SEPTEMBER 2018

VIEWPOINT

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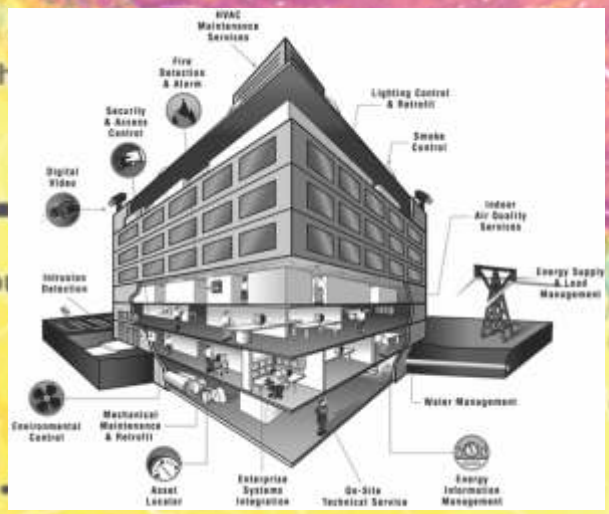
Built Environment -Energy Conservation for Utilities



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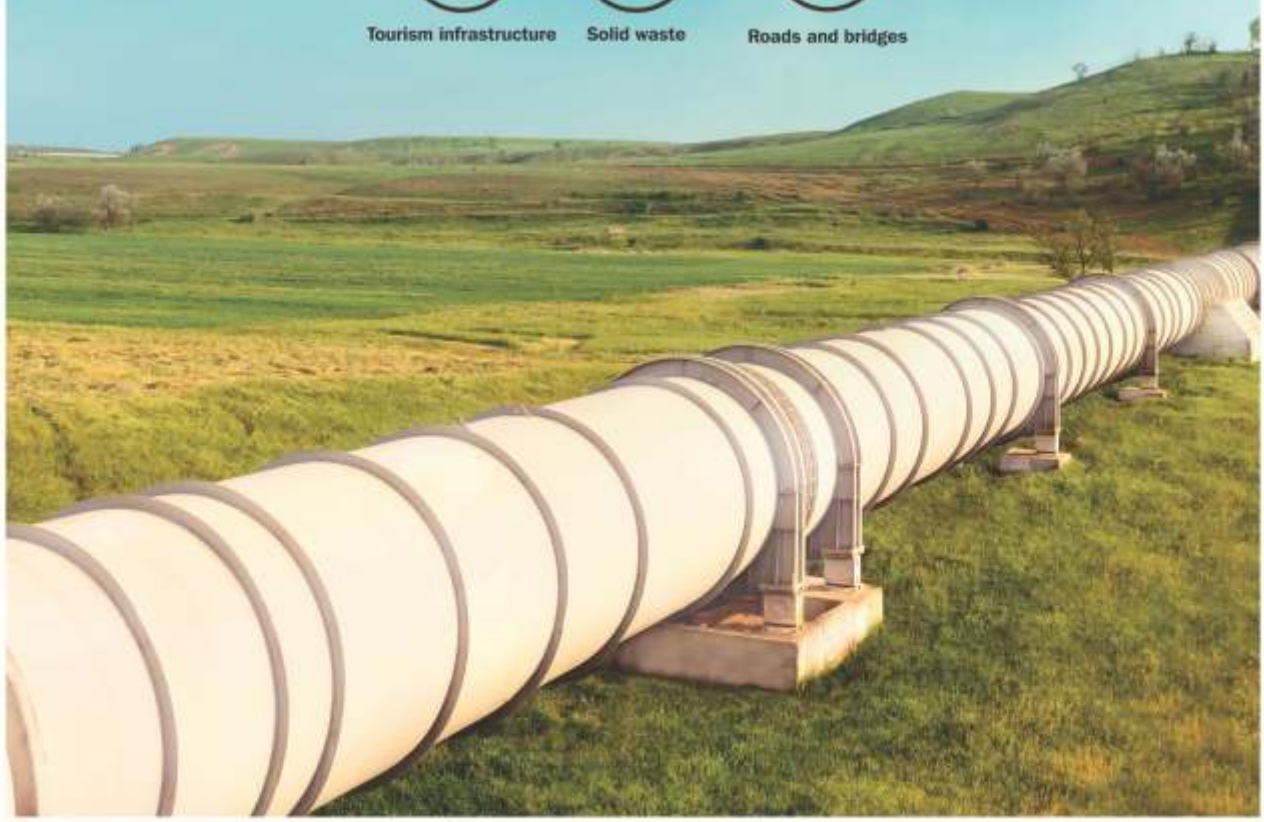

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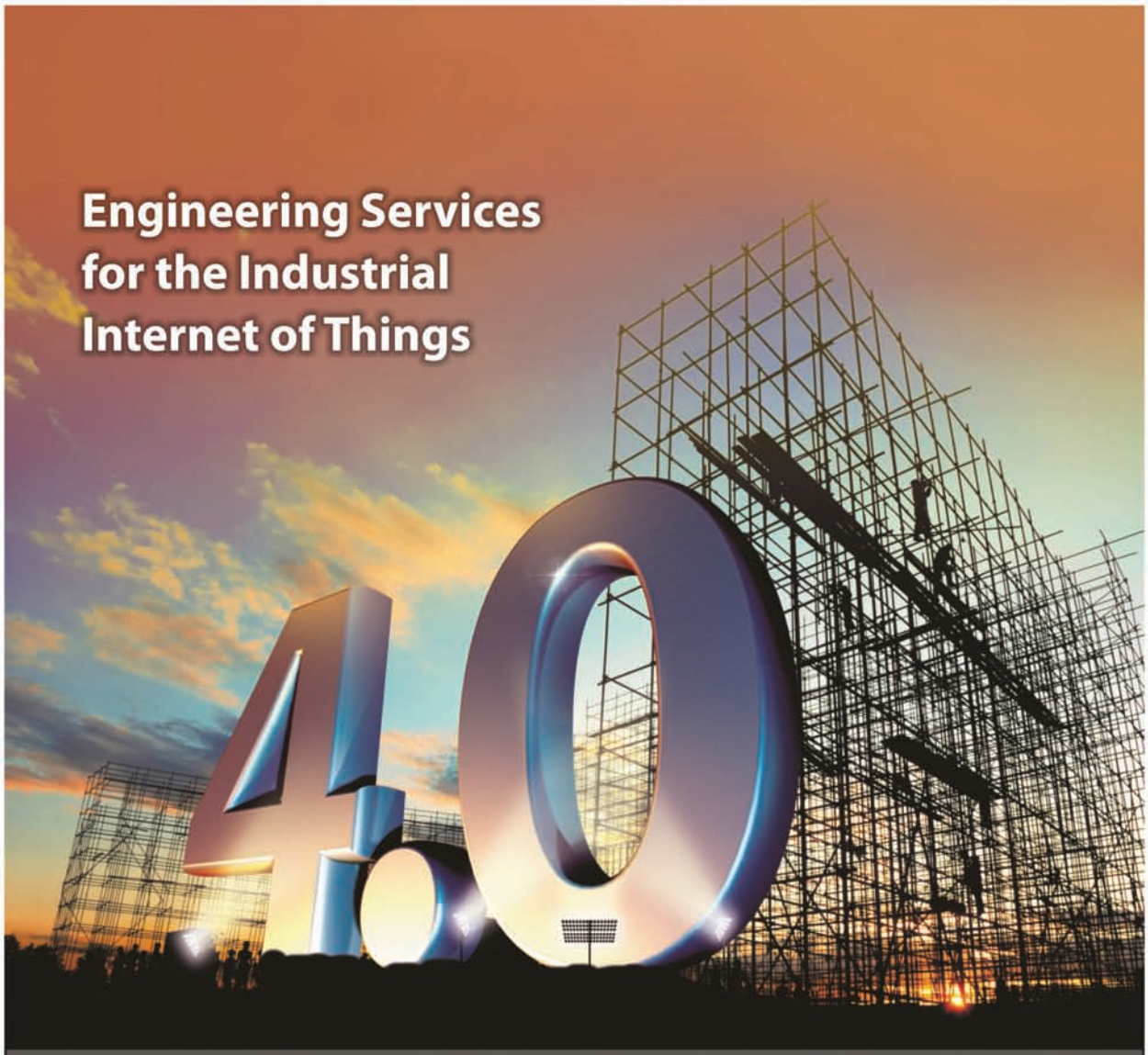

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MESSAGE FROM CHIEF EDITOR

Dear Fellow Consulting Engineers,

The built environment is expanding at a very fast space and with that the demand for electrical energy. Whilst all that it being done to improve the quality of life and liveability, commitment to sustainability requires, neigh, demands that the present and future generations usethe natural resources judiciously. Electrical energy being the sine qua non for to meet the goals of quality of life and liveability, especially with automation and robotics becoming a part and parcel of our lives, there is need that it be conserved and utilize alternate green resources for its generation. Codes have been evolved to disseminate the criteria and best practices to be followed to conserve energy. However, these need to be updated at shorter intervals to keep abreast of changing technology, usage and consequent demand.

Energy conservation for the built environment has to be dealt with in a holistic manner, integrating across all disciplines and branches of not only engineering, architecture and town planning but also encompass economics and finance, since at the end they must also be economically and financially viable. Tall buildings, which are becoming the order of the day to maximize land use, are like small towns in themselves. Energy conservation must therefore start right from their conceptualization with features and facilities built-in in an architecturally cum technically optimized well planned and coordinated manner, intertwining the energy aspects for centralized monitoring and control. At a building level they could all be integrated in to the Building Management System and for a town or city in Area and City Management Systems.

In a report, Auerbach and Wan based on extreme value analysis predict that by 2050 skyscrapers would outpace other urbanization modes and that there would be 6,800 skyscrapers per 1 billion people as against the current 800 skyscrapers per 1 billion people. Whether that's the right way to go, is debatable. However, if that happens, then with that density of population, each skyscraper would need to be self sufficient to a very great extent.

Elements must be incorporated towards mitigation of the frequently or periodically occurring natural disasters and even those that could occur due to man-made circumstances. They must be factored into and be a part and parcel of the Conceptualization to Operation cum Sustainability cycle.

Integrated design process is essential to enable optimization of the functioning of all the services/ utilities in the built environment. Sensors be they actuated by light, heat, motion, audio, visuals, etc. are all essential and it is their input and output that must be coordinated by a well designed fail safe integrated network

to a centralized control for energy conservation to be truly implemented and be effective. The systems, needless to add, would need adequate redundancies to be incorporated in them, to provide hundred percent uptime in order that safety and security are not compromised at any point of time. An integrated system effort with the objective to Reduce, Recycle and Reuse would play a very important part in economic feasibility.

This issue on the theme of *"Built Environment – Energy Conservation for Utilities"* follows the build-up from the ones on *"Environment & Climate Change"* and *"Asset Management"*. The disasters in the recent months have proved that playing with Nature results in its rebounding with a fury that leaves humans helpless. It would therefore be saner to heed the warnings, live with and in Nature in an ecologically balanced manner. It behooves that the authorities and the developers concerned ensure that experienced engineers are involved to objectively advise and also execute works in consonance with the environment thus ensuring a safe and sustainable habitat for our future generations.

Happy Reading and Learning

A P Mull

BUILT ENVIRONMENT – ENERGY CONSERVATION FOR UTILITIES

Pradeep Chaturvedi
Member, Governing Council, CEAI

Sporadic actions have been taken in urban habitat development, for example, identification of smart cities and shifting the goal posts on numbers; launching programme of survey for 60 solar cities and launching programme for skills development for sustainable and energy sufficiency. Various exhibitions and conferences on smart cities and sustainable cities have shown actions taken by individual businessmen for promotion of their products – mainly on small scale. As energy sufficiency for sustainable and smart cities is more an issue of transmission and distribution it has not received specific attention.

Promoting sustainable cities that are primarily energy efficient requires multi-sectoral investments and a range of actions including the following:

a) Planning, design and implementation of energy programme for densely, compact and accessible cities

b) Designing of clean, efficient and affordable public transportation options

c) Retrofitting of old buildings and designing of energy and resource efficient buildings (green buildings)

d) Generating energy from local clean energy sources

e) Adopting efficient municipal waste management system with resource recovery

f) Promoting efficiency in use of resources including water and electricity in the commercial and industrial sectors, as well as in the generation and transportation of energy

Cities are the most critical arena for sustainable energy deployment. For reduction in the cost of energy, efficiency improvement and use of renewable energy sources together with the associated competition in the business sector is the golden opportunity for deployment of sustainable energy in cities. This gives cities an unprecedented opportunity to transform, de-carbonize and enhance the resilience of their energy supply and consumption.

Priority Actions

The two major actions are 'policy reform' and 'more technology innovation'. There is strong need for policy reform in a dynamic mode in the energy sector considering the different innovation that had happened in the last two decades. Energy is no longer a monopoly of the sole national energy utility company. The second issue is that the innovation on the technology front, with energy efficient appliances it is becoming more and more reliable and affordable.

Growth of Urban Building

The expanding urban population of India calls for a corresponding growth in urban infrastructure for housing and for commercial growth. The NITI Aayog estimates that per capita residential space in India will increase from 1.8 m^2 to 5.9 m^2 in 2012 to 35 m^2 in 2047, and per capita commercial building space from 0.7 m^2 to 5.9 m^2 over the same

duration (estimated in 2015). As urbanization takes place at a fast pace bringing rural population to urban areas, provision of adequate housing and work space becomes an important public investment. Some urban experts believe that it is not a fact that urban areas in India are growing at unprecedented rate. The urban population in India is massive but its growth is rather slow. However, as far as energy utilisation is concerned compact and dense urbanization is much more efficient than low density urban sprawl.

The construction sector contributed to 8.2% of the National GDP and 11.52% of total employment in 2014. As economic activity in urban hot spots grows, people spend an increasing amount of time inside buildings. In developed countries people spend as much as 87% of their life time indoors, demonstrating the importance of buildings in economic growth. For India, therefore, buildings form one of the crucial areas for boosting development. The Indian construction market is expected to become the world's third largest by 2030.

Statistics of construction in residential and commercial buildings reflect this importance. In the housing segment India already had a shortage of 18.78 million housing in 2012 and needs to build a further 170 million houses between 2015 and 2030 to accommodate its urbanizing population. A multiplicity of schemes, like the Pradhan Mantri Awas Yojana (PMAY) and the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) will be dovetailed with the Smart Cities Mission, which will see provisions for adequate urban housing and a shift in the predominant fuel for domestic needs from organic fuels to electricity. The International Energy Agency projected in 2015 that in the wake of rising incomes, shifting preferences in choice of fuel, and growing markets for electrical appliances, the annual electricity consumption per household in India is expected to increase from about 1,500 kWh in 2013 to almost 3,500 kWh in 2040 (International Energy Agency, 2015). The total electricity demand of the residential sector could increase by as much as eight times in the business-as-usual scenario till 2050.

Focus on Energy Efficient Measures

The government has always focused on energy efficiency in commercial buildings. As a matter-of-fact the Energy Conservation in Buildings Code (ECBC) was developed by the Bureau of Energy Efficiency as one of the earliest step in efficiency in buildings. The Energy Conservation in Buildings Code for Housing is still to be announced. In the commercial building sector, 2017 observed a leasing volume of 3.9 million m^2 of building space, with major absorption occurring in urban centers of Bengaluru, Delhi-NCR, Mumbai, Hyderabad, Pune, Chennai and Kolkata. It has been estimated that over 800 million m^2 of commercial building space, namely hotels, hospitals, offices, retail, education buildings and places of worship, will be added to Indian cities in next 20 years. Unlike the residential sector, commercial buildings are already heavily dependent on electricity for meeting energy requirements. Electricity consumption in commercial buildings will exponentially rise with the growth of physical infrastructure, as each square metre constructed can add anywhere between 100 to 200 units to the annual electricity demand.

There is a need to disaggregate the energy consumption as per economic segments Roughly 50% of population in urban areas are without car and A.C., who consume roughly 5% of energy (also produce similar carbon/GHG emissions), whereas people with cars and A.C. consume 95% of energy and equal % of GHG/Carbon emissions (5 to 10 mt/ capita/yr.)

It is necessary to emphasise on the three critical areas of energy consumption which are – mobility, cooking and A.C. As per NITI Aayog, with a financial growth of 7 to 8% per annum every building by 2031 will be air conditioned. For cooking, it may be suggested to mandate that the establishments serving more than 600 meals/day shall use at least 80% of renewable energy (large hotels, restaurants, canteen, hostels, langars, railway stations, army/ police mess, etc.)

It is not difficult to see then, how the buildings sector in India will assume an ever greater importance in the national energy consumption landscape. In 2013 buildings contributed 41% to the total energy consumption of India. If no

interventions are made for energy efficiency this share will still climb rapidly. Studies place the energy saving potential in the commercial buildings sector to up to 21 billion units of electricity through implementation of energy efficient measures. Minimum Energy Performance Standards (MAPS) and appliance energy labels could mitigate residential energy consumption by 23% and 24% respectively. In the case where existing and planned policies are implemented, the share of buildings in total energy consumption could come down to 23% by 2040.

India's efforts at energy conservation measures have been accepted worldwide. It has found recognition in The World Bank, UNDP and studies by other international organisations. India has introduced innovative implementation strategies and its energy efficiency policies are being implemented at some of the largest scale in the world. The UJALA Yojana has seen the price of energy efficient LED bulbs decreasing rapidly due to demand aggregation introduced by BEE. The Bureau of Energy Efficiency launched the Standards and Labeling scheme for appliances in 2006, which has effected and estimated energy saving of 111.68 billion units of electricity till March 2018. The Energy Conservation in Buildings Code (ECBC) launched in 2007 and revised in 2017, targets energy efficiency in the commercial buildings sector through minimum energy performance standards and passive design, and has been made mandatory by eleven major states and union territories of the countries.

The latest version of the National Building Code (2016) also has provision on energy conservation measures and sustainability measures to make green buildings and bring down the energy consumption levels. The National Building Code of the Bureau of Indian Standards is not a mandatory code, but only recommendatory. However, it is left for various central and state urban local bodies to adopt this code for buildings under construction. Once it is adopted then it becomes mandatory in the jurisdiction of those urban local bodies. By and large the urban local bodies are adopting the National Building Code and therefore provisions are becoming legally binding on builders. Such a move is expected to make its impact over time.

Major Challenges to Energy Efficiency in Building in India

The Energy and Resources Institute (TERI) has observed that as of 2016, green buildings, of which energy efficiency is a key component, represented about 3% of the built environment in India. Given that the ECBC was launched by the Ministry of Power (MoP) in 2007, the Green Rating for Integrated Habitat Assessment (GRIHA) was developed by TERI and adopted by the Ministry of New and Renewable Energy (MNRE) in the same year, and the Indian Green Building Council (IGBC) was formed in 2001, this is still a very small proportion. The low penetration rate is a testament to the barriers faced by the movement to make buildings more energy efficient. Although the concept of energy efficient buildings has made considerable inroads into the domestic discourse over the past two decades, so much so that it was mentioned as one of the key strategies to mitigate CO_2 emissions in the Nationally Determined Contributions (NDC) to the Paris Agreement in 2015, its adoption on-ground remains thin.

The challenges of building energy efficiency vary and are many. The biggest challenge is of attaining energy efficiency through retrofitting old buildings. Basically the challenges can be categorized under technical challenges, financial challenges and policy challenges. For the purpose of the present paper, the issues concerning technical challenges will suffice.

The number of qualified civil engineers and contractors in the construction sector is significantly high. But the inadequacy of technical capacity for implementing and analyzing energy efficiency measures comes glaringly to the fore when we consider required skilled expertise on part of building practioners including architects, engineers and maintenance personnel. There is also lack of understanding on part of the officials handling building by-laws and real estate regulators which become a major hindrance in effectively implementing energy efficiency programmes. Most often the urban local body officials are trained civil engineers but are lacking in technical capacity to evaluate particular energy efficiency measures. Such bodies also do not have additional staff that can be trained on ECBC.

There are energy efficient building designs that are being discussed and considered by architects. Such measures are always accompanied by additional investment at the construction stage. The architects and builders are not able to convince the owners about the savings due to energy efficiency technologies. Many a times they are not able to indicate cost additions because of such measures. The examples show that builders project such additional costs anywhere from 2% to 10%. But none of them will be able to back it up with correct data analysed by any authentic agency.

This becomes much more challenging in case of retrofits. In many cases energy efficiency can be achieved from zero cost measures involving only operational changes. Such data may or may not be available with the operation and maintenance team for creation of baseline. The difficulties can go on and on. Higher upfront costs are definitely considered to be a bane in energy efficiency measures.

Study by INAE

Indian National Academy of Engineering (INAE) has launched a study on energy solutions for sustainable and smart cities with the title "Clean and Green Energy in Urban Development" in collaboration with TERI. This has just been launched after considering the following objectives.

a) To study sufficiency and effectiveness of the energy policies and actions at national, state and municipal levels for meeting energy requirements in all sectors and to propose effective policy interventions.

b) To study the design and planning of the urban form, infrastructure and buildings, according to their local environment and climate and identify areas of energy and resource efficiency including in materials.

c) To study the impact of programme of smart cities and solar cities and propose effective models for smart grids for major energy efficiency and project the use of ICTs for ensuring efficient energy application in the end use.

d) To identify bottlenecks in urban transport systems and the road map for technology development for effective transportation and battery storage system and switching over to inter-model system.

e) To develop a framework as to how researchers and industrialists should jointly work to develop technologies and effective implementation strategies and efficient project management so that the manufacturers in India not only meet Indian demand but also capture international markets.

f) To identify financial needs for cost effective development of all activities related to the above objectives and indentify sources of funding in a turbulent time when banks are not willing to take the strategic business risks and fund new projects.

g) The Way Forward

The study is expected to identify major actions for implementation in different sectors which include energy efficiency in building sector.

Conclusion

The consultants have an important role to identify the challenges and their implementable solutions not only for the technical issues but also for market barriers, policy framework, financing, limited capacity for design, planning and implementation, affordability, and reliability of energy supply all the time. The consultants also have an important role of communication with the government agencies, planners, owners, and regulators to ensure that the messages to various stakeholders are effectively communicated. Any lack of communication could cause a serious setback.

ENERGY CONSERVATION IN BUILT ENVIRONMENT IN SMART CITIES

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ABSTRACT

Installed capacity of power generation in India is 344 GW and there is not likely to be any significant capex investment in coal fired plants. The Government is providing thrust on the generation side through renewables and on the demand side through energy efficiency of built environment. As more and more people move to the cities for livelihood, the Ministry of Housing and Urban Affairs is implementing 100 Smart City projects in the country with smart solutions to enhance liveability index in urban areas. Energy efficient infrastructure is a key component of these smart solutions. This paper describes various concepts adopted for energy conservation in built environment especially in smart cities along with integration of renewables.

1. INTRODUCTION

Total installed capacity of Power Generation in India, as of March 31, 2018, is 344 GW[1]. Coal-fired plants account for 57% of this and Renewable Energy 20%. Projected installed capacity by 2021-22 is 479 GW and by 2026-27, 619 GW. The projections indicate that there would not be addition of any new coal based plants in the near future and the only addition would be from plants which are in various stages of construction. The Government of India has taken policy decisions for adding more Renewable Energy which is targeted to reach 44% by the year 2027 and Solar alone is targeted to reach 100GW of installed capacity by the year 2022 [1]. The Government also has plans on the Demand Side Management, through which measures are taken at each consumer end for Energy Conservation, for e.g., Energy Efficiency measures in Building Codes and building designs, time of use tariff, reduction in AT&C losses, energy efficient lighting solutions, distributed generation and micro-grids.

The Smart City initiative of Government of India is primarily intended to improve quality of life in an environment friendly manner and also adopt some of the above measures which would minimize carbon foot print in city space and provide sustainable living conditions to the population at large. An attempt is made in this paper to review Energy Conservation techniques and Renewable Energy technologies that could be adopted in Built Environment, Urban spaces and Manufacturing sectors in Smart Cities.

2. SMART CITIES PROGRAM OF THE GOVERNMENT OF INDIA

As per 2011 Census data of the Government of India, about 31% of India's Population lives in Urban Areas contributing 63% to the GDP of the country. As per projections, urban population in India would be 40% of total population by 2030 and would contribute 75% of the overall GDP. This necessitates a comprehensive development of Physical, Institutional, Social and Economic Infrastructure of Urban Local Bodies (ULBs) of the country. The Ministry of Housing and Urban Affairs (MOHUA) has come up with the Smart City Mission Program as a structured strategy to face this challenge. The mission is to cover 100 cities over a period of 5 years starting from Financial Year 2015-16 and ending by 2019-20.

The objective of the Smart City Mission in these 100 cities, which are already providing basic infrastructure to their citizens, is to adopt Smart solutions which would have an impact on Liveability index of the city. The main pillars that constitute the Liveability index of a city are shown in Figure 1[2].

As a part of this program, ULBs need to adopt Smart solutions which would have following features.

- World-class benchmark Liveability Index by providing 24x7 Water supply, 100% Power supply and Solid waste management facilities
- Environmentally sustainable technology to minimize pollution levels of air, water and land
- Minimum 10% of city's power demand met from renewable energy source
- Robust IT and digitization framework
- Affordable housing for urban poor
- e-Governance with citizen participation
- Urban mobility and public transport
- Pollution free urban transport by adopting Electric Vehicles
- Health and Education
- Safety and Security of Citizens

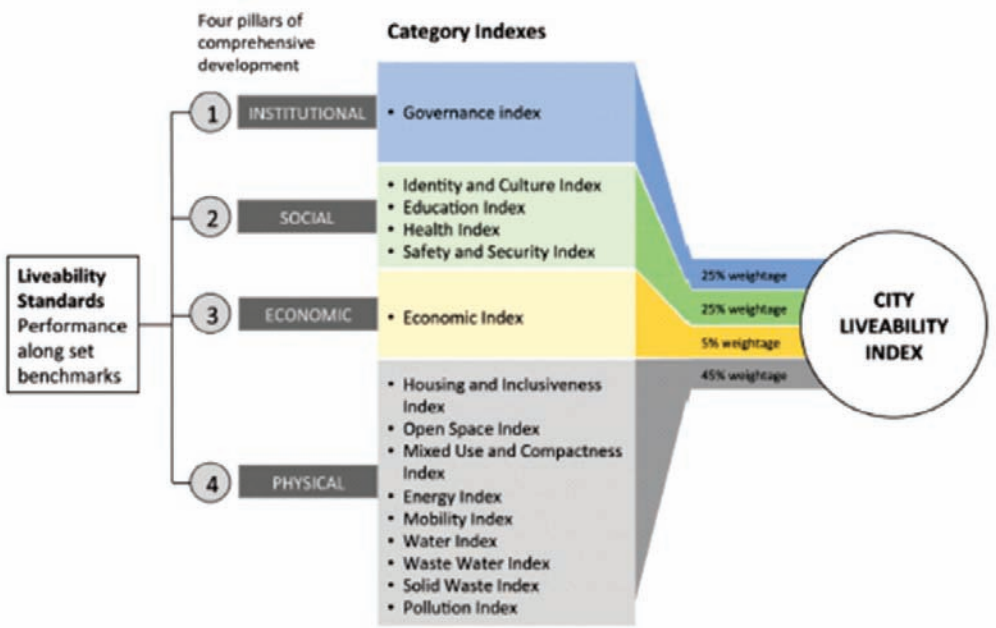

Figure 1: Factors impacting Liveability Index[2]

Total allocation of funds for Smart city projects by Government is Rs. 100,000 Cr. Smart city projects are classified into two categories, viz., Pan City Projects and Area Based Development (ABD) Projects. Key features of Pan city projects are related to Information and Communication Technology (ICT) – that includes laying of optical fiber cables, Integrated Traffic Management System (ITMS), e-Governance, Automated city level waste collection system, Utility Management System, City Level Command and Control Centre, etc. Further, roof top solar on the Government Buildings also forms a part of these projects. In ABD projects, a small area within the city is identified and the infrastructure in this area is developed with identified smart solutions so that this area becomes a benchmark for Infrastructure and develops as a Role model for other parts of the city in Infrastructure development. The ABD

projects are classified broadly into 3 categories:

City Improvement projects (Retrofitting) – a minimum area of 500 acres (202.3 hectares) is identified for which a holistic improvement of infrastructure is worked out adopting smart solutions.

City Renewal projects (Redevelopment) – a minimum area of 50 acres (20.23 hectares) of existing area inside the city is identified. Old and dilapidated structures are removed and new layout is developed in the same space with extra Floor Space Index (FSI) and Smart Infrastructure.

City Extension projects (Greenfield) involve developing a vacant area available in the city with higher FSI and world class infrastructure.

3. SMART CITIES PROGRAM

The Smart Cities program could be considered to have begun in 2010 with the GIFT (Gujarat International Financial Tech city) city project at Gandhinagar, Gujarat. It is a green field project developed with mixed land use catering for the purposes of an International Financial Business hub. It is planned to occupy 800 acres (323.75 hectares) of land with a total built-up area of 8.5 million m^2 catering to a population of 900,000.

