# STUDY OF PURCHASE INTENT FOR SOLAR RENEWABLES IN THE INDIAN DOMESTIC HOUSEHOLDS

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Research Proposal submitted to the Aligarh Muslim University for registration for PhD Degree


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**RESEARCH PROPOSAL SUBMITTED TO THE ALIGARH MUSLIM UNIVERSITY FOR REGISTRATION FOR PHD DEGREE**

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ABSTRACT

Increasing demand of energy has triggered a wave of alternate energy options in the society. In particular, solar energy has shown considerable promise world over and the sector has been growing with dramatic reduction in commercial pricing, improved efficiencies and improved deployments/usage conveniences. With an increased focus on green technologies, there is a considerable need for improving the penetration of this initiative. This research proposes to review models of consumer behaviors like theory of planned behavior/ past performance/ diffusion of technologies/ black box of consumer behavior and focusses on a quantitative approach to understand the Indian consumer's purchase intent as a function of the consumer's attitude to solar purchase duly toned by the impact of the perceived normative behavior in the society –AND the perceived controls on the solar renewable purchase behavior. Besides an improved understanding of enablers/inhibitors in the solar consumer behavior, the study hopes to identify policy & marketing interventions to build the sector.

## RESEARCH HIGHLIGHTS

- Empirical analysis of attitudes to solar purchase; opinion leader/ opinion seeker perspectives; subjective norms and perceived behavior controls including perception of solar SI expertise; switching costs/ fears and consumer self-confidence in solar

- Quantitative model of solar purchase intent in Indians along with inferential and descriptive statistical analysis of the solar consumer related behavioral factors

## KEYWORDS

Solar Technology awareness, Theory of planned behavior, solar consumer, opinion leaders - influencers/subjective behavior, green habits, solar attitudes/ behavior controls

## DISCLAIMER

This research proposal is the author's original work and has not already been presented, published or submitted for presentation or publication.

We need to target 50% of our electricity from solar by 2030…

Prof Ashok Jhunjhunwala, IIT Chennai

# INTRODUCTION

Sustainable development mandates efficient use of natural resources. To build our energy security, and to promote universal access to energy as a part of our inclusive growth programs, India needs to review mining the renewable energy sources like solar in a more efficient manner.

With the Jawaharlal National Solar Mission, India has embarked on an ambitious mission of 'farming' 22GW+ of solar power in India by 2022. Having achieved 2GW solar installation base in Sep 2013, and with a clear roadmap for the 12th plan, the target is very much achievable.

However, long run success of the solar mission is when it evolves devoid of any state supported subsidy as a social revolution with societal acceptance and use of the solar technologies and the solar resource. The shift to cleaner energy sources will be driven by addressing various technical, financial and institutional constraints. The last frontier will be the human resistance to change.

*This study is a part of the author's PhD research work and focusses on the purchase intent of the Indian solar renewable consumer and builds a consumer buyer behavior model using an empirical study based on the theory of planned behavior.*

# SOCIAL PENETRATION OF RENEWABLE ENERGY

Popular Solar Technologies in the market place are based on either Solar Thermal (heating) or Solar Photovoltaic (electricity generation).

Solar Water Heater Systems (SWHS) based on solar thermal technologies have gained considerable penetration in parts of India – specifically, in Karnataka and parts of South Maharashtra. On the other hand, despite having started in North India, the SWHS penetration in North is very low. Discussions with the industry have indicated a history of poor performing products on issues like:

- Use of soft water systems, while most parts in North India had hard water that' scaled and corroded systems that worked in Southern India

- Use of copper tubes in the heat collectors where hard water scales insulated and degraded performance over time
- Inadequate understanding of thermal engineering issues by local plumbers and inadequately trained technicians which compromised the execution by using GI pipes without insulation, under-spec'd the system against requirements, used larger diameter pipes with more start-up waste water…and with inadequate understanding of many design nuances.

Yet, the successful users of the SWHS were a highly satisfied lot, with fast payback of investment and convenient, 24 hr hot water supply as needed. Definitely, cities like Bangalore have seen a high penetration get achieved basis the satisfaction of the user base.

Solar Photovoltaic or SPV technologies generate electricity directly from the Sun. The DC voltage generated can be stored in a battery, converted to AC in an inverter for domestic use – or fed directly on a dc line to dc devices like LED lighting, DC fans and electronics. This technology has also shown considerable traction and growth in select global markets. Germany is the highest solarized nation in the world. And it achieved 50% of its national electricity needs on 27 May'12 thru solar! Again, rooftop solar PV farming like Germany is going to be increasingly technically, commercially feasible over the coming decades.

However, a relevant factor that has to be understood and addressed is the social acceptance of the solar technologies. Human resistance to change has created the new product diffusion curve – linked to the psyche of the users at various stages in the new product diffusion cycle. The early adapters are the techno-maniacs and visionaries who adopt the product for its technology or application promise…the pragmatists demand a practical ROI. However, seed the early adopters well, capture the opinion leaders – and the right marketing can set the stage for the product concept to go mainstream.

## REVIEW OF EXISTING LITERATURE

Like many countries, India faces a series of fundamental challenges related to energy and electricity use. Growing consumption of energy fuels and services bolsters the Indian economy, but also exposes it to volatile

prices, depleting resources/ costly imports and potential disruptions in supplies. Providing electricity to rural villages is a stated goal – but in many cases it is difficult to reach the hinterlands and the cost of conventional grid electricity deployment is phenomenal. A renewable strategy has inevitably become a part of the energy mix that most nations are rolling out.

In India, this initiative is driven by the Government of India thru Ministry of New & Renewable Energy (MNRE). The MNRE initiative is captured in its policy document- Jawaharlal Nehru National Solar Mission Phase II(2013). The draft document for phase II records ambitious goals for solarization as:

- SWHS to grow from 5.83 mln sq. meters installed capacity on 31st Aug'12 to grow by additional 8 mln sq. meters in the plan period 2012-2017 – and to aim at 20 sq. meters cumulative installed base by 2020.
- Solar PV (SPV) to grow from ~1 GW of installed base in end 2012 by additional 10 GW in 2012-2017 plan period – and aim at 22+ GW by the end of 2022. The NDA Government has now set a goal of scaling up the Solar plan by an order of magnitude to enable 30+GW by end 2017 and 100 GW by end 2022.

Both these objectives set a measurable goal with industry, academia and Government aligning on the vision of solarizing India. In fact, Dr Ashok Jhunjhunwala(Jhujhnwala 2013) in his paper at the National Conference on "accelerating technology innovation for inclusive and sustainable growth' has presented a paper "Targeting 50% of Indian electricity needs thru solar by 2030" – outlining potential technology/paths to the goal.

However, the final results will depend on the social acceptance of solar technologies and policies.

A healthy collection of the energy policy literature has explored the behavioral aspects of energy and solar usage. Most of these studies have reviewed the behavioral patterns and social acceptance in the United States, Europe, China and other developed countries. Upham(Upham P 2009) conducted a large scale study in United Kingdom to investigate the main theoretical issues in relation to social acceptance and a broader

range of energy technologies. Coad and Woersdorfer's study (PH Coad 2009) showed that social acceptance of green cars from consumers will be improved with the introduction of fiscal incentive and promotion.

Wustenhagen study (R Wustenhagen 2007) substantiates that social acceptance should be taken into consideration during policy making as it is hard to achieve the goal of renewable energy development with low level of social acceptance. The social acceptance of local residents to the renewable energy technologies is influential not only to the renewable energy project itself but also to the success of the sustainable development of that region (PD Rio 2008) . In this context, Lloyd & Rouileau's work on international policy (Lloyd CR 2008) issues regarding solar water heating, with a focus on New Zealand, looks at international policies regarding solar water heating to see which aspects have been effective in gaining an increased penetration of solar systems for water heating. Gillingham also studied the economic efficiency of solar hot water policy (Gillingham 2009) in New Zealand.

Emmanuel Ndzibah studies the diffusion of solar technologies in Ghana and his study (Ndzibah 2010) indicates that for users in developing countries affordability, finance and accessibility was more important than 'greenness' of the solar energy. Paul & Uhomibi's work (DI Paul 2012) on solar power generation and sustainable development in emerging economies brings out the problems of lack of qualified solar technicians in un-established Photovoltaic (PV) markets among other issues. Riad Chedid has reviewed the policy development for solar water heaters in Lebanon (Chedid 2002) given the usual constraints of technical, financial limitations, decision criteria and policy instruments. Michelson & Madlener have looked at Theory of Planned Behavior to propose an integrated framework for a homeowner's decision in favor of a residential heating system with specific reference to the German market(Michelsen and Madlener 2011) .

Yuan, Zuo and Ma (Xueliang Yuan 2011) have studied the social acceptance of solar energy technologies in China from the end user perspective in Shandong province. Dianshu, Sovakul and Vu have done an assessment of household electricity savings and consumer behavior in Liaoning province of China(Feng Dianshu 2010). Li Xuesong , Li Hao and Wang Xingwu have applied the Theory of Planned Behavior to suggest interventions to introduce solar houses to Chinese farmers and stimulate market activities (Li, Li et al. 2013).

