IEREK PRESS
Academic Research Community
http://www.press.ierek.com
ARChive
CrossMark
ISSN (Print: 2537-0154, online: 2537-0162)
International Journal on:
The Academic Research Community Publication
**DOI:** 10.21625/archive.v2i3.351

# Reducing Energy Consumption Strategies in University Buildings in Egypt

**Iman Osama Abd El Gwad[1], Ayman Alsayed Altaher Mahmoud[2]**

[1]*Associate Professor of Architecture Department, Faculty of Fine Arts, Helwan University.*

[2]*Teaching Assistant, Architecture Department, Giza Higher Institute For Engineering*

## Abstract

Recent times have seen academic buildings face challenges when it comes to high energy consumption in comparison to relatively low performance, which affects the interior of the building by reducing the comfort level of the area. Reduced comfort level holds the risk of preventing students from having an optimal space in which studying or attending scientific classes to achieve high grades. As a result, we must critically evaluate the principles in place that regulate planning policies intended to ensure a space that uses low energy consumption but has a high performance. In particular, we must analyze building design strategies, low energy design plans, along with their systems and integration methodologies.

By focusing on the evaluation system crietria for international and locality system in comaprtive and for four study cases in a comparative methodology of building energy efficiency will help identify the most viable strategy for creating a leading green design for university campuses in egypt with an integrated low-cost energy consumption methdologies.



***Keywords***

University building; Energy consumption; Criteria; Strategy; Universities; Egypt

## 1. Introduction

University's has an essential role in sustainable development; though the motivation is not solely linked to the potential for financial prosperity, instead, the more prominent benefit is a carefully created setting that will, as mentioned before, directly influence the quality of life, comfort, security, and health factors for students and staff. Achieving sustainability in design and construction is the emphasized goal currently. There were several theoretical basics evaluated; however, a number of them do not appear to be sensible. The vernacular design has several sustainability aspects. However, historical data reveals substantial challenges that compromise the feasibility of the model as a reliable strategy. The technology and its achievements have typically taken a space from being "part of an environment" to create a separate setting. As such, the design disrupts the existing set-up profoundly, making it non-economic as a solution. In response to these findings, new solutions need to seek not just to implement new technology but to find a sound way to interact with the existing environment in place. In this regard, sustinabillty approaches conferred and outlined in the building and design sector boosting these challenges.

Inadequate studies of lighting and thermal comfort that failed to measure how much space is needed for facilities to run optimally have resulted in insecure building envelopes, leading to faults in energy consumption and environmental sustainability (meaning, the building is more susceptible to failures due to the surrounding climate conditions, etc.). The main issue that continues to need to be addressed is the low efficiency where bio-life aspects (environmental and human factors) are concerned. pérez, l., ortiz, j., maestre, r. & coronel, j.f.,2012)

## 2. Universities and sustainable Architecture Characteristics Policy

A “fully mature” approach to university sustainability may be summarized as “one in which the activities of a university are ecologically sound, socially and culturally just and economically viable”. How the transition towards sustainability is expressed in a particular university must inevitably reflect the social, cultural, economic and be expressed in different ways, there are well-defined foundational principles which characterize university sustainability .In general terms, a university consciously choosing the path of sustainable development would exemplify the following principles:
A. Seeks to minimize its consumption of resources by putting in place measures to conserve water, energy and paper, etc.
B. Cuts waste output through a process of reducing consumption and reusing materials via recycling where possible makes purchasing decisions based on knowledge of the environmental and social impacts of the product, e.g. paper manufactured from sustainably managed forests.
C. Encourages environmentally preferred transport options such as carpooling, bicycle facilities, public transport facilities and staff incentives to discourage car based on :
• Engages staff and students and supports them to continually improve environmental practices and reduce their negative environmental impacts.
• Ensures that any maintenance and construction is carried out to minimize environmental impacts and constantly improves the environmental performance of the university facilities; and Makes decisions about financial investments and research with consideration given to the social and environmental implications of those decisions.
D. Ensure that any strategies will be taken in low energy consumption must have two basic principles attention:
• Human comfort: students and stuff needs and requirements.
• Saving environmental: by using strategy that made sustainable environment and dis-effecting to bio-environmental liv in those (material using in construction, technologies using, renewable or nonrenewable energy, co2 emission)
There are many factors that make a university green in terms of operations. The examples given above are by no means an exhaustive list. Examples given above are by no means an exhaustive list.

## 3. University Buildings and Energy Consumption Through Sustainable Architecture Operations

To get the full diagrammatic policy for low energy consumption, we must define the whole policy and principles for its implementation. The implementing solution principles will be located throughout the university sustainable to ensure that, in the future, we might need to adjust the solution principles, and we may easily refer to the existing system. (R. J. Cole, 2012).
The following steps will be an outline the problematic solution; architecture whole strategy and methodology principles policy and integrated principles will be (unep,2014) :
A. Whole systems design integration : all systems and entities are accounted for and incorporated into the system design, to achieve whole system design we must be had an integration method that have more to improve the complex of all relatively in that method (new project ) (human , culture ,ecology).
1) Human factor : have a main step done the sociological steps to know what the usersneeds.
2) Culture factor: build to enclose open space to have the total privacy conservation enviromnt.
3) Community factor : experience of place project location as verncular architecture processing.
B. Bold ecology: a biological pattern of functioning.whiv.ch means save environment and compatibility between building, environment and human comfrtable.

