INVESTIGATING PREFERENCES OF HOUSEHOLDS FOR RESIDENTIAL PHOTOVOLTAIC SYSTEMS: A SURVEY STUDY IN ANKARA, TURKEY

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

EREN ASLIHAK

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
EARTH SYSTEM SCIENCE

SEPTEMBER 2016

Approval of the thesis:

**INVESTIGATING PREFERENCES OF HOUSEHOLDS FOR RESIDENTIAL PHOTOVOLTAIC SYSTEMS:
A SURVEY STUDY IN ANKARA, TURKEY**

submitted by **EREN ASLIHAK** in partial fulfillment of the requirements for the degree of **Master of Science in Earth System Science Department, Middle East Technical University** by,

Prof. Dr. Gülbin Dural Ünver ____________________
Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Ayşen Yılmaz ____________________
Head of Department, **Earth System Science Dept.**

Prof. Dr. Özlem Özdemir ____________________
Supervisor, **Business Administration Dept., METU**

Prof. Dr. Bülent G. Akınoğlu ____________________
Co-Supervisor, **Physics Dept., METU**

Examining Committee Members:

Prof. Dr. Ramazan Sarı ____________________
Business Administration Dept., METU

Prof. Dr. Özlem Özdemir ____________________
Business Administration Dept., METU

Prof. Dr. Bülent G. Akınoğlu ____________________
Physics Dept., METU

Prof. Dr. Burak Günalp ____________________
Economics Dept., Hacettepe University

Assoc. Prof. Dr. Bahar Gedikli ____________________
City and Regional Planning Dept., METU

Date: ____________________

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last Name : EREN ASLIHAK

Signature :

ABSTRACT

INVESTIGATING PREFERENCES OF HOUSEHOLDS FOR RESIDENTIAL PHOTOVOLTAIC SYSTEMS: A SURVEY STUDY IN ANKARA, TURKEY

Aslıhak, Eren

M.Sc., Department of Earth System Science

Supervisor: Prof. Dr. Özlem Özdemir

Co-supervisor: Prof. Dr. Bülent G. Akınoğlu

September 2016, 83 pages

Climate change, a natural consequence of extensive usage of fossil fuels, emerges as the biggest human made catastrophe ever nowadays. Consequently, the need to increase the share of renewables in current energy demand became obvious. In this regard, solar energy emerges as the most abundant, widespread and sustainable source of energy in most parts of the World.

On the other hand, relatively higher accounting costs, economic dislocation and social/cultural issues are among important barriers to form a resistance toward widespread utilization of solar applications. Nevertheless, residential photovoltaic applications are expected to have an accelerating role for the diffusion of solar energy technologies and overcome these barriers.

This study aims to investigate the factors such as environmental behavior, environmental concern and socio-demographic variables affecting willingness to pay of households in Ankara (Turkey) for the installation of residential photovoltaic systems. The study uses data from a household survey conducted at selected regions of Ankara. The survey includes New Ecological Paradigm Scale to measure environmental concern and Self-Reported Pro-environmental Behavior Scale to gather information about the behavioral patterns of the respondents.

The obtained results show that although the general attitude towards roof-top PV systems is very positive while general information and awareness level for the systems are too low and the initial cost of PV systems is still higher than the willingness to pay of households.

It has been found that the relation between pro-environmental behavior and environmental concern is weak and only pro-environmental behavior is significant in predicting willingness to pay and the likelihood of technology adoption. Participants' perception of the cost of PV systems is significantly effective in determining their willingness to pay and likelihood of adoption. Gender, income and education level are also affective in predicting the purchase decision of households. Increasing awareness through media campaigns and promoting independent electricity production may help diffusion of roof-top PV systems.

Keywords: Willingness to Pay, Renewable Energy, Photovoltaics

ÖZ

FOTOVOLTAİK SİSTEMLERE YÖNELİK HANEHALKI TERCİHLERİNİN BELİRLENMESİ: ANKARA - TÜRKİYE'DE BİR ANKET ÇALIŞMASI

Aslıhak, Eren
Yüksek Lisans, Yer Sistem Bilimleri Bölümü
Tez Yöneticisi: Prof. Dr. Özlem Özdemir
Ortak Tez Yöneticisi: Prof. Dr. Bülent G. Akınoğlu

Eylül 2016, 83 sayfa

Fosil yakıt kullanımının doğal sonucu olan iklim değişikliği, günümüzde insan kaynaklı en büyük felaket olarak karşımıza çıkıyor. Sonuçta yenilenebilir enerji kaynaklarının daha etkili düzeylere çıkarılması gerekliliği belirginleşmekte. Bu noktada güneş enerjisi Dünya'nın bir çok yerinde en bol, yaygın ve en sürdürülebilir enerji kaynağı olarak ortaya çıkmakta.

Diğer taraftan, yüksek nominal maliyetler (mevcut), ekonomik yer değiştirme ve kültürel faktörler güneş enerjisini yaygın kullanımına engel oluşturmakta. Konutlarda kullanılan fotovoltaik sistemlerin ise, bu engellerin aşılmasında ve güneş enerjisinin yayılmasında hızlandırıcı bir rol alması beklenmekte.

Bu çalışma sosyo-demografik göstergelerle, çevresel duyarlılık ve ekolojik davranış gibi değişkenlerin, fotovoltaik sistemlere yönelik talep üzerindeki etkilerini belirlemeyi amaçlamaktadır. Çalışma, Ankara'nın seçilmiş konut bölgelerinde uygulanan bir anket çalışmasının verilerini kullanmaktadır. Elde edilen sonuçların politika yapıcılara yönelik teşvik, farkındalık artırma vb. gibi fotovoltaik sistemlerin yaygınlığını artırmaya yönelik politika önerileri ortaya koyması amaçlanmıştır.

Elde edilen sonuçlara göre, fotovoltaik sistemlere yönelik genel tutum çok olumlu olmakla beraber, farkındalık ve genel bilgi düzeyi oldukça düşüktür ve katılımcıların ödemeye razı oldukları tutarla güncel pazar fiyatları arasında önemli bir fark bulunmakta. Çevreci davranışla, çevresel ilgi düzeyi arasında güçlü bir ilişki olmadığı ve sadece çevreci davranışların ödemeye isteklilik ve satınalma olasılığı ile pozitif yönlü ilşkisi olduğu belirlenmiştir.

Katılımcıların fotovoltaik sistemlerin fiyatı ile ilgili algılarının ödemeye isteklilikleri üzerinde önemli olduğu, cinsiyet, gelir ve eğitim düzeylerinin de satınalma olasılığı üzerinde belirleyici değişkenler olduğu tespit edilmiştir. Teknolojinin yayılımının hızlandırılması için medya aracılığıyla farkındalığın artırılması ve bağımsız elektrik üretiminin teşvik edilmesi tercih edilen politika önerileri arasındadır.

Anahtar Kelimeler: Ödemeye İsteklilik, Yenilenebilir Enerji, Fotovoltaik

to Sun; our "star"...

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my supervisor Prof. Dr. Özlem Özdemir for the unlimited support, encouragement, guidance and tolerance she provided throughout the study.

I would like to show my special appreciation to my co-supervisor Bulent G. Akınoğlu for his continuous commitment, helpful advices and criticism.

I would like to thank to my examining committee members; Prof. Dr. Ramazan Sarı, Prof. Dr. Burak Günalp and Assoc. Prof. Dr. Bahar Gedikli for their supportive criticisms.

I am also thankful to Alparslan Bayraktar, Savaş Zafer Şahin and Tutku Özmen Kurt for their comments on my thesis.

Many thanks to my dear friends, who are the main motivator for where I am, what I am doing… I would also like to thank my friends Mehmet Ali Karadağ, Zeynep Ertekin and Suzan Ceylan for their support on my analysis.

This thesis would not be possible without the participation of the respondents; thanks to all of them. I would also like to thank to Hazal Babur and Ahmet Cinay who helped me during the implementation of the survey.

I would also like to extend my thanks to the professors of the Earth System Science (ESS) Department of METU, especially to Prof. Dr. Ayşen Yılmaz who always supported students in their academic works. I would also like to thank Research Assistant Yeliz Galioğlu for organizational support she provided.

Finally, I would sincerely thank to my parents for their limitless love and support throughout my life.

TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

CHAPTER 1

INTRODUCTION

Until recently, one of the main problems humanity was facing about the energy use was that the majority of resources are limited and by current rates of usage they will become scarcer in near future. Again until recent decades, usage of these resources was associated with local pollution; however today it has become clear that climate change, the inevitable consequence of carbon emissions resulting from over usage of fossil fuels, is the common global threat for the humanity, and the world has already met with the negative consequences of it during the last decade.

This over usage of traditional sources, which make up nearly 80% of global consumption in total (IEA, 2015), is also responsible for local air pollution, acid rains, aspiration problems in the cities and contamination of chemicals to natural resources. In addition to environmental problems, human being's over-reliance on traditional sources creates another problem; energy security; due to the fact that coal, natural gas and petroleum are all depletable resources. Energy security has become a global issue of debate in the World as especially energy needs of developing economies are booming. As a consequent, "sustainable energy" concept emerges at this point as a solution to climate change, pollution and energy security problems, implying that sustainability of energy resources does not only mean the long term availability of energy sources, but it also means producing energy without causing any damage to the natural ecosystems (Elliot, 2007). In relation to above mentioned reasons, renewable energy issues are attracting more attention nowadays than before due to the need for a shift towards low carbon, environmentally friendly technologies. Renewable energy sources are expected to play a critical role to end humans' over-reliance on traditional fossil resources in the next few decades as researchers point out the renewables as a solution to environmental problems, particularly the global environmental issues linked to fossil fuel usage (Wolsink, 2007).

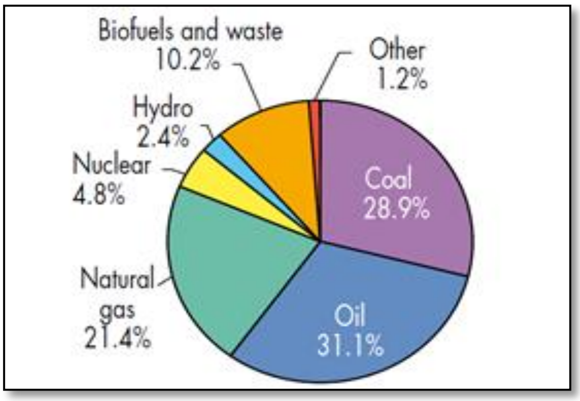


Figure 1-1: Energy Supplies of the World by Source
(Source: Key World Energy Statistics, International Energy Agency, 2015)

Figure 1-1 shows the energy supply sources of the World by the year 2013. Wind and solar energy are included under "other" category with a share of total 1.2 %. As seen on the figure, besides coal and other fossil resources mentioned above, nuclear power is another widely utilized source of energy in the World. In some European countries nuclear power meets more than half of the total energy demand. Nuclear plants do not emit GHGs during regular operation. However it's highly controversial due to the accidents like Chernobyl, which negatively affected lives of millions of people in the following ten years after the accident. Besides nuclear energy requires huge investments at the beginning and the problem of nuclear waste has not been solved yet, creating contamination risk.

Hydropower is another technology that does not create greenhouse gas emissions. It's a significant alternative source of energy in the countries where there is enough hydro potential and is also considered to be an inexpensive way of electricity production. However, there are several controversial issues including environmental damage given to local ecosystems and social problems created due to relocation of people in the construction area. Turkey has been facing these problems especially during the last decade with severe protests against dams and similar social events. In addition, hydropower has a limited potential in Turkey preventing it to be a powerful alternative for fossil sources.

Together with nuclear power, hydropower may be added to the conventional energy sources that are being in operation for many years around the World. On the other hand, new or “renewable” energy sources are booming in the last years that include; solar, wind, wave, biomass and geothermal energy which are expected to lead energy production in the coming decades due to the reasons mentioned above, forming a sustainable energy supply system to help shift away from traditional way of energy production.

Among these resources, biomass, wave and geothermal energy can be found at limited geography around the World compared to solar and wind energy. Figure 1-2 shows the relative annual and total potentials of energy sources of the World. At this point, solar energy emerges as the most abundant, widespread and most sustainable source of energy. Annual solar potential of the World is incomparably larger than other sources thus, capturing a little amount of solar potential would be sufficient to satisfy the World’s energy demand without any damage to sensitive ecosystems.

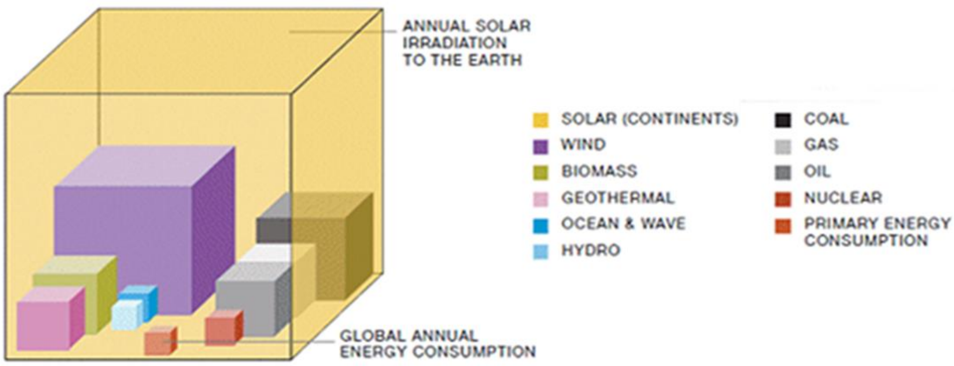


Figure 1-2: Total Reserves of Conventional Fuels & Yearly Potentials of Renewables

(Source: Greenpeace & EPIA Report on Solar Generation 6, 2011)

There are several technologies used to capture and transform solar irradiation. Photovoltaic technology is one of them which converts sunlight directly to electricity, it has distinct environmental benefits over conventional technologies; it does not produce any noise, toxic-gas emissions or greenhouse gases during operation (Kalschmitt et al. 2007). Figure 1-3 shows the per-kwh greenhouse gas emissions of various energy sources; the big gap between PV technology and conventional fossil sources is obvious.

Despite these environmental benefits, share of solar energy in energy mix is about 1 % (Figure 1-1) due to the existence of barriers against diffusion of PV systems which will be discussed in Chapter 2. Roof-top systems, residential PV modules for individual use, are the convenient way of using photovoltaic technology for microgeneration with its advantages over central production which can help to overcome these diffusion barriers. Besides, buildings are responsible for 40% of energy consumption and 36% of Carbon Dioxide emissions in the EU (European Commission, 2003). Using buildings for energy production enables to produce energy at the point of use, decreasing transfer loses and increasing energy savings by “take-back affect”, which will be discussed further. Consequently, residential photovoltaic applications are expected to have an accelerating role for the diffusion of solar energy technologies.

