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Green Building and Energy Saving

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***Abstract*—**In a world of climate change and limited fossil fuel resources, renewable energy sources are playing an increasingly important role. Due to industrializations and population growth our economy and technologies today largely depend upon natural resources, which are not replaceable. Approximately 90% of our energy consumption comes from fossil fuels (viz. coal, oil and natural gas). The irony is that these resources are depleting. Also, the huge consumption of fossil fuels has caused visible damage to the environment in various forms viz. global warming, acid rains etc.

***Keywords*—**[KW: Kilo Watt], [KWH: Kilo Watt Hour], [CO_2 : Carbon Di-oxide], [PV: Photovoltaic], [EPA: Environmental Protection Agency], [KD: Kwaiti Dinar].

I. Introduction

THE world needs to respect the planet's scarce resources and drive thru to make energy ever cleaner and greener. Therefore, if not today, tomorrow world will have serious problems with the availability of power thru non-renewable resources. The time is ripe to think about alternative sources of power which potentially seems to be Solar Power. The solar energy falling on the Earth's continents is more than 200 times the total annual commercial energy currently being used by humans.

The experts now believe that renewable sources are poised to achieve a major break-through in the world's energy market. At present so many alternative fuels have been developed, still they are able to meet only a small proportion of our actual demand. There is a huge potential for solar power specially in the Middle East. However, the focus is definitely going to shift towards renewable sources because;

i) Renewable Energy sources are not depleted.
i) It won't create any environmental pollution problems.
iii) By a onetime investment we can draw energy for many decades without affecting the environment.

II. Green Building?

A. What is a Green Building

A green building is an environmentally sustainable or high performance building, designed, constructed and operated to minimize the total environmental impacts.

B. Green Building Strategies

The main strategies to achieve a green building include:

– Reduced energy consumption
– Water conservation
– Recycling waste

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Well-designed green buildings will save money, increase comfort and create healthier environments for people to live and work, using improved indoor air quality, natural daylight, and thermal comfort.

Energy use by depleting natural resources as well as CO_2 emissions is one of our most important environmental impacts. Every 1000 KWH of electricity saved reduces 10000 pounds of Carbon Di-oxide (a Greenhouse gas) dumped into the atmosphere

C. Components of Green Building

- Energy Efficiency and Renewable Energy
- Water Efficiency
- Waste reduction
- Toxics Reduction
- Protecting occupant health and improving employee productivity
- Indoor Air Quality
- Environmentally Preferable Building Material and Specification

D. What Building Types can be Green?

- Any type of building/Facilities has the potential to become a green or sustainable building
  - Homes,
  - Commercial and Public Buildings
  - Laboratories
  - Healthcare Facilities
  - Core & Shell
  - Mosques
  - Hotels
  - Light Industry
  - Sports

E. Green Building Assessment System

- BREEAM /The British Green Building Assessment System/ was established in 1990 as a tool to measure the sustainability/BASED ON BRE - founded in 1921/
- LEED/ North America Green Building Assessment System/ Developed by the US Green Building Council (USGBC) in 1998
- GREEN STAR /TheAustralian Environmental Rating System/ - Launched in 2003 by the Green Building Council of Australia.
- QSAS / The Qatar Green Building Assessment System/ Founders of QSAS-" Barwa& Qatari Diar Institute - currently known as Gulf Organization for Research and Development (GORD).

III.QSAS Rating System

A. The Eight Categories of QSAS are the Following

1. Urban Connectivity [UC]

The Urban Connectivity category consists of factors associated with the urban environment such as zoning, transportation networks and loadings. Loadings on the urban environment include traffic congestion and pollution.

2. Site [S]

The Site category consists of factors associated with land use such as land conservation or remediation and site selection, planning and development.

3. Energy [E]

The Energy category consists of factors associated with energy demand of buildings, the efficiency of energy delivery, and the use of fossil energy sources that result in harmful

4. Water [W]

The Water category consists of factors associated with water consumption and its associated burden on municipal supply and treatment systems.

5. Materials [M]

The Materials category consists of factors associated with material extraction, processing, manufacturing, distribution, use/re-use, and disposal.

6. Indoor Environment [IE]

The Indoor Environment category consists of factors associated with indoor environmental quality such as thermal comfort, air quality, acoustic quality, and light quality.

