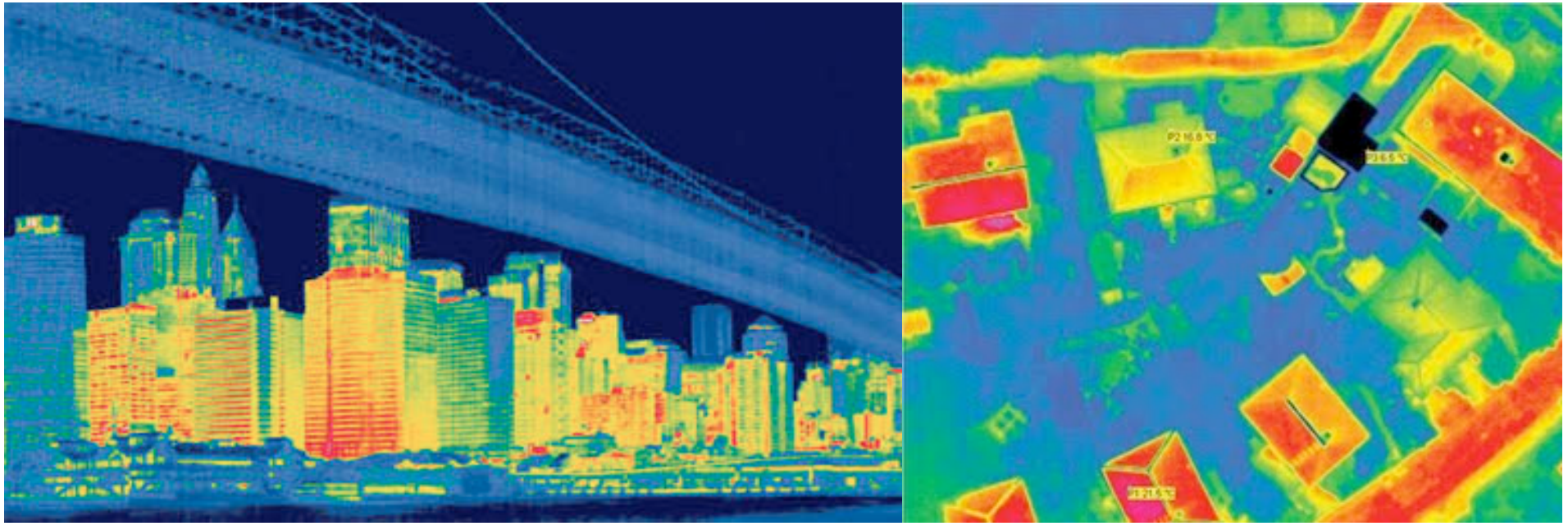
COMMUNITY-BASED INNOVATIONS IN ENERGY EFFICIENCY

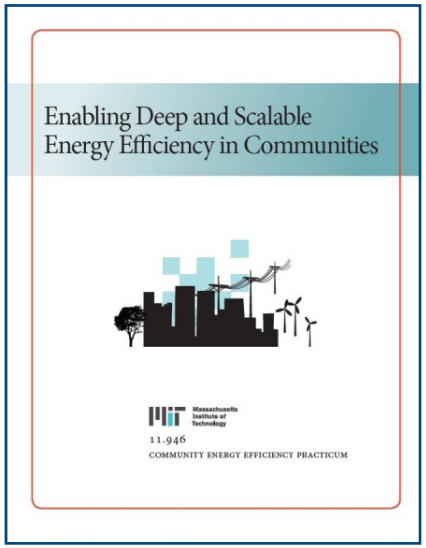
April 29, 2011

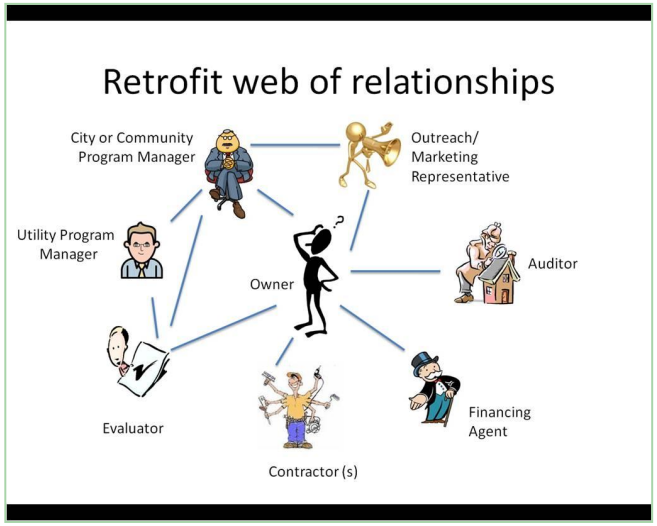


MIT ENERGY EFFICIENCY STRATEGY PROJECT

Delivering on the promise of Efficiency –

Communities – an effective deployment strategy?





