

**M.SC. THESIS**  
**TITLE OF RESEARCH**  
**EXPERIMENTAL INVESTIGATION ON BURNT CLAY POTS OF**  
**VARIOUS HEIGHTS FOR ROOF INSULATION OF RESIDENTIAL**  
**BUILDINGS**



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**October, 2018**

## **DECLARATION**

I, hereby declare that the research work presented in this thesis is my own independent work under supervision of Professor Dr. Muhammad Arif Khan and Engr. Abdul Mueed Iqbal. It has never been presented elsewhere. All sources consulted are dully acknowledged.

Signature:\_\_\_\_\_

Date:\_\_\_\_\_

I dedicate this work to my teachers and parents, whose prayers have always  
been with me.

## ACKNOWLEDGMENT

Sense of acknowledgement are expressed to almighty **ALLAH**, the creator of universe, the most merciful and beneficent for best owing me the will and ability to complete my project and this report, which is an essential requirement for the completion of my degree.

Deep tributes are presented to **The Holly Prophet (peace be upon him)** being a source and symbol of knowledge and guidance to the entire mankind.

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At the end, I wish to thank all those who contributed intellectually and materially, in words and deeds in the preparation of the report in its present form.

**Engr. Junaid Shafique**

October, 2018

## **ABSTRACT**

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

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## **CHAPTER 1 INTRODUCTION**

### **1.1 General**

In this research the burnt inverted Clay pots (BCP) are investigated in terms of thermal insulation of the roof. As it is reported in various studies that clay has 0.6 W/mK thermal conductivity and air is considered as best insulator with 0.025 W/mK thermal conductivity. The technique which is investigated in this research is combination of clay as well as air by using inverted Burnt Clay pots on top of roof. According to literature review, although this technique is applied on buildings for thermal insulation of roof but there is not any study pertaining to investigation on volumes/height of the pots. Therefore this research focuses on various heights/volumes of the burnt clay pots for optimum solution to achieve better results for thermal insulation of roof and residential buildings.

### **1.2 Problem Statement**

The roof is the most important component of any building that significantly affects the quality of the indoor thermal comfort as it contributes about 50-70% in heating and cooling load of a building. This load can be reduced by insulating roof through various materials and techniques to control indoor temperature at comfortable level during summer and winter. In both cases roof is required to act as an effective barrier for heat flow from external to internal and internal to external environment. To achieve this goal there are several materials and techniques which have been recommended in various studies. However, among cost effective solutions; the use of burnt clay pots on roof with mud and brick tile covering has been widely used in Asian countries such as Bagladesh, India and Sirilanka. There is need to investigate how much thermal indoor condition can be improved by increasing the volume of air pockets in this method.

This research explores the impact of volume and height of burnt clay pots for obtaining better indoor thermal condition in buildings. In this context an experimental study is carried out by using burnt clay pots of varied volume and heights on test rooms in the Lab of Architectural Engineering Department and data on indoor/outdoor temperature profile is recorded on 24 hours basis for each height and volume. On the basis of conclusion, the study recommends use of burnt clay pots on roofs with optimum height and volume to improve indoor thermal condition of residential building in Lahore.

### **1.3 Objectives**

- i. To investigate the effectiveness of burnt clay pots for controlling the indoor thermal condition in residential building.
- ii. To make a comparative study of burnt clay pots of various heights/volume for roof insulation in residential building through experimental investigation and also to find out the optimum height/volume to recommend for application.
- iii. To validate experimental results through relevant software.
- iv. To compare burnt clay pot roof with traditional Reinforcement Cement Concrete (R.C.C.) roof for insulation properties in terms of cost and payback period.

### **1.4 Significance of Research**

The use of burnt clay pots in roof assembly of residential building is passive technique which involves low cost. This technique is useful in summer as well as in winter without involving any additional cost. The material and expertise are locally available therefore this technique is sustainable and approachable to everybody. This low cost technique will be very helpful to make energy efficient homes in Pakistan and subsequently in saving energy use during summer as well as winter.

### **1.5 Research Methodology**

Comprehensive literature review will be made that will inform about the sizes, shapes of burnt clay pots for better insulation of roof. Different techniques and methods will be traced out on use of burnt clay pots on roof for thermal insulation. On the conclusion of literature review for effect of various height and volume of burnt clay pots will be analysed. In this respect, experiment will be designed and performed. Burnt clay pots of various heights/volume will be designed to place on top roof of test rooms of AED Environmental Lab. The pots will be covered with mud and mud plaster and subsequently roof tiles. Indoor and outdoor temperature will be recorded on 24hrs basis. Results will be compiled and analysis will be performed. The cost analysis and payback period of burnt clay pots for insulation of roof will also be calculated. After the discussion, the conclusion will be extracted and recommendations will be given about the effectiveness of optimum height of the inverted burnt clay pots for roof insulation in buildings.

## **1.6 Literature Review**

Literature reconnaissance is vital part of research process. Literature review can be described as process of locating, analysing, evaluating and interpreting scholarly material. It helps in gaining insight knowledge and awareness and allows us to choose methodology to acquire significant research results. It justifies the reason of research and identify gap which could be filled by research.

This chapter discuss the previous studies and introduces present studies that have examined the issue of thermal comfort by the passive design. This section additionally examined the concluded outcomes of the study. The results are assessed by professionals with respect to how different passive design technology reduces heating and cooling in a building and improve the quality of living in terms of energy savings and cost effectiveness.

Dr. Umamah eshwaran Rajasekar, Pankaj Khanna and Vishal Mehta using clay pots to keep roofs cool has been traditionally practiced in hot and dry areas, such as Rajasthan and Gujarat. Earthen pots are commonly available almost throughout the India and can also be made to specific sizes by potters. They are an affordable material to insulate roofs by forming air pockets which limit heat flow through the roof. A lightweight filler like cinder or building waste can also be used in concrete to fill the spaces and then with an impervious layer like ceramic tiles. China Mosaic Tiling (Cement: Sand: Aggregate = 1:2:4), 20-25mm Cement Mortar bedding (Cement: Sand = 1: 4) inverted earthen pots (diameter -175mm & depth - 75mm) fixed with cement mortar (Cement: Sand = 1:4) 4 to 5mm water proofing. Performance as compared to RCC slab and the treated space remains around 1.5-2 degree centigrade cooler as compared to untreated space, with the performance being consistent throughout the day [1].

According to Bijon Sarma, in the summer season the average sunshine per day in the major cities of Bangladesh varies from 5.7 to 9.1 hours (Sarma, 1997). During this time the roof gets direct solar radiation from 10.00 AM to 5.00 AM. He uses the Burnt clay pots (size: diameter 250 mm, height 75 mm) for thermal insulation. The temperature difference between the above and below roof of BPRI and Conventional type of Lime Terracing remains same like 3.41 degree centigrade. BPRI (Burnt Pot Roof Insulation) is extremely cheap 10% cost of the lime tracking, This research paper include comparative study of two kinds of roofing techniques, lime terracing with BPRI. . The effective

performances of BPRI roofing cause increase in demand of using burnt potter passive design technique and its production. The reason is BPRI show better insulation as the air-pockets created by the burnt-pots and cause heat reduction. BPRI is unlikely lime tracking, free from wear and tear and humidity leakage, BPRI has more significant than lime terracing for cost effective and health [2].

According to Meghana Charde and Rajiv Gupta, the effect of a proposed hollow roof (independent of and combined with a designed brick-cavity wall with brick projections and static sunshade) on indoor air temperature has been analysed experimentally by constructing four rooms of habitable dimensions (3.0×4.0×3.0-m high) and studying average hourly temperatures for 1 year. Each room has a different combination of type of roof, wall, and static sunshade; hence, the difference in indoor air temperature of the rooms will primarily be attributable to differences in heat transferred through these building elements. The proposed hollow roof combined lessened indoor air temperature in summer and increased indoor air temperature in winter mornings and nights. By creating air pockets in roof, he achieve the optimum thermal condition of room [3].

According to Irshad Ahmad, rooms with concrete slab roofs directly exposed to the sun become unbearably hot during summer and very cold during winter. Huge amounts of energy are required to keep them comfortable. Application of thermal insulation on roofs significantly reduces energy required for heating and cooling. This report presents the results of an experiment conducted at the Attock Refinery Limited (ARL) Rawalpindi to assess the performance of the antisolar insulated roof system. A detailed thermal analysis of the room shows that cost of an anti solar system is paid back in less than a year in the form of savings of energy required for air-conditioning in summer and for gas heating in winter. It also avoids the addition of 150 kg of CO<sub>2</sub> for each square meter of the floor area covered with ant solar system. This research show the payback period and cost analysis of thermal insulation of roof by ant solar material [4].

According to C.V. Subramanian, N. Ramachandran and S. Senthamil Kumar, focusing on the importance of solar passive architecture and passive cooling architectural design interventions for thermal comfort in residential buildings. Vijay kumare. (2006) found a new concept of laying Hollow Clay Tiles (HCT) over RCC roof instead of conventional Weathering Course (WC). It is found that 38-63% of energy savings can be achieved than the conventional WC roof by this method, Nahar et al. (2003) carried out experiment on eight different passive techniques used over roof for

cooling of buildings in arid climate regions and analyzed, its performance at Jodhpur, India. After analysis during the hot summer it was found that different passive cooling techniques in increasing order with respect to Sania covering over the concrete roof, 50 mm cement vermiculate insulation over the roof, white painting by cement, roof provided with air void insulation using earthen pots, roof pond with movable thermal insulation, white glazed tiles over roof and evaporative cooling [5].

Mohammad Arif Kamal explains passive cooling techniques in building; the passive cooling systems use non-cal methods to maintain a comfortable indoor temperature. In the study the research found that the decrease of indoor temperature by using the following passive cooling techniques like solar shading, shading by overhangs, louvers and awnings etc. shading of roof by plant cover, by earthen pots and by roof shades, shading by trees and vegetation, shading by textured surfaces. Indoor temperature also decrease by using the Induced ventilation techniques, Solar chimney, Air vents, Wind tower, Radiative cooling, Diode roof, Roof pond, Evaporative cooling, Passive downdraft evaporative cooling (PDEC), Roof surface evaporative cooling (RSEC), Earth berming, Desiccant cooling Earth berming. The applications of using these techniques decrease their cooling load up to 50% - 70% [6].

According to Neha Gupta & Gopal N. Tiwari, explains different type of cooling techniques for buildings, solar shadings devices of roof extensively covered in this review. Inverted earthen pots use for the roof insulation to decrease the energy consumption, for high indoor temperature can be controlled by providing a roof cover made from locally available material like hay, terracotta tiles, inverted earthen pots, solid cover (sheets), thermal insulation .BCP use as a horizontal insulation roof of the building, it controlled the optimum level of indoor room temperature and save the energy consumption in winters and summers. It also reduces pollution, and also adds to the architectural appeal of the building [7].

According to Hemchandra Pawar and Pradeep Hangargekar explains, In integrated approach for buildings, building components should be so designed to reduce the heat gain, to modify heat transfer, and certain cooling techniques like Ventilation Cooling , Evaporative , Earth-Air pipe system , Wind Tower, spraying white washing of the roof and the roof covered by inverted earthen pots with a layer of earth over should be adopted to remove the heat gained by the building. In this paper various methods and

techniques have been discussed, which can be implemented for passive cooling in hot and dry climate zone of India to achieve objective of energy conservation [8].

According to I. Hernández-Pérez, G. Álvarez, J. Xamán, I. Zavala-Guillén, J. Arce and E. Sim, presents a review on the application of reflective materials on buildings' walls and roof. The thermal performance of these materials has been analysed using different methodologies. The passive cooling techniques for roofs using architecturally and non-architecturally methods, the cool materials applied to building roofs were able to reduce cooling energy consumption by a factor ranging between 1% and 80%, depending on the climate, thermal insulation, internal gains and previous condition of the roofs. It has been shown that a cool roof has a great potential to reduce the daily heat gain. This reductions reached a factor ranging between 11 and 60%, depending on the roof thermal resistance and the climatic conditions. More work is needed to analyse the influence of reflective materials in more complex configurations such as ventilated roofs, domed roofs and roofs made of hollow blocks [9].

In this paper the San Jay Kumar and G. N. Tiwari discuss about the impact of passive cooling design on a building. This is a case study of Delhi, India. The goal of this study is to reduce the impact of heat and reduce level of heat by change the approach of designing roof and its treatment. The author approach to passive cooling roof design that saves energy. In this research paper author discussed and experimented three types of passive approach by creating cavity on the roof then experimented with air flow, water flow and combination of both. The study based on orientation direction of air and sunlight. Summer houses are designed to remain cool to maintain the comfortable living temperature in the summer months. The author discussed various methods to reduce heat levels. These non-mechanical systems of passive cooling includes solar shading for reducing radiation vegetation and earthen pots shading. Thermal load enters the building in three ways direct by sunlight, heat through walls and roof and outside infiltration. The author analysed three methods and results obtained are positive. It was observed that with the cavity air flow maximum head reduction can be obtained. This study proves by roof cavity air flow heat insulation of building and thermal comfort achieved [10].

These papers San Jay Kumar & A.Srivastava U.Singht, M. S. Sodha include the investigation of different strategies of passive design for reducing heat flux through roof. This paper consists of the case study of North India. In this paper author discuss and

analyse the different roof shading techniques by using plantation as a roof garden, removable canvas, water ponds as an evaporative cooling, and reflective shading with inverted earthen pots. In this research an analytical evaluation and comparison is done about the performance of these passive cooling techniques with the bare roof. The analytical studies shows calculations of the hourly variation of heat flux into the room through the different roof designs and their effects in the winter and summer. The roof configurations are tested across the parameters of solar radiation and atmospheric air on outer side and with constant room temperature. The results shows that the roof with inverted mud pots with 90% shading and ho  $5.7\text{W/m}^2\text{°C}$  give good performance and cause reduction in heat flux [11].

In this paper Rakesh Kumar, S.N. Garg and S.C. Kaushik perform the experiment in three different climatic zones in India and experimental evaluation of solar passive cooling techniques such as solar shading, insulation of building components (wall, roof etc.) and air exchange rate to achieve the optimum level of indoor room temperature. The experiment is done to calculate the thermal loads for the non-air conditioning building of one dimensional numerical model. Numerical calculation has been made corresponding to three different climates, viz. composite, hot and dry and warm and humid. By using solar shading and proper air flow ventilation in the building decreases the indoor room temperature in hot climate further by using the above passive techniques the insulation of roof also decreases the thickness from 8-10cm to 2cm. Using proper solar shading and air ventilation of 2 cm thermal insulation of roof will give the same results by decrease of  $4.4\text{°C}$  to  $6.8\text{°C}$  in room temperature with 8-10 cm non-solar shading and non-ventilated room. The analysis suggests that using solar shading devices with air ventilated flow room will minimize the thickness of the building component insulation like roof and wall insulations and maintain the indoor room temperature lower than conventional building [12].

In this paper Imran Tariq and Muhammad Arif Khan were performing the experiment on roof insulation in the local climate of Lahore at university of engineering and technology. The research work is based on one of the passive cooling technique on roof. The authors demonstrate the significant effect of green roof system in semi-arid climate of Lahore. Green roof is the natural cooling system of the building because the plants use the heat energy for photosynthesis and less carbon emission  $\text{CO}_2$  radiation of the building. By using the roof insulation, it decreases the room temperature, surface temperature of roof

and urban heat island effect. The significant results were analysed up to maximum difference between traditional roof surface and green roof surface temperature was 4.8 °C. from where it can be concluded that by constructing green roof system, cooling and heating loads of the building can be reduced significantly[13].

In the research, S.S. Chandel, Vandna Sharma and Bhanu M. Marwah describes the energy efficient vernacular architecture features affecting the indoor thermal comfort condition for applied on modern architecture building. This paper aims to reduce cost of residential buildings, decreasing operational costs and construction costs and the correlation was derived between construction costs, heating energy costs, proper shape and orientation of the building, for example the replacement of rubble stone masonry by burnt clay brick masonry and stabilized soil block will decreasing the construction cost without affecting the indoor thermal comfort, the Replacement of vernacular building materials by modern materials like cement, burnt clay bricks therefore not only have an adverse effect on indoor thermal comfort environment but also increase overall energy consumption of the house for maintaining indoor thermal comfort. The local available material like clay/earth is prominently used as vernacular building material due to its ease access of availability and thermal insulation property. However, there is need to improve its durability and compressive strength to use it as modern building material. Burnt earth roof tiles use as insulation for roof, in warm and humid climates prominent features are: court yard planning, natural ventilation through roof/ wind catchers, high thermal mass, earth as construction material where as in cold climates main features are high thermal mass, sunspaces, attic for insulation, sloped roofs, covered veranda and compact less opening. Further the Vernacular houses have solar passive features inherent in their design, planning, orientation and construction technique [14].

Anjali Jaiswal, Laasya Bhagavatula (June 2017) make a report on cool roofs can result in more comfortable conditions indoors. The authors discuss the Identify cost-effective cool roof solutions for low-income housing. The most significant factor of cool roof are maintaining the thermal comfort in homes, offices and buildings while contributing to reducing the urban heat island effect, air pollution, smog, and energy demand—especially during peak hours. In this report it gives the scalable financial mechanism to support the cool roofs program to clients. Moreover the cool roofs can improve not only an individual's life, but also an entire city's [15].

C. V. Subramanian<sup>1</sup>, M. Divya (Dec. 2016) describes the various types of passive cooling techniques available can be appropriately incorporated in the building design for warm humid climate of Tamilnadu region. Shading of roof, diode roof, water sprinkle top roof are the passive cooling techniques explain in this research. The orientation and proper air flow in building decreases the room temperature in summer, it mainly depend upon the outer climate and construction of building orientation. Shading requirements vary according to climate and orientation of buildings. The building interior can provide optimum comfort by incorporating such passive techniques and also decreases the artificial energy consumption. This reduces duration of overheated period of the building, dependence for air conditioner and other active cooling device. Architects and Engineers can incorporate such techniques in the modern construction, also during modifying and retrofitting of old buildings. In the recent years, the usage of air conditioning system has been in rapid increase for the purpose of cooling the building which results in high energy consumption. Passive cooling techniques are the method to increase the comfort level without or less usage of active cooling techniques. Solar Passive Architecture cooling techniques will certainly be an appropriate design solution for this hot region [16].

Sabahat Arif, Arif Khan, And Khalid Alamgir (2012) describes the indoor thermal comfort in a building has been an important issue for the environmental sustainability. The optimum thermal comfort level in the room is to feel friendly for the occupants in the building. An appropriate orientation of a building can provide thermally comfortable indoor temperatures which otherwise can consume extra energy to condition these spaces through all the seasons. The experimental study investigates the potential effect of this solar passive design strategy on indoor room temperatures and a simple model is presented for predicting indoor room temperatures based upon the outdoor temperatures. It can be employed in architectural planning for predicting heating and cooling for indoor thermal comfort Architects and Developers in Pakistan can achieve the national energy efficiency for temperature control in housing sector [17].

Badia Ghassan Masoud Isabel Crespo & Rafael Mur Soteras describes the cool roof, the maximum surface that receives solar radiation and is affected in buildings is the roof, it recives about 50% of heat entrance in the building. In the thesis authors explains the different types of cool roof and explain that how does it perform under the solar radiation attack is a must to improve the comfort state of human beings indoor, and to enhance the

energy efficiency in the building. Covering of the entire surface area with the closely packed inverted earthen pots, as was being done in traditional buildings, increases the surface area for irradiative emission. BCP in the roof is the insulating cover over the roof for impedes heat flow into the building. The slope roof is compared with flat roof and explains that the 45° roof system achieved the least solar radiation that 30° roof system and flat roof. Designing the most affective geometric roof that receives least solar radiation in hot climate regions in specific Jeddah, Saudi Arabia to reduce the heat that is molesting the building, to modify the energy efficiency used inside and to reduce building energy consumption, however each type of roof perform differently under the attack of solar radiation, with proper orientation and thermal insulation of roof get better results to achieve the optimum level of temperature [18].

Anubhav Yadav, Jitendra Jayant, Sandeep Garg, Anshu Kumar, Vinay Dubey also describes that the primary function of a building is to provide a comfortable indoor environment. They explain the different passive cooling techniques in modern building. The rate of energy consumption is increasing day by day without noticing the side effect on the global; now-a-days the interior of building is made comfortable as required, with the help of electromechanical devices, air conditioners and other cooling devices. Such devices consume electromechanical power which increases with increase of cooing load of the building. The author explains different types of cool roof like pond roof, inverted earthen for roof insulation, evaporative cooling and radioactive cooling. In which experiment was done at roof top (300mm thick Shrubs) could achieve the saving of 73.8 % in a peak space load [19].

Prasanthi R. Vangimalla, Svetlana J. Olbina, Raymond R. Issa, Jimmie Hinze explains the validation of Autodesk Ecotect is environmental analysis software. The main objectives of this research were to validate accuracy of Ecotect for thermal and day lighting simulations of buildings. Experimental analysis of thermal performance of an institutional building was conducted for one year while the daylighting performance was studied from January to September. The field data of the thermal loads and illuminance levels of the building were recorded. The comparative study was designed between field and Ecotect thermal and illuminance data measurements. The validation results showed that Ecotect underestimated thermal loads more than 15% in all the analyzed cases and overestimated illuminance levels in 98% of the analyzed cases. The main reason is drawn that the HVAC system might also affect the accuracy of the thermal loads because there is the limitation

in the software that no input in the actual HVAC system schedules. Therefore, these findings show that Ecotect cannot be used for accurate simulations of thermal loads and illuminance levels. This research results suggest that the Architecture, Engineering, and Construction (AEC) community should not use Ecotect as a thermal and day lighting analysis tool in the design and construction of buildings if accuracy of results is needed [20].

Farzad Jalaei and Ahmad Jrade explain quantifying the environmental impacts and simulating the energy consumption of building's components at the conceptual design stage are very significant for designers needing to make decisions related to the selection of the best architectural design alternative that would lead to a more energy efficient building. The paper proposes an automated model that links BIM, LCA (life cycle assessment), energy analysis, and lighting simulation tools with green building certification systems. BIM tool capable of measuring the environmental impacts (EI) and embodied energy of building components and it also help to achieve the better optimum comfort level of the building. During the stage of conceptual design, it is better to visualise the cost effective solution by using select different material applied on the building which are stored in the external database, to be used in their design based on the energy and sustainability specifications and cost [21].

N.M. Nahar, P. Sharma, M.M. Purohit perform eight identical test structures each having dimensions  $1280 \times 610 \times 1100 \text{ mm}^3$  have been fabricated. The different passive techniques were used over the roof for cooling the environment inside test structures in summer and maintain the temperature inside the room in winter. Painting of roof with white cement, thermal insulation over the roof, nocturnal cooling, inverted earthen pots having 100 mm diameter and 125 mm height were provided over the roof, and roof covered with Sania, a local insulating material used over the huts in the arid regions and the controlled unit without any treatment are the passive cooling techniques used to decrease the cooling load in summer and heating load in winter. The inverted earthen pots maintain +1.0 degree insulation in winter and -5.8 degree in summer. The effectiveness of this technique will decrease the urban heat island effect and carbon emission cycle [22].

G.Z.Shi, L.P.Li, C.F.Song, S.M.Cheng, W.Q.Tao, Y.L.He, (2016) perform the experiment of 3D numerical thermal simulation on conjugate heat transfer in hollow roofs is conducted by self-compiled program based on the finite volume method to improve insulation performance. Eight kinds of hollow roofs with different box fillers are

optimized by regularly designing partitions to divide air-filled cavity on roof. With the increase of the number of cavities in height direction will give better insulation to decrease the heating and cooling load of buildings. The numerical results demonstrate that: horizontal partitions decrease the equivalent thermal conductivity by 13.65%-40.42%, whose effect is more remarkable for higher void roofs, whereas vertical partitions cause few effects. The effect of thermal radiation on conjugate heat transfer in hollow bricks was analysed by 2D numerical method. R-value and heat transfer rate of hollow bricks of greater height of air cavity will give better results and plays a significant role [23].

San Jay Kumar and G. N. Tiwari explain that in the present communication, an analytical model has been evolved for passive cooling and heating of a building. An analytical expression for room temperature has been derived for different roof treatments in which air flow through the cavity of the roof, water flowing over the roof and air and water both flowing in the roof cavity and over the roof, respectively, in the same side. Thus, the condition for cooling is achieved and the direct solar radiation intake lost due to radiation, convection and evaporation in the case of water flowing over the roof, and the rest is carried away by the flowing air inside the metallic roof. It is found that the roof treatment with both air and water flow and a large isothermal/air mass within the room gives the best load levelling and room thermal comfort temperature. Air flow and water flowing over the roof produce the cooling effect inside the room and maintain the comfort level in the room. The passive cooling technique over the roof would give better thermal indoor condition and decrease the cooling and heating loads [24].

A. Dimoudi, A. Androutsopoulos, S. Lykoudis, describes a full-scale ventilated roof component was tested under real climatic conditions. In which two types of ventilated roof of 6cm and 8cm height of air gap with and without radiant barrier were examined by the author. The ventilated roof is much better than the typical roof; the radiant barrier (phases 3 and 4) enhances the performance of the ventilated roof significantly under summer day while the opposite is observed for summer night-time but on a 24 h basis the radiant barrier is clearly favourable during summer [25].

N.M. Nahar, P. Sharma, M.M. Purohit explained the experimental study of five identical test structures have been fabricated for studying of passive techniques for better comfort conditioning in arid areas. The heat entrance in the building from roof is 50 percentage so therefore the different passive techniques uses for the cooling of roof, viz. painting of roof by white paint, thermal insulation underneath roof, shallow pond with movable insulation

and soaked gunny bags with water. It has been found that the fall in roof and ambient temperatures inside the test structures were in increasing order for roofs treated with thermal insulation, painted with white paint, shallow pond with movable thermal insulation and evaporative cooling. Considering the ease of operation, round the year use and the requirement of water, the shallow pond tank with movable thermal insulation over the roof has been found best for cooling of structures for better comfort conditioning in arid areas rather than other techniques. It decreases the indoor room temperature quiet 10° C in summer and also effective in winter [26].

Arno Schlueter, Frank Thesseling explain that in order to evaluate the energy analysis of the building which dependencies of performance criteria on form, material and HVAC systems. The building performance assessment has to integrate with design process. A prototypical tool integrated into a building information modelling software is described, enabling instantaneous energy and energy calculations and the graphical visualisation of the resulting performance indices [27].

Hyunjoo Kim, Annette Stumpf and Wooyoung Kim describes that the objective of this research is to develop energy efficient building design process using data mining technology which can help project teams discover important patterns to improve the building design. In the case study different types of materials, insulations were provided for the different elements of the building and estimate the total energy cost of the building. For roof, there were 127 energy analysis models of different material like polystyrene, concrete, bricks and other insulation materials applied on the roof, to calculate the cost effective energy analysis using Green Building Studio for energy analysis were done. In Case study revealed that data mining based energy modelling help project teams discover useful patterns to improve the energy efficiency of building design and minimum life cycle cost during the design phase [28].

## **CHAPTER 2      EXPERIMENTATION**

### **2.1      General**

This chapter explained the experimental study of the research work. It describes the passive cooling technique on R.C.C roofs in Lahore. Experiment is carried out on two typical rooms that were already constructed in Architectural Engineering and Design Department at UET Lahore. The technique used in passive cooling is application of Burnt Clay Pots (BCP) on top of the roof to maintain the thermal indoor temperature. The rooms are selected on the basis of orientation, sun path and same dimensional volume. Patent burnt Clay pots are manufactured by the detail literature review and local market survey of Lahore. So, the two different height of same diameter of BCP are placed on two experimental rooms and temperature recorded on hourly basis from December 2017 to Jan 2018 by Testo Saviers System. All steps are elaborated here in detail.

### **2.2      Experimental Model**

This chapter aims at the local market survey for locally available pots of different sizes. Experiments are performed under local climate of Lahore conditions, the climatic parameters such as ambient temperature, intensity of solar radiation, wind velocity and relative humidity were same for both the test structures as they were built side by side. In this method, clay pots having 17 inch inner diameter, 6 inch and 8inch height were kept over the two same typical roofs. Air pockets were created on roof by using inverted Burnt Clay Pots (BCP) which act as a thermal insulation of roof. Two probes were fixed on inside the two rooms for recording indoor room temperature and third probes was fixed outside the room for recording the ambient temperature on hourly bases. Average of hourly base data of winter and summer months were obtained through the Microsoft Excel Data. Data was also received for peak hours and average calculated. Comparative analysis of performance of six inches and eight inches BCP roofs were carried out with reference to temperature difference between ambient and indoor which established that height and air pockets of BCP is affecting the thermal performance of the room.

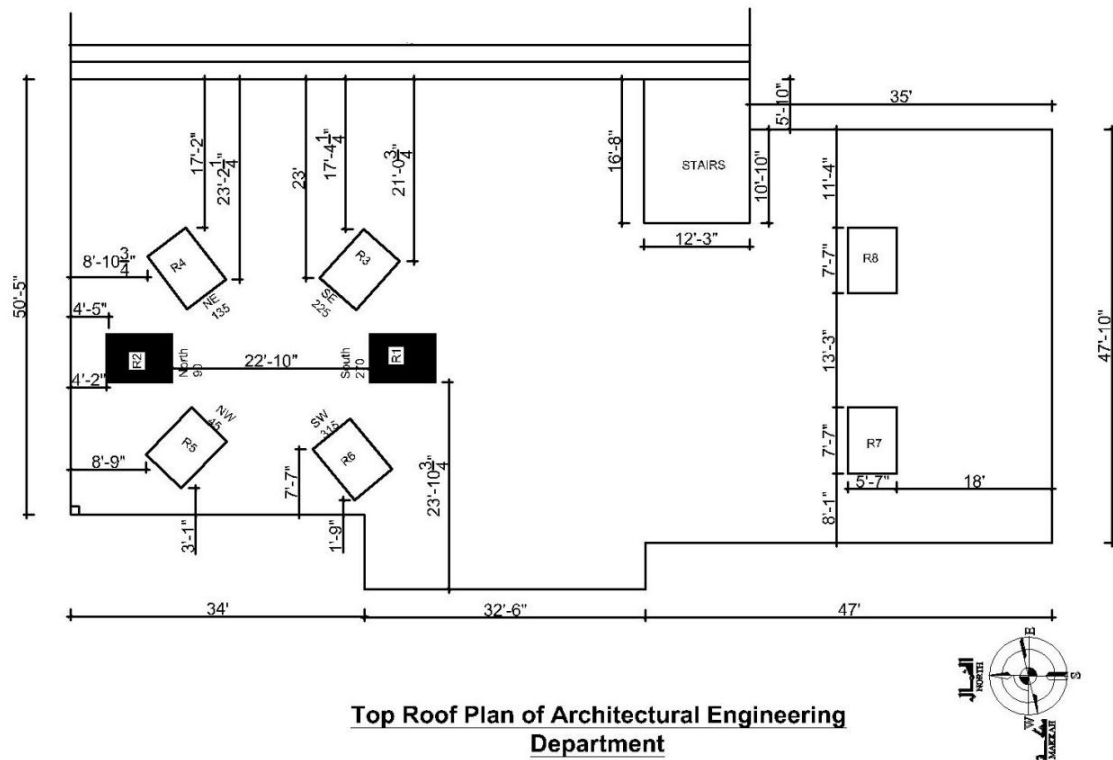
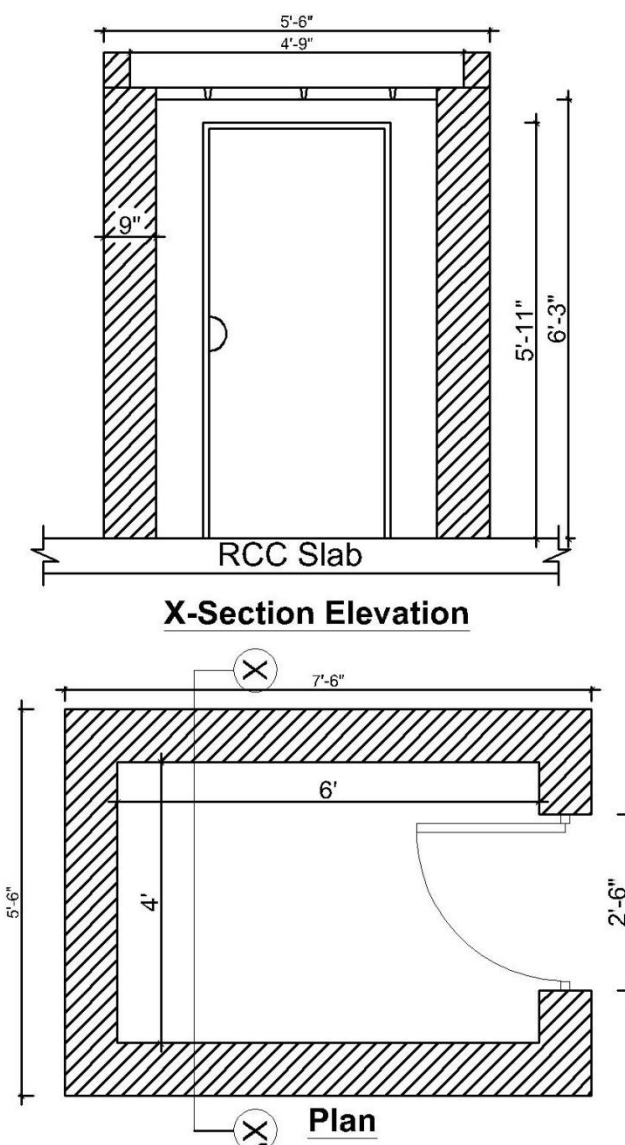


Fig-2.1 Schematic Layout of Experimental Models on Top Roof of Architectural Engineering and Design Department, UET Lahore.

### 2.2.1 Details of Experimentation Model

Experimentation was carried out on Experimental Model (EM) constructed on roof of Architectural Engineering and Design Department in UET, Lahore. Layout plan of the model is represented in Fig-2.1. After initial investigation of EM 1, 2, 3, 4, 5 & 6 were constructed on top of the roof of Architectural Engineering and Design Department. Experimental Model 1 and 2 were selected for construction of BCP roof technique. The sizes of experimental model are 5.5 ft. x 7.5 ft. x 6.25 ft. and it was constructed with 9 inches thick brick masonry on roof of AED Department at 33 ft. above road level. 3 inches thick precast RCC slabs were used as roofing system. Galvanized iron door 5 feet 11 inches x 2 feet 6 inches was installed on shorter walls of each model. Fig-2.2 shows the plan and x-sectional views of a typical experimental model.



**Existing Test Room 1 & 2 of AED Environmental Lab**

Fig-2. 2 Plan and X-Sectional of existing Experimental Model

### 2.2.2 Orientation of Experimental Model

All the experimental model were constructed at 45 degree of interval to maintain the aspect ratio. Two rooms were selected for experimental work on the basis of side to side which was 180 degree rotated with each other and 22ft. 10inches distance apart. All the rooms are constructed with similar material and typical architectural dimension.

### 2.2.3 Monitoring Equipment

In order to maintain the reliable data for indoor and outdoor thermal condition of room, for this purpose Testo Saveris System was installed as shown in Fig-2.3. In which probes, Wi-Fi Base and computers were the instruments used to measure the indoor and outdoor ambient temperature simultaneously. The data of ambient temperature outside and inside

of two experimental model under predefined time interval was continuously recorded for the days of December to May 2018 and supervised through the data logger.

Sr. No.	Zone	Serial No.	Placement
1	Zone 1	1607756	8 inch BCP Inside room 1
2	Zone 2	1550140	6 inch BCP Inside room 2
3	Zone 3	1652256	Outside Ambient Temperature



Fig-2. 3 Testo Saveris System

## 2.3 Preliminary Investigation

The same sizes of two experimental models were placed toward north and south facing. These experimental model rooms were placed at 22ft and 10 inches distance apart with each other. Further, the shading devices and windows were not present on the EM rooms. The south facing EM room is represented by eight inch height burnt Clay Pots (BCP) roof called room 1 and the north facing EM room is represented by six inch height burnt Clay Pots (BCP) roof called room 2.

### 2.3.1 Experimentation Setup

After preliminary investigation, test room 1 and 2 having north and south face orientation respectively. Comparative analysis of performance of six inches and eight inches BCP roofs is carried out with reference to temperature difference between ambient and indoor which established that height and air pockets of BCP is affecting the thermal performance of the room. The methodology use in performing this experiment is given below.

### 2.3.2 Selection of Burnt Clay Pots

Burnt Clay Pots (BCP) are easily available in the market. During the local survey of the market of Lahore, the BCP are different in size, shape and thickness. Generally burnt Clay pots mostly used for cooking, household usage and plantation. There are different types of pots available in the market which has different shape, sizes and thicknesses but they are not commonly used for thermal insulation of roof in the buildings as shown in the Fig-2.4 & 2.5.

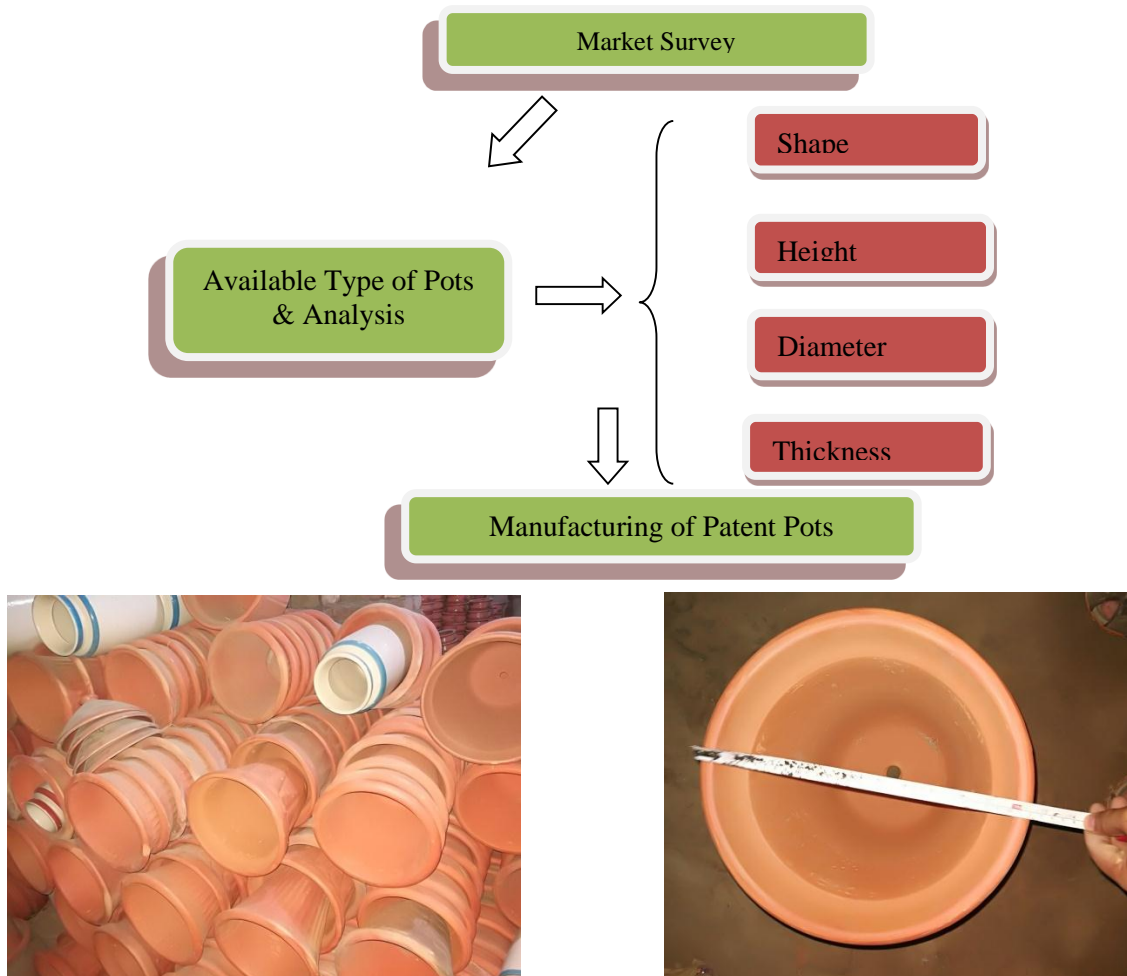


Fig-2. 4 10 inch Dia. and 10 inch height of conical shape Burnt Clay Pots (BCP).



Fig-2. 5 10 inch Dia. and 10 inch height of cylindrical shape burnt clay Pots

If we may use these different types of market base burnt clay pots for roof insulation of building and apply on the experimental model rooms of AED than some prominent problems regarding the comparative study would be faced. Pots of different height have no fix single constraint like diameter/height, surface area and pot's numbers. The proposed cross section of these rooms were drawn on Autocad as shown in the Fig-2.6.

During the local market survey the availability of pots are Pots 1 (10 inch diameter of 9 inch height) and pot 2 (4 inch diameter of 4 inch height). So, if we compare the thermal insulation of roof with the market base available pots than we have to face all these different problems like variation in diameter, shape, thickness and outside gaps. These are varying with change of height of BCP.

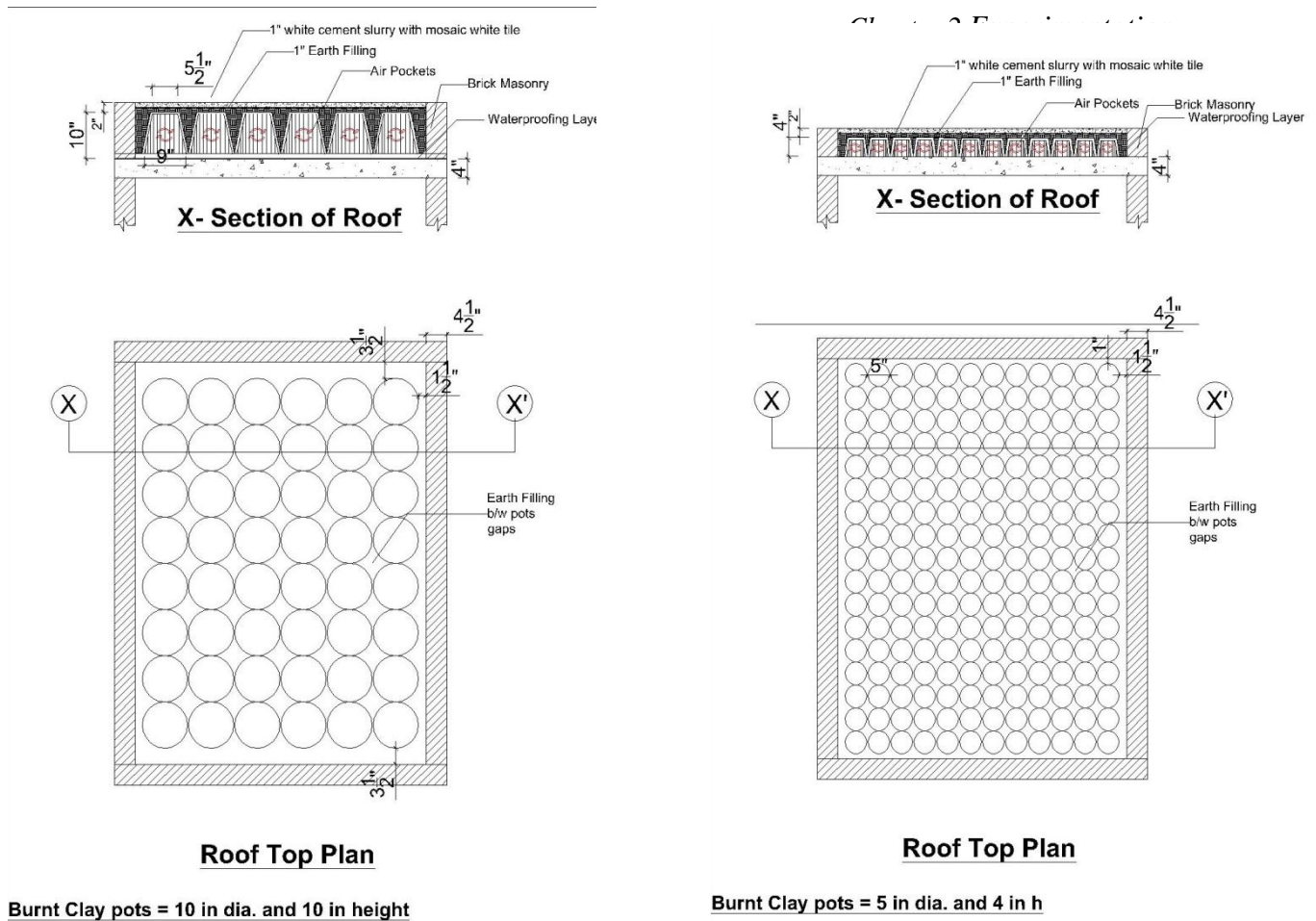




Fig-2. 7 Manufacturing of Patent Burnt Clay Pots

Pots are manufactured for giving the thermal insulation of the roof. The two heights of same diameter of Clay pots are manufactured. Before the manufacturing of Clay pots, the desire shapes of pots were adjusted at the required parameters of experimental model roof using auto cad software as shown in the Fig-2.8.

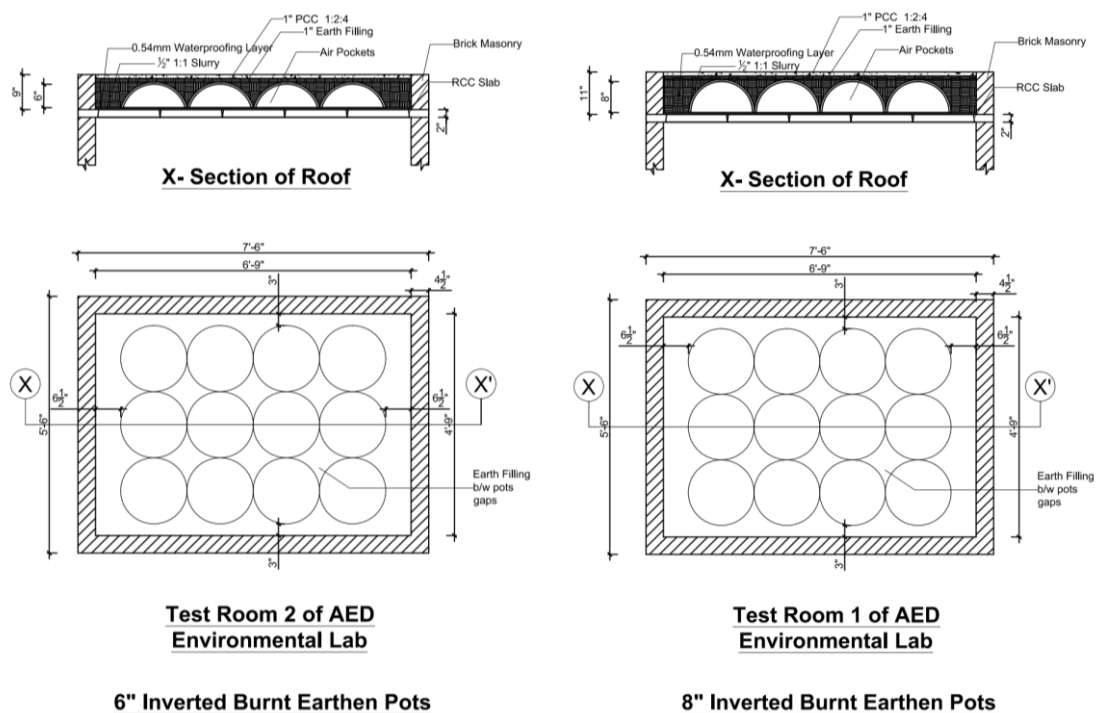


Fig-2. 8 Proposed design of BCP using Patent burnt clay pots

After fulfil the require parameters of clay pots than the pot maker was manufactured the desire shape of the pots than it went to the kiln for the heating section. In which the controlled temperature is giving so they could achieve the require strength of the pots. During heating stage the size of the pots will shrink up to 10-15%.



Fig-2. 9 Kiln (heating section of Clay pots)



Fig-2. 10 Manufacturing of Patent Burnt Clay Pots

These pots were manufactured in kiln as shown in the diagram. These patent pots were achieved the require shape and size. The two types of pots were used for performing the experiment for thermal insulation of roof as shown in Fig 2.9 & 2.10.

