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Green and Smart Building's Technology and Automated Management SystemIn India

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ABSTRACT:Green technology is inevitably our future in response to the anticipation and panic surrounding climate change, as buildings will play a crucial role in efforts to decarbonize and for our well-being and nature. Global commitment to green building and its technologies and practices is a positive sign of sustainability efforts. With government support, we will be able to see many changes in construction practices and methods, building materials, management procedures, the incorporation of intelligent automation tools and technologies, changes in standards and codes in support of net-zero emissions in the years to come. Thispaper is an attempt to give an overview of the different technologies and management tools that are currently available or are being developed for the green and smart buildings of the future. To understand, select and prioritize technologies that could be applied to new buildings and retrofits. It could also be the subject of future research and development to make them suitable for the local context and also to make them cost effective and easily applicable to the construction industry. Also, presented case study analysis of the technology of a successful green building project, as the case study shows, creating green and smart buildings of the future needs people aware of the benefits, technologies and processes make them possible. It is a sincere hope that this paper will inspire interest to champion green and smart buildings and accept nothing less.

KEYWORDS: Green, Smart, Building, Renewable, Energy,Water, Waste, Management, Technology.

I. INTRODUCTION

Climate change is having a major impact .There is a growing understanding that a transition to a low-carbon economy is required. The building and construction sector plays a central role in this transition. Together, construction and building are responsible for 40% of all carbon emissions in the world, with operational emissions (from energy used to heat, cool and light buildings) accounting for 28%. The remaining 11% comes from embodied carbon emissions, or ‘upfront’ carbon associated with materials and construction processes throughout the whole building lifecycle.

India's Prime Minister Narendra Modi made headlines at the COP26 climate change conference in Glasgow when he announced that India will achieve net-zero emissions by 2070, which is critical. India's commitment shows that developing countries can and should strike a balance between economic growth and the environment. The advanced economies of the West have been responsible for global historical emissions, but responsibility for the future rests with all countries. According to one report, 1.5 billion people from India, Pakistan and Bangladesh will be living in a place as hot as the Sahara Desert in 50 years if greenhouse gas emissions continue to rise.

According to the World Economic Forum, Mission 2070 considers Pillar 4 to achieve this goal as "Green Buildings, Infrastructure & Cities" - promoting green cities, energy-efficient buildings and environmentally friendly building technologies in the future.

Given these facts, it is imperative that significant action is taken towards the adoption and growth of green building and its technology and management in India, which can result in significant reductions in greenhouse gas emissions, especially during the operational phase of the building.

II. GREEN AND SMART BUILDING

There are different definitions of a "Green Building" and how it compares to other buildings. One of the broadest definition is: Green building is the practice of creating structures and using processes that are environmentally sound and resource efficient throughout a building's lifecycle, from siting through design, construction, operation, maintenance, renovation and deconstruction. This practice outstretches and complements the classic concerns of building design in terms of economy, utility, durability and comfort.

A 'Smart Building' can be defined as follows:Smart buildings use information technology during operation to connect a variety of subsystems that typically operate independently, allowing these systems to share information to optimize the overall performance of the building. Smart buildings look beyond the building services within their four walls. They are connected to and responsive to the smart grid, and they interact with building operators and occupants to give them a new level of visibility and actionable intelligence.

The Information and Communication Technologies (ICT) and the IoT are the two main pillars of innovative smart building solutions to meet the criteria of intelligence by connecting core systems such as lighting, electricity meters, water meters, pumps, heating, fire, cooling systems, elevators, access systems and shading with sensors and control systems.

III. RELATED TECHNOLOGY AND AUTOMATED MANAGEMENT OPTIONS

Brief idea of design technologies (i.e. passive and active technologies), renewable energytechnologies, waste and water management technologies,smart management automation technologiesare as follows:-

- **Passive Design**

Passive design uses natural energy flow such as daylight, natural ventilation, natural cooling, natural heating, shading to maintain occupant comfort (heat, ventilation and lighting) rather than over-reliance on mechanical and electrical systems. The key elements of passive design are: Location, orientation, Massing, Layout, Building Envelope.

The Building envelope technology mainly revolves around the following areas:Interior and exterior or motorized shadings; Cool roofs; Insulation such as batting or blankets, loose fill, foamed in place, rigid panels, reflective foils, Structural Insulated Panels (SIPs), sandwich walls, thermal insulation plaster; Glazing i.e. in addition to traditional single and double pane windows or glazing units,multiple pane glazing (triple pane, quadruple pane, etc.), inert gas fillings, low-e glass coatings (low emittance), selective transmission films and adaptive glazing, thermal breaks.

