



Diffusion of Residential Rooftop Solar: Role of Socio-Demographic Variables

Ashwini K Aggarwal, *PhD, FIETE, NAB CEP PVA*

Director- Applied Materials

Chairman & Subject Matter Expert: Solar Skills, National Occupations Standards Committee, Electronics Sector Skill Council of India.

Under Supervision of

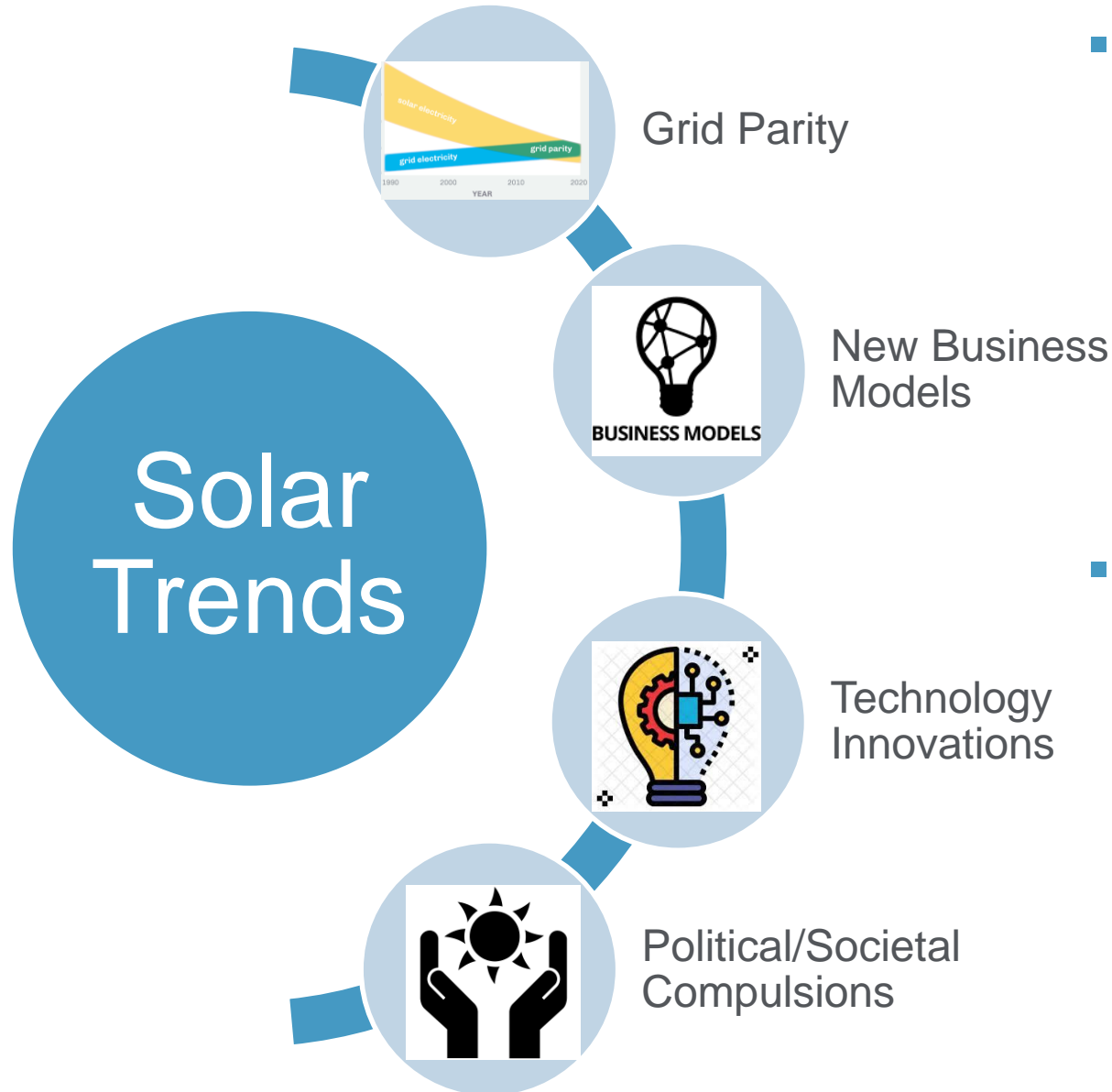
Dr. Asif Ali Syed

Professor, FMS&R/AMU

Dr. Sandeep Garg

Chief General Manager, PEC

Key global trends supporting growth of solar...



- ...But the key enabler will be consumer adoption of the new technology



- And the key disabler – the human resistance to change



Research Need...

- If the national solar visions are to be realized, it is relevant to understand the triggers of purchase intent of the rooftop solar in the Indian domestic households!



