# COOLING THE BUILT; RETROFITTING GREEN ROOF TECHNOLOGY FOR SELECTED BUILDINGS AT ABBA GEDA SUB-CITY IN ADAMA CITY

Natnael Nemomsa Abdena

A Thesis Submitted to

The Department of Architecture

School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in

Environmental Architecture

Office of Graduate Studies

Adama Science and Technology University

Adama

July, 2020

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## Approval of Board of Examiners

We, the undersigned, members of the Board of Examiners of the final open defense by Natnael Nemomsa Abdena have read and evaluated his/her thesis entitled "COOLING THE BUILT; RETROFITTING SELECTED BUILDINGS AT ABBA GEDA SUB-CITY IN ADAMA CITY" and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirement of the Degree of Master's in Environmental Architecture.

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## DECLARATION

I hereby declare that this MSc Thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

Name: Natnael Nemomsa Abdena

Signature: _____________

This MSc dissertation has been submitted for examination with my approval as thesis advisor.

Name: Eshetu Temesgen Gelan (PhD)

Signature: ___________________________

Date of Submission: 10/07/2020

## ADVISOR'S APPROVAL SHEET

**To: Architecture Department**

**Subject: Thesis Submission**

This is to certify that the thesis entitled "Cooling The Built; Retrofitting Green Roof Technology For Selected Buildings At Abba Geda Sub-City in Adama City" submitted in partial fulfillment of the requirements for the degree of Master's in Environmental Architecture, the Graduate program of the department of Architecture, and has been carried out Natnael Nemomsa Abdena Id. No A/PR 15245/10 under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby he/she can submit the thesis to the department.

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| **Name of major Advisor** | **Signature** | **Date** |

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# LIST ACRONYMS AND ABBREVIATION

| | |
|---|---|
| IPCC | Intergovernmental Panel on Climate Change |
| ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers |
| UHI | Urban Heat Island |
| HVAC | Heating, Ventilating, and Air Conditioning |
| IGR | Intensive Green Roof |
| EGR | Extensive Green Roofs |
| FLL | Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau (Landscape Development and Landscaping Research Society) |
| CISR | Corrugated Iron Sheet Roof |
| CR | Concrete Roof |
| $T_r$ | Radiant Temperature |
| clo | Thermal resistance unit for clothing |

# ABSTRACT

*The study was conducted in Adama City, Abba Geda Sub-City and it covers the area from the street by Yilma Butchar to the street which turn to Awash Bank until market centers at sar-tera. The reason to select this area was that it consists different building types (residential, commercial, institutional and mixed) which can represent the whole city. The aim of the study was to evaluate the potential of the green roofs to attenuate building's indoor temperature and find techniques with minimized initial costs and maintenance costs i.e. technologies that would be affordable and easy to retrofitting green roof for existing buildings. For this purpose it has used simple statistical processes and spatial interpretation through modeling (simulation). In doing so, assessment of indoor environmental air quality of buildings for thermal comfort have been evaluated, roofing types that are in use have been studied and evaluated in terms of their thermal gain, emission, and reflection to/from the building with the help of modeling and simulation soft wares and direct data collections (in situ-measurement). From field visit and satellite images, two types of roofing has been identified to be used and two buildings one Corrugated iron sheet and another one with concrete roof selected based on accessibility and security for instruments in use. The building having corrugated Iron sheet roof had shown higher fluctuation in maximum and minimum temperature ranging 15-18$^{o}$C which was higher than that of the concrete roofed building which was 9.7-14.3$^{o}$C. Keeping these factors in mind this research proven that retrofitting green roof can minimize the maximum indoor temperature by 8.6$^{o}$C, using applying simulation. Finally, considering easiness and availability of the green roof retrofitting materials and also the structural capability of the roof types this research recommends Geo-mat green system for iron sheet roofing and Modular green system for concrete roofs.*



**Key word:** *Green Roof, Retrofitting Green Roof, Substrate, Thermal Comfort*

# CHAPTER ONE

# INTRODUCTION

## 1.1. Background of the Study

This day the make of climate change and the heat island phenomena are forcing the temperature of cities to increase continuously. If we see throughout the globe, from the total energy production the construction industry consumes 40%, water resources from 12 to 16%, renewable and non-renewables 32%, timber 25%, raw materials 40%, creates all solid wastes of 30-40%, and issuing in 35-40% of $CO_2$ release which caused sustainability to be a vitally important global awareness in the construction industry (Darko et al., 2017). The term Climate Change for the first time has been used in the 1990s, and became partly a propelling issue due to Intergovernmental Panel on Climate Change (IPCC) definition (Hamilton, 2018; Myles et al., 2018) of its fourth assessment as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities". The past two decades were characterized by increased consent toward the adaptation of changing climate because of its adverse risks and impending uncertainties (Doherty et al., 2016). In the report of 2018 IPCC (Myles et al., 2018) stated that even, "Limiting global warming to 1.5$^0$C requires rapid and far-reaching transition in land, energy, industry, buildings, transportation, and cities."

Santamouris in his review mentions the causes for the higher urban temperatures which are the positive thermal balance of urban areas caused by the important release of anthropogenic heat, the excess storage of solar radiation by the city structures, the lack of green spaces and cool sinks, the non-circulation of air in urban canyons and the reduced ability of the emitted infrared radiation to escape in the atmosphere. And he asked for the possible solutions in order to recompense such caution, to bring the development and proposals of important mitigation techniques. Increasing the albedo of cities and the use of vegetative green roofs have been found very promising, in mitigating high heat island relatively (Santamouris, 2014).

In both scientific and non-scientific literature, green roofs (vegetated rooftops), are very important in delivering the benefits of ecosystem services which are environmental, economic, and social. Among the benefits reducing the air pollution, the effect of urban heat island, energy consumption, stormwater runoff, and noise pollution, as well as the extension of roof material's life span, the lifespan of roof materials, improving urban nature's condition, increasing urban aesthetics, and amenity value and provision of space for food production (Fjendbo et al., 2017).

Green roofs play a great roll among sustainability measures by stormwater retaining reducing the runoff effect of the rainfall on the roof surface and distributing the runoff over a long-time period, resulting in the reduced urban rainwater pollution absorbing and filtering pollutants, and lowering the thermal loading on buildings (Cardoso & Vecchia, 2013). When rainwater runoff flows across conventional roofs it picks up particulate pollutants compared to rainfall, which happened to be causing to contain many heavy metals and nutrients. But green roof before they enter into the ground aquifer purifies bonding with some soil particles and remove the impurities such as Nitrogen and Phosphorus. Plants can take a great amount of cadmium, copper, and lead, and also a prominent level of zinc and nitrogen levels, out of the rainwater. Nevertheless, green roofs have been to be possible pollutants when easily dissolvable fertilizers are applied to them (Ugai, 2016).

Lowering the surface temperature is required for the creation of cool communities. The surface characteristics such as albedo, roughness, and emissivity determine the surface temperature of roofs. The means of cooling by green roofs take place through improved reflectivity of incident solar radiation and latent heat loss. They can cool as effectively as the brightest possible white roofs, with an equivalent albedo of 0.7-0.85 compared with the typical 0.1-0.2 of a bitumen/tar/gravel roof. By measurement, green roofs have been found to reduce the summer heat gain by an average of 70-90% and the winter heat loss by 10-30% (Ugai, 2016).

Nowadays in many countries of the world green roofs are being implemented due to their multiple benefits. As a result of this many researches are being conducted on the implementation and performance of green roofs in different regions and different environmental conditions around the world. These researches have shown numerous social, environmental, and economic benefits of green roofs (Sha et al., 2018a).

Most of previous researches in the country which are related to this study area are concerned in promoting eco-design, ecological building envelope materials, enhancement of green infrastructures (vertical greening), life-cycle assessment of building materials and etc., but this research specifically studied the thermal performance of green roof. Researches have been done in other country the same way as this research has been done but they use different approach than this research. While they use down scaled building prototype this research uses the building itself to experiment.

This study was driven first, by the lack of awareness observed in the sector, intending to promote green roof and its thermal benefit in regulating the indoor temperature, second many buildings have already been built without green roof retrofitting is the only option, third in filling such gap it is important to bring forward easy and affordable ways of retrofitting green roof to encourage building owners and stakeholders. The field of study is new in the country which makes this research an eye opener.

## 1.2. Statement of the Problem

Being situated in the Great Rift Valley of East Africa, Adama is characterized by its hot climate. According to The Reporter Ethiopia, the population of Adama is estimated to be 500,000. The opening of the industrial park and the growing trade and manufacturing sector is expected to increase the population. With this addition of the population of the town, it is also expected that an increase in buildings to occur. According to the research done by Sinha et al., in a period of 32 years (1984-2015), the built-up area in Adama municipality has increased almost by 293% which showed excessive alteration of land-use occurring in the area (Sinha et al., 2016). Such a change in land use will on the other hand create massive destruction of natural habitat (vegetation) and expand the urban impervious surface.

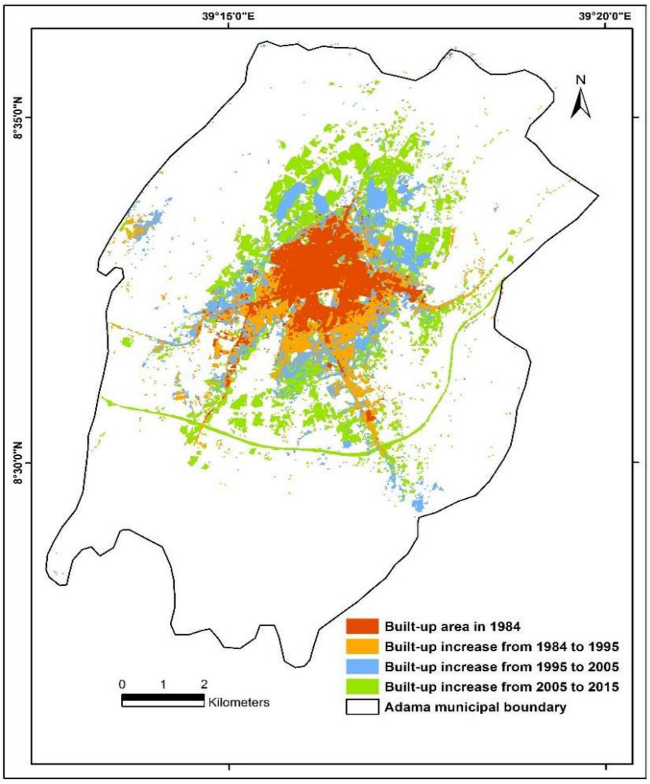



FIGURE 1*:* BUILT-UP AREA EXPANSION FROM 1984 TO 2015 IN ADAMA MUNICIPAL AREA

Source: (Sinha, Verma, & Ayele, 2016)

As a result of the expansion of built environment taking place in the city causing the degradation of the natural landscape, which has the capacity to regulate both micro and macro level climatic conditions, the creation of localized heating (urban heat island effect) and the increase of indoor air temperature are getting worse. Especially when hot seasons come the indoor temperature raise the thermal stress which is difficult for the occupants in buildings.

When the indoor temperature of a building is between 19.5 and 25.5˚C buildings can operate in free-running mode. One can maintain an acceptable thermal environment by using ceiling fans or personally controlled fans between 25.5˚C up to 30.0˚C. But for higher temperatures, one needed cooling and can use a personally controlled heater for the temperature below 19.5˚C (Forgiarini et al., 2015).

Being in direct contact with both the external and internal environment building envelops are the main contributors to this, which roof is one. Therefore, focusing on the envelopes of the building to control the internal thermal comfort is a wise decision. Among many mitigation measures that can help green roofs are practiced in a lot of western countries even until policymaking concerning the requirements for green roofing. But in opposite to such a practice, this kind of roof construction is not well known and practiced throughout the country except few.

Planning to construct buildings with the green roof is easier than to retrofit the built one; because there are additional considerations to be taken for its structural loads, waterproofing work, and also a change of features. Because of very limited research in under developing countries, building's owners and stakeholders are not aware of the green roof benefits and installing techniques. Thus, they are afraid of retrofitting their buildings with green roof in thought of failures resulting from the leakage of green roof.

The construction of green roof also has to be guided by the standards and guidelines which specify the requirements for green roof retrofitting, which the country lack. Like European countries especially German, before the practice of green roof expanded with poor quality it is important to have localized (contextual) standard and guideline for planning, construction, operation, and maintenance of green roofs.

Studies concerning green roofing are very difficult in Ethiopia. Few studies have been conducted in incorporating green infrastructures into urban areas using building envelope. But they lack depth and are not directly related to the green roof or green roof retrofitting. Abdelwehab (Mohammed, 2018), in his thesis had studied to enhance green infrastructures to bare walls. But the concern of his study was not thermal regulation or attenuation. Concerning this many researches have been conducted in developed countries like USA, Australia and European countries like German, Italy, etc.

## 1.3. Objectives

**General objective**

This study aims to evaluate the green roof's potential to attenuate building's temperature and to find techniques with minimum initial costs and maintenance costs i.e. technologies that would be affordable and easy to retrofitting the green roof on existing buildings.

**Specific objectives**

1. To assess the current trend of roofing and thermal performance of these roofing materials in Adama City Abba Geda Sub-City.
2. To examine the thermal performance of green roof and develop affordable and easy technology of retrofitting green roof for existing buildings at Abba Geda Sub-City Adama City.

## 1.4. Research Question

What are the roofing trend in Adama Abba Geda sub-city and how does they perform thermally? How much could green roof attenuate building's indoor temperature and what technique is available to retrofitting green roof easily and cost-effectively to existing buildings?

## 1.5. Significance of the Research

For one to perform well certain activity, there has to be a comfortable environment in which that person be able to function. Even if comfort is subjective there are ranges of the comfort level in which one can gain comfort which researchers established after so much researches. Buildings are the result of the search for such comfort by the protection they provide against solar radiation, rain, extreme wind, noise, and other uncomfortable things. As we have seen above instead of providing a comfortable indoor environment if buildings get to cause such trouble, there have to be measures to place them back to their purpose. Green roofing has been found to be one of the many ways to maintain thermal comfort in a building in passive way.

Buildings in our country are built without consideration for green roofing. Few hotels and school buildings are designed with a little amount of green space on their balconies or terraces. Due to this, there are no researches conducted or published with this topic that using the keywords in green roof retrofitting no research or project or any publication in the country could be found. Therefore, this research is of great value in a way one, it is among the pioneering studies on green roofing or retrofitting, two, times will come when peoples need to retrofit their buildings as mitigation for thermal comfort or as leisure, because of the changing climate. It is better starting from now on Architects and Engineers consider the greening of buildings from the start. But for those existing buildings and buildings which are being built without such consideration to think techniques to retrofitting greeneries. At such a time this research can be of great importance providing easy way of retrofitting green roof for existing buildings.  The output of this research helps not only individual building users but the entire city will be benefitted due to its impact in reducing the heat island production of the built environment.

## 1.6. Scope and Limitation of the study

The study was conducted in Adama city Abba Geda Sub-City having multiple advantages, which makes the selection of the city more appropriate. One reason was that the temperature of Adama is increasing and due to this reason, it is uncomfortable to function in the buildings without the usage of other air conditioners. The study area covers starting from the street to Yilma Butchar to the street which turn to Awash Bank until market centers at a place called sar-tera.

Evaluating thermal performance of the roofs of selected buildings and green roof, recommending potential retrofitting option for existing buildings.

The research encounters limitations of access to technology, resources, and time. When we say limitations related to access to technology on green roof practices, because this technology is not well-practiced in the country, not so many studies could be found in the area. Regarding resources, the budget given by the university is not enough to taste each design prototype green roof building, like other studies mentioned in the research as the study mainly relies on demonstration via modeling.

## 1.7. Organization of the research

This thesis is organized into five chapters. Chapter 2 presents a review of the literature relevant to the study of both conventional and Green roof systems. The chapter begins with an overview of problems caused by the built environment which green roof has been presented as a solution in this research. Next to that, it has tried to view the evolution of green roof roughly. Following this, the benefits of green roofs are discussed from different angles, which leads to the study of thermal performance and factors that affect the performance of conventional and green roofs which is the main focus of the research. This is followed by a discussion of Green roof systems, their various types, and components. The benefits related to thermal properties are discussed in detail since these are widely considered to be the primary ones from an engineering standpoint. Potential challenges and costs associated with Green roofing systems are also discussed. Heat transfer is then discussed, with emphasis on heat transfer by one-dimensional steady-state conduction, as is relevant to the current research.

Chapter 3 presents details of the setup of the case study buildings and research methodology used during the course of the research. The procedures used to calibrate the various experimental and data acquisition instruments are discussed along with an overview of the details and functioning of the environment that was used to simulate the temperature of the environment experienced during minimum and maximum temperature measured from selected buildings.

Chapter 4 presents and discusses the results of the research. Discussions of the temperature recorded from indoor environment of selected buildings in comparison with the external climate data have been presented. The result of simulation of a building model with green roof also presented comparing to the actual data that have been collected from the same building without green roof using thermal data logger.

Chapter 5 presents conclusions and recommendations based on the findings of the research presented. Two different techniques of retrofitting green roofs have also been presented as a recommendation.

## 1.8. Operational Definitions

Green Roof: in this paper the term green roof has been used to represent roofs having vegetation upon them with necessary layers.

Intensive Green Roof: a deeper type of green roof having thickness 180-400mm with plants such as shrubs, and trees which have deep roots and use irrigation system to water plants.

Extensive Green Roof: shallow green roof type having thickness 60-150mm uses plants which have small root to prevent the lower layers and the roof deck from penetration.

Growing Media (Substrate): soil layer of green roof over which plants grow.

Geotextile: thick permeable mattress laid under the soil layer which let water pass through and prevent the soil not to be washed by water; it also retain water somehow.

Drainage Cells: mostly used in an intensive green roof to retain water and let excessive water to the drain system of the roof

Thermal Comfort: according to ASHRAE it is “that condition of mind that expresses satisfaction with the thermal environment and assessed by subjective evaluation.”

Thermal Comfort Zone: those combinations of air temperature, mean radiant temperature, and humidity that are predicted to be $t_r$ an acceptable thermal environment at particular values of air speed, metabolic rate, and clothing insulation $I_{cl}$.

Humidity: a general reference to the moisture content of the air**.**

Air Temperature: The temperature of the air at a point

Climate Data: hourly, site-specific values of representative meteorological data, such as temperature, wind, speed, solar radiation, and relative humidity.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1. Introduction

The populations of the world have been increasing and peoples are migrating from place to place, resulting in the development of urban areas, to become cities. The United Nations Department of Economic and Social Affairs, Population Division had reported that in 2014 fifty-four percent of the world's population was residing in urban areas, and by 2050 the world's population residing in cities is estimated to be sixty-six percent. This results in the construction of many new buildings to accommodate the growing population. Though this has been considered as a basic requirement in the development of the urban settlement, it is bringing forth environmental problems, such as Urban Heat Island (UHI) an increase in temperature in highly dense locations. The effect of UHI is getting worse in the urban areas and cities The loss of green areas in the urban environment and cities because of the loss of green areas in such places (Wilkinson et al., 2017).

Throughout the world, the building sectors consume around one-third of the total primary energy resources around the world and producing 30% of global $CO_2$. The growing demand for improved indoor thermal comfort is responsible for the increasing use of energy by the building sector over the years due to the broader application of HVAC systems. Building's energy consumption is highly affected by air temperature more than other parameters such as air humidity, $CO_2$ concentrations, etc. in relation to indoor thermal comfort (Afroz et al., 2018).

The thermal comfort condition of the indoor environment also is affected by the shortage of vegetation in the outdoor environment causing remarkable increases in surrounding temperatures stress. By the utilization of different kinds of green systems, one can regulate the microclimatic conditions of an existing building in a cost-effective and eco-friendly way. In urban areas, the quality of the urban environment such as the quality of air and water, the management of stormwater, the densification of vegetation, decrease in the emission of temperature, and carbon can be improved by integrating these green systems with buildings (Besir & Cuce, 2018).

Roofing systems are one of the lesser understood components of a building from an engineering point of view, but they are essential components of the building envelope for ensuring its optimal in-service performance. The urban world's total roof area is estimated to be closer to 3.8 X $10^{11}m^2$ providing a very high portion of the exposed urban area. This estimation is 2.26 times lesser than which is assumed using the analysis of satellite data. From the total impermeable areas of the developed cities, 40-50% of the urban areas account for the roof area. These data show the incredible impact that if roof areas changed into green areas (green roofs) could be brought (Sha et al., 2018).

Green roofs are basically, planted roofs with different kinds of vegetation & plants using growth medium (substrate) to plant on. The components of a green roof vary depending on the type, but typically it consists of vegetation, substrate, filter layer, drainage material, insulation, root barrier, and waterproofing membranes. To get the best outcome from, it is required to have the optimal consideration during the selection of each component (Sha et al., 2018). The layering of these green roof components starting from below is, right on top of the roof deck is a waterproofing membrane to prevent moisture from entering the building. Next to this membrane is a root barrier layer designed to block roots from penetrating the waterproofing membrane and the structural roof below. Above the root barrier, a drainage layer is laid. The drainage layer can be either some engineered coarse-grained porous media or plastic profiled elements, store water for the plants in the dry season and passes excess runoff to roof drain. A filter fabric is installed next to the drainage layer to prevent soil washed away and water reaches to the drainage layer to be stored. Finally, the growing medium (substrate), a blend of mineral material enriched with organic material, upon which plants grow will complete the green roof (Fioretti et al., 2010).

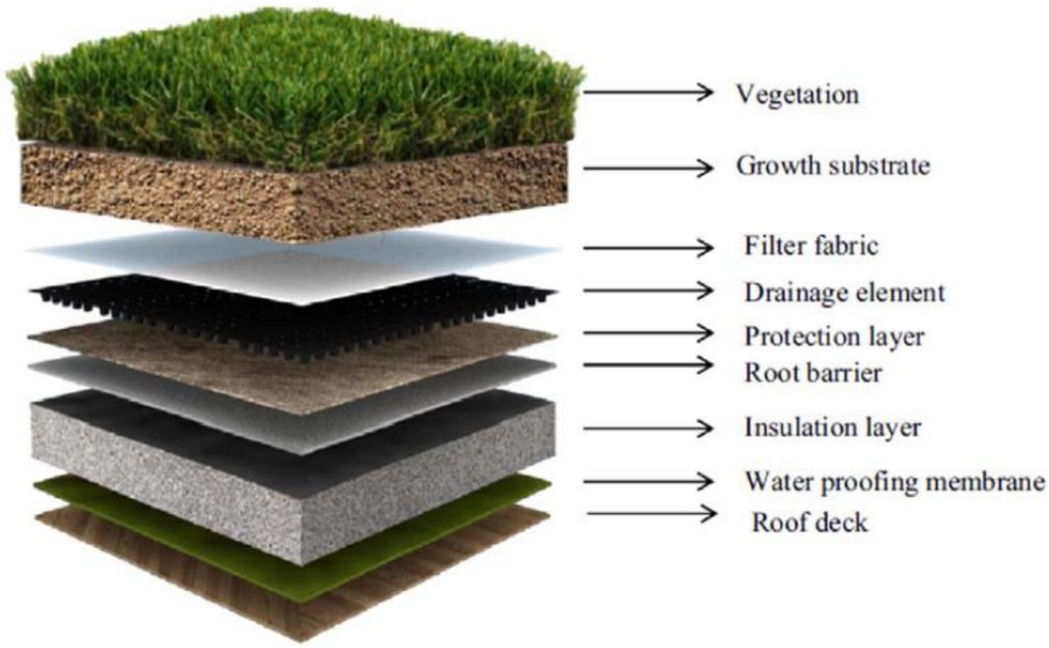



FIGURE 2: SCHEMATICS CONSTITUENTS OF GREEN ROOF

Source: (Besir & Cuce, 2018)

Multi-layer green roofs are usually classified into (a) Intensive Green Roof (IGRs), and (b) Extensive Green Roofs (EGRs). Intensive green roofs are real hanging gardens, with a thicker substrate layer allowing deeper rooting plants such as shrubs and trees to survive and require significant costs in terms of installation and long-term maintenance. The substrates are complex and also the mechanical stress (e.g., weight, solicitation, etc.) on the building structure must be carefully evaluated. Generally, thickness, mass, and nature of the vegetative layers do not allow the installation of existing buildings. An extensive green roof, on the other hand, has a thin substrate layer only low-level plants which typically are sedum or lawn known for its lightweight, require lower initial costs, and low thickness, weight, operating costs, and maintenance requirements (Castleton et al., 2010).

**Table 1:** Types of green roofs (Besir & Cuce, 2018)

| | EGRs | IGRs |
|---|---|---|
| Maintenance | Low | High |
| Irrigation | No | Regularly |
| Plant communities | Moss, Sedum, Herbs, and Grass | Lawn or perennials, Shrubs, and Trees |
| Cost | Low | High |
| Weight | 60–150 kg/m2 | 180-500 kg/$m^2$ |
| Use | Ecological protection layer | Park-like garden |
| System build-up height | 60–200 mm | 150-400 mm underground garage $\geq$ 1000 mm |

Moreover, referring to thermal performance, different researchers studied green roofs in many different approaches. Some performed simulations to obtain the annual or seasonal achievable thermal minimization. Others reported experimental analysis and result in terms of the effect on the outdoor air temperature and the vertical temperatures across the different layers, often compared with a reference control roof. Commonly, in simulations, leaf area index (LAI) and plant height, fractional cover, albedo, and stomatal resistance are the most important characteristics to define the vegetation layer.

The awareness of stakeholders and building owners concerning the benefit of green roofs in underdeveloped countries is very low because of the very limited researches. The application of green roof needs awareness creation, information sharing, and encouragement of the building owners and stakeholders (Sha et al., 2018b). The following sections endeavor to provide the reader with insight into how new approaches to roofing, in this case using Green roofing technologies, may be able to provide more sustainable roofing alternatives when compared to conventional roofing systems.

## 2.2. History of Green Roofs

The Hanging Gardens of Babylon dated back to 500 BC was believed to be the earliest examples of greenery systems. In like manner, the Roman and Greek empires also employed these systems in their eras. In the Mediterranean region, during summertime, to afford a cool and comfortable indoor environment, they use plants especially vines. But this thesis will focus only on the origins of roof vegetation that led to the modern extensive green roof rather than a broader examination of green roofs throughout the globe.

The start of the modern-day green roof dated back to 1960s at the time when the energy crisis rose to reduce the energy demands of buildings for heating and cooling. Germany is the leading country in the green roof. Between the 1980s and the late 1990s, approximately 246,000 $m^2$ of green vegetation was integrated into the building facades located in Berlin. Currently, the annual increase in green roof coverage in Germany is reported to be about 13.5 million square meters, which is remarkable. In other words, 10% of the houses in Germany can be considered as green buildings as of now.

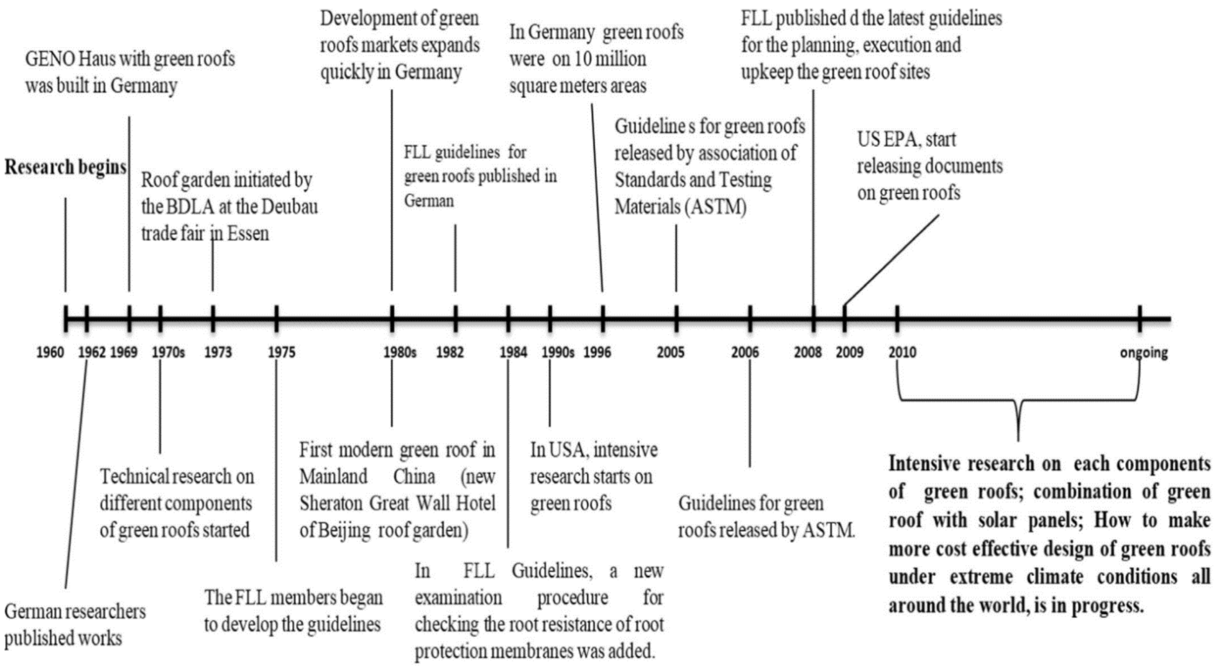



FIGURE 3: HISTORY OF GREEN ROOFS (Sha et al., 2018a)

Source: M. Sha et al, 2018

## 2.3. Benefits of Green Roof

From building level until urban level, the contribution of green roofs has been considered to resolve many environmental problems. Environmentally green roofs contribute in bringing water quality and quantity, stormwater management, air quality, biodiversity and reduction of greenhouse gas emission. Socially it can create jobs, maintains health and wellbeing, and it can be a food source for urban society. Its job creation and income generation roll for the stakeholders, cost minimization which spent for cooling and heating, energy efficiency, and others are the multiple social, economic, and environmental benefits that can be gained by green roofs. They can also minimize the city's carbon footprint by the process of photosynthesis and give an increase to the city's vegetal and animal biodiversity (Maciel, 2007).

### 2.3.1. Thermal Benefit (Thermal Mass)

Report showed that in summer green roofs can effectively reduce heat flow 70-90% while in winter prevents heat loss as effective as 10-30%. Green roof's daily surface temperature has been found to be 6$^{o}$C compared to a variation of conventional roof which was 45$^{o}$C by one detailed study conducted in Canada. (Berardi et al., 2014).

Green roofs have been highly chosen in bringing a wide range of cost-effective environmental benefits to cities. Of these diverse ranges of usefulness, green roofs contribute to the thermoregulation of buildings and of cities, which is one of the primary drivers of their proliferation in different climates around the world in an effort of mitigating challenges of a climate change. In warm seasons, conventional roof surfaces which are opaque and dark absorb heat which is re-emitted to the indoor and outdoor environment. This results in additional temperature regulation costs for indoor environments, and a hotter and more extreme outdoor urban environment. Through a combination of foliage shading, solar reflectance, insulation (soil thermal resistance), and evapotranspiration, green roof plants and substrate minimize building temperature and enhance urban thermoregulation (Sookhan et al., 2018).

The heat flux of a green roof can affect building energy demand and indoor thermal conditions. The magnitude of indoor temperature suppression in summer is usually about 2$^{o}$C or less. Downward heat flux into indoor space is a function of multiple interacting factors:

(a) External environment factors such as seasons and weather conditions;

(b) Factors related to the green roof components such as plant biomass structure and leaf area index, substrate thickness and moisture content, and thickness and design of the drainage layer; and

(c) Intrinsic building factors such as concrete thickness, thermal insulation type and efficiency, and heating, ventilation and air-conditioning (HVAC) operations. Buildings which are old having poor thermal insulation are more benefited by the thermal benefit of green roof than those new and with thermal insulation. (Jim, 2014).

### 2.3.2. Energy Saving

In many developed countries more than both industry and transportation sectors, the building sector is responsible for a larger total energy consumption by being the largest energy end-use. Globally, for about 40% of the total primary energy requirement (PER) and more than 30% of the $CO_2$ emissions are issued from buildings. An increased demand for the better thermal comfort causes the spread of HVAC installation which takes a significant proportion of the increase in energy use. (Yang et al., 2014).

It has been shown that green roofs can offer reduction of heating in winter and cooling in summer as well, by many studies conducted over the past decade to consider the potential building energy benefits. The enhancement of heat transfer through green roofs improve building's energy efficiency. When HVAC applied with green roof, the reduction of the summer temperature around green roofs provides a local free cooling effect to the fluid before it returns to the chiller which improves the efficiency of HVAC systems and the efficiency of surrounding photovoltaic panels (Jaffal & Ouldboukhitine, 2012).

### 2.3.3. Storm Water Retention

Storm water runoff is a serious problem in many cities, and most especially in densely urban areas. Replacing the displaced vegetation green roofs can help to mitigate the impact of surface runoff. It takes time to absorb water and release it slowly after saturated and retained enough water for it the over flow will be discharged over a period of time in contrast to a typical roof where storm water is immediately discharged.

Research shows that green roofs can typically retain between 45% and 76% of annual storm water events, dependent largely on climate and rainfall intensity. A summary of German green roof studies conducted between 1987 and 2003 showed that extensive green roofs retained between 42% and 81% of rainfall compared to the retention of between 9% and 38% for non-greened roofs (Barton, 2015). Based on the depth of substrate, the slope of the roof, the type of plant community, and rainfall patterns extensive roof have been found to retain 60 to 100% of the stormwater coming in. Steeper sloped and shallower substrate have greater total runoff compared to gentle sloped and deeper substrates (Ugai, 2016). Green roofs do not completely stop storm water runoff from roof surfaces but they do improve urban water runoff, allowing them to more closely approximate the natural water balance of soil conditions.

### 2.3.4. Roof Longevity

A roof's longevity is largely determined by the longevity of the roof's membrane. Because of the green roof's Compared to conventional and white roofs, properly installed green roofs last more than double the number of years required before a roof needs to be replaced. This is because a green roof's vegetation layer and growing medium protect the roofing membrane from damaging UV radiation and from fluctuations in temperature extremes. Temperature fluctuations cause daily expansion and contraction in the membrane, wearing it out over time.

A green roof's soil and vegetative layers provide significant protection to its base layer, which is almost identical to that of a black or white roof. Soil and vegetation minimize the negative effects of exposure to UV rays, wind, water and mechanical damage. Thermal mass and simple physical separation are mostly responsible for these benefits (Charlie et al., 2011).

## 2.4. The thermal character of roofs

A building's roof is continually and directly interacting with outside elements especially with solar radiation more than any other envelope structures. For most buildings, the roof is the element of its envelope that experiences the most severe fluctuations in temperature as long as the structure stands.

Thermal resistance (the R-value), thermal transmittance (the U-value), thermal mass and the condition of exterior surface are characters of the envelope that affects the thermal performance. R-value is the rate of steady-state heat transfer of material property while U-value is the rate of steady-state heat transfer of a construction. When the R-vale is high or the U-value is smaller it means there is a capability of reducing thermal gain. The ability of a material to store heat and delay the transfer of heat is known as thermal mass. A useful level of thermal mass is a combination of high heat capacity, high heat density and moderate thermal conductivity. In order to stabilize the indoor thermal environment it requires a good thermal mass which has a longer time-lag and smaller decrements factor. Each material has its own thermal conductivity (k-value). Most metals have great k-value. The k-value of the metal deck is 50 W/m.K, meanwhile, tiles: 0.84 W/m.K and concrete slab: 1.13 W/m.K. Materials of insulation have the least k-value compared to other materials (B. Rudianto et al., 2014).

The second law of thermodynamics states that heat transfer takes place spontaneously in one direction only from a higher to a lower grade state. Heat transfer in buildings occurs due to the difference in temperature between outside and inside the building.

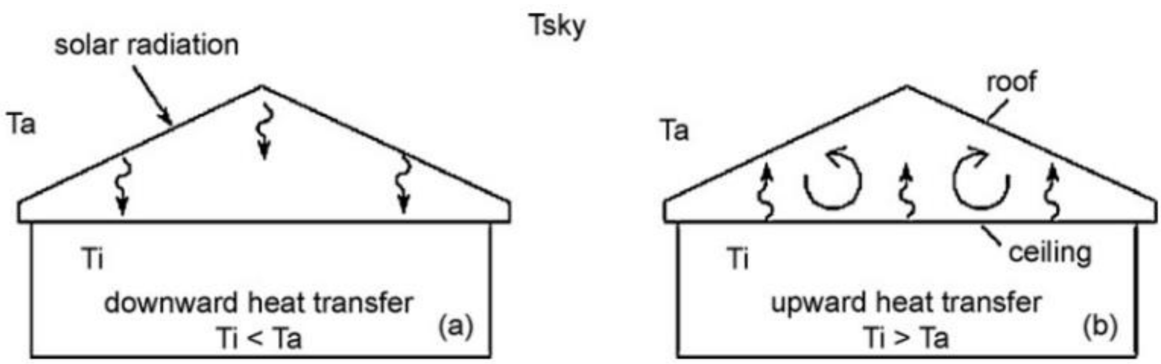



**FIGURE 4**: KIND OF HEAT TRANSFER IN A ROOF

As shown by the figure above in daytime, downward heat transfer occurs because Ta (ambient temperature) is higher than Ti (indoor temperature). Solar radiation increases roof surface heat transfer moves from the roof to the ceiling. Otherwise at night, upward heat transfer occurs because Ti is higher than Ta. Heat transfer back to the sky is trapped under the roof (B. Rudianto et al., 2014). Seasonal and daily ambient temperature variations result in the cyclic heating and cooling of the roofing system and its components in response to the temperature fluctuation of the surroundings. A thermal gradient is therefore established between the inner roof surface inside the building and the exterior surface which is exposed to ambient conditions.

## 2.5. Thermal Performance of Green Roofs

Green roofs have a potential to reduce the external surface temperature of roofs about 36$^{o}$C when applied on non-insulated roof and about 54$^{o}$C on insulated roofs. This result shows that green roofs can perform effectively in both newly built and also retrofitted into existing buildings of dry mild climate having hot, dry summer and Mediterranean area. Therefore, in both minimizing the cooling demand and provision of thermal comfort green roofs can be an effective solution. Further, both the green coverage and moisture content of the substrate controls the cooling effect of the green roof and the temperature difference between ambient air and substrate. Maintaining healthy plants and providing them with adequate watering system or water retaining system is very essential (Wilkinson et al., 2017).

### 2.5.1. Thermal Comfort

It is important first to see what thermal comfort is before we see how the green roof system contributes to human thermal comfort, “that condition of mind that expresses satisfaction with the thermal environment”. The definition leaves it open and subjective what to mean by “condition of mind” or “satisfaction,” but it correctly emphasizes that judgment of comfort is a cognitive process involving many inputs influenced by physical, physiological, psychological, and other processes (ASHRAE, 2009).

Our body’s metabolic activities are responsible almost completely for the heat we produce and we lose to maintain normal body temperatures. The heat that we produce has to be balanced with the heat that we lose. When we are cooled it is because our body is losing more heat than it produces and our body is cooling which can result in excessive heat loss (hypothermia). When we are hot, we are producing more than we lose and our body is warming which can result in overheating (hyperthermia). Skin temperature greater than 113°F or less than 64.5°F causes pain (ASHRAE, 2009). In contrast, internal temperatures rise with activity. Depending on the things such as the activity of a person and what they are wearing occupants are generally happy in room temperatures of 20-22$^{o}$C (68-72$^{o}$F). The total energy produced is called the metabolic rate (M).

$$M = W + Q$$

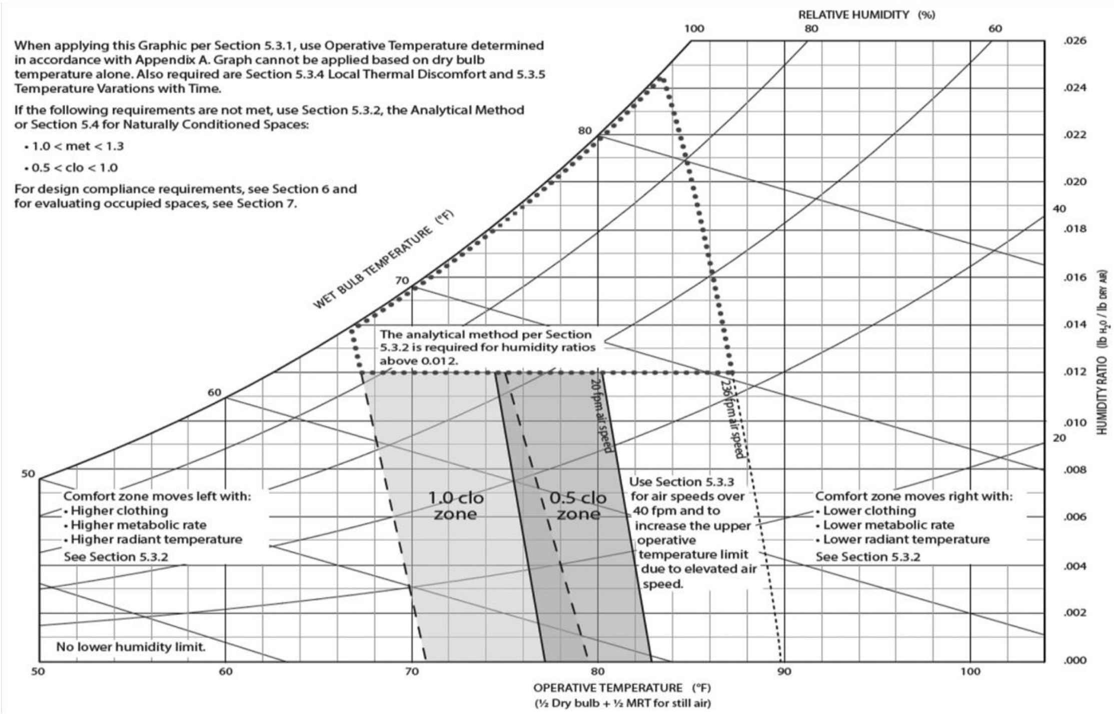
Where M= Metabolic rate, W=Mechanical Work and Q= Heat Loss

And represented by met, that a seated person produces 1met as the average man is a surface of 1.8m$^2$, an average seated person will produce slightly more than 100 Watt. The higher the activity level the higher the metabolic rate.

$$1met = 58.1\ W/m^2$$ ……. (Kitio et al., 2014)

There are two groups of factors that determine thermal comfort; personal and environmental. Personal factors are the activity level of a person and clothing while environmental factors are air temperature, air relative humidity, air relative velocity, and mean radiant temperature. Clothing acts as thermal insulation and measured by thermal resistance and expressed by the unit clo.

$$1Clo = 0.155\text{m}^2\text{K/Watt}$$ …….(Kitio et al., 2014)



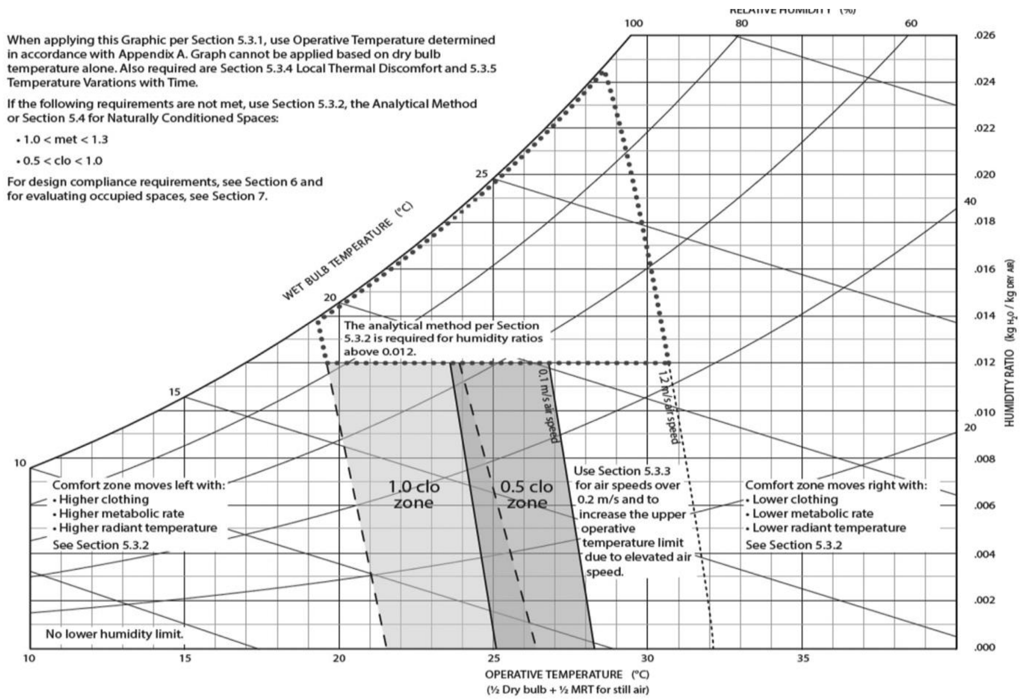



**Figure 5**: Graphic Comfort Zone

Source: (Eddy et al., 2017)

### 2.5.2. Factors Affecting Thermal Performance of Green Roofs

Green roof's energy balance is controlled by the forcing radiative heat from the sun. The combination of the sensible (convection) and latent (evaporative) heat flux from soil and plant surface with the conduction of heat into the soil substrate and long wave (thermal) radiation to and from the soil and leaf surface are useful thermal components of green roof which enables it to balance the solar radiation. (Berardi et al., 2014). The different phenomena which will take place in green roofs are:

- Because of its high heat thermal capacity, high time lag effect and low dynamic thermal transmittance the soil layer works as a thermal mass.
- The leaves give twofold benefits acting as shading device and absorbing parts of thermal energy for its photosynthesis process.
- And both the plant and soil generate evaporative and evapotranspirative cooling.

Therefore, the following modes of heat transfer and storage can help to understand the overall thermal system of green roof according to the above phenomena (Becker & Wang, 2011).

**Conduction** – it is the transfer of heat which takes place in solid materials from the areas of high temperature to the areas of lower temperature. The thermal conductivity (k) of a specific material determines the rate of heat transfer through it. If the thermal conductivity of the material is high it means that it highly conducts heat. Insulation materials have low thermal conductivity that they slow down the conductive heat transfer.

**Convection** – it is a mechanism of heat transfer through the flowing of gas or liquid. In green roof system the thermal performance of the roof can be affected by the presence of moving water through the soil and drainage layers.

**Radiation** – it is when heat transfer through the electro-magnetic wave.

**Evaporation and evapotranspiration** – As water changed from the state of liquid to gas by the heat gained, it cools the soil. And the process of plant's transpiration by taking the water retained by the soil create cool roof.

**Thermal Mass** – it is the ability of materials to delay and store heat. In green roof's substrate layer, the soil and water both can delay or store heat, stabilize the temperature of the roof.

## 2.6. Retrofitting Green Roofs

Building retrofitting is one of the great measures to be taken to achieve reduced building energy consumption and greenhouse gas emission providing minimized heating and cooling demand. Only 1.0-3.0% is the current rate of replacement of existing buildings by the new buildings. There are many challenges and also opportunities in retrofitting of buildings, such as uncertainties in climate change, change in service, behavioral change, governmental policy change, etc., affecting selection of retrofit technologies and their success. Selection of the retrofit technology is very complex due to the interactive characteristics of building sub-systems which can be impacted by the retrofit measures (Ma et al., 2012).

