

# Electrical Energy Management – Building

P. Rathna, A. Ravi kumar

**Abstract:** Late examinations have featured that a noteworthy piece of the electrical vitality utilization in private and business structures is because of an inappropriate utilization of the electrical machines. In this specific situation, a robotized control the board framework - equipped for decreasing vitality squanders while safeguarding the apparent solace level - would be amazingly engaging. To this point, we propose Green Building, a sensor-based savvy framework that screens the vitality utilization and naturally controls the conduct of machines utilized in a building. Green Building has been executed as a model and has been tested in a genuine family situation. The examination of the exploratory outcomes features that Green Building can give noteworthy vitality investment funds.

**Index Terms:** Energy, Green building, Energy savings, Households, Appliances.

## I. INTRODUCTION

Private and business structures represent roughly 20% of the general overall vitality utilization, with an expanding pattern after some time. The real reasons for vitality utilization in structures are space warming and moulding, water warming, lighting, and the utilization of PCs and other electronic gadgets. A huge piece of this vitality utilization is because of an inappropriate utilization of such machines and gadgets. Simply dispensing with vitality squanders, without bringing down the dimension of apparent solace, would lessen the general vitality utilization in structures by around 30%. One of the primary wellsprings of vitality squander is spoken to by electrical machines in backup mode which represents roughly 10% of the general vitality utilization in structures.

As indicated by various investigations, giving proper inputs to building inhabitants can altogether diminish the general vitality utilization, in the request of 5-20%. To be sure, an ongoing trial examine has appeared over 30% vitality sparing was accomplished following introducing an observing framework in a private family units; however the rate decreased to under 4% one month later. A robotized vitality, the executives of framework notwithstanding client collaboration would be absolutely a progressively successful arrangement. In this paper we propose Green Building, a framework for observing and controlling the power utilization of every machine in a building. Green Building abuses a system of remote sensors and actuators to accomplish two

fundamental objectives:

- (i) Make the client mindful of financial (and ecological) costs brought about by an ill-advised utilization of electric machines;
- (ii) Provide computerized answers for vitality proficiency through fitting administration of machines.

We actualized Green Building as a model and sent it in a genuine family unit situation. The examination of the outcomes acquired in the experimentation affirms that a lot of vitality is squandered because of inappropriate utilization of machines. We demonstrate that the vitality waste can be wiped out (or definitely diminished) by utilizing a basic vitality protection rule for every particular machine, or class of apparatuses.

## II. RELATED WORK

Remote sensor systems (WSNs) have been generally utilized in the past for natural observing applications. As of late, they have likewise been considered for ongoing and fine-grained observing of power utilization in structures. The creator portrays the structure and usage of AC me, a disseminated observing framework - in light of a system of AC control meters - that enables clients to see their individual vitality utilizations through a web interface. A similar AC control meters are additionally utilized in where, a point by point trial examine on vitality utilizations in software engineering office is portrayed. The goal of the examination is to accomplish full and nutty gritty deceivability of vitality utilization, i.e., to see how, where, and for whom power is utilized. Since utilizing a committed power meter for every electrical machine is strange and costly, the creators consider a few ways to deal with surmise the vitality utilization of single apparatuses from accumulated estimations. A similar goal is additionally focused on. In particular, proposes two calculations for disaggregating the circuit-level information into gadget level assessments, while presents a framework that can give a fine-grained acknowledgment of single machines continuously through a solitary power sensor appended to the primary electrical unit. Checking vitality utilizations in structures is likewise the objective of, where the creators dissect the vitality devoured in different structures in grounds, and in different floors inside a similar building. All the past papers for the most part centre on vitality checking, while our work additionally addresses the issue of vitality protection through on-line control the executives of electrical machines. A computerized sensor-based power-the board framework like our own is proposed. Here, be that as it may, the accentuation is for the most part on engineering and configuration issues, as opposed to on a trial investigation. Despite what might be expected, we actualized our proposed framework and sent it in a genuine family situation in order to play out a precise test examine.

