MARMARA UNIVERSITY

FACULTY OF ENGINEERING

DESIGN AND OPTIMIZATION OF A SOLAR ENERGY ASSISTED HEAT PUMP SYSTEM

BEYZA YILMAZ – 150417032

ŞABAN ÇİFTLİK – 150416027

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Supervisor

Res. Asst. MUSTAFA CEM ÇELİK

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by

Beyza Yılmaz, Şaban Çiftlik

150417032, 150416027

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Signature of Author(s) ....

Department of Mechanical Engineering

Dr. M. Cem Çelik 15.06.2022

Certified By ....

Project Supervisor, Department of Mechanical Engineering

Accepted By ....

Head of the Department of Mechanical Engineering

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ABSTRACT

The world population and accordingly the energy demand are increasing rapidly. As the demand for energy increases, the energy demand also increases. Increasing demand and some global crises increase energy prices rapidly. Turkey is in a limited position in terms of fossil/non-renewable energy resources. These resources meet a significant percentage of Turkey's energy demands. For example, natural gas is the most used non-renewable energy in Turkey. Turkey cannot produce natural gas due to a lack of resources and spends about half of the natural gas it buys to generate electricity. While these created large deficits in the Turkish economy, the Ukraine-Russia crisis also increased the natural gas prices to a high level. On the other hand, Turkey is one of the luckiest countries in Europe in terms of solar potential and this renewable resource is a great opportunity to reduce its energy demands. When used correctly, it can be a good alternative to the natural gas we heat our homes.

In this study, we designed an air conditioning system for a detached house in Istanbul. By using temperature and solar potential data for 2020, we will use a heat pump system that can meet this demand by determining the heat demand by the house. Reducing our electricity demand thanks to the heat pump. We meet the energy demand with the solar panel system we install. Thus, we believe that we have established a system that is not affected by global crises, does not harm the environment, sustainable and can keep the house at the desired temperature all year. In this report, you will see how we decided on all the components of the solar energy system and heat pump system, the combination of the systems we designed and the necessary optimizations of the entire system. In addition, you can see the results we have obtained by simulating a system that includes all parameters (temperature, sunshine duration etc.), especially the structure of the house where the system will be installed, its location and solar energy performance. We simulate the system on MATLAB. The feasibility and sustainability studies of the system will also be included in this report.

SYMBOLS

$\dot{Q}$	: Heat transfer rate
ΔT	: Temperature between inside and outside
A	: Area of heat transfer surface
BP	: Battery power
BP_c	: Capacity of battery power
BP_i	: Amount of power in battery
CoP	: Coefficient of Performance
E_{demand}	: Electric demand
$E_{gen,cap}$	: Energy generation capacity
$E_{gen,net}$	: Net energy generation
E_{grid}	: Electrical energy that sold to the grid
E_{heat}	: Electrical energy which is used in house
$E_{net,i}$	: Hourly net electrical energy situation
EoT	: Effect of Temperature on solar panel efficiency
E_P	: Efficiency of solar panel
N	: Number of different types of materials
PS	: Solar panel size
R_e	: Thermal resistance of exterior surface
R_i	: Thermal resistance of inside surface
T_{in}	: Temperature of inside
T_{out}	: Temperature of outside
U	: Heat transfer coefficient
$U_{equivalent}$	: Equivalent of heat transfer coefficient
UP	: Utility power
x	: Material thickness
Λ	: Thermal conductivity
Q	: Amount of heat transfer

ABREVIATIONS

EMRA	: Energy Market Regulatory Authority
GHI	: Global Horizontal Irradiation
IMM	: Istanbul Metropolitan Municipality
MATLAB	: MathWorks Matrix Laboratory Software
MGM	: Turkish State Meteorological Service
TSE	: Turkish Standards Institution
TÜBA	: Turkish Academy of Science
TUIK	: Turkish Statistical Institute

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1. INTRODUCTION

1.1. Heat Pump System

Heat pump systems that can both heat and cool are used to move warm air indoors in winter. It uses electricity to pump heat from a cool place to a warm one. This system works in the opposite way in the summer. Because they move heat instead of generating it, operating costs are significantly reduced.

Figure 1.1. General Heat Pump System Example

There are 3 Main Types of Heat Pumps:

Air Sources

Air source heat pumps, which are inexpensive to install and widely available, work well in temperate climates and use outside air as a medium for heat exchange.

In the working principle of air source heat pumps, the heat from the air is absorbed by a low temperature fluid. This liquid then passes through a compressor where its temperature rises and transfers the high-temperature water to the home's heating and domestic hot water circuits.

Advantages of air source heat pumps,

- Low fuel bills, especially if you are replacing traditional electric heating
- Low carbon emissions depending on the type of fuel you change
- No refuelling required
- It can heat your domestic water as well as your home.
- Requires minimal maintenance
- A ground source is easier to install than a heat pump.

There are two main types of air source heat pump systems: air-to-air and air-to-water systems.

Air to air: The air-to-air heat pump system transmits the heat it receives from outside to the fans to heat your home through air ducts. Air-to-air heating systems are slightly less likely to provide domestic hot water.

Air to water: The air to water system dissipates heat from your wet central heating system. Heat pumps operate more efficiently at a lower temperature than a standard boiler system. This makes them more suitable for underfloor heating systems or larger radiators that provide heat at lower temperatures for longer periods of time.

Water Sources

Water source heat pumps dissipate heat through water rather than air. They require access to a well, lake or other water source and are not that common.

The operating principle of heat pumps that use lakes or rivers with less depth than the sea as a heat source is similar to a ground source heat pump. Capillary tubes should be placed horizontally at a depth of at least 2.5 m. The antifreeze water mixture circulating in the pipe with the help of a pump transfers the energy it receives from the heat source to the heat carrier fluid circulating in the heat pump. The heat carrier fluid also transfers its energy to the heating and domestic hot water systems.

Advantages of water source heat pumps,

- Low fuel bills, especially if you are replacing traditional electric heating.
- Depending on the type of fuel you replace; carbon emissions are low.
- No refuelling required.
- It can heat your domestic water as well as your home.
- Requires minimal maintenance.
- An air source is more efficient than a heat pump but costs more.

Ground Sources

Through a deep ground loop, a ground source heat pump circulates a mixture of water and antifreeze around your garden. Heat from the earth is absorbed into the fluid and then transferred to the heat pump using a heat exchanger. Because the ground temperature remains constant below the surface, the heat pump can be operated for many years.

Normally, the ring is coiled horizontally or in two-meter-depth holes, but if you don't have enough space in your garden, a vertical ring up to 100 meters deep can be created. Heat pumps have an environmental impact since they require electricity to function, yet heat from the ground, air, or water is restored naturally.

Advantages of ground source heat pumps,

- Low energy costs, particularly if you're substituting electric heating.
- Carbon emissions are low, depending on the type of gasoline you substitute.
- There's no need to refuel.
- It can heat both your home and your domestic water.
- It requires very little upkeep.
- An air source heat pump is more efficient than a heat pump, but it is also more expensive.

Components and Thermodynamics of a Heat Pump

The evaporator, compressor, condenser, and expansion valve are the main components of a heat pump.

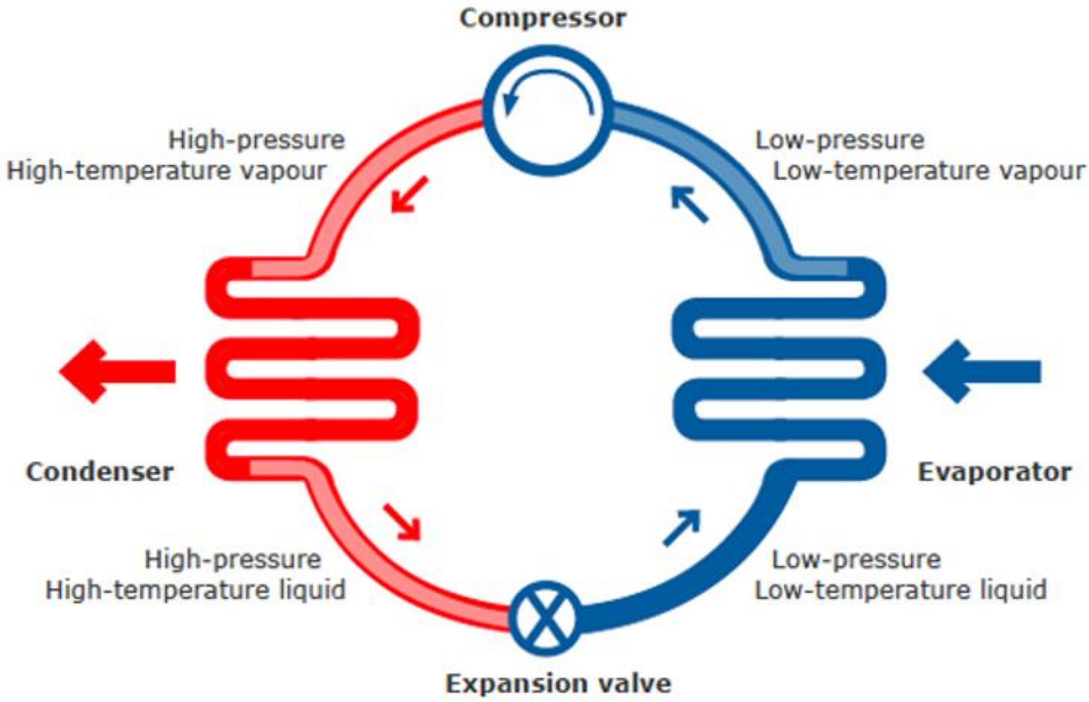


Figure 1.2. Heat Pump Working Principle

The working fluid is transformed to gas and heat energy is extracted from the evaporator side of the heat pump. As the gas liquefies and returns to liquid, the condenser side releases heat energy into the environment. The cycle then repeats again, and so on.

Working Principle of Heat Pump

A heat pump is a system that uses energy from the outside to transfer heat from a low-temperature to a high-temperature environment. The heat pump that provides heat in the winter can also provide cooling in the summer. When in heating mode, the heat pump cools the source of energy it receives, and when trying to cool, it heats. The process involves extracting energy from the gas phase change and transporting it. During the transfer and phase change, some energy is consumed. During the transfer of energy from the source to the heated or cooled environment, heat pumps consume some electrical energy

1.2. Solar Energy System

A solar panel is a system that converts the energy of sunshine into electricity. Photovoltaic semiconductor silicon cells in solar panels transform sunlight into electrical energy. The voltage generated by a silicon cell is approximately 0.5 volts. The desired panel voltage and current value are achieved by soldering the cells in series.

Figure 1.3. Roof Type Solar Panel

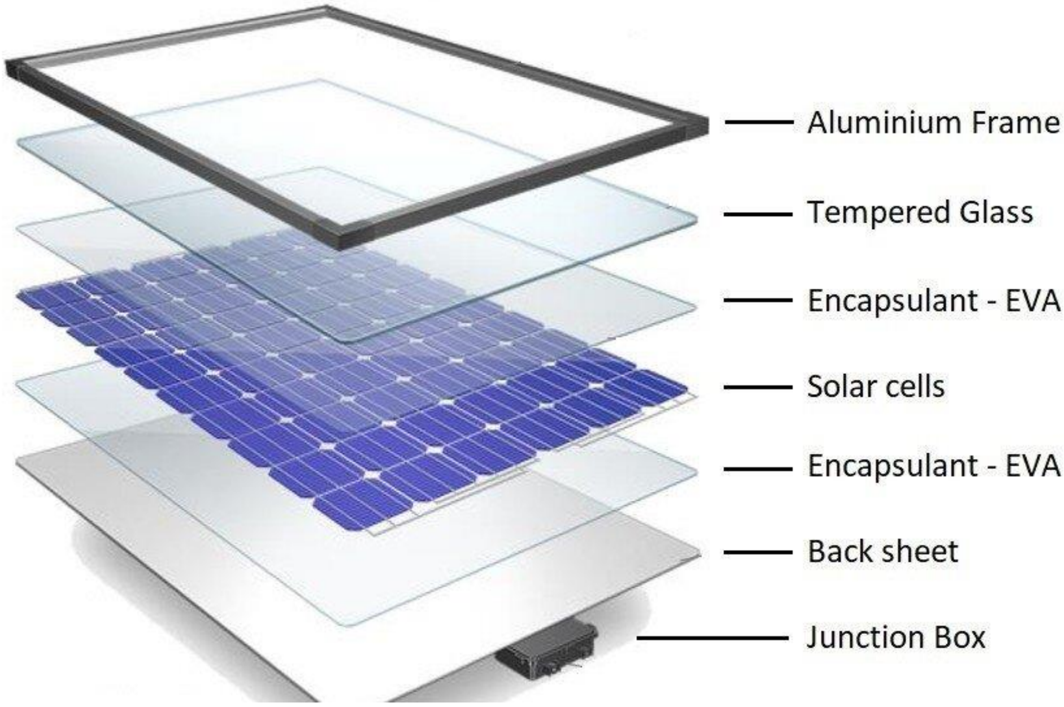


Figure 1.4. Structural Elements of Solar Panel

As seen in Figure1.4., it consists of an outside to the inside, the solar panel is made up of an aluminium frame, tempered glass, encapsulant-EVA, solar cells, encapsulant-EVA back sheet, and a junction box.

Structural Elements of Solar Panel

Aluminium Frame

Because of its conformity with industry size standards and the diversity of connecting devices, the aluminium frame protects the panel from physical forces, offers the essential structure for assembly, and allows for easy assembly. A watertight insulating substance is layered between the frame and the glass.

Tempered Glass

The strong impact resistance of tempered solar glass protects the panel against hail, wind, stone, and other similar object impacts. Another advantage of glass is that its surface is designed to allow the majority of sunlight to pass through. However, some light is reflected into the atmosphere by the glass.

Encapsulant-EVA

EVA (Ethylene Vinyl Acetate) is a unique coating that holds the parts together by filling the gap between the glass, cells, and backing foil. EVA, which is applied to both sides of the cells during production, is melted and completely surrounds the cells using the hot lamination method.

Back Sheet

The back sheet insulates the panel's backside and is specially designed to allow the panel to operate at optimal temperatures. The junction box is IP64 waterproof and incorporates panel wiring as well as a bypass (bridging) diode.

Junction box

The junction box is IP64 waterproof and includes panel wiring as well as a bypass (bridging) diode. When a shading or defect happens in one of the panel cell series, the bypass diode ensures that the rest of the panel continues to generate electricity.

Types of Solar Cells

Monocrystalline Solar Cells

Silicon material with a monoatomic crystal structure and a homogenous structure is used in its construction. It has a smooth texture and a dark tone. It is the most energy-efficient solar panel available on the market. Their efficiency is between 22-23%. Production waste is high due to its structure; hence its cost is also high. Its lifespan is greater than that of polycrystalline panels. It is suggested for usage in boats, caravans, and other applications with limited space

Polycrystalline Solar Cells

It's a form of solar cell made from silicon with a crystal structure that contains more than one atom. The interior is noticeably wavy, and the cells are a lighter blue tone. Their efficiency is between 16-18%. They are 25-30% less expensive than monocrystalline panels. It's the most used cell type on the market today. When choosing a solar panel, polycrystalline panels are preferable if there are no major space constraints.

Thin Film Solar Panel

Thin-film solar panels are low-cost and have a low efficiency of 10%. It has the advantages of being light, being able to be applied to building surfaces, being least impacted by regional shading, and not losing efficiency at high temperatures. However, because of its low yields, it is not widely used because it takes up a lot of space.

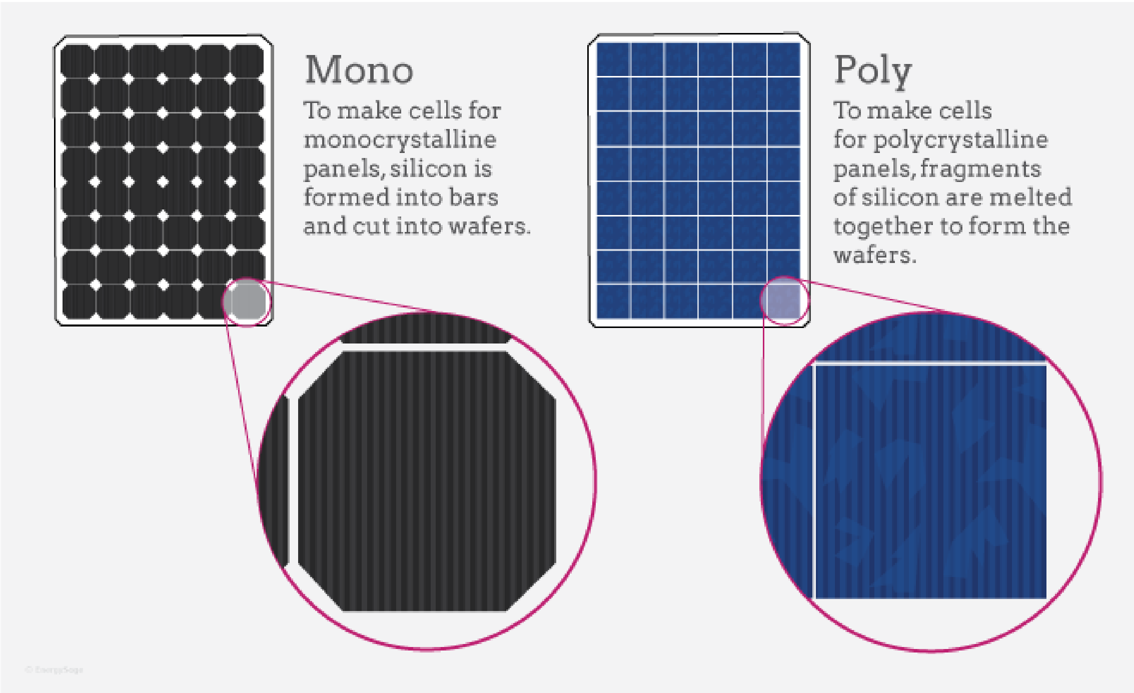


Figure 1.5. Difference Between Monocrystalline and Polycrystalline Solar Panel

The Solar Panels Electricity Production Flow

- Solar panels that absorb sunlight are known as photovoltaic (PV) panels. Each solar panel contains photovoltaic (PV) cells. Photovoltaic cells (PV cells) convert light (photons) into electricity. PV cells begin to work when sunlight strikes the solar panel, producing direct current (DC) electricity.
- DC electricity does not have the ability to power itself. It's sent to the inverters, which are where the rest of the solar energy equipment is kept.
- The electrons begin to move when the sun's rays interact with the silicon cell.
- The nodes capture electron transport and trigger the flow of electric current through the panel's wires.
- Solar cables carry direct current (DC) electricity to a solar inverter, where it is converted to alternating current (AC).

2. LITERATURE REVIEW

2.1. Solar Energy in the World/Turkey

Renewable energy sources are easily accessible and clean to the environment. Solar energy is one of the best forms of renewable energy, particularly for a country such as Turkey. On rare occasions, Turkey imported extra natural gas (to convert to the electricity half of the natural gas) and experiencing power (gas and electricity) cuts, yet Turkey has abundant sunshine almost all year round that could be converted to electric power. In this section, we will not go into the components and types of the solar energy system (you can find it in section 1.2.). You will find Turkey's and the world's research on solar energy.

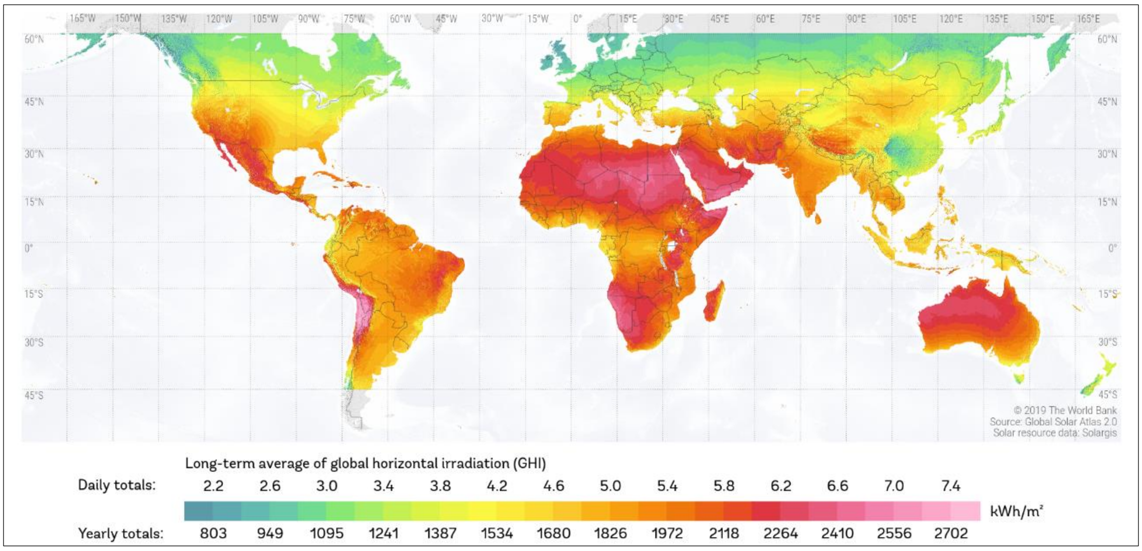


Figure 2.1. Global Horizontal Irradiation (GHI) of World

Solar Irradiance

The power from the sun that reaches a surface per unit area is referred to as solar irradiance. The part of the solar irradiance that reaches a surface directly is called direct irradiance; the part that is scattered by the atmosphere is called diffuse irradiance, and global irradiance is the sum of both diffuse and direct components reaching the same surface. Solar irradiation, on the other hand, refers to the total amount of energy received from the sun per unit area over a given period.

- GHI, Global Horizontal Irradiation
- DNI, Direct Normal Irradiation
- DIF, Diffuse Horizontal Irradiation

GHI and DIF refer to a horizontal surface, whereas DNI refers to a perpendicular to the Sun surface. Higher DIF/GHI ratios indicate more clouds, pollution, or water vapor content in the atmosphere. Companies use Solar GHI to compute flat-panel PV output. The PV potential is defined in the unit kWh/kWp and indicates the kWh of electricity that would be generated by a PV system with a 1kW peak installed capacity.

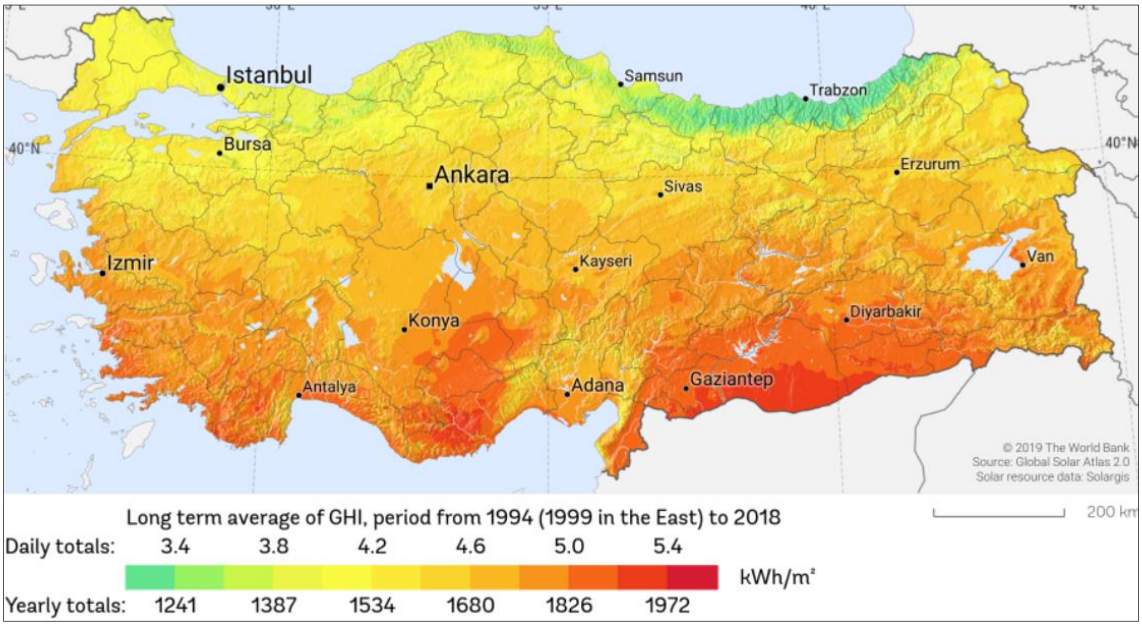


Figure 2.2. GHI of Turkey

However, there is no long-term GHI data for Turkey and Istanbul. That's why we started researching for a city/country where we can find these data as often as desired, located in parallel with Istanbul and close in location. As a result of our research, we reached the data of the Dutch company Solcast. When we examine the Netherlands and Turkey by taking different dates as examples, a constant difference is observed in the GHI data. This rate is around 25 percent. In other words, 125 percent of the Netherlands' GHI data is equal to Istanbul's GHI. In our simulations and calculations, we multiplied the GHI data from Table A.2 by 1.25 and made it suitable for Istanbul.

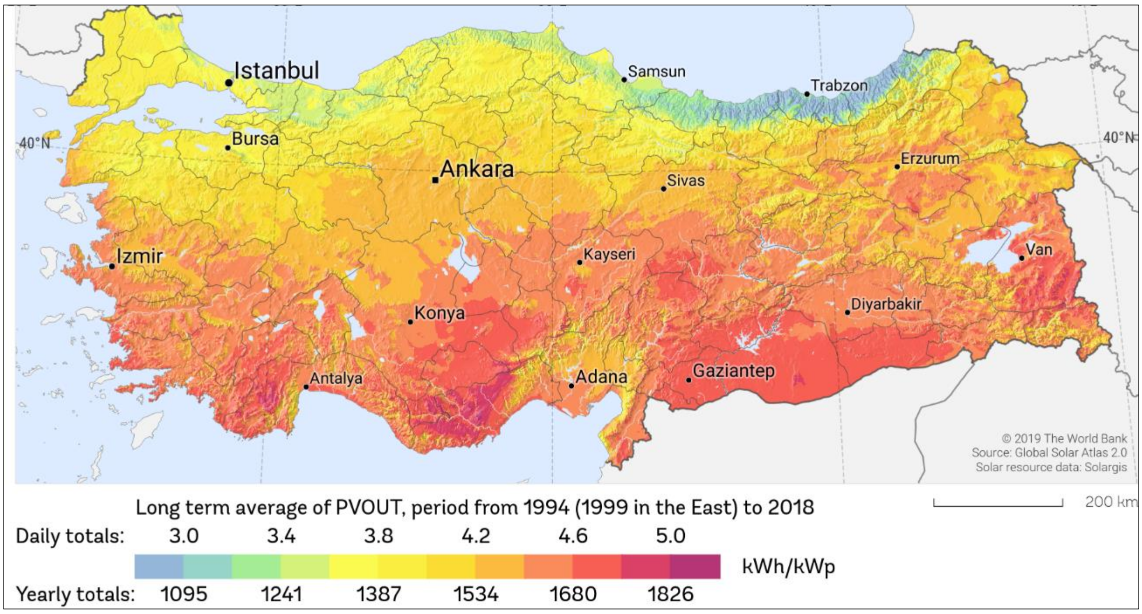


Figure 2.3. Photovoltaic Power Potential

According to the research of the World Bank, Turkey is one of the best countries in the world for solar potential, excluding deserts.

Energy Rates in the World

The ratio of energies produced in the world; 79% fossil fuels, 7% renewable energy, 7.5% hydroelectric, 6.5% nuclear energy. The ratio of solar panels is between 2-2.1%. Energy consumed for heating and cooling in the world; constitutes about half of the total energy consumed. In Europe, this rate is 46%. Only 18% of the heating and cooling demand is met from renewable energy sources, mainly from biomass and solar energy. Approximately 68% of the remaining amount is met by natural gas and fossil fuels, and 14% by electrical energy. There are similar rates for Turkey as well. In this case, for the use of solar energy technologies in heating and cooling applications in Turkey; In terms of thermal technologies, there is an opportunity of approximately 30% of our total energy consumption, and approximately 14% in terms of Photo Voltaic technologies.

In other words, to summarize, we have the potential to meet 44% of our total energy consumption with solar energy.

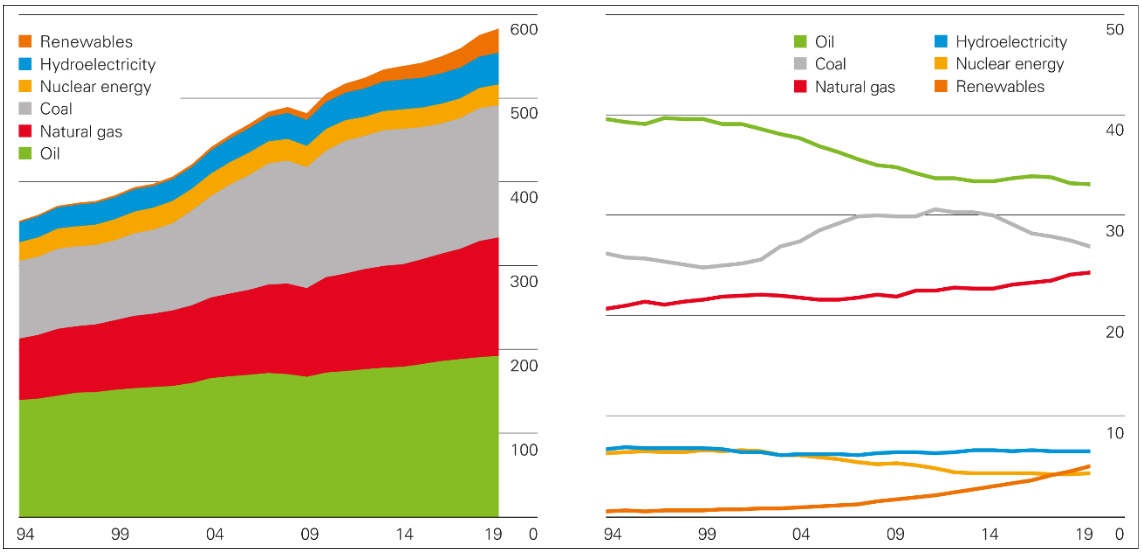


Figure 2.4. Primary Energy Sources of the World

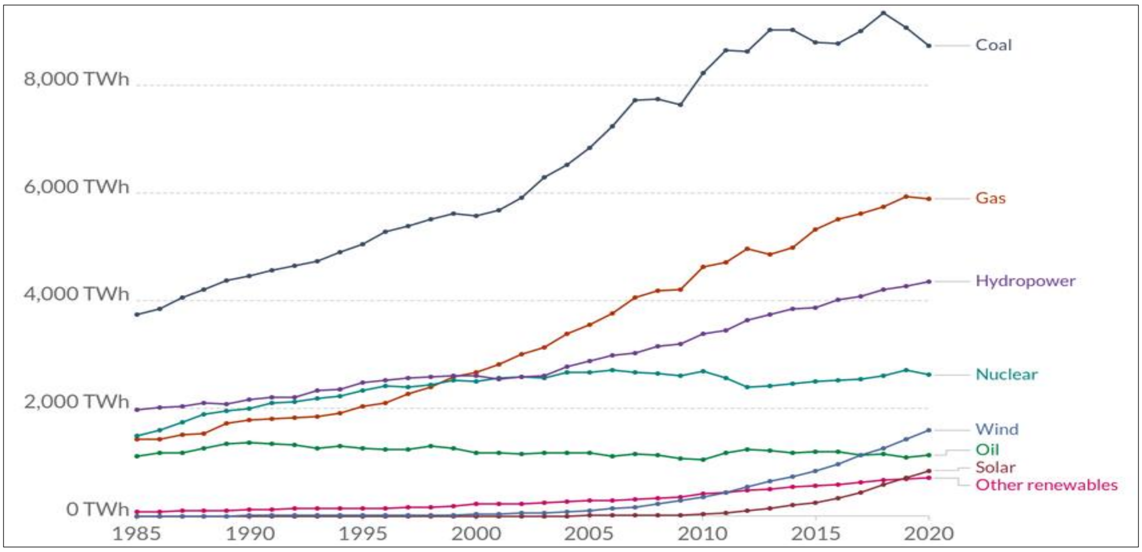


Figure 2.5. Distribution of Electricity Generation by Resources

2.2. Heat Pump

The basic theory of the heat pump cycle, which is essentially a refrigeration cycle, was first presented in 1824 by Nicolas Léonard Carnot. The heat pump was invented 26 years later, in 1850, when Lord Kelvin proposed that cooling devices may be utilized for heating. II. Many engineers and scientists undertook research and study in this field prior to World War II in order to develop and make the heat pump functional. These projects were put on hold during the war years as the industry focused its energies on more pressing issues, but they were restarted after the war.

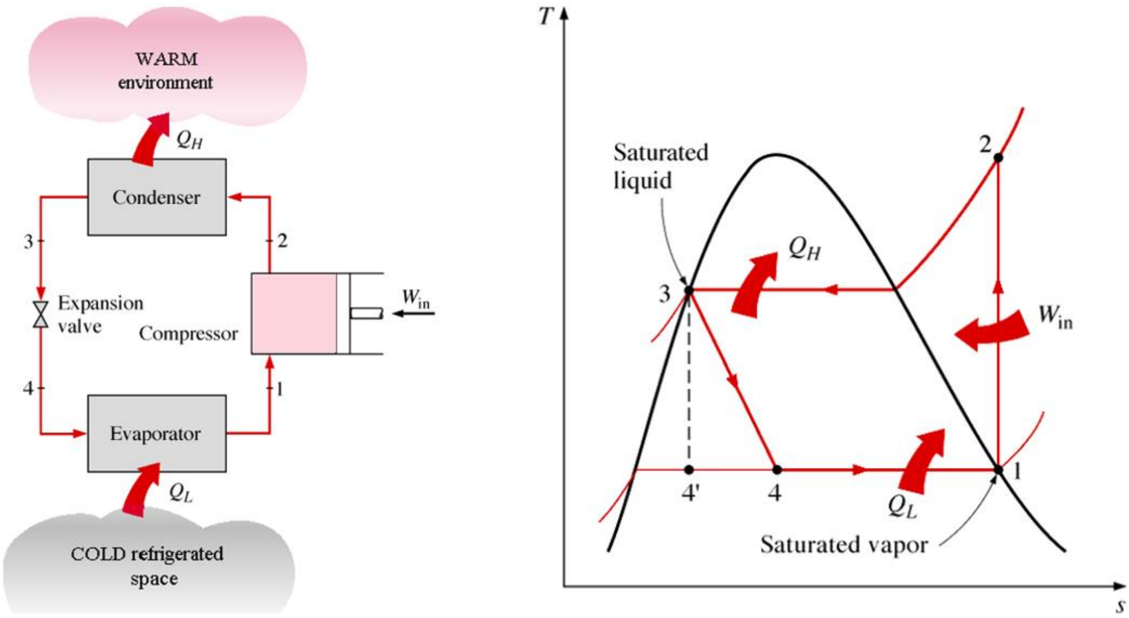


Figure 2.6. Heat Pump Working Principle and Carnot Cycle

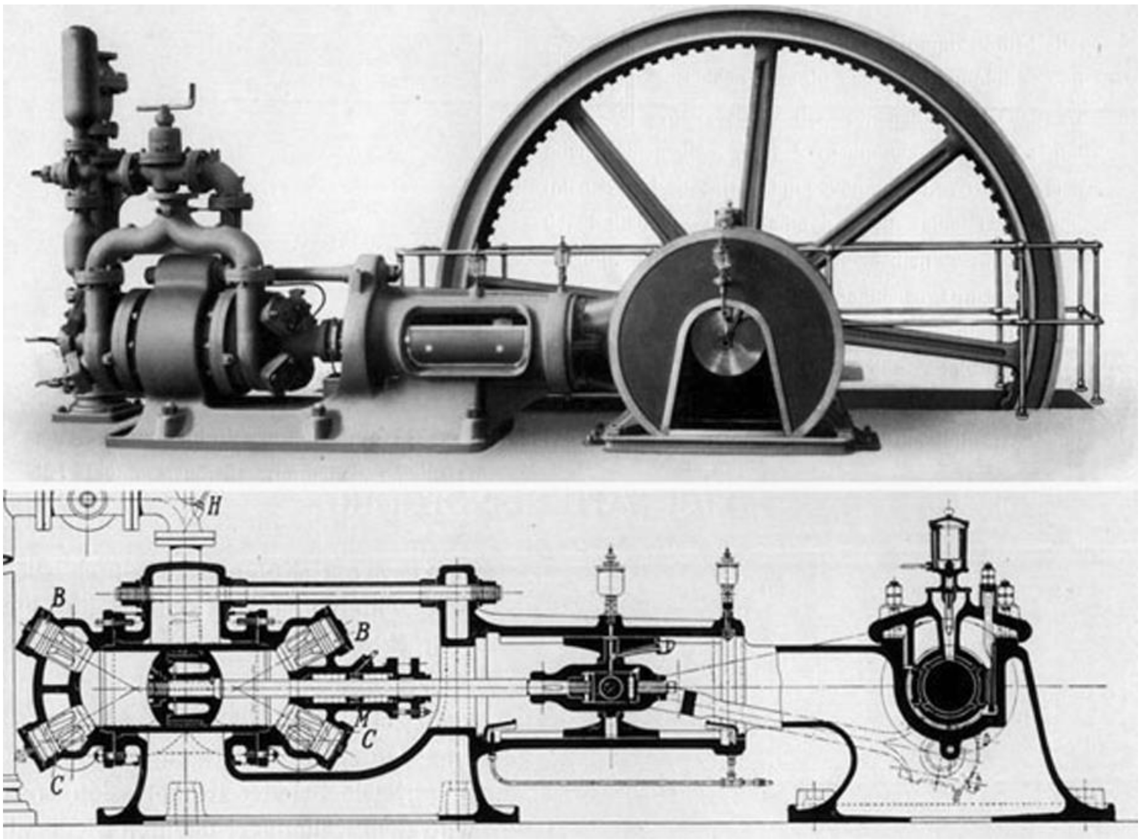


Figure 2.7. Sulzer Piston Compressor (1905)

In the Baumberger factory in Langenthal, Escher Wyss erected a heat pump in 1941 that used both heat (flushing and space heating) and cold (cooling) (production of ice and cellar cooling). Sulzer created refrigeration facilities that used both heat and refrigeration at the same time. The systems deployed at a Widnau artificial silk producer, and a Basel industrial butchery are two examples. Total CoP values of up to 5.5 have been reached with these double-benefit methods. Due to the promise of the heat pump industry in the 1950s, the high cost of setup, and the cheapening of energy based on natural gas and oil, confidence in the heat pump waned in the 1960s. After the 1973 energy crisis, heat pumps became more important, and several research have been conducted since then. The heat pump operation was halted for 13 years as a result of the completion of a waste incineration facility and the rapidly decreasing oil price during the oil crisis. Sulzer constructed and started up a new turbo heat pump with a heating capacity of 6.5 MW in 1985/1986. Many attempts were made in the 1980s to produce an absorption heat pump with a heating capacity of less than 50 kW. Batch absorption cycles have been researched for solar energy drive in particular. Small absorption heat pumps, at least in the heat pump application, were a commercial failure.

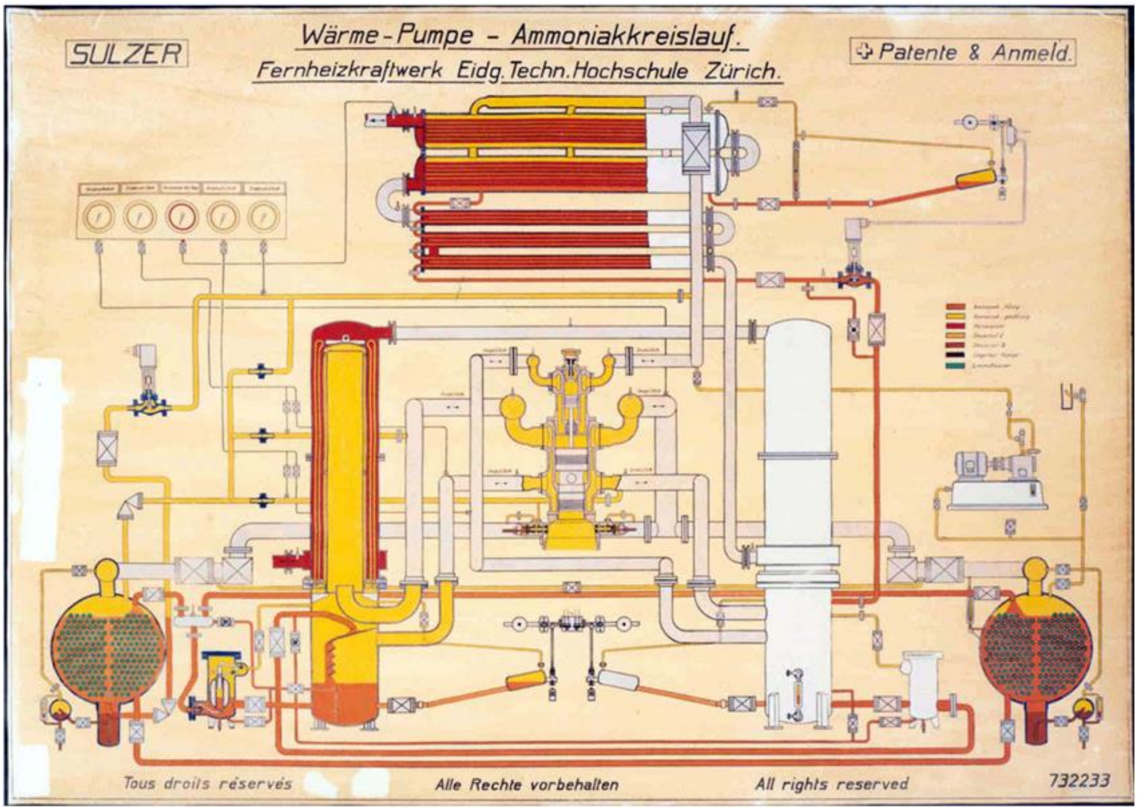


Figure 2.8. Sulzer Heat Pump With 3 Three-Stage Piston Compressors (1942)

Its usage has grown in popularity in Europe and America, particularly since the 1990s, and the number of users is growing by the day. However, as with every other issue, our country was late to adopt this technology, and despite all of the benefits afforded by the heat pump, a large number of consumers could not be reached. In the mid-1990s, heat pump applications were first implemented in Turkey. In Turkey, heat pump users are mostly persons who have encountered this system overseas, seen its benefits, and maybe experienced it firsthand, and have begun using it by requesting it when they return to Turkey. For a variety of factors, including the depletion of fossil fuels, the sharp increase in their prices, and the rise in environmental awareness, it is unavoidable that the heat pump will become widely used in our nation in the not-too-distant future.

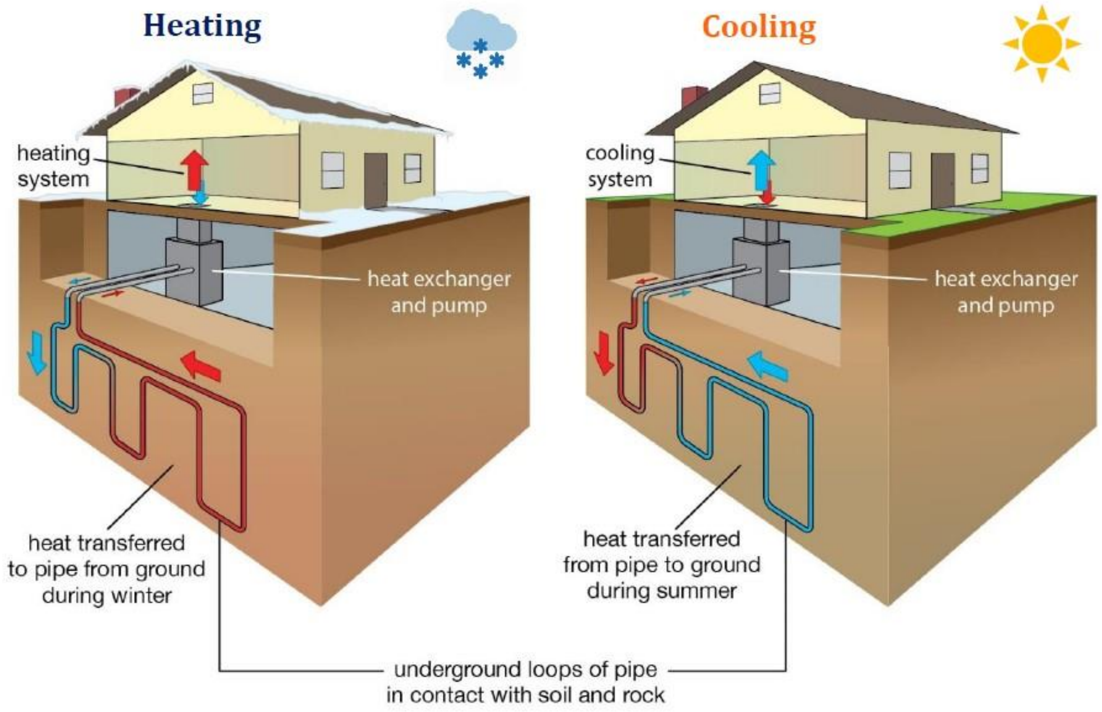


Figure 2.9. Modern Ground Sources Heat Pump Example

Similar to the project we will do, we can cite an example of the master's thesis Asma Nadaf's. In this thesis, an air source heat pump was used. Compared to a ground source heat pump, the installation phase is shorter and less costly. By examining this thesis, we made some revisions in our own system. In another article, the heat loss and heat gain values of a villa in Istanbul Hadimkoy were found and dimensioning calculations were made with a vertical type of ground source heat pump for both heating and cooling. The heat given to the soil by a meter of drill pipe in the summer season is 0.067 kW. The cost comparison of the heat pump system, which has a cost according to the 'Cost to a Value' method, with the air source heat pump system (for the same heat loss and gain) has been tabulated. It has been found that the initial investment cost of the vertical type ground source heat pump is 6% higher, the operating cost is 43% lower and the annual total cost is 19% less than the air source system.