Harvey Michaels, Director

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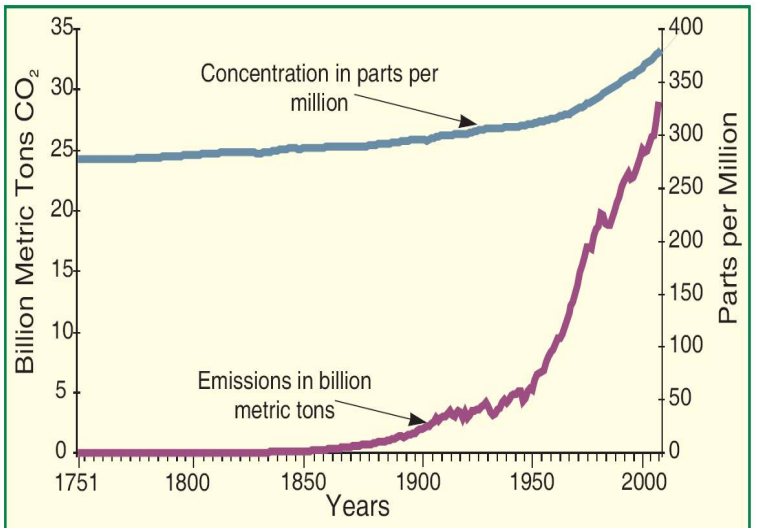
Instructor: *Enabling an Energy Efficient Society*

MIT Energy Research



Innovative solutions required:

- **By imbalanced world energy supply and demand,**
- **And to prevent unmanageable, irreversible climate change.**

1. **How Does Efficiency Stack up?**

   …i.e. How *Large, Clean, Cheap, Safe, Quick?*

2. **How does Society *make Efficiency Happen?***

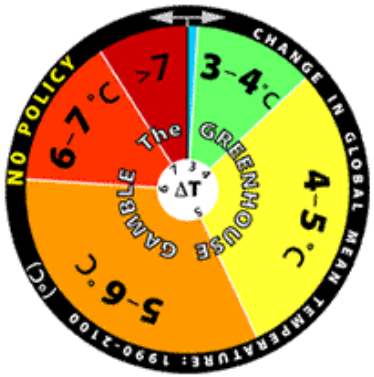
To keep climate change manageable, by 2050
We need to reduce US Carbon pp from *5.5 tons/yr to < 1 ton/yr*

ENORMOUS EFFORT:

- Capture all carbon from all coal plants (to date 0).
- Triple coal and gas plants, also with all carbon captured.
- 2/3 of all cars/trucks all-electric, rest adv. biofuels.
- In units of 1000 MW (a typical nuke) by 2050 we need:
  - 1200 wind (last year 8)
  - 1400 solar (last year .3)
  - 500 nuclear (last 20 years 0)

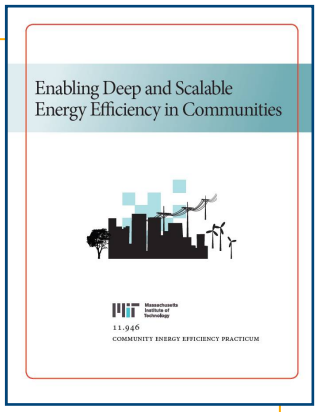
LAY-UP:

Improve energy efficiency by 3% per year.



Warming Possibilities in 2100
Under No Policy Scenario

Warming Possibilities in 2100
Under Policy Scenario



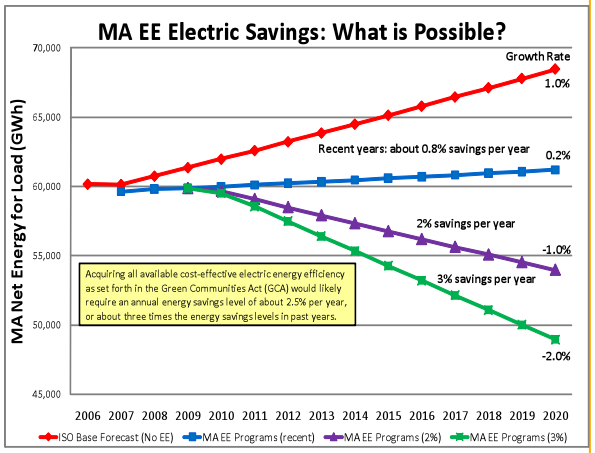
MIT Energy Efficiency Strategy Project

How will we Enable Energy Efficiency?

