A Financial Cost-effectiveness Analysis of Power Generation with PV Panels in the TRNC

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ABSTRACT

The supplying of electricity services is one of the most critical topics in the Turkish Republic of Northern Cyprus (TRNC). People residing in this area have a very high electric cost on the electricity service due to oil price fluctuations and inefficient technology and AKSA agreement is one of the most important reasons.. In this study, we will analyze and compare the feasibility between PV panels and alternative technology to find superior saving technology. To this aim, this study is utilizing data from the Cyprus Turkish Electrical Institution (KIB-TEK) and AKSA Power Generation.

This research aims to compare the alternative technology to produce electricity and solar panel to produce 70 MW of electricity capacity per year by expecting an increase of 5 MW per year with solar panels and to analyze whether it is more feasible to generate electricity with PV panels compared to alternative technology. This analysis has been calculated for 25 years by analyzing sensitivity to different parameters.

In this study, we are looking at which method (solar or current technology) is the most cost-effective. Also, we perform a sensitivity risk analysis to determine which parameters affect our results other than the base case and if it is possible to take precautions beforehand. From that, we are using the results to find break-even fuel prices for 1 KW solar capacity. Afterward, we are using those results to find annual 70 MW solar panel capacities by expecting an increase in solar panels capacity by 5

MW yearly for ten years. However, we are just looking at the maintenance rate and fuel cost because renewable solar energy is replacing them.

Keywords: Cost-effectiveness Analysis; Electrical Services; PV panel Project; Sensitivity Analysis; Turkish Republic of Northern Cyprus; Cyprus Turkish Electrical Authority.

ÖZ

Elektrik hizmetlerinin temini, Kuzey Kıbrıs Türk Cumhuriyeti'nde (KKTC) en kritik konulardan biridir. Bu bölgede ikamet eden kişiler, petrol fiyatlarındaki dalgalanmalar ve verimsiz teknoloji nedeniyle elektrik hizmetinde çok yüksek bir elektrik maliyetine sahiptir ve AKSA anlaşması en önemli nedenlerden biridir. Bu çalışmada, PV paneller ve üstün tasarruf teknolojisini bulmak için alternatif teknoloji. Bu amaçla, bu çalışmada Kıbrıs Türk Elektrik Kurumu (KIB-TEK) ve AKSA Jeneratör'ün verileri kullanılmıştır.

Bu araştırma, güneş panelleri ile yılda 5 MW artış bekleyerek, güneş paneliyile 70 MW elektrik kapasitesi üretmek için ve alternatif teknolojiyile elektrik üretmek için karşılaştırmayı ve PV panellerle elektrik üretmenin daha uygulanabilir olup olmadığını analiz etmeyi amaçlamaktadır. alternatif teknolojiye. Bu analiz, farklı parametrelere duyarlılık analiz edilerek 25 yıl boyunca hesaplanmıştır.

Bu çalışmada, hangi yöntemin (güneş enerjisi veya akım teknolojisi) en uygun maliyetli olduğuna bakıyoruz. ayrıca, baz durum dışında hangi parametrelerin sonuçlarımızı etkilediğini ve önceden önlem almanın mümkün olup olmadığını belirlemek için duyarlılık risk analizi yapıyoruz. Buradan çıkan sonuçları 1 KW güneş enerjisi kapasitesi için başa baş yakıt fiyatlarını bulmak için kullanıyoruz. Daha sonra bu sonuçları, on yıl boyunca güneş paneli kapasitesinin yılda 5 MW artmasını bekleyerek yıllık 70 MW güneş paneli kapasitesini bulmak için kullanıyoruz. Ancak, sadece bakım oranına ve yakıt maliyetine bakıyoruz çünkü yenilenebilir güneş enerjisi bunların yerini alıyor.

Anahtar Kelimeler: Maliyet-etkililik Analizi; Elektrik Hizmetleri; PV panel Projesi; Duyarlılık analizi; Kuzey Kıbrıs Türk Cumhuriyeti; Kıbrıs Türk Elektrik Kurumu.

DEDICATION

To my lovely parents

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A	Total Solar Panel Area m2
BIPV	Building-integrated photovoltaic
E	Energy for Kilowatt per Hour
EAC	Cyprus Electricity Authority
H	Yearly Average Solar Radiation in Inclined Panels
KW	Kilowatt
LCOE	Levelized cost of energy
MW	Megawatt
NIA	Nuclear Industry Association
PR	Performance Rate
PV	photovoltaic
R	Solar Panel Output or Capacity
S.T	Steam Turbine
T.D	Teknecik Diesel
TRNC	Turkish Republic of Northern Cyprus

Chapter 1

INTRODUCTION

1.1 Background to the Study

Energy is life; it is more than a power source. It is a statement about the development and economic growth of a commonwealth's energy production. An efficient and powerful power sector stimulates economic development and enhances the living conditions of citizens as well as improving workforce productivity. As a result of its efficient, the mean revenue equality of the economy raised. In other words, as economic standards improve – along with the living conditions – the necessity for enhanced energy services increases. Several countries face difficulties in regards to the generating of energy, many aims to increase and improve the development to the best of their abilities.

In order to improve social comforts regarding the demands for electricity, information containing statistics on how many megawatts are consumed, the speed, the power of the electrical system and the amount of energy transferred by the state must be supplied. The focus has shifted to the importance of the standard of the energy services and the latest technologies are used to support the renewal of electricity applications and energy management.

The world has many different types of electrical energy sources used to generate power. Although there are many different sources available in which to generate from, thus far none are able to establish great improvement mandatory for enhancement for wellbeing. While dissimilar energy sources are primarily used to produce electricity required operating; heaters, ovens, microwaves, phones, lights and machines. The world relies heavily on such electrical needs, making dissimilar energy a vital source of electrical current. We provide information on dissimilar energy sources, their uses and the potential problems they caused by them below.

Geothermal energy is a form of thermal energy that is formed and stored within the surface of the Earths' crust. It is an example of a renewable energy source as heat continuously formed by the Earths' core is extracted/ released to produce steam which is used to drive the turbines of a power plant in order to generate electricity. Thus geothermal energy is the conversion of a heat source into electricity. It has many uses such as; residential heating, electricity generation, and widely used within industrial applications. Although geothermal energy is an efficient resource, it has resulted in environmental damaged in particular regions of the world.

Hydrogen energy is formed by combining hydrogen and oxygen atoms together to create a battery like energy. This source of energy is widely available throughout the world as it can be generated from water itself. It is commonly used to generate heating, power and electricity. Hydrogen energy is used with fertilizer production, petroleum refining and transportation devices. One of the drawbacks of hydrogen energy is the fact that it requires vast volumes of water to produce it. Because the population increases day by day the demand for electricity increases, thus increasing the consumption of water used to necessity hydrogen energy. A shortage of water would render it as unattainable source of energy.

Fossil fuels can be made of charcoal, petroleum, and natural fuel gas and are considered to be the worlds’ primary power source. However, the use of such resources has a detrimental impact on environment and implicates several environmental aspects. For example, due to the outbreak of the Coronavirus (COVID-19) machines and tools that were running all over the world came to alt. After one month of paused projects, the weather improved by 20%, and the fear of the ozone layer began to subside.

The most important energy source is solar panel energy. It is gathered, obtained and stored by the use of solar panels. Deserts are occupied by large areas filled with solar panels as they have constant sunshine required to facilitate energy demand necessary to heat houses, provide warm water, run refrigerators and additional electricity outlets. One hindrance to the use of solar energy as a main resource is the fact that it relies solely on sunlight to generate energy. Thus the abundance generated is directly implicated by the level of sunlight experience. Thus, countries with long and harsh winters cannot rely on solar energy as a main energy resource.

There are two widely used forms of solar energy, which are photovoltaic energy and solar thermal power energy.

Photovoltaic energy enlists the use of photovoltaic cells, within the solar panel, to absorb light particles from the sun and release electrons, enabling it to generate an electrical current. Thus it is reliant on sunlight to function. Solar thermal panel system, utilization photovoltaic cabinets to store heat power from sunlight. The cabinet do not need fix sunshine in order to operate; already on a clouded day, they can gain create enough electricity to facilitate residential household electrical needs.

Photovoltaic cabins are produced in a semiconductor matter that is laminated; silicon is vastly used within the manufacturing of photovoltaic cabinets. When sunshine hits the cabin an electric area is formed opposite the silicone laminate, the quantity of electricity manufactured is linked to the capacity of the sunlight. The laminate of the Photovoltaic cabins are placed on top of building roofs. Photovoltaic cabins energy is measured in what's common known as "kilowatts peak". The top performing period for photovoltaic cabins, in which generate the most electric energy, is generally the summertime.

To calculate the yearly solar energy production of a photovoltaic system, an international formula which accounts for the approximation of electrical energy produced by a photovoltaic system is used:

Calculation 1: Kilowatt per Hour of Energy

$$E = A * r * H * PR \qquad (1)$$

- E = kilowatt per hour of energy
- A = total solar panel area m
- R = solar panel output or capacity(%)
- H = yearly average solar radiation in inclined panels (shadings not included)
- HR = performance rate, coefficient of damage (between 0.5 and 0.9, defect value = 0.75).

Calculation of the solar PV energy ouput of a photovoltaic system

(yellow)	Yelow cell = enter your own data
(green)	Green cell = result (do not change the value)
(white)	White cell = calculated value (do not change the value)

Global formula : E = A * r * H * PR

E = Energy (kWh)	2811	kWh/an
A = Total solar panel Area (m²)	20	m²
r = solar panel yield (%)	15%	
H = Annual average irradiation on tilted panels (shadings not included)*	1250	kWh/m².an
PR = Performance ratio, coefficient for losses (range between 0.9 and 0.5, default va	0.75	

Total power of the system	3.0	kWp

Losses details (depend of site, technology, and sizing of the system)

- Inverter losses (6% to 15 %)	8%
- Température losses (5% to 15%)	8%
- DC cables losses (1 to 3 %)	2%
- AC cables losses (1 to 3 %)	2%
- Shadings 0 % to 40% (depends of site)	3%
- Losses weak irradiation 3% yo 7%	3%
- Losses due to dust, snow... (2%)	2%
- Other Losses	0%

Figure 1: Solar PV Energy Output

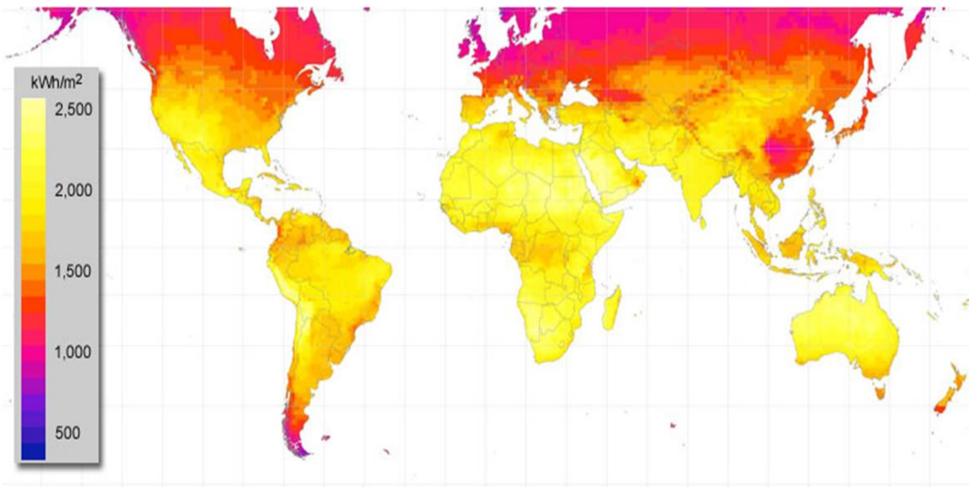

Figure 2: Yearly Sum of Global Irradiance

In the last ten years, the second kind of solar power system is used by many more human beings. There thermal solar energy utilizes the warmth of the solar panels and transforms this heat into thermal power within the solar panel. The warmth of the provided sunlight is obtained, stored and utilized to heat the water supply of local houses. A vast number of people use a traditional heated water system, involving a dip or cauldron for then there is a lack of sunlight, thus on days when the solar panels do not produce enough energy to heat water, an electrical alternative is used.

Thermal solar systems are utilized with the use of a series of panels and a totalizer or a discharge tank - one of them is placed on top of the roof. These panels at that time collect the warmth of the sun then utilize this power to warm the water stored inside a cylindrical water tank. When the liquid is pumped up and the level stored is adjusted with the used of totalizer or discharge tanks. It is then pumped up through the cylindrical tube; the store water within the water tank can be heated, using the stored solar energy, with a click of a switch.

In north Cyprus since at the beginning of the 20th century electricity has been available. It is provided by the Cyprus Electricity Authority (EAC). Cyprus lucky experiences abundant sunlight and electricity charges are comparatively costly. That is, making North Cyprus a perfect location for the use solar energy manufacturing, this has already been utilized to provide warm water in most homes. Long daily hours of sunlight aren't always plentiful, especially in the winter period. However, North Cyprus has more than 10 months of which there is plenty of sunlight. New PV cabins in solar panels are still productive even if there is reduced sunlight.

Superior 7 cause for establishing solar panels from North Cyprus:

1. Reduce your electricity cost price
2. Energy generated is storable and can be sold back to the electric board.
3. Solar panels are efficient for up to 25 years, and that is increasing your value of goods.

4. Cyprus has abundant sunlight.
5. It is a renewable power resource.
6. Solar panel saves water.
7. Solar panel is environmentally friendly.

1.2 Research Methodology

The method used in this investigation is based on sensitivity analysis of investment projects which is based on cost-effectiveness analysis. Firstly, by conducting financial analysis of the project, the study seeks to examine project viability. Lastly, we conduct sensitivity analysis and calculated the cost required to generate 1 kWh of electricity with solar energy in the last 25 years and compare with the cost of current technology used today - the cost of steam turbine and diesel power plant with 1 kWh of electricity. And finally, we investigate to discover which technologies are more efficient when considering the changes made.

1.3 Organization of the Study

This research consists of 6 chapters. In chapter 1 a short introduction is presented, chapter 2 it is a literature review providing a summary of previous work. Chapter 3 contains calculations regarding solar energy production system and sensitivity analysis for solar system production cost. In chapter 4, we calculate the alternative technology electric production systems and conduct their sensitivity analysis. Whilst in chapter 5 analyze the sensitivity calculations and results. Finally, Chapter 6 provides a conclusion and recommendation as to whether the uses solar panels are feasible or not.

Chapter 2

LITERATURE REVIEW

2.1 Types of Electricity Production in the World

In the world we have different resources in which to produce electricity from. Electricity was produced for the first time by Ben Franklin in 1752, in which he connected a key with a kite series and proved the existence of static electricity. His groundbreaking research in static electricity, paved the way for the establishment of the electricity we have today. There are many different ways to produce energy. Where, some of them are more efficient than others, but others are cleaner.

A drawback of electricity is we cannot find it freely in large quantity all over the world; it needs to be produce (thus converting other types of energy into electricity). It is manufactured and transported out of energy production sights called "power stations". Electricity is mostly produced by a power station with the use of electrical or mechanical power stations. Firstly, electricity generation is started by warmth motor bunkered or automatic division and vehicles that have kinetic power used to produce running water and wind.

Statistical Review of World Energy 2020 reports energy data for 2019. It presents a detailed image for supply and demand of primary energy sources. The yearly account provides one of the most significant sources of global energy data. Containing data from several companies' governmental agencies and non-government organizations, based on the review's statistical report, we can see that primary energy consumption has increased by 1.3% in the last year, which is half the increase experience in 2018 (2.8%). Nevertheless, consumption regarding the use of primary resources to produce energy continues to increase.

2.1.1 Fossil Fuels

Fossil fuels are gathered and then carried to the energy plant. The fossil fuels are then burned to produce warm water. The fossil fuels are then split into a lot of hydrocarbon bonds, which produce a great quantity of power. The water then produces steam so which then turns a turbine. The turbine is utilized to rotate a magnet which winds up a motor which large accelerates the generation of power. A magnet rotates to produce an electronic field, generating electric current. Consumption fossil fuels for energy is indicated below, fossil fuels make up 84% of primary global energy consumption 2019.

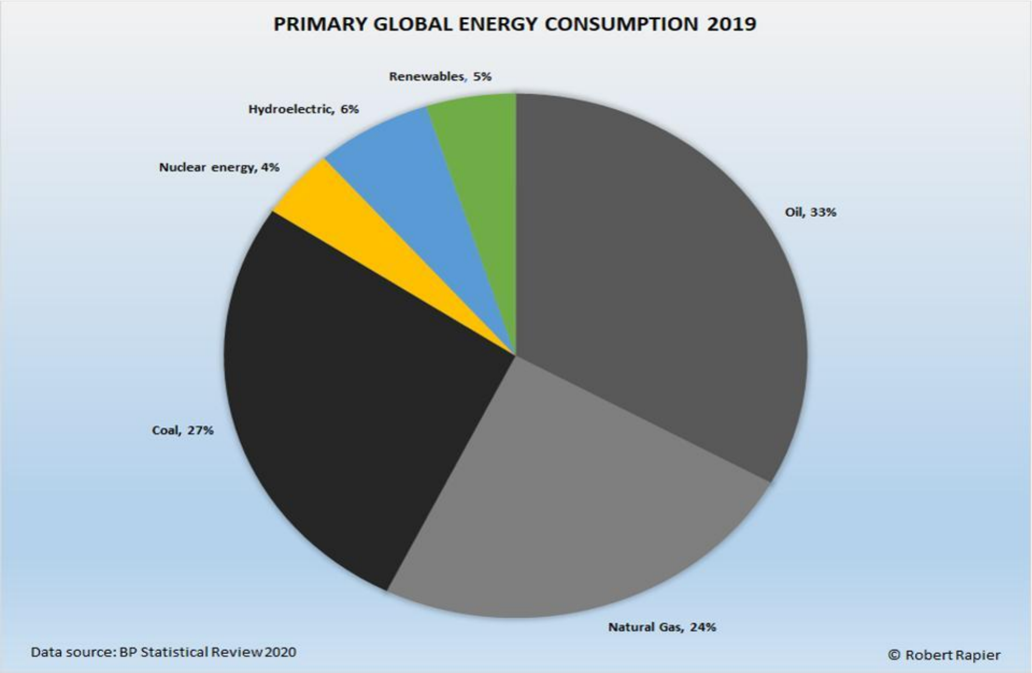

Figure 3: Primary Global Energy Consumption 2019
Source: BP statistical review 2020

2.1.2 Nuclear Power

In the 1990s, 25% of nuclear power was manufactured from the United Kingdom, this year; this amount has decreased lightly on the mean. Nuclear power steam operates from nuclear division, where uranium atoms are divided to manufacture warmth to heat water to 520 of conversion and the steam is utilized to rotate turbines within the power plant. Nuclear energy plants require Uranium to operate; it is one of the scariest minerals. However, due to its' high radioactivity it is able to generate more power than what is generated through the burning of 3,000,000 pounds of charcoal.

Because of the worry due to its radioactivity, (for example Fukushima) and their impact on the environment, the nuclear power generators within the United Kingdom plan to stop producing nuclear energy gradually in the following years, and be completely out of service by 2035.

In December 2019 the "Nuclear Industry Association (NIA)" suggests the procurement from Nuclear energy stations it will be necessary, providing that the United Kingdom is for hitting it is just zero-carbon aim. Programs for structuring a new nuclear energy plant have become submitted.

