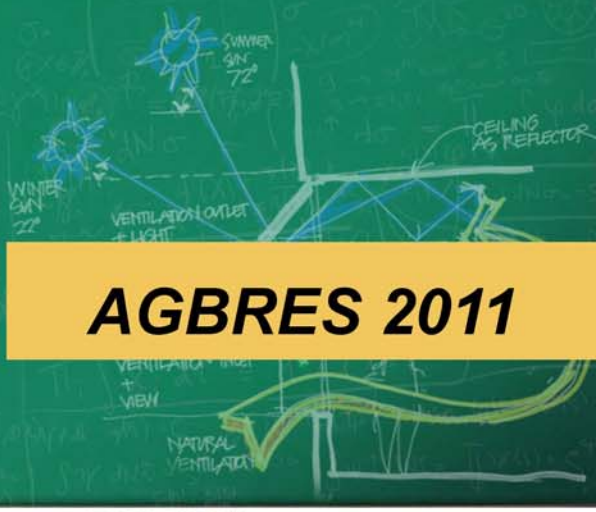
Workshop on

Awareness on Green Buildings Responsible Education in Schools

7th September 2011 at India International Centre



AGBRES 2011

Proceedings

Editor

Malti Goel

CCRS
Climate Change Research Society
New Delhi

India International Center
New Delhi

Workshop on
Awareness on Green Buildings Responsible Education in Schools

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Programme Coordinator
Dr. (Mrs) Malti Goel

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Preface

Energy is critical for development and to grow sustainably is the need of the hour. India has made tremendous strides in renewable energy development by achieving approx 21,000 MW of installed capacity (Dec 2011). However, renewable energy penetration in the building sector is quite low. Linking climate change with energy policy also demands transformational changes in the way we use energy. Energy conservation and improvement in the energy efficiency by the application of science & technology are considered fifth fuel to meet the growing energy demand in various sectors of economy viz. industry, transport and buildings.

The workshop on *Awareness on Green Building Responsible Education in Schools* (AGBRES-2011) was held on 7th September 2011 at India International Centre (IIC). The workshop was sponsored by IIC and was organized jointly with Climate Change Research Society. We thank the Programme Office, IIC and Ms. Premola Ghose for their generous support.

The workshop was unique in that the multi-disciplinary perspectives about Green Buildings were deliberated. Youth in their formative years in school need to inculcate skills on such topics of energy and environment concerns, which are not in their regular course curriculum. Participation was open and included teachers and architectural students by invitation.

We express our profound gratitude to eminent experts from the field of Education, Science & Technology, Industrial research, Planning & Architecture from the Government and Academic institutions as well as from EU, for their kind presence and sharing their vision on Green Buildings.

We are thankful to Asia Business Council for permission to reproduce excerpts from 'Building Energy Policies in India'. It appears on p 75 onwards. Special thanks are due to Ar. Sandeep Goel and Mr. Anish Tripathi for making this event a success.

Dr. (Mrs.) Malti Goel
Programme Coordinator

Foreword

Excellence in education is something which I have always desired during my professional career and afterwards. While general education broadens the vision and sharpens the intellect of the individual and leads to the overall improvement of the society, education in Science & Technology makes outlook of an individual more logical and rational and also provides a potent tool for the economic growth of the country. Profitable use and application of the knowledge of science and technology in our day-to-day life and its dissemination among the masses is therefore extremely important especially in a country of our size and population.

The present workshop is conceptualized by Dr. Malti Goel, Executive Director of Climate Change Research Society (CCRS). There is a spate of activities going on towards green buildings - residential and commercial (in all growing and upcoming areas) - rural as well as urban. Social conscious plays an important role in the matters of energy use. If care is taken to make use of the air and sunlight which are free bounties of nature, lots of wasteful use of precious energy can be saved. This has been the focus of the Workshop, organized by CCRS jointly with India International Centre. It was attended by eminent experts in the field, who liberally shared their views and experience.

It is hoped that the CCRS will continue to organize many more of such activities on environment related issues and work unceasingly to create awareness about climate change mitigation.

Dr. T. N. Hajela
President, Climate Change
Research Society

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Executive Summary

Workshop on Awareness on Green Buildings Responsible Education in Schools (AGBRES 2011) at India International Center held on 7th September 2011

Dr. T.N. Hajela (President, CCRS and Former Joint Secretary, UGC) presided over the Workshop on Awareness on Green Buildings Responsible Education (AGBRES2011). He extended warm welcome to the participants and explained that sole objective of the workshop is to impart knowledge at the basic level about energy saving and to create awareness about solar energy use in schools in the context of green buildings. The workshop was dedicated to Teacher's day, which is celebrated on the Birthday of Dr. S. Radhakrishnan on 5th September every year.

Introducing the Workshop Dr. Malti Goel (Programme Coordinator and Executive Director, CCRS) observed that green buildings are necessary in view of the fact that India is going to witness huge infrastructure growth in the coming decades. Challenges posed by climate change are the major concerns. Ways to develop educational tools by integrating design parameters and scientific solutions for saving energy and materials as well as to increase the use of renewable energy in buildings were introduced. A participation of teachers from schools was invited through nomination.

Prof. D.P. Aggrawal (Chairman, UPSC) inaugurated the Workshop. He commended this effort and said that there is lack of awareness about Green Building principles in our country. While there is great deal of concern among people on *Vaastu* principles, there is hardly any movement for being energy conscious. There is a need for a special roadmap for India and not to copy the western model of living. A judicial planning process is required which would enable people to cut down use of energy. People's participation is essential to address the prevailing dichotomy of consumption attitude in the elite society. He suggested that a multi-pronged approach would be needed to promote the responsible education at all levels.

Eminent scientist, Dr. S. Z. Qasim (Former Secretary, DoD and Member, Planning Commission) released the book "ABC of Green Buildings Responsible Education" on this occasion. The book aims to provide scientific understanding and information about green building concepts in a lucid manner - learning as A. B. C.D. with pictorial depiction. Dr. R. K. Khandal (Director, SIIR) presented the need for energy efficient green materials and technology upgradation by the use of nanotechnology. He said some of the

commonly used approaches, which have shown promise include introduction of functionalities in the polymer structure, modification of surfaces for unique optical properties as also surface properties, development of hybrid materials involving inorganic and organic, example given metals and polymers, creation of multi-phase systems for specific applications, etc. One has to adopt also the approach of designing nanomaterials so as to harness renewable energies; and use of nanoengineered concrete for sustainability.

Sh. Sushant Baliga (Ex-ADG, CPWD) said minimizing the use of energy without loss of functionality is the need of the day. A National Rating System, Green Rating for Integrated Habitat Assessment, GRIHA has been developed under the aegis of the MNRE for designing buildings in an energy efficient manner mitigating any adverse impact to the environment. The rating system takes the entire life-cycle of a building into account and has become mandatory for public buildings.

Sh. Deependra Prashad (Principle Architect and Chief Consultant, DPAP) outlined the need for environment learning and presented architectural design for the SJH School building in Meerut to describe green building parameters. Dr. S.N. Maity (Chief Scientist, CMERI, Durgapur) said that land requirement for solar energy use is huge and runs into kms. He has designed a *Solar Tree,* which can meet the renewable energy needs in buildings with space limitations. He explained concepts in solar photovoltaics. His paper received lot of interest among the audience.

Sh. R.G. Gupta, (Former Commissioner, DDA) chaired the Technical Session. He enlightened about the global, national and city level responses to the need for maintaining ecological balance in terms of 'To Stop & Control Water, Air, Noise and Soil Pollution'. He commended the workshop and said that as policy planner he found these deliberations important for the future growth of cities.

Ms Maria-Sube Elodie (EU-India Action Plan) also spoke on the occasion. She said the deliberations are very interesting and India needs to have a Roadmap of its own. Participants, particularly students of architecture echoed these sentiments and found this workshop unique and extremely useful.

Certificates were given to participating teachers. Vote of thanks was presented by Ms. Neha Tripathi.

INAUGURAL SESSION

1. Chief Guest - Prof. D. P. Aggrawal
2. Address - Sh. Sushant Baliga
3. Keynote Address - Dr. R. K. Khandal
4. Theme Address - Dr. (Mrs.) Malti Goel
5. Release of Book - Dr. S. Z. Qasim

Chief Guest Address

Prof. D. P. Agarwal
Chairman, Union Public Service Commission

I am very happy that India International Center, New Delhi jointly with Climate Change Research Society has organized a workshop on Awareness for Green Buildings Responsible Education for School teachers (AGBRES). The concept of green buildings is simple yet not adopted uniformly.

In a *Green Building* reduction of overall consumption of electricity should be targeted by proper architectural design measures. Improving building efficiency reduces energy requirements, the need for fossil fuels and reduces greenhouse gas emissions. Energy performance can be optimized by the use of energy efficient home appliances viz. office equipment, computers, elevators, cooking and refrigeration etc. Simple measures like use of compact fluorescent lamps (CFLs) and light emitting diodes (LEDs) saves lighting energy requirements of a building. We must make a habit to switch off fans, lights and computers when not in use.

A Green Building has health as primary goal of its occupants. We spend almost 90 percent of our time indoors. Plantation and garden around a habitat purify the air and add to well being of habitants. Increasing use of renewable energy and natural materials for attaining thermal comfort with changing outdoor conditions should be encouraged.

In our country some of the ancient heritage buildings are epitome of low energy architecture. We need to create awareness about them and motivate youth for being energy conscious in the building sector. Participation from youth not only in schools but also in colleges is necessary. I suggest that a multi-pronged approach be developed to promote the responsible education at all levels.

I congratulate Dr. Malti Goel for this important initiative and wish her all success.

Prof D. P. Agarwal

Address - Green Buildings and GRIHA

Sh Sushant Baliga

Ex-Additional Director General, Central PWD and Senior Advisor, Construction Industry Development Council

Prof. Aggarwal, Dr. Qasim, Dr. Hajela, Dr. Khandal, Dr. Malti Goel and other eminent speakers at this workshop and participants. It is my privilege to be amongst such eminent luminaries on the dais. I learn that this workshop is being held with the sole object of imparting knowledge about green building concepts and use of renewable sources of energy, particularly solar energy in schools to develop a future roadmap I congratulate India International Centre and The Climate Change Society for these timely efforts. Minimizing the use of energy without loss of functionality is the need of the day.

In the past few years, Green buildings and the sustainability of a habitat have become important drivers for architecture and for planning of buildings. Global warming and associated climate change has set alarm bells ringing that something needs to be done to leave a livable planet for our future generations. On the other hand we have development, inclusive development, vital to our country, which is equally important.

Economic growth requires dependable and reliable supplies of energy. Due to the fast-paced growth of India's economy, the country's energy demand has grown an average of 3.6% per annum over the past 30 years. In July 2011, the installed power generation capacity of India stood at 180,358 MW. The Indian government has set a modest target of adding 78,000 MW of installed generation capacity in the 12th Plan. The total demand for electricity in India is expected to cross 950,000 MW by 2030. Presently out of 1,80,358 MW of installed capacity, 65% is attributable to thermal power, 21% to Hydro power, 11% to renewable sources and around 3% to nuclear power.

The major contributors to carbon emissions are burning of fossil fuels, predominantly in the power and transportation sector. Coal based thermal power is coal. 54% of our installed capacity is coal based. Our usage of electric power thus directly contributes to the carbon emissions. Use of a 2.5 tonne air conditioner for an hour leads to 3 kg, a microwave oven 1.3

kg and a geyser 3.3 kg of carbon dioxide emissions. Thus, our day to day life adds up these emissions to alarming levels.

It is a cause for concern is that India is becoming the 3rd largest emitter of carbon emissions after US and China as per 2009 data and has overtaken Russia. The trend of overall carbon emissions has thus increased for the country from 2008. In the list of the top ten, China and India have substantially increased their emissions over one year. Almost all developed countries have reduced their emissions, as has the World, all countries taken together. Though one can say that per capita we are still way down, overall emissions are important. Consider that in India electric supply is accessible to few and once the demand increases the carbon emissions will raise. The time for complacence is over and there is thus an imperative need to act.

What can be done? Fortunately, a lot of new frontiers have been opened up. The Ministry of New and Renewable Energy (MNRE) is providing subsidies and incentives for setting up generating plants using hydro power of small capacity, biomass, solar photovoltaics, bagasse etc. Incentives are also available for individuals in domestic usage. The Bureau of Energy Efficiency (BEE) is leading the way in certifying the energy efficiency of various commonly used electrical and air-conditioning equipments and promoting energy conservation.

A National Rating System, Green Rating for Integrated Habitat Assessment, GRIHA has been developed under the aegis of the MNRE for designing buildings in an energy efficient manner mitigating any adverse impact to the environment. It aims to

- Minimize the demand on non-renewable resources and maximize the utilization efficiency of these resources when in use
- Maximize reuse and recycling of available resources
- Utilize renewable resources.

The rating system takes the entire life-cycle of a building into account. This has become mandatory for public buildings. It promotes right orientation of buildings to maximize use of natural lighting, reduce environmental impact by building around trees without damaging them, using the natural contours of the land without much cutting and filling, ensuring proper amenities to construction workers, using waste material like flash, using energy efficiency concepts though the life-cycle of the building and so on. Though initially the task to get a four star rating was daunting, over time one has understood that GRIHA is about good architectural and engineering practices and common sense. Another step in the right direction, which is most heartening, is that of forestation, which is being taken up aggressively

by state agencies and communities. However, despite all these efforts, the battle has only begun.

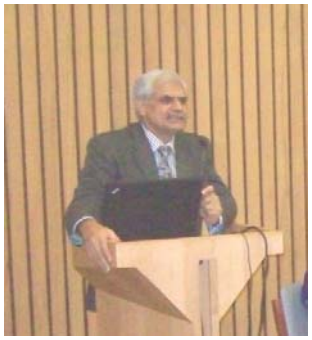
It is perhaps, most vital that the citizen gets involved and starts caring for the future and the legacy he leaves behind for his children and grandchildren. We should question - do we need to use this energy, are we wasting it? Are we doing the right thing for our environment? It is encouraging to learn that school teachers are also participating in this workshop. For, it is they who would shape our future leaders and guide children in doing the right thing. I note that eminent speakers, all experts on the subject will address you. In my interaction today I learnt that one of the speakers today has developed technology by increasing the generation of solar power per land area by imitating nature's design in the form of a solar tree. Perhaps such 'solar trees' could be positioned at schools for which the Government could provide funds. It would serve the dual purpose of demonstrating alternate energy sources to school children and also reduce the electricity bills for the schools. Water harvesting, grey water usage, energy efficient equipment all could be promoted. I do wish that you carry the message of GREEN with you and propagate it in your circle. Build sustainable habitat, live sustainably!

I again thank Dr. Malti Goel once again and the organizers for giving me this privilege of addressing you all. I wish this timely and relevant workshop all success.

Keynote Address - Energy Efficient Green Building Materials

Dr. R. K. Khandal

Director, Shriram Institute for Industrial Research, 19, University Road, Delhi-110007



In this era of industrialization and urbanization, setting up of buildings and infrastructure has led to the growing demand of energy resources, which in turn has been recognized as the main cause of global warming. Therefore, the concepts of energy efficiency have to be imbibed in all the activities of any project, starting from design to their execution. Projects related to building construction and infrastructure must also be executed in an energy efficient manner. In building construction, one of the major components of energy pertains to building materials of various types. Materials, which are both energy efficient and minimize the burden on the environment, are the need of the hour. Materials, which comply with the requirements of being energy efficient, are also called as green materials. Thus, using them for infrastructure has led to the concept of green buildings.

Green buildings are designed to ensure that the burden on the environment is minimized to the extent possible not just for a given time but for the complete life cycle of the building. Till now, such requirements were best met by natural materials such as wood, straw, etc; depletion of these resources in turn has led to the evolvement of synthetic materials such as polymers, composites, hybrids, etc. Though such materials are light-weight, durable and easily processed, there is always a need to further improve upon these materials.

There are several known ways, which have been tried to develop novel materials to be used for construction of green buildings. Some of the commonly used approaches, which have shown promise include introduction of functionalities in the polymer structure, modification of surfaces for unique optical properties as also surface properties, development of hybrid materials involving inorganic and organic, example given metals and polymers, creation of multi-phase systems for specific applications, etc.

One of the most sought after methodology relates to the development of nanomaterials, which not only deliver extraordinary performance but also comply with the essential criteria of environment protection and sustainability, given carbon footprint, etc. This is to say that amongst the technologies known, nanotechnology provides the best solution. Designing of nanomaterials has made possible the synergistic combination of optical, thermal, mechanical, etc. properties leading to novel materials for green buildings. The structures are designed in a way so as to exhibit smartness and responsive characteristics reducing the energy consumption alongside. Nanomaterials help in maneuvering of properties such as solar selectivity, absorbptivity, reflectivity, etc. thereby imparting greenness to the buildings.

One has to also adopt the approach of designing nanomaterials so as to harness renewable energies; mainly the solar energy, for sustainability. In conditions such as warm climates where coolness is desirable, solar heat can be kept out while transmitting solar light only, by using nanomaterials. Thin film coatings based on such unique properties are coated onto building components to conserve and reduce energy consumption. Focus lies on various aspects of designing nanomaterials and their role in converting one form of energy into another efficiently.

Theme Address – Introductions to Green Buildings

Dr. (Mrs.) Malti Goel
Executive Director, CCRS & Programme Coordinator

'What is the use of a house if you haven't got a tolerable planet to put it on?'

--Henry David Thoreau.

It is a great privilege for me to be here and I owe this to India International Centre and President Prof. M.G.K. Menon, a visionary scientist of the nation. He was Secretary to the Government of India where I served for 26 years, but, I never had a chance to work with him. I feel grateful and honored that Dr. S. Z. Qasim has graced this occasion at a very short notice. I profusely thank him for this kind gesture. I am extremely thankful to Prof. D. P. Aggarwal who had sometime back suggested that we should have a green building programme for people to understand its basics. He said it is so essential to be energy conscious for the country. I also thank Dr. R. K. Khandal and Dr. Sushant Baliga for various illuminating interactions in the context of green buildings and who gave me new insights.

This workshop is dedicated to Teacher's day, which is celebrated on the Birthday of Dr. S. Radhakrishan on 5th September every year. It is a unique workshop aiming to create awareness about the green building concepts and solar energy use in schools. You may ask what a green building is. Let us see how many of you can tell what a greenhouse is made of. It is made of glass. Can we make a green building with glass? Evidently, Green building is opposite of greenhouse and is constructed with a goal of zero emission.

To get an insight into green building concepts we have prepared book on **ABC of Green Buildings Responsible Education.** I suggest you use it as an information tool to have food for thought and make yourself wiser.

We hope school teachers would carry forward these concepts to children, raise questions and think about promoting use of renewable energy in their schools. I remember once in Israel I was amazed to see tiny tots from Kindergarten taken around for plantation and to show drip irrigation. They were very young to understand. But it was clarified to us that in Israel there is acute shortage of water and this exercise was to give them lessons on how precious water was and explain to them that it was necessary to conserve it. It was expected that kids will check their parents at home when a drop of water is wasted and they would carry these lessons throughout their life.

A green building for India would require different materials, different design than those in America or other parts of the world. We have tropical climate and different seasons and therefore this workshop's focus is on implementation of green building concepts in schools in the tropical climate of India. Mr. Deependra from his vast experience will give an architect's view and about how education in schools should be. Dr. R. K. Khandal would apprise on technologies developed by scientists on materials and nanomaterials for green buildings. Even if we can use solar energy to light the schools in rural areas and also in urban areas to some extent, substantial saving of conventional energy can take place. 'A solar tree for each school', you would be hearing Dr. S. N. Maity who has designed a solar tree about use of solar energy in schools.

