3-2007

Diffusion of Innovation: Factors Promoting Interest in Solar Photovoltaic Generation Systems within Air Force Installations

Daniel Diaz Jr.

DIFFUSION OF INNOVATION: FACTORS PROMOTING INTEREST IN SOLAR PHOTOVOLTAIC GENERATION SYSTEMS WITHIN AIR FORCE INSTALLATIONS

THESIS

Daniel Diaz, Jr., Captain, USAF

AFIT/GEM/ENV/07-M3

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GEM/ENV/07-M3

DIFFUSION OF INNOVATION: FACTORS PROMOTING INTEREST IN SOLAR PHOTOVOLTAIC GENERATION SYSTEMS WITHIN AIR FORCE INSTALLATIONS

THESIS

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in General Engineering Management

Daniel Diaz, Jr, BS

Captain, USAF

March 2007

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

AFIT/GEM/ENV/07-M3

DIFFUSION OF INNOVATION: FACTORS PROMOTING INTEREST IN SOLAR PHOTOVOLTAIC GENERATION SYSTEMS WITHIN AIR FORCE INSTALLATIONS

Daniel Diaz, Jr., BS
Captain, USAF

Approved:

____________________________________ __________

Alfred E. Thal, Jr., USAF, Ph.D. date

Advisor

____________________________________ __________

Kent C. Halverson, Lt Col, USAF, Ph.D. date

Reader

____________________________________ __________

Theodore H. Romaine, Capt, USAF date

Reader

AFIT/GEM/ENV/07-M3

Abstract

The purpose of this research was to identify factors which promote interest in solar photovoltaic generation systems for facility use within the United States Air Force. The construct model was developed based on past literature on Diffusion of Innovation Theory. The model consisted of measures defined as motivation, knowledge, experience, and familiarity as well as contextual variables. These measures were then used to determine whether any significant relationship existed between the measures and the overall dependent variable, interest. A phone interview was conducted with 28 Air Force energy managers from 61 active duty bases within the continental U.S. The methods of correlation and regression analysis were used to evaluate the objectives and hypotheses identified.

Results indicate that there is a positive, significant relationship between the motivation to seek new energy technologies for reducing load demands and interest in solar photovoltaic generation systems. The significant factors promoting interest were identified as knowledge, the amount of solar irradiance a base receives, the peak electrical demand loads of a base, and the population size of a base.

Acknowledgements

This paper is dedicated to all of those who contributed to the fruition of this thesis. To Dr. Alfred E. Thal, Jr., who guided the direction of the thesis and provided constructive criticism throughout. To Lieutenant Colonel Kent C. Halverson, who assisted with the statistical concepts involved, and to Captain Theodore H. Romaine who provided insight with the Air Force energy management processes. Next, to my family, thank you for your support.

Last, but by no means least, my lovely wife who has without a doubt been my strength. Thank you for the unconditional love that you continue to provide me. Not only did you have an understanding heart during this endeavor but you provided a critical eye when editing my thesis chapters. What more could I have asked.

Daniel Diaz, Jr.

Table of Contents

List of Figures

List of Tables

List of Acronyms

AC	Alternate Current
AFCESA	Air Force Civil Engineer Support Agency
AFIT	Air Force Institute of Technology
BIPV	Built Integrated Solar Photovoltaics
BOS	Balance of System
C-Si	Crystalline Silicone
CONUS	Continental Unites States
DC	Direct Current
DoE	Department of Energy
DSIRE	Database of State Incentives for Renewable Energy
ECIP	Energy Conservation Investment Program
EIA	Energy Information Administration
E.O.	Executive Order

EPA	Environmental Protection Agency
ESPC	Energy Savings Performance Contracts
HQ AF	Headquarters Air Force
KMO	Kaiser-Meyer-Olkin
KW	Kilo-watts
KwH	Kilo-watt-hour
MAJCOM	Major Command
MSR	Million Solar Roofs
MW	Mega-watts
MWH/yr	Mega-watt-hours per year
NEC	National Economic Council
NREL	National Renewable Energy Laboratory
SAI	Solar America Initiative
SEM	Structural Equation Model
SPSS	Statistical Package for Social Sciences
TAM	Technology Acceptance Model
UESC	Utility Energy Savings Contracts
UTAUT	Unified Theory of Acceptance and Use of Technology
VIF	Variance Inflation Factor

DIFFUSION OF INNOVATION: FACTORS PROMOTING INTEREST IN SOLAR PHOTOVOLTAIC GENERATION SYSTEMS WITHIN AIR FORCE INSTALLATIONS

I. INTRODUCTION

This chapter discusses the general background for this research. After providing a discussion of the current energy demands globally and nationally, it presents solar photovoltaic generation systems as a possible solution within a comprehensive energy reduction initiative. Finally, this chapter discusses the approach taken to conduct the research along with the research objectives.

1.1 BACKGROUND

The large role of energy in daily lives makes it quite apparent that society relies heavily on energy for general use. "Governments rise and fall on it, armies run on it, companies rely on it, and consumers depend on it" (Canton, 2006:25). In fact, Chevron CEO David O'Reilly was noted as saying that "energy will be one of the defining issues of this century" (Canton, 2006:25). In the U.S. alone, energy per capita demand will increase by 0.3% over the next 20 years (Energy Information Administration [EIA], 2007). This will have a significant impact on energy prices as nations such as China and India, together with the U.S., strain the energy markets. In the oil sector alone, consumption is predicted to rise by 50% by 2020 (Canton, 2006). If such predictions become reality, limited energy supplies would cause price hikes in every sector and find their way to the consumer in the form of increased costs. Surveys suggest that such increases in energy costs have a negative effect in consumer spending. A 2001 U.S. consumer poll identified that 49% of those surveyed felt that rising gasoline prices was a major problem, with 69% of them changing their behavior by adjusting their thermostat to lower energy costs (The PEW Research Center, 2001). Therefore, “social stability and growth are linked to a pipeline of abundant energy” (Canton, 2006:29). The impending energy crunch has gained the attention of U.S. administrations whose energy officials are involved in alleviating some of the energy requirements for the 500,000 buildings the U.S. government currently owns (Executive Order [E.O.] 13123, 1999). A potential technology that seems promising is solar photovoltaic technology.

Solar photovoltaic generation systems harness the sun’s solar energy to generate electricity. It was estimated that between 1997 and 2005, approximately 371 mega-watts (MW) of electricity were generated by solar photovoltaic systems in the U.S. (Sherwood, 2006). Recent research on the global applicability of solar photovoltaics has suggested that solar photovoltaic technology is “universal enough that almost any locale would improve its energy independence by adopting solar” (Zweibel, 2004:3). Even so, adoption of solar photovoltaic technology has had difficulty since it inception.

A brief history of solar photovoltaics provides evidence to suggest that this technology has had a subtle exposure in the U.S. The idea of using solar energy first came about in the late 19th century when Auguste Mouchot claimed the first ever solar steam engine. Mouchot’s invention won praise but failed to be adopted due to economic circumstances in which coal prices dropped significantly (Smith, 1995). Solar photovoltaics then received significant attention in the middle part of the 20th century when National Aeronautics and Space Administration’s (NASA) second satellite, Vanguard I, in 1954, was powered primarily by solar photovoltaics and successfully transmitted radio frequencies for eight years (Kaplan, 1999); it was during that mission that scientists realized the benefits of solar photovoltaics. However, aside from NASA's interest and a spurt of interest during the energy crises of the 1970s, solar photovoltaics have been seen primarily as a sleeper technology. Between the early 1980s and the late 1990s, U.S. research and development dropped significantly, thereby allowing countries like Japan and Germany to claim a majority stake in the market share of solar photovoltaics (McNeil Technologies, Inc., 2004).

The past trend of ignoring solar photovoltaic technology appears to have lapsed with renewed efforts from the U.S. federal government to commit to this technology. "Social and political pressures coupled with rising fossil fuel prices are increasing the motivation for most jurisdictions to evaluate additional solar programs" (Bradford, 2006:171). Recent announcements by the past two administrations have catapulted solar photovoltaics into the limelight with the Department of Energy (DoE) stating goals to

> ...reduce the average installed cost of all grid-tied PV systems to the end user to $3.30/watt (Wp), from a median value of $6.25/W in 2000. The result will be a reduction in the average cost of electricity generated by PV systems from a current $0.25/kWh to $0.09/kWh by the end of 2015 (National Renewable Energy Laboratory [NREL], 2007, para 1).

The installation of solar photovoltaics for energy generation promotes the goals set by the U.S. government to improve energy efficiency and reduce carbon emissions associated with U.S. federal facilities.

The Clinton administration signed into law the goal to install 20,000 solar energy systems by 2010 on federal installations (E.O. 13123, 1999), and the current Bush administration recently signed into law the goal of "reducing energy intensity by three percent annually through the end of fiscal year 2015 or 30% by the end of fiscal year 2015" (E.O. 13423, 2007:3919). In addition, the current Bush administration proposed increased funding and new initiatives to further commit the nation to identifying new ways of generating energy from within the U.S. In his 2006 State of the Union address, President Bush spoke of the addiction to foreign oil and how these energy resources are often imported from unstable regions (C-SPAN, 2006). His answer to this problem: an advanced energy initiative that would increase funding for research and development by 22% for a reduction in oil imports from the Middle East of 75% by 2025 (C-SPAN, 2006). This same proposal included a $148 million funding package request to Congress for the Solar America Initiative (SAI), a 127% increase from the fiscal year 2006 budget with the hopes of making photovoltaic technologies cost competitive by 2015 (National Economic Council [NEC], 2006).

While promoting the adoption of solar photovoltaic systems is beneficial, implementing a campaign to garner interest in this technology is quite challenging. Rogers (2003:247) identified solar photovoltaics as a disruptive technology in the sense that "the more radical and disruptive an innovation and the less its compatibility with existing practice, the slower its rate of adoption." For solar photovoltaics, issues such as perceived long payback periods coupled with a lack of consumer confidence on the long-term viability have made these systems unattractive (Faiers and Neame, 2006). However, Kaplan (1999) suggests that the opposite would be readily assumed for utility energy managers. With solar photovoltaic technology being common knowledge for well over two decades and the benefits of solar technologies demonstrating effective long term results even in areas where sunlight is uneven, the assumption could be made that energy managers across the U.S. would have adopted the technology long ago. "If utility managers really followed the objective criteria [to reduce peak demand loads and identify maintenance free technologies with long life cycles], they should have adopted photovoltaics in great numbers" (Kaplan, 1999:477). Yet, a national survey showed that only 2.5% of utility companies had adopted solar photovoltaics (Kaplan, 1999).

Do Air Force energy managers have a similar disposition as their utility energy counterparts of shying away from solar photovoltaic systems? If so, what factors should Air Force decision-makers consider in order to influence energy managers to gain more interest in the technology? Hence, the problem statement seeks to understand an array of factors that promote interest amongst Air Force energy managers.

1.2 RESEARCH OBJECTIVES

This research attempted to increase the knowledge of how solar photovoltaic generating systems may appeal to Air Force energy management programs. It was hypothesized that increased motivation to seek energy efficient technologies increases the knowledge and experience associated with solar photovoltaics, which leads to a sense of familiarity and subsequently leads to interest. More specifically, the following objectives were identified.

(1) Determine the number of bases that have actually adopted solar photovoltaic systems for facility use in the continental U.S.

(2) Determine the amount of knowledge energy managers have with solar photovoltaics.

(3) Determine whether location of a base is relevant to overall interest in solar photovoltaics.

(4) Determine if base size is relevant to overall interest in solar photovoltaics.

(5) Determine if motivation of energy managers affects interest in solar photovoltaic generation systems more than an energy manager's knowledge of solar photovoltaics.

(6) Determine if familiarity has more influence on an energy manager's interest than knowledge and experience combined.

1.3 SCOPE AND LIMITATIONS OF RESEARCH

This study attempted to determine if there is sufficient vested interest in solar photovoltaic generation systems amongst Air Force energy managers. This was done to provide a better picture of one aspect of the renewable technologies available to the Air Force. The study was defined by the following scope.

(1) The research comprised of both Air Force energy managers and resource energy managers, who often assist energy managers. Only energy managers located in the continental United States (CONUS) were considered.

(2) Other decision makers such as the Base Civil Engineer, Base Civil Engineering Operations Officer, Base Mission Support Commander, and Base Wing Commander were excluded from the research.

(3) The study was based on Diffusion of Innovation Theory.

(4) The study adapted Dr. Robert W. Kaplan's *National Photovoltaics Commercialization* survey (1999) for the development of a phone interview questionnaire.

(5) The model only considered solar photovoltaic generation systems. Other renewable technologies were not considered.

(6) To be considered a solar photovoltaic generation system, the system must supply electricity to a building; it can be either grid connected or off-grid; it must comply with National Electric Code, Underwriters Laboratories Standards, and Solar Rating and Certification Corporation standards; and it had to provide a minimum of 0.5 Kilowatts of electricity to a residential facility and 1.0 Kilowatts to an Air Force facility.

1.4 RESEARCH METHODOLOGY

This research consisted of phone interviews with Air Force energy managers across the continental U.S. to measure factors identified in the proposed hypothesized construct model. The questions for the interviews were developed based on Kaplan's (1999) *National Photovoltaics Commercialization* survey used for utility energy managers. The questions measured an individual's understanding and experiences relating to solar photovoltaics. The data was evaluated using the Statistical Package for the Social Sciences (SPSS) 14.0 to analyze descriptive statistics, inter-item reliability, correlation, and regression on the proposed model.

1.5 SIGNIFICANCE

The use of fossil fuels, particularly crude oil, may be at its peak limits. While calculating the availability of reserves is difficult to assess, at best, "more optimistic assessments delay the global peak by no more than 10-15 years" (Bentley, 2002:192). American geophysicist Marion King Hubbert (1956) suggested in his Hubbert Peak Theory that once global oil reserves reach their peak, a terminal decline will occur and continue even with the introduction of new reserves and technologies manifesting to alleviate demand. With a 47% increase in oil demand predicted between 2003 and 2030 (International Energy Outlook, 2006), current U.S. demand for fossil fuels will require extensive reviews to accommodate potential economic constraints that may hinder U.S. growth and economic vitality.

Fossil fuels also play a role in electricity production. The amount of fuel required to generate electricity grew by over 170% between 1973 and 2003 (Bradford, 2006). Of the 16.6 Terra-watt hours of yearly electricity produced globally in 2003, 66% percent came from coal, oil, and natural gas with coal allocating 40% of that total by itself (Bradford, 2006). In the U.S., electricity comprises only 18% of the final consumption, however, "it requires 39% of the primary fuel supplied, [losing] 65% of the energy content of its fuel during generation and transmission" (Bradford, 2006:41).

As is the case, the U.S. Air Force has taken positive steps in actively promoting the need to identify ways to reduce facility costs associated with energy use. The Air Force Chief of Staff requested research to "identify ways in which the Air Force can decrease energy consumption" (Moseley, 2006, para 7). Such a request from the highest levels of the Air Force hierarchy was the motivation behind this research. It is anticipated that this study may bring flexibility to decision making processes within Air Force installations to assist in achieving the environmental goals requested by the current administration

1.6 REVIEW OF CHAPTERS

Chapter II consists of a literature review of solar photovoltaics describing the system, its diffusement, and the current status of energy generation around the world. Chapter II also discusses Diffusion of Innovation Theory and its various research streams, to include the specific research stream for this research. Chapter III explains the methodology identifying the model that will be used to study the relationships posited. Chapter IV identifies the results of the analysis and Chapter V provides an explanation of the results.

II. LITERATURE REVIEW

2.1 INTRODUCTION

Chapter II investigates the background information necessary to provide the reader with a general understanding of solar photovoltaics and the literature behind the theory that will assist with the hypothesized model. First, a brief overview of energy source classification is taken into account followed by a discussion of solar technologies. The discussion on solar technologies is further narrowed to focus on solar photovoltaic technology, the advantages and disadvantages of these systems, and the benefits to society. In addition, a review of the theoretical background of the Diffusion of Innovation Theory focuses the research to a specific methodology that will aid the development of the hypothesized model described in Chapter III.

2.2 CLASSIFICATION OF ENERGY SOURCES

Energy sources can be classified into two main types: non-renewable energy sources and renewable energy sources. A brief description of these classifications is provided to include discussions on how these sources play a part in electricity generation.

2.2.1 Non-Renewable Energy Sources

Non-renewable energy sources are any sources of energy that once used cannot be replenished on a scale relative to its consumption (Chiras, 2006). Crude oil, natural gas, and coal are all examples of non-renewable energy sources and are most commonly referred to as fossil fuels. These fossil fuels have been immensely helpful in providing society with an abundance of by-products to include gasoline, medicines, pesticides, clothing, and even credit cards (Chiras, 2006). However, because of their natural occurring cycle spanning millions of years, fossil fuels have a finite supply.

Having a finite supply of non-renewable sources is a concern. As these resources are exhausted, "society's pattern of energy use will accelerate on the natural-resource base and on the entire environment with foreseeable repercussions on economic growth and social stability" (Bradford, 2006:45). As the supply diminishes and demand continues to increase, costs may severely impact consumer spending. By 2020, expected world projections of oil consumption alone may increase by 50% with China alone quadrupling its needs (Canton, 2006). In addition, finding large reservoirs of natural resources may be a thing of the past. In the U.S., for example, oil production peaked in the early 1970s with approximately 80% of oil reserves spent (Chiras, 2006). In addition, natural gas prices have risen sharply in recent years as experts predict that natural gas in the U.S. will reach its peak around 2008 (Chiras, 2006). This has affected pricing for home heating dramatically. Natural gas prices have tripled on average in the U.S. with Colorado seeing 100% natural gas increases every year between 2003 and 2005 (Chiras, 2006). As rapid industrialization of modern economies continue in Asian countries and as the U.S. continues to consume some 26% of the available fossil fuels (Bradford, 2006), price increases will inevitably negatively impact consumer spending.

Another aspect of fossil fuels is their negative impact to health (Bradford, 2006). Burning fossil fuels creates by-products, such as carbon monoxide, carbon dioxide, methane, and nitrous oxide (Environmental Protection Agency [EPA], 2007), which affect society from a health perspective. In developed nations, air pollution has killed between 500,000 to 1 million people (*World Development Report*, 2003). In developing nations such as China, an estimated 700,000 deaths are reportedly caused by air pollution with predicted numbers to rise to 8 million per year by 2020 at the current rate of industrialization (Dasgupta, Wang, and Wheeler, 1997).

Lastly, transportation accidents associated with fossil fuels weigh heavily on ecosystems. The ecological damage caused by the Exxon Valdez spill is one example which, to this day, continues to impact the natural habitat. Over 11 million gallons of crude oil were spilled when the Exxon Valdez struck the Bligh Reef at Prince William Sound, Alaska, in 1989 (EPA, 2007). Lingering oil has had a continual toll on the ecosystem. Animal species that have had difficulty recovering from this disaster are the Pacific Herring, cutthroat trout, sea otters, clams, oysters, and the sub-tidal communities (Exxon Valdez Oil Spill Council, 2006).

While the information presents a gloomy picture of fossil fuels, the positive side is that these impacts have facilitated an increased awareness and commercialization of other energy technologies. The increase in fossil fuel prices along with significant health and environmental hazards associated with fossil fuels have allowed for renewable energy to take a front and center stage.

2.2.2 Renewable Energy Sources

Renewable energy is defined as "energy that's regenerated by natural forces" (Chiras, 2006:22). The five most recognized renewable energy sources include biomass, hydroelectric, geothermal, wind, and solar. Together, these resources constitute approximately 6% of the total U.S. consumption of energy (Key World Energy Statistics, 2006). As shown in Figure 1, biomass and hydroelectric constitute the largest percentages of renewable energy in the U.S. with geothermal, wind, and solar each representing smaller percentages of total renewable energy use. Wind energy is currently the fastest growing renewable energy technology growing at a rate of 25% annually (Bradford, 2006) and producing 10,000 mega-watts (MW) of electricity in the U.S., which equates to the powering of 2.5 million homes (NREL, 2007).

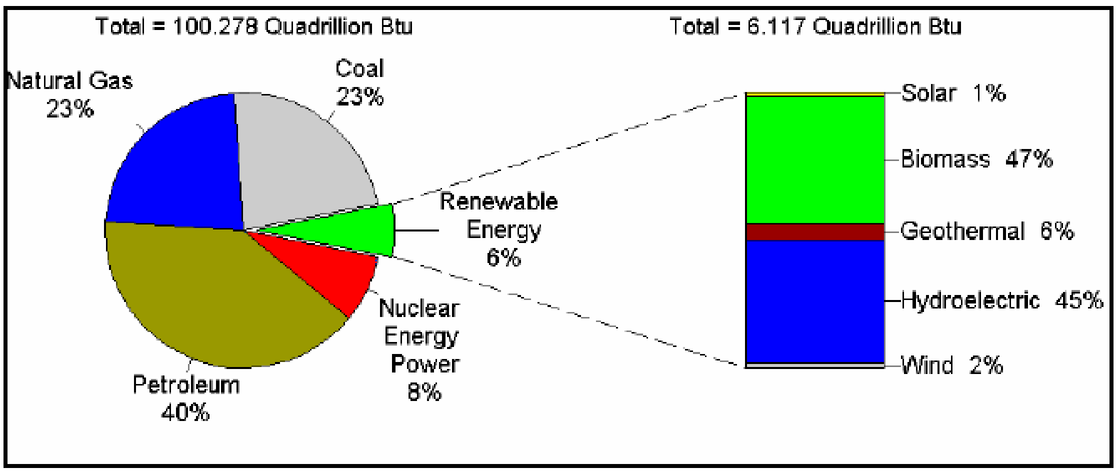

Figure 1. U.S. Supplies of Energy (Energy Information Administration, 2006)

The challenges associated with renewable energy technologies are quite different from those identified with non-renewable fossil fuels. For one, costs associated with renewable technologies are usually higher than the conventional methods for fossil fuels. For example, current electricity costs for solar photovoltaics are between 20 and 25 cents per Kilo-watt hour (KwH) compared with four to six cents for coal-fired electricity, five to seven cents for natural gas, and six to nine cents for biomass power plants (Kammen, 2006). With continuing research development, it is anticipated that renewable energy technologies will see a continual decrease in overall costs (NREL, 2007).

Another negative characteristic of renewable energy is the specificity that some require to generate significant quantities of electricity. For example, wind and wave energy are severely limited by locale and seasonal conditions. Wave generation plants are applicable to offshore locations while wind energy, although characterized as the most prolific renewable energy at this time (DoE, 2007), requires a geographic location that makes wind energy feasible for electricity generation (Energy Information Administration, 2006). This leads experts to suggest that by themselves, certain renewable technologies cannot be large-scale providers (Bradford, 2006).

The benefits associated with renewable energy are: 1) their infinite supply, 2) their reliability, 3) the fact that they are environmentally friendly, and 4) the benefits they provide to undeveloped nations. Relatively speaking, renewable sources are infinitely available for energy production. While it is true that the sun has a finite existence, it will continue to provide solar energy for many years to come. The combination of the sun's energy and the earth's rotation allow for wind, wave, and solar to be available in an infinite amount. Intuitively speaking, the reliability of these resources will continue to be quite high. While it is true that renewable sources such as wind, wave, and solar vary based on seasonal and atmospheric conditions, these variances are minimal if renewable technologies are matched to specific locales where they will be able to generate the greatest amount of electricity (Bradford, 2006).

The use of renewable resources substantially reduces the pressure on environmental resources (Faiers and Neame, 2006). Except for the manufacturing and installation costs associated with renewable technologies, renewable energy is clean and virtually non-polluting. For example, solar photovoltaics do not require generators;

therefore, carbon emissions and potential spills from indirect logistical support are eliminated. Between 1997 and 2005, an estimated 2.8 million tons of carbon dioxide (CO_2) were never introduced into the atmosphere and approximately 2.8 billion gallons of fresh water were saved due to the installation of solar photovoltaics in the U.S. In addition, noise levels and adverse land impacts on the surrounding environment that are usually associated with fossil fuel energy power plants are significantly reduced (EPA, 2007).

The previous benefits have been directed mainly to developed countries; however, solar photovoltaics are able to provide tangible benefits to people in under-developed countries as well. The ability to generate electricity with solar photovoltaics in the absence of utility companies, skilled human labor, and limiting financial resources provides owners who live in such circumstances the potential of higher levels of economic productivity and a better quality of life. For island nations in the South Pacific, the introduction of solar photovoltaic technology has allowed nations such as the Republic of Kiribati to rely less on imported energy and thus alleviate high energy fossil fuel costs to the small nation (Yu and Gilmour, 1996). "To date, solar PV systems have been installed in all the island's health "centres" to provide power for vaccine refrigeration, lights and an emergency two way radio" (Yu and Gilmour, 1996:700). On this same island group, solar photovoltaics provided electricity to community halls, schools, and ten rural communities with solar groundwater pumps. This is in stark contrast to the inhabitants of Cook Island who currently pay $1.3 million for diesel fuel for electricity generation. Cook Island officials provide large subsidies to their residents for the fuel; however, the cost of diesel has impacted the economy and stifled economic growth (Yu and Gilmour, 1996). For the South Pacific Island governments, officials hope that the adoption of solar photovoltaics "will result in reducing petroleum import bills and thus promote their people's quality of life and living standards" (Yu and Gilmour, 1996:708).

2.3 SOLAR TECHNOLOGY AND SOLAR PHOTOVOLTAICS

While a few of the technologies described in the previous section have limiting characteristics that make them only suitable in certain locations, solar technology is adaptable to many regions. "Sunlight is the only renewable energy source that is ubiquitous enough to serve as a foundation of a global economy in all locations where energy will be required" (Bradford, 2006:7). Solar energy derives from the sun's irradiance and is used to heat water for facility use, to heat facility spacing via passive heating, or to generate electricity (Energy Information Administration, 2006). Solar technologies range from passive to active systems segmented into four areas: 1) concentrating solar power systems, 2) solar photovoltaics, 3) solar heating, and 4) solar lighting (Department of Energy [DoE], 2007). Within the U.S., solar technology comprises approximately 1% of the energy generated capability (see Figure 1). The following presents a detailed observation of the principal solar technology described in this research, solar photovoltaics.

2.3.1 Solar Photovoltaics

Solar photovoltaics use semi-conducting materials to absorb short-wave irradiance to "produce free electrical charge carriers in the conduction and valence bands" (Eicker, 2003:207) to produce electricity. Crystalline silicon (c-Si) is the primary material used in the majority of photovoltaic modules comprising about 90% of solar panels in the world (Photovoltaic Power, 2002). More recent solar photovoltaic technology has reduced the amount of c-Si used in solar photovoltaic generation systems; however, the principal components of a solar photovoltaic system have not changed. A typical solar photovoltaic system is comprised of panel mounts, modules, inverters, wiring, and in cases where continual energy is required, batteries. These accessories make up the balance-of-system (BOS) components of the solar photovoltaic system.

Another characteristic of solar photovoltaics is their energy efficiency or the ability of the system to convert solar energy to electricity. How efficient a system is depends on the efficiencies of the BOS. Two key BOS components that require high efficiencies are the solar modules and the inverter. The solar modules of a photovoltaic system are able to create direct current (DC) electricity by absorbing the various visible light frequencies when sunlight hits the surface of the modules. The efficiency ratings for solar modules in laboratory tests have reached on average 18.8% for typical C-Si cells (DoE, 2006), although theoretically, the maximum efficiency that a solar cell is capable of achieving would be 44%, due in part to the width of the solar spectrum and the band gap between the valence and conduction bands (Eicker, 2003). The amount of electricity provided to a facility is further reduced when the inverter transforms the DC input power from the solar modules to alternate current (AC) electricity for facility use (Eicker, 2003). Current inverters now produce efficiency ratings of 89% to 95% (California Energy Commission, 2006). Therefore, it can be said that solar photovoltaic systems on average are currently able to provide anywhere from 17.7% to 17.9% of the solar energy that is absorbed by the solar modules.

While these efficiencies appear low, comparisons to other sources of energy plants show that solar photovoltaic may be able to compete with current existing producers of electricity. When compared to other power generation systems, these efficiencies are slightly lower than current energy plants. Kaplan (1999) identified both coal-fired and nuclear energy plants with efficiencies between 30-35% and 20%, respectively. These efficiencies do not take into account common shutdowns required for inspections or the need to bring them [coal and nuclear] up to compliance. In such cases, the efficiencies for these plants may drop drastically.

Solar photovoltaic systems are also characterized based on whether they are connected to a local utility grid. A grid-connected system is connected to the existing electrical grid provided by the local utility company. The solar photovoltaic system creates electricity during the day, requiring only a fraction of the daily energy needs from the local utility company during the peak demand hours (Bradford, 2006). At night, these grid-tied systems may purchase their electricity at off-peak rates, thereby reducing the cost per watt hour and overall electricity costs. Figure 2 presents a visual representation of the energy requirements of a facility and the electricity provided by a solar photovoltaic system. During the peak time of electricity usage, utility companies will pay for any surplus energy produced by solar photovoltaic systems not used by the facility. Thus, solar photovoltaics have an ability to generate electricity at the most opportune time, when costs are highest and demand for electricity is greatest.

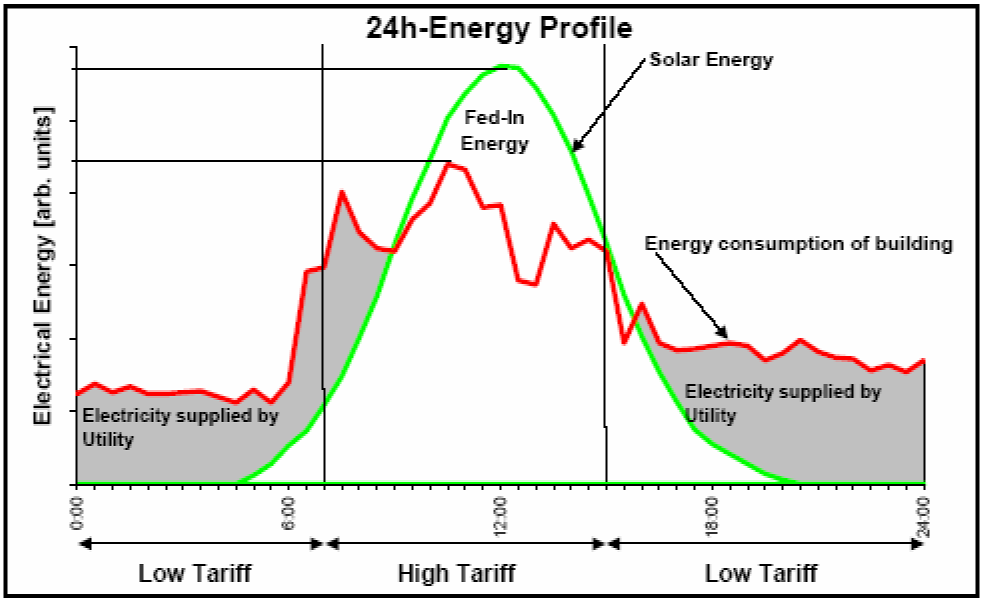

Figure 2. Energy Profile of a Typical Building (Schotts Solar, 2006)

In contrast, stand-alone photovoltaic systems, known as off-grid systems, provide electricity to facilities without the help of a utility company. The decision to build off-grid systems may be in part to the large capital costs associated with connecting to the nearest utility company. In such instances, the storage capacity of batteries supplements electricity requirements at night or during inclement weather conditions.

Finally, recent innovations in solar photovoltaic manufacturing have produced solar photovoltaic systems which permit the integration of solar photovoltaic technologies with construction materials. Known as building-integrated photovoltaics (BIPV), these solar systems are designed to serve as substitutes for current building materials used for facility construction. A few examples of such technologies are solar roofing tiles/shingles, solar cell skylights, and solar windows. BIPVs offer an opportunity to adopt solar photovoltaic system in circumstances where the view of solar modules bolted on top of rooftops is displeasing to the eye.

Past research has identified negative characteristics of solar systems. Lengthy payback periods and high initial capital costs were issues Faiers (2006) identified. Lengthy payback continues to be the main contributor to rejecting solar photovoltaics. It was discovered that payback period was the single most limiting factor determining whether or not adoption of solar photovoltaics takes place (Faiers, 2006). "If solar does (*sic*) not bring additional value for the property, then adoption will not (*sic*) be considered by householders who may move before the payback period ends" (Faiers, 2006:1804).

The lengthy payback is directly related to the upfront costs associated with solar photovoltaic systems. Decision-makers may perceive the high capital costs required for acquiring solar photovoltaics as an opportunity cost that could be applicable to other amenities. Likewise, warranty issues may raise questions as to whether solar systems are worthwhile when renovating facilities. Installing solar systems on a rooftop may void the warranty of the roof, which may potentially increase operation and maintenance (O&M) costs due to additional maintenance and repair work. A more detailed description of costs is described below.

2.3.2 Solar Photovoltaic Costs

Economics is the driving force to develop solar photovoltaics amongst consumers in developed nations and is a viable option for "creat[ing] ancillary wealth around the world" (Bradford, 2006:171). Costs for photovoltaic systems for single facility use vary on a number of factors. Three cost factors are taken into consideration although others may exist. Facility energy requirements, utility grid connectivity, and government incentives are the cost factors described. First, the size of a solar photovoltaic system is dependent on the energy requirements of a facility. Proper identification of a facility's energy consumption through correct calculations of heat coefficient values (U-values) will determine the overall energy consumption of the facility (Eicker, 2003). Facilities lacking in passive energy design, adequate ventilation, and insulation may have a larger energy envelope. All things being equal, a more energy efficient facility with the same square footage may not require as large of an array of solar panels.

Grid connectivity can also play an important role in overall costs if a net metering program is in place in which the owner has the opportunity of selling any surplus electricity to the utility company and purchasing electricity from the local utility company at off-peak prices when the system is inoperable (see Figure 2). A typical 1KW grid-connected system cost the consumer approximately $4 per watt while an off-grid system of the same size ranged anywhere from $8 to $25 per watt (Zehedi, 2006). Grid connectivity may reduce the costs to the owner; however, adequate knowledge by the local utility company to connect with the solar photovoltaic system and local availability of licensed solar electricians to connect the system impacts costs as well. Individuals wishing to install solar photovoltaics in an area that has high levels of solar irradiance may see high installation costs due to a lack of technical knowledge or a lack of available solar installers.

