) Other documents, if any.

3.2.2 provides that the contractor's review to be made under his capacity as a contractor and not as a licensed design professional unless otherwise specifically provided in the contract document.

Moreover, section 3.2.3 provides that it is not required by the contractor to ascertain that the contract documents are in accordance to the applicable laws, statutes, codes, rules and regulations, or lawful order of public authorities but shall report to the Architect any discovered nonconformity. Section 3.2.4 provides that the contractor shall not be liable to the owner or Architect for damages resulting from nonconformities of the contract documents to applicable laws, statutes, codes, rules and regulations, or lawful order of public authorities.

Finally, section 3.5.1 makes the contractor responsible to warrants that the work will conform the requirements of the contract documents and will be free from defects, while section 12.3¹⁶² provides that the owner may accept work that is not performed in accordance to the contract documents instead of requiring its correction and removal against reduction of the contract sum where such adjustment shall be made whether or not final payment has been made¹⁶³.

As owners in U.S had to register projects under the fourth version of LEED effectively after October 31, 2016, it was found that construction contracts should be revised and drafted for sustainable projects to assure the implementation of LEED requirements and to mitigate risks between parties. Accordingly, the American Institute of Architects released AIA sustainable project contract documents to be used in construction industry for reflecting the expectations of all parties in the contract for sustainable projects¹⁶⁴.

Article 1 of this document states: *"this Exhibit provides the establishment of the services of the Architect, the work of the contractor, and requirement and services of the owner, where the project includes achievement of a sustainable objective"*. The sustainable objective is also identified as "sustainability plan" which defines the owner's goal for incorporating sustainable measures during the design, construction, maintenance and operations stages of the project in order to obtain sustainability certification and for

¹⁶² "Acceptance of Nonconformity Work"

¹⁶³ A201-2017 General Conditions of the contract for Construction by the American Institute of Architects "AIA"

¹⁶⁴ Staart Kaplow, *Now is the Time to Revise your Green Building Contract*, [April 3, 2016].

achieving other benefit to the environment to enhance the health and well-being of building occupants, and to improve the efficiency of energy. It is provided under section 1.2.2 of this Exhibit that all parties including the Owner, Architect, and Contractor shall have responsibility for the sustainable measures allocated to them in the sustainability plan¹⁶⁵.

Sections under Article 2 define the role and responsibilities of the Architect to provide the following sustainability services:

1. To provide the owner with copies of all the required agreements for the certifying Authority to register the project and to obtain sustainable certification.
2. To conduct sustainability workshop with the owner and consultants in order to establish the sustainable objective and measures and to discuss their impact on the project's cost and time.
3. To prepare sustainability plan based on the targeted sustainable measures and objective.
4. To prepare schematic design and construction documents to incorporate the sustainability plan.
5. To notify the owner during the design phase with his concerns regarding the performance of any selected material or equipment that will affect the sustainable objective, but he shall not be responsible for any damages resulting from the failure of such material if the owner approved to proceed.
6. To notify the owner during construction phase with any noncompliance with the contract documents that will affect the achievement of sustainable measures.

Sections of Article 3 define the role and responsibilities of the Contractor to provide the following:

1. To perform the sustainable measures that lay under his responsibilities in the sustainability plan.
2. To prepare and complete the sustainability documentation required from the contractor by the contract documents.
3. To notify the owner during the design phase with his concerns regarding the performance of any selected material or equipment that will affect the

¹⁶⁵ AIA Document E204-2017, Sustainable projects Exhibit

sustainable objective, but he shall not be responsible for any damages resulting from the failure of such material if the owner approved to proceed.

4. To make copies of the sustainability plan available to each proposed subcontractor.
5. To verify that the project has achieved the sustainable objective.

On the other hand, Article 4 defines the role and responsibilities that should be carried out by the Owner including the following:

1. To approve the sustainability plan and to require his contractor and consultant to perform their services in accordance to the sustainability plan.
2. To provide both the contractor and the Architect with any necessary information requested by them to achieve the sustainable objective.
3. Compliance with the requirements of the certifying Authority which relate to the ownership, and operation and maintenance of the project during the construction phase and after the project's completion.

Finally, Article 5¹⁶⁶ provides that the project's parties waive claims against each other for consequential damages resulting from failure of the project to achieve the sustainable objective or one or more of the sustainable measures, while Article 6 provides that the contractor and Architect will not guarantee that the project will achieve the sustainable objective as it is dependent of factors beyond their control such as the owner's use and operation of the project, or interpretation of credit requirements by the certifying Authority, or the work and services provided by other contractor or consultants assigned by the owner¹⁶⁷. Here, it is found that Article 5 did not define the expected failure and its consequences which shall be defined clearly in order to allocate the risk between parties and to evaluate adequate compensation to the party who suffered losses "the Owner" instead of waiving claims unless failure is caused by the owner.

¹⁶⁶ "Claims And Disputes"

¹⁶⁷ AIA Document E204-2017, Sustainable projects Exhibit

4.2. New Engineering Contract (NEC) which is much favored in public sector circles in the UK.

NEC3 contracts are used in the UK and overseas for several large construction projects. They are being used for most of the projects procured by local and government bodies in UK, and became a public sector contracts¹⁶⁸.

NEC suit of contracts include Engineering and Construction Contracts (ECC) which are used for assigning a contractor to carry out both the engineering and design work and construction work for different projects such as highways, plants, infrastructure, and buildings. The suit of contracts includes also Professional Services Contract (PSC), and Term Service Contracts (TSC) which are all available with a range of options from A to G.

NEC3 Engineering and Construction Contract – Option A (priced contract with activity schedule was used by an employer named “Cornwall Sustainable Building Trust” for engaging a contractor for the construction of a new sustainable construction center for the UK named the Green Building Hub. The building itself is designed, procured, constructed , and operated as a sustainable benchmark and achieved BREEAM “Outstanding” rating after completion in July 2015¹⁶⁹.

The ECC-Option A contract is formed of nine core clauses¹⁷⁰ regulating the relation between the owner and the contractor. The contract is formed also of main option clauses A for priced contract with activity schedule, dispute resolution option W2, and secondary option clauses from X1 to Z.

First, completion of work is defined as the time when the contractor do all the work as stated in the works information along with all the work necessary for the works to be

¹⁶⁸ Standard Form of Contracts NEC

¹⁶⁹ Green Building Hub, Cornwall, UK

<https://www.neccontract.com/NEC-in-Action/Case-Studies/Green-Build-Hub-Cornwall-UK>

¹⁷⁰These nine core clauses are under the following titles:

1. General clauses.
2. The contractor’s main responsibilities.
3. Time.
4. Testing and defects.
5. Payment.
6. Compensation events.
7. Title.
8. Risk and insurance.
9. Termination.

available and delivered in to service, and when notified defects which would have been prevented the employer from using the works as corrected. A defect is defined as the contractor's failure to provide the works or any parts of the works in accordance with the work information and the contract's requirements including reduction in the quality, condition, appearance or performance of the works. Defects include the contractor's failure to undertake his design in accordance with the applicable law, or all applicable approvals or failure to get the design accepted by the project manager.

Clause (2) provides the contractor's main responsibilities including the execution of the works in accordance with the work information and the contract, and in accordance with the standards, good industry practice and all applicable law and statutory requirements. The contractor is also responsible to keep the project manager who is representing the employer informed of all material aspects of the works¹⁷¹.

Sub-clause (21.1) provides that the contractor is responsible to design the parts of the works which the works information states that they lay under the contractor's responsibilities, while sub-clause (21.5) provides that the contractor shall represent to the employer that the works designed and specified by him comply with all statutory requirements, applicable Law, and all relevant standards. Moreover, the contractor is responsible to obtain approval of his design from others if the same is stated in the works information.

Sub-clauses under clause (4) provides that the contractor and the project manager may propose not to correct the defect and to change the work information against reduction in the contract price or earlier completion.

On the other hand, this form of contract¹⁷² deals with the un corrected defects under sub-clause (45.3) by keeping the contractor liable for losses which are resulting from defects including those which are listed on the defects certificate, any acceptance certificate, and any other latent defects after the issuance of the acceptance certificate, or after the expiry and termination of the contract for any reason. Sub-clause (45.1) provides that the contractor is responsible to pay to the employer the cost of correcting the defects by other people assigned by the project manager if the contractor failed to correct the defect within the defect correction period provided that he is given access by

¹⁷¹ NEC3 ECC-Option A, Consolidated Conditions of Contract

¹⁷² NEC3 ECC-Option A, Consolidated Conditions of Contract

the employer to correct the defect. Moreover, sub-clause (46.1) is a clear condition which makes the contractor responsible for the cost of correcting a critical defect by others¹⁷³.

In regards to the contractor's performance security, sub-clause (50.8) provides that in case if the contractor didn't procure any performance bond or parent company guarantee and didn't deliver to the employer in accordance to the contract, then the employer has the right to retain 25% of the price of work done until the contractor deliver the required bonds. Sub-clause (56) provides that any damages, cost, charges, expenses, debts, sum or any other amounts which are reasonably owed to, or incurred by the employer under the contract are recovered from or payable by the contractor or may be set-off and/or deducted from any sum due to the contractor.