1. 8 inch height and 17 inch Diameter
2. 6 inch height and 17 inch Diameter

## 2.4 Preparation of Experimental Model

After the preliminary investigation, the two experimental model (EM) that were selected for the treatment of inverted Clay pots. North side room represent the 8 inch Burnt Clay Pots (8 inch BCP) and South side room represents the 6 inch Burnt Clay Pots (6 inch BCP). The methodology of construction of Burnt Inverted Clay pots is stated below.

1. The reinforced Cement concrete roof was cleaned and all sharp edges were removed.
2. For the water proofing treatment Polythene sheet was spread evenly on the roof.
3. 1 inch Cement slurry (cement: sand = 1:1 by weight) was evenly spread on the surface for fixing of BCP.
4. When the slurry turned semi-dry than place the Burnt Clay pots (size: diameter 17 inch, height 6 inch) and (size: diameter 17 inch, height 8 inch) were laid on two EM rooms. Those pots were touched one another at the rim and left minimum space in between.
5. The voids were filled with mud and in addition one inch mud layer was evenly spread on top of the burnt clay pots.
6. One inch thick P.C.C (1:2:4) was provided above mud layer to stop rain water penetration.
7. Slope for drainage of water was maintained at the top layer.
8. Indoor and outdoor Temperature of EMs were recorded by using Testo Saveris System.

#### 2.4.1 Cleaning the Surface of Roof

The top roof surface should be cleaned and free from the crack or gap. The cleaning of both rooms were done on both rooms as shown in Fig. 2.11 & 2.12.



Fig-2. 11 Cleaning of 8 inch BCP roof



Fig-2. 12 Cleaning of 6 inch BCP roof

#### 2.4.2 Water Proofing Treatment

In a construction, the building should be water proof with the usage of water proofing sheet. Polythene sheet water proofing was provided on both cases (6 Inch and 8 Inch BCP rooms) as shown in Fig. 2.13 & 2.14.



Fig-2. 13 Water proofing sheet on 8 inch BCP roof



Fig-2. 14 Water proofing sheet on 6 inch BCP roof

### 2.4.3 Cement Slurry

After the placement of water proofing sheet the cement sand (1:1) one inch thick slurry was spread on the water proofing membrane. This C: S slurry was helpful for fixing of inverted Clay pots in appropriate positions. The gaps were properly filled with 1 inch cement sand slurry, so the tightness of the pots should be done properly as seen in the Fig-2.15 & 2.16.



Fig-2. 15 Cement Sand (1:1) slurry on 8 inch BCP roof



Fig-2. 16 Cement Sand (1:1) slurry on 6 inch BCP roof

#### 2.4.4 Placement of Inverted Burnt Clay Pots

This step is the most important in which all pots are placed in a definite rows and columns, the distance between both parallel sides should be equal. Twelve BCP used for each experimental model and those BCP were placed at equal distances of 4 inches from one parallel sides and 7 inches from the other parallel sides of the EM as shown in fig- 2.18 & 2.19.



Fig-2. 17 Burnt Clay Pots at site



Fig-2. 18 Placement of 8 inch Burnt Inverted Clay Pots on roof



Fig-2. 19 Placement of 6 inch Burnt Inverted Clay Pots on roof

#### 2.4.5 Mud Filling

After the placement of burnt Inverted Clay pots, the next step was filling the inverted Clay pots with common material. The voids were filled with mud and in addition one inch mud layer was evenly spread on top of the burnt clay pots on both cases (6 Inch and 8 Inch BCP rooms) as shown in the fig- 2.20 & 2.21.



Fig-2. 20 Mud filling on 8 inch BCP roof



Fig-2. 21 Mud filling on 6 inch BCP roof

#### 2.4.6 Placement of PCC (1:2:4)

Finally the last layer of P.C.C (thickness: 1 inch) was evenly applied on the top surface. Slope for drainage of water was maintained at the top layer as shown in the Fig-2.22 & 2.23.



Fig-2. 22 PCC placement on 8 inch BCP roof



Fig-2. 23 PCC placement on 6 inch BCP roof

#### 2.4.7 Placement of Probe for Temperature Recording

The temperature of 8 inch height treated roof is that Room which is north face direction that represent as a Room no. 1 as shown in Fig-2.24. This room no. 1 is called 8 inch (17 inch diameter, 8 inch inner height and 1 inch thick) height Burnt Clay pot (BCP). The probes are set for measuring the outside and inside room temperature to check the thermal insulation. These probes are stored the hourly temperature of their surrounding environmental air.



Fig-2. 24 Measuring the Indoor Room Temperature of 8 inch BCP EM.

The temperature of 6inch height treated roof was that room which was south face direction that represent as a Room no. 2 as shown in Fig-2.25. The room no. 2 is called 6inch (17 inch diameter, 6 inch inner height and 1inch thick) height Burnt Clay pot (BCP). Probes were set for measuring the outside and inside room temperature. These probes were stored the hourly temperature of their surrounding environmental air.



Fig-2. 25 Measuring the Indoor Room Temperature of 8 inch BCP EM.



Fig-2. 26 Measuring the Outdoor ambient temperature

The data of untreated roof is taken from the thesis of Dr. Sabahat Arif in her doctorate research title “Energy Efficient House Design, effect of orientation on indoor temperature profile”. First, the outdoor temperatures of the month of December were taken from the Dr. Sabahat’s thesis than it was matched by the performing experiment day’s ambient temperature. So, the comparative study would be drawn between the treated and untreated roof.



Fig-2. 27 Measuring the Outdoor ambient temperature

The inside probes were placed 11 inches below the roof level to measure the indoor room temperature. The other probe was set outside the room to record the ambient temperature. During the days of experiment the probes were regularly checked. These

probes directly sends the data to the computer system in MS Excel format through Wi-Fi Base. The computer save the recorded data in Testo Sevies System as shown in Fig-2.28.



Fig-2. 28 Experimental Devices to calculate the thermal analysis of EM

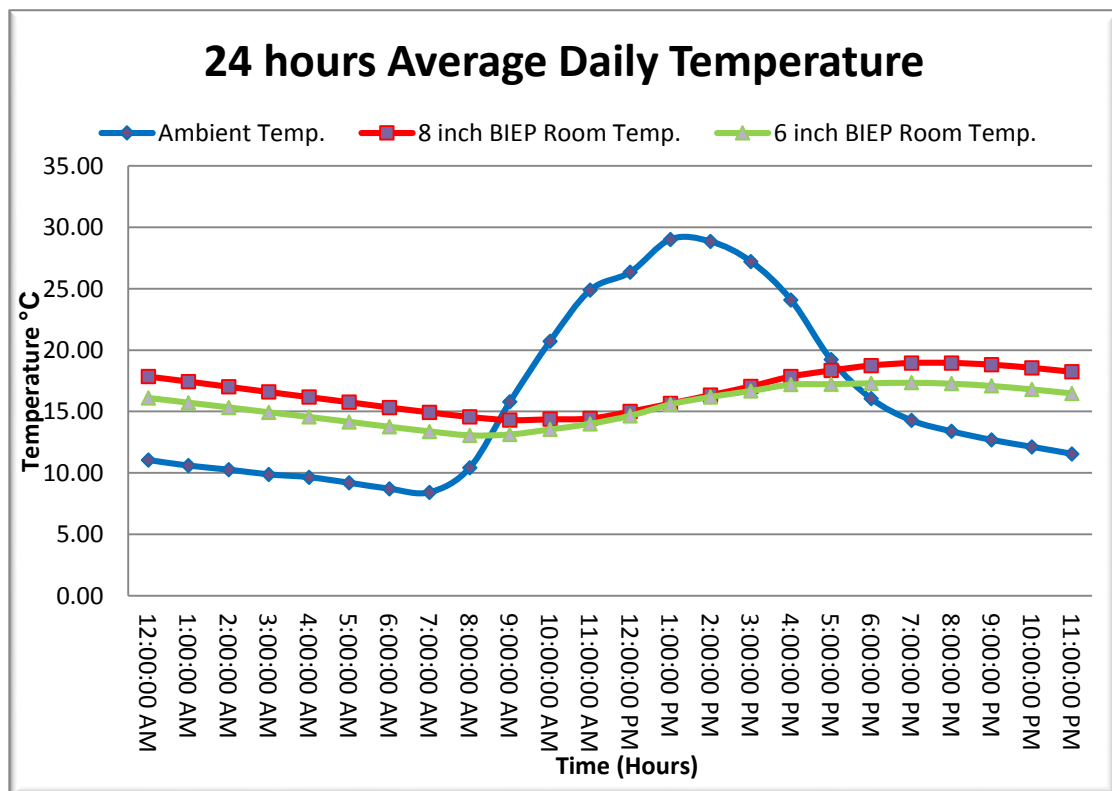
## CHAPTER 3      EXPERIMENTAL RESULTS AND ANALYSIS

### 3.1 General

This chapter contains the experimental results of the study carried out to determine the effect of thermal insulation using Burnt Clay pots on indoor room temperature in local climate of Lahore. The results are represented in graphical and tabular format with use of TESTO software. The ambient and indoor room temperature of EM of 6inch and 8inch BCP were measured at one hour time interval through Testo Sevis System. The experiment was done from December 2017 to January 2018 for winter season and from March to May 2018 for summer season as describe in Annex-A. Layout of experimental model and location are shown in chapter-2.

### 3.2 24 Hour Average Daily Temperature recorded

The indoor room temperature of 6inch and 8inch BCP EM were recorded as shown below. The 24 hour average temperature were recorded for winter months. Table 3.1 and Graph 3.1 are showing the full day variation of the average 24 hour temperature profile in winter months.



Graph 3. 1 24 hours Average Daily Temperature

Sr. No.	Time	Ambient Temp.	8 inch BCP Room Temp.	6 inch BCP Room Temp.
		C°	C°	C°
1	12:00:00 AM	11.05	17.85	16.11
2	1:00:00 AM	10.60	17.44	15.72
3	2:00:00 AM	10.27	17.02	15.34
4	3:00:00 AM	9.88	16.60	14.94
5	4:00:00 AM	9.65	16.18	14.56
6	5:00:00 AM	9.20	15.77	14.16
7	6:00:00 AM	8.71	15.34	13.76
8	7:00:00 AM	8.43	14.94	13.38
9	8:00:00 AM	10.42	14.57	13.06
10	9:00:00 AM	15.79	14.31	13.13
11	10:00:00 AM	20.73	14.38	13.54
12	11:00:00 AM	24.89	14.44	14.00
13	12:00:00 PM	26.35	15.00	14.66
14	1:00:00 PM	29.03	15.67	15.59
15	2:00:00 PM	28.85	16.35	16.20
16	3:00:00 PM	27.23	17.05	16.68
17	4:00:00 PM	24.10	17.85	17.20
18	5:00:00 PM	19.22	18.35	17.23
19	6:00:00 PM	16.05	18.75	17.31
20	7:00:00 PM	14.28	18.96	17.35
21	8:00:00 PM	13.39	18.96	17.27
22	9:00:00 PM	12.69	18.82	17.09
23	10:00:00 PM	12.13	18.56	16.80
24	11:00:00 PM	11.56	18.24	16.48

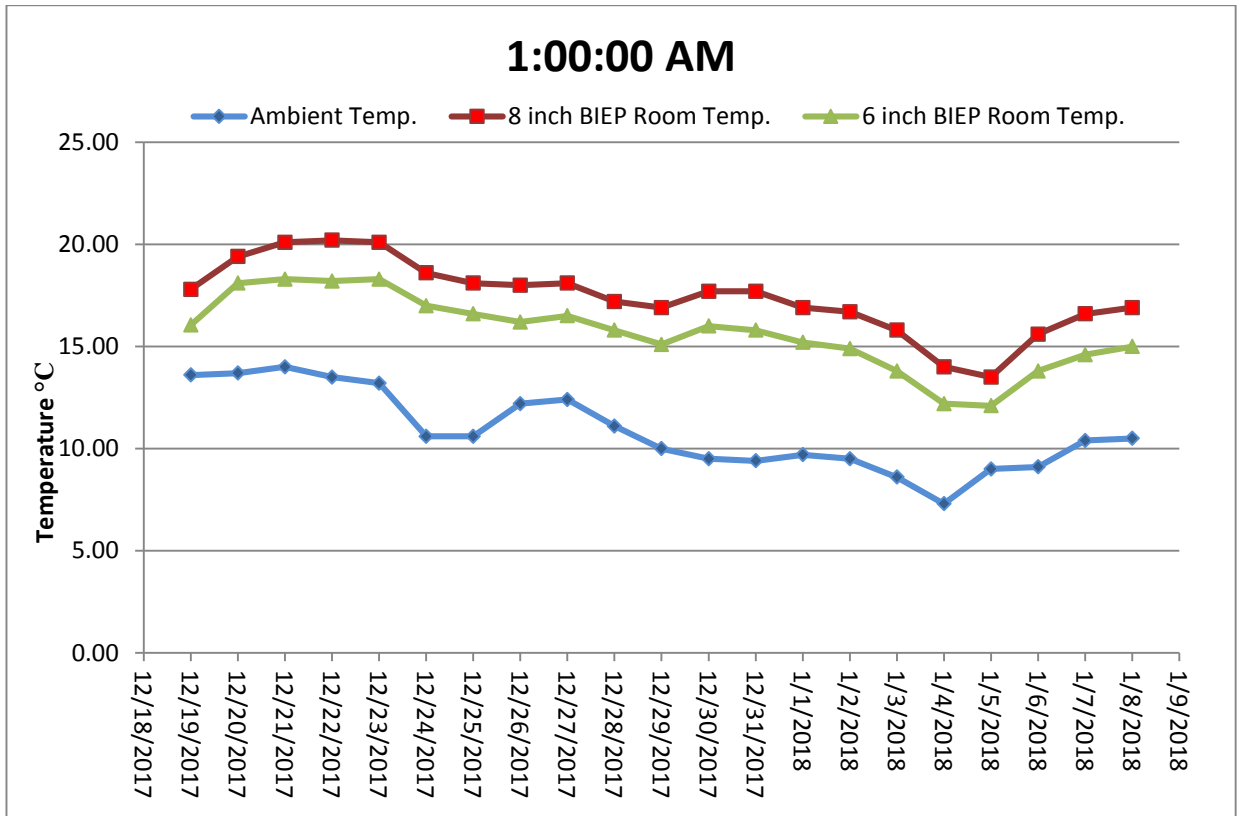
Table 3. 1 24 hours Average Daily Temperature

### 3.3 Daily Temperature recorded at Peak Hours

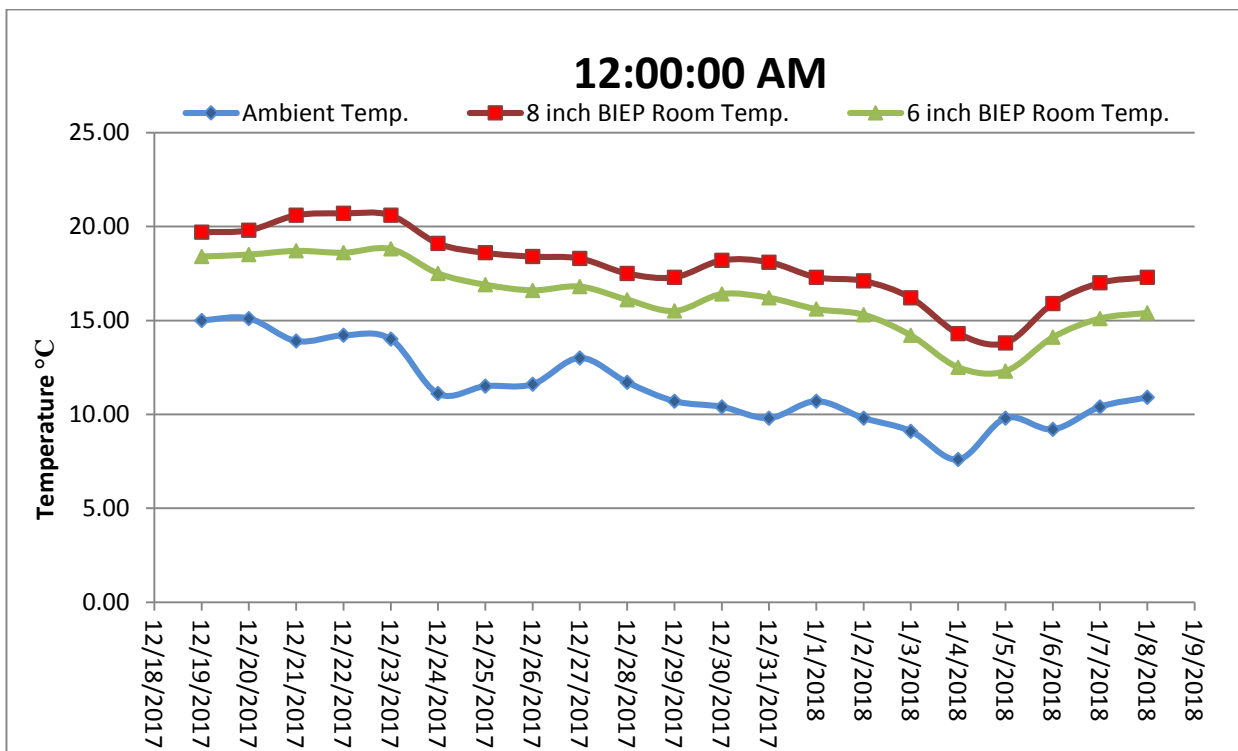
Tables and graphs 3.2, 3.3 & 3.4 are describing the 8 inch and 6 inch BCP roof's indoor room temperature and ambient temperature according to the specific date of experimentation. Temperature profile of Midnight especially 12:00 am, 1:00 am and Winter Solstice (21st December) are given below.

Sr. No.	Date	Ambient Temp.	8 inch BCP Room Temp.	6 inch BCP Room Temp.
		C°	C°	C°
1	19/12/2017	13.60	17.80	16.05
2	20/12/2017	13.70	19.40	18.10
3	21/12/2017	14.00	20.10	18.30
4	22/12/2017	13.50	20.20	18.20
5	23/12/2017	13.20	20.10	18.30
6	24/12/2017	10.60	18.60	17.00
7	25/12/2017	10.60	18.10	16.60
8	26/12/2017	12.20	18.00	16.20
9	27/12/2017	12.40	18.10	16.50
10	28/12/2017	11.10	17.20	15.80
11	29/12/2017	10.00	16.90	15.10
12	30/12/2017	9.50	17.70	16.00
13	31/12/2017	9.40	17.70	15.80
14	01/01/2018	9.70	16.90	15.20
15	02/01/2018	9.50	16.70	14.90
16	03/01/2018	8.60	15.80	13.80
17	04/01/2018	7.30	14.00	12.20
18	05/01/2018	9.00	13.50	12.10
19	06/01/2018	9.10	15.60	13.80
20	07/01/2018	10.40	16.60	14.60
21	08/01/2018	10.50	16.90	15.00

Table 3. 2 Daily Temperature Monitor at 1:00 AM



Graph 3. 2 Daily Temperature Monitor at 1:00 AM



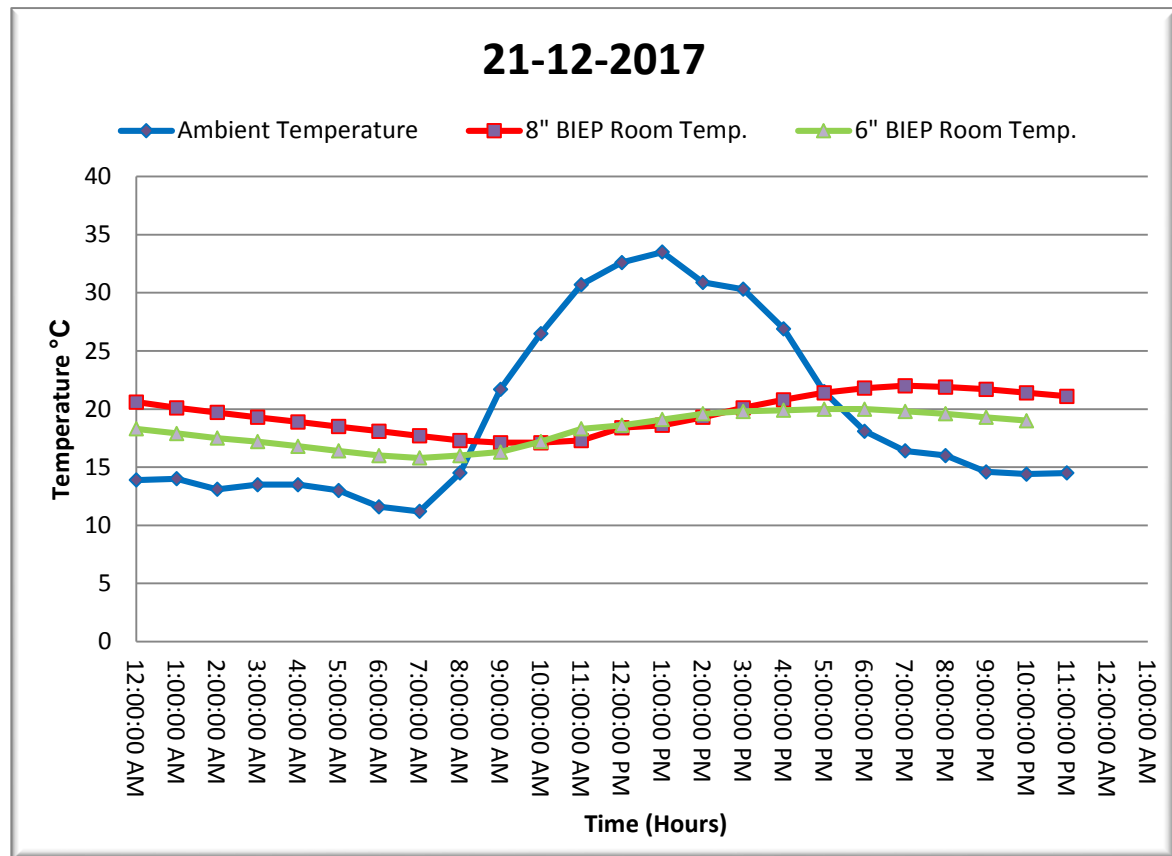
Graph 3. 3 Daily Temperature Monitor at 12:00 AM

Sr. No.	Date	Ambient Temp.	8 inch BCP Room Temp.	6 inch BCP Room Temp.
		C°	C°	C°
1	19/12/2017	15.00	19.70	18.40
2	20/12/2017	15.10	19.80	18.50
3	21/12/2017	13.90	20.60	18.70
4	22/12/2017	14.20	20.70	18.60
5	23/12/2017	14.00	20.60	18.80
6	24/12/2017	11.10	19.10	17.50
7	25/12/2017	11.50	18.60	16.90
8	26/12/2017	11.60	18.40	16.60
9	27/12/2017	13.00	18.30	16.80
10	28/12/2017	11.70	17.50	16.10
11	29/12/2017	10.70	17.30	15.50
12	30/12/2017	10.40	18.20	16.40
13	31/12/2017	9.80	18.10	16.20
14	01/01/2018	10.70	17.30	15.60
15	02/01/2018	9.80	17.10	15.30
16	03/01/2018	9.10	16.20	14.20
17	04/01/2018	7.60	14.30	12.50
18	05/01/2018	9.80	13.80	12.30
19	06/01/2018	9.20	15.90	14.10
20	07/01/2018	10.40	17.00	15.10
21	08/01/2018	10.90	17.30	15.40

Table 3. 3 Daily Temperature Monitor at 12:00 AM

Sr. No.	Time	Ambient Temp.	8 inch BCP Room Temp.	6 inch BCP Room Temp.
		C°	C°	C°
1	12:00:00 AM	13.90	20.60	18.70
2	1:00:00 AM	14.00	20.10	18.30
3	2:00:00 AM	13.10	19.70	17.90
4	3:00:00 AM	13.50	19.30	17.50
5	4:00:00 AM	13.50	18.90	17.20
6	5:00:00 AM	13.00	18.50	16.80
7	6:00:00 AM	11.60	18.10	16.40
8	7:00:00 AM	11.20	17.70	16.00
9	8:00:00 AM	14.50	17.30	15.80
10	9:00:00 AM	21.70	17.10	16.00
11	10:00:00 AM	26.50	17.10	16.30
12	11:00:00 AM	30.70	17.30	17.20
13	12:00:00 PM	32.60	18.40	18.30
14	1:00:00 PM	33.50	18.60	18.60
15	2:00:00 PM	30.90	19.30	19.10
16	3:00:00 PM	30.30	20.10	19.60
17	4:00:00 PM	26.90	20.80	19.80
18	5:00:00 PM	21.50	21.40	19.90
19	6:00:00 PM	18.10	21.80	20.00
20	7:00:00 PM	16.40	22.00	20.00
21	8:00:00 PM	16.00	21.90	19.80
22	9:00:00 PM	14.60	21.70	19.60
23	10:00:00 PM	14.40	21.40	19.30
24	11:00:00 PM	14.50	21.10	19.00

Table 3. 4 Winter Solstice (21st December) Temperature Monitor



Graph 3. 4 Winter Solstice (21st December) Temperature Monitor

In this section, the complete data was provided on the basis of experimentation. The temperature profile for important seasonal date, peak hours and 24 hours average daily temperature are analysed. It was noted that the monitored temperature of two rooms responded differently throughout the day as shown below. The analysis and discussion will be decided the optimum height of Burnt Clay pots to achieve good indoor thermal temperature.

### 3.4 Discussion

The 24 hours average temperature, peak hours and winter solstices temperature data are discuss in this section to give the best suitable BCP roof for thermal insulation of roof.

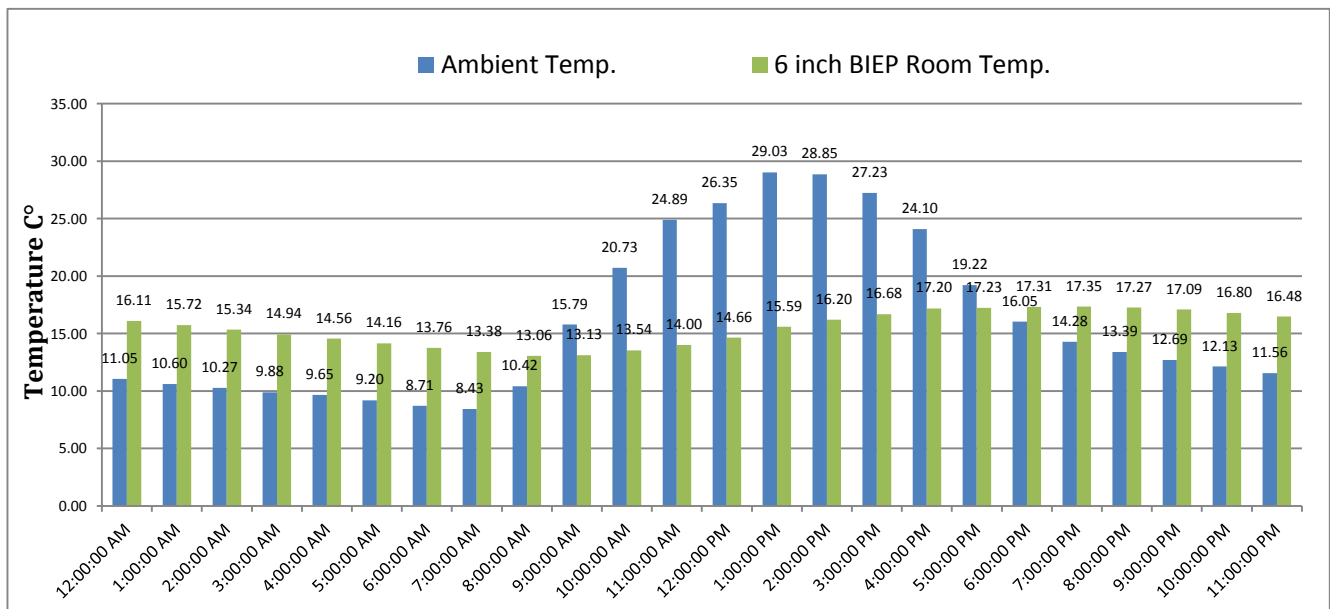
#### 3.4.1. 24 Hours Average Daily Temperature

The recorded temperature of experimental model of 6inch BCP and 8inch BCP from December 2017 to January 2018 are analysed and discuss in the following section. Tabular form of recorded data and graphs are drawn against ambient temperature.

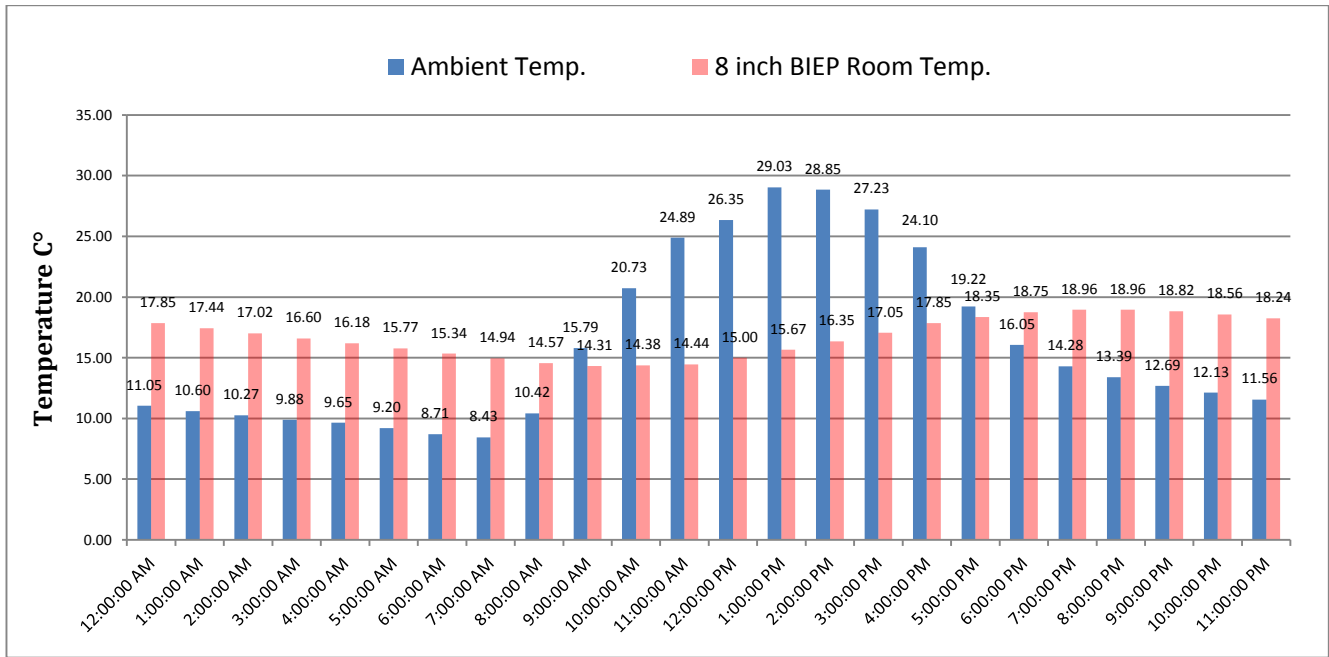
Graph 3.5 shows that the maximum ambient and 6 inch BCP indoor room temperature are 29.03°C and 15.59°C respectively at 02:00 pm. In this case, the temperature difference between ambient and indoor room temperature is 13.44°C at day time. The minimum ambient and 6 inch BCP indoor room temperature are 11.05°C and 16.11°C respectively at 12:00 am and the temperature difference between ambient and indoor room temperature is 5.06°C at night time.

Graph 3.6 shows the maximum ambient and 8 inch BCP indoor room temperature are 29.03°C and 15.67°C respectively at 02:00 pm. In this case, the temperature difference between ambient and indoor room temperature is 13.36°C at day time. The minimum ambient and 8 inch BCP indoor room temperature are 11.05°C and 17.85°C respectively at 12:00 am and the temperature difference between ambient and indoor room temperature is 6.80°C at night time.

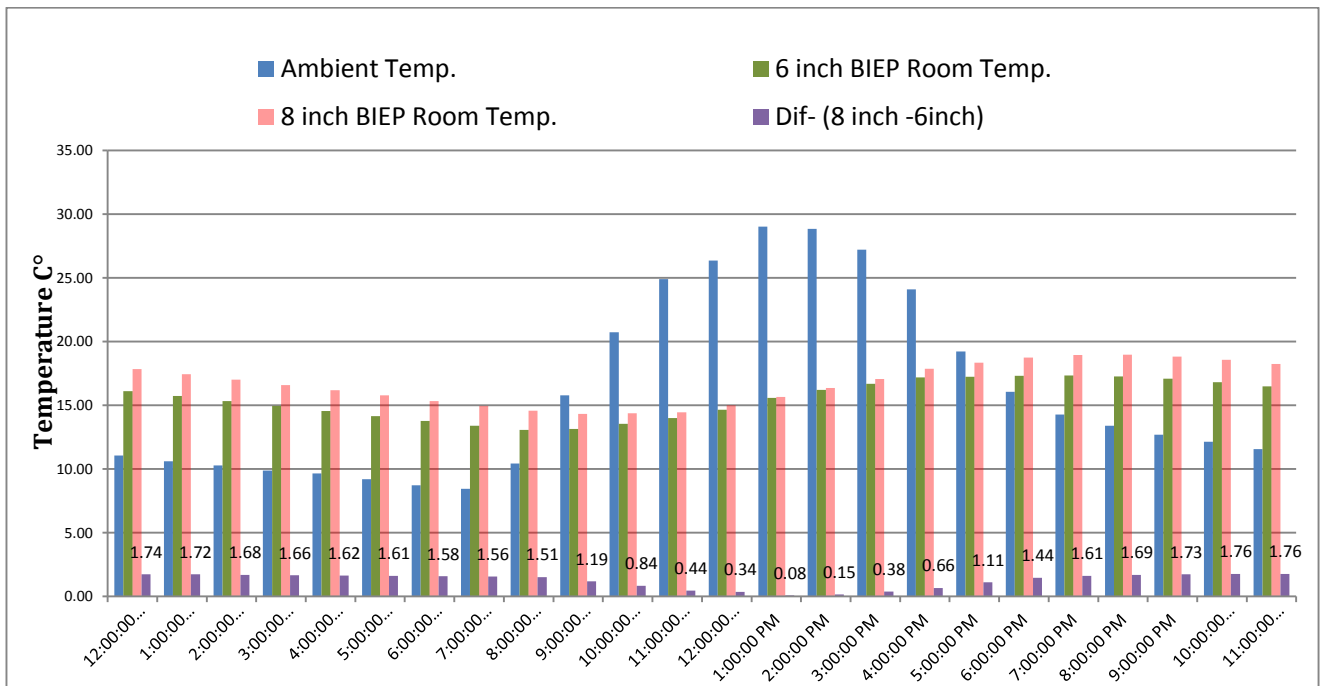
Graph 3.7 explains the comparative study of both rooms. 8 inch BCP room is 1.74°C more maintain the indoor room temperature at night/peak time in winter season as compared to 6 inch BCP room. So, it clearly justify the hypothesis that the increase the volume of air gaps in roof causes improve the thermal condition of the roof.



Graph 3.5 Ambient Temperature vs. Indoor 6inch BCP Room for 24 hours Average Temperature



Graph 3.6 Ambient Temperature vs. Indoor 8inch BCP Room for 24 hours Average Temperature



Graph 3.7 Comparison of EM of 6inch and 8inch BCP Room against ambient temperature for 24 hours Average Temperature

Sr. No.	Time	Ambient Temp.	8 inch BCP Room Temp.	6 inch BCP Room Temp.	Diff- (8 inch - 6inch)
		C°	C°	C°	C°
1	12:00:00 AM	11.05	17.85	16.11	1.74
2	1:00:00 AM	10.60	17.44	15.72	1.72
3	2:00:00 AM	10.27	17.02	15.34	1.68
4	3:00:00 AM	9.88	16.60	14.94	1.66
5	4:00:00 AM	9.65	16.18	14.56	1.62
6	5:00:00 AM	9.20	15.77	14.16	1.61
7	6:00:00 AM	8.71	15.34	13.76	1.58
8	7:00:00 AM	8.43	14.94	13.38	1.56
9	8:00:00 AM	10.42	14.57	13.06	1.51
10	9:00:00 AM	15.79	14.31	13.13	1.19
11	10:00:00 AM	20.73	14.38	13.54	0.84
12	11:00:00 AM	24.89	14.44	14.00	0.44
13	12:00:00 PM	26.35	15.00	14.66	0.34
14	1:00:00 PM	29.03	15.67	15.59	0.08
15	2:00:00 PM	28.85	16.35	16.20	0.15
16	3:00:00 PM	27.23	17.05	16.68	0.38
17	4:00:00 PM	24.10	17.85	17.20	0.66
18	5:00:00 PM	19.22	18.35	17.23	1.11
19	6:00:00 PM	16.05	18.75	17.31	1.44
20	7:00:00 PM	14.28	18.96	17.35	1.61
21	8:00:00 PM	13.39	18.96	17.27	1.69
22	9:00:00 PM	12.69	18.82	17.09	1.73
23	10:00:00 PM	12.13	18.56	16.80	1.76
24	11:00:00 PM	11.56	18.24	16.48	1.76
<b>Temperature</b>		<b>16.02</b>	<b>16.72</b>	<b>15.48</b>	<b>1.24</b>

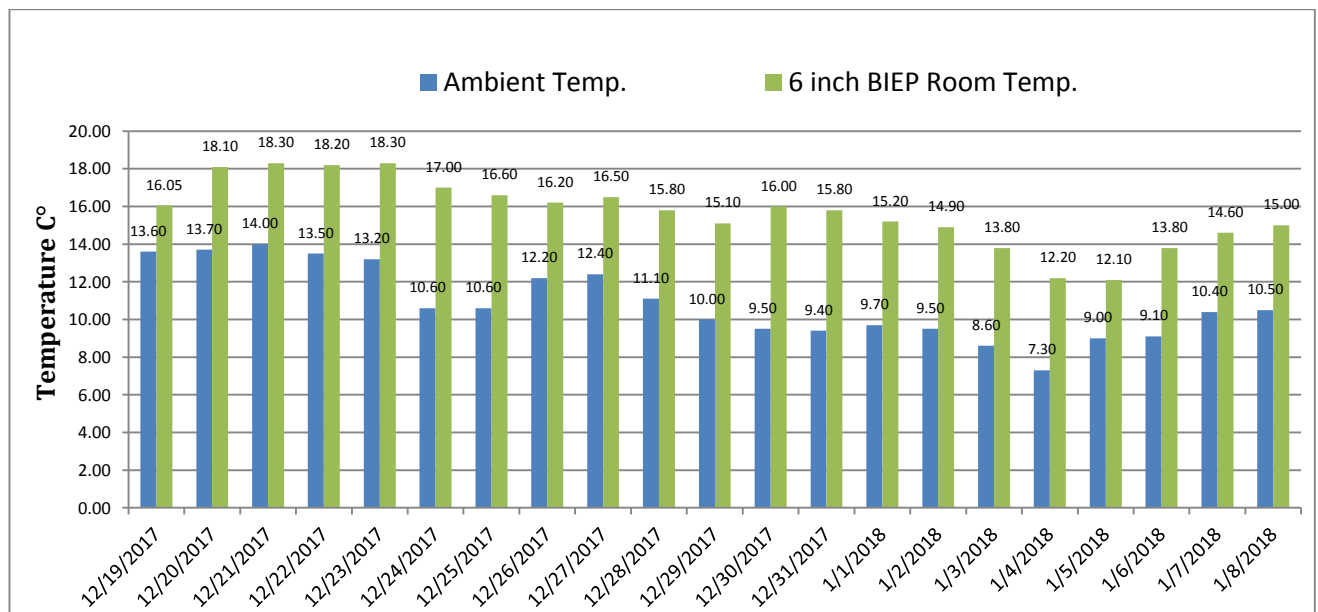
Table 3.5 Comparison of EM of 6inch and 8inch BCP against Ambient temperature for 24 hours Average Temperature

The indoor temperature profile indicates that the difference in temperature between 8 inch BCP room and 6 inch BCP room got significant during night hours in winter month of December and January as shown in Table 3.5. The differences in temperature between these two EMs are lesser in afternoon hours. On the above base analysis the data revealed that the average temperature of 8 inch BCP room keep 1.24 C° more efficient than 6 inch BCP room.

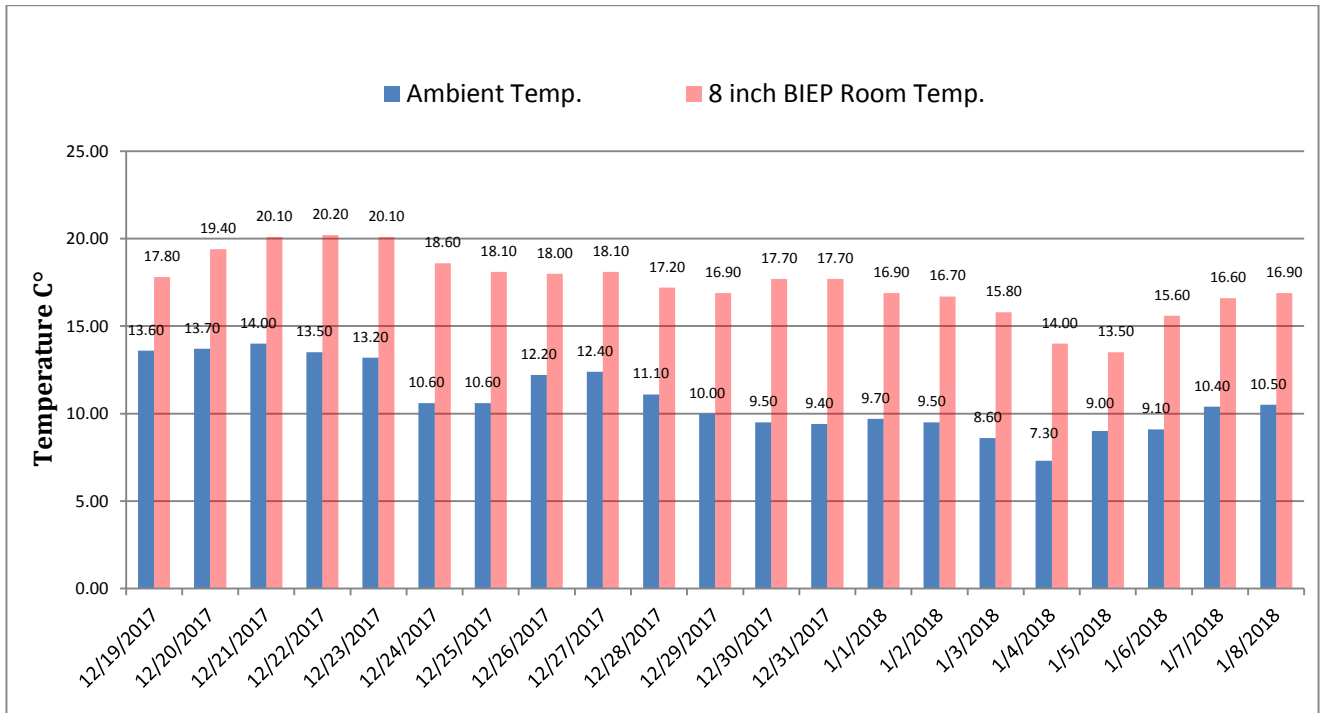
### 3.4.2 Daily Temperature Recording at 1:00 AM

The recorded temperature of experimental model of 6inch BCP and 8inch BCP from 19<sup>th</sup> December 2017 to 8<sup>th</sup> January 2018 in winter are recorded and graphically drawn against ambient temperature at 1:00 am peak hours.

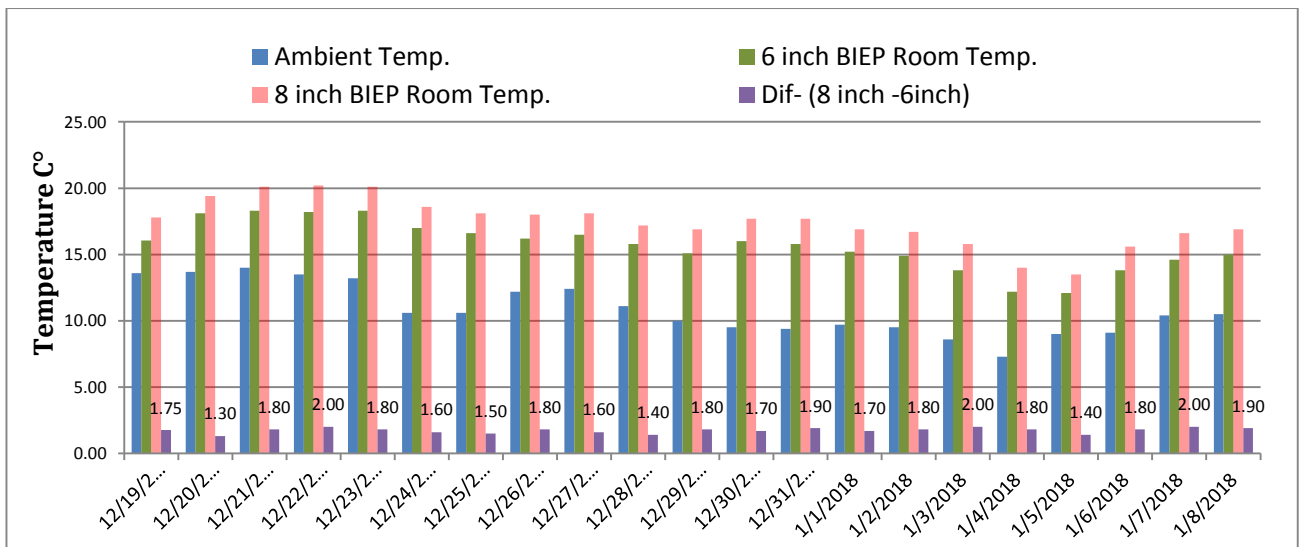
Graph 3.8 & 3.9 are showing the temperature profile of 6 inch and 8 inch BCP room temperature along date of experimentation at 1:00am. The maximum temperature difference between two EM is 2.00°C.



Graph 3.8 Ambient Temperature vs. Indoor 6inch BCP Room for Peak Hours 1:00AM.



Graph 3.9 Ambient Temperature vs. Indoor 8inch BCP Room for Peak Hours at 1:00AM.



Graph 3.10 Comparison of EM of 6inch and 8inch BCP against Ambient temperature for Peak Hours at 1:00AM.

Sr. No.	Date	Ambient Temp.	8 inch BCP Room Temp.	6 inch BCP Room Temp.	Diff- (8 inch -6inch)
		C°	C°	C°	C°
1	19/12/2017	13.60	17.80	16.05	1.75
2	20/12/2017	13.70	19.40	18.10	1.30
3	21/12/2017	14.00	20.10	18.30	1.80
4	22/12/2017	13.50	20.20	18.20	2.00
5	23/12/2017	13.20	20.10	18.30	1.80
6	24/12/2017	10.60	18.60	17.00	1.60
7	25/12/2017	10.60	18.10	16.60	1.50
8	26/12/2017	12.20	18.00	16.20	1.80
9	27/12/2017	12.40	18.10	16.50	1.60
10	28/12/2017	11.10	17.20	15.80	1.40
11	29/12/2017	10.00	16.90	15.10	1.80
12	30/12/2017	9.50	17.70	16.00	1.70
13	31/12/2017	9.40	17.70	15.80	1.90
14	01/01/2018	9.70	16.90	15.20	1.70
15	02/01/2018	9.50	16.70	14.90	1.80
16	03/01/2018	8.60	15.80	13.80	2.00
17	04/01/2018	7.30	14.00	12.20	1.80
18	05/01/2018	9.00	13.50	12.10	1.40
19	06/01/2018	9.10	15.60	13.80	1.80
20	07/01/2018	10.40	16.60	14.60	2.00
21	08/01/2018	10.50	16.90	15.00	1.90
<b>24 Hours Avg. Temperature</b>		<b>10.85</b>	<b>17.42</b>	<b>15.69</b>	<b>1.73</b>

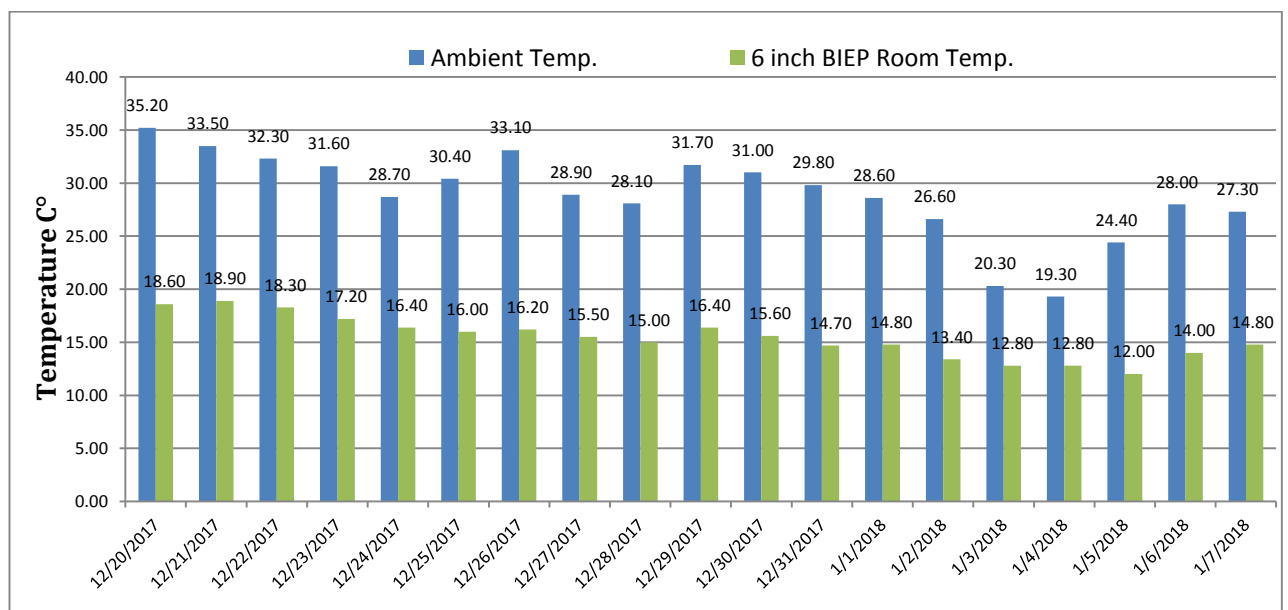
Table 3.6 Comparison of EM of 6inch and 8inch BCP against Ambient temperature for Peak Hours at 1:00AM.

