Sociological Perspectives on Sustainable Energy

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Presentation at University of New South Wales
Sydney, Australia
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Highlights of Three Studies

- San Diego Study – first development of HPHs
- NIMBY or Not? Large-scale Solar in the San Luis Valley
- SmartGridCity & PHVs

High-Performance Homes

- Study in San Diego, 2001-2006
- First HPH development in U.S.
- Builder – Shea Homes
- 306 highly energy-efficient homes

SheaHomes at Scripps Highlands

The Anatomy of High Performance by SheaHomes

SunChoice™ Power Meter

Comparison Home

San Angelo Neighborhood

Tiempo Neighborhood

Methods

- Ethnographic observation
- Qualitative interviewing
- Quantitative survey of SheaHomes (n=306) and comparison (n=103) home buyers
- Public data on sales prices
- Builder data on home types

Period of study: 2001 - 2006

Home Sales Prices

- High-performance homes are competitive on the market
- Based on actual sales data, per square foot, they sold for 9.2% *less* than comparison homes, on average

Sales Prices Controlling for Presence of PV System (Mean Price/sq.ft.)

- PV - $198.45
- Non-PV - $194.36
- Comparison - $215.89

Who Are These Homebuyers?

- Buyers of high performance homes and buyers of new conventional homes share the same demographic characteristics, environmental attitudes, and early adopter characteristics
- As expected, buyers mostly represent upper-middle class married couples with children, or mature couples
- Highly educated; concerned about environment
- Most came from the San Diego area

Original and Resale Prices
(as of 2/7/05)

Community	Original Price	Resale Price
Resale Homes in HPH Communities (n = 15)	Range: $482,900–$701,184 Mean: $556,344	Range: $680,000–$1,100,000 Mean: $862,853
Resale Homes in the Comparison Community (n = 12)	Range: $538,522–$711,887 Mean: $598,028	Range: $760,000–$995,900 Mean: $862,590

Increases in Property Values

Variable	HPHs	Comparison
Length of ownership (range)	9.9 – 43.9 mos.	17 – 40.2 mos.
Mean length of owner-ship before resale	22.5 mos.	28.1 mos.
Mean $ gain	$306,510	$262,968
Mean % of $ gain	55.4%	44.7%
Mean $ gain/mo. owned	$14,492	$9,301

Top Three Most Important Reasons for Home Purchase

Reason	SheaHomes Responses % (n=471)	Comparison Responses % (n=149)
Location	48	60
Financial	31	28
Community	10	9
Energy	6	0
Builder	4	<.05
Other	<.05	2

SheaHomes vs. Comparison Homes (Electricity and Gas Consumption Data)

Home Category	Annual Avg. Monthly Use, kWh	Annual Avg. Monthly Use, Therms
Comparison homes	793	42
SheaHomes energy efficiency/solar water pre-heating (SEE homes)	694	35
HPHs + 1.2 kW PV	573	31
HPHs + 2.4 kW PV	318	30

SheaHomes vs. Comparison Homes (Electricity Billing Data)

Home Category	Avg. Monthly Bill	% Savings
Comparison homes	$130	NA
SheaHomes energy efficiency/ solar water pre-heating (SEE homes)	$114	13%
HPHs + 1.2 kW PV	$92	30%
HPHs + 2.4 kW PV	$49	62%

SheaHomes vs. Comparison Homes (Gas Billing Data)

Home Category	Avg. Monthly Bill	% Savings
Comparison homes	$43	NA
SheaHomes energy efficiency/ solar water pre-heating (SEE homes)	$36	17%
HPHs + 1.2 kW PV	$32	27%
HPHs + 2.4 kW PV	$31	29%

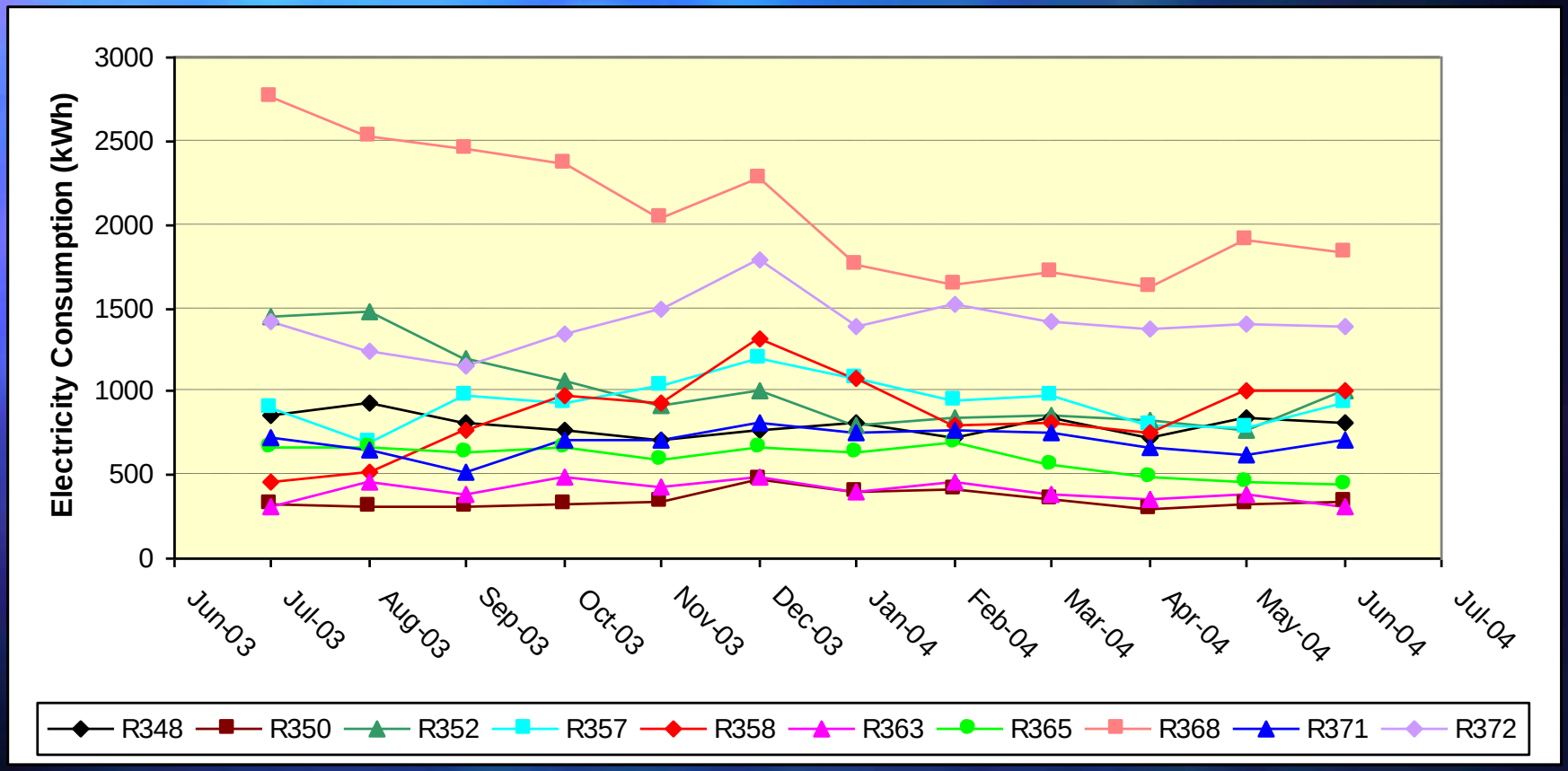
SheaHomes vs. Comparison Homes (Actual Combined Utility Bills)

Home Category	Avg. Monthly Bill	% Savings
Comparison homes	$174	NA
SheaHomes energy efficiency/ solar water pre-heating (SEE homes)	$149	14%
Shea SEE + 1.2 kW PV	$123	29%
Shea SEE + 2.4 kW PV	$ 80	54%