Clause (83) defines the contractor's responsibilities to indemnify the employer against losses resulting from several events including any loss, damage, cost or expense which incurred or suffered by the employer due to any negligence, breach of contract, breach of statutory duty, error, act, omission or default by the contractor, subject to any applicable limitation of liability agreed in the contract. Moreover, Sub-clause (83.2) provides that such contractor's indemnities remain in force during the contract period and until the expiry of any other period that give effect to them in the contract, while sub-clause (83.3) makes the contractor not responsible to indemnify the employer for any losses which are resulted from events under the employer's risk or due to negligence of the employer.

Sub-clauses (Z2.1.2) and (Z2.2.1) provides that the contractor is responsible to deliver deeds of warranty to the employer in the agreed form not later than the completion date along with deeds of warranty made by the subcontractors and sub-subcontractors in favor of the employer, purchasers and tenants. Similarly, the consultant and his sub-consultants are responsible to deliver deeds of warranty to the employer. Moreover, the contractor must warrants and undertakes to the employer in accordance to sub-clause (Z.2.7.1), that he examined the work the work information and all the documents which form the contract, and to carry out all design, workmanship, manufacture, and fabrication in accordance to the work information, applicable law, statutory

¹⁷³ *"Without prejudice to any other right or remedy of the employer, the contractor pays to the employer all costs reimbursed by the employer to others for correcting a critical certificate"*, as provided by NEC3 ECC-Option A, Consolidated Conditions of Contract

requirements and all relevant standards. Moreover, he undertakes that the works will pass any acceptance of testing required by the contract, while sub-clause (Z.2.6.1) provides that any data provided by either the employer or the project manager to the contractor doesn't relieve him from his responsibility to design and execute the work in accordance with the contract.

Sub-clause (Z2.9) – “Rejection of Works”, provides that if the contractor's works or any part of them failed to pass any performance or acceptance test specified in the works information within the allowed period to pass such test or if the actual performance is below the minimum acceptable level specified in the works information, then the employer may reject the works or such part without prejudice to his right to any low performance damages. In such a case, if the employer has paid for the rejected work or part thereof, then the employer may recover the amount paid as debt due from the contractor. Moreover, the contractor shall remove the rejected works or part from the site at his own expense in accordance to the instructions of the project manager.

Sub-clause (Z.2.22.1) provides that the contractor complies with the standards as required in order to deliver the works in accordance with Good industry practice and the contract, while sub-clause (Z2.26.1) states that the completion will not take place until the works are available where “Available” means that the works comply with the standards, safe, fit with their intended purpose, can be used without foreseeable hazards, and readily accessible and operable by the employer.

Optional clause (X7) provides that the contractor pays delay damages at the agreed rates for each week from the completion date until the earlier of either completion or the date on which the employer takes over the works. The payment of delay damages is additional to the employer's right to low performance damages and liquidated damages¹⁷⁴.

Option clause (X15) makes the contractor not liable for defects in the works resulting from his design as long as he proves that the design has been carried out by professional designer with reasonable skill, care and diligence to ensure that his design is in compliance with the works information. On the other hand, clause (X21) “Single point Design Responsibility” is an option clause which makes the contractor responsible

¹⁷⁴ NEC3 ECC-Option A, Consolidated Conditions of Contract

for the design and specifications of the works and the accuracy of the design information provided by the employer including drawings, proposals, specifications, method statements, designs, plans, or any other document developed by the employer and included in the works information except the detailed design for the stations¹⁷⁵ or camera posts at station and the specification of the free issue material¹⁷⁶.

Finally, option clause (X16) “Retention” provides that the amount retained until the earlier of completion of the works or the date on which the employer takes over the whole works is payable in two halves. The first half after the completion of the works or when the employer takes over the whole works, while the other half remains retained until the defects certificate is issued where no amount is retained in the assessments made after the defects certificate has been issued¹⁷⁷.

4.3. FIDIC model contracts “Rainbow” series which are most commonly used on an international level and UAE in particular.

The Red Book 1999 by FIDIC¹⁷⁸ is a widely used standard form of contract between the employer and the contractor where the contractor build the work in accordance to design provided by the employer. The contractor’s work may include the design of some elements for civil or MEP works.

The general conditions of the Red Book 1999 contains of twenty clauses. The following clauses were selected to find out how these conditions are applicable for the implementation of green buildings standards and regulations and how this type of contracts allocate risks between project’s parties:

First, the contract is defined under clause 1 “General Provisions” as the contract agreement, the letter of acceptance, the letter of tender, the particular conditions, the general conditions, the specification, the drawings, the schedules, and the further documents (if any) as listed in the letter of acceptance or contract agreement, where the priority of documents are in the same sequence.

¹⁷⁵ Station is defined as building, equipment or facilities designed to be used by customers to access or leave a train.

¹⁷⁶ NEC3 ECC-Option A, Consolidated Conditions of Contract

¹⁷⁷ completion of the works or the date on which the employer takes over the whole works

¹⁷⁸ The Federation Internationale des Ingenieurs-Conseils (FIDIC)

Sub-clause (3.1) provides that the employer shall appoint the engineer for carrying out the duties assigned to him, where the engineer shall be deemed to act for the employer for approvals, checking, certification, examination, inspection and testing. On the other hand sub-clause (4) defines the general obligations of the contractor including the following responsibilities:

1. To execute and complete the works in accordance with the contract and with the engineer's instructions, and shall remedy any defects in the work.
2. To design any item of plant and materials required for construction except for the design and specification of the permanent works to the extent specified in the contract.
3. To submit a performance security which shall be valid and enforceable until the contractor execute and complete the work and remedy any defects. Here, sub-clause (4.2) provides that the employer shall not make a claim under the performance security except for amount to which the employer is entitled under the contract in four events including the contractor's failure to remedy a default within 42 days after receiving the employer's notice for remedying the work¹⁷⁹.

Sub-clause (8.7) provides that delay damages shall be applied if the contractor failed to handover the project on the agreed time for completion, where the total amount of delay damages shall not exceed the maximum amount of delay damages agreed by parties.

Sub-clause (9.1) provides that the contractor shall carry out tests on completion, while sub-clause (9.4) provides that the engineer may issue a taking over certificate upon the employer's request in case of failure to pass tests on completion, where in such event, the contract price can be reduced by such amount as shall be appropriate to cover the reduced value to the employer as a result of this failure¹⁸⁰.

Moreover, sub-clause (10.1) provide that when the contractor applies by notice to the engineer for a Taking Over Certificate (TOC), the engineer shall issue the TOC

¹⁷⁹ FIDIC, *Conditions of contract for construction, for building and engineering works designed by the employer*, [First Edition, 1999]

¹⁸⁰ The same sub-clause states that "*unless the relevant reduction of this failure is stated (or its method of calculation is defined) in the contract. The employer may require the reduction to be (i) agreed by both parties (in full satisfaction of this failure only) and paid before the Taking Over Certificate is issued or (ii) determined and paid under sub-clause 2.5 [Employer's claim] and sub-clause 3.5 [Determinations]*".

or reject the contractor's application within 28 days after receiving it, otherwise, the TOC shall be deemed to have been issued on the last day of that period if the engineer failed to respond within the period of 28 days.

Sub-clause (11.4) provides that the employer may carry out the remedial work at the contractor's cost if the contractor failed to remedy the defect within the notification period. Moreover, if the defect or damage deprives the employer of substantially the whole benefit of the works or any major part of the work, the employer has the right to terminate the contract as a whole or for such major part which cannot be put to the intended use, and then the employer shall be entitled to recover all sums paid for the works or for such part plus financing costs and the cost of dismantling the same, clearing the site and returning plant and material to the contractor¹⁸¹.

Finally, sub-clause (17.2) makes the contractor liable for any loss or damage caused by any actions performed by him after the issuance of the TOC in addition to his liability for any loss or damage which occurs after the issuance of the TOC and which arose from a previous event for which the contractor was liable, while sub-clause (17.6) provides that the total liability of the contractor to the employer in connection with the contract shall not exceed the sum agreed by parties or the accepted contract amount.

¹⁸¹ FIDIC, *Conditions of contract for construction, for building and engineering works designed by the employer*, [First Edition, 1999]

Chapter 5

Instruments to implement green building standards and regulations in UAE

5.1. Governmental standard construction contracts

Construction contracts for major projects in UAE are based on three main forms of FIDIC contracts including the Red Book, the Yellow Book, and Silver Book for turnkey projects, with an increase use of the Red Book 1999, and 1987 edition.

The departments of Abu Dhabi Government must use the conditions of contract of the Abu Dhabi Government for procuring construction or design and build construction methods which are based on the 1999 editions of FIDIC Red and Yellow Books with amendments to shift more risks on to the contractor. On the other hand, the Dubai Municipality and the Roads and Transport Authority in Dubai use their own conditions of contracts which are based on the 1987 edition of FIDIC Red Book where conditions are amended to allocate additional obligations and risks on the contractor as well.

The major amendments of the FIDIC standard conditions of contract by the Government include more hard provisions for claim notifications, suspension and termination rights for the benefit of the Government as employer, in addition to deletion of clauses which entitle the contractor to certain time related costs, and allocating the risk more to the contractor in cases of errors found in design documents and unforeseeable conditions¹⁸².

A phone conversation has been held with the head of engineering contracts department in the Dubai Municipality, who reported that the general conditions of the engineering contracts by the Municipality is available on the website¹⁸³ with date May 20, 1999.