**Revised Manuscript Received on 30 May 2019.**

\* Correspondence Author

**Mrs. P. Rathna\***, Department of Management Studies, Bharath Institute of Higher Education and Research (BIHER), Chennai-600073

**Dr. A. Ravikumar**, Department of Tourism and Hospitality Management, Bharath Institute of Higher Education and Research (BIHER), Chennai-600073

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](https://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>

A computerized framework for upgrading the vitality utilization of the warming, ventilation and cooling (HVAC) framework in homes is introduced. The proposed arrangement depends on inhabitancy sensors and switches off the HVAC framework when tenants are resting or far from home. In contrast to the proposition, Green Building adopts a general strategy, i.e., it isn't custom fitted to a particular class of electrical machines. Likewise proposes a circulated remote control framework for building vitality proficiency. The accentuation there, in any case, is on productive courses for sharing data between gadgets.

### III. OBJECTIVES

- Clarify the degree and execution prerequisites of vitality frameworks in structures.
- Characterize the central laws that oversee vitality streams in structures.
- Apply these central laws to the warm structure and examination of structures.
- Plan a working so as to limit vitality use power and amplify comfort.
- Perform building vitality, day lighting, and common ventilation re-enactments just as clarify and comprehend their outcomes.

### IV. FRAMEWORK ARCHITECTURE AND DESIGN

Vitality presents one of the best difficulties to a future manageable constructed condition. The individual structures that involve our consistently extending urban scene hold the possibility to contribute noteworthy proficiency investment funds to a general blend of methodologies vital for a feasible future. This class will address the requirements of an assortment of building types and the frameworks that disperse vitality based assets to their tenants.

The course material will be shown utilizing a week after week arrangement of addresses, recitations, and assignments. Two addresses for every week present key ideas and illustrative contextual analyses. One recitation for each week further investigates data from the addresses through hands-on exercises and programming instructional exercises. Assignments will be founded on the information picked up in the addresses and recitations. Understudy gatherings will apply the assignments to theoretical space structure, a picked studio venture, or a semester-long plan venture.

There will be no formal tests in this course. You will be evaluated on your capacity to use and clarify the course ideas through your work on the progressing class venture. Recitations won't be formally reviewed, however will tally towards the support segment of an understudy's evaluation and are important to finish the homework assignments.

The general framework engineering is made out of two subsystems, to be specific the observing and the control subsystems. The previous gets at prefixed time interims proportions of the vitality utilization of the dissected electrical apparatuses and some ecological and setting data (e.g., temperature, light force, nearness of people). The last adventures the information gathered by the checking framework and some vitality protection system to control the conduct of each single apparatus. In the accompanying, we

will examine the two subsystems in detail.

#### A. Observing Subsystem

The observing subsystem utilizes various power and natural sensors for, separately, estimating the power utilization of each single electrical apparatus in the building, and checking parameters, for example, temperature, light force and human nearness. Information gathered by the two sorts of sensors are remotely imparted to a base station situated in a similar floor (there is somewhere around one base station for every floor) and, at that point, passed on to a focal server. The correspondence between base stations and the server regularly happens through a wired LAN. The server forms the information and furnishes clients with continuous or potentially intermittent reports on vitality utilization and expenses. It additionally sends ready messages to tell explicit occasions (for example a gadget dynamic when it should be dormant) proposing conceivable activities to spare vitality.

#### B. Control Subsystem

The control subsystem deals with the conduct of each single electrical apparatus, as indicated by vitality preservation rules determined by the client, in order to limit power for each single controlled electrical machine and a lot of controllers that arrange the actuators. Controllers are associated with a focal server, through a wired LAN innovation (i.e., Ethernet). The server creates directions machine in the building: directions are sent to the relating actuator through the fitting controller. As a matter of fact, the detecting and incitation functionalities could be coordinated in a similar gadget, i.e., the power sensor could likewise go about as actuator for the related apparatus. Then again, a few coordinated remote sensor/actuator stages are as of now presently accessible available, e.g., Plogg and WiSensis. Receiving a power sensor for every apparatus is costly and regularly a bit much: a solitary sensor can be adequate to screen a gathering of gadgets and take choices on the conduct of the single gadget. Clearly, so as to control every gadget self-sufficiently, we need an actuator for every gadget. In the event that we receive incorporated remote sensor/actuator stages, we are obliged to embrace sensors for every apparatus. As an option, we could utilize two distinct foundations, one for checking and the other for control. For instance, X10 items can be utilized for control. The fundamental preferred standpoint of this methodology is that the X10 innovation is dependable and shabby. A X10 controller sends directions to X10 actuators controlling electrical machines through Power-Line Communication (PLC).

