



Solar aspirations and disinclinations: learning from 3600 households

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Mithra

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Project overview

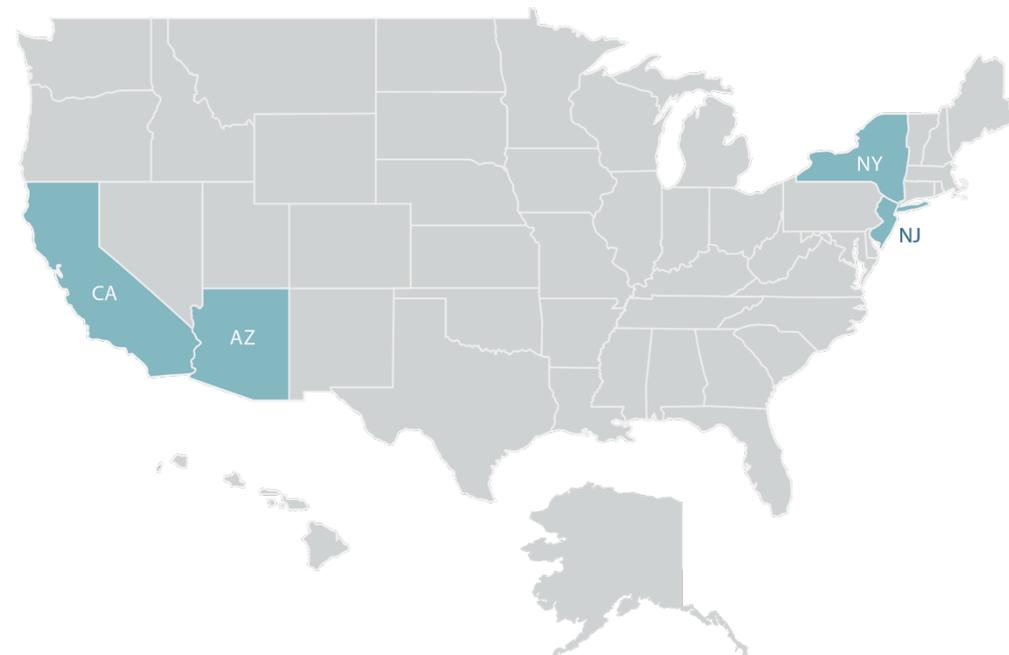
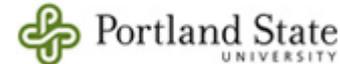
Three year study to understand drivers and barriers of consumer adoption of rooftop solar

Goals:

- Drive down customer acquisition costs
- Deepen understanding of technology diffusion

Key Activities:

- Surveys of 3,600 households: Adopters, Considerers, and General Population
- Agent-Based modeling
- Market pilots

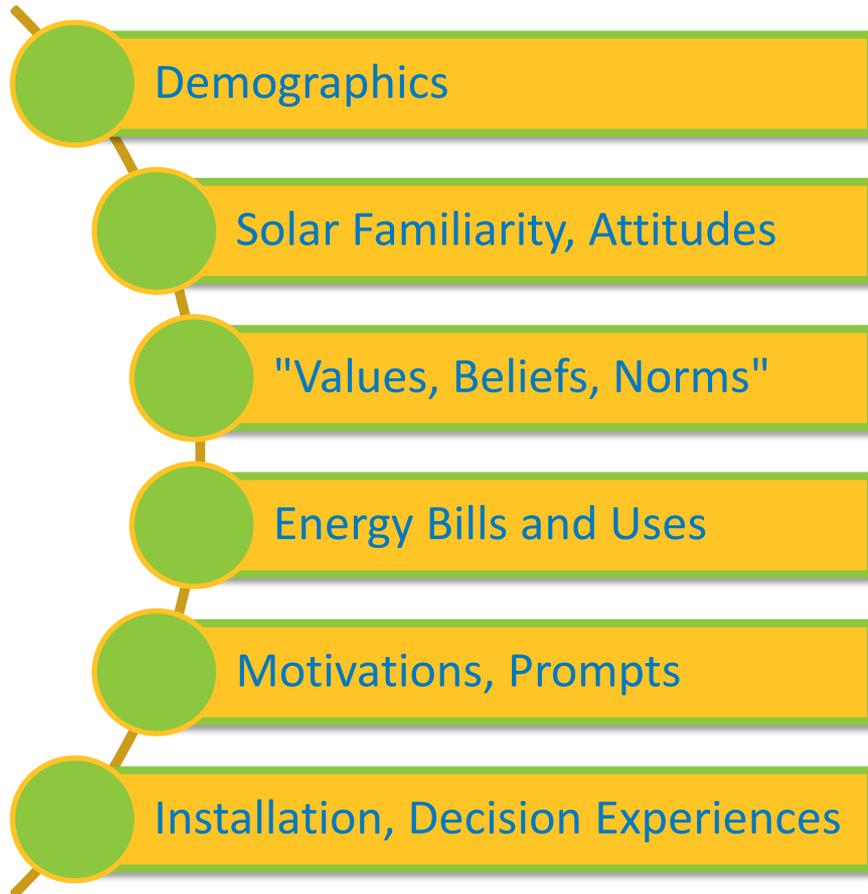


Data Collection Overview

Mithra Moezzi

Pre-review results: do not quote or cite without permission

What we collected via on-line surveys



- Surveyed ~3,600 single-family owner-occupied households in AZ, CA, NJ, and NY
- 450+ variables
- Three surveys:
 - General Population Survey
 - Considerer Survey
 - Adopter Survey
- Statistical properties complex

In addition, installer interviews by phone

Sampling details for three surveys, four states

Survey	Recruitment Source	When Fielded	Response Rate Estimate	Responses Passing Data Quality Checks				
				AZ	CA	NJ	NY	Total
General Population Survey*	Panelists	June/July 2014	N/A	351	338	315	337	1341
Considerers Survey	Lead Generators, Installers	Dec 2014 to April 2015	1.4%	13	90	9	41	153
	Panelists	March 2015	N/A	100	97	98	141	436
Adopter Survey	Installers	Dec 2014 to April 2015	8.5%	34	1181	185	187	1587
	Panelists	March/April 2015	N/A	75	0	0	0	75
			Grand Total	573	1706	607	706	3592

Results Part I

Results Part II

*Slightly different treatment of GPS respondents in Part 1 vs. Part 2, and thus somewhat different cases used.

What predicts initial interest in solar?

Results from General Population Survey

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Collaborators:

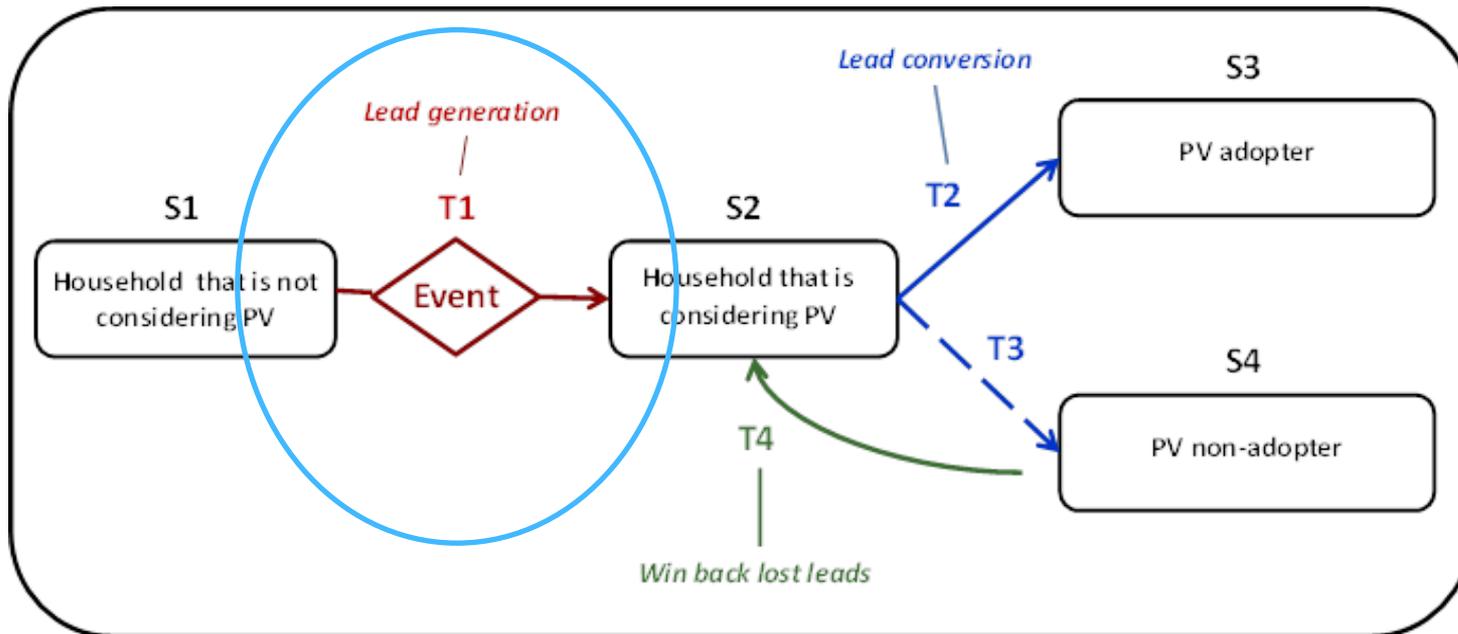
Paul Stern, National Academy of Sciences