In retrofitting green roofs, the first and foremost issue which should concern us have to be the additional loads and structural failure which could result. Therefore, it is important to determine whether the additional load is an over-load or whether the existing roof's load bearing capacity can hold it (Cascone et al., 2018). Comparing the retrofitting of green roof on new building versus on old building green roofs found to be more effective on old buildings. It is because of their poor insulation which cause them to use a lot of energy. The life span of green roofs is also a very important factor, which is estimated between 40 and 55 years (Sha et al., 2018a).

Wilkinson and Reed (Wilkinson & Reed, 2009) in their analysis for existing building potential retrofitting of green roofs in the Central Business District of Melbourne, Australia, found that approximately 15% of the building stock was suitable for retrofit. From these 61% of the buildings were concrete framed which do not require additional load bearing structural modifications. They in conclusion, list out the following criteria to judge whether a roof is suitable for retrofitting;

- Position of the building;
- Location of the building;
- Orientation of the roof;
- Height above ground;
- Pitch;
- Weight limitations of the building;
- Preferred planting;
- Sustainability of components; and
- Levels of maintenance.

In green roof retrofitting there are certain helpful steps or phases one can follow throughout the process for effective end result.

1. The project setup and pre-retrofit survey: at this stage the scope of the work will be defined and the goal of the project will be set. The concerns and financial capacity of the owner (occupant) will be identified. Pre-retrofit survey needs to be done in order to better understand the operational problems of the building. This step provides necessary information and resource support (budgeting) for refurbishment/retrofitting. The constructing company also will be selected at this stage.
2. Performance assessment (and diagnostics): this stage employs benchmarks for building energy use by using performance indicators or green building rating systems.

3. Identification of retrofit options: plant selection, soil composition, drainage type or selection of other options are included under this step.
4. Site implementation and commissioning.
5. Validation and verification of results.

The success of a building retrofit program depends on many issues. Policies and regulations, client resources and expectations, retrofit technologies, building specific information, human factors and other uncertainty factors are the key determining factors of building retrofitting (Ma et al., 2012) and they have to be considered also in green roof retrofitting.

### 2.6.1. Retrofitting Options

Green roof systems can be categorized as follows:

- Complete systems where all different components including roof membrane are an integral part of the whole system;
- Modular systems that are positioned above the existing roofing system;
- Pre-cultivated vegetation blankets (geo-mat) that consist of a growing medium and plants that are rolled onto the existing roofing system with drainage mats and root barriers as required.

Variations between systems are generally found in the manner in which growing medium and drainage

A. **Complete systems**: provide the most flexibility in terms of the type and nature of growing medium and drainage, and protection layers that can be used. These have direct impact in terms of the type of vegetation that the green roof can support. They also generally contribute the greatest amount the structural design load.

B. **Geo-mat**: is a pre-planted green roof type prepared off site and they typically come in rolled up interlocking tiles that can be placed on any roof like a mattress having thickness of 100-150mm. After the waterproofing material laid out geo-mat can be laid without additional layer required. At the state of its saturation its maximum weight is very lower than the normal green roof applied. It is also easy to maintain and its flexibility enables to adopt to any shape by cutting it into required dimension. The demand for skilled man power is small which makes it economical. It can be easily developed using wire mesh and selected soil.

**C. Modular System**: being weightier than geo-mat system these are preferable for concreate roof. As well as geo-mat system these are pre-planted off the site and placed on the required space. The depth and type of soil is flexible, however, deep soil layers are not common. Typically, a modular system will be within the depth range of 7.5 cm to 30cm. When they are arranged they can be cut and fit to the space required. Researchers used wests from material packaging.

### 2.6.2. Vegetation Development

The thinness of the substrate layer of EGRs would create a harsh environment to the plants due to; limited water availability, wide temperature fluctuations, high exposure to wind and solar radiation create a highly stress, and sometimes disturbed, environment. The vegetation in extensive systems is almost exclusively based on plants such as Sedum species and Phedimus species or Hylotelephium species. Most of the plants used are succulents that are able to store water in leaves or stems, which enables them to survive the dry environment (Emilsson, 2008).

Tobias Emilsson (Emilsson, 2008) had studied vegetation development on extensive green roof in Sweden and found that the green roofing in Sweden is mostly adopt German ("Hinweise zur Pflege und Wartung von begruenten Daechern," 2002) guidelines which are more experienced in green roof practice. This guideline was developed in Europe using over 30 years of research. America and most European countries use this guideline. FLL-based growing media have generally low water carrying capacities and high evaporation rates, in part because organic content is very low (<4% by weight) and the substrate shallow (Macivor et al., 2013). Because of this the vegetation type selection must be drought resistant.

#### A. Substrates (Growing Media)

Substrate refers to the material in which plants are grown, and is synonymous with 'media', 'medium', 'vegetation support course' and in some literature 'soil'. Green roof substrates are often a mixture of organic and inorganic materials, often combined to achieve properties pertinent to plant survival as well as the designed roof function. The substrate is arguably the most important element in a green roof system because the majority of the water holding capacity of the system is dependent upon the substrate physical properties (Griffin, 2014). Substrates for vegetated roofs are designed as a constant trade-off between system weight requirements, substrate water holding capacity and oxygen diffusion to plant roots. Long-term stability of substrates is also important and substrates have to resist decomposition and erosion through water, wind or frost (Emilsson, 2008).

Typical substrates (or growing media) are made up of five basic components: mineral particles, organic matter, water, air, and living organisms. Varying ratios of combined components contribute to the physical, chemical and biological properties that define the functionality of the substrate, developed for specific goals or an intended purpose (Barton, 2015). The list of suitable inorganic substrate components that can be used is long and the final selection is generally a compromise between the physical and chemical characteristics on the one hand, and material availability and price on the other (Emilsson, 2008).

### B. Plant species for green roofs

Plants used for Green roof applications must be very hardy, and preferably native to the area in which they are being used, (native plants species are capable of quickly adapting to the existing climate with minimal maintenance). Native species should be better able to resist local extremes of temperature and to thrive in areas where there is little moisture or soil fertility, and should also withstand windy conditions if present (Lanham, 2007).

The most vital and interesting part of the development of green roof is the selection of plant layer, which maximize the green roof life. The success of green roofs depends on plant's health. In the selection of plant, we should consider the geographic location, rainfall intensity, humidity and wind, and sun exposure. Depth of growth media can also determine the plant species we can use for the green roofs. Many authors worked on the finding of plant species based on the soil depth.

Roof greening in the tropics uses species that are different from temperate regions, species with different growth form, coverage, biomass structure and transpiration rate could notably influence long-term management input, thermal performance and energy conservation (Jim, 2014). The main influencing parameters that affect heat transfer considered by Frankenstein and Koenig for a green roof were: foliage height, leaf area index (LAI), fractional vegetation coverage, albedo, stomata resistance, etc. (Jaffal & Ouldboukhitine, 2012).

Sedum is a common and very suitable plant for using on an extensive green roof. Sedums are succulents, whereby they store water in their leaves, leaving them highly drought resistant. They are small plants that grow across the ground rather than upwards, offering good coverage and roof membrane protection. Sedum is installed in mats, which can be simply rolled onto a roof after the waterproofing and drainage layers have been installed. This means they require minimum maintenance and are easy to install as part of a roof system (Castleton et al., 2010).

Schweitzer and Erell (Schweitzer & Erell, 2014) while doing experimentation on the extensive green roof in water scarce area (Tel Aviv) where there is a moisture deficit for 10 months of the year, had selected four plant species with different appearance and adaptation strategies representing different classes of potential green roof solutions that would maximize benefit (in terms of thermal protection) and minimize cost (in terms of irrigation):

- ✓ Pennisetum clandestinum (kikuyu grass) has dense roots and is a rapidly growing and aggressive species. It is propagated easily and is drought-tolerant, and is therefore sometimes used in lawns or as salt-tolerant forage grass.
- ✓ Aptenia cordifolia is a succulent with bright green leaves and red flowers. Its vigorous growth and ability to be propagated by cuttings allow it to create a dense mat above the soil. It can thrive in a variety of soils and is capable of withstanding extremes of heat, cold and salinity.
- ✓ Sesuvium verrucosum is a perennial psammophile and has been recommended for sand dune fixation, mitigating desertification, landscaping and ornamental uses. The Sesuvium genus is known to tolerate high salinity and has shown durability and a capacity to regenerate after prolonged drought.
- ✓ Halimione portulacoides is a small greyish-green shrub resembling the saltbush. It is extremely tolerant of salt content in the ground.

Table 2: Growing medium depth required for various types of vegetation for extensive green roof and Annual average water retention as percentage of rainfall

| **Type of green roofs and vegetation** | **Depth required for growing medium (cm)** | **Water retention – annual average (% of total rainfall)** |
| --- | --- | --- |
| **Extensive green roofs** | | |
| Moss-sedum | 2 - 6 | 40 – 45% |
| Sedum-moss-herbaceous plants Sedum-herbaceous-grass | 6 - 10 | 50% |
| Sedum-herbaceous-grass plants | 10 - 15 | 55% |
| Grass-herbaceous plants | 15 - 20 | 60% |

### 2.6.3. Structural Requirement

Extensive green (vegetated) roofs have substrate layers of approximately 3–5cm thickness and a water-saturated weight of approximately 50-55 kg/m$^2$ (Emilsson, 2008). Because of their low additional loads, extensive green roofs are suitable for building retrofitting, i.e. they do not require any additional strengthening. The typical layers from the inside to the outside of extensive green roofs are: load-bearing slabs (roof deck), vapor barrier, insulation layer, roofing membrane, root barrier, drainage layer with/without aeration and storage water, filter layer, growing substrate/porous soil and vegetation layer (Gagliano et al., 2014).

By referring to a report to Manchester City council (Castleton et al., 2010) mention that although retrofitting of green roofs is technically feasible for most commercial or institutional buildings, if strengthening works are required to support the green roof the additional costs would likely outweigh any benefits. They also said that for most commercial buildings, the additional loads associated with an extensive green roof (typically about 120–150kg/m2) do not require any additional strengthening. The load that can be applied on the flat roofs of residential buildings is 200 kg/m$^2$ (about 1.96 kN/m$^2$), according to the European standard.

### 2.6.4. Green Roof Retrofitting Procedures

In developed cities, roof areas account for about 40–50% of total impermeable surfaces urban areas. There are different kinds of roof types used in the world, so first study the roof type and then select the best green roof to achieve the multiple benefits (Sha et al., 2018b).

For the retrofitting the green roofs, Wilkinson et al. studied the retrofit green roofs and walls at two different locations. First green roofs at Sydney, Australia, with a timber frame structure and another one in Rio de Janeiro, Brazil, by using block work construction. Authors want to investigate the thermal performance of these two retrofits green roofs. They investigated these two roofs with walls and compared the results with non-vegetated roofs. Both light- weight retrofit roofs show promising results for cooling as compared to non-vegetated roofs. It is also noted that the structure type and its surface colors also affect the performance of green roofs (S. Wilkinson et al., 2017).

The first phase in retrofitting a building with a green roof is to determine the existing load-bearing capacity. Because a green roof adds to the load on the roof structure, it is necessary to determine over- loading in relation to different green roof configurations and to com- pare it with the residual load bearing capacity of the building structures.

### 2.6.5. Challenges

Chen et al., in their studies of hindrances of green roof implementation in the urban China (Chen et al., 2019) identified 27 barriers that affects the green roof implementation and categorize them into five groups. These are technology barriers ($B_T$), standard and code barrier ($B_S$), cost barrier ($B_C$), attitude barrier ($B_A$) and other barriers ($B_O$).

However, there are challenges to the adoption of green roofs. In the countries like Ethiopia where the practice of green roofing is low, we have to deal not only the challenges related to green roofs, but also those related to buildings. In terms of the construction of green roofs, one of the challenges is that there is currently no national design standard for green roofs. The design of green roofs needs to be integrated into the National Building Code, or have a code of its own in order to properly define the design requirements for Ethiopian green roof construction.

It is imperative to determine the structural adequacy of the existing structures and the design parameters, as it may not be possible to retrofit. Many existing buildings were not designed to bear extra loads; however, some are overdesigned with generous safety factors incorporated. In further consideration of additional loading, the weight of the new system has to be calculated. Furthermore, this analysis will determine whether an intensive or extensive green roof is possible, and consequently it will influence which plants will be appropriate.

In some situations, green roofs are not the best option, for example, if thermal performance is the goal and the building have high levels of thermal insulation, and the roof to floor area ration is small, the thermal impact of a green roof is minimal and would not be cost effective. Niachou et al., simulated the impact of the green roof technology for different types of insulated roofs; and demonstrated that for well-insulated buildings energy saving is less than 2%.

Different buildings, different climates and different types of green roofs and walls around the world make the determination of the design parameters another challenge for green retrofitted systems. The irrigation system, where provided, for instance, has to be monitored and controlled, otherwise an opposite effect may result as the energy to cool the building would be higher compared to a building without green walls and/or a green roof. Challenges exist also with regards to maintenance of green roofs and walls and their viability on tall facades. This study is concerned with low rise housing stock and specifies a low maintenance planting specification. Maintenance issues are acknowledged as important but fall outside the focus of this paper.

## 2.7. Lessons Learned

An extensive review of the existing literature has exposed the following key factors when assessing their temperature regulating potential in the context of building use:

1. Green roofs have a potential to reduce the external surface temperature of roofs about 36$^{o}$C when applied on non-insulated roof and about 54$^{o}$C on insulated roofs. In summer green roofs can effectively reduce heat flow 70-90% while in winter prevents heat loss as effective as 10-30%.

2. The FLL recommends water holding capacity to be ≥ 35% by volume of the substrate. For single layer extensive green roofs, water holding capacity is recommended to be ≥ 20% by volume. The maximum water holding capacity should not exceed 65% by volume in any green roof substrate to avoid water logging.
3. It important to give heed to each layers of the green roof to harvest the maximum potential of the green roof system. Healthy and draught resistant plants, substrate layer with rich ingredients and good capacity to hold water for the plants, durable geotextile and drainage layers, durable root barrier and waterproofing layers are required and should be selected.
4. Green roofs if not installed or retrofitted carefully they can also be damaging. For instance they can be pollutants if manageable amount of fertilizers used, they can damage the roof structure if there is leakage, they can even be the factor for the thermal disorder in indoor environment because of their capacity of thermal mass.

# CHAPTER THREE

# MATERIALS AND METHODS

## 3.1. The Study Area

Adama is one of the largest towns of Oromiya and the country. It is located in central Ethiopia about 100 km southeast of country capital Addis Ababa at 8°26 ′15″N to 8°37 ′00″N latitude and 39°12′15″E to 39°19′45″E longitude at altitude ranges from 1489 m-1976 m above sea level. The town was established in 1916 with the introduction of the Addis Ababa to Djibouti railway line. The name of the town was derived from "Adaamii" (in Afaan Oromoo) which refers to a generic milky small plant with thick fleshy stems bearing spines called cactus/euphorbia tree'. More specifically, adaamii means Euphorbia Candelabrum, a tree of the Spurge family, while hadaamii would mean Indian fig. According to the local people, there were plenty of "Adaamii" trees in the vicinity. The town is located 96 kilometers southeast of Addis Ababa (Finfinnee) in the Great Rift Valley of East Africa. The average annual rainfall of Adama City is about 866.25 mm, most of the rain occurring in the rainy season (June to September). The minimum wind speed occurs during September (1.65m/s), while the wind with high velocity occurs during December, January, and February (3.05-3.2 m/s). The mean temperature in the City varies from 11.5$^0$C to 31$^0$C.

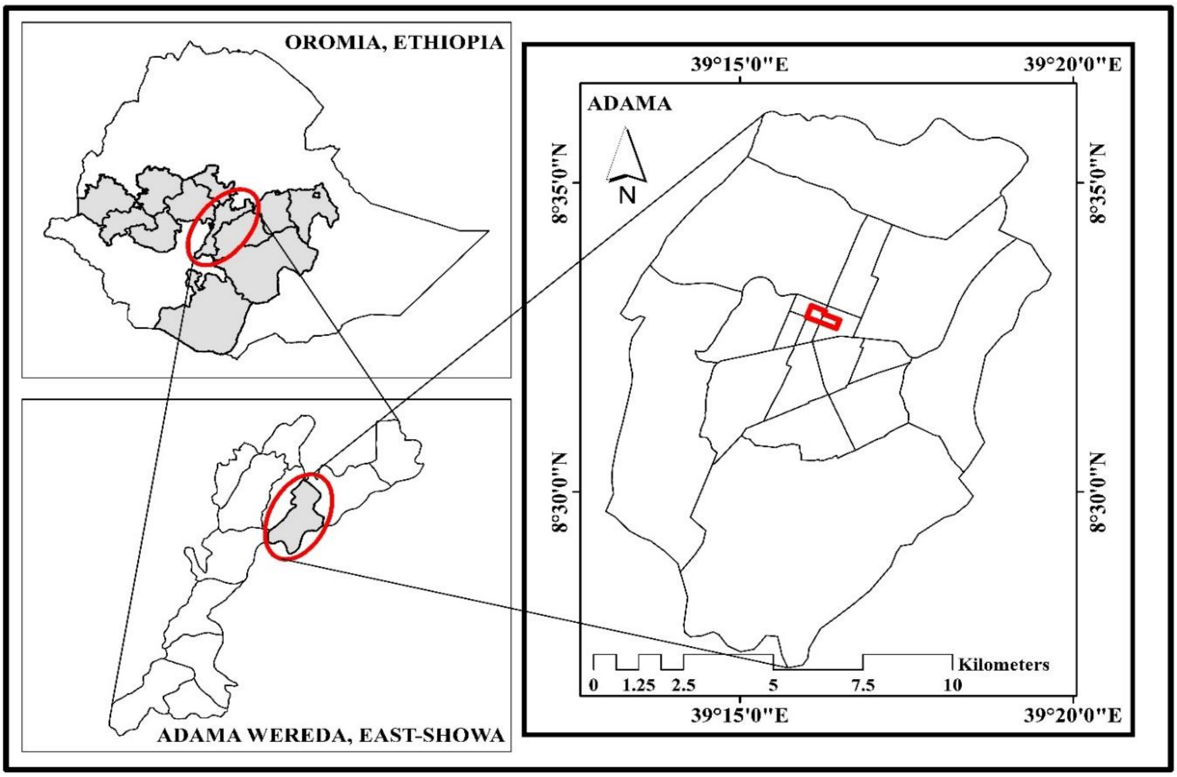



Figure 6: Location of Adama Town

Source: GIS

### 3.1.1. Climate Analysis of the Study Area

Buildings must be climate-responsive in order for their occupants to create a suitable indoor working environment. Climatic parameters such as temperature, humidity, solar radiation, and wind are basic elements that affect the performance of a building. For the processing and analysis of climatic data the impact they can bring to the building's performance has been considered. By providing the climate data into Ecotect software weather tool.

Wind direction and wind speed are important elements of climate condition if utilized properly can regulate buildings thermal performance. The climate data of Adama during the study time showed the prominent wind direction were South-West 110$^o$ below and east 90$^o$ as shown.

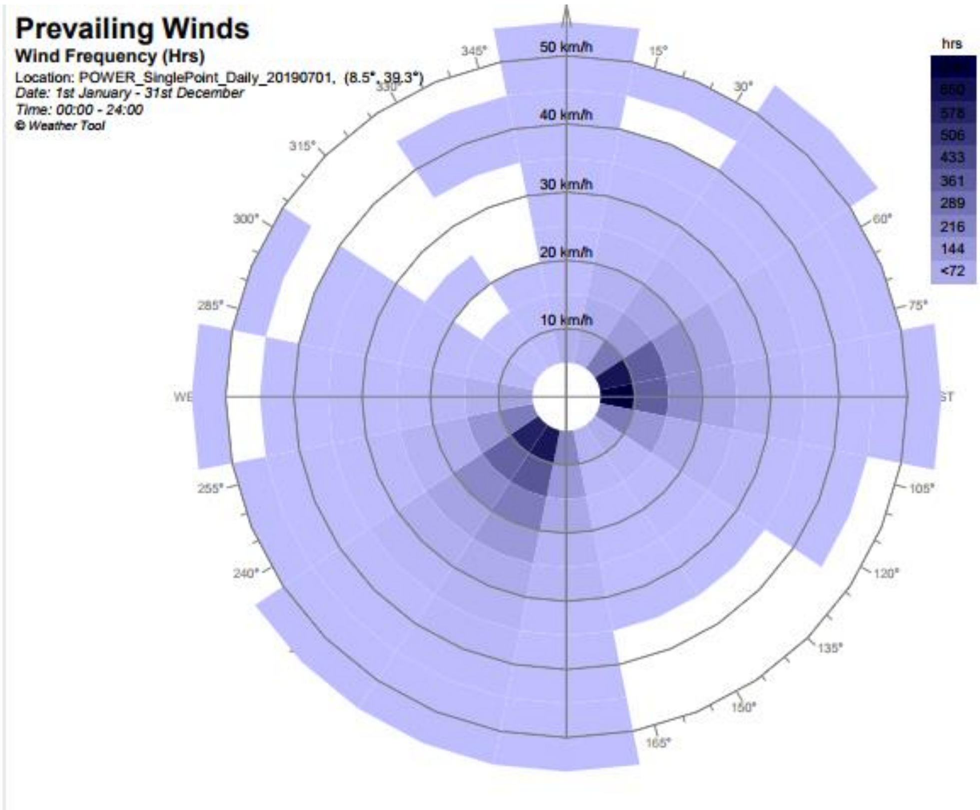



FIGURE 12: WIND ANALYSIS, ADAMA

Source: Ecotect Simulation

Orientation is critical in thermal gaining or losing from solar radiation and prevailing wind. The exposed surfaces gain more heat from solar radiation other parts lose heat due to the same reason of orientation. It also crucial to ventilate buildings which therefore, prevailing wind direction and sun orientation has to go together for better building performance. The best orientation in Adama city has been found from the simulation to be 32.5$^{o}$ N, or have to be in the range between 0-40$^{o}$ N (Figure 13). Considering this the thermal comfort for average man sitting or using computer, having worn winter time clothing (Office Suite) 1.0 $I_{cl}$ ranges 18-26$^{o}$C (Figure 14) in Adama.

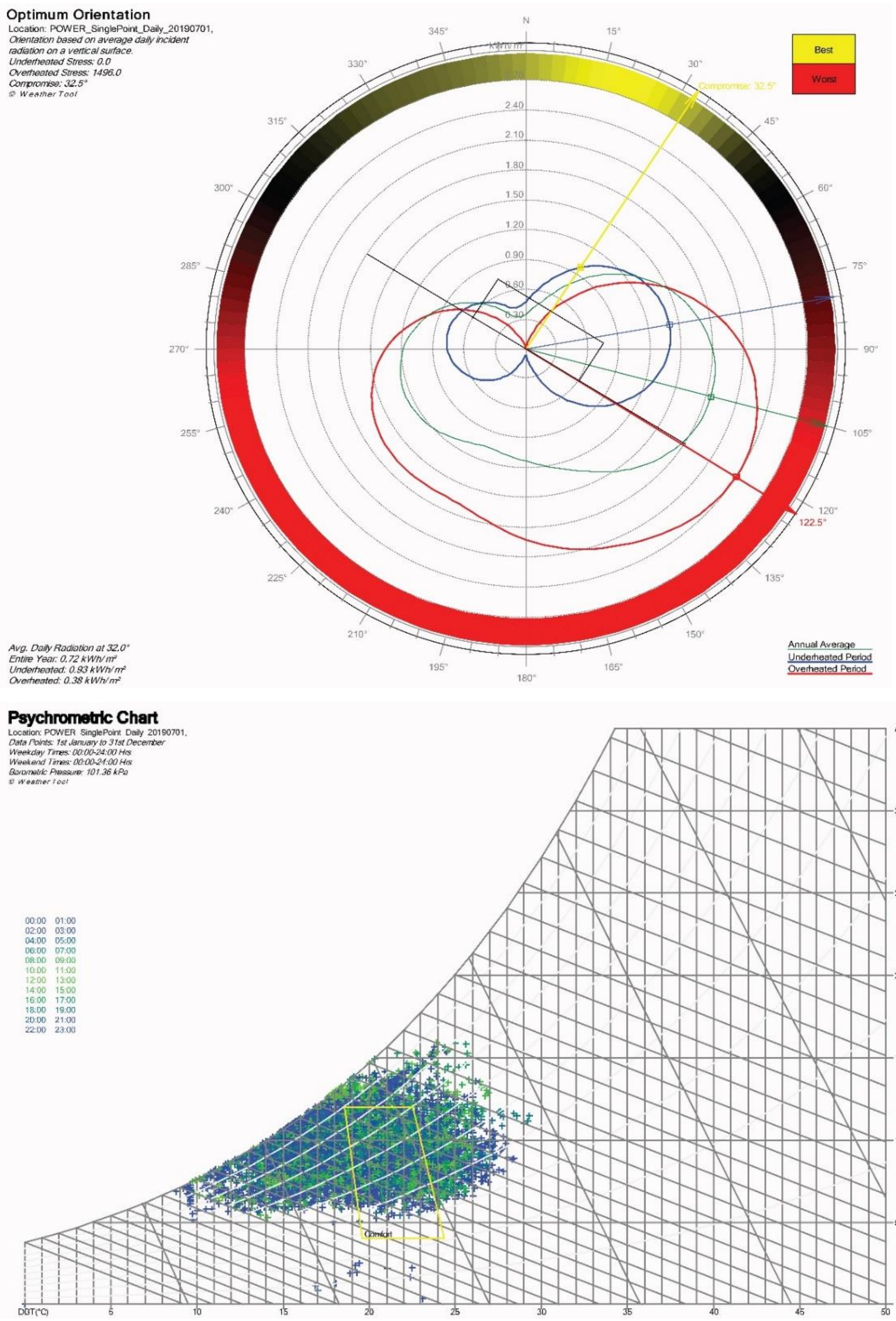



**Figure 7:** A) Optimum orientation B) Comfort zone and time

Source: Simulation

## 3.2. Research Design

This research adopted a quantitative experimental approach to data collection. The methodology comprises the use of adaptive building technologies to assist in the mitigation of problems caused by increased urbanism and climate change, such as the UHI effect and increased internal building temperature. It has used simple statistical processes and spatial interpretation through modeling (simulation). The maximum and minimum temperature recorded has been evaluated whether they are in the comfort zone or not which ranges between 18-26$^{o}$C considered for an average man with metabolic rate of 1met having clothed with office suite of 1clo within the context of Adama's climate.

Then the comparison of selected building in the study area without and with green roof (using computer modeled green roof building) on the days of maximum and minimum average temperature recorded have been done, to see the potential of green roof over the bare (conventional) one. The thermal gain and adaptability indexes also used to examine green roof performance.

Finally, based on the analysis of these data green roof technology retrofitting model have been developed using Autodesk Revit 2019 for modeling and Ecotect$^{TM}$, and Energy Plus for simulation. And then, comparison between selected building's roof material performance with and without green roof retrofitting has been conducted based on indicators such as temperature fluctuation (variation), decrement factor, and time lag.

## 3.3. Data Sources

Throughout the process in this research primary data sources are site visitation for the observations of the study area and sample buildings, temperature recorded in each sample buildings, data from the simulation of selected building. Data from the primary sources includes photographs, indoor temperatures, and focus group discussion about the thermal comfort level of the buildings and construction methods materials used in case of green roof building.

Secondary data sources and data gained include research journals, internet websites such as NASA Power Data, standards like ASHRAE, video tutorials, Seminars and eLearning's from Polythechniqo de Milano and IIT Roorkey.

## 3.4. Materials Used

The Specific objectives of the research are categorized into two parts which are:

a. To assess the current trend of roofing and thermal performance of these roofing materials in Adama City Abba Geda Sub-City.

b. To examine the thermal performance of green roof and develop affordable and easy technology of retrofitting green roof for existing buildings at Abba Geda Sub-City Adama City.

a. To assess the current trend of roofing and thermal performance of these roofing materials in Adama City Abba Geda Sub-City: There are different kinds of roofs used in Adama, so first the identification of these roof types has taken place using ortho-photo found from land administration of the city. Using these ortho-photos and thorough site visitation roof material trends of the study area have been identified.

b. To examine the thermal performance of green roof and develop affordable and easy technology of retrofitting green roof for existing buildings at Abba Geda Sub-City Adama City: To examine the performance of the identified roof against temperature imposed commercial USB data logger Extech RH10/Elitech RC-5+ reusable auto PDF data logger, which has an RH range from 0 to 100%, a temperature (T) range from −30 to 70°C (−22 to 158°F), and accuracy in RH and T of 3% and 0.6°C (1°F) respectively has been set on both sample building blocks. This instrument was also used to assess the performance of green roof constructed in Addis Ababa which is school buildings at Hope College of Business, Science and Technology (Heng de Pagter Library), and another building of iron sheet as the control.


**Figure 8:** The Data Logger

## 3.5. Sampling

By considering the potential to retrofitting green roof purposive sampling was used for the selection of building blocks with the consideration to represent the practices of different roof types. The research area was represented by 2 buildings in order to manage data from the research area and to properly handle it. They are selected because of their suitability to be retrofitted (Form), accessibility, and security for the sake of the recording instrument. There are two kinds of roofs used in Adama, which are concrete (commercial and institutional buildings) and iron sheet roof (all kinds of buildings). Even some buildings which are concrete roof covered the roof by the iron sheet for the protection of leakage and temperature. This helps to compare their performance with and without the green roof retrofitting. The study area is compacted which creates an opportunity to study the impact of the retrofitting on the surrounding in reducing UHI.

Buildings which are selected for this study are found in both areas. The building with corrugated iron sheet was from the dense commercial area while the building with flat (concrete) roof was from the institutional area. These buildings appropriately represent the characteristic of both sections. Because from the six concrete buildings in the study area four of them were from the section of concrete roof building was. The Rooms which were selected located directly under the roofing which makes directly exposed under the influence of the roof performance. Since the study's aim was to examine the performance of the roofs such position of the rooms was ideal. And another reason was security for the collecting data logs.

Respondents in the focal group discussion were selected randomly from the users of the buildings who were directly. For example, in the conversation to know about the construction of the green roof only one maintenance person was found in the university who can tell about the detail materials and methods that have been used during the construction.

**a. A building with a concrete roof**

This building is owned by the Orthodox Church and rented to Ethiopian Electrical Utility Adama sub-city. It is an office building in type and constructed of ribbed concrete roof and floor slabs too. The form of the building is so suitable to access the roof after remodeled (retrofitted) the roof was also covered by an iron sheet to protect from leakage. The exterior wall was constructed of hollow blocks plastered and painted inside and outside. Openings are Aluminum cladded windows of the same size except for some parts which use aluminum curtain walls with openings.

As the workers in the building testify the temperature inside the building was uncomfortable especially at the hot seasons. To see how the roof performs thermal data logger has been put in one of the rooms which is the file room. This instrument record the room temperature. The room is free of humans and any artificial additional impacts. It is located immediately below the roof and at the end of the floor which makes it directly exposed to external temperature. Even if the room has openings they are out of use. This makes the room so advantageous for the study.


**Figure 9:** A building with a concrete roof

Source: Researcher

### b. Iron Sheet Roof Building

This building is a mixed-use building of having four stories of shopping on the ground, first and second floors, and offices on the third floor, and drivers training center. It was oriented towards east-west direction having a roof constructed with corrugated iron sheet and it has gypsum board ceiling. It has windows in two ways but only one side of the window was functional, the other side was covered by the white board. The partition between the rooms was of single layer of MDF wall.

To observe the thermal performance of the roof the floor which has direct exposure has been selected for the study.  The room in which the data logger which collects the room temperature put lecture class room.  There were two adjacent rooms which one was an office and another one was computer lab. Because the training is mostly field oriented most of the time the room stays closed.

FIGURE 10: LEFT IRON SHEET ROOF BUILDING RIGHT THE ROOM WHERE THE DATA LOGGER HAS BEEN PUT

Source: Researcher

**c. Henk de Pagter Library**

As far as this research proceeds there was no green roof (vegetated roof) building built in Adama. Therefore, to know the performance of green roof a building with a green roof has been taken from Addis Ababa and studied in the context of Addis Ababa. Henk de Pagter Library is a building located in Addis Ababa Hope University compound. It is unique building in having built with green roof for which it has been selected. It has a steep slope which starts from the ground and makes the soil to be washed when rain comes. Because of this at dry season plants at the upper part get dry that it is required to irrigate. There are two functions in this building; offices and library. The library contains the ground floor and the mezzanine floor and also the digital rooms. Staff offices and washrooms are at the periphery of the building. Its construction ended ten years ago in 2010 and start to function in 2011. But when it started to function the roof had leakage everywhere in the room. After five years the maintenance took place by the company which works on the water proofing. The roof is intensive green roof with irrigation. At first the data logger has been put in the hall of the library. But latter because of security moved to an office in the building.

FIGURE 11: GREEN ROOF LIBRARY BUILDING

Source: Researcher

### 3.6. Data Collection

For the sake of this research roof usage of different kinds of buildings in 28 hectare of the study area has been considered. This was accomplished using Images from Google Earth and thorough site visit. Based on the result of the practice sample buildings which can represent this practice in Adama town Abba Geda Sub City selected. The in-situ measurement of thermal gain of the roofs and indoor temperature were collected daily using Elitech RC-5+ reusable auto PDF data logger, which has a RH range from 0 to 100%, a temperature (T) range from −30 to 70°C (−22 to 158°F), and an accuracy in RH and T of 3% and 0.6°C (1°F) respectively, to know the performance of each roofing material which are being used in the sub-city from the selected two buildings and from selected green roof buildings in Addis Ababa. The data collection started in rainy season which is characterized by its lower temperature. At the beginning of the data collection, the instrument was set to collect room in two minute interval which is its default. This was difficult to manage the data and the instrument is filled with the data, and it is only capable to hold 32, 000 points. The change in temperature in this interval also was not significant that the interval has been changed to one hour. Climatic data of the city is also have been collected from internet station.

Based on these climatic and measured data the model have been developed Autodesk Revit and simulated in Ecotect$^{TM}$. The result of this simulation have been presented and discussed in the next chapter. The climate data has been fetched from The National Aeronautics and Space Administration (NASA) Power Data Prediction of Worldwide Energy Resources in CSV format and used Energy Plus convert the data into WEA file format for the simulation in Ecotect$^{TM}$ Simulation Software.

## 3.7. Methods of Data Analysis

Empirical data collected from in-situ measurements have been analyzed by simple statistical processes (correlation) and those data produced by the simulation of the model roof with spatial interpretation using soft wares Ecotect$^{TM}$. For the simulation the climate data required have been fetched from NASA Power Data in CSV file format and converted into WEA file format for the simulation in Ecotect software. The model of the building built with green roof by using Autodesk Revit 2019 and exported as gbxml file into Ecotect for the analysis of its performance. And then the comparison between the performances of green roofed simulated one and the present building performance has been compared.

## 3.8. Research Procedure

The following figure shows the procedure of the research which has pass through three major processes of pre-research, research process and thesis defense. During the pre-research literatures which were helpful to the research have reviewed thoroughly. This help to see the gap in the field of study and to select a title which can contribute in filling the gap. Based on the selection of the title the proposal of the thesis has been submitted and defended. Then after the approval of the thesis proposal again thorough review of the literatures took place to see how different scholars approached to the problem raises in the research. Based on this the roadmap has been drawn which includes the methods, data types, sampling, data collecting materials, and how the data has to be interpreted and analyzed. Then these processes took place one after another and back and forth. After the interpretation and analysis of data the data presentation and discussion preceded. Finally from the presentation and discussion of the interpreted data conclusion has been reached and recommendation has been given.

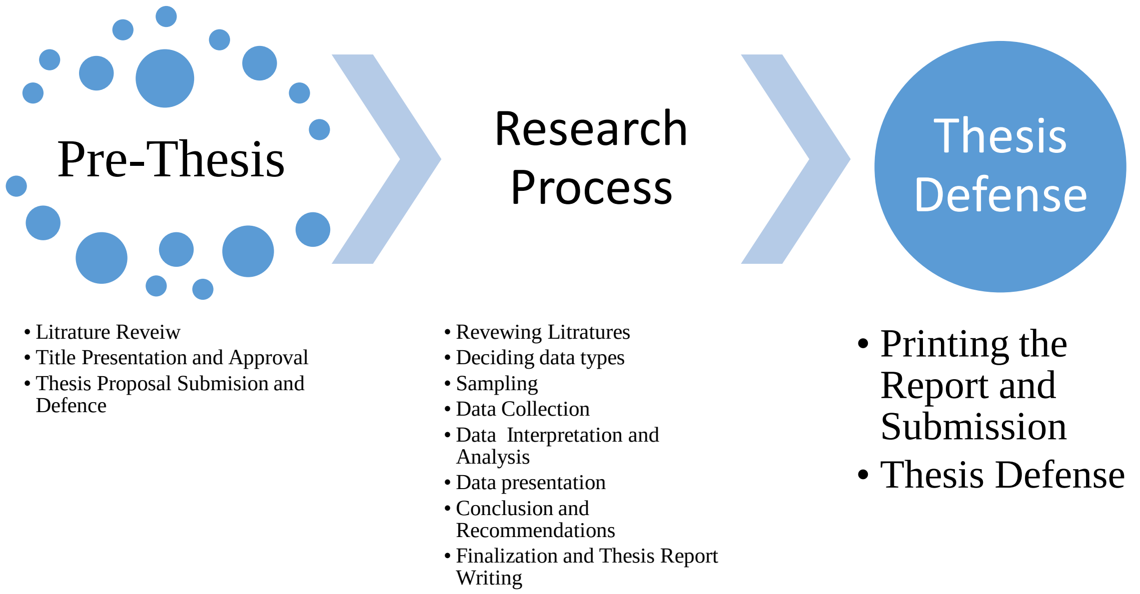



FIGURE 12: RESEARCH PROCEDURE

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.1. Introduction

This Chapter presents the results of the data collected throughout the research process and discusses them. The performance data has been collected from three buildings which of two are from Adama city which could represent the practice of roofing and another building having green roof in Addis Ababa Hope University. Bellow the result of based upon the objectives of the study presented and discussed. The first objective was to identify the practice of roofing in buildings and to examine their performance with respect to the thermal environment. This have been discussed using the data collected by photographing and using temperature recording instruments. In the same manner the second objective was also have been discussed on the performance of green roof building. This have been taken place in Addis Ababa for there was no green roof building in Adama. It was done in the context of Addis Ababa.

## 4.2. The Current Trend and Thermal Performance Roofing Materials in the Study Area

### 4.2.1. The Current Trend of Roofing Materials

Most of the time the roof types used goes with the function of the building. Buildings which were of concrete roofing were either institutional or commercial. No residential building in the study area was found with concrete roofing. It was challenging to identify what kind of roofing material used by only google earth because the oldness of the corrugated iron sheet looks like concrete roof or like the sample building, they are covered with iron sheet that it was required to have thorough site visit.

As a result, except unfinished buildings, six buildings have been found to have concrete roofing which four of them are institutional (office buildings) and two are of commercial. The lower part of the study area mostly occupied by residences and institutions while the upper part occupied by densely built commercial area. Most of this area was covered by old buildings with old corrugated iron sheet roofs. It's denseness in addition to the roofing contribute to the hotness and also for the flood risk in that area.

### 4.2.2. Thermal Performance of These Roofing Materials

A. Building with Corrugated Iron Sheet Roof in Adama (ACISR)

The recording started during the summer season starting from the 25th of July to the 7th of September and again continues from the 30th of September until 9th March, 2020. Thus, there are two rounds of recording. Totally the recording took place for more than 205 days. The record shows a change in room temperature depending upon the external temperature. Early in the morning until late in the morning was the lowest record and as the temperature raises in the afternoon the room temperature also. Unlike the other kinds of roof, the change in temperature in this room was quicker depending on the change in the external environment.

During the first round of recording the maximum temperature was 33.9$^{o}$C and the minimum was 18.6$^{o}$C with an average temperature of 23.9$^{o}$C. The maximum temperature recorded was on 31$^{st}$ August 2019 afternoon at 04:38 PM and the minimum was also in the same month on 11$^{th}$ 06:20 - 07:30 AM. The highest temperatures occurred during the daytime and the lowest has occurred early morning hours. As it is shown in Appendix (iv) the thermal variation between the maximum and minimum record in this type of roofing was high being recorded of 15.3$^{o}$C. Table 2 below shows the summary of the recording including mean kinetic temperature (MKT) while Table 3 shows the daily maximum and minimum during the first-round data collection. The mean kinetic temperature is the overall impact of temperature fluctuation. We can say the cumulative thermal stress experienced by or the temperature profile of the occupant.

**Table 3:** Summary of the recording for ACISR

***Summary***

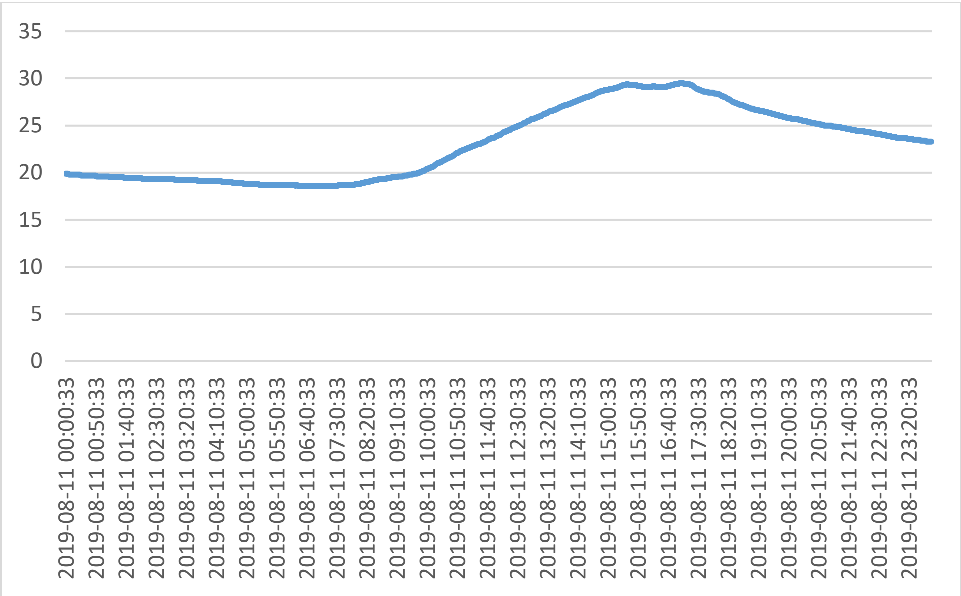
| | | | |
|---|---|---|---|
| *Max* | 33.9°C/%RH | Start Time | 2019-07-25 10:36:33 |
| *Min* | 18.6°C/%RH | Stop Time | 2019-09-07 21:16:33 (Stop when full) |
| *Avg* | 23.9°C/%RH | Elapsed Time | 44D 10H 38M 0S |
| *Mean Kinetic Temperature (MKT)* | 24.5°C | Total Points | 32000 |

Even if the first round recording took place during summer season which is rainy and coldest season the daily maximum temperature recorded were as high as other seasons of the year. This might be as a result of the high humidity level in the air and also the performance of the roof. The temperature gained from solar radiation plus the humidity level of the room brings the temperature to be high. Daily minimum temperature were within the range of 18.6-23.5°C being 21 and below 21°C most of the days, which were within the range of comfort zone. Daily maximum temperature recorded were within the range of 22.3-33.9°C which most of the time stays out of the range of thermal comfort above 26°C.

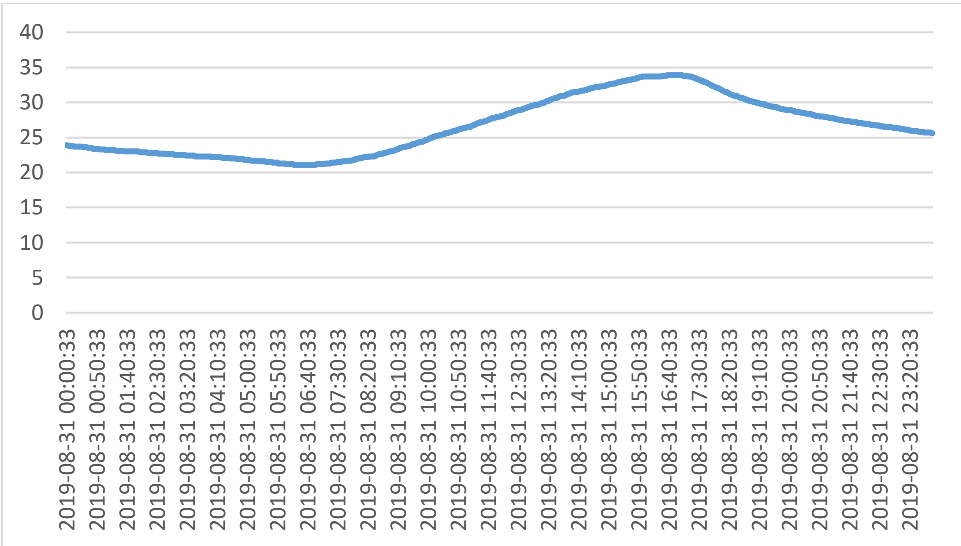
**Table 4**: Daily minimum and maximum temperature during the first round

| | *Months* | *Data* | | | | |
|---|---|---|---|---|---|---|
| | 7 | | 8 | | 9 | |
| *Days* | Max T°C | Min T°C2 | Max T°C | Min T°C2 | Max T°C | Min T°C2 |
| *1* | | | 29 | 19.6 | 32.8 | 22.1 |
| *2* | | | 33.3 | 20.3 | 29.8 | 20.3 |
| *3* | | | 30.8 | 20.6 | 33.6 | 21.1 |
| *4* | | | 28 | 20.5 | 32.1 | 21.1 |
| *5* | | | 23.8 | 19 | 32 | 21.7 |
| *6* | | | 28.2 | 19.1 | 29.7 | 21.7 |
| *7* | | | 29.4 | 20.5 | 28.1 | 20.7 |
| *8* | | | 32.8 | 21.4 | | |
| *9* | | | 27.1 | 21 | | |
| *10* | | | 24.4 | 19.9 | | |
| *11* | | | 29.5 | 18.6 | | |
| *12* | | | 23.4 | 20.8 | | |
| *13* | | | 26 | 19.5 | | |
| *14* | | | 29.6 | 19.2 | | |
| *15* | | | 30.9 | 20.6 | | |
| *16* | | | 28.4 | 20.5 | | |
| *17* | | | 28.1 | 19.8 | | |
| *18* | | | 30.2 | 20.1 | | |
| *19* | | | 31.7 | 20.2 | | |
| *20* | | | 30.4 | 21.1 | | |
| *21* | | | 30.7 | 20.6 | | |
| *22* | | | 31.1 | 20.9 | | |
| *23* | | | 32 | 21.3 | | |
| *24* | | | 25.7 | 19.2 | | |
| *25* | 29.9 | 23.5 | 31.9 | 18.8 | | |
| *26* | 24.1 | 19.4 | 30.9 | 21.2 | | |
| *27* | 22.3 | 18.9 | 30.5 | 21.1 | | |
| *28* | 29.6 | 19.2 | 28.9 | 19.6 | | |
| *29* | 25.4 | 19.7 | 29 | 20.6 | | |
| *30* | 26.4 | 18.7 | 31.4 | 19.9 | | |
| *31* | 29.1 | 19.7 | 33.9 | 21.1 | | |

As one can see from the graph below the daily pattern of the temperature recorded starts from the lowest temperature at down 04:00 AM until 10:30 AM throughout this season. This low temperature repeats itself in the mid-night around 11 PM – 12 AM. And the increase to the high pick of the daily record starts from 03:30 PM it goes on to 06:00 PM. Both the daily maximum and minimum temperatures are attained at the working times except the mid-night low temperature. The maximum temperature was beyond the comfort zone range while the minimum temperature was within the range given from the climate analysis of Adama.




a)




b)

**FIGURE 13**: DAILY TEMPERATURE PATTERN: a) the day of minimum record b) The day of maximum record

The second-round data collection for this building started on the 30th of September 2019 and extends until 09th March 2020 which is more than five months. These data include two Ethiopian seasons which are autumn (Belg) and winter (Bega). These two seasons are relatively hotter than the previous season. Winter (Bega) is the hottest and driest season from both summer (Kiremt) and autumn (Belg) while summer (Kiremt) is the rainy season of the year. As shown in the summary table below the minimum, maximum, average, and MKT recording during this time were 15.3°C/%RH, 34.1°C/%RH, 22.7°C/%RH, and 23.4°C respectively. Compared to the first round recording the minimum temperature was lesser by 3.3°C while the maximum temperature was greater by 0.2°C.