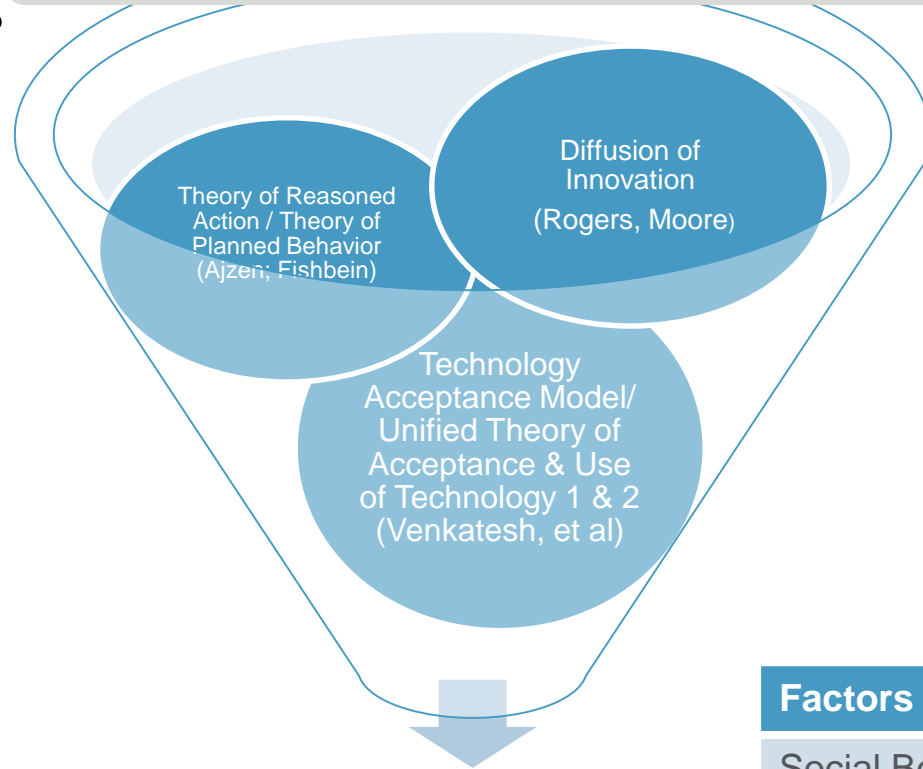
...& ITS SIGNIFICANCE

- Quantitative evidence of purchase intent triggers can refocus scarce resources to specific triggers that enable solar PV penetration at the exponential scale planned in the NSM
- Understanding the triggers can reshape government and regulatory policies
- Evolve newer business models

Learnings Extracted from Literature Review



Consumer Behavior Models in Literature



TPB & UTAUT1/2

Research Gaps Identified

- Model Structure
- Model Fit
- Inadequate Sample/ target audience selection
- Geographic Context applicability
- Test of City Context in India
- Holistic testing of adopter-procrastinator-laggard profile differences
- Holistic testing of impact of moderating and mediating variables

Factors Extracted	Other Variables	Scales from literature survey
Social Beliefs Environmental Beliefs/ Green Habits Effort Expectance Performance Expectance Price Value/ROI Beliefs Hedonic Motivation Self Efficacy Beliefs Government Policy	Moderating Variables: Demographics- Age, Gender, Income, Education Mediating Variables: Awareness, Ownership Context Variables: City	EcoScale (Stone, et al, 1995) Green Consumer Values (Haws, 2010) Hedonic/Utilitarian Attitude Scale (Spangenberg, et al, 2011) Consumers' Independent Judgment Making (CIJM Scale) (Manning, 1995)

Profile of the Target Customer/ Research Scope



- Individual residential rooftop solar buyer in India
- Target Customer is NOT an institutional buyer- his requirement is typically quantified as < 10 KW, or less than 300 liters capacity water heating system
- Focus is to study the Purchase Intent (PI) of Rooftop solar PV (RT SPV)
- Primary decision maker in a nuclear or joint family (4+ member) with roof access and roof rights
(basically - home owner - excludes tenants; customers in buildings with multiple stories & no roof rights)
- Study targets two metros
 - ▶ Delhi NCR (emerging SWHS/ SPV penetration)
 - ▶ Bangalore (high SWHS/emerging SPV)



Statement of the Problem & Objectives



- Will the purchase intention of a RT SPV buyer get triggered because the product is a green product, environmental friendly, reduces carbon emissions? Or is it influenced by the fact that it is a cost-effective energy source? Or – is there another trigger of the purchase intention?
- What are the differences between the behavior profiles/ attitudes of adopters, procrastinators and laggards of the RT SPV products?
- Are there differences between the PI of the solar buyers between a city with a higher solar penetration vs a lower solar penetration?
- What is the impact of demographics, awareness and ownership (prior Solar owner) on the PI ?
- Identify possible behavioral factors /attitudes influencing the renewable solar purchase decisions of the individual residential solar PV buyer in India
 - ▶ Identify the impact of the independent behavioral factors on the solar PI for the target customer
 - ▶ Study the impact of the moderating variables (demographics – age/gender/income/education), mediating variables (awareness) and context variables (city context, ownership) on the purchase intent of the residential solar PV buyer
- To suggest suitable recommendations to various stakeholders for increasing the purchase intention of residential rooftop solar buyers

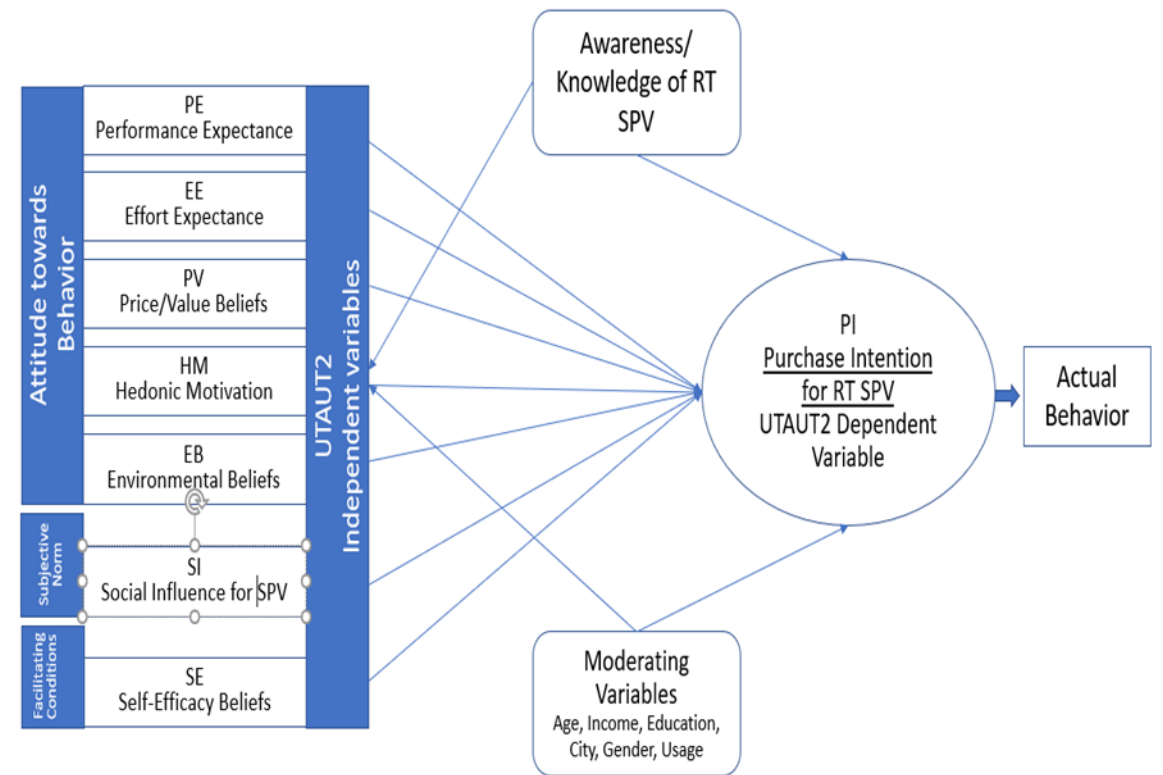
Posited Research Model for Solar PI w/UTAUT2 variables



