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High Performance Energy Efficient Buildings and Homes
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Preface

We would like to welcome you to the *First International Conference on High Performance Energy Efficient Buildings and Homes* (HPEEBH 2018) jointly organized by University of Engineering and Technology, Lahore, Pakistan and Auburn University, Alabama, USA.

The International Energy Agency (IEA) estimates that residential, commercial and public buildings account for up to 40% of the world's energy consumption. Energy efficiency in the built environment is vital to achieve economic, environmental, and development objectives in emerging economies. There is increased recognition that the cost of reducing energy consumption is much lower than the cost of generating new energy. The main aim of this conference is to bring together renowned and qualified architects, planners, contractors, engineers, project managers, clients, academics and other professionals from all over the world, for the presentation and exchange of their thoughts and experiences on energy efficient design, construction, and operations of buildings and homes. The conference is planned to provide a platform for discussion on real life case studies and the current status of the design and construction industries in the view of the participants. Such interaction will help to promote the development and implementation of modern design and construction practices in developing countries.

The conference provides an exchange of experience in new developments and in practical applications to improve energy efficient design and construction practices. In addressing issues and challenges in energy efficient design and construction, the papers presented at the conference have been organized within the following themes:

- Buildings and Materials Analysis
- Energy Production Systems
- Green Design and Construction
- Smart Buildings and Homes
- Energy Management Systems

We proudly present forty-four peer-reviewed papers in the proceedings. We would like to express our thanks and appreciation to the Organizing Committee, Advisory Committee, and the International Scientific Committee for the devotion of their precious time, advice and hard work to prepare for this Conference. But not the least, we would like to extend our appreciations to the Conference sponsors and supporting organizations, and supporting staff members who have contributed to the success of the conference. Additionally, we would like to acknowledge and give special appreciation to our keynote speakers for their valuable contribution, our delegates for being with us and sharing their experiences, and our invitees for participating in the HPEEBH 2018.

Salman Azhar
Muhammad Arif Khan
Sabahat Alamgir
Amna Salman

Lahore, Pakistan, August 2018

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Architects and Buildings in a Warming World

Norbert Lechner

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Abstract

Climate change is real, it is accelerating, and the climate could tip in the near future. To minimize the severity of its consequences, we must act now. Because buildings use about 50% of all energy, they must be designed and renovated to use as little energy as possible both at the construction and operating phases. Although climate change is also caused by the world's population and affluence, this paper addresses only the technological causes and responses. To quickly reduce the energy consumption of buildings, this paper presents some of the most effective yet free, low cost, or moderately costly strategies. Although some strategies for reducing the embodied energy are presented, most of the paper focuses on reducing the operating energy through the use of insulation, radiant barriers, and solar responsive design. The main focus is on solar responsive design because some of its strategies can greatly reduce energy consumption while costing nothing or very little. The author believes that a building cannot be sustainable if it is not solar responsive.

Keywords

Climate Change, Efficiency, Embodied Energy, Insulation, Low-Energy Design Strategies, Solar Responsive Design

Experimental and Numerical Case Studies of Buildings Integrated With Phase Change Materials

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Abstract

Thermal energy storage is an effective and environmental friendly solution to improve the energy efficiency of buildings. Among various thermal energy storage techniques, latent heat storage using phase change materials (PCM) is the most popular and promising technique that reduces energy cost, dependency on fossil fuels and will make the building thermally efficient. In this keynote speech, the following case studies are presented: 1) Application of macro encapsulated PCM incorporated in concrete walls; 2) Application of macro encapsulated steel box laminated within concrete walls; 3) Energy saving potential of buildings integrated with PCM in Islamabad, Pakistan; and 4) Energy analysis of buildings incorporated with PCM in different cities of China.

Keywords

Phase change materials, Macro encapsulation, Thermal energy storage concrete, Thermal performance, Energy savings.

Designing and Building a Medical Clinic in Thoman, Haiti

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Abstract

This research is a compilation of a 5-month project that looked at the non-profit work in Ganthier, Haiti, analyzed it, and used the best practices to create a master development plan for another non-profit project in Thoman, Haiti. This masterplan provides the programming and architectural design for the Thoman Hope Center and ultimately gives BGM a guide for similar projects in the future. This research was conducted as part of an undergraduate thesis class in the McWhorter School of Building Science that: (1) analyzed the major challenges for the Thoman topographical site, (2) created the Hope Center architectural design layout, and (3) provided a construction plan with detailed sequencing of building components. The overall goal for this paper is to (1) transfer our knowledge with others involved with international development/volunteer work and (2) propose a new construction management elective class that would give Auburn University students the opportunity to study, design, and build abroad.

Keywords

Haiti, International Development, Sustainable Design, Medical Clinic

Tube-Steel House Design for Low-Income Communities

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Abstract

A number of Auburn University Master of Building Construction students have been involved in works aimed at supporting the underdeveloped rest of the world. In relevance to this discussion, this research focuses on providing a sustainable housing solution to the Ngobe people in Panama. The basic concept and design allows a team of volunteers to construct a modest house in the span of about a week. The design of the structure utilizes a concrete slab, steel tube framing supported by shallow concrete footings, a pitched metal roof, and the flexibility to utilize mixed materials for the walls. Capstone level research has been completed on the development of this structure, focusing on appropriate design, cultural sensitivity, sustainability, ventilation and cooling, rain collection, aesthetic design development, computer aided modeling and simulation, and construction documents.

Keywords

Panama, International Development, Sustainable Design, Housing

Sustainability in Islamic Architecture Design

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Abstract

The traditional Islamic architecture is one of the most successful models in achieving the concepts of green design. The elements of the Islamic architecture work side-by-side, boosting each other's and complementing different climates as well environmental and socio-economic conditions. Traditional Islamic architecture created beautiful harmony and fine balance between form and function. Hassan Fathy the Father of Sustainable Architecture in the Middle East, He received several awards for his work, including the Aga Khan Award for Architecture in 1980. He left behind a legacy of 160 building projects ranging from small projects to large-scale communities complete with mosques and schools. Built the New Gournia Village for 3,000 families, new approach of local materials and local techniques. Mosque architecture has certain fundamental elements that perform different functions but all related to Islamic believes and references. Regional variation of mosques shows the respect that Islam to culture and adoption to local materials and techniques. Modern technologies can make use of traditional architecture in creating a more sustainable world by Choose the convenient methods to local environment, absorb the requirements of sustainable development, and mix these principles with modern technologies. This presentation will cover main concepts in design of Islamic architecture and its approach to provide positive environment that considers the best experience of users and their environment. Adopting these concepts of architecture design can help modern architecture in achieving a high level of sustainability in conjunction of with modern technologies use, systems, and products.

