URBAN ENERGY SERVICES PROGRAM

SUSTAINABLE MUNICIPAL ENERGY SERVICES (SMES)

Green Buildings and LEED Initiative Case Study in Jordan

October 2010

This publication was produced for review by the United States Agency for International Development. It was prepared by Nexant, Inc., Under Contract No. EPP-I-02-03-00007-00

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The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development of the United States Government

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1 Executive Summary

Green buildings have become increasingly popular throughout the world as operating costs for facilities continue to rise. As the value of resource efficiency is considered to be important in the marketplace, the demand for facilities that offer such services grows as well. While metrics for rating these resource efficient, or 'green buildings', have been developed throughout the world, they had not been deployed in Jordan. An exploratory study was performed by Ms. Bahar Armaghani that shed light on the existing building code process and enforcement mechanisms. While this study provided some valuable insight, there had still not been an actual use of a green building rating system in Jordan. In order to address this void in the body of knowledge, a case study was performed using one facility as a pilot for an accepted green building rating system.

The Crystalle Building, a facility in the Abdali project, was chosen as the location for the pilot study. The project was registered as a LEED Core & Shell 2.0 project in December 2008. The final project will not be operational until late 2011 or early 2012. Due to this construction schedule, this case study only incorporates the "Pre-certification" process of the facility. The "Pre-certification" involves evaluating all categories (credits and prerequisites) of the green building rating system, justifying whether a point should be pursued or not for the specific site, and building a case to the USGBC for future certification. While this does not result in a verified "green building" it still provides insight into the barriers that may be encountered when working to achieve a 'label' through a green building rating system and the submittal process therein.

The United States based LEED rating system has the following categories: Sustainable Sites (SS); Water Efficiency (WE); Energy & Atmosphere (EA); Materials & Resources (MR); Indoor Environmental Quality (IEQ) and Innovation in Design (ID). The barriers encountered, specific to Jordan, were both different in their type and magnitude. For example, the WE category was not particularly challenging, given Jordan's water scarcity issues, though the MR category was challenging as many of the "green" materials are not readily available in the local or regional markets.

Overall, the Crystalle Building's design and planned construction practices are consistent with a "green building"; the project is anticipated to achieve a LEED "Gold" rating. The challenges for Jordan's "green building" sector comes on several fronts:

- Market awareness and willingness to pay a premium
- Local equipment and labor capacity necessary for achieving LEED credits
- A clear understanding of what "baseline" should be used as a metric for gauging success in achieving "Green."

The Jordan Green Building Rating Council will play a significant role, along with the other stakeholders in both the public and private sectors, in providing a clear roadmap of how Jordan will structure its own rating system. To be cost effective, all stakeholders that were interviewed agreed that knowledge gained through the success and failures that have occurred in the international community should be leveraged for developing Jordan's green building rating system. The LEED rating system provides an excellent base to rebalance certain points in order to accommodate the needs of the country, both now and in the long term.

In addition to the discussion on building green in Jordan and details of the LEED pre-certification of the Crystalle Building, this report also includes a detailed description of a comprehensive review performed on the current Jordan energy codes, enforcement and compliance procedures. The building codes and compliance structure would require some changes for the green building rating system to be successful and more easily implementable.

It is recommended that Jordan develops an energy efficiency code which is more in line with the construction industry, weather and available resources in Jordan. This means that the current code which is based on ASHRAE 90.1-2004 will require major changes especially the incorporation of local weather zones and code requirements according to these zones. Additionally the code compliance and enforcement procedure would have to alter so that more emphasis is placed on enforcement during the construction and post-construction periods. This will ensure that all code aspects incorporated in the design are transferred to construction.

The aim of this study is to provide insights into the barriers which Jordan faces towards becoming green conscious in the construction industry. It also highlights the local factors and practices which will help in promoting green building practices.

2 Introduction

Jordan imports approximately 96% of its oil and gas needs from foreign sources. This costs the Government of Jordan (GoJ) approximately 20% of Jordan's Gross Domestic Product (GDP). The rising cost of imported energy has prompted the GoJ to actively create an infrastructure which will support and promote energy efficiency to reduce Jordan's dependence on imported fuel sources. The 2006 Jordan National Agenda also reiterates GoJ's commitment towards energy efficiency. The Agenda has put special emphasis on more stringent standards for new construction, reduction in energy consumption per capita, increasing the percentage of electricity production from renewable sources and reduction in electricity distribution losses. USAID is working with the GoJ and collaborating in the above mentioned areas through the Sustainable Municipal Energy Services (SMES) contract. One of the tasks under this contract was to conduct a case study of a building under development and evaluate the effectiveness of using a green building rating system, in this case the USGBC's LEED (Leadership in Energy and Environmental Design), to examine the applicability of such a system in Jordan. The study included three tasks:

- Taking a building, located in Amman, Jordan, through the LEED pre-certification process to understand how the USGBC system applies in Jordan
- An investigation of the current building codes and compliance practices in place
- An analysis of whether the United States based LEED rating system can be implemented in Jordan as is or if there are modifications necessary to make it more appropriate for Jordan.

The case study building, Crystalle, is a 19,500 m^2 (210,000 ft^2) multi-family mix use complex located within the new state of the art Abdali development. The Abdali development, with a total built area of approximately 1.7 million m^2 (18.3 million ft^2), will consist of numerous facilities including residential, commercial, retail and hospitality.

In order to acquire detailed information on the current status of green building industry in Jordan, building practices, codes and standards, Nexant compiled a comprehensive list of stakeholders. Over several visits, Nexant personnel held meetings with the stakeholders to gain insights on how the building industry operates in Jordan and to understand their familiarity with green building. Stakeholders included government entities, contractors, property developers, architects and engineering firms.

Information obtained from these sources was utilized for completing an analysis of the Jordan green building industry; provide recommendations for a more robust code compliance system and a critical analysis of what kind of a building rating system would be most beneficial for Jordan in promoting green building practices.

To approach the project tasks, Nexant Inc. initiated and managed the following activities:

- LEED pre-certification of the Crystalle Building
- Research of the application of LEED in Jordan and the current building code infrastructure in place that may support green building

The LEED pre-certification process provided Nexant with the opportunity to work closely with the property developer and design team. Based on this process, Nexant developed a case study, which discusses how the LEED system works in Jordan. The study investigates which credits are most relevant in the Jordan market, the associated costs in building green and the major barriers in promoting green building practices.

The presence of robust and up to date building codes and compliance procedures are imperative in promoting green building practices. Nexant investigated the current building code and compliance regime in Jordan. This included comparisons between Jordan codes and equivalent US codes as well as comparing the compliance procedure in Jordan with the procedure in selected US states. Nexant also investigated the possibility of incorporating LEED within Jordan's current code regime and what kind of changes are suggested to create a more sustainable, user-friendly and greener code compliance mechanism. The methodology used to complete the above mentioned tasks, detailed results of the pre-certification process, conclusions and recommendations are presented in the following sections and appendices.

3 LEED Pre-certification of the Crystalle building:

3.1 The Crystalle Building

The case study focuses on the Crystalle building, a mixed-use building consisting of twenty-three luxury residential spaces and eleven retail spaces. The 13,220 m² (142,255 ft²) Crystalle Building consists of four below ground floors, ground floor, a mezzanine level, five above ground floors and a technical floor. Figure 1 shows a conceptual drawing of Crystalle.

Figure 1 - Artist rendering of the Crystalle Building

The Basement level B4 contains the reservoirs for the domestic water and fire sprinklers. Domestic water reservoirs (Both Retail and Residential) have a capacity of 346 m³ (12,218 ft³) capable of storing 91,395 gallons of domestic water. The fire sprinkler reservoir has a capacity of 248 m³ (8,757 ft³) capable of storing 65,508 gallons of greywater to be used in case of emergency. Approximately 25% of this basement level is support space for accessing reservoirs for maintenance purposes.

Basement level B3 accommodates 50% of the total site's parking capacity in addition to tenant storage areas. In addition, this floor contains most of the buildings greywater system components, which include a 16 m³ (565 ft³) storage tank, clarifier tank, filters and pumps. Basement level B2 contains the remaining 50% of site's parking capacity, while providing additional tenant storage. The electrical room is located on this floor and contains the building's backup generator and associated diesel fuel storage tank, main panels and the main transformer which serves the building. This floor also houses the bicycle services area to help promote the use of bicycles instead of automobiles. The bicycle services area also contains a restroom/shower facility for bicyclist use. Basement level B1 contains storage areas for

tenants and some of the larger retail spaces, and three retail areas available for tenant lease or ownership. In addition, the tenant gym and eighteen driver rooms are located on this floor. These rooms can be used by the tenant's private drivers to rest while they are not working.

The Ground floor and Mezzanine contains eight retail spaces which are available for sale or lease, the main entrance and lobby, and various building management offices. To help reduce commuting, seven office spaces with reception, conference room and media facilities are offered to residential tenants for lease.

The remaining floors are dedicated to the luxury residential tenant spaces. Multiple configurations are available and range in size from 360 m² (3,800 ft²) for simplex models to 770 m² (8,300 ft²) for the largest Duplex Penthouse. Each of these 23 spaces will require tenant build-out by a qualified contractor. The tenant has the option to use one of the standard designs offered by the developer or to hire an independent design firm.

The Core and Shell of the Crystalle building was designed by Maisam, an architectural firm located in Amman. All Mechanical, Electrical, and Plumbing (MEP) work was performed by Universal Consultancy Services (UCS) also located in Amman.

The Crystalle building is located on plot 3D-1 within the New Amman Downtown, Abdali, which is currently under phase I development. Figure 2 shows the land use plan for the Abdali project.

Figure 2 - Land Use Plan for the Abdali Development

The Abdali New Urban Downtown project is the largest mixed-use project in the history of Amman, the capital of Jordan. The Abdali project will be developed on 384,000 m² of land acquired mainly from the Jordanian government which was used mostly for military facilities. Once the project is complete, the total built up area will be over 1.7 million m² and will consist of entertainment facilities, commercial retail outlets, residential apartments and office space. The size and location of Abdali will make it the central business and residential district within Amman. The site for Abdali was strategically chosen and is located in the center of major commercial, financial, public and touristic institutions. Figure 3 shows a conceptual skyline of the Abdali Downtown.

Figure 3 – Planned Abdali Skyline

Abdali PSC, the developer, was formed in 2004 as a partnership between the government owned real estate developer MAWARED and Horizon, an international construction conglomerate specialized in investment and development of large scale real estate and construction projects owned by Sheikh Baha'a R. Hariri. This partnership expanded when United Real Estate Company-Jordan, under the group of Kuwait Projects Estate Company – Jordan, under the group of Kuwait Projects Company (KIPCO), joined as partner. Laceco, an international engineering and consultancy firm based in Lebanon was hired by the developer to design the new urban downtown.

The land for Abdali was acquired in 2004 with initial concept/planning starting shortly thereafter with traffic and environmental studies. The development permit was issued by the Greater Amman Municipality (GAM) in 2006 with the first sub-development design reviews conducted first by the Abdali group then GAM shortly thereafter. Due to the size, complexity, and visibility of the development, the chief Abdali development company, Abdali Investment and Development PSC, worked closely with authorities at the Greater Amman

Municipality (GAM) and some regulations were modified to help streamline the process for Abdali. This resulted in a private/public partnership in which both parties review design drawings, check for code compliance and supervise construction of those projects within Abdali. Abdali Investment and Development PSC employs over 25 engineers and architects to provide the preliminary design reviews to ensure that each parcel's design adheres to the master plan. These engineers also provide general supervision for each parcel and coordination between parcels during construction.

The Abdali project is unique in that the master planners and design team included sustainable qualities into the project. This includes the requirement of all Abdali projects to incorporate its own Greywater Treatment plant to collect greywater from showers, sinks, swimming pools and laundry and to reuse it for irrigation and toilet flushing. Also required is the use of building materials with low thermal conductivity and premium insulation materials. Abdali PSC will construct an onsite chemical sewage water treatment plant to provide recycled water for all the public park areas, located within Abdali,containing vegetation. Lastly, Jordan district Energy (JDE) will provide the development with thermal energy, both hot and cold water through the use of a district heating and cooling plant. The plant will incorporate the following measures which support the sustainable theme of overall development:

- The use of an ammonia based refrigerant, R717, which does not contain CFCs or HCFCs and has no Ozone Depleting Potential (ODP) and no Global Warming Potential (GWP)
- The use of thermal energy storage to reduce electrical peak demand and overall power consumption by running compressors at night
- The use of dry condensers to eliminate the need for water in cooling towers

3.2 Summary of LEED Credits – Crystalle and applicability for projects in Jordan

3.2.1 LEED ratings system pursued, registration date, precertification details

The green building rating system that is being applied for is the LEED Core & Shell (C&S) version 2.0 system. The LEED rating system is the green building rating system administered by the United States Green Building Council (USGBC) and has been in implementation since 1998. The USGBC was a founding member of the World Green Building Council.

The Crystalle Project was registered with the USGBC in December 2008. The Core & Shell version of LEED was selected as the certification path because the Matrix group, the developer, is not involved in the interior design of the facility. The tenants of the space might pursue LEED Interior Spaces certification, though this was not evaluated in this case study.

The USGBC's LEED certification process for New Construction and Core & Shell offers two stages of certification, Pre-Certification and Certification. This case study is being performed prior to the final construction of the Crystalle building. As a result, the full certification process is not being evaluated, rather only the Pre-certification process has been explored.

The developer has the intention of pursuing the full LEED Certification for the Crystalle building.

3.2.2 Crystalle Pre-certification Credits Applied For, Estimated rating level

The USGBC's LEED CS-V2.0 rating system offers four different rating levels: Certified (23-27 points), Silver (28-33 points), Gold (34-44 points) and Platinum (45-61 points). For the Crystalle building 41 points are being attempted, an estimated Gold rating.

The LEED rating system has six categories that comprise what the USGBC considers to constitute a 'green building'. Figure 4 displays the total number of points available in each of these categories compared to the number that the Crystalle building is attempting.

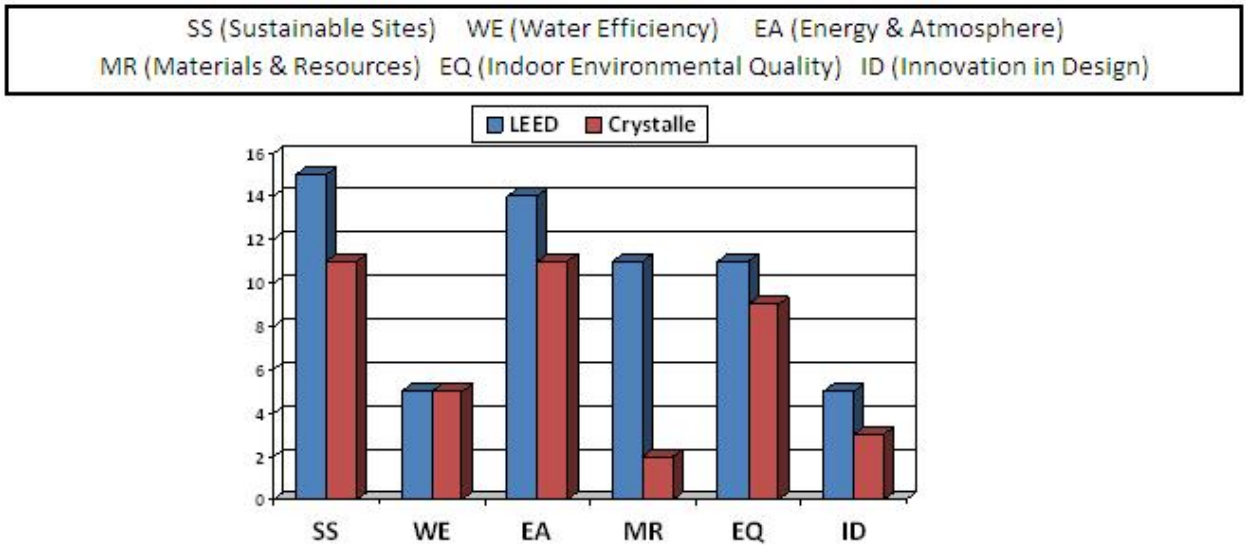

Figure 4 - Comparison of available LEED points to those pursued by Crystalle

Each LEED credit was evaluated for the difficulty of achieving the requirements in Jordan. The assessment was based, primarily, on the experience found through the LEED pre-certification work at the Crystalle building. Figures 5-10 list the most critical issues faced, that help to explain why the credits are either easy to achieve or challenging.

Sustainable Sites

Credit	*Appropriate Credit for Jordan*	*Easily Achievable in Jordan*	*Appropriate Weighting for Jordan*	*Assessment*
Site Selection	✓	✓	✓	• Limited number of environmentally sensitive sites
Density & Connectivity	✓	✓	✓	• Many mixed use buildings
Heat Island Effect	✓	✓	✓	• Large building footprints • Low cost
Tenant Guidelines	✓	✓	✓	• Low cost
Construction Activity Pollution Prevention	✓			• Not standard practice • Referenced standard emphasizes stormwater based measures • The water table in Jordan has a low susceptibility to contamination (DRASTIC index of 40-97)
Brownfield Rehabilitation	✓		✓	• No existing policy or infrastructure • Comes at a cost to developer
Alternative Transportation	✓		✓	• Biking is not common • No public bus maps
Stormwater Design	✓		✓	• Not standard practice
Lighting Pollution Reduction	✓			• Many Requirements, LEED submittal difficult • Design requirements stringent

Figure 5 - Sustainable Sites credits

Water Efficiency

Credit	*Appropriate Credit for Jordan*	*Easily Achievable in Jordan*	*Appropriate Weighting for Jordan*	*Assessment*
Water efficient Landscaping	✓	✓		• Common practice to reduce water consumption • Already low baseline
Innovative wastewater technologies	✓			• High cost to design and implement • Increasing popularity, possible free-riders
Water use reduction	✓	✓		• Challenging given Jordan's efficient use of water

Figure 6 – Water Efficiency Credits

Energy & Atmosphere

Credit	*Appropriate Credit for Jordan*	*Easily Achievable in Jordan*	*Appropriate Weighting for Jordan*	*Assessment*
Fundamental Refrigeration Management	✓	✓	✓	• Low ODP refrigerants are available • Higher upfront cost
Green Power	✓	✓	✓	• RECs can be purchased
Fundamental & Enhanced Commissioning	✓		✓	• Limited number of qualified CxA • High upfront cost
Minimum Energy Performance	✓		✓	• Which baseline to use • Is ASHRAE 90.1-2004 appropriate
Optimize Energy Performance	✓			• Which baseline to use • Is ASHRAE 90.1-2004 appropriate
On-site Renewable Energy	✓			• High upfront cost • Low financial incentives
Measurement & Verification	✓		✓	• Not standard practice • High additional cost

Figure 7 – Energy and Atmosphere Credits

Materials & Resources

It was found, during this evaluation, that none of the MR credits were easily achievable in Jordan. The USGBC requirement for these credits and the lack of readily available sustainable building materials complicated these credits.

Credit	*Appropriate Credit for Jordan*	*Easily Achievable in Jordan*	*Appropriate Weighting for Jordan*	*Assessment*
Storage and Collection of Recyclables	✓		✓	• Recycling industry in Jordan still developing
Building Reuse	✓			• Difficult to achieve
Construction waste management	✓			• Not standard practice • Limited recycling infrastructure
Materials reuse	✓		✓	• Not standard practice • Tedious tracking required
Recycled content	✓			• Not standard practice • Limited local sources
Regional materials	✓			• Limited market size
Certified wood				• Not standard practice • No local source

Figure 8 – Materials and Resources Credits

Indoor Environmental Quality

Credit	*Appropriate Credit for Jordan*	*Easily Achievable in Jordan*	*Appropriate Weighting for Jordan*	*Assessment*
Minimum IAQ performance	✓	✓	✓	• Moderate incremental cost • Not standard practice
Environmental Tobacco Smoke	✓	✓	✓	• Low cost decision • Areas can be designated
Indoor Chemical & Pollutant Source Control	✓	✓	✓	• Low incremental cost
Controllability of System Thermal Comfort	✓	✓	✓	• Low incremental cost
Daylighting	✓	✓	✓	• Must be a top requirement for designers
Environmental Tobacco Smoke Control	✓			• Smoking is common amongst the majority
Outdoor Air Delivery Monitoring	✓			• EMS and intelligent HVAC controls are rare
Increased ventilation	✓			• ASHRAE 62.1 is not commonly referenced
Construction IAQ Management Plan	✓			• Not standard practice
Low emitting materials	✓			• Not easily available • High incremental cost
Thermal Comfort Design	✓			• ASHRAE 55 is rarely used for designing

Figure 9 – Indoor Environmental Quality Credits

Overall difficulty of credits in Jordan

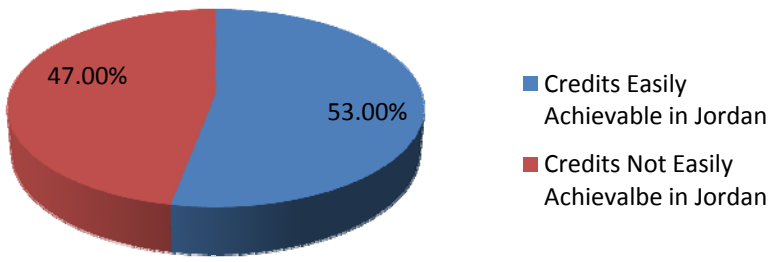

Figure 10 - Breakdown of Credits and their Achievability in Jordan

3.3 Cost Premium of Developing LEED Projects in Jordan

One of the obvious barriers in developing and implementing energy efficient and green technology is initial cost. Most new construction projects, regardless of location, are driven by first costs and significant efforts are made to control them. In any country, first cost can be influenced by the local laws, codes and statutes which are in place. For example, if a government office building is constructed in San Francisco, it must achieve LEED silver. This requirement, on top of meeting the requirements of the California Title-24 building energy code, adds significant initial costs to a project. However, with these initial costs come a more sustainable and energy efficient building with lower operating costs.