Due to the nuclear renaissance, there has been a strong increase in the uranium requirements. The demand for uranium has expanded to facilitate the need for greater nuclear energy. The expected usage of 80,383 metric tons of uranium has been estimated for 2020, increasing to 90,780 metric tons in 2025, and in 2030 increasing to 106,301 metric tons. However, approximations regarding output of uranium it is viewed at 75,000 metric tons for 2020 and near to 85,000 metric tons for 2025, thus falling below the requirement.

As stated in a new Morningstar record:

We look forward to world uranium demand to increase by 40% in 2025; it is an amazing quantity to produce. The previous 10 years had less demand.

The mined procurement of uranium should halt expenditures due to the increases demand for uranium and declined need for middle materials. There has been a reduction in uranium costs due to Fukushima and the fact that accumulated procurement shortage should end by 2023 has influence the cost for 2019. We forecast that the market price should be increased to $65 for each pound to encourage the sufficient recent procurement.

The United States nuclear capability element has become 90% of the total nuclear reactors for the past 20 years. The United States nuclear administration costs have become deductible, closing to gas for 25 days on the mean. The United State nuclear volume has become more than 91% in order to operate for 5 years. The nuclear industry reports generated for the United States imply the costs for generating without the use of capital for dual plant is cheaper than for a single plant. A dual plant as the cost of 2.5 cent/kwh, whereas a single unit costs 3.4 cents/kwh.

2.1.3 Hydroelectric Water Use

Hydro energy or hydropower is a renewable power is utilized. The water is stored into a barrel, and runs in streams to form electricity from hydro energy pulses. The pouring water rotates a turbine, which then operates a power plant. It transforms the mechanical power from the turning turbine into electrical power. Hydroelectric power is an important complementary from electricity generated globally.

Humanity has used active water in their daily operations within the past, nowadays active water is utilized in the generation of electricity. Early dates for the use of water in order to generate energy include its role in driving mills that grounding of grains, to make flour. It is evident that moving water has been utilized throughout laborious tasks historically, modern day enlist it to generate electricity.

While most power in the US is manufactured by fossil-fuel and nuclear energy places, hydroelectricity is more efficient and sustainable for long term usage. Today, large energy power plants are situated along dams. Water flowing from the dam cuts the blades of the turbine, starting the electric generating process, thus making a steady flow of water a necessity for power plants. Energy is manufactured and it is sent for houses, firms, hospitals, and schools.

As of 2019, hydro energy manufactured has been led by Canada and China, in order to gather 1,302 terawatts for each hour and 398 terawatts for per hour. However, in 2018 9.2% of global hydropower electricity spending was from Brazil. By research from IRENA stated "hydro energy is the greatest measure and price-productive hidden technology existing now".

Considering improvements in other power preservation technologies, hydro energy technological advancements are considered to be of great economic benefit as its preservation is easy making it a productive power storage source choice. Much of Brazil of hydro energy voltages derived from the north of the amazon stream catchment. However, unfortunately the residents do not seem to live in close proximity to the hydrogen energy source.

From Belo Monte barrage during the Xingu River that finished in 2019 and it is the second largest barrage from Brazil. The structured price is estimated to be more than $13 billion. The Itapúa barrage operates between Brazil and Paraguay throughout the Paraná stream. It is the second biggest barrage in the world and creates 14,000 megawatts, due to the volume of the dam. However, the construction of the recent hydroelectric energy plants has negative consequence on ecological systems, as it changes the prime stream of the water systems.

Statement by IRENA "the mean hedge price for big hydro energy plants and preservation representative average from a minimum of $1,050 /KW to a maximum of $7,650/kW, the average length of hydro energy projects are amongst $1,300/KW to $8,000/kW."

2.2 Solar System Production Place in the World

A PV panel cell or solar panel cell is the minimum and primary structure of a complex PV system (solar modules and a solar panel). There are holes modify within format averaging between 0.5 inches to 4 inches. The overhead solar PV panel transforms the solar radiance inside to straight stream electricity. Part of the conductor necessary for PV is added. The first one is monocrystalline silicon and the second one is polycrystalline silicon and a third one is microcrystalline silicon and forth one is cadmium telluride the last one is copper indium sulfide or selenide. An individual PV cell is able to generate between 1 to 2 watts of electricity. This power is too low to use for any household needs or to trade.

Photovoltaic batteries needed for a solar system require photovoltaic module that electrically reliant on range of at least 60 to 70 photovoltaic cells in Crete. This quantity has been decided on based on demand, and the demand is communicated through flow solder fibers and photovoltaic strips.

And solar PV panel is an individual PV module it only able to generate a small amount of electricity an amount too small to utilize in any household or form trading aims. To induce the electricity generating ability and produce the same quantity as a Photovoltaic module, a large solar PV panel is constructed. The ideology of the use of solar energy by human beings dates back to the 7th century B.C where that believed that sun rays are were optimized to start fires, with the help of a magnifying material. Within this era, many chose to worship solar as it was thought of as a source of life. The Greeks and Romans mobilized solar power to recreate light sources, such as torches, for religious gatherings and events in the 3rd century B.C. Meanwhile, the Chinese only started to use solar lighting in 20 A.D.

In the latest 1700s and 1800s, analysts and scholars had established the utilization of sunlight for energy kilns in arrangement to the tall journey. They further utilized energy from the sun for growing solar powerful steamer. It is evident that the use of solar panels existed thousands of years ago, the idea to use sunlight has a power source was developed many years ago. Solar energy is one of the oldest utilizations of the solar system; in fact in solar was utilized for power minion. Since 1958, the first Vanguard minion utilized a small one-watt panel for energy that is wireless. After that year, the second Vanguard discovered third and Sputnik-3 whole start by the PV system overboard. In 1964, NASA released Nimbus satellite into orbit. This worked solely on a 470-watt photovoltaic solar panel structure. This development shed light on the ability for solar energy to work efficiently for both households and businesses.

In 1966, NASA started the global initial Orbiting Astronomical Observatory, strangled by a one-kilowatt arrangement. The first solar power place was established in 1973 by the University of Delaware, they established the initial solar structure that is called "solar one". The technology advancement started with the procurement of solar thermal and solar photovoltaic power. Another primary example is the structure involving the combination photovoltaic and thermal which is called BIPV. However, this combination was not efficient. Instead, solar panels have been placed inside roofing, similar to the recent Tesla project.

From 1957 to 1960 Hoffman Electronics focused on innovation regarding photovoltaic panels' performance, in order to transform and improve the quantity of output generated by them. This increase is reported to be between 8% and 14%. Shortly after in 1985 another transformation was made by the University of South Wales, who were able to improve performance by 20% with the use of silicon holes. In 1999, Public Renewable Power Laboratory, with the help of Spector Lab Inc., was able to improve performance further by 33.3%. According by Paul Breeze from power generation technologies second edition:

> Solar cells are manufactured using technologies similar to those used to manufacture microchips and transistors. Most of these are made using slices of perfect silicon crystals that are then etched and doped to create the complex structures that are required for computers and other electronic devices. Solar cells, though normally simpler in structure than a microchip, can be manufactured in a similar way [1].

In 1979, Jimmy Carter - former head of state - had solar panels installed on top of the White House during his legislation. In 1981, Ronald Reagan – acting president at that time – removed the solar panels from the White House. In 2010, Obama – the head of state during that period – installed solar panel for both solar power energy and a solar water heater for the White House.

Solar power output by the government:

California's government is rated highly amongst the top creators of electricity with the use of solar energy. The golden state has created almost 37% of the United Stated aggregate total of 9,723 thousand megawatts per hour in March, according to "Choose energy.com".

Table 1: Top 10 Sate Solar Generation by Percentages

state	March solar generation	% of U.S. total
California	3569	36.7
Arizona	672	6.9
North Carolina	667	6.9
Florida	623	6.4
Texas	517	5.3
Nevada	454	4.7
New Jersey	324	3.3
Massachusetts	318	3.3
New York	270	2.8
Utah	213	2.2

Source: Choose Energy website

According to Jemin Desai and Mark Nelson, the Japanese environment department motioned: the quantity of solar panel energy output used by Japan each year will increase by between 10,000 to 800,000 tons by 2040. The Japanese are not able to meet such a demand in a safely fashion.

To provide that calculation: EP approximated the forecasts, of 2016 including the whole amount from operating, the solar panels, and artificial the costs of those that would be retired in 25 years, which is the mean lifetime of a solar panel. Afterwards the EP forecasted of the amount of electricity manufactured from the beginning.

The remaining nuclear residuals are stored in a series of barrels and methodically follow up.

Nowadays, solar panels create harmful residuals. Solar panels store toxic minerals which can be to harmful. Natural elements, like cadmium and carcinogen, both commonly in the manufacturing of batteries, are highly toxic and can cause cancer. The installment of solar panels has increased in recent years. The installment of new solar panels usually requires access to governmental grants, and involves following administrative commands. The volume of installed panels was more than doubled between 2012 and 2015. Since 2016, solar energy has provided1.3 % of the world's electricity, generating 301 gigawatts.

In the same year, atom reactors also accounted for 10 % of global electricity. In a newly released statement it was mentioned that it would take up to 19 years for Toshiba to achieve it ecological resolutions by completely recycling the solar residual that Japan has manufactured since 2020. It is predicted that as of 2034, the yearly residual manufacture will be between 70 to 80 times higher than what was created in 2020.

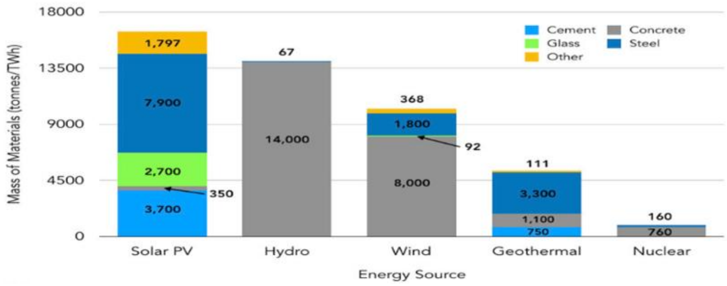

Figure 4: Materials Output According to Types from Power Welding
Source: Quadrennial Technology Review

2.2.1 The Top Solar Panels in the World Market

Finding the best solar panels for your home can seem challenging, as there are over a hundred not so dissimilar trademarks of solar panels to choose from within the market place. In this paragraph, I will explain how solar panel producers join forces to create product and which producers supply top rage solar panels.

There are a lot of solar panels brands that exist today.

Out of all of the current solar panels firms, some dominant as the best solar panel companies around the world have control over the market place, frequently joining forces to create more advanced solar panels. Said dominators are listed below.

Table 2: current solar panel brand names in the world

Rank	Brand Names
1	Sun Power
2	LG
3	Panasonic
4	Silfab
5	Q CELLS
6	Canadian Solar
7	JinkoSolar
8	Trina Solar
9	REC Sola

Source: energysage website

As of 2020, sun power, LG, and Panasonic are considered to be the greatest performing solar panels, as they provide the greatest output, have ambitious pricing and a guaranty for 25 years. All mentioned factors have contributed to the producers' strength and credibility, making them dominant trademarks within the solar panel industry. The top solar panels also contain monocrystalline holes in which an individual crystal of silicon replaces the use of a lot of melted silicon parts in common. These holes enable the panels to in transform more sunshine into electricity. Although, this benefit makes the cost of production greater resulting high market price tag.

2.2.2 The Top Solar Panels are arranged by Output:

Solar panel volume is by measured of how well the solar panel transfers sunshine used to generate electricity. It is related to its' module capacity performance. There are the 5 top solar panels producers in the world which are reported below according to their efficiency.

Table 3: Top Solar Panels According To Output

RANK	MANUFACTURER	PANEL EFFICIENCY
1	Sun Power	22.8%
2	LG	21.7%
3	REC Group	21.7%
4	CSUN	21.2%
5	Solaria	20.5%

Source: energysage website

2.2.3 Top Solar Panels in the World Arranged by Temperature Factor:

Solar panel has supply guarantees are either in the form of furnishing guarantees - in which to maintain supplies throughout environmental elements faced, or guarantees against manufacturing failures – such supply guarantees exists for solar farms. There is a list of the top solar panel producer in the world provided below.

Table 4: List of Top Solar Panel Producer in the World

Rank	top solar panels	years
1	LG	25 years
2	Panasonic	25 years
3	Silfa	25 years
4	Solaria	25 years
5	Sun Power	25 years
6	Q CEELS	25 years

Source: energy sage website

As indicated above, there is a total of 6 top solar panel producers, this is decided on based on the ability of suppliers' guarantees to be maintained, where it is suggested that a guarantee of 10 years (material warranty) is a sign of being a top solar panel producer.

Displayed below the top solar panels exist within 2019.

Table 5: The Top Solar Panels Existing in 2019

MANUFACTURER	EFFICIENCY RANGE	TEMPERATURE COEFFICIENT RANGE	MATERIALS WARRANTY
Amerisolar	14.75% to 17.01%	-0.43 to -0.43	12 years
Axitec	15.37% to 19.41%	-0.44 to -0.39	12 years
BenQ Solar (AUO)	15.5% to 18.3%	-0.42 to -0.39	10 years
Boviet Solar	16.5% to 17.5%	-0.4 to -0.4	12 years

MANUFACTURER	EFFICIENCY RANGE	TEMPERATURE COEFFICIENT RANGE	MATERIALS WARRANTY
Canadian Solar	15.88% to 19.91%	-0.41 to -0.37	10 years
CentroSolar	15.3% to 17.8%	-0.44 to -0.42	10 years
CertainTeed Solar	15.4% to 19.9%	-0.45 to -0.37	10 years
China Sunergy	14.98% to 21.17%	-0.42 to -0.41	10 years
ET Solar	15.67% to 19.07%	-0.44 to -0.41	10 years
GCL	16% to 17%	-0.41 to -0.41	10 years
Grape Solar	16.21% to 17.64%	-0.5 to -0.4	10 years
Green Brilliance	14.24% to 15.58%	-0.45 to -0.45	5 years
Hansol	14.97% to 18.05%	-0.45 to -0.41	10 years

Source: Choose Energy, Inc. a Red Ventures Company - 1423 Red Ventures Drive, Fort Mill, SC, 2970

2.3 The Electricity Production in North Cyprus

The TRNC began generating electricity from a self-generation welding 19-years ago. Before 1994, in the 1970s electricity was manufactured from diesel-powered gas turbine energy places.

The manufacturing of electricity by Turkey within 1990 required taking slow steps in order to meet the $125 million capital required to construct a modern steam turbine power plant, which is based in Teknecik. The initial unit was completed in 1995, and another unit was developed in 1996. Energy generated is from two units, each of which generates 60 Megawatts (MW) to 120 megawatts of energy. Within the energy places, No. 6 fuel oil is utilized. Southern Cyprus used steam turbine energy places to reserves the electricity it gave to TRNC in March 1996. From then on until 2003, the energy place met most of the country's power needs.

Greater economic growth of a community causes a rise within the number workspaces and households; this in turn results in a greater level of demand for electricity in order to provide the necessary level of comfort. Electric plant sources by steam aren't enough to supply require volume at all times. Gas turbines, which are frequently outdated and costly, are placed inside a processing unit in order to try and fulfill the nonstop growing demand. However, they are also considered to be insufficient, and sometimes need to undergo construction, which requires the energy plant to be shutoff temporarily.

In the beginning of the 2000s, the ever growing request for electricity has been unmatched by two units in Teknecik, recent energy places have outsourced with the use of rental equipment and purchase of services. With a special investment, under governmental supervision, Kalecik energy place began generating electricity within the Kalecik area in 2003. The two generating units produce a sum of 35 megawatts of energy. That generation of this volume partly solved the issue regarding the costs associated with energy production at that time. However, the volume produced was insufficient. Since then, this plant has been able to supply the complete volume required, the only issue being that there is no spare energy generated. Thus in times of maintenance or servicing a deduction, within the energy supplied, is unavoidable.

After the Annan plan referendum date, debating the solution for Cyprus in 2004, there was a full explosion destroying a church which increase electricity spending in order to repair it back to its existing state. The rise in power spending at that period was well over the regular level, on average between 10% to 12% increase. They were able to form enough volume in order to backup volume needed. 17.5 Megawatts of power were produced in Kalecik; there capital was provided by an investment with collateral. As part of the collateral, a volume of 87.5 Megawatts from the Kalecik power plant were transferred to spending centers. In 2009, a second Kalecik contract agreement was signed for a growth in supply until 2024. An additional 17.5 Megawatts diesel device and an 8 Megawatts steam caldron and steam turbines were added in 2013.

A backlog of 17.5 Megawatts was competed in 2014 to ensuring nonstop power was provided for the AKSA Company. As of now, all energy plants of Kalecik are 8 times larger than the 17.5 MW diesel, and 8MW steam turbine, thus generating 148 MW. There is a contact available for buying 700 million KWH for each year. In 2006, ministers within the TRNC set up schemes in order to improve the power supply, with the help of judgments made by the Board. Within this period and onwards, investments to help provide backup power have come from Turkey. Investments have been made to form diesel energy plants, in request for 17.5 MW of energy. As of 2007, four diesel devices have supplied 70 MW of energy and this has had an investment cost of 32 million Euros. Since 2008, all structural ground work and electrical devices have been powered by two diesel device units, which generate 35 MW of energy each and had an investment cost of 20 million Euros.

From 2015, as the judgment of the Board of Directors of KIB-TEK, an agreement was signed with the Wartsila Company to procure 35 Megawatts from all of energy places. Megawatts energy was established in prior spaces in 2008. The present investment cost added to each energy place project is 15,665,000 Euros. The assembly of the energy place selected in July 2015 is now finished and has been granted acceptance to function. As part of the finished project, a Teknecik Diesel energy place has been established which generates a 140 Megawatts of energy. 1 Megawatt of solar energy is generated by the solar energy place in Serhatköy, a 120 Megawatts of energy is obtained from stream turbines and 261 Megawatts is formed by KIB-TEK energy places.

TRNC established energy is recently 409 MW. Over the years, there has been a rise in the burden of quantity of power demanded in the TRNC. The largest burden reported was 106 MW in 1996; and 301 MW in 2015. In 2011, Southern Cyprus had a shortage of power as a result of the boom at the Vasiliko energy plant; they wanted electricity from the TRNC. From 2011 to 2012 electricity generation of 169,123,000 KWH was sold to Southern Cyprus from the generated energy available within TRNC. The following tables show the installed and available power status for 2019 and the current production and average cost information.

Table 6: The Installed and Available Power Status for 2019

electricity generation and cost by sources in 2019		
Total electricity production	1,665,810,000.00 kWh	
Electric generation resources		cost for each kwh
steam turbine (KIB-TEK)	23.7%	0.15 $/kwh
teknecik diesel (KIB-TEK)	32.7%	0.10 $/kwh
teknecik diesel (AKSA)	43.2%	0.13 $/kwh
serhatköy solar	0.1%	
South Cyprus	0.5%	

Source: Cyprus Turkish Electrical Institution (KIB-TEK)

The weighted average production cost average that is include total production cost is 0.124 $/ kWh in 2019.

Today North Cyprus use three different sources to produce electricity that is; diesel (AKSA), diesel (KIB-TEK), and steam (KIB-TEK).