Tom Dietz, Michigan State University



FREDERICK A. & BARBARA M.
ERB INSTITUTE
UNIVERSITY OF MICHIGAN

How can we lower the soft costs of generating new leads?



Some common assumptions...

People Go Solar...

For the Planet.



To Save Money.



Because it's Cool.



Some common assumptions...

People Go Solar...

For the Planet.



Value-Belief-Norm
theory
(Stern *et al*, 1999)

To Save Money.



Theory of Planned
Behavior
(Ajzen, 1991)

Because it's Cool.



Diffusion of Innovations
(Rogers 2003)

General Population Survey

- 1,156 respondents with complete data
- Examined two types of Interest in PV:

Social Curiosity



Interest in Talking to Installer



Analytic strategy

- How much do socio-demographics alone explain?
- 3 Path Analyses:
 - VBN variables, controlling for socio-demographics
 - TPB variables, controlling for socio-demographics
 - DOI variables, controlling for socio-demographics
- Final integrated model to understand relative importance of different variables

How much do socio-demographics explain?

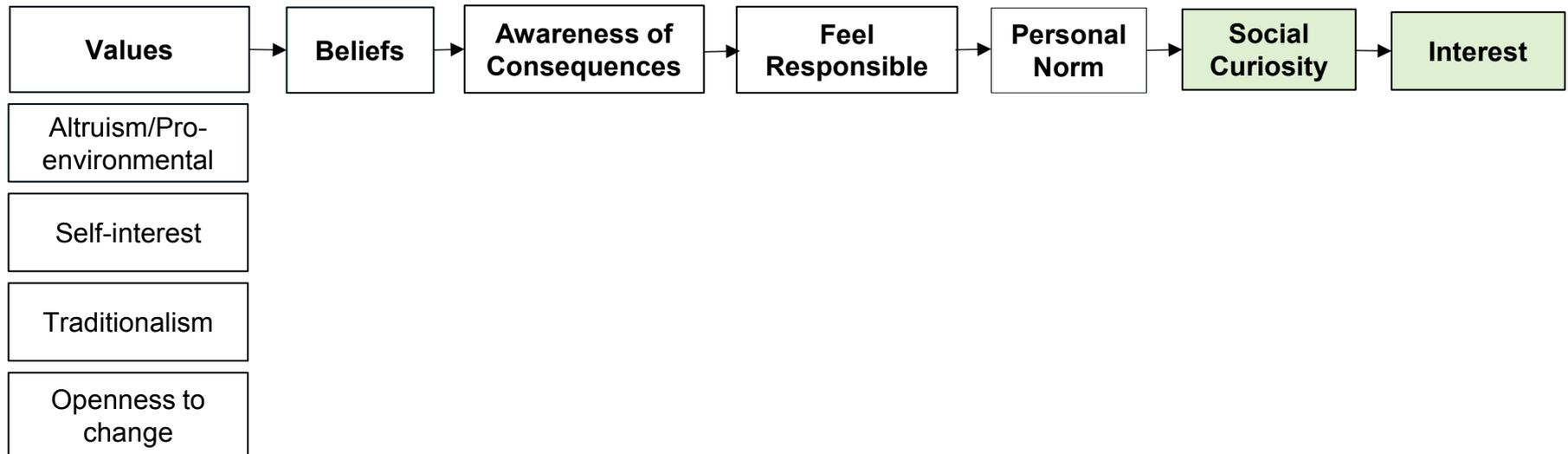
- Explain 11% of variance in Interest.

Significant predictors:

- Age: Younger individuals more interested
 - Gender: Males more interested
 - High summer bills
 - Lower household incomes
 - Have experienced more power outages
-
- Once we control for psychological variables, only age and gender remain significant

1) Solar as an eco-friendly behavior?

Value-Belief-Norm Model (Stern *et al.*, 1999)

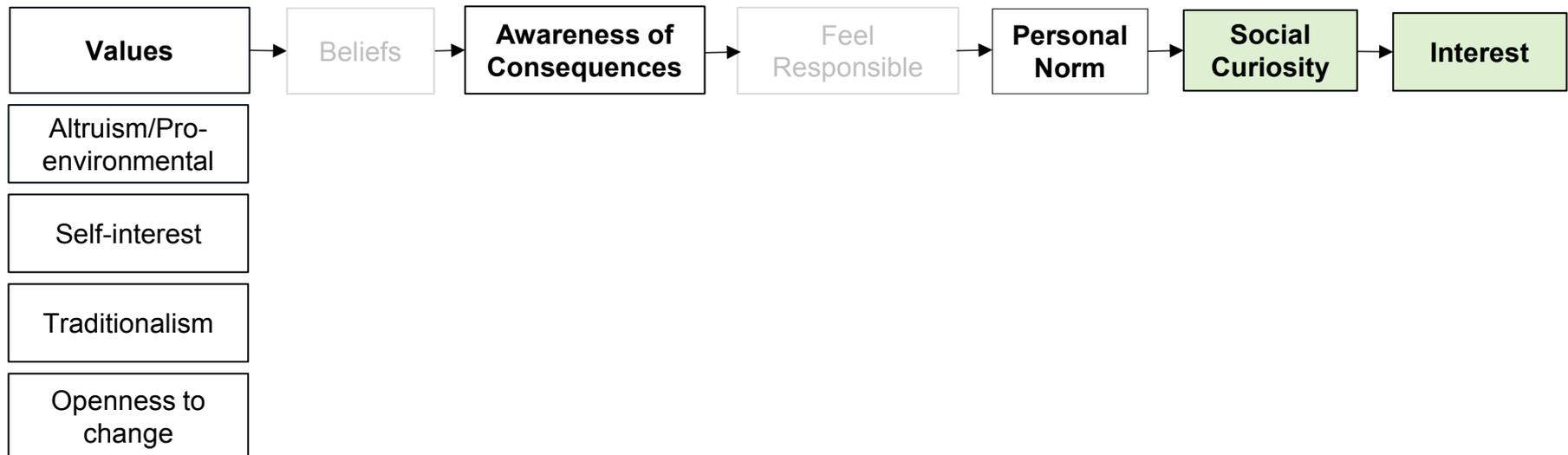


VBN: People who have strong altruistic and environmental values, believe the environment is threatened, and that they can do something to help, will feel a moral obligation to take action, and are more likely to pursue PV.



1) Solar as an eco-friendly behavior?