7. Cultural & Economic Value [CE]

The Cultural and Economic Value category consists of factors associated with cultural conservation and support of the national economy.

8. Management & Operations [MO]

The Management and Operations category consists of factors associated with building design management and operations.

B. Phases That can be Rated Using QSAS

- Design
- Construction
- Operations: New/Existing Buildings

C. QSAS Certification

- The scoring scale of -1 to 3 (-1, 0, 1, 2, 3) or 0 to 3, depending on the criterion's level of impact.
- Certification can only be achieved when the final score is greater than or equal to 0, earning a rating of 1, 2, 3, 4, 5, or 6 stars. The highest score a building can achieve is 3.0 and the highest certification level is 6 stars.

IV.Case Study

A. Benefit

The main benefits of green buildings are:

1. Reduced Operating Cost

- Reducing energy consumption directly reduces the cost of operating buildings.
- Energy is not a fixed cost.
- Total energy cost (KWD) = cost of energy (KWD/kWh) x energy consumption (kWh).
- Reduced energy consumption will reduce your total energy cost.
- Build Green can develop an energy management plan to reduce your operating costs.

2. Increased Comfort for Occupants

Increased comfort for occupants can be achieved by:

- Natural light
- Reduced temperature variation
- Improved indoor air quality

Indoor air quality is particularly important for commercial buildings. Some building and furniture materials can slowly release toxins into the indoor environment. Green building design incorporates improvements to indoor air quality, leading to increased productivity of occupants.

3. Improved Corporate Image

- Another benefit of green buildings is that you are taking action towards being environmentally responsible and this will improve your corporate image.
- By reducing energy consumption, you will reduce the need for new power plants and help reduce global CO_2 emissions which have a direct effect on global warming.

B. Efficient Energy Use & Lighting System For the Green Building

1- Building Envelope

- Building Orientation
  - Maximizing South and North Exposure and Minimizing East and West Exposure within the given boundaries of the PROPOSED building form.
  - The fenestration is maximized on the north orientation to minimize heat gains from windows and for facilitating simple solar control and to maximize day lighting.
  - Can't be achieved (Between Existing Building)
- Insulation
  - The U value of the Wall and Roof for proposed building shall be $\leq$ 0.05 Btu/hr-Sqft-F and $\leq$ 0.045 Btu/hr-Sqft-F and this can be achieved by using 100mm thermal insulation in place of 50 mm and 75 mm thermal insulation respectively in general.
  - This will reduce the cooling load demand of building approx. 2-2.5%.

- The U value and shading coefficient of glass for proposed building shall be ≤ 0.27 Btu/hr-Sqft-F and 0.26 respectively.
- The above thermal properties of glass can be achieved by using double glazed glass of composition 6-12-6/6-16-6 and this will further reduce the cooling demand of building approx. 4.5%.

- Green Roofs
  - Reduce CO_2 impact
  - Reduce summer air conditioning costs
  - Reduce winter heat demand
  - Potentially lengthen roof-life 2 to 3 times

- Sun Control and Shading Devices
  - Light Shelf Design
    - ✓ Prevent the sunrays from coming in contact with the equipment and material.
    - ✓ Increase the intensity of the light in the space by reflecting the sunrays onto its ceiling.
    - ✓ Very cost effective and extremely helpful.
  - Shading
    - ✓ To control the amount of sunlight admitted into a building.
      - ➢ In warm, sunny climates excess solar gain may result in high cooling energy consumption;
      - ➢ In cold and temperate climates winter sun entering south-facing windows can positively contribute to passive solar heating;
      - ➢ In nearly all climates controlling and diffusing natural illumination will improve daylighting.

Depending on the amount and location of fenestration, reductions in annual cooling energy consumption of 5% to 15% have been reported

2- Advance Type of Lamps

- As claimed by different manufacturers, LED lamps can reduce the lighting power consumption by 15-30 %. Although, the LED technology is very new and is evolving, initial cost and subsequent maintenance/ replacement are comparatively high. and the performance of the same is yet to be proven, direct power saving figures are very encouraging.
- In addition to the above, the lighting power consumption can be further reduced approximately by 30-40% by controlling the LED lights.
- In addition to the power/money saving for the company, it has larger impact on environment.

