GRASS

A NEW BUILDING RATING SYSTEM FOR LEBANON

Farah Mneimneh, Haneen Hamdan
Mechanical Department
Faculty of Engineering III – Lebanese University
Beirut, Lebanon

Adel Mourtada
Lebanese Association For Energy Saving and For Environment, ALMEE
adel.mourtada@yahoo.fr

Abstract— **Being more aware of global warming and climate change, the world today is shifting toward a more environmentally friendly style of living. Buildings are considered to be one of the main contributors to CO_2 emissions and thus to climate change. The market place of the design and construction of high performance buildings, also known as green buildings, is dynamic and evolving. In order to evaluate the level of sustainability, countries all over the world have established building rating systems to evaluate and rate green buildings. Lebanon is in an urge to introduce more energy efficient and environmentally friendly techniques in the building construction industry. This paper intends to introduce a new building rating system for Lebanon to serve as a step forward towards sustainability in this country. This rating system, GRASS, can be applied on both commercial and residential buildings. Throughout this paper, the minimum requirements of the credits will be illustrated as well as the criterion to be followed in order to earn the certification.**

Keywords- green buildings; sustainability; building rating system; GRASS.

I. INTRODUCTION

The world today is facing tremendous environmental problems mainly caused by climate change. It is the crisis of our time for its impacts are so obvious on animals, agriculture and human population. Climate change is due to the increase of greenhouse gases in the atmosphere and mainly CO_2. There is a little dispute now that buildings, and through all the stages of design and construction, are responsible for large amounts of CO_2 emissions in the atmosphere. Buildings account for more than 40% of global CO2 emissions and 30% of global raw materials consumption and solid waste output. Moreover, building construction may also lead to resource depletion, land disruption, water contamination, waste generation, soil pollution, and other environmental problems.

Green buildings are simply environmentally responsible, sustainable and resource efficient buildings. Green buildings have shown to reduce energy by about 25%, CO_2 emissions by 35% and water consumption by 40%. In order to evaluate the level of sustainability of buildings, rating systems have been established. The US LEED, the British BREEAM and the French HQE are the most wildly recognized assessment methodologies globally used in the construction industry today.

Lebanon is not far from the "Going Green" phenomenon. Nowadays, there is a tendency to implement and adopt green building concept by referring to international standards. In 2011, LGBC, Lebanese Green Building Council has established ARZ, the first Lebanese building rating system, in the cooperation with IFC. ARZ is only applied on existing commercial buildings.

Building sector is the most energy-consuming sector in Lebanon and it is growing faster in the absence of legislations and laws that take into account energy efficiency and sustainability. For this reason, it is necessary to start planning rating tools that evaluate the all types of buildings from the early design stage to the operation one. GRASS, Green Recovery and Sustainable Solutions, is a new rating system that suites Lebanon's climate, style of living and available resources. This methodology is not restricted to commercial buildings but also extends to residential ones. Moreover, GRASS could be used as a guide in order to build a green building in Lebanon.

II. OVERVIEW

GRASS is a new approach for a Pure Lebanese rating system for New Designed and Existing Commercial & Residential Buildings. From its name, its intent is to mitigate negative impacts of buildings on the environment including CO2 emissions, heat island effect, intensive energy consumptions, water consumption…etc. Not only that, but also it aims to provide our next generations the opportunity to live in healthier, durable, and friendly environmental buildings.

"GRASS" consists of four major indicators:

- Envelope
- Green sites
- Energy system design and equipment
- Water management and indoor environment

The table below shows the credits to be evaluated in each of the four indicators:

III. EXPLANATION OF THE CREDITS

A. *Envelope*

The "Envelope" indicator consists of three credits.

The first credit, Heating & Cooling Energy Needs, evaluates the thermal performance of the building. The "Thermal Standard for Buildings in Lebanon 2010" is used as a baseline and the Trade-off path that specifies the maximum thermal performance levels and the maximum exposure to solar gains is used to evaluate the building. Note that if the building does not comply with the thermal standard, it is not eligible to be certified. Points will be awarded according to the level of enhancement with respect to the thermal standard's requirements.