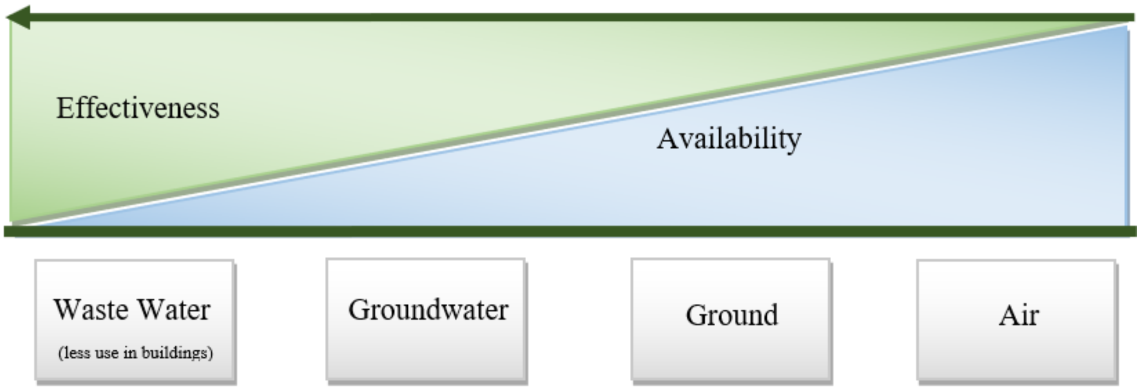


Figure 2.10. Effectiveness & Availability of The Heat Pump According to Source Types

While the availability of air source heat pumps is high, its effectiveness is low compared to other types. The ground source heat pump we chose is average in effectiveness and availability. This is one of the reasons why we chose this resource.

2.3. Solar Panel

We've come a long way from attempting to harness the sun's power through various experiments. Solar panels are now utilized to generate electricity by capturing the sun's power, due to years of scientific research. Solar photovoltaic devices are what we call the solar panels we use nowadays. The term "photovoltaic" refers to the photovoltaic effect, which occurs when a substance, such as silicon, is exposed to light and creates energy via electrons. Although the sun's energy potential and application have been known for millennia, it is only recently that the full scope and potential of the photovoltaic effect has been realized.

During the 1973 oil embargo, when gas shortages were widespread in the United States, solar power appeared to be a "better option than fossil fuels" for the first time. President Jimmy Carter encouraged Americans to save energy and began to promote investments in photovoltaic technology. It even installed solar panels on the roof of the White House. Solar power is currently less expensive than coal, making it more cost-effective to invest in renewable energy sources such as solar arrays rather than fossil-fuel power plants. The price of natural gas increased by 2-3 times as a result of the Russia-Ukraine dispute.

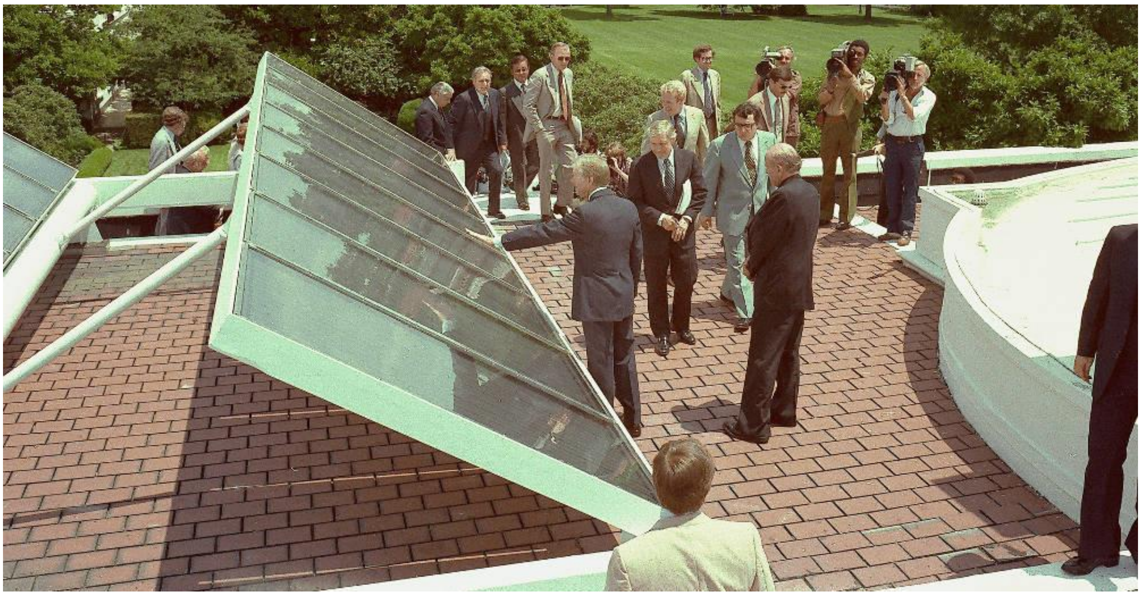


Figure 2.11. Solar Panels on the White House Roof (1979)

Alexandre E. Becquerel constructed the first solar cell, known as a photovoltaic cell, capable of carrying an electric current from light, in 1839 while working with metal electrodes and an acidic solution. Charles Fritts invented the first solar panels in the 1880s, using selenium sheets as solar cells. Willoughby Smith discovered that selenium is photovoltaic. The first solar panels were installed on a New York City roof, but they were inefficient, converting only 1% of the energy they collected.

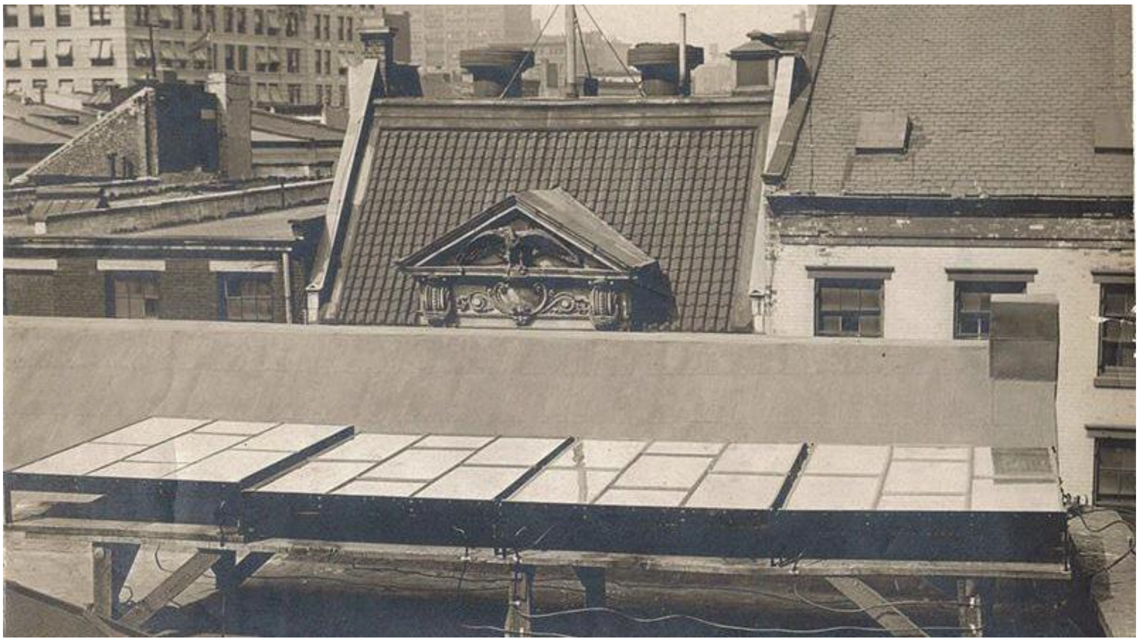


Figure 2.12. First Solar Panel (New York 1883)

Solar energy is the dominant clean energy technology for venture capital and private equity investment, with global investment in clean energy exceeding $100 billion. PV modules have dropped in price from around $5 per watt to under $1 per watt, owing to continued substantial subsidies in Germany and new subsidy plans in Spain, Italy, and Australia. Following that, Chinese manufacturing businesses began to construct big automated solar cell and solar module manufacturing plants, lowering module costs even more to $.70 per watt. As the world embraces more renewable energy, solar panels will continue to grow in popularity and be necessary for the transition off of fossil fuels.

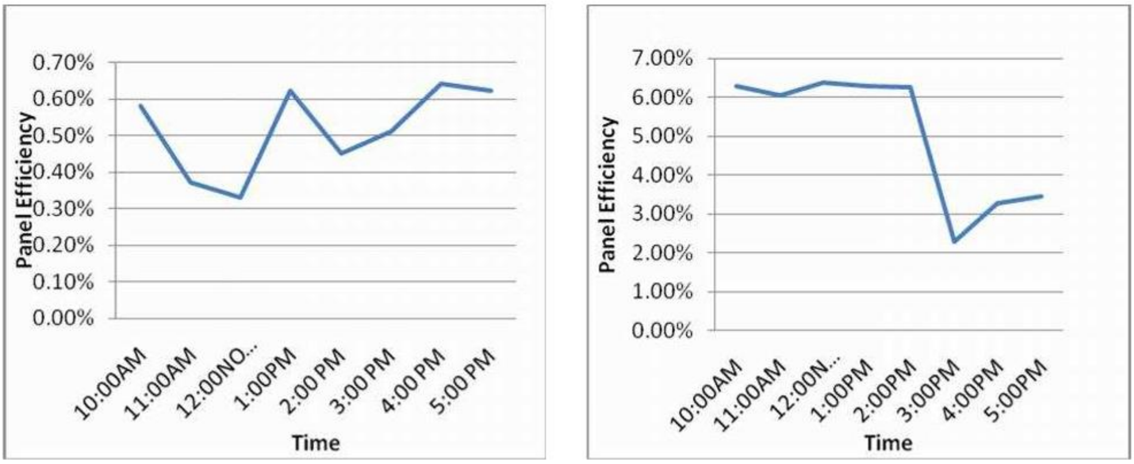


Figure 2.13. Dust effect on Panel Efficiency (Clean Left - Dusty Right)

In a study by Sudhakar, the effect of pollination on panel yield was measured. In our opinion, an important shortcoming of the study is that they did not make this loss of efficiency on the panels that were cleaned and not cleaned frequently, and rain, humidity, winds were not taken into account. One of the most important problems, clouding, has not been considered. However, the fact that the decrease was around 90% made us think about this issue and we found it right to add the periodic cleaning cost to the costs. Thus, we will not experience such a loss of efficiency. Considering dusting/humidity/wind/cloud, similar studies were examined and as a result, we decided to take our solar panel efficiency as 15%, which was 19-20%. In other words, we reduced our panel efficiency by 25%. This will give us a more realistic result.

3. DESIGN OF SYSTEMS

System design will be one of the most common issues we will face in our engineering careers. While designing this system, we conducted a comprehensive literature review as you can see in section 2. So, we began by deciding on our home system. The accessibility of comprehensive information on location, temperature data, and solar capacity were all important factors in our decision. After we decided on our home system with all the details, we calculated the energy requirement of the house system throughout the year, so it became easier for us to decide on the heat pump system we need.

We decided on the components we wanted to use in the heat pump system. Our biggest motivation in this selection was to create a long-lasting and efficient system without increasing the installation cost too much. On the other hand, we think that our heat pump system should work with minimum energy with maximum efficiency. The low required electrical energy will reduce the installation cost of the solar energy system. After finishing the component selections and calculations of the house and heat pump systems, we found the amount of electrical energy we need.

In the solar energy system, we prefer simple, inexpensive systems to install, and most importantly, have a very low probability of failure, instead of expensive, complex systems that are likely to fail frequently. Thus, we chose to design a user-friendly system. We combined these three systems by designing an optimum system that complies with the features mentioned above and complies with our calculations. To summarize, we decided on our home system, made energy calculations on the system, and optimized it according to the results, and established a tailored home system. Then we decided on an adequate pump system for the house, performing the same process in the heat pump, with optimized energy requirement results. We designed a solar system suitable for the electrical energy required by the latest heat pump. You can find all calculations in the final and intermediate steps in section 4. In this topic, you can find the reasons and details of the systems we have chosen.

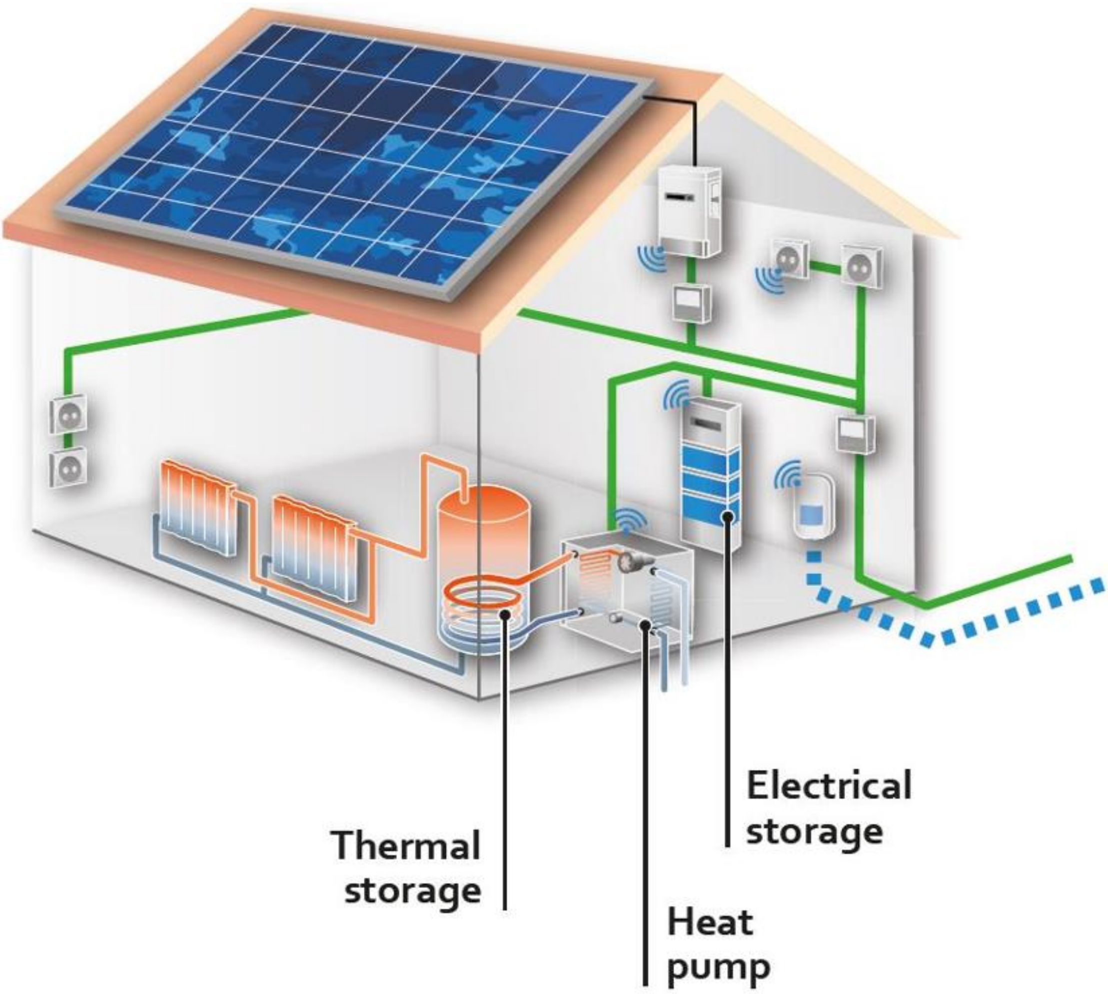


Figure 3.1. General view of Our System

3.1. House System Details

Considering the population distribution in Turkey, we thought it would be healthier to choose a region where more than 16 million people live as a pilot region. Therefore, the city of Istanbul was chosen as the location. There are sensors in Istanbul that collect many temperature data. These data are made in cooperation with MGM and IMM. We also found it appropriate to choose the sensor close to Marmara University's central campus. You can see the table of these data in Table A.1. When it comes to house design, since we are going to install a ground source heat pump system, space is needed for both the system that is the pipe for the liquid to pass through, and the solar energy system that needs to be installed on the roof. The suitable building type in Istanbul is detached buildings. Therefore, the suitable building type to install our system is detached buildings. We used a detached building in the system we simulated.

Figure 3.2. Detached House in Istanbul

As it is known, there are 4 heat zones in Turkey. According to these regions, the types, quantities, and roof types of the materials used in the houses vary. Depending on these, the thermal transmittance (U-value) coefficients change. According to TUIK, the highest number of people in Istanbul and Turkey live in the 2nd heat zone. This is one of the main reasons for our choice of city.

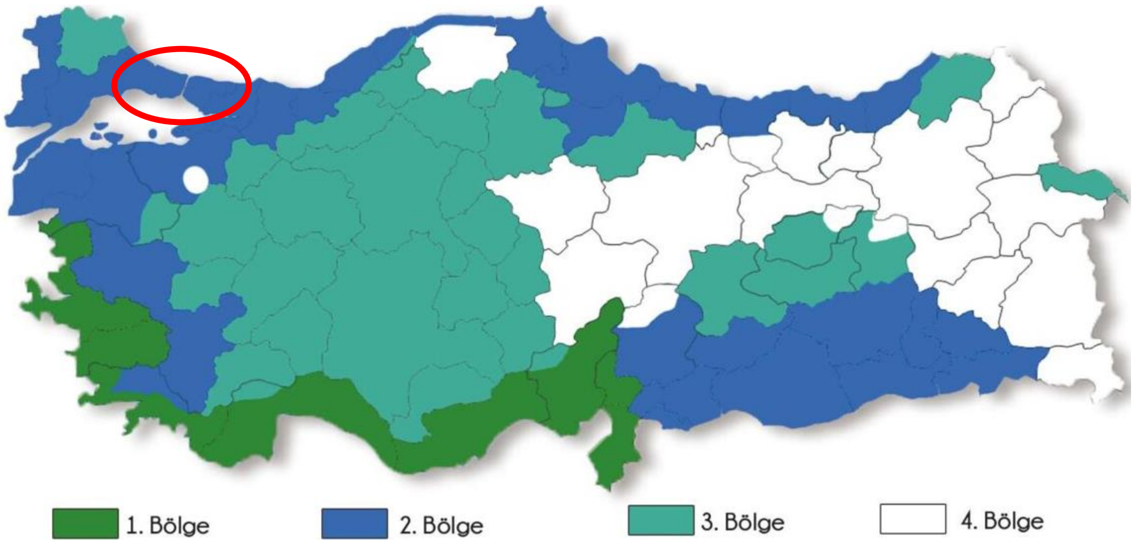


Figure 3.3. U-value maps of Turkey (Blue colour = 2nd Heat Zone)

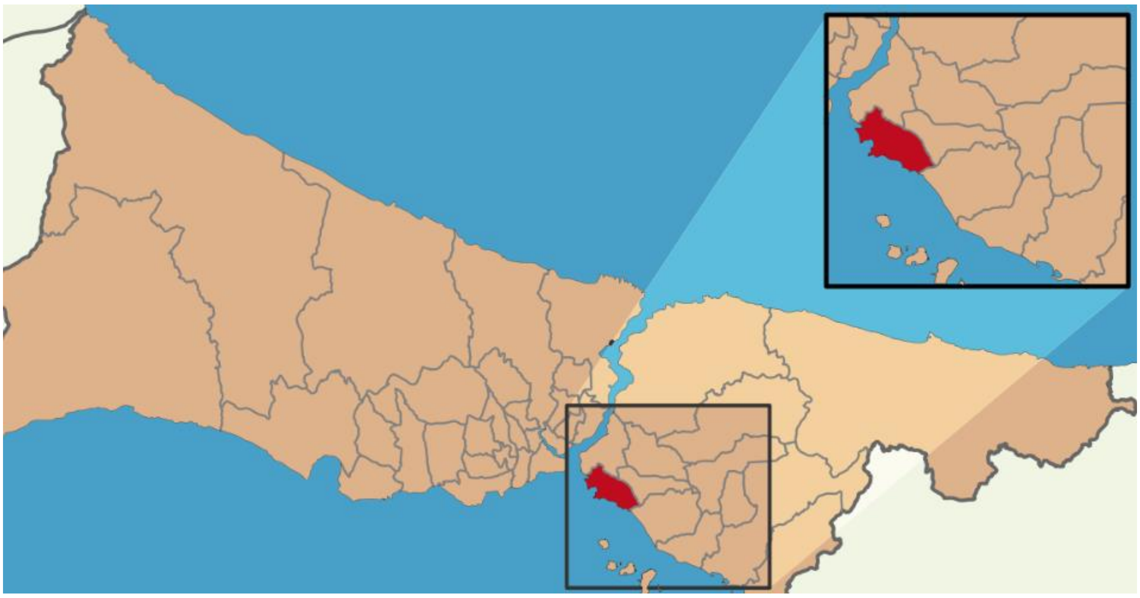


Figure 3.4. Location of the sensor where temperature data is collected. Kadikoy/Istanbul

In the report of the Turkish Standards Institute named TSE 825, the distribution of the heat zones in Turkey, the expected U-value according to these heat zones, and more importantly, the materials needed for the buildings to be established in these zones are written in detail. We determined the most suitable building materials for Istanbul, where we examined the report, and collected them (you can see in Table 3.1).

Table 3.1. Building Materials and Details Table

Heat losing surface	Structural elements in the building	Thickness d(m)	Thermal Conductivity λ_h (W/mK)	Thermal Resistance R(m^2K/W)
Wall	R_i			0.13
	Plaster	0.02	1	0.02
	Horizontal perforated brick	0.19	0.36	0.528
	Heat insulation material	0.04	0.035	1.143
	Plaster	0.008	0.35	0.023
	R_e			0.04
Ceiling (With Roof)	R_i			0.13
	Plaster	0.02	1	0.02
	Reinforced concrete	0.12	2.50	0.048
	Heat insulation material	0.08	0.04	2.0
	R_e			0.08
Ground	R_i			0.17
	Hardwood fibre board	0.005	0.13	0.038
	Alum	0.03	1.40	0.021
	Heat insulation material	0.04	0.03	1.333
	Levelling alum	0.02	1.40	0.014
	Lightweight concrete	0.1	1.10	0.091
	R_e			0

When the data received by TUIK is examined. The average square meters of detached buildings in Istanbul are between 130-170. That's why we imagined a single-storey building of 150 m^2 (10m*15m) and decided that the wall height of the house would be 3 meters. We did not find it very accurate to go into the details of the number of rooms, because we saw that the heat losses of the buildings are a collective loss rather than the number of rooms and their layout for the building.

Since it is a detached building, we decided to make one exterior door and one garden door. Again, we chose these doors and windows from the TSE 825. Exterior doors are usually steel supported due to security and privacy issues. The garden door is glass supported due to the removal of privacy problems. This increases the U-value.

Figure 3.5. Exterior Door (left) and Garden Door (right) Example

Choosing the doors was easy because most of the doors are fixed and uniform. However, the choice of windows is a matter entirely left to us. As a result of the choices, we made based on the two tables (TS 2164 6A/6B) mentioned in the same report.

- Double glazed (4mm glass thickness),
- Low-E coated,
- 12mm gap between glasses,
- Argon gas,
- PVC joinery (3 chambers).

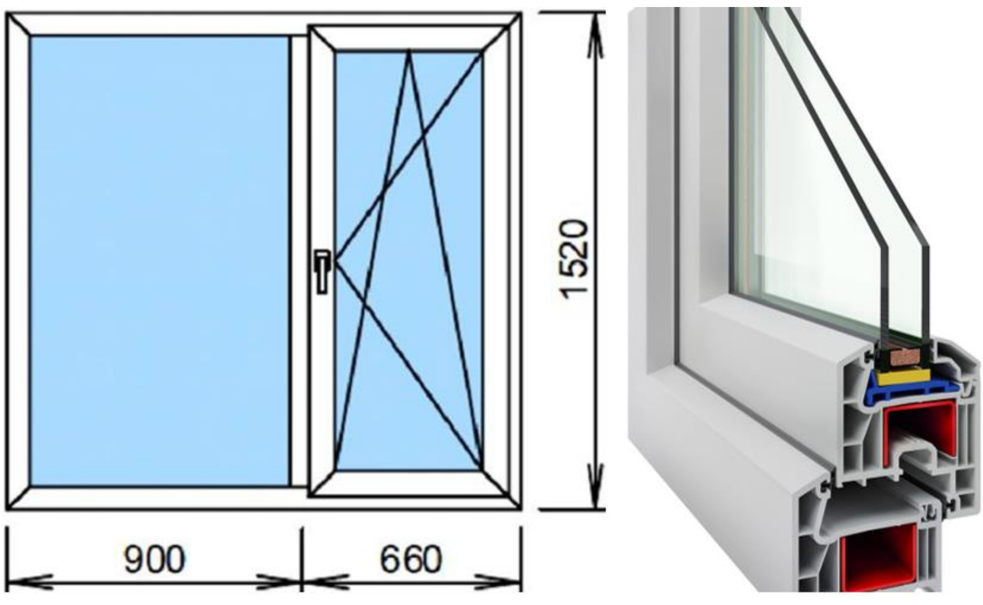


Figure 3.6. Window Dimensions and Details

When the tables are examined as a result of these elections. It was observed that the U-value of the windows was 2.1. We think that it is sufficient to use 4 such windows. In Section 4.1, appropriate calculations were made by considering all these parameters of the building.

3.2. Heat Pump System Details

Heat pumps are becoming increasingly popular in Turkey. It has a number of advantages, including increased energy efficiency and a lower carbon footprint. We chose the ground source heat pump based on the information we gathered during our literature review. They perform considerably more efficiently than other species due to the consistent temperature of the earth, and they require less upkeep. As we all know, there are two types of ground source heat pumps. There are two types of these: horizontal and vertical. In our report, we preferred to dig vertical boreholes. The soil temperature does not fluctuate significantly with the seasons as you go deeper into the soil, which lowers the changes in the CoP value of the heat pump and requires less soil area than the horizontal piping system. We shall employ vertical boreholes for these reasons. Two tiny diameter polyethylene tubes will be used in this method, which will be inserted into the excavated borehole. Depending on the environment and the equipment employed, the depth of this borehole should be between 15-200m. In our report, we'll dig a 100-meter (ideal) borehole and insert the tubes. We preferred a ground source heat pump in this report. The ground source heat pump is generally not preferred in Turkey. This is because of the high initial cost due to the pipes laid under the ground. The ground source heat pump is more efficient than other sources. In our report, we preferred the ground source one.

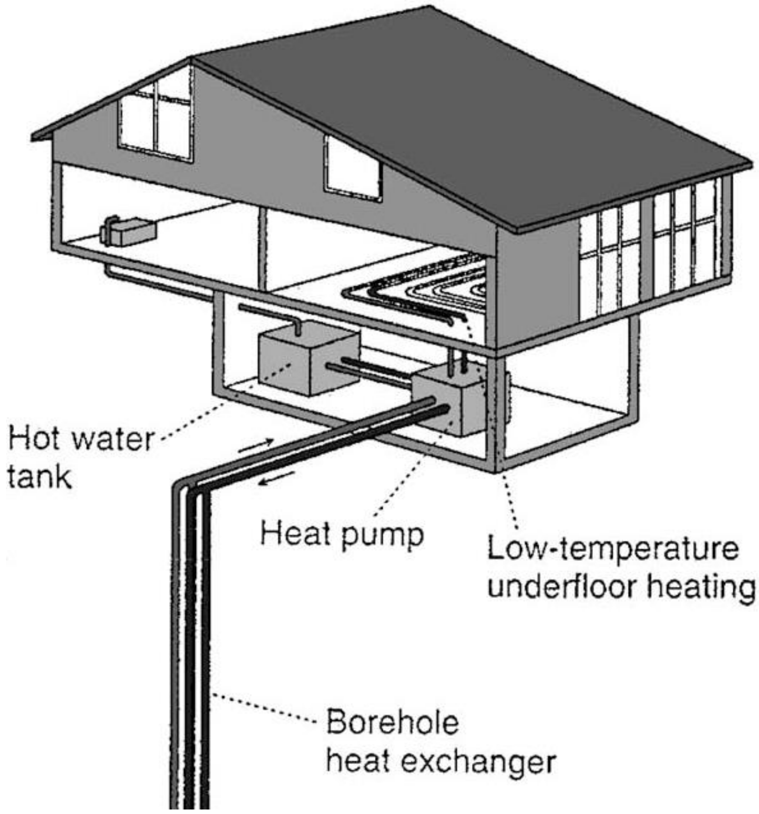


Figure 3.7. Vertical Ground Sources Heat Pump

Our analyses and simulations revealed that our hourly heat demand is no more than 4.5 kW you can see in Figure 5.7. The NIBE S1155-6 heat pump is an excellent choice for this application. It's a 6-kilowatt heat pump. This heat pump will be used for both heating and cooling. These processes will be carried out using the fan coil system. We use this system mostly because we will be cooling as well as heating. For these reasons, we'll be using the DAIKIN FWV-DAF model. In terms of mounting and cleaning the air filter, it is more suitable for villa use than other fan coil kinds. A pump is also required to circulate the water in this system. We selected with the ETNA ECP 25-10-180 model for our pump. We selected with a frequency-controlled product since it uses less energy than standard 3-speed circulation pumps.

3.3. Solar Energy System Details

After deciding on the heat and electricity demands of the house, it was time to design the solar energy system. First, as we mentioned in Section 1, we started with the building blocks of the solar panel. The most important factor was its yield and size. There is a lot of misinformation about this. Doubling the number of cells is thought to double the panel efficiency as well, and companies claim they use a large number of cells by using it. Another similar misconception is that the Watt amount is told directly by the company. This wattage is misleading for people with a fixed production target. When we researched according to these criteria, we thought that the 6 pieces of LG Neon LG400N2W-V5 would be suitable for us. It is one of the leaders in the market with its 2 m^2 surface area and 19.2 percentage efficiency (The fact that silicon is monocrystalline is effective in this). We used the yield as 15 in transactions. We have made your description of this drop in the report in Section 4.

The important thing in battery selection is price performance. Our goal is to have a battery with a capacity of 20 kWh. Since we do not think about long-term storage, this amount will be enough for us. We have researched the market and we will have a warehouse area of 19.2 kWh in total by using 5 Vision Tech-LFP48100s, both cheap and high quality.

Inverter selection was very challenging for us. First of all, we looked at whether the panels used meet the energy needs, and more importantly, we examined whether the excess electricity will be generated or not. There is a quantity of electricity to be sold as shown in Figure 5.19. That's why we chose an inverter compatible with the grid. At the same time, we use string inverters because there is not much cloud and rain problem, and the panels will be serviced frequently. In this way, our installation cost decreases. To talk about the capacity of the inverter, it is seen in the same figure that a 3-kW inverter is more than enough. InfiniSolar Plus II 3kW is enough for us.

4. CALCULATION

Calculations are the most important step in engineering. Because we should examine the accuracy of our calculation method and determine the reliability of the data we use. We should be able to control the accuracy of the calculations we make with the real error. We have two main data sets for the systems we have chosen in this report. Examining the details of Annual outside temperature (We got the outdoor temperature data from the general directorate of meteorological service) (Table A.1) and Annual GHI (Table A.2) data on the whole system. Temperature data is the most important factor in almost every step, from the calculation of the energy demand to the amount of heat pump and solar energy (electrical energy) production. GHI is critical for our electricity generation amount. Unfortunately, since we have more than 8000 data, we cannot calculate all of them manually. Therefore, we will simulate our system with the help of these data using MATLAB software. Since our data is dynamic, we decided to create a correct algorithm first. The algorithm is suitable for both simulation and manual solutions. To demonstrate our calculation method, we will make an example calculation with the data we will use for a completely randomly chosen date while remaining true to the algorithm. In this calculation, we will assume the amounts of some values that change depending on the previous data, such as the battery power amount. In order to show the accuracy of the algorithm, we will do our calculations in accordance with the steps of the algorithm.

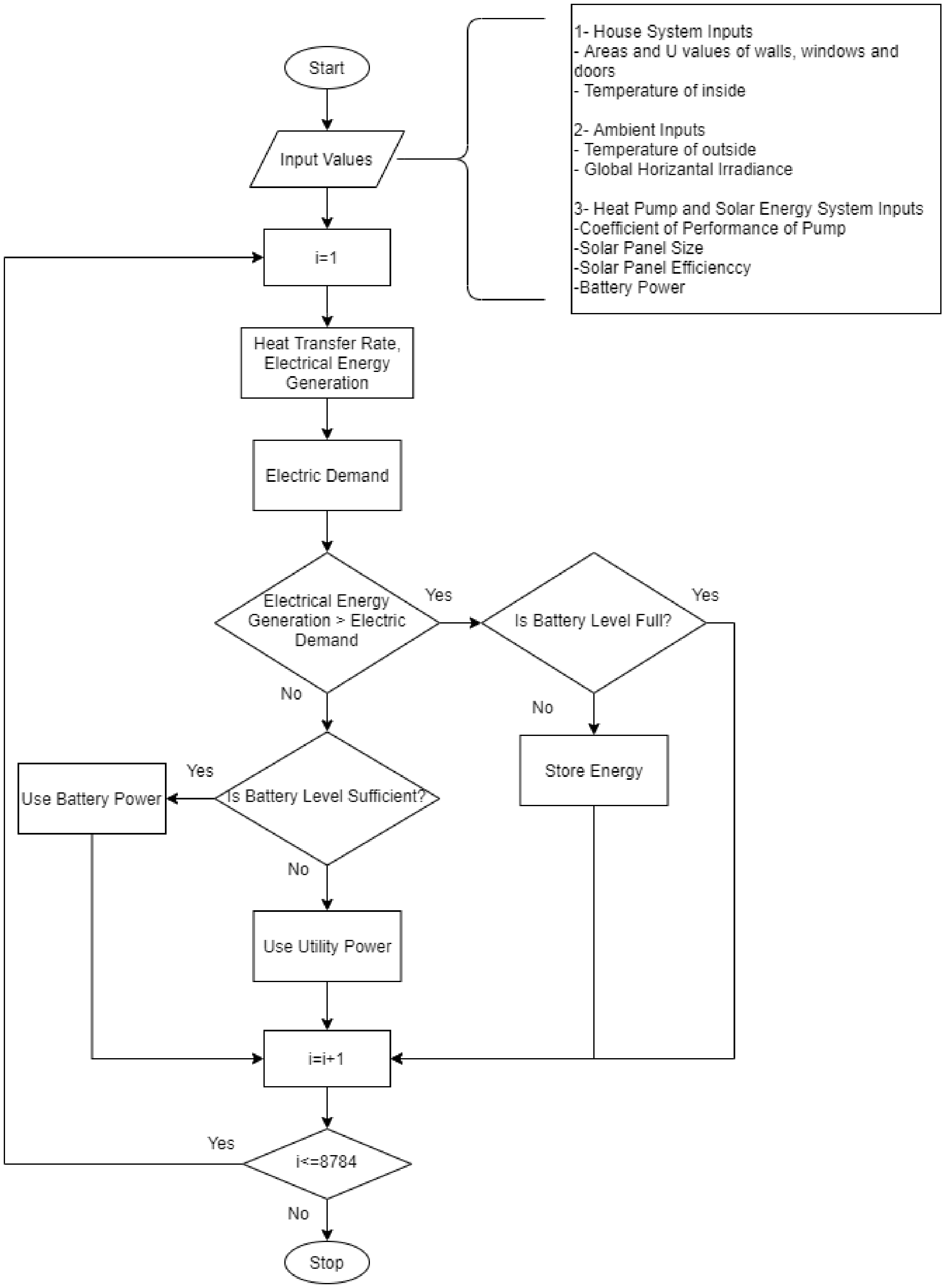


Figure 4.1. The Shema of System Algorithm

As seen in the algorithm, the thing that does not change according to the outside temperature and GHI is the house system and its details. So first of all, we can do the calculations of the house system. This is a valid calculation for every day of the year.

4.1. House System Calculations

The general heat transfer coefficient formula,

$$\frac{1}{U} = R_i + R_o + \sum_{i=1}^{n} \frac{x_i}{\lambda_\mathrm{i}}$$

Where:

R_o = Thermal resistance of outside surface (m^2K/W)

R_i = Thermal resistance of inside surface (m^2K/W)

x = Material thickness (m)

λ = Thermal conductivity (W/mK)

n = Number of different types of materials

R_o and R_i values based on standard TS 825.

Heat transfer coefficient calculations, (Data from Table 3.1 were used)

For walls,

$$\frac{1}{U_{walls}} = 0.13 + 0.04 + \left[\frac{0.02}{1} + \frac{0.19}{0.36} + \frac{0.04}{0.035} + \frac{0.008}{0.35}\right]$$

$$U_{walls} = 0.53\ W/m^2K$$

For ceiling,

$$\frac{1}{U_{ceiling}} = 0.13 + 0.08 + \left[\frac{0.02}{1} + \frac{0.12}{2.5} + \frac{0.08}{0.04}\right]$$

$$U_{ceiling} = 0.44\ W/m^2K$$

Since there is a roof in the ceiling, the heat transfer coefficient will decrease to 80 percent.

Therefore,

$$U_{ceiling} = 0.44 * 0.8 = 0.35\ W/m^2K$$

For ground,

$$\frac{1}{U_{ground}} = 0.17 + 0 + \left[\frac{0.005}{0.13} + \frac{0.03}{1.40} + \frac{0.04}{0.03} + \frac{0.02}{1.40} + \frac{0.10}{1.10}\right]$$

$$U_{ground} = 0.6\ W/m^2K$$

Since there is an earth contact in the ceiling, the heat transfer coefficient will decrease to 50 percent.

Therefore,

$$U_{ground} = 0.6 * 0.5 = 0.3\ W/m^2K$$

U-values determined for windows and doors are specified in Section 3.1.

For window,

$$U_{window} = 2.1\ W/m^2K$$

For exterior door,

$$U_{ED} = 1.5\ W/m^2K$$

For garden door,

$$U_{GD} = 1.8\ W/m^2K$$

As mentioned in same section as below, the dimensions of house are $10m * 15m * 3m$ surface areas of the walls, ceiling, ground of the house,

$$A_{wall_1} = A_{wall_2} = (10m * 3m) - (2m * 1m) = 28m^2$$

$$A_{wall_3} = A_{wall_4} = (15m * 3m) - (2 * 1.56m * 1.52m) = 40.26m^2$$

$$A_{ceiling} = A_{\ ground} = 10m * 15m = 150m^2$$

$$A_{window} = 1.56m * 1.52m = 2.37m^2$$

$$A_{Edoor} = A_{GDoor} = 2m * 1m = 2m^2$$

4.2. Electric Demand Calculations

Let's start by calculating ΔT,

$$\Delta T = T_{outside} - T_{inside}$$

Rate of heat transfer formula,

$$\dot{Q}(W) = [U(W/m^2K) * A(m^2) * \Delta T(K)]$$

$$\dot{Q}_{total} = \dot{Q}_{wall_1} + \dot{Q}_{wall_2} + \dot{Q}_{wall_3} + \dot{Q}_{wall_4} + \dot{Q}_{ceiling} + \dot{Q}_{ground} + \dot{Q}_{window} + \dot{Q}_{ED} + \dot{Q}_{GD}$$

To calculate $\dot{Q}_{wall_{1\&2}}$,

$$\dot{Q}_{wall_{1,2}} = A_{wall_{1,2}} * U_{walls} * \Delta T$$

To calculate $\dot{Q}_{wall_{3\&4}}$,

$$\dot{Q}_{wall_{3,4}} = A_{wall_{3,4}} * U_{walls} * \Delta T$$

To calculate $\dot{Q}_{ceiling}$,

$$\dot{Q}_{ceiling} = A_{ceiling} * U_{ceiling} * \Delta T$$

To calculate $\dot{Q}_{ground}$,

$$\dot{Q}_{ground} = A_{ground} * U_{ground} * \Delta T$$

To calculate $\dot{Q}_{window}$,

$$\dot{Q}_{window} = A_{window} * U_{window} * \Delta T$$

To calculate $\dot{Q}_{ED}$,

$$\dot{Q}_{ED} = A_{ED} * U_{ED} * \Delta T$$

To calculate $\dot{Q}_{GD}$,

$$\dot{Q}_{GD} = A_{GD} * U_{GD} * \Delta T$$

Considering the CoP value of the heat pump, the demand of electrical energy can be calculated,

$$E_{demand,i}(W) = \frac{\dot{Q}_{total}\ (W)}{CoP}$$

4.3. Electrical Energy Generation Calculations

The electrical energy generation can be calculated from the GHI, the panel size (PS) and the efficiency of the panel (E_P).

Formula of electrical energy generation capacity power,

$$E_{gen,capacity}(kW) = GHI\left(\frac{kW}{m^2}\right) * PS(m^2)$$

Considering the effects (dust, clouds, and wind etc.), we estimate that the panel yield will decrease to 15 percent,

$$E_p = 15\%$$

Formula of effects outside air temperature on the panel,

$$EoT(Effect\ of\ Temperature) = [-0.38\ T_{outside}(℃) + 109.5]\%$$

To find the net electrical energy generation, we must also calculate the panel efficiency and the effect of temperature on the panel.

$$E_{gen,net} = \left[E_{gen,capacity} * E_P\right] * EoT$$

$$E_{gen,net} = [GHI * PS * E_P] * EoT$$

4.4. Sample Date Calculations

First, let's write the data where the inputs are clear and fixed. The heat transfer coefficient and surface areas are above.

$$T_{in} = 20°\mathrm{C}$$

$$PS = 12\, m^2$$

$$BP_c = 20kWh$$

We chose the date 23 May 2020 17:00 completely randomly. You can see the temperature and GHI data in Figure 4.2.

$$i = 3450$$

	DATE_TIME	T_OUTSIDE	GHI
3447	23.05.2020 13:00	20.3327	646
3448	23.05.2020 14:00	20.6276	591
3449	23.05.2020 15:00	20.6058	349
3450	23.05.2020 16:00	18.9897	393
3451	23.05.2020 17:00	16.8439	232
3452	23.05.2020 18:00	16.3390	90

Figure 4.2. Sample Data and Date (23.05.2020 / 17:00)

As seen in Figure 4.2., $T_{out,i}$ and GHI_i is,

$$T_{out,3450} = 16.84°\mathrm{C}$$

$$GHI_{3450} = 232 * 1.25 = 290\, W/m^2$$

Let's assume that the battery has 10 kWh of energy,

$$BP_c = 10kWh$$

Let's start by calculating ΔT,

$$\Delta T_i = T_o - T_i$$

$$\Delta T_{3450} = 16.84°\mathrm{C} - 20°\mathrm{C}$$

$$\Delta T_{3450} = -3.16\ °\mathrm{C}$$

To calculate $\dot{Q}_{total}$,

$$\dot{Q}_{wall_{1,2},3450} = 28 * 0.53 * (-3.16) = -46.89\ W$$

$$\dot{Q}_{wall_{3,4},3450} = 40.26 * 0.53 * (-3.16) = -67.43W$$

$$\dot{Q}_{ceiling,3450} = 150 * 0.35 * (-3.16) = -165.9\ W$$

$$\dot{Q}_{ground,3450} = 150 * 0.3 * (-3.16) = -142.20\ W$$

$$\dot{Q}_{window,3450} = 2.37 * 2.1 * (-3.16) = -15.73\ W$$

$$\dot{Q}_{ED,3450} = 2.0 * 1.5 * (-3.16) = -9.48\ W$$

$$\dot{Q}_{GD,3450} = 2.0 * 1.8 * (-3.16) = -11.38\ W$$

Heat transfer at 25.05.2020 / 17:00,

$$\dot{Q}_{total,i} = (-46.89 * 2) + (-67.43 * 2) + (-165.9) + (-142.2) + (-15.73 * 4) + (-9.48) + (-11.38)$$

$$\dot{Q}_{total,3450} = -620.52\ W$$

For one hour,

$$Q_{total,3450} = 620.52W * 1(h) = 620.52\ Wh$$

We found our energy requirement in the specified one-hour range. Now, using the heat pump system we have chosen and the outside temperature data, we will find the CoP value and thus find the electric demand.