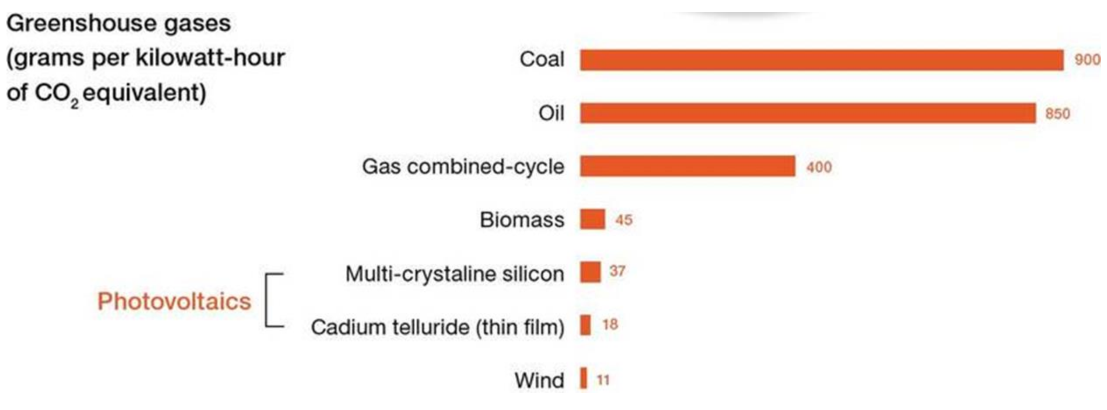


Figure 1-3: GHG Emissions of Various Energy Sources

(International Energy Agency, 2007)

This study aims to investigate the factors affecting willingness to pay and preferences of households in Ankara for roof-top PV systems and find out clues to increase the motivation to install these systems. The relation of socio-demographic characteristics and willingness to pay (WTP) for renewables have been investigated extensively by several studies, many of these studies have used a few question items to measure environmental attitudes of respondents, as a variable that is affective on WTP. Using data from a survey conducted in selected regions of Ankara, socio-demographic variables and two well-structured scales to measure environmental concern and pro-environmental behavior have been used to analyze the relation between these variables and their correlation with WTP. An approximate calculation of WTP of the sample has been made using contingent valuation. The results of this study may reveal some valuable input for policy makers and photovoltaic sector to determine policies to help diffusion of photovoltaics; set subsidies, increase awareness etc.

The following chapter includes general technical information on photovoltaic technology, net-metering system and discusses the barriers against diffusion of PV systems. Chapter 3 gives the current picture of photovoltaic sector in Turkey with a brief history, current legislation and government regulations. Chapter 4 includes examples from the literature on WTP for renewables, introduces the model and the variables used in this study. The survey methodology, sample and data description have been discussed in Chapter 5. Results of the analysis are given in Chapter 6 followed by Chapter 7, that includes the comments, conclusion and limitation of the study.

CHAPTER 2

PHOTOVOLTAIC TECHNOLOGY & DIFFUSION BARRIERS

2.1. Photovoltaic Technology

Although renewable technologies and specifically photovoltaic technology are considered as new developments, French scientist Edmond Becquerel first discovered the photovoltaic effect in 1839. He observed that when two electrodes were placed in an electrolytic solution and exposed to sunlight, the electricity generated by the cell was affected increasingly. In 1876, William Grylls Adams and Richard Evans Day discovered that selenium element produced electrically charged particles when exposed to sunlight. The electricity produced by these studies was too small to be useful and did not turn out to be commercial. In spring 1953, Gerald Pearson, a physicist at Bell Laboratories, made a solar cell using silicon that was far more efficient than solar cells made from selenium. Two other Bell scientists, Daryl Chapin and Calvin Fuller contributed to Pearson's discovery and finally the first solar cell capable of converting enough energy of sunlight into electricity that is usable in equipment’s was discovered (For historical details see: US Department of Energy, 2013).

Solar PV systems generate electricity by converting sunlight into electricity by means of the photoelectric effect (For historical details see: Jackson et al., 2000). PV cells can produce electricity even on cloudy days with diffused sunlight; this is why PV cells are applicable in many parts of the World. In most PV cells semiconductor materials are used at the core with varying efficiency and cost; crystalline silicon, some plastic types and thin film technology are mostly used materials in solar panels (Eicker, 2003). Electricity production by PV technology is commonly deployed in one of the two ways: large-scale solar PV farms, where many PV modules are connected to produce huge amounts of electricity, and microgeneration systems on building rooftops (Bradford, 2006). This study focuses on the latter, specifically on residential PV systems.

2.2. Roof-Top PV Systems and Net Metering

Photovoltaic panels can be used at roof tops of buildings with their highly modular characteristics. The system size may change according to the surface area of panels. The Figure 2-1 shows an illustration of a roof-top PV system and net metering.

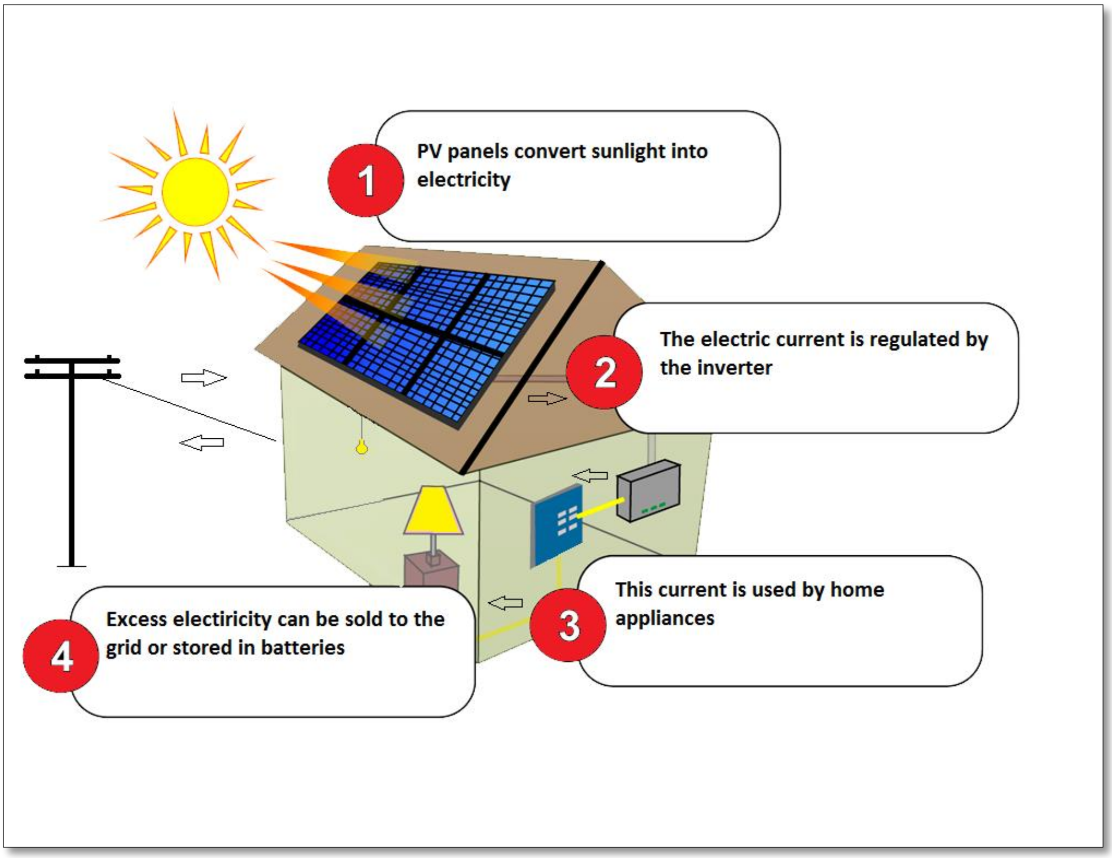


Figure 2-1: Illustration of a Roof-Top PV System and Net Metering

The photovoltaic panels convert sunlight to electric current. The current produced is than regulated by inverter; a part of the system which converts direct current to alternative current, the regulated current is than given to use of home appliances. Residential solar energy production systems can be divided into two categories according to their grid connectedness:

Off-grid solar houses are not connected to the utility grid. The electricity produced can be stored in batteries if any, or directly used by home appliances and the excess energy is wasted. These systems may have some supplementary energy source like diesel generator or wind turbine to provide continuity of energy supply. Such systems are called hybrid systems.

Grid-tied systems connected to the utility grid, may also have batteries for storage of excess energy. The extra electricity produced with these systems is not wasted; it's given to the utility grid through a net meter. Net metering system enables households to sell the extra energy to utility providers and earn credits to be used or make profits. During the day when there is sunshine, the solar system produces most of, or even more than the energy the house needs, so the surplus energy is fed into the grid to gain credits. This system is much more feasible than other systems because the grid behaves like a limitless and free storage space for the system.

Agreement conditions of net metering system vary among different countries and even different cities around the World. Some local electricity suppliers may provide the necessary components of the system to the customer (inverter, meter etc.). The credits earned are priced also differently among countries. In most countries, the electricity fed into the grid by the customers is credited with the wholesale price of that utility. In some countries like Germany where residential energy production is highly supported by the government, the credits are priced at a premium through which customers can have excessive gains by the system (Barber et al., 2010).

Rationally, it is widely supported over the World as the most economic and effective way of residential energy production since it helps to increase the share of solar energy in total energy supply.

2.3. Economic and Social Drivers of Roof-top Photovoltaics

Solar PV systems offer a number of positive features compared to other energy production technologies to make them attractive by economic and social drivers in addition to environmental benefits already mentioned.

Solar PV systems do not have moving parts and require little maintenance making them durable with an expected lifetime of 30+ years. PV systems do not produce noise during operation. Installation is easy, solar PV systems can be arranged to meet a wide range of power requirements by changing the area of PV panels (IEA Renewable Energy Working, 2002).

Another benefit arising from roof-top PV use is the “take-back effect”. This concept implies that due to the increase in awareness on energy related issues, total consumption of a household that adopted a microgeneration technology decreases. Keirstead (2007) examined the energy use and production of UK households that adopted PV systems. The study found that PV technology motivates households to make further energy savings by modifying their electricity usage patterns, causing a saving of 6 % on average.

Cities are places with extensive levels of energy needs; this may sometimes cause energy poverty or shortages. Roof-top PV systems help tackle this issue by contributing to energy supply sources of the cities (Bahaj et al. 2007). Another concept relating urban environments is the “heat island” effect. The excessive energy consumed in the cities in the end turns into greater amounts of heat deposit on cities which basically causes cities to be warmer than their surroundings. This phenomenon is called urban heat island effect which causes several problems like greater amounts of energy use or health problems. PV technology may also help reducing heat island effect by preventing energy imports to the cities (Göksu, 2008).

Almost all kinds of energy production technologies necessitate usage of huge agricultural lands or forestry areas. Nuclear power plants, coal power plants and big solar farms are all established on big areas. Consequently, these energy production ways create some environmental drawbacks due to land usage. Residential energy production with PV technology does not require extra land for production. Buildings have already occupied a certain area of land; solar panels can easily be integrated on the roofs of residential buildings, eliminating the need for extra land.

Buildings are responsible for an important portion of energy consumption all over the World. Producing the energy at the point of use by PV systems prevents approximately 10% loss of electricity caused by long distance transfer of energy from power plants to points of consumption.

In recent years peak energy demand occurs in summer days especially due to the need for cooling; conditioners and other cooling technologies like refrigerators have a large share in residential electricity consumption. PV systems produce peak levels of energy in those hot summer times reducing the peak pressure on energy suppliers.

Locality is an important concept for sustainability. Contrary to central energy production plants, residential energy production with solar source creates employment opportunities at local level.

Not only photovoltaics but solar energy in general is a local source for every country. Most European countries, Japan, China, USA and Turkey import huge amounts of oil, coal and natural gas to meet their energy demand. Producing energy with solar technologies decreases the dependency of countries on foreign energy sources. Besides, transport cost of these fossil fuels and extra carbon emissions produced during transportation is avoided.

2.4. Barriers Against the Diffusion of Photovoltaics

More than 60 years have passed over the first invention of photovoltaic technology, in addition, despite its extensive benefits previously mentioned, the share of PV technology in current energy balance is too small, and the uptake of roof-top systems is slow even in the countries where the legislation and technology is available for many years. As a result, it can be sad that there are some barriers against the diffusion of solar technologies (Barber et al., 2010). These barriers vary among countries however, cost of the systems (initial capital costs), institutional & cultural factors, technical issues, awareness and demand factor are among the important ones (Tsoutsos et al. 2005).

The general opinion that cost of electricity production with solar energy seems to be an important factor against its diffusion. Some studies analyzing the feasibility of PV systems with the nominal market costs concluded that they can hardly be profitable in parts of the World with less solar irradiation, unless they are supported by government, or a cost reduction is made possible by tax policies or similar subsidies (Brigham et al. 2007). This is why PV industry is subsidized by governments at the initial stages of market penetration. But one should keep it in mind that these costs are nominal costs, which mean monetary costs calculated according to the market conditions. However, when we are talking about energy and environmental issues, real costs of services should also be considered beside nominal costs.

Two important concepts should be discussed while talking about cost of energy production:

Externalized or external cost concept is at the center of many environmental problems. External cost can be defined as the cost, that rise from damages given to the environment during the production of a good or service, of which economic value is not calculated in the nominal (monetary) cost of the service or product (Longo et al, 2008).

For example, agricultural economic losses due to acid rains caused by coal power plants are not calculated in the cost of energy produced by those plants. So those economic losses are externalized. Recently there is a growing tendency on internalizing these external costs of services and products due to negative environmental effects. Carbon trade is a good example: until carbon trade, creating carbon emission was a free activity for producers. But this externalized cost is now being internalized through carbon agreements around the World. External cost concept has strong implications for solar energy and other renewables. As more external costs are internalized, environmentally harmful services become more expensive relative to sustainable services and processes. So we may conclude that this picture is changing in favor of renewables.

Economies of scale is one of the most basic concepts in economics. It can be basically defined as the cost advantage that can be obtained by expansion, at company or industry level. Certain amount of money has been spent on research and development activities of solar energy and investments have been made. At this stage of the market penetration, increasing the amount of production of solar technologies will cause significant decreases in the average cost. Oil and coal industries are benefiting from economies of scale for many years. This is why in nominal values, the average cost of energy production with solar source seems to appear more expensive than fossil fuels. However, nominal cost of PV technology is decreasing rapidly (Mills et al, 2008).

Cost related barriers explain a limited amount of slow diffusion for PV systems. Institutional factors and concepts such as economic dislocation have also been found to play a preventive role in solar PV diffusion. Economic dislocation can shortly be defined as the change in place, technology, ownership of an industry or replacement of an industry with another (Del Rio et al., 2007). There is a huge industry around fossil fuels; they are in use for more than 200 years which created subindustries and employment. This naturally creates a resistance for change and transition. Some measures are to be taken by governments to overcome these barriers, making this transition beneficial for every side such that solar industry have created a significant number employment opportunities in Germany in the last decade.

There are also some technical barriers against PV industry in special. The most important barrier is the grid-integration infrastructure. The current electricity network is designed for centralized electricity generation and it allows one-way flow, so technical changes in network will be required if microgeneration technologies like roof-top PV systems will contribute significantly to the energy supply (Allen et. al, 2007).

Low level of awareness is one of the critical barriers against diffusion. This is also one of the most common findings of research that deal with the demand for renewables which will be discussed in the following chapter. Every country takes some unique measures to increase information level among households, according to the specific needs that have been defined by such studies.

CHAPTER 3

PHOTOVOLTAIC ENERGY IN TURKEY

Turkey is a country of sun, with huge solar potential and also excessive need for energy due to rapid development. Before discussing the present state of photovoltaics in Turkey, current developments in PV industry in the World can be summarized very briefly:

In 2014, investments on renewable energy technologies have increased by 16 % in the World totaling 310 billion dollars. China, USA and Japan were the major investors. Solar energy had the biggest share among renewable energy investments. The pioneering country in solar energy is China with approximately 50000 MW installed capacity followed USA, Germany, Japan and Italy. There are ambitious targets set by the leading economies of the World. In terms of new investments on photovoltaics; China is followed by Japan, USA and United Kingdom. Despite the fact that PV industry is a new contributor in energy sector, it plays a considerable role in electricity generation in some countries. In 2015, solar PV met 7.8% of electricity demand in Italy, 6.5% in Greece and 6.4% in Germany. Average price of PV modules fell approximately 12 % annually during the last decade while PV industry has been expanding with a growth rate of 35 % each year. By 2015, China produced about two-thirds of the photovoltaic modules in the World followed by European Union with a share of 6 % (REN21 Global Status Report, 2016).