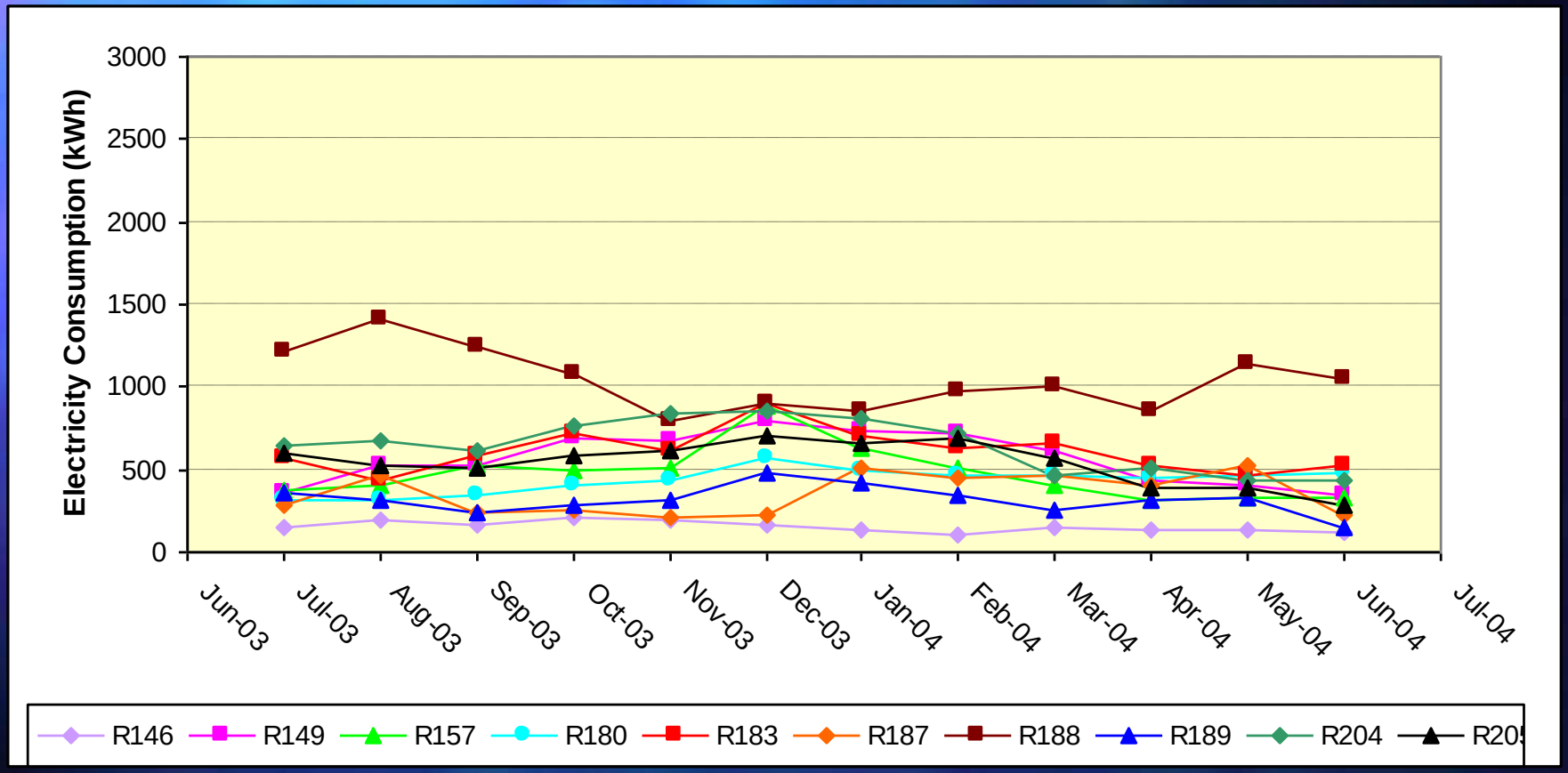
Combined Annual Utility Bills (Actual Utility Bills)

Home Category	Avg. Annual Total Utility Bill	% Savings
Comparison homes	$2,080	NA
HPHs + 2.4 kW PV	$ 961	54%

Monthly Electricity Consumption in 10 Individual Comparison Homes

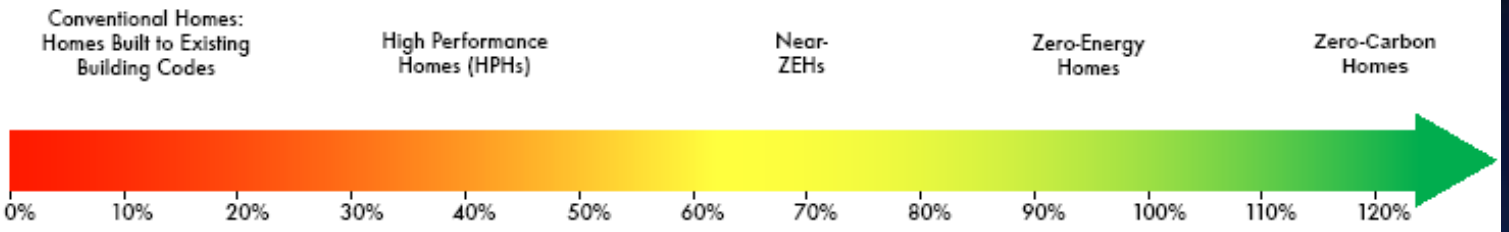


Monthly Electricity Consumption in 10 Individual PV Homes



Recommendations and Concluding Remarks

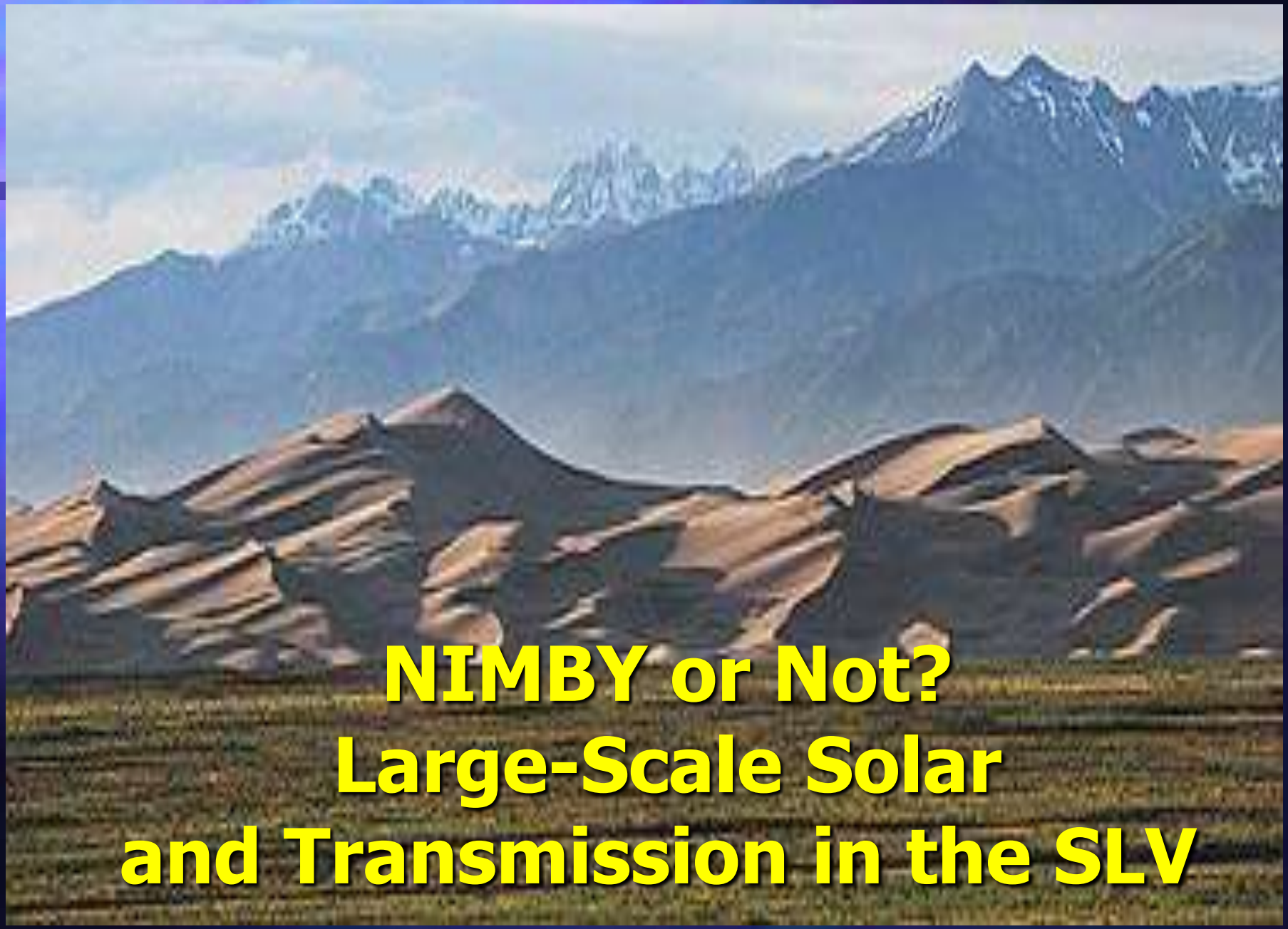
- Builders should offer ZEHs standard (not optional) (high efficiency, solar thermal, larger PV systems)(other models possible)
- Include digital displays that conveniently show kWh production and consumption
- Early adopters relative to ZEHs are builders, utility companies, and ZEH policy makers (not homebuyers)
- ZEH homebuyers are not a niche market; they are THE market



Net Percentage of Energy Saved and Supplied by New Homes Annually

New Housing Energy Continuum

Convential homes: Built to comply with existing building energy codes; 100% reliant on utility-supplied electricity and natural gas.
High-performance homes (HPHs): Save 30% to 50% of utility costs over conventional homes using efficiency and solar technologies
Near-zero energy homes (near-ZEHs): Save 60% to 90% of utility costs over conventional homes.
Zero-energy homes (ZEHs): Homes that, in the net, supply virtually all of their own electricity and space and water conditioning.
Zero-carbon homes: ZEHs that export electricity equivalent to 20% more than the energy used in the home for at least 25 years, thereby offsetting the energy embedded in building the home.