¹⁸² M. Kerr, D. Ryburn, B. McLaren, and Zehra, Construction and projects in United Arab Emirates: Overview, [2013/2014]
www.practicallaw.com/1-519-3663

¹⁸³ <https://login.dm.gov.ae/wps/wcm/connect/ae115571-0862-465b-a3d7-d97d5ca1399f/CONDITIONS+OF+CONTRACT+FOR+WORKS+OF+CIVIL+ENGINEERING+CONSTRUCTION.pdf?MOD=AJPERES>

The General conditions of construction contracts by the Dubai Municipality contains of main twenty six clauses¹⁸⁴. The following paragraphs will demonstrate the clauses which can be applied for the implementation of green building requirements, and other selected clauses which are related to responsibilities of parties, allocation of risks, consequences of defected works, and performance securities:

First, clause (5.1) provides that the contractor shall adhere to both the applicable Law and regulations of Dubai Municipality¹⁸⁵. Then, clause (5.3) lists the documents which form the contract in the sequence of priorities¹⁸⁶. It is provided also that specification may contain of two parts as General specifications and Particular specifications, where in such a case the particular specification will have priority over the general specifications. Accordingly, clause (5.1) may apply as a condition for the adherence to the green building regulations as a part of Dubai Municipality's regulations. Moreover, sustainable design, and sustainable plan could be a part of the particular specifications as one of the contract documents listed under clause (5.3).

Second, clause (7.1) provides that the Engineer has the authority to issue supplementary drawings, specifications, and instructions as shall be necessary for the completion of works and to remedy any defect, where the contractor is bound to carry out the works by these supplementary documents and instructions in addition to the original documents. These supplementary documents could be the owner's green building

¹⁸⁴ These main clauses are titles as: Definitions and Interpretation, Engineer and Engineer's representative, Assignment and subcontracting, Contract Documents, General Obligations, Labor, Material, Plant, and Workshop, Suspension, Commencement and Delays, Defects Liability, Alterations, Additions, and Omissions, Procedure for Claims, Contractor's Equipment, Temporary Works and Materials, Measurement, Provisional Sums, Nominated Subcontractors, Certificates and Payments, Expulsions and Remedies, Special Risks and Termination, Release from Performance, Settlement of Disputes, Notices, Default of Employer, Changes in Cost and Legislation, Joint Venture, and Miscellaneous.

¹⁸⁵ Dubai Municipality, Condition of Contract for Works of Civil Engineering Construction, [May 20, 1999]

¹⁸⁶ The sequence of priorities of contract documents as follows:

- (i) Contract Agreement.
- (ii) Letter of Acceptance.
- (iii) Tender and Appendix to Tender.
- (iv) Particular conditions of contract.
- (v) General conditions of contract.
- (vi) Specifications.
- (vii) Drawings.
- (viii) Priced Bill of Quantities.
- (ix) Other documents as listed in the Appendix of Tender.

requirements. Moreover, clause (7.2)¹⁸⁷, and clause (7.3)¹⁸⁸ make the contractor liable when he design any permanent work under his scope of work. Such scope may include a sustainable design or any other part of the green building requirements. Clause (8.1) also makes the contractor responsible to design to the extent provided in the contract, execute and complete the works, and remedy any defects with due care and diligence in accordance with the contract's provisions. It is also provided that the contractor shall be liable for the consequences of incorporating defective materials, equipment and plant in the works and for workmanship¹⁸⁹.

Clause (10.1) provides that the contractor shall provide a performance security to the employer in the sum of 10 percent of the contract price and in the form of an unconditional bank guarantee from an approved bank. Such performance security shall be valid until the contractor provides the final NOCs from Authorities supported by copy of defects liability certificate to the employer, or for 90 days after the effective date of the contract, which ever comes later. This validity period is not sufficient for sustainable projects, and this condition should be improved as recommended in chapter six.

Clauses (37.4) and (39.2) provides that the contractor shall make good the defective plant, equipment, materials, structural elements or structures which are rejected by the engineer. Otherwise, the employer has the right to employ and pay other persons to correct the defected work in case of default of contractor in compliance to the engineer's instructions. These clauses could be applied in cases of noncompliance to the green building requirements.

Clause (60.5) – “Retention Money” provides that a retention amount 10 percent shall be made in the interim payments, while clause (60.6) provides that upon the issue of TOC after the completion of the whole works 50 percent of the retained amount becomes payable to the contractor while the remaining 50 percent shall be payable when the

¹⁸⁷ Clause (7.2) provides that the contractor shall submit to the engineer for approval any drawings, specifications, and calculations designed by him for any permanent works as provided in the contract.

¹⁸⁸ clause (7.3) provides that approval of the contractor's submittals by the engineer shall not relieve the contractor of any of his responsibilities and liabilities under the contract

¹⁸⁹ The same clause (8.1) makes the engineer responsible and liable under his contract with the employer in case if the contractor did not discover any defects in the design or specifications while reviewing the contract's documents.

engineer issue the defects liability certificate for the whole works¹⁹⁰. This condition should be improved as recommended in chapter six as it does not protect the employer if the actual green building rating of the building is less than the proposed rating.

On the other hand, Abu General Services “Musnada”¹⁹¹ uses standard conditions of contract. The General and particular conditions, specifications and other tender documents of a construction contract provided by ‘Musnada’ for the construction of a community “Emirati Housing Neighborhood”, are obtained by approaching a construction company in Abu Dhabi, and the same documents are used here as a case study to find out the strength and weaknesses of contracts used for constructing projects owned by Abu Dhabi Government¹⁹² for implementing the green building requirements.

First, the contract agreement is formed of seven documents which shall be deemed to be read and construed as part of the contract with priority in the agreed sequence¹⁹³. The General conditions of this contract between the employer and the contractor contains of twenty two main clauses¹⁹⁴, in the same structure of the 1999 edition of the Red Book by FIDIC, with additional clauses (21) and (22).

The following conditions are selected to demonstrate the conditions of contract which deal with the allocation of risks, responsibilities of parties, and consequences of defected works, in order to find out how the standard contract of Abu Dhabi

¹⁹⁰ Dubai Municipality, Condition of Contract for Works of Civil Engineering Construction, [May 20, 1999]

¹⁹¹ Musnada was established by Law 27/2007 as public joint stock company to provide services to government entities, and to support Abu Dhabi Government on design and construction of projects owned by the government

¹⁹² <http://www.musanada.com/en/about-us/Pages/Musanada-Brief.aspx>

¹⁹³ The contract documents are listed in the following sequence:

- A. The Letter of Acceptance.
- B. The Letter of Tender along with Appendix to Tender.
- C. The Addenda.
- D. The conditions of contract.
- E. The specification.
- F. The drawings
- G. The completed schedule.

¹⁹⁴ These twenty two main clauses with the following titles: 1.General provisions, 2.The Employer, 3.The Engineer, 4.The Contractor, 5.Nominated Subcontractor, 6.Staff and Labor, 7.Plant, .Materials and Workmanship, 8.Commencement, Delays, and Suspension, 9.Tests on Completion, 10.Employer’s Taking Over, 11.Defects Liability, 12.Tests after Completion, 13.Variations and Adjustments, 14.Contract Price and Payment, 15.Termination by Employer, 16.Suspension and Termination by Contractor, 17.Risk and Responsibility, 18.Insurance, 19.Force Majeure, 20.Claims, Disputes and Arbitration, 21.Direct Agreement, and 22.Regulations.

Government could be applied for the execution of the owner's requirements to construct a sustainable community, and how the contract support the green building obligations:

First sub-clause (3.1) defines the engineer's responsibilities¹⁹⁵, and sub-clause (3.3) provides that the engineer has the right to issue additional or modified drawings or instructions as found necessary for executing the works and to remedy any defect, where the contractor shall comply with such instructions.

Then, clause (4) provides the contractor's general obligations and responsibilities including design¹⁹⁶ as specified in the contract, execution and completion of work, and remedying any defects in accordance with the contract and with the engineer's instructions¹⁹⁷. The contractor is responsible also to warrant the employer that design and execution works are carried out with reasonable care and diligence to ensure economic, safe, and efficient commercial operation of the works after completion to minimize interruption for repair and maintenance¹⁹⁸. Additionally, sub-clause (18.5)¹⁹⁹ makes the contractor obliged to provide insurance for design.

So, clauses 3 and 4 of this contract are the reference to any third party such as arbitrators to define the obligations of the two parties who are assigned by the employer for designing and executing his project and achieving his green building requirements. In my opinion, the responsibilities of the engineer and the contractor for designing and constructing a green building should be detailed in a separate annexure as a supplementary document to the contract. However, the same will be illustrated in

¹⁹⁵ This sub-clause provides that the engineer's approval, checking, certification, inspection, and tests all shall not relieve the contractor from his responsibilities including his responsibility for errors, omissions, discrepancies and non-compliances

¹⁹⁶ If the contractor shall design part of the permanent works which is specified in the contract, then he shall submit to the engineer this design. However, the contractor shall be responsible for this part in order to fit for the purposes for which such part is intended as specified in the contract.

¹⁹⁷ Musanada, *The General Conditions of Contract*

¹⁹⁸ Additionally, sub-clause (4.18) makes the contractor responsible to protect the environment during construction and to ensure that emissions shall not exceed the values specified in the contract and applicable Laws.