Keywords

Sustainability, Islamic Architecture, Design, Hassan Fathy, Mosque Architecture

Building a New Campus: American University of Sharjah

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Abstract

The challenge of building a brand new campus from scratch is enormous task that requires a high level of planning, designing, construction, and operation. Understanding fully the mission, goals and objectives of the new university is instrumental in tailoring the facilities to serve the new campus needs. Sharing the experience of building new campus of the American University of Sharjah, Sharjah, U.A.E.; would greatly benefit professionals who would be involved in planning and executing a new sustainable higher education campuses. Building a new campus from scratch requires extensive planning to match the academic needs and the conditions of the campus physical plant. The example of building the new American University of Sharjah can explain the level of efforts, coordination and momentums required to build and operate the new facilities. Managing teams of professionals to achieve the task of opening the door of a new campus on time in a tight schedule situation and high level of performance expectation. The American University of Sharjah opened its doors October 1997, at University City, Sharjah, United Arab Emirates. The University is a private comprehensive university that Started with five colleges residing on a beautiful 1,600 acre Complex. The distinctive architecture of the domes and arches with graceful Islamic architectural themes. Forbes Middle East has ranked American University of Sharjah as the best private university in the Persian Gulf region. Construction Lean approaches helped greatly in in schedule and efforts to get the construction of the Campus completed and ready for the scheduled grand opening in October 1997. This presentation will share the approach used to convert this campus for a construction site into an operational campus and phasing stages that were used to complete campus facilities into a living environment to students, faculty, staff, and visitors. This presentation will cover the lessons learned from the case of the American University of Sharjah Campus of construction and operation under a tight schedule by using Lean construction approaches that cut waste and safe time and efforts. How campus facilities be adopted to the changes in delivering education in current higher education environment.

Keywords

Building a New Campus, Consideration of Local and Regional Impact, American University of Sharjah, Lean Construction Approaches, Goals & Strategies Integration of Buildings and Landscape

Green Remodeling Strategies for High Performance Energy Efficient Buildings and Homes

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Abstract

Buildings are responsible for serious negative environmental impacts caused by their excessive energy and resource consumption, which all contribute to global warming due to greenhouse gas emissions. Energy efficient building practices can minimize negative environmental impacts and improve economic growth and social prosperity, but although the use of energy efficient methods for new buildings is now widely accepted in the world, they are seldom implemented for the renovation of existing buildings. Therefore, it is very important to develop a highly efficient energy-efficient remodeling framework to facilitate the implementation of energy saving strategies and technologies for existing buildings. The presentation will address the Green Remodeling Framework (GRF) developed in South Korea for energy efficient renovation that includes 'E-Scope', 'E-Ray', 'Impact Tables A&B', and 'E-Spectrum'. The GRF will support energy-efficient remodeling processes and helps all remodeling stakeholders to implement energy saving renovation strategies and technologies which eventually achieve the goals of high performance energy efficient building and homes.

Keywords

Green Remodeling, High Performance, Energy Efficiency, Buildings, Homes

Development, Testing, and Life Cycle Cost Analysis of Energy Efficient Designs for Typical Single Family Detached Houses in Pakistan

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Abstract

Pakistan has been facing an unprecedented energy crisis over the past several years. The persistent shortage of electricity has adversely affected the national economy. Residential sector is the largest consumer of electricity in Pakistan which currently consumes 47% of total electricity production. The process of energy consumption can be made more efficient by using an energy efficient house design. In Pakistan, the lack of basic understanding of a sustainable house and a higher upfront cost of sustainable design are two biggest barriers hindering the implementation of green solutions. The purpose of this research study was to develop typical single family detached house designs for Pakistan and apply different Energy Efficiency Measures (EEMs) to study their impact on electricity consumption. For house modeling, data related to climatic conditions, house designs, construction materials and electricity rates was collected from Lahore, Pakistan. eQUEST® (Quick Energy Simulation Tool) was used for baseline modeling and running energy simulations. Four different house designs within size range of 75 m² to 475 m² were modeled. A baseline design was first developed in accordance with typically used construction practices in Pakistan. In energy efficiency designs, several energy efficiency measures were separately applied to baseline design to see their impact on electricity consumption. Results showed that by applying these energy efficiency measures, there is a potential of reducing electricity costs by up to 26%. It was observed that lighting-power density, roof color, roof insulation and wall insulation result in most reduction in electricity consumption. The Life-Cycle Cost Analysis (LCCA) results further indicated that the combined initial investment for these energy efficiency measures can be recovered within 7 to 10 years of building's service life. It is strongly recommended that various energy efficiency measures should be implemented in residential designs in Pakistan. The Implementation process will require continuous effort from government, housing authorities, designers, contractors and house owners. The LCCA results produced as part of this research can be used as a benchmark.

Keywords

Energy efficient design, Residential construction, Green house, Energy simulations, Life Cycle Cost Analysis

Energy Performance Analysis of a Commercial Building using eQUEST

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Abstract

Energy consumption in a building largely depends upon the type of materials and design of the buildings. This paper analyses the energy consumption pattern of an academic building located in Karachi using eQUEST. Some common and easy to adopt energy efficiency measures (EEMs) are proposed and applied to the baseline building to evaluate their energy savings potential. Of all the discussed, appropriate selection of air conditioning system has highest energy savings potential. When all the EEMs are applied together, the baseline building shows an energy saving potential of 30.5%.

Keywords

Energy performance analysis, eQUEST, Commercial buildings, Energy efficiency measures.

Energy Consumption Profile of a K-12 School Building and Identification of Energy Conservation and Energy Efficiency Measures

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Abstract

The main objective of this research is to take a school building in Rawalpindi as a case study and investigate its annual energy consumption. This study has identified that electricity and natural gas are the main energy sources but due to power failures and unreliable supply from the national grid, the school is also dependent on a generator for power generation. It is concluded from the analysis that in terms of cost electricity dominates other sources. In Pakistan majority of the buildings are not energy efficient and hence require large amount of energy to meet their cooling and heating demands. This study also suggests energy conservation and energy efficiency measures for reducing the energy consumption of the building.

Keywords

K-12 Buildings, Energy Conservation, Energy Efficiency

Experimental and Finite Element Analysis on Thermal Conductivity of Fiber Reinforced Building Materials

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Abstract

In recent years, the construction industry has seen a significant rise in the use of natural and synthetic fibers, for producing energy efficient building materials. Plant-based natural fibres are low cost renewable materials with less embodied energy and less carbon emission. The types of fibers used in the study are jute, sisal, polyester (waste), bamboo and coconut coir added 1% by weight of cement and clay in preparation of mortar (FRM) and brick (FRB) specimens, respectively. Experimental and analytical studies were conducted to investigate the influence of fibers on thermal properties of FRM and FRB. The experimental results show that the use of fibers has considerably decreased the thermal conductivity of mortar and brick. Jute and bamboo fiber showed highest reduction of 10% while 4%, 8% and 6% by sisal, polyester and coconut coir respectively, in FRM samples, as compared to reference specimen (without any fiber). Whereas in FRB samples, coconut coir decreased thermal conductivity by 18% while Jute, sisal, polyester and bamboo showed 6%, 9%, 16% and 11% reduction respectively. Analytical models were developed by using finite element platform of ANSYS AIM 18.2, all experimental results were simulated and a close correspondence was observed between experimental and analytical values. The work presented herein is a significant step towards the modeling of composites for investigation and prediction of its thermal behavior using dynamic analysis environment.

