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Cost Benefit Analysis of an Eco-Friendly Auditorium over a Normal Auditorium

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Abstract

With the advancement of green building movement in India, many companies have evinced keen interest in having a holistic green design and construction framework for upcoming multipurpose buildings. The booming national GDP and the manufacturing sector demanding more industries in the country. While the growth is imminent it is imperative that the development should happen in an environmentally sustainable manner.

Green factory building can have tremendous benefits, both tangible and intangible. The most tangible benefits are the reduction in water and energy consumption right from day of occupancy. The energy savings could range from 30 – 40 % and water savings around. 20 – 30%. Intangible benefits of green factory include enhanced indoor air quality, good day lighting, health, well-being and safety of the workmen.

Water demand is expected to rise with the expanding urbanization and industrialization. The green building encourages use of water in a self - sustainable manner through reduce, recycle and reuse strategies. Segregation of waste at source, diverting the material to the local recycling facilities and reuse of materials, thereby reducing waste dumped in the landfills are some of the strategies encouraged by the green building movement. This paper aims to alleviate with the related cost benefit analysis of an eco-sustainable auditorium over a conventional auditorium.

Keywords: Green concept.

Introduction

The buildings sector is the single largest contributor to global greenhouse gas emissions (GHG), with approximately, one third of global energy end use taking place within buildings. Further, the construction sector is responsible for more than a third of global resource consumption, including 12% of all fresh water use, and significantly contributes to the generation of solid waste, estimated at 40% of the total volume(REF. 7).

Greening buildings can also contribute significantly to health, livability and productivity improvements. The increased productivity of workers in green buildings can yield savings higher than those achieved from energy efficiency, which are themselves considerable. Women and children tend to be most at risk due to their daily exposure (REF.1). Improved access to water and basic sanitation are significant other benefits that come with green building programmes.

Cost benefits analysis of an eco-sustainable auditorium:

In this paper the cost benefit analysis of a Eco-sustainable auditorium was compared with the normal auditorium. In the total analysis the elementary design of an eco-sustainable and conventional was assumed to be the same and the analysis was carried out on the basis of additional features on the building, and increase in cost and the returns on savings to be achieved in course of time. *For analysis a normal and an eco-sustainable auditorium of 10,000 Square feet area having a design life of 40 years was taken.*

Green features incorporated in eco-sustainable auditorium:

a) Site selection:

The site was selected such that site takes maximum advantage of solar access, existing vegetation, and natural geological features.

b) Orientation of the Building:

The Building was oriented in such a way that it gives maximum day light and does not allow heat to enter in to inside there by reduces load on air conditioning systems.

c) Landscape features:

Trees and plants on site were saved and incorporated into the landscape helped to prevent soil erosion, and also provide shade to the Auditorium from summer sun and savings in power. Natural breeds,

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locally available and special species of cactus were used for plantation which provides better appearance and also act as water retention species. In between them water consuming fibrous flowering plants were planted thus maximum utilization of water.

d) External Insulation:

Spray foam insulation is applied throughout the Auditorium exterior walls. This expands and hardens and makes hence results in saving on labor and material cost.

e) Usage of low E glass coating glass windows:

Large windows with low E glass coating and facing south are provided in order to increase day lighting and wherever possible and appropriate onsite materials and having built-in recyclable containers are used.

f) Rain water harvesting:

Storm water and irrigation runoff, roof top rain water, water from cooling towers and heating, ventilating, and air-conditioning (HVAC) systems are directed into collection area (storage tank). A pressure pipes under gravity was connected and water is used for irrigation or plantation. Drip irrigation is preferred for plantation.

g) Doors and windows:

Factory built trusses, prehung doors and prefabricated doors and prefabricated walls allow for more efficient use of raw materials. This reduces the amount of wastage and debris at site there by reduction of site pollution was achieved. Exterior doors are covered to help to prevent water intrusion, and these reduce maintenance and enhance durability. Ample overhangs also protect against direct summer sun.

h) Indoor Features:

Auditorium is provided with fiber cement siding, made of natural materials which is termite and water resistant and warranted to last 50 years is used. The low volatile organic compounds (VOC) materials are used to significantly reduce emission of smog forming compounds and make living environment healthy.

i) Provision of Solar Panels:

Auditorium is mounted with Photovoltaic Solar panels on roof to provide electrical power. Additional energy demand and energy required during non solar energy supply period can be met with the conventional power grid.

j) Provision of Geothermal heat pumps:

Auditorium is provided with a ground source heat pump that uses the earth's relatively consistent year round temperature and transfers heat out of the auditorium and back into earth in the summer, there by reduces load on Air conditioning systems and result in power efficiency. Geothermal heat pumps work with the earth's renewable energy and can also heat water.

k) Provision of electrical appliances:

All efficient appliances used in the Auditorium are energy star appliances save an average 30% over standard models. Whole Auditorium mechanical ventilation is integrated into heating/cooling ductwork in order to bring in fresh air for a healthy indoor environment.

l) Provision of Sewerage treatment system:

An efficient system for separation of liquid and solid waste is provided. The liquid waste treated by means of special species of plants which use sewerage effluents as food and the water is reused for irrigation purposes. And the solid waste separated is treated and compost is used as manure for the plants. All the above green features are shown in the schematic drawing (Fig.1) of the eco-sustainable auditorium.