In India with its population of 1.2 billion, there are over a million schools. We are facing the crunch of energy and grid electricity has not reached to over 400 million people. And in 2030 it is expected to become at least 800 GW. In the total installed capacity of 170 GW, the building sector's share is 13-14%. It is expected to become at least 30% by 2030. It is therefore necessary to extend this effort to develop education tools for the schools, an education which may not be part of their curriculum, but would be essential to develop skills in the times to come.

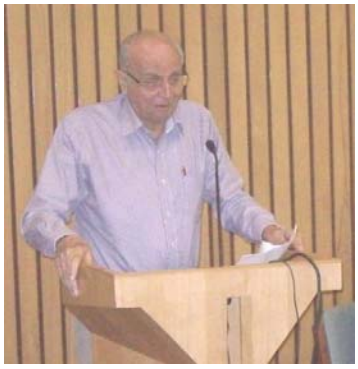
I am very grateful to EU-India Action Plan support facility for providing the report on how we can learn from best practices in the European Union. We are obliged by the presence of Elodie MARIA-SUBE.

I would urge that in current green building movement taking place worldwide, we should move ahead with a clear perception, develop a vision for future and integrate these concepts, which are not far in the horizon, on day-to-day basis. We would welcome your suggestions to develop a roadmap.

Special Address and Release of Book

Dr. S. Z. Qasim

Former Member, Planning Commission & Ex-Secretary, DoD



Energy is the most important input for the economic growth for a nation. India is facing greatest challenge of meeting the basic energy needs of its people. Among the various initiatives taken by the Government, energy efficiency is highlighted in all sectors of energy demand and generation. Bureau of Energy Efficiency (BEE) has established Energy Conservation Building Code (ECBC) in the building sector. One of the Mission under the National Climate Change Action Plan of the Indian Government is Sustainable Habitat. It is important for the growth of green buildings in India.

I am pleased to learn that the Awareness Workshop on Green Building Responsible Education in Schools (AGBRES 2011) is being held for creating awareness about green buildings among school teachers. I am not familiar with what exactly a green building means. Sometimes back I tried to install a solar water heater in my rooftop, but could not do so as there are suppliers, but could not get any expert advice about its feasibility. I would feel that green building concepts are related to reduce energy consumption, increased use of renewable energy in buildings and a lot of greenery around it.

I very much appreciate that a book on **ABC of Green Buildings Responsible Education** has been brought out on this occasion. I am sure it will add to basics of what green building should be in the Indian context. I congratulate the organizers, India International Centre and commend the outstanding scientific contributions of Dr. Malti Goel. I have found her always passionate about the promotion of science and technology and making significant contribution to the society.

Prof. S. Z. Qasim

ABC of Green Buildings Responsible Education

Dr. S.Z. Qasim, Former Member Planning Commission and Ex-Secretary DoD, releasing the book. Prof D.P. Aggrawal, Chief Guest and Dr Malti Goel looks on.

The Climate Change Research Society is extremely grateful to Dr. Syed Zahoor Qasim who graced the occasion at a short notice. Dr. S. Z. Qasim is an eminent Indian marine scientist and has made pioneering contributions in Antarctica research. He led the first successful expedition to Antarctica in 1981 and succeeded in putting India's Flag in the unknown territory. He served as the first Secretary to the Department of Environment and also first Secretary to Department of Ocean Development, Government of India. He is honored as *Padam Bhushan* by Government of India and is recipient of numerous national and international awards, honours and distinctions. The latest being Sir Syed Award of Excellence 2012, in recognition of outstanding achievements in the field of Scientific Development. The award was conferred by Sir Syed Foundation and was presented by H.E. Devanand Konwar, Governor of Bihar.

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Brief Remarks and Vote of Thanks

Elodie MARIA-SUBE, EU-India Action Plan support facility addressing the audience

Ms Neha Goel Tripathi presenting the Vote of Thanks

TECHNICAL SESSION

1. Chairman, Sh. R. G. Gupta - Policy on Awareness on Green Buildings
2. Dr. Malti Goel - Why do we Need Green Building?
3. Dr. R. K. Khandal - Energy efficient Green Building Materials
4. Dr. S. N. Maity - Solar Power Tree: a New Concepts of Harnessing Solar
5. Ar. Deependra Prasad - Environment Friendly Building and Pedagogy

Policy on Awareness on Green Buildings

Sh. R. G. Gupta
City / Policy Planner, UPS Campus Block A, Preet Vihar, Delhi

Policy on Awareness on Green Building requires keeping Ecological balance in terms of 'To Stop & Control Water, Air, Noise and Soil Pollution'. Nature has helped us a lot at all levels: starting from Global; National; States; Settlements level and individual buildings.

- At the Global level, there are 258 countries; the 1st China with a population of about 1400M, India 1200M……. 21 countries namely (i) Navassa Island, (ii) Antarctica Islands ……..with Zero population. It shows that there is too much contrast within habitation and open / green areas.
- India has 35 States with a large contrast in density of population in terms of persons per SKM. Examples of 8 state have been given under;

  Delhi – 11297; Chandigarh – 9258; Pondicherry – 2598; Daman & Diu – 2169; Arunachal – 17; Andaman Nicobar – 46; Mizoram – 52; Sikkim – 86;
- Within states say Delhi density of population in Trans Yamuna area is 40000 people SKM and In Lutyian Delhi it is 660 persons SKM.
- Delhi is the best city in India it has 195 SQKM for Natural features (Forest, Wild Life Sanctuary, Ridge, River Yamuna and other water bodies/ drains) i.e. 13.16%.

A. Master Plan of Delhi has emphasized :

1. Conservation of the Ridge – Northern Ridge – 87 Ha.; Central – 864 Ha.; South Central (Mehrauli) – 626 Ha.; Southern – 6200 Ha.;
2. Development of river Yamuna
3. Lungs spaces / recreational areas in green belt to the extent of 15- 20%

B. Different types of parks are also proposed:

S.No.	Category	Planning Norms & Standards	
1.	City Park	10 lakh	100
2.	District Park	5 lakh	25
3.	Community Park	1 lakh	5

Delhi can be stated as a city of stadiums & playgrounds

(1) Games Village, (2) Siri Fort Sports Complex, (3) Yamuna Sports Complex, (4) Saket Sport Complex, (5) Jawahar Lal Nehru Stadium, (6) Thyagaraj Sports Complex, (7) Major Dhyanchand National Stadium, (8) Indira Gandhi Indoor Stadium (9) Karni Singh Shooting Range, (10) Talkatora Indoor Stadium, (11) Delhi University, (12) R.K. Khanna Tennis Complex, (13) SPM Swimming Pool Complex, (14) India Gate

(2)

C. Development Controls in schools

Ground Coverage and parking

Nursery School – 33.33%, (ii) Primary School – 30%, (iii) Sr. Secondary School – 35%, (iv) School for Mentally challenged – 50%, (v) School for Physically challenged – 50%, (vi) Vocational Training Centre (ITI/Polytechnic/Vocational /Training Institute / Management Institute / Teacher Training Institutes etc.) / Research and Development centre – 35%, (vii) General College – 35%, (viii) Professional College (Technical) – 35%, (ix) University Campus including International Education Centre (IEC) – Large campus (10ha and above) – 30% and Sports and Cultural activities – 10%.

In any planned school coverage is not more than 20%, after adding play ground therefore 80% will be in the green, parking and plane areas.

Other points which can make the school area as green.

- Plant and nurture trees;
- Don't burn leaves, make compost;
- Don't litter, use dustbins;
- Conserve water and power every day;
- Install solar water heater, solar lamps and solar cooking systems quickly and avail 30 per cent government subsidy;
- Save oil, save energy every day;
- Switch to clean fuels such as CNG in vehicles;
- Adopt inverters instead of diesel generator sets'
- Use Battery powered vehicles and avail 29.5 per cent rebate;
- Use Metro frequently and curb vehicular congestion;

- Adopt green building technologies and cover building materials at construction sites;
- Always dispose of electronic wastes properly.

D. Greens within the Buildings

As per development controls in any master plan or building bye laws volume of building is fixed weather you make two story or twenty story

(i) Within the Building

- Interior design services
- In door & Outdoor landscape services.
- In door & Outdoor sports facilities.
- Adequate space provisions for social functions & celebration.
- Swimming and Gymnasium.
- Hobby workshops and space for exhibitions, displays etc.
- Club house with restaurant.
- Housekeeping services and daily cleaning services.
- Garbage collection with separation.

(ii) The services requirement of high rise buildings are broadly divided into the followings:

- Fire Fighting
- Elevator
- Sanitary and publishing installations
- Electrical installations
- Water supply installation
- Other amenities

(iii) Recreational Facilities

- Restaurant
- Party Hall
- Gymnasium
- Squash Court
- Table Tennis
- Billiards
- Caroms
- Kids Play Area
- Massage room with Souna steam bath

(iv) Security services

- Common security services and surveillance

Why do we need Green Buildings?

Dr. (Mrs.) Malti Goel,
Executive Director, CCRS

Buildings of Two Centuries- Emergence of Green Buildings in 21st centurary

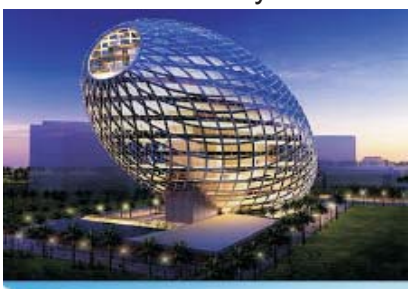
The eclectic century: 19th century AD

Glass. Cast iron and Prefabrication
AD 1837 - 1851

- High Tech Buildings
- Computer programmed Sun tracking
- Use of new new materials like titanium steel

- More High Tech
- Integration of Various Concepts
- Address Social Aspects of Climate Change

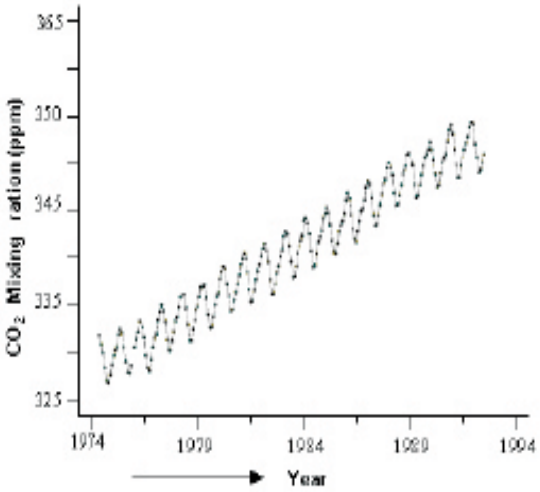
Modernist Movement
in 20th century

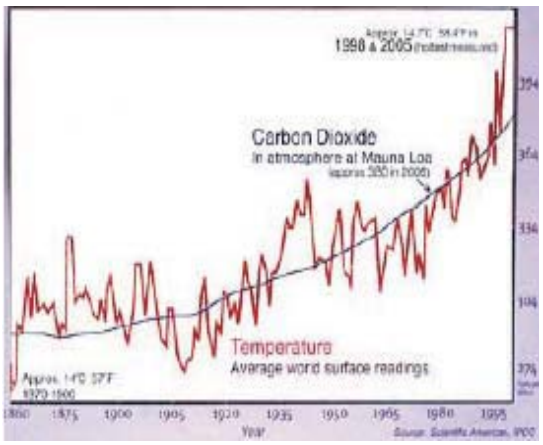


Concrete over Metal Structure

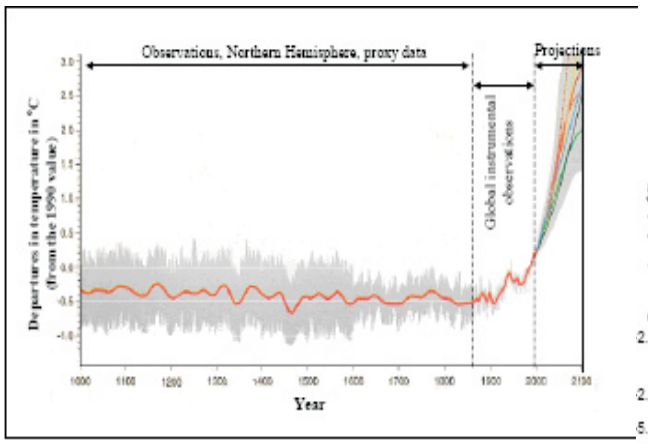
- Natural Materials
- Resource Conservation
- Waste Recycling
- Use of Renewable Energy
- Thermal Comfort

CO_2 and Global Temperature Profiles of Thousands or More Years

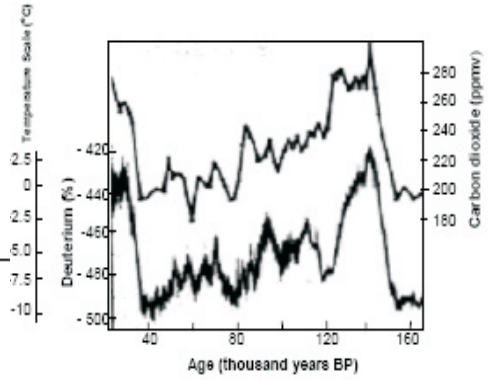


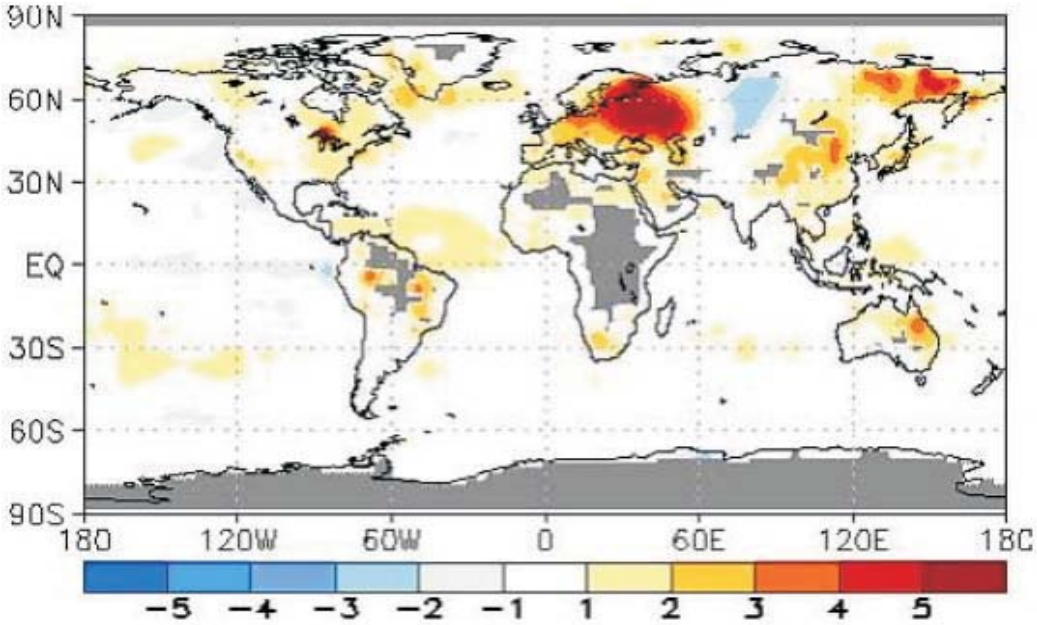


CO_2 Measured in Recent Past and Rising Temperatures

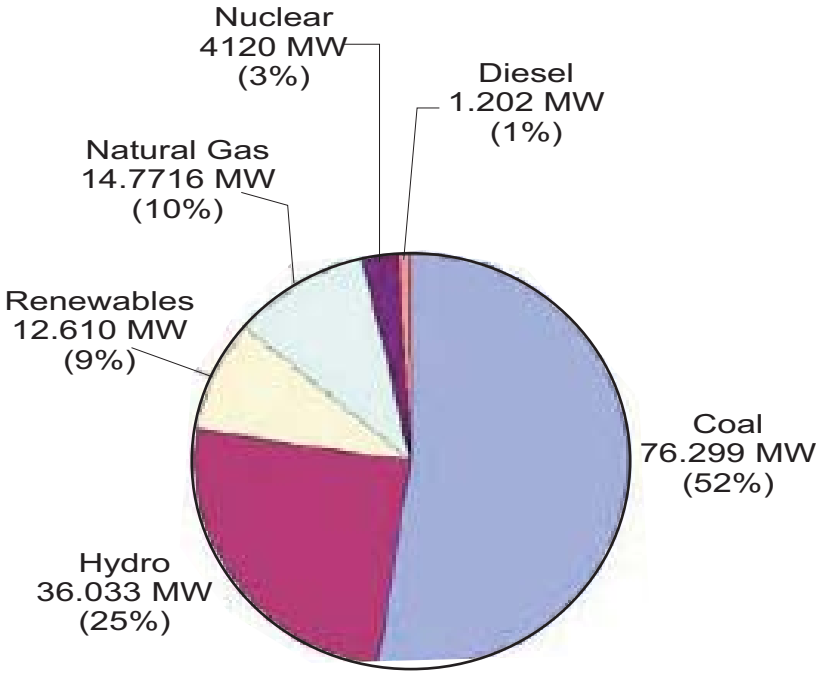


CO_2 concentrations and Temperature relationship





Energy Security: Towards Reduction of CO_2 Emissions



Total installed: 144.980MW

Sources of Energy

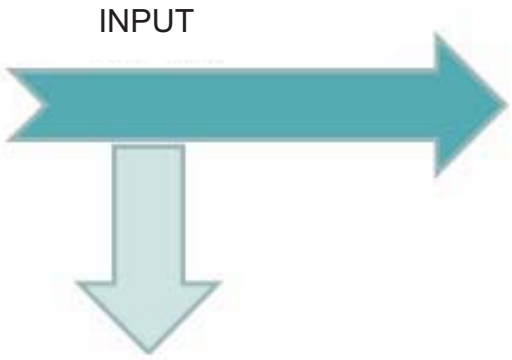
- Conserving resources like energy, water, soil & forests
- Minimizing waste
- Reduction in Conventional Energy Demand
- Expanding use of Renewable Energy Sources
- Recognizing the Need for Materials efficiency

A Green Building has

- Health and safety
- Water Efficiency and recycling
- light efficiency
- Energy saving
- Reduction of $C0_2$ emissions
- Good air circulation and Internal Environment balance
- External environment balance
- use of Renewable energy
- low Energy Materials and use of local materials

Energy efficiency - Applying First and Second Laws of Thermodynamics

- First law of thermodynamics for energy conservation.



$$E_i = E_o + E_L$$

here E_i is energy input

E_o is useful energy output

E_L is energy losses

Energy efficiency $e_1 = E_o / E_i$

if output is more or losses are minimised, the efficiency can be increased

- Second Law of Thermodynamics states that one has always to expend more energy than that could be retrieved from a source after the conversion has taken place.