NIMBY or Not?
Large-Scale Solar
and Transmission in the SLV

Outline

- Background and research setting
- Research questions and approach
- Interview findings (perceived advantages and disadvantages; community support and opposition; transmission issues)
- The transmission controversy
- Solar policy positions in light of study findings
- Conclusions and recommendations

Community Acceptance

Factors related to community acceptance:

- Distributive justice (distribution of costs and benefits of facility)
- Procedural justice (inclusiveness of decision-making process)
- Amount of trust placed in actors from outside the community

CSP & the SLV

- WGA Solar Task Force/NREL identified SLV as premier site for CSP facility siting in Colorado
- Land area of 2,124 miles square in SLV identified for CSP
- Policy recommendations to streamline permitting

WGA-defined CSP Benefits

- Expands domestic energy supply
- Avoids emissions
- Provides hedge against carbon taxes
- Flexible (large or smaller-scale)
- Provides local economic benefits
- Utilities more comfortable with central-station technology
- Helps meet RPS requirements
- Adds diversity to energy supply, increasing security

Research Setting

- Historically Native American and Spanish land grants, ceded to US in 1848
- Became part of Colorado territory in 1861
- Six counties (Alamosa, Conejos, Costilla, Mineral, Rio Grande, and Sagauche)
- About 52% is federal land (USFS and BLM)

Research Setting, cont'd.

- Water is sensitive issue
- Total population of SLV in 2006: 48,291
- Lowest in CO in median income, cost-of-living, purchasing power
- Valley floor: 2.1 million acres
- Potato growing, ranching, tourism
- Highest, largest alpine valley in the world
- Best solar resource in Colorado

Research Questions

- Key governmental entities in CSP decision processes?
- Should there be local ownership?
- New model for decision processes?
- Key water, land, and other issues?
- Level of awareness & knowledge?
- Level of community support and opposition?

Research Questions

- Issues relative to transmission?
- Policy, regulatory, and sociological barriers?
- Public lands involved? CSP included in BLM's RMPs?
- Role of environmentalists?
- Institutional barriers?

Methods

- Stakeholder analysis
  - Sampling
  - Data collection
  - Analysis
- Review BLM PEIS process
- Gathered information on the transmission controversy over the CPCN application at the PUC

Stakeholder Interviewees

- Education, advocacy, professional organizations
- SLV economic groups
- Farmers, ranchers and their orgs.
- Government/regulatory agencies, orgs, and representatives
- Solar/CSP industry representatives
- Environmental orgs
- Utilities

Types of Perceived Advantages of CSP (n=231 responses)

Type	%
Economic	44
Environmental	26
Technological	19
Social-psychological	9
Policy/regulatory	2

Types of Perceived Disadvantages of CSP (n=158 responses)

Type	%
Environmental	42
Economic	23
Technological	19
Social-psychological	11
Policy/regulatory	4

Stakeholders Identified

- 125 stakeholder groups identified (partial list)
- Farmers and ranchers
- CSP developers/trade assns.
- Environmental organizations
- Economic development groups
- Educational institutions
- Elected officials

Stakeholders Identified

- Federal electricity agencies
- Federal government agencies
- State government agencies
- Local/regional gov't./NGOs
- Landowners
- Law firms
- Private companies

Stakeholders Identified

- Service organizations
- The public
- Solar and sustainable energy advocates
- Spiritual groups
- Utilities

Community Support

- Lines of support and opposition took shape early (by fall 2008)
- Supporters – county commissioners, farmers w/ land to sell, irrigating farmers, economic development advocates, the college, workforce training offices

Community Opposition

- “Residents of the Valley”
- SLV EcoSystem Council
- Residents of Crestone
- Rural Electric Cooperative
- Spanish land-grant families
- Local solar advocates

Valley Concerns

- Self-protection; want local control of decisions; no outsiders
- Favorable to renewable energy, but not knowledgeable about CSP; need education
- Misinformation is out there
- Want distributed generation

Support for Transmission

- Desire to export power
- Need for security/redundancy
- Need for improved power infrastructure

Opposition toTransmission

- Fear of “industrialization of the Valley floor” (500-1,000 acres of land/100-MW facility)
- Aesthetic concerns
- Fear of loss of control
- Wildlife concerns
- Legal-regulatory concerns

Context: Federal Policy

- 1. BLM Policy Memorandum
- 2. BLM-PEIS
- 3. Investment Tax Credit (ITC)
- 4. DOE Report to Congress

Context: State Policy

1. RPS: 30% of electricity from renewable sources by 2020
2. Benchmark goal: reduce carbon emissions 20% by 2020

DOUBLE-CIRCUIT
230KV LINE WITH
DOUBLE-CIRCUIT
69KV UNDERBUILD.

154 FEET TALL.


BLANCA RANCH


TRINCHERA RANCH
NOW ENTERIN
SANGRE DE CRIS
RANCHES
PRIVATE PROPE
COVENANT
PROTECTED
COMMUNITY

Arguments in Support

- SLV Power Authority wants distributed CSP linked to existing substations
- County commissioners want tax $ from IPPs; school districts want support
- Xcel wants transmission redundancy; 230-kV line LaVeta Pass -Calumet station; for “1000’s of MWs” from the SLV

Arguments Opposed

- Local environmentalists want distributed solar generation (up to one GW seen as OK; want transmission over Poncha Pass)
- Trinchera Ranch et al. opponents want different route

Proponent Statements in Light of Study Findings

- Utility goal for “thousands of MW” (10s of thousands of acres) (fear of “industrialization”)
- Statewide permitting (would remove local control)
- Solar exemption from sales & property taxes (would prevent key local economic benefits of CSP siting)

Conclusions

- Widespread support for solar energy development in SLV, but for distributed CSP
- Lack of knowledge/need for education stakeholders in/outside the Valley
- Complex decision processes that lack transparency

Conclusions, cont'd.

- Public participation processes are more procedural than substantive
- Social-psychological effects are not well understood
- Organized opposition to the La Veta Pass transmission line has developed (in addition to Louis Bacon's opposition)

Concluding Remarks

- The SLV could become a laboratory for developing new approaches to siting decision making
- The most effective, socially acceptable institutional arrangements for generation and distribution of renewable energy may still need to be invented.

Afterword

- Xcel Energy will file a revised renewable energy portfolio plan in June 2010; “We may have to go somewhere else.”
- Xcel is seeking a relaxed solar requirement reducing solar by 48%; opponents say alternative transmission routes exist
- PUC still to decide.

