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Reduction of Energy Consumption in Buildings

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Abstract- In today's world global warming is a very big issue and the entire world is having problem with it. Greenhouse gases that are emitted from buildings and vehicles are a major cause of global warming that is the major threat of 21st century. So to deal with it we need to implement some methods to reduce the global warming in order to save this world from this big giant. So to do that we are implementing a green building in which we will cover some techniques to save energy as well as reduce global warming as energy consumption is less so heat energy is reduced. This paper also describes about home automation system that is being implemented in all parts of the world as it makes the things easier and save a lot of time that you can utilize on other activities while the work is done by the automation system. It also discusses about the energy saving that can be done by the automation system and implementation of green buildings. About 40% of power is consumed by the business sectors that we can save from implementing green buildings. In this paper we will describe a green building model which can be implemented in a cost efficient manner also how to reduce the power consumption in that building by converting it into green building by implementing various methods that includes solar energy, automation etc.

Keywords- Home automation, intelligent building, green building, solar power, energy analysis

I. Introduction

In nowadays we know that with the speed this world is growing the more is the need of energy is there. For this it is extremely necessary to conserve our electricity in order to use it efficiently and so that there should not be any shortage to electricity. According to the different survey reports we found that 22% Residential, 19% Commercial, 31% Industrial and 28 % Transportation sectors consume electricity throughout the world. So if we see closely then we see that approximately 40% electricity is being consumed by the buildings. So it is very important that we do something to reduce the consumption of electricity by reducing the wastage of electricity and cutting the use of electricity in order to save electricity.

If we take a look on the energy generation from the various methods of production then we can see that thermal sector provides us 68% of total energy whereas Hydro accounts for 15%, Nuclear for 12%, Wind for 2% and rest others are also 2%. So we see that thermal industry is the highest electricity producing sector of the world. Now if we try to reduce the energy production done by thermal then it is not possible for the other sectors to compete with the production of electricity as there is a not proper condition to do electricity generation by other sectors and also the cost of production from other sectors and quite high. So in order to reduce the production from thermal industry we need to reduce the power usage of buildings by cutting the unnecessary use of power and make equipments more efficient.

In developed countries the energy consumption growth rate is only marginally higher compared to the population growth rate. In USA, energy consumption is projected to grow at 1.3% while the population growth rate is projected to grow at 0.8%.

In developing countries like India population growth rate is expected is expected to grow at 10%. This trend is straining the Indian energy sector to a large extent challenging the to grow at 1.3% while the energy consumption rate energy planners for further fresh investments in power sector in addition to program for energy efficiency change.

As buildings are key to Asia's future, building heating and cooling are the most energy-intensive activities, followed by electricity use for lighting and appliances (Harvey, 2009). India being in a temperate climate, demand for cooling is more intensive than heating. Greenhouse gas emissions from buildings energy use significantly exceed those from transportation. It was predicted by International Panel on Climate Change (IPCC) that CO2emissions from buildings (including through the use of electricity) could increase from 8.6 billion tones in 2004 to 15.6 in 2030 under a high growth scenario. Energy consumption at lower costs (passive methods) in buildings will offer greater potential to meet CO2reduction targets than any other sectors. Energy used for heating and cooling can be reduced through ventilation, heat sinks, the use of

solar panel and improved insulation. Electricity consumption can also be reduced through use of CFL & LED lighting or increased use of natural lighting and the use of energy-efficient appliances. Improved efficiency in the building sector and de-carbonizing the power sector could offer significant potential emissions reduction.