Therefore, similar to the procedure used in the "Thermal Standard for Buildings in Lebanon", the assessor must calculate U- envelope, U- façade, and WWR-eq (window to wall ratio). The thermal resistance of the slabs on the ground must be calculated as well.

Points will be awarded according to the percentage of reduction of the U- envelope, U- façade, and WWR-eq with respect to the thermal standard's requirements according to the climatic zone where the building is situated.

As mentioned above, the three values must be less than the reference ones. Each of these values is evaluated apart by calculating its own reduction factor RF.

$$RFx = \frac{Yref - Y}{Yref} * 100$$

x= envelope, facade, or WWR-eq

Yref= reference value of U-envelope, U-façade, or WWR-eq

Y= calculated value of U-envelope, U-façade, or WWR-eq

Scoring will be according to the value of the reduction factor for each component.

Tables I, II & III show the scoring criteria:

TABLE I. Scoring Point Distribution for U-Envelope

RF(U-envelope)	Scoring points
0%-5%	5
5.1%-10%	10
10.1%-20%	20
20.1%-30%	25
≥ 30.1%	30

TABLE II. Scoring Point Distribution for U- façade

RF(U-facade)	Scoring points
0%-5%	5
5.1%-10%	10
10.1%-20%	20
20.1%-30%	25
≥ 30.1%	30

TABLE III. Scoring Point Distribution for WWR-eq

RF(WWR-eq)	Scoring points
0%-5%	5
5.1%-10%	10
10.1%-20%	20
20.1%-30%	25
≥ 30.1%	30

Regarding the evaluation of the thermal resistance of the slab, the thickness must comply with the baseline reference values specified in the "Thermal Standard for Buildings in Lebanon". The evaluation is according to the ATR, Added thickness ratio.

$$ATR = \frac{W - Wref}{wref} * 100$$

Wref = reference value of the insulation width
W= actual value of the insulation width

Table IV specifies the scoring criteria.

TABLE IV. Scoring Point Distribution for WWR-eq

RF(WWR-eq)	Scoring points
0%-5%	5
5.1%-10%	10
10.1%-20%	20
≥20%	30

Extra points could be achieved if part of the un-insulated flooring area is covered with thermal insulation.
Scoring points are given according to the percentage of the insulated slab.
Table V specifies the scoring criteria:

TABLE V. Scoring Point Distribution for the Insulated Slab

Percentage of insulated slab	Scoring points
0%-5%	5
5.1%-10%	10
10.1%-20%	20
20.1%-30%	25
≥30.1%	30

The second credit, "Eco-construction", evaluates the construction materials whether it is eco-friendly or not. Ecofriendly materials are recyclable, can be reused and have low embodied energy. Points will be given according to the percentage of eco-friendly materials used.

Finally, the Green roof credit, checks if the roof is either vegetated or coated by materials of high solar reflectance and emittance, these two values must be greater than the minimum required set by ENERGY STAR. This will maximize energy saving by reducing thermal transmittance through its surface.

B. Green Sites

The "Green Sites" indicator consists of six credits.
The first credit, Pre-developed Lands, gives points for buildings that are constructed on sites whose ecological benefits have been already reduced.
The Existing Infrastructure credit checks if the building is constructed on a site that already contains infrastructure. This means that no excavation activities are needed to develop roads, supply the building with water lines, or provide other infrastructure. Note that if this is not feasible, thus the building will not be connected to the main sewers in this case, the building owner is obliged to provide an on-site sewage treatment system where wastewater must undergo primary and secondary treatment.

The Proximity to Basic Services credit specifies the maximum distances between the building and the location of the basic services mainly needed by the employees in commercial buildings and occupants in the residential buildings. The most important service is the public transportation line.
The Site plantation credit obliges the building owner to provide at least 20% of the site's area planted. Extra points will be given if this value exceeds 20%, if trees are planted on the eastern and western sides of the building, and if the facades are planted.