US Buildings consume 71% of all electricity, 55% of all natural gas

Goal: 30% efficiency achievable by 2030 with 4 Deployment options:

- **Public funding models, utilities:** ***carrots***
- **Codes and Standards:** ***sticks***
- **Data and intelligence-driven :** ***information***
- **New Business Models:** ***innovation***



Transforming the nation's consumers: **Good energy decisions (ie lower discount rates)** ***change everything.***

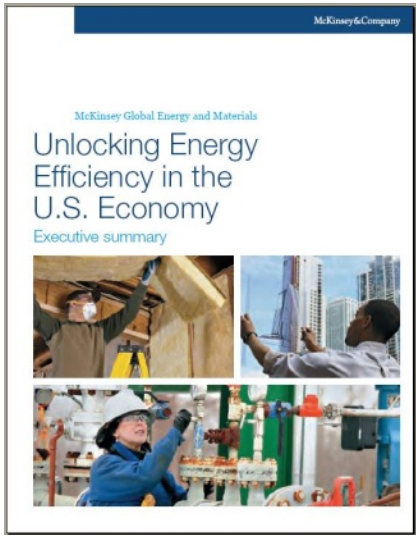
Massachusetts – 2008 Green Communities Act

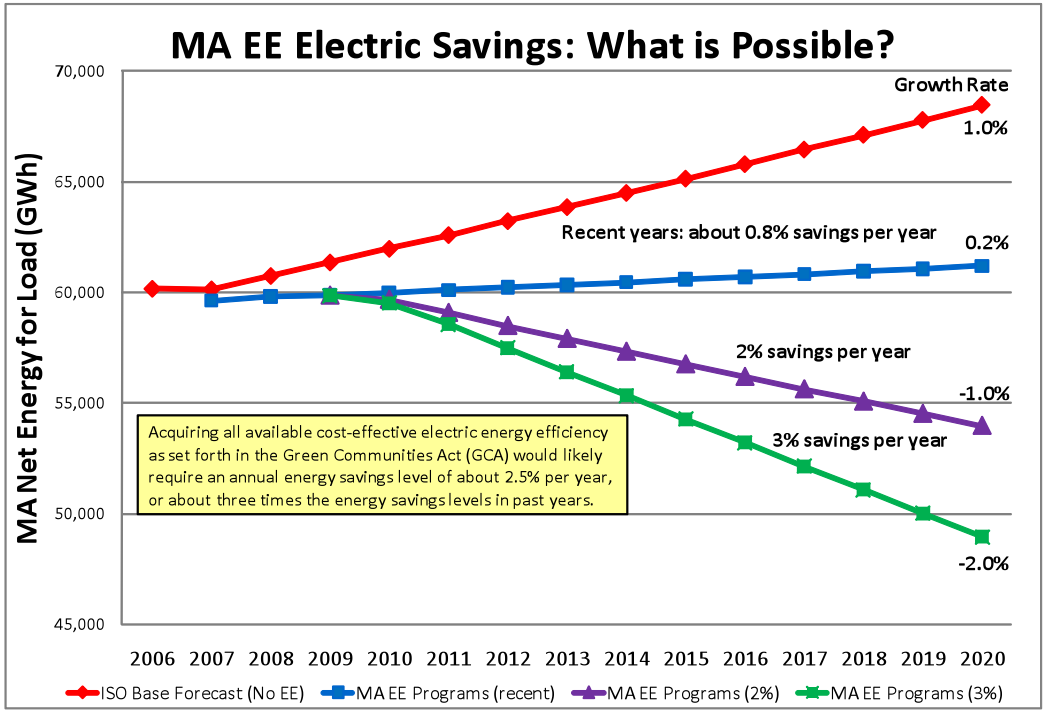
Establishes the requirement that utilities support their customers to install:

- ***All-cost effective efficiency*** **that costs less than energy supply, 1/1/2010 to 12/31/2012**
- **Target: Reduce energy needs with efficiency by 2.4% per year by 2012**
- **Utility Efficiency Budgets: $125 mm 2009 - $2 B 2010- 2012**

Some headwinds, some delays,

- ***but moving forward.***





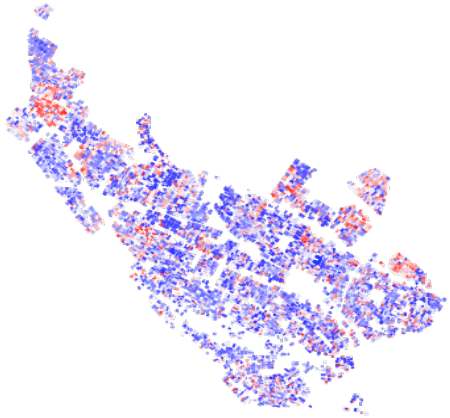
Granular Energy Data:
- *energy diagnostics, feedback, control*

Behavior impacts of smart grid-based information options *may be as high as 30%:*

