Austin Energy Green Building

U.N. Habitat Scroll of Honour

2011 Submission

Contact: Richard.Morgan@austinenergy.com
Mailing address: 721 Barton Springs Road
Austin, Texas 78704 United States
Background

*Austin Energy Green Building Mission Statement: To lead the building industry to a sustainable future.*

Austin Energy Green Building (AEGB), founded in 1991, is the first municipal green building program in the United States designed to encourage sustainable building practices in residential and commercial construction.

<table>
<thead>
<tr>
<th>An Abbreviated History</th>
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<tr>
<td>1985 Austin City Council creates the Austin Energy Star program to promote energy efficiency in new residential construction</td>
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<tr>
<td>1991 Using a grant from the U.S. Department of Energy, Austin Energy Star evolves into the Green Building Program, whose staff creates the first residential green building rating tool</td>
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<td>1992 The Green Building Program wins an award for local government environmental initiatives at the U.N. Earth Summit in Rio de Janeiro</td>
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<td>1994 Austin City Council passes a resolution to apply green building standards to city facilities, implemented by the Green Building Program and Public Works</td>
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<td>1995 The Green Building Program inaugurates its commercial building program</td>
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<tr>
<td>1998 The Green Building Program creates the multifamily building program and becomes part of Austin Energy, the municipal electric utility</td>
</tr>
<tr>
<td>1999 The City of Austin Neighborhood Housing and Community Development department partners with AEGB to incentivize green affordable housing construction</td>
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<tr>
<td>2000 AEGB establishes Manage It Green consulting services to help other cities and utilities create green building programs</td>
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<tr>
<td>2001 The City of Austin adopts the International Energy Conservation Code with local amendments to be implemented by AEGB</td>
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<td>2002 AEGB hosts the first U.S. Green Building Council national conferences</td>
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<tr>
<td>2003 City Council requires all downtown construction to earn an AEGB rating</td>
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<tr>
<td>2004 City Council adopts the Master Development Agreement for the Mueller neighborhood, a planned sustainable community built on city-owned land, where all buildings would be required to achieve high levels of green building</td>
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<tr>
<td>2005 AEGB rates over 1,000 single family homes in just one year</td>
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<tr>
<td>2007 City Council adopts the Austin Climate Protection Plan and the Zero Energy Capable Homes task force recommendation that all new single family homes be zero energy capable by 2015</td>
</tr>
<tr>
<td>2008 The Dell Children’s Medical Center of Central Texas in the Mueller neighborhood becomes the first commercial building to earn fives stars from AEGB and the first LEED Platinum hospital in the world</td>
</tr>
<tr>
<td>2010 AEGB hosts the annual Affordable Comfort conference for the second time</td>
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<tr>
<td>2011 AEGB celebrates its 20th anniversary</td>
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Housed at Austin Energy, the City of Austin’s municipally-owned electric utility, the program has two major goals. The first of these is to provide valuable electric demand, energy, water and construction waste savings to the utility, the city and the community. The provision of these resource savings, quantified in kilowatts, kilowatt hours, gallons and tons, is a critical function of a successful utility, and is the economic justification for the program’s existence. Austin Energy and the City of Austin recognized in the early 1980s that Austin was growing fast, and would need to build more power plants to meet the electric demands of its burgeoning population. (Indeed, its population has more than doubled in the last three decades and is expected to double
again by 2030.) Recognizing that energy efficiency programs could meet growing demand more cost-efficiently than building new power plants, the city began developing its now nationally-recognized conservation program.

AEGB’s other major goal is to ensure buildings make a positive, sustainable, durable contribution to the City of Austin. Buildings are not just consumers (however efficient or inefficient) of kilowatt hours or gallons of water. They are workplaces, schools, homes, places of worship—the building blocks of the unique, colorful neighborhoods that comprise the City of Austin. In the United States, people spend about 90 percent of their time indoors, making buildings truly the modern human habitat. For this habitat to be one that contributes positively to human health, well-being, achievement and culture, buildings and neighborhoods must be not only environmentally sustainable, but they must also be economically viable and contribute to increasing social equity.

Description of the Initiative

AEGB has a full-time staff of 20 people, including professional architects, engineers, construction managers, policy and planning professionals and support staff. This group is responsible for serving the entire Austin Energy service territory, which spans 437 square miles and is made up of almost 1 million customers. The program, which provides the most cost-effective electric demand savings of any efficiency program at Austin Energy, has an annual budget of about $1.7 million dollars.

Program Activities

AEGB achieves its goals through three major activities:

a) Building rating and consulting; b) Energy code development, education and compliance improvement; and c) Education and outreach.

Building Rating and Consulting: AEGB uses its single family residential, multifamily residential and commercial green building rating tools to help Austin buildings set and achieve sustainability goals. These tools are developed and regularly updated by staff and are specially adapted to the hot and humid Central Texas climate. The rating levels range from one to five stars, where five stars is the highest level of sustainability. The rating tools address building sustainability in the following areas:

- Site
- Energy
- Water
- Materials
- Indoor environmental quality
- Social equity
- Education
- Innovation

Energy Code Development, Education and Compliance Improvement: In 1982, the City of Austin became one of the first cities to adopt an energy code to improve minimum standards of energy efficiency city wide, with the goal of delaying the construction of new power plants to meet the electricity needs of a growing population. Today, AEGB is responsible for ensuring this code remains one of the most stringent in the country, with exemplary compliance rates.

Education and Outreach: AEGB administers a number of green building education programs aimed at homeowners, building professionals and trade contractors. The program offers free monthly professional development seminars, taught by local building experts, where architects, engineers and other building professionals can network and earn continuing education hours. Green By Design is a quarterly single family residential green building workshop aimed at homeowners and building professionals new to the principles of
sustainable building. Finally, the program offers a 12-session single family green building education series for trade contractors, architects and builders, known as Green Boots. In addition to these regular offerings, AEGB staff share their expertise by supporting, organizing and speaking at Central Texas sustainability events, as well as participating in fairs, trade shows and conferences.

**Main Partners (Selected)**

**Green Affordable Housing**

*Casa Verde Builders:* An AmeriCorps YouthBuild program and partner of AEGB, Casa Verde Builders was the first YouthBuild program in the nation to use green building strategies for the homes it was developing. Thanks to its success, the national YouthBuild organization hired Casa Verde staff as a green building consultant to introduce green building strategies to all YouthBuild programs. Today, all Casa Verde homes earn a five-star AEGB rating.

*Foundation Communities:* One of the largest affordable housing developers in Austin, all Foundation Communities projects earn an AEGB rating. The organization solicited input from AEGB staff to develop a building occupant education program for residents of two of its multifamily buildings.

*Habitat for Humanity Austin:* The local Habitat for Humanity International affiliate collaborates with AEGB to earn five-star ratings on all of its green homes. Habitat also partnered to build the U.S. Department of Energy grant-funded Green Habitat Learning Project, a model home built to demonstrate advanced sustainable building techniques in 1994.

**Technology, Green Building & Code Development**

*The Center for Maximum Potential Building Systems:* Partnered to develop the first residential green building rating tool.

*International Code Council (ICC):* Long-time collaborators in energy code development, the ICC invited AEGB staff to participate in the development of the first International Green Construction Code.

*Pecan Street Project:* Local non-profit whose goal is to develop the clean energy vision for Central Texas. AEGB has been a close collaborator, leading a team responsible for researching and designing the energy efficiency vision and participating in the design of a demonstration home that will serve as a test lab for sustainable best practices and clean technologies.

*Texas A&M University Energy Systems Laboratory:* Partnered with AEGB to develop the Texas Climate Vision calculator, a residential energy code compliance calculator. Frequent collaborators on new initiatives, such as the development of Building Information Modeling tools.

*U.S. Department of Energy:* Provided three grants in the early 1990s to launch the program now known as AEGB.

*The University of Texas at Austin:* Partners in developing the vision for the Pecan Street Project, as well as countless other projects. AEGB has a close relationship with the School of Architecture and the Indoor Air Quality research group.
Workers Defense Project: Partners in offering a point toward a green building rating for signing a legal contract requiring fair and equitable treatment of construction workers.

Education and Capacity Building

The American Institute of Architects: Partners to offer continuing education units for professional architects for attending AEGB professional development seminars, among other activities such as tours and outreach.

Austin Building Professionals: Hundreds of local building professionals—306 are listed in the Building Professionals Directory—participate with AEGB on project teams.

Home Builders Association of Austin: Cosponsors for the Green Boots residential green building education series for trade contractors. Partners in the development of the Zero Energy Capable Homes plan and other energy code updates.

National Association of Home Builders: Partners to offer National Green Building Standard certification equivalency when a home earns an AEGB rating.


U.S. Green Building Council & the Green Building Certification Institute: Partners to offer continuing education units for LEED Accredited Professionals for attending AEGB professional development seminars, among other activities such as tours and outreach.

Impact

Major Areas of Achievement

There are two major areas of achievement that best reflect the spirit of the U.N. Habitat Scroll of Honour award: a) Integral role in the development of green affordable housing in Austin; and b) Driving high sustainability standards for all buildings in Austin—not just the “green” ones—through the development and implementation of progressive codes and standards.

Green Affordable Housing

In the past, green building has been misunderstood as a luxury reserved for the well-off. AEGB, from its very early years, has been dedicated to demonstrating that green building is possible for all kind of projects, including affordable housing development. Low-income housing can be built with very little or no first-cost premium, using low- and no-cost green building strategies such as correct building orientation, passive design and efficient use of resources. The benefits of green homes are myriad, and meet many affordability goals. Green homes cost less to operate in terms of utilities and provide health benefits due to high indoor environmental quality. When homes are located in mixed-use, transit-oriented developments, residents can benefit by spending less on transportation.

In 1995, Casa Verde Builders, the local branch of AmeriCorps YouthBuild, partnered with Austin Energy Green Building to integrate green building strategies into their affordable housing and job training program. Since 1999, it has been City of Austin policy that all affordable housing receiving incentives from the city in the form of fee waivers and expedited permit review earn an AEGB rating. This policy was adopted as part of
the nationally-recognized S.M.A.R.T. Housing program, designed to encourage Safe, Mixed-income, Accessible, Reasonably-priced, Transit-oriented single family and multifamily housing development in Austin. Today, all affordable housing developers in Austin achieve a minimum Austin Energy Green Building rating, with several developers, such as Casa Verde Builders and Habitat for Humanity achieving five stars—the highest rating possible—on all their homes. Large production buildings, such as K.B. Homes, have raised sustainability standards on all construction to meet Austin Energy Green Building standards, as they implement plans for affordable homes for entire neighborhoods and subdivisions.


<table>
<thead>
<tr>
<th>Number of homes</th>
<th>3,530</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total energy conserved (kilowatt hours)*</td>
<td>4,942,000</td>
</tr>
</tbody>
</table>

*Energy savings are estimated based on an energy model of an average single family home meeting AEGB one-star requirements, where the baseline is the City of Austin energy code.

**Multifamily Green Affordable Housing (S.M.A.R.T. Housing) (2000 – present)**

<table>
<thead>
<tr>
<th>Number of units</th>
<th>8,793</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total energy conserved (kilowatt hours)</td>
<td>5,976,006</td>
</tr>
<tr>
<td>Total indoor water conserved (gallons)</td>
<td>9,105,229</td>
</tr>
</tbody>
</table>

**Sustainable Building Citywide**

Green building ratings are not limited to green affordable housing development. AEGB rates a mix of voluntary and mandatory projects to achieve its annual participation, energy, water and construction waste savings goals. These rated projects represent a significant portion of the new construction market in Austin. (In 2010, AEGB-rated homes represented 38 percent of new single family homes.) Perhaps more importantly, however, when local building professionals participate in an AEGB-rated project, they are introduced to new, more sustainable building strategies that can be applied to any building. This cultivates expertise and a veritable culture of green building in Austin, leading to a superior building stock for Austin residents.


