First International Conference on Carbon Neutral Built Environment (CNBT–I)
"A Step towards Sustainable Future"
December 20-21, 2018, Karachi, Pakistan

Greenhouse Gas Emissions Report for NED University of Engineering & Technology – A Case Study of Main Campus

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Abstract
Keeping in view the commitment made as a signatory of the Talloires Declaration to strive towards becoming a carbon-neutral campus, this article provides an overview of the work performed for the estimation of Carbon Footprint for the NED University of Engineering & Technology – Main Campus. The agents contributing towards the emission of greenhouse gases are listed and their effect is quantified in terms of total emissions for one year. A brief outline of the steps needed to offset the emission impact is also presented.

Keywords
Greenhouse gas emissions, carbon footprint, green campus

1. Introduction

The negative impact of greenhouse gases (GHG) upon global environment has been proven by recent researches establishing it as a leading contributor to climate change. As leaders in engineering and technical education, we must realize our responsibility and tirelessly work towards a drastic reduction of carbon dioxide emissions at our campuses.

NED University is one of the oldest institutions and a leading engineering university of Pakistan. On February 12, 2018, the NED University of Engineering & Technology became a signatory to the Talloires Declaration manifesting an institution-wide determination to strive towards becoming Pakistan's first Carbon Neutral Campus and leading other higher education institutions by example.

A number of universities and colleges around the world have already prepared and published their emission reports computing the carbon footprint for their respective institutions (Martin *et al.*, 2009, Bailey and LaPoint, 2016). The tool mainly used for the organization and estimation of such emissions is "Clean Air-Cool Planet Campus Carbon Calculator" (CA-CP) (UNH-SI, 2013)

1.1 Greenhouses Gases and Carbon Footprint

The greenhouse gases, such as water vapours, carbon dioxide (CO_2), methane, nitrous oxide, ozone, and chlorofluorocarbons, are the gases in our atmosphere which absorb and emit radiation within the thermal infrared range. 'Greenhouse Effect' is defined as the rise in temperature caused by the trapping of longwave radiation due to the presence of these gases in the atmosphere; that should have been transmitted into space otherwise.

Carbon footprint is a measure of the carbon dioxide emissions made into the atmosphere by a certain establishment or activity either directly (burning of fossil fuels) or indirectly (purchasing of utilities dependent on fossil fuels). The effect of other greenhouse gases can also be translated as carbon footprint in terms of metric tons of equivalent carbon dioxide released, MT eCO_2. Due to wide acceptance of the term carbon footprint, GHG signatures are often replaced by this term.

1.2 The Talloires Declaration (1990)

The Talloires Declaration is an international commitment made by the administrators of 22 universities from across the globe to work towards the environmental sustainability in higher education institutions. The declaration was first presented in 1990 at an international conference in Talloires, France, on "The Role of Universities in Environmental Management and Sustainable Development". The Talloires Declaration encourages its signatories to address sustainability in academia and take initiatives to operationalize environmental sustainability within the institutional infrastructure.

2. Carbon Emission Factors

Martin *et al.* have defined the emission of carbon dioxide and other GHGs under three sources or scopes as illustrated in Figure 1.

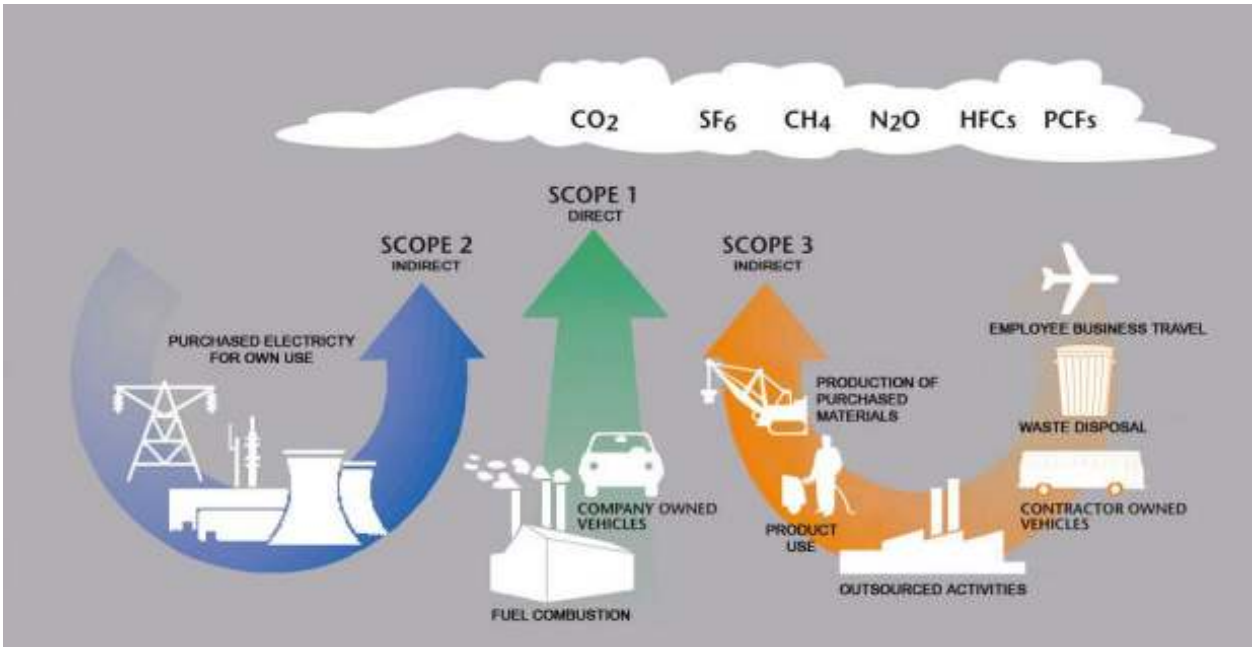

Figure 1: A summary of emissions under different scopes (Ozeki, 2016)

Scope 1 – Direct Emissions – Emissions of GHGs from the activities being performed at the campus site such as combustion of fossil fuels for heating or electricity generation purposes, university owned vehicles, waste generated, etc.
Scope 2 – Imported Indirect Emissions – Indirect emissions from sources not owned by the university; these emissions result from the combustion of fuels by a third party (steam and electricity generated off site) for use at the campus.
Scope 3 – Outside Indirect Emissions – Emissions resulting from university activities that occur from sources controlled by another company or entity and are optional for reporting, for e.g. carbon dioxide emitted during the commute of students and staff to and from the campus.

3. NED University Main Campus Carbon Footprint

3.1 Setting and Infrastructure

The academic and research activities at the NED University of Engineering & Technology are being carried out three campus sites; Main campus, LEJ campus, and the City campus. The Main campus is situated on Main University road, in the Gulshan-e-Iqbal Town of the Karachi Metropolitan City. Total area covered by the campus is 400,000 m² and is setup in a semi-arid urban location.

3.2 Carbon Footprint Estimation Method

The "Clean Air – Cool Planet Campus Carbon Calculator" or CA-CP calculator is a tool developed to aggregate all emission sources and to convert them into comparable units. This calculator has been used by over 500 universities and institutions across North America to estimate GHG emission inventories in their campuses. It is developed in the form of a Microsoft Excel® spreadsheet with many input, conversion, and emission factor tabs and is available online from the University of New Hampshire Sustainability Institute website. The calculator uses emissions factors garnered from the Environmental Protection Agency to convert all data into MT eCO_2. The American Colleges & University Presidents Climate Commitment (ACUPCC) recommends its signatories to use the CA-CP to calculate GHG emissions on campus (Ozeki, 2016). The contents of this report have been arranged using the same calculator.

3.3 NED Main Campus Carbon Footprint Estimates

A comprehensive study was performed under the CA-CP guidelines on all types of emission sources on account of the NED University Main Campus activities. A summary of the equivalent carbon dioxide emissions under each scope is detailed with respect to the major activity heads in Table 1. All the data provided is for one year i.e. July 2017 to June 2018.

Table 1: Distribution of NED University GHG Emissions under the scope and activity heads

	Activity Head	Estimated Amount	MT eCO_2	Total
Scope 1	Diesel for power generation	1500 Gallons	13	~1600 MT eCO_2
	Natural gas	22000 MMBtu	1100	
	Diesel for 19 University shuttles	21000 Gallons	300	
	Refrigerants	250 lbs	200	
	Organic fertilizers	6250 lbs	1	
Scope 2	Purchased electricity	3,655 MWh	1500	~1500 MT eCO_2
Scope 3	Students and staff commute	9.2 miles one-way	18100	~18400 MT eCO_2
	Solid waste	10 tons	30	
	Paper	220,000 lbs	270	

From the data presented in Table 1, it is evident that among the Scope 1 direct emissions, natural gas consumption comprises as the major carbon emission source. Yet its magnitude becomes insignificant when compared to the Scope 3 emissions solely due to the commute of students and staff members to and from the campus site. Although this number is based on a rough estimate taking into account weighted average of distances travelled by the campus population from across the city and major modes of transport used, given the highly dispersed and densely populated areas of Karachi city and the size of the university population, this estimate may be considered a reasonable figure for the identification of total carbon footprint under the Scope 3.

In order to realize the magnitude of these numbers, the number of trees required to offset these emissions may be used. Assuming that an average full-grown adult tree absorbs around 22 kg of carbon dioxide and sequesters it into biomass during a year, the number of trees required to offset the GHGs reported in Table 1 are as follows:

Table 2: Number of Trees required to Offset NED University annual GHG Emissions

	Activity Head	MT eCO_2	Trees Required
Scope 1	Natural gas	1100	50,000
	Diesel / Refrigerants / Others	500	23,000
Scope 2	Purchased electricity	1500	70,000
Scope 3	Students and staff commute	18100	825,000
	Paper / Solid waste	300	14,000

Of course, given the urban setup of the University and semiarid climate of Karachi, planting and sustaining this large number of trees to offset the campus carbon footprint will not be the most realistic solution. A more opportunistic approach would be reducing the carbon footprint of the campus activities by designing and modifying the existing activities and structures to make the campus more 'green'.

4. Offsetting Carbon Footprint

Since becoming Pakistan's first ever signatory of the Talloires Declaration, the NED University has exhibited complete determination towards formulating and implementing initiatives for the recognition of NED University as a 'Green Campus'. Around 1.2 million USD are spent annually from the University budget on the previously ongoing sustainability efforts. Now, the University leadership is determined to steer the sustainability efforts toward a carbon-neutral campus in new dimensions. A few of the programs in progress and recommended to achieve this goal are outlined below.

4.1 Awareness and Knowledge Building

First and foremost front in bringing about any significant change is to raise the awareness level among all the stakeholders instilling a drive to works towards achieving a common goal. The NED University has been offering young engineers a number of courses for their technical grooming and among those a significant number of courses are related to environment and sustainability (5% undergraduate, 7% postgraduate). On the other hand, total amount of research funds dedicated to 18 sustainability related research projects in 2017-18 has been more than 820,000 US Dollars.

In 2017-18, there were 06 events organized by the academic, administrative, and students' bodies of NED University addressing and highlighting environment and sustainability issues including Annual Tree Plantation Campaign. The Green Society of the NED University actively promotes Recycle, Reuse, and Reduce campaign to reduce the waste generation in the University campuses as well as to encourage the minimal use of paper and plastic products at the campus and in daily lives among the students and the staff members of the University.

4.2 Plantation

At present, the NED University has a wide variety of flora in the form of trees, shrubs, and hedges. These plantations have been estimated to be equivalent to around 5500 fully grown adult trees (EFGT), as shown in Table 3. Evidently, these trees are insufficient to curb the carbon emissions for any of the major source. The NED University has been striving hard to maximize the area of the main campus covered in vegetation and trees to not only offset the carbon emissions but to improve the environment and ambience of the university premises.

Table 3: Number of Trees planted at the NED University main campus

Type		Nos.	Running feet	Conversion Factor	EFGT
Trees & Plants	>6'	2952	-	1	2952
	3'-6'	1935	-	2	968
	<3'	1649	-	5	330
Hedges	>6'	-	3570	3	1190
	3'-6'	-	300	6	50
	<3'	-	1075	15	72
Total					**5561**

The major challenge in realizing the plantation of more trees at the main campus is the availability of water for their irrigation. NED University is currently treating 20,000 gallons of wastewater per day to be used to irrigate the vegetation across the main campus along with fresh water. Work is in progress for the augmentation of the current wastewater treatment facility capacity to provide more water for irrigation and hence less will be wasted in the sewerage lines.

4.3 Renewable / Sustainable Power Production

Major contributions of the carbon footprint come from the Scope 1 and Scope 2 emissions (Table 1) i.e. due to the purchased electricity, the natural gas for heating requirements, and diesel for power generation. All these heads can be minimized and ideally eliminated if the entire power and heating requirements of the campus are fulfilled using onsite electricity generation via renewable and sustainable resources such as solar cells and wind turbines. Industrial collaboration and engineering ingenuity of the NED students can be helpful in realising this goal in the near future.

