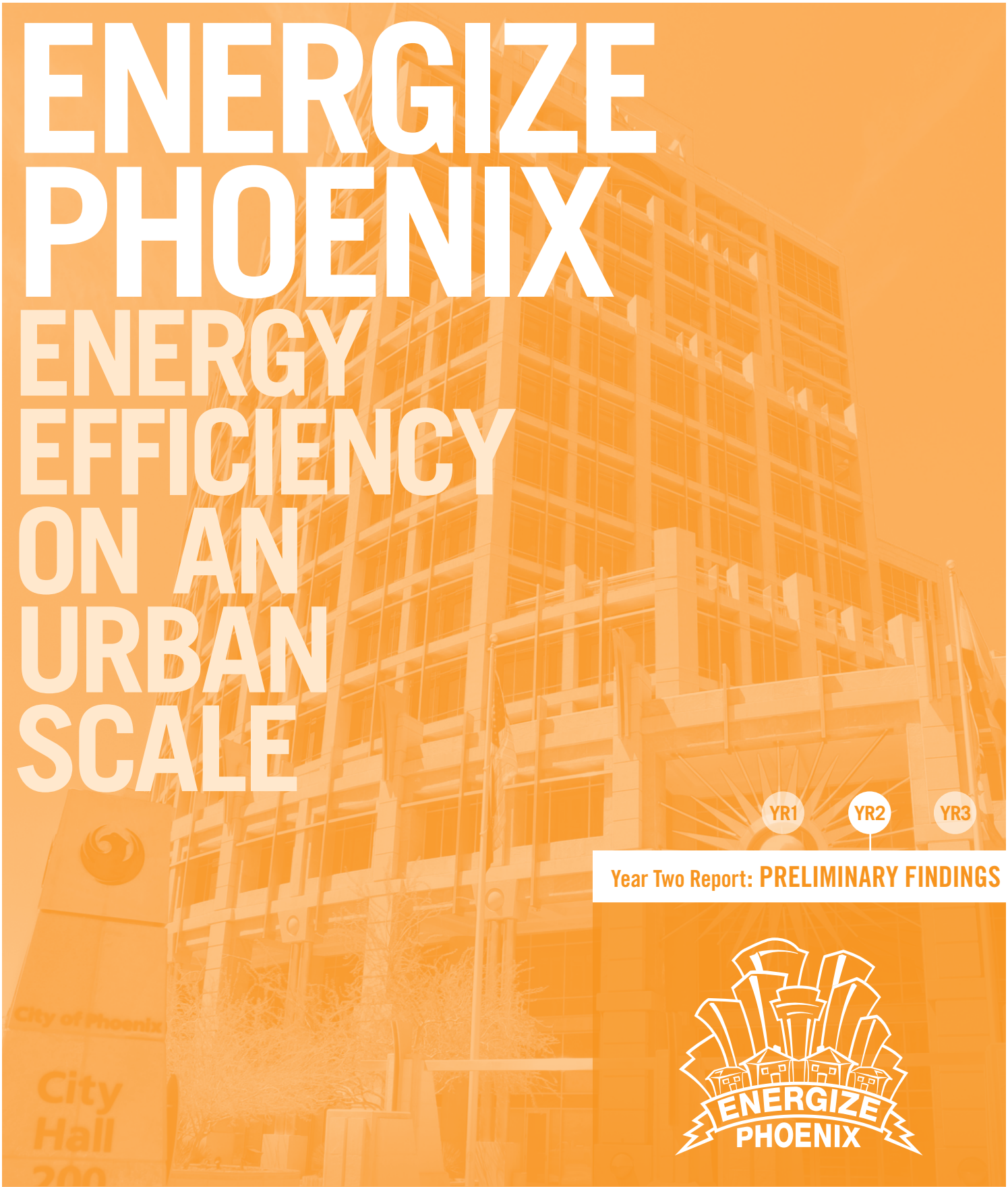
ENERGIZE PHOENIX

ENERGY EFFICIENCY ON AN URBAN SCALE



YR1 YR2 YR3

Year Two Report: PRELIMINARY FINDINGS

ENERGIZE PHOENIX

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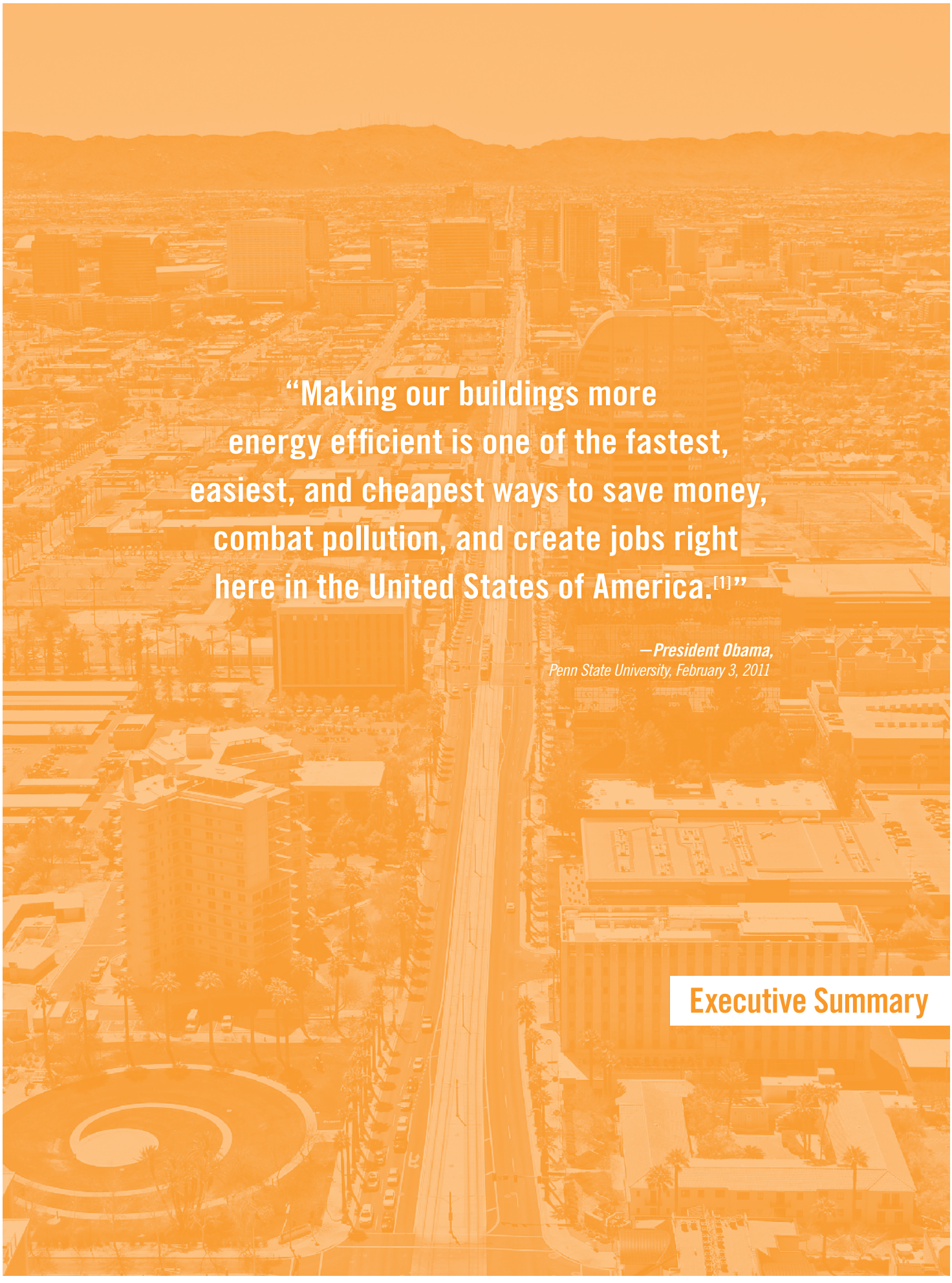


"Making our buildings more energy efficient is one of the fastest, easiest, and cheapest ways to save money, combat pollution, and create jobs right here in the United States of America.[1]"

—President Obama,
Penn State University, February 3, 2011

Executive Summary

Executive Summary

Energy efficiency programs have become popular across the United States as a strategy for increasing energy security and supporting other economic, environmental, and sociopolitical goals. This is with good reason. Saved or recovered energy is considered the least expensive energy resource around, running about one-third lower in cost than conventional energy sources.

Actual results from energy efficiency programs, however, haven't reached their full potential. The barriers typically derive from a trio of interconnected forces — technical, economic, and socio-behavioral — that continue to hinder energy efficiency program scaling. Research underway for Energize Phoenix is aimed at understanding and helping resolve these barriers.

Energize Phoenix is a three-year energy efficiency program led by a joint collaboration of major institutions — the City of Phoenix, Arizona State University, and Arizona Public Service — the state's largest electricity provider. The program is supported by the U.S. Department of Energy's Better Buildings Neighborhood Program and the American Recovery and Reinvestment Act of 2009.

The purpose of Energize Phoenix is to create a sustainable large-scale model of urban energy efficiency in a 10-square-mile urban corridor of Phoenix along the newly constructed Metro light rail. The goals are to upgrade the energy efficiency of 1,700 residential units and 30 million square feet of office and industrial space, while decreasing energy consumption by 30% (residential) and 18% (commercial), and eliminating carbon emissions by 50,000 metric tons per year.