<table>
<thead>
<tr>
<th>Single family homes</th>
<th>9,662</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multifamily units</td>
<td>11,795</td>
</tr>
<tr>
<td>Multifamily projects</td>
<td>79</td>
</tr>
<tr>
<td>Commercial square feet</td>
<td>12,592,019</td>
</tr>
<tr>
<td>Commercial projects</td>
<td>107</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Avoided electric demand (megawatts)</th>
<th>137</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total energy conserved (kilowatt hours, since 2000)</td>
<td>53,550,871</td>
</tr>
<tr>
<td>Total water conserved (gallons, since 2006)</td>
<td>65,826,959</td>
</tr>
<tr>
<td>Construction waste diverted (tons, since 2004)</td>
<td>120,698</td>
</tr>
</tbody>
</table>
Sustainability

Capacity Building

One piece of evidence in strong support of AEGB’s sustainability into the future is its focus on local capacity building in terms of education provision and workforce development. AEGB does more than rate buildings and improve citywide standards; the program also maintains three regular education programs, with more to come in the future. These education programs ensure that the local building community has access to the resources they need to meet the high levels of sustainability demanded in construction in the City of Austin.

Education Provision and Workforce Development

<table>
<thead>
<tr>
<th>Program</th>
<th>Attendance</th>
<th>Education Beneficiary Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free monthly professional development seminars</td>
<td>574*</td>
<td>1,148*</td>
</tr>
<tr>
<td>(5/2010 – 6/2011)</td>
<td></td>
<td>(2 hours x 574 attendees)</td>
</tr>
<tr>
<td>Quarterly workshop on single family residential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>green building</td>
<td></td>
<td>(8 hours x 3,902 attendees)</td>
</tr>
<tr>
<td>Green Boots (2009-2011)</td>
<td>176</td>
<td></td>
</tr>
<tr>
<td>12-course green building education series for</td>
<td></td>
<td></td>
</tr>
<tr>
<td>trade contractors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Attendance and education beneficiary hours for professional development seminars are significantly underrepresented. Attendee data collection began 5/2010; monthly professional development seminars have been held since 1999.

Policy and Council-Adopted Targets

City Council has adopted a series of plans with very high goals for energy efficiency and sustainability, providing additional evidence that AEGB’s influence on sustainable building in Austin will continue to grow.

Austin Climate Protection Plan

Under the Homes and Buildings Plan, a part of the Austin Climate Protection Plan, adopted by City Council in 2007, AEGB is responsible, in collaboration with other city departments, for:

- Updating building codes to make all new single-family homes capable of meeting 100% of their energy needs with on-site generation of renewable energy by 2015.
- Enhancing building codes to increase energy efficiency in all other new buildings by 75% by 2015.
- Requiring disclosure of historic energy use and cost-effective energy efficiency improvements upon the sale of all buildings.
- Enhancing technical assistance, standards and incentives for Austin Energy Green Building

Zero Energy Capable Homes Plan

Under the Zero Energy Capable Homes Plan, adopted by City Council in 2007, AEGB is responsible for improving the single family residential energy code to the point where, by 2015, all newly constructed homes in Austin will be net zero energy capable homes. Net zero energy capable is defined, for the purposes of the
policy, to be “homes that are energy efficient enough to be zero energy homes over the course of the year with the addition of a small solar photovoltaic system.”

**Austin Energy Generation Resource and Climate Protection Plan**

Under the Austin Energy Generation Resource and Climate Protection Plan, adopted by Council in 2010, AEGB, in collaboration with other city departments, will be responsible for achieving an additional 800 megawatts of avoided electric demand by 2020. Meeting this goal will require swift and continuous improvement to and expansion of AEGB’s activities. To this end, AEGB is undertaking a reorganization to determine more effective ways to achieve resource savings beyond the so-called low-hanging fruit.

**Transferability and Upscaling**

**U.S. Green Building Council Leadership in Energy and Environmental Design Certification**

The non-profit USGCB established its LEED green building certification standards in 2000, relying on AEGB staff input and the residential and commercial rating tools the program created. LEED standards are now used all over the United States and the world, providing the most striking example of the potential for transfer and upscaling of the green building standards pioneered in Austin. As of July 2011, the USGBC has LEED-certified 1.46 billion square feet of commercial building space (21,951 projects) and over 10,000 single family homes.

**International Green Construction Code**

The International Code Council, American Institute of Architects and ASTM International have partnered to develop the first national green building code, known as the International Green Construction Code (IGCC). As a recognized leader in sustainable building code development, AEGB manager Richard Morgan was appointed to serve as one of the 28 voting members of the Sustainable Building Technology Committee. He also serves as chair of the energy working group, responsible for developing the standards related to energy efficiency and renewable energy. The IGCC will be published for the first time in 2012, making it the first comprehensive, accessible and enforceable set of green building standards, available for adoption by all jurisdictions.

**Memphis Light Gas & Water, Memphis, Tennessee, EcoBuild Program**

In 2002, AEGB, through its Manage It Green consulting services, provided technical assistance to Memphis Light Gas & Water, helping them to create their EcoBuild residential green building program. In 2009, EcoBuild homes represented 8.1 percent of all new single family residential permits in the MLGW service territory.

In addition to these striking examples, AEGB has provided leadership, input and expertise to governmental, non-governmental and private organizations since its inception. At the local level, Austin City Council has relied on AEGB as a standard for and a mark of superior development by mandating minimum levels of green building ratings in many neighborhoods and zoning districts, including downtown Austin. There are currently 25 zones and development programs requiring or providing incentives for green building ratings. At the state level, AEGB advises legislators, state agencies and other decision makers on legislation and programs designed to increase building sustainability across Texas. Internationally, AEGB has provided consulting services to governments and organizations all over the world, including the Korea Institute for Energy Research, the Argentine Council for International Relations, the Japan Green Building Association, the Canada National Master Specification Secretariat and the U.S. Air Force.
Innovation

Code Development and Implementation

Perhaps one of the most important innovations introduced by AEGB is its unique way of raising baseline energy efficiency standards citywide. To advance the code (see Figure 1), AEGB incorporates increasingly advanced sustainable building standards into the AEGB building rating. Once local building professionals have become accustomed to the new techniques through their work on AEGB-rated projects, the sustainable standards can be integrated into the city of Austin Energy Code. As part of the code, the sustainable techniques are standard for all new construction, not just AEGB-rated construction. AEGB updates its rating tools periodically to ensure its standards continue to be more stringent than the citywide energy code.

![Figure 1](image)

New sustainable building techniques are introduced to local building community through AEGB building rating and consulting activities

AEGB updates its rating tool to stay ahead of energy code

New sustainable building techniques incorporated into energy code, where they are standard city-wide

Social Equity

Green building is more than saving water, conserving energy, reducing material waste and doing it affordably. Environmental preservation and economic viability are just two parts of the sustainability story. The last critical piece has to do with working toward greater social equity.

One way in which AEGB strives for greater social equity in Austin is through the green affordable housing initiatives already described in this award application. But the program has also integrated social equity into its building ratings, representing the idea that to achieve a sustainable building, a design team must consider social equity at every phase of the building life cycle, from site selection all the way through demolition or building repurposing.

AEGB introduced equity as a formal category its multifamily rating tool in 2010. The tool now awards points toward a green building rating for providing affordable housing and locating buildings in places where residents can reduce their dependency on expensive-to-own-and-maintain single occupancy vehicles. The tool also encourages providing a free computer lab with Internet access for residents, for whom personal computers and Internet service might be a substantial expense.
AEGB has also partnered with Austin non-profit the Workers Defense Project to increase equity in the local construction industry. AEGB participants can earn a point toward a green building rating by adhering to a legal contract that provides a framework for making Austin a better place of employment for construction workers and contractors.

**Raising the Bar Far Into the Future**

AEGB strives to lead Austin to a future with net-zero energy buildings, high-density mixed-use communities, green infrastructure and low-carbon transportation options—where healthy indoor environments are the standard, not a novelty. The path to this future is paved with innovations, many of which are underway.

- As codes and standards advance, it becomes more difficult to achieve high levels of energy efficiency using a systems-and-components approach. In the future, codes will evolve into performance-based standards such as “kWh per square foot, per year”—standards that can implicitly recognize the differences among building types, age and usage. To this end, AEGB has created a new incentive program to encourage uptake of whole-building energy modeling, under which Austin Energy will provide a rebate for qualified energy modeling services.

- AEGB staff have been key players in the City of Austin’s effort to create policies and programs to facilitate the installation of green roofs.

- AEGB is looking toward a future where building sustainability encompasses transportation: Staff have collaborated with electricians, electrical inspectors, car dealers and manufacturers to make recommendations for building code changes to accommodate electric vehicle charging stations. In addition, the 2010 AEGB building rating systems incentivize electric vehicles, public transit, bicycle routes, pedestrian access and car share programs.

**Recognition of the Initiative and Resources**

**Awards**

- 1992 United Nations Earth Summit Local Government Honours Award
- 2002 National Association of Home Builders’ Outstanding Green Building Program
- 2002 “Exemplary” Recognition from the American Council for an Energy-Efficiency Economy
- 2003 U.S. Green Building Council Public Sector Leadership Award
- 2008 Austin Chronicle Best of Austin Readers Poll Best Architectural Trend
- 2010 Environmental Awareness Awards

**Austin Energy Green Building Publications and Resources**

- 2010 Annual Report
- 2009 Annual Report
- Pecan Street Project Energy Efficiency Recommendations (attached as annex)
- AEGB Building Professionals Directory
- AEGB Single Family Rating Guidebook
- AEGB Multifamily Rating Guidebook
- AEGB Commercial Rating Guidebook
City of Austin Publications and Resources

- Austin Climate Protection Plan
- Austin Energy Generation Resource Plan
- Zero Energy Capable Homes Plan

Press and Press Releases

- Austin Business Journal, Austin Energy Green Building program prevented 20K tons of CO2 emissions
- Austin Business Journal, Austin Energy offers green building incentive for enforcing safety
- Austin Chronicle, Developing Stories: Greening the Neighborhood
- Austin Chronicle, Developing Stories: Pioneering at Mueller: Affordable Housing Ready for Takeoff
- Austin Energy, Nation’s First Green Building Program Celebrates 20 Years
- Austin Energy, Austin Energy Green Building to Offer Dual-Certification with National Green Standard
- Austin Energy, Austin Energy Green Building Launches New Requirements, Online Processing
- Austin Energy, City Council Adopts New Energy Code Amendments
- Austin Energy, Austin Energy Green Building Publishes 2009 Energy, Demand Results in First Annual Report
- Austin Energy, Austin’s Green Map Highlights Green Sites
- Austin Energy, Austin to Study Series of City Codes Changes for ‘Zero-Energy Capable’ Homes by 2015
- Austin Energy, Austin Energy Green Building Program to Offer Green Building Workshop for Public
- ClimateWire, Austin Seeks a New Blueprint for Power Utilities
- Ecohome, Program Profile: Austin Energy Green Building
- KVUE News, Austin Energy recognized for 20-year Green Building program
- New York Times, A New Enforcer in Buildings, the Energy Inspector
- New York Times, What You Get for ... $975,000
- New York Times, Green Blog, Austin Aiming for a Grid Makeover
- New York Times, A Mundane Approach to a Vexing Problem
- Public Power Weekly, Austin Energy creates incentive for just treatment of construction workers (p. 14)
- Shades of Green Energy, Austin Energy Green Building Program

Other Recognition

- Building an Emerald City: A Guide to Creating Green Building Policies and Programs (p. 3) (attached as annex)
- Environmental Law Institute, Municipal Green Building Policies: Strategies for Transforming Building Practices in the Private Sector
- Habitat for Humanity Website
- Institute for Market Transformation Fact Sheet on Building Code Compliance (p. 2) (attached as annex)
- KB Home 2010 Sustainability Report (p. 21)
- Mueller Neighborhood Website
- Pecan Street Project March 2010 Report of Recommendations
- “This Old House” Season-Long Green Building Renovation Featured on PBS
Pecan Street Project
Energy Efficiency Scenario

JULY 15, 2009

SUBMITTED BY CORE TEAM 2

Team Leader: Richard Morgan, Austin Energy Green Building
Joel Barnett, SEMATECH
Jeff Howard, McLean & Howard, LLP
Alex Howell, University of Texas School of Architecture
Werner Lang, University of Texas School of Architecture
Joep Meijer, The Right Environment
Craig Overmiller, Texas Solar Power Company
Susan Peterson, Austin Energy Green Building
Rachel Proctor-May, Austin Energy
Julie Raish, University of Texas School of Architecture
Brent Stephens, University of Texas Cockrell School of Engineering
Matt Weaver, University of Texas School of Architecture

Questions regarding this report should be directed to Richard Morgan, Program Manager for Austin Energy Green Building (Richard.Morgan@austinenergy.com).
Summary

This report describes the energy efficiency programs, policies and strategies recommended by Core Team 2 for implementation as part of the Pecan Street Project. The 10 recommendations are divided into three categories: a) Energy code transformation; b) New technology development; and c) Existing buildings.