The SmartGridCity™ Project: Community Context and Household Perceptions

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Institute of Behavioral Science
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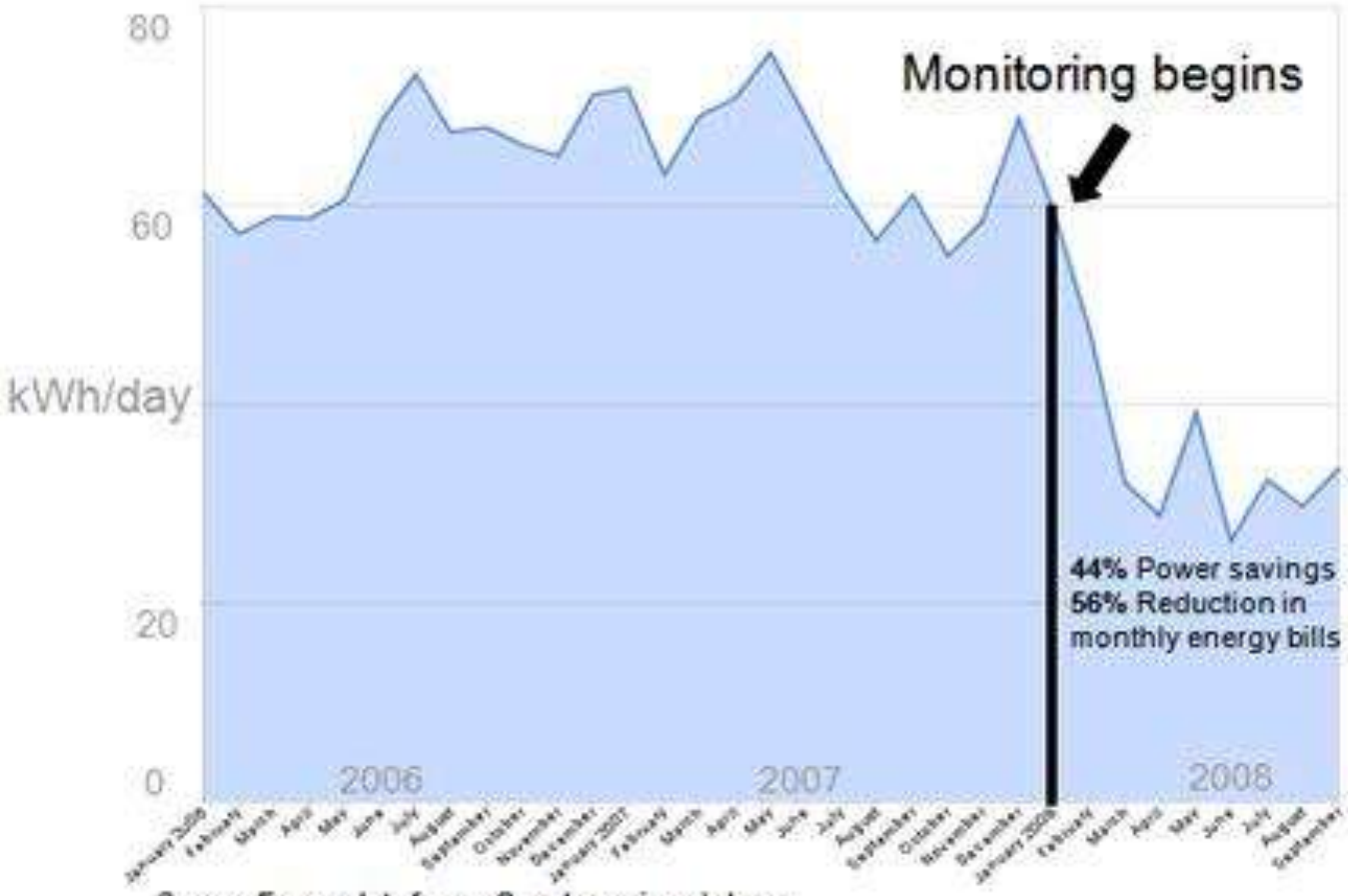
Presentation for WREC-XI
27 September 2010
Abu Dhabi

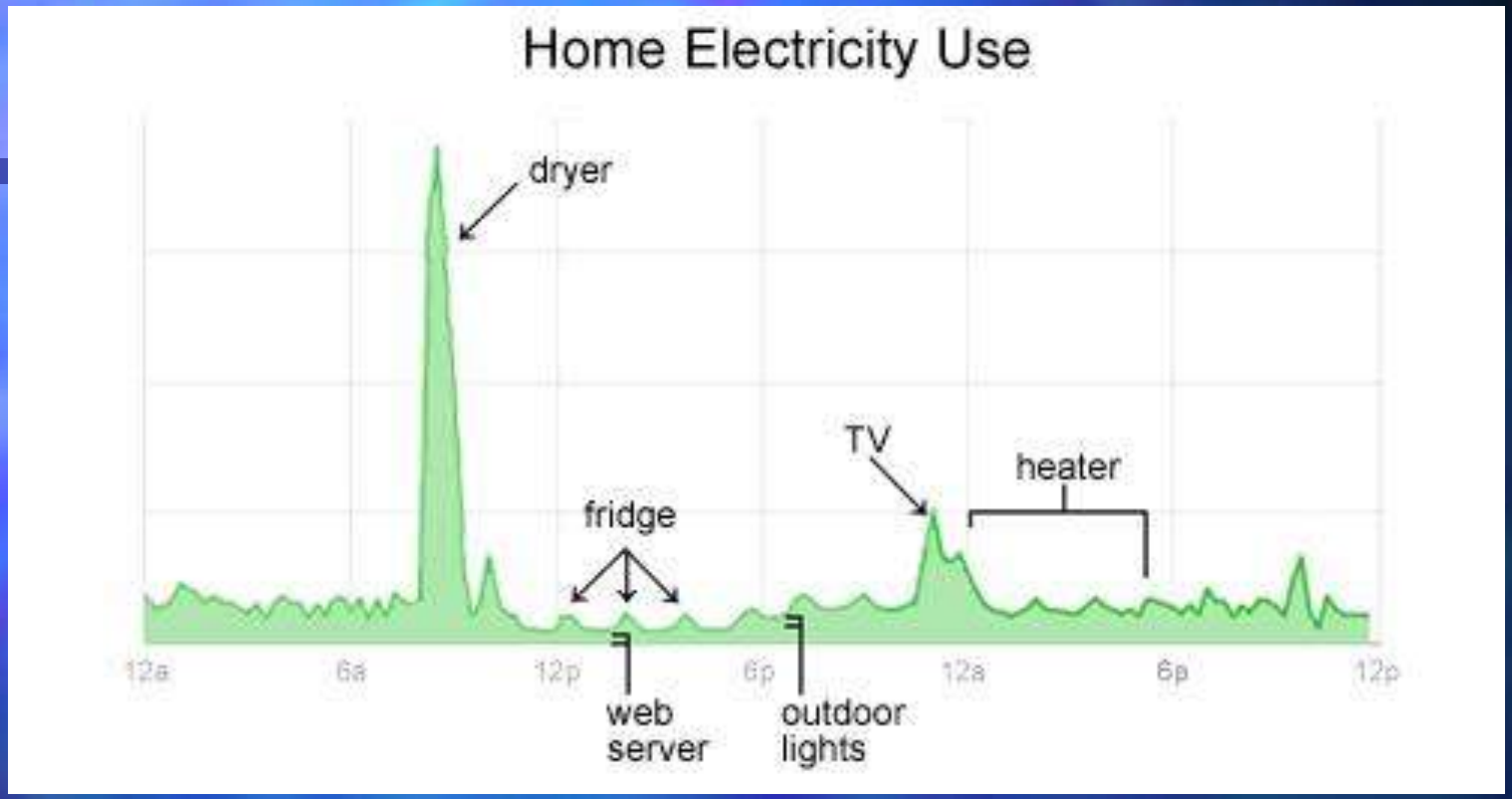
Presentation Outline

- What is “smart grid?”
- Community context - Boulder
- Research questions and methods
- Respondent characteristics
- Reasons for participation (or not)
- Perceived disadvantages
- Preliminary conclusions
- Current situation

One Googler's experience with home energy monitoring



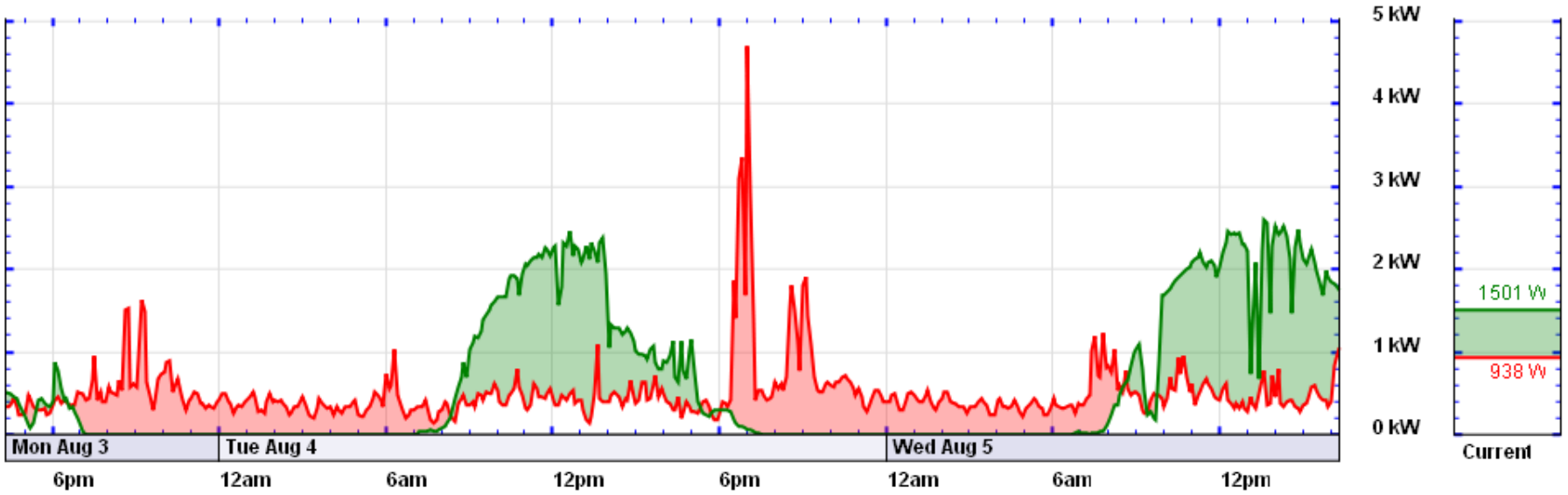
Source: **Energy data from a Google engineer's home**