Relatively less work has been done on the patterns and barriers in India. Patil & Garud has covered the trials and tribulations of Harish Hande, social entrepreneur in solar sector at SELCO (Rakesh Kumar Pati 2011) – his rural solarization entity. Anoop Singh has reviewed the economics of supplying CFL/LED/solarized energy options to hawkers (Singh 2009) and policy interventions for low income group transition to these technologies. Pillai & Banerjee (IR Pillai 2007) have given a theoretical framework for estimating the potential for solar water heating in a target area with an illustration for a synthetic area in India with an area of sq. 2 km and a population of 2000. However, their approach though quantitatively describing the potential is limited in scoping the diffusion barriers and enablers in the estimation. Purohit and Michaelowa have studied the CDM potential of solar water heating systems in India and looked at policy interventions on subsidies linked to the CER revenue(P Purohit 2008).

## RESEARCH GAPS IDENTIFIED FROM THE LITERATURE SURVEY

A review of the existing literature brings out that there is no quantitative research employing theory of planned behavior in the context of the Indian (individual/residential) solar renewable buyer behavior.

As India looks at scaling up its solar program by a clean order of magnitude, there is a need to explore the consumer behavior of the solar renewable adopters beyond the conventional price sensitivity tests and to explore mechanisms for improved solar penetration – a global need at this time.

This research focusses on the behavioral factors that could underlie the solar penetration, role of the opinion leaders in the community, the gaps in the perceived execution of solar programs in India. There is a need to study the differences in solar penetration in Delhi NCR vs high penetration cities like Bangalore. There is also a clear need to review the study in the Indian context given the economic and socio-cultural differences unique to Indians.

This study will also establish the information sources and the opinion leaders normally consulted by the solar renewable adapters. Intuitively, construction industry is influenced by the builders/architects who are intimately involved in the design and recommendations for home constructions. Understanding of their role vs

traditional solar system integrators will hopefully give clear indicators for policy intervention to improve successful solar installations/ satisfied user base and solar penetration goals.

## RESEARCH SCOPE/ TARGET CUSTOMER

In its scaled vision of the National Solar Mission Phase II, Indian Government has put a target of 100 GW of solar electricity installations by 2022. Of this, 40GW is proposed as solar rooftop. Given that this installation base is barely ~100 MW at this time, this represents a phenomenal aspirational goal in ~7-8 years. As a rough thumb rule, the solar rooftop market is estimated at $40bln cumulative till 2022.

The rooftop solar market can further be divided into the institutional buyer and the domestic/residential buyer. We are focusing this research scope to the target customer of the individual domestic/residential buyer. Following additional elements will qualify the target customer being studied at this stage:

- Since this customer is not an institutional buyer, his requirement is typically quantified as <5 KW, or less than 300 litres capacity water heating requirement.
- We will study this for two metros for a category (tentative: SWHS/SPV will be benchmarking Delhi NCR (emerging SWHS/SPV penetration) wrt (higher SWHS/ SPV penetration metros).
- Since the domestic household user must potentially have terrace rights, we are likely looking at a SEC A/B decision maker in a nuclear or joint family with a home/roof access.
- We will also review the political/economic 'will' in the form of policy support for rooftop solar in the specific territory being considered. This becomes relevant as traditionally government has used a subsidy incentive as a basis to catalyze the solar consumer.

## RESEARCH OBJECTIVES & QUESTIONS

To understand and give some suitable explanation for the solar renewable purchase decision by individuals, it is important to explore which behavioral factors influence the decisions of Indian Individual/domestic solar renewable adaptors.

This research focuses on achieving the following objectives:

1. Identify possible behavioral factors/ attitudes influencing the renewable solar purchase decisions of individual Solar buyer in India
    - Identify the perceived control behavioral factors of individual Solar buyer on solar purchase intent
    - Identify Sources of information, Opinion leaders consulted by individual Solar buyer and the societal perceptions
2. Develop a model of Solar purchase intent as linked to behavioral attributes like attitudes, perceived societal norms, perceived controls on behavior of Individual Solar buyer

To achieve the research objectives, some questions are framed. The study may be investigating the following queries:

- What are the behavioral variables influencing the individuals purchase of solar?
- Are green habits for solar buyer significantly different from those of non-Adopters?
- What sources of information are consulted? Profiles of the opinion leaders consulted? What was the perceived expertise of the opinion leader?
- What triggers purchase intent – green habits/ attitudes, economic benefits or social pressures?
- What is the impact of government policy on the purchase intent?
- Are there any differences between behavioral or demographic variables profiling the solar buyer in low and high penetration markets in India?

**Significance of the research**

Parts of India have seen some success in their deployment of Solar Water Heater Systems (SWHS) – Solar PV (SPV) is a relatively emerging option in the Indian landscape especially in the Individual buyer category. The research should help generate a profile of the individual Solar Renewable technology adopter and of the behavior factors enabling the solar purchase decision.

By investigating the opinion leaders consulted, usage satisfaction it should be possible to develop suitable policy and marketing/ technical programs to enable an improved satisfaction rate/ solar penetration.

## CONCEPTUAL FRAMEWORK

Consumer behavior traditionally leverages a black box model of external stimuli, internal stimuli/ consumer characteristics and the decision process and buyer response. Consumer psyche is a key element of the overall buying behavior – and in the diffusion of technologies. Past performance & User experience are important inputs in the buying decision. At one side, the marketing stimuli shape the buyer response – at the other side, trends in the buyer environment, social influences/ peer pressures shape the buyer response.

| **Environmental factors** | | **Buyer's black box** | | **Buyer's response** |
|---|---|---|---|---|
| **Marketing Stimuli** | **Environmental Stimuli** | **Buyer Characteristics** | **Decision Process** | |
| Product<br>Price<br>Place<br>Promotion | Economic<br>Technological<br>Political<br>Cultural<br>Demographic<br>Natural | Attitudes<br>Motivation<br>Perceptions<br>Personality<br>Lifestyle<br>Knowledge | Problem recognition<br>Information search<br>Alternative evaluation<br>Purchase decision<br>Post-purchase behavior | Product choice<br>Brand choice<br>Dealer choice<br>Purchase timing<br>Purchase amount |

The research framework is based on I Ajzen's Theory of Planned Behavior (TPB) which gives a predictive persuasive model linking beliefs and behaviors. Essentially, the TPB says that attitude towards a behavior;

subjective norms and perceived behavior control (or capacity/self-efficacy for that behavior) will build individual behavior intention and lead to actual behavior.

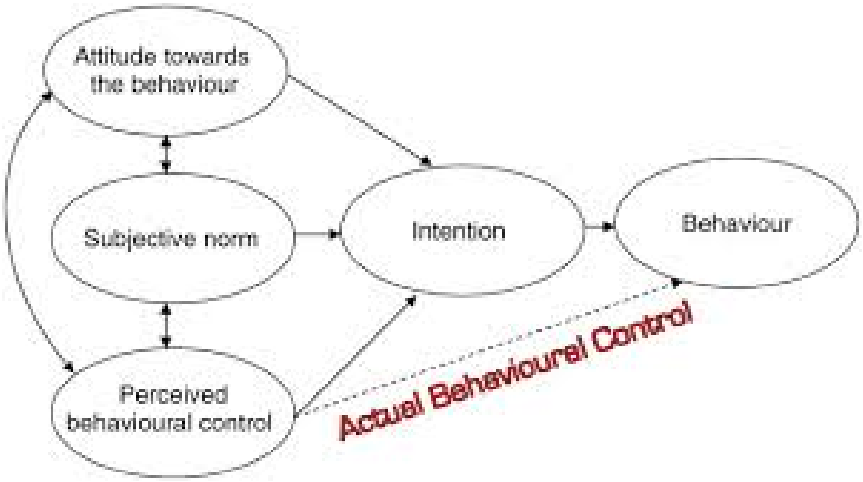
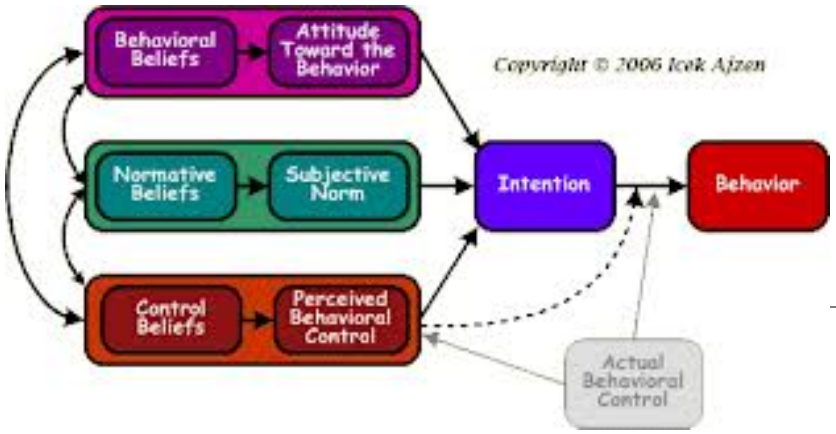



**Exhibit 1. Source: Icek Ajzen, 1985, Theory of Planned Behavior**

Human behavior is guided by three kinds of consideration,

1. **"Behavioral beliefs or attitudes,"** which is defined as the degree of favorableness (or un-favorableness) of a person's evaluation of a behavior.
2. **"Normative beliefs," or "Subjective Norm"** is the individual's perception regarding approval and disapproval of his behavior by significant others. The direct influencers may be family, friends, colleagues, or immediate proximity neighbors. For example, a normally controlled personality joining a crowd cheering a team in a stadium is getting normative support from the crowd!
3. And "control beliefs" or "**perceived behavioral control**" is defined as an individual's perception of ease or difficulty in performing the behavior of interest, linked to resources, opportunities, self-confidence.