2.3.1 AKSA Generation Electricity

In 1968, Ali Metin Kazanci established an electrical plant engine. By 1984, AKSA developed the initial power plant with professional machinery and equipment necessary to generate a small quantity of power. In 1994, the AKSA group officially operated legally under the name of Kazanci Holding and expanded to the current structure in place today. AKSA is the owner of a board array of different companies located within Turkey; this includes mainly 200 industrial firms and shipment companies. AKSA power plants enlist the use of petrol, diesel, and native oil within their generator system. Within the world, AKSA is considered to be one of the major creators of a range of products and has a string of continuous investment projects. As of May 2012, AKSA has established one of the major power plants in the world. The importance of it stems from the fact that it is one of the largest in size standing at

100,000m^2. Which enables this plant to form 24,000 units a year with the use of diesel generators? It has 16 testing areas with the most recent technology are provided in order to test 25 MVA volume. AKSA is one of the initial power producers around the world in which the power plants ran on native fuel gas. It plants remain unchallenged by sync ranges, AKSA power plants continuously boosts their investments within technological aspects of the power plant, in order to maintain advanced with modifications necessary for having an environmentally friendly power plant.

2.3.2 DIESEL Electric Generation

The diesel power plant is a beneficial device that manufactures electrical by inflaming diesel fuel. These plants are utilized to combine an electrical power plant with a diesel motor in order to create electricity. The diesel power plant transforms some of the chemical power formed from the ignition of diesel, to generate mechanical power. The generated mechanical power is then used to operate a crank which manufactures the formation of electricity. Power fees are influenced by the use of fibers used within motions taking place within the magnetic area. Within electrical power plants, two polarized magnets are usually implemented in order to create a magnetic field. Fibers are placed around the circumference of the crankshaft within the diesel power plant, which lies among the magnets within the magnetic field. When the diesel motor veer rounds the crankshaft, the fibers are then shifted along the magnetic area, which can warn electric currents.

A common rule of thumb for regulating a diesel power plant is that it will usually require 0.4 liters of diesel manufacture each KWH. The diesel motor utilizes the warmth from the buildup of pressure from the ignition of the fuel within the injection room. Commonly, diesel motors permit high usages of Carnot in order to heat up the fuel and generate energy. Diesel motors increase in usage may be due to the fact that there is high inflation regarding the procurement and storing of crude oil. The diesel motor uses fuels such as; native gas, alcohols, petrol, wood gas, and diesel operate.

2.3.3 Electric Generation by Steam Motor

Steam motors are considered to be the best primary source in which to generate electricity within a power plant, the electricity is generated for steam. This stream is formed from water gathered - with the help of a pump - from the open sea. It is then warmed to 165 degrees by the use cauldrons or to 500 with the use of warmth convertors. Steam has a limited temperature than has the capacity of mining 30 each second, and won't generate greater electricity than this. This is done to assure that nothing is wasted. Steam motors will automatically set their energy generation and steam utilization based on the stream available to the electricity system. The pause option on a steam motor will screen to check that is stream energy generation is feasible.

Steam motors are placed within two seaports, which permit a surplus of steam through. This makes the employment of steam motors quite common. An area of open sea and the use of 20 cauldrons provide the right proportion of stream needed to run 40 steam motors. Cauldrons are utilized to warm up the open sea water, and the steam motors are used to generate energy.

There we can see data on the types of technology used for electricity production and the amount per kWh which has been received from the KIB-TEK electricity institution.

2.4 Solar System Production in North Cyprus

TRNC has matchless Mediterranean weather. As stated by Meteorological Service of north Cyprus (2007), the winter months are a little wet from the ending of November till the15th of March, but in the summer months the weather is warm and dry - from the 15th of April until the 15th of October. The last two seasons are separated by a shortfall and spring because of a modification in climate status.

Because of the weather conditions in the TRNC is considered to be primarily sunny, the daily mean solar radiation generated is 5.4 kWh/ m^2. Moreover, the daily sunlight duration ranges between 5.5 hours during the winter, to between 12.5 hours -14.5 hours during the summer. Whereas: the high mountainous area, "Troodos Mountains" is very cloudy during the winter months and has mean sunlight duration of 4 hours. In July, the sunlight shines each day for a number of hours; records suggest duration of 11 hours each day.

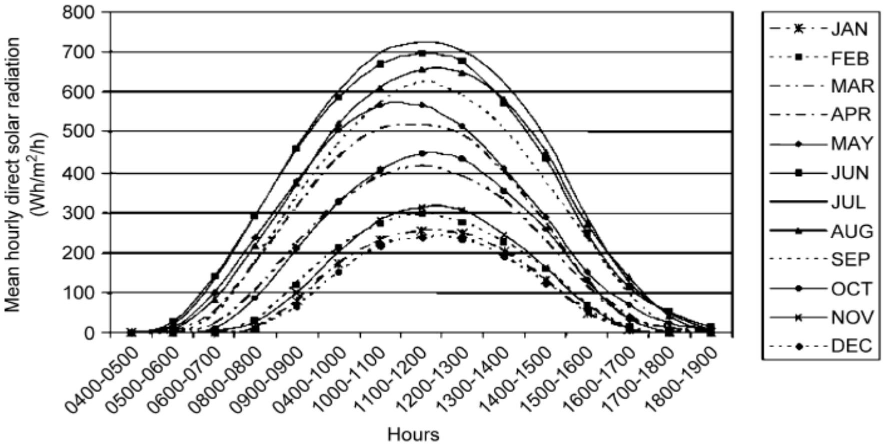

Figure 5: Typically Hourly Solar Radiation in North Cyprus in the Month in the Year
Source: World Bank Group

From figure below we can see the solar direct normal irradiation long term average from 1994 to 2018 according by "world Bank Group", to find the daily and yearly solar irradiation from different area.

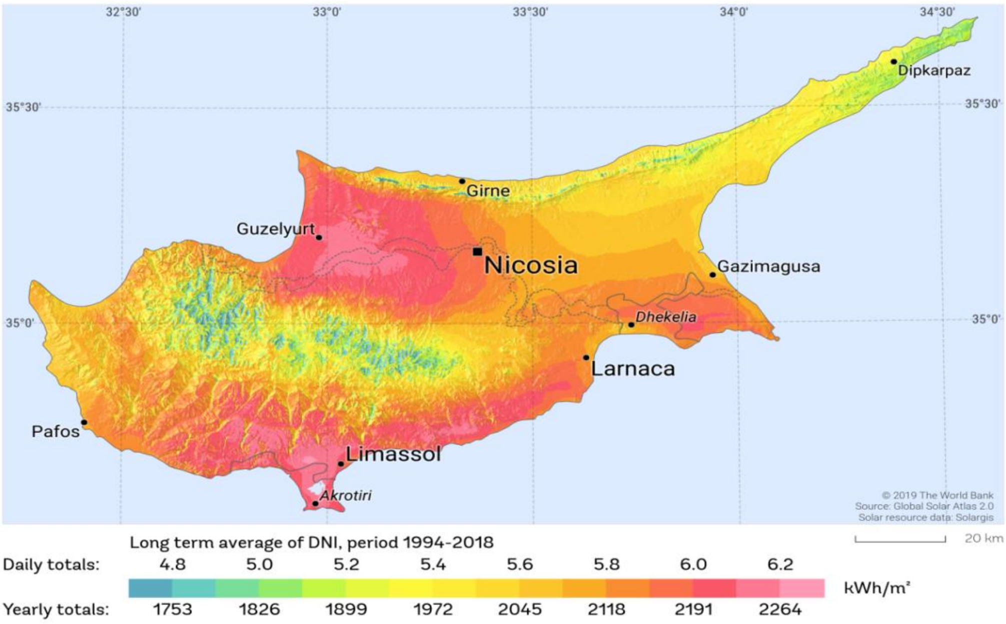

Figure 6: Daily and Yearly Long Term Average for Direct Solar Irradiation

Solar power panels allowed to be installed within the TRNC are 120 MW but so far 70 MW have been installed only. Thus, if 1 KW established solar panel can almost generate 1,600 kWh electric for each year, we can produce almost 112 million kWh of electricity by the sunshine each year and all our spending from RES share is equal to 5.6%.

In 20016, a 14,000 M^2 PV panel electric generation project plan had been finished by International Cyprus University's (UKÜ). It is the largest photovoltaic power project within TRNC; furthermore the range is situated in an international space.

The PV panel project has been administered for four different spaces; a flat roof, a sloping roof, flat land and car park areas. The total cost for established this solar project is near to $1,779,148.381.

As Abbasoğlu informed, in that project established by 4131 panels, and generating electricity is 350,000 kWh will be dedicated to the TRNC Energy Transmission Line. Also he added that producing electricity in those ways will be contributing to the economy from TRNC by 200,000 TL per year. He is convinced this project will supply 80% of electricity quantity utilization pending the all-day times from the Cyprus International University.

2.4.1 Size vs. Quantity: Typical Solar Panel Ratings and Capacity

A solar panel's quality and performance is not solely reliant on the power output of the panel. Some panels have higher power output because of its size characteristics (larger panels) instead of their advanced technology or higher efficiency. For instance, depending on the location of the solar panel, although a 5 KW system may produce 8,000 kWh of electricity every year in Los Angeles, the same solar panels system may produce 6,000 kWh of electricity in Boston due to the amount of sun each location has every year. In addition, two solar panels can have the same efficiency rate (assuming 15%), the first one can generate an output of 250 watts and the second one generates 300 watts. The difference is the physical size of the two systems and it means that the second panel is 20% larger than the first. Moreover, a 5 KW solar panel system could consist of either 20 250-Watt solar panels, or 16 300-Watt solar panels.

Note: Always need to add 25% to KWH that energy is needed due to weather conditions.

Table 7 presents the list of operational cost of a solar energy system before and after taking out the federal solar tax credit, which would decrease the solar panels system cost by 26%.

Table 7: List of Operational Costs

In the Case of 5 kWp Solar PV System, the Operational Cost Include the Following Expenses:		
OPERATIONAL COSTS FOR	**FREQUENCY**	**AVERAGE AMOUNT PER YER**
Solar panel cleaning	every 1 to 3 years	$125 to $150 (5 kWp)
Maintenance	annuually	$200
Photovoltic-insurance	annuually	$200
Electricity of inverter	annuually	$50
Liability insurance	annuually	$50
Total operatinal costs	per year for 5 kWp	$700 to $800
Solar power inverter	on average every ten years	1.5% of investment cost

Source: Choose Energy website

Chapter 3

SOLAR SYSTEM ELECTRICITY PRODUCTION COST

3.1 Solar System Electricity Production Costs in North Cyprus

In the presented work, we will calculate the PV panel system for solar capacity 1 kW, in this regard, our solar load factor is 19%, and the prices for each KW are $1100 for small-sized PV panels, $850 for mid-sized, and $750 for large scale. The degradation of solar panels per year is 1%, the discount rate is 10%, and the working hours yearly are 8760 hours. The system stabilization cost is $0.005 for each kWh, and our project life is 25 years. If the roof is not suitable for the installation of solar panels, additional work might be required, such as welding work, and their cost is around 10% to 15%. These parameters, such as solar factor, solar price, and discount rate, will be changed to analyze the changes that will happen in the result. And the majority of solar in Northern Cyprus is a small size solar panel in the world the solar kWh price is equal to $ 0.08. And additionally that, from TRNC the energy ministry received an offer of about $ 0.08 for a major investment. We utilized the equations below to investigate the issue above:

Calculation 2: PV of Electricity Produced

$$PV\ of\ ELECTRICITY\ PRODUCED\ = \sum_{i=1}^{n} \left(\frac{\mathrm{value}_1}{\mathrm{rate}^1} + \frac{\mathrm{value}_2}{\mathrm{rate}^2} + \frac{value_3}{rate^3} + \frac{value^n}{rate_n} - initinal\ electric\ produced \right) \tag{2}$$

Calculation 3: Levelized Cost of Energy

$$LCOE = \frac{KW\ price\ of\ solar}{PV\ of\ electricity\ produced} \tag{3}$$

Calculation 4: Total Solar Cost

$$total\ solar\ cost = LCOE + system\ stabilization\ cost \tag{4}$$

Table 8: Small-Sized PV Panel Cost

Result of Total Solar Cost From Small Sized PV Panel		
SOLAR CAPACITY	1	KW
SOLAR LOAD FACTOR	19.0%	
KW PRICE OF SOLAR	1100	USD
SOLAR DEGRADATION FACTOR	-1%	per year
DISCOUNT RATE	10.00%	
HOURS IN A YEAR	8760	
PV of ELECTRICITY PRODUCED	14,045	kWh
SOLAR LCOE (without system stabilization cost)	**0.078**	**$/kWh**
System stabilization cost	**0.005**	**$/kWh**
TOTAL SOLAR COST	**0.083**	**$/kWh**

Source: own calculation from the data obtained from KIB-TEK

We can see from table (8) that the LCOE is equal to 0.078 $/kWh without system stabilization cost, and the total cost is 0.083 $/kWh.

In the tables below, we are calculating mid-sized cost and large scale with the same parameters with the solar prices changed. We can see the LCOE for mid-size without system stabilization cost is equal to 0.061 $/kWh, and with the system stabilization cost, the total cost is equal to 0.066$/kWh. For the large-scale panels, we can see that the LCOE without system stabilization cost is equal to 0.053 $/kWh and the total cost with system stabilization cost is equal to 0.058 $/kWh.

Table 9: Mid-Size PV Panel Cost

Result of Total Solar Cost From Mid-Sized PV Panel		
SOLAR CAPACITY	1	KW
SOLAR LOAD FACTOR	19.0%	
KW PRICE OF SOLAR	850	USD
SOLAR DEGRADATION FACTOR	-1%	per year
DISCOUNT RATE	10.00%	
HOURS IN A YEAR	8760	
PV of ELECTRICITY PRODUCED	14,045	kWh
SOLAR LCOE (without system stabilization cost)	**0.061**	**$/kWh**
System stabilization cost	**0.005**	**$/kWh**
TOTAL SOLAR COST	**0.066**	**$/kWh**

Source: own calculation from the data obtained from KIB-TEK

Table 10: Large Scale PV Panel Cost

Result of Total Solar Cost From large scale PV Panel		
SOLAR CAPACITY	1	KW
SOLAR LOAD FACTOR	19.0%	
KW PRICE OF SOLAR	750	USD
SOLAR DEGRADATION FACTOR	-1%	per year
DISCOUNT RATE	10.00%	
HOURS IN A YEAR	8760	
PV of ELECTRICITY PRODUCED	14,045	kWh
SOLAR LCOE (without system stabilization cost)	**0.053**	**$/kWh**
System stabilization cost	**0.005**	**$/kWh**
TOTAL SOLAR COST	**0.058**	**$/kWh**

Source: own estimation from the data collected from KIB-TEK

3.2 Sensitivity Analysis for Solar System Electricity Production

From table 7, table 8, and table 9, we calculated the LCOE for three different PV panel sizes to find the total cost. Now we will calculate the LCOE by changing parameters to measure the sensitivity.

3.2.1 Sensitivity Analysis with the Solar Load Factor

Today, 1 KW solar panel can produce electricity yearly by 8670 hrs. But this number represents only 19% of its capacity because, at night, there is no sunlight to generate electricity. Moreover, in winter, sunlight is meager. Due to the reasons mentioned above, the PV panels produce just 19% of electricity from the total yearly hours. However, if in the future solar panels become more efficient or the inventors improve the technology and find a way to increase the load factor, the cost will be less.

Table 11: LCOE and Total Cost for Small Size by Changing Load Factor

Solar LCOE and Total Cost for Small size by Changing Solar Load Factor			
SOLAR LOAD FACTOR	SOLAR LCOE (without system stabilization cost)	SYSTEM STABILIZATION COST	TOTAL SOLAR COST
19.0%	**0.078**	**0.005**	**0.083**
19.5%	0.076	0.005	0.081
20.0%	0.074	0.005	0.079
20.5%	0.073	0.005	0.078
21.0%	0.071	0.005	0.076
21.5%	0.069	0.005	0.074

Source: own calculation from the data obtained from KIB-TEK

Table 12: LCOE and Total Cost for Mid-Size by Changing Load Factor

Solar LCOE and Total Cost for Mid-Size by Changing Solar Load Factor			
SOLAR LOAD FACTOR	SOLAR LCOE (without system stabilization cost)	SYSTEM STABILIZATION COST	TOTAL SOLAR COST
19.0%	0.061	0.005	0.066
19.5%	0.059	0.005	0.064
20.0%	0.057	0.005	0.062
20.5%	0.056	0.005	0.061
21.0%	0.055	0.005	0.060
21.5%	0.053	0.005	0.058

Source: own calculation from the data obtained from KIB-TEK

Table 13: LCOE and Total Cost for Large Scale by Changing Solar Load Factor

Solar LCOE and Total Cost for Large Scale by Changing Solar Load Factor			
SOLAR LOAD FACTOR	SOLAR LCOE (without system stabilization cost)	SYSTEM STABILIZATION COST	TOTAL SOLAR COST
19.0%	0.053	0.005	0.058
19.5%	0.052	0.005	0.057
20.0%	0.051	0.005	0.056
20.5%	0.049	0.005	0.054
21.0%	0.048	0.005	0.053
21.5%	0.047	0.005	0.052

Source: own calculation from the data obtained from KIB-TEK

From the tables above, we can notice that the load factor is affecting the LCOE and total cost significantly. When the load factor is increasing from 19% to 21.5%, the LCOE and total cost are decreasing. We are using the same changing load factor for all three different solar panel sizes. From the small size the LCOE values are equal to 0.078, 0.076, 0.074, 0.073, 0.071, 0.069 USD for each kWh respectively, and if we add the system stabilization by 0.005$/kWh the total cost are equal to 0.083, 0.081, 0.079, 0.078, 0.076, and 0.074 USD for each kWh respectively.

For the mid-size solar panels, changes in load factor affected the LCOE and the total PV panels cost negatively. We can see the LCOE are equal to 0.061, 0.059, 0.057, 0.056, 0.055, 0.053 USD for each kWh without the system stabilization cost if we add this cost, the total costs are equal to 0.066, 0.064, 0.061, 0.060, and 0.058 $/kWh respectively.

Also, that changes in load factor negatively changed the LCOE and total cost on the large scale of PV panel. We can see without system stabilization cost the LCOE are decreasing 0.053, 0.052, 0.051, 0.049, 0.048, and 0.047 $/kWh respectively and when we are adding the system stabilization cost the total cost is equal to 0.058, 0.057, 0.056, 0.054, 0.053, and 0.052 $/kWh respectively.

3.2.2 Sensitivity Analysis with the Solar KW Price

We are calculating the LCOE and total cost by changing solar price for 1 KW both positively and negatively to examine the results of three different solar size.