The increase in initial costs for a LEED certified facility is related to both the design and the construction stages of a project. There are certain pre-requisites if a project is planning to file for LEED certification. One pre-requisite is that the project should be 15% more energy efficient than the current building energy code. In the United States, building energy codes are updated every three years and each new revision is on average 15% more energy efficient as the last one. This is a good mechanism in pushing manufacturers and designers to develop new innovative technologies to keep increasing the efficiency of products and improving on design and construction practices. In parallel, this increases the cost of the project just to meet the basic code requirements. So, if the project has to be at least 15% better than the current energy code, the first cost will increase just to meet this one requirement.

This is one example of how the total project cost will experience an increase. There are several other aspects to LEED certification which will also increase the project cost. Several studies have been published in United States to quantify the incremental increase in the total cost of a project pursuing LEED certification. Costs of LEED projects are usually classified as follows:

- Soft costs which include costs upstream of construction including designing, LEED administration, LEED consulting, energy modeling, compliance documentation and commissioning.
- Hard costs which include costs related to the construction process like more site work, recycling, waste water management as well as the incorporation of high efficiency equipment and green materials in the project.

Soft costs related to LEED are easier to quantify than hard costs; hard costs depend on the specific LEED points the project is going after. As for the soft costs, these costs can be categorized according to the project end use as well as the size of the project. From the studies conducted, there is an addition of 1%-3% to the soft costs.[1]

[1] Analyzing the Cost of Obtaining LEED Certification. http://www.cleanair-coolplanet.org/for_communities/LEED_links/AnalyzingtheCostofLEED.pdf

As stated, an increase in hard costs is difficult to quantify and extensive data is not easily available. From the limited data points researched, the cost of using greener materials, sustainable construction practices and high efficiency equipment can put a premium of 3-8% on the construction process. So on the whole cost of a LEED certified building may be 4% to 11% higher than a code compliant facility. The 11% increase reflects projects which focus more on initial cost intensive credits such as designing and constructing an energy efficient building with the most cutting edge and advanced envelope and HVAC systems. Though these types of credits have a higher initial cost, they have the greatest potential for payback through energy savings. Points which are not so cost intensive such as alternative transportation, building reuse and construction waste management may not ever payback but do demonstrate the projects commitment to green building practice.

Recently, studies have been published[2] based on data gathered in the United States which state that the incremental cost is getting lower as market is getting transformed towards more sustainable and green building practices. In addition to the reduction in the first cost premium, the gains in property value and reduction in operational cost also makes LEED certification more viable over the life of the project.

The above mentioned costs and the financial advantages of LEED certification can be realized when there is:

- A solid infrastructure in place for sustainable building practices
- A strong local presence of manufacturers of building materials, energy efficiency equipment and other green technologies
- Stringent code compliance and permitting procedure.
- An elaborate mechanism of providing tax relief, incentives and subsidies for green and sustainable building practices.

Jordan is moving in the right direction of creating this platform required to launch a successful green building campaign. In order to achieve success and negotiate the numerous market barriers, the government of Jordan and the private entities in the construction arena should work together in putting in place or initiating work on the above mentioned aspects.

A recent study[3] has aimed to evaluate the cost impacts of each credit in the LEED 2009 for New Construction (NC) rating system using a generic commercial or institutional building as a benchmark in the United States. Though the case study involves LEED CS v2.0, it was found during this study that many NC credits are similar to those found in CS. Furthermore,

[2] Cost of Green Revisited: Reexamining the Feasibility and Cost Impact of Sustainable Design in the Light of Increased Market Adoption,; 2007
http://www.davislangdon.com/upload/images/publications/USA/The%20Cost%20of%20Green%20Revisited.pdf

[3] The Cost of LEED: A report on the Cost Expectations to Meet LEED 2009 for New Construction and Major Renovations;2010

the switch from LEED CS 2.0 to LEED 2009 consisted mainly of a reweighting of credits with minor changes to the intent and requirements.

At least 8 credits investigated were found to be not quantifiable due to the difficulty of associating costs with certain, or all, costs associated with the measure. The same would hold true in Jordan as the costs for credit compliance are subject to many variables that are difficult to predict. Many are subject to the projects location. The cost of locating a project in an area near public transportation, for example, is strictly dependent on the market value of real estate in those areas considered. For credits like MRc1 and MRc3, credit cost would be subject to what is available at the time of the project, which is highly variable. Table 1 shows which credits were found to be unquantifiable both in the reference study as applied to the US, and through Nexant's research in Jordan.

	Point Title	Non-Quantifiable in Jordan?	Comment
SS1	Site Selection	Yes	The referenced study could not associate a cost for compliance with this point. For Jordan, it is also difficult to predict the "typical" cost associated with point compliance.
SS2	Development Density and Community Connectivity	Yes	The referenced study could not associate a cost for compliance with this point. The purchase of a compliant site as opposed to a non-compliant site is highly variable and difficult to estimate in any case.
SS4.1	Alt Transportation - Public Transportation Access	Yes	Credit compliance is based on site selection. The purchase of land near public transportation as opposed to a non-compliant site is highly variable and difficult to estimate in any case.
SS4.4	Alt Transportation - Parking Capacity	Yes	It is difficult to quantify the costs associated with adding or removing parking capacity, especially in Jordan.
MR1	Building Reuse	Yes	Is difficult to quantify since costs and savings are highly dependent on what is available at the site
MR3	Materials Reuse	Yes	Is difficult to quantify since costs and savings are highly dependent on what is available at the time of the project
MR5	Regional Materials	Yes	Is non quantifiable since materials must come from a source 500 miles from the project site. Costs may differ depending on project site within Jordan.
IEQ8.2	Daylight and Views - Views	Yes	The cost for this point would vary based on building design, layout and footprint , all of which vary per project

Table 1 - Non-Quantifiable Credits

Another 8 credits, according to this referenced study were found to be no cost measures. Though this may be the case for projects in the US, it was not the case for most of these points in Jordan. Table 2 shows each of these points.

Those credits not included in tables 1 and 2 have costs associated with them, according to the referenced study. However, these costs are estimated for a typical project in the United States and do not necessarily correlate to projects in Jordan. A good example is for IEQ 4 which requires the use of low VOC materials such as paints, adhesives and sealants. In the United States, these products are readily available. As a result, the referenced study mentions that a "negligible premium" would be applied to purchase low VOC materials. However, in Jordan such products would need to be imported, adding substantially to the cost. It is for this reason

that the few studies available for the cost of LEED in the US cannot be directly applied to projects in Jordan. Since the case study project, the Crystalle building, had not yet been completed at the time this report was written, financial information for construction based points such as low VOC materials was not yet available.

	Point Title	No-Cost in Jordan?	Comment
SSP1	Construction Activity Pollution Prevention	No	Unlike in the US, the LEED referenced standard, which requires the creation and implemenation of a SWPP Plan is not a local requirement. This means that to comply with this LEED requirement, a Jordan based project would have to create and implement this plan adding to planning and construction costs
EA4	Enhanced Refrigeration Management	No	There are no rules or regulations in Jordan which prohibit certain types of refrigerants. As a result, to obtain HVAC&R equipment which use low ODP and GWP refrigerants may require a premium cost.
IEQP1	Minimum IAQ Performance	Yes	This credit requires compliance with ASHRAE 62.1-2004 ventilation requirements. Though this standard is not typically referenced, it is not expected to add cost should the design team consider these requirements up front, while designing ventilation systems
IEQP2	Environmental Tobacco Smoke Control	Yes	Like with the referenced study, simply making the building non-smoking will not add to costs.
IEQ2	Increased Ventilation	Yes	See IEQP1 Comment
IEQ3.1	Construction IAQ Management Plan - During Construction	No	Typically, projects in Jordan do not follow the compliance path set forth as a requirement for this credit. This credit will most likely add to planning and construction costs.
IEQ7.1	Thermal Comfort - Design	Yes	This credit requires compliance with ASHRAE 55-2004, guidelines for thermal comfort. Though this standard is not typically referenced, it is not expected to add cost should the design team consider these requirements up front, while designing HVAC systems
IEQ7.2	Thermal Comfort - Verification	No	Despite results from the referenced study, compliance with ASHRAE 55-2004 will need to be verified with survey's and spot temperature readings. These activities will require some additional cost.

Table 2 - No-Cost Credits

Based on numerous inputs received from the several meetings held with property developers, design firms and contractors, the most prominent barrier in LEED certification or Green building is the increase in the first cost of a project. According to a recent study completed by Harvard Business School[4], LEED certification alone will increase the first cost of a project by approximately 15% within Jordan. Following is a breakdown of some of the different steps, tasks and components which will add to the increase in first cost:

3.3.1 Design Costs

For a project to achieve LEED certification, practices have to be put in place in the early design stage to:

[4] Green Buildings in Jordan, Harvard Business School

- Document the design procedure for building features and systems that are applicable to LEED credits
- Provide reviews of the design and construction documents to make sure that all LEED requirements are being met
- Create documentation to ensure that all of the Owners Project Requirements (OPR) have been incorporated in the design
- Create and update the Basis of Design (BOD) and ensure that the all design aspects have been incorporated in the construction documents
- Populate LEED submittal templates with narrative and associated proof of compliance

These additional tasks can be accomplished by a LEED Accredited Professional (AP) within the current design team or a separate LEED consultant can be hired to accomplish these tasks. Either way there is an additional cost associated with the completion of these tasks. There is no requirement to involve a LEED AP, however one extra credit is available for projects that do.

This cost can increase further if there is no local LEED expertise available and the project requires an overseas consultant. However, LEED is becoming popular in Jordan and there are already more than 35 LEED APs locally present and part of different consulting, design and construction firms. With more awareness and education this number can grow further. With more projects attempting certification local LEED consulting companies could gain a foothold in the building industry.

3.3.2 Commissioning

Commissioning is the process which confirms that the project has been built according to the design specification and all systems including HVAC, plumbing and electrical are operating as intended. For LEED certification, fundamental Commissioning is a pre-requisite and this entails hiring a commissioning agent which will perform detailed field testing of all the different systems mentioned above to ensure their operations according to specification. During the construction phase, the commissioning agent provides oversight to ensure that the construction is progressing according to design specifications.

In United States, the cost of fundamental commissioning varies from \$0.3/ft^2 (\$3/m^2) for large projects to \$2.5/ ft^2 (\$27/m^2) for smaller ones[5]. In addition to fundamental commissioning, LEED-CS V2.0 offers two credits if the project pursues enhanced commissioning. Enhanced commissioning requires additional steps which include detailed review of design and construction documents, submittal reviews as well as a warranty walk through usually after 6

[5] Measuring the cost to become LEED certified. http://www.facilitiesnet.com/green/article/Measuring-The-Cost-To-Become-LEED-Certified--10057

months of operation. On average this will add another $0.2/ft^2 ($2/ m^2) to the commissioning cost.

In Jordan for most mega projects, the commissioning agents are hired from overseas by the large property developers or design firms. Locally there are very few firms which can provide commission services especially for LEED projects. This will add a substantial premium to the first cost. In order to control this cost, it is very important that aggressive capacity building is initiated in the field of energy consulting and commissioning which will reduce the cost by hiring local firms.

Depending on whether a local or overseas firm is hired, fundamental and enhanced commissioning can add 1% to 5% to the first cost of the project. For Crystalle, fundamental commissioning was pursued as required to gain LEED certification. One local commissioning firm was available to provide these services and charged 10,000 JD or $14,200 USD. This translates to 0.75 JD/m² or $0.1/ft².

3.3.3 LEED Registration Fee and Documentation Cost

A significant portion of the LEED activities and cost is related to documenting the entire process from design through construction and operation. This documentation, which includes design specifications, design drawings, construction drawings, a list of LEED credits and a narrative for each credit explaining the compliance path, needs to be organized in a submittal form and provided to the United States Green Building Council (USGBC) for review and approval. The project also needs to be registered with USGBC. The registration fee is $600 plus an additional certification fee of $2,250 to $22,500 based on the size of the project.

These costs can add another 1% to the first cost of the project. For Jordan, if the LEED consultant is local, the increase in cost will not be as much as in the United States because of the lower labor rates. This should be an important driver for creating awareness and providing education to the local construction community in green building rating systems and sustainable construction practices.

3.3.4 Energy Modeling

One compliance path for Energy and Atmosphere Prerequisite 2 and Credit 1 involves creating a calibrated hourly simulation model for the building utilizing local hourly weather data in a standardized format. The energy performance of the proposed design is then compared with a code compliant building to verify that the design is at least 15% more efficient than the current building energy code on a whole building level. Currently there are not many firms in Jordan which provide energy modeling services or which have expertise in doing LEED energy modeling. For the Crystalle Building, the energy modeling is being performed by an overseas firm. Without educating local firms in building energy simulations and utilizing indigenous resources, this task also adds significantly to the total project cost.

Depending on the firm hired and the size of the project, this will add another 1%-2% to the total project cost.

3.3.5 Building Material

In LEED there are several credits related to the manner in which construction is performed as well as the type of building materials used. If a project is going for such credits this also adds a premium to the first cost to include for example:

- Insulated Concrete Forms (ICF) for better insulation
- Low emitting materials for carpeting, paints and adhesives
- High Solar Reflective Index (SRI) coating or material to mitigate heat island effect
- Recycled materials
- Sustainably harvested materials

All these added materials or features increase the cost of the project. The exact rate of increase will depend on how much of these materials/technologies are imported compared with what is manufactured/grown locally. In case of Jordan, most of the green construction materials will be imported which will add cost to the project. In the long run, for the green construction and sustainability to prosper in Jordan, it is imperative that local industries are set up which can produce at least some of the required material to be used in green buildings.

3.3.6 High Performance Envelope, Lighting and HVAC Equipment

For LEED-CS v2.0 projects, one pre-requisite requires the performance of the building to be 15% above ASHRAE 90.1-2004 building energy code. This translates directly to the efficiency of the envelope, lighting and HVAC systems. This high efficiency equipment is expensive and substantially adds to the first cost of the project, especially if imported. However, if local assembling or manufacturing facilities are available, the cost is reduced significantly. This should be the long term vision for Jordan, in terms of moving towards green building. Petra, which is a Jordan based company, is becoming a leading manufacturer of HVAC equipment and provides state of the art air conditioning products for a very diverse customer base.

Construction process, building material and high efficiency equipment combined will add approximately 10%-15% to the first cost of the project. In addition to the above, there are several other tasks including promoting alternative transportation, brown field development, construction activity pollution prevention, considering construction Indoor Air Quality (IAQ) requirements and others which add to the project cost. Taking into account all the different components, in Jordan a LEED certified building will require 15%-20% more capital upfront than a conventional building to successfully go through the certification process. However, a more in-depth study is needed in Jordan to quantify a more accurate cost premium associated

with LEED certification and in general with building green. As already, the actual cost data from Crystalle Building will provide a good initial data point in this regard.

3.4 Recommendations on a tailored Green Building Rating System for Jordan

3.4.1 Scenario 1 - Adopt USGBC System Permanently

The USGBC LEED rating system has been used both in the United States and internationally to assign a ranking based on a standardized level of sustainability included in both the design and construction of a building. Until recently, though there have been many International LEED applications and certifications, the rating systems are based on sustainable design standards developed and used in the United States. Recently, some countries have chosen to adapt the original US LEED system to better suit the needs of sustainable design and construction in their country. It was found that the building industry, construction practices, and building resources availability in Jordan differs significantly from the United States.

Should Jordan adopt the USGBC system directly, credits like Indoor Air Quality 4 – Low Emitting Materials will be difficult to achieve until Low VOC products are more easily available in Jordan. In addition, the standards referenced in the USGBC system in some cases do not appropriately apply to projects in Jordan. For example, Sustainable Sites Prerequisite 1 – Construction Activity Pollution Prevention requires compliance with a very specific United States requirement called the 2003 Environmental Protection Agency (EPA) Construction General Permit (CGP).

This document outlines the provisions necessary to comply with Phase I and Phase II of the National Pollutant Discharge Elimination System (NPDES) program. The provisions focus heavily on protecting stormwater runoff from pollution and require a Stormwater Protection Plan. The motive behind these provisions is to protect groundwater from construction activity pollution. Though Jordan does get precipitation, a greater concern is pollution transmittance via wind. Though there are some provisions required to reduce wind borne pollution, they are minimal when compared to the amount of stormwater protection provisions. The continued use of this prerequisite would result in the implementation of measures that are not optimal for reducing construction activity pollution prevention in Jordan. So in this case, an amended set of provisions tailored to Jordan may be better suited to effectively reduce construction activity pollution prevention thereby more successfully meeting the intent of the prerequisite.

3.4.2 Scenario 2 - Hybrid system

One potential mechanism for developing a green building rating system in Jordan is to use one non-Jordan based system for a period of time, e.g. 3 years, then integrate the Jordan based rating system gradually over, for example, 2 years, until the Jordan based system is exclusively used. There are several factors that should be realistically considered when a green building rating system is suggested for Jordan, such as:

- Human Capacity - The speed of training green building experts

- Credit Development - The time required to adapt or create a green building credits specific to Jordan
- Institutional acceptance

Through discussions with the Jordan Green Building Council it was found that efforts are currently underway to have a green building rating system, with credits that are tailored for Jordan. In the long term, a locally appropriate and an affordable system are the two basic requirements that must be met in the green building rating system. The development of such a system will be most cost effectively achieved through leveraging the efforts of other green building rating systems and simply making it appropriate for Jordan.

Making a green building rating system locally appropriate for Jordan can be achieved through both reweighting credit categories and specific credits. For example, given the water resource constraints present in Jordan it is important to place a great emphasis on the equivalence of LEED's Water Efficiency credits, through the use of increased relative point allocation. Such a reallocation was performed by Harvard Business Students for a USAID-funded project. The results of that study were based on information collected from a variety of stakeholders; a further analysis should be performed that ensures stakeholder buy-in.

This case study of the Crystalle building, including other research for credit application in Jordan provides tangible evidence that many LEED credits should be reweighted based on the needs of the country and its building industry. As seen in Figure 6, all Water Efficiency (WE) credits were achieved while other categories, such as Materials & Resources (MR), only a fraction of the credits were achieved. Many Jordanians understand the condition of their scarce water resource and design and build their facilities accordingly to be "water efficient". The need for water efficiency within Jordan created the infrastructure necessary to easily comply with the LEED requirements in this field. The recycling industry was developing in Jordan at the time of this study. The lack of infrastructure made achieving the MR based credits difficult on three fronts:

- Limited recycling firms located in Jordan to collect recyclables
- Limited local source of recycled materials for compliance with credits
- Most materials needed to be imported, with the exception of steel

The reweighting of points should be performed with careful consideration to ensure that the allocation of points meets the needs of Jordan.

3.4.3 Scenario 3 - Develop their own system through the Jordan Green Building Council (JGBC)

Like the USGBC, the JGBC is part of the World Green Building Council (WGBC); both green building councils have similar qualities. The JGBC was established in late 2009 with the first assembly meeting and board elections in January 2010. The JGBC is in the process of becoming established in the green building community.

The USGBC released its first LEED Pilot Project Program, LEED Version 1.0 in August 1998. After extensive modifications, the LEED Green Building Rating system Version 2.0 was released in March 2000. The JGBC may choose to create a unique green building rating system tailored towards Jordan that is not affiliated with the LEED rating system. It should be considered that to do this in the United States, it took the USGBC 5 years to implement the first green building rating system; there have been numerous revisions since. Though some guidance may be available through the existing green building rating systems and the World Green Building Council, should the JGBC attempt to develop their own system, such a feat could take up to 5 years. The JGBC has recently initiated two efforts, one to encourage neighboring countries to collaborate on components of national green building rating systems as well as working to tailor a green building rating system to Jordan specifically. Since the JGBC is currently affiliated with the world green building council, perhaps the most appropriate path of action would be to develop LEED Jordan, as has been the popular option in other countries such as Canada and India.

4 Building Codes and LEED

4.1 Code Development in Jordan

The USGBC LEED rating system requires a project applying for certification to exceed the United States building codes and best practices. For Jordan, it was necessary to investigate the current codes, their development as well as both design and construction practices to evaluate how appropriate it is to use a foreign system in Jordan. To investigate the system in place for code development Dr. Engineer Jamal Qtaishat, Director - Jordan National Building Council and Dr. Mohammad Ahmad Hamdan from the Al-Zahtoonah University of Jordan along with various members of the Jordanian Engineers Association (JEA) were separately interviewed to understand the current infrastructure in place for code development. These interviews combined with language from the Jordanian National Building Law 7 provided a clear understanding of how the building process in Jordan should be administered.

Dr. Mohammad Hamdan was responsible for developing and translating the Jordan 2008 energy code.

The Jordan 2008 energy code is the most relevant code pertaining to green building in Jordan and currently is in the process of becoming law. Historically, there have been no energy related codes in Jordan. The 2008 Jordan Energy Efficiency code has largely been adapted from India's 2006 Energy Conservation Building Code (ECBC). Both the Indian and Jordanian codes are based on ASHRAE 90.1-2004. The implementation of an energy code is essential to set standards for building energy efficiency in any country. Dr. Hamdan did comment that the energy code is stringent when referring to current building practices regarding envelope, lighting, and HVAC systems currently being used in the country. However, he felt that the code is complicated by the fact that it is difficult to follow in Arabic. The process for developing the energy code seems to be similar for developing other building codes within Jordan.

The interviewed parties expressed that many Jordanian National Building Codes are taken directly from other countries codes without changes. This creates a situation where codes or parts of codes may be excessively stringent. It is unclear what process, if any, is used to decide whether a code needs to be created from scratch or a code from another country can be adopted as is. It is also unclear how the JNBC or the technical committee determines which country's code should be referenced or if there is any process to determine which parts should be tailored to better suit Jordan. The major concern is that the code requirements may exceed the available resources within Jordan, requiring costly import.

For example, Jordan does have a local manufacturer of HVAC equipment named Petra. If Petra does not offer a unit that is up to the standards of if the Jordan 2008 building code, then builders will be required to import an HVAC unit, adding cost to the project. An alternative

would be to adapt the energy code to include building materials and systems that are domestically available in Jordan.