At midnight winter season more heating load is required to achieve the comfort level in inside room. The data reveal that 8inch BCP room maintain 1.73°C more efficient roof than 6 inch BCP roof at midnight and the maximum temperature difference between 8inch BCP and 6 inch BCP room was seen on 22.12.2017 at 12:00 AM and 1:00 AM of 2.10°C and 2.00°C respectively as describe in Graph 3.10.

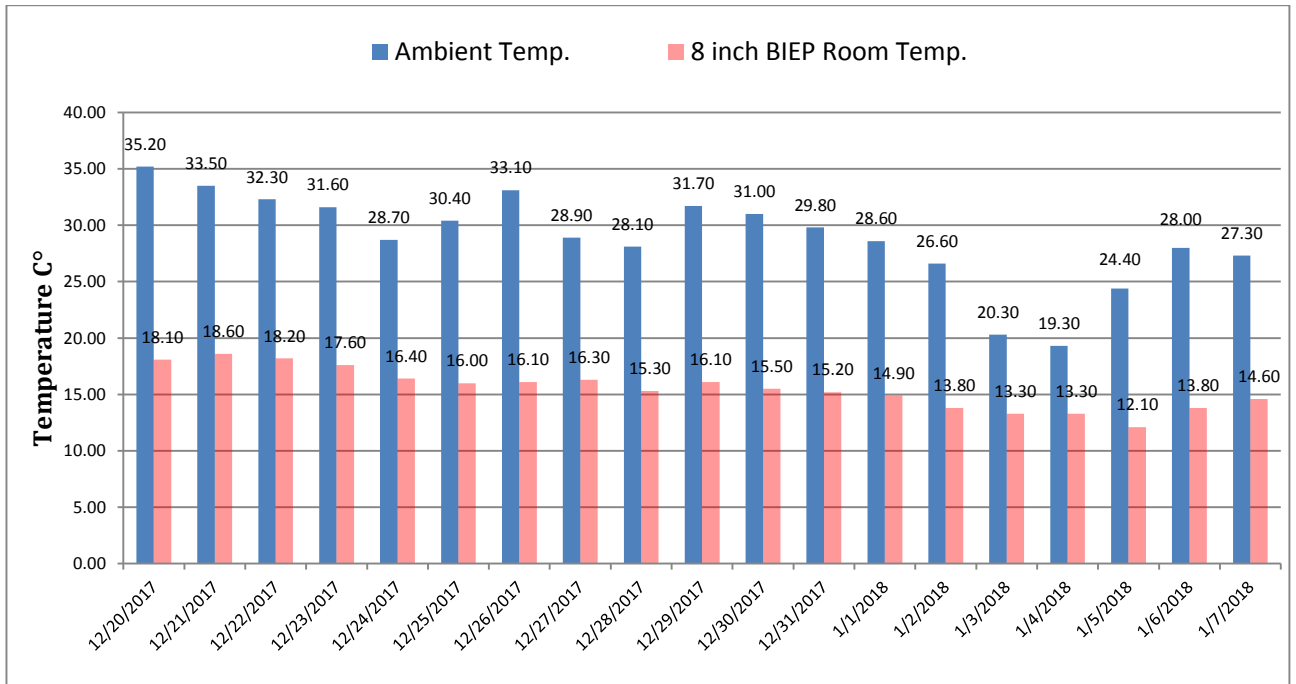
### 3.4.3 Daily Temperature Recording at 1:00 PM

The recorded temperature of experimental model of 6inch BCP and 8inch BCP from 19<sup>th</sup> December 2017 to 8<sup>th</sup> January 2018 were recorded and graphically drawn against ambient temperature at 1:00 pm peak hours.

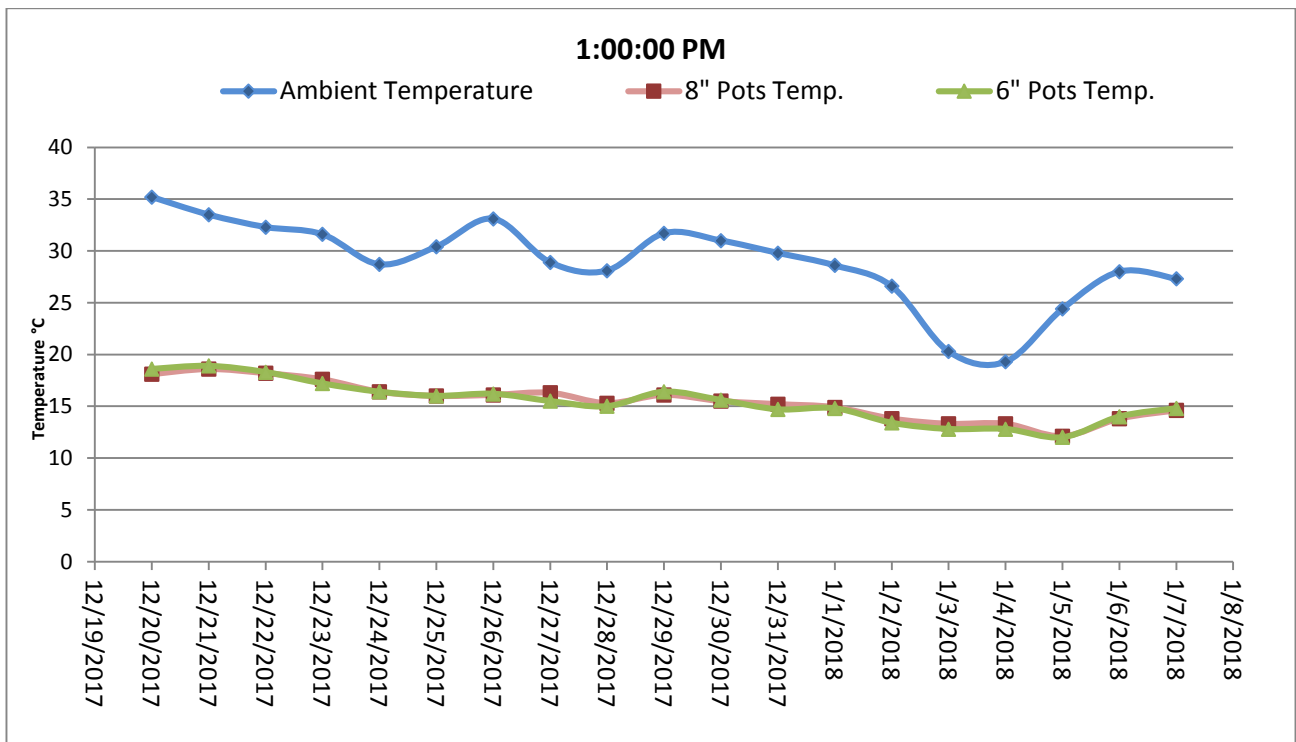
Graph 3.11, 3.12 & 3.13 shows the temperature profile of 6 inch BCP, 8 inch BCP and comparison between these two EM respectively. The average ambient, 6 inch BCP room and 8 inch BCP room temperatures are 28.88°C, 15.44°C and 15.54°C respectively. The difference between treated with ambient roof is about 13.44°C.



Graph 3.11 Ambient Temperature vs. Indoor 6inch BCP Room for Peak Hours at 1:00 PM



Graph 3.12 Ambient Temperature vs. Indoor 6inch BCP Room for Peak Hours at 1:00 PM



Graph 3.13 Comparison of EM of 6inch and 8inch BCP against Ambient temperature for Peak Hours at 1:00 PM.

Sr. No.	Time	Ambient Temp.	8 inch BCP Room Temp.	6 inch BCP Room Temp.	Dif- (8 inch - 6inch)
		C°	C°	C°	C°
1	20/12/2017	35.20	18.10	18.60	-0.50
2	21/12/2017	33.50	18.60	18.90	-0.30
3	22/12/2017	32.30	18.20	18.30	-0.10
4	23/12/2017	31.60	17.60	17.20	0.40
5	24/12/2017	28.70	16.40	16.40	0.00
6	25/12/2017	30.40	16.00	16.00	0.00
7	26/12/2017	33.10	16.10	16.20	-0.10
8	27/12/2017	28.90	16.30	15.50	0.80
9	28/12/2017	28.10	15.30	15.00	0.30
10	29/12/2017	31.70	16.10	16.40	-0.30
11	30/12/2017	31.00	15.50	15.60	-0.10
12	31/12/2017	29.80	15.20	14.70	0.50
13	01/01/2018	28.60	14.90	14.80	0.10
14	02/01/2018	26.60	13.80	13.40	0.40
15	03/01/2018	20.30	13.30	12.80	0.50
16	04/01/2018	19.30	13.30	12.80	0.50
17	05/01/2018	24.40	12.10	12.00	0.10
18	06/01/2018	28.00	13.80	14.00	-0.20
19	07/01/2018	27.30	14.60	14.80	-0.20
<b>Avg. Temperature</b>		<b>28.88</b>	<b>15.54</b>	<b>15.44</b>	<b>0.09</b>

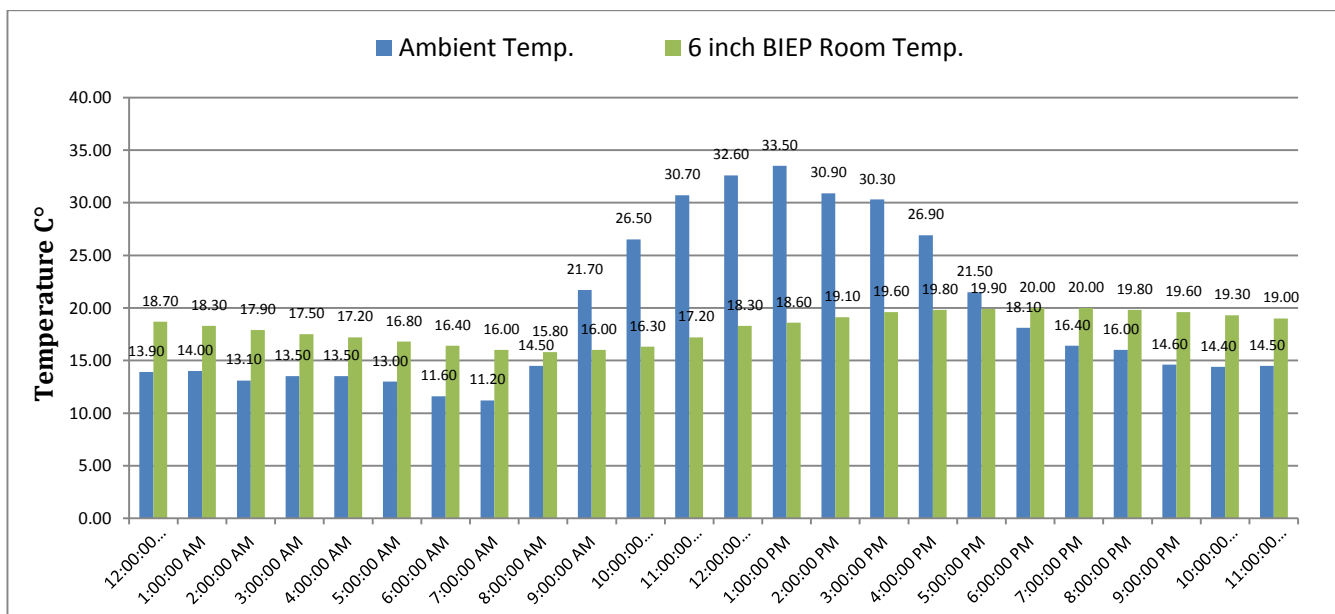
Table 3.7 Comparison of EM of 6inch and 8inch BCP against Ambient temperature for Peak Hours at 1:00PM.

The effectiveness of both 8 inch BCP and 6 inch BCP roof are same at the day time or after noon hours. Both thermal conditions are overlap with each other at 1:00 PM . The temperature difference is 0.09°C or almost zero as describe in Table 3.7.

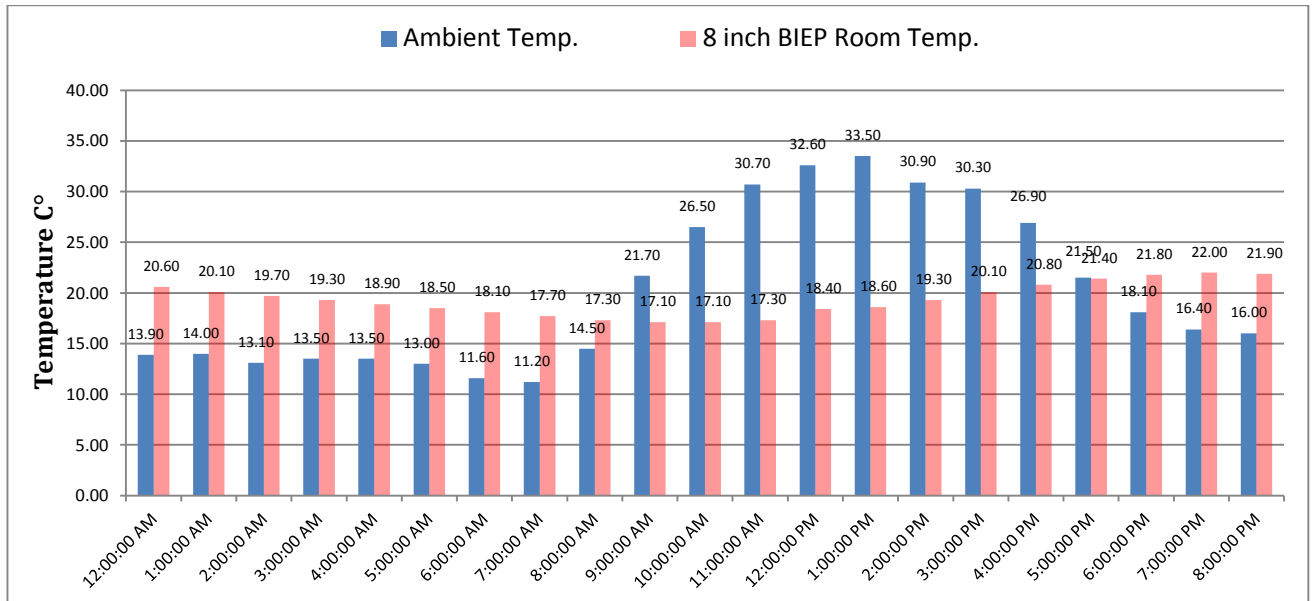
### 3.4.4 Winter Solstice (21st December) Temperature Monitoring

The recorded temperature of experimental model of 6inch BCP and 8inch BCP are graphically drawn against ambient temperature at Winter Solstice (21st December) as shown in Graph 3.14 & 3.15. The maximum temperature difference is seen from 08:00 PM – 07:00 AM varied from 2.1 C° to 1.7 C° on winter solstice day.

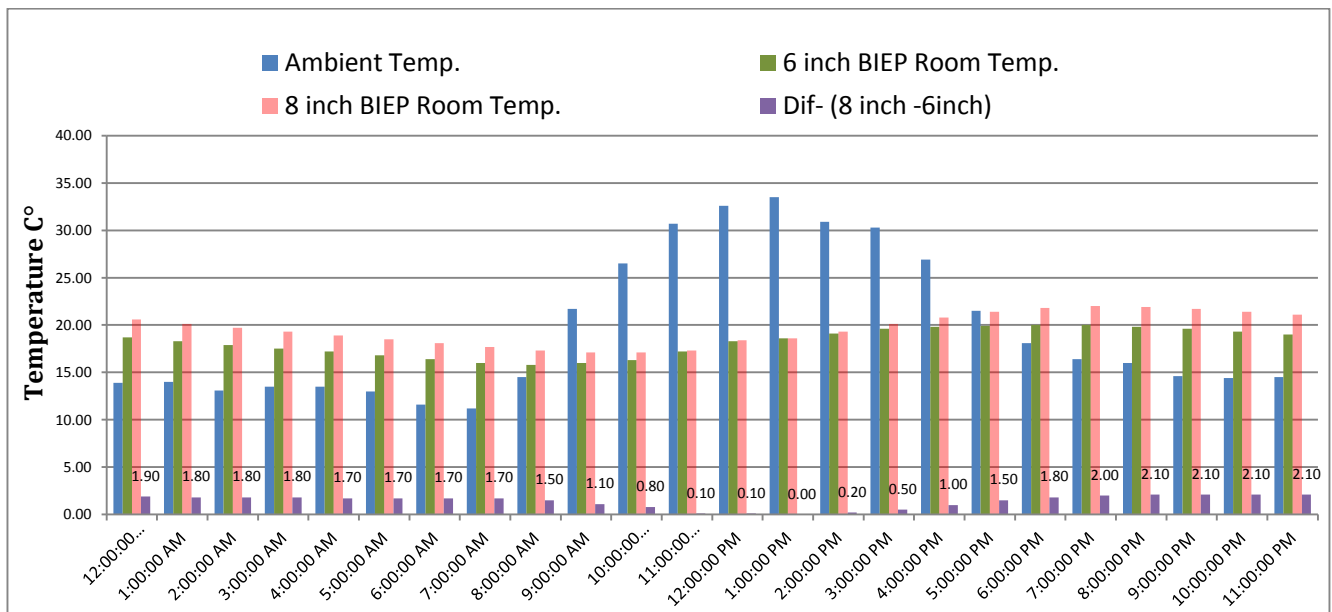
Graph 3.14 & 3.15 shows the temperature profile of 6 inch BCP, 8 inch BCP and comparison between these two EM respectively. The average ambient, 6 inch BCP room and 8 inch BCP room temperatures are 19.45°C, 18.21°C and 19.59°C respectively. The difference between 8 inch and 6 inch BCP treated roof is about 1.38°C.



Graph 3.14 Ambient Temperature vs. Indoor 6 inch BCP Room for Winter Solstice (21<sup>st</sup> December)



Graph 3.15 Ambient Temperature vs. Indoor 8 inch BCP Room for Winter Solstice (21<sup>st</sup> December)



Graph 3.16 Comparison of EM of 6inch and 8inch BCP against Ambient temperature for Winter Solstice (21st December)

Sr. No.	Time	Ambient Temp.	8 inch BCP Room Temp.	6 inch BCP Room Temp.	Dif- (8 inch - 6inch)
		C°	C°	C°	C°
1	12:00:00 AM	13.90	20.60	18.70	1.90
2	1:00:00 AM	14.00	20.10	18.30	1.80

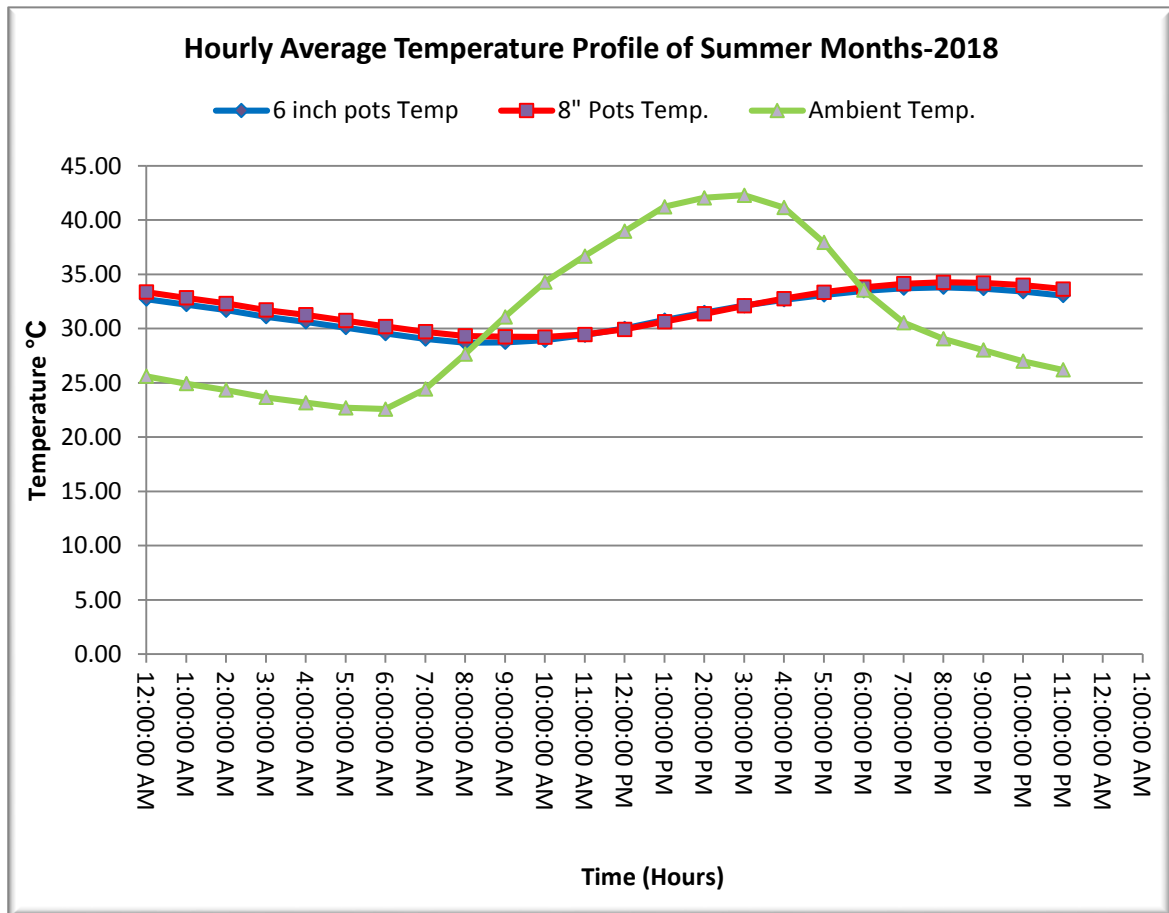
3	2:00:00 AM	13.10	19.70	17.90	1.80
4	3:00:00 AM	13.50	19.30	17.50	1.80
5	4:00:00 AM	13.50	18.90	17.20	1.70
6	5:00:00 AM	13.00	18.50	16.80	1.70
7	6:00:00 AM	11.60	18.10	16.40	1.70
8	7:00:00 AM	11.20	17.70	16.00	1.70
9	8:00:00 AM	14.50	17.30	15.80	1.50
10	9:00:00 AM	21.70	17.10	16.00	1.10
11	10:00:00 AM	26.50	17.10	16.30	0.80
12	11:00:00 AM	30.70	17.30	17.20	0.10
13	12:00:00 PM	32.60	18.40	18.30	0.10
14	1:00:00 PM	33.50	18.60	18.60	0.00
15	2:00:00 PM	30.90	19.30	19.10	0.20
16	3:00:00 PM	30.30	20.10	19.60	0.50
17	4:00:00 PM	26.90	20.80	19.80	1.00
18	5:00:00 PM	21.50	21.40	19.90	1.50
19	6:00:00 PM	18.10	21.80	20.00	1.80
20	7:00:00 PM	16.40	22.00	20.00	2.00
21	8:00:00 PM	16.00	21.90	19.80	2.10
22	9:00:00 PM	14.60	21.70	19.60	2.10
23	10:00:00 PM	14.40	21.40	19.30	2.10
24	11:00:00 PM	14.50	21.10	19.00	2.10
<b>24 Hours Avg. Temp.</b>		<b>19.45</b>	<b>19.59</b>	<b>18.21</b>	<b>1.38</b>

Table 3.8 Comparison of EM of 6inch and 8inch BCP against Ambient temperature for Winter Solstice (21<sup>st</sup> December)

### 3.5 24 Hours average daily temperature were recorded in summer

The temperature recorded of experimental model of 6inch BCP and 8inch BCP for the month of March, April and May 2018 are analysed and discuss in the following section, Tabular form of 24 hour average recorded temperature table 3.9 and graph 3.17 for the months of summer are drawn against ambient temperature.

Graph 3.17 shows that the ambient and 6 inch BCP indoor room temperature are 42.05°C and 31.48°C respectively at 02:00 pm. In this case, the temperature difference between ambient and indoor room temperature is 10.57°C at day time. Similarly, for second EM the ambient and 6 inch BCP indoor room temperature are 42.05°C and 31.36°C respectively at 02:00 pm. In this case, the temperature difference between ambient and indoor room temperature is 10.69°C at day time.



Graph 3.17 Summer Months Temperature Profile Monitor

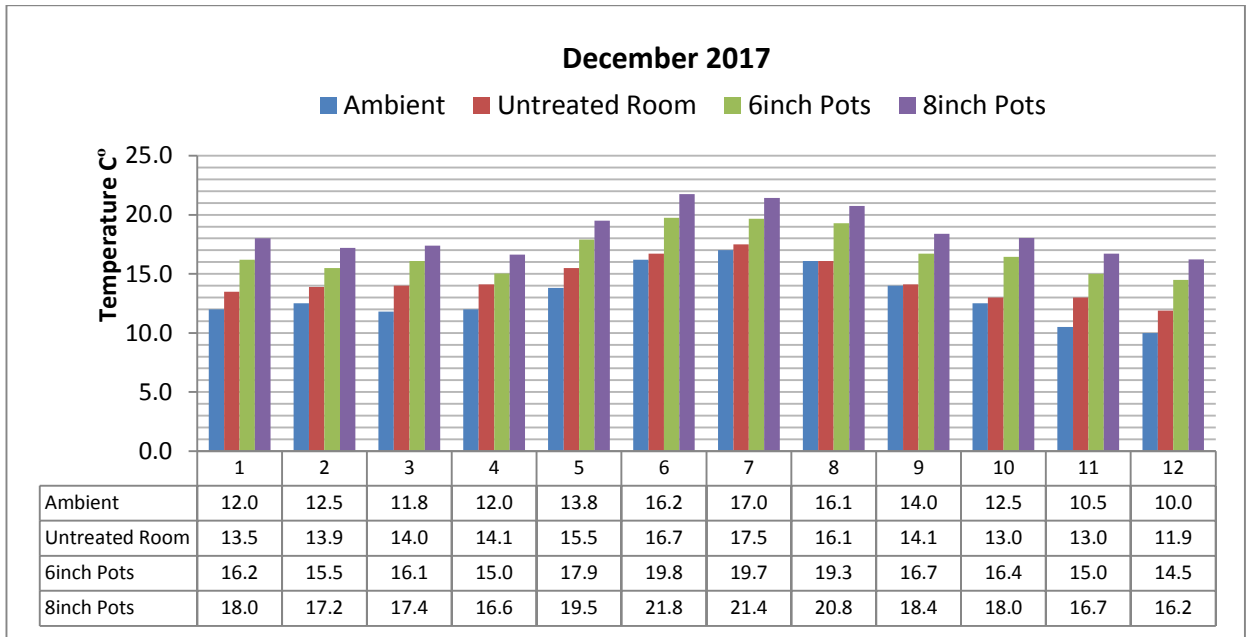
Sr. No.	Time	8inch pots	6inch pots	Ambient	Dif.(Ambient -8" BCP)	Dif.(Ambient -6" BCP)
		C°	C°	C°	C°	C°
1	12:00:00 AM	33.36	32.71	25.60	(7.76)	(7.11)
2	1:00:00 AM	32.84	32.22	24.93	(7.91)	(7.29)
3	2:00:00 AM	32.31	31.69	24.34	(7.97)	(7.35)
4	3:00:00 AM	31.72	31.10	23.66	(8.06)	(7.44)
5	4:00:00 AM	31.27	30.62	23.17	(8.10)	(7.45)

6	5:00:00 AM	30.73	30.09	22.70	(8.04)	(7.39)
7	6:00:00 AM	30.19	29.54	22.58	(7.61)	(6.96)
8	7:00:00 AM	29.71	29.04	24.43	(5.28)	(4.61)
9	8:00:00 AM	29.33	28.68	27.65	(1.68)	(1.03)
10	9:00:00 AM	29.25	28.74	31.08	1.83	2.34
11	10:00:00 AM	29.22	28.92	34.30	5.08	5.38
12	11:00:00 AM	29.46	29.40	36.69	7.22	7.29
13	12:00:00 PM	29.93	30.02	38.98	9.04	8.96
14	1:00:00 PM	30.63	30.79	41.23	10.60	10.44
15	2:00:00 PM	31.36	31.48	42.05	10.69	10.57
16	3:00:00 PM	32.09	32.11	42.29	10.19	10.18
17	4:00:00 PM	32.77	32.66	41.15	8.38	8.50
18	5:00:00 PM	33.35	33.10	37.93	4.58	4.83
19	6:00:00 PM	33.80	33.48	33.54	(0.26)	0.06
20	7:00:00 PM	34.13	33.72	30.55	(3.58)	(3.18)
21	8:00:00 PM	34.26	33.81	29.05	(5.21)	(4.76)
22	9:00:00 PM	34.21	33.69	28.02	(6.19)	(5.67)
23	10:00:00 PM	33.99	33.42	26.99	(7.01)	(6.43)
24	11:00:00 PM	33.64	33.04	26.20	(7.44)	(6.84)

Table 3.9 Comparison of EM of 6inch and 8inch BCP against Ambient temperature for Summer Months

### 3.6 Comparison of Treated and untreated Room indoor and Outdoor Temperature

The data of untreated roof are taken from the thesis of Dr. Sabahat Arif in her doctorate research title “Energy Efficient House Design, effect of orientation on indoor temperature profile”. First, the outdoor temperatures of the month of December were taken from the Dr. Sabahat’s thesis than it was matched by the performing experiment day’s ambient temperature. So, the comparative study will be drawn between the treated and untreated roof.



Graph 3.18 Comparison of EM of untreated roof 6inch and 8inch BCP roof against ambient temperature at the midnight.

The maximum temperature difference between 8 inch BCP treated roof and untreated roof is 6.2 C° at the midnight, it varies from 4.4 C° to 6.2 C° at midnight. And as comparison of 6 inch BCP treated roof with untreated roof the temperature difference varies from 2.7 C° to 4.5 C° as shown in Graph 3.18. It clearly shows that at the time of peak hours the 8inch BCP are more significant in winter nights and also decrease the heating loads of the building. 8 inch BCP roof achieve the most optimum comfort level of room.

Further the effectiveness of inverted Clay pots is also happened in summer season. The results are carried out from the Autodesk Energy Analysis Software that will explain in the next chapter.

## **Chapter 4 EXPERIMENTAL RESULTS VALIDATION THROUGH SOFTWARE**

### **4.1 General**

After the complete experimentation and detail data analysis, the results revealed that increase in heights of burnt clay pots effects on indoor temperature. The increase in heights of pots resulted increase in volume of the pots to create more air space which become an effective barrier for passing heat from external to internal environment. These results are validated through software analysis. In this regards Autodesk Ecotect and Autodesk Revit were selected for the analysis for the purpose to validate the experimental results. This chapter presents the results of analysis run on Ecotect and Revit (Green Building Studio). The chapter also highlights the feasibility of software for such validation. In addition, the software analysis also facilitates to know for effectiveness of optimum height/volume of pots. Heating cooling loads, cost effectiveness and payback period are also the part of this chapter.

### **4.2 Validation of Experimental Results vs Autodesk Ecotect Analysis**

For validation of experimental result, 3D model of experimental room were constructed in Autodesk Ecotect software with same specification and materials as used in construction of these rooms. To calculate the thermal loads of the experimental models, energy settings are required to validate the experimental results. Input regarding location, orientation, roof specification and volume of BCP pots and other specifications were given while constructing 3D models in software. Fig-4.1 & 4.2 are explaining the orientation and 3D Models. Before going for running analysis the material properties are also provided to software as input and finally thermal analysis is run. Fig-4.3 & 4.4 are reflecting the material properties and height/volume of BCP pots. For analysis the months were selected same as done in experimentation. The results obtained through analysis for 6 inches and 8 inches pots on 24 hours bases reflect no difference in terms of indoor temperature as shown in Fig-4.5 & 4.6. This reflects that increase in volume of pots creates no impact on indoor temperature of the room.

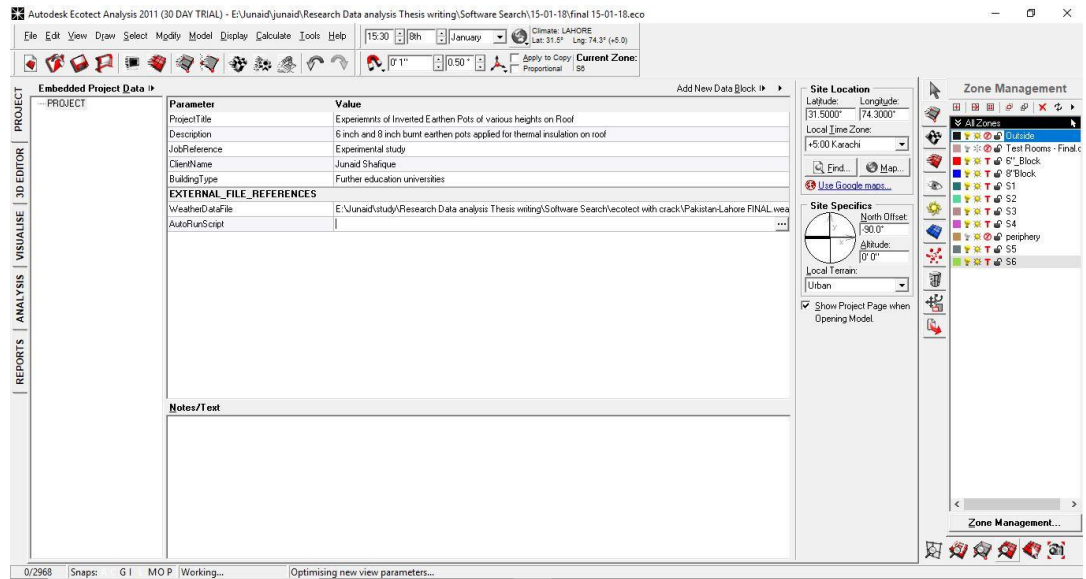


Fig-4.1 Orientation and Location of EM

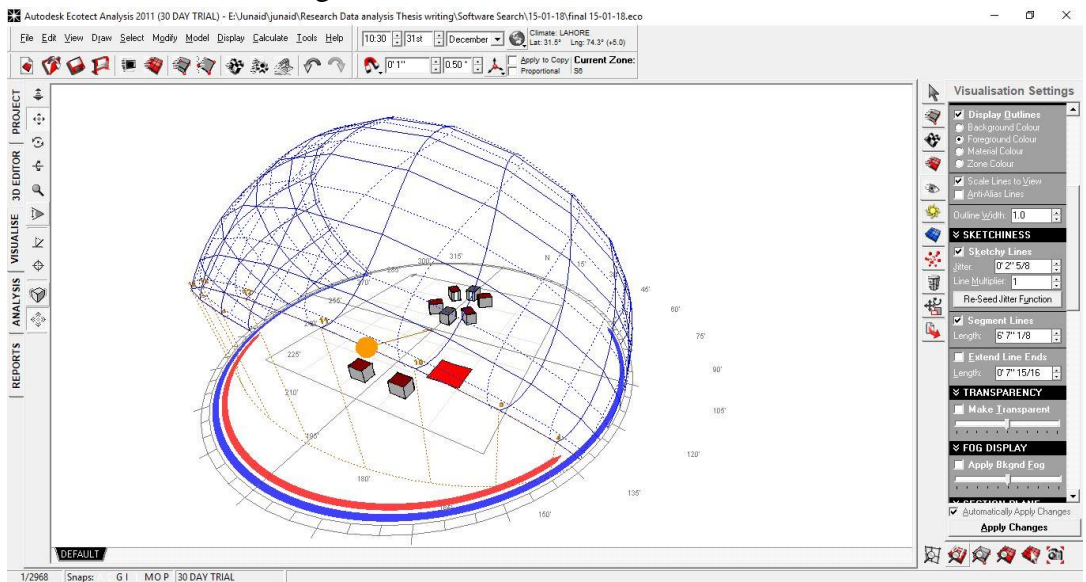


Fig-4.2 3D modulation of Experimental Rooms at Autodesk Ecotect

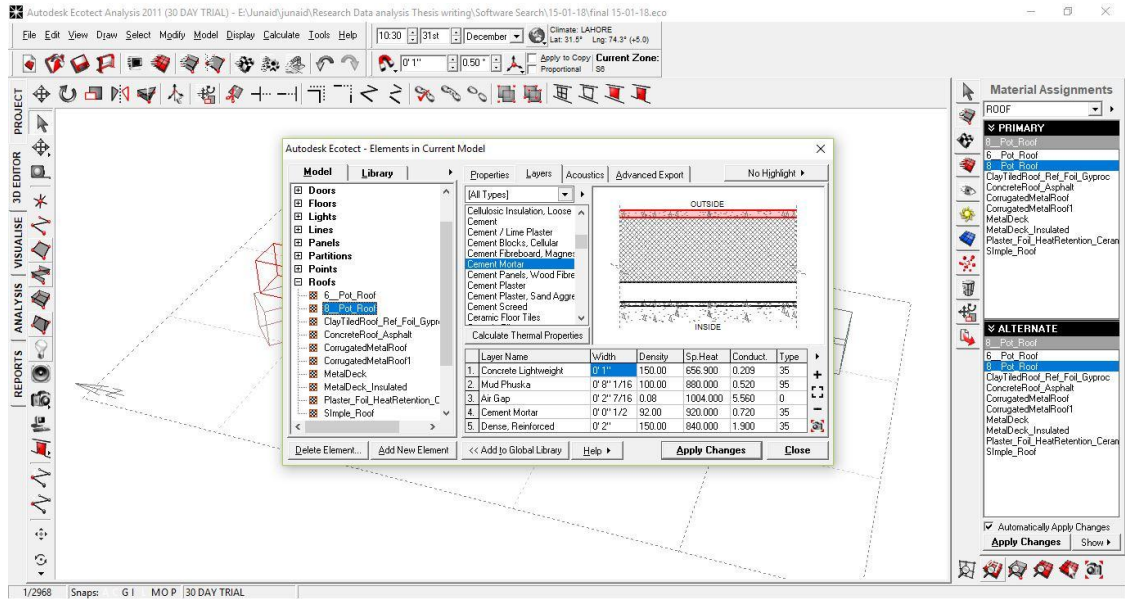


Fig-4.3 Eight Inch BCP Room Material Properties

The average 24 hours daily temperature profile for 6 inches and 8 inches BCP is obtained through analysis.

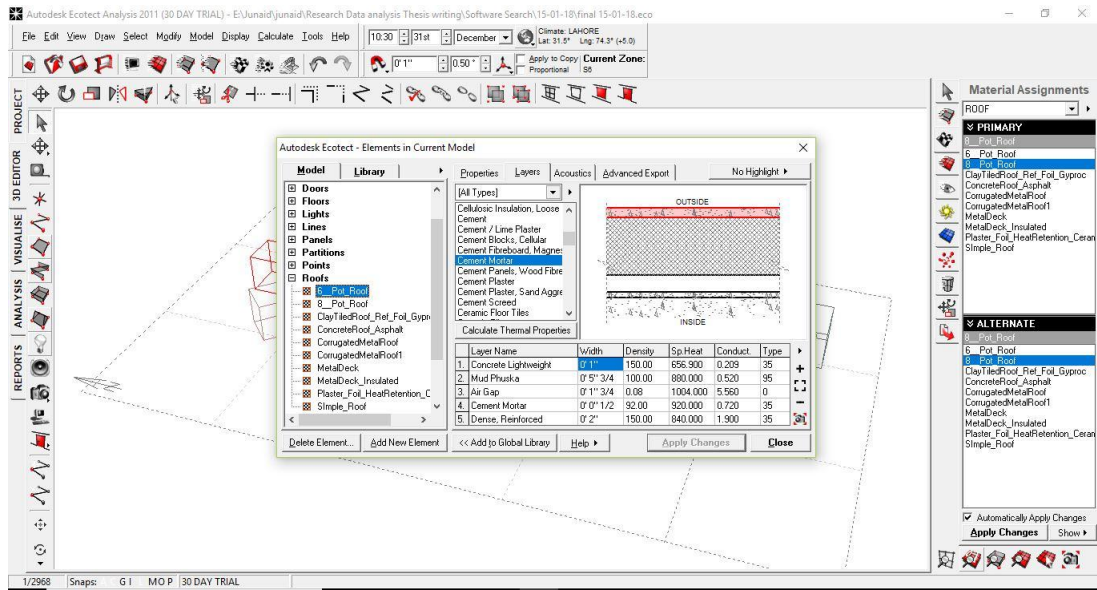


Fig-4.4 Six Inch BCP Room Material Properties

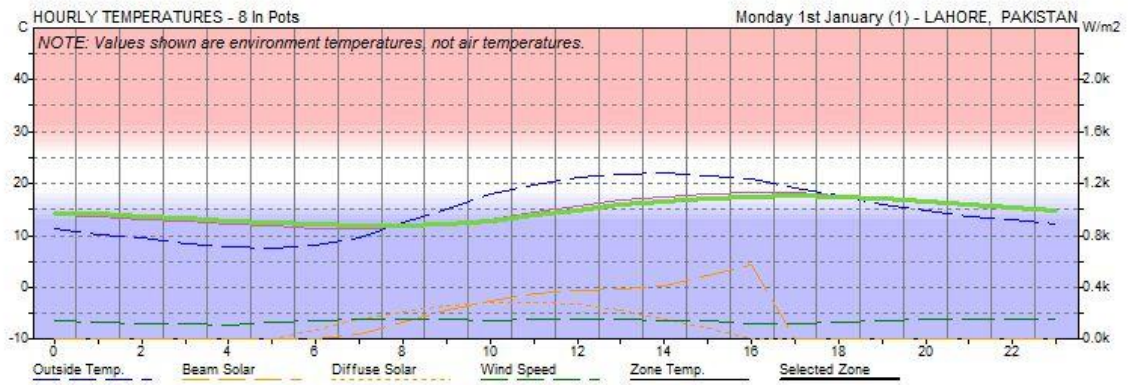


Fig-4.5 Eight Inch BCP Results

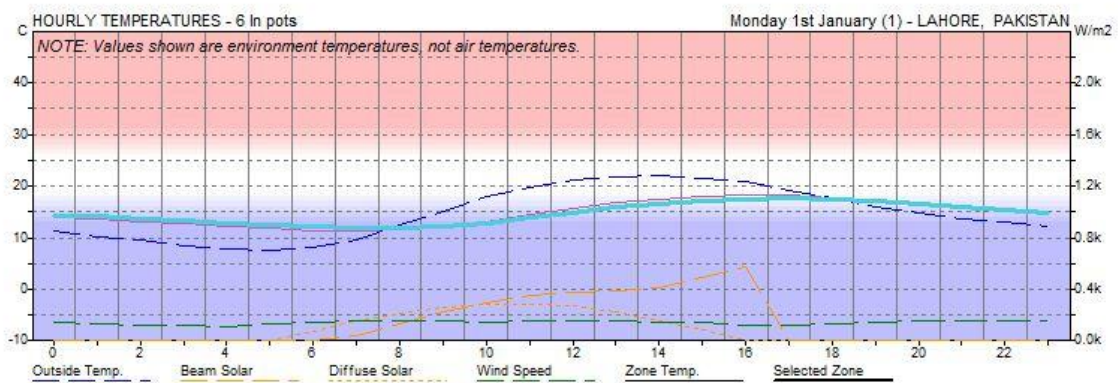


Fig-4.6 Six Inch BCP Results

According to experimental investigation the average temperature difference on 24 Hours bases between ambient and indoor temperature is  $4.67^{\circ}\text{C}$  for 6 inch BCP roof during the month of Jan. 2018. Whereas according to Ecotect analysis the temperature difference is  $1.46^{\circ}\text{C}$ . For the case of 8 inch BCP roof the temperature difference between ambient and indoor room temperature is  $6.33^{\circ}\text{C}$  in experimental investigation and  $1.35^{\circ}\text{C}$  in Ecotect. This proof a significant difference between experimental and software results. Annex-B is providing information on experimental data for BCP 6 inches and 8 inches for the period from Dec. 2017 to Jan. 2017.

### 4.3 Validation of Experimental Results vs Autodesk Revit (Green Building Studio) Energy Analysis

As there was no difference between the experimental and software results in Ecotect, therefore it was decided to proceed for validation of results through another software that is Autodesk Revit (Green Building Studio).

First, the existing experimental models were drawn in Autodesk Revit Architecture. Secondly, then output was given with reference to location, orientation, materials specifications etc. The room volume and other parameters were kept constant. On the other side, the height and volume of BCP were changed from 4 to 12 inches with 2 inches increase. Energy models for six options were developed including untreated roof and analysis was run. Fig-4.7 is giving information on 3D models and orientation of subject model. Data for U-Value for 4", 6", 8", 10" and 12" BCP roof is reflecting in Table-4.1 and it is obtained from software analysis. This values proves that the U-value is reciprocal to volume of pots.