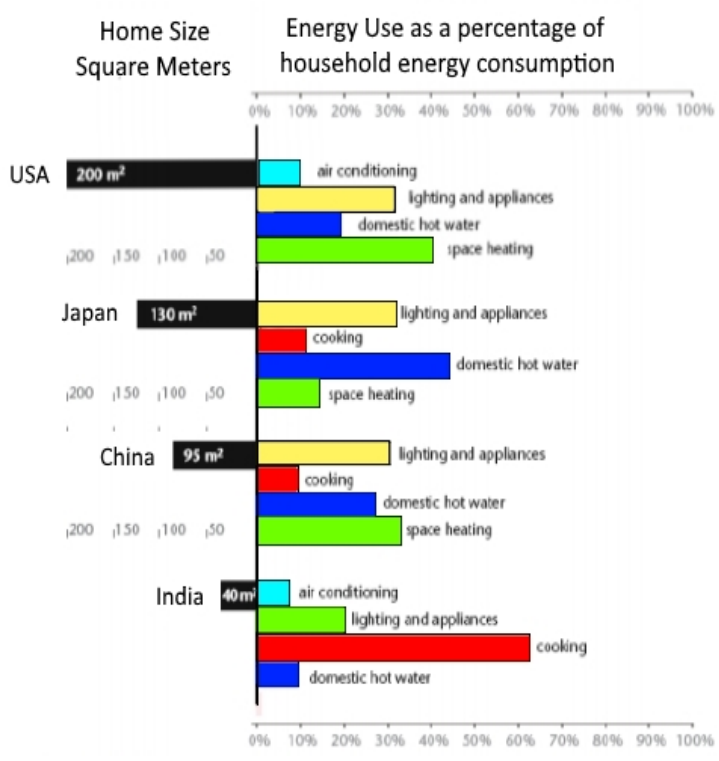

Figure 1: Household Energy Consumption Chart

II. Home Automation

Home automation systems face four main challenges; these are high cost of ownership, inflexibility, poor manageability, and difficulty in achieving security. The main objectives of this research is to design and implement a home automation system using IoT that is capable of controlling and automating most of the house appliances through an easy manageable web interface. The proposed system has a great flexibility by using Wi-Fi technology to interconnect its distributed sensors to home automation server. This will decrease the deployment cost and will increase the ability of upgrading, and system reconfiguration.

The proposed system is a distributed home automation system, consists of server, sensors. Server controls and monitors the various sensors, and can be easily configured to handle more hardware interface module (sensors). The Intel Galileo development board, with built in WiFi card port to which the card is inserted, acts as web server. Automation System can be accessed from the web browser of any local PC in the same LAN using server IP, or remotely from any PC or mobile handheld device connected to the internet with appropriate web browser through server real IP (internet IP). WiFi technology is selected to be the network infrastructure that connects server and the sensors. WiFi is chosen to improve system security (by using secure WiFi connection), and to increase system mobility and scalability.

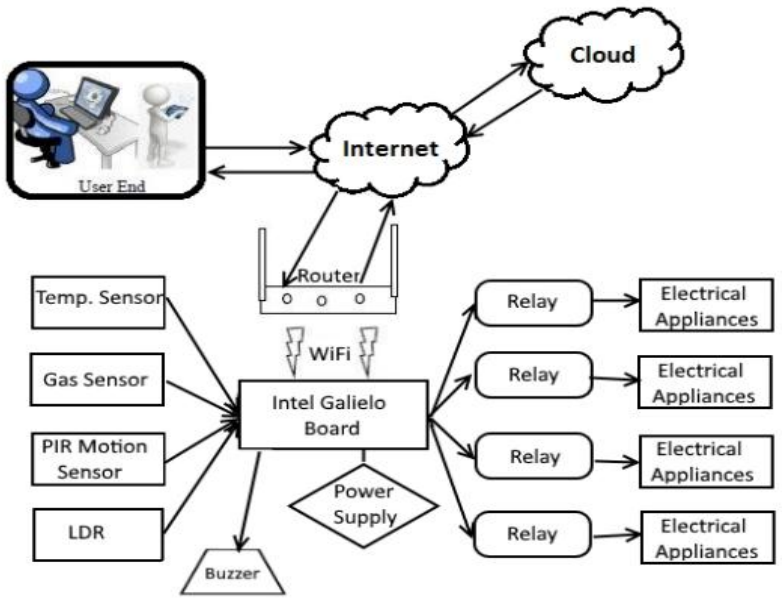

Figure 2: Proposed model of Home automation system

The proposed model of the home automation system is as shown in the figure 2. The model consist of different sensors like temperature, gas, motion and LDR. Initially the Intel Galileo connects to the internet through WiFi. When the connection is established it will start reading the parameters of sensors like p1, p2, p3 etc. The threshold levels for the required sensors are set as t1, t2, t3 etc. The sensor data are sent to the web server and stored in the cloud. The data can be analyzed anywhere any time. If the sensor parameters are greater than the threshold level then the respective alarm a1, a2, a3 etc. will be raised and the required actuation is done for the controlling of the parameters. In the proposed model the temperature, gas leakage, motion in the house is monitored. The temperature and the motion detection is stored in cloud for analysis. If the temperature exceeds the threshold level then the cooler will turn on automatically and it will off when the temperature comes to control. Similarly when there is a leakage of gas in the house alarm is raised giving the alert sound. The required lights are turned on/off automatically by detecting the light outside the house. The user can also monitor the electric appliances through the internet via web server. If the lights or any electrical appliances are left on in hurry can be seen and turned off remotely through simply typing the IP address of the web server.