Variable Type	Variable Name	Brief Description	Acronym Used
Dependent Variable	Purchase Intent	willingness of the customer to buy a certain product (rooftop solar PV, in this context)	PI
Independent Variables	Environmental Beliefs	Measures the degree of environment concern, underlying environmental beliefs and actual green habits that the consumer has	EVB
	Performance Expectancy	Measures how practical, safe and easy-to-operate the households believe a rooftop solar usage will be	PE
	Effort Expectancy	Measures how much the residential RT solar buyer feels comfortable in using the system and ease to adopt	EE
	Hedonic Motivation	Measures the influence of hedonic (emotive) parameters on the consumer purchase decision	HM
	Social Beliefs	Measures influence of others on acceptance and usage of technology	SB
	Price Value Beliefs	Measures the cost perceptions and the perceived economic utility	PV
	Self-Efficacy	Measures the perceived degree of ease in installing the rooftop solar	SE
Moderating Variables	Age, Gender, Education Levels, Household (HH) Income		SWHS ->
Mediating Variables	Solar Awareness		Solar Water Heater System SPV ->
Context Variables	City Groups, Solar Ownership		Solar Photo-Voltaic RT -> Roof-Top



Research Model for Solar PI with UTAUT2 variables



Main Survey Instrument Metrics



Stage 3 : MAIN FIELD SURVEY

Methodology: Basis Finalized Questionnaire from stage 2 for understanding the purchase Intent of Rooftop Solar in Domestic Households

Target group- Primary decision makers in household and must be a house owner with roof access rights.

Sampling Plan- 200 respondents from Delhi/ NCR; 200 respondents from Bangalore (Total 400 responses, 95% confidence level/5% max error)

Research Tools

Final Questionnaire, discussion guideline

Recruitment of respondents:

The Published Circle Rates in Delhi/ NCR were used to define the six city clusters. For Bangalore, the city was divided into 5 zones (North, South, East, West and Central Zone). From these clusters, colonies are selected – and from these colonies the ‘Resident Welfare Association’ database is used. The final respondent was selected basis convenience sampling in each cluster. The # of respondents in each cluster was kept the same.

Deliverables

- Hardcopy and digital scan of final survey forms
- Data from field survey, final check on reliability of questionnaire
- Analysis of Data, results and insights.

Final Instrument 4 page OMR form

AIMA ALL INDIA MANAGEMENT ASSOCIATION

ROOFTOP SOLAR PERCEPTION SURVEY

INSTRUCTION FOR FILLING
 Incorrect shading
 Correct shading
 Correct shading
 Correct shading

This survey is being undertaken as a part of a doctoral research program - and no individual data will be shared with anyone. Please fill the appropriate button - the survey should take about 10 minutes.

Please read each question carefully and answer it to the best of your ability. There are no correct or incorrect responses - we are merely interested in your point of view.

As an appreciation of your time and effort to support this survey, we are pleased to offer you a hands-on booklet 'Rooftop Solar: Tips, Tricks and Traps'.

Ashwini K Aggarwal (Doctoral Student - AIMA PhD program)

Are you a homeowner with roof rights?

Are you one of the primary decision makers in your household?

Only if both the above responses are 'yes' then continue with the questionnaire.

Name

Faridabad Gurgaon Noida Delhi/other NCR Bangalore Any other city

City

Cell # Gender

Age A.Upto 35 B.35-60 yrs C.60+ yrs

Total HH Income/yr A.Upto 20L B.20-50L C.50+L

Education A.Upto School B. UnderGrad C.Postgrad+

Are you an existing user of
 Solar Water Heater System

Solar PV System

Brief Description of your system

AIMA ALL INDIA MANAGEMENT ASSOCIATION

ROOFTOP SOLAR PERCEPTION SURVEY

INSTRUCTION FOR FILLING
 Incorrect shading
 Correct shading
 Correct shading
 Correct shading

Section 1		100%	Often	50:50	Often	100%	
1.1 I replace light bulbs with CFL/ LED bulbs	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
1.2 I put wet and dry waste into separate bins at home	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
1.3 I take steps to reduce my contributions to global warming/pollution	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
Section 2							
If I purchase/ install a Rooftop SPV							
1.4 It will be a pollution free energy source	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
1.5 It will replace Diesel Gen Sets (& reduce diesel fumes)	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
1.6 It will reduce global warming/climate change	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
1.7 Pollution free energy source is	Extremely undesirable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely desirable
1.8 Reduction of Diesel fumes of DG sets is	Extremely undesirable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely desirable
1.9 Global Warming/climate change is	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
Section 3							
I believe RT SPV with battery backup							
1.10 is practical and will reduce dependence on grid power	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
1.11 Operates easily with little intervention once set up	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
1.12 is as safe as grid or DG power	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
1.13 Practical power option that reduces dependence on grid power is	Extremely undesirable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely desirable
1.14 Easy operations with little intervention post setup is	Extremely undesirable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely desirable
1.15 Electric Safety is important	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
Section 4							
I believe RT SPV							
1.16 Purchase/installation will be an exciting experience	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
1.17 I will be happy to install a RT SPV system	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree
1.18 Satisfying to be among first to install a RT SPV	Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree



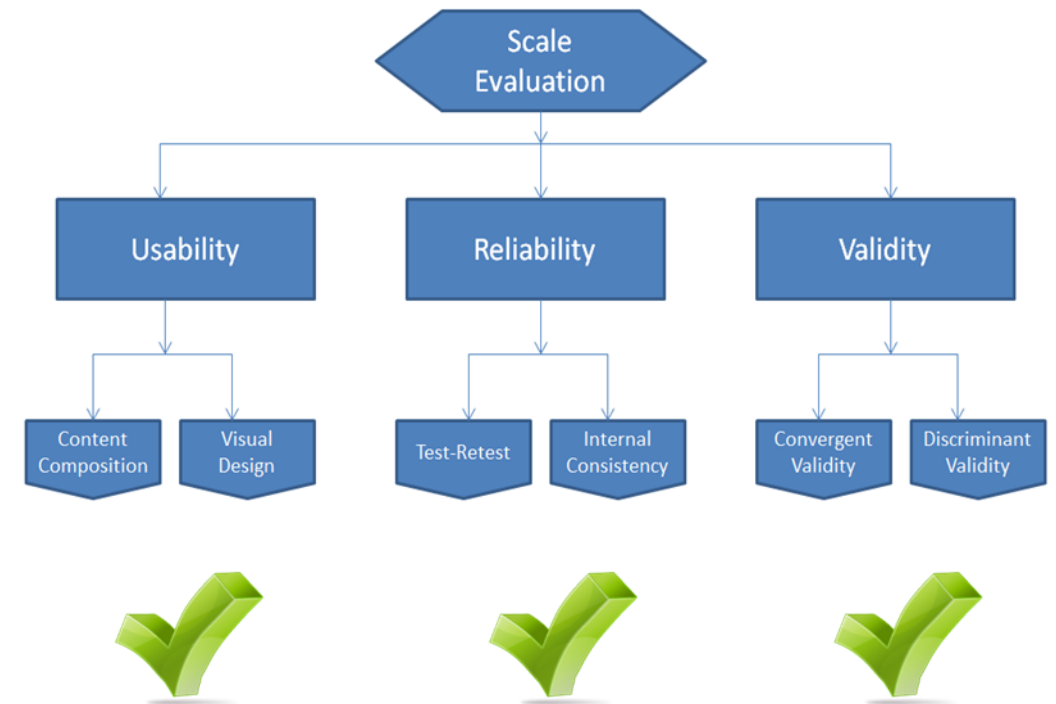
Stage 3: Main Survey Instrument Metrics

- Reliability Statistics for the final instrument (cases: 405; 204 Delhi NCR; 201 Bangalore)

Construct	Cronbach Alpha	Cronbach Alpha based on standardized items	Number of items
Environment Value Behaviors (EB)	0.867	0.870	9
Performance Expectancy (PE)	0.758	0.760	6
Hedonic Motivation (HM) (w/o item 1.21)	0.613 0.744	0.679 0.757	6 5
Effort Expectancy (EE)	0.601	0.595	3
Price Value (PV)	0.746	0.748	6
Self-Efficacy (SE)	0.655	0.660	4
Social Beliefs (SB)	0.906	0.905	4
Overall Reliability	0.800	0.801	38

- Strong convergent & discriminant validity

	CR> 0.7	AVE >0.5	MS V	Max R (H)	PV	EVB	PE	HM	EE	SB	SE
PV	0.915	0.644	0.343	0.922	0.802						
EV B	0.883	0.500	0.050	0.937	0.112	0.704					
PE	0.938	0.716	0.342	0.947	0.386	0.086	0.846				
HM	0.930	0.690	0.343	0.937	0.586	0.185	0.524	0.831			
EE	0.911	0.772	0.311	0.912	0.491	0.224	0.298	0.348	0.879		
SB	0.843	0.574	0.311	0.847	0.482	0.176	0.343	0.407	0.558	0.758	
SE	0.840	0.567	0.342	0.840	0.471	0.146	0.585	0.558	0.334	0.407	0.753





Factor Analysis

Stage 1: Data Readiness & Sample Size

- Factor Analysis requires Metric Data
Ref slide 28,29...meets norms.
- Sample Respondent Size
Ref Slide 28, sample size of 405 considered good for factor analysis (Tabachnik & Fidell, 2001) & (Chawla, 2011)



Stage 2: Sample Significance

- Cronbach alpha = 0.80
- KMO & Bartlett Test of sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.917
Bartlett's Test of Sphericity	Approx. Chi-Square	11046.365
	Df	703
	Sig.	.000

KMO > 0.6 ; Bartlett's Test of Sphericity significant



Factor Analysis (Contd)

Stage 4: Extracting final set of factors in the PCA



- Examining the communalities and screening the final set of extracted variables using the following criteria

1. Minimum items loading on appropriate factors should be above 0.50
2. Items should not load on multiple factors
3. Items should not demonstrate negative loadings

(ex. EVB1 and EVB2 are showing communality of 0.375 and 0.459 and are excluded from final analysis)

Description of Extracted Factors

Factor	Factor Description
Environmental Concern	Measures the degree of environment concern, underlying environmental beliefs and actual green habits that the consumer has
Social Beliefs	Measures influence of others on acceptance and usage of technology
Hedonic motivation	Measures the influence of hedonic (emotive) parameters on the consumer purchase decision
Performance Expectancy	Measures how practical, safe and easy-to-operate the households believe a rooftop solar usage will be
Price-Value	Measures the cost perceptions and the perceived economic utility
Self- Efficacy	Measures the perceived degree of ease in installing the rooftop solar
Effort Expectancy	Measures how much the residential RT solar buyer feels comfortable in using the system and ease to adopt.