According to (nina, Stefan, alexander, Michaela, Henrique and Arnold.2016), energy consumption reduction had an ecology approach in the conceptual frame work for social-ecological systems integration, reduction energy affected in 80% percent in this frame because reduction energy will be have an effecting regulation process in ( reduction co2 andco1 , increasing estimated green power ,environmental benefit through green strategies that reduction energy consumption ( green areas , green wall ,green roofs , organic material ,etc. ) ) .so achieving increasing in inductive quantity evaluate system criteria will be increased bold ecology main whole strategy.

C. Intelligent construction : which means have applied crietria (closed building energy cycle, low cost energy strategy, low cost energy , smart design, high energy efficiency, waste water, utilization, high energy yield, contaminant, recycle material, conservation, resource conservation, energy conservation , inner air,smart grid,renewble energy powered in university ).

D. Intelligent limits :wich means there were limits in using smart programs or materials that will be chosen in design process for implemminting porcedures

1) Local material: we could be used the local material from the local site for the new university projects because it's had compatible with the local environment and climate zone , local material have also low cost and easily in manufactured and setup.

2) Integration to landscape: land scape in or out door play a main role and make better option in establish new project example:

- Waste water treatment.
- Air quality improvement.
- More satisfying and feeling comfortable.
- Save environment sociality and civilized.

## 4. University and Sustainble Environmental International Assessment Methods Focusing Energy Consumption Meusring Comparison

The widely used schemes measurement accreditation leadership in energy and environmental field (leed), building analysis environmental assessment technique (BREEAM) and STAR GREEN australian, UI Green metric . LEED was created and developed by the u.s. inexperienced building council (USGBC) and has worldwide acceptanc as a benchmark for inexperienced building practices. Breeam was created by the u.k. building analysis establishment (bre) and is adopted by the u.k., Universitas Indonesia (UI) initiated a world university ranking in 2010, later known as UI GreenMetric World University Ranking, to measure campus sustainability efforts. all four schemes unit of measurement affordable scoring system of aggregation credits that applies to an honest vary of every new building types and existing buildings. All aspects of an expansion of environmental issues like materials, energy, water, pollution, indoor environmental quality and heap. One in every of necessary credits throughout all the three schemes that is additionally the essential consider the final effort to realise sustainable development, is that the consumption of energy or succeeding carbon emissions in buildings, see general comparative three main assessments ways table 1. (ya roderick, david, carlos, 2010).

Table 1. General comparison between LEED, BREEAM and GREEN STAR, UI Green metric campuses schemes

| | LEED Campus Guidance<br>Applicable new construction v.3 ,2009 | BREEAM<br>UK,2015 | Green star<br>Education building v.2 | UI green world metric campuses,<br>2016 |
|---|---|---|---|---|
| Assessment method | Performance rating method (PRM) based on ASHRAE<br>90.1-2004 appendix g | Uk national calculation, Methodology (NCM) based on approved document | National Australian built Environment rating System (NABERS) energy methodology | Indonesian built with environment rating system Green ship developed with |

| | | | | |
|---|---|---|---|---|
| Scope of assessment | % of improvement based On annual energy cost. | Energy performance<br>Certificate (epc) rating: co2 based index | Predicted greenhouse gas emissions | Score Efforts on sustainability improvement in four sustainability major indicator |
| Simulation tool | Software approved by the Rating authority and subject to requirements specified in ASHRAE 90.1-2004 appendix g | -approved dynamic Simulation modelling Software<br>- approved software Interfaces to scheme method | Software must meet the Requirements laid down In green star office design tool. | Software developed by LEED system and STARS sustainability assessment methods. |
| Max. Credit level performance based criteria | 10 points for over 42% of improvement. | 15 credits for zero co2 index (net zero co2 emissions) + 1 exemplar points for innovation | 20 points for zero predicted greenhouse gas emission (carbon neutral). | 2100 points for energy and climate change criteria |
| Min. Credit level performance based criteria | 2 points minimum for 14%<br>Of improvement; | 1 credit for 63 co2 index | Conditional requirement is 110 kgco2/m2/year | Ranked for bet practice around world |
| Energy performance related credits/points (%) | 23% of total available Points | 20 % of total available Credits | 25 % of total available points | 21% of total available points |
| University consideration | Included schools building ranking | -Pre-school<br>- Schools and sixth form colleges - Further education/ vocational colleges Higher education institutions | -Pre-school<br>- Schools and sixth form colleges - Further education/ vocational colleges Higher education institutions | Based for university campuses buildings |