Currently, the University has installed solar power generation capacity of 15 kW panels in the departments of Civil and Mechanical Engineering. The electricity produced is being utilized for powering certain offices and buildings at the main campus. It has been estimated that around 13000 to 14000 solar panels will need to be installed to fully cater the power requirements of the main campus. In the future, study projects can be offered to aspiring students and researchers to investigate the possibility of transforming NED's fleet into zero emission vehicles using any surplus power available from the solar panels.

4.4 Smart Built Environment

NED University is working towards ultimate transformation of its facilities into smart built environments. As a test case, work has already been started on the Central Library to transform it into a green building with focus on getting it certified by the Leadership in Energy and Environmental Design (LEED), which is the most widely used green building rating system in the world.

5. Conclusion

The GHG emissions were estimated for the main campus of NED University for one year and it was found that the biggest contributor for the campus carbon footprint is due to the daily commute of the university population followed by the purchased electricity and natural gas consumption, respectively. This amount of carbon footprint cannot be fully offset by simply planting more trees but drastic measures are required to reduce the power and fuel consumption on the campus, implementation of smart building framework across the campus, renewable and sustainable power generation onsite, and most importantly, provision of ample environmentally friendly and comfortable low- or zero-emission transport facilities to the students and staff of the university coming to the campus from all across the city.

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Green Computing: Techniques and Challenges

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Abstract
Nowadays, computer is being used not only in the organization, but also in homes, schools, universities and many other places where there is a need of a workstation. With the usage of computers on daily routine consumption of energy is rising swiftly due to that carbon dioxide is also increasing which causes environment effect. Green computing has gained various attentions from researchers, scientists, educators, and industrialist all around the world. The main point of green computing is to expand the effectiveness of the IT objects and its life cycle. Furthermore, it also supports the reusing of useless electronic equipment's. In this paper, we introduce the concept and history of green computing. Moreover, we also explained the challenges of green computing and techniques of green computing to use IT related products in an efficient way so less carbon emission can be generated.

Keywords
Green Computing, Energy Consumption, Techniques, Challenges, Awareness.

1. Introduction

Green computing is an up-and-coming idea towards reducing dangerous material and to save our surroundings from the destructive impacts of the usage of workstations and other products of electronic. In today's world with the development of most modern technologies the use of Smart gadgets is creating a harmful impact on the environment. Due to this reason green computing has gained various awareness among universities, governments, councils and researcher in the world (Bob Crook*et al*., 2009). This era belongs to the PC, Laptops and smart devices. These devices have powerful features that often require recharging of battery because of high energy utilization while using the appliances. With the usage of Computers and IT devices, it will continue to lead more and more effect on the environment so concentration has to be focused on creating a powerful platform. By familiarizing yourself in green computing it can be very helpful to save our environment because mostly computer and electronic devices energies are often used carelessly. For example, by leaving the computer on when it is not in use a lot energy is wasted because CPU and monitors will be consuming the power (Bello Abdullahi Birchi, 2015). So there is a great need to save energy consumption for common man to save our environment. The main

idea of green computing is to use the resources in the most effective manner so that atmosphere effect can be decreased.

2. What is Green Computing?

Green Computing is not all about using computers and other electronic devices in an efficient and effective manner. But also to decrease the environmental effect which is caused by computers and IT products. The aim of green computing is to reduce the usage of harmful material, increases the power effectiveness of all through the life span of IT products and support the recyclability or biodegradability of obsolete products and industrial unit misuse (Dr. I. Lakshmi and G. D. DhanaLakshmi, 2015).

3. History of Green Computing

The movement of Green Computing was started way back in 1992 when the United States, US Environment Protection Agency (EPA) began 'energy star' plan to promote energy efficient schemes. Energy Star served as a type of intended label awarded to computer and other IT related products that succeeded in diminishing the usage of power while maximizing efficiency. This resulted in the extensive adoption of sleep mode among users electronics (Pardeep and Navdeep, 2013).
Energy star is practical to products like TV sets, PC screens and controlling of temperature devices like fridges, AC and related items.
At the same time, the Swedish association TCO advancement commenced the certification program to support low magnetic and electrical emission from CRT-based Computer display. This program was afterward extended to include criteria on energy utilization and usage of harmful material in buildings.

4. Advantages and Disadvantages of Green Computing

Every Technology of past, present and in the upcoming future will have some pros and cons. When we are going to implement green computing we will see different pros and cons in every structure. Below here are some of the following advantages and disadvantages of green computing (Hezbullah and Tariq, 2015).

4.1 Advantages of Green Computing

By using the techniques of Green Computing we can decrease energy consumption, which result in less carbon dioxide. Green Computing supports the exercise of renewable resources such as Oxygen, Fresh Water, Solar Energy and biomass. It is also sponsored the natural resourced deployment. Furthermore, removing the risk that exists in the laptop and PCs such as chemical, radiation that can cause skin sickness, cancer and nerve injury and so on. We can save as much life as we can from dangerous radiations. Green Computing also agrees to the modification of governmental policies to encourage and lowering the usage of energy by business and individuals (Kiruthika and Parimala, 2017).

4.2 Disadvantages of Green Computing

Green Computing is very good for the environment. But it is quite expensive because it desires the most recent machinery to deal with the removal procedure. For example, if you choose to buy some kind of high powered green computer like Mac Book. It will charge you at first-class prices. A quantity of computers that are green may be noticeably underpowered. Many people are needed for exceptional power-consuming and powerful workstations to deal with work that they are given to do. People who have supercomputers believe that they have green computers. This is another issue because powerful and green computers are more expensive such as Apple's Computers. Changing of Technology Rapidly have a low initial price and with intended obsolescence has resulted in a quick-rising surplus of unused hardware around the globe.

5. Techniques of Green Computing

5.1 Power Management

The computer is consuming more electricity, which causing harmful impact on the environment. Turning on the power management feature on your computer, you can save energy and save on a huge amount of energy and money. By doing this will automatically decrease the atmospheric effect (Prantosh and Dangwal, 2012).

5.1.1 Sleep Mode

Put the Computer on low power consumption state. 60 to70 percent of the energy can be saved.

5.1.2 Hibernate Mode

In this mode, everything is shut down. When coming out of this mode, the PC reestablishes the memory state, restoring the PC to its Pre-restate**.**

5.1.3 Monitor Brightness

The majority of users who are using PCs uses at high Brightness which causes more electricity to be consumed. When we are using a PC we should turn down the level of brightness level to save energy.

Figure 1: Sleep Mode Function for Window 8

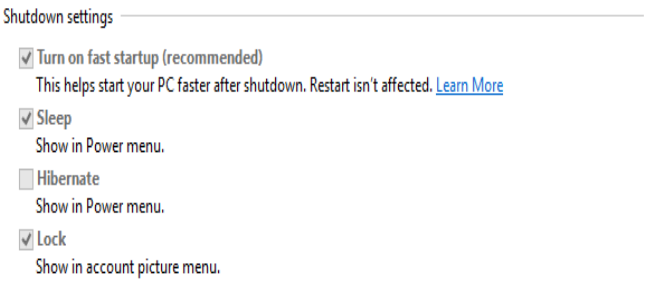

Figure 2: Hibernate Option for Window 8

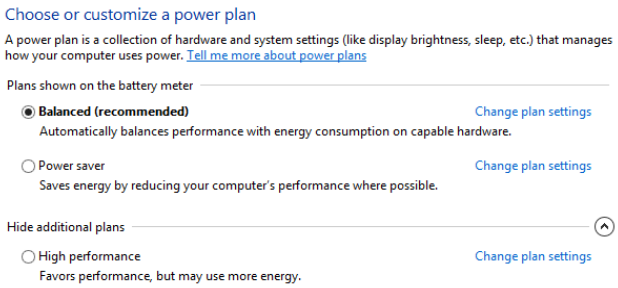

Figure 3: Adjust Monitoring Brightness for Window 8

5.2 Recycling of E-Waste

E-waste referred to any electronic waste that is never again needed. For example, if a PC is out of date, it doesn't mean that all computing equipment is useless. Some material can be used for recycling to decreased surrounding effects (Rina*et al*., 2015).

Figure 4: Use recycling to reduce environmental effects

5.3 Virtualization

This is the most important name in green computing. In virtualization, an administrator could merge numerous physical systems into virtual machines in one solitary, influential system, in so doing unplugging the only one of its kind hardware and diminishing power and cooling utilization. Virtualization can aid in giving out work so that servers are also full of activity or place in a low-power sleep state (Richa*et al*., 2017).

5.4 Telecommunicating

Teleconferencing and Telepresence are the important traditions to promote the idea of green computing. In this technique there are many benefits such as increasing employee satisfaction, decreased in greenhouse gases and also increases profit margins.

5.5 Using of Energy Efficient Products

Buying of various electronic and electrical energy efficient products we can consume less power due to that we can save money. Therefore, it is necessary to use energy star labeled products to make our homes, cities, offices and business' green (Lakshmi*et al*., 2012).

5.6 Replacing of Paper with Online Communication System

Nowadays, everything is linked to the internet. We can send our message through emails, whatsapp and social media and many more. By reducing the use of papers we can save a lot of money and energy. It is significant to keep in mind that reducing the use of paper can also reduce the environmental effect that is created when we are manufacturing this product.

6. Challenges of Green Computing

In this era the need computing has become a necessity in our daily life (Swasti Saxena, 2015).Due to which computers are using a large amount of energy. Therefore, it has become a major challenge for the computing industries. Because of this reason green computing must focus on lessening the IT framework and machinery associated costs as natural resources are being consumed enormous.

Major IT companies are focusing on developing energy efficient machinery, power cooling system, data center and so on. According to the researchers in the field of green computing following are the some challenges that are being faced today (Sonu Choudhary, 2014).

6.1 Investment Return

One of the most difficult things that are faced by green computing is satisfying association and their partners to spend on substantial beneficial computing. A setback is that they want to see a prompt impact, but it takes a significant lot of time for the investment to demonstrate real advantages and changes.

6.2 Electronic Wastes Removal

Appropriate disposes and finding ways to proper recycling of the electronic items also are a problem, which needs to be resolved to decrease the harmful effect on the environment.

6.3 Consuming of Power

Many IT, manufacturing companies are trying to discover a creation of IC chips that have high effectiveness and also can deliver better performance without consuming too much energy. But it is not an easy process. It will take a lot of time and money to accomplish this goal.

6.4 Increasing of Energy Requirement

A few individuals need or like to utilize high processors to accomplish their undertakings. Be that as it may, these necessities require an awesome measure of intensity with the green PCs with similar details considered greatly costly, for example, the Apple's capacity scope of PCs.

7. Outcomes of Green Computing

During writing this paper, we have come across some of the following aspects that in Pakistan, the concept of green computing is less than average scale. Most underdeveloped cities are not aware of green computing concepts. In addition, we have found that developed cities have some knowledge of green computing and the practices of green computing in urban cities are average. Some educational sector and organization sector have the awareness of green computing, but the practice is very low. The Fig.5 clearly shows the overall awareness of green computing that was taken from students, teachers and professional workers through link den, Facebook, Email and other social websites. From the result we found out that the awareness of green computing among respondents is very low (Sivasangari and Norasnita, 2015).

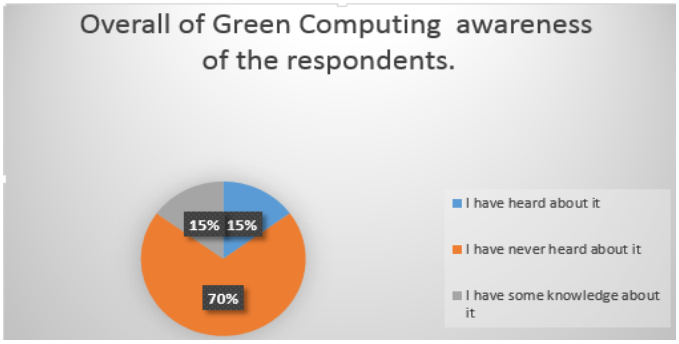

Figure 5: Overall Green Computing awareness of the respondents

In 2015, among Asian countries, Pakistan was one of those countries that had a least forest area which is shown in figure 7 that was complied by ANN/Data leads. The country has just 1.9 percent of its ground under wrap with forest area.

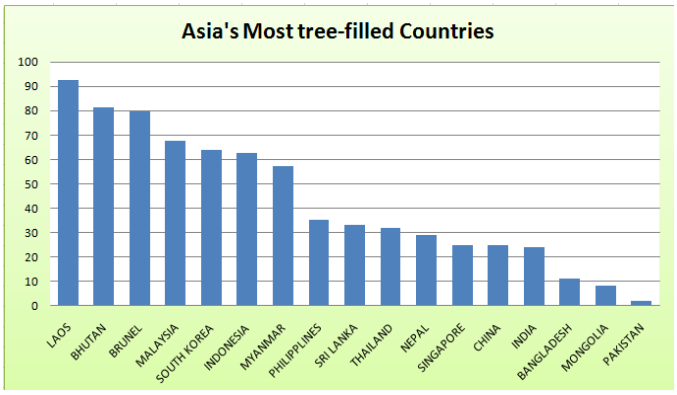

Figure 6: Pakistan has a lowest forest area among other countries in Asia.