Proposed Home Automation System Functions:

The proposed home automation system has the capabilities to control the following components in users home and monitor the following alarms:

- Temperature and humidity
- Motion detection
- Fire and smoke detection
- Light level

The proposed home automation system can control the following appliance:

- Lights on/off/dim
- Fan on/off
- On/off different appliance

III. Home Network Remote-Controlling Benefits

Remote control saves times, at the same time providing increased security & flexibility. As an example, if a message comes to a user that an intrusion was happened in his house, he can connect to the internet and watch the video cameras to see what had happened or can happen, other examples are possibility to turn various appliances on before entering the house to save time using mobile or PDA. Due to the good scalability, independence of location and high flexibility due to different existing protocols make remote controlling most suitable for the present day scenario.

Remote control saves time; it also provides increased security and flexibility. For example, if the user receives a SMS saying that there was an intrusion, he/she can connect to the internet and watch the video cameras inside the house to see what happens, another example could be the possibility to turn on the heaters from the distance using a mobile, laptop or PDA so as soon as the user reaches the house it will be hot already, this could be really useful especially in cold countries. Many computers and mobile devices also already have instant messaging clients installed (Aurell, 2005). Good scalability properties, independence of location or geographical distance, and high flexibility due to the different existing protocols make remote-controlling HASs suitable for most user needs.

Home network remote-controlling issues:

- Interoperability
- Scalability
- Security
- Limited services
- Usability
- Existence of multiple standards

Advantages of Home automation systems:

Nowadays with the Wi-Fi being common for home networking it can give us several advantages that cannot be achieved with a wired network. Firstly, it reduces cost because no wires are needed. Secondly, it is advantageous when we need to extend our network as and when required. Thirdly, we can integrate the mobile devices such as PDAs, smart phones with the automation system so that we can control our system from everywhere, as our system will be in reach to the system. Lastly, it is also essential for those buildings where laying of wires are not possible like buildings with glass architecture, historical buildings etc. So for all these reasons wireless technology is crucial for making a good automation system nowadays.

In recent years, wireless systems like Wi-Fi have become more and more common in home networking. Also in home and building automation systems, the use of wireless technologies gives several advantages that could not be achieved using a wired network only. 1)

Reduced installation costs: First and foremost, installation costs are significantly reduced since no cabling is necessary. Wired solutions require cabling, where material as well as the professional laying of cables (e.g. into walls) is expensive. 2) System scalability and easy extension: Deploying a wireless network is especially advantageous when, due to new or changed requirements, extension of the network is necessary. In contrast to wired installations, in which cabling extension is tedious. This makes wireless installations a seminal investment. 3) Aesthetical benefits: Apart from covering a larger area, this attribute helps to full aesthetical requirements as well. Examples include representative buildings with all-glass architecture and historical buildings where design or conservatory reasons do not allow lying of cables. 4) Integration of mobile devices: With wireless networks, associating mobile devices such as PDAs and Smart phones with the automation system becomes possible everywhere and at any time, as a device's exact physical location is no longer crucial for a connection (as long as the device is in reach of the network). For all these reasons, wireless technology is not only an attractive choice in renovation and refurbishment, but also for new installations.

IV. Advancement in Building Technology

Building energy by sources:

Electricity and natural gas are the main energy commodities used in OECD countries, (diesel is also used in developing counties like India and China) accounting for over 70% of total energy demand in 2005, while renewable (mostly traditional biomass) and coal contributed much higher shares of energy consumption in China, India and South Africa than developed countries (Figure 4), but the share is decreasing due to inefficient traditional biomass use. Development and urbanization are associated with increased electricity use, which significantly increased energy demand in China and India during the past years [6]. More efficient renewable energy resources are sought to meet the increased energy demsand. It is accounted worldwide, taking into account its entire lifespan; buildings are responsible in each country for: 25 -40% of the total energy use, 30 -40% of solid waste generation, 30 -40% of Global Green House Gas Emissions (CO2, N20, CH4, HFC, PFC, SF6).