Looking at the developments summarized above, it can be concluded that PV industry will soon be a major electricity supplier in the World with this positive trend. With its increasing energy demand, Turkey aims to support expansion of renewable energy production and some legislative measures have been taken which will be discussed in this chapter accordingly. With annual average sunshine duration of 2737 hours, Turkey has a huge solar potential due to its geographical location (Directorate of Renewable Energy, 2015). Figure 3-1 shows the annual solar irradiation map of Turkey. According to this map prepared by Directorate of Renewable Energy, solar irradiation increases from Northern to Southern regions naturally, but with adequate level of sunlight in almost every province.

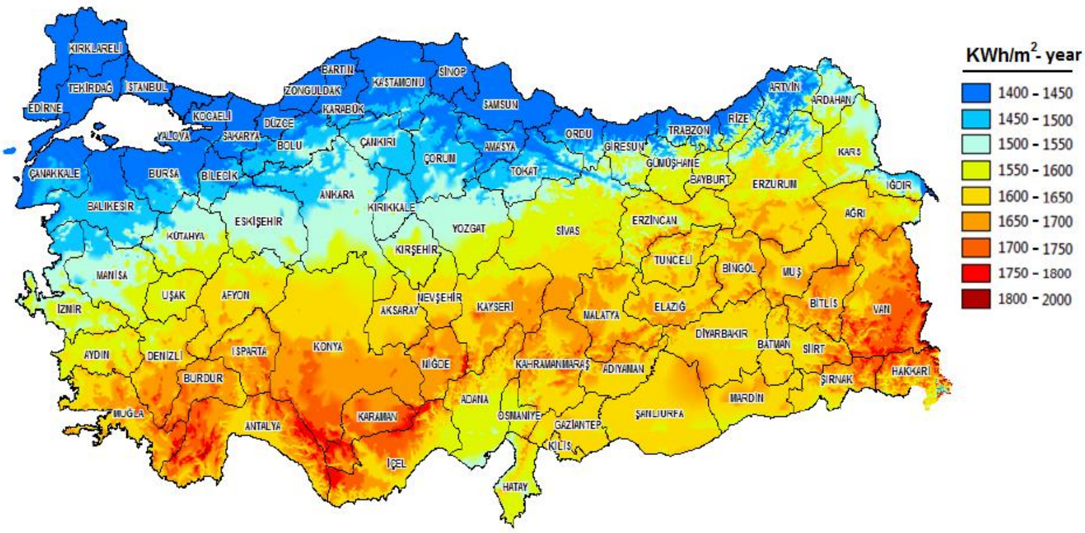


Figure 3-1: Annual Solar Irradiation Map of Turkey

(Renewable Energy General Directorate, 2015)

Despite this big potential and geographical prevalence, solar energy's share in total electricity production of Turkey is below 1 %. According to Turkish Ministry of Energy, total installed capacity of PV in Turkey has reached 505 MWs in 2016 compared to global total capacity reaching 227000 MW (REN21 Global Status Report, 2016). Turkey's share in total PV capacity of the World is under 0.5 %. Figure 3-2 shows the share of various energy sources in total electricity production of Turkey. Approximately 75 % of electricity production depends on fossil fuels, similar with the total ratio of the World. This figure also demonstrates that electricity production of Turkey is highly dependent on foreign, imported sources which create a risk in terms of energy security.

This picture clearly reveals the need for an expansion in the share of renewables and solar energy in specific with its high potential in Turkey. Considering past experiences, solar heating technology has been widespread among residential buildings in not only southern provinces but in whole parts of Turkey for many years such that Turkey is placed 2nd in solar thermal heating capacity following China.

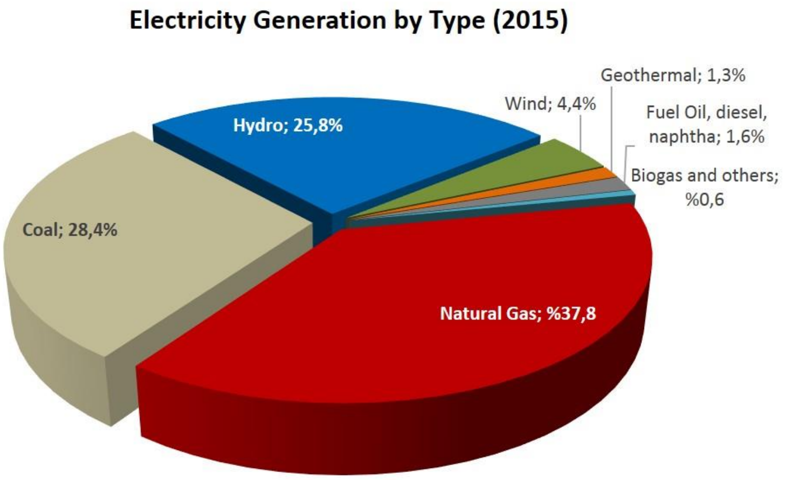


Figure 3-2: Electricity Generation of Turkey by Source (Turkish Ministry of Energy, 2015)

Solar thermal heaters can be used during 70% of the year on average. Turkey is also among main producers of solar thermal collectors with a capacity of 750.000 – 1.000.000 square meters annually (Kılıç, 2015). On the other hand, photovoltaic industry is at the very early stage of market penetration and in terms of residential roof-top systems, there is not even considerable number of buildings that adopted this technology. Using the previously mentioned experience on solar thermal may help to accelerate diffusion of photovoltaics in the near future. The legislative measures taken by the government is presented in the following part.

3.1. Current Legislation in Turkey

Turkish Ministry of Energy, Directorate of Renewable Energy and Turkish Energy Market Regulatory Authority are the authorities that are responsible for legislative regulations on electricity market. In Turkey renewable energy is mainly supported by the Renewable Energy Supporting Mechanism (YEKDEM) developed by Turkish Energy Market Regulatory Authority, which has entered into force in 2013. The support mechanism consists of feed-in tariffs for both licensed and unlicensed electricity manufacturers producing electricity from renewable sources. According to YEKDEM, the retail companies assigned by Turkish Energy Market Regulatory Authority are required to purchase the electricity produced from the electricity manufacturers which are in scope of this mechanism from the tariffs determined with this regulation. Retail companies are responsible for establishing the metering system to the microgeneration facilities. These companies are also responsible for recording the producer's total consumption and total electricity production. The feed-in tariffs to be applied vary among various energy sources; for instance, the tariff for photovoltaic energy is 13,3 USD Cent/kWh whereas it is 7,3 USD Cent/kWh for hydroelectricity. The tariffs can be seen on Table 3-1.

Table 3-1: YEKDEM tariffs

YEKDEM Tariffs	
Renewable Energy source	**(US Dollar cent/kWh)**
a. Hydroelectric	7,3
b. Wind	7,3
c. Geothermal	10,5
d. Biomass	13,3
e. Solar	13,3

(Source: Directorate of Renewable Energy, 2016)

In addition to the purchase guarantees with the above tariffs, the electricity manufacturer may also benefit from the local equipment support if any local equipment is used in the power plant. These amounts are added to the feed-in tariffs and such paid to the electricity manufacturer. Amount of local equipment support also depends on the energy resource used as in the feed-in tariffs.

Aim of YEKDEM as a support mechanism is to encourage renewable energy investments. By 2016 nearly 550 power plants have been taken in scope of this mechanism with a total capacity of approximately 16.000 MW. The scale and effectiveness of the support mechanism in Turkey can be argued however it is a fact this legislation is helpful for the initial efforts to include photovoltaics as a major contributor in the future energy mix.

CHAPTER 4

LITERATURE REVIEW, OBJECTIVE OF THE STUDY AND THE MODEL

A number of studies have investigated the relations between socio-demographic, economic variables, certain environmental attitude measures and willingness to pay for renewables. The studies revealed that certain socio-economic and behavioral attributes have an impact on WTP and certain consumer segments are more likely to adopt renewable energy technologies. Most commonly used variables in these studies were age, income, gender, education level, information level on renewables or environmental issues, perceived cost of renewables, political and religious orientations and measures of environmental concern, awareness or pro-environmental behavior. To measure respondents' environmental concerns or certain attributes related to environmental issues, most WTP studies produce their own measure, some of these measures are constructed from few questions and these questions are not always based on any attitude-behavior theories and it is doubtful whether they actually measure what they intend to measure (Ndebele et al. 2014). Well-structured measures of environmental attitudes that depend on theories of social psychology are widely used by social sciences however only a few studies in environmental economics have used them.

A summary of the literature on investigating the factors affecting WTP and attitude for renewables is given below followed by the literature on the relation between environmental concern and pro-environmental behavior.

4.1. Willingness to Pay for Renewables

In this part, a summary of the studies dealing with WTP for renewables is given first, and then the most common variables that are investigated in the literature are discussed.

A research by Farhar et al. (2000) interviewed US families about the decision of installing PV system on their roof-top. The study used a scoring system in terms of positive attitude towards renewables and awareness level. In the question of favorability of PV system, score was 7.5 (full score is 10). In the question of familiarity of PV system, score was 3.2. The survey showed that the awareness and information levels were too low while attitudes for roof-top photovoltaics is highly positive, so one of the main barriers of PV adoption was that residents are not willing to install it until they have sufficient information about PV systems.

Zarnikau (2003) assessed the main drivers of WTP for electricity from renewable sources in USA. Income and information level had a positive correlation with WTP. Although gender is usually found to be insignificant on WTP, the study suggested that male respondents tend to have higher WTP for renewables than females. Age was negatively correlated with WTP for renewable electricity.

Longo et al. (2006) investigated WTP of households in UK in scope of a hypothetical program for promoting green electricity. The study found that higher income and pro-environmental behavior patterns are correlated positively with WTP as well as liberal political views and higher levels of education.

Keirstead (2007) on the other hand conducted a study on households in UK who has already adopted roof-top photovoltaic systems. The study revealed that the adopters of photovoltaic technology were older, wealthier, better educated and more likely to own their own home.

Two other studies conducted in USA specifically focused on WTP for renewable energy research and development (Li et al., 2009; Mueller, 2013). Significant predictors of WTP for energy R&D included income, gender, political ideology, and beliefs about the importance of energy issues. Mueller (2013) found that belief in human-caused climate change was a significant predictor for WTP in USA.

Sovacool (2009) investigated why renewables provide only 3% of electricity in US while having such environmental and economic benefits. 181 interviews have been conducted with a diverse group of stakeholders and the study finally suggested that social or cultural barriers are critical, such that utility operators and the conventional energy industry reject renewable resources because they are used to work with big industrial level power plants and fossil sources.

Claudy et al. (2010) searched the consumer awareness towards microgeneration renewable energy technologies in Ireland. The relation between consumer awareness and demographic variables such as gender, age, household size and employment status has been investigated. The study found out that; males, older people, people with higher levels of education and full time employed people were significantly more likely to have higher levels of awareness of renewable energy technologies. Perceived initial cost is also found to be a strong barrier against diffusion of renewables.

Stigka et al. (2014) investigated the social acceptance of renewable sources by Greek citizens through contingent valuation. The study suggested that WTP for renewable energy is positively correlated with income, exposure to information about energy issues and level of education; on the other hand WTP is found to be negatively correlated with age and size of household.

Tsantapoulos et al. (2014) aimed to represent the attitude of Greek citizens towards photovoltaics through a survey study and found out that half of the respondents were willing to pay for photovoltaics, education was positively correlated with WTP and respondents found these systems expensive; perceived cost of the systems had a strong negative correlation with their WTP.

Streimikiene et al. (2015) examined the willingness to pay of households in Lithuania for renewables in accordance with the socio-economic information. The results indicated that information level and environmental awareness of respondents play a crucial role in willingness to pay for renewables in Lithuanian households. The study also revealed that people having higher income and higher education are willing to pay more for renewable energy. The gender and age were not found to have a significant impact on WTP.

The socio-demographic and economic variables most commonly included in studies searching WTP for renewables and common findings on their impacts may be summarized as follows:

The effect of age on WTP is a matter of discussion: some studies suggest that age is a significant predictor of attitude toward renewables while others claim the opposite. The research question of the study may also reveal distinct results about the effect of age. Walsh (1989) found that younger households are more likely to make investments in energy conservation while Hirst et al. (1982) found that middle age people are more likely to make investments on energy savings. As mentioned before, Keirstead (2007) suggests that older people are more likely to adopt PV systems in UK, on the other hand Zarnikau (2003) found that younger people in USA are willing to pay more for renewable electricity. In addition, age is consistently suggested as a strong predictor of environmental concern such that younger people have greater environmental concern than older people (Van Liere & Dunlap, 1980).

Gender is found to be insignificant in predicting WTP in most studies. However research on environmental concern suggests that women have slightly greater environmental concern than men do (Davidson & Freudenburg, 1996), while this tendency is moderate and not universal. On the other hand, according to Zarnikau (2003), males tend to pay more for renewables compared to female participants in USA.

Education level is another variable investigated in many studies on WTP for renewables and found to have a positive effect on WTP (Keirsted, 2007; Claudy et al 2010; Streimikiene et al., 2015). Education level also has a consistent positive relation with environmental concern (Jones & Dunlap, 1992).

Income is positively correlated with WTP for renewables in studies where different groups of income levels have been included (Longo et al. 2006; Keirsted, 2007; Claudy et al. 2010; Streimikiene et al., 2015). The relation of income and environmental concern is not proved to be strong and this relation is contradictory; Klineberg et al. (1998) found income to be a strong predictor of environmental concern and behavior, whereas Jones and Dunlap (1992) suggested income as a poor predictor of environmental concern.

Especially taking into account the fact that renewables and solar energy is a new technology which households are not familiar with, information level is expected to have a positive effect on their WTP. In parallel to this, information level and awareness on renewables and photovoltaic energy in special is consistently found as a significant predictor of WTP (Farhar, et al., 2000; Claudy et al., 2011; Islam, 2013; Stigka et al., 2014; Streimikiene et al., 2015).

Perceived cost of renewables by households is an important determinant of WTP as initial cost of these systems still creates an important barrier against diffusion. Perceived cost have been found as a significant variable in studies that search for WTP for renewables (Claudy et al. 2010; Tsantapoulos et al. 2014).

Political ideology and religion are other variables sometimes used to investigate their impact on WTP for renewables. Political ideology have been found to be effective on WTP in USA such that people with more liberal views are willing to pay more for renewables and their attitudes for renewables are more positive (Jones & Dunlap, 1992; Zarnikau, 2003). Longo et al. (2007) also found that in UK, liberal political orientations is a determinant of WTP for renewables. Religion has been included in studies that have a heterogeneous population in terms of religious beliefs and it is found to be less effective on determining WTP (Greeley, 1993; Klineberg et al., 1998).

4.2. Measuring Environmental Concern & Behavior

Individual behavior and its sources have been the subject of many studies in the fields of psychology and sociology. On the other hand, as negative consequences of human behaviors on natural systems became clear, researches on the factors that affect pro-environmental behavior gained importance. These research mainly aim to discover how environmentally harmful behaviors can be changed towards more sustainable, pro-environmental behaviors and their connections with more intrinsic values. A person’s concern for the environment would naturally be linked with the attitudes toward renewable energy technologies. The environmental benefits of renewable energy sources may create an expectation that those people with higher levels of environmental concern would support these technologies. However it would be a mistake to assume that those with similar levels of environmental concern will act in similar manner. One reason for this is that environmentalism covers a broad range of issues, from biodiversity conservation to local air pollution, and those with high levels of environmental concern can have different priorities regarding purchasing or supporting renewable technologies. In addition, the relations between environmental concern and behaviors have been studied by several researchers and the correlation between these factors has not been proved to be strong (Schultz et al. 2005).