STRATEGIES

Energy Code Transformation

The most effective way to reduce energy consumption in buildings and communities is to transition from using prescriptive energy codes to using performance-based energy codes (Idea 2.10). This switch, which represents a fundamental change in the way energy is used, will require several years and a great deal of political will and buy-in from diverse stakeholders.

In the interim, Team 2 recommends increasing uptake of passive design (Idea 2.04) and smart community design (Idea 2.05) strategies in order to ease the transition to the new energy codes. To garner political will and public buy-in, Team 2 also recommends the construction of a zero net energy demonstration community (Idea 2.09), which will demonstrate the potential of good design combined with appropriate technologies to meet a performance goal.

New Technology Development

The recommendations in this report mostly revolve around existing, but underused, technology such as solar water heating or “no-tech” design strategies. These are the most cost effective and the easiest to implement in the immediate future since the technologies do not require further development.

However, there are two technologies whose development and adaptation Team 2 recommends to complement the code transformation process: a) building-integrated photovoltaic systems (Idea 2.07) and b) solar absorption cooling (Idea 2.08). If developed to a point where they were easily accessible and cost-effective, each of these technologies would provide significant energy savings to designers and developers striving to meet increasingly stringent energy standards.

Existing Buildings

Austin Energy administers a number of effective rebate and incentive programs aimed at improving the efficiency of Austin’s existing building stock. Team 2’s recommendations for existing buildings are intended to complement and supplement these programs by increasing uptake of solar hot water heaters (Idea 2.01), wireless lighting controls (Idea 2.02) in commercial buildings, smart on/off power strips (Idea 2.03) and tree plantings for energy efficiency (Idea 2.06).

ENERGY SAVINGS

If implemented, Team 2 estimates the existing buildings retrofitting strategies have the potential to reduce energy use by 83,000 megawatt-hours (total program potential). While the savings for new construction are difficult to quantify due to insufficient research on certain strategies, Team 2 estimates annual savings of about 5,000 megawatt-hours (new savings each year) from just three of six new construction strategies (see Chart 3, p. 26).
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July 27, 2009
The Vision

The year is 2020.

It has been 10 years since the implementation of the Pecan Street Project began. The roll-out of the smart grid combined with a highly efficient building stock have created a new net energy market that has revolutionized the way energy is used and sold. Energy rates are no longer tied to consumption, creating opportunities for Austin Energy to market services and benefits linked to energy use while reducing actual kilowatt hour use and the concomitant greenhouse gas emissions from fossil fuel power plants. The grid has become a communications system that allows both AE and its customers to monitor energy use and systems operations to achieve levels of efficiency that were unimaginable before the Pecan Street Project. New energy efficiency programs and building codes have allowed previously wasted energy to be channeled into productive uses, creating greater value for Austin Energy, the city and the community.

NEW BUILDINGS

New buildings on the AE system have been designed and built to comply with a performance-based energy code for several years. This simplified system allocates a set annual energy use per square foot for each building type or use, promoting innovation in the design and construction of commercial and residential buildings. To achieve performance standards, new buildings in Austin have highly energy-efficient outer wall and roof systems, which not only conserve thermal energy effectively but also harvest environmental energy, such as solar radiation, reducing the demand for energy derived from fossil fuels.

To address building-related emissions from transportation, infrastructure construction and the embodied energy and carbon impact from sprawl, the city of Austin has designed the energy allocations to be tiered based on density and proximity to employment centers. Thus, building energy allocations may be more permissive for buildings located in high-density, transit-oriented, centrally located developments. Conversely, buildings located in lower density neighborhoods will have more stringent energy allocations, since their occupants will use more energy in transit to and from employment and amenities.

All new low-rise buildings now are energy efficient enough to be converted to net zero energy buildings with the installation of moderately-sized PV systems and high-rise buildings can have their grid-supplied energy needs significantly reduced through the installation of either roof top or building-integrated PV systems.

Changes in code and incentives have reduced the growth of energy use in buildings to less than 1 percent per year from more than 2 percent in the years following the 2008-09 recession. This reduction in growth has allowed AE more flexibility in making decisions about generation planning. The higher density and resulting reductions in building envelope-to-volume ratio have begun to increase the system load factor resulting in more efficient use of both the generation and transmission and distribution assets.

EXISTING BUILDINGS

Austin also made strides toward improving its existing building stock very early in the implementation phase of the Pecan Street Project. The city set into motion four cost-effective projects using existing technology and providing almost immediate energy use reductions:

- A program incentivizing retrofitting homes with solar water heaters
• A coupon rebate program for smart on/off power strips to reduce “vampire” loads.

• An program incentivizing wireless lighting controls for commercial buildings, allowing existing buildings to provide individualized occupancy or daylight sensors without the expense of rewiring the lighting systems

• A program prioritizing tree plantings that provide exterior shade to buildings, reducing their summer cooling loads

Prior to the implementation of Pecan Street, existing homes had energy intensities ranging from 6.5 kWh per square foot to 9 kWh per square foot. The new programs and codes have brought existing homes into a range of 5 to 6.5 kWh per square foot. Similar improvements have been made to roughly 190 million square feet of commercial buildings that were in place when Pecan Street was implemented.
Energy Efficiency Strategy Descriptions

Idea 2.01: Solar Water Heating

Solar water heating systems are a time-tested technology, highly efficient at reducing energy use and carbon emissions. For example, a 4-occupant residence can save 2323 KWH and 3215 pounds of CO₂ each year.

The Austin Energy’s Power Saver program currently offers cash and tax credit rebates on solar thermal systems amounting to $2250 - $3000 per system. Despite the city’s rebate and the high impact of solar thermal systems, Austin Energy rebated only 17 systems in 2008.

Idea 2.02: Lighting Controls and Daylight Sensors

Lighting controls reduce electricity use by using information about daylight levels and building occupancy to determine whether lights should be on or off. Lighting typically consumes 20-25 percent of office building electrical energy.

A substantial portion of this energy can be saved by installing lighting controls in existing office buildings where they currently do not exist. A 1000 square foot open office area can reduce its energy use for lighting by 2000 kWh annually by using lighting controls with occupancy and daylight sensors, representing a 35 percent savings over the baseline case.

One of the major obstacles to retrofitting buildings with lighting controls is the perception among facilities managers that they must rewire the entire building to accommodate the controls and sensors, which would result in a prohibitive initial cost. However, wireless sensors make it possible to overcome the rewiring problem.

Idea 2.03: Smart On/Off Power Strips

Smart on/off power strips dramatically reduce or eliminate appliance “ghost” or “vampire” load, which the electricity devices consume when they are plugged in but not in use. A California study of 10 homes showed an average home has a vampire load of 67 watts – consuming 587 kWh of electricity every year. A more extensive, more recent Australian study placed the average standby load at 92 watts – or 806 kWh per year.

At $20 - $90 apiece, smart strips can cheaply mitigate needless energy demand by cutting off the power supply to devices when they are in standby mode.

Idea 2.04: Passive Design Strategies

Climate-appropriate passive design is the correct use of no-energy design strategies (such as building orientation, window placement and thermal mass) to reduce demand. Making passive design the standard rather than the exception will require the eventual development of zoning regulations.

A 2300 square foot single family home built to Austin’s 2006 energy code specifications could see 28 percent electricity savings and 21 percent savings in natural gas by incorporating passive design elements (See Appendix B: Energy Modeling p. 33).
**Idea 2.05: Community Design Strategies**

The most energy efficient developments are dense, mixed-use and transit-oriented. Smart community design dramatically decreases energy and carbon impacts because there will be energy savings from transportation as well as from the built environment. Prevailing zoning philosophy requires developers to trade away something in exchange for additional density.

Instead, additional density should be incentivized since high density development alone results in significantly lower per capita energy consumption. A Toronto study found that transportation requirements for low-density suburban development are twice as energy and GHG emissions-intensive per unit of living space as high-density city core development. While Austin residents rack up an average of 9,125 vehicle miles each year, people living in a downtown Toronto condominium complex average just 1,350 vehicle miles per year (see Quantification, Chart 6.2, section VI).

**Idea 2.06: Exterior Shading**

Shading is a passive design strategy that uses trees, canopies, projecting roofs, screens, blinds or shutters to reduce the need for cooling. Exterior shading is more effective than interior shading devices (such as vertical blinds) since interior elements allow heat to enter the building and depend on user behavior. Applying exterior shading in the form of overhangs is more likely to be accepted when integrated into the design in new buildings.

For existing buildings, Team 2 recommends tree planting for energy efficiency. California study showed that trees shading the combined west and south sides of homes provide a 5.2 percent reduction in summertime electricity bills. Each square meter of canopy cover on the west side of a house decreased summertime (May – September) electricity consumption by 1.71 kWh.

**Idea 2.07: Building-Integrated Photovoltaic Systems**

BIPV is the integration of photovoltaic cells on the façade or roof of a building. Solar radiation in central Texas reaches levels of up to 6 kWh per square meter per day. A building-integrated PV system with 10 – 15 percent efficiency could offset a considerable portion of a building’s energy demand during the hottest (sunniest) part of the day, when the highest cooling demands occur.

**Idea 2.08: Solar Absorption Cooling**

Solar absorption cooling systems use thermal energy for cooling. While an established technology for large scale applications, small scale applications require further development. Solar absorption cooling can reduce cooling energy use by 25 – 50 percent. The same technology can be used for space and water heating. This technology has the impressive potential to reduce building energy use by 20 – 30 percent.

Heating, ventilation and air conditioning systems make up 40 – 60 percent of energy demand in U.S. residential and commercial buildings. Replacing a conventional cooling system with a solar system dramatically reduces overall building energy demand, particularly as the number of annual cooling days per year increases in Austin.
Idea 2.09: Zero Net Energy Demonstration Project

The Zero Net Energy Buildings Demonstration Project is a model high density, transit oriented, highly energy efficient, sustainable, mixed-use community. The project would be a test bed to evaluate the impacts and value of various energy efficiency, transit, smart grid, and regulatory strategies that will define urban development in the future. If realized, this project would be internationally influential.

Idea 2.10: Performance-Based Building Codes

Performance based energy codes are codes that allocate an amount of energy, usually kWh or kWh equivalent per square foot for each building type or use and allows discretion in how that level of energy use is achieved. Current codes are a mix of mandatory measures and performance calculations (see Chart 1, p. 13).
Roadmap to the Vision

Achieving the Pecan Street vision (see The Vision, p. 4) will require a decade of persistent, aggressive effort, political will and public support. The following three-part narrative and accompanying graphic (see Chart 2, p. 20) describe, in broad strokes, the steps necessary to implement the 10 programs recommended by Team 2 (see Energy Efficiency Strategy Descriptions, p. 6).