When the heat pump catalogue is examined, the CoP value of the pump when the outside air temperature is above 12℃,

$$CoP_{3450} = 4.86$$

$$E_{demand,3450} = \frac{\dot{Q}_{total,3450}}{CoP_{3450}} = \frac{620.52}{4.86} = 127.68\ W$$

We calculated the electric demand.

Now let's calculate the electrical energy we can produce in the specified range.

We use 6 panels of 2 m^2 each, and the panel efficiency is 15%,

Effects outside air temperature on the panel,

$$EoT = -0.38 * 16.84 + 109.5 = 103.1\%$$

$$E_{gen,capacity} = GHI_i * PS = \left(290\frac{W}{m^2}\right) * (12m^2) = 3{,}480\ W$$

$$3{,}480W * \frac{15}{100} = 522\ W$$

$$E_{gen\_net,3450} = 522\ W * \frac{103.1}{100} = 538\ W$$

We had a system with a battery capacity of 20 kWh and we considered the scenario where it was half full. We plan to store the excess energy, to use the energy demand from the storage, and to use energy from the grid at the point where the battery power is not enough.

Net energy calculation excess/demand,

$$E_{net,i} = E_{gen\_net,i} - E_{demand,i},$$

$$E_{net,3450} = 538 - 127.68 = 410.5\ W$$

Since there is an excess of energy,

$$UP_i = UP_{3450} = 0$$

To store excess energy, battery fill should be checked.

$$BP_c > BP + E_{need,i}$$

$$20\ kW > 10kW + 0.411\ kW$$

$$20\ kW > 10.411\ kW$$

There is enough space in the battery so we can add it to battery,

$$BP = 10.411\ kW$$

5. SIMULATIONS & RESULTS

5.1. System Simulations

We found it right to use everything we learned in our university life as much as we could. That's why we decided to simulate our project in MATLAB.

```
%% Input Constant Values
i=1:8784;    % Hours && 366*24=8784 (h)
T_in=20;     % Inside Temperature (Celcius)
BPc=20;      % Battery Power Capacity (kWh)
BP=0;        % Considering we have empty battery at beginnnig
PS=12;       % Panel Size (m^2) (6panel*2m2)
Ep=15/100;   % Efficiency of Panel
```

Figure 5.1. Inputs for Constant Values

These inputs are constant for our entire simulation (except for the parameters) and what they correspond to is written next to them. The reason why we decided to start the battery empty is that the battery level is clearly zero since December and enters the new year as 0, as seen in figure X.

```
%% Temperature Data Input
T_out=xlsread('DataYearly.xlsx','B:B'); % Outside Temperature (Celcius)
delta_T=abs(T_out-T_in);                % Change in Temperature Absolute
d_T= T_out-T_in;                        % Change in Temperature

%% Solar Irradiation (GHI) Data Input
GHI_Ned=xlsread('DataYearly.xlsx','C:C'); %Global Horizontal Irradiation for Netherlands(W/m^2)
GHI=1.25.*GHI_Ned;                        %Global Horizontal Irradiation for Turkey/Istanbul(W/m^2)
```

Figure 5.2. Temperature and GHI inputs

Our data goes from January to December. The structure of the Excel file named DataYearly.xlsx is an array of 8784x3. The first column contains the date, the 2nd column contains the hourly average temperature data, and the 3rd column contains the hourly GHI data. However, if we put this data in our thesis in this way, it would be too long. Therefore, we have shared these data in Table A.1 and Table A.2 so that they can be examined more easily.

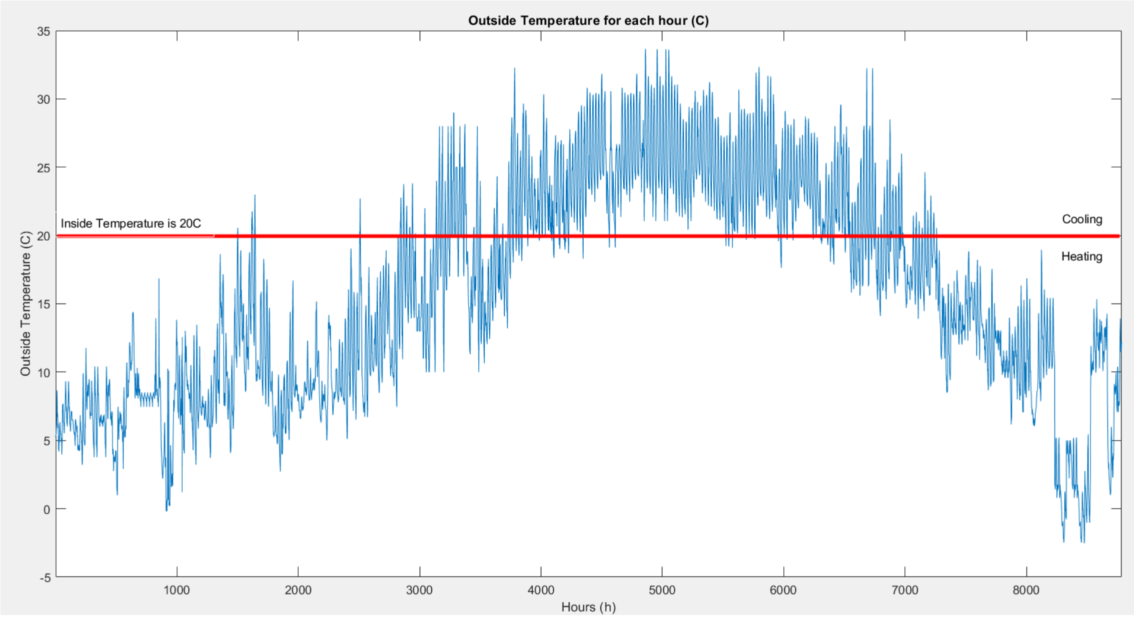


Figure 5.3. Yearly Outside Temperature

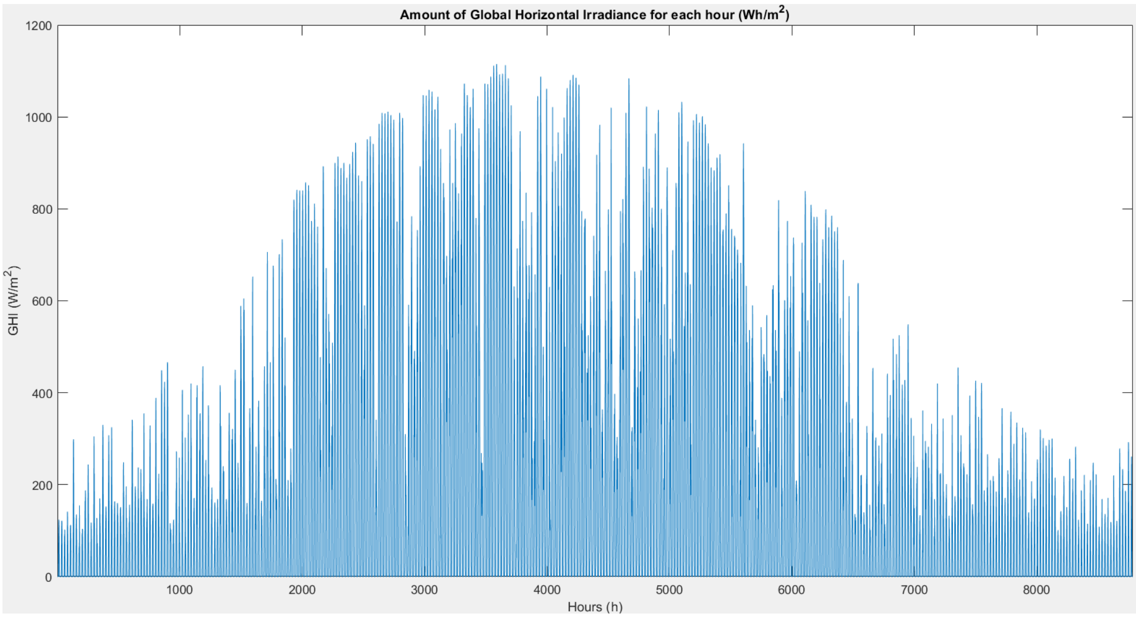


Figure 5.4. Yearly GHI Value

```
%% Areas and U-Values of House System
% Wall 1&2
A_wall12=28;        % Surface Area (a_wall-a_windows)(m^2)
U_wall=0.53;        % Heat Transfer Coefficient of Wall (W/m2K)
% Wall 3&4
A_wall34=40.26;     % Surface Area (a_wall-a_doors)(m^2)
U_wall=0.53;        % Heat Transfer Coefficient of Wall (W/m2K)
% Windows
A3=2.37;            % Surface Area (m^2)
U_win=2.1;          % Heat Transfer Coefficient of Window (W/m2K)
% Exterior Door
A_door=2;           % Surface Area (m^2)
U_ed=1.5;           % Heat Transfer Coefficient of Exterior Door (W/m2K)
% Garden Door
A_door=2;           % Surface Area (m^2)
U_gd=1.8;           % Heat Transfer Coefficient of Garden Door (W/m2K)
% Ceiling
A5=150;             % Surface Area (m^2)
U_ceiling=0.35;     % Heat Transfer Coefficient of Ceiling (W/m2K)
% Ground
A6=150;             % Surface Area (m^2)
U_ground=0.3;       % Heat Transfer Coefficient of Ground (W/m2K)
```

Figure 5.5. House System Details Input

We calculated U-values and areas separately for possible changes in our house system (door window size etc.).

```
%% Heat Transfer Rate Calculations
Q_w12=A_wall12*U_wall*delta_T; % Heat Transfer Rate of Wall 1&2 (Watt)
Q_w34=A_wall34*U_wall*delta_T; % Heat Transfer Rate of Wall 3&4 (Watt)
Q_win=A3*U_win*delta_T;        % Heat Transfer Rate of Windows (Watt)
Q_ed=A_door*U_ed*delta_T;      % Heat Transfer Rate of Exterior Door (Watt)
Q_gd=A_door*U_ed*delta_T;      % Heat Transfer Rate of Garden Door (Watt)
Q_ce=A5*U_ceiling*delta_T;     % Heat Transfer Rate of Ceiling (Watt)
Q_gr=A6*U_ground*delta_T;      % Heat Transfer Rate of Ground (Watt)
% Total
Qh=(2*Q_w12+2*Q_w34+Q_ce+Q_gr+4*Q_win+Q_ed+Q_gd)./10^3; % Heat Transfer Rate of House System (k-Watt)
```

Figure 5.6. Heat Transfer Rate Calculations

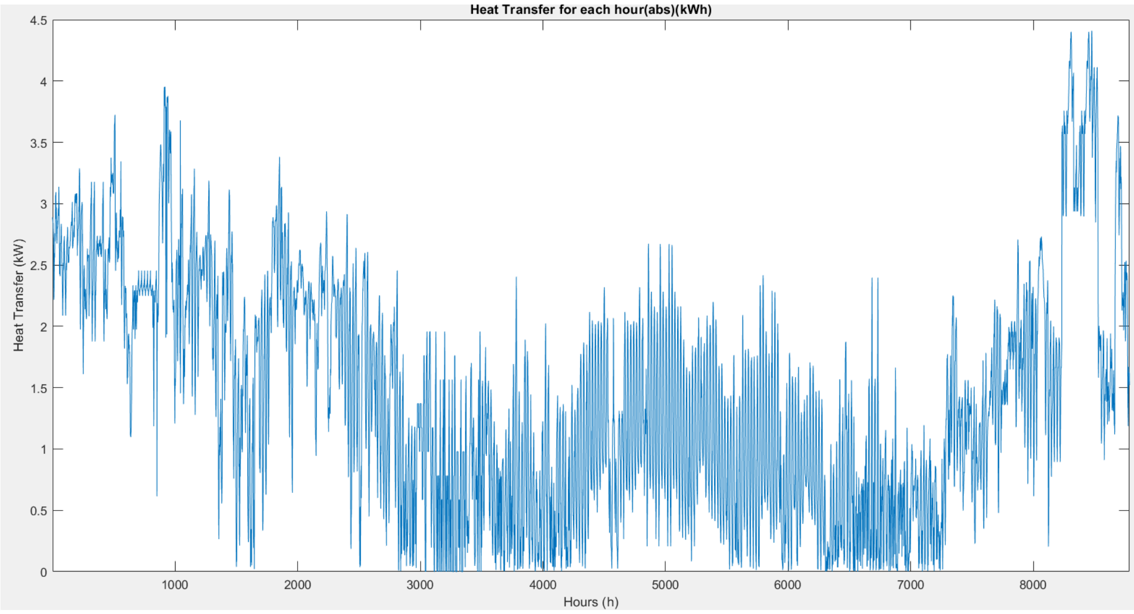


Figure 5.7. Heat Transfer for Each Hour (absolute)

We calculated the heat exchange in absolute terms because we needed the total energy whose transfer we had to prevent. Another important point we saw here was how big of a heat pump we needed. This information formed one of the main sources of the heat pump we decided on in Section 3.2.

```
%% Total Heat Transfer for a Year
Qt=sum(Qh);  %kWh

%% Daily / Hourly Average Amount of Heat Transfer
avg_Qt_day=Qt/366; % Daily (kWh)
avg_Qt_hour= Qt/8784; % Hourly (kWh)
```

```
Command Window
Qt =

   1.2772e+04


avg_Qt_day =

   34.8973


avg_Qt_hour =

    1.4541
```

Figure 5.8. Yearly Total Heat Transfer and Daily/Hourly Average Heat Transfer

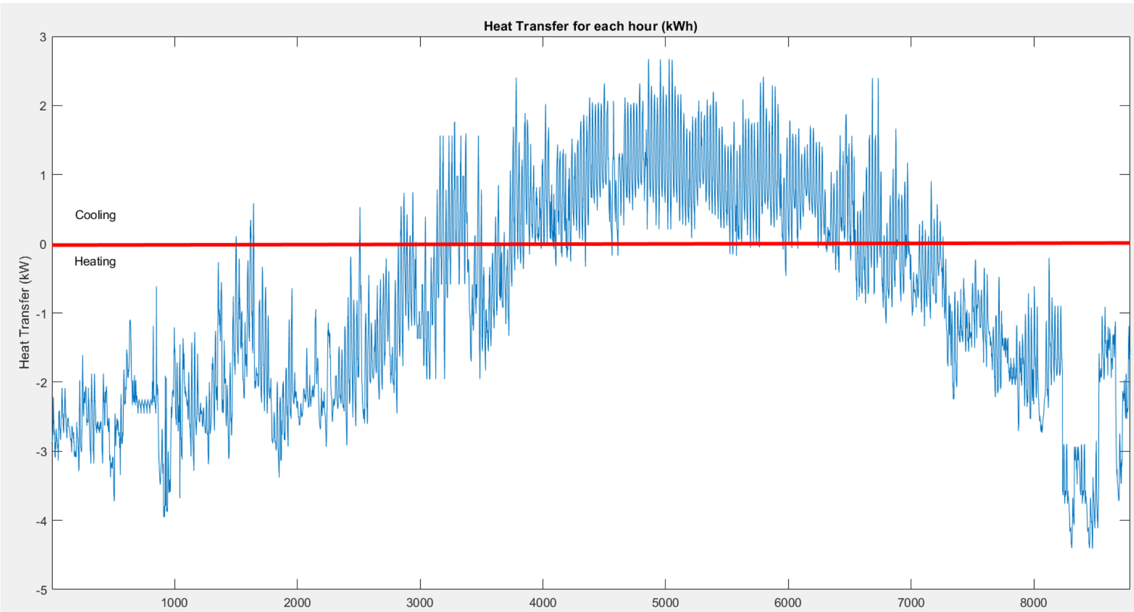


Figure 5.9. Heat Transfer for Each Hour (Gain/Loss)

```
% Cooling Total Yearly
h_cool=find(Qhd>=0);                % Cooling hours
Qhd_cooling=Qhd(h_cool);            % Cooling Heat Transfer Rate
Qtd_cooling=sum(Qhd_cooling);       % Total Heat Transfer Used for Cooling

% Heating Total Yearly
h_heat=find(Qhd<0);                 % Heating hours
Qhd_heating=Qhd(h_heat);            % Heating Heat Transfer Rate
Qtd_heating=sum(Qhd_heating);       % Total Heat Transfer Used for Heating
```

Command Window

```
>> Qtd_cooling

Qtd_cooling =

   2.8674e+03

>> Qtd_heating

Qtd_heating =

  -9.9050e+03
```

Figure 5.10. Yearly Total Heat Transfer (2,867.4 kWh Gain & 9,905 kWh Loss)

The figure above showed us that the main issue is the lost heat. We think that it is possible to obtain more specific results by examining the monthly and seasonal total heat transfer.

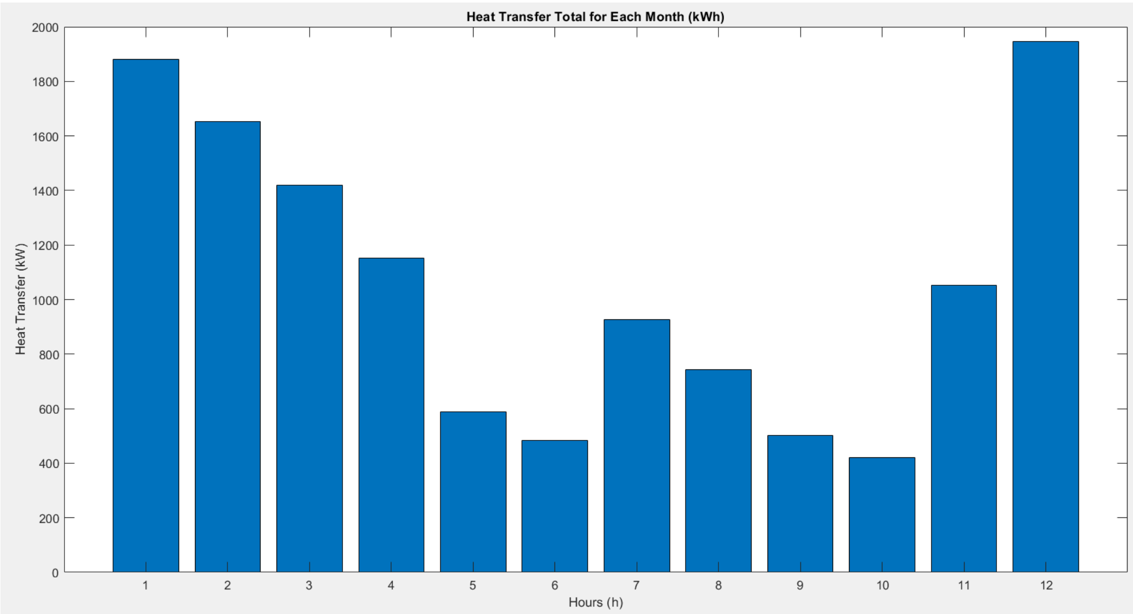


Figure 5.11. Monthly Total Heat Transfer (1=January, 12=December)

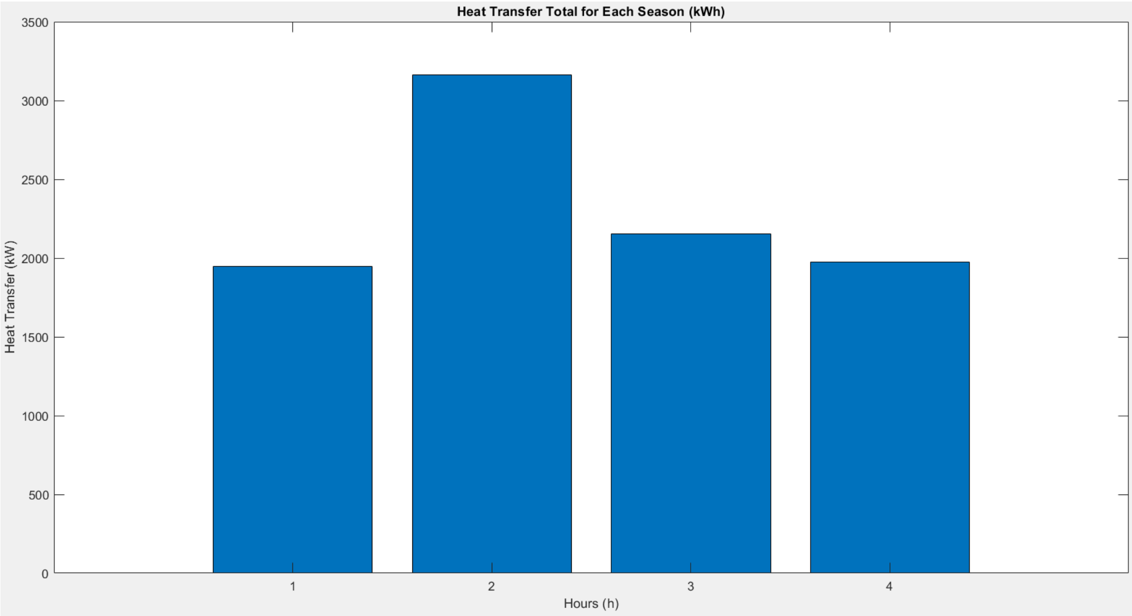


Figure 5.12. Seasonal Total Heat Transfer (1=Winter, 4=Fall)

```
%% COP Selection Distributed by Outside Temperature
for x=1:1:length(T_out)
    if T_out(x)>=-7 && T_out(x)<2      % CoP value (3.06) when outside temperature between -7C to 2C
      COPt(x)=3.06;
    elseif T_out(x)>=2 && T_out(x)<7   % CoP value (3.97) when outside temperature between 2C to 7C
      COPt(x)=3.97;
    elseif T_out(x)>=7 && T_out(x)<12  % CoP value(4.63) when outside temperature between 7C to 12C
      COPt(x)=4.63;
    else
      COPt(x)=4.86;                    % CoP value(4.86) when outside temperature bigger than 12C
    end
end
COP=transpose(COPt);                   % Coefficient of Performance
```

Figure 5.13. CoP Distribution

After deciding on the heat pump, we learned in the catalog (Table A.5) that the performance coefficient (CoP) of the heat pump changes according to the outside temperature.

If we divide the heat produced by the COP value, we will find the electrical energy we need to produce that heat.

```
%% Electric Demand Calculations
Edemand=Qh./COP; % Hourly Electric Demand (kW)

%% Electrical Energy Generation Calculations
Egen_cap=GHI.*PS;                 % Electric Generation Potantial (without efficiency)(W)
EoT=(-0.38.*T_out+109.5)./100;    % Effect of Temperature on Panel Efficiency
Egen_net_W=(Egen_cap.*Ep).*EoT;   % Net Electric Generation (W)
Egen_net=Egen_net_W./10^3;        % Net Electric Generation (kW)

%% Net Energy Calculation
Enet=[Egen_net - Edemand]; %Net Electric= Electric Generation - Electric Demand (kW)
```

Figure 5.14. Electric Demand/Generation/Net Calculations

In addition to these, it is necessary to examine the energy we use for heating and cooling the house and the excess electricity we sell to the grid. In addition to these, it is necessary to examine the excess electricity we sell to the grid.

```
%% Battery, Egrid and Utility Power Calculations
for a=1:1:length(Enet)
if Enet(a)>=0
    UPt(a)=0;
    if BPc> BP+Enet(a)      %Scenario 1 ; Net Electric is positive & battery is not full.
        BP=BP+Enet(a);      %Result = Store excess energy. Do not use Utility power.
        BPtable(a,:)=[BP];
        E_gridt(a)=0;       %Electricity Sold to the Grid
    else                    %Scenario 2 ; Net Electric is positive & battery is full.
        BP=BP;              %Result= Do not Store Energy. Do not use Utility power.
        BPtable(a,:)=[BP];
        E_gridt(a)=Enet(a);%Electricity Sold to the Grid
    end
elseif BP-(-Enet(a))>0      %Scenario 3 ; Net Electric is negatif & battery is sufficient.
    UPt(a)=0;               %Result= Use Battery Power. Do not use Utility Power
    BP=BP-(-Enet(a));
    BPtable(a,:)=[BP];
    E_gridt(a)=0;           %Electricity Sold to the Grid
else                        %Scenario 4 ; Net Electric is negatif & battery is not sufficient
    UPt(a)=-Enet(a);        %Result= Use Utility Power
    BP=BP;
    BPtable(a,:)=[BP];
    E_gridt(a)=0;           %Electricity Sold to the Grid
end
end
UP=transpose(UPt);          %Utility Power
E_grid=transpose(E_gridt);%Electricity Sold to the Grid
```

Figure 5.15. Battery, Egrid and Utility Power Calculations

Electricity to the grid occurs only in scenario 2. In other words, if the batter is full and the electricity generation is still more than the demand, we planned to generate additional income by selling that additional to the grid.

Here it is also possible to detect the utility power used and the change of the battery power.

```
%% Total Utility Power Usage
UP_total=sum(UP); % Total Utility Power Used (kWh)
```

```
Command Window
>> UP_total

UP_total =

   1.4125e+03
```

Figure 5.16. Total Utility Power Usage

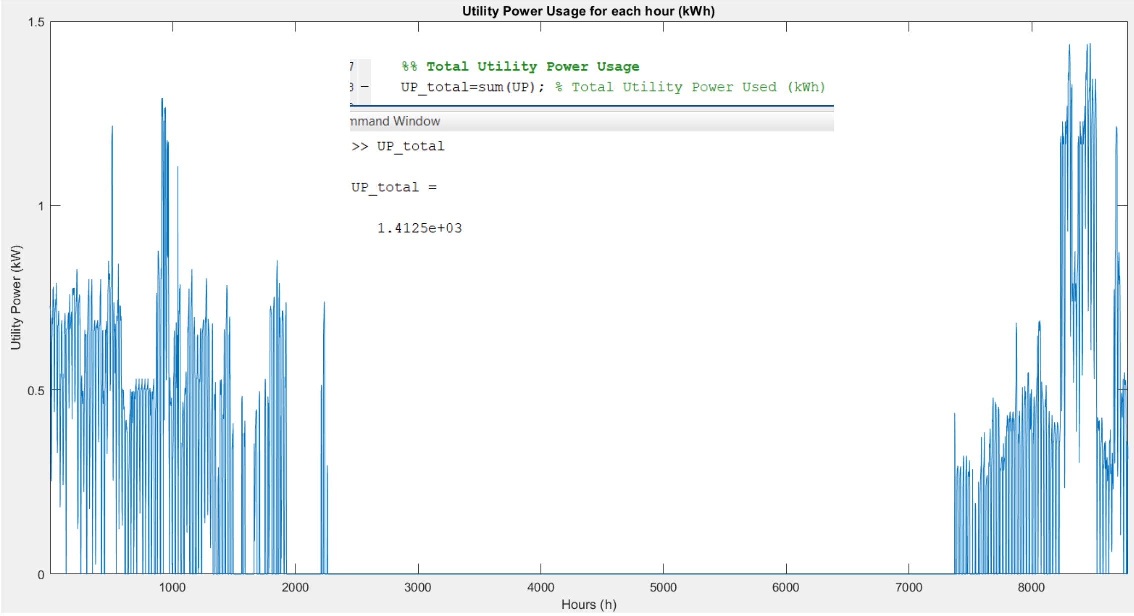


Figure 5.17. Utility Power Usage

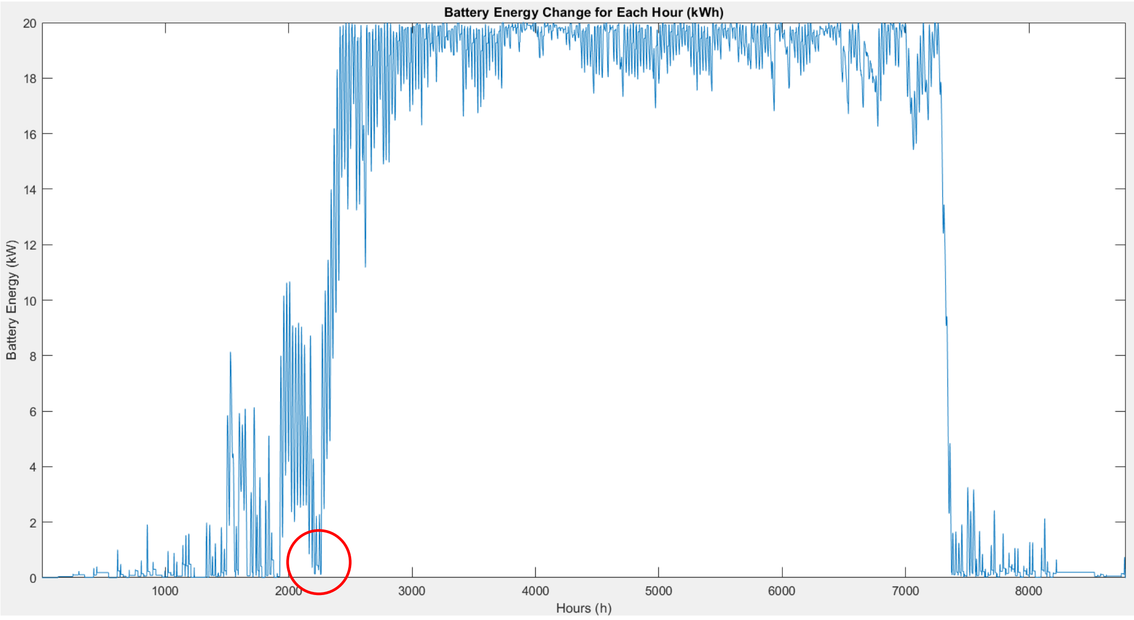


Figure 5.18. Yearly Battery Power Change

It is very important for us that the battery is full, especially during the transition from hot to cold. The red marked part on the figure shows that we are operating the battery at maximum capacity.

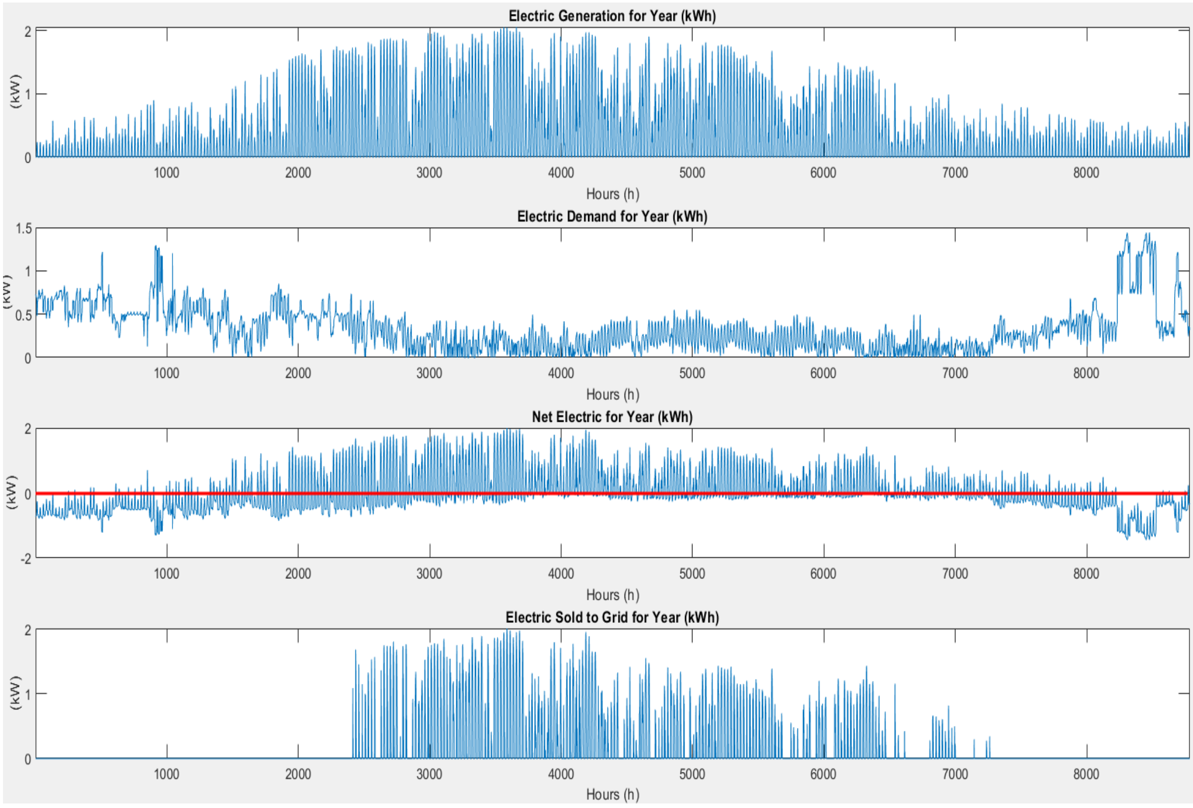


Figure 5.19. Electricity Details

Considering that our electric demand in the figure above is 1.5kW at most, we thought that a 3kW inverter, one of the inverters sold as 1-3-5 kW, would be sufficient for us.

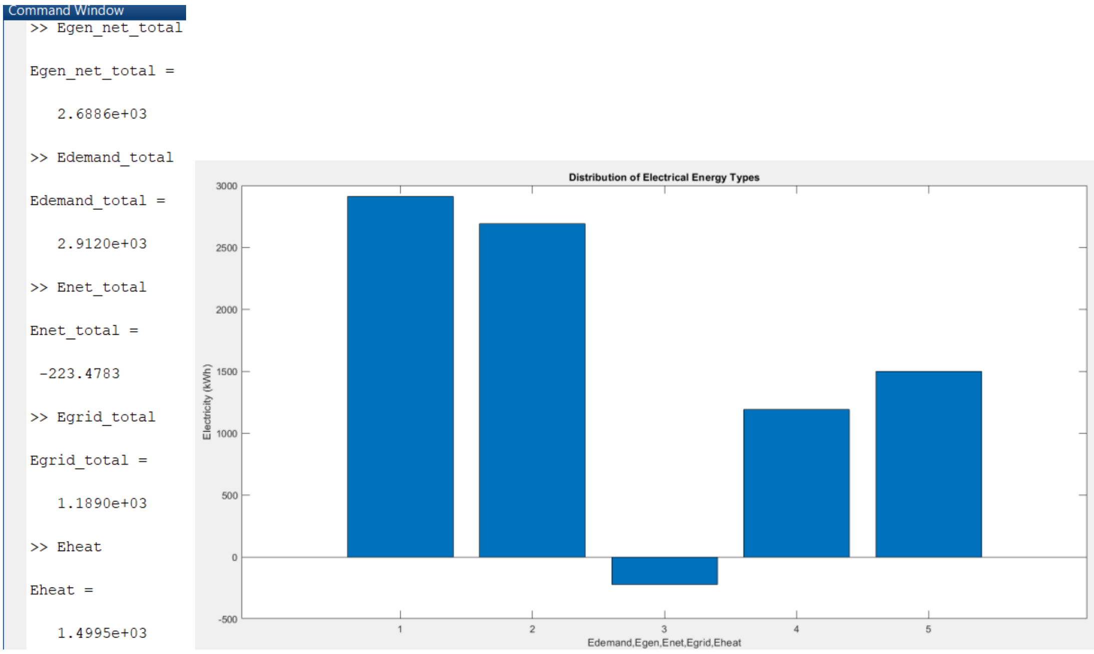


Figure 5.20. Total Electric Details (Edemand-Egen-Enet-Egrid-Eheat)

With a simple calculation, we can find out how many of the electricity produced is used for the house,

$$\frac{2.886 - 1.500}{2.886} * 100 = \%48$$

The fact that this rate is low should not mean that there is something wrong with our system. A very high part of this rate is the low demand despite the high production in the (mostly) spring and summer months. Considering that the average temperature in the spring was 20°C, the hourly demand was close to 0.

It would be a nice approximation if we make similar calculations for the hottest and coldest days.

For hottest day of the 2020 (21 July 2020),

```
%% Hottest Day of Year Details
%Hottest day of year is 21.07.2020
Tavg_hot=sum(T_out([4849:4872],:))/24;          %Average Temperature
Qt_hot= sum(Qh([4849:4872],:));                 %Total Heat Transfer
Qh_hot= Qh([4849:4872],:);                      %Heat Transfer

Enet_hot= Enet([4849:4872],:);                  %Net Electric Energy
Et_net_hot= sum(Enet([4849:4872],:));           %Total Net Electric Energy
Edemand_hot= Edemand([4849:4872],:);            %Electric Demand
Et_demand_hot= sum(Edemand([4849:4872],:));     %Total Electric Demand
Egen_net_hot= Egen_net([4849:4872],:);          %Electric Generation
Et_gen_net_hot= sum(Egen_net([4849:4872],:));   %Total Electric Generation
```

Command Window

```
>> Tavg_hot

Tavg_hot =

   27.3958

>> Qt_hot

Qt_hot =

   34.7479
```

Command Window

```
Et_net_hot =

    7.3176

>> Et_demand_hot

Et_demand_hot =

    7.1498

>> Et_gen_net_hot

Et_gen_net_hot =

   14.4674
```

Figure 5.21. Outputs of Hottest Day

$$T_{avg} = 27.40\ °C$$

$$Q_{daily} = 34.74\ kWh$$

$$E_{gen} = 14.46\ kWh$$

$$E_{demand} = 7.14\ kWh$$

$$E_{net} = 7.32\ kWh$$

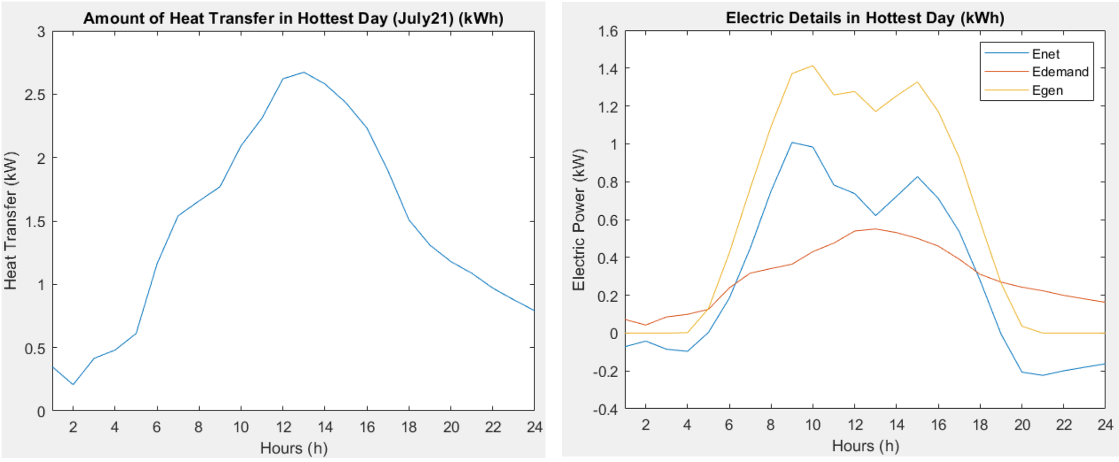
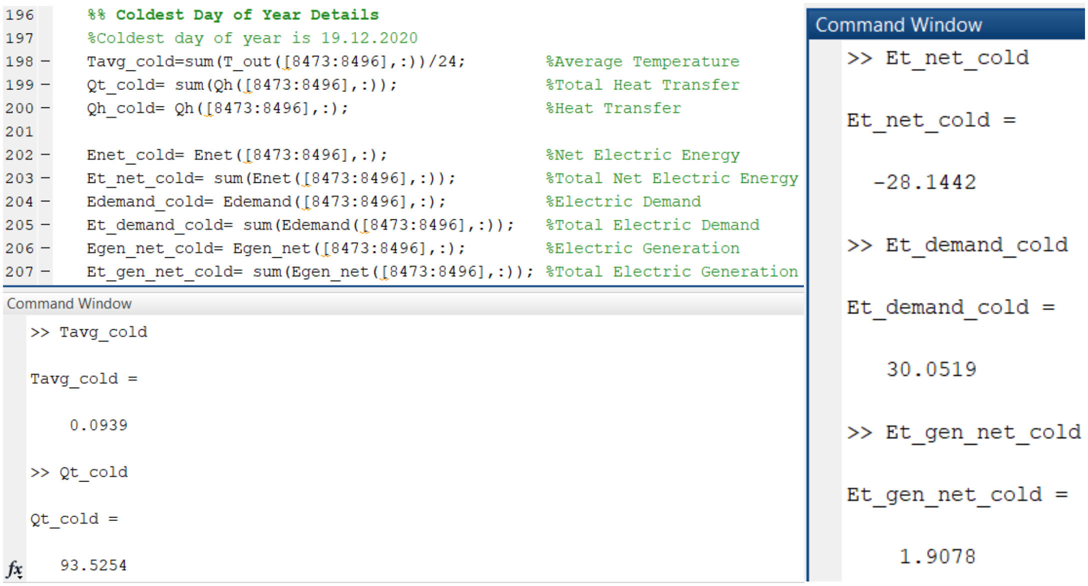


Figure 5.22. Hottest Day Graphs

For coldest day of the 2020 (19 December 2020),



```
%% Coldest Day of Year Details
%Coldest day of year is 19.12.2020
Tavg_cold=sum(T_out([8473:8496],:))/24;          %Average Temperature
Qt_cold= sum(Qh([8473:8496],:));                 %Total Heat Transfer
Qh_cold= Qh([8473:8496],:);                      %Heat Transfer

Enet_cold= Enet([8473:8496],:);                  %Net Electric Energy
Et_net_cold= sum(Enet([8473:8496],:));           %Total Net Electric Energy
Edemand_cold= Edemand([8473:8496],:);            %Electric Demand
Et_demand_cold= sum(Edemand([8473:8496],:));     %Total Electric Demand
Egen_net_cold= Egen_net([8473:8496],:);          %Electric Generation
Et_gen_net_cold= sum(Egen_net([8473:8496],:));   %Total Electric Generation
```

```
Command Window
>> Tavg_cold

Tavg_cold =

    0.0939

>> Qt_cold

Qt_cold =

   93.5254
```

```
Command Window
>> Et_net_cold

Et_net_cold =

  -28.1442

>> Et_demand_cold

Et_demand_cold =

   30.0519

>> Et_gen_net_cold

Et_gen_net_cold =

    1.9078
```

Figure 5.23. Outputs of Coldest Day

$$T_{avg} = 0.09\ ℃$$

$$Q_{daily} = 93.53\ kWh$$

$$E_{gen} = 1.91\ kWh$$

$$E_{demand} = 30.05\ kWh$$

$$E_{net} = -28.14\ kWh$$

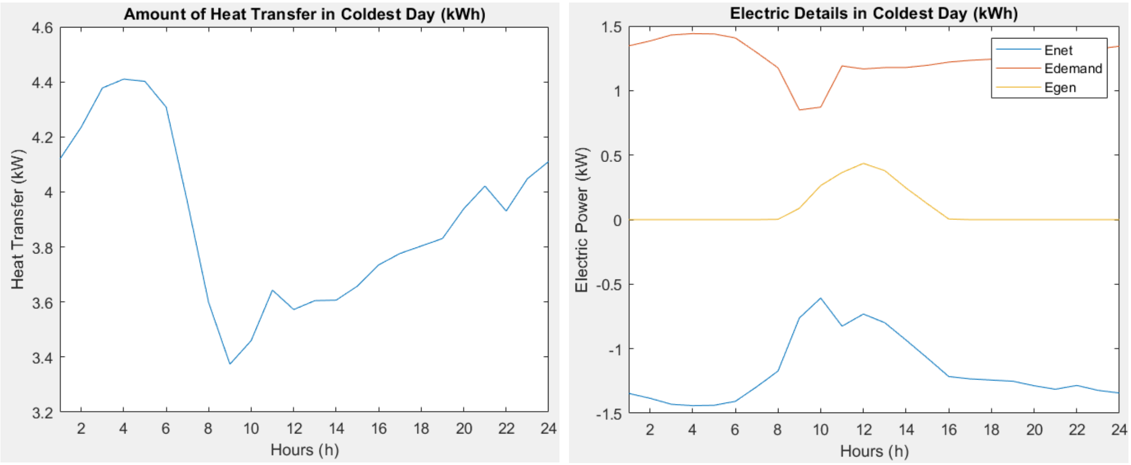


Figure 5.24. Coldest Day Graphs

5.2. Parameter Effects

We designed our system and got all the outputs of this system in 5.1. Under this title, we will look at the effect of our 2 main parameters, the battery capacity and the number of solar panels, on our electricity data.

Battery Power Variation

Battery capacity has no effect on electricity production and consumption. Essentially our main focus on changing battery power will be its impact on the Utility Power. Because if we intend to use the stored energy for a long time, we must consider the current changes. What we mean by our current changes, we will look at the effect of 10-20-30 kWh battery capacity. We are currently using 20 kWh.