Home Electricity Use
dryer
fridge
TV
heater
12a
6a
12p
6p
12a
6p
12p
web server
outdoor lights

Power Consumption/Generation

Time range: Mon Aug 3, 4:19 PM - Wed Aug 5, 4:19 PM (Energy: 29.1 kWh kWh generated, 24.2 kWh kWh used, -4.9 kWh kWh net)

Time zoom: Max 1y 31d 7d 4d 2d 1d 6h 1h Power zoom: Auto 200kW 100kW 50kW 10kW 5kW 1kW 500W 100W 50W



Legend:

Power used	Power generated	Energy from grid	Energy to grid
Solar gen./ used	Load1 gen./ used	Load2 gen./ used	

Since now

	Avg. Power	Energy
Generated:	1501.0 W	0.0 kWh
Consumed:	938.0 W	0.0 kWh
Net:	-563.0 W	-0.0 kWh

SmartGridCity

The "general definition of a smart grid is an intelligent, auto-balancing, self-monitoring power grid that accepts any source of fuel (coal, sun, wind) and transforms it into a consumer's end use (heat, light, warm water) with minimal human intervention" (www.xcelenergy.com/smartgridcity)

Benefits/Claims

- Switch electricity use to off-peak
- Increase household control
- Can be done automatically
- Select attributes (price vs. green vs. comfort vs. other attributes)
- Feedback on electricity use/cost
- Reduces electricity bills
- Integrate PV, PHEV
- Reduce carbon footprint

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SUNDAY, MARCH 29, 2009 | $1.00

Meter volunteers sought

New devices to give customers real-time electricity use data

By Ryan Morgan
Camera Staff Writer

Xcel Energy is looking for 10,000 volunteers to install high-tech electric meters, as part of the company's effort to turn Boulder into a smart-grid city.

Company spokesman Tom Henley said Xcel has spent the last year installing more than 100 miles' worth of fiberoptic cable in Boulder. That cable now carries vital information about the grid's performance to Xcel.

That will help the company more quickly track down and fix power outages. And, Henley said, that information also will let customers who install the meters log on to a Web site to monitor their energy consumption in nearly real-time.

"Studies have shown that when

See XCEL, 4A

4A | SUNDAY, MARCH 29, 2009

Smart grid may be vulnerable

By Heath Urie
Camera Staff Writer

Determined hackers with as little as $500 worth of equipment and some computer know-how could cripple the smart-grid technology being piloted in Boulder and rolled out nationwide, security experts say.

Seattle-based IOActive, a computer security-assessment firm, says a yearlong independent test of smart-grid technology and infrastructure plans found that the systems are vulnerable to the same types of attacks as most any computer system.

But unlike the common PC, the power industry hasn't spent decades combating cyber crime, experts say.

"The people who are rolling out this technology haven't crossed that bridge before," said Josh Pennell, founder of IOActive. "People are talking about what is theoretically possible."

Pennell's company went to work testing those theories about smart grid vulnerabilities, and determined the threat from hackers is very real.

Attacks on the computer networks running the power distribution systems could expose utility companies to "fraud, extortion attempts, [illegible] or widespread sys-

Getting on the smart grid

Xcel Energy is looking for volunteers willing to hook up "smart meters" at their homes. To apply, visit **http://smartgridcity.xcelenergy.com** and click on "Get involved in SmartGrid City."

He declined to answer questions about whether measures are being taken to protect the technology being used within the Boulder system, or whether it's vulnerable, saying only that "maintaining the reliability and security of the computers, control systems and other cyber assets ... is a top priority within the company."

Kara Mertz, assistant to the Boulder city manager and the liaison to the smart-grid project, said the city has not had any discussions with Xcel about security — because it hasn't come up.

"Certainly we will look into it," Mertz said. "It wouldn't be acceptable to us if our residents' and business' energy is somehow compromised."

According to current estimates, there are more than 2 million so-called "smart meters" already being used across the United States.

About 73 utility companies

Xcel lo

Continued from 1A

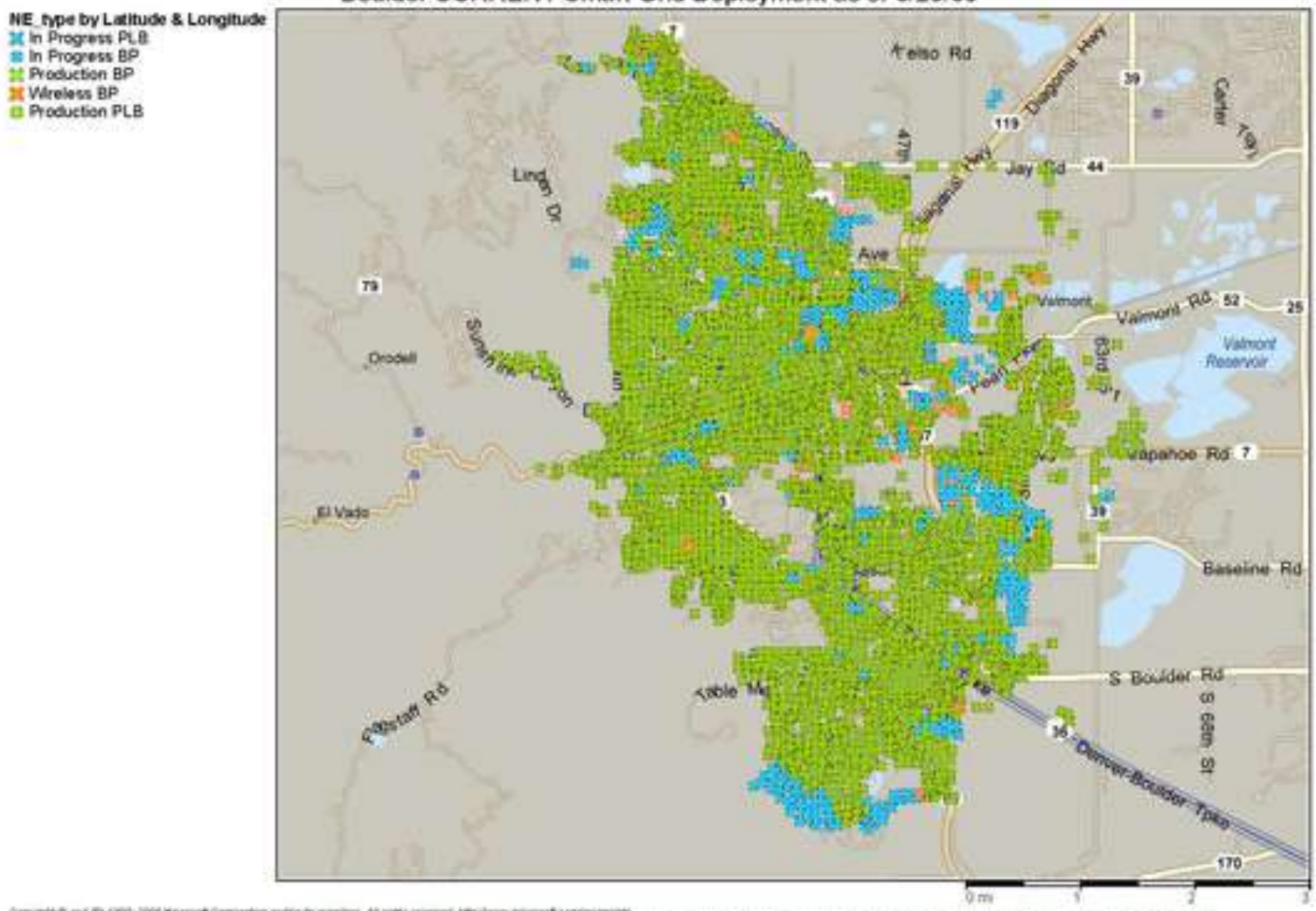
customers have that in[f]
tion, they actually take
tage of it," he said.

"When they do that,
end up getting a reduced
gy bill and are more e
conscious consumers."

Within the next few m
those customers also w
able to use "smart plug
which will let consumers
trol their appliances re
— as well as programm
thermostats and battery
up kits.

Xcel Energy also will
be asking regulators fo
right to start charging
sumers for electricity ba
demand, rather than
price. If their efforts suc
customers will be able

Boulder CURRENT Smart Grid Deployment as of 6/25/09



Research Questions

- What are reasons given for volunteering? Perceived advantages
- What reasons for not volunteering?
- What are perceived disadvantages/ problems/issues of SGC?
- What kinds of people volunteer (or not)? Attitudes toward SGC project? Level of energy literacy? Energy improvements already made?
- Community acceptance of SGC?