Finally, cost factors for solar photovoltaic systems are dependent on state and federal incentives. Incentive programs by local or state governments such as those in parts of California and Texas provide local residents with up to 50% rebates on total installation costs for the installation of solar photovoltaics at their homes. These incentive programs result in a shorter payback period for the consumer and are more appealing to the homeowner or business owner. "Since buyers receive cash payment at the time of installation, their economic risk is dramatically reduced” (Bradford, 2006:174). At the same time, in accordance with the contract, the city is able to purchase the unused electricity generated by the solar photovoltaic system to power other areas of the city (Los Angeles Solar Incentive Program website, 2006). In addition, a federal incentive in the form of tax credits provides up to $2000 for the installation of solar photovoltaics and solar water heating technologies, thereby further reducing installation costs and payback period (Database of State Incentives for Renewable Energy [DSIRE], 2006). Such incentive programs provide the ability for residential and business consumers to adopt solar photovoltaics at a reduced cost.

2.4 GLOBAL AND U.S. ACCEPTANCE OF SOLAR PHOTOVOLTAICS

Incentive programs coupled with higher fossil fuel costs have enabled solar photovoltaics to receive slight acceptance around the world with 5000 mega-watts (MW) or .038 percent of the world’s total energy consumption of photovoltaic capacity to date (Gibbs, 2006). Japan and other European nations have been propelled as solar photovoltaic leaders in large part due to the incentive programs these nations have allocated to installing solar systems. Japan generated half of the world’s solar power in 2003 with an energy capacity four times more than the solar power capacity in the U.S. (Businessweek, 2004). Germany outpaced Japan as the top installer of solar photovoltaics in 2005, installing approximately 635 MW of photovoltaic power systems (Photon International, 2006). This is in comparison to 289.9 MW in Japan and 103 MW in the U.S. (Hirschman, 2006). Japan remains the leader in the solar photovoltaic production industry, producing 824 MW of solar photovoltaic cells in 2005 in comparison to the U.S. production rate of 156 MW. However, Welter, Siemer & Hering (2006) suggest that the incentive programs instituted in the 1990s by Japan and Germany may have reached their end.

Whether solar photovoltaics will continue to be adopted amongst future generations without the subsidies provided by governments remains to be seen. Researchers suggest that high fossil fuel costs for electricity generation in European and Asian nations allow for solar photovoltaic systems to compete with utility costs. Known as grid parity, the terminology describes when solar electricity prices and utility meter prices for end-customers are the same (Welter, Siemer & Hering, 2006). Because countries in Japan and Germany continue to see high utility prices of 25 cents/kWh (Chiras, 2006), as shown in Figure 3, researchers conclude that grid parity may take place in the near future and end-consumers may opt for solar photovoltaic systems even without incentives. In contrast, U.S. reluctance to accept solar photovoltaic systems may be due to low utility prices out-competing average installation and maintenance costs for solar photovoltaic systems. “Retail electric prices lower than 15 cents/kWh are predicted in the foreseeable future” (Welter and others, 2006:160). Figure 4 shows average electricity costs in the U.S. with current prices averaging 10.6 cents/kWh (Energy Information Administration, May 2006).

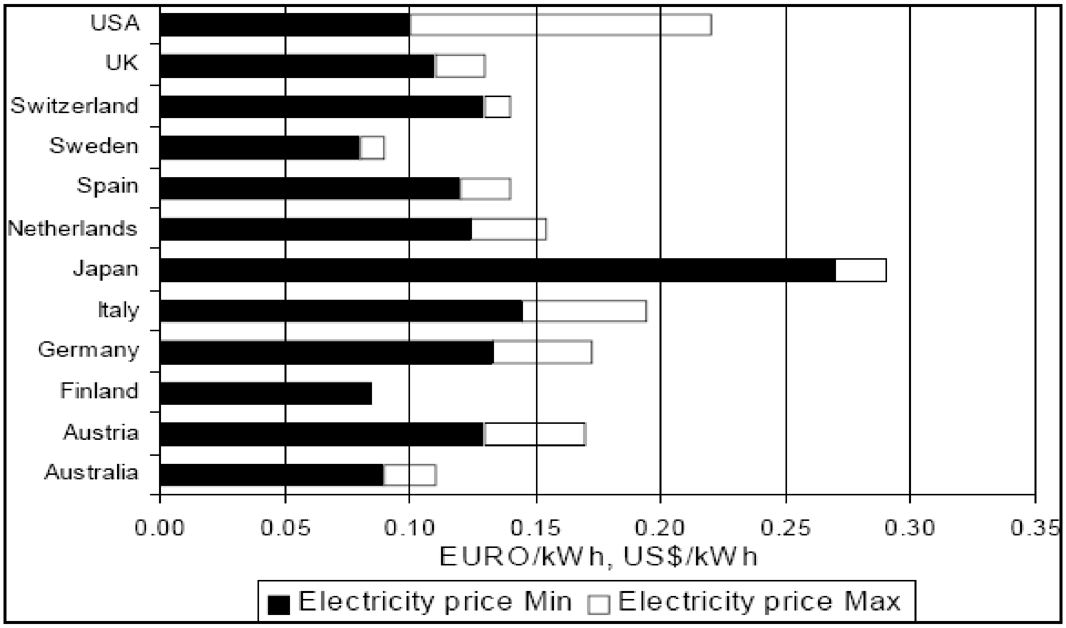

Figure 3. Comparison of Min and Max Prices of Electricity Around the World (Eiffer, 2003)

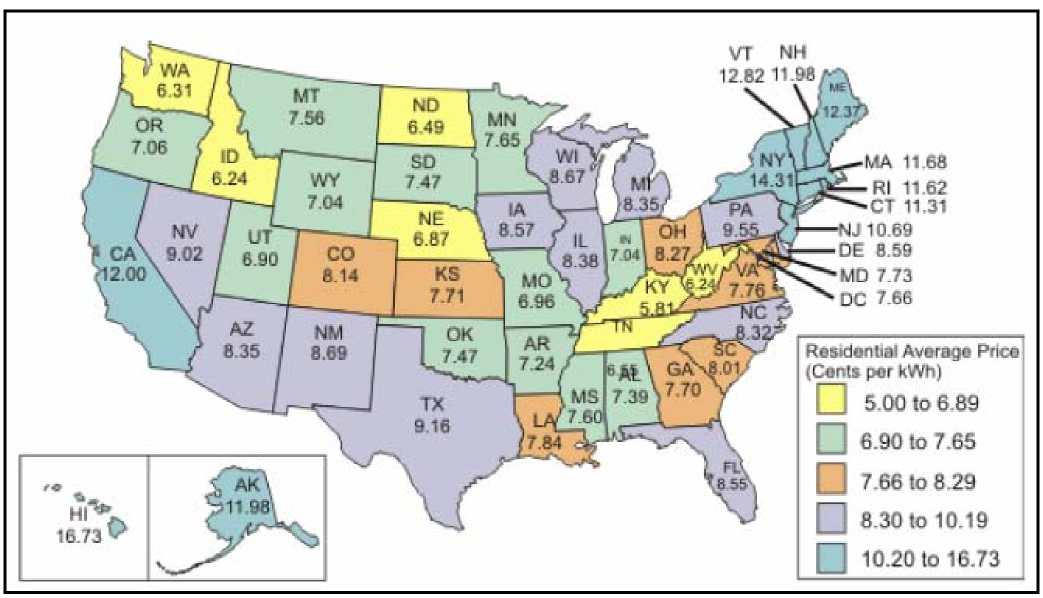

Figure 4. Residential Average Electricity Costs
(Energy Information Administration Form EIA-861, 2006)

2.4.1 U.S. Photovoltaic Programs

The removal of the solar photovoltaic system from the White House in the early 1980s by the Reagan Administration (Port, 2004) foreshadowed the direction of the U.S. solar market. Starting in the 1980s, the U.S. solar photovoltaic market share decreased from approximately 50% in the early 1980s to less than 20% in 2004 as shown in Figure 5. Research and development investments in global energy research by the federal government dropped by nearly two-thirds between 1979 and 1996 due to low fossil fuel costs and "changing geo-political priorities" (Bradford, 2006:176). However, starting in the late 1990s, programs began promoting solar photovoltaics in hopes of reversing the downward trends with respect to solar manufacturing and installation.

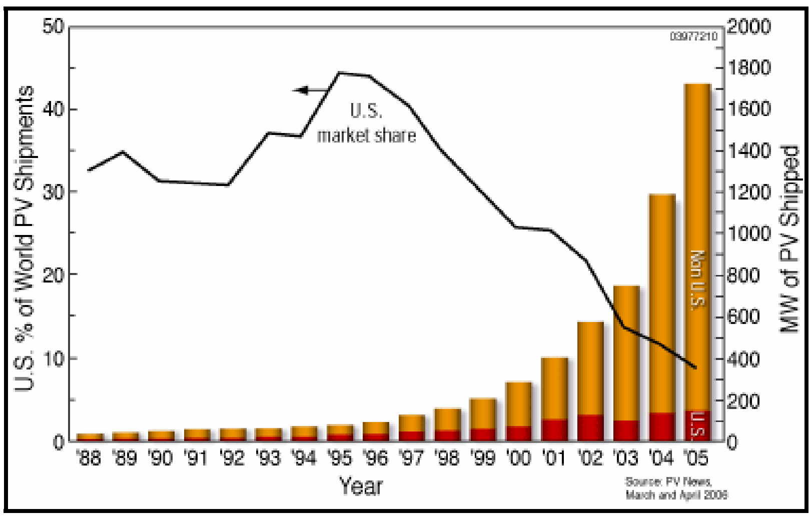

Figure 5. U.S. Market Share of Solar Photovoltaic Production (PV News, 2006)

In 1996, a new program commenced in the U.S. to promote interest in solar photovoltaics and "overcome barriers to market entry for solar energy technologies" (Sherwood, 2006:2). The Million Solar Roofs (MSR) initiative began with a goal of installing a million solar roofs by 20l0. MSR's definition of solar technology encompassed solar photovoltaics, solar water heating, transpired solar collectors, solar space heating and cooling, and pool heating (Sherwood, 2006). At the end of 2006, MSR was renamed the Solar America Initiative (SAI).

The SAI is comprised of various organizations. The program incorporates 94 key partnerships with local governments, universities, non-profit organizations, utility companies and private sector companies (Sherwood, 2006). Figure 6 identifies the percentages of the various groups with private sector entities having the majority. Between 1999 and 2004, the Department of Energy provided $16M, approximately 66% of total funds, for SAI to be used by the partnerships for technical assistance, electronic communications to partnerships, regional peer-to-peer workshops, and national telephone seminars (Sherwood, 2006).

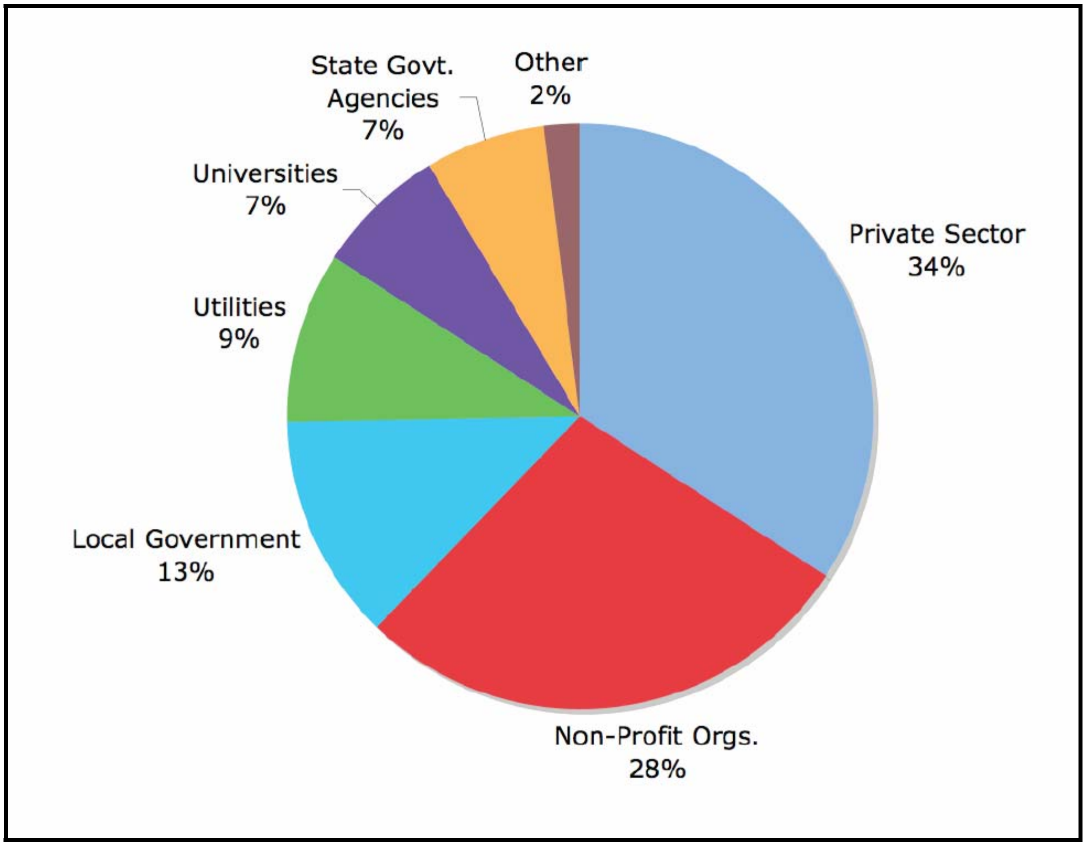

Figure 6. Distribution of SAI Partnerships (Sherwood, 2006)

2.4.2 U.S. Key Barriers to Solar Photovoltaic Adoption

The SAI identified the following key barriers to adoption of solar energy technologies within the U.S. (Sherwood, 2006):

1. High costs
2. Lack of consumer awareness and understanding
3. Interconnection standards that inhibit solar electric development and net metering objectives
4. Lack of trained installers and inspectors
5. Lack of solar friendly building practices, standards, and zoning
6. Lack of knowledge and best practices to architecturally integrate solar into overall design

7. Lack of financing options and no well defined value analysis
8. Inconsistent government policy related to photovoltaics and lack of access to system benefit funds for solar thermal
9. Lack of energy star and other validation performance
10. Consumer accessibility issues: lack of standard products and purchasing channels

Through its key partnerships, SAI has produced solutions to these barriers ranging from the development of incentive programs for reducing overall installation costs to the creation of teacher workshops to increase awareness and knowledge of solar energy technologies. While installations of solar energy systems have increased, Figure 7 indicates that the program may not reach its goal of 1 million installations. Since the inception of the MSR through 2005, approximately 400,000 solar installations took place in the U.S. and 140,000 were for solar photovoltaic generation systems. This translated to 320,000 MWH/yr of electricity produced from solar photovoltaics (NREL, 2006). While solar pool heating has out-gained solar photovoltaics up to this point, significant public policy promoting solar photovoltaics has gained 90% of the incentive programs allocated to solar technology adoption (Sherwood, 2006). Table 1, identifies the top ten states that have grid-connected solar photovoltaics with California and New Jersey leading the installation of solar photovoltaics.

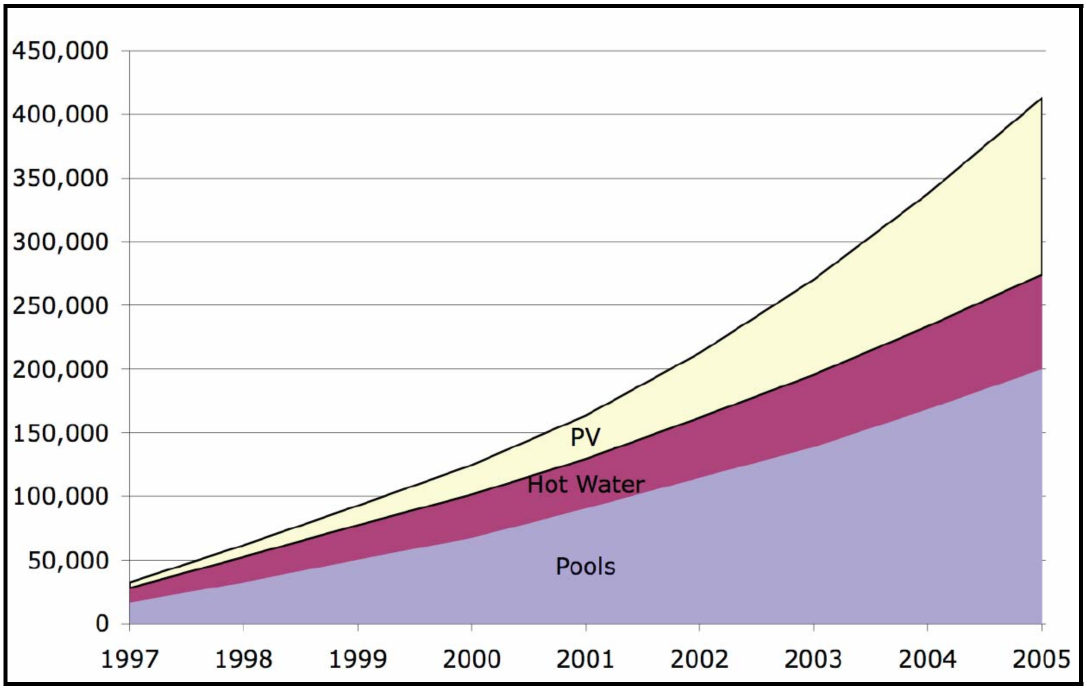

Figure 7. Cumulative Equivalent U.S. Solar Installations from 1997-2005 (Sherwood, 2006)

Table 1. Top Ten States for Grid Connected Solar Photovoltaic Systems in 2006 (Sherwood, 2006)

State	**Capacity (MW_{DC})**
1. California	36.6
2. New Jersey	6.7
3. New York	1.3
4. Arizona	1.0
5. Colorado	0.5
6. Texas	0.4
7. Massachusetts	0.3
8. Nevada	0.3
9. Oregon	0.2
10. Connecticut	0.2

2.4.3 Department of Defense Interest in Solar Photovoltaics

As part of a 2005 comprehensive energy initiative, the Department of Defense (DoD) have sought to pursue off-grid generation systems to provide peak saving opportunities and energy security (DoD Annual Energy Management Report, 2005). The Air Force has been the leader for the DoD in the pursuit of the comprehensive energy initiative. The Environmental Protection Agency (EPA) ranked the Air Force as the top green energy consumer from the green power partnership composed of public and private companies like the Wells Fargo and IBM (EPA, 2006). For its part, the Air Force used 1,043,558,000 kWh of green energy in fiscal year 2006. The Air Force also used Energy Savings Performance Contracts (ESPC), Utility Energy Savings Contracts (UESC), and Energy Conservation Investment Program (ECIP) as the funding vehicles for the various energy projects (DoD Annual Energy Mgt Report, 2005). While these contracts do not solely promote the use of solar photovoltaic power generation systems, they do promote the objectives required by E.O. 13123 and E.O. 13423. One example of this was the $9.6 million UESC project which installed a 122 KW solar photovoltaic system on the rooftop of Luke AFB's Base Exchange store (see Figure 8). With the help of a $488,000 utility rebate, the base is expected to save 12.4 million KWh of electricity every year with a 20-year savings of $21.8 million (*Thunderbolt*, 2006).

The following bases were identified as having received funding for an energy management project. Eight ESPC contracts were awarded to Altus AFB, OK; Minot AFB, ND; Nellis AFB, NV; Hill AFB, UT; Charleston AFB, SC; Luke AFB, AZ; Cannon AFB, NM; and Goodfellow AFB, TX. Three UESC contracts were awarded to Hurlburt AFB, FL; Andrews AFB, MD; and Ellsworth AFB, SD. Finally, as shown in

Table 2, two ECIP projects at March Air Reserve Base have been awarded with one pending at Fresno Yosemite, CA (DoD FY 2005 Energy Management Report, 2005).

Figure 8. Installation of 122 KW Solar Photovoltaic System on Luke AFB Base Exchange (*Thunderbolt,* 20 Jan 2006)

Table 2. Air Force Photovoltaic Projects

(Air Force Civil Engineering Support Agency, 2006)

Photovoltaic	Installed	Funding Type	Capacity (KW)
Mountain Home Air Force Base, Idaho	1996	ECIP	78
Ascension Island, CA	1997	ECIP	86
Multiple AF Lighting Apps	1997-2001		23
China Lake, CA	1990		28
Hickam Air Force Base, HI (Oahu Island)	1996		18
Hickam Air Force Base, HI (Ford Island)	2000		2
Altus Air Force Base, OK	2000		0.233
Goodfellow Air Force Base, TX	2000		4.8
Luke Air Force Base, AZ	2005	ESPC	122
Luke Air Force Base, (Phase 2)	2006	ESPC	250
March Air Reserve Base, CA	2006	ECIP	300
March Air Reserve Base, CA (Phase 2)	2006	ECIP	100
Fresno Yosemite, CA	Pending	ECIP	Pending
Lackland, Air Force Base, TX	Pending	ESPC	Pending

2.5 DIFFUSION OF INNOVATION THEORY

Diffusion describes how an innovation is "communicated through certain channels over time among members of a social system" (Rogers, 2003:5). An innovation is anything that is perceived new to the individual, social group, or organization. Therefore, innovations can take shape with respect to technology or service, production processes, organizational structure, people, and policy (Fidler and Johnson, 1984).

Diffusion of Innovation Theory suggests that a process begins with individuals characterized as innovators and early adopters who possess the knowledge of a new innovation. Over time, if the innovation's characteristics are appealing and social networks use their respective communication channels to effectively promote the innovation, then and only then does an innovation become fully adopted. Individuals identified as late majority and laggards eventually adopt the innovation but only after the product has clearly shown its relative advantage over similar competitive products. "The rapid growth in the middle of the curve occurs only after the initial adopters have proven its usefulness and corrected out the bugs in the innovation, hence reducing the risk for the majority" (Dunphy and Herbig, 1995:194). When a large majority accepts the innovation, the saturation point is reached and "the most promising areas [of the innovation] have been exploited" (Dunphy and Herbig, 1995:194). This adoption process is more commonly referred to as the classic s-curve as shown in Figure 9 (Fahar, 2006).

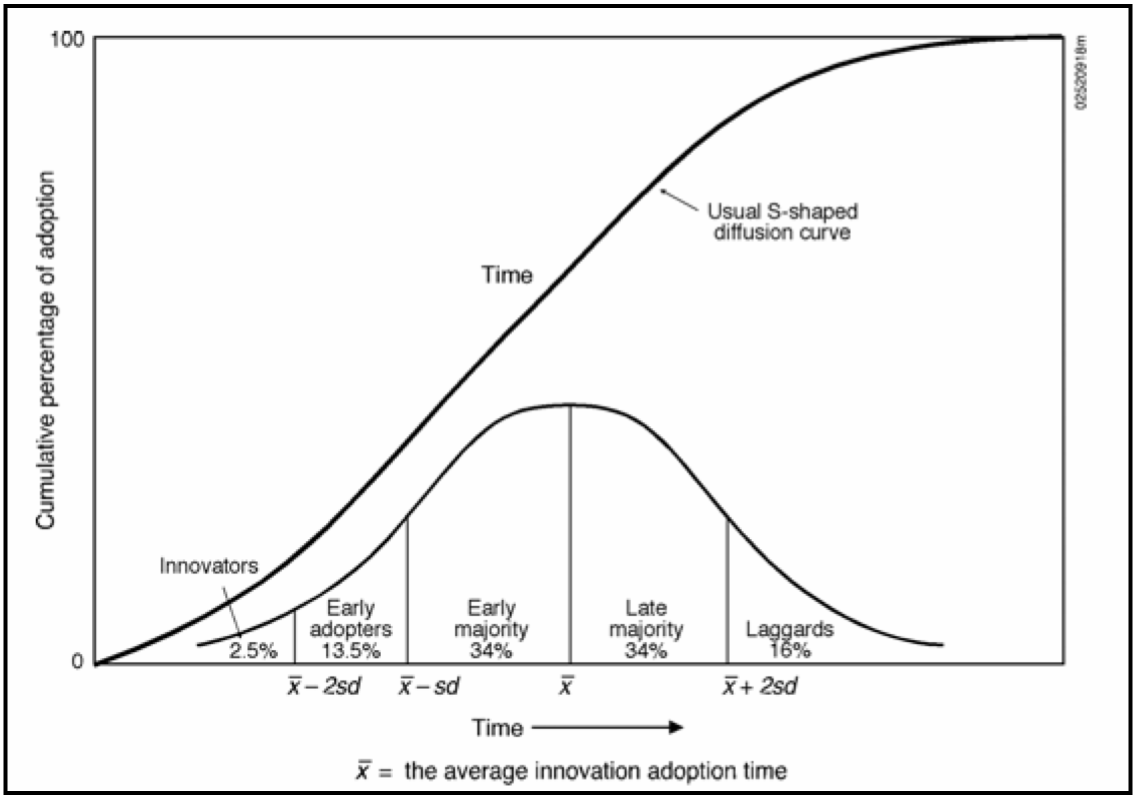

Figure 9. Bell Shaped Curve and S-Shaped Curved Associated with Diffusion Theory (Fahar, 2006)

Innovation adoption has been studied in a variety of disciplines. Hence, there are a few different approaches from which to research an innovation and its possible adoption into an organization. For example, Theory of Planned Behavior, in which "attitudes towards a behavior are determined by relevant internal beliefs" (Au and Enderwick, 1999:267), incorporates the perceived attributes of adoption theory. The Technology Acceptance Model (TAM) is another research stream based on the theoretical constructs of intention, perceived usefulness, and perceived ease of use. The TAM theory follows pre-test and post-test data collection to determine overall technology acceptance after the technology is implemented (Szajna, 1996). A third research stream of adoption theory is the Theory of Reasoned Action, which "suggests that people consider the consequences of alternative behaviors before engaging in them" (Bang and others, 2000:450). The model tests an individual's intention toward performing the behavior. Finally, new research suggests that a Unified Theory of Acceptance and Use of Technology (UTAUT) brings the various areas of adoption theories under one umbrella (Venkatesh, 2003).

The variety of possible research streams available to study innovation adoption has one major setback. Venkatesh (2003) states that since several theoretical models exist within diffusion theory, researchers must pick and choose constructs across varying models or choose favored models of more renowned experts over lesser known models and end up ignoring significant contributions of the latter. This study favors a balanced approach to this dilemma and incorporates diffusion theory by combining the efforts of Rogers (2003), a well-known expert in the field, with follow-on work conducted by Kaplan (1999). For purposes of this research, the focus is solely on the Diffusion of Innovation Theory due to its wide acceptance in the energy analysis community (Farhar, 2006). Diffusion of Innovation Theory is comprised of the following four main areas in which research has been conducted. Each research stream is explained briefly in this section, with the research stream used for this thesis explained in more detail.

1. Attributes of the innovation (characteristics promoting adoption)
2. Communication Channels (social networks)
3. Social Systems (organizational)
4. Time (innovation-decision process)

2.5.1 Attributes of the Innovation

Rogers and Shoemaker (1971) are credited for their research into the attributes of an innovation which increase the probability for adoption. Understanding the perceptions toward these attributes enables researchers to gauge the eventual adoption rate of the innovation. These attributes are: 1) relative advantage, 2) compatibility, 3) complexity, 4) trialability, and 5) observability (Rogers, 1971, 1995, 2003).

Relative advantage is frequently associated with cost benefits and the degree to which an innovative product is considered better than its predecessors (Ostlund, 1974). "It can be expressed as the intensity of the reward or penalty by adopting or rejecting the technology" (Dunphy and Herbig, 1995:202). Research suggests that a positive relationship exists between relative advantage and rate of adoption (Rogers, 2003).

Compatibility is the degree to which the technology is consistent with the existing lifestyle of the individual (Rogers, 2003). "Previously introduced ideas will impact the adoption of any new innovation and the more compatible it is with the previous [innovation], the less change is required" (Dunphy and Herbig, 1995:202). Research suggests that a positive relationship also exists between compatibility and rate of adoption (Rogers, 2003).

Complexity relates to the "degree to which a technology is perceived difficult to understand and use" (Rogers, 2003:257). Some innovations face barriers to adoption due to their complexity. For example, the home computer initially was well received amongst U.S. households by individuals who loved technological gadgets (Rogers, 2003). These individuals did not perceive the computer as complex; however, other individuals were challenged by this new technology. "They were baffled by how to connect the various components, how to use the word processor and software" (Rogers, 2003:257).

As a result, initial adoption of home computers was slow. Research has shown that complexity is highly negatively correlated with the rate of diffusion (Dunphy and Herbig, 1995).

Trialability is the degree to which an individual feels they have to test the technology prior to assuming ownership (Rogers, 2003). The ability to try out an innovation prior to adopting permits an individual to test the innovation and "allowing an individual to give meaning and dispel uncertainty" (Rogers, 2003:258). However, some innovations are more difficult to test than others. For instance, innovations with high costs may not be readily available for testing. Since solar photovoltaics can fall into this category and individuals may not have exposure to the technology, it would be difficult to test solar systems in the individual's environment. Research suggests that trialability has a positive correlation with the rate of diffusion (Dunphy and Herbig, 1995).

Observability is the "degree to which an individual believes that the benefits are visible" (Rogers, 2003:258). Solar photovoltaics, by their very nature, are observable and therefore the perceptions of the visible attributes are more apparent. For instance, modules on rooftops or carports may be perceived by individuals as unsightly and may request other alternatives rather than solar photovoltaics to meet their renewable energy requirements. On other hand, an individual may perceive solar modules as a step in the right direction. Therefore, while observability has had a positive correlation to adoption (Rogers, 2003), solar photovoltaics may be an exception to this rule.

To conclude, Table 3 summarizes the relationships that each attribute has on the rate of adoption. These attributes have accounted for 49% to 87% of the variance in the eventual adoption rate (Rogers, 1992); however, Rogers proposed that these were not the only significant attributes. Other attributes of innovations may present themselves as having more preference than those proposed. For example, in organizational settings, the decision to adopt an innovation is dependent on the inherent consequences, both positive and negative, and "the very novelty of the innovation for the organization entails more risk as a whole" (Lidler and Johnson, 1984:705). Since the chances of loss are less predictable in a new innovation than the status quo, the greater the degree of perceived risk and less likelihood for adoption (Lidler and Johnson, 1984).

Table 3. Attributes Relating to Adoption Rates

ATTRIBUTE	RELATIONSHIP TO ADOPTION RATE
Relative Advantage	+
Compatibility	+
Complexity	-
Trialability	+
Observability	+
Risk	-

The attributes of innovation described above have been provided as one possible research stream. Relative advantage, compatibility, complexity, trialability, observability and risk are all proposed as potential attributes that influence the rate of adoption. In their results, Rogers and Shoemaker (1971) remarked that it is the individual's perceptions of an innovation and not fact which promote new ideas. In many cases, the perceptions that individuals formulate of an innovation arise from their respective communication channels.

2.5.2 Communication Channels

"Advocating change necessarily results in increased uncertainty, which can lead to resistance to innovations by adoption units" (Fidler and Johnson, 1984:705). Therefore, it is suggested that communication channels are key to reducing uncertainty in the innovation; however, it can also be advocated that communication channels can also act as barriers to innovation. Communication channels promote diffusion when a novel idea is adopted by an individual and later relayed to another individual who has not adopted. The way in which the innovation is communicated determines whether the individual receiving the message will actually accept or decline the idea (Rogers, 2003). It is very possible that a non-innovative person may receive a positive message early in the diffusion process and decide to adopt; the same can be said of an innovative person receiving a negative message and delaying adoption (Midgley and Dowling, 1993). Rogers (2003) identifies two sets of communication channels through which diffusion takes place: mass media and interpersonal channels.

Radio, television, newspapers, and the Internet all contribute as mass media communication channels. It is because of these channels that ideas gain credibility and eventual adoption although the same can be said that mass media can prohibit adoption. "Mass media can reach a large audience rapidly, create knowledge and spread information, or change weakly held attitudes" (Rogers, 2003:205). Copp (1958) discovered that a sequence was involved in agricultural communication such that mass media directed awareness to groups and individuals. Finally, it has been suggested that mass media is more important at the beginning stages of the diffusion process, while interpersonal channels persuade an individual in the latter stages (Rogers, 2003).

Interpersonal channels have been shown to work more effectively because of the subjective evaluations most individuals use when conveying certain likes or dislikes about a new idea. "Often the capacity of interpersonal communications to provide social support and enhanced confidence in the outcomes of the innovation can be crucial to innovation implementation" (Fidler and Johnson, 1984:709). These communication channels become even more effective when both the sender and the receiver have the same socioeconomic status (Rogers, 2003). Peers with similar dispositions in life are more inclined to accept one another's message than if the same peers were receiving the information from individuals from an outside group, individuals with more education, or individuals with more money. For example, in a 1967 marketing research study, it was found that housewives who had received coupons to purchase a new food product at two-thirds off its selling price, but still felt it too risky, sought out the opinion of their neighborhood peers prior to purchasing (Rogers, 1976). The adopters of new innovations therefore should have fairly consistent behaviors "while the non-innovative individuals subject to interpersonal influences should display variability in their behavior" (Midgley and Dowling 1993:611). It has also been shown that susceptibility to influence by others is dependent on an individual's personal characteristics, such as self-esteem and intelligence. For example, research shows that individuals with low self-esteem are readily influenced by others (Bearden, Netemeyer, and Teel, 1989).

The overall role of communication channels is to provide knowledge to the non-adopter in order to reduce the perceived risks associated with the innovation. An individual may have insufficient knowledge to reach a decision to adopt. Such was the case when Wilton and Pessemier (1981) identified the effects that information had on individuals and their behaviors with subcompact electric vehicles. "[P]otential adopters of an important innovation have limited relevant information and, not infrequently, a good deal of misinformation" (Wilton and Pessemier, 1981:162). Moving individuals from one state of knowledge (low information) to another state of knowledge (intermediate or maximum) changes the perceptions of the individual and strongly influences their choice to accept or reject. It is possible that within the structure of the federal government, wide levels of information and misinformation exist among employees with respect to solar technologies such that their perceived understanding of solar photovoltaics is distorted.

2.5.3 Social Systems

The rate of adoption may also depend on the infrastructure of a social system. A social system is defined as "a set of interrelated units that are engaged in joint problem solving to accomplish a common goal" (Rogers, 2003:23). Many times the setup of the social systems promotes or prohibits diffusion of new ideas to take place. Rogers and Kincaid (1981) researched the complexity of social structures and the effect they may have on an individual's intention to adopt. Their research involved two Korean women with similar socioeconomic status who lived in different villages and how they adopted or failed to adopt contraceptives. Even though contraceptives were promoted equally in both villages, the social network in one village was more accepting of contraceptives while the social network in the second village was less accepting. Therefore, it was predicted that the women would adopt/not adopt because of peer pressure within their respective social networks (Rogers and Kincaid, 1981). Due to their homophilous characteristics to associate and bond with others who are similar in social status, social networks can facilitate effective communication, "but they act as a barrier [as well] preventing new ideas from entering the [social] network" (Rogers, 2003:26).