The Key Infrastructure features developed at GIFT city include Integrated underground utility tunnel which carries power cables, optical fibre cable (OFC), solid waste collection pipes, chilled water, treated water, potable water etc.; District cooling system, Automatic waste collection system, Reuse of treated water for HVAC system, flushing, etc., Sustaining buildings meeting all green building norms and no DG back up for buildings by providing reliable power supply system, taking dedicated power supply from 2 different source substations, ring main underground cable distribution network, compact distribution substation, etc.

The green field industrial townships at 8 nodes for DMICDC (Delhi Mumbai Industrial Corridor Development Corporation) at Dholera, Manesar-Bawal, Pithampur-Dhar-Mhow, Shendra-Bidkin, Khushkhera-Bhiwadi-Neemrana, Dadri-Noida-Ghaziabad, Jodhpur-Pali-Marwar and Dighi Port Industrial Area / Investment Regions in the states of Gujarat, Haryana, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh are also considered as Smart cities. As per DMICDC's official website [3] 'Delhi - Mumbai Industrial Corridor (DMIC) is India's most ambitious infrastructure program aiming to develop new industrial cities as "Smart Cities" and converging next generation technologies across infrastructure sectors. The objective is to expand India's Manufacturing & Services base and develop DMIC as a "Global Manufacturing and Trading Hub". The program will provide a major impetus to planned urbanization in India with manufacturing as the key driver [3].

For all of the above projects, some of the key infrastructure components considered include 24x7 water supply with minimum NRW (non-revenue water) losses in distribution system meeting international bench mark; Reuse of treated water for flushing and gardening; and providing dual plumbing system in buildings; All buildings are constructed meeting green building norms; Roof top solar on all buildings with net metering; 24x7 power supply with power quality meeting global standards considering smart grids, energy storage, ring underground cable distribution system, etc.; Automatic waste collection system and complete processing of waste generated; Integrated utility corridors; District cooling system; Energy efficient street lighting; SCADA system for utility management; Smart metering for water and power; CCTV cameras for safety and disaster management and OFC cables, city level command and control center for city management, traffic management and e-Governance.

The Ministry of Housing and Urban Affairs (MOHUA) initiated the process for selecting 100 smart cities all over India in 2016. The selection process had two stages: Stage – 1, that involved selection at each state level and selected entries forwarded to Central Government; and Stage – 2, a challenge round, in which the potential city is expected to

prepare a proposal document by studying the city conditions in a holistic manner for development. The proposals by the participating cities were evaluated and the wining cities were included in the list of 100 smart cities and accordingly allocated funds for development.

Consulting Engineers were actively involved in supporting various Municipalities in preparing the Challenge Proposals. The time duration for preparing the challenge was typically 3 months. The budget allocation for each city varied from Rs.1,000 to Rs. 2,000 crores approximately.

The Cities which qualified to enter the 100 smart cities list formed a Special Purpose Vehicle (SPV) and floated tenders for Project Management Consultancy (PMC) to execute the projects. The main task of these PMC's is to support the SPV's to execute the projects on the ground as identified in Smart City Challenge Proposals.

4. ENERGY CONSERVATION IN BUILT ENVIRONMENT IN SMART CITIES

The Energy Conservation Act was enacted in 2001 and the Bureau of Energy Efficiency (BEE) was created in 2002. Due to various measures initiated by BEE, 2.8% of total energy consumption could be saved by the year 2013, which avoided generation of 36 GW.

Bureau of Energy Efficiency has revised the Energy Conservation Building Code (ECBC) in 2017 [4] which is a step towards achieving energy neutrality in commercial buildings. This establishes minimum performance standards for buildings. ECBC 2017 defines performance levels and incorporates advanced technologies, integration of renewable energy and passive design strategies (using local resources and climatic conditions in design). It defines mandatory requirements, prescriptive requirements and whole building performance method for ease of compliance.

In the following sections, some of the measures adopted by the authors in the design of smart cities are described.

Typical break up of Power demand for a Built Environment consisting of Residential and Commercial complexes is indicated in Table 1.

Description	Break up in %
Lighting & all socket loads	60%
HVAC	30%
Others	10%

Table 1: Breakup of Power Demand in a typical Built Environment [5]

As is evident from Table 1, significant Power Demand in Built Environment is shared by Lighting and HVAC systems. Hence various measures, as listed below, need to be deployed in these areas to achieve energy conservation.

4.1 HVAC System

In an HVAC system, some of the reasons for high power consumption are:

- Oversized Equipment
- Variable Load
- Manually Operated System
- Inefficient / aged system
- Inefficient preventive maintenance

The technologies to address these challenges and bring down the power consumption are discussed below.

4.1.1 Variable Speed Chillers

In most of the buildings in Indian cities, the type of air conditioning used is of air cooled type which consumes power in the range of 1.3kW per ton refrigeration (TR). As per study conducted by ASHRAE in 2001, it is possible to bring down the power consumption to 0.5kW per TR through utilization of Variable Speed Chillers and real time sensing of temperature, humidity and automation for varying the speeds accordingly.

Figure 2 below shows graphical representation of how the power demand for HVAC system can be optimized by using various techniques [6].

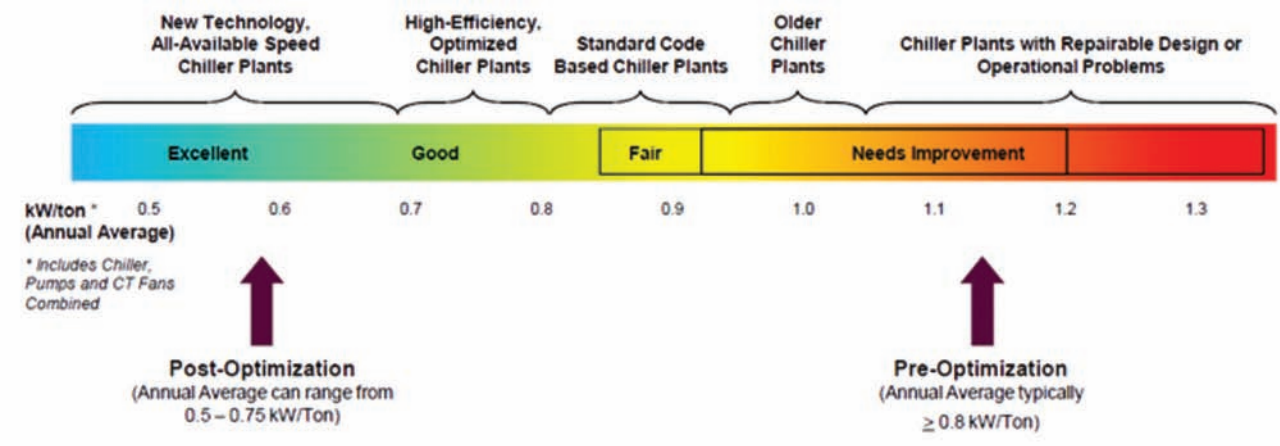

Figure 2: Optimization of HVAC system [6]

4.1.2 Reuse of Byproducts from HVAC system

Effectively using the byproducts of a HVAC plant would result in overall energy efficiency. HVAC plant generates hot water and buildings such as hotels and hospitals require hot water. During planning and design stages of HVAC system for such buildings, utilization of hot water generated should be considered.

4.1.3 Sustainable Planning for Buildings

Sustainable planning involves carrying out thermal modeling of a particular site and the built environment to analyze the path of sunlight and then optimize its shape and orientation so that the building is exposed to optimum heat minimizing the temperature difference between outside and inside of the building thereby minimizing overall HVAC requirement. External cladding and glazing could also be planned and designed to minimize heat gain/ loss as well increase natural ventilation in and around the building, as desired. Some of the BIM (Building Information Modeling) tools have this capability.

Another approach involves 100% natural HVAC system which is developed by studying the wind patterns, velocity and direction. This is known as Passive Downdraught Evaporative Cooling (PDEC). For this wind towers are built at strategic locations of building to capture the wind and channelize the wind through ducts which are sprayed with water. The Hot air entering from outside evaporates the water and during the evaporation process the air gets cooled and the same is circulated inside the building.

Further, buildings with glass facades can be provided with double glazed glass which is having better thermal insulation properties. The glazing could also be designed to get minimum direct solar heat.

DISCOMS may implement time of the day metering system with lower power costs during nonpeak hours. Buildings with centralized chiller plants may be provided with thermal storage facility for chilled water in the basements or in underground holes. Most of the commercial complexes require the HVAC system during day time, so the buildings with thermal storage can operate their chiller plants during nonpeak hours and store the chilled water and same could be utilized during day time.

4.1.4 City Level Infrastructure Planning

In green field projects with mixed land use, i.e., built up area consisting of residential and commercial spaces, with large requirement of HVAC systems, the design may be carried out as city level Centralized District Cooling System (DCS). This could also be implemented in existing urban areas which are being redeveloped or space available to suitably locate a DCS plant.

Utilizing some of the concepts listed above, the power demand for HVAC system can be optimized to about 0.9 kW per TR. Another tangible benefit that can be achieved with this system is utilization of recycled water from Sewerage Treatment Plants (STPs) for make-up water in cooling towers of the District cooling systems.

The overall Schematic Diagram of DCS for a typical city project is shown in Figure 3 below [7]:

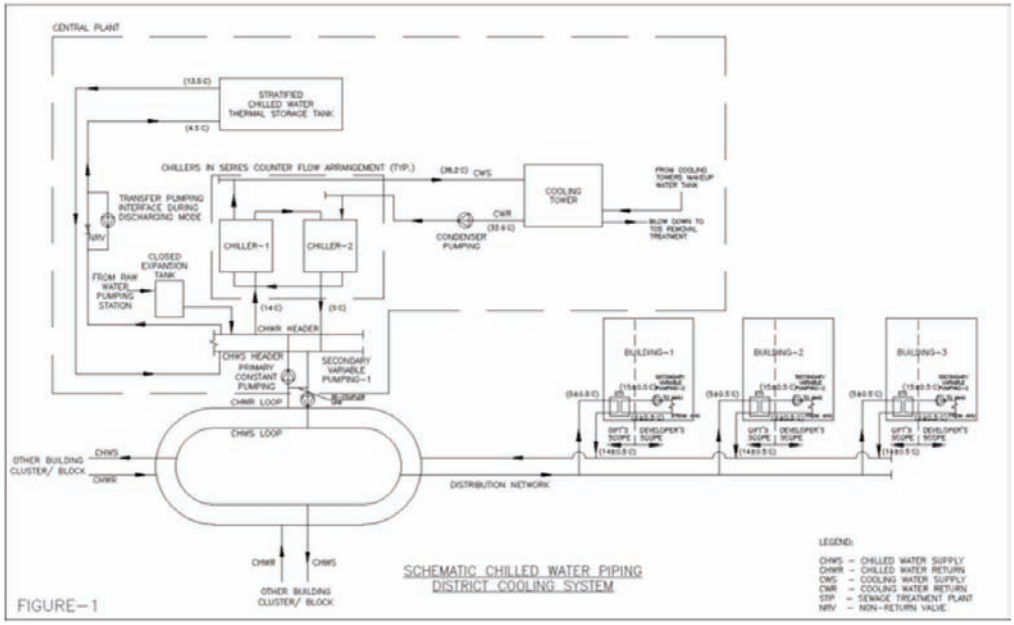

Figure 3: Overall schematic of a District Cooling System [7]

4.2 Lighting System

Lighting system includes building lighting, all socket loads such as refrigerators, fans, etc., area lighting and street lighting and is the prime energy consumer in a city. Some of the best practices followed to achieve energy efficient lighting designs are:

- Use of energy efficient control gears

- Integration of lighting system design with day light using BIM tools
- Use of occupancy sensors for switching on/ off or dimming the light
- Use of fixtures with photometric characters suitable for specific task for which lighting is used
- Avoidance of wastage of light by selecting proper cut-off angle of luminaire
- Use of LED lamps instead of conventional lamps
- Use of LED lamps for street lighting instead of high pressure sodium vapor (HPSV) lamps
- Design of Intelligent Street Lighting Management system which turns on/ off based on traffic as well as day light

Table 2 below gives a comparison between LED lamps and conventional lamps [8].

Light Technology	High Pressure Sodium Light	Compact Florescent Light	Florescent Light	LED Light
Life Time (approx.)	12000	6000 – 15000	10000	50000
Lumens per watt	45 – 130	50 – 70	60 – 100	70 – 150
Color Temperature	2000K	3500K	2700K – 6200K	4000K – 6400K
Color Rendering Index	25	80	70 – 80	85 – 90
Ignition Time	Minutes	Second	Instant	Instant
Drawback	Mercury & Lead	Mercury	UV Radiation	High Initial Cost

Table 2: Comparison of LED lamps with conventional lamps [8]

4.3 Energy Efficient Pump Drives

In a typical city, water supply, waste/ sewage water and storm water management requires considerable amount of power. The systems since they consists of intake water pumping stations, treatment plants, sewage pumping stations and sewage treatment plants, pumping for disposal or reuse, storm water pumping stations & plants, treatment plants and disposal or reuse. Many of these assets in Indian cities are more than 30 years old and are working on out- dated equipment and hence require efficiency improvements.

In such situations, energy audits must be conducted on existing assets and pumping systems must be redesigned with energy efficient motors for pumps along with deployment of variable frequency drives (VFD's) wherever required. Redesign of the water distribution networks with proper zoning and design of the systems with gravity flows minimizing pumping requirement would result in energy efficiency. Similarly, sewage systems may be redesigned with decentralized package STPs which can minimize the sewage pumping requirements. Further, all treatment plants and pumping stations can be automated with SCADA system along with deployment of IOT sensors in distribution networks, pumping stations and treatment plants with necessary control logics in place to ensure energy efficiency. Same applies to storm water management as well.

5. RENEWABLE ENERGY INTEGRATION IN SMART CITIES

As mentioned earlier, the share of renewable energy sources (RES) in country's installed generation capacity is about 20% and Ministry of Power has set a target of achieving 37% share by year 2022; the targeted quantum is 175 GW. Out of this, the targeted share of roof top solar is 40GW. Therefore, MOHUA has set guidelines that in all Smart

Cities, 10 % of city power demand needs to be met from renewable energy sources. Considering the Indian cityscape, following are some of the practicable renewable energy sources that could be planned in the city.

- Roof top solar units
- Power generation from municipal waste
- Cogeneration in sewage treatment plants

5.1 Roof Top Solar Plants

The concept of roof top plant is based on grid connected solar panels installed on terraces of various buildings in urban areas. A typical concept diagram is shown below in Figure 4.

1kW generation through solar panels would typically need an area of 10 to 12 m^2. In order to encourage installation of roof top solar units in the cities, the state needs to implement a net metering policy and conventional energy meters need to be replaced with net meters at each consumer end.

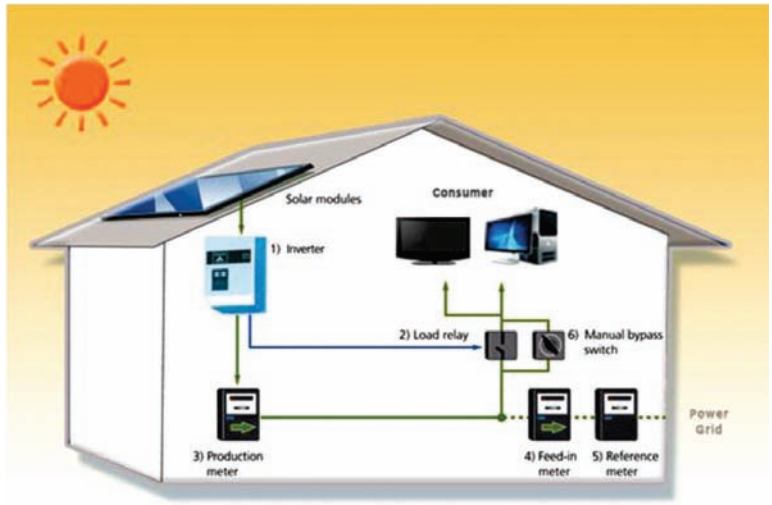

Figure 4: Typical Concept Diagram for Roof Top Solar Unit

In all Smart cities, the authorities have planned to implement roof top solar units in following spaces:

- Terrace areas of all government buildings
- Top of canals
- On the sides of roads above cycle tracks
- Solar trees in open areas and gardens
- Bus stops (top of shelters) and top of skywalk roofs
- Opens spaces available in sewage treatment plants, water treatment plants and pumping stations
- e-Vehicle charging stations

As per existing energy policy in many states, each consumer can export power to grid starting from 10% to 100% of existing contract demand as per regulatory norms of each state.

In most of Smart city projects, roof top solar units are planned on PPP mode in which the Municipal authorities are facilitating providing space at public areas and government buildings. Private operators install the Solar panels and have agreement with space owners for installing the panels. Space owners would have separate agreements with

electricity boards for installing net metering and agreement for selling excess power. Some cities have proposed tendering through EPC mode in which the city authorities are identifying places such as top of canals, treatment plants, along roadsides, on top of skywalk, etc., and are using that power either to meet power demand or to sell excess power.

5.2 Power Generation from Municipal Waste

In all cities, solid waste management is a major challenge and all smart cities have planned a robust solid waste management system and processing of the waste after collection. A typical Waste to Energy (WTE) plant requires minimum 300 TPD solid wastes as input to make the system economically viable. 1 MW Waste to Energy plant requires 100 TPD waste as input.

There are broadly two types of waste processing technologies used – thermal process and biological process. Figure 5 gives an overview of various technologies [9].

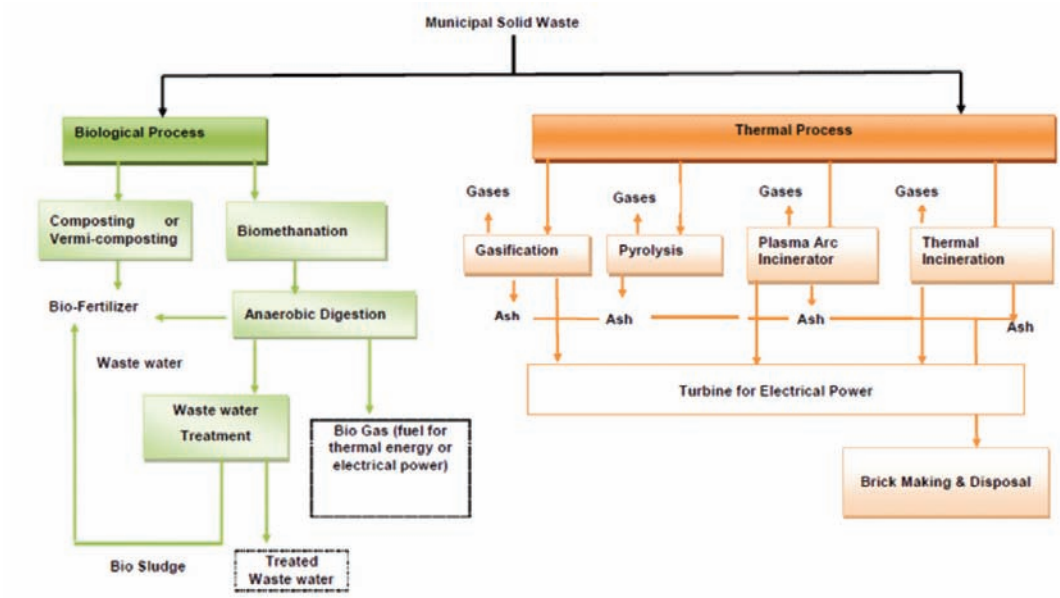

Figure 5: Waste to Energy Technologies [9]

5.3 Cogeneration in Sewerage Treatment Plants

STP consumes high power based on the type of process being used. There are two options in which cogeneration can be harnessed from STPs:

Option-1: Burning of Methane Gas Generated from Process. This is based on BOD content of sewage and ambient temperature, and approximately 8 to 10kW of Power can be generated per MLD of installed capacity of STP. This can recover approximately 30 to 40 % of power demand of STP operation. This option is economically viable for STPs with capacity of 50 MLD and above.

Option-2: Installing Solar Panels in Open Spaces & Roof Tops in Treatment Plant. This is based on open spaces and roof tops available in each STP. Roof top solar panels can be installed at the rate of 10 to 12 m^2 per kW, as mentioned earlier.

The CPCB has classified the cities based on their population. Approximate capacity of STP's, its potential for power generation and space requirement (assuming Sequential Batch Reactor – SBR technology for waste water treatment) for the same is depicted in Table 3 [10].

Sr No	City Category	Approximate STP capacity in MLD	Potential for Cogeneration in MW	Space Requirement based on SBR technology in m^2
1	Class-1 Cities having population > 10 Lakhs	346	3.46	190,300
2	Class-1 Cities having population 5 - 10 Lakhs	120	1.2	66,000
3	Class-1 Cities having population 2 - 5 Lakhs	40	Economically Unviable	22,000
4	Class-1 Cities having population 1 - 2 Lakhs	18	Economically Unviable	9900
5	Class-2 Town having population 0.5 - 1 Lakhs	6	Economically Unviable	330

Table 3: Cogeneration potential in Sewerage Treatment Plants [10]

Considering 50% of space is available for installation of roof top solar units, there would be a potential for generation of at least 8MW solar power in addition to what is stated in Table 3.

6. BEYOND THE BUILT ENVIRONMENT

All smart cities are provided with an integrated City level Command and Control Center, which is a city level management system with e-Governance and physical infrastructure.

A typical Block diagram of City Management System is shown in Figure 6.

The broad components of City Management System are shown below:

- Command and Control Center consisting of video wall and data center
- City wide Optical fiber network
- IOT sensors for collection of data
- Interface with SCADA system of utilities

This management ecosystem would collect huge amounts of data from various city level activities; the collected data would be analyzed using data analytics and utilized for activities mentioned below.

- Forecasting of Physical Utility Infrastructure
- e-Governance
- Disaster Management
- Safety and Security
- Health and Education

An integrated command center can be programed with control logics to ensure energy efficiency at the city level.

Energy Management System at the level of public built utilities as well as utilities beyond built environment (public spaces) can be a part of either a local command center or an integrated command and control center at the city level.

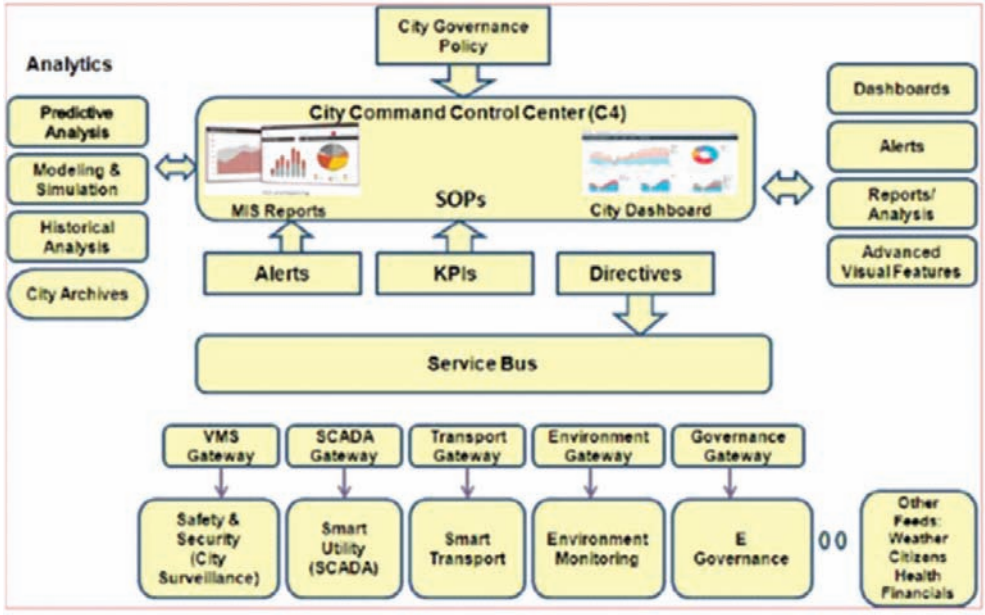

Figure 6: City Management System

7. ROLE OF BIM IN ENERGY CONSERVATION

Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. BIM can be utilized during the complete Life Cycle of any Built Environment Project.

3D tools are available to develop integrated 3D models which may be located on a GIS platform enabling development of accurate thermal models of a building. Based on the thermal model of a building, an optimized HVAC system could be designed and by leveraging the natural light, the building lighting design can be optimized ensuring energy efficiency.

BIM is utilized to design advanced Building Management System (BMS) where the digital twin of the building can be located at a Central Monitoring Station and utilized for real time monitoring of climatic conditions, access control, security monitoring, utility tracking, lighting management, outage management and maintenance requirements. Energy efficiency is ensured through the monitoring stations.

In green field projects, where a new master plan is developed on a GIS platform integrated with BIM, and necessary energy efficiency measures are a part of the design using Industry 4.0 principles. In brownfield projects, the area to be developed is digitized by conducting Drone Surveys and laser scans of underground utilities and the data is integrated on a GIS platform. This digitized GIS maps are used in City level Command and Control Center for City Management activities.

8. INDUSTRY 4.0 AND ENERGY CONSERVATION

Cities of the future would be smart and connected. Electricity value chain that has traditionally been one way (generation, transmission, distribution, devices and consumer) is maturing into a two-way distributed resources regime in which every consumer is a generator as well. Information is collected at every instant and based on need; anyone can consume or share energy from their roof top or their electric vehicle. Access to energy gets decentralized. Smart

transportation systems including electric vehicles with charging infrastructure, energy storage facilities, micro-grids with renewable integration, smart grids, smart water and waste water systems, public spaces, built utilities and commercial spaces, homes, parks, buildings, all can get connected with each other with sensors and instrumentation in place generating and transmitting huge amount of data which gets analyzed; analytics ensures decisions are taken to becoming more and more 'smarter' day by day in energy consumption. Artificial intelligence plays a key role in making these smarter and self-learning. Necessary information and communication infrastructure needs to be in place and the future is all about utilizing minimum amount of energy efficiently and ensuring sustainability.

9. SUMMARY

With the thrust on renewable energy by the Government of India on the generation side, several measures are initiated also on utilizing available energy smartly and efficiently on the demand side. 40% of India's population is expected to be in urban environment by 2030 and Smart cities program is intended to make the cities more livable and energy efficient. Various energy conservation measures adopted in built environment in these smart cities is discussed in detail with respect to HVAC, lighting, water and waste water management, etc. Renewable integration in smart cities is described focusing on roof top solar, power generation from municipal waste and cogeneration from sewerage treatment plants. Role of BIM and Industry 4.0 are stated in making our future cities smarter and self-learning with respect to energy conservation.

10. TCE's contribution to growth of Smart Cities

TCE started their work on Smart Cities with the GIFT (Gujarat International Financial Tech city) city project at Gandhinagar, Gujarat. Three of the townships for DMICDC (Delhi Mumbai Industrial Corridor Development Corporation) at Dholera, Dadri-Noida-Ghaziabad, and Vikram Udyogpuri in Ujjain are conceptualized by TCE. The Vikram Udyogpuri township is planned over an area of 1096 acres (443.54 hectares) as an industrial township. The city is planned for mixed used development with a manufacturing hub for non-polluting industries, higher education hub and residential development. The Industrial Township at Dadri is developed on an area of 755 acres (305.54 hectares) with 50% area earmarked for industries which mainly include Hitech industries, Biotech and R&D setups. In Dholera TP-2 (West) is an industrial township at Dholera, Gujarat. The total area of this township is 43 sq km.

The successful cities for which TCE assisted in preparation of proposals were: Vadodara, Rajkot, Dahod, Gandhinagar, Amritsar, Chennai, Puducherry, Tiruchirapally, Aligarh, and Moradabad.

A snapshot of TCE's engagement as PMC in execution of Smart City projects is shown in Figure A. At present, out of 100 cities, TCE is involved as PMC for 13 cities across 7 states in India and is responsible for a capital expenditure of more than Rs. 22,000 crores. Out of this, execution is in progress for Rs. 1,500 crores. Tenders have been floated for about Rs. 8,000 crores. Further work is in progress and this engagement would continue till 2023.

Tata Consulting Engineers is also involved in several WTE projects including 3000TPD project at Deonar for Municipal Corporation of Greater Mumbai and Refuse Derived Fuel (RDF) based WTE project at Kancheepuram in Tamil Nadu.