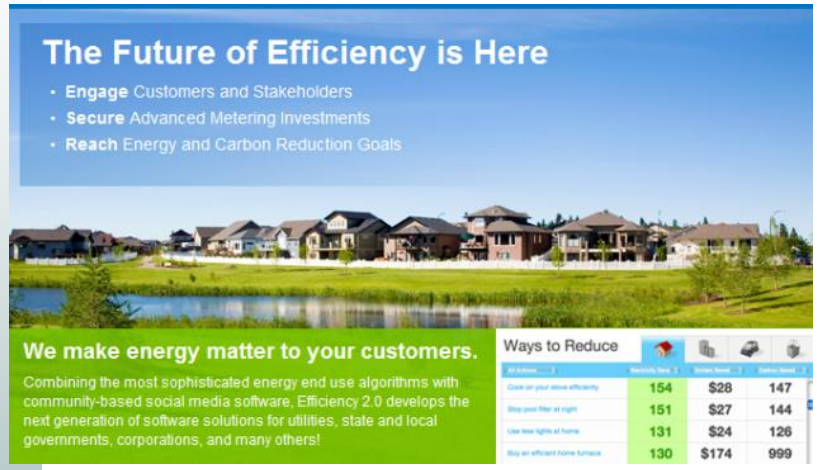
- **Daily**
- **End-use**
- **Carbon Footprint?**
- **Collective Action?**
- **Fault-detection**
- **Thematic Control – *make me green***
- **Control Precision**
- **Adaptive Control Strategies**

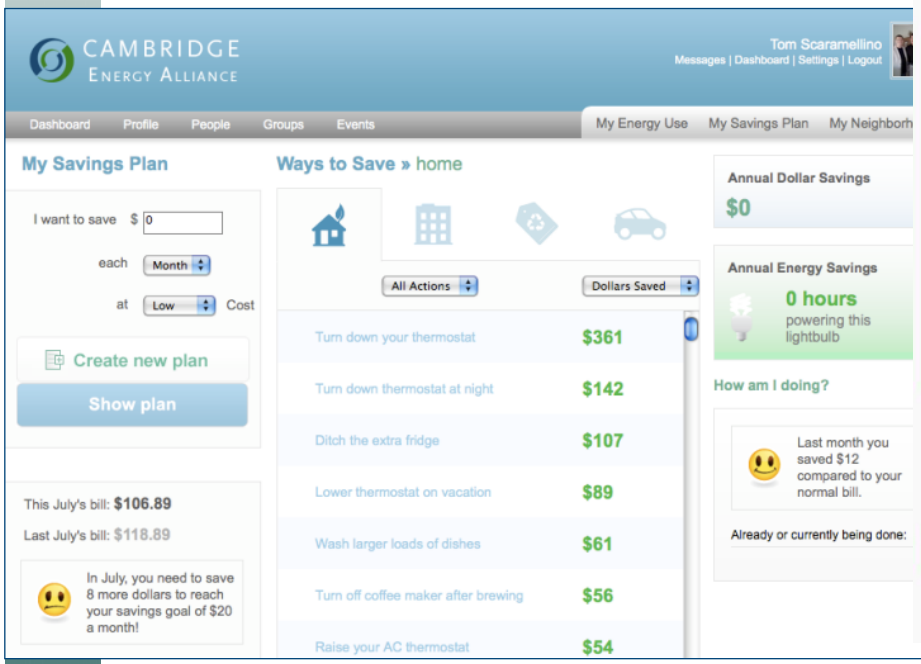
Layered community data systems:.