Value-Belief-Norm Model (Stern *et al.*, 1999)

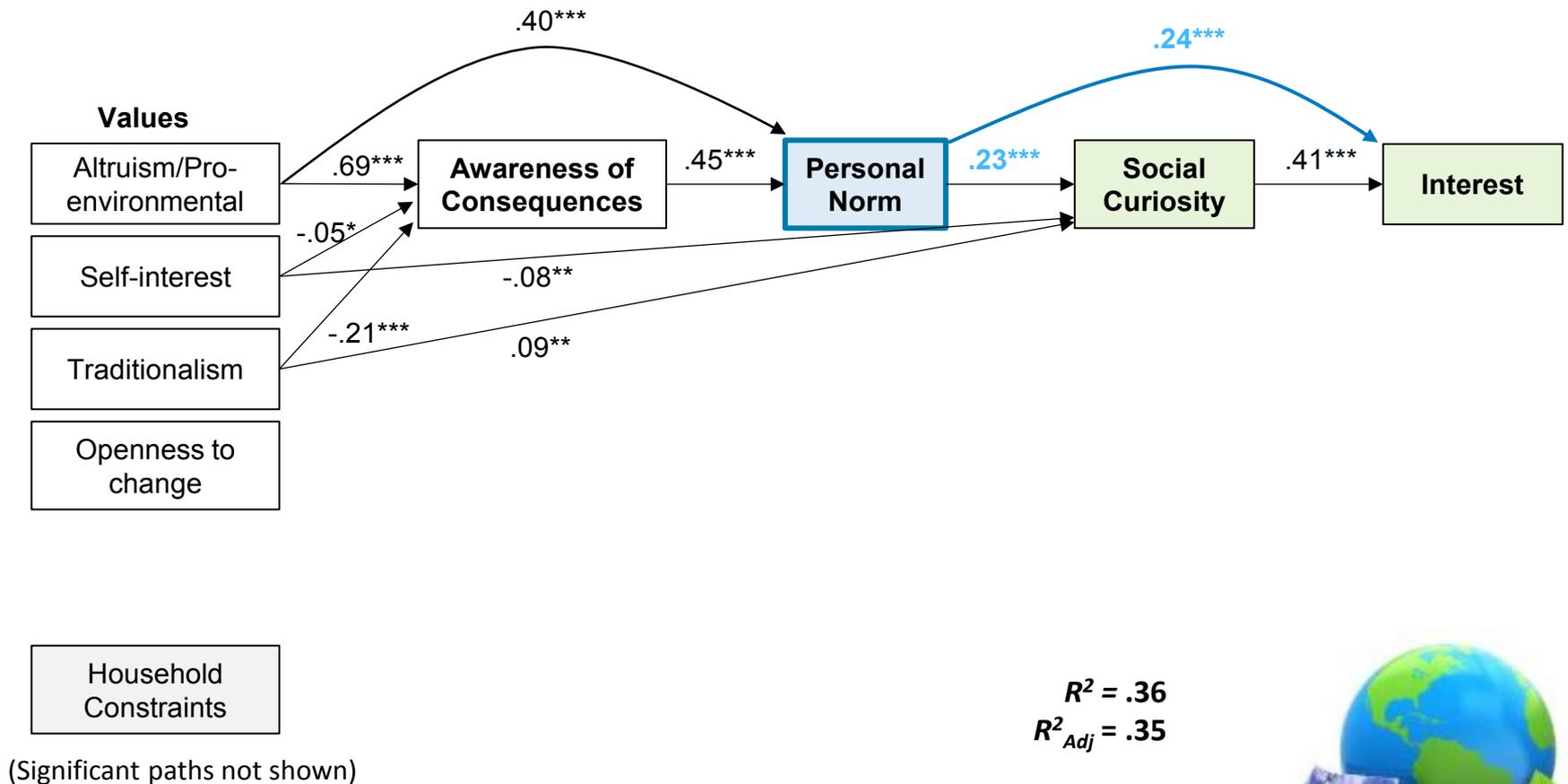


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1) Solar as an eco-friendly behavior?

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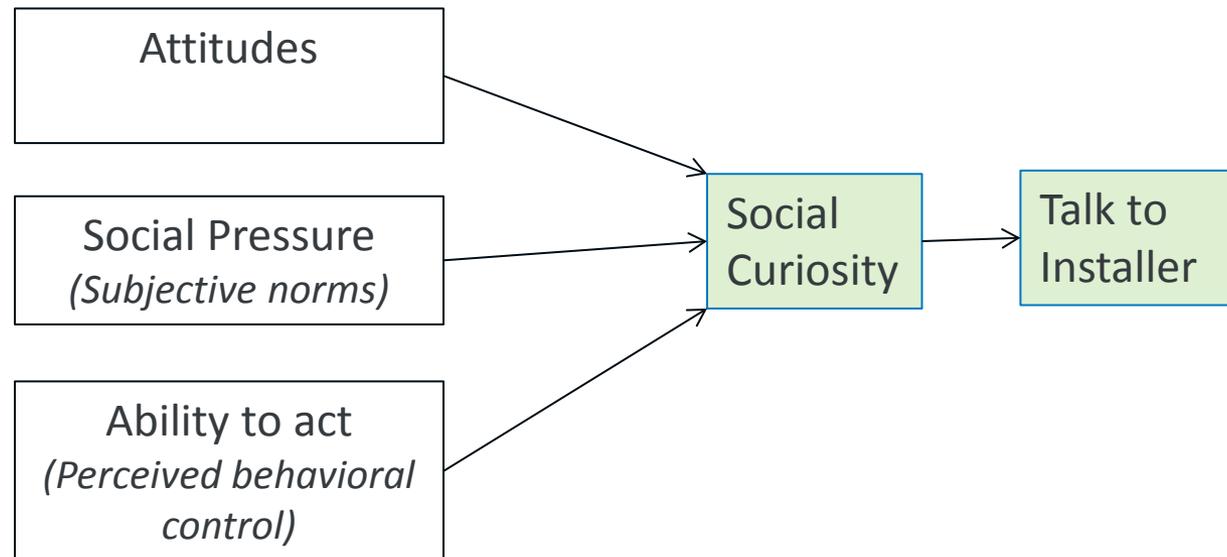


VBN explains 11% of variance after controlling for household constraints (excluding SC)



2) Solar as a consumer good?

Theory of Planned Behavior (Ajzen, 1991)

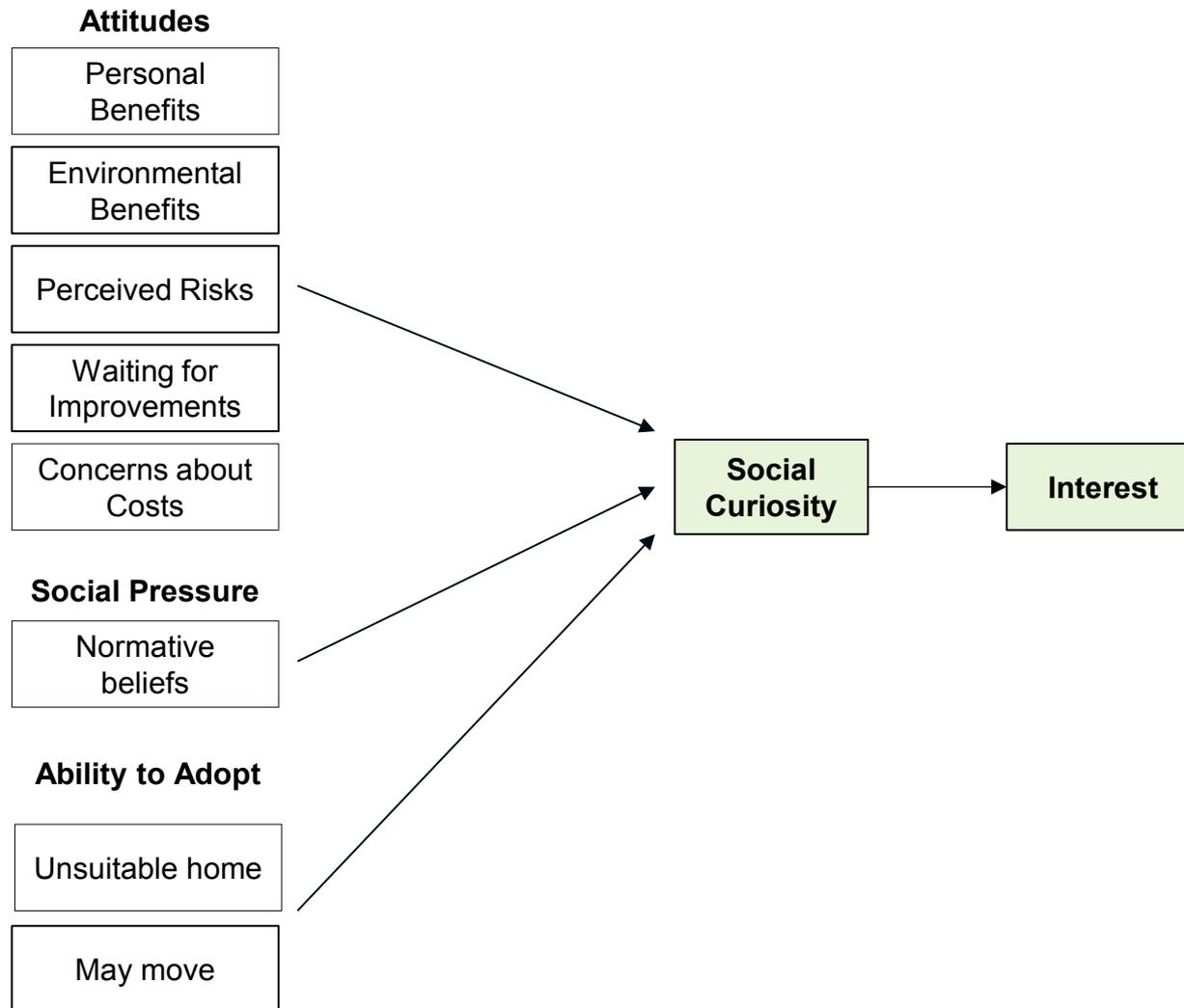


TPB: People decide whether to engage in a behavior after rationally weighing the pros and cons, taking into account their beliefs and attitudes about solar, social expectations and whether they think they're capable of getting PV.