¹⁹⁹ Sub-clause (18.5) – "Insurance for Design" provides that the contractor shall provide professional indemnity insurance effective and maintained throughout the design, execution and completion of the works, and for a period of 12 years from the date specified in the TOC, where the limit of indemnity should cover any claims against the contractor in relation to his obligations concerning the design of the works.

chapter six as recommendations to strengthen the construction contracts for implementing the green building requirements.

Moreover, sub-clause (4.2) makes the contractor responsible to obtain a performance security for proper performance in the amount specified in the Appendix of Tender, and valid until the contractor complete the works and remedy any defects, where the employer shall return the performance security to the contractor after receiving a copy of the performance certificate²⁰⁰. In my opinion, this sub-clause is weak as the validity period of the performance security as defined in this sub-clause is not sufficient to protect the employer in case of failure in achieving the proposed green building targets. Chapter six will illustrate the recommended modifications to this condition.

On the other hand, the employer shall be responsible for any defect in the sustainable design or any other materials provided by him or his representative to the contractor to execute his vision and targets in accordance to sub-clause (4.20)²⁰¹ and sub-clause (17.3)²⁰².

Sub-clause (9.4) under clause (9)²⁰³ provides that in case of failure to pass tests on completions, the contract price shall be reduced by an amount to cover the reduced value to the employer as a result of this failure. Additionally, it is provided under clause (11)²⁰⁴ that if the defect or damage deprives the employer of substantially the whole benefit of the works or any major part of the works, the employer without prejudice to any other rights under the contract or otherwise recover all sums paid for the works or for such part in addition to the financing costs and any other cost of dismantling the

²⁰⁰ Musanada, *The General Conditions of Contract*

²⁰¹ Sub-clause (4.20) provides that the contractor shall not be liable for defects or default of materials provided free by the employer for the works as such defects may not be apparent to the contractor at the time of his visual inspection. In such a case, the employer is liable for any equipment and material provided by him, and he is liable to rectify any defect or default in the materials.

²⁰² Sub-clause (17.3) provides that the employer's risk include design of any part of the works

²⁰³ Clause (9) makes the contractor responsible to carry out tests on completion, and to submit a certified report of the results to the engineer, and to repeat the test at his cost if failed.

²⁰⁴ Clause (11) – "Defects Liability" provides that the contractor shall execute all work required to remedy damage or defects stayed in the TOC at his risk and cost before the expiry date of the defects notification period. Otherwise, the employer may carry out the work himself or by others at the contractor's cost if the contractor failed to do so but the contractor shall not be responsible for such work.

defected work, clearing site, and return to the contractor, while sub-clause (11.5)²⁰⁵ provides that the employer's consent for removing a defective part of the works²⁰⁶ may require the contractor to increase the amount of the performance security by the full replacement cost of these items, or to provide other appropriate security²⁰⁷. Moreover, sub-clause (14.3)²⁰⁸ provides that the engineer has the right to withhold certification of the estimated cost of any work which remains to be executed under the "defects liability" clause until such work has been executed²⁰⁹. These conditions make the contractor obliged to make the defected work correct, and could be applied to compensate the employer in case of non-compliance with the green building specified standards or if the actual building's performance is found less than the proposed and designed green building targets.

Finally, sub-clause (17.6)²¹⁰ of the general conditions of contract provides that neither party shall be liable to the other party for loss of use of any work, loss of profit, loss of any contract or for any indirect or consequential loss or damage which may be suffered by the other party in connection with the contract except for the cases of payment on termination and indemnities towards persons and any property under sub-clause (17.1).

On the other hand, the particular conditions of this contract include amendments to the general conditions, and additional clauses. The following particular conditions are selected:

²⁰⁵ Musanada, *The General Conditions of Contract*

²⁰⁶ Sub-clause (11.5) states that if the defect or damage cannot be remedied expeditiously on the site, then the contractor may remove from the site upon the employer's consent for the repair of the defective items.

²⁰⁷ Sub-clause (11.10) provides that the contract shall be deemed to remain in force after the issuance of the performance certificate, where each party shall remain liable to fulfill his obligation which remains unperformed at that time.

²⁰⁸ Sub-clause (14.3) – "Application for Interim Payment Certificates" provides that amounts payable every month are based on the progress of work considering any deductions including deduction for retention in the same percentage stated in the Appendix to Tender, while sub-clause (14.9) provides that the retention money shall be certified by the engineer for payment to the contractor after the latest of the expiry dates of the defects liability period for works excluding Mechanical and Electrical works and for Mechanical and Electrical works respectively.

²⁰⁹ Musanada, *The General Conditions of Contract*

²¹⁰ "Limitation of Liability"

Sub-clause (1.13) makes the contractor obliged to obtain all the necessary approvals from authorities²¹¹. Moreover, it provides that the executions of the works and completed works shall comply with the Laws and the applicable specifications, technical standards, building codes, construction and environmental regulations in the UAE and the Emirate of Abu Dhabi, in addition to the compliance with codes of practice, regulations applicable to the product being produced from the works and the standards specified in the design²¹². So, the contractor shall comply with the applicable green building code and standards²¹³.

Sub-clause (18.5) – “Insurance for Design” is amended to make the contractor responsible to maintain a project specific professional indemnity insurance covering all its liability without limitation.

Finally, the specifications provided with this contract include volume as general requirements, and other volumes which include the particular specification of “Sustainability Estidama Requirements”²¹⁴, and “Sustainable Design Guide”. Section (01010) includes Estidama requirements for the project in general, while section (01600) includes Estidama requirements for materials. It is provided under section the former section that the contractor shall execute the work in compliance with all applicable PCRS²¹⁵ requirements where the required PCRS credits are described. On the other hand, the sustainable design guide includes section for “sustainable construction guide line” where the section describes general requirements and procedures to comply with Estidama Pearl Rating (2 Pearls), stating that the project shall comply with the requirements of all credits fulfilled during the design stages as clarified in the “Scorecard” which is attached to the specification as Appendix 1.

²¹¹ Sub-clause (1.13) provides that the contractor shall obtain all permits, licenses and approvals as required by any Authority and any Laws in relation to the design, execution, and completion of the works and the remedying of any defects including any municipality completion certificates and approvals of all installations from relevant authorities which are necessary for the intended use and occupation of the works and which are not under the employer’s responsibility.

²¹² Musanada, *The particular conditions of contract*

²¹³ Additional clause (23) – “Standards” provides that all standards and codes of practice referred in the specification, Drawings and other contract documents shall be references to the most recent editions.

²¹⁴ DORSCH CONSULTANT, *General Requirements, construction of Emirati HoUsing Neighborhood (306 villas)*, [June, 2017].

²¹⁵ The Pearl Community Rating System

5.2. Law enactment and regulations

The following Articles are extracted from different sections of the UAE Civil Transaction Code to find out the how are the following relations are regulated by the Law in UAE:

1. The employer and the contractor.
2. The employer and the architect.
3. The seller and the purchaser, who are the employer and the tenant.

In regards to the relation between the employer and the contractor, and between the employer and the architect, the following Articles can be applicable to define their obligations towards each other:

- Part (2) of Articles (141) and (246) may apply in the case if the parties agreed on the targeted green building rating without specifying detailed requirements in the contract.
- Article (42) provides that harm shall be made good, while Article (282) states that any harm done to another shall render the doer, even though not a person of discretion, liable to make good the harm.
- Article (300) provides that a person who caused damage to a property shall be obliged to make it good. Moreover, Article (301)²¹⁶ is found as a very strong reference which could be used to compensate the employer with the running costs resulted from the differences in the cost between the proposed consumption and the actual consumption of energy and water. Employer could be compensated also for any losses resulting from the contractor's non-

²¹⁶ Article (301) stipulates that in case of partial damage, the person causing the damage shall be bound to make good the decrease in value, and if such decrease in value is serious then the owner of the property may either to take the equivalent of the decrease in the value or to abandon the damaged property and take the full value thereof, subject to the general provisions relating to indemnifications.

compliance with the green building requirements by applying Article (389)²¹⁷ and Article (390)²¹⁸.

- Article (887) stipulates that the contractor must complete the work in accordance with the conditions of the contract, and gives the right to the employer to terminate the contract immediately if the contractor carried out the work in defective manner and it is impossible to make good the defected works²¹⁹.
- Article (880) states that the architect who made the plans and the contractor who carry out the work under the architect's supervision be jointly liable for a period of ten years or any other longer period, to compensate the employer for any partial or total collapse of the building which has been constructed, and for any defect which threatens the safety and stability of the building²²⁰. This Article could be modified to support the green building obligations as recommended in chapter 6.

On the other hand, the following Articles regulate the relation between the sellers and purchasers or parties entered a lease contract:

- Article (516) obliges the seller to deliver the goods sold to the purchaser in the same condition as they were at the time of sale. This Article could be applied to regulate the relation between the employer as seller and tenants as purchasers in case of selling a property off plan.

²¹⁷ Article (389) provides that the judge shall assess the amount of compensation in an amount equivalent to the actual damage suffered at the time of occurrence, if the amount of compensation is not fixed by law or by the contract.

²¹⁸ Article (390) provides that even if the amount of compensation is fixed between the contracting parties in the contract, the judge may in all cases vary such agreement in order to make the compensation equal to the loss, upon the request of either of the parties.

