How Internet of things and green Building can lead to a zero energy Building

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Abstract- An ideal green building must be a building that is build on green concepts of construction and remains green throughout its life span i.e zero energy consumption from the grid , complete reliance on eco-friendly energy options and a based on concepts of holistic living or working environment. This paper defines green buildings, Zero energy buildings and elaborates the role of Internet of things to achieve a Zero Energy Building.

Keywords – Zero energy building, IOT, Green Buildings

I. INTRODUCTION

Zero Energy building is a compelling vision for the future-it's a technically rigorous, creative and an innovative pursuit. Along with energy solutions it offers an opportunity to work with program, site and climate.[3] It can also embrace innovative technologies-Internet of things offers immense opportunity to tap energy resources monitoring and control in buildings, this paper aims in defining a green building, a zero energy building and how Internet of things can be used to help a green building constructed and with renewable/low energy features achieve Zero Energy-complete freedom from grid dependency, wastage, in a building or building complex.

II. GREEN BUILDING

A. Constitution of a green building –

A green building incorporates design, construction and operational practices that significantly reduce or eliminate its negative impact on the environment and its occupants[1] *(Green building council Australia*).. Building green is an opportunity to use resources efficiently while creating healthier environments for people to live and work in. Such a building is a construction and lifetime of operation that assures the healthiest possible environment while representing the most efficient and least disruptive use of land, water, energy and resources.It should be a dynamic environment that responds to their occupants need and lifestyle.[2]The green building design is a process that begins in the conceptual stage and can be continued for the complete lifespan of the building ;site considerations, green construction techniques, local material, locally responsive design, improvement in indoor air quality and temperature within, wind pattern response to name a few. It has time and again also proven that this practice can now significantly reduce construction and performance costs.

Green buildings are buildings that are integrated and harmonious with their contexts. They are buildings that take into account the movement of the sun, the flow of the wind, and daylight requirements. They are built with environment-friendly materials and address the spaces between them and are more comfortable to their occupants and consume less energy.[1] Construction of water harvesting, waste disposal and treatment, solar panels for electricity, water re-use are done to create a green building complex.

B. Future of green buildings and Zero Energy buildings –

The process of a green building should not end with construction and installation of photovoltaic panels or water harvesting, further more things can be done in combination with these techniques to create a ZERO impact building i.e a building after construction with 'green' practises that further reduces energy, water, maintenance cost etc.

A zero-energy building is a building with zero net energy consumption, meaning the total amount of energy used by the building on an annual basis is roughly equal to the amount of renewable energy created on the site. These buildings consequently do not increase the amount of greenhouse gases in the atmosphere. They do at times consume non-renewable energy and produce greenhouse gases, but at other times reduce energy consumption and greenhouse gas production elsewhere by the same amount.

The intent of this paper is to define green building, internet of things and how combination of both can lead to a zero energy building, after construction and installation phase with cloud computing for energy tracking, and moderation the used electricity/power in a building to be controlled for minimum wastage and appropriate application, and lead to ZERO energy complex.

Successful zero energy building combines green building parameters and minimum conventional electrical practices. Time tested passive solar or artificial conditioning, principles that work with the on-site assets, Sunlight and solar heat, prevailing breezes etc.. All such technologies needed to create zero energy buildings are available off-the-shelf today.

Zero-energy buildings are built with significant energy-saving features. The heating and cooling loads are lowered by using high-efficiency equipment, added insulation, high-efficiency windows, natural ventilation, and other techniques. These features vary depending on climate zones in which the construction occurs. Water heating loads can be lowered by using water conservation fixtures, heat recovery units on waste water, and by using solar water heating, and high-efficiency water heating equipment. In addition, day lighting with skylights or solar tubes can provide 100% of daytime illumination within the home. Night time illumination is typically done with fluorescent and LED lighting that use 1/3 or less power than incandescent lights, without adding unwanted heat..

Zero-energy buildings are often designed to make dual use of energy including white goods, for example, using refrigerator exhaust to heat domestic water, ventilation air and shower drain heat exchangers, office machines and computer servers, and body heat to heat the building. These buildings make use of heat energy that conventional buildings may exhaust outside.

