3rd Workshop

Awareness in Green Building Responsible Education in Schools

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Proceedings

Workshop Theme - Green Buildings and Smart Cities

Editor

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Workshop on
Capacity Building
and Smart Cities

3rd Workshop on

Awareness in Green Building Responsible Education

AGBRES III

India International Centre, January 31, 2014

PROCEEDINGS

Green Buildings and Smart Cities

PREFACE

Smart Building, Smart Grids *and* ***Smart Cities*** *are currently 'buzz' terms for sustainable urban growth and development. Smart building is now termed as Green Building, which according to Ministry of New and Renewable Energy (MNRE) is 'a building which can function using an optimum amount of energy, consume less water, conserve natural resources, generate less waste and create spaces for healthy and comfortable living, as compared to conventional buildings'. Smart city is one which has increasing use of renewable energy, integrated energy management, water & waste management networks and offers an opportunity to develop cities neat and clean with e-governance.*

Climate Change Research Institute (CCRI) organized the third workshop on Awareness in Green Buildings and Responsible Education in Schools (AGBRES II) at the India International Centre, New Delhi on 31st January 2014. This workshop theme was on ***Green Buildings and Smart Cities.*** *At the CCRI, we feel proud that Shri Gireesh Pradhan, Chairman, Central Electricity Regulatory Commission (CERC) could make it to the workshop in spite of his very busy schedule. I am personally indebted to our Chief Guest for his inspiring address. I convey my sincere thanks to the eminent Panelists and distinguished participants. I am thankful to Dr A. K. Tripathi, Director MNRE, Prof A. K. Maitra and Shri R. G. Gupta for sharing their experiences and thoughtful insights.*

I thank Prof Mahavir, Head, Environment Planning, SPA for chairing very lively Technical Session. Presentations were made by Mr. Karan Mangotra, UNDP; Dr. Kakoli Saha, School of Planning & Architecture-Bhopal; Dr. Sudhakar Sundaray, TERI and and myself. My thanks are due to Ministry of New and Renewable Energy and our joint partner India International Centre for support. We thank Ms. Premola Ghose, Chief Programme Officer, for providing the platform and IIC for excellent facilities for the workshop.

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Workshop on Green Buildings and Smart Cities - Awareness in Green Buildings and Responsible Education in Schools: (AGBRES III) held
31st January, 2014 at Seminar II, India International Centre, New Delhi

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EXECUTIVE SUMMARY

''The deliberations at the green building and smart city workshop evolved around the need to create awareness about these emerging topics in the context of climate change and expose the participants to key issues that could lead to sustainable future.'

Although Green Buildings are much talked about for past two decades, general awareness in India about the need for it and how to go about constructing a green building is missing. Even those in-charge of such projects fail to understand the critical role of information & communication technologies for achieving the success in the long run. 'Smart Cities' is another 'buzz' word in the urban growth and offer an opportunity to develop cities neat and clean with e-governance.

In an attempt to turn the spotlight on these recent developments emerging fast on economic scene in India Climate Change Research Institute jointly with India International Centre organized a workshop on 'Green Buildings and Smart Cities' on January 31st, 2014. India has immediate plans to develop seven 'Smart Cities' along the Delhi-Mumbai-Industrial-Corridor (DMIC) for freight transport; and in the medium term each State is expected to have at least one 'Smart City'. The workshop is supported by Ministry of New and Renewable Energy (MNRE).

Shri Gireesh Pradhan, Chairman, Central Electricity Regulatory Commission and former Secretary, Ministry of New and Renewable Energy inaugurated the workshop. The Chief Guest in his Inaugural address said that urbanization in our country is taking place at a very rapid pace. By 2050, more than 60% of our population will be in cities. He encouraged the youth present from architectural colleges to look for out-of-the box solutions to address concerns in Indian cities. These may not look glamorous to them, but there are enormous challenges which software engineers and urban planners will have to solve.

Shi Pradhan said that as future planners, a holistic look at use of energy, energy efficiency, water conservation, waste management and transportation etc. can only create sustainable urban environment. It is estimated that 68% of the GDP of the world will come from 600 cities. Much can be done in terms of using renewable forms of energy in the building related activities. Although one of the most critical issues we are facing today is that of integration of renewable energy with the present day grid, there is

a great hope in future for rooftop solar power generation feeding into power grids under the Jawaharlal Nehru National Solar Mission programme of MNRE.

Dr. Malti Goel said Climate Change Research Institute has taken upon itself to organize awareness workshops for students on key topics in Energy and Climate Change. On Green Buildings, it is the third workshop in the series. Introducing the theme of the workshop she said that we have to find solutions for Green Buildings and Smart Cities having similar concerns. These are; (i) Energy and fuel saving - both have to save fuel through improving energy efficiency and maximizing use of renewable energy (ii) Information technology - its use is very important to green buildings as well as smart cities for finding solutions. (iii) Improving quality of life - we want to have good cities and good houses; both are linked with human comfort and are addressing environmental challenges. We need efficient services for electricity and water, transport systems which are sustainable and efficient, buildings with sensors to control energy consumption, and service networks managed in a smarter way. It is futuristic, but planners look for long-term perspectives and smart cities are just that.

Dr. Arun K. Tripathi, Director, MNRE in his address said that India has installed capacity of 2,30,000 MW and the share of renewable sources in 30,000 MW, which is more than 13% of total capacity. Our target is to reach 20% share by 2022. Green building GRIHA rating was developed by TERI and MNRE in 2009 and already 425 buildings are already registered. Paryavaran Bhavan newly constructed building has been designed as net zero emission building and it has around one megawatt solar PV installations. He said that to achieve sustainability in building sector, there is need for change of mind set of builders and one needs to be technology savvy. Smart cities are 'to be dealt in a very planned and in a very enthusiastic manner through large scale application of renewable energy. Problems are faced in cities due to increasing migration, increasing load to basic amenities and builders' attitude'. Jawaharlal Nehru Urban & Rural Mission Phase II is targeting solar cities. To enhance contribution of solar energy in 60 cities across the country MNRE is in the process of preparing their integrated solar master plans. He emphasized on the role of changing mind sets and concern about the surroundings.

"We have one existing smart building in Delhi, the Indian Oil Corporation building and they have got solar panels all around the building and you don't even notice them" said Prof. A.K. Maitra, former Director, School of Planning & Architecture. He said that India would need 3000 new towns of at least one lakh population in the next 20-25 years and these can be designed as green cities. In big cities like Delhi we have faced many challenges of juggi clusters and slum areas, said Shri R.G. Gupta, Ex-additional Commissioner, DDA. According to him, Delhi has 369 urban and rural villages, about 500

unauthorized residential colonies and 1600 unauthorized industrial colonies. With so many unauthorized clusters and over 100 thousand commercial areas with unauthorized parking, there are the practical problems in Delhi and smart city development is very challenging when growth is unplanned.

Prof Mahavir, Head, Environment Planning, SPA chaired the Technical Session. Panelists included from UNDP, TERI, SPA (Bhopal). Solar cities and Innovations (Dr. Malti Goel); What about Smart City and Green Buildings (Mr. Karan Mangotra); Use of information technology in assessing the solar potential of a region in Bhopal city (Dr. Kakoli Saha) and Solar rooftop programme of TERI (Dr. Sudhakar Sundaray) were the topics discussed. It emerged that certain regulations in municipalities for green buildings and for the success of solar rooftop integration into grids can accelerate the process of transformation in urban development to address environmental challenges.

The workshop was special in a way that school teachers, students and practitioners attended. Architectural fraternity, teachers, students from Universal Public School as well as youth from various universities actively participated

RECOMMENDATIONS

1. Green buildings are something which is not very difficult to make. It may add around 10 to 15 percent to the cost of the building. But if we compare that to the overall cost of electricity that will be saved for a long period of time, it is an expenditure which is worth making. In multi storey apartment buildings, innovative green building techniques can be used. Design principles may be different, but there will be enormous savings. Information technology has a big role to play.

2. India would need about 3000 new towns of about one lakh population each in the next 20-25 years. Now these can all be designed as Smart Cities. We can also retrofit the existing cities, wherever it is possible. In another 40 years time, 68% of the GDP of the world will come only from 600 cities. In the Indian context 750-800 million people are going to stay in cities. It will be a huge problem and would require some really fundamentally out of the box thinking. No solution is too small. Some of our greatest benefits have come out of very small solutions. Youth should not look only at the glamour part of solar energy or green buildings from a western perspective.

3. We have to build 75%-80% of our infrastructure yet. If we put in place which is on a sustainable path, the benefits of that will be enormous. Concept of water management, energy management, waste management will form the core of anything smart whether it's a city, whether it's a building, whether it's a colony or a city. The concept and the

word ‘smart’ will come into play in the urban context, only if three things, water, waste and energy are managed well. Future planning which doesn’t take into consideration of these three basic elements is not going to succeed.

4. Under green building program, MNRE is trying to motivate the architects and builders through awards and incentives. Basically, builders are responsible for the construction. The buildings having minimum solar lighting system, waste management, producing biogas can be termed as Green. There is misconception about their high cost. But, the lifetime cost analysis has proven that in the long run it is economical.

5. Many planning measures have been taken but there are neither approachable to the public nor benefitted the public at large. Urban planning should be taught to everyone. Today we are facing biggest problem in the country of lack of social education. This workshop is a good initiative to create awareness among youth. More such workshops should be planned. For those in schools, the workshop would sensitize them to choose science as future career.

INAUGURAL SESSION

Workshop on Green Buildings and Smart Cities Awareness in Green Buildings and Responsible Education in Schools: (AGBRES III)

WELCOME

Dr. (Mrs.) Malti Goel, executive Director, Climate Change Research Institute

1. Good morning to you all! Our Chief Guest Shri Gireesh Pradhan, Chairman, Central Electricity Regulatory Commission has been on the helm of affairs in power sector and former Secretary, Ministry of New and Renewable Energy (MNRE). He is held up in another seminar and would be joining shortly. I extend warm welcome to Dr. Arun K. Tripathi, Director, MNRE, Shri R.G. Gupta, Ex-additional Commissioner, Delhi Development Authority and city planner and Professor A.K. Maitra, Former Director, School of Planning & Architecture and esteemed panelists and delegates present.

2. The workshop theme is **Green Buildings and Smart Cities**. It is an interdisciplinary subject. In the 21st century, 'Smart' is a 'buzz word' 'Smart phones', 'Smart cars', 'Smart gadgets', 'Smart cities'. To connect solar energy to our homes, we need Smart grid. Although Smart cities are futuristic, but everyone wants to be a part of it. 'Smart' is two way communication between man & machine and machine & machine.

3. The theme of the workshop is 'Green Buildings and Smart Cities'. Smart cities and green buildings have some similarities. Both are **energy and fuel saving** because resources are depleting. Then second thing which is common is 'Information Technology'. Role of information technology is very important for green buildings as well as for smart cities. And the third, their ultimate goal **'improving the quality of life'.** We want to have good cities and we want to have good buildings, good houses. Both are connected with the Human Comfort. Environmental challenges are to be addressed, pollution is to be reduced and development has to be towards sustainability. Sustainability is a key word in 21st century.

4. As a followup of 1972 Global Summit on Environment and Development 'our common future' report defines Sustainable Development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs.' In 1992, UN Earth Summit was held in Rio de Janeiro, Brazil. In this Summit need for awareness about global warming and climate change was highlighted. Agenda 21 was proposed to address the environmental challenges as an action plan in every sector of economy. Differentiated responsibilities were considered important in the implementation and the role of developing countries because of their large population. More than 170 countries participated in the Summit. UN Framework Convention on Climate Change was introduced. As on today, 193 nations have signed it.

5. International Greenhouse Gas Technology Information Exchange started soon after by International Energy Agency to take technology actions for mitigation of climate change. The aim was sharing of greenhouse gas technology informations. I recall as first Country Officer from India in one of the meeting, it was decided to collate information about existing Green Buildings, which were then called 'intelligent buildings'. I searched whether India has such buildings. I could locate one in Bangalore as intelligent building and projected this in international forum. Later the term Green building was coined and building were expected to be rated green under some measurable parameters. Initially LEED rating was introduced in India and buildings were given Gold, Platinum and Silver ratings. Now we have a GRIHA rating. LEED ratings were applied to only commercial buildings but GRIHA rating is for all type of buildings. GRIHA is been devised by Ministry of New and Renewable Energy (MNRE). The MNRE gives incentives to owners, and to the architects are given. So many office complexes are now becoming green.

6. Why 'Smart Cities'? Does India have any smar city? As planner, one always look for long-term perspectives. Smart cities offer that and have have long-term perspective. In India, seven smart cities are planned along the Delhi-Mumbai Industrial Corridor (DMIC). Ministry of Urban Development has announced recently that in each state of India, there will be one smart city under Jawaharlal Nehru Rural and Urban Mission. India is on the track for making smart cities.

7. The Climate Change Research Institute has taken upon itself to organize awareness workshops for youth on sustainability issues in Energy and Climate Change. On Green buildings, it is the third workshop in the series.

ADDRESS

Shri R.G. Gupta, Ex-Additional Commissioner, DDA and City Planner

1. I was in DDA 20 years back. I will talk about India. India has maximum population after China, near about 120 crores. There are thousands of cities, may be 6000- 7000 and 6 to 7 lakhs rural settlements. There is not a single smart city yet. In Delhi there are 13 minor points or problems, which we are not able to solve. The worst point is *jhuggi clusters*. In 1976-77, DDA shifted 1.48 lakh families from jhuggis to resettlement colonies. Big achievement of DDA, people came from different countries and praised us. These resettlement colonies were provided plots of 21 square meters for single storey. Now they have gone two storeys, three storeys. We have provided only for living, they have gone to commercial gain. As a result, these have become the worst colonies. How can there be smart city? We have given them free; they have sold it high cost.

2. Second is, *slum areas*. In 1956, we prepared Slum Act. Under this many areas, inside the wall city of Delhi were identified slums. There were facing many problems, water pollution, air pollution, noise pollution, soil pollution. Slum areas are not having proper living conditions, but no body is able to solve their problem. The Act is not followed. Third point is villages. There are 369 urban and rural villages. In 1910, the Britishers have put a red line, we call it Laal Dora i.e., you don't disturb anybody within Laal Dora. In 1977, government ordered, these should be regularized within Laal Dora, outside Laal Dora. But it does not work anymore, it has become two times, three times, ten times.

3. Delhi is densely populated city with a population approaching 40 lakhs. It ha maximum density in the capital cities of the world. I would pose a question again. How many unauthorized / regularized residential colonies are there? About 500

unauthorized residential colonies and 1600 unauthorized industrial colonies in Delhi. One can't move in these colonies. In addition there are hundreds or thousands unauthorized commercial areas having serious parking problems. In Delhi, good number of peoples have two cars. Where to park them? Huge traffic on the road junctions, vehicles don't move, people can't move. Religious places are built, anywhere. I don't think Delhi can anytime be a smart city. Green building will perhaps be there.

4. I may add in the building sector also, too many problems are being faced. Multi storied buildings are coming up without taking care of load on infrastructure in terms of water, sewage, drainage, power etc. First Master Plan for Delhi was prepared wayback in 1870. Second Plan came in 1956-1960 after independence. Then 1961, 1962, then in 1980 and 1985. So many planning measures but these are but not approachable to the public at large. This subject should be taught to everyone. May be in the courses, may be like this awareness workshop. Today we are facing biggest problem in the country of lack of social education.

Thank you. I'll be happy to answer some questions.

BRIEF ADDRESS

Prof. A.K. Maitra, Former Director, School of Planning & Architecture

1. I shall begin with Smart Cities first. We like to be smart in performance and smart in all kinds of things, but smart city is something where things get done without you being too much bothered about it. Smart cities and smart buildings are need of the day. A few years ago I saw headquarters of the Vivarian Electricity Supply Corporation in Germany. Beautiful building, completely glass, with glass ceilings and with quite a lot of land around it. I said, 'my god', this building must be energy guzzler, because everything is made of glass. In this cold climate, it could be really bad.

2. The Chairman of the Corporation then explained that in this building they did not consume even one watt of electricity. They produced all their electricity by the building itself. The building also produces hot water. It gives us everything and it is a completely Smart Building. Building closes down, as the last person goes out. When one goes out of the room, the supply of electricity gets cut. Roof is made completely of solar cells and is giving all the electricity. The toilets waste is converted into gas. The little bit of gas is used in the kitchen, rest is producing electricity. Even system of hot water is perfect. Hot water is stored during the summer and released during the winter to give heating to the building. Only rarely grid electricity is used. There are times when it snows so heavily that it cannot manage its energy. It may be one month maximum when electricity is consumed from the grid.

