



وزارة الأشغال  
ومشؤون البلديات  
والتخطيط العمراني  
Ministry of Works,  
Municipalities Affairs  
and Urban Planning

## Sustainable Green Buildings



*Construction Projects Directorate*

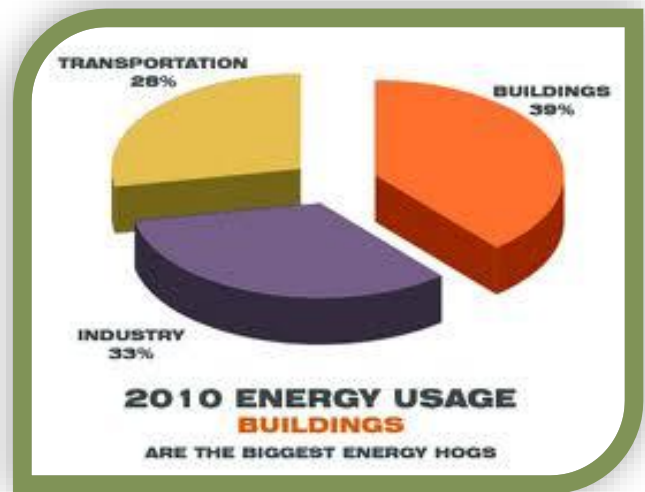
*11<sup>th</sup> March 2019*

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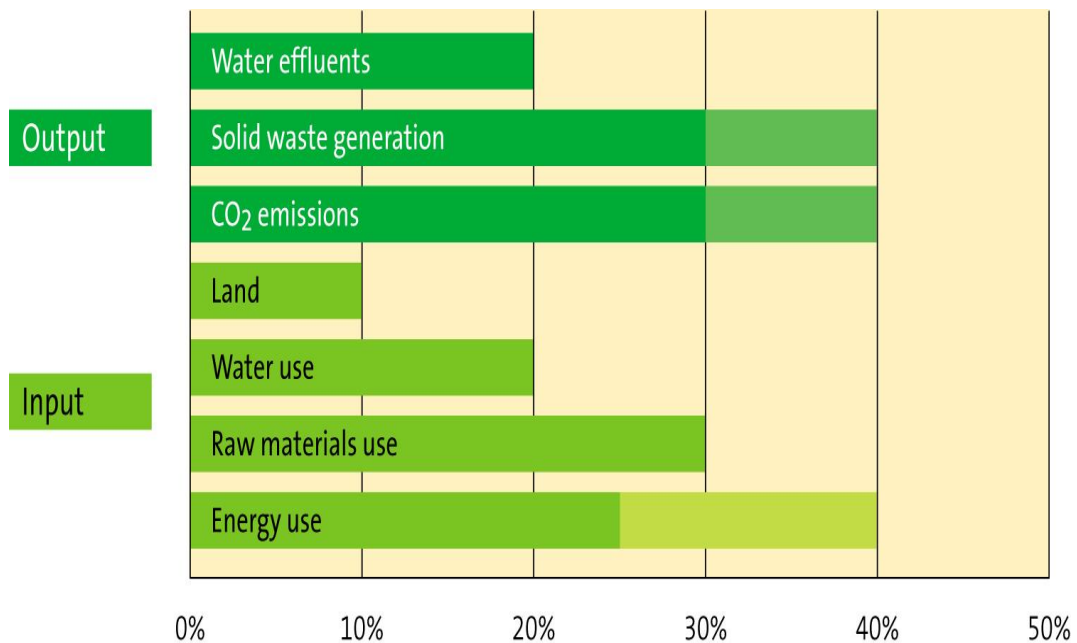
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## OVERVIEW

- In line with Bahrain vision 2030 and MoW's strategic plan, Ministry of Works sets its objective to develop the green building and sustainability program aiming to enforce the implementation of sustainable solution and green building in design, construction and operation & maintenance.



- The implementation of integrated green building principles and sustainability will transform conventional practice in the building industry into an approach that reduces the environment impact of construction related activities while introducing meaningful savings to the government.