In contrast to the small social network settings described in the previous example, past research of denser and highly complex organizations may provide similar parallels to those of the military bureaucracy. Researchers have theorized that often times the external environment is what promotes innovation in large organizations; hence "characteristics of an organization's environment may be critical to its ability to innovate" (Damanpour and Schneider, 2006:217). Properly identifying the environmental context may allow Air Force policy makers to exploit the constraints of the environment to promote change.

The unique characteristic of military bases with an extended bureaucracy outside of the base complicates the notion of the external environment. External stimuli delegating requirements and constraints to respective bases raises questions as to whether an energy management team at a base can be identified as a separate organization or if it is a subset to the Major Command (MAJCOM) organization, and if the MAJCOM organization is a subset to Headquarters Air Force (HQ AF), and whether HQ AF is a subset to the Department of Defense (DoD). In this respect, is it worthwhile to investigate the innovative drive of an energy management team at a local Air Force installation if the organization is so complex that it leaves little room for creativity?

This question regarding complexity may very well be the deciding factor that determines an organization's decision to adopt new technologies. Researchers seem to argue for both sides of the issue. Empirical analysis by Blau and McKinley (1979) identified complexity and size of organizations among the most important predictors of organization innovation. It was concluded that large, complex organizations have higher technical knowledge and expertise to complement innovation. On the other hand, Damonpour and Schneider (2006) suggest that small organizations are more innovative due to less bureaucracy. In such small organizations, "the depth and diversity of the knowledge base stimulate creativity and increase awareness and cross-fertilization of ideas, facilitating initiation" (Damonpour and Schneider, 2006:219). These sets of relationships appear to be the case for Air Force energy managers and, while single studies cite data suggesting for and against complex organizations, "quantitative reviews suggest a positive relationship between size and innovation" (Damonpour and Schneider, 2006:219).

2.5.4 The Innovation-Decision Process

The fourth and final research stream under Diffusion of Innovation Theory considers five stages occurring over time to decide whether to adopt an innovation. It is also the research stream this thesis research attempts to incorporate. The innovation-decision process is best described as:

> …the process through which an individual or other decision making unit passes from gaining an initial knowledge of the innovation, to forming an attitude toward the innovation, to making a decision to adopt or reject, to implementation of the new idea, and to confirmation of the decision (Rogers, 2003:168).

The innovation-decision process follows a unitary sequence pattern (Mintzberg, Raisinghani, and Theoret, 1976). The unitary pattern assumes linear order, whereas a multiple sequence pattern is more random and the sequence cannot be predicted (Damonpour and Schneider, 2006). The innovation-decision process begins with knowledge, proceeds to persuasion, then to a decision to adopt or not adopt, followed by implementation, and finally concluding with confirmation of the adoption. Figure 10 represents Rogers' innovation-decision process.

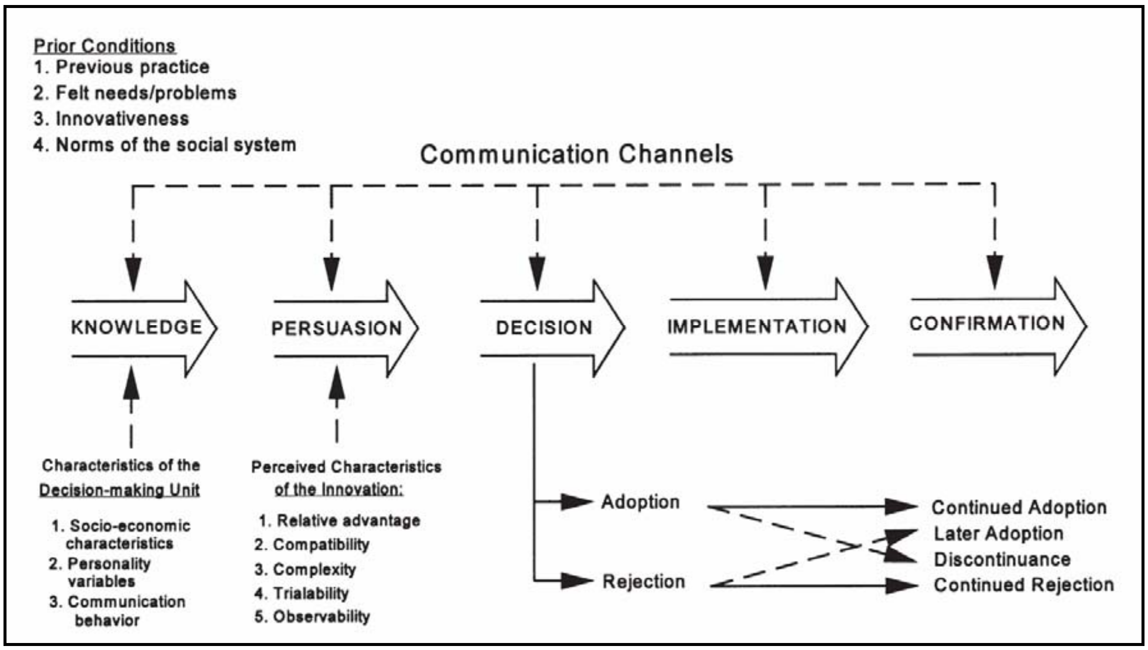

Figure 10. Innovation Decision Unitary Path Process (Rogers 2003)

Knowledge is the awareness of an innovation and the attempts by the individual to gain an understanding of it (Rogers, 2003). People tend to know more about topics that interest them; therefore, there is a close association between knowledge of innovations and interest. Studies point to low and high associations with interest and knowledge (Tobias, 1992). One frequently cited study assessed students' interest by rating reactions to story titles (Tobias, 1992). The study found a non-significant mean correlation of .09 between knowledge and interest. On the other hand, Tobias (1992) found significant correlation between knowledge and interest in a study examining interest on the acquisition of meta-cognitive checking techniques. Lastly, Kaplan's (1999) study on photovoltaic interest amongst energy managers found a significant beta correlation of .34 ($p < .01$) between knowledge and interest.

While the correlation between knowledge and interest can be debated, the definition of knowledge does not imply a technical understanding of the innovation. For example, many people understand and know how to use a computer very well, but they would not know how to repair the internal components should the computer fail. Individuals may also have selective perceptions or tendencies towards certain communications based on their own biases or beliefs. Therefore, individuals also tend to expose themselves to ideas that are in compliance with their existing values (Rogers, 2003). Similar to Tobias' (1992) and Kaplan's (1999) conclusions, this research acknowledges that "there is a substantial linear relationship between interest and knowledge" (Tobias, 1994:9).

With knowledge readily available, an individual may proceed to analyze the innovation based on its attributes which may lead to the next stage, persuasion. Persuasion occurs when an individual forms an attitude toward the innovation. This attitude may be favorable or unfavorable but is brought about by actively seeking information that will sway the individual one way or the other (Rogers, 2003). The individual begins to pay closer attention to attributes such as relative advantage, compatibility, and complexity (Rogers, 2003). Their attitudes may be swayed as they seek out information from peers regarding the information as interpersonal communication becomes a dominant factor. "At the persuasion stage, an individual seeks evaluation information to reduce uncertainty" (Rogers, 2003:175).

A decision occurs when an individual engages in activities that lead to the adoption or rejection of the innovation. "Adoption is a decision to make full use of the innovation, while rejection is a decision not to adopt an innovation" (Rogers 2003:177). Prior to a decision, trial testing may be done by the individual or organization on a probationary basis to validate the usefulness of the innovation. During this stage, the attributes of the innovation are compared with the status quo. In some cases, the experiences from peers may substitute for an individual's own understanding of the innovation and serve as a benchmark to gauge the worth of the innovation (Kaplan, 1999). In the case of solar photovoltaics, Air Force energy managers at MAJCOM levels may be swayed to solar photovoltaic systems after listening to success stories from their peers.

Implementation implies a behavior change to physically acquire the innovation; however, uncertainties may still exist. Problems of implementing a technology are more challenging at an organizational level. An organization's size, complexity of processes within the organization, and managerial influences all contribute in the implementation stage (Damanpour and Schneider, 2006). If implementers of solar photovoltaics are different from the decision makers, an organization may resist adopting, or vice versa. It may also be modified to suit the needs of the individual or the organization (Rogers, 2003).

Confirmation is the final stage where an individual or organization seeks to reinforce their decision to adopt or reverse their decision and seek to avoid any dissonance (Rogers, 2003). If the individual still has conflicting internal beliefs towards the innovation, the individual may change their behavior completely. For example, if an individual has developed a favorable attitude towards the innovation but has not yet adopted it, then "the individual is motivated to adopt by the dissonance between what they believe and what he or she is actually doing" (Rogers, 2003:189).

Just as likely, dissonance may very well force an individual to discontinue the innovation. Not being able to adopt an innovation may force an individual to discontinue seeking the innovation all together. If the innovation does not meet the perceived expectations of the individual or organization, then the innovation may be removed in favor of a different innovation, a newer version of the innovation, or revert back to the previous system. For example, an Air Force base that adopts the use of a solar photovoltaic system for facility use may decide to discontinue based on a number of issues that may arise after its installation. Negative experiences with the initial installation, recurring maintenance issues with the system, or even acceptance of other renewable technologies may affect whether the solar photovoltaic system maintains its adopted status.

III. METHODOLOGY

3.1 INTRODUCTION

Chapter III introduces the research design, sample, and the data collection involved. The chapter then discusses the validity and reliability of the interview questions. Lastly, descriptions of the measures that formulate the hypothesized model are discussed along with the statistical modeling tool used for analysis.

3.2 RESEARCH DESIGN

The research design incorporated Rogers' (2003) conceptual model and Kaplan's (1999) model to hypothesize causal relationships between the latent, independent variables of knowledge, experience, and familiarity and the dependent variable, interest. In addition, the research added communication to the construct model to recognize the potential influence of communication channels between the sample population of interest, base energy managers and their respective Major Commands (MAJCOM). Each variable used is expected to be correlated with one another. To identify the potential relationships between the latent constructs, simple and multiple linear regression was used.

3.3 SAMPLING

Convenience sampling was the method of choice for identifying cases for this research. Cases were restricted to Air Force energy managers within the U.S. While Schwab (2005) points out that restricting the sampling range may introduce bias between the independent and dependent variables, care was taken to identify cases dispersed geographically within the U.S. to increase the likelihood of variation in the analysis. Segregating the data collection to a certain region of the country, such as the southwestern part of the U.S., would potentially limit the inferences that could be made from the model.

To determine the sample size, Tabachnick & Fidell (1996) provided a simple rule of thumb. For multiple correlation, the equation was: $n \geq 50 + 8m$, where m is the number of independent variables, and to test for individual predictors, the equation was: $n \geq 104 + m$. Tabachnick & Fidell (1996) further explained that when both correlation and independent variables are examined, both equations should be calculated and the resultant larger sample size used. However, limitations in data collection with the research prevented the likelihood of receiving the large sample size needed for statistical analysis. A sample size of $n = 30$ invokes the Central Limit Theorem (Schwab, 2005); therefore, this was the sample size this research attempted to reach. A large enough sample size increases the validity, reliability, and normality of the measures in question (Devore, 2000). Lastly, since the research seeks to identify the factors that promote interest in solar photovoltaic systems, only bases that had not adopted solar photovoltaic systems were used in the analysis. Bases that had adopted solar photovoltaics were screened and removed from the database prior to the analysis.

3.4 DATA COLLECTION

Data was collected via phone interviews. The interview questions were Likert-based and consisted of various items for each measure within the model. Since energy managers were dispersed throughout the continental U.S., scheduling appointments for the interviews was necessary. In addition, once the appointment was set, the interview questions were sent to the energy manager prior to the phone interview reducing the interview time. Questions that were asked in the phone interview are provided in Appendix A.

3.5 VALIDITY

Determining the appropriateness of the construct model required construct validation. In order to identify the potential accuracy of the construct model, procedures such as face validity, content validity, criterion validity, and convergent validity were identified to minimize random and systematic errors. Appropriate construct validity "allows item measures to yield numerical values that accurately represent the characteristics [of the measures]" (Schwab, 2005:26).

"Face validity is based on a cursory review of items [seen] by untrained judges" (Fink, 1995:35). It was conducted to ensure that sentence wording was within the context of the test subject's understanding. Kaplan (1999) tested utility managers in urban and rural settings; therefore, the interview questions were structured to relate to a utility energy manager's understanding of their working environment and how it affected their interest toward solar photovoltaics. Because of the difference in environmental context between Kaplan's utility managers and Air Force energy managers and the manner in which the data was received from the subjects, items were reworded to assist the test subjects in understanding the items as it pertained to their military working environment. The untrained judges used to test for face validity were 23 civil engineering officers enrolled at the Air Force Institute of Technology (AFIT). While these officers were knowledgeable of the role of a base energy manager, it was unlikely that they would contain the expertise to judge the items in question. Rather, their feedback on wording, misspellings, and confusing sentence structure assisted in restructuring the questions for the phone interview.

Whereas face validity reviewed the items to determine how closely the items reflect the measure, content validity is measured when “the items are judged to accurately reflect the domain of the construct as defined conceptually” (Schwab, 2005:31). Content validity was taken into account when the interview questions were provided to two subject matter experts: the energy manager instructor at the Air Force Civil Engineer and Services School, Wright Patterson AFB, OH, and an Air Force energy manager currently assigned to an Air Force base. While content validity is not quantified statistically and is only representative of the opinions of experts (Fink, 1995), it provides a good foundation on which to build sets of valid questions. The feedback provided by these two experts was taken into consideration. To note, care was taken to ensure that the two individuals were not participants in the data collection for this research.

While content validity filtered the interview questions with a critical eye, criterion validity, and more specific, concurrent validity, measured how well the questions compared to a “gold standard instrument from previous research” (Fink, 1995:37). Since Kaplan’s survey derived from Rogers’ decision-innovation model, which is considered the gold standard within Diffusion of Innovation Theory, it was assumed that high levels of reliability for each measure would identify the strength of the model. The research results in Chapter 4 will determine how valid the research inter-item reliabilities of the model compared to the reliabilities produced by Kaplan’s instrument.

Lastly, construct validity, comprised of both convergent and divergent validity, is the most valuable means of validating instruments (Fink,1995). Convergent validity measures how well an instrument "performs in a multitude of settings and populations over a number of years" (Fink, 1995:43). Since this research only used groups of unrelated instruments, convergent validity was not an issue.

3.6 RELIABILITY

Reliability is a "statistical measure of how reproducible the survey instrument's data is" (Fink, 1995:6) and also "the degree to which the measurement scores are free of random errors" (Schwab, 2005:32). While it identifies the amount of random error in a construct model, it does not take into account the systematic errors that may exist (Schwab, 2005). However, it is still a process that brings a higher level of credibility to the inferences made (Fink, 1995). The two types of reliability discussed are alternate form reliability and internal consistency reliability. While alternate form reliability measures the same attribute with differently worded items, the same population sample must be tested (Fink, 1995:13). Because the population samples between this research and Kaplan's research were different, internal consistency reliability was the preferred method.

Internal consistency reliability was used to determine the consistent variance of the measures. Internal consistency reliability "refers to the similarity of item scores that are obtained on a measure that has multiple items" (Schwab, 2005:32) and applies "to a group of items that are thought to measure different aspects of the same measure" (Fink, 1995:21). This is measured statistically with Cronbach's coefficient alpha. Cronbach's alpha “measures how well different items complement each other in their measurement of different aspects of the same variable or quantity” (Fink, 1995:24). Cronbach’s alphas from Kaplan’s study shown in Table 4 were compared to the results of this research. Significant changes in the Cronbach’s alphas may determine that wording against the original survey changed. Significant changes in the reliability would provide misleading information “leading to errors when statistical inferences are drawn” (Schwab, 2005:245). Lastly, in accordance with Nunnally (1978), a reliability of $\alpha \geq .70$ for each measure was sought.

Table 4. Reported Cronbach Alphas (Kaplan, 1999)

Measures	Cronbach's Alpha
Motivation	0.77
Knowledge	0.73
Experience	0.70
Familiarity	0.89
Interest	0.90

3.7 MODEL DEVELOPMENT

Development of the hypothesized model was based on past innovation-decision models. Roger’s (2003) innovation-decision process model (see Figure 10) was adapted to the hypothesized model for this research, however, the model was limited to the first two stages of Rogers’ innovation-decision model. As Kaplan (1999) suggested, rewording persuasion to interest was necessary as not all utility energy managers had fully adopted solar photovoltaics in their utility companies.

> Rogers' persuasion here is equated with interest: a state in which potential adopters arrive at some level of affective investment in a technology and are able to express an attitude that a respondent at the knowledge stage cannot. Interest offers both improved measurement and an endpoint more distinct from decision than persuasion (Kaplan, 1999:470).

Similarly, it was assumed that only a small percentage of Air Force bases had adopted solar photovoltaic power generating systems for facility use. The assumption then follows that interest rather than persuasion was used as the behavioral construct. Figure 11 identifies the first two stages of Rogers (2003) innovation-decision model.

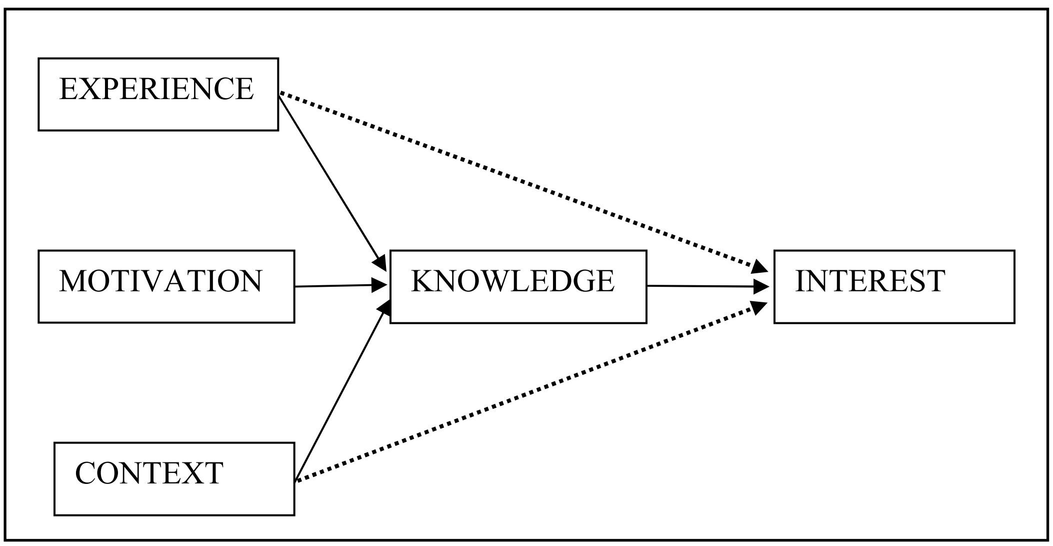

Figure 11. Operationalized Innovation Decision Process Model (Kaplan, 1999)

Kaplan (1999) enhanced Rogers' model by incorporating variables and relationships that were not suggested by Rogers as shown in Figure 12. While Rogers contends that knowledge precedes interest, Kaplan suggests that other variables deserve further investigation.

> The conventional model does not involve simultaneous equations and suggests no direct link between experience on many of the contextual

variables and ultimate persuasion or interest, and that familiarity "demonstrates significant effects on a manager's interest in adopting solar electric technology (Kaplan, 1999:470).

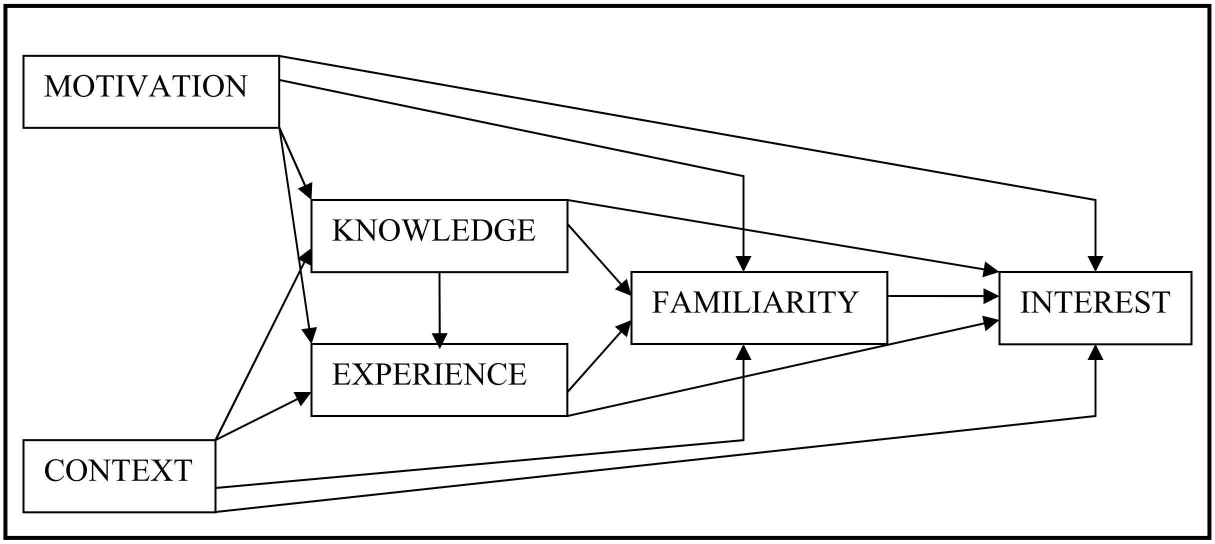

Figure 12. Kaplan's Updated Innovation-Decision Model (Kaplan, 1999)

The hypothesized model for this research included communication as an added measure that seeks to understand the communication channel at the initial stage of the proposed model. Literature identified in Chapter II suggested that communication was a significant variable contributing to a complex organization's potential to adopt new innovations. Rogers' (2003) innovation-decision model emphasizes communication channels having influence throughout the innovation-decision model. As stated in the previous chapter, highly complex organizations with poor communication may impede innovation. Communication plays an active role in an Air Force energy manager's motivation toward interest in solar photovoltaics. The model also includes exogenous, contextual variables relating to the organizational, environmental, and personal settings that may affect energy managers at their respective bases. The final model used for this research is depicted in Figure 13.

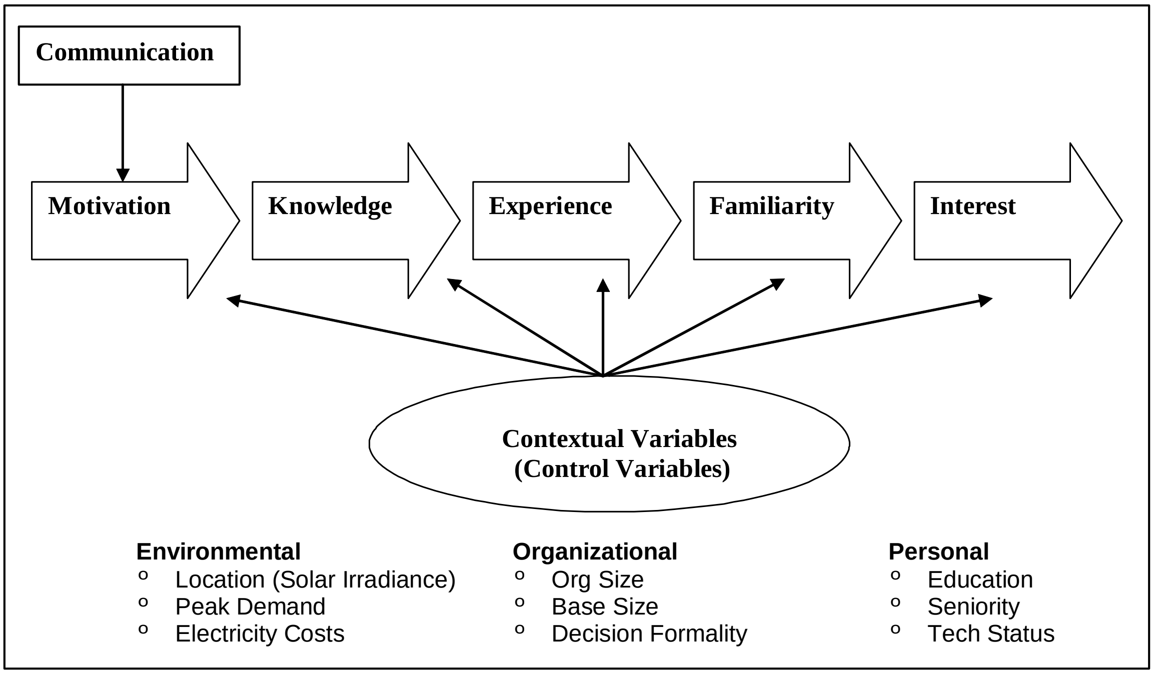

Figure 13: New Decision Process Model

3.8 MEASURES

The construct model identified a set of exogenous, contextual variables and five measures to determine the factors which promote overall interest in solar photovoltaics. Motivation, experience, knowledge, familiarity, and communication were the independent variables; interest was the overall dependent variable. The following is a description of these variables and how they relate to one another. In addition to describing these measures, the appropriate items associated with each measure were identified.

3.8.1 Context

Context is an important measure since "innovations are not independent of their environmental settings" (Ormrod, 1990:111). These settings evolve, and depending on the contextual environment, new innovations may or may not be accepted. For the purposes of this research, the variable context was comprised of various control variables that relate to the framework in which Air Force energy managers are positioned. Because of the various differences in numerical scales, the items in this measure were normalized prior to analysis. Contextual categories were organized into three facets: organizational, environmental, and personal.

Organizational context refers to the size of the organization, the decision formality within the organization, and the complexity of the organization. Many Air Force energy management sections are small, often consisting of one to two individuals. Sometime, there are additional personnel; for example, alongside the base energy manager, there may be a resource energy manager or utility manager with similar roles. Or, in instances where a vacancy exists, enlisted or officer personnel may fill the temporary role of energy manager even though they may have no technical expertise.

In addition to the size of the energy management section, the decision formalities involved in energy management were also considered. The decision-making at Air Force bases may consist of groups of individuals with long-term energy plans usually taking long periods of time to implement. Coordination between the commander and the energy management section is relevant for long-term strategic implementation. A single item index was developed using the first four statements described in question item 29 of the interview questionnaire (see Appendix A). Simple patterns of formality were deduced based on the respondent's answers of question item 29. For example, if a respondent selected answers that identified their energy management section as an organization that rationally plans their energy management decision with formal analysis, then this was considered characteristic of a very formal decision-making section. On the other hand, if the individual perceived energy decisions as incrementally resolved and seat-of-the pants judgment, the section was considered to be informal. Table 5 identifies the scale by which question item 29 was measured to determine the level of decision formality.

Table 5. Decision Formality Index (Kaplan, 1994)

Scale	**Decisions are made rationally (1)**	**Decisions are made incrementally (2)**	**Decisions are based on formal analysis (3)**	**Decisions are based on seat of the pants judgment (4)**
1	0	1	0	1
2	0	0/1	0	0/1
3	1	0/1	0/1	0/1
4	1	0/1	1	0/1
5	1	0	1	0

Environmental context refers to the solar irradiance, the peak power, and the electrical costs charged to the base by utility companies. To identify the amount of solar irradiance a base receives, a solar irradiation map provided by the National Renewable Energy Laboratory (NREL) was used. Figure 14 identifies the varying degrees of solar irradiation provided in the U.S. Each base interviewed was given an irradiance rating based on their location. In addition, each base provided the average summer and winter peak power demands as well as the average electricity costs charged by the local utility company. It was posited that a small base with low peak demand and in an area where electricity costs were relatively cheap may not deem solar photovoltaic systems appealing. In contrast, large bases with high peak demand and high electricity costs may seek to inquire the feasibility of installing solar photovoltaics. The "flows of information are typically place-specific" (Ormond, 1990:110); therefore, it was also posited that high degrees of knowledge with respect to solar photovoltaics may exist in areas where the perception exists that solar photovoltaics are suitable. Finally, individuals may perhaps have knowledge of solar photovoltaics; however, a lack of certified experts to construct such systems may dissuade them from truly becoming interested in the technology.

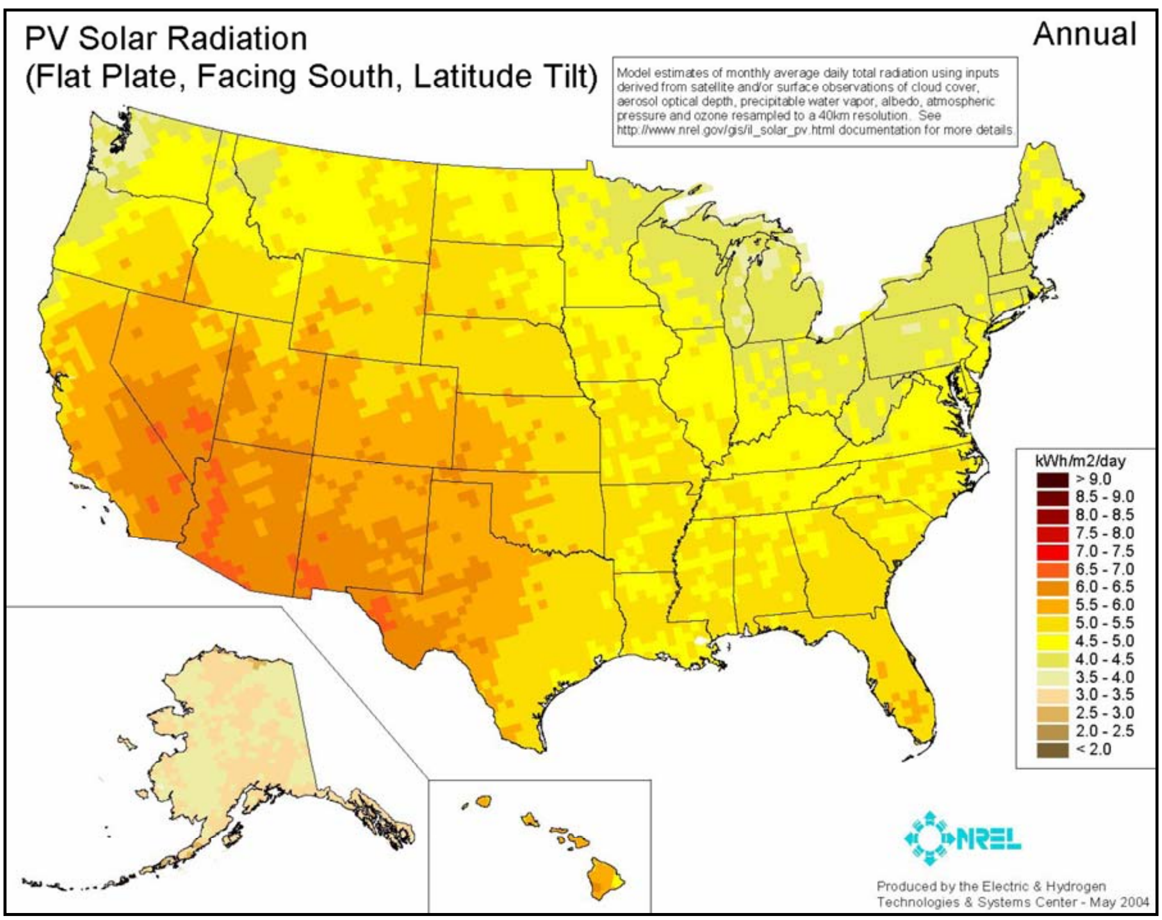

Figure 14. Solar Irradiation in the U.S. (NREL, 2007)

The last group of items that measured context was personal context. Personal context considered education, seniority, and job technicality as important roles in dictating whether or not adoption takes place. In other words, would an energy manager with a higher education, higher rank, and an extensive technical background perceive solar photovoltaics differently than a counterpart with less education, non-technical experience, and less seniority?

The first two variables of education and seniority were relatively easy to develop with the last variable, technical status, requiring the use of three questions from the interview questionnaire. Education was based on a 0 to 5 scale with no education coded 0 and a doctoral degree coded 5. For seniority, item 36B provided the amount of months an energy manager has held their current position. Technical status was a dummy variable comprised of three questions: degree field specialty (item 34B), managerial job position (item 37A), and technical job position (item 37B). If the energy manager had a technical degree, such as an electrical or mechanical engineering, and identified their job description as technical in nature, then their technical status was coded as "1." If the base energy manager did not receive a technical degree and was more of an administrator than a technical advisor, then technical status was coded as "0."

Important to note are the variables not included within personal context. Past diffusion research has suggested that a significant relationship between salaries and rate of adoption exists. "Adopter evaluations of innovations and decisions to adopt or not adopt are seen primarily as a matter of individual economic circumstances or social status" (Ormrod, 1990:111). Since an Air Force energy manager's salary is independent from whether an Air Force base adopts solar photovoltaics, the amount of pay that an Air Force energy manager receives is irrelevant to this research. Tables 6 thru 8 identify the various contextual variables and the corresponding items from the questions asked in the phone interview.

Table 6. Organizational Context and Associated Items

ORGANIZATIONAL CONTEXT ITEMS
Organizational Size (Q22). How many employees are there in your energy management section?
Base Size (Q25). What is the approximate size of the base you are at?
Decision Formality (Q29). How would you characterize the decision-making process in your energy management section?

Table 7. Environmental Context and Associated Items from Questionnaire

ENVIRONMENTAL CONTEXT ITEMS
Peak Demand (Q23A). What is your base's average, daily summer peak demand?
Peak Costs (Q24A). What is the average peak cost of electricity to the base?
Solar Expertise (Q26). How difficult would it be to identify certified solar photovoltaic installers in your immediate area?

Solar Irradiance (Q33/Q46). What Air Force base do you represent?

Table 8. Personal Context and Associated Items from Questionnaire

PERSONAL CONTEXT ITEMS
Education (Q34A): Please indicate your highest degree you have earned.
Seniority (Q36B): How many years have your worked in your current position?
Tech Status (Q37C): What is your degree specialty (Q34B) and What is the closest job description that describes your position (37A/B)?

3.8.2 Motivation

Downs and Mohr (1979) indicated that past research often left out the motivation to innovate. Motivation can be described as "a state of dissatisfaction or frustration that occurs when an individual's desires outweigh the individual's actualities" (Rogers, 2003:172). Kaplan's research investigated motivation and found it to be a central factor in determining interest in solar photovoltaic adoption.

> An activity that is highly motivating can become all encompassing to the extent that the individual experiences a sense of total involvement, lose track of time and space and other events. Action follows actions in which there is little distinction between self and environment, between stimulus and response or between past, present, and future" (Davis, 2001:550).

Motivation is thought to play an important role, one that was not included in Rogers' innovation-decision model; however, it was included in this research to determine whether motivation is a genuine factor among Air Force energy managers. Table 9 identifies the items associated with this measure.