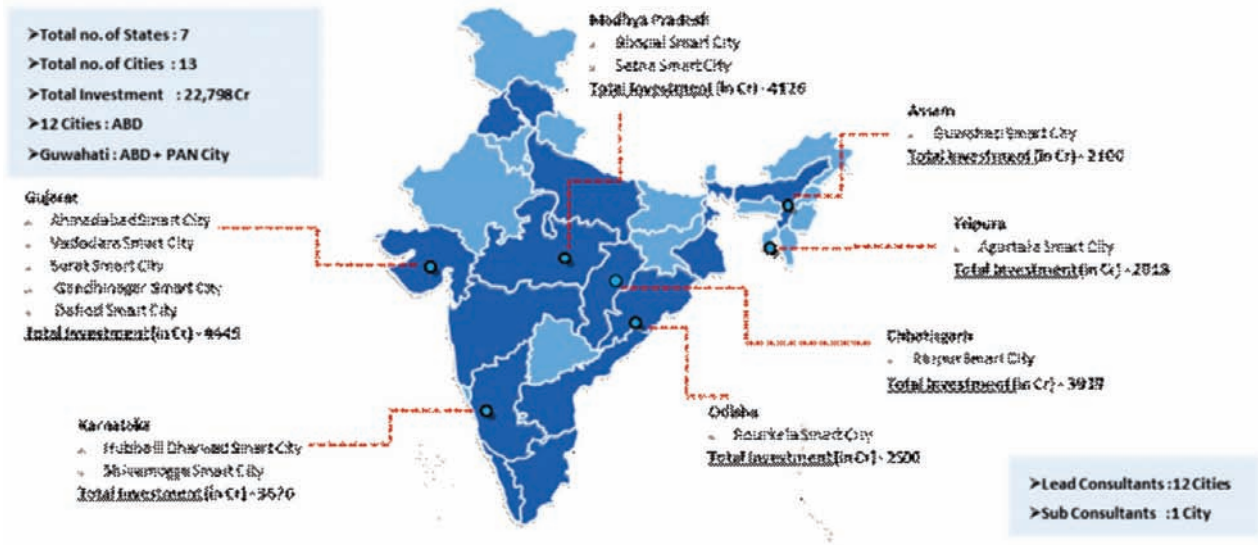

Figure A: TCE's involvement as PMC for Smart Cities

11. REFERENCES

1. National Electricity Plan, Central Electricity Authority, Ministry of Power, Government of India, January 2018
2. Liveability Standards in Cities, Ministry of Housing and Urban Affairs Government of India, 2017
3. Delhi Mumbai Industrial Corridor Development Corporation, website, http://dmicdc.com/about-DMICDC
4. Energy Conservation Building Code 2017, Bureau of Energy Efficiency, Ministry of Power, Government of India, 2017
5. Sanjay Seth, Energy Efficiency Initiatives in Commercial Buildings, Bureau of Energy Efficiency, Presentation, https://www.coolrooftoolkit.org/wpcontent/uploads/2012/04/ Seth-Presentation.pdf
6. American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) Journal Year 2001
7. Bankable Feasibility Report for GIFT City, Gujarat, prepared by Tata Consulting Engineers Limited, 2014
8. Wikipedia and Website of Eco Sol Energy
9. Development of Waste to Energy Project, Feasibility and Detailed Project Report, Tata Consulting Engineers, October 2016
10. Website, Central Pollution Control Board, cpcb.nic.in

SYNERGY OF ENERGY WITH CITIES AND BUILDINGS

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Energy is the lifeline of cities and buildings. It is not just a mere infrastructure facility, but flows through them to run them efficiently and effectively. More importantly energy determines the form of the cities. About 200 years ago engines and electricity radically changed the lifestyle and whole urban pattern. The engines (motor car, street cars, trains, tramways, buses, etc.) and modern oils (petrol, diesel, etc) in 1859 shortened the distances, revolutionized the transport system and triggered the development of mega-cities. The lifts, elevators and the electric services gave birth to multi-storied buildings, compact and dense cities, multiplying the potential of limited urban land. These set in motion a wave of upsizing the urban economy, industry, houses, buildings and roads.

As a follow up, the urban plans and zoning codes were revised to keep up with the challenges of a more dynamic, energised, integrated urban development and infrastructure services. The concept of Energy Return on Investment (ERoI) emerged as an important tool to manage the metabolism of the cities and their energy efficiency. This is calculated by dividing the amount of usable energy generated in a system by the amount of energy used to locate it. This approach is manifested world over by global cities- New York, Chicago, Hong Kong, Shanghai, Singapore, London and many others. Unfortunately, Indian mega-cities, except Mumbai, maintained the status-quo and perpetuated with 19th century planning approaches and zoning regulations for the 21st century cities.

In most Indian cities, electricity is generated at few large plants, often powered by fossil fuels, and then fed into the electric grid, which are managed by outdated analogue systems and do not respond well to volatility. When the grid is overstressed, the whole system crashes as it happened in Northern India in 2012.

A steam turbine coal-fired power plant is able to convert only 39-47% of the coal's heat to electricity. Another 6.5% of energy is lost due to line losses or friction in the grid. The bulk power system is also inflexible. Coal-fired power plants, designed to run twenty -four hours a day, are not easy to turn on and off. They are also highly polluting.

The World's energy systems are riddled with wastes. Globally they produce 15 trillion watts of power every day, emitting 32,000 million metric tons of CO_2 into the air per year, along with many other pollutants. This waste is changing the climate and polluting air and water. Only when there is an aspiration for the metabolism of the cities to be just as naturally pure, would it be brought into balance with nature. The IPCC Fourth Assessment Report reported that fossil fuels provide 85% of the total primary energy (2008). Furthermore, the combustion of fossil fuels accounted for 56.6% of all anthropogenic GHG emissions (CO_2eq) in 2004.

Primary energy use in India is dominated by coal (40 percent), followed by fuel wood (34 percent) and petroleum fuels (15 percent). The share of fossil fuels increased from around 60 percent during 1995-1996 to 85 percent of total energy use by 2010.

Cities account for three quarters of the total global energy demand and produce almost 80% of CO_2 emissions. Since the early 2000s, the energy supply has become more carbon intensive, thereby amplifying the increase resulting from growth in GDP per capita.

Energy Efficient Urban Structure

Urban system in India comprises 7936 cities/ towns, 377 million urban population, heterogeneous, 50% unplanned/ informal areas, 25% cities/ towns with master plans which are largely outdated. In India, the total number of towns and cities increased from 5161 in 2001 to 7935 in 2011. From 377 million urban population in 2011, it is projected that by the year 2031, 600 million people would live in urban areas and 78 cities in India would become metropolitan (million plus). Although the Indian cities generate 60% of GDP and 70% of jobs, the state of infrastructure services remains awfully poor, impeding sustainability and economy.

The power demands in cities are growing exponentially, generation of which emits about one-fourth of carbon footprint. This needs action to reduce the power demand, and resorting to energy efficiency. Load management techniques should be adopted and schemes to minimise power losses should be enforced. Renewable energy sources like solar/ wind energy need mandatory incentives and instruments. Cooling, heating and lighting often account for bulk of the electrical consumption.

A basic need is to create a sustainable urban structure, comprising modules of local hub/ neighbourhood, community and eco-districts/ zones, which allow a compact form with mixed land use with the following mandate:

- Integrated planning of land use, energy and public transport based on the concept of ERoI and smart micro-grid.
- Reorganisation of land use and rationalisation of density, urban restructuring for travel reduction.
- Use of sustainable/ renewable energy for transport and bulk cooking
- Integration of bus, MRTS, rail corridor, cycles, walking, stations and terminals, integrated traffic and transit operations and management, and using subterranean space for transport and parking
- Telecommunication, electronic mail, video conferencing, radio paging, mobile phones, computer networking, e-mail, etc. to save travel.

Smart growth land use practices aim to create more accessible land use patterns, which reduce the amount of travel needed to reach goods and services. The high density, compact cities can lead to wealth creation and employment generation by enhancement of residential and commercial floor spaces from 5 sm/capita to 30 sm/capita, each. However, it should also ensure simultaneous reservation of greens, social infrastructure (education, health, security, etc.) and transport (roads, railways, air, metro, parking, etc.) at 10 sm/capita, each.

Transport and TOD

The spatial model impacts the sustainability (less travel time and thus energy saving). A compact city structure should be developed to achieve high dense settlements and less dependence on automobile. Compact cities can have significant implications to energy efficiency, inter-area or inter-building transport and environment. Critical instruments for this policy option include coordination with public transport, infrastructure development, mixed land use and coordination of different levels of government. Data from international cities indicates correlation of urban density with less transport energy use and car use per capita.

Travel and transport demand can be reduced by mixed land use and better synergy among public transport, walking, Non-Motorised Transport (NMTs), urban structure (form, density and floor area ratio) and by Transit Oriented Development (TOD). An important element of policy should aim to shift private vehicle users to public transport. Apart from aspects like frequency, inter-modal integration, single ticketing systems, the quality of public transport, particularly buses, would need to be significantly upgraded, inter-alia, keeping in view the element of clean and green

fuel and traffic calming. Organisation of land use, circulation pattern and decisions regarding density, Floor Area Ratio (FAR) and other controls should be around the Public Transport System and the concept of walk to work, which reduce the need of personal vehicles and transport. The spatial model should be based upon the principle of less travel, more energy savings. This would significantly help in saving fossil fuel consumption, climate change and environment. A high density, high FAR urban pattern with efficient public transport, infrastructure services and mixed land use can reduce the need to travel. A least-cost life cycle analysis of urban mobility options and transportation systems across a range of carriageways and modes should establish an optimum long-term mix. A mix of pedestrians, bicycles, people movers, hyper- trams, hyper-buses and ferries provide safer, faster and cheaper mobility than the personal car. This call for replanning of urban form which promotes walkability and NMTs, and curtail the need to travel. Transport policy and plans linked to pollution control, including noise, should be part of a City Plan. Providing a barrier free access is a mandatory requirement for outdoor and indoor environment.

In India, irrespective of any plans and policies, TOD is happening on its own. Look at the areas around metros, bus and railway stations, main roads, highways and road junctions. There is ample confusion whether the TOD has to be along Bus Rapid Transit (BRT) corridors (e.g. Ahmedabad) or only along the Metro Rail Transit System (MRTS) (Delhi). What about corridor along Rapid Rail Transit System (RRTS)/ local trains? The TOD policy in India should embrace the organic forms of the TOD, which does not dislocate the indigenous settlements, jobs and homes. In fact, the basic purpose and paradigms of land use and DCR have to undergo a radical change (do we really need them?).

Sustainable Energy and Buildings

Energy efficiency and renewable energy are the twin pillars of sustainable energy policy which can reduce the level of energy demand and slow down the rate at which resources are depleted. According to the International Energy Agency, improved energy efficiency in buildings, industrial processes and transportation could reduce the world energy needs in 2050 by one third and help control the emissions of greenhouse gases. The integration of renewable energy in buildings offers an economically viable way to meet building power/thermal loads by superior environmental performance with high efficiency and low greenhouse gas emissions. In order to improve energy efficiency, use of renewable energy and related technologies (biomass, solar, hydrogen, geothermal, wind, and mini-hydraulic energy sources, waste recycling), the government has worked out several policy reforms and programmes.

The cost-effective options to reduce end-use energy demand through efficiency measures, include both new technologies and more efficient practices. Examples can be found in efficient appliances and systems for lighting, heating and cooling in the building sector. For example, compact fluorescent or light-emitting diode lamps use much less electricity to produce a lumen of light than does a traditional incandescent lamp. Properly sized variable-speed electric motors and improved efficiency compressors for refrigerators, air conditioners and heat pumps can lower primary energy use in many applications. Energy efficient high-rise and mix use buildings could reduce emissions and substantial cost savings.

There is a need to disaggregate the energy consumption as per economic segments. Roughly 50%of population in urban areas are without car and A.C., who consume roughly 5% of energy (also produce similar carbon /Green House Gas (GHG) emissions), whereas people with cars and A.C. consume 95% of energy and equal % of GHG/ Carbon emissions (5 to 10 mt/capita/yr.)

It is necessary to emphasise on the three critical areas of energy consumption which are - mobility, cooking and A.C. As per Neeti Ayog, with a financial growth of 7 to 8 % per annum almost every building by 2031 would be air conditioned. As such, SRT would make sense in synergy with EAT and PEDC. For cooking, it may be suggested to mandate that the establishments serving more than 600 meals/ day should use at least 80% of renewal energy (large hotels, restaurants, canteens, hostels, langars, railway stations, army/ police mess, etc.)

Energy Efficient Building Design

The generic principles of energy efficient building design comprise the following:

- Integration of energy concept from project outset, demand management
- Compact shape, minimize power requirement
- Daylight design
- Energy efficient lighting, ventilation and space conditioning, site planning and landscape design
- Shading, green roof, building envelope
- Fenestration and window/ openings design, glazing design
- Efficient use of passive solar energy, renewable energy
- Energy-efficient, easy-to-use technical systems
- Low water use sanitary ware
- Low-energy electrical appliances
- Use of low embodied energy, recyclable construction materials • Increased insulation, elimination of thermal bridges wherever possible
- Safety against fire and other hazards.

Building design involves a synergy of various levels of planning, design, construction, and maintenance, leading to a sustainable and energy efficient regime.

Site Planning: Ensure that the proposed building is appropriately oriented and sensitive to the natural features and microclimate of the site. Assess its micro-climatic character taking into account exposure, shelter, natural shading of buildings, interaction of buildings, solar access through the seasons, atmospheric pollution, water and drainage, noise gradients across the site. This gives a basic picture of the qualities of the site and its potential. Minimise earth movements and excavations where possible. Respect ground water levels and design to manage surface water through natural processes. Avoid the formation of heat island and inversion effect by layout planning.

Landscape development: This should improve the shaded areas, micro-climate and visual amenity by the greenery, green roofs, climbing plants on walls, window boxes and balcony gardens, the type of trees to be planted along the roads and near buildings need careful attention. Deciduous trees which shed their leaves during winter permit penetration of sunshine onto building facades and help in heating of buildings. Proper landscaping reduces direct sun from striking and heating up building surfaces. Landscaping creates different airflow patterns and can *be* used to direct or divert the wind advantageously by causing a pressure difference. Additionally, the shade created by trees and the effect of grass and shrubs reduce air temperatures adjoining the building and provide evaporative cooling. Trees are the primary elements of an energy-conserving landscape.

Form and Orientation: The objective is to minimize solar heat during the summer and maximise solar gain during the winter so as to reduce the need for cooling, heating and lighting, thus reducing the demand for energy. Design to reduce surface area for heat transfer by avoiding elongated thin forms, spread out, and low density development. Compact forms are preferred with grouping of the buildings for multiple use zoning.

Major components of passive architecture are orientation of building, sun shades, double-glazed windows, smart glazing window overhangs, thermal storage wall/ roof, roof painting, ventilation, evaporative cooling, day lighting, wind towers, earth air tunnelling and construction materials. The active and passive systems can be used simultaneously in innovative ways to make an integrated system.

Sunshine is one of the desired aspects in the buildings, especially the residential buildings. As a matter of urban planning and design as well as building bye-laws, the ratio of road width to building height becomes an important factor.

Besides use of energy efficient building materials, the energy demand in buildings can be saved substantially by proper designing of walls and roofs, windows and lighting. Improved insulation of walls and roof can reduce the heating and cooling load by 25 per cent. Improved multi-pane windows can reduce the air conditioning load significantly. New compact fluorescent lamps require less than a quarter of the electricity consumed by conventional lighting bulbs.

Wall to Window Ratio, U Factor, SHGC and VLT Values: ECBC recommends a maximum U-factor of 3.3 W/ m^2K, SHGC of 0.25 for a wall to window ratio (WWR) of upto 40 %, and SHGC of 0.2 for WWR of 40-60 %. A glazing area in excess of 60% of gross external wall area is not recommended. The VLT value linked to WWR should be as per ECBC. SHGC value is particularly critical for South, East and West facade. For glazing U factor and Solar Heat Gain Coefficient (SHGC) should be minimized, whereas VLT (Visible Light Transmittance) should be maximum.

Volume and Building Envelope: Generally, avoid oversized, higher interior spaces in designing for specific functions. Thermal character of building envelope, roof, walls and fenestration should be compatible to U and R values.

Internal Layout: To reduce need for artificial light and for optimum temperatures, cluster the activities uses which need similar environmental conditions. Avoid open plan to allow for better control of services by the users.

Windows/ Doors: Consider the percentage of fenestration on different facades and plan to minimise different temperature zones. Use southerly orientation for passive solar gain. Consider type of glazing and summer/winter ventilation. Use blinds, curtains, shutters draught lobbies and air curtains. Use energy efficient glass with spectrally selective coating to take the maximum advantage of daylight.

Cooling and Air-conditioning: Use natural ventilation, where possible. Consider the use of atria to achieve some of these requirements and to provide amenity space for building users. Minimise the use of air conditioning. Consider the interaction between energy and ventilation strategies to balance potentially conflicting demands. Avoid the use of wet cooling where air conditioning is installed. Specify low-energy, high efficiency plant and fittings, sensor controls and appliances as per BEE certification. Explore new methods of air-conditioning, such as Passive Energy Draft Cooling (PEDC), High Efficiency Chilling System, earth embedded cooling, thermal storage system, etc. As a thumb rule following standards can be adopted for energy efficiency:

- Lighting power density is less than 15-20 W/m^3
- Lighting performance index lies in the range 21-28 kWh^2/hr
- Air conditioning performance index for different climate zones are:

Warm & humid: 195 kWh/m^2 per year (24 hours operation)
Moderate: 105 kWh/m^2 per year (10 hours operation)
Composite: 144 kWh/m^2 per year (10 hours operation)
Square metres per tonne of refrigeration (sqmt/TR) lies in the range 32-42.

Passive Building Design

"Passive design", "Energy-conscious design", "bio-climatic approach" and now "green building" are the buzz words of the architects and engineers. All these strive towards more comfortable, energy-efficient and non-toxic built environment. Passive building design is a systematic process comprising various measures, such as orientation, envelope, form, day lighting, openings, shading, renewable energy and cooling, Table below gives a broad matrix of these factors.

Table: Passive Measures Affecting Energy Efficient Design

Passive Design Measure	*Sub factor for passive design option*	*Benefit of Evaluation*
Orientation	• Latitude • No. of storeys • Siting • Building form	Helps to evaluate the best direction for orientation
Envelope material	• Thermal transmittance value • Thickness of envelope • Time- lag of material	Calculate the conductance of envelope & assess the heat gain or loss
Building form & effect of surrounding building	• Climate type • Vol. of the mass to be cooled • Surface area, no. of storeys	Increase in surface area increases incident radiation & thus heat gain. Analyze effect of mutual shading with surrounding buildings.
Natural lighting/Day lighting design	• Area of opening • Room height • Aspect ratio of openings • Sill height as compared to height of working plane • Location of windows• Reflection • Co- efficient of walls • Sky conditions • Daylight requirement	Determine impact of natural lighting on cooling load due to reduction in the need of artificial lighting
Glazing area of Openings	• Sky conditions • Climate type • Glazing area decided by heat gain/ heat loss • Height of the openings	Extent of natural lighting supplemented & also heating in colder regions
Efficiency of Shading device	• Depth of overhang • Solar altitude • Solar wall – azimuth • Sky Condition	Effective blocking of transmission of radiation, thus protecting from morning & afternoon sun
Solar energy utilization	• Building type & occupancy type • Cost of project	Minimizing external loads on system & providing backup to electricity requirements
Cooling approach	• Climate type	Passive approach can be a substitute to active systems of cooling & thus reduce the load on the system
	Building type & occupancy type • Orientation of openings • Climate type • Location & size of openings	Evaluation of thermal conditions indoors

Source: ECBC, 2017

The passive measures can have substantial impact on energy performance of building, as given below:

(i) Orientation has the maximum impact on the performance. It can increase heat gain up to 41%

(ii) Materials and building form can lead to energy performance by 18%.

Building Envelope and Surface to Volume Ratio

For any given building volume, the more compact the shape, the less wasteful it is in gaining/ losing heat. Also, the building form determines the airflow pattern around the building, directly affecting its ventilation. The depth of a building also determines the requirements for artificial lighting-greater the depth, higher the need for artificial lighting. A proper envelope design should be followed by an efficient lighting and space conditioning design to save energy.

The building envelope and its components are key determinants of the amount of heat gain and loss and wind that enters inside. The primary elements affecting the performance of a building envelope are:

- Materials and construction techniques
- Roof
- Walls
- Fenestration and shading
- Finishes

The following measures can be considered to reduce heat gain by envelope design:

- Select high performance glazing with low U-value, low Shading Coefficient, and high VLT (Visual Light Transmittance).
- Insulate the wall. The options for insulation materials can be extruded polystyrene, expanded polystyrene (thermocol), polyurethane, glass wool, and the likes.
- Brick wall with air cavity can also significantly reduce the heat ingress.
- Hollow blocks, fly ash bricks, and AAC (Autoclaved Aerated Concrete) blocks are also good insulators.
- The heat ingress through the roof can be as high as 12%-15%. Heat reflective paints and garden roofs result in substantial heat reduction.
- Consider shading devices for window openings and skylights.

The choice of materials also helps to maximize indoor comfort.

Building Management System (BMS)/ Intelligent Buildings

The use of Building Management System (BMS) for operation and control of building, development design, construction, and operation, optimizes its resources efficiency and performance, and helps to reduce consumption of energy. The concept of intelligent building further extends the concept of energy saving to other building services, creating a total package for energy management. This improves maintenance and reduces dependence on operators, who may not perform efficiently.

The concept of intelligent building is the one in which all the building services, safety, and security aspects are controlled and monitored by microprocessor based controls, monitoring devices and accessories. Basically such systems are “hands free”, requiring very little human interface for operation, and control. The various functions which can be performed are listed as follows:

(a) Control and monitoring of the HVAC System.

(b) Control and monitoring of internal and external lighting.
(c) Monitoring of the incoming electric supply, DG sets and other electrical equipment
(d) Controlling and/ or monitoring of the water supply system
(e) Monitoring of the sprinkler system
(f) Monitoring the operation and functioning of fire detection system, which should preferably be intelligent type.
(g) Monitoring the functioning of firefighting equipment *i.e.* fire pumps and accessories.
(h) Controlling entry to a building through an access control system.
(i) Monitoring fire exits and other exit points of the building
(j) Enhancing security of the building by installing closed circuit TV (CCTV).
(k) Providing passive infrared and other sensing devices to detect unauthorized entry around or into the building.
(l) Automatic management of car park systems.

All the above functions are performed by microprocessor based controllers and their activities are monitored by personal computers (PC) or dedicated control panels. One or more elaborate software programmes are customized and fed into-the system to perform the various tasks. The programme helps to optimize the operation of various equipment and reduce consumption of all types of energy, which can be between 12% and 20%. The system also provides for maintenance checks and necessary advice. This helps the maintenance staff to carry out preventive maintenance, thus reducing the chances of breakdowns and consequent cost of repairs.

Heating, Ventilation and Air Conditioning

Heating, Ventilation and Air Conditioning (HVAC) refers to the equipment, distribution systems, and terminals that provide, either collectively or individually, the heating, ventilation, or air-conditioning requirement to a building. The HVAC system accounts for a significant (nearly 50%) portion of a commercial building's energy use. HVAC energy use in a commercial building can increase/decrease significantly depending on how efficiently the combination of air side systems and central plant operates. The requirements generally vary from 40% to 90% of full load. Proven technologies and design concepts can be used to build energy efficiencies in the system, generate significant energy, and cost savings besides efficient performance.

HVAC systems affect the health, comfort, and productivity of occupants. Issues like user discomfort, improper ventilation, lack of air movement and poor indoor air quality, and poor acoustic design are linked to HVAC system design and operation. In many existing buildings, envelope upgrades are often necessary to improve comfort and energy efficiency, through improvements such as reducing envelope leakage. Generally, upgrading an existing building envelope is expensive. Other strategies such as central plant, airside, or control system upgrade may be necessary to improve occupant comfort and energy efficiency.

The best HVAC design considers all the interrelated building systems while addressing indoor air quality, thermal comfort, energy consumption, and environmental benefits. Optimizing both the design and the benefits requires that the architect and HVAC system designer address these issues early in the schematic design phase and continually revise subsequent decisions throughout the remaining design process. It is also essential that innovative, local options, as given below, are considered along with standard HVAC systems.

Earth Air Tunnel and Envelope Air-Conditioning

Earth is an effective moderator of climate. Though surface thermal conditions show patterns of yearly cycles warming the surface during summer and cooling it during winter, at depths below 4-5 meters yet this affect is negligible and the

temperature remains more or less constant-equal to yearly mean solar temperature. The moderating characteristic of earth, *i.e.*, variation of temperature with depth, given by the laboratories (1979), is shown in the Table given below.

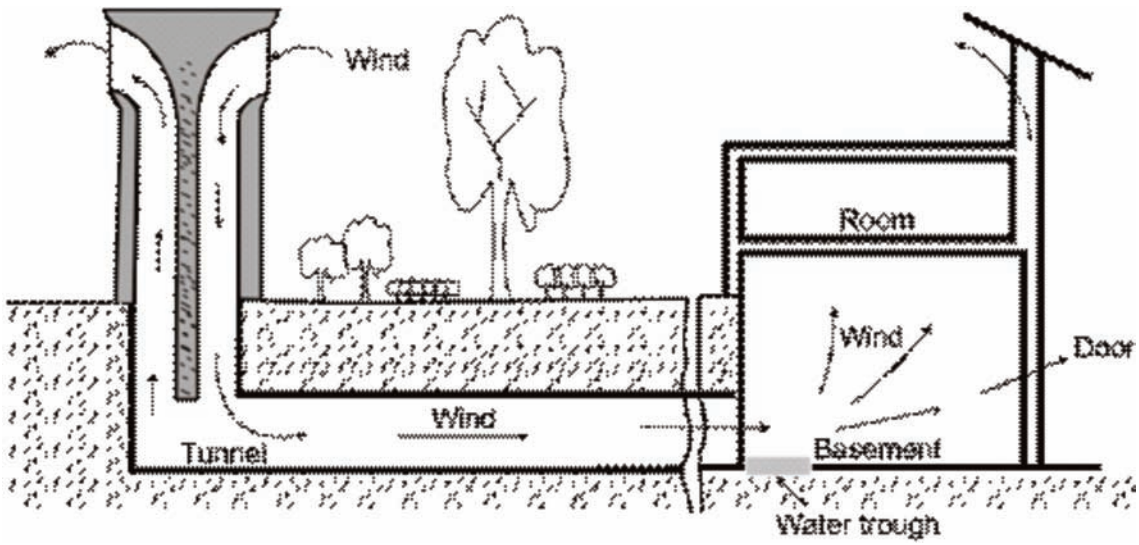
Estimated average earth temperatures for some Indian cities show that even in the hottest locations, earth temperatures remain below 30°C. The capacity of the earth to condition the air by effectively damping the ambient air temperature and filtering out the effects of solar radiation can be used in combination with buried pipes or underground tunnels, scoops and evaporative cooling.

Table: Summer earth temperatures 4 metres below the surface in selected cities

Sl. No	Name of City	Climatic Zone	Earth Temperature
1.	Bangalore	Composite	24°C
2.	Mumbai	Warm and Humid	28°C
3.	Delhi	Composite	25°C
4.	Jodhpur	Hot & Dry	29°C

Source: Kachru, U (1994)

The main barrier to design of buildings is the lack of insulation of the roof slab. Major heat gains in summer are through the roof. In Delhi, for example, 45-50 percent of the total summer solar radiation is transferred through the roof. The envelope system becomes ineffective unless techniques are developed to produce inexpensive horizontal cavities to enclose the roof area. A system of promoting wind flow though the building and reducing heat intake is earth berms with wind shafts opening within the rooms. The temperature of subterranean air is almost constant at any time of the year.



Earth-air tunnel with a scoop

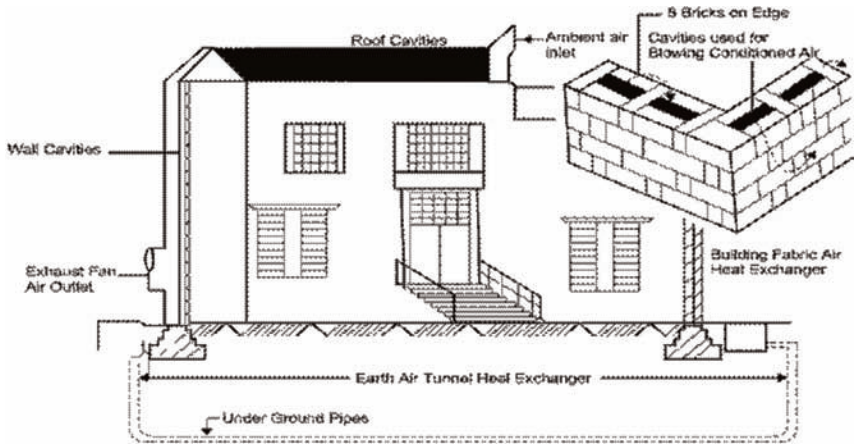
Source: Kachru, Upendra, (1994)

Air drawn through the earth into buildings reduces air-conditioning load. However, to provide large cooling loads, the construction costs of the tunnels becomes prohibitive. Other limitations of the system could be the following:

- The ducts provide access to foul smells, fungi, micro-organisms, insects and rodents and thereby create a health hazard,

- The conditioned air does not provide cooling during periods of high humidity, monsoons, and
- Cold air delivered is not at low temperatures; therefore large quantities of air are required.

The combined impact of improved temperature differential, increased surface area and turbulent air-flow improves the efficiency of transfer of thermal energy over conventional passive methods.