## OBJECTIVES

- Integrating “Sustainability and Green Building” principles in the Construction Projects towards Optimal Energy usage throughout the life-cycle of the project.
- Reducing Operation & Maintenance costs
- Minimizing negative Environmental impacts
- Create Healthy Environment
- Enhancing Occupants Productivity.
- Improving overall Quality of Life



*Girls Primary/Intermediate School at Wadi Al-Sail*



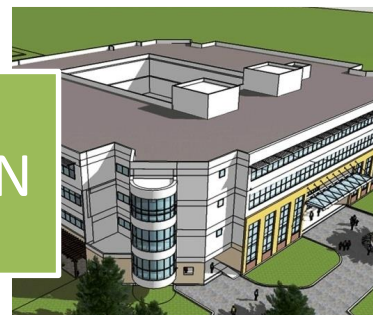
## WHY GREEN?

Green buildings consume less energy:

Compared to the average commercial building, Green Buildings in general:

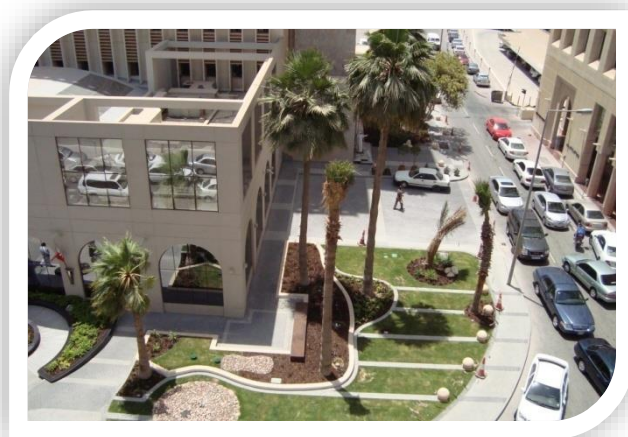
- Consume 25% less energy and 11% less water
- Have 19% lower maintenance costs
- 27% higher occupant satisfaction
- 34% lower greenhouse gas emissions
- Consume fewer resources

# 1. BUILDING ORIENTATION



Building orientation has a significant impact of heat on the building and its ability to reduce cooling load. The way a building is orientated on any particular site will also has major effect on the natural ventilation and utilization of natural light.

- Design long facades with windows facing north-south orientation. Thus, the ideal orientation a building is recommended to be along the east-west axis which can decrease summer cooling bills as well as winter heating load.
- Minimize window areas on the east and west facades.
- Non air-conditioned areas such service rooms can be design along east & west areas of the building to allow some buffer to the conditioned areas.
- Any windows on West facades have to be properly insulated and specified with low emissivity (Low-e) to reduce solar heat gain
- Consider building orientation to the sun to harness energy or to shield it from heat and UV light.
- Optimize building shape & orientation to take advantage of sunlight, wind natural features.
- Evaluate site resources to ascertain how each can enhance the proposed project and vice versa.
- Locate building to minimize environmental impact.



## 2. BUILDING ENVELOPES



The building envelope is comprised of the outer elements of building:

- Foundations/Floors
- Walls
- Roof
- Windows
- Doors

The primary purposes of the building envelope are to provide shelter, security, solar and thermal control, moisture control, indoor air quality control, access to daylight, and views to outside, fire resistance, acoustics and aesthetics.

Due to extreme hot summer in Bahrain, the building "shell" or "thermal envelope" needs to be protected from excessive heat loss and gain.

The building envelope has direct impacts on the thermal and visual comfort of building's occupants. Proper integration and design coordination of the envelope enclosures will constitute to minimize internal conditioning loads which is important for our buildings to be energy efficient.

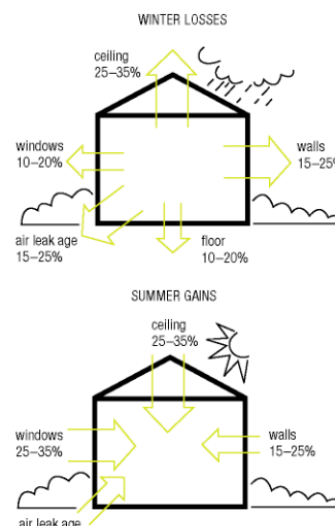


Figure 7.1: Heat flow without insulation



## • INSULATED CONCRETE BLOCKS

One of the major elements of building envelope that has been regulated by Electricity and Water Authority of Bahrain (EWA) is to use Insulated Concrete Blocks for the perimeter walls of a building.