There is an extraordinary number of scales to measure environmental behavior, environmental concern and attitudes such that Stern (1992) describes this situation as an ‘‘anarchy of measurement’’. In addition, many studies on renewable energy use only a few, unique questions as a measure of environmental attitudes (Ndebele, 2014). Compatible with the purpose of this study, it will be useful to initially define values, environmental beliefs - environmental concern, attitudes and pro-environmental behavior more clearly.

Basic values: Basic values are defined as the stable and universal basic values of individuals, which affect their evaluations of the objects and their behaviors (Stern et al. 1995). With this regard, basic values are distinguished from behaviors, attitudes and beliefs being the most abstract variables of the social psychology. Definition and measurement of basic values has been the subject of many research especially due to the theory that they give rise to the more measurable variables such as beliefs, attitudes and behaviors (Stern et al., 1994). Schwartz (1994) defines basic values as “cognitive manifestations of social and biological demands placed on individuals”. Although there are numerous definitions, basic values are widely accepted as being standards of individuals for guiding their actions, and they are stable. There are also few basic values which give rise to a broader range of behaviors, attitudes and beliefs. Thus, their measurement has limited use in directly predicting behavior (Hofstede 2001).

Environmental Beliefs: Basic values are widely accepted as the originators of beliefs. Beliefs are standards that individuals use to prioritize their actions or behaviors and are higher than values in order of magnitude. Environmental beliefs or environmental concern refer to beliefs that are specific to an environmental context (Zinn et al. 1998). In the study of pro-environmental behavior, basic values are fundamental to environmental beliefs and environmental beliefs are defined by Dunlap et al. (2000) as "the orientations that an individual has toward the world around them (including other species in the ecosystem, other people)" A widely used and reliable scale of environmental beliefs is the New Ecological Paradigm (NEP) scale (Dunlap et al. 2000), which will be discussed in detail further in this chapter.

Environmental Attitudes: Environmental attitudes are built upon basic values and environmental beliefs; however there are many attitude types and they are less stable compared to basic values and environmental beliefs. An attitude is an evaluation of an individual that causes consistent reactions to some object (positively or negatively). Attitudes are relatively durable and well-organized. An individual having positive environmental attitude would be expected to pay attention to environmental problems, and be concerned with pro-environmental actions (Hernandez et al. 2000). "Clean environment is more important than a big economy," is an example of attitudes because it expresses a positive or negative evaluation about other objects. Research on attitudes suggests that attitudes can indirectly have an influence on behavior, thus study of attitudes is of importance in the study of pro-environmental behavior and understanding the attitudes of a person or a population may help estimate the level of pro-environmental behavior (Kuhlemeier et al. 1999).

Pro-environmental Behavior: Social psychological variables that affect attitudes towards renewables include basic values, environmental beliefs, environmental attitude that have been introduced previously and Pro-environmental behavior (PEB). Broadly, PEB is defined as "human behavior that has a positive impact on the Earth's systems and natural resources" (Stern, 2000). Pro-environmental behaviors are the final, realized, observed behaviors so it is easier to measure PEB by using revealed behavior patterns of individuals. Pro-environmental behaviors are commonly defined by two separate categories by researchers as: public sphere and private sphere (Stern, 2000). Examples of public-sphere PEB include writing to government institutions or the media, attending protests, volunteering for environmental organizations and membership in an environmental organization. Private-sphere PEB examples include using public transit, recycling, conserving water and electricity etc. Schultz et al. (1995) searched the relation between socio-demographic variables and recycling as an environmental behavior. Results of the study suggested that income is a good predictor of recycling behavior, whereas gender and age are not. General environmental concern is found to be related to recycling behavior only when recycling requires a high degree of effort.

Several studies investigated the relation between environmental concern and pro-environmental behavior and sources of environmental concern. Some of the examples from the literature are summarized below:

Thapa (1999) investigated the relation between environmental attitudes and environmentally responsible behaviors among college students in USA. Overall, college students in this sample had high NEP scores showing a high concern for ecological world view however, except for recycling, students were not very participative in various pro-environmental behaviors. Additionally, consistent with previous studies, the attitude-behavior relation was weak.

The study by Poortinga et al. (2004) showed that differences in geography and local opportunities play significant role in determining environmental behavior. The study suggests that the internal attitudinal variables could explain a significant but modest amount of variance in the various types of environmental behavior. Individual opportunities, abilities and difficulty of the action to perform are also affective on pro-environmental behavior.

Schultz et al. (2005) investigated the relation between values, environmental concern and pro-environmental behavior. The study used New Ecological Paradigm Scale to measure environmental concern, Schwartz' value survey (Schwartz, 1992) to measure value categories and self-reported pro-environmental behavior items (Schultz et al. 2005) to assess behaviors. Overall, the study suggested that the link between values and environmental concern was clear however values and environmental concern explained only a small amount of variance in environmental behaviors.

4.3. Objective of the Study & the Model

In Turkey, several technical feasibility studies have been conducted to assess technical features and productivity of rooftop photovoltaic systems. However, there is not any study investigated the factors influencing WTP for roof-top photovoltaic systems. It is important to find clues to help widespread utilization of roof-top PV systems in Turkey, having a high solar potential and also having a positive experience in solar thermal heating systems in the past. As the legislation now allows production of electricity by microgeneration, assessing willingness to pay of households, who will benefit from these systems and will be future investors of the systems, play a crucial role for the policy makers and the suppliers.

Turkey is a developing country and unlike European countries and USA the introduction and dissemination of renewable energy is still at an initial stage and accordingly research is also scarce. The present study aims to achieve the following objectives:

(a) To investigate home owners’ willingness to pay and the factors affecting their WTP for solar PV systems in selected residential areas of Ankara.

(b) To put forward recommendations to the policy makers by using the participants’ responses to policy related questions, their information level on photovoltaics and most influential motivations for possible adoption decisions.

As mentioned at the beginning of this chapter, studies conducted on measuring WTP for renewables used mostly their own measures of environmental attitudes with a few unique question items. This study aims to contribute to the literature by differentiating between environmental concern and pro-environmental behavior and their measurements by using well-structured, widely accepted scales to measure these variables separately and investigate the relation between them and their correlation with WTP.

To distinguish between different attitude concepts and measure them with separate scales creates the opportunity to handle them as separate variables to affect WTP and investigate the relation among them. For this purpose NEP scale was used in this study as a measure of environmental concern (or beliefs) which represents the abstract values. On the other hand Self-reported Pro-environmental behavior scale has been used to measure environmental behavior, which is the ultimate observed behavior, directly affecting the ecosystems.

Although the New Ecological Paradigm Scale is one of the instruments most frequently used by social scientists to measure environmental concern (Dunlap, 2008; Hawcroft & Milfont, 2010), only a few studies in environmental economics have used this scale. In this study, 15 item version of NEP scale is used to measure environmental concern as an independent variable. Environmental behaviors are measured by the self-reported pro-environmental behavior items (Schultz et al., 2005) that have been used in cross-country studies with multinational characteristics of the items.

In this study; age, gender, monthly income, education level, information level, perceived cost, environmental concern and pro-environmental behavior were selected as independent variables to be investigated for their relation with WTP for PV systems. Political ideology and religious orientations were not included in the study due to the privacy concerns. Dependent variables of the model are; WTP for PV systems before market price information, which will be investigated through a multiple linear regression analysis; and “purchase” vs “not purchase” responses of participants on whether they would be willing to pay the current market price of a PV system or not, which will be assessed through a binary logistic regression analysis. All dependent and independent variables in the model and how they are measured can be seen on Table 4-1. Equations of the Model are given below:

$$\mathrm{WTP}=\beta 0+\beta 1\mathrm{Age}+\beta 2\mathrm{Gender}+\beta 3\mathrm{Income}+\beta 4\mathrm{Education}+\beta 5\mathrm{Information}+\beta 6\mathrm{Perceived\ Cost}+\beta 7\mathrm{NEPscore}+\beta 8\mathrm{Behaviour\ Score}+\mathrm{error\ term}$$

Y: purchase decision

$$Log\left[\frac{Y}{1-Y}\right] = \beta0 + \beta1\text{Age} + \beta2\text{Gender} + \beta3\text{Income} + \beta4\text{Education} + \beta5\text{Information} + \beta6\text{Perceived Cost} + \beta7\text{NEPscore} + \beta8\text{Behaviour Score} + \text{error term}$$

Table 4-1: Variables in the Model and Measurement Methods

Variables and Measurement	
Dependent Variables	
WTP before Info (Continuous)	Maximum WTP of the respondent for PV system before price information
Purchase Decision (Binary)	Whether the respondent would be willing to pay the market price (1=Yes, 0=No)
Independent Variables	
Age	Age of the respondent
Gender	1 = female, 2 = male
Education Level	1 = primary school, 2 = secondary school 3 = high school, 4= 2 year degree 5 = university, 6 =master's 7= PhD
Monthly Income	Average monthly income of the respondent
Information Level	Perceived information level of the respondent on solar energy 1= no information > 6= very good
Perceived Cost	Perceived cost of the respondent (Cost of the system is very high: 1=strongly disagree> 5 strongly agree)
Total Behaviour	Score of Self-Reported Pro-environmental Behaviour Scale
Total NEP	Score of New Ecological Paradigm Scale

CHAPTER 5

METHODOLOGY

5.1. Variable Measurement & Survey Design

This section describes the methodology of the study broadly, the variables used in the model and how they are measured with the sample data and statistics. To serve to the previously mentioned purposes of the study, a survey questionnaire was designed to gather data from participants which includes 9 parts: the first part of the questionnaire dealt with gathering information about the location of the household, household size, total area of the house and monthly electricity bill. The second part contains the 15 question items of the Self-Reported Pro-environmental Behavior Scale and the third part includes the 15 items of the New Ecological Paradigm scale. Forth part includes questions regarding the information and awareness level of the respondents on solar energy and photovoltaics in special, fifth part gives general information about the grid connected roof-top PV systems and net metering. Sixth part tries to measure willingness to pay of respondents with contingent valuation and choice experiment methods and informs the participants on the current market price of the systems. Seventh part presents two system alternatives to the participants (2 kW and 3 kW system size) and tries to explore if some of the respondents see the PV system as an investment opportunity. Part 8 includes questions to investigate respondents' preferred policy options and factors that may be affective on their future adoption decisions. Items in this part were adopted from a study conducted in USA (Zhai, 2010) that aimed to investigate environmental, policy and social analysis of photovoltaics. The final part includes the demographic information questions including age, gender, monthly income and education level. The complete questionnaire can be seen at Appendix A.

5.1.1. The New Ecological Paradigm (NEP) Scale

The New Ecological Paradigm (NEP) is a scale to measure ecological worldview of a person using a survey instrument constructed of fifteen statements. Having an ecological worldview means the believing that humanity is a part of nature and not a ruler over it (Dunlap et al., 2000). The NEP Scale measures ecocentric beliefs (i.e., humans as a part of nature) as opposed to anthropocentric beliefs (i.e., humans superior to other organisms in nature).

It was first created as New Environmental Paradigm scale in 1978 by Dunlap & Van Liere. The developers of the scale aimed to measure the place of a population in its transition from the Dominant Social Paradigm towards ecological world view. The dominant world view of the society; Dominant Social Paradigm (DSP) was changing and the scale was developed to measure the phase of this transition. The original NEP had twelve items and it was criticized for several weaknesses such as lack of internal consistency, weak correlation between scale results and actual behavior of respondents, and “dated” language.

New Ecological Paradigm Scale was then developed as the revised version of the original scale which is sometimes referred to as the revised NEP scale. The scale has 15 items that can be seen at Appendix A. Respondents are asked to indicate the strength of their agreement or disagreement with each statement. Eight of the items reflect endorsement of the new paradigm and the other seven items represents endorsement of the DSP. Using a Likert scale, respondents are asked to indicate their level of agreement with each statement (strongly agree, agree, unsure, disagree and strongly disagree). NEP scale measures environmental concern by focusing on the primitive beliefs of individuals. The scale uses only general environmental topics to measure the overall relationship between humans and the environment and such it does not became dated (Dunlap et al., 2000). The scale has been the most widely used measure to investigate environmental issues in the last 30 years (Hawcroft et al., 2010).

Furman (1998) used NEP scale to measure environmental concern in his study conducted in İstanbul. In our study the Turkish version of the scale translated by Furman was used. In addition, to gain a single score of NEP scale, DSP items (odd number items) were considered as reverse items for practical purposes (Strongly agree > strongly disagree) and a single score over 5.00 was obtained to be used it the multiple regression analysis. Average scores and the reliability statistics of our sample can be seen at Appendix C.

5.1.2. Self-Reported Pro-Environmental Behavior Scale

Environmental behaviors of the respondents were measured by self-reported pro-environmental behavior items developed by Schultz et al. (2005). A Likert scale was used to rate past behavior of participants, they were asked to indicate "how often you have done each of the following in the past year." The 15 items in the scale can be seen at Appendix A.

Response categories were never, rarely, sometimes, often, and very often. A "not applicable" response was also provided in the question items if there was no opportunity for the action. "Not applicable" options were regarded as missing values and Expectation Maximization (EM) algorithm was used to impute those missing items, such that a single score over 5.0 was attained for each participant.

5.1.3. Measuring Willingness to Pay

Willingness to Pay (WTP) is the method used to determine the price of a good or set a range for what consumers are willing to pay for a new market good. Measuring the willingness to pay for a product plays a crucial role in many areas of marketing management like pricing decisions or new product development. Especially in Environmental Economics this method is widely used to value services (Breidert et al. 2006).

Contingent Valuation Methodology (CVM) is used to gather information about participants WTP for PV systems in this study. It is a valuation technique that combines economic theory and survey methodology to understand how individuals value goods by asking them how much they would be willing to pay for the goods (Carson, 2000). In Part 6 of the questionnaire, participants were initially asked about their attitude towards installing a PV system, than they were asked to state the maximum amount they would be willing to pay for a 2 kW roof-top PV system after being informed on PV technology and net metering system. The participants were then informed about the average market price of a 2 kW roof-top system and were asked if they would be willing to pay the market price.

In Part 7, respondents were asked to make a choice between two hypothetical system options with 2 kW and 3 kW system sizes. The prices of the presented systems were based on the contemporary market data. 2 kW is the system size which can meet the monthly electricity need of an average household, 3 kW is the system size that can produce more electricity than an average household needs and thus can be seen as a tool for investment by enabling to sell the excess electricity to grid. This question aimed to explore whether PV systems can also be preferred as an investment opportunity.

5.2. Sampling and Data Description

Roof-top PV system, as a new technology consumer product, is at the very early stage of market penetration in Turkey; accordingly this study mainly aims to gather information on WTP and preferences of homeowner households that may be considered in early adopters and early majority market segments for PV systems. According to the "Diffusion of Innovations", a popular marketing theory developed by Everett Rogers in 1962, these segments are in the majority that adopt a new technology earlier, having above average socio-economic status, higher education and income level compared to the population average (Rogers, 2003). For this purpose, residents of Çankaya and Batıkent (Yenimahalle) regions, which have above average socio-economic status compared to overall Ankara population, have been included in the study. The study targeted to contact approximately 200 participants in the survey from these two regions with a geographical cluster sampling approach. A quota was applied to include 50 participants from Çayyolu and 50 participants from Batıkent districts (the residential suburban areas of Çankaya and Yenimahalle). The rest of the participants were the residents in other parts of Çankaya region. Participants were randomly selected households. The precondition to be included in the study was being a homeowner and being over 18 years old. The decision maker households were the target group however if not found at home, the residents of the house over 18 were also included in the study. A total of 205 households participated in the survey, 4 of them have been excluded from the analysis due to lack of critical information and low response level to question items and thus, 201 households' responses have been included in the analysis. The households who admitted to participate in the study were asked to fill out the questionnaire. The cover letter explained the purpose of the questionnaire, in addition the implementer of the survey made the necessary explanations to the participants before they filled out the survey. As the sequence of questionnaire items were crucial to follow (price information of PV systems), the participants were warned and controlled on this issue by the implementers.