In their respective aggregates, "behavioral beliefs" produce a favorable or unfavorable "attitude toward the behavior"; "normative beliefs" result in "subjective norm"; and "control beliefs" gives rise to "perceived behavioral control."




In combination, "attitude toward the behavior," "subjective norm," and "perceived behavioral control" lead to the formation of a "behavioral

intention". In particular, "perceived behavioral control" is presumed to not only affect actual behavior directly, but also affect it indirectly through behavioral intention.

As a general rule, the more favorable the attitude toward behavior and subjective norm, and the greater the perceived behavioral control, the stronger the person's intention to perform the behavior in question should be. Finally, given a sufficient degree of actual control over the behavior, people are expected to carry out their intentions when the opportunity arises.

In its simplest form, the theory of planned behavior can be expressed as the following mathematical function:

$$BI=(W_1)AB[(b)+(e)]+(W_2)SN[(n)+(m)]+(W_3)PBC[(c)+(p)]$$

*BI*: Behavioral intention

*AB*: Attitude toward behavior

(*b*): the strength of each belief

(*e*): the evaluation of the outcome or attribute

*SN*: Subjective norms

(*n*): the strength of each normative belief

(*m*): the motivation to comply with the referent

*PBC*: Perceived Behavioral Control

(*c*): the strength of each control belief

(*p*): the perceived power of the control factor

*W' : empirically derived weight/coefficient*

To the extent that it is an accurate reflection of actual behavioral control, perceived behavioral control can, together with intention, be used to predict behavior.

TPB has been applied to study, predict and influence behavior in health, nutrition and environment psychology. In environment psychology, it has been used to explain why despite sustainable beliefs individuals can have unsustainable actions.

TPB's limitations are that it is primarily linked to theory of reasoned behavior – and impulse, emotive or habituated behavior is not modelled in it.

We propose using the TPB framework in the following manner. We propose testing the linkages between the following variables in the TPB framework as applied to the solar renewable buyer in the Indian context.

| Belief Type | Variables |
|---|---|
| **Attitude towards Solar Renewable Usage (SWHS; SPV)** | • Green Habits<br>• Perceived Usage Economic Benefit<br>• Perceived Government Benefit<br>• Perceived other Usage benefits<br>• Existing Solar usage related perceptions (satisfaction/ Regret)<br>• Opinion Seeker/ Techno-maniac/ Visionary/ Pragmatist buyer profile |
| **Subjective Norms** | • Opinion leaders ( Architects, Builders, Solar System Integrators) voice<br>• Influencer (Friends, family, referral) voice |
| **Perceived Business Control** | • Finance availability |

| | |
|---|---|
| | • Perception of Switching cost<br>• Home owner/ roof access<br>• Consumer Self-confidence<br>• Perception of Solar System Integrator Expertise |
| **Behavior Intention** | • Purchase intention for a rooftop solar renewable solution |

# RESEARCH METHODOLOGY

This section presents the research design of the study as well as the targeted population, and the methods used to collect and analyze data. It starts with discussing the choice of research design, a description of the population/universe and the sampling technique to be used. In addition, a brief description of the data collection process and the data collection instrument is presented along with the explanation of the questionnaire design and the measurements. Data Analysis and statistical techniques including Descriptive Statistics, Factor Analysis, Cronbach Alpha reliability test and Structural Equation Modelling are discussed in the remaining parts of the synopsis.

## A. RESEARCH DESIGN

**Stage I.** At the exploratory phase of the study, a cross-section of the organizations involved in the solar sector as well as end-users would be visited and based on semi-structured interviews and secondary data, an assessment of the behavioral factors, usage behavior, post purchase satisfaction, opinion leaders and their roles/behaviors would be developed. This stage, coupled with literature review, will also help decide on the target regions for the study ( Delhi/NCR vs high-penetration region). Further, this stage will also give the

indicators to decide the type of opinion leader that will be researched for his role in the solar penetration (example. solar vendor; architect; local fitter/plumber).

Initiating indications are that Bangalore could be a reference point as a SWHS high-penetration market while Gandhi Nagar could be a reference point for a SPV high-penetration market. Also, generic opinion leader for home builders (individual buyers) could be the architect.

This would be used in further fine-tuning the stage II design.

**Stage II.** At this stage, primary research would be conducted in 2 regions/cities (Delhi/NCR vs higher solar penetration metros):

a. On the solar renewable technology adopters
    a. Behavior factors
    b. Information seeking pattern/opinion leader profile consulted
    c. Satisfaction level/ reasons
    d. Post purchase referral behavior
    e. Demographic profiles
b. On the home-makers who are not using solar renewables
c. On the opinion leaders and their attitudes/awareness levels for solar renewables

## B. POPULATION / UNIVERSE

- Target base of Individual Solar rooftop buyers/prospective buyers
    - It should also be possible to get a list of individual home owners from the resident welfare associations in the targeted regions. Example: Delhi NCR – we can use published Circle rate classification to get colonies at particular premium level – then use the RWA database for the resident lists.
- Target base of Opinion leaders

- A comprehensive All India Architect Directory is available from the Council of Architects listing practicing architects by the region. It can be further reviewed by adding the local chapter data. For example, there are 436 architects in Gurgaon and 229 architects in Faridabad as per the Council of Architects. There are over 12000 practicing architects registered with the Indian Council of Architects. It is proposed to improve the coverage/ reduced the cost per contact by using a mixture of web-surveys (forms designed on SurveyMonkey), tele-marketing and field contacts.

- Target base of Individual Solar Renewable Users
  - In India, most states incentivize individual solar renewable buyers of SWHS and SPV systems. It is proposed to requisition this list of subsidized users if required.

## C. SAMPLING PROCEDURE

In statistics, a sampling frame is the source material or device from which a sample is drawn. It is the list of all those within a population who can be sampled. In this study, the sampling frame is evolving from well-defined database/ sources as described above.

As the research aims at exploring the behavioral factors of Indian investor, a relative large sample size is planned. We are targeting generating at least 300 individual respondents to be studied in order to have fit for the statistical factor analysis.

For descriptive statistical analysis, the focus will be on selecting samples to ensure a minimum 95% confidence level and a max (5 to) 10% error. This means that we are targeting ~100(-400) samples for descriptive statistics.

It is planned to do a multi-stage (cluster) sampling between the Delhi NCR and high-penetration market selected (200 each). In each of these cities, we will select 5 colonies at random and then select samples at random from them.

The stage 1 exploratory research would be conducted primarily 1;1 contacts. The stage 2 primary research would be conducted via physical / tele-survey /online surveys. These will be conducted thru a mix of personal engagements as well as contracted field survey.

Single cross-sectional research design will be used to collect data from target customers at one point of time and the data will be analyzed to test the stated hypothesis.

## D. DATA COLLECTION INSTRUMENT

In order to further the primary research investigations, a structured OMR questionnaire (Annexure 1/sample) will be designed using Remark OMR software for a large scale field/phone survey in select cities. An equivalent web-survey form would also be designed using surveymonkey.

Discussions with Solar industry leaders and with government officials driving the solar program will enable one to polish the questionnaire post pilots. To establish a baseline, this paper focusses on Gurgaon/ Faridabad in the Delhi National Capital Region. This is a relatively affluent community and is characterized with a low penetration but emerging consciousness on the solar technologies. Subsequently, we may cover high solar penetration regions like Bangalore/or Gandhinagar and compare behavior characteristics to determine perception/awareness/ attitude differences.

For the individual users, the questionnaire may have sections on behavior factors, Information Seeking/ Opinion leader patterns; Usage/Post purchase satisfaction/ enabler-disablers/ post-purchase referral behavior and profile.

For the primary study, we expect effectively three sections in the questionnaire. First section maps the awareness, attitude and experience with solar technologies for the respondent, the second part will be a TPB questionnaire for the respondent and the last part profiles the respondent.