²¹⁹ The Articles provides also that the contractor shall repair the work within a reasonable period, if it is possible to make good the work. Moreover, if the contractor failed to repair the work within the reasonable time, then the employer will have the right to engage another contractor to complete the work at the expense of the first contractor.

²²⁰ Article (881) makes the architect liable for the defects in design only if he is not responsible to supervise the execution work.

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- Article (494) – part (2) provides that the seller shall be obliged to give the buyer the opportunity to test the goods, while Articles (543) – (555) provides different cases to regulate the relation between the seller and the purchasers in case of old defects and new defects in the goods, which give the right to the purchaser for reduction in the price caused by the defect.

 - Article (773) provides that it is permissible for the lessee to require that the contract be cancelled or that the rent be reduced, and to claim for any loss suffered by him as a result of a defect which prevented the lessee from enjoying the thing leased. So, the lessee can reduce the rent if the property or the community were not complying with the green building specifications included in the lease contract. In such a case, the property owner should be able to claim the difference in rates from the contractor and/or the architect provided that they are in default in fulfilling green building obligations.

 - Finally, Article (776) makes the lessee obliged to preserve the thing hired with care of reasonable man who shall be liable for any damage or loss arising out of his default or wrongful act.

5.3. Analysis to find out the strength and weaknesses of the existing instruments

The first instruments are the standard construction contracts used by the governmental authorities.

The Dubai Municipality is using the FIDIC general conditions of the Red Book 1987 as a base for its standards contracts between the employer and the contractor. The conditions of contract makes the contractor obliged to comply with the regulations of Dubai Municipality, and contract documents including specification which may contain particular specifications. Article (8.1) obliges the contractor to comply with the green building targets and measures included in the general and particular specifications of the contract, and to execute the work in accordance to the regulations of Dubai Municipality including AL SA'AFAT.

Based on clauses (10.1) and (60.5)²²¹ of the Dubai Municipality standard contract, the employer holds 15%²²² of the contract value which might be not sufficient as compensation if green building rating is assessed and found less than the designed and proposed targets, taking in to consideration that performance of the building should be monitored and evaluated for two years when occupied by tenants. So, improvements to these clauses are recommended as illustrated in chapter six.

On the other hand, the standard contract by Musanada is found efficient as an instrument for implementing the green building requirements where the strength is found in Sub-clauses (4.18), (9.4), Clause (11) including sub-clause (11.5) in particular and sub-clause (11.10), Sub-clause (18.5), and sub-clause (1.13) as amended in the particular conditions.

Moreover, separate volumes are provided to specify sustainability requirements, and sustainable design guide, while requirements of all credits fulfilled in the design stage are clarified in the “scorecard” which is a part of the contract.

However, weaknesses are found in sub-clause (4.2) as illustrated above under section 5.1 and sub-clause (17.6) where liability of parties is limited. Sub-clause (17.6) will not support the employer if he suffered running losses resulting from the low performance of the building caused by the contractor and/or the architect.

The second instrument is Law enactment, including articles of Law in UAE which enforce the conditions of contracts, and enforce the implementation of the green building standards and regulations. Articles of UAE Civil Transaction Code are demonstrated above, where strength is found in Articles (141), (246), (300), (390), (516), (543) – (555), and (773).

It is found that provisions of UAE Civil Transaction Code are efficient in regulating the relation between parties either in a construction contract or a lease contract where responsibilities and obligations are well defined along with their liabilities. However, recommendations to improve some articles will be illustrated in chapter 6 where such

²²¹ As demonstrated under section 5.1, the employer hold performance security in the sum of 10 percent of the contract’s price valid until NOCs from Authorities are obtained with a copy of the defects liability certificate, and retain 10 percent of the value of work done which to be paid in two halves where the second half representing 5% of the contract price is payable when the engineer issue the defects liability certificate for the whole works.

²²² 5% represents second half of retention, and 10 % by encashment of the performance bank guarantee

improvement may support the implementation of the green building standards and regulations in the UAE.

Moreover, the Civil Transaction Code doesn't include provisions regulating the green building obligations, while the Environmental Law doesn't regulate the following issues:

1. Carbon emission associated with building operation, and resulting from construction work.
2. Ozone depletion and climate change resulting of using refrigerants with ozone depletion potential and global warming potential which are not in compliance with standards.
3. Consumption of energy and water in percentages and rates against the sustainability strategic plan and vision in the UAE.

The general principles of the Federal Law No. 24 of 1999 are demonstrated under section 3.4. After analyzing the nine chapters of the Environmental Law, it is found that there is no legally binding cap on carbon emissions²²³.

Moreover, Article (9) of the Law stipulates that parties responsible for planning, economic, and construction development shall consider aspects of protection of environment, control of pollution, and rational use of natural resources. However, the Law doesn't include a chapter to regulate the consumption of energy and to make the parties in a construction development obliged to generate power using renewable sources of energy. Additionally, chapter 2 provides Articles for the protection of drinking water and underground water, but no Articles to regulate the consumption of drinking water and wastage of water. Similarly, chapter 4 provides ten Articles for the protection of air from pollution but doesn't include articles to control the emission of carbon and usage of harmful refrigerants. Accordingly, the current Environmental Law shall be updated for achieving the strategic plans and green building visions established by the Governmental authorities in the UAE.

²²³ M. Kerr, D. Ryburn, B. McLaren, and Zehra, Construction and projects in United Arab Emirates: Overview,[2013/2014]
www.practicallaw.com/1-519-3663

Chapter 6

Recommended conditions of contracts to resolve disputes and allocate the risk of parties' failure to implement the green building requirements

6.1. Risk and Disputes arise between parties

Owners aim the higher selling price and rental rates, less operational costs, while tenants and consumers seek for energy efficient building to reduce the running electricity bills, and for healthier life style and environment. Accordingly, owners develop projects requiring goals which need certain measures and techniques that to be designed and executed by the architect and the contractor respectively to fulfill the tenants' desires²²⁴. Owner's goals and tenants' desires include the following:

1. Reduction in consumption of energy.
2. Reduction in consumption of water.
3. Reduction of Co2 emission.
4. Indoor air quality and thermal comfort.
5. Minimizing air pollution.
6. Long life cycle for the building.
7. Variety of housing types and sizes.

Disputes may arise if the architect and /or the contractor failed to achieve any of the owner's goals by a wrongful act causing damages and losses to the owner. Here, owners suffer either a fixed loss equal to the cost of making the building incompliance with the goals specified in the contract documents or running losses including reduction in selling price and rental rates, and higher operational cost if the defect could not be fixed.

On the other hand, tenants or buyers may raise a claim against the owner due to their dissatisfaction with the sold or rented property if it is not complying with the specification represented in the contract. They have the right to cancel the contract or to

²²⁴ D.Prum & S. Del Percio, *Green Building Claims: What Theories Will a Plaintiff Pursue, Who Has Exposure, and A Proposal for Risk Mitigation*, [US]

reduce the rent or to claim for any loss suffered by them as stipulated by Article (773) of UAE CTC²²⁵.

6.2. Risk allocation

Owner's risk include the selected procurement method to design and construct his project and type of contract , use of standards forms of construction contracts which are not updated to suit the green building requirements, defining his goals to the architect and/or the contractor, provision of free materials to the contractor, contracts with third parties for certain provisions such as the generation of renewable energy at site, selling the properties based on a certain green building rate before assessment and certification, renting the property relying on green building certification which is not achieved.

Architect's risk include the preparation of project's specification and sustainability plan, communicating alternative techniques and measures with the owner to plan and design his requirements, default and errors in design and sustainability plan, and supervision of the work.

On the other hand, contractor's risk include the execution of the owner's and engineer's vision, procuring materials from responsible sources and suppliers, assigning work to subcontractors, submission of collateral warranties and guarantees, documentation required for green building assessment, awareness of the latest applicable green building regulations and new codes.

6.3. Recommended Conditions of contracts

Referring to the green building standards and regulations, and conditions of standards construction contracts as demonstrated under the sections of chapters 2, 3, 4, and 5, the following conditions are recommended to be included in the construction contracts when the proposed project require high green building rating:

First, it is recommended to the employer to assign the whole design and construction works to a contractor by entering design-build or turnkey contract, in order to shift the risk to one party being responsible to achieve the employer's requirements and vision. In such a case, the contractor shall purchase professional indemnity insurance for errors and omissions in sustainability design and plan.

²²⁵ The Civil Transaction Code

Second, it is recommended to add a sustainability agreement as part of the contract documents as an exhibit as applied by AIA contracts for sustainable projects as demonstrated under section 4.1 instead of including the sustainability goals and standards with the specifications which is the case of UAE governmental contracts. Such sustainability agreement is found necessary to define the employer's vision and the applied green building assessment system, the required rating level, and the sustainability plan including the measures and techniques specified to achieve the sustainability goals.

The recommended sustainability agreement shall define the performance targets defined and agreed between the employer, design engineer, and contractor and their services and responsibilities in two cases; (i) when the employer assign the design works to an architect and assign the execution works to the contractor through separate construction contract such as The Red Book 1999 by FIDIC, or (ii) when the employer assign the whole works to a contractor using a design-build contract such as The Yellow Book. For the first case, this sustainability agreement to be signed by the three parties of the project; the employer, the architect, and the contractor, and for the second case to be signed by the employer and the contractor.