#### Vitality Conservation Strategies

The framework engineering has been structured with the point of permitting an adaptable and productive administration of each single machine in order to give the possibilities to actualizing suitable vitality preservation techniques for every apparatus (or class of machines). In the accompanying we give a (non thorough) rundown of such methodologies.

#### C. Vitality Conservation Strategies

On the off chance that clients know about the vitality utilization of each single machine,



they can utilize electrical vitality in a progressively effective and advantageous way. To this point, Green Building gives the clients nutty gritty and continuous data on the quick vitality utilization and status (i.e., on/reserve/off) of single apparatuses, even remotely. Further, it can likewise send occasional reports (e.g., by email) on the utilization of electrical vitality. At last, Green Building can alarm the clients by making an impression on a compact gadget when some particular occasions happen (e.g., a machine is dynamic when it should be idle), additionally recommending conceivable activities to spare vitality.

#### D. Decrease of remain by Consumptions

For every particular machine, Green Building enables the client to indicate a proper administration technique to diminish (or additionally dispense with) backup squanders. In reality, Green Building can perceive when an apparatus is in reserve mode and take proper activities to execute the methodology characterized by the client. For instance, the framework can turn off a specific squanders in the building. The subsystem utilizes one actuator apparatus after a predefined time interim has slipped by from when it entered the backup mode.

#### E. Planning of Flexible Tasks

The expense of electrical vitality fluctuates amid the day and normally is less expensive amid the night. Along these lines, some vitality devouring undertakings that don't require a client inclusion can be booked for execution when the vitality cost is lower. Green Building enables the client to determine the specific time or time interim (e.g., the space time when the vitality costs are lower) when a specific errand is to be executed by a particular apparatus (e.g., the clothes washer). The cooperative energy between the systems for suitable planning of adaptable assignments and decrease of reserve utilization can really limit the vitality utilization of electrical apparatuses. For instance, the clothes washer can be exchanged on by the framework just at the pre-modified time. When the assignment has been finished the apparatus enters the reserve mode. This is recognized by the framework and the clothes washer is then turned off.

#### F. Versatile Control of Electrical Appliances

A noteworthy division of vitality is squandered because of electrical machines that are superfluously dynamic, e.g., lights exchanged on when the outer light power is high, cooling framework giving a too low encompassing temperature, etc. To take out this sort of squanders, Green Building depends on natural sensors fit for observing encompassing conditions (e.g., temperature, light force, mugginess, nearness of people, and so on.). Information procured by ecological sensors are passed on to the focal server, through base stations situated at each floor, and utilized by the framework to adjust the conduct of each single machine, in view of standards indicated by the client (e.g., wanted light power).

#### G. Talk

The framework design depicted above has various fascinating properties. Above all else, it is particular and versatile, along these lines making it appropriate additionally for huge structures. Second, the framework establishment is

non-intrusive, because of the utilization of remote sensors (and PLC gadgets, if present, that depends on the previous electrical system). At last, the extra vitality devoured by the framework is insignificant as for the general vitality utilization of the building. In vast structures the focal server could be executed by a PC or PC, whose control utilizations are generally 30W and 100W, Respectively. In little houses the server could be executed through a low-control gadget, e.g., the home switch associating with the Internet, whose control utilization is regularly under 10W (in addition, the home switch is ordinarily dynamic more often than not for Internet network). The power utilizations of electrical sensors/actuators rely upon the particular stage. For the WiSensis stage utilized in our tried, the power utilization is around 2.5W for base stations (there is just a single base station for each floor) and 0.2-0.4W for sensors/actuators. Rather, the power utilization of natural sensors is in the request of W. At long last, if a devote control framework is utilized we have to consider additionally the power utilization of the X10 controller (2.5W overall; one X10 controller for every building is adequate), and actuators (about 0.2W).