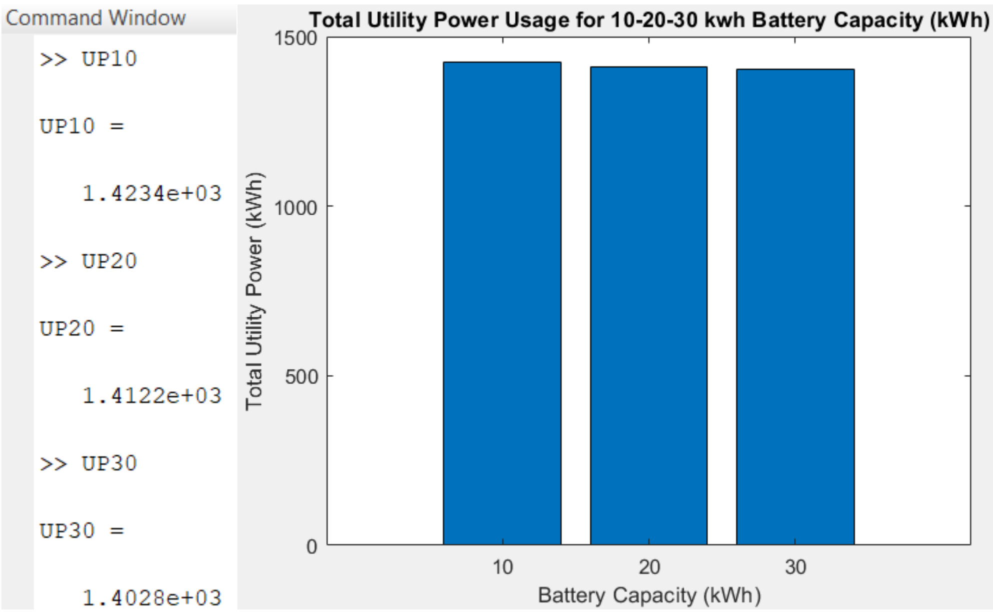


Figure 5.25. Total Utility Power Usage for 10-20-30 kWh Battery Capacity

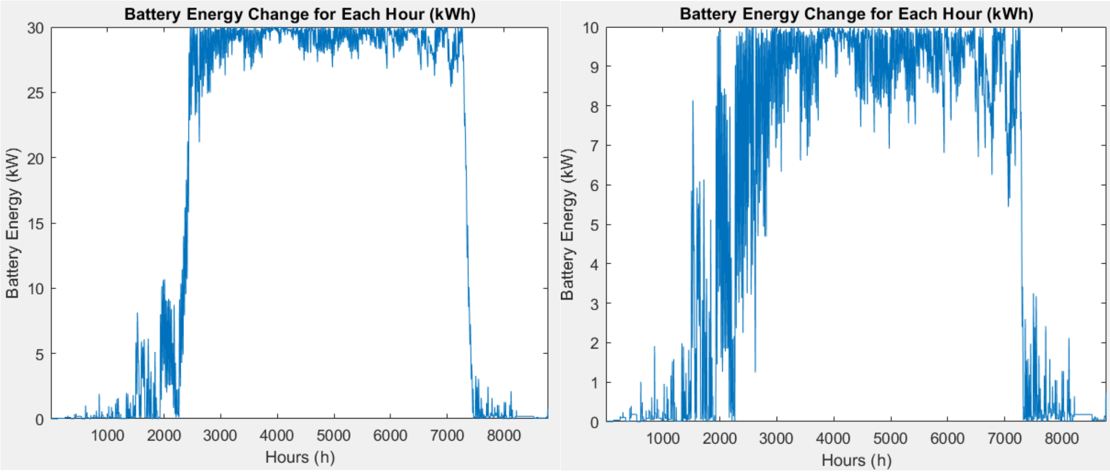


Figure 5.26. Yearly Battery Power Change (Left=30kWh, Right=10kWh)

Panel Number Variation

Our other parameter is: If we increase the panel size, can we make the system more convenient? Our main goal here is to increase 'Eheat'. That is, to use the energy we produce for the home. When we sell the excess energy for half the price and buy it again when we need it, it hurts us to pay the difference.

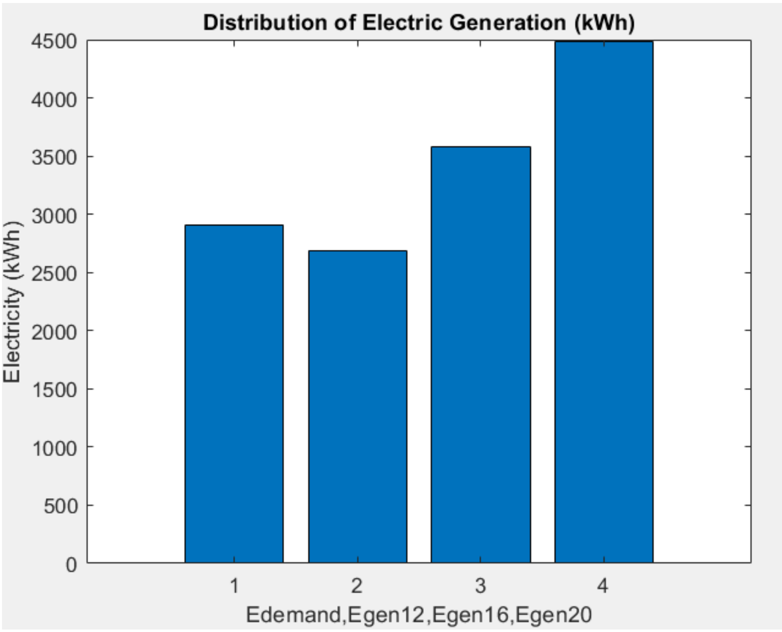


Figure 5.27. Distribution of Electric Generation for 6-8-10 panels

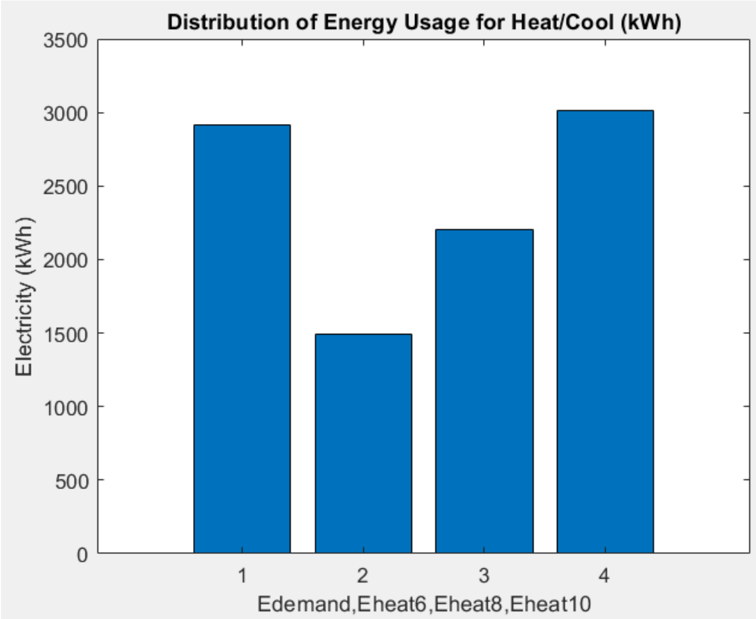


Figure 5.28. Distribution of Electrical Energy Used for House (12-16-20 m2)

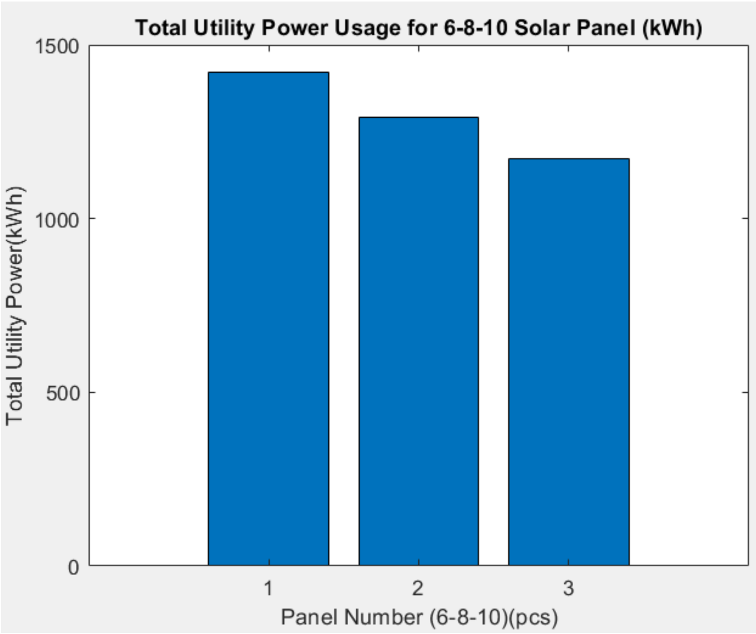


Figure 5.29. Total Utility Power Usage for Difference Number of Panels

5.3. Result Analysis

Especially when the outdoor temperature is examined, the difference in daytime temperature is very high during the seasonal transitions. Contrary to what was thought, this situation resulted in a higher amount of heat transfer in spring months than in hot summer days. It can be said that the greater the fluctuation, the greater the heat transfer. The fact that the GHI is higher in the hot summer months than in the spring months made it more logical for us to focus on the spring months and balance those months. Because in the hot summer months, our net electricity production is positive for a long time and almost uninterruptedly, no matter how big we make the battery capacity in the cold winter months. The long uninterrupted net electricity being negative reduces the importance of the battery quantity.

In particular, with the harshness of December in 2020, the highest heat transfer and the lowest level of GHI this month of the year, maximized our electricity demand. This situation has left us with a huge sustainability and adequacy problem. Although we have significantly reduced the amount of electricity taken from the utility power. We looked at whether we could lower this amount without making major changes to our system.

In the simulation we started by increasing the battery amount to 1.5 times, it caused a very, very small utility power drop. This is because, as we said above, the net electricity amount is almost uninterruptedly positive for eight months and almost uninterruptedly negative for the next four months. We have seen that to solve this, it is necessary to increase the battery capacity by at least 10 times. Since we thought that this would cause a very high cost in terms of both space and money, we did not find it logical. Well, if using batteries has no effect, then why do we use batteries with a capacity of 20 kWh? The answer is very simple, in fact, our purpose of using batteries is to provide the small amount of energy demand during the seasonal transition months. In this way, we think that we have established a system that is inexpensive, but effective in terms of price and performance. As seen in the red circled area in Figure 5.18, it is seen that all of the short-term energy demands are met from this small-capacity battery. Thus, we managed to keep the amount of UP low.

Secondly, one of the main factors is how much of the electrical energy we did use in home and how much we have to sell because of oversupply the energy. This rate was almost half. We examined the details of this rate, the main reason why this rate is so high is to get a lot of sun for 5-6 months with low electricity demand. We do not see it as a feasible study to increase the number of batteries so that the energy we produce is sufficient in the cold months. We aimed to increase the amount of electrical energy used for the house, which we call E_{heat}, by increasing the number of panels by two and four. As can be seen in Figure 5.28, increasing it by two did not change much, but increasing it by four did make a significant impact. If we have to decide at this stage, it may make sense to increase the number of panels from 6 to 10, but since the installation cost of our system is already expensive enough, we are considering not increasing the installation cost in order to find a place in the sector. On the other hand, Figure 2.29. When examined, it was also observed that UP did not decrease significantly. The reason for this is the low electricity production under the long-term winter effect and the insufficiency of the battery that we mentioned before cannot be solved.

6. COST ANALYSIS

The cost analysis should be considered because the economic situation is one of the most important criteria in a project. The project's costs are split between manufacturing and industrial costs. They are thoroughly investigated in the table below.

Table 6.1. Table of Cost Details

Product	**Number or Amount**	**Cost (Euro)**
Ground Source Heat Pump System	1	6,454
Fan Coil System	3	981
Circulation Pump	1	188
Drilling Application	1	2,690
Solar Panel	6	5,430
Hybrid Inverter	1	1,240
Battery	4	3,375
Wiring Application	1	200
Installation	1	500
Total		21,058

Solar Panel System Maintenance	Total for a year	150
Heat Pump System Maintenance	Once a year	300
Annual Maintenance Cost		450

As can be seen above, the cost required for the first installation in this project is 21,058 Euros. Apart from this installation cost, annual systemic maintenance should be done. The total annual maintenance cost for solar panel and heat pump systems is 450 Euros.

According to the statement made by EMRA Turkey, in annual agreements with the state, the amount of electricity you sell is deducted from the amount of electricity you use. There is no separate billing for sales and purchases. The kWh of electricity is 0.254 euro. The kWh of natural gas is 0.090 Euro right now for UK. We pick UK because it is a country which is closer to the average of European energy prices.

Looking at the values seen in Figure 5.20, we see that the difference of electric demand to electric generation is 223kWh.

$$Unit\ Energy\ Price\ \left(\frac{Euro}{kWh}\right) * Total\ Energy\ Demand\ (kWh) = Total\ Energy\ Cost$$

$$0.254\frac{Euro}{kWh} * 223\ kWh = 56.42\ Euros$$

If this project had not been used, the amount of electricity we would need for heating would have been 9.905 MWh and cooling will be 2.867 MWh (See in Figure 5.10). We will do the heating with natural gas and the cooling with electricity.

Electrical energy will be used for cooling. Considering that the CoP value of an average air conditioner is 2, the energy to be spent on cooling is,

$$Unit\ Energy\ Price\ \left(\frac{Euro}{kWh}\right) * \frac{Total\ Energy\ Demand\ (kWh)}{Coefficient\ of\ Performance} = Total\ Energy\ Cost$$

$$0.254\frac{Euro}{kWh} * \frac{2{,}867\ kWh}{2} = 364.11\ Euros$$

Natural gas energy is used for heating. However, the efficiency of natural gas is 10 percent less than electricity. That's why we should use 10 percent more of what we need.

Therefore, consumption should be more than 10% of the calculated need. This is what we call efficiency.

$$Unit\ Energy\ Price\ \left(\frac{Euro}{kWh}\right) * Total\ Energy\ Demand\ (kWh) * Efficiency$$
$$= Total\ Energy\ Cost$$

$$0.090\frac{Euro}{kWh} * 9{,}905\ kWh * 1.10 = 980.60\ Euros$$

A total of 1,344.70 euros is paid, 364.11 euros for electricity to cool the house and 980.60 euros for natural gas to heat the house.

Our annual net profit is as follows.

$$(1{,}344.70) - (450 + 56.42) = 838.28\ Euros$$

Payback period,

$$\frac{21{,}058}{838.28} \cong 25\ Years$$

Thanks to this system, even when it is thought that energy prices will not increase, it pays for itself in 25 years. Considering the increasing trend of energy prices, this period will be even shorter.

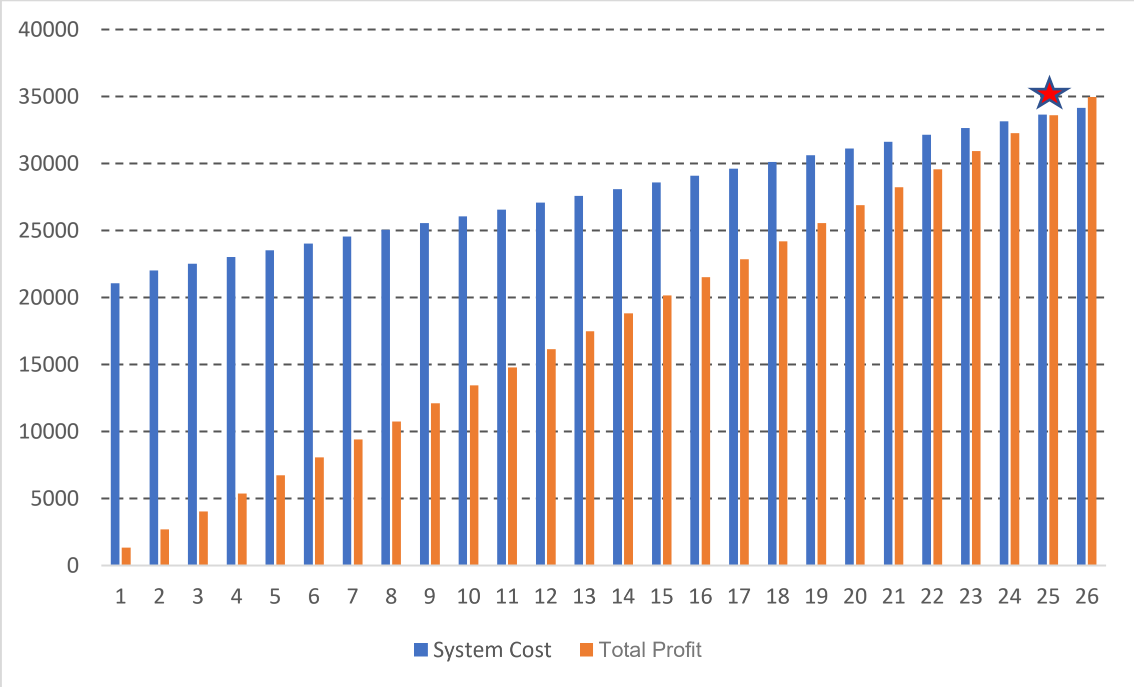


Figure 6.1. Graph of System Profit and Cost

7. DISCUSSION & CONCLUSION

In this undergraduate thesis, a self-sufficient heat pump and solar energy system without using fossil fuels were designed and simulated for one year. For the simulation results to be accurate, your model must be designed most accurately. Therefore, for the house system, we received the heat information about the location of the house from TSE, the most prestigious institution in the country we live in. We determined the square meter of the house by examining the data of TUIK, the official statistical institution of the Turkish state. We think that this is how we model our house most realistically. The most challenging process we faced throughout the thesis was to find accurate, reliable, and one-year-old data. We requested the ambient temperature from the joint data acquisition system of IMM and MGM. We found the temperature data except for some (maintenance and repair etc.) deficiencies. We completed the missing data using various sources. Our other data was the GHI data, which is important to learn the amount of electricity production. We did very extensive research for this data. The most comprehensive study for Turkey was about a month. By examining the GHI data for the Netherlands, which is a country that can be considered close, we determined the ratio between that one-month data and the Netherlands data, which corresponds to the same month, as 1.25, and spread it over the whole year. After that, it was to make heat pump and solar panel selections by collecting the correct codes and outputs. We wrote the code from MATLAB. Based on the outputs of the code, we did a few trials and made a system design that we thought was ideal. For example, for the heat pump, we decided to drill vertical boreholes due to the small size of the garden in Istanbul. We determined that a 6-kW heat pump would be sufficient for us. In addition, we used batteries with a small capacity. Because we have simulated different battery capacities and decided that it is not feasible to increase the battery capacity. We tried to show the effect of different numbers of panels on the number of panels. We can say that the increase in the number of panels has been effective in our system. However, considering the installation cost, we did not change the number of panels, as we saw that we increased the cost too much. We would like to point out that it can be used as an option. Speaking of our results, we have significantly reduced our main goal of fossil fuel use. While doing this, for the system we have established to be attractive, it must pay for itself after a while. We have established a system where we can make a profit and shared the details with you.

Considering the future and scalability of the study, the first development is undoubtedly the collection of GHI data with the help of sensors placed in certain areas of Istanbul. After that, with the development of the software and turning it into an application, people entered the information of their own houses (wall types, number of windows, location etc.), first in Istanbul and then all over Turkey. For them, a user-friendly application can be made that can show the ideal system proposal and its average cost. In this way, it can be ensured that this system, which is always sustainable and environmentally friendly, becomes widespread.

In summary, establishing a sustainable home system using the highest possible level of renewable energy is very important for now, and more importantly for our future. Why do we turn to fossil fuels when we can get our energy needs from an important source like the Sun? Leaving the Earth green for our grandchildren should not be a matter of choice for us. It should be a must. Through our work, we discovered that this process is more than just a lesson. It taught us how to manage our future and daily lives, as well as how to deal with problems that may arise in our professional lives. All things considered, this is more than a project; it is a process aimed at developing different perspectives, identifying problems, and developing practical solutions to these problems.

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A. APPENDIX

Table A.1. Istanbul Hourly Average Temperature Data For 2020 (℃)

Day/Hour	January	February	March	April	May	June	July	August	September	October	November	December
1 00:00:00	5.25	8.16	4.20	6.46	13.98	16.59	21.41	21.93	21.79	17.24	13.13	7.75
1 01:00:00	5.35	8.05	4.09	6.39	13.59	16.13	21.36	21.67	21.36	17.12	12.65	7.46
1 02:00:00	5.33	7.96	4.16	6.30	13.80	16.06	22.15	21.76	21.39	17.48	12.13	7.39
1 03:00:00	5.47	7.86	4.52	6.35	14.42	15.80	22.45	21.77	21.43	16.78	11.45	7.40
1 04:00:00	5.49	7.84	4.31	6.37	14.99	16.48	24.26	23.07	21.76	16.96	11.01	7.27
1 05:00:00	5.76	7.75	5.09	6.56	15.67	18.53	26.91	25.48	23.08	19.58	11.73	6.98
1 06:00:00	5.93	7.46	7.31	7.15	16.75	19.83	28.22	26.57	25.30	20.96	12.40	6.88
1 07:00:00	6.06	7.95	8.51	7.58	18.47	19.95	28.72	28.24	26.66	22.04	13.41	7.05
1 08:00:00	6.14	8.22	9.28	7.81	18.40	16.82	29.05	29.68	28.71	22.36	14.11	7.28
1 09:00:00	6.62	8.25	10.04	8.43	19.20	16.26	29.56	30.00	28.11	22.17	14.06	7.13
1 10:00:00	8.29	8.30	10.51	9.36	19.41	16.04	30.14	30.74	28.08	22.49	14.12	6.97
1 11:00:00	8.68	8.32	10.47	9.21	19.76	17.23	30.81	31.05	29.77	22.09	15.04	6.99
1 12:00:00	8.45	8.30	11.23	8.74	20.56	19.08	30.76	30.44	31.70	22.24	14.86	6.95
1 13:00:00	7.82	8.47	10.43	7.79	20.33	18.94	30.12	30.06	31.22	21.78	14.31	6.61
1 14:00:00	7.33	8.51	10.04	7.56	20.63	17.78	29.67	29.13	29.65	21.21	13.61	6.28
1 15:00:00	6.73	8.35	9.21	7.49	20.61	19.36	28.72	28.25	28.41	19.76	11.91	6.24
1 16:00:00	6.87	8.32	7.65	7.26	18.99	18.08	27.69	26.97	26.80	17.60	10.40	6.28
1 17:00:00	6.92	8.26	7.06	7.35	16.84	16.51	26.21	25.76	25.51	16.92	9.90	6.10
1 18:00:00	5.90	8.25	6.84	7.77	16.34	15.88	25.24	25.03	24.69	16.67	9.70	6.21
1 19:00:00	6.25	8.21	6.81	8.02	15.89	15.69	24.57	24.55	23.98	16.71	9.33	6.45
1 20:00:00	6.26	8.20	7.15	8.25	15.51	15.51	24.28	24.21	23.47	16.55	9.76	6.53
1 21:00:00	6.17	8.19	6.90	8.40	15.37	15.51	24.14	23.74	22.96	16.61	8.90	6.63
1 22:00:00	5.97	8.05	6.06	8.32	15.17	15.43	23.95	23.26	22.50	16.33	8.56	6.52
1 23:00:00	5.07	8.06	5.88	8.30	14.83	15.32	23.74	22.89	22.13	16.34	8.52	6.34
2 00:00:00	4.32	8.16	5.83	8.31	14.38	15.47	23.42	22.56	21.90	16.41	8.51	6.12
2 01:00:00	4.50	8.05	6.37	8.30	14.21	15.31	23.44	21.97	21.73	16.64	8.90	6.04
2 02:00:00	4.28	7.96	7.28	8.20	13.93	15.28	23.45	21.55	21.39	17.52	8.90	6.17
2 03:00:00	4.19	7.86	7.53	7.94	14.27	15.34	23.55	21.41	21.21	18.35	8.84	6.24
2 04:00:00	4.76	7.84	7.19	7.86	16.09	15.64	24.33	22.90	21.78	18.19	8.54	6.30
2 05:00:00	5.29	7.75	8.50	7.86	17.41	16.33	25.86	24.68	24.00	19.88	9.52	6.48
2 06:00:00	5.31	7.46	10.71	8.02	19.24	18.93	23.38	25.98	25.66	21.64	13.04	6.59
2 07:00:00	4.83	7.95	11.47	8.35	19.50	19.63	27.52	27.44	26.91	22.86	14.55	6.92
2 08:00:00	5.39	8.22	13.05	8.63	20.21	20.03	29.35	28.50	28.65	23.37	15.11	7.00
2 09:00:00	6.04	8.25	14.16	9.00	20.84	19.80	30.16	28.92	30.08	23.53	15.90	7.04
2 10:00:00	6.11	8.30	14.49	9.09	21.71	19.93	30.46	29.28	31.29	23.22	16.40	7.14
2 11:00:00	6.34	8.32	14.53	8.35	23.39	20.31	30.31	29.67	31.64	23.64	16.46	7.19
2 12:00:00	6.15	8.30	14.71	7.68	23.82	20.88	30.06	29.43	31.34	23.60	16.45	7.24
2 13:00:00	5.74	8.47	16.12	7.50	23.51	20.08	29.63	28.84	30.66	23.86	15.33	7.35
2 14:00:00	5.64	8.51	15.13	7.45	22.12	20.02	29.00	27.79	29.23	22.86	14.40	7.42
2 15:00:00	5.71	8.35	14.29	7.44	20.62	19.47	28.22	27.02	27.70	20.71	12.54	7.42
2 16:00:00	5.61	8.32	13.24	7.46	20.25	18.56	27.20	25.82	25.79	18.72	11.41	7.70
2 17:00:00	5.38	8.26	12.86	7.33	18.98	17.67	25.82	24.68	24.52	18.04	11.22	7.88
2 18:00:00	5.54	8.25	12.37	7.27	19.21	17.40	24.96	24.10	24.05	18.95	11.25	8.14
2 19:00:00	5.35	8.21	11.82	7.18	18.59	17.03	24.51	23.72	23.62	19.03	11.25	8.23
2 20:00:00	5.19	8.20	11.99	6.92	17.81	16.66	24.22	23.44	23.17	17.72	10.65	8.34
2 21:00:00	5.14	8.19	11.92	6.67	15.85	16.32	23.86	23.06	22.73	17.44	9.99	8.51
2 22:00:00	4.94	8.05	11.42	6.22	14.83	16.19	23.71	22.78	22.61	17.44	9.91	8.60
2 23:00:00	4.87	8.06	11.00	6.01	14.52	15.96	23.52	22.44	22.28	16.62	9.85	8.62
3 00:00:00	5.18	8.16	11.60	5.85	14.40	14.99	23.29	22.13	21.99	16.79	9.70	8.61
3 01:00:00	5.01	8.05	11.83	5.36	13.98	14.08	23.22	21.91	21.75	16.58	9.61	8.71
3 02:00:00	4.46	7.96	10.76	5.00	13.97	14.14	22.97	21.46	22.04	15.59	9.42	8.76
3 03:00:00	3.97	7.86	10.92	5.14	14.24	15.21	23.30	21.33	22.29	15.63	9.65	8.93
3 04:00:00	4.58	7.84	10.32	5.46	15.14	16.13	24.30	22.29	22.76	15.68	10.28	9.12
3 05:00:00	4.89	7.75	11.76	5.79	16.83	16.72	25.83	24.62	24.65	19.04	10.96	9.26
3 06:00:00	5.41	7.46	15.14	6.23	17.66	17.11	27.28	25.82	24.20	22.22	12.09	9.75
3 07:00:00	6.56	7.95	16.15	7.04	18.85	17.33	28.29	26.64	24.61	23.79	13.71	10.40
3 08:00:00	7.61	8.22	18.10	7.43	17.86	18.01	29.22	27.23	28.29	24.59	15.18	11.20
3 09:00:00	7.35	8.25	18.91	7.82	17.70	18.31	29.65	28.01	29.79	25.43	15.62	12.77
3 10:00:00	7.37	8.30	19.58	8.44	16.69	18.08	29.95	28.35	30.33	25.35	15.80	13.82
3 11:00:00	7.07	8.32	19.80	8.96	17.93	18.43	30.28	28.51	29.84	25.33	15.58	14.23
3 12:00:00	7.58	8.30	20.56	10.49	18.43	18.26	30.30	28.33	29.28	25.67	15.25	14.32
3 13:00:00	7.69	8.47	20.40	11.17	20.16	18.75	30.17	27.83	29.64	25.55	14.72	13.62
3 14:00:00	6.93	8.51	19.49	12.26	18.38	19.60	29.65	27.01	28.86	25.02	14.09	12.85
3 15:00:00	6.33	8.35	18.03	13.59	16.53	18.66	28.70	26.00	28.02	23.39	13.71	11.92
3 16:00:00	6.32	8.32	17.15	13.63	16.58	17.80	27.19	25.07	26.48	22.44	13.97	11.42
3 17:00:00	6.34	8.26	16.73	13.36	15.93	16.99	25.72	24.08	25.19	21.44	13.71	11.04
3 18:00:00	6.32	8.25	14.91	13.63	14.24	15.95	24.96	23.45	24.63	19.72	13.27	10.51
3 19:00:00	6.29	8.21	14.21	14.18	14.13	15.48	24.66	22.97	24.36	20.22	13.22	9.26
3 20:00:00	6.12	8.20	13.99	13.34	14.00	14.71	24.49	22.77	24.10	19.68	13.47	9.13
3 21:00:00	5.75	8.19	13.50	13.17	14.00	14.71	24.29	22.41	23.88	18.83	13.60	8.79
3 22:00:00	5.59	8.05	13.17	13.26	14.00	14.47	24.04	22.16	23.69	17.65	13.30	9.15
3 23:00:00	5.52	8.06	12.81	13.59	14.00	14.41	23.83	22.04	23.40	16.63	13.10	8.79
4 00:00:00	6.03	8.31	12.18	13.63	13.00	14.26	23.54	21.91	23.08	16.28	12.90	9.26
4 01:00:00	6.63	9.01	11.94	13.36	13.00	13.65	22.91	22.07	22.80	16.47	12.90	8.64
4 02:00:00	6.64	9.84	11.97	13.20	13.00	13.21	22.46	21.87	22.53	16.54	12.83	8.54
4 03:00:00	7.00	9.74	11.73	12.67	13.00	13.79	22.72	21.56	22.04	16.38	12.78	8.07
4 04:00:00	7.19	9.59	11.19	12.96	13.00	15.88	24.14	22.62	23.06	16.74	12.74	7.87
4 05:00:00	7.31	9.36	11.11	12.62	13.00	18.44	25.86	24.76	24.94	19.54	12.71	8.14
4 06:00:00	7.48	8.30	13.11	12.33	13.00	20.17	27.13	23.67	25.66	23.33	14.38	9.52
4 07:00:00	7.87	11.55	15.56	12.98	13.00	20.59	28.27	22.70	26.68	24.26	13.57	11.55
4 08:00:00	8.34	12.74	15.63	13.42	14.00	21.12	29.67	25.18	26.63	25.85	14.55	14.07
4 09:00:00	8.71	13.94	15.51	11.98	14.00	21.85	29.95	27.77	26.43	27.73	14.74	17.06

4 10:00:00	9.33	12.82	16.84	11.56	14.00	22.97	30.34	28.27	25.08	27.00	15.29	18.96
4 11:00:00	9.32	9.87	16.63	11.82	14.00	23.30	30.36	28.35	22.60	27.02	16.67	18.51
4 12:00:00	8.64	9.92	18.56	11.73	14.00	23.81	30.44	28.06	23.80	28.03	15.39	18.36
4 13:00:00	8.58	9.16	18.78	11.68	14.00	25.11	30.11	28.18	24.44	27.78	15.57	17.77
4 14:00:00	8.22	9.05	18.91	9.99	14.00	25.42	29.70	27.16	23.94	26.84	14.09	15.64
4 15:00:00	7.82	8.59	17.01	9.55	14.00	24.80	29.06	26.22	22.75	24.22	13.71	13.84
4 16:00:00	7.15	8.50	14.42	9.49	15.00	23.49	27.86	25.25	21.94	21.87	13.97	13.06
4 17:00:00	7.21	8.64	15.38	9.22	15.00	20.84	26.39	24.24	21.59	21.00	13.71	12.73
4 18:00:00	7.45	8.29	16.04	9.12	15.00	19.26	25.55	23.87	21.53	20.79	13.27	12.41
4 19:00:00	7.26	8.38	15.57	8.84	14.00	19.09	25.12	23.61	21.33	20.35	13.22	12.66
4 20:00:00	6.41	8.64	15.35	8.80	13.00	18.67	24.87	23.37	20.48	19.94	13.47	12.70
4 21:00:00	6.25	8.79	14.74	8.80	13.00	18.59	24.51	23.11	20.79	19.84	13.60	12.66
4 22:00:00	6.21	8.46	14.00	8.75	13.00	17.84	24.19	22.86	20.56	19.86	13.30	12.16
4 23:00:00	6.13	8.29	13.55	8.60	13.00	17.17	23.84	22.43	20.38	19.44	13.10	10.70
5 00:00:00	6.03	8.16	12.39	8.25	13.00	17.24	23.57	21.69	20.37	18.73	12.90	10.65
5 01:00:00	6.63	8.05	12.50	7.69	13.00	17.03	23.63	21.16	20.25	18.61	12.90	10.45
5 02:00:00	6.64	7.96	12.63	7.36	13.00	16.84	23.41	20.43	19.79	18.23	12.83	10.57
5 03:00:00	7.00	7.86	12.68	7.01	13.00	17.16	23.62	20.53	20.07	18.56	12.78	10.06
5 04:00:00	7.19	7.84	12.23	6.87	13.00	19.05	24.61	21.81	19.58	18.55	12.74	9.60
5 05:00:00	7.31	7.75	12.31	6.86	13.00	21.33	26.19	24.75	20.14	20.56	14.60	9.55
5 06:00:00	7.48	7.46	12.93	6.99	14.00	22.72	27.71	25.36	22.13	20.75	15.15	9.87
5 07:00:00	7.87	7.95	13.49	7.30	14.00	23.30	28.93	26.83	23.18	24.44	15.51	11.03
5 08:00:00	8.34	8.22	14.91	7.45	14.00	24.39	29.69	27.61	24.12	27.57	15.78	13.25
5 09:00:00	8.71	8.25	14.66	7.58	14.00	25.63	30.05	28.44	24.44	28.58	16.39	15.52
5 10:00:00	9.33	8.30	13.80	7.74	14.00	26.22	30.38	29.02	24.84	30.38	17.33	16.05
5 11:00:00	9.32	16.86	15.03	7.75	14.00	27.13	30.24	29.42	24.70	32.24	17.46	15.50
5 12:00:00	8.64	13.99	14.93	8.27	15.00	27.34	30.24	29.03	24.88	31.86	16.82	15.10
5 13:00:00	8.58	11.25	12.60	8.53	15.00	27.94	29.79	28.66	24.85	27.78	16.71	14.37
5 14:00:00	8.22	9.63	12.40	8.54	15.00	28.64	29.37	27.98	24.35	26.84	16.61	13.64
5 15:00:00	7.82	8.82	12.66	8.46	17.00	28.56	28.77	27.01	23.93	24.22	16.34	13.44
5 16:00:00	7.15	9.04	12.70	8.37	17.00	27.96	27.56	26.00	22.99	21.87	16.17	13.42
5 17:00:00	7.21	9.38	11.04	8.30	17.00	24.21	26.04	24.66	22.26	21.00	15.84	13.28
5 18:00:00	7.45	9.62	10.59	8.03	17.00	21.77	25.33	23.92	21.23	20.79	15.85	13.08
5 19:00:00	7.26	9.56	10.41	8.05	17.00	21.52	25.00	23.44	20.75	20.35	15.89	12.96
5 20:00:00	6.41	9.38	9.94	8.15	17.00	21.97	24.81	23.14	19.63	19.94	15.90	12.84
5 21:00:00	6.25	9.36	9.90	8.16	15.00	20.01	24.70	22.86	19.42	19.84	15.20	12.47
5 22:00:00	6.21	9.34	10.01	8.20	15.00	18.95	24.60	22.76	18.73	19.86	14.30	11.58
5 23:00:00	6.13	9.01	9.82	8.21	15.00	19.13	24.52	22.40	18.24	19.44	13.70	11.64
6 00:00:00	6.06	8.36	9.68	8.46	13.00	18.56	24.41	22.39	18.01	16.28	12.96	11.31
6 01:00:00	5.87	8.11	9.55	8.58	13.00	18.51	24.21	22.21	17.99	16.47	12.54	10.73
6 02:00:00	5.65	7.34	9.10	8.51	13.00	18.02	24.08	21.40	17.91	16.54	12.14	10.62
6 03:00:00	5.75	6.21	8.74	8.50	13.00	18.66	24.10	21.06	17.64	16.38	12.02	10.35
6 04:00:00	6.26	5.62	8.63	8.65	11.00	20.26	25.10	22.47	18.84	16.74	12.11	9.79
6 05:00:00	6.80	4.80	8.56	10.19	11.00	24.73	26.67	24.98	22.40	19.54	12.46	9.94
6 06:00:00	6.81	4.53	8.65	10.20	11.00	26.36	27.70	26.30	24.18	23.33	14.67	11.75
6 07:00:00	6.82	4.27	8.68	10.20	11.00	27.46	29.02	27.80	25.21	24.26	14.92	14.01
6 08:00:00	7.14	4.12	9.06	10.20	12.00	27.97	30.31	27.86	25.58	25.85	14.37	14.81
6 09:00:00	7.07	3.83	9.91	10.20	13.00	28.30	31.02	28.99	26.17	27.73	14.11	14.79
6 10:00:00	7.12	3.64	11.11	10.28	14.00	28.64	31.39	29.15	26.43	27.00	13.76	15.43
6 11:00:00	7.09	3.21	12.64	10.20	15.00	29.83	31.61	29.14	27.17	27.02	14.22	15.24
6 12:00:00	7.10	3.15	13.80	10.24	16.00	31.34	31.84	29.33	27.86	28.03	14.93	14.42
6 13:00:00	7.13	2.91	14.22	10.09	17.00	31.02	31.53	29.32	27.37	27.78	15.13	13.57
6 14:00:00	6.76	2.67	13.39	9.71	18.00	32.28	30.54	28.78	26.37	26.84	14.94	12.65
6 15:00:00	6.48	2.56	13.35	9.39	19.00	31.21	29.37	27.87	25.30	24.22	14.68	12.05
6 16:00:00	6.50	2.41	12.47	8.94	20.00	29.45	28.20	26.86	24.23	21.87	14.21	11.84
6 17:00:00	6.49	2.21	11.78	8.67	21.00	27.81	26.85	25.51	23.26	21.00	14.13	11.47
6 18:00:00	6.53	2.22	11.10	8.58	22.00	26.00	25.97	24.79	22.84	20.79	13.69	11.53
6 19:00:00	6.54	2.31	11.19	8.34	21.00	24.96	25.24	24.45	22.66	20.35	13.46	11.45
6 20:00:00	6.48	2.49	11.13	8.28	20.00	23.96	24.86	24.39	22.28	19.94	12.82	11.09
6 21:00:00	6.45	2.67	10.95	8.30	18.00	22.41	24.56	24.22	21.49	19.84	12.81	10.90
6 22:00:00	6.42	3.00	11.07	8.07	16.00	22.43	24.49	24.00	21.23	19.86	13.01	10.71
6 23:00:00	6.25	3.32	11.84	7.91	13.00	21.21	24.58	23.59	21.07	19.44	13.08	10.52
7 00:00:00	6.21	3.35	11.73	7.80	12.00	20.08	24.47	23.33	20.90	18.73	12.96	10.25
7 01:00:00	6.20	3.56	11.81	7.92	11.00	19.46	24.41	23.17	20.55	18.61	12.54	10.27
7 02:00:00	6.05	3.70	11.20	8.07	11.00	19.22	24.34	23.07	20.35	18.23	12.14	10.36
7 03:00:00	5.82	3.78	10.21	7.94	11.00	18.86	24.59	22.79	20.07	18.56	12.02	10.40
7 04:00:00	5.80	3.81	10.16	8.38	11.00	20.13	25.40	23.59	20.57	18.55	12.11	10.56
7 05:00:00	5.74	4.10	11.56	9.54	10.00	21.75	26.11	25.05	22.80	20.56	12.46	10.47
7 06:00:00	5.64	4.43	14.15	10.63	10.00	22.63	26.54	26.47	24.69	20.75	14.67	11.38
7 07:00:00	5.56	5.09	15.89	11.27	11.00	23.13	28.53	27.58	26.18	24.44	14.92	12.20
7 08:00:00	5.59	5.56	17.06	11.86	12.00	24.14	29.63	28.96	27.20	27.57	14.22	14.81
7 09:00:00	5.43	6.31	17.58	12.11	13.00	24.59	29.69	29.74	28.29	28.58	13.84	14.79
7 10:00:00	5.58	6.33	17.89	12.22	13.00	24.70	29.67	29.76	29.11	30.38	13.72	15.43
7 11:00:00	5.59	5.86	18.16	12.41	15.00	26.17	29.93	29.71	29.03	32.24	14.19	15.24
7 12:00:00	5.54	5.32	18.57	12.28	15.00	27.16	30.09	29.89	28.98	31.86	13.92	14.42
7 13:00:00	5.39	4.22	18.77	11.86	15.00	27.25	30.51	30.59	28.36	27.78	12.99	13.57
7 14:00:00	5.15	3.51	18.09	11.05	15.00	27.51	30.56	30.01	27.41	26.84	13.13	12.65
7 15:00:00	4.97	3.02	16.83	10.23	15.00	26.26	30.22	29.09	26.02	24.22	13.51	12.05
7 16:00:00	4.78	3.30	15.18	9.28	15.00	24.23	29.05	27.60	24.59	21.87	13.46	11.84
7 17:00:00	4.60	3.16	15.00	8.72	15.00	22.68	27.06	26.01	23.75	21.00	13.11	11.47
7 18:00:00	6.53	3.62	14.77	8.59	15.00	20.85	26.40	25.05	23.39	20.79	13.11	11.53
7 19:00:00	6.54	3.77	13.97	8.67	15.00	20.13	26.19	24.76	23.13	20.35	13.15	11.45
7 20:00:00	6.48	2.78	14.12	8.89	13.00	19.72	26.34	24.60	22.87	19.94	13.31	11.09
7 21:00:00	6.45	1.11	13.44	8.62	12.00	19.69	26.31	24.70	22.29	19.84	13.32	10.90
7 22:00:00	6.42	0.01	13.04	8.58	12.00	19.48	25.73	24.62	21.39	19.86	13.30	10.71
7 23:00:00	6.25	-0.19	13.30	8.45	12.00	19.26	25.18	24.27	21.11	19.44	13.41	10.52
8 00:00:00	6.21	-0.07	13.19	8.40	12.00	18.84	24.79	24.11	20.51	19.30	13.45	10.25
8 01:00:00	6.20	0.60	12.78	8.30	11.00	18.67	23.34	24.33	19.92	19.10	13.31	10.27
8 02:00:00	6.05	0.47	14.36	8.17	11.00	18.54	22.78	24.54	19.79	19.00	13.05	10.36
8 03:00:00	5.82	-0.07	16.80	8.30	10.00	18.91	22.52	24.78	19.69	19.70	12.55	10.40