Regression Analysis:

Testing conditions of normality, Collinearity and goodness-of-fit



- Multiple regression analysis model summary shows goodness of fit = 0.792

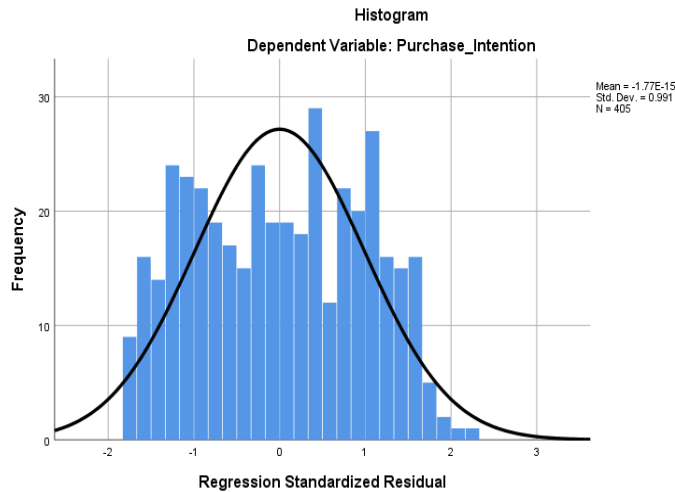
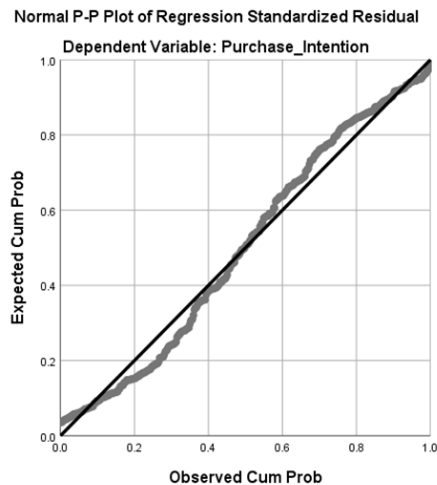


Table 5.16: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.890 ^a	.792	.788	.29439

- a. Predictors: (Constant), SE Mean, EVB Mean, EE Mean, SB Mean, PE Mean, PV Mean, Hedonic Mean
- b. Dependent Variable: Purchase Intention



Observed Probability distribution compared with probability distribution of a normal population. P-P plot seen snaking around diagonal an indication of normality of population

- ANOVA confirms valid statistical relationship between PI & UTAUT2 constructs

Table 5 17: ANOVA^a

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	130.991	7	18.713	215.920	.000 ^b
	Residual	34.407	397	.087		
	Total	165.398	404			



Regression Analysis:

Multiple Regression Analysis table for Coefficients for constructs finds relationship significant ($=0.000 < 0.05$)



▪ Linear Regression Equation Model

Purchase Intention = $-0.686 + (.240 \times \text{Social Beliefs}) + (0.235 \times \text{Effort Expectancy Beliefs}) + (.211 \times \text{Price Value Beliefs}) + (0.191 \times \text{Performance Expectancy Beliefs}) + (0.176 \times \text{Hedonic Motivation Beliefs}) + (0.169 \times \text{Environmental Beliefs}) + (0.122^* \times \text{Self Efficacy beliefs})$

Table 5.18: Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.686	.150		-4.572	.000
	EVB_Mean	.202	.028	.169	7.137	.000
	PE_Mean	.197	.029	.191	6.693	.000
	Hedonic_Mean	.143	.025	.176	5.729	.000
	EE_Mean	.165	.020	.235	8.353	.000
	PV_Mean	.174	.025	.211	6.984	.000
	SB_Mean	.177	.021	.240	8.611	.000
	SE_Mean	.139	.033	.122	4.190	.000
			Total	1.168		

Social beliefs is the most dominant factor – unit change in it drives 20.5% change in PI
 Self-efficacy is the least influential – unit change in it drives ~10% change in PI

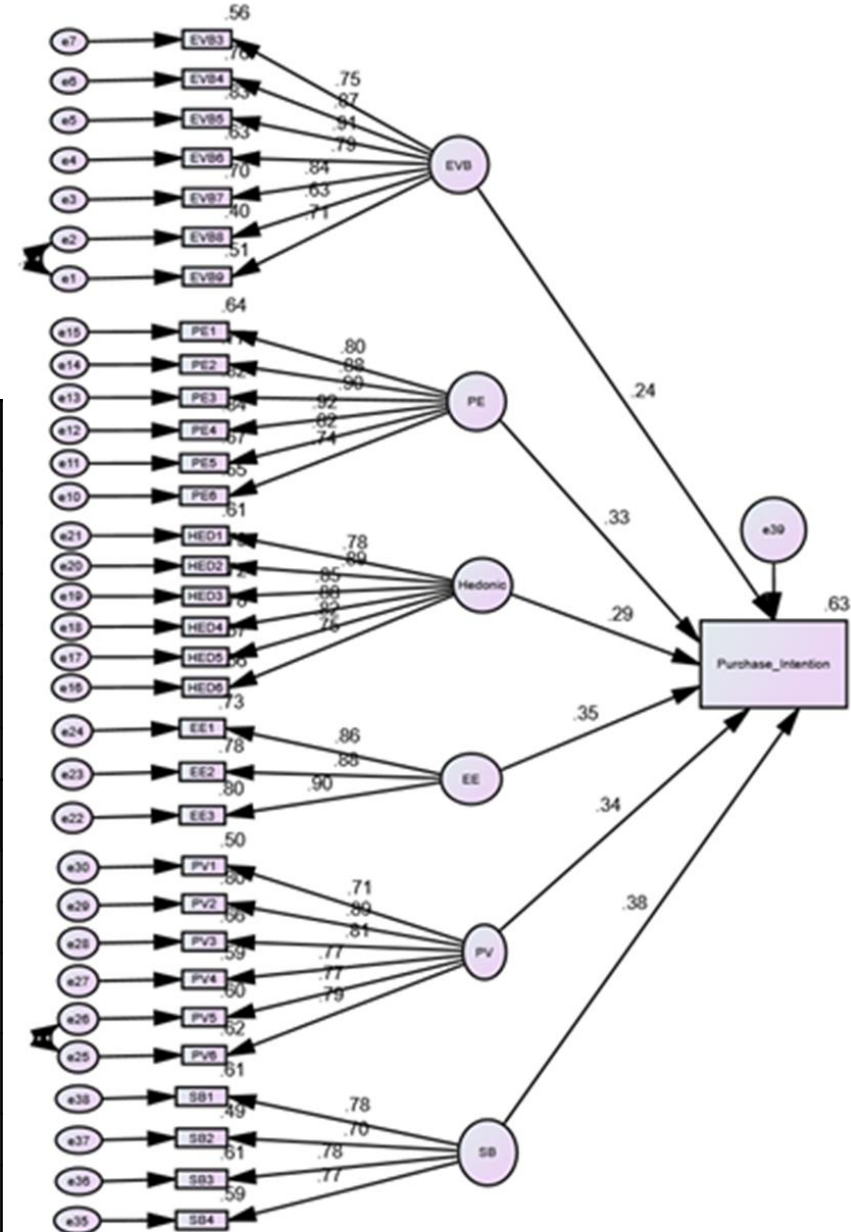
SEM: Stage 3- Developing a Structure Model