There are two options to earn the Parking structure and design credit. Either provide at least 50 % of parking underground or provide environmentally friendly external parking that has low negative impacts on the environment. Others features to be present are, permeable paving, onsite storm water management, and at least 30% parking lots must be covered.

In the Parking Capacity credit, GRASS rewards commercial buildings that specify preferred parking spaces for vanpools and buses. "Parking Capacity" credit is to reduce environmental impacts of transportation.

C. Energy System Design and Equipment

The Solar Water Heating credit evaluates the building according to the percentage of hot water obtained from solar heating system. At least a value of 40% is demanded to gain this credit. Building will gain extra credits if PV-panels are being used to power or more variable-speed DC pumps.

In the Renewable Energy credit, the building is rewarded if it installs PV systems or wind generators in order to provide part of its electricity demand from renewable energy sources. The evaluation of this credit is upon the percentage of electricity provided from renewable sources with respect to the total electrical demand of the building. At least a value of 1% is demanded to gain this credit.

The Daylight design credit evaluates the daylight in the indoor spaces by calculating the ADF, Average Daylight

factor. This factor is used to predict whether the amount of daylight in the room is sufficient or not. To achieve this credit, minimum 70% of the building's room must have ADF greater than or equal to 2%. Note that extra points will be given if the day lighting controls are installed, if the lighting fixtures are arranged in zones with similar daylight availability and space function, and if are arranged in rows parallel to the window. This will assure that only lamps at the back of the room are illuminated during day occupancy.

The Natural ventilation credit evaluates if the building is naturally ventilated. First, the orientation of the building must be checked, it must be perpendicular to the summer winds.

Table VI shows the direction of winds with respect to each climatic zone in Lebanon.

TABLE VI Wind direction

Climatic zone	Wind direction
coastal	South-east (moderate winds), East (mild winds)
Mid-mountain	West
Inland plateau	South-west, north-west
High mountain	North-west (mild to strong winds)

To make sure that natural ventilation is efficient, the following rule may be used. The depth of plan over which ventilation can be expected to work is specified in terms of the floor to ceiling height. in case of cross ventilation, the depth of the plan must be maximum five times the height, and in case the openings are single sided, this value must be maximum 2.5.

The Mechanical Ventilation credit discusses two factors. First, the CFM of fresh air w.r.t the zone's function must be within the ranges of ASHRAE and IMC, International Mechanical Code. Second, points are given if an energy recovery unit is being installed.
Table VII shows the ranges of CFM in commercial buildings with respect to the occupancy category.

TABLE VII CFM Requirements

Occupancy category	CFM/person
Correctional facility cell	10 - 20
Educational classroom	13 - 15
Public assembly space or theater auditorium	5 - 15
General or office conference room	6 - 20
Office building office space	17 - 20
Hotel, motel, resort, and dormitory lobbies	10 - 15

In case of residential buildings, ASHRAE 62.2 standard is used to evaluate this credit. The minimum ventilation volume must be a minimum of 1 CFM for each 100 sq. ft. of floor area plus 7.5 CFM for each occupant. The number of occupants is determined by multiplying the number of bedrooms and then adding one.

$$CFM = 0.01(Asf) + 7.5\,(Nbr + 1)$$

Asf = area of bedroom
Nbr = number of bedrooms
Moreover, extra points will be awarded if CO_2 sensors are installed to measure the change in carbon dioxide levels in the zone in order to control the amount of outdoor air.

The Lighting Efficiency credit evaluates the lamps being installed. Lamps inside the building must be of high efficiency such as fluorescent, compact fluorescent lamps and other no incandescent lamps must be installed. Another factor to consider is the power density installed, it must be greater than or equal to 2.5 Watt/m^2/100lux. As for parking lighting, the evaluation will be according to the luminous efficacy. For Covered, parking it should be more than 60 lm/watt, whereas for uncovered parking it should be greater than 50 lm/watt.