The questionnaire will be designed using OMR fonts, and for readability using a PC OMR software (Gravis Remark). End-to-end design will be pre-tested for question validity, usability and fill-time to prevent respondent fatigue.

## E. DESIGN OF MEASUREMENTS

Direct TPB measures would be generated via literature review and further developed in pilot work to make sure that they have satisfactory psychometric properties and internal consistency.

We plan to use 5-point bipolar adjective scales (e.g., harmful - beneficial) in our TPB questionnaire-the format of these scales is based on work with the semantic differential. (Some authors recommend 7 points as optimal. However, as recorded by I Aizen, there is nothing sacred about 7 points and it is at the investigator's discretion to use fewer or more scale points).

The reliability and validity of direct TPB measures are estimated in formative research. First, a TPB questionnaire is constructed in accordance with established guidelines. The direct items designed to assess a given TPB construct (attitude, subjective norms, perceived behavioral control, intention, and behavior) are then submitted to an internal consistency analysis thru Cronbach's Alpha (min value 0.7) to establish reliability. However, internal consistency is not a requirement of the behavioral, normative, and control belief composites because different accessible beliefs may well be inconsistent with each other. If reliability in the sense of temporal stability is also considered important, the questionnaire must be administered a second time and test- retest correlations are computed. However, temporal stability is not relevant to this investigation.

## F. RESEARCH HYPOTHESIS

Following null hypothesis are proposed to be tested:

Ho: Attitude towards purchasing solar renewable has no effect on Indian Consumer's Purchase Intent of solar

Ho: Subjective norms in purchase of solar renewables have no effect on Indian Consumer's Purchase Intent of solar

Ho: Perceived Behavioral Control in purchase of solar renewables has no effect on Indian Consumer's Purchase intent of solar

Ho: Behavioral profile of Individual Solar buyer is not different between emerging & high-penetration metros

Ho: Attitude difference of Individual Solar buyer is not different between emerging & high-penetration metros

Ho: Perceived behavior control is not different between emerging & high-penetration metros.

As the prelim results are received in the survey, additional insights will evolve for inclusion in the primary research and analysis, viz, nature of information seeking/ opinion leader engaged and whether the opinion leader knowledge is adequate to build user satisfaction.

## G. DATA ANALYSIS TECHNIQUES

The OMR questionnaires will be scanned to collate data which will be subjected to prelim analysis in the Remark OMR analytics. In parallel, the collected e-survey data will be processed and merged with the OMR data and analyzed by SPSS and AMOS software. At first, the data will be cleaned by removing the responses with poor quality such as too many missing values or bias ratings. Following statistical techniques will be employed for data analysis to achieve the research objectives.

| Type of Analysis | Description |
|---|---|
| **Descriptive Statistics** | Presents the data in summarized form. Simple tools like percentages, central tendencies, standard deviation/variance; frequency distributions will be used to describe the data and provide guidance for conducting the multi-variate analysis. Only behavioral variables that remain after factor analysis and Cronbach's alpha test are put into the consideration for the description. |
| **Inferential Statistics** | Will validate the hypothesized inference about the population based on its sample by using statistical tools |
| **Exploratory Factor** | Is a variable reduction technique. It will be used to identify the latent core |

| | |
|---|---|
| **Analysis** | constructs and the underlying structure of a set of behavioral variables.<br><br>Factor loadings, KMO, Total variance explained, Eigenvalue – will be used to confirm the suitability and acceptability of EFA.<br><br>Factor loadings of the items on a behavioral factor should be greater than 0.5 (with the sample size is 100) to confirm that EFA has a practical significance to the analyzed data.<br><br>The Kaiser-Meyer-Olin measure of sampling adequacy (KMO) will be used to confirm the reliability of using EFA for this research. The KMO between 0.5 and 1.0 (significant level less than 0.005) will be used to make sure that the factor analysis is suitable for the data.<br><br>Total variance explained will be used to identify the number of retained behavioral factors. It will suggest which factors can be retained until the last factor represents a small proportion of the explained variance. The total variance explained is suggested to be more than 50%.<br><br>Eigen-value is an attribute of factors, being defined as the amount of variance in all items (variables) explained by a given factor. Eigen-value should be greater than 1 because Eigenvalue <1 means that information explained by the factor is less than by a single item. |
| **Confirmatory Factor Analysis** | CFA is a statistical technique that helps the researcher to test the hypothesis that a relationship exists between the observed variables and their underlying constructs. EFA is used to determine the factor structure while CFA is used to verify the factor structure.<br><br>Confirmatory factor analyses are employed to show that the items measuring a given construct can be considered indicators of the same latent variable; and that a model in which the attitude, subjective norm, perceived control, and intention items are treated as assessing separate constructs is superior to a model in which all items are considered to measure the same underlying construct. |
| **Structural Equation Modeling (SEM)** | SEM is used to confirm which behavior factors have the impact on purchase intent as well as the regression weights between them. Structural Equation Modeling will simultaneously test all relationships in the hypothesized model to determine the extent to which the model is consistent with the data. According to the literature, structural equation modeling is best suited for the study of multiple dependence relationships such as those investigated in the present research. |

# WORK PLAN

2 years –split into 8 quarters

| Work plan Sr.No | TASKS TO BE ACCOMPLISHED | WEEKS | COMMENTS |
|---|---|---|---|
| **Q1** | EXPLORATORY STUDY | 8 WEEKS | |
| | LITERATURE REVIEW | 12 WEEKS | ON-GOING |
| | QUESTIONNAIRE 1ST DRAFT | 2 WEEKS | |
| | DATABASE REQUISITION APP | | |
| **Q2** | PILOT SURVEY | 8 weeks | REFINE QUESTIONNAIRE V2 |
| | (HA)REDA EXPERT OPINION SURVEY | | |
| | VENDOR SURVEY | | |
| **Q3-Q5** | DATA COLLECTION – PRIMARY SURVEY | 16-20 WEEKS | PRIMARY SURVEY |
| | PRELIM ANALYSIS | 2-4 WEEKS | |
| | OPINION LEADER SURVEY | 4-8 WEEKS | |
| | INITIATING PAPERS | 4 WEEKS | |
| **Q5-Q6** | DATA PROCESSING | 4 WEEKS | |
| | DATA ANALYSIS | 4-8 WEEKS | |
| | FIRST DRAFT REPORT | 8 WEEKS | |
| **Q7-Q8** | FINAL THESIS /REPORT | | Total 2 years |

# SURVEY LIMITATIONS & RECOMMENDATIONS FOR FUTURE INVESTIGATIONS

This research is limited to the Delhi NCR and one reference high solar penetration city (Bangalore-SWHS) due to time and financial constraints. We may extend it to Gandhi nagar(high-SPV experimental city) depending on resource constraints. Comparisons across the high and low penetration segments will bring out variables of significance as well as specific variables applicable to specific SPV / SWHS categories.

Further, it will be relevance to map the differences between rural and urban penetrations in future studies.

Again, there may also be relevant lessons on penetrations in low-rise, bungalow/villa based cities and high-rise apartment cities.

Finally, since the opinion leaders/channels are only one of the constructs in the solar penetration, it will be relevant to study them in detail to understand the issues, disablers and enablers to create a more encompassing study and policy recommendations for solar penetration in India. Understanding of the channels of delivery and their role will throw light on the delivered cost of the system, awareness creation process at the channels ( of technology, its benefits, its cost effectiveness value proposition/ROI), maintenance issues, need for trained technicians to ensure a good installation, performance and high user satisfaction.

This paper has only investigated the SPV/SWHS categories. It has not examined the solar cooker penetration as it could involve a different decision maker in the home owner family (the wife). While the model can be evolved to this, it was felt that this should be scoped for a separate study. This study focusses on the rooftop solar product categories.

Finally findings of the study are limited to Indian consumers and cannot be automatically generalized to other nationalities.

## ACKNOWLEDGEMENTS

I am grateful for the insights gained from discussions with Dr Sandeep Garg, EESL; Prof Chetan Solanki/ IIT Bombay on grid-connected roof-top solar PV project. I am also inspired by Prof Ashok Jhunjhunwala's articulation of a vision, "Can India get 50% of its electricity from solar by 2030?' My work at Applied Materials, interactions with industry colleagues has contributed to my foundation for the solar sector. Inputs from Dr Asif Ali Syed, AMU have refined this synopsis. And I must acknowledge discussions with Hareda officer, Mr. PK Sharma, and with Mr. S Jinturkar of Sudarshan Saur – a SWHS manufacturer, who have given rich insights into the SWHS penetration in the Indian markets.