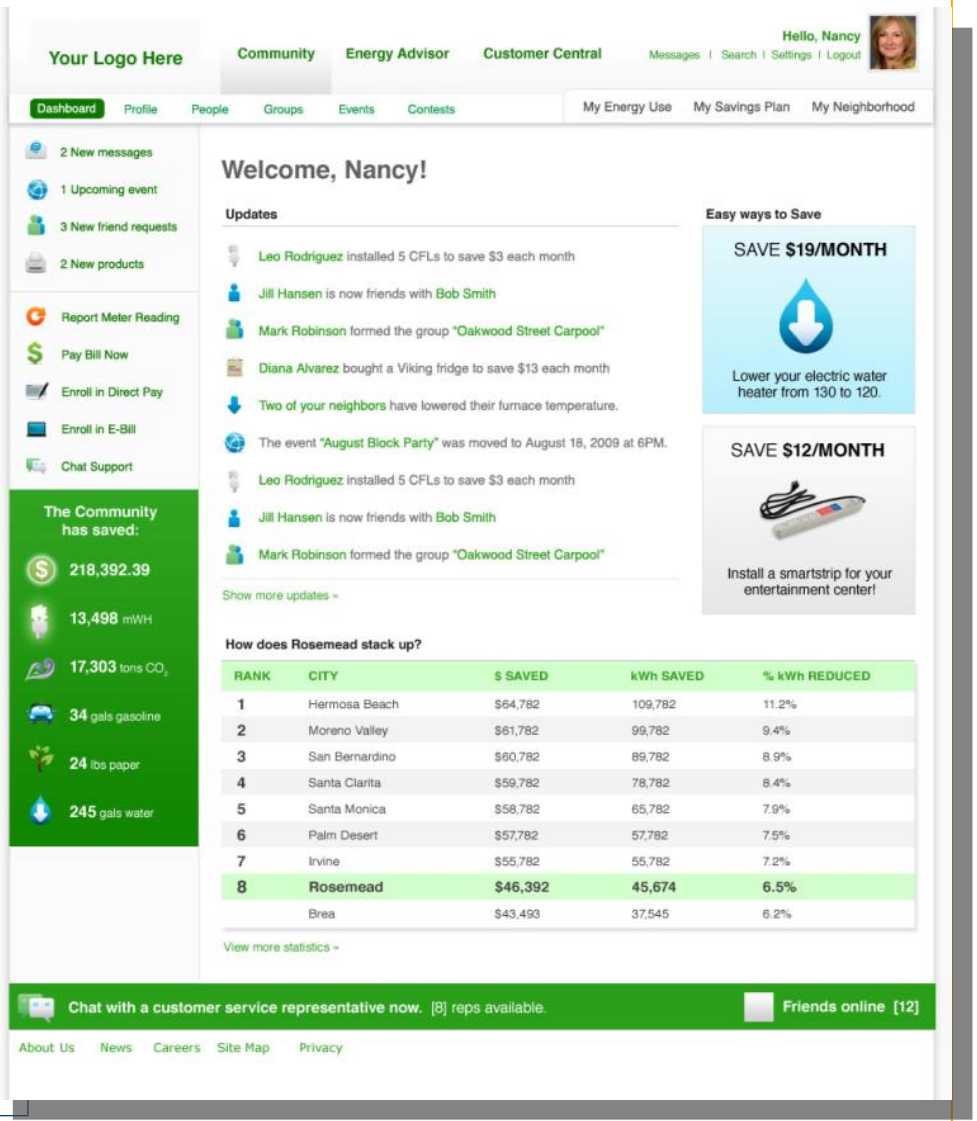
- ***Efficiency discovery***
- ***Efficiency delivery***
- ***Efficiency measurement***



Personal and Community Analysis







Thinking about Community Mobilization

- Why might communities mobilize better than 1-1?
- Are communities so unique that each program needs to be freshly designed, or can a common framework work?
- Utility vs. Fed vs. State – too confusing?
- What about Ad Hoc communities (school groups, church groups, web 2.0?)
- Can utilities create the *gameboard* where communities can create and sell the efficiency?

Partnering with Communities

Panel Preview

- Maintaining Momentum after the Stimulus
- Transforming Markets and Transforming Communities
- Complexities of Community Efficiency Programs
- Motivating People: Community Energy Services