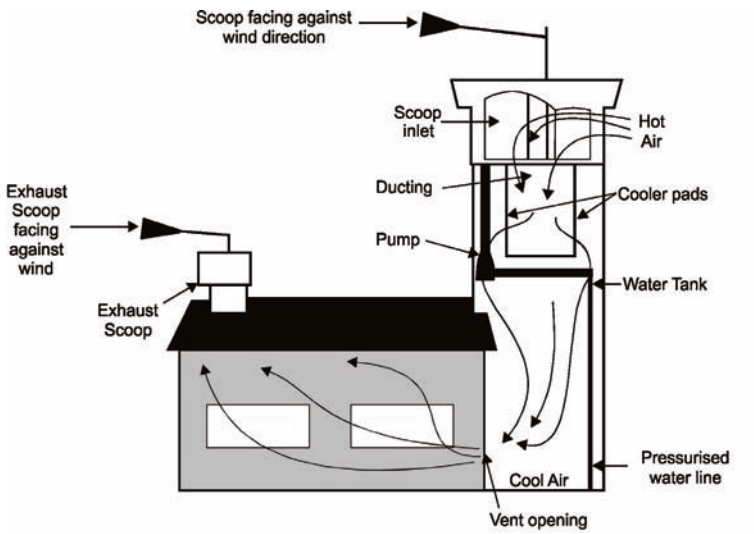
Schematic diagram of envelope conditioning system

Source: Kachru, Upendra (1994)

Evaporative Cooling *can also lower indoor air temperature by evaporating water. It is effective in hot and dry climate where the atmospheric humidity is low. In evaporative cooling, the sensible heat of air is used to evaporate water, thereby cooling the air, which cools the interior space of the building.*

Passive Down-Draught Cooling

Wind catchers guide outside air over water-filled pots or cooler pads, inducing evaporation and causing *a* significant drop in temperature before the air enters the interior. Such wind catchers become primary elements of the architectural form also.



Passive down draught cooling

Renewable Energy

The harnessing of renewable energy aims not only increasing energy generation, but also helps in a pollution-free environment. It is estimated that India has a potential of generating more than 1,00,000 MW from renewable sources of energy. India is endowed with abundance of sun. In a cloudless region roof area of 100 sq. mt, receives about 500 KW per day from eight hours of sunshine. In the hot-arid regions (the greatest solar radiation intensity occurs between latitudes 15 and 35 degree north or south) more than 3,000 hours of solar radiation could be obtained and even in the warm-humid region there are about 2300 hours of solar radiation. Where there is a lack of conventional fuels such as coal and oil, the solar energy can be viable option. Solar water heating for hot water or as part of home heating has become widely used in some countries in response to the energy and environment crisis.

The full utilization of renewable sources such as wind and solar power can be enhanced by energy storage. Storing energy as heat is commonly practised today, and multiple means of storing electricity have been developed. These include flywheel storage of kinetic energy, compressed air storage and batteries. If electric vehicles become a major fraction of the fleet, it is possible to utilize their batteries in a vehicle-to-grid system for managing the variability of RE supply.

Energy efficiency and renewable energy sources offer a big scope for cutting carbon emissions. The two missions, Solar Mission and Enhanced Energy Efficiency Mission, seek to address these issues. For energy saving within the buildings, the National Mission on Sustainable Habitat promotes the use of energy-efficient appliances, creation of mechanisms that would help finance DSM [demand side management], etc. The National Solar Mission provides a policy framework and strategies to achieve the goals of renewable energy.

Solar Cities

The Ministry of New and Renewable Energy (MNRE) has initiated various programmes for promoting solar water heating systems, SPV systems/ devices in urban areas. A National Rating System developed in association with The Energy and Resources Institute (TERI) for promotion of energy efficient/green buildings. The system is adaptable for all types of buildings in different climatic zones of the country.

The MNRE took a program for the development of about 60 cities and towns as solar cities during the eleventh five year plan (2007-2012). Out of these, 11 cities, namely Gandhinagar, Chandigarh, Faridabad, Dehradun, Kohima, Muradabad, Nagpur, Kalyan and Gurgaon, etc. were taken up in the first phase. A solar city is an urban area with an active programme to achieve not only lower reliance on fossil fuel but also sustainable greenhouse gas emission levels. The solar city programme strives to integrate:

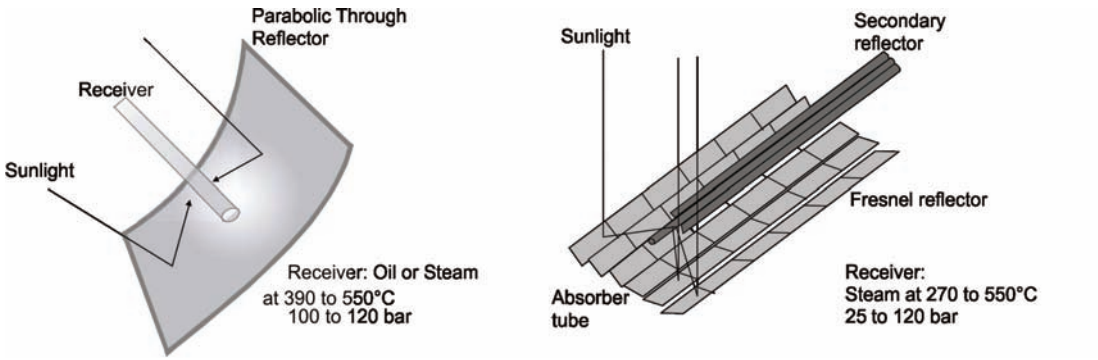
- Energy conservation and energy efficiency measures so as to reduce the energy demand
- Utilisation of locally available resources such as solar and other renewable energy resources to meet the increasing energy demand.

India's first initiative towards the development of solar cities was undertaken by the Gujarat Energy Development Agency (GEDA), Government of Gujarat. It decided to make its capital city Gandhinagar as a Solar City. Accordingly, a Master Plan for the same was prepared by TERI in 2007, which is being implemented.

Solar Cooking: As solar energy is initially captured in the form of heat, it is therefore best use of a variety of heating purposes. Solar water heaters (e.g. for canteens, industry, schools, homes and hotels), solar steam cookers and water distillation units provide examples of practical applications of solar energy. It is time that solar energy is made mandatory for cooking in large establishment (hotels, restaurants, railway stations, langars, religious centers, etc.).

Brahm Kumari Ashram at Mount Abu is using high tech solar cookers producing about 1200 meals per day which saves huge consumption of LPG cylinders. Tirumal Tirupati Devasthanam (TTD) has solar steam cooking system for 30,000 meals per day, which saves 200 liters of diesel every day. Sai Baba Sansthan Temple at Shirdi uses solar cooking system for 7000 meals per day with enhanced capacity to cook 20,000 meals.

The Solar Bowl is a unique concentrating technology used by the solar kitchen in Auroville, Pondicherry. Unlike nearly all concentrating technologies that use tracking reflector systems, the solar bowl uses a stationary spherical reflector. This reflector focuses light along a line perpendicular to the sphere's surface and a computer control system moves the receiver to intersect this line. Steam is produced in the solar bowl's receiver at temperatures reaching 150°C and then used for process heat in the kitchen where 1,000 meals per day are served.

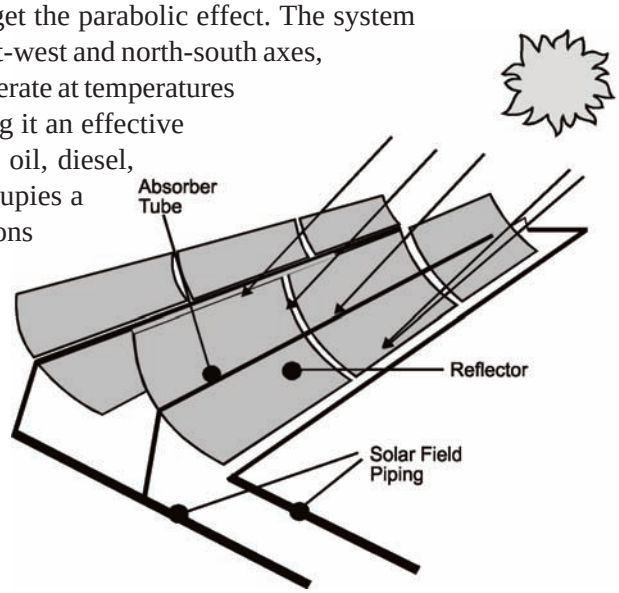


Parabolic Trough Solar Energy System

The Akshardham Temple in Delhi has installed a solar cooker for cooking 4,000 meals every day. The solar concentrator produces steam which powers the cooking process. It works on the principle of a parabola. It uses an ingenious, two-dimensional, Fresnel mirror arrangement to get the parabolic effect. The system automatically tracks the sun from its rise to set on both the east-west and north-south axes, intercepting maximum sunlight. The receiver is designed to operate at temperatures up to 400 degrees Celsius and works as a solar boiler, making it an effective replacement of conventional polluting fuels such as furnace oil, diesel, PNG and coal. The dish is mounted on a single pole and occupies a ground area of 3m by 3m and can therefore be erected in locations with space constraints.

Parabolic Trough

Parabolic trough power plants use a curved, mirrored trough which reflects the direct solar radiation onto a glass tube containing a fluid (also called a receiver, absorber or collector) running the length of the trough, positioned at the focal point of the reflectors. A change of position of the sun parallel to the receiver does not require adjustment of the mirror.



Solar Parabolic Trough

Solar Power Tower: Solar Tower mirrors focus the light on the top of the tower. The white surfaces below the receiver are used for calibrating the mirror positions. Power towers (also known as 'central tower' power plants or 'heliostat' power plants) capture and focus of the sun's thermal energy with thousands of tracking mirrors (called heliostats). A tower resides in the center of the heliostat field. The heliostats focus concentrated sunlight on a receiver which sits on

top of the tower. Within the receiver the concentrated sunlight heats molten salt to over 1,000°F (538°C). The heated molten salt then flows into a thermal storage tank where it is stored, maintaining 98% thermal efficiency, and eventually pumped to a steam generator. The steam drives a standard turbine to generate electricity. This process, also known as the "Rankine cycle" is similar to a standard coal-fired power plant, except it is fuelled by clean and free solar energy.

The advantage of this design above the parabolic trough design is the higher temperature. Thermal energy at higher temperatures can be converted to electricity more efficiently and can be more cheaply stored for later use.

Parabolic Solar Dish

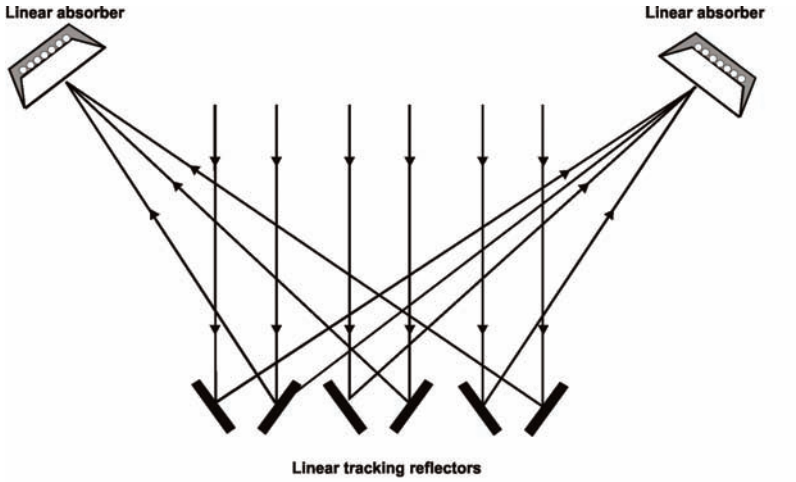
Parabolic Solar Dish: A parabolic solar dish generates energy by concentrating the sun's rays on the heating element of a Stirling engine. The entire unit acts as a solar tracker. A Dish Sterling system uses a large, reflective parabolic dish. It focuses all the sunlight that strikes the dish up onto a single point above the dish, where a receiver captures the heat and transforms it into a useful energy form. Typically the dish is coupled with a Sterling engine, which creates rotational kinetic energy that can be converted to electricity using an electric generator.

The advantage of a dish system is that it can achieve much higher temperatures due to the higher concentration of light. Higher temperatures lead to better conversion to electricity and the dish system is very efficient on this point.

Fresnel Reflectors: A linear Fresnel reflector power plant uses a series of long, narrow, shallow-curvature or even flat mirrors to focus light onto one or more linear receivers positioned above the mirrors. On top of the receiver a small parabolic mirror can be attached for further focusing the light. These systems aim to offer lower overall costs by sharing a receiver between several mirrors as compared with trough and dish concepts, while still using the simple line focus geometry with one axis for tracking.

Rival single axis tracking technologies include the relatively new Linear Fresnel Reflector (LFR) and Compact-LFR (CLFR) technologies. The LFR differs from that of the parabolic trough in that the absorber is fixed in space above the mirror field. The CLFR offers an alternate solution to the LFR problem. CLFR power plants offer reduced costs in all elements of the solar array. These reduced costs encourage the advancement of this technology.

Parabolic Solar Oven: Solar cookers and ovens use no fuel, which means no smoke, no carbon emissions, no ashes or soot, no fire hazard, lesser fuel cost and reduced deforestation. Widespread use of solar cookers gives huge economic and environmental benefits. Solar water heaters/geysers and solar box cookers attain temperatures of up to about 165°C (325° F). They can be used to heat water or cook the food. However, the box cookers are slow and good enough for a small family. It does not work during night or cloudy days. For mass cooking parabolic solar ovens are becoming popular.



Fresnel Reflector

Solar Bowl in Auroville

A hybrid solar oven is equipped with a conventional electrical heating element for cloudy days or night time cooking. A hybrid solar grill consists of an adjustable paraboloid reflector suspended in a tripod with a movable grill surface. These outperform box cookers in temperature range and cooking time. When solar energy is not available the design uses any conventional fuel such as gas, electricity, or wood. Integrated solar cooking combines solar cooker, a fuel-efficient cook-stove and an insulated container/ basket to store heated food.

Among various types of solar cookers, solar kettle stands out which uses vacuum tube technology. It uses evacuated glass tubes to capture, accumulate, and store solar energy needed to power the kettle. Since the stagnating temperature of solar vacuum glass tubes is a high 220°C (425°F), these solar kettles can also deliver dry heat and function as ovens and autoclaves. As solar vacuum glass tubes work on accumulated rather than concentrated solar thermal energy,

solar kettles only need diffused sunlight to work and need no sun tracking at all. Solar kettles use solar vacuum tubes with insulation that keeps heated water hot throughout the night. These are most suitable for hostels, hotels and other establishments which feed large number of people every day. The system with hybrid (electric) support can be connected to water taps for bathing, washing, and kitchen use.

Smart Micro-Grid and Eco-Districts

Neighbourhood-scaled micro-grids are becoming increasingly viable. The waste solar energy systems and treatment plants can generate excess electricity from their bio-gas digesters to power thousands of nearby homes. Solar power on the roofs of buildings can also produce excess power to share with neighbour.

Smart grids form mesh networks, where each node has a capacity to generate and disseminate its own energy and information, but is also able to relay the energy and information to other nodes. If one or more link in the networks goes down, others can pick up the slack. This allows micro-grid to be self-healing. Because multiple, dynamically balanced energy and information pathways are woven together, if one link breaks, the others continue to provide power. Smart grids can detect power imbalances, analyse the causes and respond. They observe the behaviour of humans and equipment that use power, learn to predict their patterns, and can provide feedback to help reduce use of power in times of stress. This integration of energy and information begins to function as 'emergy'.

A meshed energy/information network can provide consumers with direct feedback on their energy use, helping to shift energy behaviours, and through social media to encourage a culture of energy conservation. Micro-grids also support equality in ecological economics. In contrast to an electrical system operated by a few giant investors-owned utilities, most elements of a meshed energy system are owned by users which make them diverse and sustainable.

Eco-districts, neighbourhoods that work together to plan and implement integrated systems, apply the intelligence, range of scale and diversity of micro-grids to urban infrastructure system. These aim to integrate power systems, open spaces, drainage, traffic management, parking, and other elements of urban metabolism so as to make them more ecological, cost-effective, and resilient. Studies show that such systems are cheaper to build and operate, are more resilient to failure, and have much lower environment impacts.

Eco-districts require us to think differently. Rather than designing cities and buildings to function independently, we need to think how co-dependence of energy with cities and buildings can synergise sustainability.

References

1. Bureau of Energy Efficiency (2017), Energy Conservation Building Code, BEE, New Delhi
2. IPCC (2008), Fourth Assessment Report of the Intergovernmental Panel on Climate Change, B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds) Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
3. Jain A.K. (2018) City Planning for a Changing India, Synergy Books, New Delhi
4. Jain A.K. (2016), Architecture and Urbanism, Synergy Books, New Delhi
5. Kachru, Upendra (1994), A Novel Method of Cooling & Heating of Buildings - Envelope Conditioning, Proceedings on Conference "Excellence in Housing," Feb. 24-25, 1994, Dallas, Texas; Energy Efficient Building Association, Wasua, U.S.A.
6. MONRE, Technical Memorandum on Waste to Energy Technologies, National Mission on Waste to Energy, Ministry of New and Renewable Energy, Government of India.
7. Rose Johnathan FP (2016) The Well-Tempered City, Harper Collins Pub., New York

ENERGY CONSERVATION FOR UTILITIES MEANS SUSTAINABILITY

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Insight

Energy conservation using technology and keeping sustainability in mind is the main goal today's competitive landscape. The intent is to help the world in conserving the environment and at the same time create revenue from innovative works. Aside from the Energy Conservation, the combined MEP and utility designs have focused on reducing carbon dioxide emissions through system selection, maximizing system and equipment efficiency and exploiting renewable energy resources. Sustainability is thus inherent in the theme of Energy Conservation for Utilities.

Energy and water play a significant role in the utilities with the current technological competitive landscape and are to be reckoned with in targeting any benchmarking program in terms of energy conservation. Ratings could be given for every work being done based on engineering experiences and judgment for achieving energy and water conservation plus other predicted factors to enhance the planning and services design considering the following:

- Enhanced envelope performance (reduces infiltration and conduction),
- Glazing shading and enhanced solar performance,
- Use of natural lighting,
- Low energy (LED) light sources,
- Lighting controls systems,
- Significant PV installation for Electrical Lighting Post,
- Cooling towers (instead of air-cooled chillers) through District Cooling,
- Demand (CO_2) controlled ventilation,
- Displacement ventilation (with some free cooling potential),
- Energy recovery wheels in fresh air AHUs,
- Specification of high efficiency pumps and fans,
- Low-use water outlets,
- Grey water capture and recycling, and
- Use of Treated Sewage Effluent (TSE) for cooling towers and irrigation.

However, for the above to be achieved, the Engineer has to plan the utilities system and design requirements to be aligned with the requirement of the local authority and with references to the specific British or American Standards including the approved local standards as well as the requirements of the clients and the stakeholders in valuing the concept of energy conservation within the competitive landscape.

With the enumerated features, the utilities comprise of services dealing with the notional interface point of approximately 1-meter or as applicable outside the building line that has been defined as the interface between MEP and Utilities/

Infrastructure. From this point, the MEP design is to provide the required containment, plant, and equipment. However, the utilities are services composed of utility connections such as MEP with the following:

1. Power System, this refers to the electrical cabling and the electrical grid.
2. Chilled Water System, this refers to the infrastructure district cooling.
3. Potable Water System, this refers to the water supply network distribution.
4. Domestic Hot Water, this refers to the infrastructure district heating.
5. Treated Sewage Effluent, this is commonly known as TSE which is recycled water.
6. Foul and Waste Water Drainage, this is the sewerage water network to the TSE plant.
7. Storm Water Drainage, this is the surface run-off water usually discharged to a water body or treated and reused.
8. Fire Hydrant Water Network, is the hydrant water collection station which the Firefighters use for fire suppression within the city landscape.

The Importance of Energy Conservation

With all the utilities, this paper covers partly and briefly the importance of Treated Sewage Treatment System, Renewable Energy, Chilled Water Plant, and the importance of the Building Information Modeling within the Energy Conservation and Sustainability platform.

However, before proceeding, let me identify the importance of energy conservation, what it means to us and how it works, its implication in our daily lives as well as awareness in support to the global environment climate change. It is now mandatory to reduce the quantum of energy being used from the grid source by energy efficient usage. With all the options brought on the table, the common energy that individuals use can be decreased through innovative alternative solutions. Reducing the common energy consumption is one of the easiest ways in helping our mother Earth.

Energy conservation plays an important since it has a significant role in reducing the effect on global climate change. Replacement of non-renewable resources with renewable energy can impact the environmental possibilism in the competitive landscape. (Refer '*Environmental Possibilism*' by Ronald Valledor Gomeseria in VIEWPOINT March 2018 for further details of the impact of climate change brought on the competitive landscape). Energy conservation in the design is often the most inexpensive solution for energy shortages and is a more environmental friendly alternative than increased energy production.

Energy can be considered as the capacity of a physical system to perform work or the ability to perform to complete any type of work which could be a physical or mental activity. The chain of converting different forms of energy into heat and power could be understood through the following:

- When oil burns it gives off heat which is converted to light and also power
- The heat is also used to boil water and turn it into steam
- Steam from the water generates heat
- When steam trapped, its pressure turns a turbine
- The turbine is coupled to an electric generator
- The generator produces electricity from the steam
- The electricity generated is distributed and powers light bulbs
- Using a light bulb gives off light and heat

The above also illustrates the effect of using natural resources on climate change and the need to conserve energy within the utilities for sustainable living.

Utilities Scope for Horticulture/ Irrigation and Water Management Conservation

The use of Treated Sewage Effluent (TSE) rather than using potable water for Horticulture/ Irrigation should be a part of the water management and energy conservation strategy. TSE supplied by the local body/ government, is available throughout the infrastructure and distributed based on the demand required for particular areas within the competitive landscape.

TSE irrigation is an essential parameter in planting concepts for energy conservation in water management especially in the desert regions, as water is a rare commodity in arid climates. Water conservation strategies are one of the choices for landscape design either using the treated sewage effluent water or the grey water which is being captured and recycled from buildings and other infrastructure. By an integrated system between the buildings and the landscape areas, efficient water management can be implemented using the grey water recycled from the building for horticulture/ irrigation purposes. Some of the water conservation strategies that maybe applied within the utilities infrastructure include the following:

- Using xeriphytic species of plants that are adapted to dry conditions.
- Using water retaining organic matter for the soil.
- Installation of wind breakers and fences to slow the winds and reduce the evapo-transpiration within the landscape area.
- Watering in the early morning before the sun's heat is intense helps to reduce the water lost from evaporation in the landscape.
- Use treated grey water that has been collected in the building instead of fresh water to conserve energy.
- Reduce use of fertilizers since they encourage rapid growth which results in higher water requirement,
- Use trickle, drip irrigation and root zone systems. Since the water is applied directly to the soil and the root, rather than onto the plant, evaporation from leaf surfaces is reduced.
- Provide a sensor technology for the monitoring of the watering system and of the soil conditions. The release of water should be triggered by sensors in each planted area, so that all plants are supplied with sufficient water and no water run-off occurs,
- Set the timer so that the landscape is irrigated early in the morning or in the evening when wind and evaporation are lowest, and
- Using TSE water for irrigation purposes within the landscape areas.

The above water conservation strategies mentioned above give a positive impact as well as assure energy conservation depending on the practices and demand requirement.

The sewage within the domestic infrastructure should flow through to the pumping station and on to the sewage treatment plant facility using a sustainable sewer network. The sewage water is treated according to the environmental processes and methodology requirement by physical, chemical, biological processes until the affluent meets the biological level to produce safe water for the environment.

The TSE process in the utility system is clearly defined as one of the sustainable utilities in conserving human, commercial, and industrial by recycling water rather than using and wasting fresh water. TSE is now commonly used for horticulture, irrigation, and industrial purposes. Use of Treated Sewage Effluent (TSE) has been broadened and is used for flushing of water closets as well as for the Cooling Heat Rejection. These are the key components in a sustainability strategy to reduce both on-site energy consumption and potable water consumption.

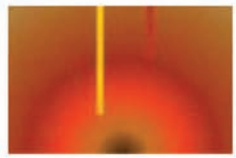
A complete analysis should be done for determining the Peak Irrigation Demand, holding tank requirement for the water closet flushing in high rise buildings, and also the Peak Cooling Tower Water Make-Up Water Demand. That

aids in ensuring that the quantum of Treated Sewage Effluent (TSE) is reliable and correct for a 24 hours storage tank, with a potable water backup connection as well plus an external connection for filling by water tankers.

Renewable Energies

The major renewable sources of energy available on site and their assessment for integration in the design of a project within the energy conservation of competitive landscape are given in Table 01.

Table 01: Renewable Energy Sources on Site

Type	Solar Thermal	Photovoltaic	Ground source Cooling	Wind Power
				
Description	Collection and conversion of sun's rays for generation of heat which is then used for heating water.	Conversion of light into electricity using solar panels, which generate electrical power	Use of the difference between the above- ground air temperature and the subsurface soil temperature to move heat in support of space cooling	Use of air flow through wind turbines to mechanically power generators for electric power
Evaluation	Although the hot water demand is not high, a limited portion of collectors is reasonable	Given the high solar radiation available on the roof surface, the installation of PV is recommended	In combination with a heat pump is one of the most sustainable cooling systems. No similar system in Qatar so far.	Given the urban location and the small height of the building, the wind conditions are not favorable for Wind turbines. Further small wind turbines are not efficient.
Implementation potential	HIGH Flat-plate collectors can be installed on the roof.	HIGH PV panels can be installed on the roof.	MEDIUM This is a new technology for the region. Missing information about the geological opportunities and normative framework	LOW The efficiency of the system as well as the local wind conditions makes the system unsuitable.

The Chilled Water Plant in the Utility Grid

The chilled water plant is one of the most important aspects in HVAC Industry for residential, commercial, and

industrial applications whether the conceptual views might be an independent or a district cooling that will serve within the infrastructure landscape. In the researches I have done in the University with my Ph.D. Courses, again, I want to share of the following table which will describe briefly for the selection of chilled water plant in conserving energy within the competitive landscape.

Table 02, Key Features for Chilled Water Plant Selection

System	Description	Efficiency	Carbon	Cost	Comment
Air Cooled Chiller Concept Option	Air Cooled Chiller located externally	Air Cooled Chiller COP=2.5-3	Primary energy source is electricity coupled with low COP would be highest carbon consumer	Cheapest option	Unlikely to offer any Sustainability delivery savings over benchmark building
Water Cooled Chiller + Cooling Tower	Water cooled chiller located internally with cooling tower located externally	Water cooled chiller COP=5-8	Primary energy source is electricity however more efficient than air cooled chiller	More expensive than air cooled chillers but less so than others	Requires make up water for cooling tower likely treated sewage effluent (TSE)
Ground Source Cooling	Open loop borehole extracts cold water from underground aquifer, which passes through a heat exchanger and provides the building with either direct cooling or pre-cooling for chillers	Highest possible efficiency (subject to no supplementary electric chillers being used)	Highest possible carbon saving (subject to no supplementary electric chillers being used)	If supplementary electric chillers used this option could be more costly than air cooled and water cooled options	Hydro geologic all study required over a period of time to understand the aquifer characteristics
Geothermal Cooling	Borehole extracts hot water from hot rock layer, which passes through an absorption chiller to create chilled water	Absorption chiller COP=0.6-0.8 (Single-effect)	Primary energy source is geothermal therefore carbon saving potential high	Absorption chiller more expensive then water cooled. Borehole deeper than ground source	Geotechnical survey required. Heat rejection required for cooling water, likely to be cooling towers which require TSE
Solar Thermal Cooling	Solar thermal collectors used to generate hot water, which is passed through an absorption chiller to create chilled water	Absorption chiller COP=0.6-0.8 (Single-effect)	Primary energy source is the sun therefore carbon saving potential high	Large array of solar thermal collectors potentially required	Heat rejection required for cooling water, likely to be cooling towers which require TSE

The value of Table 02 is to provide a selection guide for stakeholders for them to differentiate the system applications that will be suited in the project and for the Return on Investment (ROI). However, with the selections as shown in the table as far as Energy Conservation is concerned, using the Water Cooled Chillers with the Cooling Towers are most preferable with all the system selection where can be justified based on the requirements and considerations in the competitive landscape for the project as follows:

- Most of the infrastructure building built environment, sustainability is always the core and passionately amend with due respect to environmental concerned in aligning with the goals and objectives of the Green Building Council and the Environmental Protection Agency for the project within the utility grid.
- The air-cooled chillers are the second option and commonly used in the residential, commercial, and industrial industries, however, this will be used mainly as the basis of conceptual design analysis, but this is always the case to be improved in the direction to sustainability, which is the Water Cooled Chillers with the Cooling Towers.
- The efficiencies equivalent to district cooling systems can be achieved using the Water Cooled Chillers with the Cooling Towers in the building built-environment, however, district cooling system is most preferably within the community perspective for energy conservation and environmental concerned which is equipped with Water Cooled Chillers with the Cooling Towers in the utility grid.
- Energy represents a significant proportion of a sustainability scorecard and is key to achieving LEED Platinum requirements in attaining energy conservation.
- Smaller footprint is an additional benefit to accommodate of the evolving requirements in the design process and key driver in system selection for energy, environmental and sustainability concerned.
- Importance of water-cooled chillers has increased in terms of sustainability and the use of Treated Sewage Effluent (TSE) which is part of the water management energy conservation strategy for cooling heat rejection in the system.