Keywords

Fibers; Mortar; Brick; Thermal conductivity; Finite Element Analysis

Influence of Natural and Synthetic Fibers on Physical, Mechanical and Thermal Properties of Brick

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Abstract

Building sector consumes about 40% of total electricity. In order to minimize this consumption, the need for sustainable solution has become mandatory. The aim of the research is to explore such economical materials for wall and roof which can minimize use of energy in buildings. This work focuses on development of thermally efficient bricks by using fibers. To achieve this purpose; bamboo, coconut coir, jute, polyester and sisal fibers were used 1% by weight of soil to make a brick. Properties including water absorption, bulk density, open porosity, thermal conductivity and compressive strength of fiber reinforced brick (FRB) specimens were assessed. It was observed that lightweight bricks can be manufactured by using fibers. Increase in water absorption and open porosity was observed except for bamboo and jute FRB specimens for which open porosity was decreased. Due to porous nature of bricks incorporating fibers, thermal conductivity decreased for all FRB specimens. Coconut coir FRB specimen showed maximum reduction of 18% in thermal conductivity. While bamboo, jute, polyester and sisal FRB specimens showed 11%, 6%, 16% and 9% reduction in thermal conductivity, respectively, as compared to reference brick (without any fiber). Compressive strength decreased for all FRB specimens except for coconut coir FRB specimen. Based on this study, it can be concluded that fibers can be effectively used to produce energy efficient and sustainable material.

Keywords

Energy, Natural fibers, Synthetic fibers, Thermal conductivity, Fiber reinforced bricks

Building Energy Simulations for Different Climate Zones and Building Envelopes

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Abstract

In recent years, the topic of energy consumption of buildings has received widespread attention both in the industry and the academia which has resulted into better building designs in terms of building energy consumptions, comfort, and carbon footprint. Building energy calculations are very complex and depend on a myriad of factors. Computers using building energy simulation software are indispensable tools for such calculations. This paper applies DesignBuilder™ software to investigate the effect of location and building envelope types on the building energy and related performance metrics. A test model of a building was subjected to annual energy simulations for six locations and two building envelope types. The chosen locations represented varying climate zones corresponding to the main categories of the Koppen Climate Classification System. Two envelopes showed the variation in terms of insulation provided to the building. The findings suggested that the energy performance of a building corresponds to the climate to which it is subjected. The envelope with insulation provisions may improve the energy consumption in some aspects such as heating energy needs but in other aspects, the energy performance may deteriorate. Therefore, modifications and tweaking of the envelope components may be needed to improve the energy performance in more or all aspects.

Keywords

Building Energy Simulation, Building Envelope, Hot climate, Cold climate, CO₂ emission

Comparison of Green and Conventional Building Materials in Relation to Efficiency and Cost in Pakistan

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Abstract

Depletion of natural resources placed a tremendous strain on environment. Construction and operation of buildings is affecting the consumption of world's resources. Many examples of architecture are designed to provide the necessities like thermal comfort, clean air, ventilation and water without using the technology and wasting resources. In Pakistan, the present-day need is 'green' buildings, building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impact, on climate and natural environment. The study compares the material that can convert a conventional building into green in relation to their efficiency and cost. Materials like green roof, insulation, low E window and low VOC paint are efficient to use more than conventional ones to save energy. Cool brick and fly ash brick are discussed as upcoming green materials. Study shows that going green cost more than conventional but a green building is crucial for sustainability of our environment thus they shouldn't be ignored for extra cost. Architects know the benefits of these materials but contractors and builders along with the users of the buildings must be guided about the benefits of green materials. The study also reveals that going green not only contribute to one unit but to whole society.

Keywords

Green Buildings, Green Materials, Sustainability

Priority Algorithm for Energy Management (Low Energy Building)

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Abstract

Energy management is the integral part of low energy smart buildings. Energy management can provide better support for demand side management. It potentially enables the system to use less energy in order to fulfill its need on available resources. Recent studies shows that building energy consumption can be saved upto 30% through optimized operations which are usually based on efficient energy management with the help of load priority algorithm. Therefore, there is still huge potential for building energy savings through optimized and efficient operation. Smart grids facilitates power system with a desirable infrastructure for improving energy consumption efficiency in buildings. The key to establish an energy efficient operations is to develop a rules-set based on priority algorithms for energy consumptions. Priority algorithm is usually followed when energy bank is limited and up to specific time energy supply to a system is mandatory. In this paper, an priority algorithm is proposed and tested in a practical background of a low energy buildings. Moreover, a critical review is also presented of different priority algorithms which is implemented in different smart and intelligent buildings across the globe.

Keywords:

Priority algorithm, Very low energy buildings, smart buildings;

Towards Predictive Analytics for Utility Bills and Power Outage

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Abstract

The vision of smart homes has been under the significant attention of researchers over the past few years. This is because of the breakthrough in the field of IoT and inventions of the huge number of different sensors. In this era of smart cities, smart homes are much important for making a city smart. Owing to a lot of work in making a home smart by operating appliances smartly, there still lies a gap in this domain, and that is to encompass the future prediction factor. The addition of future prediction factor will make this work appealing and exclusive. Moreover, Google also has introduced a selflearning smart home. Despite this, we can also teach our homes according to different occasions. Here, we will provide one step ahead in this domain which includes Future Predictions that can be useful to make a home smart. We will be discussing the main challenges and opportunities that Smart Homes and Buildings (SHB) will entail and will open new spheres of research as well. The research paper will also discuss the knowledge of data handling and accumulation of real-life data sets and use them for human benefit using artificial intelligence tools and techniques.

Keywords

Future Predictions; Classification; Decision Tree; Smart Homes; Smart Buildings.

Design and optimization of Standalone/Hybrid (Wind/Solar/Diesel Generator/Battery) off grid system for the rural area electrification of Balochistan (District Khuzdar) with real time measured data

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Abstract

Pakistan is facing some of the most serious crises in energy shortfall. Supply and demand gap of energy is increasing day by day. A large number of remotely located villages in Pakistan are still without electricity. The main purpose of this research is to design a technically and economically feasible hybrid system (Wind/Solar/Battery) to electrify the chosen remote area. Proposed design of hybrid system meet the energy requirement of a small community of district Khuzdar located at coordinates 27.8165° N, 66.6057° E. Solar and wind data was taken from MHPs stations installed by World Bank at Khuzdar BUET. The data is further processed from 10 minutes to 60 minutes average of last 3 years available real time data. Annual average of solar irradiance is 6.11 KWh/m²/day and the annual wind speed is around 3.09 m/s. seven different cases were considered, two as standalone while five as hybrid energy models to design the system. The load data estimated by no. of devices per home and the usage of desired community. The proposed system with combination PV/Wind/Diesel-Genset/Battery is found to be techno-economically feasible after performing the simulations for each case by HOMER Pro on the basis of levelized cost of energy (COE) and net present cost (NPC) and, these parameters used by the Homer Pro for choosing cost effective and optimized system.

Keywords

Resources Assessment, HOMER Pro, Hybrid energy system, Net Present Cost (NPC), Standalone system, Levelized Cost of energy (LCOE), solar PV, wind energy.

Demand Response Enhancement via Home Energy Management

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Abstract

In Smart Grid (SG), a Home Energy Management (HEM) system plays a vital role in allowing demand response program to be used by domestic consumers. In our paper, a smart HEM system is proposed for handling high power feeding appliances for demand response (DR) study. The domestic load is achieved with predetermined priority and assurance on the suggested set of rule and total power feeding should below definite level. To show the application of a proposed set of rules for DR at appliance level, a simulating device is employed. This paper determines that device can be used for DR capabilities of domestic consumers.