3. As many of you would know we also have one Smart Building, the Indian Oil Corporation building on Chirag Dilli Road. It's a completely smart, oneu cannot get into the building unless one has digital pass. The door will not open. It has solar panels all around the building and they are so well done that one doesn't notice them. The

roof is also solar roof. Building is completely smart and consumes very little electricity whenever it is necessary. It was actually built at the time, when solar cells were quite expensive. In a recent In the School of Planning and Architecture we had a seminar on green buildings and some of the experts from the field pointed out that the price of solar electricity has come down and it is almost compatible with the grid electricity. But these panels are being imported from China. I do not know why India can not produce or manufacture them.

4. Our ancient buildings have always been green. While I was in the Architecture Department in the School of Planning and Architecture, an experiment was carried out in a village in Haryana in collaboration of London University. Maximum temperature was measured, but unfortunately, temperature variations during the day could not recorded not the variations. What we found was that the buildings of that village were 5 degrees cooler than the surroundings. Fans were not needed, the building construction was such that inside the building it was quite comfortable.

5. In another example, Indian Institute of Technology Delhi had conducted a temperature survey around Nai Sadak in 1980s. Again we found that temperature was 5 degrees cooler than outside. Last year the same survey was repeated. This time it was found to be 5 degrees higher than the surroundings. Why? Construction density has increased and all the buildings in the vicinity are using air conditioners. They are throwing the heat out and due to lack of ventilation, temperature has gone up.

6. As I said before green buildings are something which is not very difficult to make. While it may around 10- 15 percent to the cost of the building. It comes out much less compared to the overall cost of electricity that will be saved over its life time. It is an expenditure which is worth making. In multi storey apartment buildings also, green building techniques can be used. Design principles may be different, but there will be enormous saving. On the Smart Cities I may add that by a conservative estimate, India would need about 3000 new towns of at least one lakh population each in the next 20-25 years. Now these can all be designed as Smart Cities. We can also retrofit the existing cities, wherever it is possible.

Thank you.

KEYNOTE ADDRESS

Dr. Arun K. Tripathi, Director, Ministry of New and Renewable Energy, Government of India

1. A very good morning to all of you! Prof. A. K. Maitra, Dr. Malti Goel and all the distinguished participants in this workshop. What we heard from Shri R.G. Gupta about the situation in major urban centre like Delhi, it is a reality, we are facing today. I perceive that we have forgotten the views of Gandhi jee. When our country got independence, he gave a suggestion that if you really want to develop India, you should develop the rural India first. We are doing the opposite and that is causing rural-urban migration. Every city in our country is facing this kind of load on basic infrastructure. There is no planning for them in the cities and they are forced to live and make slums.

2. Coming to the Smart cities, now we have to have the smart cities, smart buildings and smart everything. Smart city is a city which responds to your problems. That means you are facing a problem, it responds to that, it rectifies that, in a very simple way is a Smart city. We expect whole thing o be mechanized. Every smartness costs. For example, in mechanized car parking, we look for a solution, bear the cost but find that it is ultimately not a solution. Because if plan for 1100 cars, next day there are 2200 cars to be parked. It takes huge amounts of electricity. huge amount of other resources, but does not become the ultimate solution. The planners have to consider these issues. Until we address them, we cannot become 'Smart'; we cannot even become a very normal city. But we have hope.

3. Re-development is one of the options. Things are to be dealt in a very planned and in a very enthusiastic manner. The public is equally responsible for the chaos. The green buildings are not something new as Prof. A.K. Maitra has just said, earlier we used to

have green buildings. A Green building utilizes the maximum natural resources. It makes use of maximum sunlight to reduce lightening load and utilizes minimum or maximum heat of the sun depending upon the season. It conserves the external conventional energy use in the building by way of its various features.

4. First feature is building design, building orientation. The second is energy efficiency measures taken, like green building materials used. Green building material means are the material which has been produced using less embodied energy compared to the normal building materials. Then the water recycling and water saving measures are adopted by recycling the water for non-potable uses in the toilets and other places. Green building has its own waste management and even produces some energy from the waste. Near zero building is the building which is using as less as possible the conventional energy. It calls for the architects and engineers to make proper design, using materials and techniques to make it as green as possible.

5. India has installed capacity of approx, 2,30,000 megawatt from all the resources. Yet, we are really a power deficit country. Renewables have 30,000 megawatt share, which is 13% of total electricity installed and 6% of electricity produced. That means some of the electricity we are using here is renewable electricity. From wind, from solar, from biomass and so many other resources. Our target is to reach 20% from renewables by 2022.

6. As far as green building status in our country is concerned, we started our programme in the Ministry sometimes in 1993 on solar passive architecture based building designs and supported trainings. Some unique designs were made by the known engineering colleges and our Ministry supported them. Thereafter commercially a rating system started around 2001 as LEED India, based on LEED US rating system. This was created by Indian Green Building Council. They adapted to those norms, indigenized and developed into our Indian conditions and started rating the commercial buildings. Green ratings were also developed for the small buildings as well as for the big buildings, for the campuses, for the commercial buildings, for the shopping malls etc. Now there is a big compendium of all these rating systems.

7. Around 2008, TERI has developed a system called GRIHA rating. Our Ministry was part of that and also provided support in developing the rating system and its implementation in Indian buildings. Around 425 buildings have been registered for the GRIHA rating so far. Through these initiatives, people are voluntarily coming for having their building rated, because it means is a direct saving for their electricity. A solar plant if we install at our house, it has a payback period of five to six years

without any subsidy. Twenty five years is the life of solar panels therefore for the next twenty years or so one does not need to pay for that much electricity.

8. The MNRE has started a program of grid connected rooftops. Earlier solar panels used to have battery systems to store and use it in the night. Such system holds good for those areas where grid is either not available or the supply is not there. But in cities like in Delhi, electricity availability is high. In that case, the grid connected rooftops would mean that a plant of 2 kilowatt on rooftop, daytime requirement of electricity can be met from this. All the electrical appliances, including fridge, cooler, lighting system etc., except air-conditioners can run through a one or two kilowatt plant. It's a good proposition for houses as they can have the solar panel connected to their existing inverter mechanism. There are retrofitting chargers available in the market. They can be retrofitted in houses. Electronic chargers cost around 1000 or 1500 rupees.

9. I would suggest that you should install the panel and become a power producer in your house. Over and above, the Government of India is providing 30% incentives right now. It is being provided to make solar energy economically sustainable and to make it user's friendly so that one can adopt it. If one lakh families in Delhi adopt it would mean 1 lakh kilowatt conventional electricity is saved. The electricity saved can be then diverted to rural areas or for other fruitful purposes. At the same time, it is a commercially viable proposition. If we do the economic analysis of cars, which is one of the most uneconomical instruments we have, we find that the moment a car is bought, its price goes down. It has very high depreciation. That investment if used on solar panels can reap rich benefits.

10. Use of energy efficient lighting systems like CFLs, T5 tube lights, energy efficient fans etc. is another preferred option. All these can reduce consumption. In the offices, maximum electricity is required during the daytime, but Saturdays and Sundays no electricity is needed. Many big commercial buildings and office buildings are coming up with solar rooftops, Paryavaran Building next to Jor Bagh Metro Station has around 1 megawatt solar installation. It is a Net Zero building. It is going to produce electricity for use on week days and feed it to the grid during Saturdays and Sundays. Net Zero building means, in 365 days energy fed to the grid balances the energy consumed by the building. How much energy a building consumes and how much energy it has fed to the grid is important. I feel the role of architects to let the people know about these things and the builders is very important.

11. Under green building program, we are also trying to motivate the architects and builders through awards and incentives. Basically, builders are responsible for the construction. In informal meetings, I found that some prominent builders have misconceptions about green buildings and assumed that plantation is enough for a Green township. We have to explain to them that buildings having solar lighting system, waste management, producing biogas can be termed as Green. The other misconception is about their high cost. But, the lifetime cost analysis has proven that in the long run it is economical.

Thank you very much! If anything you would like to discuss, I shall be very happy to do it.

INAUGURAL ADDRESS BY CHIEF GUEST

Shri Gireesh Pradhan, Chairman, Central Electricity Regulatory Commission & Former Secretary, Ministry of New and Renewable Energy

1 I complement the organizers for a very timely workshop on a crucial subject, Integration of renewable energy with present day grid for sustainable growth, is a major issue today. In sustainable development, renewable energy plays a vital role in changing the balance in power sector. In this connection, there are two extreme positions, which country experts take; one is that any infusion of renewable energy has a very detrimental effect and impact on the grid. Grid faces lot of jerks due to its intermittent nature of renewable energy. Others feel that preference be given to encouragement to grid connectivity for achieving sustainable development goals.

2. I feel that today's deliberations on Green Buildings and Smart Cities concern both and it is crucial that the young people of today are aware of how much can be done in terms of using renewable forms of energy as well as by energy efficiency in all the construction and other urban activities. Urbanization in our country is taking place at a very rapid pace. It is likely that in the next thirty to thirty five years by 2050, the larger proportion of our population will be in cities. Massive problems on various elements like waste management, energy management, transportation and in terms of water management would be created by this transition.

3. I am sure many of the young friends from the architecture side will have to look at issues related to spaces constraints in the future urban planning. To be able to create a sustainable environment in terms of competing area requirements for transportation; water management; energy efficiency; use of energy etc. a holistically look would be needed. But in the short-term or in the immediate context, there are several actions. First we are concerned with the use of water and conserving water. In Delhi city, water conservation and water

replenishment as a statutory requirement has been enforced for anybody who is building a house. Chennai city has set another unique example in water conservation and harvesting of rain water. The efforts are pursued vigorously in storing whatever water is available and utilizing run-off water.

4. The second issue is about energy conservation and energy efficiency. Maximizing the efficiency of a particular building under construction is one of the basic tenet of green building strategy. For a new house it's relatively easier. One needs to plan for electrical gadgets and lighting solutions, which are efficient and use less energy. The way electrical wiring system is planned is also important. Use of LEDs is something that needs to be looked right from the beginning. LEDs though an expensive alternative, pay for itself not only in the long run, but in the medium run. These should be integrated with the way the building sitting is done by architects. The siting of the building is very important so that maximum light in the building is natural.

5. Energy for cooling of houses is the major consideration in view of Indian climate conditions. I am sure that energy efficiency bureau can tell about various methods by which cooling energy can be reduced. Even solar panels can be used to cool the building. There can be lot of other things for example; use of solar water heaters which can sustain hot water supply can be used. All new buildings in Bangalore and Pune have to necessarily, compulsorily have solar water heaters.

6. Another important dimension is use of solar panels on the rooftop where the roofs are big. Solar panels can be used to offset some dedicated load of the building. In a medium size house, it's quite possible to have lighting requirements totally linked to solar panels. Recently, I came to know that a reputed firm has launched use of solar panels to charge inverters. Inverter is very inefficient way of using grid power for storage because the leakage as well as the wastage and use for charging your inverter, is really criminal. If this can completely by met by solar panels DC supply, it will save enormous energy.

7. The program launched by the Ministry of New and Renewable Energy in some of the cities to make them solar cities is in its infancy, but I have great hope in future with roof top solar power generation feeding into the power grids in these cities. One would get paid for whatever is being generated out of the rooftop and fed to grid. Some of the regulations on this front have already been introduced by the Central Electricity Regulatory Commission. State regulators have to also participate and implement these on large scale.

8. Apart from the large grid integrated solar projects which are coming up in Rajasthan, Gujarat, Maharashtra and other states, use of solar energy in buildings is one of the areas about which I am passionate. I am building my own house and the terrace would have provision for putting solar panels. I would like to share with you, especially young children from schools is that in a convocation address delivered at Indian Institute of Technology Mumbai I asked, why do you think that solutions which are affecting the common man are not glamorous enough to work on? Why is if that most of our IITs, brightest people work on things which have relevance on an international context? The best and the brightest of our young go to IITs and work hard towards getting a degree and address the problems which not connected with the ground reality.

9. I give you an example. Almost 37 years ago, when I was an IAS officer who had just joined, one of my friends, at that time from the Ministry (then called Alternative Sources of Energy) came with a shiny box and pulled it open and said, 'have a look at this'. It was a solar cooker. It was unwieldy big thing with lot of mirrors around. I was impressed. Two or three years ago when I became Secretary, MNRE I saw a solar cooker again, I found that there was not much change in the design, nothing much had changed. I would think that there should have been much more research on the solar cooker in forty years to make it more user's friendly. Shouldn't our best and brightest minds have looked at this problem?

10. We should be capable of thinking out-of-the-box. No solution is too small. Some of our greatest benefits have come out of very small solutions. A solar cooker could make a revolution if you come up with a design which is feasible, which is usable and which is cost effective. Imagine the kind of change it would bring in the lives of people. Youth should not only look at the glamour part of solar energy or green buildings from a western perspective. There are issues which we are facing on a day to day basis, which you as the best and the brightest could possibly solve.

11. I am sure in both the green building and urban planning in terms of smart cities, youngsters thinking of those problems will come up with solutions which will be long-term and which will be really sustainable. We have to build 75%-80% of our infrastructure yet. If we put in place which is on a sustainable path, the benefits of that will be enormous. They will benefit you, they will benefit the coming generations. In terms of smart cities, lot is to be done. Water is one of the most severely impacted essential goods that you are already facing and are going to face even more. Water conservation could be severe in terms of levels of urbanization we expect. Concept of

water management, energy management, waste management will form the core of anything smart whether it's a city, whether it's a building, whether it's a colony. The concept and the word 'smart' will come into play in the urban context, only if three things, water, waste and energy are managed well. Future planning which doesn't take into consideration of these three basic elements is not going to succeed.

12. In urban energy, transportation is included because it consumes significant energy. Today, urban transportation is a major issue. Land is another concern. The pressure on the land is increasing and multi storey is going to be solution. I am flagging this issue for my young friends from the architecture field that there is no alternative but to go up in the Indian context. It is a unique opportunity. There is a total difference in designing and planning. It has tremendous opportunity for a city planning, which is basically going to consist of a large number of high rise apartments for accommodating families, not in the large houses.

13. In another 40 years time, 68% of the GDP of the world will come only from 600 cities. In Indian context, 750-800 million people are going to stay in cities. It will be a huge problem and would require some really fundamental out-of-the-box thinking.

Thank you. If there are any questions, any interactions, I will be glad to interact with you.

TECHNICAL SESSION

VOTE OF THANKS

Dr. Neha Goel Tripathi, Asstt. Prof. School of Planning & Architecture

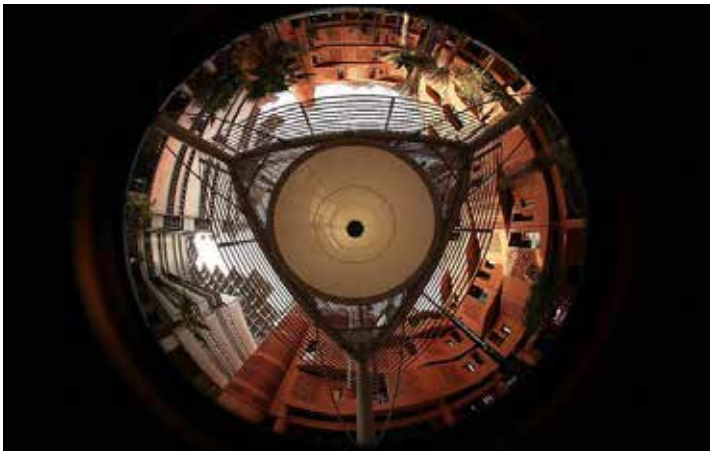
1. It is a privilege for me to convey Vote of Thanks for the workshop on Awareness in Green Buildings and Responsible Education in Schools (AGBRES III). On behalf of Climate Change Research Institute, it is to convey our grateful thanks to Chief Guest and most eminent speaker Shri Gireesh Pradhan, Chairman, Central Electricity Regulatory Commission for gracing the occasion. We convey our thanks to Dr. Arun K. Tripathi, Director, Ministry of New and Renewable Energy, Government of India, for making it to the workshop. We are thankful to Shri R.G. Gupta, Ex-additional Commissioner, Delhi Development Authority and to Prof. A.K. Maitra, Former Director, School of Planning & Architecture, Delhi. I take this opportunity to greet Dr. (Mrs.) Malti Goel, President, Climate Change Research Institute and Former Senior Advisor, Ministry of Science & Technology. She has been the moving force in actively directing the workshop.