Maintaining Momentum: Life after the Stimulus

Amy Stitely, MCP

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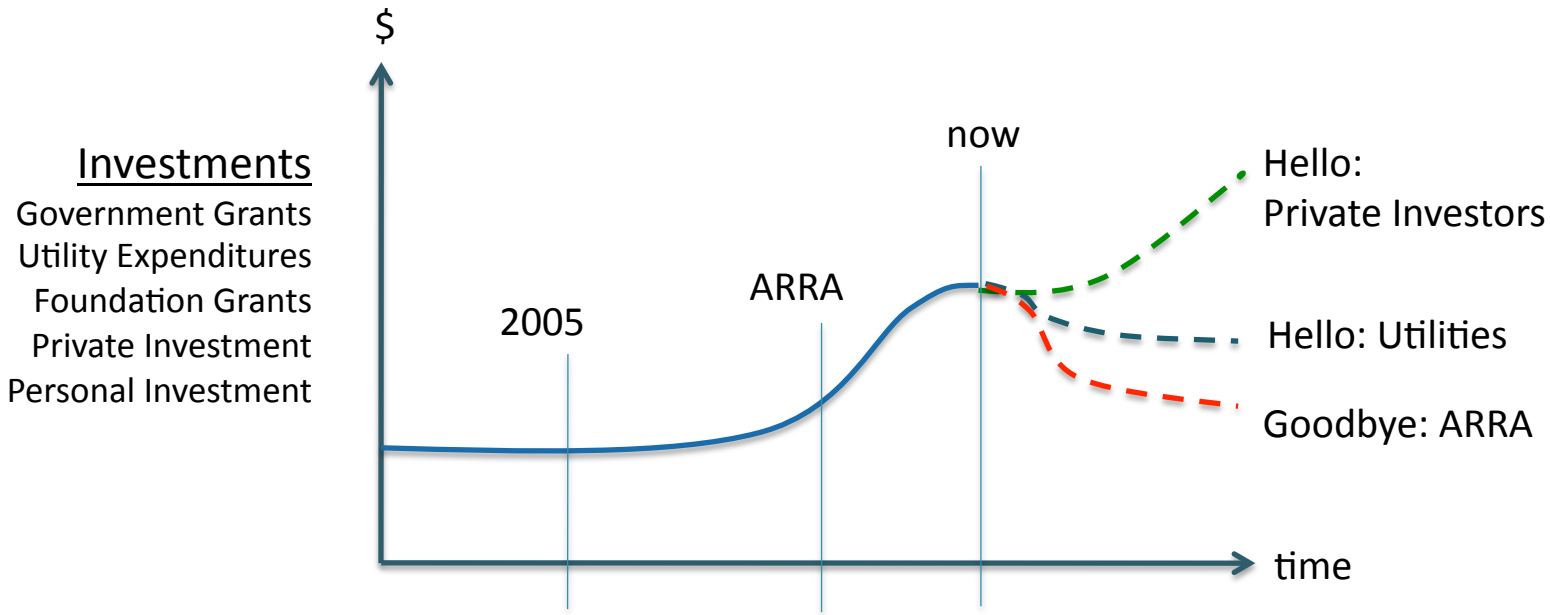
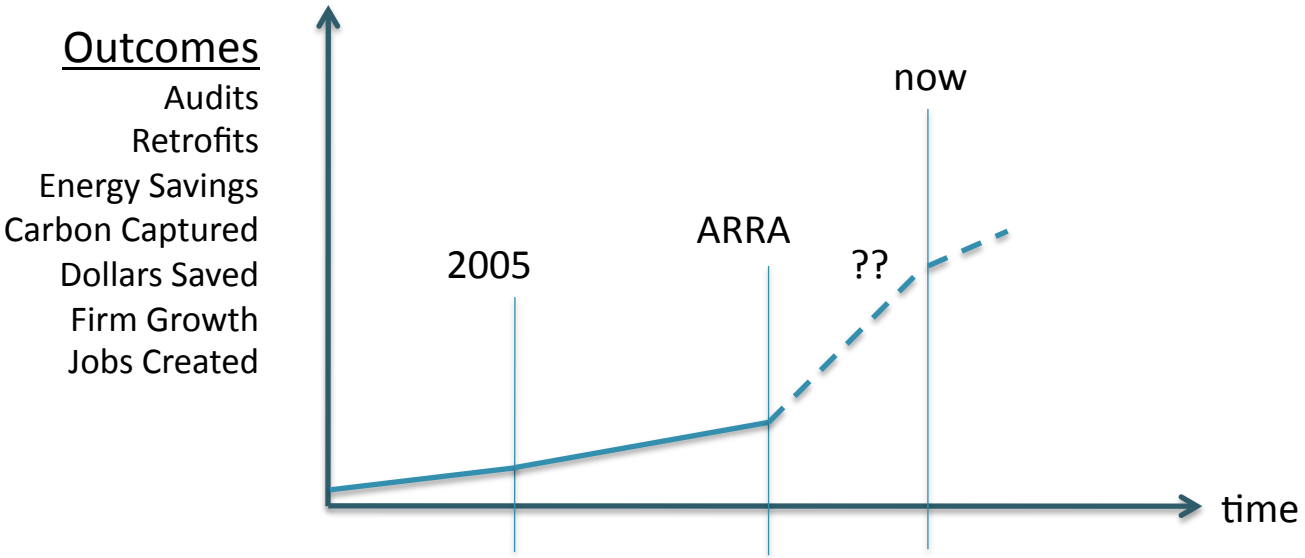
Did we build a market?



Changes in environment
Elected Leaders
Policy Innovations
Normative Views - Climate

What was the "Community" Effect?



Capturing Community Value

Mobilizing Masses

for policy change

to create demand

Leveraging Networks

for outreach

and penetration

Partnering on Programs

for design and

implementation

Transforming Markets and Transforming Communities: Lessons from BetterBuildings

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Klan/Nazis Attack Labor Organizers

-Special Edition-

Southern Struggle

FIGHTING TO BREAK THE CHAINS OF ALL OPPRESSION

VOL. 37, NO. 6 NOVEMBER-DECEMBER 1979 Published by the Southern Conference Educational Fund (SCEF), Atlanta, Ga.

KLAN KILLS FIVE;

FEDS, CITY AID RACISTS

On Nov. 3, the Ku Klux Klan attacked an anti-Klan protest in Greensboro, N.C. Their attack left five dead and ten wounded. It also sparked one of the largest outpourings of anti-Klan sentiment in years.

By Nov. 4, SCEF members were on the scene, investigating the murders.