8 04:00:00	5.80	-0.15	17.28	8.50	10.00	20.21	22.22	25.13	20.35	20.10	12.34	10.56
8 05:00:00	5.74	-0.19	18.26	9.42	10.00	22.21	22.48	26.22	23.54	22.19	13.07	10.47
8 06:00:00	5.64	0.08	19.80	10.25	10.00	21.40	21.62	27.17	24.93	23.61	14.50	11.38
8 07:00:00	5.56	0.53	21.26	10.60	10.00	23.30	22.30	28.18	26.20	24.88	15.87	12.20
8 08:00:00	5.86	0.69	20.99	10.90	11.00	23.68	24.02	28.70	26.99	25.32	16.02	14.81
8 09:00:00	6.08	0.59	20.39	11.69	12.00	24.12	24.71	29.70	27.97	25.13	16.64	14.79
8 10:00:00	5.27	0.88	21.76	12.13	13.00	24.60	23.86	29.77	28.14	25.33	16.98	15.43
8 11:00:00	5.44	10.25	21.76	12.20	14.00	25.74	24.57	28.26	28.03	24.01	17.11	15.24
8 12:00:00	5.40	1.52	21.47	11.99	15.00	25.49	24.01	27.25	27.83	21.69	17.01	14.42
8 13:00:00	5.16	1.78	20.69	11.45	16.00	25.20	23.58	27.36	27.85	20.11	16.75	13.57
8 14:00:00	4.36	0.96	20.77	10.46	16.00	26.22	23.39	27.84	26.90	19.32	16.10	12.65
8 15:00:00	4.76	0.65	19.73	9.60	17.00	25.87	23.31	27.30	25.90	18.88	15.35	12.05
8 16:00:00	4.28	0.71	17.38	8.49	18.00	24.83	22.90	26.66	24.72	17.77	14.96	11.84
8 17:00:00	4.48	0.76	16.97	8.38	19.00	22.22	21.79	25.87	24.03	17.42	15.14	11.47
8 18:00:00	4.51	0.87	16.14	8.20	18.00	20.72	21.28	25.50	23.71	17.19	15.33	11.53
8 19:00:00	4.53	10.09	15.24	7.95	18.00	20.12	21.07	25.43	23.45	16.87	15.28	11.45
8 20:00:00	4.44	10.12	14.78	7.97	17.00	19.82	21.02	25.22	23.21	17.50	15.01	11.09
8 21:00:00	4.26	0.35	14.64	7.89	17.00	19.35	20.97	25.09	23.07	17.08	14.78	10.90
8 22:00:00	4.65	0.24	15.02	7.86	16.00	18.91	20.84	24.80	22.98	16.44	14.43	10.71
8 23:00:00	4.66	0.40	14.62	7.89	15.00	18.47	20.50	24.60	22.70	17.02	14.40	10.52
9 00:00:00	4.25	0.47	13.51	8.10	15.00	18.13	20.30	24.41	22.65	16.74	14.36	1.84
9 01:00:00	4.37	0.43	12.52	8.00	14.00	18.23	19.87	24.42	22.71	15.84	14.11	1.68
9 02:00:00	4.50	0.36	12.19	7.88	14.00	18.90	19.20	24.60	22.61	15.77	13.92	1.77
9 03:00:00	4.37	0.20	12.30	7.65	14.00	19.15	19.12	24.84	22.58	15.49	13.00	1.56
9 04:00:00	4.30	0.21	11.92	7.61	14.00	20.86	21.63	25.35	22.85	15.27	12.30	1.43
9 05:00:00	4.28	0.20	14.03	8.68	14.00	23.48	23.90	25.88	24.03	16.64	12.93	1.61
9 06:00:00	4.24	0.98	18.55	9.52	14.00	24.04	24.49	27.05	22.69	18.38	15.98	1.79
9 07:00:00	5.27	2.01	18.80	10.81	15.00	26.16	25.56	27.73	23.73	19.59	17.70	2.46
9 08:00:00	5.51	2.49	20.98	12.49	16.00	27.44	26.02	29.17	27.03	19.66	18.31	3.80
9 09:00:00	5.74	3.83	22.62	13.60	16.00	28.20	26.12	28.90	27.42	20.07	18.23	4.93
9 10:00:00	6.85	4.55	22.99	13.91	17.00	28.97	26.39	28.77	27.92	20.57	18.84	5.19
9 11:00:00	6.19	4.66	22.02	13.92	18.00	28.08	26.36	29.46	28.10	20.63	18.79	5.10
9 12:00:00	6.40	4.31	20.93	13.74	18.00	27.90	26.25	29.52	27.49	20.37	18.79	5.10
9 13:00:00	6.32	3.84	19.89	13.58	19.00	28.33	26.70	28.41	26.86	19.32	18.15	4.37
9 14:00:00	6.11	3.25	18.00	12.90	19.00	29.66	30.56	28.06	25.73	17.78	17.27	3.40
9 15:00:00	5.78	2.58	15.16	11.95	19.00	29.39	30.22	27.08	24.63	17.33	16.40	2.81
9 16:00:00	5.71	1.95	13.10	10.56	20.00	28.01	29.05	26.34	23.68	16.82	15.77	1.76
9 17:00:00	5.71	1.64	11.97	9.28	20.00	26.05	27.06	25.58	23.04	16.22	15.30	0.80
9 18:00:00	5.67	1.61	10.67	8.27	20.00	25.32	26.40	25.33	22.63	15.95	14.87	1.05
9 19:00:00	5.58	1.60	9.97	7.68	19.00	24.43	26.19	24.90	22.27	16.14	14.39	1.01
9 20:00:00	5.37	1.96	9.59	7.38	19.00	23.72	26.34	24.69	21.94	15.79	14.03	1.58
9 21:00:00	5.21	2.29	9.30	7.03	18.00	23.43	26.31	24.50	21.45	15.30	13.01	1.77
9 22:00:00	4.79	2.44	9.55	6.53	17.00	22.44	25.73	23.83	20.43	15.00	13.17	1.29
9 23:00:00	5.03	2.43	9.67	6.27	16.00	22.67	25.18	23.09	20.69	14.71	14.78	1.59
10 00:00:00	4.51	2.58	9.86	5.92	15.00	22.40	24.79	23.10	20.98	14.45	15.50	1.68
10 01:00:00	4.07	2.28	9.60	5.25	14.00	21.41	23.34	23.17	20.77	14.43	15.40	1.77
10 02:00:00	3.52	1.76	9.53	5.13	13.00	21.51	22.78	23.36	20.58	14.26	15.23	1.56
10 03:00:00	3.21	1.80	9.37	5.11	12.00	21.50	22.52	23.69	19.76	14.11	15.26	1.43
10 04:00:00	3.36	1.67	9.62	5.91	12.00	22.61	22.22	24.53	19.64	14.53	15.22	1.61
10 05:00:00	3.38	1.84	9.67	8.65	11.00	24.95	22.48	26.23	22.88	16.57	15.38	1.79
10 06:00:00	4.28	3.30	9.93	10.50	10.00	26.27	21.62	27.53	24.03	16.65	15.71	2.46
10 07:00:00	7.10	4.34	10.33	11.26	11.00	27.58	22.30	28.88	25.56	18.45	15.95	3.89
10 08:00:00	7.92	5.16	10.57	12.61	13.00	28.95	24.02	29.53	26.56	20.44	16.28	4.77
10 09:00:00	8.32	5.84	10.88	13.82	15.00	29.18	24.71	30.19	27.56	21.55	16.62	4.93
10 10:00:00	9.67	6.38	10.76	14.71	16.00	28.91	23.86	30.67	28.21	21.41	16.47	5.19
10 11:00:00	9.92	6.98	10.44	13.79	16.00	28.75	24.57	30.27	28.51	21.14	16.18	5.20
10 12:00:00	8.86	7.95	10.51	15.29	18.00	28.82	24.01	30.16	28.53	20.52	16.31	4.37
10 13:00:00	8.24	7.74	10.46	16.06	19.00	28.08	23.58	29.18	27.25	20.23	16.17	3.40
10 14:00:00	7.48	7.11	10.36	14.99	20.00	27.52	23.39	28.55	26.54	19.53	15.99	2.81
10 15:00:00	6.00	7.18	10.22	14.39	21.00	27.42	23.31	27.64	25.18	18.59	15.87	1.76
10 16:00:00	5.34	7.42	10.35	12.75	22.00	25.87	22.90	26.54	24.38	17.62	15.82	0.80
10 17:00:00	5.10	7.38	10.39	11.12	23.00	24.25	21.79	25.37	23.63	17.14	15.79	1.05
10 18:00:00	5.08	7.57	10.41	10.18	24.00	23.37	21.28	24.90	23.33	16.65	15.48	1.01
10 19:00:00	4.99	8.49	10.38	9.85	23.00	22.46	21.07	24.58	22.95	16.55	15.10	1.58
10 20:00:00	4.94	8.77	10.05	9.67	22.00	21.43	21.02	24.32	22.65	16.41	14.44	1.77
10 21:00:00	4.90	8.99	9.84	9.99	20.00	21.08	20.97	24.01	22.27	16.63	14.01	1.29
10 22:00:00	4.75	9.09	9.53	9.01	18.50	20.90	20.84	23.58	21.96	16.27	13.91	1.30
10 23:00:00	4.73	9.08	9.56	8.55	17.00	20.65	20.50	23.66	21.64	15.96	13.90	1.35
11 00:00:00	4.61	8.94	9.76	8.17	17.00	20.12	20.30	23.50	21.42	16.03	13.81	1.29
11 01:00:00	4.71	9.19	9.64	8.31	17.00	19.63	19.87	23.36	21.13	16.37	13.95	1.00
11 02:00:00	4.70	9.21	9.43	8.54	17.00	19.21	19.20	22.92	21.02	16.28	13.98	1.09
11 03:00:00	5.70	9.11	9.49	8.34	16.00	19.70	19.12	22.46	21.21	16.20	13.91	0.76
11 04:00:00	6.32	8.99	9.73	8.69	16.00	20.97	21.63	23.26	22.10	16.68	13.78	0.78
11 05:00:00	5.92	9.06	10.20	12.12	16.00	22.92	23.90	25.70	23.60	18.05	13.78	0.69
11 06:00:00	7.56	8.68	12.47	13.83	16.00	23.44	24.49	26.43	24.62	19.98	14.15	0.51
11 07:00:00	9.32	9.08	14.62	16.57	17.00	23.24	25.56	27.72	25.38	20.96	14.77	0.14
11 08:00:00	10.11	9.93	15.37	18.30	18.00	23.94	26.02	29.14	25.62	21.87	16.14	0.01
11 09:00:00	10.71	10.52	15.71	18.91	19.00	24.60	26.12	29.74	26.20	22.21	15.98	-0.21
11 10:00:00	11.77	12.18	14.85	19.05	20.00	25.39	26.39	30.12	26.45	22.65	16.06	-0.65
11 11:00:00	10.78	12.51	14.94	18.56	21.00	26.32	26.36	30.27	26.64	23.27	16.56	-0.99
11 12:00:00	9.97	13.67	15.40	17.66	22.00	27.38	26.25	30.23	26.30	23.58	16.59	-1.14
11 13:00:00	9.75	13.83	15.89	17.59	23.00	26.07	26.70	29.96	25.82	22.91	16.14	-1.27
11 14:00:00	8.95	12.59	15.01	17.15	24.00	25.15	26.25	29.47	24.92	22.67	15.62	-1.12
11 15:00:00	7.68	12.28	13.87	15.89	25.00	23.82	26.25	28.49	24.38	21.76	15.06	-1.07
11 16:00:00	7.41	11.96	12.24	14.18	26.00	23.89	26.57	27.60	23.64	20.64	14.92	-1.28
11 17:00:00	8.28	12.26	11.92	12.76	27.00	22.78	25.95	25.90	23.05	19.95	14.86	-1.22
11 18:00:00	7.24	12.00	11.08	11.98	28.00	21.87	25.46	24.99	22.78	19.53	14.61	-1.13
11 19:00:00	7.39	11.75	10.68	11.52	26.00	21.31	25.10	24.59	22.62	18.85	14.43	-0.94
11 20:00:00	8.45	11.46	10.28	10.92	25.00	21.36	24.85	24.13	22.50	18.10	13.94	-1.37
11 21:00:00	8.55	10.92	9.69	10.50	23.00	21.44	24.75	23.83	22.41	17.63	13.56	-1.59

11 22:00:00	8.23	7.89	9.37	10.13	22.00	21.31	24.65	23.57	22.22	17.34	13.50	-1.92
11 23:00:00	8.59	7.48	9.08	9.73	20.00	21.09	24.60	23.29	21.99	16.55	13.29	-2.21
12 00:00:00	8.77	7.28	8.77	9.23	19.00	20.76	23.16	23.03	22.10	15.91	13.00	-2.11
12 01:00:00	9.07	7.06	8.60	8.67	19.00	20.51	23.02	22.50	22.32	16.00	12.78	-2.07
12 02:00:00	8.76	7.08	8.54	7.67	19.00	20.39	22.05	22.20	22.83	15.68	12.73	-2.43
12 03:00:00	8.57	6.99	8.26	7.16	19.00	20.49	22.32	22.24	23.04	15.34	12.62	-2.48
12 04:00:00	8.40	6.92	8.45	8.08	17.00	21.61	22.25	23.29	23.22	15.33	11.20	-2.39
12 05:00:00	8.23	6.60	10.54	9.89	17.00	23.17	23.22	25.03	23.72	17.34	11.30	-2.04
12 06:00:00	8.50	6.88	13.28	11.67	17.00	23.90	23.49	24.52	24.47	20.23	14.29	-1.95
12 07:00:00	9.05	8.15	14.87	12.97	18.00	24.18	24.60	28.24	25.06	21.84	16.06	-1.48
12 08:00:00	9.11	8.66	15.65	14.17	19.00	24.02	26.02	29.75	26.27	23.22	16.99	-0.75
12 09:00:00	9.21	9.84	17.44	15.36	20.00	24.08	26.12	30.50	26.66	24.09	17.75	-0.71
12 10:00:00	9.23	10.83	18.29	15.86	21.00	24.61	26.39	30.97	26.43	24.74	18.17	0.56
12 11:00:00	9.43	10.93	18.02	15.70	22.00	25.54	26.36	31.23	26.71	24.97	18.21	1.26
12 12:00:00	9.48	11.24	17.89	15.41	23.00	25.80	26.25	31.19	27.16	25.54	17.55	0.86
12 13:00:00	9.32	9.97	17.11	15.17	24.00	25.41	26.70	30.95	26.74	24.09	16.80	1.12
12 14:00:00	9.10	9.51	15.64	14.23	24.00	23.86	26.25	30.25	25.99	22.96	15.76	0.62
12 15:00:00	8.54	8.98	14.37	13.12	26.00	23.04	26.25	29.32	25.25	21.34	14.71	0.18
12 16:00:00	8.10	8.50	13.52	11.78	26.00	22.93	26.57	28.17	24.43	19.27	14.21	-0.11
12 17:00:00	8.02	7.84	12.73	10.35	25.00	21.85	25.95	26.46	24.17	19.78	13.86	-0.02
12 18:00:00	7.51	7.07	12.25	9.64	27.00	21.35	25.46	25.59	24.06	19.86	13.50	-0.12
12 19:00:00	6.85	6.68	11.77	9.16	28.00	20.93	25.10	25.00	24.03	18.72	13.30	-0.63
12 20:00:00	6.55	6.15	10.94	8.80	26.00	20.56	24.85	24.51	24.00	18.06	13.09	-0.53
12 21:00:00	7.10	6.21	11.14	8.20	24.00	20.52	24.75	24.11	24.00	17.92	12.83	-0.54
12 22:00:00	6.97	7.03	10.12	8.22	22.00	20.43	24.65	23.69	23.88	17.41	12.80	-0.47
12 23:00:00	6.81	7.02	9.22	8.05	20.00	20.26	24.60	23.33	23.65	17.28	12.76	-0.78
13 00:00:00	6.86	7.47	8.88	7.72	18.00	20.08	23.16	22.69	23.55	17.56	12.70	5.00
13 01:00:00	6.92	8.00	8.76	7.31	16.00	20.01	21.36	22.15	23.60	17.59	12.57	4.80
13 02:00:00	6.85	8.07	8.26	6.52	14.00	19.83	22.15	22.11	23.58	16.90	12.31	4.65
13 03:00:00	6.83	7.51	7.63	6.66	12.00	20.18	22.45	22.26	23.52	16.81	11.97	4.50
13 04:00:00	6.86	6.83	7.77	7.15	12.00	20.83	24.26	23.61	23.68	17.21	10.89	4.20
13 05:00:00	6.81	7.11	8.78	8.85	11.00	21.58	26.91	26.05	24.09	19.28	11.00	4.10
13 06:00:00	6.82	9.69	10.22	10.81	10.00	22.04	28.22	27.64	25.03	23.07	13.40	4.00
13 07:00:00	7.67	10.90	12.10	12.56	11.00	23.15	28.72	28.23	25.73	24.80	15.17	4.30
13 08:00:00	8.26	10.81	14.07	13.50	13.00	23.86	29.05	29.76	26.71	25.87	15.98	4.40
13 09:00:00	9.37	11.36	15.86	14.82	15.00	23.20	29.56	30.38	27.35	27.37	16.60	5.00
13 10:00:00	8.65	1.21	15.83	14.20	16.00	23.09	30.14	30.50	27.35	28.50	17.76	4.80
13 11:00:00	8.60	12.57	16.42	14.27	16.00	24.18	30.81	30.40	26.11	27.69	17.27	4.60
13 12:00:00	8.48	9.36	16.78	15.36	18.00	23.52	30.76	30.05	25.67	27.73	16.34	4.40
13 13:00:00	8.42	10.05	16.80	15.82	19.00	22.98	30.12	29.43	25.59	25.33	16.12	4.20
13 14:00:00	7.87	9.36	16.16	14.77	20.00	22.87	29.67	28.67	25.50	20.14	15.33	4.00
13 15:00:00	7.27	8.20	15.04	14.32	21.00	23.43	28.72	27.78	24.69	18.80	14.65	4.00
13 16:00:00	6.91	6.98	13.33	13.33	22.00	23.26	27.69	26.62	24.26	18.92	14.43	3.84
13 17:00:00	6.62	6.24	12.03	11.42	23.00	21.56	26.21	25.49	23.96	19.74	14.25	3.44
13 18:00:00	6.60	5.87	11.18	11.64	24.00	20.74	25.24	25.00	23.80	20.18	14.09	3.44
13 19:00:00	6.35	5.50	10.87	11.44	23.00	20.49	24.57	24.57	23.72	20.29	14.00	3.34
13 20:00:00	5.86	5.57	10.37	10.17	22.00	20.47	24.28	24.28	23.69	20.33	13.95	3.24
13 21:00:00	5.48	5.70	9.74	10.19	20.00	20.40	24.14	24.00	23.57	20.18	13.71	3.04
13 22:00:00	5.17	4.99	9.55	10.95	18.50	20.72	23.95	23.66	23.33	19.85	13.65	2.64
13 23:00:00	4.97	4.28	8.85	10.92	17.00	20.77	23.74	23.33	23.13	19.81	13.60	2.24
14 00:00:00	4.67	4.31	8.10	10.50	17.00	20.73	23.42	23.06	23.07	20.04	13.50	5.00
14 01:00:00	4.71	4.36	7.51	10.11	17.00	20.38	23.44	22.73	22.99	20.08	13.47	4.80
14 02:00:00	4.41	4.46	7.47	10.95	17.00	20.19	23.45	22.16	22.75	20.12	13.40	4.65
14 03:00:00	4.45	4.34	7.73	10.16	16.00	20.40	23.55	21.81	22.46	19.96	13.32	4.50
14 04:00:00	4.07	4.05	8.53	11.44	16.00	20.80	24.33	22.58	22.59	19.97	13.47	4.20
14 05:00:00	3.77	5.87	10.02	14.54	16.00	21.24	25.86	24.32	24.38	21.48	13.53	4.10
14 06:00:00	5.20	8.82	12.25	16.58	16.00	20.95	23.38	25.07	25.68	23.05	13.53	4.00
14 07:00:00	7.75	9.46	13.57	17.97	17.00	20.50	27.52	25.92	27.07	23.23	13.17	4.30
14 08:00:00	8.58	9.93	14.27	18.93	18.00	20.54	29.35	27.04	28.06	22.83	13.27	4.40
14 09:00:00	9.46	10.74	14.56	20.32	19.00	21.56	30.16	27.92	28.71	23.35	13.23	5.00
14 10:00:00	10.09	11.59	14.71	19.39	20.00	21.93	30.46	28.45	28.43	23.07	13.11	4.80
14 11:00:00	10.41	12.37	13.60	20.19	21.00	22.33	30.31	28.57	28.40	22.85	12.51	4.60
14 12:00:00	9.76	13.02	12.52	21.84	22.00	23.38	30.06	28.45	28.49	23.72	12.47	4.40
14 13:00:00	9.42	12.65	11.45	22.71	23.00	24.00	29.63	28.41	27.35	22.72	13.08	4.20
14 14:00:00	8.49	12.53	9.88	21.27	24.00	24.21	29.00	27.29	26.31	22.13	13.07	4.00
14 15:00:00	8.29	11.52	9.47	19.76	25.00	23.28	28.22	25.93	25.39	20.81	12.90	4.00
14 16:00:00	8.48	10.72	9.12	18.35	26.00	22.99	27.20	24.85	24.38	19.25	12.71	3.84
14 17:00:00	7.94	11.15	9.00	17.67	27.00	22.20	25.82	23.87	23.87	18.54	12.54	3.44
14 18:00:00	7.88	11.57	8.89	16.70	28.00	21.80	24.96	23.43	23.60	18.15	12.47	3.44
14 19:00:00	7.48	11.90	8.83	15.84	26.00	22.57	24.51	23.17	23.45	17.91	12.77	3.34
14 20:00:00	6.75	11.87	8.62	15.84	25.00	22.60	24.22	22.75	23.23	17.78	12.70	3.24
14 21:00:00	6.63	11.65	8.60	15.59	23.00	21.38	23.86	22.28	22.98	17.69	11.65	3.04
14 22:00:00	6.57	10.69	8.56	16.94	22.00	20.21	23.71	21.96	22.82	17.04	11.64	2.64
14 23:00:00	6.60	9.74	8.60	16.04	20.00	19.80	23.52	21.89	22.72	16.60	11.89	2.24
15 00:00:00	4.67	9.82	8.69	13.74	19.00	19.81	23.29	21.51	22.33	16.38	11.89	1.84
15 01:00:00	4.71	9.61	9.07	12.93	19.00	19.62	23.22	21.25	22.33	16.18	11.49	1.68
15 02:00:00	4.41	9.28	9.33	11.83	19.00	19.69	22.97	21.19	22.55	16.03	11.22	1.77
15 03:00:00	4.45	8.93	9.23	10.31	19.00	20.13	23.30	21.35	22.17	15.82	10.86	1.56
15 04:00:00	4.07	9.06	9.02	9.82	17.00	20.93	24.30	22.27	22.41	15.75	10.66	1.43
15 05:00:00	3.77	9.26	9.37	9.68	17.00	22.15	25.83	24.15	24.19	18.38	11.27	1.61
15 06:00:00	5.20	9.44	9.68	9.64	17.00	22.67	27.28	25.34	25.31	21.55	11.96	1.79
15 07:00:00	7.75	9.11	10.05	9.53	18.00	24.56	28.29	26.89	26.96	22.78	12.37	2.46
15 08:00:00	8.58	8.72	10.07	9.16	19.00	25.82	29.22	27.86	27.75	23.06	12.49	3.80
15 09:00:00	9.46	8.76	8.39	8.60	20.00	25.67	29.65	28.41	28.25	23.16	13.20	4.93
15 10:00:00	10.09	9.00	8.63	8.21	21.00	25.87	29.95	28.66	28.39	23.63	13.63	5.19
15 11:00:00	10.41	9.11	8.14	8.31	22.00	25.02	30.28	28.67	28.57	23.52	13.56	5.10
15 12:00:00	9.76	8.93	7.75	8.11	23.00	26.06	30.30	28.25	28.23	23.41	13.89	5.10
15 13:00:00	9.42	8.85	7.49	7.75	24.00	26.26	30.17	27.90	27.68	22.98	13.71	4.37
15 14:00:00	8.49	8.62	6.92	7.60	24.00	26.01	29.65	26.86	26.64	22.25	13.28	3.40
15 15:00:00	8.29	8.61	6.49	7.56	26.00	24.92	28.70	25.71	25.61	20.62	12.99	2.81

15 16:00:00	8.48	8.60	5.80	7.41	26.00	24.07	27.19	24.58	24.41	18.94	12.74	1.76
15 17:00:00	7.94	8.55	5.57	7.28	25.00	23.31	25.72	23.61	23.77	18.35	12.44	0.80
15 18:00:00	7.88	8.42	5.45	7.06	27.00	22.75	24.96	23.11	23.55	18.27	12.08	1.05
15 19:00:00	7.48	8.17	5.40	7.29	28.00	22.66	24.66	22.75	23.25	17.85	12.11	1.01
15 20:00:00	6.75	8.05	5.47	7.47	26.00	22.05	24.49	22.39	23.04	17.60	11.08	1.58
15 21:00:00	6.63	8.16	5.37	7.68	24.00	21.09	24.29	22.35	22.85	17.72	10.11	1.77
15 22:00:00	6.57	8.47	5.24	7.78	22.00	20.17	24.04	22.06	22.69	17.16	10.10	1.29
15 23:00:00	6.60	8.29	5.47	7.79	20.00	20.12	23.83	21.86	22.47	16.54	10.24	1.59
16 00:00:00	6.46	8.34	5.40	7.81	20.00	21.03	23.54	21.74	22.14	16.30	9.92	1.68
16 01:00:00	6.24	8.22	5.48	7.46	20.00	20.45	22.91	21.17	22.02	16.80	9.20	1.77
16 02:00:00	6.26	8.04	5.59	6.87	20.00	19.99	22.46	21.12	21.94	16.90	9.23	1.56
16 03:00:00	6.12	7.65	5.65	6.73	20.00	20.34	22.72	21.61	22.19	16.46	8.93	1.43
16 04:00:00	6.04	7.10	5.61	7.44	20.00	21.21	24.14	22.57	22.57	16.82	8.67	1.61
16 05:00:00	6.02	7.01	5.62	9.37	20.00	23.67	25.86	24.08	23.81	18.94	8.80	1.79
16 06:00:00	6.60	7.26	5.71	10.82	20.00	24.63	27.13	25.01	24.76	21.96	11.67	2.46
16 07:00:00	6.36	8.58	6.18	12.14	20.00	26.14	28.27	25.77	25.80	23.18	14.24	3.89
16 08:00:00	6.78	9.71	7.39	13.13	24.00	26.34	29.67	26.76	26.62	23.28	14.66	4.77
16 09:00:00	6.33	10.15	7.36	13.72	24.00	26.74	29.95	27.14	26.99	24.02	14.18	4.93
16 10:00:00	6.46	10.52	7.56	14.20	24.00	27.41	30.34	27.32	27.50	24.55	14.68	5.19
16 11:00:00	6.58	10.40	7.23	14.52	24.00	28.80	30.36	27.25	27.46	24.32	14.73	5.20
16 12:00:00	6.80	9.63	7.18	14.87	24.00	29.61	30.44	27.05	27.24	24.61	14.67	4.37
16 13:00:00	6.85	8.94	6.92	14.88	24.00	30.34	30.11	26.57	26.84	23.80	14.49	3.40
16 14:00:00	6.87	8.52	6.48	14.31	29.00	30.13	29.70	26.03	25.64	22.59	13.86	2.81
16 15:00:00	6.89	8.04	5.71	13.81	29.00	28.78	29.06	25.19	24.69	20.26	13.04	1.76
16 16:00:00	6.65	7.68	5.40	12.62	29.00	27.08	27.86	24.14	23.78	18.74	12.59	0.80
16 17:00:00	6.57	7.04	5.37	11.20	29.00	24.98	26.39	23.30	23.24	18.30	12.11	1.05
16 18:00:00	6.33	6.70	5.44	10.46	27.00	23.76	25.55	22.99	22.98	18.34	11.63	1.01
16 19:00:00	6.33	6.40	5.33	9.92	26.00	23.12	25.12	22.89	22.78	18.85	11.41	1.58
16 20:00:00	6.31	6.71	5.40	8.91	24.00	23.25	24.87	22.38	22.58	20.58	11.26	1.77
16 21:00:00	6.30	6.53	5.39	7.90	22.00	23.16	24.51	22.33	22.23	20.68	10.32	1.29
16 22:00:00	6.29	6.19	5.29	8.24	20.00	22.68	24.19	22.52	21.70	20.49	9.30	1.30
16 23:00:00	6.18	5.94	5.21	7.80	21.00	22.10	23.84	22.44	20.75	20.03	8.95	1.35
17 00:00:00	6.46	5.73	4.98	7.27	20.00	21.28	23.57	21.92	19.88	19.87	9.12	1.29
17 01:00:00	6.24	5.58	4.81	6.69	20.00	20.51	23.63	21.33	19.82	19.82	9.11	1.00
17 02:00:00	6.26	5.25	4.74	6.77	20.00	20.05	23.41	21.60	19.72	19.53	9.45	1.09
17 03:00:00	6.12	5.11	4.76	7.09	20.00	20.40	23.62	21.88	20.09	18.91	9.08	0.76
17 04:00:00	6.04	4.41	4.91	8.98	20.00	22.14	24.61	22.72	20.82	19.56	9.19	0.78
17 05:00:00	6.02	4.29	5.77	12.07	20.00	23.45	26.19	23.91	22.58	21.81	9.73	0.69
17 06:00:00	6.60	7.25	6.50	12.46	20.00	24.99	27.71	22.14	24.01	23.36	11.95	0.51
17 07:00:00	6.36	8.36	7.28	13.01	20.00	25.70	28.93	24.25	24.91	24.31	14.26	0.14
17 08:00:00	6.78	9.52	7.85	13.28	20.00	26.67	29.69	25.72	25.62	25.80	15.86	0.01
17 09:00:00	6.33	10.66	8.54	14.11	20.00	27.27	30.05	26.76	26.47	26.00	16.86	-0.21
17 10:00:00	6.46	12.16	9.50	15.19	25.00	27.67	30.38	26.88	27.02	25.27	17.30	-0.65
17 11:00:00	6.58	12.71	9.53	16.52	25.00	27.49	30.24	27.15	27.54	24.96	17.55	-0.99
17 12:00:00	6.80	12.63	9.81	16.52	25.00	28.28	30.24	27.22	27.44	23.75	17.24	-1.14
17 13:00:00	6.85	11.69	9.53	17.70	25.00	28.08	29.79	26.89	27.00	22.36	15.97	-1.27
17 14:00:00	6.87	10.14	8.57	17.00	25.00	28.61	29.37	25.96	26.14	21.48	14.71	-1.12
17 15:00:00	6.89	8.80	7.37	16.00	25.00	27.84	28.77	25.01	25.22	20.01	13.84	-1.07
17 16:00:00	6.65	7.40	6.04	15.00	25.00	26.38	27.56	24.13	24.08	19.58	13.43	-1.28
17 17:00:00	6.57	6.78	5.17	14.00	25.00	24.47	26.04	23.26	23.52	19.21	13.06	-1.22
17 18:00:00	6.33	6.47	4.87	13.00	25.00	23.63	25.33	22.76	23.17	19.39	12.60	-1.13
17 19:00:00	6.33	6.06	4.73	12.00	25.00	23.31	25.00	22.40	22.86	19.81	11.64	-0.94
17 20:00:00	6.31	5.63	4.48	11.00	23.00	22.98	24.81	21.97	22.63	19.98	10.50	-1.37
17 21:00:00	6.30	5.29	4.25	10.01	23.00	22.88	24.70	21.61	22.08	20.21	9.86	-1.59
17 22:00:00	6.29	5.19	3.97	10.00	22.00	22.37	24.60	21.31	21.59	19.69	9.47	-1.92
17 23:00:00	6.18	4.89	3.80	9.87	21.00	21.76	24.52	21.40	21.15	19.69	9.26	-2.21
17 00:00:00	4.67	4.58	3.40	9.81	19.00	20.87	24.41	20.83	20.61	19.49	9.38	-2.11
18 01:00:00	4.71	3.93	3.17	9.76	19.00	20.95	24.21	20.09	20.24	19.38	9.50	-2.07
18 02:00:00	4.41	4.04	3.01	9.75	19.00	20.39	24.08	19.54	20.06	19.40	9.39	-2.43
18 03:00:00	4.45	3.60	2.73	9.70	19.00	21.15	24.10	19.23	20.33	19.20	9.46	-2.48
18 04:00:00	4.07	3.22	3.32	9.84	17.00	22.55	25.10	21.26	21.02	19.10	10.60	-2.39
18 05:00:00	3.77	3.87	5.05	10.20	17.00	23.12	26.67	24.33	22.84	19.24	11.34	-2.04
18 06:00:00	5.20	7.19	6.60	10.94	17.00	22.75	27.70	25.20	24.22	18.31	13.17	-1.95
18 07:00:00	7.75	9.37	7.83	12.12	18.00	20.66	29.02	25.53	25.17	17.38	15.05	-1.48
18 08:00:00	8.58	10.71	8.17	13.67	19.00	20.35	30.31	26.01	26.08	17.35	14.30	-0.75
18 09:00:00	9.46	12.38	8.30	14.18	20.00	20.85	31.02	26.53	26.89	18.28	13.15	-0.71
18 10:00:00	10.09	12.71	8.43	14.15	21.00	21.66	31.39	27.00	27.18	19.12	13.61	0.56
18 11:00:00	10.41	13.47	8.69	13.88	22.00	22.60	31.61	27.33	26.78	19.20	14.05	1.26
18 12:00:00	9.76	12.68	8.59	13.61	23.00	23.54	31.84	26.94	26.81	18.98	13.54	0.86
18 13:00:00	9.42	12.38	8.42	13.31	24.00	23.73	31.53	26.66	26.24	18.65	13.01	1.12
18 14:00:00	8.49	10.66	7.74	13.19	24.00	23.76	30.54	26.44	25.09	18.20	12.43	0.62
18 15:00:00	8.29	9.35	5.30	12.38	26.00	24.37	29.37	25.57	24.03	17.61	12.57	0.18
18 16:00:00	8.48	7.98	4.02	11.66	26.00	23.41	28.20	24.50	23.27	17.25	12.86	-0.11
18 17:00:00	7.94	7.32	4.25	11.32	25.00	21.83	26.85	23.66	22.83	16.79	13.04	-0.02
18 18:00:00	7.88	7.12	4.74	11.47	27.00	21.28	25.97	23.23	22.57	16.12	13.04	-0.12
18 19:00:00	7.48	7.00	5.03	10.64	28.00	20.71	25.24	22.84	22.49	15.88	12.93	-0.63
18 20:00:00	6.75	6.65	3.98	10.29	26.00	20.99	24.86	22.52	22.17	15.92	12.99	-0.53
18 21:00:00	6.63	6.45	4.03	10.28	24.00	20.47	24.56	22.30	22.13	15.71	12.62	-0.54
18 22:00:00	6.57	6.36	5.37	10.28	22.00	20.21	24.49	21.52	21.79	15.47	12.48	-0.47
18 23:00:00	6.60	6.07	6.62	10.19	20.00	20.56	24.58	20.63	21.37	15.10	12.44	-0.78
19 00:00:00	8.77	5.85	6.94	10.09	20.00	20.90	24.47	19.77	21.20	14.69	12.30	-1.04
19 01:00:00	9.07	6.30	6.97	10.15	20.00	20.38	24.41	19.38	20.85	14.85	12.24	-1.63
19 02:00:00	8.76	6.80	6.27	10.01	20.00	19.81	24.34	19.21	20.73	15.23	12.17	-2.36
19 03:00:00	8.57	6.89	5.87	10.13	20.00	20.57	24.59	19.22	20.68	15.34	12.14	-2.53
19 04:00:00	8.40	7.07	6.93	10.16	20.00	21.43	25.40	20.35	20.85	15.05	12.11	-2.49
19 05:00:00	8.23	7.25	7.57	10.38	20.00	21.04	26.11	23.53	21.67	14.97	12.08	-2.01
19 06:00:00	8.50	7.56	8.91	10.68	20.00	22.15	26.54	24.83	22.59	15.72	12.44	-0.24
19 07:00:00	9.05	8.42	8.97	10.87	20.00	23.47	28.53	26.33	23.39	16.53	12.67	1.62
19 08:00:00	9.11	10.04	9.48	11.21	20.00	23.70	29.63	27.35	23.74	16.69	12.76	2.76
19 09:00:00	9.21	10.02	9.65	12.42	20.00	19.62	29.69	27.01	24.03	17.14	13.06	2.33

19 10:00:00	9.23	11.89	8.65	12.43	25.00	19.96	29.67	27.58	23.74	17.38	13.06	1.39
19 11:00:00	9.43	11.60	9.52	12.32	25.00	21.22	29.93	28.54	23.82	17.90	12.94	1.75
19 12:00:00	9.48	10.47	9.54	12.01	25.00	20.63	30.09	28.93	23.34	17.47	12.76	1.59
19 13:00:00	9.32	9.86	9.85	12.27	25.00	21.27	30.51	29.02	22.77	17.23	12.33	1.58
19 14:00:00	9.10	8.98	9.63	12.66	25.00	21.54	30.56	28.23	22.05	16.76	11.95	1.32
19 15:00:00	8.54	9.37	8.93	13.19	25.00	22.32	30.22	26.91	21.01	16.48	11.84	0.92
19 16:00:00	8.10	8.03	7.92	13.84	25.00	22.54	29.05	25.18	20.00	16.41	11.71	0.71
19 17:00:00	8.02	7.83	7.31	14.37	25.00	21.71	27.06	23.90	19.65	16.48	11.60	0.57
19 18:00:00	7.51	7.51	6.75	14.39	25.00	20.60	26.40	23.39	19.77	16.60	13.04	0.43
19 19:00:00	6.85	7.39	5.96	13.67	25.00	20.19	26.19	23.08	19.87	16.63	12.93	-0.12
19 20:00:00	6.55	7.41	5.52	12.25	23.00	20.73	26.34	22.83	20.05	16.61	12.99	-0.54
19 21:00:00	7.10	7.49	5.77	11.05	23.00	19.40	26.31	22.42	20.02	16.55	12.62	-0.08
19 22:00:00	6.97	7.23	5.59	11.00	22.00	18.85	25.73	21.81	19.57	16.48	12.48	-0.68
19 23:00:00	6.81	7.00	6.05	10.75	21.00	18.60	25.18	20.91	19.38	16.20	12.44	-1.00
20 00:00:00	6.79	6.93	5.98	10.57	19.00	18.53	24.59	21.06	19.64	16.20	12.30	-1.01
20 01:00:00	6.66	6.91	5.49	10.44	17.32	18.57	24.13	20.90	19.59	16.15	12.24	-0.22
20 02:00:00	6.45	6.91	5.57	10.47	17.07	18.36	23.15	20.90	19.56	16.13	12.17	-0.12
20 03:00:00	6.36	6.81	5.98	10.53	17.01	18.98	23.99	20.93	19.83	16.11	12.14	0.72
20 04:00:00	6.26	6.93	6.03	10.92	17.80	21.06	24.65	21.97	19.97	16.08	12.11	1.32
20 05:00:00	6.13	7.08	6.73	12.16	20.19	23.63	25.00	22.86	20.30	15.99	12.08	1.84
20 06:00:00	6.08	7.27	7.63	13.75	23.12	24.70	25.16	22.03	20.29	16.10	11.16	2.57
20 07:00:00	6.98	7.75	8.40	14.63	23.90	25.30	25.46	19.09	20.51	15.29	12.46	3.35
20 08:00:00	7.13	7.88	9.67	14.97	26.41	25.80	25.68	19.41	21.05	15.65	12.91	4.42
20 09:00:00	7.00	7.88	10.56	15.60	26.87	25.86	26.79	21.79	21.26	17.04	12.92	4.70
20 10:00:00	7.00	7.99	10.71	16.36	27.48	26.08	26.40	23.34	20.92	17.73	12.75	4.70
20 11:00:00	6.26	8.26	10.21	16.93	27.70	26.36	26.19	24.73	20.22	17.55	12.90	5.46
20 12:00:00	5.72	8.13	10.80	15.21	28.15	26.39	26.34	26.46	19.90	17.58	13.06	5.00
20 13:00:00	4.40	7.57	10.85	14.14	27.31	27.04	26.31	26.87	20.29	17.77	11.94	1.58
20 14:00:00	3.98	7.41	10.31	14.42	24.94	27.07	25.73	25.46	20.61	17.65	11.22	1.32
20 15:00:00	4.06	7.49	9.64	12.68	25.22	27.34	26.55	24.32	20.79	17.53	11.06	0.92
20 16:00:00	4.37	7.41	8.49	11.90	23.00	26.13	27.25	23.27	20.60	17.26	11.01	0.71
20 17:00:00	4.39	7.49	8.03	10.87	22.40	24.52	28.45	22.18	20.75	17.04	10.60	0.57
20 18:00:00	4.19	7.57	7.34	10.27	22.01	22.50	27.06	21.47	21.04	17.39	10.46	0.43
20 19:00:00	3.99	7.51	7.94	10.08	21.48	21.62	26.40	20.93	20.81	17.14	10.62	-0.12
20 20:00:00	3.66	7.68	8.04	9.83	21.56	21.65	26.19	20.67	20.86	16.17	10.54	-0.54
20 21:00:00	2.76	7.60	7.19	9.50	22.32	21.92	26.34	20.50	20.81	16.46	10.45	-0.08
20 22:00:00	3.11	7.39	7.15	9.25	22.27	21.73	26.31	20.61	20.73	16.64	10.27	-0.68
20 23:00:00	3.51	7.16	6.32	9.03	21.72	22.37	25.73	20.37	20.56	15.97	9.82	-1.00
21 00:00:00	3.76	6.86	5.75	8.64	20.78	22.45	21.79	20.35	20.48	16.20	9.81	-1.01
21 01:00:00	3.80	6.73	5.99	8.52	18.38	21.63	21.06	20.72	19.92	16.07	9.90	-0.22
21 02:00:00	3.72	6.51	5.78	8.49	18.01	20.66	22.12	21.36	19.81	16.27	9.99	-0.12
21 03:00:00	3.61	6.53	5.04	8.85	17.95	21.32	22.46	21.05	20.10	16.83	10.54	0.72
21 04:00:00	3.61	6.47	5.13	10.32	17.88	22.75	23.12	20.28	20.38	17.03	10.85	1.32
21 05:00:00	3.51	6.60	7.84	12.35	18.23	24.48	25.93	22.64	20.91	17.73	10.42	1.84
21 06:00:00	3.46	6.68	9.94	13.73	18.15	25.32	27.87	24.27	21.46	18.69	10.01	2.57
21 07:00:00	3.60	7.20	10.97	15.32	18.82	25.78	28.47	24.17	22.04	19.35	10.14	8.65
21 08:00:00	3.52	7.54	11.75	15.86	18.69	26.26	29.04	25.24	22.49	19.86	10.72	9.23
21 09:00:00	3.90	7.67	12.19	15.79	18.74	26.15	30.69	26.32	23.19	20.26	10.87	11.10
21 10:00:00	3.61	7.89	12.81	15.98	18.84	26.35	31.81	26.96	24.18	21.34	11.58	11.92
21 11:00:00	3.40	7.50	13.43	16.73	18.25	26.70	33.39	27.32	25.06	21.46	10.85	11.35
21 12:00:00	3.75	7.88	14.25	17.30	17.57	26.86	33.62	27.28	25.31	21.05	11.14	11.25
21 13:00:00	4.21	7.65	14.41	17.38	17.68	26.55	33.18	27.23	24.82	20.33	11.18	10.36
21 14:00:00	4.13	7.22	13.26	15.46	16.97	24.79	32.42	26.95	23.48	19.62	10.98	10.10
21 15:00:00	4.22	6.99	12.09	14.77	16.11	23.24	31.40	26.13	22.47	18.80	10.98	9.76
21 16:00:00	4.27	6.85	10.23	15.13	15.69	22.79	29.69	25.18	21.90	18.31	10.26	9.97
21 17:00:00	4.25	6.78	9.39	13.83	15.21	22.87	27.71	24.32	21.66	18.11	10.02	10.06
21 18:00:00	4.21	6.65	8.84	13.01	14.86	22.01	26.69	23.73	21.44	18.06	10.24	9.99
21 19:00:00	4.16	6.61	8.37	12.05	14.79	20.41	26.02	22.95	21.17	17.46	10.09	10.19
21 20:00:00	3.84	6.55	7.83	11.29	14.63	19.84	25.55	21.78	20.80	17.47	9.74	10.32
21 21:00:00	3.51	6.50	7.58	11.36	14.70	19.30	24.95	21.19	20.44	17.42	9.63	10.64
21 22:00:00	3.02	6.37	7.41	10.34	14.42	19.37	24.48	20.73	20.01	16.91	9.60	10.56
21 23:00:00	1.88	6.27	7.26	9.75	13.98	20.01	24.04	20.40	19.82	15.92	9.57	10.62
22 00:00:00	1.40	6.11	7.33	9.53	13.37	19.54	24.01	20.62	19.77	15.69	9.81	10.20
22 01:00:00	1.35	6.05	7.84	9.53	12.73	19.27	23.76	20.17	19.47	15.72	9.90	10.73
22 02:00:00	1.33	5.99	7.54	9.22	12.21	19.01	23.46	20.17	19.32	15.20	9.99	10.81
22 03:00:00	1.17	6.00	7.08	9.41	11.77	19.38	23.46	20.47	19.35	14.96	10.54	10.70
22 04:00:00	1.03	6.00	7.14	11.04	11.53	21.08	23.97	21.09	19.71	14.95	10.85	10.57
22 05:00:00	0.98	6.13	10.50	13.49	11.48	23.34	26.12	22.28	20.52	16.14	10.42	10.13
22 06:00:00	2.39	6.61	13.27	14.99	11.51	23.55	27.74	23.47	21.37	19.12	10.01	10.13
22 07:00:00	5.62	7.27	14.13	15.41	11.31	23.82	28.81	25.58	23.80	20.59	10.14	10.59
22 08:00:00	6.15	7.77	14.55	15.40	11.64	25.29	29.87	26.43	24.12	20.37	10.72	12.51
22 09:00:00	7.08	8.20	14.84	15.96	13.57	26.67	30.62	27.16	24.04	20.32	10.87	13.43
22 10:00:00	7.47	8.54	16.05	16.36	14.82	26.38	31.16	27.17	24.39	21.18	11.58	14.67
22 11:00:00	7.08	8.77	16.47	16.30	14.64	25.88	31.52	28.13	24.48	21.68	10.85	14.52
22 12:00:00	6.68	8.59	16.72	17.69	15.10	26.85	31.66	30.54	24.09	21.71	11.14	14.32
22 13:00:00	6.38	8.31	15.10	17.82	15.00	26.98	31.20	30.69	23.39	20.88	11.18	13.43
22 14:00:00	5.95	7.95	11.65	17.21	16.00	26.73	30.40	29.60	22.60	19.99	10.98	12.72
22 15:00:00	5.11	7.12	9.86	16.83	16.00	25.44	29.52	28.57	22.05	19.16	10.98	12.38
22 16:00:00	5.05	6.28	9.36	16.04	17.00	24.85	28.28	27.33	21.56	18.74	10.26	12.40
22 17:00:00	5.12	6.28	9.05	13.88	17.00	23.99	26.54	26.05	21.36	18.35	10.02	12.06
22 18:00:00	5.67	5.88	8.93	12.73	16.00	23.32	25.57	25.27	21.33	18.00	10.24	11.88
22 19:00:00	6.11	5.89	8.91	11.89	16.00	22.63	24.96	24.66	21.38	17.69	10.09	11.75
22 20:00:00	6.50	6.15	8.91	11.50	15.00	22.21	24.54	24.07	21.32	17.34	9.74	11.55
22 21:00:00	6.54	5.68	8.74	10.99	14.00	22.09	24.22	23.58	20.42	16.64	9.63	11.46
22 22:00:00	6.58	5.21	8.45	11.25	15.00	21.55	24.04	22.89	18.88	16.28	9.60	11.53
22 23:00:00	6.64	4.73	8.30	11.49	14.00	21.31	23.84	22.61	18.18	16.20	9.57	11.25
23 00:00:00	6.69	4.48	8.37	11.77	13.98	21.13	23.66	22.29	18.07	15.60	9.81	10.91
23 01:00:00	6.62	4.17	8.38	11.74	13.59	20.93	23.50	22.24	18.67	15.20	9.90	10.04
23 02:00:00	7.11	3.72	8.14	11.99	13.80	21.10	23.28	21.74	19.00	14.80	9.99	9.95
23 03:00:00	6.95	3.80	8.19	11.85	14.42	21.59	23.03	21.93	19.32	13.90	10.54	10.11