Methods

Field work in the community (collecting documents, artifacts, clippings; attending meetings; conducting interviews)

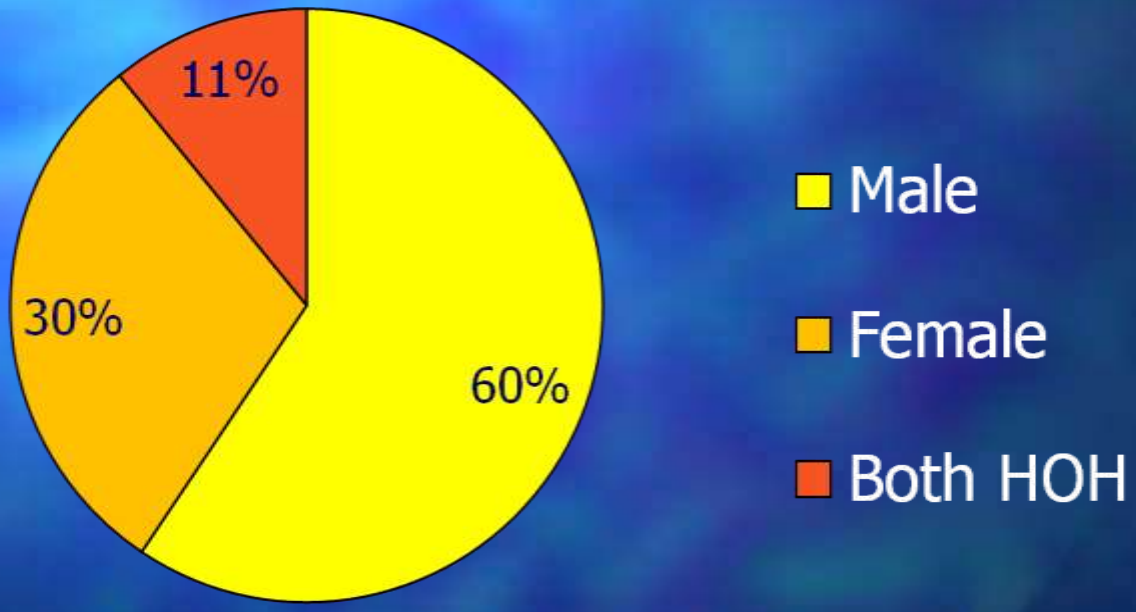
Methods

- Qualitative in-depth open-ended face-to-face interviews
  - -- Households: 47
  - -- Respondents: 52
- -- Sampling -- Purposive, snowball, random
- -- Not statistically generalizable

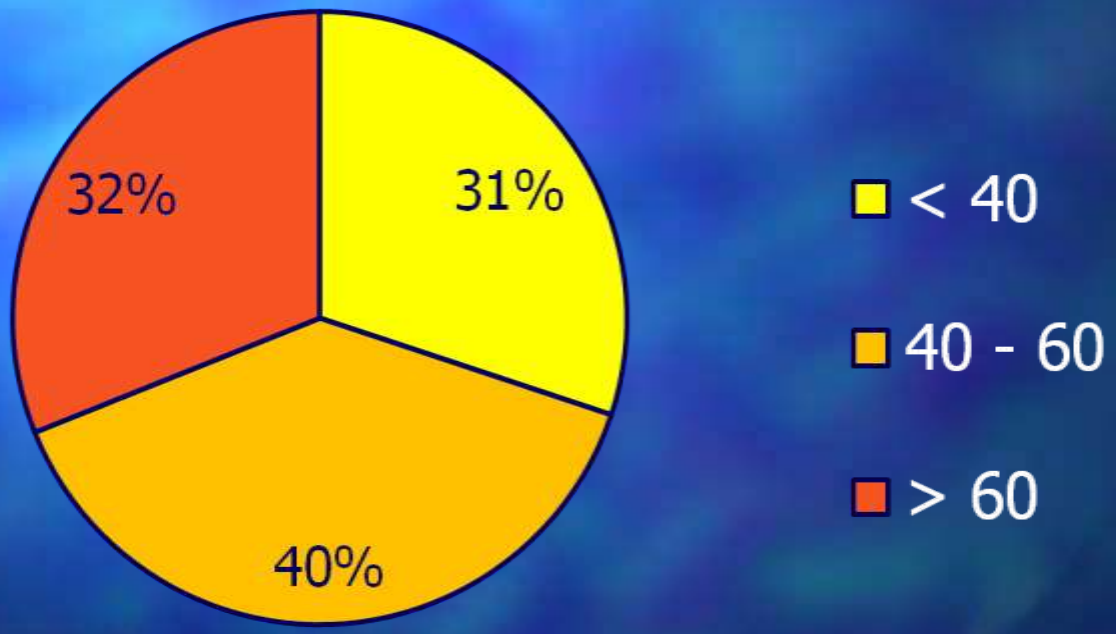
Community Context

- Carbon tax (first city to vote in)
- Funds Climate Smart program
- Neighborhood climate action groups
- Municipalization activists
- Financing ee/re retrofits through property taxes
- Boulder Climate Action Network
- Grassroots demonstrations against local coal power plant