8. Recommendations

Start Awareness campaign among universities and industries promote those methods and techniques and check out the measure success and publicize success (Tunku*et al*., 2014). The government should make policies and guidelines for disposal of used equipment. The government should obtain a suitable space for storing the electronic waste and monitors. The government should develop a green purchasing policy for computers and electronic equipment's. Manufactures should start using electrical efficiency standards.

The Research & Development Area in those companies which are creating IT products must find a way to improve environmental impact. Pakistani Universities must revisit it polices and must create an institution of strong foundations for green policies, initiative and program. Moreover, Universities of Pakistan of every type which include business, engineering, humanities, laws, medical and many more etc. should consist of pro- environmental behavior courses and make it obligatory in their curriculum.

Many People spend their time online, the universities and organizations should be create website related to green computing to generate additional knowledge. The website should have information on saving money and energy, university green policies. Organizations and Universities must organize various workshops, seminars and conferences on green issues to create better understanding of the environment and other problems as well. Planting of tree in different cities and the strategies, maintenance campaign should be mounted in order to absorb the carbon dioxide emitted resulting from computing practices.

9. Strategies for to Go Green

Green computing is a proposal that was cropped out due to current environmental issues. The government of every country is trying to maintain the environmental problems through awareness programs, policies and so on. Furthermore, green computing isn't only helpful for the environment, but it is also cost efficient. There are many strategies to save money and energy for example: The device should be turned off if they are not in use. Devices such as scanner, laptop, printer and speakers (Tariq and Sarwar, 2012). Laptops should be used instead of desktop because they consume less energy. We should keep track of your electricity bills with the help of the Smart Meter. By using this smart device you can control and monitor your energy consumption. Computer Applications and Monitor should be turned off when you are not using. By doing this, we can extend the lifetime of computers and monitors. Taking advantage of Natural Light (Daylight Harvesting). Natural light lets owners and residents to switch off artificial light, thus resulting in energy cost savings. Natural light aids, to manage and lessen glare, allowing families and commerce owners to allocate light more equivalently all the way through a space. Finally, people who breathe and work in an environment packed with natural light be inclined to be better-off and more creative.

10. Conclusion

Green Computing will be the main drive for future computing. Green Computing represents the using of computer and other related resources in such a manner that atmosphere should be minimized. We have also seen the advantages and disadvantage of Green Computing. Furthermore, we have talked about different techniques for green computing to save energy and money and challenges. In addition, we have examined what were the consequences and what recommendations should be taken. Developing Countries should start an awareness program with the assist of newspaper, TV-adds, meeting, conference and many more things.

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Awareness of Green Computing among Students of NED University of Engineering and Technology.

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Abstract
Green computing is getting more and more aware due to growing of energy cost and increase of environmental effect. Green Computing is the examination and exercise of using the IT related assets in a well-organized and effective way so that consumption of energy can be reduced. The main feature of Green Computing is to reduce CO2 emission. The main objective of this investigation is to verify awareness and use of green computing between the undergraduates of the NED University. In addition, to find out level of awareness and practices of green computing a questionnaire was distributed among engineering and non-engineering students of different departments. The result that we have calculated shows us that most undergraduates don't know about green computing. Despite the fact that people are using an energy saving function of computers and other IT related products for their research, work, and for other purposes. Still, they are unaware of the concept of green computing. The investigation outcome suggests that further awareness is mandatory among pupil so that approaches can be taken to reduce environmental effects.

Keywords
Green Computing, Energy Consumption, Techniques, Awareness.

1. Introduction

Nowadays, computers are the most commonly used machines invented in the 21 century. Every day, millions of people use computer in workplaces, homes, libraries, laboratories and many other various places to make their work stress free. Due to large amount of people using the computer on a daily basis it requires a sufficient amount of energy. It is known that a particular computer consume electricity between 95 and 650 watt on a daily basis. Just assume if a single computer is consuming this much energy then how much power will be consumed by millions of workstation on a daily basis. Furthermore, most people are not aware about the harmful impacts that are generated by computers. Many PC and related equipment are manufactured by using toxic chemicals like lead, chromium and many more which cause environmental effect. Usage of computers and other IT related products will continue to expand which will cause more and more damage unless proper actions are taken to decrease or

eliminate environmental hazards. The method of examining the environment effect which caused by PC and consumption of energy is often referred to as Green Computing (Mittal and Kaur, 2013).

Green Computing is not just the responsibility for environmental and but also the exercise of using IT related resources in an efficient way. According to Murugan green computing can be described as " the study and practice of scheming, developed, utilizing and discarding of PC's, servers, and linked subsystems, such as screens, laser printer, storage space, gadgets, and system administration and e-mail systems, proficiently and successfully with insignificant or no effect on conditions".

The core purpose of green computing is to encourage a machinery and procedure outline that is vital, resourcefulness and ecologically friends with lesser or no dangerous material used or produced. Moreover, it is also promoting the recyclability of utilized PC gadgets and reduced electronic unwanted. Many of the IT manufacturers and dealers are investing their money to design energy efficient devices for reducing the harmful environmental effect and make their appliances to work for longer lifetime (Kumar *et al*., 2014).

The US Environmental Protection Agency (EPA) started a charitable labeling program known as an Energy Star program in the year 1992. The aim of this program was to support and identify energy- efficiency in monitors, equipment's for controlling climate, printers, TV and many other technologies.

The aim of Green Computing is to decrease the consumption of power of the IT products so that less CO2, emission can be produced, to increase the life of IT equipment as far as possible, to decrease or eliminate the harmful effect to the surrounding which caused by the used of dangerous materials and to promote the reuse of old products.

The main benefits of Green Computing are to lower energy expenses, improved operating efficiency, and extended long-term computing devices, Better utilization of resource and Friendly environment.

2. Literature View

This paper was inspired due to the increasing rate of energy in Botswana, lessening of raw materials, growing anxiety for the atmosphere by the both college populations. The primary purpose of this paper was to determine the level of knowledge of student and staff members with respects to green computing. According to the results, level of awareness was low because most of the users were unaware of energy saving techniques (BATLEGANG, 2012).

The most important intention of this paper was to calculate the level of awareness among undergraduates with respect to green computing. Likewise to check the information of the undergraduates and green IT practices. A survey was intended a circulated among the undergraduates of the School of Innovative Technologies and Engineering, University of Technology, Mauritius. The respondents were both males and females and level of study was between from First year to third year. From the outcome we saw that the understudy has the moderate learning about green computing. But require various low execution practices (Dookhitram*et al*., 2012).

In this era Greening its practices are one of the biggest challenges that our generations have to face. The governing bodies all around the world and manufacturing companies of their own products are now fully persuaded for making products more sustainable so that the globe will be less contaminated and energy bill will be lesser. The studies demonstrate that attentiveness and practices of green IT among apprentice and commercial students at the University of Worcester are average. The time has come to expand the awareness and practices of green it and its standards. According to the author believe educational institution has a significant task to carry out in this procedure. Each person who utilized present day computational gadgets needs to look at his very own practices and make alteration if important (Boloz, 2015).

The main inspiration of this research was to estimate the level of green computing awareness between Zayed university students. Moreover, to check their responsiveness level towards green computing; a survey was planned and circulated amongst them. Based on the exploration of results, it is decided that learners know about of the expression "Green Computing", however, don't know about how it is executed. There are numerous approaches to raise awareness among Zayed University students and that is by giving green computing workshops, seminars, conferences and preparation curriculums for the undergraduates and Post Graduates and launching programs and methodology to improve helpful 'green' practices between them (Ahed and Amira, 2018).

3. Objective and Methodology

The aim objective of this paper is to compute out the awareness of green computing between undergraduates of Ned University of Engineering & Technology. This awareness based paper mainly focused on the following questions, such as Usage of Computer and Other related IT products by the students, Knowledge of Green Computing, Practices of Green Computing by the students and measuring the attitude of students towards green computing (Badariah*et al*., 2013).

To find the answer of above questions 15 item questionnaire was arranged and were shared amongst students of various departments. The survey comprises of three areas:

In section (A) was demographic knowledge. In section B was usage of computer and in section C was knowledge and practices of green computing.

In section A was demographic questions regarding students' gender and their level of study. In section B consist of the following questions:

- How numerous years have you been utilizing computers?
- How countless hours out of each day do you use computers?
- How many hours out of each day would you say you are connected to the internet?
- How many computers do you claim?
- What is the normal no of pages do you print every day?
- How many years have you been using your current PC?

In Section C, questions were exhibited to monitor the demeanor of the students towards their obligation of the atmosphere, student's understanding about green computing and theirs meaning to apply green computing.

4. Result

4.1 Demographic Facts

The data we have collected from the students was 70 % of males and 30 % of girls. From the data we analysis that most students were from the third and fourth year. Furthermore, we have also collected feedback from post-graduates students.

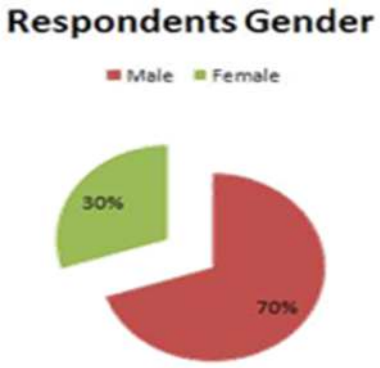

Figure 1: Respondents Gender

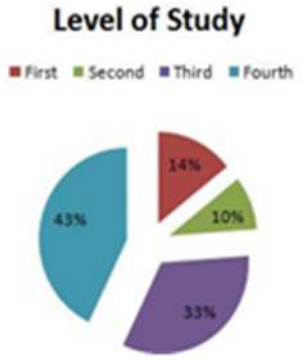

Figure 2: Study level among the student

4.2 Usage of Computers

According to the information taken from the students more than 80 percent of the students have been using computers and laptops for more than 6 years and 50 % of the student have owned 2 or more computers or laptops. We further examined that students use computer 2 to 5 hours per day. But still it is a fact that smart phones are mini computers and many of the students are connected with the internet more than 10 hours per day. In terms of printing, mostly students' print average of 3 to 10 pages per day.

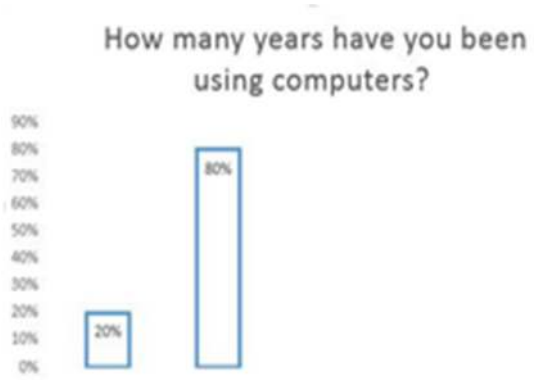

Figure 3: Years of Using Computers

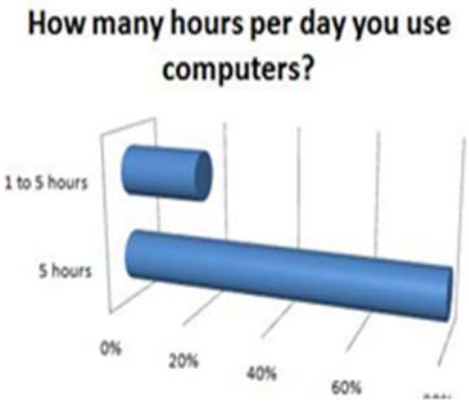

Figure 4: Usage of Computers on daily basis

4.3 Knowledge and Practices of Green Computing

The result in Figure 5 shows that 80 % students haven't heard about green computing. Only 20% percent of students have about green computing. Furthermore, we have examined the use of energy efficient products among

students. More than 80% students use only energy efficient products in their homes, business and so on. In addition, we also investigated that the majority of the students know the about the low energy consuming modes that are present in computers, laptops and so on (Abdullahi *et al*., 2013). The Fig. 7 results show clear that 60 % of the students always used low energy consumption modes. 25 % student use low energy consumption modes something's. Only 10% are unaware of these low energy consumption modes. Moreover, we questioned student if they were aware of environmental issues. In figure.8 the outcome clearly shows us that 70% of the students are aware, 25% are somewhat aware and only 5% are not concerned**.**