Passive heating technologies takes into account the energy of the sun to provide occupant comfort while reducing the energy used by mechanical systems to provide same. For instance, Massing and alignment for heating, Trombe walls, Phase change materials, Thermal mass.

Passive cooling technologies includes Massing and Alignment for natural ventilation, openings for cross ventilation, wing walls, stack ventilation, solar chimney, double skin facades etc. Passive lightning such as skylights, Fenestrations, light shelves ,mirror ducts ,light pipes, transparent insulation etc.

- **Active Design**

Active design technology is all about giving us the advantages of passive design by using artificial electronic devices, but these should be essentially energy efficient.
These involves innovation in HVAC system, Artificial lightning, Technical building systems like pumps, compressors, elevators, escalators, etc.; Plugs, loads or socket loads.

- **Renewable Energy**

Integrating renewable energy into buildings is a challenge as the space and provision for it can compete with other functional requirements. Also, not all renewable energies available today can be integrated into buildings. We focus on renewable energy technologies that integrate well into buildings as energy generation sources. These are:-Solar Photovoltaic (PV) Energy, Rooftop Solar PV, Building Integrated Photovoltaic (BIPV), Thermal solar collectors, Solar thermal cooling and air conditioning, wind energy, Geothermal energy, Bio-gas plant, Energy Storage.

- **Waste and Water Management**

Buildings use a significant amount of water for various needs such as plumbing, kitchen, laundry, utilities, heating/cooling, and landscaping. The availability of clean water is a major challenge in several parts of the world and hence water conservation in buildings is imperative. Buildings can also generate significant amounts of waste throughout their lifecycle, from construction to demolition. The waste generated by building occupants and facilities must also be managed to reduce its environmental impact.

The following involves Water sub-metering; leak detection; water efficient fittings such as Water-saving faucets and faucet adapters, Water-saving showerheads, High pressure or trigger spray nozzles, Showers and faucets with automatic water shut-off, Water demand sensors ,Water heater, Low volume and dual flush toilet cisterns, Waterless urinals, Composting toilets, Labels for water-saving devices etc.; Greywater Recycling; Rainwater Harvesting; water efficient landscaping; water reduction in cooling towers.

Reducing construction waste by reuse and recovery of Building material, Prefabricated Volumetric construction, Optimizing the use of materials during construction and deconstruction, Waste reduction, reuse and recycling.

- **Building Management And Automation Technologies**

Building management systems (BMS) or building automation systems (BAS) are computerized control systems installed in buildings that monitor and control the building's mechanical and electrical devices likeventilation, lighting, power systems, fireprotection systems, and security systems. They collect and analyze data so provide insights or take the mandatory actions to enhance building efficiency and productivity. A BMS consists of two components: hardware and software. The hardware used is that for data acquisition (analog and digital meters and sensors), data analysis (computers or serversand dashboards for visualization), controls or actuators. The software program is an interface between the measurements dispensed and therefore
the building manager or the controller. A layer of software applications is additionally often employed in combination, and these applications define the control strategies (HVAC controls, lighting controls, etc.), instructions, and optimization routines.
The following are the key components of an IoT-enabled building management system:
1. Devices directly connected to the cloud, e.g. Smartphones and smart meters.
2. Sensors that collect data from objects and spaces.
3. Gateways that transfer the information to the cloud (could be a company cloud, e.g. intranet
or the open internet).
4. Networking and data storage:
a. Communication between the sensors and gateways and therefore the gateway and
also the server.
b. the information centre or server that collects and stores the information and
provides the computing hardware.
5. Software and data analysis engine that processes the info in a very meaningful way,
calculates optimal operating parameters and helps the residents and facility managers to
visualise the info appropriately.
6. Actuators connected to the net via the gateway.
BMS installation in green buildings of India are:ITC Green Centre, Gurgaon; Wipro Technologies Development Center, Gurgaon; CII – Godrej Green Business Center, Hyderabad.