The use of insulated blocks will contribute to a better building performance as far as thermal insulation and energy conservation are concerned:

Insulated concrete blocks deliver:

- **Better thermal & noise insulation**
- **Reduce heat gain thus reduce HVAC cost**
- **Upgrade internal comfort**
- **Complied to Local Authority's Requirement for Wall Thermal Insulation**



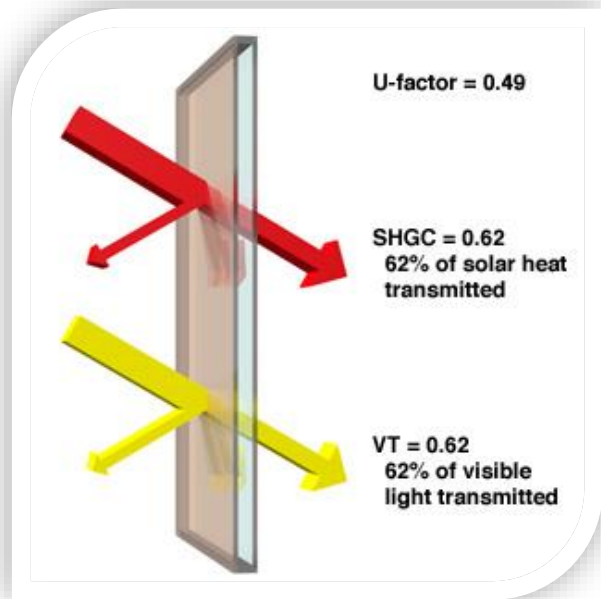
*300mm Block with Expanded Polystyrene Insulation for External Walls (Sandwich Type)*



- **DOUBLE INSULATED & TINTED GLAZING**

Double Insulated and tinted glazing cuts heat loss in half due to the insulating air space between the glass layers.

Bronze and gray tinted glass products are similar in energy performance.



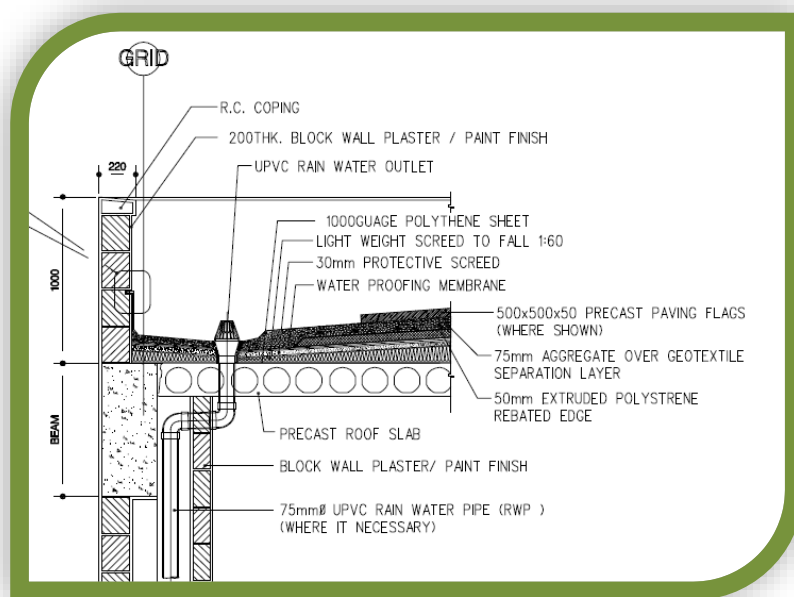
Insulated glazing:

- Reduce heat loss during winter & minimize heat gain during summer.
- Improved energy efficiency and effective thermal resistance.
- Deliver excellent thermal performance with whole window U-values as low as 2.0 W/m<sup>2</sup>k.
- Complied with the Electricity & Water Authority requirements.
- Reduced noise transmission.