Table 9. The Associated Items Related to the Variable, Motivation

MOTIVATION (10 ITEM)

Q6B. How suitable or appropriate do you consider your base location to be for solar power generation with respect to the political receptivity of solar photovoltaics?
Q6D. How suitable or appropriate do you consider your base location to be for solar power generation with respect to their economic usefulness?
Q6E. How suitable or appropriate do you consider your base location to be for solar power generation with respect to a facility user's acceptability of solar photovoltaics?
Q19B. Please assess your own interest in the following item: Exploring technologies that can reduce capacity problems.

Q27A. Please indicate the extent to which these trends are likely for your energy management section in the next 5-10 years: Increasing use of load control/load management.
Q27B. Please indicate the extent to which these trends are likely for your energy management section in the next 5-10 years: Increased necessity to generate power ourselves.
Q27C. Please indicate the extent to which these trends are likely for your energy management section in the next 5-10 years: Greater reliance on renewable energy sources.
Q27D. Please indicate the extent to which these trends are likely for your energy management section in the next 5-10 years: Increased independence from power-providing utilities
Q28C. In your view, how receptive is your energy management section to ideas like these? Positioning to be competitive with other energy providers

Q28D. In your view, how receptive is your energy management section to ideas like these? Promoting any new energy technology which is cost effective

3.8.3 Knowledge

The innovation-decision process is an information seeking and processing activity that attempts to reduce the risk involved in a new innovation by assessing the advantages and disadvantages of the innovation (Rogers, 2003). As such, knowledge is considered the starting point in Rogers' innovation-decision process with prior conditions set as antecedents (Kaplan, 1999). These prior conditions involve individual, social, and communication behavior necessary to induce knowledge seeking. However, high levels of knowledge do not translate to interest. A person who does not understand the technical knowledge involved with computers is just as interested in computers as the highly technical computer engineer. To dissect knowledge further, Rogers (2003) identified three types of knowledge: awareness, how-to, and principles knowledge.

Awareness knowledge is "the affirmation that a technology exists" (Rogers, 2003:172). This may come about from reading an article on the innovation or viewing it from mass media. For example, The Discovery Channel may present a documentary on solar photovoltaic systems that may generate interest with an energy manager for the first time. The energy manager may then seek additional knowledge about the innovation through how-to knowledge or principles knowledge.

How-to knowledge "consists of information necessary to use an innovation properly" (Rogers, 2003:173). Proper application of the innovation is important. If insufficient how-to knowledge is not acquired, an individual or organization may reject the innovation. In the case of highly complex systems like solar photovoltaic systems, a thorough understanding of solar modules, its balance of systems, and how they are integrated into a grid-tied or stand alone system are important.

Finally, principles knowledge consists of "information dealing with the functioning principles underlying how an innovation works" (Rogers, 2003:173). In the case of solar photovoltaic systems, understanding the benefits of solar photovoltaics to

Air Force installations along with proper placements for maximum efficiency all relate to how-to knowledge. Questions that ask respondents the applicability of solar photovoltaic systems tests the individual's understanding of these systems. For this research, both how-to knowledge and principles knowledge were taken into consideration. The measure consisted of a nine items. However, even having how-to knowledge may not persuade an individual's interest toward solar photovoltaics. This may be in due part to their lack of experiences with the technology. Kaplan's (1999) model research identified motivation as a significant measure for predicting knowledge (Beta = .31, p < .01). Table 10 identifies the items related to this measure.

Table 10. The Associated Items Related to the Variable, Knowledge

KNOWLEDGE (9 ITEM)
Q5C. Please indicate how strongly you agree or disagree with the following statement: PVs offer reliable source of electricity?
Q7. Which of the following do you perceive as the biggest technical obstacles to the installation of photovoltaics? From the list given name the three most serious. (battery storage, pv cell efficiency, cost/kilowatt hour, durability, siting constraints, pv tech training, lack of pv suppliers, lack of Air Force funding, available sunlight, reliability, lack of suitable applications
Q10A. Please indicate how effectively you think PVs would perform in each case: Walkway lighting
Q10C. Please indicate how effectively you think PVs would perform in each case: Cathodic pipe protection
Q10D. Please indicate how effectively you think PVs would perform in each case: Residential space heating
Q10E. Please indicate how effectively you think PVs would perform in each case: Peak power generation
Q10G. Please indicate how effectively you think PVs would perform in each case: On-site power generation
Q10H. Please indicate how effectively you think PVs would perform in each case: Central-station generation
Q11_Overall. If PVs were implemented, would the demand for other fuels be reduced at all? If so, out of the fuels provided, identify the top three.

3.8.4 Experience

Perkins and Rao (1990) showed that expertise in any area is more than just book learning. Experience is comprised of several types of concepts that are interwoven into what Rogers (2003) called previous practice. Four types of experiences present the overarching experience measure which follows knowledge in the construct model. Exposure, direct experience, vicarious experience, and innovativeness are explained in further detail.

Exposure is the experience an individual receives when a new innovation is brought to their attention. However, exposure has no correlation to comprehension (Oskamp, 1990). Rather, it is a first step in promoting new innovations to an individual seeking solutions to their needs. “Exposure is a component of any kind of experience” (Kaplan, 1999:471). Air Force energy managers exposed for the first time to new energy efficient technologies may not necessarily adopt then, especially if the messages received regarding solar photovoltaics are not in line with their own ideas. “Individuals may subconsciously avoid messages that are in conflict with their predisposition” (Rogers, 2003:171). Exposure is the beginning to possible adoption based on the individual’s motivations and future decision process to determine compatibility with the individual or organizational need.

Direct experiences refer to first-hand experiences with the innovation. Examples include participation in solar photovoltaic classes with hands-on instruction or the use of solar photovoltaics for personal use. Studies suggest that direct experience affords individuals time to absorb the advantages and disadvantages of the innovation and promotes memory retention since the experience is more personal and hands-on (Kaplan, 1994). Motivation toward the innovation is higher as the individual grants special status to their own special experiences than those of others (Hoch and Deighton, 1989).

Vicarious experiences come as a result of the passive experiences of others brought to the attention of the individual. Success of other Air Force bases installing solar photovoltaics may affect the perceptions of energy managers regarding solar photovoltaics. Bandura's (1999) work on social learning and self-efficacy has led to the conclusion that people can learn by observing someone else's behavior. On the other hand, negative influences can promote a negative transfer of the innovation. Kaplan (1999) suggested that energy managers who have had negative experiences with a solar water heater may perceive all solar technologies to be defective and not suitable to their installation. Kaplan's research identified motivation (Beta = .31, $p < .01$) as having a significant impact. Table 11 identifies the items related to this measure.

Table 11. The Associated Items Related to the Variable, Experience

EXPERIENCE (6 ITEM)
Q1. When did you first hear about solar photovoltaics?
Q9A. Please indicate how much experience you have with high efficiency lighting
Q9B. Please indicate how much experience you have with load control devices
Q9C. Please indicate how much experience you have with solar hot water heating
Q9D. Please indicate how much experience you have with oil/gas/diesel peaking generators
Q21_AVG. How familiar are you with existing utility efforts to demonstrate and use PVs at Air Force Installations?

3.8.5 Familiarity

Familiarity is the accumulation of knowledge and experience, it is "a state of comfort and confidence with the innovation which comes as a result of exposure to the innovation as well as experience" (Kaplan, 1999:472). Familiarity will breed trust as suggested in Gulati's (1995) study of organizational alliances with corporate entities. As more experience with corporate entities took place, familiarity in the contractual methods by both companies brought familiarity in the transaction processes involved and bred trust. Similarly, as Air Force energy managers gain familiarity with solar photovoltaic generation systems, their trust on these systems may promote interest and lead to adoption. Two approaches were used to identify familiarity: 1) measuring an innovation in terms of how much a person knows about the innovation and 2) measuring in terms of how much a person thinks they know about the innovation (Park and Lessig, 1981). This research investigated the latter by asking questions such as "How comfortable do you feel…," "How confident do you feel…," and "How knowledgeable do you feel." Kaplan (1999) identified knowledge (Beta = .27, $p < .01$) and experience (Beta = .39, $p < .01$) as the significant measures influencing familiarity. Table 12 identifies the items related to this measure.

Table 12. The Associated Items Related to the Variable, Familiarity

FAMILIARITY (11 ITEM)
Q4a. How comfortable are you with installing PVs on your own home?
Q4b. How comfortable are you with installing PVs on your energy management office building?
Q14a. How confident do you feel about your ability to describing PVs to your next door neighbor
Q14b. How confident do you feel about your ability to judging PV projects for a science fair?
Q14c. How confident do you feel about recommending PVs as a generation option to a customer?
Q14d. How confident do you feel about explaining PV applications to a local Boy Scout troop?
Q38a. How knowledgeable about PVs do you feel as to how they work technically?
Q38b. How knowledgeable about PVs do you feel as to their cost effectiveness?
Q38c. How knowledgeable about PVs do you feel as to customer acceptance?
Q38d. How knowledgeable about PVs do you feel as to their availability of applications locally?
Q38e. How knowledgeable about PVs do you feel as to your base energy section's familiarity with PVs?

3.8.6 Interest

Interest is the dependent, latent, endogenous variable used in the model. As Kaplan (1999) suggested, interest is synonymous with Rogers' second stage of the innovation-decision model, persuasion. In this stage, because of the development of knowledge, an individual or organization begins to analyze the innovation's various traits and perceive advantages and disadvantages for their needs based on relative advantage, compatibility, complexity, trialibility, and observability. “Interest is operationalized in the strongest terms possible, as an overall measure of *behavioral intention*, the step immediately prior to actual adoption itself” (Kaplan, 1999:472). In Kaplan’s study, it was shown that 49% of the variance in his interest model was explained by the measures: motivation (Beta = .32, $p < .01$), familiarity (Beta = .25, $p < .01$), knowledge (Beta = .21, $p < .01$), and experience (Beta = .17, $p < .01$). Included in the phone interview were various questions which sought the opinions of the interest of pursuing feasibility studies on solar photovoltaics and funding of solar photovoltaic projects. Table 13 identifies the items related to this measure.

Table 13. The Associated Items Related to the Variable, Interest

INTEREST (12 ITEM)
Q41a. How likely is it that your base will formally study the feasibility for PVs in the next 10 years (small scale)
Q41b. How likely is it that your base will formally study the feasibility for PVs in the next 10 years (medium scale)
Q41c. How likely is it that your base will formally study the feasibility for PVs in the next 10 years (large scale)
Q42a. How likely is it that your base will request funding in these systems in the next 10 years? (small scale)
Q42b. How likely is it that your base will request funding in these systems in the next 10 years? (medium scale)
Q42c. How likely is it that your base will request funding in these systems in the next 10 years? (large scale)
Q43a.How beneficial do you think it is for your base to request funding in PVs in the next 10 years? (small scale)
Q43b. How beneficial do you think it is for your base to request funding in PVs in the next 10 years? (medium scale)
Q43c. How beneficial do you think it is for your base to request funding in PVs in the next 10 years? (large scale)
Q44a.How soon do you think the base should consider PVs (small scale)
Q44b. How soon do you think the base should consider PVs (medium scale)
Q44c. How soon do you think the base should consider PVs (large scale)

3.8.7 Communication

Communication in large, bureaucratic organizations such as the Air Force presents a hierarchy that exists within the communication channels. As Rogers (2003) points out, “communication effects thus occur in a hierarchy for most with different communication channels playing a different role in causing different effects” (Rogers, 2003:204). Communication plays a key role in diffusing new technologies from the high levels of the organization to the lower echelons of the organization. Specifically for this research, "interpersonal channels are relatively more important in the persuasion state of the innovation-decision process" (Rogers, 2003:18); for change of behavior from strong attitudes to take place, interpersonal channels must take place.

Interpersonal channels provide a medium for two-way exchange between the source and receiver. This relationship allows individuals to overcome social-psychological barriers such as selective exposure and selective perception (Rogers, 2003). Selective exposure is defined as "the tendency to attend to communication messages that are consistent with the individual's existing attitudes," while selective perception is defined as the "tendency to interpret communication messages in terms of the individual's existing attitudes and beliefs" (Rogers, 2003). Balance Theory and Dissonance Theory both reflect these perceptions (Thogerson & Olander, 2003). This two-way exchange is representative of the organizational structure of MAJCOM energy managers to their base energy manager counterparts as shown in Figure 15. Communication relating to base energy managers has a four item scale as shown in Table 14.

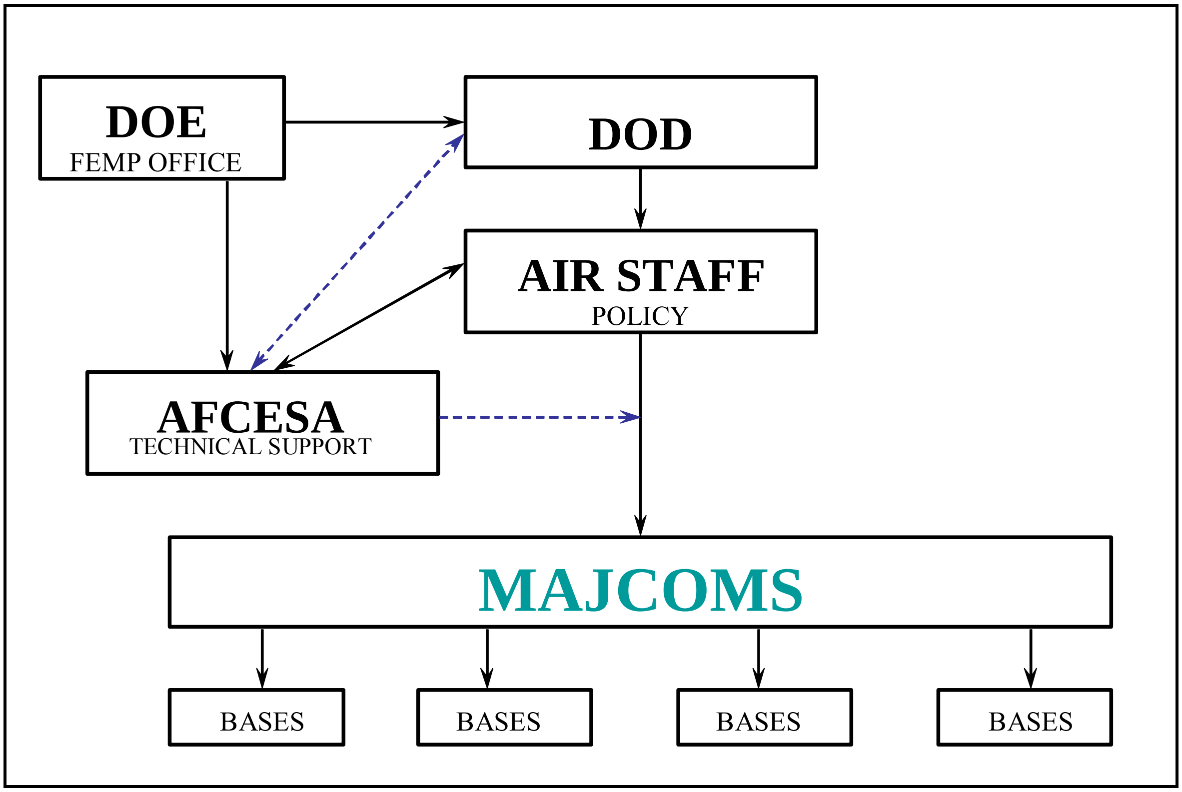

Figure 15: Air Force Energy Management Hierarchy
(U.S. Air Force Civil Engineer and Services School, 2006)

Table 14. The Associated Items Related to the Variable, Communication

COMMUNICAITON (4 Item)
Q30a. Our MAJCOM effectively communicates ideas to resolve energy issues
Q30b. I feel I can freely communication renewable energy ideas with MAJCOM.
Q30c. Communication between MAJCOM energy manager is difficult.
Q30d. I feel that our MAJCOM is not open to our ideas to promote solar pv.

3.9 THE OVERALL CONCEPTUAL MODEL

Having identified the measures and the items associated with each, Statistical Package for the Social Sciences (SPSS), version 14.0, was used to analyze the direct relationships in question. The following identifies the procedures used to manipulate the data for SPSS analysis. In addition, the hypotheses in question are identified and explained.

Prior to the use of SPSS, the data was screened and analyzed. In the initial stages prior to data analysis, the sample data was reviewed to ensure accurate data collection. Items worded negatively, such as item 5.5, were reverse coded. In addition, descriptive statistics were used to ensure items followed a normal distribution. When items used varying scales, such as the variables identified as context-based, the data was normalized. After the data screening, descriptive statistics was conducted to identify means, standard deviations, and inter-item reliabilities. After testing for reliability, correlation analysis was done to identify the significant associations between the measures. Because the measures were assumed to correlate with one another, an oblimin rotation was favored over a varimax rotation. Once factorial analysis was completed, correlation statistics identified the significant relationships between the measures. Finally, simple and multiple variable regression analysis identified the strengths of those measures to prove or disprove the hypotheses identified below.

3.10 HYPOTHESES

A total of five hypotheses were investigated. The first two hypotheses related to the contextual environment in which a base energy manager resides. It was posited that bases located in areas of high solar irradiance would be more interested in solar photovoltaics than those situated in areas where solar irradiance was not as high.

Hypothesis 1: The location of a base will have a significant positive relationship with a base energy manager's interest toward solar photovoltaics.

The second hypothesis posits that the size of a base may have a significant relationship with interest in solar photovoltaics. As Ormond (1990) suggested, organizational size plays a major role in adopting innovations. Similarly, this research posits that the size of a base positively influences an interest in solar photovoltaics.

Hypothesis 2: The size of a base will have a significant positive relationship with a base energy manager's interest toward solar photovoltaics

The third hypothesis investigated the role motivation has towards interest and whether an association exists. While Rogers (2003) remarked that motivation was a perceived need, an actual measure was never created to determine whether motivation played a role in Diffusion of Innovation Theory. Having a significant relationship would identify that motivation should indeed be considered as part of the initial stages of Diffusion of Innovation Theory.

Hypothesis 3: Motivation has a significant positive relationship with interest toward solar photovoltaics.

The fourth hypothesis further investigates the measure, motivation; and its association with knowledge. It is posited that motivation plays a significant role in an energy manager's acquisition of knowledge as it relates to solar photovoltaic systems. The perceived need to identify ways to reduce fossil fuel dependency and promote renewable energy technologies as dictated by Executive Order 13423 provides this motivation. Therefore, in contrast to Rogers (2003) innovation-decision model where knowledge is the starting point, this research posits that motivation is the initial stage of the innovation-decision process.

Hypothesis 4: Interest in solar photovoltaics is more dependent on motivation than knowledge.

The final hypothesis theorized that knowledge and experience breeds familiarity with solar photovoltaics. A base energy manager who has gained knowledge about solar photovoltaic systems and has gained experience will have a strong relationship to interest; however, unlike Rogers' (2003) model, familiarity was included to determine its impact on interest as well. Therefore, the hypothesis ascertained that interest was impacted more by an energy manager's familiarity with solar photovoltaics than by knowledge or experience.

Hypothesis 5: Interest in solar photovoltaic systems is more dependent on familiarity than both knowledge and experience combined.

IV. RESULTS AND ANALYSIS

4.1 INTRODUCTION

This chapter summarizes the results of the data analysis. First, descriptive statistics are provided for each variable identified. Next, results of a preliminary factor analysis are provided followed by reliability results of the measures. Finally, results of the linear regression are presented to determine how the various independent variables influenced the dependent variable, interest.

4.2 DESCRIPTIVE STATISTICS

Descriptive statistics for each variable was determined. Out of the population of 61 active duty Air Force bases (*Airman Magazine*, 2007) in the continental U.S., 31 bases were contacted. Of those, three bases were identified as having adopted solar photovoltaics for facility use. A sample size of $n = 28$ was thus achieved. In addition, each measure was tested for normality by reviewing the standard deviations and the normal distribution charts created by the Statistical Package for the Social Sciences (SPSS). The measures appeared to have normal distributions along with standard deviations below one. Standard deviations less than one contain approximately 68.3% of the cases in the sample population (Schwab, 2005). For a more thorough review of the descriptive statistics for each measure, see Appendix B.

In a few instances, some measures had fewer items than previously identified in Chapter III. This was due to the reliability analysis of each measure. Reliabilities of $\alpha \geq .70$ were preferred as suggested by Nunnally (1978); however, in two instances, an α of

.69 was considered suitable. Motivation, experience, and familiarity each had alphas greater than .70. For the measure, knowledge, items Q7Overall, 10C, and 10D were deemed too confusing to the interviewees and hence removed. Removing these items resulted in an α of .69. Similarly, the communication variable also had an α of .69; however, it did not require the removal of any items. Finally, for the item associated with interest, item 45A was removed since it may have confused interviewees from the standpoint that small-scale solar photovoltaics may already exist on their base; however, a response to reflect this reality did not exist. Table 15 presents the measures, the reliabilities, and the items used to develop each measure. The items related to the grouping of contextual variables are also included.

Table 15. Final Questionnaire Items Used with Respective Cronbach's Alpha

CONSTRUCT	ITEMS TO QUESTIONNAIRE	CRONBACH'S ALPHA
Communication	Q30A, Q30B, Q30C, Q30D	.69
Motivation	Q6B, Q6D, Q6E, Q19B, Q27A, Q27B, Q27C, Q27D, Q28C, Q28D	.78
Knowledge	Q5C, Q10A, Q10E, Q10G, Q10H, Q11Overall	.69
Experience	Q1, Q9A, Q9B, Q9C, Q9D, Q21AVG	.70
Familiarity	Q4A, Q4B, Q14A, Q14B, Q14C, Q14D, Q38A, Q38B, Q38C, Q38D, Q38E	.93
Interest	Q42A, Q42B, Q42C, Q43A, Q43B, Q43C, Q44A, Q44B, Q44C, Q45B, Q45C	.73
Context Variables (Prior to standardizing)	Q22, Q23A, Q24A, Q25, Q26, Q29, Q34A, Q36_SeniorityMonths, Q37C, Q46	NA

4.3 EXPLORATORY FACTOR ANALYSIS

Exploratory factory analysis was performed to identify whether the items identified in Table 15 correspond with the indicated factors. With 28 degrees of freedom and 62 item parameters, it was necessary to group the factor items into three analyses. The first analysis calculated the items associated with motivation and interest. The second factor analysis calculated the items corresponding to knowledge, experience, and familiarity. The third analysis consisted of the communication variable. Principal axis factor analysis was conducted using a direct oblimin rotation and factor restriction for each analysis. A Kaiser-Meyer-Olkin (KMO) value of .315 was calculated for the items related to knowledge, experience, and familiarity, while a KMO value of .389 was calculated for the items related to the two variables of motivation and interest. A KMO value of .554 was received for the variable dealing with communication.

For the three factor restriction analysis related to knowledge, experience, and familiarity, items 10A, 10C, 10D, and 11Overall were removed due to negative loading or no loading on any factor. Items 10A, 10C, and 10D sought to measure the knowledge an individual may have regarding the applicability of solar photovoltaic systems. Inter-item reliability identified a higher reliability value if items 10C and 10D were removed. Item 10A appears to be worded in a confusing manner and therefore removed.

For the two factor restriction related to motivation and interest, items 6E, 45A, 45B, and 45C were removed due to negative loading or no loading. While inter-item reliability did not identify item 6E as increasing the reliability of the measure, it may have been worded in a confusing manner due to the ambiguity of the statement. Likewise, while inter-item reliability did identify removing 45A for increased reliability, 45B and 45C are perceived to have been too ambiguous for the subjects. Removing these items, factor analysis was conducted once more. Items with eigenvalues greater than one and absolute factor loadings of 0.30 were reported. The results for each measure are presented in Appendix D.

While factor analysis provided a revised look of how items relate to the measures, it was not appropriate for this research. First, in order to stay consistent with Kaplan's (1999) research, the items identified in the measures via Cronbach's Alpha were favored over factor analysis methods. As was evident in measuring the inter-item reliabilities, the majority of the items used in Kaplan's research were retained, while factor analysis removed many items or in some instances, items were convoluted to the point that properly defining measures distinctly relating to motivation, experience, familiarity, and interest was deemed too complex. Of more importance is the fact that low KMO values were determined for all initial factor analysis, with the exception of the communication measure. A sample data with low KMO values may be inappropriate for factor analysis (Heilmann, 2006:17).

4.4 CORRELATION STATISTICS

After concluding that factor analysis could not be used, correlation statistics were calculated to identify the linear relationships between each measure. The associations identified as significant were consistent with the hypothesized model; however, it was expected that familiarity would have a positive, significant relationship with interest, but it did not. It was also thought that communication would have a relationship with motivation, but there was no significant relationship suggesting that communication between a Major Command (MAJCOM) energy manager is not important in determining motivation. Motivation had a positive, significant relationship with knowledge as suggested from the Chapter II. Knowledge also had a positive, significant relationship with familiarity. Experience, also had a positive, significant relationship with familiarity. The high Pearson correlation (.74) associated between experience and familiarity raises questions as to whether multi-collinearity exists between experience and familiarity. Finally, interest was shown to have positive, significant relationships with both motivation and knowledge. Table 16 identifies the significant relationships between each measure along with the reported Cronbach's Alphas, while Figure 17 shows a visual interpretation of the significant relationships identified.

In addition, correlation statistics of the contextual variables as they relate to the measures and to one another were also identified. The contextual variables, organization size, peak costs, and solar irradiance each had a significant, positive relationship with interest. Solar irradiance also had positive, significant relationships with motivation and peak costs. The context variable identified as seniority had a significant, negative relationship with interest and a positive, significant relationship with education. Peak demand was found to have a significant, positive relationship with experience. Base size had a positive, significant relationship with peak demand but not with peak costs. Lastly, decision formality had a positive, significant relationship with peak. The complete correlation table is presented in Appendix B, Table B.2.

Table 16. Descriptive Statistics and Pearson Correlation for Measures

	Descriptives			Pearson Correlation					
Measure	N	Mean	S.D.	1	2	3	4	5	6
1. Motivation	28	3.38	0.658	(0.78)					
2. Knowledge	28	3.40	0.736	**.508****	(0.69)				
3. Experience	28	2.77	0.691	.011	.149	(0.70)			
4. Familiarity	28	3.05	0.875	.269	**.465***	**.737****	(0.93)		
5. Interest	28	3.51	0.964	**.450***	**.425***	.200	.350	(0.73)	
6. Communication	28	4.11	0.850	.214	.187	-.066	.118	-.262	(0.69)

* $p < .05$ (2-tailed)
** $p < .01$ (2-tailed)
Cronbach's alpha values are shown in parenthesis along diagonal

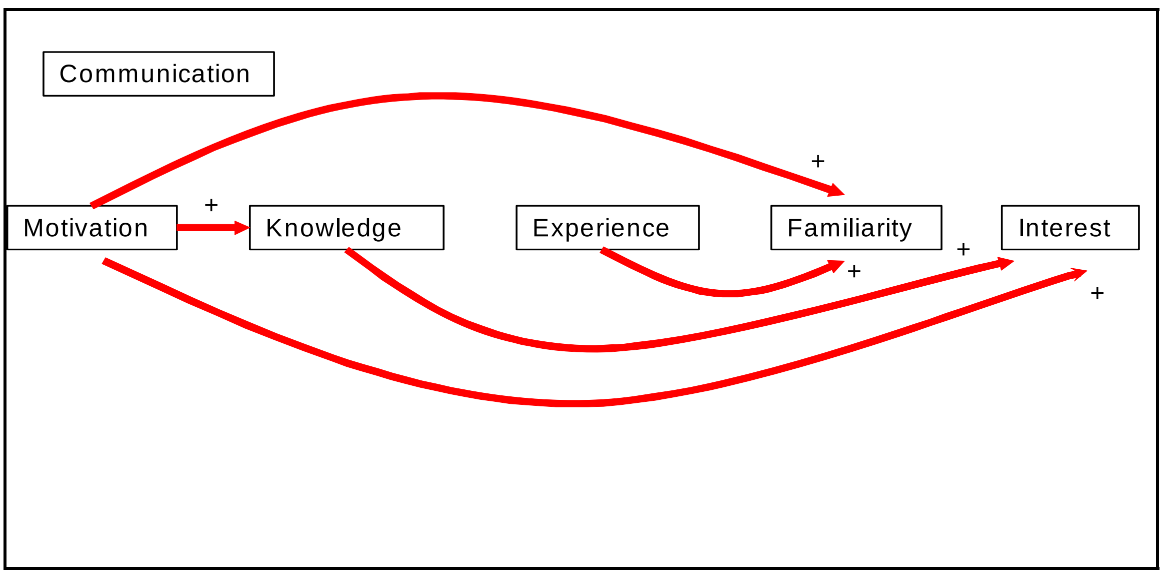

Figure 16. Illustration of Significant Correlation Relationships

While correlation statistics identified the existence of significant associations between measures, regression analysis was then conducted to determine the strength of those relationships. Simple regression between motivation and interest, motivation and knowledge, and finally knowledge and interest were calculated. In addition, a multiple linear regression was calculated for the variables knowledge and experience towards interest. Motivation was found to have a beta coefficient of .33, but was statistically insignificant. Motivation also had a significant beta coefficient of .37 ($p < .05$) with respect to knowledge and explained 17.3% of the variance between these two variables. Knowledge was found to have a significant beta coefficient of .68 ($p < .05$) with the dependent variable, interest, and explained 11.0% of the variance between the two variables. Finally, the multiple regression analysis of knowledge and experience to the dependent variable interest identified a significant, beta coefficients of .40 ($p < .05$) and explained 72.3% of the variance. Table 17 provides a summary of the regression analysis.

Table 17. Summary of Regression Analysis

Measure	to	Measure	Sample Size	Beta Coefficient	Adjusted R^2	F statistic	P-Value	Durbin Watson	Collinearity Statistics	
									Tolerance	VIF
Motivation	to	Interest	28	.33	0.66	2.54	.13	1.01	1.00	1.00
Motivation	to	Knowledge	28	.37	0.17	6.64	*0.02	1.96	1.00	1.00
Knowledge & Experience	to	Interest	28		0.72	3.66	*0.05	1.03	0.91	1.11
Knowledge	to	Interest	28	.68	0.11	4.23	*0.05	1.82	1.00	1.00

* $p < .05$ (2-tailed)
** $p < .01$ (2-tailed)

4.5 STATISTICAL EVALUATION OF HYPOTHESES

The hypotheses described in Chapter 3 are reported below. Each hypothesis is readdressed along with a brief explanation of the results.

Hypothesis 1: The location of a base will have a significant positive relationship with a base energy manager's interest toward solar photovoltaics

Correlation statistics identified location as having a positive, significant correlation ($r = .62$, $p < .01$, $n = 28$). Table 18 identifies the Pearson Correlation table representing this result. This finding does support the hypothesis; therefore, Hypothesis 1 was not rejected. Furthermore, regression analysis identified a statistically significant beta coefficient of .60 for solar irradiance.

Table 18. Correlation with Base Size and Base Location with Familiarity and Interest

	Pearson Correlation			
Measure	**1**	**2**	**3**	**4**
1. Q25 (Base Size)	1			
2. Q46 (Solar Irradiance)	-0.08	1		
3. Familiarity	-0.03	0.00	1	
4. Interest	**-0.32***	**.62****	0.350	1

** $p < .01$ (1-tailed)
* $p < .05$ (1-tailed)

Hypothesis 2: The size of a base will have a significant positive relationship with a base energy manager's interest toward solar photovoltaics

Table 18 also identifies the size of a base as having a negative, significant association with an energy manager's interest in solar photovoltaic systems. As a base size increases, complexity and bureaucracy may stymie the innovation-decision model. Futhermore, a statistically significant beta coefficient of -.37 ($p < .05$) was identified.

Hypothesis 3: Motivation has a positive, significant relationship with interest toward solar photovoltaics.

Correlation statistics identified in Table 16 revealed that motivation has a positive, significant relationship with interest, ($r = .450$, $p < .05$, $n = 28$). Therefore, Hypothesis 3 is not rejected. However, while it is not rejected, a beta coefficient of .33 was identified as being statistically insignificant.

Hypothesis 4: Interest in solar photovoltaics is more dependent on motivation than knowledge.

It was expected that interest would depend more on an energy base manager's motivation than simply their knowledge. Regression using stepwise analysis identified knowledge as being statistically significant with a beta coefficient of .36 ($p < .05$). This finding rejects Hypothesis 4.

Hypothesis 5: Interest in solar photovoltaic systems is more dependent on familiarity than both knowledge and experience combined.

It was thought that interest was impacted more by an energy manager's familiarity with solar photovoltaics than by knowledge or experience combined. It was shown that knowledge and experience combined explain 72.3% of the model and are statistically significant with $p < .05$. Familiarity was not identified as being a significant factor to the model; therefore, Hypothesis 5 was rejected.

V. CONCLUSIONS

5.1 INTRODUCTION

This chapter reflects on the major research objectives presented. The questions identified in Chapter I are discussed along with the five hypotheses posited. In addition, limitations to the study are presented along with recommendations for future research.

5.2 CONCLUSIONS

5.2.1 Research Objective Discussion

Recall that the first objective of the research was to determine whether bases had adopted solar photovoltaics. Similar to Kaplan's (1999) study on utility energy managers, it was discovered that only a small percentage of Air Force bases have adopted solar photovoltaic systems. Of the active duty bases in the continental U.S., 50.8% were interviewed with 90.3% of those interviewed having yet to adopt solar photovoltaics.

The second objective sought to identify how much knowledge energy managers had of solar photovoltaics. Based on the five point Likert scale for the measure knowledge, a mean of 3.40 suggests that energy managers have a slightly higher than average understanding of solar photovoltaics. In addition, knowledge was identified as the single most important measure able to predict interest. This is similar to Rogers' (2003) understanding of the innovation-decision process and similar to Tobias' (1994) conclusions that a linear relationship exists between knowledge and interest. The last four objectives were answered based on the hypotheses identified in Chapters III and IV. A short discussion of each is provided.

5.2.2 Research Hypotheses Discussion

Hypothesis 1: The location of a base will have a significant positive relationship with a base energy manager's interest toward solar photovoltaics.

The results show that a significant relationship exists between the location of a base and an energy manager's interest in solar photovoltaics. This presents an issue that could perhaps be answered with a larger sample size. Further analysis in the form of ANOVA testing should be conducted to determine whether solar irradiance can further delineate between locations of bases. ANOVA testing with a larger sample size may determine if the difference in means between bases that have adopted and bases that have not adopted is statistically significant. Similarly, difference of means could be tested to determine if the solar irradiance mean of bases situated in northern parts of the U.S. may be important to consider.

Hypothesis 2: The base size will have a significant positive relationship with a base energy manager's interest toward solar photovoltaics.