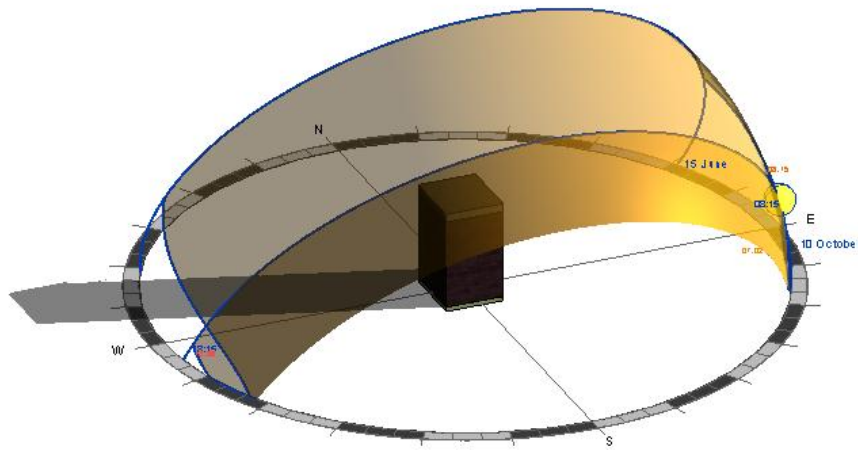


Fig-4.7 3 D Model and orientation

Cases	Description	Top Roof Details	
		Thickness	U-Value
		In	Btu/(h.ft <sup>3</sup> .F)
U	Untreated Roof	2.0	3.626
4R	4" burnt pots Top roof	8.5	0.224
6R	6" burnt pots Top roof	10.5	0.139
8R	8" burnt pots Top roof	12.5	0.097
10R	10" burnt pots Top roof	14.5	0.073
12W	12" burnt pots Top roof	16.5	0.060

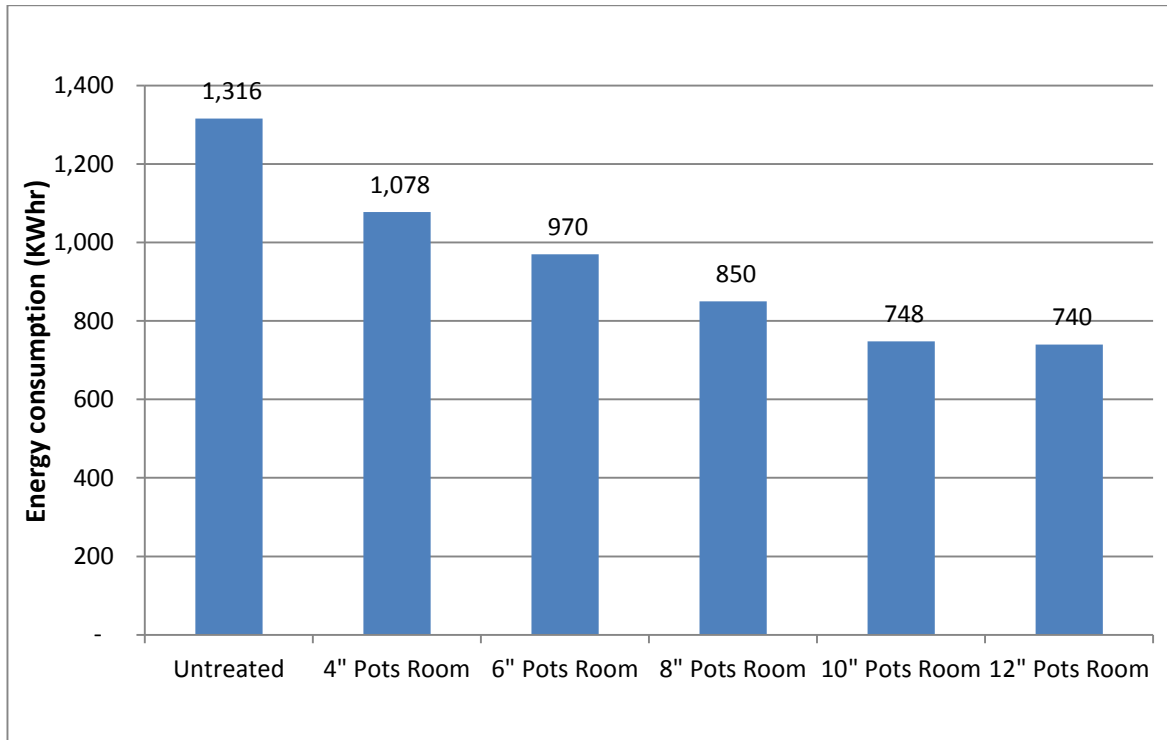
Table 4. 1 U-Value of untreated and five BCP roof

### **Analysis, Results and Discussion**

The energy models were developed with the roofs of 4,6,8,10,12 inches radius BCP and analysis was run in Autodesk Revit Energy with respect to annual energy consumption, annual heating/cooling load and electricity consumption. Graph-4.1 shows that energy consumption in untreated roof is 1316 KWhr/annum where as in treated roof it is 1078, 970, 850, 748 & 740 KWhr/annum for 4",6",8",10" &12" respectively.

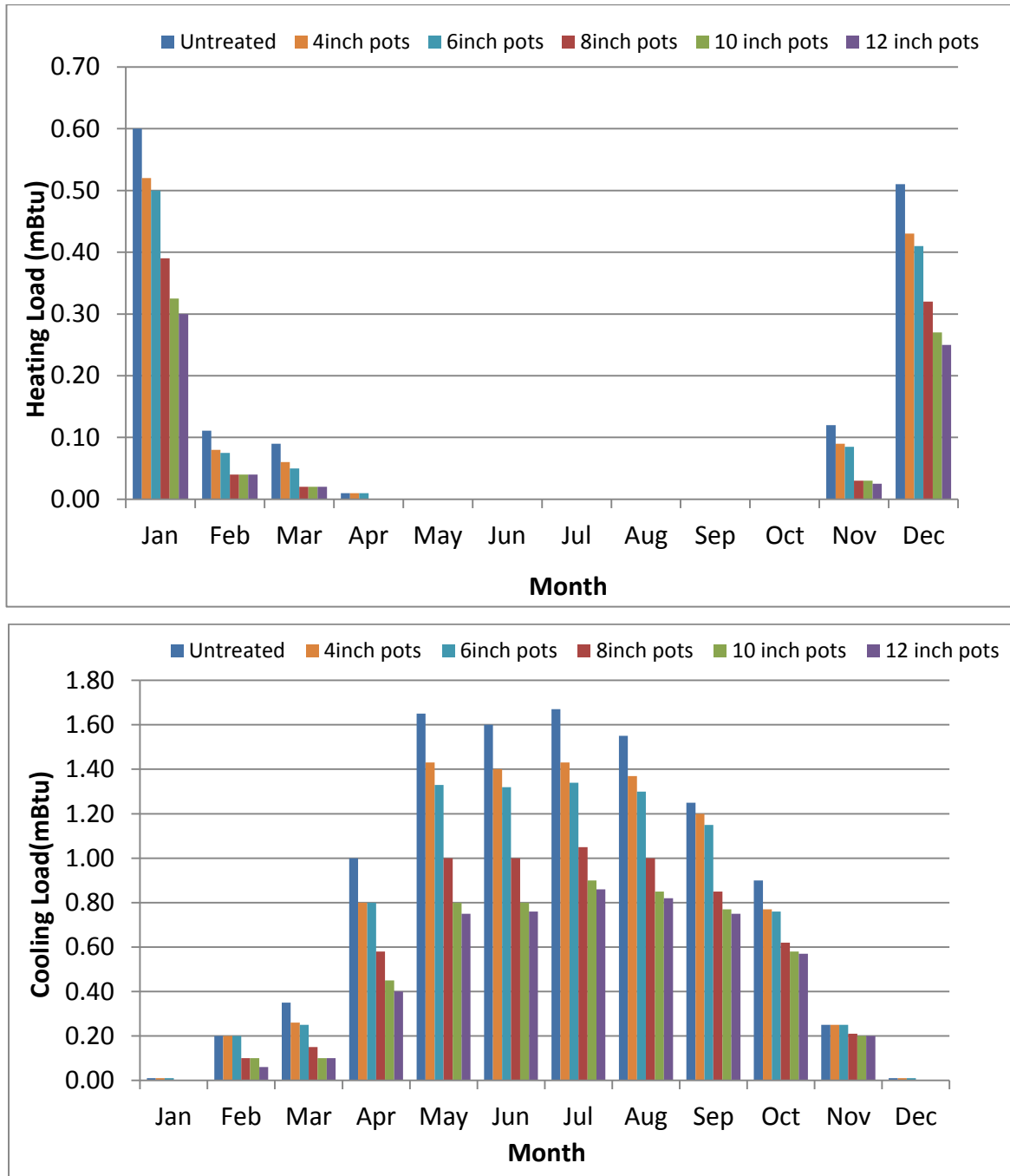
In case of heating and cooling load explains about heating/cooling load and electricity consumption. According to Annex-C heating load for untreated roof is 0.120 mBTu/annum and for 4",6",8",10" &12" treated roofs are 0.99, 0.94, 0.067, 0.057 and 0.055 mBTu/annum respectively. Cooling load for untreated roof is 1.45 mBTu/annum and for 4",6",8",10" &12" treated roofs are 1.27, 1.21, 0.91, 0.76 and 0.73 mBTu/annum respectively as shown in Graph 4.2. Electricity consumption for untreated roof is 132.17 KWhr/annum and 4",6",8",10" &12 treated roofs are 132.17, 110.00, 105.83, 74.17, 63.00 and 60.17 KWhr/annum as shown in Graph 4.3.

The trend in energy consumption in each case is similar as it was found in experiment for average difference in indoor and outdoor temperature. But most importantly the 2 inches increase in radius/air gap of the BCP is regularly decreasing percentage of energy consumption, if we compare all cases with untreated roof then annual energy saving will be 18%, 26.3%,35.4%,43.2% and 43.7% for 4,6,8,10 and 12 inches BCP roofs respectively. Although it confirms the hypothesis developed from experimental investigation but the most suitable or optimum pot for roof treatment appears is 10 inches radius BCP.



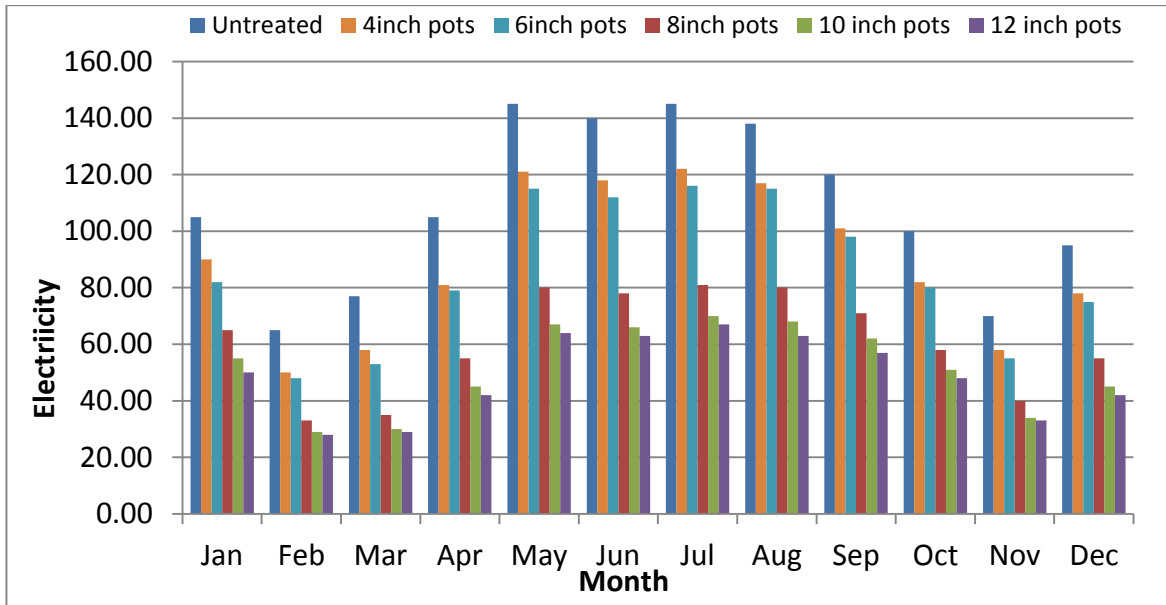
Graph 4.1: Comparative Analysis of Annual Energy Consumption of Experimental Model

**Heating and Cooling Loads:** The results taken from six different BCP roof cases from Autodesk Revit Energy Analysis reveals that the average heating loads for the months from Nov to Feb are 17%, 22%, 44%, 52% and 54% with 4\",6\",8\",10\" &12\" pots respectively. The average cooling loads for the months April to Sept are 13%, 17%, 37%, 48% and 50% with 4R, 6R, 8R, 10R and 12R pots respectively shown in Graph 4.2



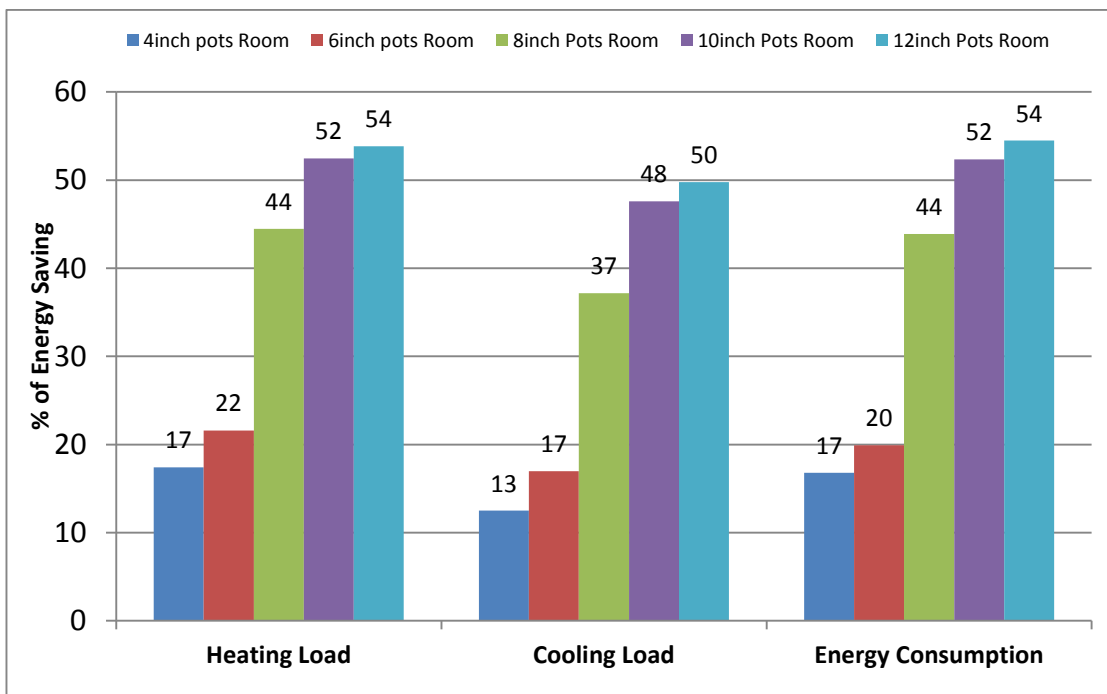
Graph 4.2 Monthly Heating & Cooling Load of different cases of BCP Test Rooms.

The average reduction in electricity consumption for the months of April. to Sept. are 17%, 20%, 44%, 52% and 53% with 4R, 6R, 8R, 10R and 12R pots respectively as compared to untreatd roof. In winter, electricity consumption for the months of Nov. to Feb. are 18%, 22%, 42%, 51% and 52% with 4R, 6R, 8R, 10R and 12R pots respectively as compared to untreatd roof as shown in Graph 4.3. Results reveals that the 10 inch BCP has optimum performance in all respects.



Graph 4.3 Monthly Electricity Consumption of different cases of BCP Test Rooms

Among all cases the percentage performance is improving abruptly from 4” BCP roof to 10” BCP roof but with further increasing the volume of air gaps the percentage performance of energy saving is not much improved. The percentage performance of heating load, cooling load and energy consumption for 10 inch BCP is 52%, 48% and 52% respectively as shown in Graph 4.4.



Graph 4.4 Comparative Analysis of performance of BCP pots roof vs. conventional roof for Energy Saving

Description	Surface area of Roof (sft)	Untreated Roof~@R.s 49/sft	4 inch Pots Roof @R.s 82/sft	6inch Pots Roof @R.s 83/sft	8inch Pots Roof @R.s 83/sft	10 inch Pots Roof @R.s 84/sft	12 inch Pots Roof @R.s 84/sft
Total Expense	32.1	1,571	2,629	2,661	2,661	2,693	2,693
Extra Cost of Pots and material	32.1	-	1,058	1,090	1,090	1,122	1,122
Energy Saving	32.1	-	238	345	456	567	601
Pay Back Period /yr.	32.1	-	4.45	3.16	2.39	1.98	1.87

Table 4. 2 Payback period of BCP Roof Cases

The payback period and energy saving in each cases are provided in detail in the Table 4.2. Average this house is saving Rs. 601 annually or 23% reduce the cost of the single room of experimental Model as describe in Table 4.2.

## **Chapter 5 CONCLUSION AND RECOMMENDATION**

### **5.1 General**

Roof insulation is main barrier for the heat and cold entrance in the building. Proper insulation of roof decreases the energy consumption patterns, electricity consumption, heating and cooling load of the building.

The thermal analysis showed that the thermal response of roof is strongly depended on the type of insulation on roof and air pockets on BCP insulation on roof. The thermal performance of room is improved by increasing the volume of air pockets. So, 8 inch BCP insulation is more effective than 6 inch BCP insulation because the volume is increases from 11 Litters to 15 Litters.

### **5.2 Conclusion**

The results are compared with results of experimental investigation, which confirms the hypothesis that the effectiveness of burnt clay pots for controlling the indoor thermal condition in residential building. The analysis of Hourly and peak hour's bases average temperature for winter revels that thermal performance of test rooms with 6 inches BCP and 8 inches BCP give average temperature difference between indoor and ambient are 4.30 °C drop and 5.90 °C drop respectively. So, the thermal performance of 8inch BCP treated room is 1.60 °C more warmer than 6inch BCP treated room in winter. The comparison of 6 and 8 inches BCP roofs for thermal performance in winter unfolds that increasing the volume/height of BCP will increase the difference in temperature to achieve the optimum height of BCP.

The analysis of Hourly and peak hour's bases average temperature for summer revels that thermal performance of test rooms with 6 inches BCP gives average temperature difference between ambient and indoor is 7.51 °C. In this case, the average ambient and indoor teperature is appeared 38.41 °C and 30.90°C respectively. For 8 inch BCP roofs the average temperature difference is found 7.61 °C. In this case ambient and indoor temperature comes out 38.41 °C and 30.80°C respectively. The comparison of 6 and 8 inches BCP roofs for thermal performance in summer unfolds that increasing the air gap will increase the difference in temperature.

It can be concluded that by constructing BCP roof system, cooling and heating loads of the building can be reduced significantly. The experimetal investigation revealed that BCP

roof was also helpful in maintaining 5.90 °C overall room temperature in winter and reducing 7.61 °C overall room temperature in summer. The reduced temperature will ultimately be helpful in reducing the electricity consumption and urban heat island effect if executed at vast scale.

The results taken from Autodesk Revit energy analysis and it verify that the indoor room temperature will improve with increasing the height/volume of BCP in roof insulation. Among five different cases of treated roof, the 10 inch BCP roof is more optimum height for roof insulation, it decrease from 1,316 KWhr into 716 KWhr energy saving like 45.6%. The payback period of 10 inch BCP roof technique is 1.9 years. Average this house is saving Rs. 601 annually or 23% reduce the cost of the single room of experimental Model. This research work clearly domenstrate that the significance of Burnt Clay Pots is minimizing energy catastrophe.

### **5.3 Recommendation**

Building controlling authorities in Pakistan must declare use of insulation for roof envelope mandatory. Building controlling authorities must give incentives to residents for using insulation on roof. Use of insulation for new and old houses may be included in building codes with defined U-values. It is recommended for future studies to evaluate the effectiveness of 10” BCP by installing them on actual residential buildings.

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## **Annexures**

- A**     Experimental hourly indoor air temperature in 8" and 6" Burnt Clay Pots Treated rooms and ambient/outdoor air temperature during Dec-17-Jan-18 & March-18-May-18.
- B**     Ecotect Result of Hourly Temperature from December 2017-January 2018.
- C**     Autodesk Revit Energy Analysis Results of monthly Heating Load (mBtu), Cooling Load (mBtu) and Energy Consumption (KWhr).
- D**     Autodesk Revit Energy Analysis Reports incorporated by Green Building Studio.

**Annexure A:** Experimental hourly indoor air temperature in 8" and 6" Burnt Clay Pots Treated rooms and ambient/outdoor air temperature during Dec-17-Jan-18 & March-18-May-18

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
18-Dec-2017	4:00:00 PM	20.60	22.10	21.00
18-Dec-2017	5:00:00 PM	20.00	20.40	18.10
18-Dec-2017	6:00:00 PM	20.10	19.80	16.10
18-Dec-2017	7:00:00 PM	20.20	19.40	13.30
18-Dec-2017	8:00:00 PM	20.10	19.00	13.30
18-Dec-2017	9:00:00 PM	19.80	18.60	11.50
18-Dec-2017	10:00:00 PM	19.50	18.20	10.70
18-Dec-2017	11:00:00 PM	19.10	17.70	9.20
19-Dec-2017	12:00:00 AM	18.70	17.20	7.50
19-Dec-2017	1:00:00 AM	18.20	16.70	8.20
19-Dec-2017	2:00:00 AM	17.70	16.20	8.60
19-Dec-2017	3:00:00 AM	17.20	15.70	7.90
19-Dec-2017	4:00:00 AM	16.80	15.30	7.70
19-Dec-2017	5:00:00 AM	16.30	14.90	7.80
19-Dec-2017	6:00:00 AM	15.80	14.40	6.90
19-Dec-2017	7:00:00 AM	15.40	14.00	6.00
19-Dec-2017	8:00:00 AM	14.90	13.80	9.70
19-Dec-2017	9:00:00 AM	14.70	14.10	16.30
19-Dec-2017	10:00:00 AM	14.60	14.80	23.40
19-Dec-2017	11:00:00 AM	15.50	15.80	26.30
19-Dec-2017	12:00:00 PM	17.30	17.60	28.20
19-Dec-2017	1:00:00 PM	18.10	18.60	31.70
19-Dec-2017	2:00:00 PM	19.00	19.30	32.80
19-Dec-2017	3:00:00 PM	19.80	20.10	31.10
19-Dec-2017	4:00:00 PM	20.30	20.10	26.60
19-Dec-2017	5:00:00 PM	20.50	20.10	20.00
19-Dec-2017	6:00:00 PM	20.80	20.10	18.50
19-Dec-2017	7:00:00 PM	21.00	20.00	17.30
19-Dec-2017	8:00:00 PM	21.00	19.80	15.90
19-Dec-2017	9:00:00 PM	20.80	19.50	15.50
19-Dec-2017	10:00:00 PM	20.50	19.20	15.20
19-Dec-2017	11:00:00 PM	20.20	18.90	15.20
20-Dec-2017	12:00:00 AM	19.80	18.50	15.10
20-Dec-2017	1:00:00 AM	19.40	18.10	13.70
20-Dec-2017	2:00:00 AM	19.00	17.70	12.60
20-Dec-2017	3:00:00 AM	18.60	17.30	12.50
20-Dec-2017	4:00:00 AM	18.20	16.90	12.20
20-Dec-2017	5:00:00 AM	17.80	16.50	11.80
20-Dec-2017	6:00:00 AM	17.40	16.10	11.80
20-Dec-2017	7:00:00 AM	17.00	15.80	11.90
20-Dec-2017	8:00:00 AM	16.70	15.50	14.30
20-Dec-2017	9:00:00 AM	16.50	15.70	20.40
20-Dec-2017	10:00:00 AM	16.40	16.10	24.30
20-Dec-2017	11:00:00 AM	16.70	16.90	29.60
20-Dec-2017	12:00:00 PM	17.30	17.60	32.30
20-Dec-2017	1:00:00 PM	18.10	18.60	35.20
20-Dec-2017	2:00:00 PM	19.00	19.30	35.60
20-Dec-2017	3:00:00 PM	19.90	19.50	28.20

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
20-Dec-2017	4:00:00 PM	20.70	19.80	25.90
20-Dec-2017	5:00:00 PM	21.30	19.90	21.70
20-Dec-2017	6:00:00 PM	21.60	20.00	19.20
20-Dec-2017	7:00:00 PM	21.80	20.00	17.60
20-Dec-2017	8:00:00 PM	21.80	19.90	17.00
20-Dec-2017	9:00:00 PM	21.60	19.70	16.00
20-Dec-2017	10:00:00 PM	21.30	19.40	15.10
20-Dec-2017	11:00:00 PM	21.00	19.10	14.70
21-Dec-2017	12:00:00 AM	20.60	18.70	13.90
21-Dec-2017	1:00:00 AM	20.10	18.30	14.00
21-Dec-2017	2:00:00 AM	19.70	17.90	13.10
21-Dec-2017	3:00:00 AM	19.30	17.50	13.50
21-Dec-2017	4:00:00 AM	18.90	17.20	13.50
21-Dec-2017	5:00:00 AM	18.50	16.80	13.00
21-Dec-2017	6:00:00 AM	18.10	16.40	11.60
21-Dec-2017	7:00:00 AM	17.70	16.00	11.20
21-Dec-2017	8:00:00 AM	17.30	15.80	14.50
21-Dec-2017	9:00:00 AM	17.10	16.00	21.70
21-Dec-2017	10:00:00 AM	17.10	16.30	26.50
21-Dec-2017	11:00:00 AM	17.30	17.20	30.70
21-Dec-2017	12:00:00 PM	18.40	18.30	32.60
21-Dec-2017	1:00:00 PM	18.60	18.70	33.50
21-Dec-2017	2:00:00 PM	19.30	19.10	30.90
21-Dec-2017	3:00:00 PM	20.10	19.60	30.30
21-Dec-2017	4:00:00 PM	20.80	19.80	26.90
21-Dec-2017	5:00:00 PM	21.40	19.90	21.50
21-Dec-2017	6:00:00 PM	21.80	20.00	18.10
21-Dec-2017	7:00:00 PM	22.00	20.00	16.40
21-Dec-2017	8:00:00 PM	21.90	19.80	16.00
21-Dec-2017	9:00:00 PM	21.70	19.60	14.60
21-Dec-2017	10:00:00 PM	21.40	19.30	14.40
21-Dec-2017	11:00:00 PM	21.10	19.00	14.50
22-Dec-2017	12:00:00 AM	20.70	18.60	14.20
22-Dec-2017	1:00:00 AM	20.20	18.20	13.50
22-Dec-2017	2:00:00 AM	19.80	17.80	13.20
22-Dec-2017	3:00:00 AM	19.30	17.30	12.20
22-Dec-2017	4:00:00 AM	18.80	16.90	11.90
22-Dec-2017	5:00:00 AM	18.30	16.50	11.20
22-Dec-2017	6:00:00 AM	17.80	16.00	11.00
22-Dec-2017	7:00:00 AM	17.30	15.60	11.10
22-Dec-2017	8:00:00 AM	16.90	15.30	15.20
22-Dec-2017	9:00:00 AM	16.60	15.50	21.20
22-Dec-2017	10:00:00 AM	16.50	16.00	26.00
22-Dec-2017	11:00:00 AM	16.80	16.70	30.10
22-Dec-2017	12:00:00 PM	17.40	17.50	31.30
22-Dec-2017	1:00:00 PM	18.20	18.30	32.30
22-Dec-2017	2:00:00 PM	19.00	19.10	32.60
22-Dec-2017	3:00:00 PM	19.80	19.70	32.40
22-Dec-2017	4:00:00 PM	20.50	20.00	28.80
22-Dec-2017	5:00:00 PM	21.20	20.10	22.70
22-Dec-2017	6:00:00 PM	21.70	20.20	18.90
22-Dec-2017	7:00:00 PM	22.00	20.20	17.00

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
22-Dec-2017	8:00:00 PM	22.00	20.10	16.60
22-Dec-2017	9:00:00 PM	21.80	19.90	15.90
22-Dec-2017	10:00:00 PM	21.50	19.60	15.20
22-Dec-2017	11:00:00 PM	21.10	19.20	15.00
23-Dec-2017	12:00:00 AM	20.60	18.80	14.00
23-Dec-2017	1:00:00 AM	20.10	18.30	13.20
23-Dec-2017	2:00:00 AM	19.60	17.90	11.40
23-Dec-2017	3:00:00 AM	19.10	17.40	11.00
23-Dec-2017	4:00:00 AM	18.50	16.90	10.90
23-Dec-2017	5:00:00 AM	18.00	16.40	10.40
23-Dec-2017	6:00:00 AM	17.40	15.90	9.70
23-Dec-2017	7:00:00 AM	16.90	15.40	9.50
23-Dec-2017	8:00:00 AM	16.40	15.00	13.10
23-Dec-2017	9:00:00 AM	16.10	15.10	19.70
23-Dec-2017	10:00:00 AM	16.10	15.50	24.90
23-Dec-2017	11:00:00 AM	16.30	16.10	32.10
23-Dec-2017	12:00:00 PM	16.80	16.80	32.90
23-Dec-2017	1:00:00 PM	17.60	17.20	31.60
23-Dec-2017	2:00:00 PM	18.50	17.80	28.10
23-Dec-2017	3:00:00 PM	19.10	18.30	26.80
23-Dec-2017	4:00:00 PM	19.70	18.60	25.20
23-Dec-2017	5:00:00 PM	20.20	18.80	21.40
23-Dec-2017	6:00:00 PM	20.50	18.90	17.00
23-Dec-2017	7:00:00 PM	20.60	18.90	14.80
23-Dec-2017	8:00:00 PM	20.50	18.80	13.50
23-Dec-2017	9:00:00 PM	20.30	18.60	12.60
23-Dec-2017	10:00:00 PM	19.90	18.30	12.10
23-Dec-2017	11:00:00 PM	19.50	17.90	11.40
24-Dec-2017	12:00:00 AM	19.10	17.50	11.10
24-Dec-2017	1:00:00 AM	18.60	17.00	10.60
24-Dec-2017	2:00:00 AM	18.10	16.60	10.20
24-Dec-2017	3:00:00 AM	17.70	16.10	10.20
24-Dec-2017	4:00:00 AM	17.20	15.60	9.70
24-Dec-2017	5:00:00 AM	16.70	15.20	9.30
24-Dec-2017	6:00:00 AM	16.20	14.80	9.00
24-Dec-2017	7:00:00 AM	15.80	14.40	9.00
24-Dec-2017	8:00:00 AM	15.40	14.00	11.20
24-Dec-2017	9:00:00 AM	15.10	14.20	18.40
24-Dec-2017	10:00:00 AM	15.10	14.40	21.80
24-Dec-2017	11:00:00 AM	15.30	15.00	24.60
24-Dec-2017	12:00:00 PM	15.80	15.70	28.00
24-Dec-2017	1:00:00 PM	16.40	16.40	28.70
24-Dec-2017	2:00:00 PM	17.20	17.10	28.80
24-Dec-2017	3:00:00 PM	17.90	17.30	26.70
24-Dec-2017	4:00:00 PM	18.60	17.80	25.30
24-Dec-2017	5:00:00 PM	19.20	17.90	19.80
24-Dec-2017	6:00:00 PM	19.50	18.00	16.80
24-Dec-2017	7:00:00 PM	19.70	18.10	15.70
24-Dec-2017	8:00:00 PM	19.70	18.10	14.40
24-Dec-2017	9:00:00 PM	19.50	17.90	13.80
24-Dec-2017	10:00:00 PM	19.30	17.60	12.50
24-Dec-2017	11:00:00 PM	18.90	17.30	12.40

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
25-Dec-2017	12:00:00 AM	18.60	16.90	11.50
25-Dec-2017	1:00:00 AM	18.10	16.60	10.60
25-Dec-2017	2:00:00 AM	17.70	16.10	10.60
25-Dec-2017	3:00:00 AM	17.30	15.70	10.00
25-Dec-2017	4:00:00 AM	16.80	15.30	9.90
25-Dec-2017	5:00:00 AM	16.40	14.90	9.60
25-Dec-2017	6:00:00 AM	15.90	14.40	8.60
25-Dec-2017	7:00:00 AM	15.50	14.00	8.60
25-Dec-2017	8:00:00 AM	15.10	13.70	10.70
25-Dec-2017	9:00:00 AM	14.80	13.70	16.30
25-Dec-2017	10:00:00 AM	14.70	14.00	22.80
25-Dec-2017	11:00:00 AM	14.90	14.50	27.40
25-Dec-2017	12:00:00 PM	15.30	15.20	30.20
25-Dec-2017	1:00:00 PM	16.00	16.00	30.40
25-Dec-2017	2:00:00 PM	16.80	16.70	31.20
25-Dec-2017	3:00:00 PM	17.60	17.40	30.50
25-Dec-2017	4:00:00 PM	18.30	17.70	26.50
25-Dec-2017	5:00:00 PM	18.90	17.70	20.00
25-Dec-2017	6:00:00 PM	19.40	17.80	16.20
25-Dec-2017	7:00:00 PM	19.60	17.90	14.30
25-Dec-2017	8:00:00 PM	19.60	17.80	13.00
25-Dec-2017	9:00:00 PM	19.40	17.60	12.30
25-Dec-2017	10:00:00 PM	19.20	17.30	12.30
25-Dec-2017	11:00:00 PM	18.80	17.00	11.50
26-Dec-2017	12:00:00 AM	18.40	16.60	11.60
26-Dec-2017	1:00:00 AM	18.00	16.20	12.20
26-Dec-2017	2:00:00 AM	17.60	15.90	12.40
26-Dec-2017	3:00:00 AM	17.20	15.50	12.50
26-Dec-2017	4:00:00 AM	16.80	15.20	11.80
26-Dec-2017	5:00:00 AM	16.40	14.80	11.00
26-Dec-2017	6:00:00 AM	16.00	14.50	10.10
26-Dec-2017	7:00:00 AM	15.70	14.10	9.80
26-Dec-2017	8:00:00 AM	15.30	13.80	12.10
26-Dec-2017	9:00:00 AM	15.20	13.80	17.20
26-Dec-2017	10:00:00 AM	15.10	14.00	22.80
26-Dec-2017	11:00:00 AM	15.30	14.30	26.10
26-Dec-2017	12:00:00 PM	15.60	14.70	27.50
26-Dec-2017	1:00:00 PM	16.10	16.20	33.10
26-Dec-2017	2:00:00 PM	16.80	16.30	29.20
26-Dec-2017	3:00:00 PM	17.40	16.60	26.60
26-Dec-2017	4:00:00 PM	18.00	16.90	22.70
26-Dec-2017	5:00:00 PM	18.50	17.10	19.20
26-Dec-2017	6:00:00 PM	18.80	17.30	16.60
26-Dec-2017	7:00:00 PM	19.00	17.50	15.80
26-Dec-2017	8:00:00 PM	19.00	17.50	15.00
26-Dec-2017	9:00:00 PM	18.90	17.40	14.30
26-Dec-2017	10:00:00 PM	18.80	17.20	14.40
26-Dec-2017	11:00:00 PM	18.60	17.00	13.90
27-Dec-2017	12:00:00 AM	18.30	16.80	13.00
27-Dec-2017	1:00:00 AM	18.10	16.50	12.40
27-Dec-2017	2:00:00 AM	17.80	16.30	12.00
27-Dec-2017	3:00:00 AM	17.40	16.00	11.40

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
27-Dec-2017	4:00:00 AM	17.10	15.70	11.60
27-Dec-2017	5:00:00 AM	16.80	15.30	10.80
27-Dec-2017	6:00:00 AM	16.50	15.00	10.50
27-Dec-2017	7:00:00 AM	16.10	14.70	10.40
27-Dec-2017	8:00:00 AM	15.90	14.40	12.00
27-Dec-2017	9:00:00 AM	15.70	14.30	15.10
27-Dec-2017	10:00:00 AM	15.60	14.30	19.00
27-Dec-2017	11:00:00 AM	15.60	14.40	22.70
27-Dec-2017	12:00:00 PM	15.90	14.90	26.80
27-Dec-2017	1:00:00 PM	16.30	15.50	28.90
27-Dec-2017	2:00:00 PM	16.90	16.00	28.00
27-Dec-2017	3:00:00 PM	17.40	16.40	23.10
27-Dec-2017	4:00:00 PM	17.80	16.70	21.50
27-Dec-2017	5:00:00 PM	18.20	17.00	18.40
27-Dec-2017	6:00:00 PM	18.40	17.10	15.90
27-Dec-2017	7:00:00 PM	18.50	17.20	14.10
27-Dec-2017	8:00:00 PM	18.50	17.10	13.70
27-Dec-2017	9:00:00 PM	18.40	17.00	12.80
27-Dec-2017	10:00:00 PM	18.10	16.70	12.20
27-Dec-2017	11:00:00 PM	17.80	16.40	12.00
28-Dec-2017	12:00:00 AM	17.50	16.10	11.70
28-Dec-2017	1:00:00 AM	17.20	15.80	11.10
28-Dec-2017	2:00:00 AM	16.80	15.40	11.10
28-Dec-2017	3:00:00 AM	16.50	15.10	10.30
28-Dec-2017	4:00:00 AM	16.10	14.70	9.90
28-Dec-2017	5:00:00 AM	15.70	14.30	9.40
28-Dec-2017	6:00:00 AM	15.30	14.00	9.10
28-Dec-2017	7:00:00 AM	14.90	13.60	8.40
28-Dec-2017	8:00:00 AM	14.60	13.30	9.00
28-Dec-2017	9:00:00 AM	14.30	13.10	12.40
28-Dec-2017	10:00:00 AM	14.20	13.40	18.70
28-Dec-2017	11:00:00 AM	14.30	13.90	25.30
28-Dec-2017	12:00:00 PM	14.70	14.50	27.40
28-Dec-2017	1:00:00 PM	15.30	15.00	28.10
28-Dec-2017	2:00:00 PM	16.00	15.70	29.10
28-Dec-2017	3:00:00 PM	16.70	16.30	27.30
28-Dec-2017	4:00:00 PM	17.40	16.50	22.00
28-Dec-2017	5:00:00 PM	18.00	16.70	17.70
28-Dec-2017	6:00:00 PM	18.40	16.80	14.60
28-Dec-2017	7:00:00 PM	18.50	16.80	13.20
28-Dec-2017	8:00:00 PM	18.50	16.70	12.00
28-Dec-2017	9:00:00 PM	18.30	16.50	11.60
28-Dec-2017	10:00:00 PM	18.00	16.20	11.20
28-Dec-2017	11:00:00 PM	17.70	15.90	10.80
29-Dec-2017	12:00:00 AM	17.30	15.50	10.70
29-Dec-2017	1:00:00 AM	16.90	15.10	10.00
29-Dec-2017	2:00:00 AM	16.50	14.70	9.40
29-Dec-2017	3:00:00 AM	16.00	14.30	9.40
29-Dec-2017	4:00:00 AM	15.60	13.90	9.20
29-Dec-2017	5:00:00 AM	15.20	13.50	8.80
29-Dec-2017	6:00:00 AM	14.80	13.10	8.40
29-Dec-2017	7:00:00 AM	14.40	12.70	7.70

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
29-Dec-2017	8:00:00 AM	14.00	12.40	9.40
29-Dec-2017	9:00:00 AM	13.70	12.50	16.50
29-Dec-2017	10:00:00 AM	13.70	12.80	22.60
29-Dec-2017	12:00:00 PM	17.20	17.00	27.70
29-Dec-2017	1:00:00 PM	16.10	16.40	31.70
29-Dec-2017	2:00:00 PM	16.60	17.10	32.70
29-Dec-2017	3:00:00 PM	17.20	17.20	30.40
29-Dec-2017	4:00:00 PM	18.00	17.50	27.10
29-Dec-2017	5:00:00 PM	18.70	17.60	20.40
29-Dec-2017	6:00:00 PM	19.20	17.70	16.90
29-Dec-2017	7:00:00 PM	19.50	17.80	15.20
29-Dec-2017	8:00:00 PM	19.50	17.70	13.70
29-Dec-2017	9:00:00 PM	19.30	17.50	12.40
29-Dec-2017	10:00:00 PM	19.00	17.20	12.10
29-Dec-2017	11:00:00 PM	18.60	16.80	11.20
30-Dec-2017	12:00:00 AM	18.20	16.40	10.40
30-Dec-2017	1:00:00 AM	17.70	16.00	9.50
30-Dec-2017	2:00:00 AM	17.20	15.50	8.90
30-Dec-2017	3:00:00 AM	16.70	15.00	8.50
30-Dec-2017	4:00:00 AM	16.20	14.50	8.30
30-Dec-2017	5:00:00 AM	15.70	14.00	7.80
30-Dec-2017	6:00:00 AM	15.20	13.60	7.50
30-Dec-2017	7:00:00 AM	14.70	13.10	7.40
30-Dec-2017	8:00:00 AM	14.30	12.70	9.90
30-Dec-2017	9:00:00 AM	14.00	12.80	17.10
30-Dec-2017	10:00:00 AM	13.90	13.10	23.10
30-Dec-2017	11:00:00 AM	14.20	13.90	27.80
30-Dec-2017	12:00:00 PM	14.70	14.80	30.60
30-Dec-2017	1:00:00 PM	15.50	15.60	31.00
30-Dec-2017	2:00:00 PM	16.30	16.40	30.60
30-Dec-2017	3:00:00 PM	17.20	16.90	29.00
30-Dec-2017	4:00:00 PM	18.00	17.20	27.00
30-Dec-2017	5:00:00 PM	18.60	17.30	20.40
30-Dec-2017	6:00:00 PM	19.20	17.50	16.70
30-Dec-2017	7:00:00 PM	19.40	17.50	14.50
30-Dec-2017	8:00:00 PM	19.40	17.50	13.10
30-Dec-2017	9:00:00 PM	19.30	17.30	12.30
30-Dec-2017	10:00:00 PM	19.00	17.00	11.10
30-Dec-2017	11:00:00 PM	18.60	16.60	10.40
31-Dec-2017	12:00:00 AM	18.10	16.20	9.80
31-Dec-2017	1:00:00 AM	17.70	15.80	9.40
31-Dec-2017	2:00:00 AM	17.20	15.40	9.60
31-Dec-2017	3:00:00 AM	16.70	14.90	9.00
31-Dec-2017	4:00:00 AM	16.30	14.50	9.00
31-Dec-2017	5:00:00 AM	15.80	14.10	9.10
31-Dec-2017	6:00:00 AM	15.40	13.60	8.80
31-Dec-2017	7:00:00 AM	15.00	13.20	8.10
31-Dec-2017	8:00:00 AM	14.60	12.90	9.10
31-Dec-2017	9:00:00 AM	14.30	12.80	14.10
31-Dec-2017	10:00:00 AM	14.20	13.00	21.20
31-Dec-2017	11:00:00 AM	14.30	13.50	25.00
31-Dec-2017	12:00:00 PM	14.60	14.00	27.80

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
31-Dec-2017	1:00:00 PM	15.20	14.70	29.80
31-Dec-2017	2:00:00 PM	15.90	15.40	29.60
31-Dec-2017	3:00:00 PM	16.60	16.00	28.80
31-Dec-2017	4:00:00 PM	17.20	16.30	24.00
31-Dec-2017	5:00:00 PM	17.70	16.40	18.80
31-Dec-2017	6:00:00 PM	18.20	16.60	15.70
31-Dec-2017	7:00:00 PM	18.40	16.70	13.30
31-Dec-2017	8:00:00 PM	18.40	16.70	12.30
31-Dec-2017	9:00:00 PM	18.20	16.50	11.90
31-Dec-2017	10:00:00 PM	18.00	16.20	11.50
31-Dec-2017	11:00:00 PM	17.70	15.90	10.90
1-Jan-2018	12:00:00 AM	17.30	15.60	10.70
1-Jan-2018	1:00:00 AM	16.90	15.20	9.70
1-Jan-2018	2:00:00 AM	16.50	14.80	9.10
1-Jan-2018	3:00:00 AM	16.00	14.40	8.90
1-Jan-2018	4:00:00 AM	15.60	14.00	9.10
1-Jan-2018	5:00:00 AM	15.20	13.60	8.90
1-Jan-2018	6:00:00 AM	14.80	13.20	8.10
1-Jan-2018	7:00:00 AM	14.40	12.80	8.00
1-Jan-2018	8:00:00 AM	14.00	12.50	9.70
1-Jan-2018	9:00:00 AM	13.80	12.50	15.20
1-Jan-2018	10:00:00 AM	13.70	12.80	20.20
1-Jan-2018	11:00:00 AM	13.90	13.30	23.70
1-Jan-2018	12:00:00 PM	14.30	13.90	27.20
1-Jan-2018	1:00:00 PM	14.90	14.80	28.60
1-Jan-2018	2:00:00 PM	15.60	15.50	26.80
1-Jan-2018	3:00:00 PM	16.30	16.00	26.20
1-Jan-2018	4:00:00 PM	17.00	16.30	25.50
1-Jan-2018	5:00:00 PM	17.50	16.30	19.70
1-Jan-2018	6:00:00 PM	18.00	16.40	14.80
1-Jan-2018	7:00:00 PM	18.20	16.50	13.00
1-Jan-2018	8:00:00 PM	18.20	16.40	12.20
1-Jan-2018	9:00:00 PM	18.10	16.30	11.20
1-Jan-2018	10:00:00 PM	17.80	16.00	10.40
1-Jan-2018	11:00:00 PM	17.50	15.60	10.00
2-Jan-2018	12:00:00 AM	17.10	15.30	9.80
2-Jan-2018	1:00:00 AM	16.70	14.90	9.50
2-Jan-2018	2:00:00 AM	16.20	14.40	9.70
2-Jan-2018	3:00:00 AM	15.80	14.00	8.80
2-Jan-2018	4:00:00 AM	15.30	13.60	8.10
2-Jan-2018	5:00:00 AM	14.90	13.20	7.40
2-Jan-2018	6:00:00 AM	14.40	12.70	7.10
2-Jan-2018	7:00:00 AM	14.00	12.30	7.10
2-Jan-2018	8:00:00 AM	13.60	11.90	8.50
2-Jan-2018	9:00:00 AM	13.30	12.00	14.50
2-Jan-2018	10:00:00 AM	13.10	11.90	14.40
2-Jan-2018	11:00:00 AM	13.10	12.20	20.80
2-Jan-2018	12:00:00 PM	13.40	12.70	23.70
2-Jan-2018	1:00:00 PM	13.80	13.40	26.60
2-Jan-2018	2:00:00 PM	14.40	14.20	27.70
2-Jan-2018	3:00:00 PM	15.10	14.80	26.80
2-Jan-2018	4:00:00 PM	15.80	15.00	21.40

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
2-Jan-2018	5:00:00 PM	16.40	15.10	16.70
2-Jan-2018	6:00:00 PM	16.90	15.20	13.70
2-Jan-2018	7:00:00 PM	17.10	15.30	12.40
2-Jan-2018	8:00:00 PM	17.10	15.30	11.30
2-Jan-2018	9:00:00 PM	17.00	15.10	10.80
2-Jan-2018	10:00:00 PM	16.80	14.80	10.40
2-Jan-2018	11:00:00 PM	16.50	14.50	9.80
3-Jan-2018	12:00:00 AM	16.20	14.20	9.10
3-Jan-2018	1:00:00 AM	15.80	13.80	8.60
3-Jan-2018	2:00:00 AM	15.40	13.50	8.50
3-Jan-2018	3:00:00 AM	15.10	13.20	8.30
3-Jan-2018	4:00:00 AM	14.80	13.00	8.40
3-Jan-2018	5:00:00 AM	14.50	12.70	8.60
3-Jan-2018	6:00:00 AM	14.20	12.40	8.40
3-Jan-2018	7:00:00 AM	13.90	12.20	7.60
3-Jan-2018	8:00:00 AM	13.60	11.90	7.20
3-Jan-2018	9:00:00 AM	13.30	11.70	7.80
3-Jan-2018	10:00:00 AM	13.20	11.50	9.90
3-Jan-2018	11:00:00 AM	13.10	11.90	17.50
3-Jan-2018	12:00:00 PM	13.10	12.20	18.90
3-Jan-2018	1:00:00 PM	13.30	12.80	20.30
3-Jan-2018	2:00:00 PM	13.70	13.20	21.90
3-Jan-2018	3:00:00 PM	14.30	13.60	19.50
3-Jan-2018	4:00:00 PM	14.70	13.70	16.80
3-Jan-2018	5:00:00 PM	15.10	13.70	12.90
3-Jan-2018	6:00:00 PM	15.30	13.70	10.70
3-Jan-2018	7:00:00 PM	15.40	13.70	9.40
3-Jan-2018	8:00:00 PM	15.30	13.50	8.70
3-Jan-2018	9:00:00 PM	15.20	13.30	8.50
3-Jan-2018	10:00:00 PM	14.90	13.10	8.60
3-Jan-2018	11:00:00 PM	14.60	12.80	8.00
4-Jan-2018	12:00:00 AM	14.30	12.50	7.60
4-Jan-2018	1:00:00 AM	14.00	12.20	7.30
4-Jan-2018	2:00:00 AM	13.70	12.00	7.40
4-Jan-2018	3:00:00 AM	13.40	11.70	7.00
4-Jan-2018	4:00:00 AM	13.10	11.50	6.80
4-Jan-2018	5:00:00 AM	12.80	11.20	6.60
4-Jan-2018	6:00:00 AM	12.60	10.90	6.40
4-Jan-2018	7:00:00 AM	12.30	10.70	6.10
4-Jan-2018	8:00:00 AM	12.00	10.40	6.30
4-Jan-2018	9:00:00 AM	11.80	10.30	7.40
4-Jan-2018	10:00:00 AM	11.70	10.20	12.00
4-Jan-2018	11:00:00 AM	11.70	11.00	17.70
4-Jan-2018	12:00:00 PM	11.80	11.20	17.80
4-Jan-2018	1:00:00 PM	13.30	12.80	19.30
4-Jan-2018	2:00:00 PM	12.90	12.30	18.40
4-Jan-2018	3:00:00 PM	13.20	12.30	15.40
4-Jan-2018	4:00:00 PM	13.60	12.40	13.30
4-Jan-2018	5:00:00 PM	13.90	12.50	12.20
4-Jan-2018	6:00:00 PM	14.10	12.70	11.70
4-Jan-2018	7:00:00 PM	14.20	12.70	11.50
4-Jan-2018	8:00:00 PM	14.20	12.80	11.50