In the Effectiveness of Heating and Cooling credit, the efficiency of the installed equipment is to be considered. In case of heating, COP is evaluated however, EER is evaluated in case of cooling. The minimum requirements of these two values depend on the type and the size of the equipment installed. Moreover, the efficiency of air distributing ventilation system is evaluated. Its efficiency is determined by calculating the CF, circulation factor that must be greater or equal to 5. Points will be given if VAV, variable air volume, systems are used, and if energy recovery units are installed. Regarding boilers, the annual fuel utilization efficiency, AFUE, is evaluated. Extra points are given if a carbon monoxide detector is installed. Commercial buildings will have the chance of gaining more points if air curtains are installed at the main entrances of the building.

The Backup Electricity credit discusses the best practice of reducing toxic emissions and noise pollution of Diesel Generators. It focuses on installing air filters, sound attenuators, heat recovery units, and encourages usage of biomass diesel fuels.

The Building Management System, BMS, includes the installation of HVAC controls such as variable air volumes, VFD for fans, Thermostats, CO2 detectors…etc., and Lighting controls such as movement sensors, daylight sensors…

D. Water Management and Indoor Environment

The last indicator is "Water Management and Indoor Environment" and it consists of three credits.

The first credit, Health Protection, specifics the usage of Low VOC paints and adhesives for these materials are harmful to occupants' health.
The Indoor Plantation evaluates the percentage of vegetated indoor spaces.

The Water Conservation credit tackles three sub-credits. The first one is intended to reduce water consumption by using low consumption sanitary fixtures such as composting urinals, on demand faucet and others. The evaluation is according to the percentage of reduction in water consumption per person per day taking the EPA 1992 as a baseline for fixture performance requirements. Note that these values are being used as **a** baseline since in Lebanon there are no requirements or even recommendations for the usage of sanitary fixtures.

The second sub-credit checks if the building is harvesting rainwater and/or treating greywater for reusing it for toilet flushing. In this sub-credit, the amount of potable water being saved in liters/person/day is calculated and accordingly points will be scored. To calculate the volume of collected rainwater the following formula is used.

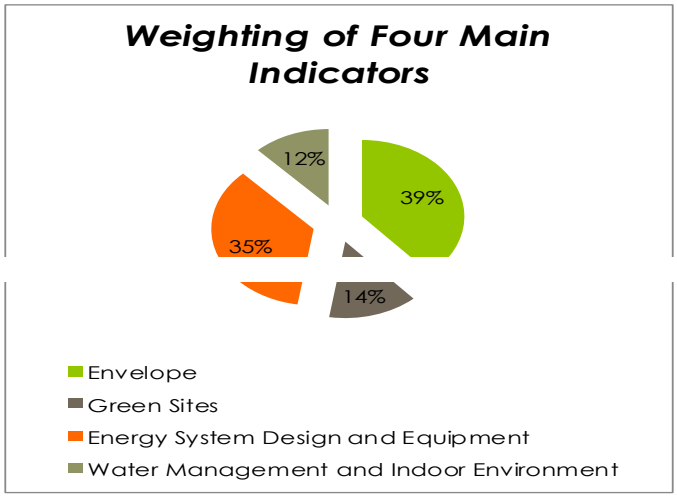
$$volume = \frac{A * P * 0.8}{1000}$$

Volume= volume of collected rain water (m^3/year)
A=Collection area (m2)
P = Average annual precipitation (in mm/year)
It is equal to 661mm/year in coastal zone and Mountain and 420mm/year in Inland Plateau
0.8 = Collection factor to account for filtering losses and small rainfall that does not generate runoff.