KEY METRICS AND INSIGHTS

This report provides *preliminary* findings and lessons learned during Year Two of the program.

Completed Projects

- 154 commercial building upgrades have been completed for a total contractor-estimated savings of 11,374,729 kilowatt hours per year (kWh/Yr); 154 more upgrade projects are in process.
- 7 residential single-family home upgrades have been completed for a total contractor-estimated savings of 19,133 kWh/Yr; 73 additional homes have completed energy checkups, the first step in the upgrade process.
- 182 residential multi-family unit upgrades have been completed for a total contractor-estimated savings of 357,740 kWh/Yr; 179 more are underway and 908 applications are in process.

Corridor Statistics and Geography

- An expansion of the Energize Phoenix Corridor in 2011 from 6.66 to 10.33 square miles increased residential parcels by 77% and commercial by 41%.
- Geographic project clustering emerged in two regions of the Corridor — one where participation is higher than expected and another where participation is lower.

Dashboards Study Challenges and Lessons Learned

- Technical, economic, and social challenges upended original plans to study single-family renters.
- Unforeseen issues included high vacancy rates, poor renter/landlord relations, and foreclosure issues.
- Year Three study will focus on two new groups: students living in dorms and low-income renters in a city-owned complex.
- Lessons learned include recommendations to allow ample time to recruit participants and to run a small pilot program from start to finish before full implementation.

Energize Phoenix representatives survey community members.

Behavioral Change Insights

Demography

- Commercial participants were more likely than nonparticipants to own their space, employ more staff, and have customers visit their location.
- Residential participants were more likely than nonparticipants to be older, more affluent, White/Caucasian (62.8%) or Hispanic/Latino (24.7%), and not live with extended families, despite a diverse Corridor demography.

Attitudes

- Both commercial and residential participants and nonparticipants identified saving money as their most important value.
- Commercial participants were more likely than nonparticipants to believe that saving energy was good for promoting their business and making their business competitive. Residential participants were less likely than nonparticipants to believe in human-caused global warming and to have environmentally based reasons for conserving energy.

Drivers

- Businesses with preexisting fluorescent lighting were nearly 6.5 times more likely to upgrade than others.
- Companies established as corporations and companies that owned their buildings were more than 3.2 times more likely to upgrade than others.
- Companies that believed they could make an environmental difference were somewhat more likely than others to upgrade.
- Woman-owned businesses and technical and financial businesses were much less likely to upgrade, all other variables being equal.

Econometrics of Total Energy Consumption

- Per square foot, commercial customers with historically higher electricity usage were likely to achieve larger savings than their counterparts.
- Commercial participants who spent 10% to 20% of their operating costs on electricity experienced more savings than other participants.
- Organizations that participated in the Small Business Program saved more energy per square foot than those that participated in the other commercial programs.
- Businesses that learned about the program from contractors were likely to save more energy than others.

Commercial Energy Analysis Insights and Savings

- Analysis of 38 commercial projects showed that actual savings were good (10%), but not as good as contractor estimates (16%).
- Estimated energy savings must be more accurate, otherwise financial markets are likely to steer clear of or charge more for risk in these investments.
- Lighting is the most straightforward and incentivized upgrade, but other measures will be needed to achieve deeper savings.

Focused Marketing and Continuous Engagement

- Focused media outreach generated nearly 40 stories in local publications and blogs.
- "It's Easy With Energize Phoenix," a community event, drew 500 residents and led to 130 registrations for a home energy checkup and double rebate incentives.
- The Energize Phoenix website has drawn 16,000 visitors to date and enabled monitoring of marketing campaigns.
- To add concrete human impact to the program, an "Energy Saving Super Heroes" marketing campaign profiled upgrade participants.
- A comprehensive marketing strategy of brand-building advertising, direct marketing by contractors and ASU students, call-to-action neighborhood events, and speaking engagements proved critical to growing the flow of Energize Phoenix participation.

Community events deliver information and spur action.

LOOKING TO YEAR THREE

The final year of the Energize Phoenix grant will provide an opportunity to significantly increase the number of participants as well as the extent of post-upgrade utility data. This will dramatically increase the strength of the analysis and the depth of insights into how to design and implement energy efficiency programs for maximum energy savings.

Introduction

Introduction: Energy Efficiency on an Urban Scale

Energize Phoenix is a three-year energy efficiency building upgrade program managed by the City of Phoenix in partnership with Arizona State University (ASU) and Arizona Public Service — the state's largest electricity provider. The program is funded by the U.S. Department of Energy's Better Buildings Neighborhood Program and the American Recovery and Reinvestment Act of 2009.

The purpose of Energize Phoenix is to create a sustainable large-scale model of urban energy efficiency in a portion of the Phoenix urban core. The goals are to:

- Upgrade 1,700 residential units and 30 million square feet of office and industrial space for greater energy efficiency
- Reduce energy consumption for residential participants by 30%
- Decrease energy use for commercial participants by 18%
- Cut carbon emissions by as much as 50,000 metric tons per year

This report is the second in a series of three to be published annually by the Global Institute of Sustainability at ASU on behalf of the Energize Phoenix project. The purpose of the reports is to cumulatively present results and lessons learned from a large-scale effort to create and sustain energy efficiency in a diverse urban corridor in the city of Phoenix.

The first year report (available at http://energize.asu.edu) covered program design and implementation. This second year report covers preliminary results from the analyses of upgrade projects and supplementary research data. The third report, which will be released in 2013, will share conclusive findings and insights based on a comprehensive analysis of results of the program.

Energy efficiency programs have been proliferating as a strategy for increasing energy security while reducing carbon dioxide emissions. Due to rising energy prices and climate change concerns, efficiency programs are considered a valuable clean energy resource by governments and utilities across the U.S. and abroad. Their popularity is such that budgets in the U.S. for utility ratepayer-funded energy efficiency programs totaled $6.8 billion in 2011 (see Figure 2) [3].

With no standardized program design available, energy efficiency program managers have had to learn from experience. In particular, they have had to be flexible and inventive in addressing three interrelated barrier forces — technical, economic, and socio-behavioral — which are thought to be common challenges of all energy efficiency programs.

Energize Phoenix's interdisciplinary research is expected to contribute important insights about these three challenge areas. The ongoing research, as an integral component of the larger Energize Phoenix program, also heralds a new style of energy efficiency program that values "collaborative rationality," [4] a process of reflection and open dialogue to address lingering questions about the so-called "energy efficiency gap" between potential and actual energy savings observed by predecessor programs.

Many preliminary lessons were learned during this period of the program, which also included an expansion of the physical program boundary by 55%. While much more data will be gathered in the coming year, the second year has been especially valuable for providing the opportunity to test and work through research methods, statistical models, and data gaps in preparation for the third year's comprehensive final analysis.

ENERGIZE PHOENIX IS A PARTNERSHIP OF

City of Phoenix

ASU Global Institute of Sustainability
Arizona State University

aps

Better Buildings
U.S. Department of Energy

Bridging the Gap

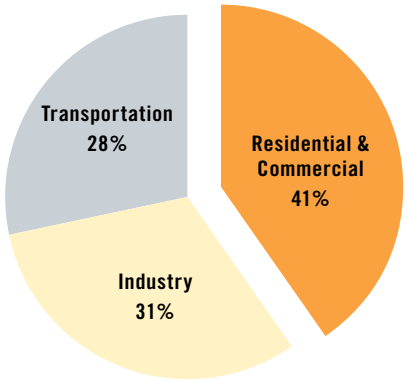
Bridging the Gap: Three Challenges to Energy Efficiency

How can the U.S. best develop a domestic supply of clean energy to meet energy demand while also creating jobs, boosting the economy, reducing carbon emissions, and improving social equity? One prominent component is energy efficiency.

In 2012, the nation's commercial and residential buildings are projected to consume roughly 40% of the country's delivered primary energy [5]. Much of that energy will be wasted through inefficiency in systems, operations, or both. Recovering or saving that wasted energy is currently the cheapest energy resource in our economy, running about one-third less than the cost of other conventional energy sources.

Energy saved through efficiency not only reduces consumer costs, new energy infrastructure, energy imports, and greenhouse gas emissions, but also improves reliability of the energy supply and national security. Indeed, for the past several decades, projects to expand the energy efficiency market have increased as part of broader efforts to address energy security [6].

FIGURE 1: U.S. PRIMARY ENERGY CONSUMPTION BY SECTOR (2012)



Data Source: Buildings Energy Data Book, US DOE

PUBLIC AND PRIVATE SUPPORT

In 2009 the American Recovery and Reinvestment Act awarded the U.S. Department of Energy's Office of Energy Efficiency $16.8 billion to fund its programs and initiatives [7]. This influx of capital led to a surge of 2,000 new efficiency projects through four programs: the Better Buildings Neighborhood Program, Low Income Weatherization Program, Energy Efficiency and Conservation Block Grant Program, and State Energy Program [8]. Energize Phoenix was awarded one of 41 competitive grants funded through the Better Buildings Neighborhood Program [9].

Beyond federal dollars, energy efficiency programs have also received support from ratepayer-funded budgets. These sources generated $6.8 billion in the U.S. during 2011, a 25% increase over 2010 funding [10].