Table 14: LCOE and Total Cost for Small Size PV Panel by Changing the Solar KW Price

Solar LCOE and Total Cost for Small Size by Changing Solar KW Price			
KW PRICE OF SOLAR	SOLAR LCOE (without system stabilization cost)	SYSTEM STABILIZATION COST	TOTAL SOLAR COST
800	0.057	0.005	0.062
900	0.064	0.005	0.069
1000	0.071	0.005	0.076
1100	0.078	0.005	0.083
1200	0.085	0.005	0.090
1300	0.093	0.005	0.098
1400	0.100	0.005	0.105

Source: own calculation from the data obtained from KIB-TEK

Table 15: LCOE and Total Cost for Mid-Size PV Panel by Changing the Solar KW Price

Solar LCOE and Total Cost for Mid-Size by Changing Solar KW Price			
KW PRICE OF SOLAR	SOLAR LCOE (without system stabilization cost)	SYSTEM STABILIZATION COST	TOTAL SOLAR COST
550	0.039	0.005	0.0442
650	0.046	0.005	0.0513
750	0.053	0.005	0.0584
850	**0.061**	**0.005**	**0.0655**
950	0.068	0.005	0.0726
1050	0.075	0.005	0.0798
1150	0.082	0.005	0.0869

Source: own calculation from the data obtained from KIB-TEK

Table 16: LCOE and Total Cost for Large Scale PV Panel by Changing the Solar KW Price

Solar LCOE and Total Cost for Large Scale by Changing Solar KW Price			
KW PRICE OF SOLAR	SOLAR LCOE (without system stabilization cost)	SYSTEM STABILIZATION COST	TOTAL SOLAR COST
450	0.032	0.005	0.037
550	0.039	0.005	0.044
650	0.046	0.005	0.051
750	**0.053**	**0.005**	**0.0584**
850	0.061	0.005	0.066
950	0.068	0.005	0.073
1000	0.071	0.005	0.076

Source: own calculation from the data obtained from KIB-TEK

Tables show that increasing KW price from 800 to 1400 for the three different PV panels size are negatively influencing LCOE and total solar cost. In small-size panels from table 14 we can see that LCOE without system stabilization cost are equal to 0.057, 0.064, 0.071, 0.078, 0.085, 0.093, and 0.010 $/kWh respectively. When we add the system stabilization cost of 0.005 $/kWh, the total solar coat are 0.062, 0.069, 0.076, 0.083, 0.090, 0.098, and 0.105 $/kWh respectively.

From table 15, we can see that changing the price of solar power negatively change LCOE and total solar cost for the mid-size solar panel. Results suggests that LCOE without system stabilization cost are equal to 0.039, 0.046, 0.053, 0.061, 0.068, 0.075, and 0.082 $/kWh. When adding the system stabilization cost, the total solar cost is equal to 0.044, 0.051, 0.058, 0.066, 0.073, 0.080, and 0.087 $/kWh respectively.

In table 16, we can see that changing the solar kWh price is also negatively affecting the LCOE and total solar cost of the large scale solar panels. The LCOE without system stabilization cost are equal to 0.032, 0.039, 0.046, 0.053, 0.061, 0.068, and 0.071 $/kWh. If we add the system stabilization cost, the total solar cost are equal to 0.037, 0.044, 0.051, 0.058, 0.066, 0.073, and 0.076 $/kWh respectively.

3.2.3 Sensitivity Analysis with the Discount Rate

In this calculation, we changed the discount rate between the range of 7% to 13% to see the effect of an increasing discount rate on the three different solar size LCOE and total solar cost. Results show evidence of a positive relationship between the discount rate and LCOE and total solar cost.

Table 17: LCOE and Total Cost for Small Size PV Panel by Changing the Discount Rate

Solar LCOE and Total Cost for Small Size by Changing Discount Rate			
DISCOUNT RATE	SOLAR LCOE (without system stabilization cost)	SYSTEM STABILIZATION COST	TOTAL SOLAR COST
7%	0.062	0.005	0.067
8%	0.067	0.005	0.072
9%	0.073	0.005	0.078
10%	**0.078**	**0.005**	**0.083**
11%	0.084	0.005	0.089
12%	0.090	0.005	0.095
13%	0.096	0.005	0.101

Source: own calculation from the data obtained from KIB-TEK

Table 18: LCOE and Total Cost for Mid-Size PV Panel by Changing the Discount Rate

Solar LCOE and Total Cost for Mid-Size by Changing Discount Rate			
DISCOUNT RATE	SOLAR LCOE (without system stabilization cost)	SYSTEM STABILIZATION COST	TOTAL SOLAR COST
7%	0.048	0.005	0.053
8%	0.052	0.005	0.057
9%	0.056	0.005	0.061
10%	**0.061**	**0.005**	**0.066**
11%	0.065	0.005	0.070
12%	0.070	0.005	0.075
13%	0.074	0.005	0.079

Source: own calculation from the data obtained from KIB-TEK

Table 19: LCOE and Total Cost for Large Scale PV Panel by Changing the Discount Rate

Solar LCOE and Total Cost for Large Scale by Changing Discount Rate			
DISCOUNT RATE	SOLAR LCOE (without system stabilization cost)	SYSTEM STABILIZATION COST	TOTAL SOLAR COST
7%	0.042	0.005	0.047
8%	0.046	0.005	0.051
9%	0.050	0.005	0.055
10%	**0.053**	**0.005**	**0.058**
11%	0.057	0.005	0.062
12%	0.061	0.005	0.066
13%	0.065	0.005	0.070

Source: own calculation from the data obtained from KIB-TEK

Results show that increasing the discount rate has an unpleasant outcome on the three types of PV panels because an increasing discount rate is increasing the cost of LCOE, and total solar cost. Table 17 shows that when the rate is increasing from 7% to 13 % the cost of LCOE without system stabilization cost for small size is increasing as follow: 0.062, 0.067, 0.073, 0.078, 0.084, 0.090, and 0.096 $/kWh. When adding the 0.005 $/kWh system stabilization cost, the total solar cost is equal to 0.067, 0.072, 0.078, 0.083, 0.089, 0.095, and 0.101 $/kWh.

Table 18 presents the results for mid-size panels with a changing discount rate. Similar to results from the small size PV panel, an increasing discount rate is negatively influencing the LCOE and total solar cost. The LCOE without system stabilization cost is equal to 0.048, 0.052, 0.056, 0.061, 0.065, 0.070, and 0.074 $/kWh. After we add the system stabilization cost of 0.005 $/kWh, the total cost is equal to 0.053, 0.057, 0.061, 0.066, 0.070, 0.075, and 0.079 $/kWh respectively.

For large-scale panels, results are similar to small-size and mid-size panels' results. Table 19 shows that increasing the discount rate increases both LCOE and the total solar cost, the LCOE without system stabilization cost are equal to 0.042, 0.046, 0.050, 0.053, 0.057, 0.061, and 0.065 $/kWh, and when we add the system stabilization cost of 0.005 $/kwh, the total solar cost is equal to 0.047, 0.051, 0.055, 0.062, 0.066, and 0.070 $/kWh respectively.

3.2.4 Sensitivity Analysis with System Stabilization Cost

When installing the solar power system, we have to pay the extra cost for the equipment that makes the system stable. Some power plants have to wait if solar energy does not work efficiently, if the weather is so cloudy, they intervene immediately. Therefore, the System has a stabilization cost. So we are calculating the different possibilities of LCOE and total solar cost for three different types of solar size by changing system stabilization cost.

Table 20: LCOE and Total Cost for Small Size PV Panel by Changing the System Stabilization Cost

Solar LCOE and Total Cost for Small Size by Changing System Stabilization Cost		
SYSTEM STABILIZATION COST	SOLAR LCOE (without system stabilization cost)	TOTAL SOLAR COST
0	0.078	0.078
0.0025	0.078	0.081
0.005	**0.078**	**0.083**
0.0075	0.078	0.086
0.01	0.078	0.088

Source: own calculation from the data obtained from KIB-TEK

Table 21: LCOE and Total Cost for Mid-Size PV Panel by Changing the System Stabilization Cost

Solar LCOE and Total Cost for Mid-Size by Changing System Stabilization Cost		
SYSTEM STABILIZATION COST	SOLAR LCOE (without system stabilization cost)	TOTAL SOLAR COST
0	0.061	0.061
0.0025	0.061	0.063
0.005	**0.061**	**0.066**
0.0075	0.061	0.068
0.01	0.061	0.071

Source: own calculation from the data obtained from KIB-TEK

Table 22: LCOE and Total Cost for Large Scale PV Panel by Changing the System Stabilization Cost

Solar LCOE and Total Cost for Large Scale by Changing System Stabilization Cost		
SYSTEM STABILIZATION COST	SOLAR LCOE (without system stabilization cost)	TOTAL SOLAR COST
0	0.053	0.053
0.0025	0.053	0.056
0.005	**0.053**	**0.058**
0.0075	0.053	0.061
0.01	0.053	0.063

Source: own calculation from the data obtained from KIB-TEK

In tables 20, 21, and 22, we analyzed the changes happening to the LCOE and the total solar cost by changing system stabilization cost by increasing it from 0. to 0.01 $/kwh. Results show that with the increase of the system stabilization cost, the LCOE and total solar cost are rising. In table 20 we can see that LCOE without the system stabilization cost from small size is equal to 0.078 $/kWh but when we are adding the system stabilization cost the total solar cost is 0.078, 0.081, 0.083, 0.086, and 0.088 $/kWh respectively.

From the mid-size panel's results in table 21, results are similar to the small size solar panels; LCOE and total solar cost are increasing when system stabilization costs are increasing. The LCOE without the system stabilization cost is equal to 0.061 $/kWh. The total cost with stabilization cost is equal to 0.061, 0.063, 0.066, 0.068, and 0.071 $/kWh respectively.

Same as small size and mid-size panels, the large scale solar panels LCOE and total solar cost are increasing when increasing the stabilization cost. The LCOE without system stabilization cost is equal to 0.053 $/kWh. After we add the system the stabilization cost, the total cost are equal to 0.053, 0.056, 0.058, 0.061, and 0.063 $/kWh respectively.

Chapter 4

ALTERNATIVE ELECTRICITY PRODUCTION COST

4.1 Diesel and Steam Electricity Production Cost

In this study, we are calculating the operating cost of S.T. and T.D (excluding labor) by using the Diesel and Steam technology electricity production, taking the information from the KIB-TEK Electricity Authority. To calculate the operating costs, we are using the following parameters: Fuel price of 373 $/tonne, freight cost (today) of 34 $/tonne, S.T fuel consumption (including oil) of 285 gr/kWh, T. D. fuel consumption (including oil) of 210 gr/kWh, S.T. variable cost (excluding fuel and labor) of 0.003 $/kWh, and T. D. variable cost (excluding fuel and labor) of 0.009 $/kWh. The fuel price is going to be the base of the sensitivity analysis as it is going to be changed to see the effect on other variables. We can use this formula below to calculate the operating cost. However, we are just looking at the maintenance rate and fuel cost because renewable solar energy is replacing them.

Calculation 5: Operating Cost

$$\text{Operating cost} = \frac{\text{fuel consumption (including oil)} * (\text{Average fuel price} + \text{Freight})}{1{,}000{,}000} + \text{variable cost} \tag{5}$$

Table 23: Operating Cost for S.T. and T.D. Excluding Labor Cost

Average Fuel Price (since 2002)	**373**	**$/tonne**
Freight (today)	**34**	**$/tonne**
S.T. fuel consumption (including oil)	**285**	**gr/kWh**
T. D. fuel consumption (including oil)	**210**	**gr/kWh**
S.T. variable cost (excluding fuel and labor)	**0.003**	**$/kWh**
T. D. variable cost (excluding fuel and labor)	**0.009**	**$/kWh**
OPERATING COST OF S.T. (excluding labor)	**0.119**	**$/kWh**
OPERATING COST OF T.D. (excluding labor)	**0.094**	**$/kWh**

Source: own calculation from the data obtained from KIB-TEK

In table 23, by using the formula above, we are calculating the operating cost for diesel and steam technology. We can see that the operating cost from S.T. for each kWh is equal to 0.119 $, and the operating cost for T.D. for each kWh is to 0.094 $.

4.2 Sensitivity Analysis by Fuel Price

In the table below, we are analyzing the operating cost for S.T. and T.D. cost while taking into account labor and changing the fuel price:

Table 24: Operating Cost by Changing the Fuel Price

Operating Cost by Changing Fuel Price

Fuel Price	OPERATING COST OF S.T. (excluding labor)	OPERATING COST OF T.D. (excluding labor)
$ 73.00	0.033	0.031
$ 173.00	0.062	0.052
$ 273.00	0.090	0.073
$ 373.00	0.119	0.094
$ 473.00	0.138	0.115
$ 573.00	0.166	0.136
$ 673.00	0.195	0.157

Source: own calculation from the data obtained from KIB-TEK

We can see that increasing oil price is negatively affecting the operating cost because when fuel price increase from $73 to $ 673, the operating cost from S.T. increase as follows: 0.033, 0.062, 0.090, 0.119, 0.138, 0.166, and 0.195 $/kWh. Similarly, for values T.S. the values increase and are equal to 0.031, 0.052, 0.073, 0.094, 0.115, 0.136, and 0.157 $/kWh respectively.

Chapter 5

ANALYSIS AND RESULT

5.1 Analyzing Saving and Cost

In this part, we will examine and compare the saving/cost between the solar panel and alternative technology used in North Cyprus like the S.T. and T.D. system by using the total solar cost and operating cost (excluding labor). Afterwards, the parameters such as solar factor, solar price, discount rate, and fuel will be changed to see what will happen to the result with three different solar panel size. We are going to use the equation below to calculate saving or cost

Calculation 6: Saving or Cost

$$saving\ or\ cost = operating\ cost\ for\ alternative\ technology - total\ solar\ cost \quad (6)$$

As is evident from table 7, the total cost of the solar panel is 0.098 $/kWh. To find saving and cost for the small size solar panel, we are including the total cost of the solar panel with operating cost (excluding labor) for S.T. and T.D. Results are presented in table 25.

Table 25: Saving and Cost From Small Size Solar Panel

Saving/Cost for Small Size Solar Panel	
TOTAL SOLAR COST	0.083
OPERATING COST OF S.T. (excluding labor)	0.119
OPERATING COST OF T.D. (excluding labor)	0.094
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.036
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.011

Source: own calculation from the data obtained from KIB-TEK

Presented in the table above, we can see the operating cost of S.T. is higher than the total solar price presented as under these conditions solar panel is cheaper than the steam turbine by 0.036$/kWh. But for the diesel system, the table shows that the T.D. operating cost is more costly than the total cost of a solar panel by 0.0011 $/kWh.

Table 26: Saving and Cost From Mid-Size Solar Panel

Saving/Cost for Mid-Size Solar Panel	
TOTAL SOLAR COST	0.066
OPERATING COST OF S.T. (excluding labor)	0.119
OPERATING COST OF T.D. (excluding labor)	0.094
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.053
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.029

Source: own calculation from the data obtained from KIB-TEK

Table 26 presents the results of the saving and cost of the mid-size panel. Results suggest that with both of the technology S.T. and T.D., solar panels are better for generating electricity. In this calculation, the solar panels are cheaper than the S.T to generate electricity by 0.0.053 $/kWh, and when comparing the solar cost with the T.D, the solar is 0.0.029 $/kWh cheaper.

Table 27: Saving and Cost From Large Scale Solar Panel

Saving/Cost for Large Scale Solar Panel	
TOTAL SOLAR COST	0.058
OPERATING COST OF S.T.	0.119
OPERATING COST OF T.D.	0.094
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.061
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.036

Source: own calculation from the data obtained from KIB-TEK

Table 27 shows that using the solar panels for generating electricity is better than using S.T. and T.D. systems because the solar cost is 0.061 $/kWh cheaper than the S.T. system and 0.036 $/kWh cheaper than the T.D. system.

5.2 Sensitivity Analysis for Saving/Cost

In this part, we will study the sensitivity of the results by changing the parameters such as solar factor, solar price, discount rate, and fuel price to see the effect of the change on the results across the three different solar panel sizes.

5.2.1 Sensitivity Analysis for Saving/Cost by Changing Solar Factor

As demonstrated in tables 10, 11, and 12, changing the load factor of the solar panel affected the total solar cost on the three different solar sizes. Because of that condition, we will investigate the saving/cost by changing the load factor for all three different solar sizes.

Table 28: Saving/Cost from Small Size Solar Panel by Changing Load Factor

Saving/Cost from Small Size Solar Panel by Changing Load Factor						
solar load factor	19.0%	19.5%	20.0%	20.5%	21.0%	21.5%
total solar cost	0.083	0.081	0.079	0.078	0.076	0.074
OPERATING COST OF S.T. (excluding labor)	0.1190	0.1190	0.1190	0.1190	0.1190	0.1190
OPERATING COST OF T.D. (excluding labor)	0.0945	0.0945	0.0945	0.0945	0.0945	0.0945
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.0357	0.0377	0.0396	0.0414	0.0431	0.0448
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0112	0.0132	0.0151	0.0169	0.0186	0.0203

Source: own calculation from the data obtained from KIB-TEK

Looking back at table 10, we have calculated the total solar cost by changing the load factor for small size solar panel, so we are taking this result to calculate saving/cost sensitivity analysis by the load factor. The result from table 28 shows that when the solar load factor is increasing from 19% to 21.5 %, the total solar cost is decreasing, and in turn, the saving is increasing. Compared to the S.T. system in all stages, we can save with solar panels because the solar panels are cheaper. And also, for the T.D. system, if the load factor increasing from 19% to 21.5%, the total solar cost is decreasing, and in turn, the saving is increasing.

Table 29: Saving/Cost for the Mid-Size Solar Panel by Changing the Load Factor

Saving/Cost from Mid-Size Solar Panel by Changing Load Factor						
solar load factor	**19.0%**	19.5%	20.0%	20.5%	21.0%	21.5%
total solar cost	**0.066**	0.064	0.062	0.061	0.060	0.058
OPERATING COST OF S.T. (excluding labor)	**0.1190**	0.1190	0.1190	0.1190	0.1190	0.1190
OPERATING COST OF T.D. (excluding labor)	**0.0945**	0.0945	0.0945	0.0945	0.0945	0.0945
SAVING/COST OF SOLAR AS COMPARED TO S.T.	**0.0535**	0.0550	0.0565	0.0579	0.0592	0.0605
SAVING/COST OF SOLAR AS COMPARED TO T.D.	**0.0290**	0.0305	0.0320	0.0334	0.0347	0.0360

Source: own calculation from the data obtained from KIB-TEK

In table 11, we calculated the total solar cost by changing the solar load factor for the mid-size solar panel. As it has been pointed out in table 11, the increased load factor is negatively affecting the total solar cost. This result means that when the factor load is increasing, the solar panel's total cost becomes cheaper. Results presented in table 29 show that the total solar cost is decreased when increasing the solar load factor and became less expensive than the operating cost of S.T. and T.D.

Table 30: Saving/Cost from Large Scale Solar Panel by Changing Load Factor

Saving/Cost from Large Scale Solar Panel by Changing Load Factor						
solar load factor	19.0%	19.5%	20.0%	20.5%	21.0%	21.5%
total solar cost	0.058	0.057	0.056	0.054	0.053	0.052
OPERATING COST OF S.T. (excluding labor)	0.1190	0.1190	0.1190	0.1190	0.1190	0.1190
OPERATING COST OF T.D. (excluding labor)	0.0945	0.0945	0.0945	0.0945	0.0945	0.0945
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.0606	0.0620	0.0633	0.0645	0.0657	0.0668
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0361	0.0374	0.0387	0.0400	0.0412	0.0423

Source: own calculation from the data obtained from KIB-TEK

Same as the previews two solar panel size in table 12, we have calculated the total solar cost by changing the load factor for large scale panels. As demonstrated, increasing the solar load factor, the total solar cost is decreasing, so, when the load factor is rising, the solar panel becomes cheaper than the S.T. and T.D. system.