- The efficiency e2 (entropy efficiency) can be written as,

$$e_2 = e_1 / e_i$$

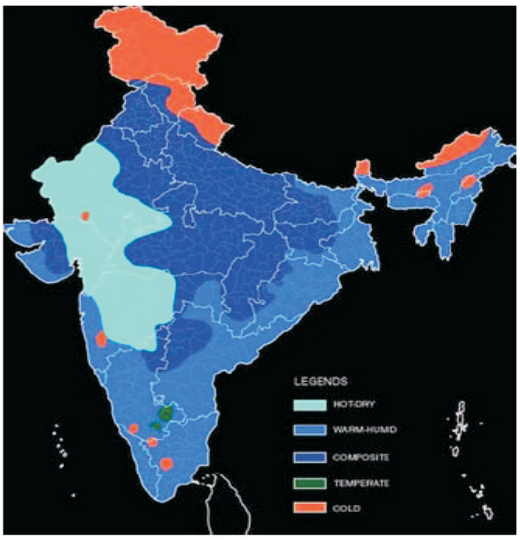
where, e1 is actual thermal efficiency and ei is ideal thermal efficiency of a process.

- The ratio of actual efficency to ideal efficiency could vary from 0.50 to 1.00
- a most efficient process would have e2 = 1.

Thermal Performance Index and Building Thermal Load in Different Seasons

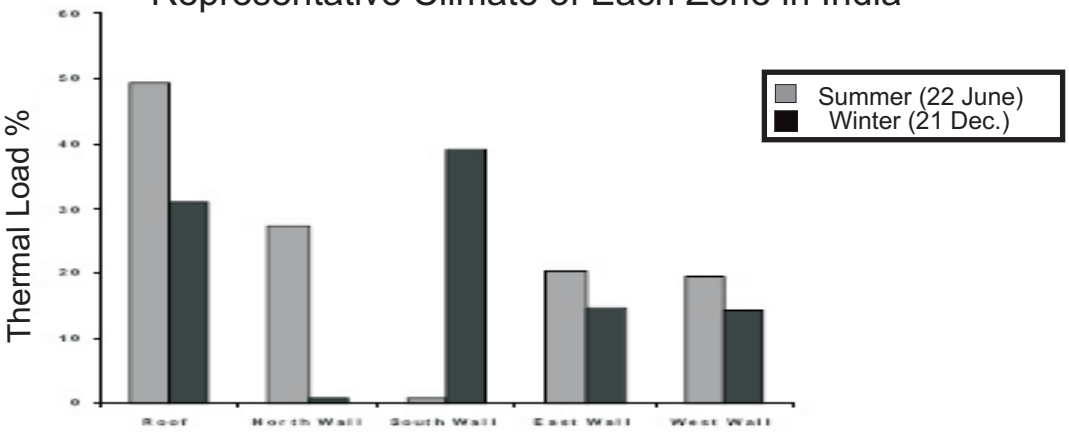
- Human confort is that state of mind. which expresses satisfaction with the thermal environment.
- In Human being the metabolic rate can vary from 40 to

  250 W/m2 depending on the physical activity. The human skin surface area measures 1.8 sqm on average.
- Each Cloth has a cooling ensemble defined as clo. The clo factor or index I clo varies from 0.1 for light summer clothing to 3.0 for very heavy winter clothing.
- Climate plays an important role
- Gender differences in Tropical climates exist:
  Males - 1.33. Females - 1.42



- 1. Composite (Delhi)
- 2. Hot Dry (Ahmadabad)
- 3. Hot Humid (Kolkata),
- 4. Moderate (Bangalore)
- 5. Cold (Shillong)

Representative Climate of Each Zone in India



Building Thermal Load in Different seasons

Integration of Green Building Concepts through Energy Simulations

- Energy Conservation Act 2001
- Energy conservation Building Codes 2007
- National Mission on Sustainable Habitat 2010
- Green Rating for Integrated Habitat Assessment (GRIHA)

National Energy Simulations

- Integrate heating, cooling, lighting needs, materials, equipment and building envelop
- Integration of various software for HVAC, Lighting simulations and CAD
- Quantum of Data needed depends on activity, occupancy, comfort, illumination and climate etc.
- Predictions are made for
  - Thermal behavior
  - Energy efficiency
  - Building code compliance

National Green Building Rating System - GRIHA and Regulation in Different Countries

GRIHA - India

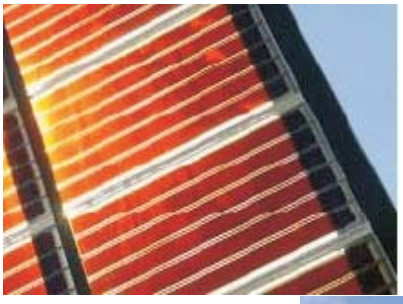
- It is a green building 'design evaluation system' and is suitable for all kinds of buildings in different climate zones of the country
- All future buildings in India are expected to meet GRIHA requirements, which include 34 criteria and awards points on a scale of 100.
- The building need to be registered with a government authority and must achieve minimum of 50 points to be eligible for certification. It requires enormous data and computer simulations to certify.

Other countries

- Title 24, Part 6, of the California Code of Regulations
- Building Research Establishment's Environment Assessment Method (BREEM)
- United States Green Building Concept (USGBC)
- ISO Standard for Energy Efficiency of New Buidlings
- Leadership in Energy and Environment Design (LEED)

Renewable Energy Use in Buildings - Active and passive Solar Energy

- Solar Energy
- Wind Energy
- Geothermal energy
- Biomass
- Hdrogen Fuel Cells

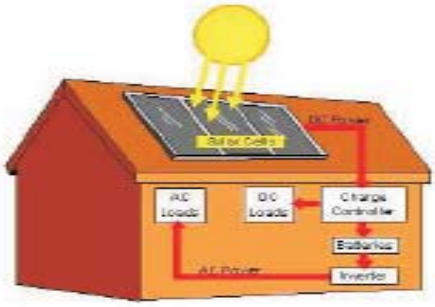


Active and Passive Uses

- Solar energy in buildings can be used in the passive, Active and Hybrid forms. It reduces load on electricity produced from fossil fuels.
- *Passive solar* uses are for lighting and heat, without moving parts. A window can be a passive solar device.
- *Solar passive and active thermal energy* is used in water heating, process heat and space air conditioning.
- Solar thermal systems also collect the sun's energy.
- *Solar collectors* are a set of mirrors used for collecting solar heat and achieving higher temperatures.

Heliotechnology of future

- *Solar wall* is a system that allows solar heat to create warmness in the interior environment. It can be designed with use of perforated metal panels to pre-heat ventilation air.
- *Solar balcony* is an enclosed balcony that acts as a solar collector.
- *Solar dye cells* provide color windows materials that generate electricity and help in low energy sustainable construction technologies.



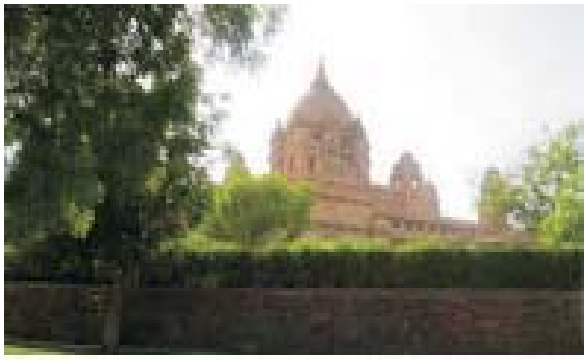
Solar light energy can be used directly for producing electricity. Solar Photovoltaic cells are often called PVs for short. PV arrays convert solar light to electricity for meeting lighting and cooling needs.

Building Materials Embodied Energy and Examples of Use of Local Materials

- ✓ Embodied energy comprises of energy used in manufacturing, refining, processing, packaging, transport of a building material
- ✓ Materials Embodied Energies can vary from 0.5 to 35 GJ/ tons
- ✓ All materials can be classified into Low - Medium - High energy materials
- ✓ Selection of low energy materials is preferred for
  - ✓ Materials for structural and non structural applications
  - ✓ Materials for windows and frames
  - ✓ Materials for paints and floorings
  - ✓ Materials for sound proofing

Material Requirements

- Natural Materials
- Reused and recycled
- Harvested materials,
- High Recyclability
- Durability,
- Longevity,
- Local production.



Sand Stone

Bamboo as Green Material





Bamboo as Structural Material

Elastic Modulus	20,000	20,0000
Tensile strength	80 - 150	160
Bending strength	70 - 270	140

Courtesy - CRDT, IITD

Conclusions

- Green building concepts are interlinked with design and physical environment of the building.
- Climate Change, Energy Security and National Policies are main drivers of Green building movement
- Use of renewable energy, particularly solar energy can be enhanced by appropriate means.
- Indian Heritage buildings can provide good example of local materials
- Schools should take initiatives to develop means of reducing energy consumption by educations tools

Energy Efficient Green Building Materials

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Director, Shriram Institute for Industrial Research, 19, University Road,
Delhi – 110007

Preamble

In order to bring the new concepts and trend-setting requirements to the society, the best way is to involve the young students in the whole process. It is a great idea to go about doing this through the teachers. Once the teachers are made aware of the challenges of the future, the knowledge is passed onto the students in a simple and easy manner. For future challenges, this way, the society is prepared well in advance. Also, the students are motivated and inspired to opt for higher studies leading to the development of technologies for green building materials including nanomaterials.

It is a wise thought on the part of Dr. Malti Goel to have organized a one-day programme on "Awareness on Green Buildings and Renewable Energy in Schools "(AGBRES). I give felicitations to her for this high-impact event.

In this era of industrialization and urbanization, setting up of buildings and infrastructure has led to the growing demand of energy resources, which in turn has been recognized as the main cause of global warming. Therefore, the concepts of energy efficiency have to be imbibed in all the activities of any project starting from design to their execution. Projects related to building construction and infrastructure must also be executed in an energy efficient manner. In building construction, one of the major components of energy pertains to building materials of various types. Materials, which are energy-efficient and minimize the burden on the environment, are the need of the hour. Materials, which comply with the requirements of being energy efficient, are also called as green materials. Thus, using them for infrastructure has led to the concept of green buildings.

Green buildings are designed to ensure that the burden on the environment is minimized to the extent possible not just for a given time but for the complete life cycle of the building. Till now, such requirements were best met by natural materials such as wood, straw, etc; depletion of these resources in turn has led to the evolvement of synthetic materials such as polymers, composites, hybrids, etc. Though such materials are light-weight, durable and easily processed, there is always a need to further improve upon these materials.

There are several known ways, which have been tried to develop novel materials to be used for construction of green buildings. Some of the commonly used approaches, which have shown promise include introduction of functionalities in the polymer structure, modification of surfaces for unique optical properties as also surface properties, development of hybrid materials involving inorganic and organic, e.g. metals and polymers, creation of multi-phase systems for specific applications, etc.

One of the most sought after methodology relates to the development of nanomaterials, which not only delivers extraordinary performance but also complies with the essential criteria of environment protection and sustainability, e.g. carbon footprint, etc. This is to say that amongst the technologies known, nanotechnology provides the best solution. Designing of nanomaterials has made possible the synergistic combination of optical, thermal, mechanical, etc. properties leading to novel materials for green buildings. The structures are designed in a way so as to exhibit smartness and responsive characteristics reducing the energy consumption alongside. Nanomaterials help in maneuvering of properties such as solar selectivity, absorbptivity, reflectivity, etc. thereby imparting greenness to the buildings.

One has to also adopt the approach of designing nanomaterials so as to harness renewable energies; mainly the solar energy, for sustainability. In conditions such as warm climates where coolness is desirable, solar heat can be kept out while transmitting solar light only, by using nanomaterials. Thin film coatings based on such unique properties are applied onto building components to conserve and reduce energy consumption.

1. Introduction

With increasing economic development and urbanization, total global energy consumption has been increasing significantly over decades. Buildings, worldwide account for 40% of total end-use energy. There is over 50% saving potential in the building sector, which is considered as the most promising sector to meet the challenges of global energy and climate change. Intelligent designing of buildings using renewable materials and energy resources or construction of green buildings are the options to ensure efficient use of energy and reduced carbon footprint. When energy- efficiency increases in homes or buildings, it not only brings the utility bill down, but it also has environmental benefits such as reduction in (i) green house gas emissions and (ii) air pollution

2. Concept of Green Buildings

When the term “green” is used, the picture that comes immediately to one’s mind is that of a lush tree, where the extent of lushness depicts the extent of greenness.

“Green” is also a color, which is synonymous with light, hope, progress and growth while “gray”, the opposite of green is synonymous with darkness, sorrow, haziness, stagnancy and decay.

All human beings desire to be surrounded by positivity and that would need “green buildings”. Construction of green buildings involves designing and constructing houses that use less energy resources at all stages. Green buildings are designed in such a way that the burden on the environment is minimized for the entire lifetime of the building and that includes the environment-friendly disposal of building materials. Green buildings are also known as sustainable buildings, which emphasize the use of natural resources like sunlight, plants and trees. For this, one needs to use the green materials.

Designing green buildings can be best understood by comparing it with a tree, the shadow of which changes during the course of the day. The extensiveness, intensity and direction of the shadow depend on the position of the sun. When the sun is directly overhead indicating a situation of maximum heat to which the tree is subjected, shadow coverage by the tree is optimum. This is the most ideal situation where the shadow offers maximum protection. The aim in designing a green building is to replicate the situation by designing buildings, which keep the interiors cool during summer and warm during winter. Accordingly, the materials are chosen for different facades of the buildings. Moreover, the aspects like how the sunlight would fall at different faces of the building during different times of the day as well as at different times of the year are taken care of while using green materials for green buildings. The idea is to maximize the use of solar energy for making the building energy-efficient.

1. Criteria for Green Materials

Materials used in green buildings play a key role in ensuring an energy-efficient living. Green building materials include rapidly renewable plant materials like bamboo, straw and wood, recycled stone, recycled metal, and other products that are non-toxic, reusable, renewable, and/or recyclable. Local extraction and manufacture of materials reduce the energy involved in transportation. Renewable materials are sustainable and they are known to have minimum carbon emissions. Also, materials that are recyclable and reusable would also be considered as green materials. Materials like fly ash bricks, cement with high percentage of fly ash, paints with low volatile organic compounds, water-efficient fixtures, energy-efficient electrical equipment, usage of recycled steel and glass, highly permeable paving materials, etc. are all environment-friendly and fall in the category of green building materials.

The attributes of green buildings therefore would include the following:

1. Use of renewable materials
2. Ability to withstand all weather conditions
3. No burden on the environment at all stages of its use until the disposal
4. Utilizes natural resources like solar energy, water, etc. in a sustainable manner
5. Materials and services having low carbon footprint

To qualify different materials for their greenness, one has to study the following:

i. Energy involved in creating the materials, which means the complete process starting from basic inputs to the manufacture of final product.
ii. Emissions during the manufacturing process release emissions, which are polluting the environment and therefore the material does not qualify to be green.
iii. Disposal of the material must be in an environment-friendly manner without any harmful degraded products. The reusable and recyclable ones would be greener than the others.

This means energy, emissions, recyclability, reusability, degradability and cradle-to-grave approach are the main criteria to certify green materials. Some of the examples can be used to better explain this aspect.

Use of materials like stone where the essential processes involved are cutting, shaping and polishing are of low energy and hence, stone is termed as a green material. Moreover, stones leave no emissions and meet the criteria of cradle-to-grave approach. On the other hand, use of burnt clay bricks involve processes such as firing which is highly energy intensive and therefore it is less green than stones. Similarly, the use of by-products such as fly ash from coal, for construction, is an industrial waste, and it can be therefore classified as “green”.

Other than the conventional materials used for making green buildings, there are several other types of materials which render certain specific and unique attributes towards making the buildings green. Such materials will also fall in the category of green materials. Some of the notable examples of such materials are as stated below:

i. Spectrally selective materials used as coatings for windows, etc.
ii. Photochromic windows with switchable properties, i.e. which darken on exposure to light and lighten as light source is removed.
iii. Thermochromic windows which respond to heat.
iv. Coatings that prevent heat from reaching a building’s interior or reduce air-conditioning use, thus, saving energy

The objective is to conserve as also to capture the solar energy. Designing such materials has been the focus area of research for scientists world over.

1. Energy Efficient Nanomaterials

Nanomaterials and nanotechnologies have been used to design intelligent buildings with improved control systems, advanced sensory technologies and interfaces. Materials with improved optical, mechanical and electrical properties with high reliability in extreme environments are required today for energy applications. Technologies to create green nanomaterials basically aim at improving the overall factors essential for green buildings.

Materials with high sensitivity to solar radiation, high ratio of strength to mass and resistance to weathering conditions are some of the important criteria based on which nanomaterials for green buildings are designed. Several types of nanomaterials being developed for the purpose are as stated below:

i. Nanocomposites in the form of coatings are used for improved control of light reflection, absorption and transmission in a building.
ii. Materials with photocatalytic, hydrophilic or hydrophobic properties with self cleaning and easy cleaning properties.
iii. Materials with antimold properties have been made possible by the use of nano based films and coatings.
iv. Nanomaterials with electrochromic properties for smart windows, which can be deposited on glass permitting a dynamic control of the light entering the building. The advantages of such materials include reduced heating, cooling and ventilating loads on the building.
v. Nanomaterials with fire retardant properties provide good protection to a building.

2. Path Forward

In times to come, there would be a need for nanomaterials for construction of green buildings. Development of such materials would demand for the novel methodologies and innovative ideas. The future generation will have to be prepared to meet the challenges of the future. The programme organized by Dr. Malti Goel for school teachers would go a long way in creating such possibilities. More such programmes would have to be organized to realize the goals of developing green building materials,

What is Green Design?