With growing resources come higher expectations for success. For this reason, policymakers and program managers are looking for new shared insights and research findings to help measure and maximize efficiency gains in their programs.

HUMAN AND ORGANIZATIONAL BEHAVIOR

One of the biggest hurdles to overcome is the "energy efficiency gap." [11] This is the observed difference between the potential for energy efficiency in homes and businesses and the actual level of investment or uptake in energy saving measures and technologies. To resolve this phenomenon, program designs must transition from traditional models to a more holistic approach that uses behavioral change to persuade families and organizations to invest in a home or building energy upgrade. This requires effectively identifying and overcoming the barriers that prevent participation.

FIGURE 2: U.S. RATEPAYER-FUNDED ELECTRIC EFFICIENCY BUDGETS (2007-2011)

Electric Efficiency 2007-2011 U.S. Budgets

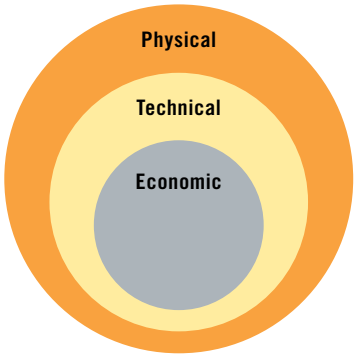
Total		Utility	Non-Utility	Utility Share of Total	Percent Increase
2007	$2,722,788,884	$2,413,639,443	$309,149,441	89%	
2008	$3,165,329,920	$2,704,072,429	$461,257,491	85%	16%
2009	$4,370,445,097	$3,796,110,308	$574,334,789	87%	38%
2010	$5,433,087,642	$4,789,681,107	$643,406,535	88%	24%
2011	$6,812,079,691	$5,750,298,200	$1,061,781,491	84%	25%

Notes: 2010 values include non-survey data provided by Arkansas Public Service Commission. CEE survey total for 2010 budget is $5,422,548,158.

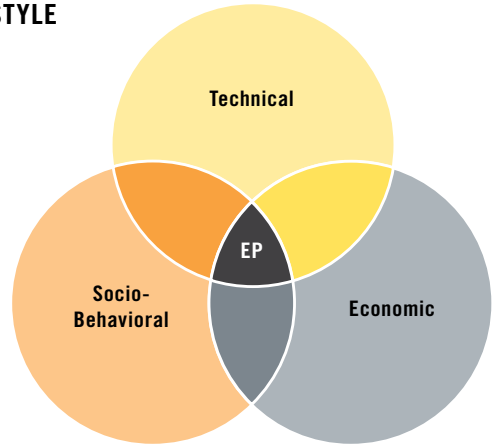
Source: Consortium for Energy Efficiency

FIGURE 3: ENERGY EFFICIENCY PROGRAM MODELS

OLD STYLE



NEW STYLE



Source: ASU Global Institute of Sustainability

Early energy efficiency program strategies were based on an engineering perspective known as the Physical Technical Economic Model (PTEM) [12]. This perspective aims to make buildings more efficient by providing utility customers conclusive information about the value of energy savings, while also including some type of incentive to act. The assumption is that people will act in an economically rational manner.

Human behavior, however, doesn't always follow suit. A homeowner, for example, might purchase a new high-efficiency HVAC unit to reduce energy costs, and then use the savings to buy a high energy consuming plasma TV. This effectively cancels out any efficiency gains accrued [13]. In addition, traditional programs are losing effectiveness as easy measures, such as lighting retrofits, are being exhausted [14]. A new strategy is needed.

THREE CHALLENGES

The experience of Energize Phoenix suggests that, to maximize energy efficiency scaling, programs must address the following set of interrelated technical, economic, and socio-behavioral challenges.

- *Technical*: Current technology and building science can tell us the potential for energy efficiency savings in buildings, but it doesn't tell us how that potential plays out in real-world settings. Energize Phoenix research is exploring the gap between potential and actual savings to find some of the underlying mechanisms that affect it.

EXAMPLE TECHNICAL CHALLENGES
Moving from component to whole systems approach
Quantifying actual savings
"One-off" nature of building design and construction
Quality of installation

- *Economic*: Private sector investment must be spurred to create a self-sustaining energy efficiency industry, but one roadblock is the uncertainty in predicting energy savings from efficiency measures — the basis on which investment decisions are made. Energize Phoenix is working to improve savings estimates by using both a top-down and bottom-up analysis scheme.

EXAMPLE ECONOMIC CHALLENGES
Landlord/Tenant split incentives
Mismatch of investment time horizons
Resistance to taking on debt
Uncertainty of revenue streams

- *Socio-Behavioral*: Program managers need to understand the behaviors of increasingly diverse groups and communicate in ways that motivate them to act. Additionally, they need to remove legal and policy impediments to action. Energize Phoenix research is looking for ways to understand the non-economic needs of the market so that programs can more effectively target messages and policies to specific audiences.

EXAMPLE SOCIO-BEHAVIORAL CHALLENGES
Market segmentation for targeted messaging
Invisibility of energy usage/savings
Lack of social norms for efficiency
Policy barriers such as appraisal rules

The interdisciplinary research team is structured to address all three of these challenge areas (see Figure 4).

FIGURE 4: HOW ENERGIZE PHOENIX RESEARCH ADDRESSES THREE CHALLENGE AREAS

	Integrated Evaluative Model		
EP Research Initiatives	**Technical**	**Economic**	**Socio-Behavioral**
Program Management	X	X	X
Energy Dashboards	X	X	X
Behavioral Change		X	X
Commercial	X		
GIS Analysis	X	X	X
Economics	X	X	X
Marketing	X	X	X

Source: ASU Global Institute of Sustainability

Examining the Facts

Examining the Facts: Motivation, Trends, and Barriers

Year Two of the Energize Phoenix program (2011-2012) yielded a solid foundation of data and insights across the range of technical, economic, and socio-behavioral challenges. The following sections present preliminary findings as well as lessons learned to date.

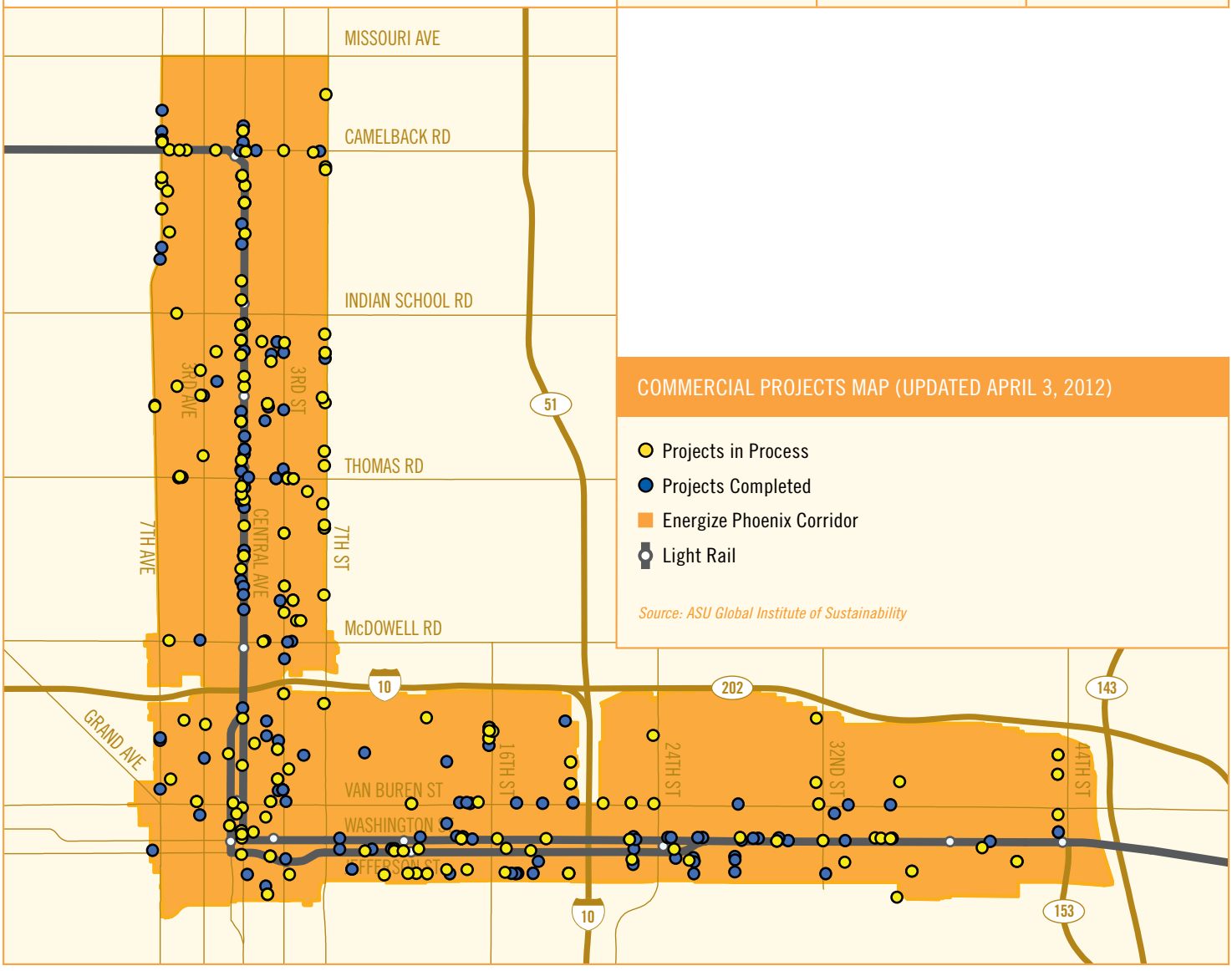
UPGRADE PROGRESS

As of March 31, 2012, Energize Phoenix contractors had completed 154 commercial building, 7 single-family home, and 182 multi-family residential unit upgrades for a total contractor-estimated annual savings of 11,751,602 kWh. This is roughly the equivalent of taking 1,590 passenger vehicles off the road for one year [15] (see Figure 5). At the same time, an additional 154 commercial buildings and 1,087 multi-family units were in the upgrade or application process and 73 more single-family homes had completed energy checkups, the first step in the upgrade process. Altogether, 40% of the commercial upgrades were processed in the first quarter of 2012, a significant increase over 2011 production.