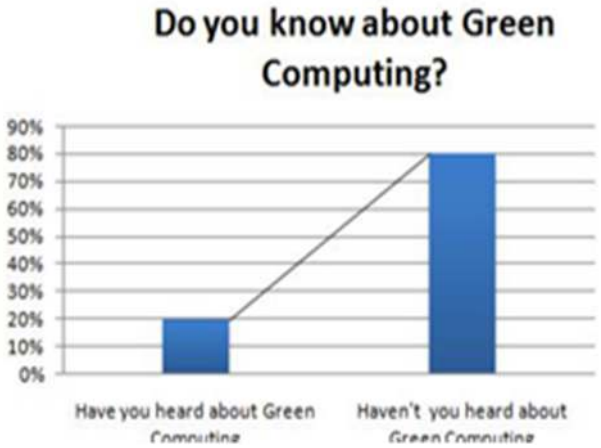

Figure 5: Knowledge of Green Computing

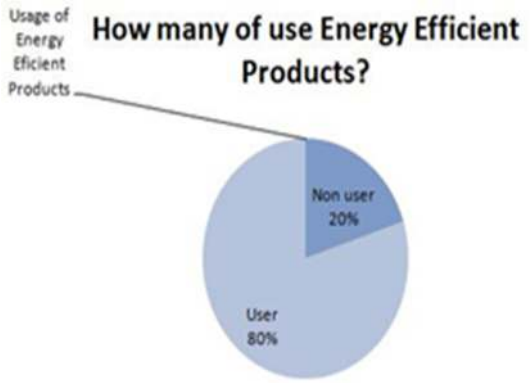

Figure 6: Usage of Energy Efficient Products

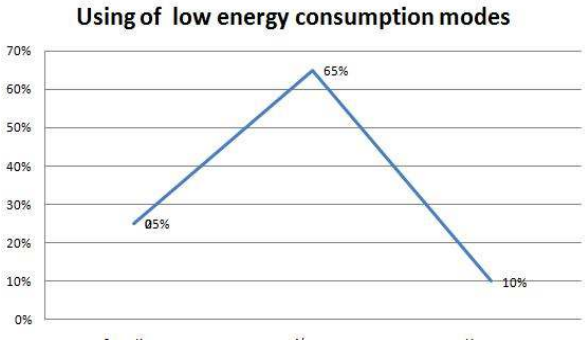

Figure 7: Usage of low energy consumption modes

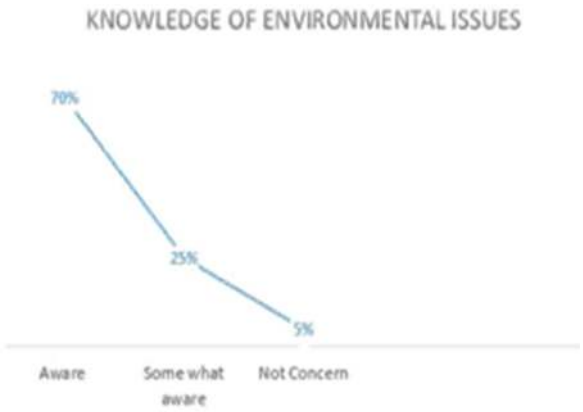

Figure 8: Knowledge of Environmental Issues

5. Discussions

Form the data we have collected from undergraduates indicates that the most of the students is PC educated and utilizes a PC on a daily basis. Moreover, we founded that most students spend their time on the internet. The internet is one of the best sources where students can learn energy efficient it products and can gain it related environmental knowledge.

We have observed that the knowledge of green computing among students is very low. The majority of the students are not aware about green computing. We have also investigated that not knowing the term of "Green Computing" students do not know the benefit of green computing.

Furthermore, we also check if the students have any knowledge of harmful emission which is caused by computers and other it products that impact on the environments. More than average students have knowledge on environmental issues that is caused by computers and its related products. We also asked many of the students about energy efficient products that are coming on the market. Many of the students agreed that they buy and used energy efficient products in their homes so that energy can be consumed less. Moreover, we check if student uses low power consumption modes in Computers or laptops. Only 10% students were unaware of this kind of option in computers. Despite, the fact majority of the students do not know about green computing, but still it is to be notified that students know about environmental issues, energy efficient products, recycling and power consumption.

6. Recommendations

Following are some recommendations that were taken from many journals, research paper, books and from the internet. To create more awareness among NED students of different departments. The University needs, identify green strategies that are controlled by Advisory Committees of Environmental and these guidelines must be updated on a standard basis so that stronger foundation can be built on green policies. Many of the students spend their times on the internet. The Campus should design a website for green computing to increase the awareness (Selyamani and Ahmad, 2015). The website must contain the contents how can energy be saved, policies, environmental issues and other related information about green computing. The university should organize several workshops, session lectures, conferences, competitions and several more programs to help the students to get more knowledge and awareness of green computing (VADHANI *et al*., 2017).

7. Conclusion

Green Computing is the promising technology, which will assist to lessen the electronic waste. The foremost aspire of the paper was to calculate the understanding level of pupil with admiration to green computing. A feedback form was arranged and dispersed among the students the NED University of Engineering & Technology. The respondents were students both gender and the year of study choice from first year to last year. We experimented that the student has less know how of green computing and the practices of green computing is above averages.

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First International Conference on Carbon Neutral Built Environment (CNBT–I)
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December 20-21, 2018, Karachi, Pakistan

Key Drivers for Organisational Sustainability Performance

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Abstract

Construction companies are under an enormous pressure the to improve their sustainability performance. However, there is little known to what organisational attributes helps to improve organisational sustainability performance of construction organisations. This study aims at examining the top drivers of organisational sustainability performance with in the construction industry. Under this aim the detailed objectives are to: (i) examine the main internal and external drivers of organisational sustainability; (ii) rank these drivers in order of importance; (iii) establish a relationship between sustainability awareness and sustainability performance. Data was collected from top Australian construction organisations via online questionnaire. The results of statistical analysis show that amongst internal drivers organisational culture and supply chain capabilities are the highest ranked drivers for organisational sustainability. While, legislation is ranked as most important amongst the external drivers.

Key Words

Construction organisations; organisational sustainability

1. Introduction

The contribution of construction industry is very positive to most countries in terms of employment and GDP yet, on the other side it consumes most of the world's energy and resources. This very substantial and value providing sector is underperforming in terms of sustainability (Mill and Glass, 2009). With the increased pressure from governments and conservationists construction companies are required to reduce these adverse impacts and improve their sustainability performance (Pagell and Gobeli, 2009; Chatterji et al., 2009). Therefore, sustainability performance is established as an essential agenda on the organisational planned strategy. Du Plessis (2007) specified that construction industry should not only respond to the need for adequate housing and swift urbanisation, but it should be done in a way does not harm the society and ecology.

Many researchers have shown interest in organisational sustainability performance. This include development of sustainability frameworks (e.g. Hill and Bowen, 1997; Shen et al., 2010) and assessment of sustainability practices of different industries (e.g. Labuschagne et al., 2005; Hahn and Scheermesser (2006);

Jones et al., (2010). Still, little is known about the organisational attributes that could help to improve sustainability performance of construction companies. Following the literature this paper identified six key organisational attributes and asked the top managers of Australian construction industry to rank them in order of importance. This paper used a survey research design which aimed to investigate the top drivers of sustainability performance within construction organisations. Under this objective the specific objectives are to: (i) examine the main internal and external drivers of organisational sustainability; (ii) rank these drivers in order of importance; (iii) establish a relationship between sustainability awareness and sustainability performance. Data was collected from top Australian construction organisations via online questionnaire. The results of statistical analysis show that amongst internal drivers organisational culture and technology are the highest ranked drivers for organisational sustainability.

2. Organisational Sustainability and Sustainability Performance

Acording to Khalili (2011) sustainbility demands to reduce of the effects of human expansion on the curent physical and social structure of the society and its natural systems. Due to the interdepndent nature of natural, economic and social systems sustainability has three dimensions environment, economy and society. Organisational sustainability incorporates the values of sustainable development with in organisations. International institute for sustainable development defined corporate sustainability as ‘‘adoption of business strategies and activities that meet the needs of the enterprise and its stakeholders while protecting, sustaining, and enhancing the human and natural resources that will be needed in the future’’ (IISD, 1992). The triple bottom line concept (TBL) of organisational sustainability requires the companies to find a balance between the three main aspects of sustainability. Similarly, Dyllick and Hockerts (2002, p.131) defined organisational sustainability as “meeting the needs of a company’s direct and indirect stake holders (e.g. clients, employees, stakeholders) without negotiating its ability to meet the needs of future stakeholders”. They emphasised that at the present time economic performance alone is not adequate for the overall success of corporations.

To manage sustainability, organisations need to improve their performance against economic, social and environmental bottom lines. Schaltegger and Wagner, (2006, p2) defined sustainability performance as “the performance of a company in all areas and for all drivers of corporate sustainability”. Orlitzky and Swanson (2012), highlighted that the aim organisational sustainability performance objectives is to see if organisations’ activities are associated with sustainable development, considering its obligations to the society on the institutional, organisational and individual levels.

2.1 Measurement of sustainability performance

Sustainability performance measurement emphases on defining of sustainability indicators, the set of indicators as a system with categories of indicators and the processes to design and implement sustainability management system. One of the most important challenge in the corporate sustainability field is find a standard method for evaluating Corporate sustainability. Most organisations use already created scales and instruments by other organisations. Examples include Dow Jones sustainability index (DJSI), Environmental management systems (EMS) and the Global Reporting Initiative (GRI).

2.2 Key drivers of organisational sustainability performance

This section discusses the main drivers of organisational sustainability performance. Despite much work done regarding sustainability it is recognised that little attention has been given to the methods of improving sustainability performance of construction organisations. As identified by Bansal and Roth (2000) the four main drivers of organisational sustainability are: regulation; stakeholder pressure; business opportunities and ethical motivations. Linnenluecke and Griffiths (2010) and Epstein (2008) grouped the drivers of organisational sustainability performance into internal drivers and external drivers. External drivers include law and regulation set by governments, or pressures from different stake holders such as community groups and the customers. Internal organisational drivers include: organisational culture; human resource management; supply chain management; employee skills and the business strategies.

According to Epstein (2008), organisations should align several sustainability elements into their organisational values, strategies and mission, they should also monitor how their company's operations are impacting the society and environment. He also outlined that organisations need financial to train staff with sustainability principles who will then be able to implement various sustainability programs. The amount of financial and human resources assigned to sustainability would significantly influence the ability to implement sustainability programs.

Winn (1995) studied the drivers of innovative environmental performance identified that demands by different pressure groups together with law and order are as the most significant drivers of environmental performance. Similarly, Lawrence and Morell (1995) outlined that organisations need motivation, opportunity, resources and processes to improve environmental performance. Banerjee et al. (2003) suggested that stakeholder pressure, regulation, competitive advantage and top management commitment are amongst important drivers of corporate sustainability performance. Table 1 summarizes the various drivers of organisational sustainability identified in previous studies.

This study have identified six internal drivers of organisation sustainability performance based on the previous studies these are: organisational culture; organisational structure; skills and attitudes of employees; supply chain capabilities; technological capabilities and business strategies. In this study the focus is on how these drivers could affect companies' sustainability performance as a group.

Senge et al. (1999) outlined that it is impossible to achieve sustainability without innovation and innovation is best accomplished in a culture that embraces and adopts learning and change. This is in line with Hartman (2006) who emphasised that in order to improve sustainability performance companies need to implement an organisational culture, which inspires learning and innovative behaviour.

In terms of organisational structure Burton et al. (2006) suggested that organisational structure affects the business strategy, which defines the sustainability performance. Several studies emphasised (e.g.: Naffziger and Montagno, 2003; Gadenne et al., 2009) on the importance of employees' skills and attitudes towards improving sustainability performance.

The next driver considered important for organisational sustainability performance is supply chain capability. Organisational researchers have realised that management of sustainability does not end at the boundaries of organisation. Krause et al. (2009) mentioned that an organisation can only be sustainable if its suppliers care about sustainability. Therefore, sustainability encompasses both internal processes and activities of external supply chain members. Researcher like Desarbo et al. (2005); Johnson and Clayton (1998) and Thrope et al., (2007) suggested that technological capabilities (including process improvement technology and information technology) could lead to improved efficiency and better sustainability performance. Dyllick and Hockert (2002) highlighted that sustainability need to be integrated into business

and into general business management. Table 1 summarises the drivers of organisational sustainability performance as identified in this study.

Table 1: Drivers of organisational sustainability

	Drivers	Previous studies
Internal Drivers	Organisational culture	Baumgartner (2009); Cameron & Quinn (2006); Linnenluecke, 2010; Eccles et al. 2011
	Organisational structure	Epstein and Roy (2001); Petrini and Pozzebon (2009); Burton et al. (2006)
	Human resources/ employees' skills and behaviour	Ángel Del Brío et al. (2007); Shastri and Srivastava (2009); Naffziger and Montagno (2003); Gadenne et al. (2009)
	Technological capabilities	Teece and Pisano, 1994; Verona, 1999; Thrope et al. (2007); Aw and Batra (1998)
	Supply chain capabilities	Krause et al. (2009); Eltayeb et al. (2011); Ofori (2000)
	Business Strategies	Figge et al. (2002); Dyllick and Hockert (2002); Salzman et al. (2005)
External Drivers	Legislation	Sharma and Henriques (2005), Wolf (2014)
	Stakeholder pressure	Bromley (2007)
	Business opportunities	Sharma and Henriques (2005)

3. Research Methodology

A survey research design was adopted in this research in which data was collected via an online questionnaire in Australia. For that purpose, the UNSW survey portal was used. The survey included various sections. In the first section respondents were required to provide general information about the nature, size and age of their company. Consequent sections asked about the sustainability performance of their organisations, main organisational drivers to improve sustainability performance and barriers for sustainability adoption. The respondents were asked to give responses on a seven-point Likert Scale, with scale point, ranging from 1 (very low/ bad) to 7 (high/ good). Braunsberger and Gates (2009) recommended that Likert scales should contain commonly used and defined scale points as they enable the researcher for the proper calculation of the means and standard deviations of items under examination. In this study, the questionnaire was preliminary tested and authenticated by three respondents from the construction industry, who were outside our sample frame. Required amendments were made to the questionnaire before the actual survey was sent to the sample. For the survey, simple random probability sampling was used whereby 165 possible companies were selected from a sampling frame of top 200 commercial and housing contractors in Australia. A key informant approach was adopted in this research where only one person filled the questionnaire. Out of 165 invitations 42 completed the survey (a response rate of 25.5%). Table 2 summarises the sample profile used for analysis.