# ANNOTATED BIBILOGRAPHY AND WORKS CITED

***(2013). Jawaharlal Nehru National Solar Mission Phase II. New Delhi, MNRE, Govt of India.***

Presents the vision document with quantified targets for India's National Solar Mission Phase II starting 2012-2017

***Aggarwal, A. K. (2012). "Financial Enablers of the Indian Solar Industry." FICCI.***

Analyzes the financial inhibitors and enablers for the solar sector in India from the point of view of the complete supply chain starting from the developer business model

***Aggarwal, A. K. (2012). "India's technology options on Solar PV sector." FICCI.***

Analyzes the different Solar PV technologies, their respective market shares and pros-and-cons from Indian perspective of thin film vs cSi PV with the trends in the international arena

***Aggarwal, A. K. (2013). "Global Trade Wars: Scenario analysis for Indian Solar Industry." FICCI India Industry paper March 2013.***

Analyzes the impact on India of the Global Trade wars in Solar

***Aggarwal, A. K. (2013). "Making the Indian Solar Industry Shine v6." FICCI(Jan 2013).***

A detailed analysis of the solar sector demand over the period 2013-2020 as catalyzed by the government led on-grid, off-grid programs of the central JNNSM and the state solar missions - with an impact flow across the entire supply-chain from the developers to the module , cell and poly-silicon suppliers.

***Ajzen, I. (1991). "The theory of planned behavior." Organizational behavior and human decision processes 50: 179-211.***

Presents a model of actual behavior as derived from attitudes about the behavior, duly tempered by subjective norms and individuals perceived behavior control.

***Alan C Goodrich, D. M. P., Ted L James, Michael Woodhouse, Tonio Buonanssisi "Assessing the drivers of regional trends in solar photovoltaic manufacturing." Energy & Environment Science, DOI 10.1039/c33340701b.***

***Dr Madhu Atre, Dr. VS Gangadhar Rao. (2010). "Towards achieving India's Solar Mission Goals." Global Solar Technology(Fall 2010).***

Analyzes the implications of India's National Solar Mission 2010 on the solar supply-chain eco-system

***Blakely, J. W. and S. M. Smith (1981). "THE EVOLUTION OF DISTRIBUTION CHANNELS FOR SOLAR PRODUCTS: CONSUMER DECISION MAKING IN PERSPECTIVE." Advances in Consumer Research 8(1): 637-641.***

Consumer acceptance of solar products Is examined from a distribution channel perspective. The current focus on the consumer as the central decision maker for solar products is criticized. New channels of distribution are presented, along with the variables that will facilitate their adoption. Future directions for solar consumer research and public policy decisions are given.

***Bollinger, B. and K. Gillingham (2012). "Peer Effects in the Diffusion of Solar Photovoltaic Panels." Marketing Science 31(6): 900-912,1022.***

Social interaction (peer) effects are recognized as a potentially important factor in the diffusion of new products. In the case of environmentally friendly goods or technologies, both marketers and policy makers are interested in the presence of causal peer effects as social spillovers can be used to expedite adoption. Authors provide a methodology for the simple, straightforward identification of peer effects with sufficiently rich data, avoiding the biases that occur with traditional fixed effects estimation when using the past installed base of consumers in the reference group. Authors study the diffusion of solar photovoltaic panels in California and find that at the average number of owner-occupied homes in a zip code, an additional installation increases the probability of an adoption in the zip code by 0.78 percentage points. The results provide valuable guidance to marketers designing strategies to increase referrals and reduce customer acquisition costs. They also provide insights into the diffusion process of environmentally friendly technologies.

***Chedid, R. B. (2002). Policy development for solar water heaters: the case of Lebanon. Energy conversion and Management. 43: 77-86.***

***Chowdhury, S. (2003). Photovoltaics as a renewable energy technology in Bangladesh and its potential for increasing welfare, gender equity, and environmental sustainability. Ann Arbor, University of Maryland, College Park. 3094468: 296-296 p.***

Situated in the northeast corner of the South Asian sub-continent, Bangladesh is a developing country with high population density, low life expectancy, low rate of literacy and extremely low access to modern energy sources. Lack of access to electrification remains a major constraint to the country's economic development. In this context, as in other countries, Bangladeshi development practitioners have tended to pursue outputs that rely on new technologies as a means to leapfrog to higher levels of development. However, independent analysis of such efforts, in terms of achieving sustainable development outcomes, remains lacking. The full potential of renewable energy technologies in Bangladesh has yet to attract widespread recognition from policy makers. In this thesis, it is reviewed that solar PV technology since it has already been attempted as a rural off-grid electrification option in Bangladesh. It is argued that the applications of technology should follow, and not precede, considerations for human well-being. It is also important to have a more holistic perspective on human welfare, which should include the basic dimensions of choice and opportunities, and not just income levels. The Government of Bangladesh and its development partners need to

expand support to renewable energy technologies and so redirect the focus of policy formulation and implementation to sustainable human development. Author emphasizes that people-centered public policy has a key role to play in the introduction of a technology such as the solar photovoltaics pioneered by Grameen Shakti, a not-for-profit company in Bangladesh. While equity in terms of a fair distribution of wealth and income may continue to be an illusion, innovations such as solar PV are indeed promising with respect to opening up opportunities and possible benefits for women, the environment and--more generally--human well-being. This thesis is based on work in rural areas complementary to various professional responsibilities that author held in Bangladesh between 1999 and 2001. Author examined (mainly solar photovoltaic energy projects) through interviews, as well as formal and informal exchanges with rural and urban Bangladeshis, observation and a review of documents. This thesis presents findings, discuss their implications and offer general recommendations for improving the present practice.

***Claudy, M. C., et al. (2013). "Understanding the Attitude-Behavior Gap for Renewable Energy Systems Using Behavioral Reasoning Theory." Journal of Macromarketing 33(4): 273-287.***

Consumer adoption of renewable energies is an important step towards less carbon-intensive and more sustainable energy systems. But despite growing ecological awareness and articulated preferences for green products, renewable energies face slow rates of diffusion in consumer markets. This has been hard to explain given consumers' favorability to the concept of products that lower one's impact on the natural environment. This study uses data from 254 homeowners in Ireland to investigate the psychological process of adopting a renewable energy system – solar energy panels. Applying Behavioral Reasoning Theory (BRT), this research examines a proposed model in which reasons both for and against adopting solar panels mediate the relationship between consumers' attitudes, values and adoption intentions. Results suggest the model is generally supported with both reasons for adoption and reasons against adoption having countervailing influences in the psychological processing of adoption intentions. These findings suggest that researchers and marketers should include mediating constructs, such as (i) reasons for adoption, (ii) reasons against adoption, and (iii) attitudes toward a technology when attempting to explain how consumers think about the adoption of renewable energy systems

***De Hoyos-Ruperto, M. (2000). A method to assess the potential market and economic feasibility of a renewable energy product: The solar air conditioning system case. Ann Arbor, University of Puerto Rico, Mayaguez (Puerto Rico). 1397847: 298-298 p.***

The Solar Absorption Air Conditioning Systems (SAACS) represent an ideal and innovative technology to offset energy consumption in the Caribbean and maybe in a great portion of the world. SAACS, developed in Puerto Rico, is technically feasible for other places as long as those places have a similar climate to Puerto Rico. However, at this moment, the economic feasibility of the SAACS has not been demonstrated. This research studies the economic feasibility of the SAACS in Puerto Rico. In order to reach the commercialization phase, it is necessary to accomplish technical requirements, as well as, economic feasibility. The objectives of this research were the followings: (1) to provide a good estimate of the potential market and possible revenues for this technology, (2) to make a cost analysis of this innovative technology and to develop a cost template that aggregates the total product cost. This research will be used as a model to study the economic feasibility of the system in the Caribbean. In terms of the market the most important conclusions of this research are: (1) there are potential customers willing to buy SAACS, (2) service and maintenance and a competitive selling price are key criteria in the decision to purchase the SAACS. In developing the new business to manufacture and distribute the new technology two key factors have to be considered: (1) it is crucial a joint venture between the private and the government sector that facilitates having a good market position in a very competitive industry and (2) the competitive selling price suggests that SAACS need continuous strategic cost management. This strategy should allow to the new company to fulfill customer's expectations and achieve competitive advantage.

***DI Paul, James Uhomoibhi (2012). Solar power generation for ICT and sustainable development in emerging economies. Campus-wide information systems, Emerald Group publishing Ltd. 29: 213-225.***

***Environment, C. f. S. (2012). "Facing the sun- policies for sustainable grid-connected solar energy." CSE Dec 2012.***

Analyses the issues and options for India in creating a sustainable solar sector - highlights the impact of US imports and US EX-IM subsidy on the domestic manufacturing sector

***Feng Dianshu, B. K. S., Khuong Minh Vu (2010). The barriers to energy efficiency in China: Assessing household electricity savings and consumer behavior in Liaoning province. Energy Policy. 38: 1202-1209.***

***Fitzmorris, A. J. Solar Domestic Water Heating Technology: Market Barriers and Adoption Strategies. 2010 IEEE Green Technologies Conference (IEEE-Green-2010), Place of Publication: Piscataway, NJ, USA; Grapevine, TX, USA. Country of Publication: USA., IEEE.***

This paper analyzes the United States' domestic water heating industry and solar domestic water heating technology adoption from the standpoint of Porter's five forces model and the technology adoption life cycle model. Using Porter's five forces model, the key barriers to entry for solar water heating technology are high buyer price sensitivity and unequal access to distribution channels. In the context of the technology adoption life cycle, current solar water heating technology is disruptive but it has not yet crossed the chasm. Further, a dominant design has not emerged. Two strategies are proposed to address these barriers and facilitate crossing the chasm. One strategy focuses on establishing a beach head with the home owner using a focused sales approach involving six factors and convincing them that the value of a solar water heater more than outweighs the initial cost. The other strategy seeks to shift the upfront cost away from the home owner using an approach similar to that being taken by the solar electric industry with Solar Power Purchase Agreements.