Once the code has been established and builders are implementing requirements using domestically available materials, the code can be updated with partners in industry like Petra and other material suppliers. This will ensure that the building industry and its codes and standards advance in parallel with domestically available building materials and systems. This creates a system that is achievable and cost effective for builders, and allows both the supply and demand of these materials to grow simultaneously. As the industry grows, codes and standards such as the 2008 Jordan Energy Efficiency code can become more stringent, pushing the industry and Jordan towards their energy efficiency goals. It is recommended that further research be conducted to explore this methodology.

The current absence of an appropriate standard for building efficiency adapted for Jordan, not only condones the design and installation of inefficient building systems, but makes it difficult to assess the level of efficiency for buildings which claim to be efficient. The energy code is subject to the same development and implementation procedures as any other building code in Jordan. At the time of this case study, there were 35 Jordanian National Building Codes implemented and enforced under the auspices of the Jordanian National Building Law 7 for the year 1993 and the Jordan 2008 building energy efficiency code was under review for implementation.

4.1.1 Existing Infrastructure for Code Development

Th Jordanian National Building Law 7 has 15 articles that describe the official process of the code development and enforcement. The law appoints a council, referred to as the Jordanian National Building Council which is chaired by the Minister of Public Works Prof. Mohammad Taleb Obaidat. Other council members include those shown in Figure 11[6]:

[6] http://www.jnbc.gov.jo/Web/PageInfo.aspx?Lng=1&PageID=29

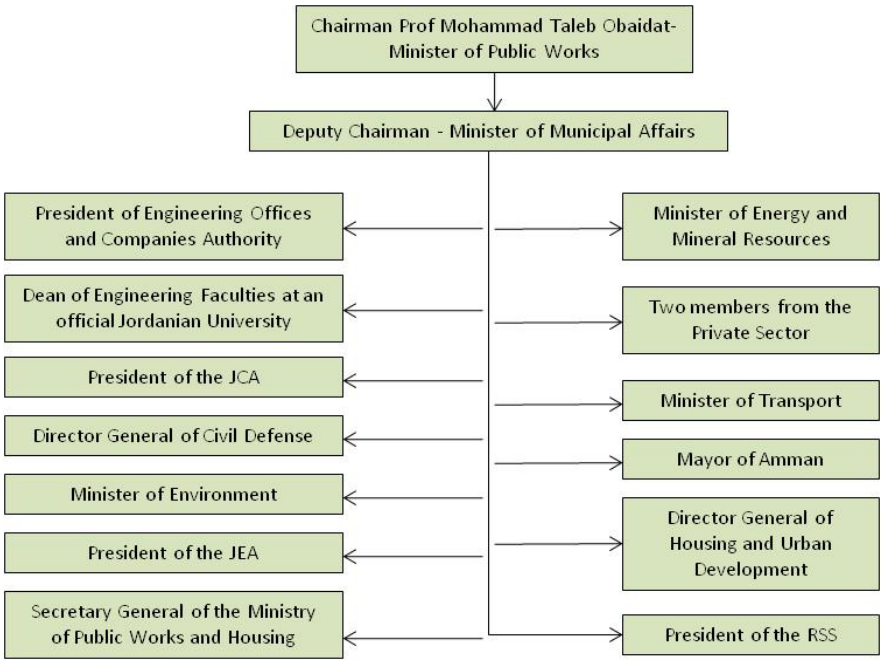

Figure 11 - JNBC Organizational Chart

The Jordanian National Building Council is vested with the following tasks and powers:

- Formulation of the bases and principles of the Jordanian National Building Codes and designation of the scope of each code following a recommendation by the Technical Committee.
- Adopting the various Jordanian National Building Codes and submitting the latter to the Council of Ministers for approval.
- Studying the recommendations of the Technical Committee and taking appropriate decisions in respect thereof.
- Deciding on any objection to the approved codes or to any amendment thereof according to the provisions of this Law.
- Entering into contract with any scientific agency for the preparation of new code or for carrying out any amendment of any approved code, determining the cost of such contract and approving its disbursement.
- Publication and circulation of the adopted codes.
- Issuance of regulations related to the application of the codes at the stages of design, execution, supervision, maintenance, operation, public safety works and all the engineering works related thereto

Jordanian National Building Law 7 also appoints a second committee called the Technical Committee of the Jordanian National Building Codes. This committee is chaired by the

Secretary General of the Ministry of Public Works, Engineer Sami Halaseh. Other technical committee members include those shown in Figure 12:

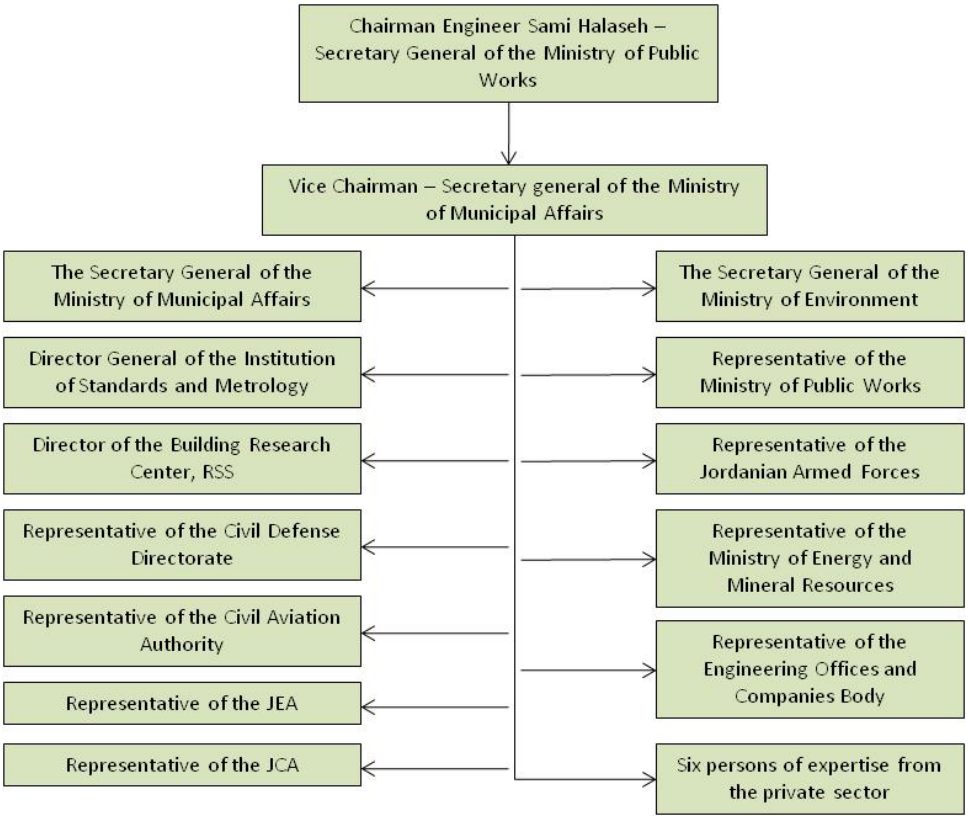

Figure 12 - Technical Committee Organizational Chart

The Technical Committee of Jordanian National Building Codes is responsible for carrying out the following functions:

- Preparation of the bases and principles of the Jordanian National Building Codes and making recommendations concerning them to the Building Council.
- Recommendation to the Council of any amendments of the approved codes.
- Reviewing objections to the codes referred to (Technical Committee) and submitting its recommendations thereon to the Council.
- Following up the works of specialized committees and scientific parties which are charged with the preparation, modification and development of codes.
- Any other tasks and duties related to the codes and entrusted to the Technical Committee in accordance with regulations issued by the Council for this purpose including the regulation related to the application of the codes.

4.1.2 New Code Development or Alteration of Existing Code

Typically, a private or governmental organization will approach JNBC with a request for a new code or an existing code to be altered. The JNBC will form a specialized committee within the council to evaluate the request. Figure 13 shows the process for a code to become law in Jordan.

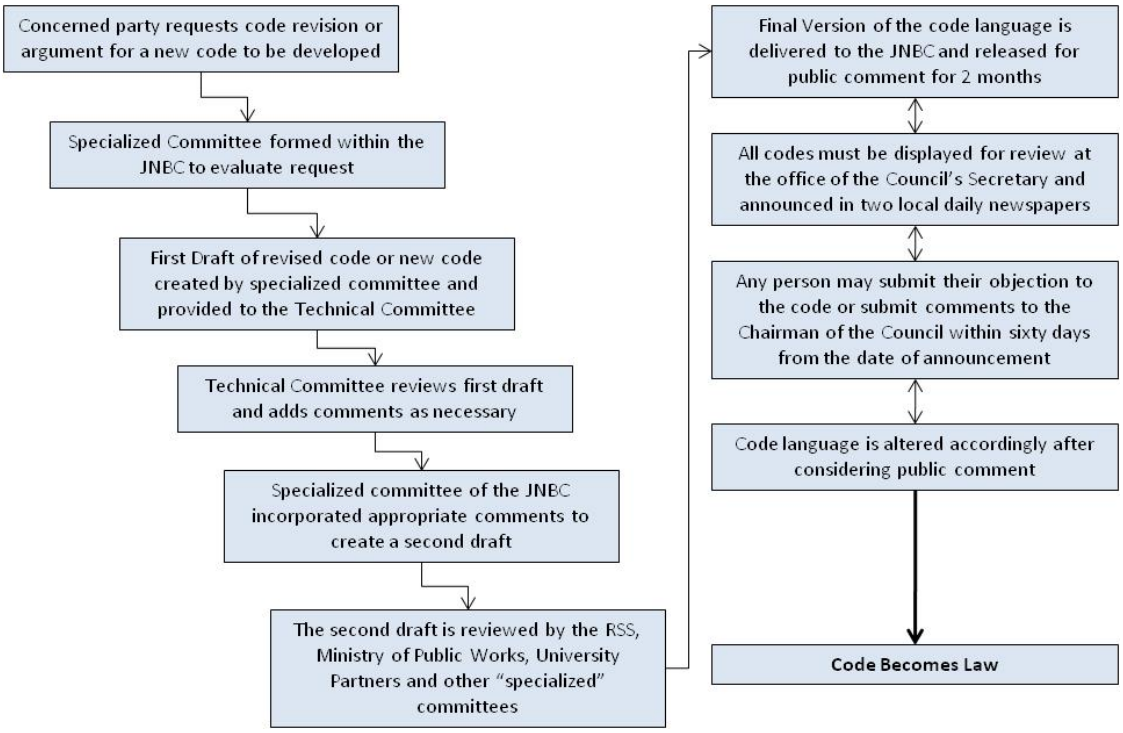

Figure 13 - New Code or Code Revision development process in Jordan

The Council is entitled to take the necessary measures to ensure that the adopted codes are applied in all stages of the engineering work including design, checking, supervision, execution, operation maintenance, public safety works and all the engineering works related thereto. Whoever violates the provisions of paragraph (a) of Article (12) of this Law shall be penalized by a fine of no less than one hundred Jordanian Dinars and not exceeding three thousand Jordanian Dinars for each violation of any code in accordance with the magnitude of such violation.

4.1.3 Recommendations for Codes Review and Updating Process

The Jordan 2008 energy savings building code is a good first step in developing a more robust and up to date energy efficiency code which is tailored specifically for the country of Jordan. However in order to create a code which is more in line with Jordan building practices and available resources, Nexant has identified the following steps which will benefit Jordan's building code structure and will help put in place a defined strategy for updating future energy code versions according to the changes in the local and international building practices and technologies:

1. *Development and maintenance of a detailed weather database for the 15 different climates identified in Appendix A of the building code*

   Accurate and up to date weather information is necessary in creating an energy code which most closely depicts the local conditions for the requirements as well as assist in realizing energy efficiency gains from the implementation of these codes. Hourly weather data including all important parameters of the 15 climate zones mentioned should be logged and archived. This weather data is also very helpful in creating weather formats which can be used in energy simulations. In United States, National Renewable Energy Laboratory (NREL) and Pacific Northwest National Laboratory (PNNL) run and operate many weather stations and archive weather data which is then used to update energy codes and creating standardized weather formats like TMY (Typical Meteorological Year) and WYEC (Weather Year for Energy Calculations).

2. *Development of Detailed and Generalized Energy Simulation Models for Residential and Non-Residential End Uses*

   Currently the Jordan code is a hybrid between a code and a guideline. In most sections, the requirements which have been put forward are prescriptive. This means that the proposed building should conform to the code for each specific component, for example, the proposed design should have a specific wall R-value as well as a specific Window U-factor. It is recommended that in addition to this approach, a performance approach should also be included in the code. In the performance approach, the designer will have more flexibility in creating an energy efficient design which will comply only if it is better than the code compliant building as a whole rather than for each component. So even if the Wall R-values are more than the prescriptive requirement, the building will be code compliant if the total energy consumption of the building is less than the code compliant building.

   In order to incorporate this approach in the code, a detailed study is required to create a generic simulation model of commercial and residential buildings in Jordan. This model should be capable of simulating different scenarios of weather, end-use, envelope and system types. This type of a simulation model will also be very beneficial in analyzing any updates which are required in building codes or any amendments proposed by local authorities according to their building practices. This approach is in common use in the United States. Any amendments to energy codes from local municipalities are analyzed through these weather dependent simulation models and these amendments only become part of the code if they are at least as stringent or more stringent than the current energy code.

3. *Envelope and System Requirement according to Climate Zones*

Currently all the prescriptive requirements in the Jordan code are not climate specific so for example the envelope insulation requirements for Al-Shoubak region and Ghoor Al-Safi region are exactly the same. This is not an ideal setup as these requirements might make the code too stringent for one climate zone while too relaxed for another climate zone. It is being recommended that the simulation models described above be used to analyze what kind of prescriptive requirements should be included in the codes according to the different climate zones so that the specific energy consumption of each end-use is similar for different climate zones. This will create a code which will be more uniformly stringent across the nation.

4. *Involvement of all Stakeholders at different building code development stages*

Jordan already has a public comments period for the energy codes. However, from the review it still seems that majority of the requirements have been copied from ASHRAE 90.1 2004, which makes the code stringent but in many cases not very practical or economically feasible. For example, in Jordan the use of passive cooling and natural ventilation is still a more common design practice than in United States. In many commercial buildings, there is no central cooling, all windows are operable and, during mild weather, cooling load is met by natural ventilation plus air movement through ceiling fans. For residences, central courtyards and high thermal capacity construction provides passive cooling during late morning and some of the cooling load is also dissipated by natural air movements through the houses.

So if the Jordan code is just a translation of Western codes without the incorporation of local building practices, then it seems that the local practices are being forced to change towards what is currently being practiced in the West. A detailed comparison between JNBC and ASHRAE 90.1-2004 is presented in Appendix C.

It is recommended that in addition to improving the code based on cutting edge technologies and making it more stringent, a balance should be maintained which allows the positive local practices to be a part of the codes. This will also help in developing local industry rather than depending on expensive imported items for increasing energy efficiency. For each code cycle, all the stakeholders (contractors, property developers, manufacturers, importers, engineers) should be involved in the discussion and all the major changes should be individually discussed to make sure that the changes being made to the code will result in better design and construction practices, which is the ultimate goal of this exercise.

The international Code Council (ICC) and American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) hold bi-annual meetings to discuss

propositions and code amendments from all segments of building industry. There are standing committees for each code section and these committees listen to each proposition and then vote to accept or reject the amendment. In the long run, Jordan would require a similar system in place to make sure that all amendments which become part of the code are in actuality practical for the local environment and do contribute towards increasing the efficiency of the new building stock.

5. *Update of building codes every three years*

   As discussed above, the building code should be updated at regular intervals to keep abreast of the new technologies as well as to address any other local issues raised by Stakeholders. Once the weather database is in place and a powerful simulation tool is available for the Jordan National Building Council, updating codes is a relatively streamlined procedure once all inputs from the stakeholders have been analyzed. Major version updates can occur every three years while minor changes/mistakes can be published as addendums. This is a standard practice followed both by ICC and ASHRAE.

6. *Review process for analyzing local amendments*

   For codes in United States, local municipalities can enforce their own building codes as long as it is more stringent than the state/national version. These amendments are submitted to the State's code compliance agency which reviews these amendments and once it is established that the amendments will not relax code requirements, the local municipality can go ahead and publish it as the local code. JNBC can put in place similar procedures for handling local changes to provide more venues for developing more localized energy efficient building practices. Currently JNBC uses the same protocol for each amendment as needed for a complete new code. This level of detail might not be necessary for individual amendments however some procedure should be in place to check the stringency of the change.

Building codes in Jordan are moving in the right direction. Creation of Jordan energy code is the first step towards incorporating energy efficiency in design and construction. Over the next several years, utilizing the above mentioned steps, Jordan will have a building energy code which will incorporate cutting edge technologies while at the same time utilize local building practices and materials to give the designers and engineers a comprehensive tool for creating energy efficient buildings.

4.2 Effect of Current Codes and Enforcement in Jordan on the Green Building Rating System

To effectively use a green building rating system, it must clearly answer the question 'is this building better than normal'. In order to answer this question, it must be widely accepted what exactly is 'normal'. The role of building codes, along with the enforcement of those

codes, provides a basis that can be agreed upon by key stakeholders, to define what a 'normal' building is. In Jordan, the standard for the existing stock and the new construction projects cannot be determined exclusively by evaluating the building codes.

It was found, during this case study, that there are facilities that do not meet the minimum standard in the country. It will need to be determined as to whether these buildings are to be included in resource consumption baselines. If these buildings are to not be included, this may create a baseline that is difficult to achieve, or exceed, for many of the building developers. It may be prudent to explore which tenants, or land occupiers, would be affected by the chosen baseline.

4.3 Example of an Alternate Code Compliance Regime

As Jordan moves towards more sustainable design and construction practices with more stringent code requirements, it is imperative that the compliance and permits procedure currently in place is also updated. Code enforcement is an integral part of promoting energy efficiency and sustainability in the buildings. Codes also help in driving the manufacturers in producing higher efficiency products.

Nexant met with stakeholders from all groups of the building industry including design firms, developers, contractors and government agencies. Feedback was obtained on the general construction process and current code compliance procedures as well as how it can be further improved. The general compliance procedure and inputs gathered have been summarized as follows:

- The building energy code is still in its infancy and efforts are currently underway to finalize the code and make it enforceable within the next year.
- Current code enforcement is more weighted during the design phase. For projects in Amman, completed drawings are submitted to the Greater Amman Municipality (GAM) which performs their general review.
- The drawings are then passed to the Jordan Engineers Association (JEA) for the technical design review.
- Once the design review is complete and approved, GAM verifies the hiring of a site supervisor and then issues the construction permit.
- The site supervisor is hired by the developer and should be registered with JEA. In some cases the design team can facilitate the hiring of, or will provide the site supervisor. No independent supervision is provided by GAM or any other authority.
- There are two major inspections which are conducted once the construction is complete, GAM inspection for checking dimension and setbacks (i.e. required area is left open on the periphery per law) and civil defense inspection for safety (i.e. fire, egress etc.).

- No inspection is conducted to verify that the final constructed structure has been built exactly according to the permit drawings. The site supervisor is the only person responsible for this.
- The review and compliance procedure also depends on the size and type of the project. For Abdali, since this is a high visibility project, there are numerous levels for verifying compliance. Abdali development has their own internal approval system; the drawings are then provided to GAM with a recommendation from Abdali to grant the permit For this development project, Abdali is also making sure that the supervising engineer is onsite to oversee the construction process rather than visiting the site occasionally which is more common for other smaller developments.
- For many residential projects, there is no compliance regime in place. The construction process can start and finish while completely bypassing the permits process.
- In most projects, the Jordan National Building Code (JNBC) is followed. However, in cases when foreign design firms are involved, international building codes are sometimes also utilized. The designs are also subject to JEA scrutiny and are required to be at least equivalent to JNBC, if not more stringent.
- Currently the energy code is not enforceable so the design review is only for the general building codes (i.e. electrical, mechanical, plumbing)
- Multiple parties interviewed agreed that better compliance and inspection as well oversight during and after construction is necessary.

In order to better implement energy efficiency and green building practices, this current code compliance procedure will require changes which will help streamline the process as well as make code enforcement more practical for the local authorities.

In the United States, the building inspection and code compliance system in general is the same for different states however there are some minor differences at the state level and even at the cities level depending on the governing codes, size of the building stock and other laws (environmental, air quality etc).

In order to appreciate how extensive and detailed the building permit process is, a detailed description of the process followed at the city of San Francisco is provided below.

Planning Meeting

Step 1 is to have an initial meeting with the city planning department to discuss the proposed project. Any major issues with the project will come to light in this meeting. For example if the neighborhood selected allow for building higher than 300 feet and it will require re-zoning of the area, then the project will be rejected at that time. Or if the end-use will cause more pollution to the area than any other existing business then the applicant would have to submit a detailed environmental assessment report with planning application.

Planning Application Review

Once the major issues have been discussed in the meeting, a planning application is filled with city planning department which will review it to assess the impact of this new project on neighborhood as a whole i.e. water resources consumption, increase in electrical demand, increase in traffic, pollution and so on. If all the criteria set forth by this department are met then the planning application is approved and the applicant can go ahead and start producing design drawings from the earlier schematics.

Permit Drawings Review

When the design drawings are complete, the applicant can request a quick review of the drawings in order to catch any evident issues with the drawings and code compliance documents before the detailed review. After this quick review, the entire set of drawings, Code compliance worksheets and load calculations are submitted to the building permits department. The submittals reviewed in detail by the permits department and checked for compliance with various codes including California-Title 24, plumbing, electrical and environmental codes. If any of the sections in the design are out of compliance, the applicant will have to rectify the issue and resubmit.

Building Permit Issued

The permit is issued after the drawing set and other submittals have been approved. The applicant can start construction but at the same time also schedule inspections for the plumbing, electrical, mechanical and building. In addition to these four inspections, if the site has an environmental impact or safety issues, then other inspections are also needed for example from the Bay Area Air Resource Board or the Occupational Safety and Health Administration (OSHA). If site fails on any of these inspections, the building permit department can issue a stop work order until the particular issue has been resolved. The inspections are performed during the construction phase. If the construction does not finish within the timeline laid out in the permit, the applicant needs to file for an extension before the expiration date.

Final Inspection and Sign off

Once the construction is complete, one final inspection is required by the building department. This inspection needs to be scheduled, conducted and passed before the actual occupancy and operation of the building. After the facility passes this inspection, the inspector signs off on the project which approves the facility for use.