FIGURE 5: ENERGIZE PHOENIX INTERIM PROGRAM RESULTS

COMMERCIAL PROGRAM RESULTS

Status	Completed (as of 03/31/12)	Pipeline
kWh Saved	11,374,729	N/A
Rebate Amount	$1,332,873	N/A
Final Project Cost	$6,048,409	N/A
Job Hours	26,966	N/A
Jobs	13	N/A
Square Feet	10,672,567	N/A
Number of Buildings	154	154



COMMERCIAL PROJECTS MAP (UPDATED APRIL 3, 2012)

- Projects in Process
- Projects Completed
- Energize Phoenix Corridor
- Light Rail

Source: ASU Global Institute of Sustainability

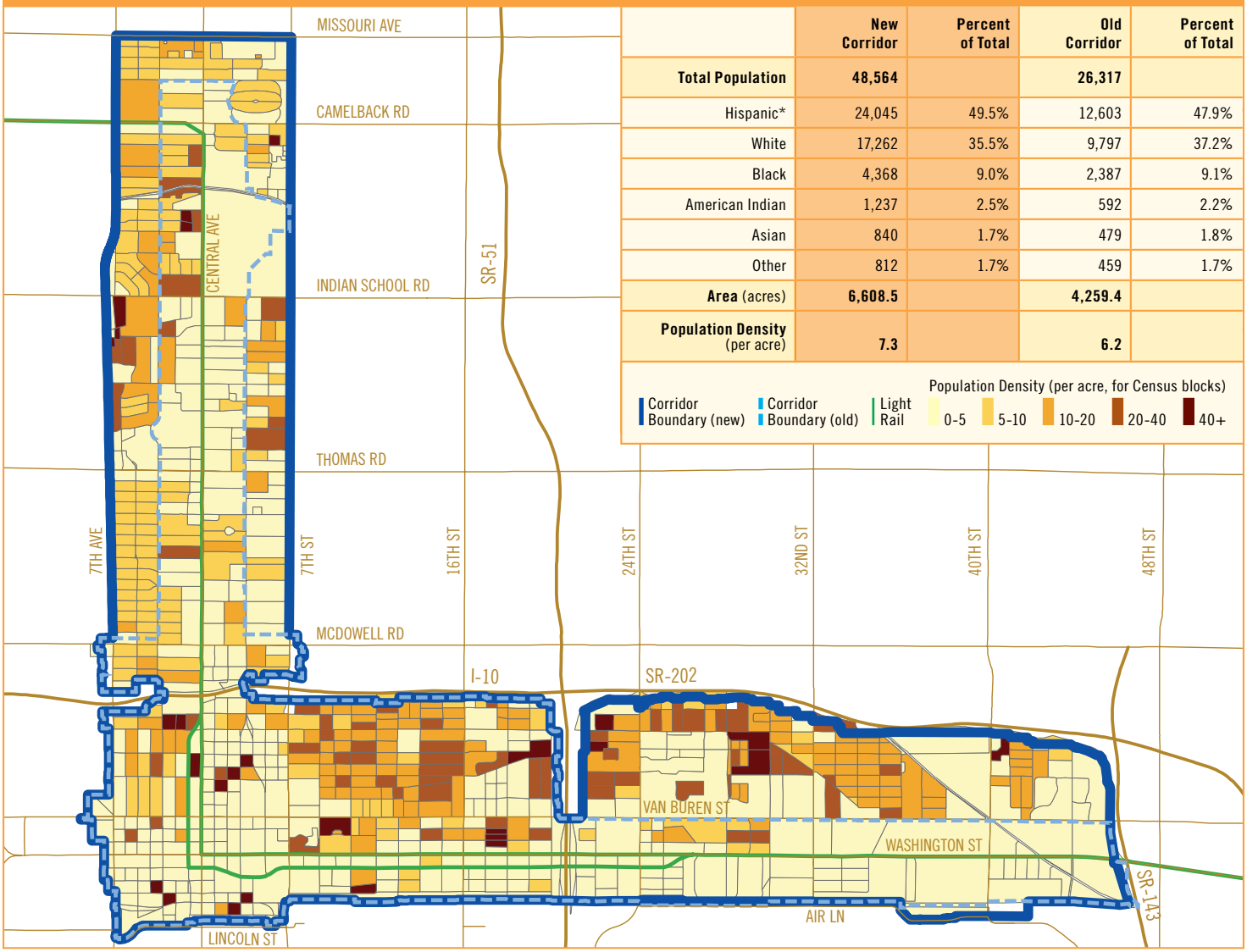
FIGURE 5 *(CONTINUED)*: ENERGIZE PHOENIX INTERIM PROGRAM RESULTS

RESIDENTIAL SINGLE-FAMILY PROGRAM RESULTS		
Status	**Completed Upgrades (as of 03/31/12)**	**Completed Checkups**
kWh Saved	19,133	N/A
Rebate Amount	$4,412	N/A
Final Project Cost	$15,411	N/A
Job Hours	229	N/A
Jobs	0.1	N/A
Number of Buildings	7	73

RESIDENTIAL MULTI-FAMILY PROGRAM RESULTS			
Status	**Completed Upgrades (as of 03/31/12)**	**Under Construction**	**Applications In-Process**
kWh Saved	357,740	N/A	N/A
Rebate Amount	$7,419	N/A	N/A
Final Project Cost	$30,838	N/A	N/A
Job Hours	287	N/A	N/A
Jobs	0.1	N/A	N/A
Number of Buildings	1	N/A	N/A
Number of Units	182	179	908

Source: City of Phoenix and ASU Global Institute of Sustainability

FIGURE 6: BOUNDARY AND POPULATION COMPARISON OF NEW AND OLD ENERGIZE PHOENIX CORRIDORS



	New Corridor	Percent of Total	Old Corridor	Percent of Total
Total Population	**48,564**		**26,317**	
Hispanic*	24,045	49.5%	12,603	47.9%
White	17,262	35.5%	9,797	37.2%
Black	4,368	9.0%	2,387	9.1%
American Indian	1,237	2.5%	592	2.2%
Asian	840	1.7%	479	1.8%
Other	812	1.7%	459	1.7%
Area (acres)	**6,608.5**		**4,259.4**	
Population Density (per acre)	**7.3**		**6.2**	

**The Census Bureau treats Hispanic ethnicity and race as separate, cross-cutting categories. In other words, a person can claim both Hispanic ethnicity and whatever racial category desired. Here, the category "Hispanic" includes all people who claimed Hispanic ethnicity, regardless of race. For the race categories, tabulations are for non-Hispanic respondents in that category.*

Source: Census 2010 Redistricting Data

CORRIDOR EXPANSION

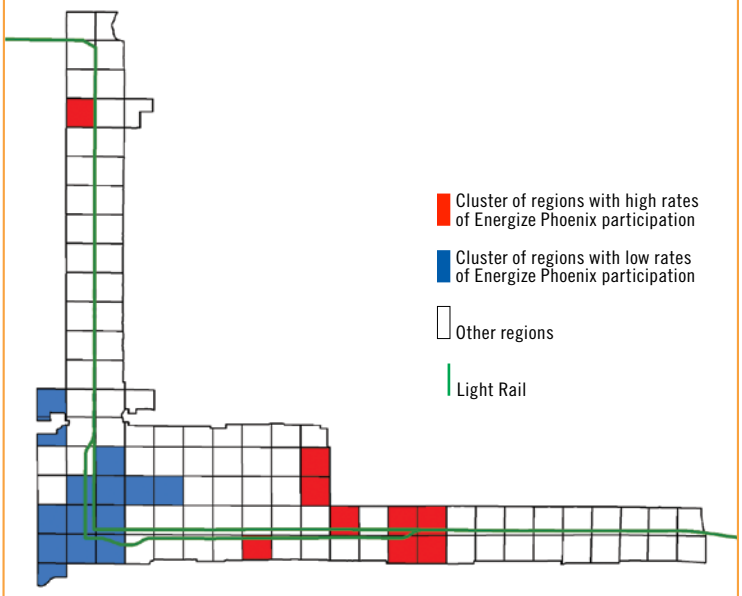
The Energize Phoenix Corridor was expanded significantly in 2011 as a mid-program adjustment to boost residential participation. The goal was to increase the number of homeowners eligible for upgrades and unite neighborhoods that the previous boundaries had unintentionally split (see Figure 6). The expansion increased Corridor size by 55%, from 6.66 square miles to 10.33 square miles (see Figure 7). The northern portion of the Corridor was widened to include areas within ½ mile of the light rail (up from ¼ mile), while the eastern portion of the Corridor was extended northward to include all areas south of the Loop 202 freeway.