Table 2: Sample profile

Description	Frequency	Percentage
Type of organisation		
Public listed	9	21.4%
Proprietary Limited	33	78.6%
Nature of construction activity		
Residential construction	8	19%
Residential and Commercial	14	33.3%
Non-residential	10	23.8%
Residential/commercial/engineering	3	7.1%
Commercial/ Engineering	3	7.1%
Engineering		9.5%
No of employees		
<100	15	35.7%
101-250	11	26.2%
251-500	6	14.3%
501-1000	4	9.5%
>1000	6	14.3%

4. Results and Discussions

Figure 1 indicates the sustainability awareness of the sample profile. The respondents were asked to rate the sustainability awareness of their organisation on the on a seven-point Likert Scale (1= unfamiliar; 2= least familiar; 3= slightly familiar; 4= somewhat familiar; 5= moderately familiar; 6= very familiar; and 7= extremely familiar). It is interesting to note that most organisations are familiar with the concept of sustainability. Only 4 respondents reported to be slightly familiar with the concept of sustainability.

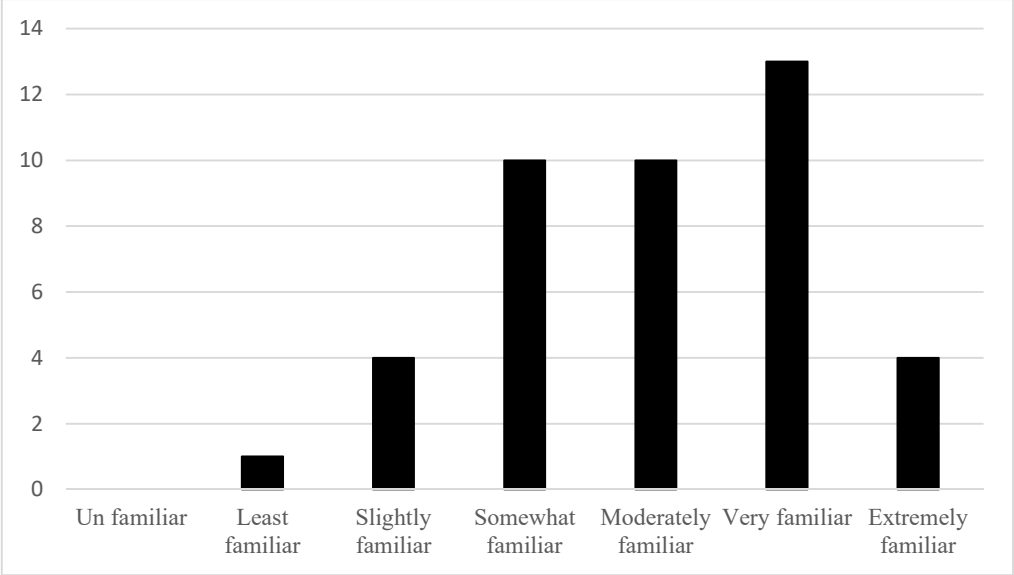

Fig 1: Sustainability awareness of Sample companies

Figure 2 shows that actual sustainability performance of sample companies. The respondents were asked to rank the sustainability performance of their company on a seven-point Likert Scale (1=very bad;2=pretty bad;3=bad; 4= acceptable; 5= good; 6= very good; 7= pretty good). Most respondents reported their company's performance to be acceptable (38%). While 12% rated the performance to be very good and 14 % rated it to be pretty good. This shows that most companies in the top 100 list are working proactively to achieve better sustainability performance. However, it should be noted that 22% respondents still consider their company's sustainability performance is pretty bad.

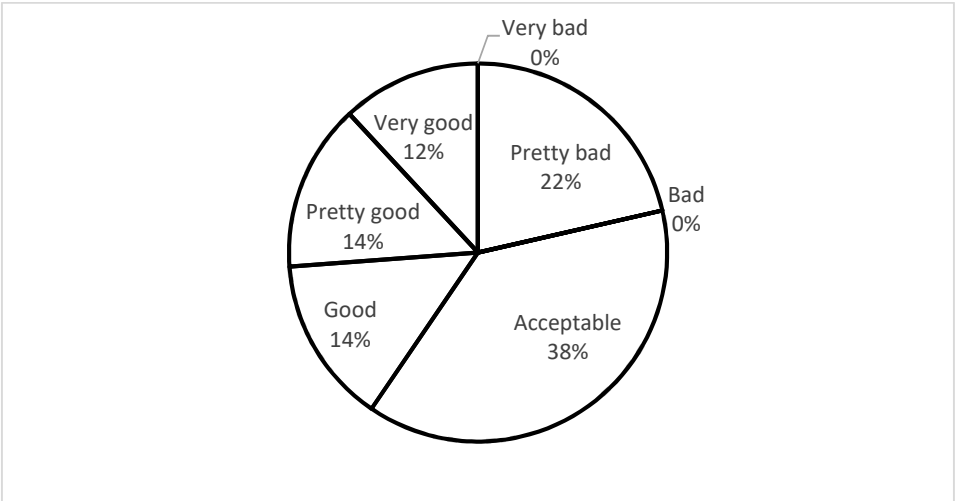

Fig 2: Sustainability performance of sample companies

Table 3 summarises the correlation between sustainability awareness and sustainability performance of the respondent companies. The correlation is calculated using spearman's Rho which is used to measure the strength of relation between two variables, where r = 1 means a perfect positive correlation and the value r = -1 means a perfect negative correlation. The equation used to calculate r given as:

$$r_s = 1 - \frac{6 \sum D^2}{N^3 - N}$$

The value of r is 0.873 and the two-tailed value of p is 0. This indicate that sustainability awareness and sustainability performance are highly corelated (p = 0). This explains that the sustainability performance of the company would be better that has more awareness of sustainability.

Table 3: Correlations

		Sustainability awareness	Sustainability performance
Spearman's rho	Sustainability awareness	1.00	0.873**
	Sig. (2-tailed)		0.00
	N	42	42
	Sustainability performance	0.873**	1.00
	Sig. (2-tailed)	0.00	
	N	42	42

**. Correlation is significant at the 0.01 level (2-tailed)

Table 4 shows the results of Friedman test. Friedman test is a non-parametric test used to measure the differences between groups when the dependent variable being measured is ordinal. The respondents were asked to rank the drivers on a Likert Scale of 1 to 7(1=not a driver at all;2= negligible driver; 3=moderate driver; 4=somewhat of a driver; 5= moderate driver; 6= high driver; 7= extreme driver). These responses were analysed using SPSS, a non-parametric Friedman test was conducted and rendered a Chi-square value of 108.729 which was significant (p=0.00). Supply chain is ranked as the most important driver of sustainability performance (average rank 7.08), followed by business strategies (average rank 5.71) and technological capabilities (average rank 5.63). According to the ranks given by the respondents organisational structure is found to be the least important driver for organisational sustainability performance.

Table 4: Mean rank of drivers for organisational sustainability performance

	Driver	Mean Rank
Internal	Organisational culture	4.31
	Organisational structure	1.86
	Skills and attitudes of employees	4.88
	Supply chain capabilities	7.08
	Technological capabilities	5.63
	Business strategies	5.71
External	Legislation	5.79
	Stakeholder Pressure	4.25
	Business opportunities	5.49

The findings affirm that if the organisation wants to improve sustainability performance, then management of sustainability has to go beyond the boundaries of company. These findings are similar to Elkington (2002), who suggested that sustainability cannot be accomplished by organisations' actions alone. Partnerships must be formed with other affiliates with in the supply chain to develop products and services based on environmental integrity, social justice and commercial capability. As construction industry is heavily dependent on supply chain practices, if sustainability is incorporated in supply chain it would help to improve the overall sustainability performance of the company. Amongst the external drivers legislation is ranked as the top driver (mean rank =5.79) for organisational sustainability performance. This result contradicts the study done by Banerjee et al. (2003) who concluded that public concern has higher rank than legislations as a driver to improve sustainability performance.

5. Conclusion

The research use survey research design in which the data was collected via an online questionnaire from the top 100 construction companies. The results indicate that amongst the internal drivers supply chain capabilities is the most important driver of sustainability performance, followed by business strategies and technological capabilities. However organisational structure is found to be least important. In terms of external drivers legislation is found to be the most important driver.

This study contributed to the body of knowledge in construction business management by successfully testing the drivers of organisational sustainability performance that emphasised the collective efforts of organisations' resources, capabilities and strategies towards improving organisational sustainability performance. However, it should be noted that there are some limitations of this research. The survey data is based on the responses given by the key informants. It follows that the rank of key drivers may be exaggerated by common method variance, and furthermore, the results may be prone to social desirability bias (i.e., informant bias) and distorted self-reporting error. The other limitation relates to the small sample size, consequently the results may not be definitive but only an indication of common trends. Therefore, further and detailed investigations should be conducted for more generalised findings.

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First International Conference on Carbon Neutral Built Environment (CNBT–I)
"A Step Towards Sustainable Future"
December 20-21, 2018, Karachi, Pakistan

OPTIMUM TILT ANGLES FOR ENERGY POLICY MAKING OF A CITY - CASE STUDY OF KARACHI

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Abstract
Karachi city has significant solar potential available, whose proper assessment will lead to shorten energy supply demand gap. In this paper, optimum tilt angles has been evaluated for monthly, seasonally and yearly basis. A formula is devised to calculate shadow length fall by adjacent panel. This is helpful to get the total number of panels being mounted on a roof top without any shadow. Finally, a case study of pharmaceutical company has discussed where solar power plant implementation reduced the energy consumption of 25.39% from national grid. Results revealed that the monthly optimum tilt angles vary from 0° to 57°, receiving maximum solar energy of 2419.07 kWh/m^2-year. Similarly, the optimum tilt angles for winter, spring, summer and autumn are 52°, 9°, 0° and 38° respectively, receiving maximum solar energy of 2389.9 kWh/ m^2-year. The half-yearly optimum tilt angles are 33° and 13°, with the yearly collected solar energy of 2249.09 kWh/m^2-year and finally the optimum tilt angle for Karachi is approximately same as latitude i.e. 24° with the yearly collected solar energy of 2223.94 kWh/ m^2-year. Thus yearly and half yearly adjustments have minimal difference between them. This study will have remarkable effect on renewable and sustainable energy schemes of Karachi city and assumed to be the major recommendation of renewable energy policy strategy.

Keywords
Renewable Policy, Karachi, Optimum tilt angles, Resource assessment.

1. Introduction

Energy sources are essential requirements for all human activities and its demand is increasing continuously. The two major reasons for high energy consumptions are increasing population and strive for enhanced social and economic developments (Şen 2004). The continuous demand of energy, in contrast with depleting fossil fuels, suggests that energy will become one of the major issues in the world. Also, conventional fossil fuel leads toward harmful environmental effects. It is a proven fact that the SO_2 emission is the main source of acid rain and it adverse results damaged more than half the forests in the Northern Europe. Based on these factors, world is shifting the technology toward more sustainable, renewable and clean sources. Therefore, green energy technology has been in focus by researchers for the last few decades.

Karachi (24.86°N and 67.011°E) is the gateway and large revenue generating city of Pakistan has been through strong urbanization and shortage of electricity. Sajjad et al. analysed various factors for Karachi city including urbanization and population. Based on available data, their results reveal that 1500% of increment has been observed in urban population and urban area from independence to 2008. Karachi city has more than 22 million consumers of electricity which are mainly relying on the electricity generation by Karachi Electric (KE) Limited. KE has a generation capacity of around 1847MW whereas the peak demand load of Karachi city is higher than supply load. This supply and demand gap has been shortened by purchasing of electricity through Independent Power Producers (IPP's). However, this purchasing will not remove the gap and thus the citizens of Karachi have to face load shedding in various areas. Naz and Ahmed (Naz and Ahmad 2013) emphasized the energy demand and supply gap. They focused on malfunctioning in power distribution that leads to load shedding in Karachi.

Karachi has a tremendous renewable energy sources and in particular has a great potential of solar energy. According to NASA-SSE database, the average DNI of Karachi is 6.21 kWh/m^2/day annually. Based on highly insolation area, various researchers have focused the Karachi city as their case study. Awan and Khan (Awan and Khan 2014) suggested the utilizing PV system for direct conversion of solar energy into electricity. Yousuf et al. (Yousuf et al. 2017) discussed about the Badescu model as best suited sky model among four models based on actual data. These researches have shown great potential in evaluating solar energy potential and will be of great importance in energy policy making strategies of Karachi.

The inspiration for this research arises from the on-going energy crises and increased pollution levels in Karachi. In this study, Badescu (BA) Model has been used to calculate optimum tilt angle on monthly, seasonally and yearly basis using ground measurements data as literature suggested it to be the best suited model. Based on optimum tilt angle, shadow cast between panels has been carried out. Finally, a case study of an industry will be discussed in the end, where the PV panels implementation show effective outcomes in term of electricity generation. The overall methodology has formulated on MATLAB for easy assessment. This study will provide a helpful recommendation to government for renewable and sustainable energy policy making of Karachi.