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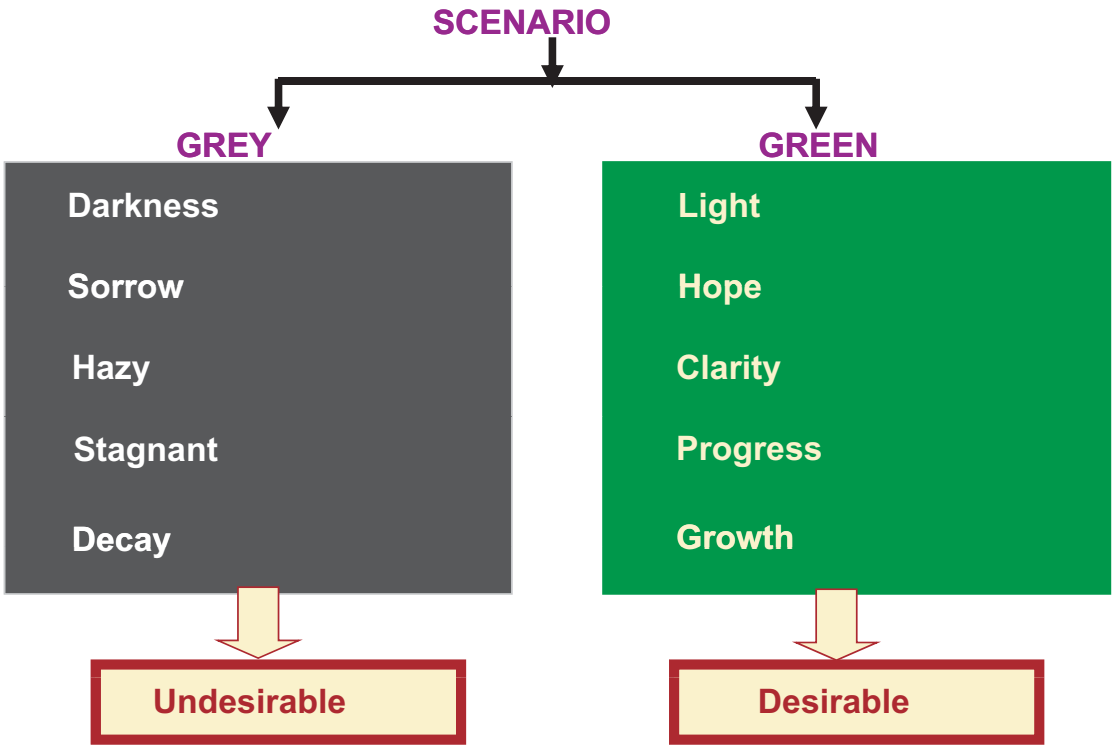
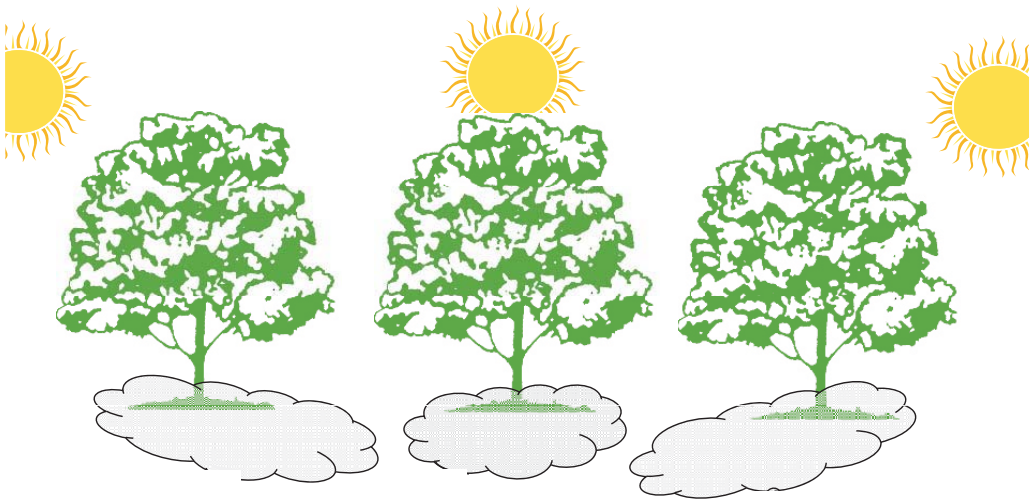


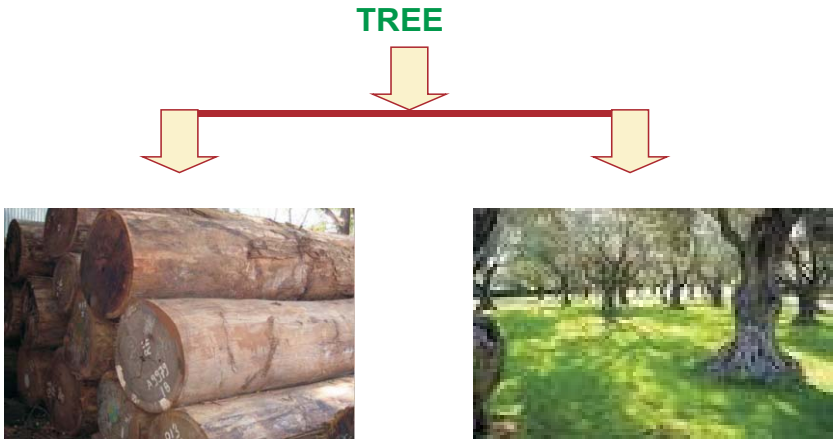


- Intensity
- Coverage
- Direction

} Variable Intensiveness & Extensiveness

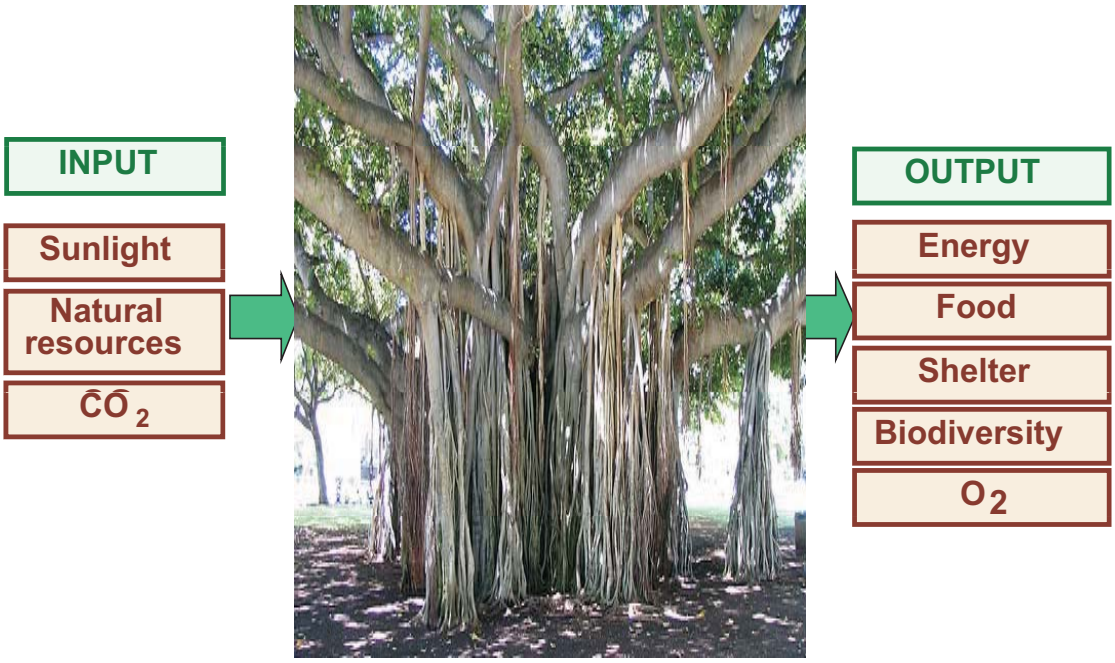
→ This needs to be replicated while designing a green building

Greenest Material?



Greenest Material Greenest Shelter

➡ To create materials with green properties is a challenge!



➢ Green building is one which is sustainable, like plants!

Greenest Material: Attributes and Features

Green : Attributes	
Renewable	Unending Production cycle (lifecycle)
Withstands all weather conditions	Balances Climate
No burden on environment	Integral part of system that supports life
Utilizes natural resources in a sustainable manner	Cleanses & scavenges environment pollutants
In sync with the natural cycle	Preserves the ecology
Energy balance (C footprint)	Carbon-sink

- Materials possessing the basic characteristics akin to the mechanism in plants can be termed as green
- Reduce
  - energy consumption
  - natural habitat depletion
  - pollution
  - water consumption
- Recycling & Reuse is possible

Green Materials: Features for Greenness

	Feature	Significance	Greenness
Raw Materials	Renewable	Sustainable	High
	Synthetic	Depleting	Low
Processing	Energy intensive	C- emission	Low
	Alternative	Low C-emission	Medium
	Bioroute	No C-emission	High
Materials	Durable	Energy-Efficient	Low
	Recyclable	Env.-friendly	Medium
	Reusable	Sustainable	High

→ There are many ways to obtain green materials from various raw materials.

→ Greenness is derived from the overall emissions of carbon; Carbon-footprints.

Greenest Material: Criteria

	Criteria
Input	
Source of raw material	Renewable
Processing	Efficient
Energy	Conservation
Waste	Minimum
Output	
Effect	Long – lasting
Performance	Safety
Durability	Life – Cycle
Disposal	
Waste reduction	Reusability / Recyclability
Cradle-to-grave	Degradability
Safe	Non-hazardous degradation products

Condition	Effect	Criteria
Heat	Temperature ⇨ Dimension	⇨ Transfer ⇨ Conserve ⇨ Retain
Light	⇨ Illumination ⇨ Heating	⇨ Transmission ⇨ Reflection ⇨ Conversion
Mechanical	⇨ Dimension ⇨ Structure	⇨ Strength ⇨ Life-cycle
Weathering	⇨ Decay ⇨ Erosion	⇨ Stability ⇨ Longevity
Rains	⇨ Absorption	⇨ Rain- proof
Fire	⇨ Destruction	⇨ Fire-proof ⇨ Flame-proof
Operational Activities	⇨ Emissions ⇨ Pollution	⇨ Self-ventilation
Environment Pollution	⇨ Aesthetics ⇨ Hygiene ⇨ Health	⇨ Dust-proof ⇨ Sound proof ⇨ Insect proof

⇨ Green Materials & green buildings should be self sustainable.

Greenest Material: Examples and Properties

Materials	Process	Feature	Greenness
Stone	➢ Cutting ➢ Shaping ➢ Polishing	Low Energy	High
Unburnt bricks	➢ Soil preparation ➢ Casting ➢ Drying	Low Energy	High
Burnt Clay bricks	➢ Firing	High Energy	Low
Flyash brick	➢ Casting	Low Energy	High
Cement block	➢ Cement manufacture ➢ Casting ➢ Curing	High Energy	Low

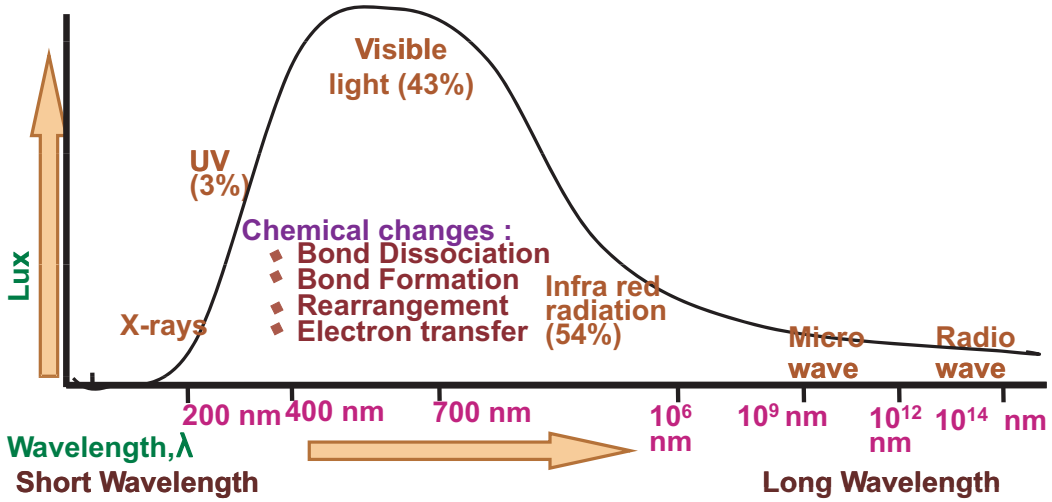
➔ Being energy-efficient and durable, make the energy-intensive materials relatively greener.

Windows: Properties	Requirements
Switchability	❖ Photochromic ❖ Thermochromic
Selectivity	❖ Spectrally selective ❖ IR reflective
Thermal resistance	❖ High R values > 18.3-44.1 (m/K)/W ❖ Low thermal conductivity
Low emissivity	❖ Transmit solar energy & reflect IR energy in winter ❖ Reject solar energy & heat in summer
Transmission	❖ Visible Transmittance in all mode

Insulation	•Cellulose insulation •Mineral wool •Silicate foam •Cotton & fiber glass •Phase change materials
Roofing	•Fire resistance •Light weight •Light coloured •Reflect IR rays
Windows & Doors	•Double glass •Gas filled windows •Low emissivity •Photochromic
Skylights	•Maximize the use of natural light
Shading Devices	•Sunshades •Landscape elements •Canopies •Trees

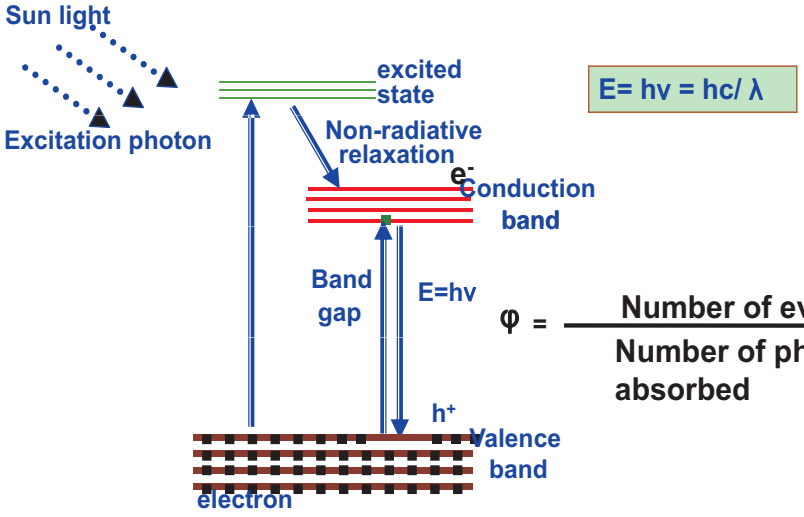
➢ **By selecting green building materials, a healthier & more efficient environment can be created!**

Solar Spectrum and Photo Chemical Convention



- The energy of electron 1.23 eV ≅ λ_{1000nm}; thus, energies corresponding to λ < 1000nm can bring about chemical changes.
- The region from 200nm to 1000nm is most useful for photochemical conversion.

The Energy E of single photon is given by the Planck equation:-

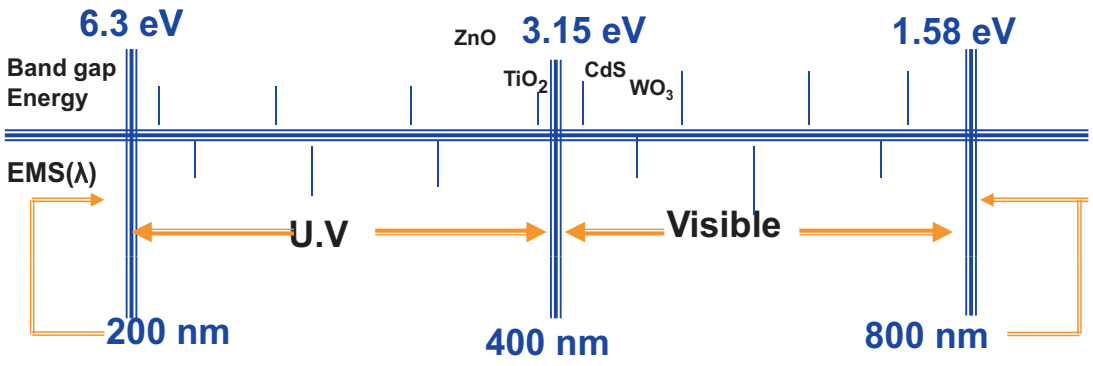


⇨ Every photochemical conversion process requires as an initial steps the absorption of photon energy and conversion into the internal energy of the first excited state of the molecule of the material

Green Materials: Spectrally Selective Materials

Criteria	Requirement	Design	Materials
Admit light, reject solar heat	Transmit: 400 to 700nm Reflect: > 700 nm	Dielectric/ Metal/ Dielectric layer	TiO_2 Bi_2O_3 Zn/ Cu, Ag, Au/TiO_2 Bi_2O_3
Solar heating	Transmit /absorb: <2500nm Reflect : >2500nm	Oxides Semiconductor	Al_2O_3 / MO/ Al_2O_3
Radiative cooling	Emit : >5000nm	Cermet Coating	SiO_2;oxynitrides

➡ Thin film coatings based on the unique properties of spectrally selective materials are coated onto building components for conservation of energy and reduced energy consumption.



TiO_2 = 3.20 eV

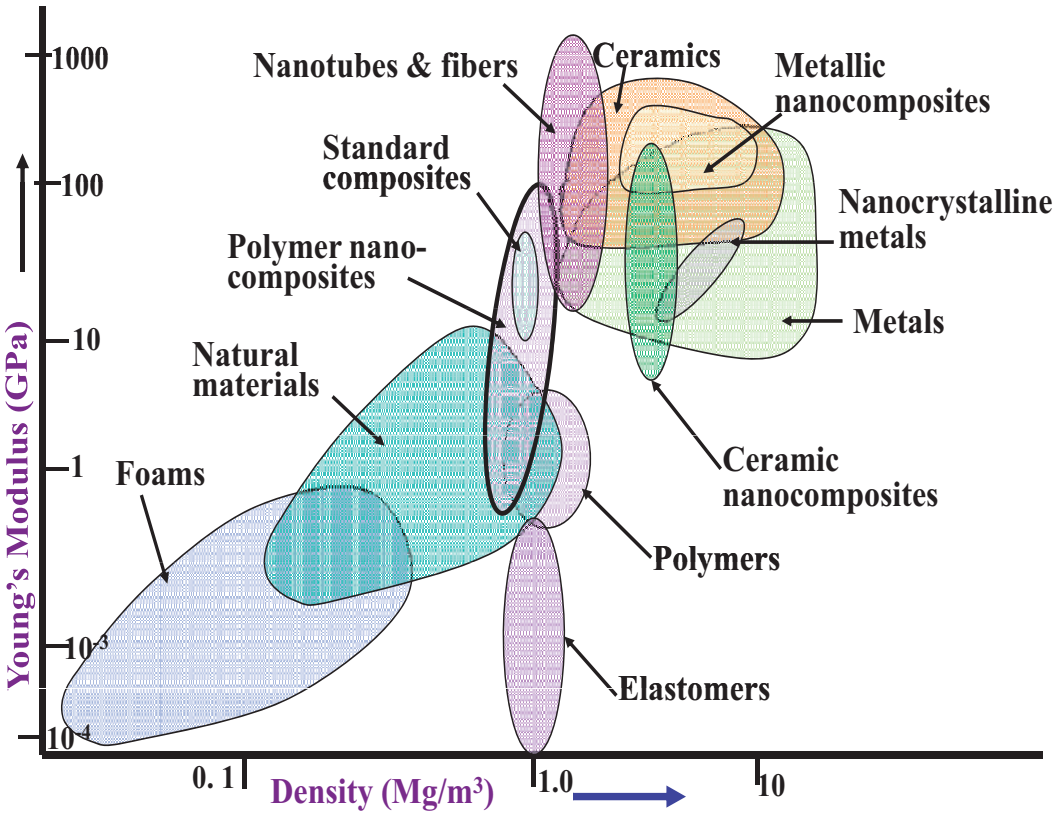
ZnO = 3.35 eV

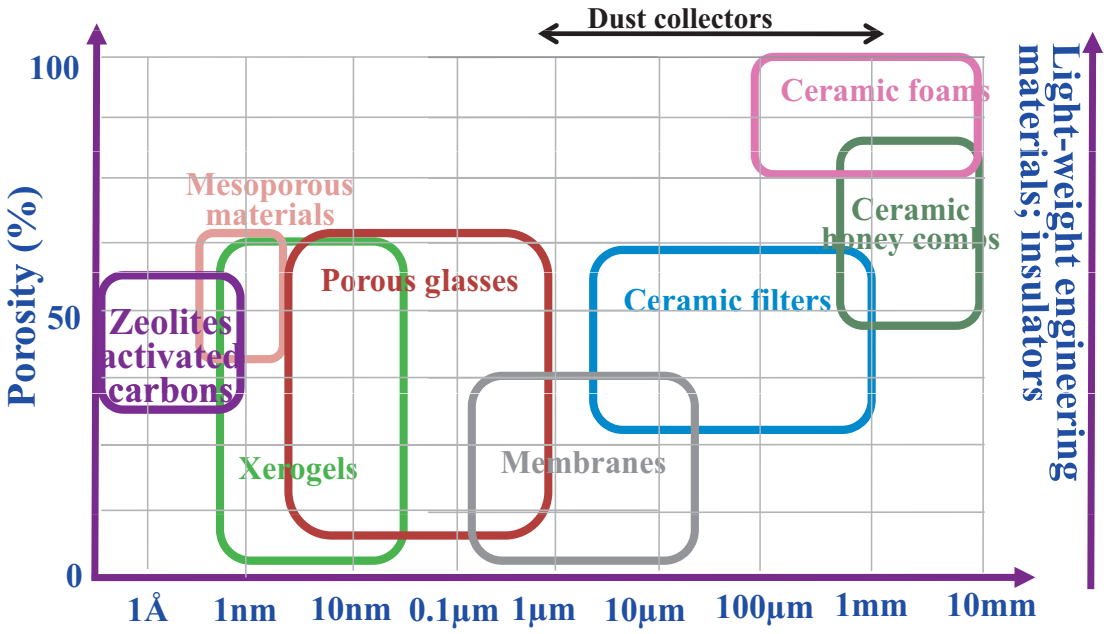
WO_3 = 2.80 eV

CdS = 2.42 eV

⇨ Solar active (UV, visible & I.R.) materials can be designed by modifying the inherent band gap energy of materials by doping, ion impregnation etc.