This special edition of the Southern Struggle brings you their reports: an in-depth story on what actually happened Nov. 3; an expose of the Justice Department and police; and following these, some background to the murders and Greensboro, N.C. This issue also reports on a victorious anti-Klan march in Dallas, Texas.

BCC Initiates Truth & Reconciliation Commission

Greensboro, N.C. Case

- Beloved Community Center Collaborative
- Program designed to achieve economies of scale and social equity
  - 10X increase in scale; Reach 100% of households
  - Geographic targeting; Healthy homes
  - Train community organizers for outreach
  - Project bundling & bulk purchasing
  - Workforce development for people with barriers to employment

BetterBuildings Background

- Competitive DoE Program, EECBG funded
- Administered by cities and NGO's affiliated with local and state governments
- 34 grantees, $484M in Federal funding
- Focus on achieving market transformation
- 90% partnering with community org's
- 60% targeting low-income communities

Lessons for Energy Efficiency Programs

1. Market transformation and social equity can go hand in hand.
2. Social justice partners can help to design and implement energy efficiency programs that transform local markets.

Understanding the Complexities of Community Efficiency Programs

Erin Brandt

MA Candidate

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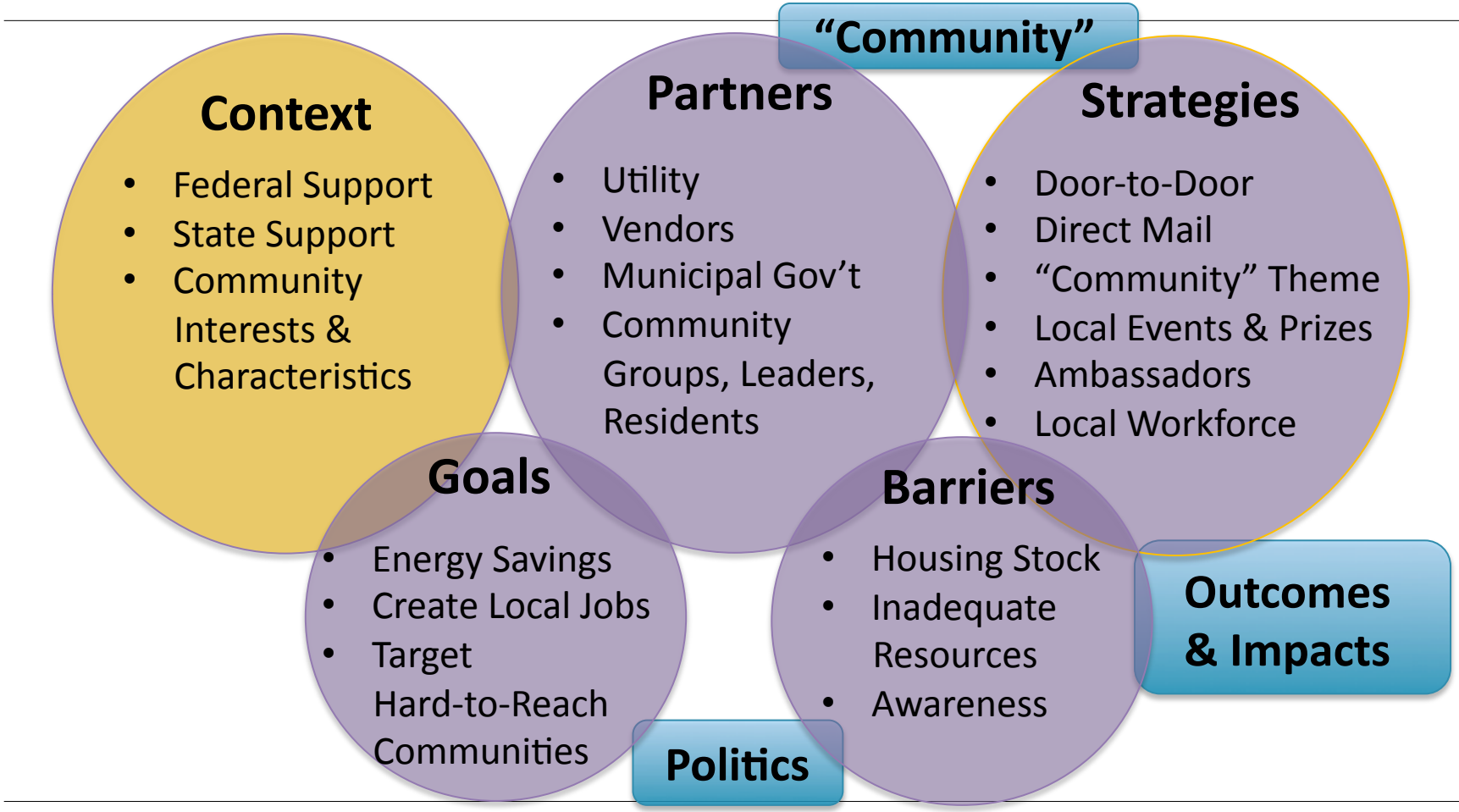
Two Community Programs

Marshfield Energy Challenge

New Bedford CMI

How Do Community Programs Differ?