Stage 3. SEM Path model with causal relationships in line with UTAUT2 theory

- EVB1 and EVB2 (green habits) have very low weight (~0.151) on EVB (ref calculated std regression weights) below
- Self-efficacy dropped to enable CFI of 0.91

SB	Estimate	EE	Estimate	PV	Estimate	PE	Estimate
SB1	0.779	EE1	0.857	PV1	0.710	PE1	0.803
SB2	0.698	EE2	0.884	PV2	0.894	PE2	0.878
SB3	0.783	EE3	0.896	PV3	0.813	PE3	0.905
SB4	0.7700			PV4	0.768	PE4	0.917
				PV5	0.775	PE5	0.817
				PV6	0.789	PE6	0.743
HM	Estimate	EVB	Estimate	PI	Estimate		
HM1	0.778	EVB3	0.747	PI←SB	0.381		
HM2	0.891	EVB4	0.869	PI←PV	0.345		
HM3	0.851	EVB5	0.913	PI←EE	0.346		
HM4	0.883	EVB6	0.791	PO←HM	0.287		
HM5	0.819	EVB7	0.837	PI←PE	0.327		
HM6	0.749	EVB8	0.632	PI←EVB	0.235		
		EVB9	0.714				



Section B. The Research Hypothesis



SET 1	UTAUT2 Predictor Constructs and their relationship with PI of target customer
SET 2	Relationship of the moderating variables(age, gender, education, income) with the PI and UTAUT2 independent variables
SET 3	Relationship between various UTAUT2 variables and Context Variables (City; prior ownership)
SET 4	Relationship between various UTAUT2 variables and Awareness
SET 5	Relationship between various UTAUT2 variables and Adopters/ Procrastinators/non-adopters

Example:

$H_0 1i$:

There is no significant relationship between purchase intent and the independent variables in the UTAUT2 Constructs

$H_0 1a$: There is no significant relationship between purchase intent and the environmental beliefs

$H_0 1b$: There is no significant relationship between purchase intent and the Performance Expectancy

$H_0 1c$: There is no significant relationship between purchase intent and the Effort Expectancy beliefs

$H_0 1d$: There is no significant relationship between purchase intent and the Social Beliefs

$H_0 1e$: There is no significant relationship between purchase intent and the price value beliefs

$H_0 1f$: There is no significant relationship between purchase intent and the Self efficacy beliefs

$H_0 1g$: There is no significant relationship between purchase intent and the hedonic motivation beliefs

Set 3 Hypothesis- Results & Discussions (moderating variables)



Income Groups

H₀ 5a :	There is no significant relationship between PI & the income groups	Accepted
H₀ 5b :	There is no significant relationship between PE & the income groups	Accepted
H₀ 5c :	There is no significant relationship between EE & the income groups	Accepted
H₀ 5d :	There is no significant relationship between SB& the income groups	Accepted
H₀ 5e :	There is no significant relationship between HM beliefs & income groups	Accepted
H₀ 5f :	There is no significant relationship between PV beliefs & the income groups	Accepted
H₀ 5g :	There is no significant relationship between EVB & the income groups	Accepted
H₀ 5h :	There is no significant relationship between SE beliefs & the income groups	Rejected

There is no statistical relationship between income groups and UTAUT2 constructs (except self-efficacy)

Post-hoc shows self-efficacy belief difference between low income and high income groups

Education level Groups

H₀ 6a :	There is no significant relationship between PI & the education levels	Accepted
H₀ 6b :	There is no significant relationship between PE & the education levels	Accepted
H₀ 6c :	There is no significant relationship between EE & the education levels	Accepted
H₀ 6d :	There is no significant relationship between SB & the education levels	Accepted
H₀ 6e :	There is no significant relationship between HM & education levels	Accepted
H₀ 6f :	There is no significant relationship between PV beliefs & the education levels	Accepted
H₀ 6g :	There is no significant relationship between EVB & the education levels	Accepted
H₀ 6h :	There is no significant relationship between Self-efficacy beliefs & the education levels	Accepted

There is no statistical relationship between Education levels and UTAUT2 constructs

Set 3 Hypothesis- Results & Discussions (moderating variables)



▪ Genders

H₀ 7a : There is no significant relationship **Accepted**
between PI & gender

H₀ 7b : There is no significant relationship **Accepted**
between PE & gender

H₀ 7c : There is no significant relationship **Accepted**
between EE & gender

H₀ 7d : There is no significant relationship **Accepted**
between SB & gender

H₀ 7e : There is no significant relationship **Accepted**
between HM beliefs & gender