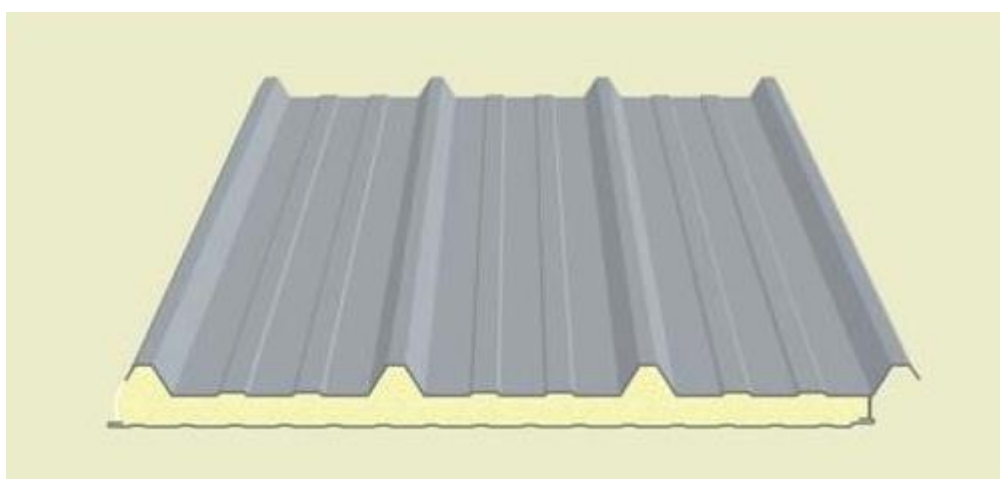


- **INSULATED ROOF**

- **Precast roof slab with insulation system & composite panel roofing reduce heat loss during winter & minimize heat gain during summer.**
- **Improved energy efficiency and effective thermal resistance.**
- **Deliver excellent thermal performance with U-values as low as 0.4  $W/m^2k$ .**
- **Complied with the Electricity & Water Authority requirements.**



*Standard details of the roof gives thermal performance with U-values as low as 0.4  $W/m^2k$ .  
(Complied to EWA's Thermal Insulation Requirements)*



*Composite Metal Roof panel for the Multipurpose Hall in School Projects provides thermal performance with U-values of less than 0.4  $W/m^2k$ .*

*(Complied to EWA's Thermal Insulation Requirements)*

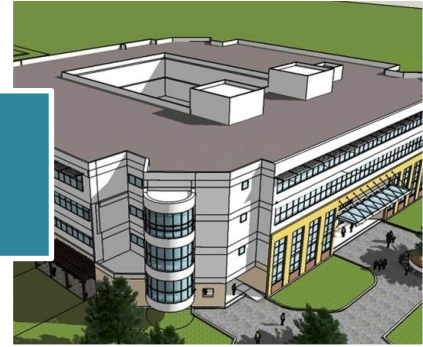
- **ROLLER BLINDS**

The efficiency of thermal insulation in a built environment can also be enhanced by adding roller blinds. For all new school projects by MOW's Construction Projects Directorate, the classrooms and teachers' rooms have been specified with roller blinds as part of green design. The effects of roller blinds:

- **Reduce the impact of heating and air conditioning towards room climate control by offering sun block out.**
- **Blinds and curtains also help to reduce heat gain and loss by trapping air in an insulating layer between the window pane and the covering.**
- **Allow for better light control inside the rooms**



## 3. MEP



The next most important aspect of design for sustainability is to develop specifically-identified technologies for buildings which are cost effective and can have a tremendous impact on energy savings. This can be achieved through integrations of Mechanical, Electrical & Plumbing (MEP) Systems of a building.

### MECHANICAL

#### A. Thermal Comfort

Minimize loads on mechanical systems by optimizing site orientation and enclosure  
Organize interior spaces and locate equipment to minimize loads.  
Proper zoning

Analyse the thermal requirements of each space and choose the most appropriate mechanical system.

Allow for thermally diverse environments that accommodate the cooling requirements.

Give building occupants optimal & practical control over individual zones.  
Use a building management system (BMS) to monitor, control and optimize system performance.



## B. Indoor Air Quality

- Effective ventilation system - give special attention to ventilation requirements and system configuration and controls.
- Avoid materials and furnishings comprised of petrochemicals to reduce harmful off gassing.
- Perform cleaning and maintenance with nontoxic cleaning products and procedures.



*Better working & living environment means happier life and better productivity*

## ELECTRICAL

### Lighting Systems

- The aim of implementing green building principles in electrical system is to minimize/reduce the electrical energy usage in the building, hence reduce the toxic emission.