BUILDING CODE TRANSFORMATION

This section describes Team 2’s recommendation for transitioning from prescriptive to performance-based energy codes (Idea 2.10) by increasing uptake of passive (Idea 2.04) and community design (Idea 2.05) strategies, and by demonstrating the potential of integrated building design in a zero net energy demonstration project (Idea 2.09).

Context: Business as Usual

Contemporary building and energy codes are fragmented checklists prescribing standards for specific building features, such as insulation thickness and air conditioning system efficiency. These prescriptive codes do an inadequate job of addressing the energy consumption of whole buildings¹ and do not address community design at all.

In the past, prescriptive codes have been effective in driving equipment efficiency improvements. Heating, ventilation and air conditioning (HVAC) system efficiency has improved by almost 40 percent since the early 1990s when national standards for energy efficient appliances were first adopted. The widespread adoption of double-pane, thermally-broken, Low-E window technology has transformed windows from holes in the wall into relatively efficient wall components. Other major technology improvements, such as solid state lighting (SSL), could have a similar impact in the future.

But prescriptive codes have reached the end of their useful life. As a result of decades of adoption of increasingly stringent prescriptive codes, many of the energy consuming systems in buildings are now efficient enough that it is more cost-effective and energy efficient to focus first on design for efficiency. Once the site, shell, envelope and whole building design have been optimized, project engineers can specify the most efficient mechanical systems the project budget will allow to meet the remaining energy requirements.

This is the same integrated, design-first principle we apply when installing PV systems: Make the building as efficient as possible to ensure the expensive PV systems can reach their maximum offsetting potential. The same principle should apply to other mechanical systems.

Chart 14 (see p. 42) demonstrates the growing difference between equipment efficiency and design efficiency. Most telling is that changing from a 13 SEER HVAC system (current code) to 16 SEER only improves overall energy efficiency by 3.7 percent. However, changing a single family detached home into a row house (without making any other design improvements or reducing unit size) improves energy efficiency by 9.3 percent.

¹ For example, a code prescribing a certain level of efficiency for a building’s air conditioning system may ignore building orientation. A badly-oriented building with a high percentage of west-facing glazing heats up quickly in the sun, forcing the designers to specify a larger, more energy-intensive HVAC system than they would for a building with better orientation. This negates the reduction in energy use intended by prescribing a high-efficiency air conditioning system.
Prescriptive building codes also fail to address the indirect energy use caused by buildings, such as the energy required by occupants to travel to and from the building. A very efficient office building located far from employees’ residences and requiring employees to commute by car is in fact a very consumptive building because it has a large transportation energy impact.

Current codes, based on mandated levels of equipment efficiency, cannot accommodate a design-first approach to energy efficiency if the emphasis remains on prescribing systems. In some instances, prescriptive codes even impede the most energy efficient approaches to building. This is because prescriptive building codes act only as sticks, punishing practices that fall outside the standards set by code but not encouraging or incentivizing practices that reduce energy use beyond prescribed requirements.

The Way Forward: Performance-Based Building Codes (Idea 2.10)

The best way to transform the way people consume energy is to implement performance-based building codes which address whole building, whole community energy consumption. Rather than prescribing minimums for specific mechanical systems, these codes would allocate energy on a per-square-foot basis for the various building uses and types. These standards would encourage good passive design as well as efficient use of mechanical systems. (For a side-by-side comparison of prescriptive and performance-based codes, see Chart 1, p. 13.)

In addition to promoting the construction of more efficient buildings, performance-based codes can be used to influence or incentivize denser, transit-oriented development by allowing designers to take credit for reductions in energy embedded in the infrastructure of the building. For example, a multifamily rental or condominium project located on a public transit line would receive energy efficiency credits for energy use avoided for transportation and infrastructure development. As a result of these savings, the building would have a slightly lower energy efficiency requirement than a suburban single family home. This is because the single family home requires occupants to travel long distances by car and requiring more physical infrastructure than the multifamily building.

If Austin continues on its current trajectory of advancing prescriptive codes, the implementation of performance-based building codes could begin as late as mid-century or might never be achieved. The Pecan Street Project is exactly the initiative needed to ignite the process of transforming building codes and the way people consume energy.

Team 2 recommends a trio of interdependent strategies which, implemented together, could bring performance-based building codes decades closer to realization: a) Increasing uptake of passive design strategies; b) Promoting better community design; and c) Planning and building a zero net energy demonstration project.

Passive Design Strategies (Idea 2.04)

<table>
<thead>
<tr>
<th>Current state</th>
<th>Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-10% of Austin buildings use passive design</td>
<td>20% of new construction in 5 years will use passive design strategies</td>
</tr>
</tbody>
</table>

Using passive design strategies is the most effective way of reducing the direct energy use of a building, i.e. the energy it draws from the utility day-to-day. Passive design strategies are non-mechanical design elements, such as optimal building orientation or the use of thermal mass to regulate temperature. Passive design is an incredibly effective, cost-effective, no-tech way to dramatically reduce building energy consumption.
coupled with mechanical systems, such as solar panels, buildings showcasing the best passive design strategies can achieve net zero energy consumption. (See Chart 2, p. 20 for rough implementation timeline and steps.)

**Community Design Strategies (Idea 2.05)**

<table>
<thead>
<tr>
<th>Current penetration</th>
<th>Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mueller, North Burnet/Gateway, transit-oriented developments</td>
<td>All new planned communities</td>
</tr>
</tbody>
</table>

Where passive design strategies reduce the building’s direct energy use, smart community design is the best way to reduce a building’s overall energy consumption. The most important element of energy efficiency is configuration of buildings. Detached single family homes use energy least efficiently and attached buildings, such as row houses or apartment and condominium buildings using the same technologies use significantly less energy simply because shared walls reduce heat gain and loss.

Buildings are also responsible for the embodied energy of their materials, the embodied energy of the infrastructure used to support and surround them and the transportation needs of their occupants. High-density, transit-oriented, mixed-use community design dramatically reduces carbon footprint of buildings by reducing the personal vehicle miles traveled per building occupant and infrastructure. (See Chart 2, p. 20 for rough implementation timeline and steps.)

**Zero Net Energy Demonstration Project (Idea 2.09)**

<table>
<thead>
<tr>
<th>Current state</th>
<th>Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning phase</td>
<td>Up and running by 2015</td>
</tr>
</tbody>
</table>

Team 2 strongly recommends the planning and construction of a zero net energy demonstration project showcasing the optimal combination of passive and community design strategies. The project will be a high-density, transit-oriented, mixed-use community that, almost entirely through design rather than technology or mechanical systems, has the lowest energy demand possible. The addition of solar panels and other on-site renewable energy sources will reduce the project’s total annual energy use to net zero. The project will serve as the physical location of the Pecan Street Project, a community the public can locate on a map, visit and take pride in.

This project should also serve as a demonstration site for other Pecan Street initiatives. Combining Smart Grid Demand Response strategies with the high level of energy efficiency of the buildings in the project should allow AE to reduce requirements for distribution infrastructure in this and similar projects. At the very least, it would allow AE an opportunity to test different configurations for reliability. Similar synergies exist for distributed generation and transportation strategies to be co-located within the demonstration site.

However, this project will not be an end in and of itself. The primary objective of implementing this project will be to drive the advancement of performance-based building codes and passive design strategies. At present, the process of raising standards and updating codes is slow, painstaking work that lags behind technology. Showcasing the optimal combination of passive and community design strategies in the demonstration project will persuade decision makers, stakeholders and the public of the importance of design, and the critical need for a swift transformation in energy codes. (See Chart 2, p. 20 for rough
implementation timeline and steps. See Appendix A: Work Breakdown Structure for Zero Net Energy Demonstration Project, p. 32 for a breakdown of tasks involved in getting this project on the ground.)

**Dependencies**

Each of these strategies (passive design, community design and the zero net energy demonstration project) could be implemented in isolation. However, each strategy informs and advances the others — and the combination of the three drives the transformation of the energy code. For example, passive design strategies could be applied to buildings and significantly reduce daily electricity use in individual buildings. But if building has 1000 occupants, all of whom commute 10 – 30 miles to work every day, its total energy use is much higher. Applying good community design strategies, where those occupants have access to mass transit and live in high-density development near their offices, significantly mitigates the total energy use the building is responsible.

Mandating high standards for passive and community design through performance-based building codes will require buy-in from all members of the Austin community. Persuading them of the efficacy of these strategies through the zero net energy demonstration project will allow the code transformation to take place within the next decade, making Austin a national leader in sustainable building codes.

In addition, implementing performance-based building codes will require job training in energy modeling (Idea 8.11). Currently there is very little professional knowledge about building energy modeling even among Professional Engineers. AE should undertake an educational program sponsoring seminars or workshops to advance modeling capabilities in our community. These programs will provide a small income stream for a few years until the knowledge becomes more widespread.
### Chart 1: Prescriptive vs. Performance-Based Codes

<table>
<thead>
<tr>
<th>Prescriptive Energy Codes</th>
<th>Performance-Based Energy Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy use</strong></td>
<td></td>
</tr>
<tr>
<td>Provide energy efficiency specifications for individual building elements and mechanical systems</td>
<td>Set standards for energy consumption of whole building and indirect energy consumption caused by building, such as occupant transit and the embodied energy of supporting infrastructure</td>
</tr>
<tr>
<td><strong>Code compliance</strong></td>
<td></td>
</tr>
<tr>
<td>Code compliance can only be checked at the time of a building inspection, when an inspector can confirm the presence of certain systems. Inspections occur at the time of building construction and in the case of complaints.</td>
<td>Allow for continuous monitoring of code compliance through electric metering (i.e. a building with a given square footage and a given energy allocation per square foot should never exceed a given energy usage per year), encourages continuous commissioning.</td>
</tr>
<tr>
<td><strong>Building permitting</strong></td>
<td></td>
</tr>
<tr>
<td>Rely mostly on the assumption that code compliant systems and equipment will be installed. If systems are installed in a poorly designed building, energy use will be high.</td>
<td>Rely on energy modeling to project building energy consumption in the permitting process. Modeling integrates the efficiency of all systems, mechanical and passive, to determine code compliance.</td>
</tr>
<tr>
<td><strong>Non-mechanical specifications</strong></td>
<td></td>
</tr>
<tr>
<td>Design is largely ignored for equipment and systems efficiency.</td>
<td>Encourage integrated design-first approach since energy allocations promote the choice of the least expensive energy efficiency strategies (passive design) before the application of more expensive mechanical systems.</td>
</tr>
<tr>
<td><strong>New technology development</strong></td>
<td></td>
</tr>
<tr>
<td>Can stifle innovation, as code can lag behind new technology development.</td>
<td>Encourages innovation since code mandates the outcome rather than the path.</td>
</tr>
</tbody>
</table>
NEW TECHNOLOGY DEVELOPMENT

Context: New vs. Existing Technology

The recommendations in this report mostly revolve around existing, but underused, technology such as solar water heating or “no-tech” design strategies. These are the most cost effective and the easiest to implement in the immediate future since the technologies do not require further development.

However, there are two technologies whose development and adaptation Team 2 recommends to complement the code transformation process: a) Building-integrated photovoltaic systems and b) Solar absorption cooling.


Building-Integrated Photovoltaic Systems (Idea 2.07)

<table>
<thead>
<tr>
<th>Current penetration</th>
<th>Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated custom applications (i.e. City Hall) (very expensive due to design and custom manufacturing costs).</td>
<td>Relatively inexpensive BIPV systems easily adapted to shading devices and other design features become standard practice. All new buildings and major renovations incorporate BIPV.</td>
</tr>
</tbody>
</table>

Solar radiation in central Texas reaches levels of up to 6 kWh per square meter per day. A building-integrated photovoltaic (BIPV) system with 10 – 15 percent efficiency could offset a considerable portion of a building’s energy demand during the hottest (and sunniest) part of the day, when the highest energy demands occur.