Keywords

Demand-Side Management, Smart Grid, Home Energy Management

Demand Response Programs and Load Forecasting Schemes within Smart Grid

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Abstract

Demand Side Management (DSM) is a promising domain for utility managers and policymakers to curtail consumers load within Smart Grid (SG). Due to demand-supply miss-management, various problems arise, such as (a) voltage drift (b) current variation, (c) active and reactive-power miss-match, (d) reduced consumer empowerment and consumer satisfaction, and (e) low economic development of utility in the wholesale market. Considering above, there is a pressing need to emphasize DSM for an optimized operation of SG system. With this motivation, we reviewed Demand Response Programs (DRPs) and Load Forecasting Schemes (LFSs) as primary operational entities for efficient operation of SG. Moreover, we investigated the role of various DRPs for peak-shaving of consumers load profile. Furthermore, the vital role of LFSs in economic development stabilized the operation of SG system, and inter-relationship to DRPS is reviewed. Finally, a case study is presented describing computer-based simulation study of DRPs and LFSs utilizing real-time data of Texas (United States).

Keywords

Demand-Supply Management, Load Forecasting Scheme, Demand Response Programs, Smart Grid

Renewable Energy Resources Penetration within Smart Grid

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Abstract

The recent trend of renewable energy resources penetration into the electricity supply mix has put forward more requirements on the power grid for the quality of supply. Integration of distributed generation units into the power grid has increased planning and operational challenges. Considering above, capacity planning, grid operations, and demand-side management need to be addressed for beneficial integration. This paper presents a detailed study on Renewable Energy Resources (RERs) integration within Smart Grid (SG). We present advantages, complexities, issues and promising solutions for deploying renewables in an SG environment. Our work also analyzes the efficient integration of RERs in electricity market with enhanced generation capacity, improved power quality, and increased reliability. The issues pertaining to the integration of renewables into SG are reviewed in this paper. In addition, a detailed model of SG with integrated renewables is also presented. Moreover, this paper provides a perspective view of SG in terms of evolution, economic growth, and barriers to its implementation. Furthermore, technical issues and challenges pertaining to the penetration of RERs within SG are also discussed.

Keywords

Renewable Energy Resources (RERs), Smart Grid (SG), consumer empowerment, operational costs, consumption patterns

Energy Consumption in Residential Sector of Pakistan

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Abstract

Energy consuming buildings account for 30-40% of the overall energy consumption in the world and are responsible for more than one third of greenhouse gases emissions. In Pakistan Residential building sector has around 47% share in total energy consumption. Study is conducted to identify the energy consumption pattern and the areas of energy wastage in residential sector of Islamabad. From the analysis of its annual energy usage it can be clearly seen that electricity consumption dominates in term of cost but natural gas has major share in annual energy consumption. Recommendations are provided which include required energy retrofit measures for improving building performance and financial assistance from Government officials. Through these energy efficiency measure significant reduction in carbon footprint can be achieved.

Keywords

Energy Conservation, Energy Consumption, Residential Sector, Pakistan

On State of Charge Estimation of Lithium-Ion Battery for Solar Application

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Abstract

Solar panels have become one of the emanate energy sources and its attractiveness has led to the rise of batteries that can store excessive solar power for later use and among these, Lithium-Ion (Li-Ion) batteries have been chosen as an effective solution because of its significant advantages e.g. good charge/discharge performance, high energy and current density, and optimum power support. A Battery Management System (BMS) is used to maintain the safety and reliability of a Li-Ion battery pack. Among various parameters in a BMS, State of Charge (SOC) of Li-Ion cells is a key indicator which represents the ratio of the stored energy in the battery to the total energy that the battery can contain. In this paper, state of the art SOC estimation using Ampere-hour (Ah) counting and Extended Kalman filter (EKF) methods have been presented. First, EKF for estimating SOC of Li-Ion battery is mathematically designed. Then electrical battery model is implemented using Ah counting and EKF in MATLAB/Simulink. A comparison of the two methods is given which indicates that the SOC evaluation of the battery using EKF is more accurate than Ah counting method. The error observed from the results of EKF is less than 1%.

Keywords

Solar Power, Lithium-ion Batteries (Li-Ion), State of Charge (SOC), Extended Kalman Filter (EKF), Ampere-hour Counting (Ah counting).

Electric Vehicles: Vehicle-to-Grid (V2G) and Grid-to-Vehicle (G2V) Interactions for Efficient Energy Performance within Smart Grid

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Abstract

Electric Vehicles (EVs) evolution brought a revolutionary change in domain of electric transformation. The development of EVs is growing day-by-day. The rapid growth in EV technology is diverting consumers from normal cars to electric vehicles. EV has become the need of modern era. Fossil fuel reserves are depleting that results in inflation of fuel prices. The solution for this problem is to develop new technologies that are independent of fossil fuels. EVs are the answer to the massive increase of oil prices. Therefore, this paper presents two interactive modes of EVs, namely: (a) Vehicle-to-Grid (V2G) and (b) Grid-to-Vehicle (G2V) operational modes. Moreover, interactions of V2G and G2V are discussed with respect to SG dynamics and control. Finally, a case study of EVs operating in Wide Area Smart Grid System (WASGS) is presented in context of: **(a)** wide area system stability, **(b)** voltage control, and **(c)** active and reactive power management. The computer-based simulation of EVs is evaluated in three areas of the WASGS with distributed parking stations.

Keywords

Smart Grid, Electric Vehicles, Energy Flows, Vehicle-to-Grid, Grid-to-Vehicle, Wide Area Smart Grid System, Energy Efficiency

CFD Evaluation of 1kW Small-Scale Horizontal Axis Wind Turbine for Operations in Low Wind Speed Regions

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Abstract

In this research, small horizontal axis wind turbines aerodynamicis have been studied to optimise them for operations in low wind speed regions. A 1 kW small wind turbine was selected based on the BEMT design. To decrease the cost of validating the BEMT model through experimentaion, computational fluid dynamics approach is selected to validate and calculate the efficiency of 1 kW wind turbine. The simulations were done in commercialy availabe CFD code ANSYS FLUENT. The flow was taken as steady state and pressure based approach was employed to solve the governing equations. Kw-SST model was employed to model the turbulence. At rated wind speed, coefficient of performance was calculated to be 0.35, producing about 1 kW power. The comparison with the BEMT result show good agreement, considering the 3D losses calculated in CFD. The starting wind speed of rotor is calculated to be less than 5 m/s.

Keywords

Small wind turbine, Computational fluid dynamics (CFD), low wind speed regions, Coefficient of performance (Cp), aerodynamics

Vertical Axis Wind Turbine for Low Wind Speed Corridors

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Abstract

Wind is the cheapest and most environmental friendly resource of renewable energy. Wind power generation has so far favored the multi-megawatt horizontal axis wind turbine (HAWT) over the vertical axis wind turbine (VAWT) technology. Principal advantages of the VAWT technology are: (a) Omni-directional operation independent of the directional changes in the wind, (b) heavy components such as the electric generator installed close to the ground, (c) simple design, less manufacturing and maintenance costs, (d) small operating space requirement (high farm power density), and (e) low environmental impact and noise signature. These properties support the application of VAWT in urban environments. However, the VAWT characterizes lower power coefficient C_p compared to the HAWT due to the presence of dynamic stall and associated bladewake interaction induced vibrations. Generally, wind turbines are designed at rated wind speeds of 10-12 m/s. However, for low wind speed corridors such as Pakistan, maximum wind speed of 8 m/s is available. At such low wind speeds, a turbine can be significantly large compared to higher wind speed designs. In addition, a small-scale application will also incur low Reynolds number effects. The current study is therefore focused on designing a VAWT rotor for low wind speeds of 5-8 m/s by considering a number of design variables and parameters. The double multiple stream tube (DMST) model, an advance type of the blade element momentum theory (BEMT) is being used to design the VAWT rotor. The DMST model is coupled to an optimizer in order to obtain optimum rotor geometry for low wind speeds. An optimal selection of different design variables can lead to a smaller yet effective VAWT rotor design in terms of performance.