**Table 5**: Summary of the second-round data recording

***Summary***

| | | | |
|---|---|---|---|
| *Max* | 34.1°C/%RH | Start Time | 2019-09-30 11:15:53 |
| *Min* | 15.3°C/%RH | Stop Time | 2020-03-09 09:15-:53 (Stop by button) |
| *Avg* | 22.7°C/%RH | Elapsed Time | 160D 22H 0M 0S |
| *Mean Kinetic Temperature (MKT)* | 23.4°C | Total Points | 3863 |

March was hottest month during the second-round recording, having an average temperature of 31°C; while December and January are the two months with the minimum average temperature. The minimum daily temperature was recorded on 19th January, 2020 in the morning at 07:15:53 and the maximum was on 2020-02-29 16:15:53. Both the minimum and the maximum recording this round fall out of the comfort zone. The maximum temperature was recorded at working hour while the minimum temperature most of the time was not a working hour.

**Table 6:** Daily minimum and maximum temperature of the second round

| | Year | Month | Data | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | | | | | | 2020 | | | | | |
| | 10 | | 11 | | 12 | | 1 | | 2 | | 3 | |
| **Days** | Max T°C | Min T°C | Max T°C | Min T°C | Max T°C | Min T°C | Max T°C | Min T°C | Max T°C | Min T°C | Max T°C | Min T°C |
| **1** | 26.8 | 18.7 | 30.4 | 19 | 25.2 | 16.9 | 26.6 | 18.2 | 28.4 | 19.4 | 32.4 | 21.8 |
| **2** | 26.8 | 19 | 29.6 | 19.2 | 26.6 | 16.7 | 27.4 | 18.5 | 28.3 | 20 | 32 | 21.5 |
| **3** | 27.4 | 19.5 | 27.7 | 19.3 | 26.5 | 17.9 | 26 | 19.7 | 27.3 | 19.6 | 33.7 | 21.8 |
| **4** | 26.5 | 19.3 | 27.2 | 20.2 | 26.8 | 17.7 | 27.2 | 19.2 | 29.4 | 19.2 | 31.2 | 22.8 |
| **5** | 25.4 | 20.2 | 27.4 | 19.8 | 26.6 | 18.5 | 28.3 | 17.7 | 28.8 | 19.3 | 33.4 | 23.3 |
| **6** | 28.6 | 19.3 | 27.5 | 19.4 | 25.5 | 18.3 | 26.1 | 18.9 | 28.6 | 19.5 | 32.8 | 22.7 |
| **7** | 29 | 19.5 | 27.9 | 20.5 | 25.9 | 17.1 | 25.8 | 19.3 | 28.6 | 19.7 | 32.3 | 23.4 |
| **8** | 26.8 | 20 | 29 | 20.4 | 25.1 | 17.3 | 26.3 | 18.8 | 28.1 | 19.7 | 30.6 | 22.5 |
| **9** | 26.6 | 19.1 | 29.1 | 20.8 | 23.7 | 18.3 | 27.6 | 18.3 | 28 | 19.3 | 25.3 | 22.2 |
| **10** | 27.2 | 18.9 | 28.8 | 19.5 | 25.5 | 18.7 | 30.4 | 18.4 | 29 | 19 | | |
| **11** | 25.7 | 19 | 28.1 | 19.5 | 24.4 | 18.5 | 29.2 | 19.7 | 31.8 | 19.8 | | |
| **12** | 27.7 | 18.8 | 27.4 | 19.3 | 25.7 | 18.4 | 22.6 | 18.2 | 24.3 | 17.7 | | |
| **13** | 25.7 | 19.7 | 27.4 | 18.8 | 25.8 | 18.3 | 21 | 16.5 | 20.6 | 16.8 | | |
| **14** | 26.7 | 18.8 | 28 | 19 | 24.4 | 17.9 | 24 | 16.9 | 23.1 | 16.3 | | |
| **15** | 28.1 | 18 | 28 | 18.3 | 24.9 | 16.5 | 24.5 | 16.6 | 26.5 | 16.3 | | |
| **16** | 27.7 | 19.4 | 28.6 | 18.9 | 26 | 16.2 | 25.6 | 16.6 | 30 | 17.9 | | |
| **17** | 27.4 | 19.7 | 29.5 | 19.2 | 25.2 | 16.9 | 26.7 | 16.1 | 31.6 | 19.8 | | |
| **18** | 26.9 | 19.3 | 30.2 | 19.7 | 24.4 | 17.5 | 25.6 | 15.6 | 30.7 | 21.4 | | |
| **19** | 25.7 | 20.1 | 29.5 | 20.2 | 24.1 | 16.8 | 26.4 | 15.3 | 30.7 | 21.5 | | |
| **20** | 27 | 19.6 | 28.8 | 21.6 | 24.4 | 16.4 | 25.5 | 17.1 | 30.5 | 21.6 | | |
| **21** | 28.2 | 19.1 | 29.2 | 20.8 | 24.7 | 17 | 26.5 | 15.6 | 30.3 | 20.6 | | |
| **22** | 28.1 | 19.6 | 23.8 | 19.9 | 25.1 | 16.9 | 27.4 | 17 | 29.3 | 21.1 | | |
| **23** | 27.4 | 18.8 | 25.4 | 18.2 | 27.2 | 17.5 | 26.9 | 18.3 | 29.3 | 20.9 | | |
| **24** | 29 | 17.3 | 20.5 | 18.6 | 26.6 | 17.8 | 26.9 | 18.8 | 30.5 | 20.9 | | |
| **25** | 28.8 | 17.7 | 24.2 | 18 | 26.6 | 18.2 | 24.8 | 18.5 | 33.9 | 21 | | |
| **26** | 28.7 | 18.2 | 24.5 | 18.4 | 26.1 | 18.1 | 20.6 | 17.9 | 29.5 | 21.2 | | |
| **27** | 28.9 | 18.1 | 25.2 | 17.9 | 27 | 18 | 21 | 16.2 | 29.1 | 21.1 | | |
| **28** | 29.1 | 18.1 | 25.6 | 16.2 | 26.5 | 18.2 | 26 | 17.5 | 30.9 | 20.3 | | |
| **29** | 29.1 | 19 | 25.6 | 16.9 | 25.8 | 18.6 | 26.8 | 18.3 | 34.1 | 20.8 | | |
| **30** | 28.7 | 18.3 | 25 | 17.5 | 26 | 18.1 | 27.9 | 18.3 | | | | |
| **31** | 29.9 | 18.5 | | | 26.1 | 18 | 29.6 | 18.4 | | | | |

B. Building with Concrete Roofing in Adama

This building is owned by the Orthodox Church and is a five-story building located next to Yilma Butcher in the study area. Ethiopian Electric Utility (EEU) Adama district rented it for office purposes. To investigate the roof performance of the building the thermal recording instrument was placed in the same manner of the building with an iron sheet roof in a room immediately under the roof. But unlike the iron sheet roofed building the room in this building was almost inaccessible except to put and take file documents because it is a file room. The recording of the data started at the same time as the corrugated iron sheet roof sheet, but the stopping day extends more because of the key holder of the room changed without informing the new key holder that there was an instrument in that room.

In the same manner as the CISR building, the first-round recording of temperature started in this building the same day. Because of its form and structure, this building is comfortable for the retrofitting. Even if it hadn't been intended to record for a longer period than the CISR building the extension could be considered as an opportunity to analyze three seasons of the year. The maximum temperature recorded during this time was 30.6$^{o}$C/%RH while the minimum was 20.4°C/%RH with an average temperature of 24.7°C/%RH and 24.7$^{o}$C Mean Kinetic temperature (MKT).

**Table 7:** Summary of concrete roof first-round recording

Summary

| | | | |
|---|---|---|---|
| Max | 30.6°C/%RH | Start Time | 2019-07-24 16:17:37 |
| Min | 20.9°C/%RH | Stop Time | 2019-09-07 02:55:37(Stop when full) |
| Avg | 24.5°C/%RH | Elapsed Time | 44D 10H 38M 0S |
| Mean Kinetic Temperature (MKT) | 24.7°C | Total Points | 32000 |

The daily maximum temperature ranges between 24.4-30.6°C and the daily minimum temperature ranges between 20.9-24.9°C. In terms of both time lag and decrement factor concrete roof show better results than corrugated iron sheet roof in this round. The minimum temperature ranges within the thermal comfort while most of the days maximum temperature ranges were above the thermal comfort range.

**Table 8:** Daily minimum and maximum temperature of the first round

| | *Month* | *Data* | | | | |
|---|---|---|---|---|---|---|
| | 7 | | 8 | | 9 | |
| *Days* | Max T°C | Min T°C | Max T°C | Min T°C | Max T°C | Min T°C |
| *1* | | | 27 | 21.9 | 29.9 | 24.4 |
| *2* | | | 28.8 | 22.4 | 28.7 | 23.3 |
| *3* | | | 28.1 | 23 | 30.6 | 23.7 |
| *4* | | | 27.4 | 22.9 | 30.1 | 23.9 |
| *5* | | | 24.4 | 22 | 29.2 | 24.3 |
| *6* | | | 26.7 | 21.6 | 28.8 | 23.9 |
| *7* | | | 26.6 | 22.5 | 25.7 | 24.9 |
| *8* | | | 29.4 | 23 | | |
| *9* | | | 26.6 | 23.6 | | |
| *10* | | | 24.7 | 22 | | |
| *11* | | | 26.4 | 21.1 | | |
| *12* | | | 26.4 | 22.3 | | |
| *13* | | | 25.4 | 21.3 | | |
| *14* | | | 28 | 21.4 | | |
| *15* | | | 28.7 | 22.9 | | |
| *16* | | | 27.6 | 21.4 | | |
| *17* | | | 27 | 22.3 | | |
| *18* | | | 28 | 22.4 | | |
| *19* | | | 29.1 | 22.8 | | |
| *20* | | | 29.5 | 23.4 | | |
| *21* | | | 29.2 | 23.7 | | |
| *22* | | | 29.4 | 23.7 | | |
| *24* | 29.3 | 23 | 26 | 22.5 | | |
| *25* | 27.7 | 22 | 28.9 | 21.7 | | |
| *26* | 24.8 | 21.5 | 28.8 | 23.4 | | |
| *27* | 22.3 | 21 | 27.9 | 23.2 | | |
| *28* | 26.9 | 21 | 27.4 | 22.3 | | |
| *29* | 25.4 | 21.8 | 28.3 | 23 | | |
| *30* | 26 | 20.9 | 29.2 | 22.9 | | |
| *31* | 27.1 | 21.7 | 30.4 | 23.6 | | |

The second-round thermal recording of this building started on July 24$^{th}$ and continued until May 14$^{th}$ of 2020. It comprises the hottest and also the coldest average temperature of the study period. During this time the record showed maximum temperature on 11$^{th}$ April, 2020 which was 34.7°C/%RH and minimum temperature was on 19th January which was 20.4°C/%RH, with average temperature of 26$^{o}$C and MKT of 26.4. March and April were the two months with highest average temperature of 32.42$^{o}$C and 31.87$^{o}$C respectively while December and January were months with the lowest minimum average temperature of 21.68$^{o}$C and 22.04$^{o}$C.

***Table 9**: Summary of the second-round concrete roof building thermal recording*

***Summary***

| | | | |
|---|---|---|---|
| *Max* | 34.7°C/%RH | Start Time | 2019-09-30 11:38:20 |
| *Min* | 20.4°C/%RH | Stop Time | 2020-05-14 10:38:20 (Stop by button) |
| *Avg* | 26.0°C/%RH | Elapsed Time | 226D 23H 0M 0S |
| *Mean Kinetic Temperature (MKT)* | 26.4°C | Total Points | 5448 |

The daily record showed that the temperature variation between the maximum and minimum temperature was 14.3. An increment in temperature has been observed during the second-round recording. Even though both the time lag and the decrement factors of this building were better than that of CISR building both the maximum and minimum temperature were recorded at the working hours. When we see these results by taking the range of thermal, the maximum temperature was higher than the comfort temperature having difference of 8.7$^{o}$C, but the minimum temperature was within the range of thermal comfort. And this happened at 11:38:20 which is the working hour meaning occupants were there at this time.

**Table 10**: Daily minimum and maximum temperature of the second round

| | Month | Year | Data | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 | | 11 | | 12 | | 1 | | 2 | | 3 | | 4 | | 5 | |
| | 19 | | 19 | | 19 | | 20 | | 20 | | 20 | | 20 | | 20 | |
| Days | MT | mT | MT | mT | MT | mT | MT | mT | MT | mT | M T | mT | MT | mT | MT | mT |
| 1 | 25.7 | 21.6 | 30.2 | 23 | 27.3 | 21 | 28.7 | 22.4 | 29.1 | 23.2 | 32.9 | 26.1 | 33.7 | 27.2 | 32 | 25.8 |
| 2 | 27.3 | 21.6 | 29.6 | 23 | 28.1 | 20.9 | 28 | 22.5 | 29.9 | 23.6 | 33.2 | 25.9 | 33.5 | 27.3 | 29.5 | 25.6 |
| 3 | 28.5 | 22.5 | 28.1 | 23.2 | 28.2 | 21.7 | 27.8 | 23 | 29.7 | 23.5 | 33.4 | 26.1 | 33 | 27.1 | 29.9 | 24.4 |
| 4 | 27.7 | 22.8 | 27.9 | 23.2 | 28.4 | 21.6 | 28.8 | 22.9 | 30.4 | 23.3 | 33.5 | 26.8 | 33.6 | 27.1 | 30.2 | 24.2 |
| 5 | 27.5 | 23.4 | 28.7 | 23 | 28.4 | 22.3 | 29.6 | 22.3 | 29.8 | 23.6 | 34 | 27.1 | 33.6 | 27.2 | 32 | 24.6 |
| 6 | 28.8 | 22.6 | 28.9 | 22.8 | 27.8 | 22.2 | 28.5 | 23 | 29.8 | 23.2 | 33.2 | 26.9 | 33.2 | 26.7 | 32.5 | 26 |
| 7 | 29.6 | 23.1 | 29.6 | 23.7 | 27.8 | 21.4 | 28 | 23.2 | 29.9 | 23.7 | 33.4 | 27.2 | 33.3 | 26.8 | 31.7 | 26.6 |
| 8 | 27.6 | 23.5 | 30.4 | 23.8 | 27.2 | 21.5 | 28.9 | 23 | 29.9 | 23.7 | 32.8 | 26.7 | 34 | 26.8 | 31.9 | 26.2 |
| 9 | 27.2 | 22.6 | 30.2 | 24.1 | 27.4 | 22.1 | 29.8 | 22.9 | 29.8 | 23.5 | 33 | 26.5 | 34.2 | 27 | 32.3 | 26.2 |
| 10 | 28.3 | 22.5 | 29.8 | 23.7 | 28.2 | 22.3 | 30.8 | 22.8 | 30.3 | 23.2 | 33.4 | 26.8 | 34.2 | 26.8 | 32.2 | 26.5 |
| 11 | 27.3 | 22.4 | 29.6 | 23.4 | 26.6 | 22.3 | 30.3 | 23.7 | 31.4 | 23.8 | 29.9 | 26.5 | 34.7 | 27.8 | 32.3 | 26.3 |
| 12 | 28.8 | 22.3 | 29.1 | 23.4 | 26.6 | 22 | 26.5 | 23.1 | 26.8 | 22.7 | 32.3 | 25.4 | 33.3 | 28 | 32.3 | 26.1 |
| 13 | 27.5 | 23.2 | 28.9 | 23 | 27 | 21.7 | 24.7 | 21.5 | 24.6 | 21.6 | 33.4 | 25.9 | 32.5 | 26.3 | 32.6 | 26.2 |
| 14 | 28.5 | 22.5 | 29.5 | 23.1 | 25.8 | 21.7 | 26.7 | 21.1 | 26.3 | 20.8 | 33.1 | 26.9 | 33.4 | 26 | 28.6 | 26.5 |
| 15 | 29 | 22.2 | 29.2 | 22.8 | 27.2 | 20.7 | 27.3 | 21.1 | 27.8 | 20.7 | 33.5 | 26.9 | 28.7 | 25.2 | | |
| 16 | 29 | 23 | 29.8 | 22.9 | 27.2 | 20.5 | 27.8 | 21.1 | 29.9 | 21.8 | 33.1 | 27.1 | 28.8 | 24.9 | | |
| 17 | 28.7 | 23 | 30.4 | 23.2 | 27.2 | 21 | 28.1 | 21 | 31.6 | 23.3 | 30.6 | 25.6 | 29.8 | 25.5 | | |
| 18 | 27.3 | 22.8 | 30.4 | 23.6 | 27.2 | 21.3 | 27.4 | 20.8 | 31.2 | 24.9 | 32.3 | 25.8 | 31.4 | 25 | | |
| 19 | 27.2 | 22.9 | 30.4 | 23.8 | 26.8 | 21 | 28 | 20.4 | 31.9 | 25 | 33.3 | 26.4 | 31.4 | 24.9 | | |
| 20 | 28.7 | 23 | 29.6 | 24.6 | 27.2 | 20.7 | 27.8 | 21.1 | 31.9 | 25.2 | 32.2 | 26.7 | 31.3 | 26 | | |
| 21 | 29.1 | 23 | 30.9 | 24.5 | 27.2 | 21.1 | 28.1 | 20.6 | 31.9 | 24.9 | 30.2 | 26.3 | 28.9 | 25 | | |
| 22 | 29.5 | 23.2 | 26.7 | 23.6 | 27.7 | 21.2 | 28.7 | 21.3 | 31 | 25.2 | 31.7 | 24.7 | 30.4 | 24.6 | | |
| 23 | 28.7 | 22.7 | 27.4 | 22.3 | 28.6 | 21.7 | 28 | 22.3 | 31.2 | 25 | 28.4 | 25 | 30.5 | 25.4 | | |
| 24 | 29.2 | 21.7 | 23.9 | 22.1 | 28.6 | 21.8 | 28.3 | 22.7 | 31.7 | 25 | 32.2 | 24 | 27.4 | 25 | | |
| 25 | 29 | 22.1 | 26.7 | 21.3 | 28.8 | 22.3 | 27.2 | 22.7 | 32.7 | 25 | 31.5 | 25 | 30.1 | 23.4 | | |
| 26 | 29.4 | 22.3 | 26.5 | 21.7 | 28.5 | 22.5 | 24.8 | 22.1 | 31.5 | 25.8 | 30.9 | 25.1 | 32.7 | 25.4 | | |
| 27 | 29.2 | 22.3 | 27.1 | 21.5 | 28.6 | 22.2 | 24 | 20.6 | 31.4 | 25.3 | 31.5 | 24.4 | 31.6 | 26.4 | | |
| 28 | 29.5 | 22.3 | 26.5 | 20.8 | 28.5 | 22.3 | 27.6 | 20.8 | 32.3 | 25 | 32.3 | 24.6 | 31.2 | 25.2 | | |
| 29 | 29.7 | 22.7 | 27.7 | 21.1 | 28.6 | 22.6 | 28.8 | 22.1 | 33.1 | 25.4 | 33 | 25.6 | 30.4 | 24.8 | | |
| 30 | 29.3 | 22.6 | 26.8 | 21.5 | 28.6 | 22.4 | 29.2 | 22.3 | | | 33.3 | 26 | 31.3 | 25.6 | | |
| 31 | 29.8 | 22.5 | | | 28.8 | 22.2 | 29.9 | 22.7 | | | 33.5 | 26.9 | | | | |

## 4.4. Thermal Performance of the Green Roof Building

A. The Henk de Pagter Library, Hope University

Henk de Pagter Library building is found in Hope University, the only building with a green roof. The roof starts down from the ground and goes to the other side with a steep sloop. It has one open-down on the left and right side of the building with greeneries providing a good amount of light to the inside study spaces. It also has box-like structures used as ducts for ventilation and skylights. Because of its steepness, the slope of the roof makes the soil be washed down and it makes it difficult for the upper area plants to survive in dry season without irrigation. Even, as it can be observed from the picture above, though it is irrigated most parts of the green roof plants are still dry. This might be caused due to the washing of the soil unreplaceable important minerals might be washed too.

a

b

c

**Figure 14:** Henk de Pagter Library Building a) Open Down and Duct boxes b) Vent duct inside the office c) skylight

Source: Researcher

As the director of the library and the chief maintenance had said, the roof built first by a Chinese contractor called China Jiangsu International Economic-Technical Cooperation Corporation with layers of waterproofing paint, lightweight aggregates, protection fleece, growing media (substrate) and plants. But after the construction, it started to leak which required to be maintained. After five years rebuilt by the company working on waterproofing the roof by removing the previously constructed green roof layers. At this time the layers of the roof changed including the waterproofing. From the bottom to top are waterproofing membrane, lightweight aggregates, geotextile, growing media (substrate), and plant (grass).

In both cases, they did not apply the root barrier which protects the waterproofing and also the roof deck from damage. That might be one reason the roof leaked not long ago after construction. The lightweight aggregates were used as the drainage to let the runoff to the roof drain and to retain some extent of the water for plants. On the aggregates was the geotextile mattress laid to protect the soil not to be washed, it also used to make the water pass through for retention or to be the drain. For the substrate, they simply used the local soil without any synthetic mineral composed to it. The grasses selected for green roof actually can sustain dry seasons, but they just sorted from grassland. Water drains down to the ground using the slope of the roof and at the porch, drainage pipes were receiving the water drained from the green roof pass to the porch slab roof which had downpipes.

**Figure 15**: The drainage pipe from the green roof into drainage system

Source: Researcher

When we come to the thermal performance of the building the recording started during the summer season starting from 22nd of July to 16th of September and again continues from 16th of September until 16th March, 2020. Thus, there are two rounds of recording. Totally the recording comprises more than 240 days.

During the first round of recording the maximum temperature was 30.4°C and minimum was 22.7°C with an average temperature of 24.15°C. The maximum temperature recorded was on 10th September 2019 at around noon time at 11:22 AM and the minimum was on 29th of July at 10:19 AM. Both the highest and lowest temperatures occurred during the daytime around noon time in different seasons. As it is shown in Appendix (v) the thermal variation between the maximum and minimum record in this type of roofing was high being recorded of 7.7. Table below shows the summery of the recording while Table shows the maximum, minimum and average temperature during the first-round data collection.

**Table 11**: Summery of green roof first round thermal recording

| *Summary* | | | |
|---|---|---|---|
| *Max* | 30.4°C/%RH | Start Time | 2019-07-22 09:41:06 |
| *Min* | 22.7°C/%RH | Stop Time | 2019-09-16 11:30:16(Temporary Stop) |
| *Avg* | 23.3°C/%RH | Elapsed Time | 21D 2H 22M 0S |
| *Mean Kinetic Temperature (MKT)* | 23.8°C | Total Points | 15192 |

The second-round data collection for this building started on 1st of October 2019 and extends until 13th March 2020 which is more than four months. These data include three Ethiopian seasons which are autumn (Belg) and winter (Bega). These two seasons are relatively hotter than the previous season. Winter (Bega) is the hottest and driest season from both summer (Kiremt) and autumn (Belg) while summer (Kiremt) is the rainy season of the year. As shown in the summery table below the minimum, maximum, average and mean kinetic recording during this time were 22.9°C/%RH, 30.8°C/%RH, 26.6°C/%RH and 26.8°C respectively. The maximum external temperature of Addis Ababa was 25.91$^{o}$C while the minimum was 13.73$^{o}$C on the day the maximum temperature has been recorded.

**Table 12**: Summery of green roof second round thermal recording

| *Summary* | | | |
|---|---|---|---|
| *Max* | 30.8°C/%RH | Start Time | 2019-10-01 11:41:40 |
| *Min* | 22.9°C/%RH | Stop Time | 2020-03-16 11:41:40(Stop by button) |
| *Avg* | 26.6°C/%RH | Elapsed Time | 182D 0H 0M 0S |
| *Mean Kinetic Temperature (MKT)* | 26.8°C | Total Points | 4369 |

For the climate of Addis Ababa, the maximum temperature recorded might not be stressful while the minimum temperature recorded 22.9$^{o}$C was in the comfort level. As the library personnel testify both when other places are cooled and hot in the library the temperature is modest. The data also prove this testimony. Thermal variation of this building was very smaller than the previous ones being 7.9$^{o}$C.

**Table 13**: Daily temperature recording of green roof the second-round thermal recording where MT-maximum temperature and mT-minimum temperature in $^{o}$C.

| | **Months** | **Years** | **Data** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9 | | 10 | | 11 | | 12 | | 1 | | 2 | | 3 | |
| | 2019 | | 2019 | | 2019 | | 2019 | | 2020 | | 2020 | | 2020 | |
| **Days** | MT | MiT | MT | MiT | MT | MiT | MT | MiT | MT | MiT | MT | MiT | MT | MiT |
| **1** | | | 24.9 | 23.5 | 28 | 25 | 28.4 | 25 | 28.7 | 25.7 | 28.2 | 26.1 | 30 | 27.5 |
| **2** | | | 25.1 | 23.3 | 28.3 | 25.2 | 28.6 | 25.1 | 28.7 | 25.7 | 28.7 | 26.1 | 30.2 | 27.8 |
| **3** | | | 24.9 | 23.3 | 27.9 | 25.2 | 29 | 25.6 | 28.8 | 25.9 | 28.7 | 26.3 | 30.4 | 28 |
| **4** | | | 25.1 | 23.6 | 28.5 | 25.7 | 29.2 | 25.8 | 29.4 | 26 | 28.3 | 26.1 | 30.6 | 28.2 |
| **5** | | | 25.9 | 23.6 | 28.7 | 25.7 | 28.3 | 25.8 | 29.4 | 25.8 | 28.8 | 25.9 | 30.6 | 28.5 |
| **6** | | | 25.7 | 23.9 | 28.7 | 25.7 | 28.7 | 25.5 | 29.4 | 26.1 | 28.7 | 26.1 | 30.5 | 28.3 |
| **7** | | | 26.1 | 23.9 | 28.3 | 25.9 | 29 | 25.5 | 29.3 | 26.3 | 28.9 | 25.9 | 30.4 | 28.6 |
| **8** | | | 26.1 | 24.2 | 28.7 | 25.9 | 28.4 | 25.5 | 29.6 | 26 | 28.8 | 26 | 30.5 | 28.3 |
| **9** | | | 26.1 | 24.3 | 28.7 | 25.9 | 28.3 | 26.1 | 29.5 | 25.8 | 28.8 | 26.1 | 30.4 | 28.2 |
| **10** | | | 26.5 | 24.6 | 28.6 | 25.9 | 27.3 | 25.9 | 29.6 | 26.1 | 29.2 | 26 | 30.7 | 28.5 |
| **11** | | | 26.4 | 24.3 | 29.3 | 26.5 | 26.9 | 25.2 | 29.7 | 26.6 | 29.3 | 26.2 | 30.7 | 28.8 |
| **12** | | | 26.2 | 24.3 | 29 | 26.2 | 27.2 | 24.5 | 29.4 | 26.8 | 28.9 | 26.8 | 30.8 | 28.6 |
| **13** | | | 26.1 | 24.7 | 29.1 | 26 | 28.2 | 24.6 | 28.7 | 26.4 | 28 | 26.5 | 30.8 | 28.5 |
| **14** | | | 26.6 | 24.2 | 28.5 | 26.2 | 27.8 | 24.7 | 28.4 | 26.3 | 28 | 25.8 | 30.8 | 28.9 |
| **15** | | | 26.4 | 24.2 | 28.7 | 25.9 | 28 | 24.5 | 29.1 | 25.7 | 28.3 | 25.5 | 30.7 | 28.7 |
| **16** | 28.1 | 24 | 26.7 | 24.2 | 28.7 | 26 | 28.4 | 24.6 | 28.7 | 25.6 | 28.8 | 25.6 | 29.8 | 28.7 |
| **17** | 25.3 | 23.7 | 26.7 | 24.3 | 29.1 | 25.9 | 28.6 | 24.9 | 29 | 25.5 | 28.9 | 26 | | |
| **18** | 25.1 | 23.7 | 26.3 | 24.1 | 29.4 | 26.3 | 28.7 | 25.1 | 28.8 | 25.4 | 29.3 | 26.4 | | |
| **19** | 24.7 | 23.1 | 26.7 | 24.5 | 29.5 | 26.6 | 28.6 | 24.9 | 28.7 | 25.3 | 29.4 | 26.6 | | |
| **20** | 24.5 | 22.9 | 26.9 | 24.7 | 28.7 | 26.8 | 28.2 | 24.9 | 28.7 | 25.3 | 29.2 | 26.6 | | |
| **21** | 24.5 | 23.4 | 27 | 24.5 | 28.6 | 26.3 | 28.2 | 25.1 | 28.7 | 25.2 | 29.5 | 26.5 | | |
| **22** | 24.3 | 23.2 | 27 | 24.6 | 28.5 | 26.5 | 27.9 | 25.3 | 28.6 | 25.4 | 29.2 | 26.7 | | |
| **23** | 24.2 | 23 | 27 | 24.5 | 28.3 | 26.3 | 28.7 | 25.3 | 28.7 | 25.6 | 29.2 | 26.7 | | |
| **24** | 24.3 | 22.9 | 26.9 | 24.2 | 26.9 | 25.9 | 29.1 | 25.6 | 28.5 | 25.9 | 29.5 | 26.6 | | |
| **25** | 24.7 | 23.1 | 27 | 24.3 | 27.4 | 25.5 | 29.3 | 26 | 28.6 | 26 | 29.6 | 26.6 | | |
| **26** | 24.9 | 23.1 | 27.1 | 24.4 | 27.4 | 25.1 | 29 | 26.1 | 28.2 | 25.9 | 29.5 | 27.2 | | |
| **27** | 24.7 | 23.2 | 27.3 | 24.4 | 27.5 | 24.8 | 29.3 | 26 | 27.3 | 25.9 | 29.8 | 27.2 | | |
| **28** | 24.3 | 23.2 | 27.3 | 24.5 | 27.9 | 24.5 | 29 | 26.1 | 28.6 | 25.6 | 29.9 | 27.3 | | |
| **29** | 24.8 | 22.9 | 27.6 | 24.7 | 28.1 | 24.9 | 28.7 | 26 | 28.6 | 25.9 | 29.8 | 27.4 | | |
| **30** | 24.9 | 23.4 | 27.8 | 24.7 | 28.3 | 25.1 | 28.8 | 25.9 | 28.7 | 26 | | | | |
| **31** | | | 27.9 | 24.8 | | | 29.4 | 25.5 | 28.5 | 25.9 | | | | |

C. Simulation of Green Roof Model in Adama

To see to what extent retrofitting green roof can attenuate the above results, the selected building has been modeled by using Autodesk Revit 2019 and exported to ecotect for the thermal simulation. But the green roof covers only the room where the thermal recorder has been put before (the third-floor roof) area which was represented or named zone 4.

The setting of the room in the model was the same as it was in the real building. Wall material was hollow concrete block plastered and painted inside and outside, having 250mm thickness including the plastering and painting which overall U-value of 1.985 $W/m^2K$ and 1.5 x 1.5m window opening, internal partition wall. The floor and roof were constructed of hallow block concrete ribbed slab in the two rounds the days that the maximum and minimum temperature recorded were selected for the comparison between the records of the vegetated roof and the built one. The roof has been covered with normal green roof layers which are waterproofing membrane 2mm, root barrier 2mm, drainage cells 40mm, geotextile 4mm, and growing media with plant 150mm.

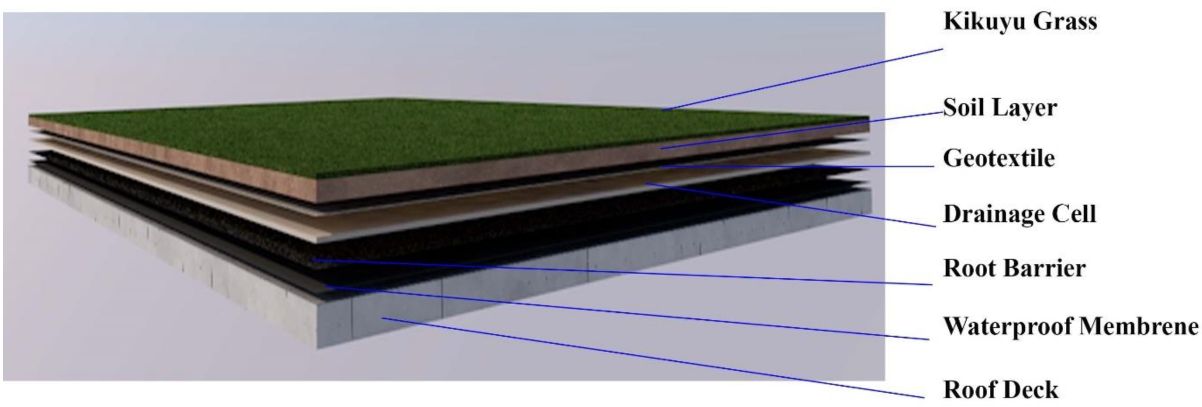



FIGURE 16: GREEN ROOF USED FOR THE SIMULATION

After the simulation took place, the days which are with the highest and lowest average temperature recorded has been selected to compare the performance of retrofitted roof and non-retrofitted one. As a result, an hourly recording from the collected data of non-retrofitted building on 11$^{th}$ April, 2020 and thermal profile of retrofitted building from simulation result of the same day have been taken. On this day the maximum temperature of non-retrofitted building was recorded which was 34.7$^oC$ but the maximum temperature for the retrofitted was 26.1$^oC$ having variation of 8.6$^oC$. Nevertheless, this happen not at the same time, for retrofitted model it was at noon time when the outside temperature also was high while for the non-retrofitted one it was in the late afternoon at 04:00 and 05:00 PM. But the maximum temperature for the retrofitted model building was in the range of thermal comfort which was according to the climate analysis done by using climate tool of the same software which was 18-26°C, considering the activity level sedentary 70W. In both cases lowest and highest average temperature, if we see the variation of the retrofitted building model it has only a small gap relative to the non-retrofitted one.

HOURLY TEMPERATURES - Saturday 27th Jan

Zone: 4 Room

Avg. Temperature: 19.7°C (Ground 19.3°C)

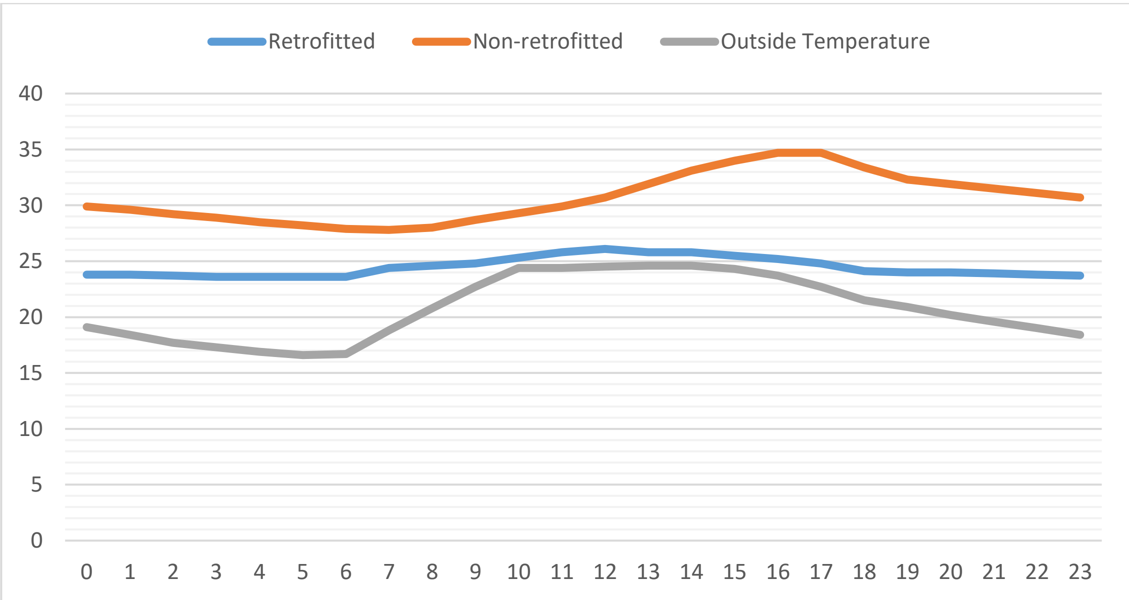
Total Surface Area: 180m$^2$.

Total Exposed Area: 153 m$^2$

Total South Window: 6.75 m$^2$

Total Window Area: 6.75 m$^2$

Response Factor: 12.34




a)

b)

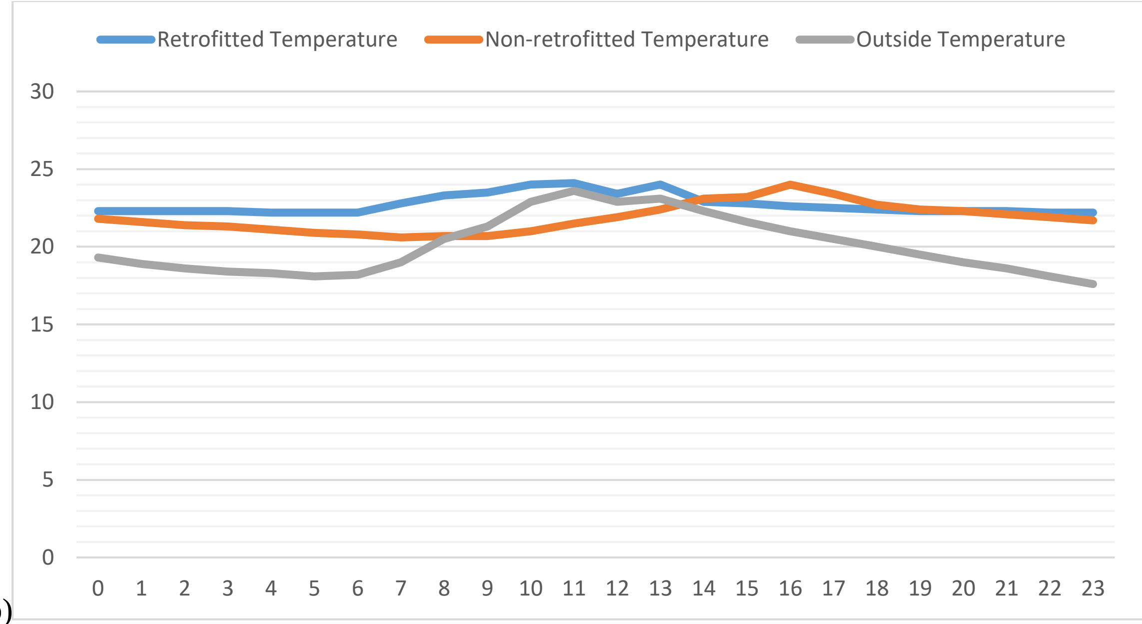



FIGURE 17: HOURLY TEMPERATURE COMPARISON a) Highest and b) Lowest average temperature

Source: Data interpretation

The relationship of the outside temperature and inside temperature shows the characteristics of building elements building envelope (wall and Roof), occupancy, the function of the room, the position with respect to its exposition to solar radiation, air conditioning, etc. Regardless of other factors which can affect the indoor temperature, the result shows the great contribution of green roof retrofitting in attenuation of thermal comfort. When we see the outside and inside temperature the increment in retrofitted roof occurred at the same time of the increase in temperature of the outside which means that it has low time lag. But the temperature that have been gained by the retrofitted building was much smaller than the non-retrofitted one which shows the decrement factor (capacity) of retrofitted green roof was higher than the non-retrofitted. This conclusion has been reached because the change in the building happens only on the roofing. The term decrement factor is applied to the surface of each building envelop which in case of this research calculated as cumulative decrement factor. The decrement factor can be calculated by:

$$\text{Decrement factor} = \frac{\Delta \mathrm{T}i}{\Delta To} = \frac{Ti\, max - Ti\, min}{To\, \mathrm{max}\ - To\, min}$$

Using this equation, the cumulative decrement factor of the retrofitted building on the days of highest average temperature have been 0.3125, while for non-retrofitted building was

0.8625. This means that the outside temperature will only be decrease inside the building. The effect will be multiplied when the time lag is high because the accumulated temperature will be released.

Other factors that have been seen were the thermal gain index and adaptability index. Temperature gain came as a result of solar heated ventilation and infiltration gains through crack and openings (sQv), internal loads from lights, people and equipment (sQi), and Indirect solar loads through solar gains on opaque surfaces (sQss). Cracks, openings, and opaque surfaces were also causing for temperature loss inside the room as shown in the figure bellow. This occur when the outdoor temperature gets below 19°C.

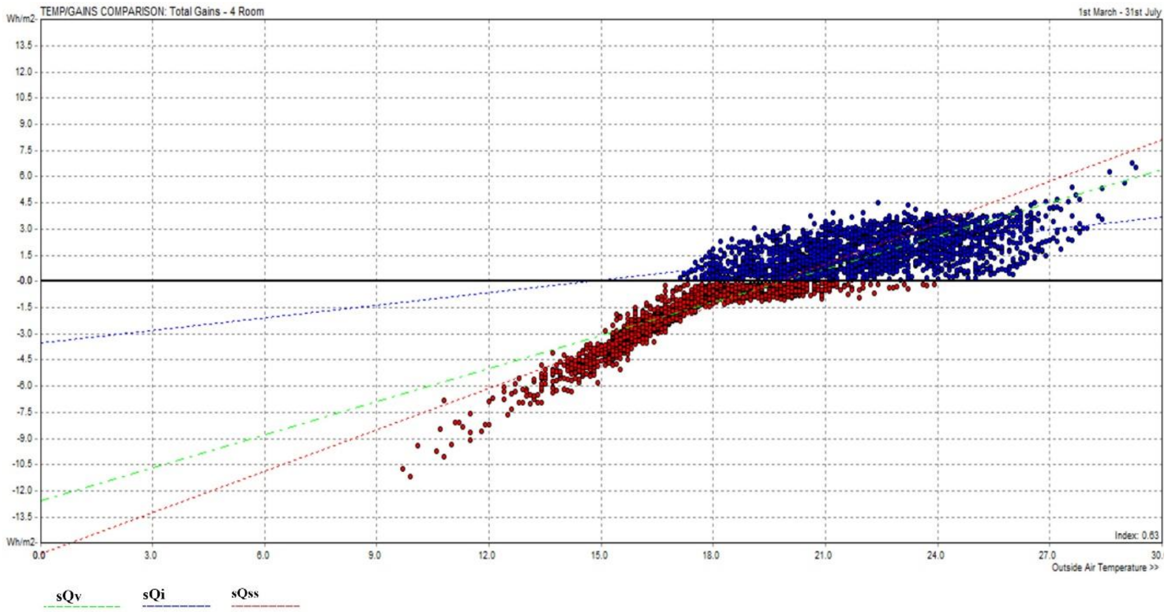



FIGURE 18: THERMAL GAIN; where sQv-Ventilation, sQi-Internal loads and sQss-Indirect solar loads

Source: Simulation

Adaptability is the relationship of indoor temperature or acceptable temperature ranges to the outdoor meteorological or climatological parameters. The figure below shows the acceptable index of this relation which is 0.33 which means whenever the outside air temperature is 1°C it is acceptable for the indoor temperature in the range of 1-3°C. This result begotten under the use of no mechanical cooling or heating, occupant's metabolic rate being 1 met with formal office suite of 1.0 clo.

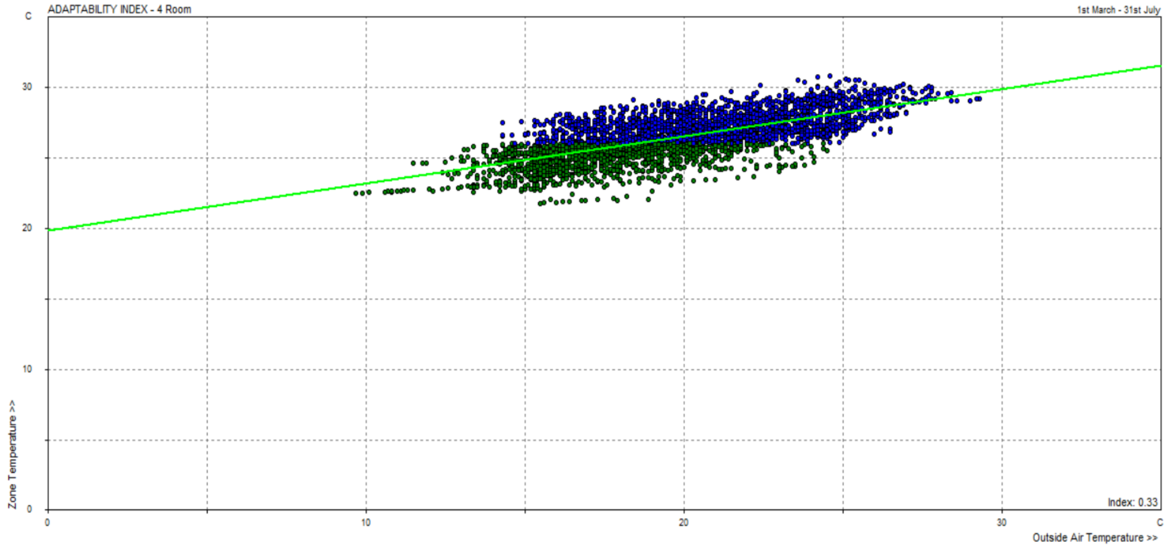



FIGURE 19: ADAPTABILITY INDEX

Source: Simulation

# CHAPTER FIVE

# CONCLUSION AND RECOMMENDATION

## 5.1. Conclusion

From field visit and satellite images, it has been found that buildings in the study area were built with a corrugated iron sheet except for six buildings which are built with concrete roof. None of the buildings taken as samples have an insulation system either with their roofing or with their wall systems. This was true for the buildings they represent. Roofs are poorly constructed which makes the idea of retrofitting them with green roofs where they need to be waterproofed and structurally able to carry the additional load. Because of this, the better potential of retrofitting was found in concrete roofs. The flat roofs in the study area are owned by institutions that potentially can retrofit the buildings with green roof.

Both, results of data analysis as well as other research reviewed revealed that retrofitting existing buildings with green roof gives thermal benefit in cooling the indoor temperature. Considering that roof is the very exposed surface to solar radiation than other parts of any building, the performance it has in terms of insulation and thermal mass properties enables it to give the expected benefit. In this case, the addition of a green roof increases its insulation properties and adds thermal mass to the roof. In their thorough study on retrofitting lightweight green roof to houses (S. Wilkinson & Feitosa, 2015) proofed that green roofs have great potential in attenuating extreme temperature of the indoor environment because of their increased insulation and thermal mass properties.