Energy Conservation Design through Building Information Modeling

Adopting BIM (Building Information Modeling) is a matter of investment for the company where most of the neighboring countries have had provided in such a way to provide justified and realistic details, and thus, securing the work without compromising the basic needs of design and construction. BIM is now popular and accurate to work with; in particular, it is the Building Information modeling, where has been invented many years ago since the 1980s and has been popular commercially through the endorsement of the Autodesk in late 2000. BIM is an intelligent 3D model-based process that creates and helps the Architecture, Engineering, and Construction (AEC) Professionals of the insight and tools to make more efficient in preparing plans, designs, and construction in particular and managing the buildings and infrastructure for the utilities, where to facilitate the requirements.

It is indeed, as a Consultant working in the Consulting Firm, I am endorsing the importance using the BIM Component through the AEC Firms to facilitate the design works in every particular project we are taking to facilitate in designing services exactly what it means to be overall. It is not only for our self endeavor, however, but for the clients to understand what will be happening in the projects as well as in the progression. Notwithstanding, with all the followings benefits that can be achieved using the BIM (Building Information Modeling) in the building and utility projects with the following significant facts as follows;

- BIM has the quality and reliability of Electra-Mechanical Construction;
- The CAD MEP and Utilities software helps the design and construction in achieving of the goals in securing the project a realistic vision;
- BIM is more accurate, efficient, and deliver more innovative building and infrastructure strategies that nobody can excuse from it;
- Through the BIM (Building Information Modeling) will help in helping to increase the project quality and safety while minimizing project cost and schedules that have been stated in the construction documents by both parties, most especially for the client sake monitoring;
- Where the creation of the Autodesk REVIT, the project development have had allowed communicating detailed design with the entire team in the design and construction process efficiently and accurately at all aspects;
- BIM in general, the project visualizations will help us to convey the technical aspects of every engineering

designs for the clients to understand everything that may need further visualization a justification and evidence for the projects;

- Using BIM (Building Information Modeling), in particular, will help them in securing a better understanding of those designs as far as AEC is concerned;
- Through BIM (Building Information Modeling) will create a visual collaboration that enables us (Engineers, Designers, Stakeholders and the Clients) to translate of individual needs into optimal solutions to simplify the coordination in the design stages and construction process; and
- Overall, will create and have a multi-discipline understanding of a project that may help further inform of design alternatives and decision-making for a perfect solution without compromising the needs of the project.

Adoption in the country, I may say that has been practicing for the decades now, where most of the top list's companies in the world, have had provided and implemented.

Most of the companies are now motivated to simplify the project coordination and documentation efficiencies as the major benefits of BIM (Building Information Modeling) actually, whereas benefiting the company status as an innovator to simplify the design and construction projects. However, as an experienced design engineer gained from the AEC Firms where most of my career had been developed throughout the years and BIM exposure, indeed, it takes different view whereas they putting into project visualization at the top of the list as they are graphically-oriented, to be honest, especially in the utilities application.

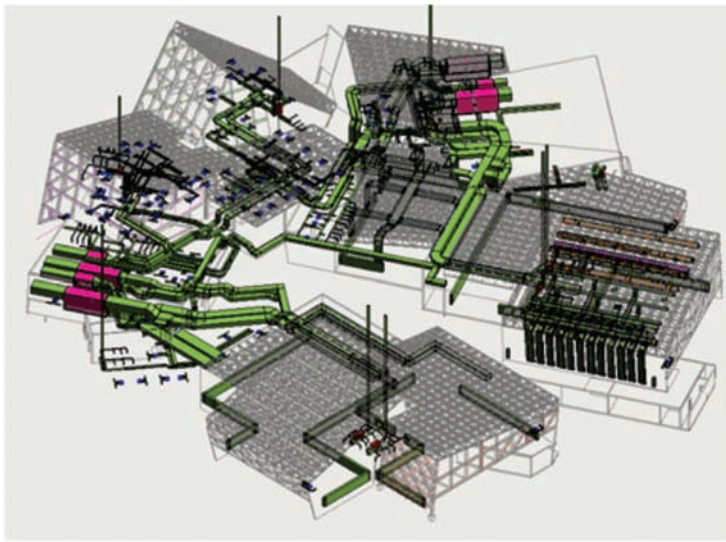


Figure 1, BIM Works Sample; done by MJimenez

As a conclusion, BIM (Building Information Modeling, e.g. Figure 1) adoption has been practicing in the developing countries not only in the developed countries as these are already mandated not only for the clients need but for the stakeholders whereas the model enables those who interact with the building and utilities to optimize their actions, resulting in a greater whole life value for the asset. Adoption, for me, is mandatory as technology evolves, we need to equip ourselves with the latest trends to simplify all issues what we have experienced in the conventional way to conserve re-work and energy conservation within the building built-environment as far as buildings and the utilities are concerned.

References

Ronald Valledor Gomeseria, (2018), "Building Services Design and Construction Management", a Thesis for DBCE 111 subject course, PhD in Building and Construction Engineering; School of Science and Engineering, Atlantic International University, AIU USA

Ronald Valledor Gomeseria, (2018), "Renewable Energy Technologies", a Thesis for DBCE 112 subject course, PhD in Building and Construction Engineering; School of Science and Engineering, Atlantic International University, AIU USA

Ronald Valledor Gomeseria, (2018), "Energy Conversion Technology", a Thesis for DBCE 106 subject course, PhD in Building and Construction Engineering; School of Science and Engineering, Atlantic International University, AIU USA

BUILT ENVIRONMENT – ENERGY CONSERVATION FOR UTILITIES: A CASE STUDY ON HVAC SYSTEM

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1.0 BACKGROUND

This case study pertains to performance analysis and recommendations on Energy Conservation for a HVAC System and is based on a detailed Energy Audit carried out for IT office buildings in Kolkata. An air-conditioning system of a modern day office building consumes about 55%-60% of the total electrical energy consumption; hence the scope of this energy audit was restricted to the air-conditioning system. The building has a centralized air-conditioning system, catering to two buildings - Building No. 1 & 2 inside a complex. Broadly, the air-conditioning system comprised of Water-Cooled Chillers and the associated downstream equipment viz. Cooling Towers, Cooling Water and Chilled Water Pumps, and Air Handling Units (AHUs).

The specification of the existing Chillers which were installed the two buildings were:

Type	Year of installation	Area Served	Design Capacity of each Chiller (TR)	No. Of Chillers installed	Refrigerant
Water-Cooled Screw Chiller with Twin Compressors	1998	Building No. 1	250	3	R-22
Water-Cooled Screw Chiller with Twin Compressors	2004	Building No. 2	300	3	R-22

2.0 EXISTING CHILLER PERFORMANCE STUDY

2.1 Existing Chiller Performance Report of Building Nos. 1 & 2

The performance analysis of the existing chillers was conducted on different days during the summer season. The measurements of the Chiller Output vis-à-vis Power Consumption were taken by calibrated instruments such as Power Analyzer, Ultrasonic Flow Meter, Digital Temperature Sensor, Pressure Gauges, etc. The performance analyses of the chillers are presented below:

Sl. No.	Parameter	Unit	Building 1 (250 TR Chillers)			Building 2 (300 TR Chillers)		
			Chiller 1	Chiller 2	Chiller 3	Chiller 1	Chiller 2	Chiller 3
1	Outside Air DBT	^{0}C	33.5	34.5	32.5	37	38	39
2	Outside Air WBT	^{0}C	24	24.5	25	29	28.5	28
3	Average Voltage	V	421.05	418.54	415.68	420.36	420.10	410.48
4	Compressor Average Current	A	257.00	266.00	255.00	304.65	294.75	306.20

Sl. No.	Parameter	Unit	Building 1 (250 TR Chillers)			Building 2 (300 TR Chillers)		
			Chiller 1	Chiller 2	Chiller 3	Chiller 1	Chiller 2	Chiller 3
5	Power Factor	Cos Ø	0.73	0.82	0.75	0.79	0.79	0.83
6	Power Input (IkW)	kW	137.38	158.50	137.69	175.22	169.43	179.60
7	Suction Pressure	Psig	72.00	70.00	82.00	71.00	70.00	70.00
8	Discharge Pressure	Psig	206.00	200.00	186.00	185.00	188.00	187.00
9	Discharge Temperature	^{0}C	57.3	64.2	62.4	56.1	63.4	57.1
10	Percentage Loading	%	90.00	100.00	90.00	100.00	100.00	100.00
11	Condenser Water Inlet Temperature	^{0}C	30.10	30.40	30.10	32.3	32.8	32.10
12	Condenser Water Outlet Temperature	^{0}C	33.50	33.60	33.3	35.6	36.2	35.50
13	Condenser Water Temperature Difference	^{0}C	3.40	3.20	3.20	3.30	3.40	3.40
14	Condenser Water Inlet Pressure	psi	59.74	59.74	59.74	82.50	82.50	83.92
15	Condenser Water Outlet Pressure	psi	51.20	51.20	51.20	75.38	75.38	76.81
16	Condenser Water Pressure Drop	psi	8.53	8.53	8.53	7.11	7.11	7.11
17	Condenser Water Flow Rate	USGPM	859	881	870	991	991	991
18	Chilled Water Inlet Temperature	^{0}C	12.3	12.4	12.2	11.5	11.4	11.6
19	Chilled Water Outlet Temperature	^{0}C	8.6	8.5	8.9	8.1	8	8.2
20	Chilled Water Temperature Difference	^{0}C	3.7	3.9	3.3	3.4	3.4	3.4
21	Chilled Water Inlet Pressure	psi	61.16	61.16	64.01	65.43	62.58	66.85
22	Chilled Water Outlet Pressure	psi	55.47	55.47	56.89	58.32	55.47	59.74
23	Chilled Water Pressure Drop	psi	5.69	5.69	7.11	7.11	7.11	7.11
24	Chilled Water Flow Rate	USGPM	599	597	630	828	823	837
25	Cooling capacity	TR	166.17	174.51	155.83	211.08	209.96	213.33
26	Specific Energy Consumption (IKW/TR)	KW/TR	0.827	0.908	0.884	0.830	0.807	0.842

2.2 Observations

1. Average IKW/TR of Chillers of Building No. 1 is 0.873.
2. Average IKW/TR of Chillers of Building No. 2 is 0.826.
3. These values are very high compared to present generation chillers, which have full load IKW/TR of <0.65.

4. The performances of the chillers, both in terms of capacity outputs and energy consumptions, have deteriorated due to ageing.

3.0 Chiller Recommendations:

Replacement of the existing chillers of both the buildings, in a phased manner, was recommended as a major energy conservation measure. Since the chillers of Building No. 1 were almost 20 years old, the recommendations and post-implementation benefits for those chillers were the prime focus.

For Building No. 1, the specific recommendation was to replace the existing chillers with -

Option 1: Energy Efficient Water-Cooled Screw Chiller, working on refrigerant R-134a and having twin compressors with Non-VFD Starter.

Option 2: Energy Efficient Water-Cooled Screw Chiller, working on refrigerant R-134a and having single compressor with VFD Starter.

3.1 Energy Conservation Opportunities with both Options

3.1.1 OPTION 1

Replacing the Existing 3 x 250 TR screw chillers of Building No. 1, with 3 Nos. Energy Efficient 265 TR Water-Cooled Screw Chiller, having Twin Compressors. This would improve the specific power consumption and thereby, save electrical energy. The recommended chillers would have full load IKW/TR of 0.62 at 32^{0}C Cooling Water Inlet temperature and a NPLV value of 0.40.

Energy Saving potential of Option 1

Total Power consumed by the two Existing Chillers in Operation	295.90	KW
Total TR delivered	338.81	TR
Average IKW/TR of the Existing Chillers	0.873	KW/TR
Total running hours of the plant per year	3072	hrs
Total Energy Consumed	909004.8	KWh
Total capacity delivered by 2 nos. 265 TR New Chiller at 65% loading and Condenser Water Inlet Temperature of 32^{0}C **(Note: 65% Loading is considered as 2 New Chillers running at 65% loading would deliver 340-345 TR Capacity which is the running building cooling requirement)**	345	TR
Total IKW/TR value of the New Chillers at 65% loading	0.642	KW/TR
Total power consumed by the New Chillers	221.49	KW
Total energy consumed by the New Chillers	680417.28	KWh
Total Energy Conservation feasible	228587.52	KWh
Estimated Life of proposed system	15	Years

3.1.2 Benefits of the above Recommendation

1. Lesser Full Load IKW/TR in the range of 0.62, based on Cooling Water Inlet Temperature of 32^{0}C, compared to

present IKW/TR in the range of 0.873 even at 30^{0}C Cooling Water Inlet Temperature.

2. Lesser input current and power consumption and therefore, reduction in overall electricity demand and energy bill.

3.1.3 OPTION 2

Replacing the Existing 3 x 250 TR Chillers of Building No. 1, with 3 Nos. Energy Efficient VFD based 240 TR Water-Cooled Screw Chiller with Single Compressor, thereby improving the specific power consumption and saving electrical energy. The chiller would have full load IKW/TR of 0.65 at 32^{0}C Cooling Water Inlet temperature and NPLV value of 0.364.

Energy Saving potential of Option 2

Total Power consumed by the two Existing Chillers in Operation	295.90	KW
Total TR delivered	338.81	TR
Total KW/TR based on NPLV condition (Why different terminology?)	0.873	KW/TR
Total running hours of the plant	3072	hrs
Total Energy Consumed	909004.80	KWh
Total capacity delivered by 2 nos. 240 TR New Chiller at 71% loading and Condenser Water Inlet Temperature of 32^{0}C **(Note: 71% Loading is considered as 2 New Chillers running at 71% loading would deliver 340-345 TR Capacity which is the running building cooling requirement)**	342.84	TR
Total IKW/TR value of the new chillers at 71% loading	0.625	KW/TR
Total power consumed by the New Chillers	214.28	KW
Total energy consumed by the New chillers	658252.8	KWh
Total Energy Conservation feasible	250752.00	KWh
Estimated Life of proposed system	15	Years

3.1.4 Benefits of the above Recommendation

1. Lesser IKW/TR, in the range of 0.656 based on Cooling Water Inlet Temperature of 32^{0}C compared to present IKW/TR in the range of 0.873 even at 30^{0}C Cooling Water Inlet Temperature.
2. Lesser input current consumption and power consumption and therefore, reduction in overall electricity demand and energy bill.
3. Compressor Motors of the chillers, run at higher efficiency even at part load conditions, being VFD controlled.

4.0 PERFORMANCE STUDY OF WATER PUMPS OF HVAC IN BUILDING No. 1

4.1 Detail Design Data of Pumps

1. 3 Nos. Primary Chilled Water Pumps - 20 M Head, 150 CMH Flow, 15 KW Motor
2. 3 Nos. Secondary Chilled Water Pumps - 30 M Head, 220 CMH Flow, 30 KW Motor
3. 3 Nos. Condenser Water Pumps - 30 M Head, 220 CMH Flow, 30 KW Motor

4.2 Design v/s Measured Parameters

UNIT DATA	Condenser Pump 1		Condenser Pump 2		Condenser Pump 3	
Location	Building 1					
TEST DATA	DESIGN	ACTUAL	DESIGN	ACTUAL	DESIGN	ACTUAL
Pump/Motor Speed RPM	1470	1473	1470	1468	1470	1477
Total Dynamic Head (m)	30	18	30	18	30	18
Final Flow (L/s)	61.60	67.20	61.60	68.60	61.60	65.80
Power input (kW)	33.33	31	33.33	33	33.33	26
Hydraulic Power (KW)	18.13	11.87	18.13	12.11	18.13	11.62
System Efficiency (%)	0.544	0.383	0.544	0.367	0.544	0.447

UNIT DATA (Primary Pumps)	PCHW Pump 1		PCHW Pump 2		PCHW Pump 3	
TEST DATA	DESIGN	ACTUAL	DESIGN	ACTUAL	DESIGN	ACTUAL
Pump/Motor Speed RPM	1455	1464	1455	1455	1455	1465
Total Dynamic Head (m)	20	20	20	20	20	20
Final Flow (L/s)	42.00	33.60	42.00	39.20	42.00	39.20
Power input (kW)	17	14.31	17	15.23	17	14.89
Hydraulic Power (KW)	8.24	6.59	8.24	7.69	8.24	7.69
System Efficiency (%)	0.494	0.461	0.494	0.505	0.494	0.517

UNIT DATA (Secondary Pumps)	SCHW Pump 1		SCHW Pump 2		SCHW Pump 3	
TEST DATA	DESIGN	ACTUAL	DESIGN	ACTUAL	DESIGN	ACTUAL
Pump/Motor Speed RPM	1470	1487	1470	1486	1470	1484
Total Dynamic Head (m)	30	30	30	30	30	30
Final Flow (L/s)	61.60	50.96	61.60	51.52	61.60	52.08
Power input (kW)	33.33	29.0	33.33	31.44	33.33	32.25
Hydraulic Power (KW)	18.13	15.00	18.13	15.16	18.13	15.33
System Efficiency (%)	0.544	0.517	0.544	0.482	0.544	0.475

4.3 Observations:

1. Actual System Efficiencies of the existing Pumps Motor sets are lower than the design efficiency values.
2. Lower efficiency values are obviously leading to high power consumption.
3. The Secondary Pumps are running without VFD as the existing VFDs are not functional and hence, these are running at fixed speed and at lower efficiencies during part load.
4. The Pumps Motor sets are running for more than 15 years and hence their effective life is nearly over. Replacement is therefore recommended.

4.4 Recommendations 2

Replacing the existing Chilled Water and Condenser Water Pumps and Motors of HVAC system, with new energy efficient pumps and motors along with VFD for the secondary pumps.

4.4.1 Detail Design Data of New Pumps

1. 3 Nos. Primary Chilled Water Pumps - 20 M Head, 160 CMH Flow, 15 KW Motor
2. 3 Nos. Secondary Chilled Water Pumps - 30 M Head, 220 CMH Flow, 30 KW Motor
3. 3 Nos. Condenser Water Pumps - 30 M Head, 235 CMH Flow, 30 KW Motor

Particular	Rating of Pump Motor (KW)	Actual input Power consumption of Pump Motors (KW)	Design Efficiency of existing Motor (%)	Design Efficiency of existing Pumps (%)	Design Efficiency of Proposed Motors (%)	Design Efficiency of Proposed Pumps (%)	Calculated Capacity (KW)	Selected Capacity (KW)
Primary Chilled Water Pump	15	14.81	80.00	62.00	92.10	82.70	11.82	15
Secondary Chilled Water Pump	30	30.9	85.00	64.00	93.60	80.20	23.98	30
Condenser Water Pump	30	30	85.00	64.00	93.60	80.20	23.98	30

4.4.2 Energy Conservation arising out of the Recommendation

Energy Saving Potential

Power consumption of the CDW Pump of Building 1 Chillers	90.00	KW
Power consumption of the PCHW Pump of Building 1 Chillers	44.43	KW
Power consumption of SCHW Pump of Building 1 Chillers	92.69	KW
Total running hours of the Pumps	3072	hrs
Total energy consumption of the Pumps	697712.64	KWh

Power requirement of the new CDW Pump Motor (KW) of Building 1 Chillers	71.93	KW
Power requirement of the new PCHW Pump Motor (KW) of Building 1 Chillers	35.45	KW
Considering the 90% flow with 60% time of Secondary Chilled Water Pump operation & 70% flow with rest 40% time of Secondary Chilled Water Pump operation & annual running time 3000 hours.		
The power consumption with new Secondary chilled water pump with VFD will be:		
(0.9)3 x 30 + 5% fixed losses (Due to Harmonics)	18.68	kW
(0.7)3 x 30 + 5% fixed losses (Due to Harmonics)	9.42	kW
Annual Energy Consumption with 90% flow	34428.4	kWh
Annual Energy Consumption with 70% flow	11579.3	kWh
Annual Energy Consumption for 3 pumps with VFD	138023.2	kWh
Total annual Energy Consumption of new pump motors	467895.9	KWh
Annual Energy Savings	229817	KWh
Estimated Life of proposed system	15	Years

4.4.3 Benefits of the above Recommendation:

1. Reduction in Power consumption because of better motor and pump efficiency.
2. Higher motor and pump efficiency would lead to reduction of losses and therefore reduction in overall electricity demand and energy bill.

ACTUAL ENERGY SAVINGS OBTAINED ONE YEAR AFTER IMPLEMENTATION OF THE RECOMENDATIONS

1.0 BACKGROUND

The recommendations on energy conservations measures very implemented as follows:

1. Replace the existing 3 x 250 TR Water-Cooled Screw Chillers with 2 Nos. Energy Efficient VFD based 240 TR Water-Cooled Screw Chillers with Single Compressor and 1 No. Energy Efficient 265 TR Water-Cooled Screw Chiller with Twin Compressors
2. Replace the existing pumps with new Energy Efficient Pumps and Motors, along with VFD and Pump Controller in the Secondary Pumps.
3. Install online BTU Meter on the Chiller Outlet for monitoring the output capacity, based on flow.

The performance study was conducted again during the first summer post-commissioning of the new equipment. The results are

2.0 PERFORMANCE STUDY POST IMPLEMENTATION

2.1 CHILLER DETAILS

Type	Year of installation	Area Served	Design Capacity (TR)	Total No. of chillers installed	Refrigerant
Water-cooled Screw Chiller VFD with Single Compressor	2017	Building No. 1	240	2	R-134a
Water-cooled Screw Chiller Non-VFD with Twin Compressor	2017	Building No. 1	265	1	R-134a

Photograph: 240 TR VFD Chiller

2.2 Chiller Performance Report:

Sl. No.	Parameter	Unit	Existing non-VFD Chiller	New VFD-based Chiller 1	New VFD-based Chiller 2
1	Outside Air DBT	^{0}C	34.50	34.50	34.50
2	Outside Air WBT	^{0}C	30.50	30.50	30.50
3	Average voltage	V	418.00	420.00	414.00
4	Compressor average current	A	289.20	239	245
5	Power factor	Cos Ø	0.744	0.75	0.756
6	Power input (IKW)	kW	155.77	130.39	132.81
7	Suction Pressure	psig	36	36	37

Sl. No.	Parameter	Unit	Existing non-VFD Chiller	New VFD-based Chiller 1	New VFD-based Chiller 2
8	Discharge Pressure	psig	127	120	122
9	Discharge Temperature	^{0}C	51.17 & 51.83	55.22	52.22
10	Percentage Loading	%	100% & 100%	98.5%	100%
11	Condenser Water Inlet Temperature	^{0}C	32.8	32.1	31.4
12	Condenser Water Outlet Temperature	^{0}C	37.1	36.1	35.8
13	Condenser Water Temperature Difference	^{0}C	4.3	4	4.4
14	Chilled Water Inlet Temperature	^{0}C	14.5	12.8	11.1
15	Chilled Water Outlet Temperature	^{0}C	10	8.7	7.2
16	Chilled Water Temperature Difference	^{0}C	4.5	4.1	3.9
17	Chilled Water flow rate	USGPM	166.30	156.30	176.40
18	Cooling capacity	TR	247.12	209.32	226.53
19	IKW /TR	kW/TR	0.630	0.623	0.586

Average IKW/TR of the new chillers of Building No. 1= 0.613

2.3 Actual Benefits:

1. **The IKW/TR has reduced from 0.873 to 0.613.**
2. **VFD Chillers have very low staring current and hence reduced the demand charge of Building No. 1.**

Photograph: 265 TR Non-VFD Chiller

3.0 PERFORMANCE STUDY OF PUMPS FOR BUILDING 1 CHILLERS

3.1.1 Detail Design Data of new Pumps

1. 3 Nos. Primary Chilled Water Pumps - 20 M Head, 160 CMH Flow, 15 KW Motor, Motor Efficiency = 92.10%, Pump Efficiency = 79%.
2. 3 Nos. Secondary Chilled Water Pumps with VFD - 30 M Head, 220 CMH Flow, 30 KW Motor, Motor Efficiency = 93.60%, Pump Efficiency = 77%.
3. 3 Nos. Condenser Water Pumps-30 M Head, 235 CMH Flow, 30 KW Motor, Motor Efficiency = 93.60%, Pump Efficiency = 78%.

3.1.2 Features of the New Pumps

1. High Motor and Pump Efficiency. Motor is Eff1/IE3 category.
2. Cast Iron Pump Body, Bronze Impeller, Carbon Steel (CS)/ Stainless Steel (SS)/ Alloy Steel (AS) Shaft.
3. Sealing Arrangement. Gland Packing.

3.2 Design v/s Measured Parameters of New Pumps:

UNIT DATA	**Condenser Pump 1**		**Condenser Pump 2**		**Condenser Pump 3**	
Location			**Building-1**			
TEST DATA	DESIGN	ACTUAL	DESIGN	ACTUAL	DESIGN	ACTUAL
Suction Pressure (kg/cm^2)		2.5		2.5		2.65
Discharge Pressure (kg/cm^2)		5.8		5.8		6.1
Total Dynamic Head (m)	30	33	30	33	30	34.5
Final Flow (L/s)	65.80	56.70	65.80	57.96	65.80	54.81
Power input (kW)	32.05	26.16	32.05	28.09	32.05	27.23
Hydraulic Power (KW)	19.36	18.36	19.36	18.76	19.36	18.55
System Efficiency (%)	0.604	0.702	0.604	0.668	0.604	0.681

Photograph: Condenser Pumps

UNIT DATA	PCHW Pump 1		PCHW Pump 2		PCHW Pump 3	
Location			**Building-1 1**			
TEST DATA	DESIGN	ACTUAL	DESIGN	ACTUAL	DESIGN	ACTUAL
Pump/Motor Speed RPM	1455	1464	1455	1455	1455	1465
Total Dynamic Head (m)	20	20	20	20	20	20
Final Flow (L/s)	42.00	33.60	42.00	39.20	42.00	39.20
Power input (kW)	17	14.31	17	15.23	17	14.89
Hydraulic Power (KW)	8.24	6.59	8.24	7.69	8.24	7.69
System Efficiency (%)	0.494	0.461	0.494	0.505	0.494	0.517

Photograph: Primary Chilled Water Pump

UNIT DATA	SCHW Pump 1		SCHW Pump 2		SCHW Pump 3	
Location			**Building 1**			
TEST DATA	DESIGN	ACTUAL	DESIGN	ACTUAL	DESIGN	ACTUAL
Pump/Motor Speed RPM	1470	1487	1470	1486	1470	1484
Total Dynamic Head (m)	30	30	30	30	30	30
Final Flow (L/s)	61.60	50.96	61.60	51.52	61.60	52.08
Power input (kW)	33.33	29.0	33.33	31.44	33.33	32.25
Hydraulic Power (KW)	18.13	15.00	18.13	15.16	18.13	15.33
System Efficiency (%)	0.544	0.517	0.544	0.482	0.544	0.475

Photograph: Secondary Chilled Water Pump

Pump	SL No	Voltage			Current			POWER FACTOR			Total Power (KW)
		R	Y	B	R	Y	B	R	Y	B	
CDW PUMP (Building 1)	1	241	242	240	45.5	44	44.5	0.82	0.81	0.8	26.16
	2	241	241	240	48.5	47	48	0.81	0.82	0.81	28.09
	3	242	241	240	47	46.5	46	0.82	0.8	0.81	27.23
SCHW PUMP (Building 1)	1	242	241	240	20	22.5	25	0.73	0.74	0.73	11.93
	2	241	240	241	24.5	22	20	0.74	0.73	0.74	11.79
	3	241	240	242	22.5	24.5	20	0.73	0.74	0.75	11.94
PCHW PUMP (Building 1)	1	240	239	241	26	26.5	25.5	0.77	0.78	0.76	14.42
	2	241	240	239	26.5	26	25.5	0.76	0.78	0.77	14.41
	3	239	241	240	26	25.5	26	0.76	0.77	0.78	14.32

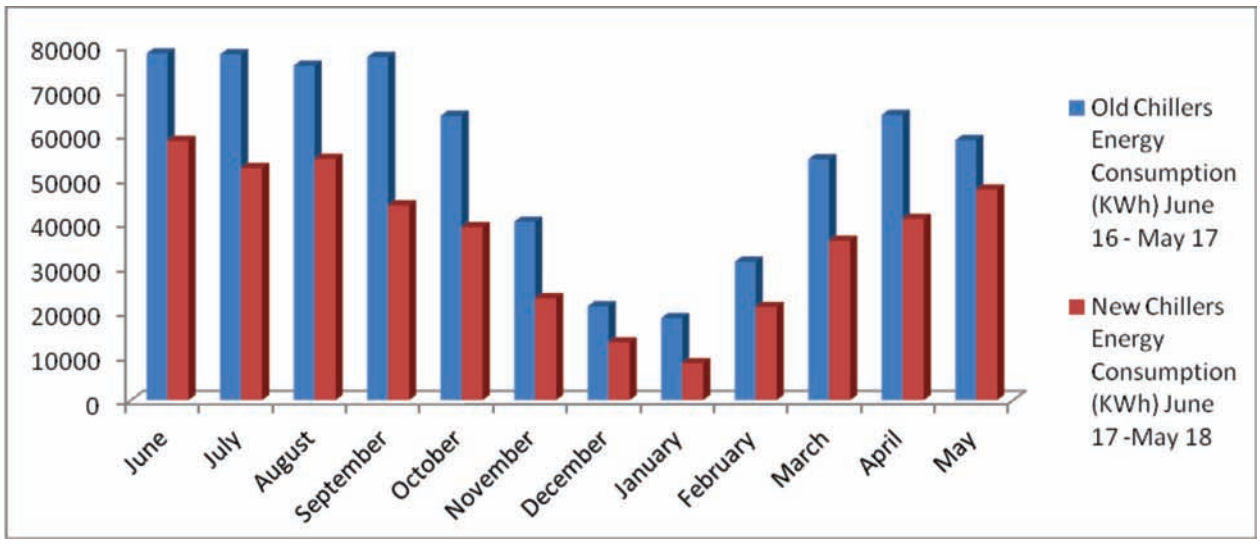
3.3 Benefits:

1. **Reduction in Input Power consumption as a consequent of better motor and pump efficiencies.**
2. **The total savings from the new VFD-based secondary pumps were significantly high due to lesser energy consumption at part load conditions, based on variations in demand.**
3. **Reasonable savings were achieved in Condenser Pumps to the tune of 10% with 7% higher flow rate.**
4. **The CHW flow across the chillers increased by around 10-15%, when two chillers were in operation, due to the new primary pumps. That was however, with no increase in power consumption vis-à-vis the earlier PCHW pumps. Hence the incidental saving is 10%.**
5. **As a result of the increased flow, one primary pump was sufficient when only one chiller was in operation. This was not the case with the earlier pumps. Two pumps were required to run even for operating one chiller earlier. Therefore, in this case the incidental saving was to the tune of 50%.**

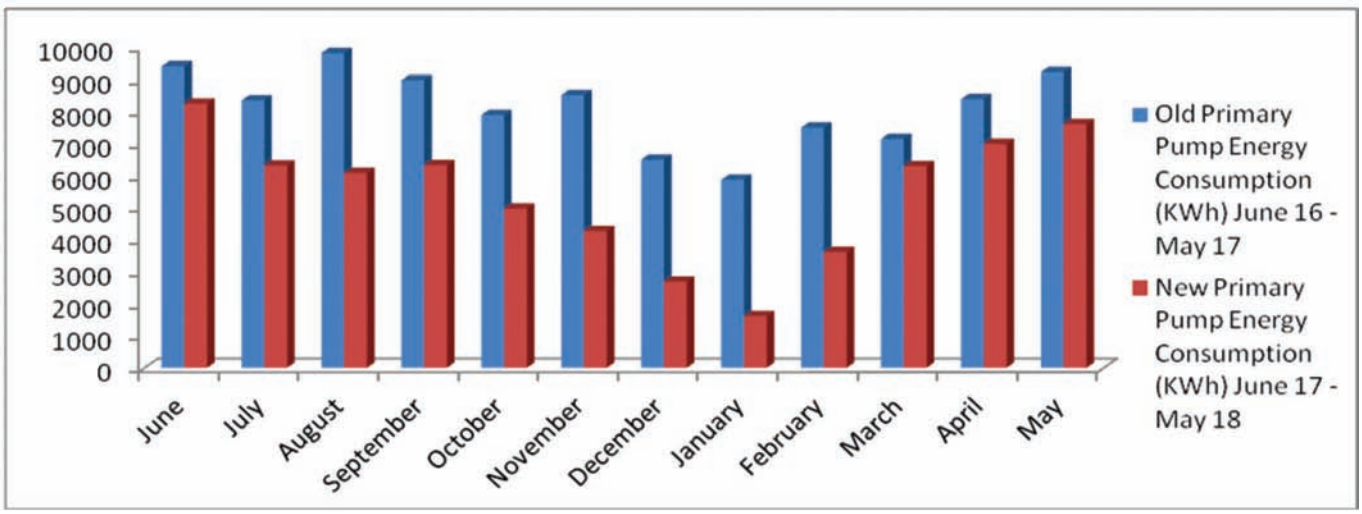
4.0 Energy Monitoring:

The customer/ end-user has been monitoring the consumption of their chillers on 24x7 basis, using digital energy meters. Their month-wise data, given below, further corroborates the actual energy consumption of the chillers and pumps vis-à-vis the earlier equipment operating in the previous year.