2. In the Technical Session Mr. Karan Mangotra, UNDP; Dr. Kakoli Saha, School of Planning & Architecture-Bhopal and Dr. Sudhakar Sundaray, The Energy and Resources Institute, New Delhi made presentations about their work. We thank them and all other distinguished participants, teachers, students and members of Climate Change Research Institute for their active participation in the workshop.

SMART CITIES AND INNOVATIONS

Dr. (Mrs.) Malti Goel,
Former Adviser
Department of Science & Technology

A TALE OF TWO CITIES

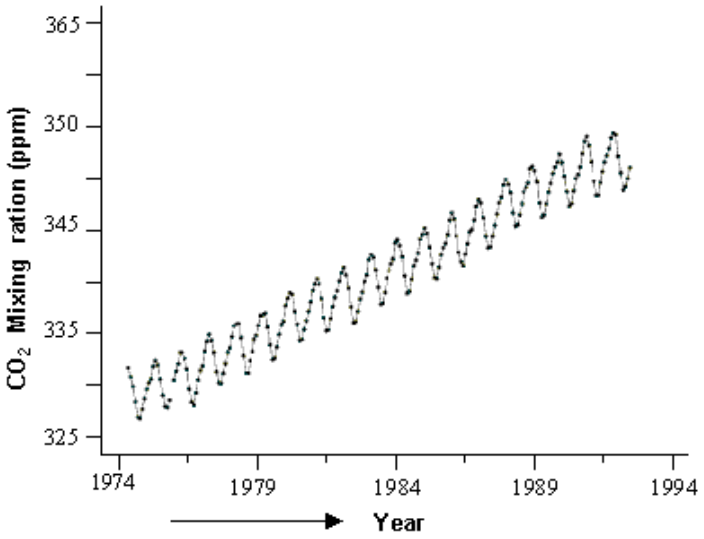


Masdar Smart City –

IT Leader - Utilizes high-tech computer networks to efficiently manage the city.

A ventilation tower using natural airflow
World's First Zero Carbon City

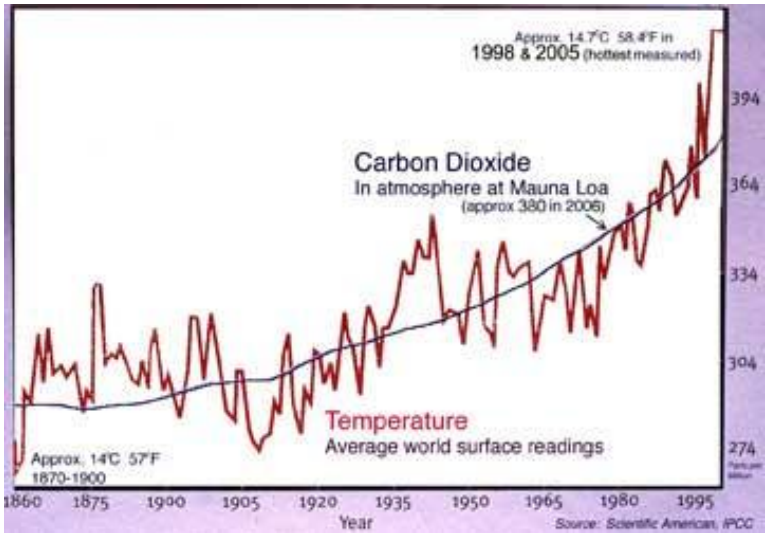
GREEN BUILDINGS CONTEXT: CLIMATE CHANGE



Carbon Dioxide measured in the atmosphere

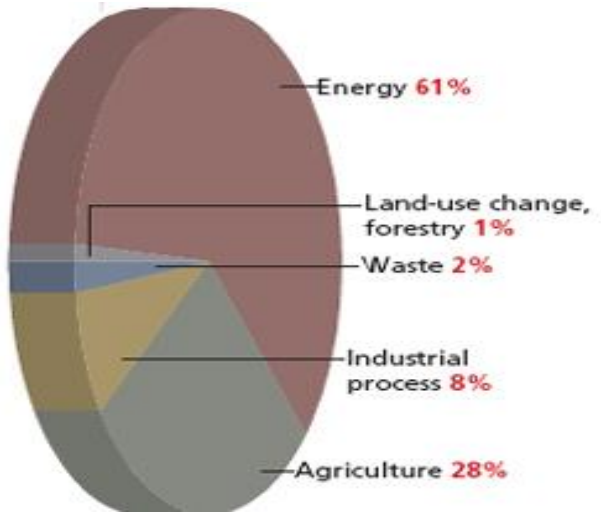
EARTH SUMMIT 1992 IN RIO DE JANEIRO

- Rio Summit, highlighted the need for awareness about global climate change and environment protection
- UN Framework Convention on Climate Change was introduced. Agenda 21 came up.
- Climate Change needed to be addressed globally by all nations

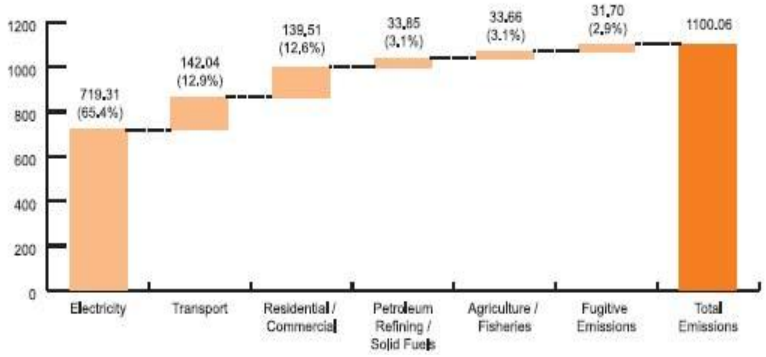


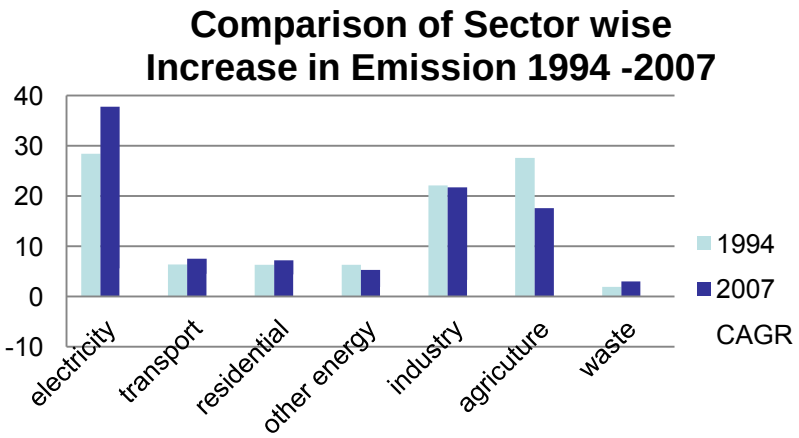
Rising Global temperatures leading to Climate Change adverse Impacts

INDIA'S GREENHOUSE GAS EMISSIONS



Sectoral contribution to greenhouse gases





GREEN BUILDINGS CONTEXT: CLIMATE CHANGE

- Concept of green buildings got highlighted in 1996.
- In India, LEED rating was introduced almost same time and commercial buildings were rated as Platinum, Gold and Silver.
- With GRIHA rating all kinds of buildings are incentivised. Ratings are not constant. They continue to be updated

BUILDING ENERGY DEMAND

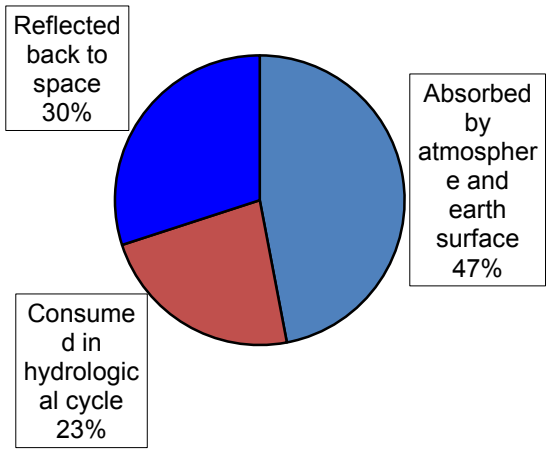
- Building Sector consumes almost 70-80 % of electricity
- Total energy demand for a building during its lifetime can be understood as

$$E = \sum E_c + \sum E_o$$

AVAILABILITY OF SOLAR ENERGY

- Amount of solar energy falling on different parts of the earth is uneven.
- It can vary from
  - From summer to winter season many folds
  - Availability of Sun's energy also varies from surface to surface,
  - On an inclined surface it can be a 10% greater than on horizontal surface.
- The changing elevation of the Sun and the greater availability of surface area on vertical surfaces in winter are turned to advantage in the design of passive solar houses.

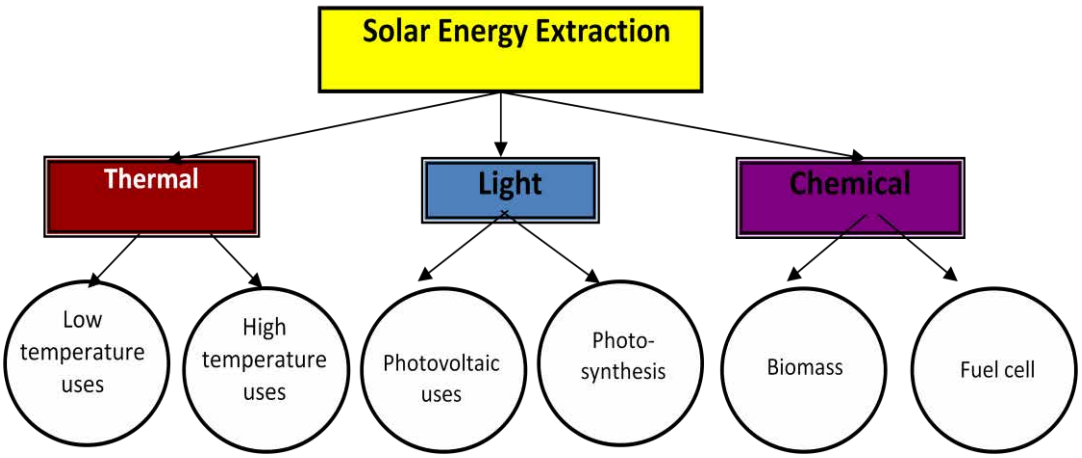
USE OF SOLAR ENERGY AS RESOURCE



- Sun radiates 10^{27}w energy in all directions in the form of electromagnetic radiation varying from x-rays to long waves.
- Almost 99% of the energy lies between 0.3μ to 4.6μ (ultraviolet-visible-infrared)
- At the outer bounds of earth's atmosphere the intensity of solar radiation is 1368w/m^2 per year.

FORMS OF SOLAR ENERGY EXTRACTION

INPUT	OUTPUT
• Heat • Light • Chemical energy	• Thermal Energy – water heater and space heating • Electricity • Plant growth by photosynthesis • Hydrogen production • Desalination



PASSIVE Vs ACTIVE SOLAR HEAT ENERGY IN BUILDINGS

- Two ways in which buildings can make use of solar energy are
  - Passive and
  - Active
- Passive Solar Energy
  - Design approach is based on maximum capture of solar energy in the building. The heat is then distributed around the building by natural thermal conduction, convection and radiation.

PASSIVE SOLAR ENERGY

- Ancient Greeks used passive solar techniques for heating as well as cooling their houses.
- Romans used tinted glass to retain the heat longer and to increase the warmth of the house.
- Built East West terraces which can have maximum exposure to winter sun. Solar gain is high through windows.
- Palaces in India were designed using passive solar energy with climatic comfort.
- Active use of solar energy involves use of solar collectors of different designs. These can then be transferred to building and can be used for heating or cooling.
- Building that combines both passive and active feature are known as **hybrid buildings.**

ACTIVE SOLAR ENERGY USES

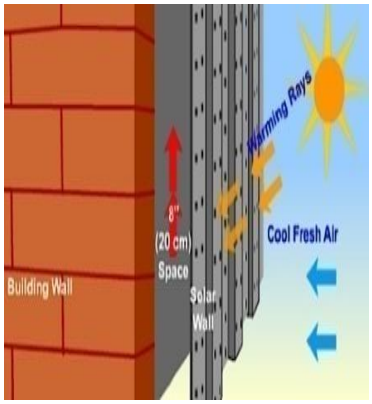
- **Solar thermal** energy can be used in water heating, process heat and space air conditioning.

- **Solar collectors** are a set of mirrors used for collecting solar heat and achieving higher temperatures.

- **Solar light energy** can be used directly for producing electricity. Solar photovoltaic arrays convert solar light to electricity for meeting lighting and cooling needs.

HYBRID SOLAR ENERGY USES

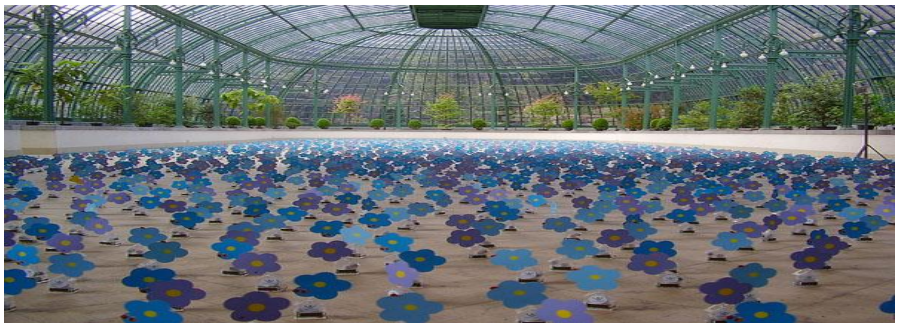
- Solar wall is a system that allows solar heat to create warmness in the interior environment. It can be designed with use of perforated metal panels to pre-heat ventilation air.