Key words

Vertical Axis wind Turbine, Double Multiple Stream Tube Method, Blade Element Momentum Theory, Low Wind Speed Corridor.

Optimum planning of Wind-Solar-Biomass hybrid energy system for electrification using HOMER Pro: A Case of Bahawalpur district, Pakistan

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Abstract

Electricity generation using hybrid renewable technologies emerge as reliable and cost effective solution for electrifying remote areas. The main purpose of this study is to focus on using biomass potential of Pakistan along with solar and wind energy resources to overcome energy shortage in chosen area. An optimal design of stand-alone hybrid system consisted of PV/Wind/Biomass resources to supply a load of 230.3 KWh/day for a small residential community in Bahawalpur district of Pakistan is presented in this paper. Wind and solar data is taken from Meteorological high precision units installed at Bahawalpur. Biomass data is taken from biomass mapping project conducted by World Bank. Biomass resources along with solar and wind energy resources provides a self-sustain hybrid system capable of electrifying our desired area. A community consisted of residential houses is supposed to be supplied electricity through proposed hybrid system. Sensitive parameters including biomass price, biomass potential, solar and wind irradiance are used for sensitive analysis. This paper discuss the best possible hybrid system options available for electrifying desired area on the basis of Net present cost. Result shows that designed hybrid system is economical and sustainable alternative for off grid rural electrification in area under study.

Keywords

Hybrid PV-Wind-Biomass system, Techno-economic analysis, Net Present Cost (NPC), Cost of Energy (COE), Meteorological High Precision (MHP) Unit.

On Active and Reactive Power Control of Shunt Connected VSC with Energy Storage System of Renewable Application

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Abstract

Utilization of Distributed Generation (DG) has become a great concern for the utility to provide sufficient electrical energy. DGs like wind, PV and fuel cells rely on voltage source converter (VSC) due to their high controllability of voltage, current and power. This paper presents an active and reactive power (PQ) control for three phase VSC of renewable in grid-connected mode. The control is designed in synchronous reference frame. The proposed method utilizes PI controller to provide control capability of PQ sharing between grid and VSC. The results are presented to validate the performance of the proposed controller in MATLAB/Simulink.

Keywords

Voltage Source Converter (VSC), PLL, Current Controller, Renewable, Active and Reactive Power (PQ) Control.

A Comparative Analysis of Net Metering and Battery Backup Scheme for Educational Institutes with Photo Voltaic Systems in Developing Countries

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Abstract

Due to a drastic increase of energy consumption in developing countries, the energy shortage has become a big concern and it effects multiple sectors especially educational institutes. The installation of Photo Voltaic (PV) systems have also increased in order to overcome the problems of energy shortage. This paper aims to present a comparative analysis of different schemes of PV systems for an education institute designed on base of the load pattern of the institute. The schemes that are analyzed are net metering and battery backup system sized on the basis of different energy saving scenarios.

Keywords

Photo voltaic, Net metering, Nano-grid, energy optimization, energy storage

Electric Vehicle Interaction and Energy Storage Technologies deployed for EVs within Smart Grid

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Abstract

Smart Grid (SG) is an inter-connection of renewable energy resources, power system, and advanced communication infrastructure that is heading towards green environment. This green environment trend forced scientists and researchers to develop green systems independent of Carbon-Dioxide (CO₂) emissions, thus named 'Electric-Vehicle (EV)' system. EV is the latest technology in SG that meets current and future environmental, economic, transportation, and energy challenges efficiently. EVs contribute to Energy Management Systems (EMS) to achieve high-efficiency level. In peak-hours, energy demand is high, thus high energy generation is required. To keep SG system stable, the peak-hour load is shifted to an off-peak hour through advanced EMS of EVs. Furthermore, storage devices, such as DC batteries employed in EVs are elaborated in detail, describing: **(a)** classification, **(b)** working function mechanism, and **(c)** involved material's properties.

Keywords

Smart Grid, Electric Vehicles, Energy Efficiency, Energy Storage Devices, Green Environment

To Investigate the Impact of Recycled Coarse Aggregate as a Partial Substitute of Natural Aggregate achieved from Dismantled Structures from different Environs of Khuzdar District

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Abstract:

The Concrete industry has stepped towards Sustainable development, the timeworn buildings and infra structures being demolished for the construction of new and modern structures, thus the dumping of smashed waste became a foremost problem in urban areas, and on further the pressure on devastating of natural aggregate is tremendously rising. The above stated disputes initiating a serious problem and polluting Environment. The only resolution to overwhelm these serious issues is to recycle the demolished structures. This research targeted to discourse the possibilities of replacement of Natural aggregate with Recycled aggregates. The work comprises the use of recycled aggregates achieved from different neighborhood of District Khuzdar. For experimental works the Physical and Mechanical properties of 28 cylinders (6" dia and 12" height) and 10 beam of 6"x6"x20" was determined and cured for 28 days. The experimental results shown that up to 40% of replacement of natural aggregate by recycled aggregate has no effect on Comprehensive strength of concrete, Tensile strength and Flexural strength. The strength of specimens to some extent reduced when replaced by recycled aggregate over and above 40%.

Keywords:

Natural Aggregate, recycled aggregate, demolished waste, Concrete.

Passive Cooling: Cool Minarets for a Mosque in Islamabad, Pakistan

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Abstract

Mosques have distinctive physical architectural vocabulary and form comprising of domes and minarets. The original purpose of a minaret was to provide an elevated platform for the calls to prayers. Nowadays, the calls to prayers are made through a sound amplification system with loud speakers nestled in the minarets. As such, the use of the minarets is no longer the use it was originally intended and built for. Since the minarets are usually already included in the design of mosques, these have a potential to be used as Cool Towers for passive cooling – hence the terms, “Cool Minarets.” Cool Minarets can provide economical cooling in a warm/hot and dry climate, when coupled with an evaporative cooling system. These are to be included in Ayesha Mosque, designed by this author/architect, in Gulberg, a new community development in the outskirts of Islamabad, Pakistan. Ayesha Mosque is now under construction with the five Minarets, which also represent the five Pillars of the Islamic faith. This theoretical research points out that the Cool Minarets could provide adequate passive evaporative cooling for 4 of the 6 months long summer duration, hence saving considerable cooling energy, when compared with conventional compressive air conditioning.

Keywords:

Cool Towers, Wind Towers, Passive Cooling, Evaporative Cooling, Ayesha Mosque

Impact of Classroom Color Scheme on Learning

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Abstract

This study was conducted to ascertain the role of color in motivating children towards learning. The sample was selected from two government schools of a village named Rao Khan Wala near Lahore. Triad color schemes were used as they provide a unique balance of both the cool and warm colors. Furthermore for the selection of the sample's age Piaget's theory of cognition was used and children falling in concrete operational stage were selected in this research. The study employed experimental research method in which it was divided into two phases for data accumulation, the pre stage and post stage. The findings of the study revealed that colors positively increase children's motivation toward learning in classroom settings.