BIPV expands the surface area available for on-site solar power generation. Whereas traditional solar modules can only be installed on certain surfaces (mostly roofs), PV can be installed on many kinds of surfaces, such as the building façade, or a domed roof. BIPV has an aesthetic advantage as well as a technical one, since developers and designers have more flexibility with the placement of PV systems when they can integrate it. What’s more, the cost of building-integrated PV systems can sometimes be offset by savings on materials. For example, if a designer substitutes a wall made of building-integrated PV for a curtain wall, the cost of the curtain wall is eliminated. (See Chart 2, p. 20 for rough implementation timeline and steps.)

Solar Absorption Cooling (Idea 2.08)

<table>
<thead>
<tr>
<th>Current penetration</th>
<th>Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 30-ton application at Sand Hill Energy Center Administration &amp; Control Center</td>
<td>300 small commercial and residential installations/year</td>
</tr>
</tbody>
</table>

Few technologies provide energy savings as substantial as solar absorption cooling (SAC), which can reduce overall building energy use by 20 – 30 percent. This technology is currently used for large-scale applications such as Sand Hill and Mueller Energy Centers. To promote more widespread use, solar absorption cooling needs to be developed for small scale applications, in the range of 1.5 – 5 tons of cooling. (See Chart 2, p. 20 for rough implementation timeline and steps.)


**Economic Development Potential**

Since these two technologies are not yet fully developed and marketable, there is the exciting potential to bring the manufacturing base to Austin, creating jobs, adding economic sectors and strengthening the local and regional economy. Team 2 strongly recommends identifying and partnering with manufacturers. Early adoption of these technologies will demonstrate to manufacturers that they will find markets for their projects in Austin and persuade them to set up shop here.

Business model opportunities exist for both BIPV and SAC. Solar absorption cooling will require development to scale it to the needs of small business and residential customers. Austin Energy or Pecan Street should undertake an evaluation to determine the most appropriate, cost effective uses for SAC, especially those uses that combine SAC with solar water heat and space heating. This may create a density of use that would allow AE to undertake a “sell the service” model by owning or leasing this technology and charging for the service rather than the kWh. This has the added advantage of allowing AE to sell service that is currently supplied by other fuels, expanding market share.

**Dependencies**

The development of these two technologies could have an important impact on the advancement of the zero net energy demonstration project, the implementation of passive and community design strategies and the eventual development of performance-based building codes.

The zero net energy demonstration project would be an ideal place to test and showcase these technologies. The use of solar absorption cooling and building-integrated photovoltaic systems in the community would also substantially help the community developers reach their goal of zero net energy.

The development of solar absorption and building-integrated photovoltaic technologies will impact the development of community and passive design standards. The availability of these technologies could influence design guidelines. Conversely, design standards could shape the development of the new technologies.

Because solar absorption cooling and building-integrated photovoltaic technologies have such great energy saving potential, their availability could ease the transition to performance-based building codes by making it easier for building owners to meet energy allocation standards. The availability of these technologies could also impact decisions about the levels of energy allocations under the new codes.
These technologies also have dependencies with other Pecan Street Project core teams:

- SAC acts as a demand response (Core Team 3) tool by replacing high demand electric air conditioners with cooling that is powered by solar energy.

- BIPV is a distributed generation (Core Team 1) technology. The team has a recommendation to study and implement BIPV as broadly as possible. Team 2 proposes developing design guidelines for BIPV with Team 1 working on the application of BIPV.

- SAC will require close coordination with System Operations and Integration since it is a potentially a high peak demand technology drawing grid resources if the solar power fails.
IMPROVING AUSTIN’S EXISTING BUILDINGS

Context

The city of Austin, through its Power Saver program, has a varied portfolio of strategies to promote retrofitting of the existing building stock. In addition, effective June 1, 2009, an ordinance went into effect mandating energy audits at the point of sale for all residential facilities, and for all commercial and multifamily properties by June 1, 2011. In just the few weeks since it took effect, the ordinance has already been an effective market transformation tool. Decision makers are poised to increase the stringency of the ordinance in coming years to mandate not only the energy audit but also building upgrades, which are currently not mandatory. Team 2 views the energy audit ordinance track as the mid- to long-term driver for upgrades to the building stock.

The Way Forward: Filling in the Gaps

Team 2’s recommendations for improving Austin’s existing building stock fill the gaps in Austin’s portfolio of strategies. They are practical, hard-hitting, short-term programs designed to promote market transformation.

Solar Water Heating (Idea 2.01)

<table>
<thead>
<tr>
<th>Current penetration</th>
<th>Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 installations in 2008</td>
<td>500 installations/year</td>
</tr>
</tbody>
</table>

The Austin Energy Power Saver Program has a rebate program for solar water heaters, but it has not been very effective. In 2008, Austin Energy rebated only 17 solar thermal systems, whereas it provided rebates for 210 solar photovoltaic systems. This is despite the fact that solar thermal systems have a much shorter payback period than photovoltaic systems.

Our major recommendation is to jumpstart uptake of solar thermal technology by partnering with a manufacturer willing to help implement a pilot program with an enhanced rebate. The timeline for the different phases of this strategy are outlined below.

July 27, 2009
Lighting Controls (Idea 2.02)

<table>
<thead>
<tr>
<th>Current penetration</th>
<th>Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-15% of existing commercial buildings</td>
<td>25% of existing commercial buildings</td>
</tr>
</tbody>
</table>

One of the major obstacles to retrofitting buildings with lighting controls is the perception among facilities managers that they must rewire the entire building to accommodate the controls and sensors, which would result in a prohibitive initial cost. However, wireless sensors make it possible to overcome the rewiring problem.

Team 2’s primary recommendation is to increase market penetration for wireless sensors and lighting controls by implementing a pilot program for municipal buildings and a rebate program for private sector buildings. The timeline is outlined below.

Smart On/Off Power Strips (Idea 2.03)

<table>
<thead>
<tr>
<th>Current penetration</th>
<th>Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectively none</td>
<td>25% of residential customers</td>
</tr>
</tbody>
</table>

At $20 - $90 each, smart on/off power strips can cheaply mitigate needless energy demand. At present, there is effectively no market penetration. The Austin Energy CFL coupon rebate program provides a perfect model for a rebate program for smart on/off power strips. Partnerships with manufacturers or sellers of DVRs and other home entertainment equipment may be a good option, as well, since these power strips are particularly useful in reducing the energy demand of recording equipment. The timeline is outlined below.
Exterior Shading (Idea 2.06)

**Current penetration** | **Vision**
--- | ---
65% of Austin single family homes | 20% of single family homes currently without trees

Retrofitting buildings with exterior shading elements such as awnings is historically very unpopular with architects, developers and building owners since it changes the appearance of the façade of a building. However, tree planting is another very effective way to reduce a building’s energy use. Team 2 recommends a targeted tree planting program similar to one recently initiated in the city of Dallas. The timeline is outlined below.

- **July 27, 2009**
  - Use GIS mapping to ID SF lots that could gain energy efficiency from a tree planting.
  - Target homeowners using a door hanger campaign and offering a free tree for energy efficiency, on the condition it is planted in an optimal spot and that the owner cares for it. Offer tree in tandem with information about solar screen rebate program to cover the transition time while tree develops into a shade tree.
  - Track trees. Monitor survival rate, energy efficiency gains, etc.

- **2010 – 2015**
  - Develop/implement a training program for building and design professionals & building owners to build awareness about the energy-saving impact of exterior shading strategies.

July 27, 2009
Develop and implement performance-based building codes

Chart 2: Roadmap to the Vision

Pecan Street Core Team 2: Energy Efficiency
Getting Started

Nearly all of the strategies described in this recommendation report are ready to be implemented. Near term strategies could see results in six months. Longer-term projects will need to have foundations laid in the short-term to ensure results in the out years. This chapter isolates the steps that could be taken to put programs on the ground in the first six months of phase II of the Pecan Street Project.

NEAR TERM STRATEGIES

Idea 2.01: Solar Water Heating

- Survey Austin Energy customers who have rebated a photovoltaic system to determine why they chose solar panels over a solar water heating system
- Implement marketing plan to make the benefits of solar water heating transparent to customers
- Partner with a solar water heating systems manufacturer to initiate a pilot program to install 1000 systems over 2 years with an enhanced rebate.

Idea 2.02: Wireless Lighting Controls

- Initiative a pilot program to install lighting controls in municipal buildings.
- Implement a rebate program for other existing private sector buildings.
- Market lighting controls as part of the ECAD compliance process.

Idea 2.03: Smart On/Off Power Strips

- Implement a rebate program similar to the CFL program where the rebate coupon is taped to the device at the point of purchase.
- Partner with cable companies, computer and DVR sellers to market power strips as an accessory to home entertainment set-ups.

Idea 2.06: Exterior Shading

- Partner with the City Arborist Program and Treefolks to implement a program to encourage proper tree placement for maximum energy efficiency benefits.
- To encourage owners to retrofit their buildings with exterior shading elements, the city should implement a training and awareness-building program for building and design professionals.
LAYING THE FOUNDATIONS: NEAR-TERM PHASES FOR LONGER TERM STRATEGIES

Idea 2.04: Passive Design Strategies

- Develop a menu of energy efficient and cost effective passive design strategies for new construction and existing buildings.

Idea 2.05: Community Design Strategies

- Conduct a density values study analyzing the following:
  
  a) the carbon impacts of improved community design (including the value of carbon reductions due to reduced linear footage of infrastructure and reduction in private vehicle trips)
  
  b) level of satisfaction of residents of the higher-density Mueller redevelopment

Idea 2.07: Building-Integrated Photovoltaic Systems

- Identify obstacles to developing BIPV in Austin by a) surveying manufacturers to find out why, despite very high traditional PV rebates, they have not set up a plant in Austin and b) surveying design professionals to find out what a manufacturer would have to provide in order to make BIPV a viable building tool.

- Develop best practices guidelines for BIPV use and partner with manufacturers to design semi-standardized, cost effective applications for BIPV products

Idea 2.08: Solar Absorption Cooling

- Identify applications for smaller scale solar absorption cooling systems and barriers to adapting technology to a different scale.

Idea 2.09: Zero Net Energy Demonstration Project

- Develop a guidebook outlining a recommendation for building a zero net energy community to be used as a tool to vet qualified master developers and present the idea to various stakeholders.
Overarching Assumptions

The following broad assumptions apply to all of the recommendations described in this report:

- Energy efficiency will continue to be a high priority for Austin Energy.
- AE rates and business model will evolve in a way that allows AE to be financially sound even as sales kilowatt-hours decline.
- The city of Austin will continue to support aggressive measures to increase density. These measures will include revisions to the building and land development codes.
- As density increases, the availability and quality of public services such as transportation, schools, and recreation and entertainment facilities will also improve.
- As density and energy efficiency increases, smart grid technologies will be developed and deployed that will allow AE to better manage grid loads. This will allow AE and other city services to take advantage of energy efficiency and reduced demand by reducing distribution infrastructure and costs.

Team 2 made the following assumptions in quantifying the potential of the recommended programs. (See Quantification, p. 26.)

Idea 2.01: Solar Water Heating

Market potential: There are about 180,000 single family homes in the AE service area. Of these, about 20 percent (36,000 homes) have electric water heat. This is the market potential for replacing electric water heaters with solar thermal systems.

Program potential: The program potential is 10 percent, meaning that it can be reasonably expected that 10 percent of the 36,000 homes with electric water heat will convert to solar given the right nudges within 10 years.

Idea 2.02: Wireless Lighting Controls

Existing buildings are the right target: The use of lighting controls has become standard practice in new construction and Team 2 assumes that more stringent lighting allowances in the codes will only increase the use and efficiency of lighting controls in new buildings. Therefore, existing buildings should be the target for a lighting controls initiative.