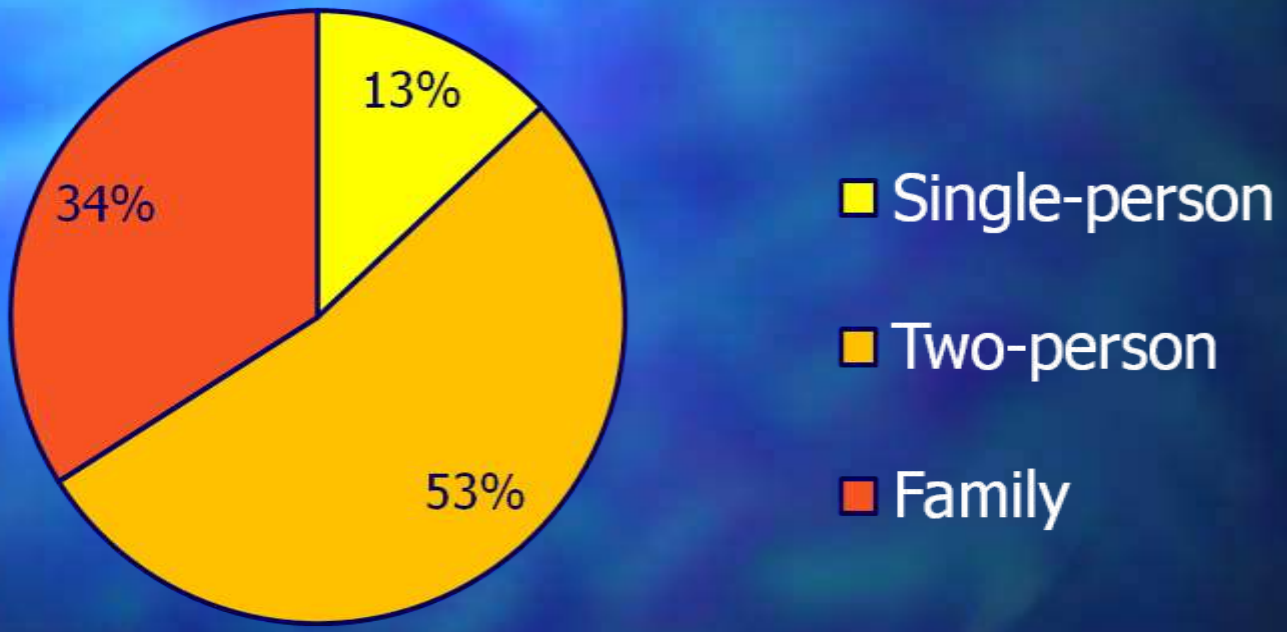
Gender



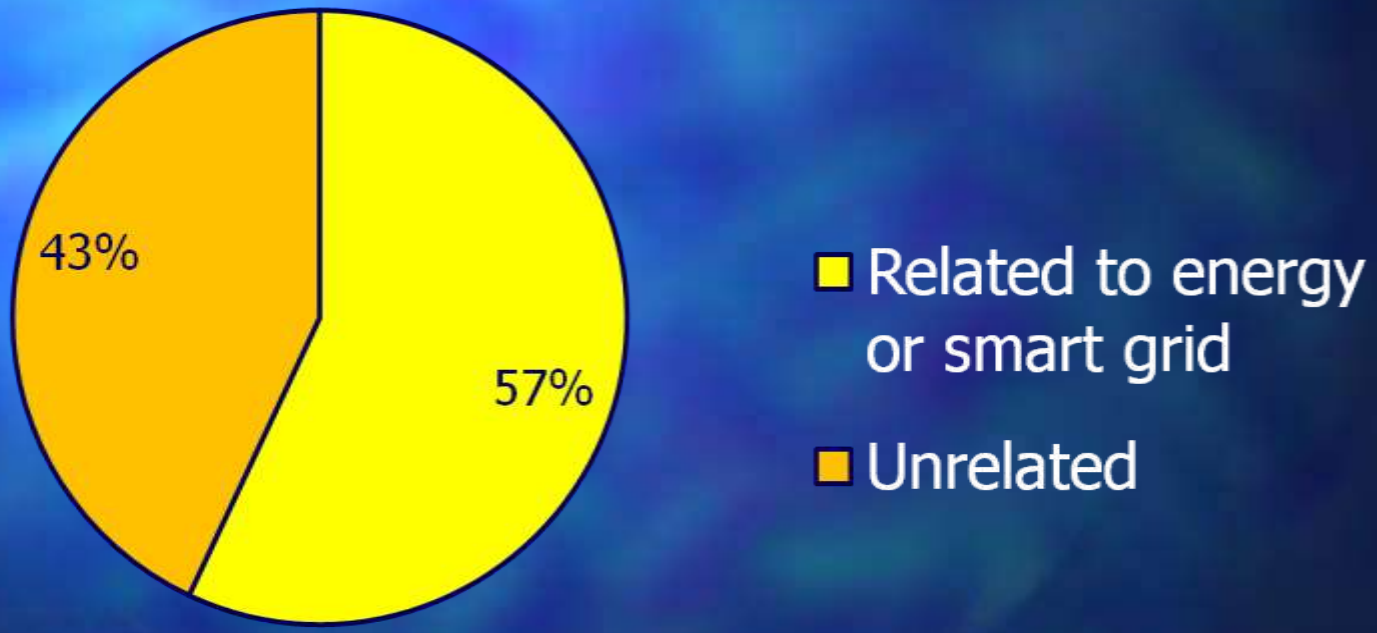
Age



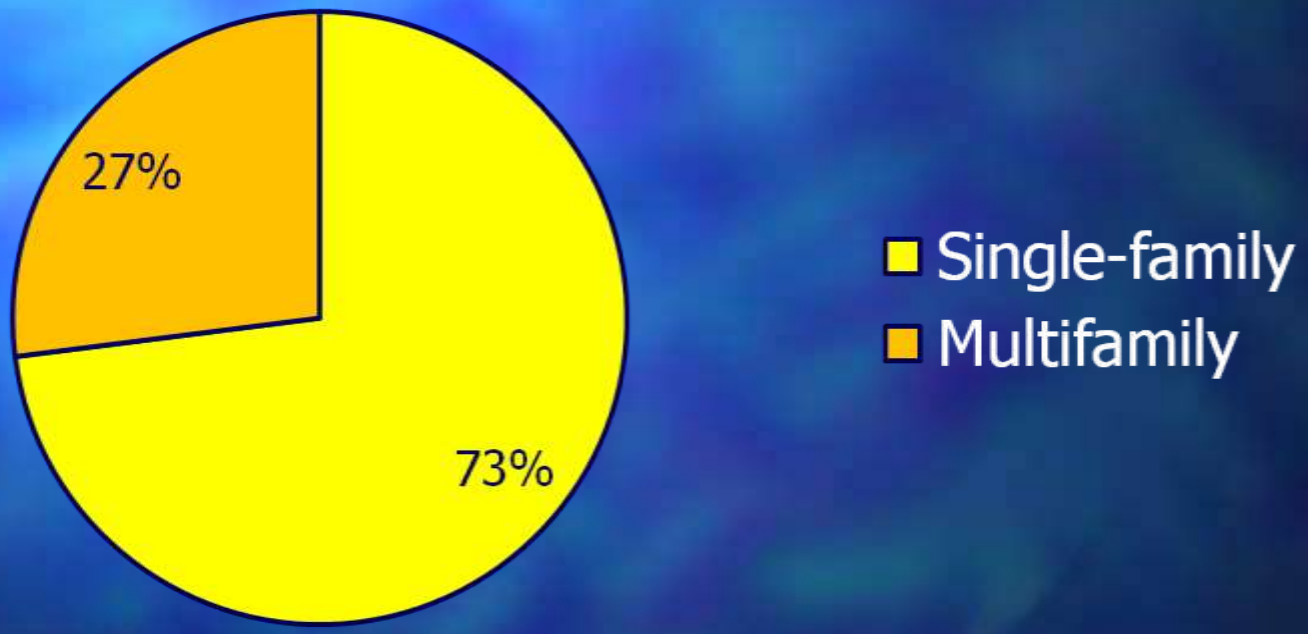
Household Characteristics



Occupation



Housing Type

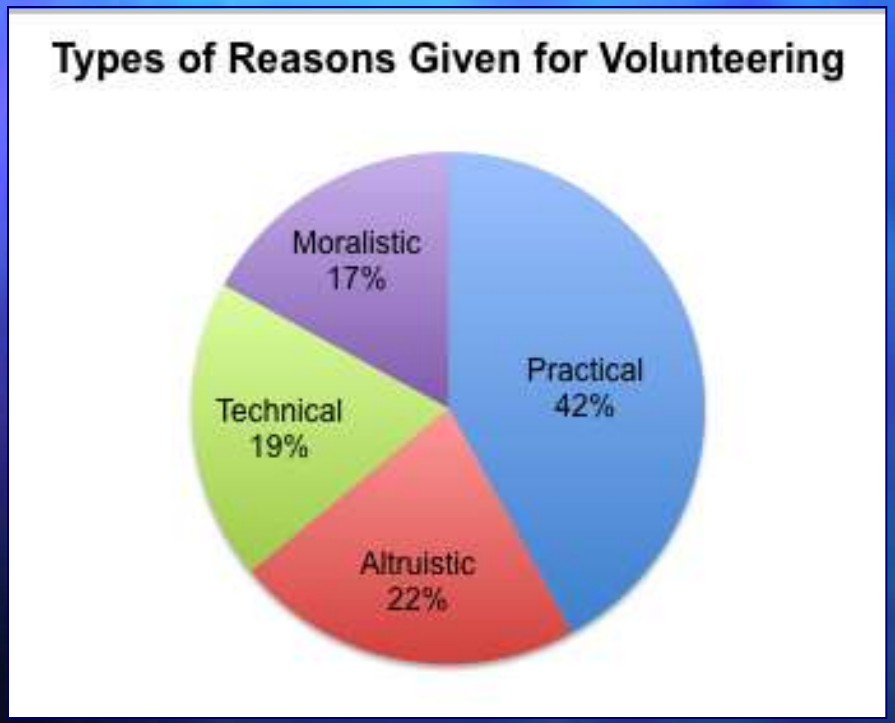


Other Characteristics

- Non-university/University-related
  - 81%/19%
- Volunteers for SGC/or not
  - 81%/19%
- 52% have a/c
- 56% have smart meter when interviewed
-