5.2.2 Sensitivity Analysis by Changing Solar Price

As we saw from tables 13, 14, and 15, the solar price affects the total cost price, when the solar panel price increase, the total solar cost increases. Therefore, we will estimate the saving/cost by changing the solar price parameter.

Table 31: Saving/Cost from Small Size Solar Panel by Changing Solar Price

Saving/Cost from Small Size Solar Panel by Changing Solar Panel Price							
solar panel price	$ 800.00	$ 900.00	$ 1,000.00	**$ 1,100.00**	$ 1,200.00	$ 1,300.00	$ 1,400.00
total solar cost	0.062	0.069	0.076	**0.083**	0.090	0.098	0.105
OPERATING COST OF S.T. (excluding labor)	0.1190	0.1190	0.1190	**0.1190**	0.1190	0.1190	0.1190
OPERATING COST OF T.D. (excluding labor)	0.0945	0.0945	0.0945	**0.0945**	0.0945	0.0945	0.0945
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.0570	0.0499	0.0428	**0.0357**	0.0286	0.0214	0.0143
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0325	0.0254	0.0183	**0.0111**	0.0040	-0.0031	-0.0102

Source: own calculation from the data obtained from KIB-TEK

From table 13, we calculated the total solar cost for small size solar panel by changing solar panel prices. We saw that increasing the solar price is raising the total solar cost. Table 31 shows the results for the saving or cost and the comparison between solar panel cost with S.T. and T.D system for generating electricity. Results suggest that the solar cost is cheaper than the S.T. system if the solar price is between $ 800- $1400. For the T.D. system, solar costs are less expensive if the solar price falls between $800_$1200. However, if the solar price is equal to or more than $ 1300, the T.S. system cost becomes cheaper than the total solar cost.

Table 32: Saving/Cost from Mid-Size Solar Panel by Changing Solar Price

Saving/Cost from Mid-Size Solar Panel by Changing Solar Panel Price							
solar panel price	$ 550	$ 650	$ 750	$ 850	$ 950	$ 1,050	$ 1,150
total solar cost	$ 0.044	$ 0.051	$ 0.058	$ 0.066	$ 0.073	$ 0.080	$ 0.087
OPERATING COST OF S.T. (excluding labor)	0.1190	0.1190	0.1190	0.1190	0.1190	0.1190	0.1190
OPERATING COST OF T.D. (excluding labor)	0.0945	0.0945	0.0945	0.0945	0.0945	0.0945	0.0945
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.0748	0.0677	0.0606	0.0535	0.0464	0.0392	0.0321
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0503	0.0432	0.0361	0.0289	0.0218	0.0147	0.0076

Source: own calculation from the data obtained from KIB-TEK

In table 14, we calculated the total solar cost for the mid-size solar panel and made solar panel prices vary. We saw that increasing the solar price is increasing the total solar cost. Table 32 shows the calculations of savings or costs for the three systems compared to each other. Results show that although increasing the solar price is increasing the total solar cost, the total solar cost is still cheaper than the S.T electricity generation system cost. And also, when compared to the T.D electricity generation system, the solar panel cost is cheaper than alternative technology if the solar panel price is between $ 550_ $ 1150.

Table 33: Saving/Cost from Large Scale Solar Panel by Changing Solar Price

Saving/Cost from Large Scale Solar Panel by Changing Solar Panel Price							
solar panel price	$ 450	$ 550	$ 650	$ 750	$ 850	$ 950	$ 1,050
total solar cost	0.037	0.044	0.051	0.058	0.066	0.073	0.076
OPERATING COST OF S.T. (excluding labor)	0.1190	0.1190	0.1190	0.1190	0.1190	0.1190	0.1190
OPERATING COST OF T.D. (excluding labor)	0.0945	0.0945	0.0945	0.0945	0.0945	0.0945	0.0945
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.0820	0.0748	0.0677	0.0606	0.0535	0.0464	0.0428
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0574	0.0503	0.0432	0.0361	0.0289	0.0218	0.0183

Source: own calculation from the data obtained from KIB-TEK

Similar to the small size and mid-size solar panels, table 15 shows the different values of total solar cost for large-scale when changing solar panel prices move in the same direction. We are using this result to find sensitivity for saving/cost by changing the solar price. Table 33 presents the results of the sensitivity for saving/cost, and it states that the total solar cost, when compared with S.T and T.D electricity production system, is still cheaper.

5.2.3 Sensitivity Analysis by Changing Solar Price Discount Rate

According to tables 16, 17, and 18 we saw that when the discount rate increases, the total solar cost is increasing. Therefore, we will test the sensitivity by changing the discount rate for three different types of solar panels.

Table 34: Saving/Cost from Small Size Solar Panel by Changing Discount Rate

Saving/Cost from Small Size Solar Panel by Changing Discount Rate							
discount rate	7%	8%	9%	10%	11%	12%	13%
total solar cost	0.067	0.072	0.078	0.083	0.089	0.095	0.101
OPERATING COST OF S.T. (excluding labor)	0.1190	0.1190	0.1190	0.1190	0.1190	0.1190	0.1190
OPERATING COST OF T.D. (excluding labor)	0.0945	0.0945	0.0945	0.0945	0.0945	0.0945	0.0945
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.0520	0.0470	0.0410	0.0360	0.0300	0.0240	0.0180
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0275	0.0225	0.0165	0.0115	0.0055	-0.0005	-0.0065

Source: own calculation from the data obtained from KIB-TEK

Table 16 indicated that when increasing the discount rate, the total solar cost increases as well. In table 34 we are using the total solar cost to find the saving/cost. Results show that the total solar cost is cheaper than the S.T electricity generation system. When comparing the solar system with the T.D electricity generation system, if the discount rate is between 7% and 11%, the solar panel is cheaper. But, if the discount rate is equal to or more than 12%, the T.D electricity generation system is cheaper than the solar panel electricity production system.

Table 35: Saving/Cost from Mid-size Solar Panel by Changing Discount Rate

Saving/Cost from Mid-Size Solar Panel by Changing Discount Rate							
discount rate	7%	8%	9%	10%	11%	12%	13%
total solar cost	0.0530	0.0570	0.0610	0.0660	0.0700	0.0750	0.0790
OPERATING COST OF S.T. (excluding labor)	0.1190	0.1190	0.1190	0.1190	0.1190	0.1190	0.1190
OPERATING COST OF T.D. (excluding labor)	0.0945	0.0945	0.0945	0.0945	0.0945	0.0945	0.0945
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.0660	0.0620	0.0580	0.0530	0.0490	0.0440	0.0400
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0415	0.0375	0.0335	0.0285	0.0245	0.0195	0.0155

Source: own calculation from the data obtained from KIB-TEK

Table 17 shows the values of the total solar cost when changing the discount rate for the mid-size solar panel and shows that a rise in the discount rate would induce a hike in the total solar cost. Looking at the results shown in table 35, although the total solar cost is increased, when compared with S.T and T.D electric generation system, the solar cost is still cheaper than both alternative systems.

Table 36: Saving/Cost from Large Scale Solar Panel by Changing Discount Rate

Saving/Cost from Large Scale Solar Panel by Changing Discount Rate							
discount rate	7%	8%	9%	10%	11%	12%	13%
total solar cost	0.047	0.051	0.055	0.058	0.062	0.066	0.070
OPERATING COST OF S.T. (excluding labor)	0.1190	0.1190	0.1190	0.1190	0.1190	0.1190	0.1190
OPERATING COST OF T.D. (excluding labor)	0.0945	0.0945	0.0945	0.0945	0.0945	0.0945	0.0945
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.0720	0.0680	0.0640	0.0610	0.0570	0.0530	0.0490
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0475	0.0435	0.0395	0.0365	0.0325	0.0285	0.0245

Source: own calculation from the data obtained from KIB-TEK

After obtaining results from table 18 in large scale solar panel when the discount rate increase, the solar cost is also increasing, using that result, we are analyzing saving/cost, between solar panel cost and S.T and T.D electric production system. Table 36 presents the results of saving/cost analysis. It shows that although the solar panel cost is increasing, it is still cheaper than the S.T and T.D alternative electric production technology.

5.2.4 Sensitivity Analysis by Changing System Stabilization Cost

In tables 19, 20, 21 we investigated the total solar cost by changing system stabilization cost for three different sizes of solar panels. Based on that, we will examine the sensitivity for saving/cost by changing system stabilization cost.

Table 37: Saving/Cost from Small Size Solar Panel by Changing System Stabilization Cost

Saving/Cost from Small Size Solar Panel by Changing System Stabilization Cost					
system stabilization cost	$ -	$ 0.0025	$ 0.0050	$ 0.0075	$ 0.0100
total solar cost	0.078	0.081	0.083	0.086	0.088
OPERATING COST OF S.T. (excluding labor)	0.1190	0.1190	0.1190	0.1190	0.1190
OPERATING COST OF T.D. (excluding labor)	0.0945	0.0945	0.0945	0.0945	0.0945
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.0407	0.0382	0.0357	0.0332	0.0307
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0161	0.0136	0.0111	0.0086	0.0061

Source: own calculation from the data obtained from KIB-TEK

In table 19 we have calculated the total solar cost by changing system stabilization cost for small-size solar panels, and we saw that increasing system stabilization cost is causing an increase in the total solar cost. Table 37 presents the results of the saving/cost between small-size solar panel cost and alternative electric production cost. Results show that although the total solar panel cost is rising, solar power is still cheaper than the S.T electric production cost. And also, when compared with the T.D system, it is apparent that if the system stabilization cost is between $0 _$0.01, solar power is still cheaper than T.D electric production technology.

Table 38: Saving/Cost from Mid-Size Solar Panel by Changing System Stabilization Cost

Saving/Cost from Mid-Size Solar Panel by Changing System Stabilization Cost					
system stabilization cost	$ -	$ 0.003	**$ 0.005**	$ 0.008	$ 0.010
total solar cost	0.061	0.063	**0.066**	0.068	0.071
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.1190	0.1190	**0.1190**	0.1190	0.1190
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0945	0.0945	**0.0945**	0.0945	0.0945
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.0585	0.0560	**0.0535**	0.0510	0.0485
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0339	0.0314	**0.0289**	0.0264	0.0239

Source: own calculation from the data obtained from KIB-TEK

Table 20 measures the solar cost values when changing the system stabilization cost in mid-size solar panels. It indicates that when the system stabilization cost rise, the solar cost increase as well. Using that result, we are analyzing saving/cost between solar panel cost and S.T and T.D electric production systems. Table 38 presents the analysis of the saving/cost. Results show that although the solar panel cost is higher, it is still cheaper than the S.T and T.D alternative electric production technology.

Table 39: Saving/Cost from Large Scale Solar Panel by Changing System Stabilization Cost

Saving/Cost from Large Scale Solar Panel by Changing System Stabilization Cost					
system stabilization cost	$ -	$ 0.0025	**$ 0.0050**	$ 0.0075	$ 0.01
total solar cost	0.053	0.056	**0.058**	0.061	0.063
OPERATING COST OF S.T. (excluding labor)	0.1190	0.1190	**0.1190**	0.1190	0.1190
OPERATING COST OF T.D. (excluding labor)	0.0945	0.0945	**0.0945**	0.0945	0.0945
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.0656	0.0631	**0.0606**	0.0581	0.0556
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0411	0.0386	**0.0361**	0.0336	0.0311

Source: own calculation from the data obtained from KIB-TEK

As it might be seen in table 21, in large-scale solar panels, when system stabilization cost is increasing, the solar cost is also rising. By using that result, we are analyzing saving/cost between solar panel cost and S.T and T.D electric production system. Results in table 38 indicate that although the solar panel cost is increasing, it is still cheaper than the S.T and T.D alternative electric production technology.

5.2.5 Sensitivity Analysis by Changing Fuel Price

The changing fuel price influences the saving/cost result. As shown in Table 23, when fuel price is changed, the operating cost from the S.T and T.D alternative electric generation technology is increasing. Therefore in the tables below, we will examine the sensitivity of the costs with regards to changing fuel price for three different solar sizes to compare the total solar cost and operating cost for alternative technology.

Table 40: Saving/Cost from Small Size Solar Panel by Changing Fuel Price

Saving/Cost from Small Size Solar Panel by Changing Fuel Price							
fuel price	$ 73.00	$ 173.00	$ 273.00	$373.00	$ 473.00	$ 573.00	$ 673.00
total solar cost	0.083	0.083	0.083	0.083	0.083	0.083	0.083
OPERATING COST OF S.T. (excluding labor)	0.033	0.062	0.090	0.119	0.138	0.166	0.195
OPERATING COST OF T.D. (excluding labor)	0.031	0.052	0.073	0.094	0.115	0.136	0.157
SAVING/COST OF SOLAR AS COMPARED TO S.T.	-0.050	-0.021	0.007	0.036	0.054	0.083	0.111
SAVING/COST OF SOLAR AS COMPARED TO T.D.	-0.052	-0.031	-0.010	0.011	0.032	0.053	0.074

Source: own calculation from the data obtained from KIB-TEK

The variability in fuel price from small size solar panel is affecting the result of saving/cost sensitivity analysis in table 40. It is apparent that when fuel price rise, the operating cost from S.T and T.D is rising and the total solar cost for each kWh is equal to $ 0.083. So, if the fuel price is between $73_$173 for each tonne, the operating cost from S.T is cheaper than the total solar cost. But, if the fuel price is equal to and higher than $273 for each tonne, the total solar cost is cheaper than the S.T operating cost. Moreover, if the fuel price is between $ 73- $273 for each tonne, the T.S operating cost is less expensive than the total solar cost. But if the fuel price is equal to or higher than $373, the total solar cost is cheaper than the T.S operating cost.

Table 41: Saving/Cost from Mid-Size Solar Panel by Changing Fuel Price

Saving/Cost from Mid-Size Solar Panel by Changing Fuel Price							
fuel price	$73.00	$173.00	$273.00	$373.00	$473.00	$573.00	$673.00
total solar cost	0.066	0.066	0.066	0.066	0.066	0.066	0.066
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.0335	0.0620	0.0905	0.1190	0.1378	0.1663	0.1948
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.0315	0.0525	0.0735	0.0945	0.1155	0.1365	0.1575
SAVING/COST OF SOLAR AS COMPARED TO S.T.	-0.0320	-0.0035	0.0250	0.0535	0.0723	0.1008	0.1293
SAVING/COST OF SOLAR AS COMPARED TO T.D.	-0.0341	-0.0131	0.0079	0.0289	0.0499	0.0709	0.0919

Source: own calculation from the data obtained from KIB-TEK

The changing fuel price from the mid-size solar panel is also affecting the result of saving/cost sensitivity analysis in table 41. Table 41 shows that when the fuel price is increasing, the operating costs of S.T and T.D are growing and the total solar cost for each kWh is equal to $ 0.066. Results suggest that if the fuel price is between $73_$173 for each tonne, the operating cost from S.T is cheaper than the total solar cost. However, if the fuel price is equal to and more than $ 273 for each tonne, the total solar cost is cheaper than the S.T operating cost. Furthermore, if the fuel price is between $73- $173 for each tonne, the T.S operating cost is less expensive than the total solar cost. But, if the fuel price is equal or above $273 the total solar cost is cheaper than T.S operating cost.

Table 42: Saving/Cost from Large Scale Solar Panel by Changing Fuel Price

Saving/Cost From Large Scale Solar Panel by Changing Fuel Price							
fuel price	$73.00	$173.00	$273.00	**$373.00**	$473.00	$573.00	$673.00
total solar cost	0.058	0.058	0.058	**0.058**	0.058	0.058	0.058
OPERATING COST OF S.T. (excluding labor)	0.0335	0.0620	0.0905	**0.1190**	0.1378	0.1663	0.1948
OPERATING COST OF T.D. (excluding labor)	0.0315	0.0525	0.0735	**0.0945**	0.1155	0.1365	0.1575
SAVING/COST OF SOLAR AS COMPARED TO S.T.	-0.0249	0.0036	0.0321	**0.0606**	0.0794	0.1079	0.1364
SAVING/COST OF SOLAR AS COMPARED TO T.D.	-0.0269	-0.0059	0.0151	**0.0361**	0.0571	0.0781	0.0991

Source: own calculation from the data obtained from KIB-TEK

The changing fuel price from large scale solar panel also impacts the result of saving/cost sensitivity analysis in table 42. Findings reveal that when the fuel price is increasing, the operating cost from S.T and T.D is growing and the total solar cost for each kWh is equal to $ 0.058. Results state that if the fuel price is equal to $73 for each tonne, the operating cost from S.T is cheaper than the total solar cost. But, if the fuel price is equal and above $ 173 for each tonne, the total solar cost is cheaper than the S.T operating cost. Moreover, if the fuel price is between $ 73_ $173 for each tonne, the T.S operating cost is less expensive than the total solar cost. Still, if the fuel price is equal or above $273 the overall solar cost is cheaper than T.S operating cost.

5.3 Analyzing the Breakeven Fuel Price for Alternative Electric Production Technology

In this part, we are estimating the breakeven fuel price for alternative electricity production technology, assuming the fuel price is constant for the next 25 years if solar panels replace alternative electricity generation systems. Moreover, the total solar cost and fuel consumption (including oil) for alternative electricity production technology are utilized to calculate breakeven fuel price. Furthermore, the S.T fuel consumption (including oil) is equal to 285gr/kWh, and T.D fuel consumption (including oil) is 210gr/kWh. How much is the breakeven fuel price for three different solar sizes? We can use the formula below to find the result.

Calculation 7: Breakeven Fuel Price

$$\text{Breakeven fuel price} = \frac{\text{Total solar cost} * 1{,}000{,}000}{\text{Fuel consumption (including oil)}} \qquad (7)$$

Table 43: Breakeven Fuel Price for S.T and T.D Alternative Technology for Small Size Technology

Small Sized PV Panel		
SOLAR CAPACITY	1	KW
SOLAR LOAD FACTOR	19.0%	
KW PRICE OF SOLAR	1100	USD
SOLAR DEGRADATION FACTOR	-1%	per year
DISCOUNT RATE	10.00%	
HOURS IN A YEAR	8760	
PV of ELECTRICITY PRODUCED	14,045	kWh
SOLAR LCOE (without system stabilization cost)	**0.078**	**$/kWh**
System stabilization cost	**0.005**	**$/kWh**
TOTAL SOLAR COST	**0.083**	**$/kWh**
OPERATING COST OF S.T. (excluding labor)	0.119	$/kWh
OPERATING COST OF T.D. (excluding labor)	0.094	$/kWh
S.T. variable cost (excluding fuel and labor)	0.003	$/kWh
T. D. variable cost (excluding fuel and labor)	0.009	$/kWh
S.T. fuel consumption (including oil)	285	gr/kWh
T. D. fuel consumption (including oil)	210	gr/kWh
BREAKEVEN FUEL PRICE FOR S.T. (including freight)	292	$/tonne
BREAKEVEN FUEL PRICE FOR T.D. (including freight)	397	$/tonne

Source: own calculation from the data obtained from KIB-TEK

Table 43 present the results of the breakeven fuel price for both alternative electric productions for North Cyprus S.T and T.D for small size solar panels. If the S.T fuel consumption is equal to 285 gr/kWh and the total solar cost is 0.083 $/kWh, the breakeven fuel price for S.T is equal to 292 $/tonne. And, if T.D fuel consumption is equal to 210 gr/kWh and the total solar cost is equivalent to 0.083 $/kWh, the breakeven fuel price for T.D is equal to 397 $/tonne.