This research mainly deals with the thermal performance of existing buildings by applying extensive green roof of 150mm thick as a measure to cool indoor temperature. Simulation have been done on the developed retrofitted building model in Ecotect. And it has proven that it has a significant impact in attenuating indoor air temperature.

The building having corrugated Iron sheet roof had shown higher fluctuation in maximum and minimum temperature ranging 15-18$^{o}$C which was higher than that of the concrete roofed building which was 9.7-14.3. They both had no insulation installed. Because of this and other factors such as relative humidity, orientation of the building, poor workmanship, air ventilation, the function of the building, the activity that took place in the building, etc.

affects thermal performance. Keeping these factors in mind this research proven that retrofitting green roof can minimize the maximum indoor temperature by 8.6$^{o}$C, using applying simulation. But the minimum temperature recorded in a bare concrete roofed was less than the minimum which was of the simulated. When we compere the graphs of the retrofitted model it was flatter than that of non-retrofitted one indicating that thermal variation of retrofitted building was small. Therefore, in regulating temperature fluctuation and heat fluxes green roof has showed better performance.

In order for one to retrofit a building with green roof first, there has to be considerations concerning the type of green roof to be retrofitted. Research shows that the type and structural capability of roofing and the measures or function required, determines the selection of green roof retrofitting. According to (Besir & Cuce, 2018) extensive roof which is preferable for retrofitting purpose can weigh 60-150 Kg/m$^2$ when saturated and having 60-200 mm thickness. And (Castleton et al., 2010) in his research reported that commercial buildings can handle 120-150 Kg/m$^2$ extensive green roof without additional strengthening required.

Plant selection is the critical part of green roof retrofitting. It depends on the drought resistance of plants and their root growth, since the thickness of the extensive substrate is small, it can penetrate through the root barrier and also the roof deck. In many researches Sedum plants are selected for extensive green roof, while others recommend Kikiyu grass. They can easily be found, known for their drought resistance, grow rapidly and propagate aggressively.

Some applies drainage cells or light weight aggregates to retain and drain water upon root barrier while others applied directly the substrate layer after water proofing and root barrier membranes. When directly substrate layer applied it minimizes the cost of retrofitting. The simulation model in this research applied the drainage layer of deltaflorax water retainer and draining.

## 5.2. Recommendations

This field of study is untouched still requiring many to participate in the study of it in a micro and macro level. In micro level the contribution of each layers of green roof in relation to other factors such as humidity level, ventilation, wall and opening materials, insulations and air conditioners, energy consumption and others.

Even if it's environmental, Social and economic benefits are great, there is undeniable knowledge gap which became an obstacle for green roof not to be practiced. Environmentally the contribution it brings with respect to water quality and quantity, storm water management, air quality, greenhouse gas emission, biodiversity. Socially it can create jobs, maintains health and wellbeing, and it can be food source for urban society. Its income generation for the stakeholders, cost minimization for cooling and heating, energy efficiency and other benefits of green roof are still need to be studied in the contextual manner.

To increase the thermal performance of green roof it is important to consider the whole components, starting from the plant to the water proofing membrane. For the reason that retrofitting buildings with green roof needs to be bearable by existing roof structures extensive green roof took the lead. Plants must have to be drought resistant to sustain the dry seasons alive and functioning. Growing media has to have the ability to retain water for longer time to supply plants within required thickness and weight. The geotextile layer also has to play the both the roll of keeping the substrate soil and water, which at the same time has to pass extra water to drainage layer.

Both indicators the time lag and the decrement values are dependent on the performance of each layers of green roofing. Therefore, to maximize the time lag and decrement value of the green roof it is important to give heed to each layers. The thicker the soil substrate on the roof, the better it reduces heat gain/loss into/out of the building.

It has been observed that, structural limitation is also one of the main challenges in retrofitting green roof. Many studies are being conducted in this direction but not in relation to green roof.

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# APPENDICES

# Appendix 1: Climate Data of Adama City

-BEGIN HEADER-
NASA/POWER SRB/FLASHFlux/MERRA2/GEOS 5.12.4 (FP-IT) 0.5 x 0.5 Degree Daily Averaged Data
Dates (month/day/year): 07/01/2019 through 05/14/2020
Location: Latitude 8.5269 Longitude 39.2856
Elevation from MERRA-2: Average for 1/2x1/2 degree lat/lon region = 1915.26 meters Site = na
Climate zone: na (reference Briggs et al: http://www.energycodes.gov)
Value for missing model data cannot be computed or out of model availability range: -999
Parameter(s):
WS50M MERRA2 1/2x1/2 Wind Speed at 50 Meters (m/s)
WS50M_MIN MERRA2 1/2x1/2 Minimum Wind Speed at 50 Meters (m/s)
WS10M_MIN MERRA2 1/2x1/2 Minimum Wind Speed at 10 Meters (m/s)
WS50M_MAX MERRA2 1/2x1/2 Maximum Wind Speed at 50 Meters (m/s)
T2MWET MERRA2 1/2x1/2 Wet Bulb Temperature at 2 Meters (C)
T2M_RANGE MERRA2 1/2x1/2 Temperature Range at 2 Meters (C)
T2M MERRA2 1/2x1/2 Temperature at 2 Meters (C)
WS10M_RANGE MERRA2 1/2x1/2 Wind Speed Range at 10 Meters (m/s)
TS MERRA2 1/2x1/2 Earth Skin Temperature (C)
T2M_MAX MERRA2 1/2x1/2 Maximum Temperature at 2 Meters (C)
WS10M_MAX MERRA2 1/2x1/2 Maximum Wind Speed at 10 Meters (m/s)
WS50M_RANGE MERRA2 1/2x1/2 Wind Speed Range at 50 Meters (m/s)
T2M_MIN MERRA2 1/2x1/2 Minimum Temperature at 2 Meters (C)
WS10M MERRA2 1/2x1/2 Wind Speed at 10 Meters (m/s)
T2MDEW MERRA2 1/2x1/2 Dew/Frost Point at 2 Meters (C)
-END HEADER-