TABLE I
FINANCIAL ANALYSIS

Area (m^2)	Present Technology		Proposed Technology		Additional Cost KD
	Conventional Lamps Cost(KD)	KWH	LED Lamps Cost (KD)	KWH	
5000	60,000	459,900	90,000	337,260	30,000

- Power Saving Related Calculations: Using LED Lamps in place of Conventional Lamps
  - Power consumption with conventional lamps = 90 KW
  - Equivalent KHW = 90KWx 14 hrs. per day x 365 days = 459900KWH
  - Power consumption with LED lamps = 40 KW (approx.)
  - Power saving = 90 – 40 = 50 KW (approx.)
  - % age Power Saving = 100 x 50/90= 55%
  - Equivalent annual KWH saving = 50x 14 hrs. per day (average) x 365 days = 255500 Units
  - Equivalent annual CO2 reduction to the environment= 7.18 x 10-4 x 255500 Metric Tons = 183 MT (annual)

- Using Automatic Control of LED Lamps
  - Annual Power Consumption after using LED type Lamps = 40KW x 14 Hrs. per day x 365 days= 204,400KWH
  - As highlighted above, further saving of approx.40% is expected by implementing automatic control of installed lights, which will be =204,400 x 40/100 KWH = 81,760 KWH
  - Therefore, total annual power saving by using LED Lamps and implementing their automatic controls = 255,500 KWH + 81,760 KWH = 337,260 KWH
  - Equivalent annual CO2 reduction to the environment = 7.18×10^{-4} x 81,760 Metric Tons = 59 MT (annual)
  - Overall annual % age Saving = 100 x 337260 / 459900 = 73 % (approx.) (LED Lighting + Lighting Control)
  - Annual Power consumption after using LED lamps with Automatic Controls = 459900 - 337260 = 122,640 KWH

3- Stainable Lighting Solution

Self-contained solar powered, battery backed lighting poles equipped with led type fixtures are available. As claimed by manufacturers, the expected life of these fixtures is approximately 20 years (batterylife of min. 10 years) without any maintenance.

4- Savings Due To Power Factor Correction

To brief about Power Factor Improvement, commonly on inductive loads, the current drawn by the load comprises active and reactive component. The reactive components of the current does not do any work, however, it is required to make it run. Therefore, the concept of power factor improvement considers supplying the reactive power locally, which in turn reduces the flow of reactive power through the upstream system (viz. cables, busbars, Transformer etc.), in turn saving power on account of I^2R loss. Typical savings for residential units will vary from 6% to 10%; commercial from 6% to 17%; and industrial from 6% to 25%, depending up on the extent of improvement

5- Solar Water Heater

- Solar water heating systems use solar panels, called collectors, fitted to your roof. These collect heat from the

sun and use it to heat up water which is stored in a hot water cylinder. A boiler or immersion heater can be used as a back -up to heat the water further to reach the temperature you want.

Example: The Electric heater is 3.5 KW. If this power is to be supplied by a solar heater, following observations are made;

The annual power consumption = 4200 KWH.
=16800 KWH(4 water heater)

Lifetime power consumption = 63000 KWH (@15 yrs.)
=252000KWH(@ 15Yrs. 4 water heater)

Equivalent amount of CO2 = 63000 x 7.18 x 10^{-4}
= 45.2 MT
=180.8MT (4 water heater)

- **Hot Water throughout the Year**: the system works all year round, though you'll need to heat the water further with a boiler or immersion heater during the winter months.
- **Solar PV power**