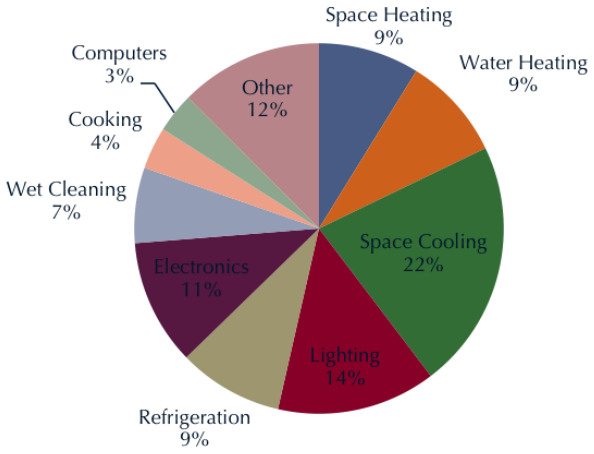

Figure 3: Energy Chart

Contributions by intelligent and green buildings to GHG reductions:

High performance buildings reduce the overall demand for energy, helping to limit the need for new power plants. As many new plants still burn coal, this reduction also helps limit associated emissions.

Intelligent buildings make several contributions to reducing GHG emissions (table 1.). More than 40% CO2 emissions in developed countries come from eating, cooling and powering buildings. It was estimated that cutting UK building emissions by 25%

would have a similar impact to take every car off the road in the UK. For existing buildings, good insulation, efficient boiler, window glazing and recovering heat from ventilation systems are efficient ways to reduce emissions

Key benefits of intelligent buildings:

An intelligent building is one that uses both technology and processes to create a facility that is safer and more productive for its occupants and more operationally efficient for its owners. It exhibits key attributes of environmental sustainability to benefit present and future generations. Each building is unique in its mission and operational objectives, and therefore, must balance short and long term needs. A building is typically termed intelligent when the building's subsystems provide the occupants with productive and comfortable conditions by responding to their requirements and enhancing the workplace environment.

Background of Energy Efficiency in India:

There is an urgent need to improve the energy efficiency of the Indian economy. About 70% of the infrastructure in 2030, such as buildings, will be added in next two decades—between 2012 and 2032. The projections for energy demand in 2032imply a fourfold increase in requirements. Such a dramatic increase of energy supply will be difficult to manage because of resource constraints..In 2001, the Government of India (GoI) passed the Energy Conservation Act (ECAct, 2001) and the following year established the Bureau of Energy Efficiency (BEE) under its provisions. One of the first initiatives of BEE was to prepare an Energy Conservation Action Plan, which was released in August 2002. In June 2008, India released the first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate change mitigation and adaptation. The plan identifies eight cores 'national missions' including a National Mission for Enhanced Energy Efficiency (NMEEE).

Energy efficiency in building is an accumulation of energy efficiencies of appliances used like ACs, lighting, chillers, AHUs, Fans and various other systems. BEE as an national agency has been introducing and monitoring efficiencies of buildings and appliances in India. Figure 5showsthe annual energy-saving potential for about 25 products estimated in a recent study**.** One can see that infinite amount of resources are available, a good strategy would be to focus on the top 7–10 appliances and capture most of the energy savings.

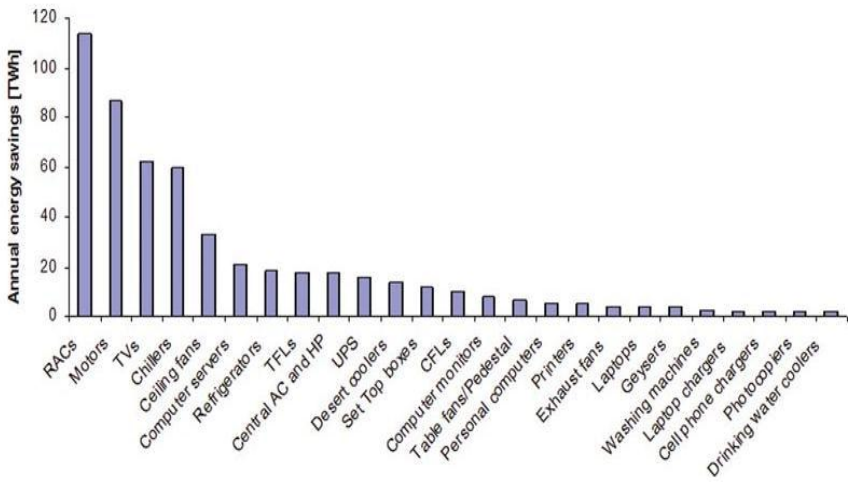

Figure 4: Annual saving potential of top 25 products.