- **Integrated Design Concepts And Tools**

The integrated design process requires all design professionals to work collaboratively towards common goals from day one. This is often easier said than done as each professional and stakeholder has their own perspectives, goals and performance targets for building design, and some of these may compete or contradict each other. However, by establishing communication and collaboration early in the project, there are fewer "surprises" that lead to delays and higher costs.
Various built-in design tools are:

Tools like Building Information Modelling (BIM) are very useful during the building design phase to get a fairly accurate visual representation of the building and to document its design features in an easily accessible way. BIM is a 3D digital model of all aspects of a building, including architectural, structural and mechanical elements. It differs from the previously popular architectural design tools in that it allows the addition of more information such as time, cost, manufacturer information, sustainability and maintenance information, etc. to the building model. When everyone is working on a file, it's easy to see what information is missing and what areas of the design need focus or refinement, greatly aiding the decision-making process.
BIM used in India: Nagpur Metro; Personal Rapid Transit System, Amritsar ;Bangalore International Airport.
There are also Energy modelling , Effective cost-energy savings model, Airflow modelling ,etc.

IV. STANDARDS AND CODES

In India, the Green Building Code is a hodgepodge of codes and standards in state regulations, the National Building Code, the Energy Conservation Building Code (ECBC) and in the standards of the rating programs, such as Leadership in Energy and Environmental Design-India (LEED-India), the standards and guidelines established by Indian Green Building for the residential sector Council (IGBC), TERI-GRIHA and other such certifications. Basic and General Guidelines for Efficient Energy Use in the National Building Code (NBC) exist, but they are guidelines only. This efficient energy Guidelines for use after 18 years in the event of an amendment to the NBC in 2005.

It's urgent and imperative that we don't just pass policies that require it all existing buildings and new buildings according to green building criteria, but also relevant laws and regulations for effective implementation of these guidelines. The honest implementation of laws is the order of the day. This Laws should provide incentives for commercial builders in the form of tax breaksand quick approvals. Penalties should also be imposedwhere necessary. Laws and regulations for green building in our country are voluntary. Till date, India has no effective and comprehensive Green Building Code.

V. RATING SYSTEMS

- **GRIHA**:

GRIHA or Green Rating for Integrated Habitat Rating, is the national rating system of India for everyone completed construction. It was developed by TERI (The Energy and Resources Institute) and is supported by the MNRE (Ministry of New and Renewable Energy). It is a assessment tool to measure and assess a building environmental performance. GRIHA is a point-based rating system consisting of 34 criteria categorizedunder various areas such as site selection and site planning, conservation and efficient use of resources, building operation and maintenance, innovation etc. It helps in the improving the environment by reducing greenhouse gases (Greenhouse gas) emissions, reducing energy consumption and the strain on natural resources, thereby reducing pollution loads and waste generation.

- **IGBC:**

IGBC is the non-profit research institute based in CII-Sohrabji Godrej Green Business Centre which itself a LEED certified building. Then it reached them prestigious LEED rating for its own centre in Hyderabad in2003, the green building movement caught on tremendous momentum in India. So IGBC took over LEED for India as USGBC's Indian partner. It acts as channel for registering Indian projects under LEED Program. The IGBC building rating system is quite similarthat of USGBC, but modified slightly to suit native Indian Conditions .LEED certified buildings have 34 percent less CO_2 emissions and consume 25 percent less Energy. water conservation efforts in green buildings is intended to reduce and save water consumption by 15 percent and more than 10 percent of the operating costs .

- **BEE:**

The Bureau of Energy Efficiency (BEE) has developed its own rating scale based on 1 to 5 star scale. More stars mean more energy efficiency. BEE developed the Energy Performance Index (EPI).

VI. CASESTUDY

In line with the efforts to reduce environmental impacts of buildings, the objective of this case study is to determine the current practices level of Green and smart Technologies and management automation system ,to identify the improvement areas of it's implementation and to suggest some strategies regarding the same. Case study were conducted for data collection. Data were collected through semi-structured interview with the Head of respective site and printed data were also provided by them.

SITE NAME : Gandhi Research Foundation, Jalgaon
LOCATION: Jain Hills, Jalgaon
FOUNDER: Bhavarlal Jain
SITE COMPLETION YEAR: 2013

- About Site Area Distribution:

a. The total site area is 9000 m2.
b. The built-up area developed is 6000 m2.
c. The Air-conditioned area out of built-up area is 4,600 m2.
d. The Non Air-conditioned area out of built-up area is 1,400 m2.

- Sustainable site planning:

a. The building blocks were designed in accordance with the site's terrain to ensure there is minimal site disturbance.
b. All existing trees were preserved on site and are part of the building post occupancy.
c. Planting native trees ensures a minimal impact on the environment.
d. Use of efficient rainwater management.
e. Installation of permeable paving on site for more than 60% of the paved area.
f. Use of electric vehicles on site.