Third, the sustainability agreement shall include a condition obliging the employer to enter a contract between him and energy supplier for the generation of electricity from renewable energy source only, as specified by both BREEAM standards and PCRS under sections 2.2 and 2.4.1 respectively.

Forth, the following additional conditions and improvement to the existing conditions of the standard construction contracts are recommended:

1. The employer shall enter a contract between him and energy supplier for the generation of electricity from renewable energy source only, where such contract shall be valid for three years at least from the date when the building becomes occupied with tenants, and shall include the annual purchase amount and the source of the renewable energy with confirmation that the annual purchases are sufficient for the community infrastructure energy consumption during the period of this contract.

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2. Referring to sub-clause (Z2.9) of the NEC contract as demonstrated under section 4.2, and Article (516) of the UAE CTC, conditions of contracts for sustainable projects shall provide that:

‘The employer is obliged to deliver the property sold to the purchaser in the same specifications as they were at the time of sale before construction; off plan, therefore, if the contractor failed to handover the works in compliance to the specified green building goals and rating and/or if the actual performance is below the minimum acceptable level specified in the works information, then, the employer can be compensated in the amount equivalent to the differences in rental rates or selling price, and difference between the actual operational cost and the proposed operational cost of the building including the cost of the annual consumption of energy and water which exceeds the proposed consumption’.

3. Referring to clause (83) of NEC contract demonstrated under section 4.2, and sub-clause (17.6) of construction contracts by Musanada as demonstrated under section 5.1, “Limitation of Liability” clause²²⁶ is found weak and should be improved to make each party liable to the other party, and to include any consequential losses resulting from the nonconformity with green building requirements which remains without compliance.
4. Referring to the assessing and commissioning criteria specified by PCRS and BREEAM under sections 2.4.1 and 2.2 respectively, conditions of contracts for sustainable projects shall provide that:

- (a) ‘The contract shall be deemed to remain in force for two years after the issuance of the performance certificate, where each party shall remain liable to fulfill his obligation which remains unperformed at that time, and to evaluate the performance of the building for achieving the proposed

²²⁶ “Limitation of Liability” clause included in standard contracts provides that neither party shall be liable to the other party for loss of use of any work, loss of profit, loss of any contract or for any indirect or consequential loss or damage which may be suffered by the other party in connection with the contract except for the cases of payment on termination and indemnities towards persons and any property.

consumption of energy and water during the operational period when the building is occupied by tenants’.

- (b) The contractor shall assess the performance of the building after two years at least from the construction completion and when the project becomes 80% occupied, or for such a period to carry out seasonal commissioning process through twelve months at least, once the building is occupied by tenants to collect data from actual annual building water and energy consumption after occupation, and to review occupant’s satisfaction towards thermal comfort, lighting and ventilation.
5. Based on Articles (102.02) and (102.03) of AL Sa’afat regulations demonstrated under section 3.3, conditions of contracts for sustainable projects shall provide the following as well:
- (a) “The “Energy compliance method” shall be carried out by an approved third party assigned by the contractor to evaluate the annual consumption of energy of the proposed building in comparison to the base line building. The Proposed Building’s Performance improvement can be calculated using the following formula:
- $$\text{Percentage Improvement} = (100 \times (\text{Baseline Building Performance in Kwh/yr} - \text{Proposed Building Performance in Kwh/yr})) / (\text{Baseline Building Performance in Kwh/yr}^{227})’.$$
- (b) The “Water Compliance Method” shall be carried out by an approved third party assigned by the contractor to evaluate the building’s compliance with the elemental requirements for water efficient fixtures by comparing the annual water consumption of the proposed building with the consumption of the base line building.
6. The contractor shall provide additional performance security to the employer in the sum of 20 percent of the contract price and in the form of an unconditional bank guarantee from an approved bank, and shall be valid for two years after the

²²⁷ Kilo watt hour per year

issuance of the performance certificate for assessing building's performance and for any other latent defects after the issuance of the performance certificate. This performance security shall be submitted when the employer return to the contractor the original performance bond when the engineer issue the performance certificate after the successful completion of the defects liability period.

7. When the employer assigns the whole works to a contractor using a design-build contract, "Insurance for Design" clause is recommended to oblige the contractor to provide professional indemnity insurance effective and maintained throughout the design, execution and completion of the works, and for a period of 12 years at least from the date specified in the TOC/performance certificate, where the limit of indemnity should cover any claims up to amount equal to the project value against the contractor resulting from error, omission, or deficiency in the design of the works including sustainable design and specifications.

6.4. Improvement of the existing instruments in UAE

Referring to the different regulations demonstrated under the sections of chapter 3, and Articles of UAE Law demonstrated in chapter 5, improvements to the existing regulations and Articles of Law in UAE are recommended for better implementation to the green building mandatory requirements, as follows:

1. Sustainability measures established and specified in the sustainability agreement between parties in a construction project shall be submitted to the Municipality and recorded as sustainability requirements while applying for the building permit. Accordingly, Building Completion Certificate shall not be issued if the proposed building did not comply with sustainability measures recorded with the municipality²²⁸. Moreover, Municipality shall assign accredited energy assessor to test new buildings, and to issue 'Energy Performance Certificate'.
2. In case of contravention with regulations, and failure of project's parties to comply with the building regulations, the local authority covering the area where the building work is carried out has the power to notify the parties formally to enforce the regulations. If contravention is made by the contractor, then the local

²²⁸ These recommendations is based on the regulations of the UK as demonstrated under section 3.2, and Article 2 of AIA sustainable project contract document under section 4.1.

authority may approach the applicable court to impose fines in accordance to the applicable Law, if defected works remained uncorrected. On the other hand, the authority may raise an enforcement notice to the owner to remove the building works which are not complying with the regulations. If no compliance by the owner with such notice, then the local authority can undertake the work on behalf of the owner and recover the cost of rectifying the work from the owner²²⁹.

3. LEED, BREEAM, and Estidama are not governmental regulations. However, they shall have legally binding implications if they are referred to by governmental entities or by governmental executive orders and rules²³⁰.
4. It is recommended to add part (2) to Article (880)²³¹ of the UAE CTC to include nonconformity with green building regulations, stipulating that
“the architect who made the plans and the contractor who carry out the work under the architect’s supervision shall be jointly liable for a period of two years if the performance of the building is assessed and found below the proposed green building targets agreed between parties, provided that the building is 80 % occupied by tenants within this period, to compensate the employer for losses resulting from any of the following cases:
 - (i) Consumption of energy exceeding the targets proposed for the building,
 - (ii) Consumption of water exceeding the targets proposed for the building,
 - (iii) Defects which affect the quality of indoor air for the building, and thermal comfort of occupiers.
 - (iv) Defects which affect outdoor air and the environment.

²²⁹ The same is applied by the Building Act 1984 in the UK as demonstrated under section 3.2

²³⁰ This recommendation is based on the same concept as demonstrated under section 3.1 for the implementation of green building regulations in the U.S.

²³¹ Article (880) states that the architect who made the plans and the contractor who carry out the work under the architect’s supervision be jointly liable for a period of ten years or any other longer period, to compensate the employer for any partial or total collapse of the building which has been constructed, and for any defect which threatens the safety and stability of the building.

7. CONCLUSION

The dissertation demonstrated the green building standards and regulations applied in the UAE in comparison to BREEAM and LEED standards and mandatory regulations in UK and US. The Pearl rating system by Estidama is found similar to LEED rating system, but limited only to communities, new buildings and villas. It is recommended to apply federal green building regulations in the UAE instead of applying a separate regulation for each emirates where the same is applied in US where Los Angeles apply the same green building code of California. Moreover, it is found that the process of obtaining the building permits and building completion certificates from the local authorities should be improved in the same way as applied in US and UK in order to strengthen the implementation of the green building goals.

The dissertation demonstrated the conditions of the existing standard construction contracts and Governmental contracts in the UAE, where it is found that improvements to the existing conditions and forming additional conditions to the standard contracts is required in order to close the gaps in allocating the risks between the parties who are involved to construct a sustainable project, and to define each party liabilities and methods to compensate the employer in cases of disputes such as noncompliance with the designed and proposed savings in consumption of water and energy, and Claims raised by the subsequent buyers of the property against the employer.