- 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 ACTIVE ROOFTOPS



Belgium Solar Flowers

Solar Roof in Spain

Solar Home in Japan

GREEN BUILDING ENERGY SAVING MEASURES

- Resource Efficiency, Recycled Content of Materials used
- Its Impact on Air Quality, its moisture resistance
- Energy efficiency to reduce energy consumption in buildings and facilities
- Water conservation to reduce water consumption in buildings and conserve water in landscaped areas
- Affordability to achieve life-cycle costs comparable to conventional materials

FUTURE GREEN MATERIALS – BUILDING INNOVATIONS IN NANOMATERIALS

- Building Nanomaterials are made of particles with nanometer size
- They allow better void filling, have more atoms on surface and improved bonding between the aggregates
- Nono engineered concrete makes high strength / high performance concrete
- Nanosized additives increase strength beyond what is attained with conventional materials

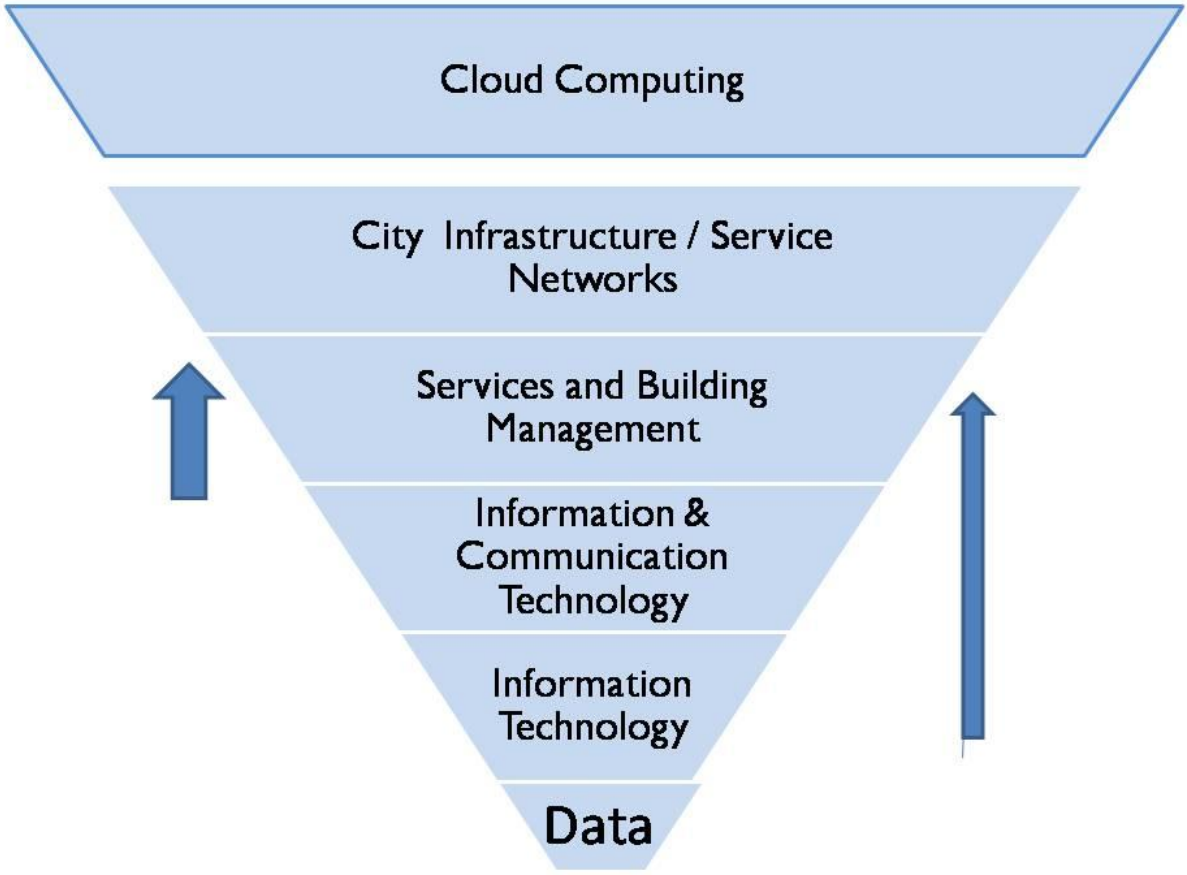
CITY GROWTH FROM - ANCIENT TIMES

- Cities came up along rivers or water front as Water Hubs
- 19th century post industrialization
  - gave birth to Industrial clusters or cities
- 'Smart Cities' appeared in late 80s
- 21st century Smart Cities planned as Transport hubs

WHAT IS COMMON FOR GREEN BUILDINGS AS WELL AS SMART CITIES?

- Energy and Fuel saving
- Use of Information Technology
- Improving quality of life

TECHNOLOGY PYRAMID



WE NEED

- Efficient services for electricity and water
- Transport systems which are sustainable and efficient
- Buildings with sensors to control energy consumption.
- Service Networks managed in a smarter way.

SMART CITIES ARE BOOMING WITH INNOVATIONS!

- e-governance
- e-services
- e-business
- e-learning
- e-security
- Intelligent traffic control
- Accident / risk warning

EXISTING EXAMPLES OF ICT

- CTV in homes and offices
- Internet of things
- e-sale or e-purchase
- Banking sector
- Karorpati Entertainment

INNOVATION IN INFORMATION AND COMMUNICATION TECHNOLOGY

- Water management
- Road infrastructure
- Electricity audits
- Street lighting
- Traffic control
- Health care facilities
- Waste management neural networks

SMART CITIES IN INDIA

DO WE NEED SMART CITIES?

- We use technology everywhere competing requirements for human activities
- We need to plan - planners need long-term perspective

CURRENT SITUATION

- Seven Smart Cities along DMIC corridors are under planning stage
- In the Phase-I, Dholera Industrial City in Gujrat is to become India's first Smart City with real time control and e-governance
- The others are Shendra in Maharastra, Manesar in Haryana and Khushkera in Rajsthan
- In the medium term each State in India is expected to one Smart City
- Kochi is a proposed IT based Smart City in Kakkanadu, in Kerala.
    - It is a joint venture of the state government of Kerala and a Dubai based Tecom company.
    - Proposed to change Kochi as a major IT hub of the world.

GOAL: SUSTAINABLE CITIES

- Environment protection
- Energy conservation
- Economic sustainability
- Consumer empowerment

"India needs to build a minimum of 500 new cities urgently"

- Said Management Guru C K Prahalad in 2009:

Thank you

WHAT ABOUT SMART CITY AND GREEN BUILDINGS

Mr. Karan Mangotra, UNDP

What about Smart City

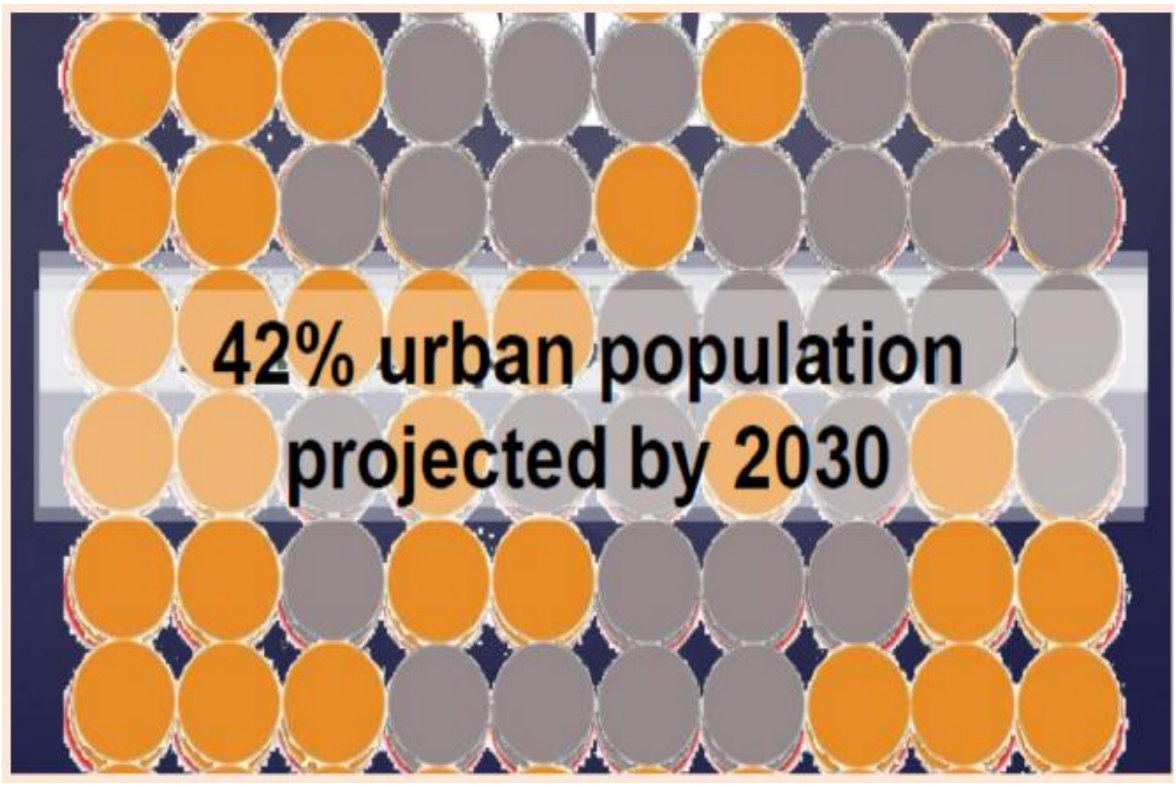
"Smart city has become a buzzword that's thrown about freely. There's an aweful lot of paper-pushing as cities are still trying to figure out what the term smart city means for them and what specific actions to take."

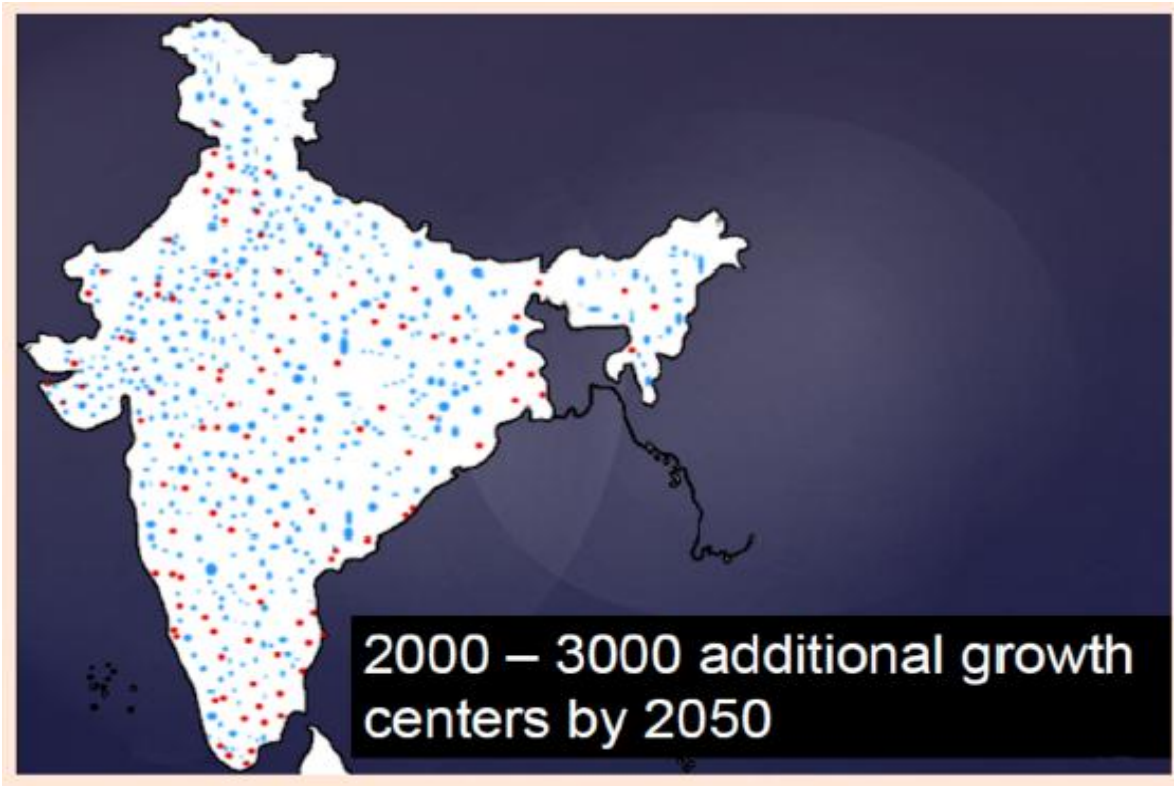
Kurt Othendal Nielsen, Siemens

What is a Smart City?
Starting from what the Smart City is not

- A city is not smart when there is too much of everything in it. An excess of cars, food, water, energy consumption etc. is the sign of an unsustainable city defined by inefficiency. A **Smart City turns its surplus into resources**.
- A city is not smart when the different networks which define it are not able to communicate and function together in systems. The **solutions of the Smart City must be integrated and multi-functional**.

- A city is not smart when the systems and networks which it contains are static and immobile. A **Smart City is characterized by a high level of mobility** allowing people, information, capital, and energy to flow together easily.
- A city is not smart when it does not include all its stakeholders in the decision and planning process leading to new development. The **Smart City is based on knowledge sharing and collaboration across all levels of society**. It is an open source community, where the ideas of one actor can be borrowed, improved and ultimately returned to the community by another.


42% urban population
projected by 2030


2000 – 3000 additional growth
centers by 2050

In developed nations, urban population growth is next to stagnant (0.67 % on an annual average basis since 2010)

Urban Growth Drives Residential Demand

(Democratic Republic of Congo) and Karachi (Pakistan) – is **higher than Europe's entire population**.

- One in every seven cities in the world is in India
- Half of these were created post-independence and are less than 65 years old
- Not one of them makes it to any list of cities worth living in
- $20 billion spent through national urban renewal mission from 2005
- Not one of the cities with these funds can still make it to any list of cities worth living in


WHAT WILL OUR WORLD
BE LIKE
IN 2030?


600
500
400
300
200
100
0
Housing Units in Millions
Urban Housing
Rural Housing
>70 Million New Urban Houses Needed Over the Next 20 Years
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Source: Planning Commission 11th Plan Report & EDS Analysis
Housing Demand Growth in India

Construction Materials required for this would mean
2.3 million GWh of Energy Use
1.8 billion Tons of CO_2 Emissions
28 new Power Plants*

Even if the Units are not air conditioned this would mean an additional
700,000 GWh of Energy Use
600 million Tons of CO_2 Emissions
9 new Power Plants

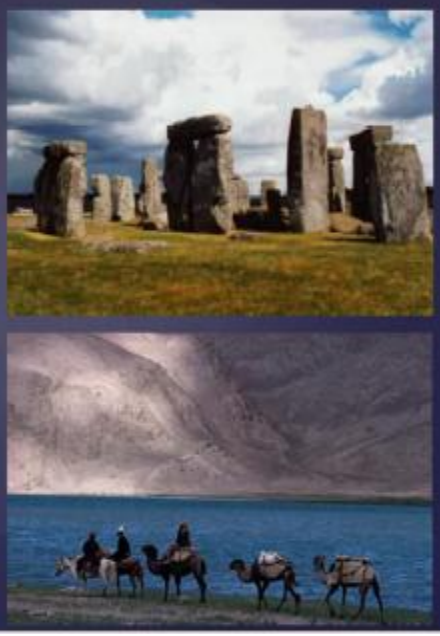
And if all new Units have airconditioning in 20 years then this would add
2.4 million GWh of Energy Use
1.9 billion tons of CO_2 Emissions
28 new Power Plants
These new housing units will require over 15 billion liters of water per year

Over 70 million New Urban Housing Units to be added over the next 20 Years

*600 MW Power Plant running at 6000 Hrs PLF

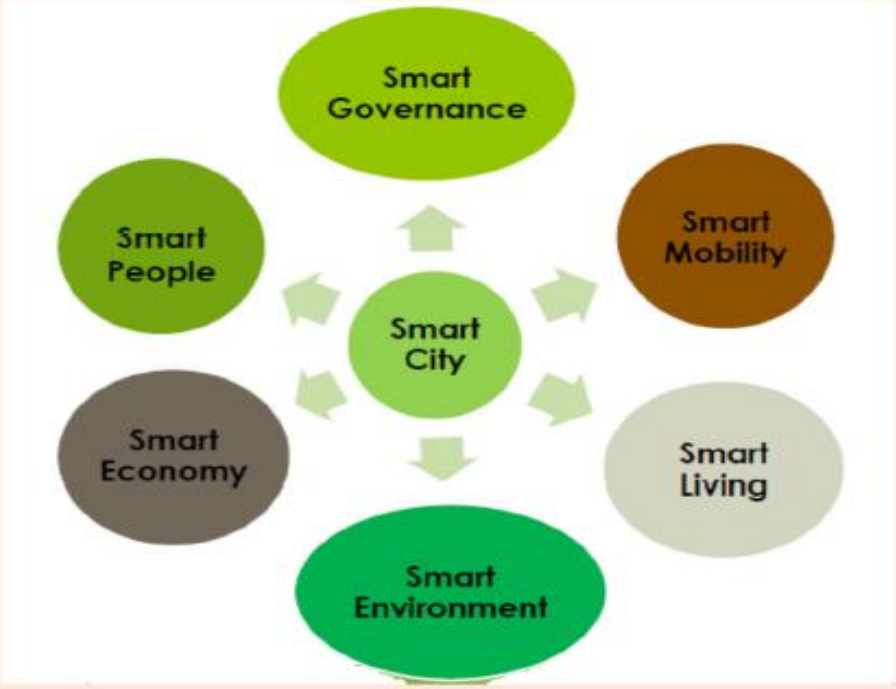
Ecological Building: What can be learnt from history?