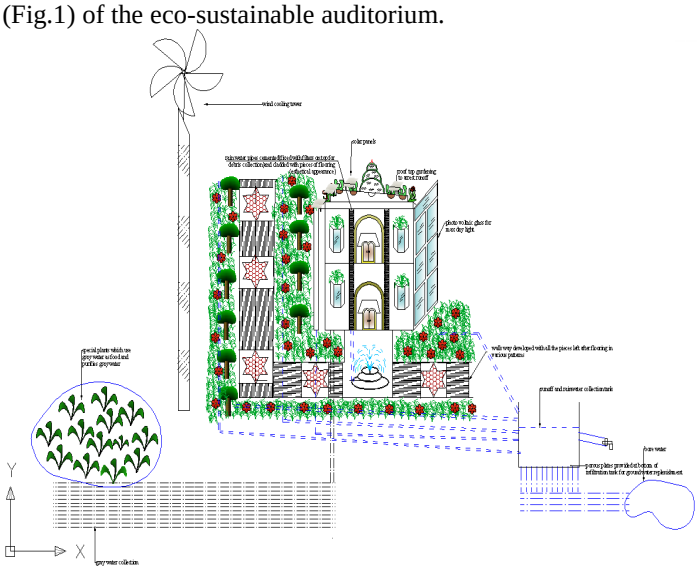

FIG.1 Schematic drawing of a green building

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Cost Comparison of Additional Features in an Eco-Sustainable Auditorium than a Normal Auditorium

S.No	Category	Energy efficient features in eco-sustainable auditorium	Features in normal building	No of appliances if applicab		Cost of each appliance		Cost of each appliance	
				Eco-sustai	Normal	Eco-sustainable	Normal	Eco-sustainable	Normal
1	Water Conservation Features	Dual flush toilets(costs obtained from M.L Sharma and company)	Single flush toilet	**6**	**6**	**15,400**	**6000**	**92,400**	**36,000**
								Diff=56,400	
		Low-flow shower heads	normal –flow showerheads	**3**	**3**	**850**	**400**	**2550**	**1200**
								Diff=1350	
		Low-flow faucets	normal –flow faucets	6	**6**	**952**	**562**	**5712**	**3912**
								Diff=1800	
		Rainwater collection system	**Nil**	**1**	**-**	**1,00,000**	**-**	**1,00,000**	**-**
								Diff=1,00,000	
		Drip irrigation system	**Nil**	**15**	**-**	**2500**	**-**	**37500**	**-**
								Diff=37500	
2	**Sewerage treatment system**	Liquid sewerage treatment pond	**Nil**	**1**	**-**	**20,000**	**-**	**20000**	**-**
								Diff=20,000	
		Solid sewerage treatment pond or vermin-compost pit	**Nil**	**1**	**-**	**12,500**	**-**	**12500**	**-**
								Diff=12,500	
3	**Energy Efficiency Features**	SIPs (structural insulated panels)	**Nil**	**3**	**-**	**11000**	**-**	**33000**	**-**
								Diff=33000	
		Photovoltaic solar panels (**cost ref**. SELCO)	**Nil**	**1**	**-**	**37400**	**-**	**37400**	**-**
								Diff=37400	
		Solar water heater	Electric water heater	**1**	**1**	**25000**	**12,000**	**25,000**	**12,000**
								Diff=13,000	
		Energy-efficient windows	**Normal Glass panels**	**1**	**1**	**325150**	**185800**	**325150**	**185800**
								Diff=92900	