| LAT | LON | YEAR | MO | DY | T2M_RA | TS | T2MDEW | T2MWET | T2M_MA | T2M_MI | T2M | WS50M_ | WS10M_ | WS50M_ | WS10M_ | WS50M_ | WS10M_ | WS50M | WS10M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.52691 | 39.28561 | 2019 | 7 | | 110.74 | 21.88 | 14.18 | 13.99 | 26.75 | 16.01 | 20.6 | 4.87 | 4.44 | 1.43 | 0.88 | 6.3 | 5.32 | 4.07 | 2.92 |
| 8.52691 | 39.28561 | 2019 | 7 | | 29.23 | 21.49 | 14.62 | 14.48 | 25.81 | 16.57 | 20.5 | 1.48 | 1.88 | 1.24 | 0.69 | 2.72 | 2.57 | 1.92 | 1.4 |
| 8.52691 | 39.28561 | 2019 | 7 | | 37.51 | 20.09 | 14.26 | 14.18 | 22.94 | 15.43 | 19.2 | | 6.35.07 | 0.18 | 0.18 | 6.48 | 5.25 | 2.93 | 1.99 |
| 8.52691 | 39.28561 | 2019 | 7 | | 412.56 | 22.04 | 13.41 | 13.29 | 27.23 | 14.67 | 21.0 | | 3.53.29 | 0.47 | 0.31 | 3.97 | 3.6 | 2.28 | 1.69 |
| 8.52691 | 39.28561 | 2019 | 7 | | 510.63 | 22.52 | 13.52 | 13.4 | 26.79 | 16.16 | 21.1 | 4.29 | 2.56 | 0.9 | 0.77 | 5.19 | 3.33 | 2.51 | 1.73 |
| 8.52691 | 39.28561 | 2019 | 7 | | 612.4 | 22.67 | 13.78 | 13.62 | 27.53 | 15.13 | 21.0 | 4.38 | 4.24 | 1.36 | 0.78 | 5.74 | 5.02 | 3.37 | 2.43 |
| 8.52691 | 39.28561 | 2019 | 7 | | 710.93 | 22.61 | 14.01 | 13.86 | 27.22 | 16.28 | 21.1 | 4.36 | 4.01 | 1.37 | 0.93 | 5.72 | 4.93 | 3.12 | 2.23 |
| 8.52691 | 39.28561 | 2019 | 7 | | 812.54 | 23.21 | 13.55 | 13.39 | 28.14 | 15.6 | 21.4 | 4.63 | 3.62 | 1.72 | 1.34 | 6.35 | 4.95 | 3.82 | 2.59 |
| 8.52691 | 39.28561 | 2019 | 7 | | 911.78 | 23.57 | 13.52 | 13.37 | 28.05 | 16.28 | 21.8 | 3.86 | 1.92 | 0.79 | 1.02 | 4.65 | 2.94 | 2.76 | 1.91 |
| 8.52691 | 39.28561 | 2019 | 7 | 10 | 6.35 | 20.46 | 14.47 | 14.39 | 23.09 | 16.75 | 19.7 | | 2.60.95 | 1.16 | 1.05 | 3.76 | | 2 2.19 | 1.47 |
| 8.52691 | 39.28561 | 2019 | 7 | 11 | 9.01 | 20.28 | 13.95 | 13.82 | 24.57 | 15.56 | 19.6 | 3.42 | 3.61 | 2.4 | 1.44 | 5.82 | 5.06 | 3.91 | 2.81 |
| 8.52691 | 39.28561 | 2019 | 7 | 12 | 12.88 | 21.38 | 13.18 | 13.02 | 27.32 | 14.44 | 20.3 | 4.95 | 3.81 | 0.56 | 0.71 | 5.5 | 4.51 | 3.38 | 2.26 |
| 8.52691 | 39.28561 | 2019 | 7 | 13 | 6.37 | 18.44 | 14.28 | 14.23 | 21.63 | 15.25 | 18.0 | 4.05 | 2.63 | 0.38 | 0.24 | 4.43 | 2.87 | 2.01 | 1.35 |
| 8.52691 | 39.28561 | 2019 | 7 | 14 | 10.78 | 19.55 | 12.55 | 12.44 | 24.79 | 14.01 | 18.5 | 2.65 | 1.72 | 2.42 | 1.71 | 5.07 | 3.43 | 3.81 | 2.52 |
| 8.52691 | 39.28561 | 2019 | 7 | 15 | 13.05 | 21.56 | 12.46 | 12.34 | 26.87 | 13.83 | 20.2 | 3.21 | 2.54 | 1.29 | 0.88 | 4.49 | 3.42 | 2.91 | 1.94 |
| 8.52691 | 39.28561 | 2019 | 7 | 16 | 10.64 | 21.88 | 13.53 | 13.39 | 26.4 | 15.76 | 20.6 | 2.73 | 2.89 | 1.28 | 0.7 | 4.01 | 3.59 | 2.02 | 1.49 |
| 8.52691 | 39.28561 | 2019 | 7 | 17 | 10.67 | 21.59 | 13.89 | 13.76 | 26.18 | 15.51 | 20.2 | 4.17 | | 4.21.81 | 1.01 | 5.97 | 5.22 | 4.25 | 3.07 |
| 8.52691 | 39.28561 | 2019 | 7 | 18 | 9.12 | 20.38 | 13.26 | 13.14 | 24.56 | 15.44 | 19.2 | 5.78 | | 4.71.79 | 1.61 | 7.58 | 6.31 | 5.11 | 3.67 |
| 8.52691 | 39.28561 | 2019 | 7 | 19 | 11.69 | 21.67 | 13.23 | 13.08 | 26.04 | 14.35 | 20.2 | 4.69 | 3.61 | 0.82 | 0.56 | 5.51 | 4.17 | 3.13 | 2.1 |
| 8.52691 | 39.28561 | 2019 | 7 | 20 | 10.97 | 22.32 | 13.57 | 13.44 | 27.27 | 16.3 | 20.9 | 3.04 | 1.42 | 2.04 | 1.68 | 5.08 | 3.11 | 3.49 | 2.42 |
| 8.52691 | 39.28561 | 2019 | 7 | 21 | 10.44 | 22.48 | 13.65 | 13.51 | 26.93 | 16.49 | 21.1 | 4.16 | 2.04 | 0.88 | 1.22 | 5.04 | 3.26 | 3.3 | 2.28 |
| 8.52691 | 39.28561 | 2019 | 7 | 22 | 10.26 | 21.84 | 13.57 | 13.42 | 26.49 | 16.22 | 20.6 | | 3.53.36 | 3.64 | 2.72 | 7.14 | 6.08 | 5.06 | 3.72 |
| 8.52691 | 39.28561 | 2019 | 7 | 23 | 10.76 | 21.55 | 14.1 | 13.97 | 26.8 | 16.04 | 20.3 | 3.08 | 2.78 | 2.63 | 1.34 | 5.71 | 4.13 | 4.04 | 2.89 |
| 8.52691 | 39.28561 | 2019 | 7 | 24 | 9.37 | 21.58 | 14.4 | 14.27 | 25.91 | 16.54 | 20.6 | 4.46 | 2.65 | 0.34 | 0.22 | 4.8 | 2.88 | 2.86 | 2.03 |
| 8.52691 | 39.28561 | 2019 | 7 | 25 | 11.92 | 21.68 | 14.39 | 14.27 | 27.01 | 15.09 | 20.7 | 5.05 | 3.15 | 0.17 | 0.44 | 5.22 | 3.59 | 2.87 | 1.85 |
| 8.52691 | 39.28561 | 2019 | 7 | 26 | 6.14 | 19.25 | 15.27 | 15.23 | 22.57 | 16.43 | 18.7 | 3.34 | | 2.61.8 | 1.64 | 5.15 | 4.24 | 3.9 | 2.67 |
| 8.52691 | 39.28561 | 2019 | 7 | 27 | 8.8 | 20.89 | 14.46 | 14.32 | 24.88 | 16.09 | 19.6 | 3.92 | | 2.10.65 | 0.45 | 4.57 | 2.56 | 2.21 | 1.43 |
| 8.52691 | 39.28561 | 2019 | 7 | 28 | 10.58 | 21.53 | 14.79 | 14.68 | 26.28 | 15.7 | 20.4 | | 3.52.03 | 0.76 | 0.87 | 4.26 | 2.9 | 2.45 | 1.66 |
| 8.52691 | 39.28561 | 2019 | 7 | 29 | 10 | 20.87 | 14.12 | 14.02 | 25.35 | 15.34 | 19.9 | 3.03 | 3.37 | 2.6 | 1.29 | 5.63 | 4.66 | 4.28 | 3.05 |
| 8.52691 | 39.28561 | 2019 | 7 | 30 | 11.33 | 21.07 | 13.86 | 13.74 | 25.93 | 14.6 | 20.2 | 3.83 | 3.82 | 1.38 | 0.71 | 5.2 | 4.53 | 3.18 | 2.31 |
| 8.52691 | 39.28561 | 2019 | 7 | 31 | 10.76 | 21.03 | 14.21 | 14.11 | 25.62 | 14.86 | 20.0 | 2.41 | 3.27 | 2.83 | 1.46 | 5.23 | 4.73 | 4.5 | 3.18 |
| 8.52691 | 39.28561 | 2019 | 8 | | 110.62 | 21.21 | 14.23 | 14.12 | 26.16 | 15.54 | 19.9 | 1.23 | 2.49 | 3.8 | 2.06 | 5.03 | 4.55 | 4.34 | 3.08 |
| 8.52691 | 39.28561 | 2019 | 8 | | 210.14 | 21.06 | 14.47 | 14.35 | 25.81 | 15.67 | 20.0 | 3.38 | | 4.23.13 | 1.5 | 6.51 | 5.7 | 5.2 | 3.59 |
| 8.52691 | 39.28561 | 2019 | 8 | | 38.59 | 19.99 | 14.22 | 14.11 | 23.71 | 15.11 | 19.0 | 3.58 | 3.19 | 2.24 | 1.4 | 5.82 | 4.59 | 3.8 | 2.58 |
| 8.52691 | 39.28561 | 2019 | 8 | | 49.04 | 20.31 | 13.89 | 13.79 | 24.73 | 15.69 | 19.3 | 2.29 | 3.15 | 4.06 | 2.24 | 6.34 | 5.38 | 5.37 | 3.75 |
| 8.52691 | 39.28561 | 2019 | 8 | | 58.46 | 18.73 | 12.24 | 12.14 | 22.91 | 14.45 | 17.9 | 1.31 | 2.89 | 5.9 | 3.29 | 7.21 | 6.18 | 6.74 | 4.85 |
| 8.52691 | 39.28561 | 2019 | 8 | | 610.65 | 19.69 | 12.74 | 12.64 | 24.76 | 14.11 | 18.7 | 2.96 | 2.53 | 3.85 | 1.95 | 6.81 | 4.48 | 5.06 | 3.5 |
| 8.52691 | 39.28561 | 2019 | 8 | | 77.36 | 19.04 | 14.03 | 13.96 | 22.75 | 15.39 | 18.4 | 4.07 | 3.87 | 1.69 | 1.11 | 5.76 | 4.98 | 3.73 | 2.54 |
| 8.52691 | 39.28561 | 2019 | 8 | | 810.74 | 20.73 | 13.9 | 13.79 | 25.25 | 14.51 | 19.6 | | 3.33.45 | 1.59 | 0.8 | 4.89 | 4.24 | 3.72 | 2.63 |
| 8.52691 | 39.28561 | 2019 | 8 | | 94.92 | 17.97 | 15.05 | 15.02 | 20.51 | 15.59 | 17.7 | 3.73 | 3.39 | 0.48 | 0.22 | 4.21 | 3.61 | 2.31 | 1.63 |
| 8.52691 | 39.28561 | 2019 | 8 | 10 | 5.44 | 17.4 | 14.16 | 14.14 | 20.31 | 14.87 | 17.0 | | 5.45.46 | 2.75 | 1.47 | 8.15 | 6.93 | 5.61 | 3.91 |
| 8.52691 | 39.28561 | 2019 | 8 | 11 | 7.49 | 17.75 | 14.25 | 14.21 | 21.53 | 14.04 | 17.4 | 3.69 | 3.13 | 2.11 | 1.16 | 5.81 | 4.29 | 4.13 | 2.75 |
| 8.52691 | 39.28561 | 2019 | 8 | 12 | 5.2 | 17.34 | 14.17 | 14.14 | 20.36 | 15.16 | 17.1 | 2.72 | | 2.9 | 2 1.11 | 4.72 | 4.02 | 3.72 | 2.57 |
| 8.52691 | 39.28561 | 2019 | 8 | 13 | 8.38 | 18.24 | 14.42 | 14.37 | 22.4 | 14.02 | 17.7 | 3.91 | 2.78 | 1.17 | 0.67 | 5.08 | 3.45 | 2.97 | 1.88 |
| 8.52691 | 39.28561 | 2019 | 8 | 14 | 5.6 | 17.3 | 14.4 | 14.38 | 20.36 | 14.76 | 17.1 | 3.75 | 2.62 | 1.1 | 0.69 | 4.85 | 3.3 | 2.99 | 2.01 |
| 8.52691 | 39.28561 | 2019 | 8 | 15 | 10.18 | 19.69 | 14.77 | 14.7 | 24.67 | 14.5 | 19.0 | 3.66 | 2.32 | 1.2 | 1.16 | 4.86 | 3.48 | 3.03 | 2.03 |
| 8.52691 | 39.28561 | 2019 | 8 | 16 | 10.78 | 19.62 | 14.47 | 14.39 | 24.73 | 13.96 | 19.1 | 4.64 | 3.84 | 0.8 | 0.57 | 5.44 | 4.41 | 2.85 | 2.03 |
| 8.52691 | 39.28561 | 2019 | 8 | 17 | 11.28 | 20.09 | 14.9 | 14.81 | 25.37 | 14.08 | 19.5 | 4.72 | | 3.60.09 | 0.36 | 4.8 | 3.96 | 2.69 | 1.82 |
| 8.52691 | 39.28561 | 2019 | 8 | 18 | 9.02 | 19.84 | 15.45 | 15.38 | 24.22 | 15.2 | 19.5 | 4.47 | 3.56 | 0.64 | 0.33 | 5.11 | 3.9 | 2.69 | 1.92 |
| 8.52691 | 39.28561 | 2019 | 8 | 19 | 8.16 | 19.58 | 15.33 | 15.27 | 24.22 | 16.06 | 19.2 | 3.65 | 3.42 | 1.06 | 0.64 | 4.72 | 4.06 | 2.24 | 1.7 |
| 8.52691 | 39.28561 | 2019 | 8 | 20 | 7.51 | 18.79 | 15.44 | 15.36 | | 2315.5 | 18.6 | 3.68 | | 3.40.6 | 0.39 | 4.28 | 3.8 | 2.02 | 1.55 |
| 8.52691 | 39.28561 | 2019 | 8 | 21 | 7.39 | 18.21 | 14.98 | 14.91 | 22.46 | 15.07 | 18.3 | 3.27 | 3.14 | 0.31 | 0.16 | 3.58 | 3.3 | 1.91 | 1.51 |
| 8.52691 | 39.28561 | 2019 | 8 | 22 | 9.95 | 18.95 | 14.81 | 14.72 | 23.76 | 13.81 | 18.6 | 4.75 | 3.31 | 0.71 | 0.4 | 5.46 | 3.71 | 2.95 | 2.03 |
| 8.52691 | 39.28561 | 2019 | 8 | 23 | 8.86 | 18.99 | 14.96 | 14.9 | 23.52 | 14.67 | 18.9 | 4.35 | 3.88 | 0.61 | 0.37 | 4.97 | 4.25 | 2.45 | 1.81 |
| 8.52691 | 39.28561 | 2019 | 8 | 24 | 10.14 | 19.42 | 14.25 | 14.17 | 24.64 | 14.51 | 19.1 | 5.55 | | 4.31.01 | 0.67 | 6.56 | 4.97 | 3.47 | 2.5 |
| 8.52691 | 39.28561 | 2019 | 8 | 25 | 8.83 | 19.28 | 14.37 | 14.28 | 23.87 | 15.04 | 19.2 | 2.51 | 2.47 | 0.2 | 0.12 | 2.71 | 2.59 | 1.76 | 1.38 |
| 8.52691 | 39.28561 | 2019 | 8 | 26 | 9.03 | 19.07 | 14.71 | 14.64 | 23.52 | 14.49 | 18.7 | 4.84 | 2.92 | 0.21 | 0.15 | 5.05 | 3.08 | 3.07 | 2.13 |
| 8.52691 | 39.28561 | 2019 | 8 | 27 | 8.19 | 18.25 | 14.24 | 14.19 | 22.53 | 14.34 | 17.9 | 4.04 | | 4.13.74 | 2.14 | 7.78 | 6.24 | 5.58 | 3.74 |
| 8.52691 | 39.28561 | 2019 | 8 | 28 | 10.47 | 18.7 | 14.02 | 13.92 | 23.71 | 13.24 | 18.3 | 3.97 | 1.55 | 0.62 | 0.71 | 4.59 | 2.26 | 2.17 | 1.38 |
| 8.52691 | 39.28561 | 2019 | 8 | 29 | 9.41 | 18.63 | 14.33 | 14.27 | 23.31 | 13.91 | 18.4 | 3.49 | 2.67 | 1.47 | 0.98 | 4.95 | 3.66 | 2.98 | 2.08 |
| 8.52691 | 39.28561 | 2019 | 8 | 30 | 10.3 | 18.9 | 14.14 | 14.07 | 24.13 | 13.83 | 18.6 | | 5.23.88 | 0.83 | 0.67 | 6.04 | 4.55 | 3.09 | 2.12 |
| 8.52691 | 39.28561 | 2019 | 8 | 31 | 10.9 | 19.27 | | 1413.89 | 24.72 | 13.82 | 19.3 | 3.32 | 2.64 | 0.06 | 0.04 | 3.38 | 2.68 | 2.09 | 1.52 |
| 8.52691 | 39.28561 | 2019 | 9 | | 110.92 | 19.84 | 14.49 | 14.36 | 24.96 | 14.03 | 19.6 | 1.83 | 1.14 | 1.02 | 0.6 | 2.85 | 1.74 | 1.87 | 1.37 |
| 8.52691 | 39.28561 | 2019 | 9 | | 29.15 | 19.54 | 15.17 | 15.1 | 23.91 | 14.76 | 19.3 | 4.52 | 3.02 | 1.1 | 0.7 | 5.62 | 3.72 | 3.25 | 2.22 |
| 8.52691 | 39.28561 | 2019 | 9 | | 37.85 | 18.57 | 14.57 | 14.52 | 22.43 | 14.58 | 18.2 | 1.85 | 1.63 | 2.46 | 1.59 | 4.31 | 3.21 | 3.39 | 2.28 |
| 8.52691 | 39.28561 | 2019 | 9 | | 412.14 | 19.69 | 14.03 | 13.94 | 25.52 | 13.38 | 19.1 | 3.09 | 2.61 | 1.76 | 1.34 | 4.85 | 3.95 | 3.23 | 2.19 |
| 8.52691 | 39.28561 | 2019 | 9 | | 510.42 | 19.66 | 14.9 | 14.81 | 24.77 | 14.35 | 19.3 | | 3.41.98 | 0.84 | 0.69 | 4.24 | 2.68 | 2.63 | 1.79 |
| 8.52691 | 39.28561 | 2019 | 9 | | 67.59 | 19 | 15.34 | 15.3 | | 2315.41 | 18.8 | 4.39 | 4.07 | 1.24 | 0.66 | 5.63 | 4.72 | 3.2 | 2.2 |
| 8.52691 | 39.28561 | 2019 | 9 | | 79.15 | 19.16 | 14.99 | 14.91 | 23.99 | 14.84 | 19.0 | 3.17 | 1.55 | 0.72 | 0.55 | 3.89 | 2.1 | 2.13 | 1.41 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.52691 | 39.28561 | 2019 | 9 | 8 | 10.75 | 19.11 | 14.63 | 14.57 | 24.5 | 13.75 | 18.8 | 3.31 | 3.25 | 1.73 | 1.16 | 5.04 | 4.41 | 3.45 | 2.35 |
| 8.52691 | 39.28561 | 2019 | 9 | 9 | 11.03 | 19.72 | 14.24 | 14.15 | 25.22 | 14.19 | 19.0 | 5.23 | 4.41 | 1.74 | 1.24 | 6.97 | 5.65 | 4.18 | 2.78 |
| 8.52691 | 39.28561 | 2019 | 9 | 10 | 10.84 | 19.79 | 14.12 | 14.03 | 24.95 | 14.12 | 19.2 | 4.58 | 3.53 | 1.82 | 1.17 | 6.4 | 4.7 | 3.81 | 2.58 |
| 8.52691 | 39.28561 | 2019 | 9 | 11 | 9.51 | 19.74 | 14.67 | 14.59 | 24.33 | 14.82 | 19.1 | 4.27 | 3.17 | 0.55 | 0.65 | 4.82 | 3.82 | 2.68 | 1.75 |
| 8.52691 | 39.28561 | 2019 | 9 | 12 | 8.35 | 18.29 | 14.5 | 14.43 | 22.69 | 14.33 | 18.1 | 2.81 | 1.25 | 1.09 | 1.01 | 3.9 | 2.26 | 2.29 | 1.56 |
| 8.52691 | 39.28561 | 2019 | 9 | 13 | 12.25 | 18.92 | 13.36 | 13.25 | 24.86 | 12.61 | 18.7 | 3.75 | 2.73 | 1.18 | 0.82 | 4.92 | 3.55 | 2.96 | 2.01 |
| 8.52691 | 39.28561 | 2019 | 9 | 14 | 11.07 | 19.21 | 14.13 | 14.03 | 24.62 | 13.55 | 19.0 | 4.39 | 2.87 | 0.5 | 0.35 | 4.89 | 3.22 | 2.54 | 1.78 |
| 8.52691 | 39.28561 | 2019 | 9 | 15 | 8.72 | 19.62 | 14.89 | 14.8 | 24.24 | 15.52 | 19.3 | 3.06 | 1.57 | 0.37 | 0.38 | 3.43 | 1.96 | 1.8 | 1.28 |
| 8.52691 | 39.28561 | 2019 | 9 | 16 | 8.21 | 18.7 | 15.14 | 15.08 | 23.02 | 14.81 | 18.2 | 2.35 | 2.66 | 2.59 | 1.47 | 4.94 | 4.13 | 3.86 | 2.66 |
| 8.52691 | 39.28561 | 2019 | 9 | 17 | 8.8 | 19.08 | 15.12 | 15.05 | 23.65 | 14.85 | 18.7 | 3.94 | 3.36 | 0.39 | 0.21 | 4.32 | 3.58 | 2.36 | 1.71 |
| 8.52691 | 39.28561 | 2019 | 9 | 18 | 9.64 | 19.24 | 14.3 | 14.23 | 24.28 | 14.64 | 18.9 | 4.79 | 4.07 | 0.69 | 0.52 | 5.48 | 4.59 | 3.03 | 2.1 |
| | 39.28561 | 2019 | 9 | 19 | 9.32 | 19.33 | 14.15 | 14.06 | 24.42 | 15.1 | 19.04 | 4.19 | 3.3 | 1.08 | 0.91 | 5.26 | 4.21 | 2.93 | 2.05 |
| 8.52691 | 39.28561 | 2019 | 9 | 20 | 8.63 | 18.72 | 14.25 | 14.15 | 23.26 | 14.63 | 18.36 | 4.19 | 3.53 | 0.31 | 0.19 | 4.5 | 3.71 | 2.83 | 2.06 |
| 8.52691 | 39.28561 | 2019 | 9 | 21 | 9.37 | 19.64 | 15.04 | 14.96 | 24.53 | 15.17 | 19.07 | 2.68 | 2.65 | 0.31 | 0.1 | 2.99 | 2.75 | 1.5 | 1.17 |
| 8.52691 | 39.28561 | 2019 | 9 | 22 | 8.3 | 19.06 | 14.41 | 14.33 | 23.06 | 14.76 | 18.77 | 3.42 | 2.51 | 0.9 | 0.57 | 4.32 | 3.09 | 2.11 | 1.55 |
| 8.52691 | 39.28561 | 2019 | 9 | 23 | 7.92 | 19.22 | 14.81 | 14.75 | 22.89 | 14.97 | 18.77 | 2.01 | 1.5 | 0.35 | 0.23 | 2.36 | 1.73 | 1.38 | 1 |
| 8.52691 | 39.28561 | 2019 | 9 | 24 | 7.6 | 19.51 | 14.83 | 14.77 | 23.32 | 15.72 | 19.05 | 1.69 | 1.63 | 1 | 0.6 | 2.69 | 2.23 | 1.47 | 1.1 |
| 8.52691 | 39.28561 | 2019 | 9 | 25 | 7.8 | 18.96 | 14.74 | 14.7 | 22.79 | 14.98 | 18.49 | 2.71 | 1.7 | 0.91 | 0.86 | 3.63 | 2.56 | 2.33 | 1.6 |
| 8.52691 | 39.28561 | 2019 | 9 | 26 | 8.37 | 18.89 | 14.32 | 14.26 | 23.73 | 15.37 | 18.7 | 3.82 | 3.57 | 1.24 | 0.65 | 5.07 | 4.22 | 3.35 | 2.32 |
| 8.52691 | 39.28561 | 2019 | 9 | 27 | 9.7 | 19.16 | 14.91 | 14.83 | 23.87 | 14.17 | 18.69 | 2.81 | 2.6 | 0.52 | 0.35 | 3.33 | 2.95 | 2.1 | 1.55 |
| 8.52691 | 39.28561 | 2019 | 9 | 28 | 7.25 | 18.68 | 15.32 | 15.29 | 22.73 | 15.49 | 18.34 | 3.85 | 1.86 | 0.66 | 0.68 | 4.51 | 2.54 | 2.3 | 1.48 |
| 8.52691 | 39.28561 | 2019 | 9 | 29 | 6.98 | 17.76 | 15.15 | 15.11 | 21.59 | 14.61 | 17.69 | 2.97 | 2.97 | 1.24 | 0.73 | 4.21 | 3.7 | 2.34 | 1.73 |
| 8.52691 | 39.28561 | 2019 | 9 | 30 | 8.96 | 18.91 | 14.52 | 14.47 | 23.34 | 14.38 | 18.4 | 2.1 | 2.09 | 1.88 | 1.1 | 3.98 | 3.2 | 3.1 | 2.13 |
| 8.52691 | 39.28561 | 2019 | 10 | 1 | 8.44 | 18.73 | 14.58 | 14.52 | 23.23 | 14.79 | 18.41 | 4.51 | 2.11 | 0.14 | 0.07 | 4.65 | 2.17 | 2.11 | 1.26 |
| 8.52691 | 39.28561 | 2019 | 10 | 2 | 7.07 | 17.7 | 14.87 | 14.84 | 21.7 | 14.63 | 17.37 | 5.67 | 4.7 | 0.59 | 0.35 | 6.26 | 5.05 | 3.18 | 2.24 |
| 8.52691 | 39.28561 | 2019 | 10 | 3 | 8.56 | 17.5 | 13.96 | 13.88 | 21.82 | 13.26 | 16.97 | 2.82 | 3.38 | 2.77 | 1.55 | 5.59 | 4.93 | 3.96 | 2.84 |
| 8.52691 | 39.28561 | 2019 | 10 | 4 | 8.37 | 17.95 | 14.65 | 14.62 | 22.28 | 13.91 | 17.33 | 3.03 | 3.58 | 3.5 | 1.82 | 6.52 | 5.39 | 5.08 | 3.49 |
| 8.52691 | 39.28561 | 2019 | 10 | 5 | 5.65 | 15.58 | 13.4 | 13.37 | 18.85 | 13.2 | 15.48 | 2.15 | 3.05 | 3.27 | 1.61 | 5.42 | 4.67 | 4.41 | 2.89 |
| 8.52691 | 39.28561 | 2019 | 10 | 6 | 7.86 | 16.39 | 12.32 | 12.23 | 20.71 | 12.85 | 15.97 | 5.11 | 4.82 | 2.46 | 1.61 | 7.57 | 6.43 | 5.27 | 3.62 |
| 8.52691 | 39.28561 | 2019 | 10 | 7 | 10.39 | 17.1 | 11.84 | 11.65 | 22.91 | 12.52 | 17.06 | 5.86 | 5.25 | 1.96 | 1.21 | 7.82 | 6.46 | 5.01 | 3.47 |
| 8.52691 | 39.28561 | 2019 | 10 | 8 | 10.82 | 17 | 12.68 | 12.54 | 22.5 | 11.68 | 16.76 | 5.17 | 5.21 | 3.55 | 2.12 | 8.72 | 7.33 | 6.22 | 4.37 |
| 8.52691 | 39.28561 | 2019 | 10 | 9 | 10.66 | 16.25 | 10.8 | 10.62 | 21.9 | 11.23 | 15.91 | 4.38 | 4.82 | 4.03 | 2.26 | 8.41 | 7.08 | 6.03 | 4.1 |
| 8.52691 | 39.28561 | 2019 | 10 | 10 | 10.6 | 16.39 | 12.1 | 12.04 | 21.77 | 11.17 | 15.86 | 4.07 | 4.51 | 3.71 | 2.18 | 7.78 | 6.69 | 5.58 | 3.88 |
| 8.52691 | 39.28561 | 2019 | 10 | 11 | 10.18 | 17.17 | 13 | 12.93 | 22.3 | 12.12 | 16.49 | 5.34 | 5.17 | 2.76 | 1.59 | 8.1 | 6.76 | 5.78 | 4.04 |
| 8.52691 | 39.28561 | 2019 | 10 | 12 | 10.54 | 17.56 | 12.94 | 12.82 | 22.86 | 12.32 | 16.98 | 3.31 | 4.26 | 4.19 | 2.22 | 7.5 | 6.48 | 6.06 | 4.1 |
| 8.52691 | 39.28561 | 2019 | 10 | 13 | 8.22 | 17.17 | 13.04 | 12.97 | 21.39 | 13.18 | 16.73 | 3.99 | 4.39 | 3.23 | 1.82 | 7.22 | 6.2 | 5.02 | 3.41 |
| 8.52691 | 39.28561 | 2019 | 10 | 14 | 11.06 | 16.71 | 10.27 | 10.16 | 22.79 | 11.73 | 16.41 | 4.2 | 4.86 | 4.03 | 2.25 | 8.24 | 7.12 | 5.98 | 4.18 |
| 8.52691 | 39.28561 | 2019 | 10 | 15 | 12.59 | 16.6 | 10.46 | 10.34 | 23.4 | 10.81 | 16.37 | 4.64 | 5.04 | 3.55 | 2.02 | 8.19 | 7.06 | 5.68 | 4.01 |
| 8.52691 | 39.28561 | 2019 | 10 | 16 | 12.11 | 16.9 | 11.58 | 11.51 | 23.11 | 11 | 16.49 | 4.56 | 4.76 | 2.71 | 1.6 | 7.27 | 6.36 | 5.29 | 3.75 |
| 8.52691 | 39.28561 | 2019 | 10 | 17 | 12.75 | 17.12 | 11.04 | 10.95 | 23.86 | 11.11 | 16.49 | 3.21 | 3.95 | 4.44 | 2.4 | 7.65 | 6.36 | 5.81 | 4 |
| 8.52691 | 39.28561 | 2019 | 10 | 18 | 12.63 | 17.25 | 12.08 | 11.9 | 23.42 | 10.79 | 16.58 | 4.84 | 5.14 | 3.6 | 2.05 | 8.44 | 7.2 | 6.13 | 4.42 |
| 8.52691 | 39.28561 | 2019 | 10 | 19 | 8.89 | 16.91 | 12.73 | 12.63 | 21.64 | 12.75 | 16.38 | 3.45 | 4.86 | 5.46 | 2.7 | 8.91 | 7.57 | 7.14 | 4.92 |
| 8.52691 | 39.28561 | 2019 | 10 | 20 | 9.69 | 17.85 | 12.91 | 12.82 | 23.32 | 13.63 | 17.19 | 3.38 | 4.67 | 5.11 | 2.57 | 8.49 | 7.24 | 6.98 | 4.81 |
| 8.52691 | 39.28561 | 2019 | 10 | 21 | 12.42 | 17.69 | 11.78 | 11.7 | 24.03 | 11.61 | 17.01 | 3.49 | 4.07 | 4.01 | 2.29 | 7.5 | 6.36 | 6.02 | 4.14 |
| 8.52691 | 39.28561 | 2019 | 10 | 22 | 12.63 | 16.86 | 11.21 | 11.14 | 23.23 | 10.6 | 16.19 | 3.61 | 4.1 | 3.35 | 1.99 | 6.96 | 6.09 | 5.57 | 3.88 |
| 8.52691 | 39.28561 | 2019 | 10 | 23 | 14.3 | 15.68 | 6.22 | 6.06 | 23.91 | 9.61 | 15.57 | 4.78 | 4.82 | 2.64 | 1.61 | 7.42 | 6.43 | 5.28 | 3.73 |
| 8.52691 | 39.28561 | 2019 | 10 | 24 | 15.73 | 15.75 | 4.91 | 4.78 | 24.56 | 8.82 | 15.84 | 2.79 | 2.91 | 3.05 | 1.88 | 5.85 | 4.8 | 4.43 | 3.14 |
| 8.52691 | 39.28561 | 2019 | 10 | 25 | 13.85 | 16.76 | 6.29 | 6.19 | 25.18 | 11.34 | 16.87 | 4.63 | 3.78 | 1.6 | 0.99 | 6.23 | 4.76 | 4.01 | 2.86 |
| 8.52691 | 39.28561 | 2019 | 10 | 26 | 14.28 | 16.85 | 6.73 | 6.67 | 25.51 | 11.24 | 16.97 | 4.33 | 4.04 | 1.97 | 1.27 | 6.3 | 5.32 | 4.33 | 3.12 |
| 8.52691 | 39.28561 | 2019 | 10 | 27 | 14.44 | 17.19 | 6.73 | 6.55 | 25.67 | 11.23 | 17.28 | 3.96 | 3.06 | 2.15 | 1.34 | 6.11 | 4.4 | 4.13 | 2.94 |
| 8.52691 | 39.28561 | 2019 | 10 | 28 | 13.7 | 18.07 | 10.97 | 10.69 | 24.9 | 11.19 | 17.68 | 4.77 | 3.84 | 2.6 | 1.69 | 7.37 | 5.53 | 4.94 | 3.5 |
| 8.52691 | 39.28561 | 2019 | 10 | 29 | 13.47 | 17.77 | 9.3 | 9.01 | 25.01 | 11.53 | 17.23 | 3.78 | 4.52 | 4.4 | 2.57 | 8.18 | 7.09 | 6.42 | 4.36 |
| 8.52691 | 39.28561 | 2019 | 10 | 30 | 14.97 | 16.38 | 5.92 | 5.87 | 24.61 | 9.64 | 16.41 | 4.18 | 4.47 | 3.57 | 2.26 | 7.75 | 6.74 | 5.67 | 4.03 |
| 8.52691 | 39.28561 | 2019 | 10 | 31 | 14.8 | 16.98 | 6.82 | 6.75 | 25.25 | 10.45 | 16.81 | 2.92 | 2.25 | 2.65 | 1.73 | 5.57 | 3.98 | 3.91 | 2.82 |
| 8.52691 | 39.28561 | 2019 | 11 | 1 | 14.34 | 17.45 | 6.9 | 6.86 | 25.8 | 11.46 | 17.47 | 4.93 | 4.11 | 2.05 | 1.34 | 6.97 | 5.45 | 4.3 | 3.06 |
| 8.52691 | 39.28561 | 2019 | 11 | 2 | 14.04 | 16.91 | 6.69 | 6.65 | 25.03 | 10.99 | 17.15 | 5.73 | 5.48 | 2.82 | 1.8 | 8.55 | 7.28 | 5.71 | 4.05 |
| 8.52691 | 39.28561 | 2019 | 11 | 3 | 14.09 | 17.38 | 8.63 | 8.48 | 24.37 | 10.27 | 16.99 | 5.69 | 6.16 | 4.38 | 2.44 | 10.08 | 8.6 | 7.26 | 5.05 |
| 8.52691 | 39.28561 | 2019 | 11 | 4 | 10.33 | 17.22 | 12 | 11.93 | 22.39 | 12.06 | 16.47 | 4.91 | 5.41 | 3.8 | 2.11 | 8.71 | 7.53 | 6.09 | 4.36 |
| 8.52691 | 39.28561 | 2019 | 11 | 5 | 11.52 | 17.45 | 11.61 | 11.53 | 23.2 | 11.68 | 16.64 | 4.41 | 5.12 | 3.66 | 2.1 | 8.07 | 7.22 | 5.72 | 4.14 |
| 8.52691 | 39.28561 | 2019 | 11 | 6 | 12.62 | 17.81 | 10.61 | 10.48 | 24.08 | 11.46 | 16.98 | 3.72 | 4.09 | 4.21 | 2.2 | 7.93 | 6.3 | 6.26 | 4.28 |
| 8.52691 | 39.28561 | 2019 | 11 | 7 | 9.63 | 18.02 | 12.59 | 12.5 | 22.93 | 13.3 | 17.23 | 3.75 | 3.46 | 2.69 | 1.36 | 6.45 | 4.82 | 4.88 | 3.34 |
| 8.52691 | 39.28561 | 2019 | 11 | 8 | 10.34 | 18.86 | 12.81 | 12.7 | 24.03 | 13.7 | 17.94 | 3.04 | 3.53 | 3.74 | 2.02 | 6.78 | 5.55 | 5.14 | 3.51 |
| 8.52691 | 39.28561 | 2019 | 11 | 9 | 14.08 | 18.29 | 7.21 | 7.02 | 25.93 | 11.85 | 17.67 | 3.92 | 3.74 | 2.94 | 1.96 | 6.86 | 5.7 | 5.06 | 3.46 |
| 8.52691 | 39.28561 | 2019 | 11 | 10 | 14.27 | 17.68 | 7.84 | 7.78 | 25.74 | 11.47 | 17.57 | 4.66 | 4.12 | 2.31 | 1.46 | 6.97 | 5.59 | 4.72 | 3.37 |
| 8.52691 | 39.28561 | 2019 | 11 | 11 | 14.56 | 18.12 | 9.03 | 8.94 | 25.57 | 11.01 | 17.49 | 4.65 | 4.56 | 3.01 | 1.92 | 7.66 | 6.48 | 5.37 | 3.79 |
| 8.52691 | 39.28561 | 2019 | 11 | 12 | 14.58 | 17.86 | 9.46 | 9.35 | 24.77 | 10.18 | 16.96 | 3.77 | 4.69 | 4.12 | 2.3 | 7.89 | 6.99 | 6.28 | 4.33 |
| 8.52691 | 39.28561 | 2019 | 11 | 13 | 13.76 | 18.61 | 10.87 | 10.75 | 25.08 | 11.32 | 17.51 | 2.68 | 3.47 | 4.2 | 2.24 | 6.88 | 5.71 | 5.91 | 3.98 |
| 8.52691 | 39.28561 | 2019 | 11 | 14 | 13.99 | 18.75 | 11.13 | 11.04 | 25.19 | 11.2 | 17.74 | 3.27 | 4.13 | 4.25 | 2.32 | 7.52 | 6.45 | 6.22 | 4.25 |
| 8.52691 | 39.28561 | 2019 | 11 | 15 | 14.29 | 18.6 | 10.63 | 10.53 | 25.53 | 11.25 | 17.5 | 2.06 | 2.87 | 4.98 | 2.65 | 7.04 | 5.52 | 5.79 | 3.85 |
| 8.52691 | 39.28561 | 2019 | 11 | 16 | 14.93 | 18.33 | 8.83 | 8.74 | 25.73 | 10.8 | 17.42 | 3.39 | 3.33 | 3.39 | 2.09 | 6.78 | 5.42 | 5.29 | 3.62 |
| 8.52691 | 39.28561 | 2019 | 11 | 17 | 14.85 | 19.11 | 10.21 | 10.09 | 25.99 | 11.14 | 17.95 | 3.85 | 2.64 | 3.36 | 2.11 | 7.21 | 4.75 | 4.91 | 3.26 |
| 8.52691 | 39.28561 | 2019 | 11 | 18 | 13.44 | 20.11 | 11.95 | 11.85 | 26.44 | 12.99 | 18.92 | 4.17 | 3.29 | 2.54 | 1.64 | 6.71 | 4.94 | 4.79 | 3.15 |
| 8.52691 | 39.28561 | 2019 | 11 | 19 | 11.85 | 20.03 | 13.08 | 12.98 | 25.64 | 13.79 | 19.01 | 2.38 | 3.33 | 4.65 | 2.25 | 7.03 | 5.58 | 5.7 | 3.79 |
| 8.52691 | 39.28561 | 2019 | 11 | 20 | 9.45 | 19.4 | 14.7 | 14.64 | 24.23 | 14.78 | 18.69 | 2.13 | 3.64 | 4.41 | 2.13 | 6.54 | 5.77 | 5.43 | 3.6 |
| 8.52691 | 39.28561 | 2019 | 11 | 21 | 8.62 | 18.79 | 14.63 | 14.58 | 23.51 | 14.9 | 18.24 | 3.68 | 2.54 | 2.95 | 1.64 | 6.62 | 4.18 | 4.78 | 3.1 |
| 8.52691 | 39.28561 | 2019 | 11 | 22 | 5.64 | 17.66 | 14.99 | 14.97 | 20.93 | 15.29 | 17.33 | 3.45 | 4.04 | 4.01 | 2.34 | 7.47 | 6.38 | 5.59 | 3.95 |
| 8.52691 | 39.28561 | 2019 | 11 | 23 | 7.86 | 18.11 | 14.68 | 14.66 | 22.34 | 14.48 | 17.46 | 3.81 | 4.21 | 3.21 | 1.65 | 7.03 | 5.86 | 5.36 | 3.8 |
| 8.52691 | 39.28561 | 2019 | 11 | 24 | 8.93 | 18.98 | 14.68 | 14.63 | 23.95 | 15.02 | 18.16 | 3.01 | 4.02 | 4.48 | 2.42 | 7.49 | 6.44 | 6.07 | 4.36 |
| 8.52691 | 39.28561 | 2019 | 11 | 25 | 6.52 | 17.81 | 14.85 | 14.83 | 21.7 | 15.18 | 17.35 | 3.12 | 3.98 | 5.1 | 3.17 | 8.22 | 7.15 | 6.47 | 4.7 |
| 8.52691 | 39.28561 | 2019 | 11 | 26 | 7.67 | 17.61 | 13.75 | 13.69 | 21.89 | 14.22 | 17.04 | 2.73 | 3.98 | 5.56 | 3.13 | 8.28 | 7.11 | 7.21 | 5.11 |
| 8.52691 | 39.28561 | 2019 | 11 | 27 | 9.71 | 16.31 | 11.25 | 11.16 | 21.2 | 11.49 | 15.67 | 3.72 | 4.55 | 4.16 | 2.4 | 7.88 | 6.95 | 6.19 | 4.26 |
| 8.52691 | 39.28561 | 2019 | 11 | 28 | 13.06 | 16.99 | 10.55 | 10.49 | 23.81 | 10.75 | 16.21 | 3.71 | 3.86 | 2.7 | 1.62 | 6.4 | 5.48 | 4.68 | 3.36 |
| 8.52691 | 39.28561 | 2019 | 11 | 29 | 13.01 | 17.26 | 10.94 | 10.86 | 23.79 | 10.78 | 16.22 | 3.41 | 3.79 | 3.4 | 2.01 | 6.81 | 5.79 | 4.93 | 3.5 |
| 8.52691 | 39.28561 | 2019 | 11 | 30 | 12.52 | 16.9 | 10.51 | 10.44 | 22.98 | 10.46 | 15.78 | 3.38 | 3.84 | 3.48 | 1.88 | 6.86 | 5.72 | 5.44 | 3.83 |
| 8.52691 | 39.28561 | 2019 | 12 | 1 | 13.69 | 17 | 9.63 | 9.56 | 23.49 | 9.8 | 15.81 | 2.57 | 2.61 | 3.21 | 1.86 | 5.78 | 4.47 | 4.49 | 3.13 |
| 8.52691 | 39.28561 | 2019 | 12 | 2 | 14.41 | 18.36 | 9.75 | 9.62 | 25.41 | 10.99 | 17.29 | 4 | 2.89 | 1.34 | 0.96 | 5.35 | 3.85 | 3.37 | 2.37 |
| 8.52691 | 39.28561 | 2019 | 12 | 3 | 14 | 18.55 | 9.79 | 9.69 | 25.18 | 11.17 | 17.41 | 4.29 | 3.17 | 2.19 | 1.61 | 6.48 | 4.78 | 4.24 | 2.97 |
| 8.52691 | 39.28561 | 2019 | 12 | 4 | 13.21 | 18.31 | 10.29 | 10.19 | 24.19 | 10.98 | 17 | 2.59 | 2.19 | 3.4 | 2.07 | 5.98 | 4.27 | 4.66 | 3.15 |
| 8.52691 | 39.28561 | 2019 | 12 | 5 | 13.55 | 18.33 | 10.76 | 10.68 | 24.37 | 10.82 | 17.09 | 4.06 | 3.32 | 2.56 | 1.66 | 6.62 | 4.98 | 4.93 | 3.39 |
| 8.52691 | 39.28561 | 2019 | 12 | 6 | 13.38 | 17.7 | 10.22 | 10.12 | 24.37 | 11 | 16.5 | 3.59 | 4.53 | 4.33 | 2.3 | 7.93 | 6.84 | 5.95 | 4.07 |
| 8.52691 | 39.28561 | 2019 | 12 | 7 | 15.15 | 16.42 | 7.19 | 7.05 | 23.88 | 8.72 | 15.5 | 3.73 | 4.26 | 3 | 1.87 | 6.74 | 6.13 | 5.03 | 3.56 |
| 8.52691 | 39.28561 | 2019 | 12 | 8 | 13.08 | 17.51 | 12.46 | 12.31 | 23.68 | 10.61 | 16.52 | 4.01 | 4.53 | 3.95 | 2.34 | 7.96 | 6.87 | 5.7 | 4.2 |
| 8.52691 | 39.28561 | 2019 | 12 | 9 | 9.14 | 18.9 | 14.16 | 14.11 | 23.78 | 14.64 | 17.94 | 4.75 | 5.55 | 3.8 | 1.84 | 8.56 | 7.39 | 6.37 | 4.62 |
| 8.52691 | 39.28561 | 2019 | 12 | 10 | 10.05 | 19.39 | 14.47 | 14.42 | 24.48 | 14.43 | 18.32 | 2.86 | 4.2 | 5.69 | 3.14 | 8.55 | 7.34 | 6.76 | 4.86 |
| 8.52691 | 39.28561 | 2019 | 12 | 11 | 6.3 | 17.16 | 14.4 | 14.37 | 20.86 | 14.56 | 16.8 | 4.65 | 5.01 | 3.41 | 1.69 | 8.06 | 6.7 | 6.35 | 4.54 |
| 8.52691 | 39.28561 | 2019 | 12 | 12 | 10.19 | 18 | 12.79 | 12.71 | 23.45 | 13.27 | 17.21 | 4.41 | 5.11 | 3.36 | 1.67 | 7.77 | 6.78 | 5.52 | 3.87 |
| 8.52691 | 39.28561 | 2019 | 12 | 13 | 13.1 | 17.38 | 9.82 | 9.66 | 24.26 | 11.15 | 16.67 | 4.64 | 4.52 | 2.47 | 1.56 | 7.11 | 6.09 | 5.21 | 3.67 |
| 8.52691 | 39.28561 | 2019 | 12 | 14 | 9.7 | 16.61 | 11.45 | 11.32 | 21.2 | 11.5 | 15.97 | 3.85 | 3.99 | 2.81 | 1.96 | 6.66 | 5.96 | 5.41 | 3.76 |
| 8.52691 | 39.28561 | 2019 | 12 | 15 | 13.82 | 16.19 | 7.24 | 7.01 | 23.71 | 9.88 | 15.67 | 3.33 | 3.9 | 3.07 | 1.91 | 6.4 | 5.81 | 5.05 | 3.63 |
| 8.52691 | 39.28561 | 2019 | 12 | 16 | 14.08 | 16.55 | 6.91 | 6.77 | 24.44 | 10.35 | 16.28 | 4.56 | 3.91 | 1.04 | 0.7 | 5.6 | 4.61 | 3.57 | 2.63 |
| 8.52691 | 39.28561 | 2019 | 12 | 17 | 13.01 | 17.07 | 9.51 | 9.36 | 23.98 | 10.97 | 16.58 | 4.39 | 4.38 | 2.16 | 1.43 | 6.55 | 5.81 | 4.62 | 3.38 |
| 8.52691 | 39.28561 | 2019 | 12 | 18 | 13.97 | 16.51 | 9.26 | 9.15 | 23.37 | 9.4 | 15.53 | 3.61 | 3.88 | 3.52 | 2.1 | 7.13 | 5.97 | 5.39 | 3.84 |
| 8.52691 | 39.28561 | 2019 | 12 | 19 | 14.7 | 15.22 | 5.67 | 5.56 | 22.78 | 8.08 | 14.57 | 3.69 | 4.37 | 3.4 | 2.11 | 7.09 | 6.47 | 5.55 | 3.96 |
| 8.52691 | 39.28561 | 2019 | 12 | 20 | 14.79 | 16.19 | 8.51 | 8.32 | 23.26 | 8.47 | 15.1 | 2.97 | 3.43 | 2.97 | 1.87 | 5.94 | 5.3 | 4.58 | 3.32 |
| 8.52691 | 39.28561 | 2019 | 12 | 21 | 14.21 | 17.62 | 10.23 | 10.12 | 24.07 | 9.86 | 16.25 | 3.41 | 2.66 | 2.53 | 1.83 | 5.94 | 4.49 | 4.12 | 2.94 |
| 8.52691 | 39.28561 | 2019 | 12 | 22 | 12.81 | 17.81 | 10.5 | 10.4 | 23.85 | 11.03 | 16.67 | 3.79 | 3.52 | 1.86 | 1.21 | 5.65 | 4.73 | 3.92 | 2.88 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.52691 | 39.28561 | 2019 | 12 | 23 | 13.49 | 18.77 | 9.71 | 9.59 | 25.25 | 11.76 | 17.44 | 3.81 | 2.93 | 2.05 | 1.15 | 5.86 | 4.08 | 3.64 | 2.56 |
| 8.52691 | 39.28561 | 2019 | 12 | 24 | 13.82 | 19.28 | 10.09 | 10.01 | 25.87 | 12.05 | 17.92 | 3.25 | 1.96 | 2.44 | 1.66 | 5.69 | 3.62 | 3.63 | 2.54 |
| 8.52691 | 39.28561 | 2019 | 12 | 25 | 14.1 | 19.53 | 10.62 | 10.54 | 25.84 | 11.74 | 17.88 | 3.1 | 1.62 | 2.54 | 1.77 | 5.64 | 3.39 | 3.83 | 2.63 |
| 8.52691 | 39.28561 | 2019 | 12 | 26 | 13.24 | 18.89 | 11 | 10.92 | 24.78 | 11.54 | 17.37 | 2.63 | 2.69 | 3.34 | 2.09 | 5.97 | 4.78 | 4.68 | 3.33 |
| 8.52691 | 39.28561 | 2019 | 12 | 27 | 15.18 | 18.94 | 10.43 | 10.34 | 25.91 | 10.73 | 17.43 | 2.65 | 1.57 | 2.48 | 1.65 | 5.14 | 3.22 | 3.5 | 2.48 |
| 8.52691 | 39.28561 | 2019 | 12 | 28 | 14.2 | 18.65 | 11.35 | 11.24 | 25.06 | 10.86 | 17.25 | 3.13 | 2.61 | 2.66 | 1.66 | 5.79 | 4.27 | 4.09 | 2.95 |
| 8.52691 | 39.28561 | 2019 | 12 | 29 | 11.86 | 18.37 | 12.21 | 12.14 | 23.78 | 11.92 | 16.93 | 2.01 | 3.01 | 4.03 | 2.21 | 6.04 | 5.22 | 5.01 | 3.5 |
| 8.52691 | 39.28561 | 2019 | 12 | 30 | 12.83 | 18.11 | 11.22 | 11.15 | 23.93 | 11.1 | 16.86 | 2.1 | 3.31 | 3.93 | 2.31 | 6.03 | 5.62 | 5.13 | 3.63 |
| 8.52691 | 39.28561 | 2019 | 12 | 31 | 14.51 | 18.05 | 9.68 | 9.6 | 24.93 | 10.41 | 16.91 | 2.9 | 3.36 | 2.91 | 1.83 | 5.81 | 5.2 | 4.81 | 3.43 |
| 8.52691 | 39.28561 | 2020 | 1 | 1 | 14 | 19 | 11.04 | 10.92 | 25.41 | 11.41 | 17.45 | 4.13 | 3.62 | 2.01 | 1.34 | 6.14 | 4.97 | 4.13 | 2.94 |
| 8.52691 | 39.28561 | 2020 | 1 | 2 | 13.76 | 19.61 | 11.49 | 11.39 | 25.47 | 11.72 | 18.23 | 3.91 | 4.04 | 3.01 | 1.79 | 6.92 | 5.83 | 5.31 | 3.68 |
| 8.52691 | 39.28561 | 2020 | 1 | 3 | 11.97 | 18.58 | 11.58 | 11.48 | 24.43 | 12.46 | 17.59 | 3.55 | 4.08 | 4.03 | 2.47 | 7.58 | 6.54 | 5.99 | 4.21 |
| 8.52691 | 39.28561 | 2020 | 1 | 4 | 14 | 18.72 | 10.8 | 10.7 | 25.11 | 11.1 | 17.55 | 2.84 | 3.71 | 4.25 | 2.38 | 7.09 | 6.1 | 5.66 | 3.99 |
| 8.52691 | 39.28561 | 2020 | 1 | 5 | 14.21 | 18.97 | 8.8 | 8.71 | 25.89 | 11.68 | 17.99 | 3.84 | 4.05 | 2.75 | 1.76 | 6.59 | 5.82 | 4.78 | 3.52 |
| 8.52691 | 39.28561 | 2020 | 1 | 6 | 15.11 | 18.92 | 9.4 | 9.27 | 25.58 | 10.48 | 17.48 | 2.13 | 2.82 | 4.02 | 2.4 | 6.15 | 5.22 | 5.07 | 3.56 |
| 8.52691 | 39.28561 | 2020 | 1 | 7 | 13.37 | 19.13 | 11.59 | 11.48 | 25.26 | 11.88 | 17.79 | 3.59 | 4.53 | 4.42 | 2.46 | 8.01 | 6.99 | 6.28 | 4.39 |
| 8.52691 | 39.28561 | 2020 | 1 | 8 | 12.51 | 19.05 | 10.27 | 10.01 | 25.52 | 13.01 | 17.81 | 3.04 | 4.31 | 4.49 | 2.57 | 7.53 | 6.88 | 6.68 | 4.67 |
| 8.52691 | 39.28561 | 2020 | 1 | 9 | 16.12 | 18.62 | 7.52 | 7.49 | 26.34 | 10.22 | 17.56 | 3.04 | 3.26 | 3.46 | 2.14 | 6.49 | 5.4 | 5.01 | 3.62 |
| 8.52691 | 39.28561 | 2020 | 1 | 10 | 15.45 | 19.62 | 7.75 | 7.71 | 26.56 | 11.12 | 18.25 | 1.86 | 1.91 | 2.87 | 1.84 | 4.73 | 3.75 | 3.59 | 2.66 |
| 8.52691 | 39.28561 | 2020 | 1 | 11 | 14.49 | 20.19 | 9.32 | 9.21 | 26.15 | 11.66 | 18.59 | 2.98 | 3.21 | 2.58 | 1.62 | 5.56 | 4.84 | 4.13 | 2.98 |
| 8.52691 | 39.28561 | 2020 | 1 | 12 | 9.97 | 18.62 | 11.69 | 11.59 | 23.06 | 13.1 | 16.8 | 2.59 | 3.5 | 3.74 | 2.09 | 6.32 | 5.58 | 5.28 | 4.02 |
| 8.52691 | 39.28561 | 2020 | 1 | 13 | 13.45 | 18.83 | 10.6 | 10.53 | 24.5 | 11.06 | 16.9 | 2.56 | 3.13 | 3.7 | 2.03 | 6.26 | 5.15 | 4.98 | 3.67 |
| 8.52691 | 39.28561 | 2020 | 1 | 14 | 13.26 | 18.85 | 10.47 | 10.32 | 25.16 | 11.9 | 17.11 | 4.66 | 5.59 | 3.88 | 2.14 | 8.54 | 7.73 | 6.02 | 4.37 |
| 8.52691 | 39.28561 | 2020 | 1 | 15 | 14.64 | 17.61 | 8.09 | 7.93 | 24.29 | 9.65 | 15.99 | 3.2 | 4.15 | 3.55 | 2.08 | 6.76 | 6.24 | 5.33 | 3.89 |
| 8.52691 | 39.28561 | 2020 | 1 | 16 | 16.35 | 17.88 | 6.51 | 6.22 | 25.58 | 9.23 | 16.09 | 3.9 | 4.28 | 3.58 | 2.07 | 7.47 | 6.35 | 5.02 | 3.58 |
| 8.52691 | 39.28561 | 2020 | 1 | 17 | 17.72 | 17.86 | -0.35 | -0.3 | 27.65 | 9.93 | 17.09 | 6.53 | 5.8 | 0.35 | 0.3 | 6.88 | 6.11 | 3.56 | 2.67 |
| 8.52691 | 39.28561 | 2020 | 1 | 18 | 15.96 | 17.63 | -0.36 | -0.25 | 26.9 | 10.94 | 17.43 | 6.61 | 5.67 | 0.64 | 0.46 | 7.25 | 6.13 | 3.59 | 2.72 |
| 8.52691 | 39.28561 | 2020 | 1 | 19 | 15.94 | 17.41 | -0.93 | -0.92 | 26.61 | 10.67 | 17.01 | 6.67 | 5.69 | 0.64 | 0.44 | 7.31 | 6.13 | 3.81 | 2.89 |
| 8.52691 | 39.28561 | 2020 | 1 | 20 | 15.64 | 17.21 | 2.44 | 2.47 | 25.24 | 9.6 | 16.47 | 5.42 | 5.03 | 1.74 | 1.2 | 7.16 | 6.23 | 4.82 | 3.66 |
| 8.52691 | 39.28561 | 2020 | 1 | 21 | 17.07 | 18.65 | 5.45 | 5.46 | 26.66 | 9.59 | 17 | 4.02 | 2.69 | 2.39 | 1.59 | 6.4 | 4.28 | 3.86 | 2.82 |
| 8.52691 | 39.28561 | 2020 | 1 | 22 | 16.57 | 19.36 | 6.04 | 6.03 | 26.42 | 9.84 | 17.47 | 3.07 | 1.7 | 1.63 | 1.83 | 4.71 | 3.53 | 3.11 | 2.3 |
| 8.52691 | 39.28561 | 2020 | 1 | 23 | 14.34 | 20.14 | 8.3 | 8.24 | 25.7 | 11.37 | 18.25 | 1.91 | 2.49 | 2.45 | 1.52 | 4.36 | 4 | 3.47 | 2.51 |
| 8.52691 | 39.28561 | 2020 | 1 | 24 | 13.02 | 20.09 | 10.96 | 10.85 | 25.23 | 12.21 | 18.16 | 2.21 | 2 | 2.67 | 2.08 | 4.88 | 4.08 | 3.95 | 2.94 |
| 8.52691 | 39.28561 | 2020 | 1 | 25 | 11.05 | 20.47 | 12.84 | 12.75 | 24.69 | 13.64 | 18.39 | 1.25 | 2.8 | 4.5 | 2.81 | 5.75 | 5.61 | 5.11 | 4.03 |
| 8.52691 | 39.28561 | 2020 | 1 | 26 | 10.98 | 19.74 | 12.17 | 12.09 | 24.15 | 13.17 | 17.66 | 1.95 | 2.98 | 4.57 | 3.33 | 6.52 | 6.31 | 5.57 | 4.61 |
| 8.52691 | 39.28561 | 2020 | 1 | 27 | 11.71 | 19.55 | 12.15 | 12.07 | 24.58 | 12.87 | 17.62 | 2.25 | 2.9 | 3.86 | 2.57 | 6.11 | 5.47 | 5.14 | 4.1 |
| 8.52691 | 39.28561 | 2020 | 1 | 28 | 11.86 | 21.35 | 12.79 | 12.68 | 25.7 | 13.85 | 19.12 | 1.62 | 2.79 | 4.14 | 2.53 | 5.77 | 5.32 | 5.02 | 4.02 |
| 8.52691 | 39.28561 | 2020 | 1 | 29 | 13.8 | 21.41 | 11.11 | 11.02 | 26.96 | 13.16 | 19.15 | 3.08 | 2.76 | 3.42 | 2.71 | 6.5 | 5.47 | 4.85 | 3.71 |
| 8.52691 | 39.28561 | 2020 | 1 | 30 | 15.18 | 21.18 | 9.9 | 9.81 | 27.41 | 12.24 | 19.03 | 3.03 | 3.27 | 3.33 | 2.06 | 6.35 | 5.32 | 4.95 | 3.59 |
| 8.52691 | 39.28561 | 2020 | 1 | 31 | 15.11 | 22.38 | 9.54 | 9.5 | 27.96 | 12.85 | 19.76 | 4.7 | 2.69 | 1.51 | 1.38 | 6.21 | 4.07 | 3.62 | 2.49 |
| 8.52691 | 39.28561 | 2020 | 2 | 1 | 11.9 | 20.91 | 11.61 | 11.52 | 25.19 | 13.29 | 18.82 | 2.02 | 2.57 | 3.67 | 2.07 | 5.69 | 4.65 | 4.5 | 3.6 |
| 8.52691 | 39.28561 | 2020 | 2 | 2 | 10.11 | 20.56 | 11.72 | 11.6 | 25.02 | 14.9 | 18.87 | 3.83 | 4.13 | 2.79 | 1.81 | 6.62 | 5.94 | 5.01 | 3.84 |
| 8.52691 | 39.28561 | 2020 | 2 | 3 | 11.5 | 20.43 | 10.44 | 10.36 | 25.53 | 14.04 | 18.62 | 2.87 | 4 | 4.17 | 2.26 | 7.04 | 6.26 | 5.47 | 3.95 |
| 8.52691 | 39.28561 | 2020 | 2 | 4 | 14.73 | 21.91 | 9.93 | 9.85 | 27.74 | 13 | 19.72 | 3.67 | 2.78 | 2.67 | 1.62 | 6.34 | 4.4 | 4.38 | 3.06 |
| 8.52691 | 39.28561 | 2020 | 2 | 5 | 12.87 | 22.22 | 9.84 | 9.8 | 27.11 | 14.24 | 20.08 | 3.82 | 3.94 | 3.15 | 1.72 | 6.97 | 5.65 | 5.04 | 3.64 |
| 8.52691 | 39.28561 | 2020 | 2 | 6 | 13.78 | 21.11 | 10.08 | 10.03 | 26.56 | 12.78 | 19.09 | 4.07 | 4.52 | 3.35 | 1.95 | 7.41 | 6.47 | 5.47 | 3.92 |
| 8.52691 | 39.28561 | 2020 | 2 | 7 | 14.69 | 21.04 | 9.36 | 9.32 | 26.92 | 12.24 | 19.11 | 4.1 | 4.95 | 4.15 | 2.3 | 8.25 | 7.25 | 6.05 | 4.36 |
| 8.52691 | 39.28561 | 2020 | 2 | 8 | 15.52 | 20.99 | 6.58 | 6.51 | 27.88 | 12.36 | 19.4 | 4.97 | 5.79 | 4.34 | 2.45 | 9.31 | 8.24 | 6.88 | 4.91 |
| 8.52691 | 39.28561 | 2020 | 2 | 9 | 16.01 | 20.64 | 3.89 | 3.98 | 27.87 | 11.86 | 19.18 | 3.79 | 4.47 | 3.78 | 2.33 | 7.57 | 6.8 | 6.07 | 4.38 |
| 8.52691 | 39.28561 | 2020 | 2 | 10 | 16.42 | 21.4 | 7.08 | 6.99 | 28.19 | 11.76 | 19.53 | 2.45 | 3.15 | 3.72 | 2.24 | 6.17 | 5.38 | 5.1 | 3.75 |
| 8.52691 | 39.28561 | 2020 | 2 | 11 | 16.52 | 23.35 | 9.41 | 9.26 | 29.5 | 12.98 | 20.63 | 4.58 | 1.91 | 1.25 | 1.5 | 5.83 | 3.41 | 3.52 | 2.42 |
| 8.52691 | 39.28561 | 2020 | 2 | 12 | 10.68 | 20.28 | 12.07 | 11.98 | 24.45 | 13.77 | 18.07 | 2.47 | 2.79 | 5.04 | 3.73 | 7.51 | 6.52 | 6.22 | 5.26 |
| 8.52691 | 39.28561 | 2020 | 2 | 13 | 12.18 | 19.39 | 11.28 | 11.2 | 24.52 | 12.34 | 17.36 | 5.04 | 5.11 | 3.93 | 2.97 | 8.97 | 8.08 | 6.39 | 5.17 |
| 8.52691 | 39.28561 | 2020 | 2 | 14 | 11.45 | 19.28 | 9.89 | 9.71 | 24.53 | 13.08 | 17.47 | 3.69 | 5.6 | 5.51 | 2.77 | 9.2 | 8.37 | 7.2 | 5.47 |
| 8.52691 | 39.28561 | 2020 | 2 | 15 | 16.28 | 20.72 | 7.91 | 7.9 | 27.5 | 11.23 | 18.7 | 4.02 | 4.36 | 3.04 | 1.72 | 7.07 | 6.08 | 5.37 | 3.82 |
| 8.52691 | 39.28561 | 2020 | 2 | 16 | 16.55 | 22.67 | 8.3 | 8.29 | 29.25 | 12.71 | 20.52 | 4.01 | 3.84 | 2.13 | 1.29 | 6.14 | 5.13 | 4.62 | 3.23 |
| 8.52691 | 39.28561 | 2020 | 2 | 17 | 15.55 | 23.7 | 8.87 | 8.9 | 29.96 | 14.41 | 21.63 | 3.7 | 3.9 | 2.88 | 1.77 | 6.58 | 5.67 | 5.03 | 3.53 |
| 8.52691 | 39.28561 | 2020 | 2 | 18 | 14.57 | 22.82 | 9.65 | 9.65 | 28.88 | 14.31 | 20.98 | 4.24 | 4.47 | 2.73 | 1.74 | 6.97 | 6.2 | 5.52 | 3.99 |
| 8.52691 | 39.28561 | 2020 | 2 | 19 | 15.25 | 23.14 | 9.22 | 9.21 | 29.53 | 14.27 | 21.22 | 3.64 | 4.34 | 3.24 | 1.95 | 6.88 | 6.3 | 5.48 | 3.96 |
| 8.52691 | 39.28561 | 2020 | 2 | 20 | 14.35 | 22.65 | 8.15 | 8.19 | 29 | 14.64 | 20.99 | 6.05 | 5.58 | 1.96 | 1.3 | 8.01 | 6.88 | 5.54 | 4.19 |
| 8.52691 | 39.28561 | 2020 | 2 | 21 | 15.04 | 21.74 | 9.61 | 9.53 | 27.9 | 12.86 | 19.68 | 2.48 | 3.53 | 4.6 | 2.42 | 7.09 | 5.96 | 5.93 | 4.21 |
| 8.52691 | 39.28561 | 2020 | 2 | 22 | 14.39 | 21.52 | 9.72 | 9.68 | 27.42 | 13.03 | 19.64 | 2.59 | 4.31 | 5 | 2.58 | 7.58 | 6.88 | 6.54 | 4.61 |
| 8.52691 | 39.28561 | 2020 | 2 | 23 | 15.7 | 21.85 | 8.65 | 8.61 | 28.24 | 12.54 | 19.83 | 2.82 | 4.09 | 4.82 | 2.55 | 7.64 | 6.64 | 6.38 | 4.53 |
| 8.52691 | 39.28561 | 2020 | 2 | 24 | 15.83 | 21.73 | 6.11 | 6.09 | 28.58 | 12.75 | 19.95 | 2.02 | 2.74 | 3.55 | 1.96 | 5.57 | 4.7 | 4.73 | 3.3 |
| 8.52691 | 39.28561 | 2020 | 2 | 25 | 15.79 | 23.58 | 4.83 | 4.92 | 30.22 | 14.44 | 21.43 | 5.05 | 2.92 | 1.2 | 0.81 | 6.25 | 3.72 | 3.55 | 2.45 |
| 8.52691 | 39.28561 | 2020 | 2 | 26 | 13.52 | 22.21 | 10 | 9.92 | 27.12 | 13.6 | 20.06 | 2.31 | 4.3 | 5.82 | 3.14 | 8.13 | 7.44 | 7.12 | 5.37 |
| 8.52691 | 39.28561 | 2020 | 2 | 27 | 14.59 | 22.23 | 11.25 | 11.15 | 27.89 | 13.3 | 20.08 | 3.32 | 4.92 | 4.8 | 2.46 | 8.11 | 7.37 | 6.67 | 4.93 |
| 8.52691 | 39.28561 | 2020 | 2 | 28 | 15.8 | 22.44 | 7.63 | 7.13 | 29.28 | 13.48 | 20.36 | 3.33 | 4.01 | 3.75 | 2.21 | 7.08 | 6.23 | 5.71 | 4.13 |
| 8.52691 | 39.28561 | 2020 | 2 | 29 | 16.4 | 23.13 | 2.3 | 2.26 | 30.57 | 14.17 | 21.48 | 4.14 | 3.39 | 1.58 | 1.09 | 5.72 | 4.47 | 3.58 | 2.6 |
| 8.52691 | 39.28561 | 2020 | 3 | 1 | 15.72 | 23.47 | 3.03 | 3.11 | 30.54 | 14.82 | 21.81 | 5.06 | 4.43 | 2.26 | 1.5 | 7.32 | 5.92 | 4.85 | 3.56 |
| 8.52691 | 39.28561 | 2020 | 3 | 2 | 16.03 | 23.29 | 5.33 | 5.44 | 29.96 | 13.92 | 21.19 | 4.44 | 4.24 | 2.73 | 1.71 | 7.17 | 5.95 | 5.11 | 3.74 |
| 8.52691 | 39.28561 | 2020 | 3 | 3 | 15.48 | 23.23 | 6.87 | 6.85 | 29.61 | 14.12 | 21.22 | 3.74 | 4.46 | 3.6 | 2.01 | 7.35 | 6.46 | 5.44 | 3.96 |
| 8.52691 | 39.28561 | 2020 | 3 | 4 | 16.38 | 24.55 | 8.08 | 8.11 | 30.91 | 14.54 | 22.31 | 2.45 | 3.46 | 4.17 | 2.26 | 6.62 | 5.72 | 5.38 | 3.81 |
| 8.52691 | 39.28561 | 2020 | 3 | 5 | 11.3 | 24.1 | 10.32 | 10.28 | 27.86 | 16.56 | 21.85 | 3.66 | 4.84 | 3.13 | 1.68 | 6.79 | 6.52 | 5.14 | 3.88 |
| 8.52691 | 39.28561 | 2020 | 3 | 6 | 13.19 | 25.2 | 8.13 | 8.18 | 30.23 | 17.03 | 22.91 | 2.09 | 3.47 | 3.59 | 1.78 | 5.68 | 5.25 | 4.92 | 3.39 |
| 8.52691 | 39.28561 | 2020 | 3 | 7 | 14.25 | 24.66 | 8.09 | 8.17 | 29.96 | 15.71 | 22.52 | 2.08 | 3.34 | 4.73 | 2.53 | 6.8 | 5.87 | 5.8 | 4.11 |
| 8.52691 | 39.28561 | 2020 | 3 | 8 | 14.79 | 23.8 | 7.62 | 7.64 | 29.73 | 14.94 | 21.64 | 3.13 | 4.42 | 4.64 | 2.47 | 7.76 | 6.9 | 6.27 | 4.58 |
| 8.52691 | 39.28561 | 2020 | 3 | 9 | 16.91 | 24.65 | 6.79 | 6.89 | 31.4 | 14.49 | 22.39 | 3.64 | 3.78 | 3.06 | 1.89 | 6.7 | 5.68 | 5.03 | 3.76 |
| 8.52691 | 39.28561 | 2020 | 3 | 10 | 15.15 | 25.28 | 10.45 | 10.44 | 30.48 | 15.33 | 22.75 | 3.89 | 4.26 | 3.4 | 1.92 | 7.28 | 6.18 | 5.44 | 4.08 |
| 8.52691 | 39.28561 | 2020 | 3 | 11 | 8.79 | 21.89 | 11.89 | 11.78 | 24.93 | 16.14 | 19.89 | 7.15 | 6.85 | 1.25 | 0.97 | 8.4 | 7.82 | 5.24 | 4.29 |
| 8.52691 | 39.28561 | 2020 | 3 | 12 | 12.65 | 23.32 | 11.6 | 11.51 | 28.59 | 15.94 | 21.31 | 5.64 | 4.96 | 0.68 | 0.42 | 6.32 | 5.38 | 4.14 | 3.08 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.52691 | 39.28561 | 2020 | 3 | 13 | 15.9 | 26.66 | 8.79 | 8.83 | 32.15 | 16.25 | 23.8 | 6.25 | 4.57 | 0.84 | 0.53 | 7.09 | 5.1 | 3.61 | 2.65 |
| 8.52691 | 39.28561 | 2020 | 3 | 14 | 11.46 | 24.54 | 10.9 | 10.88 | 28.74 | 17.28 | 22.47 | 3.6 | 4 | 2.3 | 1.23 | 5.9 | 5.23 | 4.45 | 3.25 |
| 8.52691 | 39.28561 | 2020 | 3 | 15 | 12.23 | 24.91 | 12.35 | 12.27 | 29.37 | 17.14 | 22.59 | 3.05 | 3.68 | 3.16 | 1.66 | 6.21 | 5.35 | 5.04 | 3.77 |
| 8.52691 | 39.28561 | 2020 | 3 | 16 | 11.35 | 23.45 | 14.24 | 14.1 | 28.37 | 17.02 | 21.55 | 3.16 | 3.78 | 3.99 | 2.59 | 7.15 | 6.37 | 5.61 | 4.5 |
| 8.52691 | 39.28561 | 2020 | 3 | 17 | 7.8 | 21.37 | 14.59 | 14.46 | 24.6 | 16.8 | 20.23 | 4.55 | 4.5 | 1.6 | 0.97 | 6.16 | 5.47 | 4.43 | 3.45 |
| 8.52691 | 39.28561 | 2020 | 3 | 18 | 12.11 | 23.91 | 12.6 | 12.46 | 29.35 | 17.24 | 22.21 | 5.84 | 5.46 | 0.44 | 0.33 | 6.28 | 5.79 | 3.7 | 2.84 |
| 8.52691 | 39.28561 | 2020 | 3 | 19 | 15.23 | 24.46 | 11.48 | 11.33 | 30.74 | 15.51 | 22.57 | 5.3 | 5.15 | 2.21 | 1.29 | 7.5 | 6.44 | 5.31 | 3.84 |
| 8.52691 | 39.28561 | 2020 | 3 | 20 | 13.43 | 24.41 | 13.44 | 13.25 | 29.75 | 16.32 | 22.22 | 3.87 | 3.93 | 2.58 | 1.44 | 6.45 | 5.37 | 4.49 | 3.53 |
| 8.52691 | 39.28561 | 2020 | 3 | 21 | 10.17 | 22.98 | 14.32 | 14.16 | 27.17 | 17 | 21.1 | 4.63 | 3.67 | 0.25 | 0.14 | 4.88 | 3.81 | 3.16 | 2.39 |
| 8.52691 | 39.28561 | 2020 | 3 | 22 | 6.91 | 20.3 | 15.4 | 15.3 | 23.66 | 16.75 | 19.48 | 2.45 | 1.86 | 1.94 | 1.28 | 4.39 | 3.15 | 2.88 | 2.04 |
| 8.52691 | 39.28561 | 2020 | 3 | 23 | 7.21 | 19.65 | 14.94 | 14.85 | 22.75 | 15.54 | 18.94 | 3.13 | 3.22 | 1.05 | 0.65 | 4.18 | 3.87 | 3.01 | 2.32 |
| 8.52691 | 39.28561 | 2020 | 3 | 24 | 14.45 | 22.97 | 13.52 | 13.36 | 28.68 | 14.23 | 20.92 | 4.62 | 2.79 | 0.47 | 0.56 | 5.09 | 3.35 | 2.66 | 1.73 |
| 8.52691 | 39.28561 | 2020 | 3 | 25 | 11.2 | 21.94 | 13.86 | 13.53 | 26.75 | 15.55 | 20 | 4.77 | 4.2 | 1.9 | 1.75 | 6.67 | 5.95 | 4.11 | 3.28 |
| 8.52691 | 39.28561 | 2020 | 3 | 26 | 14.33 | 21.99 | 9.63 | 9.22 | 28.38 | 14.05 | 19.96 | 6.75 | 6.33 | 1.3 | 0.81 | 8.05 | 7.15 | 4.5 | 3.42 |
| 8.52691 | 39.28561 | 2020 | 3 | 27 | 15.04 | 21.5 | 8.51 | 8.47 | 28.27 | 13.23 | 19.85 | 5.91 | 5.6 | 2.5 | 1.44 | 8.41 | 7.04 | 5.13 | 3.79 |
| 8.52691 | 39.28561 | 2020 | 3 | 28 | 16.19 | 21.91 | 9.46 | 9.41 | 29.48 | 13.29 | 20.46 | 5.39 | 5.12 | 1.7 | 1.06 | 7.09 | 6.18 | 4.32 | 3.21 |
| 8.52691 | 39.28561 | 2020 | 3 | 29 | 14.68 | 22.77 | 9.81 | 9.78 | 30.01 | 15.33 | 21.56 | 7.45 | 6.55 | 0.73 | 0.52 | 8.18 | 7.07 | 4.59 | 3.44 |
| 8.52691 | 39.28561 | 2020 | 3 | 30 | 15.09 | 23 | 11.14 | 11.03 | 30.06 | 14.97 | 21.52 | 6.52 | 5.96 | 2.02 | 1.29 | 8.54 | 7.25 | 5.2 | 3.9 |
| 8.52691 | 39.28561 | 2020 | 3 | 31 | 14.23 | 22.49 | 13.13 | 12.99 | 28.58 | 14.35 | 20.97 | 5.54 | 5.83 | 3.53 | 1.97 | 9.06 | 7.81 | 6.33 | 4.62 |
| 8.52691 | 39.28561 | 2020 | 4 | 1 | 12.27 | 22.06 | 13.68 | 13.49 | 28.18 | 15.91 | 20.81 | 3.68 | 4.84 | 4.68 | 2.35 | 8.36 | 7.19 | 6.26 | 4.37 |
| 8.52691 | 39.28561 | 2020 | 4 | 2 | 12.17 | 21.72 | 13.67 | 13.49 | 27.69 | 15.52 | 20.46 | 2.97 | 3.45 | 3.44 | 1.84 | 6.41 | 5.3 | 4.94 | 3.39 |
| 8.52691 | 39.28561 | 2020 | 4 | 3 | 12.98 | 22.28 | 13.54 | 13.4 | 27.76 | 14.78 | 20.8 | 5.2 | 5.63 | 3.57 | 2.05 | 8.78 | 7.67 | 6.35 | 4.62 |
| 8.52691 | 39.28561 | 2020 | 4 | 4 | 12.9 | 23.33 | 12.7 | 12.52 | 29.18 | 16.28 | 21.56 | 3.49 | 4.74 | 4.96 | 2.42 | 8.45 | 7.17 | 6.48 | 4.55 |
| 8.52691 | 39.28561 | 2020 | 4 | 5 | 14.09 | 23.66 | 12.09 | 11.96 | 29.63 | 15.54 | 21.83 | 3.34 | 4.98 | 5.14 | 2.59 | 8.48 | 7.57 | 6.9 | 4.91 |
| 8.52691 | 39.28561 | 2020 | 4 | 6 | 14.83 | 23.81 | 10.55 | 10.33 | 30.03 | 15.2 | 21.88 | 3.65 | 4.71 | 4.44 | 2.44 | 8.09 | 7.15 | 6.53 | 4.62 |
| 8.52691 | 39.28561 | 2020 | 4 | 7 | 15.74 | 23.57 | 8.65 | 8.55 | 30.25 | 14.51 | 21.65 | 3.33 | 3.95 | 4.22 | 2.19 | 7.55 | 6.13 | 6.2 | 4.23 |
| 8.52691 | 39.28561 | 2020 | 4 | 8 | 16.63 | 24.14 | 9.66 | 9.66 | 30.76 | 14.12 | 22.18 | 4.05 | 4.77 | 4.3 | 2.23 | 8.35 | 6.99 | 6.35 | 4.36 |
| 8.52691 | 39.28561 | 2020 | 4 | 9 | 15.16 | 24.98 | 10.65 | 10.58 | 31.12 | 15.96 | 22.81 | 4.14 | 4.5 | 3.2 | 1.76 | 7.34 | 6.26 | 5.51 | 3.74 |
| 8.52691 | 39.28561 | 2020 | 4 | 10 | 15.17 | 24.95 | 10.12 | 10.03 | 31.29 | 16.12 | 22.93 | 6.57 | 6.28 | 1.44 | 0.69 | 8.01 | 6.97 | 5.33 | 3.86 |
| 8.52691 | 39.28561 | 2020 | 4 | 11 | 12.99 | 24.39 | 11.48 | 11.41 | 29.85 | 16.87 | 22.42 | 5.25 | 5.21 | 3.09 | 1.82 | 8.34 | 7.03 | 5.7 | 4.22 |
| 8.52691 | 39.28561 | 2020 | 4 | 12 | 11.6 | 22.81 | 14.33 | 14.16 | 28.26 | 16.66 | 21.26 | 3.62 | 4.01 | 3.76 | 2.4 | 7.38 | 6.41 | 5.77 | 4.21 |
| 8.52691 | 39.28561 | 2020 | 4 | 13 | 10.81 | 22.66 | 14.8 | 14.6 | 27.98 | 17.18 | 21.27 | 3.65 | 4.32 | 3.1 | 1.73 | 6.75 | 6.06 | 5.28 | 3.78 |
| 8.52691 | 39.28561 | 2020 | 4 | 14 | 12.11 | 22.77 | 14.75 | 14.59 | 27.62 | 15.5 | 20.93 | 3.16 | 3.74 | 3.15 | 1.74 | 6.32 | 5.48 | 4.61 | 3.49 |
| 8.52691 | 39.28561 | 2020 | 4 | 15 | 5.96 | 20.24 | 15.92 | 15.85 | 23.22 | 17.26 | 19.4 | 2.1 | 1.92 | 2.16 | 1.17 | 4.26 | 3.1 | 3.07 | 2.23 |
| 8.52691 | 39.28561 | 2020 | 4 | 16 | 12.09 | 22.65 | 13.94 | 13.71 | 27.66 | 15.57 | 20.85 | 4.65 | 4.36 | 1.79 | 1.13 | 6.44 | 5.49 | 3.83 | 3 |
| 8.52691 | 39.28561 | 2020 | 4 | 17 | 10.92 | 22.7 | 14.7 | 14.52 | 27.1 | 16.18 | 20.75 | 4.16 | 3.4 | 0.71 | 0.66 | 4.87 | 4.07 | 2.58 | 2.05 |
| 8.52691 | 39.28561 | 2020 | 4 | 18 | 8.57 | 21.33 | 15.55 | 15.44 | 25.1 | 16.53 | 19.9 | 2.55 | 2.43 | 1.88 | 1.24 | 4.42 | 3.67 | 2.92 | 2.31 |
| 8.52691 | 39.28561 | 2020 | 4 | 19 | 7.49 | 19.79 | 14.62 | 14.48 | 23.99 | 16.49 | 18.81 | 3.07 | 2.98 | 1.45 | 0.87 | 4.52 | 3.85 | 2.96 | 2.19 |
| 8.52691 | 39.28561 | 2020 | 4 | 20 | 7.75 | 20.12 | 14.73 | 14.61 | 23.64 | 15.88 | 19.14 | 2.55 | 1.13 | 0.25 | 0.35 | 2.79 | 1.49 | 1.44 | 0.93 |
| 8.52691 | 39.28561 | 2020 | 4 | 21 | 7.75 | 19.46 | 14.97 | 14.86 | 23.08 | 15.33 | 18.51 | 2.67 | 3.2 | 1.91 | 1.16 | 4.58 | 4.36 | 3.24 | 2.56 |
| 8.52691 | 39.28561 | 2020 | 4 | 22 | 9.75 | 20.21 | 14.32 | 14.22 | 24.58 | 14.83 | 18.79 | 6.1 | 5.03 | 0.24 | 0.34 | 6.34 | 5.37 | 3.68 | 2.79 |
| 8.52691 | 39.28561 | 2020 | 4 | 23 | 9.58 | 20.44 | 14.86 | 14.78 | 24.71 | 15.13 | 19.04 | 3.14 | 3.79 | 3.1 | 1.65 | 6.24 | 5.44 | 4.39 | 3.24 |
| 8.52691 | 39.28561 | 2020 | 4 | 24 | 8.05 | 19.04 | 14.51 | 14.45 | 23.34 | 15.29 | 18.25 | 3.24 | 3.27 | 2.14 | 1.37 | 5.38 | 4.64 | 3.42 | 2.47 |
| 8.52691 | 39.28561 | 2020 | 4 | 25 | 12.22 | 20.85 | 13.48 | 13.33 | 26.46 | 14.25 | 19.78 | 4.93 | 4.45 | 1.7 | 1.15 | 6.62 | 5.6 | 4.31 | 3.19 |
| 8.52691 | 39.28561 | 2020 | 4 | 26 | 10.69 | 21.04 | 14.78 | 14.66 | 26.12 | 15.43 | 20.01 | 3.74 | 3.44 | 1.12 | 0.71 | 4.86 | 4.15 | 2.96 | 2.1 |
| 8.52691 | 39.28561 | 2020 | 4 | 27 | 10.63 | 20.95 | 14.91 | 14.81 | 25.74 | 15.11 | 19.92 | 4.69 | 3.83 | 0.46 | 0.33 | 5.16 | 4.17 | 2.79 | 1.94 |
| 8.52691 | 39.28561 | 2020 | 4 | 28 | 8.66 | 19.84 | 15.45 | 15.37 | 24.44 | 15.77 | 19.19 | 4 | 1.67 | 0.73 | 0.67 | 4.73 | 2.33 | 2.17 | 1.32 |
| 8.52691 | 39.28561 | 2020 | 4 | 29 | 10.72 | 20.77 | 15.48 | 15.38 | 25.75 | 15.03 | 20.05 | 2.62 | 1.99 | 0.53 | 0.38 | 3.15 | 2.37 | 2.03 | 1.45 |
| 8.52691 | 39.28561 | 2020 | 4 | 30 | 7.36 | 19.44 | 15.96 | 17.64 | 23.38 | 16.02 | 19.32 | 2.28 | 1.51 | 0.28 | 0.14 | 2.56 | 1.65 | 1.33 | 0.94 |
| 8.52691 | 39.28561 | 2020 | 5 | 1 | 8.23 | 20.27 | 15.9 | 17.79 | 24.35 | 16.12 | 19.68 | 4.14 | 2.35 | 0.55 | 0.4 | 4.69 | 2.75 | 2.69 | 1.86 |
| 8.52691 | 39.28561 | 2020 | 5 | 2 | 8.95 | 20.14 | 15.89 | 17.78 | 24.43 | 15.49 | 19.67 | 2.56 | 1.68 | 0.17 | 0.1 | 2.73 | 1.78 | 1.44 | 1.06 |
| 8.52691 | 39.28561 | 2020 | 5 | 3 | 6.38 | 19.28 | 15.45 | 17.08 | 22.64 | 16.26 | 18.72 | 4.24 | 3.94 | 0.3 | 0.19 | 4.53 | 4.13 | 3.04 | 2.26 |
| 8.52691 | 39.28561 | 2020 | 5 | 4 | 8.64 | 18.89 | 14.32 | 16.45 | 23.3 | 14.66 | 18.58 | 4.67 | 3.91 | 0.61 | 0.45 | 5.28 | 4.36 | 3.23 | 2.32 |
| 8.52691 | 39.28561 | 2020 | 5 | 5 | 9.89 | 19.49 | 15.58 | 17.23 | 24.47 | 14.58 | 18.87 | 5.53 | 4.74 | 1.58 | 1.24 | 7.11 | 5.99 | 4.21 | 3.01 |
| 8.52691 | 39.28561 | 2020 | 5 | 6 | 10.21 | 19.07 | 14.63 | 16.56 | 24.39 | 14.18 | 18.49 | 3.71 | 3.86 | 2.72 | 1.65 | 6.43 | 5.52 | 4.32 | 3.15 |
| 8.52691 | 39.28561 | 2020 | 5 | 7 | 9.18 | 17.98 | 14.76 | 16.29 | 22.37 | 13.19 | 17.81 | 5 | 3.58 | 2 | 1.4 | 7.01 | 4.97 | 4.5 | 3.19 |
| 8.52691 | 39.28561 | 2020 | 5 | 8 | 6.85 | 18.55 | 15.42 | 16.86 | 22.16 | 15.32 | 18.31 | 3.97 | 4.24 | 3.55 | 1.82 | 7.52 | 6.07 | 5.42 | 3.71 |
| 8.52691 | 39.28561 | 2020 | 5 | 9 | 9.13 | 19.27 | 15.79 | 17.25 | 23.6 | 14.47 | 18.71 | 3.88 | 4.19 | 3.12 | 1.93 | 6.99 | 6.11 | 5.14 | 3.73 |
| 8.52691 | 39.28561 | 2020 | 5 | 10 | 5.23 | 17.02 | 14.58 | 15.87 | 19.95 | 14.71 | 17.16 | 4.17 | 3.79 | 1.27 | 0.69 | 5.44 | 4.47 | 4.02 | 2.67 |
| 8.52691 | 39.28561 | 2020 | 5 | 11 | 9.59 | 18.38 | 14.92 | 16.42 | 23.26 | 13.67 | 17.92 | 5.66 | 4.87 | 0.73 | 0.52 | 6.39 | 5.38 | 4.08 | 2.86 |
| 8.52691 | 39.28561 | 2020 | 5 | 12 | 10.75 | 18.79 | 14.38 | 16.52 | 24.92 | 14.16 | 18.67 | 5.2 | 5.19 | 3.39 | 1.98 | 8.59 | 7.16 | 6.13 | 4.22 |
| 8.52691 | 39.28561 | 2020 | 5 | 13 | 11 | 18.59 | 13.62 | 16.3 | 24.96 | 13.96 | 18.97 | 5.43 | 5.36 | 2.97 | 1.75 | 8.39 | 7.11 | 5.53 | 3.94 |
| 8.52691 | 39.28561 | 2020 | 5 | 14 | 10.44 | 19.19 | 14.45 | 16.94 | 25.3 | 14.86 | 19.43 | 5.18 | 5.13 | 2.34 | 1.44 | 7.52 | 6.57 | 4.78 | 3.5 |