- Incorporate high efficiency fixtures, lamps and controls. Strive to reduce watts-per-square-foot design targets and actual connected loads.
- Enable occupant control of individual work stations or small work areas with task-ambient lighting systems, as opposed to large, uniformly lit interior areas.



- Include lighting systems in regular maintenance procedures to ensure optimum light output and energy efficiency.
- Begin with an effective day lighting scheme that optimizes the use of natural light.
- Design controls to balance available daylight with the secondary need for electric light.



# PLUMBING

## Water Efficiency

- Dual flush low capacity flushing cisterns should be used.
- Delay taps & Sensor taps with a flow rate of 2 litres/min can also be installed.
- Use water fittings with Water Efficiency Labels



***We never know the  
worth of water till the  
well is dry.***

*Thomas Fuller*

## Sustainable MEP Solutions



# MEP



# SUSTAINABLE MEP SOLUTIONS

## 1. HIGH EFFICIENCY EQUIPMENT

The most important part of mechanical solution for energy efficient design is by using mechanically high efficient equipment.

High-efficiency equipment is based on design and functionality which leads to consuming less energy over time than conventional equipment that performs the same function.

The following considerations are highly recommended:

- Reduce the overall energy use in the building
  - Whenever possible, choose products and equipment with high efficiency standards, demonstrated by industry rating that support a whole building design strategy and a reduction in overall emissions.
  - Using energy efficient equipment can reduce the building's overall energy load and reduce emissions.
- Specify energy efficient equipment and technologies
  - Look for and use rating labels that identify the energy efficiency level of the product or equipment you are purchasing.
- Educate building owners, operators, and occupants
  - On function and operations of installed technologies

In MOW's approach towards sustainability design, highly efficient mechanical equipment has been installed:

- High Efficient Energy Ratio (EER)
- Reputable Manufacturer
- Certified Equipment
- Safe accessories
- Coated Coils
- Double Skin Body
- Non Corrosive Material
- Double Circuits
- High Efficiency Filters

Advantages:

- Less operating cost.
- Long life.
- Ozone friendly.
- Occupants Satisfaction.



## 2. VARIABLE VOLTAGE & VARIABLE FREQUENCY (VVVF) LIFT

Variable Voltage Variable Frequency (VVVF) Lift Drive employs frequency inverter technology which regulates input voltage and frequency throughout the journey, drawing much less current during acceleration and deceleration.

When compared with other modes of drives, one can see that the VVVF drive offers low starting current (approximately 1.8x of the rated current), high power factor (i.e. better efficiency in power supply) with good ride quality and floor levelling. It can reduce motor starting currents by as much as 50 to 80% compared with conventional motor drives. Further, wear and tear of the equipment can also be less during start/stop of the motor by using VVVF motor drive.

Advantages:

- Energy Saving
- Less operating cost
- Higher reliability
- Comfortable travel



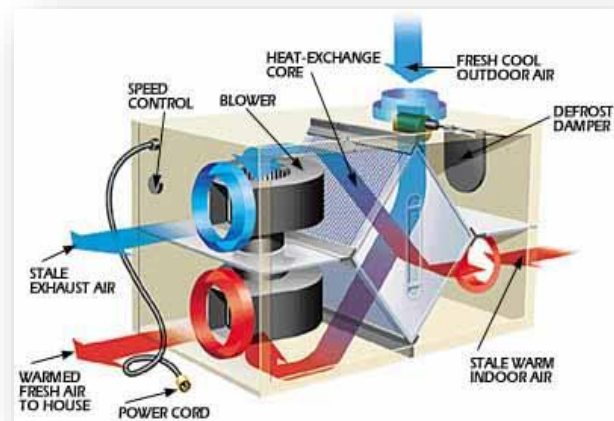
### 3. ERV (ENERGY RECOVERY VENTILATORS)

An energy recovery ventilator (ERV) is a type of mechanical equipment that features a heat exchanger combined with a ventilation system for providing controlled ventilation into a building.

An energy recovery ventilator with humidity regulation incorporates a method to remove excess humidity or add humidity to the ventilating air that is being brought into a building.