This is the general flow of the construction process in San Francisco. The city also provides some additional resources to assist in the process. For example, if a new project is going for LEED Gold, the city has a priority permitting process which can provide quicker review feedbacks, expedited inspections and so on. Recently city of San Francisco passed a legislation that all municipal buildings (new construction or major renovation) will have LEED Silver certification.

The city of San Francisco and California in general are at the cutting edge of energy efficiency and environmental projection. The above mentioned construction review process may be more stringent then practiced by other states/cities but at the same time the overall structure would be the same. The other states will be less stringent because the building codes and laws are less stringent. But as far as following the construction process with the different review and inspection stages, the flow is the same and the compliance level will be as stringent as San Francisco. All the design reviews are conducted by professional or certified engineers. Inspections are also conducted by certified inspectors employed by the city.

In Jordan, all engineers registered with JEA can review and sign off on design documents. There is no test and any other such requirements for this registration. So there is a chance that engineers who are reviewing the design may not be experienced in building technologies or practices. As stated above, in United States only professional engineers certified through state entities can sign off on reviews. And there is a very rigorous method of testing engineers before they can acquire Professional Engineer (PE) license. If Jordan can create a similar procedure of licensing engineers, it will be beneficial for the code compliance as more experienced professionals can assist the design teams in catching and rectifying major issues with the project design.

5 Conclusion / Summary of Recommendations

For any country to have a successful green building practice and an associated green building rating system, it is imperative to have a strong energy efficiency base and a developed and enforceable building codes system. So in order to address all aspects of the current status of green building practices in Jordan, this study not only took the Crystalle Building through the LEED pre-certification process but also studied in detail the building codes and compliance procedures currently in place. Over the course of this investigation, Nexant met with multiple stakeholders to understand the building industry as a whole in Jordan. Nexant met with the Jordanian National Building Council to gain further understanding of the code development and implementation process within Jordan. Nexant also met with independent general building contractors to understand the practical use of the code and how it is applied by construction companies and how if any green building practices are incorporated in the current process.

Multiple developers were consulted to understand their role in the construction process and to get their feedback on building green, local code and its applicability. Architects and Engineers were also interviewed to gain feedback on code compliance and their experience with Green Buildings in Jordan. Other key stakeholders that provided valuable feedback on topics covered in this report include the JEA, Jordanian Green Building Council, members of the Royal Scientific Society, and University faculty.

Jordan has an effective infrastructure in place for building and energy code development. However this set up is not being fully utilized to develop and maintain the right energy code which accurately represents the different climate zones and construction practices of Jordan. Once a well balanced base energy code is developed, this infrastructure can be used to develop codes which are more focused towards green building practices.

Jordan is currently in the process of introducing the Jordan 2008 Building Energy Code. This code, based largely on India's Energy Conservation Building Code (ECBC) 2006, was developed mainly by university faculty and the Royal Scientific Society. Both the Jordan 2008 and ECBC 2006 code are based on ASHRAE 90.1-2004, which in is an appropriate starting point. It was found through the code comparison analysis (Appendix C) that many sections of ASHRAE 90.1 have been adopted with little or no changes for implementation in Jordan. It is recommended that in order to maximize the relevance and effectiveness of the energy code, the Jordan 2008 version should be further tailored according to local climate, current construction practices along with availability and affordability of technology. Furthermore, Jordan may also consider varying the prescriptive requirements of the energy code according to different climates. To do this, a more detailed database of hourly weather data would need to be maintained for the main cities in Jordan for each developed climate zone. It is apparent that in Jordan's 2008 energy code that some effort was allocated to

breaking up the cities within Jordan by their weather profile. This work could easily be used to develop climate zones throughout Jordan so that varying prescriptive requirements could be applied to each.

The successful implementation of an energy code and a green building rating system is dependent on building code compliance and building inspection infrastructure. If current codes that are in place are not being complied with, it is unlikely that many projects will attempt to exceed code requirements. Furthermore, if there are no inspections or third-party verifications to validate that code compliance is being achieved, any project can claim of being a green building.

Interviews with stakeholders suggest that the current process from design review to permit issue in Jordan is fundamentally sound, however more capacity and implementation is required to ensure that all projects receive a detailed design review. With the addition of more engineers and more detailed design reviews, a stronger design review process will ensure that all projects are in compliance with the current and future energy and green building codes.

Though the concept of how Jordan handles design review is sound, certain deficiencies were identified in the construction review, or post-permit process. According to multiple interviewees, there is no involvement of the code reviewing parties post-permit. Any major design changes, even those that could potentially bypass code requirements, can be approved by the supervising engineer without any follow up review by the permitting authority. Furthermore, the supervising engineer is paid by the owner producing a conflict of interest. These deficiencies could be resolved if a non-bias third party engineer employed by an organization not affiliated with the project follows up post permit to review the final design and its compliance with local code. This person could also be used to investigate non-permitted buildings to ensure that all buildings within Jordan are built to code.

Perhaps the most effective way to investigate Green Building in Jordan, was to subject a new construction project to an internationally recognized green building rating system. The LEED C&S V2.0 rating system served as an appropriate choice since it offers credits for a wide range of green building strategies. By actively administering the pre-certification process, each credit offered as part of this rating system was investigated for the Crystalle building. Using the information obtained, and supplemental research, each credit was also analyzed in terms of attainability, for Jordan in general. Certain credits were found to be challenging to obtain in Jordan and others were found to be easy to achieve, compared to common practice in the United States. It was found that design based credits are more easily obtainable than construction based credits. Though this was found to be the case, design standards used in USGBC system may not be optimized for Jordan. For example, certain design standards in ASHRAE 90.1-2004 may not be appropriate. Once Jordan 2008 energy code becomes law, it is recommended that it is used instead of ASHRAE 90.1-2004 for certain design based credits and prerequisites.

Construction based credits are more difficult to achieve due to lack of locally available resources. This includes building materials with recycled content, low VOC paints, and construction material recycling. In addition, some standards in the USGBC LEED system may not be applicable in Jordan. For example, the requirements of the Construction General Permit for a Stormwater Pollution Prevention plan may be considered overkill for Jordan.

The lack of an existing 'recycling' market creates a potential roadblock that will need to be considered as the 'green building' market grows. The services that are offered, primarily by 'Entity Green', are valuable though this firm is not in a position to scale up to a nationwide operation in the near term. Efforts should be made to collaborate either with the private sector, e.g. Entity Green, or the public sector, e.g. the Greater Amman Municipality (GAM). GAM could have its existing garbage collectors perform a more thorough recycling collection as well. The suggestion of GAM performing recycling collection was made by the JGBC. Assuming that the recycling collection is performed, there is still a lack of local or regional infrastructure for processing used materials that is up to international standards or best practices. The area of recycling is one where public assistance could greatly be used. This could come in the form of Public-Private Partnerships, grants, loans, etc.

Furthermore, the use of certain materials required by the USGBC create trade-offs. An example of this is FSC certified wood, where much of this wood comes from North America. So to use this wood there is an increase use of fossil fuels, thus the content has a higher embedded energy, as compared to using more regionally harvested wood.

A hybrid green building rating system (Jordan adopts USGBC LEED system until they can develop their own) appears to be most appropriate path keeping in the current building practices, expertise and resources available. Given this investigation and the findings therein, it does not appear optimum to permanently adopt USGBC System. In addition, the JGBC does not appear established enough to quickly and effectively create and implement its own unique rating system. It took the USGBC 5 years of development to introduce the first pilot version of LEED which has been altered many times since. The most logical path is that the JGBC continue to use USGBC system temporarily until JGBC can create a tailored and appropriate LEED rating system in collaboration with the World Green Building Council. This would involve altering and reweighing each credit in a manner that makes each credit appropriate for Jordan.

Once a green building rating system is in place, it seems logical that the JGBC should be the entity which oversees the green building rating system or process.

Appendix A –LEED Credit Performance

USGBC LEED Rating System and its application in Jordan

Design-based Credits Pursued – Crystalle and applicability for projects in Jordan

SS 1 – Site Selection

Credit Intent

To avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

There are not many environmentally sensitive sites in Amman or Jordan based on the US standards reference for this credit. The ministry environment closely monitors all environmentally sensitive sites and any building near these sites. For example, one project near the city of As-Salt, northwest of Amman is being built on public parkland which contains an ancient roman forest. The developer was required to relocate each tree on the project site at their cost. Though this project near As-Salt would not comply with this particular credit, it does provide some insight as to the role of the Ministry of Environment in Jordan. The Ministry of Environment and in turn Jordan may have different definitions and requirements for environmentally sensitive sites. Further research is recommended to understand Jordanian environmental standards in comparison to the US standards referenced for this credit.

Results at Crystalle

Since most areas of Amman, including the Abdali site, are not considered environmentally sensitive based on the US standards referenced for this credit, the credit was easy to achieve.

SS2 – Development Density & Community Connectivity

Credit Intent

To reduce pollution and land development impacts from automobile use.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

As the majority of the population in Jordan lives in urban areas, many existing buildings or new constructions occur in areas that are nearby a variety of services.

Results at Crystalle

The Crystalle building is in the Abdali project, which is an area that involves commercial and residential spaces. Many of the services will be available after final construction within the Abdali project alone. The project is going into an area where there are these services already.

This credit was achieved by evaluating the existing infrastructure and noting the proximity to the Crystalle project.

SS4– Alternative Transportation

Credit Intent

To reduce pollution and land development impacts from automobile use.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

SS4.1

Public transit is available in Amman, with public buses being used. Additionally there are mini buses that are used as a form of public transportation, though not organized by a municipal authority. These forms of transportation can be used in many parts of the city. The challenge that is faced is in finding publically accessible maps of the transportation system. In the case of the Crystalle building, it was found that there was a need to write a formal letter to the municipal authority, which creates a barrier that makes such a credit not easily achievable even though the infrastructure does exist.

SS4.2

From a building standpoint, this point is not difficult to achieve since it simply requires more infrastructure. However, the additional infrastructure will add to design and construction costs, which are not desirable. The main issue in Jordan is that bikes are rarely used.

SS4.3

The market availability of fuel-efficient vehicles creates a challenge for this credit. While the parking space can be provided, without many vehicles that fit this category, there may be the tendency for this to not happen. A building developer may not be interested in allocating prime parking spaces for cars that are not owned by building occupants. The inclusion of this credit in Jordan's eventual green building rating system may be dependent on either fuel-efficiency requirements or the market size of fuel-efficient vehicles.

Public Transportation

Results at Crystalle

The Abdali project, in particular the Crystalle building, is located near several public bus stops. Additional stops will be installed once the Abdali project is completed, though the compliance path that was chosen for this credit was to pursue it based on the existing bus routes.

Bicycle Storage and Changing Rooms

Results at Crystalle

Though the developer was skeptical that this credit is appropriate for both the Crystalle building and buildings in general in Amman, they made arrangements for point compliance.

This included dedicating a room in the underground parking section which can contain at least 30 bikes. Two shower and changing facilities, one for males and one for females, were provided to comply with the requirement of this credit.

Low-Emitting & Fuel Efficient Vehicles

Results at Crystalle

The Crystalle building will have parking spaces allocated for low-emitting and fuel-efficient vehicles. This is based on the desire of the building developer to be as green as economically possible. There will be fleet vehicles provided for use by building tenants, with a driver provided by the building. There are a total of 115 parking spaces for the facility and 9 of these spaces will be used by the low-emitting or fuel-efficient vehicles.

SS6 – Stormwater Design

Credit Intent

To limit disruption of natural hydrology by reducing impervious cover, increasing on-site filtration, reducing or eliminating pollution from stormwater runoff and eliminating contaminants.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

SS6.1

In Jordan, Amman included, stormwater runoff will eventually make its way to a Wadi, an Arabic term meaning valley or in some cases, a dry riverbed that contains water only during times of heavy rain. Though rain is scarce in Jordan, this condition highlights the importance of this credit.For this credit, designers would need to consider pre- and post- discharge rates and consider methods that would reduce site runoff to keep from polluting these Wadis. . Projects in Jordan may not easily comply with this credit without additional infrastructure that may not be included in a typical design.

SS6.2

The design costs and infrastructure required for implementing a rainwater harvesting system to reduce runoff can be costly. However, due to the scarcity of water in Jordan, it is becoming increasingly popular especially with the mega-projects to implement systems to harvest rainwater. Though there are multiple compliance path's the intent of the credit is to limit the disruption of natural hydrology which doesn't necessarily mean that a rainwater harvesting system is necessary. Other less expensive strategies could be implemented such as vegetation, cisterns, manhole treatment devices and retention ponds could be used. The desert climate with minimal natural hydrology characteristics do not lend themselves to the less expensive strategies. This raises some question as to the appropriateness of this credit for Jordan. It appears that the most effective compliance path in Jordan is the use of a rainwater

harvesting system. The fact that the design and implementation of a rainwater harvesting system is costly is a significant barrier. Due to the desert conditions, the use of other compliance methods may not be as effective since the disruption of the natural hydrology is not of significant concern in Jordan.

Quantity Control

Results at Crystalle

The Crystalle building site was previously a dirt lot, which had an imperviousness of less than 50%. The requirement for this case is to keep the post development peak discharge rate and quantity from exceeding the predevelopment peak discharge rate and quantity for the 1- and 2- year 24 hour design storm. To comply with this requirement and those of the Abdali master development, a rainwater harvesting system that captures 100% o f the water which lands on the roof was created. This allows nearly all stormwater to be collected on site much of which is used for greywater. The remaining water which is not collected on the roof, typically ends up rivers and springs in neighboring valleys (Wadis).

Quality Control

Results at Crystalle

The project team has included a rainwater harvesting system which collects 100% of the rainwater which lands on the roof which was a requirement to build within the greater Abdali development. According to the project team, the building footprint/rooftop takes up 95% of the total site area which would suggest that 95% of the total site's annual rainfall is collected through this system. This rainwater harvesting system is connected to a piping network which delivers this water to the Greater Abdali central water treatment plant. The water is then stored as greywater and used for the Abdali development's irrigation and other greywater needs.

Though the specific details regarding the filtration characteristics were unknown at the time of precertification, it is expected that more that 80% of the total suspended solids (TSS) are removed through this process. The remaining 5% of site runoff is collected by a separate street level storm sewer network. It is also unknown as to what happens to the remaining 5% of water which is captured by the street level storm sewer network.

The fact that over 95% of the average annual rainfall is captured and treated through the rainwater harvesting system demonstrated compliance with this credit. Without the use of this rainwater harvesting system, water which lands on the roof would have simply been diverted to the street level storm sewer network, or would have simply left the site through other channels. Water that ends up in Amman’s stormwater network typically drains to the nearest Wadi, an Arabic term for a dry river bed. Most of these stormwater drains divert water to the Zarka river valley. Since over 90% of the sites annual rainfall is captured and treated to remove at least 80% of TSS, compliance with this point was verified.

SS7.2 – Heat Island Effect – Roof

Credit Intent

To reduce heat islands in order to help minimize impacts on microclimates and human and wildlife habitats.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

From a building standpoint, this point was not difficult to comply with since it simply requires painting the roof a reflective color or selecting roofing materials that are reflective. The design and construction team must specify these light colored or reflective roofing materials. For buildings in Jordan, Option 1 would be the only appropriate compliance path. A vegetated roof would be a difficult compliance path due to limited water resources in this desert climate.

Results at Crystalle

Since roofing materials are required on any project, the incremental cost to comply with this point is minimal should option 1 be pursued. The contractor can simply purchase a roofing material with a color that provides a Solar Reflective Index (SRI) greater than 78. At the time that the report was written, the design team and developer had not finalized the roofing configuration and materials. The developer and design team were considering a rooftop patio. The use of reflective materials on a rooftop patio may cause occupant discomfort due to glare and brightness. As a result, compliance with this point could not be verified, though the intent to use reflective materials was present.

SS8.1 – Light Pollution Reduction

Credit Intent

To minimize light trespass from the building and site, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction and reduce development impact from lighting on nocturnal environments.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

This point is difficult to achieve since designers in Jordan rarely reference the required standards for this credit. In addition, unlike other credits, there are multiple requirements for interior exterior and Lighting Power reduction/controls. This makes this credit hard internationally, not just in Jordan. The design team reported that designing a lighting system that is compliant with the referenced standards for this credit was not difficult; it is just not standard practice. Due to the nature of lighting systems in Jordan, most buildings may unintentionally comply with the standard. Most buildings in Jordan do not have much exterior lighting and lighting power densities are traditionally lower than those in the United States.

Results at Crystalle

The lighting engineer was tasked with compliance with this point. After her research on the credit she designed a compliant lighting system and produced the necessary documentation to demonstrate compliance with the required standard.

SS9 – Tenant Design & Construction Guidelines

Credit Intent

The point of this credit is to educate tenants about implementing sustainable design and construction features in their tenant improvement build-out.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

There is not significant barrier for achieving this credit in Jordan as it could be provided by any of the project team members. This is something that may be most easily produced by the LEED consultant or the building developer but there is unlikely to be a significant increase in cost as a result of this.

Results at Crystalle

The Crystalle building's developer, the Matrix Group, will be producing the guidelines, once all suggested interior designs have been finalized. Marketing material will be produced that draws attention to many of the green building features of the facility, though in addition to this a specific guideline will be produced. The incremental cost of this has not yet been determined for the Crystalle project.

WE1 – Water Efficient Landscaping

Credit Intent

To limit or eliminate the use of potable water or other natural surface or subsurface water resources available on or near the project site for landscape irrigation.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

This credit can be achieved in Jordan by utilizing appropriate plants and other landscape design features or by simply not including any landscaping or associated irrigation. Since Jordanians are very water conscious, it is uncommon to include landscaping in a design. Should landscaping be included this credit can be achieved in Jordan by utilizing native and adapted plants and other landscape design features, based on results from soil/climate analysis. Stormwater, greywater, and/or condensate water can be used as sources for irrigation if needed. The 'mid-summer baseline case' for calculating water efficiency, should irrigation be included on a project, is not clearly defined for Jordan. Due to the climatic differences between the United States and Jordan, a baseline calculation based on the United States LEED system may not be appropriate.

Results at Crystalle

There is no water used for irrigation at Crystalle, which allows the project to achieve both points automatically.

WE2 – Innovative Wastewater Technologies

Credit Intent

To reduce wastewater generation and potable water demand while increasing the local aquifer recharge.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

The design costs and infrastructure required for implementing a wastewater reuse system can be costly, however due to the scarcity of water in Jordan, it is becoming increasingly popular and more buildings are implementing the technology. Many of the mega projects are implementing greywater systems regularly, though there is no specific requirement for a system to be in place. Both options are viable in Jordan, however since Option 2 was pursued for the case study due to plans already in place by the developer, Option 1 was not investigated.

Results at Crystalle

To comply with the requirements of the Abdali master development, each projects was required to incorporate its own Grey Water Treatment Plant to collect grey water from showers, sinks, swimming pools and laundry. Once treated this water was to be reused for irrigation and toilets flushing. This not only reduces wastewater generation but also domestic water consumption. This requirement made LEED point compliance easy for Crystalle. For projects outside of Abdali, intial cost for design and construction of a greywater system may deter developers or owners from implementing such a system. For these cases, option 1 may be a more appropriate compliance path. Since the availability of water conserving fixtures is unknown, it is difficult to evaluate the possibility of an Option 1 compliance path. For Crystalle, a rainwater harvesting system is in place. Water from this harvesting system is delivered to the central Abdali water treatment plant. Though the option 1 compliance path was not attempted, Crystalle is eligible for this credit using either option 1 or option 2.

WE3 – Water Use Reduction

Credit Intent

To further increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

The design costs are not affected by specifying low flow water closets, urinals, lavatory faucets, showers and kitchen sinks. The only cost that would be affected in this case is the implementation costs. The availability of low-flow fixtures remains unknown. However, it is assumed that low flow fixtures can be imported at a minimal incremental cost. Jordanians are very conscious of their water use and the intent of this credit is in line with their overall building ethic. The use of greywater systems also contribute to potable water savings. Since many mega projects are implementing greywater systems regularly, this increased the chances for compliance within Jordan.

Results at Crystalle

At the time of the pre-certification submittal, the design team and contractor had not yet finalized the water fixture schedule. It has been agreed by all parties that the project will utilize use low-flow faucets, showers, water closets, and urinals throughout the building in all but residential spaces. Tenant spaces will require build-outs which could result in a conventional flow water fixture being used though there will be an effort to push low-flow fixtures, this cannot be a requirement.

For the design case, to address this, it was assumed that 50% of occupants will use conventional flow water closets while the other 50% will be using low-flow water closets located in non-tenant areas. Given the multi-occupant nature of this building, there will be more residential lavatories, kitchen sinks and showers than in non-tenant spaces. To address this, precertification templates were populated assuming 75% of lavatories, kitchen sinks and showers will be conventional flow with 25% being low flow. Since there is no tenant requirement to use low flow fixtures, it cannot be assumed that they will be used. Since the water fixture schedule had not yet been specifically selected, fixture details like manufacturer and model were unknown at the time of this pre-certification submittal.

In addition to the use of low-flow fixtures, the project uses a greywater system which is used for all flush type fixtures on site. As calculated through the use of this template, design case flush fixture water usage is 295,445 gallons/yr. Since the greywater system has been sized to handle all flush fixture water usage, 295,445 gallons of non-potable water will be used instead of potable water. When considering both the greywater reuse and the plans for low flow fixture usage, the Crystalle building uses 30.4% less potable water than the baseline calculated based on Energy Policy Act-1992.

EAP2 – Minimum Energy Performance

Credit Intent

To establish the minimum level of energy efficiency for the proposed building and systems to reduce environmental and economic impacts associated with excessive energy use.

Easily Achievable in Jordan ☐

Not Easily Achievable in Jordan ☑

Though the energy modeling work is easy to outsource, there are not many firms within Jordan which provide energy modeling services. In addition, there is some question on the appropriateness of the AHSRAE 90.1 requirements for Jordan. This is complicated by the variation in Jordan design practice when compared to the United States design practice which is what ASHRAE standards are based on.