2. Materials and Methods

2.1. Study Location Description

Karachi is the capital of Sindh province and one of the largest cities in Pakistan. Geographically, Karachi is located on the coast of the Arabian Sea. The metropolitan city, along with its suburbs, covers an area of about 3,530 square kilometers, including large industrial zones such as Karachi Export Processing Zone, SITE, Korangi, Northern Bypass Industrial Zone, Bin Qasim and North Karachi. The hottest month is May with average GHI of 6.67 kWh/m^2/day and the coldest month is December with average GHI of 4.11 kWh/m^2/day.

2.2. Data Collection

World Bank and Alternative Energy Development Board (AEDB) have implemented a Renewable Energy Resource Mapping activity with total budget of US $ 4.47 million covering all of Pakistan. This project is funded by World Bank's Energy Sector Management Assistance Program (ESMAP) and focuses on the assessment of wind, solar and biomass resources, including ground-based data collection, GIS analysis and geospatial planning. World Bank and Alternative Energy Development Board (AEDB) for ESMAP Project set up nine stations in overall country, in which one is situated in Karachi, as shown in Figure 1. The weather station is situated in NED University of Engineering and Technology (24.933001°N, 67.111664°E). The station is equipped with a CSPS Twin-sensor Rotating Shadowband Irradiometer (RSI), a Kipp&Zonen CMP10 pyranometer for redundant GHI measurement, a Campbell Scientific CR1000 data logger, CS215 temperature and relative humidity probe, CS100 barometric pressure sensor, NRG #40C anemometer and

NRG #200P wind direction sensor on a wind mast of 10 m height above the roof top (Yousuf, Siddiqui, and Rehman 2018).

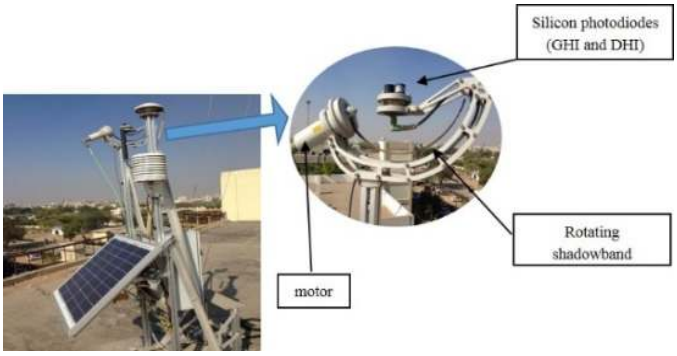

Figure 1: Weather station installed at NED University under the program of ESMAP

2.3. Optimum tilt angle

The estimation method using empirical models is a widely adopted technique to evaluate solar energy at location of interest. Literature suggests that there are several sky models available to estimate solar radiations on tilted surface. These models are classified as isotropic (Liu & Jordan, Tian, Koronakis and Badescu) and anisotropic (Hay, Reindl et al., Hay and Davies, Klucher and Reindl models, Skartveit and Olseth, and Steven & Unsworth).

Badescu Model (BA) suggested as the best suitable sky model for Karachi city. Therefore, the same model has used for finding optimum tilt on monthly, seasonally, half yearly and yearly basis.

According to BA model, a surface tilt at an angle β has a view factor of:

$$F_{c-s} = \frac{3+cos2\,\beta}{4} \tag{1}$$

2.4. Adjacent Row Shadow Analysis

For any tilt angle (β), the front row will cast shadow to the adjacent row. This shadow has temporal as well as spatial nature. The shading length depends on the collector layout i.e. collector height and row length, as well as latitude. This shadow distance has to measure in order to calculate available area. The shadow cast by a panel has shown in Figure 2.

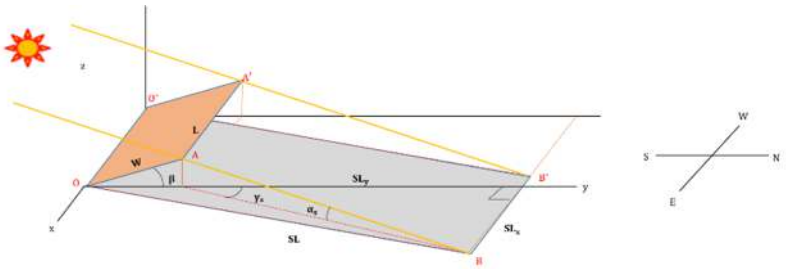

Figure 2: Components of shadow cast due to beam radiations

Using trigonometric relationships, the components of Shadow Length SL_x and SL_y can be evaluated as:

$$SL_x = W sin\beta \frac{sin\gamma_s}{tan\alpha_s} \tag{2}$$

$$SL_y = W cos\beta + W sin\beta \frac{cos\gamma_s}{tan\alpha_s} \quad (3)$$

The shadow lengths has calculated to find out the maximum numbers of panels that can be mount on a roof top without any shadow.

3. Results and Discussion

3.1 Open Plains

Using the Badescu (BA) model, the monthly average daily solar radiation availability on surfaces, tilted from 0° to 90°, was determined. From the results shown in Figure 3, it was found that for each month, there is a particular tilt angle at which the surface (or collector) receives maximum solar radiations.

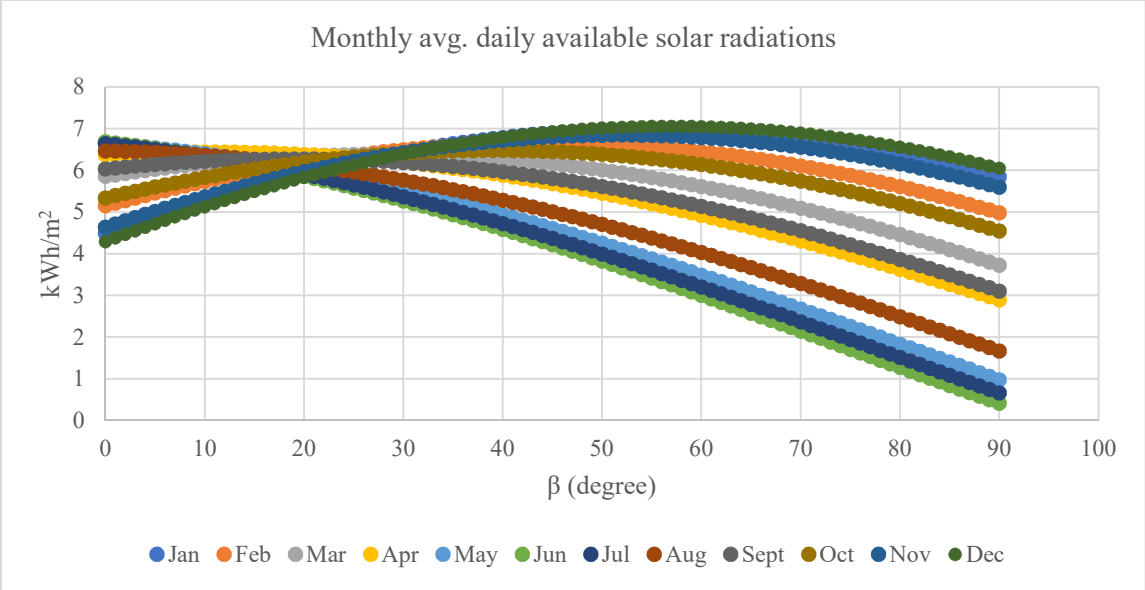

Figure 3. Monthly average daily solar radiations using BA model.

For open plains, the optimum tilt angles for each month, season, half-year and whole year are found by running the simulation model for each single month, in set of season (winter, spring, summer and autumn), in set of half-year (December-May and June-November) and in set of complete year respectively. Against optimum angle, the global solar energy received on tilted surface (or collector) is evaluated and is shown in table 1.

Table 1. Solar Energy estimation at different optimum tilt angles

Mon	H_T	β	H_T	season	H_T	β	H_T	Half year	H_T	β	H_T	Year	H_T	β
12	218.60	**57**	2419.07	Winter	618.91	**52**	2389.9	1st half	1136.09	**33**	2249.09	Fixed	2223.94	24
1	216.26	**54**												
2	186.35	**44**		Spring	582.73	**9**								
3	197.77	**27**												
4	193.20	**10**												
5	205.91	**0**		Summer	606.76	**0**		2nd Half	1112.99	**13**				
6	200.54	**0**												
7	205.80	**0**												
8	200.43	**0**												
9	188.12	**19**		Autumn	581.52	**38**								
10	200.76	**39**												
11	205.34	**52**												
The values of H_T are in kWh/m^2														

Results shows that the monthly optimum tilt angles vary from 0° to 57°, the optimum tilt angles for winter, spring, summer and autumn are 52°, 9°, 0° and 38° respectively, the half-yearly optimum tilt angles are 33° and 13° and the fixed optimum tilt angle for Karachi is approximately same as latitude i.e. 24°.

3.2. Urban Area

The household is not interested in optimum tilt angle every time. Rather, he is more interested in maximize solar energy. Larger panel area will increase the shadow length thus decreasing the available area.

For calculation of maximum area, Abbott Laboratories (pharmaceutical industry) has been analyzed as case study. The industry has 5 departments - finished goods warehouse, packaging warehouse, diagnostic division, pharma building and Engineering Block. We focused our analysis on Engineering Block as initial step having roof top area of 334 m^2. Selected panel is of 320W, Si-polycrystalline with dimensions of 0.992m x 1.957m. Two rows of panel placed adjacently such that a single unit area has become 3.882 m^2.

Based on analysis of 21st December, the number of panels required to avoid any shading is given in table 2:

Table 2: Number of panels based on tilt angle

tilt angle	no of panels	Average Solar Irradiation for a single panel (kWh/m^2)
10	98	5.609
20	78	5.734
30	68	5.756
40	60	5.677
50	56	5.497
60	56	5.222
70	54	4.862
80	56	4.425
90	60	3.927

Based on analysis, the maximum rooftop area is available when panels are tilted at an angle of 10°. Based on available roof top area, the number of panels found out to be 360 panels for finished goods warehouse rooftop, 420 panels for packaging warehouse rooftop, 100 panels for diagnostic division rooftop, 940 panels for pharma building rooftop and 98 panels for Engineering Block rooftop (Figure 4). Therefore the total rated 631 kW of generation capacity has installed.

Figure 4: Engineering Block Rooftop layout

4. Conclusions

Solar Energy Policy of Karachi has discussed in this paper. The monthly, seasonally, half-yearly and fixed optimum tilt angles obtained from Badescu (BA) Model. The monthly optimum tilt angles vary from 0° to 57°, receiving maximum solar energy of 2419.07 kWh/ m^2-year. Similarly, the optimum tilt angles for winter, spring, summer and autumn are 52°, 9°, 0° and 38° respectively, receiving maximum solar energy of 2389.9 kWh/ m^2-year. The half-yearly optimum tilt angles are 33° and 13°, with the yearly collected solar energy of 2249.09 kWh/ m^2-year and finally the optimum tilt angle for Karachi is approximately same as latitude i.e. 24° with the yearly collected solar energy of 2223.94 kWh/ m^2-year. Thus yearly and half yearly adjustments have minimal difference between them.

The successful implementation of solar panels on a pharmaceutical industry and its effective results open a gateway for other industries. This will not only minimize load on national grid but also decrease harmful environmental effects. The government should declare necessary policy for utilizing rooftop solar potential from residential societies as well as industries.

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First International Conference on Carbon Neutral Built Environment (*CNBT–I)*
"A Step Towards Sustainable Future"
December 20-21, 2018, Karachi, Pakistan

Building Information Modelling (BIM): an approach for reducing carbon emissions of buildings.

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Abstract
Carbon emission at higher degrees is nowadays becoming a significant issue that leads to adverse problems like global warming, ill environment, and unpredictable climatic changes, etc. Construction Industry is on top in the list of industries producing carbon as it ejects an approximate of 1.8 gig tons of CO_2 yearly. The reason behind this is the use of conventional construction methods being adopted. Pakistan, being a developing country, also follows such traditional methods. One of the techniques used to cope up with this issue of excess carbon footprint is the adoption of Green Buildings Construction Idea which is a pathway to sustainable green development. Such buildings not only have a very low carbon footprint but are also more efficient in terms of Water, Energy, and Material than the conventional buildings. Efficient designs with lower energy consumptions at project commencement phase can help in reducing the number of carbon emissions produced by the AEC industry. It can be reduced by using BIM processes and latest software's like Green Building Studio(GBS). Numerous functions of BIM have been studied, such as energy analysis, HVAC analysis and modeling of project. This paper, thus, brings out and validates the concept of low carbon emission in Construction Industry of Pakistan with the help of Green Buildings Studio and Building Information Modelling (BIM) with minor changes in building components.

Keywords
Carbon Emissions, Construction Industry, Pakistan, Green Buildings, Building Information Modelling, Autodesk Revit.