The most notable differences created by the expansion were a substantial jump in the number of residential parcels, which increased by 77%, and a large rise in total population, which increased by 85% and added a relatively high proportion of Hispanic and American Indian/Alaska Native residents in comparison to the original Corridor. Commercial parcels increased 41% from the expansion.

COMMERCIAL CLUSTERS

The Geographic Information Systems team examined clustering of completed commercial energy efficiency projects using geographic and spatiotemporal (tracking location and time together) methods. Analysis of the completed commercial projects identified two initial non-random clusters. One of the clusters, located in the eastern end of the Corridor, was characterized by high levels of commercial participation. The other cluster, located near downtown, exhibited low participation (see Figure 8).

FIGURE 8: SPATIAL CLUSTERING IN ENERGIZE PHOENIX COMMERCIAL PARTICIPATION



Source: ASU Global Institute of Sustainability

FIGURE 7: SIZE COMPARISON OF NEW AND OLD ENERGIZE PHOENIX CORRIDORS

Use Category	Statistic	New Corridor	Old Corridor	Added Area	Percent Change
	Area (square miles)	10.33	6.66	3.67	55%
Residential	Parcels[1]	9,370	5,289	4,081	77%
	Population[2]	48,564	26,317	22,247	85%
	Hispanic	24,045	12,603	11,442	91%
	White	17,262	9,797	7,465	76%
	Black	4,368	2,387	1,981	83%
	American Indian and Alaskan Native	1,237	592	645	109%
	Asian	840	479	361	75%
	Other	812	459	353	77%
Commercial	Parcels[1]	4,538	3,218	1,320	41%
	Employers[3]	6,256	4,888	1,368	28%

[1] *Maricopa County Assessor's office, 2011.*
[2] *Census 2010. All populations claiming Hispanic ethnicity are counted as Hispanic and not in their respective racial categories.*
[3] *Infogroup, 2009.*

Source: ASU Global Institute of Sustainability

What could be driving these clusters? The eastern part of the Corridor is notable for economic activities such as manufacturing, construction, and warehousing. It is possible that these types of businesses may be more knowledgeable about energy efficiency because they have high energy expenditures, leading to increased interest in programs like Energize Phoenix. The low participation cluster, meanwhile, may be influenced by at least two factors. First, a large portion of businesses in the area lease their properties and may not have either the desire or the ability to undertake energy-saving upgrades. Second, the downtown area has a relatively high concentration of government buildings, which may have already been upgraded under other programs or policies.

More general circumstances could also be driving the clustering process. Large industry concentrations can create a geographic cluster of related companies for economic or convenience reasons or due to external factors such as transportation access, zoning, and land values. Clusters could also arise from business leaders in an area recommending the upgrade programs to one another in face-to-face communication with their neighbors. Clusters could also be the result of successful outreach by contractors in targeted neighborhoods. If these clusters persist or if others emerge in the third year, further analysis will be undertaken to help understand why.

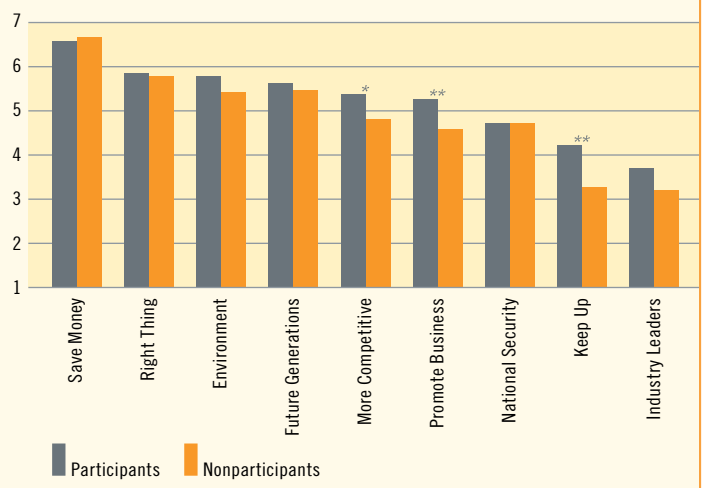
UNDERSTANDING CHARACTERISTICS AND ATTITUDES

Many characteristics of businesses and residents can affect their participation in energy efficiency programs. To better understand how, the behavioral change team collected and analyzed demographic, behavioral, attitudinal, and energy usage information from both participants and nonparticipants.

Commercial surveys were collected from 144 organizations. These differed widely in size (1 to 3,600 employees) and economic sector (retail, manufacturing, aerospace engineering, schools, law firms, and more). Of the 144 respondents, a total of 90 (62.5%) had opted to get upgrades on their facilities through the Energize Phoenix program. Comparing upgrade participants to nonparticipants revealed several differences.

Participants were significantly more likely to own their buildings (73% versus 47% of nonparticipants). This suggests owner-occupants have more autonomy in making upgrade decisions and/or are better positioned to receive the financial benefits of their investments through lower energy bills and increased capital value of their facilities. This preliminary finding corresponds with the broader industry challenge of aligning the rewards of energy efficiency with those who make the investment.

FIGURE 9: REASONS TO CONSERVE ENERGY AMONG ORGANIZATIONS



** marginally significant difference*
*** significant difference*
Source: ASU Global Institute of Sustainability

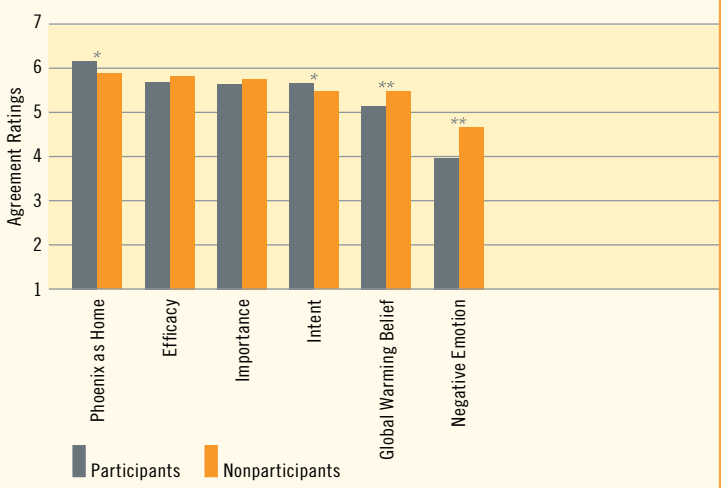
Upgrade participants, on average, tended to have a greater number of employees than nonparticipants (9 versus 5), and had been in their commercial space longer (19.1 years versus 14.8 years). Also, a higher percentage of participants (92% versus 80%) said that customers visited their location.

The surveys also asked respondents to rate their reasons for conserving energy, whether they participated in the Energize Phoenix program or not (see Figure 9). Significantly more commercial upgrade participants said they participated to promote their business and to keep up with business trends. Marginally more participants said they upgraded to be more competitive.

RESIDENTIAL FINDINGS

The original Energize Phoenix Corridor boundaries were chosen, in part, to maximize diversity among those eligible to participate, and residential surveys are representative of this diversity. Surveys collected from a total of 615 respondents showed they represented a wide range of ethnicities, income, political affiliations, household compositions, and other characteristics. Within those respondents were 115 Energize Phoenix program participants (individuals who received home energy checkups or upgrades).

FIGURE 10: RESIDENTIAL ENERGY-RELATED ATTITUDES AND BELIEFS



** marginally significant difference*
*** significant difference*
Source: ASU Global Institute of Sustainability

Among survey respondents as a whole:

- 53.5% were female and 46.5% male.
- 62.8% were White/Caucasian, 24.7% Hispanic/Latino, 6.2% African American, and 4.4% Asian American (1.9% marked "Other" or declined to respond).
- 600 surveys were completed in English, with the remaining 15 completed in Spanish.
- Median respondent age was 45.0 years and average length of time lived in Arizona was 25.6 years.
- Median household income was $65,000/year (only 74.6% of participants responded).
- 74.2% owned the home they lived in and average length of time in the home was 11.3 years.
- Political affiliations were 35.7% Democrat, 17.6% Independent, 13.3% Republican, 2.8% Green, and 2.2% Libertarian (9.6% marked "other" and 18.8% declined to respond).