Energy demand and use savings: There are about 52 million square feet of office space in the AE service area. (There are 194 million total commercial square feet, but office space will yield the best results.) Team 2 estimates that 10-15 percent of the office space has already been retrofitted with some level of lighting controls. Average lighting use in offices is 6.8 kWh per square foot annually. A conservative estimate is that controls can save 30 percent of lighting energy use, (6.8 x .3 = 2.04).

Program potential: Team 2 estimates that 25 percent of the potential space can be retrofitted with an effective program within 5 years.
Idea 2.03: Smart On-off Power Strips

Market potential: Austin Energy has approximately 340,000 residential meters. The average use for residential customers is 12,000 kWh annually.

Energy savings: Lawrence Berkeley National Lab estimates that 10 percent of residential electric use is due to vampire loads. Since some outlets must be activated at all times we estimate that the potential savings per unit is 600 (0.05 x 12,000) kWh.

Program potential: A program similar to the CFL coupon program could result in 25 percent penetration of smart on/off power strips within 5 years.

Idea 2.06: Exterior Shading (tree planting)

Market potential: There are 180,000 single family homes in the Austin Energy service area. Of these, Team 2 estimates 65 percent have either good shade or have other conditions that would preclude planting shade trees for shading. Therefore, the market potential is 63,000 single family homes.

Energy demand and use savings: A study done by the Sacramento Municipal Utility District in Sacramento, CA shows energy savings ranging from 340-850 kWh per home as a result of trees shading the south and west sides of houses. A well-structured program operated by AE and TreeFolks could result in 20 percent of the eligible homes planting well-located shade trees within 5 years. The demand reduction potential (0.3 kW) was calculated using the following (very rough) conversion: 1 kW : 1900 kWh.

Idea 2.08: Solar Absorption Cooling

Market potential: Quantification is based on the estimate of the construction of 3,000 units of residential and small commercial construction each year.

Energy demand and use savings: Typical peak demand for a 3-5 ton HVAC system is 3-4 kW. With a 50-60 percent demand reduction we estimate a 2 kilowatt savings/unit and a typical energy savings of 2,200 kWh annually. With effective marketing, solar absorption cooling may capture 10% of the market 5-10 years after it becomes commercially available.

Idea 2.04: Passive Design Strategies

Market potential: 3,000 units represent residential and 2 million square feet commercial represents completions in a typical year. Among residential buildings, Team 2 estimates 5 – 10 percent use some level of passive design strategies in a given year, putting the market potential at 92.5 percent of annual residential construction. Among commercial buildings, Team 2 estimates near zero penetration - almost no commercial buildings currently use passive design strategies.

Energy demand and use savings: The demand and energy savings for residential buildings are based on computer simulations (see Appendix B, p. 33). The commercial savings are based on a 30 percent additional (from current projections) reduction from the current typical per square foot energy use of commercial buildings due to code advancements and improved technology.

Program potential: Team 2 estimates that 20 percent of new construction will incorporate these strategies within 5 years, and that they can be incorporated into the energy code when approximately this level of uptake is achieved.
Idea 2.06: Exterior Shading (new construction)

Market potential: Extended overhangs and other shading features are common on new residential construction so we will focus on new commercial construction, which averages about 2 million square feet per year.

Energy savings: Our estimate is that shading can reduce cooling energy use by as much as 25% from business as usual.

Idea 2.09: Community Design

The community design quantification work can be found in Chart 4 (see p. 27). It is based on case studies of existing communities.

Idea 2.05: Zero Net Energy Demonstration Project

Energy demand and use savings: The demonstration project will not have a large direct impact on energy use or demand itself, but will have an important indirect impact because it will help drive the implementation of performance-based energy codes. It may also act as the “physical center” of the Pecan Street Project, where other technologies and concepts can be tested.

Idea 2.10: Performance Based Energy Codes

Energy demand and use savings: Performance-based energy codes will maximize potential new construction savings because codes will institutionalize savings described in 2.04, 2.06, and 2.09.
## Chart 3: Energy Savings from Proposed Programs

### EXISTING BUILDINGS INITIATIVES

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<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>2.01</td>
<td>Solar water heat</td>
<td>0</td>
<td>36,000 SF homes with electric water</td>
<td>0.630 kw/SF home</td>
<td>2,772</td>
<td>99,792</td>
<td>9,979</td>
<td>$3,500-4,000</td>
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<tr>
<td>2.02</td>
<td>Wireless lighting controls</td>
<td>10-15%</td>
<td>45,500,000 ft² commercial space (excluding industrial &amp; retail)</td>
<td>0.001 kw/ft²</td>
<td>2.04</td>
<td>92,820</td>
<td>23,205</td>
<td>$50-75/ft²</td>
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<tr>
<td>2.03</td>
<td>Smart on/off power strips</td>
<td>0</td>
<td>340,000 total residential</td>
<td>Very small associated demand reduction</td>
<td>600 kw/hes.</td>
<td>204,000</td>
<td>40,800</td>
<td>$30-35/residential unit</td>
</tr>
<tr>
<td>2.06</td>
<td>Exterior shading</td>
<td>65% of 180,000 SF homes in AE service area</td>
<td>63,000 SF homes w/o shade trees</td>
<td>0.30 Demand and peak demand reduction</td>
<td>340-860 kw/SF *</td>
<td>37,485</td>
<td>9,371</td>
<td>Existing AE programs + grants = No cost to consumers</td>
</tr>
</tbody>
</table>

### NEW CONSTRUCTION INITIATIVES

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<tr>
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<tbody>
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<td>2.08</td>
<td>Solar absorption cooling</td>
<td>0</td>
<td>3,000 units/year (small commercial and residential)</td>
<td>2.00 kw/unit</td>
<td>2,200</td>
<td>6,600</td>
<td>660 (assumes 10% uptake)</td>
<td>Incremental change from current practice @ $3,000?</td>
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<tr>
<td>2.04</td>
<td>Passive design strategies (residential)</td>
<td>5-10%</td>
<td>2,775 units/year (residential)</td>
<td>1.25 kw/unit</td>
<td>2,050</td>
<td>8,186</td>
<td>1,637 (assumes 20% uptake)</td>
<td>Less than 1% of building cost</td>
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<tr>
<td>2.05</td>
<td>Passive design strategies (commercial)</td>
<td>0</td>
<td>2,000,000 ft²/year (commercial)</td>
<td>0.0021 kw/ft²</td>
<td>4.05</td>
<td>8,180</td>
<td>2,025 (assumes 25% uptake)</td>
<td>Net zero cost to consumer. (Increased planning costs offset by lower mechanical costs.)</td>
</tr>
<tr>
<td>2.06</td>
<td>Exterior shading (building-integrated elements, solar screens for commercial construction)</td>
<td>5-10%</td>
<td>2,000,000 ft²/year (commercial)</td>
<td>0.0008 kw/ft²</td>
<td>1 kw/ft²</td>
<td>2,000</td>
<td>500 (assumes 25% uptake)</td>
<td>Low/no-tech design strategy - very, very low incremental cost</td>
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<td>2.07</td>
<td>Building-integrated PV</td>
<td>More research is needed to determine additional energy savings (beyond savings provided by traditional PV systems).</td>
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<td>Unknown</td>
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<tr>
<td>2.08</td>
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<td>See Chart 6.2 for carbon impact and energy use comparison of three communities of varying density.</td>
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<td>Unknown</td>
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### Total energy savings for all proposed existing buildings initiatives: 83,355 mwh

### Total annual energy savings for new construction strategies

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### Total annual energy savings for new construction strategies 2.04, 2.06, 2.08 (excludes 2.07 & 2.09): 4,822 mwh/year

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### Total annual energy savings for new construction strategies 2.05 & 2.10: Annual savings would likely meet or exceed the sum of all new construction strategies combined.

* Technical potential for existing buildings is total savings if a program were implemented in all existing buildings.

Technical potential for new construction is the annual savings if a program were implemented in all new construction each year.
## Chart 4: Energy Use and Carbon Impacts of Varying Community Designs

<table>
<thead>
<tr>
<th>Development</th>
<th>Development Description</th>
<th>Density</th>
<th>Average Dwelling Size</th>
<th>Total Building Energy Use*</th>
<th>Carbon from Building Operations (MT/unit)</th>
<th>Carbon from Building Operations (lbs/unit)</th>
<th>Carbon from Building Operations (lbs/ft²/year)</th>
<th>Carbon from Transportation (MT/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BedZED</td>
<td>Compact, MU brownfield redevelopment; 3 stories, 3.5 acres</td>
<td>20.2 dwelling units/acre</td>
<td>Av. dwelling size: 825 sq. ft.</td>
<td>7.60 kwh/f</td>
<td>4.35 metric tons/unit/year</td>
<td>9590 pounds/unit/year</td>
<td>12 lbs./ft²/year</td>
<td>1.43 metric tons/year</td>
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<tr>
<td>Toronto</td>
<td>New conventional construction; 15 story res. building downtown</td>
<td>54 dwelling units/acre</td>
<td>700 sq. ft.</td>
<td>15.96 kwh/f</td>
<td>2.30 metric tons/unit/year</td>
<td>5033 pounds/unit/year</td>
<td>7 lbs./ft²/year</td>
<td>0.62 metric tons/year</td>
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<tr>
<td>Austin</td>
<td>City of Austin Neighborhood Planning Area</td>
<td>8 dwelling units/acre (median net residential unit density of Austin Neighborhood Planning Areas)</td>
<td>2171 sq. ft. (mean of SF and duplex units only, within the Austin Neighborhood Planning Area)</td>
<td>9.70 kwh/f</td>
<td>7.90 metric tons/unit/year electricity</td>
<td>22046 pounds/unit/year</td>
<td>10 lbs./ft²/year</td>
<td>4.20 metric tons/year</td>
</tr>
</tbody>
</table>

* Gas use converted to kWh for comparison
Financial and Economic Viability

Team 2’s recommendations will transition AE from paying people to use less of our product (in the form of rebates and incentives) to requiring them to use less of our product (when performance-based energy codes take effect). This will eventually require AE to decouple its revenue stream from volumetric kWh sales.

However, there are other potential revenue streams that can be developed from the Team 2 recommendations. There is a significant business opportunity to “sell the service” if solar absorption cooling becomes scalable in the near future. Solar absorption cooling (SAC) is easily adapted so that it can provide not just cooling but also hot water and space heating from a single installation. A “sell the service” model could be used for AE to own SAC systems and sell the consumer cooling, hot water, and space heating. It also has the advantage of putting AE in a position to sell services (hot water and space heating) that are currently being provided by other energy sources. This model may also be scalable to more dense developments using large SAC systems.

Similar potential may exist for BIPV and other recommendations. The Team 2 recommendations have been discussed with the Business Model Team and the Economic Development Team and will be included in their reports.
**Tipping Points**

For the purposes of this report, Team 2 will define tipping point as the point at which the market can be considered transformed and incentives and special marketing programs can be discontinued.

It would be very difficult to identify a level of market penetration (i.e. 20 percent) at which a market could be considered transformed. Rather, programs and technologies should be piloted and incentivized until there is a reasonable level of visibility and public acceptance. The tipping point is when industry stakeholders are comfortable and familiar enough with the new technology, process or design to allow it to become the standard.

Austin Energy already has a model for this pilot-to-standard approach: The Austin Energy Green Building program.

Since 1998, AEGB has worked with the city’s Watershed Protection and Development Review Department to improve energy codes and code enforcement. The departments use two tactics to advance this goal: a) quality control and training for inspectors and plan reviewers and b) code development and adoption.

AEGB works with the leaders in the building industry to evaluate the most efficient and cost-effective strategies. These products and systems are piloted through incorporation into the AEGB building rating. As use of these newer systems becomes more common, Green Building moves them into the energy code in regular cycles. As the codes become more stringent, the AEGB rating tools have become stronger to stay ahead of the codes. This is a continuous improvement cycle that has led to a progressive energy code and a green building initiative recognized as the most advanced and effective in the U.S.