5.2.1. Data Description

Table 5-1, Table 5-2 and Table 5-3 show the descriptive socio-demographic statistics of the participants. Table 5-4 shows participants' own ratings of their information level on solar energy. According to the sample data, the average monthly income is 5695.19 TL with a standard deviation of 3134.366. Average age is 43.28 with a range between 21 and 76 and approximately 80 % of participants have a higher education degree. Looking at this figure, it can me concluded that the socio-demographic characteristics of the sample is compatible with the purpose of this study. SPSS output for the descriptive statistics of the sample can be seen at Appendix B.

Table 5-1: Age and Income Averages of Participants

Age & Monthly Income				
	Minimum	Maximum	Mean	Std. Deviation
Age	21	76	43.28	12.192
Monthly Income	1000	20000	5695.19	3134.366

Table 5-2: Gender Distribution of Participants

Gender		
	Frequency	Percent
female	103	51.2
male	98	48.8

Table 5-3: Education Level of the Participants

Education Level		
	Frequency	Percent
primary	1	.5
secondary	6	3.0
high school	33	16.4
two-year degree	7	3.5
college	113	56.2
master	33	16.4
PhD	8	4.0
Total	201	100.0

Table 5-4: Respondents' Own Ratings of Their Information Level on Solar Energy

Information Level		
	Frequency	Percent
no idea	1	.5
very poor	37	18.5
poor	63	31.5
moderate	70	35.0
good	23	11.5
very good	6	3.0
Total	200	100.0
Missing	1	

5.3. Results of Willingness to Pay

Firstly, the findings indicate that respondents' attitudes towards PV systems are generally very positive, Table 5-5 shows the replies to the question "How would you consider installing a roof-top PV system?" 192 respondents replied positively to the question.

Table 5-5: Attitude of Respondents for Adopting PV systems

	Frequency	Percent
positive	192	95.5
negative	9	4.5
Total	201	100.0

Average WTP of respondents before being informed on current market price was 3.857 TL as seen on Table 5-6. Participants were then informed on the market price range of a 2 kW roof-top system (8.000-10.000 TL) and asked if they would consider buying the system with this price. 123 respondents replied positively (Table 5-7). Maximum WTP of respondents was calculated by considering Yes and No respondents' maximum WTP amount for the systems separately (if a respondent agreed to pay the market price, Max WTP was taken as 9.000 TL). Table 5-7 shows that after being informed about the reference market price range, average WTP became 7.247 TL which is closer to the market price but there still exists a significant gap. On the other hand "No" respondents WTP increased to 3118.94 TL from 2231.59 TL after price information.

Table 5-6: Average WTP and WTP Change with Price Information

	Maximum	Mean	Std. Deviation
WTP before info	20000	3857.18	3667.533
Rejecter's' WTP before info	5500	2231.59	1536.708
Rejecter's' WTP after info	6500	3118.94	1596.674
MAXWTP	20000	7247.84	3415.501

Table 5-7: Frequency of Respondents Who Agree to Pay the Market Price

		Frequency	Percent	Valid Percent
	yes	123	61.2	62.1
	no	75	37.3	37.9
	Total	198	98.5	100.0
Missing		3	1.5	
Total		201	100.0	

5.4. Results on Policy Related Questionnaire Items

Four separate question items of the questionnaire in Part 8 tries to find clues about the future motivations of the participants to install PV systems, which factors would be most effective in their decisions, their preferred policy recommendation for the diffusion of the technology and their trust level on the net metering system. Frequency outputs of the responses to the items can be seen at Appendix B.

According to these responses, lack of information and cost seems to be effective barriers against diffusion. Also not seeing anyone who has installed the system in close neighborhood seems to be critical factor. This implies that “word of mouth” and social pressure will be effective for the diffusion of the technology. Most common motivations for future installations among respondents are economic benefits, environmental benefits, other neighbors’ adoption of PV systems and producing their own electricity independently.

The two highly preferred diffusion policies were raising awareness through TV and other media and government to pay the partial cost of the systems.

People think that the net metering system will function fairly well to moderate in separate areas like financing, measurement and payments, government related procedures and maintenance.

CHAPTER 6

ANALYSIS & RESULTS

6.1. Reliability Test Statistics of the Scales

In order to test for the reliability of the scales used in this study, Cronbach's alpha coefficient has been used. The Cronbach's alpha coefficient was 0.699 for the total NEP scale, 0.772 for the eight NEP items (even numbered items) and 0.650 for the seven DSP items (odd numbered items) indicating a sufficient degree of internal consistency in patterns of response to the component items. The reliability test results of all NEP scale items are given in Appendix C.

The Cronbach's alpha coefficient was 0.877 for the Self-reported Pro-environmental Behavior scale, indicating a high level of internal consistency in response patterns to the scale components. Reliability test results table of the Self-reported Pro-environmental Behavior scale can also be found in Appendix C. The analysis in this study was conducted with IBM SPSS software version 23.

6.2. Correlations of the Variables in the Model

Before discussing the results of the multivariate regression analysis, a brief overview of the bivariate correlations between the independent variables and the dependent variable is presented in Table 6-1, to provide an assessment of the individual relationships among of the independent variables and the dependent variable. The correlation matrix also gives information on whether the relationships between variables are statistically significant.

As seen on the table, highest correlation (0.403) exists between the monthly income and education level as expected. Respondent's perception on the cost of the PV systems is highly correlated with their WTP (0.401). Coherent with previous literature, education level is significantly correlated with NEP score. There is also a remarkable correlation between the age and Pro-environmental behavior, this relation can be connected to the fact that private sphere pro-environmental behaviors (saving

Table 6-1: Correlation Matrix for the Independent & Dependent Variables

Correlation Matrix										
		WTP before info	Age	Gender	Education Level	Monthly Income	Information level	Perceived Cost	Total Behaviour	Total NEP
WTP before info	Pearson Correlation	1	.036	.133	.086	,163*	.061	-,401**	,200**	.076
	Sig. (2-tailed)		.633	.081	.261	.035	.426	.000	.008	.319
	N	174	174	174	174	166	173	165	174	174
Age	Pearson Correlation	.036	1	.118	-.089	-.046	,177*	-.059	,375**	.131
	Sig. (2-tailed)	.633		.096	.207	.532	.012	.420	.000	.063
	N	174	201	201	201	187	200	189	201	201
Gender	Pearson Correlation	.133	.118	1	-.005	-.072	,199**	-.057	-,172*	-.106
	Sig. (2-tailed)	.081	.096		.944	.331	.005	.436	.015	.133
	N	174	201	201	201	187	200	189	201	201
Education Level	Pearson Correlation	.086	-.089	-.005	1	,403**	.050	-.018	.024	,203**
	Sig. (2-tailed)	.261	.207	.944		.000	.481	.802	.736	.004
	N	174	201	201	201	187	200	189	201	201
Monthly Income	Pearson Correlation	,163*	-.046	-.072	,403**	1	.090	-,187*	.039	.127
	Sig. (2-tailed)	.035	.532	.331	.000		.224	.013	.599	.083
	N	166	187	187	187	187	186	175	187	187
Information level	Pearson Correlation	.061	,177*	,199**	.050	.090	1	-.110	,149*	-,150*
	Sig. (2-tailed)	.426	.012	.005	.481	.224		.131	.035	.034
	N	173	200	200	200	186	200	189	200	200
Perceived Cost	Pearson Correlation	-,401**	-.059	-.057	-.018	-,187*	-.110	1	-.062	.110
	Sig. (2-tailed)	.000	.420	.436	.802	.013	.131		.394	.131
	N	165	189	189	189	175	189	189	189	189
Total Behaviour	Pearson Correlation	,200**	,375**	-,172*	.024	.039	,149*	-.062	1	,147*
	Sig. (2-tailed)	.008	.000	.015	.736	.599	.035	.394		.037
	N	174	201	201	201	187	200	189	201	201
Total NEP	Pearson Correlation	.076	.131	-.106	,203**	.127	-,150*	.110	,147*	1
	Sig. (2-tailed)	.319	.063	.133	.004	.083	.034	.131	.037	
	N	174	201	201	201	187	200	189	201	201
*. Correlation is significant at the 0.05 level (2-tailed).										
**. Correlation is significant at the 0.01 level (2-tailed).										

energy, recycling etc.) increase with age. The correlation coefficient between NEP score and Pro-environmental behavior scale is 0.147 with a 0.05 level of significance which shows that environmental beliefs and pro-environmental behaviors are not strongly related.

6.3. Results of Multiple Regression Analysis

A multiple linear regression analysis approach was employed to test the combined relationships between the independent variables and the continuous dependent variable: respondent's willingness to pay for the PV system without market price information.

Table 6-2: Multivariate Regression Model output[a]

Linear Regression Model Output			
Independent Variables	**Coefficients (St. Error)**	**St. Coeff.**	**Sig.**
Age	-29.202 (23.658)	-0.097	0.219
Gender	1343.360 (545.499)	0.184*	0.015
Education Level	51.886 (249.767)	0.016	0.836
Monthly Income	0.088 (0.092)	0.075	0.341
Information Level	-97.073 (266.030)	-0.027	0.716
Perceived Cost	-1432.206 (399.432)	-0.381**	0.000
Total Behaviour	1164.093 (399.432)	0.230**	0.004
Total NEP	787.159 (593.285)	0.100	0.187
(Constant)	1592.095 (2810.736)		0.572
F statistics	*6.124***		
Adjusted R^2	*0.200*		
p<0.05, **p<0.01			

[a]In our data, education and information level were not normally distributed variables. A further analysis was also run with the log transformed education and information level data; however the results did not change significantly. The SPSS output of the analysis can be seen at Appendix C, Table C-4

The regression model involved the eight independent variables (age, gender, education level, monthly income, information level on solar energy, cost perception, behavior scale and NEP scale) as predictors of willingness to pay. Overall, Table 6-2 shows that the regression analysis of the factors affecting WTP accounted for nearly

24 percent (R^2=.239) of the variance in WTP for PV systems and yields significant explanatory power ($F_{8,156} = 6.124$, $p < 0.01$). The residuals of the regression analysis are approximately normally distributed and the assumption of homoscedasticity is not violated. Significant predictors of WTP for PV systems include perceived cost (standardized coefficient β = -0.381, p < 0.01), pro-environmental behavior (β = 0.230, p < 0.01) and gender (β = 0.184, p < 0.05) (male respondents have higher WTP). Although some research on environmental concern has found that women express slightly greater environmental concern than men do (Davidson & Freudenburg, 1996), we know that the relation between environmental concern and pro-environmental behaviors is contradictive. In addition, cultural and sociological factors specific to Turkey may still be effective on households such that, decision maker in purchasing issues still seems to be the man at household level although both man and woman participate in labor force.

Age, monthly income, information level, education level and NEP do not appear as significant predictors of WTP.

After informing the respondents on the reference market price of a 2 kW PV system, a binary logistics regression analysis has been employed to analyze the relationship between the independent variables, and the binary dependent variable (1 or 0, purchase or not purchase) to test whether the independent variables have a predictive power on determining respondents likelihood to purchase PV systems and which factors are more effective on the purchase decision. As seen on Table 6-3, the correct prediction rate is 69.5 % with a Nagelkerke R square value of 0.231 (p<0.01). Looking at the coefficients output of the model in detail, perceived cost (β = 0.819, p < 0.01), age (β = 0.035, p < 0.05) and education level (β = -0.352, p < 0.05) are found to have a significant relation with respondents likelihood of purchase decisions. Gender (β = -0.623, p < 0.10), monthly income (β = 0.000, p < 0.10) and pro-environmental behavior (β = -0.453, p < 0.10) are slightly below the statistically significance level or significant in 90 % confidence interval. NEP score and information level were again found to be insignificant in predicting likelihood of purchase decision.

Table 6-3: Logistic Regression Model Output

Logistic Regression Model Output				
Independent Variables	**β (St. error)**	**Wald**	**Expected β**	**Sig.**
Age	0.035* (0.016)	4.679	1.036	0.031
Gender	-0.623 (0.367)	2.880	0.536	0.090
Education Level	-0.352* (0.163)	4.644	0.703	0.031
Monthly Income	0.000 (0.000)	3.296	1.000	0.069
Information Level	-0.119 (0.182)	0.431	0.887	0.511
Perceived Cost	0.819** (0.208)	15.565	2.269	0.000
Total Behaviour	-0.453 (0.262)	2.989	0.636	0.084
Total NEP	-0.124 (0.406)	0.093	0.884	0.760
(Constant)	-1.564 (1.827)	0.733	0.209	0.392
Model Chi-Square	*32.389***			
Nagelkerke R^2	*0.231*			
Correct Prediction (%)	*69.5*			
$p<0.05$ **$p<0.01$				

The results of the two regression analysis can be summarized as follows: people find roof-top PV systems expensive and their perception of the cost is strongly significant in determining their willingness to pay and likelihood of their purchase decision.

Pro-environmental behavior is significant in determining WTP however environmental beliefs (NEP scale) does not appear to be a significant predictor of WTP. Looking at this finding and the correlation matrix, an important result can be driven such that the correlation between environmental beliefs and pro-environmental behavior is not strong and only pro-environmental behavior has a positive impact on WTP for PV systems. Education is positively correlated with NEP score as expected, while age seems to be a determinant of Pro-environmental behavior. Younger people are more likely to adopt PV systems in the future. Again education has a positive effect on the likelihood of purchase decision while male respondents tend to be willing to pay more for PV systems compared to female respondents. Overall information level on solar energy did not prove to be significant in either analysis however this is probably due to the fact that overall information level was too low among respondents (see Table 5-4) and there were only a few people who rate their information level high, so statistically significant results could not be reached in terms of information level (only 6 respondents in total rate their information level as very good)

CHAPTER 7

CONCLUSION

Main objective of this study was to determine the factors affecting households' WTP for roof-top photovoltaic systems in Ankara and find clues to drive recommendations for an efficient diffusion policy. For this purpose, the key findings of the study can be summarized as below:

There is great market potential for roof-top PV systems such that approximately 90% of participants of the study show positive attitude for installing PV systems in the future. However this percentage falls significantly when they were asked if they would be willing to pay the current market prices for the systems. Also there remains a significant gap between home owners' willingness to pay for PV and actual market prices of solar systems. Households' perception towards the cost of systems is found to be the most significant barrier against the widespread utilization of the systems, as it was also found as a significant factor affecting WTP and adoption decision. The findings suggest that prices for solar panels have to fall before a significant increase in adoption can be expected or other policies and incentives may be put into practice to remove this gap.

A critical finding of the study is that environmental concern is insignificant in predicting WTP and purchasing decision while Pro-environmental behavior is one of the strong determinants of WTP and likelihood of purchasing. In addition, environmental concern is not strongly correlated with Pro-environmental behavior.

Gender has been found as another significant factor influencing WTP of respondents. The finding about gender suggests that males tend to pay more for PV systems compared to females without knowledge of the market price. However, this finding should be supported with further research to prove meaningful as some cultural factors may be affective on WTP of the two separate genders.

Education level and age are among factors determining the likelihood of purchase decision. According to this, younger and more educated people are more likely to adopt PV systems in the future as expected. However without the knowledge about the market price, they fall behind gender and pro-environmental behavior in terms of their predictive power.

Income is one of the common factors found to be affective on WTP in the literature, it also seems to affect people’s adoption decision in our study; however, significance of income in predicting WTP and likelihood of technology adoption may increase if a sample representing the average characteristics of the population is analyzed by including higher ratio of participants from lower income levels. This study targeted a sample that has a higher average socio-economic status due to the reasons mentioned before.