Table2. Energy criteria indictors considering in assessment methods by author

| Energy criteria indictors considering in assessment methods | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LEED , Applicable new construction(NC, v.4) | PO. | WE.C. | BREEAM UK,2014 | PO. | WE.C. | Green star Education building v.2 | PO. | WE.C. | UI green world metric campuses, 2016 | PO. | WE.C. |
| Fundamental Commissioning of Building Energy Systems | Re. | Re. | Energy efficiency | 15 | 15.79 % | Greenhouse gas emission scope | 20 | 12.8% | Energy efficient appliances usage | 200 | 2% |
| Minimum Energy Performance | Re. | Re. | | | | | | | | | |
| CFC Reduction in HVAC&R Equipment | Re. | Re. | | | | | | | | | |
| Optimize Energy Performance | 19 | 13.49 | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| On-site Renewable Energy | 7 | 4.97 | Sub-metering of substantial energy use | 1 | 0.79% | Energy Sub-metering | 1 | 0.64% | Smart building implementation | 300 | 3% |
| Enhanced Commissioning | 2 | 1.42% | External Lighting | 1 | 0.79% | Peak Energy Demand Reduction | 2 | 1.28% | Renewable energy usage | 300 | 3% |
| Enhanced Refrigerant Management | 2 | 1.42% | Low and Zero Carbon Technologies | 3 | 2.37% | Lighting Zoning | 1 | 0.64% | The ratio of total electricity usage towards campus population | 300 | 3% |
| | | | Sub metering of high energy areas and tenancy | 1 | 0.79% | Unoccupied Areas | 2 | 1.28 % | The ratio of renewable energy produce towards energy usage | 200 | 2% |
| Measurement and Verification Green Power | 3 | 2.19% | Lefts | 2 | 1.58% | Stairs | 1 | 0.64 % | Element of green building implementation | 300 | 3% |
| | | | Energy Efficient Transportation Systems | 1 | 0.79% | Efficient External Lighting | 1 | 0.64 % | Greenhouse gas emission reduction program | 200 | 2% |
| | | | | | | Shared Energy Systems | 1 | 0.64 % | The ratio of total carbon footprint towards campus population | 300 | 3% |
| Total | 33 | 23% | Total | 24 | 20 % | Total | 29 | 25% | Total | 2100 | 21 % |

### 4.1. Result of Comparison

Every assessment method have a step in management system for energy consumption as main criteria, lEED's has an optimum defined criteria (Energy Efficiency Best Management Practices), Green star has divided in to 2 focusing indictor (energy sub-metering, peak energy demand reduction), BREEAM has explained in 2 indictor (Low and Zero Carbon Technologies, Energy Monitoring) but them have not measured considering campus issued. UI green metric has a main indictor will be a great chance in optimized measuring indictor, that was (Smart building implementation), UI offered to enhance campus building to do more effort for all principles that control this criteria (management system, smart materials, smart equipment's and smart design), it can be developed as global demand for any new measured indictor and affected in decreasing energy consumption ratios.

### 4.2. Local Asessment Method of Egypt: Green Pyramids Rating System

The Green Pyramid Rating System is a national environmental rating system for buildings. It provides definitive criteria by which the environmental credentials of buildings can be evaluated, and the buildings themselves can be rated. The Rating can be used to assess individual new buildings at either or both of the following stages: 1.At Design Stage, 2.At Post-Construction Stage. ), Projects will be rated, based on Credit Points accumulated, according to the following rating system (GPRS Certified: 40–49 credits, Silver Pyramid: 50–59 credits, Gold Pyramid: 60–79 credits and Green Pyramid: 80 credits and above)

### 4.3. G.P.R.S. Energy Performance Evaluation Criteria for Design Stage

So according to research scope we must be studied the criteria that related to energy performance and that will be:
i. Mandatory Minimum Requirements (M.1 Minimum Energy Performance Level- M.2 Energy Monitoring & Reporting- M.3 Ozone Depletion avoidance)
ii. Energy Efficiency Improvement:.............................................. (10 points)
iii. Passive External Heat Gain Reduction:.......................................( 7 points )
iv. Energy Efficient Appliances :....................................................( 3 points)
v. Vertical Transportation Systems: ................................................(3 points)
vi. Peak Load Reduction:............................................................( 6 points)
vii. Renewable Energy Sources:......................................................( 12 points)
viii. Environmental Impact...........................................................( 4 points)
ix. Operation and Maintenance:......................................................( 1 points)
x. Optimized balance of Energy and Performance:..................................( 4 points)
xi. Energy and Carbon Inventories:...................................................( 2 points)