H₀ 7f : There is no significant relationship **Accepted**
between Beliefs & gender

H₀ 7g : There is no significant relationship **Accepted**
between EVB & gender

H₀ 7h : There is no significant relationship **Accepted**
between SE beliefs & the gender

Table 5.38: One-way ANOVA: Gender with Purchase Intention

Purchase Intention					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.125	1	.125	.305	.581
Within Groups	165.273	403	.410		
Total	165.398	404			

$$P=0.581 > 0.5$$

There is no statistical relationship between gender groups and UTAUT2 constructs

Set 4 Hypothesis- Results & Discussions (solar ownership)



■ Solar Ownership

H₀ 8a : There is no significant relationship between PI & the ownership variable **Accepted**

H₀ 8b : There is no significant relationship between PE & the ownership variable **Accepted**

H₀ 8c : There is no significant relationship between EE & ownership variable **Accepted**

H₀ 8d : There is no significant relationship between SB & ownership variable **Accepted**

H₀ 8e : There is no significant relationship between HM beliefs & ownership variable **Accepted**

H₀ 8f : There is no significant relationship between PV beliefs & the ownership variable **Accepted**

H₀ 8g : There is no significant relationship between EVB & the ownership variable **Accepted**

H₀ 8h : There is no significant relationship between SE beliefs & the ownership variable **Accepted**

There is no statistical relationship between solar ownership and UTAUT2 constructs

Table 5.40: One-way ANOVA PI with Solar user (SWHS or SPV user)

Purchase Intention					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.149	1	.149	.362	.548
Within Groups	165.249	403	.410		
Total	165.398	404			

Table 5.41: One-way ANOVA PI with SWHS user

Purchase Intention					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.182	1	.182	.444	.506
Within Groups	165.215	403	.410		
Total	165.398	404			

Table 5.42: One-way ANOVA PI with SPV user

Purchase Intention					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.422	1	.422	1.031	.310
Within Groups	164.975	403	.409		
Total	165.398	404			

Set 5 Hypothesis- Results & Discussions (awareness)



■ Awareness

H₀ 9a :	There is no significant relationship between PI & different awareness levels	Accepted
H₀ 9b :	There is no significant relationship between PE & different awareness levels	Accepted
H₀ 9c :	There is no significant relationship between EE & different awareness levels	Accepted
H₀ 9d :	There is no significant relationship between SB & different awareness levels	Accepted
H₀ 9e :	There is no significant relationship between HM beliefs & different awareness levels	Accepted
H₀ 9f :	There is no significant relationship between PV beliefs & the different awareness levels	Rejected
H₀ 9g :	There is no significant relationship between EVB & the different awareness levels	Accepted
H₀ 9h :	There is no significant relationship between SE beliefs & the different awareness levels	Accepted

There is no statistical relationship between awareness and UTAUT2 constructs except Price Value beliefs.

Clearly, just because one is aware of solar does not precipitate a PI at this stage of market maturity

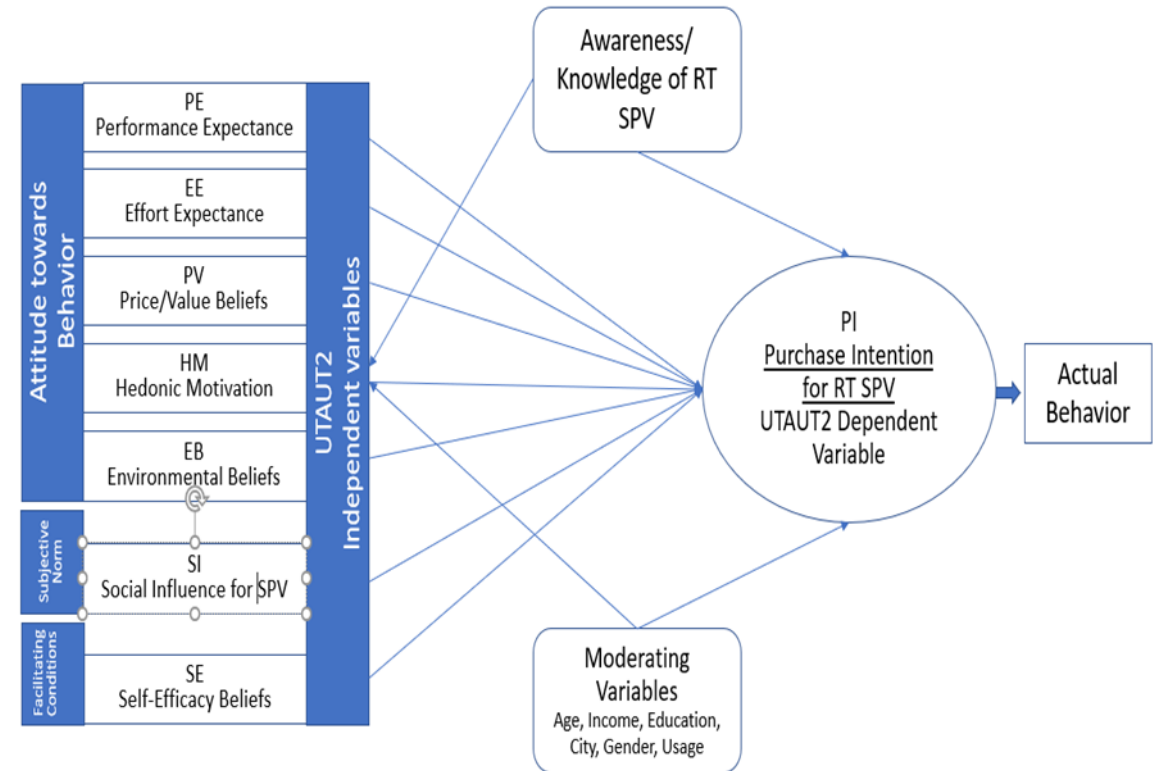
Table 5.47: One-way ANOVA test/ RT Solar awareness & UTAUT2 Variables