It means that if we buy solar panels today and they have 25 years of activity, the total cost would be $ 0.083 for each kWh. Thus, it refers to the price of fuel if we were to produce it with diesel or steam. Since steam turbine burns at a rate of 285 g/kWh and it has a cost of 0.003 $/kWh for maintenance and repair and $ 0.083 for each kWh to solar panels, This indicates that if electricity is produced using steam turbines, it means that fuel would cost 292 $/tonne. Moreover, if diesel is used, taking into account that diesel uses fuel at a rate of 210 g / kWh. It has a cost of 0.009 $ / kWh for maintenance and repair, by giving $ 0.0.083 for each kWh to solar panels, if electricity production utilized diesel, it means that fuel would cost 397 $/tonne.

Table 44: Breakeven Fuel Price for S.T and T.D Alternative Technology for Mid-Size Technology

Mid-Sized PV Panel		
SOLAR CAPACITY	1	KW
SOLAR LOAD FACTOR	19.0%	
KW PRICE OF SOLAR	850	USD
SOLAR DEGRADATION FACTOR	-1%	per year
DISCOUNT RATE	10.00%	
HOURS IN A YEAR	8760	
PV of ELECTRICITY PRODUCED	14,045	kWh
SOLAR LCOE (without system stabilization cost)	**0.061**	**$/kWh**
System stabilization cost	**0.005**	**$/kWh**
TOTAL SOLAR COST	**0.066**	**$/kWh**
OPERATING COST OF S.T. (excluding labor)	0.119	$/kWh
OPERATING COST OF T.D. (excluding labor)	0.09447	$/kWh
S.T. variable cost (excluding fuel and labor)	0.003	$/kWh
T. D. variable cost (excluding fuel and labor)	0.009	$/kWh
S.T. fuel consumption (including oil)	285	gr/kWh
T. D. fuel consumption (including oil)	210	gr/kWh
BREAKEVEN FUEL PRICE FOR S.T. (including freight)	230	$/tonne
BREAKEVEN FUEL PRICE FOR T.D. (including freight)	312	$/tonne

Source: own calculation from the data obtained from KIB-TEK

Table 44 presents the results of the breakeven fuel price for both alternative electric productions for North Cyprus S.T and T.D for the mid-size solar panel. Results indicate that if the S.T fuel consumption is equal to 285 gr/kWh and the total solar cost is equal to 0.066 $/kWh, the breakeven fuel price for S.T is equal to 230 $/tonne. And, if T.D fuel consumption is equal to 210 gr/kWh and the total solar cost is equivalent to 0.066 $/kWh, the breakeven fuel price for T.D is equal to 312 $/tonne.

Results suggest that if we buy solar panels today and they have 25 years of activity, it would cost $ 0.066 for each kWh. Results indicate how much the price of fuel would be if we were to produce it with diesel or steam. Since steam turbine burns 285 g/kWh of fuel and it has a cost of 0.003 $/kWh for maintenance and repair, by giving $ 0.066 for each kWh to solar panels, and the production of power was with steam turbines, fuel cost would be 230 $/tonne. Also, diesel has a burning rate of fuel of 210 g / kWh, and it has a cost of 0.009 $ / kWh for maintenance and repair. Today, by giving $ 0.066 for each kWh to solar panels, if electricity production were with diesel, fuel cost would be 312 $/tonne.

Table 45: Breakeven Fuel Price for S.T and T.D Alternative Technology for Large Scale Technology

Large Scale PV Panel		
SOLAR CAPACITY	1	KW
SOLAR LOAD FACTOR	19.0%	
KW PRICE OF SOLAR	750	USD
SOLAR DEGRADATION FACTOR	-1%	per year
DISCOUNT RATE	10.00%	
HOURS IN A YEAR	8760	
PV of ELECTRICITY PRODUCED	14,045	kWh
SOLAR LCOE (without system stabilization cost)	**0.053**	**$/kWh**
System stabilization cost	**0.005**	**$/kWh**
TOTAL SOLAR COST	**0.058**	**$/kWh**
OPERATING COST OF S.T. (excluding labor)	0.119 $/kWh	
OPERATING COST OF T.D. (excluding labor)	0.0945 $/kWh	
S.T. variable cost (excluding fuel and labor)	0.003 $/kWh	
T. D. variable cost (excluding fuel and labor)	0.009 $/kWh	
S.T. fuel consumption (including oil)	285 gr/kWh	
T. D. fuel consumption (including oil)	210 gr/kWh	
BREAKEVEN FUEL PRICE FOR S.T. (including freight)	205	$/tonne
BREAKEVEN FUEL PRICE FOR T.D. (including freight)	278	$/tonne

Source: own calculation from the data obtained from KIB-TEK

Table 45 displays the results of the breakeven fuel price for both alternative electric productions for North Cyprus S.T and T.D for large scale solar panels. Results point out that if the S.T fuel consumption is equal to 285 gr/kWh and the total solar cost is equal to 0.058 $/kWh, the breakeven fuel price for S.T is equal to 205 $/tonne. Moreover, if T.D fuel consumption is equal to 210 gr/kWh and the total solar cost is equal to 0.058 $/kWh, the breakeven fuel price for T.D is equal to 278 $/tonne.

The results propose that if we buy solar panels today and they have 25 years of activity, the cost would be $ 0.058 for each kWh. Findings specify the price of fuel when it is produced with diesel or steam. Steam turbine burns 285 g/kWh, and it has a cost of 0.003 $/kWh for maintenance and repair, by giving $ 0.058 for each kWh to solar panels, if production were carried out with steam turbines, fuel cost would be 205 $/tonne. Also, diesel has a fuel consumption of 210 g / kWh, and it has a price of 0.009 $ / kWh for maintenance and repair. Today, by giving $ 0.058 for each kWh to solar panels, if electricity production were carried out with diesel, fuel cost would be 278 $/tonne.

5.4 Sensitivity Analysis for Breakeven Fuel Price

Total solar cost is influenced by changing the parameters like solar load factor, solar KW price, discount rate, and system stabilization cost, and in turn, that can change breakeven fuel price. Therefore, we will analyze the sensitivity for breakeven fuel prices by changing the parameters mentioned above.

5.4.1 Sensitivity Analysis by Changing Solar Load Factor

Tables 10, 11, and 12, presented the results of the total solar cost in regards to a changing value of the solar load factor, we are using that result to explore the sensitivity for breakeven fuel price.

Table 46: Breakeven Fuel Price by Changing Solar Load Factor for Small Size Solar Panel

Breakeven Fuel Price by Changing Solar Load Factor for Small Size Solar Panel			
solar load factor	total solar cost	S.T. fuel consumption (including oil)	T. D. fuel consumption (including oil)
		285 gr/kWh	210 gr/kWh
19.0%	**0.083**	**292 $/tonne**	**397 $/tonne**
19.5%	0.081	285 $/tonne	387 $/tonne
20.0%	0.079	279 $/tonne	378 $/tonne
20.5%	0.078	272 $/tonne	369 $/tonne
21.0%	0.076	266 $/tonne	361 $/tonne
21.5%	0.074	260 $/tonne	353 $/tonne

Source: own calculation from the data obtained from KIB-TEK

As demonstrated in table 10, a rise in solar load factor would trigger a decrease in the total solar cost, so from table 46 above, we can see the breakeven fuel price is decreasing for both alternative electric production technologies.

Table 47: Breakeven Fuel Price by Changing Solar Load Factor for Mid-Size Solar Panel

Breakeven Fuel Price by Changing Solar Load Factor for Mid-Size Solar Panel			
solar load factor	total solar cost	S.T. fuel consumption (including oil)	T. D. fuel consumption (including oil)
		285 gr/kWh	210 gr/kWh
19.0%	**0.066**	**230 $/tonne**	**312 $/tonne**
19.5%	0.064	224 $/tonne	305 $/tonne
20.0%	0.062	219 $/tonne	298 $/tonne
20.5%	0.061	214 $/tonne	291 $/tonne
21.0%	0.060	210 $/tonne	285 $/tonne
21.5%	0.058	205 $/tonne	278 $/tonne

Source: own calculation from the data obtained from KIB-TEK

As it has been pointed out in table 11, a hike in solar load factor would lower the total solar cost. From table 47, we can see that the total solar cost is decreasing when changing the load factor; the breakeven fuel price is also decreasing for S.T and T.D electric production system.

Table 48: Breakeven Fuel Price by Changing Solar Load Factor for Large Scale Solar Panel

Breakeven Fuel Price by Changing Solar Load Factor for Large Scale Solar Panel					
solar load factor	total solar cost	S.T. fuel consumption (including oil)		T. D. fuel consumption (including oil)	
		285	gr/kWh	210	gr/kWh
19.0%	**0.058**	**205**	**$/tonne**	**278**	**$/tonne**
19.5%	0.057	200	$/tonne	272	$/tonne
20.0%	0.056	196	$/tonne	265	$/tonne
20.5%	0.054	191	$/tonne	260	$/tonne
21.0%	0.053	187	$/tonne	254	$/tonne
21.5%	0.052	183	$/tonne	249	$/tonne

Source: own calculation from the data obtained from KIB-TEK

As is evident from table 12, when the solar load factor increase, the total solar cost decrease. Table 48 suggests that if the total solar cost is less when the load factor is increased, the breakeven fuel price from S.T and T.D alternative electric generation is decreased.

5.4.2 Sensitivity Analysis by Changing Solar KW Price

As presented in tables 13, 14, and 15, we calculated the total solar cost values when changing solar KW price. We are using that result to test the sensitivity for breakeven fuel price for three different solar sizes.

Table 49: Breakeven Fuel Price by Changing Solar KW Price for Small Size Solar Panel

Breakeven Fuel Price by Changing Solar KW Price for Small Size Solar Panel							
solar kw price		total solar cost	S.T. fuel consumption (including oil)		T. D. fuel consumption (including oil)		
			285	gr/kWh	210	gr/kWh	
$	800.00	0.062	217	$/tonne	295	$/tonne	
$	900.00	0.069	242	$/tonne	329	$/tonne	
$	1,000.00	0.076	267	$/tonne	363	$/tonne	
$	**1,100.00**	**0.083**	**292**	**$/tonne**	**397**	**$/tonne**	
$	1,200.00	0.090	317	$/tonne	431	$/tonne	
$	1,300.00	0.098	342	$/tonne	465	$/tonne	
$	1,400.00	0.105	367	$/tonne	498	$/tonne	

Source: own calculation from the data obtained from KIB-TEK

As can be seen in table 13, when the solar KW price increases, the total solar cost is rising. So we are using that information in table 49 to inspect sensitivity for breakeven fuel price for two type's alternative electric production technology from Cyprus. Results from table 49 indicate that if the solar KW price rise, the total cost also increases, so the breakeven fuel price is increasing significantly.

Table 50: Breakeven Fuel Price by Changing Solar KW Price for Mid-Size Solar Panel

Breakeven Fuel Price by Changing Solar KW Price Mid-Size Solar Panel						
solar kw price		total solar cost	S.T. fuel consumption (including oil)		T. D. fuel consumption (including oil)	
			285	gr/kWh	210	gr/kWh
$	550.00	0.044	155	$/tonne	210	$/tonne
$	650.00	0.051	180	$/tonne	244	$/tonne
$	750.00	0.058	205	$/tonne	278	$/tonne
$	**850.00**	**0.066**	**230**	**$/tonne**	**312**	**$/tonne**
$	950.00	0.073	255	$/tonne	346	$/tonne
$	1,050.00	0.080	280	$/tonne	380	$/tonne
$	1,150.00	0.087	305	$/tonne	414	$/tonne

Source: own calculation from the data obtained from KIB-TEK

Table 51: Breakeven Fuel Price by Changing Solar KW Price for Large Scale Solar Panel

Breakeven Fuel Price by Changing Solar KW Price for Large Scale Solar Panel						
solar kw price		total solar cost	S.T. fuel consumption (including oil)		T. D. fuel consumption (including oil)	
			285	gr/kWh	210	gr/kWh
$	450.00	0.037	130	$/tonne	176	$/tonne
$	550.00	0.044	155	$/tonne	210	$/tonne
$	650.00	0.051	180	$/tonne	244	$/tonne
$	**750.00**	**0.058**	**205**	**$/tonne**	**278**	**$/tonne**
$	850.00	0.066	230	$/tonne	312	$/tonne
$	950.00	0.073	255	$/tonne	346	$/tonne
$	1,050.00	0.076	267	$/tonne	363	$/tonne

Source: own calculation from the data obtained from KIB-TEK

Tables 14 and 15 suggest that when solar KW price is higher, the total solar cost is also higher for both mid-size and large-scale solar panels. We utilized those calculations to check the sensitivity for breakeven fuel prices for mid-size and large-scale solar panels. Tables 50 and 51 present the results of the breakeven analysis. Results propose that the total solar cost is higher because of the increase in solar KW price, which in turn affected the breakeven fuel price to increase.

5.4.3 Sensitivity Analysis by Changing Discount Rate

Tables 16, 17, and 18 present the values of total solar cost, taking into account the changing value of the discount rate. In this part, we are drawing results from the abovementioned tables to study the sensitivity for breakeven fuel price.

Table 52: Breakeven Fuel Price by Changing Discount Rate from Small Size Solar Panel

Breakeven Fuel Price by Changing Discount Rate for Small Size Solar Panel					
discount rate	total solar cost	S.T. fuel consumption (including oil)		T. D. fuel consumption (including oil)	
		285	gr/kWh	210	gr/kWh
7%	0.067	235	$/tonne	319	$/tonne
8%	0.072	253	$/tonne	343	$/tonne
9%	0.078	274	$/tonne	371	$/tonne
10%	**0.083**	**292**	**$/tonne**	**397**	**$/tonne**
11%	0.089	312	$/tonne	424	$/tonne
12%	0.095	333	$/tonne	452	$/tonne
13%	0.101	354	$/tonne	481	$/tonne

Source: own calculation from the data obtained from KIB-TEK

Table 53: Breakeven Fuel Price by Changing Discount Rate from Mid-Size Solar Panel

Breakeven Fuel Price by Changing Discount Rate for Mid-Size Solar Panel			
discount rate	total solar cost	S.T. fuel consumption (including oil)	T. D. fuel consumption (including oil)
		285 gr/kWh	210 gr/kWh
7%	0.053	186 $/tonne	252 $/tonne
8%	0.057	200 $/tonne	271 $/tonne
9%	0.061	214 $/tonne	290 $/tonne
10%	**0.066**	**230 $/tonne**	**312 $/tonne**
11%	0.070	246 $/tonne	333 $/tonne
12%	0.075	263 $/tonne	357 $/tonne
13%	0.079	277 $/tonne	376 $/tonne

Source: own calculation from the data obtained from KIB-TEK

Table 54: Breakeven Fuel Price by Changing Discount Rate from Large Scale Solar Panel

Breakeven Fuel Price by Changing Discount Rate for Large Scale Solar Panel			
discount rate	total solar cost	S.T. fuel consumption (including oil)	T. D. fuel consumption (including oil)
		285 gr/kWh	210 gr/kWh
7%	0.047	165 $/tonne	224 $/tonne
8%	0.051	179 $/tonne	243 $/tonne
9%	0.055	193 $/tonne	262 $/tonne
10%	**0.058**	**205 $/tonne**	**278 $/tonne**
11%	0.062	218 $/tonne	295 $/tonne
12%	0.066	232 $/tonne	314 $/tonne
13%	0.070	246 $/tonne	333 $/tonne

Source: own calculation from the data obtained from KIB-TEK

After we calculated the total solar cost from tables 16, 17, 18 for small size, mid-size, and large scale solar panels respectively, it is clear to see that when the discount rate increases, the total solar cost is also increasing. Tables 52, 53, and 54, present the breakeven fuel price for three different solar sizes with S.T and T.D generation electricity from Cyprus. Results from tables 52, 53, and 54, suggest that when the total solar cost rises, the breakeven fuel prices are also rising with two alternative electric production systems.

5.4.4 Sensitivity Analysis by Changing System Stabilization Cost

Tables 19, 20, and 21, presented the values of total solar cost taking into account the changing system stabilization cost. These values are utilized to evaluate the sensitivity for breakeven fuel price for three different solar sizes.

Table 55: Breakeven Fuel Price by Changing System Stabilization Cost from Small Size Solar Panel

Breakeven Fuel Price by Changing System Stabilization Cost for Small Size Solar Panel					
system stabilization cost	total solar cost	S.T. fuel consumption (including oil)		T. D. fuel consumption (including oil)	
		285	gr/kWh	210	gr/kWh
0.0000	0.078	275	$/tonne	373	$/tonne
0.0025	0.081	284	$/tonne	385	$/tonne
0.0050	**0.083**	**292**	**$/tonne**	**397**	**$/tonne**
0.0075	0.086	301	$/tonne	409	$/tonne
0.0100	0.088	310	$/tonne	421	$/tonne

Source: own calculation from the data obtained from KIB-TEK

Table 56: Breakeven Fuel Price by Changing System Stabilization Cost from Mid-Size Solar Panel

Breakeven Fuel Price by Changing System Stabilization Cost for Mid-Size Solar Panel			
system stabilization cost	total solar cost	S.T. fuel consumption (including oil)	T. D. fuel consumption (including oil)
		285 gr/kWh	210 gr/kWh
0.00	0.061	212 $/tonne	288 $/tonne
0.0025	0.063	221 $/tonne	300 $/tonne
0.005	**0.066**	**230 $/tonne**	**312 $/tonne**
0.0075	0.068	239 $/tonne	324 $/tonne
0.01	0.071	247 $/tonne	336 $/tonne

Source: own calculation from the data obtained from KIB-TEK

Table 57: Breakeven Fuel Price by Changing System Stabilization Cost from Large Scale Solar Panel

Breakeven Fuel Price by Changing System Stabilization Cost for Large Scale Solar Panel			
system stabilization cost	total solar cost	S.T. fuel consumption (including oil)	T. D. fuel consumption (including oil)
		285 gr/kWh	210 gr/kWh
0.00	0.053	187 $/tonne	254 $/tonne
0.0025	0.056	196 $/tonne	266 $/tonne
0.005	**0.058**	**205 $/tonne**	**278 $/tonne**
0.0075	0.061	214 $/tonne	290 $/tonne
0.01	0.063	222 $/tonne	302 $/tonne

Source: own calculation from the data obtained from KIB-TEK

The estimation of the total solar cost in tables 19, 20, 21 with changing system stabilization cost for small size, mid-size and large scale solar panels are considered in tables 55, 56, and 57. We can see from the tables 55, 56, 57 that if the system stabilization cost is increasing the total solar cost are growing, which in turn stimulated the breakeven fuel price to increase for both alternative technology system.

5.5 Analyzing Total Annual Saving/Cost of Solar with Alternative Technology

To estimate the total annual saving/cost of solar panels and to compare with alternative technologies, the following parameters are considered: The installation capacity for the TRNC is 70MW solar, the difference between alternative electric generation system and solar generation electricity for three different solar sizes for each kWh in S.T is equal to 0.036, 0.053, 0.061 $/kWh, and for T.D system the difference between alternative electric generation system and solar generation electricity for three different solar sizes in T.D system is equal to 0.011, 0.029, and 0.036 $/kWh. The tables below show as that result for three different solar sizes.