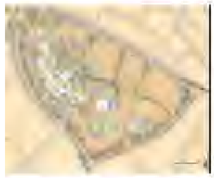
## 5. Chosen Case Studies Check List

Benchmark rating tool will be depended on merging the sociological part, bold ecology, low-cost energy consumption criteria in questioner methodology to find the way to apply standards and low-cost design strategy in integration between them. Depending on the analysis, principles for all strategies will show how to improve efficiency and quality for the indoor and outdoor environment of the university, see table (6). The three study cases were chosen by same climatic zone aspects, also have the full benefits of the applied energy criteria to, indeed, have the accreditation. The case studies had chosen because the high accreditation assessment certification for them , case study one had an environmental assessment certification (6 green star certification) Australian programing equal to platinum LEED certificate, second case study had LEED platinum certificated and Arabian relativity. third case study has a main role because it had placed in Egypt , AUC university FIFTH Settlement had a new university campus construction occupied in 2009 for first year , it had been chosen for its traditional design mixing with modern design style ( called postmodern art ) , traditional building element had constructed to have a good regulation with environment aspects, that's will be guided in final analysis what traditional style needed to be regulated in the recent age, AUC university had ranked 104 overall world according to green metric campuses,

case studies will be explained the main issued for found the best sustainable indictors practice focusing energy consumption.

Table 3. Benchmark rate tool, by author

| Check list evaluation for university building | | | |
|---|---|---|---|
| 1- Symmrized Basic info | | | |
| Basic info. | Case study 1<br>SBRC Wollongong, Australia | Case study 2<br>King abd alaziz (kaust),K.S.A. | Case study 3<br>New American university, fifth settlement, Egypt. |
| Gross area | 11100 square meter | 496102,234 square meter | 1144000 square meter |
| Climatic zone | Hot humid | Hot humid | Hot arid |

| | | | |
|---|---|---|---|
| **Energy consumption** | 721,5m watt\year | 450720.331 megawatt/hours annually | 103500 megawatt/hours annually |
| **Reducing energy consumption** | 70% | 40% | 29% |
| **Location** |  |  |  |
| **Occupied** | 2010 | 2009 | 2009 |
| **When low energy strategy applied** | Beginning | Beginning | After occupied |

**2- Criteieria questionerey**

**A) Client needs (stuff and student )**

**"Had architecture applied system design calculation for high efficiency suitable with (spaces, planning plan zooning, security factor) and suitable indoor environment "?**

| **Num. Case study** | **Applied quest.** | | **Functional performance criteria Grading (yes condition )** |
|---|---|---|---|
| | **Yes** | **No** | **Certificated programing grade** |
| Case study 1 :SBRC, Wollongong | ● | | 95 % (19% from 20 % weighted indoor environment quality, G.S.A) |
| Case study 2 : king Abd Alaziz (KAUST) | ● | | 86.6% (18.8% from 21.7% weighted indoor environment quality, LEED) |
| Case study 3: New American university, fifth settlement, Egypt. | ● | | 75 % (4.5 % from 6 % from total score ( EC2 and EC6 ,UI) |

Details: every case study applied specified space norms, high quality indoor environment (efficiency lighting, efficiency ventilation , acoustic reducing ,material furnishing) for design whole university, but every case study must be have a previous experience of located sociological (colored preferred ,preferred furnishing material , design style preferred and sociological spaces ) .

**Case study 1:** Ventilation rates are designed for 50% improvement above the fresh air rate requirements in AS 1668.2-2002. A carbon dioxide monitoring system is specified to track and adjust ventilation rates with low carbon dioxide levels upon occupancy. Also, a VOC monitoring system is specified to detect and alert when pollutants are too high in the building. Daylight modelling shows that 60% of the project's nominated area provides a Daylight Factor (DF) of 2% for building users. Internal noise levels are designed for minimization.

95% of painted surfaces, adhesives, sealants and tenancy fit out items and all carpets and flooring are specified to be low in volatile organic compounds. All composite wood products specified have low-formaldehyde emissions. Automated blinds and external shading are components of the design, reducing glare from natural lighting. High frequency ballasts are to be included to reduce occupants' eye strain from low frequency flicker. Lighting levels are designed to be maintained at no more than 25% above the minimum maintained IL luminance levels recommended in AS1680.2.3 Table E1. 60% of the nominated area is designed for direct line of site to the outdoors or a day-lit internal atrium.

**Case study 2 :** KAUST has chosen construction materials and buildings methods that reduce harmful airborne particulates:

A. All campus buildings and most city center buildings will be constructed using adhesives, sealants, paints, carpets and furniture systems that contain no or low volatile organic compounds (VOCs).

B. All campus buildings and most city center buildings will be constructed with composite wood and agrifiber products that do not contain urea-formaldehyde.

C. After construction, all campus buildings will perform a building flush-out to ensure that all VOCs, particulates, dust and harmful chemicals left from construction are removed from the building before occupancy.

D. MERV 13 and 14 filters have been placed on all HVAC systems. These filters ensure removal of very fine particulates from the ventilation stream within the buildings.

E. Walk-off grates have been installed at all entrances to ensure that dust, sand and particulates from outside are not brought into the interior of the buildings.

F. all campus building users have access to personal light (task lights) and thermal controls (thermostats). Having access to these controls ensures that building users have sufficient light for their task at hand and are thermally comfortable depending on their level of activity. This increases levels of productivity and health among building users.