Advantages:

- Better indoor air quality
- Utilization of exhaust air energy in order to partially offset the fresh air load.
- Satisfy ventilation requirements.



### DUAL FAN WITH DOUBLE SPEED OPERATION

Advantages:

- Saving in energy by controlling through occupied and unoccupied mode.
- Satisfy ventilation requirement in case of fan breakdown/maintenance.



#### 4. HIGH EFFICIENCY FILTER

The four main factors used to determine the environmental impact of a filter are Indoor Air Quality (IAQ), Energy Savings, Source Material, and Disposal. IAQ is important to the health and wellbeing of individuals within the building. The higher the efficiency of a filter, the better the IAQ. Filters with lower pressure drop and higher efficiency will lower the operating cost of your HVAC system, resulting in Energy Savings. Lower energy consumption reduces greenhouse gas emissions. Source material considers potential environmental impact of raw materials used to make the filters. Finally Disposal refers to the impact of disposing the filter at the end of service

Advantages:

- Better indoor air quality
- Less maintenance & operating cost.



#### 5. PROGRAMMABLE THERMOSTAT

A **programmable thermostat** is a thermostat which is designed to adjust the temperature according to a series of programmed settings that take effect at different times of the day. Programmable thermostats may also be called **setback thermostats** or **clock thermostats**.

Advantages:

- Saving in energy consumption by better monitor & control.
- Operation scheduling.



## 6. PREINSULATED AIR DUCTS

Pre insulated ducting is becoming popular for HVAC industry as it is installed in single fix, eliminating the need for second fix which saves significant time and cost. It is made up of a rigid close cell polysocianate board / rigid phenolic insulated panels faced by an aluminium foil on both the side.

Advantages:

- Lightweight
- Fast Track Installation
- Superb Insulation with a thermal conductivity of 0.1475 BTU in/hr ft<sup>2</sup> °F (0.0206 Watt/m °C).
- Airtight
- Reducing the initial cost.
- Space saving.
- Reduce load on the building structure.
- Clean air.
- Saving in maintenance cost.

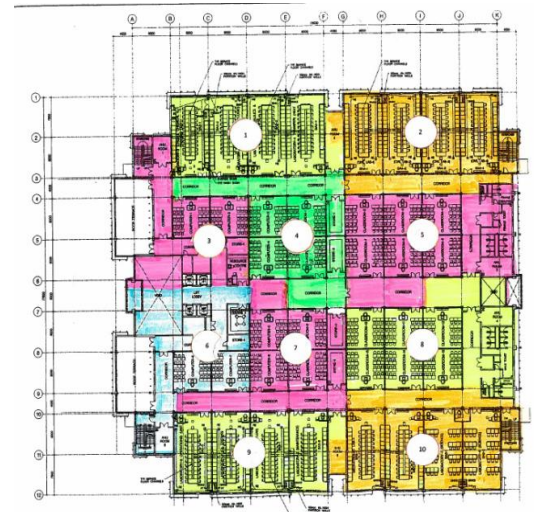


## 7. ZONING

Zoning and Zone Control of Heating, Ventilating and AirConditioning (HVAC) systems are two ways of describing individual temperature control from one central HVAC System. Zoning system is a professionally installed zone control system consisting of a damper and thermostat for each room or zone of the building and wired into a central control panel that sequences each thermostat's call with the zone dampers in the ducts and the HVAC Unit.

### Advantages:

- Comfort - meets the specific temperature and airflow requirements of one area, without affecting other areas
- Efficiency - a well-designed zoning system can save you hundreds of dollars in energy costs each year
- Control - divides the building into multiple areas with adjustable comfort levels
- Quiet Performance - delivers peak performance and efficiency without continually operating at peak capacity; less noise generated at lower speeds
- More satisfaction for the occupants
- Flexibility in control



## 8. AIR LOCK SYSTEM

### Advantages:

- Minimize exfiltration
- Provide intermediate indoor condition.
- Maintain indoor air quality.