- In the past, human beings lived in harmony with their environment
  - Comfort requirements were different
  - Small population meant ample space, modest requirements, low energy needs and emissions
  - Waste products mostly recyclable & bio-degradable
  - Mobile communities
  - Low threat to the environment

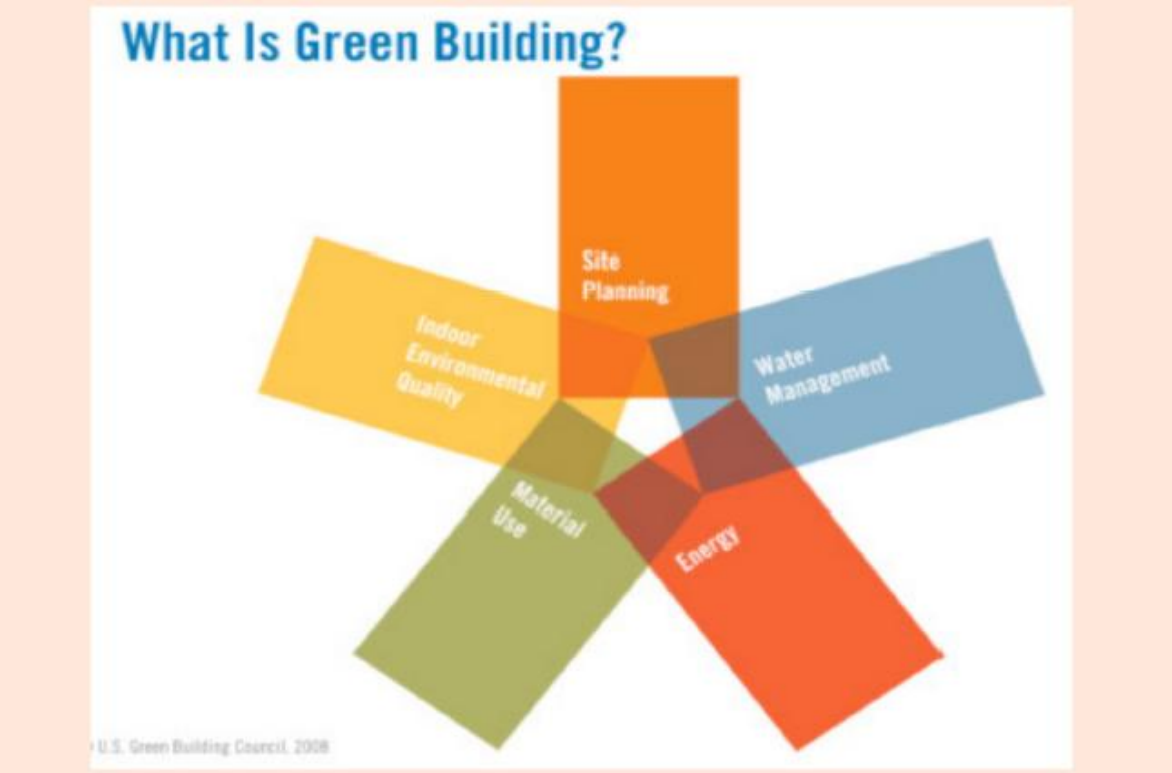


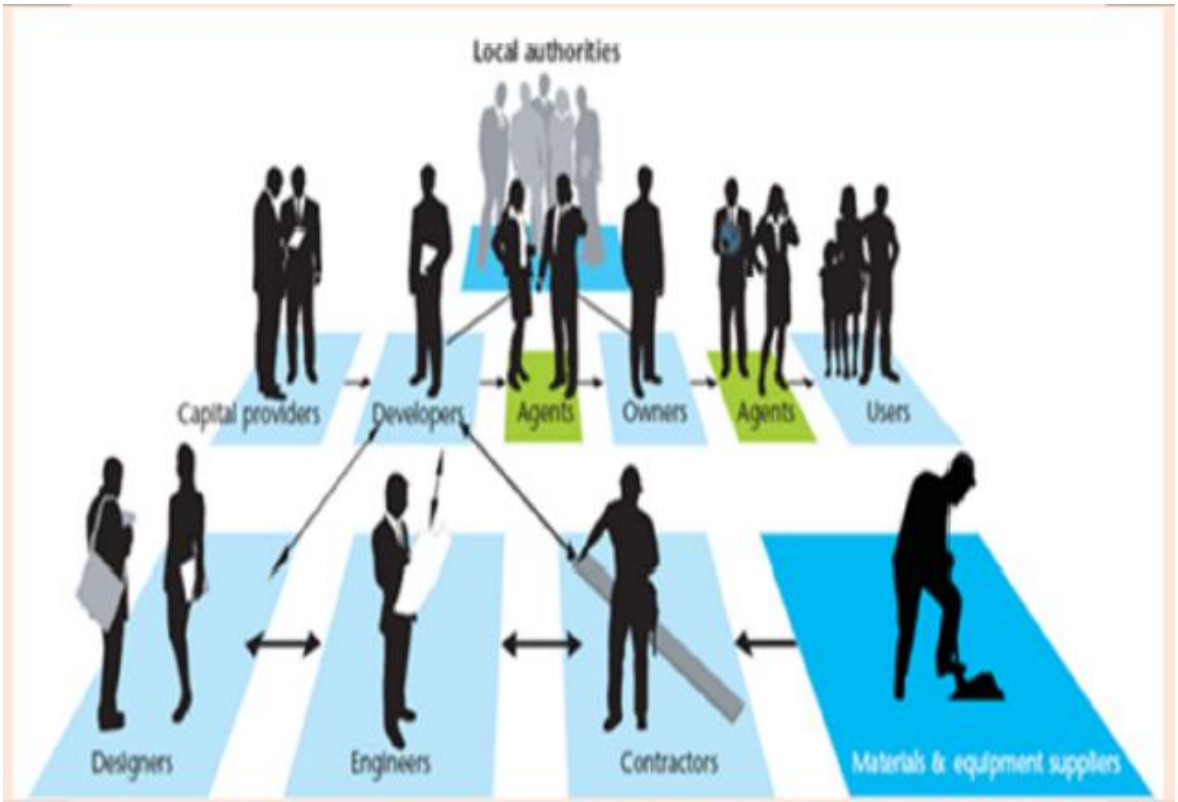
The Modern Built Ecosystem

building materials	→	used materials
energy	→	wasted heat. CO_2, CO, SO_2
water	→	gray water, sewer
consumer goods	→	waste, recyclable materials
solar radiation	→	warm air
wind	→	polluted air


Smart Governance
Smart People
Smart Mobility
Smart City
Smart Economy
Smart Living
Smart Environment


SUSTAINABLE HOMES ARE THE KEY TO THE SOLUTION


What Is Green Building?
Site Planning
Water Management
Energy
Material Use
Indoor Environmental Quality
U.S. Green Building Council, 2008


Local authorities
Capital providers
Developers
Agents
Owners
Agents
Users
Designers
Engineers
Contractors
Materials & equipment suppliers


Indoor environmental quality (IEQ)
9 to 50% reduction in sickness
9 to 20% reduction in communicable respiratory diseases.
18 to 25% reduction in allergies and asthma
20 to 50% reduction in non-specific health and discomfort
Site
reduced sprawl
preservation of natural spaces, wildlife habitat and native species
minimized reliance on cars from improved access to infrastructure
reduced soil erosion from sustainable landscaping
minimized light pollution from reduced and optimized lighting
Energy and atmosphere
reduced greenhouse gas emissions
reduced energy consumption
Materials and resources
waste reduction
locally sourced materials and resources
minimized material usage due to durability
renewable resources
natural materials
Water
reduced water consumption
water reuse and collection


Conclusion
"Here is your country. Cherish these natural wonders, cherish the natural resources, cherish the history and romance as a sacred heritage, for your children and your children's children. Do not let selfish men or greedy interests skin your country of its beauty, its riches or its romance."

Thank you

ASSESSING SOLAR ENERGY POTENTIAL FOR GREEN CITY USING GEOINFORMATICS

Dr. Kakoli Saha, Principal Investigator of DST Project, SPA Bhopal

The risk of climate change due to emission of carbon dioxide from fossil fuels is considered to be the main environmental threat from the existing energy system. Sustainable development of a region depends on the health of renewable energy resources like solar, water, vegetation, livestock etc. Photovoltaic (PV) solar electricity is one of the leading approaches to renewable production of electrical energy and, thus, to reduce CO_2 emissions. Solar energy is an obvious source of renewable energy for a country with high average incoming solar radiation (insolation) like India. In this research an attempt is made to extract building rooftops automatically so that available area for solar panel installation can be estimated. For this purpose Digital Surface Model or DSM generated from Cartosat 1 stereo pairs is used as base data and Ward No. 30 of Bhopal Municipal Area is selected as test area.

1. What is DSM?

DSM does not only contain information about the topographic surfaces like Digital Elevation Models (DEM), but also about buildings and other objects higher than the surrounding topographic surface, e.g. trees. The elevation data acquired directly from the remotely sensed images are always DSM. DSMs traditionally originating from conventional techniques of pointwise digitising and interpolation have limited capabilities for data manipulation due to labour-intensive efforts to determine arbitrary elevation points; however, there are now a number of sources available for DSM generation. Options range from photogrammetric restitution of stereoscopic aerial and satellite imagery, through laser scanning to airborne laser ranging, commonly termed lidar and Interferometric Synthetic Aperture Radar (InSAR). In this research, 5 m resolution DSM is extracted from 2.5 m resolution Cartosat-1 data using commercial-off-the-self (COTS) software such as Leica Photogrammetric Suite (LPS) by ERDAS Inc.

2. What is Cartosat-1 stereo image?

On 5 May 2005, the Indian Space Research Organization (ISRO) launched Cartosat-1, the eleventh satellite of its IRS constellation, dedicated to the stereo viewing of the Earth's surface. Cartosat-1 carries two high-resolution imaging cameras: the afterward looking

camera (Aft) and the foreword looking camera (Fore), both able to collect panchromatic images with a spatial resolution of 2.5 m on the ground. The imaging cameras are fixed to the spacecraft to acquire near-simultaneous imaging of the same scene (with a delay of 52 s between the Fore and the Aft acquisitions) from two different angles: +26° with respect to nadir for the Fore camera and -5° with respect to nadir for the Aft camera. Image pairs taken from two different viewing positions with certain overlap is called stereo pairs. In photogrammetric measurements, the extraction of elevation information from any image is possible only if the same image is taken from two different viewing positions. Generation of DSM in LPS comprised of five steps – 1) Creating of block files or .blk files, 2)Setting up internal geometry, 3)Generation of Mass Point by Automatic Image Matching, 4) GCP collection and RPC correction, 5) Automated extraction of DSM.

3. Generating nDSM

As DSM provides representation of the surface of the ground with all objects on it, using filtering methods it is possible to filter out objects from the DSM and extract the terrain. DSM is filtered using DSM2DEM algorithm available in PCI Geomatica. The algorithm strips buildings and trees from the DSM to produce a bare-Earth DTM. The subtraction of the DTM from the DSM of the same scene is called a normalized DSM (nDSM):

$$nDSM = DSM - DTM$$

The nDSM is loaded in advance remote sensing software named eCognition Developer and object-oriented classification is performed.

4. What is object-oriented classification?

Object-oriented classification is based on recognition of individual objects rather than pixel-by-pixel classification. Such an approach greatly reduces the number of units and eliminates the "salt-and-pepper" effect common in per-pixel classifiers. Also, when landforms are extracted as individual polygons, information such as asymmetry, size, and orientation can be obtained automatically for each polygon, whereas those details are inaccessible in pixel- by-pixel classifications.

Using height information as threshold the building rooftops are extracted from nDSM. As rooftops are extracted as polygons their area is automatically extracted which came as 300,850 sqm for ward no.30. With available 5.781kwh/m^2/day solar radiation Ward No. 30 has potential for generating 173.92MW electricity per day.

POWER POINT PRESENTATION

Dr. Kakoli Saha, Principal Investigator of DST Project, SPA Bhopal

INTRODUCING THE PRESENTER

- B.Sc. (Honors: Geography, Specialization: Environmental Geography) from Presidency College, Kolkata, (1998-2001).
- M.Sc. in Geography, Specialization: Regional Planning) from Calcutta University, Kolkata, (2001-2003).
- Ph.D. In "Object-Oriented Classification of Drumlins from Digital Elevation Model or DEM" from Kent State University, Kent, Ohio, USA (2006-2010). Advisor: Prof. Mandy Munro-Stasiuk.

INTRODUCING THE PROJECT

- Project Title- Optimization of Photovoltaic Solar Panel Installation Using Remote Sensing Techniques
- Sponsoring Agency- Department of Science and Technology, Govt. of India
- Project Scheme- DST Fast Track project under Young Scientist Scheme
- Duration- September 2012– September 2015
- Host Institute: SPA Bhopal, Bhopal, MP, India

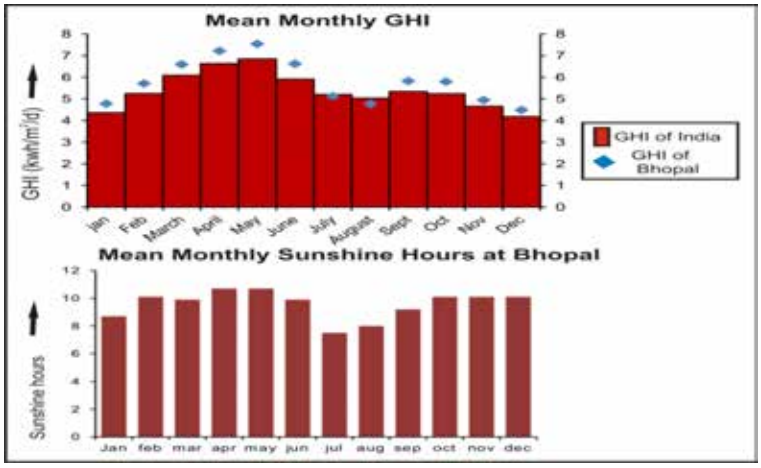
DEFINING GEOINFORMATICS

- Geoinformatics is an umbrella term covering a wide gamut of GIS and related technologies such as Remote Sensing, Global Positioning System, Image Processing.
- Geographic Information System or GIS – Hardware, software kind of technology which help us to solve planning and management related geographical problems by manipulation, analysis, display, and modeling.

GREEN CITY CONCEPT

- Cities are focal points of regional economic development.
- Composed of financial, educational, technological and industrial sectors.
- Green energy needed to make the cities sustainable
- Solar energy through PV panels

WHY SOLAR?



- Solar energy is clean, safe and abundant
- Location of India within Solar Belt (40°N to 40°S).
- Bhopal is located between 23°09′N and 23°21′N latitude and 77°19′E and 77°31′E longitude.

