The Xcel SmartGridCity<sup>TM</sup> Project: Community Context and Household Perceptions

> Barbara C. Farhar, Ph.D. Institute of Behavioral Science University of Colorado Presentation for RASEI Brown Bag November 10, 2009

### The SGC Research Team at IBS - CU

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

### One Googler's experience with home energy monitoring





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	_ =≔≕ Solar gen./ use	ed 🔲 == Load1 ger	Jused 📃 ≕ Loa	ad2 gen./ used		Generated:	1501.0 VV	0.0 K	Wh

### 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

Consumed: 938.0 W 0.0 kWh -563.0 W -0.0 kWh llet:

### It's National Policy

FERC Docket No. PL09-4-000 – Smart Grid Policy 31909 "It is the policy of the U.S. to support . . .the Smart Grid." (p. 5)

ARRA Funding

- \$11 bn stimulus funding for smart grid
- \$4.5 bn to DOE for smart grid demonstration programs

# 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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### **GRIDIRON SURVIVOR COMPETITION** Life & Arts, 1D CU's Walters aims for comeback after leg surgeries Sports, 1C

SUNDAY, MARCH 29, 2009 | \$1.00

### **Meter volunteers sought**

### By Ryan Morgan Camera Staff Writer

**SAVE OVER** 

coupons

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 in- cable now carries vital information

New devices to give customers real-time electricity use data

stalling more than 100 miles' worth about the grid's performance to of fiberoptic cable in Boulder. That 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.

**BODYBUILDERS TONE FOR** 

"Studies have shown that when See XCEL. 4A



## Smart grid may be vulnerable

store only!

### By Heath Urie Camera Staff Writer

4A | SUNDAY, MARCH 29, 2009

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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. at But unlike the common ta PC, the power industry hasn't se spent decades combating co cyber crime, experts say. cy "The people who are ty

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

vork 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, lawsuits 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."

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### inid used 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

### Continued from 1A customers have that inf

Xcel lo

tion, they actually take a tage of it," he said. "When they do that,

end up getting a reduced gy bill and are more er conscious consumers." Within the next few mo

those customers also w able to use "smart plug which will let consumers trol their appliances rem — as well as program thermostats and batteryup kits.

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



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

X Wireless BP Production PLB

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 openended face-to-face interviews -- Households: 47 -- Respondents: 52 -- Sampling -- Purposive, snowball, random -- Not statistically generalizable

# Community Context for SmartGridCity

## 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

# Respondent Characteristics





Male
Female
Both HOH



## Household Characteristics



Single-person
 Two-person
 Family

### Occupation



 Related to energy or smart grid
 Unrelated

## Housing Type



## Single-familyMultifamily

## 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

Energy Literacy -Developed scale to measure energy literacy (15 points) -- 17% Low energy literacy -- 58% Moderate energy literacy -- 25% High energy literacy -(Electricity fuel sources, Valmont, "peak load," "electricity grid," centralized/distributed, smart grid, GHGs causal in climate change, use of coal causal in air pollution/health impacts)

Energy Behavior Rating Scale -30% Energy conservation/ renewable energy part of lifestyle -20% Make extra effort to reduce energy use 41% Try to conserve if cheap, convenient, comfortable - 7% Willing to cut waste - 2% Indifferent to energy use

# Reasons for Volunteering for SmartGridCity

### Reasons for Volunteering

### Four types of reasons (214 responses)

### Types of Reasons Given for Volunteering



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



# Reasons for NOT Volunteering for SmartGridCity

Stated Reasons for <u>Not</u> 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 <u>Not Volunteering</u> - 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 Disadvantages (106 Cesponses)
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%

## % saying they would be willing to . . .

-Pay higher peak rates 80% 57% -Allow Xcel to adjust a/c **Allow Xcel remotely adjust** other appliances 56% -Shift/reduce energy use for **TOU** pricing 53%

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toward S	GC
-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 coprovisioning of the city's electricity, the interest and expertise are there



## Thank you for your attention!

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