- Reduction of water consumption:

a. Native planting and use of an efficient irrigation system
b. Use of low-flow and flush fittings
c. Use of non-potable water for landscaping

- For visual comfort:

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a. Passive techniques such as appropriate building orientation, highly efficient envelope and mutual shading reduce the external heat gains.
b. The daylight design integration reduces the need for artificial lighting. A total LPD of 0.4 w/sq.ft was achieved in the building, resulting in savings of 61%.
c. On-site generation of renewable energy contributes about 8% of the total connected load of air conditioning and lighting.
d. Efficient daylight design ensures thermal and visual comfort in the building.
e. Good daylight and views in the classrooms and administration area.
f. The museum has been designed according to the specific lighting requirements.

To achieve thermal comfort: Based on thedesigncriteria of NBC standards, the building HVAC systems are designed to maintain thermal comfort conditions.

- Use of low-energy materials:

a. Natural stone and locally produced sun-dried fly ash bricks were used for the blockwork.
b. The roof of the museum building is a prefabricated construction, which has largely reduced the building's concrete consumption.

- On-site installed renewable energy technologies:

a. The PV modules installed at GRF have an installed capacity of 20.24 kWp with an annual generation of 26199 kWh.
b. 100% external lighting needs are covered by installed RE.
c. 60% of the internal lighting needs are covered by installed RE.
d. Reduction in energy consumption: 65% reduction in energy consumption compared to the GRIHA benchmark
e. EPI: 41 kWh/m2/year KWh/m2/year
f. Renewable Energy: The nominal capacity of the solar PV installed on site is 20.24 kWp
g. Bio-gas plant capacity: 1.668 MW
h. Feed: 120-160 MT/day
i. Bio-gas generation:- 12000-18000 M3 /day
j. Electricity generation:28000-35000 units/day
k. Refrigeration for VAM: 300-400 TR
l. Organic compost: 10 TPD
m. Power Utilization: Grid interacted captive consumption
n. Refrigeration Utilization: Photovoltaic building, Onion cold storage.

- Design Team:

a. The Client is Gandhi Research Foundation, Jain Hills Jalgaon
b. The Project Coordinator is Ms. Dipti Talwar
c. The Principal Architect is A. Mridul
d. The Project Architect is Mr. Prashant Patel
e. The Landscape Architect is Mr. Ajay Kale
f. The Project Management Consultant is Mr. Narayan Lalwani
g. The Structural Consultant is Mr. Narayan Lalwani
h. The Electrical Consultant is Mr. Vikrant Bhangale
i. The Green Building Design and Certification is done by Ms. Dipti Talwar

- Green Awards:

a. GRIHA Exemplary Performance Award
b. Artist in Concrete Award(GRF) 2013-14
c. Artist in Concrete Award(Anubhuti School) 2013-14
d. LEED India NC Platinum -2014
e. 'Five star' rating under GRIHA
f. National Energy Conservation Award
g. Global CSR Excellence Leadership Award

VII. CONCLUSIONS

Green and Smart Building technologies discussed and presented not necessarily all new and cutting-edge technologies. Some of them were available for decades. However, the adoptionrates of these technologies are still very low. However, the list of technologies covered is notexhaustive, can be a brief guide for builders, planners, architects and facility managers to design and operate green and smart buildings. If the technologies discussed here can be adopted for new buildings and buildings retrofits can lead to energy, water and waste footprint of the built environment significantly reduce, while at the same time ensuring comfort and safety for the occupants with the right selection of technologies.

It revealed that a lot of effort has been made in India to address the areas of Green Building Concept, Green Building Benefits, Green Building Rating Systems, Barriers and Challenges in Adopting Green Building Concept. to explore excessively as well as outside of India.

It is high time to shift our concerns and research to detailing the solutions which will help to tackle the existing issues regarding Green and smart building implementation throughout it's lifecycle. As we know, the number of existing buildings is more than the constructing ones, there should also be focus on to how minimize it's operational emissions. We need to wholesomely

look at the picture, there are available Technologies and automation systems which helps right from the design phase till the demolition to make whole process green and sustainable. There is a need to be aware of these Technologies and Automation level at every level of society and also to make them locally available for the accessibility of all. There is long way to go to achieve a green and smart building in every phase of a building.
The high performance building case study tells us that the technology required to create green and smart buildings is now available. It will always be a further technological development, but using existing technologies, it is possible to design and operate buildings that may be of very low or even zero energy, water and waste consumption.

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