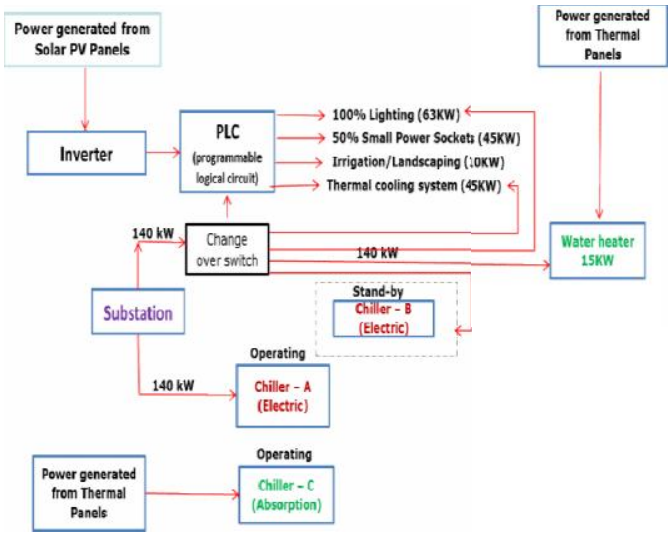

Fig. 1 Flow Chart for the Solar Power

C. Water Efficiency

1- Dual Flush Toilet

A dual-flush toilet is a variation of the flush toilet that uses two buttons or handles to flush different levels of water. It has been proven to save up to 67% of water usage in most homes

2- A Faucet Aerator

A faucet aerator (or tap aereator) is often found at the tip of modern indoor water faucets. Without an aerator, water usually flows out of a faucet as one big stream. An aerator spreads this stream into many little droplets. This helps save water and reduce splashing.

Faucet aerators are often used in homes with low water pressure in order to increase the perceived water pressure

3- Automatic Faucet

An automatic faucet or tap (also hands-free faucet, touchless faucet, electronic faucet, motion sensing faucet, sensor faucet, or infrared faucet) is a faucetequipped with a motion detector and mechanism that opens its valve to allow water to flow in response to the presence of a hand or hands in close proximity. The faucet closes its valve again after a few seconds or when it no longer detects the presence of hands. Most automatic faucets are battery powered and incorporate a passive infrared sensor to detect hand motion. Automatic faucets are common in public washrooms, particularly in airports and hotels, where they help to reduce water consumption [1] and reduce the transmission of disease causing microbes.

4- Gray Water

Any washwater that has been used in the home/offices, except water from toilets, is called graywater. Dish, shower, sink, and laundry water comprise 50-80% of residential "waste" water. This may be reused for other purposes, especially landscape irrigation, flush toilets and car washing.

D. Indoor Environment

1- Vertical plant

Green walls are found most often in urban environments where the plants reduce overall temperatures of the building. "The primary cause of heat build-up is insolation, the absorption of solar radiation by roads and buildings and the storage of this heat in the building material and its subsequent re-radiation. Plant surfaces however, as a result of transpiration, do not rise more than 4–5 °C above the ambient and are sometimes cooler."

2- Air Sanitizing Solutions

- Benefits of implementing
  - Sanitise Air Conditioning Systems
  - Increase Indoor Air Quality
  - Provide a pleasant Working Environment
  - Right Air cleaned coils reduces energy consumption
  - Reduce sick leave by approximately 30%
  - Increase Productivity
  - Inhibit mould, Fungus and Bacteria grow
- Applications of use

Successfully used in areas such as shopping centres, hotels, accommodation facilities, restaurants, office buildings, assisted living facilities, health care facilities, schools and houses. The reasons for use in these situations are quite varied, sometimes to control mould, sometimes to reduce sickness amongst the staff, to eliminate odours, or to treat a yeast or mould infection in the air-conditioning system.