For a building to be true to its aim of Zero energy consumption while all the above elements are incorporated in the building a further step can be taken to achieve this parameter named as IOT.(Internet of Things).It is a scenario in which objects, or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Application of this feature to the electronic working grid of a complex can help with self sustainable vision for a building.[12]

A report from Greensense, an Australian sustainability software developer, estimates that buildings in its country are vacant for about 72 percent of a year, between off hours and holidays. Still, those buildings consume about 55 percent of their annual electricity use during those periods. The report indicates that figures are about the same in the U.S.Buildings account for 40% of total energy usage. That's more than transportation or industrial sector. Energy costs and water shortages are two of the biggest drivers of green building and energy policies. Buildings consume electricity in terms of lighting, cooling, heating, computers monitors, printers, lifts and appliances.[5]

C. Green building in collaboration with IOT –

Imagine coming to the office or home and it wakes up. This is not a futuristic dream. It's already a reality and it's called the Internet of Things.

The moment you reach your desk, an occupancy sensor switches on the fan and lights only above you or close by, similarly for all other occupants, so if a seating arrangement of a IT complex has 100 occupants and 80 have reported that day the optimum amount of lights/fan/ HVAC ducts will be working that day, other areas like meeting rooms, pantry, toilets are also electrically responsive only by your presence. The moment you turn off your system or any other equipment with more than 10 min. Standing time (coffee maker, photocopier, fax, and printer) should also automatically switch off to save standby power, considering it is always manually possible to switch them ON/OFF at any instant and a similar scenario for residences, hotels, institutes etc. where the building responds to occupants, requirement, and a pre-fed schedule simultaneously.

To achieve this scenario it will be required to

-Linking all electrical equipment with IOT that should link all electrical usage and main switchboards, as per schedules, requirements, occupancy.

- A program that tracks life, usage, extra electrical consumption or defects in an electrical equipment as per pre fed data and notifies to the server.

The above applications can be achieved using IoT and cloud computing. They are largely binary, on or off. On the other hand, using computing intelligence to recognize a condition, interpret it, and act on it would allow in-home smart devices or office equipment (such as water heaters, clothes dryers, dishwashers, fridges, printers etc.) to, for example, operate according to real-time electricity prices to lower the electricity bill. A smart thermostat would analyze outdoor and indoor conditions (temperature, humidity, and daylight) and instruct the raising or lowering of the blinds or sunscreens. IoT can improve the performance and efficiency of air conditioning systems. Inexpensive sensors can capture data about HVAC performance and ambient conditions. This data can be compared to a reference model from similar homes and systems to determine whether the HVAC system is operating within acceptable parameters. In such automation, the power of IoT is in capturing data, analyzing it, and acting on it without human input.[2][6]

A commercial, institutional or office building, even though all these run on a schedule and almost fixed timings, no moderation or controlling of the electricity is done, all such complexes are manually dependant for switching on and off all electronic components or their repair notifications, damage etc. which can now be modified as per a program that connects all appliance and overall electrical usage of a building with a smart software that can change, adjust, verify and control all from a single location and program.

III. IOT FOR ZERO IMPACT BUILDING

Internet of things for a Zero impact building can provide timely, integrated system information for its owners so that they may make intelligent decisions regarding its operation and maintenance, and has an implicit logic that effectively evolves with changing user requirements and technology, ensuring continued and improved intelligent operation, maintenance and optimization.[7]

The idea of leveraging intelligence to enhance building performance, either for energy efficiency or occupant comfort and thereby obtaining credits is also acknowledged by USGBC. "If the objective is clear, the credit system under LEED is geared to recognize building performance that has been enhanced by automation and IT-centric intelligence," states USGBC.[8]