Results at Crystalle

To comply with the requirements, a United States firm was hired to complete a simulation model using ASHRAE 90.1 as baseline.

EAP3 – Fundamental Refrigeration Management

Credit Intent

To reduce stratospheric ozone depletion.

Easily Achievable in Jordan ☑

Not Easily Achievable in Jordan ☐

The use of non-CFC refrigerants does occur in Jordan, especially on mega projects such as Abdali. Since no refrigerant based Direct Expansion type systems were used at Crystalle, it was difficult to understand the various refrigerant options available in Jordan for smaller units. There is currently no requirement in Jordan to use any specific refrigerants. More research is necessary to understand the availability of refrigerants in Jordan.

Results at Crystalle

All of Crystalle's HVAC equipment utilizes chilled and hot water delivered from the central plant. For Abdali, the entire development is piped from a central plant. The chillers located at this central plant, including the one which serves the Crystalle Project use R-717 - Ammonia Refrigerant which does not contain CFCs.

EA1 – Optimize Energy Performance

Credit Intent

To achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

Easily Achievable in Jordan ☐

Not Easily Achievable in Jordan ☑

Building on the EAP2 discussion, this point has two characteristics which were considered for this case study. The first consideration is the relevance of the referenced code, in this case ASHRAE 90.1-2004. The building ethic in Jordan is much different than in the United States. When compared to the typical building in the United States, an equivalent building in the Jordan has less façade and other exterior lighting, large operable windows for natural ventilation, and unconditioned support spaces such as corridors. At the time of this study, this practice wasn't based on any energy code or requirement; it was just the standard to minimize building operation costs. These types of building practices make overall site energy density lower when compared to an ASHRAE 90.1-2004 building.

The ASHRAE standard has various sub-sections which cover various aspects of a building and its systems. Some sub-sections like site lighting power density, Jordan will easily exceed ASHRAE 90.1-2004 standards. Other sub-sections for HVAC equipment efficiency ratings, Jordan may have issues meeting the standard. Though more research is necessary, it is apparent that Jordan would benefit more from an energy code tailored specifically to the existing building industry and common practices within Jordan, instead of adopting the ASHRAE 90.1 standard outright. Further investigation is recommended.

Regardless of what standard for building efficiency is used, the second consideration is the capacity of qualified personnel to perform the energy model. It was found during the case study that some capacity building is necessary. Though the energy modeling work is easy to outsource, the availability of these services in Jordan are scarce.

Results at Crystalle

The Crystalle project team pursued Option 1 by initiating a Whole Building Energy Simulation. To do this the project team elected to hire an independent energy modeling firm based in the United States to demonstrate that their building design not only meets, but exceeds the mandatory provisions required in ASHRAE 90.1-2004. The energy modeling firm hired for this project was WinBuild, Inc. located at 11103 Redford Court Fairfax, VA 22030. WinBuild used Design Builder 2.2 version which uses Energy plus as the simulation engine.

The proposed case model was developed based on design drawings and multiple conversations/clarifications from the various members of the design team. The base case model was created per the ASHRAE 90.1 Appendix G requirements. Results of simulation runs suggest that the proposed design of the Crystalle building exceeds an ASHRAE 90.1 compliant building by 42.8% based on energy and 44.3% by cost. More detailed information regarding simulation inputs and outputs and a summary spreadsheet of energy use for both the baseline and proposed models can be found in Appendix B.

EA4 – Enhanced Refrigeration Management

Credit Intent

To reduce ozone depletion and support early compliance with the Montreal Protocol while minimizing direct contributions to climate change.

Easily Achievable in Jordan ☑

Not Easily Achievable in Jordan ☐

The use of low or no GWP or ODP based refrigerants does occur in Jordan as recognized at the Abdali central Since no refrigerant based Direct Expansion type systems were used at Crystalle, it was difficult to understand the various refrigerant options available in Jordan for smaller units. There is currently no requirement in Jordan to use any specific refrigerants. More research is necessary to understand the availability of refrigerants in Jordan.

Results at Crystalle

As mentioned for EAP3, the Crystalle apartment building is served by the central plant of the greater Abdali project. Chilled and hot water is piped from the central plant to the air handler units at the site which serve the entire building. As a result, there are no refrigerants being utilized onsite. The chiller installed at the Abdali central plant uses R-717, an ammonia based refrigerant which has both 0 GWP and ODP, demonstrating compliance.

EA 5– Measurement & Verification

Credit Intent

To provide for the ongoing accountability of building energy consumption over time.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

EA5.1

This credit requires infrastructure to track the whole building's electricity usage over time. Depending on the compliance path chosen, this information can be used to verify electricity at the systems level or to calibrate the building model created for EAP-2 and EA 1. By keeping a calibrated energy model on file, future energy conservation measures can be evaluated with an accurate baseline condition. If this credit is combined with EAP-2 and EA 1, this credit can easily be achieved in Jordan. Extra funding would need to be allocated to creating an M&V plan, installing metering equipment, analyzing the data and for the energy modeler to calibrate the base model.

EA5.2

This credit requires infrastructure to track tenant electricity usage over time. This requirement can be integrated into a tenant billing structure which will allow the building owner to accurately bill tenants based on their electricity usage. This will encourage tenants to use electricity responsibly and will keep energy conscious tenants from being overcharged which can happen with less intuitive tenant billing systems. If budgeted properly, the use of the tenant metering/billing system, which would need to be installed to achieve this credit, could be paid for through the billing strategy.

Base Building

Results at Crystalle

The project team plans on pursuing compliance with this point through Option 1 which consists of adhering to the requirements of Option D: Calibrated Simulation, of the IPMVP. Since a Calibrated building model was created to comply with the requirements of EAP-2 and EA 1, this model will used in part to demonstrate compliance with EA Credit 5.1 and 5.2. The project team will incorporate the necessary infrastructure (i.e building master- and sub-meters) to facilitate metering whole building and tenant space electrical loads. After the building has achieved a reasonable degree of occupancy and operational stability, a total of 1-year of data will be used for comparison to the predicted energy use of the building.

The information gained from M&V will be used for calibration of the as-built simulation model. This calibrated simulation model will allow for meaningful performance comparisons and the accurate determination of verified savings for any future energy based projects.

Tenant Sub Metering

Results at Crystalle

Like with EA 5.1, though the M&V plan is not currently in place, the project team plans to create and implement this plan prior to the certificate of occupancy being issued. The project team has incorporated the necessary infrastructure (i.e building master- and sub- meters) to facilitate metering whole building and tenant space electrical loads. The focus of EA 5.2 is to allow any tenant that leases space within the Crystalle building to be able to earn EA Credit 3 in LEED-CI. Each tenant, both residential and commercial will be sub-metered so that the building owner can charge each tenant for their electricity usage. Furthermore, sub-metering allows for tenants with a mechanism to account for their electricity consumption. In the event that any tenant makes an energy savings investment, they will have the capability of tracking their usage both before and after implementation.

MRP1 –Storage & Collection of Recyclables

Credit Intent

Assist in the reduction of waste generated by the building occupants that is hauled to and disposed of in landfills.

Easily Achievable in Jordan ☐

Not Easily Achievable in Jordan ☑

While it is possible to have recyclables collected in Jordan, the industry is still in its infancy. All materials are not all locally recycled, though these materials can all be collected by both private and public entities. It is possible to arrange for recyclable materials to be picked up through these entities, however the capacity of these entities would need to grow to support the growing recycling industry in Jordan. At the time of this report, one of the larger recyclers had the capacity to collect and recycle the required materials for this credit. This company claimed a recycling rate of about 80%-90% which means 10-20% of materials supplied to the recycler still end up in landfills or incinerators. A recycling rate of 80-90% is common also in the United States.

Results at Crystalle

There will be recycling collected at the Crystalle building, by a local recycling firm. While the contracts have not been signed yet, there is intention by the building developer to have this in place. The market for recycling collection has grown in a timely manner for the Crystalle building to be able to utilize the existing collection and handing infrastructure that is in place in Amman.

IEQP1 – Minimum IAQ Performance

Establish minimum indoor air quality performance to enhance indoor air quality in buildings, thus contributing to the comfort and well-being of the occupants.

Easily Achievable in Jordan ☑

Not Easily Achievable in Jordan ☐

This can be achieved as the design teams in Jordan typically abide by the local code which is stringent. This credit could be achieved by a developer in Jordan without a great difficulty if it were so desired, as part of a Green Building certification system.

Results at Crystalle

The Mechanical Engineer for the Crystalle Building designed the ventilation system to meet the minimum requirements for both the mechanically and naturally ventilated spaces. The residential and common areas in the Crystalle building are mechanically ventilated. The retail spaces are naturally ventilated, though large doors are expected to be open allowing for the indoor air to regularly exchange with the outside air.

IEQP2 – Environmental Tobacco Smoke Control

Required Prerequisite

Credit Intent

To prevent or minimize exposure to building occupants, indoor surfaces and ventilation air distribution systems to environmental tobacco smoke (ETS).

Easily Achievable in Jordan ☑

Not Easily Achievable in Jordan ☐

This prerequisite simply requires the owner to designate smoking areas outside of the building away from operable windows and fresh air intakes. Smoking is popular in Jordanian culture, however the health benefits to non-smoking tenants are important.

Results at Crystalle

The Crystalle building will have a no-smoking policy in all public areas with the exception of a dedicated smoking area for the drivers. This area will be completely isolated from other areas, have its own ventilation system and will maintain negative pressure to prevent smoke from exiting into adjacent areas. This policy will be enforced by posting signs identifying the non-smoking and smoking areas of the building, alerting the security personnel to look-out for and identify anyone violating this policy. Since one of the chief selling point to tenants is the healthy aspects of living at Crystalle, the developer doesn't believe this policy to have any negative impacts.

IEQ5 – Indoor Chemical & Pollutant Source Control

Credit Intent

Minimize exposure of building occupants to potentially hazardous particulates and chemical pollutants.

Easily Achievable in Jordan☑

Not Easily Achievable in Jordan ☐

This point can be easily achieved in Jordan should the design team pay attention to the detailed requirements of this credit. The spaces with hazardous materials will have to be taken into account during the design phase to ensure that the HVAC system is designed appropriately for them. MERV 13 filters were not studied in this report as to whether they are affordable in Jordan, though it is unlikely that the cost of these would preclude a large portion

of the market interested in 'green buildings' from seeking out this credit. There will be some incremental cost should the design team include permanent entryway systems for point compliance. Roll-out mat type entryway systems are common in commercial buildings and can be leveraged for point compliance as well.

Results at Crystalle

The design team and the developer have the intent of achieving this credit. Due to this commitment, floor mats or permanent entryway systems will be installed. The rooms with hazardous materials are intended to have pressure differentials that, at a minimum, meet the requirements for this credit.

IEQ6 – Controllability of Systems – Thermal Comfort

Credit Intent

Provide thermal comfort control to a high level so that individual occupants and specific groups of multi-occupants can promote productivity, comfort and well-being.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

Being able to achieve this credit is highly dependent on the market that will be occupying the building.

Results at Crystalle

The Crystalle building, a building that serves a high-end clientele, will provide residential and commercial tenants with dedicated temperature controls. The design of the buildings airside systems include dedicated fan coil units which are served by the building's chilled and hot water loop. Since each of these units will have dedicated controls, a high level of control is given to all occupants.

IEQ7 – Thermal Comfort – Design

Credit Intent

To provide a comfortable thermal environment that promotes occupant productivity and well being.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

It is rare that AHSRAE 55 is referenced when designing the HVAC and thermal comfort system in Jordan. Though the standard is appropriate, and most buildings fall somewhere within the requirements of ASHRAE 55, there is no active code or requirement to ensure ASHRAE 55 is followed.

Results at Crystalle

The Crystalle apartment building receives chilled and hot water from a central plant located within the greater Abdali project. Both the chilled and hot water is piped from the source (chilled water plant) to two separate heat exchangers. These heat exchangers are connected to a chilled and hot water distribution network which distributes hot water and chilled water

throughout the building. All occupied spaces, both residential and commercial, have taps to connect the distribution system to air handling units (AHUs).

Tenants in commercial spaces are required to size their AHUs accordingly based on space requirements so details on commercial AHUs are not included until tenant lease agreements have been finalized. For residential, each space has an adequately sized fan coil unit which contains provisions for both heating and air conditioning.

Each individual room has its own fan coil unit so the occupant can set zone temperatures accordingly. The fan coil system for residential tenants have been sized based on cooling design day and heating design day temperatures for Amman, Jordan while considering the internal loads of the building. The fan coil units will maintain max/min space temperatures as well as max space Relative Humidity (RH) values above for each space. Table 3 shows Crystalle Building Indoor space temperatures, as designed.

Season	Max Indoor Space Design Temp (deg C)	MinIndoor Space Design Temp (deg C)	Max Indoor Space Design Humidity
Spring	24	22	50
Summer	24	22	50
Fall	23	21	50
Winter	23	21	50

Table 3 - Crystalle Building Design Conditions

IEQ 8 – Daylight and Views

Credit Intent

To provide for the building occupants with a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

Though it is easily achievable, designers must be on top of the requirements for this credit. They must locate regularly occupied spaces on the perimeter or under skylights so that at least 75% of these occupied spaces have access to effective daylighting. To get both points, designers must also locate regularly occupied spaces on the perimeter so that at least 90% of these occupied spaces have access to outdoor views. The hard part is getting the designers to consider this credit up front and design accordingly.

Results at Crystalle

Since the design was finalized in parallel with the LEED pre-certification efforts, the USGBC supplied Daylight and Views calculator was used to calculate the D&V characteristics of the building. For this credit each space both residential and commercial was given sufficient

access to both daylight and views. As the attached elevations show there are many windows for both the retail and residential spaces.

A total of 40 spaces, 16 commercial and 24 residential were analyzed and the glazing factor was calculated based on the regularly occupied areas of each space. For controlling glare in both commercial and residential space, a window with a low visible transmittance (0.45) was used. To compensate for this low VT, more windows were added. For residential spaces, fixed shades were added to reduce glare. It should be noted that windows with shades were not included in the calculation. Using the LEED recommended calculation methodology for Option 1, 76.64% of regularly occupied spaces have a Glazing Factor of 2% or more, demonstrating compliance with this credit.

For EQ 8.2, all tenant and building developer owned spaces were evaluated. The design team placed all regularly occupied tenant and developer owned spaces near the highly glazed perimeter to provide occupants with clear views and a connection to outdoor spaces. As displayed in the elevations glazing for most floors extends from floor to ceiling. This maximizes the amount of vision glazing for all building occupants. The attached floor plans and elevations were used to determine a connection for regularly occupied spaces to vision glazing. Based on the Views calculation, 93.62% of regularly occupied spaces which include both residential and commercial spaces have access to views. There are some windows which have fixed shades over them; these windows with shades were not included in the calculation.

Innovation in Design

Credit Intent

To provide design teams and projects the opportunity to achieve exceptional performance above the requirements set by the LEED Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

Due to the flexibility of these points, this ID credit is as achievable as any other country with LEED rating systems. Though it is easily achievable, the project team must still create and implement an innovative design or construction practice that would be considered innovative by the USGBC. For Jordan, It may be more appropriate if perhaps the Jordan Green Building Council decided what was innovative for Jordan. What the USGBC may consider innovative may not align with the design and construction industry in Jordan. Using compliance path two, for exemplary performance, the project must exceed the requirements of those credits eligible for exemplary performance. Using either compliance path, four points are available for this ID credit.

Point 1.1 - Green Building Rating System Case Study in the Hashemite Kingdom of Jordan

Results at Crystalle

Easily Achievable in Jordan ☑

Not Easily Achievable in Jordan ☐

There will be additional incremental costs that will be associated with these activities, though they are important pieces in education and awareness activities. Education and awareness activities are an integral aspect of building an active 'green' market. The activities that will have incremental costs will be: print material, development and production; website development, in particular annual updating; public event attendance, preparation and attendance fees.

Point 1.2 - Residential Tenant - Commercial Office Space

Results at Crystalle

As part of the precertification submittal the project team suggested an innovation in design credit named "Residential Tenant - Commercial Office Space". The intent of this credit is to reduce pollution and land development impacts from automobile use by offering full office space and amenities to residential tenants within the same building.

As part of the ID submittal, the project team must include a narrative on the suggested compliance path. The following narrative was included:

"This credit will require the project and building owner to offer full working office amenities which include, but are not limited to, private office space, a conference room, computers, secretary, copy center, and a phone system made available to only residential tenants of the same building."

The Crystalle Project will have a commercial section of the building containing multiple private office spaces, conference rooms, copy center and a phone system which are only available to the residential tenants of the building. These office spaces will have a shared secretary which will answer phones and route the call to the office accordingly. It is important to note that these office spaces and the facilities described will only be available to residential tenants to reduce their dependence on automobile use. Should the spaces not be filled, they will not be leased out to companies or people that do not reside within Crystalle and will be reserved for future tenants who may want to lease this space in addition to their residential unit.

Point 2 LEED AP

Credit Intent

To support and encourage the design integration required by LEED to streamline the application and certification process.

Requirements

At least 1 principal participant of the project team shall be a LEED AP.

Easily Achievable in Jordan ☑

Not Easily Achievable in Jordan ☐

Many LEED APs are available for participation in projects within Jordan.

Results at Crystalle

Mr. Bishr Sakkal was the chief point of contact and project manager for Matrix Inc, developer for the Crystalle Project. As the developer, he is responsible from overseeing the project from conception to occupancy. He participated in the earliest conceptual phases, hired the design team and worked with them to fulfill the vision of Crystalle. His work continued into the construction phase where he worked with the Greater Amman Municipality and the Abdali Project (Larger development in which Crystalle is a part of) to begin construction. During construction, he personally ensured that all LEED requirements for credits and prerequisites applied for were conformed too. He was also responsible for any tracking required for any of the credits/prerequisite. Bishr was the most involved person on this project in both the design and construction phases.

Design-based Credits Not Pursued for Crystalle and applicability for projects in Jordan

SS3 – Brownfield Redevelopment

Credit Intent

To rehabilitate damaged sites where development is complicated by environmental contamination and to reduce pressure on undeveloped land.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

Though there are sites, namely in Amman, that could be considered a Brownfield, the Jordanian government does not currently have a program which identifies Brownfields. Infrastructure would need to be set up. An ASTM or equivalent site assessment could be conducted, however this would be added cost to the developer.

Results at Crystalle

The site of the Crystalle building had previously been used by the military and was not a Brownfield. This credit is tied to where the facility is being built and since the Abdali site located the plot in an area that was not a Brownfield, the Crystalle building is not pursing this credit.

SS4.4 – Alternative Transportation Parking Capacity

Credit Intent

The point of this credit is to reduce pollution and land development impacts from automobile use.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

In general this credit could be achieved in Jordan. If the local code is abided by and not exceeded this would satisfy the intent of this credit. Option 1 can be achieved, with relative ease in Jordan. Option 2, may have more challenges as this is not standard practice. While there are mini buses, which pick up people at designated locations, this differs from carpools all originating at one location. Option 3, this could be achieved relatively easily. Option 4, would be challenging to achieve because of the dependence of automobiles in Jordan.

Results at Crystalle

The Crystalle building is intended for high-end users, where one luxury feature is the provision of abundant parking for multiple cars. By working towards this goal, this compromises the eligibility for this credit. The Crystalle building's target market is not a normal market in Jordan so this does not directly mean that is very difficult to achieve this credit in Jordan.

SS 5.2 Maximize Open Space

Credit Intent

To conserve existing natural areas and to restore damaged areas to provide habitat and promote biodiversity.

Easily Achievable in Jordan ☐

Not Easily Achievable in Jordan ☑

In the urban areas of Amman there is a high level of density. The aspects of this credit that accommodate this situation utilize technologies that are not common to Jordan. Green roofs are not commonly used, though this credit serves as an opportunity to encourage their use. Having a pond in Jordan is not very realistic given the scarcity of water sources in the Country. This is a credit that could be applicable to areas that are at the perimeter of the city.

Results at Crystalle

The Abdali project involves master planning that has each plot designated for a given developer. The Crystalle building has been designed for one parcel and there is no additional land area that can be used in the adjacent area that is or will be under the operational control of the owner or operator of the Crystalle building.

EA2 – Onsite Renewable Energy

Credit Intent

To encourage and recognize increasing levels of on-site renewable energy self-supply to reduce environmental and economic impacts associated with fossil fuel energy use.

Easily Achievable in Jordan ☐

Not Easily Achievable in Jordan ☑

The initial cost of Solar PV is high in Jordan. Though some benefits for the technology are offered "duty free", more is needed according to local design and construction professionals interviewed for this study.

Results at Crystalle

According to the rules of the Abdali project the projects within the space are not allowed to use self-generation of power other than back-up generators.

IEQ1 - Outdoor Air Delivery Monitoring

Credit Intent

To provide capacity for ventilation system monitoring to help promote occupant comfort and well-being.

Easily Achievable in Jordan ☐

Not Easily Achievable in Jordan ☑

The use of a Building EMS with intelligent HVAC controls is rare in Jordan. In addition, the upfront cost is not attractive for this point since only a small portion of those benefits are allocated to the party that would be paying for the materials and activities required to achieve the credit, even though the benefits may be high for the building occupants.

Results at Crystalle

This project was not sought after because there was a relatively high incremental cost for additional carbon dioxide monitoring equipment and the payback is expected to be too high.

IEQ2 – Increased Ventilation Rate

Credit Intent

To provide capacity for ventilation system monitoring to help promote occupant comfort and well-being.

Easily Achievable in Jordan ☐

Not Easily Achievable in Jordan ☑

It is rare that AHSRAE 62.1 is referenced when designing the ventilation system in Jordan. Though the standard is appropriate, buildings in Jordan typically leverage natural ventilation and small split HVAC units per room rather than installing large central AHUs.

Results at Crystalle

The mechanical system was designed to meet the ASHRAE requirements but not to exceed them at this point.

Construction-based Credits Pursued – Crystalle and applicability for projects in Jordan

SSP1 – Construction Activity Pollution Prevention

Required Prerequisite

Credit Intent

To reduce pollution from construction activities by controlling soil erosion, waterway sedimentation and airborne dust generation. More specifically, this point aims to prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse. In turn compliance with this prerequisite will help prevent sedimentation of storm sewers or receiving streams and pollution of the air with dust and particulate matter.