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
4-Jan-2018	9:00:00 PM	14.20	12.70	11.70
4-Jan-2018	10:00:00 PM	14.10	12.60	11.20
4-Jan-2018	11:00:00 PM	13.90	12.50	10.30
5-Jan-2018	12:00:00 AM	13.80	12.30	9.80
5-Jan-2018	1:00:00 AM	13.50	12.10	9.00
5-Jan-2018	2:00:00 AM	13.30	11.80	8.60
5-Jan-2018	3:00:00 AM	13.00	11.60	8.20
5-Jan-2018	4:00:00 AM	12.80	11.30	8.00
5-Jan-2018	5:00:00 AM	12.50	11.00	7.50
5-Jan-2018	6:00:00 AM	12.10	10.70	7.00
5-Jan-2018	7:00:00 AM	11.80	10.40	6.80
5-Jan-2018	8:00:00 AM	11.50	10.10	8.20
5-Jan-2018	9:00:00 AM	11.40	10.20	12.90
5-Jan-2018	11:00:00 AM	11.30	10.60	16.70
5-Jan-2018	12:00:00 PM	11.60	11.20	21.60
5-Jan-2018	1:00:00 PM	12.10	12.00	24.40
5-Jan-2018	2:00:00 PM	12.80	12.90	26.70
5-Jan-2018	3:00:00 PM	13.60	13.70	28.30
5-Jan-2018	4:00:00 PM	14.40	14.30	27.30
5-Jan-2018	5:00:00 PM	15.20	14.70	23.20
5-Jan-2018	6:00:00 PM	15.90	14.80	17.70
5-Jan-2018	7:00:00 PM	16.40	15.00	14.00
5-Jan-2018	8:00:00 PM	16.80	15.20	12.60
5-Jan-2018	9:00:00 PM	16.90	15.20	11.90
5-Jan-2018	10:00:00 PM	16.80	15.00	10.70
5-Jan-2018	11:00:00 PM	16.60	14.80	10.00
5-Jan-2018	12:00:00 PM	16.30	14.50	9.50
6-Jan-2018	12:00:00 AM	15.90	14.10	9.20
6-Jan-2018	1:00:00 AM	15.60	13.80	9.10
6-Jan-2018	2:00:00 AM	15.10	13.40	9.10
6-Jan-2018	3:00:00 AM	14.70	13.00	8.60
6-Jan-2018	4:00:00 AM	14.30	12.60	8.00
6-Jan-2018	5:00:00 AM	13.90	12.20	7.50
6-Jan-2018	6:00:00 AM	13.50	11.80	7.50
6-Jan-2018	7:00:00 AM	13.10	11.40	7.40
6-Jan-2018	8:00:00 AM	12.70	11.00	9.10
6-Jan-2018	9:00:00 AM	12.40	11.20	14.80
6-Jan-2018	10:00:00 AM	12.30	11.60	19.30
6-Jan-2018	11:00:00 AM	12.50	12.30	22.90
6-Jan-2018	12:00:00 PM	13.00	13.10	25.70
6-Jan-2018	1:00:00 PM	13.80	14.00	28.00
6-Jan-2018	2:00:00 PM	14.70	14.90	28.00
6-Jan-2018	3:00:00 PM	15.50	15.60	29.10
6-Jan-2018	4:00:00 PM	16.40	15.90	26.20
6-Jan-2018	5:00:00 PM	17.10	16.10	19.10
6-Jan-2018	6:00:00 PM	17.70	16.20	15.50
6-Jan-2018	7:00:00 PM	18.10	16.30	14.10
6-Jan-2018	8:00:00 PM	18.20	16.30	13.30
6-Jan-2018	9:00:00 PM	18.10	16.10	12.60
6-Jan-2018	10:00:00 PM	17.80	15.80	11.40
6-Jan-2018	11:00:00 PM	17.40	15.40	10.20
7-Jan-2018	12:00:00 AM	17.00	15.10	10.40

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
7-Jan-2018	1:00:00 AM	16.60	14.60	10.40
7-Jan-2018	2:00:00 AM	16.10	14.20	9.70
7-Jan-2018	3:00:00 AM	15.60	13.80	8.90
7-Jan-2018	4:00:00 AM	15.20	13.40	8.70
7-Jan-2018	5:00:00 AM	14.70	12.90	8.00
7-Jan-2018	6:00:00 AM	14.20	12.50	7.50
7-Jan-2018	7:00:00 AM	13.80	12.10	7.00
7-Jan-2018	8:00:00 AM	13.40	11.70	9.70
7-Jan-2018	9:00:00 AM	13.10	11.90	16.70
7-Jan-2018	10:00:00 AM	13.00	12.40	21.20
7-Jan-2018	11:00:00 AM	13.20	13.10	25.60
7-Jan-2018	12:00:00 PM	13.80	13.90	27.50
7-Jan-2018	1:00:00 PM	14.60	14.80	27.30
7-Jan-2018	2:00:00 PM	15.50	15.60	28.20
7-Jan-2018	3:00:00 PM	16.30	16.20	28.00
7-Jan-2018	4:00:00 PM	17.10	16.50	25.00
7-Jan-2018	5:00:00 PM	17.70	16.60	19.80
7-Jan-2018	6:00:00 PM	18.30	16.70	15.70
7-Jan-2018	7:00:00 PM	18.50	16.80	13.00
7-Jan-2018	8:00:00 PM	18.50	16.70	12.10
7-Jan-2018	9:00:00 PM	18.40	16.50	12.30
7-Jan-2018	10:00:00 PM	18.10	16.20	12.00
7-Jan-2018	11:00:00 PM	17.80	15.80	11.30
8-Jan-2018	12:00:00 AM	17.30	15.40	10.90
8-Jan-2018	1:00:00 AM	16.90	15.00	10.50
8-Jan-2018	2:00:00 AM	16.40	14.60	10.40
8-Jan-2018	3:00:00 AM	15.90	14.20	10.40
8-Jan-2018	4:00:00 AM	15.40	13.70	10.00
8-Jan-2018	5:00:00 AM	15.00	13.30	8.70
8-Jan-2018	6:00:00 AM	14.50	12.90	8.00
8-Jan-2018	7:00:00 AM	14.10	12.50	7.90
8-Jan-2018	8:00:00 AM	13.70	12.10	10.00
8-Jan-2018	9:00:00 AM	13.40	12.30	15.80
8-Jan-2018	10:00:00 AM	13.30	12.70	20.40
8-Jan-2018	11:00:00 AM	13.50	13.40	25.20
8-Jan-2018	12:00:00 PM	14.00	14.10	26.40
5-Mar-2018	10:00:00 AM	22.10	21.60	30.90
5-Mar-2018	11:00:00 AM	22.10	21.60	32.10
5-Mar-2018	12:00:00 PM	22.70	22.40	34.10
5-Mar-2018	1:00:00 PM	23.50	23.40	37.30
5-Mar-2018	2:00:00 PM	24.40	24.30	35.70
5-Mar-2018	3:00:00 PM	25.40	25.10	35.60
5-Mar-2018	4:00:00 PM	26.20	25.70	33.90
5-Mar-2018	5:00:00 PM	26.90	26.10	32.20
5-Mar-2018	6:00:00 PM	27.30	26.40	25.30
5-Mar-2018	7:00:00 PM	27.60	26.60	23.10
5-Mar-2018	8:00:00 PM	27.70	26.70	21.70
5-Mar-2018	9:00:00 PM	27.70	26.50	20.40
5-Mar-2018	10:00:00 PM	27.40	26.20	19.40
5-Mar-2018	11:00:00 PM	27.00	25.80	19.30
6-Mar-2018	12:00:00 AM	26.50	25.30	18.40
6-Mar-2018	1:00:00 AM	26.00	24.80	17.80

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
6-Mar-2018	2:00:00 AM	25.40	24.20	17.10
6-Mar-2018	3:00:00 AM	24.90	23.60	16.60
6-Mar-2018	4:00:00 AM	24.30	23.10	16.40
6-Mar-2018	5:00:00 AM	23.70	22.50	15.60
6-Mar-2018	6:00:00 AM	23.20	22.00	15.30
6-Mar-2018	7:00:00 AM	22.60	21.40	15.90
6-Mar-2018	8:00:00 AM	22.20	21.10	20.80
6-Mar-2018	9:00:00 AM	22.00	21.20	25.50
6-Mar-2018	10:00:00 AM	22.00	21.50	29.40
6-Mar-2018	11:00:00 AM	22.30	22.20	31.40
6-Mar-2018	12:00:00 PM	23.10	23.20	33.00
6-Mar-2018	1:00:00 PM	23.80	24.00	35.00
6-Mar-2018	2:00:00 PM	24.60	24.90	37.20
6-Mar-2018	3:00:00 PM	25.50	25.60	37.40
6-Mar-2018	4:00:00 PM	26.30	26.20	35.90
6-Mar-2018	5:00:00 PM	27.10	26.60	33.80
6-Mar-2018	6:00:00 PM	27.80	27.00	26.70
6-Mar-2018	7:00:00 PM	28.20	27.20	24.00
6-Mar-2018	8:00:00 PM	28.40	27.30	22.50
6-Mar-2018	9:00:00 PM	28.40	27.20	21.60
6-Mar-2018	10:00:00 PM	28.20	26.90	20.90
6-Mar-2018	11:00:00 PM	27.90	26.50	20.30
7-Mar-2018	12:00:00 AM	27.40	26.00	19.70
7-Mar-2018	1:00:00 AM	26.90	25.50	19.00
7-Mar-2018	2:00:00 AM	26.40	25.00	18.60
7-Mar-2018	3:00:00 AM	25.80	24.50	18.20
7-Mar-2018	4:00:00 AM	25.30	24.00	17.90
7-Mar-2018	5:00:00 AM	24.70	23.50	17.50
7-Mar-2018	6:00:00 AM	24.20	23.00	17.10
7-Mar-2018	7:00:00 AM	23.70	22.50	17.10
7-Mar-2018	8:00:00 AM	23.30	22.10	21.50
7-Mar-2018	9:00:00 AM	23.10	22.20	26.50
7-Mar-2018	10:00:00 AM	23.10	22.60	31.40
7-Mar-2018	11:00:00 AM	23.40	23.20	32.40
7-Mar-2018	12:00:00 PM	24.00	24.10	34.10
7-Mar-2018	1:00:00 PM	24.70	24.90	35.80
7-Mar-2018	2:00:00 PM	25.70	25.90	37.50
7-Mar-2018	3:00:00 PM	26.60	26.80	38.70
7-Mar-2018	4:00:00 PM	27.50	27.30	37.00
7-Mar-2018	5:00:00 PM	28.30	27.70	34.70
7-Mar-2018	6:00:00 PM	28.90	28.10	27.90
7-Mar-2018	7:00:00 PM	29.30	28.40	24.90
7-Mar-2018	8:00:00 PM	29.60	28.50	23.10
7-Mar-2018	9:00:00 PM	29.50	28.30	21.80
7-Mar-2018	10:00:00 PM	29.30	28.00	20.30
7-Mar-2018	11:00:00 PM	28.90	27.60	19.70
8-Mar-2018	12:00:00 AM	28.50	27.10	19.30
8-Mar-2018	1:00:00 AM	27.90	26.60	18.30
8-Mar-2018	2:00:00 AM	27.40	26.10	17.90
8-Mar-2018	3:00:00 AM	26.80	25.50	17.40
8-Mar-2018	4:00:00 AM	26.30	24.90	17.00
8-Mar-2018	5:00:00 AM	25.70	24.40	16.90

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
8-Mar-2018	6:00:00 AM	25.10	23.80	15.90
8-Mar-2018	7:00:00 AM	24.60	23.30	16.30
8-Mar-2018	8:00:00 AM	24.20	22.90	21.40
8-Mar-2018	9:00:00 AM	23.90	23.00	27.30
8-Mar-2018	10:00:00 AM	23.90	23.50	31.90
8-Mar-2018	11:00:00 AM	24.20	24.20	34.80
8-Mar-2018	12:00:00 PM	24.90	25.10	37.60
8-Mar-2018	1:00:00 PM	25.80	26.00	37.40
8-Mar-2018	2:00:00 PM	26.80	26.90	40.20
8-Mar-2018	3:00:00 PM	27.70	27.40	35.60
8-Mar-2018	4:00:00 PM	28.40	27.90	33.40
8-Mar-2018	5:00:00 PM	29.00	28.30	31.90
8-Mar-2018	6:00:00 PM	29.50	28.50	27.00
8-Mar-2018	7:00:00 PM	29.70	28.70	25.30
8-Mar-2018	8:00:00 PM	29.80	28.70	24.30
8-Mar-2018	9:00:00 PM	29.70	28.50	23.40
8-Mar-2018	10:00:00 PM	29.40	28.30	23.00
8-Mar-2018	11:00:00 PM	29.10	28.00	22.50
9-Mar-2018	12:00:00 AM	28.70	27.60	21.90
9-Mar-2018	1:00:00 AM	27.70	26.90	19.30
9-Mar-2018	2:00:00 AM	27.20	26.40	19.50
9-Mar-2018	3:00:00 AM	26.80	26.00	19.10
9-Mar-2018	4:00:00 AM	26.40	25.40	18.00
9-Mar-2018	5:00:00 AM	25.90	24.90	16.90
9-Mar-2018	6:00:00 AM	25.40	24.30	16.40
9-Mar-2018	7:00:00 AM	24.80	23.80	16.60
9-Mar-2018	8:00:00 AM	24.30	23.40	20.80
9-Mar-2018	9:00:00 AM	24.00	23.40	27.50
9-Mar-2018	10:00:00 AM	24.00	23.70	31.00
9-Mar-2018	11:00:00 AM	24.20	24.30	33.90
9-Mar-2018	12:00:00 PM	24.70	25.10	36.60
9-Mar-2018	1:00:00 PM	25.50	25.80	37.10
9-Mar-2018	2:00:00 PM	26.40	26.60	37.80
9-Mar-2018	3:00:00 PM	27.20	27.40	38.00
9-Mar-2018	4:00:00 PM	28.00	27.80	36.50
9-Mar-2018	5:00:00 PM	28.70	28.20	35.00
9-Mar-2018	6:00:00 PM	29.20	28.50	27.40
9-Mar-2018	7:00:00 PM	29.60	28.70	24.50
9-Mar-2018	8:00:00 PM	29.80	28.80	23.20
9-Mar-2018	9:00:00 PM	29.70	28.60	22.00
9-Mar-2018	10:00:00 PM	29.50	28.30	21.70
9-Mar-2018	11:00:00 PM	29.10	27.90	21.10
10-Mar-2018	12:00:00 AM	28.70	27.40	20.30
10-Mar-2018	1:00:00 AM	28.10	26.90	20.30
10-Mar-2018	2:00:00 AM	27.50	26.30	19.90
10-Mar-2018	3:00:00 AM	26.90	25.80	19.80
10-Mar-2018	4:00:00 AM	26.40	25.20	19.00
10-Mar-2018	5:00:00 AM	25.90	24.70	18.20
10-Mar-2018	6:00:00 AM	25.30	24.20	17.40
10-Mar-2018	7:00:00 AM	24.80	23.70	17.70
10-Mar-2018	8:00:00 AM	24.40	23.30	22.90
10-Mar-2018	9:00:00 AM	24.10	23.20	26.00

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
10-Mar-2018	10:00:00 AM	24.10	23.60	30.70
10-Mar-2018	11:00:00 AM	24.40	24.10	32.40
10-Mar-2018	12:00:00 PM	24.90	24.90	35.00
10-Mar-2018	1:00:00 PM	25.60	25.80	36.40
10-Mar-2018	2:00:00 PM	26.50	26.60	36.40
10-Mar-2018	3:00:00 PM	27.30	27.20	35.10
10-Mar-2018	4:00:00 PM	28.00	27.80	34.20
10-Mar-2018	5:00:00 PM	28.60	28.10	32.40
10-Mar-2018	6:00:00 PM	29.10	28.40	27.30
10-Mar-2018	7:00:00 PM	29.40	28.60	25.20
10-Mar-2018	8:00:00 PM	29.60	28.70	24.10
10-Mar-2018	9:00:00 PM	29.50	28.50	23.20
10-Mar-2018	10:00:00 PM	29.30	28.30	22.50
10-Mar-2018	11:00:00 PM	28.90	27.90	21.80
11-Mar-2018	12:00:00 AM	28.50	27.40	20.60
11-Mar-2018	1:00:00 AM	28.10	27.00	20.70
11-Mar-2018	3:00:00 AM	27.50	26.50	20.50
11-Mar-2018	4:00:00 AM	27.10	26.00	19.70
11-Mar-2018	5:00:00 AM	26.60	25.50	19.50
11-Mar-2018	6:00:00 AM	26.00	25.00	19.30
11-Mar-2018	7:00:00 AM	25.50	24.50	18.90
11-Mar-2018	8:00:00 AM	25.10	24.10	19.10
11-Mar-2018	9:00:00 AM	24.70	23.80	23.60
11-Mar-2018	10:00:00 AM	24.50	23.80	30.00
11-Mar-2018	11:00:00 AM	24.50	24.20	33.00
11-Mar-2018	12:00:00 PM	24.90	24.90	37.90
11-Mar-2018	1:00:00 PM	25.60	25.80	39.00
11-Mar-2018	2:00:00 PM	26.50	26.80	38.40
11-Mar-2018	3:00:00 PM	27.50	27.80	39.10
11-Mar-2018	4:00:00 PM	28.50	28.70	38.30
11-Mar-2018	5:00:00 PM	29.20	29.10	37.50
11-Mar-2018	6:00:00 PM	29.90	29.60	35.10
11-Mar-2018	7:00:00 PM	30.60	30.00	29.50
11-Mar-2018	8:00:00 PM	31.10	30.20	27.00
11-Mar-2018	9:00:00 PM	31.30	30.30	25.90
11-Mar-2018	10:00:00 PM	31.30	30.20	24.90
11-Mar-2018	11:00:00 PM	31.00	29.90	24.10
12-Mar-2018	12:00:00 AM	30.70	29.50	23.00
12-Mar-2018	1:00:00 AM	30.20	29.10	21.60
12-Mar-2018	2:00:00 AM	29.70	28.60	20.80
12-Mar-2018	3:00:00 AM	29.20	28.10	20.30
12-Mar-2018	4:00:00 AM	28.70	27.60	19.60
12-Mar-2018	5:00:00 AM	28.20	27.10	18.90
12-Mar-2018	6:00:00 AM	27.60	26.50	19.30
12-Mar-2018	7:00:00 AM	27.00	26.00	18.30
12-Mar-2018	8:00:00 AM	26.50	25.50	19.40
12-Mar-2018	9:00:00 AM	26.10	25.10	24.30
12-Mar-2018	10:00:00 AM	25.90	25.10	27.60
12-Mar-2018	11:00:00 AM	25.90	25.30	32.90
12-Mar-2018	12:00:01 PM	27.40	27.40	33.70
12-Mar-2018	1:00:00 PM	27.70	27.70	37.50
12-Mar-2018	2:00:00 PM	28.30	28.50	38.90

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
12-Mar-2018	3:00:00 PM	29.00	29.10	37.10
12-Mar-2018	4:00:00 PM	29.70	29.60	36.70
12-Mar-2018	5:00:00 PM	30.30	30.00	32.50
12-Mar-2018	6:00:00 PM	30.80	30.30	29.50
12-Mar-2018	7:00:00 PM	31.10	30.50	26.70
12-Mar-2018	8:00:00 PM	31.20	30.50	24.80
12-Mar-2018	9:00:00 PM	31.10	30.40	23.90
12-Mar-2018	10:00:00 PM	30.90	30.10	23.00
12-Mar-2018	11:00:00 PM	30.50	29.60	22.00
13-Mar-2018	12:00:00 AM	30.00	29.10	21.70
13-Mar-2018	1:00:00 AM	29.50	28.60	21.60
13-Mar-2018	2:00:00 AM	29.00	28.10	21.40
13-Mar-2018	3:00:00 AM	28.50	27.50	21.00
13-Mar-2018	4:00:00 AM	27.90	27.00	20.10
13-Mar-2018	5:00:00 AM	27.40	26.50	19.40
13-Mar-2018	6:00:00 AM	26.90	26.00	18.30
13-Mar-2018	7:00:00 AM	26.30	25.40	18.70
13-Mar-2018	8:00:00 AM	26.00	25.10	24.20
13-Mar-2018	9:00:00 AM	25.70	25.10	29.80
13-Mar-2018	10:00:00 AM	26.20	25.80	32.60
13-Mar-2018	11:00:00 AM	26.20	26.40	37.90
13-Mar-2018	12:00:00 PM	26.90	27.30	41.40
13-Mar-2018	1:00:00 PM	27.80	28.30	42.80
13-Mar-2018	2:00:00 PM	28.90	29.30	42.50
13-Mar-2018	3:00:00 PM	29.80	30.10	40.90
13-Mar-2018	4:00:00 PM	30.70	30.60	38.30
13-Mar-2018	5:00:00 PM	31.40	31.00	35.90
13-Mar-2018	6:00:00 PM	31.90	31.20	30.50
13-Mar-2018	7:00:00 PM	32.30	31.40	27.80
13-Mar-2018	8:00:00 PM	32.40	31.50	26.30
13-Mar-2018	9:00:00 PM	32.30	31.40	24.90
13-Mar-2018	10:00:00 PM	32.00	31.00	24.60
13-Mar-2018	11:00:00 PM	31.60	30.50	24.00
14-Mar-2018	12:00:00 AM	31.20	30.00	23.50
14-Mar-2018	1:00:00 AM	30.60	29.50	22.60
14-Mar-2018	2:00:00 AM	30.10	28.90	21.90
14-Mar-2018	3:00:00 AM	29.50	28.40	21.40
14-Mar-2018	4:00:00 AM	28.70	27.90	20.50
14-Mar-2018	5:00:00 AM	28.00	27.20	19.50
14-Mar-2018	6:00:00 AM	27.40	26.60	18.90
14-Mar-2018	7:00:00 AM	26.80	26.10	19.30
14-Mar-2018	8:00:00 AM	26.40	25.70	23.50
14-Mar-2018	9:00:00 AM	26.20	25.60	28.10
14-Mar-2018	10:00:00 AM	26.20	25.90	30.10
14-Mar-2018	11:00:00 AM	26.40	26.60	34.30
14-Mar-2018	12:00:00 PM	27.00	27.30	36.30
14-Mar-2018	1:00:00 PM	27.90	28.30	38.50
14-Mar-2018	2:00:00 PM	28.70	29.00	38.90
14-Mar-2018	3:00:00 PM	29.40	29.60	40.30
14-Mar-2018	4:00:00 PM	30.10	30.00	35.10
14-Mar-2018	5:00:00 PM	30.50	30.20	30.30
14-Mar-2018	6:00:00 PM	30.80	30.40	26.80

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
14-Mar-2018	7:00:00 PM	31.00	30.50	25.20
14-Mar-2018	8:00:00 PM	31.10	30.50	24.50
14-Mar-2018	9:00:00 PM	31.00	30.30	23.80
14-Mar-2018	10:00:00 PM	30.70	29.90	22.90
14-Mar-2018	11:00:00 PM	30.30	29.50	22.50
15-Mar-2018	12:00:00 AM	29.70	28.90	21.60
15-Mar-2018	1:00:00 AM	29.10	28.40	20.40
15-Mar-2018	2:00:00 AM	28.40	27.70	19.40
15-Mar-2018	3:00:00 AM	27.90	27.20	19.10
15-Mar-2018	4:00:00 AM	27.50	26.70	19.80
15-Mar-2018	5:00:00 AM	27.00	26.20	18.90
15-Mar-2018	6:00:00 AM	26.30	25.60	17.60
15-Mar-2018	7:00:00 AM	25.90	25.10	18.10
15-Mar-2018	8:00:00 AM	25.50	24.70	22.20
15-Mar-2018	9:00:00 AM	25.20	24.60	25.90
15-Mar-2018	10:00:00 AM	25.10	24.90	30.70
15-Mar-2018	11:00:00 AM	25.20	25.30	32.60
15-Mar-2018	12:00:00 PM	25.70	26.00	35.60
15-Mar-2018	1:00:00 PM	26.40	26.80	39.10
15-Mar-2018	2:00:00 PM	27.20	27.70	39.60
15-Mar-2018	3:00:00 PM	28.10	28.40	40.30
15-Mar-2018	4:00:00 PM	28.80	28.80	34.10
15-Mar-2018	5:00:00 PM	29.50	29.10	31.10
15-Mar-2018	6:00:00 PM	29.90	29.40	26.90
15-Mar-2018	7:00:00 PM	30.20	29.50	24.40
15-Mar-2018	8:00:00 PM	30.30	29.50	23.20
15-Mar-2018	9:00:00 PM	30.20	29.30	22.30
15-Mar-2018	10:00:00 PM	29.90	29.00	21.60
15-Mar-2018	11:00:00 PM	29.50	28.50	20.70
16-Mar-2018	12:00:00 AM	28.90	28.00	20.40
16-Mar-2018	1:00:00 AM	28.40	27.50	19.50
16-Mar-2018	2:00:00 AM	27.80	26.90	19.30
16-Mar-2018	3:00:00 AM	27.20	26.30	18.30
16-Mar-2018	4:00:00 AM	26.60	25.70	17.80
16-Mar-2018	5:00:00 AM	26.00	25.10	16.90
16-Mar-2018	6:00:00 AM	25.40	24.50	16.50
16-Mar-2018	7:00:00 AM	24.90	24.00	17.30
16-Mar-2018	8:00:00 AM	24.40	23.60	22.10
16-Mar-2018	9:00:00 AM	24.10	23.50	26.70
16-Mar-2018	10:00:00 AM	24.10	23.90	31.00
16-Mar-2018	11:00:00 AM	24.40	24.50	33.80
16-Mar-2018	12:00:00 PM	25.00	25.20	35.40
16-Mar-2018	1:00:00 PM	25.80	26.20	38.80
16-Mar-2018	2:00:00 PM	26.60	27.10	40.20
16-Mar-2018	3:00:00 PM	27.50	27.80	40.10
16-Mar-2018	4:00:00 PM	28.40	28.40	37.10
16-Mar-2018	5:00:00 PM	29.10	28.80	34.50
16-Mar-2018	6:00:00 PM	29.70	29.20	28.30
16-Mar-2018	7:00:00 PM	30.10	29.50	26.00
16-Mar-2018	8:00:00 PM	30.30	29.60	24.80
16-Mar-2018	9:00:00 PM	30.30	29.50	24.00
16-Mar-2018	10:00:00 PM	30.10	29.10	22.60

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
16-Mar-2018	11:00:00 PM	29.80	28.80	21.50
17-Mar-2018	12:00:00 AM	29.30	28.30	21.20
17-Mar-2018	1:00:00 AM	28.80	27.80	21.10
17-Mar-2018	2:00:00 AM	28.30	27.30	20.30
17-Mar-2018	3:00:00 AM	27.70	26.70	19.80
17-Mar-2018	4:00:00 AM	27.10	26.10	19.30
17-Mar-2018	5:00:00 AM	26.50	25.60	18.90
17-Mar-2018	6:00:00 AM	26.00	25.00	17.50
17-Mar-2018	7:00:00 AM	25.40	24.50	18.70
17-Mar-2018	8:00:00 AM	25.00	24.10	23.90
17-Mar-2018	9:00:00 AM	24.70	24.10	29.60
17-Mar-2018	10:00:00 AM	24.70	24.50	32.60
17-Mar-2018	11:00:00 AM	25.10	25.10	34.60
17-Mar-2018	12:00:00 PM	25.80	25.90	36.60
17-Mar-2018	1:00:00 PM	26.60	26.80	36.40
17-Mar-2018	2:00:00 PM	27.40	27.60	38.50
17-Mar-2018	3:00:00 PM	28.20	28.30	38.40
17-Mar-2018	4:00:00 PM	28.90	28.80	36.80
17-Mar-2018	5:00:00 PM	29.50	29.20	34.80
17-Mar-2018	6:00:00 PM	30.10	29.60	28.80
17-Mar-2018	7:00:00 PM	30.60	29.80	26.20
17-Mar-2018	8:00:00 PM	30.80	29.90	24.50
17-Mar-2018	9:00:00 PM	30.70	29.70	22.80
17-Mar-2018	10:00:00 PM	30.50	29.40	21.70
17-Mar-2018	11:00:00 PM	30.10	29.00	21.00
18-Mar-2018	12:00:00 AM	29.60	28.50	20.40
18-Mar-2018	1:00:00 AM	29.10	27.90	19.70
18-Mar-2018	2:00:00 AM	28.60	27.40	20.40
18-Mar-2018	3:00:00 AM	28.00	26.80	19.80
18-Mar-2018	4:00:00 AM	27.40	26.20	19.20
18-Mar-2018	5:00:00 AM	26.80	25.70	18.40
18-Mar-2018	6:00:00 AM	26.30	25.10	17.00
18-Mar-2018	7:00:00 AM	25.70	24.50	18.10
18-Mar-2018	8:00:00 AM	25.20	24.20	25.20
18-Mar-2018	9:00:00 AM	25.00	24.10	29.60
18-Mar-2018	10:00:00 AM	25.00	24.60	34.10
18-Mar-2018	11:00:00 AM	25.40	25.30	36.30
18-Mar-2018	12:00:00 PM	26.00	26.20	37.70
18-Mar-2018	1:00:00 PM	26.90	27.00	39.60
18-Mar-2018	2:00:00 PM	27.90	27.70	38.40
18-Mar-2018	3:00:00 PM	28.80	28.60	36.20
18-Mar-2018	4:00:00 PM	29.50	29.10	35.80
18-Mar-2018	5:00:00 PM	30.10	29.50	34.80
18-Mar-2018	6:00:00 PM	30.60	29.90	29.50
18-Mar-2018	7:00:00 PM	31.00	30.10	26.40
18-Mar-2018	8:00:00 PM	31.10	30.10	24.70
18-Mar-2018	9:00:00 PM	31.00	30.00	23.70
18-Mar-2018	10:00:00 PM	30.80	29.70	22.50
18-Mar-2018	11:00:00 PM	30.40	29.30	21.70
19-Mar-2018	12:00:00 AM	29.90	28.80	21.20
19-Mar-2018	1:00:00 AM	29.40	28.20	20.10
19-Mar-2018	2:00:00 AM	28.90	27.70	19.00

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
19-Mar-2018	3:00:00 AM	28.30	27.10	19.60
19-Mar-2018	4:00:00 AM	27.70	26.50	18.40
19-Mar-2018	5:00:00 AM	27.10	25.90	17.40
19-Mar-2018	6:00:00 AM	26.50	25.40	17.80
19-Mar-2018	7:00:00 AM	26.00	24.90	18.90
19-Mar-2018	8:00:00 AM	25.60	24.50	24.20
19-Mar-2018	9:00:00 AM	25.30	24.50	27.10
19-Mar-2018	10:00:00 AM	25.20	24.70	30.30
19-Mar-2018	11:00:00 AM	25.50	25.20	33.40
19-Mar-2018	12:00:00 PM	26.00	25.80	36.10
19-Mar-2018	1:00:00 PM	26.70	26.70	37.80
19-Mar-2018	2:00:00 PM	27.50	27.50	39.30
19-Mar-2018	3:00:00 PM	28.30	28.30	40.70
19-Mar-2018	4:00:00 PM	29.10	28.80	39.30
19-Mar-2018	5:00:00 PM	29.80	29.30	36.20
19-Mar-2018	6:00:00 PM	30.40	29.70	30.20
19-Mar-2018	7:00:00 PM	30.90	30.00	27.00
19-Mar-2018	8:00:00 PM	31.10	30.20	25.50
19-Mar-2018	9:00:00 PM	31.10	30.10	24.30
19-Mar-2018	10:00:00 PM	31.00	29.80	23.30
19-Mar-2018	11:00:00 PM	30.60	29.50	22.40
20-Mar-2018	12:00:00 AM	30.20	29.10	22.50
20-Mar-2018	1:00:00 AM	29.70	28.60	21.90
20-Mar-2018	2:00:00 AM	29.20	28.10	20.80
20-Mar-2018	3:00:00 AM	28.70	27.60	20.80
20-Mar-2018	4:00:00 AM	28.10	27.00	20.70
20-Mar-2018	5:00:00 AM	27.50	26.50	20.10
20-Mar-2018	6:00:00 AM	27.10	26.00	19.30
20-Mar-2018	7:00:00 AM	26.60	25.50	20.10
20-Mar-2018	8:00:00 AM	26.30	25.10	21.90
20-Mar-2018	9:00:00 AM	25.90	24.80	22.30
20-Mar-2018	10:00:00 AM	25.60	24.60	22.60
20-Mar-2018	11:00:00 AM	25.40	24.60	26.30
20-Mar-2018	12:00:00 PM	25.50	25.00	31.50
20-Mar-2018	1:00:00 PM	25.70	25.20	29.80
20-Mar-2018	2:00:00 PM	25.70	25.10	25.00
20-Mar-2018	3:00:00 PM	25.90	25.20	24.90
20-Mar-2018	4:00:00 PM	25.80	25.30	23.30
20-Mar-2018	5:00:00 PM	25.80	25.20	22.80
20-Mar-2018	6:00:00 PM	25.70	25.10	21.80
20-Mar-2018	7:00:00 PM	25.60	24.90	21.60
20-Mar-2018	8:00:00 PM	25.40	24.70	21.70
20-Mar-2018	9:00:00 PM	25.10	24.50	21.30
20-Mar-2018	10:00:00 PM	24.70	24.10	20.10
20-Mar-2018	11:00:00 PM	24.40	23.80	19.70
21-Mar-2018	12:00:00 AM	24.10	23.50	19.00
21-Mar-2018	1:00:00 AM	23.90	23.20	18.80
21-Mar-2018	2:00:00 AM	23.50	22.80	18.80
21-Mar-2018	3:00:00 AM	23.20	22.30	18.00
21-Mar-2018	4:00:00 AM	22.70	22.00	16.90
21-Mar-2018	5:00:00 AM	22.40	21.70	16.40
21-Mar-2018	6:00:00 AM	21.90	21.40	16.30

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
21-Mar-2018	7:00:00 AM	21.60	21.10	16.60
21-Mar-2018	8:00:00 AM	21.20	20.60	16.20
21-Mar-2018	9:00:00 AM	20.80	20.20	16.20
21-Mar-2018	10:00:00 AM	20.50	20.10	19.80
21-Mar-2018	11:00:00 AM	20.50	20.40	26.90
21-Mar-2018	12:00:00 PM	20.80	20.70	29.90
21-Mar-2018	1:00:00 PM	21.20	21.40	31.30
21-Mar-2018	2:00:00 PM	21.60	21.40	27.70
21-Mar-2018	3:00:00 PM	22.00	21.70	24.10
21-Mar-2018	4:00:00 PM	22.10	21.70	18.60
21-Mar-2018	5:00:00 PM	22.10	21.80	18.00
21-Mar-2018	6:00:00 PM	22.00	21.70	17.60
21-Mar-2018	7:00:00 PM	21.80	21.50	17.90
21-Mar-2018	8:00:00 PM	21.60	21.20	17.90
21-Mar-2018	9:00:00 PM	21.30	20.90	17.90
21-Mar-2018	10:00:00 PM	21.00	20.60	17.60
21-Mar-2018	11:00:00 PM	20.70	20.20	16.60
22-Mar-2018	12:00:00 AM	20.40	19.90	15.80
22-Mar-2018	1:00:00 AM	20.10	19.60	15.90
22-Mar-2018	2:00:00 AM	19.70	19.30	15.20
22-Mar-2018	3:00:00 AM	19.30	18.90	14.40
22-Mar-2018	4:00:00 AM	19.00	18.60	13.90
22-Mar-2018	5:00:00 AM	18.60	18.20	13.50
22-Mar-2018	6:00:00 AM	18.30	17.90	13.30
22-Mar-2018	7:00:00 AM	18.00	17.60	15.30
22-Mar-2018	8:00:00 AM	17.70	17.40	18.90
22-Mar-2018	9:00:00 AM	17.80	17.60	23.50
22-Mar-2018	10:00:00 AM	18.00	18.00	27.10
22-Mar-2018	11:00:00 AM	18.50	18.80	29.80
22-Mar-2018	12:00:00 PM	19.30	19.70	31.90
22-Mar-2018	1:00:00 PM	20.20	20.90	36.00
22-Mar-2018	2:00:00 PM	21.30	21.90	36.40
22-Mar-2018	3:00:00 PM	22.30	22.80	37.70
22-Mar-2018	4:00:00 PM	23.30	23.50	35.80
22-Mar-2018	5:00:00 PM	24.20	24.10	32.90
22-Mar-2018	6:00:00 PM	24.90	24.70	26.30
22-Mar-2018	7:00:00 PM	25.50	25.10	23.60
22-Mar-2018	8:00:00 PM	25.90	25.30	22.40
22-Mar-2018	9:00:00 PM	26.00	25.30	21.70
22-Mar-2018	10:00:00 PM	25.90	25.10	21.00
22-Mar-2018	11:00:00 PM	25.70	24.80	20.40
23-Mar-2018	12:00:00 AM	25.30	24.40	19.90
23-Mar-2018	1:00:00 AM	24.90	24.00	19.50
23-Mar-2018	2:00:00 AM	24.50	23.50	19.00
23-Mar-2018	3:00:00 AM	24.00	23.10	18.50
23-Mar-2018	4:00:00 AM	23.50	22.60	18.00
23-Mar-2018	5:00:00 AM	23.10	22.20	17.30
23-Mar-2018	6:00:00 AM	22.70	21.70	16.70
23-Mar-2018	7:00:00 AM	22.20	21.30	18.20
23-Mar-2018	8:00:00 AM	21.90	21.10	22.80
23-Mar-2018	9:00:00 AM	21.80	21.10	27.40
23-Mar-2018	10:00:00 AM	21.90	21.60	30.60

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
23-Mar-2018	11:00:00 AM	22.40	22.30	33.40
23-Mar-2018	12:00:00 PM	23.20	23.30	35.10
23-Mar-2018	1:00:00 PM	24.10	24.40	38.60
23-Mar-2018	2:00:00 PM	25.10	25.30	38.90
23-Mar-2018	3:00:00 PM	26.10	26.20	40.20
23-Mar-2018	4:00:00 PM	27.00	27.00	38.10
23-Mar-2018	5:00:00 PM	27.90	27.60	35.50
23-Mar-2018	6:00:00 PM	28.60	28.20	29.70
23-Mar-2018	7:00:00 PM	29.20	28.50	26.40
23-Mar-2018	8:00:00 PM	29.60	28.70	24.70
23-Mar-2018	9:00:00 PM	29.60	28.60	23.40
23-Mar-2018	10:00:00 PM	29.40	28.40	22.50
23-Mar-2018	11:00:00 PM	29.10	28.00	21.30
24-Mar-2018	12:00:00 AM	28.70	27.60	20.60
24-Mar-2018	1:00:00 AM	28.20	27.10	20.30
24-Mar-2018	2:00:00 AM	27.70	26.50	20.20
24-Mar-2018	3:00:00 AM	27.20	26.00	19.60
24-Mar-2018	4:00:00 AM	26.60	25.50	20.10
24-Mar-2018	5:00:00 AM	26.10	25.00	19.60
24-Mar-2018	6:00:00 AM	25.60	24.50	19.50
24-Mar-2018	7:00:00 AM	25.10	24.00	20.90
24-Mar-2018	8:00:00 AM	24.70	23.70	25.80
24-Mar-2018	9:00:00 AM	24.60	23.80	30.60
24-Mar-2018	10:00:00 AM	24.70	24.10	33.50
24-Mar-2018	11:00:00 AM	25.20	24.70	35.80
24-Mar-2018	12:00:00 PM	25.90	25.50	37.30
24-Mar-2018	1:00:00 PM	26.70	26.50	39.00
24-Mar-2018	2:00:00 PM	27.60	27.40	39.30
24-Mar-2018	3:00:00 PM	28.40	28.30	39.00
24-Mar-2018	4:00:00 PM	29.20	28.90	38.10
24-Mar-2018	5:00:00 PM	30.00	29.50	34.60
24-Mar-2018	6:00:00 PM	30.60	29.90	30.00
24-Mar-2018	7:00:00 PM	31.00	30.20	27.50
24-Mar-2018	8:00:00 PM	31.20	30.30	26.40
24-Mar-2018	9:00:00 PM	31.10	30.20	25.60
24-Mar-2018	10:00:00 PM	30.90	29.80	24.70
24-Mar-2018	11:00:00 PM	30.50	29.40	24.10
25-Mar-2018	12:00:00 AM	30.00	29.00	23.50
25-Mar-2018	1:00:00 AM	29.50	28.50	22.90
25-Mar-2018	2:00:00 AM	28.90	28.00	22.50
25-Mar-2018	3:00:00 AM	28.30	27.40	21.70
25-Mar-2018	4:00:00 AM	27.80	26.90	20.90
25-Mar-2018	5:00:00 AM	27.20	26.30	20.50
25-Mar-2018	6:00:00 AM	26.60	25.80	19.20
25-Mar-2018	7:00:00 AM	26.10	25.30	20.70
25-Mar-2018	8:00:00 AM	25.70	24.90	25.90
25-Mar-2018	9:00:00 AM	25.50	25.00	31.20
25-Mar-2018	10:00:00 AM	25.60	25.30	34.70
25-Mar-2018	11:00:00 AM	26.10	26.00	37.30
25-Mar-2018	12:00:00 PM	26.80	26.90	38.80
25-Mar-2018	1:00:00 PM	27.70	27.90	39.60
25-Mar-2018	2:00:00 PM	28.70	28.90	41.30

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
25-Mar-2018	3:00:00 PM	29.60	29.60	41.10
25-Mar-2018	4:00:00 PM	30.40	30.30	39.40
25-Mar-2018	5:00:00 PM	31.10	30.80	36.80
25-Mar-2018	6:00:00 PM	31.70	31.30	31.80
25-Mar-2018	7:00:00 PM	32.20	31.50	28.70
25-Mar-2018	8:00:00 PM	32.40	31.60	27.40
25-Mar-2018	9:00:00 PM	32.40	31.50	26.50
25-Mar-2018	10:00:00 PM	32.20	31.20	25.80
25-Mar-2018	11:00:00 PM	31.80	30.70	25.20
26-Mar-2018	12:00:00 AM	31.40	30.20	24.70
26-Mar-2018	1:00:00 AM	30.90	29.70	23.90
26-Mar-2018	2:00:00 AM	30.30	29.20	23.00
26-Mar-2018	3:00:00 AM	29.70	28.60	22.20
26-Mar-2018	4:00:00 AM	29.20	28.10	21.50
26-Mar-2018	5:00:00 AM	28.60	27.50	21.70
26-Mar-2018	6:00:00 AM	28.00	27.00	20.60
26-Mar-2018	7:00:00 AM	27.50	26.50	22.30
26-Mar-2018	8:00:00 AM	27.10	26.20	26.80
26-Mar-2018	9:00:00 AM	26.80	26.10	31.40
26-Mar-2018	9:21:00 AM	31.80	31.70	41.50
26-Mar-2018	10:21:00 AM	32.50	32.20	38.20
26-Mar-2018	11:21:00 AM	33.20	32.60	31.80
26-Mar-2018	12:21:00 PM	33.60	32.80	29.40
26-Mar-2018	1:21:00 PM	33.70	32.90	27.80
26-Mar-2018	2:21:00 PM	33.60	32.80	26.10
26-Mar-2018	3:21:00 PM	33.30	32.40	24.90
26-Mar-2018	4:21:00 PM	32.90	32.00	23.70
26-Mar-2018	5:21:00 PM	32.40	31.40	22.70
26-Mar-2018	6:21:00 PM	31.80	30.90	22.20
26-Mar-2018	7:21:00 PM	31.20	30.30	21.50
26-Mar-2018	8:21:00 PM	30.60	29.60	20.90
26-Mar-2018	9:21:00 PM	30.00	29.00	20.20
26-Mar-2018	10:21:00 PM	29.40	28.40	19.50
26-Mar-2018	11:21:00 PM	28.70	27.70	19.50
27-Mar-2018	12:21:00 AM	28.20	27.20	22.40
27-Mar-2018	1:21:00 AM	27.70	26.80	27.20
27-Mar-2018	2:21:00 AM	27.50	26.80	31.40
27-Mar-2018	3:21:00 AM	27.60	27.40	35.30
27-Mar-2018	4:21:00 AM	28.10	28.20	37.80
27-Mar-2018	5:21:00 AM	28.80	29.10	40.30
27-Mar-2018	6:21:00 AM	29.70	30.10	42.10
27-Mar-2018	7:21:00 AM	30.70	31.00	43.10
27-Mar-2018	8:21:00 AM	31.70	31.70	44.80
27-Mar-2018	9:21:00 AM	32.50	32.20	37.10
27-Mar-2018	10:21:00 AM	33.20	32.70	37.60
27-Mar-2018	11:21:00 AM	33.70	33.00	32.30
27-Mar-2018	12:21:00 PM	34.00	33.20	29.60
27-Mar-2018	1:21:00 PM	34.10	33.30	28.10
27-Mar-2018	2:21:00 PM	34.00	33.10	26.70
27-Mar-2018	3:21:00 PM	33.70	32.80	25.90
27-Mar-2018	4:21:00 PM	33.20	32.40	24.80
27-Mar-2018	5:21:00 PM	32.60	31.90	23.50

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
27-Mar-2018	6:21:00 PM	32.10	31.30	22.80
27-Mar-2018	7:21:00 PM	31.50	30.70	22.70
27-Mar-2018	8:21:00 PM	31.00	30.10	22.10
27-Mar-2018	9:21:00 PM	30.40	29.60	21.60
27-Mar-2018	10:21:00 PM	29.90	29.00	21.00
27-Mar-2018	11:21:00 PM	29.30	28.50	21.20
28-Mar-2018	10:00:00 AM	28.30	28.30	36.40
28-Mar-2018	11:00:00 AM	28.60	28.70	40.50
28-Mar-2018	12:00:00 PM	29.20	29.50	42.20
28-Mar-2018	1:00:00 PM	30.00	30.40	42.80
28-Mar-2018	2:00:00 PM	30.90	31.30	42.90
28-Mar-2018	3:00:00 PM	31.80	32.00	43.20
28-Mar-2018	4:00:00 PM	32.60	32.60	42.30
28-Mar-2018	5:00:00 PM	33.30	33.10	39.80
28-Mar-2018	6:00:00 PM	33.80	33.50	34.00
28-Mar-2018	7:00:00 PM	34.40	33.80	30.20
28-Mar-2018	8:00:00 PM	34.60	33.90	28.40
28-Mar-2018	9:00:00 PM	34.60	33.80	27.50
28-Mar-2018	10:00:00 PM	34.30	33.40	26.70
28-Mar-2018	11:00:00 PM	33.90	32.90	26.00
29-Mar-2018	12:00:00 AM	33.30	32.40	24.90
29-Mar-2018	1:00:00 AM	32.70	31.80	24.70
29-Mar-2018	2:00:00 AM	32.10	31.20	24.40
29-Mar-2018	3:00:00 AM	31.40	30.60	24.10
29-Mar-2018	4:00:00 AM	30.80	30.00	24.30
29-Mar-2018	5:00:00 AM	30.20	29.40	23.50
29-Mar-2018	6:00:00 AM	29.70	28.80	23.40
29-Mar-2018	7:00:00 AM	29.20	28.30	24.30
29-Mar-2018	8:00:00 AM	28.80	28.00	28.70
29-Mar-2018	9:00:00 AM	28.70	28.10	32.20
29-Mar-2018	10:00:00 AM	28.70	28.50	36.60
29-Mar-2018	11:00:00 AM	29.20	29.10	39.20
29-Mar-2018	12:00:00 PM	29.90	29.80	39.60
29-Mar-2018	1:00:00 PM	30.70	30.80	42.30
29-Mar-2018	2:00:00 PM	31.50	31.60	42.10
29-Mar-2018	3:00:00 PM	32.40	32.40	42.30
29-Mar-2018	4:00:00 PM	33.00	32.90	39.40
29-Mar-2018	5:00:00 PM	33.60	33.30	35.50
29-Mar-2018	6:00:00 PM	34.10	33.60	32.80
29-Mar-2018	7:00:00 PM	34.40	33.70	30.10
29-Mar-2018	8:00:00 PM	34.40	33.60	29.10
29-Mar-2018	9:00:00 PM	34.20	33.40	27.70
29-Mar-2018	10:00:00 PM	33.90	33.00	26.90
29-Mar-2018	11:00:00 PM	33.40	32.40	26.10
30-Mar-2018	12:00:00 AM	32.90	31.90	25.30
30-Mar-2018	1:00:00 AM	32.20	31.30	24.70
30-Mar-2018	2:00:00 AM	31.50	30.70	23.80
30-Mar-2018	3:00:00 AM	30.80	30.00	22.70
30-Mar-2018	4:00:00 AM	30.00	29.30	23.60
30-Mar-2018	5:00:00 AM	29.40	28.70	22.30
30-Mar-2018	6:00:00 AM	28.80	28.10	22.00
30-Mar-2018	7:00:00 AM	28.30	27.50	23.40