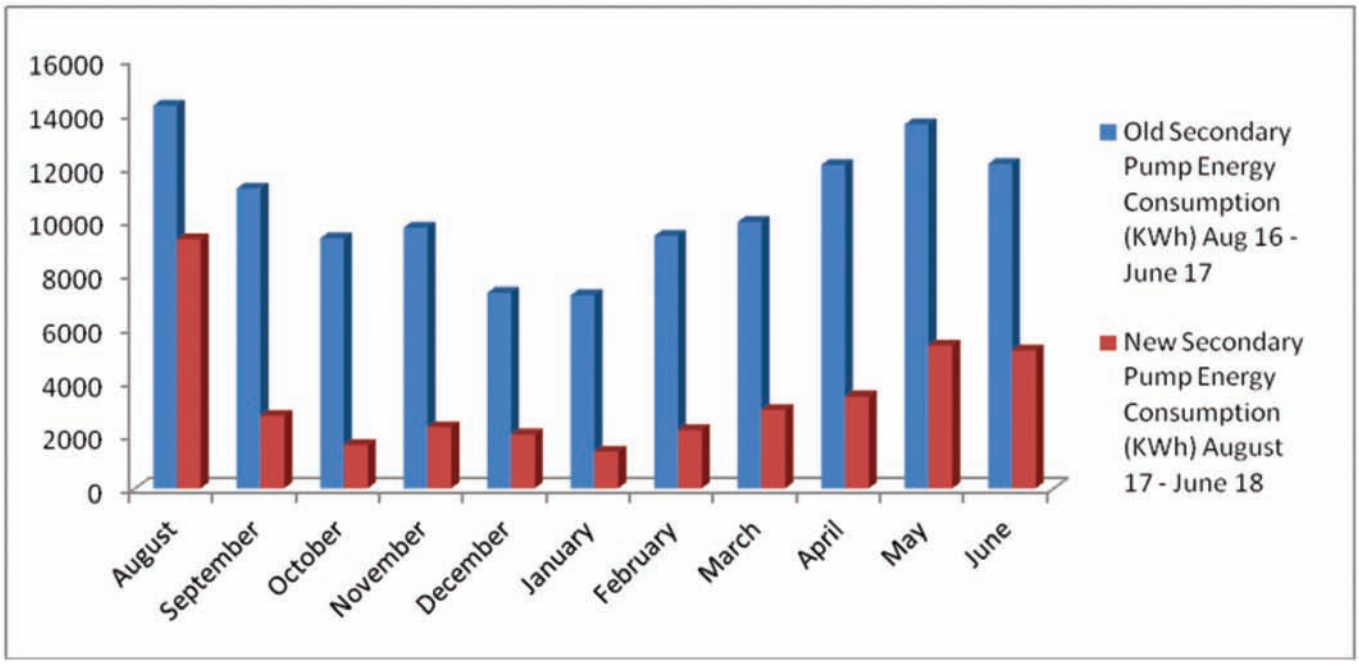
Month	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Total Savings
Old Chillers Energy Consumption (KWh)	78350	78141	75566	77543	64188	40259	21278	18586	31190	54375	64418	58712	
Month	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	
New Chillers Energy Consumption (KWh)	58553	52369	54469	43916	39000	23069	13099	8333	21067	35938	40854	47526	
TOTAL SAVINGS	**19797**	**25772**	**21097**	**33627**	**25188**	**17190**	**8179**	**10253**	**10123**	**18437**	**23564**	**11186**	**224413**



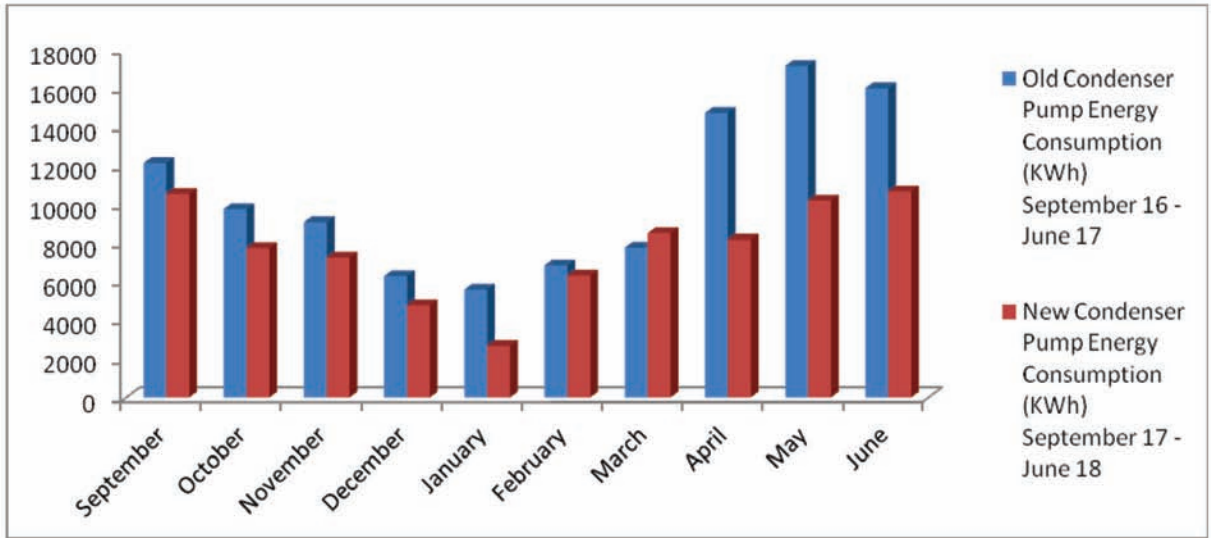
Month	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Total Savings
Old Primary Pump Energy Consumption (KWh)	9406	8355	9819	8983	7904	8519	6512	5876	7506	7156	8396	9229	
Month	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	
New Primary Pump Energy Consumption (KWh)	8257	6329	6090	6334	4977	4277	2696	1620	3622	6305	6998	7619	
TOTAL SAVINGS	1149	2026	3729	2649	2927	4242	3816	4256	3884	851	1398	1610	32537



Month	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Total Savings
Old Secondary Pump Energy Consumption (KWh)	14260	11182	9316	9724	7298	7207	9408	9944	12056	13569	12094	
Month	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	
New Secondary Pump Energy Consumption (KWh)	9282	2703	1614	2268	2010	1367	2166	2927	3417	5318	5134	
TOTAL SAVINGS	**4978**	**8479**	**7702**	**7456**	**5288**	**5840**	**7242**	**7017**	**8639**	**8251**	**6960**	**77852**



Month	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Total Savings
Old Condenser Pump Energy Consumption (KWh)	12151	9774	9088	6293	5583	6856	7786	14747	17172	16043	
Month	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	
New Condenser Pump Energy Consumption (KWh)	10566	7760	7266	4796	2672	6325	8517	8187	10214	10700	
TOTAL SAVINGS	**1585**	**2014**	**1822**	**1497**	**2911**	**531**	**-731**	**6560**	**6958**	**5343**	**28490**



Total Savings of Chillers + Primary Pumps + Secondary Pumps + Condenser Pumps (Sum of all 'Total Savings' values of all the four Tables above	**363293 KWh**

NOTE:

1. The total actual Energy Savings of the new system after 1 year of implementation was 363,293KWh.
2. The new Screw Chillers and Primary Pumps were commissioned in June 2017.
3. The Secondary Pump Controllers were commissioned by mid August 2017 and Cooling Towers refurbishment work like replacement of Structural Material was completed (although this was not recommended, however, it was deemed necessary at the time of Detail Engineering due to damage to the Cooling Towers Structures) by end of August 2017. Hence the data for Secondary Chilled Water and have been indicated from August and September respectively.

5.0 CONCLUSION

The Energy Conservation actually achieved at this site made it a successful revamp/ retrofit project.

SMART WATER: A KEY BUILDING BLOCK FOR A SMART CITY

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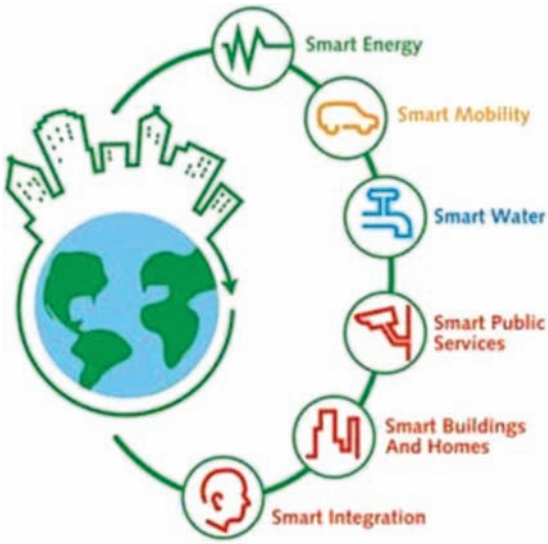
The World Health Organization reports that for the first time ever, the majority of the world's population lives in cities, and the trend would continue to grow with projections of 70 percent by 2050. Currently, around half of all urban dwellers live in cities with populations between 100,000 and 500,000 people, and almost 10 percent of urban dwellers live in megacities. As cities around the world experience this exploding growth, the need to ensure that they expand sustainably, operate efficiently, and maintain a high quality of life for residents becomes even greater than it is today.



That is where smart cities come into the picture. A smart city encompasses the various services that improve the quality of liveability.

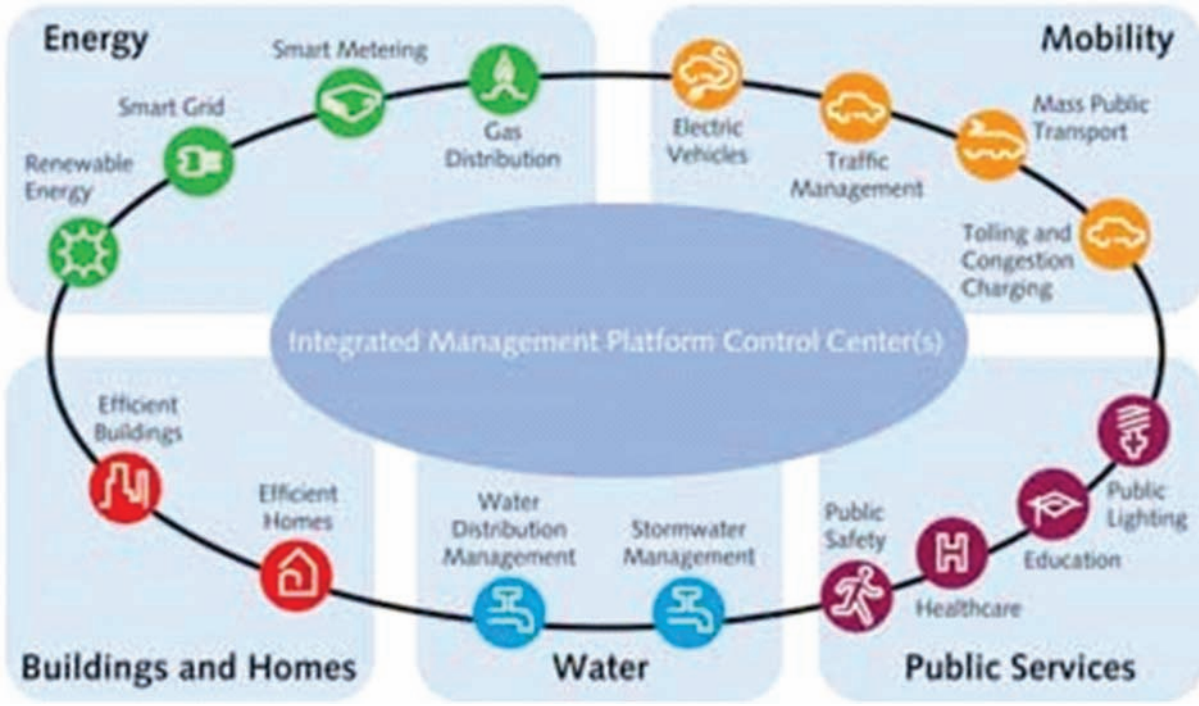
The term "Smart Cities" is trending amongst governments, urban planners and even the private sector to address the projected demands of cities in the future. Making cities smarter to improve liveability and support growth is emerging as a key area of focus for governments and the private sector alike. This decade, cities around the world will invest $108 billion in smart city infrastructure, such as smart meters and grids, energy-efficient buildings, water supply 24x7, water recycling, solid waste conversion to energy, etc. based on data analytics, according to Navigant Research Reports.

Smart Cites - Smart Water

A city's most critical infrastructure is it's water systems. With populations in cities growing, it is inevitable that water consumption will grow as well. The term "smart water" points to water and wastewater infrastructure that ensures this precious resource - and the energy used to transport it - is managed effectively. A smart water system is designed to gather meaningful and actionable data about the flow, pressure, and distribution of a city's water. Further, it is critical that that the consumption and forecasting of water use is accurate based on Demand vs Supply.

Integrated Smart Management platform based on IT support has been formulated for all smart cities which encompasses all activities related with citizens living in that city based on Mobility, Energy, Water, Public services and Building homes themes as shown below.

Smart cities require innovating water and waste treatment solutions, which are customised and need-based systems at the same time versatile, robust, and performance-oriented. They would comprise Intake and Pumping systems, Water Treatment, Supply and Distribution, Sewage and Storm Water Collection systems, Sewage & Storm Water



Treatment Plants and Recycling of Treated water for Industrial application/ disposal in designated manner. Technological changes in Pressure filtration techniques like Ultra Filtration and Reverse Osmosis have been adopted instead of conventional Rapid Gravity Sand Filters (RGSF). These technologies give high purity water and consistent quality on a sustained basis. These are highly automated plant operated through SCADA systems with high level of instrument control systems for better process control and monitoring.

Smart Water Segments

The broad segments of smart water are:

1) Intake and Pumping
2) Water Treatment
3) 24x7 Water Supply, Distribution and Metering.
4) Sewage & Storm Water Collection
5) Sewage & Storm Waters Treatment Plants
6) Recycling of treated Sewage & Storm Waters for Industrial applications or disposal, and
7) Solid Waste Management - Waste to Energy

Water Treatment Systems

Water Treatment solutions includes a wide range extending from intake systems to transportation to treatment plants as well as Process equipment's with various types of chemical dosing with allied Electrical Equipment, Instrumentation systems along with Monitoring and control package. The development and implementation of water treatment technologies have been mostly driven by three primary factors: the discovery of new rarer contaminants, the promulgation of new water quality standards, and cost. For the first 75 years of this century, chemical clarification, granular media filtration, and chlorination were virtually the only treatment processes used in municipal water treatment.

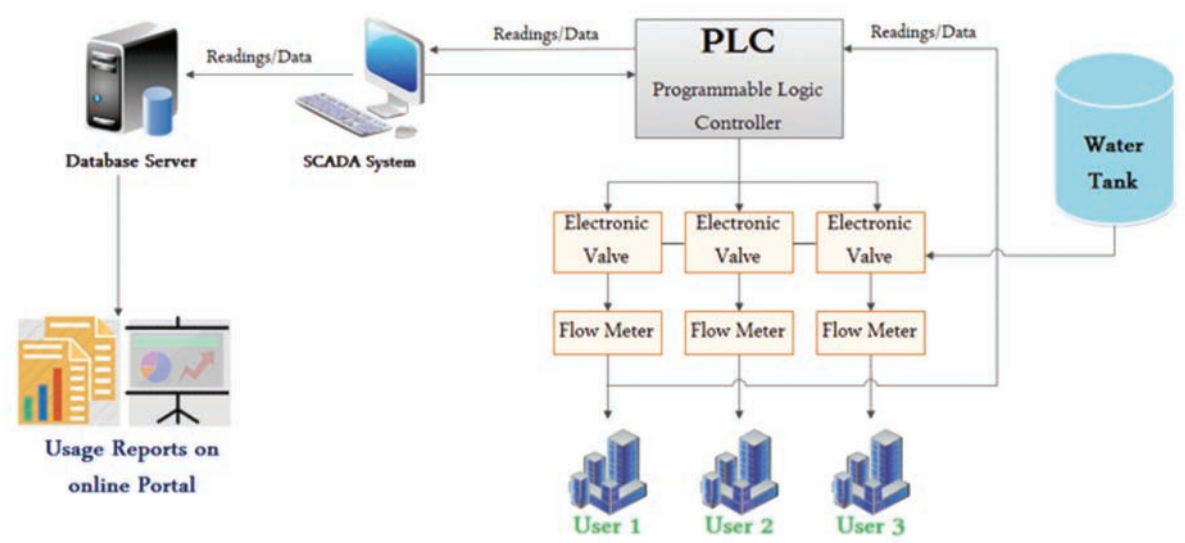
However, of late dramatic changes have emerged in the water industry's approach to water treatment in which water utilities have started to seriously consider alternative treatment technologies to the traditional filtration/chlorination treatment approach.

There are two classes of membrane treatment systems that are commonly adopted now 1) low-pressure membrane systems (such as microfiltration and ultrafiltration) and 2) pressure membrane systems (such as nanofiltration and reverse osmosis). Low-pressure membranes, including microfiltration (MF) and ultrafiltration (UF), are operated at pressures ranging from 10 to 30 psi, whereas high-pressure membranes, including nanofiltration (NF) and reverse osmosis (RO), are operated at pressures ranging from 75 to 250 psi. High pressure technologies are largely utilised for Food, Beverage and Pharma Industry in view of their stringent water quality standards. Low pressure treatment techniques are used in Municipal for Drinking water and Industrial applications where cooling tower and Steam generation are prevalent. Voltas had executed similar WTP based on concurrent Technology for GIFT City, Gujarat and its operating successfully.

24x7 Water Supply, Distribution and Metering

It is getting widely accepted that 24×7 supply is the preferred way forward for Smart Cities. The supply is more hygienic, more cost effective, and more productive for the consumer, since with pressure in the pipelines there is lesser chance of the line getting polluted from external water at points of leakage. Today Technology is available for reliable supply of drinking water using Water Distribution Control Systems to reduce the rate of leakage, Customer Information Management Technology using smart meter systems to monitor consumption Pattern, forecast Peak and Minimum demand. Pressure control across the distribution network has been optimised based on demand to conserve Energy costs which is vital cost element of Water Distribution system. Smart city water supply control systems are completely based on PLC and SCADA technologies. In SCADA model the activities like date, time, flow and volume of water are recorded in Database system (SQL Server 2008) and data which is recorded in SQL Database is shown on the online portal of the water supply control system. User can access the information as well as bills, usage of water as per the dates and time as well. Data can be monitored through SCADA software as the whole SCADA is connected remotely to the SQL Database server 2008. Even the non-technical person can access the online portal made for our project. To display the generated values i.e. flow in litres, date and time for a particular day can be viewed on the online portal. User can access daily usage and own information as well as monthly bills from the portal itself.

SMART CITY WATER DISTRIBUTION SYSTEM DESIGN

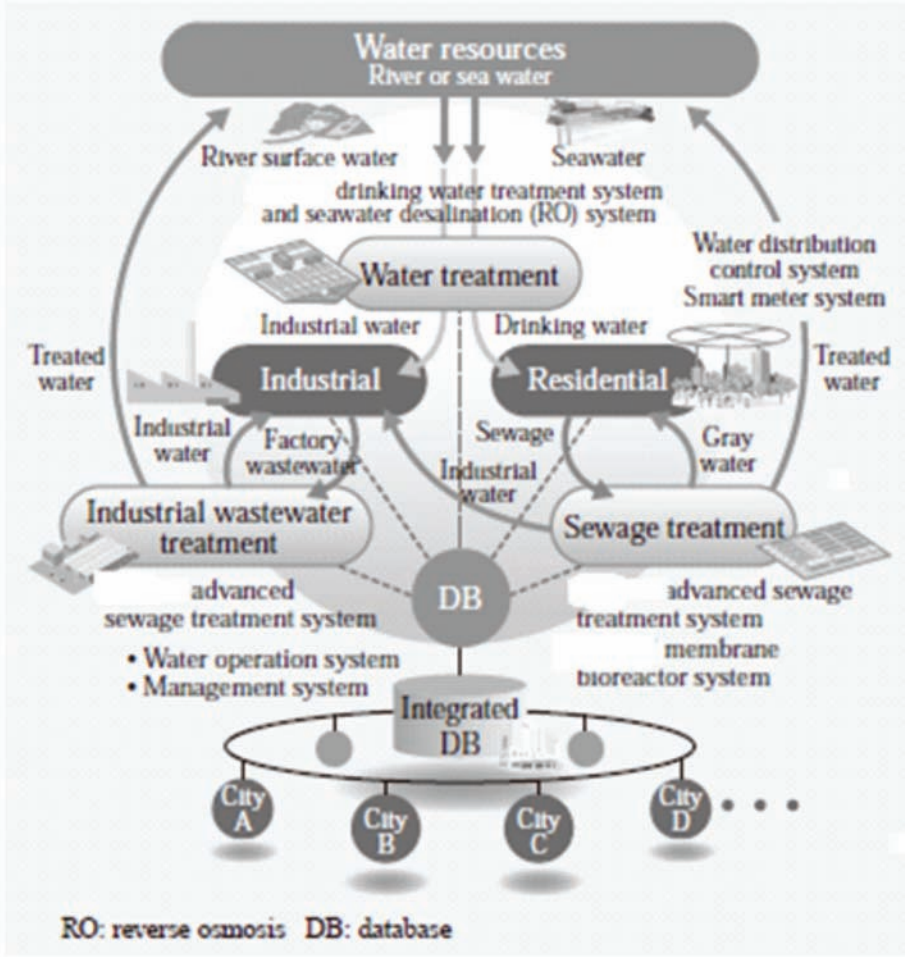


Water loss management is becoming increasingly important as supplies are stressed by population growth or water scarcity. Incorporating smart water technologies allows water providers to minimize Non-Revenue Water (NRW) by finding leaks quickly and even predicatively using real-time SCADA data and comparing that to model network simulations. Reducing NRW also allows municipalities to recover costs incurred in treatment and pumping - this can be significant.

ADVANTAGES OF ABOVE SYSTEMS:

a. Through SCADA system we can monitor the whole system and we can supply, usage detect errors & control water distribution.
b. Increases overall efficiency of water distribution.
c. Effective utilization of resources.
d. Reduces Human Efforts.
e. Any non-technical person can handle the whole system easily.

Large scale projects for establishing distribution network and connecting to each house hold through digital meters are being executed in cities like Nagpur, Bangalore, Pune and Chandigarh. State Governments of Odisha, MP, Bihar, Rajasthan have embarked on similar initiatives to provide potable water to each and every house hold.



Sewage Treatment Plants

Sanitation has been the single most important Public Health infrastructure for all communities and 'Sanitation For All' remains a key objective for India under Swach Bharat Scheme. Approximately 80% of all waste water generated in India is discharged untreated, thus polluting the rivers, lakes, ponds, and seas.

In Smart Cities, Local Urban Bodies are executing projects on expanding/ renovating existing Sewerage network to collect the entire domestic sewage, collect them and pump it to nearest STP for treatment. Treated water qualities are being monitored by State Pollution and Central Pollution Control Boards to comply with the applicable standards and ensure that the STP's are operated efficiently on a sustained basis. Sewage Treatment Plants in the country are with conventional ASP technology as well as SBR technologies. STP plants of capacities 43 MLD and 37MLD based on SBR technology are being implemented for BUIDCO, Patna, Bihar.

Other innovations that are emerging in sustainable wastewater management include the use of pressure sewers and smart discharge scheduling to Sewerage Treatment Plants to moderate inflow patterns to optimize the operation and capacity of these plants.

The sludge generated in STP is being used to generate power. The sludge is digested in pressure vessels along with nutrients to decompose it, thus generating methane which is converted into electrical power through gas engines. The power generated meets the captive needs of STP operation and nearby habitation. Several STP's in Rajasthan are operated on this approach efficiently in harmony with the environment plus generating Carbon Credits.

Recycling of Sewage Water for Industrial Applications

Due to scarcity of water, recycling of water has become mandatory across the globe. Industries have been forced to reduce intake of fresh water and use treated sewage water after tertiary treatment which involves a Membrane Bio-Reactor followed by a RO plant and then disinfection by Ozone is generally adopted. Many municipal bodies have adopted this for supplying treated water to industries in states of Maharashtra, Karnataka and Tamil Nadu at a cheaper price than the potable water.

Fit For Purpose recycled water schemes are emerging to maximise recycled water usage where baseline recycled water quality is reticulated with additional treatment facilities to 'Fit For Purpose' standards located on the Demand Side of the system.