Keywords

Color, Motivation, Learning, Experiment, Triad color scheme, Cool Colors, Warm Colors, Piaget's Theory of Cognition, Concrete Operational Stage.

Benchmarking IECC for climatic and passive design classification

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Abstract

Building contributes the major component of the residential sector, consuming more than 40% of the energy and 75% of the electricity produced in the world. Like many other developing countries, Pakistan is also facing a big challenge of energy and environmental crisis. Residential buildings in Pakistan lack the energy conservation strategies, and practices. The aim of this research is to benchmark the IECC for the identification of climate zone and their suitable passive design features. The paper will give a review of IECC on the format analysis of administrative requirements, various definitions used in codes, climate zone classification, residential energy efficiency and reference standards. The climate data of annual temperature and precipitation for Lahore was collected from the meteorological department. The paper uses the method of using the International climatic zone definition as described in IECC. The paper identified the climate zone of Lahore as moist. It will further classify insulation, fenestration and their passive design requirements for the identified climate zone of Pakistan.

Keywords

Benchmarking; IECC; Climatic classification; Passive Design; Residential Sector

Evaluation of Daylight Performance on the Selected Design Parameters of Light Shelves

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Abstract

This paper describes how changes in the light shelf design parameters can affect its efficiency under overcast sky conditions. The objective of this study is to choose the most appropriate design of light shelves optimized according to position and height. The city is characterized by very large amount of daylight Illuminance especially during summer season. Analysis is performed using a base model of selected Study space to evaluate the lighting demand and simulate the model with selected types of light shelves. Detailed daylight analysis is carried out on Radiance software. The consequence of this study shows that the external light shelves at a height of 7' can be observed as the most suitable option. However, it is very important to pay extra attention to light shelves height and it's position, because it has a greater effect on light shelf performance.

Keywords:

Daylight simulation; Light shelf; Overcast sky; Radiance; Ecotect

COMPARISON OF LEED CREDIT ACHIEVED BY CASE STUDY BUILDING BEFORE AND AFTER RETROFITTING.

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Abstract

Leadership in Energy and Environmental Design (LEED) is the most widely used green building rating system worldwide for nearly all types of buildings and community developments. It provides a framework to form healthy, highly efficient and cost-saving green buildings. LEED certification is a globally recognized symbol of sustainability achievement. Instead of targeting new buildings this research aims to find the optimal retrofitting solutions for existing building keeping in mind the cost and availability of products in Pakistan. An educational institute in NUST was chosen as a case study. The methodology involves simple understanding of LEED v4 (BD+C) and Autodesk REVIT 2017 software along with some manual calculations. The retrofitting solutions proposed in this study can be used to achieve Silver certification of LEED for case study building.

Keywords:

LEED, LEED Certification, BIM, Retrofitting and Case Study.

COMPARISON OF PERFORMANCE OF RAT TRAP BRICK BOND WITH THE CONVENTIONAL BRICK BOND

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Abstract

Energy efficiency and sustainability are the basic needs of modern era. In order to achieve this there are several building construction techniques and environment friendly materials have been introduced. But there is a need to use these techniques and material in a proper combination so that they could be adoptable and economical and play a vital rule in the improvement of energy efficiency and sustainability. One such building technique to save energy is the use of 'Rat Trap Bond'(RTB) masonry. Contrary to other technologies, this amazing building technology is not new. RTB was first introduced in 1970. Since then, it has been used in many buildings and small houses. In this modern age, we have overlooked this extremely useful technology which, while providing the same strength to the walls also saves us time and labor and also material cost to the extent of about 23% when compared with a standard brick masonry wall. In this research an attempt is made to compare the conventional brick bond wall and RTB brick wall. The cost, energy use and thermal comfort of a house is compared by using both types of brick bond wall. It is concluded that RTB brick wall performed very well in saving energy and reducing the electricity bill cost.

Keywords:

Rat Trap Bong, Energy Efficiency, Thermal Comfort, Affordable Housing, Cost Effective Construction Technology, Design and Construction.

Design of an 87 kW Photovoltaic System for a University Building to Support LEED Certification

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Abstract

Leadership in Energy and Environmental Design (LEED) is one of the most popular green building assessment system developed by US Green Building Council (USGBC). US-Pakistan Center for Advanced Studies in Energy (USPCAS-E) aims to achieve LEED Certification for its building situated in NUST, Islamabad. This paper describes the design process of a Solar Photovoltaic (PV) system to meet some of the energy requirements of the building. An 87-kW system, designed by using Step Robotics solar site analysis tool, suggests that it can meet 17% of annual electricity demand of the building using solar energy. This will lead to reduced emissions and will enhance the energy performance of the building.

Keywords

Solar Photovoltaics, Leadership in Energy and Environmental Design (LEED), Site analysis, Shading, Sustainable Buildings

Sustainable Residential Buildings in Pakistan: Challenges and Opportunities

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Abstract

This study systematically investigates potential opportunities and challenges pertaining to sustainable residential buildings in Pakistan. Throughout the world the concept of sustainable buildings is rapidly gaining popularity and to assess the potential of such buildings in Pakistan, various stakeholders were surveyed. It targets architects, builders, contractors, home owners, service providers, material providers, investors and general public. This study tells us about the awareness of the stakeholders in the areas of construction environmental impacts, energy efficiency and conservation, environmentally preferable products, materials recycling, reduction of waste and water efficiency. We also considered government policies and incentives in reducing emissions and renewable energy integration and overall people's perception about features and design of buildings.

Keywords

Green buildings, Energy Efficient Homes, High Performance Building, LEED, Green Homes

BIM and agriculture: An integrated platform for Building Integrated Agriculture

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Abstract

The UN statistics shows that the world's population is expected to be 9 billion by the 2050. As a result, the food production must also to be raised 70% or more. The production of food can be achieved by combining higher yield crops and expansion of cultivation area. However, availability of extra agricultural land is limited, irregular and unsuitable for crops. Therefore, more efficient and sustainable solution like Building Integrated Agriculture (BIA) and Vertical Farming would be required to fulfil the challenging demand. Evidently, Building information modelling has proven its numerous benefits to the AEC and FM industry, and it can be a powerful solution to design Vertical Farms to solve future food production problems. This paper, therefore, shares the understanding of future food challenges and BIM and its relevance to stimulate the production of crops through review of literature, proposing a framework for the development of a sustainable Vertical Farm and integrating plants data to BIM model, which can be utilised to provide ideal conditions for crop production and processes.

Keywords:

Agriculture, urban agriculture, building integrated agriculture, building information modelling, vertical farming and sustainability, data integration

Awareness of People of Lahore to Sustainable Building Design Fundamentals

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Abstract

Sustainable Building Design (SBD) has come a long way in recent years from being a building extra to an integral part of the design. Therefore, it is imperative to learn about the residential occupant's awareness to the developed practices of sustainable building design. This research aims at the sole purpose to learn about such awareness. For this, a questionnaire was developed keeping in view the major sustainable practices which was then distributed to various residential occupants at Defence Housing Authority (DHA) Lahore, Pakistan. It was found out that people awareness regarding site potential and indoor air quality is high while for other fundamentals it is low. In general, it can be summarized that most people are not well aware regarding sustainable building design fundamentals.