This hypothesis was not rejected and it leads us to understand the importance of how larger organizations may have difficulties in adopting new ideas. As Damonpour and Schneider (2006) suggest, smaller organizations are better able to adopt innovation due to the simplicity of the organization, whereas as an organization gets larger, it may be more difficult to adopt new innovations such as solar photovoltaics. Lastly, it is suggested that the actual population of a base be identified rather than asking respondents to estimate the base population. For this research, respondents were asked to approximate the size of their base based on four intervals: 1) less than 1000 people, 2) between 1000 and 2000 people, 3) between 2000 and 5000 people, and 4) more than 5000 people. The mean for this question was 3.52 with significant skewness of -1.07.

This suggests that the majority of the bases identified have a population of upwards 2000 personnel. Changing this response from an interval to an actual number may perhaps give a better indication of whether base size has a relationship with interest.

Hypothesis 3: Motivation has a positive, significant relation with interest toward solar photovoltaics.

The results show that the variable, motivation, is an important factor to consider in Diffusion of Innovation Theory. Future research should incorporate the use of a measure that identifies the need to innovate. Furthermore, the significance of the correlation between motivation and interest is important to state. With a beta coefficient of .45, it appears that motivation is needed to start energy managers on the innovation-decision path.

Hypothesis 4: Interest in solar photovoltaics is more dependent on Motivation than Knowledge.

The analysis identified knowledge and the contextual variables, solar irradiance, base size, and peak demand as the factors that promote interest. While motivation is important to begin the innovation-decision model, it is not as important as gaining the knowledge to understand how solar photovoltaic systems work.

Hypothesis 5: Interest in solar photovoltaic systems is more dependent on familiarity than both knowledge and experience combined.

Hypothesis 5 was rejected because it was shown that knowledge and experience were more significant than the measure familiarity. While the results suggest this, multicollinearity was present in the results. First, a Pearson correlation of .74 between the independent measures experience and familiarity alluded to the fact that multicollinearity may be present. A Variance Inflation Factors (VIF) for familiarity of 3.1 and a condition index of 19.9 led to the conclusion that multicollinearity existed between these two measures. High multicollinearity attenuates beta coefficients and standard error which results in sample estimates that are less reliable.

5.3 LIMITATIONS

In an ideal situation, researchers attempt to minimize the amount of error that is present in research data in order to produce results that mirror the actual environment. In many cases, systematic or random error is present to a level of degree that may introduce uncertainty to the results of the research. The following is an explanation of limitations that the researcher suggests played an important role. In addition, systematic and random error is discussed to explain how these errors may have affected the analysis.

5.3.1 Sample Size

A small sample size may have contributed to not identifying key relationships cited in past literature. Recall that correlation data did not identify knowledge and experience as having a significant relationship. While past Diffusion of Innovation research has concluded knowledge and experience to be significantly correlated to one another (Kaplan, 1999), a small sample size may prove in the end to be the limiting factor. A small sample size may have also impacted the low Kaiser-Meyer-Olkin (KMO) measure of sampling which influenced the decision not to use factor analysis. Comrey and Lee (1992) provide further general guidance on factor analysis explaining that a sample size of 50 would provide very poor results, 100 would provide poor results, and 300 and above would provide good results. Considering that the sample size for this research was n = 28, it is presumed that factor analysis would not have benefited the research.

5.3.2 Systematic Error

Systematic error, also known as statistical bias, relates to the instrument involved in gathering the data and whether the instrument achieved a high level of accuracy (Schwab, 2005). The questions used for the phone interviews served as the measuring instrument. It consisted of what were perceived to be valid items relating to the measures identified in past literature review of Diffusion of Innovation Theory. The manner in which the data was collected may have introduced high levels of error. The phone interviews were inconsistent in nature, meaning each interview varied in phone content between the interviewer and test subject. In some cases, the interviewer explained certain items in the survey that confused the individual. Because there was a lack of standardization throughout the interview process, bias may have inadvertently been added.

Another action that may have introduced system error was the method in which missing data was remedied. For example, in cases where an energy manager did not have information concerning base peak electrical demand, the researcher used similar base size and base location and assumed that bases similar in size and location would require the same amount of electrical generation. This assumed that the level of activity for both bases was constant. With respect to electricity costs, in a few cases, average retail electrical costs were gathered from the DoE and used for those bases that did not provide the information.

Finally, system error was introduced by assuming that the individuals interviewed were equivalent to base energy managers. Of the 28 test cases used, one individual was classified as a Resource Energy Manager and two test cases categorized themselves as

Associate Energy Managers. This may have influenced the results. Individuals under a different categorization may have dispositions completely different from those of base energy managers. The amount of technical knowledge may not be on par with that of base energy managers. This is especially true if the degrees received from formal education are substantially different. Approximately 79% of the sample population had a technical degree in electrical, mechanical, or architectural engineering. Therefore, approximately 20% either did not report their degrees or the respondents had a non-technical degree.

A respondent's self-report of the questions asked during the phone interview are also considered a limiting factor. While demographic data provided by respondents can be verified by other sources, "validating people's descriptions of their feelings or intentions" (Podsakoff and Organ, 1986:533) cannot be verified. Abstract variables of motivation, interest, and familiarity ask respondents to engage in high order cognitive processes "that involve not only recall, but weighting inference, prediction, interpretation and evaluation" (Podsakoff and Organ, 1986:533). When a respondent provides data for these abstract factors, any distortion of one measure may inadvertently affect the other measure. Such distortion may occur when respondents may answer questions in a manner that will present them in a favorable light. This then may lead to erroneously justifying significant correlation relationships between the measures (Podsakoff and Organ, 1986).

5.3.3 Random Error

Random error is error that deviates from what is intended to be measured (Schwab, 2005). For this research, there were two main areas of contention that may have introduced random error. The first is the manner in which sampling took place. Convenience sampling was used in this research. Random sampling was not incorporated due to the small population of energy managers (N = 61). A larger sample size of energy managers may alleviate the random error, since the Central Limit Theorem would average the outcomes and form a normal distribution (Schwab, 2005). The second reason that random error may be present is based on the fact that the results of the factor analysis were not utilized in this research. Low KMO values prevented the use of factor analysis. The disadvantage with not using factor analysis is that while the measures used in the model may have a high level of inter-item accuracy, the precision or ability to truly measure the observed variable may impact the inferences attained.

5.4 IMPLICATIONS

One positive aspect of conducting phone interviews was the level of candor provided by each of the participants. In the discussions, it was identified that each base energy manager was highly cognizant of the need to pursue renewable technologies to increase energy efficiencies for Air Force base facilities. Bases are pursuing the implementation of renewable energy technologies for electrical generation; however, solar photovoltaics continue to be location dependent. This study suggests that four factors determine overall interest. An energy manager's knowledge of solar photovoltaics, the amount of solar irradiance received at a base, the peak demand electricity loads of a base and the base size all play relevant roles in determine overall interest with 72% of the model explained by these factors. A greater emphasis on increasing the knowledge and experience with respect to solar photovoltaic applicability may generate interest in them. The development of Air Force renewable energy symposiums with classes primarily targeted for solar photovoltaic technology may increase the level of new knowledge. In addition, such symposiums will provide opportunities for energy managers to gain vicarious experiences by listening to Air Force bases who have successfully adopted solar photovoltaic systems for their respective bases.

5.5 RECOMMENDATIONS FOR FUTURE RESEARCH

Four recommendations are presented to either improve upon the research presented or guide additional research in Diffusion of Innovation Theory. The first three recommendations are based on how to improve upon this research. The last recommendation seeks to guide future researchers to a different research stream within Diffusion of Innovation Theory that may be beneficial for seeking further insight to the topic of solar photovoltaic technologies.

First, increasing the sample size is of great importance. Increasing the sample size will do two things. First, it will increase the level of credibility of the results received by reducing the level of random error present. A larger sample population may allow researchers to run factor analysis to ensure that the items are consistent with the measures identified in the construct model, thus minimizing random error. Second, it may permit the use of complex modeling software, such as structural equation modeling, that incorporates direct and indirect relationships simultaneously. Since the population size of Air Force base energy managers may be too small to run factor analysis, it is recommended that this research accumulate data from all the sister services: Army, Navy, Marines, and Coast Guard. Doing so will not only increase the sample size, but it will also model the interest military energy managers have toward solar photovoltaics.

Second, reducing the length of the questionnaire and rewording certain items will provide a more convenient survey that takes less time and may be easier to understand. During the phone interview process, several comments suggested that there were too many questions for a phone interview. Furthermore, questions such as item 11 could be worded with more clarity. With regards to this question, the test subjects often commented on whether the question was based on their Air Force base applicability or if the question was based from a national perspective of how solar photovoltaics could lessen national dependency on other sources of energy production. Lastly, trimming the number of items related to abstract measures that may be considered similar to other measures may reduce common method variance; however, it does assume that a research is able to identify those items that respondents would perceive as conceptually similar (Podsakoff and Organ, 1986).

Third, while removing some items from the questionnaire is advisable, the likelihood of it remaining quite lengthy is foreseeable. Therefore, it is recommended that a web-based version of the interview questions be produced. This will be helpful from the standpoint of both the researcher and the test subjects. From the researcher's point of view, a web-base survey would make data collection easier and the time required to collect the data for data analysis may be reduced significantly. From the test subject's point of view, minimizing the amount of time required would greatly increase the probability that the web-based survey would be completed.

Finally, to further investigate the incorporation of solar photovoltaic systems into base infrastructure, it may be possible to use the questionnaire from this research to investigate the attributes of innovation identified in Chapter 3. To recall, the attributes of innovation were: 1) relative advantage, 2) compatibility, 3) complexity, 4) trialibility, and 5) observability. Identifying items within the questionnaire associated with these attributes may identify information on the perceptions of solar photovoltaic technology and its potential adoption rate.

5.6 CONCLUSION

To summarize, this study was developed to identify factors that promote interest in solar photovoltaic generation systems. The hypothesized model was conceived from past literature research within Diffusion of Innovation Theory. The findings suggest that factors such as knowledge, base location, base size, and electricity peak demand may play a key role in determining the level of interest an energy manager has toward solar photovoltaic systems. Developing a system that incorporates a knowledge base approach along with vicarious experiences of other bases who have successfully implemented solar photovoltaics may perhaps garner interest in this renewable technology.

Appendix A. Phone Interview Questions

For questions 1 thru 41, when the question asks about solar photovoltaic systems, assume that the systems being referred to are solely large systems which are placed on rooftops, carports, or integrated into the building infrastructure (ie. solar shingles, solar windows) for the generation of electricity for that facility. Please do not assume the questions are referring to small solar photovoltaics that can be used for traffic lighting, etc.

1. When did you first hear about photovoltaic power generation systems?

Never, until this survey	Within the last year	1-2 yrs ago	3-5 yrs ago	6-10 yrs ago	More than 10 yrs ago

2. How did you *first* learn about PVs?

1 Newspaper article
2 Technical article
3 A survey you received
4 Stories from another AF base
5 Experience outside of work
6 Advertisement in magazine/journal
7 A conference or formal course
8 Stories from your own base
9 Television program
10 Neighbors, friends, or relatives
11 MAJCOM Energy Mgt teams
12 AF base residents
13 AFCESA
14 Other: ___________________________

3. Approximately *how many* PV power generation systems has your base installed?

0	1	2	3-5	6-10	11-20	21-50	>50

If your base has installed any PV power generation systems, please answer the following questions. *Otherwise, we shall proceed to question #4.*

3A. Were you involved in the use of PVs?

	Not involved . . . . Very involved				
Technology choice	**1**	**2**	**3**	**4**	**5**
Purchase recommendations, decisions	**1**	**2**	**3**	**4**	**5**
AF Funding request	**1**	**2**	**3**	**4**	**5**
Installation procedures	**1**	**2**	**3**	**4**	**5**
Operation and maintenance	**1**	**2**	**3**	**4**	**5**
Evaluation	**1**	**2**	**3**	**4**	**5**

3B. If you *have* had a role in your base's PV application, please indicate your assessment of that experience. If you had no personal role, we will *skip to question #4*:

	Low. . . . . High				
How much confidence did you gain about PV reliability?	**1**	**2**	**3**	**4**	**5**
How good was your information about PV applications?	**1**	**2**	**3**	**4**	**5**
How much uncertainty do you have about PV potential?	**1**	**2**	**3**	**4**	**5**
How helpful were the experiences of other AF bases?	**1**	**2**	**3**	**4**	**5**
How useful were stories about PVs from colleagues/magazines?	**1**	**2**	**3**	**4**	**5**
How familiar were you with PVs at the end of the project?	**1**	**2**	**3**	**4**	**5**

4. How comfortable are you with the idea of installing PVs on your own building rooftops for on-site power generation?

	Not comfortable . . . . Very comfortable				
Your own home	**1**	**2**	**3**	**4**	**5**
Your energy management office building	**1**	**2**	**3**	**4**	**5**

5. Please indicate how strongly you agree or disagree with the following statements:

	Strongly disagree . . . . Strongly agree				
PVs are a fascinating option	**1**	**2**	**3**	**4**	**5**
PVs are a distraction from other options	**1**	**2**	**3**	**4**	**5**
PVs offer a reliable source of electricity	**1**	**2**	**3**	**4**	**5**
PVs are a threat to our base energy program	**1**	**2**	**3**	**4**	**5**
PVs are a failure	**1**	**2**	**3**	**4**	**5**
PVs are long overdue	**1**	**2**	**3**	**4**	**5**
PVs are risky	**1**	**2**	**3**	**4**	**5**
PVs are a radically new for bases	**1**	**2**	**3**	**4**	**5**
PVs on rooftops are displeasing to the eye	**1**	**2**	**3**	**4**	**5**

6. How suitable or appropriate do you consider your base location to be for solar power generation?

	Very low . . . . .Very high				
Climatic suitability	**1**	**2**	**3**	**4**	**5**
Political receptivity	**1**	**2**	**3**	**4**	**5**
Base interest	**1**	**2**	**3**	**4**	**5**
Economic usefulness	**1**	**2**	**3**	**4**	**5**
Facility User(s) acceptability	**1**	**2**	**3**	**4**	**5**

7. Which of the following do you perceive as the biggest technical obstacles to the installation of photovoltaics? Please tell us which three you feel are most serious:

1 Battery storage
2 PVcell efficiency
3 Cost/kilowatthour
4 Durability (ie. hail)
5 Siting constraints
6 PV Tech Training
7 Lack of PV suppliers
8 Lack of AF Funding
9 Available sunlight
10 Reliability
11 Lack of suitable applications
12 Other: ___________________

8. How similar do you consider PVs to be in comparison to technologies *your base currently uses*?

	Not similar .Very similar					Do not use
High-efficiency lighting	**1**	**2**	**3**	**4**	**5**	**0**
Load control devices	**1**	**2**	**3**	**4**	**5**	**0**
Solar hot water heating	**1**	**2**	**3**	**4**	**5**	**0**
Oil/gas/diesel peaking generator	**1**	**2**	**3**	**4**	**5**	**0**
Coal-fired power plant	**1**	**2**	**3**	**4**	**5**	**0**

9. Please indicate how much experience you have with each of these same technologies:

	No experience . . . . Lots of experience				
High-efficiency lighting	**1**	**2**	**3**	**4**	**5**
Load control devices	**1**	**2**	**3**	**4**	**5**
Solar hot water heating	**1**	**2**	**3**	**4**	**5**
Oil/gas/diesel peaking generator	**1**	**2**	**3**	**4**	**5**

10. Here are some potential applications for PVs. Please identify how effectively you think PVs would perform in each case:

	Very Ineffective . . . . Very Effective				
Walkway lighting	**1**	**2**	**3**	**4**	**5**
Hot water heating	**1**	**2**	**3**	**4**	**5**
Cathodic pipe protection	**1**	**2**	**3**	**4**	**5**
Residential space heating	**1**	**2**	**3**	**4**	**5**
Peak power generation	**1**	**2**	**3**	**4**	**5**
Baseload generation	**1**	**2**	**3**	**4**	**5**
On-site power generation	**1**	**2**	**3**	**4**	**5**
Central-station generation	**1**	**2**	**3**	**4**	**5**

11. In your view, if PVs were implemented, would the demand for other fuels be reduced at all? If so, out of fuels provided which top three do you think PVs would *most likely replace*. If PVs will not reduce demand on other fuels please state so.

Oil **Natural Gas** **Uranium** **Coal** **Wind** **Water** **None**

12. How would you characterize the prevailing attitude toward PVs? If you've heard *no* views from a particular customer class please state so.

	Very negative . . . . Neutral . . . . Very positive											None
Residential	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**9**
Commercial	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**9**
Industrial	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**9**
Air Force	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**9**

13. In your opinion, *how aggressive or active* in PV commercialization should each of the following institutions be?

		Inactive . . . . .Very active				
Federal Government	**1**	**2**	**3**	**4**	**5**	
US Air Force		**1**	**2**	**3**	**4**	**5**
State government (e.g., state energy office)		**1**	**2**	**3**	**4**	**5**
Public utility commissions		**1**	**2**	**3**	**4**	**5**
Investor owned utilities		**1**	**2**	**3**	**4**	**5**
Individual homeowners		**1**	**2**	**3**	**4**	**5**
My own base, regardless of others		**1**	**2**	**3**	**4**	**5**

14. How *confident* do you feel about your ability to undertake the following PV-related activities?

	Low confidence	. . . .	. . . .	. . . .	.High confidence
Describing PVs to your next door neighbor	**1**	**2**	**3**	**4**	**5**
Judging PV projects for a science fair	**1**	**2**	**3**	**4**	**5**
Recommending PVs as an option to a customer	**1**	**2**	**3**	**4**	**5**
Explaining PVs to a local Boy Scout troop	**1**	**2**	**3**	**4**	**5**

15. Please indicate your level of agreement with statements about solar hot water heating (SHW). If no experience, please state so and we shall proceed to question #16.

	Strongly disagree ..	. . . .	. . . .	. . . .	. Strongly agree
My own experience with solar SHW has been positive	**1**	**2**	**3**	**4**	**5**
General experience with solar SHW has been good	**1**	**2**	**3**	**4**	**5**
I would readily promote the use of solar SHW now	**1**	**2**	**3**	**4**	**5**
My own SHW experience boosts my interest in PVs	**1**	**2**	**3**	**4**	**5**
The general solar SHW experience encourages PV use	**1**	**2**	**3**	**4**	**5**

16. Are you familiar with any electric utilities or military bases in your region which have made particularly significant strides in utilizing PVs? **Yes: [ ] or No: [ ]** If no, we shall proceed to question number #17. *If yes*, please name two PV-innovative utilities or military bases you are most familiar with, and identify their location (city, state):

#1:____in ________________________________

#2:____in ________________________________

17. In your opinion, which of the following would most help to encourage your base to invest in PVs?

	Not helpful	. . . .	. . . .	. . . .	.Very helpful
Federal subsidy for PV mass production	**1**	**2**	**3**	**4**	**5**
PV technical assistance from AF MAJCOM	**1**	**2**	**3**	**4**	**5**
Mandate from MAJCOM for PV Use	**1**	**2**	**3**	**4**	**5**
Change in perspective by U.S. president	**1**	**2**	**3**	**4**	**5**
Dramatic drop in PV cost/KWh	**1**	**2**	**3**	**4**	**5**
Increase in electricity costs by local utility	**1**	**2**	**3**	**4**	**5**

18. Which of the following items would increase your own interest in adopting photovoltaics?

	No increase	. . . .	. . . .	. . . .	Big increase
Visit by DOE/NREL official	**1**	**2**	**3**	**4**	**5**
Additional technical information	**1**	**2**	**3**	**4**	**5**
Success stories from other AF bases	**1**	**2**	**3**	**4**	**5**
AF MAJCOM PV conference	**1**	**2**	**3**	**4**	**5**
Focus group discussion of PV options	**1**	**2**	**3**	**4**	**5**
Widespread interest/demand for PVs	**1**	**2**	**3**	**4**	**5**
Local/State incentives to install solar pv power	**1**	**2**	**3**	**4**	**5**

19. Please assess your *own* interest in the following items:

	Low	. . . .	. . . .	. . . .	High
Installing PVs among AF bases	**1**	**2**	**3**	**4**	**5**
Exploring technologies that reduce capacity problems	**1**	**2**	**3**	**4**	**5**

20. Please indicate how often *you personally* talk with officials at these organizations, and circle whether you are the one usually making contact with someone at that organization:

	At least Weekly	Monthly	Twice a Year	Yearly	Never	Do you Initiate?
Electric Power Research Institute (EPRI)	**1**	**2**	**3**	**4**	**5**	**Yes No**
Edison Electric Institute (EEI)	**1**	**2**	**3**	**4**	**5**	**Yes No**
Nat'l Rural Electric Co-op Assoc (NRECA)	**1**	**2**	**3**	**4**	**5**	**Yes No**
AF MAJCOM Energy Manager	**1**	**2**	**3**	**4**	**5**	**Yes No**
Solar Energy Industries Association (SEIA)	**1**	**2**	**3**	**4**	**5**	**Yes No**
U.S. Department of Energy (DOE)	**1**	**2**	**3**	**4**	**5**	**Yes No**
National Renewable Energy Laboratories	**1**	**2**	**3**	**4**	**5**	**Yes No**
Sandia National Laboratories	**1**	**2**	**3**	**4**	**5**	**Yes No**
Nat'l Assoc of Regulatory Util Comm (NARUC)	**1**	**2**	**3**	**4**	**5**	**Yes No**
AF Civil Engineering Support Agency	**1**	**2**	**3**	**4**	**5**	**Yes No**
Nat'l Assoc of State Energy Officials (NASEO)	**1**	**2**	**3**	**4**	**5**	**Yes No**
Other: ______________________________	**1**	**2**	**3**	**4**	**5**	**Yes No**

21. How familiar are you with existing efforts to demonstrate and use PVs at Air Force installations? (For researcher, use this key: **1** = never heard of PV project; **2** = heard of it but know almost nothing about it; **3** = have read about it; **4** = have talked to project representatives; **5** = have personally visited one of their PV installations.)

	Not familiar				. Very familiar
Hickam AFB, HI	**1**	**2**	**3**	**4**	**5**
Cannon AFB, NM	**1**	**2**	**3**	**4**	**5**
Sacramento Municipal Utility District	**1**	**2**	**3**	**4**	**5**
March Air Reserve Base, California	**1**	**2**	**3**	**4**	**5**
Austin City Electric Department	**1**	**2**	**3**	**4**	**5**
Luke AFB, AZ	**1**	**2**	**3**	**4**	**5**
Nellis AFB, NV	**1**	**2**	**3**	**4**	**5**
Beale AFB, CA	**1**	**2**	**3**	**4**	**5**
Other: ____________________	**1**	**2**	**3**	**4**	**5**

To help us understand your organizational context, please tell us about your energy management section.

22. How many employees are there in the energy management section as a whole? _________

23. What is your bases' average *DAILY* peak demand:

During Summer: _____________ (KW)

During Winter: _____________(KW)

24. What is the average cost of electricity to the base?

Peak Hours: ________ (¢/kWh)

Off-Peak Hours: ________(¢/kWh)

25. What is the approximate size of the base you are at?

[ ] Less than 1000 people
[ ] Between 1000 and 2000 people
[ ] Between 2000 and 5000 people
[ ] More than 5000 people

26. If your base were to install a solar photovoltaic generation system for a facility, how difficult would it be to identify certified solar photovoltaic installers in your immediate area (no more than 50 miles from base)?

Mark one:

[ ] It would be difficult to find certified local installers:
[ ] It would not be difficult to find certified local installers:

27. Please indicate the extent to which these trends are likely for your energy management section in the next 5-10 years:

	Not likely	. . . .	. . . .	. . . .	Very likely
Increasing use of load control/load management	**1**	**2**	**3**	**4**	**5**
Increased necessity to generate power ourselves	**1**	**2**	**3**	**4**	**5**
Greater reliance on renewable energy sources	**1**	**2**	**3**	**4**	**5**
Increased independence from utilities	**1**	**2**	**3**	**4**	**5**

28. In your view, how receptive is your energy management section to ideas like these? Please give your honest assessment:

	Not receptive	. . . . . .	. . . . . .	. . . . . .	Very receptive
A new program to encourage photovoltaics by facility users	**1**	**2**	**3**	**4**	**5**
Trying out a technology like PVs or fuel cells *in-house*	**1**	**2**	**3**	**4**	**5**
Positioning to be competitive with other energy providers	**1**	**2**	**3**	**4**	**5**
Promoting any new energy technology which is cost-effective	**1**	**2**	**3**	**4**	**5**

29. How would you characterize the decision-making process in your energy management section? Please say yes, or no if the following decision processes take place.

1 Decisions are made rationally
2 Decisions are made incrementally
3 Decisions are based on formal analysis
4 Decisions are based on seat-of-the-pants judgments
5 Decisions are made quickly and efficiently
6 Decisions take a long time to reach a conclusion
7 Decisions involve only a few key experts
8 Decisions involve both experts and non-experts

30. For the following, please identify how you would characterize communication between your base and MAJCOM: (For researchers: **If base energy manager are being interviewd use question # 30. If MAJCOM energy managers are being interviewed, use question #31.)**

	Strongly Disagree	. . . .	. . . .	. . . .	Strongly Agree
MAJCOM effectively communicates ideas to resolve energy issues	1	2	3	4	5
I can freely communicate renewable energy ideas with MAJCOM	1	2	3	4	5
Communication between MAJCOM is difficult	1	2	3	4	5
Our MAJCOM is not open to our ideas to promote solar pv	1	2	3	4	5

31. For the following, please identify how you would characterize communication between your bases:

	Strongly Disagree . . . . Strongly Agree				
I effectively communicate ideas to resolve base energy issues	1	2	3	4	5
Bases communicate their ideas on renewable energy issues	1	2	3	4	5
I can freely communicate renewable energy ideas to AF HQ	1	2	3	4	5
AF HQ is not open to our ideas to promote solar pv	1	2	3	4	5
Communication between base energy managers is difficult	1	2	3	4	5

To help us learn about our respondents, we would like to ask you a few background questions:

32. When were you born? Year: _______

33. What Air Force base do you represent? _______

34. Please indicate the highest degree you have earned and the field you studied:

Highest degree earned (ie. High School, Associate, Bachelor, Graduate, Doctoral): _______________

Degree Field/specialty: _________________

35. From the following job descriptions I provide, please indicate which closest describes your job position?

1. Base Energy Manager
2. Resource Efficiency Manager
3. Associate Energy Manager
4. MAJCOM Energy Manager
5. Other: _______________

36. How many years have you worked for the energy management section?
__years _____months.
How many years have you worked in your current position: _____years _____months.

37. Of your description, would you consider your job to be more:

	Is your current position in this area?	
Administration (ie. Manager)	**Yes**	**No**
Technical/Engineering	**Yes**	**No**

38. How knowledgeable about PVs do you feel? Please indicate the level that is closest to your self-assessment for these characteristics:

None at all . . . . A great deal					
How they work technically	**1**	**2**	**3**	**4**	**5**
Their cost-effectiveness	**1**	**2**	**3**	**4**	**5**
Customer acceptance	**1**	**2**	**3**	**4**	**5**
Availability of applications locally	**1**	**2**	**3**	**4**	**5**
Your base energy section's familiarity with PVs	**1**	**2**	**3**	**4**	**5**

39. In general, I feel the responses of most other members of my organization would agree with the responses I have provided on this survey?

Strongly Disagree . . . . Strongly Agree

1 2 3 4 5

40. In general, please assess whether most members of your organization are:

More cautious about PVs . . . . About the same . . . . More receptive to PVs

-5 -4 -3 -2 -1 0 1 2 3 4 5

41. Which of these sources would you first turn to in order to become more informed about photovoltaics? Please identify your top three from the following list:

1 AFCESA
2 Contact at another utility
3 *Business Week*/*Wall Street Journal*
4 *Popular Science* magazine
5 *Independent Energy*
6 *Electrical World*
7 *Public Utilities Fortnightly*
8 *PV Engineering Handbook*
9 *Public Power* magazine
10 American Public Power Association
11 Edison Electric Institute
12 AFIT CE Schoolhouse Energy Instructor
13 Electric Power Research Institute
14 U.S. Department of Energy
15 U.S. Rural Electrification Administration
16 Solar Energy Industry Association
17 Nat'l Assoc of Reg Utility Commissioners
18 Nat'l Renewable Energy Laboratory
19 Sandia National Laboratory
20 Television show(s)
21 Other: ___________________________

For questions 42-45, please consider the following three categories for PV applications:

Small-scale: 1 W - 1 kW, *off-grid PVs*. Examples: consumer applications; walkway lighting system, remote radio trans-mitter, water pumping, cathodic protection, navigation beacon, plant warning siren, sectionalizing switch, flow meter.

Mid-scale: 1 - 100 kW, *grid-support PVs*. Examples: electric motor, single-family dwelling rooftop system, small substation replacement, commercial HVAC system, peak shaving support, island/park/ranch power, grid-tied projects.

Large-scale: 100 KW or more, *bulk power PVs*. Examples: village or neighborhood power project, central station generating facility, large substation replacement, and other large grid-tied applications.

42. How likely is it that your base will *formally study the feasibility* for PVs in the next 10 years?

	Not likely . . . . Very likely					Already have
Small-scale	**1**	**2**	**3**	**4**	**5**	**9**
Mid-scale	**1**	**2**	**3**	**4**	**5**	**9**
Large-scale	**1**	**2**	**3**	**4**	**5**	**9**

43. How likely is it that your base will *request funding* in these systems in the next 10 years?

	Not likely . . . . Very likely					Already have
Small-scale	**1**	**2**	**3**	**4**	**5**	**9**
Mid-scale	**1**	**2**	**3**	**4**	**5**	**9**
Large-scale	**1**	**2**	**3**	**4**	**5**	**9**

44. How beneficial do *you* think it is for your base to request funding in PVs in the next 10 years?

	Not beneficial . . . . Very beneficial				
Small-scale	**1**	**2**	**3**	**4**	**5**
Mid-scale	**1**	**2**	**3**	**4**	**5**
Large-scale	**1**	**2**	**3**	**4**	**5**

45. How *soon* do you think the base should consider PVs?

	This year . . . . Within 10 yrs					Never
Small-scale	**1**	**2**	**3**	**4**	**5**	**9**
Mid-scale	**1**	**2**	**3**	**4**	**5**	**9**
Large-scale	**1**	**2**	**3**	**4**	**5**	**9**

Respondents Comments:

Appendix B: Descriptive Statistics of Measures

Descriptive statistics for each measure are presented here. Identified in the descriptive statistics were the mean, standard deviation and items associated with each measure. Normality curves are also presented to justify the assumption of normal distributions for the measures. Table B.1 displays the complete list of descriptive statistics for each measure. Finally, Pearson correlation data for the contextual variables is also displayed in Table B.2.

Motivation: This 10-item, Likert scale is contrived from Rogers' (2003) definition stating that motivation is "a state of dissatisfaction or frustration that occurs when an individual's desires outweigh the individual's actualities," (Rogers, 2003:172). The five point scale is anchored by "Very Low" to "Very High," "Not Likely" to "Very Likely," to "Not Receptive" to "Very Receptive" (M = 3.38, S.D. = .658; items 6B, 6D, 6E, 19B, 27A, 27B, 27C, 27D, 28C, and 28D). The Cronbach's Alpha for this measure was .78 (n = 28). Figure B.1 shows the normal distribution curve for this measure.

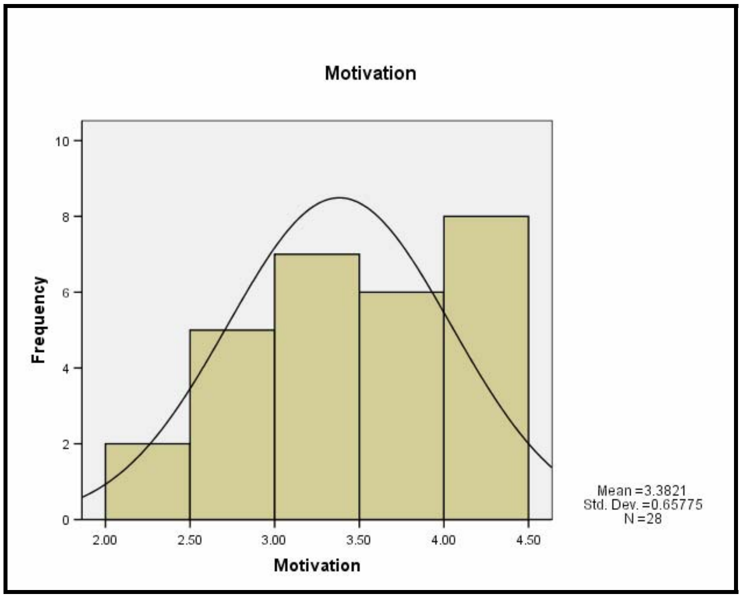

Figure B.1. Motivation

Knowledge: This six-item, Likert scale is contrived from Rogers' (2003) research on his innovation-decision process. It encompasses the level of knowledge that the subject has with respect to the applicability of solar photovoltaics. The five point scale is anchored by "Very Ineffective" (1) to "Very Effective" (5), (M = 3.40, S.D. =.736; items 5C, 10A, 10E, 10G, 10H, and 11Overall). The Cronbach's Alpha for this measure was .69 (n = 28). Figure B.2 presents the normal distribution for knowledge with a slight skew to the left.

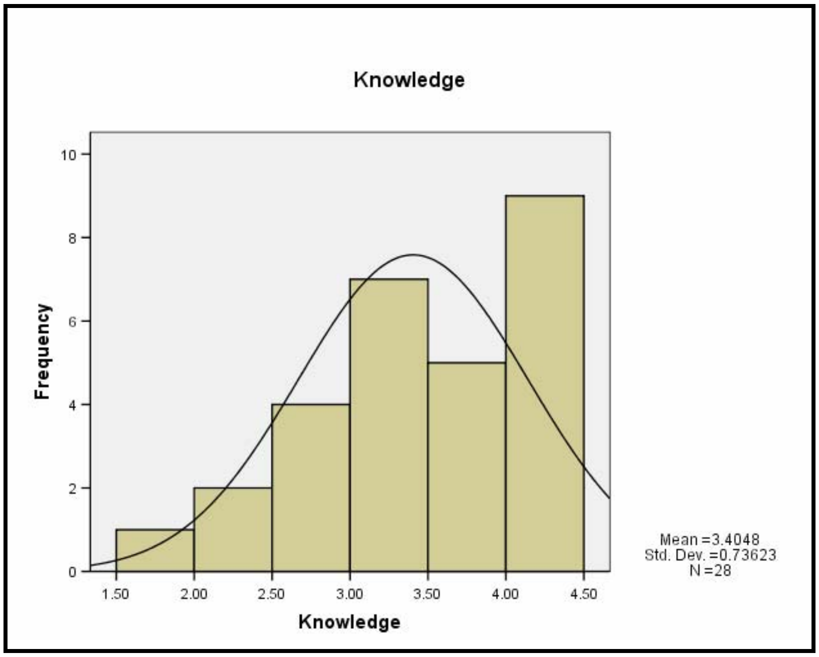

Figure B.2. Knowledge

<u>Experience:</u> This six-item, Likert scale is derived from Rogers (2003), and Kaplan (1999). It measured the subject's degree of exposure, direct experience, and vicarious experiences with solar photovoltaic systems. The measure is based on a six point scale anchored by "Never, until this survey" (1) to "More than 10 Years Ago" (6), and five points scales anchored by "No Experience" (1) to "Lots of Experience" (5), and "Not Familiar" (1) to "Very Familiar" (5), (M = 2.77, S.D. = .691; items 1, 9A, 9B, 9C, 9D, and 21AVG). The Cronbach's Alpha for this measure was .74 (n = 402). The normal distribution curve for Career Orientation is shown in Figure B.3.