# Appendix 2: Climate Data of Addis Ababa

-BEGIN HEADER-
NASA/POWER SRB/FLASHFlux/MERRA2/GEOS 5.12.4 (FP-IT) 0.5 x 0.5 Degree Daily Averaged Data
Dates (month/day/year): 07/01/2019 through 05/14/2020
Location: Latitude 9.0372 Longitude 38.7363
Elevation from MERRA-2: Average for 1/2x1/2 degree lat/lon region = 2415.26 meters Site = na
Climate zone: na (reference Briggs et al: http://www.energycodes.gov)
Value for missing model data cannot be computed or out of model availability range: -999
Parameter(s):
T2MWET MERRA2 1/2x1/2 Wet Bulb Temperature at 2 Meters (C)
WS50M_MAX MERRA2 1/2x1/2 Maximum Wind Speed at 50 Meters (m/s)
T2M_MIN MERRA2 1/2x1/2 Minimum Temperature at 2 Meters (C)

WS10M_RANGE MERRA2 1/2x1/2 Wind Speed Range at 10 Meters (m/s)
T2M_MAX MERRA2 1/2x1/2 Maximum Temperature at 2 Meters (C)
WS10M_MIN MERRA2 1/2x1/2 Minimum Wind Speed at 10 Meters (m/s)
WS50M MERRA2 1/2x1/2 Wind Speed at 50 Meters (m/s)
WS10M MERRA2 1/2x1/2 Wind Speed at 10 Meters (m/s)
TS MERRA2 1/2x1/2 Earth Skin Temperature (C)
WS50M_MIN MERRA2 1/2x1/2 Minimum Wind Speed at 50 Meters (m/s)
T2MDEW MERRA2 1/2x1/2 Dew/Frost Point at 2 Meters (C)
WS50M_RANGE MERRA2 1/2x1/2 Wind Speed Range at 50 Meters (m/s)
WS10M_MAX MERRA2 1/2x1/2 Maximum Wind Speed at 10 Meters (m/s)
T2M_RANGE MERRA2 1/2x1/2 Temperature Range at 2 Meters (C)
T2M MERRA2 1/2x1/2 Temperature at 2 Meters (C)
-END HEADER-