		Sum of Squares	Df	Mean Square	F	Sig.
EVB Mean	Between Groups	.522	1	.522	1.821	.178
	Within Groups	115.577	403	.287		
	Total	116.099	404			
PE Mean	Between Groups	.011	1	.011	.029	.864
	Within Groups	155.525	403	.386		
	Total	155.536	404			
Hedonic Mean	Between Groups	1.289	1	1.289	2.081	.150
	Within Groups	249.664	403	.620		
	Total	250.953	404			
EE Mean	Between Groups	1.554	1	1.554	1.883	.171
	Within Groups	332.590	403	.825		
	Total	334.144	404			
PV Mean	Between Groups	3.241	1	3.241	5.464	.020
	Within Groups	239.059	403	.593		
	Total	242.300	404			
SB Mean	Between Groups	.705	1	.705	.942	.332
	Within Groups	301.706	403	.749		
	Total	302.411	404			
SE Mean	Between Groups	.009	1	.009	.030	.863
	Within Groups	127.363	403	.316		
	Total	127.373	404			

Learnings & Contributions



- **The UTAUT2 Variables have a significant relationship with the Purchase Intent in the ANOVA tests.** (Labay & Kinnear, 1981) had found considerable difference between adopters and non-adopters in their study. Likewise, this research confirms that there is a statistical relationship of UTAUT2 variables (SB, EE, PV, HM, SE) across the adopter/procrastinator/non-adopter categories.
- Demographic Variables like age, gender, education, income have no significant relationship with PI.
- Awareness has no empirical relationship with Purchase intent at the current state of market maturity. Practically, everyone in the target market has seen a solar rooftop and is generally aware of solar – however, this does not translate into a purchase intent – at least, at this stage of market maturity.
- Solar ownership has no statistical relationship with purchase intent. Particularly, SWHS ownership does not translate into a purchase intent for SPV.
- City context has no statistical relationship with PI (Delhi NCR vs Bangalore).
- **This study shows that attitudes are more important than socio-demographic variables and context (currently) for shaping the residential RT SPV purchase intent.**





Learnings & Contributions

Factors	Suggested Actions
Social Beliefs	<ul style="list-style-type: none"> • Move from spray-n-pray to focused solar community development • Build solar community organizations, solar word-of-mouth, solar champs
Effort Expectance Beliefs	<ul style="list-style-type: none"> • Facilitate easy-integration into home • With battery back-up for seamless use • Thru seamless out-of-box experience delivered by well-trained solar-integrator network • Well-engineered execution that delivers • Options of Capex and Opex operating models
Price Value Beliefs	<ul style="list-style-type: none"> • Operationalize easy Net-metering • Marketing Collaterals with ROI justification • Programs to cluster solar sites for efficient, cost-effective executions
Performance Expectance Beliefs	<ul style="list-style-type: none"> • Define Product quality/ functionality standards • Define Site installation/ performance standards
Hedonic Motivation Beliefs	<ul style="list-style-type: none"> • Build solar word-of-mouth, solar champs, early bird-recognition
Environmental Beliefs	<ul style="list-style-type: none"> • Policies that promote SPV, demote DG sets
Self-efficacy Beliefs	<ul style="list-style-type: none"> • In this research, SE beliefs relate to perception on self-capacity to resource RT SPV. Financial assistance programs for consumers are policy options. However, as EFA results (Aggarwal et al., 2019) indicate, other factors are more potent triggers. Just because one has access to funds, one will not have a Purchase Intent for RT SPV.

Learnings for UAE/Other Markets



- UTAUT2 model emerges as a potentially more comprehensive model to describe the residential rooftop solar behavior
- There are several parallels between Delhi NCR , Bangalore city contexts that have been studied and the cities in UAE. Both the geographic contexts are rich in solar irradiation and are cosmopolitan, developed cities. ANOVA results indicate that city context and PI have no relationship. This paper and prior work (Aggarwal et al., 2019) gives some insights and some generalizations can be reviewed across these contexts. However, it will be appropriate to test these results independently in the specific geographic contexts involved. Cultural, political and evolutionary stage differences could prevent a simple generalization.



Ashwini K Aggarwal
Director-Government Affairs | Applied Materials India Pvt Ltd
Advisor- India Electronics & Semiconductor Association
Past Chairman 2017-18, IESA
Aggarwal.ashwini@gmail.com
Mobile +91 9910 555 970

 /xlashwini  /xIAshwini

<http://www.India-inspires.com>
<https://orcid.org/0000-0001-9503-7874>



Limitations of this Study

- Geographic Limited to two metros (Delhi NCR and Bangalore)
 - ▶ Bangalore has a high SWHS penetration, need to benchmark with a high SPV penetration city as well
 - ▶ Rural vs Urban penetrations need to be reviewed
 - ▶ Penetration differences in low-rise bungalow/ villa based contexts vs high-rise apartment cities needs to be studied
- Time Horizon
 - ▶ Longitudinal studies are required to map the market evolution from early adopter markets to mainstream markets
- Limited Solar PV install base
 - ▶ Results could be distorted because solar PV is very new to the Indian residential users and has very limited installed base
- Findings of the study are limited to Indian consumers and cannot be automatically generalized to other nationalities because of potential cultural, socio-economic and policy/ political context differences

Recommendations for future studies



- Geographical Context Extensions in India/ abroad
- User Experience Studies
- Opinion leader/ Referral Channel Studies
- Vendor Studies
- Longitudinal Studies
- Demand Modeling
- Environmental Impact Modeling

Someday, India will have Solar as a prominent percentage of its national energy mix (50% by 2030 as envisaged by Prof.Ashok Jhunjhunwal, IIT Chennai, 2013)

Solar sector will clearly be a very promising and fertile ground for academic studies in the quest to make this vision a reality!