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
30-Mar-2018	8:00:00 AM	28.20	27.50	28.90
30-Mar-2018	9:00:00 AM	27.60	27.20	33.00
30-Mar-2018	10:00:00 AM	27.80	27.70	37.60
30-Mar-2018	11:00:00 AM	28.40	28.40	40.90
30-Mar-2018	12:00:00 PM	29.20	29.50	43.10
30-Mar-2018	1:00:00 PM	30.20	30.60	44.80
30-Mar-2018	2:00:00 PM	31.30	31.70	46.30
30-Mar-2018	3:00:00 PM	32.30	32.60	46.20
30-Mar-2018	4:00:00 PM	33.30	33.30	46.50
30-Mar-2018	5:00:00 PM	34.20	33.90	41.30
30-Mar-2018	6:00:00 PM	34.90	34.30	35.80
30-Mar-2018	7:00:00 PM	35.50	34.70	31.20
30-Mar-2018	8:00:00 PM	35.70	34.90	28.80
30-Mar-2018	9:00:00 PM	35.70	34.80	27.40
30-Mar-2018	10:00:00 PM	35.50	34.50	27.20
30-Mar-2018	11:00:00 PM	35.00	34.00	25.50
31-Mar-2018	12:00:00 AM	34.50	33.40	24.20
31-Mar-2018	1:00:00 AM	33.80	32.80	23.20
31-Mar-2018	2:00:00 AM	33.20	32.10	21.90
31-Mar-2018	3:00:00 AM	32.50	31.40	21.00
31-Mar-2018	4:00:00 AM	31.70	30.60	19.90
31-Mar-2018	5:00:00 AM	31.00	29.90	19.20
31-Mar-2018	6:00:00 AM	30.20	29.20	19.10
31-Mar-2018	7:00:00 AM	29.60	28.40	21.30
31-Mar-2018	8:00:00 AM	29.00	27.90	26.80
31-Mar-2018	9:00:00 AM	28.70	27.80	30.90
31-Mar-2018	10:00:00 AM	28.60	28.10	32.70
31-Mar-2018	11:00:00 AM	29.00	28.80	35.00
31-Mar-2018	12:00:00 PM	29.60	29.70	37.90
31-Mar-2018	1:00:00 PM	30.40	30.60	39.70
31-Mar-2018	2:00:00 PM	31.20	31.30	39.40
31-Mar-2018	3:00:00 PM	31.90	31.80	39.20
31-Mar-2018	4:00:00 PM	32.60	32.30	38.10
31-Mar-2018	5:00:00 PM	33.20	32.60	36.10
31-Mar-2018	6:00:00 PM	33.60	32.90	32.20
31-Mar-2018	7:00:00 PM	33.80	33.00	29.40
31-Mar-2018	8:00:00 PM	33.90	33.00	28.00
31-Mar-2018	9:00:00 PM	33.80	32.80	27.30
31-Mar-2018	10:00:00 PM	33.50	32.50	26.50
31-Mar-2018	11:00:00 PM	33.10	32.00	25.70
1-Apr-2018	12:00:00 AM	32.60	31.50	24.60
1-Apr-2018	1:00:00 AM	32.10	31.00	23.60
1-Apr-2018	2:00:00 AM	31.60	30.50	23.00
1-Apr-2018	3:00:00 AM	31.00	29.90	22.30
1-Apr-2018	4:00:00 AM	30.40	29.40	21.70
1-Apr-2018	5:00:00 AM	29.80	28.90	21.00
1-Apr-2018	6:00:00 AM	29.30	28.30	20.80
1-Apr-2018	7:00:00 AM	28.80	27.80	22.40
1-Apr-2018	8:00:00 AM	28.30	27.40	25.90
1-Apr-2018	9:00:00 AM	28.10	27.30	29.80
1-Apr-2018	10:00:00 AM	28.10	27.70	32.90
1-Apr-2018	11:00:00 AM	28.40	28.40	36.20

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
1-Apr-2018	12:00:00 PM	29.00	29.20	38.90
1-Apr-2018	1:00:00 PM	29.80	30.00	41.00
1-Apr-2018	2:00:00 PM	30.60	30.80	41.20
1-Apr-2018	3:00:00 PM	31.40	31.50	41.30
1-Apr-2018	4:00:00 PM	32.20	32.00	40.80
1-Apr-2018	5:00:00 PM	32.80	32.50	36.70
1-Apr-2018	6:00:00 PM	33.30	32.80	32.00
1-Apr-2018	7:00:00 PM	33.70	33.00	29.50
1-Apr-2018	8:00:00 PM	33.80	33.10	28.30
1-Apr-2018	9:00:00 PM	33.80	33.00	27.40
1-Apr-2018	10:00:00 PM	33.60	32.80	26.60
1-Apr-2018	11:00:00 PM	33.20	32.40	26.00
2-Apr-2018	12:00:00 AM	32.80	32.00	25.30
2-Apr-2018	1:00:00 AM	32.30	31.50	24.60
2-Apr-2018	2:00:00 AM	31.90	31.00	24.40
2-Apr-2018	3:00:00 AM	31.40	30.50	23.70
2-Apr-2018	4:00:00 AM	30.90	30.00	23.40
2-Apr-2018	5:00:00 AM	30.40	29.50	22.80
2-Apr-2018	6:00:00 AM	29.90	29.00	21.80
2-Apr-2018	7:00:00 AM	29.40	28.60	23.40
2-Apr-2018	8:00:00 AM	29.00	28.20	27.40
2-Apr-2018	9:00:00 AM	28.90	28.20	31.10
2-Apr-2018	10:00:00 AM	28.90	28.60	34.80
2-Apr-2018	11:00:00 AM	29.30	29.30	36.90
2-Apr-2018	12:00:00 PM	29.90	30.00	39.00
2-Apr-2018	1:00:00 PM	30.60	30.80	40.20
2-Apr-2018	2:00:00 PM	31.30	31.40	40.80
2-Apr-2018	3:00:00 PM	32.00	32.00	38.90
2-Apr-2018	4:00:00 PM	32.70	32.50	37.40
2-Apr-2018	5:00:00 PM	33.20	32.90	34.90
2-Apr-2018	6:00:00 PM	33.60	33.20	31.90
2-Apr-2018	7:00:00 PM	33.90	33.40	30.30
2-Apr-2018	8:00:00 PM	33.90	33.40	29.10
2-Apr-2018	9:00:00 PM	33.80	33.30	28.30
2-Apr-2018	10:00:00 PM	33.60	33.00	27.70
2-Apr-2018	11:00:00 PM	33.20	32.70	27.10
3-Apr-2018	12:00:00 AM	32.80	32.30	26.60
3-Apr-2018	1:00:00 AM	32.40	31.90	26.10
3-Apr-2018	2:00:00 AM	32.00	31.40	25.40
3-Apr-2018	3:00:00 AM	31.50	31.00	24.80
3-Apr-2018	4:00:00 AM	31.10	30.60	24.90
3-Apr-2018	5:00:00 AM	30.70	30.10	24.40
3-Apr-2018	6:00:00 AM	30.30	29.70	24.40
3-Apr-2018	7:00:00 AM	30.00	29.30	25.30
3-Apr-2018	8:00:00 AM	29.70	29.10	28.30
3-Apr-2018	9:00:00 AM	29.60	29.00	31.80
3-Apr-2018	10:00:00 AM	29.50	29.00	30.40
3-Apr-2018	11:00:00 AM	29.40	29.00	30.60
3-Apr-2018	12:00:00 PM	29.70	29.20	33.90
3-Apr-2018	1:00:00 PM	29.90	29.80	37.10
3-Apr-2018	2:00:00 PM	30.30	30.30	38.90
3-Apr-2018	3:00:00 PM	30.80	30.80	39.90

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
3-Apr-2018	4:00:00 PM	31.30	31.20	39.70
3-Apr-2018	5:00:00 PM	31.80	31.60	36.60
3-Apr-2018	6:00:00 PM	32.20	32.00	32.80
3-Apr-2018	7:00:00 PM	32.60	32.30	30.20
3-Apr-2018	8:00:00 PM	32.70	32.40	28.90
3-Apr-2018	9:00:00 PM	32.70	32.40	27.80
3-Apr-2018	10:00:00 PM	32.60	32.20	27.00
3-Apr-2018	11:00:00 PM	32.30	31.90	26.40
4-Apr-2018	12:00:00 AM	31.90	31.50	25.90
4-Apr-2018	1:00:00 AM	31.50	31.10	25.30
4-Apr-2018	2:00:00 AM	31.00	30.60	24.50
4-Apr-2018	3:00:00 AM	30.60	30.10	23.70
4-Apr-2018	4:00:00 AM	30.10	29.60	22.90
4-Apr-2018	5:00:00 AM	29.60	29.20	22.60
4-Apr-2018	6:00:00 AM	29.10	28.70	22.00
4-Apr-2018	7:00:00 AM	28.70	28.20	23.60
4-Apr-2018	8:00:00 AM	28.50	28.00	29.20
4-Apr-2018	9:00:00 AM	28.30	28.00	33.90
4-Apr-2018	10:00:00 AM	28.50	28.30	37.60
4-Apr-2018	11:00:00 AM	28.90	29.00	41.10
4-Apr-2018	12:00:00 PM	29.60	29.80	43.00
4-Apr-2018	1:00:00 PM	30.40	30.80	44.90
4-Apr-2018	2:00:00 PM	31.40	31.70	45.40
4-Apr-2018	3:00:00 PM	32.40	32.50	44.30
4-Apr-2018	4:00:00 PM	33.20	33.20	41.90
4-Apr-2018	5:00:00 PM	33.90	33.80	38.80
4-Apr-2018	6:00:00 PM	34.50	34.30	34.70
4-Apr-2018	7:00:00 PM	34.90	34.60	31.90
4-Apr-2018	8:00:00 PM	35.20	34.70	30.90
4-Apr-2018	9:00:00 PM	35.20	34.60	29.90
4-Apr-2018	10:00:00 PM	35.10	34.40	29.20
4-Apr-2018	11:00:00 PM	34.60	34.00	27.20
5-Apr-2018	12:00:00 AM	34.10	33.50	26.10
5-Apr-2018	1:00:00 AM	33.50	33.00	25.50
5-Apr-2018	2:00:00 AM	33.00	32.50	24.60
5-Apr-2018	3:00:00 AM	32.50	31.90	23.90
5-Apr-2018	4:00:00 AM	32.00	31.40	23.60
5-Apr-2018	5:00:00 AM	31.50	30.90	24.20
5-Apr-2018	6:00:00 AM	30.90	30.40	23.40
5-Apr-2018	7:00:00 AM	30.40	29.80	23.60
5-Apr-2018	8:00:00 AM	30.00	29.50	28.10
5-Apr-2018	9:00:00 AM	29.90	29.40	33.80
5-Apr-2018	11:00:00 AM	30.30	30.30	36.90
5-Apr-2018	12:00:00 PM	30.60	30.90	40.60
5-Apr-2018	1:00:00 PM	31.20	31.50	41.60
5-Apr-2018	2:00:00 PM	32.00	32.20	39.40
5-Apr-2018	3:00:00 PM	32.80	32.80	40.60
5-Apr-2018	4:00:00 PM	33.40	33.20	39.60
5-Apr-2018	5:00:00 PM	34.00	33.70	38.60
5-Apr-2018	6:00:00 PM	34.40	34.00	34.30
5-Apr-2018	7:00:00 PM	34.60	34.30	30.50
5-Apr-2018	8:00:00 PM	34.60	34.40	29.00

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
5-Apr-2018	9:00:00 PM	34.60	34.30	28.30
5-Apr-2018	10:00:00 PM	34.40	34.00	27.60
5-Apr-2018	11:00:00 PM	34.10	33.60	26.80
6-Apr-2018	12:00:00 AM	33.70	33.20	26.10
6-Apr-2018	1:00:00 AM	33.30	32.80	25.70
6-Apr-2018	2:00:00 AM	32.80	32.30	25.00
6-Apr-2018	3:00:00 AM	32.40	31.80	24.30
6-Apr-2018	4:00:00 AM	31.90	31.30	23.80
6-Apr-2018	5:00:00 AM	31.40	30.80	23.80
6-Apr-2018	6:00:00 AM	30.80	30.30	23.00
6-Apr-2018	7:00:00 AM	30.40	29.80	25.00
6-Apr-2018	8:00:00 AM	30.00	29.50	29.10
6-Apr-2018	9:00:00 AM	29.80	29.40	33.60
6-Apr-2018	10:00:00 AM	30.00	29.90	38.90
6-Apr-2018	11:00:00 AM	30.40	30.50	41.60
6-Apr-2018	12:00:00 PM	31.00	31.40	43.50
6-Apr-2018	1:00:00 PM	31.90	32.30	43.20
6-Apr-2018	2:00:00 PM	32.70	32.70	37.40
6-Apr-2018	3:00:00 PM	33.50	33.40	41.30
6-Apr-2018	4:00:00 PM	34.20	34.00	42.10
6-Apr-2018	5:00:00 PM	34.60	34.40	37.80
6-Apr-2018	6:00:00 PM	35.00	34.70	34.10
6-Apr-2018	7:00:00 PM	35.20	34.90	31.50
6-Apr-2018	8:00:00 PM	35.10	34.90	28.90
6-Apr-2018	9:00:00 PM	34.80	34.60	27.00
6-Apr-2018	10:00:00 PM	34.40	34.20	26.40
6-Apr-2018	11:00:00 PM	34.10	33.60	26.10
7-Apr-2018	12:00:00 AM	33.70	33.10	25.00
7-Apr-2018	1:00:00 AM	33.20	32.60	24.70
7-Apr-2018	2:00:00 AM	32.70	32.00	24.00
7-Apr-2018	3:00:00 AM	32.10	31.40	23.20
7-Apr-2018	4:00:00 AM	31.60	30.90	22.90
7-Apr-2018	5:00:00 AM	31.00	30.30	22.30
7-Apr-2018	6:00:00 AM	30.40	29.80	21.70
7-Apr-2018	7:00:00 AM	29.90	29.20	24.10
7-Apr-2018	8:00:00 AM	29.50	28.90	28.30
7-Apr-2018	9:00:00 AM	29.30	28.90	32.80
7-Apr-2018	10:00:00 AM	29.40	29.30	37.00
7-Apr-2018	11:00:00 AM	29.80	30.00	41.30
7-Apr-2018	12:00:00 PM	30.50	30.90	43.10
7-Apr-2018	1:00:00 PM	31.40	31.80	45.50
7-Apr-2018	2:00:00 PM	32.40	32.70	44.70
7-Apr-2018	3:00:00 PM	33.30	33.60	45.50
7-Apr-2018	4:00:00 PM	34.10	34.20	43.80
7-Apr-2018	5:00:00 PM	34.80	34.70	40.50
7-Apr-2018	6:00:00 PM	35.40	35.20	35.60
7-Apr-2018	7:00:00 PM	35.90	35.50	32.20
7-Apr-2018	8:00:00 PM	36.10	35.60	30.60
7-Apr-2018	9:00:00 PM	36.10	35.50	29.60
7-Apr-2018	10:00:00 PM	35.90	35.20	28.70
7-Apr-2018	11:00:00 PM	35.50	34.90	27.70
8-Apr-2018	12:00:00 AM	35.10	34.40	27.10

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
8-Apr-2018	1:00:00 AM	34.60	33.80	25.60
8-Apr-2018	2:00:00 AM	34.00	33.10	24.70
8-Apr-2018	3:00:00 AM	33.50	32.60	24.50
8-Apr-2018	4:00:00 AM	32.90	31.90	23.60
8-Apr-2018	5:00:00 AM	32.30	31.20	23.10
8-Apr-2018	6:00:00 AM	31.60	30.50	22.50
8-Apr-2018	7:00:00 AM	31.00	30.00	23.80
8-Apr-2018	8:00:00 AM	30.60	29.60	27.30
8-Apr-2018	9:00:00 AM	30.40	29.50	31.10
8-Apr-2018	10:00:00 AM	30.40	29.90	35.10
8-Apr-2018	11:00:00 AM	30.60	30.50	38.70
8-Apr-2018	12:00:00 PM	31.20	31.20	41.50
8-Apr-2018	1:00:00 PM	31.90	32.10	42.40
8-Apr-2018	2:00:00 PM	32.70	32.80	42.40
8-Apr-2018	3:00:00 PM	33.50	33.40	41.60
8-Apr-2018	4:00:00 PM	34.20	34.00	40.30
8-Apr-2018	5:00:00 PM	34.60	34.50	36.60
8-Apr-2018	6:00:00 PM	34.90	34.80	32.80
8-Apr-2018	7:00:00 PM	35.00	35.00	30.70
8-Apr-2018	8:00:00 PM	35.00	34.90	29.60
8-Apr-2018	9:00:00 PM	34.90	34.70	29.00
8-Apr-2018	10:00:00 PM	34.70	34.40	28.90
8-Apr-2018	11:00:00 PM	34.20	33.90	26.90
9-Apr-2018	12:00:00 AM	32.70	32.90	22.00
9-Apr-2018	1:00:00 AM	31.80	32.10	21.70
9-Apr-2018	2:00:00 AM	31.20	31.40	21.20
9-Apr-2018	3:00:00 AM	30.50	30.60	20.70
9-Apr-2018	4:00:00 AM	30.00	30.00	20.70
9-Apr-2018	5:00:00 AM	29.50	29.30	20.60
9-Apr-2018	6:00:00 AM	29.10	28.50	20.50
9-Apr-2018	7:00:00 AM	28.60	28.00	21.80
9-Apr-2018	8:00:00 AM	28.20	27.60	25.30
9-Apr-2018	10:00:00 AM	28.80	28.70	33.80
9-Apr-2018	11:00:00 AM	28.50	28.50	36.70
9-Apr-2018	12:00:00 PM	28.80	29.10	38.00
9-Apr-2018	1:00:00 PM	29.40	29.90	40.60
9-Apr-2018	2:00:00 PM	30.20	30.60	42.70
9-Apr-2018	3:00:00 PM	31.10	31.30	41.90
9-Apr-2018	4:00:00 PM	31.80	31.90	40.60
9-Apr-2018	5:00:00 PM	32.50	32.50	36.10
9-Apr-2018	6:00:00 PM	33.00	32.90	32.10
9-Apr-2018	7:00:00 PM	33.30	33.20	29.60
9-Apr-2018	8:00:00 PM	33.40	33.30	28.20
9-Apr-2018	9:00:00 PM	33.40	33.30	27.70
9-Apr-2018	10:00:00 PM	33.30	33.00	27.30
9-Apr-2018	11:00:00 PM	33.10	32.70	27.00
10-Apr-2018	12:00:00 AM	32.80	32.40	27.00
10-Apr-2018	1:00:00 AM	32.50	32.00	26.70
10-Apr-2018	2:00:00 AM	32.10	31.60	26.30
10-Apr-2018	3:00:00 AM	31.70	31.20	25.90
10-Apr-2018	4:00:00 AM	31.30	30.80	25.70
10-Apr-2018	5:00:00 AM	31.00	30.40	25.30

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
10-Apr-2018	6:00:00 AM	30.60	30.10	24.90
10-Apr-2018	7:00:00 AM	30.30	29.80	26.20
10-Apr-2018	8:00:00 AM	30.10	29.50	28.00
10-Apr-2018	9:00:00 AM	30.00	29.50	31.60
10-Apr-2018	10:00:00 AM	30.10	29.70	36.30
10-Apr-2018	11:00:00 AM	30.30	30.00	34.40
10-Apr-2018	12:00:00 PM	30.50	30.30	34.10
10-Apr-2018	1:00:00 PM	30.90	30.90	37.10
10-Apr-2018	2:00:00 PM	31.40	31.50	39.60
10-Apr-2018	3:00:00 PM	31.90	32.00	38.60
10-Apr-2018	4:00:00 PM	32.40	32.30	35.80
10-Apr-2018	5:00:00 PM	32.80	32.60	35.20
10-Apr-2018	6:00:00 PM	33.10	32.90	31.60
10-Apr-2018	7:00:00 PM	33.30	33.00	29.20
10-Apr-2018	8:00:00 PM	33.30	32.90	28.30
10-Apr-2018	9:00:00 PM	33.20	32.70	27.50
10-Apr-2018	10:00:00 PM	33.00	32.50	26.90
10-Apr-2018	11:00:00 PM	32.70	32.20	26.40
11-Apr-2018	12:00:00 AM	32.30	31.80	26.20
11-Apr-2018	1:00:00 AM	30.90	31.00	20.40
11-Apr-2018	2:00:00 AM	29.90	30.30	19.10
11-Apr-2018	3:00:00 AM	29.80	29.60	19.50
11-Apr-2018	4:00:00 AM	29.10	28.90	20.10
11-Apr-2018	5:00:00 AM	28.40	28.30	19.90
11-Apr-2018	6:00:00 AM	27.70	27.50	19.20
11-Apr-2018	7:00:00 AM	27.20	27.00	20.10
11-Apr-2018	8:00:00 AM	26.70	26.40	22.20
11-Apr-2018	9:00:00 AM	26.40	26.20	25.50
11-Apr-2018	10:00:00 AM	26.40	26.40	29.90
11-Apr-2018	11:00:00 AM	26.60	26.80	32.60
11-Apr-2018	12:00:00 PM	27.10	27.40	35.00
11-Apr-2018	1:00:00 PM	27.60	28.30	37.40
11-Apr-2018	2:00:00 PM	28.40	29.00	38.30
11-Apr-2018	3:00:00 PM	29.20	29.60	39.30
11-Apr-2018	4:00:00 PM	29.90	30.00	40.80
11-Apr-2018	5:00:00 PM	30.50	30.50	33.20
11-Apr-2018	6:00:00 PM	31.00	30.90	29.60
11-Apr-2018	7:00:00 PM	31.40	31.10	27.70
11-Apr-2018	8:00:00 PM	31.60	31.20	26.50
11-Apr-2018	9:00:00 PM	31.50	31.10	25.70
11-Apr-2018	10:00:00 PM	31.30	30.90	25.00
11-Apr-2018	11:00:00 PM	31.00	30.50	24.00
12-Apr-2018	12:00:00 AM	30.60	30.20	23.60
12-Apr-2018	1:00:00 AM	30.20	29.80	23.80
12-Apr-2018	2:00:00 AM	29.70	29.30	23.10
12-Apr-2018	3:00:00 AM	29.30	28.80	22.00
12-Apr-2018	4:00:00 AM	28.80	28.30	21.40
12-Apr-2018	5:00:00 AM	28.30	27.90	21.20
12-Apr-2018	6:00:00 AM	27.90	27.30	21.10
12-Apr-2018	7:00:00 AM	27.50	26.90	24.50
12-Apr-2018	8:00:00 AM	27.20	26.70	29.30
12-Apr-2018	9:00:00 AM	27.10	26.80	33.90

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
12-Apr-2018	10:00:00 AM	27.40	27.30	37.00
12-Apr-2018	11:00:00 AM	27.90	28.10	38.60
12-Apr-2018	12:00:00 PM	28.60	29.00	40.50
12-Apr-2018	1:00:00 PM	29.50	30.00	42.70
12-Apr-2018	2:00:00 PM	30.40	30.80	42.90
12-Apr-2018	3:00:00 PM	31.20	31.50	43.20
12-Apr-2018	4:00:00 PM	32.00	32.10	44.00
12-Apr-2018	5:00:00 PM	32.70	32.70	39.00
12-Apr-2018	6:00:00 PM	33.20	33.10	33.40
12-Apr-2018	7:00:00 PM	33.60	33.50	29.10
12-Apr-2018	8:00:00 PM	33.80	33.50	27.10
12-Apr-2018	9:00:00 PM	33.60	33.40	25.40
12-Apr-2018	10:00:00 PM	33.30	33.00	23.80
12-Apr-2018	11:00:00 PM	32.90	32.40	22.90
13-Apr-2018	12:00:00 AM	32.30	31.80	21.80
13-Apr-2018	1:00:00 AM	31.70	31.10	21.10
13-Apr-2018	2:00:00 AM	31.00	30.40	20.20
13-Apr-2018	3:00:00 AM	30.30	29.70	20.50
13-Apr-2018	4:00:00 AM	29.60	29.00	19.60
13-Apr-2018	5:00:00 AM	28.90	28.30	19.70
13-Apr-2018	6:00:00 AM	28.20	27.60	19.90
13-Apr-2018	7:00:00 AM	27.70	27.00	24.30
13-Apr-2018	8:00:00 AM	27.30	26.60	29.50
13-Apr-2018	9:00:00 AM	27.10	26.70	34.70
13-Apr-2018	10:00:00 AM	27.30	27.10	37.50
13-Apr-2018	11:00:00 AM	27.90	27.80	39.70
13-Apr-2018	12:00:00 PM	28.80	28.70	41.50
13-Apr-2018	1:00:00 PM	29.70	29.40	39.00
13-Apr-2018	2:00:00 PM	30.60	30.20	38.30
13-Apr-2018	3:00:00 PM	31.40	31.10	43.50
13-Apr-2018	4:00:00 PM	32.10	31.70	43.10
13-Apr-2018	5:00:00 PM	32.80	32.20	39.80
13-Apr-2018	6:00:00 PM	33.20	32.70	32.90
13-Apr-2018	7:00:00 PM	33.50	33.00	30.50
13-Apr-2018	8:00:00 PM	33.70	33.20	29.00
13-Apr-2018	9:00:00 PM	33.70	33.10	27.60
13-Apr-2018	10:00:00 PM	33.50	32.80	26.10
13-Apr-2018	11:00:00 PM	33.10	32.50	25.00
14-Apr-2018	12:00:00 AM	32.70	32.00	24.10
14-Apr-2018	1:00:00 AM	32.20	31.50	23.50
14-Apr-2018	2:00:00 AM	31.60	31.00	23.70
14-Apr-2018	3:00:00 AM	31.00	30.40	23.40
14-Apr-2018	4:00:00 AM	30.50	29.90	23.50
14-Apr-2018	5:00:00 AM	30.10	29.40	23.20
14-Apr-2018	6:00:00 AM	29.70	29.00	22.90
14-Apr-2018	7:00:00 AM	29.30	28.60	25.80
14-Apr-2018	8:00:00 AM	29.00	28.30	29.60
14-Apr-2018	9:00:00 AM	28.90	28.40	35.80
14-Apr-2018	10:00:00 AM	29.00	28.70	37.60
14-Apr-2018	11:00:00 AM	29.50	29.50	41.20
14-Apr-2018	12:00:00 PM	30.20	30.40	42.40
14-Apr-2018	1:00:00 PM	31.10	31.30	43.80

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
14-Apr-2018	2:00:00 PM	32.10	32.20	45.10
14-Apr-2018	3:00:00 PM	33.10	33.10	44.00
14-Apr-2018	4:00:00 PM	33.80	33.70	44.10
14-Apr-2018	5:00:00 PM	34.50	34.30	39.20
14-Apr-2018	6:00:00 PM	35.10	34.80	35.10
14-Apr-2018	7:00:00 PM	35.40	35.10	32.00
14-Apr-2018	8:00:00 PM	35.60	35.20	30.50
14-Apr-2018	9:00:00 PM	35.60	35.10	29.00
14-Apr-2018	10:00:00 PM	35.40	34.80	28.00
14-Apr-2018	11:00:00 PM	35.10	34.50	26.90
15-Apr-2018	12:00:00 AM	34.60	33.50	26.40
15-Apr-2018	1:00:00 AM	34.20	33.50	25.30
15-Apr-2018	2:00:00 AM	33.70	33.00	24.90
15-Apr-2018	3:00:00 AM	33.10	32.40	24.20
15-Apr-2018	4:00:00 AM	32.50	31.90	23.70
15-Apr-2018	5:00:00 AM	32.00	31.30	22.90
15-Apr-2018	6:00:00 AM	31.40	30.80	23.50
15-Apr-2018	7:00:00 AM	31.00	30.30	27.50
15-Apr-2018	8:00:00 AM	30.70	30.00	32.90
15-Apr-2018	9:00:00 AM	30.60	30.10	36.80
15-Apr-2018	10:00:00 AM	30.80	30.40	41.10
15-Apr-2018	11:00:00 AM	31.20	31.10	43.30
15-Apr-2018	12:00:00 PM	31.90	32.10	45.30
15-Apr-2018	1:00:00 PM	32.80	33.00	47.90
15-Apr-2018	2:00:00 PM	33.70	33.90	47.20
15-Apr-2018	3:00:00 PM	34.70	34.80	49.10
15-Apr-2018	4:00:00 PM	35.60	35.40	43.90
15-Apr-2018	5:00:00 PM	36.20	36.00	41.80
15-Apr-2018	6:00:00 PM	36.80	36.50	37.10
15-Apr-2018	7:00:00 PM	37.10	36.80	33.90
15-Apr-2018	8:00:00 PM	37.30	36.90	32.40
15-Apr-2018	9:00:00 PM	37.30	36.80	31.80
15-Apr-2018	10:00:00 PM	37.00	36.60	31.00
15-Apr-2018	11:00:00 PM	36.70	36.20	30.60
16-Apr-2018	12:00:00 AM	36.30	35.80	29.90
16-Apr-2018	1:00:00 AM	35.90	35.30	28.90
16-Apr-2018	2:00:00 AM	35.20	34.80	26.90
16-Apr-2018	3:00:00 AM	34.60	34.30	26.40
16-Apr-2018	4:00:00 AM	33.80	33.60	25.00
16-Apr-2018	5:00:00 AM	33.10	32.90	23.50
16-Apr-2018	6:00:00 AM	32.60	32.30	23.50
16-Apr-2018	7:00:00 AM	31.80	31.60	21.90
16-Apr-2018	8:00:00 AM	31.10	30.90	22.30
16-Apr-2018	9:00:00 AM	29.40	29.60	22.60
16-Apr-2018	10:00:00 AM	29.30	29.50	27.80
16-Apr-2018	11:00:00 AM	29.40	29.60	32.70
16-Apr-2018	12:00:00 PM	29.60	29.90	36.30
16-Apr-2018	1:00:00 PM	30.10	30.40	39.10
16-Apr-2018	2:00:00 PM	30.60	30.90	41.80
16-Apr-2018	3:00:00 PM	31.20	31.30	42.10
16-Apr-2018	4:00:00 PM	31.70	31.70	40.00
16-Apr-2018	5:00:00 PM	32.10	32.10	34.30

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
16-Apr-2018	6:00:00 PM	32.40	32.40	30.50
16-Apr-2018	7:00:00 PM	32.50	32.60	28.00
16-Apr-2018	8:00:00 PM	32.40	32.60	26.30
16-Apr-2018	9:00:00 PM	32.20	32.30	24.70
16-Apr-2018	10:00:00 PM	31.90	31.90	24.10
16-Apr-2018	11:00:00 PM	31.60	31.50	23.40
17-Apr-2018	12:00:00 AM	31.10	31.00	22.60
17-Apr-2018	1:00:00 AM	30.40	30.30	22.10
17-Apr-2018	2:00:00 AM	29.90	29.70	22.00
17-Apr-2018	3:00:00 AM	29.30	29.10	22.00
17-Apr-2018	4:00:00 AM	28.80	28.60	21.80
17-Apr-2018	5:00:00 AM	28.30	28.10	21.20
17-Apr-2018	6:00:00 AM	27.70	27.60	21.90
17-Apr-2018	7:00:00 AM	27.40	27.10	24.50
17-Apr-2018	8:00:00 AM	27.10	26.90	28.00
17-Apr-2018	9:00:00 AM	27.10	27.00	31.80
17-Apr-2018	10:00:00 AM	27.40	27.40	35.60
17-Apr-2018	11:00:00 AM	27.90	28.20	38.10
17-Apr-2018	12:00:00 PM	28.70	29.10	40.70
17-Apr-2018	1:00:00 PM	29.60	30.10	44.40
17-Apr-2018	2:00:00 PM	30.70	31.10	46.40
17-Apr-2018	3:00:00 PM	31.60	31.90	46.50
17-Apr-2018	4:00:00 PM	32.50	32.60	43.50
17-Apr-2018	5:00:00 PM	33.20	33.20	39.70
17-Apr-2018	6:00:00 PM	33.80	33.80	34.10
17-Apr-2018	7:00:00 PM	34.10	34.10	31.10
17-Apr-2018	8:00:00 PM	34.40	34.30	29.90
17-Apr-2018	9:00:00 PM	34.40	34.20	28.70
17-Apr-2018	10:00:00 PM	34.20	33.90	27.60
17-Apr-2018	11:00:00 PM	33.80	33.50	26.50
18-Apr-2018	12:00:00 AM	33.40	33.10	25.30
18-Apr-2018	1:00:00 AM	32.90	32.50	25.00
18-Apr-2018	2:00:00 AM	32.30	32.00	24.30
18-Apr-2018	3:00:00 AM	31.70	31.40	23.90
18-Apr-2018	4:00:00 AM	31.20	30.80	23.20
18-Apr-2018	5:00:00 AM	30.60	30.20	22.70
18-Apr-2018	6:00:00 AM	30.10	29.70	22.60
18-Apr-2018	7:00:00 AM	29.60	29.20	25.40
18-Apr-2018	8:00:00 AM	29.20	28.80	29.50
20-Apr-2018	9:00:00 AM	27.70	28.40	25.70
20-Apr-2018	10:00:00 AM	26.10	27.10	28.20
20-Apr-2018	11:00:00 AM	25.70	26.60	22.70
20-Apr-2018	12:00:00 PM	25.60	26.30	21.30
20-Apr-2018	1:00:00 PM	25.80	26.40	24.50
20-Apr-2018	2:00:00 PM	26.00	26.50	27.90
20-Apr-2018	3:00:00 PM	26.30	26.70	30.20
20-Apr-2018	4:00:00 PM	26.50	26.80	32.20
20-Apr-2018	5:00:00 PM	26.70	26.80	27.50
20-Apr-2018	6:00:00 PM	26.90	27.00	27.70
20-Apr-2018	7:00:00 PM	26.80	27.10	20.80
20-Apr-2018	8:00:00 PM	26.50	26.90	18.60
20-Apr-2018	9:00:00 PM	26.20	26.70	18.40

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
20-Apr-2018	10:00:00 PM	26.00	26.30	18.30
20-Apr-2018	11:00:00 PM	25.60	25.90	18.70
21-Apr-2018	12:00:00 AM	25.20	25.40	18.80
21-Apr-2018	1:00:00 AM	24.80	24.90	17.80
21-Apr-2018	2:00:00 AM	24.30	24.40	17.30
21-Apr-2018	3:00:00 AM	23.80	23.90	17.40
21-Apr-2018	4:00:00 AM	23.30	23.40	16.10
21-Apr-2018	5:00:00 AM	22.90	22.90	15.70
21-Apr-2018	6:00:00 AM	22.50	22.40	16.20
21-Apr-2018	7:00:00 AM	22.10	22.10	19.10
21-Apr-2018	8:00:00 AM	21.90	21.80	23.10
21-Apr-2018	9:00:00 AM	21.90	22.00	28.10
21-Apr-2018	10:00:00 AM	22.30	22.50	31.50
21-Apr-2018	11:00:00 AM	23.00	23.30	35.30
21-Apr-2018	12:00:00 PM	23.90	24.40	36.90
21-Apr-2018	1:00:00 PM	24.90	25.50	39.80
21-Apr-2018	2:00:00 PM	26.00	26.50	40.70
21-Apr-2018	3:00:00 PM	27.10	27.40	41.30
21-Apr-2018	4:00:00 PM	28.00	28.20	39.90
21-Apr-2018	5:00:00 PM	28.80	29.00	36.10
21-Apr-2018	6:00:00 PM	29.50	29.60	31.80
21-Apr-2018	7:00:00 PM	29.90	30.00	27.50
21-Apr-2018	8:00:00 PM	30.20	30.30	26.10
21-Apr-2018	9:00:00 PM	30.30	30.40	25.00
21-Apr-2018	10:00:00 PM	30.10	30.10	24.00
21-Apr-2018	11:00:00 PM	29.80	29.80	23.30
22-Apr-2018	12:00:00 AM	29.50	29.40	22.50
22-Apr-2018	1:00:00 AM	29.00	28.90	22.00
22-Apr-2018	2:00:00 AM	28.50	28.30	21.50
22-Apr-2018	3:00:00 AM	28.00	27.80	20.10
22-Apr-2018	4:00:00 AM	27.50	27.20	19.30
22-Apr-2018	5:00:00 AM	27.00	26.60	18.70
22-Apr-2018	6:00:00 AM	26.40	26.10	19.30
22-Apr-2018	7:00:00 AM	25.90	25.60	23.60
22-Apr-2018	8:00:00 AM	25.60	25.30	27.80
22-Apr-2018	9:00:00 AM	25.50	25.40	32.10
22-Apr-2018	10:00:00 AM	25.90	25.90	35.20
22-Apr-2018	11:00:00 AM	26.50	26.70	39.20
22-Apr-2018	12:00:00 PM	27.40	27.80	40.50
22-Apr-2018	1:00:00 PM	28.40	28.90	43.30
22-Apr-2018	2:00:00 PM	29.50	29.80	44.10
22-Apr-2018	3:00:00 PM	30.50	30.70	45.00
22-Apr-2018	4:00:00 PM	31.30	31.50	44.70
22-Apr-2018	5:00:00 PM	32.10	32.10	40.30
22-Apr-2018	6:00:00 PM	32.80	32.70	35.90
22-Apr-2018	7:00:00 PM	33.30	33.20	30.90
22-Apr-2018	8:00:00 PM	33.60	33.50	29.10
22-Apr-2018	9:00:00 PM	33.70	33.50	27.60
22-Apr-2018	10:00:00 PM	33.60	33.30	26.40
22-Apr-2018	11:00:00 PM	33.30	32.90	25.70
23-Apr-2018	12:00:00 AM	32.80	32.40	24.80
23-Apr-2018	1:00:00 AM	32.30	31.90	24.40

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
23-Apr-2018	2:00:00 AM	31.70	31.30	23.80
23-Apr-2018	3:00:00 AM	31.10	30.70	23.00
23-Apr-2018	4:00:00 AM	30.60	30.10	22.40
23-Apr-2018	5:00:00 AM	30.00	29.50	22.20
23-Apr-2018	6:00:00 AM	29.40	28.90	22.20
23-Apr-2018	7:00:00 AM	28.90	28.40	26.00
23-Apr-2018	8:00:00 AM	28.60	28.10	30.60
23-Apr-2018	9:00:00 AM	28.50	28.10	34.70
23-Apr-2018	10:00:00 AM	28.70	28.60	39.00
23-Apr-2018	11:00:00 AM	29.40	29.40	41.00
23-Apr-2018	12:00:00 PM	30.20	30.50	43.80
23-Apr-2018	1:00:00 PM	31.20	31.50	45.30
23-Apr-2018	2:00:00 PM	32.20	32.50	47.20
23-Apr-2018	3:00:00 PM	33.20	33.40	45.80
23-Apr-2018	4:00:00 PM	34.00	34.10	46.50
23-Apr-2018	5:00:00 PM	34.80	34.70	42.90
23-Apr-2018	6:00:00 PM	35.40	35.30	38.10
23-Apr-2018	7:00:00 PM	35.80	35.80	33.40
23-Apr-2018	8:00:00 PM	36.20	36.00	31.00
23-Apr-2018	9:00:00 PM	36.20	35.90	29.10
23-Apr-2018	10:00:00 PM	36.00	35.70	28.00
23-Apr-2018	11:00:00 PM	35.60	35.30	26.30
24-Apr-2018	12:00:00 AM	35.20	34.80	25.60
24-Apr-2018	1:00:00 AM	34.60	34.20	24.90
24-Apr-2018	2:00:00 AM	34.00	33.60	23.90
24-Apr-2018	3:00:00 AM	33.40	32.90	23.10
24-Apr-2018	4:00:00 AM	32.80	32.30	22.60
24-Apr-2018	5:00:00 AM	32.20	31.60	22.50
24-Apr-2018	6:00:00 AM	31.50	31.00	22.80
24-Apr-2018	7:00:00 AM	31.00	30.50	29.40
24-Apr-2018	8:00:00 AM	30.70	30.20	36.30
24-Apr-2018	9:00:00 AM	30.60	30.20	41.00
24-Apr-2018	10:00:00 AM	30.90	30.70	43.40
24-Apr-2018	11:00:00 AM	31.60	31.60	43.20
24-Apr-2018	12:00:00 PM	32.50	32.70	45.50
24-Apr-2018	1:00:00 PM	33.50	33.80	47.10
24-Apr-2018	2:00:00 PM	34.60	34.70	48.90
24-Apr-2018	3:00:00 PM	35.50	35.60	49.40
24-Apr-2018	4:00:00 PM	36.40	36.40	48.10
24-Apr-2018	5:00:00 PM	37.20	37.00	44.20
24-Apr-2018	6:00:00 PM	37.80	37.60	38.80
24-Apr-2018	7:00:00 PM	38.30	38.00	35.50
24-Apr-2018	8:00:00 PM	38.50	38.10	33.40
24-Apr-2018	9:00:00 PM	38.40	38.00	31.60
24-Apr-2018	10:00:00 PM	38.20	37.80	29.80
24-Apr-2018	11:00:00 PM	37.80	37.40	28.60
25-Apr-2018	12:00:00 AM	37.30	36.80	27.30
25-Apr-2018	1:00:00 AM	36.80	36.30	26.40
25-Apr-2018	2:00:00 AM	36.20	35.70	25.80
25-Apr-2018	3:00:00 AM	35.60	35.00	25.50
25-Apr-2018	4:00:00 AM	35.00	34.40	24.90
25-Apr-2018	5:00:00 AM	34.30	33.80	24.10

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
25-Apr-2018	6:00:00 AM	33.70	33.20	24.30
25-Apr-2018	7:00:00 AM	33.20	32.60	29.00
25-Apr-2018	8:00:00 AM	32.90	32.30	34.10
26-Apr-2018	9:00:00 AM	33.40	33.20	38.10
26-Apr-2018	10:00:00 AM	33.60	33.40	42.30
26-Apr-2018	11:00:00 AM	34.10	34.10	45.70
26-Apr-2018	12:00:00 PM	34.80	34.90	49.50
26-Apr-2018	1:00:00 PM	35.70	35.90	50.90
26-Apr-2018	2:00:00 PM	36.60	36.80	52.30
26-Apr-2018	3:00:00 PM	37.50	37.60	52.30
26-Apr-2018	4:00:00 PM	38.40	38.40	52.70
26-Apr-2018	5:00:00 PM	39.10	39.00	47.00
26-Apr-2018	6:00:00 PM	39.70	39.50	42.00
26-Apr-2018	7:00:00 PM	40.20	39.90	36.90
26-Apr-2018	8:00:00 PM	40.40	40.20	34.50
26-Apr-2018	9:00:00 PM	40.40	40.10	33.40
26-Apr-2018	10:00:00 PM	40.20	39.80	31.70
26-Apr-2018	11:00:00 PM	39.80	39.40	30.40
27-Apr-2018	12:00:00 AM	39.30	38.90	29.50
27-Apr-2018	1:00:00 AM	38.80	38.30	28.70
27-Apr-2018	2:00:00 AM	38.20	37.70	28.50
27-Apr-2018	3:00:00 AM	37.60	37.10	28.00
27-Apr-2018	4:00:00 AM	37.00	36.40	27.50
27-Apr-2018	5:00:00 AM	36.40	35.80	26.50
27-Apr-2018	6:00:00 AM	35.80	35.30	27.90
27-Apr-2018	7:00:00 AM	35.30	34.70	29.20
27-Apr-2018	8:00:00 AM	34.90	34.30	34.10
27-Apr-2018	9:00:00 AM	34.70	34.10	36.20
27-Apr-2018	10:00:00 AM	34.80	34.50	41.70
27-Apr-2018	11:00:00 AM	35.10	35.00	46.40
27-Apr-2018	12:00:00 PM	35.70	35.60	46.80
27-Apr-2018	1:00:00 PM	36.50	36.40	48.80
27-Apr-2018	2:00:00 PM	37.30	37.20	50.20
27-Apr-2018	3:00:00 PM	38.00	37.90	49.70
27-Apr-2018	4:00:00 PM	38.70	38.50	45.50
27-Apr-2018	5:00:00 PM	39.20	39.00	43.10
27-Apr-2018	6:00:00 PM	39.60	39.40	39.60
27-Apr-2018	7:00:00 PM	39.90	39.70	36.70
27-Apr-2018	8:00:00 PM	39.90	39.70	35.10
27-Apr-2018	9:00:00 PM	39.70	39.60	34.30
27-Apr-2018	10:00:00 PM	39.30	39.20	33.00
27-Apr-2018	11:00:00 PM	39.00	38.80	31.90
28-Apr-2018	12:00:00 AM	38.60	38.20	31.00
28-Apr-2018	1:00:00 AM	38.10	37.70	30.10
28-Apr-2018	2:00:00 AM	37.60	37.20	29.10
28-Apr-2018	3:00:00 AM	37.10	36.70	28.50
28-Apr-2018	4:00:00 AM	36.60	36.10	28.10
28-Apr-2018	5:00:00 AM	36.00	35.60	27.70
28-Apr-2018	6:00:00 AM	35.40	34.90	27.50
28-Apr-2018	7:00:00 AM	34.90	34.40	29.20
28-Apr-2018	8:00:00 AM	34.50	34.00	31.80
28-Apr-2018	9:00:00 AM	34.30	33.90	35.50

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
28-Apr-2018	10:00:00 AM	34.40	34.20	39.30
28-Apr-2018	11:00:00 AM	34.70	34.80	43.00
28-Apr-2018	12:00:00 PM	35.30	35.40	46.90
28-Apr-2018	1:00:00 PM	36.00	36.20	50.00
28-Apr-2018	2:00:00 PM	36.80	37.00	50.20
28-Apr-2018	3:00:00 PM	37.60	37.70	51.40
28-Apr-2018	4:00:00 PM	38.40	38.40	49.00
28-Apr-2018	5:00:00 PM	39.20	39.00	46.00
28-Apr-2018	6:00:00 PM	39.70	39.50	41.40
28-Apr-2018	7:00:00 PM	40.10	39.90	37.30
28-Apr-2018	8:00:00 PM	40.30	40.10	35.30
28-Apr-2018	9:00:00 PM	40.20	40.00	34.10
28-Apr-2018	10:00:00 PM	40.00	39.50	32.70
28-Apr-2018	11:00:00 PM	39.60	38.90	30.80
29-Apr-2018	12:00:00 AM	39.10	38.50	29.60
29-Apr-2018	1:00:00 AM	38.60	38.00	28.40
29-Apr-2018	2:00:00 AM	38.00	37.40	27.70
29-Apr-2018	3:00:00 AM	37.30	36.70	27.00
29-Apr-2018	4:00:00 AM	36.70	36.10	26.30
29-Apr-2018	5:00:00 AM	36.10	35.50	26.40
29-Apr-2018	6:00:00 AM	35.40	34.90	26.20
29-Apr-2018	7:00:00 AM	34.80	34.30	28.70
29-Apr-2018	8:00:00 AM	34.40	33.90	32.20
29-Apr-2018	9:00:00 AM	34.20	33.80	36.70
29-Apr-2018	10:00:00 AM	34.20	34.00	40.70
29-Apr-2018	11:00:00 AM	34.60	34.60	44.70
29-Apr-2018	12:00:00 PM	35.20	35.30	46.90
29-Apr-2018	1:00:00 PM	36.00	36.10	49.00
29-Apr-2018	2:00:00 PM	36.80	37.00	50.70
29-Apr-2018	3:00:00 PM	37.70	37.70	49.50
29-Apr-2018	4:00:00 PM	38.40	38.30	47.10
29-Apr-2018	5:00:00 PM	39.10	38.90	43.70
29-Apr-2018	6:00:00 PM	39.50	39.30	39.70
29-Apr-2018	7:00:00 PM	39.80	39.60	36.60
29-Apr-2018	8:00:00 PM	40.00	39.70	34.80
29-Apr-2018	9:00:00 PM	39.90	39.60	33.60
29-Apr-2018	10:00:00 PM	39.70	39.30	32.10
29-Apr-2018	11:00:00 PM	39.30	38.90	31.10
30-Apr-2018	12:00:00 AM	38.90	38.40	30.20
30-Apr-2018	1:00:00 AM	38.40	37.90	29.10
30-Apr-2018	2:00:00 AM	37.80	37.30	28.10
30-Apr-2018	3:00:00 AM	37.30	36.70	27.00
30-Apr-2018	4:00:00 AM	36.60	36.10	26.50
30-Apr-2018	5:00:00 AM	36.00	35.50	26.00
30-Apr-2018	6:00:00 AM	35.40	34.90	26.20
30-Apr-2018	7:00:00 AM	34.90	34.30	29.30
30-Apr-2018	8:00:00 AM	34.50	33.90	34.80
30-Apr-2018	9:00:00 AM	34.40	33.90	40.20
30-Apr-2018	10:00:00 AM	34.50	34.30	44.20
30-Apr-2018	11:00:00 AM	35.00	35.00	48.20
30-Apr-2018	12:00:00 PM	35.70	35.80	51.10
30-Apr-2018	1:00:00 PM	36.60	36.80	50.40