| LAT | LON | YEAR | MO | DY | T2M_RA | TS | T2MDE | T2MWET | T2M_MA | T2M_MI | T2M | WS50M_ | WS10M_ | WS50M_ | WS10M_ | WS50M_ | WS10M_ | WS50 | WS10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.0372 | 38.7363 | 2019 | 7 | 1 | 8.66 | 17.8 | 12.4 | 12.4 | 21.72 | 13.0 | 16.4 | 4.34 | 3.64 | 0.59 | 0.64 | 4.93 | 4.27 | 3.05 | 2.19 |
| 9.0372 | 38.7363 | 2019 | 7 | 2 | 8.54 | 16.6 | 12.4 | 12.4 | 20.64 | 12.0 | 16.1 | 4.13 | 3.36 | 0.58 | 0.62 | 4.71 | 3.98 | 3.2 | 2.24 |
| 9.0372 | 38.7363 | 2019 | 7 | 3 | 7.4 | 15.6 | 12.0 | 12.0 | 19.02 | 11.6 | 15.3 | 4.94 | 4.08 | 0.23 | 0.2 | 5.17 | 4.29 | 2.53 | 1.83 |
| 9.0372 | 38.7363 | 2019 | 7 | 4 | 11.0 | 17.4 | 11.6 | 11.5 | 22.55 | 11.4 | 16.8 | 2.72 | 2.3 | 0.37 | 0.26 | 3.09 | 2.57 | 1.6 | 1.18 |
| 9.0372 | 38.7363 | 2019 | 7 | 5 | 10.7 | 17.5 | 11.5 | 11.4 | 22.71 | 11.9 | 17.0 | 2.24 | 1.9 | 0.05 | 0.04 | 2.29 | 1.94 | 1.25 | 0.95 |
| 9.0372 | 38.7363 | 2019 | 7 | 6 | 10.5 | 17.6 | 12.3 | 12.2 | 21.95 | 11.3 | 16.5 | 2.39 | 1.94 | 0.78 | 0.51 | 3.17 | 2.44 | 2.13 | 1.51 |
| 9.0372 | 38.7363 | 2019 | 7 | 7 | 9.19 | 18.4 | 12.6 | 12.5 | 22.44 | 13.2 | 17.2 | 3.53 | 3.5 | 0.93 | 0.51 | 4.46 | 4.01 | 2.24 | 1.54 |
| 9.0372 | 38.7363 | 2019 | 7 | 8 | 10.5 | 18.5 | 12.5 | 12.4 | 22.62 | 12.1 | 17.0 | 3.98 | 3.19 | 0.1 | 0.2 | 4.08 | 3.38 | 2.21 | 1.51 |
| 9.0372 | 38.7363 | 2019 | 7 | 9 | 8.48 | 18.0 | 12.1 | 12.0 | 21.93 | 13.4 | 17.3 | 1.54 | 0.82 | 0.46 | 0.43 | 1.99 | 1.25 | 1.19 | 0.77 |
| 9.0372 | 38.7363 | 2019 | 7 | 10 | 6.53 | 15.9 | 12.4 | 12.4 | 19.34 | 12.8 | 15.6 | 2.03 | 1.91 | 0.69 | 0.42 | 2.72 | 2.33 | 1.94 | 1.44 |
| 9.0372 | 38.7363 | 2019 | 7 | 11 | 7.55 | 15.4 | 11.8 | 11.8 | 19.35 | 11.8 | 15.2 | 2.17 | 2.26 | 1.52 | 1.1 | 3.69 | 3.36 | 2.6 | 2.02 |
| 9.0372 | 38.7363 | 2019 | 7 | 12 | 10.4 | 16.2 | 11.4 | 11.3 | 21.29 | 10.8 | 15.6 | 2.97 | 1.65 | 0.83 | 0.86 | 3.81 | 2.51 | 2.45 | 1.69 |
| 9.0372 | 38.7363 | 2019 | 7 | 13 | 6.32 | 14.9 | 11.8 | 11.8 | 18.51 | 12.1 | 14.7 | 1.6 | 1.54 | 1.45 | 1.05 | 3.05 | 2.59 | 2.53 | 1.74 |
| 9.0372 | 38.7363 | 2019 | 7 | 14 | 7.94 | 15.7 | 10.8 | 10.8 | 19.39 | 11.4 | 15.0 | 2.29 | 2 | 0.45 | 0.33 | 2.75 | 2.33 | 1.73 | 1.24 |
| 9.0372 | 38.7363 | 2019 | 7 | 15 | 11.0 | 16.9 | 11.0 | 10.9 | 21.68 | 10.5 | 16.3 | 3.61 | 3.06 | 0.34 | 0.24 | 3.95 | 3.29 | 2.21 | 1.66 |
| 9.0372 | 38.7363 | 2019 | 7 | 16 | 8.87 | 17.6 | 12.2 | 12.1 | 21.76 | 12.9 | 16.7 | 2.26 | 2.02 | 0.47 | 0.33 | 2.73 | 2.34 | 1.64 | 1.18 |
| 9.0372 | 38.7363 | 2019 | 7 | 17 | 8.78 | 16.6 | 12.3 | 12.2 | 20.47 | 11.6 | 15.6 | 2.96 | 3.23 | 1.88 | 1.1 | 4.84 | 4.34 | 2.73 | 2.07 |
| 9.0372 | 38.7363 | 2019 | 7 | 18 | 6.76 | 15.6 | 11.7 | 11.7 | 18.46 | 11.7 | 14.8 | 2.68 | 2.91 | 2.44 | 1.49 | 5.13 | 4.4 | 3.7 | 2.66 |
| 9.0372 | 38.7363 | 2019 | 7 | 19 | 9.32 | 16.4 | 11.8 | 11.8 | 20.37 | 11.0 | 15.5 | 2.22 | 2.09 | 1.11 | 0.66 | 3.33 | 2.76 | 2.17 | 1.54 |
| 9.0372 | 38.7363 | 2019 | 7 | 20 | 9.45 | 17.4 | 12.1 | 12.1 | 22.16 | 12.7 | 16.7 | 2.65 | 2.39 | 0.72 | 0.35 | 3.37 | 2.74 | 2.23 | 1.52 |
| 9.0372 | 38.7363 | 2019 | 7 | 21 | 9.74 | 17.9 | 12.2 | 12.2 | 22.28 | 12.5 | 17.1 | 3.56 | 2.94 | 0.22 | 0.16 | 3.78 | 3.1 | 2.35 | 1.6 |
| 9.0372 | 38.7363 | 2019 | 7 | 22 | 8.31 | 17.1 | 12.3 | 12.2 | 20.76 | 12.4 | 16.3 | 2 | 1.77 | 1.58 | 1.21 | 3.59 | 2.98 | 2.59 | 1.79 |
| 9.0372 | 38.7363 | 2019 | 7 | 23 | 9.92 | 17.7 | 12.4 | 12.4 | 22.1 | 12.1 | 16.4 | 2.29 | 0.98 | 1.47 | 1.26 | 3.76 | 2.24 | 2.61 | 1.75 |
| 9.0372 | 38.7363 | 2019 | 7 | 24 | 8.4 | 17.1 | 12.6 | 12.6 | 21.02 | 12.6 | 16.2 | 2.44 | 1.86 | 1.46 | 0.99 | 3.9 | 2.85 | 2.92 | 2.02 |
| 9.0372 | 38.7363 | 2019 | 7 | 25 | 8.83 | 16.5 | 12.9 | 12.8 | 20.5 | 11.6 | 16.3 | 2.41 | 2.39 | 1.35 | 0.86 | 3.77 | 3.24 | 2.48 | 1.83 |
| 9.0372 | 38.7363 | 2019 | 7 | 26 | 6.82 | 16.3 | 13.1 | 13.1 | 19.42 | 12.6 | 15.8 | 1.49 | 1.35 | 1.58 | 1.32 | 3.07 | 2.67 | 2.69 | 1.89 |
| 9.0372 | 38.7363 | 2019 | 7 | 27 | 6.2 | 16.3 | 12.5 | 12.5 | 19.17 | 12.9 | 15.3 | 2.34 | 1.46 | 0.74 | 0.57 | 3.08 | 2.03 | 1.88 | 1.2 |
| 9.0372 | 38.7363 | 2019 | 7 | 28 | 8.47 | 16.2 | 12.7 | 12.7 | 20.18 | 11.7 | 15.7 | 1.5 | 0.92 | 1.6 | 1.09 | 3.09 | 2.01 | 2.4 | 1.62 |
| 9.0372 | 38.7363 | 2019 | 7 | 29 | 8.8 | 16.4 | 12.3 | 12.3 | 20.87 | 12.0 | 16.0 | 2.05 | 1.34 | 0.44 | 0.25 | 2.49 | 1.6 | 1.37 | 1.01 |
| 9.0372 | 38.7363 | 2019 | 7 | 30 | 9.73 | 16.1 | 12.4 | 12.3 | 20.2 | 10.4 | 15.3 | 3.46 | 2.53 | 0.13 | 0.08 | 3.59 | 2.61 |  | 1.35 |
| 9.0372 | 38.7363 | 2019 | 7 | 31 | 9.89 | 16.6 | 12.4 | 12.4 | 21.1 | 11.2 | 16.0 | 1.86 | 1.69 | 0.83 | 0.56 | 2.7 | 2.26 | 1.83 | 1.39 |
| 9.0372 | 38.7363 | 2019 | 8 | 1 | 9.42 | 17.4 | 12.8 | 12.8 | 21.34 | 11.9 | 16.2 | 2.94 | 2.81 | 1.01 | 0.76 | 3.94 | 3.57 | 2.25 | 1.62 |
| 9.0372 | 38.7363 | 2019 | 8 | 2 | 6.95 | 15.9 | 13.1 | 13.1 | 19.41 | 12.4 | 15.4 | 2.65 | 3.17 | 2.61 | 1.43 | 5.26 | 4.61 | 3.88 | 2.72 |
| 9.0372 | 38.7363 | 2019 | 8 | 3 | 8.52 | 16.0 | 11.8 | 11.7 | 19.62 | 11.0 | 15.1 | 4 | 3.45 | 0.4 | 0.33 | 4.41 | 3.78 | 2.49 | 1.81 |
| 9.0372 | 38.7363 | 2019 | 8 | 4 | 6.47 | 16.0 | 12.9 | 12.9 | 19.11 | 12.6 | 15.3 | 2 | 2.09 | 1.93 | 1.29 | 3.93 | 3.38 | 2.86 | 1.97 |
| 9.0372 | 38.7363 | 2019 | 8 | 5 | 6.91 | 15.6 | 11.8 | 11.8 | 18.59 | 11.6 | 14.7 | 2.59 | 2.59 | 2.95 | 2.12 | 5.54 | 4.71 | 4.12 | 2.94 |
| 9.0372 | 38.7363 | 2019 | 8 | 6 | 6.64 | 14.9 | 11.6 | 11.6 | 17.95 | 11.3 | 14.3 | 1.45 | 1.89 | 2.52 | 1.51 | 3.97 | 3.4 | 3.37 | 2.42 |
| 9.0372 | 38.7363 | 2019 | 8 | 7 | 7.37 | 15.2 | 12.3 | 12.3 | 18.88 | 11.5 | 14.7 | 2.05 | 1.81 | 1.45 | 1.23 | 3.5 | 3.04 | 2.74 | 1.9 |
| 9.0372 | 38.7363 | 2019 | 8 | 8 | 6.21 | 15.4 | 12.5 | 12.6 | 18.55 | 12.3 | 15.0 | 2.28 | 2.68 | 2.05 | 1.15 | 4.33 | 3.83 | 3.03 | 2.24 |
| 9.0372 | 38.7363 | 2019 | 8 | 9 | 5.9 | 14.6 | 12.6 | 12.6 | 17.62 | 11.7 | 14.4 | 2.7 | 2.47 | 0.41 | 0.17 | 3.11 | 2.63 | 2.13 | 1.53 |
| 9.0372 | 38.7363 | 2019 | 8 | 10 | 5.33 | 14.5 | 12.3 | 12.4 | 17.29 | 11.9 | 14.2 | 4.87 | 4.51 | 0.92 | 0.46 | 5.79 | 4.97 | 3.38 | 2.41 |
| 9.0372 | 38.7363 | 2019 | 8 | 11 | 5.28 | 14.7 | 11.9 | 12 | 17.47 | 12.1 | 14.1 | 2.33 | 2.9 | 2.73 | 1.53 | 5.06 | 4.43 | 4.01 | 2.77 |
| 9.0372 | 38.7363 | 2019 | 8 | 12 | 5.15 | 14.0 | 11.8 | 11.9 | 16.9 | 11.7 | 13.8 | 3.36 | 2.9 | 0.52 | 0.41 | 3.88 | 3.31 | 2.42 | 1.73 |
| 9.0372 | 38.7363 | 2019 | 8 | 13 | 7.31 | 14.6 | 12.2 | 12.2 | 18.2 | 10.8 | 14.1 | 0.98 | 1.61 | 2.72 | 1.53 | 3.7 | 3.14 | 3.23 | 2.21 |
| 9.0372 | 38.7363 | 2019 | 8 | 14 | 7.18 | 15.3 | 12.1 | 12.1 | 18.78 | 11.6 | 14.7 | 2.21 | 1.2 | 0.59 | 0.4 | 2.8 | 1.6 | 1.43 | 0.95 |
| 9.0372 | 38.7363 | 2019 | 8 | 15 | 9.21 | 16.6 | 12.7 | 12.7 | 21.17 | 11.9 | 15.8 | 3.22 | 1.68 | 0.14 | 0.07 | 3.36 | 1.75 | 1.61 | 1.05 |
| 9.0372 | 38.7363 | 2019 | 8 | 16 | 9.17 | 15.9 | 12.5 | 12.5 | 20.39 | 11.2 | 15.5 | 2.44 | 2.19 | 0.5 | 0.38 | 2.94 | 2.57 | 1.94 | 1.42 |
| 9.0372 | 38.7363 | 2019 | 8 | 17 | 9.85 | 16.7 | 12.9 | 12.8 | 21.09 | 11.2 | 16.0 | 1.87 | 1.87 | 0.9 | 0.65 | 2.77 | 2.51 | 2.03 | 1.54 |
| 9.0372 | 38.7363 | 2019 | 8 | 18 | 8.66 | 16.7 | 13.0 | 13.0 | 20.8 | 12.1 | 16.1 | 2.05 | 1.89 | 0.35 | 0.24 | 2.39 | 2.14 | 1.33 | 0.93 |
| 9.0372 | 38.7363 | 2019 | 8 | 19 | 8.04 | 15.8 | 12.6 | 12.6 | 20.46 | 12.4 | 16 | 2.19 | 2.09 | 0.74 | 0.48 | 2.93 | 2.57 | 1.93 | 1.47 |
| 9.0372 | 38.7363 | 2019 | 8 | 20 | 8.87 | 15.2 | 12.7 | 12.6 | 20.3 | 11.4 | 15.6 | 2.34 | 2.25 | 1.51 | 1.01 | 3.85 | 3.26 | 2.68 | 1.97 |
| 9.0372 | 38.7363 | 2019 | 8 | 21 | 9.35 | 15.4 | 12.3 | 12.3 | 20.83 | 11.4 | 15.8 | 3.88 | 3.47 | 1.43 | 1.01 | 5.31 | 4.48 | 3.29 | 2.46 |
| 9.0372 | 38.7363 | 2019 | 8 | 22 | 9.52 | 15.7 | 12.3 | 12.2 | 20.51 | 10.9 | 15.5 | 2.71 | 2.2 | 0.43 | 0.43 | 3.14 | 2.62 | 2.15 | 1.56 |
| 9.0372 | 38.7363 | 2019 | 8 | 23 | 8.65 | 16.2 | 12.7 | 12.7 | 20.3 | 11.6 | 15.8 | 2.24 | 1.92 | 0.77 | 0.59 | 3.01 | 2.51 | 1.83 | 1.27 |
| 9.0372 | 38.7363 | 2019 | 8 | 24 | 9.59 | 16.9 | 12.4 | 12.4 | 20.94 | 11.3 | 15.8 | 2.62 | 1.35 | 0.69 | 0.73 | 3.31 | 2.08 | 1.76 | 1.29 |
| 9.0372 | 38.7363 | 2019 | 8 | 25 | 8.05 | 16.6 | 12.3 | 12.2 | 20.87 | 12.8 | 16.2 | 1.92 | 1.99 | 0.81 | 0.53 | 2.74 | 2.52 | 1.86 | 1.43 |
| 9.0372 | 38.7363 | 2019 | 8 | 26 | 9.68 | 16.0 | 12.1 | 12.1 | 20.7 | 11.0 | 15.6 | 1.22 | 1.28 | 1.19 | 0.75 | 2.41 | 2.03 | 1.78 | 1.34 |
| 9.0372 | 38.7363 | 2019 | 8 | 27 | 6.09 | 14.5 | 11.9 | 11.9 | 17.35 | 11.2 | 14.1 | 4.25 | 4.19 | 2.11 | 1.23 | 6.36 | 5.42 | 4.39 | 3.17 |
| 9.0372 | 38.7363 | 2019 | 8 | 28 | 8.79 | 14.7 | 11.6 | 11.6 | 18.96 | 10.1 | 14.4 | 2.02 | 1.04 | 1.37 | 0.86 | 3.39 | 1.91 | 2.34 | 1.59 |
| 9.0372 | 38.7363 | 2019 | 8 | 29 | 8.97 | 15.5 | 12.1 | 12.0 | 19.99 | 11.0 | 15.3 | 1.31 | 1.28 | 0.16 | 0.05 | 1.48 | 1.32 | 0.94 | 0.71 |
| 9.0372 | 38.7363 | 2019 | 8 | 30 | 9.33 | 16 | 12.0 | 12.0 | 20.44 | 11.1 | 15.7 | 2.07 | 1.86 | 0.72 | 0.48 | 2.79 | 2.34 | 1.54 | 1.16 |
| 9.0372 | 38.7363 | 2019 | 8 | 31 | 9.21 | 16.2 | 12.1 | 12.0 | 21.22 | 12.0 | 16.4 | 2.11 | 1.9 | 0.56 | 0.37 | 2.67 | 2.28 | 1.47 | 1.15 |
| 9.0372 | 38.7363 | 2019 | 9 | 1 | 9.88 | 16.5 | 12.7 | 12.6 | 21.44 | 11.5 | 16.4 | 1.95 | 1.28 | 1.23 | 0.88 | 3.18 | 2.16 | 2.02 | 1.44 |
| 9.0372 | 38.7363 | 2019 | 9 | 2 | 7.91 | 16.0 | 13.2 | 13.2 | 19.87 | 11.9 | 15.7 | 2.57 | 2.1 | 0.1 | 0.03 | 2.68 | 2.13 | 1.12 | 0.83 |
| 9.0372 | 38.7363 | 2019 | 9 | 3 | 9.01 | 16.1 | 12.5 | 12.5 | 20.69 | 11.6 | 15.8 | 2.24 | 2.19 | 1.25 | 0.87 | 3.49 | 3.06 | 2.41 | 1.74 |
| 9.0372 | 38.7363 | 2019 | 9 | 4 | 10.2 | 16.8 | 12.4 | 12.3 | 21.35 | 11.1 | 16.0 | 1.68 | 1.57 | 0.24 | 0.13 | 1.92 | 1.69 | 1.4 | 1 |
| 9.0372 | 38.7363 | 2019 | 9 | 5 | 8.78 | 16.1 | 12.8 | 12.8 | 20.98 | 12.2 | 16.1 | 3.27 | 2.31 | 0.09 | 0.05 | 3.36 | 2.36 | 1.8 | 1.25 |
| 9.0372 | 38.7363 | 2019 | 9 | 6 | 6.15 | 15.0 | 12.9 | 12.9 | 18.18 | 12.0 | 15.0 | 2.09 | 2.04 | 1.34 | 0.76 | 3.43 | 2.81 | 2.17 | 1.56 |
| 9.0372 | 38.7363 | 2019 | 9 | 7 | 7.67 | 15.2 | 12.7 | 12.7 | 19.71 | 12.0 | 15.5 | 2.27 | 1.99 | 0.48 | 0.3 | 2.75 | 2.28 | 1.72 | 1.26 |
| 9.0372 | 38.7363 | 2019 | 9 | 8 | 9.33 | 15.8 | 12.6 | 12.5 | 20.78 | 11.4 | 15.8 | 1.52 | 1.26 | 0.82 | 0.73 | 2.34 | 1.99 | 1.61 | 1.2 |
| 9.0372 | 38.7363 | 2019 | 9 | 9 | 8.88 | 15.8 | 12.3 | 12.3 | 19.97 | 11.0 | 15.2 | 4.55 | 3.83 | 0.57 | 0.4 | 5.11 | 4.23 | 2.25 | 1.6 |
| 9.0372 | 38.7363 | 2019 | 9 | 10 | 9.61 | 16.2 | 12.5 | 12.5 | 20.76 | 11.1 | 15.7 | 2.57 | 2.2 | 0.26 | 0.22 | 2.83 | 2.42 | 1.51 | 1.08 |
| 9.0372 | 38.7363 | 2019 | 9 | 11 | 7.8 | 15.6 | 12.7 | 12.7 | 19.45 | 11.6 | 15.2 | 2.47 | 2.03 | 1.04 | 0.88 | 3.52 | 2.91 | 2.22 | 1.54 |
| 9.0372 | 38.7363 | 2019 | 9 | 12 | 8.29 | 15.0 | 12.3 | 12.3 | 19.47 | 11.1 | 14.7 | 2.85 | 2.65 | 1.01 | 0.64 | 3.86 | 3.29 | 2.89 | 2.06 |
| 9.0372 | 38.7363 | 2019 | 9 | 13 | 10.7 | 15.9 | 11.6 | 11.6 | 20.57 | 9.87 | 15.2 | 2.17 | 1.75 | 0.7 | 0.63 | 2.86 | 2.39 | 1.72 | 1.22 |
| 9.0372 | 38.7363 | 2019 | 9 | 14 | 10.1 | 15.8 | 12.2 | 12.2 | 20.81 | 10.6 | 15.6 | 2.44 | 1.45 | 0.55 | 0.4 | 2.99 | 1.85 | 1.73 | 1.26 |
| 9.0372 | 38.7363 | 2019 | 9 | 15 | 9.66 | 15.8 | 12.7 | 12.7 | 20.76 | 11.1 | 15.6 | 2.26 | 1.5 | 1.14 | 0.86 | 3.4 | 2.36 | 2.27 | 1.61 |
| 9.0372 | 38.7363 | 2019 | 9 | 16 | 9.25 | 14.8 | 12.5 | 12.5 | 19.82 | 10.5 | 14.8 | 1.72 | 2.16 | 2.85 | 1.76 | 4.56 | 3.91 | 3.72 | 2.59 |
| 9.0372 | 38.7363 | 2019 | 9 | 17 | 9.12 | 15.4 | 12.7 | 12.7 | 20.14 | 11.0 | 15.0 | 4.18 | 2.12 | 0.55 | 0.59 | 4.73 | 2.71 | 2.66 | 1.8 |
| 9.0372 | 38.7363 | 2019 | 9 | 18 | 6.77 | 15.6 | 12.7 | 12.7 | 19.17 | 12.4 | 15.1 | 3.51 | 3.09 | 0.53 | 0.48 | 4.04 | 3.57 | 2.29 | 1.66 |
| 9.0372 | 38.73631 | 2019 | 9 | 19 | 8.67 | 15.14 | 12.21 | 12.16 | 20.08 | 11.41 | 15.25 | 3.63 | 3.1 | 1.18 | 0.77 | 4.81 | 3.88 | 3.19 | 2.24 |
| 9.0372 | 38.73631 | 2019 | 9 | 20 | 10.55 | 15.19 | 12.27 | 12.18 | 20.64 | 10.09 | 14.98 | 2.02 | 1.71 | 2.41 | 1.62 | 4.44 | 3.33 | 3.69 | 2.54 |
| 9.0372 | 38.73631 | 2019 | 9 | 21 | 8.6 | 15.46 | 12.8 | 12.78 | 19.96 | 11.36 | 15.05 | 2.57 | 1.24 | 1.04 | 1.02 | 3.61 | 2.26 | 2.4 | 1.67 |
| 9.0372 | 38.73631 | 2019 | 9 | 22 | 7.87 | 15.8 | 12.35 | 12.33 | 19.34 | 11.47 | 15.28 | 1.89 | 1.77 | 0.58 | 0.31 | 2.47 | 2.08 | 1.79 | 1.27 |
| 9.0372 | 38.73631 | 2019 | 9 | 23 | 7.65 | 16.28 | 12.98 | 12.96 | 19.82 | 12.17 | 15.66 | 1.73 | 0.74 | 0.95 | 0.86 | 2.67 | 1.59 | 1.74 | 1.17 |
| 9.0372 | 38.73631 | 2019 | 9 | 24 | 7.33 | 16.5 | 12.8 | 12.78 | 19.89 | 12.56 | 15.92 | 3.48 | 2.84 | 0.12 | 0.05 | 3.6 | 2.89 | 1.76 | 1.15 |
| 9.0372 | 38.73631 | 2019 | 9 | 25 | 5.26 | 15.37 | 12.97 | 12.99 | 18.23 | 12.97 | 15.15 | 3.54 | 1.88 | 0.47 | 0.32 | 4.01 | 2.2 | 2.16 | 1.47 |
| 9.0372 | 38.73631 | 2019 | 9 | 26 | 7.73 | 14.97 | 12.47 | 12.46 | 19.09 | 11.35 | 14.86 | 1.93 | 2.66 | 3.42 | 1.94 | 5.35 | 4.59 | 4.26 | 2.96 |
| 9.0372 | 38.73631 | 2019 | 9 | 27 | 9.54 | 15.35 | 12.8 | 12.75 | 20.3 | 10.76 | 15.08 | 2.46 | 2.59 | 1.59 | 0.94 | 4.05 | 3.54 | 2.83 | 2.07 |
| 9.0372 | 38.73631 | 2019 | 9 | 28 | 6.31 | 15.05 | 13.17 | 13.18 | 18.67 | 12.37 | 15.07 | 2.95 | 2.21 | 0.34 | 0.27 | 3.29 | 2.48 | 1.81 | 1.28 |
| 9.0372 | 38.73631 | 2019 | 9 | 29 | 8.7 | 15.03 | 12.78 | 12.76 | 19.86 | 11.16 | 14.97 | 1.88 | 1.74 | 0.63 | 0.44 | 2.52 | 2.19 | 1.88 | 1.34 |
| 9.0372 | 38.73631 | 2019 | 9 | 30 | 6.49 | 15.24 | 12.75 | 12.76 | 18.84 | 12.36 | 14.98 | 3.9 | 3.61 | 1.23 | 0.8 | 5.13 | 4.41 | 3.46 | 2.47 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.0372 | 38.73631 | 2019 | 10 | 1 | 7.09 | 14.86 | 12.53 | 12.52 | 18.48 | 11.39 | 14.82 | 4.02 | 3.61 | 0.4 | 0.26 | 4.42 | 3.87 | 2.4 | 1.77 |
| 9.0372 | 38.73631 | 2019 | 10 | 2 | 6.77 | 14.45 | 12.5 | 12.49 | 18.13 | 11.36 | 14.33 | 2.05 | 1.45 | 2.24 | 1.3 | 4.29 | 2.75 | 2.99 | 2.02 |
| 9.0372 | 38.73631 | 2019 | 10 | 3 | 9.83 | 14.65 | 11.53 | 11.43 | 19.58 | 9.74 | 14.25 | 2.61 | 2.85 | 2.76 | 1.68 | 5.37 | 4.53 | 3.97 | 2.78 |
| 9.0372 | 38.73631 | 2019 | 10 | 4 | 8.78 | 14.35 | 11.78 | 11.76 | 19.12 | 10.33 | 14 | 2.21 | 3.06 | 3.9 | 2.17 | 6.11 | 5.23 | 4.74 | 3.27 |
| 9.0372 | 38.73631 | 2019 | 10 | 5 | 6.39 | 12.16 | 9.94 | 9.95 | 15.93 | 9.54 | 12.28 | 2.38 | 2.38 | 2.7 | 1.68 | 5.09 | 4.07 | 4.07 | 2.68 |
| 9.0372 | 38.73631 | 2019 | 10 | 6 | 10.11 | 12.81 | 8.89 | 8.84 | 18.96 | 8.85 | 12.82 | 3.72 | 4.14 | 4.05 | 2.37 | 7.77 | 6.5 | 5.79 | 3.84 |
| 9.0372 | 38.73631 | 2019 | 10 | 7 | 12.06 | 12.84 | 8.58 | 8.45 | 19.62 | 7.56 | 12.96 | 4.23 | 4.38 | 3.47 | 2.11 | 7.7 | 6.49 | 5.61 | 3.9 |
| 9.0372 | 38.73631 | 2019 | 10 | 8 | 11.91 | 12.85 | 9.47 | 9.44 | 19.51 | 7.6 | 12.79 | 4.59 | 4.81 | 4.1 | 2.4 | 8.69 | 7.21 | 6.15 | 4.27 |
| 9.0372 | 38.73631 | 2019 | 10 | 9 | 12.88 | 12.97 | 8.55 | 8.47 | 19.94 | 7.06 | 12.73 | 2.12 | 2.96 | 4.19 | 2.41 | 6.31 | 5.37 | 5.49 | 3.72 |
| 9.0372 | 38.73631 | 2019 | 10 | 10 | 11.76 | 13.6 | 10.22 | 10.16 | 19.52 | 7.76 | 13.09 | 3.62 | 4.11 | 3.68 | 2.21 | 7.3 | 6.32 | 5.26 | 3.68 |
| 9.0372 | 38.73631 | 2019 | 10 | 11 | 11.47 | 14.08 | 10.71 | 10.63 | 20.23 | 8.76 | 13.66 | 1.94 | 2.89 | 3.83 | 2.17 | 5.77 | 5.06 | 4.96 | 3.39 |
| 9.0372 | 38.73631 | 2019 | 10 | 12 | 13.08 | 14.02 | 9.92 | 9.84 | 20.88 | 7.8 | 13.7 | 2.9 | 3.69 | 4.31 | 2.42 | 7.21 | 6.11 | 5.35 | 3.63 |
| 9.0372 | 38.73631 | 2019 | 10 | 13 | 10.55 | 13.76 | 10.48 | 10.47 | 19.11 | 8.56 | 13.41 | 3.09 | 4.02 | 4.36 | 2.39 | 7.44 | 6.41 | 5.41 | 3.76 |
| 9.0372 | 38.73631 | 2019 | 10 | 14 | 11.36 | 13.48 | 8.79 | 8.74 | 20.09 | 8.73 | 13.31 | 2.86 | 3.84 | 4.6 | 2.47 | 7.47 | 6.31 | 5.57 | 3.84 |
| 9.0372 | 38.73631 | 2019 | 10 | 15 | 13.5 | 13.2 | 8.88 | 8.77 | 20.31 | 6.82 | 12.96 | 2.98 | 3.86 | 4.7 | 2.6 | 7.68 | 6.46 | 5.7 | 3.9 |
| 9.0372 | 38.73631 | 2019 | 10 | 16 | 12.58 | 13.69 | 10.22 | 10.18 | 19.83 | 7.25 | 13.17 | 1.76 | 2.93 | 4.62 | 2.52 | 6.37 | 5.44 | 5.32 | 3.6 |
| 9.0372 | 38.73631 | 2019 | 10 | 17 | 13.5 | 13.86 | 9.47 | 9.42 | 20.94 | 7.44 | 13.33 | 2.3 | 2.38 | 3.93 | 2.79 | 6.23 | 5.17 | 5.39 | 3.49 |
| 9.0372 | 38.73631 | 2019 | 10 | 18 | 13.51 | 13.56 | 9.49 | 9.39 | 20.18 | 6.67 | 13.16 | 3.44 | 4.04 | 3.59 | 2.03 | 7.03 | 6.06 | 5.63 | 3.88 |
| 9.0372 | 38.73631 | 2019 | 10 | 19 | 9.97 | 13.49 | 10.08 | 10.07 | 18.98 | 9.01 | 13.12 | 5.59 | 5.82 | 4.34 | 2.31 | 9.93 | 8.13 | 6.68 | 4.62 |
| 9.0372 | 38.73631 | 2019 | 10 | 20 | 11.55 | 14.41 | 10.65 | 10.63 | 20.84 | 9.3 | 13.98 | 3.73 | 4.49 | 4.54 | 2.48 | 8.27 | 6.97 | 6 | 4.14 |
| 9.0372 | 38.73631 | 2019 | 10 | 21 | 12.99 | 14.46 | 10.59 | 10.57 | 21.19 | 8.21 | 13.97 | 1.72 | 2.81 | 4.32 | 2.4 | 6.04 | 5.21 | 5.2 | 3.49 |
| 9.0372 | 38.73631 | 2019 | 10 | 22 | 14.04 | 13.64 | 9.79 | 9.75 | 20.54 | 6.5 | 13.06 | 1.79 | 2.52 | 4.46 | 2.63 | 6.25 | 5.15 | 5.35 | 3.58 |
| 9.0372 | 38.73631 | 2019 | 10 | 23 | 14.86 | 12.38 | 5.85 | 5.74 | 20.65 | 5.79 | 12.3 | 2.11 | 1.63 | 4.03 | 2.69 | 6.14 | 4.32 | 4.97 | 3.35 |
| 9.0372 | 38.73631 | 2019 | 10 | 24 | 16.7 | 11.82 | 4.3 | 4.08 | 20.74 | 4.04 | 12 | 2.98 | 2.13 | 3.17 | 2.31 | 6.14 | 4.43 | 4.48 | 3.05 |
| 9.0372 | 38.73631 | 2019 | 10 | 25 | 15.01 | 12.88 | 5.96 | 5.77 | 21.3 | 6.29 | 13.17 | 2.35 | 1.45 | 2.62 | 1.87 | 4.97 | 3.32 | 3.76 | 2.6 |
| 9.0372 | 38.73631 | 2019 | 10 | 26 | 15.2 | 13.3 | 6.86 | 6.67 | 21.91 | 6.7 | 13.47 | 2.16 | 1.09 | 3.14 | 2.14 | 5.3 | 3.23 | 4 | 2.73 |
| 9.0372 | 38.73631 | 2019 | 10 | 27 | 15.18 | 13.43 | 6.52 | 6.3 | 21.75 | 6.57 | 13.5 | 2.42 | 1.55 | 2.73 | 2.03 | 5.15 | 3.57 | 4 | 2.75 |
| 9.0372 | 38.73631 | 2019 | 10 | 28 | 15.12 | 14.26 | 8.73 | 8.4 | 21.97 | 6.85 | 14.13 | 2.51 | 0.78 | 3.3 | 2.27 | 5.81 | 3.05 | 4.1 | 2.75 |
| 9.0372 | 38.73631 | 2019 | 10 | 29 | 13.18 | 13.42 | 8 | 7.9 | 20.9 | 7.72 | 13.24 | 1.91 | 3.13 | 4.78 | 2.71 | 6.7 | 5.84 | 5.84 | 3.94 |
| 9.0372 | 38.73631 | 2019 | 10 | 30 | 15.33 | 11.86 | 5.16 | 5.06 | 20.38 | 5.05 | 12.09 | 2.68 | 3.22 | 4.32 | 2.73 | 7 | 5.95 | 5.34 | 3.76 |
| 9.0372 | 38.73631 | 2019 | 10 | 31 | 16.08 | 12.54 | 6.13 | 6 | 20.88 | 4.79 | 12.66 | 2.39 | 2.53 | 2.18 | 1.45 | 4.57 | 3.98 | 3.54 | 2.52 |
| 9.0372 | 38.73631 | 2019 | 11 | 1 | 14.54 | 13.37 | 6.84 | 6.69 | 21.42 | 6.88 | 13.51 | 2.35 | 0.95 | 3.29 | 2.22 | 5.64 | 3.17 | 4.03 | 2.75 |
| 9.0372 | 38.73631 | 2019 | 11 | 2 | 14.47 | 12.53 | 6.4 | 6.28 | 20.8 | 6.33 | 12.79 | 2.89 | 3.29 | 4.18 | 2.63 | 7.07 | 5.92 | 5.51 | 3.87 |
| 9.0372 | 38.73631 | 2019 | 11 | 3 | 13.87 | 12.38 | 7.18 | 7.09 | 19.86 | 5.99 | 12.49 | 4.9 | 4.99 | 4.17 | 2.57 | 9.06 | 7.55 | 6.25 | 4.39 |
| 9.0372 | 38.73631 | 2019 | 11 | 4 | 11.47 | 13.59 | 9.85 | 9.82 | 19.52 | 8.05 | 13.07 | 3.58 | 4.4 | 4.39 | 2.41 | 7.97 | 6.81 | 5.71 | 3.99 |
| 9.0372 | 38.73631 | 2019 | 11 | 5 | 12.67 | 14.36 | 10.41 | 10.37 | 20.68 | 8.01 | 13.75 | 2.33 | 3.03 | 4.56 | 2.5 | 6.89 | 5.53 | 5.42 | 3.72 |
| 9.0372 | 38.73631 | 2019 | 11 | 6 | 11.37 | 14.26 | 9.45 | 9.4 | 20.38 | 9.01 | 13.66 | 1.9 | 3.13 | 4.65 | 2.49 | 6.55 | 5.62 | 5.41 | 3.61 |
| 9.0372 | 38.73631 | 2019 | 11 | 7 | 10.38 | 13.75 | 10.4 | 10.36 | 19.06 | 8.68 | 13.39 | 1.91 | 1.39 | 3.34 | 2.17 | 5.25 | 3.55 | 4.21 | 2.7 |
| 9.0372 | 38.73631 | 2019 | 11 | 8 | 11.59 | 14.92 | 10.71 | 10.65 | 20.64 | 9.06 | 14.34 | 1.51 | 1.83 | 3.66 | 2.15 | 5.17 | 3.98 | 4.25 | 2.83 |
| 9.0372 | 38.73631 | 2019 | 11 | 9 | 13.51 | 14.05 | 6.49 | 6.39 | 21.69 | 8.17 | 14.08 | 1.5 | 1.26 | 3.17 | 2.01 | 4.67 | 3.27 | 3.85 | 2.61 |
| 9.0372 | 38.73631 | 2019 | 11 | 10 | 14.82 | 13.68 | 6.75 | 6.62 | 21.94 | 7.13 | 13.88 | 2.34 | 2.05 | 3.17 | 2.1 | 5.51 | 4.15 | 4.05 | 2.8 |
| 9.0372 | 38.73631 | 2019 | 11 | 11 | 13.88 | 14.21 | 8.05 | 7.93 | 21.68 | 7.8 | 13.85 | 2.25 | 2.11 | 3.83 | 2.36 | 6.08 | 4.47 | 4.83 | 3.27 |
| 9.0372 | 38.73631 | 2019 | 11 | 12 | 14.87 | 13.75 | 7.32 | 7.23 | 21.64 | 6.76 | 13.43 | 1.55 | 2.71 | 4.8 | 2.75 | 6.35 | 5.46 | 5.66 | 3.79 |
| 9.0372 | 38.73631 | 2019 | 11 | 13 | 14.4 | 14.6 | 9.49 | 9.34 | 21.59 | 7.19 | 13.96 | 2.22 | 2.54 | 3.87 | 2.42 | 6.09 | 4.96 | 5.2 | 3.4 |
| 9.0372 | 38.73631 | 2019 | 11 | 14 | 13.81 | 14.83 | 9.51 | 9.44 | 21.73 | 7.92 | 14.24 | 1.53 | 2.76 | 4.54 | 2.43 | 6.07 | 5.18 | 5.25 | 3.45 |
| 9.0372 | 38.73631 | 2019 | 11 | 15 | 14.87 | 14.49 | 8.53 | 8.46 | 21.92 | 7.05 | 13.99 | 2.56 | 2.11 | 2.92 | 2.06 | 5.48 | 4.17 | 4.39 | 2.87 |
| 9.0372 | 38.73631 | 2019 | 11 | 16 | 14.38 | 14.42 | 8.13 | 8.04 | 21.86 | 7.49 | 13.93 | 2.84 | 1.57 | 3.46 | 2.52 | 6.3 | 4.1 | 4.62 | 3.05 |
| 9.0372 | 38.73631 | 2019 | 11 | 17 | 14.7 | 14.8 | 9.08 | 8.87 | 21.59 | 6.89 | 14.09 | 3.99 | 2.3 | 1.92 | 1.75 | 5.91 | 4.05 | 4.04 | 2.63 |
| 9.0372 | 38.73631 | 2019 | 11 | 18 | 12.84 | 16.15 | 11.08 | 11.03 | 22.1 | 9.26 | 15.22 | 2.37 | 1.47 | 2.95 | 2.09 | 5.32 | 3.56 | 4.09 | 2.65 |
| 9.0372 | 38.73631 | 2019 | 11 | 19 | 12.13 | 16.17 | 11.85 | 11.8 | 21.68 | 9.56 | 15.34 | 2.27 | 1.91 | 3.41 | 2.24 | 5.68 | 4.16 | 4.48 | 2.88 |
| 9.0372 | 38.73631 | 2019 | 11 | 20 | 10.43 | 16.22 | 12.74 | 12.72 | 21.13 | 10.69 | 15.6 | 3.41 | 3.47 | 2.15 | 1.33 | 5.56 | 4.79 | 4.06 | 2.65 |
| 9.0372 | 38.73631 | 2019 | 11 | 21 | 8.35 | 15.95 | 12.39 | 12.39 | 20.47 | 12.12 | 15.36 | 2.78 | 2.13 | 2.57 | 1.54 | 5.35 | 3.67 | 3.96 | 2.55 |
| 9.0372 | 38.73631 | 2019 | 11 | 22 | 8.36 | 14.59 | 12.19 | 12.19 | 18.99 | 10.63 | 14.37 | 2.44 | 3.14 | 3.39 | 1.83 | 5.84 | 4.97 | 4.35 | 2.96 |
| 9.0372 | 38.73631 | 2019 | 11 | 23 | 8.08 | 15.03 | 12.15 | 12.17 | 19.35 | 11.27 | 14.64 | 1.84 | 2.64 | 3.72 | 2 | 5.56 | 4.65 | 4.49 | 2.99 |
| 9.0372 | 38.73631 | 2019 | 11 | 24 | 8.7 | 14.85 | 12.14 | 12.15 | 19.73 | 11.03 | 14.65 | 2.63 | 3.22 | 3.41 | 1.83 | 6.04 | 5.05 | 4.52 | 3.06 |
| 9.0372 | 38.73631 | 2019 | 11 | 25 | 8.43 | 14.31 | 11.81 | 11.82 | 19.29 | 10.86 | 14.15 | 2.51 | 3.44 | 4.11 | 2.23 | 6.62 | 5.66 | 5.21 | 3.51 |
| 9.0372 | 38.73631 | 2019 | 11 | 26 | 10.87 | 14.76 | 10.83 | 10.82 | 20.84 | 9.97 | 14.22 | 2.91 | 3.87 | 4.73 | 2.52 | 7.64 | 6.39 | 5.97 | 4.09 |
| 9.0372 | 38.73631 | 2019 | 11 | 27 | 12.29 | 13.35 | 8.75 | 8.71 | 20.1 | 7.81 | 12.86 | 1.7 | 3.21 | 4.99 | 2.68 | 6.69 | 5.88 | 5.76 | 3.93 |
| 9.0372 | 38.73631 | 2019 | 11 | 28 | 14.96 | 13.88 | 8.54 | 8.5 | 21.61 | 6.65 | 13.17 | 1.9 | 1.96 | 2.97 | 2 | 4.86 | 3.97 | 4.03 | 2.74 |
| 9.0372 | 38.73631 | 2019 | 11 | 29 | 15.19 | 14.44 | 8.79 | 8.72 | 21.72 | 6.53 | 13.65 | 3.02 | 1.1 | 2.17 | 1.94 | 5.19 | 3.05 | 3.47 | 2.34 |
| 9.0372 | 38.73631 | 2019 | 11 | 30 | 14.44 | 15.01 | 9.26 | 9.2 | 21.54 | 7.1 | 13.77 | 4.26 | 2.25 | 1.33 | 1.38 | 5.59 | 3.62 | 3.64 | 2.47 |
| 9.0372 | 38.73631 | 2019 | 12 | 1 | 14.13 | 15.39 | 9.19 | 9.11 | 21.56 | 7.43 | 14.22 | 4.77 | 2.71 | 0.36 | 0.34 | 5.12 | 3.06 | 2.8 | 1.76 |
| 9.0372 | 38.73631 | 2019 | 12 | 2 | 12.7 | 15.78 | 9.51 | 9.37 | 21.79 | 9.09 | 15.11 | 2.42 | 1.2 | 0.66 | 0.59 | 3.07 | 1.79 | 1.83 | 1.24 |
| 9.0372 | 38.73631 | 2019 | 12 | 3 | 13.07 | 16.09 | 9.66 | 9.57 | 22.04 | 8.97 | 15.15 | 3.79 | 1.83 | 0.87 | 0.74 | 4.66 | 2.57 | 2.34 | 1.51 |
| 9.0372 | 38.73631 | 2019 | 12 | 4 | 12.6 | 16.4 | 9.54 | 9.45 | 21.81 | 9.22 | 15.1 | 3.9 | 2.29 | 0.47 | 0.44 | 4.37 | 2.73 | 2.73 | 1.7 |
| 9.0372 | 38.73631 | 2019 | 12 | 5 | 14.6 | 16 | 9.63 | 9.56 | 22.4 | 7.8 | 14.87 | 3.89 | 1.57 | 1.82 | 1.65 | 5.71 | 3.22 | 3.7 | 2.46 |
| 9.0372 | 38.73631 | 2019 | 12 | 6 | 14.43 | 15.5 | 9.1 | 9.02 | 22.77 | 8.34 | 14.39 | 3.08 | 1.54 | 2.78 | 2.44 | 5.86 | 3.98 | 4.37 | 2.88 |
| 9.0372 | 38.73631 | 2019 | 12 | 7 | 15.76 | 13.71 | 5.61 | 5.51 | 22.02 | 6.26 | 13.06 | 1.98 | 1.95 | 3.65 | 2.37 | 5.63 | 4.32 | 4.6 | 3.13 |
| 9.0372 | 38.73631 | 2019 | 12 | 8 | 16.95 | 14.38 | 9.5 | 9.33 | 22.1 | 5.15 | 13.56 | 1.33 | 2.25 | 3.97 | 2.04 | 5.29 | 4.29 | 4.64 | 3.22 |
| 9.0372 | 38.73631 | 2019 | 12 | 9 | 9.61 | 15.46 | 11.61 | 11.61 | 20.77 | 11.16 | 14.73 | 4.7 | 5.2 | 3.66 | 1.88 | 8.36 | 7.08 | 5.63 | 3.96 |
| 9.0372 | 38.73631 | 2019 | 12 | 10 | 10.6 | 15.9 | 12.05 | 12.05 | 21.47 | 10.87 | 15.13 | 4.18 | 5 | 4.59 | 2.39 | 8.77 | 7.39 | 6.13 | 4.24 |
| 9.0372 | 38.73631 | 2019 | 12 | 11 | 8.95 | 14.32 | 11.34 | 11.34 | 19.03 | 10.07 | 14.08 | 4.68 | 5.13 | 4.09 | 2.31 | 8.77 | 7.44 | 5.75 | 3.98 |
| 9.0372 | 38.73631 | 2019 | 12 | 12 | 11.98 | 14.56 | 9.8 | 9.77 | 21.27 | 9.28 | 13.91 | 2.19 | 3.01 | 3.87 | 2.2 | 6.06 | 5.21 | 5.09 | 3.44 |
| 9.0372 | 38.73631 | 2019 | 12 | 13 | 15.19 | 14.32 | 7.52 | 7.43 | 22.32 | 7.12 | 13.65 | 2.52 | 1.83 | 3.58 | 2.12 | 6.1 | 3.94 | 4.62 | 3.14 |
| 9.0372 | 38.73631 | 2019 | 12 | 14 | 13.62 | 14.19 | 8.89 | 8.79 | 20.88 | 7.26 | 13.45 | 2.43 | 1.57 | 3.45 | 2.29 | 5.88 | 3.86 | 4.46 | 2.99 |
| 9.0372 | 38.73631 | 2019 | 12 | 15 | 15.57 | 13.62 | 4.49 | 4.4 | 22.11 | 6.54 | 13.2 | 1.52 | 2.24 | 4.04 | 2.56 | 5.56 | 4.8 | 4.81 | 3.28 |
| 9.0372 | 38.73631 | 2019 | 12 | 16 | 15.78 | 13.49 | 4.11 | 4.01 | 22.16 | 6.38 | 13.34 | 2.48 | 1.04 | 2.03 | 1.63 | 4.51 | 2.67 | 3.09 | 2.17 |
| 9.0372 | 38.73631 | 2019 | 12 | 17 | 15.53 | 14.13 | 6.8 | 6.66 | 22.27 | 6.73 | 13.69 | 2.79 | 1.22 | 3.22 | 2.15 | 6.01 | 3.36 | 4.06 | 2.82 |
| 9.0372 | 38.73631 | 2019 | 12 | 18 | 15.68 | 14.18 | 6.94 | 6.85 | 22.16 | 6.49 | 13.24 | 2.93 | 1.82 | 3.74 | 2.49 | 6.66 | 4.31 | 4.83 | 3.27 |
| 9.0372 | 38.73631 | 2019 | 12 | 19 | 16.86 | 12.31 | 3.1 | 3 | 21.08 | 4.23 | 11.67 | 2.02 | 3.15 | 4.83 | 2.78 | 6.85 | 5.92 | 5.61 | 3.85 |
| 9.0372 | 38.73631 | 2019 | 12 | 20 | 17.19 | 13.7 | 6.12 | 5.88 | 21.95 | 4.75 | 12.81 | 3.14 | 0.95 | 2.22 | 2.02 | 5.36 | 2.98 | 3.53 | 2.41 |
| 9.0372 | 38.73631 | 2019 | 12 | 21 | 14.96 | 15.3 | 8.17 | 8.07 | 22.4 | 7.44 | 14.33 | 2.65 | 1.39 | 1.29 | 1.06 | 3.94 | 2.45 | 2.45 | 1.65 |
| 9.0372 | 38.73631 | 2019 | 12 | 22 | 14.37 | 15.98 | 8.93 | 8.83 | 22.41 | 8.04 | 14.8 | 3.35 | 2.1 | 0.39 | 0.27 | 3.74 | 2.38 | 2.19 | 1.55 |
| 9.0372 | 38.73631 | 2019 | 12 | 23 | 12.33 | 15.95 | 9.42 | 9.31 | 21.46 | 9.13 | 14.77 | 2.7 | 1.91 | 0.46 | 0.39 | 3.16 | 2.3 | 2.2 | 1.48 |
| 9.0372 | 38.73631 | 2019 | 12 | 24 | 14.1 | 17.02 | 9.15 | 9.05 | 23.36 | 9.26 | 15.82 | 2.84 | 1.81 | 0.27 | 0.21 | 3.12 | 2.02 | 1.94 | 1.29 |
| 9.0372 | 38.73631 | 2019 | 12 | 25 | 13.91 | 17.39 | 9.78 | 9.68 | 23.23 | 9.33 | 16.14 | 2.62 | 1.66 | 0.39 | 0.51 | 3 | 2.17 | 1.74 | 1.21 |
| 9.0372 | 38.73631 | 2019 | 12 | 26 | 13.81 | 17.09 | 9.22 | 9.13 | 23.77 | 9.96 | 16.16 | 2.99 | 1.72 | 0.6 | 0.5 | 3.59 | 2.22 | 2.05 | 1.4 |
| 9.0372 | 38.73631 | 2019 | 12 | 27 | 16.02 | 16.59 | 8.93 | 8.85 | 23.85 | 7.84 | 15.57 | 2.61 | 2.07 | 0.68 | 0.59 | 3.29 | 2.66 | 2.01 | 1.47 |
| 9.0372 | 38.73631 | 2019 | 12 | 28 | 15.06 | 16.42 | 8.66 | 8.56 | 23.74 | 8.67 | 15.85 | 3.05 | 2.05 | 0.53 | 0.42 | 3.57 | 2.47 | 1.7 | 1.24 |
| 9.0372 | 38.73631 | 2019 | 12 | 29 | 14.77 | 16.93 | 9.59 | 9.5 | 23.58 | 8.81 | 15.27 | 4.45 | 2.5 | 1.16 | 1.15 | 5.61 | 3.66 | 3.3 | 2.25 |
| 9.0372 | 38.73631 | 2019 | 12 | 30 | 14.45 | 16.07 | 9.19 | 9.12 | 22.64 | 8.19 | 14.64 | 1.52 | 2.11 | 4.56 | 2.59 | 6.09 | 4.7 | 5.06 | 3.51 |
| 9.0372 | 38.73631 | 2019 | 12 | 31 | 16.18 | 15.21 | 7.38 | 7.32 | 22.82 | 6.64 | 13.99 | 1.76 | 2.07 | 4.3 | 2.58 | 6.06 | 4.65 | 4.93 | 3.41 |
| 9.0372 | 38.73631 | 2020 | 1 | 1 | 16.18 | 15.93 | 7.77 | 7.63 | 23.33 | 7.15 | 14.5 | 4.56 | 2.15 | 1.21 | 1.14 | 5.77 | 3.28 | 3.35 | 2.24 |
| 9.0372 | 38.73631 | 2020 | 1 | 2 | 15.44 | 16.32 | 9.28 | 9.2 | 23.06 | 7.62 | 14.92 | 3.15 | 1.59 | 3.49 | 2.35 | 6.65 | 3.94 | 4.69 | 3.16 |
| 9.0372 | 38.73631 | 2020 | 1 | 3 | 14.71 | 15.93 | 8.85 | 8.79 | 22.78 | 8.07 | 14.88 | 2.76 | 2.98 | 3.82 | 2.25 | 6.57 | 5.23 | 5.26 | 3.68 |
| 9.0372 | 38.73631 | 2020 | 1 | 4 | 15.87 | 16.15 | 8.41 | 8.34 | 23.5 | 7.63 | 14.98 | 2.03 | 2.48 | 4.22 | 2.61 | 6.24 | 5.08 | 5.09 | 3.47 |
| 9.0372 | 38.73631 | 2020 | 1 | 5 | 16.06 | 16.18 | 6.03 | 5.93 | 24.2 | 8.13 | 15.17 | 3.17 | 2.14 | 3.32 | 2.08 | 6.49 | 4.23 | 4.49 | 3.11 |
| 9.0372 | 38.73631 | 2020 | 1 | 6 | 16.86 | 16.14 | 6.78 | 6.66 | 23.95 | 7.09 | 14.85 | 2.82 | 1.32 | 3.48 | 2.51 | 6.3 | 3.83 | 4.52 | 3.08 |
| 9.0372 | 38.73631 | 2020 | 1 | 7 | 16.56 | 16.28 | 8.5 | 8.41 | 24.07 | 7.51 | 14.98 | 2.75 | 2.55 | 4.43 | 2.62 | 7.18 | 5.17 | 5.39 | 3.71 |
| 9.0372 | 38.73631 | 2020 | 1 | 8 | 15.64 | 16.21 | 7.41 | 7.19 | 24.51 | 8.87 | 15.02 | 1.94 | 2.81 | 5.19 | 2.81 | 7.12 | 5.62 | 5.85 | 4.02 |
| 9.0372 | 38.73631 | 2020 | 1 | 9 | 17.82 | 16.02 | 5.86 | 5.79 | 24.35 | 6.53 | 14.84 | 2.73 | 1.83 | 2.98 | 2.47 | 5.72 | 4.31 | 4.37 | 3.03 |
| 9.0372 | 38.73631 | 2020 | 1 | 10 | 16.18 | 17.38 | 7.02 | 6.82 | 24.05 | 7.86 | 15.9 | 3.57 | 2.56 | 0.44 | 0.2 | 4.01 | 2.76 | 1.81 | 1.3 |
| 9.0372 | 38.73631 | 2020 | 1 | 11 | 15.14 | 18.22 | 7.77 | 7.65 | 24.44 | 9.31 | 16.62 | 4.07 | 3.03 | 0.44 | 0.4 | 4.51 | 3.43 | 2.44 | 1.68 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.0372 | 38.73631 | 2020 | 1 | 12 | 12.69 | 18.02 | 10.14 | 10.04 | 23.21 | 10.52 | 15.93 | 3.85 | 3.12 | 1.66 | 1.72 | 5.5 | 4.85 | 3.69 | 2.67 |
| 9.0372 | 38.73631 | 2020 | 1 | 13 | 14 | 18.38 | 9.41 | 9.31 | 23.66 | 9.67 | 16.21 | 3.11 | 2.42 | 1.57 | 1.46 | 4.68 | 3.88 | 3.25 | 2.32 |
| 9.0372 | 38.73631 | 2020 | 1 | 14 | 16.8 | 17.28 | 7.76 | 7.61 | 25.42 | 8.61 | 15.56 | 3.15 | 3.21 | 3.23 | 1.96 | 6.39 | 5.18 | 4.62 | 3.26 |
| 9.0372 | 38.73631 | 2020 | 1 | 15 | 19.06 | 15.18 | 4.85 | 4.65 | 23.93 | 4.87 | 13.5 | 2.84 | 2.29 | 3.76 | 2.67 | 6.6 | 4.97 | 5.09 | 3.54 |
| 9.0372 | 38.73631 | 2020 | 1 | 16 | 19.74 | 15.6 | 3.51 | 3.29 | 24.7 | 4.97 | 13.81 | 4.88 | 2.71 | 1.32 | 1.22 | 6.2 | 3.93 | 3.98 | 2.67 |
| 9.0372 | 38.73631 | 2020 | 1 | 17 | 18.15 | 15.98 | 0.8 | 0.79 | 25.65 | 7.5 | 15.3 | 5.02 | 3.17 | 0.46 | 0.32 | 5.48 | 3.49 | 2.69 | 1.89 |
| 9.0372 | 38.73631 | 2020 | 1 | 18 | 17.04 | 15.99 | 0.34 | 0.34 | 25.71 | 8.68 | 15.52 | 5.9 | 3.63 | 0.24 | 0.17 | 6.14 | 3.79 | 2.7 | 1.91 |
| 9.0372 | 38.73631 | 2020 | 1 | 19 | 17.04 | 15.9 | -0.6 | -0.68 | 25.47 | 8.43 | 15.31 | 5.11 | 2.58 | 0.86 | 0.66 | 5.97 | 3.24 | 2.66 | 1.86 |
| 9.0372 | 38.73631 | 2020 | 1 | 20 | 18.03 | 16.01 | 1.67 | 1.61 | 25.37 | 7.33 | 15.09 | 3.1 | 1.53 | 2.37 | 1.74 | 5.47 | 3.27 | 3.4 | 2.47 |
| 9.0372 | 38.73631 | 2020 | 1 | 21 | 17.99 | 16.82 | 4 | 3.95 | 25.19 | 7.2 | 15.47 | 3.67 | 2.62 | 0.21 | 0.26 | 3.89 | 2.88 | 2.34 | 1.69 |
| 9.0372 | 38.73631 | 2020 | 1 | 22 | 17.2 | 16.85 | 5.22 | 5.13 | 23.95 | 6.75 | 15.18 | 1.5 | 2.13 | 2.64 | 1.68 | 4.14 | 3.81 | 3.29 | 2.5 |
| 9.0372 | 38.73631 | 2020 | 1 | 23 | 13.65 | 17.51 | 7.49 | 7.39 | 22.69 | 9.04 | 15.67 | 3.43 | 3.8 | 2.14 | 1.27 | 5.57 | 5.08 | 3.64 | 2.77 |
| 9.0372 | 38.73631 | 2020 | 1 | 24 | 14.18 | 17.45 | 9.07 | 8.98 | 22.77 | 8.59 | 15.55 | 2.46 | 3.06 | 2.48 | 1.47 | 4.94 | 4.53 | 3.72 | 2.79 |
| 9.0372 | 38.73631 | 2020 | 1 | 25 | 14.98 | 18.79 | 10.04 | 9.92 | 24.51 | 9.53 | 16.62 | 2.01 | 2.08 | 2.02 | 1.66 | 4.03 | 3.74 | 3.11 | 2.28 |
| 9.0372 | 38.73631 | 2020 | 1 | 26 | 14.65 | 19.71 | 9.91 | 9.77 | 25.54 | 10.89 | 17.28 | 3.2 | 2.07 | 0.99 | 1.34 | 4.19 | 3.41 | 2.8 | 2.27 |
| 9.0372 | 38.73631 | 2020 | 1 | 27 | 13.83 | 18.82 | 10.18 | 10.09 | 24.02 | 10.19 | 16.44 | 4.14 | 2.58 | 1.33 | 1.65 | 5.47 | 4.23 | 3.51 | 2.83 |
| 9.0372 | 38.73631 | 2020 | 1 | 28 | 12.87 | 20.2 | 10.91 | 10.79 | 24.91 | 12.04 | 17.76 | 4.29 | 2.48 | 0.07 | 0.18 | 4.37 | 2.66 | 2.2 | 1.56 |
| 9.0372 | 38.73631 | 2020 | 1 | 29 | 14.23 | 19.95 | 9.37 | 9.21 | 25.67 | 11.44 | 17.68 | 3.96 | 2.63 | 0.13 | 0.18 | 4.09 | 2.82 | 1.62 | 1.04 |
| 9.0372 | 38.73631 | 2020 | 1 | 30 | 16.77 | 19.55 | 8.61 | 8.48 | 26.17 | 9.4 | 17.23 | 3.54 | 2.34 | 1.87 | 1.16 | 5.41 | 3.5 | 3.37 | 2.57 |
| 9.0372 | 38.73631 | 2020 | 1 | 31 | 12.97 | 20.19 | 9.98 | 9.84 | 24.55 | 11.57 | 17.62 | 3.91 | 3.7 | 0.15 | 0.1 | 4.06 | 3.81 | 2.01 | 1.57 |
| 9.0372 | 38.73631 | 2020 | 2 | 1 | 11.86 | 19.33 | 10.88 | 10.79 | 23.51 | 11.65 | 17.04 | 2.71 | 2.45 | 0.07 | 0.16 | 2.79 | 2.61 | 1.42 | 1.1 |
| 9.0372 | 38.73631 | 2020 | 2 | 2 | 9.7 | 18.79 | 10.78 | 10.66 | 22.76 | 13.05 | 17.01 | 4.28 | 3.52 | 0.48 | 0.41 | 4.76 | 3.93 | 2.78 | 2.2 |
| 9.0372 | 38.73631 | 2020 | 2 | 3 | 9.92 | 18 | 10.04 | 9.95 | 21.92 | 12.01 | 16.15 | 1.82 | 2.2 | 2.93 | 2.02 | 4.74 | 4.22 | 3.58 | 2.71 |
| 9.0372 | 38.73631 | 2020 | 2 | 4 | 13.34 | 19.17 | 9.98 | 9.87 | 23.79 | 10.45 | 16.69 | 2.81 | 2.51 | 1.16 | 1.09 | 3.97 | 3.6 | 2.82 | 2.01 |
| 9.0372 | 38.73631 | 2020 | 2 | 5 | 11.26 | 18.88 | 10.12 | 10.02 | 23.3 | 12.05 | 16.69 | 3.57 | 2.73 | 0.97 | 0.59 | 4.55 | 3.31 | 2.95 | 2.19 |
| 9.0372 | 38.73631 | 2020 | 2 | 6 | 13.66 | 18.38 | 8.89 | 8.81 | 24.05 | 10.39 | 16.33 | 4.28 | 2.97 | 2.16 | 1.36 | 6.44 | 4.33 | 4.29 | 3.1 |
| 9.0372 | 38.73631 | 2020 | 2 | 7 | 16.78 | 18.08 | 7.53 | 7.47 | 25.33 | 8.55 | 16.08 | 3.61 | 3.76 | 4.02 | 2.37 | 7.63 | 6.13 | 5.5 | 3.95 |
| 9.0372 | 38.73631 | 2020 | 2 | 8 | 17.15 | 17.23 | 4.92 | 4.81 | 25.38 | 8.23 | 15.72 | 3.73 | 4.77 | 4.51 | 2.58 | 8.24 | 7.35 | 6.54 | 4.71 |
| 9.0372 | 38.73631 | 2020 | 2 | 9 | 18.1 | 17.4 | 3.26 | 3.26 | 25.73 | 7.64 | 15.82 | 2.86 | 3.21 | 4.58 | 2.87 | 7.44 | 6.08 | 5.95 | 4.15 |
| 9.0372 | 38.73631 | 2020 | 2 | 10 | 19.06 | 19.07 | 6.57 | 6.46 | 26.64 | 7.58 | 16.87 | 3.76 | 2.41 | 2.04 | 1.75 | 5.8 | 4.16 | 3.86 | 2.65 |
| 9.0372 | 38.73631 | 2020 | 2 | 11 | 16.85 | 20.52 | 8.52 | 8.3 | 26.56 | 9.71 | 18.02 | 2.59 | 2.38 | 1.33 | 1.26 | 3.92 | 3.64 | 2.79 | 2.06 |
| 9.0372 | 38.73631 | 2020 | 2 | 12 | 10.43 | 18.65 | 10.48 | 10.39 | 22.29 | 11.86 | 16.44 | 3.94 | 3.38 | 2.05 | 1.98 | 5.99 | 5.35 | 4.03 | 3.12 |
| 9.0372 | 38.73631 | 2020 | 2 | 13 | 13.43 | 18.35 | 9.62 | 9.55 | 23.53 | 10.1 | 16.02 | 3.12 | 2.31 | 3.23 | 2.38 | 6.35 | 4.7 | 4.67 | 3.79 |
| 9.0372 | 38.73631 | 2020 | 2 | 14 | 14.21 | 17.98 | 7.61 | 7.5 | 24.27 | 10.06 | 15.77 | 2.24 | 3.94 | 4.96 | 2.89 | 7.2 | 6.83 | 6.36 | 4.86 |
| 9.0372 | 38.73631 | 2020 | 2 | 15 | 17.61 | 18.23 | 6.07 | 6.03 | 25.44 | 7.83 | 15.92 | 2.32 | 2.38 | 4.11 | 2.65 | 6.42 | 5.03 | 5.18 | 3.58 |
| 9.0372 | 38.73631 | 2020 | 2 | 16 | 18.08 | 19.65 | 7.01 | 6.9 | 26.57 | 8.49 | 17.17 | 2.93 | 1.87 | 2.61 | 1.98 | 5.55 | 3.85 | 3.98 | 2.69 |
| 9.0372 | 38.73631 | 2020 | 2 | 17 | 17.18 | 20.63 | 7.58 | 7.52 | 27.44 | 10.27 | 18.35 | 2.62 | 2.73 | 3.26 | 1.97 | 5.88 | 4.7 | 4.14 | 2.99 |
| 9.0372 | 38.73631 | 2020 | 2 | 18 | 14.97 | 20.24 | 7.94 | 7.93 | 26.6 | 11.63 | 18.3 | 4.56 | 3.88 | 1.83 | 1.25 | 6.39 | 5.14 | 4.29 | 3.16 |
| 9.0372 | 38.73631 | 2020 | 2 | 19 | 16.56 | 19.72 | 8.11 | 8.05 | 26.68 | 10.12 | 17.62 | 2.46 | 2.64 | 3.71 | 2.25 | 6.17 | 4.89 | 4.9 | 3.5 |
| 9.0372 | 38.73631 | 2020 | 2 | 20 | 17.53 | 19.72 | 6.07 | 6.01 | 27.02 | 9.49 | 17.62 | 4.45 | 2.87 | 3.31 | 2.17 | 7.76 | 5.04 | 4.96 | 3.67 |
| 9.0372 | 38.73631 | 2020 | 2 | 21 | 18.01 | 19.74 | 6.97 | 6.82 | 27.04 | 9.03 | 17.34 | 3.12 | 2.16 | 4.31 | 2.97 | 7.44 | 5.13 | 5.61 | 3.96 |
| 9.0372 | 38.73631 | 2020 | 2 | 22 | 16.42 | 19.14 | 7.87 | 7.82 | 25.83 | 9.41 | 16.86 | 1.75 | 3.3 | 5.53 | 3.04 | 7.29 | 6.34 | 6.26 | 4.46 |
| 9.0372 | 38.73631 | 2020 | 2 | 23 | 17.37 | 18.98 | 6.78 | 6.71 | 26.34 | 8.97 | 16.8 | 1.85 | 3.41 | 5.6 | 2.99 | 7.46 | 6.39 | 6.42 | 4.55 |
| 9.0372 | 38.73631 | 2020 | 2 | 24 | 17.39 | 19.22 | 4.93 | 4.87 | 26.81 | 9.42 | 17.14 | 1.71 | 2.82 | 3.96 | 2.28 | 5.67 | 5.1 | 4.74 | 3.44 |
| 9.0372 | 38.73631 | 2020 | 2 | 25 | 15.24 | 21.48 | 6.09 | 6 | 27.12 | 11.88 | 18.7 | 2.75 | 1.23 | 1.13 | 1.1 | 3.88 | 2.33 | 2.35 | 1.65 |
| 9.0372 | 38.73631 | 2020 | 2 | 26 | 16.42 | 20.25 | 8.26 | 8.19 | 26.25 | 9.83 | 17.83 | 3.34 | 3.47 | 3.33 | 2.37 | 6.68 | 5.84 | 5.23 | 3.9 |
| 9.0372 | 38.73631 | 2020 | 2 | 27 | 18.07 | 21.22 | 8.29 | 8.15 | 28.13 | 10.06 | 18.64 | 3.67 | 3.11 | 4.02 | 2.33 | 7.69 | 5.44 | 5.34 | 4.15 |
| 9.0372 | 38.73631 | 2020 | 2 | 28 | 17.41 | 21.21 | 6.84 | 6.55 | 28.21 | 10.79 | 18.57 | 2.12 | 2.72 | 2.82 | 1.77 | 4.94 | 4.48 | 3.92 | 2.79 |
| 9.0372 | 38.73631 | 2020 | 2 | 29 | 17.37 | 21.75 | 3.25 | 3.15 | 28.45 | 11.09 | 19.31 | 2.66 | 2.18 | 1.33 | 0.84 | 3.99 | 3.02 | 2.54 | 1.79 |
| 9.0372 | 38.73631 | 2020 | 3 | 1 | 16.45 | 22.53 | 4.16 | 4.12 | 28.72 | 12.27 | 19.92 | 3.12 | 2.53 | 1.47 | 0.97 | 4.59 | 3.5 | 2.91 | 2.15 |
| 9.0372 | 38.73631 | 2020 | 3 | 2 | 16.6 | 22.88 | 5.51 | 5.52 | 28.77 | 12.18 | 19.87 | 3.79 | 2.55 | 1.36 | 0.86 | 5.15 | 3.41 | 2.97 | 2.15 |
| 9.0372 | 38.73631 | 2020 | 3 | 3 | 16.81 | 22.58 | 6.09 | 6.03 | 28.69 | 11.88 | 19.68 | 2.82 | 3.31 | 3.56 | 1.83 | 6.37 | 5.14 | 4.4 | 3.23 |
| 9.0372 | 38.73631 | 2020 | 3 | 4 | 16.02 | 22.58 | 8.02 | 7.96 | 28.19 | 12.17 | 19.73 | 2.66 | 3.37 | 2.23 | 1.17 | 4.88 | 4.54 | 3.75 | 2.77 |
| 9.0372 | 38.73631 | 2020 | 3 | 5 | 14.4 | 22.86 | 8.8 | 8.7 | 27.88 | 13.47 | 19.96 | 3.15 | 3 | 0.5 | 0.37 | 3.66 | 3.37 | 2.56 | 2.09 |
| 9.0372 | 38.73631 | 2020 | 3 | 6 | 12.14 | 22.65 | 8.7 | 8.6 | 26.39 | 14.25 | 20 | 3.33 | 3.3 | 0.83 | 0.44 | 4.17 | 3.74 | 2.15 | 1.6 |
| 9.0372 | 38.73631 | 2020 | 3 | 7 | 10.9 | 21.78 | 8.78 | 8.7 | 25.01 | 14.11 | 19.5 | 4.19 | 4.45 | 1.87 | 0.99 | 6.06 | 5.44 | 3.71 | 2.71 |
| 9.0372 | 38.73631 | 2020 | 3 | 8 | 16.24 | 22.61 | 7.07 | 7.08 | 28.3 | 12.05 | 19.9 | 1.81 | 2.32 | 3.55 | 2.21 | 5.36 | 4.53 | 4.32 | 3.14 |
| 9.0372 | 38.73631 | 2020 | 3 | 9 | 18.04 | 23.53 | 5.63 | 5.65 | 30.39 | 12.35 | 20.76 | 2.91 | 2.45 | 1.76 | 1.51 | 4.67 | 3.96 | 3.22 | 2.37 |
| 9.0372 | 38.73631 | 2020 | 3 | 10 | 16.1 | 23.75 | 7.68 | 7.63 | 29.32 | 13.23 | 20.59 | 5.04 | 3.75 | 1.15 | 0.73 | 6.2 | 4.48 | 3.11 | 2.41 |
| 9.0372 | 38.73631 | 2020 | 3 | 11 | 13.71 | 21.86 | 9.58 | 9.48 | 27.21 | 13.5 | 18.93 | 4.76 | 4.45 | 1.26 | 0.78 | 6.02 | 5.24 | 3.39 | 2.87 |
| 9.0372 | 38.73631 | 2020 | 3 | 12 | 12.18 | 21.46 | 10.21 | 10.12 | 25.91 | 13.73 | 18.89 | 2.88 | 2.64 | 2.38 | 1.68 | 5.26 | 4.33 | 3.89 | 3.04 |
| 9.0372 | 38.73631 | 2020 | 3 | 13 | 14.89 | 24.34 | 8.67 | 8.61 | 29.22 | 14.33 | 20.86 | 4.36 | 3.24 | 0.3 | 0.29 | 4.66 | 3.53 | 2.19 | 1.67 |
| 9.0372 | 38.73631 | 2020 | 3 | 14 | 10.78 | 21.42 | 10.35 | 10.29 | 24.9 | 14.12 | 19.08 | 2.48 | 3.14 | 2.66 | 1.59 | 5.15 | 4.74 | 3.83 | 2.96 |
| 9.0372 | 38.73631 | 2020 | 3 | 15 | 10.3 | 20.82 | 11.71 | 11.6 | 24.85 | 14.55 | 18.92 | 2.8 | 2.89 | 1.79 | 1.27 | 4.59 | 4.16 | 3.23 | 2.38 |
| 9.0372 | 38.73631 | 2020 | 3 | 16 | 9.47 | 19.5 | 12.65 | 12.57 | 23.64 | 14.17 | 17.84 | 2.97 | 3.36 | 1.7 | 0.87 | 4.67 | 4.23 | 3.25 | 2.41 |
| 9.0372 | 38.73631 | 2020 | 3 | 17 | 9.17 | 18.92 | 12.46 | 12.4 | 23 | 13.83 | 17.11 | 4.53 | 4.28 | 1.13 | 0.59 | 5.66 | 4.87 | 3.4 | 2.61 |
| 9.0372 | 38.73631 | 2020 | 3 | 18 | 12.72 | 20.21 | 10.99 | 10.86 | 25.94 | 13.22 | 18.34 | 4.99 | 4.16 | 0.4 | 0.25 | 5.39 | 4.41 | 3.48 | 2.62 |
| 9.0372 | 38.73631 | 2020 | 3 | 19 | 14.88 | 20.42 | 10.89 | 10.77 | 26.45 | 11.57 | 18.44 | 2.81 | 3.74 | 3.39 | 1.99 | 6.2 | 5.73 | 5.18 | 3.74 |
| 9.0372 | 38.73631 | 2020 | 3 | 20 | 12.39 | 20.53 | 11.89 | 11.76 | 25.55 | 13.16 | 18.51 | 5.11 | 4.67 | 1.02 | 0.76 | 6.13 | 5.43 | 3.08 | 2.34 |
| 9.0372 | 38.73631 | 2020 | 3 | 21 | 7.51 | 18.39 | 12.41 | 12.34 | 21.78 | 14.26 | 16.99 | 3.85 | 3.16 | 0.4 | 0.4 | 4.25 | 3.56 | 2.62 | 1.87 |
| 9.0372 | 38.73631 | 2020 | 3 | 22 | 9.33 | 17.91 | 12.12 | 12.05 | 22.24 | 12.92 | 16.78 | 2.04 | 2.05 | 1.37 | 0.87 | 3.42 | 2.92 | 2.45 | 1.7 |
| 9.0372 | 38.73631 | 2020 | 3 | 23 | 9.25 | 18.17 | 11.99 | 11.92 | 22.04 | 12.79 | 16.78 | 2.29 | 1.6 | 1.31 | 0.82 | 3.6 | 2.42 | 2.24 | 1.65 |
| 9.0372 | 38.73631 | 2020 | 3 | 24 | 15.02 | 21.12 | 10.15 | 9.9 | 27.1 | 12.08 | 18.94 | 2.71 | 2.27 | 0.11 | 0.15 | 2.81 | 2.43 | 1.66 | 1.26 |
| 9.0372 | 38.73631 | 2020 | 3 | 25 | 15.04 | 20.68 | 7.78 | 7.38 | 27.85 | 12.81 | 19.17 | 3.42 | 3.07 | 0.32 | 0.27 | 3.74 | 3.34 | 2.18 | 1.77 |
| 9.0372 | 38.73631 | 2020 | 3 | 26 | 15.67 | 21.19 | 7.96 | 7.59 | 27.28 | 11.62 | 18.16 | 6.17 | 4.29 | 0.21 | 0.2 | 6.38 | 4.49 | 3 | 2.12 |
| 9.0372 | 38.73631 | 2020 | 3 | 27 | 16.79 | 20.62 | 6.42 | 6.38 | 27.12 | 10.33 | 17.94 | 4.57 | 2.42 | 2.12 | 1.97 | 6.69 | 4.39 | 3.88 | 2.73 |
| 9.0372 | 38.73631 | 2020 | 3 | 28 | 17.72 | 20.77 | 7.83 | 7.73 | 27.82 | 10.1 | 18.41 | 2.5 | 1.55 | 2.39 | 1.78 | 4.89 | 3.33 | 3.53 | 2.46 |
| 9.0372 | 38.73631 | 2020 | 3 | 29 | 16.08 | 21.49 | 7.21 | 7.15 | 28.6 | 12.52 | 19.35 | 5.99 | 4.62 | 0.87 | 0.62 | 6.87 | 5.23 | 3.84 | 2.78 |
| 9.0372 | 38.73631 | 2020 | 3 | 30 | 17.72 | 21.49 | 8.1 | 7.91 | 28.91 | 11.2 | 19.12 | 4.05 | 3.31 | 3.39 | 2.09 | 7.44 | 5.4 | 4.7 | 3.45 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.0372 | 38.73631 | 2020 | 3 | 31 | 16.97 | 20.69 | 9.03 | 8.81 | 28.02 | 11.05 | 18.54 | 4.02 | 4.88 | 4.07 | 2.23 | 8.1 | 7.11 | 6.07 | 4.41 |
| 9.0372 | 38.73631 | 2020 | 4 | 1 | 15.23 | 19.91 | 10 | 9.82 | 26.76 | 11.52 | 18.09 | 3.22 | 4.15 | 4.48 | 2.46 | 7.71 | 6.61 | 6.15 | 4.35 |
| 9.0372 | 38.73631 | 2020 | 4 | 2 | 15.35 | 20.4 | 9.49 | 9.29 | 26.37 | 11.02 | 18.31 | 3.01 | 3.26 | 3.77 | 2.19 | 6.78 | 5.45 | 5.18 | 3.71 |
| 9.0372 | 38.73631 | 2020 | 4 | 3 | 16.13 | 21.04 | 9.27 | 9.13 | 27.81 | 11.68 | 18.86 | 4.73 | 5.11 | 3.41 | 2.01 | 8.14 | 7.11 | 5.87 | 4.39 |
| 9.0372 | 38.73631 | 2020 | 4 | 4 | 14.37 | 20.65 | 9.78 | 9.64 | 26.54 | 12.17 | 18.4 | 2.32 | 3.55 | 4.9 | 2.61 | 7.21 | 6.16 | 6.01 | 4.31 |
| 9.0372 | 38.73631 | 2020 | 4 | 5 | 17.12 | 20.75 | 8.97 | 8.83 | 27.68 | 10.56 | 18.42 | 2.96 | 4.45 | 4.79 | 2.54 | 7.75 | 6.99 | 6.42 | 4.65 |
| 9.0372 | 38.73631 | 2020 | 4 | 6 | 16.61 | 20.94 | 7.65 | 7.36 | 27.86 | 11.25 | 18.49 | 2.95 | 4.14 | 4.67 | 2.64 | 7.62 | 6.78 | 6.39 | 4.56 |
| 9.0372 | 38.73631 | 2020 | 4 | 7 | 17.98 | 21.12 | 5.91 | 5.82 | 28.13 | 10.15 | 18.58 | 2.44 | 3.22 | 4.91 | 2.65 | 7.35 | 5.87 | 5.98 | 4.23 |
| 9.0372 | 38.73631 | 2020 | 4 | 8 | 17.95 | 21.37 | 6.68 | 6.67 | 28.37 | 10.42 | 18.95 | 2.71 | 3.61 | 4.64 | 2.53 | 7.35 | 6.14 | 5.88 | 4.09 |
| 9.0372 | 38.73631 | 2020 | 4 | 9 | 18.36 | 22.19 | 7.61 | 7.49 | 29.07 | 10.71 | 19.46 | 3.46 | 3.38 | 3.68 | 2.2 | 7.14 | 5.59 | 5.28 | 3.65 |
| 9.0372 | 38.73631 | 2020 | 4 | 10 | 15.92 | 22.72 | 7.31 | 7.28 | 29.08 | 13.16 | 20.18 | 3.68 | 4.08 | 3.08 | 1.74 | 6.77 | 5.82 | 5.02 | 3.66 |
| 9.0372 | 38.73631 | 2020 | 4 | 11 | 17.13 | 22.16 | 7.87 | 7.89 | 28.68 | 11.55 | 19.58 | 3.72 | 4.05 | 3.29 | 2.06 | 7.01 | 6.11 | 5.03 | 3.88 |
| 9.0372 | 38.73631 | 2020 | 4 | 12 | 14.54 | 20.31 | 10.73 | 10.61 | 26.24 | 11.69 | 18.51 | 2.22 | 3.27 | 3.92 | 2.11 | 6.14 | 5.38 | 4.95 | 3.54 |
| 9.0372 | 38.73631 | 2020 | 4 | 13 | 9.76 | 18.54 | 12.42 | 12.35 | 23.42 | 13.66 | 17.48 | 5.49 | 5.53 | 2.19 | 1.28 | 7.68 | 6.81 | 4.57 | 3.4 |
| 9.0372 | 38.73631 | 2020 | 4 | 14 | 14.92 | 20.73 | 12 | 11.86 | 26.27 | 11.35 | 18.5 | 3 | 2.77 | 1.9 | 1.37 | 4.9 | 4.13 | 3.29 | 2.48 |
| 9.0372 | 38.73631 | 2020 | 4 | 15 | 5.55 | 18.03 | 12.98 | 12.91 | 20.31 | 14.75 | 17.23 | 3.53 | 3.34 | 0.5 | 0.27 | 4.03 | 3.61 | 2.61 | 1.93 |
| 9.0372 | 38.73631 | 2020 | 4 | 16 | 13.11 | 20.22 | 11.53 | 11.33 | 25.51 | 12.4 | 18.21 | 2.71 | 2.88 | 1.29 | 0.79 | 4.01 | 3.67 | 2.58 | 1.97 |
| 9.0372 | 38.73631 | 2020 | 4 | 17 | 7.65 | 18.79 | 12.64 | 12.56 | 21.3 | 13.66 | 17.02 | 1.77 | 1.32 | 0.46 | 0.38 | 2.23 | 1.7 | 1.4 | 1 |
| 9.0372 | 38.73631 | 2020 | 4 | 18 | 7.83 | 18.13 | 12.77 | 12.72 | 21.44 | 13.61 | 16.71 | 1.52 | 1.53 | 0.7 | 0.43 | 2.22 | 1.96 | 1.79 | 1.3 |
| 9.0372 | 38.73631 | 2020 | 4 | 19 | 6.62 | 16.24 | 11.4 | 11.34 | 19.45 | 12.82 | 15.27 | 3.13 | 3.31 | 1.53 | 0.9 | 4.66 | 4.21 | 3.37 | 2.46 |
| 9.0372 | 38.73631 | 2020 | 4 | 20 | 8.7 | 16.65 | 11.39 | 11.32 | 20 | 11.3 | 15.89 | 3.38 | 3 | 0.72 | 0.53 | 4.1 | 3.54 | 2.36 | 1.81 |
| 9.0372 | 38.73631 | 2020 | 4 | 21 | 12.02 | 18.34 | 11.09 | 10.94 | 23.19 | 11.17 | 17.08 | 2.93 | 2.54 | 0.73 | 0.5 | 3.66 | 3.05 | 2.4 | 1.72 |
| 9.0372 | 38.73631 | 2020 | 4 | 22 | 10.58 | 18.86 | 11.98 | 11.89 | 22.84 | 12.26 | 16.96 | 3.81 | 2.3 | 0.85 | 0.81 | 4.66 | 3.11 | 2.48 | 1.76 |
| 9.0372 | 38.73631 | 2020 | 4 | 23 | 9.27 | 18.45 | 12.4 | 12.34 | 22.16 | 12.88 | 16.82 | 1.86 | 1.44 | 2.11 | 1.4 | 3.97 | 2.84 | 2.81 | 1.98 |
| 9.0372 | 38.73631 | 2020 | 4 | 24 | 8.28 | 17.72 | 11.65 | 11.55 | 21.36 | 13.09 | 16.38 | 2.52 | 2.06 | 1.09 | 0.94 | 3.61 | 2.99 | 2.17 | 1.51 |
| 9.0372 | 38.73631 | 2020 | 4 | 25 | 13.18 | 19.43 | 11.07 | 10.96 | 24.97 | 11.79 | 17.74 | 1.89 | 2.28 | 2.66 | 1.59 | 4.55 | 3.87 | 3.66 | 2.75 |
| 9.0372 | 38.73631 | 2020 | 4 | 26 | 11.1 | 18.86 | 12.2 | 12.08 | 23.71 | 12.61 | 17.53 | 1.75 | 1.93 | 1.64 | 1.08 | 3.4 | 3.01 | 2.78 | 1.97 |
| 9.0372 | 38.73631 | 2020 | 4 | 27 | 10.04 | 19.08 | 12.66 | 12.58 | 23.15 | 13.11 | 17.49 | 3.01 | 2.03 | 0.64 | 0.43 | 3.65 | 2.45 | 2.34 | 1.59 |
| 9.0372 | 38.73631 | 2020 | 4 | 28 | 6.72 | 16.95 | 13.25 | 13.24 | 19.81 | 13.09 | 16.21 | 2.82 | 1.36 | 0.32 | 0.26 | 3.15 | 1.61 | 1.53 | 0.96 |
| 9.0372 | 38.73631 | 2020 | 4 | 29 | 9.35 | 18.46 | 13.18 | 13.11 | 22.7 | 13.34 | 17.73 | 1.68 | 0.99 | 1.38 | 0.95 | 3.06 | 1.94 | 1.98 | 1.48 |
| 9.0372 | 38.73631 | 2020 | 4 | 30 | 6.84 | 17.03 | 13.41 | 15.12 | 20.68 | 13.84 | 16.84 | 1.91 | 1.83 | 1.17 | 0.77 | 3.08 | 2.61 | 1.97 | 1.45 |
| 9.0372 | 38.73631 | 2020 | 5 | 1 | 7.49 | 17.67 | 13.43 | 15.26 | 21.26 | 13.77 | 17.09 | 2.87 | 1.94 | 0.2 | 0.15 | 3.08 | 2.09 | 1.74 | 1.24 |
| 9.0372 | 38.73631 | 2020 | 5 | 2 | 8.94 | 17.91 | 12.89 | 15.14 | 22.18 | 13.24 | 17.39 | 1.69 | 1.6 | 0.85 | 0.61 | 2.54 | 2.21 | 1.75 | 1.38 |
| 9.0372 | 38.73631 | 2020 | 5 | 3 | 8.91 | 17.01 | 12.4 | 14.3 | 21.32 | 12.41 | 16.2 | 3.55 | 3.6 | 1.93 | 1.24 | 5.49 | 4.84 | 3.61 | 2.7 |
| 9.0372 | 38.73631 | 2020 | 5 | 4 | 11.31 | 17.63 | 11.89 | 14.36 | 23.24 | 11.93 | 16.84 | 3.28 | 3.1 | 1.91 | 1.24 | 5.19 | 4.35 | 3.86 | 2.76 |
| 9.0372 | 38.73631 | 2020 | 5 | 5 | 11.94 | 17.59 | 12.13 | 14.36 | 23.21 | 11.28 | 16.59 | 3.09 | 3.17 | 2.18 | 1.56 | 5.28 | 4.73 | 4.06 | 2.86 |
| 9.0372 | 38.73631 | 2020 | 5 | 6 | 13.46 | 17.29 | 9.94 | 13.21 | 23.96 | 10.5 | 16.47 | 2.81 | 2.92 | 2.99 | 1.71 | 5.8 | 4.63 | 4.14 | 2.94 |
| 9.0372 | 38.73631 | 2020 | 5 | 7 | 14.38 | 16.57 | 11.56 | 13.65 | 22.7 | 8.31 | 15.75 | 2.96 | 3.49 | 3.43 | 2.2 | 6.38 | 5.69 | 4.86 | 3.51 |
| 9.0372 | 38.73631 | 2020 | 5 | 8 | 9.75 | 17.54 | 12.25 | 14.47 | 22.15 | 12.41 | 16.69 | 2.29 | 2.87 | 3.82 | 2.01 | 6.11 | 4.88 | 4.95 | 3.4 |
| 9.0372 | 38.73631 | 2020 | 5 | 9 | 12.4 | 17.74 | 12.57 | 14.65 | 23.41 | 11 | 16.74 | 2.39 | 3.19 | 3.35 | 2.01 | 5.74 | 5.2 | 4.73 | 3.41 |
| 9.0372 | 38.73631 | 2020 | 5 | 10 | 6.1 | 14.29 | 11.29 | 12.75 | 17.26 | 11.16 | 14.21 | 2.47 | 3.07 | 2.95 | 1.56 | 5.42 | 4.63 | 4.19 | 2.87 |
| 9.0372 | 38.73631 | 2020 | 5 | 11 | 11.46 | 16 | 11.47 | 13.54 | 21.97 | 10.51 | 15.61 | 3.44 | 3.87 | 2.56 | 1.37 | 6 | 5.23 | 4.86 | 3.36 |
| 9.0372 | 38.73631 | 2020 | 5 | 12 | 14.86 | 16.14 | 9.77 | 12.7 | 23.97 | 9.1 | 15.62 | 3.5 | 4.26 | 4.33 | 2.43 | 7.83 | 6.69 | 6.17 | 4.29 |
| 9.0372 | 38.73631 | 2020 | 5 | 13 | 14.17 | 16.04 | 10.35 | 13.03 | 23.19 | 9.02 | 15.7 | 4.58 | 4.99 | 4.47 | 2.65 | 9.04 | 7.64 | 6.35 | 4.54 |
| 9.0372 | 38.73631 | 2020 | 5 | 14 | 14.35 | 17.12 | 11.28 | 13.92 | 24.32 | 9.97 | 16.56 | 2.8 | 3.43 | 3.56 | 2.26 | 6.36 | 5.69 | 5.19 | 3.69 |