**Case study 3:** AUC applied Arabic style design architecture and vernacular architecture with using natural material (80% sand stone) and use traditional textures with "mashrabia" and arcades to achieving high envelop passive cooling performance to make a thermal comfort indoor.

| B) Bold ecology<br>"Had architecture applied ecology strategies studies on building and help on improve environmental ecological for location?" | | | |
|---|---|---|---|
| **Num. Case study** | **Applied quest.** | | **Functional performance criteria Grading (yes condition )** |
| | **Yes** | **No** | **Certificated programing grade** |
| Case study 1 :SBRC, Wollongong | ● | | 90 % (20 from22 point ) |
| Case study 2 : king Abd Alaziz (KAUST) | ● | | 84% (LEED) |
| Case study 4: New American university, fifth settlement, Egypt. | ● | | 60 % (UI) |

Details: **case study 1:** All specified HVAC refrigerants have an Ozone Depleting Potential (ODP) of zero.

All specified thermal insulation avoids the use of ozone-depleting substances in both manufacture and composition.

A. Predicted project outflow to the sewerage system from building occupants' usage has been reduced more than 20% compared to an average-practice benchmark.

B. Exterior lighting designs comply with AS4282 and do not direct any light beams into the night sky or beyond site boundaries. At least 95% of outdoor spaces are not to exceed the minimum requirements of AS1158 for IL luminance levels. No water-based heat rejection systems to be included in the project.

C. The topsoil on the site, and its productivity, will be preserved. All topsoil impacted by construction works will be separated and protected. Development will have minimal environmental impact upon the site.

D. SBRC will have a red material list: The project cannot contain any of the following Red List materials or chemicals42.

• Asbestos • Cadmium • Chlorinated Polyethylene and Chloral sulfated Polyethlene43 • Chlorofluorocarbons (CFCs) • Chloroprene (Neoprene) • Formaldehyde (added) • Halogenated Flame Retardants44 • Hydro chlorofluorocarbons (HCFCs) • Lead (added) • Mercury • Petrochemical Fertilizers and Pesticides45 • Phthalates • Polyvinyl Chloride (PVC) • Wood treatments containing Creosote, Arsenic or Pentachlorophenol

There are temporary exceptions for numerous Red List items due to current limitations in the materials economy. Refer to the Living Building Community Dialogue for complete and up-to-date listings. Also made : L1 Green Wall

- L2 Green Roof with testing beds- L3 Native agriculture garden- L4 Permaculture Garden

**Case study 2:** the KAUST field design and style could be a direct sustainable and economical response to the given web site and climate. Buildings square measure specifically situated and sorted to maximize the advantages of the distinctive web site microclimate and scheme, and mitigate the detriments of the sun's movement and also the harsh Saudi climate:

1. Structured as ancient Arabic cities, the field is compressed the maximum amount as attainable to {reduce} the quantity of exterior envelope exposed to the sun and reduce out of doors walking distances. . As found in a very ancient open-air marketplace, or Arabic market, shaded and passively cooled circulation thoroughfares square measure characterized by dramatic lightweight and social areas.

2. The Arabic Bedouin tent impressed designers to make a monumental roof system that spans across building lots to avoid sun on building facades and into the pedestrian spine, to facilitate natural ventilation and to filter lightweight. Star panels covering the surface capture the sun's energy. Passive ventilation methods of the standard Arabic house influenced the look of picture, solar-powered wind towers that harness energy from the sun and wind to passively produce flow of air in pedestrian walkways.

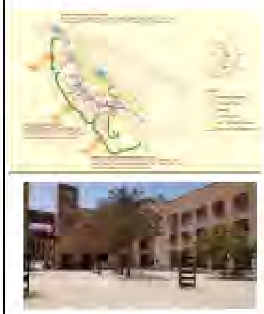
3. The same as Arabic screening referred to as 'mashrabiya,' the field shades windows associate degreed skylights with an integral shading system that reduces heat hundreds whereas making dramatic patterned lightweight.

**Case study 3:** the same as KAUST university + makes vernacular design style principles and parts (passive ventilation methods of the standard Arabic house influenced the look of picture, solar-powered wind towers that harness energy from the sun and wind to passively produce flow of air in pedestrian walkways) had utilized in auc campus (open courts, arcades, separated entrance and wide sand stone walls, etc.)

figure 2 case study 1: analysis for location environmental aspects for site (wind movement)

Figure 3.case study 2: Analysis for location environmental aspects for site (wind movement)

figure4. Case study 3: analysis for location environmental aspects for site (wind movement)



**C) Low cost design construction methodology criteria**

**"Had architecture applied low cost energy consuming strategies?**

| Num. Case study | Applied quest. | | Functional performance criteria Grading (yes condition ) |
|---|---|---|---|
| | Yes | No | Certificated programing grade |
| Case study 1 :SBRC, Wollongong | ● | | 86 % (25 point from 29,G.S.A) |
| Case study 2 : king Abd Alaziz (KAUST) | ● | | 70 % (11 from 17 point ) |
| Case study 3: New American university, fifth settlement, Egypt. | ● | | 75% (1550 point from 2100,UI) |