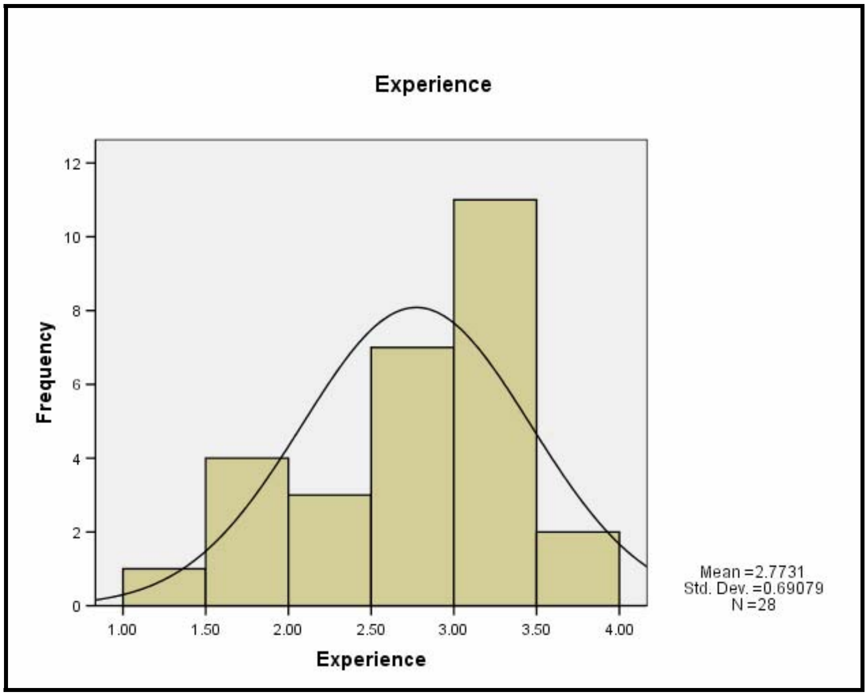

Figure B.3. Experience

Familiarity: This 11-item, Likert scale is derived from Kaplan (1999). It measured the subject's degree of comfort and confidence with solar photovoltaic systems. The measure is based on a five point scale anchored by "Not Comfortable" (1) to "Very Comfortable" (5), "Low Confidence"(1) to "High Confidence," (5) and "Not at All (1) to "A Great Deal" (5), (M = 3.05, S.D. = .875; items 4A, 4B, 14A, 14B, 14C, 14D, 38A, 38B, 38C, 38D, and 38E). The Cronbach's Alpha for this measure was .93 (n = 28). The normal distribution curve for Career Orientation is shown in Figure B.4.

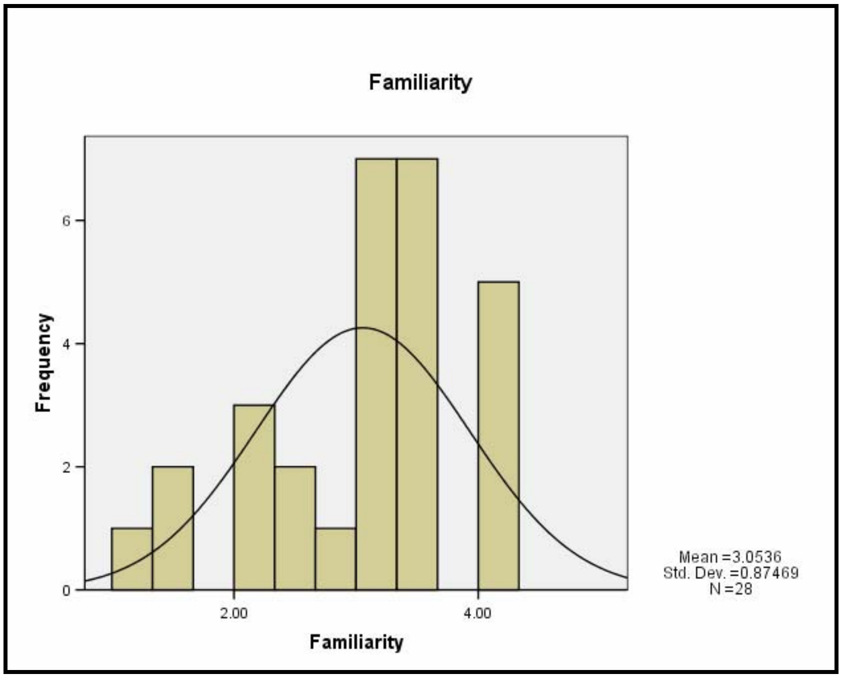

Figure B.4. Familiarity

Interest: This 11-item, Likert scale is derived from Kaplan (1999). It measured the subject's degree of acceptance towards solar photovoltaics in potentially including them on their base installations. The measure is based on a five point scale anchored by "Not Likely" (1) to "Very Likely" (5), "Not Beneficial" (1) to "Very Beneficial" (5), "This year" (1) to "Within 10 yrs" (5), (M = 5.37, S.D. = .55; items 42A, 42B, 42C, 43A, 43B, 43C, 44A, 44B, 44C, 45B, and 45C). The Cronbach's Alpha for this measure was .73 (n = 28). The distribution curve for this measure is depicts a fairly normal distribution as shown in Figure B.5.

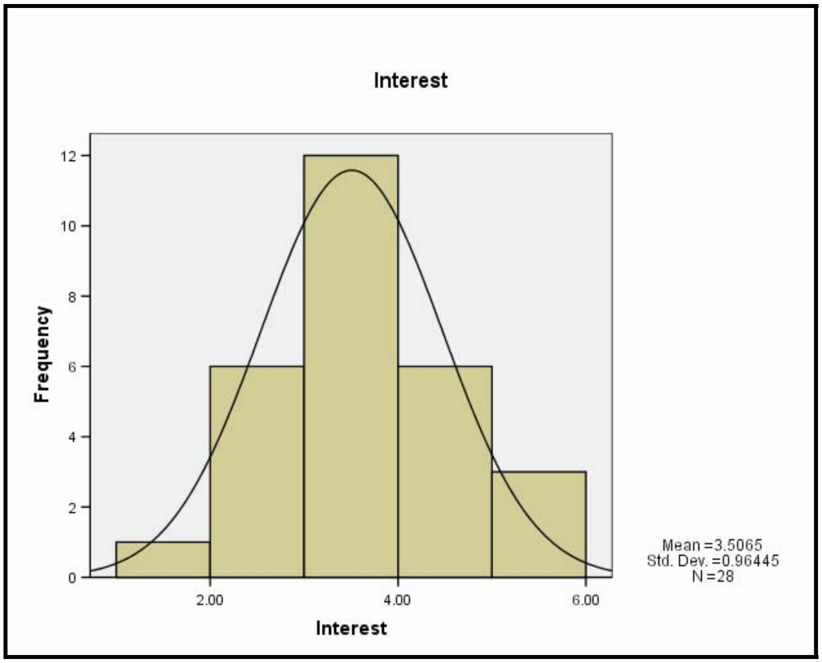

Figure B.5. Interest

<u>Communication:</u> This four-item, Likert scale is derived from. It measured the subject's degree of perception of communication of energy and solar photovoltaic issues between themselves and their MAJCOM energy manager. It was based on a five point scale anchored by "Strongly disagree" (1) to "Strongly Agree" (5), (M = 4.08, S.D. = .971; items 30A, 30B, 30C, 30D). The Cronbach's Alpha for this measure was .69 (n = 28). Figure B.6 shows the distribution curve skewed to the left.

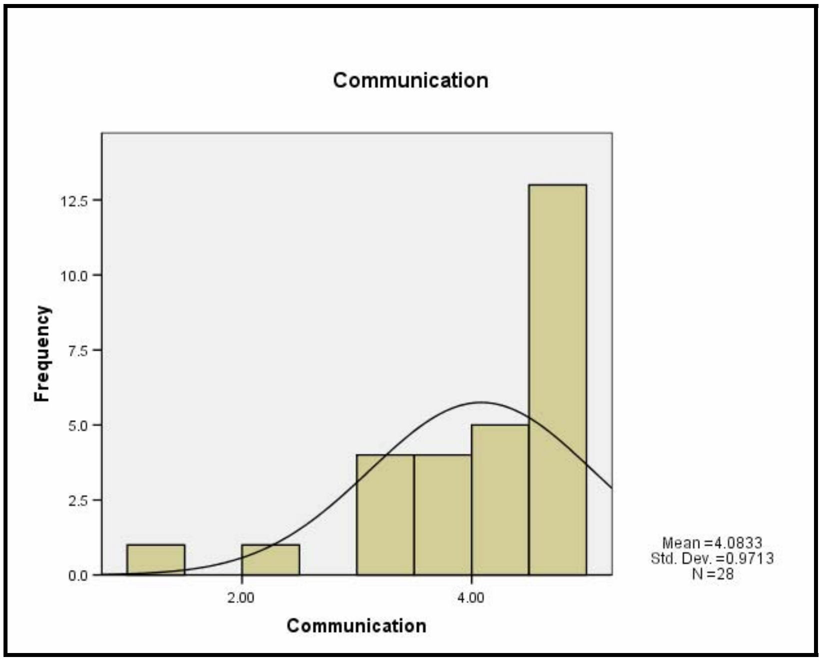

Figure B.6. Communication

Table B.1. Descriptive Statistics of Measures

		Motivation	Knowledge	Experience	Familiarity	Interest	Communication
N	Valid	28	28	28	28	28	28
	Missing	0	0	0	0	0	0
Mean		3.3821	3.4048	2.7731	3.0536	3.5065	4.0833
Std. Error of Mean		.12430	.13913	.13055	.16530	.18226	.18356
Std. Deviation		.65775	.73623	.69079	.87469	.96445	.97130
Variance		.433	.542	.477	.765	.930	.943
Skewness		-.141	-.534	-.748	-.790	.037	-1.418
Std. Error of Skewness		.441	.441	.441	.441	.441	.441
Kurtosis		-.884	-.236	-.440	.014	.620	2.353
Std. Error of Kurtosis		.858	.858	.858	.858	.858	.858
Range		2.30	2.83	2.60	3.27	4.55	4.00
Minimum		2.10	1.67	1.17	1.00	1.09	1.00
Maximum		4.40	4.50	3.77	4.27	5.64	5.00

Table B.2. Correlation Statistics of Measures and Contextual Variables

Measures & Normalized Contextual Variables	Descriptives			Pearson Correlations															
	N	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Motivation	28	3.38	0.66	1															
2. Knowledge	28	3.4	0.736	.51(**)	1														
3. Experience	28	2.77	0.69	0.01	0.149	1													
4. Familiarity	28	3.05	0.88	0.27	.47(*)	.74(**)	1												
5. Interest	28	3.51	0.96	.45(*)	.43(*)	0.2	0.35	1											
6. Communication	28	4.11	0.85	0.23	0.17	0.08	0.22	-0.20	1										
7. Zscore(Q22) Org. Size	28	0	1.00	0.13	-0.24	0.12	0.10	.41(*)	0.03	1									
8. Zscore(Q23A) Peak Demand	28	0	1.00	0.07	0.21	.38(*)	0.36	0.15	-0.10	-0.09	1								
9. Zscore(Q24A) Peak Costs	28	0	1.00	0.31	0.10	0.06	0.28	.49(**)	-0.07	0.12	0.26	1							
10. Zscore(Q25) Base Size	28	0	1.00	0.15	0.10	-0.03	-0.03	-0.32	0.15	-0.36	.39(*)	0.06	1						
11. Zscore(Q26) Solar Expertise	28	0	1.00	0.18	-0.04	0.13	0.12	0.03	-0.14	-0.14	0.03	0.05	0.07	1					
12. Zscore(Q29) Decision Formality	28	0	1.00	0.02	0.28	0.10	0.02	0.09	0.03	-0.19	.39(*)	0.10	0.22	0.22	1				
13. Zscore(Q34A) Education	28	0	1.00	0.11	0.19	0.19	0.18	0.10	-0.10	-0.04	-0.26	0.03	-0.11	0.37	-0.05	1			
14. Zscore(Q36_SeniorityMonths)	28	0	1.00	-0.21	-0.22	0.28	-0.02	-.49(**)	0.22	-0.28	-0.13	-0.24	0.02	0.12	-0.11	.39(*)	1		
15. Zscore(Q37C) Tech Status	28	0	1.00	-0.33	-0.07	0.31	0.28	0.07	-0.12	-0.14	0.20	0.18	-0.23	0.18	0.03	0.13	0.26	1	
16. Zscore(Q46) Base Location	28	0	1.00	.42(*)	0.15	-0.16	0.00	.62(**)	-0.22	0.21	-0.28	.39(*)	-0.08	0.06	-0.11	0.16	-0.35	-0.15	1

** Correlation is significant at the .01 level
* Correlation is significant at the .05 level

Appendix C: Survey Data

Case	Q1	Q2	Q2_Other	Q3	Q3A	Q3BA	Q3BB	Q3BC
1	5	2	No Answer	1	2.00	999.00	999.00	999.00
2	5	7	No Answer	1	2.00	999.00	999.00	999.00
3	6	14	Grade School	1	2.00	999.00	999.00	999.00
4	5	9	No Answer	1	2.00	999.00	999.00	999.00
5	6	2	No Answer	1	2.00	999.00	999.00	999.00
6	5	1	No Answer	1	2.00	999.00	999.00	999.00
7	5	14	utility company	1	2.00	999.00	999.00	999.00
8	2	7	No Answer	1	2.00	999.00	999.00	999.00
9	6	14	DoE installed pv at McClellan AFB	1	2.00	999.00	999.00	999.00
10	6	2	No Answer	1	2.00	999.00	999.00	999.00
11	6	14	NREL lab	1	2.00	999.00	999.00	999.00
12	4	2	No Answer	1	2.00	999.00	999.00	999.00
13	6	2	No Answer	1	2.00	999.00	999.00	999.00
14	6	2	No Answer	1	2.00	999.00	999.00	999.00
15	5	9	No Answer	2	1.00	1.00	1.00	1.00
16	3	2	No Answer	1	2.00	999.00	999.00	999.00
17	6	7	No Answer	1	2.00	999.00	999.00	999.00
18	5	7	No Answer	1	2.00	999.00	999.00	999.00
19	6	2	No Answer	3	1.00	5.00	5.00	5.00
20	6	5	No Answer	1	2.00	999.00	999.00	999.00
21	6	7	No Answer	1	2.00	999.00	999.00	999.00
22	5	5	No Answer	1	2.00	999.00	999.00	999.00
23	6	2	No Answer	3	1.00	5.00	5.00	5.00
24	4	-	No Answer	1	2.00	999.00	999.00	999.00
25	4	-	No Answer	1	2.00	999.00	999.00	999.00
26	2	8	No Answer	2	1.00	1.00	1.00	1.00
27	5	10	No Answer	2	1.00	1.00	1.00	1.00
28	6	11	No Answer	1	2.00	999.00	999.00	999.00
29	4	5	No Answer	1	2.00	999.00	999.00	999.00
30	6	14	Grade School	1	2.00	999.00	999.00	999.00
31	4	14	does not remember	1	2.00	999.00	999.00	999.00
32	6	5		1	999.00	999.00	999.00	999.00
33	5	14	college	1	999.00	999.00	999.00	999.00

Case	Q3BD	Q3BE	Q3BF	Q3CA	Q3CB	Q3CC
1	999.00	999.00	999.00	999.00	999.00	999.00
2	999.00	999.00	999.00	999.00	999.00	999.00
3	999.00	999.00	999.00	999.00	999.00	999.00
4	999.00	999.00	999.00	999.00	999.00	999.00
5	999.00	999.00	999.00	999.00	999.00	999.00
6	999.00	999.00	999.00	999.00	999.00	999.00
7	999.00	999.00	999.00	999.00	999.00	999.00
8	999.00	999.00	999.00	999.00	999.00	999.00
9	999.00	999.00	999.00	1.00	999.00	999.00
10	999.00	999.00	999.00	999.00	999.00	999.00
11	999.00	999.00	999.00	999.00	999.00	999.00
12	999.00	999.00	999.00	999.00	999.00	999.00
13	999.00	999.00	999.00	999.00	999.00	999.00
14	999.00	999.00	999.00	999.00	999.00	999.00
15	5.00	5.00	5.00	5.00	5.00	1.00
16	999.00	999.00	999.00	999.00	999.00	999.00
17	999.00	999.00	999.00	999.00	999.00	999.00
18	999.00	999.00	999.00	999.00	999.00	999.00
19	4.00	4.00	5.00	5.00	5.00	1.00
20	999.00	999.00	999.00	999.00	999.00	999.00
21	999.00	999.00	999.00	999.00	999.00	999.00
22	999.00	999.00	999.00	999.00	999.00	999.00
23	5.00	4.00	4.00	1.00	5.00	5.00
24	999.00	999.00	999.00	999.00	999.00	999.00
25	999.00	999.00	999.00	999.00	999.00	999.00
26	1.00	3.00	2.00	1.00	4.00	2.00
27	1.00	3.00	3.00	2.00	-	-
28	999.00	999.00	999.00	1.00	1.00	999.00
29	999.00	999.00	999.00	999.00	999.00	999.00
30	999.00	999.00	999.00	999.00	999.00	999.00
31	999.00	999.00	999.00	999.00	999.00	999.00
32	999.00	999.00	999.00	999.00	999.00	999.00
33	999.00	999.00	999.00	999.00	999.00	999.00

Case	Q3CD	Q3CE	Q3CF	Q4A	Q4B	Q5A	Q5B
1	999.00	999.00	999.00	5.00	5.00	3.00	5.00
2	999.00	999.00	999.00	4.00	4.00	5.00	5.00
3	999.00	999.00	999.00	5.00	5.00	3.00	5.00
4	999.00	999.00	999.00	3.00	4.00	4.00	3.00
5	999.00	999.00	999.00	5.00	5.00	5.00	5.00
6	999.00	999.00	999.00	2.00	2.00	3.00	4.00
7	999.00	999.00	999.00	4.00	4.00	5.00	5.00
8	999.00	999.00	999.00	1.00	1.00	3.00	3.00
9	999.00	999.00	999.00	1.00	1.00	3.00	4.00
10	999.00	999.00	999.00	1.00	1.00	5.00	4.00
11	999.00	999.00	999.00	3.00	3.00	3.00	4.00
12	999.00	999.00	999.00	3.00	3.00	5.00	3.00
13	999.00	999.00	999.00	5.00	5.00	3.00	5.00
14	999.00	999.00	999.00	4.00	1.00	4.00	1.00
15	1.00	1.00	5.00	5.00	5.00	5.00	2.00
16	999.00	999.00	999.00	4.00	4.00	5.00	3.00
17	999.00	999.00	999.00	5.00	5.00	5.00	5.00
18	999.00	999.00	999.00	2.00	4.00	4.00	4.00
19	2.00	4.00	-	5.00	4.00	4.00	1.00
20	999.00	999.00	999.00	3.00	3.00	4.00	3.00
21	999.00	999.00	999.00	5.00	5.00	5.00	5.00
22	999.00	999.00	999.00	4.00	4.00	5.00	5.00
23	2.00	3.00	4.00	4.00	4.00	5.00	2.00
24	999.00	999.00	999.00	5.00	5.00	4.00	4.00
25	999.00	999.00	999.00	3.00	3.00	3.00	4.00
26	3.00	2.00	4.00	4.00	4.00	5.00	1.00
27	-	-	-	2.00	3.00	4.00	2.00
28	999.00	999.00	999.00	3.00	2.00	5.00	5.00
29	999.00	999.00	999.00	1.00	1.00	4.00	4.00
30	999.00	999.00	999.00	5.00	5.00	5.00	5.00
31	999.00	999.00	999.00	5.00	5.00	5.00	3.00
32	999.00	999.00	999.00	5.00	5.00	5.00	1.00
33	999.00	999.00	999.00	1.00	1.00	5.00	3.00

Case	Q5C	Q5D	Q5E	Q5F	Q5G	Q5H	Q5I
1	4.00	5.00	5.00	3.00	3.00	5.00	4.00
2	3.00	5.00	5.00	4.00	3.00	2.00	4.00
3	5.00	5.00	5.00	4.00	4.00	2.00	4.00
4	3.00	4.00	3.00	3.00	4.00	2.00	3.00
5	5.00	5.00	5.00	5.00	5.00	5.00	5.00
6	2.00	4.00	4.00	3.00	3.00	4.00	4.00
7	3.00	5.00	5.00	4.00	3.00	3.00	5.00
8	3.00	3.00	3.00	3.00	3.00	3.00	3.00
9	2.00	4.00	2.00	3.00	2.00	4.00	3.00
10	5.00	5.00	5.00	3.00	3.00	5.00	5.00
11	3.00	5.00	3.00	3.00	4.00	4.00	3.00
12	4.00	5.00	5.00	5.00	3.00	2.00	3.00
13	5.00	5.00	5.00	5.00	4.00	3.00	3.00
14	3.00	3.00	1.00	4.00	2.00	4.00	2.00
15	5.00	1.00	1.00	4.00	1.00	1.00	1.00
16	3.00	5.00	5.00	4.00	4.00	2.00	4.00
17	4.00	5.00	5.00	4.00	4.00	2.00	5.00
18	3.00	5.00	4.00	4.00	3.00	3.00	3.00
19	5.00	1.00	1.00	5.00	4.00	2.00	1.00
20	3.00	4.00	4.00	4.00	3.00	3.00	4.00
21	3.00	5.00	5.00	3.00	2.00	4.00	5.00
22	3.00	5.00	5.00	4.00	3.00	3.00	3.00
23	5.00	1.00	1.00	5.00	5.00	2.00	1.00
24	4.00	5.00	5.00	4.00	5.00	5.00	5.00
25	3.00	4.00	4.00	3.00	4.00	3.00	4.00
26	4.00	1.00	1.00	5.00	3.00	4.00	2.00
27	3.00	2.00	2.00	2.00	4.00	5.00	2.00
28	5.00	5.00	5.00	2.00	3.00	3.00	4.00
29	3.00	5.00	3.00	3.00	5.00	4.00	3.00
30	5.00	5.00	5.00	5.00	4.00	2.00	5.00
31	3.00	5.00	5.00	3.00	5.00	3.00	5.00
32	5.00	1.00	3.00	5.00	3.00	4.00	1.00
33	5.00	1.00	1.00	3.00	4.00	3.00	3.00

Case	Q6A	Q6B	Q6C	Q6D	Q6E	Q7A	Q7B
1	4.00	4.00	4.00	4.00	4.00	2.00	3.00
2	4.00	4.00	5.00	4.00	3.00	2.00	8.00
3	5.00	5.00	2.00	2.00	5.00	3.00	5.00
4	4.00	3.00	4.00	4.00	4.00	3.00	4.00
5	4.00	5.00	.00	5.00	.00	3.00	8.00
6	3.00	4.00	2.00	2.00	3.00	1.00	3.00
7	5.00	5.00	4.00	4.00	4.00	2.00	3.00
8	4.00	5.00	4.00	4.00	4.00	.00	8.00
9	3.00	2.00	3.00	3.00	3.00	1.00	2.00
10	1.00	3.00	3.00	1.00	3.00	3.00	4.00
11	1.00	2.00	3.00	3.00	3.00	5.00	9.00
12	4.00	3.00	4.00	4.00	3.00	4.00	5.00
13	2.00	1.00	1.00	1.00	3.00	3.00	8.00
14	4.00	1.00	3.00	2.00	3.00	1.00	3.00
15	5.00	5.00	5.00	5.00	3.00	1.00	#NULL!
16	5.00	3.00	3.00	3.00	3.00	4.00	6.00
17	3.00	4.00	2.00	4.00	1.00	3.00	8.00
18	4.00	4.00	3.00	3.00	3.00	4.00	8.00
19	5.00	5.00	3.00	3.00	4.00	3.00	5.00
20	5.00	4.00	4.00	4.00	3.00	3.00	5.00
21	2.00	4.00	3.00	2.00	3.00	2.00	3.00
22	4.00	3.00	3.00	2.00	3.00	2.00	3.00
23	5.00	5.00	3.00	3.00	3.00	3.00	5.00
24	4.00	3.00	4.00	4.00	4.00	1.00	2.00
25	4.00	4.00	4.00	4.00	4.00	3.00	8.00
26	5.00	4.00	3.00	4.00	4.00	1.00	8.00
27	5.00	5.00	4.00	4.00	5.00	2.00	3.00
28	3.00	4.00	3.00	2.00	3.00	3.00	8.00
29	3.00	3.00	3.00	3.00	3.00	4.00	.00
30	5.00	4.00	4.00	4.00	4.00	1.00	3.00
31	3.00	4.00	4.00	2.00	4.00	3.00	8.00
32	3.00	3.00	3.00	2.00	4.00	3.00	8.00
33	4.00	3.00	4.00	3.00	3.00	#NULL!	.00

Case	Q7C	Q7Other	Q7Overall	Q8A	Q8B	Q8C	Q8D
1	8.00	#NULL!	4.00	4.00	3.00	4.00	.00
2	9.00	#NULL!	3.00	2.00	3.00	.00	2.00
3	8.00	#NULL!	3.00	1.00	1.00	.00	.00
4	10.00	#NULL!	3.00	4.00	.00	.00	.00
5	12.00	#NULL!	3.00	1.00	4.00	1.00	3.00
6	8.00	#NULL!	3.00	2.00	3.00	.00	.00
7	4.00	#NULL!	4.00	1.00	5.00	.00	4.00
8	.00	#NULL!	1.00	.00	.00	.00	.00
9	10.00	#NULL!	3.00	2.00	2.00	5.00	2.00
10	8.00	#NULL!	3.00	3.00	.00	.00	1.00
11	10.00	#NULL!	1.00	4.00	2.00	3.00	2.00
12	10.00	#NULL!	1.00	3.00	3.00	.00	.00
13	9.00	#NULL!	3.00	3.00	3.00	1.00	1.00
14	8.00	#NULL!	3.00	2.00	.00	5.00	2.00
15	#NULL!	#NULL!	5.00	2.00	2.00	.00	.00
16	8.00	#NULL!	1.00	3.00	3.00	.00	3.00
17	9.00	#NULL!	3.00	3.00	2.00	.00	.00
18	10.00	#NULL!	1.00	4.00	5.00	.00	.00
19	8.00	#NULL!	3.00	1.00	4.00	.00	5.00
20	8.00	#NULL!	3.00	2.00	.00	.00	3.00
21	9.00	#NULL!	4.00	3.00	3.00	4.00	.00
22	8.00	#NULL!	4.00	1.00	.00	.00	.00
23	8.00	#NULL!	3.00	1.00	4.00	5.00	5.00
24	3.00	#NULL!	4.00	2.00	2.00	5.00	2.00
25	.00	#NULL!	3.00	.00	.00	.00	.00
26	11.00	#NULL!	2.00	3.00	2.00	.00	.00
27	8.00	#NULL!	4.00	4.00	4.00	.00	.00
28	9.00	#NULL!	3.00	2.00	3.00	.00	.00
29	.00	#NULL!	1.00	1.00	1.00	2.00	2.00
30	8.00	#NULL!	3.00	.00	.00	.00	.00
31	9.00	#NULL!	3.00	2.00	.00	.00	.00
32	9.00	#NULL!	3.00	3.00	3.00	.00	.00
33	.00	12	1.00	999.00	999.00	999.00	999.00

Case	Q8E	Q9A	Q9B	Q9C	Q9D	Q10A	Q10B
1	.00	4.00	3.00	2.00	2.00	2.00	1.00
2	.00	4.00	4.00	1.00	4.00	4.00	3.00
3	.00	3.00	3.00	3.00	3.00	4.00	4.00
4	.00	3.00	1.00	1.00	1.00	4.00	2.00
5	3.00	4.00	3.00	2.00	3.00	5.00	3.00
6	.00	4.00	3.00	3.00	3.00	3.00	1.00
7	.00	5.00	5.00	1.00	1.00	5.00	4.00
8	.00	1.00	1.00	1.00	1.00	3.00	3.00
9	2.00	4.00	4.00	2.00	3.00	3.00	3.00
10	.00	5.00	3.00	1.00	3.00	5.00	3.00
11	2.00	5.00	3.00	2.00	3.00	4.00	2.00
12	.00	4.00	4.00	4.00	4.00	3.00	4.00
13	1.00	2.00	3.00	1.00	4.00	3.00	3.00
14	.00	4.00	2.00	1.00	5.00	4.00	3.00
15	.00	4.00	5.00	1.00	1.00	3.00	3.00
16	.00	1.00	1.00	2.00	2.00	3.00	3.00
17	.00	5.00	3.00	1.00	1.00	5.00	5.00
18	.00	3.00	4.00	1.00	1.00	5.00	4.00
19	.00	4.00	5.00	4.00	5.00	1.00	5.00
20	.00	2.00	1.00	2.00	1.00	3.00	1.00
21	.00	4.00	3.00	3.00	3.00	5.00	2.00
22	.00	5.00	3.00	3.00	2.00	5.00	4.00
23	.00	5.00	5.00	4.00	4.00	1.00	4.00
24	2.00	2.00	2.00	5.00	2.00	2.00	5.00
25	.00	1.00	2.00	1.00	1.00	4.00	3.00
26	.00	2.00	4.00	1.00	1.00	5.00	5.00
27	.00	2.00	2.00	1.00	1.00	4.00	4.00
28	2.00	4.00	4.00	1.00	1.00	4.00	4.00
29	2.00	3.00	1.00	1.00	1.00	4.00	2.00
30	.00	4.00	3.00	2.00	1.00	5.00	2.00
31	.00	4.00	1.00	1.00	1.00	5.00	2.00
32	1.00	4.00	4.00	4.00	3.00	5.00	1.00
33	999.00	1.00	1.00	1.00	1.00	3.00	3.00

Case	Q10C	Q10D	Q10E	Q10F	Q10G	Q10H	Q11A
1	1.00	2.00	5.00	3.00	3.00	2.00	1.00
2	3.00	4.00	3.00	4.00	4.00	4.00	7.00
3	4.00	4.00	4.00	4.00	4.00	4.00	2.00
4	2.00	3.00	4.00	4.00	2.00	2.00	1.00
5	5.00	2.00	4.00	3.00	4.00	4.00	1.00
6	3.00	2.00	2.00	2.00	2.00	2.00	1.00
7	4.00	3.00	4.00	2.00	2.00	2.00	#NULL!
8	3.00	3.00	3.00	3.00	3.00	3.00	7.00
9	4.00	1.00	2.00	2.00	1.00	1.00	7.00
10	5.00	3.00	3.00	2.00	3.00	3.00	1.00
11	4.00	2.00	2.00	2.00	2.00	2.00	7.00
12	3.00	3.00	4.00	4.00	4.00	4.00	2.00
13	5.00	4.00	1.00	1.00	1.00	1.00	7.00
14	4.00	1.00	2.00	4.00	1.00	4.00	2.00
15	3.00	3.00	5.00	5.00	5.00	5.00	2.00
16	3.00	3.00	4.00	4.00	5.00	5.00	1.00
17	3.00	3.00	3.00	3.00	3.00	2.00	1.00
18	3.00	2.00	4.00	4.00	3.00	3.00	1.00
19	1.00	5.00	4.00	5.00	5.00	2.00	7.00
20	2.00	1.00	4.00	4.00	3.00	3.00	2.00
21	2.00	2.00	5.00	4.00	5.00	4.00	1.00
22	2.00	4.00	5.00	5.00	5.00	5.00	2.00
23	5.00	5.00	4.00	4.00	4.00	2.00	7.00
24	3.00	5.00	3.00	3.00	3.00	3.00	1.00
25	1.00	2.00	1.00	2.00	3.00	3.00	1.00
26	3.00	1.00	1.00	1.00	4.00	4.00	1.00
27	3.00	2.00	4.00	2.00	3.00	3.00	1.00
28	4.00	3.00	4.00	3.00	4.00	3.00	4.00
29	3.00	3.00	2.00	2.00	2.00	3.00	4.00
30	2.00	2.00	3.00	1.00	5.00	4.00	1.00
31	5.00	3.00	4.00	4.00	4.00	4.00	1.00
32	5.00	1.00	4.00	2.00	4.00	2.00	1.00
33	3.00	3.00	4.00	3.00	2.00	3.00	1.00

Case	Q11B	Q11C	Q11Overall	Q12A	Q12B	Q12C
1	2.00	4.00	5.00	.00	4.00	.00
2	999.00	999.00	1.00	4.00	4.00	4.00
3	3.00	4.00	4.00	1.00	3.00	2.00
4	2.00	4.00	5.00	3.00	2.00	3.00
5	2.00	4.00	5.00	3.00	2.00	3.00
6	2.00	4.00	5.00	3.00	2.00	2.00
7	2.00	4.00	3.00	2.00	2.00	1.00
8	999.00	999.00	1.00	9.00	9.00	9.00
9	999.00	999.00	1.00	.00	.00	.00
10	2.00	4.00	5.00	9.00	9.00	9.00
11	999.00	999.00	1.00	4.00	2.00	2.00
12	999.00	999.00	3.00	2.00	2.00	2.00
13	999.00	999.00	1.00	.00	.00	.00
14	4.00	6.00	3.00	-3.00	1.00	-5.00
15	999.00	999.00	5.00	.00	4.00	4.00
16	2.00	999.00	4.00	3.00	3.00	3.00
17	2.00	4.00	5.00	.00	.00	.00
18	2.00	4.00	5.00	.00	3.00	3.00
19	#NULL!	#NULL!	1.00	2.00	2.00	2.00
20	3.00	4.00	2.00	1.00	2.00	3.00
21	2.00	3.00	2.00	-1.00	1.00	-2.00
22	3.00	4.00	2.00	2.00	.00	-2.00
23	#NULL!	#NULL!	1.00	3.00	3.00	3.00
24	2.00	999.00	4.00	9.00	9.00	9.00
25	2.00	4.00	5.00	1.00	1.00	1.00
26	2.00	4.00	5.00	9.00	4.00	4.00
27	2.00	4.00	5.00	2.00	3.00	.00
28	999.00	999.00	3.00	2.00	-1.00	-1.00
29	999.00	999.00	3.00	2.00	2.00	2.00
30	2.00	4.00	5.00	-1.00	1.00	1.00
31	2.00	4.00	5.00	4.00	4.00	4.00
32	2.00	4.00	5.00	2.00	9.00	9.00
33	999.00	999.00	2.00	.00	.00	.00