***Force, F. T. (2013). "Creating Supply-chains for sustainable end-demand." FICCI June 2013.***

Analyzes the solar sector end-demand as created by the government of India in its latest version of the JNNSM II program and resulting impact on the entire supply-chain for building a sustainable solar sector in India

***Furukawa, C. (2014). "Do Solar Lamps Help Children Study? Contrary Evidence from a Pilot Study in Uganda." The Journal of Development Studies 50(2): 319.***

Over half a billion children lack adequate lighting and use dim, smoky and dangerous kerosene-based lighting for their evening studies. This article examines the conventional wisdom that the brighter, clean, safe and zero-marginal-cost light of solar lamps enhances children's learning outcomes. In a randomized experiment, unexpectedly, solar lamps lowered test scores by five points out of 100 (0.25 standard deviation), but increased reported study time by approximately 30 minutes per day. This may be due to flickering from lack of full charge, lowering their productivity. The nationwide learning assessment suggests that solar lamps likely have an insignificant effect on educational attainment.

***Gay, Dr. Charlie. (2012). "Accelerating PV Cost reduction to global grid parity." Applied Materials Inc.***

An insight into the trends and technology evolution in the global arena driving the solar mainstream by pushing the envelope on grid parity

***Gillingham, K. (2009). Economic Efficiency of solar hot water policy in New Zealand. Energy Policy. 37: 3336-3347.***

***Groba, F. (2014). "Determinants of trade with solar energy technology components: evidence on the porter hypothesis?" Applied Economics 46(5): 503.***

Studies analyzing renewable energy (RE) market development usually investigate electricity capacity or investment. Characteristics, roles and determinants of trade with RE system components remain blurred. Policies are important in promoting RE utilization and innovation. Yet, their effect on determining exports remains ambiguous. The Porter hypothesis and the lead-market literature argue that environmental regulation leads to comparative export advantages. Empirical studies, however, reach diverging conclusions, rarely focus on the RE-sector and use broad proxies of environmental regulation. Focusing on solar energy technology components (SETCs), we believe this is the first study describing structure and development of international trade and estimating the role of RE policies on determining trade flows. We empirically estimate a gravity trade model using Poisson-Pseudo-Maximum-Likelihood (PPML) estimation to test the role of RE policies and trade barriers on SETC

exports. We use panel data representing annual bilateral trade flows of 21 OECD countries exporting SETCs to 118 importing countries between 1999 and 2007. We find a rapidly growing market with trade dominated by Europe. The study supports the Porter and the lead-market hypotheses as early adopters of RE policies gained a comparative advantage. Analyzing the importer side, the study suggests that regulatory policies and import tariffs determine SETC export flows.

***Hadi, M. A., et al. (2012). ECONOMIC ASSESSMENT OF THE USE OF SOLAR ENERGY IN KUWAIT, Hilo, Institute for Business & Finance Research.***

In Kuwait, the current method of generating electricity using conventional power plants cannot provide the beneficiaries with adequate service unless more plants are constructed. In addition to their high cost, these plants cause environmental damage, creating the need to investigate an alternative source of clean energy. The objective of this study is to assess the technical and economic feasibility of implementing Photovoltaic (PV) solar energy in residential houses in Kuwait. First, data and information were collected and the appropriate PV system was selected according to cost and PV specifications. Second, the equivalent annual costs of the PV system with various discount rates were estimated together with the cost per kWh both for new and existing houses. Third, the annual reduction of CO2 emissions resulting from implementing grid-tied PV systems was calculated. The results showed that with a 6.7% discount rate the annual savings on energy costs for a new house and a previously constructed one were KD 745 and KD 653 respectively.

***Herron, J. (2011). "Return of the Oligopoly." Photon International May 11.***

Analyzes the poly-silicon manufacturing status and the play by limited polysilicon manufacturers shaping the trends that were driving the cSi PV technology mainstream

***IR Pillai, R. B. (2007). Methodology for estimation of potential for solar water heating in a target area. Solar Energy. 81: 162-172.***

***Ismanzhanov, A. I., et al. (2013). THE IMPACT ON THE SOCIOECONOMIC SITUATION IN KYRGYZSTAN BY ATTRACTING RENEWABLES TO THE POWER BALANCE, Varazdin, Varazdin Development and Entrepreneurship Agency (VADEA).***

The report examines social and economic aspects of attraction of renewables to the power balance of Kyrgyzstan. Currently the population energy demands are met by electric power produced by 17 large and small HPPs and two CHPPs, natural gas imported from Kazakhstan, Russia and Uzbekistan, oil products, as well as by local coal. However, these resources cannot meet all the Republic demands. The load on the main (traditional) resources could be considerably reduced by attracting renewables and alternative energy sources. Kyrgyzstan has almost all types of renewables. As for solar energy resources it occupies one of the first places in the Central Asia. The number of solar days is 250-260 and the maximum solar radiation can reach 900 W/m2 or higher. Wind energy, biomass and geothermal energy resources are also considerable. The main obstacles for wide spreading of renewable energy plants are their relative expensiveness and low purchasing power of the population.

***Jhujhnwala, D. A. (2013). Targeting 50% of Indian electricity needs thru solar by 2030. National Conference on Accelerating technology innovation for inclusive & sustainable growth, Dept. of Scientific and Industrial Research, Ministry of Science & Technology, Gov of India.***

Presents a vision of a Universal DC solution in power distribution to enable an optimally efficient distribution of power that can leverage solar as well as potentially eliminate blackouts in the Indian power landscape

***Kobos, P. H. (2002). The implications of renewable energy research and development: Policy scenario analysis with experience and learning effects. Ann Arbor, Rensselaer Polytechnic Institute. 3072207: 164-164 p.***

This dissertation analyzes the current and potential future costs of renewable energy technology from an institutional perspective. The central hypothesis is that reliable technology cost

forecasting can be achieved through standard and modified experience curves implemented in a dynamic simulation model. Additionally, drawing upon region-specific institutional lessons highlights the role of market, social, and political institutions throughout an economy. Socio-political influences and government policy pathways drive resource allocation decisions that may be predominately influenced by factors other than those considered in a traditional market-driven, mechanistic approach. Learning in economic systems as a research topic is an attractive complement to the notion of institutional pathways. The economic implications of learning by doing, as first outlined by Arrow (1962), highlight decreasing production costs as individuals, or more generally the firm, become more familiar with a production process. The standard approach in the literature has been to employ a common experience curve where cumulative production is the only independent variable affecting costs. This dissertation develops a two factor experience curve, adding research, development and demonstration (RD&D) expenditures as a second variable. To illustrate the concept in the context of energy planning, two factor experience curves are developed for wind energy technology and solar photovoltaic (PV) modules under different assumptions on learning rates for cumulative capacity and the knowledge stock (a function of past RD&D efforts). Additionally, a one factor experience curve and cost trajectory scenarios are developed for concentrated solar power and geothermal energy technology, respectively. Cost forecasts are then developed for all four of these technologies in a dynamic simulation model. Combining the theoretical framework of learning by doing with the fields of organizational learning and institutional economics, this dissertation argues that the current state of renewable energy technology costs is largely due to the past production efforts (learning by doing) and RD&D efforts (learning by searching) in these global industries. This cost pathway, however, may be altered through several policy process feedback mechanisms including targeted RD&D expenditures, maintenance of RD&D to promote learning effects, and financial incentive programs that support energy production from renewable energy technologies.

***Labay, D. G. and T. C. Kinnear (1981). "Exploring the Consumer Decision Process in the Adoption of Solar Energy Systems." Journal of Consumer Research (pre-1986) 8(3): 271.***

This study examines residential solar energy systems within an adoption and diffusion of innovations framework. The findings indicate considerable differences between adopters and non-adopters on many measures. Multivariate nominal scale analysis is used to develop classification models based on both attribute perceptions of solar energy systems and demographic characteristics.