Integrated design Process:

The integration design of buildings requires the integration of many kinds of information into an elegant, useful, and durable whole. An integrated design process includes the active and continuing participation of users and community members, code officials, building technologists, contractors, cost consultants, civil engineers, mechanical and electrical engineers, structural engineers, specifications specialists, and consultants from many specialized fields. The best buildings result from continual, organized collaboration among all players.

Building design for green buildings involves many professionals across different areas. Many factors need to be taken into account, including climate, building share, comfort levels, material and systems, and health. Figure 7.illustrates the interrelationships among these four main influences on energy efficiency and the key energy consumers. It shows that energy use are affected by many factors, for example, four factors including design, building envelope, equipment and infrastructure all have impacts on the energy needs for heating, ventilation and air conditioning (HVAC).

Building energy performance depends not only on the performance of an individual technology but also on how these perform as an integrated system. The building envelope is the starting point of energy efficient buildings, interacting with HAVC system and lighting, while design will bring together all elements influences energy efficiency.

An integrated design process involves all relevant participants from the start. Integration of both passive and active measures is crucial to effective building design and construction. Figure7. indicates that integrated design approaches will achieve the best performance in terms of energy saving.

Integrated design approaches could reduce energy use by as much as 72%. But projects could be more expensive than individual solutions and thus require financial support and incentives from government regulation to reinforce this holistic approach. Integrating building with programmed and computerized networks (fig 8) of electronic devices for control and monitoring of systems such as HVAC, lighting, security, fire and life safety, and elevators (Known as building automation systems (BAS) and building energy management system (BEMS)) 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 improved occupant comfort, optimum energy consumption, and cost-effective building operation.

Energy Efficient built -Green Building concept:

Innovations in technology and production processes have resulted in significant changes in building industry. The future of buildings depends not only on innovation by homebuilders, but also on promotion by planners. Growth of green buildings in India Planners are interested in promoting innovative practices[14]that conserve the environment, improve quality and reduce costs. The direct emissions from energy use in buildings are only part of total footprints; moreover, structural green building planning can contribute to the sustainability development in terms of building location and public transportation (Harvey, 2009)

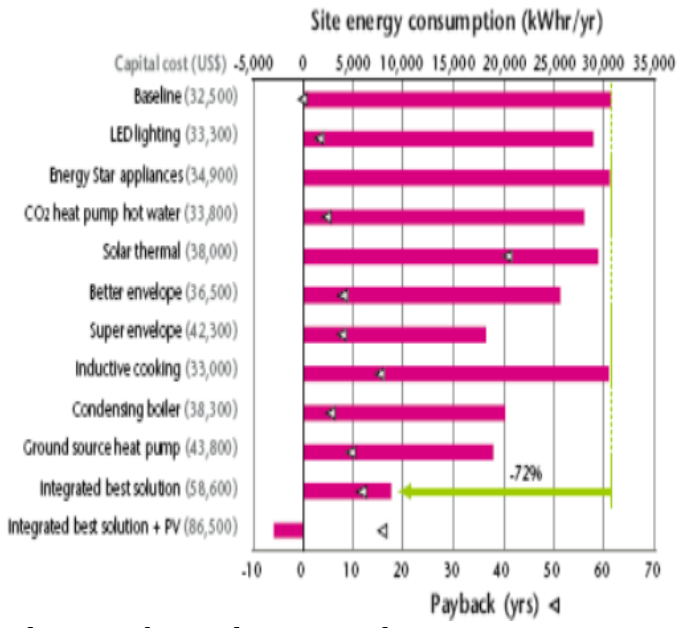

Figure 5. Integrated building design as best solution to reduce energy consumption (Source: WBSCD, 2009).