Case	Q12D	Q13A	Q13B	Q13C	Q13D	Q13E	Q13F
1	3.00	3.00	3.00	3.00	3.00	3.00	3.00
2	4.00	5.00	5.00	5.00	5.00	5.00	4.00
3	4.00	5.00	5.00	5.00	5.00	5.00	3.00
4	4.00	3.00	3.00	5.00	4.00	5.00	4.00
5	3.00	5.00	4.00	5.00	5.00	4.00	3.00
6	4.00	4.00	3.00	3.00	3.00	3.00	3.00
7	3.00	4.00	4.00	4.00	4.00	3.00	3.00
8	9.00	4.00	4.00	4.00	4.00	3.00	3.00
9	.00	3.00	3.00	2.00	2.00	3.00	3.00
10	3.00	5.00	5.00	5.00	5.00	4.00	3.00
11	-1.00	3.00	3.00	4.00	2.00	3.00	3.00
12	4.00	5.00	5.00	5.00	5.00	5.00	5.00
13	.00	5.00	5.00	5.00	4.00	4.00	3.00
14	3.00	4.00	2.00	3.00	2.00	1.00	2.00
15	5.00	5.00	5.00	4.00	5.00	5.00	3.00
16	1.00	4.00	4.00	5.00	3.00	3.00	3.00
17	.00	5.00	5.00	5.00	5.00	5.00	4.00
18	4.00	5.00	5.00	5.00	4.00	4.00	3.00
19	2.00	5.00	5.00	5.00	5.00	5.00	5.00
20	3.00	4.00	4.00	4.00	4.00	3.00	3.00
21	3.00	5.00	4.00	4.00	3.00	5.00	4.00
22	2.00	4.00	4.00	4.00	3.00	3.00	4.00
23	3.00	5.00	5.00	5.00	5.00	5.00	5.00
24	9.00	5.00	5.00	5.00	3.00	3.00	5.00
25	1.00	4.00	4.00	4.00	4.00	4.00	3.00
26	4.00	5.00	5.00	5.00	5.00	5.00	2.00
27	2.00	3.00	3.00	4.00	4.00	3.00	2.00
28	3.00	5.00	4.00	5.00	4.00	5.00	3.00
29	2.00	3.00	3.00	3.00	3.00	3.00	3.00
30	3.00	5.00	5.00	5.00	4.00	4.00	4.00
31	4.00	5.00	5.00	4.00	5.00	5.00	3.00
32	4.00	5.00	5.00	5.00	5.00	5.00	5.00
33	.00	3.00	3.00	3.00	3.00	3.00	3.00

Case	Q13G	Q14A	Q14B	Q14C	Q14D	Q15	Q15A
1	3.00	5.00	4.00	4.00	4.00	2.00	999.00
2	5.00	4.00	4.00	4.00	4.00	2.00	999.00
3	5.00	4.00	4.00	4.00	4.00	1.00	3.00
4	4.00	2.00	2.00	2.00	2.00	2.00	999.00
5	3.00	4.00	4.00	4.00	4.00	2.00	999.00
6	3.00	4.00	4.00	4.00	4.00	1.00	3.00
7	4.00	4.00	3.00	4.00	3.00	2.00	999.00
8	3.00	1.00	1.00	1.00	1.00	2.00	999.00
9	3.00	4.00	4.00	3.00	4.00	1.00	3.00
10	2.00	4.00	4.00	3.00	4.00	2.00	999.00
11	2.00	3.00	3.00	4.00	3.00	2.00	999.00
12	5.00	3.00	3.00	4.00	3.00	1.00	4.00
13	3.00	2.00	1.00	1.00	1.00	2.00	999.00
14	2.00	4.00	3.00	5.00	3.00	2.00	999.00
15	5.00	5.00	5.00	5.00	5.00	2.00	999.00
16	5.00	4.00	3.00	3.00	4.00	2.00	999.00
17	5.00	5.00	4.00	4.00	5.00	2.00	999.00
18	4.00	3.00	2.00	2.00	2.00	2.00	999.00
19	5.00	5.00	5.00	4.00	5.00	1.00	3.00
20	5.00	3.00	3.00	3.00	3.00	1.00	3.00
21	4.00	5.00	4.00	4.00	5.00	1.00	4.00
22	4.00	4.00	3.00	4.00	4.00	2.00	999.00
23	5.00	5.00	5.00	5.00	5.00	1.00	3.00
24	5.00	4.00	3.00	3.00	3.00	1.00	5.00
25	4.00	3.00	3.00	2.00	1.00	2.00	999.00
26	5.00	3.00	3.00	3.00	3.00	2.00	999.00
27	3.00	2.00	3.00	2.00	2.00	2.00	999.00
28	4.00	4.00	4.00	2.00	4.00	2.00	999.00
29	3.00	1.00	1.00	1.00	1.00	1.00	2.00
30	5.00	4.00	3.00	3.00	4.00	2.00	999.00
31	5.00	3.00	4.00	4.00	3.00	2.00	999.00
32	5.00	5.00	5.00	5.00	5.00	2.00	999.00
33	3.00	2.00	2.00	2.00	2.00	2.00	999.00

Case	Q15B	Q15C	Q15D	Q15E	Q16	Q16A
1	999.00	999.00	999.00	999.00	2.00	No Answer
2	999.00	999.00	999.00	999.00	2.00	No Answer
3	1.00	3.00	4.00	3.00	1.00	NASA Solar Demo
4	999.00	999.00	999.00	999.00	2.00	No Answer
5	999.00	999.00	999.00	999.00	1.00	Nellis solar farm
6	2.00	3.00	3.00	2.00	1.00	Tucson Electric Power
7	999.00	999.00	999.00	999.00	1.00	Solar array
8	999.00	999.00	999.00	999.00	2.00	No Answer
9	3.00	2.00	2.00	1.00	2.00	No Answer
10	999.00	999.00	999.00	999.00	2.00	No Answer
11	999.00	999.00	999.00	999.00	2.00	No Answer
12	4.00	5.00	5.00	4.00	1.00	Solar system on roof
13	999.00	999.00	999.00	999.00	2.00	No Answer
14	999.00	999.00	999.00	999.00	2.00	No Answer
15	999.00	999.00	999.00	999.00	1.00	Nevada Water Authority
16	999.00	999.00	999.00	999.00	1.00	pilot solar farm
17	999.00	999.00	999.00	999.00	2.00	No Answer
18	999.00	999.00	999.00	999.00	1.00	solar pv
19	1.00	3.00	4.00	3.00	1.00	NREL
20	3.00	4.00	4.00	4.00	2.00	No Answer
21	3.00	4.00	4.00	4.00	1.00	solar array
22	999.00	999.00	999.00	999.00	2.00	No Answer
23	1.00	3.00	3.00	3.00	1.00	NREL
24	1.00	5.00	5.00	3.00	2.00	No Answer
25	999.00	999.00	999.00	999.00	1.00	solar farm
26	999.00	999.00	999.00	999.00	1.00	solar roof
27	999.00	999.00	999.00	999.00	1.00	solar roof
28	999.00	999.00	999.00	999.00	2.00	No Answer
29	2.00	999.00	2.00	2.00	2.00	No Answer
30	999.00	999.00	999.00	999.00	2.00	No Answer
31	999.00	999.00	999.00	999.00	2.00	No Answer
32	999.00	999.00	999.00	999.00	2.00	No Answer
33	999.00	999.00	999.00	999.00	2.00	No Answer

Case	Q16A1	Q16B	Q16B1
1	No Answer	No Answer	No Answer
2	No Answer	No Answer	No Answer
3	Edwards AFB	Fort Irwin	Army base in California
4	No Answer	No Answer	No Answer
5	Nellis AFB	No Answer	No Answer
6	Tucson, AZ	Luke AFB BX solar project	Luke AFB
7	Nellis AFB	Solar system	Luke AFB
8	No Answer	No Answer	No Answer
9	No Answer	No Answer	No Answer
10	No Answer	No Answer	No Answer
11	No Answer	No Answer	No Answer
12	Luke AFB	No Answer	No Answer
13	No Answer	No Answer	No Answer
14	No Answer	No Answer	No Answer
15	Las Vegas	March Air Reserve Base	California
16	Goodfellow AFB	solar farm	Nellis AFB
17	No Answer	No Answer	No Answer
18	Luke AFB	solar pv	Cannon AFB
19	No Answer	29 Palms	California
20	No Answer	No Answer	No Answer
21	Nellis AFB	U.S. Postal Service	Oakland, CA
22	No Answer	No Answer	No Answer
23	Colorado	Sandia	New Mexico
24	No Answer	No Answer	No Answer
25	Nellis AFB	No Answer	No Answer
26	Luke AFB	No Answer	No Answer
27	Luke AFB	No Answer	No Answer
28	No Answer	No Answer	No Answer
29	No Answer	No Answer	No Answer
30	No Answer	No Answer	No Answer
31	No Answer	No Answer	No Answer
32	No Answer	No Answer	No Answer
33	No Answer	No Answer	No Answer

Case	Q17A	Q17B	Q17C	Q17D	Q17E	Q17F	Q18A
1	999.00	999.00	5.00	999.00	5.00	999.00	999.00
2	5.00	5.00	5.00	5.00	5.00	4.00	4.00
3	3.00	3.00	4.00	3.00	5.00	4.00	3.00
4	4.00	5.00	5.00	2.00	5.00	3.00	2.00
5	2.00	3.00	5.00	4.00	5.00	5.00	4.00
6	4.00	3.00	4.00	3.00	5.00	4.00	2.00
7	1.00	1.00	4.00	3.00	5.00	4.00	1.00
8	5.00	5.00	5.00	4.00	4.00	5.00	3.00
9	2.00	1.00	1.00	2.00	2.00	1.00	2.00
10	3.00	3.00	4.00	1.00	5.00	5.00	2.00
11	3.00	4.00	3.00	2.00	5.00	5.00	3.00
12	4.00	5.00	5.00	4.00	5.00	5.00	3.00
13	5.00	5.00	1.00	1.00	5.00	1.00	1.00
14	4.00	2.00	2.00	2.00	4.00	3.00	2.00
15	5.00	5.00	4.00	3.00	5.00	3.00	1.00
16	5.00	5.00	4.00	2.00	5.00	3.00	3.00
17	5.00	5.00	5.00	5.00	5.00	5.00	3.00
18	5.00	4.00	5.00	5.00	5.00	5.00	3.00
19	5.00	5.00	5.00	3.00	5.00	5.00	5.00
20	2.00	4.00	3.00	3.00	4.00	4.00	2.00
21	4.00	2.00	1.00	1.00	5.00	4.00	3.00
22	3.00	5.00	5.00	3.00	5.00	4.00	2.00
23	5.00	5.00	5.00	5.00	5.00	5.00	5.00
24	5.00	5.00	5.00	5.00	5.00	5.00	5.00
25	4.00	4.00	4.00	3.00	5.00	4.00	4.00
26	5.00	5.00	5.00	5.00	5.00	5.00	3.00
27	4.00	3.00	2.00	3.00	5.00	4.00	3.00
28	5.00	5.00	5.00	4.00	5.00	5.00	3.00
29	3.00	3.00	3.00	3.00	3.00	3.00	3.00
30	3.00	3.00	5.00	4.00	3.00	4.00	4.00
31	5.00	3.00	5.00	5.00	5.00	5.00	3.00
32	5.00	2.00	1.00	2.00	5.00	5.00	1.00
33	5.00	5.00	5.00	1.00	1.00	1.00	1.00

Case	Q18B	Q18C	Q18D	Q18E	Q18F	Q18G	Q19A
1	999.00	4.00	999.00	999.00	999.00	4.00	4.00
2	5.00	5.00	5.00	5.00	5.00	5.00	5.00
3	3.00	4.00	3.00	3.00	4.00	4.00	5.00
4	3.00	4.00	3.00	2.00	3.00	1.00	4.00
5	3.00	4.00	4.00	4.00	3.00	5.00	5.00
6	2.00	3.00	2.00	2.00	3.00	4.00	3.00
7	1.00	1.00	1.00	1.00	3.00	1.00	4.00
8	4.00	4.00	4.00	4.00	4.00	4.00	4.00
9	2.00	1.00	2.00	2.00	2.00	2.00	1.00
10	2.00	2.00	2.00	2.00	2.00	2.00	4.00
11	3.00	4.00	3.00	3.00	2.00	3.00	2.00
12	5.00	5.00	4.00	4.00	5.00	5.00	5.00
13	1.00	1.00	2.00	2.00	2.00	1.00	1.00
14	2.00	2.00	2.00	2.00	2.00	2.00	2.00
15	1.00	1.00	1.00	1.00	1.00	1.00	5.00
16	3.00	3.00	4.00	3.00	4.00	5.00	5.00
17	5.00	5.00	5.00	5.00	5.00	5.00	5.00
18	4.00	4.00	4.00	4.00	4.00	4.00	4.00
19	5.00	5.00	5.00	3.00	3.00	5.00	5.00
20	3.00	4.00	4.00	3.00	3.00	4.00	4.00
21	3.00	2.00	2.00	2.00	3.00	5.00	5.00
22	3.00	3.00	5.00	4.00	4.00	4.00	4.00
23	5.00	5.00	5.00	3.00	3.00	5.00	5.00
24	4.00	5.00	5.00	5.00	5.00	5.00	5.00
25	2.00	2.00	3.00	3.00	3.00	4.00	4.00
26	5.00	5.00	3.00	4.00	5.00	5.00	5.00
27	3.00	3.00	2.00	2.00	3.00	4.00	4.00
28	3.00	4.00	3.00	3.00	4.00	3.00	3.00
29	4.00	4.00	3.00	3.00	4.00	3.00	3.00
30	3.00	2.00	4.00	4.00	3.00	5.00	5.00
31	4.00	4.00	3.00	4.00	4.00	5.00	5.00
32	1.00	1.00	2.00	2.00	2.00	5.00	5.00
33	5.00	5.00	5.00	5.00	5.00	5.00	3.00

Case	Q19B	Q20A	Q20A1	Q20B	Q20B1	Q20C	Q20C1
1	5.00	5.00	999.00	5.00	999.00	5.00	999.00
2	5.00	5.00	999.00	5.00	999.00	5.00	999.00
3	5.00	5.00	999.00	5.00	999.00	5.00	999.00
4	2.00	5.00	999.00	5.00	999.00	5.00	999.00
5	3.00	5.00	999.00	5.00	999.00	5.00	999.00
6	3.00	5.00	999.00	5.00	999.00	5.00	999.00
7	4.00	5.00	999.00	5.00	999.00	5.00	999.00
8	4.00	5.00	999.00	5.00	999.00	5.00	999.00
9	1.00	5.00	999.00	5.00	999.00	4.00	999.00
10	4.00	5.00	999.00	5.00	999.00	5.00	999.00
11	3.00	5.00	999.00	5.00	999.00	5.00	999.00
12	5.00	5.00	999.00	5.00	999.00	5.00	999.00
13	1.00	5.00	999.00	5.00	999.00	5.00	999.00
14	2.00	5.00	999.00	5.00	999.00	5.00	999.00
15	5.00	5.00	999.00	5.00	999.00	5.00	999.00
16	5.00	5.00	999.00	5.00	999.00	5.00	999.00
17	5.00	5.00	999.00	5.00	999.00	5.00	999.00
18	4.00	5.00	999.00	5.00	999.00	5.00	999.00
19	5.00	4.00	1.00	4.00	1.00	3.00	1.00
20	4.00	5.00	999.00	5.00	999.00	5.00	999.00
21	5.00	5.00	999.00	5.00	999.00	5.00	999.00
22	4.00	5.00	999.00	5.00	999.00	5.00	999.00
23	5.00	4.00	1.00	4.00	1.00	4.00	1.00
24	5.00	5.00	999.00	5.00	999.00	5.00	999.00
25	3.00	5.00	999.00	5.00	999.00	5.00	2.00
26	5.00	5.00	#NULL!	5.00	#NULL!	5.00	#NULL!
27	5.00	5.00	#NULL!	5.00	#NULL!	5.00	#NULL!
28	4.00	5.00	999.00	5.00	999.00	5.00	999.00
29	4.00	5.00	999.00	5.00	999.00	5.00	999.00
30	5.00	5.00	999.00	5.00	999.00	5.00	999.00
31	4.00	5.00	999.00	5.00	999.00	5.00	999.00
32	5.00	5.00	999.00	5.00	999.00	5.00	999.00
33	3.00	5.00	999.00	5.00	999.00	5.00	999.00

Case	Q20D	Q20D1	Q20E	Q20E1	Q20F	Q20F1	Q20G
1	2.00	999.00	5.00	999.00	3.00	1.00	5.00
2	2.00	1.00	5.00	999.00	5.00	999.00	5.00
3	2.00	1.00	5.00	999.00	2.00	1.00	5.00
4	2.00	1.00	5.00	999.00	999.00	999.00	5.00
5	3.00	999.00	5.00	999.00	5.00	999.00	5.00
6	2.00	1.00	5.00	999.00	1.00	1.00	5.00
7	1.00	1.00	5.00	999.00	2.00	1.00	3.00
8	5.00	999.00	5.00	999.00	5.00	999.00	5.00
9	3.00	999.00	3.00	999.00	2.00	999.00	2.00
10	2.00	999.00	5.00	999.00	2.00	999.00	3.00
11	2.00	1.00	5.00	999.00	4.00	1.00	4.00
12	2.00	1.00	5.00	999.00	5.00	999.00	5.00
13	3.00	2.00	5.00	999.00	5.00	999.00	5.00
14	2.00	1.00	5.00	999.00	5.00	999.00	4.00
15	1.00	1.00	5.00	999.00	3.00	2.00	5.00
16	1.00	1.00	5.00	999.00	3.00	1.00	5.00
17	2.00	1.00	5.00	999.00	4.00	1.00	5.00
18	2.00	1.00	5.00	999.00	3.00	1.00	5.00
19	1.00	1.00	4.00	1.00	1.00	1.00	1.00
20	3.00	1.00	5.00	999.00	4.00	2.00	4.00
21	1.00	1.00	5.00	999.00	2.00	1.00	3.00
22	2.00	1.00	5.00	999.00	4.00	1.00	5.00
23	2.00	1.00	4.00	1.00	2.00	1.00	2.00
24	2.00	1.00	3.00	1.00	5.00	999.00	5.00
25	2.00	1.00	5.00	2.00	2.00	1.00	4.00
26	2.00	1.00	5.00	#NULL!	4.00	1.00	5.00
27	2.00	1.00	5.00	#NULL!	2.00	1.00	5.00
28	2.00	1.00	5.00	999.00	4.00	1.00	4.00
29	5.00	999.00	5.00	999.00	5.00	999.00	5.00
30	1.00	1.00	5.00	999.00	2.00	1.00	2.00
31	2.00	999.00	5.00	999.00	3.00	999.00	5.00
32	2.00	1.00	5.00	999.00	4.00	1.00	5.00
33	4.00	2.00	5.00	999.00	3.00	1.00	5.00

Case	Q20G1	Q20H	Q20H1	Q20I	Q20I1	Q20J	Q20J1
1	999.00	5.00	999.00	5.00	999.00	3.00	1.00
2	999.00	5.00	999.00	5.00	999.00	2.00	1.00
3	999.00	5.00	999.00	5.00	999.00	2.00	1.00
4	999.00	5.00	999.00	5.00	999.00	4.00	2.00
5	999.00	5.00	999.00	5.00	999.00	3.00	999.00
6	999.00	3.00	1.00	5.00	999.00	2.00	1.00
7	1.00	5.00	999.00	5.00	999.00	2.00	1.00
8	999.00	5.00	999.00	5.00	999.00	4.00	2.00
9	999.00	3.00	999.00	999.00	999.00	3.00	999.00
10	999.00	5.00	999.00	5.00	999.00	2.00	999.00
11	1.00	5.00	999.00	5.00	999.00	2.00	1.00
12	999.00	5.00	999.00	5.00	999.00	3.00	1.00
13	999.00	5.00	999.00	5.00	999.00	5.00	999.00
14	1.00	4.00	1.00	5.00	999.00	2.00	1.00
15	999.00	5.00	999.00	5.00	999.00	1.00	1.00
16	1.00	5.00	999.00	5.00	999.00	3.00	1.00
17	999.00	5.00	999.00	5.00	999.00	2.00	1.00
18	999.00	5.00	999.00	5.00	999.00	3.00	1.00
19	1.00	4.00	1.00	3.00	1.00	2.00	1.00
20	999.00	5.00	999.00	5.00	999.00	3.00	1.00
21	1.00	5.00	999.00	5.00	999.00	2.00	1.00
22	999.00	5.00	999.00	5.00	999.00	3.00	1.00
23	1.00	4.00	1.00	3.00	1.00	2.00	1.00
24	999.00	5.00	999.00	5.00	999.00	5.00	999.00
25	1.00	5.00	999.00	5.00	999.00	4.00	1.00
26	#NULL!	5.00	#NULL!	5.00	#NULL!	3.00	1.00
27	#NULL!	5.00	#NULL!	5.00	#NULL!	2.00	1.00
28	999.00	4.00	2.00	5.00	999.00	2.00	1.00
29	999.00	5.00	999.00	5.00	999.00	2.00	1.00
30	999.00	5.00	999.00	5.00	999.00	3.00	1.00
31	999.00	5.00	999.00	5.00	999.00	4.00	999.00
32	999.00	5.00	999.00	5.00	999.00	3.00	1.00
33	999.00	5.00	999.00	4.00	1.00	5.00	999.00

Case	Q20K	Q20K1	Q20L_Other
1	4.00	1.00	
2	5.00	999.00	
3	5.00	999.00	
4	5.00	999.00	
5	5.00	999.00	
6	5.00	999.00	
7	5.00	999.00	
8	5.00	999.00	
9	3.00	999.00	
10	5.00	999.00	
11	5.00	999.00	
12	5.00	999.00	
13	5.00	999.00	
14	5.00	999.00	
15	5.00	999.00	
16	5.00	999.00	
17	5.00	999.00	
18	5.00	999.00	
19	2.00	1.00	AFCEE
20	5.00	999.00	
21	5.00	999.00	
22	5.00	999.00	
23	2.00	1.00	
24	5.00	999.00	
25	5.00	999.00	
26	5.00	#NULL!	
27	5.00	#NULL!	
28	5.00	999.00	
29	5.00	999.00	
30	5.00	999.00	
31	5.00	999.00	
32	5.00	999.00	Ohio alternative energy group
33	5.00	999.00	

Case	Q20L	Q20L1	Q21A	Q21B	Q21C	Q21D	Q21E
1	999.00	999.00	1.00	1.00	1.00	1.00	2.00
2	999.00	999.00	1.00	1.00	1.00	1.00	1.00
3	999.00	999.00	3.00	1.00	1.00	1.00	1.00
4	999.00	999.00	1.00	1.00	1.00	1.00	1.00
5	999.00	999.00	1.00	1.00	1.00	1.00	1.00
6	999.00	999.00	1.00	1.00	3.00	1.00	1.00
7	999.00	999.00	1.00	1.00	1.00	1.00	1.00
8	999.00	999.00	1.00	1.00	1.00	1.00	1.00
9	999.00	999.00	1.00	1.00	1.00	1.00	1.00
10	999.00	999.00	3.00	3.00	1.00	2.00	1.00
11	999.00	999.00	1.00	1.00	1.00	1.00	1.00
12	999.00	999.00	2.00	3.00	1.00	1.00	2.00
13	5.00	999.00	1.00	1.00	1.00	1.00	1.00
14	999.00	999.00	1.00	1.00	1.00	1.00	1.00
15	5.00	999.00	1.00	2.00	1.00	4.00	1.00
16	999.00	999.00	1.00	1.00	1.00	1.00	1.00
17	999.00	999.00	1.00	1.00	1.00	1.00	1.00
18	999.00	999.00	1.00	2.00	1.00	1.00	1.00
19	3.00	1.00	1.00	3.00	1.00	1.00	1.00
20	999.00	999.00	2.00	1.00	1.00	1.00	1.00
21	999.00	999.00	1.00	1.00	1.00	1.00	1.00
22	999.00	999.00	2.00	1.00	1.00	1.00	1.00
23	#NULL!	#NULL!	1.00	1.00	1.00	1.00	1.00
24	999.00	999.00	1.00	1.00	1.00	1.00	1.00
25	999.00	999.00	1.00	1.00	1.00	1.00	1.00
26	#NULL!	#NULL!	1.00	1.00	1.00	1.00	1.00
27	#NULL!	#NULL!	2.00	1.00	1.00	1.00	1.00
28	999.00	999.00	2.00	2.00	1.00	1.00	1.00
29	999.00	999.00	1.00	1.00	1.00	1.00	1.00
30	999.00	999.00	1.00	1.00	1.00	1.00	1.00
31	999.00	999.00	3.00	1.00	1.00	1.00	1.00
32	2.00	1.00	2.00	2.00	2.00	1.00	1.00
33	999.00	999.00	1.00	1.00	1.00	1.00	1.00

Case	Q21F	Q21G	Q21H	Q21I_Other	Q21J_Other	Q21AVG
1	4.00	2.00	1.00	No Answe	999.00	1.63
2	1.00	1.00	1.00	No Answe	999.00	1.00
3	3.00	3.00	3.00	No Answe	999.00	2.00
4	1.00	2.00	1.00	No Answe	999.00	1.13
5	1.00	2.00	1.00	No Answe	999.00	1.13
6	3.00	3.00	1.00	No Answe	999.00	1.75
7	3.00	4.00	1.00	No Answe	999.00	1.63
8	1.00	1.00	1.00	No Answe	999.00	1.00
9	1.00	1.00	1.00	No Answe	999.00	1.00
10	2.00	3.00	2.00	No Answe	999.00	2.13
11	1.00	1.00	1.00	No Answe	999.00	1.00
12	3.00	3.00	3.00	No Answe	999.00	2.25
13	1.00	1.00	1.00	No Answe	999.00	1.00
14	1.00	4.00	1.00	No Answe	999.00	1.38
15	1.00	5.00	1.00	No Answe	4.00	2.00
16	4.00	4.00	1.00	No Answe	999.00	1.75
17	1.00	4.00	1.00	No Answe	999.00	1.38
18	4.00	2.00	1.00	No Answe	999.00	1.63
19	1.00	4.00	1.00	No Answe	999.00	1.63
20	2.00	2.00	1.00	No Answe	999.00	1.38
21	1.00	4.00	1.00	No Answe	999.00	1.38
22	1.00	1.00	1.00	No Answe	999.00	1.13
23	1.00	1.00	1.00	No Answe	999.00	1.00
24	1.00	1.00	1.00	No Answe	999.00	1.00
25	1.00	2.00	1.00	No Answe	999.00	1.13
26	5.00	1.00	1.00	No Answe	999.00	1.50
27	5.00	1.00	1.00	No Answe	999.00	1.63
28	1.00	4.00	1.00	No Answe	999.00	1.63
29	1.00	1.00	1.00	No Answe	999.00	1.00
30	3.00	1.00	1.00	No Answe	999.00	1.25
31	1.00	4.00	1.00	No Answe	999.00	1.63
32	3.00	1.00	1.00	No Answe	999.00	1.63
33	1.00	1.00	1.00	No Answe	999.00	1.00

Case	Q22	Q23A	Q23A_Normalized	Q23B	Q24A	Q24A_Normalized
1	8.00	8500.00	1.00	6000.00	6.30	3.00
2	2.00	10054.00	1.00	7957.60	10.00	4.00
3	4.00	38000.00	3.00	22000.00	15.00	5.00
4	1.00	13000.00	1.00	9000.00	8.00	3.00
5	1.00	19000.00	2.00	17000.00	4.50	2.00
6	3.00	19000.00	2.00	19000.00	7.00	3.00
7	1.00	13000.00	1.00	8500.00	7.90	3.00
8	4.00	9000.00	1.00	8000.00	5.00	2.00
9	6.00	24448.10	2.00	14360.10	6.00	3.00
10	1.00	12046.00	1.00	9560.00	2.49	1.00
11	1.00	12300.00	1.00	6400.00	3.40	2.00
12	5.00	6200.00	1.00	4500.00	4.00	2.00
13	2.00	13600.00	2.00	12400.00	5.14	2.00
14	1.00	7500.00	1.00	7800.00	5.00	2.00
15	2.00	19000.00	2.00	19000.00	8.56	3.00
16	1.00	5754.24	1.00	8383.68	8.00	3.00
17	1.00	23800.00	2.00	19500.00	9.50	4.00
18	1.00	30000.00	3.00	16000.00	8.50	3.00
19	3.00	21000.00	2.00	13000.00	5.40	2.00
20	1.00	13000.00	1.00	9000.00	7.20	3.00
21	2.00	28000.00	3.00	25000.00	8.13	3.00
22	1.00	12000.00	1.00	8000.00	4.80	2.00
23	3.00	21000.00	2.00	13000.00	5.40	2.00
24	2.00	13600.00	2.00	12400.00	5.14	2.00
25	2.00	6500.00	1.00	5500.00	4.00	2.00
26	2.00	19000.00	2.00	19000.00	8.00	3.00
27	2.00	19000.00	2.00	19000.00	8.00	3.00
28	1.00	13423.00	2.00	12186.00	4.20	2.00
29	1.00	23800.00	2.00	19500.00	3.56	2.00
30	2.00	6500.00	1.00	5500.00	4.00	2.00
31	2.00	16269.00	2.00	12614.00	4.40	2.00
32	1.00	65000.00	5.00	49000.00	4.50	#NULL!
33	2.00	5754.24	1.00	8383.68	6.36	#NULL!