23 04:00:00	6.22	4.03	8.18	12.81	14.99	22.59	23.75	22.57	19.52	14.30	10.85	10.22
23 05:00:00	6.38	4.14	8.38	16.14	15.67	23.91	25.24	24.64	20.67	16.40	10.42	10.40
23 06:00:00	6.98	5.72	8.74	17.17	16.75	23.95	27.36	25.40	21.86	17.10	10.01	12.28
23 07:00:00	6.95	7.85	9.06	17.51	18.47	25.81	27.92	26.74	22.31	17.81	10.14	13.93
23 08:00:00	6.94	8.15	9.72	17.70	18.40	26.68	29.03	27.35	23.01	19.52	12.19	13.88
23 09:00:00	6.94	8.72	10.04	18.35	19.20	24.40	29.99	28.43	24.10	19.93	13.29	14.12
23 10:00:00	6.94	9.78	10.53	17.62	19.41	21.75	30.54	28.91	25.30	21.05	13.98	15.35
23 11:00:00	6.75	9.40	10.08	18.92	19.76	20.59	30.76	29.24	25.43	20.84	13.91	14.58
23 12:00:00	6.57	9.14	9.05	17.65	20.56	19.68	31.04	28.85	25.27	20.77	13.68	14.17
23 13:00:00	6.44	8.99	8.69	16.84	20.33	20.13	30.89	28.21	24.14	19.70	12.74	13.82
23 14:00:00	6.06	8.40	9.01	15.95	20.63	21.71	30.43	27.49	23.28	19.04	11.43	12.72
23 15:00:00	5.83	7.43	8.69	15.86	20.61	21.87	29.45	26.62	22.18	17.63	10.57	12.67
23 16:00:00	5.79	6.41	8.61	15.21	18.99	20.82	28.12	25.28	20.80	16.70	10.18	12.61
23 17:00:00	5.89	5.96	8.86	14.87	16.84	19.48	26.38	24.31	19.82	16.41	9.89	12.88
23 18:00:00	6.00	6.06	9.03	14.61	16.34	19.16	25.44	23.81	19.22	16.12	9.38	12.78
23 19:00:00	6.02	6.34	9.09	14.50	15.89	19.52	24.95	23.37	19.22	15.95	9.01	12.44
23 20:00:00	6.07	6.20	9.09	14.40	15.51	18.97	24.40	22.68	19.05	15.77	8.54	11.88
23 21:00:00	6.09	6.38	9.05	14.36	15.37	19.10	24.10	22.42	19.82	15.60	8.31	11.95
23 22:00:00	5.64	6.50	8.93	13.86	15.17	19.47	23.56	22.03	19.40	15.48	7.92	11.76
23 23:00:00	4.93	6.59	8.72	12.78	14.83	19.64	22.51	21.72	19.07	15.35	7.46	11.83
24 00:00:00	4.92	6.60	8.63	12.93	17.00	19.80	23.16	21.40	18.79	15.62	6.78	11.56
24 01:00:00	5.61	6.80	8.32	13.34	17.00	19.73	21.36	20.65	18.11	16.60	6.17	11.71
24 02:00:00	5.64	6.78	8.02	13.33	17.00	19.52	22.15	20.64	18.36	17.05	6.71	11.66
24 03:00:00	5.35	7.08	7.87	14.06	16.00	19.80	22.45	21.17	17.88	17.23	6.42	12.16
24 04:00:00	4.16	7.43	7.96	15.10	16.00	21.05	24.26	22.54	17.98	17.31	6.53	12.52
24 05:00:00	2.91	8.47	8.11	16.09	16.00	22.79	26.91	24.36	20.60	17.57	6.81	12.92
24 06:00:00	4.60	8.93	8.29	17.05	16.00	23.49	28.22	25.36	22.55	17.95	9.34	12.80
24 07:00:00	5.87	9.29	8.35	17.98	17.00	24.17	28.72	26.94	23.95	18.55	11.00	11.55
24 08:00:00	6.62	10.75	8.38	17.93	18.00	24.16	29.05	27.69	25.58	19.29	11.70	10.49
24 09:00:00	7.86	11.17	8.38	17.13	19.00	24.79	29.56	28.81	26.07	19.71	12.30	10.28
24 10:00:00	8.24	10.96	8.12	16.06	20.00	24.39	30.14	29.28	26.56	20.03	12.80	12.81
24 11:00:00	8.89	10.69	7.82	15.74	21.00	23.36	30.81	29.18	26.93	20.40	12.20	13.87
24 12:00:00	8.08	10.76	7.85	14.72	22.00	21.71	30.76	29.14	28.01	20.58	12.50	13.54
24 13:00:00	8.10	11.31	7.80	13.71	23.00	23.96	30.12	28.69	27.95	20.28	12.15	13.03
24 14:00:00	6.79	11.62	7.53	12.71	24.00	25.61	29.67	27.58	26.31	19.25	11.61	12.73
24 15:00:00	5.47	10.96	7.31	12.30	25.00	24.97	28.72	26.53	24.47	17.75	10.91	12.33
24 16:00:00	5.35	11.03	7.23	11.78	26.00	24.71	27.69	25.46	22.65	16.95	10.46	12.29
24 17:00:00	5.20	11.12	7.15	11.74	27.00	23.31	26.21	24.44	21.96	16.68	11.00	12.40
24 18:00:00	5.34	9.96	7.16	11.85	28.00	22.12	25.24	23.94	21.32	16.63	11.37	12.88
24 19:00:00	5.52	9.72	7.26	11.82	26.00	21.38	24.57	23.62	21.22	16.13	11.35	12.53
24 20:00:00	5.61	9.52	7.24	11.52	25.00	20.81	24.28	23.36	21.27	16.20	11.56	12.11
24 21:00:00	5.77	9.41	6.95	10.88	23.00	20.21	24.14	22.98	21.09	15.88	11.25	12.24
24 22:00:00	5.24	8.75	6.72	10.46	22.00	19.82	23.95	22.73	21.00	15.70	10.49	12.60
24 23:00:00	5.72	8.06	6.60	9.91	20.00	19.56	23.74	22.20	21.95	15.68	9.87	13.36
25 00:00:00	6.05	7.61	6.62	9.70	18.00	19.13	21.79	21.34	21.66	15.20	10.20	13.74
25 01:00:00	6.07	7.07	6.60	9.91	16.00	18.69	21.06	20.37	21.24	15.23	10.30	13.54
25 02:00:00	5.89	6.68	6.60	10.13	14.00	18.76	22.12	19.81	20.97	15.07	9.81	12.97
25 03:00:00	5.80	6.35	6.60	10.32	12.00	19.66	22.46	19.70	20.88	14.81	9.51	13.36
25 04:00:00	6.12	6.21	6.70	10.46	12.00	20.85	23.12	20.71	21.14	14.46	9.65	13.30
25 05:00:00	7.24	6.70	6.93	10.32	11.00	21.85	25.93	24.56	22.21	15.47	10.32	12.95
25 06:00:00	8.03	9.32	7.24	10.46	10.00	24.16	27.87	25.82	23.19	18.20	11.08	12.65
25 07:00:00	9.09	10.86	7.27	10.72	11.00	24.62	28.47	26.75	23.82	21.15	11.67	12.73
25 08:00:00	9.63	11.08	7.50	11.12	13.00	25.84	29.04	27.89	24.89	22.92	12.69	12.40
25 09:00:00	10.20	11.72	7.68	11.56	15.00	26.57	30.69	28.60	25.54	23.30	13.33	12.40
25 10:00:00	10.65	12.63	8.09	11.81	16.00	26.88	31.81	28.80	25.86	24.63	12.85	11.81
25 11:00:00	10.71	13.27	8.21	11.77	16.00	27.09	33.39	28.50	25.74	24.27	12.96	11.00
25 12:00:00	10.20	13.13	8.20	12.31	18.00	27.78	33.62	28.69	26.31	23.66	12.81	10.43
25 13:00:00	9.85	13.56	8.02	12.39	19.00	27.41	33.18	28.93	26.85	23.02	12.44	10.08
25 14:00:00	9.30	12.82	7.81	11.73	20.00	26.87	32.42	27.97	25.57	21.18	11.69	11.18
25 15:00:00	8.27	10.76	7.44	10.98	21.00	25.81	31.40	26.61	24.44	19.57	11.11	11.33
25 16:00:00	8.10	9.03	7.29	10.44	22.00	24.82	29.69	25.17	22.43	18.61	11.53	11.52
25 17:00:00	8.19	8.91	7.24	9.98	23.00	23.75	27.71	24.17	21.47	18.29	11.60	11.54
25 18:00:00	8.21	8.70	7.18	9.78	24.00	23.12	26.69	23.67	20.96	17.98	11.35	11.39
25 19:00:00	8.28	8.72	7.22	10.00	23.00	22.79	26.02	23.42	21.07	17.83	11.35	11.47
25 20:00:00	8.27	8.45	7.30	9.63	21.00	22.54	25.55	23.05	21.35	17.76	11.24	11.53
25 21:00:00	8.39	8.71	7.28	9.61	18.00	22.31	24.95	22.60	20.82	17.48	11.13	11.54
25 22:00:00	8.19	9.48	7.50	9.64	16.00	22.36	24.48	22.33	20.51	16.93	10.81	11.25
25 23:00:00	8.38	9.12	7.49	9.71	14.00	21.98	24.04	21.86	20.29	17.43	10.21	10.73
26 00:00:00	9.05	9.15	7.29	9.77	12.32	21.82	24.01	21.68	20.40	17.33	9.67	11.94
26 01:00:00	9.44	8.87	7.47	9.66	12.28	21.70	23.76	21.27	20.80	17.01	9.48	13.22
26 02:00:00	9.34	8.56	7.72	9.38	12.28	21.34	23.46	20.50	20.86	17.01	8.71	13.28
26 03:00:00	9.24	8.02	7.74	8.97	12.05	21.40	23.46	20.13	20.46	16.64	8.01	12.85
26 04:00:00	9.25	7.68	7.78	9.67	12.60	22.49	23.97	21.24	21.12	16.28	8.59	12.57
26 05:00:00	9.28	9.80	7.97	10.96	13.30	23.55	26.12	24.77	23.59	17.56	9.48	12.59
26 06:00:00	9.76	12.51	8.18	12.06	14.97	24.49	27.74	25.49	25.56	19.51	11.76	12.73
26 07:00:00	10.21	13.72	8.39	13.64	15.97	25.02	28.81	26.46	26.49	20.28	13.08	13.05
26 08:00:00	11.81	14.54	8.60	14.24	15.11	24.99	29.87	28.01	27.86	20.31	14.08	13.11
26 09:00:00	12.19	16.64	8.93	15.11	16.40	24.77	30.62	28.59	28.91	20.91	14.72	13.19
26 10:00:00	12.15	18.06	9.28	16.00	17.68	25.98	31.16	28.96	28.77	21.85	14.84	13.16
26 11:00:00	11.76	18.04	9.23	16.51	17.09	26.68	31.52	28.31	29.47	21.61	14.40	13.32
26 12:00:00	11.94	18.64	9.33	17.11	17.77	26.75	31.66	27.34	29.56	21.37	13.90	12.38
26 13:00:00	11.87	16.86	9.28	17.34	17.75	26.58	31.20	26.90	29.26	20.51	13.16	11.61
26 14:00:00	11.44	15.66	9.16	16.74	18.29	26.44	30.40	26.45	29.57	19.98	12.25	11.90
26 15:00:00	11.10	14.93	9.20	15.48	17.25	25.48	29.52	25.85	28.85	19.01	11.40	11.94
26 16:00:00	10.85	14.94	8.95	13.66	17.68	24.90	28.28	24.78	26.01	18.41	10.88	12.33
26 17:00:00	10.43	14.71	8.68	11.51	15.32	23.71	26.54	24.10	25.92	17.53	10.50	12.79
26 18:00:00	10.17	15.11	8.57	10.59	13.89	23.18	25.57	23.74	25.93	16.63	9.93	13.71
26 19:00:00	10.25	15.15	8.64	11.56	13.47	22.96	24.96	23.43	26.01	16.17	8.87	13.92
26 20:00:00	10.10	14.06	8.70	10.69	13.54	22.67	24.54	22.98	26.32	16.29	8.65	13.38
26 21:00:00	10.12	13.97	8.89	9.79	13.09	22.26	24.22	22.29	26.50	16.27	9.16	13.61

26 22:00:00	10.28	14.80	8.62	9.34	12.86	22.03	24.04	21.60	25.59	16.01	7.96	14.28
26 23:00:00	10.40	14.69	8.59	8.73	12.42	21.81	23.84	20.85	24.04	15.61	7.95	14.02
27 00:00:00	10.75	14.37	8.40	8.42	12.08	21.45	23.66	20.71	21.89	15.60	8.77	12.26
27 01:00:00	10.58	14.00	8.30	7.95	11.72	20.97	23.50	20.40	20.17	15.65	8.24	8.90
27 02:00:00	10.54	13.43	8.35	7.56	11.37	20.97	23.28	20.60	20.15	15.65	8.36	7.68
27 03:00:00	10.91	13.51	8.46	7.46	11.01	21.41	23.03	19.93	20.61	15.65	8.27	7.01
27 04:00:00	10.86	12.80	8.60	9.56	10.65	22.63	23.75	20.85	21.45	15.70	8.42	6.14
27 05:00:00	10.85	13.52	8.80	12.82	12.00	24.27	25.24	24.21	23.32	15.76	8.33	5.28
27 06:00:00	11.30	14.94	8.85	13.87	15.10	25.54	27.36	24.68	23.49	16.54	9.88	4.48
27 07:00:00	11.68	15.29	9.24	14.67	14.00	26.13	27.92	24.62	25.22	18.62	12.20	4.29
27 08:00:00	12.67	16.13	9.90	16.43	13.00	26.85	29.03	25.84	25.82	20.50	13.85	3.55
27 09:00:00	13.79	16.58	11.01	16.47	14.00	27.40	29.99	26.43	25.76	21.57	15.47	3.20
27 10:00:00	14.30	16.08	11.55	17.57	15.18	27.32	30.54	27.18	26.14	22.38	16.34	3.01
27 11:00:00	14.32	17.16	12.30	18.06	14.70	27.62	30.76	28.79	27.06	22.92	15.70	2.88
27 12:00:00	14.35	17.11	12.24	18.82	14.18	27.64	31.04	29.00	26.98	22.48	15.00	3.37
27 13:00:00	14.38	16.68	11.82	19.88	13.95	27.52	30.89	28.60	27.41	21.76	14.64	3.02
27 14:00:00	14.39	16.41	11.07	19.95	14.30	27.05	30.43	27.74	25.81	20.53	13.82	2.45
27 15:00:00	14.23	15.55	10.28	19.31	14.28	26.38	29.45	27.26	24.04	19.49	12.52	2.35
27 16:00:00	14.19	12.75	9.70	17.49	14.20	25.17	28.12	26.00	22.73	18.94	11.72	2.26
27 17:00:00	13.99	9.70	9.35	15.61	13.40	23.75	26.38	24.63	21.43	18.51	11.33	2.16
27 18:00:00	13.48	8.12	8.97	14.75	13.40	23.01	25.44	23.89	21.70	18.50	10.81	2.09
27 19:00:00	13.02	7.53	8.70	14.10	13.57	22.62	24.95	23.34	20.94	18.57	10.10	1.99
27 20:00:00	12.81	7.75	8.59	13.85	13.64	22.21	24.40	22.81	20.27	18.22	8.94	1.74
27 21:00:00	12.34	7.99	8.39	13.26	13.57	21.78	24.10	21.69	20.00	17.98	8.27	1.73
27 22:00:00	11.42	8.45	8.29	12.57	13.31	21.41	23.56	20.58	20.59	17.67	8.32	1.45
27 23:00:00	10.74	8.49	8.19	12.11	12.56	21.09	22.51	20.36	20.31	17.63	7.60	1.40
28 00:00:00	10.31	8.38	8.05	11.90	12.32	20.85	21.79	20.23	19.90	18.00	7.08	1.29
28 01:00:00	10.01	8.03	7.92	11.67	12.28	20.64	21.06	20.26	18.97	18.28	7.11	1.00
28 02:00:00	9.84	7.81	7.91	11.84	12.28	20.37	22.12	19.74	18.75	18.40	7.11	1.26
28 03:00:00	9.74	7.51	7.94	11.94	12.05	21.00	22.46	19.81	18.96	18.42	7.33	1.20
28 04:00:00	9.59	7.51	7.98	13.55	12.60	22.17	23.12	21.16	19.17	18.56	7.04	1.26
28 05:00:00	9.36	7.71	7.98	16.62	13.30	23.99	25.93	24.78	22.29	18.81	7.19	1.06
28 06:00:00	8.30	8.55	8.19	18.11	14.97	25.80	27.87	27.20	24.37	19.60	10.06	1.69
28 07:00:00	8.07	9.23	8.42	20.02	15.97	27.01	28.47	28.15	24.86	20.13	12.98	3.64
28 08:00:00	8.54	10.41	8.66	21.02	15.11	27.78	29.04	29.05	25.46	20.83	14.42	5.11
28 09:00:00	8.99	11.44	9.44	20.55	16.40	28.30	30.69	30.76	26.72	20.99	14.81	5.54
28 10:00:00	9.30	11.90	9.24	21.43	17.68	28.70	31.81	31.59	26.88	21.20	15.29	5.99
28 11:00:00	9.87	12.87	10.00	21.92	17.09	28.95	33.39	31.93	27.23	21.68	14.07	5.47
28 12:00:00	9.92	12.27	10.32	22.78	17.77	29.07	33.62	31.47	27.97	21.54	13.64	5.19
28 13:00:00	9.16	11.96	9.90	22.66	17.75	29.01	32.46	30.99	27.04	21.27	13.00	4.83
28 14:00:00	9.05	11.55	9.39	21.88	18.29	28.39	31.25	30.08	26.68	20.70	11.64	4.18
28 15:00:00	8.59	10.54	8.85	20.73	17.25	27.71	30.55	28.74	25.39	19.95	9.85	3.43
28 16:00:00	8.50	9.75	8.56	18.68	17.68	26.57	27.52	27.06	23.56	19.35	8.96	3.05
28 17:00:00	8.64	9.68	8.41	17.03	15.32	24.81	25.87	25.47	23.05	18.99	8.73	2.78
28 18:00:00	8.29	9.76	8.24	16.10	13.89	23.59	24.99	24.56	22.86	18.88	8.55	3.83
28 19:00:00	8.38	10.04	8.11	15.05	13.47	22.84	24.43	24.06	22.91	18.88	8.40	3.19
28 20:00:00	8.64	10.03	7.96	14.08	13.54	22.25	23.99	23.64	23.10	18.51	9.43	2.58
28 21:00:00	8.79	9.97	8.15	12.97	13.09	21.93	23.36	22.78	23.17	18.45	10.71	2.29
28 22:00:00	8.46	10.05	8.36	12.68	12.86	21.63	22.76	23.00	22.83	18.24	10.72	2.28
28 23:00:00	8.29	9.94	8.43	12.88	12.42	21.33	22.28	23.16	21.65	17.97	10.51	2.45
29 00:00:00	10.31	8.76	8.46	12.54	12.55	21.03	21.79	22.58	21.13	17.94	10.43	3.29
29 01:00:00	10.01	7.80	8.60	11.72	13.01	20.77	21.06	22.25	20.74	18.00	9.75	4.07
29 02:00:00	9.84	7.05	8.68	11.49	13.35	20.22	22.12	22.19	20.36	18.03	9.14	3.69
29 03:00:00	9.74	6.79	8.75	10.95	13.84	20.38	22.46	22.33	19.96	18.14	8.38	3.56
29 04:00:00	9.59	6.52	8.69	13.53	14.88	21.22	23.12	22.97	20.27	18.20	8.17	3.70
29 05:00:00	9.36	6.76	8.75	16.26	16.21	23.44	25.93	25.07	22.35	16.79	8.14	4.11
29 06:00:00	8.30	7.25	8.99	17.65	16.10	22.62	27.87	26.70	25.94	15.30	10.32	4.87
29 07:00:00	8.07	7.33	9.21	19.09	16.90	25.28	28.47	27.97	26.46	16.35	12.97	6.37
29 08:00:00	8.54	7.62	8.67	20.88	17.38	27.89	29.04	30.79	25.34	17.44	13.64	7.50
29 09:00:00	8.99	8.13	8.83	22.94	18.46	28.64	30.69	31.68	22.37	18.64	15.77	8.11
29 10:00:00	9.30	8.81	9.14	23.14	18.51	29.12	31.81	32.07	20.17	20.56	16.86	9.09
29 11:00:00	9.87	9.33	9.10	23.37	18.87	29.43	33.39	32.35	19.96	19.91	16.23	9.13
29 12:00:00	9.92	9.56	9.53	23.76	19.18	29.54	33.62	31.91	20.38	19.29	15.85	8.59
29 13:00:00	9.16	9.12	9.51	22.63	19.33	29.24	33.18	31.05	20.64	18.71	15.05	8.59
29 14:00:00	9.05	8.73	9.33	21.78	19.22	28.87	32.42	29.80	20.82	18.31	13.25	8.71
29 15:00:00	8.59	8.38	9.31	21.01	18.60	28.23	31.40	28.20	20.94	17.63	11.88	8.83
29 16:00:00	8.50	7.63	9.19	19.32	17.15	27.05	29.69	26.32	21.05	17.08	11.80	8.93
29 17:00:00	8.64	7.19	8.95	19.16	16.29	25.05	27.71	24.92	20.01	16.90	11.78	8.74
29 18:00:00	8.29	6.81	8.80	18.81	15.72	23.81	26.69	24.31	18.83	16.70	10.93	8.48
29 19:00:00	8.38	6.46	8.78	18.17	15.13	22.97	26.02	23.88	18.31	16.67	11.63	8.36
29 20:00:00	8.64	5.87	8.85	17.88	15.01	22.29	25.55	23.75	18.08	16.68	11.24	8.42
29 21:00:00	8.79	5.91	8.70	17.61	14.84	21.76	24.95	23.56	17.82	16.19	10.96	8.85
29 22:00:00	8.46	5.20	8.67	16.68	14.63	20.95	24.48	23.31	17.29	15.41	10.43	9.35
29 23:00:00	8.29	4.54	9.13	16.47	15.14	20.34	24.04	23.10	17.37	14.80	9.77	9.59
30 00:00:00	8.16		9.28	16.02	14.55	19.87	24.01	23.03	17.42	14.46	9.27	9.95
30 01:00:00	8.05		9.58	14.94	13.79	18.84	23.76	23.12	17.47	14.80	8.70	8.88
30 02:00:00	7.96		9.55	14.74	13.74	18.31	23.46	23.12	17.13	14.87	8.62	8.69
30 03:00:00	7.86		9.27	14.68	14.29	18.90	23.46	22.88	16.45	14.98	8.86	9.00
30 04:00:00	7.84		9.71	15.99	15.90	20.75	23.97	23.25	15.83	15.03	8.97	8.62
30 05:00:00	7.75		10.58	18.10	17.84	24.32	26.12	24.43	16.85	15.73	9.14	8.68
30 06:00:00	7.46		11.92	19.77	18.55	25.08	27.74	26.15	18.78	16.92	11.09	8.03
30 07:00:00	7.95		13.62	19.11	18.95	25.69	28.81	27.74	19.49	18.07	13.24	7.41
30 08:00:00	8.22		14.15	19.24	19.15	27.07	29.87	28.60	20.49	18.57	14.59	7.35
30 09:00:00	8.25		14.51	21.03	19.64	26.74	30.62	29.41	22.12	18.90	15.23	7.11
30 10:00:00	8.30		14.49	20.87	19.63	27.33	31.16	29.65	22.26	17.87	15.37	7.68
30 11:00:00	8.32		14.44	21.61	20.58	27.91	31.52	30.00	22.42	17.66	13.78	8.34
30 12:00:00	8.30		15.01	22.08	20.81	29.45	31.66	30.01	22.41	15.35	12.08	9.27
30 13:00:00	8.47		15.18	22.18	21.78	27.91	31.20	29.43	21.69	13.93	11.12	10.19
30 14:00:00	8.51		14.32	21.04	22.01	28.08	30.40	28.37	21.02	14.05	10.44	10.41
30 15:00:00	8.35		13.73	18.92	21.63	28.38	29.52	26.98	20.00	13.63	9.98	10.27

30 16:00:00	8.32		12.44	17.96	20.07	28.15	28.28	25.35	19.24	13.68	10.13	8.99
30 17:00:00	8.26		11.09	16.65	18.76	26.55	26.54	24.44	19.45	13.67	10.03	7.53
30 18:00:00	8.25		10.33	16.09	17.61	24.16	25.57	24.06	18.72	13.54	9.53	7.18
30 19:00:00	8.21		10.41	15.54	16.54	24.25	24.96	23.75	18.55	13.28	8.97	7.05
30 20:00:00	8.20		10.23	15.67	16.07	23.19	24.54	23.50	18.23	13.02	8.60	7.19
30 21:00:00	8.19		9.65	15.06	15.60	22.26	24.22	23.16	17.15	12.41	8.60	7.66
30 22:00:00	8.05		10.62	14.42	15.07	21.85	24.04	22.80	16.66	11.64	8.45	7.74
30 23:00:00	8.06		10.76	14.32	14.71	21.57	23.84	22.55	16.07	11.12	8.16	7.82
31 00:00:00	8.16		10.64		15.21		23.66	22.89		11.49		7.86
31 01:00:00	8.05		10.79		15.09		23.50	23.16		11.52		7.54
31 02:00:00	7.96		10.93		15.05		23.28	23.20		11.02		7.58
31 03:00:00	7.86		11.42		15.47		23.03	23.26		10.94		7.62
31 04:00:00	7.84		11.58		17.20		23.75	23.56		11.93		7.75
31 05:00:00	7.75		11.02		19.31		25.24	24.15		12.00		7.93
31 06:00:00	7.46		11.53		20.74		27.36	24.49		12.31		8.89
31 07:00:00	7.95		11.12		21.27		27.92	25.59		12.91		9.95
31 08:00:00	8.22		10.45		21.54		29.03	27.12		13.81		11.15
31 09:00:00	8.25		9.82		21.59		29.99	28.22		14.87		12.30
31 10:00:00	8.30		9.45		22.41		30.54	28.68		15.58		13.18
31 11:00:00	8.32		9.15		22.82		30.76	29.09		16.16		13.15
31 12:00:00	8.30		8.95		23.57		31.04	28.99		16.16		13.94
31 13:00:00	8.47		8.41		24.32		30.89	28.56		15.23		13.46
31 14:00:00	8.51		8.03		24.30		30.43	27.38		14.42		12.81
31 15:00:00	8.35		7.88		22.71		29.45	26.19		13.38		11.81
31 16:00:00	8.32		7.56		21.69		28.12	24.80		13.26		11.47
31 17:00:00	8.26		7.38		19.21		26.38	24.08		14.33		11.61
31 18:00:00	8.25		7.13		19.06		25.44	23.68		15.08		12.10
31 19:00:00	8.21		6.95		18.63		24.95	23.38		15.42		12.07
31 20:00:00	8.20		6.78		17.29		24.40	23.13		15.27		11.91
31 21:00:00	8.19		6.72		16.32		24.10	22.86		15.58		11.70
31 22:00:00	8.05		6.52		16.14		23.56	22.73		15.58		12.12
31 23:00:00	8.06		6.51		17.13		22.51	22.40		14.15		12.23

Table A.2. Hourly Global Horizontal Irradiance GHI (W/m^2)

Day/Hour	January	February	March	April	May	June	July	August	September	October	November	December
1 00:00:00	0	0	0	0	0	0	0	0	0	0	0	0
1 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
1 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
1 03:00:00	0	0	0	0	0	4	2	0	0	0	0	0
1 04:00:00	0	0	0	0	6	40	21	9	0	0	0	0
1 05:00:00	0	0	0	20	23	139	32	48	41	0	0	0
1 06:00:00	0	0	2	145	66	314	53	228	89	16	1	0
1 07:00:00	1	4	53	307	246	529	161	436	162	46	33	3
1 08:00:00	30	41	146	449	207	670	391	419	429	39	79	70
1 09:00:00	54	82	177	405	379	784	343	385	319	92	122	173
1 10:00:00	76	134	340	484	378	860	401	371	283	112	140	226
1 11:00:00	91	202	344	537	243	890	466	359	255	106	129	241
1 12:00:00	99	244	360	398	323	771	593	270	181	79	131	193
1 13:00:00	88	263	323	300	393	740	483	283	155	81	96	115
1 14:00:00	60	182	219	397	362	631	532	450	230	91	89	69
1 15:00:00	8	73	165	239	358	413	489	529	393	75	38	7
1 16:00:00	0	2	59	126	308	291	362	386	250	52	0	0
1 17:00:00	0	0	1	44	127	128	282	231	98	2	0	0
1 18:00:00	0	0	0	1	36	105	127	88	3	0	0	0
1 19:00:00	0	0	0	0	0	9	24	5	0	0	0	0
1 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
1 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
1 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
1 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
2 00:00:00	0	0	0	0	0	0	0	0	0	0	0	0
2 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
2 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
2 03:00:00	0	0	0	0	0	3	2	0	0	0	0	0
2 04:00:00	0	0	0	0	9	42	23	10	0	0	0	0
2 05:00:00	0	0	0	9	111	221	46	89	53	1	0	0
2 06:00:00	0	0	1	78	258	378	241	237	198	31	4	0
2 07:00:00	1	7	26	263	202	532	358	328	354	157	48	7
2 08:00:00	29	46	57	457	355	668	343	485	497	168	90	52
2 09:00:00	60	85	119	191	442	773	280	529	611	174	122	108
2 10:00:00	85	122	161	241	356	842	561	443	655	262	327	212
2 11:00:00	97	124	198	426	537	867	473	566	527	205	364	228
2 12:00:00	97	127	167	253	603	844	734	694	514	250	342	217
2 13:00:00	91	115	172	235	579	724	691	757	447	123	232	148
2 14:00:00	58	98	146	371	507	673	532	664	495	82	129	71
2 15:00:00	9	48	86	319	443	453	462	538	279	57	46	4
2 16:00:00	0	1	42	113	330	364	388	389	112	25	0	0
2 17:00:00	0	0	0	37	183	184	170	231	86	1	0	0
2 18:00:00	0	0	0	1	46	27	68	86	2	0	0	0
2 19:00:00	0	0	0	0	0	4	18	2	0	0	0	0
2 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
2 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
2 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
2 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
3 00:00:00	0	0	0	0	0	0	0	0	0	0	0	0
3 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
3 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0

3 03:00:00	0	0	0	0	0	3	5	0	0	0	0	0
3 04:00:00	0	0	0	0	9	47	44	5	0	0	0	0
3 05:00:00	0	0	0	13	47	141	107	38	5	0	0	0
3 06:00:00	0	0	12	88	135	248	203	182	33	11	4	0
3 07:00:00	0	8	116	195	285	520	409	286	33	32	72	7
3 08:00:00	18	38	257	246	494	659	500	500	62	39	177	77
3 09:00:00	57	102	382	151	615	766	567	509	127	62	217	161
3 10:00:00	72	145	471	219	714	820	390	415	194	125	183	219
3 11:00:00	70	269	340	261	692	698	416	417	311	93	246	238
3 12:00:00	82	311	430	214	531	739	754	214	300	72	191	215
3 13:00:00	71	275	360	219	362	477	786	142	197	60	119	156
3 14:00:00	49	147	194	407	309	426	658	204	122	68	95	73
3 15:00:00	0	63	128	388	267	412	442	230	154	81	24	6
3 16:00:00	0	2	75	228	176	289	328	180	123	37	0	0
3 17:00:00	0	0	3	75	72	139	182	112	58	0	0	0
3 18:00:00	0	0	0	2	19	53	95	55	0	0	0	0
3 19:00:00	0	0	0	0	0	7	14	3	0	0	0	0
3 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
3 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
3 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
3 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
4 00:00:00	0	0	0	0	0	0	0	0	0	0	0	0
4 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
4 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
4 03:00:00	0	0	0	0	0	2	1	0	0	0	0	0
4 04:00:00	0	0	0	0	7	6	25	27	0	0	0	0
4 05:00:00	0	0	0	24	26	15	48	145	21	1	0	0
4 06:00:00	0	0	9	156	107	58	181	303	107	25	2	0
4 07:00:00	0	8	90	321	376	107	252	460	174	81	60	6
4 08:00:00	25	79	261	474	596	219	214	603	323	92	183	74
4 09:00:00	63	135	393	599	731	270	247	717	305	253	197	158
4 10:00:00	113	120	484	684	807	505	172	794	455	232	157	217
4 11:00:00	105	163	443	720	838	349	291	782	481	356	191	240
4 12:00:00	79	179	440	705	819	320	278	671	462	363	185	220
4 13:00:00	70	99	464	642	753	378	250	609	403	332	189	161
4 14:00:00	39	81	364	536	647	248	196	586	423	212	148	76
4 15:00:00	7	52	230	395	507	221	175	515	368	184	39	6
4 16:00:00	0	2	79	235	348	132	127	347	183	53	0	0
4 17:00:00	0	0	2	77	186	66	73	157	60	0	0	0
4 18:00:00	0	0	0	2	49	51	53	60	0	0	0	0
4 19:00:00	0	0	0	0	0	8	12	2	0	0	0	0
4 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
4 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
4 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
4 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
5 00:00:00	0	0	0	0	0	0	0	0	0	0	0	0
5 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
5 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
5 03:00:00	0	0	0	0	0	1	4	0	0	0	0	0
5 04:00:00	0	0	0	0	29	10	31	22	0	0	0	0
5 05:00:00	0	0	0	31	164	23	56	128	22	0	0	0
5 06:00:00	0	0	3	168	332	57	75	287	174	18	0	0
5 07:00:00	1	16	32	332	498	33	132	440	342	65	31	6
5 08:00:00	31	92	56	485	644	100	178	580	381	109	70	65
5 09:00:00	60	157	94	610	757	193	312	692	564	171	108	141
5 10:00:00	87	308	108	694	761	306	341	769	619	237	114	103
5 11:00:00	88	359	108	731	775	571	532	805	509	156	161	105
5 12:00:00	90	352	128	716	837	282	431	796	453	242	178	172
5 13:00:00	74	292	111	652	709	350	402	741	352	161	156	130
5 14:00:00	61	149	96	544	661	387	446	646	281	71	114	54
5 15:00:00	9	85	56	402	521	485	359	518	348	122	38	5
5 16:00:00	0	6	33	240	361	401	378	368	131	47	0	0
5 17:00:00	0	0	0	83	197	196	194	183	46	0	0	0
5 18:00:00	0	0	0	3	54	50	85	65	0	0	0	0
5 19:00:00	0	0	0	0	0	9	14	2	0	0	0	0
5 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
5 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
5 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
5 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
6 00:00:00	0	0	0	0	0	0	0	0	0	0	0	0
6 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
6 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
6 03:00:00	0	0	0	0	0	6	4	0	0	0	0	0
6 04:00:00	0	0	0	0	29	62	45	20	0	0	0	0
6 05:00:00	0	0	0	34	164	140	120	77	42	0	0	0
6 06:00:00	0	0	4	169	327	167	290	229	170	26	0	0
6 07:00:00	1	16	51	330	489	540	286	433	298	61	34	1
6 08:00:00	32	107	114	478	633	535	340	572	466	124	95	23
6 09:00:00	92	223	204	597	747	647	318	683	468	158	217	55
6 10:00:00	163	307	280	677	820	746	443	758	367	110	252	69
6 11:00:00	239	339	293	711	847	775	639	790	330	161	315	78
6 12:00:00	231	309	234	692	826	627	624	776	523	155	235	81
6 13:00:00	179	234	260	477	760	371	528	720	432	228	229	63
6 14:00:00	95	200	240	441	654	284	532	625	398	167	117	40
6 15:00:00	14	94	167	208	516	251	398	498	258	166	35	1
6 16:00:00	0	8	78	88	358	165	365	351	202	51	0	0
6 17:00:00	0	0	1	33	196	132	225	200	58	0	0	0
6 18:00:00	0	0	0	1	56	33	137	65	1	0	0	0
6 19:00:00	0	0	0	0	0	7	25	1	0	0	0	0
6 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0

6 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
6 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
6 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
7 00:00:00	0	0	0	0	0	0	0	0	0	0	0	0
7 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
7 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
7 03:00:00	0	0	0	0	0	5	3	0	0	0	0	0
7 04:00:00	0	0	0	0	29	21	25	19	0	0	0	0
7 05:00:00	0	0	0	34	158	87	93	118	39	1	0	0
7 06:00:00	0	0	23	165	331	321	357	279	171	36	0	0
7 07:00:00	1	20	146	327	493	339	430	434	322	76	43	3
7 08:00:00	39	125	289	479	636	619	436	574	460	141	112	37
7 09:00:00	83	242	409	601	748	527	559	688	496	197	119	67
7 10:00:00	94	328	494	683	819	453	816	765	550	91	126	108
7 11:00:00	108	373	522	720	844	274	607	801	590	119	108	114
7 12:00:00	102	369	329	707	820	360	370	793	569	186	109	109
7 13:00:00	78	318	347	646	753	268	415	737	579	249	103	94
7 14:00:00	51	226	218	539	620	207	479	641	453	111	103	51
7 15:00:00	7	108	143	399	431	277	382	513	332	86	37	4
7 16:00:00	0	11	67	238	263	231	199	364	146	34	0	0
7 17:00:00	0	0	2	78	120	161	108	208	49	0	0	0
7 18:00:00	0	0	0	2	29	61	64	67	0	0	0	0
7 19:00:00	0	0	0	0	0	6	12	1	0	0	0	0
7 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
7 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
7 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
7 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
8 00:00:00	0	0	0	0	0	0	0	0	0	0	0	0
8 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
8 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
8 03:00:00	0	0	0	0	0	4	1	0	0	0	0	0
8 04:00:00	0	0	0	0	18	62	26	15	0	0	0	0
8 05:00:00	0	0	0	25	109	222	48	103	13	0	0	0
8 06:00:00	0	0	11	144	312	342	67	276	56	15	1	0
8 07:00:00	0	7	79	322	476	390	142	430	92	37	57	1
8 08:00:00	20	65	107	469	616	442	160	570	137	126	165	24
8 09:00:00	50	93	82	582	723	251	201	683	160	95	260	81
8 10:00:00	51	76	137	661	795	461	147	757	155	73	322	139
8 11:00:00	60	84	118	694	813	668	283	787	167	53	341	144
8 12:00:00	124	62	150	677	614	389	215	766	158	91	316	175
8 13:00:00	82	67	177	612	479	346	202	707	147	91	247	134
8 14:00:00	49	82	226	506	413	536	268	608	131	80	146	61
8 15:00:00	7	63	135	368	452	541	318	460	144	64	38	4
8 16:00:00	0	3	57	215	257	408	206	269	95	25	0	0
8 17:00:00	0	0	1	73	124	187	124	46	37	0	0	0
8 18:00:00	0	0	0	3	43	53	57	27	0	0	0	0
8 19:00:00	0	0	0	0	1	14	7	0	0	0	0	0
8 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
8 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
8 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
8 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
9 00:00:00	0	0	0	0	0	0	0	0	0	0	0	0
9 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
9 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
9 03:00:00	0	0	0	0	0	3	1	0	0	0	0	0
9 04:00:00	0	0	0	0	19	19	39	5	0	0	0	0
9 05:00:00	0	0	0	20	115	61	47	29	15	0	0	0
9 06:00:00	0	0	16	72	299	170	73	156	50	28	1	0
9 07:00:00	0	10	101	176	480	283	134	364	99	93	44	1
9 08:00:00	14	34	167	329	621	483	209	542	125	115	103	30
9 09:00:00	56	64	182	564	734	482	230	647	127	196	111	48
9 10:00:00	76	79	295	682	807	333	231	721	340	353	180	91
9 11:00:00	64	95	280	718	835	313	243	754	350	146	278	121
9 12:00:00	83	99	306	702	816	542	152	746	392	150	251	104
9 13:00:00	82	98	233	641	752	534	173	690	257	277	168	85
9 14:00:00	56	55	229	537	647	493	200	595	182	231	123	38
9 15:00:00	6	37	122	400	511	403	206	469	157	118	34	2
9 16:00:00	0	3	94	244	354	219	173	323	104	21	0	0
9 17:00:00	0	0	8	91	195	118	107	164	32	0	0	0
9 18:00:00	0	0	0	5	56	69	45	47	0	0	0	0
9 19:00:00	0	0	0	0	1	15	8	1	0	0	0	0
9 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
9 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
9 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
9 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
10 00:00:00	0	0	0	0	0	0	0	0	0	0	0	0
10 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
10 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
10 03:00:00	0	0	0	0	0	4	2	0	0	0	0	0
10 04:00:00	0	0	0	0	7	16	21	4	0	0	0	0
10 05:00:00	0	0	0	48	72	86	62	38	18	0	0	0
10 06:00:00	0	0	3	191	67	266	131	208	101	49	1	0
10 07:00:00	0	7	23	354	138	501	273	388	285	179	52	3
10 08:00:00	31	39	39	505	452	634	182	466	468	278	161	60
10 09:00:00	102	125	79	624	681	580	336	608	581	291	256	140
10 10:00:00	132	154	127	706	744	538	378	712	451	316	319	203
10 11:00:00	94	136	132	739	630	325	389	711	332	106	337	205
10 12:00:00	132	218	101	721	295	206	411	609	400	179	310	197
10 13:00:00	150	183	104	658	302	133	418	453	321	126	241	125
10 14:00:00	92	148	90	552	221	157	636	562	494	61	141	55