Easily Achievable in Jordan ☐

Not Easily Achievable in Jordan ☑

Creating an Erosion and Sedimentation control plan is not standard practice in Jordan. Some of the USEPA Construction General Permit (CGP) requirements are heavily placed on stormwater erosion control and less on wind erosion control. In addition, Jordan has a DRASTIC index (a rating system to quantify the susceptibility of the groundwater to contamination) of 40-97 out of a total of 230. In order to comply with the USGBC prerequisite, an international consultant familiar with the US EPA CGP would need to be hired. Based on estimates from the LEED consultant, this would add approximately JD 5,000 to the upfront cost of the project.

Results at Crystalle

Since creating and implementing an Erosion and Sedimentation control plan is not standard practice, it proved difficult to arrange for such a plan to be created on the Crystalle project. The project team relied on the LEED consultant to develop the plan in accordance with the 2003 EPA CGP since no formal codes or standards exist in Jordan. Furthermore, since the USEPA CGP weighs heavily on storm water protection, it was determined that this reference standard is inappropriate for construction activities in Jordan. A referenced standard that relies more heavily on reducing wind borne pollution is recommended. The estimate of JD 5,000 to produce this plan is based on the LEED consultant's time commitment to provide a 2003 EPA CGP compliant Erosion and Sedimentation control plan. Benefits include those indicated in the Credit Intent.

SS7.1 – Heat Island Effect – Non Roof

Credit Intent

To reduce heat islands' to minimize impacts on microclimates, human and wildlife habitats.

Easily Achievable in Jordan ☑

Not Easily Achievable in Jordan ☐

From a building standpoint, this point is not difficult to achieve since the footprint of most buildings in Jordan take up over 95% of the total site area and exterior parking is rarely used.

Typically, the remaining site area is grey or white concrete which both have SRI values greater than 29. In addition, underground parking is a common theme in Jordan which makes for easy integration with SS7.2 if a cool roof is used. However, some portions of option 1 are not likely to occur, nor are appropriate for Jordan. This includes using trees to shade the hardscape, or the use of a pervious open grid pavement system.

Results at Crystalle

The project team designed the project to have 100% underground parking. Due to the nature of the project and the size of the parcel, design team and developer had two options: Provide no parking, or provide parking underground. Since the developer wanted to provide tenants with parking, the only option was to put it underneath the building. Per the requirements of Option 2 for this credit, compliance is based on placing at least 50% of parking underground with a roof that has an SRI value of at least 29. At the time that the report was written, the design team and developer had not finalized the roofing configuration and materials, though the intent was to use roofing materials with an SRI greater than 29.

EAP1 – Fundamental Commissioning

Required Prerequisite

Credit Intent

To verify that the project's energy-related systems are installed, calibrated and perform according to the owner's project requirements, basis of design, and construction documents.

Easily Achievable in Jordan ☐

Not Easily Achievable in Jordan ☑

There is only one qualified CxA in Amman that was found. On top of the lack of qualified personnel is the additional upfront cost; which is a difficult sell to most developers without knowledge of the energy savings figures that can be achieved from Cx practices.

Results at Crystalle

The lack of qualified personnel with commissioning experience in Amman did not prove to be a barrier for Crystalle specifically. Should the demand for commissioning services increase within Amman, this credit could become increasingly difficult to achieve in Jordan. Based on a Lawrence Berkeley Lab study, a typical new construction project can expect to pay approximately \$1.16/ft² for commissioning services with an estimated savings of \$0.18/ft²-year. This suggests a simple payback period of 4.2 years for new construction projects[7]. Since the commissioning procedure had yet to be initiated, the energy savings from the process had yet to be determined. The costs to comply with the requirements of this credit and to complete the commissioning process based on the contract between developer and commissioning authority was JD 10,000 or \$14,200.

[7] Mills, Dr. Evan. 2009 "Building Commissioning, A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions" Lawrence Berkeley National Laboratory

MR4 – Recycled Content

Credit Intent

This credit is intended to increase the demand for building products that incorporate recycled content materials, thereby reducing the impacts resulting from the extraction and processing of the fresh materials.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

Recycling materials is not a common practice in Jordan, so there are a limited number of suppliers that can provide this service. While it is possible acquire such materials, there is an additional incremental cost that may not be a priority for some developers.

Results at Crystalle

The Crystalle building will be constructed using 100% recycled steel (pre-consumer) and concrete with 7% recycled material content (pre-consumer). The total quantities of these two materials are 1000 tons and 25,000 tons, respectively. The total value of these materials is estimated to be JD 500,000 and JD 600,000, respectively. The total value of all materials that will be included in the construction of the Crystalle project has not yet been calculated, though it is the intent of the building developer, the Matrix Group, to achieve this credit.

MR5 – Regional Materials

Credit Intent

This credit is intended to increase the demand for building products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts from transportation.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

Regionally extracted, processed and manufactured materials are not common in Jordan, so there are a limited number of suppliers that can provide this to people. While it is possible to acquire such materials, there is an additional incremental cost that may not be a priority for some developers.

Results at Crystalle

The Crystalle building will be constructed using concrete that has been manufactured within 500 miles of the project site. The raw materials were extracted and processed within 500 miles of the site as well. The total quantity of this material is 25,000 tons. The total value of this material is estimated to be JD 600,000. The total value of all materials that will be included in the construction of the Crystalle project has not yet been calculated, though it is the intent of the building developer, the Matrix Group, to achieve this credit.

MR6 –Certified Wood

Credit Intent

The intent of this credit is to encourage environmentally responsible forest management.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

FSC certified wood is not locally produced in Jordan and is expensive to receive. There are other wood certifications that are available, though these are different from FSC.

Results at Crystalle

The Crystalle project will be using Klausner certified word, though this is not FSC certified wood. It is the intention of the building developer to use 'sustainable' wood but the cost of FSC certified wood is very high in Jordan.

Figure 14 - Klausner Wood

IEQ3 – Construction IAQ Management Plan –During Construction

Credit Intent

To reduce IAQ problems resulting from construction or renovation and promote the comfort and well being of construction workers and building occupants.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

In Jordan, typically there is no IAQ management plant to protect construction workers' comfort and well being by reducing IAQ problems. The LEED consulting team had to create one for the project team to implement accordingly.

Results at Crystalle

Though creating and implementing an IAQ management plan is not standard practice, it was not difficult to arrange for such a plan to be created and implemented on the Crystalle project. The project team relied on the LEED consultant to develop the plan in accordance with SMACNA IAQ guidelines to comply with this credit. At the time of this report, various housekeeping requirements were already being conducted with the intent to follow through with all aspects of the plan as construction progresses. The benefits of the implementation of this plan include a clean and organized working environment for employees, better IAQ during construction for workers, and overall better IAQ once the building is completed. Additional cost for credit compliance is hard to gauge since the developer and general

contractor may already implement some or all of these practices. Gauging from other current construction projects in Amman and interviews with developers and contractors, most of the SMACNA requirements are not distinctly followed during construction.

IEQ4 – Low-Emitting Materials

Credit Intent

To reduce the quantity of indoor air contaminants that is odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

It is difficult to get low VOC products in Jordan. If products are low VOC they are seldom marked as such. Since there has historically been no demand for this type of product, it cannot be expected that it would be produced and readily available in Jordan. Based on initial research, all low VOC products for this project would need to be imported. In the United States, these products or more readily available, making this credit harder to achieve in Jordan.

Results at Crystalle

Though construction had not yet gotten to the point where adhesives and sealants, paints and coatings, and composite wood and agrifiber products would be selected or used, the developer committed to hiring sub-contractor that would comply with this requirement. This commitment was demonstrated by the implementation of a LEED specification section to be included in construction documents supplied for bidding. The benefits of complying with these credits include a better IAQ by reducing contaminants from construction materials. This will create a healthier environment for occupants and construction workers. Costs and contractor compliance regarding these products was not yet known.

Construction-based Credits Not Pursued for Crystalle and applicability for projects in Jordan

SS5 – Site Development

Credit Intent

To conserve existing natural areas and to restore damaged areas to provide habitat and promote biodiversity.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

There are two points available through this credit: Protect or restore habitat and maximize open space. Jordan is predominantly a desert climate with little or no vegetation. In this regard it is easy to protect or restore the desert habitat within the project site. However, it is not common for buildings in Jordan to include landscaping, at least in Amman. This makes it difficult to supply a landscaping plan as part of the submittal documentation which focuses on using native vegetation for a building feature that rarely exists. In addition, for most commercial buildings, the building footprint takes up the majority of the sites area and they are typically very close to the next building. This leaves only a small percentage of the site area to protect or restore habitat in and makes it near impossible to maximize open space.

Results at Crystalle

Though this site was previously developed, the building footprint occupies more than 90% of the total site area. The remaining foot print consists of concrete driveways and walkways with minimal area that can be restored to include native or adapted vegetation. Due to the relatively small size of the site area (not including the building footprint), the intent of this credit could not be met.

EA3 – Enhanced Commissioning

Credit Intent

To begin the commissioning process early in the design process and execute additional activities after systems performance verification is completed.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

As found while investigating EAP 1- Fundamental Commissioning, there is only one qualified Commissioning Agent in Amman that was found. On top of the lack of qualified personnel is the additional upfront cost; which is a difficult sell to most developers without knowledge of the energy savings figures that can be achieved from Commissioning practices.

Results at Crystalle

The Commissioning authority was not designated prior to the start of construction documents phase, nor were any reviews of the OPR, BOD and design documents performed prior to 50% Construction Drawings stage.

EA6 – Green Power

Credit Intent

To encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

Though a renewable energy contract is not available for purchase through the Jordanian Utilities, projects in Jordan can achieve this point by purchasing Renewable Energy Certificates RECs through a third party vendor.

Results at Crystalle

Though this credit was not attempted for precertification, the developer is prepared to purchase the required amount of Renewable Energy Certificates during the certification design or construction approvals should the project need extra points to achieve the desired level of certification.

MR1 – Building Reuse

Credit Intent

To extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

There is much opportunity, especially in Amman, for Jordanians to comply with this point. The cost savings associated with reusing older buildings structure for a new project is well known within Jordan. The practice of renovating an older structure to meet the requirements of a new building is also very common.

Results at Crystalle

Since this is a new construction project with no building previously on the site, this credit did not apply.

MR2 – Construction Waste Management

Credit Intent

To divert construction and demolition debris from disposal in landfills and incineration facilities. Redirect recyclable recovered resources back to the manufacturing process and reusable materials to appropriate sites.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

At the time of this study, Jordan was lacking the infrastructure to comply with this point. The recycling industry was in the process of growing and capacity was limited. Since the industry was just getting started, the recycler approached during this study had targeted the hospitality sector with emphasis on hotel waste. Towards the end of this study, the same recycler had expanded services to supermarkets by collecting cardboard used for shipping boxes. It was

also found that there is a shortage of recyclers in Jordan. They recycler interviewed for this study was perhaps the most prominent.

Results at Crystalle

Though talks were initiated with one of the more prominent private sector recyclers, services to remove and recycle construction debris were unavailable. Regardless, the project developer kept recyclable materials separate from other construction waste.

Figure 15 - Crystalle project material storage area

MR3 – Materials Reuse

Credit Intent

To reuse materials and products to reduce demand for virgin materials and reduce waste, thereby lessening impacts associated with the extraction and processing of virgin resources.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

At the time of this study, there were no construction waste salvage companies in Jordan. As a result, it was difficult to obtain salvaged materials to comply with this credit. The lack of capacity makes this point very difficult to achieve within Jordan. Though there is no industry set up to buy and sell salvaged materials, projects may be able to handle the purchase of salvaged materials on a case-by-case basis. An example would be the use of materials from a nearby building undergoing a renovation or demolition.

Results at Crystalle

Due to the design of the building and the lack of availability of salvaged materials, this credit was not pursued.

IEQ4.3 – Low-Emitting Materials – Carpet Systems

Credit Intent

To reduce the quantity of indoor air contaminants that is odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

Easily Achievable in Jordan ☐
Not Easily Achievable in Jordan ☑

The lack of availability of the required flooring materials with the necessary certification or that meets the required standard make the low-emitting material credits difficult for projects in Jordan. Based on the Crystalle case study, most of the low-emitting products will need to be imported.

Results at Crystalle

The Crystalle building did not include carpets in its design. All floors were specified as hard surface. Due to the increased cost associated with importing floorscore certified flooring, this credit was not attempted. All other low-emitting credits were attempted.

Appendix B – LEED Credit Requirements

Sustainable Sites Credits

SSP1 - Construction Activity Pollution Prevention

Create and implement an Erosion and Sedimentation Control Plan during the design phase of the project. This plan must conform to the erosion and sedimentation requirements of the 2003 EPA Construction General Permit (CGP) or local codes and standards, whichever is more stringent. An alternative compliance path is for the contractor to create the ESC or under the direction of the Civil Engineer. The plan must be implemented prior to the beginning of project construction.

SS 1- Site Selection

Don't develop buildings, hardscape, roads or parking areas on portions of sites that meet the following criteria:

1.) Prime farmland as defined by the United States Department of Agriculture in the US Code of Federal Regulations, Title 7, Volume 6, Parts 400-699, Section 657.5(Citation 7CFR657.5).

2.) Previously undeveloped land whose elevation is lower than 5 feet above the elevation of the 100 year flood as defined by FEMA.

3.) Land that is specifically identified as habitat for any species on Federal of State Threatened or endangered species lists.

4.) Within 100 feet of any wetlands as defined by the US Code of Federal Regulations 40 CFR, Parts 230-233 and Part 22, and isolated wetlands or areas of special concern identified by state of local rule, OR within setback distances from wetlands prescribed in state or local regulations, as defined by local or state rule or law, whichever is more stringent.

5.) Previously undeveloped land that is within 50 feet of a water body, defined as seas, lakes, rivers, streams and tributaries which support or could support fish, recreation or industrial use, consistent with the terminology of the Clean Water Act

6.) Land which prior to acquisition for the project was public parkland, unless land of equal or greater value as parkland is accepted in trade by the public landowner.

SS 2- Development Density & Community Connectivity

Construct and renovate building on previously developed site and within ½ mile of a residential zone or neighborhood with an average density of 10 units per acre net and within ½ mile of at least 10 Basic Services and pedestrian access between the building and the services.

SS 3 - Brownfield Rehabilitation

Option 1

Develop on a site documented as contaminated by means of an ASTM E1903-97 Phase II Environmental site Assessment or a local voluntary cleanup program

Option 2

Develop on a site defined as a brownfield by a local, state, or federal government agency

SS 4.1- Alternative Transportation: Public Transportation

Option 1 – Rail station Proximity

Locate the project within ½ mile walking distance (measured from main building entrance) of an existing or planned and funded commuter rail, light rail or subway

Option 2 – Bus Stop Proximity

Locate the project within ¼ mile walking distance (measured from main building entrance) of 1 or more stops for 2 or more public, campus, or private bus lines usable by building occupants.

SS 4.2 - Alternative Transportation: Bicycle Storage & Changing Rooms

For the case of Crystalle, a mixed use facility, the commercial and residential facilities had different requirements for this credit. For the residential portion, the project needs to provide covered bicycle storage facilities for 15 or more of building occupants. For the commercial portion, the project needs to provide secure bicycle racks or storage for 5% of non-residential building users and provide shower and changing facilities for 0.5% of non-residential building users AND provide shower and changing facilities for 0.5% of non-residential FTE Occupants.

SS 4.3 - Alternative Transportation: Low Emitting & Fuel Efficient Vehicles

Provide preferred parking(spots closest to the main entrance) for low-emitting and fuel efficient vehicles (ZEV or have achieved a minimum green score of 40 per ACEEE) for 5% of the total vehicle parking capacity of the site. If the requires payment for parking a discounted parking rate is an acceptable alternative.

OR

Install alternative-fuel fueling stations for 3% of the total vehicle parking capacity of the site. Liquid or gaseous fuelding facilities must be separately ventilated or located outdoors.

SS 4.4 – Alternative Transportation - Parking Capacity

There are four compliance paths for this credit:

- Option 1 – Non-residential
  - Size parking capacity to no exceed minimum local zoning requirements
- Option 2 – Non-residential
  - For projects that provide parking for less than 3% of FTE building occupants: provide preferred parking for carpools or vanpools, marked as such, for 3% of total provided parking spaces.
- Option 3 – Residential
  - Size parking capacity to not exceed minimum local zoning requirements and provide infrastructure and support programs to facilitate shared vehicle usage such as carpool drop-off areas, designated parking for vanpools, or car-share services, ride boards and shuttle services to mass transit.

- Option 4 – All
    - Provide no new parking

SS 5.1- Site Development: Protect or Restore habitat

Case 1 Greenfield Sites (sites that are not previously developed or graded and remain in a natural state)

Limit all site disturbance 40 feet and beyond the building perimeter, 10 feet beyond surface walkways, patios, surface parking and utilities less than 12" in diameter, 15 feet beyond primary roadway curbs and main utility branch trenches, 25 feet beyond constructed areas with permeable services.

Case 2 Previously Developed Areas (Site previously contained buildings, roadway, or parking lots) or Graded Sites

Restore or protect a minimum of 50% of the site (excluding building footprint) with native or adapted vegetation.

SS 5.2 – Site Development: Maximize Open Space

Case 1 – Sites with Local Zoning Open Space Requirements

Reduce the development footprint (building, hardscape, access roads and parking) and/or provide vegetated open space within the project boundary such that the amount of open space exceeds local zoning requirements by 25%

Case 2 – Sites with No Local Zoning Requirements

Provide vegetated open space area adjacent to the building that is equal in area to the building footprint.

Case 3 – Sites with Zoning Ordinances but No open space requirements

Provide vegetated open space equal to 20% of the project's site area.

SS 6.1-Stormwater Design: Quantity Control

Case 1 – Sites with Existing Imperviousness 50% or Less (e.g. dirt field)

Option 1

Implement a stormwater management plan that prevents the post development peak discharge rate and quantity from exceeding the predevelopment peak discharge rate and quantity for the 1- and 2- year 24 hour design storm

Option 2

Implement a stormwater management plan that protects receiving stream channels from excessive erosion. The stormwater management plan must include a stream channel protection and quantity control strategies.

Case 2 – Sites with Existing Imperviousness is greater than 50%(e.g. parking lot)

Implement a stormwater management plan that results in a 25% decrease in the volume of stormwater runoff from the 2-year 24 hour design storm.

SS 6.2-Stormwater Design: Quality Control

Implement a stormwater management plant which reduces impervious cover, promotes infiltration and captures and treats the runoff from 90% of the annual rainfall using acceptable BMPs which are capable of removing post-development total suspended solids (TSS).

SS 7.1- Heat Island Effect: Non-Roof

Option 1

Use any combination of the following strategies for 50% of the site hardscape (including roads, sidewalks, courtyards and parking lots)

- Shade from the existing tree canopy or within 5 years of landscape installation
- Shade from structures covered by solar panels
- Shade from architectural devices or structures with an SRI value of at least 29
- Use of Hardscape materials with an SIR of at least 29
- Use of an open grid pavement system (at least 50% pervious)

Option 2

Place a minimum of 50% of parking spaces under cover. Any roof used to cover must have an SRI of at least 29, a vegetated green roof or solar panels.

SS 7.2- Heat Island Effect: Roof

Option 1

Use roofing materials with a solar reflectance index (SRI) equal to or greater than the 78 for low sloped (2:12 or below) or 29 for steep sloped (2:12 or greater).

Option 2

Install a vegetated roof that covers at least 50% of the roof area

Option 3

Install high SRI and vegetated roof surfaces that, in combination, meet the following criteria.

SS 8- Light Pollution Reduction

Option 1

Reduce input power on all nonemergency interior luminaires with a direct line of sight to any opening in the envelope (translucent or transparent) by at least 50% between 11pm and 5am. After-hours override may be provided by a manual or occupant sensing device provided the override lasts no more than 30 minutes.

Option 2

All openings in the envelope (translucent or transparent) with a direct line of sight to any nonemergency luminaires must have shielding (controlled/closed by automatic device for a resultant transmittance of less than 10% between 11pm and 5am).

For Exterior Lighting

Option 1

Light areas only as required for safety and comfort. Lighting power densities must not exceed ANSI/ASHRAE/IESNA Standard 90.1-2004 for the classified zone. Classify the project under 1 of the following zones (LZ1, LZ2, L3, LZ4)

SS 9- Tenant Design & Construction Guidelines

Publish an illustrated document that provides tenants with design and construction information that details the following:

- Provides a description of the sustainable design and construction features incorporated in the core and shell project and delineates the project intent with respect to sustainability goals and objectives including those for tenant spaces.
- Provides information that enables a tenant to coordinate their space design and construction with the core and shell's building systems. Most of the buildings LEED-CS credits to be addressed when applicable.

Provides information on the LEED Green Building Rating System for Commercial Interiors (LEED-CI) and how the core and shell building contributes to achieving these credits.

Water Efficiency Credits

WE 1.1-1.2- Water Efficient Landscaping: Reduce by 50% (1 Point) or No Potable Water Use (2 Points)

Option 1(1 point)

Reduce potable water consumption for irrigation by 50% from a calculated midsummer baseline case. Reductions must be attributed to any combination of the following items:

- Plant species factor
- Irrigation efficiency
- Use of captured rainwater
- Use of recycled wastewater
- Use of water treated and conveyed by a public agency specifically for non-potable uses.

Option 2 (2 points)

Meet the requirements for option 1 and comply with one of the following paths:

Path 1: Use only captured rainwater, recycled wastewater, recycled graywater or water treated and conveyed by a public agency specifically for non potable uses for irrigation

Path 2: Install landscaping that does not require permanent irrigation systems. Temporary irrigation systems used for plant establishment are allowed only if removed within 1 year of installation

WE 2- Innovative Wastewater Technologies

Option 1

Reduce potable water use for building sewage conveyance by 50% through the use of water-conserving fixtures (e.g. water closets, urinals) or nonpotable water (e.g. captured rainwater, recycled graywater, on-site or municipally treated wastewater)

Option 2

Treat 50% of wastewater on-site to tertiary standards. Treated water must be infiltrated or used on-site.