Table 58: Yearly Saving/Cost for Small Size Solar Panels

The Result of Yearly Saving/Cost for Small Size Solar Panel	
OPERATIONAL SOLAR CAPACITY	70 MW
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.036 $/kwh
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.011 $/kwh
SOLAR LOAD FACTOR	19%
HOURS IN A YEAR	8760
TOTAL ANNUAL SAVING/COST OF SOLAR WITH S.T.	**4,194,288.00 $**
TOTAL ANNUAL SAVING/COST OF SOLAR WITH T.D.	**1,281,588.00 $**

Source: own calculation from the data obtained from KIB-TEK

Table 58 suggests that if annual cost/saving for 1 KW is equal to 0.036 $/kWh for S.T technology and 0.011 $/kWh for the T.D system, and for 70 MW using solar panels instead of S.T technology would save $ 4,194,288. And, using the solar panels instead of T.D would save more than the T.D system by $ 1,281,588.

Table 59: Yearly Saving/Cost for Mid-Size Solar Panels

The Result of Yearly Saving/Cost for Mid-Size Solar Panel	
OPERATIONAL SOLAR CAPACITY	70 MW
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.053 $/kwh
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.029 $/kwh
SOLAR LOAD FACTOR	19%
HOURS IN A YEAR	8760
TOTAL ANNUAL SAVING/COST OF SOLAR WITH S.T.	**6,174,924.00 $**
TOTAL ANNUAL SAVING/COST OF SOLAR WITH T.D.	**3,378,732.00 $**

Source: own calculation from the data obtained from KIB-TEK

Table 59 presents the results for the total annual saving/cost for 70 MW between alternative technology and solar technology for mid-size solar panels. Results indicate that using the solar panels instead of alternative technology would save $ 6,174,924 more than S.T technology and $ 3,378,732 more than T.D technology.

Table 60: Yearly Saving/Cost for Large Scale Solar Panels

The Result of Yearly Saving/Cost for large scale Solar Panel	
OPERATIONAL SOLAR CAPACITY	70 MW
SAVING/COST OF SOLAR AS COMPARED TO S.T.	0.061 $/kwh
SAVING/COST OF SOLAR AS COMPARED TO T.D.	0.036 $/kwh
SOLAR LOAD FACTOR	19%
HOURS IN A YEAR	8760
TOTAL ANNUAL SAVING/COST OF SOLAR WITH S.T.	**7,106,988.00 $**
TOTAL ANNUAL SAVING/COST OF SOLAR WITH T.D.	**4,194,288.00 $**

Source: own calculation from the data obtained from KIB-TEK

Table 60 shows the results of the total annual saving/cost for 70 MW between alternative technology and solar technology for large scale solar panel. Results propose that using the solar panels instead of alternative technology would save $ 7,106,988 more than S.T technology and $ 4,194,288 more than T.D technology.

5.6 Sensitivity Analysis for Solar Panel Capacity

Solar panel capacity is expected to increase by 5 MW solar capacities annually. Therefore, we will create a table for ten years by increasing 5MW for each year to calculate the sensitivity of annual saving/cost to the changing value of solar panel capacity for three different solar sizes.

Table 61: Saving/Cost by Changing Solar Capacity for Small Size Solar Panel

The result of sensitivity by changing solar capacity for small size solar panel												
saving/cost for 1 mw of solar compare to S.T	0.036											
saving/cost for 1 mw of solar compare to T.D	0.011											
solar load factor	19%											
hours in a year	8760											
years		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
solar capacity by KW		70	75	80	85	90	95	100	105	110	115	120
TOTAL ANNUAL SAVING/COST OF SOLAR WITH S.T.		$4,194,288	$4,493,880	$4,793,472	$5,093,064	$5,392,656	$5,692,248	$ 5,991,840	$ 6,291,432	$ 6,591,024	$ 6,890,616	$ 7,190,208
TOTAL ANNUAL SAVING/COST OF SOLAR WITH T.D.		$1,281,588	$1,373,130	$1,464,672	$1,556,214	$1,647,756	$1,739,298	$ 1,830,840	$ 1,922,382	$ 2,013,924	$ 2,105,466	$ 2,197,008

Source: own calculation from the data obtained from KIB-TEK

Table 61 presents the results of the effects of increasing solar capacity on the total annual saving/cost for small size solar panels. When the solar capacity is increasing annually by 5 MW, the solar panel system is more cost-efficient than the S.T technology for generating electricity. And also, with the same parameters, the solar panel system is more cost-efficient than the T.D technology for generating electricity.

Table 62: Saving/Cost by Changing Solar Capacity for Mid-Size Solar Panel

The result of sensitivity by changing solar capacity for mid-size solar panel												
saving/cost for 1 mw of solar compare to S.T	0.053											
saving/cost for 1 mw of solar compare to T.D	0.029											
solar load factor	19%											
hours in a year	8760											
years		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
solar capacity by KW		70	75	80	85	90	95	100	105	110	115	120
TOTAL ANNUAL SAVING/COST OF SOLAR WITH S.T.		$6,174,924	$6,615,990	$7,057,056	$7,498,122	$7,939,188	$8,380,254	$ 8,821,320	$ 9,262,386	$ 9,703,452	$ 10,144,518	$ 10,585,584
TOTAL ANNUAL SAVING/COST OF SOLAR WITH T.D.		$3,378,732	$3,620,070	$3,861,408	$4,102,746	$4,344,084	$4,585,422	$ 4,826,760	$ 5,068,098	$ 5,309,436	$ 5,550,774	$ 5,792,112

Source: own calculation from the data obtained from KIB-TEK

Table 62 portrays the results of the sensitivity analysis for the total annual saving/cost of mid-size solar panels taking into account the changing value of solar capacity for 10 years. As demonstrated in the results, with the increase in solar panels capacity, savings of the solar panels system increase. Therefore, the solar panel system offers more savings compared to both alternative technologies.

Table 63: Saving/Cost by Changing Solar Capacity for Large Scale Solar Panel

The reuslt of sensitivity by changing solar capacity for large scale solar panel												
saving/cost for 1 mw of solar compare to S.T	0.061											
saving/cost for 1 mw of solar compare to T.D	0.036											
solar load factor	19%											
hours in a year	8760											
years		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
solar capacity by KW		70	75	80	85	90	95	100	105	110	115	120
TOTAL ANNUAL SAVING/COST OF SOLAR WITH S.T.		$7,106,988	$7,614,630	$8,122,272	$8,629,914	$9,137,556	$9,645,198	$10,152,840	$10,660,482	$11,168,124	$ 11,675,766	$ 12,183,408
TOTAL ANNUAL SAVING/COST OF SOLAR WITH T.D.		$4,194,288	$4,493,880	$4,793,472	$5,093,064	$5,392,656	$5,692,248	$ 5,991,840	$ 6,291,432	$ 6,591,024	$ 6,890,616	$ 7,190,208

Source: own calculation from the data obtained from KIB-TEK

Table 63 indicates the results of the sensitivity analysis for the total annual saving/cost for solar panels for large scale solar panels while changing the values of solar capacity for 10 years. Similar to the results from small size and mid-size panels, results indicate that solar capacity rise would trigger a hike in savings of the solar panel system. Consecutively, the solar panel system offers more savings when compared to the alternative technologies considered in this research.

5.7 Results of sensitivity Analysis

5.7.1 Forecast Results from Total Solar Cost

A feasibility analysis is carried out to implement sensitivity analysis and gain more information about the data in hand. The key parameters from the project (solar load factor, KW price of the solar, discount rate, system stabilization cost, fuel price) have been examined to see how the project responds to possible changes in these estimations.

Table 64: Results for Solar Cost by Changing Solar Load Factor

solar size	small size below 10 kw	mid-size between 10kw- 100 kw	large scale above 100 kw
base case total solar cost value	0.083 $/kwh	0.066 $/kwh	0.058 $/kwh
total solar cost value by changing solar load factor			
solar load factor	small size	mid-size	large scale
19.0%	0.083	0.066	0.058
19.5%	0.081	0.064	0.057
20.0%	0.079	0.062	0.056
20.5%	0.078	0.061	0.054
21.0%	0.076	0.060	0.053
21.5%	0.074	0.058	0.052

Source: own calculation from the data obtained from KIB-TEK

The table above presents the total solar cost based on the changing value of the solar load factor for three different solar panel sizes. As can be seen from the table, the total solar cost from sensitivity analysis becomes lower than the base case if the solar load factor increases in the future for the three different sizes of solar panels.

Table 65: Results for Total Solar Cost by Changing Solar KW Price

solar size		small size below 10 kw		mid-size between 10kw- 100 kw		large scale above 100 kw	
base case total solar cost value		0.083 $/kwh		0.066 $/kwh		0.058 $/kwh	
total solar cost value by changing solar kw price							
solar kw price for small size	small size	solar kw price for mid-size	mid-size	solar kw price for large scale	large scale		
$ 800.00	$ 0.062	$ 550.00	$ 0.044	$ 450.00	$ 0.037		
$ 900.00	$ 0.069	$ 650.00	$ 0.051	$ 550.00	$ 0.044		
$ 1,000.00	$ 0.076	$ 750.00	$ 0.058	$ 650.00	$ 0.051		
$ 1,100.00	$ 0.083	$ 850.00	$ 0.066	$ 750.00	$ 0.058		
$ 1,200.00	$ 0.090	$ 950.00	$ 0.073	$ 850.00	$ 0.066		
$ 1,300.00	$ 0.098	$ 1,050.00	$ 0.080	$ 950.00	$ 0.073		
$ 1,400.00	$ 0.105	$ 1,150.00	$ 0.087	$ 1,050.00	$ 0.076		

Source: own calculation from the data obtained from KIB-TEK

Table 65 shows the difference between total solar costs in the base case with sensitivity analysis for the solar power price for three different solar sizes. As indicated in the table, when the solar KW price rises, the total solar cost becomes more costly than the base case of total solar cost.

Table 66: Results for Total Solar Cost by Changing Discount Rate

solar size	small size below 10 kw	mid-size between 10kw- 100 kw	large scale above 100 kw
base case total solar cost value	0.083 $/kwh	0.066 $/kwh	0.058 $/kwh
total solar cost value by changing discount rate			
discount rate	small size	mid-size	large scale
7.0%	0.067	0.053	0.047
8.0%	0.072	0.057	0.051
9.0%	0.078	0.061	0.055
10.0%	0.083	0.066	0.058
11.0%	0.089	0.070	0.062
12.0%	0.095	0.075	0.066
13.0%	0.101	0.079	0.070

Source: own calculation from the data obtained from KIB-TEK

Table 66 presents the difference between the total base case and the total cost from the sensitivity analysis. Results clearly show that the increasing discount rate is pushing the total solar cost to become more expensive with the three different solar panel sizes.

Table 67: Results for Total Solar Cost by Changing System Stabilization Cost

solar size	small size below 10 kw	mid-size between 10kw- 100 kw	large scale above 100 kw
base case total solar cost value	0.083 $/kwh	0.066 $/kwh	0.058 $/kwh
total solar cost value by changing system stabilization cost			
System stabilization cost	**small size**	**mid-size**	**large scale**
0	**0.078**	**0.061**	**0.053**
0.0025	**0.081**	**0.063**	**0.056**
0.005	**0.083**	**0.066**	**0.058**
0.0075	**0.086**	**0.068**	**0.061**
0.01	**0.088**	**0.071**	**0.063**

Source: own calculation from the data obtained from KIB-TEK

Table 67 displays the difference between the total base case and the total cost from the sensitivity analysis in regards to system stabilization cost. The increasing system stabilization cost would hike the cost of the solar panels for the three different solar panel sizes.

5.7.2 Forecast Results from Saving and Cost of Solar as Compared with Alternative Technology System

Table 68: Results for Saving/Cost by Changing Solar Load Factor

solar size	small size below 10 kw		mid-size between 10kw- 100 kw		large scale above 100 kw	
base case saving/cost by comparing solar with S.T	0.036 $/kwh		0.053 $/kwh		0.061 $/kwh	
base case saving/cost by comparing solar with T.D	0.011 $/kwh		0.029 $/kwh		0.036 $/kwh	
Calculating Saving/Cost from Solar Panels by Changing Solar Load Factor						
solar size	**small size**					
Solar load factor	**19.0%**	**19.5%**	**20.0%**	**20.5%**	**21.0%**	**21.5%**
saving/cost by comparing solar with S.T	**0.036**	**0.038**	**0.040**	**0.041**	**0.043**	**0.045**
saving/cost by comparing solar with T.D	**0.011**	**0.013**	**0.015**	**0.017**	**0.019**	**0.020**
solar size	**mid-size**					
Solar load factor	**19.0%**	**19.5%**	**20.0%**	**20.5%**	**21.0%**	**21.5%**
saving/cost by comparing solar with S.T	**0.053**	**0.055**	**0.057**	**0.058**	**0.059**	**0.061**
saving/cost by comparing solar with T.D	**0.029**	**0.030**	**0.032**	**0.033**	**0.035**	**0.036**
solar size	**large scale**					
Solar load factor	**19.0%**	**19.5%**	**20.0%**	**20.5%**	**21.0%**	**21.5%**
saving/cost by comparing solar with S.T	**0.061**	**0.062**	**0.063**	**0.064**	**0.066**	**0.067**
saving/cost by comparing solar with T.D	**0.036**	**0.037**	**0.039**	**0.040**	**0.041**	**0.042**

Source: own calculation from the data obtained from KIB-TEK

Table 68 shows the comparison between the saving/cost from the base case and saving/cost from sensitivity analysis focusing on changing the values of the solar load factor. Results suggest that a higher solar load factor has a positive effect on the solar panel which means that solar panels would be more cost-efficient than the S.T and T.D systems.

Table 69: Results for Saving/Cost by Changing Solar Panel Price

solar size	small size below 10 kw	mid-size between 10kw- 100 kw	large scale above 100 kw
base case saving/cost by comparing solar with S.T	0.036 $/kwh	0.053 $/kwh	0.061 $/kwh
base case saving/cost by comparing solar with T.D	0.011 $/kwh	0.029 $/kwh	0.036 $/kwh

Calculating Saving/Cost from Solar Panels by Changing Solar Panel Price

solar size	small size						
Solar Panel Price	$ 800	$ 900	$ 1,000	$ 1,100	$ 1,200	$ 1,300	$ 1,400
saving/cost by comparing solar with S.T for each kwh	$ 0.057	$ 0.050	$ 0.043	$ 0.036	$ 0.029	$ 0.021	$ 0.014
saving/cost by comparing solar with T.D for each kwh	$ 0.033	$ 0.025	$ 0.018	$ 0.011	$ 0.004	$ -0.003	$ -0.010
solar size	**mid-size**						
Solar Panel Price	$ 550	$ 650	$ 750	$ 850	$ 950	$ 1,050	$ 1,150
saving/cost by comparing solar with S.T for each kwh	$ 0.075	$ 0.068	$ 0.061	$ 0.053	$ 0.046	$ 0.039	$ 0.032
saving/cost by comparing solar with T.D for each kwh	$ 0.050	$ 0.043	$ 0.036	$ 0.029	$ 0.022	$ 0.015	$ 0.008
solar size	**large scale**						
Solar Panel Price	$450.00	$550.00	$650.00	$ 750.00	$ 850.00	$950.00	$ 1,050.00
saving/cost by comparing solar with S.T for each kwh	$ 0.082	$ 0.075	$ 0.068	$ 0.061	$ 0.053	$ 0.046	$ 0.043
saving/cost by comparing solar with T.D for each kwh	$ 0.057	$ 0.050	$ 0.043	$ 0.036	$ 0.029	$ 0.022	$ 0.018

Source: own calculation from the data obtained from KIB-TEK

Table 69 presents the comparison between the saving/cost from the base case and saving/cost from sensitivity analysis focusing on changing the values of the solar KW price. We can see if the solar KW price raise, solar panel saving decrease. For the small size solar panels, solar panel is more saving than the S.T if the solar KW price is changing between $800 _ $1400. In addition, T.D system is less costly if the price of the small-size solar panel is equal or higher than the $1300. Furthermore, when the solar panel KW price is higher, both mid-size and large-scale solar panels become still more saving than the alternative technology.

Table 70: Results for Saving/Cost by Changing Discount Rate

solar size	small size below 10 kw		mid-size between 10kw- 100 kw		large scale above 100 kw		
base case saving/cost by comparing solar with S.T	0.036	$/kwh	0.053	$/kwh	0.061	$/kwh	
base case saving/cost by comparing solar with T.D	0.011	$/kwh	0.029	$/kwh	0.036	$/kwh	
Calculating Saving/Cost from Solar Panels by Changing Discount Rate							
solar size	**small size**						
discount rate	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**	**13%**
saving/cost by comparing solar with S.T for each kwh	**$ 0.052**	**$ 0.047**	**$ 0.041**	**$ 0.036**	**$ 0.030**	**$ 0.024**	**$ 0.018**
saving/cost by comparing solar with T.D for each kwh	**$ 0.027**	**$ 0.022**	**$ 0.016**	**$ 0.011**	**$ 0.005**	**$ -0.001**	**$ -0.007**
solar size	**mid-size**						
discount rate	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**	**13%**
saving/cost by comparing solar with S.T for each kwh	**$ 0.066**	**$ 0.062**	**$ 0.058**	**$ 0.053**	**$ 0.049**	**$ 0.044**	**$ 0.040**
saving/cost by comparing solar with T.D for each kwh	**$ 0.041**	**$ 0.037**	**$ 0.033**	**$ 0.028**	**$ 0.024**	**$ 0.019**	**$ 0.015**
solar size	**large scale**						
discount rate	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**	**13%**
saving/cost by comparing solar with S.T for each kwh	**$ 0.072**	**$ 0.068**	**$ 0.064**	**$ 0.061**	**$ 0.057**	**$ 0.053**	**$ 0.049**
saving/cost by comparing solar with T.D for each kwh	**$ 0.047**	**$ 0.043**	**$ 0.039**	**$ 0.036**	**$ 0.032**	**$ 0.028**	**$ 0.024**

Source: own calculation from the data obtained from KIB-TEK

From the results in table 70 we can see that for small size when discount rate is increasing the solar panel still more saving than the S.T technology for generating electricity but by T.D if discount rate equal or above12% solar panels, solar panel cost is higher than the T.D alternative electric generation system. However, for the mid-size and large-scale solar panels, regardless of the increase in the discount rate, the solar panel is more cost-efficient than the alternative electric generation system.