STUDY AREA AND TEST AREA

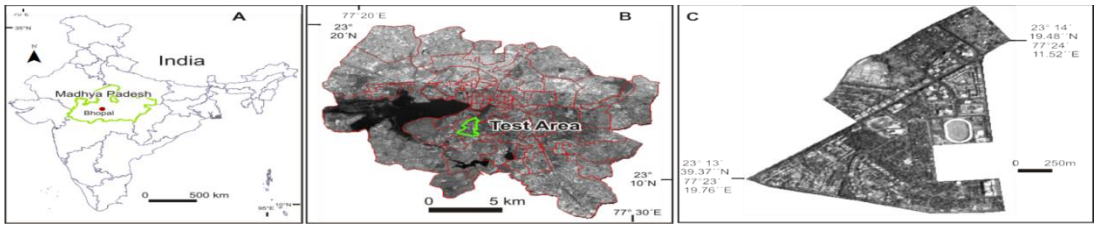
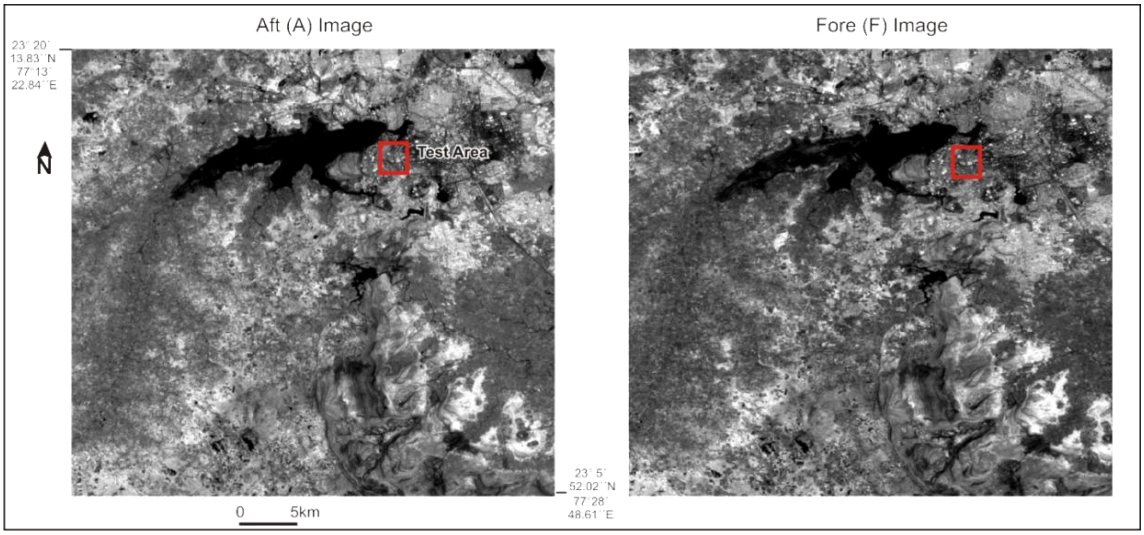


Figure 1: A. location of Bhopal city within India, B. Ward wise division of Bhopal Municipal area, C. Test area or Ward No. 30

DATA USED

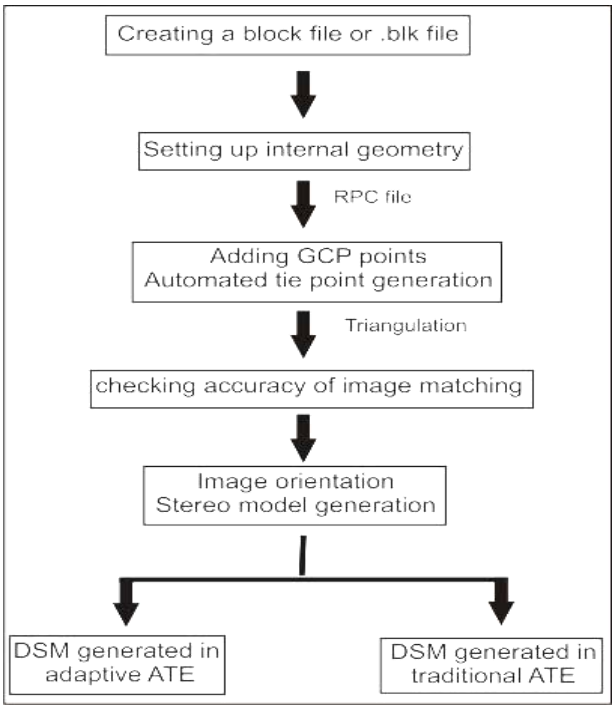


Aft and Fore images of Cartosat-1 stereo pair

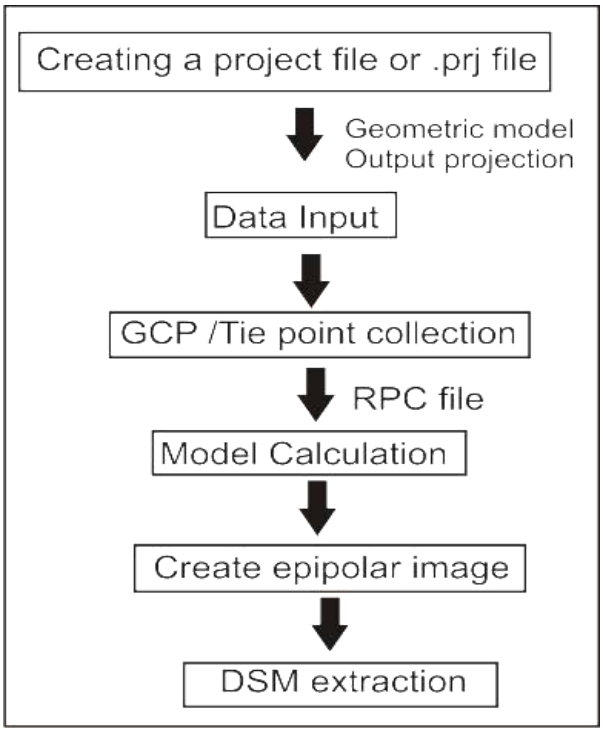
Product ID	Path	Row	Date of pass	Orbit No	Sun Elevation	Sun Azimuth
132873900401	0532	0290	16th Feb 2012	36719	47.31	144.35
132873900302	0532	0289	16th Feb 2012	36719	49.42	141.77

METHODOLOGY ADOPTED

GENERATING DIGITAL SURFACE MODEL (DSM) FOR BHOPAL CITY

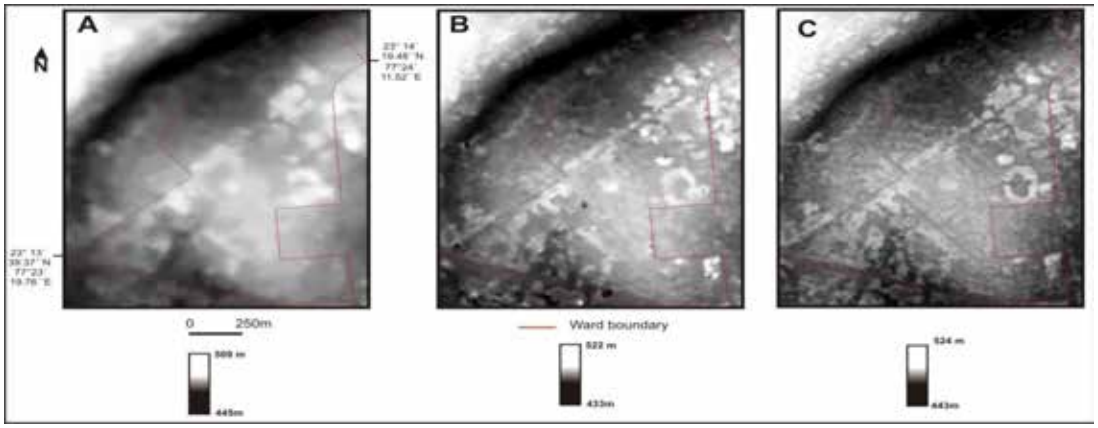


Steps for generating DSM from Cartosat-1 data in LPS



Steps for generating DSM in Orthoengine

THREE DSMS GENERATED IN THREE DIFFERENT TECHNIQUES



A- generated in Adaptive ATE of LPS; B- generated in Traditional ATE of LPS;C- generated in Orthoengine from Rolta Geomatica

ACCURACY ASSESSMENT OF DSMS

ASSESS THE QUALITY OF THE MATCHING (BETWEEN ORTHOENGINE AND LPS)

Software used	$RMSE_X$ (m)	$RMSE_Y$ (m)	$RMSE_{Total\ Image}$ (Pixel)
Orthoengine	6.34	7.20	4.02
LPS	3.630	2.314	0.697

ASSESS THE QUALITY OF THE MATCHING (WITHIN LPS)

General Mass point Quality	Adaptive ATE	Traditional ATE
Excellent	69.1596%	61.9695%
Good	30.6764%	23.1289%
Fair	0.1639%	0.0000%
Isolated	0.0000%	0.0000%
Suspicious	0.0000%	14.9016%

COMPARING VERTICAL ACCURACY BETWEEN BLOCK GCP AND DSM (PART-1)

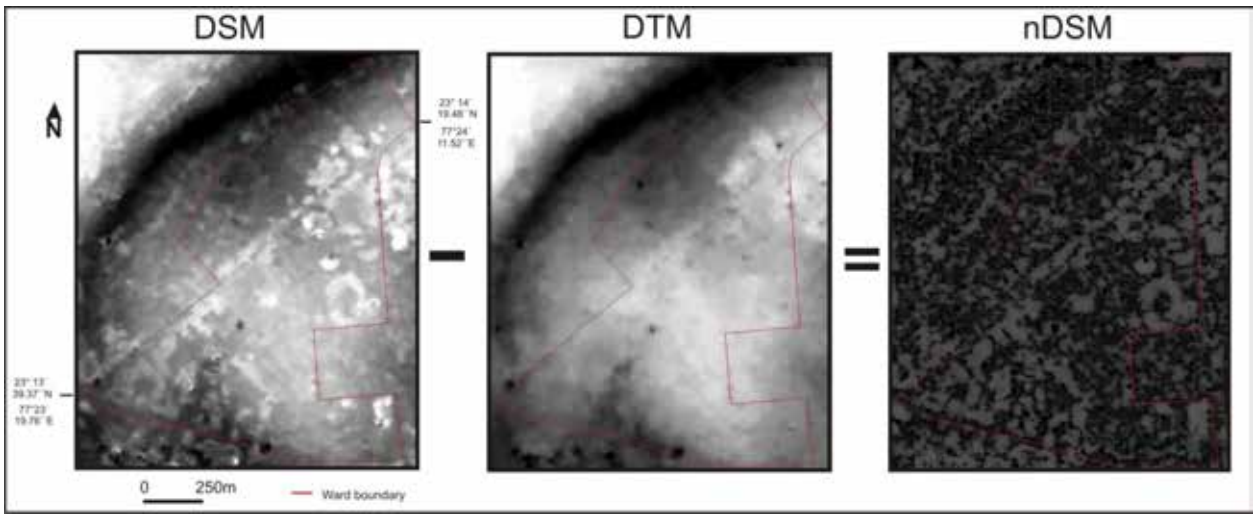
Point Id	DGPS value (m)	Calculated $value_{(LPS)}$ in m	$Residual_{(LPS)}$ in m	Calculated $value_{(Orthoengine)}$ in m	$Residual_{(Orthoengine)}$ in m
A	465.599	469.4079	3.8089	462.90	-2.70
B	467.453	470.3809	2.9279	463.89	-3.56
C	473.494	475.9545	2.4605	471.85	-1.65
D	458.406	454.7504	-3.6556	456.24	-2.17
E	469.96	485.5863	15.6263	487.78	17.82
F	459.995	463.5344	3.5394	469.37	9.38

COMPARING VERTICAL ACCURACY BETWEEN BLOCK GCP AND DSM (PART-2)

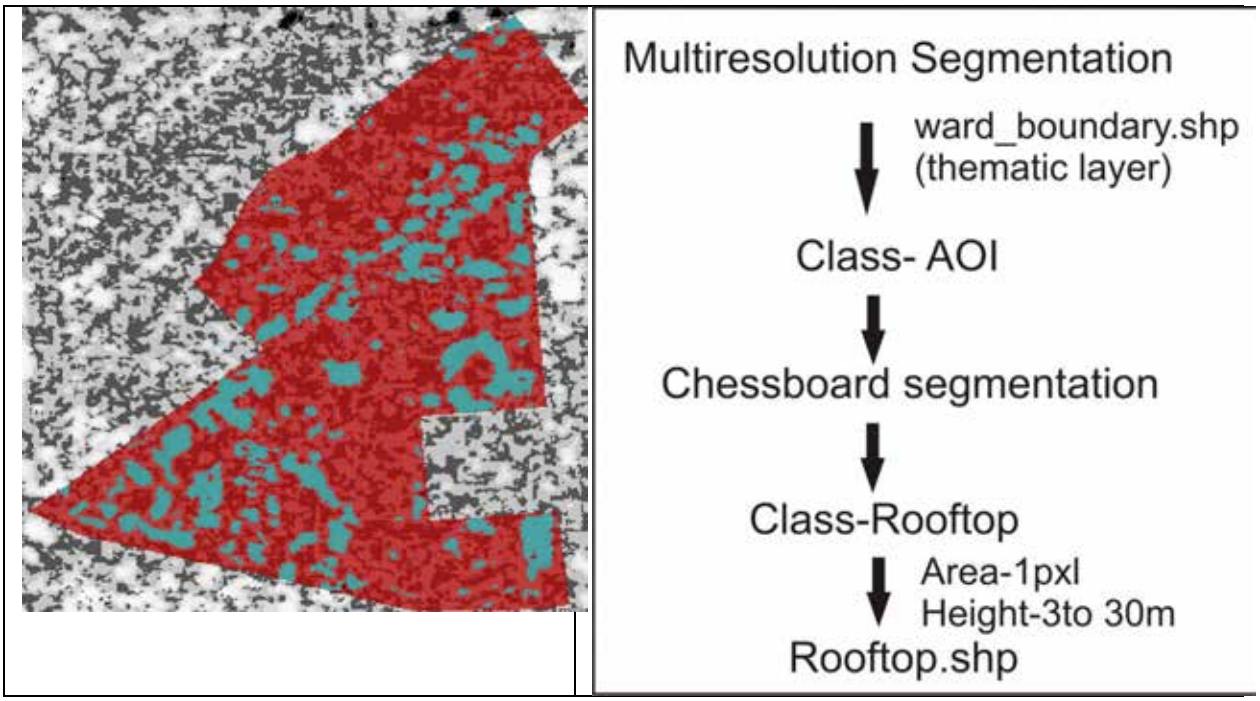
	LPS	Orthoengine
Mean Absolute Error	5.3364	6.212681
Mean Error	4.1179	2.851453
RMSE	7.0617	8.492889

METHODOLOGY (CONT.)

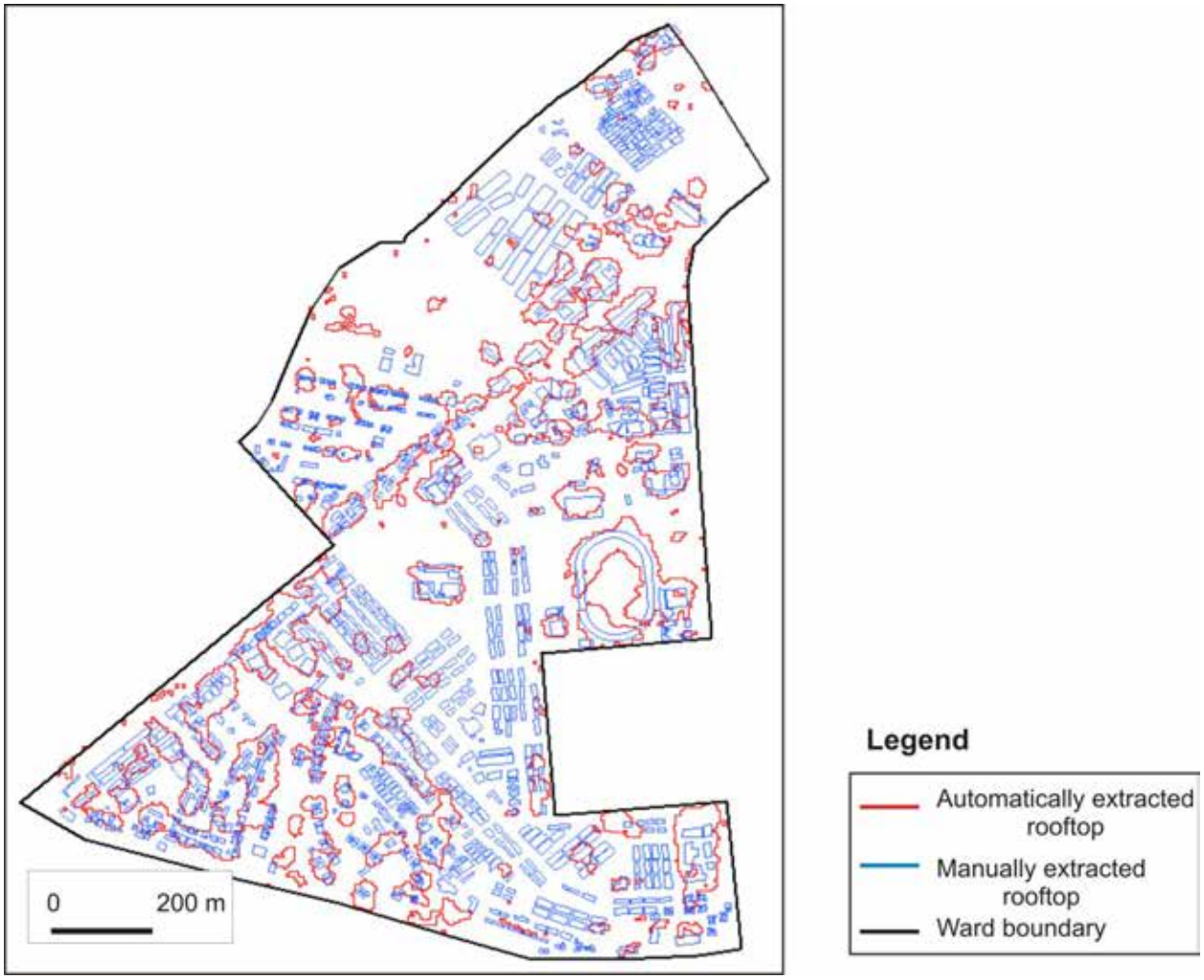
GENERATING NORMALIZED DIGITAL ELEVATION MODEL OR NDSM



AUTOMATED ROOFTOP EXTRACTION IN ECOGNITION DEVELOPER



RESULTS OF AUTOMATED EXTRACTION AND VISUAL COMPARISON



POTENTIAL FOR ENERGY GENERATION

- Estimated rooftop area from automated map- 300,850 sqmt
- Mean annual Global Horizontal Irradiance for Bhopal is 5.781 kWh/m^2/day.
- With this much of area net energy to be captured is 1739.213 MWh/day
- Normally solar cells having less than 10% efficiency
- Net electricity can be generated 173.92 MWh/day or 173,920 kWh/day.
- Considering 10 kWh/day electricity requirement per household, this amount of electricity can serve approximately 17,392 households.