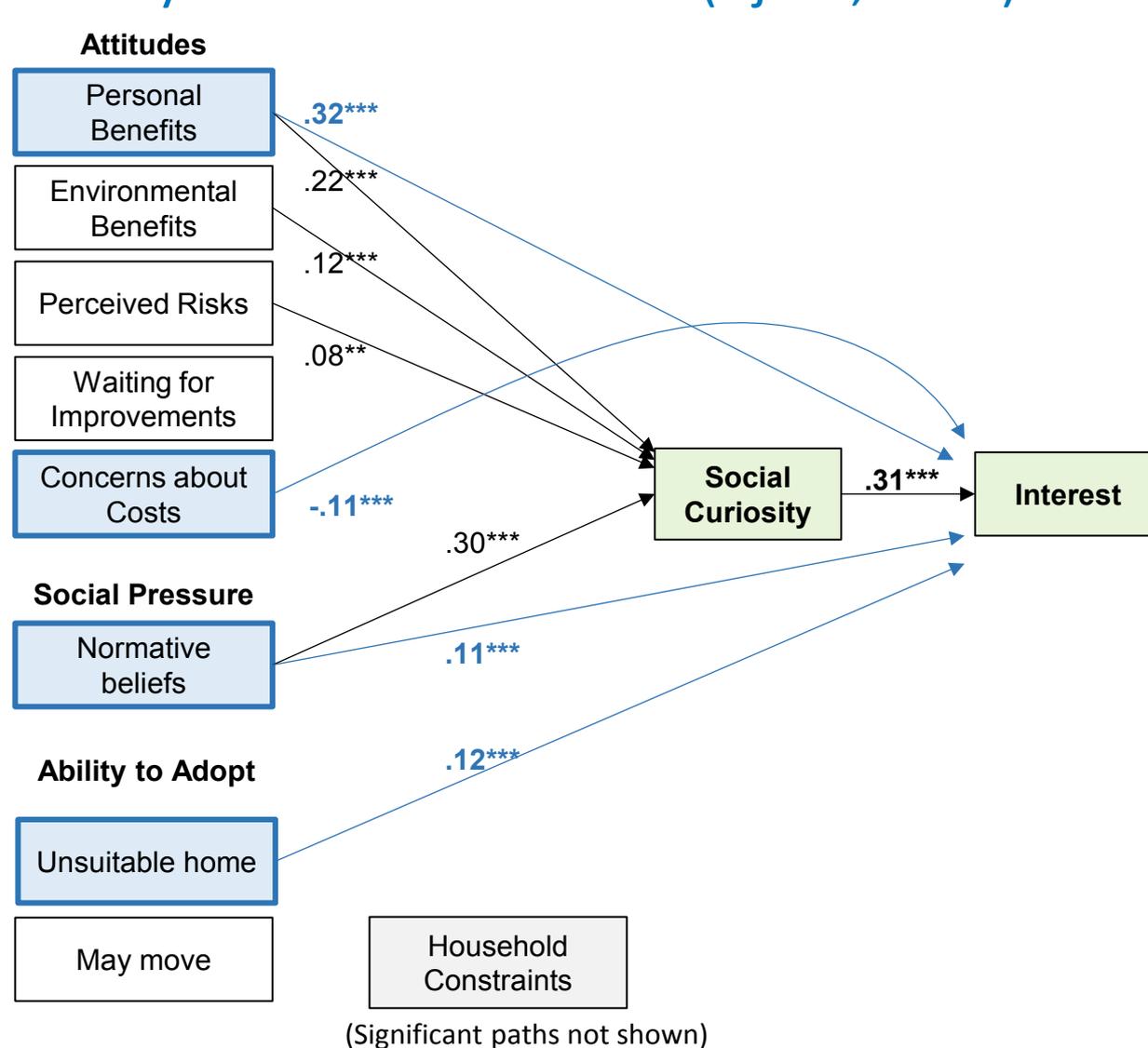
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2) Solar as a consumer good?

Theory of Planned Behavior (Ajzen, 1991)



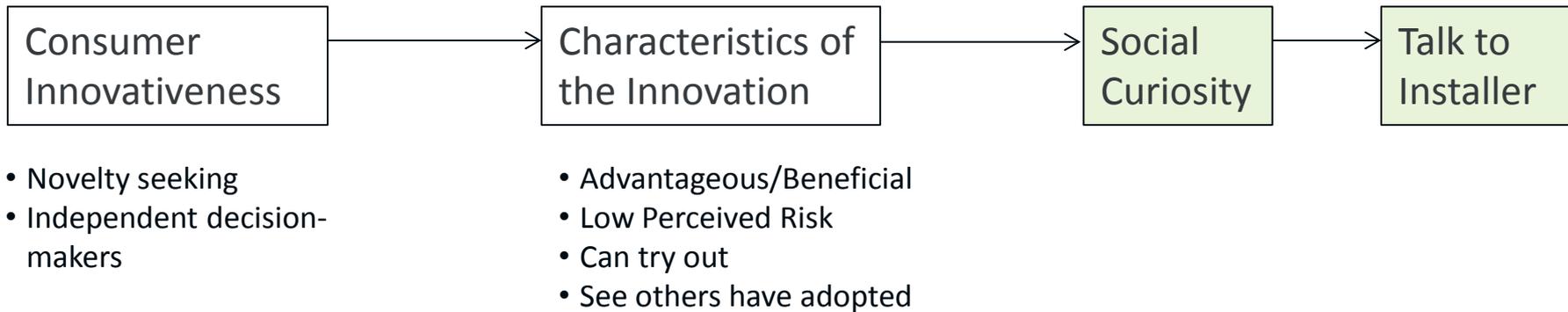
$R^2 = .45$
 $R^2_{Adj} = .44$

TPB explains 27% of variance after controlling for household constraints (excluding SC)



3) Solar as an innovative technology?

Diffusion of Innovations (Rogers, 2003)