# Appendix 3: Temperature Record of Concrete Roof Building

Data Report

File created on: 08/06/2020 07:42:31

Device Info

| | | | |
|---|---|---|---|
| Model | RC-5+ | Probe Type | Temperature (Internal) |
| S/N | EFI193B01019 | Firmware | V1.4 |

Trip Description

| | |
|---|---|
| Trip Number | 0000001 |
| Trip Description | EEU Adama CR temperature recording. |

Config. info

| | | | |
|---|---|---|---|
| Start Mode | Immediate | Log Interval | 1:0:0 |
| Start Delay | 0H0M | Multi-boot | Enable |
| Time Zone | UTC +03:00 | Stop Mode | Press Button |

Mark Time

N/A

| Alarm Threshold | Alarm Delay | Over-limit duration | Out-of-limit Times | Alarm Status |
|---|---|---|---|---|

Summary

| | | | |
|---|---|---|---|
| Max | 34.7°C/N/A°C | Start Time | 30/09/2019 11:38:20 |
| Min | 20.4°C/N/A°C | Stop Time | 14/05/2020 10:38:20(Stop by button) |
| Avg | 26.0°C/N/A°C | Elapsed Time | 226D 23H 0M 0S |
| Mean Kinetic Temperature (MKT) 26.4°C | | Total Points | 5448 |

| No. | Time | CR Temperature (ºC) |
|---|---|---|
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| 439 | 18/10/2019 17:38:20 | 26.3 |
| 440 | 18/10/2019 18:38:20 | 25.7 |
| 441 | 18/10/2019 19:38:20 | 25.4 |
| 442 | 18/10/2019 20:38:20 | 25 |
| 443 | 18/10/2019 21:38:20 | 24.5 |
| 444 | 18/10/2019 22:38:20 | 24.3 |
| 445 | 18/10/2019 23:38:20 | 24.3 |
| 446 | 19/10/2019 00:38:20 | 23.8 |
| 447 | 19/10/2019 01:38:20 | 23.8 |
| 448 | 19/10/2019 02:38:20 | 23.7 |
| 449 | 19/10/2019 03:38:20 | 23.4 |
| 450 | 19/10/2019 04:38:20 | 23.4 |
| 451 | 19/10/2019 05:38:20 | 22.9 |
| 452 | 19/10/2019 06:38:20 | 22.9 |
| 453 | 19/10/2019 07:38:20 | 23 |
| 454 | 19/10/2019 08:38:20 | 23.5 |
| 455 | 19/10/2019 09:38:20 | 23.7 |
| 456 | 19/10/2019 10:38:20 | 24.3 |
| 457 | 19/10/2019 11:38:20 | 25 |
| 458 | 19/10/2019 12:38:20 | 25.4 |
| 459 | 19/10/2019 13:38:20 | 25.5 |
| 460 | 19/10/2019 14:38:20 | 26.1 |
| 461 | 19/10/2019 15:38:20 | 27.2 |
| 462 | 19/10/2019 16:38:20 | 26.3 |
| 463 | 19/10/2019 17:38:20 | 25.9 |
| 464 | 19/10/2019 18:38:20 | 24.9 |
| 465 | 19/10/2019 19:38:20 | 25 |
| 466 | 19/10/2019 20:38:20 | 24.9 |
| 467 | 19/10/2019 21:38:20 | 24.7 |
| 468 | 19/10/2019 22:38:20 | 24.5 |
| 469 | 19/10/2019 23:38:20 | 24.4 |
| 470 | 20/10/2019 00:38:20 | 24.3 |
| 471 | 20/10/2019 01:38:20 | 24.1 |
| 472 | 20/10/2019 02:38:20 | 23.9 |
| 473 | 20/10/2019 03:38:20 | 23.7 |
| 474 | 20/10/2019 04:38:20 | 23.5 |
| 475 | 20/10/2019 05:38:20 | 23.3 |
| 476 | 20/10/2019 06:38:20 | 23.1 |
| 477 | 20/10/2019 07:38:20 | 23 |
| 478 | 20/10/2019 08:38:20 | 23.3 |
| 479 | 20/10/2019 09:38:20 | 23.7 |
| 480 | 20/10/2019 10:38:20 | 24.2 |
| 481 | 20/10/2019 11:38:20 | 25 |
| 482 | 20/10/2019 12:38:20 | 25.8 |
| 483 | 20/10/2019 13:38:20 | 26.4 |
| 484 | 20/10/2019 14:38:20 | 26.5 |
| 485 | 20/10/2019 15:38:20 | 28 |
| 486 | 20/10/2019 16:38:20 | 28.7 |
| 487 | 20/10/2019 17:38:20 | 28.3 |
| 488 | 20/10/2019 18:38:20 | 26.8 |
| 489 | 20/10/2019 19:38:20 | 25.9 |
| 490 | 20/10/2019 20:38:20 | 25.7 |
| 491 | 20/10/2019 21:38:20 | 25.5 |
| 492 | 20/10/2019 22:38:20 | 25.3 |
| 493 | 20/10/2019 23:38:20 | 25 |
| 494 | 21/10/2019 00:38:20 | 24.6 |
| 495 | 21/10/2019 01:38:20 | 24.4 |
| 496 | 21/10/2019 02:38:20 | 24.2 |
| 497 | 21/10/2019 03:38:20 | 23.9 |
| 498 | 21/10/2019 04:38:20 | 23.7 |
| 499 | 21/10/2019 05:38:20 | 23.4 |
| 500 | 21/10/2019 06:38:20 | 23 |

# Appendix 4: Temperature Recording of CISR Building

## Data Report

File created on: 2020-03-09 10:19:27

### Device Info

| | | | |
|---|---|---|---|
| Model | RC-5+ | Probe Type | Temperature (Internal) |
| S/N | EFI193B01096 | Firmware | V1.4 |

### Trip Description

| | |
|---|---|
| Trip Number | 0000001 |
| Trip Description | Adama CIS temperature recording. |

### Config. Info

| | | | |
|---|---|---|---|
| Start Mode | Immediate | Log Interval | 1:0:0 |
| Start Delay | 0H0M | Multi-boot | Enable |
| Time Zone | UTC +03:00 | Stop Mode | Press Button |

### Mark Time

N/A

| Alarm Threshold | Alarm Delay | Over-limit duration | Out-of-limit Times | Alarm Status |
|---|---|---|---|---|

### Summary

| | | | |
|---|---|---|---|
| Max | 34.1°C/N/A%RH | Start Time | 2019-09-30 11:15:53 |
| Min | 15.3°C/N/A%RH | Stop Time | 2020-03-09 09:15:53(Stop by button) |
| Avg | 22.7°C/N/A%RH | Elapsed Time | 160D 22H 0M 0S |
| Mean Kinetic Temperature (MKT) 23.4°C | | Total Points | 3863 |

| No. | Time | CISR Temp (°C) |
|---|---|---|
| 1 | 2019-09-30 11:15:53 | 28.6 |
| 2 | 2019-09-30 12:15:53 | 24.8 |
| 3 | 2019-09-30 13:15:53 | 26 |
| 4 | 2019-09-30 14:15:53 | 26.9 |
| 5 | 2019-09-30 15:15:53 | 26 |
| 6 | 2019-09-30 16:15:53 | 24.4 |
| 7 | 2019-09-30 17:15:53 | 23.9 |
| 8 | 2019-09-30 18:15:53 | 23.3 |
| 9 | 2019-09-30 19:15:53 | 22.6 |
| 10 | 2019-09-30 20:15:53 | 21.9 |
| 11 | 2019-09-30 21:15:53 | 21.4 |
| 12 | 2019-09-30 22:15:53 | 21 |
| 13 | 2019-09-30 23:15:53 | 20.6 |
| 14 | 2019-10-01 00:15:53 | 20.4 |
| 15 | 2019-10-01 01:15:53 | 20.1 |
| 16 | 2019-10-01 02:15:53 | 19.9 |
| 17 | 2019-10-01 03:15:53 | 19.6 |
| 18 | 2019-10-01 04:15:53 | 19.4 |
| 19 | 2019-10-01 05:15:53 | 19 |
| 20 | 2019-10-01 06:15:53 | 18.7 |
| 21 | 2019-10-01 07:15:53 | 19 |
| 22 | 2019-10-01 08:15:53 | 19.8 |
| 23 | 2019-10-01 09:15:53 | 21.5 |
| 24 | 2019-10-01 10:15:53 | 23 |
| 25 | 2019-10-01 11:15:53 | 25 |

| | | |
|---|---|---|
| 26 | 2019-10-01 12:15:53 | 26.8 |
| 27 | 2019-10-01 13:15:53 | 26.6 |
| 28 | 2019-10-01 14:15:53 | 25.6 |
| 29 | 2019-10-01 15:15:53 | 26.3 |
| 30 | 2019-10-01 16:15:53 | 26.6 |
| 31 | 2019-10-01 17:15:53 | 25.6 |
| 32 | 2019-10-01 18:15:53 | 24.5 |
| 33 | 2019-10-01 19:15:53 | 23.7 |
| 34 | 2019-10-01 20:15:53 | 23 |
| 35 | 2019-10-01 21:15:53 | 22.4 |
| 36 | 2019-10-01 22:15:53 | 21.9 |
| 37 | 2019-10-01 23:15:53 | 21.4 |
| 38 | 2019-10-02 00:15:53 | 21 |
| 39 | 2019-10-02 01:15:53 | 20.6 |
| 40 | 2019-10-02 02:15:53 | 20.3 |
| 41 | 2019-10-02 03:15:53 | 19.9 |
| 42 | 2019-10-02 04:15:53 | 19.6 |
| 43 | 2019-10-02 05:15:53 | 19.3 |
| 44 | 2019-10-02 06:15:53 | 19.1 |
| 45 | 2019-10-02 07:15:53 | 19 |
| 46 | 2019-10-02 08:15:53 | 19.3 |
| 47 | 2019-10-02 09:15:53 | 20.5 |
| 48 | 2019-10-02 10:15:53 | 22.7 |
| 49 | 2019-10-02 11:15:53 | 24.2 |
| 50 | 2019-10-02 12:15:53 | 25.3 |
| 51 | 2019-10-02 13:15:53 | 25.5 |
| 52 | 2019-10-02 14:15:53 | 26.4 |
| 53 | 2019-10-02 15:15:53 | 26.7 |
| 54 | 2019-10-02 16:15:53 | 26.8 |
| 55 | 2019-10-02 17:15:53 | 26.5 |
| 56 | 2019-10-02 18:15:53 | 25.5 |
| 57 | 2019-10-02 19:15:53 | 24.2 |
| 58 | 2019-10-02 20:15:53 | 23.6 |
| 59 | 2019-10-02 21:15:53 | 23 |
| 60 | 2019-10-02 22:15:53 | 22.5 |
| 61 | 2019-10-02 23:15:53 | 21.8 |
| 62 | 2019-10-03 00:15:53 | 21.6 |
| 63 | 2019-10-03 01:15:53 | 21.2 |
| 64 | 2019-10-03 02:15:53 | 20.7 |
| 65 | 2019-10-03 03:15:53 | 20.4 |
| 66 | 2019-10-03 04:15:53 | 20.1 |
| 67 | 2019-10-03 05:15:53 | 19.8 |
| 68 | 2019-10-03 06:15:53 | 19.6 |
| 69 | 2019-10-03 07:15:53 | 19.5 |
| 70 | 2019-10-03 08:15:53 | 20.2 |
| 71 | 2019-10-03 09:15:53 | 20.3 |
| 72 | 2019-10-03 10:15:53 | 19.9 |
| 73 | 2019-10-03 11:15:53 | 20.5 |
| 74 | 2019-10-03 12:15:53 | 22.5 |
| 75 | 2019-10-03 13:15:53 | 24.5 |
| 76 | 2019-10-03 14:15:53 | 25.9 |
| 77 | 2019-10-03 15:15:53 | 27.2 |
| 78 | 2019-10-03 16:15:53 | 27.4 |
| 79 | 2019-10-03 17:15:53 | 27.4 |
| 80 | 2019-10-03 18:15:53 | 26.4 |
| 81 | 2019-10-03 19:15:53 | 25.3 |
| 82 | 2019-10-03 20:15:53 | 24.4 |
| 83 | 2019-10-03 21:15:53 | 23.7 |
| 84 | 2019-10-03 22:15:53 | 23 |
| 85 | 2019-10-03 23:15:53 | 22.3 |
| 86 | 2019-10-04 00:15:53 | 21.8 |
| 87 | 2019-10-04 01:15:53 | 21.4 |
| 88 | 2019-10-04 02:15:53 | 20.9 |
| 89 | 2019-10-04 03:15:53 | 20.5 |
| 90 | 2019-10-04 04:15:53 | 20.1 |
| 91 | 2019-10-04 05:15:53 | 19.7 |
| 92 | 2019-10-04 06:15:53 | 19.4 |
| 93 | 2019-10-04 07:15:53 | 19.3 |
| 94 | 2019-10-04 08:15:53 | 19.8 |
| 95 | 2019-10-04 09:15:53 | 20.3 |
| 96 | 2019-10-04 10:15:53 | 21.6 |
| 97 | 2019-10-04 11:15:53 | 23.2 |
| 98 | 2019-10-04 12:15:53 | 24.5 |
| 99 | 2019-10-04 13:15:53 | 25.5 |
| 100 | 2019-10-04 14:15:53 | 26.3 |
| 101 | 2019-10-04 15:15:53 | 26.5 |
| 102 | 2019-10-04 16:15:53 | 26.1 |
| 103 | 2019-10-04 17:15:53 | 26.4 |
| 104 | 2019-10-04 18:15:53 | 25.4 |
| 105 | 2019-10-04 19:15:53 | 24.4 |
| 106 | 2019-10-04 20:15:53 | 23.7 |
| 107 | 2019-10-04 21:15:53 | 23.2 |
| 108 | 2019-10-04 22:15:53 | 22.7 |
| 109 | 2019-10-04 23:15:53 | 22.3 |
| 110 | 2019-10-05 00:15:53 | 22 |
| 111 | 2019-10-05 01:15:53 | 21.6 |
| 112 | 2019-10-05 02:15:53 | 21.3 |
| 113 | 2019-10-05 03:15:53 | 20.9 |
| 114 | 2019-10-05 04:15:53 | 20.6 |
| 115 | 2019-10-05 05:15:53 | 20.4 |
| 116 | 2019-10-05 06:15:53 | 20.2 |
| 117 | 2019-10-05 07:15:53 | 20.3 |
| 118 | 2019-10-05 08:15:53 | 21.7 |
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| 121 | 2019-10-05 11:15:53 | 24.4 |
| 122 | 2019-10-05 12:15:53 | 24.4 |
| 123 | 2019-10-05 13:15:53 | 25.1 |
| 124 | 2019-10-05 14:15:53 | 24 |
| 125 | 2019-10-05 15:15:53 | 24.4 |

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|---|---|---|
| 126 | 2019-10-05 16:15:53 | 25.4 |
| 127 | 2019-10-05 17:15:53 | 25.2 |
| 128 | 2019-10-05 18:15:53 | 24.5 |
| 129 | 2019-10-05 19:15:53 | 23.8 |
| 130 | 2019-10-05 20:15:53 | 23 |
| 131 | 2019-10-05 21:15:53 | 22.3 |
| 132 | 2019-10-05 22:15:53 | 21.9 |
| 133 | 2019-10-05 23:15:53 | 21.5 |
| 134 | 2019-10-06 00:15:53 | 21 |
| 135 | 2019-10-06 01:15:53 | 20.5 |
| 136 | 2019-10-06 02:15:53 | 20.2 |
| 137 | 2019-10-06 03:15:53 | 20 |
| 138 | 2019-10-06 04:15:53 | 19.8 |
| 139 | 2019-10-06 05:15:53 | 19.5 |
| 140 | 2019-10-06 06:15:53 | 19.3 |
| 141 | 2019-10-06 07:15:53 | 19.3 |
| 142 | 2019-10-06 08:15:53 | 19.9 |
| 143 | 2019-10-06 09:15:53 | 22.1 |
| 144 | 2019-10-06 10:15:53 | 23.7 |
| 145 | 2019-10-06 11:15:53 | 25 |
| 146 | 2019-10-06 12:15:53 | 26 |
| 147 | 2019-10-06 13:15:53 | 27.1 |
| 148 | 2019-10-06 14:15:53 | 27.9 |
| 149 | 2019-10-06 15:15:53 | 28.6 |
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| 153 | 2019-10-06 19:15:53 | 25.1 |
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| 155 | 2019-10-06 21:15:53 | 23.7 |
| 156 | 2019-10-06 22:15:53 | 23 |
| 157 | 2019-10-06 23:15:53 | 22.3 |
| 158 | 2019-10-07 00:15:53 | 21.7 |
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| 160 | 2019-10-07 02:15:53 | 21.1 |
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| 166 | 2019-10-07 08:15:53 | 21.7 |
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| 168 | 2019-10-07 10:15:53 | 24.3 |
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| 173 | 2019-10-07 15:15:53 | 28.9 |
| 174 | 2019-10-07 16:15:53 | 29 |
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| 177 | 2019-10-07 19:15:53 | 25.8 |
| 178 | 2019-10-07 20:15:53 | 25.2 |
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| 182 | 2019-10-08 00:15:53 | 22.4 |
| 183 | 2019-10-08 01:15:53 | 22 |
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| 185 | 2019-10-08 03:15:53 | 21.3 |
| 186 | 2019-10-08 04:15:53 | 20.9 |
| 187 | 2019-10-08 05:15:53 | 20.5 |
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| 189 | 2019-10-08 07:15:53 | 20.3 |
| 190 | 2019-10-08 08:15:53 | 20.9 |
| 191 | 2019-10-08 09:15:53 | 21.5 |
| 192 | 2019-10-08 10:15:53 | 23 |
| 193 | 2019-10-08 11:15:53 | 24.4 |
| 194 | 2019-10-08 12:15:53 | 25.5 |
| 195 | 2019-10-08 13:15:53 | 26.5 |
| 196 | 2019-10-08 14:15:53 | 26.7 |
| 197 | 2019-10-08 15:15:53 | 26.8 |
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| 203 | 2019-10-08 21:15:53 | 22.1 |
| 204 | 2019-10-08 22:15:53 | 21.3 |
| 205 | 2019-10-08 23:15:53 | 20.8 |
| 206 | 2019-10-09 00:15:53 | 20.5 |
| 207 | 2019-10-09 01:15:53 | 20.4 |
| 208 | 2019-10-09 02:15:53 | 20.1 |
| 209 | 2019-10-09 03:15:53 | 19.8 |
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| 211 | 2019-10-09 05:15:53 | 19.3 |
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| 213 | 2019-10-09 07:15:53 | 19.7 |
| 214 | 2019-10-09 08:15:53 | 20.9 |
| 215 | 2019-10-09 09:15:53 | 22 |
| 216 | 2019-10-09 10:15:53 | 23.2 |
| 217 | 2019-10-09 11:15:53 | 24.4 |
| 218 | 2019-10-09 12:15:53 | 25.6 |
| 219 | 2019-10-09 13:15:53 | 26.6 |
| 220 | 2019-10-09 14:15:53 | 26.4 |
| 221 | 2019-10-09 15:15:53 | 26.4 |
| 222 | 2019-10-09 16:15:53 | 26.4 |
| 223 | 2019-10-09 17:15:53 | 26.6 |
| 224 | 2019-10-09 18:15:53 | 25.9 |

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| 225 | 2019-10-09 19:15:53 | 25.5 |
| 226 | 2019-10-09 20:15:53 | 24.7 |
| 227 | 2019-10-09 21:15:53 | 23.7 |
| 228 | 2019-10-09 22:15:53 | 22.9 |
| 229 | 2019-10-09 23:15:53 | 22 |
| 230 | 2019-10-10 00:15:53 | 21.1 |
| 231 | 2019-10-10 01:15:53 | 20.1 |
| 232 | 2019-10-10 02:15:53 | 20 |
| 233 | 2019-10-10 03:15:53 | 19.6 |
| 234 | 2019-10-10 04:15:53 | 19.4 |
| 235 | 2019-10-10 05:15:53 | 19.2 |
| 236 | 2019-10-10 06:15:53 | 19.1 |
| 237 | 2019-10-10 07:15:53 | 18.9 |
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| 239 | 2019-10-10 09:15:53 | 20.9 |
| 240 | 2019-10-10 10:15:53 | 22.4 |
| 241 | 2019-10-10 11:15:53 | 23.7 |
| 242 | 2019-10-10 12:15:53 | 25 |
| 243 | 2019-10-10 13:15:53 | 26.1 |
| 244 | 2019-10-10 14:15:53 | 26.7 |
| 245 | 2019-10-10 15:15:53 | 27.2 |
| 246 | 2019-10-10 16:15:53 | 27.2 |
| 247 | 2019-10-10 17:15:53 | 26.1 |
| 248 | 2019-10-10 18:15:53 | 25.6 |
| 249 | 2019-10-10 19:15:53 | 24.6 |
| 250 | 2019-10-10 20:15:53 | 23.8 |
| 251 | 2019-10-10 21:15:53 | 23.1 |
| 252 | 2019-10-10 22:15:53 | 22.5 |
| 253 | 2019-10-10 23:15:53 | 22 |
| 254 | 2019-10-11 00:15:53 | 21.4 |
| 255 | 2019-10-11 01:15:53 | 20.9 |
| 256 | 2019-10-11 02:15:53 | 20.4 |
| 257 | 2019-10-11 03:15:53 | 20.1 |
| 258 | 2019-10-11 04:15:53 | 19.8 |
| 259 | 2019-10-11 05:15:53 | 19.5 |
| 260 | 2019-10-11 06:15:53 | 19.3 |
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| 262 | 2019-10-11 08:15:53 | 19 |
| 263 | 2019-10-11 09:15:53 | 19.4 |
| 264 | 2019-10-11 10:15:53 | 20.2 |
| 265 | 2019-10-11 11:15:53 | 21.2 |
| 266 | 2019-10-11 12:15:53 | 21.9 |
| 267 | 2019-10-11 13:15:53 | 22.7 |
| 268 | 2019-10-11 14:15:53 | 23.8 |
| 269 | 2019-10-11 15:15:53 | 25.1 |
| 270 | 2019-10-11 16:15:53 | 25.7 |
| 271 | 2019-10-11 17:15:53 | 25.5 |
| 272 | 2019-10-11 18:15:53 | 24.9 |
| 273 | 2019-10-11 19:15:53 | 24.1 |
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| 275 | 2019-10-11 21:15:53 | 22.6 |
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| 278 | 2019-10-12 00:15:53 | 21.1 |
| 279 | 2019-10-12 01:15:53 | 20.7 |
| 280 | 2019-10-12 02:15:53 | 20.4 |
| 281 | 2019-10-12 03:15:53 | 19.9 |
| 282 | 2019-10-12 04:15:53 | 19.5 |
| 283 | 2019-10-12 05:15:53 | 19.1 |
| 284 | 2019-10-12 06:15:53 | 18.8 |
| 285 | 2019-10-12 07:15:53 | 18.8 |
| 286 | 2019-10-12 08:15:53 | 20 |
| 287 | 2019-10-12 09:15:53 | 21.2 |
| 288 | 2019-10-12 10:15:53 | 22.6 |
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| 290 | 2019-10-12 12:15:53 | 25 |
| 291 | 2019-10-12 13:15:53 | 25.9 |
| 292 | 2019-10-12 14:15:53 | 26.7 |
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| 294 | 2019-10-12 16:15:53 | 27.7 |
| 295 | 2019-10-12 17:15:53 | 27.5 |
| 296 | 2019-10-12 18:15:53 | 26.4 |
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| 298 | 2019-10-12 20:15:53 | 24.7 |
| 299 | 2019-10-12 21:15:53 | 24 |
| 300 | 2019-10-12 22:15:53 | 23.2 |
| 301 | 2019-10-12 23:15:53 | 22.6 |
| 302 | 2019-10-13 00:15:53 | 22.2 |
| 303 | 2019-10-13 01:15:53 | 21.7 |
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| 305 | 2019-10-13 03:15:53 | 20.8 |
| 306 | 2019-10-13 04:15:53 | 20.5 |
| 307 | 2019-10-13 05:15:53 | 20 |
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| 317 | 2019-10-13 15:15:53 | 24.9 |
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| 320 | 2019-10-13 18:15:53 | 24.2 |
| 321 | 2019-10-13 19:15:53 | 23.3 |
| 322 | 2019-10-13 20:15:53 | 22.8 |
| 323 | 2019-10-13 21:15:53 | 22.2 |
| 324 | 2019-10-13 22:15:53 | 21.6 |

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|---|---|---|---|---|---|---|---|---|
| 325 | 2019-10-13 23:15:53 | 21 | 359 | 2019-10-15 09:15:53 | 21.3 | 391 | 2019-10-16 17:15:53 | 27.5 |
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| 327 | 2019-10-14 01:15:53 | 20 | 361 | 2019-10-15 11:15:53 | 24.2 | 393 | 2019-10-16 19:15:53 | 25.4 |
| 328 | 2019-10-14 02:15:53 | 19.7 | 362 | 2019-10-15 12:15:53 | 25.5 | 394 | 2019-10-16 20:15:53 | 24.4 |
| 329 | 2019-10-14 03:15:53 | 19.5 | 363 | 2019-10-15 13:15:53 | 26.5 | 395 | 2019-10-16 21:15:53 | 23.9 |
| 330 | 2019-10-14 04:15:53 | 19.3 | 364 | 2019-10-15 14:15:53 | 27.3 | 396 | 2019-10-16 22:15:53 | 23.2 |
| 331 | 2019-10-14 05:15:53 | 19.1 | 365 | 2019-10-15 15:15:53 | 27.9 | 397 | 2019-10-16 23:15:53 | 22.6 |
| 332 | 2019-10-14 06:15:53 | 18.8 | 366 | 2019-10-15 16:15:53 | 28.1 | 398 | 2019-10-17 00:15:53 | 22.1 |
| 333 | 2019-10-14 07:15:53 | 19.2 | 367 | 2019-10-15 17:15:53 | 27.8 | 399 | 2019-10-17 01:15:53 | 21.6 |
| 334 | 2019-10-14 08:15:53 | 20.3 | 368 | 2019-10-15 18:15:53 | 26.5 | 400 | 2019-10-17 02:15:53 | 21.1 |
| 335 | 2019-10-14 09:15:53 | 21.3 | 369 | 2019-10-15 19:15:53 | 25.3 | 401 | 2019-10-17 03:15:53 | 20.9 |
| 336 | 2019-10-14 10:15:53 | 22.4 | 370 | 2019-10-15 20:15:53 | 24.5 | 402 | 2019-10-17 04:15:53 | 20.5 |
| 337 | 2019-10-14 11:15:53 | 23.5 | 371 | 2019-10-15 21:15:53 | 24 | 403 | 2019-10-17 05:15:53 | 20.1 |
| 338 | 2019-10-14 12:15:53 | 24.6 | 372 | 2019-10-15 22:15:53 | 23.2 | 404 | 2019-10-17 06:15:53 | 19.7 |
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| 340 | 2019-10-14 14:15:53 | 26 | 374 | 2019-10-16 00:15:53 | 21.8 | 406 | 2019-10-17 08:15:53 | 21.1 |
| 341 | 2019-10-14 15:15:53 | 26.5 | 375 | 2019-10-16 01:15:53 | 21.2 | 407 | 2019-10-17 09:15:53 | 22 |
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| 343 | 2019-10-14 17:15:53 | 26.7 | 377 | 2019-10-16 03:15:53 | 20 | 409 | 2019-10-17 11:15:53 | 24.2 |
| 344 | 2019-10-14 18:15:53 | 25.7 | 378 | 2019-10-16 04:15:53 | 19.8 | 410 | 2019-10-17 12:15:53 | 25.1 |
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| 348 | 2019-10-14 22:15:53 | 22.3 | 382 | 2019-10-16 08:15:53 | 20.9 | 414 | 2019-10-17 16:15:53 | 27.4 |
| 349 | 2019-10-14 23:15:53 | 21.7 | 383 | 2019-10-16 09:15:53 | 21.9 | 415 | 2019-10-17 17:15:53 | 27.2 |
| 350 | 2019-10-15 00:15:53 | 21.1 | 384 | 2019-10-16 10:15:53 | 23 | 416 | 2019-10-17 18:15:53 | 26.3 |
| 351 | 2019-10-15 01:15:53 | 20.4 | 385 | 2019-10-16 11:15:53 | 24.3 | 417 | 2019-10-17 19:15:53 | 25 |
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| 353 | 2019-10-15 03:15:53 | 19.4 | 387 | 2019-10-16 13:15:53 | 26.3 | 419 | 2019-10-17 21:15:53 | 23.6 |
| 354 | 2019-10-15 04:15:53 | 18.9 | 388 | 2019-10-16 14:15:53 | 27.1 | 420 | 2019-10-17 22:15:53 | 23 |
| 355 | 2019-10-15 05:15:53 | 18.5 | 389 | 2019-10-16 15:15:53 | 27.5 | 421 | 2019-10-17 23:15:53 | 22.4 |
| 356 | 2019-10-15 06:15:53 | 18 | 390 | 2019-10-16 16:15:53 | 27.7 | 422 | 2019-10-18 00:15:53 | 21.9 |
| 357 | 2019-10-15 07:15:53 | 18.4 | | | | 423 | 2019-10-18 01:15:53 | 21.3 |
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|---|---|---|
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| 428 | 2019-10-18 06:15:53 | 19.3 |
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| 432 | 2019-10-18 10:15:53 | 22.6 |
| 433 | 2019-10-18 11:15:53 | 23.8 |
| 434 | 2019-10-18 12:15:53 | 25 |
| 435 | 2019-10-18 13:15:53 | 26 |
| 436 | 2019-10-18 14:15:53 | 26.9 |
| 437 | 2019-10-18 15:15:53 | 26.9 |
| 438 | 2019-10-18 16:15:53 | 26.5 |
| 439 | 2019-10-18 17:15:53 | 26.1 |
| 440 | 2019-10-18 18:15:53 | 25.6 |
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| 447 | 2019-10-19 01:15:53 | 21.3 |
| 448 | 2019-10-19 02:15:53 | 21 |
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| 450 | 2019-10-19 04:15:53 | 20.5 |
| 451 | 2019-10-19 05:15:53 | 20.3 |
| 452 | 2019-10-19 06:15:53 | 20.1 |
| 453 | 2019-10-19 07:15:53 | 20.1 |
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| 455 | 2019-10-19 09:15:53 | 21.1 |
| 456 | 2019-10-19 10:15:53 | 22.1 |
| 457 | 2019-10-19 11:15:53 | 23.2 |
| 458 | 2019-10-19 12:15:53 | 24.3 |
| 459 | 2019-10-19 13:15:53 | 24.8 |
| 460 | 2019-10-19 14:15:53 | 25 |
| 461 | 2019-10-19 15:15:53 | 25.7 |
| 462 | 2019-10-19 16:15:53 | 25.2 |
| 463 | 2019-10-19 17:15:53 | 24.9 |
| 464 | 2019-10-19 18:15:53 | 24.2 |
| 465 | 2019-10-19 19:15:53 | 23.4 |
| 466 | 2019-10-19 20:15:53 | 23 |
| 467 | 2019-10-19 21:15:53 | 22.5 |
| 468 | 2019-10-19 22:15:53 | 22.2 |
| 469 | 2019-10-19 23:15:53 | 21.8 |
| 470 | 2019-10-20 00:15:53 | 21.5 |
| 471 | 2019-10-20 01:15:53 | 21.2 |
| 472 | 2019-10-20 02:15:53 | 21 |
| 473 | 2019-10-20 03:15:53 | 20.6 |
| 474 | 2019-10-20 04:15:53 | 20.2 |
| 475 | 2019-10-20 05:15:53 | 19.9 |
| 476 | 2019-10-20 06:15:53 | 19.7 |
| 477 | 2019-10-20 07:15:53 | 19.6 |
| 478 | 2019-10-20 08:15:53 | 19.9 |
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| 481 | 2019-10-20 11:15:53 | 23.7 |
| 482 | 2019-10-20 12:15:53 | 25 |
| 483 | 2019-10-20 13:15:53 | 25.6 |
| 484 | 2019-10-20 14:15:53 | 25.7 |
| 485 | 2019-10-20 15:15:53 | 26.5 |
| 486 | 2019-10-20 16:15:53 | 27 |
| 487 | 2019-10-20 17:15:53 | 26.7 |
| 488 | 2019-10-20 18:15:53 | 25.6 |
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| 490 | 2019-10-20 20:15:53 | 23.7 |
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| 496 | 2019-10-21 02:15:53 | 20.9 |
| 497 | 2019-10-21 03:15:53 | 20.4 |
| 498 | 2019-10-21 04:15:53 | 20 |
| 499 | 2019-10-21 05:15:53 | 19.6 |
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| 502 | 2019-10-21 08:15:53 | 20.6 |
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| 507 | 2019-10-21 13:15:53 | 26.7 |
| 508 | 2019-10-21 14:15:53 | 27.5 |
| 509 | 2019-10-21 15:15:53 | 28 |
| 510 | 2019-10-21 16:15:53 | 28.2 |
| 511 | 2019-10-21 17:15:53 | 27.8 |
| 512 | 2019-10-21 18:15:53 | 26.6 |
| 513 | 2019-10-21 19:15:53 | 25.7 |
| 514 | 2019-10-21 20:15:53 | 25 |
| 515 | 2019-10-21 21:15:53 | 24.3 |
| 516 | 2019-10-21 22:15:53 | 23.5 |
| 517 | 2019-10-21 23:15:53 | 22.8 |
| 518 | 2019-10-22 00:15:53 | 22.3 |
| 519 | 2019-10-22 01:15:53 | 21.7 |
| 520 | 2019-10-22 02:15:53 | 21.1 |
| 521 | 2019-10-22 03:15:53 | 20.7 |
| 522 | 2019-10-22 04:15:53 | 20.4 |
| 523 | 2019-10-22 05:15:53 | 19.9 |
| 524 | 2019-10-22 06:15:53 | 19.6 |

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|---|---|---|
| 525 | 2019-10-22 07:15:53 | 19.9 |
| 526 | 2019-10-22 08:15:53 | 21 |
| 527 | 2019-10-22 09:15:53 | 22.2 |
| 528 | 2019-10-22 10:15:53 | 23.7 |
| 529 | 2019-10-22 11:15:53 | 24.9 |
| 530 | 2019-10-22 12:15:53 | 26 |
| 531 | 2019-10-22 13:15:53 | 27 |
| 532 | 2019-10-22 14:15:53 | 27.7 |
| 533 | 2019-10-22 15:15:53 | 28 |
| 534 | 2019-10-22 16:15:53 | 28.1 |
| 535 | 2019-10-22 17:15:53 | 27.6 |
| 536 | 2019-10-22 18:15:53 | 26.4 |
| 537 | 2019-10-22 19:15:53 | 25.3 |
| 538 | 2019-10-22 20:15:53 | 24.6 |
| 539 | 2019-10-22 21:15:53 | 23.9 |
| 540 | 2019-10-22 22:15:53 | 23.2 |
| 541 | 2019-10-22 23:15:53 | 22.6 |
| 542 | 2019-10-23 00:15:53 | 22 |
| 543 | 2019-10-23 01:15:53 | 21.4 |
| 544 | 2019-10-23 02:15:53 | 20.9 |
| 545 | 2019-10-23 03:15:53 | 20.3 |
| 546 | 2019-10-23 04:15:53 | 19.8 |
| 547 | 2019-10-23 05:15:53 | 19.3 |
| 548 | 2019-10-23 06:15:53 | 18.8 |
| 549 | 2019-10-23 07:15:53 | 19.4 |
| 550 | 2019-10-23 08:15:53 | 20.5 |
| 551 | 2019-10-23 09:15:53 | 21.4 |
| 552 | 2019-10-23 10:15:53 | 22.5 |
| 553 | 2019-10-23 11:15:53 | 23.7 |
| 554 | 2019-10-23 12:15:53 | 24.9 |
| 555 | 2019-10-23 13:15:53 | 25.9 |
| 556 | 2019-10-23 14:15:53 | 26.6 |
| 557 | 2019-10-23 15:15:53 | 27.2 |
| 558 | 2019-10-23 16:15:53 | 27.4 |
| 559 | 2019-10-23 17:15:53 | 27.2 |
| 560 | 2019-10-23 18:15:53 | 26 |
| 561 | 2019-10-23 19:15:53 | 24.9 |
| 562 | 2019-10-23 20:15:53 | 24.1 |

# Appendix 5: Temperature Recording of Green Roof Building

Data Report

File created on: 2020-03-21 15:40:08

Device Info

| | | | |
|---|---|---|---|
| Model | RC-5+ | Probe Type | Temperature (Internal) |
| S/N | EFI193B01083 | Firmware | V1.4 |

Trip Description

| | |
|---|---|
| Trip Number | 0000001 |
| Trip Description | HGR temperature recording. |

Config. Info

| | | | |
|---|---|---|---|
| Start Mode | Immediate | Log Interval | 1:0:0 |
| Start Delay | 0H0M | Multi-boot | Enable |
| Time Zone | UTC +03:00 | Stop Mode | Press Button |

Mark Time

N/A

| Alarm Threshold | Alarm Delay | Over-limit duration | Out-of-limit Times | Alarm Status |
|---|---|---|---|---|

Summary

| | | | |
|---|---|---|---|
| Max | 30.8°C/N/A%RH | Start Time | 2019-09-16 11:41:40 |
| Min22.9°C/N/A%RH | | Stop Time | 2020-03-16 11:41:40(Stop by button) |
| Avg | 26.6°C/N/A%RH | Elapsed Time | 182D 0H 0M 0S |
| Mean Kinetic Temperature (MKT) | 26.8°C | Total Points | 4369 |

| No. | Time | Temperature (°C) |
|---|---|---|
| 1 | 2019-09-16 11:41:40 | 28.1 |
| 2 | 2019-09-16 12:41:40 | 25 |
| 3 | 2019-09-16 13:41:40 | 25.1 |
| 4 | 2019-09-16 14:41:40 | 25.3 |
| 5 | 2019-09-16 15:41:40 | 25.2 |
| 6 | 2019-09-16 16:41:40 | 25 |
| 7 | 2019-09-16 17:41:40 | 24.7 |
| 8 | 2019-09-16 18:41:40 | 24.4 |
| 9 | 2019-09-16 19:41:40 | 24.3 |
| 10 | 2019-09-16 20:41:40 | 24.3 |
| 11 | 2019-09-16 21:41:40 | 24.2 |
| 12 | 2019-09-16 22:41:40 | 24.1 |
| 13 | 2019-09-16 23:41:40 | 24 |
| 14 | 2019-09-17 00:41:40 | 23.9 |
| 15 | 2019-09-17 01:41:40 | 23.8 |
| 16 | 2019-09-17 02:41:40 | 23.8 |
| 17 | 2019-09-17 03:41:40 | 23.7 |
| 18 | 2019-09-17 04:41:40 | 23.7 |
| 19 | 2019-09-17 05:41:40 | 23.7 |
| 20 | 2019-09-17 06:41:40 | 23.7 |
| 21 | 2019-09-17 07:41:40 | 23.7 |
| 22 | 2019-09-17 08:41:40 | 23.7 |
| 23 | 2019-09-17 09:41:40 | 23.8 |
| 24 | 2019-09-17 10:41:40 | 24.1 |
| 25 | 2019-09-17 11:41:40 | 24.8 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 26 | 2019-09-17 12:41:40 | 25.1 | 58 | 2019-09-18 20:41:40 | 24 | 92 | 2019-09-20 06:41:40 | 22.9 |
| 27 | 2019-09-17 13:41:40 | 25.3 | 59 | 2019-09-18 21:41:40 | 23.9 | 93 | 2019-09-20 07:41:40 | 23.1 |
| 28 | 2019-09-17 14:41:40 | 25.2 | 60 | 2019-09-18 22:41:40 | 23.8 | 94 | 2019-09-20 08:41:40 | 23.4 |
| 29 | 2019-09-17 15:41:40 | 25 | 61 | 2019-09-18 23:41:40 | 23.8 | 95 | 2019-09-20 09:41:40 | 23.7 |
| 30 | 2019-09-17 16:41:40 | 24.9 | 62 | 2019-09-19 00:41:40 | 23.7 | 96 | 2019-09-20 10:41:40 | 24.1 |
| 31 | 2019-09-17 17:41:40 | 24.6 | 63 | 2019-09-19 01:41:40 | 23.7 | 97 | 2019-09-20 11:41:40 | 24.1 |
| 32 | 2019-09-17 18:41:40 | 24.4 | 64 | 2019-09-19 02:41:40 | 23.6 | 98 | 2019-09-20 12:41:40 | 24 |
| 33 | 2019-09-17 19:41:40 | 24.3 | 65 | 2019-09-19 03:41:40 | 23.5 | 99 | 2019-09-20 13:41:40 | 24 |
| 34 | 2019-09-17 20:41:40 | 24.3 | 66 | 2019-09-19 04:41:40 | 23.4 | 100 | 2019-09-20 14:41:40 | 24.2 |
| 35 | 2019-09-17 21:41:40 | 24.2 | 67 | 2019-09-19 05:41:40 | 23.2 | 101 | 2019-09-20 15:41:40 | 24.5 |
| 36 | 2019-09-17 22:41:40 | 24.1 | 68 | 2019-09-19 06:41:40 | 23.2 | 102 | 2019-09-20 16:41:40 | 24.5 |
| 37 | 2019-09-17 23:41:40 | 24 | 69 | 2019-09-19 07:41:40 | 23.1 | 103 | 2019-09-20 17:41:40 | 24.2 |
| 38 | 2019-09-18 00:41:40 | 24 | 70 | 2019-09-19 08:41:40 | 23.2 | 104 | 2019-09-20 18:41:40 | 24 |
| 39 | 2019-09-18 01:41:40 | 23.9 | 71 | 2019-09-19 09:41:40 | 23.5 | 105 | 2019-09-20 19:41:40 | 23.8 |
| 40 | 2019-09-18 02:41:40 | 23.8 | 72 | 2019-09-19 10:41:40 | 23.8 | 106 | 2019-09-20 20:41:40 | 23.8 |
| 41 | 2019-09-18 03:41:40 | 23.8 | 73 | 2019-09-19 11:41:40 | 24.3 | 107 | 2019-09-20 21:41:40 | 23.7 |
| 42 | 2019-09-18 04:41:40 | 23.7 | 74 | 2019-09-19 12:41:40 | 24.7 | 108 | 2019-09-20 22:41:40 | 23.7 |
| 43 | 2019-09-18 05:41:40 | 23.7 | 75 | 2019-09-19 13:41:40 | 24.4 | 109 | 2019-09-20 23:41:40 | 23.7 |
| 44 | 2019-09-18 06:41:40 | 23.7 | 76 | 2019-09-19 14:41:40 | 24.2 | 110 | 2019-09-21 00:41:40 | 23.7 |
| 45 | 2019-09-18 07:41:40 | 23.7 | 77 | 2019-09-19 15:41:40 | 24.3 | 111 | 2019-09-21 01:41:40 | 23.6 |
| 46 | 2019-09-18 08:41:40 | 23.7 | 78 | 2019-09-19 16:41:40 | 24.5 | 112 | 2019-09-21 02:41:40 | 23.5 |
| 47 | 2019-09-18 09:41:40 | 24 | 79 | 2019-09-19 17:41:40 | 24.3 | 113 | 2019-09-21 03:41:40 | 23.5 |
| 48 | 2019-09-18 10:41:40 | 24.6 | 80 | 2019-09-19 18:41:40 | 24.1 | 114 | 2019-09-21 04:41:40 | 23.4 |
| 49 | 2019-09-18 11:41:40 | 24.9 | 81 | 2019-09-19 19:41:40 | 24 | 115 | 2019-09-21 05:41:40 | 23.4 |
| 50 | 2019-09-18 12:41:40 | 25.1 | 82 | 2019-09-19 20:41:40 | 23.8 | 116 | 2019-09-21 06:41:40 | 23.4 |
| 51 | 2019-09-18 13:41:40 | 25 | 83 | 2019-09-19 21:41:40 | 23.7 | 117 | 2019-09-21 07:41:40 | 23.4 |
| 52 | 2019-09-18 14:41:40 | 24.5 | 84 | 2019-09-19 22:41:40 | 23.7 | 118 | 2019-09-21 08:41:40 | 23.5 |
| 53 | 2019-09-18 15:41:40 | 24.6 | 85 | 2019-09-19 23:41:40 | 23.6 | 119 | 2019-09-21 09:41:40 | 23.7 |
| 54 | 2019-09-18 16:41:40 | 24.5 | 86 | 2019-09-20 00:41:40 | 23.5 | 120 | 2019-09-21 10:41:40 | 23.9 |
| 55 | 2019-09-18 17:41:40 | 24.3 | 87 | 2019-09-20 01:41:40 | 23.4 | 121 | 2019-09-21 11:41:40 | 24.4 |
| 56 | 2019-09-18 18:41:40 | 24.2 | 88 | 2019-09-20 02:41:40 | 23.3 | 122 | 2019-09-21 12:41:40 | 24.5 |
| 57 | 2019-09-18 19:41:40 | 24.1 | 89 | 2019-09-20 03:41:40 | 23.2 | 123 | 2019-09-21 13:41:40 | 24.3 |
| | | | 90 | 2019-09-20 04:41:40 | 23.1 | 124 | 2019-09-21 14:41:40 | 24.1 |
| | | | 91 | 2019-09-20 05:41:40 | 23 | 125 | 2019-09-21 15:41:40 | 24.3 |

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|---|---|---|
| 126 | 2019-09-21 16:41:40 | 24.3 |
| 127 | 2019-09-21 17:41:40 | 24.1 |
| 128 | 2019-09-21 18:41:40 | 23.9 |
| 129 | 2019-09-21 19:41:40 | 23.8 |
| 130 | 2019-09-21 20:41:40 | 23.8 |
| 131 | 2019-09-21 21:41:40 | 23.7 |
| 132 | 2019-09-21 22:41:40 | 23.7 |
| 133 | 2019-09-21 23:41:40 | 23.7 |
| 134 | 2019-09-22 00:41:40 | 23.6 |
| 135 | 2019-09-22 01:41:40 | 23.6 |
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| 137 | 2019-09-22 03:41:40 | 23.4 |
| 138 | 2019-09-22 04:41:40 | 23.3 |
| 139 | 2019-09-22 05:41:40 | 23.3 |
| 140 | 2019-09-22 06:41:40 | 23.2 |
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| 142 | 2019-09-22 08:41:40 | 23.2 |
| 143 | 2019-09-22 09:41:40 | 23.3 |
| 144 | 2019-09-22 10:41:40 | 23.4 |
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| 169 | 2019-09-23 11:41:40 | 24.2 |
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