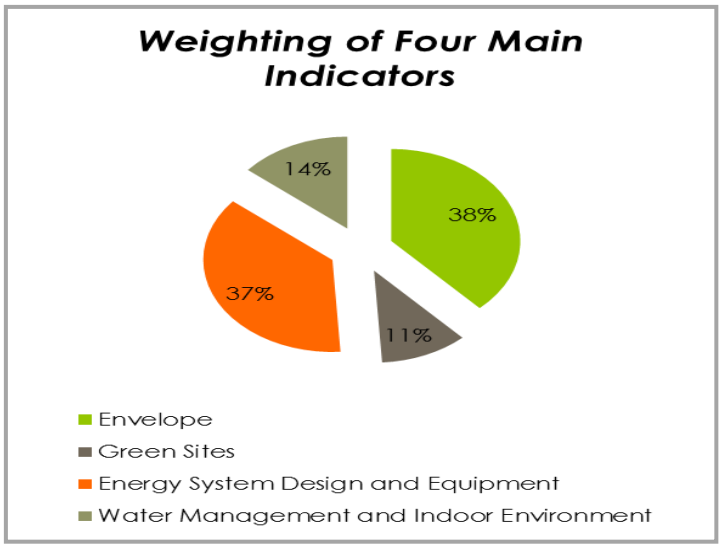
The third sub-credit intends to reduce potable water consumption by planting native trees that does not require irrigation and by installing micro-irrigation systems such as spray, sprinkle, mist and drip. Extra points are awarded if irrigation system controllers are installed. Examples of these controllers are rain sensors that prevent sprinkler systems from turning on during and immediately after rainfall and soil moisture sensors that activate sprinklers only when soil moisture levels drop below pre-programmed levels.

IV. Distribution of the Weighting

A. Commercial Buildings



B. Residential Buildings



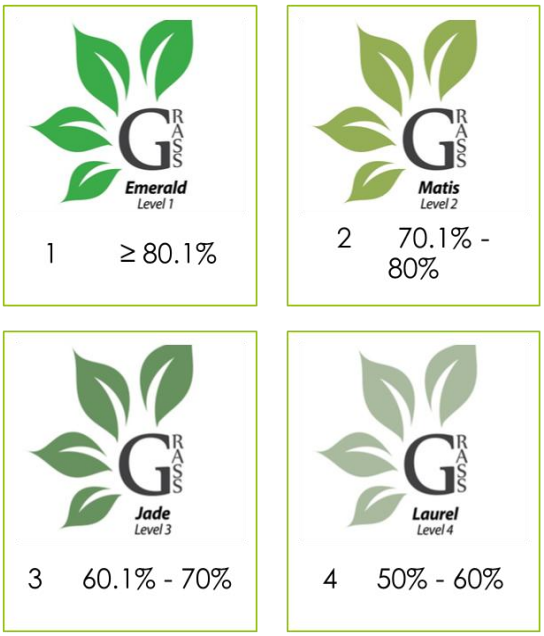
V. Earning Certificate

The following steps must be followed in order to earn GRASS certifications. First, the assessor must go through all the credits of the four indicators. Second, the assessor must make sure that all the minimum requirements are satisfied and reward the building with the appropriate scoring point. Finally, he/she must sum up all of the points in order to identify the level achieved.

The total scoring point that could be achieved is 500. To identify the level achieved, the assessor must calculate the following percentage.

$$percentage = \frac{points\ acheived * 500}{100}$$

According to the percentage, the building will attain one of the four levels as shown in the figure bellow.



V. CONCLUSION

Green buildings is not a new trend to the Lebanese culture, it has been familiar to the building construction industry for the past few years. However, certified buildings are restricted to the luxurious ones because of the high and unsuitable standards set by the rating systems being used, most commonly LEED and BREEAM.

As mentioned previously, Lebanon is in an urge to start introducing green and sustainable technologies to use energy more efficiently and to save water and other earth's natural resources.

GRASS is a new approach to promote green buildings construction in Lebanon. Moreover, it encourages the Lebanese stakeholders, designers and engineers to start thinking green. It contributes to a comprehensive and coherent strategy for energy conservation in the buildings sector.

This paper gives the guidelines and standards that the building should be evaluated, based on. The operational procedure of "GRASS" is monitored by ALMEE. The stages of the assessment procedure start from the project's registration to the certification stage.

ALMEE is providing training courses for professional that can carry out the assessment procedure and accredits them.

Finally ALMEE with the support of the Lebanese University, ADEME and other professional organizations is working to GRASS attains credibility and trust not only in Lebanon but at regional Level and especially in Southern Mediterranean Countries.

.