Keywords

Sustainable Building Design, Residential Occupants, Awareness, Lahore

Smart Grid tied Low Energy Smart Building (An introduction)

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Abstract

Smart grid is replacing actual power system on account of energy efficiency, economics, reliability, power security and environmental outcomes. Building, being part of power grid, and considering its distributed generation and controllable demand capabilities, is now become key player in the process of liberalization of energy market. Smart grid tied very low energy buildings will increase market revenue, transmission and distribution capital saving along with improvement in asset utilization. It will also result in theft reduction, improved energy efficiency and power quality as well as green environment. In this research activity a detailed review is presented on smart grid tied very low energy building model along-with it components that are onsite energy harnessing, building infrastructure, demand side energy management and communication protocols needed for connecting humans with smart environment.

Keywords:

Smart grid, Very low energy buildings, smart buildings;

Towards Predicting Waste-Bin Levels for Smart Waste Management

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Abstract

With the growing interest in artificial intelligence and acknowledgment of its usefulness for the betterment of human life, artificial intelligence and various machine learning techniques are being studied and deployed for the very same purposes. For the amelioration of cities and communities, many new solutions are being proposed based on machine learning. Smart Waste Management System (SWMS) is also a part of the same chain. SWMS will provide many advantages in the form of the clean city as smart bins will be available for use in different parts of the city and optimize waste collection and disposal routes. This paper mainly focuses on the element of future predictions i.e. saturation time of waste bins. Three important things required for Future Prediction comprises of Data Accumulation, Data Classification & Data Evaluation. A user-friendly interface helps users using the system to predict the saturation time of waste bins and a simulation shows a route for the waste management truck from its starting point to the location of the waste bin before time. The system will make an exceptional advancement in the waste management systems by predicting the status of waste bins and formulizing routes based on location of those filled-up waste bins.

Keywords

Smart Waste Bins; Future Predictions; Classification; PART; Linear Regression.

Assessment of Previous design and Redesigning of a Robust Energy Efficient Portable Stove

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Abstract

Portable cooking has been a major concern since the evolution of stove. It usually includes the regular burning material whether in terms of fuels. A basic platform to hold the pans/cooking utensils on heat. This whole apparatus is known as stove. Portable stoves are used for domestic purposes but also in the outdoors for adventure/ recreation, camping and in the disastrous areas. In this research paper a camping/portable stove has been designed to fulfill the basic need and function of portable stove for earth quake management, field hospitals, camping lovers and picnic. Existing stoves are not very efficient (in terms of energy consumption and handling) in fulfilling all of the above mentioned tasks of portability & camping efficiently. This research paper is about the redesign of efficient and ergonomically better camping or portable stove. The primary concern is to deliver the maximum energy efficiency as this would be used in the areas where approach of resources is limited. A brief focus has been delivered to the efficient LPG consumption and its minimal waste possible through burner openings and time to burn ratio. In order to identify the flaws in the existing designs of portable stove, a review of literature and market survey was done. The findings helped in the redesign of a robust stove. In this paper the existing camping stoves, its draw backs and problems have been identified and after that a complete redesign is done on the basis of found problems, ergonomics also fulfilling the parameters of aesthetics.

Keywords

Portable Cooking, Energy efficient design, Ergonomics, Camping, Field Hospitals

What is the Energy Price of Independent Living? A Review of Energy Consumption of AT Products in Inclusive Smart Homes

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Abstract

Maintaining good health and independence for as long as possible is essential for a globally ageing population and people with disabilities. Assistive Technology (AT) products are intended to enhance the functional capabilities and increase independence for elderly and individuals living with disabilities. Some of AT products are relatively low-tech devices such as glasses, grips, and crutches. The application of safety-critical products that consume comparatively large amounts of domestic energy may require additional consideration in regions where reliability of energy delivery may be an issue. A mainstream ‘smart home’ offers the owner the convenience of monitoring and controlling their domestic environment. These proprietary environmental controllers are now affordable through commercial systems such as monitoring and controlling environment controllers for instance Hive, Amazon Alexa, Echo and Siri etc. These systems are often low-voltage and do not appear to add significantly to domestic energy consumption. Individuals and families living with a cognitive or physical disability often require motorized systems that draw much more energy than monitoring systems. Whilst energy consumption relating to mainstream smart homes is well documented, energy use in daily activities among those with physical disability is less well defined. This leads to the question: “what is energy consumption and associated cost for independent living for the people with disabilities within a smart home?” To explore this question further, a literature review of smart home and specific high-energy requirement equipment was completed. Databases were chosen that provide a wide range of literature that has a focus on smart homes and AT products associated with tasks that aid manual handling and moving. A number of personas were created from information gathered from the literature review to provide an indication of the amount of energy consumed, with an indication of when spikes in demand may occur. The study concludes with the comparison of an AT smart home with a mainstream equivalent, savings in care costs and consequences of power outage for the AT homes. Areas for further research are also suggested.

Keywords:

Assistive Technologies, Energy Consumption, Independent Living, Smart Homes,

CONVERSION OF NATIONAL TELECOMMUNICATION CORPORATION BUILDING INTO NET ZERO ENERGY BUILDING

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Abstract

Energy consumption in building sector in Pakistan is almost 30% of its total energy use and it is increasing with annual growth rate of 2.5% in commercial sector. The existing stock of commercial buildings in Lahore reveals that most of the buildings were constructed without energy conscious design, techniques and materials. Therefore, these buildings have a lot of potential for energy conservation. A planned and serious attention on these buildings in terms of energy load reduction, reclamation and generation may lead to convert the buildings into Net Zero Energy Buildings. Conversion of existing commercial buildings into Zero Energy Buildings may also help to possibly even putting energy back on the grid resulting reduction of load on National Grid. This paper focusses on converting of National Telecommunication Corporation building into Net Zero Energy building by upgrading the Building Envelope, Lighting Systems, using Renewable Energy Sources, Net Metering and relevant BIM tools.

Keywords:

Net-Zero Energy Building, Renewable Energy Sources, Net Metering, Building Envelope, Energy Utilization Intensity (EUI)

FIRST STEP TO CONVERT AN EXISTING BUILDING INTO NET ZERO ENERGY BUILDING

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Abstract

This research introduces first step for converting an existing building into Net Zero Energy Building. It has been established in previous researches that three major steps are involved for converting an existing building into Net Zero Energy building which includes Reduction, Reclamation and Generation. Before entering into Reduction phase, it is important to know that what %age reduction we can achieve in existing energy consumption pattern of a building. As lighting and HVAC loads contribute 25-30% and 50% towards total energy consumption respectively in any building. Therefore, these loads are critical and needs to be focused carefully for investigation. The exact calculation of existing lighting and thermal loads of the building may lead to effective decision and planning accordingly. This research presents that how lighting loads of an existing building can be calculated manually as well as on a software to assess the energy consumption with reference to lighting load of the building. The existing lighting loads of a building are calculated with the help of a software Dialux and subsequently these are analyzed with respect to actual requirement. The comparison of existing and actual lighting load concludes that a significant reduction can be made in lighting load leading to energy saving in building and estimation for reduction and also making assessment phase more effective and meaningful for converting an existing building into Zero Energy building.