Thank you

SOLAR ENERGY WITH RESPECT TO BUILDINGS: TECHNOLOGY, ECONOMICS & CASE STUDIES

Dr. Sudhakar Sundaray, Research Associate, TERI, New Delhi

ABOUT TERI

TERI is a not for profit, independent research organization working towards energy environment and sustainable development

PHILOSOPHY

The basic thrust is to seek solutions to the energy-related issues that are sustainable and environmentally benign

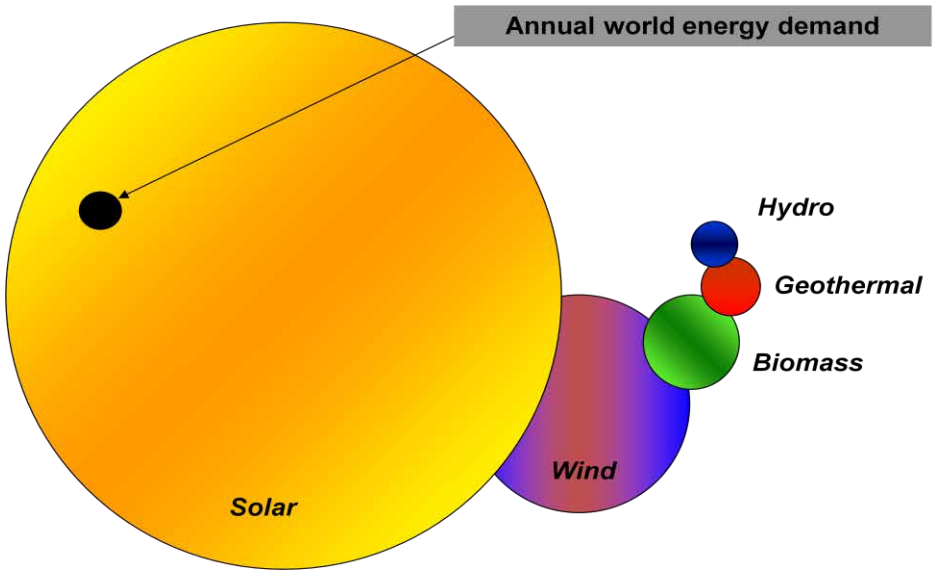
RENEWABLE ENERGY TECHNOLOGIES: TERI'S FOCUS

- Solar energy
  - Solar photovoltaic
  - Solar water heating system
- Bio-energy
- Wind energy
- Micro/small hydro
- Renewables based distributed generation system and smart mini grid

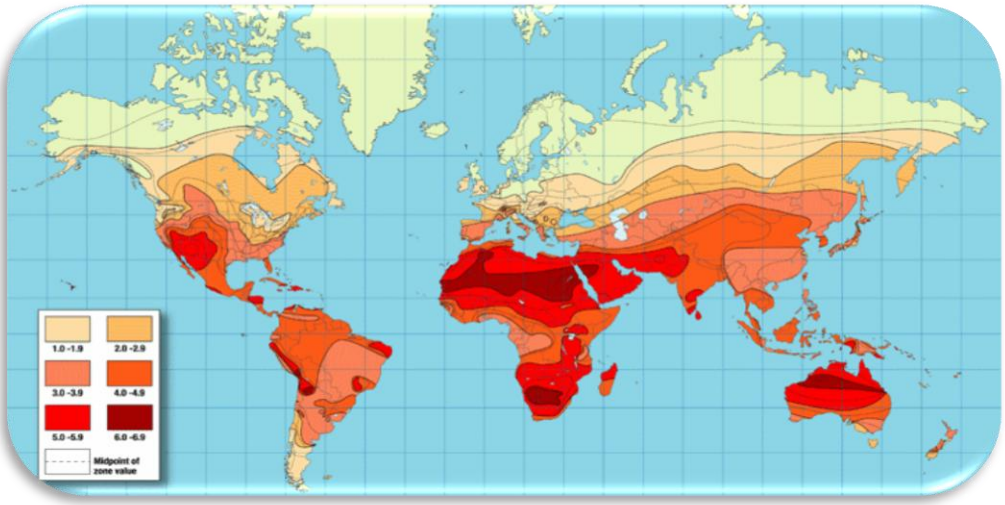
SOLAR ENERGY INTERVENTIONS IN BUILDINGS

- Solar photovoltaic systems for electricity needs
- Solar water heating systems for all hot water needs

SOLAR ENERGY AVAILABILITY

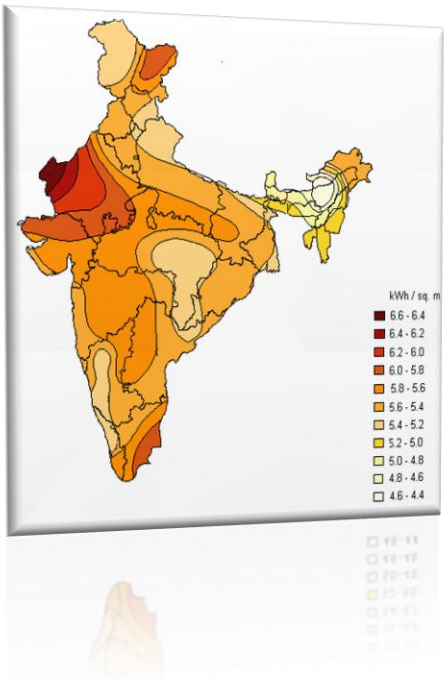


GLOBAL SOLAR ENERGY AVAILABILITY



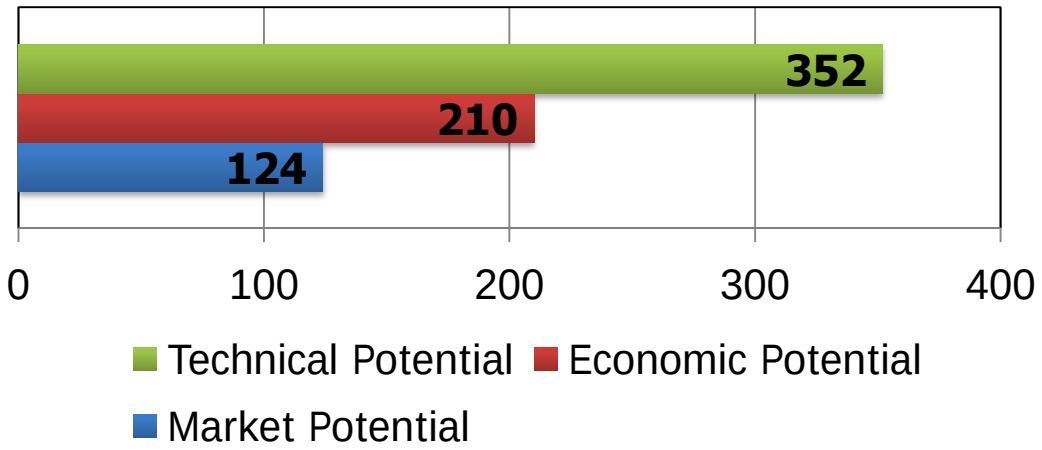
Earth receives 1.7 x 10^{14} kW (i.e. 174 Petawatts) of incoming solar radiation at the upper atmosphere

SOLAR ENERGY AVAILABILITY IN INDIA



- India is in the sunny belt of the world and the annual global radiation varies from 1600 to 2200 kWh/m^2.
- The country receives 5000 Trillion kWh annual solar radiation
- The equivalent energy potential is about 6,000 million GWh of energy per year.

ALL-INDIA ROOFTOP SOLAR POTENTIAL IN GWP



ROOF TOP SOLAR PHOTOVOLTAIC SYSTEM

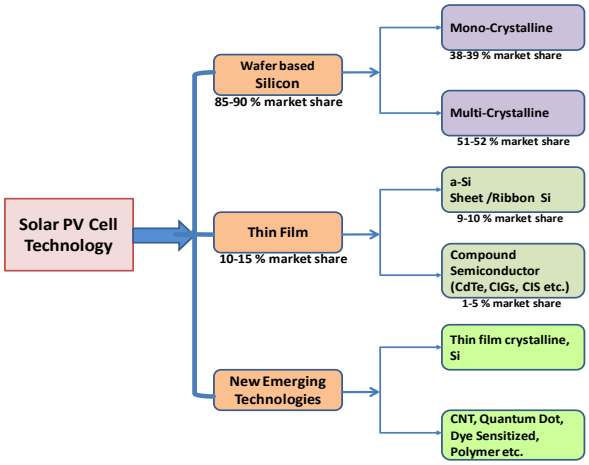
2x 100 kW systems at M/s Omax Autos Ltd, Manesar, Haryana

- Suitable for diesel abatement at places where power cuts are high during day time
- Can curtail the use of DG sets
- Systems designed to have minimal storage batteries with first use of solar power
- A 100 kW system could save up to 50,000 liter of diesel/yr
- Pays back the cost in 5-6 yrs with MNRE support

SOLAR PHOTOVOLTAIC ROOF

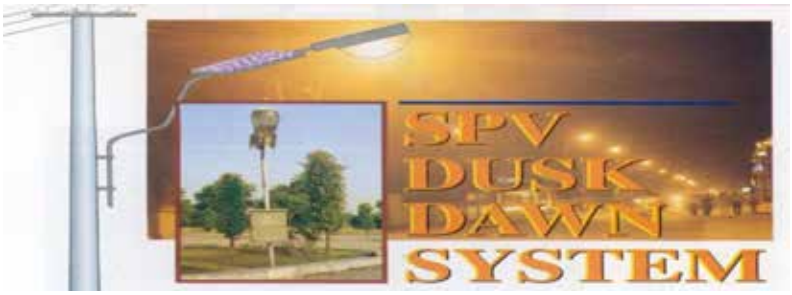
Roof Integrated Solar Photovoltaic

SOLAR PV TECHNOLOGIES



- Solar PV is the most flexible power generation technology.
- Decentralized energy supplyIsolated System Roof top Large grid connected system

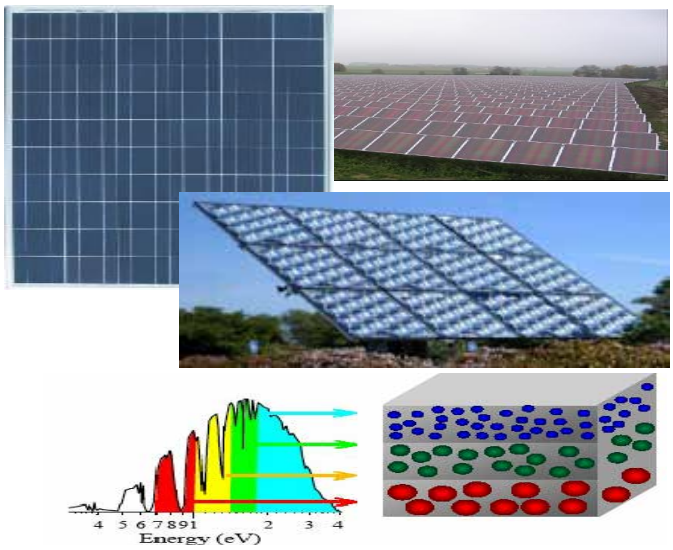
STREET/ GARDEN LIGHTS



- LED based lights are cost effective due to lower requirement of SPV modules
- Suitable for areas having frequent power cuts in evenings
- Avoid use of DG sets thereby reducing diesel consumption & air /noise pollution

- At Fortis Hospital in Delhi, 30% of LED based external lighting fixtures powered by SPV thus saving 22% of electrical load for external lighting

TECHNOLOGICAL LANDSCAPE

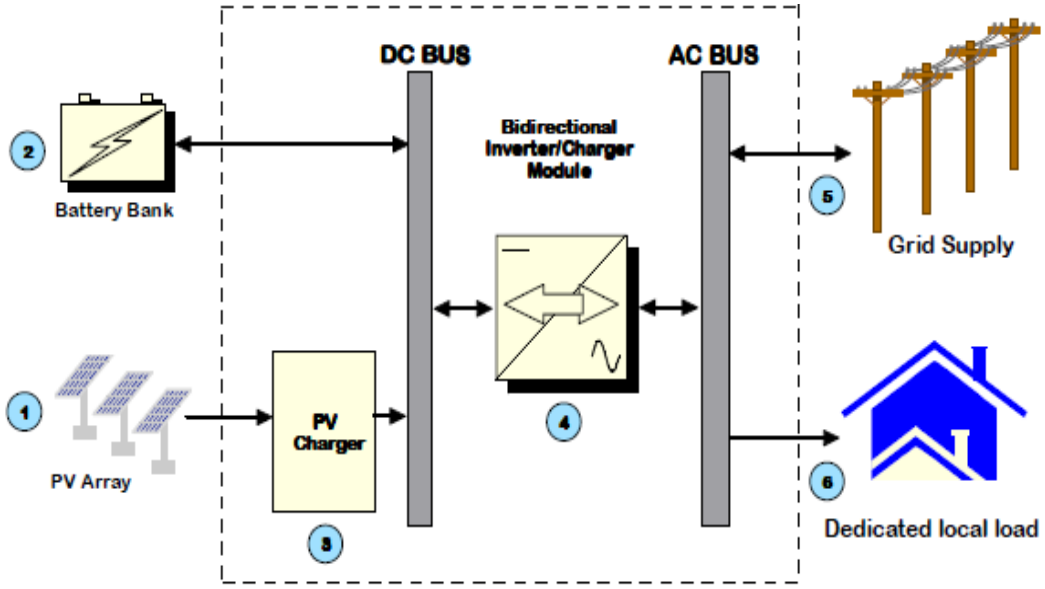


- Crystalline Silicon
  - Most mature technology
  - Largest market share
  - Suitable for roof-top as well as large installations
- Thin Film
  - The second most mature technology
  - High growth due to silicon shortage
  - Great potential to reduce cost
  - Technology is reaching maturity
- Concentrating PV
  - Tremendous promise to reduce cost in MW installations.
  - Market development underway
- Nano-Technology
  - Future technology for cost reduction and new applications
  - In the R&D phase

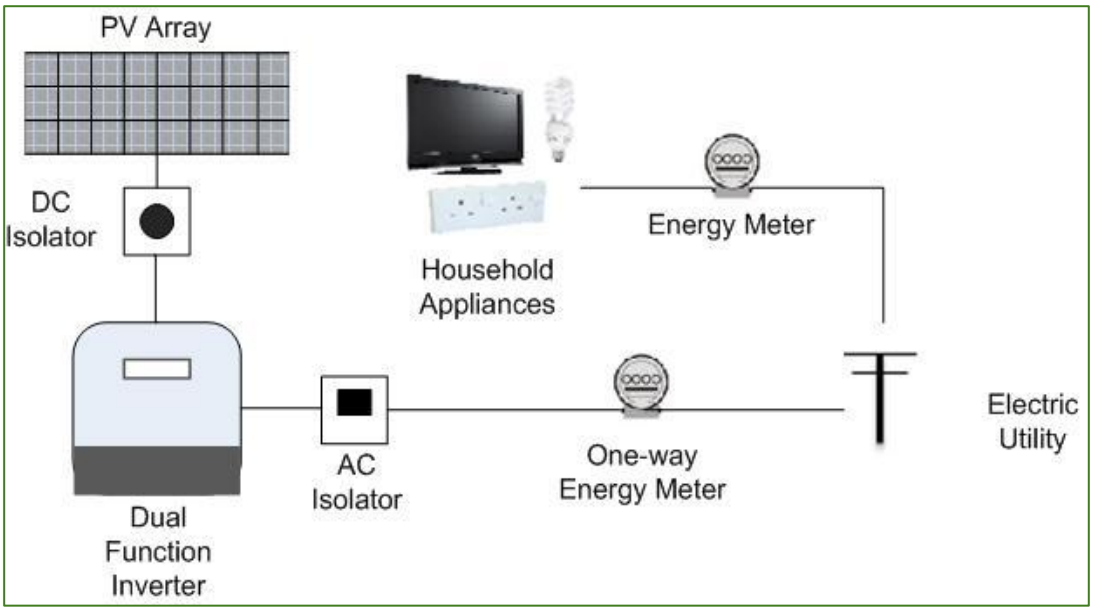
ESSENTIAL COMPONENTS OF SOLAR PV SYSTEM

- PV modules
- Module mounting structure
- Cables
- PCU
- Battery bank
- ACDB
- DCDB
- AJB/MJB
- Earthing system