WE 3.1-3.2- Water Efficient Landscaping: Reduce by 20% (1 Point) or 30% (2 Points)

Employ strategies that in aggregate use 20% less (or 30% for 2 points) water than the water use baseline calculated for the building (not including irrigation) after meeting the Energy Policy Act of 1992 (and as amended) fixture performance requirements. Calculations are based on estimate occupant usage and shall include only the following fixtures: water closets, urinals, lavatory faucets, showers and kitchen sinks.

Energy & Atmosphere Credits

EAP 1- Fundamental Commissioning of the Building Energy Systems

The following commissioning process activities must be completed by the project team:

- Designate an individual as the commissioning authority (CxA) to lead, review and oversee the completion of the commissioning process activities.
    - CxA must have documented commissioning authority experience in at least 2 building projects
    - CxA must be independent of the project's design and construction management
    - CxA must report results, findings and recommendations directly to the owner
    - For projects less than 50,000 ft², the CxA may be a qualified person on the design or construction teams
- The owner must document the owner's project requirements. The design team must develop the basis of design. The CxA must review these documents for clarity and completeness. The owner and design team must be responsible for updates to their respective documents
- Develop and incorporate commissioning requirements into the construction documents
- Develop and implement a commissioning plan
- Verify the installation and performance of the systems to be commissioned
- Complete a summary commissioning report

Commissioned systems must include (at minimum)

1. HVAC
2. Lighting and daylighting controls
3. Domestic hot water systems
4. Renewable energy systems

EAP 2- Minimum Energy Performance

Requirements

Option 1: Whole Building Energy Simulation

Demonstrate a 14% improvement in the proposed building performance rating in the proposed building performance rating, compared with the baseline building. The baseline building should be calculated in accordance with Appendix G of Standard 90.1-2004.

EAP 3- Fundamental Refrigeration Management

Do not use CFC based refrigerants in new base building HVAC&R systems.

EA 1- Optimize Energy Performance

Option 1: Whole Building Energy Simulation (1-8 points)

Demonstrate a percentage improvement in the proposed building performance rating compared with the baseline building performance rating. The minimum energy cost savings percentage for each point threshold is as follows:

New Buildings	Existing Buildings	Points
10.5%	3.5%	1
14%	7%	2
17.5%	10.5%	3
21%	14%	4
24.5%	17.5%	5
28%	21%	6
31.5%	24.5%	7
35%	28%	8

Option 2: Prescriptive Compliance Path (1-3 Points)

Comply with the ASHRAE Advanced Energy Design Guide for Small Office Buildings for the Climate Zone in which the building is located. This compliance path may only be used for office buildings up to 20,000 ft^2

Option 3: Prescriptive Compliance Path: Advanced Buildings Core Performance Guide

Comply with the Basic Criteria and Prescriptive Measures of the NBI Advanced Building Benchmark Version 1.1.

EA 2- On-Site Renewable Energy

The following requirements are needed in order to achieve this point:

- Use on-site renewable energy to reduce the facilities consumption of fossil fuels
- Calculate the project performance of the renewable energy system by calculating the amount of on-site generation as a percentage of the total cost energy consumption caused by the facility.

The building annual energy cost can be estimated as the same quantity calculated in EA Credit 1 or the U.S. Department of Energy Commercial Building Energy Consumption Survey (CBECS) database can be used to determine the estimated annual electricity use.

EA 3- Enhanced Commissioning

In addition to those requirements in EAP 1 Fundamental Commissioning, Comply with the following requirements:

- Designate a commissioning authority prior to the start of construction documents phase
- Conduct at least commissioning design review of the Owner's Project Requirements (OPR), Basis of Design (BOD), and design documents (including drawings and specifications) prior to 50% Construction Documents (CD) phase
- Conduct a parallel review (With A/E reviews) of contractor submittals applicable to systems being commissioned for compliance with the OPR, BOD.
- Organize the development of a systems manual that provides future operating staff with the information needed to understand and optimally operate the commissioned systems
- Verify the training of O&M staff by installing contractors
- Demonstrate involvement or plan therof in reviewing the operation of the building with O&M staff within 10 months after substantial completion. A plan for resolving outstanding commissioning related items must be included.

EA 4- Enhanced Refrigeration Management

Option 1

Do not use Refrigerants

Option 2:

Select HVAC&R equipment that uses refrigerants which minimize or eliminate the emission of compounds that contribute to ozone depletion and global climate change. The requirement of this credit extends beyond the prerequisite of simply not using CFC based refrigerant. This credit involves accounting for the GWP and ODP values of all refrigerants used on site. Equipment with less than 0.5lbs of refrigerant shall not be counted for this credit.

EA 5.1 Measurement & Verification – Base Building

Provide the necessary infrastructure within the base building design to facilitate metering buiding electricity and tenant electrical end-uses as appropriate

And

Develop and implement a Measurement and Verification Plan consistent with Option D: Calibrated Simulation, or Option B: Energy Conservation Measure Isolation, as specified in the International Performance M&V Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April, 2003.

EA 5.2 Measurement & Verification – Tenant Sub-Metering

Include a centrally monitored electronic metering network in the base building design that is capable of being expanded to accommodate the future tenant sub-metering as required by LEED for CI Rating System EA Credit 3.

Develop a tenant M&V plan that documents and advises future tenants of this opportunity and the means of their achievement.

EA 6- Green Power

Engage in at least a 2-year renewable energy contract to provide at least 35% of the building's electricity from renewable sources, as defined by the Center for Resources Solutions' Green-e Energy product certification requirements. Purchases shall be based on the quantity of energy consumed, not the cost. The core and shell building's electricity is defined as the electricity usage of the core and shell square footage, as defined by BOMA standards, but not less than 15% of the buildings total gross square footage.

Option 1: Determine Baseline Electricity Use

Use the annual electricity consumption from the results of EA Credit 1: Optimize Energy Performance

Option 2: Estimate Baseline Electricity Use

Use the US DOE Commercial Buildings Energy Consumption Survey Database (CBECS) to determine the estimated electricity use.

Materials & Resources Credits

MRP 1 – Storage and Collection of Recyclables

Provide dedicated collection and storage areas, accessible by all areas of the building, for the following non-hazardous materials: glass, plastic, cardboard, plastics and metals.

MR 1– Building Reuse: Maintain Existing Walls, Floors and Roof

Maintain at least 25% the existing building structure (including structural floor and roof decking) and envelope (the exterior skin and framing, excluding window assemblies and nonstructural roofing material). Projects may elect to reuse 50% of the existing building structure for 2 points.

MR 2.1 and 2.2– Construction Waste Management: Divert 50% From Disposal, 75% for 2 credits

Recycle and/or salvage nonhazardous construction and demolition debris. Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or comingled. Excavated soil and land-clearing debris do not contribute towards this credit. Calculations can be done by weight or volume but must be consistent throughout. Projects can divert 50% of debris for 1 point or 75% for 2 points.

MR 3– Materials Reuse

Use salvaged, refurbished or reused materials, the sum of which constitutes at least 1% based on cost, of the total value of materials on the project.

MR 4 – Recycled Content

Use materials with recycled content so that the sum of the post-consumer recycled content and one-half of the pre-consumer material total at least 10% of the total value of the materials in the project. The recycled content of the material shall be determined by weight.

MR 5 – Regional Materials

Use building materials or products that have been extracted, harvested or recovered, and manufactured, within 500 miles of the project site for a minimum of 10% of the building materials (calculated as a % of total cost). The quantity of the regional material shall be determined by weight.

MR 6 – Certified Wood

Use a minimum of 50% of wood-based materials and products, which are certified in accordance with the Forest Stewardship Council's (FSC) Principle and Criteria, for wood building components.

Indoor Environmental Credits

IEQP 1- Minimum IAQ Performance

The minimum requirements, listed in Sections 4 through Sections 7 of ASHRAE 62.1-2004 Ventilation for Acceptable Indoor Air Quality, must be met. Naturally ventilated buildings shall comply with ASHRAE 62.1-2004. The mechanical ventilation systems installed during the core and shell construction should be able to meet the minimum requirements for the anticipated future tenant level.

IEQP.2- Environmental Tobacco Smoke (ETS) Control

Prohibit Smoking in the building and prohibit on-property smoking within 25 ft of entries, outdoor air intakes and operable windows. Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or on the entire property.

IEQ 1 – Outdoor Air Delivery Monitoring

Requirements

There is a need to install HVAC controls so that the designed minimum ventilation is obtained. If the controls vary by 10% or more from their setpoints then a visual or audio alarm must go off to inform the building operator of this issue, via the building automation alarm, or the building occupants must receive a visual or audio alarm.

- Mechanically ventilated spaces
    - For mechanically ventilated spaces there must be monitoring of the outside airflow and alarms set to go off if it goes outside of a 15% tolerance of the design minimum airflow rate, as defined by ASHRAE 62.1-2004.
- Naturally ventilated spaces
    - Monitor carbon dioxide concentration in all naturally ventilated spaces. Those monitors must be located between 3 and 6 feet (inclusively) above the floor. One carbon dioxide sensor may be used to represent multiple spaces if the natural ventilation design uses means, including passive stack(s), to induce airflow equally and simultaneously amongst those spaces sharing the sensor without intervention by the building occupants.

IEQ2– Increased Ventilation

The following are what is needed in order to achieve this credit:

- Mechanically Ventilated Spaces
  - Increase breathing zone outdoor air ventilation rates to be 30% above the ASHRAE 62.1-2004 minimum requirements, as determined in EQ Prerequisite 1.
- Naturally Ventilated Spaces
  - Design those areas designated for natural ventilation to comply with the Carbon Trust Good Practice Guide 237 (1998). Use the flow diagram in Figure 1.18 of the Chartered Institution of Building Service Engineers (CIBSE) Applications Manual 10:2005 to determine the effective strategy for natural ventilation.

    AND
  - Use calculations and drawing to confirm that the recommendations set forth in the aforementioned CIBSE manual are being abided by.

    OR
  - Use a macroscopic, multi-zone, analytic model to predict room-by-room airflow and confirm that it will comply with ASHRAE 62.1-2004 Chapter 6, as a naturally ventilated space, for 90% of the occupied spaces.
  - The tenants must be able to achieve this credit in their build-out for core and shell projects.

IEQ3– Construction IAQ Management Plan

Develop and implement an IAQ management plan for the construction and preoccupancy phases of the building as follows:

- During construction, meet or exceed the recommended Control Measures of the SMACNA IAQ guidelines for Occupied buildings under construction, 1995, Chapter 3
- Protect stored on-site or installed absorptive materials from moisture damage
- If permanently installed air handlers are used during construction, filtration media with a MERV 8 rating shall be used at each return air grille, as determined by ASHRAE 52.2-1999. Replace all filtration media immediately prior to occupancy.

IEQ4– Low Emitting Materials

4.1 – Adhesives and Sealants

The design team or developer must specify that All adhesives and sealants used on the interior of the building (inside of the weatherproofing system and applied onsite) must comply with the VOC levels published in the LEED 2009 reference manual per SCAQMD Rule #1168 as applicable to the project scope. Specify low VOC paints and coatings in the construction documents. Ensure that VOC limits are clearly stated in each section of the specifications where adhesives and sealants are addressed.

4.2 – Paints and Coatings

The design team or developer must specify low VOC paints and coatings in the construction documents. Ensure that VOC limits are clearly stated in each section of the specifications where paints and coatings are addressed. Design specifications must require that VOC limits of Paints and Coatings not exceed limits established in Green Seal Standard GS-11, Paints, First Edition, May 20, 1993.

4.3 – Carpet Systems

- All carpets installed in the building interior must be Green Label Plus Certified
- All carpet cushion installed in the building must be Green Label Certified
- All carpet adhesive must have a VOC limit below 50 g/l
- Hard Surface flooring must be certified as compliant with FloorScore standard by an independent third party
- Floor finishes must meet the SCAQMD Rule 1113
- Tile setting adhesives and grout must meet SCAQMD Rule 1168

4.4 – Composite Wood and Agrifiber

The design team or developer must specify wood and agrifiber products that contain no added urea-formaldehyde resins. In addition laminating adhesives for field and shop applied assemblies that contain no added urea-formaldehyde resins.

IEQ5– Indoor Chemical & Pollutant Source Control

Design the facility so that pollutants are both minimized and controlled by preventing their entry into the building as well as transfer from space to space once in the building. There are several ways that this can be achieved:

- Employ permanent entryway systems, e.g. installed grates, filles, or slotted systems that allow for cleaning underneath. Roll-out mats are also acceptable, so long as there is a contract for having them cleaned on a weekly basis. The entryways that are considered relevant for this credit are those that sever as regular entry points for the building users.
- Areas where hazardous gases and chemicals may be present or used. The exhaust rate in those spaces, of at least 0.50 cfm/sq.ft. The pressure differential between it and the surrounding areas must be on average 5 Pa and at least 1 Pa, when the door to the room is closed.
- The outside and return air filters must have a Minimum Efficiency Reporting Value (MERV) of at least 13.

IEQ6– Controllability of Systems Thermal Comfort

- Provide individual comfort controls for 50%, at a minimum, of the building occupants to enable variations to meet their individual task needs and preferences. Operable windows can create an exception for spaces that are within 20 ft, in front of the window, and 10 ft, on either side of the window. ASHRAE 62.1-2004, paragraph 5.1, should be followed in order to achieve this credit.
- Offer comfort system controls for all shared multi-occupant spaces to enable adjustments to suit group needs and preferences. ASHRAE 55-2004 should be abided by to control one of the primary factors, e.g. air temperature.

Easily Achievable in Jordan ☑
Not Easily Achievable in Jordan ☐

Being able to achieve this credit is highly dependent on the market that will be occupying the building. If the anticipated tenants are likely to be demanding of local climate control capabilities then these may need to be installed.

IEQ7–Thermal Comfort-Design

Requirements

Design HVAC systems and the building envelope to meet the requirements of ASHRAE 55-2004, Thermal Environment Conditions for Human Occupancy. Demonstrate design compliance in accordance with the Section 6.1.1 documentation. The core and shell base building mechanical system must allow for the tenant build-out to meet the requirements of this credit. Project teams that design their project for mechanical ventilation that do not purchase or install the mechanical system are not eligible to achieve this credit. Compliance for this point requires indoor design temperatures to be within the shaded area in Figure 16.

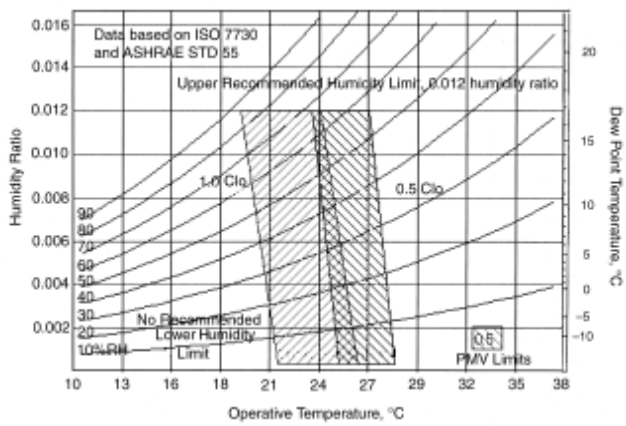

Figure 16 - ASHRAE 55.1 requirements for indoor design temperatures

IEQ8.1–Daylight 75% of spaces

Option 1 Glazing Factor Calculation

Achieve a minimum glazing factor of 2% in a minimum of 75% of all regularly occupied areas. The glazing factor is calculated as follows:

$$Glazing\ Factor = (Window\ Area\ (sf))/(Floor\ Area\ (sf)\ ) \times Window\ Geometry\ Factor \times (Actual\ Tvis)/(Minimum\ Tvis) \times Window\ Height\ factor$$

Option 2 Simulation

Demonstrate through computer simulations that 75% or more of all regularly occupied spaces achieve daylight illumination levels of a minimum of 25 footcandles. Modeling must

demonstrate 25 horizontal footcandles under clear sky conditions at noon, on the equinox at 30" above the floor.

Option 3 Measurement

Demonstrate, through records of indoor light measurements, that a minimum daylight illumination level of 25 footcandles has been achieved in at least 75% of all regularly occupied areas. Measurements must be taken on a 10 ft grid for all occupied spaces and must be recorded on building floor plans.

Option 4 Prescriptive

Use a combination of side-lighting and top-lighting to achieve a total daylighting zone that is at least 75% of all the regularly occupied spaces. The design should adhere to the LEED CS v2.0 reference manual prescriptive requirements.

IEQ8.2–Views 90% of spaces

Achieve a direct line of sight to the outdoor environment via vision glazing between 20" and 90" above the finish floor for building occupants in 90% of all regularly occupied spaces. See LEED 2009 reference manual for calculation methodology. The core and shell design must incorporate a feasible tenant layout(s) per the default occupancy counts that can be use in the analysis of this credit

Innovation in Design Credits

ID1 – Innovation in Design

Path1: Innovation in Design

The proposal of a Green or Sustainable Building Design or Construction Technique not covered in the current LEED CS v2.0 system. Project must identify the following in writing:

- The intent of the proposed innovation credit
- The proposed requirement for compliance
- The proposed submittals to demonstrate compliance
- The design approach used to meet the requirements

Path2: Exemplary Performance

Achieve exemplary performance in any applicable credits eligible for this path. Exemplary performance points may be earned for achieving double the credit requirements and/or achieving the incremental percentage threshold of an existing credit in LEED.

ID2 – LEED AP

At least 1 principal participant of the project team must be a LEED AP.

Appendix C – Comparison Between USA and Jordan Energy Codes

ASHRAE 90.1-2004 vs. Jordan National Building Code 2008

Overview

The 2008 Jordan building energy code was prepared by specialists in the Building Research Center of the Royal Scientific Society in accordance with the agreement signed between the Jordanian National Building council and the Royal Scientific Society.[8] The purpose of this evaluation is to compare the requirements of this code with other similar energy codes accepted internationally. The structure and layout of the 2008 Jordanian code is based on the Energy Conservation Building Code of India which was developed by the International Institute for Energy Conservation (IIEC) under contract with the United States Agency for International Development (USAID)[9]. The ECBC 2006 in turn is a slightly modified version of ASHRAE 90.1-2004. The aim of this review is to compare the Jordan 2008 energy savings code to ASHRAE 90.1-2004 and to assess how applicable the Jordanian code is when compared with the current construction and design practices within Jordan. Some sections of the Jordan code have not been taken from ASHRAE 90.1-2004. The sources of these sections were analyzed in detail as well.

Part 1 Generalities

The Generalities section covers the purpose of the code and the goals of its implementation. It also offers an explanation of the context of its use, and an introduction to the different sections of the code. The outline of sections 1-1 through 1-3 is based on ASHRAE 90.1-2004 Sections 1 and 2.

Section 1-4 and 1-5 of Jordan's Energy code outlines the technical requirements for design approval and for inspections.

The section entitled "Technical Requirements for design approval" outlines the process of the design approval which includes requirements for design drawings and specifications, designed and operational plans, detailed information regarding energy intensive systems covered in the energy code (HVAC, Lighting, etc), detailed energy calculations, equipment specifications and model numbers. Typically all of this information should be located in construction documents as is common practice. However no direction is provided in this section as to who will be the reviewing authority for these documents and how the requirements of this section will be enforced during the design stage.

The section 1-5 entitled "Inspections and Preview" outlines the inspection process of the construction approval. It mentions that "authorities" shall inspect building envelope properties such as thermal insulation and windows, HVAC systems, and lighting for

[8] Jordanian National Building Codes – Energy-Saving Building Codes, 2008
[9] Case Study: Energy Conservation Building Codes in India, Majumdar, Mili, Unknown Year

consistency with the design drawings and energy code. Though Section 1-4 and 1-5 seems to be roughly based on section 4 of ASHRAE 90.1-2004, details are limited. More information regarding specific roles of building inspectors and enforcement is recommended. Section 1-6 through 1-8 are definition sections which contains similar information to Section 3 of ASHRAE 90.1-2004.

Part 2 Building Envelope and Architectural

The Building Envelope and Architectural section is based on section 5 of ASHRAE 90.1-2004, in terms of structure, however from the information and language included, it is not entirely clear whether this section is enforceable code or just as a guideline. This section seems more of a best practices design guide rather than focusing on technical specifics such as R-Value of walls and window Solar Heat Gain Coefficient (SHGC) and U-factor, though this information is present.

The green building guide approach is a positive aspect of this section and should be retained however, it is recommended that instead of incorporating best practices within the enforceable energy code, a separate document or an appendix should be created to provide these guidelines. This will help to avoid confusion and in some cases grey areas for compliance. The compliance and enforceable code section should only include minimum efficiency requirements for each building component.

The code makes suggestions and emphasizes the importance of passive solar design such as building orientation. Though the fundamental concept is good, it is suggested that more detail be included. For example, Section 2-4-2-C-2 mentions "In general, it is preferable to direct the long axis of the building to east-west direction in the kingdom because it is the perfect choice in terms of thermal performance." Though this is true, a more thorough explanation will provide the designer with more insight regarding their design choice. The same section could read "Align the building along an east-west axis so windows face either north or south. In southern or hot climates, design large north windows to take in cool, diffuse north light. Minimize window height on the south side (strip windows work well), and shade the window from direct sunlight. When the sun is high in the south sky, a canopy or a deciduous tree makes an excellent sunshade.[10]" Again this type of information is more appropriate for an energy efficiency design guide rather than a code.

Sections 2-1 to 2-3 offer a general explanation of part 2, architectural design goals based on this code, and design considerations. Section 2-4 outlines the design requirement for buildings. This section does not seem to be directly based on ASHRAE 90.1-2004 as far as content though certain elements are present.

[10] Utah Green Homes, Building Orientation Article.
http://www.utahgreenhomes.com/?page_id=19

The first design requirement is to consider climatic data of the site with reference to appendix data for different regions of Jordan. According to this appendix, there are varying climatic zones in Jordan. For example, the average temperature for the month of January in the Al-Shoubak region of Jordan is 4.1°C with a typical rainfall of 71.5 mm in January and an average temperature of 20.4°C with a typical rainfall of 0 mm in July. The Ghoor Al-Safi region of Jordan has an average temperature of 15.9°C with a typical rainfall of 13.2 mm in January and an average temperature of 33.7°C with a typical rainfall of 0 mm in July. This displays a considerable difference in climate which based on the fundamental idea of an energy code, could require different building practices. Though some climate information is present, it is recommended that this concept be developed. This would include a study to investigate more detailed weather data for the sites mentioned in the Appendix. Once more detailed weather data is discovered, a supplemental study to understand optimum insulation values for roof and walls as well as window properties is recommended.