Awareness towards PV systems and information level of households are too low, which may be another explanation for the slow uptake of the technology despite the positive attitude towards PV systems. Only 20% of respondents stated that they have seen PV panels in the city they live in. Usage of TV and other media channels is the main preference of participants for increasing awareness towards photovoltaic systems. In our analysis, information level did not prove to be one of the significant factors affective on WTP and adoption decision although participants’ WTP increased after being informed about the market prices. This may be caused by the very low number of people with high information level, which may prevent obtaining statistically significant results.

Mostly preferred support policy of the participants was government to meet a portion of the cost of the system. This can indirectly be accomplished via lower or zero tax policies which may help to remove the gap between willingness to pay and the market prices.

Word of mouth and social pressure seem to be important factors that may accelerate adoption among households as participants stated that other neighbors’ installing the system would be a really effective motivator for them to adopt roof-top PVs. Thus, increasing social pressure is likely to accelerate uptake of the technology. Showcase installations of PV systems in certain highly populated areas may help to increase awareness and “spread the word”, provide opportunities to learn about these technologies and ultimately increase social pressure and foster diffusion.

Home owners were also asked about the importance of the benefits provided by PV systems in regard to their buying decisions. Overall, the responses show that economic benefits, environmental friendliness of the technology and independence from energy providers are regarded as the most important motivators for future adoption decision. The finding which implies producing electricity independently is a significant motivator for homeowners in Turkey, may give some clues to decision makers and the PV sector for effective marketing strategies to help break cost barrier.

7.1. Limitations

Readers of this thesis study should be aware of the following limitations. First, this research is a current picture of evolving environmental and renewable energy attitudes, so the findings and WTP of the population should be re-estimated in time parallel with the changes in demand, awareness and price levels. As homeowners’ information level increases and they become more familiar with the technology by neighborhood installations, their WTP and the most influential variables on WTP will possibly differ.

The results reflect the respondent’s attitudes in 2015 in selected regions of Ankara. These results might not hold when a larger geographical region is studied, as the preferences and socioeconomic characteristics of people in other regions might be different. Roof-top PV market is at a very early stage of diffusion and there is not sufficient number of adopters to investigate, as adoption rate of PVs reach to a certain level, revealed preferences of adopters will give opportunity for future research to use other estimation techniques and such new models could be worked to drive demand for the technology by looking at past adoption data.

The socioeconomic characteristics of the sample is not parallel with average Ankara residents, this study has intentionally been designed to gain preferences of middle and upper middle income homeowner population, who are regarded as “early adopters" and "early majority", the market segments which new technology products target and diffuse initially.

A final limitation to this study is the variance accounted by the independent variables. Although there were several independent variables that had strong and statistically significant relationships with the two dependent variables, they only accounted for a modest amount of variation in each dependent variable. Thus, there may be other possible variables not included in this study having strong relationships with the dependent variables and account for a larger amount of the variance in the dependent variables. Some of the studies in the literature have proved that political views and religious orientation are variables to be also significant determinants of attitudes towards renewables and WTP; however our method of data collection would not allow to include these variables in Turkey such that response rate of participants could significantly fall due to the privacy concerns.

REFERENCES

1. Allen, S.R., Hammond, G.P., McManus, M.C., (2007). *Prospects for and barriers to domestic micro-generation: a United Kingdom perspective*. Appl. Energy 85 (6), 528–544.

2. Bahaj, A. S. & James, P. A. B. (2007). *Urban energy generation: The added value of photovoltaics in social housing.* Renewable and Sustainable Energy Reviews, 11, 2121-2136.

3. Barber, E. & Provey, J. (2010). *Convert Your Home To Solar Energy*, The Taunton Press, Newtown.

4. Bennett, D. (2007) *Here Comes The Sun*, New Scientist, Vol 196, p32-37.

5. Bradford, T. (2006). *Solar Revolution: The economic transformation of the global energy industry*. Cambridge: MIT Press.

6. Breidert, C., Hahsler, M. & Reutterer, T. (2006), *A Review of Methods for Measuring Willingness-To-Pay*, Innovative Marketing

7. Brigham, M. & Gipe, P. (2007). *Feasibility Analysis for a Solar Share Co-operative in the City of Toronto*: Toronto Renewable Energy Co-operative. Brown.

8. Carson, R.T. (2000). *Contingent valuation: A user's guide*. Environmental Science and Technology 34, 1413-1418

9. Claudy, M.C., Michelsen, C., O'Driscoll, A. (2011). *The diffusion of microgeneration technologies – assessing the influence of perceived product characteristics on home owners' willingness to pay*. Energy Policy 39 (2), 1459–1469.

10. Davidson, D. J., & Freudenburg, W. R. (1996). *Gender and Environmental risk Concerns*. Environment and Behavior, 28, 302-33.

11. Del Rio, P. (2007). *Encouraging the implementation of small renewable electricity CDM projects: An economic analysis of different options*. Renewable and Sustainable Energy Reviews, 11, 1361-1387.

12. Dunlap, R.E., Van Liere K.D., Mertig, A.G., Jones, R.E. (2000) *Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale*. Journal of Social Issues, 56(3), 425-442.

13. Dunlap, Riley E. (2008). *The new environmental paradigm scale: From marginality to worldwide use.* Journal of Environmental Education , 40 (1), 3–18.

14. Eicker U. (2003) *Solar Technologies for Buildings*, Wiley, West Sussex.

15. Elliott D. (2007) *Sustainable Energy; Opportunities And Limitations*, Palgrave Macmillan, New York.

16. EPIA, *Economic Benefits of Solar Photovoltaics: The PV Value Chain*, European Photovoltaic Industry Association, 2012.

17. European Commission. (2003). European Energy and Transport Trends to 2030. Brussels

18. Farhar, B., Coburn, T., (2000). *A market assessment of residential grid-tied PV systems in Colorado*. NREL technical report, 2000, September.

19. Furman, A. (1998). *A note on environmental concern in a developing country: Results from an Istanbul survey*. Environment and Behavior, 30, 520-534.

20. Göksu Ç., (2008) *Küresel Isınma ve Türkiye'nin Güneş Projeleri*. Güncel Yayıncılık. İstanbul.

21. Greeley, A. (1993). *Religion and attitudes toward the environment*. Journal for the Scientific Study of Religion, 32(1), 19-28

22. Guo X., Liu, H., Mao, X., Jin, J., Chen, D., Cheng, S., (2014). *Willingness to pay for renewable electricity: A contingent valuation study in Beijing, China*, Energy Policy, Elsevier, vol. 68(C), pages 340-347.

23. Hawcroft, L. J., & Milfont, T. L. (2010). *The use (and abuse) of the new environmental paradigm scale over the last 20 years: A meta-analysis*. Journal of Environmental Psychology , 30 , 143–158.

24. Hofstede, G.H. (2001), *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations across Nations*, Sage Publications, Thousand Oaks, California.

25. IEA, *Technology Roadmap, Solar Photovoltaic Energy,* International Energy Agency, 2010.

26. IEA, Renewable Energy Working (2002). *Renewable Energy...into the Mainstream*. International Energy Agency.

27. International Energy Agency. (2007). *World Energy Outlook,* Paris.

28. International Energy Agency. (2014). *Technology Roadmap: Solar Thermal Electricity,* OECD/IEA, Paris.

29. International Energy Agency. (2015). *World Energy Outlook*, Paris.

30. Islam T. (2013). *Household level innovation diffusion model of photovoltaic (PV) solar cells from stated preference data*, Energy Policy 65 (2014) 340–350

31. Jaccard, Scarpa R, Willis K (2010) *Willingness-to-pay for renewable energy: primary and discretionary choice of British households' for micro-generation technologies*. Energy Econ 32:129–136

32. Kalschmitt, M., Schroder, G., and Schneider, S. (2007). *Renewable Energy Technology, Economics and Environment,* pp. 287-293. New York, Springer

33. Karaveli A. B., Soytas U., & Akinoglu B. G., (2015), *Comparison of large scale solar PV (photovoltaic) and nuclear power plant investments in an emerging market*, Energy, vol. 84, pp. 656–665.

34. Keirstead, J., (2007). *Behavioural responses to photovoltaic systems in the UK domestic sector*. Energy Policy 35, 4128–4141.

35. Kılıç, F. Ç. (2015). *Güneş Enerjisi, Türkiye'deki Son Durumu ve Üretim Teknolojileri*, Mühendis ve Makina, cilt 56, sayı 671, s. 28-40.

36. Kuhlemeier, H., Bergh, H.V. and Langerweij, N. (1999), *Environmental Knowledge, Attitudes, and Behavior in Dutch Secondary Education*, Journal of Environmental Education, vol. 30, pp. 4-15

37. Larson, E.C. (2013). *Utah Residents' Attitudes Toward Renewable Energy Facilities*. (Master's thesis). Retrieved from UMI database. (accession no. 1547005)

38. Li, H., Jenkins-Smith, H.C., Silva, C.L., Berrens, R.P., Herron, K.G., (2009). *Public support for reducing US reliance on fossil fuels: Investigating household willingness-to-pay for energy research and development*. Ecological Economics 68, 731-742.

39. Longo, A., Markandya, A., Petrucci, M., (2008). *The internalization of externalities in the production of electricity: willingness to pay for the attributes of a policy for renewable energy*. Ecological Economics 67, 140–152.

40. Mills, A.,Wiser, R., Barbose, G., Golove,W., (2008). *The impact of retail rate structures on the economics of commercial photovoltaic systems in California*. Energy Policy 36, 3266–3277.

41. MoENR, The official page of the Ministry of Energy and Natural Resources. www.enerji.gov.tr. [Accessed: 15.06.2016]

42. Mueller, J.M., (2013). *Estimating Arizona residents' willingness to pay to invest in research and development in solar energy*. Energy Policy 53, 462-476.

43. Ndebele, T. & Marsh, D. (2013). *Consumer choice of electricity supplier: Investigating preferences for attributes of electricity services*. New Zeland Agricultural and Resource Economics Society

44. Poortinga, W., Steg, L., & Vlek, C. (2004). *Values, environmental concern and environmental behavior: a study into household energy use*. Environment and Behavior, 36, 70–93.

45. REN21, *Renewables 2012 Global Status Report*, REN21 Secretariat, 2012.

46. Rogers, E. M. (2003). *Diffusion of innovations.* New York, The Free Press

47. Schultz, P.W., Gouveia, V., Cameron, L. D., Tankha, G., Schmuck, P., and Franek, M. (2005). *Values and Their Relationship to Environmental Concern and Conservation Behavior*. Journal of Cross Cultural Psychology 36(4): 457–475.

48. Schultz, P.W., Oskamp, S., & Mainieri, T. (1995). *Who recycles and when? A review of personal and situational factors*. Journal of Environmental Psychology, 15, 105–121

49. Schwartz, S. H. (1994). *Are there universal aspects in the structure and contents of human values*? Journal of Social Issues, 50(4), 19-45.

50. Sovacool, B.K., Cooper, C., (2006). *Green means 'go?'—A colorful approach to a U.S. national renewable portfolio standard*. The Electricity Journal 19(7), 19-32.

51. Stern, P. C. (1992). *Psychological dimensions of global environmental change*. Annual Review of Psychology, 43, 269–302.

52. Stern, P. C. (2000). *Towards a coherent theory of environmentally significant behavior*. Journal of Social Issues, 56(3), 407-424.

53. Stern, P. C., & Dietz, T. (1994). *The value basis of environmental concern*. Journal of Social Issues, 50(3), 65-84.

54. Stern, P. C., Dietz, T., & Guagnano, G. A. (1995). *The new ecological paradigm in social- psychological context.* Environment and Behavior, 27(6), 723-743.

55. Stern, P. C., Dietz, T., & Guagnano, G. A. (1998). *A brief inventory of values*. Educational and Psychological Measurement, 58(6), 984-1001.

56. Stern, P. C., Dietz, T., Kalof, L.& Guagnano, G. A. (1995).*Values, beliefs, and pro-environmental action: Attitude formation toward emergent objects*. Journal of Applied Social Psychology, 25(18), 1611-1636.

57. Stern, P. C., Dietz, T., Ruttan, V.W., Socolow, R. H., Sweeney, J. L. (1997). *Environmentally significant consumption*. Washington, DC: National Academy Press

58. Stern, P.C., Dietz, T., Abel, T., Guagnano, G. A., Kalof, L. (1999). *A value-belief-norm theory of support for social movements: The case of environmentalism.* Research in Human Ecology, 6(2), 81-97.

59. Stigka, E.K., Paravantis, J.A., Mihalakakou, G.K., (2014). *Social acceptance of renewable energy sources: A review of contingent valuation applications*. Renewable and Sustainable Energy Reviews 32, 100-106.

60. Streimikiene, D., Balezentis, A., (2015). *Assessment of willingness to pay for renewables in Lithuanian households*. Clean Technology and Environmental Policy 17:515–531.

61. Thapa, B. (1999). *Environmentalism: The relation of environ- mental attitudes and environmentally responsible behaviors among undergraduate students*. Bulletin of Science, Technology, & Society, 19, 426–438.

62. Tisdell T, Wilson C, Nantha S.H., (2008). *Contingent valuation as a dynamic proces*s. J Socio-Econ ; 37:1443–58.

63. Tsantopoulos, G., Arabatzis, G., Tampakis S. (2014) *Public attitudes towards photovoltaic developments: Case study from Greece*, Energy policy, vol. 71, pp. 94-106.

64. Tsoutsos, T., Stamboulis, Y., (2005). *The sustainable diffusion of renewable energy technologies as an example of an innovation-focused policy*. Technovation, 25, 753-761.

65. United States Department of Energy, 2009. *Hybrid electric vehicles (HEVs): what are HEVs?*/http://www1.eere.energy.gov/vehiclesandfuels/technologies/systems/hybrid_electric_vehicles.htmlS [Accessed: 15.06.2016]

66. Liu, W.L., Wang C., Arthur P.M., (2013) *Rural public acceptance of renewable energy deployment: the case of Shandong in China*, Appl. Energy, vol. 102, pp.1187–1196.

67. Walsh, M. (1989). *Energy tax credits and housing improvements*. Energy Economics, 11(4), 275-284.

68. Wustenhagen, R., Wolsink, M., Burer, M.J., (2007). *Social acceptance of renewable energy innovation: an introduction to the concept*. Energy Policy 35, 2683-2691.

69. YEGM. Yenilenebilir Enerji Genel Müdürlüğü. 2015. http:// www.eie.gov.tr/yenilenebilir/g_enj_tekno.aspx,

70. Zarnikau J. (2003) *Consumer demand for "green power" and energy efficiency*. Energy Policy Policy;31:1661–72.

71. Zhai P. (2010). *Environmental, Policy and Social Analysis of Photovoltaic Technologies* (Doctoral dissertation), Retrieved from UMI database (Accession no: 3432643)

72. Zinn, H, Manfredo, M.J., Vaske, J.J., and K. Wittman. (1998). *Using normative beliefs to determine the acceptability of wildlife management actions*. Society and Natural Resources 11: 649-662.

APPENDICIES

APPENDIX A

The Questionnaire

FEN BİLİMLERİ ENSTİTÜ MÜDÜRLÜĞÜ
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

GÜNEŞ ENERJİSİ SİSTEMLERİNE YÖNELİK HANEHALKI TERCİHLERİNİN BELİRLENMESİ ÇALIŞMASI

Bu tez çalışması, ODTÜ Yer Sistem Bilimleri Bölümü (ESS) yüksek lisans öğrencisi Eren ASLIHAK tarafından, Prof. Dr. Özlem ÖZDEMİR ve Prof. Dr. Bülent AKINOĞLU danışmanlığında yürütülmektedir. Çalışma, iklim değişikliği ile mücadelede önemli yeri olan Güneş enerjisi teknolojileri için Ankara'da hane halkının tercihlerini belirlemeyi amaçlamaktadır.