Membrane Bio Reactor System with one module of Filtration Membranes shown separately

Storm Water Drainage Management

The annual phenomenon of flooding every monsoon causing disruption of everyday life in the country is on account of inadequate and/ or improper network of Storm Water Drainage Systems. With advent of Satellite based weather forecasting, the onset of heavy rains and consequent possible flooding can be known well in advance. Initiatives based on Information Technology inter alia include watershed management which can automatically share storm water modelling information. The latter predicts probable flooding zones and times based on predictive precipitation intelligence. The departments concerned can then reroute or hold road or rail movement and even air traffic accordingly and pre-

emptively alert the population using mass notification. Large scale storm water drain pipe line networks are being constructed in big cities to overcome flooding and ensure smooth flow of traffic.

Solid Waste to Energy

The upcoming smart city projects in the country, offer viable opportunities for waste-to-energy solutions. With more than 7,000 tonnes of waste generated each day in large metros such as Mumbai and Delhi, the local administrations are seeking integrated solutions. The upcoming smart cities, too, are looking at waste-to-energy solutions as part of the larger plan.

In Hyderabad, a Solid Waste Treatment plant was commissioned which provides an integrated waste-to-energy solution through the bio-methanation process. The Methane gas generated is fired as fuel in Gas based power generators to produces electrical power. While the treated raw sewage is transformed into purified water that can be reused, the sludge generated in the process is then combined with organic kitchen waste generated in homes and communities can be used as organic fertilizer. This innovative concept of Waste to Energy is making smart city reduce grid power dependency.

Achieving a Smart Water Future

Smart Cities is an innovative initiative by the Government of India towards improving the quality of life and attracting people and investment, setting in motion a virtuous cycle of Growth and Development.

One of the biggest obstacles to implementation of the initiative is access to funding. As cities and municipalities look to achieve smarter water systems, there are a number of options available to help them get started. One very effective path is through leveraging Energy-Saving Performance Contracts (ESPCs).

ESPCs are a form of a Public-Private Partnership (PPP or P3) financial model that capitalise on the flexibility and resources of the private sector to pay for energy-saving capital upgrades using future energy savings. The initial investment is provided by the private financial community, and services are delivered by Energy Service Companies (ESCOs). The financier is paid from the accrued energy savings, with the ESCO guaranteeing the savings amount. Though Smart City is a nascent concept and because of the socio-economic conditions in the country, it requires effective leadership and optimum utilisation of the resources by the players in each sector involved.

References:

1) Practical SCADA for Industry- David Bailey- Bailey and Associates, Perth, Australia.
2) Smart Cities-Applications, Technologies, Standards, and Driving Factors Editors: McClellan, Stan, Jimenez, Jesus, Koutitas, George (Eds.)
3) Smart Cities- Foundations, Principles and Applications by Sabina Jeschke, Tamim Sookoor, Ravi Srinivasan, Houbing Song, Publisher: Wiley
4) Smart Cities: Big Data, Civic Hackers and the Quest for a new Utopia (Anthony M. Townsend, 2014)
5) Figures are sourced from Smart City website.

75 Years of Howrah Bridge- A Typical Saga of Energy Conservation

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1. Introduction

Howrah Bridge, also called *Rabindra Setu*, the icon of Kolkata, still amazes modern world due to its megalomaniac structure. However, if one looks into the details of construction, one would be surprised to learn the huge amount of energy conservational efforts undertaken for its standing tall till now. Prior to the present Howrah Bridge, Calcutta was at that time the capital of British India and enjoyed the glory as the second city of Empire after London when 2/3rd of the entire world was under British rule. Calcutta (as it was then know) was growing at a very fast rate along with Howrah on the other bank right since the 18th century. That had necessitated the construction of a pontoon bridge to facilitate the movement of men and goods in lieu of the river transportation mode like boat, streamer, etc. The old bridge was a floating pontoon bridge built in 1874 and designed by Sir Bradford Lesile, Chief Engineer of Eastern Bengal Railway. The old pontoon bridge had a total length of 1528 ft. with a removable central section of 200 ft. that allowed ships to cross. It had an estimated life of 25 years but served for 68 years before it was replaced.

This old bridge had to cater to the growing road traffic across the river, consisting mostly of bullock carts laden with goods and carriages drawn by horses that ferried across the trading community and visitors alike, conveyed raw materials sourced from the rest of India for Britain via the port and the finished materials from the colonial masters to the populace of the city. The pontoon bridge with its removable section often in detached condition created traffic bottlenecks that found standing traffic for almost a whole day along causing a great loss of energy both for mankind and animal folk. Demand grew rapidly for a high level bridge that would allow unhindered movement of road vehicles as also the river traffic, with planning for a bridge that will cross the river in a single span – a very tall order indeed for the then state of art of technology.

Figure 1: Howrah Bridge, then & now

2. Howrah Bridge- Success Story of Energy Conservational Efforts

Search for a New Alternative

The search for an alternative solution(s) started in 1909, with the formation of a committee by the Government of Bengal. Following problems of the floating bridge were cited:

(i) With tidal variations in the lower Ganges (bridge site) 4 times a day and throughout the year, the approach gradients varied from 1 in 15 to 1 in 25 during high tides, making navigation impossible.

(ii) Opening & closing of the central span for allowing traffic (both road and river or vice versa) took more than ½ hours causing huge transportation bottlenecks.

(iii) With overloading due to pedestrian crowding and movement of heavy vehicles the pontoons sank by upto 2ft. causing great loss of strain energy to the old bridge structure.

The site of the new Howrah bridge was selected in such a way that the existing pontoon bridge could cater for traffic without any energy loss. Moreover due to the presence of religious structures immediate upstream of the existing pontoon bridge at Calcutta end and keeping public sentiments in mind, the site of the new Howrah bridge was chosen so that the ! of the new bridge was 630ft. upstream of the existing pontoon bridge on the Calcutta side & 580ft. on the Howrah side. Selection of this new site was also influenced by the facts that most of the land was under the ownership of Bridge Commissioners for the Port of Calcutta.

Planning of New Howrah Bridge

a) In 1901, a new station building was proposed on the Howrah side of the bridge due to increased traffic demand for rail travel. The British architect Halsey Ricardo designed the new station for Howrah which was opened to the public on 1st December, 1905 and still exists as the current Howrah Station building.

b) Due to heavy traffic through the old bridge, the level crossing of Port Commissioners' railway on the Calcutta approach was replaced by Port Commissioners by a subway in 1912.

c) In 1916 old teak wood railway deck was replaced by steel beams.

d) In 1925 the triple girder shore span was replaced by two new twin girder spans.

e) Finally by 1933, it was considered that the pontoon bridge was inadequate both in terms of volume and load of traffic.

Since the early 20th Century, as the old pontoon bridge showed signs of distress, the Commissioners for the Port of Calcutta instituted a committee under the convenorship of Mr. John Scott, the then Chief Engineer of the Port, who after considering the financial aspects and traffic potential decided to call for a global tender from 23 firms for design/ construction of a new bridge with a prize money £3,000 (Rs.45,000,at the then exchange rate),which was bagged by a German firm M.A.N.(Maschinenfabik Augsburg Nurnberg) out of 9 firms and 18 different designs, though their scheme based on floating bridges was discarded by the authorities due to the above strain energy considerations.

A new committee headed by Mr. Basil Mott, President of Institution of Civil Engineers was appointed and they made a recommendation for installing an Arch Bridge with 1400ft. span and 170ft. height which was rejected from the consideration of inadequate foundation strata & likely effect of seismic (earthquake) energies. The First World War (1914-1919) interrupted further progress with the bridge.

In 1922 the New Howrah Bridge Commission was set up, to which the new Mukherjee Committee (under the chairmanship of Sir. R. N. Mukherjee, the 1st President of Institution of Engineers that came into being in 1921) submitted its report. In the report the committee examined the following type of bridges.

a) Single Span Arch Bridge – Rejected on account of Lateral thrust

b) Suspension Bridge - Rejected on account of Lateral thrust

c) Pier & Girder Bridge – Most Economical but rejected due to possible change in the bathymetry of the river.

d) Floating Bridge – Rejected on account of relatively temporary nature of the bridge and not suitable for a great city like Calcutta.

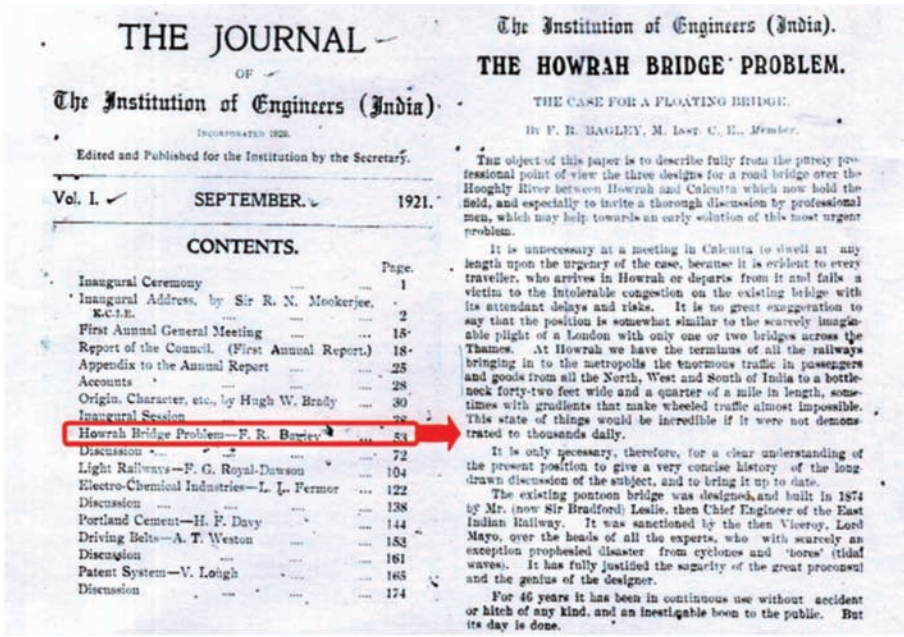
e) Cantilever Bridge – Finally adopted.

Almost all of the above, except (e) got rejected due to faulty energy considerations. Sir Rajendranath as he was known, steered the finalization of the present bridge into reality though he did not live long to see his fruit of success.

Make in India 1.0

With the WWI now over and continued rumblings in the European political theatre, allocation of funds was a big stumbling block. With war clouds forming across the horizon once again, the need for a bridge across the Ganges assumed a strategic importance for the second largest city of the British Empire and the actual implementation responsibilities were entrusted on the Commissioners for the Port of Calcutta (CPC), who were custodian for all river related matters.

The planned bridge required a clear span of 1500ft. and a clearance of 29ft. above the highest H.F.L mark to ensure unhindered passage of large steam boats and unaffected river hydraulics and siltation pattern, both prime importance to CPC for whom river traffic remained main life line for flourishing trade which sustained Calcutta Port. Various



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The Institution of Engineers (India).

THE HOWRAH BRIDGE PROBLEM.

THE CASE FOR A FLOATING BRIDGE.

By F. R. BAGLEY, M. Inst. C. E., *Member*.

The object of this paper is to describe fully from the purely professional point of view the three designs for a road bridge over the Hooghly River between Howrah and Calcutta which now hold the field, and especially to invite a thorough discussion by professional men, which may help towards an early solution of this most urgent problem.

It is unnecessary at a meeting in Calcutta to dwell at any length upon the urgency of the case, because it is evident to every traveller, who arrives in Howrah or departs from it and falls a victim to the intolerable congestion on the existing bridge with its attendant delays and risks. It is no great exaggeration to say that the position is somewhat similar to the scarcely imaginable plight of a London with only one or two bridges across the Thames. At Howrah we have the terminus of all the railways bringing in to the metropolis the enormous traffic in passengers and goods from all the North, West and South of India to a bottle-neck forty-two feet wide and a quarter of a mile in length, sometimes with gradients that make wheeled traffic almost impossible. This state of things would be incredible if it were not demonstrated to thousands daily.

It is only necessary, therefore, for a clear understanding of the present position to give a very concise history of the long drawn discussion of the subject, and to bring it up to date.

The existing pontoon bridge was designed, and built in 1874 by Mr. (now Sir Bradford) Leslie, then Chief Engineer of the East Indian Railway. It was sanctioned by the then Viceroy, Lord Mayo, over the heads of all the experts, who with scarcely an exception prophesied disaster from cyclones and 'bores' (tidal waves). It has fully justified the sagacity of the great proconsul and the genius of the designer.

For 46 years it has been in continuous use without accident or hitch of any kind, and an inestimable boon to the public. But its day is done.

Figure 2: First Journal of Institution of Engineers (India), published September, 1921

alternate designs were examined by Rendel Palmer and Tritton, the consultants to CPC. Given the soft soil on the banks and space limitations, the popular options for long span bridges like Arch or Suspension Cable constructions were ruled out. Interesting debates shaped the formation of the new bridge as it stands out today. The bidders came up with interesting solutions, some of them futuristic and too daring on energy/ technological requirements at that point of time and some of them included such concepts like partial cable supported arrangement and orthotropic deck system-and that too in 1937. The designers decided on a balanced cantilever suspension bridge: a 1,500ft. long ropeway of steel, slung on two towers rising above 300 ft. above the ground on both sides. The 1500ft. length has 3 parts, 2 arms of 470 ft. each cantilevered from the end towers (at a gentle slope of 1in 40, to make it easy for bullock carts that made up the bulk of the traffic) which in turn support a central suspended girder of 560 ft.The 2 arms have 2 short anchor spans, held down by massive concrete anchor blocks behind each tower. The concept of the central suspended girder deck over which the vehicles pass is a platform hanging from the main bridge truss with the help of steel hangers secured by pins – like a new born baby being held from its head and legs by father and mother – a mere zero energy concept for the bridge designers.

M/s Cleveland Bridge & Engineering Co. Ltd., a UK based firm, the 2nd lowest bidder who got the construction contract had to engage an Indian firm titled 'The Braithwaite, Burn & Jessop (BBJ)' as subcontractor of structural fabrications, due to the rumblings of the new Indian independence movement prevailing at that time. Thus, the energy and skills acquired during the 1st Howrah Bridge saw them shaping up all the major bridges in India and abroad for the next 60 years, including the 2nd Hooghly Bridge-the *Vidyasagar Setu*. The Bridge used 'high tensile steel' which had 1½ times high yield energy compared to that of mild steel and here also the demand of an Indian firm could not be ignored with TATA Steel staking claims and 23,500tons out of total 26,500 tons of steel were manufactured from their Jamshedpur works. With the use of higher % of Copper (Cu) and Chromium (Cr) as shown in Table 1, corrosion resistance energy was ensured.

Table 1: Material Composition

Items	C	Mn	Cr	Cu	Si	P	S
Steel							
Manganese- Chromium:Imported	0.3% 0.3%	0.7% to 1% 0.8% to 1.2%	0.7% to 1% 0.4% to 0.7%	0.3% to 0.5% 0.3% to 0.5%			
Manganese- Chromium: India	0.23% to 0.28%	1% to 1.3%	0.5% to 0.62%	0.3% to 0.6%			
Rivets	0.18% to 0.22%	0.6% to 0.75%	—	0.3% to 0.6%			

Foundation works for the bridge (using Indian Cement) was done by another Indian company, Hindustan Construction Co. of Bombay, which involved high-tech digging at levels much below the Ganges river bed, a technique which ignited the dream to construct underground tunnels underneath the river Ganga, as it has been done for the Kolkata Metro-Rail Expansion Project. The actual construction of the Howrah bridge was completed well within schedule (4 -5 years) bears a testimony to the fact that how much energy was saved in that era, whereas the present day projects flounder even with modern technologies into energy guzzling NPAs. However, all is well that ends well. When it was completed in 1943, World War II was going on; the Howrah Bridge was then covered under barrage balloons for few days, as a safety measure against high impact energy Japanese bombings.

3. Conclusions

Much water has flown through the Ganges since the construction of the Howrah Bridge, which freely lent its name to many films including one by the same name. We mark the anniversaries of people, even institutions, but seldom keep track of the magnificent structures surrounding us, providing service to us, till one day, they begin to show signs of energy distress, and then suddenly a witch-hunt begins to find the scapegoat!

Acknowledgement

The President of Bengal Chamber of Commerce & Industry, who also happens to be an office bearer of CEAI, to my surprise, invited me for an All India Seminar on '*75 years of Howrah Bridge*', organized by IEI, West Bengal State Centre, Civil Engineering Division.

References

1. Howrah Bridge Diary, Amitabha Ghoshal, Outlook Magazine, 30th April issue, 2018, last page
2. Proceedings of All India Seminar on 75 years of Howrah Bridge, organized by IEI, West Bengal State Centre, Civil Engineering Division on June 7-8,2018 at Sir. R. N. Mukherjee Hall, 8, Gokhale Road, Kolkata-700020

CEAI NEWS

SEMINAR ON 'RIVER ACTION PLAN, FLOOD MANAGEMENT AND BASIN DEVELOPMENT'

CONSULTING ENGINEERS ASSOCIATION OF INDIA (CEAI) organized a two-day Seminar on ***"River Action Plan, Flood Management and Basin Development"*** at Shangri-La's Eros Hotel at Connaught Place, New Delhi on 27th and 28th July 2018**.**

The seminar was supported by The National Mission for Clean Ganga (NMCG) of the Ministry of Water Resources, River Development and Ganga Rejuvenation**,** NITI Aayog, Inland Waterways Authority of India of the Ministry of Shipping, Bureau of Indian Standards, International Commission on Irrigation and Drainage, Indian Water Resources Society, Central Water Commission, The Australian Water Partnership.

The seminar comprised delegates from various central and state government agencies, academic institutions, professionals and practitioners in the field of water resources management, hydraulics, hydrology and environmental engineering, representatives from Civil Society, technology and research companies, in addition to large participation from contracting and consulting companies.

Mr. Somenath Ghosh, Vice President CEAI welcomed all the dignitaries, speakers and delegates present to the seminar.

Ms. Sayona Philip, President CEAI introduced the Seminar theme and mentioned the primary focus of the seminar with respect to the subject was to highlight the issues, concerns and key challenges, discuss appropriate solutions and thus the way forward.

Mr. S Masood Hussain, Chairman, Central Water commission, Government of India, was the Guest Speaker. He described the status of water resources, its management, the need for water security, its planning, and deliberated for sustainable solutions to secure resources for the future of our nation. The need for a comprehensive master plan, holistic approach of river basin management with concurrence of States is greatly emphasized.

Mr. U P Singh, Secretary, Ministry of Water Resources, River Development and Ganga Rejuvenation was the Chief Guest. His keynote address gave a deep insight of the different pertinent issues and its probable solutions with regards to abatement of river pollution a holistic approach to basin development and flood management.

Over two days, there were two plenary sessions, five technical sessions and a concluding panel session. Based on the deliberations, some of the important points made were:

a) The need to enforce water sharing agreements through a deliberate and fair process and how the Government Authorities have a major role in this.

b) The impact of climate change should be built into our designs; else we are in for a shock. In a manner of speaking, we need to internalize climate change and a holistic framework is needed for it.

c) It is absolutely essential to ensure Environmental flows in a river, by augmentation or whatever means, since river water quality is dynamic based on influent and recipient water quality and quantity. Also maintaining a minimum draft in the rivers enables navigability.

d) Dam management to regulate the upstream release of water, the role of the I R Basin Development Authority

e) To ensure that we keep our rivers clean, despite the large populations residing on their banks, and in pristine condition, it is imperative that policy making, planning and implementation consider innovative and sustainable solutions.

f) In view of the huge infrastructure investment, it is necessary to have balanced procurement policies and contracts rather than one sided contracts which could derail the success of a project.

g) To improve the project implementation process, apart from Consultants, capacity building of the Executing agencies, Contractors and the decision making is vital.

Over the two days, speakers and discussants had an interactive session with eminent members of the audience, which facilitated development of greater clarity among the participants.

It was unanimously agreed that the seminar met its objectives in familiarizing the participants with latest status, development of new holistic approaches, related issues, challenges and probable solutions with sharing of best practices in 'River Action Plan, Flood Management and Basin Development'.

For more details on the Seminar the reader can access the Seminar Report on CEAI website https://ceai.org.in/events/seminar-on-river-action-plan-flood-management-and-basin-development/

At the Registration Desk

Mr K K Kapila and Dr. Ajay Pradhan greet Mr. Masood Husain

Mr. UP Singh and Mr. Masood Husain at the venue

Welcome address by Mr. Somenath Ghosh

Mr. UP Singh inaugurating the Seminar

Souvenir Release

Mr. UP Singh, Secretary MoWR etc delivering the Keynote Address

Mr. Masood Husain, Chairman CWC addressing the audience

View of Audience

Plenary Session on River Basin Management

Dr. Guna Nidhi Paudyal on the Mekong Basin

View of Audience

Technical Session on Integrated Flood Management

Prof. Zulfikar Ahmad, IIT Roorkee

Mr. M S Dhillon presenting his views

Technical Session on Climate Change & Sustainability

Dr. Dhanya C T, Prof IIT Delhi

Audience Interaction

Mr. A B Pandya, Chairperson at the session on Policies for Effectiveness

Dr. S Chatterjee, presenting a memento to Mr. Pandya

Our esteemed audience

Plenary Session on River Action Plan

Prof. A K Gosain, IIT Delhi making some important points

Dr. Rooprekha Dalwani, former DG, NRCD

Technical Session on Pollution Abatement

Mr. D P Mathuria, ED, NMCG presenting his views

Mr. V K Dhingra making his presentation

Mr. Guha Sircar summing up

Mr. Sitaram Aggarwal presenting a memento to Mr. Mathuria

Attentive audience

Mr. Harish Verma, ED ICID making his presentation

Mr. Virendra Sharma presenting his views

Mr. Avinash Mishra, NITI Aayog making his presentation

Dr. Dhaval Parikh Chairing session on Capability & Capacity Building

Mr. Somenath Ghosh summing up

Ms. Veena Nabar introducing the session chairperson and speakers

Ms. S Philip Chairing the Concluding Panel Discussion

Audience Participation

Dr. Ajay Pradhan summarising the two day proceedings

CEAI-IIC LECTURE SERIES

CEAI jointly with India International Centre, New Delhi is organising a series of six Lectures on ***'Engineer & the Society***'. The Lectures will be held every month till January 2019. The purpose of these lectures is to make general public aware of the role that engineers play in providing safe, sustainable, and efficient infrastructure including housing to the people.

The first lecture in the series was held on the topic ***"Role of Engineers in the Society"*** on 20th August 2018. This lecture was delivered by Mrs. Sayona Philip and Mr. Sudhir Dhawan and was presided over by Padma Bhushan Dr. Kirit Parikh, Former Member, Planning Commission, Government of India.

Dignitaries on the Dias (L to R) Mr. Mahendra Raj, Mr. Sudhir Dhawan, Dr. Kirit Parikh, Ms. Sayona Philip

Padma Bhushan Dr. Kirit S Parikh delivering the Inaugural Address

Ms. Sayona Philip, President CEAI has spent about 30 years of her career in the Infrastructure sector and is considered an Expert in her field. She presented her views on Infrastructure and about how the quality of infrastructure plays a large role in determining a country's long-term economic and social trajectory, human development and poverty reduction. At a tangible level the most important contributory factor with respect to the built environment is physical infrastructure. She spoke about the range of services an engineer provides across the project life cycle and how engineers are involved in all aspects from concept to commissioning. She described the importance of different kind of basic infrastructure ranging from urban development, water and waste management energy and mining, and transportation.

Mr. Sudhir Dhawan, Immediate Past President has spent over 40 years in the Industry and Infrastructure sector. He covered the Industry perspective and gave a futuristic view of the advances in the infrastructure and industry sector. His presentation mainly dealt with Industry Revolution 4. The presentation mentioned new advances in Artificial Intelligence, Virtual Reality, robotics, simulation techniques, farm implements etc.

The lectures attracted a full house and had a lively question answer session with the participants and extended beyond hours.

A view of the Audience

The second lecture of the series was on the theme of ***"Art of Tall Buildings"*** and was held in India International Centre, New Delhi on 20th Sep 2018.

The Chairperson of the session was Mr. P K Tripathi, (IAS) Former Chief Secretary of the Government of Delhi

Mr P K Tripathi addressing the audience

Prof. Mahesh Tandon, Tandon Consultants Pvt. Ltd., President Indian Society of Wind Engineering, Past President - Indian Association of Structural Engineers and Indian Concrete Institute, Fellow, Indian National Academy of Engineers spoke about the tall buildings and how they could predominate the skyline when more than 70% of the population starts residing in the urban areas by around 2030. He mentioned about how the Empire State building with 102 floors was built in 15 odd months…. how the design is such that taller buildings tend to become safer than shorter buildings. Advances are being made in the design and construction of tall buildings. In Japan more than 5000 base isolated structures have been constructed against just 10 in India…but this will vastly increase in the future. He also spoke about the challenges in providing lifts, electrical cabling, HVAC and plumbing for tall buildings.

Prof Mahesh Tandon delivering his lecture

Dr Prem Krishna delivering his lecture

The second presentation was by Dr. Prem Krishna, Former Professor of Civil Engineering of University of Roorkee, Past President of International Association of Wind Engineering, Past President of Indian Society of Wind Engineering, Fellow of Indian National Academy of Engineering. Dr Krishna spoke of the important of lateral and wind loads in the design and about wind storms. He also mentioned about the importance of providing safe designs for utilities and how NDMA has suggested a higher factor of safety provision for utilities as they could be critical.

Interaction from audience

FIDIC TRAINING PROGRAM

CEAI organised inhouse programs from 24th September to 27th September 2018, on the FIDIC Training Module 1- '***Practical Use of FIDIC Conditions of Contract'*** & Module 2 – '***Management of Claims and Disputes Resolution'*** for senior officials of the Dedicated Freight Corridor Corporation of India Ltd (DFCCIL) at the India Habitat Centre, New Delhi.

For each module, there were about 40 attendees. Capt Prerana Dubey, Deputy Director, CEAI welcomed the gathering on behalf of CEAI.

Training for DFCCIL

DFCCIL officials with trainer Mr Bogdan Oprea

CEAI also organized a two day open FIDIC Training Course on Module I ***"Practical Use of FIDIC Conditions of Contract"*** on 28th & 29th September 2018 at the PHD Chamber of Commerce and Industry, New Delhi.There were about 40 participants.

Ms S Philip addressing the participants

The Training programs was attended by participants from various organizations such as, IKEA India Pvt Ltd / Synergiz Global Services Pvt. Ltd / Legacy Law Offices / GMR Infrastucture Limited / Bharat Aluminium Limited Company / Boskalis Smit India LLP / LEA Associates / IL&FS Maritime Infrastructure Company Ltd / Amara Raja Batteries Limited / RITES Ltd / SUEZ/ Shapoorji Pallonji and Co Pvt Ltd / Tata Consulting Engineers Ltd, et al.

Ms S Philip and Mr Bogdan Oprea with the participants

Open Training in Progress

Mr. Bogdan Oprea, a FIDIC accredited faculty, conducted all the training program.

CEAI NATIONAL AWARDS 2018

To recognise and promote the engineering consultancy profession, the Consulting Engineers Association of India has instituted the National Awards for Excellence in Engineering Consultancy Services.

Nominations are invited for the following awards from organisations as well as individuals:

FOR ORGANISATIONS

1) Awards for Excellence in Engineering Consultancy Services in each of the following categories:

Category A) Excellence in Project Engineering
Category B) Excellence in Innovation Engineering

The Awards would be given separately for three groups of firms. The firms would be defined on the basis of average turnover for the previous 3 years:

a) Group 1: Less than Rs. 10 crores
b) Group 2: Between Rs. 10 to Rs. 50 crores
c) Group 3: Above Rs 50 crores

FOR INDIVIDUALS

2) Achievement Awards for individuals as Expert/ Young Professional:

Category A) Excellence in Project Engineering
Category B) Excellence in Innovation Engineering

3) Lifetime Achievement Award for Individuals

CEAI will constitute an independent jury comprising of eminent persons to select the awardees.

The last date for receipt of nomination is **15thNovember 2018.**

In order to ensure wider participation of the engineering community in India, the Governing Council has decided to open the CEAI awards to Non- CEAI Members also. However, for non CEAI members, a nominal processing fee of Rs 2,500/- for Individual and Rs 5000/- for Corporate firms will be charged. We hope this will also pave the way for improve Indian participation at the International FIDIC Awards.

For more details please contact CEAI Secretariat or visit CEAI Website www.ceai.org

GOVERNING COUNCIL ELECTION 2019-2020

The election process for the Governing Council 2019-2020 has been started and the notice was issued on 1st September 2018, inviting nominations from Member Organisations and Individual Members for contesting GC Elections.

Members, who have not paid their membership subscription, so far, are requested to pay their due subscriptions immediately to be eligible to participate in the GC Election.