Table 71: Results for Saving/Cost by Changing System Stabilization Cost

solar size	small size below 10 kw		mid-size between 10kw- 100 kw		large scale above 100 kw
base case saving/cost by comparing solar with S.T	0.036 $/kwh		0.053 $/kwh		0.061$/kwh
base case saving/cost by comparing solar with T.D	0.011 $/kwh		0.029 $/kwh		0.036$/kwh
Calculating Saving/Cost from Solar Panels by Changing System Stabilization Cost					
solar size	**small size**				
system stabilization cost	**$ -**	**$0.0025**	**$0.0050**	**$ 0.0075**	**$ 0.01**
saving/cost by comparing solar with S.T for each kwh	**$ 0.04**	**$ 0.04**	**$ 0.04**	**$ 0.03**	**$ 0.03**
saving/cost by comparing solar with T.D for each kwh	**$ 0.02**	**$ 0.01**	**$ 0.01**	**$ 0.01**	**$ 0.01**
solar size	**mid-size**				
system stabilization cost	**$ -**	**$0.0025**	**$0.0050**	**$ 0.0075**	**$ 0.01**
saving/cost by comparing solar with S.T for each kwh	**$ 0.058**	**$ 0.056**	**$ 0.053**	**$ 0.051**	**$ 0.048**
saving/cost by comparing solar with T.D for each kwh	**$ 0.034**	**$ 0.031**	**$ 0.029**	**$ 0.026**	**$ 0.024**
solar size	**large scale**				
system stabilization cost	**$ -**	**$0.0025**	**$0.0050**	**$ 0.0075**	**$ 0.01**
saving/cost by comparing solar with S.T for each kwh	**$ 0.066**	**$ 0.063**	**$ 0.061**	**$ 0.058**	**$ 0.056**
saving/cost by comparing solar with T.D for each kwh	**$ 0.041**	**$ 0.039**	**$ 0.036**	**$ 0.034**	**$ 0.031**

Source: own calculation from the data obtained from KIB-TEK

Table 71 presents the comparison results between base case saving/cost and sensitivity analysis saving and cost by changing the value of system stabilization cost for the solar panel if replaced with alternative technology. Results suggest that with a higher system stabilization cost, the small-size, mid-size and large-scale solar panels, we can see that the solar panels are more cost-efficient than alternative technologies.

Table 72: Results for Saving/Cost by Changing Fuel Price

solar size	small size		mid-size		large scale		
	below 10 kw		between 10kw- 100 kw		above 100 kw		
base case saving/cost by comparing solar with S.T	0.036	$/kwh	0.053	$/kwh	0.061	$/kwh	
base case saving/cost by comparing solar with T.D	0.011	$/kwh	0.029	$/kwh	0.036	$/kwh	
Calculating Saving/Cost from Solar Panels by Changing Fuel price							
solar size	**small size**						
fuel price per tonne	**$ 73**	**$ 173**	**$ 273**	**$ 373**	**$ 473**	**$ 573**	**$ 673**
saving/cost by comparing solar with S.T for each kwh	**$ -0.050**	**$ -0.021**	**$ 0.007**	**$ 0.036**	**$ 0.054**	**$ 0.083**	**$ 0.111**
saving/cost by comparing solar with T.D for each kwh	**$-0.0519**	**$-0.0309**	**$-0.0099**	**$ 0.0111**	**$ 0.0321**	**$ 0.0531**	**$ 0.0741**
solar size	**mid-size**						
fuel price per tonne	**$ 73**	**$ 173**	**$ 273**	**$ 373**	**$ 473**	**$ 573**	**$ 673**
saving/cost by comparing solar with S.T for each kwh	**$ -0.032**	**$ -0.004**	**$ 0.025**	**$ 0.053**	**$ 0.072**	**$ 0.101**	**$ 0.129**
saving/cost by comparing solar with T.D for each kwh	**$ -0.034**	**$ -0.013**	**$ 0.008**	**$ 0.029**	**$ 0.050**	**$ 0.071**	**$ 0.092**
solar size	**large scale**						
fuel price per tonne	**$ 73**	**$ 173**	**$ 273**	**$ 373**	**$ 473**	**$ 573**	**$ 673**
saving/cost by comparing solar with S.T for each kwh	**$ -0.025**	**$ 0.004**	**$ 0.032**	**$ 0.061**	**$ 0.079**	**$ 0.108**	**$ 0.136**
saving/cost by comparing solar with T.D for each kwh	**$ -0.027**	**$ -0.006**	**$ 0.015**	**$ 0.036**	**$ 0.057**	**$ 0.078**	**$ 0.099**

Source: own calculation from the data obtained from KIB-TEK

Table 72 displays the findings of the comparison between base case saving/cost and sensitivity analysis saving and cost by changing the value of fuel price for the different solar panels size if replaced with alternative technology. From the base case, we know that the fuel price is equal to 373 $/tonne.

From the sensitivity analysis, we can see that higher fuel price for the small size solar panels are less costly than the S.T system if fuel price equal to or more than 273 $/tonne. In addition, solar panels are less costly than the T.D if it is equal or more than 373 $/tonne. However, for other solar panel sizes, they have more savings if the fuel price for mid-size is equal or more than 273$/tonne, and for large scale if fuel price equal or more than $173 for each tonne the solar become is more saving than the S.T technology and by T.D if fuel price is equal or more than $ 273 the solar became more saving.

5.7.3 Forecast Results from Breakeven Fuel Price

Table 73: Results for Breakeven Fuel Price by Changing Solar Load Factor

solar size	small size		mid-size		large scale	
	below 10 kw		between 10kw- 100 kw		above 100 kw	
breakeven fuel price for S.T. (including freight) from bace case	292	$/tonne	230	$/tonne	205	$/tonne
breakeven fuel price for T.D (including freight) from bace case	397	$/tonne	312	$/tonne	278	$/tonne
Calculating Breakeven Fuel Price by Changing Solar Load Factor						
solar size	**small size**					
Solar load factor	**19.0%**	**19.5%**	**20.0%**	**20.5%**	**21.0%**	**21.5%**
breakeven fuel price for S.T. (including freight) for per tonne	**$ 292**	**$ 285**	**$ 279**	**$ 246**	**$ 266**	**$ 260**
breakeven fuel price for T.D (including freight) for per tonne	**$ 397**	**$ 387**	**$ 397**	**$ 369**	**$ 361**	**$ 353**
solar size	**mid-size**					
Solar load factor	**19.0%**	**19.5%**	**20.0%**	**20.5%**	**21.0%**	**21.5%**
breakeven fuel price for S.T. (including freight) for per tonne	**$ 230**	**$ 224**	**$ 219**	**$ 214**	**$ 210**	**$ 205**
breakeven fuel price for T.D (including freight) for per tonne	**$ 312**	**$ 305**	**$ 298**	**$ 291**	**$ 285**	**$ 278**
solar size	**large scale**					
Solar load factor	**19.0%**	**19.5%**	**20.0%**	**20.5%**	**21.0%**	**21.5%**
breakeven fuel price for S.T. (including freight) for per tonne	**$ 205**	**$ 200**	**$ 196**	**$ 191**	**$ 187**	**$ 183**
breakeven fuel price for T.D (including freight) for per tonne	**$ 278**	**$ 272**	**$ 265**	**$ 260**	**$ 254**	**$ 249**

Source: own calculation from the data obtained from KIB-TEK

Table 73 shows the results of breakeven fuel price for alternative electricity production technology if the fuel is bought today at a fixed price for the next 25 years and solar panels replace alternative electricity generation electricity with changing the values of the solar load factor. Results convey that a higher solar load factor would decrease the breakeven fuel price for all solar panel sizes compared to alternative technologies.

Table 74: Results for Breakeven Fuel Price by Changing Solar Panel Price

solar size	small size		mid-size		large scale		
	below 10 kw		between 10kw- 100 kw		above 100 kw		
breakeven fuel price for S.T. (including freight) from bace case	292	$/tonne	230	$/tonne	205	$/tonne	
breakeven fuel price for T.D (including freight) from bace case	397	$/tonne	312	$/tonne	278	$/tonne	
Calculating Breakeven Fuel Price by Changing Solar Panel Price							
solar size	**small size**						
solar price	**$ 800**	**$ 900**	**$ 1,000**	**$ 1,100**	**$ 1,200**	**$ 1,300**	**$ 1,400**
breakeven fuel price for S.T. (including freight) for per tonne	**$ 217**	**$ 242**	**$ 267**	**$ 292**	**$ 317**	**$ 342**	**$ 367**
breakeven fuel price for T.D (including freight) for per tonne	**$ 295**	**$ 329**	**$ 363**	**$ 397**	**$ 431**	**$ 465**	**$ 498**
solar size	**mid-size**						
solar price	**$ 550**	**$ 650**	**$ 750**	**$ 850**	**$ 950**	**$ 1,050**	**$ 1,150**
breakeven fuel price for S.T. (including freight) for per tonne	**$ 155**	**$ 180**	**$ 205**	**$ 230**	**$ 255**	**$ 280**	**$ 305**
breakeven fuel price for T.D (including freight) for per tonne	**$ 210**	**$ 244**	**$ 278**	**$ 312**	**$ 346**	**$ 380**	**$ 414**
solar size	**large scale**						
solar price	**$ 450**	**$ 550**	**$ 650**	**$ 750**	**$ 850**	**$ 950**	**$ 1,050**
breakeven fuel price for S.T. (including freight) for per tonne	**$ 130**	**$ 155**	**$ 180**	**$ 205**	**$ 230**	**$ 255**	**$ 267**
breakeven fuel price for T.D (including freight) for per tonne	**$ 176**	**$ 210**	**$ 244**	**$ 278**	**$ 312**	**$ 346**	**$ 363**

Source: own calculation from the data obtained from KIB-TEK

Table 74 represents the breakeven fuel price with changing values of the solar panel price and comparing it with the base case and sensitivity analysis. A higher solar price would increase the breakeven fuel price for the three different solar panel sizes.

Table 75: Results for Breakeven Fuel Price by Changing Solar Panel Price

solar size	small size below 10 kw		mid-size between 10kw- 100 kw		large scale above 100 kw		
breakeven fuel price for T.D (including freight) from bace case	292	$/tonne	230	$/tonne	205	$/tonne	
Calculating Breakeven Fuel Price by Changing Solar Panel Price	397	$/tonne	312	$/tonne	278	$/tonne	
Calculating Breakeven Fuel Price by Changing Discount Rate							
solar size	**small size**						
discount rate	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**	**13%**
breakeven fuel price for S.T. (including freight) for per tonne	**$ 235**	**$ 253**	**$ 274**	**$ 292**	**$ 312**	**$ 333**	**$ 354**
breakeven fuel price for T.D (including freight) for per tonne	**$ 319**	**$ 343**	**$ 371**	**$ 397**	**$ 424**	**$ 452**	**$ 481**
solar size	**mid-size**						
discount rate	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**	**13%**
breakeven fuel price for S.T. (including freight) for per tonne	**$ 186**	**$ 200**	**$ 214**	**$ 230**	**$ 246**	**$ 263**	**$ 277**
breakeven fuel price for T.D (including freight) for per tonne	**$ 252**	**$ 271**	**$ 290**	**$ 312**	**$ 333**	**$ 357**	**$ 376**
solar size	**large scale**						
discount rate	**7%**	**8%**	**9%**	**10%**	**11%**	**12%**	**13%**
breakeven fuel price for S.T. (including freight) for per tonne	**$ 165**	**$ 179**	**$ 193**	**$ 205**	**$ 218**	**$ 232**	**$ 246**
breakeven fuel price for T.D (including freight) for per tonne	**$ 224**	**$ 243**	**$ 262**	**$ 278**	**$ 295**	**$ 314**	**$ 333**

Source: own calculation from the data obtained from KIB-TEK

Table 75 presents the findings of the breakeven fuel price while changing the values of the discount rate in the base case and sensitivity analysis of three different solar sizes. From the base case, we have a 10% discount rate, so the sensitivity analyses indicate that a higher discount rate would increase the breakeven fuel price.

Table 76: Results for Breakeven Fuel Price by Changing Solar Panel Price

solar size	small size below 10 kw		mid-size between 10kw- 100 kw		large scale above 100 kw
breakeven fuel price for S.T. (including freight) for per tonne	292	$/tonne	230	$/tonne	205 $/tonne
breakeven fuel price for T.D (including freight) for per tonne	397	$/tonne	312	$/tonne	278 $/tonne
Calculating Breakeven Fuel Price by Changing system stabilization cost					
solar size	**small size**				
system stabilization cost	**$ -**	**$ 0.0025**	**$ 0.0050**	**$ 0.0075**	**$ 0.0100**
breakeven fuel price for S.T. (including freight) for per tonne	**$ 275**	**$ 284**	**$ 292**	**$ 301**	**$ 310**
breakeven fuel price for T.D (including freight) for per tonne	**$ 373**	**$ 385**	**$ 397**	**$ 409**	**$ 421**
solar size	**mid-size**				
system stabilization cost	**$ -**	**$ 0.0025**	**$ 0.0050**	**$ 0.0075**	**$ 0.01**
breakeven fuel price for S.T. (including freight) for per tonne	**$ 212**	**$ 221**	**$ 230**	**$ 239**	**$ 247**
breakeven fuel price for T.D (including freight) for per tonne	**$ 288**	**$ 300**	**$ 312**	**$ 324**	**$ 336**
solar size	**large scale**				
system stabilization cost	**$ -**	**$ 0.0025**	**$ 0.0050**	**$ 0.0075**	**$ 0.01**
breakeven fuel price for S.T. (including freight) for per tonne	**$ 187**	**$ 196**	**$ 205**	**$ 214**	**$ 222**
breakeven fuel price for T.D (including freight) for per tonne	**$ 254**	**$ 266**	**$ 278**	**$ 290**	**$ 302**

Source: own calculation from the data obtained from KIB-TEK

Table 76 shows the result of the breakeven fuel price taking into account changing values of the system stabilization cost in the base case and sensitivity analysis of three different solar sizes. From the base case, we have a $ 0.005 system stabilization cost, so the sensitivity analyses suggests that a rise in the system stabilization cost would increase the breakeven fuel price.

5.7.4 Forecast Results from Yearly Saving/Cost from 70 MW Solar Panel Capacities by Increasing 5 KW Each Year

Table 77: Results for Yearly Saving/Cost for 70 MW Solar Panel Capacities by Expecting to Increase 5 KW Each Year

solar size	small size below 10 kw	mid-size between 10kw- 100 kw	large scale above 100 kw
TOTAL ANNUAL SAVING/COST OF SOLAR WITH S.T.	$ 4,194,288.00	$ 6,174,924.00	$ 7,106,988.00
TOTAL ANNUAL SAVING/COST OF SOLAR WITH T.D.	$ 1,281,588.00	$ 3,378,732.00	$ 4,194,288.00

The Reslt of Breakeven Fuel Price by Changing System Stabilization Cost

years	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
solar capacity by KW	70	75	80	85	90	95	100	105	110	115	120
solar size	**small size**										
TOTAL ANNUAL SAVING/COST OF SOLAR WITH S.T.	$4,194,288	$4,493,880	$4,793,472	$5,093,064	$5,392,656	$5,692,248	$ 5,991,840	$ 6,291,432	$ 6,591,024	$ 6,890,616	$ 7,190,208
TOTAL ANNUAL SAVING/COST OF SOLAR WITH T.D.	$1,281,588	$1,373,130	$1,464,672	$1,556,214	$1,647,756	$1,739,298	$ 1,830,840	$ 1,922,382	$ 2,013,924	$ 2,105,466	$ 2,197,008
solar size	**mid-size**										
TOTAL ANNUAL SAVING/COST OF SOLAR WITH S.T.	$6,174,924	$6,615,990	$7,057,056	$7,498,122	$7,939,188	$8,380,254	$ 8,821,320	$ 9,262,386	$ 9,703,452	$10,144,518	$10,585,584
TOTAL ANNUAL SAVING/COST OF SOLAR WITH T.D.	$3,378,732	$3,620,070	$3,861,408	$4,102,746	$4,344,084	$4,585,422	$ 4,826,760	$ 5,068,098	$ 5,309,436	$ 5,550,774	$ 5,792,112
solar size	**large scale**										
TOTAL ANNUAL SAVING/COST OF SOLAR WITH S.T.	$7,106,988	$7,614,630	$8,122,272	$8,629,914	$9,137,556	$9,645,198	$10,152,840	$10,660,482	$11,168,124	$11,675,766	$12,183,408
TOTAL ANNUAL SAVING/COST OF SOLAR WITH T.D.	$4,194,288	$4,493,880	$4,793,472	$5,093,064	$5,392,656	$5,692,248	$ 5,991,840	$ 6,291,432	$ 6,591,024	$ 6,890,616	$ 7,190,208

Source: own calculation from the data obtained from KIB-TEK

Table 76 presents the result of the annual saving/cost of solar panels with alternative technology. Based on our base case, solar panel capacity for generating electricity is equal to 70 MW yearly. From that point if we are replacing the solar panel of alternative technology for different size of solar panels, the solar panel are more cost efficient than the alternative technologies by increasing 5 KW solar capacity each year for 10 years.

Chapter 6

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The electricity bill is very high in the Turkish Republic of Northern Cyprus. The recent increase in electricity bills is cited as additional taxes, such as distribution costs and contributions to energy output costs. Consecutive increases in electricity and additional costs reflected in the bill bring extra burden to citizens. In electricity, exit prices from the power plant are 35-40 kurus per kilowatt, and the consumer reaches about 70 kurus after the distribution fee, taxes, and contributions are added. In other words, electricity prices from the power plant to the consumer doubles. Due to the coronavirus, there has been a significant decline in the world economy since March 2020, affecting the financial situation of everyone, including the private sector and civil servants. This situation significantly affected the TRNC.

The results of this feasibility research show that the 70 MW solar panels capacities undertaking saving/cost and breakeven fuel price indicates that the project is viable as it can serve the saving cost by analyzing the sensitivity. We only looked at the maintenance rate and fuel cost because renewable solar energy is replacing them. However, the parameters for solar prices and fuel prices, which are the most important parameters, appear to be very sensitive. Especially when we look at the fuel costs today, even the fuel costs are below the average we use, so today's fuel costs do not seem to be solar feasible. Generating electricity with diesel seems to be more feasible, even more cost-effectiveness in inefficient steam turbines with low fuel costs. If the fuel costs are lower than solar, the solar investment made today can be very costly because you give money to the solar once today, you have buy fuel at a certain price to 25 years, but since the fuel prices can be changed over time, as we have seen today at low fuel costs this price risk will always be on the solar.

Generating electricity with an LNG system is drastically cleaner and cheaper than the current electric generation system. In particular, because the cost of LNG is much cheaper, it is much more effective to produce LNG in diesel, which we use as fossil fuel at the moment, according to today's prices and solar and at almost today's prices and according to the data we have received from experts in KIB-TEK. The operation cost of producing with LNG the cost of replacing solar, is between $ 0.02 and $ 0.04, so when we compare it to $ 0.083 solar cost, production with LNG is much cheaper. Because of that, KIB-TEK improved its electricity generating system and doing this research.

This thesis is just financial analysis, and my results could have been different if it was economic analysis. Because solar saving carbon emissions, so there is some positive externality of solar renewable energy. This result that mentions financial analysis only and economic results could have different because of the environmental impacts.

All data used in this study was obtained through the following resources: Cyprus Turkish Electrical Institution (KIB-TEK), Deputy Prime Ministers and Ministry of Foreign Affairs "Turkish Republic of Northern Cyprus" website, 2016 AKSA Power Generation website, Cyprus Turkish Electrical Institution (KIB-TEK) website, and

Statista web Average prices of diesel fuel in North Cyprus from 2004 to 2020. All the data is available and provided with the research.

6.2 Recommendation

Because of the operation cost of producing with LNG the cost of replacing solar is between \$ 0.02 and \$ 0.04 therefore when we compare it to \$ 0.083 solar cost production with LNG is much cheaper than the solar. I would recommend doing serious work on this.

Before investing in solar energy, I advise other technologies to do risk analysis at different prices as we do here. Because the price can be changed, so the results are will be changing. It does not mean that solar is more effective.

LNG investment is said to be much cheaper as experts now say, and as it is very common in the world, and it is very cheap to generate electricity from solar panels, it is said that there is a cost of fuel and variable costs between \$ 0.02 and \$ 0.04, I would recommend doing serious work on this.

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