Toplanan bilgiler gizli tutulacak ve sadece bilimsel yayınlarda kullanılacaktır.

Çalışma hakkında daha fazla bilgi almak ve/veya soru sormak için iletişim bilgileri:

Eren ASLIHAK

Tel: 0505 5237396 – 0312 2107177

E-posta: aslihak@metu.edu.tr

Bu çalışmaya katılım tamamen gönüllülük esasına dayanmaktadır ve istediğiniz zaman çalışma kapsamından çıkabilirsiniz. Çalışmaya katılarak anket kapsamında verdiğiniz bilgilerin bilimsel amaçlı yayınlarda kullanılmasını kabul etmiş olursunuz.

TEŞEKKÜRLER!

Bölüm 1.

1. Oturduğunuz konutun sahibi misiniz?	
☐ Evet	☐ Hayır

2. Oturduğunuz konutta kaç yıldır yaşıyorsunuz?
……………yıl

3. Ankara'nın hangi ilçesinde / semtinde yaşıyorsunuz?	
İlçe: ………………………………	Semt: ………………………………

4. Oturduğunuz konutun tipi nedir?	
☐ Müstakil	☐ Apartman Dairesi

5. Oturduğunuz konutun kullanım alanı yaklaşık kaç metrekaredir?
……………m^2

6. Aylık ortalama elektrik faturanız yaklaşık kaç TL'dir?
………… TL

7. Hanenizde kaç kişi yaşıyor?
……………*kişi*

Bölüm 2. Lütfen aşağıdaki davranışları <u>son 1 yılda</u> ne sıklıkla gerçekleştirdiğinizi belirtiniz?

		Hiçbir zaman	Ara sıra	Bazen	Genellikle	Çok sık	Uygulama olanağı yok
1.	Kâğıt, kutu, poşet vb. eşyaları tekrar kullanmaya çalıştım.	○	○	○	○	○	○
2.	Gazeteleri geri dönüşüme gönderdim.	○	○	○	○	○	○
3.	Teneke kutu ve cam şişeleri geri dönüşüme gönderdim.	○	○	○	○	○	○
4.	Ailemi ve arkadaşlarımı geri dönüşüm yapmaya teşvik ettim.	○	○	○	○	○	○
5.	Çevreye daha az zararlı ürünleri satın almaya çalıştım.	○	○	○	○	○	○
6.	Başkaları tarafından açığa atılmış çöpleri alıp çöpe attım.	○	○	○	○	○	○
7.	Yiyecek artıklarını değerlendirdim. (doğal gübre, hayvan yemi vb.)	○	○	○	○	○	○
8.	Yürüyerek veya bisiklete binerek benzin tasarrufu yaptım.	○	○	○	○	○	○
9.	Çevre ile ilgili bir konuda şikâyet veya destek amacıyla dilekçe / mektup yazdım.	○	○	○	○	○	○
10.	Seçimlerde çevre duyarlılığı yüksek adayları destekledim.	○	○	○	○	○	○
11.	Çevreci bir organizasyona para bağışı yaptım.	○	○	○	○	○	○
12.	Çevre ile ilgili bir organizasyon için gönüllü çalışma yaptım.	○	○	○	○	○	○
13.	Evde elektrik ve/veya ısı tasarrufu için tedbirler aldım.	○	○	○	○	○	○
14.	Su tasarrufu için gerekli tedbirleri aldım, su israfını önlemeye çalıştım.	○	○	○	○	○	○
15.	Araba kullanmak yerine toplu taşıma araçlarını kullanmaya çalıştım.	○	○	○	○	○	○

Bölüm 3. Lütfen aşağıdaki ifadelerle ilgili size en uygun seçeneği işaretleyiniz.

		Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1.	Nüfus, dünyanın taşıma kapasitesini kısa zamanda aşacak bir hızla artmaktadır.	○	○	○	○	○
2.	İnsanlar kendi istek ve arzuları doğrultusunda doğayı değiştirme hakkına sahiptirler.	○	○	○	○	○
3.	İnsanoğlunun doğaya müdahalesi genellikle felaketlerle sonuçlanır.	○	○	○	○	○
4.	İnsanoğlu aklı ve yaratıcılığı sayesinde, her durumda Dünya'yı yaşanabilir kılacaktır.	○	○	○	○	○
5.	İnsanlar doğayı ve doğal kaynakları aşırı düzeyde kullanmakta ve tüketmektedirler.	○	○	○	○	○
6.	Aslında doğru kullanmayı ve geliştirmeyi bildiğimiz takdirde Dünya'daki doğal kaynaklar sınırsızdır.	○	○	○	○	○
7.	Hayvanlar ve bitkilerde en az insanlar kadar yaşama hakkına sahiptirler.	○	○	○	○	○
8.	Doğanın modern endüstrileşmiş toplumların tüm negatif etkilerini bertaraf edecek kadar güçlü bir dengesi vardır.	○	○	○	○	○
9.	İnsanoğlu zekâ gibi çok özel yeteneklere sahip olsa da yine de doğa kanunlarına tabiidir.	○	○	○	○	○
10.	Ekolojik kriz denilen olay çok fazla abartılmaktadır.	○	○	○	○	○
11.	Dünya çok kısıtlı sayıda odası ve kaynağı olan bir uzay gemisi gibidir.	○	○	○	○	○
12.	İnsanoğlu doğaya hükmetme hakkına sahiptir.	○	○	○	○	○
13.	Doğanın çok çabuk bozulabilecek, çok hassas bir dengesi vardır.	○	○	○	○	○
14.	İnsan düşünce gücü ve zekâsı sayesinde doğanın tüm inceliklerini öğrenecek ve onu istediği gibi kontrol altına alacaktır.	○	○	○	○	○
15.	Bugünkü tüketim alışkanlıkları değiştirilmezse ileride çok büyük çevre problemleri ile karşı karşıya gelinecektir.	○	○	○	○	○

Bölüm 4.

1. Güneş enerjisi panelleri sizce ne işe yararlar? (Birden fazla seçeneği işaretleyebilirsiniz)
☐ Güneş ışığını önce ısıya sonra elektriğe dönüştürürler.
☐ Güneş ışığını doğrudan elektriğe dönüştürürler.
☐ Güneş ışığını su ısıtmak için kullanırlar.
☐ Hiçbiri
☐ Bilmiyorum

2. Güneş enerjisiyle ilgili bilgi düzeyinizi nasıl değerlendirirsiniz?					
☐ Bilgim yok	☐ Çok az	☐ Az	☐ Orta	☐ İyi	☐ Çok iyi

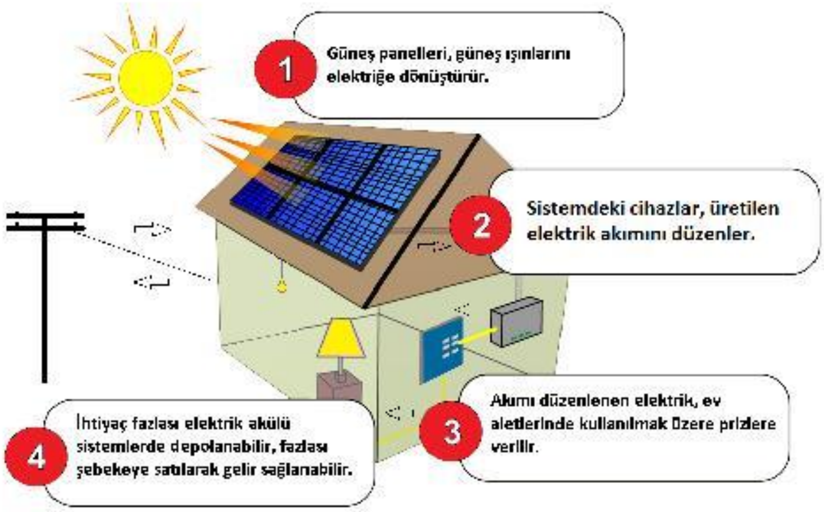
3. Yaşadığınız yakın çevrenin (mahalle, semt) çevresel kalitesini nasıl değerlendirirsiniz?					
☐ Bilgim yok	☐ Çok az	☐ Az	☐ Orta	☐ İyi	☐ Çok iyi

Bölüm 5. Elektrik Üreten Güneş Panelleri (Fotovoltaik) ve Şebekeye Bağlı Sistemler

Su ısıtmada kullanılan güneş panellerinden farklı olarak, elektrik üretmek amacıyla da Güneş enerjisi kullanılabilir. Elektrik üretmede kullanılan Güneş enerjisi teknolojisine Fotovoltaik Teknoloji denir. Fotovoltaik güneş panelleri, güneş ışığını doğrudan elektrik enerjisine dönüştürürler. Güneş enerjisi sistemleriyle konutlarınızda kendi elektriğinizi üretebilir, ürettiğiniz elektriğin fazlasını şebekeye satarak gelir elde edebilirsiniz. Sisteme dahil olan çift yönlü elektrik sayacı, ürettiğiniz ve tükettiğiniz elektrik miktarını net olarak hesaplayarak, ay sonundaki alacak veya borcunuzu belirler.

Enerji ve Tabii Kaynaklar Bakanlığı tarafından yürürlüğe konulan "Lisanssız Elektrik Üretimine İlişkin Yönetmelik" kapsamında, bu projelerin onay ve kabul işlemleri için TEDAŞ Bölge Koordinatörlükleri görevlendirilmiştir. Buna göre hâlihazırda şebekeye bağlı elektrik aboneliği olanların, konutlarında ürettikleri ve şebekeye verdikleri elektrik miktarının fiyatlandırılması, Enerji Piyasası Düzenleme Kurulu tarafından yapılan "Yenilenebilir Enerji Kaynaklarının Belgelendirilmesi ve Desteklenmesine İlişkin Yönetmelik" (YEKDEM Yönetmeliği) ile düzenlenmiştir.

Güneş panelleriyle elektrik üretimi (Fotovoltaik Teknoloji)



Bölüm 6.

1.Daha önce yukarıda tarif edilen güneş enerjisi sistemlerinden gördünüz mü?	
☐ Evet	☐ Hayır
↓	
Cevabınız <u>Evet</u> ise lütfen nerede gördüğünüzü belirtiniz:	
☐ Televizyonda ☐ İnternette ☐ Gazete-dergide ☐ Diğer..	☐ Yaşadığım şehirde ☐ Türkiye'de başka bir şehirde ☐ Yurt dışında

2. Evinize, elektrik üretmek amacıyla güneş paneli entegre edilmesine nasıl bakarsınız?	
☐ Olumlu	☐ Olumsuz

3. Evinize bağlatacağınız bir güneş enerjisi sistemini satın almak için en fazla ne kadar ödemeye razı olursunuz?
.......................TL

4. Ortalama bir hanenin elektrik ihtiyacını karşılayabilecek güneş enerjisi sisteminin büyüklüğü 2kw, fiyatı 8.000-10.000 TL ve geri ödeme (kendini amorti etme) süresi 7-8 yıldır. Güneş panellerinin ortalama kullanım süresi 30 yıldır. Bu özelliklerdeki bir sistemi satın alır mısınız?	
☐ Evet	☐ Hayır

5. Yukarıdaki soruya cevabınız <u>Hayır</u> ise belirtilen özelliklerdeki bir sistem için en fazla ne kadar ödemeye razı olursunuz?
.......................TL

Bölüm 7. Lütfen birini satın alacak olsanız, aşağıda belirtilen koşul ve özelliklerdeki güneş enerjisi sistemlerinden hangisini tercih edeceğinizi, kutucuğu işaretleyerek belirtiniz.

SEÇENEK 1	SEÇENEK 2
☐	☐
Sistem büyüklüğü: **2 kilowatt**	*Sistem büyüklüğü:* **3 kilowatt**
2 Kw: *Ortalama bir hanenin aylık tüketimini karşılayacak sistem büyüklüğüdür.*	***3 Kw:*** *Ortalama bir hanenin aylık tüketiminden fazla elektrik üreterek,* ***gelir kazandırabilecek*** *sistem büyüklüğüdür.*
Maliyetini amorti etme süresi: **Yaklaşık 8 yıl**	*Maliyetini amorti etme süresi:* **Yaklaşık 7 yıl**
**Fotovoltaik panellerin ortalama kullanım ömrü 30 yıldır*	**Fotovoltaik panellerin ortalama kullanım ömrü 30 yıldır*
Yaklaşık Piyasa Fiyatı: **8.000-10.000 TL**	*Yaklaşık Piyasa Fiyatı:* **11.000-13.000 TL**

Akülü güneş enerjisi sistemleri, ürettiğiniz enerjinin bir kısmını akülerde depolayarak gerektiğinde şebekeden bağımsız olarak (elektrik kesintisi vb. durumlarda da) kullanmanıza olanak verir. Akülü sistemler ortalama büyüklükte bir hane için yaklaşık 1500-2000 TL ek maliyet gerektirmektedir.

Yukarıdaki sistemlerden birini satın alsanız, 1500-2000 TL ek maliyeti de göz önünde bulundurarak akülü bir sistem almayı tercih eder misiniz?	
☐ **Evet**	☐ **Hayır**

Bölüm 8.

1.Henüz evime güneş paneli taktırmadım çünkü:					
	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
Yeterince bilgi sahibi değilim	○	○	○	○	○
Maliyeti çok yüksek	○	○	○	○	○
Yeterince elektrik üretebileceğimi düşünmüyorum	○	○	○	○	○
Evimin görüntüsünü bozacağını düşünüyorum	○	○	○	○	○
Çevreye faydalı olduğunu düşünmüyorum	○	○	○	○	○
Çevremde sistemi satın almış kimseyi görmedim	○	○	○	○	○
Bakım onarım işlerinin fazla olacağını düşünüyorum	○	○	○	○	○
Bürokratik işlemlerle uğraşmak istemiyorum	○	○	○	○	○
Diğer(belirtiniz)..	○	○	○	○	○

2. Aşağıdaki faktörler ilerde güneş enerjisi sistemi satın almanızda ne kadar etkili olabilir?					
	Çok Etkisiz	Etkisiz	Ortalama	Etkili	Çok Etkili
Ekonomik faydaları	○	○	○	○	○
Çevresel faydaları	○	○	○	○	○
Estetik görüntüsü	○	○	○	○	○
Diğer komşularımın da satın alması	○	○	○	○	○
Kendi (bağımsız) elektriğimi üretebilmek	○	○	○	○	○
Diğer (Belirtiniz)...	○	○	○	○	○

3. Sizce Güneş enerjisi gibi uygulamaların yaygınlaşmasında aşağıdaki politikalar ne kadar etkili olabilir?					
	Çok Etkisiz	Etkisiz	Ortalama	Etkili	Çok Etkili
Düşük vergi politikası	○	○	○	○	○
Bu sistemlerin yerli üretiminin teşvik edilmesi	○	○	○	○	○
Farkındalığın artması için okullarda eğitim verilmesi	○	○	○	○	○
TV programları ve medya aracılığı ile farkındalığın arttırılması	○	○	○	○	○
Maliyetin bir kısmının devlet tarafından karşılanması	○	○	○	○	○
Başka politika ve uygulama önerileriniz varsa lütfen belirtiniz?	....				

4. Türkiye'de bu sistemin aşağıdaki alanlarda ne kadar iyi işleyeceğini düşünüyorsunuz?					
	Çok kötü	Kötü	Ortalama	İyi	Çok iyi
Bakım-tamirat, teknik konular	○	○	○	○	○
Banka, finansman, kredi vb.	○	○	○	○	○
Ölçüm, üretim-tüketim miktarlarının hesaplanması ve ödenmeler	○	○	○	○	○
Kamu kurumlarıyla ilgili prosedürler	○	○	○	○	○
Diğer:..	○	○	○	○	○

Bölüm 9- Demografik Bilgiler

1.Doğum tarihiniz (yıl olarak): ....