Details : **case study 1:** the indoor atmosphere can operate in naturally aerated mode for up to seventieth of occupied hours, assumptive associate degree inhabitant comfort band of 18-27degc. Spare plug-in points have provided to mechanical facility and air handling units to permit the building to plug into experimental technologies: fastened sunshade devices to manage solar gain, cross ventilation via opposing high and low level operable openings, reused railway track structure, reused masonry applied to internally expose thermally mass and reused timber protective cover to external insulating skin. Site generate material off-cut screen. And used : ( greening universities toolkit,2014)

A. E1 Main Switchboard, Micro-grid and battery storage - E2 Power quality testing lab and distribution board

E3 Mon crystalline Photovoltaic- E4 Building integrated photovoltaic thermal- E5 Wind Turbine- E6 Future energy

B. F1 fixed sunshade devices to control solar gain.- F2 cross ventilation via opposing high and low level operable openings- F3 reused railway track structure- F4 reused brickwork applied to internally exposed thermally mass- F5 reused timber cladding to external insulating skin- F6 site generate material off-cut screen

C. C1 Vertical bore and horizontal pit ground source loops- C2 Ground source heat pumps and mechanical

water manifold- C3 Air cooled chiller- C4 Ground level AHU- C5 Level 1 displacement AHU with connection

to rooftop PV thermal experiment- C6 Hydroid floor heating with user controlled floor vents from displacement air

C7 Roof top PV thermal experiment- C8 Solar wall testing site - C9 Future mechanical water sources for- building plug-see figure 2

**Case study 2:** the development things for KAUST included: native concrete and steel with high levels of recycled content, interior finishes with low levels of volatile organic compounds and high levels of recycled content (gypsum board, carpet tile, ceiling tiles, paints, adhesives, millwork), interior article of furniture systems that contain no volatile organic compounds (voc), had inexperienced guard certified, and have high levels of recycled content. All the wood for the KAUST field was purchased from sustainability managed forests and is forest post council (fsc) certified. Over 75 % of all construction waste was recycled for the KAUST field. The field paving style incorporates pastel stone autochthonic to similar harsh climates – reflective instead of fascinating heat. The reflective nature of the stone and therefore the shaded trellises scale back the heat-island impact on field and improves occupants' comfort levels throughout the year( greening universities toolkit,2014)

To reduce heat gain, high insulating building materials should be used fitly round the building envelope. The effectiveness of insulation of sure envelope components may be assessed mistreatment their u-value (which represents the quantity of warmth radiation (w) that may enter the building per meter sq. Of space and at a temperature deferent of 1 degree). Well insulated walls, roofs and floors ought to have a u-value of 0.35 at most. Heat gain through windows – that constitutes four-hundredth of warmth gain – may be controlled by reducing the quantitative relation of glazing to the building facades and by mistreatment glazing with low solar heat gain coefficient (SHGC), that represents the quantitative relation of warmth that enters the indoor to the warmth that reaches the window. The utilization of high performance window, as an example, yields a SHGC of 0.22.(masdar,2017)

**Case study 3:** the field used strengthened concert with sand stone (80%) for decrease heat gain, sunshades to shield glazing and exposed building walls however to maximize daylight handiness to interior areas. Pedestrian arcades on south and west facades to shade walls and windows specifically for those orientations. Interior article of furniture systems that contain no volatile organic compounds (voc), have inexperienced guard certified, and have high levels of recycled content.

The buildings have self-shading facades and have oriented to produce most shade yet as sheltering adjacent buildings and therefore the pedestrian streets below. The perforations for light-weight and shade have supported the patterns found within the ancient design of Islam. To scale back heat gain, high insulating building materials should be used fitly round the building envelope. The effectiveness of insulation of sure envelope components may be assessed mistreatment their u-value (which represents the quantity of warmth radiation (w) that may enter the building per meter sq. Of space and at a temperature deferent of 1 degree). Well insulated walls, roofs and floors ought to have a u-value of 0.3 at most. Heat gain through windows – that constitutes fifty take advantage of heat gain – may be controlled by reducing the quantitative relation of glazing to the building facades and by mistreatment glazing with low star heat gain constant (SHGC), that represents the quantitative relation of warmth that enters the indoor to the warmth that reaches the window. The utilization of high performance window, as an example, yields a SHGC of 0.25.( greening universities toolkit,2014)

Figure 3.case study 1: analysis solar roof top ,elevation (shading and shadows)