The dissertations investigated the strength and weaknesses of the Environmental Law and Civil Transaction Code in the UAE, where it is found that the Environmental Law needs to be updated in order to impose power for implementing the sustainability strategies of the Government. Moreover,

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9. WORD COUNT

Word Count: 22,099

APPENDIX – A

Table - 1²³²: BREEAM Communities 2012 category aims and weightings

Category	Aim	Weighting
Governance	Promotes community involvement in decisions affecting the design, construction, operation and long-term stewardship of the development.	9.3%
Social and economic wellbeing	Local economy: To create a healthy economy (employment opportunities and thriving business).	14.8%
	Social wellbeing: To ensure a socially cohesive community.	17.1%
	Environmental conditions: To minimize the impacts of environmental conditions on the health and wellbeing of occupants.	10.8%
Resource and energy	Addresses the sustainable use of natural resources and the reduction of carbon emissions.	21.6%
Land use and ecology	Encourages sustainable land use and ecological enhancement.	12.6%
Transport and movement	Addresses the design and provision of transport and movement infrastructure to encourage the use of sustainable modes of transport.	13.8

²³² This table is copied from BREEAM communities 2012

Table - 2²³³: Governance assessment issue weightings

Governance assessment issue	Weighting	Credits available	Value of each credit
GO 01 - Consultation plan	2.3%	1	2.3%
GO 02 - Consultation and engagement	3.5%	2	1.7%
GO 03 - Design review	2.3%	2	1.2%
GO 04 - Community management of facilities	1.2%	3	0.4%

²³³ This table is copied from BREEAM communities 2012

Table - 3²³⁴: Social and economic wellbeing assessment issue weightings

Category	Social and economic wellbeing issues	Weighting	Credits available	Value of each credit
Local economy	SE 01 - Economic impact	8.9%	2	4.4%
Local economy	SE 17 - Training and skills	5.9%	3	2%
Social wellbeing	SE 02 - Demographic needs and priorities	2.7%	1	2.7%
Social wellbeing	SE 05 - Housing provision	2.7%	2	1.4%
Social wellbeing	SE 06 - Delivery of services, facilities and amenities	2.7%	7	0.4%
Social wellbeing	SE 07 - Public realm	2.7%	2	1.4%
Social wellbeing	SE 09 - Utilities	0.9%	3	0.3%
Social wellbeing	SE 11 - Green infrastructure	1.8%	4	0.5%
Social wellbeing	SE 12 - Local parking	0.9%	1	0.9%
Social wellbeing	SE 14 - Local vernacular	0.9%	2	0.5%
Social wellbeing	SE 15 - Inclusive design	1.8%	3	0.6%
Environmental conditions	SE 03 - Flood risk assessment	1.8%	2	0.9%
Environmental conditions	SE 04 - Noise pollution	1.8%	3	0.6%
Environmental conditions	SE 08 - Microclimate	1.8%	3	0.6%
Environmental conditions	SE 10 - Adapting to climate change	2.7%	3	0.9%
Environmental conditions	SE 13 - Flood risk management	1.8%	3	0.6%
Environmental conditions	SE 16 - Light pollution	0.9%	3	0.3%

²³⁴ This table is copied from BREEAM communities 2012

Table - 4²³⁵: Resources and energy assessment issue weightings

Resources and energy assessment issue	Weighting	Credits available	Value of each credit
RE 01 - Energy strategy	4.1%	11	0.4%
RE 02 - Existing buildings and infrastructure	2.7%	2	1.4%
RE 03 - Water strategy	2.7%	1	2.7%
RE 04 - Sustainable buildings	4.1%	6	0.7%
RE 05 - Low impact materials	2.7%	6	0.5%
RE 06 - Resource efficiency	2.7%	4	0.7%
RE 07 - Transport carbon emissions	2.7%	1	2.7%

²³⁵ This table is copied from BREEAM communities 2012

Table - 5²³⁶: Land use and ecology assessment issue weightings

Land use and ecology assessment issue	Weighting	Credits available	Value of each credit
LE 01 - Ecology strategy	3.2%	1	3.2%
LE 02 - Land use	2.1%	3	0.7%
LE 03 - Water pollution	1.1%	3	0.4%
LE 04 - Enhancement of ecological value	3.2%	3	1.1%
LE 05 - Landscape	2.1%	5	0.4%
LE 06 - Rainwater harvesting	1.1%	3	0.4%

²³⁶ This table is copied from BREEAM communities 2012

Table - 6²³⁷: Transport and movement assessment issue weightings

Transport and movement assessment issues	Weighting	Credits available	Value of each credit
TM 01 - Transport assessment	3.2%	2	1.6%
TM 02 - Safe and appealing streets	3.2%	4	0.8%
TM 03 - Cycling network	2.1%	1	2.1%
TM 04 - Access to public transport	2.1%	4	0.5%
TM 05 - Cycling facilities	1.1%	2	0.5%
TM 06 - Public transport facilities	2.1%	2	1.1%

²³⁷ This table is copied from BREEAM communities 2012

Table 7²³⁸: Type of buildings that can be assessed using the BREEAM 2011 New Construction scheme

Sector	Building type	Description
Commercial	Offices	<ul style="list-style-type: none"> - General office buildings - Offices with research and development areas (i.e. category 1 labs only)
	Industrial	<ul style="list-style-type: none"> - Industrial unit – warehouse storage/distribution - Industrial unit – process/manufacturing/vehicle servicing
	Retail	<ul style="list-style-type: none"> - Shop/shopping Centre - Retail park/warehouse - ‘Over the counter’ service provider e.g. financial, estate and employment agencies and betting offices - Showroom - Restaurant, cafe & drinking establishment - Hot food takeaway
Public (non-housing)	Education	Pre-School Schools and Sixth Form Colleges Further Education/Vocational Colleges Higher Education Institutions
	Healthcare	Teaching/specialist hospitals General acute hospitals Community and mental health hospitals

²³⁸ This table is copied from BREEAM New construction Non domestic building, Technical Manual, SD5073-2.0:2011

		GP surgeries Health centres and clinics
	Prisons	High security prison Standard secured prison Young offender institution and juvenile prisons Local prison Holding centre
	Law Courts	Crown & criminal courts County courts Magistrates' courts Civil justice centres Family courts Youth courts Combined courts
Multi-residential accom- modation/Supported living facility	Residential institutions	Residential care home Sheltered accommodation Residential college/school (halls of res-idence) Local authority secure residential accom-modation Military barrack
Other	Residential Institutions	Hotel, hostel, boarding and guest house Secure training centre Residential training centre
	Nonresidential institutions	Art gallery, museum Library Day centre, hall/civic/community centre Place of worship
	Assembly and leisure	Cinema

		Theatre/music/concert hall Exhibition/conference hall Indoor or outdoor sports/fitness and recreation (with/without pool)
	Other	Transport hub (coach/bus station and above ground rail station) Research and development (cat 2 or 3 labs - Non Higher Education) Crèche

Table 8: BREEAM 2011 New Construction environmental sections and assessment issues²³⁹:

Section	Assessment issues
1.Energy	2.Water
Reduction of CO2 emissions	Water consumption
Energy monitoring	Water monitoring
Energy efficient external lighting	Water leak detection and prevention
Low or zero carbon technologies	Water efficient equipment (process)
Energy efficient cold storage	3.Waste
Energy efficient transportation systems	Construction waste management
Energy efficient laboratory systems	Recycled aggregates
Energy efficient equipment (process)	Operational waste
Drying space	Speculative floor and ceiling finishes
4.Transport	5.Materials
Public transport accessibility	Life cycle impacts
Proximity to amenities	Hard landscaping and boundary protection
Cyclist amenities	Responsible sourcing of materials
Maximum car parking capacity	Insulation
Travel plan	Designing for robustness
6.Land use and ecology	7.Pollution
Site selection	Impact of refrigerants
Ecological value of site/protection of eco-logical features	NOx emissions
Mitigating ecological impact	Surface water run-off
Enhancing site ecology	Reduction of night time light pollution
Long term impact on biodiversity	Noise attenuation
8.Health and wellbeing	9.Management
Visual comfort	Sustainable procurement
Indoor air quality	Responsible construction practices
Thermal comfort	Construction site impacts
Water quality	Stakeholder participation
Acoustic performance	Service life planning and costing
Safety and security	10.Innovation
	New technology, process and practices

²³⁹ This table is copied from BREEAM New construction Non domestic building, Technical Manual, SD5073-2.0:2011

Table 9²⁴⁰: BREEAM rating benchmarks

BREEAM Rating	% score
OUTSTANDING	≥ 85
EXCELLENT	≥ 70
VERY GOOD	≥ 55
GOOD	≥ 45
PASS	≥ 30
UNCLASSIFIED	< 30

²⁴⁰ This table is copied from BREEAM New construction Non domestic building, Technical Manual, SD5073-2.0:2011

Table 10²⁴¹: specifies benchmark scale²⁴² :

BREEAM credits	BREEAM credits	BREEAM credits
1	0.06	Requires a performance improvement progressively better than the notional building level (as defined in the 2010 version of the Building Regulations, Part L2a).
2	0.12	
3	0.18	
4	0.24	
5	0.30	
6	0.36	BREEAM Excellent requires a minimum EPRNC of 0.36 (6 credits) and a 25% reduction in CO2 emissions arising from regulated building energy consumption.
7	0.42	
8	0.48	
9	0.54	
10	0.6	BREEAM Outstanding requires a minimum EPRNC of 0.60 (10 credits) and a 40% reduction in CO2 emissions arising from regulated building
11	0.66	

²⁴¹ This table is copied from BREEAM New construction Non domestic building, Technical Manual, SD5073-2.0:2011

²⁴² The achieved (EPR_{NC}) should be compared to assess the building's operational energy performance and Co2 emission

12	0.72	energy consumption
13	0.78	
14	0.84	
15	0.9	15 credits require a minimum EPRNC of 0.90 and a 100% reduction in CO2 emissions arising from regulated building energy consumption i.e. zero net CO2 emissions.