E. HVAC

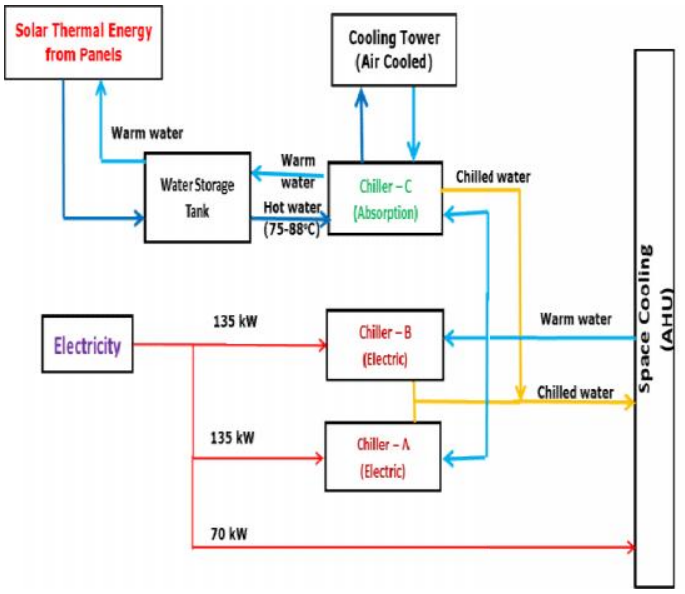

Fig. 2 Flow chart for thermal HVAC system

- *HVAC Conclusion*
  - The Cooling load and power demand for conventional method of cooling:-
    - Total cooling load of building=300 TR (Approx.)
    - Total Power Demand=600 KW
  - The Cooling load of building by considering improving technology r:-
    - Total cooling load of building=180 TR (Approx.)
    - 90KW power will be saved by deleting future extension of HVAC (60TR) from phase 2(by reducing the chillers capacity from 180TR to 160TR)
    - Total HVAC Power Demand for complete phase 3 =360 KW (including 90KW from phase-2)
  - Saving:-
    - Cooling Load=300-180=120 TR(Approx.)
    - Power Demand=600-360=240 KW (Approx.) + (90KW from phase 2)
    - Net saving = 240 KW+90 KW=330 KW

F. Summary

TABLE II
LOAD COMPARISON AND POWER SAVING SUMMARY

	Construction of Burgan Office Complex Phase III Extension	KW Conventional	KW (LED + UV Rated glass)	KW(SOLAR + LED + UV Rated glass)
1	Lighting (Office + car park+bldg.- perimeter fence+ Substation and Plant Bldg.)	80+5+10 +10=105	63	0
2	Power sockets - (offices+pantry+heaters + split units+Substaion and Plant Bldg.)	90+5+15 +12=122	122	62
3	HVAC	600	370	370 (150Kw will be as standby Source include 90KW from phase 2)
4	Mechanical equipment (Fire Pumps + Irrigation Pumps+ Portable Water + Lift.)	50+10+ 10+15=85	85	75
5	IT +Fire alarm System+ Telephone	25+5+1	31	31
	TOTAL LOAD	943	671	538
	Transformer KVA	1250	1000	750

- **Power Saving Related Calculations:**
  - Power consumption in Normal condition= 950 KW
  - Equivalent KHW = 950x 14 hrs. per day x 365 days = **4,854,500KWH**
  - Power consumption for running load= 388 KW (approx.)
  - Power saving = 950 – 388 = 562 KW (approx.)
  - % age Power Saving = 100 x 562/950= 59%
  - Equivalent annual KWH saving = 562x 14 hrs. per day (average) x 365 days =2,871,820KWH
  - Equivalent annual CO2 reduction to the environment = 7.18 x 10-4 x 2,871,820 KWH= 2062 MT (annual)
- **Summary of Cost Estimation**
  - Deletion

    Deleted the S/S = 500,000KD
    Deletion of future HVAC load=24,000KD
    Saving due to Thermal Cooler =36,000KD(Since Thermal Cooling system is used in place of Standby Chiller)
    Total saving =560,000 KD
  - Addition

    Additional cost due to used thermal and PV cells =535,000 KD
    LED lighting = 40,000KD
    Improving Insulation= 17,000KD

Improving Glass UV rating = 7000 KD
Total additional cost=599,000 KD

- Additional cost to the project = 39,000KD approx.

- **Payback period**
  - Annual saving as per MEW rates @ 2 fills per unit (KWH) = = 2,871,820 x 0.002 KD = 5744 KWD
  - Payback period as per MEW Rates = 39000KWD/ 5744 KWD = 7 years.
  - Excluding the price of the vegetated roof, vertical plant, gray water and re-cycling indoor material

- **Recommendation**
  - Monitoring, analyzing and reporting energy consumption.
  - Training for maintenance to deal with solar and thermal system.
  - Low value maintenance contract for solar and thermal System

REFERENCES

[1] http://buildgreen.co.nz/definition.html
[2] http://www.qsas.org/ Qatar Sustainability Assessment System (QSAS)
[3] http://en.wikipedia.org/wiki/Green_building Green Building-Wikipedia, the free encyclopedia
[4] http://www.calrecycle.ca.gov/greenbuilding/materials/ Green Building Materials : Sustainable Building
[5] www.ecotherm.com ECOTHERM Company
[6] http://www.rezaroma.com/1/Equipment-Service-and-Support/Diffusion-systems.aspx