Part 3 Ventilation

The 2008 Jordan Building code separates ventilation requirements from Heating and Air Conditioning. Additionally, requirements for the ventilation section of the Jordan 2008 building code is not based on ASHRAE 90.1 though some parts are extracted from ASHRAE 62.1-2004 including values for flow rates of exhaust fans serving kitchen and bathrooms. It should be noted that Table 3/1 in the 2008 Jordan Building code refers to "bedrooms" which would only be applicable to high-rise residential or hotels. It appears that this table suggests ventilation rates based on the number of bedrooms and square footage. The origin of this table is unknown and seems contradictory to Table W/6 in Appendix F, which has the same structure as Table 6.1 in ASHRAE 62.1-2004.

Both the Jordan 2008 and AHSRAE 62.1 tables, display varied ventilation rates based, on space type, square footage and occupancy density. For example, in an office building, a break room will have a different ventilation requirement than a private office based not only on space type, but occupant density. Table 3.4 and W/6 in Appendix F in the 2008 Jordan code both contain this information however there is some confusion as to which table to use. The Jordan 2008 code clearly mentions that "Ventilation quantities rate are in accordance to the type of application, should not exceed the values shown in table 3.4 for smokers occupants." The problem here is that the ASHRAE table that this is based on (Table 6.1) clearly states that these values are for non-smoking areas. It appears that table W/6 in Appendix F in the 2008 Jordan code is for smoker occupancy. The values in this table are approximately twice that of table 3.4 in 2008 Jordan code and table 6.1 in ASHRAE 62.1-2004 indicating that these figures are for occupancies with smoking allowed. Due to the implications that smoking has on indoor air quality, ASHRAE promotes prohibiting smoking in commercial buildings. As a result, breathing ventilation rates are based solely on non-smoking spaces with a small section

on how to adjust these values should they be smoking areas. It appears that table W/6 in Appendix F contains ventilation rates that have been adjusted for smoking type occupancy.

If Jordan plans to continue to allow smoking in commercial buildings, it is recommended this discrepancy be clarified. Should a non-smoking building follow the guidelines set forth in the Jordan 2008 code, the ventilation system may be unnecessarily oversized requiring unnecessary electricity usage. A system designed for a non-smoking building will require less fan power requirements since lower ventilation rates are required. This would only be applicable to commercial buildings in Jordan that specifically prohibit smoking in the building and provide enforcement. Should the building's ventilation system be designed as "non-smoking" without prohibiting smoking in the building, Indoor air quality will suffer.

Part 4 Heating and Air Conditioning

Part 4 of the 2008 Jordan code is focused on equipment selection and efficiencies with a clear requirement for non residential projects to meet the minimum efficiencies listed. The requirements for equipment efficiencies are taken directly from ASHRAE 90.1-2004 (pre 2006 values). Figure 1 lists Jordan 2008 tables with reference to their ASHRAE 90.1-2004 counterparts.

Jordan 2008 Code	ASHRAE 90.1-2004 Code	Description
Table 4/1	Table 6.8.1A	Min Efficiency Requirements for DX Air Conditioning
Table 4/2	Table 6.8.1B	Min Efficiency Requirements for Heat Pumps
Table 4/3	Table 6.8.1D	Min Efficiency Requirements PTAC and ATHP
Table 4/4	Table 6.8.1E	Min Efficiency Requirements Furnaces
Table 4/5	Table 6.8.1F	Min Efficiency Requirements Boilers
Table 4/6	Table 6.8.1A	Min Efficiency Requirements Condensers
Table 4/7	Table 6.8.1G	Min Efficiency Requirements Heat Rejection Equip.
Table 4/9	Table 6.8.1C	Min Efficiency Requirements Water Chillers

HVAC equipment Efficiency requirement comparison

ASHRAE is internationally recognized for constantly updating their standards to keep up with available technology. Their influence in the HVAC industry keeps manufacturers active in constantly improving their equipment in terms of efficiency and reliability. As a result, basing Jordan's equipment efficiency requirements on ASHRAE standard 90.1 is a sensible choice. It is recommended that Jordan update their equipment efficiency codes in parallel with ASHRAE to ensure that it keeps current with the most efficient HVAC equipment technology.

Section 4/4/2 requires manufacturers selling equipment in Kingdom of Jordan to affix energy efficiency labels in accordance with Jordanian Standard Specifications 2-1772. Equipment included for this requirement includes window type and split type air conditioning units. These labels contain a code (A-E) which identifies the Energy Efficiency Ratio (EER) rating

of the unit. This simplified approach allows contractors or other purchasers to look at the EER tag affixed to the unit and judge the efficiency. For example, a unit with the code A has an EER greater than 12, which would be optimum. A unit with the code E has an EER between 8.5 and 9.4 which would be the minimum efficiency available. Requiring manufacturers to affix efficiency labels should be continued. This demonstrates an active role in which the Jordanian government has chosen to track efficiency ratios of units being used within the Kingdom.

Placing a requirement specifically for manufacturers to sell in Jordan creates a market focus. In this case manufacturers, should they want to conduct business with Jordan, will have to meet the requirements of the Kingdom by affixing this label and guaranteeing its efficiency. In addition, the A-E system simplifies the design and construction process. Designers can now refer to a code rather than requiring a specific EER. In addition, contractors can more easily request a unit with a specific code from the manufacturers rather than discussing EER.

For heating and air conditioning controlling means, Section 4.4.2 of Jordan's 2008 building code, the requirements are based on selected section of ASHRAE 90.1-2004 section 6.3.2(i) and 6.4.3.1.2. This section of Jordan's building code requires the minimum recommended measures for system control, meaning ASHRAE 90.1-2004 goes into much further detail. At this stage of development, the controlling requirements should be sufficient for smaller system. However, Jordan will most likely want to increase the requirements of this section to include larger VAV systems with zone and system control or other complex systems with requirements for chilled or hot water control.

For ductwork thermal isolation, ASHRAE 90.1-2004 requires different insulation values depending on climate zone. Instead of varying the requirements by climate zone, the Jordan 2008 building code uses the ASHRAE format and takes the largest values in table 6.8.2B for each scenario. For example, in Jordan 2008 code, exterior mounted supply ducts must have R-8 insulation. In ASHRAE 90.1-2004, this value varies based on Climate Zone from R-6 to R-8. Typically, taking the higher R value requirement is the more conservative approach. Should Jordan adopt its own climate zone system for purposes of energy code as discussed in section 1.3, there is the option to conduct testing regarding optimal thermal insulation of ductwork in addition to envelope per Jordanian Climate Zone. System balancing requirements are similar to that of ASHRAE 90.1-2004 with reference to current Jordan Building code.

The economizer section of the 2008 Jordan energy code begins with an explanation of the two types of economizer: Airside and Waterside. Once explained, this code then lists the requirements which are similar to some portions of ASHRAE 90.1-2004. The requirements listed for economizers in Jordan's energy code could be considered basic; there are multiple control strategies that can be used to effectively operate the economizer, including dry-bulb and enthalpy. Currently, there is no mention of these strategies. Furthermore, there is

mention that projects in hot-dry and warm-humid climate zones are exempt. This description is somewhat subjective and could be misinterpreted. Even in hot-dry climates, spring and fall temperature may be conducive to economizer operation however testing would be required. It is recommended that if Jordan initiates a climate zone system as recommended in the previous sections, that further research be conducted to understand which areas of Jordan would benefit from economizer use and specify a control (i.e. dry-bulb or enthalpy accordingly).

The Jordan 2008 energy code provides additional requirements for pipe insulation. This section provides the requirements for calculating the minimum thickness of the pipe insulation based on the thermal resistance properties. Table 4/13 is based on table 6.8.3 in ASHRAE 90.1-2004 which is a good standard for this application.

Section 4/5/2-5 in 2008 Jordan building code list simple guidelines for building load calculations, equipment size and selection, and temperature and humidity control systems as well as auxiliary heating requirements. It is recommended that these guidelines be moved to an informative appendix or a separate design guide. Section 4/5/6 lists requirements for Heat recovery systems which is taken directly from ASHRAE 90.1-2004.

Part 5 Water Heating

The requirements for water heating in the 2008 Jordan building codes are somewhat minimal compared to ASHRAE 90.1-2004. However, the code does include performance requirements for storage type water heaters. The ASHRAE 90.1-2004 code has Table 7.8 – Performance Requirements for Water Heating Equipment. This table lists various hot water heater configurations and the required minimum efficiency to meet code. In the Jordan code, this information can be found in table 5/1.

Part 6 Lighting

Most sections of the 2008 Jordan lighting energy code are appropriately taken directly from ASHRAE 90.1-2004. Like with other sections, not all the information found in the ASHRAE text was adopted by Jordan. Instead it appears that the only the key items are taken. This includes adopting the requirement for the lighting designer to calculate interior lighting power density through two methods specifically covered in ASHRAE 90.1-2004. This includes the building area method, where the designer can calculate the building's allowable Lighting Power Density through the use of an included table which is adapted from ASHRAE 90.1-2004.

Another option is to calculate the allowable Lighting Power Density through the use of an alternative calculation method called the space function method which requires the use of a different table also adopted from ASHRAE 90.1-2004. After presenting the two options for calculating interior lighting, Jordan 2008 explains what fixtures should be included in the calculation. In addition, the code outlines how to calculate wattages for permanently installed

ballasts/fixtures applicable to fluorescent and incandescent. The requirements in this section are also taken directly from ASHRAE 90.1-2004.

For exterior lighting Table 6/3 is a simplified version of Table 9.4.5. For this table three values are taken from table 9.4.5 for tradable surfaces (Building Entrances with and without a canopy, and building exits) and one was taken for a non tradable surface (Building Façade).

Part 7 Electrical

The 2008 Jordan Building Code covers efficiency requirements for transformers, motors, power factor correction, metering and power distribution systems. The content of this section is not covered in ASHRAE 90.1-2004 but is obtained from ECBC 2006.

The original source for Table 7/1 is in Jordan 2008 energy code is unclear but this table is also listed in the 2006 ECBC under table 8.2.1.1. The figures found in both tables are identical; however, the ECBC code also includes maximum allowable power loss for 22 kV transformers in addition to 11 kV transformers. This may be due to the fact that only 11 kV service is offered in Jordan.

For motors, Jordan 2008 code mentions the requirements for selecting and installing polyphase motors 0.375 kW or more. Furthermore, the code also requires installations to meet the minimum acceptable motor efficiencies. Table 7/2 in Jordan 2008 building code is taken from table 10.8 in ASHRAE 90.1-2004. These figures are based on the requirement of EPACT 1992, a document which set goals, created mandates, and amended utility laws to increase clean energy use and improve overall efficiency in the US. Given that both ASHRAE 90.1-2004 and ECBC 2006 both adopted this code, its implementation is appropriate for Jordan 2008.

Power factor correction and Check-metering and monitoring is not specifically addressed in ASHRAE 90.1-2004, however both are addressed in ECBC 2006. Jordan 2008 building code has adopted the requirements from ECBC 2006.

Power Distribution systems are covered in ASHRAE 90.1-2004, however, the requirements are somewhat limited. Jordan 2008 building code has adopted the power distribution systems section from ECBC 2006. Jordan 2008 and ECBC 2006 have identical requirements for this section.

Appendix D - Code Compliance and Building Inspection

Building Process in Jordan

For construction projects in Jordan, the most involved parties in the building process are the developers, design team and contractors. To understand the building process, one design team, four developers, and three contractors were interviewed. The purpose of this effort was to understand the industry practice and its use of the building code with respect to the infrastructure put in place by the JNBC. The focus of this study is to understand how a green building rating system fits into the current Jordanian system. During this study, the Jordan 2008 Building Energy Efficiency Code was in the process of becoming law. Once law, this code will join 35 other building codes currently in place. This would make it subject to existing infrastructure in place for the compliance and enforcement of all building codes.

An energy code is the foundation for any green building rating system. To help evaluate the appropriateness of a green building rating system in Jordan, one must first look at the codes and standards currently in place, the design and construction processes, and the compliance and enforcement mechanisms therein. Without industry compliance and enforcement of these base codes and standards in building efficiency, it will be difficult to develop and implement a green building rating system and have it be widely accepted and utilized. Green building rating systems aside, without set codes and standards in place, it is difficult to set even basic goals for energy efficiency.

From interviewed sources, it was commonly expressed that there are three classifications of projects within Jordan:

1. Mega projects – Large Buildings 250,000 m² and greater like in Abdali, typically high rise
2. Commercial and Large Residential
3. Residential and Small Commercial

Though the Residential and Small Commercial sectors take the biggest market share in Jordan, it is the least regulated and least designed in the country. More than half of the residential projects will not even have a designer or a set contractor, and most will not even apply for a permit. In some cases a 4 story apartment building could be built with no engineering.

There is some correlation as to the level of regulation and design that goes into the project and the likelihood that sustainable "green" design and building materials will be employed without some type of incentive. As all interviewed parties indicated, initial cost is what drives the building projects within Jordan. If the residential sector and portions of the commercial sector are mostly not obtaining permits or hiring a design team, it is unlikely that buildings in these sectors are consciously complying with building code. Should the 2008 Jordan Building Energy Code be introduced, it is very unlikely that it will be referenced by

these sectors, especially since it will require an increase in initial cost. Since the 2008 Jordan Building Energy Code had not yet been implemented during this study it remains unknown how closely it will be followed by the mega projects and large commercial/residential as well.

If projects don't comply with local code, it would be even more unlikely that they would attempt to exceed it. All parties interviewed agreed that there should be more regulation and code enforcement on the small commercial and residential sectors. It remains unclear as to why there is not more regulation in these sectors. Though more research is recommended to better identify the reason for the deficiency, it is most likely due to the current capacity of the regulating authority. Perhaps with more funding and qualified personnel working for the regulating authority, more regulation and code enforcement on the residential and small commercial side can be provided.

Without capacity building, only high profile Mega Projects and commercial/large residential buildings will continue to comply with building codes and conform to the infrastructure put in place by the Jordanian National Building Council. An alternative to bulking up the regulating authority would be to provide projects in all sectors with a financial incentive for demonstrating how the project has exceeded the requirements of the energy code. Though most parties interviewed agreed that for the most part mega projects and large commercial/residential projects are code compliant, some deficiencies were discovered in the current code compliance and enforcement structure. Though the compliance and enforcement system is fundamentally sound from project conception until the permit is issued, once construction begins compliance and enforcement weakens.

Design

The owner or developer will acquire land with a project in mind for development. In some cases like in Abdali, the developer will buy into a master planned project with at least a building type in mind. Once acquired, the developer will solicit work from an Architectural/Engineering firm. The developer will have some type of conceptual drawing or discuss the requirements for the design, and introduce their project requirements. The project requirements include ideas and interests in correlation to the wants and needs of the owner or developer. It establishes the expectations of the building's use & operation, occupancy and O&M systems and goals. In the case for Crystalle, it also documented environmental, sustainable, energy efficiency, and air quality goals.

In Jordan, depending on the classification of the project, the owner or developer has multiple options when selecting an Architectural/Engineering Firm. For design professionals, there are five classes of architectural design companies in Jordan

Class 1 – Big Architectural firms with multiple engineers and architects employed and capable of producing design drawings for a Mega project on their own.
Class 2 – Large Architectural Firm: Many architects but few engineers. This type may need to sub out work to engineering firms for MEP
Class 3 – Medium architectural Firm: At most 2 architects and 1 engineer.

Class 4 – Small architectural firm: 1 architect and 1 engineer.
Class 5 – Smallest architectural firm: Single architect or engineer.

Once the design team is selected based on the needs of the project, a set of drawings will be created. As the design progresses, a basic set of drawings will be released referred to as the design drawings. This will be used as progress drawings to discuss the initial design with the developer. Once the owner agrees with the direction of the design, a skeleton package-for construction will be released. Typically this set will have basic details with much of the core and shell designed. This allows for the MEP firm to begin placing ductwork, piping, etc.

Typically, the skeleton package will be forwarded to GAM to apply for a permit. Two documents must be provided during the application process:

- A full set of drawings and specifications
- A contract with an engineer on staff to provide supervision

All engineers working on active construction process must be registered and properly licensed with the JEA or an equivalent international organization. In Jordan, there is no test for engineers. The standard process for licensing includes appearing before the JEA and presenting their degree in a relevant engineering subject. Though not required, this application can be supplemented by an international professional engineering license.

Both members of the design team and the supervising engineer must be registered by the JEA and hired by the owner prior to a permit being issued. The developer will choose and fund both the design team and supervising engineer. Some design firms employ engineers who specialize in site supervision. If this is the case, the developer has the option to hire a staff engineer from the design firm or through another source. The supervising engineer's main responsibilities are to supervise all construction activities, ensure that the building is being construction to design specifications, and to review code compliance.

Once design drawings and the supervising engineer's contract have been received GAM will pass the drawings to the JEA for their review. For the case of Crystalle, the drawings and the supervising engineer's contract was required to first pass through the supervising engineers on staff for Abdali Investment and development PSC before going to GAM to ensure the design conforms to Abdali architectural and engineering requirements.

GAM then passes the design drawings to the JEA for their design and code compliance review. This process serves as the only design and code compliance review by a third party, not funded by the owner/developer for the entire project. Once approved by the JEA, GA M checks setbacks and reviews the supervising engineer's contract. If all requirements are met, the construction permit is issued.

One developer provided a rough estimate that ninety percent of large residential and commercial (up to 4,000 m^2) obtain permits. Of this ninety percent, seventy percent are completely up to code. It is not uncommon for developers to start construction prior to

obtaining a permit, as was the case with Crystalle. The same developer made the claim that a building collapse in early April, 2010 was a project that did not obtain a permit.

Construction

A reputable contractor based in Amman explained the level of classification of contractors within Jordan and the standard bidding process. The ministry of Public works in collaboration with the Jordan Contractors Association decides the grade of each contracting organization. There are three levels:

- 1st Grade – Most Capable, has many cranes and construction equipment and is capable of large scale construction including mega projects
- 2nd Grade – Capable, has a few cranes and a good amount of construction equipment and is capable of medium size commercial projects
- 3rd Grade – Least Capable, has maybe one crane and some basic construction tools for residential projects

Most construction projects, both public and private, excluding small residential in Jordan are competitively bid. Based on the size and requirements of the project, general contractors will be invited to bid based on their grade. Some developers of mega-projects hire international construction management firms to oversee construction while using local labor. Local labor in Jordan consists mainly of ex-patriots and laborers from neighboring countries.

Since the construction industry is typically initial cost driven, the lowest bidder will often be selected. This makes complying with a green building rating system or using sustainable or "green" building materials difficult for the contractor to implement if it was not already included in the design. If the cost of sustainable building materials remains higher than their non-sustainable counterpart, contractors risk losing work should they decide to include them in their bid. This places the decision to "go green" on the owner/developer with some influence from the design team.

Once construction begins, code enforcement and major design changes rely solely on the supervising engineer with no review or recheck of the change by GAM or the JEA. Since no review of these changes is required by the concerned authority, there could be a situation where a code compliant aspect of the building could be changed unknowingly or knowingly to a non-code compliant situation. It is unknown how often this happens, if at all, however this potential conflict of interest should be investigated further. All design professionals, contractors, and developers interviewed agreed that the lack of post-permit code enforcement is a significant weakness in the Jordanian system. The fact that the owner funds the supervising engineer becomes an ethical conflict of interest since a design change or overlooking of a code violation has the ability to cost or save the building owner/developer money. It is unknown how often such activities occur and further research is recommended.

For Abdali, an increased level of enforcement is conducted through the Abdali Investment and Development PSC infrastructure. Abdali supervising engineers will visit sub-

developments to ensure that the supervising engineer assigned to the project is present. In addition, all design changes must be presented to Abdali I&D PSC for their review. The system utilized for Abdali covers all bases for code enforcement. The initial design reviews by GAM, JEA and Abdali, with post permit design and construction reviews with overall project supervision from Abdali is a strong system for code compliance enforcement in Jordan and a good example of an effective public and private partnership. A strong system of base code compliance enforcement as demonstrated within Abdali is necessary in order to implement, administer and review or enforce a green building rating system.

Once construction is complete, the general contractor must contact both Civil Defense and GAM for final inspection. All parties interviewed agreed that Civil Defense performs a very thorough review of the fire suppression and alarm system, and other health and safety requirements. In the event that problems are discovered, the project team must address and fix the issue before Civil defense can finalize their approval of the building. In parallel, GAM will also inspect the building for any setback violations. In the event that a GAM inspector discovers a setback violation, a fine will be issued depending on the severity of the violation. Once GAM and Civil Defense finalize their inspection, a Certificate of Occupancy is granted. The Certificate of Occupancy is required for utilities such as phone, water and power to be connected.

Code Enforcement

According to Jordanian National Building Law 7, the planning authority which issued the license has discovered that construction works are being carried out in contradiction with the license stipulations, this authority must issue an executive warning or notification to the employer and contractor to stop work until the committed violation is corrected. In case the notified person fails to remove the causes of violation within the period defined in the notification, the authority which has issued the notification may take legal action against the employer and contractor to implement the necessary penalties against them including their obligation to remove the causes of violation.

The Council is entitled to take the necessary measures to insure that the adopted codes are applied in all stages of the engineering work including design, checking, supervision, execution, operation maintenance, public safety works and all the engineering works related thereto.

Whoever violates the provisions of paragraph (a) of Article (12) of this Law shall be penalized by a fine of no less than one hundred Jordanian Dinars and not exceeding three thousand Jordanian Dinars for each violation of any code in accordance with the magnitude of such violation. Of those contractors, developers, and design professionals interviewed, none had ever heard of such a fine being issued for a lack of code compliance. However, all did agree that the Greater Amman Municipality does regularly issue fines for setback violations.

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