#### H. Model Implementation

Structures, as they are planned and utilized today, add to genuine ecological issues on account of extreme utilization of vitality and other common assets. The nearby association between vitality use in structures and ecological harm emerges in light of the fact that vitality concentrated arrangements tried to develop a building and satisfy its needs to warm, cooling, ventilation and lighting cause serious consumption of priceless natural assets. Be that as it may, structures can be intended to address tenant's issue for warm and visual solace at diminished dimensions vitality and assets utilization. Vitality asset effectiveness in new developments can be affected by receiving a coordinated way to deal with building structure. The essential strides in this methodology would be to: Incorporate sun oriented inactive strategies in a building configuration to limit load on ordinary frameworks (warming, cooling, ventilation and lighting)

Passive frameworks give warm and visual solace by utilizing characteristic vitality sources and sinks for example sunlight based radiation, outside air, sky, wet surfaces, vegetation, inward gains and so forth. Vitality streams in these frameworks are by regular methods, for example, by radiation, conduction, convection with negligible or no utilization of mechanical methods. The sun powered aloof frameworks in this way, fluctuate from one atmosphere to the next for example in a cool atmosphere a planners' point would be structure a working so that sunlight based increases are expanded, yet in a hot atmosphere his essential point is diminish sun based additions, amplify common ventilation, etc. Structure vitality productive lighting and HVAC frameworks (warming, ventilation and cooling) Once the inactive sun oriented compositional ideas are connected to a plan, the heap on regular frameworks (HVAC and lighting) is decreased.

## Electrical Energy Management – Building

Further, vitality preservation is conceivable by wise plan of the fake lighting and HVAC framework utilizing vitality productive supplies, controls and task techniques. Utilize sustainable power source frameworks (sun oriented photovoltaic frameworks/sun based water warming frameworks) to meet a piece of building load. The weight on the world's non-inexhaustible assets can be reduced by prudent utilization of earth's sustainable assets for example sunlight based vitality. Utilize sunlight based vitality for addressing electrical requirements for a building can additionally diminish utilization of regular types of vitality. Utilize low vitality materials and strategies for development and diminish transportation vitality. A designer additionally should go for productive auxiliary plan, decrease of utilization of high vitality building material (glass, steel and so on.) and transportation vitality and utilization of low vitality structures materials. In this way to something up, a vitality proficient building adjusts all parts of vitality use in a building: lighting, space-moulding and ventilation, by giving an upgraded blend of uninvolved sun oriented structure techniques, vitality productive types of gear and inexhaustible wellsprings of vitality. Utilization of materials with low typified vitality additionally structures a noteworthy segment in vitality effective building plan. The book covers 44 contextual investigations on vitality and asset productive structural tasks in India". Each undertaking features the vitality effectiveness measures, for example aloof sunlight based mediations, vitality productive frameworks, structures materials with low exemplified vitality, embraced by a few draftsmen in their particular ventures. The undertakings have been ordered atmosphere shrewd. The warm execution of a chose number of structures has likewise been exhibited. The gradual expenses for fuse of vitality productivity measures to structures have been featured wherever such information was accessible. This section quickly expounds the aloof structural strategies that have been received by the engineers and draws models from tasks which have been shrouded in the book. Draftsmen can accomplish vitality proficiency in the structures they configuration by concentrate the full scale and smaller scale atmosphere of the site, applying bioclimatic compositional standards to battle the unfriendly conditions, and exploiting the attractive conditions. Some normal structure components that specifically or in a roundabout way influences warm solace conditions and along these lines the vitality utilization in a building are (a) finishing, (b) proportion of fabricated structure to open spaces, (c) area of water bodies, (d) introduction, (e) stage, and (f) building envelope and fenestration. Notwithstanding, in extraordinary climatic conditions, one can't accomplish agreeable indoor conditions by these plan contemplations as it were. There are sure tried and set up ideas which, whenever connected to a plan in such climatic conditions, can to a great extent fulfill the warm solace criteria.