CEAI OUTREACH

CEAI continues to expand its outreach by way of providing support to other professional events and promoting its own, to reach out to new members. Some of the events are:

- 15th International Exhibition and Conference on Smart & Sustainable City Solutions, organised by MUNICIPALIKA which was held on 19, 20 & 21 September 2018 at Bombay Exhibition Centre, Mumbai.
- Conference on *'International and Domestic Arbitration: Current Scenario and Way Ahead'* on October 26-27, 2018 being organized by India Institution of Technical Arbitrators at Chennai.
- BAUMA CONEXPO INDIA 2018 which will take place in December 2018 at HUDA Grounds, Gurgaon

FIDIC NEWS

FIDIC- ASPAC CONFERENCE 2018, COLOMBO, SRI LANKA

FIDIC-ASPAC Conference 2018 was held in Sri Lanka from 24th to 27th June, 2018, at the BMICH (Bandarnayake Memorial International Conference Hall) Conference Complex, Colombo. The event was hosted by the Association of Consulting Engineers, Sri Lanka (ACESL) on the theme ***'Infrastructure Connectivity in the ASPAC Region'***. The Conference was attended by around 200 delegates, from 10 countries. A large contingent of 50 came from China. Interestingly, there were 14 delegates from Nepal, perhaps the largest number after the host country and China. CEAI was represented by Mr. Sudhir Dhawan, Mr. Amitabha Ghoshal and Dr. S. Chatterjee. Besides two more Young Professionals (YP), Mr. Akshat Nayar and Ms. Preeti of ICT, had joined the Indian squad.

Mr Dhawan, ASPAC EC Member, participates in session

The first day, 24th June, 2018, was mainly for YPF programme, apart from a couple of other meetings. Significantly, there was a good attendance of YPs from Sri Lanka, with active participation. It was a well organised YPF event, followed by a YPF reception, for all the delegates. ASPAC EC meeting was also held, in which the theme for ASPAC 2019 Delhi Conference, *'Quality Infrastructure for Clean and Sustainable Development'* proposed by CEAI was confirmed. The main Conference started on the 25th. June. The Chief Guest for the Inaugural Session was Mr. Patali Champika Ranawaka, Minister of Megapolis, and Western Development, Government of Sri Lanka. His address was

interesting, practical with an overview of the infrastructural development programme of Sri Lanka.

CEAI Delegation

The main Conference started on the 25th. June. The Chief Guest for the Inaugural Session was Mr. Patali Champika Ranawaka, Minister of Megapolis, and Western Development, Government of Sri Lanka. His address was interesting, practical with an overview of the infrastructural development programme of Sri Lanka. In the first technical session, the main speaker was Prof Mohan Kumaraswamy, Honorary Professor of The Hong Kong University, who spoke on 'Targeting Best Value Sustainable Infrastructure'.

A number of presentations were made over the seven technical sessions during the two days. Mr. Amitabha Ghoshal made a presentation on *'Future Infrastructure for Regional Connectivity – Road Ahead'*, in the last technical session. Mr. Sudhir Dhawan was invited to make a presentation on the next *ASPAC 2019 Delhi Conference*. The technical sessions were not crowded with too many papers, which allowed ample time for the speakers, as well as for Q & A, following the talks. ASPAC GAM was held after the technical sessions on the 26th June. At the end of GAM, the incumbent Chairman Mr. Liu Luobing of China, relinquished his position on completion of his term and Mr. Irawan Koesoemo of Indonesia was installed as the new Chairman.

A view of participants

The different aspects of Infrastructure development, improvement and connectivity, transport network, green technology, roles of consulting engineers, contractors and financing aspects were covered by the two days of deliberations. There were a few speakers from outside Sri Lanka.

A welcome reception hosted by the National Chapter of ACESL was held on the 25th evening.The Gala Dinner was on the 26th evening. Very good and attractive ethnic/ heritage cultural shows were organised for the three evenings, during the receptions and Gala Dinner. Overall, the Conference was very well organised by the host, raising the bar for CEAI for the 2019 Conference.

Reported by *Dr S Chatterjee, Former President, CEAI*

FIDIC INTERNATIONAL INFRASTRUCTURE CONFERENCE 2018, BERLIN

The 2018 FIDIC International Infrastructure Conference was held in Berlin from 9-11 September 2018. The main theme of the conference was ***"Mobility & Smart Infrastructure"***.

The CEAI delegation included Ms. S Philip, Mr. Somenath Ghosh, Mr. Sudhir Dhawan, Mr Kiran Kapila, Mr Kishore Kumar, Dr Dhaval Parikh, Maj SJM Jafri and Mr Prashant Kapila. The Pre Conference meetings started on 8thSeptember 2018. They included the Directors and Secretaries (DNS) meeting and the Presidents meeting. Both meetings were attended by the CEAI team.

Some of the important points made at the meetings were that FIDIC plans to move out a major part of the Headquarters from Geneva has been shelved and the status quo will continue. In order to control costs, the

endeavour would be to hold the future FIDIC conferences, after the next conference, in any of four cities - one each in Asia, Africa, Europe and America. The next FIDIC Conference in 2020 will be held in Mexico.

The new structure would involve a Board in place of an Executive Committee and a Chief Executive Officer in place of a Managing Director.

The conference was very well attended with over 600 delegates with diverse participation from FIDIC countries from all continents.

09 September, Sunday was Business Day 1

The first session was on 'FIDIC Best Business Practices, involving the Forum of FIDIC COMMITTEE CHAIRPERSONS.

During this session, the Chairpersons of the FIDIC Specialised Committees discussed FIDIC tools and services available to Members and to the industry. They mainly covered the Market Challenges in the Consulting Engineering Industry, how FIDIC should be positioned to address challenged to think globally and to deliver locally.

The next session was a FIDIC Young Professional Symposium which was about the future of Consulting Engineering. After the welcome message by the FIDIC CEO, the session was introduced by the young professional Jomanah AlBtoush from Jordan who spoke on **"The Reflection of YPFSC in 2018".**

The session had interesting talks on sustainability and innovation in urban mobility, women in engineering, management of infrastructure projects and use of technology in smart cities, etc.This was followed by a FIDIC Future Leaders Workshop.

In parallel was the ASPAC EC meeting which was attended by Mr Dhawan, ASPAC EC member accompanied by Ms S Philip and Mr Somenath Ghosh. One of the main Agenda points at the ASPAC EC meeting was the modalities of conducting FIDIC ASPAC 2019 in Delhi in July next year.

The main conference commenced on 10th September 2018.

10 September, Monday was Conference Day 1:

The theme was Mobility & Business – Global Perspectives**.**

The conference delegates were welcomed by the FIDIC President and thereafter by the hosts, Presidents of EFCA (the European body) and VBI (the German Member Association).

Thereafter, was the break and visit to the Exhibition stalls. CEAI had put up a stall for FIDIC ASPAC 2019. CEAI also showed a promotional movie and put up posters about CEAI. Delegates from several ASPAC countries and FIDIC EC members visited the stall.

The further sessions included the CEO's Forum with top management from SWECO, AECOM, Mott, Jacobs and Sheladia Associates giving their perspective of the Consulting business.

A very interesting session was held on the impact of the digital technology on mobility and business with top executives from Bentley Systems (Greg Bentley) and BST Global participating.

The session on the 'City of today and tomorrow: Challenges and Smart Options' had speakers from the western world, primarily with their perspective.

The next session was regarding the 'Impact of the global digital economy on the funding and financing of smart cities and infrastructure, private and public opportunities' It covered global investment strategies for local use and explored how these were changing considering the funders and financiers preferred investment models and instruments.

At the end of Day 1 was the FIDIC GALA and Awards night with lively entertainment. The event was well attended. The main awards were won by China and the dynamic young professional JomanahAlBtoush from Jordan won the FIDIC Award for Young Professionals.

11 September , Tuesday was Conference Day 2

The theme was Smart Infrastructure.

After the customary welcome by the hosts, there was a session on 'Urban Sustainability' with speakers from the Government of Germany who gave an overview of the challenges and progress made towards a simplified decentralized governmental and administrative structure and the need for interdisciplinary collaboration to optimally use the data driven value creation processes in Industry 4.0.

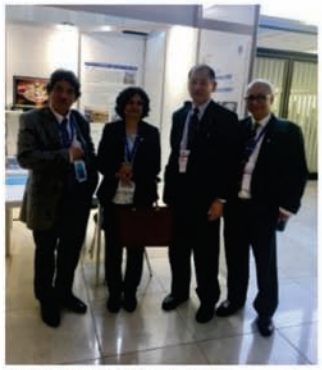
CEAI President, Ms Philip, Vice President Mr Ghosh and Past Presidents - Mr Kapila & Mr Dhawan, with Vice President - FIDIC Board

Ms Aisha Nadar, FIDIC Board member from Sweden, at CEAI booth

Ms Aisha Nadar, with CEAI Members

Mr Enrico Vink, former MD, FIDIC

With President, CESA, Mr Neresh Pather



With FIDIC ASPAC chairman, Mr Irawan and EC Member Mr Kurashige

With ICEG, Ukraine members

CEAI and ICEG delegates

CEAI at Gala Dinner

The next session was by speakers from the Multilateral development banks on 'Innovative approaches to investing in smart infrastructure' who spoke primarily on new models of investment and financial tools.

The session on urban connectivity was very interesting with participation from Buro Happold, CDM Smith, Past President of CESA. It covered various aspects of advanced technologies in urban mobility and the challenges that lay ahead.

The Keynote Address which followed, reflected on the deep dive done on various aspects of the conference theme and the related human resource challenges related to the conference theme.

The concluding session on 'Future Leaders Outlook' gave an opportunity to the younger leadership to reflect on the insights shared by the Expert professionals on the conference theme of Mobility and Smart Infrastructure and offer their considered views and vision of the future way forward.

Mr. Alain Bentejac, President, FIDIC and Mr. Nelson Ogunshaken, CEO brought the conference to a close.

After closure of the conference, the GAM was held with participation from FIDIC Board, CEO- FIDIC, Presidents and office bearers of the Member Association from about 100 countries. The results of the elections held for the sole vacancy that had arisen was announced. The member from Netherlands had won. Other matters were discussed and the Conference concluded.

FIDIC ASPAC CONFERENCE IN 2019

CEAI is honoured to have accepted an invitation to host the FIDIC-ASPAC International Conference in July 2019 in New Delhi.

ASPAC represents the consulting engineering industry in Asia and Pacific Region as the regional grouping of FIDIC Member Associations. ASPAC has 22 member countries. The main objective is to encourage regional cooperation amongst the member associations by sharing and enhancing knowledge on the different infrastructure requirements of each country.

The Conference theme ***"Quality Infrastructure for Clean and Sustainable Development"*** has been selected keeping safety of the people in mind. Many of the member associations of ASPAC are investing significantly in infrastructure development not only with their own financial resources but also with funding from MDBs. The theme of the Delhi conference is expected to cover the most important parameters for infrastructure development i.e. Quality, Clean and Sustainable Solutions.

We expect business leaders from all nations representing the ASIA-Pacific Region. It would be of great benefit for members to attend the conference and have the opportunity to network with global industry leaders from the Asia-Pacific Region.

Further details about the conference will be communicated soon and put up on CEAI's website.

CEAI SIGNED MOU WITH UKRAINE ASSOCIATIONS

With a view to promote and develop the engineering industry in India and Ukraine, CEAI signed MoUs with the following Ukraine Associations during the FIDIC International Infrastructure conference held from 9 to 11 September 2018 at Berlin:

a) Association of Engineers-Consultants of Ukraine (AECU)

The MoU between CEAI and AECU (Member Association of FIDIC) was signed by Ms S Philip President CEAI and Mr Maksim Baranov, Vice President , AECU. The MoU covers:

- Exchange of engineering information and materials
- Joint study and research activities

MoU signed between CEAI and AECU, Ukraine MA

- Joint seminar and symposium
- Firm level cooperation
- Promotion of other cooperation on mutually beneficial basis in the field of engineering

b) Interstate Consultants Engineers Guild (ICEG)

The MoU between CEAI and ICEG (Affiliate Member of FIDIC) was signed by Ms S Philip President CEAI and Mr Oleksandr Nepomnyashchyy, President ICEG. The MoU includes the following and undertakes to:

- Recognise the importance of economic cooperation for the development of Ukraine and India
- Have a partnership with ICEG on a case to case basis where there can be cooperation between its members
- Encourage and develop mutual contacts between their respective members in India and Ukraine
- Confirm the existing interest towards strengthening and deepening of the cooperation between parties in order to conceive, design, plan and implement project in various sectors including construction.
- Continue mutual consultations in order to develop their relations and the partnership between their member organisations.

MoU signed between CEAI and ICEG, Ukraine

CEAI members are encouraged to utilize the MOUs between the CEAI and the two Associations to their company's benefit, either by partnering for overseas projects in Ukraine or projects in India which require International collaboration, in various sectors. In case of interest, please do get in touch with ceai.ceai@gmail.com, prerana@ceai.org.in addressed to Capt Prerana Dubey, Dy Director, CEAI.

FUTURE EVENTS

NATIONAL SEMINAR ON SUSTAINABLE INFRASTRUCTURE DEVELOPMENT

The Institute of Public Health Engineers, India in association with Consulting Engineers Association of India (Eastern & North East Region) and ICE (UK) is organizing a 2-day Seminar on ***'Sustainable Infrastructure Development – The Kolkata Story'*** on 16th and 17th November 2018 at the Rotary Sadan Auditorium, Kolkata.

The two-day event will observe expert presenters discussing about the heritage, innovative development, rehabilitation and future plans of Kolkata's infrastructure and their future sustenance as the city embarks on its journey in the new millennium.

The seminar will explore the history and heritage of Kolkata's urban development including inception, establishment, development, and future from an engineering perspective that turned a patch of marshy land into a sprawling metropolis. The basic themes of this seminar will include Urban Planning, Urban Transport Systems, Water Supply and Waste Management & Environment.

The objective of the Seminar is to bring together all stake holders, namely the policy makers, government departments, local bodies, NGOs, and professionals on a common platform for addressing the issue generally confronted by the practicing professionals in execution of a variety of projects.

For more details please contact, Mr. Amitabha Ghoshal, Chairman, Organising Committee, Consulting Engineers Association of India, C/o Ghosh Bose Associates Pvt Ltd, Harrington Mansion, 8 Ho Chi Minh Sarani, Kolkata 700071. Mob. 9830281368, email: gamitabha@yahoo.com

OTHER NEWS, VIEWS & NOTES

5TH NATIONAL STANDARDS CONCLAVE, NEW DELHI, 2018

The 5th National Standards Conclave was organised by the Department of Commerce, Ministry of Commerce and Industry, Government of India and the Confederation of Indian Industry (CII) at the Taj Mahal Hotel, New Delhi., on 18-19 June, 2018. CEAI was invited and was represented by Dr. S. Chatterjee, who attended on the first day. BIS and NABCB were among the Co-Organisers. It was very well attended with international participations. The event was inaugurated by Mr. C. R. Chaudhary, Minister of State for Consumer Affairs, Food and Public Distribution, Government of India.

The theme of the Conclave was ***'Implementing the Indian National Strategy for Standardisation'***. There were many eminent speakers, from the Government, standards and quality related bodies, domestic as well as international, trade and industry, multilateral agencies and other stake holders. With globalisation, increasing international competition and diminishing trade barriers, under the WTO regime, the boundaries between local and global standards is getting blurred. It is also becoming incumbent upon the engineering and manufacturing industries to strictly adhere to established standards. The imminent demand for awareness on standards is needed for survival in the global space.

BIS INDUSTRY INTERACTION WITH SERVICES SECTOR

As you would be aware, CEAI has been interacting with the Ministry of Commerce, to be mentor for CEAI from the Government, since early this year and continues its dialogue with the Ministry of Commerce (MoC) for the benefit of the fraternity. In this regard the MoC mentioned about how the Government plans to identify champion sectors and consultancy could be a consideration.

The Government of India has now identified 12 Champion sectors which would be focused priority sectors.

CEAI is pleased to inform its members that Construction **andRelated Engineering Services** is one of the Champion Sectors identified by the Ministry of Commerce.

The Service Sector is one of the key drivers of the Indian economy with a huge potential to grow into one of the largest markets of the world. Standards play a major facilitative role in this regard. Since the standardization needs and priorities of the sector are determined through consultation with the industry and standards developed with their involvement and participation, BIS planned an interaction with various associations and industry representatives on **24th August 2018** at BIS Auditorium, Manak Bhawan, New Delhi 110002.

CEAI was invited to attend the Interaction session held by BIS. Ms S Philip attended on behalf of CEAI.

DG, BIS Ms. Surina Rajan, chaired the Session which was also attended by ADG Mr. CB Singh and two DDGs of BIS.

Presentations were given by representatives from CII, ASSOCHAM, service sectors like telecom, healthcare (Apollo) and others.

BIS would be forming Sectoral Committees for the Champion Sectors to take it forward. CEAI will be interacting with BIS in this regard.

OBITUARY

CEAI regrets to convey the sad demise of Dr Prem C Jain, Chairman IGBC, and Life Member of CEAI on 19 September 2018.

In his demise, we have lost a great champion of sustainability and the green building movement , as he championed the cause of standardization in Sustainability of buildings and built environment through introduction of a new chapter in the NBC in 2015.

Dr. Prem C. Jain had a bachelor's degree, a master's and a doctorate in mechanical engineering. Upon returning to India in 1970 from the U.S after his higher studies., he served as a visiting professor at IIT Kanpur for post-graduate studies and set up a laboratory for environmental engineering. He was on the visiting faculty for the School

of Planning and Architecture at Delhi University for a long time, starting 1973.

In addition to his academic accomplishments, he was a business entrepreneur, founding Spectral Services Consultants Private Limited (now an AECOM company) in 1980 with the mission of providing energy-efficient, fire safe, fully-coordinated MEP services design for all varieties of planned buildings in India.

He founded the Indian Society of Heating, Refrigerating and Air Conditioning Engineers in 1980, and the India Chapter of the American Society of Heating, Refrigerating and Air Conditioning Engineers in 1989. He also rewrote the section on air conditioning, heating and ventilation for the National Building Code of India-NBC 2005, bringing it up to the international level of codes, standards and practices.

The recipient of numerous awards and honors, Dr. Jain has been in various Who's Who lists for Asia in the USA.

We pray to the Almighty to give peace to the departed soul. As a mark of respect and true homage to him, let us all strive to follow the path shown by him to make our mother earth green and sustainable for generations to come.

VIEW POINT

The next issue of the View Point will be published in **December 2018.** The theme for the December issue will be on ***"Engineering Consultancy for Nation Building"***

Considering the experience of CEAI members and various stakeholders in the subject, CEAI would be happy to receive articles on the above theme.

Authors could share their knowledge enriched by the works executed, first hand accounts of the challenges faced, practical issues experienced and the solutions to those, etc. Photographs would benefit our readers for better appreciation of the issues encountered and addressed.

The articles for December issue need to reach CEAI by 10th November 2018. Articles need to be in Times New Roman 12 with single line spacing on A4 size.

ADVERTISEMENT IN VIEW POINT

VIEW POINT is circulated to all CEAI Members, FIDIC, Ministries of the Government of India, Public & Private Sector Undertakings, Construction Firms, Contractors, Consultants, Foreign missions and Funding Institutions in India and other organisations related to or dealing with the engineering profession.

Therefore, advertising in the VIEW POINT gives the advertiser wide exposure and visibility.

The rates for advertisements in VIEWPOINT are given below. This is excluding GST @18% or as prescribed, which will be extra:

ADVERTISEMENT TARIFF

	Rate Per issue *	Discounted rate at 20% for 4 consecutive issues (from September 2018 to June 2019)*
Back Cover	- Rs. 25,000/-	Rs 80,000/-
Inside Front Cover	- Rs. 15,000/-	Rs 48,000/-
Inside Back Cover	- Rs. 15,000/-	Rs 48,000/-
Full Page	- Rs. 10,000/-	Rs 32,000/-

**GST @ 18% or as prescribed will be added to the above rates.*

*** Back cover, Inside Front & Back covers booked till December 2018 and June 2019, respectively.*

Tech Quiz[1]

1. Which cooling system does *Hawa Mahal* deploy?
   a. Forced ventilation
   b. Passive features
   c. Heat sinks
   d. Active cooling
   e. Natural ventilation

2. *Baodis* were cooled by?
   a. Jharokhas
   b. Evaporative systems
   c. Heat sinks
   d. Passive features
   e. Roshandans

3. When was the Energy Conservation in Buildings Code first issued?
   a. 2001
   b. 1997
   c. 2007
   d. 1999
   e. 2017

4. What cooling system was and still used in many parts of northern India?
   a. Natural ventilation
   b. Fans
   c. Ice blocks
   d. Evaporative systems
   e. Circulating water

5. Which regions are Igloos built in?
   a. Temperate
   b. Polar
   c. Tropical
   d. Forest
   e. Desert

6. When was mechanical cooling invented?
   a. 1900
   b. 1895
   c. 1905
   d. 1890
   e. 1902

7. Which lighting lamp is most energy efficient?
   a. Light Emitting Diodes
   b. Incandescent lamp
   c. Compact Fluorescent lamp
   d. Sodium Vapour lamp
   e. Halogen lamp

8. Which source has the lowest levelized energy generation cost in India?
   a. Nuclear
   b. Solar
   c. Wind
   d. Hydro
   e. Coal

9. Which energy source has the least Life-cycle greenhouse-gas emissions?
   a. Wind
   b. Coal
   c. Nuclear
   d. Solar
   e. Gas

10. Using Variable Frequency Drives can bring down the Energy Consumption because
    a. Power consumed is proportional to RPM of the pump or fan
    b. Power consumed is proportional to square of RPM of the pump or fan
    c. Power consumed is proportional to cube of RPM of the pump or fan
    d. Power consumed does not vary with respect to RPM of the pump or fan
    e. Power is not consumed by a pump or a fan

The first person who mails the correct answers to CEAI ***info@ceai.org.in*** will get a congratulatory mail and will be acknowledged by publishing his/ her photograph in the next issue.

[1]Contributed by A P Mull and Dr. Rajashekhar R Malur


Answers to Tech Quiz June 2018 issue :1(b), 2(d), 3(a), 4(c), 5(d), 6(e), 7(c), 8(e), 9(b), 10(a)

Prof Mainak Ghosal, Consultant and **Mr Rishi Raj** of Holtec are the winners of the Tech Quiz with full/ maximum marks.

FIDIC PUBLICATIONS

1	The Short Form of Contract (First Edition, 1999)	19	Selection of Consultant 2nd Ed (2013)
2	EPC Turnkey Projects (First Edition, 1999)	20	Quality Based Selection (QBS) Guidelines (2011)
3	EPC/Turnkey Contract 2nd Ed (2017 Silver Book)	21	Standard Prequalification Form for Contractors 2008
4	Construction Contract (First Ed. 1999)	22	Professional indemnity insurance and project risk 2004
5	Construction Contract 2nd Ed (2017 Red Book)	23	Insurance of Large Civil Engineering projects (2004)
6	Plant & Design-BuildConract (First Ed, 1999)	24	Conditions of Contract for Design-Build and Turnkey (1st Edition, 1995 Orange Book)
7	Plant and design-build contract 2nd ed (2017)	25	Model Representative Agreement (1st Ed, 2013)
8	Dredgers Contract 2nd Ed (2016)	26	Sub-Consultancy Agreement 2nd Edition (2017)
9	Client-Consultant Model Services Agreement (White Book) 3rd Ed, 1998	27	Integrity Management System (Fims) Guidelines 1st Ed (2011
10	Client/Consultant Model Services Agreement (White Book) 4th Ed, 2006.	28	Guidelines For Integrity Management System In The Consulting Industry 1st Ed (2015)
11	Conditions of Subcontract for Construction (First Edition, 2011)	29	Conditions of Contract for Electrical and Mechanical Works (3rd Edition, 1987; Reprinted 1988)
12	FIDIC Contracts Guide to the Construction, Plant and Design-Build and EPC/Turnkey Contracts (1st Edition, 2000)	30	Operation, Maintenance And Training Guidelines (1991 OMT)
13	Conditions of Contract for Design Build and Operate Projects (1st Ed, 2008) GOLD BOOK	31	DBO(2008 gold book) contract guide 1st edition 2011
14	MDB (Multilateral Development Bank Harmonised Harmonised Ed. Version 3: June 2010)	32	Client/Consultant Model Services Agreement (1998 White Book) Guide 2nd Ed (2001)
15	Conditions of Contract for Electrical and Mechanical Works (3rd Edition, 1987; Reprinted 1988).	33	FIDIC Procurement Procedures Guide 1st Ed (2011)
16	Conditions of Contract for Works of Civil Engineering Construction (4th Edit. 1987 reprinted 2011	34	Project Sustainability Management Guidelines (2004)
17	Client/Consultant Model Services Agreement 5th Ed (2017 White Book)	35	FIDIC Guide To Practice, The Business Of A Professional Services Firm - 2015 Edition
18	Model Joint Venture (Consortium) Agreement 2nd Edition (2017)	36	European International Contractors (EIC) Contractors Guide to the FIDIC Conditions of Contract for Plant and Design-Build (The New EIC Yellow Book Guide), 2003

[For more information, please contact CEAI Secretariat]

ASPAC 2019 DELHI

FIDIC ASPAC

ASPAC 2019 CONFERENCE

QUALITY INFRASTRUCTURE FOR CLEAN AND SUSTAINABLE DEVELOPMENT

7th - 9th July, 2019

ASPAC represents the consulting engineering industry in Asia and Pacific region as the regional group of FIDIC Member Associations. ASPAC has 22 member countries. The main objective is to encourage regional cooperation amongst the member associations by sharing and increasing knowledge on the different infrastructure requirements of each country.

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YOUNG PROFESSIONAL AWARDS

ASPAC has decided to acknowledge and promote the remarkable achievements of Young Professionals (YPs) to the consultancy engineering industry. The awards will be announced in 2018 and after due selection process will be presented during ASPAC 2019 in Delhi.

PLENARY SESSION : Infrastructure-Industry-Revolution
FOCUS SESSIONS : To cover current topics of interest
SPECIAL SESSION : Business in India & Young Professionals
SPECIAL PROGRAMS FOR SPOUSES

www.fidicaspac2019delhi.com

Organising MA
Consulting Engineers Association of India (CEAI)

CONSULTING ENGINEERS ASSOCIATION OF INDIA
Creating Value of Engineers
CEAI Centre, OCF, Plot No.2, Pocket 9, Sector B, Vasant Kunj, New Delhi-110 070
Tel. : 011-26134644 / 26139658
Email : ceai.ceai@gmail.com, info@ceai.org.in Website : www.ceai.org.in

STUP Consultants Pvt. Ltd.

STUP, established in 1963, an Indo-French organization of international repute which provides design, construction engineering, technology transfer and project management services for multiple sectors.


01


02


03


04


05


06


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09


08

Sectors

01. Airports & Aviation
02. Environmental and Public Health Engineering
03. Energy, Telecommunication and Space Infrastructure
04. Roads, Highways, Expressways
05. Urban, Rural and Industrial Development including all Types of Buildings
06. Bridges & Flyovers
07. Railways
08. Offshore, Harbour and Coastal Engineering
09. Metros
10. Water Resources and Agricultural Development
11. Construction Engineering, Project Management and Technology Transfer
12. Rehabilitation of Structures and Heritage Buildings


10


11


12

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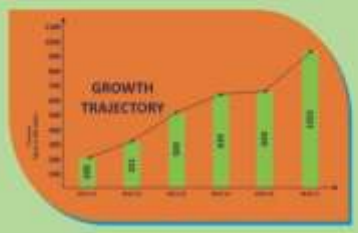

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"Build Together, A Better World"

Rodic Consultants Private Limited - a name which spells excellence and inspires confidence - was established in the year 2000 with a vision to provide a spectrum of consulting services in the filed of infrastructure. Over the last sixteen years, It has emerged as a strong, motivated and sound organisation that has time and again proven its core competence in providing expertise in the sectors of Highways, Bridges, Tunnels, Railways, Rodic has also made inroads into Hydropower. Power - T&D, Inland Waterways, Water Resources and Urban Development sectors.

Certified with an ISO9001:2008, ISO14001:2004, OHSAS 18001:2007 and TRACE certification. Rodic has moved from strength to strength in its quest for excellence. Our confidence has further grown by being associated with projects involving major funding institutions such as The World Bank and The Asian Development Bank, the Government of India. We have a strong Pan-India client base, whose confidence and trust we have earned with our exemplary expertise in the areas of Consulting and Engineering, Advisory Services, Feasibility Studies, Detailed Engineering, Proof Checking, Value Engineering, Detailed Design, Detailed Project Report Preparation, Construction Supervision, Owner's Engineer and Project Management.

Our strength lies in the value of sincerity and hardwork that our Company upholds. We are further enriched by the more than one thousand four hundred skilled and motivated professionals who work with us in a spirit of team-work and productive co-operation. A continuous striving for excellence has always been our Mantra and we lay a high premium on commitment and client satisfaction. Our Value-system encompasses - competence, innovation, client-centric approach and delivering within time frames.

AWARDS AND RECOGNITION'S

- Achievers Award 2015 conferred on Mr. Raj Kumar, Chairman and Managing Director, for successfully achieving milestones in the implementation of the AIIMS - Digha Elevated Corridor by the Hon'ble Chief Minister of Bihar Shri Nitish Kumar, on the occasion of 6th foundation day of BSRDCL.
- Rodic Consultants Pvt. Ltd. was featured in "Leading SME of India" published by Dun and Bradstreet.

JOB OPENINGS

We are also looking for qualified and experienced professionals from relevant disciplines to join Rodic family for our various current and upcoming projects on a Pan India basis. Interested candidates are encouraged to forward profiles by email to career@rodicconsultants.com

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