Green Building (GB) is synonymous with 'high performance buildings', 'sustainable design and construction' as well as other terms that refer to a holistic approach to design and construction. Green Building design strives to balance environmental responsibility, resource efficiency, occupant comfort, well being and community sensitivity. The Green Building design includes all players in an integrated development process, from the design team (building owners, architects, engineers and consultants), the construction team (material manufacturers, contractors and waste haulers), maintenance staff and building occupants. The green building process results in a high quality product that maximizes the owner's returns on investment by sustained savings of energy by 40 -50 %, Water savings: 20-30 % and a good reduction in initial investment.

A Green Building is one, which incorporates several Green features. The appearance of a Green Building will be similar to any other building. However, the difference is in the approach, which revolves round a concern for extending the life span of natural resources; provide human comfort, safety and productivity. This approach results in reduction in operating costs like energy and water, besides several intangible benefits.

The Green building movement has gained tremendous momentum during the past 3-4 years, since the CII-Godrej GBC embarked on achieving the prestigious LEED rating for its own centre at Hyderabad. The Platinum rating awarded for this building sparked off considerable enthusiasm in the country. Today a variety of green building projects are coming up in the country residential complexes, exhibition centers, hospitals, educational institutions, laboratories, IT parks, airports, government buildings and corporate offices. But recent statistics lists about 315 green buildings operational not only in four metros of India but also in fastest growing cities like Bengaluru and Hyderabad.

Looking at the merits GB offering, there is going to be a lot more growth for GB to come up in the years to come.

V. Bright Green Building

Another concept in the area of energy efficient and environment friendly building is the emergence of Bright Green Building(BGB). Bright green building is one that is both intelligent and green. It is a building that uses both technology and process to create a facility that is safe, healthy and comfortable, and enables productivity and well being for its occupants. It provides 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. A bright green building is designed, constructed, and operated with minimum impact on the environment, with emphasis on conserving resources, using energy efficiently and creating healthy occupied environments. Sustainability is measured in three interdependent dimensions: environmental stewardship, economic prosperity and social responsibility. Bright green buildings exhibit key attributes of environmental sustainability to benefit present and future generations.

In bright green buildings, fully networked systems transcend the simple integration of independent systems to achieve interaction across all systems, allowing them to work collectively, optimizing building's performance, and constantly creating an environment that is conducive to the occupants. Bright green buildings provide a dynamic environment that responds to occupants 'changing needs and lifestyles. As technology advances, and as information and communication expectations become more sophisticated, networking solutions both converge and automate divergent technologies to improve responsiveness, efficiency, and performance. To achieve this, bright green buildings converge data, voice, and video with security, HVAC, lighting, and other electronic controls on a single network platform that facilitates user management, space utilization, energy conservation, comfort, and systems improvement.

As a pilot project in association with Czechoslovakia in India, concept of BGB was taken up. In January 2011, City of Delhi announced a pilot project to install cool roofs on some government buildings in Delhi with high profile sites like the Delhi Secretariat as well as all government schools and some hospitals. Initiative has been taken up with the collaboration with Czechoslovakia; few buildings are being built with cool roof technology. Number of different cool roof materials is used, including elastomeric coatings, lime coatings and tiles. Visibility of these demonstration projects to the public has helped to raise awareness of the energy saving and thermal comfort benefits of cool roofs.

Green	Intelligent	Bright Green
Air & Energy Reduce GHG Emissions Improve IAQ Improve Energy Efficiency Waste to Energy **Water** Reduce wastewater discharge Lower contamination release **Waste & Remediation** Reuse and recycle products More brown fields instead of green fields green architecture	**Converged Networks** Data collection Measurement & verification Diagnosis, sensors, control, monitoring remote monitoring etc. **Integrated control** HVAC, lightening, energy, AV, security, fire & life safety, etc. **Infrastructure** Structured cabling solution, wireless system, unified communication system **Water Management** Monitoring and metering	Energy Management Asset Management Space Utilization Integrated Design process Sustainability-easier to maintain and built to last Renewable Energy Healthy and comfortable environment (IEQ) "Green" loans Higher resale or lease rates

VI. Conclusion

In this paper an attempt is made to reduce the energy consumption in building. Home automation, intelligent building and bright green building technology is discussed with their application and advantages. Major electricity generation is done with the help of thermal and nuclear power plants but they contribute very much to increase pollution. Reduction in energy consumption and self powering building design will help to reduce the demand of electricity and hence pollution will also decrease.

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