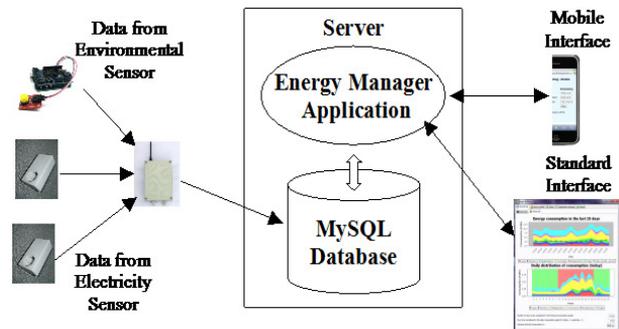


Figure: Software Architecture

These are delegated propelled aloof sun powered procedures. The two general classes of cutting edge ideas are,

1. Uninvolved warming ideas (direct addition framework, circuitous increase framework, sunspaces, and so on.) and
2. Inactive cooling ideas (evaporative cooling, ventilation, wind tower, earth-air burrow, and so forth.).

Inactive sun oriented warming frameworks can be comprehensively named:

1. Direct addition frameworks
2. Circuitous addition frameworks

### Direct Addition Frameworks:

Direct addition is the most widely recognized aloof nearby planetary group. In this framework, daylight goes into rooms through windows, warming the inside space. The coating framework is commonly situated on the southern side to get most extreme daylight amid winter (in the northern half of the globe). The coating framework is generally twofold coated, with protecting draperies to diminish heat misfortune amid night. South-bound glass concedes sun oriented vitality into the building, where it strikes warm capacity materials, for example, floors or dividers made of adobe, block, solid, stone, or water. The immediate increase framework utilizes 60-75% of the sun's vitality striking the windows. The inside warm mass tempers the power of warmth amid the day by retaining heat. During the evening, the warm mass emanates heat into the living space, in this way warming the spaces. Direct addition can be accomplished by different types of openings, for example, clerestories, bay window windows, and so forth intended for the required warming. Direct increase frameworks have been utilized for day-use rooms by draftsman Sanjay Prakash in the living arrangement for Mohini Mullick at Bhowali.

The client is amazingly happy with the warm execution of the immediate increase framework in the building. Direct increase frameworks have a few confinements. They cause extensive temperature reserve funds (normally 10 °C) in view of vast varieties in contribution of sun powered vitality. Solid daylight, glare, and bright debasement of the house material are a few disservices of direct addition frameworks. Nonetheless, being generally easy to develop and modest, they are by a long shot the most well-known frameworks utilized around the world.

### CIRCUITOUS GAIN SYSTEM:

In a circuitous addition framework, warm mass is situated between the sun and the living space.

The warm mass assimilates the daylight that strikes it and exchanges it to the living space. The roundabout addition framework utilizes 30-45% of the sun's vitality striking the glass abutting the warm mass.

**DETACHED DOWNDRAUGHT COOLING:**

It is an evaporative cooling that has been utilized for a long time. In this framework, wind catchers direct outside air over water-filled pots, prompting vanishing and causing a noteworthy drop in temperature before the air enters the inside. Such wind catchers end up essential components of the structural structure too. Aloof downdraught evaporative cooling is especially powerful in hot dry atmospheres. The contextual analysis of vitality and asset proficient design, which have been utilized one or a mix of the above ideas and procedures. Notwithstanding the above a considerable lot of the ventures have received creative day lighting techniques. Utilization of vitality proficient lighting and space moulding techniques are essential qualities of a few structures. In the present time of developing ecological concerns, these contextual investigations would move a modeller to plan and make a superior tomorrow.

**V. EXPERIMENTAL MEASURES**

To test and assess Green Building we conveyed various power and natural sensors and X10 actuators in a genuine domain (i.e., a family unit situation) and estimated the power utilization of a lot of apparatuses for a generally lengthy time span interim (15 days). The goal of this test considers is to explore conceivable vitality. We additionally connected some vitality protection methodologies to a few apparatuses and estimated the comparing vitality investment funds.