Respondents were asked to rate their attitudes and beliefs on six scales related to energy efficiency:

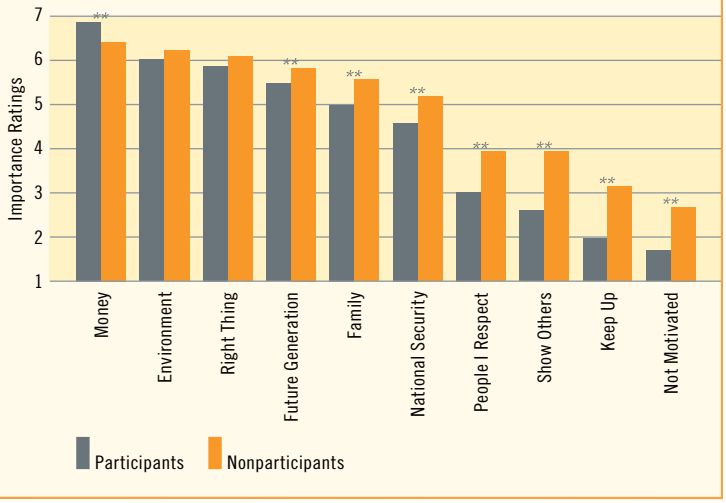
- *Phoenix as home*: how strongly respondents feel that Phoenix is their home
- *Efficacy*: how strongly respondents feel that they, and society, can change to solve environmental problems
- *Importance*: how strongly respondents agree that energy conservation is important
- *Intent*: how strongly respondents intend to conserve energy in the future
- *Global warming belief*: how strongly respondents agree humans are changing global climate
- *Negative emotionality*: how strongly respondents feel negative emotions (i.e., sadness, anger, guilt) when considering the effect of human energy use on the environment

Upgrade participants differed from nonparticipants on four of the six scales, but sometimes in surprising ways (see Figure 10). Participants were somewhat more likely to regard Phoenix as home, which was consistent with findings that they had lived in both Arizona and their current homes longer than nonparticipants. Participants were also somewhat more likely to intend to conserve energy, which was not surprising since they were about to make energy efficiency upgrades to their homes.

Upgrade participants, however, reported significantly less negative emotion about the impact of energy use on the environment, and they were significantly less likely to agree that human-caused global warming is occurring. This could indicate that environmental concerns do not weigh heavily on the decisions of early adopters.

For both participants and nonparticipants, saving money was rated as the most important reason for conserving energy, though it was significantly more important to participants (see Figure 11). Interestingly, participants rated five non-financial reasons as significantly less important than did nonparticipants. This seems to indicate an inconsistency between stronger non-financial motives and participation.

FIGURE 11: REASONS FOR CONSERVING ENERGY AMONG INDIVIDUALS



*** significant difference*
Source: ASU Global Institute of Sustainability

One possible explanation is that the marketing efforts for Energize Phoenix have centered on saving money, so people for whom that message resonated more clearly may have been more likely to participate.

It is important to note that *differences* between upgrade participant and nonparticipant groups do not necessarily indicate causes of participation. While demographic and attitudinal variables have been examined separately here, they may combine in many ways to influence people's decisions to upgrade their homes. For that reason, more sophisticated logistic regression analyses will be run in Year Three, after more data is collected, to determine which variables are statistically more *predictive* of participation. This will inform future market segmentation and tailored messaging efforts.

PREDICTING PARTICIPATION

To determine which combination of variables were most strongly associated with businesses and other organizations deciding to upgrade their facilities, the ASU Geographic Information Systems team conducted a preliminary statistical analysis of 97 organizations in the original Energize Phoenix Corridor that had completed the commercial survey by April 16, 2012, with no relevant missing data. Of these 97 organizations, a little over half (56) chose to participate in an Energize Phoenix energy efficiency upgrade. Analysis revealed that five of the seven variables showed significant differences between program participants and nonparticipants (see Figure 12).

Preliminary analysis indicated that the presence of preexisting fluorescent lighting was the strongest positive factor for predicting an organization will participate. A company with preexisting fluorescent lighting was 6.45 times more likely to upgrade than one without, all else being equal. Since nearly every upgrade involved installing improved fluorescent lighting, this is not surprising. Lighting upgrades receive the highest incentives and the upgrade is relatively nonintrusive, making it a comparatively easy sell for contractors. Yet, not every company that opted for efficient fluorescent lighting started out with it. Seven companies converted from incandescent, CFL, halogen, or other lighting.

Ownership was another strongly positive factor. Companies that owned their building were 3.23 times more likely to upgrade than companies that leased. Possible explanations are that renters may need landlord permission to undertake an upgrade, their available measures may be more limited, and they would not reap the full benefit if they had to move.

Companies established as corporations also were strongly positive. They were 3.24 times more likely to upgrade compared with all other commercial entities such as sole proprietorships, partnerships, LLCs, nonprofits, or government/schools. Explanations for this will require more research.

Significantly negative correlations raised more questions than they answered. One example is the category of woman-owned businesses, which were 5.1 times less likely to upgrade, all else being equal. Technical or financial industry businesses had a similar negative correlation.

Will these trends hold as the sample size of complete survey data increases in Year Three? Are women owners actually harder to sell on an upgrade than men, or could it be something about the marketing messages used, the nature of interaction between contractors and women owners, the

FIGURE 12: FACTORS POTENTIALLY AFFECTING UPGRADE DECISIONS

Independent Variable	Description	Coeff (B)	S.E.	Sig.	Exp(B)*
Woman	Woman-owned business	-1.623	.859	.059	.197
Own	Occupant owns the building	1.173	.527	.026	3.232
Fluorescent	Building previously had fluorescent lights	1.864	.675	.006	6.452
Only_Place	Building is occupant's only place of operation	-1.176	.549	.032	.308
Tech_Fin	Business is in a technical or financial industry	-1.626	.636	.011	.197
Corp	Business legally structured as a corporation	1.174	.554	.034	3.235
Efficacy	Opinion that org. can impact environment	.359	.216	.097	1.433
Constant		-3.161	1.427	.027	.042

** log-odds ratio*
Source: ASU Global Institute of Sustainability

nature of the economic sectors in which women tend to own businesses, the buildings they choose, the form of corporate organization, or some other factor? Do technical or financial services businesses tend to lease their office space and does that explain their under-participation rate? We emphasize that these are preliminary findings, but the trends point to a number of interesting research directions for Year Three.

BUSINESS "SWEET SPOTS"

To identify factors that affect the effectiveness of commercial upgrades, the ASU econometrics team gathered and analyzed data on 118 variables for 45 upgrade projects completed by March 31, 2012. The data was gathered from several sources:

- Information collected by the City of Phoenix as part of the application process
- Customer billing data provided by Arizona Public Service
- Building characteristics found in the Maricopa County Assessor's data
- Weather data from the National Oceanic and Atmospheric Administration
- Participant characteristics drawn from the behavioral survey during the application process

(A list of all 118 variables analyzed and their descriptions can be found in Appendix E: Descriptive Statistics for Building a Statistical Model of Total Energy Consumption by Commercial Participants of the Energize Phoenix Program.)

One variable in particular, *Percent of Operating Budget Spent on Electricity*, may identify a "sweet spot" for encouraging certain businesses to upgrade their facilities for energy efficiency. Organizations spending 10-20% on electricity (pre-upgrade) experienced significantly more energy savings per square foot than other organizations. With the vast majority of upgrades involving lighting, one possible explanation may be the combination of a strong incentive to reduce energy use and a relatively small investment to do so.

Preliminary analysis of energy use in pre- and post-upgrade time periods suggests four additional variables that have potential to positively influence the effectiveness of undertaking an upgrade in the commercial sector. Those four variables are:

- *High Energy Intensity*: High energy intensity users had a greater probability of reducing their energy use than low energy intensity users [16].
- *Small Business Program*: Participants in the Small Business Program saved more energy per square foot than participants in the general Business Program.
- *Ownership of the Building*: Organizations that owned their building(s) reduced their energy use intensity by a greater amount than non-owners.
- *Marketing Methods*: Businesses that learned about the Energize Phoenix program through contractors were more likely to reduce their energy use by a significant amount compared to those who heard about the program through other marketing channels.

RESIDENTIAL DASHBOARDS AND THEIR BARRIERS

The Residential Dashboards study is aimed at helping local residents save energy, while also providing valuable industry research to address the efficiency gap between potential and actual energy savings. The goal is to identify energy usage feedback techniques that can create the greatest savings gains.

This intervention was originally envisioned as a straightforward opportunity to employ an off-the-shelf technical solution to help create behavioral change. The reality in Year Two was that complex technical, economic, and socio-behavioral barriers revealed themselves on a large scale. As a result, the obstacles to successful implementation of the original study became unwieldy.

Researchers intended to examine the behavioral energy savings potential of one understudied population — renters of single-family residential homes. The design called for testing both in-home dashboards that provide real time energy feedback and in-person energy efficiency education in various combinations.

Instead, for Year Three, the Dashboards team will examine two different participant groups: low-income renters inhabiting a city-owned apartment complex, and students housed within an ASU dorm.

The premise of the low-income study is similar to the original study with the addition of examining the impact of renters developing an energy budget. Low-income families are under-studied with regard to in-home energy usage feedback devices.

The premise of the dorm study involves testing the impact of more formal social structures and the impact of the level of detail of the energy usage feedback. Data from both studies will be gathered through summer and fall of 2012 and results will be included in the Year Three report.

The challenges that the Dashboards team experienced in Year Two offer a good opportunity for reflection. Among the underestimated and unforeseen social barriers that prompted changes were:

- High vacancy rates in the Corridor
- High turnover activity (renters needed to be in the home for twelve prior months)
- Suspicion of government programs or government monitoring in general, and specifically related to immigration enforcement
- Inconsistent status of those living in the residence (e.g., owners living in their rental units due to economic factors)
- Negative relationships between renters and their landlords.
- Landlords resisting renter participation for fear of later demands for upgrades

Among the economic barriers to participation were:

- Renter uncertainty about their ability to continue paying the rent
- Uncertainty about future occupancy as rental homes faced possible foreclosure

Among the technical barriers encountered were:

- Old electrical panels with three-phase power, screw fuses, or insufficient space to place equipment
- Utility prohibition of equipment placement in the utility side of the electrical panel for technical reasons

Together, these barriers serve to highlight the complexity that occurs when project interactions span all three technical, economic, and socio-behavioral areas. The experience also underscores the notion that established technology is not always a sure thing when put into practice. Figure 13 illustrates the strength of several of these barriers. For example, Block 1 included 217 potential participating properties, but only three ultimately had dashboards installed.