Mechanical Properties: Porous Materials and Smart Materials (NaNo)





- Distribution of pores within the material; presence voids results in material with relatively low densities.
- Polymers & Ceramics are the upcoming thermal insulating materials

Scope: Defining Nanomaterials

Materials with particles of nanometer size

Concept

❖ For a given volume of nanomaterial :

Volume = Surface area x thickness

↑ Surface area → ↓ Thickness

More atoms at surface → Extraordinary activity

Dimensions

❖ Multi-phase systems

- ➢ Liquid : Liquid
- ➢ Solid : Liquid
- ➢ Gas : Solid
- ➢ Gas : Liquid

⇨ Surfaces and interfaces of different phases at nano scale

What Happens	Dimensions
↓ Particle size	More from less
↑ Surface area	Enhanced coverage
↑ Activity	Novel products
↑ Efficiency	Improved performance per unit mass

⇨ Maximum possible benefits from minimum possible inputs

⇨ Effecting changes through and at atomic scale

Scope: Domain and Process

Keywords	Domain
Particle size	Distribution in the continuous phase
Modification of surfaces	Interfacial tension
Surfaces	Interfaces
Rising volume fraction of dispersing phase	Homogeneity of phases

- Domain of Nanotechnology: Multi-phase systems
  - Liquid : Liquid
  - Solid : Liquid

⇨ **Surfaces and interfaces involving different phases**

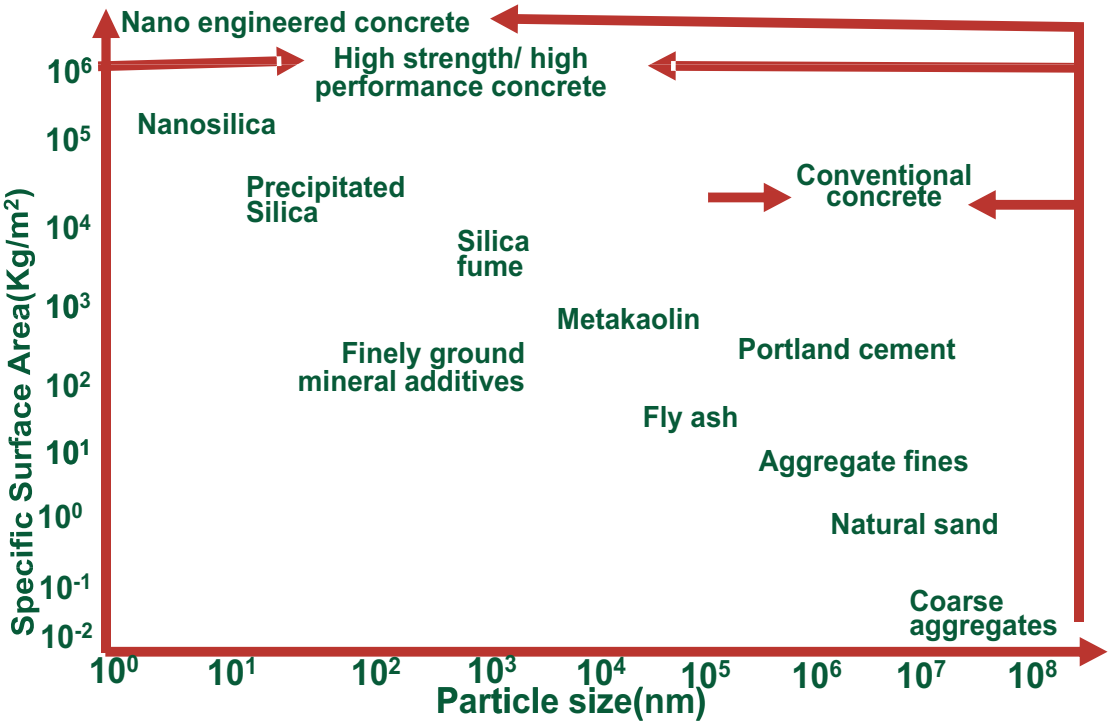
Systems	Process
Emulsion (Liquid / Liquid; Gas/Liquid)	Macro → Micro
Dispersion (Solid / Liquid)	Coarse → Fine
Solution (Solid / Liquid; Liquid/Liquid)	Colloid → Solubilization

⇨ **A process to create a continuous dispersed phase as fine as possible for homogeneity with the dispersing phase**

Nanoscience to Nanotechnology "Macro to Nano" - Nano Engineering

Copper	Opaque	Transparent
Platinum	Inert	Catalyst
Aluminium	Stable	Combustible
Gold	Inert	Catalyst

⇨ Unique properties at the nanoscale are the driving force for exploitation of nanomaterials



⇨ Nanoparticles allow better void filling & positive filler effects & improved bond between pastes aggregates; nanosized additives increase strength beyond what is attained with conventional materials

A New Concept of Harnessing Solar Power in a Smaller Space

Dr. S.N. Maity
Chief Scientist & Head, Technology Innovation Centre, C.M.E.R.I, Durgapur – 7132009

Today there is a great need of an alternative power, a source of non-conventional energies which would be purely green like solar energy, wind energy, tidal power, hydro power etc. Power from sun, as I think, is the only major alternative in comparison to other sources of renewable energies presently being tried to replace the conventional source of energies like coal, gas, oil etc.

Then how to tap the power of sun to be absorbed for our purpose? There are many ways being devised time to time for absorbing the sun rays coming towards the surface of earth. But simplest and efficient is the solid silicon crystalline photo voltaic (PV) module till date. The other methods of sun absorption like reflection, concentration, water heating etc. are the costly and complicated and efficiency is also less compared to crystalline PV modules laid direct to the sun.

One need to erect the PV panels under the sun so that the surface of panel gets the maximum sun of the day being laid at an angle. Today the general method is that hut like inclined structures are made over the land surface to hold the solar panels. Now for an example, the generation of 2MW power from PV module system requires the land of 10 Acres approx. for housing the panels only. But land is going to be the greatest crisis of the earth rather it is already a burning crisis in most of the countries. The cultivable land if used for other than agriculture it will be uncountable loss. Our many national projects are facing the severe problem of acquisition of land. Therefore if land area is used for capturing the solar power it would never be cost effective and viable for the human society.

Therefore there is a need for devising a method and fabricating a suitable device so that the solar power can be absorbed without occupying much surface area, rather utilizing

the minimum amount of land which is going to be the costliest commodity in the near future.

- **Introduction:**

There is a great hue and cry over energy crisis from all over the world mainly for two reasons, firstly the natural resources are going to be exhausted very soon and the other is whether we should continue with the available natural resources of carbonaceous compound which is posing threat of greenhouse gas effect to human being every day. People are trying over different sources to find out non conventional energies, mainly some sort of renewable source of energy or the green energy like solar energy, wind energy, tidal power, hydro power etc. Power from sun, as I think, is the only major alternative in comparison to other sources of renewable energies presently being tried to replace the conventional source of energies like coal, gas, oil etc.

Then how to tap the power of sun to be absorbed for our purpose? There are many ways being devised time to time for absorbing the sun rays coming towards the surface of earth, but most efficient and easily available is the solid silicon crystalline photo voltaic (PV) module form till date. There are other forms like amorphous or thin film etc. But efficient most is the solid crystalline PV cells for direct absorption of sun light. The other methods of sun absorption like reflection, concentration, water heating etc. are the costly and complicated and efficiency is also less compared to PV modules.

1) **Basics of Solar PV module**

Sunlight is composed of photons, which can be thought of as "packets" of energy. When photons strike a solar cell, the vast majority are either reflected or absorbed. When a photon is absorbed, its energy is transferred to the semiconductor -- in particular, to an electron in an atom of the cell. If enough energy is transferred, the electron can escape from its normal position associated with that atom. In the process, the electron causes a hole (i.e., an empty spot where the electron used to be) to form. Each photon with enough energy will normally free exactly one electron, and one hole. Note that both electrons and holes are mobile, and as such can be current carriers.

The simplest solar cells have 3 active layers -- a top junction layer (made of N-type semiconductor), an absorber layer (a P-N junction), and a back junction layer (made of P-type semiconductor). Thanks to the P-N junction, the cell has its own built-in electric field. This electric field provides the voltage needed to force electrons and holes freed by light absorption to flow in their own directions (the electrons to the N-type side, and the holes to the P-type side). If we provide an external current path, electrons will flow through this path to their original (P-type) side to unite with holes the electric field sent there, doing work for us along the way. The electron flow provides the current, and the

cell's electric field causes a voltage. With both current and voltage, we have power, which is just the product of the two.

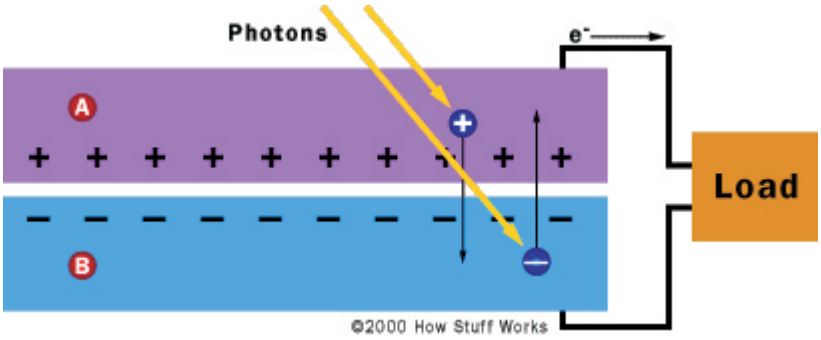


Figure 1. Operation of a photovoltaic cell

1. General methodology

In our country the solar power generation system are generally being designed by this type of solid crystalline (PV) in different places. One needs to erect the PV panels under the sun so that the surface of panel gets the maximum sun of the day being laid at an angle. Therefore it is required to have suitable structure over the landed area in an open space to hold the solar panels. Now for an example, the generation of 2MW power from PV module system requires the land of 10 Acres approx. for housing the panels only. But land is going to be the greatest crisis of the earth rather it is already a burning crisis in most of the countries. The cultivable land if used for other than agriculture it will be uncountable loss. Our many national projects are facing the severe problem of utilization of land. Therefore if land is used for capturing the solar power it would never be cost effective and viable for the human society.

2. Need for new invention

Therefore there is a need for devising a method and fabricating a suitable device so that the solar power can be absorbed without occupying much surface area or land which is going to be the costliest commodity in the near future. Rather it would be utilizing the minimum land for maximum solar power absorption by creating a holding system for maximum solar surface through installation of PV modules.

Here comes the idea of a device of installing a tall metallic pole of 50 to 70 feet height founded on a basement of (2 X 2) Sq feet or maximum (3X3) Sq feet area. The surface land therefore is used only a maximum of 4 to 9 Sq feet. Of course, it needs some base foundation for holding the taller pole but most of the foundation work will be below the ground surface.

1. Uniqueness and advantages

The uniqueness of this single pole system is that the solar PV modules will be installed throughout the tall pole following a pattern of spiraling phyllotaxy with due adjustment of load distribution over the pillar for its balancing.

The other uniqueness is that all the Solar Panels will be hanging through their connecting stem-system attached with the main trunk (Pole) and may be made flexible in all direction so that they can best avoid the wind pressure due to heavy storm affecting over the main pillar (trunk). The leaves / panels would preferably be spring loaded and the Joints of stems would be flexible. The panels will be naturally facing towards the sun at an angle as required so that they can fix up maximum solar energy in a day time.

The advantages of this system is that it takes about 1% of land area in comparison to general PV housing layout, as example it requires 0.5 Sq M basement for 2.2 KWH PV power whereas for the same solar power by present general method of housing the PV arrays, a land of 50 Sq M is necessary for layout.

The other advantage is that this system does not require the acquired big landed property at a single place, rather for this type of solar power generation the Road sides, the islands in between wide roads / highways, the boundary walls of paddy lands, the crossings of boundary walls etc. can be used for installation of S-P-Tree.

Another advantage is that the shadow having created by the panels won't touch the land in most of the cases (as the SP Trees would be very tall) and even if it touches, it won't cover the surrounding field by its penumbra so that growth of plants would be restricted.

2. Conclusion

The solar power trees can be planted without any particular land exclusively occupied for it. They can be installed on the road sides as they consume max. 4 Sq. Ft. of area. The village roads and the boundary walls of paddy lands can provide sufficient space for planting solar trees that can supply enough power for lighting the villages. The state and national highways are big sources for solar plantations. Two sides of single road high ways and the three sides of double road highways (including Island) can be utilized for solar trees. A simple calculation shows that if the National Highway (NH-2) is used for plantation of solar trees from Kolkata to Asanslol (300km) it can produce 100 MW by installing 2KW solar tree through the road at a certain interval. This would actually require 550 Acres of land for the same power generation at a single place by the present general method of laying out solar panels in a conventional way. A few solar power trees can produce energy sufficient for the Institution and campuses.

A Solar PV Lighting Systems

Dr. S. N. Maity
Chief Scientist & Head, Technology Innovation Centre, C.M.E.R.I, Durgapur - 7132009

Conventional panel & light

Conventional solar plant

Conventional PV panel layout for 2KW occupies 450 Sq. Ft land

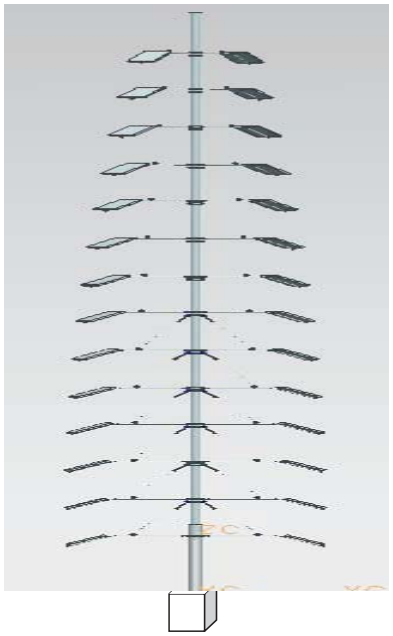
A Solar Tree

First model of solar power tree

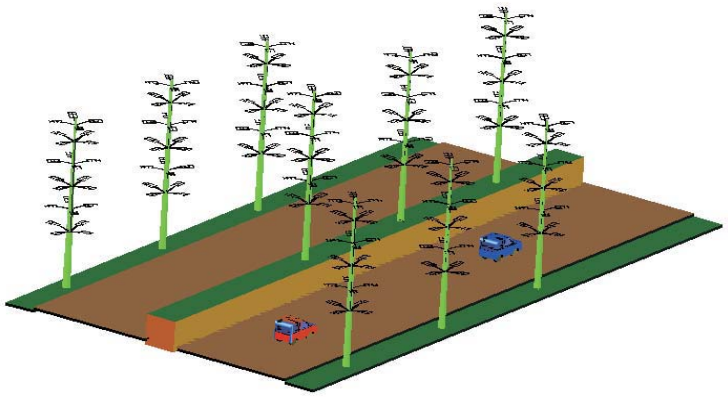
Solar power tree 1 KW capacity

Solar power tree 1 KW capacity occupies 2 Sq.Ft land

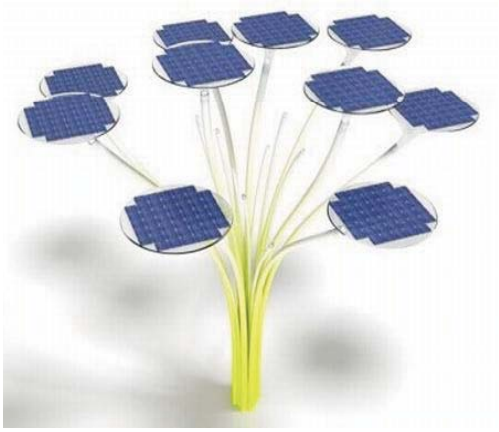
Solar Tree Options



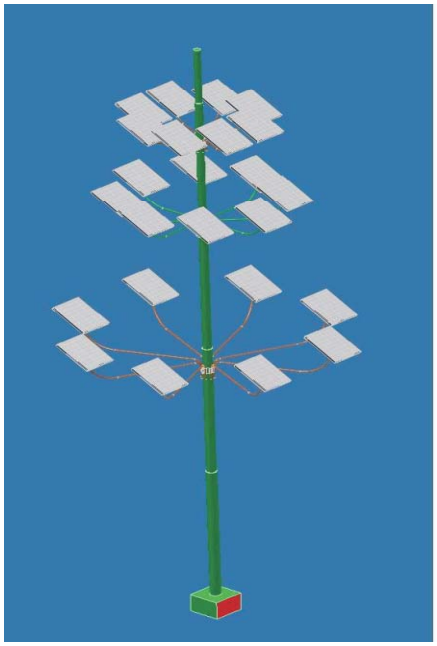
Solar power tree with SPV layout for 2KW (4 Sq.Ft. land)



Proposed Solar Power Tree on the high way



Decorative solar tree



Solar Power Tree with Phylotaxi

Solar Tree Uniqueness and Advantages:

The main advantage of this system is that it takes about 1% of land area in comparison to general PV housing layout as example it requires 0.5 Sq M basement for 2.2 KWH PV power whereas for the same solar power by present general method of housing the PV arrays, a land of 50 Sq M is necessary for layout.

This system does not require the acquired big landed property at a single place, rather for this type of solar power generation the Road sides, the islands in between wide roads highways. the boundary walls of paddy lands, boundary walls of big campuses, institutions etc. can be used for installation of S_P_Tree.