**A. Tried portrayal**

We sent power sensors and actuators in a family situations, a little loft lived by two understudies. In particular, we thought about the accompanying electrical apparatuses.

- A room light comprising of three lights (40W each).
- A workstation.
- A workstation created by a PC, a switch, a phone, a printer, and a 5.1 sound framework.
- A media station through put alluded to as Media Station.
- Consisting of a CRT TV, a decoder, a VRC, a radio repeater gadget, and a diversion comfort.
- A second media station through put alluded to as Media Station.
- Composed by a CRT TV, and a radio repeater gadget.
- A refrigerator

For Media Station 1, Media Station 2, and Workstation, we utilized a solitary power sensor to screen the total utilization of the station, while we utilized one X 10 recipients for each gadget forming the station. To the extent natural observing, we thought about light sensors and checked the light power in the room.

**B. Observing of every day utilization**

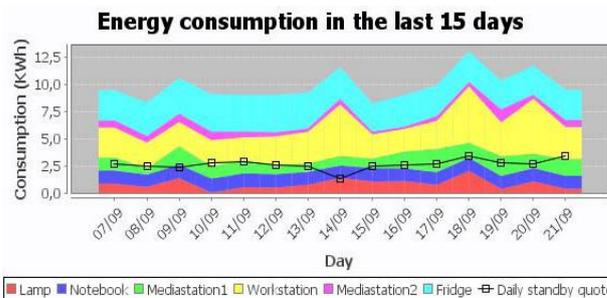
We quantified the electrical utilizations of the previously mentioned machines for 15 days. The day by day vitality utilization of each thought about apparatus for the whole length of the investigation. The plots likewise demonstrate the effect of backup squander, which is roughly steady after some

time and speaks to a noteworthy part of the general vitality utilization. The vitality utilization of every apparatus in a particular day regardless of whether the vitality utilization of every apparatus changes from everyday, the general pattern is comparable in various days. We expect that the client is utilizing a hourly duty dependent on two schedule openings, i.e., when the vitality cost is progressively costly, and) when vitality is altogether less expensive. The two spaces are featured in the plot. Information demonstrates that the utilization isn't conveyed in a helpful. Route throughout the day since a large portion of the vitality is devoured amid hours comparing to the

The vitality utilization amid the green space is for the most part because of backup (level territories in the plot).The data gave to enable the client to all the more likely comprehend his/her profile as far as electrical vitality utilizations. Fundamentally, they outwardly give two critical alerts to the client. He/she isn't taking full preferred standpoint of the hourly duty, and he/she is squandering a lot of vitality because of backup.

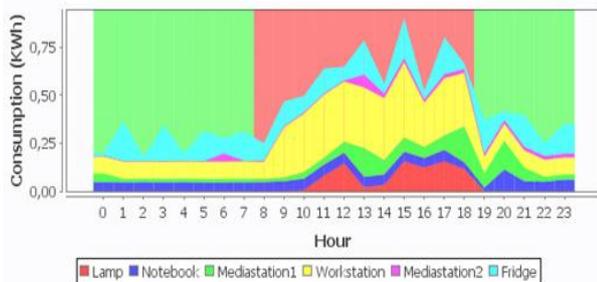
**C. Killing Standby Wastes**

Reserve squanders can be exceedingly diminished (if not wiped out) by indicating a fitting administration rule for every apparatus. In the accompanying we will accept to utilize the reserve technique SA for all the thought about machines, i.e., we expect that apparatuses are quickly turned off after entering the backup mode. The method of reasoning behind this decision is evaluating the greatest vitality sparing that could be accomplished by totally disposing of backup squanders. By and by, be that as it may, techniques SB or SC could be all the more engaging. Considered apparatuses with and without the reserve squander recognized by Green Building. Taking out the reserve segment can give a noteworthy vitality utilization decrease, up to 26%, by and large, in the thought about situation. Clearly, these outcomes firmly rely upon the particular arrangement of machines that has been considered in our investigation. Additionally, the backup squander differs fundamentally starting with one apparatus then onto the next (it is high for the workstation and media stations, while it is invalid for the ice chest and lights). Be that as it may, notwithstanding accepting a lower level of reserve squander (e.g., 10%), it obviously develops that utilizing a mechanized apparatus, similar to Green Building, for diminishing backup utilizations is advantageous.