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		ENERGY 5 STAR® light fixtures and appliances(5 BEE 5 star rated ACS+52 energy saving bulbs)	**Normal electric fixtures** (5 NormalACS+52 tube lights)	**1**	**1**	**157200**	**103600**	**157200**	**103600**
								Diff=53,600	
		Spray Foam painting	**Nil**	**1**	**-**	**25000**	**-**	**25000**	**-**
								Diff=25000	
		Geothermal Pump	**Nil**	**1**	**-**	**56,275**	**-**	**56,275**	**-**
								Diff=56,275	
4	**Sustainably Produced and Durable Materials**	FSC certified wood products	**Nil**	**-**	**-**	**-**	**-**	**-**	**-**
		Recycled-content tile	**Normal tile+ Normal tile flooring**	**1**	**1**	**1250000**	**10000000**	**1250000**	**10000000**
								Diff 250000	
		50-year siding	**Nil**	**1**	**-**	**20000**	**-**	**20000**	**-**
								Diff =20000	
		40-year metal roof	**Nil**	**1**	**-**	**62500**	**-**	**62500**	**-**
								Diff=62500	
		Locally manufactured materials when possible	**Nil**	**-**	**-**	**-**	**-**	**-**	**-**
5	**Healthy Indoor Environmental Features**	Low VOC paint	**normal paint**	**1**	**1**	**325150**	**185800**	**325150**	**185800**
								Diff=139350	
		Nontoxic finishes on flooring and cabinetry	**Nil**	**-**	**-**	**-**	**-**	**-**	**-**
		Efficient ventilation	**Nil**	**-**	**-**	**-**	**-**	**-**	**-**
6	**Low Impact Site Development**	Use of compost for erosion control	**Nil**	**1**	**-**	**15000**	**-**	**15000**	**-**
								Diff=15000	
		Vegetated “green” roof	**Nil**	**1**	**-**	**51095**	**-**	**51095**	**-**

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	and Natural Landscaping							**Diff=51095**	
		Planted wall as a retention wall	**Nil**	-	-	-	-	-	-
		Drought tolerant plant selections	**Nil**	**1**	-	**32515**	-	**32515**	-
								Diff=51095	

*A green Building costs about Rs. 10, 78, 60 more than a normal building and accounts to be 20% more than cost of a normal building.

Monetary benefits of a green building over a normal building:

Considering the auditorium of 10,000sq.ft to have no of persons to be 120 during peak days and the auditorium to be operated for a period of 250 days.

Savings in Water Consumption

a) Normal Building.

Let the consumption per person be 135 litres per person per day, then consumption of auditorium is 120*135*250 = 4,050,000

The water cost be 2.5 paise per litre (Reference from water boards)

***Total cost of water for a normal building Rs/- 101,250* .

b) Eco –sustainable Auditorium

Due to usage of double flush toilets, Low-flow showerheads and faucets Rainwater collection system and systems for re-using grey water, usage of green roof reduce storm water runoff reduced usage of water to about 30%. Hence the consumption of water reduced to 94.5 litres per person per day, then consumption of water=94.5*120*250=2,835,000.

**Total cost of water for a eco –sustainable Auditorium Rs/-70,875.*

Savings in cost of water per year is Rs/- 30,375.

Savings in Power or Electricity

a) Normal Building.

The consumption of a normal building was 121KWh/year.

**Cost of 1kwh is Rs 2475/-(reference from articles of national and power rates from electricity board India Andhra Pradesh relative)*

*Cost of 121kwh/year = 2475*121= Rs/- 299475.*

b) Eco –sustainable Auditorium:

Green roof systems provide protection to roofing membranes from the effects of UV light and frosts, and therefore lead to a longer material life span. It is generally accepted that a greened roof can double the material life. A savings of 25.9 KWh per year is being saved.

The auditorium roof has been covered by Saint-Gobain glass. These glasses allow light to enter inside but not heat. And the pressure on AC and other cooling systems were reduced. The SIPs installed on the top resulted in savings of 10KWh per year. And the solar heaters resulting in savings of 2KWh per year and geo thermal pump also helped in reducing the load on heating ventilating and air conditioning equipment. Hence the total appliances resulted in an average savings of around 43 KWh per year.

**Total power consumption for Auditorium=121-43=78 KWh per year*

Cost of 1kwh is Rs.2475/-(reference from articles of national and power rates

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from electricity board India Andhra Pradesh relative)

*Cost of 121Mwh/year=2475*78*= Rs/- 193050*
Savings in cost of electricity is per year is Rs/-106425.
Total Monetary savings per year= Rs/-136800.

Hence the additional cost of Rs. 10, 78, 60 lakhs that is spent on green eco-sustainable is paid back in a period of 8 years.

Apart from these it gives many of the non tangible benefits like increased indoor air quality, occupant productivity above all the auditorium gives an esthetical environment and a satisfaction of being with environment and by environment together with conserving it.

Conclusions & Summary

- The typical building top level was in a shape of a typical semispherical and the semispherical was designed such that maximum day light enters in to the auditorium.
- Power usage is reduced very much and a normal building of this section consumed 121MWh/year.
- Our auditorium consumed only 78MWh/year. By this an Annual Energy Savings of 43Mwh/year can be done, which saves around **Rs/-**106425. per year.
- All the additional green features and other skilled labor and all other necessary maintenance and other minor apprentices designed increased the total building cost by 21% i.e. by 10.5 lakhs.
- And the total additional cost was estimated to be received in a period of 8 years and from there on gain on building was around 4% while take care all the maintenances differentiating from a normal building.
- Apart from these it gives many of the non tangible benefits like increased indoor air quality, occupant productivity above all the auditorium gives an esthetical environment and a satisfaction of being with environment and by environment together with conserving it.

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