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
30-Apr-2018	2:00:00 PM	37.60	37.60	49.70
30-Apr-2018	3:00:00 PM	38.50	38.50	48.20
30-Apr-2018	4:00:00 PM	39.30	39.20	47.90
30-Apr-2018	5:00:00 PM	40.00	39.70	44.00
30-Apr-2018	6:00:00 PM	40.50	40.10	41.40
30-Apr-2018	7:00:00 PM	40.80	40.50	37.90
30-Apr-2018	8:00:00 PM	40.90	40.60	35.80
30-Apr-2018	9:00:00 PM	40.90	40.50	34.00
30-Apr-2018	10:00:00 PM	40.70	40.30	33.00
30-Apr-2018	11:00:00 PM	40.30	39.90	32.20
1-May-2018	12:00:00 AM	39.90	39.50	31.60
1-May-2018	1:00:00 AM	39.40	39.00	31.60
1-May-2018	2:00:00 AM	38.90	38.30	30.40
1-May-2018	3:00:00 AM	38.30	37.80	29.30
1-May-2018	4:00:00 AM	37.80	37.20	28.40
1-May-2018	5:00:00 AM	37.20	36.60	27.80
1-May-2018	6:00:00 AM	36.60	35.90	28.00
1-May-2018	7:00:00 AM	36.00	35.30	29.70
1-May-2018	8:00:00 AM	35.50	34.80	32.10
1-May-2018	9:00:00 AM	35.30	34.60	35.00
1-May-2018	10:00:00 AM	35.30	34.90	38.10
1-May-2018	11:00:00 AM	35.60	35.40	41.20
1-May-2018	12:00:00 PM	36.10	36.20	43.80
1-May-2018	1:00:00 PM	36.70	36.80	46.90
1-May-2018	2:00:00 PM	37.40	37.50	48.70
1-May-2018	3:00:00 PM	38.20	38.10	50.00
1-May-2018	4:00:00 PM	38.90	38.70	48.40
1-May-2018	5:00:00 PM	39.50	39.30	45.20
1-May-2018	6:00:00 PM	40.00	39.70	41.40
1-May-2018	7:00:00 PM	40.40	40.10	38.20
1-May-2018	8:00:00 PM	40.60	40.30	36.30
1-May-2018	9:00:00 PM	40.60	40.30	35.60
1-May-2018	10:00:00 PM	40.50	40.10	34.10
1-May-2018	11:00:00 PM	40.20	39.70	33.10
2-May-2018	12:00:00 AM	39.80	39.30	32.40
2-May-2018	1:00:00 AM	39.40	38.80	31.60
2-May-2018	2:00:00 AM	38.90	38.40	30.70
2-May-2018	3:00:00 AM	38.30	37.90	30.30
2-May-2018	4:00:00 AM	37.90	37.40	29.70
2-May-2018	5:00:00 AM	37.40	36.90	29.40
2-May-2018	6:00:00 AM	36.90	36.40	29.60
2-May-2018	7:00:00 AM	36.40	35.80	32.00
2-May-2018	8:00:00 AM	35.90	35.40	30.70
2-May-2018	9:00:00 AM	35.70	35.20	32.50
2-May-2018	10:00:00 AM	35.50	34.90	32.60
2-May-2018	11:00:00 AM	35.20	34.80	31.40
2-May-2018	12:00:00 PM	34.90	34.50	32.40
2-May-2018	1:00:00 PM	35.10	34.70	39.40
2-May-2018	2:00:00 PM	35.10	34.70	37.20
2-May-2018	3:00:00 PM	35.10	34.80	38.70
2-May-2018	4:00:00 PM	35.30	35.00	39.70
2-May-2018	5:00:00 PM	35.40	35.10	36.90

Date	Hour (hr)	Temperature (°C)		
		8" BCP Room	6" BCP Room	Ambient
2-May-2018	6:00:00 PM	35.40	35.20	33.00
2-May-2018	7:00:00 PM	35.40	35.10	30.00
2-May-2018	8:00:00 PM	35.30	35.00	28.80
2-May-2018	9:00:00 PM	35.10	34.70	27.60
2-May-2018	10:00:00 PM	34.80	34.30	26.50
2-May-2018	11:00:00 PM	34.30	33.90	25.70
3-May-2018	12:00:00 AM	33.80	33.40	25.40
3-May-2018	1:00:00 AM	33.10	32.90	24.70
3-May-2018	2:00:00 AM	32.60	32.40	25.10
3-May-2018	3:00:00 AM	32.20	31.90	23.50
3-May-2018	4:00:00 AM	31.70	31.40	23.20
3-May-2018	5:00:00 AM	31.20	30.90	23.20
3-May-2018	6:00:00 AM	30.70	30.40	23.60
3-May-2018	7:00:00 AM	30.30	30.00	26.80
3-May-2018	8:00:00 AM	30.00	29.70	29.10
3-May-2018	9:00:00 AM	29.80	29.60	31.10
3-May-2018	10:00:00 AM	29.80	29.70	35.40
3-May-2018	11:00:00 AM	30.10	30.30	38.80
3-May-2018	12:00:00 PM	30.70	30.90	42.30
3-May-2018	1:00:00 PM	31.40	31.70	44.90
3-May-2018	2:00:00 PM	32.20	32.50	47.00
3-May-2018	3:00:00 PM	33.10	33.20	46.10
3-May-2018	4:00:00 PM	33.90	34.00	45.70
3-May-2018	5:00:00 PM	34.70	34.60	41.30
3-May-2018	6:00:00 PM	35.30	35.20	36.60
3-May-2018	7:00:00 PM	35.80	35.60	33.80
3-May-2018	8:00:00 PM	36.00	35.80	32.40
3-May-2018	9:00:00 PM	36.10	35.80	31.40
3-May-2018	10:00:00 PM	35.90	35.70	30.00
3-May-2018	11:00:00 PM	35.70	35.50	29.70
4-May-2018	12:00:00 AM	35.40	35.00	29.30
4-May-2018	1:00:00 AM	35.00	34.60	28.80
4-May-2018	2:00:00 AM	34.50	34.20	28.30
4-May-2018	3:00:00 AM	34.10	33.80	27.70
4-May-2018	4:00:00 AM	33.70	33.30	27.00
4-May-2018	5:00:00 AM	33.30	32.90	26.50
4-May-2018	6:00:00 AM	32.80	32.40	26.80
4-May-2018	7:00:00 AM	32.40	32.10	28.90
4-May-2018	8:00:00 AM	32.20	31.80	31.30

**Annexure B: Ecotect Result of Hourly Temperature from December 2017-January 2018**

DATE	HOUR	6 inch BCP Room Temperature		8 inch BCP Room Temperature	
		INSIDE	OUTSIDE	INSIDE	OUTSIDE
		(°C)	(°C)	(°C)	(°C)
1/19/2018	0	16.00	12.20	16.40	12.20
	1	15.80	11.10	16.20	11.10
	2	15.40	10.10	15.70	10.10
	3	15.00	9.00	15.40	9.00
	4	14.60	8.30	15.00	8.30
	5	14.20	8.10	14.70	8.10
	6	13.80	9.20	14.30	9.20
	7	13.70	11.10	14.20	11.10
	8	13.90	14.10	14.20	14.10
	9	14.80	17.10	14.70	17.10
	10	16.10	20.10	15.60	20.10
	11	17.90	21.80	17.00	21.80
	12	19.50	23.10	18.30	23.10
	13	20.60	23.40	19.40	23.40
	14	21.10	23.50	19.90	23.50
	15	21.30	22.90	20.20	22.90
	16	21.50	22.20	20.60	22.20
	17	21.40	20.40	21.00	20.40
	18	21.00	18.70	21.00	18.70
	19	20.40	16.70	20.30	16.70
	20	18.80	15.50	18.80	15.50
	21	18.00	14.10	18.20	14.10
	22	17.20	13.70	17.40	13.70
	23	16.60	12.80	16.90	12.80
1/20/2018	0	15.90	12.10	16.30	12.10
	1	15.70	11.10	16.00	11.10
	2	15.30	10.00	15.60	10.00
	3	14.90	9.00	15.30	9.00
	4	14.50	8.30	14.90	8.30
	5	14.10	8.00	14.60	8.00
	6	13.70	9.20	14.30	9.20
	7	13.70	11.00	14.10	11.00
	8	13.80	13.90	14.10	13.90
	9	14.70	16.90	14.60	16.90
	10	16.00	19.90	15.40	19.90
	11	17.80	21.60	16.80	21.60
	12	19.30	22.90	18.10	22.90
	13	20.50	23.20	19.30	23.20
	14	20.90	23.40	19.80	23.40
	15	21.10	22.80	20.10	22.80
	16	21.40	22.10	20.50	22.10
	17	21.30	20.30	20.80	20.30
	18	20.90	18.60	20.80	18.60
	19	20.30	16.60	20.20	16.60
	20	18.60	15.30	18.70	15.30

DATE	HOUR	6 inch BCP Room Temperature		8 inch BCP Room Temperature	
		INSIDE	OUTSIDE	INSIDE	OUTSIDE
		(°C)	(°C)	(°C)	(°C)
1/21/2018	21	17.90	14.10	18.10	14.10
	22	17.10	13.70	17.30	13.70
	23	16.50	12.70	16.70	12.70
	0	15.80	12.00	16.20	12.00
	1	15.70	11.00	16.00	11.00
	2	15.20	10.00	15.50	10.00
	3	14.80	8.90	15.20	8.90
	4	14.40	8.20	14.80	8.20
	5	14.00	8.00	14.50	8.00
	6	13.60	9.10	14.20	9.10
	7	13.60	10.80	14.00	10.80
	8	13.70	13.80	14.00	13.80
	9	14.50	16.70	14.50	16.70
	10	15.80	19.60	15.30	19.60
	11	17.60	21.40	16.70	21.40
	12	19.10	22.70	18.00	22.70
	13	20.20	23.10	19.10	23.10
	14	20.70	23.30	19.60	23.30
	15	20.90	22.70	19.90	22.70
	16	21.20	22.00	20.40	22.00
	17	21.20	20.20	20.70	20.20
	18	20.80	18.50	20.70	18.50
	19	20.20	16.50	20.10	16.50
	20	18.50	15.30	18.60	15.30
	21	17.80	14.00	17.90	14.00
	22	17.00	13.60	17.20	13.60
	23	16.40	12.70	16.70	12.70
1/22/2018	0	15.70	12.00	16.10	12.00
	1	15.60	10.80	15.90	10.80
	2	15.10	10.00	15.50	10.00
	3	14.80	8.90	15.20	8.90
	4	14.30	8.20	14.70	8.20
	5	13.90	7.90	14.40	7.90
	6	13.60	9.00	14.10	9.00
	7	13.50	10.70	13.90	10.70
	8	13.60	13.70	13.90	13.70
	9	14.40	16.60	14.40	16.60
	10	15.70	19.50	15.20	19.50
	11	17.50	21.30	16.60	21.30
	12	19.00	22.60	17.90	22.60
	13	20.10	22.90	19.00	22.90
	14	20.60	23.20	19.50	23.20
	15	20.80	22.60	19.80	22.60
	16	21.00	21.80	20.20	21.80
	17	21.00	20.10	20.50	20.10
	18	20.60	18.50	20.50	18.50
	19	20.10	16.50	20.00	16.50

DATE	HOUR	6 inch BCP Room Temperature		8 inch BCP Room Temperature	
		INSIDE	OUTSIDE	INSIDE	OUTSIDE
		(°C)	(°C)	(°C)	(°C)
1/23/2018	20	18.40	15.30	18.50	15.30
	21	17.70	14.00	17.90	14.00
	22	16.90	13.60	17.10	13.60
	23	16.30	12.60	16.60	12.60
	0	15.70	11.90	16.00	11.90
	1	15.50	10.80	15.80	10.80
	2	15.00	9.90	15.40	9.90
	3	14.70	8.70	15.10	8.70
	4	14.20	8.20	14.60	8.20
	5	13.80	7.90	14.30	7.90
	6	13.40	9.00	13.90	9.00
	7	13.40	10.60	13.80	10.60
	8	13.50	13.50	13.80	13.50
	9	14.30	16.40	14.30	16.40
	10	15.60	19.30	15.00	19.30
	11	17.30	21.10	16.40	21.10
	12	18.80	22.40	17.70	22.40
	13	19.90	22.70	18.80	22.70
	14	20.40	23.10	19.40	23.10
	15	20.70	22.50	19.70	22.50
	16	20.90	21.70	20.00	21.70
	17	20.90	20.10	20.40	20.10
	18	20.50	18.40	20.40	18.40
	19	20.00	16.40	19.90	16.40
	20	18.30	15.20	18.40	15.20
	21	17.60	13.90	17.80	13.90
	22	16.80	13.50	17.00	13.50
	23	16.20	12.60	16.50	12.60
1/24/2018	0	15.50	11.80	15.90	11.80
	1	15.40	10.70	15.70	10.70
	2	14.90	9.90	15.30	9.90
	3	14.60	8.70	15.00	8.70
	4	14.10	8.10	14.50	8.10
	5	13.80	7.80	14.30	7.80
	6	13.40	8.90	13.90	8.90
	7	13.30	10.50	13.70	10.50
	8	13.40	13.40	13.70	13.40
	9	14.20	16.30	14.20	16.30
	10	15.50	19.10	14.90	19.10
	11	17.20	21.00	16.30	21.00
	12	18.70	22.30	17.60	22.30
	13	19.80	22.60	18.70	22.60
	14	20.30	22.90	19.20	22.90
	15	20.50	22.40	19.50	22.40
	16	20.80	21.60	19.90	21.60
	17	20.80	20.00	20.20	20.00
	18	20.40	18.30	20.30	18.30

DATE	HOUR	6 inch BCP Room Temperature		8 inch BCP Room Temperature	
		INSIDE	OUTSIDE	INSIDE	OUTSIDE
		(°C)	(°C)	(°C)	(°C)
1/25/2018	19	19.90	16.40	19.90	16.40
	20	18.20	15.20	18.30	15.20
	21	17.50	13.90	17.70	13.90
	22	16.70	13.50	17.00	13.50
	23	16.20	12.40	16.40	12.40
	0	15.50	11.80	15.80	11.80
	1	15.30	10.60	15.60	10.60
	2	14.80	9.80	15.20	9.80
	3	14.50	8.70	14.90	8.70
	4	14.00	8.10	14.40	8.10
	5	13.70	7.80	14.20	7.80
	6	13.30	8.70	13.80	8.70
	7	13.20	10.30	13.60	10.30
	8	13.30	13.30	13.60	13.30
	9	14.10	16.10	14.00	16.10
	10	15.30	19.00	14.80	19.00
	11	17.00	20.70	16.20	20.70
	12	18.50	22.20	17.40	22.20
	13	19.60	22.50	18.50	22.50
	14	20.10	22.80	19.10	22.80
	15	20.40	22.30	19.40	22.30
	16	20.60	21.60	19.80	21.60
	17	20.70	19.90	20.10	19.90
	18	20.20	18.20	20.10	18.20
	19	19.80	16.30	19.80	16.30
	20	18.10	15.10	18.20	15.10
	21	17.40	13.90	17.50	13.90
	22	16.60	13.50	16.80	13.50
	23	16.10	12.40	16.30	12.40
1/26/2018	0	15.40	11.70	15.80	11.70
	1	15.20	10.60	15.50	10.60
	2	14.70	9.80	15.10	9.80
	3	14.40	8.60	14.80	8.60
	4	13.90	8.10	14.40	8.10
	5	13.60	7.70	14.10	7.70
	6	13.20	8.70	13.70	8.70
	7	13.20	10.20	13.60	10.20
	8	13.20	13.20	13.50	13.20
	9	14.00	16.00	14.00	16.00
	10	15.20	18.70	14.70	18.70
	11	16.90	20.60	16.10	20.60
	12	18.40	22.00	17.30	22.00
	13	19.40	22.40	18.30	22.40
	14	20.00	22.70	18.90	22.70
	15	20.30	22.20	19.30	22.20
	16	20.50	21.50	19.70	21.50
	17	20.50	19.70	20.00	19.70

DATE	HOUR	6 inch BCP Room Temperature		8 inch BCP Room Temperature	
		INSIDE	OUTSIDE	INSIDE	OUTSIDE
		(°C)	(°C)	(°C)	(°C)
1/27/2018	18	20.10	18.20	20.00	18.20
	19	19.80	16.30	19.70	16.30
	20	18.00	15.10	18.00	15.10
	21	17.30	13.80	17.50	13.80
	22	16.60	13.40	16.80	13.40
	23	16.00	12.30	16.20	12.30
	0	15.30	11.70	15.70	11.70
	1	15.10	10.50	15.40	10.50
	2	14.60	9.70	15.00	9.70
	3	14.30	8.60	14.70	8.60
	4	13.80	8.00	14.30	8.00
	5	13.50	7.70	14.00	7.70
	6	13.10	8.60	13.60	8.60
	7	13.10	10.10	13.50	10.10
	8	13.20	13.00	13.50	13.00
	9	13.90	15.90	13.90	15.90
	10	15.10	18.60	14.60	18.60
	11	16.70	20.50	15.90	20.50
	12	18.20	21.80	17.20	21.80
	13	19.30	22.30	18.20	22.30
	14	19.90	22.60	18.80	22.60
	15	20.10	22.10	19.10	22.10
	16	20.40	21.40	19.60	21.40
	17	20.40	19.70	19.90	19.70
	18	20.00	18.10	19.90	18.10
	19	19.70	16.20	19.70	16.20
	20	17.90	15.00	18.00	15.00
	21	17.20	13.80	17.40	13.80
	22	16.50	13.40	16.70	13.40
	23	15.90	12.30	16.10	12.30
1/28/2018	0	15.20	11.60	15.60	11.60
	1	15.10	10.50	15.40	10.50
	2	14.60	9.70	14.90	9.70
	3	14.20	8.50	14.60	8.50
	4	13.80	8.00	14.20	8.00
	5	13.40	7.60	13.90	7.60
	6	13.00	8.60	13.50	8.60
	7	13.00	10.10	13.40	10.10
	8	13.10	12.90	13.40	12.90
	9	13.80	15.70	13.80	15.70
	10	15.00	18.50	14.50	18.50
	11	16.60	20.30	15.80	20.30
	12	18.10	21.70	17.10	21.70
	13	19.20	22.20	18.10	22.20
	14	19.70	22.50	18.70	22.50
	15	20.00	22.10	19.00	22.10
	16	20.30	21.30	19.40	21.30

DATE	HOUR	6 inch BCP Room Temperature		8 inch BCP Room Temperature	
		INSIDE	OUTSIDE	INSIDE	OUTSIDE
		(°C)	(°C)	(°C)	(°C)
1/29/2018	17	20.30	19.60	19.70	19.60
	18	19.90	18.00	19.80	18.00
	19	19.60	16.20	19.60	16.20
	20	17.80	15.00	17.90	15.00
	21	17.10	13.70	17.30	13.70
	22	16.40	13.30	16.60	13.30
	23	15.80	12.20	16.10	12.20
	0	15.20	11.60	15.50	11.60
	1	15.00	10.30	15.30	10.30
	2	14.50	9.60	14.80	9.60
	3	14.20	8.50	14.60	8.50
	4	13.60	8.00	14.10	8.00
	5	13.40	7.60	13.90	7.60
	6	13.00	8.50	13.50	8.50
	7	12.90	10.00	13.40	10.00
	8	13.00	12.80	13.30	12.80
	9	13.70	15.60	13.70	15.60
	10	14.80	18.30	14.40	18.30
	11	16.50	20.20	15.70	20.20
	12	17.90	21.60	17.00	21.60
	13	19.00	22.10	18.00	22.10
	14	19.60	22.40	18.60	22.40
	15	19.90	22.00	18.90	22.00
	16	20.20	21.20	19.30	21.20
	17	20.20	19.50	19.60	19.50
	18	19.80	18.00	19.70	18.00
	19	19.50	16.10	19.50	16.10
	20	17.70	14.90	17.80	14.90
	21	17.10	13.70	17.20	13.70
	22	16.30	13.30	16.50	13.30
	23	15.70	12.20	16.00	12.20
1/30/2018	0	15.10	11.50	15.40	11.50
	1	14.90	10.20	15.20	10.20
	2	14.40	9.60	14.80	9.60
	3	14.10	8.50	14.50	8.50
	4	13.60	7.90	14.00	7.90
	5	13.30	7.50	13.80	7.50
	6	12.90	8.30	13.40	8.30
	7	12.80	9.90	13.30	9.90
	8	12.90	12.70	13.20	12.70
	9	13.60	15.50	13.60	15.50
	10	14.70	18.20	14.30	18.20
	11	16.40	20.10	15.60	20.10
	12	17.80	21.50	16.80	21.50
	13	18.90	22.00	17.90	22.00
	14	19.50	22.30	18.50	22.30
	15	19.80	21.80	18.80	21.80

DATE	HOUR	6 inch BCP Room Temperature		8 inch BCP Room Temperature	
		INSIDE	OUTSIDE	INSIDE	OUTSIDE
		(°C)	(°C)	(°C)	(°C)
1/31/2018	16	20.00	21.20	19.20	21.20
	17	20.10	19.40	19.50	19.40
	18	19.60	17.90	19.50	17.90
	19	19.50	16.10	19.50	16.10
	20	17.70	14.90	17.70	14.90
	21	17.00	13.70	17.10	13.70
	22	16.30	13.30	16.50	13.30
	23	15.70	12.10	15.90	12.10
	0	15.00	11.50	15.40	11.50
	1	14.90	10.20	15.20	10.20
	2	14.30	9.60	14.70	9.60
	3	14.00	8.30	14.40	8.30
	4	13.50	7.90	13.90	7.90
	5	13.20	7.50	13.70	7.50
	6	12.80	8.30	13.30	8.30
	7	12.80	9.80	13.20	9.80
	8	12.90	12.60	13.20	12.60
	9	13.50	15.30	13.50	15.30
	10	14.60	18.10	14.20	18.10
	11	16.30	19.90	15.50	19.90
	12	17.70	21.40	16.70	21.40
	13	18.80	21.80	17.80	21.80
	14	19.40	22.20	18.40	22.20
	15	19.70	21.70	18.70	21.70
	16	19.90	21.10	19.10	21.10
	17	20.00	19.40	19.40	19.40
	18	19.50	17.80	19.40	17.80
	19	19.40	16.00	19.40	16.00
	20	17.60	14.90	17.60	14.90
	21	16.90	13.60	17.00	13.60
	22	16.20	13.20	16.40	13.20
	23	15.60	12.10	15.90	12.10
2/1/2018	0	14.90	11.40	15.30	11.40
	1	14.80	10.10	15.10	10.10
	2	14.30	9.50	14.60	9.50
	3	13.90	8.30	14.30	8.30
	4	13.40	7.90	13.90	7.90
	5	13.20	7.50	13.60	7.50
	6	12.70	8.20	13.20	8.20
	7	12.70	9.70	13.10	9.70
	8	12.80	12.40	13.10	12.40
	9	13.40	15.20	13.40	15.20
	10	14.50	18.00	14.10	18.00
	11	16.10	19.70	15.40	19.70
	12	17.60	21.20	16.60	21.20
	13	18.70	21.70	17.70	21.70
	14	19.20	22.20	18.20	22.20

DATE	HOUR	6 inch BCP Room Temperature		8 inch BCP Room Temperature	
		INSIDE	OUTSIDE	INSIDE	OUTSIDE
		(°C)	(°C)	(°C)	(°C)
	15	19.50	21.60	18.60	21.60
	16	19.70	21.00	18.90	21.00
	17	20.00	19.30	19.30	19.30
	18	19.40	17.80	19.30	17.80
	19	19.30	16.00	19.30	16.00
	20	17.50	14.80	17.50	14.80
	21	16.80	13.60	17.00	13.60
	22	16.10	13.20	16.30	13.20
	23	15.50	12.10	15.80	12.10
	0	14.90	11.40	15.20	11.40
	1	14.70	10.10	15.00	10.10
	2	14.20	9.50	14.60	9.50
	3	13.90	8.30	14.30	8.30
	4	13.30	7.80	13.80	7.80
	5	13.10	7.40	13.60	7.40
	6	12.70	8.20	13.20	8.20
	7	12.60	9.70	13.10	9.70
	8	12.70	12.30	13.00	12.30
	9	13.30	15.10	13.40	15.10
	10	14.40	17.80	14.00	17.80
	11	16.00	19.60	15.30	19.60
	12	17.40	21.10	16.50	21.10
	13	18.50	21.60	17.50	21.60
	14	19.10	22.10	18.10	22.10
	15	19.50	21.60	18.50	21.60
	16	19.60	21.00	18.80	21.00
	17	19.80	19.30	19.20	19.30
	18	19.40	17.70	19.20	17.70
	19	19.30	15.90	19.30	15.90
	20	17.40	14.80	17.40	14.80
	21	16.80	13.60	16.90	13.60
	22	16.00	13.20	16.20	13.20
2/2/2018	23	15.50	12.00	15.70	12.00
2/3/2018	0	14.80	11.30	15.20	11.30
	1	14.70	10.00	15.00	10.00
	2	14.10	9.50	14.50	9.50
	3	13.80	8.20	14.20	8.20
	4	13.30	7.80	13.70	7.80
	5	13.10	7.40	13.50	7.40
	6	12.60	8.10	13.10	8.10
	7	12.60	9.60	13.00	9.60
	8	12.60	12.20	13.00	12.20
	9	13.20	15.00	13.30	15.00
	10	14.30	17.70	13.90	17.70
	11	15.90	19.50	15.20	19.50
	12	17.30	21.10	16.40	21.10
	13	18.40	21.50	17.40	21.50

DATE	HOUR	6 inch BCP Room Temperature		8 inch BCP Room Temperature	
		INSIDE	OUTSIDE	INSIDE	OUTSIDE
		(°C)	(°C)	(°C)	(°C)
	14	19.00	22.00	18.00	22.00
	15	19.40	21.50	18.50	21.50
	16	19.50	20.80	18.70	20.80
	17	19.70	19.20	19.10	19.20
	18	19.20	17.70	19.10	17.70
	19	19.20	15.90	19.20	15.90
	20	17.30	14.80	17.40	14.80
	21	16.70	13.50	16.80	13.50
	22	16.00	13.00	16.20	13.00
	23	15.40	12.00	15.70	12.00
2/4/2018	0	14.80	11.30	15.10	11.30
	1	14.60	10.00	14.90	10.00
	2	14.10	9.40	14.40	9.40
	3	13.80	8.20	14.10	8.20
	4	13.20	7.80	13.70	7.80
	5	13.00	7.30	13.50	7.30
	6	12.60	8.10	13.10	8.10
	7	12.50	9.50	12.90	9.50
	8	12.60	12.10	12.90	12.10
	9	13.20	14.90	13.20	14.90
	10	14.20	17.50	13.90	17.50
	11	15.80	19.40	15.10	19.40
	12	17.20	21.00	16.30	21.00
	13	18.30	21.40	17.30	21.40
	14	18.90	21.80	17.90	21.80
	15	19.30	21.40	18.40	21.40
	16	19.40	20.80	18.60	20.80
	17	19.60	19.20	18.90	19.20
	18	19.20	17.50	19.00	17.50
	19	19.10	15.90	19.10	15.90
	20	17.30	14.60	17.30	14.60
	21	16.60	13.50	16.70	13.50
	22	15.90	13.00	16.10	13.00
	23	15.30	11.90	15.50	11.90
2/5/2018	0	14.70	11.20	15.00	11.20
	1	14.50	10.00	14.80	10.00
	2	14.00	9.40	14.40	9.40
	3	13.70	8.20	14.10	8.20
	4	13.20	7.80	13.60	7.80
	5	12.90	7.30	13.40	7.30
	6	12.50	8.10	13.00	8.10
	7	12.50	9.50	12.90	9.50
	8	12.50	12.00	12.80	12.00
	9	13.10	14.80	13.20	14.80
	10	14.10	17.40	13.80	17.40
	11	15.70	19.30	15.00	19.30
	12	17.10	20.80	16.20	20.80

DATE	HOUR	6 inch BCP Room Temperature		8 inch BCP Room Temperature	
		INSIDE	OUTSIDE	INSIDE	OUTSIDE
		(°C)	(°C)	(°C)	(°C)
	13	18.20	21.30	17.20	21.30
	14	18.80	21.80	17.90	21.80
	15	19.20	21.40	18.30	21.40
	16	19.40	20.70	18.60	20.70
	17	19.60	19.10	18.90	19.10
	18	19.10	17.50	18.90	17.50
	19	19.10	15.80	19.10	15.80
	20	17.20	14.60	17.20	14.60
	21	16.50	13.50	16.60	13.50
	22	15.80	13.00	16.00	13.00
	23	15.30	11.90	15.50	11.90
2/6/2018	0	14.70	11.20	15.00	11.20
	1	14.50	9.90	14.80	9.90
	2	14.00	9.40	14.30	9.40
	3	13.60	8.20	14.00	8.20
	4	13.10	7.80	13.60	7.80
	5	12.90	7.30	13.40	7.30
	6	12.50	8.00	13.00	8.00
	7	12.40	9.40	12.90	9.40
	8	12.50	12.00	12.80	12.00
	9	13.10	14.60	13.10	14.60
	10	14.10	17.40	13.70	17.40
	11	15.60	19.30	14.90	19.30
	12	17.00	20.70	16.10	20.70
	13	18.10	21.30	17.20	21.30
	14	18.80	21.70	17.80	21.70
	15	19.10	21.30	18.20	21.30
	16	19.30	20.70	18.50	20.70
	17	19.50	19.10	18.80	19.10
	18	19.00	17.50	18.90	17.50
	19	19.00	15.80	19.00	15.80
	20	17.20	14.60	17.20	14.60
	21	16.50	13.50	16.60	13.50
	22	15.80	13.00	16.00	13.00
	23	15.20	11.90	15.50	11.90
	0	14.60	11.20	15.00	11.20
	1	14.40	9.90	14.70	9.90
	2	13.90	9.40	14.30	9.40
	3	13.60	8.10	14.00	8.10
	4	13.10	7.70	13.50	7.70
	5	12.90	7.30	13.30	7.30
	6	12.40	8.00	12.90	8.00
	7	12.40	9.40	12.80	9.40
	8	12.40	11.90	12.70	11.90
	9	13.00	14.60	13.10	14.60
	10	14.00	17.30	13.70	17.30
	11	15.50	19.20	14.90	19.20

DATE	HOUR	6 inch BCP Room Temperature		8 inch BCP Room Temperature	
		INSIDE	OUTSIDE	INSIDE	OUTSIDE
		(°C)	(°C)	(°C)	(°C)
2/7/2018	12	17.00	20.60	16.10	20.60
	13	18.10	21.20	17.10	21.20
	14	18.70	21.70	17.70	21.70
	15	19.00	21.30	18.10	21.30
	16	19.20	20.60	18.40	20.60
	17	19.50	19.00	18.70	19.00
	18	18.90	17.40	18.80	17.40
	19	19.00	15.80	19.00	15.80
	20	17.10	14.60	17.10	14.60
	21	16.40	13.40	16.50	13.40
	22	15.80	12.90	15.90	12.90
	23	15.20	11.90	15.40	11.90
2/8/2018	0	14.60	11.20	14.90	11.20
	1	14.40	9.90	14.70	9.90
	2	13.90	9.30	14.30	9.30
	3	13.60	8.10	14.00	8.10
	4	13.00	7.70	13.50	7.70
	5	12.80	7.20	13.30	7.20
	6	12.40	8.00	12.90	8.00
	7	12.30	9.30	12.80	9.30
	8	12.40	11.90	12.70	11.90
	9	13.00	14.50	13.00	14.50
	10	13.90	17.20	13.60	17.20
	11	15.50	19.10	14.80	19.10
	12	16.90	20.60	16.00	20.60
	13	18.00	21.20	17.00	21.20
	14	18.60	21.60	17.70	21.60
	15	19.00	21.20	18.10	21.20
	16	19.20	20.60	18.40	20.60
	17	19.40	19.00	18.70	19.00
	18	18.90	17.40	18.70	17.40
	19	18.90	15.70	19.00	15.70
	20	17.10	14.50	17.10	14.50
	21	16.40	13.40	16.50	13.40
	22	15.70	12.90	15.90	12.90
	23	15.10	11.80	15.40	11.80

**Annexure C: Autodesk Revit Energy Analysis Results of monthly Heating Load (mBtu), Cooling Load (mBtu) and Energy Consumption (KWhr)**

Description	Months	Untreated Roof	4" BCP Room	6" BCP Room	8" BCP Room	10" BCP Room	12" BCP Room
Heating Load (mBtu)	Jan	0.60	0.52	0.50	0.39	0.325	0.32
	Feb	0.11	0.08	0.08	0.04	0.04	0.04
	Mar	0.09	0.06	0.05	0.02	0.02	0.02
	Apr	0.01	0.01	0.01	0.00	0.00	0.00
	May	0.00	0.00	0.00	0.00	0.00	0.00
	Jun	0.00	0.00	0.00	0.00	0.00	0.00
	Jul	0.00	0.00	0.00	0.00	0.00	0.00
	Aug	0.00	0.00	0.00	0.00	0.00	0.00
	Sep	0.00	0.00	0.00	0.00	0.00	0.00
	Oct	0.00	0.00	0.00	0.00	0.00	0.00
	Nov	0.12	0.09	0.09	0.03	0.03	0.03
	Dec	0.51	0.43	0.41	0.32	0.27	0.26
Cooling Load (mBtu)	Jan	0.01	0.01	0.01	0.00	0.00	0.00
	Feb	0.20	0.20	0.20	0.10	0.10	0.06
	Mar	0.35	0.26	0.25	0.15	0.10	0.10
	Apr	1.00	0.80	0.80	0.58	0.45	0.43
	May	1.65	1.43	1.33	1.00	0.80	0.76
	Jun	1.60	1.40	1.32	1.00	0.80	0.76
	Jul	1.67	1.43	1.34	1.05	0.90	0.86
	Aug	1.55	1.37	1.30	1.00	0.85	0.82
	Sep	1.25	1.20	1.15	0.85	0.77	0.75
	Oct	0.90	0.77	0.76	0.62	0.58	0.57
	Nov	0.25	0.25	0.25	0.21	0.20	0.20
	Dec	0.01	0.01	0.01	0.00	0.00	0.00
Energy Consumption (KWh)	Jan	105.00	90.00	82.00	65.00	55.00	53.00
	Feb	65.00	50.00	48.00	33.00	29.00	28.00
	Mar	77.00	58.00	53.00	35.00	30.00	29.00
	Apr	105.00	81.00	79.00	55.00	45.00	43.00
	May	145.00	121.00	115.00	80.00	67.00	65.00
	Jun	140.00	118.00	112.00	78.00	66.00	64.00
	Jul	145.00	122.00	116.00	81.00	70.00	69.00
	Aug	138.00	117.00	115.00	80.00	68.00	63.00
	Sep	120.00	101.00	98.00	71.00	62.00	57.00
	Oct	100.00	82.00	80.00	58.00	51.00	48.00
	Nov	70.00	58.00	55.00	40.00	34.00	33.00
	Dec	95.00	78.00	75.00	55.00	45.00	42.00



## Energy Simulation (Junaid's Thesis)

### Case 1 (Untreated Roof)

Analyzed at 28-Feb-18 1:23:00 AM

### Energy Analysis Result



### Building Performance Factors

Location:	Lahore, Punjab
Weather Station:	711910
Outdoor Temperature:	Max: 115°F/Min: 32°F
Floor Area:	39 sf
Exterior Wall Area:	239 sf
Average Lighting Power:	0.60 W / ft²
People:	0 people
Exterior Window Ratio:	0.00
Electrical Cost:	Rs10.00 / kWh
Fuel Cost:	Rs90.00 / Therm

### Energy Use Intensity

Electricity EUI:	34 kWh / sf / yr
Fuel EUI:	24 kBtu / sf / yr
Total EUI:	140 kBtu / sf / yr

### Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	39,482 kWh
Life Cycle Fuel Use:	281 Therms
Life Cycle Energy Cost:	Rs190,716

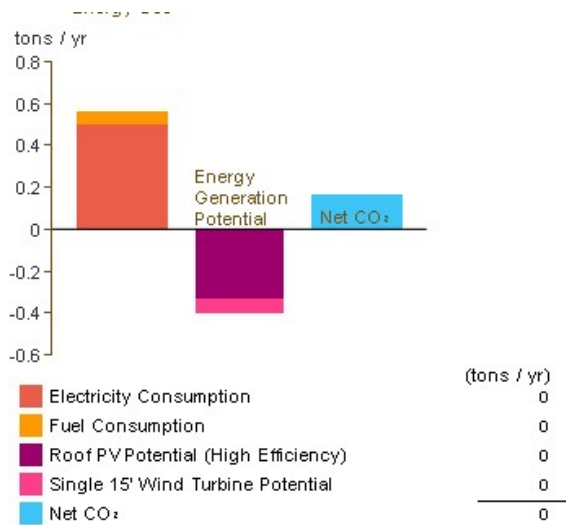
\*30-year life and 6.1% discount rate for costs

### Renewable Energy Potential

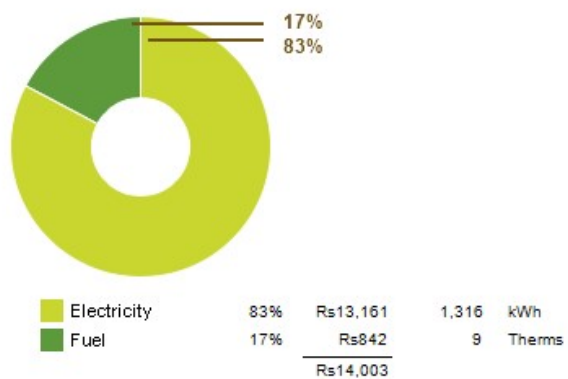
Roof Mounted PV System (Low efficiency):	286 kWh / yr
Roof Mounted PV System (Medium efficiency):	571 kWh / yr
Roof Mounted PV System (High efficiency):	857 kWh / yr
Single 15' Wind Turbine Potential:	185 kWh / yr

\*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

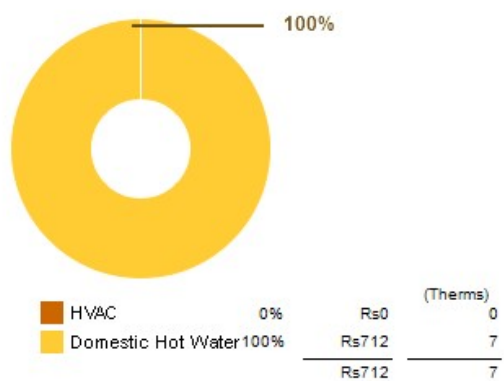
### Annual Carbon Emissions



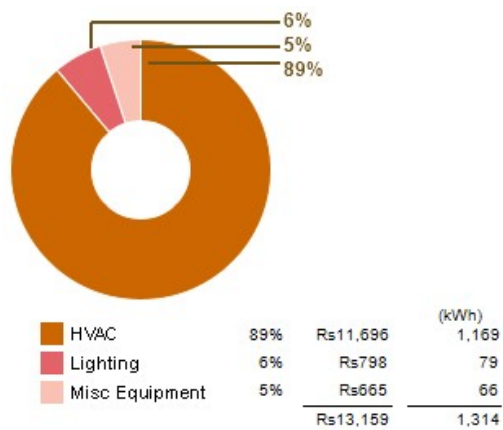
### Annual Energy Use/Cost



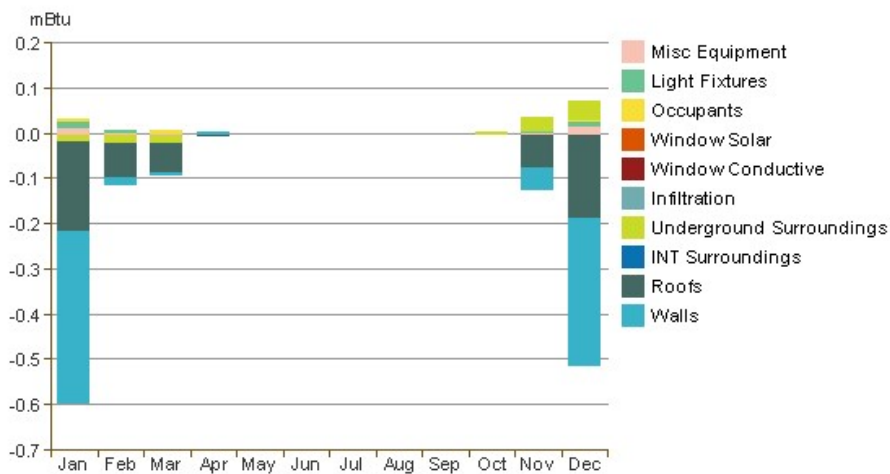
### Energy Use: Fuel



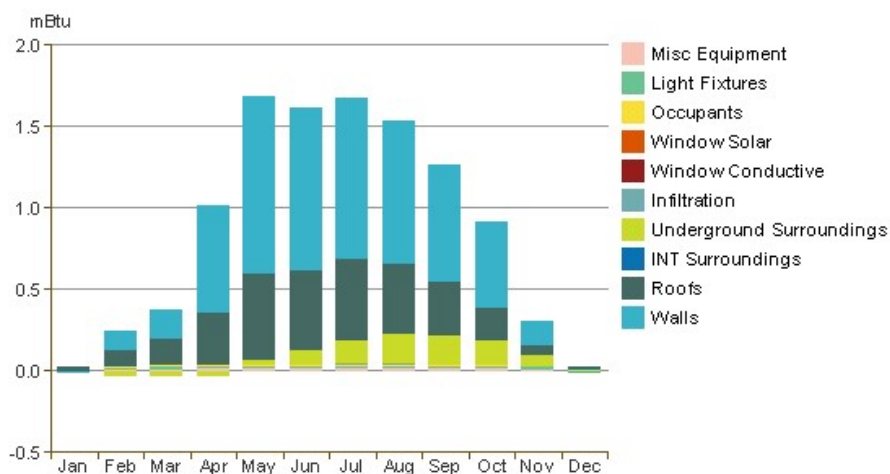
### Energy Use: Electricity



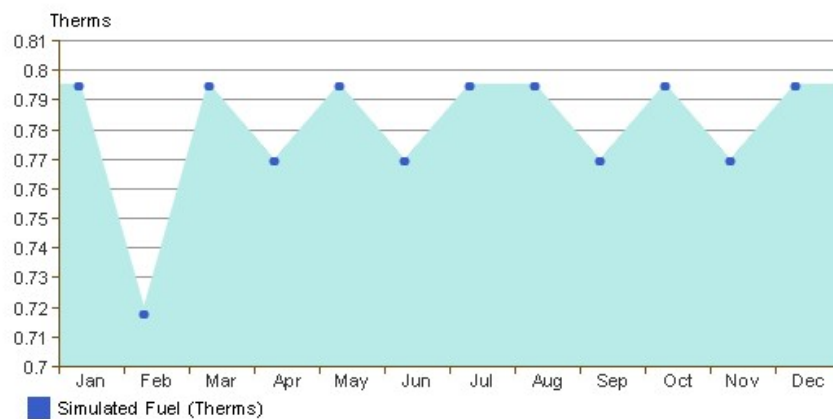
### Monthly Heating Load



### Monthly Cooling Load



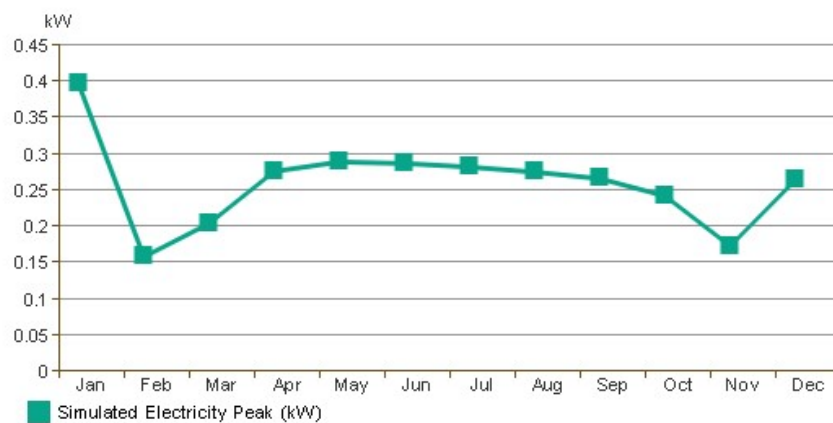
### Monthly Fuel Consumption



### Monthly Electricity Consumption



### Monthly Peak Demand



### Annual Wind Rose (Speed Distribution)



## Energy Simulation (Junaid's Thesis)

### Case 2 (4 Inch Pots Roof)

Analyzed at 28-Feb-18 1:43:57 AM

### Energy Analysis Result



### Building Performance Factors

Location:	Lahore, Punjab
Weather Station:	711910
Outdoor Temperature:	Max: 115°F/Min: 32°F
Floor Area:	39 sf
Exterior Wall Area:	253 sf
Average Lighting Power:	0.60 W / ft²
People:	0 people
Exterior Window Ratio:	0.00
Electrical Cost:	Rs10.00 / kWh
Fuel Cost:	Rs90.00 / Therm

### Energy Use Intensity

Electricity EUI:	28 kWh / sf / yr
Fuel EUI:	24 kBtu / sf / yr
Total EUI:	119 kBtu / sf / yr

### Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	32,346 kWh
Life Cycle Fuel Use:	281 Therms
Life Cycle Energy Cost:	Rs158,319

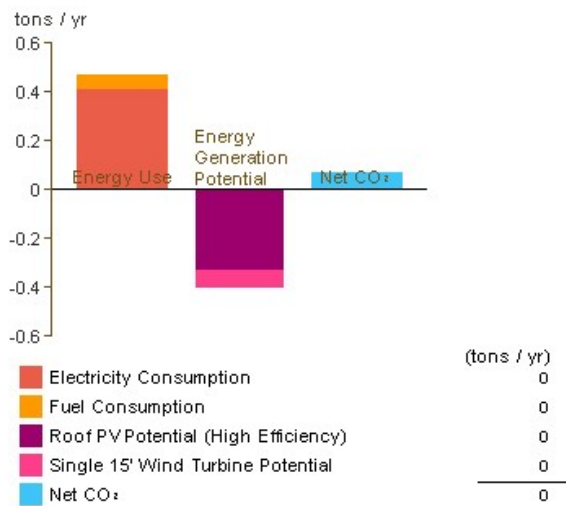
\*30-year life and 6.1% discount rate for costs

### Renewable Energy Potential

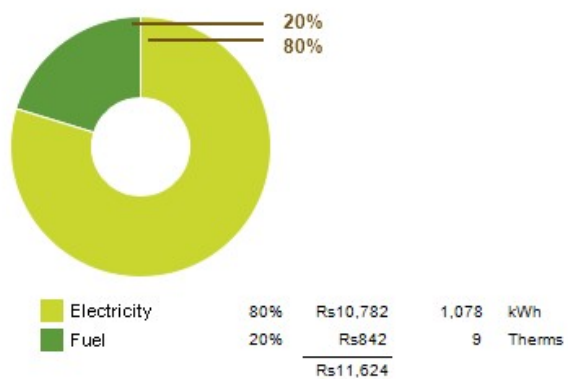
Roof Mounted PV System (Low efficiency):	286 kWh / yr
Roof Mounted PV System (Medium efficiency):	571 kWh / yr
Roof Mounted PV System (High efficiency):	857 kWh / yr
Single 15' Wind Turbine Potential:	185 kWh / yr