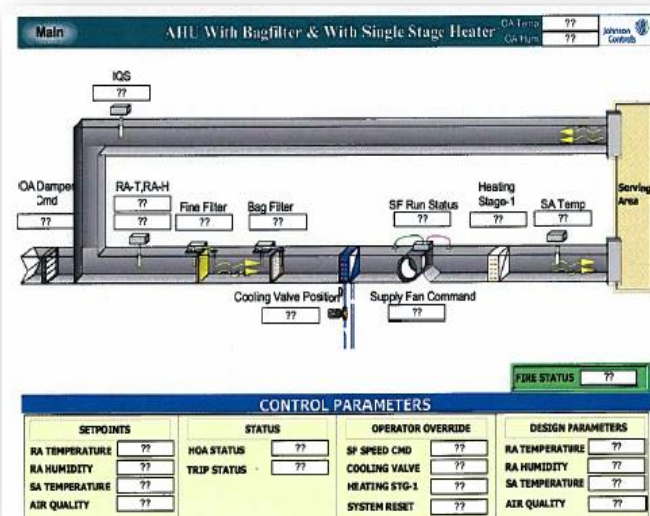
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## 9. BUILDING MANAGEMENT SYSTEM (BMS)

A **BMS** is a computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems.

Advantages:

- Low operating & maintenance cost.
- Scheduling the operation.
- History record.
- Close control and monitoring.



## 10. CLEANING CRADLE SYSTEM

Advantages:

- Improve daylight.
- Satisfy the occupants.
- Saving in operation and maintenance compare to other systems.
- Increase building life.
- Improve building performance



## 11. INSULATED WATER TANKS

Advantages:

- Maintain comfortable water temperature for use.
- Protection for UV radiation.
- Hygienic water.



## 12. REVERSE OSMOSIS (RO) PLANT

Advantages:

- Provide hygienic drinking water for use.
- Saving in operating cost (compare to portable or tanker water).
- Meets occupants needs in time





### 13. DELAY TAPS & SENSOR TAPS

Use of water fittings with Water Efficiency Labels can encourage users to use water efficiently.

Advantages:

- Saving in water consumption.
- Maintain quality of water.



### 14. PIPE IN PIPE SYSTEM

Advantages:

- Easy maintenance
- Easy leakage detection
- Less initial cost
- Hygienic water



## 15. HIGH QUALITY PLASTIC PIPES

Advantages:

- Less operating cost
- Higher reliability
- More hygienic



## 16. HIGH EFFICIENCY FIXTURES

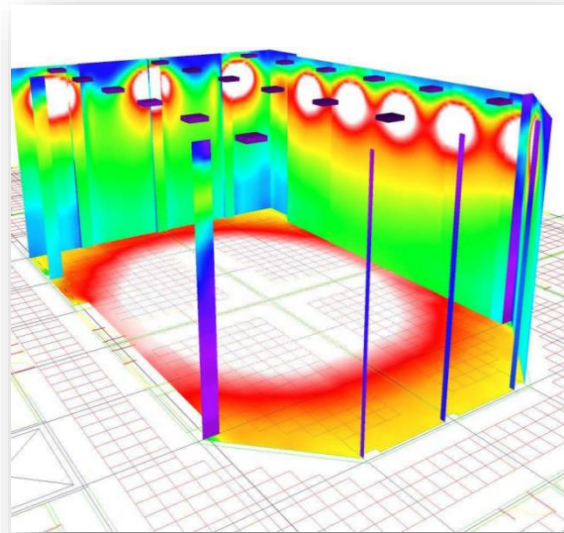
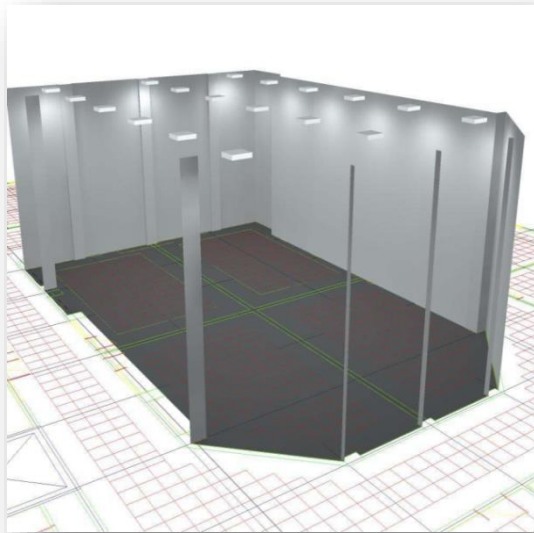
All lights are changed to Compact Florescent Bulbs (CFLs) Energy Saving Down Lights in all areas.