Table 11 ²⁴³ : Housing Categories as copied from LEED V4 Neighborhood development where categories are defined by the net floor area of dwelling units without considering the garage area:

Type	Square feet	Square meters
Detached residential, large	> 1,250	> 116
Detached residential, small	≤ 1,250	≤ 116
Duplex or townhouse, large	> 1,250	> 116
Duplex or townhouse, small	≤ 1,250	≤ 116
Dwelling unit in multiunit building with no elevator, large	> 1,250	> 116
Dwelling unit in multiunit building with no elevator, medium	> 750 to ≤ 1,250	> 70 to ≤ 116
Dwelling unit in multiunit building with no elevator, small	≤ 750	≤ 70
Dwelling unit in multiunit building with elevator, 4 stories or fewer, large	> 1,250	> 116
Dwelling unit in multiunit building with elevator, 4 stories or fewer, medium	> 750 to ≤ 1,250	> 70 to ≤ 116
Dwelling unit in multiunit building with elevator, 4 stories or fewer, small	≤ 750	≤ 70
Dwelling unit in multiunit building with elevator, 5 to 8 stories, large	> 1,250	> 116
Dwelling unit in multiunit building with elevator, 5 to 8 stories, medium	> 750 to ≤ 1,250	> 70 to ≤ 116
Dwelling unit in multiunit building with elevator, 5 to 8 stories, small	≤ 750	≤ 70
Dwelling unit in multiunit building with elevator, 9	> 1,250	> 116

²⁴³ This table is copied from LEED V4 Neighborhood development

stories or more, large		
Dwelling unit in multiunit building with elevator, 9 stories or more, medium	> 750 to $\leq 1,250$	> 70 to ≤ 116
Dwelling unit in multiunit building with elevator, 9 stories or more, small	≤ 750	≤ 70
Live-work space, large	$> 1,250$	> 116
Live-work space, small	$\leq 1,250$	≤ 116
Accessory dwelling unit, large	$> 1,250$	> 116
Accessory dwelling unit, small	$\leq 1,250$	≤ 116

Table 12²⁴⁴: Credit requirements for each section

Credit Section	Maximum Credit Points
IDP – Integrated Development Process	10
NS – Natural Systems	14
LC - Livable Communities	38
PW – Precious Water	37
RE – Resourceful Energy	42
SM – Stewarding Materials	18
IP – Innovating Practice	3
TOTAL	159

²⁴⁴ This table is copied from The Pearl Rating System for Estidama, Community Rating System, Design and Construction, version 1.0, April, 2010.

Table 13²⁴⁵: Minimum Shading Requirements

Public Realm Space Minimum % shading	Public Realm Space Minimum % shading
Exterior Surface Car Parking with more than 10 spaces (including parking on roof surfaces)	50%
Public Open Spaces	60%
Primary Pedestrian Walkways (based on 1.8m width) within the through zone	75%
Secondary Pedestrian Walkways (based on 1.8m width) within the through zone	75%
Cycle Tracks	50%
Playgrounds	90%

²⁴⁵ This table is copied from The Pearl Rating System for Estidama, Community Rating System, Design and Construction, version 1.0, April, 2010.

Table 14²⁴⁶: Outdoor thermal comfort requirements

	Percentage shading threshold			
Public Realm space	1 credit point	2 credit point	3 credit point	1 credit point
Exterior Surface car parking with more than 10 spaces (including parking on roof surfaces)	50%	55%	60%	Two heat purge strategies
Public Open Space	65%	70%	75%	
Primary Pedestrian Walkway (based on 1.8m width within the through zone)	80%	85%	90%	
Secondary Pedestrian Walkway (based on 1.8m width within the through zone)	80%	85%	90%	
Cycle tracks	55%	65%	75%	

²⁴⁶ This table is copied from The Pearl Rating System for Estidama, Community Rating System, Design and Construction, version 1.0, April, 2010.

Table 15²⁴⁷: Average Building Rating

CREDIT POINTS	REQUIREMENTS
10 (maximum)	Rating
2	Demonstrate an average building rating of at least 2
3	Demonstrate an average building rating of at least 3
6	Demonstrate an average building rating of at least 4
10	Demonstrate an average building rating of 5

²⁴⁷ This table is copied from The Pearl Rating System for Estidama, Community Rating System, Design and Construction, version 1.0, April, 2010.

Table 16²⁴⁸: Maximum credit points for each credit sections

Credit Section	Maximum Credit
IDP – Integrated Development Process	13
NS – Natural Systems	12
LB - Livable Buildings	37*
PW – Precious Water	43*
RE – Resourceful Energy	44
SM – Stewarding Materials	28
IP – Innovating Practice	3
TOTAL Credit Points	177

²⁴⁸ This table is copied from Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

Table 17²⁴⁹: Baseline Flow rate and volume

Fixture of Fixture	Percentage Reduction
Bathroom Taps,	6 liters/min at 417.7 kPa
Bathroom Taps, public	1.9 liters/min at 417.7 kPa
Shower Head	9.5 liters/min at 551.6 kPa
Kitchen Sink Faucet	6 liters/min at 417.7 kPa
Bidets	6 liters/min
Urinal	0.5 liters/flushing cycle
Toilets (Dual Flush)	6/4 liters/flushing cycle (full/low)

²⁴⁹ This table is copied from Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

Table 18²⁵⁰: Resourceful Energy section, credits rating

Credit Code	Credit Title	General	Office	Retail	Multi-Residential	School
RE-R1	Minimum Energy Performance	R	R	R	R	R
RE-R2	Energy Monitoring & Reporting	R	R	R	R	R
RE-R3	Ozone Impacts of Refrigerants & Fire Suppression Systems	R	R	R	R	R
RE-1	Improved Energy Performance	15	15	15	15	15
RE-2	Cool Building Strategies	6	6	6	6	6
RE-3	Energy Efficient Appliances	3	3	3	3	3
RE-4	Vertical Transportation	3	3	3	3	3
RE-5	Peak Load Reduction	4	4	4	4	4
RE-6	Renewable Energy	9	9	9	9	9
RE-7	Global Warming Impacts of Refrigerants & Fire Suppression Systems	4	4	4	4	4
TOTAL		44	44	44	44	44

²⁵⁰ This table is copied from Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

Table 19²⁵¹: credit points can be awarded depending on the percentage reduction in the annual external heat gain

Points Achieved	Percentage Reduction
1	10%
2	20%
3	30%
4	40%
5	50%

²⁵¹ This table is copied from Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

Table 20²⁵²: Credits award against percentage of supplied renewable energy:

Points Achieved	Required Percentage
1	1%
2	3%
3	5%
4	7%
5	10%
6	13%
7	16%
8	20%

²⁵² This table is copied from Pearl Building Rating System: Design & Construction, Version 1.0, April 2010

Table No.21²⁵³: General Requirements

Serial	Section	Chapter	Regulation	Regulation Title
			No.	
1	Chapter 1: Access and 301 Mobility	Chapter 01 - 301: Access and Mobility	301.02	Enabled Access
2		Chapter 4 - 304: Microclimate and Outdoor Comfort	304.02	Heat Rejection Equipment
3			304.04	Colours on the Outside of Buildings
4		Chapter 5 - 305: Environmental Impact Assessment	305.01	Environmental Impact Assessment
5	Building Vitality 400	Chapter 1 - 401: Ventilation and Air Quality	401.01	Minimum Ventilation Requirements for Adequate Indoor air quality
6			401.02	Air Quality During Construction
7			401.03	Air Inlets and Exhausts
8			401.04	Isolation of Pollutant Sources
9			401.05	Openable Windows
10			401.07	Indoor Air Quality Compliance – Existing Buildings
11			401.09	Inspection and Cleaning of HVAC Equipment
12			401.10	Parking Ventilation
13			401.11	Environmental Tobacco Smoke

²⁵³ This table is copied from AL SA'Fat, Dubai Green Building Evaluation system, version 1.0,2016

14		Chapter 2 - 402: Thermal Comfort	402.01	Thermal Comfort
15		Chapter 4 - 404: Hazardous Materials	404.01	Low Emitting Materials: Paints and Coatings
16			404.02	Low Emitting Materials: Adhesives and Sealants
17			404.03	Carpet Systems
18		Chapter 5 - 405: Day lighting and Visual Comfort	405.01	Provision of Natural Daylight
19			405.02	Views
20			406.01	Legionella Bacteria and Building Water Systems
21		Chapter 6 - 406: Water Quality Chapter 7 - 407: Responsible Construction	406.02	Water Quality of Water Features
22			407.01	Impact of Construction, Demolition and Operational
23	Resource Effectiveness: Energy 500	Chapter 1 - 501: Conservation and Efficiency: Building Fabric	501.03	Air Conditioning Design Parameters
24		Chapter 2 – 502: Conservation and Efficiency: Building Systems	502.03	Elevators and Escalators
25			502.07	Electronic Ballasts
26			502.09	Control Systems for Hotel Rooms
27	Resource Effectiveness: Water 600	Chapter 4 - 504: Onsite Systems: Generation & Renewable Energy	502.14	Maintenance of Mechanical systems

28			504.01	On-Site Renewable Energy – Small to Medium Scale Embedded Generators
29			504.02	Outdoor Lighting
30			603.02	Water Consumption for Heat Rejection Including Cooling
31	Resource Effectiveness: Materials and Waste 700	Chapter 3 - 603: Onsite Systems: Recovery and Treatment	701.03	Asbestos Containing Materials
32			701.04	Lead Containing Materials
33			701.05	Ozone Depletion Potential (ODP) Material Management