\*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

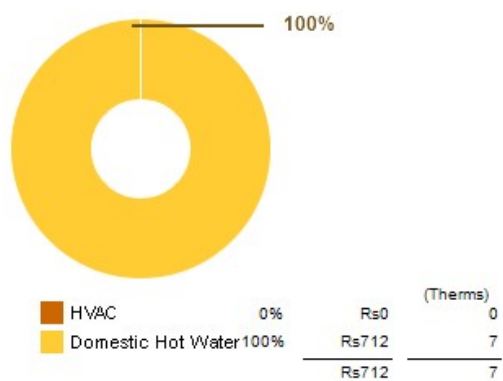
### Annual Carbon Emissions



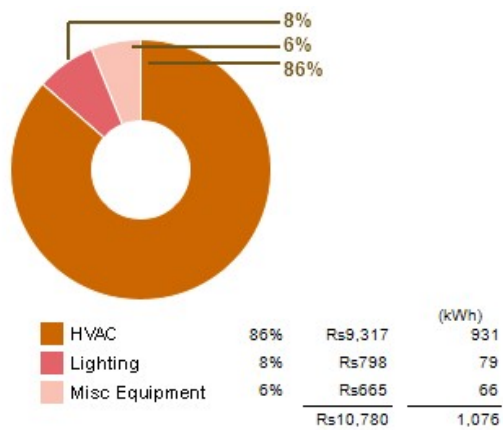
### Annual Energy Use/Cost



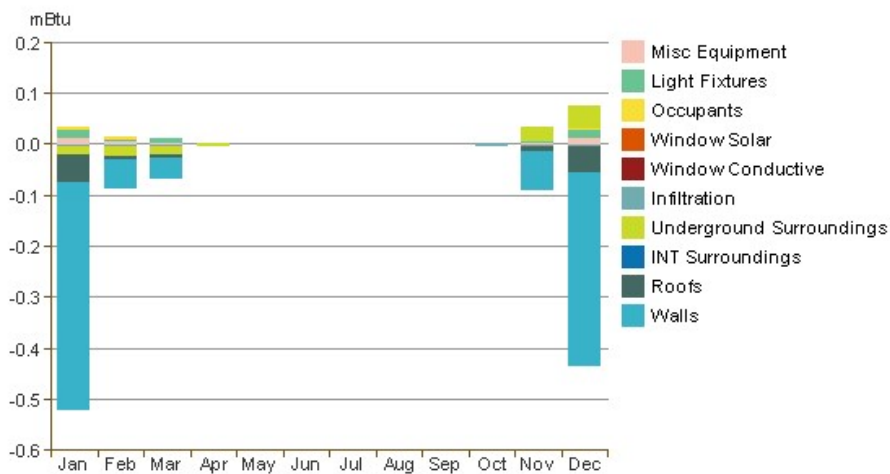
### Energy Use: Fuel



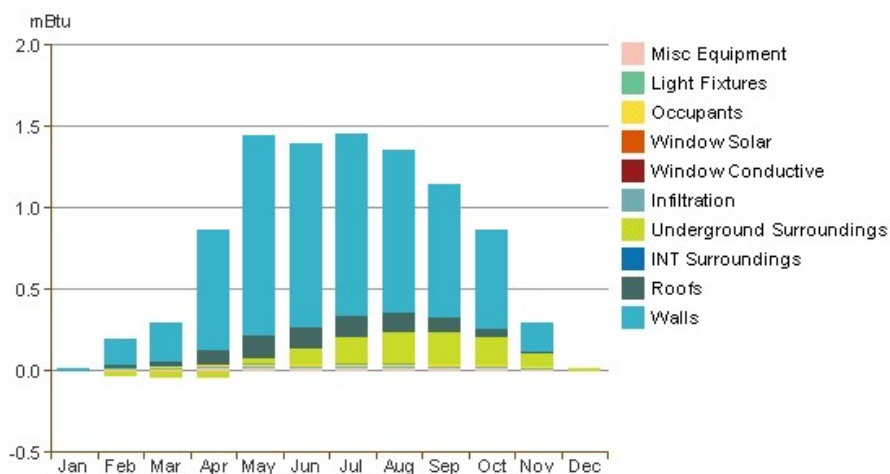
### Energy Use: Electricity



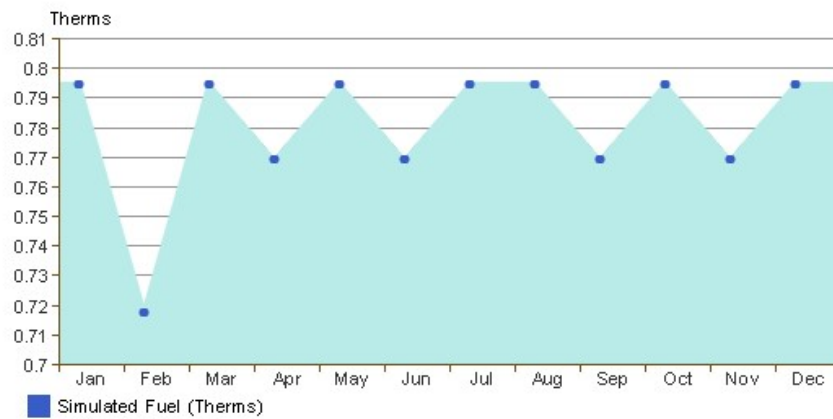
### Monthly Heating Load



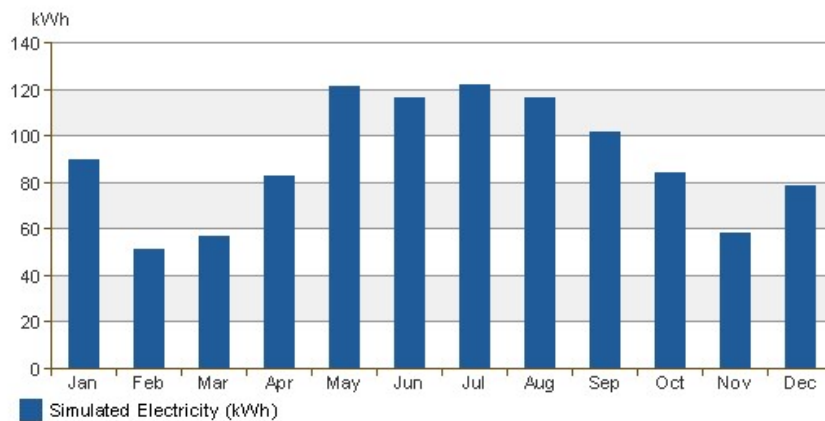
### Monthly Cooling Load



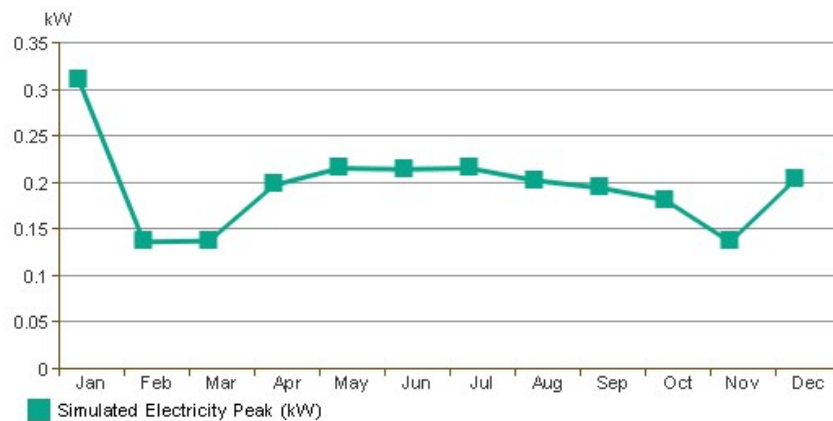
### Monthly Fuel Consumption



### Monthly Electricity Consumption



### Monthly Peak Demand



### Annual Wind Rose (Speed Distribution)



## Energy Simulation (Junaid's Thesis)

### case 3 (6 Inch Pots Roof)

Analyzed at 28-Feb-18 2:06:28 AM

## Energy Analysis Result



### Building Performance Factors

Location:	Lahore, Punjab
Weather Station:	711910
Outdoor Temperature:	Max: 115°F/Min: 32°F
Floor Area:	39 sf
Exterior Wall Area:	255 sf
Average Lighting Power:	0.60 W / ft²
People:	0 people
Exterior Window Ratio:	0.00
Electrical Cost:	Rs10.00 / kWh
Fuel Cost:	Rs90.00 / Therm

### Energy Use Intensity

Electricity EUI:	26 kWh / sf / yr
Fuel EUI:	24 kBtu / sf / yr
Total EUI:	114 kBtu / sf / yr

### Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	30,698 kWh
Life Cycle Fuel Use:	281 Therms
Life Cycle Energy Cost:	Rs150,838

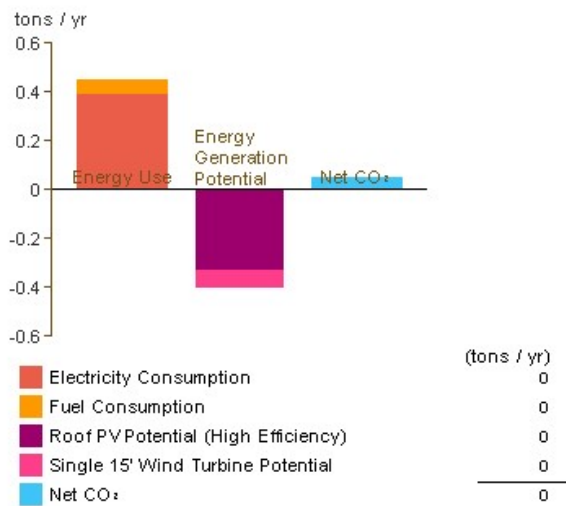
\*30-year life and 6.1% discount rate for costs

### Renewable Energy Potential

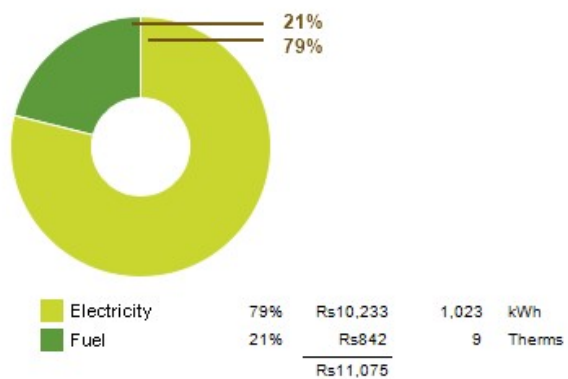
Roof Mounted PV System (Low efficiency):	286 kWh / yr
Roof Mounted PV System (Medium efficiency):	571 kWh / yr
Roof Mounted PV System (High efficiency):	857 kWh / yr
Single 15' Wind Turbine Potential:	185 kWh / yr

\*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

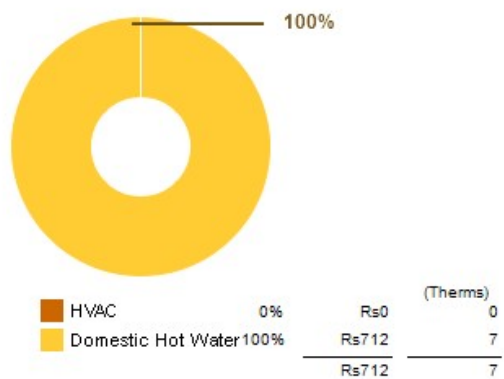
### Annual Carbon Emissions



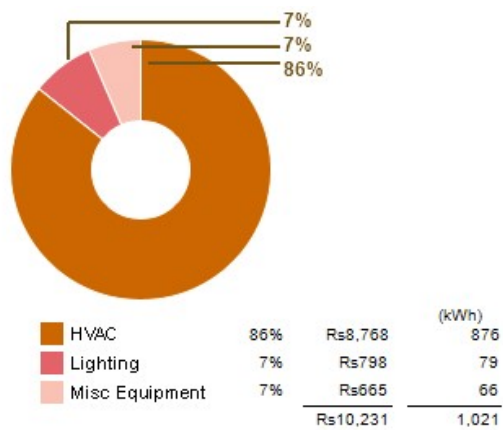
### Annual Energy Use/Cost



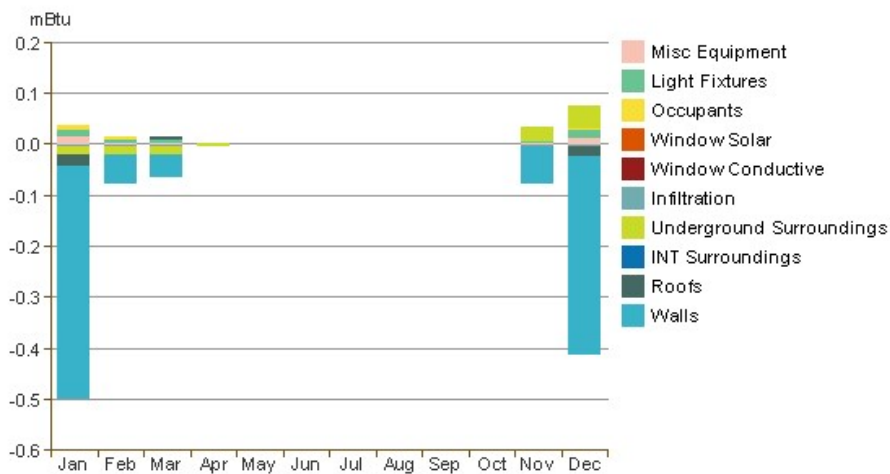
### Energy Use: Fuel



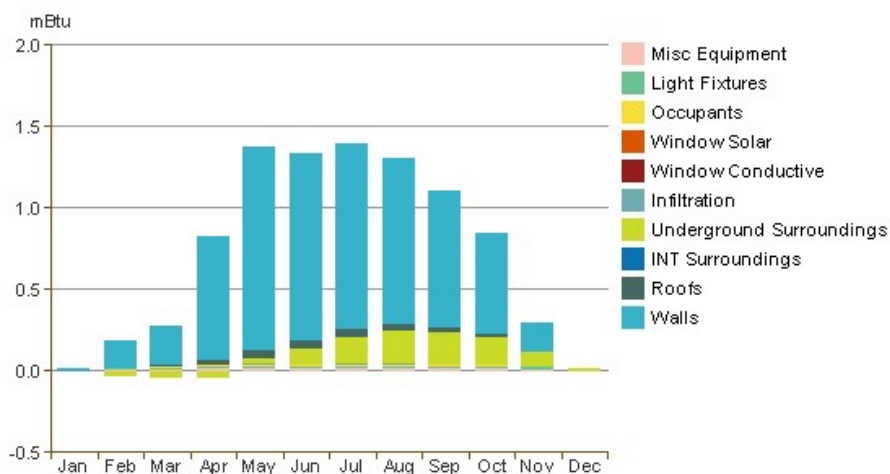
### Energy Use: Electricity



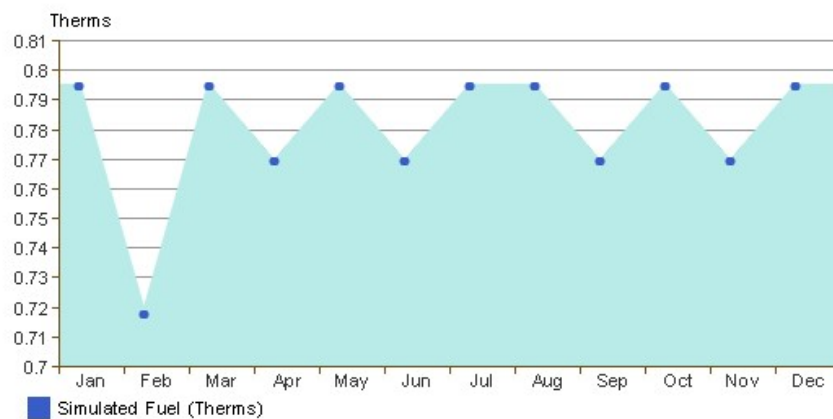
### Monthly Heating Load



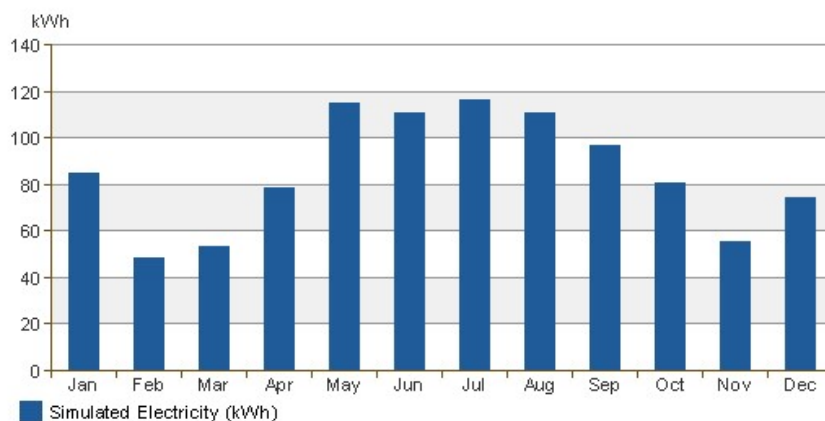
### Monthly Cooling Load



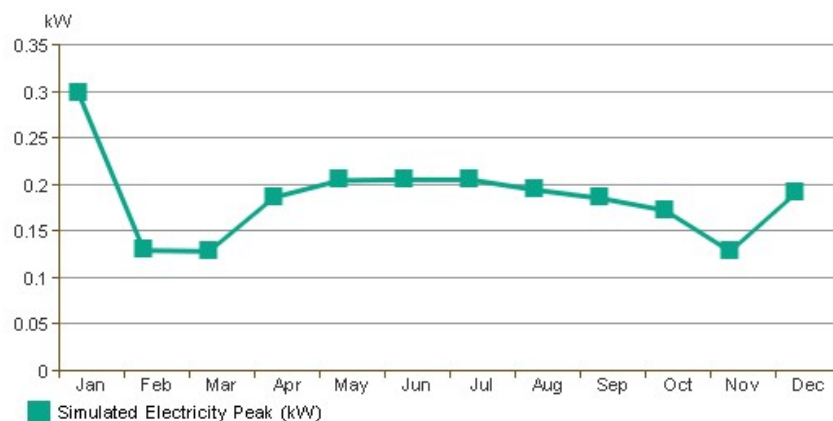
### Monthly Fuel Consumption



### Monthly Electricity Consumption



### Monthly Peak Demand



### Annual Wind Rose (Speed Distribution)



## Energy Simulation (Junaid's Thesis)

### case 4 (8 Inch Pots Roof)

Analyzed at 28-Feb-18 2:40:25 AM

## Energy Analysis Result



## Building Performance Factors

Location:	Lahore, Punjab
Weather Station:	711910
Outdoor Temperature:	Max: 115°F/Min: 32°F
Floor Area:	39 sf
Exterior Wall Area:	259 sf
Average Lighting Power:	0.60 W / ft²
People:	0 people
Exterior Window Ratio:	0.00
Electrical Cost:	Rs10.00 / kWh
Fuel Cost:	Rs90.00 / Therm

## Energy Use Intensity

Electricity EUI:	19 kWh / sf / yr
Fuel EUI:	24 kBtu / sf / yr
Total EUI:	88 kBtu / sf / yr

## Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	21,857 kWh
Life Cycle Fuel Use:	281 Therms
Life Cycle Energy Cost:	Rs110,701

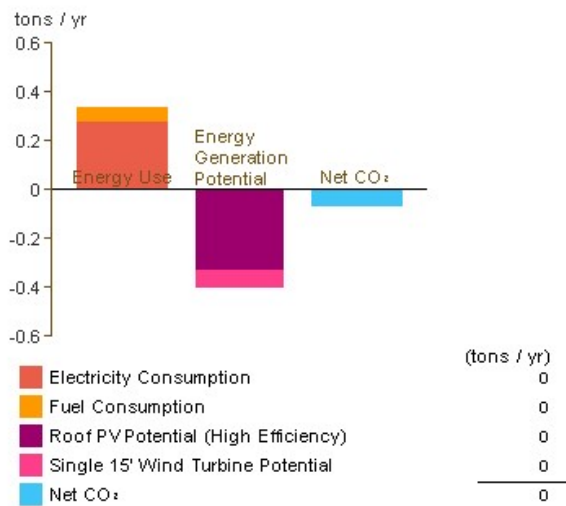
\*30-year life and 6.1% discount rate for costs

## Renewable Energy Potential

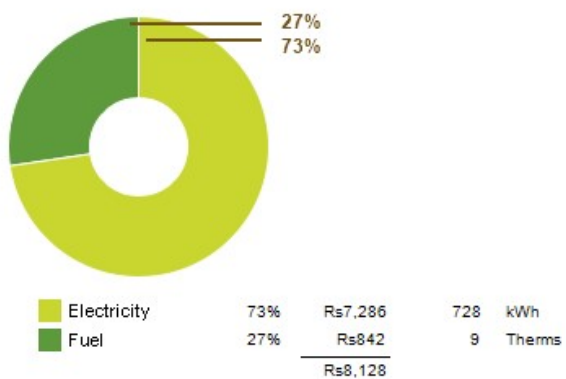
Roof Mounted PV System (Low efficiency):	286 kWh / yr
Roof Mounted PV System (Medium efficiency):	571 kWh / yr
Roof Mounted PV System (High efficiency):	857 kWh / yr
Single 15' Wind Turbine Potential:	185 kWh / yr

\*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

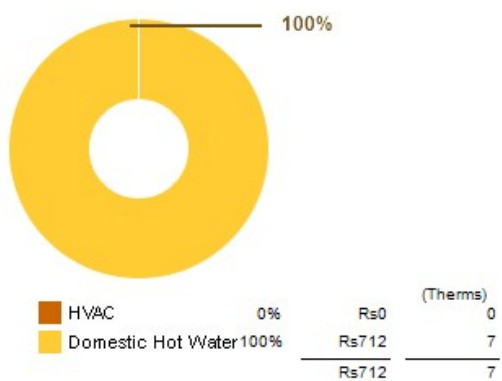
## Annual Carbon Emissions



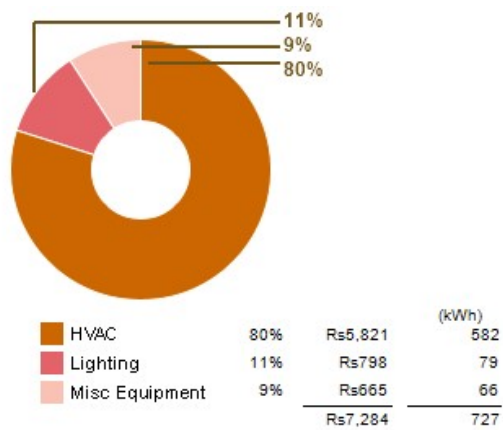
### Annual Energy Use/Cost



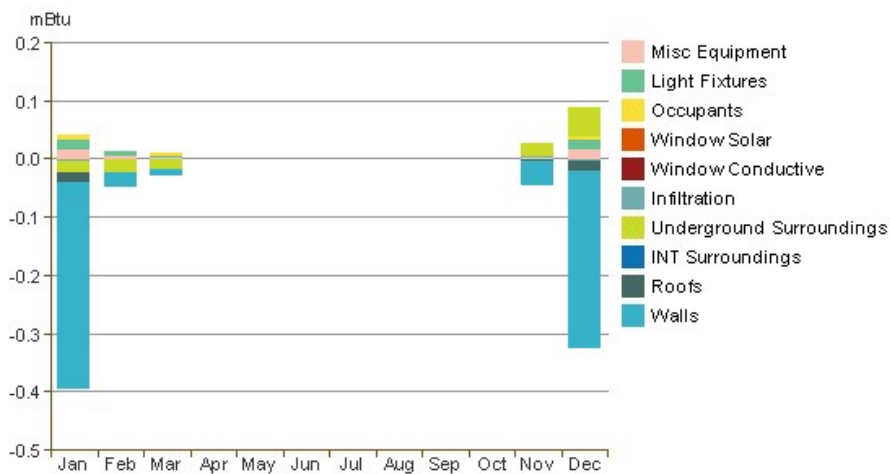
### Energy Use: Fuel



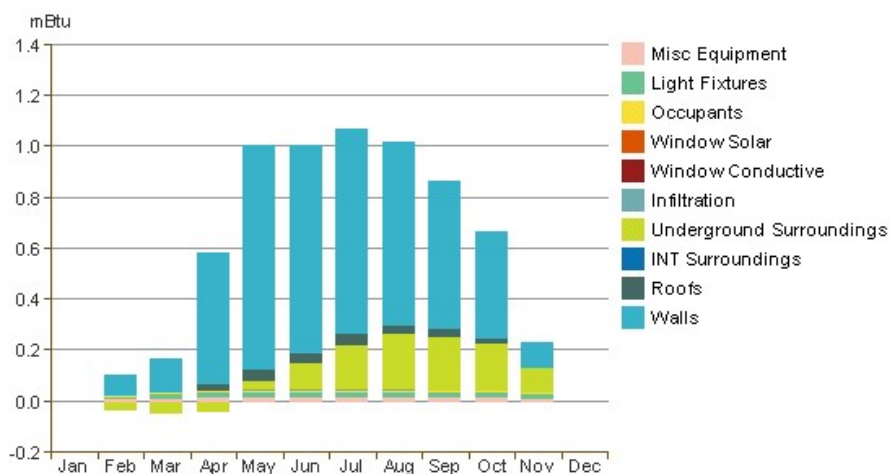
### Energy Use: Electricity



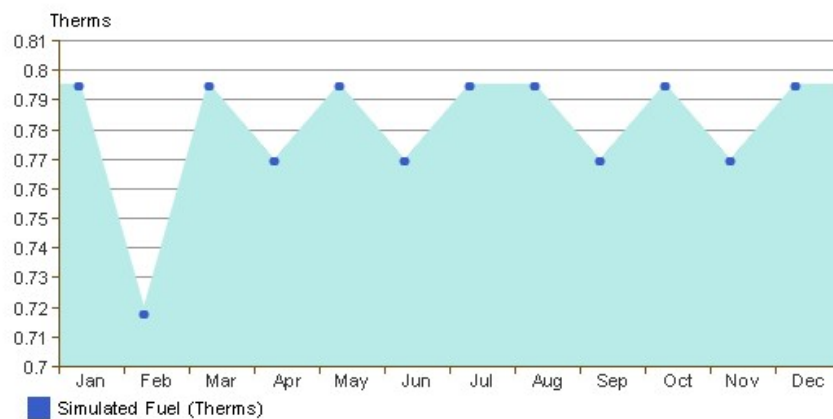
### Monthly Heating Load



### Monthly Cooling Load



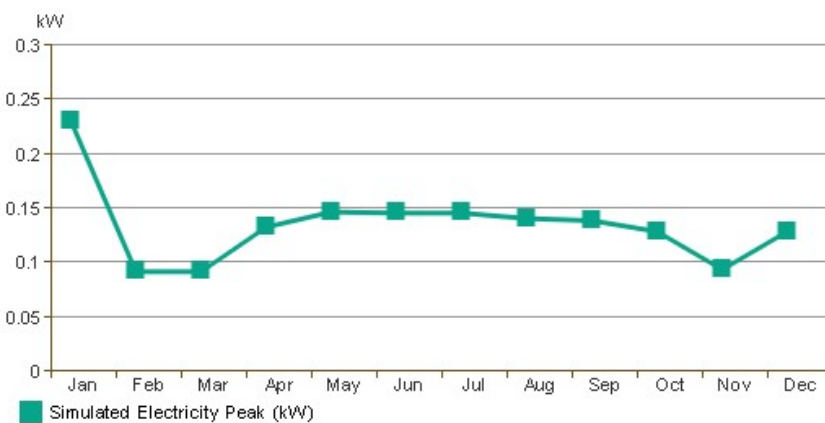
### Monthly Fuel Consumption



### Monthly Electricity Consumption



### Monthly Peak Demand



### Annual Wind Rose (Speed Distribution)



## Energy Simulation (Junaid's Thesis)

### case 5 - (10 Inch Pots Roof)

Analyzed at 28-Feb-18 2:42:40 AM

## Energy Analysis Result



## Building Performance Factors

Location:	Lahore, Punjab
Weather Station:	711910
Outdoor Temperature:	Max: 115°F/Min: 32°F
Floor Area:	39 sf
Exterior Wall Area:	259 sf
Average Lighting Power:	0.60 W / ft²
People:	0 people
Exterior Window Ratio:	0.00
Electrical Cost:	Rs10.00 / kWh
Fuel Cost:	Rs90.00 / Therm

## Energy Use Intensity

Electricity EUI:	16 kWh / sf / yr
Fuel EUI:	24 kBtu / sf / yr
Total EUI:	79 kBtu / sf / yr

## Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	18,680 kWh
Life Cycle Fuel Use:	281 Therms
Life Cycle Energy Cost:	Rs96,274

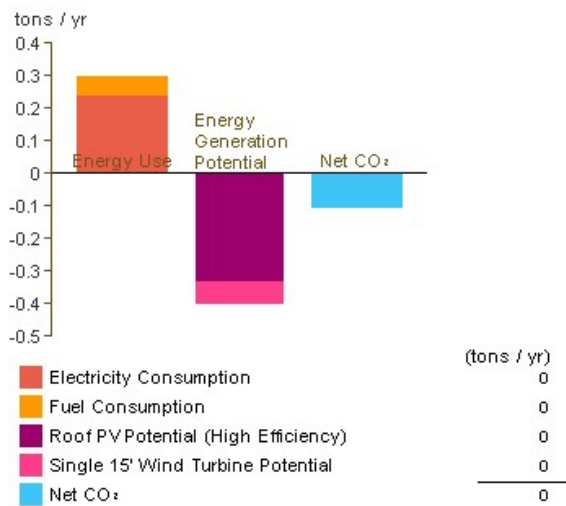
\*30-year life and 6.1% discount rate for costs

## Renewable Energy Potential

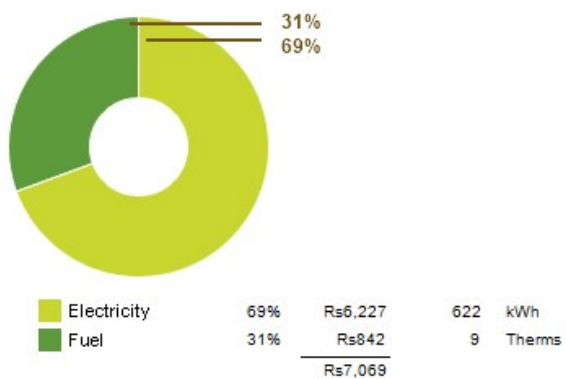
Roof Mounted PV System (Low efficiency):	286 kWh / yr
Roof Mounted PV System (Medium efficiency):	571 kWh / yr
Roof Mounted PV System (High efficiency):	857 kWh / yr
Single 15' Wind Turbine Potential:	185 kWh / yr

\*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

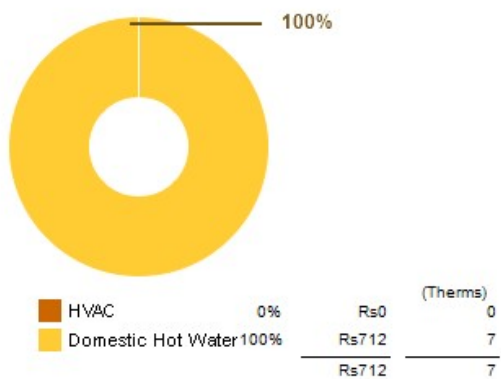
## Annual Carbon Emissions



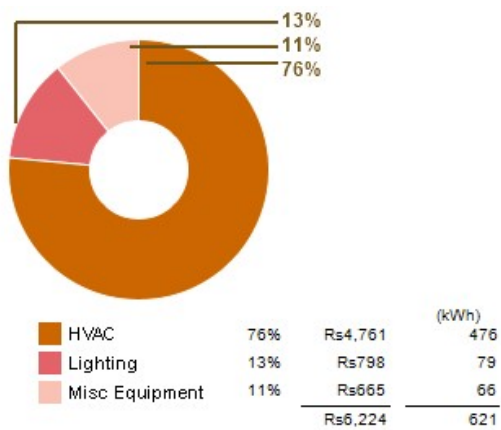
### Annual Energy Use/Cost



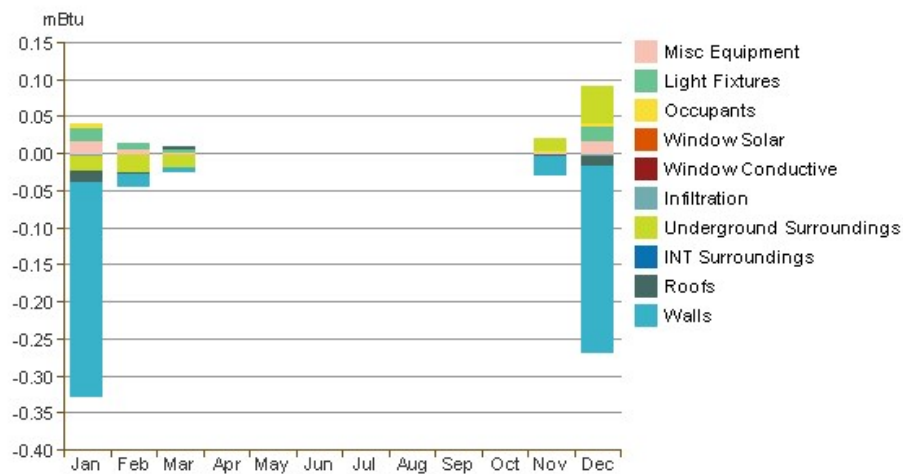
### Energy Use: Fuel



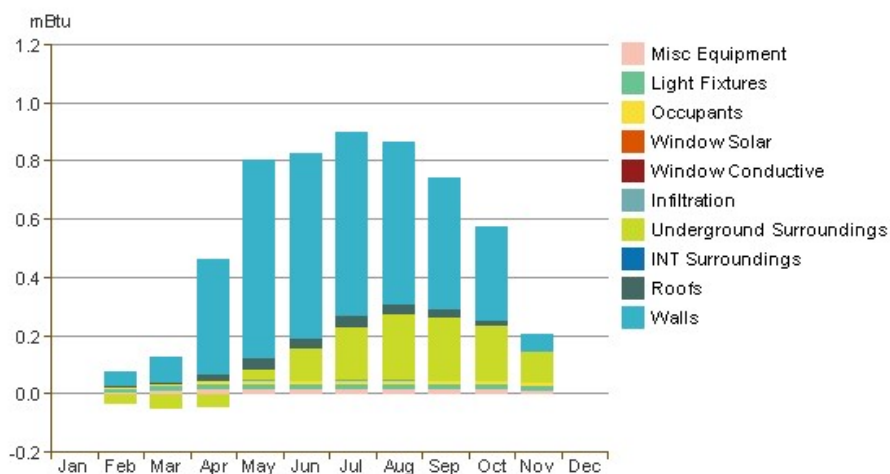
### Energy Use: Electricity



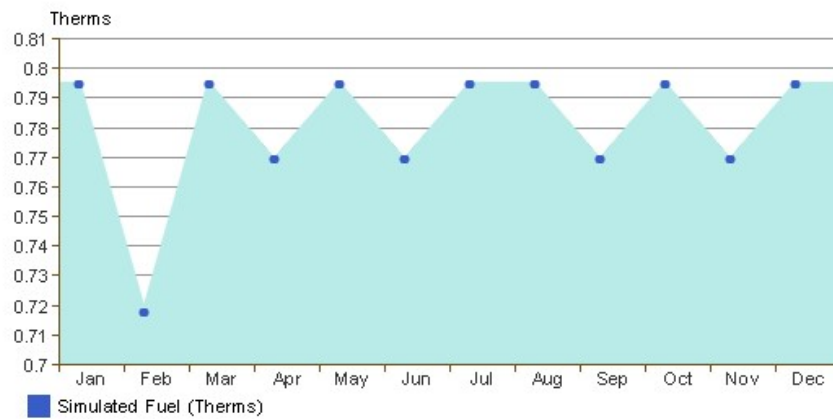
### Monthly Heating Load



### Monthly Cooling Load



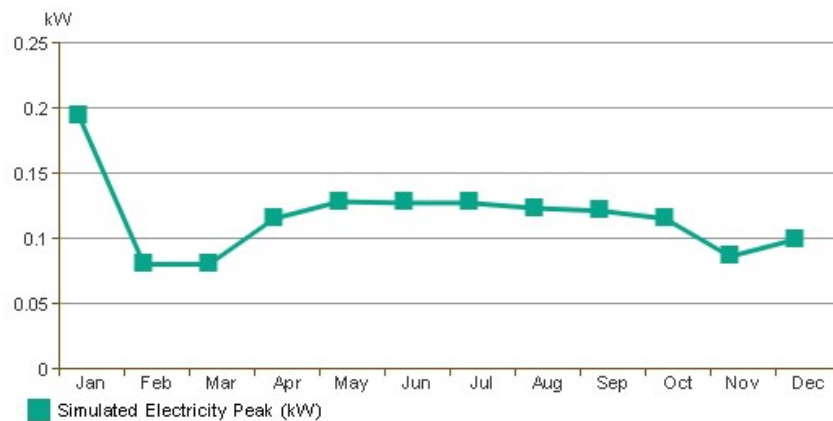
### Monthly Fuel Consumption



### Monthly Electricity Consumption



### Monthly Peak Demand



### Annual Wind Rose (Speed Distribution)



## Energy Simulation (Junaid's Thesis)

### case 6 (12 Inch Pots Roof)

Analyzed at 28-Feb-18 2:44:07 AM

## Energy Analysis Result



### Building Performance Factors

Location:	Lahore, Punjab
Weather Station:	711910
Outdoor Temperature:	Max: 115°F/Min: 32°F
Floor Area:	39 sf
Exterior Wall Area:	259 sf
Average Lighting Power:	0.60 W / ft²
People:	0 people
Exterior Window Ratio:	0.00
Electrical Cost:	Rs10.00 / kWh
Fuel Cost:	Rs90.00 / Therm

### Energy Use Intensity

Electricity EUI:	15 kWh / sf / yr
Fuel EUI:	24 kBtu / sf / yr
Total EUI:	75 kBtu / sf / yr

### Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	17,513 kWh
Life Cycle Fuel Use:	281 Therms
Life Cycle Energy Cost:	Rs90,979

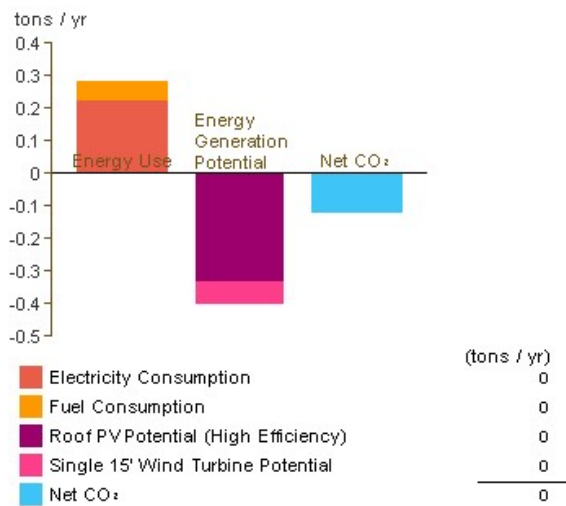
\*30-year life and 6.1% discount rate for costs

### Renewable Energy Potential

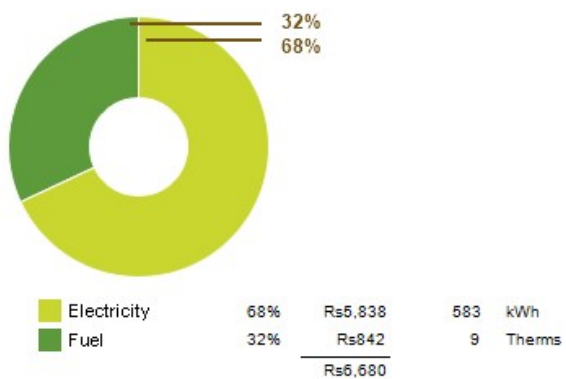
Roof Mounted PV System (Low efficiency):	286 kWh / yr
Roof Mounted PV System (Medium efficiency):	571 kWh / yr
Roof Mounted PV System (High efficiency):	857 kWh / yr
Single 15' Wind Turbine Potential:	185 kWh / yr

\*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

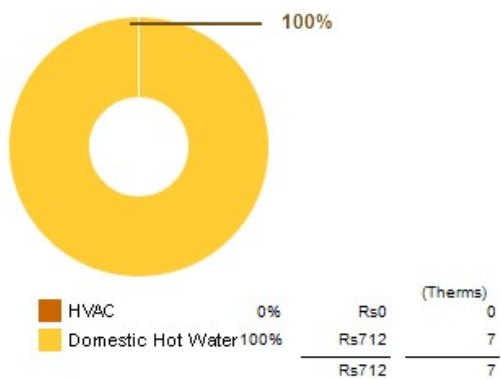
### Annual Carbon Emissions



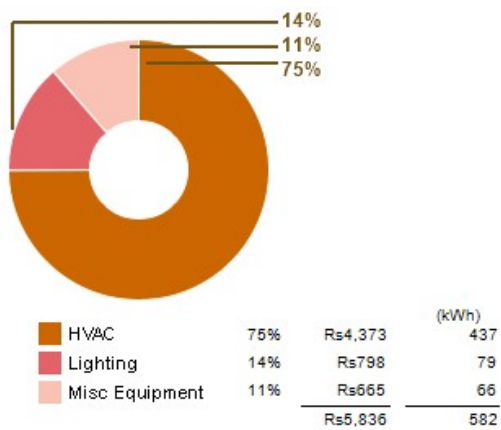
### Annual Energy Use/Cost



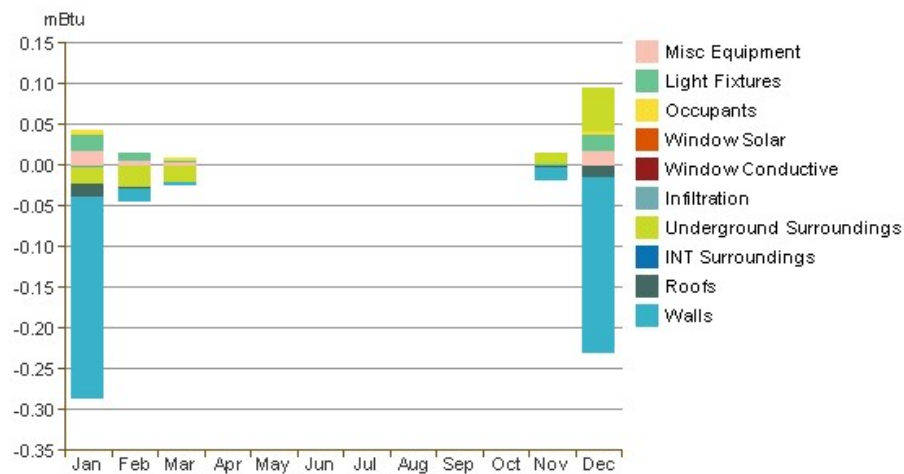
### Energy Use: Fuel



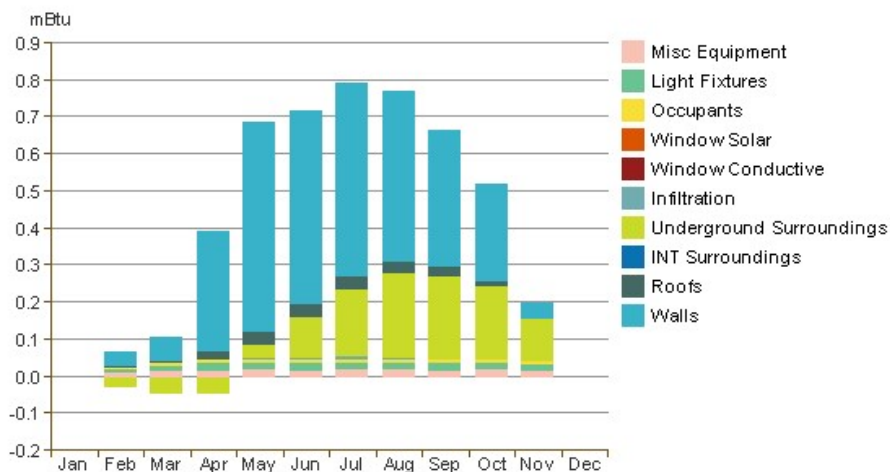
### Energy Use: Electricity



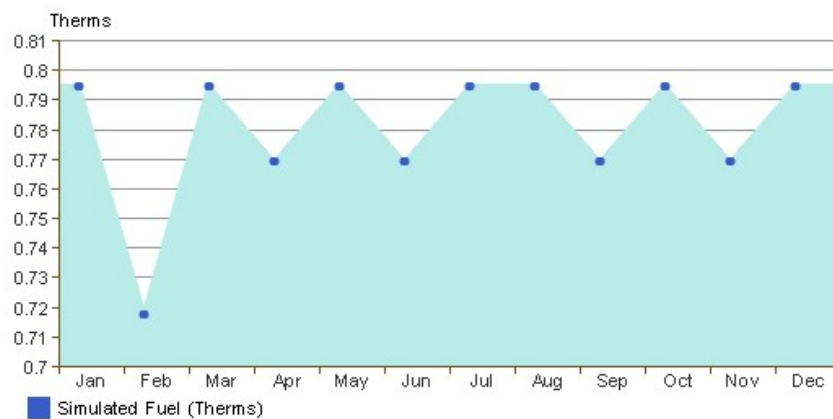
### Monthly Heating Load



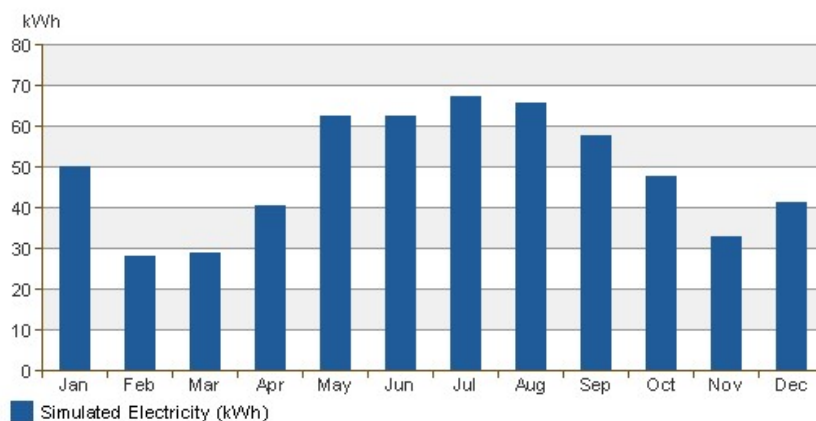
### Monthly Cooling Load



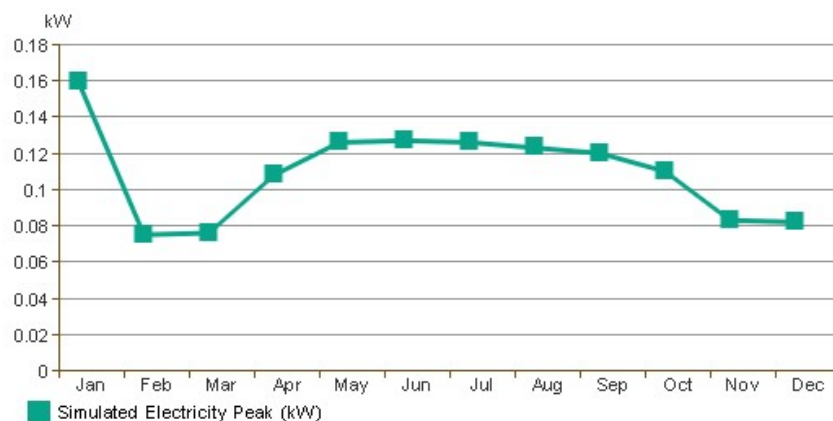
### Monthly Fuel Consumption



### Monthly Electricity Consumption



### Monthly Peak Demand



### Annual Wind Rose (Speed Distribution)