Figure 3.case study 2: Analysis for structure elevation elements

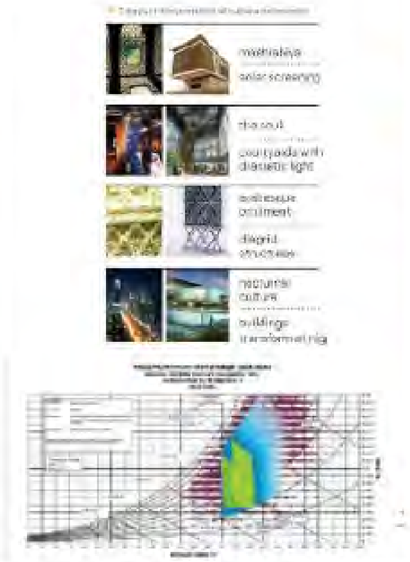


Figure 4. Case study 3: analysis for elevations

**D) Renewable energy**

**"Had university applied any renewable energy kind powered in university?"**

| **Num. Case study** | **Applied quest.** | | **Functional performance criteria Grading (yes condition )** |
|---|---|---|---|
| | **Yes** | **No** | **Certificated programing grade** |
| Case study 1 :SBRC, Wollongong | ● | | 85% (8 point from 10 ,innovation G.S.A) |
| Case study 2 : king Abd Alaziz (KAUST) | ● | | 66.6 % ( 2 point from 3 ,LEED) |
| Case study 3: New American university, fifth settlement, Egypt. | | ● | Zero |

Details: case study 1: variety of electrical phenomenon (PV) arrays were planned for the SBRC building, as well as high potency mono- or poly-crystalline (PV) panels on the subsequent surfaces) workplace roof at approx. 15° to the horizontal; ii) high slope (~70°) sq. Arrays north wall of high bay; iii) 35° slope (local latitude) long array north of high bay. Sources of information: a) from monthly mean information revealed on the bureau of meteorology web site (Bom 2011); and from hourly historical wind data over the past fourteen years from the bellambi observation post, that is found an identical distance from the outline 4km north of the SBRC web site (purchased from Bom). The common wind speeds probably to be found at the SBRC web site. From this monthly average information the approximate annual energy output from the 2 turbines was calculable to be twenty seven,150kwh/year mistreatment the remote space power provide modelling code homer (Zne report , 2016)

Case study 2: include a monumental roof capable of connecting and shielding the field buildings from the tough climate. The roof can feature nearly 12,000 sq. Meters of star thermal and electrical phenomenon arrays that may harness the well-endowed and renewable power of the sun, and manufacture up to three, 300 power unit hours of unpolluted energy annually. Whereas the roof protects the buildings from excessive star gain, atria and courtyards are integrated throughout field buildings to infuse natural daylight and facilitate natural ventilation into a majority of the inside areas. The 2 upper side star plants on the north and south laboratory buildings can occupy nearly 12,000 sq. Meters, have a most output of 1 power unit every, and manufacture up to three,300 power unit hours of unpolluted energy annually. This output can save nearly one, 700 heaps of annual carbon emissions and equals carbon offsets for seven.3 million miles of travelling (USGBC, 2010).

| E) Assessment Certification<br>"Had architecture applied any enviroment assessment evalution methods " | | | |
|---|---|---|---|
| **Num. Case study** | **Applied quest.** | | **Functional performance criteria Grading (yes condition )** |
| | **Yes** | **No** | **Certificated programing grade** |
| Case study 1 :SBRC. Wollongong | ● | | 6 star green |
| Case study 2 : king Abd Alaziz (KAUST) | ● | | Platinum award |
| Case study 3: New American university, fifth settlement, Egypt. | ● | | 104 ranked over world |
| Details : case study 1: rating system: green star ( NABRES ) , rating date: 2014,score or rating result: 6 star green star (equal platinum LEED certificate )<br>Case study 2: rating system: LEED-NC, rating date: U.S. green building council LEED-NC, SEP 2009 v.2.2, and score or rating result: platinum.<br>Case study 3: rating system: green metric campuses, rating date: 2016, green, metric UI, overall ranking: 104. | | | |

## 6. Check List Tool Results

The comparison discussed the final analysis done in step before to get the best practice in implementing a decreasing energy consumption strategically without human distribution needing and conservation of environmental aspects. The case studies will be measured affection using for implemented chosen strategy in every case study and have whole comparison feedback result from basic information that showed that have high grade and it will be masdar institute because masdar has developed a methodology to calculate carbon reduction by applying energy efficiency measures and/or fuel switching in new building units (residential, commercial, and/or institutional units). Examples include efficient appliances; efficient thermal envelope; efficient lighting systems; efficient heating, ventilation, and air conditioning (hvac) systems; passive solar design; optimal shading; building energy management systems (bems); and intelligent energy metering. This methodology was submitted and finally approved by the united nations framework convention on climate change (unfccc) in june 2011 (am0091: energy efficiency technologies and fuel switching). This is the first methodology that looks into the emission-reduction calculation of new buildings under the unfccc scheme. It is also the first time that a methodology has been approved that applies a set of measures to buildings without directly quantifying a specific emission reduction to a specific measure.

**In case studies analysis (first question) answer's had gotten:** specially insurance applying spaces connected to number of users and satisfaction according to assessment methods every case study design according fixed user number 's (stuff and student's ) , satisfaction comes from the design style that had chosen computable with surrounding environment .