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1. Introduction

Carbon footprint is a term used for the total sum of Greenhouse gases (GHG) emissions reasoning from an item, organization or a person. The GHG emissions mainly include Water (H_2O), Carbon Dioxide (CO_2) and Methane (CH_4) but CO_2 is held responsible for more than half of the Greenhouse effect. The Construction Industry is regarded as one of the major contributors of GHG emissions particularly the CO2 emissions. In the year 2005, the global emission for CO_2 increased to 28.3 Gigaton. Out of 28.3 Gigaton, Cement Industry alone produced 1.8 Gt of CO_2. These statistics indicate that the Cement industry contributed approximately 6.4% to the Global CO_2 emissions [9]. According to research conducted by the United States Green Building Council, 40% of the world's energy is used by the construction industry whose productions generate a large amount of carbon footprint. [4] The idea of 'green environment' and 'sustainable development' has been well known to the AEC industry since many past decades, the industry is still unsuccessful in terms of controlling and managing the carbon emissions and is considered and criticized as a major carbon emitter [5]. According to the results of recent researches being conducted, the AEC accounts for approximately 10% of all global energy for the manufacturing of building materials. About 30–40% of the total global Green House Gas emissions take place due to energy consumed during construction and operation phase of buildings. It is also established through researches and estimations that construction and demolition waste of the buildings constitute 40% of the total solid waste produced in the urbanized countries [5]. Technology Strategy Board of the UK informs that the construction, operation, and maintenance of the built environment accounts for 45% of total UK carbon emissions. UK Green Building Council confirms that construction sector emits out around 10% of country's carbon emissions mainly reasoning from building stages such as Manufacturing, Transportation, Construction, Maintenance, and Disposal, etc. [6].

As mentioned, carbon emissions of a building include the carbon associated with the operation of the building – the heating/cooling, powering, water, etc. but also the embodied carbon. Embodied carbon is the CO_2 associated with the manufacturing, assembly, deconstruction and ultimate disposal of the materials which constitute a building. [7]

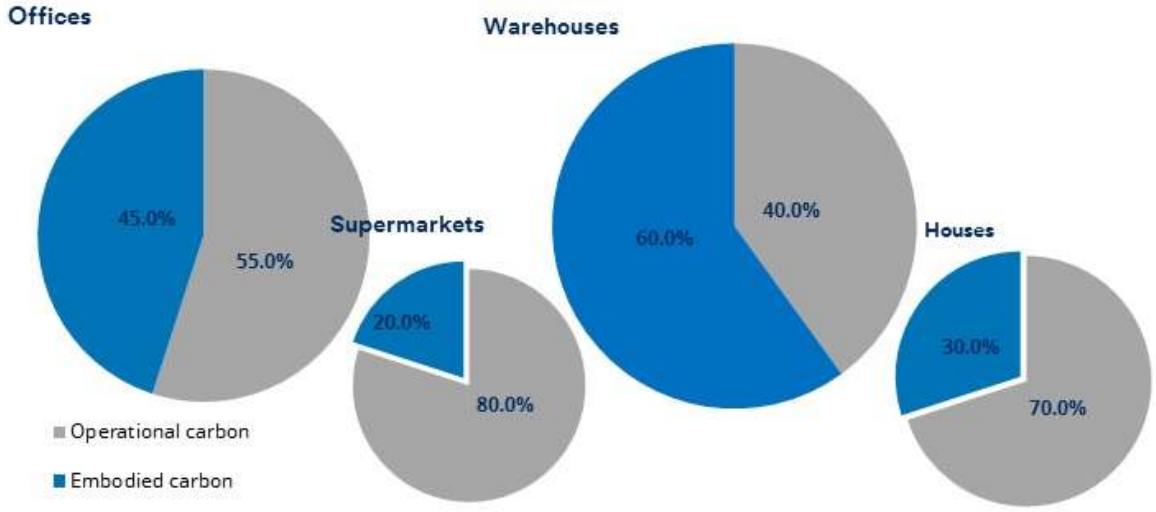


Fig. 1: Operational and Embodied Carbon Proportions

According to a survey of World Bank conducted in 2014, Pakistan was ranked 33rd with 0.90 metric tons of CO_2 emissions in the list of countries with most Carbon footprint [1]. Carbon emissions of Pakistan have also grown by 123% between 1994 and 2015. The Climate Change Bill of 2016 states that:
Despite low per capita carbon emissions of Pakistan, it ranks amongst the top ten countries most affected by climate change during the last couple of decades [2]. For 2017, the CO_2 emissions of Pakistan were recorded to be 189.19M mt lower than India and China but greater than Bangladesh [3].

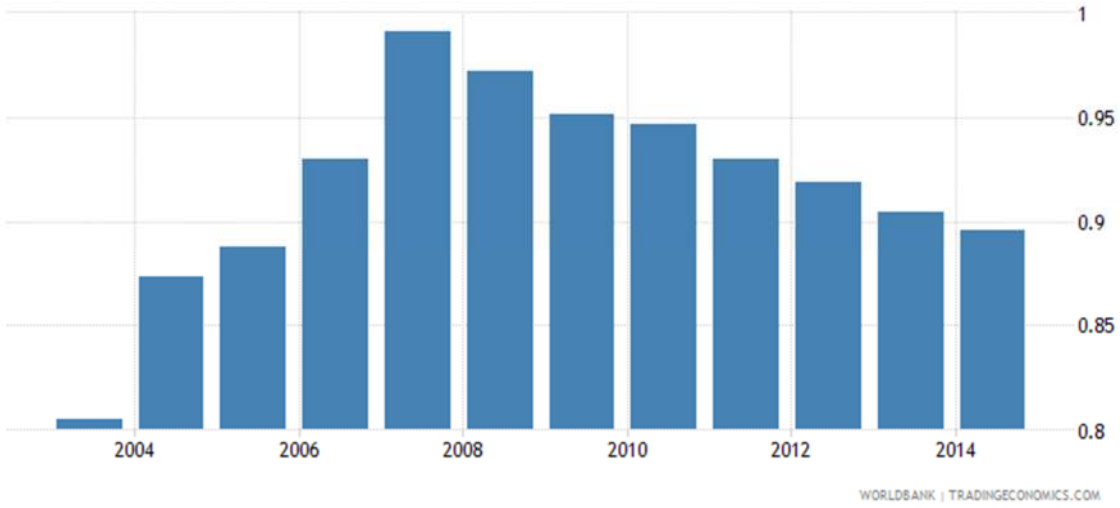


Fig. 2: Carbon Emissions of Pakistan in Years from 2004 to 2014

Pakistan consumes more than 50% of total primary energy consumption depending on coal which contributes high carbon emissions followed by oil and gas. Consequently, the environment in the country is becoming more and more polluted day by day. [8] Several measures have been taken to lessen the carbon emissions including avoiding traffics, running low carbon vehicles, insulation and using solar panels for producing electricity for buildings, optimizing the use of water and energy resources, etc. The concept of 'three Rs' – reduce, reuse and recycle – is a significant pathway for reducing carbon emissions in the construction sector.

Recently, the emergence of Building Information Modelling (BIM) has made possible for the company and client to review the project before its execution and operation. Building Information Modelling(BIM) processes with the help of BIM software like Autodesk Revit help in reducing carbon emissions. The software's and BIM process give an early idea of CO_2 emissions. The carbon emissions are reduced by different design alternatives with different materials and designs reducing the use of energy in the operational phase of buildings. This helps in paving ways towards a safe and sustainable environment as it also mentions the carbon footprint of respective materials. BIM also reduces the cost and time of a project and consequently helps to reduce, recycle and reuse the materials for green and sustainable construction.

3. Literature Review

Number of attempts have been made to calculate and reduce the carbon footprint. This estimation is often recognized as Life Cycle Assessment (LCA). For carbon foot printing purpose, LCA estimates the GHGs emitted at every step of the project's life cycle, technically termed as GHG accounting. Some standards for carrying out LCA are ISO 14025, ISO 14064, ISO 14067 and Publicly Available Specifications-2050 (PAS 2050) of British Standard Institution (BSI) [10]. In 1993, the IOA technique was used to estimate carbon emissions of six office buildings in Japan [11]. The researches have also carried out detailed study of current methods being employed for carbon footprint calculations [10].

In 2016, Australia was one of the countries with high GHG emissions per capita in the world with 18% of Australia's total Carbon footprint from construction sector [12]. In 2005, the Carbon Footprint of Irish construction industry was estimated to be 11.7% . Meanwhile, construction sector of Norway was reported responsible for 5.3 Mt carbon footprint in 2007 [13]. In a study carried out in 2009, it was concluded that the Chinese Construction Industry was highest carbon emitter among all other industries in the country with 66.5% CO_2 emissions [16]. The Malaysian AEC Industry contributed 24% of total GHG emissions of country in 2011. [15] Some carbon footprint calculators like CF Calculator website and CarbonCalculated etc. are in use but these softwares and websites are not considered as user-friendly due to their high input demand and low output of details [13]. It is established that 10% of embodied carbon can be reduced if low impact materials are employed in construction [16]. In order to bring CO_2 emission to the level of 1995, new policy incentives which are lacking in Pakistani Construction Industry must be implemented [8]. An emerging approach called BIM can be helpful in reducing carbon emissions as it helps us to reduce the energy consumption and construction waste to a greater extent and improve the quality of construction [5].

The green construction can be best served through an integrated design process and BIM is best known for facilitating the same. Keeping this in view, the usefulness of BIM is widely being recognized to facilitate the design and construction of green buildings. The use of BIM in green buildings has great contribution in estimating, managing, analyzing and controlling the environmental impacts of construction through its virtual reality technology. Therefore, continuous efforts are also being made to explore a wide range of BIM tools that can be used for supporting the green construction for example, energy simulation, lightening and air flow analyses, construction and demolition waste analysis etc [5].

It can be concluded from the extensive review of literature that carbon emissions at higher degrees is hazardous for the environment and will create hindrances in paving ways towards green and sustainable future of country. The emergence of BIM and Green Buildings has created many chances to cater the issue of carbon emissions and making way towards sustainable development that is eco-friendly but the implementation of BIM & Green Building Studio (GBS) is still in state of infancy in construction sector of Pakistan and a lot of work is being executed to reach a 'carbon neutral built environment' in country.

4. Objectives of research and Research Methodology

1. To contribute towards a safe and sustainable environment by minimizing carbon emissions.
2. To provide awareness regarding the sensitivity of the issue of pollution and global warming.
3. To enable the construction industry of Pakistan to reduce its carbon emissions for a sustainable future.
4. To make endeavors for the adaptability of green building construction in Pakistan.
5. To study and validate the effectiveness of BIM & GBS in promoting green construction

The methodology of research in this paper is based on three major components i.e. literature review, analysis on Green Building Studio and then results from green building studio related to carbon emissions followed by conclusion and recommendations.

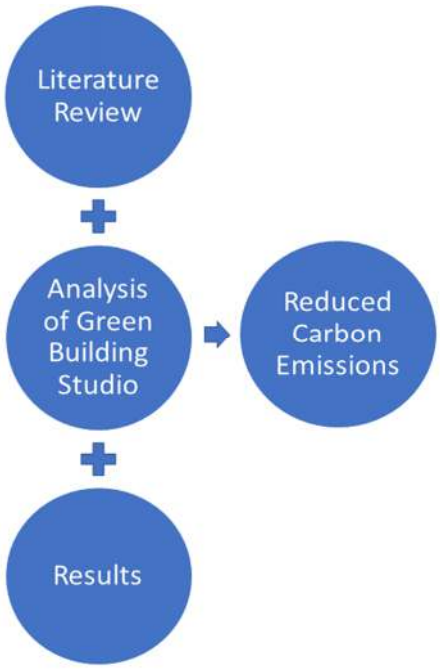
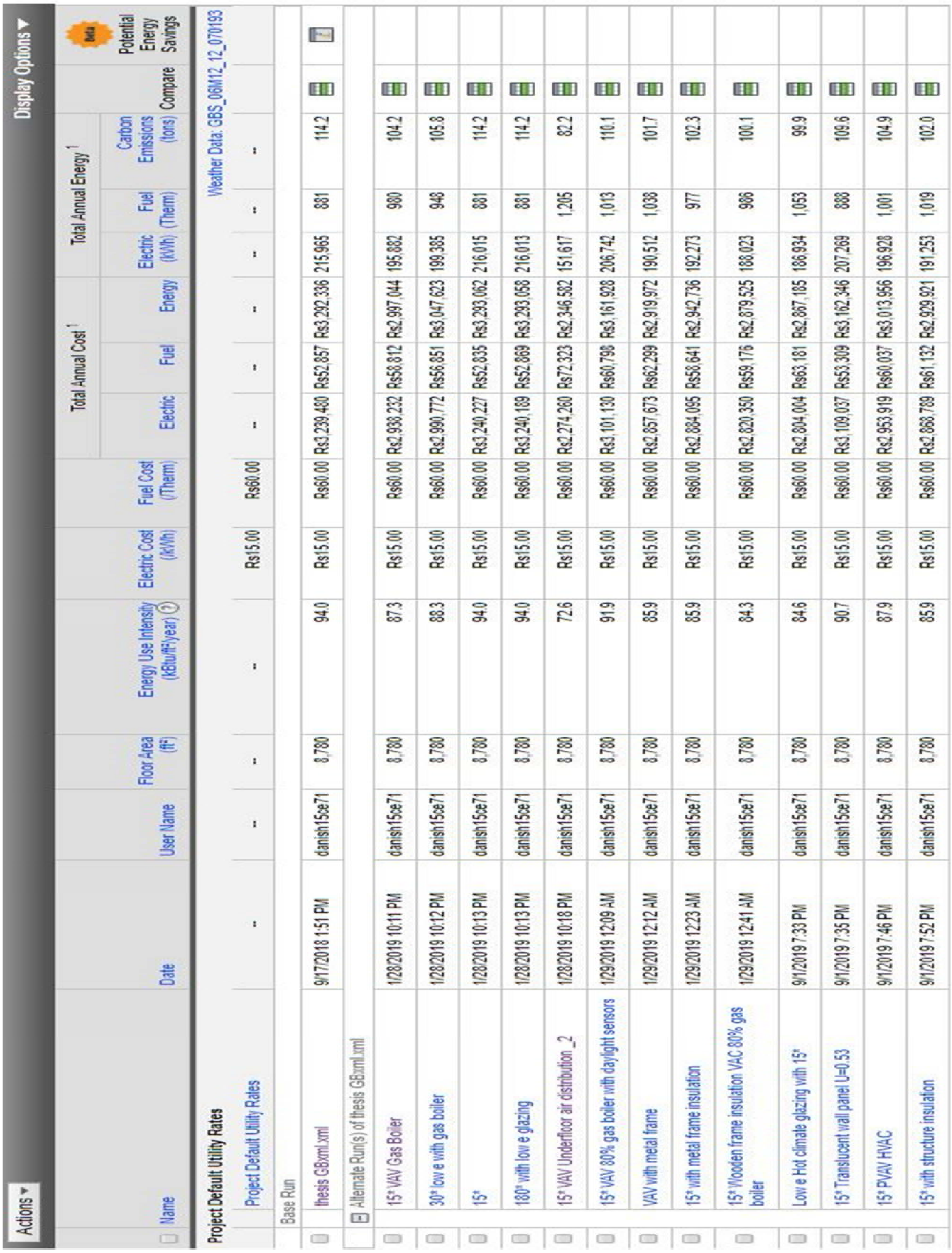