2.Cinsiyetiniz:	
☐ Kadın	☐ Erkek

3. Eğitim düzeyiniz: (En son tamamladığınız eğitim düzeyini işaretleyiniz)			
☐ İlkokul	☐ Ortaokul	☐ Lise	☐ Ön lisans
☐ Üniversite	☐ Yüksek Lisans	☐ Doktora	

4. Mesleğiniz:			
☐ Özel sektör çalışanı	☐ Kamu çalışanı	☐ Esnaf/ işadamı	☐ Öğrenci
☐ Emekli	☐ Çalışmıyor	☐ Diğer..	

5. Hanenizin aylık toplam geliri yaklaşık ne kadardır?
Yaklaşık .... TL

<u>Lütfen, anketle ilgili belirtmek istediğiniz görüş ve önerilerinizi yazınız.</u>

....
....
....
....
....

Katılım ve desteğiniz için çok teşekkürler!

APPENDIX B

Descriptive Statistics; SPSS output

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	201	21	76	43,28	12,192
Monthly Income	187	1000	20000	5695,19	3134,366

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	female	103	51,2	51,2	51,2
	male	98	48,8	48,8	100,0
	Total	201	100,0	100,0	

Education Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	primary	1	,5	,5	,5
	secondary	6	3,0	3,0	3,5
	high school	33	16,4	16,4	19,9
	two-year degree	7	3,5	3,5	23,4
	college	113	56,2	56,2	79,6
	master	33	16,4	16,4	96,0
	PhD	8	4,0	4,0	100,0
	Total	201	100,0	100,0	

How would you rate your overall information level on solar energy?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no information	1	,5	,5	,5
	very poor	37	18,4	18,5	19,0
	poor	63	31,3	31,5	50,5
	moderate	70	34,8	35,0	85,5
	good	23	11,4	11,5	97,0
	excellent	6	3,0	3,0	100,0
	Total	200	99,5	100,0	
Missing		1	,5		
Total		201	100,0		

To your knowledge, what does PV panel do?

Convert sunlight to heat, then to electricity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	58	28,9	28,9	28,9
	+	143	71,1	71,1	100,0
	Total	201	100,0	100,0	

Directly convert sunlight to electricity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	113	56,2	56,2	56,2
	+	88	43,8	43,8	100,0
	Total	201	100,0	100,0	

Use sunlight to heat water

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	50	24,9	24,9	24,9
	+	151	75,1	75,1	100,0
	Total	201	100,0	100,0	

None of the above

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	201	100,0	100,0	100,0

Have no idea

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	199	99,0	99,5	99,5
	+	1	,5	,5	100,0
	Total	200	99,5	100,0	
Missing	System	1	,5		
Total		201	100,0		

Have you ever seen the above systems before?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,5	,5	,5
	yes	120	59,7	59,7	60,2
	no	80	39,8	39,8	100,0
	Total	201	100,0	100,0	

If Yes, where have you seen the system?

tv

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	157	78,1	78,1	78,1
	+	44	21,9	21,9	100,0
	Total	201	100,0	100,0	

web

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	160	79,6	79,6	79,6
	+	41	20,4	20,4	100,0
	Total	201	100,0	100,0	

newspaper-magazine

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	178	88,6	88,6	88,6
	+	23	11,4	11,4	100,0
	Total	201	100,0	100,0	

in my city

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	160	79,6	79,6	79,6
	+	41	20,4	20,4	100,0
	Total	201	100,0	100,0	

another city

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	162	80,6	80,6	80,6
	+	39	19,4	19,4	100,0
	Total	201	100,0	100,0	

abroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	184	91,5	91,5	91,5
	+	17	8,5	8,5	100,0
	Total	201	100,0	100,0	

I haven't installed PV system yet, because:

I don't have sufficient knowledge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly disagree	12	6,0	6,3	6,3
	disagree	31	15,4	16,1	22,4
	unsure	33	16,4	17,2	39,6
	agree	91	45,3	47,4	87,0
	strongly agree	25	12,4	13,0	100,0
	Total	192	95,5	100,0	
Missing	System	9	4,5		
Total		201	100,0		

It is too expensive

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly disagree	4	2,0	2,1	2,1
	disagree	30	14,9	15,9	18,0
	unsure	42	20,9	22,2	40,2
	agree	89	44,3	47,1	87,3
	strongly agree	24	11,9	12,7	100,0
	Total	189	94,0	100,0	
Missing	System	12	6,0		
Total		201	100,0		

I don't think it will produce enough electricity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly disagree	22	10,9	11,7	11,7
	disagree	69	34,3	36,7	48,4
	unsure	63	31,3	33,5	81,9
	agree	28	13,9	14,9	96,8
	strongly agree	6	3,0	3,2	100,0
	Total	188	93,5	100,0	
Missing	System	13	6,5		
Total		201	100,0		

This system will negatively affect my homes appearance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly disagree	55	27,4	29,1	29,1
	disagree	93	46,3	49,2	78,3
	unsure	24	11,9	12,7	91,0
	agree	14	7,0	7,4	98,4
	strongly agree	3	1,5	1,6	100,0
	Total	189	94,0	100,0	
Missing	System	12	6,0		
Total		201	100,0		

It is not beneficial for the environment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly disagree	79	39,3	41,8	41,8
	disagree	79	39,3	41,8	83,6
	unsure	13	6,5	6,9	90,5
	agree	9	4,5	4,8	95,2
	strongly agree	9	4,5	4,8	100,0
	Total	189	94,0	100,0	
Missing	System	12	6,0		
Total		201	100,0		

I did not see anyone who installed the system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly disagree	15	7,5	7,9	7,9
	disagree	33	16,4	17,4	25,3
	unsure	17	8,5	8,9	34,2
	agree	76	37,8	40,0	74,2
	strongly agree	49	24,4	25,8	100,0
	Total	190	94,5	100,0	
Missing	System	11	5,5		
Total		201	100,0		

Maintenance and repair job will be too much

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly disagree	11	5,5	5,9	5,9
	disagree	41	20,4	21,8	27,7
	unsure	73	36,3	38,8	66,5
	agree	44	21,9	23,4	89,9
	strongly agree	19	9,5	10,1	100,0
	Total	188	93,5	100,0	
Missing	System	13	6,5		
Total		201	100,0		

Bureaucratic procedures will be too much

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly disagree	11	5,5	5,8	5,8
	disagree	57	28,4	30,2	36,0
	unsure	48	23,9	25,4	61,4
	agree	47	23,4	24,9	86,2
	strongly agree	26	12,9	13,8	100,0
	Total	189	94,0	100,0	
Missing	System	12	6,0		
Total		201	100,0		

How effective would the following factors be in your future adoption decision?

Economic benefits

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ineffective	2	1,0	1,0	1,0
	moderate	18	9,0	9,1	10,2
	effective	86	42,8	43,7	53,8
	very effective	91	45,3	46,2	100,0
	Total	197	98,0	100,0	
Missing	System	4	2,0		
Total		201	100,0		

Environmental benefits

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very ineffective	1	,5	,5	,5
	ineffective	2	1,0	1,0	1,5
	moderate	13	6,5	6,6	8,1
	effective	85	42,3	43,1	51,3
	very effective	96	47,8	48,7	100,0
	Total	197	98,0	100,0	
Missing	System	4	2,0		
Total		201	100,0		

Aesthetic looking

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very ineffective	13	6,5	6,6	6,6
	ineffective	50	24,9	25,4	32,0
	moderate	63	31,3	32,0	64,0
	effective	55	27,4	27,9	91,9
	very effective	16	8,0	8,1	100,0
	Total	197	98,0	100,0	
Missing	System	4	2,0		
Total		201	100,0		

Other neighbors installing the system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very ineffective	12	6,0	6,1	6,1
	ineffective	46	22,9	23,5	29,6
	moderate	41	20,4	20,9	50,5
	effective	76	37,8	38,8	89,3
	very effective	21	10,4	10,7	100,0
	Total	196	97,5	100,0	
Missing	System	5	2,5		
Total		201	100,0		

Producing my electricity independently

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very ineffective	2	1,0	1,0	1,0
	ineffective	3	1,5	1,5	2,6
	moderate	23	11,4	11,8	14,4
	effective	92	45,8	47,2	61,5
	very effective	75	37,3	38,5	100,0
	Total	195	97,0	100,0	
Missing	System	6	3,0		
Total		201	100,0		

How effective can the following policy recommendations be for the diffusion of these systems?

Lower tax policy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very ineffective	3	1,5	1,5	1,5
	ineffective	4	2,0	2,1	3,6
	moderate	11	5,5	5,6	9,2
	effective	87	43,3	44,6	53,8
	very effective	90	44,8	46,2	100,0
	Total	195	97,0	100,0	
Missing	System	6	3,0		
Total		201	100,0		

Support for domestic production

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ineffective	4	2,0	2,0	2,0
	moderate	17	8,5	8,7	10,7
	effective	95	47,3	48,5	59,2
	very effective	80	39,8	40,8	100,0
	Total	196	97,5	100,0	
Missing	System	5	2,5		
Total		201	100,0		

School education to raise awareness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ineffective	5	2,5	2,5	2,5
	moderate	18	9,0	9,1	11,7
	effective	89	44,3	45,2	56,9
	very effective	85	42,3	43,1	100,0
	Total	197	98,0	100,0	
Missing	System	4	2,0		
Total		201	100,0		

Raising awareness through TV and other media

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ineffective	3	1,5	1,5	1,5
	moderate	13	6,5	6,6	8,1
	effective	78	38,8	39,6	47,7
	very effective	103	51,2	52,3	100,0
	Total	197	98,0	100,0	
Missing	System	4	2,0		
Total		201	100,0		

Government to meet a part of the cost

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very ineffective	1	,5	,5	,5
	ineffective	2	1,0	1,0	1,6
	moderate	8	4,0	4,1	5,7
	effective	64	31,8	33,2	38,9
	very effective	118	58,7	61,1	100,0
	Total	193	96,0	100,0	
Missing	System	8	4,0		
Total		201	100,0		

How well do you think this system will work in Turkey?

Maintenance and technical issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very bad	5	2,5	2,5	2,5
	bad	33	16,4	16,6	19,1
	moderate	104	51,7	52,3	71,4
	good	48	23,9	24,1	95,5
	very good	9	4,5	4,5	100,0
	Total	199	99,0	100,0	
Missing	System	2	1,0		
Total		201	100,0		

Finance and banking issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very bad	5	2,5	2,5	2,5
	bad	25	12,4	12,6	15,1
	moderate	80	39,8	40,2	55,3
	good	69	34,3	34,7	89,9
	very good	20	10,0	10,1	100,0
	Total	199	99,0	100,0	
Missing	System	2	1,0		
Total		201	100,0		

Measurement of production-consumption and payment procedures

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very bad	4	2,0	2,0	2,0
	bad	24	11,9	12,1	14,1
	moderate	108	53,7	54,3	68,3
	good	53	26,4	26,6	95,0
	very good	10	5,0	5,0	100,0
	Total	199	99,0	100,0	
Missing	System	2	1,0		
Total		201	100,0		

Procedures relating government institutions

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very bad	23	11,4	11,6	11,6
	bad	57	28,4	28,8	40,4
	moderate	79	39,3	39,9	80,3
	good	30	14,9	15,2	95,5
	very good	9	4,5	4,5	100,0
	Total	198	98,5	100,0	
Missing	System	3	1,5		
Total		201	100,0		

APPENDIX C

Table C-1: Reliability Test Analysis of Behavior Scale Items

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Looked for ways to reuse things	38,60	118,064	,533	,869
Recycled newspapers	39,16	112,595	,604	,866
Recycled cans or bottles	38,99	112,653	,655	,863
Encouraged friends or family to re-cycle	38,97	111,679	,758	,858
Purchased environmentally friendly products	38,44	119,785	,539	,869
Picked up litter that was not your own	38,88	118,461	,515	,870
Re-used, composted food scraps (fertilizer, animal feed etc.)	39,56	117,881	,530	,869
Conserved gasoline by walking or bicycling	39,30	120,662	,414	,875
Wrote a letter or petition to support or complain an environmental issue	40,21	123,636	,414	,874
Voted for a candidate who supported environmental issues	39,03	113,162	,581	,867
Donated money to an environmental group	40,04	123,930	,366	,876
Volunteered time to help an environmental group	40,21	123,486	,424	,874
Took measures at home to save electricity and heat	38,38	118,835	,626	,866
Took measures at home to save water	38,22	118,620	,646	,865
Preferred using public transportation instead of riding my car	39,07	120,858	,390	,876

Table C-2: Reliability Test Analysis of (odd numbered) NEP Items

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
We are approaching the limit of the number of people the earth can support.	27,91	19,746	,409	,758
When humans interfere with nature it often produces disastrous consequences.	27,91	19,462	,381	,765
Humans are severely abusing the environment.	27,44	18,808	,631	,723
Plants and animals have as much right as humans to exist.	27,28	18,754	,610	,726
Despite our special abilities humans are still subject to the laws of nature.	27,74	19,773	,493	,745
The earth is like a spaceship with very limited room and resources.	28,42	20,444	,306	,776
The balance of nature is very delicate and easily upset.	28,08	19,798	,384	,763
If things continue on their present course, we will soon experience a major ecological catastrophe.	27,47	17,270	,627	,717

Table C-3: Reliability Test Analysis of (even numbered) NEP Items

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Humans have the right to modify the natural environment to suit their needs.	16,29	15,028	,350	,619
Human ingenuity will insure that we do NOT make the earth unlivable.	15,35	15,340	,377	,609
The earth has plenty of natural resources if we just learn how to develop them.	14,90	15,960	,282	,640
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	15,42	15,054	,411	,598
The so–called ''ecological crisis'' facing humankind has been greatly exaggerated.	16,38	17,606	,236	,646
Humans were meant to rule over the rest of nature.	16,34	15,725	,395	,605
Humans will eventually learn enough about how nature works to be able to control it.	15,62	15,048	,480	,579

Table C-4: SPSS Output with Log Transformed Variables

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1807,320	3069,460		,589	,557
	Age	-28,092	23,643	-,093	-1,188	,237
	Gender	1288,745	534,211	,176	2,412	,017
	education_log	831,229	2231,295	,029	,373	,710
	Monthly Income	,084	,092	,072	,919	,360
	information_log	-1295,074	2211,326	-,041	-,586	,559
	Cost Perception	-1426,398	272,120	-,380	-5,242	,000
	em_total_beha	1133,967	394,791	,224	2,872	,005
	total_NEP	800,418	580,381	,101	1,379	,170

a. Dependent Variable: WTP before info

APPENDIX D

Ethical Committee Approval

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 22 91
F: +90 312 210 79 59
ueam@metu.edu.tr
www.ueam.metu.edu.tr

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

Sayı: 28620816/277 — 503

17 Haziran 2015

Gönderilen : Prof.Dr. Özlem Yılmaz
İşletme Bölümü

Gönderen : Prof. Dr. Canan Sümer
IAK Başkan Vekili

İlgi : Etik Onayı

Danışmanlığını yapmış olduğunuz Yer Sistem Bilimleri bölümü Yüksek Lisans öğrencisi Eren Aslıhak'ın **"Konutlara Yönelik Fotovoltaik Sistemlerle İlgili Hane Halkı Tercihlerinin Araştırılması: Ankara-Türkiye'de Bir Anket Çalışması"** isimli araştırması "İnsan Araştırmaları Komitesi" tarafından uygun görülerek gerekli onay verilmiştir.

Bilgilerinize saygılarımla sunarım.

Etik Komite Onayı

Uygundur

17/06/2015

Prof.Dr. Canan Sümer
Uygulamalı Etik Araştırma Merkezi
(UEAM) Başkan Vekili
ODTÜ 06800 ANKARA

23.06.2015