10 15:00:00	16	46	66	413	93	206	590	454	357	51	34	3
10 16:00:00	0	5	36	254	75	163	443	310	202	13	0	0
10 17:00:00	0	0	4	93	53	88	287	164	55	0	0	0
10 18:00:00	0	0	0	4	18	48	139	45	0	0	0	0
10 19:00:00	0	0	0	0	0	7	26	0	0	0	0	0
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10 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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11 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
11 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
11 03:00:00	0	0	0	0	0	2	4	0	0	0	0	0
11 04:00:00	0	0	0	0	10	36	73	9	0	0	0	0
11 05:00:00	0	0	0	52	109	77	207	66	14	0	0	0
11 06:00:00	0	0	16	199	241	230	362	200	87	33	0	0
11 07:00:00	1	10	106	366	426	236	491	346	200	173	19	0
11 08:00:00	28	30	186	519	639	187	376	508	402	279	77	30
11 09:00:00	72	66	235	643	685	123	657	625	570	414	150	82
11 10:00:00	158	122	344	724	672	177	618	694	644	337	126	146
11 11:00:00	195	96	366	755	525	252	360	707	671	289	104	146
11 12:00:00	162	207	261	736	549	258	379	689	651	341	130	171
11 13:00:00	139	80	226	671	509	526	581	628	588	342	89	139
11 14:00:00	71	57	153	563	660	377	489	474	483	262	58	55
11 15:00:00	10	59	180	421	545	432	381	389	324	156	17	3
11 16:00:00	0	10	116	260	373	281	419	232	149	30	0	0
11 17:00:00	0	0	10	102	178	249	284	73	35	0	0	0
11 18:00:00	0	0	0	7	69	101	137	17	0	0	0	0
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11 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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12 05:00:00	0	0	0	43	175	218	213	52	21	0	0	0
12 06:00:00	0	0	35	186	324	374	369	146	73	39	0	0
12 07:00:00	0	21	171	340	271	526	524	337	221	123	18	2
12 08:00:00	32	69	321	481	520	663	662	461	446	158	88	59
12 09:00:00	37	139	448	588	269	768	695	615	368	238	155	145
12 10:00:00	58	186	535	666	305	836	642	696	229	220	154	205
12 11:00:00	94	225	565	698	558	835	807	729	210	237	101	226
12 12:00:00	92	317	346	663	325	735	730	711	219	387	213	205
12 13:00:00	67	325	328	493	328	606	658	654	248	353	190	148
12 14:00:00	27	146	208	409	381	323	534	561	222	241	119	62
12 15:00:00	5	96	255	226	395	193	525	444	209	129	25	1
12 16:00:00	0	17	108	194	384	153	417	301	138	15	0	0
12 17:00:00	0	0	11	79	208	159	247	145	39	0	0	0
12 18:00:00	0	0	0	6	45	75	123	35	0	0	0	0
12 19:00:00	0	0	0	0	1	15	18	0	0	0	0	0
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12 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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13 05:00:00	0	0	0	9	183	124	204	30	17	0	0	0
13 06:00:00	0	0	12	51	311	370	359	97	120	18	0	0
13 07:00:00	1	5	71	193	245	523	513	200	302	117	31	1
13 08:00:00	52	23	104	348	316	660	652	406	440	221	57	13
13 09:00:00	127	33	126	302	357	768	763	551	549	353	60	57
13 10:00:00	216	39	373	529	515	840	837	703	621	420	76	48
13 11:00:00	244	81	226	621	532	870	867	735	647	390	168	99
13 12:00:00	176	242	244	535	569	756	854	708	627	293	157	78
13 13:00:00	178	129	101	688	778	710	798	596	563	267	136	87
13 14:00:00	105	59	187	581	678	647	702	144	458	221	91	38
13 15:00:00	15	56	153	437	542	512	576	61	323	110	17	1
13 16:00:00	0	7	69	270	366	428	431	58	174	15	0	0
13 17:00:00	0	0	8	101	216	274	277	23	38	0	0	0
13 18:00:00	0	0	0	8	69	108	122	10	0	0	0	0
13 19:00:00	0	0	0	0	2	19	15	0	0	0	0	0
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13 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
13 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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14 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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14 04:00:00	0	0	0	1	48	6	21	5	0	0	0	0
14 05:00:00	0	0	0	29	197	84	27	80	18	0	0	0
14 06:00:00	0	0	30	140	348	238	79	224	128	13	0	0
14 07:00:00	0	16	116	277	516	361	136	375	273	60	27	0
14 08:00:00	29	44	157	360	554	400	150	501	411	145	72	24

14 09:00:00	77	95	264	355	416	363	204	582	523	229	121	91
14 10:00:00	102	166	514	296	523	232	253	601	598	274	175	150
14 11:00:00	64	130	541	275	544	272	226	469	626	309	122	127
14 12:00:00	46	168	330	472	685	151	184	584	607	334	156	97
14 13:00:00	55	282	336	393	479	154	105	604	543	310	166	19
14 14:00:00	58	250	241	346	586	239	260	522	439	146	100	48
14 15:00:00	9	94	156	431	546	212	173	303	305	108	17	3
14 16:00:00	0	17	66	207	388	118	153	183	158	16	0	0
14 17:00:00	0	0	7	95	224	74	116	96	28	0	0	0
14 18:00:00	0	0	0	10	78	50	63	28	0	0	0	0
14 19:00:00	0	0	0	0	3	10	5	0	0	0	0	0
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14 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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15 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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15 05:00:00	0	0	0	68	196	81	172	26	19	0	0	0
15 06:00:00	0	0	15	217	362	131	262	124	134	29	0	0
15 07:00:00	1	7	75	379	522	230	360	165	274	128	16	1
15 08:00:00	34	65	170	528	663	341	235	484	424	293	55	48
15 09:00:00	55	171	166	647	761	511	482	564	534	342	71	126
15 10:00:00	136	262	143	728	789	825	325	505	597	252	112	177
15 11:00:00	112	336	160	761	762	849	531	611	626	176	148	136
15 12:00:00	91	180	120	745	597	700	369	598	603	181	136	135
15 13:00:00	86	234	116	682	529	584	520	632	539	139	106	96
15 14:00:00	56	131	118	575	677	404	250	504	436	133	74	36
15 15:00:00	10	53	135	412	543	298	401	252	303	123	9	2
15 16:00:00	0	15	80	211	387	217	286	281	157	17	0	0
15 17:00:00	0	0	9	97	226	79	95	81	30	0	0	0
15 18:00:00	0	0	0	10	78	25	60	19	0	0	0	0
15 19:00:00	0	0	0	0	2	2	3	0	0	0	0	0
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15 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
15 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
15 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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16 04:00:00	0	0	0	1	39	14	18	1	0	0	0	0
16 05:00:00	0	0	0	43	146	47	31	33	13	0	0	0
16 06:00:00	0	0	23	220	237	66	106	168	49	17	0	0
16 07:00:00	1	6	98	392	402	87	171	369	210	74	24	0
16 08:00:00	58	33	252	541	602	237	246	509	335	112	111	22
16 09:00:00	153	51	443	660	529	372	310	616	440	160	197	49
16 10:00:00	228	113	460	737	453	504	330	681	511	384	206	79
16 11:00:00	264	114	557	766	636	358	312	599	377	439	188	71
16 12:00:00	255	137	561	743	667	229	246	652	238	409	185	80
16 13:00:00	203	135	255	675	568	142	187	489	189	317	137	92
16 14:00:00	118	99	243	565	423	119	358	433	309	237	86	42
16 15:00:00	27	55	251	396	456	80	449	130	227	114	15	0
16 16:00:00	0	9	136	187	382	98	299	50	105	14	0	0
16 17:00:00	0	0	20	79	198	99	148	26	18	0	0	0
16 18:00:00	0	0	0	6	79	43	61	15	0	0	0	0
16 19:00:00	0	0	0	0	3	13	11	0	0	0	0	0
16 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
16 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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16 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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17 04:00:00	0	0	0	2	29	54	29	4	0	0	0	0
17 05:00:00	0	0	0	59	124	191	56	32	13	0	0	0
17 06:00:00	0	0	55	187	315	355	170	108	104	16	0	0
17 07:00:00	1	31	164	355	494	507	262	226	245	99	26	0
17 08:00:00	33	149	355	525	578	618	357	442	383	172	120	19
17 09:00:00	69	198	479	641	515	704	328	508	494	143	212	47
17 10:00:00	92	312	530	720	473	687	313	605	564	178	274	97
17 11:00:00	105	91	540	753	748	605	250	402	587	169	293	144
17 12:00:00	122	179	587	735	712	817	310	265	562	276	256	168
17 13:00:00	116	333	514	671	771	621	342	518	495	116	172	109
17 14:00:00	107	234	425	565	670	599	533	342	387	97	102	47
17 15:00:00	18	105	265	427	537	447	414	104	255	92	13	1
17 16:00:00	0	25	94	268	383	205	325	204	120	12	0	0
17 17:00:00	0	0	14	113	224	27	188	130	21	0	0	0
17 18:00:00	0	0	0	12	79	14	53	28	0	0	0	0
17 19:00:00	0	0	0	0	3	4	11	0	0	0	0	0
17 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
17 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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17 00:00:00	0	0	0	0	0	0	0	0	0	0	0	0
18 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
18 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0

18 03:00:00	0	0	0	0	1	1	1	0	0	0	0	0
18 04:00:00	0	0	0	2	33	8	48	7	0	0	0	0
18 05:00:00	0	0	0	40	156	21	141	86	17	0	0	0
18 06:00:00	0	0	54	112	313	112	315	235	133	10	0	0
18 07:00:00	1	40	204	107	493	265	471	347	287	50	14	1
18 08:00:00	44	133	333	186	632	559	605	463	429	140	73	48
18 09:00:00	151	221	206	119	743	500	713	593	540	245	84	130
18 10:00:00	203	173	299	214	819	484	666	532	612	138	129	182
18 11:00:00	246	208	416	273	858	723	692	408	639	56	137	198
18 12:00:00	222	279	280	202	855	685	578	590	619	78	114	198
18 13:00:00	172	284	331	190	800	614	316	561	554	115	68	135
18 14:00:00	112	252	212	123	684	440	419	473	446	119	52	62
18 15:00:00	24	140	128	124	555	274	371	413	307	72	8	4
18 16:00:00	0	25	94	91	394	102	232	189	152	10	0	0
18 17:00:00	0	0	13	42	228	45	142	144	25	0	0	0
18 18:00:00	0	0	0	6	60	29	55	32	0	0	0	0
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18 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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19 05:00:00	0	0	0	71	111	206	79	67	14	0	0	0
19 06:00:00	0	0	16	240	327	376	212	216	115	10	0	0
19 07:00:00	2	38	35	407	487	529	214	393	259	52	17	1
19 08:00:00	55	146	96	558	625	620	480	532	394	88	104	36
19 09:00:00	138	165	141	676	736	709	609	558	504	122	185	108
19 10:00:00	200	320	117	754	809	773	765	569	579	162	166	149
19 11:00:00	260	353	146	788	838	545	818	559	608	157	178	178
19 12:00:00	234	366	168	773	823	499	746	558	588	170	147	155
19 13:00:00	176	249	129	709	763	584	564	475	519	174	102	100
19 14:00:00	117	209	115	603	663	645	355	471	410	191	64	50
19 15:00:00	30	138	116	463	532	545	269	284	273	96	16	2
19 16:00:00	0	19	57	302	382	224	276	140	128	5	0	0
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19 18:00:00	0	0	0	18	85	47	63	14	0	0	0	0
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20 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
20 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
20 03:00:00	0	0	0	0	1	9	1	0	0	0	0	0
20 04:00:00	0	0	0	5	44	74	58	2	0	0	0	0
20 05:00:00	0	0	0	94	170	228	192	23	14	0	0	0
20 06:00:00	0	0	11	256	345	360	349	109	125	5	0	0
20 07:00:00	3	19	56	423	499	509	505	168	278	29	25	0
20 08:00:00	45	61	111	574	635	526	645	146	418	51	120	21
20 09:00:00	93	83	146	693	740	484	710	105	531	73	211	58
20 10:00:00	111	174	223	772	797	182	573	205	603	76	270	73
20 11:00:00	129	166	181	807	814	570	626	279	628	100	287	70
20 12:00:00	131	203	143	791	817	651	478	266	605	107	248	87
20 13:00:00	119	120	140	723	756	736	503	546	536	83	195	75
20 14:00:00	86	115	164	611	620	499	571	468	426	71	101	46
20 15:00:00	34	68	147	467	472	220	554	326	278	45	15	2
20 16:00:00	0	18	60	305	369	322	429	153	118	2	0	0
20 17:00:00	0	0	10	141	226	288	271	81	13	0	0	0
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20 19:00:00	0	0	0	0	5	27	18	0	0	0	0	0
20 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
20 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
20 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
20 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
21 00:00:00	0	0	0	0	0	0	0	0	0	0	0	0
21 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
21 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
21 03:00:00	0	0	0	0	1	8	1	0	0	0	0	0
21 04:00:00	0	0	0	6	36	68	57	0	0	0	0	0
21 05:00:00	0	0	2	102	131	209	189	3	10	0	0	0
21 06:00:00	0	1	88	263	321	260	344	13	102	4	0	0
21 07:00:00	3	54	252	430	452	324	492	237	249	21	15	0
21 08:00:00	50	182	410	580	649	594	619	509	394	46	59	23
21 09:00:00	81	298	534	698	756	636	642	633	506	42	123	70
21 10:00:00	128	281	618	776	825	799	574	720	577	130	165	101
21 11:00:00	124	113	656	806	849	746	586	754	601	289	231	135
21 12:00:00	107	161	643	787	830	455	538	715	577	87	168	92
21 13:00:00	109	178	582	720	768	282	575	682	507	203	167	72
21 14:00:00	93	92	476	611	666	208	607	583	396	158	86	44
21 15:00:00	34	58	335	469	535	277	533	452	260	74	9	3
21 16:00:00	0	14	176	306	383	400	419	297	118	7	0	0
21 17:00:00	0	0	35	142	226	240	264	100	12	0	0	0
21 18:00:00	0	0	0	21	80	93	118	24	0	0	0	0
21 19:00:00	0	0	0	0	5	19	16	0	0	0	0	0
21 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0

21 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
21 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
21 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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22 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
22 03:00:00	0	0	0	0	1	8	1	0	0	0	0	0
22 04:00:00	0	0	0	7	7	61	51	0	0	0	0	0
22 05:00:00	0	0	3	102	22	212	175	69	11	0	0	0
22 06:00:00	0	0	96	269	46	382	307	228	111	17	0	0
22 07:00:00	3	8	258	436	127	536	484	273	264	121	13	0
22 08:00:00	34	25	416	586	258	673	586	353	404	236	72	23
22 09:00:00	83	59	545	701	374	781	635	443	515	206	168	56
22 10:00:00	115	112	633	778	624	842	719	506	586	191	248	95
22 11:00:00	118	135	673	809	532	850	771	226	608	158	268	104
22 12:00:00	121	117	660	791	399	754	661	324	583	117	243	109
22 13:00:00	102	137	596	723	251	770	601	267	512	215	182	92
22 14:00:00	91	155	488	614	437	718	453	381	402	214	92	35
22 15:00:00	39	65	345	471	429	592	440	408	264	93	13	1
22 16:00:00	0	17	183	309	233	444	409	225	118	7	0	0
22 17:00:00	0	0	38	146	98	288	257	125	11	0	0	0
22 18:00:00	0	0	0	23	38	121	114	12	0	0	0	0
22 19:00:00	0	0	0	0	2	28	15	0	0	0	0	0
22 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
22 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
22 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
22 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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23 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
23 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
23 03:00:00	0	0	0	0	0	8	0	0	0	0	0	0
23 04:00:00	0	0	0	8	12	71	33	3	0	0	0	0
23 05:00:00	0	0	4	106	65	222	171	49	9	0	0	0
23 06:00:00	0	0	90	269	135	375	253	131	54	7	0	0
23 07:00:00	4	5	250	433	210	525	302	182	71	76	12	1
23 08:00:00	41	10	410	580	387	659	522	224	199	204	59	35
23 09:00:00	82	22	540	696	661	765	476	212	382	226	132	64
23 10:00:00	133	27	631	772	780	835	732	133	450	155	134	104
23 11:00:00	187	44	672	803	753	864	799	381	247	147	169	74
23 12:00:00	199	89	661	782	662	849	812	429	194	163	97	137
23 13:00:00	150	128	599	715	646	792	751	292	251	189	140	91
23 14:00:00	138	129	492	606	591	698	497	333	134	128	81	51
23 15:00:00	44	109	349	464	349	573	352	339	103	81	8	3
23 16:00:00	0	39	187	299	393	428	260	236	73	1	0	0
23 17:00:00	0	0	41	136	232	276	108	123	3	0	0	0
23 18:00:00	0	0	0	17	90	133	48	21	0	0	0	0
23 19:00:00	0	0	0	0	8	24	5	0	0	0	0	0
23 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
23 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
23 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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24 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
24 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
24 03:00:00	0	0	0	0	2	8	0	0	0	0	0	0
24 04:00:00	0	0	0	4	50	64	14	0	0	0	0	0
24 05:00:00	0	0	5	52	187	216	48	16	8	0	0	0
24 06:00:00	0	1	100	247	215	374	134	54	99	5	0	0
24 07:00:00	4	10	263	421	110	525	172	284	219	32	15	0
24 08:00:00	36	54	419	568	109	661	249	365	343	111	92	17
24 09:00:00	57	71	547	683	106	770	420	415	440	161	180	32
24 10:00:00	157	83	634	763	129	843	265	358	551	219	236	70
24 11:00:00	92	119	672	795	198	873	479	253	276	266	259	95
24 12:00:00	96	135	657	777	170	859	640	307	146	230	214	92
24 13:00:00	102	106	595	711	168	805	577	472	132	161	132	72
24 14:00:00	71	86	490	603	176	712	456	369	115	142	60	41
24 15:00:00	34	66	350	464	185	587	539	374	173	54	7	3
24 16:00:00	0	22	190	302	150	440	326	273	84	1	0	0
24 17:00:00	0	0	44	139	97	285	100	131	4	0	0	0
24 18:00:00	0	0	0	22	38	140	48	17	0	0	0	0
24 19:00:00	0	0	0	0	3	31	7	0	0	0	0	0
24 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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25 04:00:00	0	0	0	5	50	74	24	1	0	0	0	0
25 05:00:00	0	0	7	29	194	227	38	20	6	0	0	0
25 06:00:00	0	3	107	81	354	379	75	63	84	1	0	0
25 07:00:00	4	52	277	149	508	528	153	105	191	19	14	0
25 08:00:00	38	214	435	213	646	661	171	247	146	70	81	28
25 09:00:00	64	333	562	238	620	765	154	236	196	58	174	59
25 10:00:00	92	309	648	299	775	836	151	177	298	56	195	176
25 11:00:00	96	322	686	357	858	868	232	156	289	135	251	137
25 12:00:00	109	91	672	504	840	856	345	172	304	98	234	129
25 13:00:00	125	204	608	617	780	797	474	273	232	83	174	95
25 14:00:00	92	262	499	618	681	700	359	171	136	68	86	60

25 15:00:00	40	93	356	476	551	569	264	178	129	39	9	6
25 16:00:00	0	36	183	315	400	416	127	144	58	0	0	0
25 17:00:00	0	0	47	152	244	272	68	94	3	0	0	0
25 18:00:00	0	0	0	27	101	105	23	16	0	0	0	0
25 19:00:00	0	0	0	0	9	17	2	0	0	0	0	0
25 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
25 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
25 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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26 01:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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26 03:00:00	0	0	0	0	2	6	0	0	0	0	0	0
26 04:00:00	0	0	0	10	31	83	32	1	0	0	0	0
26 05:00:00	0	0	8	109	142	213	157	12	7	0	0	0
26 06:00:00	0	1	113	269	359	364	264	39	103	4	0	0
26 07:00:00	4	15	275	434	525	516	291	103	228	94	5	0
26 08:00:00	48	54	430	572	661	653	477	119	385	215	43	27
26 09:00:00	150	167	559	597	763	763	616	100	488	248	67	70
26 10:00:00	231	192	646	775	831	833	679	129	410	219	99	86
26 11:00:00	273	145	681	807	857	856	640	225	348	336	108	89
26 12:00:00	263	184	661	790	838	830	712	199	209	164	112	97
26 13:00:00	214	172	596	725	776	766	623	159	265	185	96	68
26 14:00:00	110	143	488	619	640	662	629	140	268	117	46	34
26 15:00:00	42	183	347	479	548	526	555	198	171	71	3	5
26 16:00:00	0	49	188	318	397	198	407	135	67	1	0	0
26 17:00:00	0	0	45	155	240	56	250	88	3	0	0	0
26 18:00:00	0	0	0	28	99	35	97	10	0	0	0	0
26 19:00:00	0	0	0	0	8	11	2	0	0	0	0	0
26 20:00:00	0	0	0	0	0	0	0	0	0	0	0	0
26 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
26 22:00:00	0	0	0	0	0	0	0	0	0	0	0	0
26 23:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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27 03:00:00	0	0	0	0	4	4	0	0	0	0	0	0
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27 05:00:00	0	0	7	74	167	32	33	10	2	0	0	0
27 06:00:00	0	2	98	268	367	197	52	39	37	7	0	0
27 07:00:00	2	17	247	436	525	440	103	84	81	90	2	1
27 08:00:00	40	60	393	581	665	285	217	135	82	178	52	42
27 09:00:00	91	78	503	697	773	269	269	181	176	144	96	126
27 10:00:00	129	102	584	772	843	636	126	280	230	147	94	193
27 11:00:00	148	126	619	798	870	373	315	434	275	108	123	223
27 12:00:00	157	135	599	775	852	338	259	412	236	180	166	211
27 13:00:00	143	109	535	708	791	429	414	371	209	110	68	158
27 14:00:00	117	102	431	601	690	427	392	283	136	109	50	76
27 15:00:00	40	62	296	442	557	338	372	130	89	54	1	7
27 16:00:00	0	27	151	303	404	392	314	123	60	1	0	0
27 17:00:00	0	0	36	139	235	165	211	53	2	0	0	0
27 18:00:00	0	0	0	19	84	50	77	6	0	0	0	0
27 19:00:00	0	0	0	0	8	17	6	0	0	0	0	0
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27 21:00:00	0	0	0	0	0	0	0	0	0	0	0	0
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28 02:00:00	0	0	0	0	0	0	0	0	0	0	0	0
28 03:00:00	0	0	0	0	5	2	0	0	0	0	0	0
28 04:00:00	0	0	0	8	64	26	21	1	0	0	0	0
28 05:00:00	0	0	8	12	218	55	84	56	2	0	0	0
28 06:00:00	0	6	92	48	382	151	266	203	18	3	0	0
28 07:00:00	1	60	240	97	539	373	418	336	49	37	5	0
28 08:00:00	36	133	393	90	679	598	474	382	92	131	38	32
28 09:00:00	92	249	520	248	789	610	568	370	109	275	101	109
28 10:00:00	124	258	608	216	861	558	330	387	85	173	134	164
28 11:00:00	142	285	649	185	889	620	295	343	95	113	110	187
28 12:00:00	190	230	634	176	871	389	325	337	83	148	136	183
28 13:00:00	84	167	577	175	808	583	273	374	103	96	106	142
28 14:00:00	136	86	476	139	706	623	392	191	74	81	62	66
28 15:00:00	44	65	339	142	573	509	336	198	98	29	2	5
28 16:00:00	1	26	183	83	396	446	270	91	65	0	0	0
28 17:00:00	0	0	46	43	256	292	152	51	1	0	0	0
28 18:00:00	0	0	0	12	73	146	59	6	0	0	0	0
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29 04:00:00	0	0	0	4	71	66	38	1	0	0	0	0
29 05:00:00	0	0	11	11	230	120	166	46	1	0	0	0
29 06:00:00	0	4	120	51	392	355	316	178	21	5	0	0
29 07:00:00	3	43	284	87	550	291	379	316	73	58	7	0
29 08:00:00	67	154	379	71	689	291	369	312	259	99	70	40

29 09:00:00	178	239	481	219	797	274	498	455	361	137	168	95
29 10:00:00	187	219	414	294	866	283	493	270	509	103	188	149
29 11:00:00	131	110	516	430	892	272	605	164	464	142	204	148
29 12:00:00	148	77	581	473	871	362	685	312	511	161	190	120
29 13:00:00	143	150	609	352	805	314	658	240	323	109	148	89
29 14:00:00	129	257	507	435	701	301	676	324	261	73	61	66
29 15:00:00	55	151	369	363	566	420	547	358	182	37	6	6
29 16:00:00	1	64	209	60	410	372	397	211	58	0	0	0
29 17:00:00	0	2	57	53	251	165	241	82	1	0	0	0
29 18:00:00	0	0	0	10	106	69	94	9	0	0	0	0
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30 01:00:00	0		0	0	0	0	0	0	0	0	0	0
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30 04:00:00	0		0	2	66	41	22	1	0	0	0	0
30 05:00:00	0		15	26	220	55	108	47	2	0	0	0
30 06:00:00	0		131	228	384	129	298	103	42	1	0	0
30 07:00:00	3		264	316	540	290	449	184	87	16	9	1
30 08:00:00	82		275	403	677	379	586	219	124	58	83	46
30 09:00:00	159		190	370	781	387	698	196	92	63	165	128
30 10:00:00	244		311	486	849	488	775	234	176	106	235	203
30 11:00:00	284		382	571	874	444	808	349	170	98	256	234
30 12:00:00	124		192	588	855	242	796	266	169	65	233	221
30 13:00:00	109		200	627	792	188	741	254	172	82	172	167
30 14:00:00	93		174	553	692	251	648	336	177	57	82	83
30 15:00:00	51		220	485	475	259	524	134	101	32	8	9
30 16:00:00	1		161	274	351	125	380	107	52	1	0	0
30 17:00:00	0		43	80	234	67	229	64	0	0	0	0
30 18:00:00	0		0	14	100	27	90	4	0	0	0	0
30 19:00:00	0		0	0	15	10	5	0	0	0	0	0
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30 21:00:00	0		0	0	0	0	0	0	0	0	0	0
30 22:00:00	0		0	0	0	0	0	0	0	0	0	0
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31 02:00:00	0		0		0		0	0		0		0
31 03:00:00	0		0		6		0	0		0		0
31 04:00:00	0		0		68		34	0		0		0
31 05:00:00	0		18		225		155	28		0		0
31 06:00:00	0		145		383		308	158		4		0
31 07:00:00	7		313		537		463	357		37		0
31 08:00:00	38		470		673		604	500		74		36
31 09:00:00	82		594		781		716	488		105		112
31 10:00:00	95		678		850		792	387		106		144
31 11:00:00	103		714		875		826	471		158		206
31 12:00:00	118		699		853		816	340		281		209
31 13:00:00	135		635		788		761	363		175		165
31 14:00:00	102		527		684		666	507		91		82
31 15:00:00	49		384		549		538	380		45		9
31 16:00:00	1		222		396		390	220		0		0
31 17:00:00	0		67		228		234	101		0		0
31 18:00:00	0		1		81		89	7		0		0
31 19:00:00	0		0		8		2	0		0		0
31 20:00:00	0		0		0		0	0		0		0
31 21:00:00	0		0		0		0	0		0		0
31 22:00:00	0		0		0		0	0		0		0
31 23:00:00	0		0		0		0	0		0		0

Table A.3. TS 2164 - Table 6A – Heat Transfer Coefficient of Multilayer Glasses According to Intermediate Space Filling (TR)

Cam				Ara boşluk dolgusu cinsi (Gaz konsantrasyonu > 90)			
Tip	Cam	Normal yayınım derecesi (Emissivite,e)	Ölçüler mm	Hava	Argon	Kripton	SF6
Çift cam	Kaplamasız cam (Normal cam)	0,89	4, 6, 4	3,3	3	2,8	3
			4, 9, 4	3	2,8	2,6	3,1
			4, 12, 4	2,9	2,7	2,6	3,1
			4, 15, 4	2,7	2,6	2,6	3,1
			4, 20, 4	2,7	2,6	2,6	3,1
	Tek kaplamalı cam	< 0,4	4, 6, 4	2,9	2,6	2,2	2,6
			4, 9, 4	2,6	2,3	2	2,7
			4, 12, 4	2,4	2,1	2	2,7
			4, 15, 4	2,2	2	2	2,7
			4, 20, 4	2,2	2	2	2,7
	Tek kaplamalı cam	< 0,2	4, 6, 4	2,7	2,3	1,9	2,3
			4, 9, 4	2,3	2	1,6	2,4
			4, 12, 4	1,9	1,7	1,5	2,4
			4, 15, 4	1,8	1,6	1,6	2,5
			4, 20, 4	1,8	1,7	1,6	2,5
	Tek kaplamalı cam	**< 0,1**	4, 6, 4	2,6	2,2	1,7	2,1
			4, 9, 4	2,1	1,7	1,3	2,2
			4, 12, 4	**1,8**	1,5	1,3	2,3
			4, 15, 4	1,6	1,4	1,3	2,3
			4, 20, 4	1,6	1,4	1,3	2,3
	Tek kaplamalı cam	<0,05	4, 6, 4	2,5	2,1	1,5	2
			4, 9, 4	2	1,6	1,3	2,1
			4, 12, 4	1,7	1,3	1,1	2,2
			4, 15, 4	1,5	1,2	1,1	2,2
			4, 20, 4	1,5	1,2	1,2	2,2
Üçlü cam	Kaplamasız cam (Normal cam)	0,89	4, 6, 4, 6, 4	2,3	2,1	1,8	2
			4, 9, 4, 9, 4	2	1,9	1,7	2
			4, 12, 4, 12,4	1,9	1,8	1,6	2
	İki kaplamalı cam	< 0,4	4, 6, 4, 6, 4	2	1,7	1,4	1,6
			4, 9, 4, 9, 4	1,7	1,5	1,2	1,6
			4, 12, 4, 12,4	1,5	1,3	1,1	1,6
	İki kaplamalı cam	< 0,2	4, 6, 4, 6, 4	1,8	1,5	1,1	1,3
			4, 9, 4, 9, 4	1,4	1,2	0,9	1,3
			4, 12, 4, 12,4	1,2	1	0,8	1,4
	İki kaplamalı cam	< 0,1	4, 6, 4, 6, 4	1,7	1,3	1	1,2
			4, 9, 4, 9, 4	1,3	1	0,8	1,2
			4, 12, 4, 12,4	1,1	0,9	0,6	1,2
	İki kaplamalı cam	< 0,05	4, 6, 4, 6, 4	1,6	1,3	0,9	1,1
			4, 9, 4, 9, 4	1,2	0,9	0,7	1,1
			4, 12, 4, 12,4	1	0,8	0,5	1,1

Table A.4. TS 2164 - Table 6B – Heat Transfer Coefficient of Window Systems According to Type of Glass and Frame (TR)

Cam tipi	W/ (m^2.K)	Uf 2)								
		W / (m^2.K)								
		1	1,4	1,8	2,2	2,6	3	3,4	3,8	7
Tek cam	5,7	4,8	4,8	4,9	5	5,1	5,2	5,2	5,3	5,9
Çift cam	3,3	2,9	3	3,1	3,2	3,3	3,4	3,4	3,5	4
	3,1	2,8	2,8	2,9	3	3,1	3,2	3,3	3,4	3,9
	2,9	2,6	2,7	2,8	2,8	3	3	3,1	3,2	3,7
	2,7	2,4	2,5	2,6	2,7	2,8	2,9	3	3	3,6
	2,5	2,3	2,4	2,5	2,6	2,7	2,7	2,8	2,9	3,4
	2,3	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,7	3,3
	2,1	2	2,1	2,2	2,2	2,3	2,4	2,5	2,8	3,1
1,8	1,9	1,8	1,9	2	2,1 2,0	2,2	2,3	2,3	2,4	3
	1,7	1,7	1,8	1,8	1,9	2	2,1	2,2	2,3	2,8
	1,5	1,5	1,6	1,7	1,8	1,9	1,9	2	2,1	2,6
	1,3	1,4	1,4	1,5	1,6	1,7	1,8	1,9	2	2,5
	1,1	1,2	1,3	1,4	1,4	1,5	1,6	1,7	1,8	2,3
Üçlü cam	2,3	2,1	2,2	2,3	2,4	2,5	2,6	2,6	2,7	3,2
	2,1	2	2	2,1	2,2	2,3	2,4	2,5	2,6	3,1
	1,9	1,8	1,9	2	2	2,2	2,2	2,3	2,4	2,9
	1,7	1,6	1,7	1,8	1,9	2	2,1	2,2	2,2	2,8
	1,5	1,5	1,6	1,7	1,8	1,9	1,9	2	2,1	2,6
	1,3	1,4	1,4	1,5	1,6	1,7	1,8	1,9	2	2,5
	1,1	1,2	1,3	1,4	1,4	1,5	1,6	1,7	1,8	2,3
	0,9	1	1,1	1,2	1,3	1,4	1,5	1,6	1,6	2,2
	0,7	0,9	1	1	1,1	1,2	1,3	1,4	1,5	2
	0,5	0,7	0,8	0,9	1	1,1	1,2	1,2	1,3	1,8

1) Ug: Camın ısı geçirgenlik kat sayısı (W/m^2.K)

2) Uf: Çerçevenin ısı geçirgenlik kat sayısı (W/m^2.K)

Table A.5. Heat Pump Catalogue (NIBE S1155-6)

Product fiche

Supplier's name:	**NIBE**		
Model:	**NIBE S1155-6 (+ VPB S300)**		
Temperature application	**35**	**55**	°C
Declared load profile for water heating	**XL**		
Seasonal space heating energy efficiency class, average climate:	**A+++**	**A+++**	
Water heating energy efficiency class, average climate:	**A**		
Rated heat output, average climate:	5,5	5,5	kW
Annual energy consumption for space heating, average climate	2188	2875	kWh
Annual electricity consumption for water heating, average climate	1697		kWh
Seasonal space heating energy efficiency, average climate:	200	150	%
Water heating energy efficiency, average climate:	99		%
Sound power level LWA indoors	42	42	dB
Rated heat output, cold climate:	5,5	5,5	kW
Rated heat output, warm climate:	5,5	5,5	kW
Annual energy consumption for space heating, cold climate	2481	3287	kWh
Annual electricity consumption for water heating, cold climate	1697		kWh
Annual energy consumption for space heating, warm climate	1408	1852	kWh
Annual electricity consumption for water heating, warm climate	1697		kWh
Seasonal space heating energy efficiency, cold climate:	211	157	%
Water heating energy efficiency, cold climate:	99		%
Seasonal space heating energy efficiency, warm climate:	201	151	%
Water heating energy efficiency, warm climate:	99		%
Sound power level LWA outdoors	-	-	dB

Data for package fiche

Controller class	VI		
Controler contribution to efficiency	4		%
Seasonal space heating energy efficiency of package, average climate:	204	154	%
Seasonal space heating energy efficiency class for package, average climate:	**A+++**	**A+++**	%
Seasonal space heating energy efficiency of package, cold climate:	215	161	%
Seasonal space heating energy efficiency of package, warm climate:	205	155	%

Model(s):	**NIBE S1155-6 (+ VPB S300)**	
Type of heat source/sink:	Brine-to-water	
Low-temperature heat pump:	No	
Equipped with supplementary heater:	Yes	
Heat pump combination heater:	Yes	
Climate condition:	Average	
Temperature application:	Medium temperature (55 °C)	
Applied standards: EN14825 and EN16147		

Rated heat output	Prated	5,5	kW	**Seasonal space heating energy efficiency**	η_s	150	%
Declared capacity for part load at outdoor temperature Tj				*Declared coefficient of performance for part load at outdoor temperature Tj*			
Tj = -7 °C	Pdh	5,0	kW	Tj = -7 °C	COPd	3,06	-
Tj = +2 °C	Pdh	3,0	kW	Tj = +2 °C	COPd	3,97	-
Tj = +7 °C	Pdh	2,0	kW	Tj = +7 °C	COPd	4,63	-
Tj = +12 °C	Pdh	1,2	kW	Tj = +12 °C	COPd	4,86	-
Tj = biv	Pdh	5,4	kW	Tj = biv	COPd	2,84	-
Tj = TOL	Pdh	5,4	kW	Tj = TOL	COPd	2,84	-
Tj = -15 °C (if TOL < -20 °C)	Pdh		kW	Tj = -15 °C (if TOL < -20 °C)	COPd		-
Bivalent temperature	T_{biv}	-10	°C	Operation limit temperature	TOL	-10	°C
Cycling interval capacity for heating	Pcych		kW	Cycling interval efficiency	COPcyc		-
Degradation co-efficient	Cdh	0,99	-	Heating water operating limit	WTOL	65	°C
Power consumption in modes other than active mode				*Supplementary heater*			
Off mode	P_{OFF}	0,002	kW	Rated heat output	Psup	0,1	kW
Thermostat-off mode	P_{TO}	0,007	kW				
Standby mode	P_{SB}	0,007	kW	Type of energy input		Electric	
Crankcase heater mode	P_{CK}	0,009	kW				
Other items							
Capacity control		variable		Rated air flow rate, outdoors			m^3/h
Sound power level, indoors/outdoors	L_{WA}	42/-	dB				
Annual energy consumption	Q_{HE}	2875	kWh	Rated brine or water flow rate, outdoor heat exchanger		0,68	m^3/h
For heat pump combination heater:							
Declared load profile		**XL**		**Water heating energy efficiency**	η_{wh}	99	%
Daily electricity consumption	Q_{elec}	7,73	kWh	Daily fuel consumption	Q_{fuel}		kWh
Annual electricity consumption	AEC	1697	kWh	Annual fuel consumption	AFC		GJ
Approved by:							
Contact details	**© NIBE Energy Systems - Box 14 - Hannabadsvägen 5 - 28521 Markaryd - Sweden**						

Table A.6. Fan Coil Catalogue (Daikin FWV-DAF)

FWV-DAT/DAF

			FWV-DAT/DAF	01	15	02	25	03	35	04	06	08	10	01	15	25	02	35	03	04	06	08	10
				2-pipe										4-pipe									
Cooling capacity (standard conditions)	Latent capacity	High	kW	0.34(1)	0.44(1)	0.54(1)		0.82(1)	0.76(1)	1.18(1)	0.98(1)	1.80(1)	2.06(1)	0.32(1)	0.42(1)	0.53(1)	0.33(1)	0.75(1)	0.80(1)	1.17(1)	1.19(1)	1.79(1)	2.03(1)
	Sensible capacity	Low	kW	0.77(1)	0.93(1)	0.98(1)	1.15(1)	1.23(1)	1.41(1)	1.76(1)	2.27(1)	2.75(1)	2.94(1)	0.73(1)	0.91(1)	1.14(1)	0.96(1)	1.40(1)	1.21(1)	1.74(1)	2.23(1)	2.73(1)	2.91(1)
		Medium	kW	0.94(1)	1.10(1)	1.20(1)	1.53(1)	1.66(1)	1.99(1)	2.39(1)	2.85(1)	3.70(1)	4.46(1)	0.87(1)	1.07(1)	1.50(1)	1.18(1)	1.96(1)	1.62(1)	2.36(1)	2.80(1)	3.67(1)	4.40(1)
		High	kW	1.16(1)	1.25(1)	1.37(1)	1.82(1)	2.05(1)	2.69(1)	3.05(1)	3.55(1)	4.73(1)	5.72(1)	1.10(1)	1.22(1)	1.79(1)	1.41(1)	2.61(1)	2.01(1)	2.99(1)	3.47(1)	4.67(1)	5.61(1)
	Total capacity	Low	kW	1.02(1)	1.24(1)	1.34(1)	1.57(1)	1.73(1)	1.94(1)	2.47(1)	2.95(1)	3.88(1)	4.00(1)	0.97(1)	1.22(1)	1.55(1)	1.24(1)	1.92(1)	1.70(1)	2.44(1)	3.06(1)	3.84(1)	3.96(1)
		Medium	kW	1.21(1)	1.48(1)	1.66(1)	1.99(1)	2.34(1)	2.58(1)	3.21(1)	3.59(1)	5.14(1)	6.07(1)	1.11(1)	1.44(1)	1.96(1)	1.52(1)	2.54(1)	2.29(1)	3.17(1)	3.74(1)	5.10(1)	5.99(1)
		High	kW	1.50(1)	1.69(1)	1.91(1)	2.36(1)	2.87(1)	3.45(1)	4.23(1)	4.41(1)	6.53(1)	7.78(1)	1.42(1)	1.64(1)	2.32(1)	1.74(1)	3.36(1)	2.81(1)	4.16(1)	4.57(1)	6.46(1)	7.64(1)
Heating capacity (standard conditions)	Capacity	Low	kW	1.21(3)	1.45(3)	1.50(3)	1.74(3)	1.76(3)	2.39(3)	2.47(3)	3.31(3)	3.97(3)	4.39(3)	1.31(2)	1.36(2)	1.78(2)	1.36(2)	2.82(2)	1.88(2)	2.73(2)	3.55(2)	5.02(2)	4.85(2)
		Medium	kW	1.48(3)	1.72(3)	1.81(3)	2.26(3)	2.37(3)	3.13(3)	3.24(3)	4.08(3)	5.17(3)	6.53(3)	1.49(2)	1.56(2)	2.18(2)	1.56(2)	3.47(2)	2.31(2)	3.22(2)	4.07(2)	6.02(2)	6.29(2)
		High	kW	1.82(3)	1.84(3)	2.15(3)	2.70(3)	2.94(3)	4.05(3)	4.24(3)	4.98(3)	6.49(3)	8.37(3)	1.66(2)	1.76(2)	2.53(2)	1.76(2)	4.20(2)	2.68(2)	3.82(2)	4.64(2)	6.97(2)	7.35(2)
Power input	Low		kW	0.02	0.03	0.02	0.03		0.04		0.05	0.09	0.11	0.02	0.03		0.02	0.04	0.03	0.04	0.05	0.09	0.11
	Medium		kW	0.03	0.04				0.05	0.06	0.07	0.13	0.17	0.03	0.04			0.05	0.04	0.06	0.07	0.13	0.17
	High		kW	0.037	0.053		0.057	0.056	0.065	0.098		0.182	0.244	0.037	0.053	0.057	0.053	0.065	0.056	0.098		0.182	0.244
FCEER				E				D	E	D		E		E					D			E	
FCCOP				E					D			E		E				D	E	D		E	
Dimensions	Unit	Height x Width x Depth	mm	564x774x226			564x984x226		564x1,190x226			564x1,400x251		564x774x226		564x984x226	564x774x226	564x1,190x226	564x984x226	564x1,190x226		564x1,400x251	
Weight	Unit		kg	19.7		20.6	25.5	26.7	31.0	30.4	32.3	41.4	41.6	19.7		25.5	20.6	31.0	26.7	30.4	32.3	41.4	41.6
Casing	Colour			White - RAL9010																			
Heat exchanger	Water volume		l	0		1						2		0		1						2	
Water flow	Cooling	Low	l/h	179(1)	216(1)	234(1)	275(1)	302(1)	340(1)	431(1)	515(1)	682(1)	706(1)	169(1)	212(1)	272(1)	216(1)	336(1)	297(1)	425(1)	535(1)	676(1)	699(1)
		Medium	l/h	213(1)	261(1)	292(1)	348(1)	408(1)	451(1)	561(1)	628(1)	905(1)	1,071(1)	196(1)	254(1)	343(1)	267(1)	447(1)	400(1)	554(1)	654(1)	898(1)	1,058(1)
		High	l/h	264(1)	299(1)	337(1)	416(1)	503(1)	602(1)	743(1)	774(1)	1,152(1)	1,376(1)	250(1)	291(1)	409(1)	307(1)	594(1)	493(1)	730(1)	802(1)	1,138(1)	1,352(1)
	Heating	Low	l/h	211(3)	252(3)	260(3)	302(3)	301(3)	415(3)	430(3)	575(3)	690(3)	764(3)	115(2)	120(2)	156(2)	119(2)	247(2)	165(2)	238(2)	311(2)	440(2)	425(2)
		Medium	l/h	256(3)	300(3)	316(3)	393(3)	408(3)	545(3)	563(3)	709(3)	898(3)	1,135(3)	130(2)	137(2)	191(2)	136(2)	304(2)	202(2)	281(2)	357(2)	527(2)	551(2)
		High	l/h	317(3)	320(3)	373(3)	469(3)	506(3)	704(3)	736(3)	866(3)	1,129(3)	1,455(3)	146(2)	154(2)	222(2)	154(2)	368(2)	234(2)	334(2)	406(2)	610(2)	643(2)
Fan	Type			Centrifugal																			
	Quantity			1			2							1		2	1	2					
	Air flow rate	Low	m^3/h	178	211		241		320	361	470	570	642	174	205	238	205	316	237	356	460	565	636
		Medium	m^3/h	233	271		341		450	497	605	771	1,022	225	261	334	261	444	332	490	593	765	1,007
		High	m^3/h	319	344		442		640	706	785	1,011	1,393	307	330	432	327	628	431	690	763	998	1,362
Air filter	Type			Polypropylene net																			
Total sound power level	Low		dBA	37(4)	38(4)	40(4)	35(4)	36(4)	35 4		43(4)	47(4)	49(4)	33(4)	40(4)	34(4)	38(4)	36(4)	33(4)	39(4)	48(4)	46(4)	48(4)
	Medium		dBA	42(4)	44(4)		43(4)	42(4)	43(4)		49(4)	54(4)	60(4)	39(4)	44(4)	43(4)	44(4)	45(4)	41(4)	46(4)	53(4)	54(4)	58(4)
	High		dBA	47(4)	49(4)	50(4)	48(4)		52(4)	53(4)	56(4)	61(4)	67(4)	45(4)	49(4)	48(4)	50(4)	53(4)	47(4)	56(4)	58(4)	60(4)	66(4)
Sound pressure level	Low		dBA	32(5)	33(5)	35(5)	30(5)	31(5)	30(5)		38(5)	42(5)	44(5)	28(5)	33(5)	29(5)	33(5)	29(5)	28(5)	32(5)	43(5)	41(5)	43(5)
	Medium		dBA	37(5)	39(5)		38(5)	37(5)	38(5)		44(5)	49(5)	55(5)	34(5)	39(5)	38(5)	39(5)	38(5)	36(5)	41(5)	48(5)	49(5)	53(5)
	High		dBA	42(5)	44(5)	45(5)	43(5)		47(5)	48(5)	51(5)	56(5)	62(5)	40(5)	44(5)	43(5)	45(5)	46(5)	42(5)	51(5)	54(5)	55(5)	61(5)
Electric heater	Power input		kW	1.0	1.5		1.6		2.0			3.0		1.0	1.5	1.6	1.5	2.0	1.6	2.0		3.0	
Piping connections	Drain	OD	mm	16																			
Power supply	Phase/Frequency/Voltage		Hz/V	1~/50/230																			
Current input	Low		A	0.09	0.11		0.14		0.19			0.39	0.54	0.09	0.11	0.14	0.11	0.19	0.14	0.19		0.39	0.54
	Medium		A	0.11	0.14		0.20		0.29		0.28	0.57	0.78	0.11	0.14	0.20	0.14	0.29	0.20	0.29	0.28	0.57	0.78
	High		A	0.16	0.20		0.27		0.40		0.39	0.80	1.07	0.16	0.20	0.27	0.20	0.40	0.27	0.40	0.39	0.80	1.07

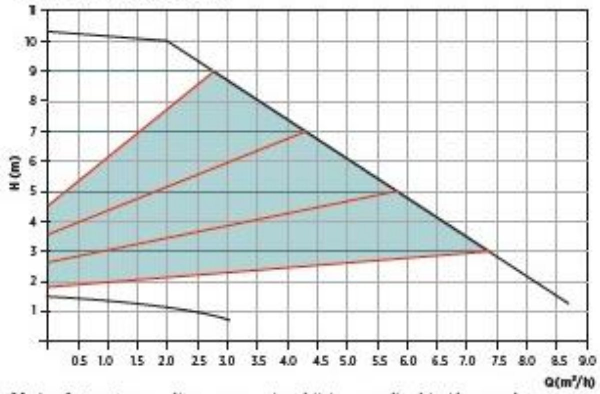
(1) Cooling: indoor temp. 27°CDB, 19°CWB; entering water temp. 7°C, water temperature rise 5K.
(2) Heating: indoor temp. 20°CDB, 15°CWB; entering water temp. 65°C, water temperature drop 10K.
(3) Heating: indoor temp. 20°CDB, 15°CWB; entering water temp. 45°C, water temperature drop 5K.
(4) Sound power level according to ISO3741
(5) The sound pressure level is measured via a microphone at 1m distance of the unit.