The concept and the realization of the "Internet of Things" make the world truly ubiquitous since the IoT radically changes the view of the "Internet" by embracing every physical object into network. Programmed and computerized networks of electronic devices are employed for control and monitoring of systems such as HVAC, lighting, security, fire and life safety, and elevators. They are known as building automation systems (BAS) and building energy management system (BEMS), these solutions typically aim at optimizing the performance, start-up, and maintenance of building systems and greatly increase the interaction of mechanical subsystems in the building. This leads to improve occupant comfort, optimum energy consumption, and cost-effective building operation. Such an application is possible remotely or from a centralized system with a minimum human-in-loop factor.[9]

Cloud computing usually plays important role in this kind of architecture since wireless sensor networks are limited in their processing power, battery life and communication speed while cloud computing is known for having powerful computational and processing capacity and the communication speed is much faster as well . Cloud computing is also believed the paradigm for delivering services for IoT environment

The architecture of an IoT actually contains three segments which are the hardware segment, the middleware segment and the presentation segment. The hardware segment mainly refers to the connection of sensors or any embedded communication hardware. The middleware segment usually refers to cloud environment which is responsible for data storage, computation and data analytics. The presentation segment, on the other hand, visualizes the result of data analytics or interprets the data in an easy and understandable format. Moreover, an IoT must possess the capabilities of communication and cooperation, addressability, identification, sensing, actuation, embedded information processing, localization and user interfaces.[10]

At the hardware segment, wireless sensor network is expected to be a key technology for various IoT applications such as home automation, and energy saving. The sensor devices in the wireless sensor network work as the communicate node and will communicate to other devices wirelessly. The sensor device also carries out its designated duty to collect data and send data to data centre. Therefore, communication and measurement are the two major functions of a wireless sensor network [11].

IV.CONCLUSION

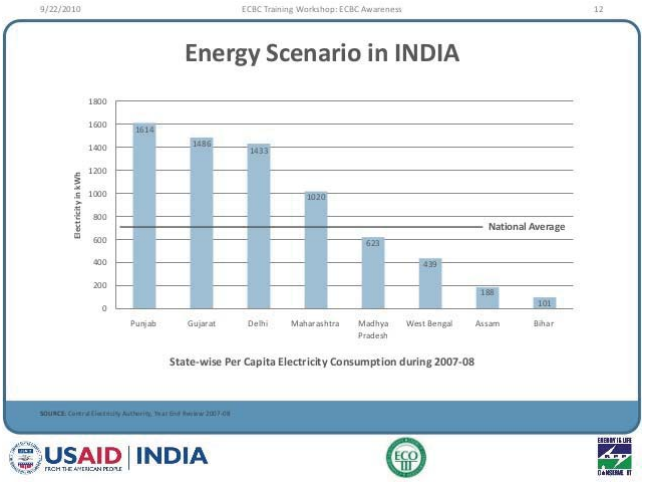

Figure1. Energy scenario in India

source: central electricity authority

Planning commission of India and central electricity authority states that

Installed Capacity in India is Approx. 160,000 MW,

Projected Capacity in 2030 – 800,000 MW

600 MW capacity additions each week

Continued deficit supply in 2007-08

-Peak power deficit of 16.6% •

-Energy Deficit of 9.9%

India is experiencing an unprecedented construction boom. The country doubled its floor space between 2001 and 2005 and is expected to add 35 billion m2 of new buildings by 2050 Buildings account for 35% of total final energy consumption in India today, and building energy use is growing at 8% annually Studies have shown that carbon policies will have little effect on reducing building energy demand. Indian building sector will grow over five times by the end of this century, driven by rapid income and population growth. The growing energy demand in buildings is accompanied by a transition from traditional biomass to commercial

fuels, particularly an increase in electricity use. This also leads to a rapid increase in carbon emissions and aggravates power shortages in India.[4] [13]

The solution lies in combination of various emerging technologies to create best possible outcome. With prevailing and proven green building construction and application parameters combination with IOT to link all electrical usage to lead to a figure of minimum annual electrical dependency can solve a huge future energy problem.

The U.S. Green Building Council (USGBC) estimates that a green building, on average, can reduce energy use in buildings by 25-30% over the national average, with IOT the percentage can be further increased manifold.

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