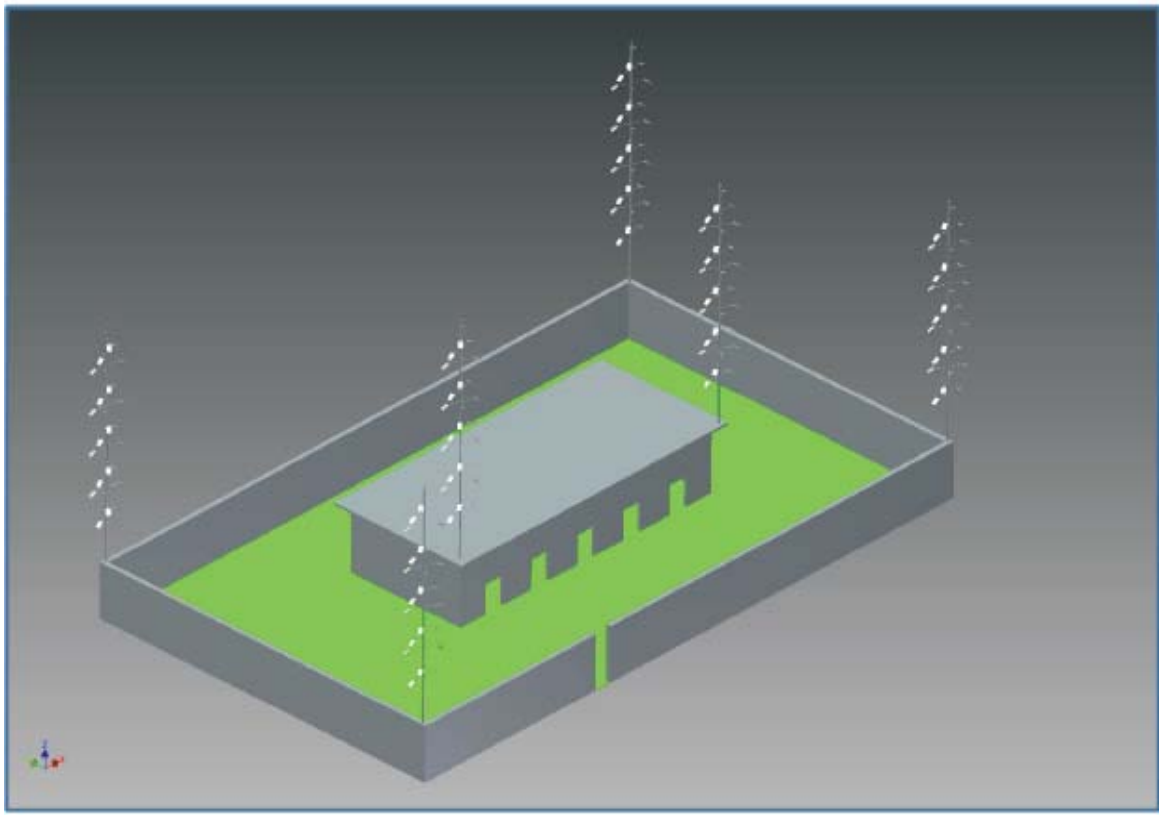
Another advantage is that the shodow having created by the panels won't touch the land in most of the cases (as the SP Trees would be very tall and panel size is small) and even if it touches, it won't cover the surrounding field by its penumbra so that growth of plants would be restricted in case it is near to cultivable land.

Because of pattern of laying of panels following phylotaxy of natural trees and using the small size panels, the shadows coming from the panels of upper level do not interfere with the lower panels in most of the daytime. if sometimes they obstruct the lower ones that cover only very small percentage of panel area and for a little while only.

The dust deposition on the panels is a big problem for such type of solar power generation. Generally, as the panels of SPT are placed at higher height they are less subject to dust deposition. Again as the SPT structure is like a pagoda tree and an arrangement of water spraying from the top of the tree could make the panels clean if it works for a minutes in the moring every day.

There is a big advantage in laying of panels inherited in this device of SPT, that all the panels can be laid in East - West direction, unlike the general fixed hut like structure where they are laid in South - North direction in general. An easy method can be devised with this SPT so that all the panels can be tilted around an angle of 45* as to get the maximum sun for whole the day Instead of sophisticated electro-automated device as a tracker, a simple mechanical device of pulling a rope can till all the panels from East - West to West - East direction to get the maximum sun path in a day quite economically.

Solar Tree Economics



Proposed SPT around the Institution campus for captive power

Estimate for a Solar tree

The height of Solar power tree : 9.3 meters weight of tube / pipe = 180 kg

cost of tube /pipe = 180 X 50 = Rs. 9000/- 25 of small tube , dia ø = 3/4" = 19 mm

Say, Rs. 10,000/- for fitting of small tubes

10, 000 + 9,000 = 19,000/-

Grouting cost (1: 1x 1/2 : 3) = (450 x 450x 900) mm foundation,

Cost = Rs. 730 Earth cutting = Rs. 45 each Total cost for Grouting = Rs. 775

Now, 19, 000 + 1000 = Rs. 20, 000/- i.e Mechanical Tree = Rs. 20, 000/-

Each panel capacity = 40 W

No. of panels = 26 Nos.

Total watt = 1040 W

cost of Solar PV cell for each watt = Rs. 80/WP

So Total cost of solar cell = 1040 x 80 = Rs. 83,200

Battery cost : No of battery = 4

Each battery cost is 6500

So, cost of all four battery = 4 x 6500 = Rs.26000/-

Battery bank with grouting = Rs. 5000/-

Total cost for 1KW of Solar Power Tree (SPT)

Mechanical tree + SPV + Battery

= 20,000+ 83000+ 26000+5000

= 1.34 Laks

For 2KW of SPT

Cost = 1,34,000+ 83000(panel cost) + 26000 (battery cost) + 7000 (handling cost) = 2.5 laks

Environment Friendly Building - Environment Friendly Pedagogy

Deependra Prashad
Principal Architect & Sustainable Design Consultant (DPAP)

Climate Change & Schools

Climate Change has put a question mark on man's existence

Development - Resource overusage - Emissions - Global Warming

- In a advocating Sustainability, we talk about ability of our children to have equal opportunity to access the earth's resources as we've had.

"Can we do more with less"

The Right to Education 2009 talk about providing Access, Retention, Equity & Quality in education

Within that framework, how to Tackle sustainability

Schools are Spaces where children Learn

- School Spaces must showcase a sustainable way of living to help create environmentally aware, responsible citizens - large multiplier potential in Later life

<u>2 ways to engage with the environment</u>

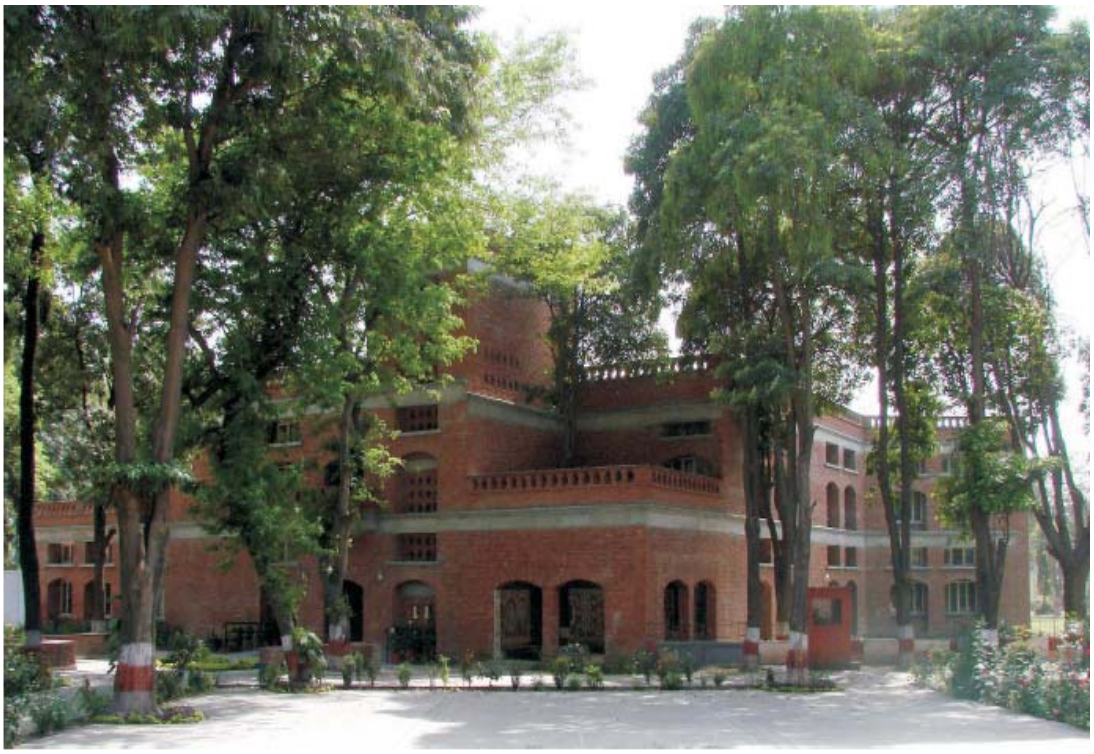
- Enriching Pedagogy with environmental info

For e.g. Environmental Studies (EVS) with many innovative teaching methods used, but sometimes seen as extra curricular activity

- The Actual school enviornment also enriches the process. But many Schools have been planned as comfort islands away from the environmental reality. Can they re-engage with their enviornment?

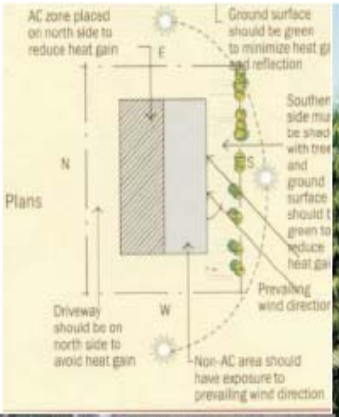
School Green Building Parameters
... help connect with ...
Environmental Learning & an experiential pedagogy

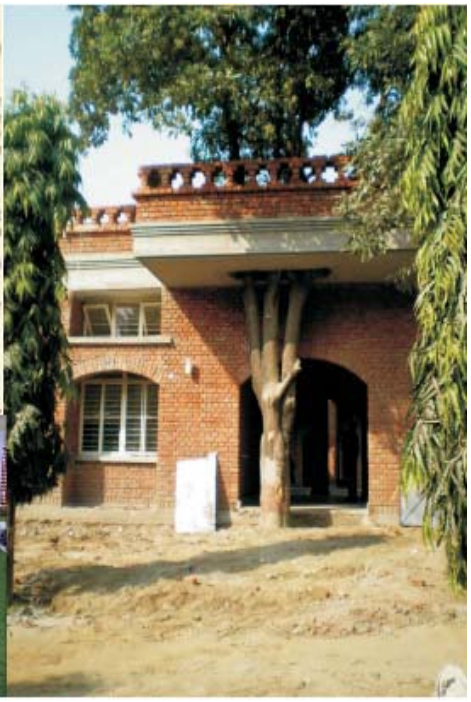
School Site Planning Landscape



- Preserving existing vegetation provides a Finish to the new bid, cuts off pollution and helps in Noise Attention (Shriram Junior High School, Meerut - Semi Urban)

- Use the Landscaping as a form determinant.
- use Deciduous trees / Evergreen trees in appropriate orientations to shade / cool school building (helps appreciate nature's dynamics)





School Air Quality

Environmental Learning & Experiential pedagogy
- Eco-Park Concept (Water Cycle with out active participation)
Rainwater for Plant growth - Plant waste - Composting - Nurseries - Evapotranspiration - clouds
- Identifying bio-diversity inherent in school premises
- “Adopt a plant” by every child - develop a nursery
- generate shaded Areas into storytelling corners, Climbing, Activity

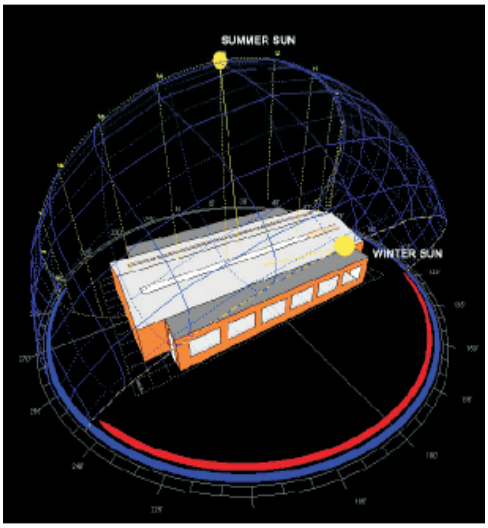
- A school which encourages Walk-to-School, Cycle-to-School, School-Bus-Transport Facilities rather than personal motorized transport
- Not using polluting backup energy from DG sets (alternative gas based systems)

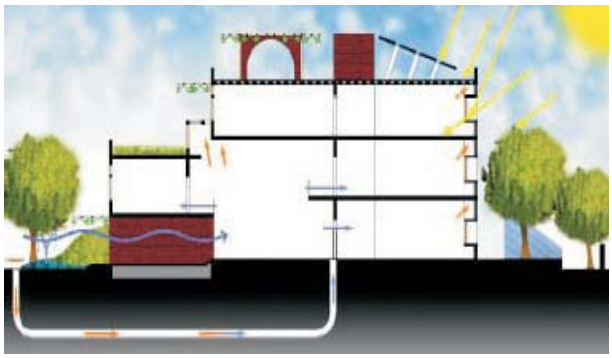
- Highlighting health benefits
- Auditing of Air Quality by schools
- Discussing a wider city level discussion to segregate fast moving traffic from pedestrians, Pedestrian etiquette & responsibilities, Connection of the school with the neighbourhood (in admissions etc.)

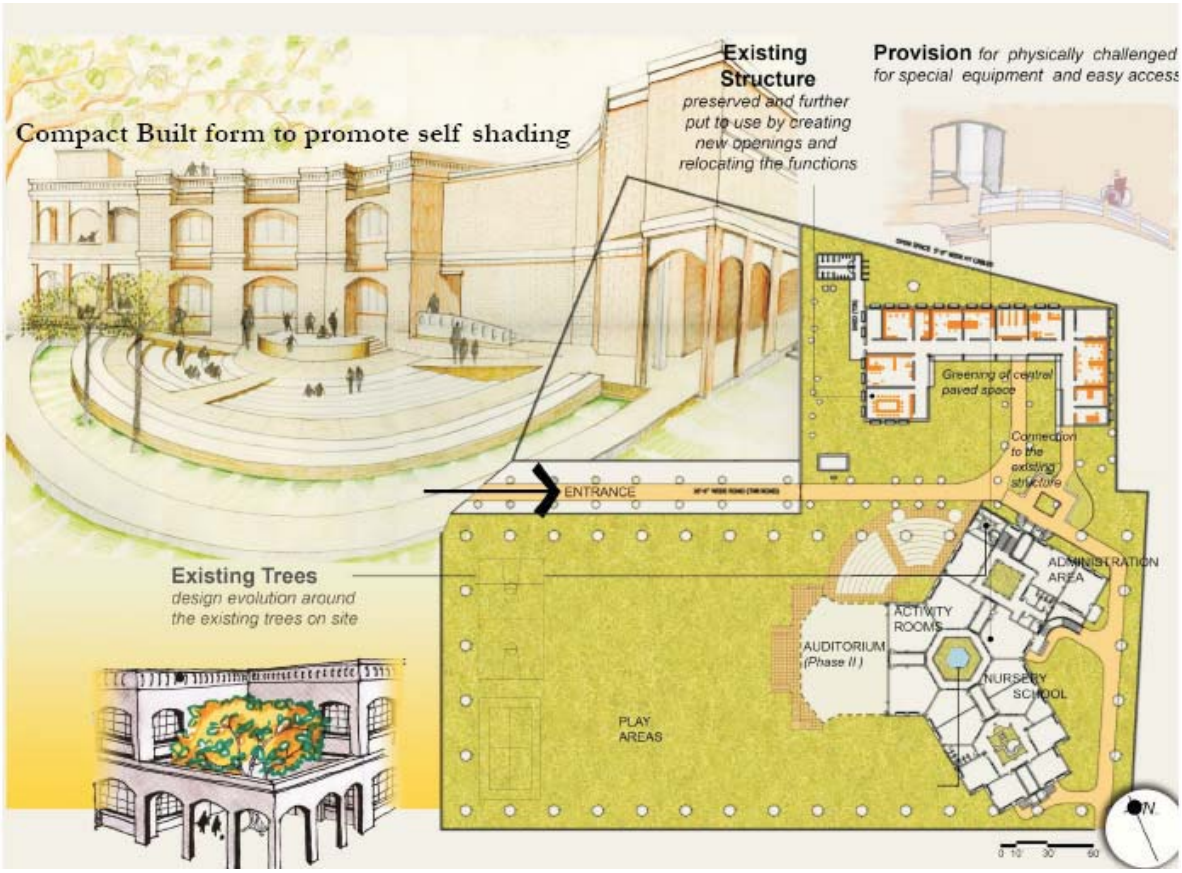
Thermal Comfort in School Buildings

- Naturally of Passively Attenuated comfort conditions rather than conditioned spaces - Roof Insulation & solar Reflectivity, Shading of Walls, Passive Cooling Devices

- Promotes Retention in schools especially in Rural areas, One of the primary goals of SSA.

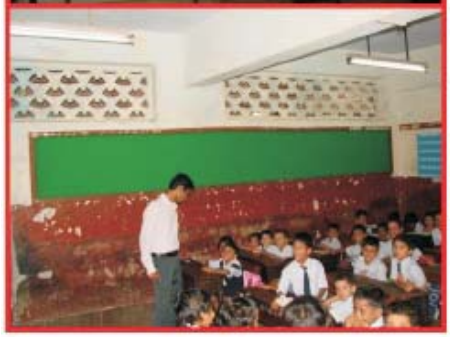


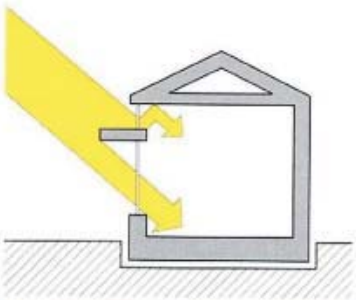




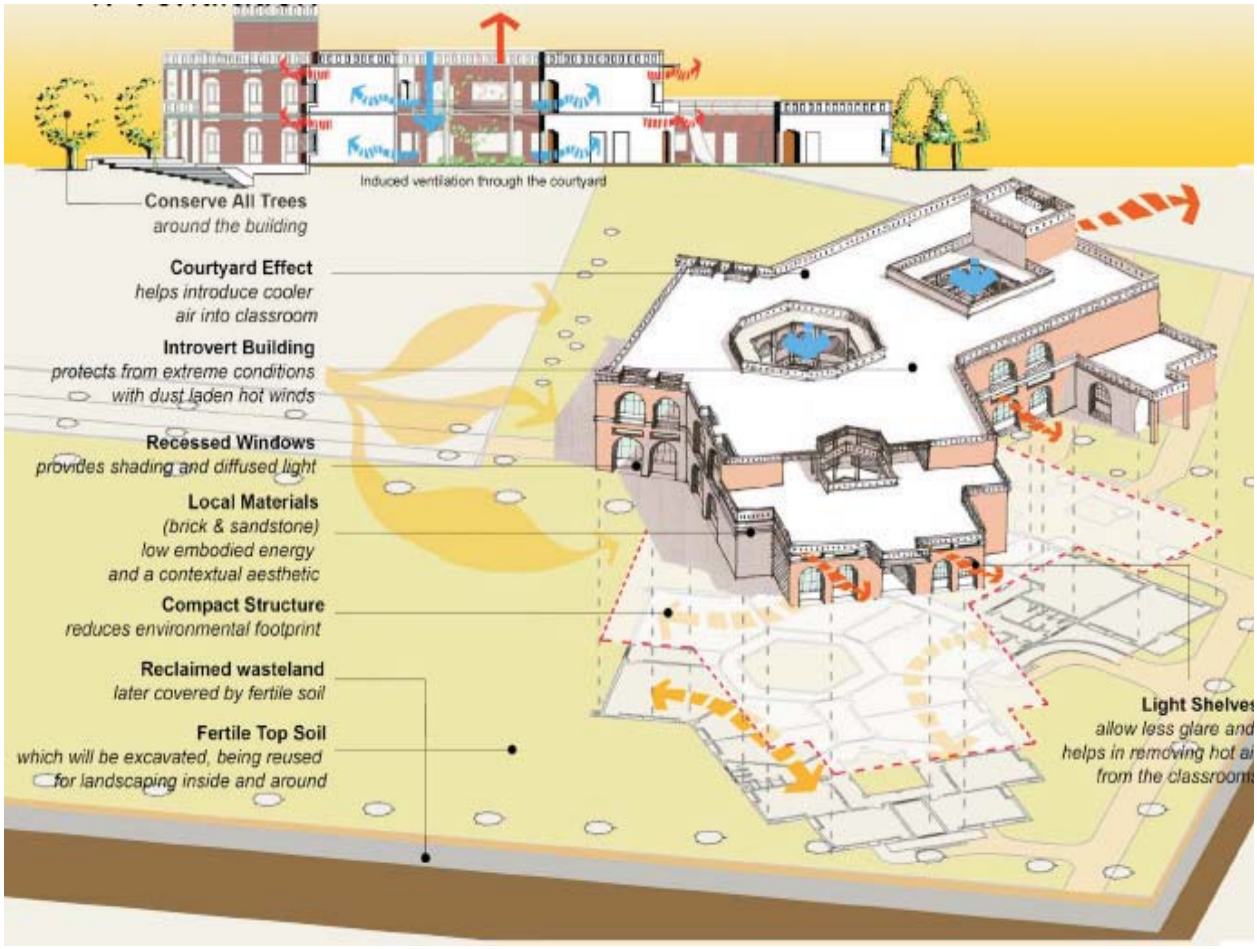
Improved Daylight and Ventilation

Improve Day lighting in classrooms but Reduce Glare, Ventilation Helps avoid buildup of pathogens
Promotes Ease of Reading / Writing, Helps classroom Usage during powercuts