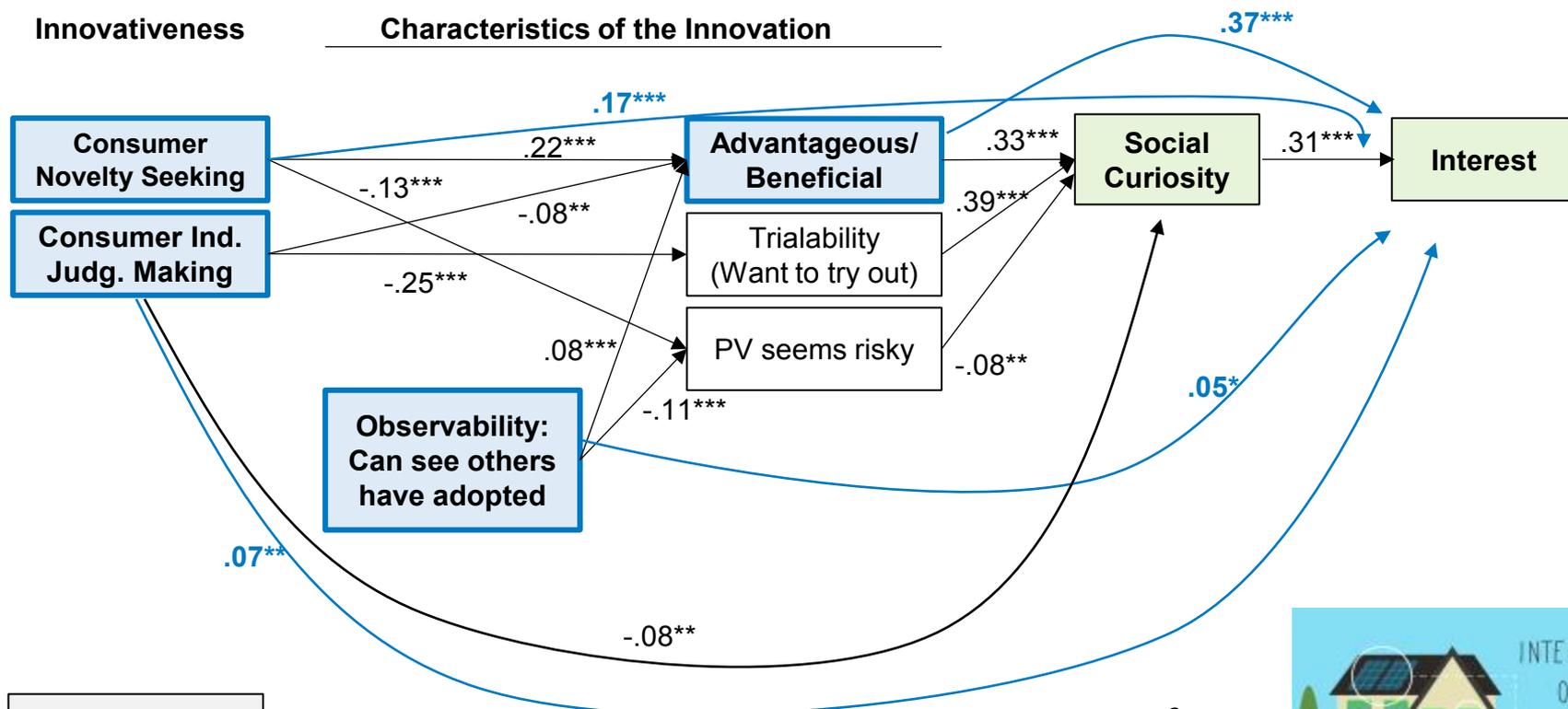


DOI describes the process by which new innovations are adopted. Innovative, novelty-seeking consumers are likely to adopt first. Adoption and diffusion occur more quickly when people hold favorable impressions of the innovation.



3) Solar as an innovative technology?

Diffusion of Innovations (Rogers, 2003)



Household Constraints

(Significant paths not shown)

$$R^2 = .45$$

$$R^2_{Adj} = .44$$

DOI explains 28% of variance after controlling for household constraints (excluding SC)

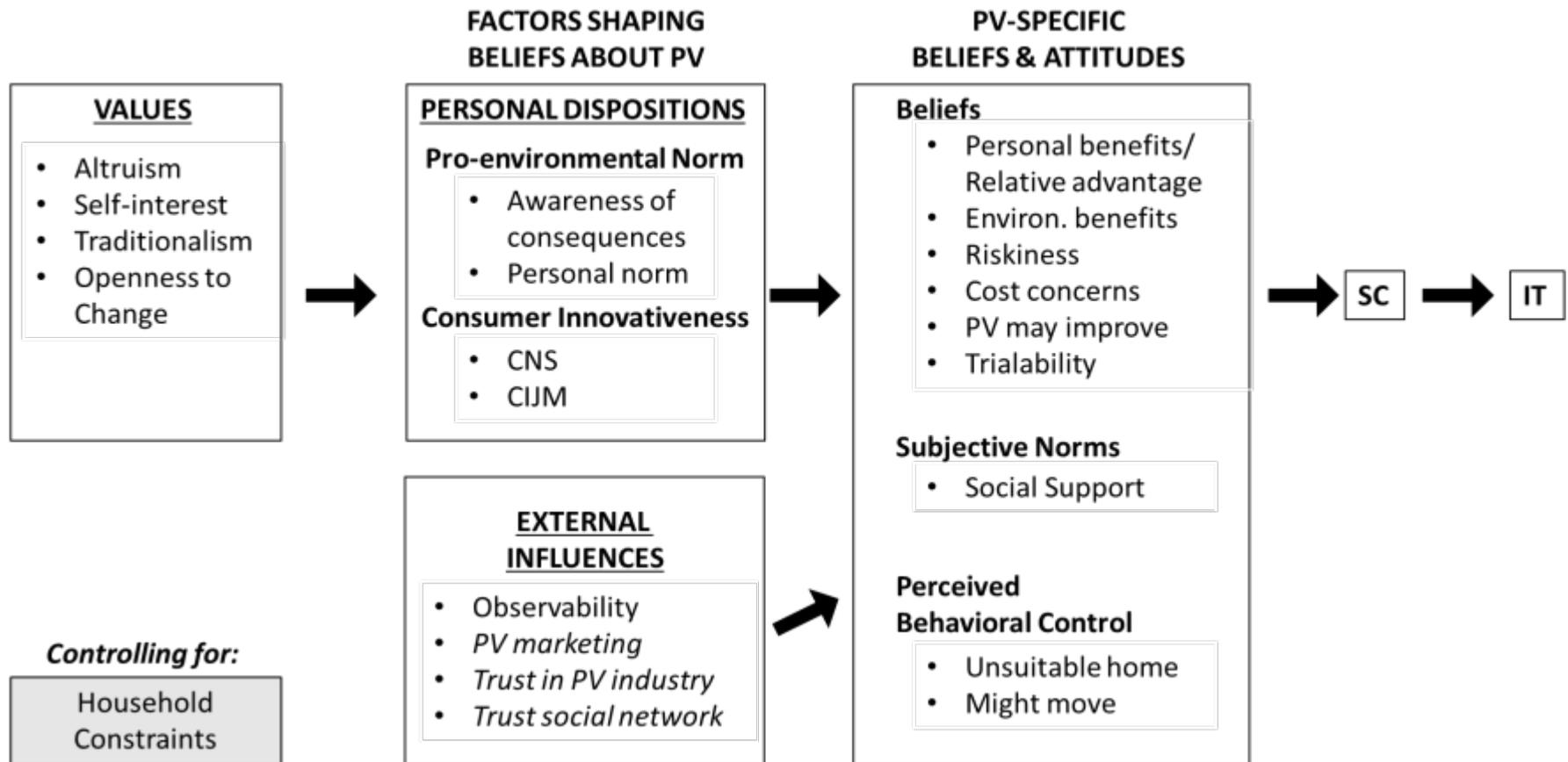


Evidence that people evaluate PV in multiple ways:

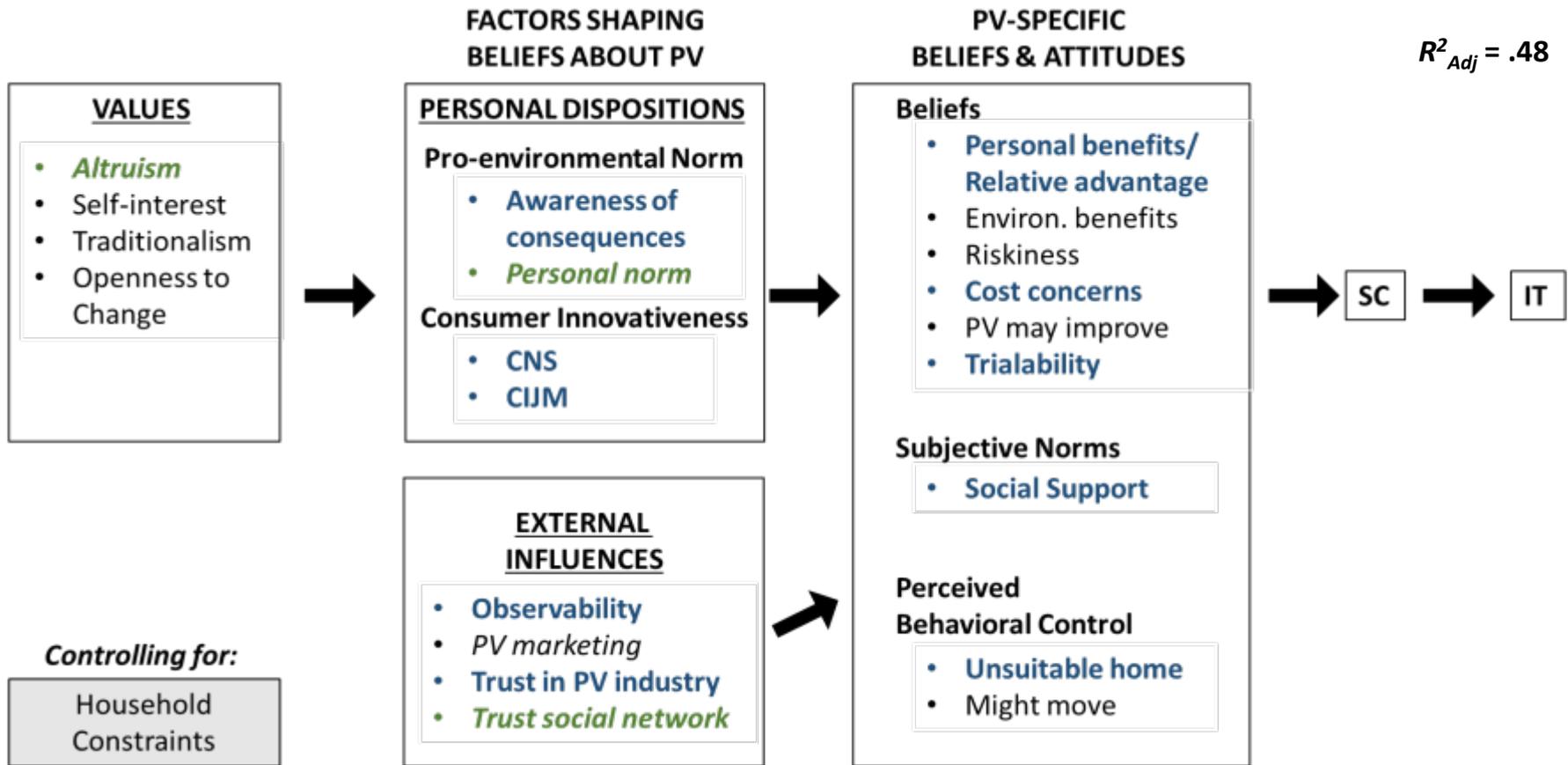
- Environmental benefit
- Consumer good
- Innovative technology

But, which matter most for generating leads?

Integrated model



Integrated model



Strongest Predictors:

- Personal benefits ($\beta = .25$)
- Novelty Seeking ($\beta = .17$)
- Trust in PV Industry ($\beta = .15$)

Predictors in *Green* have strong indirect effects

People with strong pro-environmental norms more likely to believe PV will benefit them personally

What this means for generating leads

WHO to target?

- Innovative consumers/early adopters of technology
 - Environmentally conscious*
- *Show how PV aligns with values but also demonstrate personal benefits

WHAT messaging?

- Make the financial and personal benefits clear. Show how PV meets needs and addresses concerns.

HOW?

- Tap trusted social networks and information sources
- Carefully structure incentive programs/policies

Trajectories and comparisons: a non-modeling approach to adoption and non-adoption

3-survey analysis

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Collaborators:

Aaron Ingle, Portland State University

Loren Lutzenhiser, Portland State University

Revising storylines

Why not modeling?

Who is not interested?

Who considers and then stops and why?

Who buys and why?

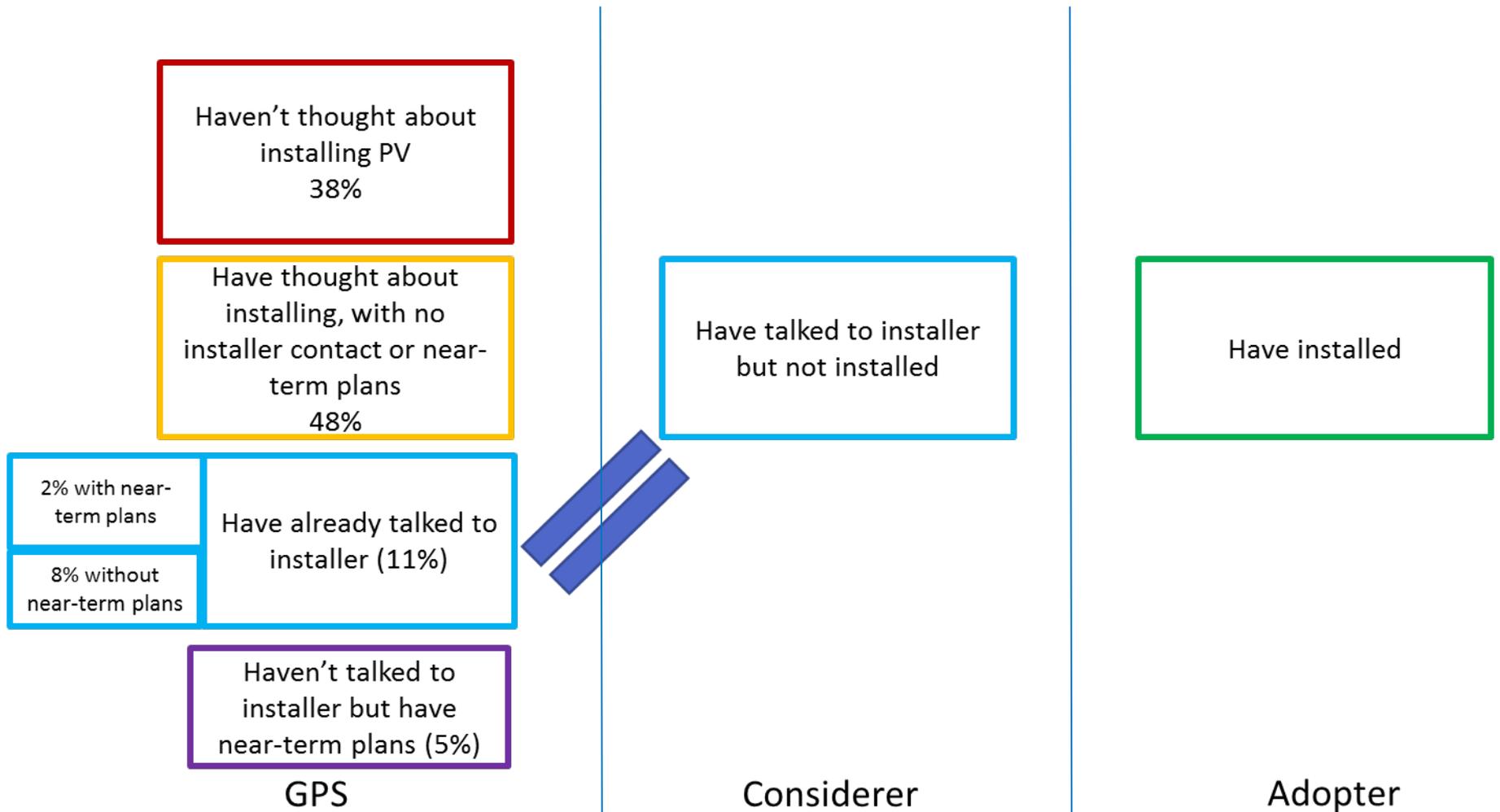
What do PV adopters think about their experiences?

What do households think is missing?

What changes will help for the future?

Meshing industry, installer, and researcher intel

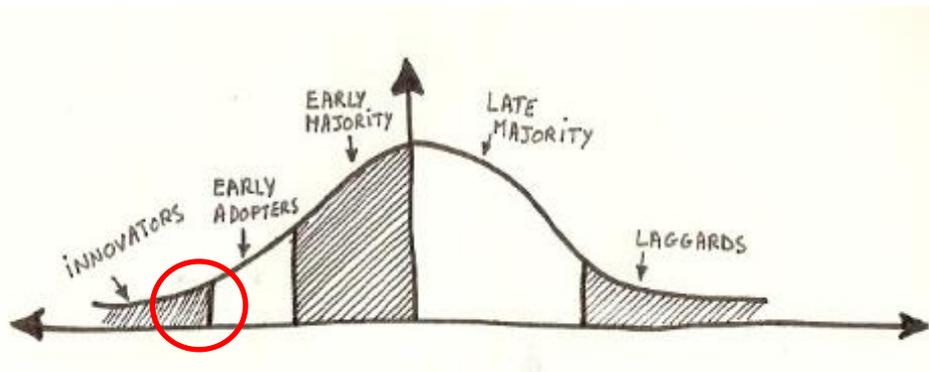
Solar status by survey type



What can we learn from early adopters? What cautions to bear in mind?