Table A.7. Circulating Pump Catalogue (ETNA ECP 25-10-180)

FREQUENCY CONTROLLED CIRCULATING PUMP
ECP32-10-180 & ECP25-10-180 SERIES

ETNA

Performance Curve



Note: 1 (one) coupling connector kit is supplied in the package.

Fluid Temperature : From -10°C to +110°C
Fluid Quality : Suitable for use with clean, abrasive solid particle free, mild and chemically neutral water.

Material Specifications

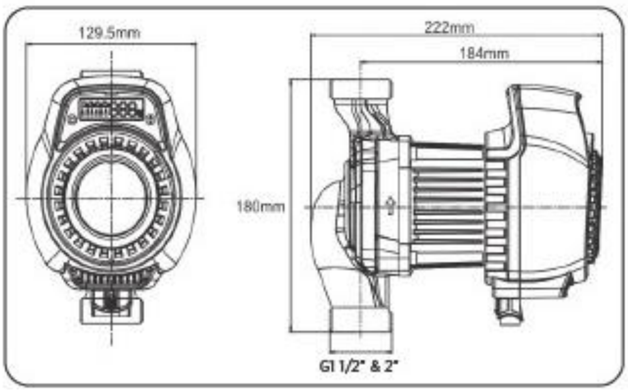
Bearing	: Ceramic
Bearing Bush	: Brass
Motor Casing	: Aluminum
Gasket	: Silicagel EPDM
Pump Casing	: Cast iron
Fan (Impeller)	: Plastic
Stainless Case	: AISI304
Protective Shield	: AISI304
Shaft	: Ceramic
Control Box	: Nylon + ABS

Pump Properties

Distance Between Couplings	: 180 mm
Electrical Connection	: Plug
Energy Efficiency (EEI) Value	: <= 0,23
Nominal Pressure	: PN 10
Pipe Connection	: Threaded Connection / G1 1/2-Rp1

Electrical Properties

Electrical Supply	: 230 V - 50 Hz Single-phase
Protection Class	: IP 44
Noise Levels	: <= 45 dB(A)
Current Rating	: 0.38A



Measures

B1	: 129.5 mm
H1	: 220 mm
H2	: 184 mm
L1	: 180 mm
G	: G1 1/2" & 2"
Net Weight	: 3.4 kg

Table A.8. Solar Panel Catalogue (LG Neon LG400N2W-V5)

LG NeON®2

LG400N2W-V5 | LG395N2W-V5

General Data

Cell Properties(Material / Type)	Monocrystalline / N-type
Cell Maker	LG
Cell Configuration	72 Cells (6 x 12)
Number of Busbars	12EA
Module Dimensions (L x W x H)	2,024 mm x 1,024 mm x 40 mm
Weight	20.3 kg
Glass(Material)	Tempered Glass with AR Coating
Backsheet(Color)	White
Frame(Material)	Anodized Aluminium
Junction Box(Protection Degree)	IP 68
Cables(Length)	1,200 mm x 2EA
Connector(Type / Maker)	MC 4 / MC

Certifications and Warranty

Certifications	IEC 61215-1/-1-1/2:2016, IEC 61730-1/2:2016, UL 1703
	ISO 9001, ISO 14001, ISO 50001
	OHSAS 18001, PV CYCLE
Salt Mist Corrosion Test	IEC 61701 : 2012 Severity 6
Ammonia Corrosion Test	IEC 62716 : 2013
Module Fire Performance	Type 1 (UL 1703)
Fire Rating	Class C (UL 790, ULC/ORD C 1703)
Solar Module Product Warranty	25 Years
Solar Module Output Warranty	Linear Warranty*

* 1) First year : 98% 2) After 1st year : 0.35% annual degradation 3) 89.6% for 25 years

Temperature Characteristics

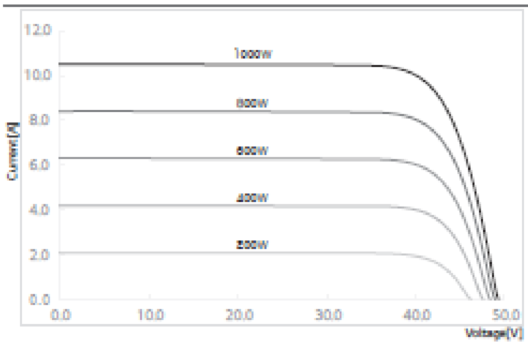
NMOT*	[°C]	42 ± 3
Pmax	[%/°C]	-0.36
Voc	[%/°C]	-0.26
Isc	[%/°C]	0.02

* NMOT (Nominal Module Operating Temperature): Irradiance 800 W/m², Ambient temperature 20 °C, Wind speed 1 m/s, Spectrum AM 1.5

Electrical Properties (NMOT)

Model		LG400N2W-V5	LG395N2W-V5
Maximum Power (Pmax)	[W]	300	296
MPP Voltage (Vmpp)	[V]	38.0	37.7
MPP Current (Impp)	[A]	7.88	7.86
Open Circuit Voltage (Voc)	[V]	46.5	46.4
Short Circuit Current (Isc)	[A]	8.40	8.37

I-V Curves



Electrical Properties (STC*)

Model		LG400N2W-V5	LG395N2W-V5
Maximum Power (Pmax)	[W]	400	395
MPP Voltage (Vmpp)	[V]	40.6	40.2
MPP Current (Impp)	[A]	9.86	9.83
Open Circuit Voltage (Voc, ±5%)	[V]	49.3	49.2
Short Circuit Current (Isc, ±5%)	[A]	10.47	10.43
Module Efficiency	[%]	19.3	19.1
Power Tolerance	[%]	0 ~ +3	

* STC (Standard Test Condition): Irradiance 1000 W/m², Cell temperature 25 °C, AM 1.5

Operating Conditions

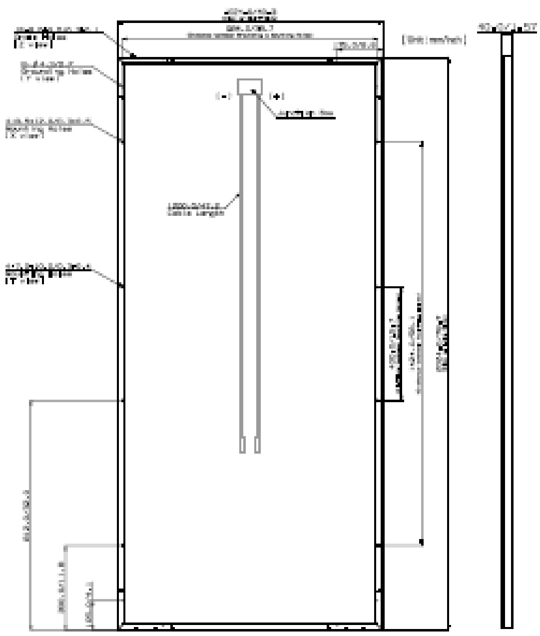
Operating Temperature	[°C]	-40 ~ +90
Maximum System Voltage	[V]	1,500(UL), 1000(IEC)
Maximum Series Fuse Rating	[A]	20
Mechanical Test Load (Front)	[Pa / psf]	5,400 / 113
Mechanical Test Load (Rear)	[Pa / psf]	3,000 / 63

* Test Load = Design load X Safety Factor (1.5)

Packaging Configuration

Number of Modules per Pallet	[EA]	25
Number of Modules per 40ft HQ Container	[EA]	550
Packaging Box Dimensions (L x W x H)	[mm]	2,080 x 1,120 x 1,226
Packaging Box Gross Weight	[kg]	551

Dimensions (mm / inch)



LG Life's Good

LG Electronics Inc.
Solar Business Division
LG Twin Towers, 128 Yeoui-daero, Yeongdeungpo-gu, Seoul 07336, Korea
www.lg-solar.com

Product specifications are subject to change without notice.
DS-V5-72-W-G-F-EN-81105

Table A.9. Battery Catalogue (Vision Tech-LFP48100)

V-LFP48100 48V100Ah

Vision Technology delivers safe lithium iron phosphate battery solutions for Telecom application.

Overview

The V-LFP 48V100Ah back-up lithium iron phosphate battery system is developed for backup of Telecom equipment. Under normal condition, grid AC power supply to rectifier module and the Telecom loads and charge battery pack; When the AC power fail, rectifier module stop power supply, the battery serves for Telecom equipment, to ensure the Telecom equipment runs normally; when the AC power is switched on again, power rectifier module for Telecom equipment recover to while charge the battery pack.

Features

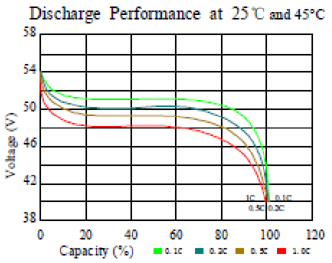
- RS485/RS232 communication output for monitoring
- Built-in BMS with Charging current limitation
- Built-in automatic protection for over-charge, over-discharge and over-temperature conditions
- State of charge and state of health indication
- Built-in battery control for efficient operation
- Internal cell balancing
- Compatible with standard Telecom rectifiers
- Maintenance free

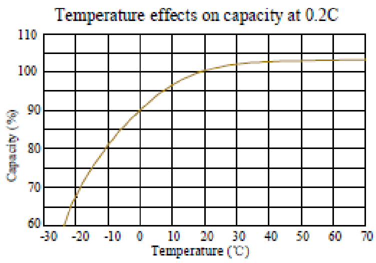
Specifications		V-LFP48100
Voltage		48 V
Nominal Capacity (40°C , 0.5C)		100 Ah
Weight (Approximate)		43.0±0.3Kg
Energy	Normal energy (40°C , 0.5C)	5120 Wh
	Volumetric energy density	153Wh/L
	Gravimetric energy density	119Wh/kg
Dimensions (W*D*H)	Width*Depth* Height	442mm*425mm*178mm
Impedance	(Max, at 1000Hz.)	<30mΩ
Standard Discharge 25°C	Max. constant current	100A
	Cut-off voltage	43.2V
Standard charge 25℃	Charge Voltage	56V
	Max. constant current	100A
	Recommended charging current and time	30A(0.3C) for 3.5 hours
Round trip efficiency(%)		＞98%
Calendar life	25℃	＞10 years
Cycle life (0.2C, 25℃)		80% DOD 4000 cycles
Recommend operating temperature		Charging: 0℃~60℃
		Discharging: -20℃~60℃
Recommend storage temperature		Recommended range: 0℃~55℃

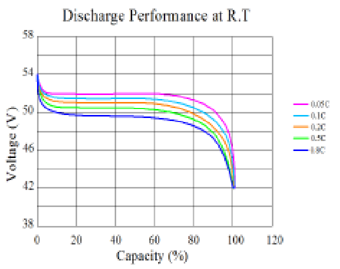
BMS Parameters.

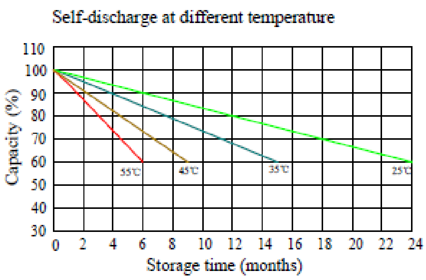
NO.	Type		Function	Setting value V-LFP48100 48V100Ah	Remarks
1	Voltage	Charge	Cell Voltage Protection	3.90V Protection	Recover at 3.6V
2			Total Voltage Protection	60.0V Protection	Recover at 54.0V
3		Discharge	Cell Voltage Protection	2.5V Protection	Recover at 3.1V
4			Total Voltage Protection	43.2V Protection	Recover at 48.0V
5	Current	charge	Normal	≤100A	
6		Discharge	Normal	≤100A	
7			Over Current Protection 1	＞100A and ＜150A	Delay 30s ,recovery in every 60s
			Over Current Protection 2	＞150A and ＜200A	Delay 3s ,recovery in every 60s
8			Short Circuit Protection	≥200A	Delay 1mS
9	Temp	Cell Temp 1	Low temp protection	Charging ＜ 0℃ Discharging ＜-20℃	Delay 1~2S
10		Cell Temp 2	High temp protection	Charging ＞70℃ Discharging ＞75℃	Delay 1~2S
11		PCB	Range	≥95℃	Recovery at 75℃
12	Cell Balance	Balance	Make all cells be balance during charging process. Current: 150mA	$V_{Max.}$≥3.40V and $V_{Max.}$-V_{Min}≥40mV, Start balance	All cell voltages≤3.65V and $V_{Max.}$ - V_{Min}≤40mV, Stop balance

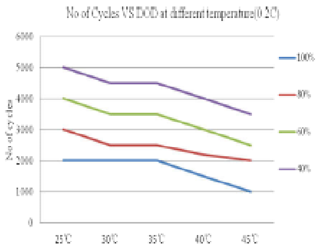
Performance Curve.











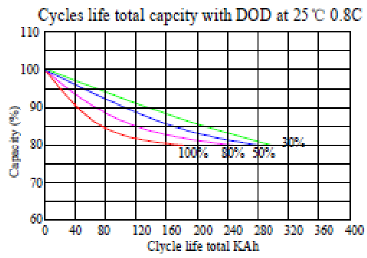


Table A.10. Inverter Catalogue (InfiniSolar Plus II 3kW)

MODEL	InfiniSolar Plus II 3KW
Phase	Single phase in / Single phase out
Maximum PV Input Power	4500 W
Rated Output Power	3000 W
Maximum Charging Power	2880 W
GRID-TIE OPERATION	
PV INPUT (DC)	
Nominal DC Voltage / Maximum DC Voltage	360 VDC / 500 VDC
Start-up Voltage / Initial Feeding Voltage	116 VDC / 150 VDC
MPP Voltage Range	280 VDC ~ 450 VDC
Number of MPP Trackers / Maximum Input Current	1 / 1 x 18 A
GRID OUTPUT (AC)	
Nominal Output Voltage	208/220/230/240 VAC
Output Voltage Range	184-265 VAC*
Nominal Output Current	13 A
Power Factor	> 0.99
EFFICIENCY	
Maximum Conversion Efficiency (DC/AC)	96%
European Efficiency@ Vnominal	95%
OFF-GRID OPERATION	
AC INPUT	
AC Start-up Voltage / Auto Restart Voltage	120-140 VAC / 180 VAC
Acceptable Input Voltage Range	170-280 VAC
Maximum AC Input Current	30 A
PV INPUT (DC)	
Maximum DC Voltage	500 VDC
MPP Voltage Range	250 VDC ~ 450 VDC
Number of MPP Trackers / Maximum Input Current	1 / 1 x 18 A
BATTERY MODE OUTPUT (AC)	
Nominal Output Voltage	208/220/230/240 VAC
Output Waveform	Pure sine wave
Efficiency (DC to AC)	93%
HYBRID OPERATION	
PV INPUT (DC)	
Nominal DC Voltage / Maximum DC Voltage	360 VDC / 500 VDC
Start-up Voltage / Initial Feeding Voltage	116 VDC / 150 VDC
MPP Voltage Range	250 VDC ~ 450 VDC
Number of MPP Trackers / Maximum Input Current	1 / 1 x 18 A
GRID OUTPUT (AC)	
Nominal Output Voltage	208/220/230/240 VAC
Output Voltage Range	184-265 VAC*
Nominal Output Current	13 A
AC INPUT	
AC Start-up Voltage / Auto Restart Voltage	120-140 VAC / 180 VAC
Acceptable Input Voltage Range	170-280 VAC
Maximum AC Input Current	30A
BATTERY MODE OUTPUT (AC)	
Nominal Output Voltage	208/220/230/240 VAC
Efficiency (DC to AC)	93%
BATTERY & CHARGER	
Nominal DC Voltage	48 VDC
Maximum Charging Current	Default 25 A, 5A - 60A (Adjustable)
GENERAL	
PHYSICAL	
Dimension, D x W x H (mm)	107x 438 x 480
Net Weight (kgs)	15.5
INTERACE	
Communication Port	RS-232/USB
Intelligent Slot	Optional SNMP, Modbus and AS-400 cards available
ENVIRONMENT	
Humidity	0 ~ 90% RH (Non-condensing)
Operating Temperature	0 to 40°C
Altitude	0 ~ 1000 m**

8.1. Codes

Main Code

```
clear
close all
format short
clc

%% Input Constant Values
i=1:8784;    % Hours && 366*24=8784 (h)
T_in=20;     % Inside Temperature (Celcius)
BPc=20;      % Battery Power Capacity (kWh)
BP=0;        % Considering we have empty battery at
beginnnig
PS=12;       % Panel Size (m^2) (6panel*2m2)
Ep=15/100;   % Efficiency of Panel

%% Temperature Data Input
T_out=xlsread('DataYearly.xlsx','B:B'); % Outside
Temperature (Celcius)
delta_T=abs(T_out-T_in);                % Change in
Temperature Absolute
d_T= T_out-T_in;                        % Change in
Temperature

%% Solar Irradiation (GHI) Data Input
GHI_Ned=xlsread('DataYearly.xlsx','C:C'); %Global
Horizontal Irradiation for Netherlands(W/m^2)
GHI=1.25.*GHI_Ned;                        %Global
Horizontal Irradiation for Turkey/Istanbul(W/m^2)

%% Areas and U-Values of House System
% Wall 1&2
A_wall12=28;       % Surface Area (a_wall-a_windows)(m^2)
U_wall=0.53;       % Heat Transfer Coefficient of Wall
(W/m2K)
% Wall 3&4
A_wall34=40.26;    % Surface Area (a_wall-a_doors)(m^2)
U_wall=0.53;       % Heat Transfer Coefficient of Wall
(W/m2K)
% Windows
A3=2.37;           % Surface Area (m^2)
U_win=2.1;         % Heat Transfer Coefficient of Window
(W/m2K)
% Exterior Door
A_door=2;          % Surface Area (m^2)
U_ed=1.5;          % Heat Transfer Coefficient of Exterior
Door (W/m2K)
```

```
% Garden Door
A_door=2;           % Surface Area (m^2)
U_gd=1.8;           % Heat Transfer Coefficient of Garden
Door (W/m2K)
% Ceiling
A5=150;             % Surface Area (m^2)
U_ceiling=0.35;     % Heat Transfer Coefficient of Ceiling
(W/m2K)
% Ground
A6=150;             % Surface Area (m^2)
U_ground=0.3;       % Heat Transfer Coefficient of Ground
(W/m2K)

%% Heat Transfer Rate Calculations
Q_w12=A_wall12*U_wall*delta_T; % Heat Transfer Rate of Wall
1&2 (Watt)
Q_w34=A_wall34*U_wall*delta_T; % Heat Transfer Rate of Wall
3&4 (Watt)
Q_win=A3*U_win*delta_T;        % Heat Transfer Rate of
Windows (Watt)
Q_ed=A_door*U_ed*delta_T;      % Heat Transfer Rate of
Exterior Door (Watt)
Q_gd=A_door*U_ed*delta_T;      % Heat Transfer Rate of
Garden Door (Watt)
Q_ce=A5*U_ceiling*delta_T;     % Heat Transfer Rate of
Ceiling (Watt)
Q_gr=A6*U_ground*delta_T;      % Heat Transfer Rate of
Ground (Watt)
% Total
Qh=(2*Q_w12+2*Q_w34+Q_ce+Q_gr+4*Q_win+Q_ed+Q_gd)./10^3; %
Heat Transfer Rate of House System (k-Watt)

%% COP Selection Distributed by Outside Temperature
for x=1:1:length(T_out)
    if T_out(x)>=-7 && T_out(x)<2      % CoP value(3.06)
when outside temperature between -7C to 2C
      COPt(x)=3.06;
    elseif T_out(x)>=2 && T_out(x)<7   % CoP value(3.97)
when outside temperature between 2C to 7C
      COPt(x)=3.97;
    elseif T_out(x)>=7 && T_out(x)<12 % CoP value(4.63)
when outside temperature between 7C to 12C
      COPt(x)=4.63;
    else
      COPt(x)=4.86;                    % CoP value(4.86)
when outside temperature bigger than 12C
    end
end
```

```
COP=transpose(COPt);                      % Coefficient of
Performance

%% Electric Demand Calculations
Edemand=Qh./COP; % Hourly Electric Demand (kW)

%% Electrical Energy Generation Calculations
Egen_cap=GHI.*PS;                   % Electric Generation
Potential (without efficiency)(W)
EoT=(-0.38.*T_out+109.5)./100;  % Effect of Temperature on
Panel Efficiency
Egen_net_W=(Egen_cap.*Ep).*EoT; % Net Electric Generation
(W)
Egen_net=Egen_net_W./10^3;      % Net Electric Generation
(kW)

%% Net Energy Calculation
Enet=[Egen_net - Edemand]; %Net Electric= Electric
Generation - Electric Demand (kW)

%% Battery, Egrid and Utility Power Calculations
for a=1:1:length(Enet)
if Enet(a)>=0
    UPt(a)=0;
    if BPc> BP+Enet(a)     %Scenario 1 ; Net Electric is
positive & battery is not full.
        BP=BP+Enet(a);     %Result = Store excess energy. Do
not use Utility power.
        BPtable(a,:)=[BP];
        E_gridt(a)=0;      %Electricity Sold to the Grid
    else                   %Scenario 2 ; Net Electric is
positive & battery is full.
        BP=BP;             %Result= Do not Store Energy. Do
not use Utility power.
        BPtable(a,:)=[BP];
        E_gridt(a)=Enet(a);%Electricity Sold to the Grid
    end
elseif BP-(-Enet(a))>0     %Scenario 3 ; Net Electric is
negatif & battery is sufficient.
    UPt(a)=0;              %Result= Use Battery Power. Do
not use Utility Power
    BP=BP-(-Enet(a));
    BPtable(a,:)=[BP];
    E_gridt(a)=0;          %Electricity Sold to the Grid
else                       %Scenario 4 ; Net Electric is
negatif & battery is not sufficient.
    UPt(a)=-Enet(a);       %Result= Use Utility Power
    BP=BP;
    BPtable(a,:)=[BP];
```

```
    E_gridt(a)=0;          %Electricity Sold to the Grid
end
end
UP=transpose(UPt);         %Utility Power
E_grid=transpose(E_gridt);%Electricity Sold to the Grid


%% OUTPUTS
%The actual working loop of our simulation is completed
above.
%Now we will write the codes to see the outputs which we
prefer to see.


%% Monthly Total Heat Transfer (to keep constant Tin=20
Celcius)
Qt_jan= sum(Qh([1:744],:));        % January (kWh)
Qt_feb= sum(Qh([745:1440],:));     % February (kWh)
Qt_mar= sum(Qh([1441:2184],:));    % March (kWh)
Qt_apr= sum(Qh([2185:2904],:));    % April (kWh)
Qt_may= sum(Qh([2905:3648],:));    % May (kWh)
Qt_jun= sum(Qh([3649:4368],:));    % June (kWh)
Qt_jul= sum(Qh([4369:5112],:));    % July (kWh)
Qt_aug= sum(Qh([5113:5856],:));    % August (kWh)
Qt_sep= sum(Qh([5857:6576],:));    % September (kWh)
Qt_oct= sum(Qh([6577:7320],:));    % October (kWh)
Qt_nov= sum(Qh([7321:8040],:));    % November (kWh)
Qt_dec= sum(Qh([8041:8784],:));    % December (kWh)
Qm=[Qt_jan;Qt_feb;Qt_mar;Qt_apr;Qt_may;Qt_jun;Qt_jul;Qt_aug
;Qt_sep;Qt_oct;Qt_nov;Qt_dec];
%Seasons
Qt_win= sum(Qh([8041:8784],:)); + sum(Qh([1:1440],:)); %
Winter total
Qt_spr= sum(Qh([1441:3648],:));     % Spring total
Qt_sum= sum(Qh([3649:5856],:));     % Summer total
Qt_fll= sum(Qh([5857:8040],:));     % Fall total
Qs=[Qt_win;Qt_spr;Qt_sum;Qt_fll];

%% Total Heat Transfer for a Year
Qt=sum(Qh);   %kWh

%% Daily / Hourly Average Amount of Heat Transfer
avg_Qt_day=Qt/366; % Daily (kWh)
avg_Qt_hour= Qt/8784; % Hourly (kWh)

%% Heat Transfer Data (Distributed for Cooling & Heating)
Q_w12d=A_wall12*U_wall*d_T; % Heat Transfer Rate of Wall
1&2 (Watt)
```

```
Q_w34d=A_wall34*U_wall*d_T; % Heat Transfer Rate of Wall
3&4 (Watt)
Q_wind=A3*U_win*d_T;        % Heat Transfer Rate of Windows
(Watt)
Q_edd=A_door*U_ed*d_T;      % Heat Transfer Rate of
Exterior Door (Watt)
Q_gdd=A_door*U_ed*d_T;      % Heat Transfer Rate of Garden
Door (Watt)
Q_ced=A5*U_ceiling*d_T;     % Heat Transfer Rate of Ceiling
(Watt)
Q_grd=A6*U_ground*d_T;      % Heat Transfer Rate of Ground
(Watt)

% Total
Qhd=(2*Q_w12d+2*Q_w34d+Q_ced+Q_grd+4*Q_wind+Q_edd+Q_gdd)./1
0^3; % Heat Transfer Rate of House System (k-Watt)

% Cooling Total Yearly
h_cool=find(Qhd>=0);           % Cooling hours
Qhd_cooling=Qhd(h_cool);       % Cooling Heat Transfer Rate
Qtd_cooling=sum(Qhd_cooling);  % Total Heat Transfer Used
for Cooling

% Heating Total Yearly
h_heat=find(Qhd<0);            % Heating hours
Qhd_heating=Qhd(h_heat);       % Heating Heat Transfer Rate
Qtd_heating=sum(Qhd_heating);  % Total Heat Transfer Used
for Heating

%% Total Utility Power Usage
UP_total=sum(UP); % Total Utility Power Used (kWh)

%% Electric Outputs
Edemand_total=sum(Edemand);          % Total Electric
Demand
Egen_net_total=sum(Egen_net);        % Total Electric
Generation
Enet_total=sum(Enet);                % Total Net Electric
Egrid_total= sum(E_grid);            % Total Sold Electric
Eheat=Egen_net_total-Egrid_total;    % Total Energy Used to
Heat/Cool the Building

%Seasons for Enet
Enet_win= sum(Enet([8041:8784],:)); +
sum(Enet([1:1440],:)); % Winter total
Enet_spr= sum(Enet([1441:3648],:));   % Spring total
Enet_sum= sum(Enet([3649:5856],:));   % Summer total
Enet_fll= sum(Enet([5857:8040],:));   % Fall total
```

```
%% Hottest Day of Year Details
%Hottest day of year is 21.07.2020
Tavg_hot=sum(T_out([4849:4872],:))/24;          %Average
Temperature
Qt_hot= sum(Qh([4849:4872],:));                 %Total Heat
Transfer
Qh_hot= Qh([4849:4872],:);                      %Heat
Transfer

Enet_hot= Enet([4849:4872],:);                  %Net Electric
Energy
Et_net_hot= sum(Enet([4849:4872],:));           %Total Net
Electric Energy
Edemand_hot= Edemand([4849:4872],:);            %Electric
Demand
Et_demand_hot= sum(Edemand([4849:4872],:));     %Total
Electric Demand
Egen_net_hot= Egen_net([4849:4872],:);          %Electric
Generation
Et_gen_net_hot= sum(Egen_net([4849:4872],:)); %Total
Electric Generation

%% Coldest Day of Year Details
%Coldest day of year is 19.12.2020
Tavg_cold=sum(T_out([8473:8496],:))/24;          %Average
Temperature
Qt_cold= sum(Qh([8473:8496],:));                 %Total Heat
Transfer
Qh_cold= Qh([8473:8496],:);                      %Heat
Transfer

Enet_cold= Enet([8473:8496],:);                  %Net
Electric Energy
Et_net_cold= sum(Enet([8473:8496],:));           %Total Net
Electric Energy
Edemand_cold= Edemand([8473:8496],:);            %Electric
Demand
Et_demand_cold= sum(Edemand([8473:8496],:));     %Total
Electric Demand
Egen_net_cold= Egen_net([8473:8496],:);          %Electric
Generation
Et_gen_net_cold= sum(Egen_net([8473:8496],:)); %Total
Electric Generation

%% Plots

%% Outside Temperature Plot
T_out_plot=plot(i,T_out);
title('Outside Temperature for each hour (C)')
```

```
xlabel('Hours (h)')
ylabel('Outside Temperature (C)')
xlim([1 8784])
%% GHI Plot
GHI_plot=plot(i,GHI);
title('Amount of Global Horizontal Irradiance for each hour
(Wh/m^2)')
xlabel('Hours (h)')
ylabel('GHI (W/m^2)')
xlim([1 8784])
%% Difference Inside and Outside Temperatures
d_T_plot=plot(i,d_T);
title('Difference Inside and Outside Temperatures for each
hour (C)')
xlabel('Hours (h)')
ylabel('Difference Inside and  Outside Temperatures (C)')
xlim([1 8784])
%% Absolute Heat Transfer Plot
Qh_hourly_graph=plot(i,Qh);
title('Heat Transfer for each hour(abs)(kWh)')
xlabel('Hours (h)')
ylabel('Heat Transfer (kW)')
xlim([1 8784])
%% Heat Transfer Plot
Qhd_hourly_graph=plot(i,Qhd);
title('Heat Transfer for each hour (kWh)')
xlabel('Hours (h)')
ylabel('Heat Transfer (kW)')
xlim([1 8784])
%% Monthly Heat Transfer Plot
Qhd_monthly_graph=bar(1:12,Qm);
title('Heat Transfer Total for Each Month (kWh)')
xlabel('Hours (h)')
ylabel('Heat Transfer (kW)')

%% Seasonly Heat Transfer Plot
Qhd_seasonly_graph=bar(1:4,Qs);
title('Heat Transfer Total for Each Season (kWh)')
xlabel('Hours (h)')
ylabel('Heat Transfer (kW)')
%% COP Value
Qhd_seasonly_graph=plot(i,COP);
title('CoP Value for Each Hour (kWh)')
xlabel('Hours (h)')
ylabel('CoP Value')
xlim([1 8784])
%% Battery Power Plot
BP_graph=plot(BPtable);
title('Battery Energy Change for Each Hour (kWh)')
```

```
xlabel('Hours (h)')
ylabel ('Battery Energy (kW)')
xlim([1 8784])
%% Utility Power Plot
plot(UP);
title('Utility Power Usage for each hour (kWh)')
xlabel('Hours (h)')
ylabel ('Utility Power (kW)')
xlim([1 8784])
%% Hottest day's Heat Transfer
Qh_hot_plot=plot(Qh([4849:4872],:));
title('Amount of Heat Transfer in Hottest Day (July21)
(kWh)')
xlabel('Hours (h)')
ylabel('Heat Transfer (kW)')
xlim([1 24])
%% Hottest day's Electric Details
plot(1:24,Enet_hot);
title('Electric Details in Hottest Day (kWh)')
xlabel('Hours (h)')
ylabel('Electric Power (kW)')
hold on
plot(1:24,Edemand_hot)
plot(1:24,Egen_net_hot)
hold off
legend('Enet','Edemand','Egen')
xlim([1 24])
%% Coldest day's Heat Transfer
Qh_cold_plot=plot(Qh([8473:8496],:));
title('Amount of Heat Transfer in Coldest Day (kWh)')
xlabel('Hours (h)')
ylabel('Heat Transfer (kW)')
xlim([1 24])
%% Coldest day's Electric Details
plot(1:24,Enet_cold);
title('Electric Details in Coldest Day (kWh)')
xlabel('Hours (h)')
ylabel('Electric Power (kW)')
hold on
plot(1:24,Edemand_cold)
plot(1:24,Egen_net_cold)
hold off
legend('Enet','Edemand','Egen')
xlim([1 24])
%% Total Electric Situation Plot
Eplot=[Edemand_total;Egen_net_total;Enet_total;Egrid_total;
Eheat];
Definition=[1;2;3;4;5];
bar(Definition,Eplot,'DisplayName','Eplot')
```

```
title('Distribution of Electrical Energy Types')
xlabel('Edemand,Egen,Enet,Egrid,Eheat')
ylabel('Electricity (kWh)')
%% Electric Plot
subplot(4,1,3)
Enet_graph=plot(i,Enet);
title('Net Electric for Year (kWh)')
xlabel('Hours (h)')
ylabel('(kW)')
xlim([1 8784])
subplot(4,1,2)
plot(i,Edemand)
title('Electric Demand for Year (kWh)')
xlabel('Hours (h)')
ylabel('(kW)')
xlim([1 8784])
subplot(4,1,1)
plot(i,Egen_net)
title('Electric Generation for Year (kWh)')
xlabel('Hours (h)')
ylabel('(kW)')
xlim([1 8784])
subplot(4,1,4)
plot(i,E_grid)
title('Electric Sold to Grid for Year (kWh)')
xlabel('Hours (h)')
ylabel('(kW)')
xlim([1 8784])
```

Battery Parameter Code

```
%% This code should be run without using any "clear"
command after running code "thesis.m".
% We simulated our system we chose at "thesis.m". (12 m2
Panel & 20 kWh battery)
% We will examine what kind of output we would get if we
use different battery capacities


%% Battery Capacity Change While Solar Panel Size is
Constant
for BPc=10:10:30
for a=1:1:length(Enet)
if Enet(a)>=0
    UPt(a)=0;
    if BPc> BP+Enet(a)     %Scenario 1 ; Net Electric is
positive & battery is not full.
```

```
        BP=BP+Enet(a);     %Result = Store excess energy. Do
not use Utility power.
        BPtable(a,:)=[BP];
    else                   %Scenario 2 ; Net Electric is
positive & battery is full.
        BP=BP;             %Result= Do not Store Energy. Do
not use Utility power.
        BPtable(a,:)=[BP];
    end
elseif BP-(-Enet(a))>0     %Scenario 3 ; Net Electric is
negatif & battery is sufficient.
    UPt(a)=0;              %Result= Use Battery Power. Do
not use Utility Power
    BP=BP-(-Enet(a));
    BPtable(a,:)=[BP];
else                       %Scenario 4 ; Net Electric is
negatif & battery is not sufficient.
    UPt(a)=-Enet(a);       %Result= Use Utility Power
    BP=BP;
    BPtable(a,:)=[BP];
end
end
UP(:,BPc)=transpose(UPt);

end

%% Total Utility Power
UP10=sum(UP(:,10));        %Total Utility Power Usage When
Battery Cap. is 10 kWh
UP20=sum(UP(:,20));        %Total Utility Power Usage When
Battery Cap. is 20 kWh
UP30=sum(UP(:,30));        %Total Utility Power Usage When
Battery Cap. is 30 kWh
UPplot=[UP10;UP20;UP30];
Capacity=[10;20;30];
bar(Capacity,UPplot,'DisplayName','UPplot')
title('Total Utility Power Usage for 10-20-30 kwh Battery
Capacity (kWh)')
xlabel('Battery Capacity (kWh)')
ylabel('Total Utility Power (kWh)')
%% Battery Plot
BP_graph=plot(BPtable);
title('Battery Energy Change for Each Hour (kWh)')
xlabel('Hours (h)')
ylabel ('Battery Energy (kW)')
xlim([1 8784])
%% Subplot for Utility Power
subplot(3,1,1)
plot(i,UP(:,10));
```

```
title('Utility Power for 10 kWh Battery Capacity (kWh)')
xlabel('Hours (h)')
ylabel('Utility Power (kW)')
subplot(3,1,2)
plot(i,UP(:,20));
title('Utility Power for 20 kWh Battery Capacity (kWh)')
xlabel('Hours (h)')
ylabel('Utility Power (kW)')
subplot(3,1,3)
plot(i,UP(:,30));
title('Utility Power for 30 kWh Battery Capacity (kWh)')
xlabel('Hours (h)')
ylabel('Utility Power (kW)')

%COUTION! Do not forget the clear battery parameter, before
passing to the panel parameter
```

Solar Panel Parameter Code

```
%% This code should be run without using any "clear"
command after running code "thesis.m".
% We simulated our system we chose at "thesis.m". (12 m2
Panel & 20 kWh battery)
% We will examine what kind of output we would get if we
use different number of panels

for PS=12:4:20
    if PS==12
        PS=12;
Egen_cap12=GHI.*PS;                   % Electric Generation
Potantial (without efficiency)(W)
Egen_net_W12=(Egen_cap12.*Ep).*EoT; % Net Electric
Generation (W)
Egen_net12=Egen_net_W12./10^3;       % Net Electric
Generation (kW)

% Net Energy Calculation
Enet12=[Egen_net12 - Edemand];       %Net Electric= Electric
Generation - Electric Demand (kW)

% Battery and Utility Power Calculations
for a=1:1:length(Enet12)
if Enet12(a)>=0
    UPt12(a)=0;
    if BPc> BP+Enet12(a)     %Scenario 1 ; Net Electric is
positive & battery is not full.
        BP=BP+Enet12(a);     %Result = Store excess energy.
Do not use Utility power.
```

```
        BPtable12(a,:)=[BP];
        E_gridt12(a)=0;
    else                        %Scenario 2 ; Net Electric is
positive & battery is full.
        BP=BP;                  %Result= Do not Store Energy.
Do not use Utility power.
        BPtable12(a,:)=[BP];
        E_gridt12(a)=Enet(a);
    end
elseif BP-(-Enet12(a))>0        %Scenario 3 ; Net Electric is
negatif & battery is sufficient.
    UPt12(a)=0;                 %Result= Use Battery Power. Do
not use Utility Power
    BP=BP-(-Enet12(a));
    BPtable12(a,:)=[BP];
    E_gridt12(a)=0;
else                            %Scenario 4 ; Net Electric is
negatif & battery is not sufficient.
    UPt12(a)=-Enet12(a);        %Result= Use Utility Power
    BP=BP;
    BPtable12(a,:)=[BP];
    E_gridt12(a)=0;
end
end
UP12=transpose(UPt12);           %Utility Power
E_grid12=transpose(E_gridt12);%Electricity Sold to the Grid
    elseif PS==16;
        PS=16;
Egen_cap16=GHI.*PS;                     % Electric Generation
Potantial (without efficiency)(W)
Egen_net_W16=(Egen_cap16.*Ep).*EoT; % Net Electric
Generation (W)
Egen_net16=Egen_net_W16./10^3;          % Net Electric
Generation (kW)

% Net Energy Calculation
Enet16=[Egen_net16 - Edemand];          %Net Electric= Electric
Generation - Electric Demand (kW)

% Battery and Utility Power Calculations
for a=1:1:length(Enet16)
if Enet16(a)>=0
    UPt16(a)=0;
    if BPc> BP+Enet16(a)        %Scenario 1 ; Net Electric is
positive & battery is not full.
        BP=BP+Enet16(a);        %Result = Store excess energy.
Do not use Utility power.
        BPtable16(a,:)=[BP];
        E_gridt16(a)=0;
```

```
    else                    %Scenario 2 ; Net Electric is
positive & battery is full.
        BP=BP;              %Result= Do not Store Energy.
Do not use Utility power.
        BPtable16(a,:)=[BP];
        E_gridt16(a)=Enet(a);
    end
elseif BP-(-Enet16(a))>0    %Scenario 3 ; Net Electric is
negatif & battery is sufficient.
    UPt16(a)=0;             %Result= Use Battery Power. Do
not use Utility Power
    BP=BP-(-Enet16(a));
    BPtable16(a,:)=[BP];
    E_gridt16(a)=0;
else                        %Scenario 4 ; Net Electric is
negatif & battery is not sufficient.
    UPt16(a)=-Enet16(a);    %Result= Use Utility Power
    BP=BP;
    BPtable16(a,:)=[BP];
    E_gridt16(a)=0;
end
end
UP16=transpose(UPt16);        %Utility Power
E_grid16=transpose(E_gridt16);%Electricity Sold to the Grid
    else PS==20;
        PS=20;
Egen_cap20=GHI.*PS;                 % Electric Generation
Potantial (without efficiency)(W)
Egen_net_W20=(Egen_cap20.*Ep).*EoT; % Net Electric
Generation (W)
Egen_net20=Egen_net_W20./10^3;      % Net Electric
Generation (kW)

% Net Energy Calculation
Enet20=[Egen_net20 - Edemand];      %Net Electric= Electric
Generation - Electric Demand (kW)

% Battery and Utility Power Calculations
for a=1:1:length(Enet20)
if Enet20(a)>=0
    UPt20(a)=0;
    if BPc> BP+Enet20(a)    %Scenario 1 ; Net Electric is
positive & battery is not full.
        BP=BP+Enet20(a);    %Result = Store excess energy.
Do not use Utility power.
        BPtable20(a,:)=[BP];
        E_gridt20(a)=0;
    else                    %Scenario 2 ; Net Electric is
positive & battery is full.
```

```
        BP=BP;                %Result= Do not Store Energy.
Do not use Utility power.
        BPtable20(a,:)=[BP];
        E_gridt20(a)=Enet(a);
    end
elseif BP-(-Enet20(a))>0     %Scenario 3 ; Net Electric is
negatif & battery is sufficient.
    UPt20(a)=0;               %Result= Use Battery Power. Do
not use Utility Power
    BP=BP-(-Enet20(a));
    BPtable20(a,:)=[BP];
    E_gridt20(a)=0;
else                          %Scenario 4 ; Net Electric is
negatif & battery is not sufficient.
    UPt20(a)=-Enet20(a);      %Result= Use Utility Power
    BP=BP;
    BPtable20(a,:)=[BP];
    E_gridt20(a)=0;
end
end
UP20=transpose(UPt20);          %Utility Power
E_grid20=transpose(E_gridt20);%Electricity Sold to the Grid
    end
end

%Utility Power
UPP=[UP,UP12,UP16,UP20];
UPP12_total=sum(UP12);
UPP16_total=sum(UP16);
UPP20_total=sum(UP20);
Egen_net12_total=sum(Egen_net12);
Egen_net16_total=sum(Egen_net16);
Egen_net20_total=sum(Egen_net20);
E_gridP=[E_grid,E_grid12,E_grid16,E_grid20];
Egen_netP=[Egen_net,Egen_net12,Egen_net16,Egen_net20];
%% Outputs
% Total Utility Power
UPPt=[UP_total;UPP16_total;UPP20_total];
bar(UPPt)
title('Total Utility Power Usage for 12-16-20 Solar Panel
(kWh)')
xlabel('Panel Number (12-16-20)(pcs)')
ylabel('Total Utility Power(kWh)')

%% Energy Generation Parameter
figure
Eplot=[Edemand_total;Egen_net_total;Egen_net16_total;Egen_n
et20_total;];
bar(1:1:4,Eplot,'DisplayName','Eplot')
```

```
title('Distribution of Electric Generation (kWh)')
xlabel('Edemand,Egen12,Egen16,Egen20')
ylabel('Electricity (kWh)')
%% Energy Usage for Heat/Cool
figure
EheatP=[Egen_netP-E_gridP];
EheatP_total=sum(EheatP);
Eplot=[Edemand_total,EheatP_total(:,2),EheatP_total(:,3),Eh
eatP_total(:,4)];
bar(1:1:4,Eplot,'DisplayName','Eplot')
title('Distribution of Energy Usage for Heat/Cool (kWh)')
xlabel('Edemand,Eheat6,Eheat8,Eheat10')
ylabel('Electricity (kWh)')

%COUTION! Do not forget the clear number of panel
parameter, before passing to the battery parameter
```