The following lessons learned may help inform design and reduce delays for other programs seeking to implement a similar initiative:

- Allocate ample time for each partner to review every step of the recruitment and rollout process; projects that involve human subjects, private property, and utility-owned equipment are complex and sensitive.
- Ensure that all relevant departments are aware of and approve the technology and configurations to be used; all potential configurations of the panel box (e.g., small spaces, three-phase, inaccessible main feeds, fuses) should be fully tested before launching into full operational mode.
- Budget extensive time for interacting with the public for recruitment and operations, and cast a wide recruitment net for potential participants.
- Promote flexibility and responsiveness to new challenges; unforeseen barriers will almost always arise.
- Perform a pilot program with a small sample of participants and take them from recruitment all the way through device installation, data collection, and evaluation; while this may seem like a large time investment, it will ensure that barriers can be identified and overcome in the early stages, saving time in the long run.

ADJUSTED ENERGY SAVINGS

One of the main objectives of the ASU commercial energy analysis team is to independently evaluate contractor estimates of savings in individual building upgrades. Whereas contractors generally estimate savings based on customer-supplied operating hours and the calculated efficiency differences between existing and replacement technology, the commercial analysis team takes a "bottom-up" approach that measures actual savings over a given period.

During Year Two, the team's primary analysis used Arizona Public Service bill data to determine baseline electricity consumption prior to upgrades for 38 projects. The team also collected relevant information about each project, including energy conservation measures employed, type of building, type of business, and square footage to determine the type of analysis needed to calculate energy savings. With most projects consisting of lighting upgrades, the main analysis compared the savings estimated by the contractor with the actual savings deduced from post-upgrade utility bills for matching calendar months.

To improve the validity of this method, the team also examined two external factors: consistency of building energy use patterns over the past three years to ensure minimal dependency on external factors, and monthly average temperature during the pre- and post-upgrade periods.

FIGURE 13: RECRUITMENT RESULTS % OF TOTAL VISITED HOMES BY OUTCOME

Residential Tracking Form			Block 1 Totals	Block 2 Totals	Block 3 Totals	Block 4 Totals	Block 5 Totals	Block 6 Totals	Block 7 Totals	Block 8 Totals	Block 9 Totals	Totals	Percent of Total Units
Number of Single-Family Homes			117	104	123	119	109	83	107	116	121	999	42.0%
Number of Multi-Family Homes			100	53	164	100	217	113	185	297	148	1377	58.0%
Total Homes			217	157	287	219	326	196	292	413	269	2376	
First Attempt			189	100	119	115	109	85	102	366	201	1386	58.3%
Follow-Up Attempt (*)			46	47	49	71	74	46	48	184	106	671	48.4%
No Contact	PC	Postcards Mailed (SF Only)	114	99	120	110	104	80	103	110	119	959	40.4%
		Left Postcard 1st Time (MF Only)	0	0	0	0	0	0	0	144	52	196	8.2%
	Vacancy	Postcard Marked Undeliverable	12	20	17	6	12	11	20	12	29	139	5.9%
		Vacant Residence	17	14	11	9	12	7	12	42	23	147	6.2%
		Vacant Land	6	2	1	0	0	0	1	9	2	21	0.9%
		Property Inaccessible	0	2	3	11	4	8	5	57	30	120	5.1%
		Did Not Feel Safe (Conditions/People)	11	0	2	6	4	3	1	29	28	84	3.5%
		No One Home	32	34	35	18	33	21	22	67	32	294	12.4%
		Left Postcard with Note	29	32	27	18	28	19	24	30	21	228	9.6%
Contact	No Participation	Assessor Classification Incorrect	0	4	3	0	0	0	1	29	25	62	2.6%
		Owner Occupied	18	9	13	23	12	7	11	17	9	119	5.0%
		Declined to Participate	15	16	22	21	14	10	16	47	23	184	7.7%
		In Residence Less Than 12 Months	5	7	10	2	6	2	1	8	1	42	1.8%
		Landlord Paid Electric Bill	0	0	0	0	1	0	0	0	6	7	0.3%
	Participation	Interest Card Captured	21	12	22	28	19	18	13	37	20	184	7.7%
		Left Consent Per Request	9	7	14	14	10	15	10	23	17	119	5.0%
		Consent Signed	9	4	10	13	7	7	4	9	8	71	3.0%
		Landlord Contacted	9	1	8	10	5	3	2	25	2	65	2.7%
		Landlord Consent Given	8	1	0	0	1	0	1	0	0	11	0.5%
		Electric Panel Assessed	8	1	0	0	0	0	1	0	0	10	0.4%
		Dashboard Installed	3	0	0	0	0	0	0	0	0	3	0.1%

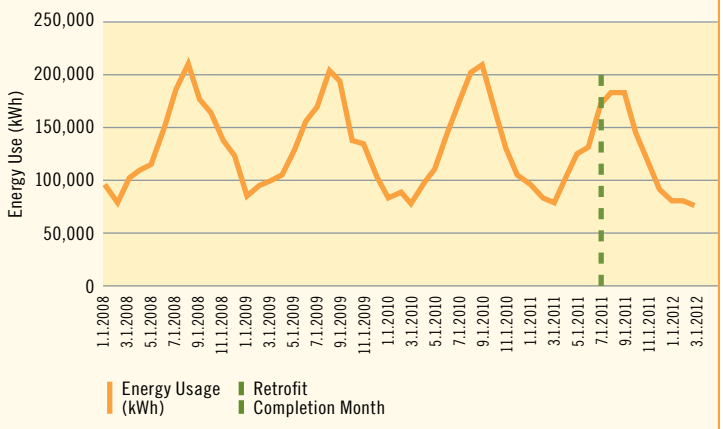
** This category pertains to single-family rentals homes only*

Source: ASU Global Institute of Sustainability

In practice, monthly comparisons of temperatures revealed strong similarity between pre- and post-upgrade conditions, suggesting that weather-correction was not necessary for this time period. An example of the analysis process for one project is illustrated in Figures 14 through 16.

The individual data and energy calculations of all 38 projects were then aggregated to determine overall performance. Actual savings was calculated to be 10%, while contractor estimates were 16% (see Figure 17).

FIGURE 14: HISTORICAL ENERGY USE PATTERN OF A SAMPLE PROJECT



Source: ASU Global Institute of Sustainability

FIGURE 15: ENERGY ANALYSIS OF A SAMPLE PROJECT

Application/Project ID	12
Building Type	Lodging
Area (Sq Ft0)	94,299
Business Type	Senior Housing
Retrofit Completion Date	07/11/11
Retrofit Type	Lighting

Summary of Energy Consumption and Savings

Month	Consumption						Savings				kWh Savings (%)	
	Billed (Pre)		Contractor Estimated		Billed (Post)		Contractor Estimated		Billed (Post)			
	kWh	$	kWh	$	kWh	$	kWh	$	kWh	$	Estimated	Billed
Jul	172,800	15,470	142,988	12,801	170,720	15,167	29,812	2,648	2,080	303	17.25	1
Aug	200,000	17,288	170,188	14,711	182,720	15,783	29,812	2,575	17,280	1,505	14.91	9
Sept	208,800	17,536	178,988	15,032	182,400	15,790	29,812	2,581	26,400	1,746	14.28	13
Oct	167,360	15,072	137,548	12,387	144,160	13,426	29,812	2,776	23,200	1,646	17.81	14
Nov	128,800	9,640	98,988	7,409	119,680	9,093	29,812	2,265	9,120	547	23.15	7
Dec	104,480	8,590	74,668	6,139	90,400	7,105	29,812	2,343	14,080	1,485	28.53	13
Jan	95,520	7,297	65,708	5,019	79,360	6,071	29,812	2,280	16,160	1,226	31.21	17
Feb	82,560	6,229	52,748	3,980	79,680	5,934	29,812	2,220	2,880	295	36.11	3
Mar	76,480	5,922	46,668	3,614	74,880	5,657	29,812	2,252	1,600	265	38.98	2
Apr	100,320	7,899	70,508	5,551	–	0	29,812	2,347	–	0	29.72	0
May	123,360	11,477	93,548	8,704	–	0	29,812	2,774	–	0	24.17	0
Jun	130,880	11,805	101,068	9,116	–	0	29,812	2,689	–	0	22.78	0
Cumulative	1,591,360	134,226	1,233,620	104,464	1,124,000	94,025	357,740	29,752	112,800	9,019	22.4%	9%

Source: ASU Global Institute of Sustainability

For Year Three, evaluation will continue to examine the extent to which contractor-predicted savings have been consistent with actual savings as determined from utility bill analysis. Further work in this regard will address the following:

- Variation of overall savings estimation accuracy by contractor, building type, business type, or any other variable
- Effectiveness of different types of upgrades
- Reasons for any specific set of projects to substantially deviate from expected performance

Year Two research also provided on-site pre-upgrade and post-upgrade energy measurement and analysis of savings on one project in which contractor estimates were 30%, but actual savings were determined to be 5%. The causes of this large discrepancy are yet to be determined. The most likely culprit is a pre-upgrade estimation error by the owner and contractor regarding the number of lighting ballasts that used an inefficient older technology.