Where are we?

One of 100s of DOI illustrations



- “If there is a dream solar technology it is probably photovoltaics” – *Science* 1977
- Still early
- Government support, heavy subsidies
- PV is a weird product
 - Electricity already works
 - Lots of future uncertainty
- First let’s look at the 98%-99%

Luc Gallopin, Creative Commons

(<https://www.flickr.com/photos/lucgaloppin/4952178612>)

The disinterested, the unaware, the antagonistic, the enthusiastic and in between

Not Thought <i>Have not thought about solar for my home</i>	38%
Not Interested/Antagonistic <i>Not at all interested in how solar could work for my home</i>	13%
Unaware <i>Haven't noticed much if anything about solar</i>	25%
Thought Not Bought* <i>Have thought about solar for my home</i>	61%
Interested <i>Interested in talking to installer or in local experience</i>	31%
Very Interested at least conceptually <i>Very interested in how solar could work for my home</i>	16%
Near Term Plans <i>Plan to talk to installer in next 6 months</i>	7%
Talked <i>Already talked to installer...similar to Considerer</i>	11%
Have Installed	< 1%**

RESISTANT

ENTHUSIASTIC

*Some categories below overlap.

**Nationally; much higher in some locales -- 6% in California.

Lots of reasons to not buy:

Which are “correct”? Which can be overcome? And how?

	Concern	Not Thought	Thought not Bought
MONEY	Not compelling financially	66%	59%
	Can't afford	35%	27%
	Not at all interested in savings from solar	27%	4%
	Low bills (electricity under \$100/mo. summer & winter)	36%	24%
TIME	May not be in home long enough*	57%	45%
	Age over 75	20%	13%
PRAGMATIC	Perceive conditions to be unsuitable **	24%	17%
	HOA disallows	open mention	open mention
	Perceive as hassle to install	32%	30%

*Average tenure in US: 13 years

** In New Jersey in particular, people mentioned the need to deal with trees on/around the property as adding expense or reducing appeal.

	Concern	Not Thought	Thought not Bought
INFO	Low trust in information sources**	49%	28%
TECHNOLOGY	Concerned with maintenance	19%	18%
	Concerned with damage to roof	16%	15%
	Mistrust technology	57%	47%
	Perceive solar as risky	34%	31%
TASTE	Not aligned w/ enviro, climate change causes	16%	7%
	Embarrassed by visuals	9%	5%
INTERNAL	Family/friends would not support	15%	8%
	Think it's better to wait	41%	43%

***Most trusted friends and neighbors -- but universities, government, installers, trade organizations, utilities, environmental organizations, and online reviews: much less

What considerers say

financial qualities
don't sync
with all buyers

"difficult to determine
best route"

"the market is very
confusing"

complex decision

"all offers were more
expensive than our
monthly bill"

"you need to pay first
and the wait for the
incentives."

"there are no
incentives for seniors,
who can't access the
tax credits"

"I get 4-7 calls a week
from solar companies,
and I'm tired of it."

annoyance

Concerns and difficulties: what stops households when considering solar?

	Considerers (%)	
How concerned were you about...?	None or A Little	Stopped
Affordability	19	58
Whether panels offered enough bang for buck	17	50
Equipment quality and reliability over time	16	44
Whether solar was a good financial decision	18	53
Taking on debt or signing a lease	25	55
Having to perform regular maintenance	25	37
Risk of damaging your roof	30	40
Might detract from home's "curb appeal"	49	29
Might be harder to sell home with solar panels	54	30
How much difficulty did you have with ...?	None or A Little	Stopped
Coming up with the money to get solar	35	55
Finding a trustworthy and competent installer	36	37
Suitability of your home site	43	36
Finding installer who would agree to do the work	58	26
Permitting, zoning, or neighborhood restrictions	58	22
Not everyone in your household being convinced	62	28

- Money stops more than half
- Only three difficulties & one concern that less than half say they experienced at least "some"

What are adopters like? State level ranges:

Electricity Bills
often high

- 31%-43% with summer or winter bills > \$275/mo. (vs. 18% GPS)
- 12%-21% with summer & winter bills < \$100/mo. (vs. 29% GPS)

Income often
high

- Except AZ, ~25% have income > \$150K/year (vs. 12% GPS)

Less female

- Except AZ, 33%-36% female (vs. 60% GPS)

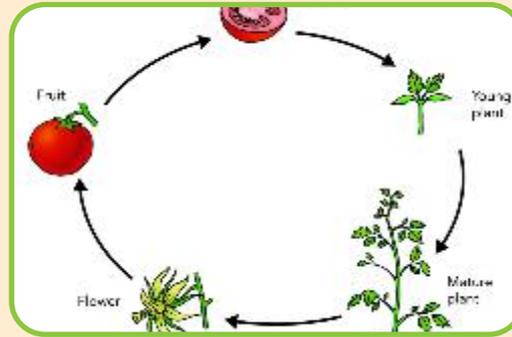
Also

- Lots of pools
- Lots of AC
- Over 40 (~80%)
- Often retired (33%+)

Decision pathways



Deliberative



Events



Opportunistic

Adopter types (but “money” is complex)



Adopter motives for considering solar: money, environment, technology, leadership ...

	Motive	“Extremely Important”
#1	Lowering your total electricity costs	78%
	Getting a good return on investment	33%
	Adding to your home's market value	23%
#2	Protection from rising electricity prices in the future	62%
	Being able to use renewable energy	#3 50%
	Being able to use a promising new technology	30%
	Reducing your environmental impact	#4 43%
	Setting a positive example for others in your community	26%

What prompted you to look into solar? What adopters say:

Prompt	% of Adopters
<i>Energy use/costs</i>	
Looking for ways to reduce energy bills	88
<i>Social</i>	
Someone you know talked about it	32
Saw advertising or news article	22
Saw solar being installed on a home	21
<i>Approached</i>	
Offered at a retail store, show, or event	7
Approached by an installer	54
<i>News about affordability</i>	
Heard it was more affordable	63
Heard about low money down options	23
<i>Planning, events</i>	
Planning for retirement	10
Came in to some money	2
Had group purchase opportunity	1
<i>Home changes</i>	
Considering a major new energy use	6
Planning/doing other work on home	5
Bought a home/moved	4

Environment vs. bills: comparing adopters to disinterested

	Low Environmental	High Environmental
Low Bills Average < \$100/month	2% 5x more common among disinterested	10% Just as common among disinterested
High Bills Average > \$275/month	13% 1/6th as common among disinterested	46% 1/12 as common among disinterested

Only respondents with strong opinions included (cells don't add to 100%).

Most adopters (especially buyers) happy so far.
Some are in disbelief that it worked out so well.

With the state payment,
federal tax credit, and loan
...this was a no-brainer. It
took me two months to
believe it.”

I can't understand why
everybody doesn't do it.

I tell other people
that my panels were
free, but nobody
believes it.

Until we were contacted by
our installers, everything we
heard about solar was
negative. But our experience
has been great!

* 14% of leasers, 9% of buyers stated they had regrets

Adopters didn't always know what they were getting into. Those paying no up-front costs might have researched less.

Very hard to figure out all the options.

Installation was free. But with higher costs of electricity, my costs are twice what I expected. I am not some stupid environmentalist.

Overall I think the solar companies are dishonest, opportunistic, and unethical.

The true-up bill was a shocker. I want other people to know about this.

I thought our PV system would provide us with power during an outage, but it didn't help. We had no power during Sandy.

It's been four months. I haven't saved any money.

Varied triggers, interpretations of what solar is for

The only reason we installed was that it didn't cost us anything.

It was the swimming pool pump that got me to install solar. We live in a very mild climate and don't use heating or cooling.