Case	Q24B	Q25	Q26	Q27A	Q27B	Q27C	Q27D
1	6.30	2.00	1.00	2.00	1.00	3.00	1.00
2	10.00	3.00	2.00	5.00	3.00	5.00	4.00
3	2.00	4.00	1.00	5.00	4.00	4.00	4.00
4	8.00	4.00	1.00	1.00	1.00	2.00	3.00
5	4.50	3.00	2.00	4.00	3.00	4.00	4.00
6	7.00	3.00	2.00	2.00	5.00	2.00	2.00
7	7.90	4.00	1.00	4.00	4.00	4.00	4.00
8	5.00	4.00	1.00	5.00	3.00	4.00	3.00
9	2.50	3.00	1.00	5.00	3.00	3.00	3.00
10	2.49	3.00	1.00	5.00	1.00	5.00	3.00
11	3.40	4.00	2.00	1.00	2.00	3.00	1.00
12	4.00	3.00	1.00	5.00	4.00	5.00	4.00
13	5.14	3.00	1.00	5.00	2.00	5.00	1.00
14	5.00	3.00	1.00	2.00	2.00	2.00	2.00
15	8.56	4.00	2.00	5.00	5.00	5.00	5.00
16	8.00	2.00	1.00	4.00	4.00	4.00	4.00
17	6.06	4.00	1.00	3.00	1.00	2.00	1.00
18	8.50	4.00	2.00	4.00	3.00	4.00	4.00
19	6.20	4.00	2.00	5.00	4.00	4.00	5.00
20	7.20	4.00	1.00	3.00	3.00	2.00	2.00
21	5.63	4.00	2.00	5.00	5.00	5.00	5.00
22	2.30	3.00	1.00	4.00	2.00	4.00	1.00
23	6.20	4.00	2.00	5.00	5.00	5.00	4.00
24	5.14	3.00	2.00	5.00	3.00	5.00	3.00
25	4.00	4.00	2.00	4.00	4.00	3.00	3.00
26	8.00	4.00	2.00	5.00	5.00	5.00	5.00
27	8.00	4.00	2.00	4.00	3.00	3.00	4.00
28	2.70	4.00	1.00	4.00	2.00	3.00	2.00
29	2.83	4.00	1.00	2.00	3.00	4.00	3.00
30	4.00	4.00	1.00	5.00	5.00	5.00	5.00
31	4.40	4.00	1.00	5.00	4.00	4.00	2.00
32	2.00	4.00	1.00	5.00	2.00	4.00	3.00
33	6.36	2.00	1.00	3.00	3.00	3.00	3.00

Case	Q28A	Q28B	Q28C	Q28D	Q29	Q30	Q30A
1	4.00	4.00	3.00	4.00	3.00	1.00	4.00
2	5.00	5.00	3.00	5.00	3.00	1.00	4.00
3	3.00	4.00	5.00	5.00	3.00	1.00	4.00
4	2.00	3.00	3.00	4.00	5.00	1.00	4.00
5	4.00	3.00	3.00	4.00	5.00	1.00	4.00
6	3.00	3.00	4.00	4.00	5.00	1.00	1.00
7	4.00	3.00	4.00	5.00	3.00	1.00	5.00
8	4.00	4.00	4.00	4.00	5.00	1.00	5.00
9	2.00	1.00	2.00	1.00	3.00	1.00	4.00
10	5.00	5.00	5.00	5.00	4.00	1.00	5.00
11	4.00	5.00	1.00	3.00	3.00	1.00	2.00
12	4.00	4.00	4.00	5.00	3.00	1.00	5.00
13	1.00	1.00	1.00	5.00	2.00	1.00	5.00
14	1.00	1.00	1.00	4.00	2.00	1.00	4.00
15	5.00	5.00	5.00	5.00	5.00	1.00	5.00
16	3.00	3.00	3.00	4.00	3.00	1.00	5.00
17	5.00	5.00	4.00	5.00	5.00	1.00	5.00
18	4.00	4.00	3.00	4.00	5.00	1.00	4.00
19	5.00	5.00	2.00	5.00	5.00	1.00	5.00
20	3.00	2.00	3.00	4.00	3.00	1.00	2.00
21	5.00	5.00	3.00	5.00	5.00	1.00	3.00
22	4.00	4.00	2.00	4.00	5.00	1.00	3.00
23	5.00	5.00	3.00	5.00	5.00	1.00	5.00
24	5.00	5.00	5.00	5.00	3.00	1.00	4.00
25	3.00	3.00	4.00	3.00	3.00	1.00	2.00
26	5.00	5.00	5.00	5.00	5.00	1.00	5.00
27	4.00	4.00	3.00	3.00	5.00	1.00	3.00
28	2.00	2.00	2.00	4.00	5.00	1.00	5.00
29	2.00	3.00	1.00	3.00	3.00	1.00	3.00
30	5.00	5.00	3.00	3.00	2.00	1.00	4.00
31	2.00	4.00	1.00	5.00	2.00	1.00	4.00
32	3.00	2.00	2.00	4.00	5.00	1.00	5.00
33	2.00	2.00	2.00	4.00	3.00	1.00	1.00

Case	Q30B	Q30C	Q30D	Q31	Q31A	Q31B	Q31C
1	5.00	5.00	3.00	.00	999.00	999.00	999.00
2	5.00	5.00	5.00	.00	999.00	999.00	999.00
3	4.00	2.00	4.00	.00	999.00	999.00	999.00
4	5.00	5.00	5.00	.00	999.00	999.00	999.00
5	5.00	5.00	4.00	.00	999.00	999.00	999.00
6	1.00	5.00	4.00	.00	999.00	999.00	999.00
7	5.00	5.00	5.00	.00	999.00	999.00	999.00
8	5.00	5.00	5.00	.00	999.00	999.00	999.00
9	4.00	3.00	2.00	.00	999.00	999.00	999.00
10	5.00	5.00	5.00	.00	999.00	999.00	999.00
11	4.00	3.00	4.00	.00	999.00	999.00	999.00
12	5.00	5.00	1.00	.00	999.00	999.00	999.00
13	5.00	5.00	5.00	.00	999.00	999.00	999.00
14	4.00	5.00	4.00	.00	999.00	999.00	999.00
15	5.00	1.00	1.00	.00	999.00	999.00	999.00
16	4.00	5.00	5.00	.00	999.00	999.00	999.00
17	5.00	5.00	5.00	.00	999.00	999.00	999.00
18	5.00	4.00	5.00	.00	999.00	999.00	999.00
19	5.00	1.00	1.00	.00	999.00	999.00	999.00
20	3.00	4.00	4.00	.00	999.00	999.00	999.00
21	4.00	5.00	5.00	.00	999.00	999.00	999.00
22	3.00	3.00	4.00	.00	999.00	999.00	999.00
23	5.00	2.00	2.00	.00	999.00	999.00	999.00
24	4.00	5.00	3.00	.00	999.00	999.00	999.00
25	4.00	5.00	5.00	.00	999.00	999.00	999.00
26	5.00	1.00	1.00	.00	999.00	999.00	999.00
27	3.00	2.00	2.00	.00	999.00	999.00	999.00
28	5.00	5.00	5.00	.00	999.00	999.00	999.00
29	3.00	5.00	5.00	.00	999.00	999.00	999.00
30	4.00	4.00	5.00	.00	999.00	999.00	999.00
31	5.00	5.00	5.00	.00	999.00	999.00	999.00
32	5.00	1.00	2.00	.00	999.00	999.00	999.00
33	1.00	1.00	3.00	.00	999.00	999.00	999.00

Case	Q31D	Q31E	Q32	Q33	Q34A
1	999.00	999.00	1946.00	Columbus AFB	3.00
2	999.00	999.00	1972.00	Dover AFB	4.00
3	999.00	999.00	1933.00	Edwards AFB	3.00
4	999.00	999.00	1960.00	Goodfellow AFB	1.00
5	999.00	999.00	1954.00	Beale AFB	4.00
6	999.00	999.00	1951.00	Davis Montham	3.00
7	999.00	999.00	1950.00	Dyess AFB	3.00
8	999.00	999.00	1977.00	Little Rock	2.00
9	999.00	999.00	1944.00	Travis AFB	3.00
10	999.00	999.00	1946.00	Ellsworth AFB	4.00
11	999.00	999.00	1950.00	McChord	4.00
12	999.00	999.00	1979.00	Vance AFB	3.00
13	999.00	999.00	1941.00	Charleston	1.00
14	999.00	999.00	1951.00	FE Warren	3.00
15	999.00	999.00	1969.00	Nellis AFB	3.00
16	999.00	999.00	1982.00	Laughlin	3.00
17	999.00	999.00	1950.00	MacDill	3.00
18	999.00	999.00	1959.00	Shepperd AFB	4.00
19	999.00	999.00	1955.00	Buckley AFB	3.00
20	999.00	999.00	1954.00	Holloman	3.00
21	999.00	999.00	1976.00	Vandenberg AFB	3.00
22	999.00	999.00	1970.00	McConell AFB	3.00
23	999.00	999.00	#NULL!	Buckley AFB	4.00
24	999.00	999.00	1952.00	Charleston AFB	2.00
25	999.00	999.00	1965.00	Schriever AFB	3.00
26	999.00	999.00	1966.00	Luke AFB	2.00
27	999.00	999.00	1984.00	Luke AFB	3.00
28	999.00	999.00	1971.00	Minot AFB	3.00
29	999.00	999.00	1962.00	Hurlburt Field	3.00
30	999.00	999.00	1948.00	Schriever AFB	3.00
31	999.00	999.00	1967.00	Whiteman AFB	3.00
32	999.00	999.00	1957.00	Wright Patterson AFB	1.00
33	999.00	999.00	1979.00	Randolph AFB	3.00

Case	Q34B	Q35	Q35_Other	Q36A	Q36B
1	Mechanical Engineering	1.00	No Answer	2.00	7.00
2	Electrical Engineering	1.00	No Answer	8.00	.00
3	Mechanical Engineering	1.00	No Answer	20.00	.00
4	None	1.00	No Answer	4.00	.00
5	Electrical Engineering	1.00	No Answer	3.00	2.00
6	Electrical Engineering	1.00	No Answer	5.00	.00
7	Electrical Engineering	1.00	No Answer	13.00	4.00
8	NA	1.00	No Answer	.00	.25
9	Electrical Engineering	3.00	No Answer	#NULL!	#NULL!
10	Mechanical Engineering	1.00	No Answer	25.00	3.00
11	Electrical Engineering	1.00	No Answer	10.00	.00
12	Mechanical Engineering Tech	1.00	No Answer	3.00	2.00
13	NA	1.00	No Answer	10.00	3.00
14	Mechanical/Industrial Eng	1.00	No Answer	11.00	.00
15	Mechanical Engineering	1.00	No Answer	2.00	7.00
16	Electrical Engineering	1.00	No Answer	.00	5.00
17	Industrial Engineering	1.00	No Answer	3.00	8.00
18	Electrical Engineering	1.00	No Answer	8.00	11.00
19	Business Administration	2.00	No Answer	.00	6.00
20	Electrical Engineering	1.00	No Answer	1.00	8.00
21	Architectural Engineering	1.00	No Answer	.00	6.00
22	Electrical Engineering	1.00	No Answer	3.00	.00
23	Mechanical Engineering	1.00	No Answer	6.00	.00
24	HVAC	1.00	No Answer	6.00	9.00
25	Mechanical Engineering	1.00	No Answer	3.00	.00
26	Mech/Electrical Technicia	1.00	No Answer	.00	6.00
27	Civil Engineering	1.00	No Answer	.00	6.00
28	Mechanical Engineering	1.00	No Answer	5.00	7.00
29	Mechanical Engineering	1.00	No Answer	8.00	.00
30	Environmental Science	2.00	No Answer	.00	3.00
31	Mechanical Engineering	1.00	No Answer	9.00	.00
32	None	1.00	No Answer	12.00	10.00
33	Electrical Engineering	3.00	No Answer	.00	5.00

Case	Q36D	Q36_SeniorityMonths	Q37A	Q37B	Q37C	Q38A
1	7.00	31.00	1.00	1.00	1.00	4.00
2	.00	120.00	1.00	1.00	1.00	4.00
3	.00	24.00	1.00	1.00	1.00	3.00
4	.00	48.00	1.00	1.00	1.00	2.00
5	2.00	38.00	.00	1.00	1.00	4.00
6	.00	60.00	1.00	1.00	1.00	2.00
7	4.00	160.00	.00	1.00	1.00	3.00
8	.25	3.00	1.00	2.00	.00	1.00
9	#NULL!	58.78	.00	1.00	1.00	3.00
10	3.00	303.00	1.00	1.00	1.00	3.00
11	.00	180.00	.00	1.00	1.00	3.00
12	2.00	38.00	1.00	1.00	1.00	4.00
13	8.00	80.00	.00	1.00	1.00	3.00
14	.00	132.00	.00	1.00	1.00	3.00
15	7.00	7.00	1.00	1.00	1.00	4.00
16	5.00	5.00	1.00	1.00	1.00	2.00
17	8.00	44.00	1.00	1.00	1.00	4.00
18	11.00	107.00	1.00	1.00	1.00	3.00
19	6.00	6.00	1.00	.00	.00	5.00
20	8.00	20.00	.00	1.00	1.00	3.00
21	6.00	6.00	1.00	1.00	1.00	3.00
22	.00	36.00	.00	1.00	1.00	2.00
23	.00	72.00	1.00	1.00	1.00	5.00
24	9.00	81.00	.00	1.00	1.00	4.00
25	.00	36.00	.00	1.00	1.00	2.00
26	6.00	6.00	1.00	.00	.00	4.00
27	6.00	6.00	1.00	1.00	1.00	3.00
28	7.00	67.00	.00	1.00	1.00	4.00
29	.00	120.00	.00	1.00	1.00	2.00
30	3.00	3.00	1.00	2.00	.00	3.00
31	6.00	30.00	.00	1.00	1.00	3.00
32	7.00	7.00	1.00	1.00	1.00	5.00
33	5.00	5.00	1.00	1.00	1.00	1.00

Case	Q38B	Q38C	Q38D	Q38E	Q39	Q40	Q41
1	3.00	3.00	3.00	4.00	2.00	-2.00	#NULL!
2	3.00	3.00	2.00	4.00	4.00	4.00	#NULL!
3	4.00	4.00	4.00	3.00	4.00	.00	14.00
4	1.50	1.00	1.00	2.00	3.00	2.00	1.00
5	3.00	1.00	2.00	4.00	4.00	3.00	#NULL!
6	4.00	3.00	3.00	3.00	3.00	.00	#NULL!
7	4.00	4.00	2.00	4.00	4.00	2.00	#NULL!
8	1.00	1.00	1.00	1.00	3.00	.00	#NULL!
9	2.00	3.00	4.00	4.00	4.00	4.00	#NULL!
10	3.00	3.00	4.00	4.00	5.00	.00	#NULL!
11	4.00	2.00	3.00	3.00	5.00	-2.00	#NULL!
12	4.00	3.00	3.00	4.00	5.00	3.00	#NULL!
13	2.00	1.00	1.00	2.00	3.00	.00	1.00
14	4.00	3.00	2.00	4.00	3.00	2.00	#NULL!
15	5.00	5.00	5.00	5.00	5.00	5.00	1.00
16	3.00	3.00	3.00	3.00	4.00	.00	#NULL!
17	4.00	4.00	3.00	3.00	3.00	.00	#NULL!
18	2.00	2.00	2.00	2.00	4.00	-2.00	#NULL!
19	5.00	4.00	4.00	5.00	4.00	-2.00	12.00
20	2.00	2.00	2.00	2.00	3.00	.00	#NULL!
21	4.00	3.00	4.00	4.00	3.00	-1.00	#NULL!
22	3.00	2.00	3.00	2.00	4.00	-2.00	#NULL!
23	5.00	5.00	5.00	5.00	5.00	-3.00	12.00
24	3.00	3.00	3.00	3.00	4.00	.00	#NULL!
25	2.00	1.00	1.00	2.00	4.00	.00	#NULL!
26	2.00	2.00	2.00	3.00	5.00	4.00	1.00
27	3.00	2.00	2.00	2.00	3.00	3.00	1.00
28	3.00	2.00	2.00	2.00	4.00	-2.00	#NULL!
29	2.00	1.00	3.00	2.00	3.00	.00	#NULL!
30	3.00	3.00	2.00	2.00	4.00	.00	#NULL!
31	3.00	3.00	4.00	3.00	4.00	3.00	#NULL!
32	3.00	3.00	3.00	3.00	3.00	-2.00	8.00
33	1.00	1.00	1.00	1.00	3.00	.00	2.00

Case	Q42A	Q42B	Q42C	Q43A	Q43B	Q43C	Q44A
1	9.00	4.00	4.00	9.00	4.00	4.00	1.00
2	1.00	4.00	3.00	3.00	5.00	4.00	4.00
3	9.00	9.00	4.00	9.00	9.00	9.00	5.00
4	2.00	2.00	5.00	2.00	999.00	5.00	3.00
5	9.00	5.00	5.00	9.00	3.00	3.00	4.00
6	9.00	5.00	5.00	9.00	5.00	5.00	4.00
7	9.00	4.00	2.00	3.00	2.00	1.00	4.00
8	1.00	1.00	5.00	1.00	1.00	5.00	1.00
9	4.00	4.00	4.00	3.00	3.00	3.00	3.00
10	4.00	1.00	1.00	4.00	1.00	1.00	3.00
11	1.00	1.00	1.00	2.00	1.00	1.00	1.00
12	5.00	5.00	5.00	5.00	5.00	5.00	5.00
13	2.00	1.00	1.00	3.00	3.00	1.00	2.00
14	4.00	1.00	1.00	4.00	4.00	4.00	1.00
15	5.00	9.00	9.00	5.00	9.00	9.00	5.00
16	4.00	4.00	9.00	3.00	3.00	4.00	5.00
17	3.00	2.00	1.00	3.00	1.00	1.00	5.00
18	4.00	4.00	4.00	3.00	3.00	3.00	4.00
19	1.00	4.00	3.00	1.00	5.00	2.00	1.00
20	1.00	3.00	4.00	9.00	4.00	4.00	1.00
21	9.00	4.00	3.00	9.00	4.00	3.00	4.00
22	5.00	4.00	2.00	4.00	3.00	1.00	4.00
23	1.00	4.00	4.00	1.00	5.00	5.00	1.00
24	3.00	5.00	3.00	4.00	4.00	2.00	3.00
25	2.00	3.00	4.00	2.00	2.00	2.00	2.00
26	9.00	9.00	9.00	5.00	5.00	5.00	5.00
27	9.00	9.00	9.00	4.00	4.00	4.00	5.00
28	4.00	2.00	2.00	4.00	2.00	2.00	4.00
29	4.00	4.00	4.00	3.00	3.00	3.00	3.00
30	5.00	5.00	3.00	5.00	5.00	3.00	5.00
31	5.00	4.00	2.00	3.00	2.00	1.00	5.00
32	4.00	5.00	2.00	5.00	5.00	5.00	3.00
33	4.00	4.00	4.00	4.00	4.00	4.00	5.00

Case	Q44B	Q44C	Q45A	Q45B	Q45C	Q46
1	5.00	5.00	3.00	5.00	5.00	5.25
2	5.00	5.00	4.00	2.00	3.00	5.25
3	3.00	3.00	1.00	1.00	1.00	6.25
4	3.00	4.00	4.00	4.00	1.00	5.75
5	4.00	5.00	2.00	3.00	3.00	5.75
6	4.00	4.00	1.00	1.00	4.00	6.25
7	3.00	2.00	2.00	4.00	5.00	5.75
8	1.00	4.00	5.00	5.00	1.00	5.25
9	3.00	3.00	3.00	3.00	5.00	5.75
10	1.00	1.00	2.00	5.00	5.00	5.25
11	1.00	1.00	5.00	1.00	1.00	4.25
12	5.00	5.00	1.00	1.00	1.00	5.75
13	2.00	1.00	5.00	5.00	5.00	4.75
14	1.00	1.00	5.00	5.00	5.00	5.25
15	5.00	5.00	1.00	1.00	1.00	6.75
16	5.00	5.00	2.00	2.00	2.00	5.75
17	3.00	3.00	1.00	4.00	4.00	5.25
18	4.00	4.00	2.00	2.00	2.00	5.25
19	5.00	5.00	9.00	3.00	3.00	5.75
20	5.00	5.00	5.00	1.00	1.00	6.25
21	4.00	4.00	1.00	1.00	3.00	5.75
22	4.00	3.00	2.00	3.00	5.00	5.25
23	5.00	5.00	9.00	3.00	3.00	5.75
24	5.00	1.00	3.00	3.00	1.00	5.25
25	3.00	4.00	5.00	5.00	5.00	6.25
26	5.00	5.00	1.00	1.00	1.00	6.75
27	5.00	5.00	1.00	1.00	1.00	6.75
28	4.00	2.00	2.00	4.00	5.00	4.75
29	3.00	3.00	2.00	2.00	2.00	4.75
30	5.00	5.00	1.00	1.00	4.00	6.25
31	4.00	2.00	3.00	2.00	1.00	5.25
32	3.00	3.00	1.00	1.00	2.00	4.25
33	5.00	5.00	3.00	3.00	3.00	5.75

Appendix D. Factor Analysis Loadings

Measure Items (Questionnaire number)	Factor						
	1	2	3	4	5	6	7
Experience (1)	0.38						
Experience (9A)	0.73						
Experience (9B)	0.56						
Experience (9C)	0.34						
Experience (9D)	0.51						
Experience (21AVG)	0.54						
Experience (14A)	0.74						
Experience (14B)	0.77						
Experience (14C)	0.82						
Experience (14D)	0.76						
Experience (38A)	0.50						
Experience (38B)	0.83						
Experience (38C)	0.81						
Experience (38D)	0.76						
Experience (38E)	0.86						
Knowledge (10E)		0.56					
Knowledge (10G)		0.84					
Knowledge (10H)		0.73					
Familiarity (5C)			0.45				
Familiarity (7Overall)			0.48				
Familiarity (10G)			0.33				
Familiarity (4A)			0.80				
Familiarity (4B)			0.82				
Motivation (19B)				0.45			
Motivation (27A)				0.78			
Motivation (27C)				0.82			
Motivation (28D)				0.49			
Motivation (44A)				0.47			

Measure Items (Questionnaire number)	Factor						
	1	2	3	4	5	6	7
Interest (6B)					0.52		
Interest (6D)					0.43		
Interest (27B)					0.48		
Interest (27D)					0.49		
Interest (28C)					0.35		
Interest (42A)					0.43		
Interest (42B)					0.73		
Interest (42C)					0.72		
Interest (43A)					0.55		
Interest (43B)					0.62		
Interest (43C)					0.68		
Interest (44B)					0.63		
Interest (44C)					0.82		
Communication (30A)						0.93	
Communication (30B)						0.89	
Communication (30C)							0.67
Communication (30D)							0.70

Appendix E: Bibliography

Advanced Energy Initiative (2006, February). The White House Economic Council.

Air Force Renewable Energy Projects. (2006). Air Force Civil Engineer Support. Retrieved on August 4, 2006, from http://www.afcesa.af.mil/ces/docs/AFRenewableEnergyProjects_000.pdf

Alexander, P.A., Schallert, D. L., & Hare, V.C. (1991). Coming to terms: How researchers in learning and literacy talk about knowledge. *Review of Educational Research*, 61, 315-343.

Au, A. K., & Enderwick, P. (1999). A cognitive model on attitude towards technology adoption. *Journal of Managerial Psychology*, 15(4), 266-277.

Bandura, A. (1999). Self efficacy pathways to childhood depressions. *Journal of Personality and Social Psychology*, 76(2), 258-269.

Bearden, W. O., Netemeyer, R. G., & Teel, J. E. (1989). Measurement of consumer susceptibility to interpersonal influence. *Journal of Consumer Research*, 15(4) 473-481.

Bentley, R.W. (2002). Global oil & gas depletion: an overview. *Energy Policy*, 30, 189-205.

Blau, J. R., & McKinley, W. (1979). Idea, complexity, and innovation. *Administrative Science Quarterly*, 24(2), 200-219.

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

Bush, G. W. (2006). State of the union address. Retrieved from C-SPAN on July 3, 2006, from Website: http://www.whitehouse.gov/news/releases/2006/01/20060131-10.html

Byrne, B. M. (2001). *Structural equation modeling with AMOS: Basic concepts, applications and programming*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Camison-Zornoza, C., Lapiedra-Alcami, R., Segarra-Cipres, M., & M. Boronat-Navarro. (2004). A meta-analysis of innovation and organizational size. *Organization Studies*, 25(3), 331-361.

Canton, J. (2006). *The extreme future*. New York: Penguin Group Inc.

Chiras, D. (2006). *The homeowner's guide to renewable energy*. Gabriola Isand: New Society Publishers.

Comrey, A. L., & Lee, H. B. (1992). *A first course in factor analysis* (2nd Ed.). New Jersey: Erlbaum.

Cooper, J. R. (1998). A multi-dimensional approach to the adoption of innovation. *Management Decision*, 36(8), 493-502.

Damanpour, F., & Schneider, M. (2006). Phases of the adoption of innovation in organizations: Effects of environment, organization and top managers. *British Journal of Management*, 17, 215-236.

Dasgupta, S., Wang, H., & Wheeler, D. (1997). Surviving success: Policy reform and the future of industrial pollution in China. Retrieved on March 5, 2007 from http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/1997/11/01/000009265_3971229181112/Rendered/PDF/multi_page.pdf

Department of Defense renewable energy assessment: Final report (2005, March 14). Office of the Secretary of Defense.

Department of Defense Energy Scorecard, FY 2005, Office of the Deputy Under Secretary of Defense: Installations and Environment: Utilities & Energy. http://www.acq.osd.mil/ie/irm/Energy/energymgmt_report/fy05/Signed%20FY%202005%20scorecard.pdf

Dooley, D. (2001). Social research methods (4th Ed.). New Jersey:Prentice-Hall, Inc.

Dunphy, S., & Herbig, P. A. (1995). Acceptance of innovations: The customer is the key. *The Journal of High Technology Management Research*, 6(2) 193-209.

Echervarria, A. J. (1997). Dynamic inter-dimensionality: A revolution in military. *Joint Force Quarterly*, Retrieved on February 4, 2007, from http://www.dtic.mil/doctrine/jel/jfq_pubs/08_15.pdf

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

Environmental Protection Agency. Climate change- Greenhouse emissions. Retrieved on March 5, 2007, from http://www.epa.gov/climatechange/emissions/index.html.

Environmental Protection Agency. Oil program: Exxon Valdez. Retrieved on March 5, 2007, from http://www.epa.gov/oilspill/exxon.htm

Environmental Protection Agency. What are the benefits of green power? Retrieved on March 5, 2007, from http://www.epa.gov/greenpower/whatis/benefits.htm

Exec. Order No. 13,123, 64 Fed. Reg. 30, 851 (June 3, 1999). Retrieved from the Office of the Federal Environmental Executive on May 15, 2006, from Website: http://www.ofee.gov/eo/eo13123.pdf

Exxon Valdez Oil Spill Council (2006). Update on injured resources and services. Retrieved on March 5, 2007, from http://www.evostc.state.ak.us/Publications/Downloadables/2006_IRS_Update_Final.pdf

Faiers, A., & Neame, C. (2006). Consumer attitudes towards domestic solar power systems. *Energy Policy,* 34, 1797-1806.

Farhar B. C. & Coburn, T. C. (2006). *A new market paradigm for zero energy homes: The comparative San Diego case study* (Publication No. NREL/TP-550-38304-01). Retrieved on January 5, 2007 from author. Available at Website: http://www.osti.gov/bridge/

Fidler, L., A. (1984). Communication and innovation implementation. *The Academy of Management Review*, 9(4), 704-711.

Fink, A. (1995). How to measure survey reliability and validity. *The Survey Handbook*. Thousand Oaks:Sage Publications, 33-45.

Fotsch, P. M. (2001). The building of a superhighway future at the New York world's fair. *Cultural Critique*, 48, 65-97.

Gagnon, Y. C., & Toulouse, J. M. (1996). The Behavior of Business Managers When Adopting New Technologies. *Technological Forecasting and Social Change*, 52, 59-74.

Gee, R. C. & LaPort, C. (1999). *Financing solar energy systems with energy savings performance contracts in the federal sector: Results of a survey on barriers* (Publication No. NREL/SR-710-26700). Retrieved on January 5, 2007, from Website: http://www.osti.gov/bridge/

Gibbs, W. W. (2006, September). Plan B for energy. *Scientific American*, 45-55.

Gibson, J. L., Ivancevich, J. M., Donnelly, J. H. Jr., & Konopaske, R. (2006). *Organizations: Behavior structure processes*. (12th Ed.). New York:McGraw Hill Irwin.

Glossary of Energy-Related Terms (2007). U.S. Department of Energy: energy efficiency and renewable energy. Retrieved on 10 January 2007, from http://www.eere.energy.gov/consumer/information_resources/index.cfm/mytopic=60001#R

Goldman, E. O., & Leslie C. E. (2003), *The Diffusion of Military Technology and Ideas*. Stanford University Press.

Guagnano, G., Hawkes, G. R., Acredolo, C., & White, N. (1986). Innovation perception and adoption of solar heating technology. *The Journal of Consumer Affairs*, 20(1), 48-64.

Gulati, R. (1995). Does familiarity breed trust? The implications of repeated ties for contractual choice in alliances. *Academy of Management Journal*, 38(1), 85-112.

Herring, R. (2006, March 20). Solar energy's bright future. *Solar Energy Industries Association*. Retrieved on February 4, 2007, from http://www.seia.org/solarnews.php?id=108

Hirshman, W. P. (2006, September). The envelope please: IEA pvps confirms Germany's Oscar as the king of installed pv capacity. *Photon International*, 143-146.

Holak, S. L. (1988). Determinants of innovative durables adoption: An empirical study with implications for early product screening. *Journal of Product Innovation Management*, 5(1), 50-69.

Hubbert, K. M. (1956). Nuclear energy and fossil fuels. Presented to the American Petroleum Institute on March 7, 1956. Retrieved on September 17, 2006, from Website: http://www.hubbertpeak.com/hubbert/1956/1956.pdf

Kammen, D., M. (2006, September). The rise of renewable energy. *Scientific American*, 45-55.

Kaplan, A.W. (1999). From passive to active about solar electricity: innovation decision process and photovoltaic interest generation. *Technovation*, 19(8), 467-481.

Key World Energy Statistics (2006). International Energy Agency. Retrieved from. http://www.iea.org/w/bookshop/add.aspx?id=144

Lovins, A. B., & Kyle E. D. (2005). Winning the oil endgame. Rocky Mountain Institute.

Luke signs energy saving contract. (2006, January 20). *Thunderbolt*, 6(3), Luke AFB, AZ. Retrieved from Website: http://www.aerotechnews.com/Thunderbolt/Tbolt_012006.pdf

McNeil Technologies, Inc. (2004). Our solar power future: the U.S. photovoltaics industry roadmap through 2030 and beyond. Retrieved from the Solar Energy Industries Association on March 10, 2006, from Website: www.seia.org/roadmap.pdf

Mintzberg, H., Raisinghani, D., & Theoret, J. A. (1976). The structure of unstructured decision processes. *Administrative Science Quarterly*, 21, 246-275.

Moseley, M. T. (2006). Memorandum for record: research topics. Sent to Lieutenant General Stephen R. Lorenz, Air University Commander on April 11, 2006. Retrieved on November 20, 2006.

The National Renewable Energy Laboratory. (2007). About geothermal electricity. Retrieved from the National Renewable Energy Laboratory on February 3, 2007, from Website: http://www.nrel.gov/geothermal/geoelectricity.html

The National Renewable Energy Laboratory. (2007). Wind research. Retrieved from the National Renewable Energy Laboratory on February 3, 2007, from Website: http://www.nrel.gov/wind/

The National Renewable Energy Laboratory. (2007). Solar research. Retrieved from the National Renewable Energy Laboratory on February 4, 2007, from Website: http://www.nrel.gov/solar/

The National Renewable Energy Laboratory. (2007). Photovoltaic research: projects. Retrieved from the National Renewable Energy Laboratory on February 3, 2007, from Website: http://www.nrel.gov/pv/projects.html#more

The National Renewable Laboratory. (2007, Feburary 4). U.S. market share. Retrieved on February 4, 2007, from http://www.nrel.gov/pv/pv_manufacturing/market_share.html

Ormrod, R. K. (1990). Local context and innovation diffusion in a well-connected world. *Economic Geography,* 66(2), 109-122.

Ostlund, L. E. (1974). Perceived innovation attributes as predictors of innovativeness. *Journal of Consumer Research.* 1(2), 23-29.

Painuly, J. P. (2001). Barriers to renewable energy penetration; a framework for analysis *Renewable Energy*, 24(1), 73-89.

Park, W. C., & Lessig, P. V. (1981). Familiarity and its impact on consumer decision biases and heuristics. *Journal of Consumer Research,* 8(2), 223-230.

Penick, T., & Bill L. (2004). Photovoltaic power generation. Retrieved on February 7, 2007 from http://www.teicontrols.com/notes/TechCommunicationsEE333T/FinalReport-PhotovoltaicPowerGeneration.pdf

The PEW Research Center. (2001). From news interest to lifestyles, energy takes hold: Americas new number one problem. Retrieved on February 3, 2007, Website: http://people-press.org/reports/display.php3?PageID=67

Podsakoff, P., M. & Organ, D., W. (1986). *Self-reports in organizational research: Problems and prospects*. Journal of Management, 12(4) 531-541.

Port, O. (2004, September 6). Another dawn for solar power. *Businessweek*. Retrieved on February 4, 2007, from http://www.businessweek.com/magazine/content/04_36/b3898119_mz018.htm.

Rogers, E. M. (1976). New product adoption and diffusion. *Journal of Consumer Research*, 2(4) 290-301.

Rogers, M. E. (2003). Diffusion of innovations (5th Ed.). New York:Free Press.

Schwab, D. P. (2005). *Research methods for organizational studies* (2nd Ed.). New Jersey: Erlbaum.

Sherwood, L. (2006). Million solar roofs initiative: metrics. Interstate Renewable Energy Council.

Silicon meltdown (2002, June). *PV Power.* Retrieved on October 11, 2006, from http://www.iea-pvps.org/pvpower/16_03.htm

Silicon valley goes solar. (2006, September 27). Retrieved on September 27, 2006, from Zee News International Edition Website: http://www.cnn.com/2006/TECH/09/25/silicon.valley.solar.ap/index.html

Smith, C. (2006). History of solar energy: revisiting solar power's past. Retrieved on October 15, 2006, from Website: http://www.solarenergy.com/info_history.html

Szajna, B. (1996). Empirical evaluation of the revised technology acceptance model. *Management Science*, 42(1), 85-92.

Tabachnick, B. G. & Fidell, L. S. (1996). *Using multivariate statistics* (3rd Ed.). New York: Harper-Collins College Publishers.

Thogersen, J. & Olander, F. (2003). Spillover of environment-friendly consumer behavior. *Journal of Environmental Psychology,* 23, 225–236.

Tobias, S. (1992). Interest and metacognition in mathematics. Paper presented at a symposium on interest, attention, and knowledge acquisition at the annual meeting of the American Education Research Association, San Francisco.

Tobias, S. (1994). Interest, prior knowledge, and learning. *Review of Educational Research*, 64, 37-54.

United States Department of Energy. (2006). International energy outlook. Retrieved on September 17, 2006, from http://tonto.eia.doe.gov/FTPROOT/forecasting/0484(2006).pdf

United States Department of Energy: Renewable energy annual 2004 with preliminary data for 2004 (2004). *Energy Information Administration*. Retrieved on June 30, 2006, from http://tonto.eia.doe.gov/FTPROOT/renewables/060304.pdf

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. (2003). User acceptance of technology: Toward a unified view. *MIS Quarterly*, 27(3), 425-478.

Weenig, M. (1999). Communication networks in the diffusion of an innovation in an organization. *Journal of Applied Social Psychology*, 29(5), 1072-1092.

Welter, P, Siemer, J., & Hering, G. (2006, September). Searching for the holy grail: The short path to a self-supporting pv market. *Photon International*, 160-163.

Wilton, P. C. & Pessemier, E. A. (1981). Forecasting the ultimate acceptance of an innovation: The effects of information. *Journal of Consumer Research,* 8(2), 162-171.

The World Bank (2002). Sustainable development in a dynamic world: Transforming Institutions, growth, and quality of life. Retrieved on March 5, 2007, from http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2002/09/06/000094946_02082404015854/Rendered/PDF/multi0page.pdf

Yu, X. & Gilmour, A. (1996). Current limitations on further introduction of renewable energy systems in the south pacific. *Energy Policy*, 24(8) 697-711.

Zahedi, A. (2006). Solar photovoltaic energy; Latest developments in the building integrated and hybrid pv systems. *Renewable Energy*, 31, 711-718.

Zuhlsdorf, M. J. (2002). Aerospace expeditionary force implementation and the effect on team cohesion. Unpublished doctoral dissertation, United States Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio.

Zweibel, K. (2004). 2nd Generation (2G) PV: CdTe, CIS, and a-Si Thin Films and some reflections on the federal R&D program. Retrieved from the National Renewable Energy Laboratory on April 10, 2006, from Website: www.nrel.gov/pv/thin_film/docs/zweibel_rice_2004_2g_thin_films.ppt

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 074-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From – To)*
22-03-2007	Master's Thesis	August 2005 – March 2007

4. TITLE AND SUBTITLE

Diffusion of Innovation: Factors Promoting Interest in Solar Photovoltaic Generation Systems within Air Force Installations

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Diaz, Jr., Daniel, Captain, USAF

5d. PROJECT NUMBER
NA

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)
Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 Hobson Way
WPAFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT/GEM/ENV/07-M3

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AFCESA
Attn: Mr. Jim Snooks
139 Barnes Drive Suite 1
Tyndall AFB, FL 32403-5319 Commercial: (850) 283-6295

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The purpose of this research was to identify factors which promote interest in solar photovoltaic generation systems for facility use within the United States Air Force. The construct model was developed based on past literature on Diffusion of Innovation Theory. The model comprised of measures defined as motivation, knowledge, experience, and familiarity as well as contextual variables. These measures were then used to determine whether any significant association existed between the measures and the overall dependent variable, interest. A phone interview was conducted on Air Force energy managers located within the continental U.S. The methods of correlation and regression analysis were used to evaluate the objectives and hypotheses identified.

Results indicate that there is a positive, significant relationship between the motivation to seek new energy technologies for reducing load demands and interest in solar photovoltaic generation systems. The significant factors promoting interest were identified as knowledge, the amount of solar irradiance a base receives, the peak electrical demand loads of a base, and the population size of a base.

15. SUBJECT TERMS
Diffusion of Innovation, Innovation-Decision, Motivation, Knowledge, Experience, Familiarity, Interest, Solar Photovoltaics, Adoption, Energy Managers

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
					Alfred E. Thal, Jr.., Ph.D., USAF (ENV)
REPORT	**ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(Include area code)*
U	U	U	UU	156	(937) 255-3636, ext 4591; e-mail: alfred.thal@afit.edu

Standard Form 298 (Rev: 8-98)
Prescribed by ANSI Std. Z39-18