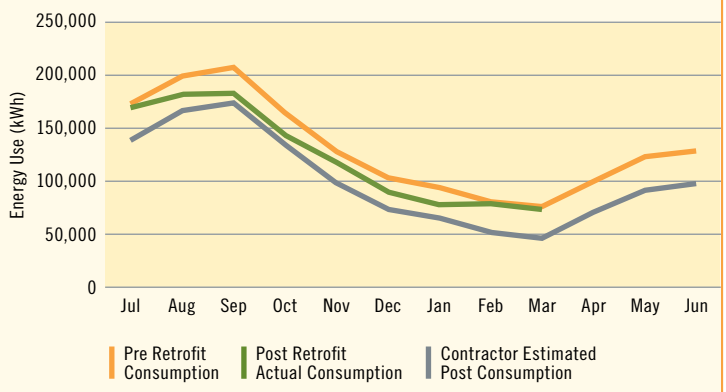
Year Three research will include performing additional on-site pre- and post-upgrade energy measurements of select projects, as well as energy modeling of select projects in order to identify additional potential upgrades for deeper savings. Although lighting projects are highly subsidized, relatively unobtrusive, and generally effective for achieving significant energy savings, deeper energy savings will require diversification into other types of upgrades. This may be starting to happen. In the first quarter of 2012, a number of participants who had undertaken lighting upgrades filed applications for additional measures.

CONTINUOUS ENGAGEMENT

The marketing approach for Year Two was designed to be diverse, consistent, and multi-layered to reach all segments of the Corridor population. Outreach efforts included a strategic media plan, highly publicized community events, ad campaigns that drove people to the website, and direct marketing by contractors and ASU students. Below are some of the activities and their outcomes.

Focused media outreach generated nearly 40 stories in local publications and blogs. Story angles included success

FIGURE 16: TIME SERIES PLOT OF ENERGY USAGE OF A SAMPLE PROJECT



Source: ASU Global Institute of Sustainability

of the commercial business program, boundary expansion, commercial financing opportunities, an energy efficiency fair and contractor exhibit, a special offer for double rebates, and a free energy checkup for residential customers.

"It's Easy with Energize Phoenix," a community event held in March 2012, attracted approximately 500 residents and led to more than 130 homeowners signing up for double rebates and home checkups with contractors. Advertising for this event consisted of door-to-door marketing via door hangers to all 7,000 single-family residences in the Corridor and ad placement in targeted community newsletters.

Energize Phoenix's website attracted more than 16,000 visitors since its launch in October 2010. Of these, nearly 9,000 were unique. This is due, in part, to all marketing efforts directing potential participants to the website to enter their address so they can determine if they are within program boundaries. Direct keyword search on the term "Energize Phoenix," however, has been the single highest source of website visitors. This indicates program branding has been a success.

Direct marketing included personal connections with Corridor homeowners by the more than 25 approved residential contractors, and with Corridor businesses by the more than 70 approved commercial contractors. These contacts have been complemented by ASU student outreach efforts, Dashboard program recruitment, and distribution of door hangers with special rebate offers. To help with recruitment, the marketing team developed program collateral for residential contractors that they could customize with their own logo and company information.

AMONG THE BEST MARKETING PRACTICES IN YEAR TWO

- *Impetus to Action*: The community energy efficiency fair, "It's Easy with Energize Phoenix," offered double rebates to eligible homeowners who attended the event, capped at 100% of the incremental cost of each measure.
- *Targeted Personal Outreach*: Program staff connected directly with neighborhood associations, local bloggers, program ambassadors, and homeowners to present and discuss program details.
- *Testimonials*: A variety of commercial and residential participants were profiled as "Energy Saving Super Heroes" to put a personal face on the program. Program staff used social media channels and the website to share relevant videos, photos, and personalized testimonials.
- *Continuous Engagement*: Recognizing that residential contractors tended to decrease their outreach efforts in summer when demand for their traditional business activities is already strong, program staff sustained Energize Phoenix messaging with a full ad campaign in July 2011. The campaign featured "money saving" messages specifically targeting the Corridor.
- *Tracking Success*: The team used Google Analytics to track unique visitors and page views on a bimonthly basis. This made it possible to monitor usage of the address look-up tool and spikes in traffic created by outside marketing efforts or secured media.

FIGURE 17: YEAR TWO COMMERCIAL ENERGY ANALYSIS METRICS

Number of projects approved to date (through May 1, 2012)	292
Number of projects with completed retrofits	203
Contractor estimated energy savings (kWh/Yr)	12,724,796
Total square footage (sq ft)	8,724,660
Total Energize Phoenix rebate amount ($)	1,353,069
Number of projects for which energy savings were determined (till March 2012)	38
Cumulative actual savings (pro-rated annually) (kWh/Yr)	2,238,955
Contractor-predicted savings (kWh/Yr)	3,756,915
Actual savings ratio to baseline energy use	10%
Contractor estimated savings ratio to baseline energy use	16%

Source: ASU Global Institute of Sustainability

Looking Ahead

Looking Ahead: Contributing to Industry Success

This report highlights the preliminary program and research findings from the DOE-funded Energize Phoenix project through Year Two of the three-year program. The aim of the report is to share information on how the issues that arise due to the "energy efficiency gap" are identified and measured. The report also draws on case studies, literature review, and interviews in order to share lessons learned and best practices from a community-scale energy efficiency project. Results are preliminary and not meant to be conclusive.

The primary value of this report is in sharing methodologies and highlighting emerging trends. These trends and newly identified ones will be studied in more depth during the third and final year of the program. As there is no single best approach for designing, implementing, and evaluating an energy efficiency program, one constant theme of Energize Phoenix has been its dynamic nature, allowing for adjustment and experimentation as needed to adapt to market changes and market responses to programs. This dynamism, as well as other experiences and results from Energize Phoenix, can contribute to the future success of evolving energy efficiency programs.

Endnotes

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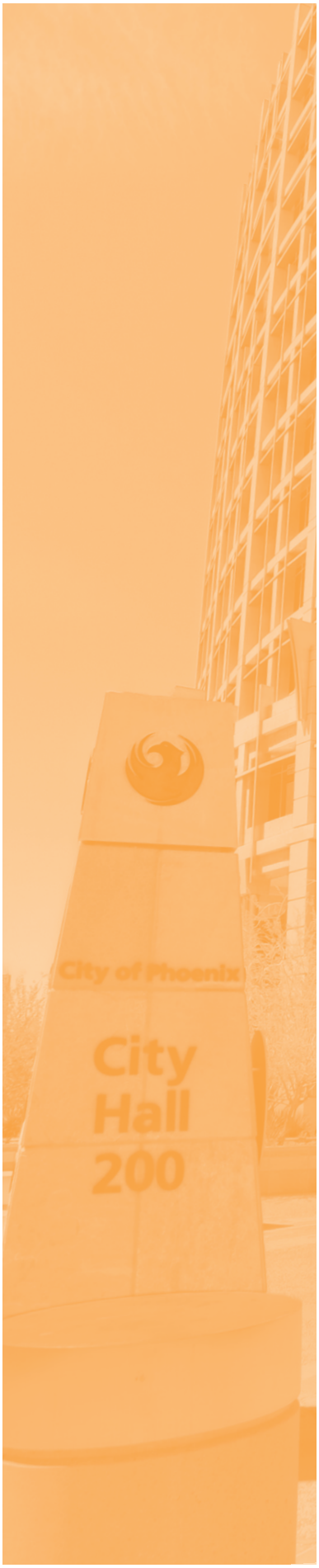
“Investments in energy efficiency that save millions in energy costs are making the American economy more competitive, protecting our air and water, and creating jobs.[17]”

—Steven Chu,
U.S. Secretary of Energy, June 14, 2012



PRINCIPAL AUTHORS OF APPENDICES (All from ASU except where noted)

Appendix A: Energize Phoenix Corridor Expansion (George Oliver, Michael Kuby)

Appendix B: Spatial and Spatio-Temporal Clustering Analysis of Project Locations (Elizabeth Mack, George Oliver, Michael Kuby)

Appendix C: Exploring the Link Between Behavior Change and Energy Use (Samantha Neufeld, Anna Berlin, Susan Ledlow)

Appendix D: Preliminary Logit Analysis of the Decision to Upgrade by Businesses (Michael Kuby, Samantha Neufeld, Anna Berlin, George Oliver)

Appendix E: Descriptive Statistics for Building a Statistical Model of Total Energy Consumption by Commercial Participants of the Energize Phoenix Program (Alex Castelazo, Anthony Evans, Tim James)

Appendix F: Logistical Anatomy of Executing a Home Energy Information (HEI) Dashboard Field Experiment (Aleksasha Webster, Karla Grijalva, Shaily Rungta, Harvey Bryan)

Appendix G: Year Two Findings of the Commercial Energy Analysis Team (Karthik Thalappully, Marcus Myers, T. Agami Reddy, Pat Phelan)

Appendix H: Marketing ReCap for Year Two (Denise D. Resnik, Michelle McGinty, Sarah Geiger – DRA Strategic Communications)

All appendices and main report are available online at energize.asu.edu

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