Fig.3 : Research Methodology

The literature review contains reviews of papers related to Building Information Modelling, Green Buildings and Carbon Emissions from which the further methodology was decided to build an integrated BIM model with Mechanical Electrical Plumbing, structural and architectural all coordinated to be tested on Green Building Studio. The model was designed in Autodesk Revit and exported as Green Building XML schema(gbXML) to green building studio for analysis. The BIM model is tested on cloud-based software Green Building Studio. Viable changes in orientation, glazing, wall to window ratio and HVAC system were made to reduce the carbon emissions and energy cost. In the end, the results of all the trials are tabulated and shown as diagrams to reach conclusions. The data was collected by the software from the nearest weather station located in Hyderabad. The rates of electricity and fuel used are according to the tariff of Hyderabad Electric Supply Company(HESCO) and Sui Southern Gas Company (SSGC).

5. Results

Amount of carbon emissions from the base run which is without any design changes is shown as base run in figure (3). Along with the base run, different design alternatives were done, the results in figure (3) show that 31.9 tons of carbon emissions can be saved by a few changes in design.
The carbon emissions in the figure are only for a year each year 31.9 tons of carbon can be saved in operational phase of the building with changes in the design stage. BIM with its efficient software's allows us to know about the cost and carbon emissions of the building before the construction and gives us time to make changes before the commencement of the project.
The results in figure (4) show the comparison of different trials that were done in green building studio. Amount of carbon emissions saved in tons are also tabulated in the figure (4).



Name	Date	User Name	Floor Area (ft²)	Energy Use Intensity (kBtu/ft²/year)	Electric Cost (/kWh)	Fuel Cost (/Therm)	Total Annual Cost[1] Electric	Total Annual Cost[1] Fuel	Total Annual Cost[1] Energy	Total Annual Energy[1] Electric (kWh)	Total Annual Energy[1] Fuel (Therm)	Total Annual Energy[1] Carbon Emissions (tons)	Compare	Potential Energy Savings
Project Default Utility Rates												Weather Data: GBS_06M12_12_070193		
Project Default Utility Rates	--	--	--	--	Rs15.00	Rs60.00	--	--	--	--	--	--		
Base Run														
thesis GBxml.xml	9/17/2018 1:51 PM	danish15ce71	8,780	94.0	Rs15.00	Rs60.00	Rs3,239,480	Rs52,857	Rs3,292,336	215,965	881	114.2		
Alternate Run(s) of thesis GBxml.xml														
15° VAV Gas Boiler	1/28/2019 10:11 PM	danish15ce71	8,780	87.3	Rs15.00	Rs60.00	Rs2,938,232	Rs58,812	Rs2,997,044	195,882	980	104.2		
30° low e with gas boiler	1/28/2019 10:12 PM	danish15ce71	8,780	88.3	Rs15.00	Rs60.00	Rs2,990,772	Rs56,851	Rs3,047,623	199,385	948	105.8		
15°	1/28/2019 10:13 PM	danish15ce71	8,780	94.0	Rs15.00	Rs60.00	Rs3,240,227	Rs52,835	Rs3,293,062	216,015	881	114.2		
180° with low e glazing	1/28/2019 10:13 PM	danish15ce71	8,780	94.0	Rs15.00	Rs60.00	Rs3,240,189	Rs52,869	Rs3,293,058	216,013	881	114.2		
15° VAV Underfloor air distribution _2	1/28/2019 10:18 PM	danish15ce71	8,780	72.6	Rs15.00	Rs60.00	Rs2,274,260	Rs72,323	Rs2,346,582	151,617	1,205	82.2		
15° VAV 80% gas boiler with daylight sensors	1/29/2019 12:09 AM	danish15ce71	8,780	91.9	Rs15.00	Rs60.00	Rs3,101,130	Rs60,798	Rs3,161,928	206,742	1,013	110.1		
VAV with metal frame	1/29/2019 12:12 AM	danish15ce71	8,780	85.9	Rs15.00	Rs60.00	Rs2,857,673	Rs62,299	Rs2,919,972	190,512	1,038	101.7		
15° with metal frame insulation	1/29/2019 12:23 AM	danish15ce71	8,780	85.9	Rs15.00	Rs60.00	Rs2,884,095	Rs58,641	Rs2,942,736	192,273	977	102.3		
15° Wooden frame insulation VAC 80% gas boiler	1/29/2019 12:41 AM	danish15ce71	8,780	84.3	Rs15.00	Rs60.00	Rs2,820,350	Rs59,176	Rs2,879,525	188,023	986	100.1		
Low e Hot climate glazing with 15°	9/1/2019 7:33 PM	danish15ce71	8,780	84.6	Rs15.00	Rs60.00	Rs2,804,004	Rs63,181	Rs2,867,185	186,934	1,053	99.9		
15° Translucent wall panel U=0.53	9/1/2019 7:35 PM	danish15ce71	8,780	90.7	Rs15.00	Rs60.00	Rs3,109,037	Rs53,309	Rs3,162,346	207,269	888	109.6		
15° PVAV HVAC	9/1/2019 7:46 PM	danish15ce71	8,780	87.9	Rs15.00	Rs60.00	Rs2,953,919	Rs60,037	Rs3,013,956	196,928	1,001	104.9		
15° with structure insulation	9/1/2019 7:52 PM	danish15ce71	8,780	85.9	Rs15.00	Rs60.00	Rs2,868,789	Rs61,132	Rs2,929,921	191,253	1,019	102.0		

Fig. 4: Trial Based Analysis-II on Green Buildings Studio

Name	Date	User Name	Floor Area (ft²)	Energy Use Intensity (kBtu/ft²/year)	Electric Cost (/kWh)	Fuel Cost (/Therm)	Total Annual Cost[1]			Total Annual Energy[1]			Compare	Potential Energy Savings
							Electric	Fuel	Energy	Electric (kWh)	Fuel (Therm)	Carbon Emissions (tons)		
Project Default Utility Rates												Weather Data: GBS_06M12_12_070193		
Project Default Utility Rates	--	--	--	--	Rs0.00	Rs0.00	--	--	--	--	--	--		
Base Run														
thesis GBxml.xml	9/17/2018 1:51 PM	danish15ce71	8,780	0.0	Rs0.00	Rs0.00	Rs0	Rs0	Rs0	0	0	0.0		
Alternate Run(s) of thesis GBxml.xml														
15° VAV Gas Boiler	1/28/2019 10:11 PM	danish15ce71	8,780	-6.7	Rs0.00	Rs0.00	-Rs301,248	Rs5,955	-Rs295,293	-20,083	99	-10.0		
30° low e with gas boiler	1/28/2019 10:12 PM	danish15ce71	8,780	-5.7	Rs0.00	Rs0.00	-Rs248,708	Rs3,994	-Rs244,714	-16,581	67	-8.3		
15°	1/28/2019 10:13 PM	danish15ce71	8,780	0.0	Rs0.00	Rs0.00	Rs747	-Rs22	Rs725	50	-0.4	0.0		
180° with low e glazing	1/28/2019 10:13 PM	danish15ce71	8,780	0.0	Rs0.00	Rs0.00	Rs710	Rs12	Rs722	47	0.2	0.0		
15° VAV Underfloor air distribution _2	1/28/2019 10:18 PM	danish15ce71	8,780	-21.3	Rs0.00	Rs0.00	-Rs965,220	Rs19,466	-Rs945,754	-64,348	324	-31.9		
15° VAV 80% gas boiler with daylight sensors	1/29/2019 12:09 AM	danish15ce71	8,780	-2.1	Rs0.00	Rs0.00	-Rs138,350	Rs7,941	-Rs130,409	-9,223	132	-4.1		
VAV with metal frame	1/29/2019 12:12 AM	danish15ce71	8,780	-8.1	Rs0.00	Rs0.00	-Rs381,807	Rs9,442	-Rs372,365	-25,454	157	-12.5		
15° with metal frame insulation	1/29/2019 12:23 AM	danish15ce71	8,780	-8.1	Rs0.00	Rs0.00	-Rs355,385	Rs5,784	-Rs349,600	-23,692	96	-11.9		
15° Wooden frame insulation VAC 80% gas boiler	1/29/2019 12:41 AM	danish15ce71	8,780	-9.7	Rs0.00	Rs0.00	-Rs419,130	Rs6,319	-Rs412,811	-27,942	105	-14.1		
Low e Hot climate glazing with 15°	9/1/2019 7:33 PM	danish15ce71	8,780	-9.3	Rs0.00	Rs0.00	-Rs435,476	Rs10,324	-Rs425,152	-29,032	172	-14.3		
15° Translucent wall panel U=0.53	9/1/2019 7:35 PM	danish15ce71	8,780	-3.3	Rs0.00	Rs0.00	-Rs130,443	Rs452	-Rs129,991	-8,696	8	-4.5		
15° PVAV HVAC	9/1/2019 7:46 PM	danish15ce71	8,780	-6.0	Rs0.00	Rs0.00	-Rs285,561	Rs7,181	-Rs278,380	-19,037	120	-9.3		
15° with structure insulation	9/1/2019 7:52 PM	danish15ce71	8,780	-8.0	Rs0.00	Rs0.00	-Rs370,691	Rs8,275	-Rs362,416	-24,713	138	-12.2		

Fig. 5: Trial Based Analysis-Comparison with base run on Green Buildings Studio

6. Conclusions

1. The results from trial based analysis illustrate that BIM is efficient in reducing the carbon emissions if used effectively in the design phase of the building.

2. The analysis of the building by changing different building components like HVAC system and putting different occupancy sensors helped in reducing carbon emissions by almost 28 tons per year and those too with minor changes in design only.

3. The more effective design will reduce more than 28 tons of carbon emissions and will be more beneficial in achieving less carbon emitter buildings.

4. Early changes at the design stage by putting occupancy sensors, changing the orientation of the building, and using different types of insulations on walls and windows can help us in achieving energy efficiency. Hence, less carbon producing buildings.

5. The saving in energy reduces the carbon emissions and can save up to 0.85 million per year of the project against its base run which was having the cost of energy at 3.2 million with carbon emissions of 114 tons magnitude.

7. Future Recommendations

1. Keeping in view the sensitivity of the issue of carbon emissions, the carbon footprint calculator for the Pakistani construction industry has become inevitable. With CF calculator, the industry can choose among the viable options of material selection to ultimately reduce the carbon emissions.

2. In this paper, only a few cases were studied, and the type of projects was limited. Therefore, a direction for future work on this issue is to develop more and more studies on various projects. Further research about the connection, adaptability, and compatibility of BIM tools with other software will also be inquired.

3. Steps should be taken by Govt. and Private Sector institutions for the encouragement and implementation of BIM and Green Construction. The courses regarding BIM must be included in the academic plan/curriculum at the undergraduate and postgraduate level. Construction firms should skill their employees to adopt and implement BIM as soon as possible because the future of BIM will not be dim.

4. Policies should be made and implemented at Government level to cater to the issue of environmental pollution in the country. Plantation should be encouraged to avoid global warming and unpredictable climatic changes.

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