***Li, X., et al. (2013). "Farmers' willingness to convert traditional houses to solar houses in rural areas: A survey of 465 households in Chongqing, China." Energy Policy 63: 882.***

In rural China, reducing low-quality fuel consumption and adopting solar technologies can mitigate pollution problems and improve farmers' living conditions. Before advising farmers to convert traditional houses to solar houses, it is necessary to understand their willingness to do so. Based on the theory of planned behavior (TPB), this study examined nine factors related to farmers' willingness (FW). A survey was conducted in Chongqing with 465 participants. Nine hypotheses were proposed based on literature studies. A binary logistic regression model was constructed to test the data with the SPSS software package. Three of the nine factors had positive and significant impacts on FW, which were quality of life, government commitments and neighbors'/friends' assessments; two factors had negative and significant impacts, which were additional monthly out-of-pocket expenses and switching cost; and the remaining four factors had no significant impacts, which were durability, popularity, timing and local solar market maturity. Based on the findings, suggestions are made to properly introduce solar houses to Chinese farmers and to quickly stimulate market activities.

***Lloyd CR, T. R. (2008). International policy issues regarding solar water heating, with a focus on New Zealand. Energy Policy. Otago, New Zealand. 36: 1843-1857.***

***Ma, B., et al. (2014). "Diffusion of solar water heaters in regional China: Economic feasibility and policy effectiveness evaluation." Energy Policy 72: 23.***

Whereas the technical feasibility of solar water heaters (SWHs) has long been established, the economic feasibility of SWHs in regional China remains to be examined. This paper constructs cost models to calculate costs per unit energy saving of SWHs in 27 Chinese provincial capital cities. The cost effectiveness of SWHs is examined at the national level. At a micro level, we analyze the financial attractiveness of consumers' investment in SWHs. A panel data model is employed to evaluate the effectiveness of a subsidy program in rural China. The results show that SWH costs, ranging from 0.305 to 0.744 CNY/kW h, are much lower than those of other major renewable energies across China. This finding indicates that the diffusion of SWHs is a cost-effective way to

reach China's renewable energy target. For consumers, incentive programs for SWHs are needed to improve the financial attractiveness of the devices in China. Existing subsidy policies for rural China have failed to significantly enhance the deployment of SWHs. The causes of the failure are examined and a new incentive program is suggested for rural areas of the country.

***Margolis, R. M. (2002). Understanding technological innovation in the energy sector: The case of photovoltaics. Ann Arbor, Princeton University. 3033029: 271-271 p.***

This dissertation examines various aspects of technological innovation in the energy sector through a detailed study of the solar photovoltaics industry. Through this case study it seeks to advance understanding of the energy technology innovation process and of how various actors, institutions and policies interact to bring about the development of new technologies. One of the central goals of this work is to shed some light on the role of government in promoting the development and dissemination of environmentally sustainable energy technologies. It focuses on two causal pathways through which government policy can influence the innovation-related decisions of firms: demand-pull policies, which are aimed at creating or expanding markets for new technologies, and supply-push policies, which are aimed at increasing firm level investments in technological innovation. In addition, it places the technology development process in the context of evolving concerns about a range of potential policy drivers, such as energy security, resource constraints, competitiveness, and the environment. In reviewing technology policies underlying the development of photovoltaics in the United States over the past three decades, this dissertation examines the range of initiatives pursued by the U.S. government and places these efforts in the context of policies and programs in a number of other countries. It specifically explores how two projects launched by the U.S. government during the 1990s (the Photovoltaic Manufacturing Technology project and the Thin-Film PV Partnership project) have served to enhance the linkages between firms, universities, and national labs. This work also examines in detail the history of four photovoltaic firms (BP Solar/Solarex, Siemens/Arco Solar, AstroPower, and Evergreen Solar) and the process--including involvement in government-led projects--that led to the development of their respective photovoltaic technologies. A key lesson for energy technology policy in the U.S. today, emerging from this dissertation, is that even in the absence of a broad public policy mandate to increase budgets for energy technology research and development or market creation, the government can still play an important role by focusing on mechanisms that help to improve the process of innovation itself.

***McCabe, M. B., et al. (2012). SUSTAINABILITY FOR HISPANICS IN CALIFORNIA: DO THEY REALLY CARE?, Hilo, Institute for Business & Finance Research.***

A study about the perceptions of well-educated Hispanics living in California regarding environmental sustainability. Hispanics in the US are growing three times faster than non-Hispanics and now comprise 16% of the population, or more than 50 million. Just in the last 10 years, Hispanics grew 43%, equivalent to more than half of the growth of the entire US population. Given its importance and the undeniable needs of creating a conscious for sustainability in California, we developed this study to learn about the attitudes and perceptions of Hispanics regarding environmental practices, vs. non-Hispanics, in an effort to find out any differences between the two groups, and how this could be beneficial for many companies trying to market their products and services to this vibrant target market. The results from our survey showed that affluent Hispanics ($ WOK +) showed a greater propensity to use less water and recycle waste than non-Hispanics in the same income group, and are more inclined to buy hybrid cars, which were both surprising. Furthermore, 23% of affluent Hispanics currently have a water heater at home; vs. only 5.7% of non-Hispanics. 10% of highly educated Hispanics have a solar water heater at home, vs. 6.7% for non-Hispanics in the same education group. This research also showed that Hispanics prefer TV and the web for media, and non-Hispanics selected newspapers and web, which is very relevant for marketers. Almost half of the Hispanics never use car pool, vs. a much lower 37% for non-Hispanics. Finally, in Social Media preferences, Facebook® ranked about the same for both groups, but Twitter® is only used by 5% of Hispanics, vs. 18. 4% for their counterpart, which was also very interesting.

***Michelsen, C. C. and R. Madlener (2011). Integrated Theoretical Framework for a Homeowner's Decision in Favor of an Innovative Residential Heating System. Rochester, Social Science Research Network.***

Insight into the homeowner's adoption decisions in favor of a specific innovative residential heating system (RHS) helps us to understand and assess the dynamics of the adoption and diffusion of such technological systems as a "social" phenomenon. This phenomenon emerges from the individual decisions of a set of heterogeneous actors on the market. In this research, authors develop an integrated theoretical framework for assessing a homeowner's adoption decision in favor of a specific innovative RHS. Taking the theory of planned behavior (TPB) (Ajzen, 1991) and the perceived

characteristics of innovations (PCI) (Moore and Benbasat, 1991) as a starting point, they propose a framework that explicitly accounts for external factors (esp. economic aspects) and personal-sphere determinants. This allows us to gain a deeper understanding of the role of a homeowner's personal-sphere as well as of the influence of perceived economic and other external factors on the RHS adoption process. This research is with background on the case of Germany. The theoretical framework can serve as a basis for empirically researching homeowners' adoption decisions in favor of a specific RHS and for developing a conceptual multi-agent simulation model for investigating the diffusion of RHS.

***Ndzibah, E. (2010). Diffusion of solar technology in developing countries: Focus group study in Ghana. Management of Environmental Quality: An international journal, Emerald Group Publishing Limited. 21: 773-784.***

***Neslin, S. A. and G. Assmus (1983). "Consumer Response to Information that Presents a Range of Possible Performance Levels for a New Product: The Case of Solar Water Heaters." The Journal of Consumer Affairs (pre-1986) 17(1): 81.***

This research examined how consumers respond to product information that presents a range of possible performance levels. Hypotheses were tested by the use of mail and telephone surveys administered to a national sample of 511 homeowners. The particular product investigated was solar water heaters. The results indicate that the respondents (1) were less likely to change their prior beliefs toward the financial viability of solar water heaters, and (2) placed more emphasis on the importance of financial risk when they were presented with a range of possible financial consequences associated with solar systems. On balance, the provision of this information did not increase or decrease the average intention of the respondents to purchase solar water heaters. The public policy implications of the study findings are discussed.

***Nijs, V., et al. (2010). "Channel Pass-Through of Trade Promotions." Marketing Science 29(2): 250-267,387-389.***

Packaged goods manufacturers spend in excess of $75 billion annually on trade promotions, even though their effectiveness has been hotly debated by academics and practitioners for decades. One reason for this ongoing debate is that empirical research has been limited mostly to case studies, managerial surveys, and data from one or two supermarket chains in a single market. In this paper, the researchers assemble a unique data set containing information on prices, quantities, and promotions throughout the entire channel in a category. They find that mean pass-through elasticities are 0.71, 0.59, and 0.41, for the wholesaler, retailer, and total channel, respectively. More importantly, at each level of the channel they observe large variances in pass-through estimates that they explain using various measures of cost and competition. They conclude by showing how the profitability of manufacturer and wholesaler deals can be improved by utilizing detailed effectiveness estimates.

***Otte, P. P. (2013). "Solar cookers in developing countries - What is their key to success?" Energy Policy 63: 375.***

In developing countries households and institutions heavily rely on biomass to satisfy their energy needs. The unsustainable use of biomass is accompanied by several negative health and environmental impacts. As a clean energy source, solar cooking presents one alternative solution. In spite of its multiple benefits; however, solar cookers have experienced little success. Curiously, there has been little discussion about this in academic circles. Most research concerns technical improvements of solar cookers, rather than on the reasons why these cookers are not actually adopted in the field. This paper fills the gap by developing a comprehensive list of variables that influence the adoption of solar cooking: (1) economic, (2) social, (3) cultural, (4) environmental, (5) political and (6) technical. Furthermore, we can see that some solar cooking promoters are able to control for some of the variables (e.g., environmental factors), but not others (e.g. technical, social and cultural factors). The latter can only be captured through a needs assessment of the target group. This sort of assessment is a demanding but necessary step for the successful outcome of a solar cooking project.