**In case studies analysis (second question) answer's had gotten:** that efforts had done in decreasing energy consumption , the most of case studies had built on enhancing building envelope by using measurement programming of sun radiation on facades , every case study have been a first thinking on how to be more efficiency, decreasing thermal conductivity from outside to indoor space's to achieve high comfortable level for users , most of case studies makes tradition element in modern style as ( mashrabia (arabian universities) , arcades ( for all case studies) , local material with high resistance and low thermal conductivity, using system insulation according to climatic zone aspects , glazing material which could be decreased heat gain by 40% and affected in reducing hvac energy consumption directly ( depend on the effectiveness of insulation of certain envelope elements can be assessed using their u-value (which represents the amount of heat radiation (w) that can enter the building per meter square of area and at a temperature deferential of one degree), fixed shading for sun radiation ( depended on sun radiation degree ( winter and summer)),facades color painted material have been great impact on reduction thermal from sun

radiation , colors have been development to can be reflecting and diffusing sun radiation as showed in case studies Other issued in decreasing energy ,that have used led artificial lights integration with daylight hours , that can be reduced energy consumption by 30 % of total energy consumption . Using recycle material have been affecting whole life cost ,most of recycle material had a greening design acceptation and conservation environmental aspect's ( eco-life ) .specified , using recycle material have appositive life cycle cost and also could avoid negative reflectance with developed material in recycling procedures .
Certificate design principles in hot areas as building from open to close as vernacular architecture elements ( separated entrances , courts ( open ,semi shaded , shaded) ,arcades, "mashrabia" in modern style ,thickness of building envelop ,cross ventilated areas , wind passive towers , landscape had decreased heat gain specification environmental quality computable with location environment ) all of those can be called passive cooling and heating elements ,as showed in case studies -expected . This main elements can improve environment indoor quality ,certificated system in assessments methods with high rated accreditation and affecting directly on decreasing energy consumption because those elements will affecting in thermal heat resistance and ventilation ,both affecting on hvac energy consuming through day.
**In case studies analysis (third question) answer's had gotten:** uses of renewable energy ( solar pv panels , wind turbines ) will provide green and sustainble power ,this will be great development in decreasing cost of energy consumption through life cost ,computable with other decreasing energy consumption aspects , campuses could be produced energy, this will decreas co2 emmission and will be meet the green houh gas emmision scope 1&2.auc must be applied renewable energy to be "green campus" helping community to be a sustainable campus leadership in Egypt.
**In case studies analysis (fourth question) answers had gotten:** using certificated environment assessment had showed that case studies have high regulated in some issued and some to be repaired as (landscaping and decreasing heat gain) to improve environment quality and energy consumption rates a certification had also provided us a clear information for current statues for each of case study to be gotten full procedure's knowledge (as research scope )for methodologies of decreasing energy consumption.

## 7. Conclusion

Through research anlaysis had appeared scientfice cosider solutions for decreasing energy consumption through inductive analysis and comparison methdologies that explained before and there were:

1. In new unversity project must be applied specified sustainble policy that will be the guid lines that controled the implemenation of the design strategy.
2. Non- talking in any mrthdologies will be used to decrease energy consumption before ensuring user's ( staff and students) experince for sociaglical satsfing (human factor).
3. New unversities and exetencemust be have a planed planning for decreasing energy consumption and created adepartment that controled and developed energy consumption and performance.
4. Universities must be applied passive cooling and heating strategies that had effected dierctley enhancing for eco-enviromental aspects and tring achieving zero carbon emmision.
5. Using material suitable with local project climate as regualated with climatic cosedration ( thermal coductivity condition , ventalited per hours condition and erasion aspects), that will be amain rule in design strategy and impleminting proccesing to decresing energy consumption relation ,because this princible through analysis have dierect related method ( low mterial condictivety in thermal condition = low using HVAC = low energy power consumption) in sample state.
6. Reneweble energy power must be included in any university building , that will great benifite to decrease whole life energy cost ,universities had researcher's that developed clean and green energy to achive zero

energy consumption , that will be according to university rule community an affected on whole commuinty decreasing non-renewble energy, this will had coserved enviroment.

7. Smart building programes ( management system , sensors analysis , room data control , smart material used(envelop building)), through analysis has been showing that a chance to have asmart reducing energy consumption in universities consiedring decreased energy consumption through delaying time ( non occubied useres ) in education spaces by management and sensors through creating a smart room data and implementing samrt gride, smart matrial defiened that developed araw material to regulated with local climate condition and users need ,that will be enhanced education space function and performance ,also raised high grading also decreased energy consumption ( HVAC- lighting ).

## 8. Recommendation for G.P.R.S.

As comparison result for evaluation systems, we would be suggested the following table to be guide line in applied energy performance evolution criteria to be considered with (any climatic zoning, best curriculum criteria and best weighted accreditation points), that's will be from GPRS system and the other systems that explained before.

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