**PASSIVE DESIGN STRATEGIES, COMMUNITY DESIGN STRATEGIES, ZERO NET ENERGY DEMONSTRATION PROJECT**

Passive design strategies (Idea 2.04) and community design strategies (Idea 2.09) will follow the AEGB model precisely. Incentives and pilots can be discontinued when the strategies are integrated into the prescriptive code, or when designers and developers are required to rely on them in order to meet mandated energy allocations under performance-based building codes (Idea 2.10).

The zero net energy demonstration project is not an end in and of itself. Rather, it is a driver toward the tipping points for passive and community design strategies and building code transformation.

The tipping point for performance-based building codes is implementation. Implementation would be the result of widespread industry and stakeholder acceptance and strong political will.

**BIPV, SOLAR ABSORPTION COOLING**

The new technologies proposed here, building-integrated PV systems (Idea 2.07) and solar absorption cooling (2.08) will have reached their respective tipping points when they are viable options for designers and building owners.

At present, BIPV is an expensive custom product, often used in demonstration projects or for model ultra-green buildings. To reach its tipping point, the city, in partnership with a manufacturer, would have to develop a uniform class of products designers want to use in their buildings.

July 27, 2009
Solar absorption cooling is an expensive, large-scale technology in operation in only a handful of buildings. It will require significant product development and high rebates to progress toward its tipping point.

**EXISTING BUILDINGS STRATEGIES**

Solar water heating (Idea 2.01), smart on/off power strips (Idea 2.03) and wireless lighting controls (Idea 2.02) are cost-effective solutions with very short payback periods. Reaching the tipping points on these retrofitting techniques is largely about raising awareness. Uptake of lighting controls could also progress with the help of the energy audit ordinance (ECAD) process. Under the ordinance, commercial building owners must complete an energy audit by June 1, 2011. The results of the audits will be made available to building purchasers and tenants, providing motivation for building owners to upgrade their buildings. Lighting controls will be one of the easiest, most cost-effective ways for owners to raise their Energy Star Portfolio Manager score.

The exterior shading (Idea 2.06) program involving planting trees for energy efficiency will likely not have a tipping point. This is because the trees will be given away, not sold, for the entire life of the program. There may ultimately be a saturation point, when every building with a potential planting space has received a tree.
Questions and Issues

Workforce Training

Team 2 believes that there are significant workforce training opportunities and requirements associated with the recommendations described here. Those opportunities and requirements have not been documented in this report. They need to be evaluated and a plan put in place to provide the required training.

Business Model and Rate Structure Development

Team 2’s recommendations will significantly impact growth of electric sales revenue. Within the next ten years, these recommendations will reduce actual sales, not just growth of sales. Decoupling AE revenues from volumetric kWh sales will be imperative.

Alignment with National Codes and Standards

Austin has led the way on codes for several years. If the recommendations described in this report are implemented, that leadership will continue. However, it is important that the rest of the state and the country also move forward with more efficient codes. The current climate change bill in Congress addresses this with a requirement for building codes to become 30 percent more efficient by 2012. Austin should support this improvement in codes and standards and promote even higher levels of efficiency.

Political Will

Austin’s land development code is the product of over 20 years of compromise between the development community, neighborhood and environmental activists. It often contradicts itself and generally penalizes density rather than promoting it. To overcome these competing special interests, political will must be strong enough to promote denser urban development in the land development code rather than hindering it.

Schools

“Family-friendly” development goes beyond providing 3- and 4-bedroom condominiums and apartments with nearby playgrounds. While high density, mixed-used developments can be planned to accommodate work, leisure, shopping and housing, these developments will attract mostly single people and couples without children unless located in high caliber school districts. Educated parents choose their homes based on the schools their children will attend. They will not move to urban cores unless they are confident their children will receive an education equal to that they would receive in the suburbs. This problem is, in some ways, a chicken-or-the-egg conundrum. Good school districts would attract educated, involved parents, and educated, involved parents would raise the caliber of the schools districts. What kind of cooperation should be fostered between the city of Austin and Austin Independent School District to promote better central Austin schools?
Appendix A: Work Breakdown Structure for Zero Net Energy Demonstration Project

Chart 5: Work Breakdown Structure for Zero Net Energy Demonstration Project

July 27, 2009
Appendix B: Energy Modeling

This appendix presents the results of the energy modeling work undertaken to support Team 2’s recommendations of increasing the use of passive design strategies in new construction (Idea 2.04); building a zero net energy demonstration project (Idea 2.09); and implementing performance-based building codes (Idea 2.10). These results serve four purposes:

a) Justify the recommendation by demonstrating potential savings from passive design strategies

b) Provide numbers for the quantification of savings from passive design strategies for this report (see Quantification, p. 26)

c) Demonstrate that the path to zero net energy buildings requires reducing baseline building consumption as much as possible through passive and low-tech design strategies before adding expensive solar PV technology

d) Demonstrate the use of a tool that will be critical to the implementation of performance-based building codes (see Roadmap to the Vision, p. 9)

RESULTS SUMMARY

Team 2 generally found that a suite of passive design strategies, combined with solar water heating (Idea 2.01), could provide total site energy savings of around 44 percent over the baseline. This level of energy consumption is low enough that the remaining energy demand could be accommodated by a solar PV or other on-site renewable electricity generation system.

These results are more impressive in the context of the baseline: A 2300 square foot single family home built today by an Austin production builder to 2006 energy code specifications. Austin’s 2006 energy code is already one of the most stringent in the country, meaning even greater savings could be achieved when applied to a building in a city with a less progressive code.

What’s more, the energy savings in the home do not include savings that could have been achieved if the home had been placed in a well-designed, high-density, mixed-use, transit-oriented community such as those described in the community design strategies (Idea 2.05) recommendation. For example, if it were located in an apartment, it would have had fewer exterior walls and thereby less exposure to the elements. The modeling exercise indicates that simply placing this home in an apartment complex could result in 13.3 percent energy savings (see Chart 14, p. 42). In addition, a home located in a high-density development would likely have fewer square feet per capita, which results in less overall energy use per capita and per dwelling unit.

PROCESS

Baseline

Team 2 energy modelers began with a model of a 2300 square foot home currently in production in Austin, adhering to 2006 energy code specifications. The baseline model was based on work already done by Austin Energy Green Building engineer Patricia House.
Energy Efficiency Modifications

The team improved the baseline model by experimenting with three different suites of mostly passive energy efficiency strategies. The strategies they explored are listed in Chart 6.

Chart 6: Energy Efficiency Strategies for Modeling Exercise

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Duplex – Joined at east wall</td>
</tr>
<tr>
<td>2</td>
<td>Duplex – Joined at west wall</td>
</tr>
<tr>
<td>3</td>
<td>Row house – Joined at east and west walls</td>
</tr>
<tr>
<td>4</td>
<td>Apartments</td>
</tr>
<tr>
<td>5</td>
<td>R-18 walls</td>
</tr>
<tr>
<td>6</td>
<td>R-25 walls</td>
</tr>
<tr>
<td>7</td>
<td>R-35 walls</td>
</tr>
<tr>
<td>8</td>
<td>R-50 attic insulation</td>
</tr>
<tr>
<td>9</td>
<td>White roof</td>
</tr>
<tr>
<td>10</td>
<td>Zero duct leakage</td>
</tr>
<tr>
<td>11</td>
<td>2-foot window overhangs</td>
</tr>
<tr>
<td>12</td>
<td>Windows: SHGC=0.29; U=0.41</td>
</tr>
<tr>
<td>13</td>
<td>No carpet (concrete floor)</td>
</tr>
<tr>
<td>14</td>
<td>Reduced infiltration (0.3 air changes per hour)</td>
</tr>
<tr>
<td>15</td>
<td>8-inch concrete walls (R-12 insulation on interior)</td>
</tr>
<tr>
<td>16</td>
<td>8-inch concrete walls (R-12 insulation on exterior)</td>
</tr>
<tr>
<td>17</td>
<td>50% reduction in lighting loads</td>
</tr>
<tr>
<td>18</td>
<td>6-inch spray foam insulation in walls</td>
</tr>
<tr>
<td>19</td>
<td>16 SEER air conditioner</td>
</tr>
</tbody>
</table>

They combined these strategies into three suites:

Combination A: Strategies 9,10,12,14,17,18

Combination B: Strategies 9,10,12,14,17,18,19

Combination C: Strategies 9,10,11,12,14,17,18

Note:

None of the suites included building type (i.e. apartment, row house). However, energy savings from building type can be found in Chart B.8.

All of the models incorporate programmable thermostats that increase the set point temperature in the cooling season to 83°F between 8 AM and 3 PM while lowering the set temperature to 78°F during the rest of the day.

The team selected the Combination C house as their “improved model.” They compared this improved model, as well as a Combination C house with added solar water heating and/or solar PV systems, to the baseline house in the results. The results below show significant reductions in electricity demand and overall energy savings over the baseline house.
RESULTS

Electricity Demand Savings

Chart 7 compares the 24-hour energy demand curves on a typical Central Texas summer day for the baseline house, a Combination C house, a Combination C house with 3 kW of PV, and a Combination C house with 6 kW of PV. Note that there is no demand curve for a Combination C house with solar water heating. This is because these are electricity demand curves. The water heating system in the baseline house is gas. Therefore, the addition of solar water heating reduces gas use, not electricity use, and does not have an effect on electricity demand.

Chart 7: Net Demand Curves
Chart 8 shows the demand of the Combination C house, the generation of a 3 kW PV system and the net demand curve of the C house with the added PV. The PV provides generation during peak hours when the sun exposure is highest, creating a high cooling demand but also providing more solar generated electricity to mitigate that cooling demand.

*Chart 8: Demand Curves (Combination C House, PV Output, Net Demand)*
Annual Energy Savings

Chart 9 compares the total site energy use (electric and gas) of the baseline home, the Combination C home, and the Combination C home with solar water heating and two different solar PV systems.

*Chart 9: Annual Site Energy Use (in MBTU)*
Chart 10 compares the total annual site energy use of the baseline house to the Combination C house with solar water heating (no PV). The chart breaks down the contribution of each energy use (i.e. domestic hot water, lighting) to the total energy use.

**Chart 10: Total Annual Site Energy Use By Type of Use**

- **Lighting end-use energy (electricity)**
- **Miscellaneous equipment end-use energy (electricity)**
- **Cooling end-use energy (electricity)**
- **Auxiliary end-use energy (pumps - electricity)**
- **Vent fan end-use energy (electricity)**
- **Miscellaneous equipment end-use energy (gas)**
- **Heating end-use energy (gas)**
- **Domestic hot water end-use energy (gas)**
Chart 11 compares annual electricity use (kWh) in the baseline house to annual electricity use in the Combination C house.

**Chart 11: Total Annual Electricity Use By Type of Use Code House vs. Improved Model**

![Chart 11: Total Annual Electricity Use By Type of Use Code House vs. Improved Model](chart.png)

- **2006 Code House**
  - Total Electricity Use: 10,692 kWh
  - Lighting end-use energy: 948 kWh
  - Miscellaneous equipment end-use energy: 4207 kWh
  - Cooling end-use energy: 1795 kWh
  - Auxiliary end-use energy (pumps): 3699 kWh
  - Vent fan end-use energy: 70768 kWh

- **Improved Model (C Strategies + Solar Water Heating)**
  - Total Electricity Use: 7736 kWh
  - Lighting end-use energy: 974 kWh
  - Miscellaneous equipment end-use energy: 4207 kWh
  - Cooling end-use energy: 1795 kWh
  - Auxiliary end-use energy (pumps): 3699 kWh
  - Vent fan end-use energy: 70768 kWh

Chart 11 shows a significant reduction in total electricity use for the Improved Model compared to the 2006 Code House.
Chart 12 compares the total annual gas use (MBTU) in the baseline house to gas use in the Combination C house (with solar water heating).