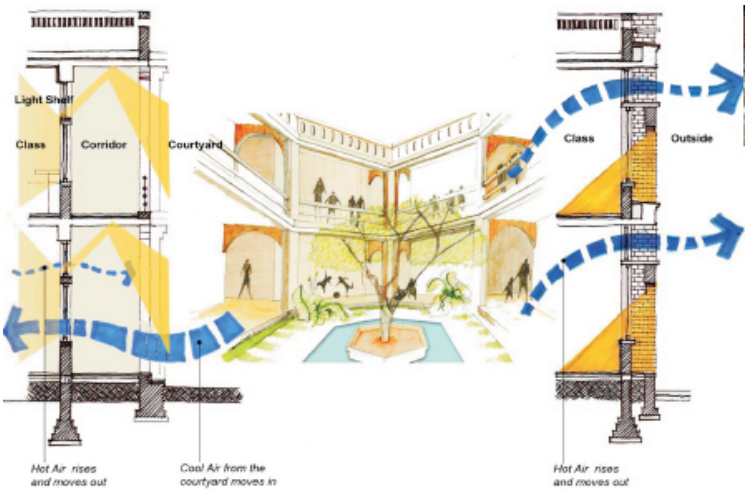




Ventilation



Cross and Stack Ventilation

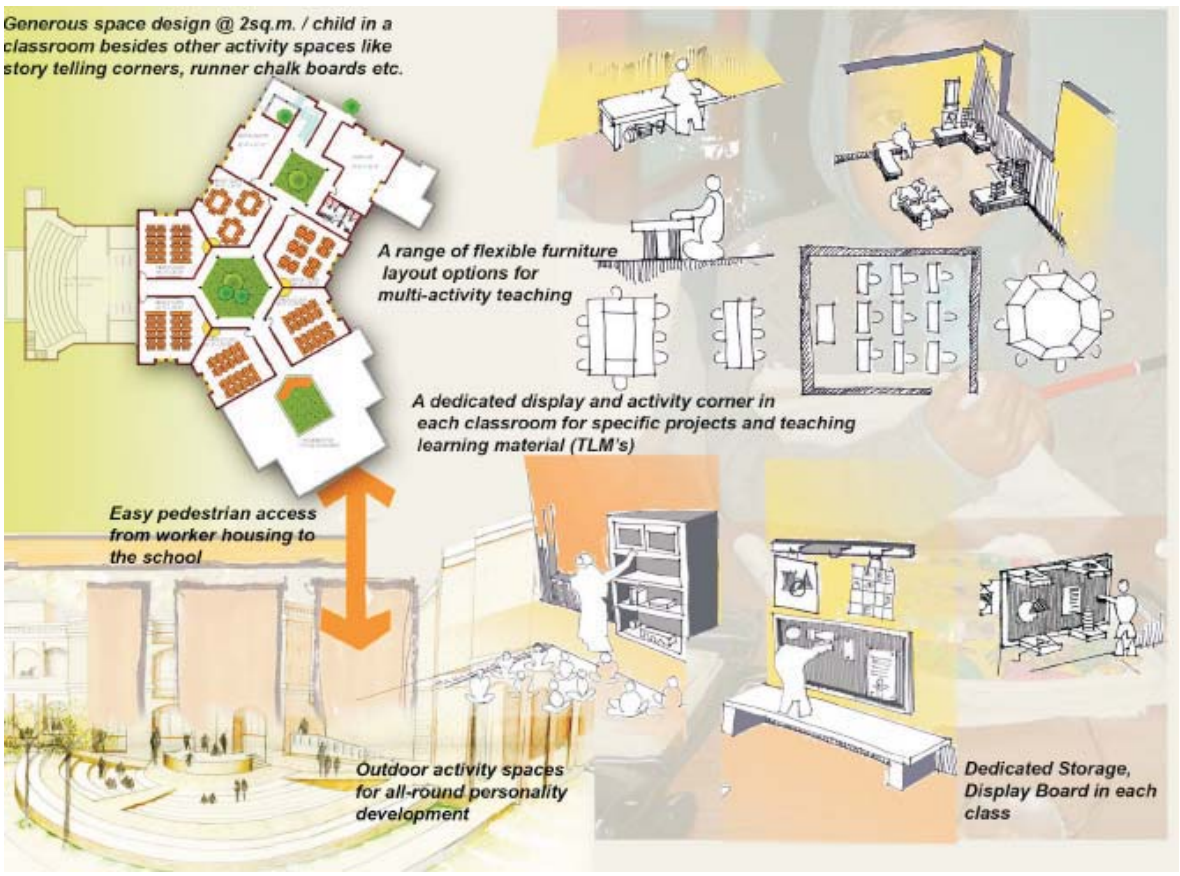


The courtyards are proportioned to be shaded and are also cooled using the principle of evaportive cooling with water. These courtyards also let in diffused light into the classrooms.

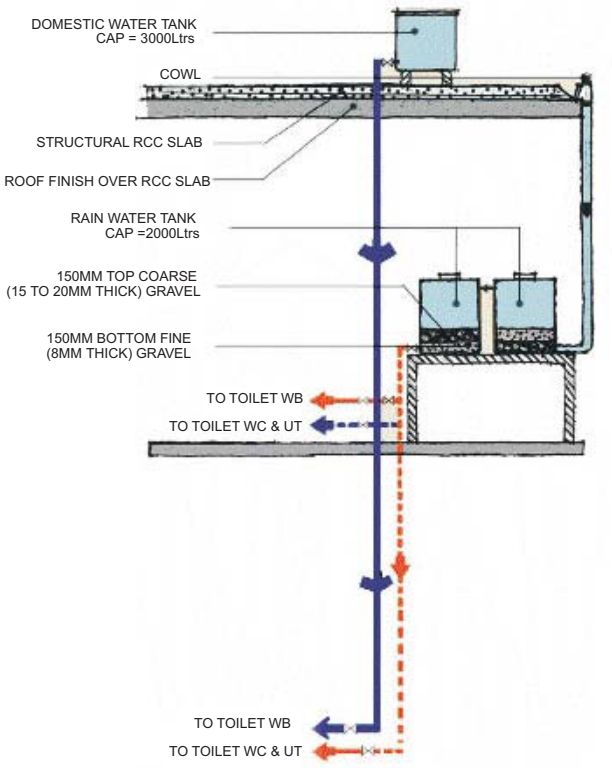
Buildings Aesthetics and Child Friendly Elements

- Child Friendly Elements in the building Space enhance the environment

- These elements work as a learning aids with minimal interventions and cost

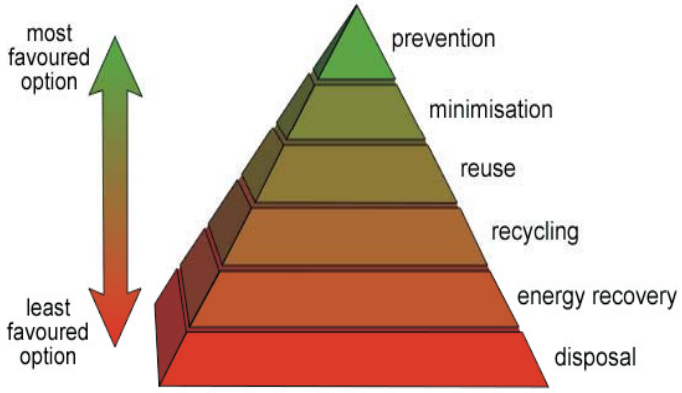


Water Efficiency and Waste Management



Waste management strategy in Schools involving the 3R's
- Reduce
- Recycling
- Reuse

- Issue of Hygiene due inappropriate waste disposal
- Waste as a resource, Paper Recycling Workshops, Artwork from waste
- Creating Composting manure for school gardens and neighbours

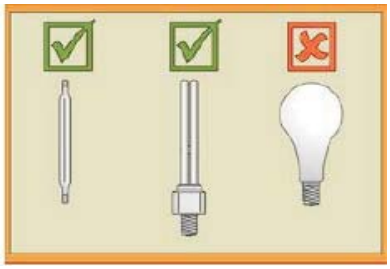


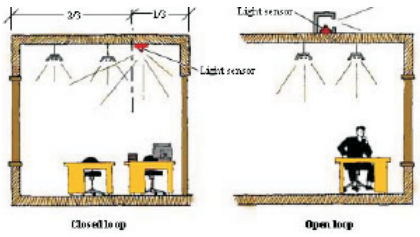
Energy Efficiency

Green building Ratings provide parameters for energy efficiency.
- We can effectively reduce Lighting energy vis-a-vis ECBC prescriptions.
- The real Competition is with Zero energy schools

- Many Rural Schools now have electrical connections but no electricity.
Prevents Computer Aided Learning. Multimedia, Radio based learning.
Evening Classes
- Schools should also be able to pay for the connection

- Lighting through energy efficient light fixtures- Increasingly common, longer life
- Use electronic ballasts
- Daylight control systems like time switches, astronomical switches and classroom master switches also result in appreciable electricity savings.
- Child safe equipment like ELCB's should be used which also prevent electricity leakage





Local materials are pertinent to lower the embodied energy of building

- Alternative materials like CSEB, Flyash, MCR tiles, Ferrocement channels with an inherently low embodied energy need to be promoted. They also provide a sense of aesthetics vis-a-vis the ubiquitous RCC box.

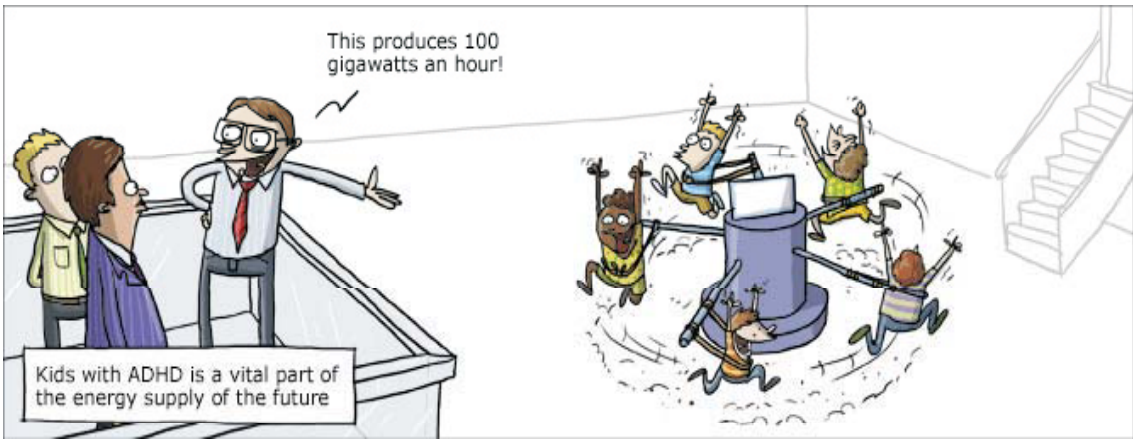
Renewable Energy

Generation of Renewable Energy through innovative mechanism besides solar
- Piezo-electricity in heavy movement areas
- Solar for lighting / external lighting / water pumping
- Biomass

Make Solar visible & Aesthetically blended

Soccer ball that captures and stores energy generated by play. (soccket)

Rotating Play Element whichproduces electricity



ADHD: Actively Deployed Hyper Device

Environmental friendliness, environmental friendliness & Energy efficiency in schools not just for their own sake for creating an overall better engineered building

Annexure 4.1

Speakers Profiles

1. Prof. D.P. Aggrawal

Prof. D.P. Aggrawal is currently Chairman Union Public Service Commission. He held the post of Director, Indian Institute of Information Technology & Management (IIITM), Gwalior. Professor Aggrawal has 30 years experience in Teaching and Research in areas such as engineering, management, Information Technology, educational administration and institutional planning and management. Prof Aggrawal obtained his Bachelor of Engineering degree from Aligarh Muslim University in 1970 and Ph.D. from Indian Institute of Technology, Delhi. He has served in the Indian Institute of Technology, Delhi, in various capacities from October 1975 to July 1994. At IIT Delhi, Professor Agrawal also held several important administrative positions including 'Dean of students' in IIT Delhi. Prof Aggrawal has been instrumental in revolutionizing the working of UPSC and has implemented major initiatives including e-governance.

2. Dr. R. K. Khandal

Dr. R.K. Khandal, Fellow of Royal Society of Chemistry, London is the Director of Shriram Institute for Industrial Research. He is also the President of a prestigious United Nations organization, WAITRO (World Association of Industrial and Technical Research Organizations). He holds a Ph.D degree in Applied Chemistry and has more than 30 years of experience in industrial research and teaching. He was a post doctoral fellow in UK and visiting research scientist in France. More than 50 research papers in high impact journals. He has authored several books and handbooks in multi-disciplinary areas such as polymers, food, water, etc. He has several chapters in various books and encyclopedia and handbooks. He has guided several Ph.D. and M. Tech students. Currently 25 students are registered for Ph.D. He holds several distinguished positions. He is a panel member of several expert committees and board of research studies of several prestigious universities. He is also on the editorial board of several prestigious journals. He is the recipient of several national and international awards.

3. Shri. S. Baliga

Shri S. Baliga retired from the post of Additional Director General, Central PWD responsibilities included CPWD Training Institute, Contracts, Specifications and Quality Assurance. Also held charge as ADG (Eastern Region) comprising North Eastern States, West Bengal, Sikkim, Bihar, Jharkhand, Orissa. During tenure was responsible for getting recognition of CPWD's Training

Institute by the Ministry for New and Renewable Energy as a Centre of Excellence for Green Buildings, thus increasing it's role in advocacy and training interventions on Green Buildings on a National scale. He is member of various professional bodies such as Indian Roads Congress. He is B. Tech (Civil) IIT Madras 1972 First and M Tech (Struct) IIT Delhi 1975 First with Distinction. He did MBA FMS, University of Delhi and obtained Certificate in Earthquake Engineering from International University of Seismology and Earthquake Engineering, Univ. of Tsukuba, Japan, under Colombo Plan.

4. Sh. R. G. Gupta

Sh R.G. Gupta is City/ Policy planner has 29 years service with Delhi Development Authority. He was Sr. Pvt. Secretary to a 'Joint Committee on Projection of Plant Varieties and Farmers' Rights Bill, 1999' in Parliament and Advisor to Town & Country Planning Deptt. of Patna – Bihar. He did Post Graduate Diploma in "Regional Development Planning" from the Institute of Social Studies, The Netherlands in 1969 and stood first, among students from 13 countries. His Post Graduate Degree is in "Town & Country Planning" in 1963 from the School of Planning & Architecture (deemed to be a University), New Delhi. He received Gold Medal in Bachelor of Architecture in 1960 from IIT, Roorkee and Bachelor of Science in 1956 from Meerut College Meerut (UP), where he got first division. He is co-opted Member of the BLS of Delhi Vidhan Sabha in 2006. He has undertaken some unique planning projects in Delhi and has vast experience in Advisory capacity in many State Governments. He has published six books on topics related to planning perspectives in urban and rural areas.

5. Dr. S. Maity

Dr. S.N. Maity is Chief Scientist & Head, Technology Innovation Centre at Central Mechanical Engineering Research Institute at Durgapur. He holds a Doctorate in Engineering.

6. Mr. Deependra Prashad

Mr. Deependra Prashad is a practicing Architect/Planner & the Secretary of INTBAU India, the International Network for Traditional Building, Architecture and Urbanism. He is teaching Sustainable Design & Planning, at the School of Planning and Architecture, New Delhi. He is Consulting Govt. of India & NGO's on issues of appropriate building materials, rainwater harvesting and community based planning for educational infrastructure development. He has been part of a number of Joint Review missions of the Sarva Shisha Abhiyan and has consulted MHRD and a no. of private international NGO's on green and child friendly school planning. He coauthored & Editor of the Blue Drops Series for UN-Habitat on "Rainwater Harvesting practices across the world" & the INTBAU publication on "New Architecture and Urbanism: Development of Indian Traditions"

7. Dr. (Mrs.) Malti Goel

Dr. (Mrs) Malti Goel is former Adviser and Scientist 'G' in the Ministry of Science & Technology, Government of India and is an energy-climate change policy specialist. She was awarded Doctorate in Physics on 'Thermo and Photoelectret Effects in Organic Solids' in 1973 from Indian Institute of Technology, Delhi. She did D.I.I.T. Solid State Physics from IIT Delhi in 1969 and Master's degree in Physics from Birla Institute of Technology & Science (BITS), Pilani. She is a recipient of Gold Medal in M.Sc. Physics and a topper in D.I.I.T. She has represented country as Vice Chair to Technical Group of CSLF, an International Forum on Carbon Sequestration and in SBSTA workshop of UNFCCC contributing to energy policy research for stabilization of greenhouse gas emissions. She has contributed books on *Energy Sources and Global Warming, (*Allied Publishers, 2005, pp 492), *Carbon Capture and Storage R&D Technologies for Sustainable Energy Future,* (Narosa Publishing House,2008, pp 242) and *CO_2 Sequestration Technology for Clean Energy* (Daya Publications, 2012 pp 212). She has authored more than 200 research scientific and research papers in the journals of international repute. She is Recipient of several awards and honors.

Annexure 4.2

Invitation Letter

5th August, 2011

Sub: Awareness on Green Building Responsible Education in Schools, 7th September, 2011

Dear Sir

As you are aware energy is critical for development and growing sustainably is the need of the hour. India has made tremendous strides in renewable energy development by achieving approx 18,000 MW of installed capacity (June 2011) and is emerging as a country with highest contribution from renewable resources. Linking climate change with energy policy however, demands transformational change in the way we use energy. Youth in their formative years in school need to inculcate skills on such topics of energy and environment concerns, which are not in their regular course curriculum.