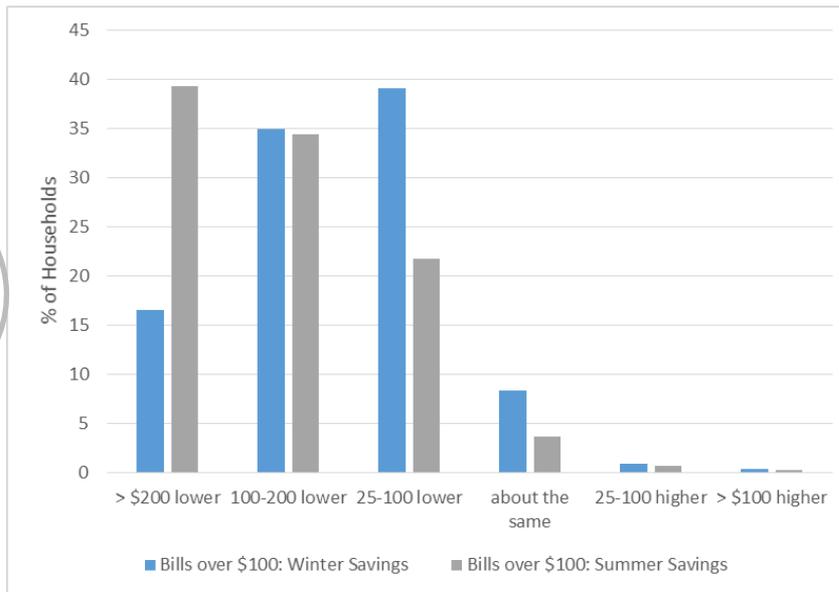
Many of your questions had nothing to do with solar... global climate change, etc.

My decision to go solar was based on a couple of huge utility bills that were never explained.

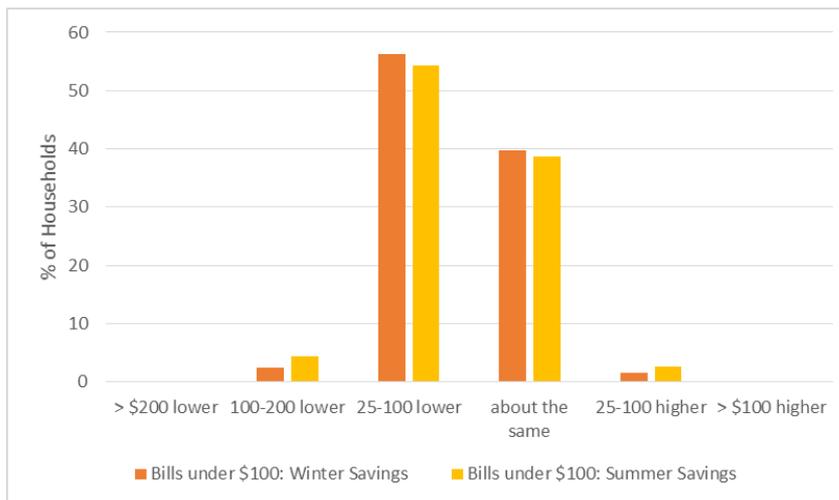
Pre-post reported savings (see cautions!*)

Some savings (& non-savings) outside “pre-post”

People with low bills can't (and don't) save that much



HIGH BILLS



LOW BILLS

*Cautions: pre-post differences for self-reported monthly bills, no annual-true up, early results for many adopters, etc.

How did solar come to be about money?

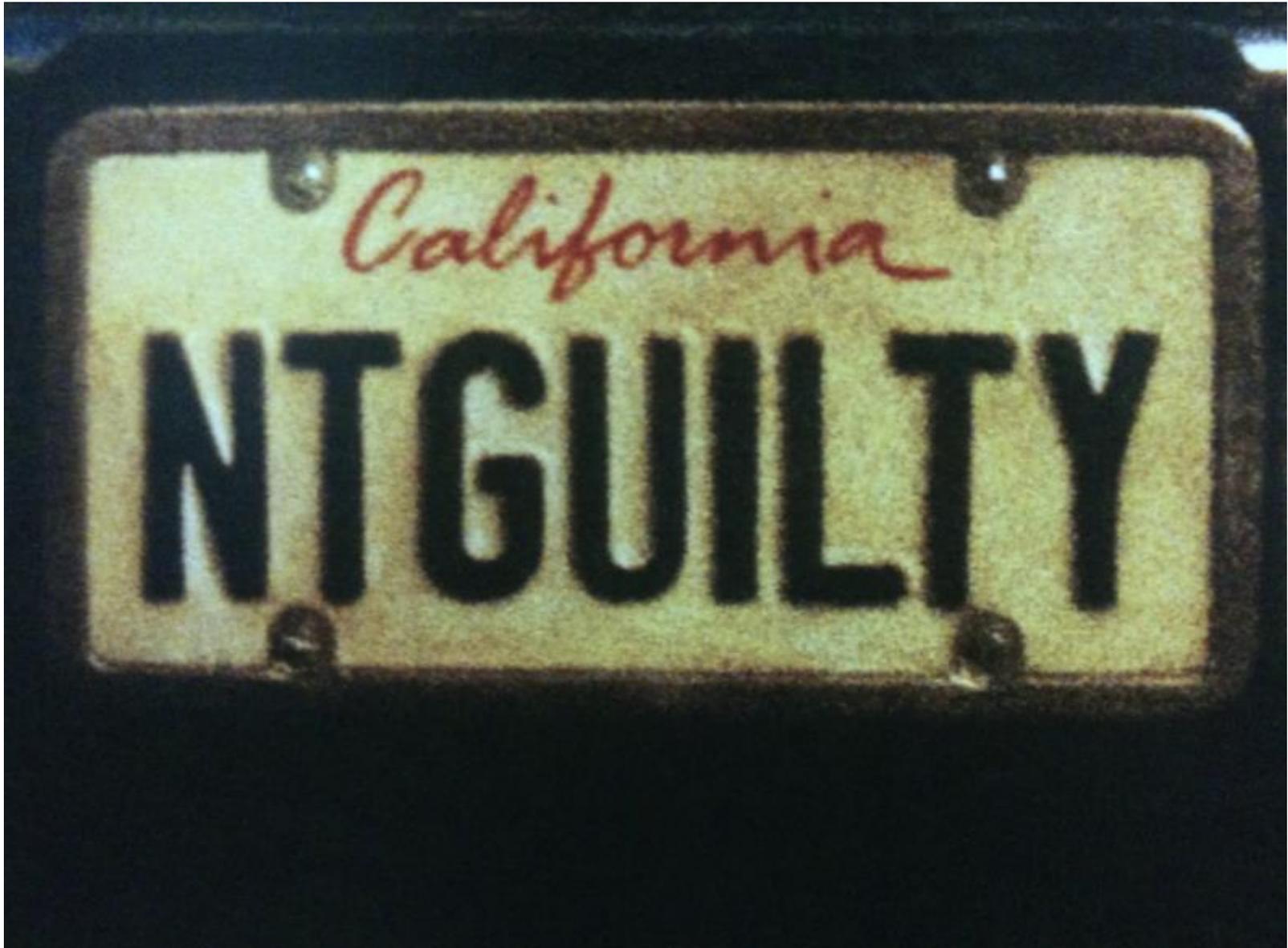


What else could be going on?



Whoever makes a DESIGN, without the Knowledge of PERSPECTIVE, will be liable to such Absurdities as are shown in this Frontispiece.

“We wanted to help the environment
while maintaining our lifestyle”



Independence, Security, Protection, De-Stress



Adopters summary

- On surface, top interest is saving money...but more is going on
- Who buys solar depends on who it is sold to & how
- For deliberators, personal benefits calculation is not easy
- Uncertainties difficult to overcome
- Some wanted better information & couldn't find it
- Environment matters to most, but may be a vague notion
- Environmental politics can be negative hot-button
- Opportunism may be a big deal
- When it's free, people may be less careful
- Some didn't really know what they are getting into
- Little post-installation investigation on experiences, changes
- Most people are happy enough
- It's still early days, market, conditions, incentives change

Non-adopters summary

- **Modest majority say they've thought about getting solar**
 - Most are “waiting” vs. actively seeking
 - Knowledge pretty low
 - Environmentally, “Thought-not-Bought” are similar to Adopters – except for “personal obligation” responses
 - Detailed circumstances matter
- **Almost 4 in 10 say they haven't thought about solar**
 - Some unaware; some don't like it or don't think it fits
 - These “Not Thought” are different
- Middle-income and moderate users may have less to gain under current conditions

Questions & recommendations

- Should solar remain “being about money”?
- What happens after installation? How do people change how they think about energy, and how (& how much) they use?
- “If only I had known” ... “it’s very confusing” ... How can information quality be improved?
- How do people know who to trust? Balanced info?
- What technical or marketing changes might help unlock under-attended niches?
- What happens when current incentives go away? How does this sync with moderate income, moderate usage?

Thank You

- Questions
- Thank you for attending the SEEDS Webinar Series
- For more information:

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<http://www.nrel.gov/seeds>

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