**Chart 12: Total Annual Gas Use by Type of Use Code House vs. Improved House**
Chart 13 shows the change in electricity, gas and total energy use achieved with the C suite of strategies, as well as the changes achieved when solar water heating is added to the suite.

Chart 13: Decrease in Electricity, Gas and Total Energy Use from Passive Design Improvements
Chart 14 breaks down the total site energy savings by individual strategy. Three of the strategies (white roofing, 2-foot window overhangs, and high-efficiency windows) actually cause a slight increase in annual energy use. This is partly due to the fact that the baseline home had few windows, and therefore had little solar heat gain to mitigate in the first place. Because these strategies are aimed at reducing the cooling load, they sometimes have the effect of increasing the heating load, since they block the sun. These strategies are perhaps not appropriate for this particular house, but are certainly appropriate for other buildings, especially those with more glazing.

Another item to note here is the savings potential of the 16 SEER air conditioner. Since Team 2's objective was to recommend passive design strategies, Team 2 did not test the effect of this strategy as part of the Combination C suite. However, high quality mechanical systems do provide important energy savings. As previously stated (see Roadmap to the Vision, p. 9), once the maximum energy efficiency gains are achieved through passive techniques, the most efficient mechanical systems allowed by the budget should be specified for a given building.

Chart 14: Changes in Site Energy Use by Design Strategy

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BUILDING
AN EMERALD CITY
A Guide to Creating Green Building Policies and Programs

LUCIA ATHENS
FOREWORD BY PLINY FISK III AND GAIL VITTORI
BOX 1.1 THE VERY FIRST GREEN BUILDING PROGRAM

Doug Setzer, codeveloper of the City of Austin Green Building Program, former state coordinator for Built Green Colorado

In the mid-1980s, the City of Austin was engaged in building an aggressive energy-efficiency portfolio that included financial incentives (rebates), low-income residential assistance, and low-interest loans for energy retrofits. One entrée on that menu of programs was the New Residential Construction Program, which developed a nonregulatory relationship with Austin home builders. Austin Energy Star encouraged voluntary energy improvements with a three-star rating system and local promotion. This market-based approach became a vehicle for continual energy improvement through educating builders and consumers and stimulating competition within the industry. It also became a core strategy for introducing a broader approach to environmental building a few years later.

In 1989, I had reconnected with a nationally known local sustainability think tank, the Center for Maximum Potential Building Systems, codirected by Pliny Fisk III and Gail Vittori. Coincidentally, I was asked by my division manager, Mike Myers, to come up with ideas for a potential grant opportunity from the Energy Task Force of Public Technology Incorporated (PTI). I called the Center to bounce around some ideas, and it was during that exchange that Gail proposed to expand Austin’s successful Energy Star program to include other resource areas: water, materials, and waste. This built on a systems-based resource flow model that the Center had evolved over the prior decade. This more comprehensive method essentially laid the groundwork for a transformational approach to buildings and the environment, since energy was the principal focus of most building-related environmental initiatives at the time. With Austin Energy Star as a springboard for changing standard practices of mainstream builders and developers, Gail, Pliny, and I took this kernel of an idea and expanded it into a grant proposal to PTI. With a public-private partnership (the City of Austin and the Center for Maximum Potential Building Systems) as the driver, the proposal was accepted. We were off and running.

The Center was contracted to develop a framework for an environmentally based rating system with an initial focus on single-family residential construction. The resulting icon-based rating system, while comprehensive and based on the Center’s extensive systems and life cycle-oriented research, was ultimately replaced by a more simplified rating format. We at the City were about to take an environmental rating system to the Texas builders. Our experience with builders had been in the energy-efficiency realm, and in the mid-eighties, this was still a hard sell. To introduce the next layer of building considerations in the form of environmental consequences of building, we felt that an incremental approach would be needed to get us in the door. Even so, as I look back at that first rating system, the list was certainly pushing the envelope.

The Austin Green Builder Program emerged (the name was later revised to the Austin Green Building Program). To our knowledge, it was the first green building program in the world. The world, it seems in retrospect, was ready for this more systems-based, albeit simplified, market-ready approach than was initially conceived. At the 1992 U.N. Earth Summit in Rio de Janeiro, the City of Austin’s Green Building Program was recognized as one of twelve exemplary local environmental initiatives—and the only recipient from the United States. The following year, David Gottfried, Rick Fedrizzi, and Mike Italiano founded the U.S. Green Building Council, acknowledging Austin’s Green Building Program as one of the inspirations to establish a nationally based organization to advance green building. In just a few short years, the term green building had entered the public lexicon. USGBC’s work on LEED began in 1995, further building off of the inspired conceptual framework that sparked Austin’s ground-breaking initiative. And, as they say, the rest is history.

SOLUTIONS, NOT PROTESTS

The success of green building appears to be outpacing many other environmental movements. Renowned geneticist David Suzuki, named one of the 2007 "Heroes of the Environment" by TIME magazine along with Al Gore, Robert Redford, and Wangari Maathai, expresses amazement at the adoption and progress of the sustainable building movement's transformation of the marketplace, compared to many other environmental movements.

Solutions, not protests.

Introduction: The Promise of Green Building + 3
$810 Million Funding Needed to Achieve 90% Compliance with Building Energy Codes

Every dollar spent yields $6 in energy savings

Strong building energy codes are one of the most fundamental, affordable and effective mechanisms for increasing the long-term energy efficiency of the nation’s buildings. Economic analysis indicates that every dollar spent on energy code compliance and enforcement initiatives yields $6 dollars in energy savings. This ratio includes the incremental costs to the private sector of constructing to code. Nevertheless, throughout most of the United States, building code development, implementation, training and enforcement have long been severely underfunded, with energy codes the most severely underfunded. As a result, many new and renovated homes and buildings do not comply with codes and consume far more energy and money to operate than they should.

In response to the Recovery Act (ARRA), every state has committed to achieve 90% energy code compliance.\(^1\) There is abundant evidence that compliance rates in most jurisdictions are far below 90%.\(^2\) An analysis by a task force of experts revealed an annual spending need of $810 million for energy code training, outreach, implementation, and enforcement efforts. The task force estimates this necessary funding level, which includes the current local, state, and federal effort and spending on code compliance and enforcement, will increase local and state capacities and expertise to the level required to achieve 90% compliance rates.

WHAT ARE ENERGY CODES?

Building energy codes are minimum local and state energy efficiency requirements for newly constructed or renovated buildings. Along with other building and safety codes, energy codes are intended to ensure sound design and construction practices to conserve energy use. Typically, permitted construction projects must demonstrate compliance with energy and other codes through a plan review and several site inspections during the construction process.

WHY ENERGY CODES?

To reach our economic, climate and energy independence goals, it is critical that our built environment become more efficient. Building energy codes are the most basic and cost-effective tools to address the energy efficiency of buildings. Funding the implementation and enforcement of energy codes to reach 90% compliance will help maximize the energy efficiency of our building stock, save Americans billions of dollars annually in energy costs, and reduce the need for costly infrastructure to meet growing peak energy demands.

CODE COMPLIANCE

Achieving code compliance is essential to effective building codes. Energy codes can deliver their potential energy savings only when projects actually comply with the code, yet statewide reports indicate significant and widespread lack of compliance. A dramatic increase in resources for compliance initiatives at all levels of government and increased enforcement at the local level are necessary to achieve high compliance rates.

RAMP UP TO $10 BILLION IN ANNUAL ENERGY SAVINGS

Building operations consumed $406 billion worth of energy in 2009 – 38% of total U.S. energy spending. Buildings that comply with energy codes are more efficient and use less energy across their lifetimes of 30 to 50 years or more. The task force economic model predicts that the additional spending\(^3\) needed to achieve 90% compliance would yield average annual energy savings ramping up to $2.7 billion in 2020 and over $10.2 billion in 2040 and each year thereafter. Including all public and private sector costs associated with code compliance, the energy savings produce a benefit-cost ratio of 6:1.\(^4\)

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\(^1\) By accepting State Energy Program funding under the American Recovery and Reinvestment Act (Recovery Act), states are required to submit and implement plans to achieve 90 percent compliance with building energy codes by 2017.

\(^2\) Yang, Brian, “Residential Energy Code Evaluations,” Building Codes Assistance Project; 2005. More study is needed on current compliance rates and current spending on enforcement and compliance initiatives. DOE and the Pacific Northwest National Labs are developing a methodology to measure compliance rates.

\(^3\) Our model assumes an additional annual investment of $610 million, based on the task force estimate that under $200 million is currently being spent on compliance efforts.

\(^4\) Estimates use as a starting point the reference case of EIA’s Annual Energy Outlook 2010, including projected construction levels, energy consumption, and fuel prices. The task force conservatively assumed a 4-year payback period from energy savings, declining to 1.5-year payback by 2020, for the incremental cost of code compliance (including design and construction costs); a 30-year average measure life; and that code-compliant buildings use 25% less energy than non-compliant buildings. The savings estimate is further understated because it does not fully include many billions of dollars in averted energy infrastructure costs. Looking only at the $810 million and not including other spending, every dollar spent yields $18 in energy savings. A real discount rate of 2% was used to calculate net present values. To assess the sensitivity of our results to the discount rate assumption, we also tested rates of 0%, 5% and 7%, and found that the benefit cost ratio was well over 3:1 in every case.

\(^5\) Enforcement spending is not tracked at the state or national level. Survey and other data indicate that most jurisdictions spend only a fraction of what is needed. See BCAP “Residential Building Energy Codes—Enforcement and Compliance Study.” October 2008.
$810 Million Funding Needed to Achieve 90% Compliance with Building Energy Codes

FUNDING NEED
The task force analysis identified a total funding need of $810 million annually for the following activities:

- **Plan Review and Inspection - $660 Million**
  Currently, most jurisdictions lack the resources to adequately conduct on-site inspections, plan reviews, and otherwise assure code compliance. This level of funding would support an appropriate number of code officials and support staff for the amount of construction needing to be reviewed, permitted, inspected and approved for occupancy. The analysis identified a best-practice level of enforcement (exemplified by Austin, Texas) and calculated the cost to replicate this enforcement nationally using 8-year average construction data from the US Census Bureau, McGraw Hill, and the Bureau of Labor Statistics.

- **Implementation and Training - $125 Million**
  This funding would support measures targeted at improved energy code implementation, including training of building code inspectors, builders, subcontractors, and design professionals; outreach to stakeholders; distribution of code books and compliance manuals; compliance evaluation; and development of alternative/pilot compliance methodologies. Costs were extrapolated from best practices in multiple jurisdictions.

- **Support at the National Level - $25 Million**
  In addition to the funding required at the state and local level, there are many code support activities that could be most effectively and efficiently completed by DOE and other national-level bodies. This scale of funding would support code adoption and code development assistance; development of training tools and manuals; and a public awareness campaign regarding the importance and benefits of building energy code compliance.

State and local governments are typically responsible for code adoption, compliance, enforcement and training. Currently, most funding for energy code enforcement comes from permit fees collected by local or state building departments. Training costs are often borne at the state level and overwhelmingly funded by U.S. Department of Energy grants. Energy codes are almost always severely underfunded and in some cases virtually ignored. There is a funding gap between current spending and the $810 million per year that is needed. The size of the gap is unknown – and additional research to better quantify the funding gap should be a high priority. Our best estimate is that the additional resources needed are greater than $610 million per year.3,5

With state and local governments facing the deepest fiscal crisis since the Great Depression and budget cuts across the board, they are not in the position to bridge this funding gap. The three best hopes for meeting this need are:

1. Increased permit fees and/or improved collection
2. System benefit charges, integrated resource planning and other ratepayer funds
3. The Federal government