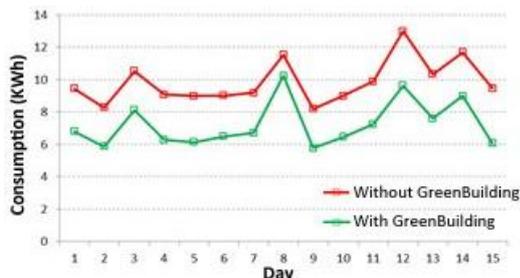


**Figure 1: Daily Energy Consumptions and impact of standby**





**Figure 2: Energy consumptions of different appliances in a specific day**



**Figure 3: Energy consumption with and without Green Building**

### D. Versatile Control of Electrical Appliances

In this area we show how Green Building can spare vitality through versatile control of electrical apparatuses. In particular, we concentrated on light force and endeavoured to keep up it at a consistent esteem; by shifting the power gave to the light, contingent upon the characteristic light force, in order to limit the vitality utilization. Light force was estimated through various Arduino light sensors sent in some vital areas in the room. These sensors measure light power as a rate running from 0% (no light) to 100% (high force). In this utilization case, the client sets the ideal light power to half, which permitted him/her to work easily at the work area or to utilize the workstation.

## VI. CONCLUSION

In this paper we have exhibited Green Building, a framework for effective electrical-vitality the executives in private and business structures. The objective of Green Building is twofold. From one hand, it enables the client to all the more likely comprehend the vitality utilization of each single machine, along these lines presenting to him/her to settle on increasingly canny decisions regarding vitality utilizations. Then again, it permits enhanced vitality effectiveness by methods for a fitting administration of each single apparatus, contingent upon principles determined by the client. We have actualized Green Building as a model framework and conveyed it in a genuine family situation. The trial results demonstrate that Green Building can give huge vitality funds, by dispensing with reserve utilizations and additionally adjusting the conduct of apparatuses to the genuine ecological conditions. The principle protest to utilizing a device like Green Building is that its expense might be excessively high contrasted with the monetary sparing it can give. In reality, flow expenses of power sensors and actuators are extremely high. Be that as it may, they are relied upon to diminish when their entrance in the market increments. Furthermore, cutting edge electrical apparatuses will incorporate inherent sensors

and actuators. General Electric has effectively built up a total suite of shrewd apparatuses utilizing ZigBee for remote correspondence among them as well as with a focal server.

### REFERENCES

1. Anastasi, G., Corucci, F., & Marcelloni, F. (2011). An intelligent system for electrical energy management in buildings. 2011 11th International Conference on Intelligent Systems Design and Applications.
2. Qureshi, W. A., Nair, N.-K. C., & Farid, M. M. (2011). Impact of energy storage in buildings on electricity demand side management. *Energy Conversion and Management*, 52(5), 2110–2120.
3. Uses of landscaping for energy conservation Giani, Florida: Department of Physical Sciences, Florida International University.
4. Manual on solar passive architecture: energy systems engineering IIT Delhi and Solar Energy Centre, Ministry of Non-conventional Energy Sources, Government of India, New Delhi).
5. Bansal N K, Hauser G, Minke G. Passive building design: A handbook of Natural climatic control. Nayak J K, Hazra R. Development of design guidelines by laws.

### AUTHORS PROFILE



**Mrs. P. Rathna, MBA, M.Phil.,** Research Scholar, Department of Management Studies, Bharath Institute of Higher Education and Research (BIHER), Chennai-600073, [palanirathna1990@gmail.com](mailto:palanirathna1990@gmail.com), Mobile: 7299018663



**Dr. A. Ravikumar, MTM., MBA., M.Phil., Ph.D. (Management),** Associate Professor, Department of Tourism and Hospitality Management, Bharath Institute of Higher Education and Research (BIHER), Chennai-600073, [rera25@gmail.com](mailto:rera25@gmail.com), Mobile: 7904643618