Keywords:

Assessment, Net Zero Energy Building, Lighting Load, HVAC Loads, NTC Building

Experimental Investigation on Burnt Clay Pots of Various Heights for Thermal Roof Insulation in Residential Building

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Abstract

In this research an experimental investigation is conducted on Burnt Clay Pots (BCP) of varying heights and volumes for thermal roof insulation of residential building. The pots were designed and got manufactured from local industry. These prototype pots were placed on the roof of the experimental rooms, indoor and outdoor room temperature readings were recorded for 5 months from December 2017 to May 2018. The comparative analysis defines that the roofs with the clay pots have better thermal performance as compared to untreated room. The results also declared that the clay pots of greater volume performed better in thermal insulation than smaller volume in treated roof. On the basis of this experimental investigation, software simulation is made for various heights and volumes of the Burnt Clay Pots and comparative energy analysis has been performed for different height of air gaps in the roof specification. The research concludes that an optimum height and volume of Clay Pots can play significant role in indoor thermal conditions of the buildings and subsequently the energy saving with low cost investment.

Keywords

Burnt Clay Pots, Energy Efficiency, Roof Insulation, Indoor Room Temperature, Air Pockets.

ENERGY EFFICIENCY SOLUTION FOR EXISTING HOUSES IN LAHORE, PAKISTAN

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Abstract

This research analyses energy efficiency of six existing houses of various representative orientations in leading housing society of Lahore, proposes various energy efficient solutions for those houses and quantifies their effectiveness by preparing and analyzing their energy models in Ecotect Software. The solutions for energy efficiency have been selected keeping in view of the minimum intervention in building operation while installation. The research recommends optimum solution for energy efficiency of residential brick masonry buildings and concludes that using thermal insulation on walls and roofs and double glazed window glass 36-37% cooling loads can be reduced while reduction in heating loads is even higher ranging from 42-45%. This retrofitting novelty can solve energy shortage problems currently faced by Pakistan.

Keywords

Energy Retrofitting, Energy Efficiency, Heating Load, Cooling Load,

Comparison of Thermal Performance of Hollow Clay Roof Tiles with Traditional Roofs

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Abstract

In this research Hollow Clay tile is developed and investigated for various engineering properties including roof thermal insulation. The tiles are further investigated through an energy model of an existing house in Defense Housing Authority of Lahore for energy efficiency and compared with R.C.C. roof with mud plaster and R.C.C. roof with solid clay tiles. The energy models are prepared on Autodesk Ecotect. The comparison of Hollow Clay Tile roof with traditional roofs finishes reveals that Hollow Clay Tile finished roof is more beneficial as compared to traditional brick tiles in terms of reducing heating and cooling loads. The results of research depict that more than 10% HVAC loads can be reduced with the use of Hollow Clay Tiles in roof assembly.

Keywords

Thermal analysis, Energy efficiency, Hollow Clay Tiles Roof, Traditional Roof, Cooling Loads

Impact of Orientation on Energy Efficiency: A Case Study of DHA Houses in Rawalpindi

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Abstract

This research explores and compares energy efficiency of one Kanal house located in DHA Rawalpindi for ten different orientations. Energy models on Auto Desk Ecotect are prepared for all the cases by varying the orientation from true North to East with an increment of 5°. These models are investigated for summer cooling loads. Simulations are run for ten options within a varying range of orientation from 0°- 45° and data related to summer cooling load (April to September) is obtained for each orientation. The comparative analysis of models with varying orientations reveals that 5° rotation of plan from true North to East is optimum solution among all options for orientation of one Kanal house in Defence Housing Authority in Rawalpindi for summer condition to minimize energy usage.

Key words

DHA bye-laws, Energy efficiency, Orientation, Ecotect, Thermal analysis

Experimental Investigation on Performance of Earth Tube System (ETS) for building in Lahore

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Abstract

Earth-Tube System (ETS) is one of the passive cooling and heating techniques for buildings which is cost effective and helps in reducing energy consumption in buildings. It is being practice in many countries but in Pakistan it has very limited application. In this research, an experimental investigation is carried out on a room of an existing building where closed ETS system is installed and monitored for indoor/ outdoor temperature and data collected. The results are critically studied, analysed and compared with established standard which reveal that ETS system is helpful in creating acceptable thermal conditions without mechanical air conditioning and further the hybrid system can reduce hours of mechanical air conditioning.

Keywords

Earth Tube System, Residential Building, Indoor Thermal Condition

A Comparative Study of Low Cost Wall and Roof Assemblies for Energy Efficiency

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Abstract

This paper explores and compares cost-effective energy efficient wall and roof construction techniques for low cost residential buildings in Lahore to facilitate the low-income group people. A house of 5 Marla size is selected in State Life Housing Society, Lahore for investigation and development of energy models using a software Revit-Green Building Studio. Four energy models are developed with various wall and roof combination to assess energy consumption in each case. The models are critically analyzed and compared in terms of heating/cooling loads and electricity consumption per annum and peak demand months. The research concludes that careful selection of construction techniques for walls & roofs in housing projects can lead to significant cost and energy saving resulting load reduction on national grid and sustainable solutions in low cost housing projects in Pakistan.

Keywords

Low Cost Energy Efficient Housing, Rat Trap Bond, Filler Slab, Compressed Stabilized Earth Blocks, Sustainable housing

Performance of Various Solar Shading Devices Against Different Orientations

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Abstract

In hot climatic regions buildings consume major part of energy for cooling. Solar heat gain through windows contributes a major part in increasing the cooling loads. There are various methods and techniques being used to reduce the cooling loads through windows. Application of shading devices on windows can reduce the cooling loads significantly. There are various types of shading devices that can be applied on windows. External shading devices are more effective than the internal ones as they stop solar heat before it gets enter into the building. Design of external shading devices depends on the sun path as sun change its position every time, so type and location of shading devices cannot be same for each orientation. Which type of external shading device is best in which orientation and how these devices contribute in reduction of solar heat gain through windows has been presented in this paper. For the comparative analysis of shading devices with respect to orientation prototype models were developed with various types of shading devices with the help of software Autodesk Ecotect. Analysis was made for solar heat gain with and without shading devices for each orientation. This study was conducted for hot climate of city Lahore in Pakistan where the over-heated period is longer than the under-heated period. The Over-heated period spans for seven months from the month of April to October. The study concludes that inclined horizontal louvers are best for South orientation and angled vertical louvers are best for east and west orientations.

Keywords

Building orientations, Shading devices, Solar heat gain, Sun path, Energy model

Experimental Investigation on Performance of wood Shaving Layer in R.C.C. Roof Assembly for thermal Insulation

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Abstract

Reinforced Cement Concrete (R.C.C.) roofs are the most common roofs for residential buildings in Lahore and other areas in Pakistan. These roofs exhibit undesirable heat transfer during summer which includes high thermal conductivity which makes adverse indoor thermal living conditions in residential and other buildings. On the other side, the energy crises in Pakistan, does not favour to meet the requirement of cooling loads in buildings through mechanical air conditioning. Further, because of continuous increase in electricity and fuel prices in Pakistan, the dependence on active means of cooling in buildings is not a viable solution. This research through experimental investigation highlights the performance of wood shaving layer in R.C.C. Roof assembly for thermal insulation during summer. The outcomes of the research will be applicable in residential buildings of R.C.C. Roofs to lower indoor temperature during summer with a waste material under minimum cost of insulation.

Keywords

Thermal Insulation, Indoor Comfort, R.C.C. Roof, Wood Shaving, Residential Buildings