It gives me immense pleasure to invite you to the workshop on *Awareness on Green Building Responsible Education in Schools (AGBRES-2011)* to be held on 7th September 2011 (10:00 AM to 04:00 PM) in Seminar Hall 2, New Extension Building F.F. India International Centre (IIC) to deliberate the need for education and develop a roadmap for the future. Participation from school teachers / Principals and others would be invited.

The Workshop has been planned in association with the IIC and the following topics are proposed be covered.

- Why do we need Green Buildings?
- Energy efficiency tools
- Solar Energy for schools
- Nanotechnology and Green Buildings
- Growing Sustainably –a Roadmap
- Hands-on Experience

Your eminent presence for the INAUGURATION would highly encourage us. Please indicate your convenience and confirm your acceptance.

Thanking you and with kind regards,

Dr. (Mrs) Malti Goel

Annexure 4.3

Presentation Highlights

1. Why do we need green buildings?

Dr. (Mrs.) Malti Goel

Former Adviser, Ministry of Science & Technology, Govt. of India and Programme Coordinator

- Emergence of Modern Buildings in 21st Century
- Climate Change: Conflict of Energy and Global Warming
- Global Temperature Profiles and Anomalies 2010
- Energy Efficiency: Towards Reduction of CO_2 Emissions
- Basic Laws of Thermodynamics
- Representative Climate of Each Zone in India
- Thermal Performance Index and Thermal Load in Different Seasons
- National Policy: Integration of Green Building Concepts through Energy Simulations
- GRIHA Regulations of Green Buildings in Different Countries
- Renewable Energy use in Buildings
- Building Materials Embodied Energy
- Promoting use of local Materials
- Conclusions

2. Energy Efficient Green Building Materials

Dr. R.K. Khandal,

Director,
Shriram Institute for Industrial Research
19, University Road, Delhi – 110007

- What is Green Building?
- Greenest Material and Attributes
- Green Materials: Features for Greenness
- Green Materials: Criteria and examples
- Energy Efficient Building Components
- Defining Nanomaterials and Nanodomain
- Nanoscience to Nanotechnology “Macro to Nano”
- Novel Materials
- Solar Spectrum and Photochemical Conversion: Mechanism
- Green Materials: Spectrally Selective Materials

- Green Materials: Self Cleaning Materials
- Mechanical Properties: Smart Materials (Nano)
- Green Materials: Porous Materials
- Green Materials: Nanoengineered Concrete

3. Solar Power Tree – a New Concept of Harnessing Solar Power in a Smaller Space

Dr. S.N. Maity,
Chief Scientist & Head,
Technology Innovation Centre
C.M.E.R.I, Durgapur 713209

- Conventional Solar Panels and Solar plant
- First model of solar power tree
- Solar power tree of 1 KW capacity occupies 2 Sq. ft land
- Conventional PV panel layout for 2 KW occupies 450 Sq. ft land
- Solar power tree with SPV layout for 2KW (4 Sq. ft Land)
- Proposed Solar Power Tree layout on the Highway
- Phyllotaxy
- Uniqueness and Advantages:
- Proposed SPT around an Institution campus for Captive Power
- Estimate for a Solar Tree

4. Environment Friendly Building, Environment Friendly Pedagogy, Developing the connections

Dr. Deependra Prashad
Principal Architect & Sustainable Design Consultant (DPAP)
Coordinator (INTBAU India)
Visiting Faculty (School of Planning and Architecture, Delhi)

- Climate Change & Schools
- School Site Planning and landscape
- School Air Quality
- Thermal Comfort in School Buildings
- Improved Day lighting and Ventilation
- Buildings Aesthetics and Child friendly Elements
- Water Efficiency
- Waste Management
- Energy Efficiency (Embodied Energy)
- Renewable Energy

Annexure 4.4

List of Participants

Workshop on Awareness on Green Building Responsible Education in Schools (AGBRES 2011) held on 7th September, 2011 At India International Centre, New Delhi.

S. No.	Name	Organisation
1	Sh. Sushant Baliga	(Retired) ADG, CPWD
2	Dr. (Mrs.) Malti Goel	Former Adviser DST
3	Dr. S. N. Maity	CMERI, Durgapur
4	Sh. Deepak Chaudhary	ISRO, Govt. of India
5	Sh. Gautam Mullick	Retired
6	Elodie Maria-Sube	Delegation on the European Union of India
7	Prof. D. P. Aggrawal	Chairman, UPSC
8	Dr. R. K. Khandal	Director, Shriram Institute for Industrial Research
9	Dr. U. K. Niyogi	HOD, Shriram Institute for Industrial Research
10	Dr. Geetha Seshadari	Sr. Scientist Shriram Institute for Industrial Research
11	Ms. Smriti	Shriram Institute for Industrial Research
12	Ms. Gunjan Suri	Shriram Institute for Industrial Research
13	Sh. Bhavesh Swami	Renewable Energy Park, Gurgaon
14	Dr. T. N. Hajela	President CCRS. Alakhnanda
15	Dr. (Mrs) Sushila Singhal	Ex-Prof. J.N.U
16	Dr. S.Z Qasim	A-15 Defense colony
17	Mr. Suresh Goel	Principal Architect
18	Dr. Deependra Prashad	Architect Designer
19	Sh. R.G. Gupta	Ex-Town Planner
20	Dr. V. Pradhan	Delhi Universtiy
21	Mr. Anish Tripathi	Digixl, New Delhi

22	Ms. Neha Tripathi	Research Scholar, SPA
23	Ms. Rita Chaudhary	Director, Green Consultant
24	Ms. Mili Dutta	Ahlcon Public School, Mayur Vihar – I
25	Ms. Anita Kapil	Ahcon Public School, Mayur Vihar – I
26	Ms. Vinita Mathur	St. Thomas' School Mandir Marg
27	Ms. Sabari Sarkar	Universal Public School, Preet Vihar
28	Ms. Ritu Mittal	Universal Public School, Preet Vihar
29	Mrs. Maya Gupta	Ex Principal, Universal Public School, Preet Vihar
30	Mr. M. D. Khera	Senior Architect
31	Mr. Ravi Jain	Senior Architect
32	Ms. Priyanka	Architect student
33	Ms. Sonali	Architect Student
34	Mr. Roushan	Student
35	Mr. Mirtunjay	Junior Architect
36	Mr. Aditya	Junior Architect
37	Mr. Parthimesh	Architect
38	Sh. Sandeep Goel	Chief Architect, (C-85 Shivalik)
39	Ms Promila Ghosh	IIC
39	Mr. Shambhu	Registration
40	Mr. Sanjay Rawat	Registration

Annexure 4.5

India - Building Energy Policies*

Wen Heng, Madelaine Steller Chiang, Ruth A. Shapiro, Mark L. Clifford

Energy is poised to be one of the biggest constraints to India's growth. Problems such as fuel shortages, an increasing dependency on imported oil, and poor financial and technical conditions of the power sector are discouraging growth in India. Against such a background, energy policy in India focuses on 'energy for all' and intends to build an environment-friendly sustainable energy supply industry. With these primary objectives, the planning commission in 2006 unveiled the latest version of India's national energy policy, the Integrated Energy Policy, which is linked with sustainable development. The Integrated Energy Policy covers all source of energy and addresses all aspects of energy use and supply including energy security, access and availability, affordability and pricing, as well as efficiency and environmental concerns. It highlights the following key elements that are needed to achieve the objective of 'energy for all';

- Markets that promote competition;
- Market-oriented energy pricing and allocation under effective and credible regulatory oversight;
- Transparent and targeted subsidies;
- Improved efficiencies across the energy chain;
- Policies that reflect externalities of energy consumption; and
- Policies that rely on viable incentives.

The Integrated Energy Policy expresses concerns over climate change and suggests a number of initiatives that will reduce greenhouse gas emissions:

- Energy efficiency in all sectors:
- Emphasis on mass transport;
- Active policy on renewable energy including bio-fuels and fuel plantations;
- Accelerated development of nuclear and hydro-electricity;
- Technology missions for clean coal technologies; and
- Focused R&D on climate-friendly technologies.

Energy-Efficiency Policies

India's first government initiative towards energy efficiency came when parliament

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passed the Energy Conservation Act in 2001 and established the Bureau of Energy Efficiency (BEE) under the Ministry of Power to implement the Act. According to the Act, The target for energy savings by 2012 is 13 percent of estimated demand. The Act requires large energy consumers to adhere to energy consumption norms, new buildings to follow the Energy Conservation Building Code, and appliances to meet energy-performance standards and to display energy consumption labels.

The Integrated Energy Policy unveiled in 2006 has placed heavy emphasis on energy efficiency and conservation, with particular focus on efficiency of electricity generation, transmission, distribution and end-use. It points out that, over the next 25 years, energy efficiency and conservation will be critical to ensure energy security and economic growth.

The Integrated Energy Policy identified the following 10 leading areas where significant savings can make a substantial impact, half of which related to the building sector:

- Mining;
- Electricity generation, transmission and distribution;
- Water pumping;
- Industrial production, processes, hauling;
- Mass transport;
- Building design;
- Construction;
- Heating, ventilation and air conditioning;
- Lighting; and
- Household appliances.

Building Energy-Efficiency Policies and Initiatives

Building Energy-Efficiency Codes

India has many central and local authorities and bodies that help compile building codes and standards that are applicable at the local and national levels. As of now, there are three different codes/regulations that have been developed by national bodies:

- The Bureau of India Standards, National Building Code (NBC), which covers all aspects of building design and construction;
- The Bureau of Energy Efficiency, Energy Conservation Building Codes (ECBC), which target building energy efficiency; and
- The Ministry of Environment and Forests, Environmental Impact Assessment (EIA) and Clearance.

Among these codes/regulations, the ECBC is expected to have the most significant impact on building energy performance. The Indian government intends to integrate NBC and ECBC in the future.

National Building Code

Building by-laws in India fall under the purview of state governments and vary with administrative regions within the state. However, the central government realized the need to develop a unified building code to reflect the latest trends in construction. The Bureau of Indian Standards developed the National Building Code, or NBC, in the early 1980s as a guiding code for municipalities and development authorities to follow in formulating and adopting building by-laws. The voluntary code is meant to serve as a guide to all governmental and private agencies controlling building activities. It covers most aspects of building design and construction, with a small part dedicated to energy efficiency.

India revised the NBC in 2005. In the latest version, the code provides guidance on aspects of energy conservation and sustainable development in various parts and sections concerning appropriate design, usage and practices with regard to building materials, construction technologies, and building and plumbing services. The document provides general guidance on potential energy-efficiency aspects of such factors as daylight integration, artificial lighting requirements, and select HVAC design norms.

Energy Conservation Building Codes

Energy Conservation Building Codes is the first stand-alone national building energy standard/code, developed after the enactment of the Energy Conservation Act of 2001. It represents India's first effort to manage energy efficiency in buildings. However, ECBC is yet to be formally adopted by authorities.

The ECBC aims to reduce India's baseline energy consumption by supporting adoption and implementation of building energy codes. It takes into account location and occupancy of the building and provides minimum standards for reducing energy demand of the buildings through design and construction practices while enhancing occupants' comfort.

Unlike the NBC, which provides general guidance relative to energy without setting any limits, the ECBC lists specific maximum and minimum limitations on a number of key building features that affect building energy use. The ECBC is mandatory for large commercial buildings and applicable to all buildings with a large air-conditioned floor area. The code is recommended for all other buildings.

ECBC has both prescriptive and performance-based compliance paths. The prescriptive path calls for adoption of minimum requirements for the building envelope and energy systems (lighting, HVAC, service water heating and electrical). The performance-based compliance path requires the application of Whole Building Simulation Approach to prove efficiency over base building as define by the code. There is also a system-level performance compliance option for the building envelope. This leaves the code inherently flexible and easy to adopt.

The Bureau of Energy Efficiency is the primary body responsible for implementing the ECBC; it works towards policy formulation as well as technical support for the development of the codes and standards and their supporting compliance tools, procedures, and forms. In developing the ECBC, the bureau has orchestrated a diverse group of in-country and international technical experts. It is also working closely with national and state-level government entities to administer and enforce the ECBE and other energy-related codes and standards.

Environmental Impact Assessment and Clearance

The Environment Impact Assessment (EIA) is an important management tool for ensuring optimal use of natural resources for sustainable development. EIA was made mandatory in India under the Environmental Protection Act (1986) for 29 categories of developmental activities involving investments of Rs. 50 crore (US$11.6 million) and above. Builders and developers must receive environmental clearance from the Ministry of Environment and Forests before beginning construction. The requirement for building energy performance in the EIA is a combination of related terms in NBC and ECBC.

Council interviews with builders and developers in India for this study show that environmental clearance leads to additional delays as the clearance process is very time and resource consuming. Also, due to the absence of normative guidelines, builders and developers are often left unsure of the options that they have adopt in their projects to make the projects environmentally sensitive.

Implementation of above codes/regulations

Building energy codes and regulations in India are still far from being well implemented. In fact, ECBC has still not been formally adopted. Effective implementation of the code is hindered by such factors as:

- Lack of a uniform and practicable energy codes;
- No clear implementation guidelines;
- No effective local implementation infrastructure for code administration and enforcement including code-checking and inspections;
- Lack of incentives from the government;

- Lack of appropriate building materials and equipment to meet requirement of codes.

Some progressive state governments have taken initiatives to legislate select measures (e.g., use of solar water heating in residential/ commercial buildings, or the use of compact florescent lamps in public buildings), but these initiatives are too few in number to be able to make a significant impact on the country's overall energy efficiency.

Appliance/Equipment Labeling and Standards

The Bureau of Energy Efficiency's standards and labeling program, currently under development, aims to ensure the availability only of energy-efficient equipment and appliances. Until now, this program covered just nine types of equipment/appliances for labeling and three types for minimum performance standards. It is a voluntary scheme and offers no direct financial incentive for industry to participate.

Other Initiatives

Green Building Standard and Certification System

Industry associations and private companies have played an important role in promoting the green building movement in India. The Indian Green Building Council (IGBC), founded by the collaboration between the Confederation of Indian Industry (CII) and the private manufacturer Godrej, has taken steps to promote the green building concept in India. Currently, IGBC is facilitating the LEED rating of the U.S. Green Building Council in India. There are about five buildings that have been rated and 25 projects are registered for rating under the LEED system. The IGBC headquarters building (see Part II) in Hyderabad was the first platinum-rated building outside of the U.S., and has generated considerable public awareness of green building.

The LEED rating system was developed around the premise that buildings are air-conditioned, whereas in India, a large number of buildings built to date are not air-conditioned or partially air-conditioned. To bridge the demand for a rating system for non-air-conditioned buildings while taking into account the possibility of a partially air conditioning building, the Energy and Resource institute (TERI) has developed its own system known as GRIHA (Green Rating for Integrated Habitat Assessment) for the new large energy-consuming segment, i.e. commercial, institutional and residential buildings (new construction). This system responds specifically to India's prioritized national concerns about extreme resource crunches in the power and water sector and rapidly eroding biodiversity. It attempts to stress passive solar techniques for optimizing indoor visual and thermal comfort and relies on refrigeration-based air conditioning systems only in cases of extreme discomfort. These are eight registered projects under GRIHA that are under construction. TERI is in the course of developing a similar standard to address the needs of other building typologies such as existing buildings.

Planned National Green Building Rating System

Now, in consultation with experts from various related fields in India, the Ministry of New and Renewable Energy Sources (MN&RE) is planning to develop a national rating system for green buildings. This system will be voluntary, to adopted by builders and individuals alike. The MN&RE hopes to develop an incentive mechanism for this rating system.

Planning Energy Audit Program

The Bureau of Energy Efficiency has planned to mandate energy audits (2007) for all existing commercial buildings above a certain threshold of connected load; it would also develop mechanisms to ensure that the recommendations of the audit are implemented within a stipulated timeframe. There would thus be a large demand for energy service companies (ESCOs), and those establishing themselves more quickly would reap maximum benefits of the mandate.

Demand-Side Management (DSM) Program

It would be fair to say that demand-side management is viewed by the government as the primary strategy for energy conservation in residential buildings. Studies show that implementation of demand-side management options to reduce demand for electricity through energy-efficient processes, equipment, lighting and buildings can help reduce the demand by an estimated 15 percent by 2032 in India. In September 2002, five states in India established demand-side management cells at utilities, and Karnataka and Maharashtra designed pilot projects. Through 2002-03, MEDA (Maharashtra Energy Development Agency) and BESCOM (Bangalore Electricity Supply Company) initiated and completed capacity-building exercises. Since then, additional capacity-building exercises for the electric utility regulators, as well as the preparation of investment-grade feasibility reports for implementing demand-side management projects, have been under way.

Renewable Energy Sources in Buildings

India is the only country that has separate government ministry exclusively for non-conventional energy sources, the MN&RE, and it has one of the largest national programs to promote the use of solar energy. MN&RE has initiated several programs focusing on utilization of renewable energy sources in buildings. For example, the solar buildings program disseminates information and provides financial support for the design and construction of energy-efficient and passive solar buildings. Solar buildings have been attempted in a few states. The government of Himachal Pradesh has made it mandatory to construct all its future buildings using passive design features.

Information Distribution

The Bureau of Energy Efficiency web site is a comprehensive information sources for energy conservation-related developments and issues. It provides an update on the related policy framework, especially in the context of EC Act 2001, as well as topical write-ups, news and highlights on India's progress with energy efficiency.

Case Study - CII-Godrej Green Business Centre Building

The CII-Godrej Green Business Centre (CII-Godrej GBC) Building is the office of CII-Godrej GBC, a joint initiative of the government of Andhra Pradesh, Confederation of India Industry (CII) and Godrej, with the technical support of USAID; it is a unique model of a successful public-private partnership that is dedicated to promote efficiency and equitable growth leading to sustainable development.

The building is the first green building in India. It is the first LEED Platinum-rated building out side the US, and was the most energy efficient building in the world at the time it was rated. It was built to promote the green building concept and demonstrate that India can build to global environmental standards. The building incorporated such features as water efficiency, energy efficiency and construction waste recycling. According to CII-Godrej GBC, the building is capable of reducing its total energy consumption by 55 percent and its lighting energy consumption by 88 percent.

The building is centered on a circular courtyard, with a series of smaller interior courtyards. Energy-efficiency features of this building include:

- North light for indoor day lighting: Almost 90 percent of the interiors are day-lit, with north lighting and windows facing onto the courtyards. (The site uses north light to minimize heat gain in its tropical location.)
- Wind towers integrated with HVAC: The wind tower is a traditional passive cooling technique of the sub-continent. Here, it has been combined with the HVAC system to reduce energy consumption. The fresh air that goes in the Air Handling Unit (AHU) is pre-cooled in the wind tower, reducing the intake air temperature by three to five degrees Celsius. The wind tower itself is made of hollow masonry, and acts as a thermal mass. It is cooled periodically by trickling water from the top of the tower.
- Solar energy photovoltaic panels: Photovoltaic panels installed on part of the roof provide about 20 percent of total energy consumption, with the roof orientation and inclination designed to maximize the solar panel's efficiency.
- Roof garden insulation: A roof garden prevents formation of heat islands on the roof and acts as insulation, while providing an aesthetic benefit at the same time.

The features incorporated in the building drew high praise from the president of India as noteworthy steps towards energy efficiency, renewable energy and water management. The Platinum rating for this building has garnered attention, particularly in the construction industry, and generated considerable public awareness about green buildings in India.