***P Purohit, A. M. (2008). CDM Potential of solar water heating systems in India. Solar Energy. 82: 799-811.***

***Pacheco, D. F. (2009). The quest for legitimacy in nascent industries: Exploring the interplay across institutional actors in the emergence of renewable energy sectors. Ann Arbor, University of Colorado at Boulder. 3366626: 246-n/a.***

This study suggests that the legitimacy and growth of nascent industries is not only a product of market conditions, but of the collective institutional efforts of distinct and multiple actors. Specifically, this work distinguishes across the initiatives of firms in nascent industries, social movement organizations, and firms in competing industries, to assess how the interdependent actions of these parties influence the normative, regulatory, and cognitive legitimacy of an emerging industry and its subsequent growth. Author argues that the ability of firms in emerging industries is to shape the legitimacy of their industries is dependent upon the strength and structure of the social movements that surround them and the responses of firms in competing industries. The author examines these relationships in the context of the solar and wind energy sectors, both of which provide rich opportunities for investigating highly active institutional environments. Through a longitudinal study across all 50 U.S. states (48 states for the wind energy sector), he finds that the participation of firms in trade associations is less effective at promoting the regulatory and cognitive legitimacy of their sectors when they are surrounded by highly active environmental social movements and by strong support from competing firms. In addition, the opposition of competing firms reduces the ability of trade associations in the wind and solar energy sectors to bring about regulatory legitimacy. Finally, the results of this study reveal that the acquisition of regulatory and cognitive legitimacy is subsequently related to the growth of these sectors by means of new firm findings.

***Parks, D. J. D. (1999). Energy and Cuban development: Past dependence and prospects for a sustainable future. Ann Arbor, Saint Mary's University (Canada). MQ56717: 131-131 p.***

This thesis examines the energy dependence experienced by Cuba throughout its thirty-year economic and political relationship with the Soviet Union. The thesis establishes that not only was Cuba's productive output dependent upon external sources of energy, but that this dependence permitted the Soviet Union to coerce changes in Cuba's foreign policy. The disintegration of the Soviet Union and Eastern Bloc in the late 1980s revealed the extent of Cuban dependence and has left the Caribbean nation isolated in terms of political ideology and access to international financial support. The thesis also asserts the need for a sustainable energy policy in order to develop a long term strategy to resolve Cuba's current energy crisis. The conceptual framework and working assumptions

draw upon elements of Eco philosophy, ecological economics, dependency and neo-Marxism, focusing specifically on the relationship between energy transformation and economic and political association. The concepts of dependence, coercion and sustainability are used to examine the current problem of Cuban energy insecurity. The research attempts to outline the nature and characteristics of Cuban energy dependence in order to determine what must be avoided if Cuba wishes to pursue its sovereign right to self-determination. In this century the Caribbean nation has experienced energy dependence on both the United States and Soviet Union and should avoid repeating this pattern of dependence on external sources of energy. The thesis concludes that a sustainable energy policy for Cuba should include the complementary use of domestic energy sources, particularly those which are non-toxic, such as biogas, bagasse, direct solar and wind, although the development of domestic energy sources is constrained by Cuba's lack of access to international credit.

***PD Rio, M. B. (2008). Assessing the impact of renewable energy deployment on local sustainability: towards a theoretical framework. Renewable and sustainable energy reviews 12 (5): 1325-1344.***

***PH Coad, J. W. (2009). Consumer support for environmental policies: an application to purchases of green cars. Ecological Economics, 68 (7): 2078-2086.***

***Porter, W. E. (2011). Renewable Energy in Rural Southeastern Arizona: Decision Factors: A Comparison of the Consumer Profiles of Homeowners Who Purchased Renewable Energy Systems With Those Who Performed Other Home Upgrades or Remodeling Projects. Ann Arbor, Arizona State University. 1491854: 172-n/a.***

Arizona has an abundant solar resource and technologically mature systems are available to capture it, but solar energy systems are still considered to be an innovative technology. Adoption rates for solar and wind energy systems rise and fall with the political tides, and are relatively low in most rural areas in Arizona. This thesis tests the hypothesis that a consumer profile developed to characterize the adopters of renewable energy technology (RET) systems in rural Arizona is the same as the profile of other area residents who performed renovations, upgrades or additions to their homes. Residents of Santa Cruz and Cochise Counties who had obtained building permits to either

install a solar or wind energy system or to perform a substantial renovation or upgrade to their home were surveyed to gather demographic, psychographic and behavioristic data. The data from 133 survey responses (76 from RET adopters and 57 from non-adopters) provided insights about their decisions regarding whether or not to adopt a RET system. The results, which are statistically significant at the 99% level of confidence, indicate that RET adopters had smaller households, were older and had higher education levels and greater income levels than the non-adopters. The research also provides answers to three related questions: First, are the energy conservation habits of RET adopters the same as those of non-adopters? Second, what were the sources of information consulted and the most important factors that motivated the decision to purchase a solar or wind energy system? And finally, are any of the factors which influenced the decision to live in a rural area in southeastern Arizona related to the decision to purchase a renewable energy system? The answers are provided, along with a series of recommendations that are designed to inform marketers and other promoters of RETs about how to utilize these results to help achieve their goals.

***R Wustenhagen, M. W., MJ Burer (2007). Social acceptance of renewable energy innovation: an introduction to the concept. Energy Policy 30 (5): 302-311.***

***Rakesh Kumar Pati, N. G. (2011). SELCO: Lighting rural India. Emerald Emerging Markets Case Study Collection, Emerald Group publishing limited.***

Records the experiences of Harish Hande, founder SELCO - an award winning, successful rural solarization initiative in India

***Rowlands, I. H., et al. (2003). "Consumers and green electricity: profiling potential purchasers." Business Strategy and the Environment 12(1): 36.***

Globally, consumers are beginning to be able to choose their electricity supplier. Increasing concerns about the environment are prompting some of them to consider green electricity - that is, electricity that has been generated by more environmentally sustainable means (for example, solar power or wind power). This article profiles the potential purchaser of green electricity. Drawing upon

the literature on green product purchasers more generally, three sets of hypotheses are presented - more specifically, it is proposed that those who would pay increasingly higher premiums for green electricity are more likely to possess particular demographic characteristics, attitudinal characteristics and socialization characteristics. Responses from a survey distributed in a major Canadian metropolitan area are then examined. Attitudinal characteristics - specifically ecological concern, liberalism and altruism - best identify the potential purchasers of green electricity. Suggestions for managers and marketers are made following these findings. Directions for future research are also presented.

***Singh, A. (2009). Informal markets for electricity: economics of lighting for hawkers in India. International journal of energy sector management, Emerald Group Publishing Ltd. 3: 308-323.***

Documents the economics of solar lighting vs kerosene fired lamps from the perspective of street hawkers in India

***SK Mittal, K. K. S., Sushil S (2013). "Longitudinal and comparative perspectives on the competitiveness of countries: learning from technology & the telecom sector." Business & Economics research journal 6(2).***

***Sommer, L. (2011). "The Theory Of Planned Behavior And The Impact Of Past Behavior." The International Business & Economics Research Journal 10(1): 91-110.***

The Theory of Planned Behavior (TPB) has since its development some 20 years ago proved to be a powerful approach to explain human behavior. It has been successfully applied to a wide range of behaviors. Interestingly, it is in particular complex behavior such as managerial decision making which saw only a few attempts to use TPB. This is in particular true for company internationalization. While the main elements of the theory are generally accepted, it has been suggested at many occasions that the model would benefit by the inclusion of more constructs in terms of explanatory quality. Among the elements proposed, Past Behavior is of particular importance. Although being vividly discussed, researchers did not come to a definitive judgment on whether or not the construct really should be integrated as an independent factor. The paper at hand addresses these issues by

developing a framework for an extended TPB which should be relevant in particular for complex behaviors such as International Entrepreneurship. It is based on an extensive literature review which identifies two main lines of research in terms of Past Behavior. Using a decomposition approach to integrate Past Behavior, the shortcomings of earlier approaches are avoided. The framework features a second contribution by explicitly modelling information processing modes, which are proposed to influence development of intentions

***Upham P, W. L., Poortinga W, Purdam K, Devine WP (2009). Public Attitudes to Environmental Change- a selective review of theory and practice, report for RC/UKK/LWEC, IWEC.Org.***

***Xueliang Yuan, J. Z., Chunyuan Ma (2011). Social Acceptance of solar energy technologies in China- End users' perspective. Energy Policy. 39: 1031-1038.***

Descriptive research of the social acceptance of solar water heater in China

# ANNEXURE 1: STUDENT DETAILS