- CFLs are four times more energy efficient than incandescent bulbs and provide the same lighting amount.



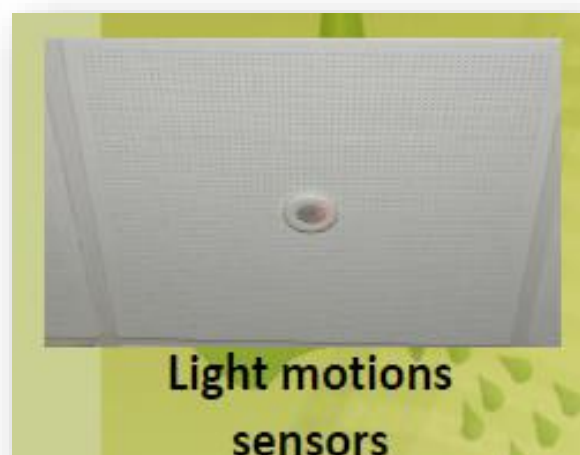
## 17. HIGH EFFICIENCY FIXTURES

Metal Halide lights fittings of high energy consumption have been changed to Dimmable Low Energy Consumption Lights at Multipurpose Hall and Sports Hall.



Programmable Automatic Lighting Control System:

- Occupancy sensors : Which put the light OFF automatically when the space is un-occupied
- Light level sensors: Which dim the light to a pre-set illumination level. It may also be integrated with the level of Day-Light.

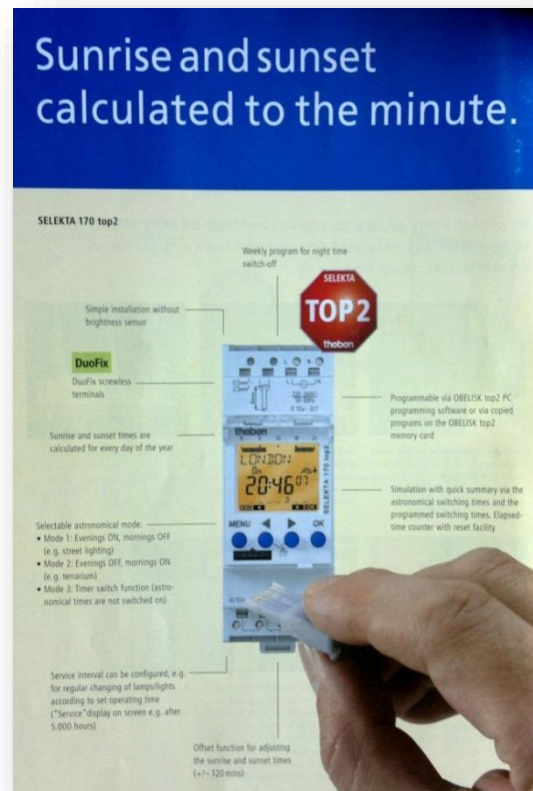


## 18. PROGRAMMABLE ASTRONOMIC OR SOLAR DIGITAL TIMER

All external lights are automatically controlled.

The timer calculates the sunrise & sunset times for each day of the year.

The lighting connected to the timer is switched ON to the minute in the evening and OFF again in the morning, based on the calculated times.



- LIGHT EMITTING DIODES (LED)
- Ceremonial Lights are changed to LED system which is very low energy consumed, has long life and low maintenance.
- LED is also used in some application indoor.



## 19. LIGHTING CONTROL SYSTEM

- Master control (touch screen) of lighting in the control room
- Control room – CCTV
- Manual / Automatic lighting switch



- Stand-alone external pole lights solar (Photo-Voltaic PV) operated.
- The use of some Renewable Energy Supplies (e.g. Solar Energy and Wind Energy) partially in some applications in the Building e.g. external lights, pumps, etc.



## ***THE WAY FORWARD...***

### **“GREEN RETROFIT” INIATIVE**

1. Carry out energy audits, in collaboration with EWA, for selected existing buildings:
  - old school
  - ministry of works building
  - med lab
2. Set recommendations for retrofit works.
3. Implement recommendations and monitor energy performance.
4. LEED certified buildings