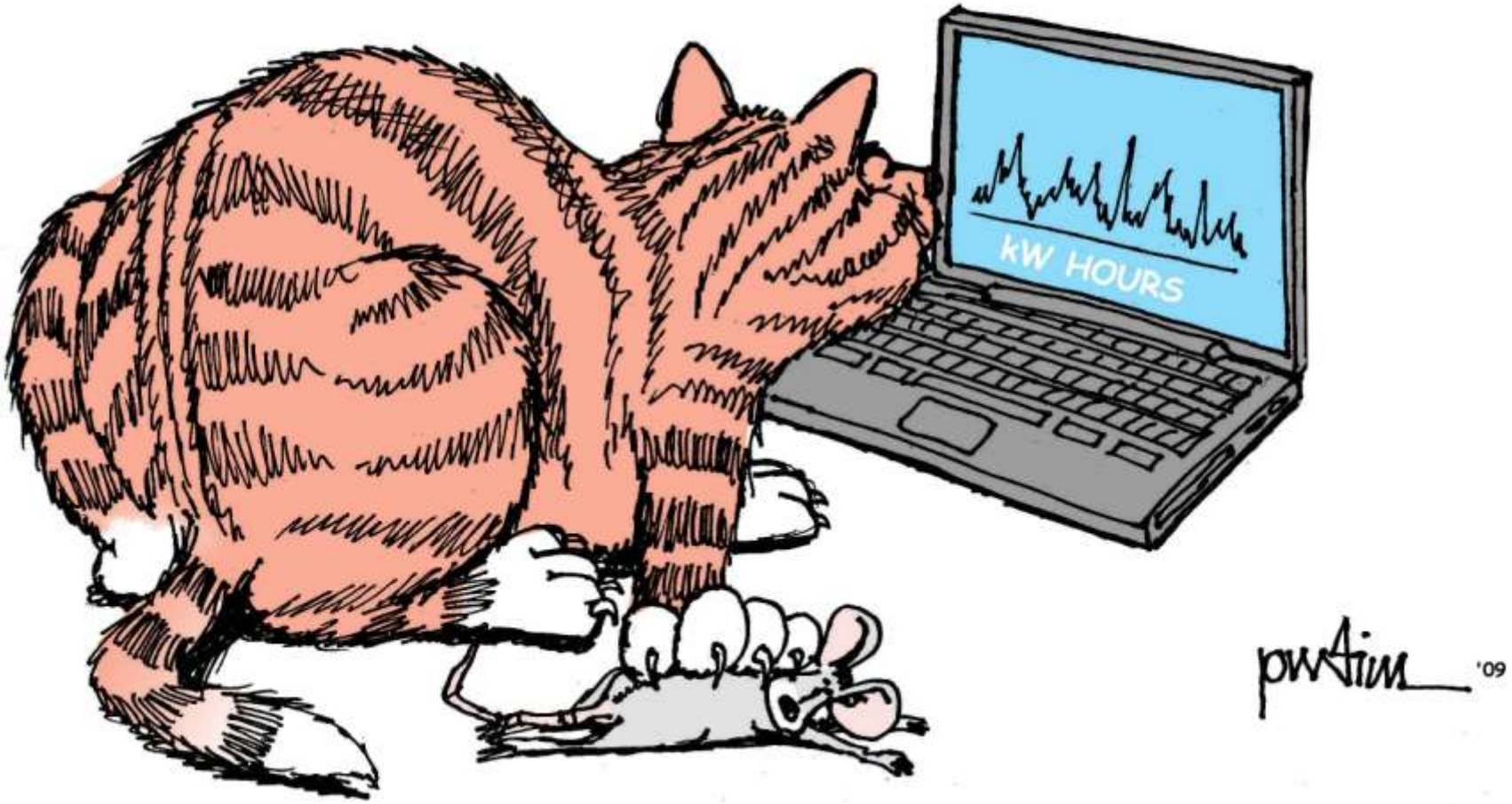
Reasons for Volunteering

Four types of reasons (214 responses)



- **Practical ~ Get feedback on electricity consumption; save money; gain knowledge.**
- **Altruistic ~ Reduce environmental impacts; help Xcel collect data; care about the planet.**
- **Technical ~ Professional interest; technological curiosity; stay informed about what's happening around town.**
- **Moralistic ~ Sanction residential a/c users; inter generational equity; neighborhood climate action groups**

CURIOSITY



Stated Reasons for *Not* Volunteering

- Not invited to participate
- Oppose because SGC is already outdated technology
- Too costly
- Our household is not using that much energy; we don't have a/c (and most don't) so SGC won't help us

More Reasons for *Not* Volunteering

- Lives in a townhome; maybe the HOA would decide about it
- Don't like/trust Xcel Energy
- Don't see what SGC brings that is different from what we already have
- Too much bother to sign up
- SGC associated with wireless technology—EMF concerns, negative health consequences

Perceived Dis-advantages (106 responses)

- Security, reliability, privacy, safety and control problems (22%)
- Lack of information (21%)
- Too costly/we'll pay (19%)
- SGC is greenwashing (16%)
- Complexity (8%)

More Perceived Dis-advantages (106 responses)

- Negative environmental consequences (4%)
- Social equity concerns (4%)
- Other (3%)

- 13% of respondents said "No disadvantages" (volunteers)

Actual Mean Monthly Energy Consumption and Cost (6 mos.)

Household data	Volunteers	Non-Vols.
Mean monthly kWh consumption	536	382
Mean monthly therm consumption	63	33
Mean monthly utility bill	$133	$88
Have a/c	50%	53%

Overall Attitude toward SGC

- Very favorable 34%
- Favorable 55%
- Neutral 2%
- Unfavorable 2%
- Very unfavorable 7%

- 89% Favorable
- 9% Unfavorable

Preliminary Conclusions

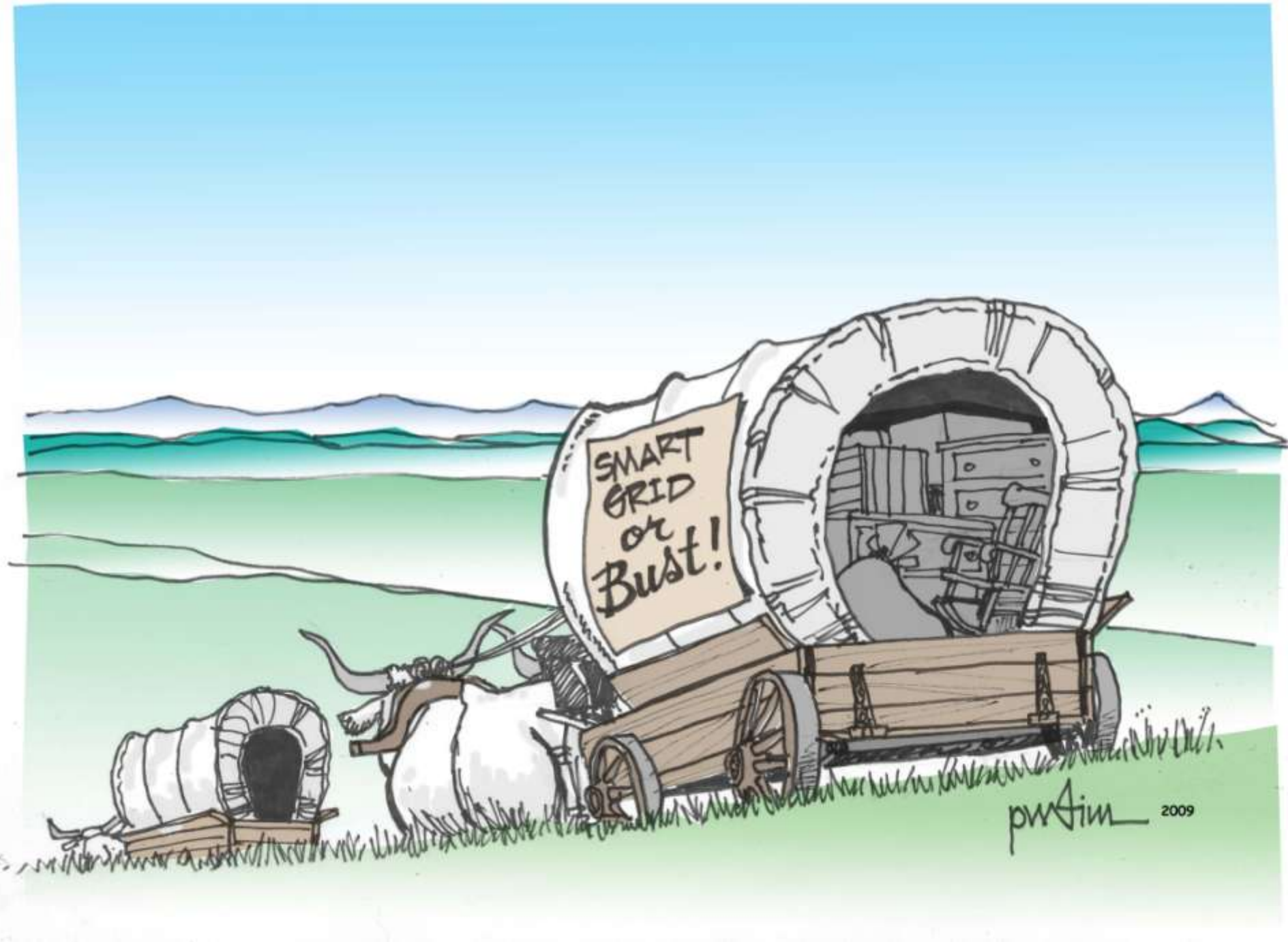
- Favorability/interest in SGC
- Sophisticated definition of problems/issues (e.g., increased carbon footprint, privacy concerns, where's the beef?)
- Different kinds of volunteers (e.g., professional curiosity, moderate altruists, dedicated moralists)
- SGC would be accepted by the City's residents; possibility of pushback
- No organized opposition found – is that changing?

Potential Scenario

- - Roll-out of SGC has been delayed
- - Concept of "co-provisioning"
- - If Xcel wanted to partner with Boulder citizens to work on co-provisioning of the city's electricity, the interest and expertise are there

Current Situation

- Online 24 hr+15 min feedback for 23,000 with smart meters (WOM only)
- Roll out of pricing pilots (CPP, TOU, PTR)
- Utility franchise with City not renewed (expires 12/31/10)
- Utility working with University of Colorado and Toyota on plug-in hybrid electric vehicle study in a smart-grid environment


SMART GRID or Bust!
2009

Coordinates

barbara.farhar@colorado.edu

303-494-1578

Web site: www.barbarafarhar.com

Thank You!