SLD FOR A TYPICAL PV POWER PLANT

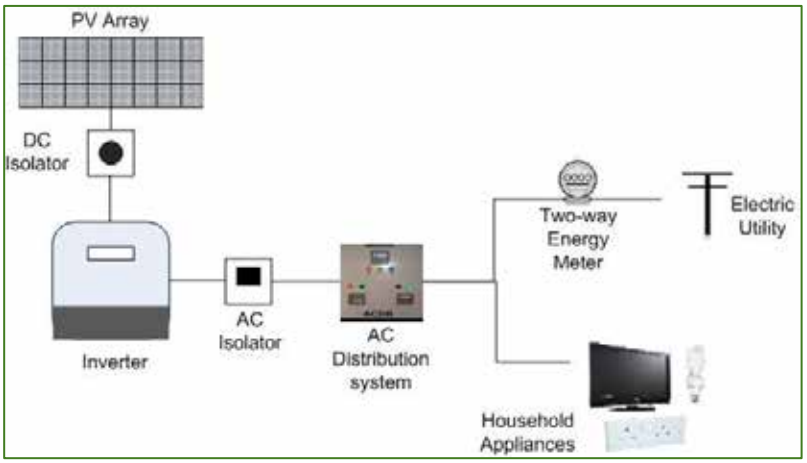


SPV SYSTEM CONFIGURATION & METERING ARRANGEMENT



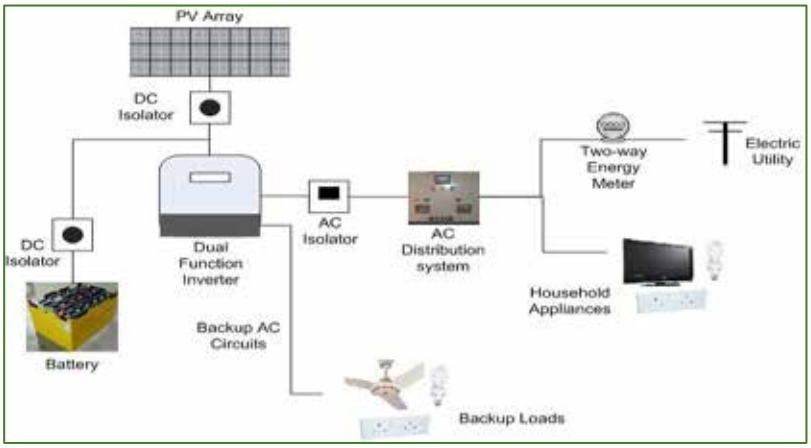
It is a simple and cost effective Rooftop Solar PV system which doesn't affect household grid connection and wiring.

SPV SYSTEM CONFIGURATIONS & METERING ARRANGEMENTS



Net Metering

- Suitable for sites with reliable grid power
- It doesn't provide backup power during power outage



Net Metering with Backup

It provides backup power during power outage

COST OF SOLAR PV SYSTEM

- Cost of a small kW scale solar PV project is INR 100,000 /kWp (without storage)
- Cost of a MW scale solar PV project is INR 80 Million/MWp

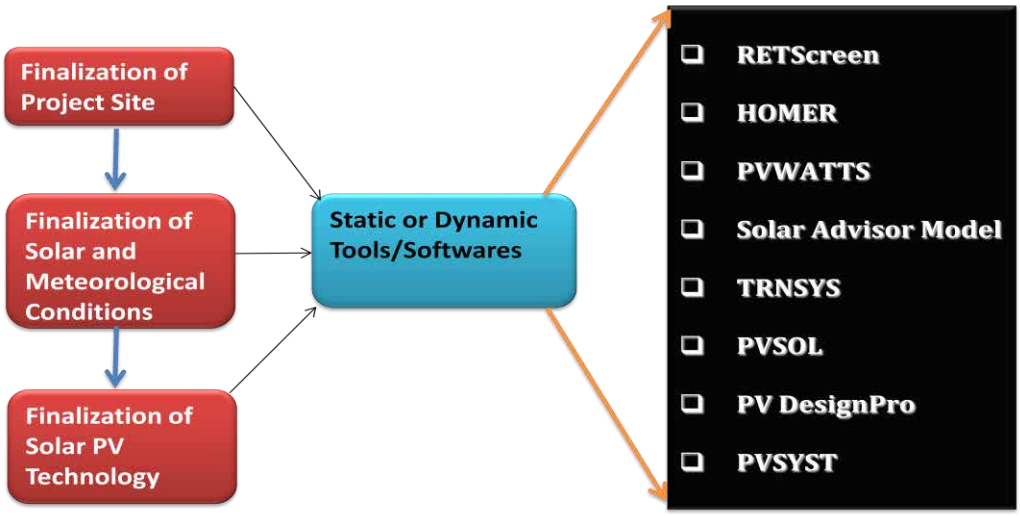
12 KWP SYSTEM INSTALLED AT DLF PROMANADE MALL - NEW DELHI

134.4 KWP SYSTEM INSTALLED AT R&B SURAT, GUJARAT

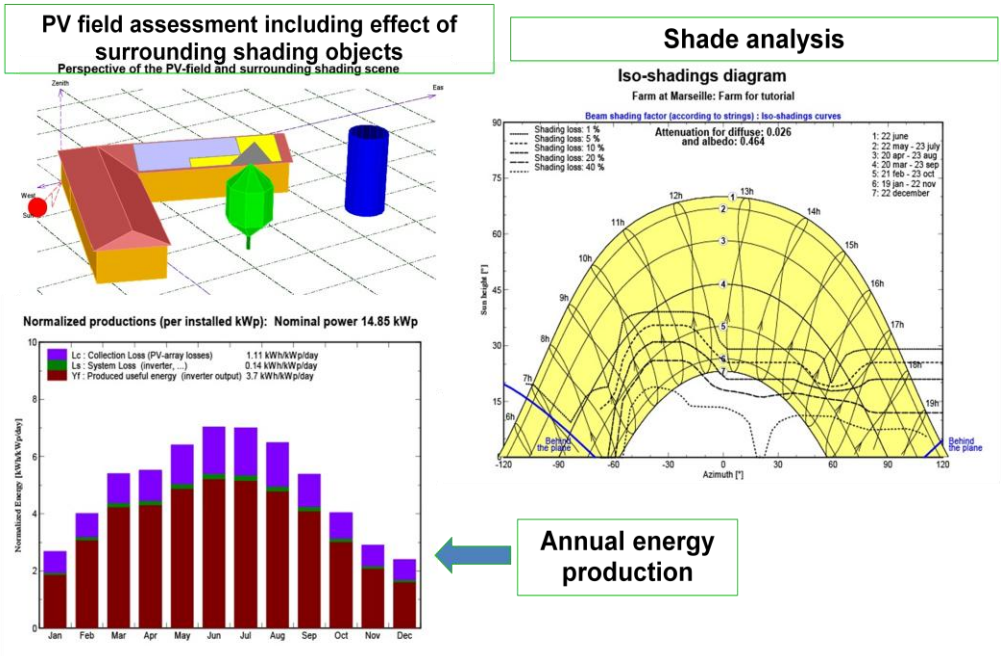
SOLAR RADIATION RESOURCE DATABASE

1. Indian Meteorological Department
2. NASA Satellite Data
3. NREL Satellite Data
4. ISHRAE Database
5. METEONORM Database

ENERGY YIELD ESTIMATION



SOLAR RESOURCE ANALYSIS USING PVSYST



SOLAR WATER HEATING SYSTEMS

FPC based system

- Commercially viable technology
- Can replace/ bypass geysers & save precious fuel oil
- Helps in peak load shavings besides reducing energy bills & CO_2 emissions

ETC based system

- Good manufacturing base with standard products & dealer's network in many cities
- 4.6 million sq. m. with over 230 million liters of hot water per day at 60-70 ^{o}C installed in India

COST ECONOMICS OF SOLAR WATER HEATING SYSTEMS

- Capacity: 5000 lpd, 100 sq. m. collector area (for a typical hotel with 80 to 100 rooms)
- Installed cost: INR 8 -10 lakhs Approx.
- Cost after subsidy: INR 6 -8 lakhs (say)
- O&M cost & life: 1 to 2% of cost & 20 years
- Savings: - Up to 75,000 units of electricity/year depending on use
  - 7,000 liters fuel oil /year @ 140 liters from each 100 lpd
- Cost of fuel: INR 4 per unit for electricity & INR 40 per liter of fuel oil including transportation
- Pay back: Less than 2 years with MNRE support

SOME INSTALLATIONS

SOLAR STEAM GENERATING SYSTEM

Can supplement conventional steam systems for

- Community cooking
- Process heat
- Laundry
- Cooling through VAM

- System of 100 sq. m. dish area can generate 40 to 50 kg steam per hour and save 5,000 liters of diesel /yr
- Pay back : 4 -5 years with MNRE support & tax benefit
- Over 100 systems functioning in the country

TERI'S ACTIVITY ON FEASIBILITY ASSESSMENT OF SOLAR PV PROJECT

- Solar radiation data analysis- ground measured as well as satellite data
- Energy generation modeling
- Solar energy system sizing including battery and inverter
- Plant layout and design optimization
- Plant cost economics and financial assessment
- Softwares- PVsyst, SAM, RETScreen, TRNSYS, Homer

Thank you

ANNEXURES

Annexure I

Green Buildings and Smart Cities

31st January, 2014, Seminar II, IIC, Kamala Devi Block, New Delhi
(Entry from Gate no. 1)

The Green Buildings III: Workshop on Awareness in Green Buildings Responsible Education in Schools (AGBRES 2014), organized by Climate Change Research Institute, India and IIC, Delhi.

Tentative Programme

09:30 Hrs.	Registration
10:15 Hrs.	Welcome Tea
10:45 Hrs.	Introduction to Theme – Dr. Malti Goel, President and ED
10:55 Hrs.	Address – Shri R. G. Gupta, City Planner & Vice President Brief Address – Shri S. Baliga, Ex-ADG, CPWD & Fellow
11:05 Hrs.	Lighting the Lamp
11:10 Hrs.	Inaugural Address by Chief Guest, Shri. G. Pradhan, Chairman, Central Electricity Regulatory Commission
11:25 Hrs	Keynote by Dr. Arun Triapathi, Senior Director, MNRE
11:45 Hrs	Vote of Thanks
11:50 Hrs.	Technical Session on Green Buildings and Smart Cities Opening Remarks by Chairperson
11:50 Hrs.	Smart Cities Innovations, Dr. Malti Goel, Former Adviser, DST
12:20 Hrs	What about Smart City and Green Buildings, Mr. Karan Mangotra, UNDP
12:45 Hrs	Assessing Solar Energy Potential for Green City using Geoinformatics Dr. Kakoli Saha, SPA, Bhopal
13:10 Hrs	Solar Rooftop in India, Mr. Sudhakar Sundaray TERI
13:35 Hrs.	Summing up followed by Questions and Answers
14:00 Hrs.	Lunch

Friday, Jan 31, 2014 at **9:30 A.M.**

Convener
Dr. Malti Goel, President and ED, CCRI

Annexure II

Workshop on Awareness in Green Buildings and Responsible Education in Schools: Green Buildings and Smart Cities (AGBRES III) held on 31st January, 2014 at Seminar II, Kamala Devi Block, India International Centre, New Delhi

LIST OF PARTICIPANTS

S. No.	Name	Organization
1.	Dr. Kakoli Saha	School of Planning and Architecture- Bhopal
2.	Dr. (Mrs.) Malti Goel	Climate Change Research Institute
3.	Dr. Sudhakar Sundaray	The Energy and Resources Institute, New Delhi
4.	Mr. Karan Mangotra	UNDP India
5.	Shri Gireesh Pradhan	Central Electricity Regulatory Commission, New Delhi
6.	Dr. Amit Kumar	The Energy and Resources Institute, New Delhi
7.	Dr. A.K. Tripathi	Ministry of New & Renewable Energy, New Delhi
8.	Dr. Ujjwal Bhattacharjee	The Energy and Resources Institute, New Delhi
9.	Ms. Arti Bhatia	Universal Public School, Delhi
10.	Dr. A. N. Siddiqui	Department of Education, Govt. of NCT of Delhi
11.	Mr. Hemant Sharma	Universal Public School, Delhi
12.	Ms. Anchal Shukla	Universal Public School, Delhi
13.	Mr. Shivam Raghav	Universal Public School, Delhi
14.	Sh. R.G. Gupta	Climate Change Research Society
15.	Ms. Abha Verma	Universal Public School, Delhi
16.	Ms. Chetna Lal	Universal Public School, Delhi
17.	Mr. Arjun Bakshi	Universal Public School, Delhi
18.	Mr. Sukrit Luthra	Universal Public School, Delhi
19.	Mr. Prakhar Kant	Universal Public School, Delhi
20.	Mr. Raveesh Nigam	Universal Public School, Delhi
21.	Mr. Rachit Patel	Universal Public School, Delhi

22.	Ms. Gagan Preet Kaur	Lady Irwin Collage, New Delhi
23.	Ms. Meenal Jain	Lady Irwin Collage, New Delhi
24.	Shri S. Baliga	Climate Change Research Institute
25.	Dr. Neha G. Tripathi	School of Planning & Architecture, New Delhi
26.	Shri Anish Tripathi	Climate Change Research Institute
27.	Shri Love Kumar Bansal	Climate Change Research Institute
28.	Shri Suresh Goel	Suresh Goel & Associates, New Delhi
29.	Ms. Zareen Fatima	Jamia Milia Islamia College, New Delhi
30.	Dr. V. Pradhan	Moti Lal Nehru College, New Delhi
31.	Major General (Dr.) Ashok Mehta	Free-lance Consultant, New Delhi
32.	Mr. Ram Kumar	Jagavan Media Institute, Noida
33.	Prof. A.K. Maitra	School of Planning & Architecture, New Delhi
34.	Shri Sandeep Goel	SSGA, New Delhi
35.	Ms. Neha	SSGA, New Delhi
36.	Mr. Abhijit Vaisy	InstaPower, Gurgaon
37.	Dr. Saravjit Dudeja	Consultant & Advisor on Science & Technology, Palwal
38.	Shri S. Yadav	Sharp Developments, Noida
39.	Dr. Mahavir	School of Planning & Architecture, New Delhi
40.	Mr. Maqsood Ahmad	Govt. Boys Senior Secondary School, New Delhi
41.	Shri Tilak Arora	Ekta Gardens, Delhi
42.	Mr. Muddassir	Ramjas School, New Delhi
43.	Ms. Shruti	Suresh Goel & Associates, New Delhi
44.	Ms. Bharti	SSGA, New Delhi
45.	Ms. Manoji Biju	SSGA, New Delhi
46.	Ms. Anuja Singh	Suresh Goel & Associates, New Delhi
47.	Ms. Kumari Soniya	SSGA, New Delhi

Vision

Mission

To innovate and become a center of excellence for capacity building in climate change mitigation and adaptation technology.

CCRI

Climate Change Research Institute is a unit of Climate Change Research Society, founded with a mission to promote environment education, innovation and teachings. It aims to address wide strata of society about the consequences of climate change on our lives and taking control measures. Institute is taking initiative to create awareness on energy security and sustainability through lectures in schools and college, workshops and internet reach. Its future work plan would include development of educational tools on topics of scientific and societal interest; such as energy, health and water in the climate change context. Research and studies would be undertaken on science & technology measures aimed at climate change mitigation and ways of CO_2 recycling.

For further information: Executive Director, Climate Change Research Institute, a unit of Climate Change Research Society, C-85 Shivalik, New Delhi-110017, Tel.: 011-41034450, (M): 9810287736, E-mail: info.acbccs@gmail.com