Informing Future Programs

1. **Go beyond "community" rhetoric**
   - Create in-depth analysis
   - Compare costs and energy savings

2. **Improve program planning**
   - Consider goals, resources, and context

3. **Create useful program models**
   - Focus less on "franchises"
   - Focus more on customization

Motivating People: Lessons from the Community Energy Services

Stephanie Stern

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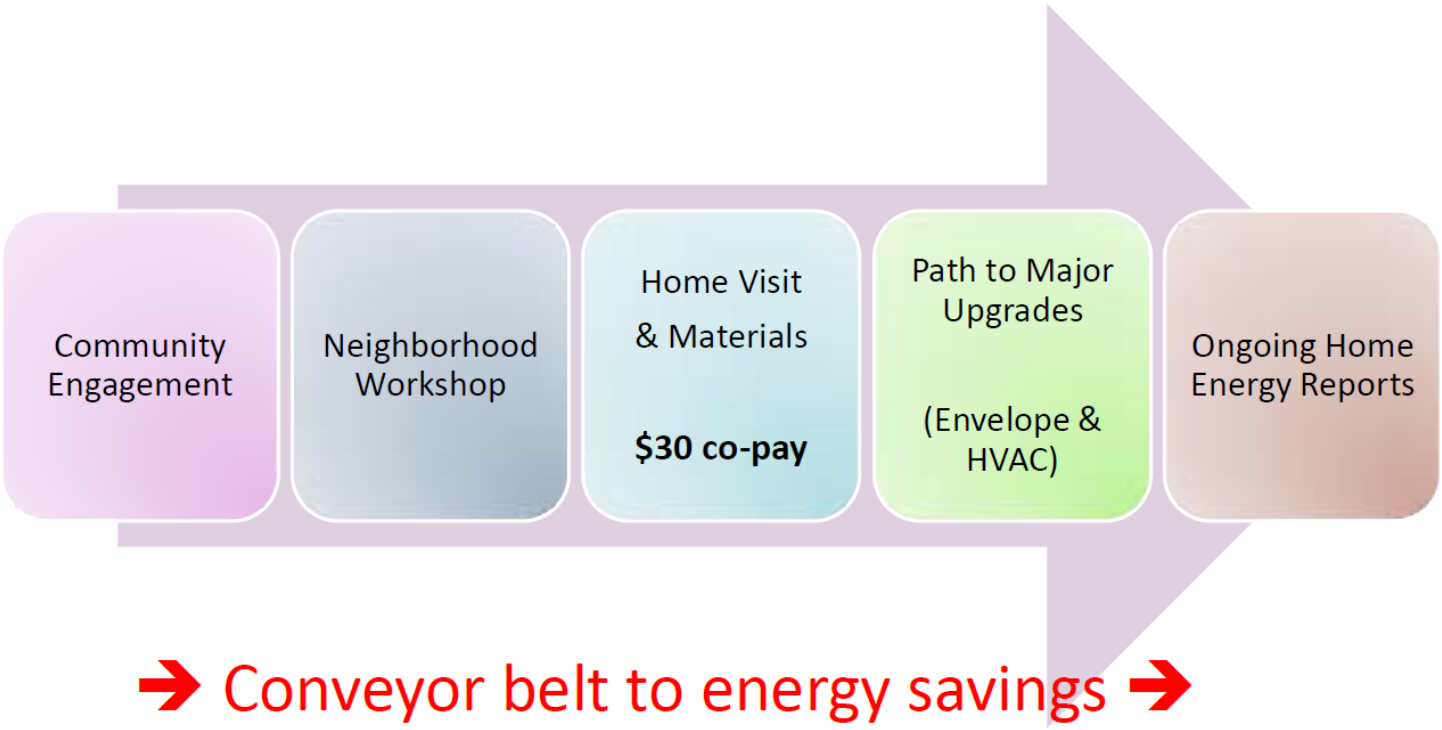
The Human Brain

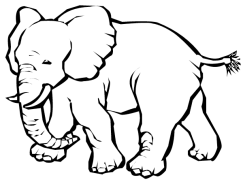
Community Energy Services Process



CES Provides

Direction

- Clarity about steps
- Expert opinion
- Vetted contractors



Motivation

- Tangible evidence
- Intangible support
- Social norms

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Maintaining Momentum after Stimulus

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Complexities of Community Programs

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Lessons from BetterBuildings

Stephanie Stern

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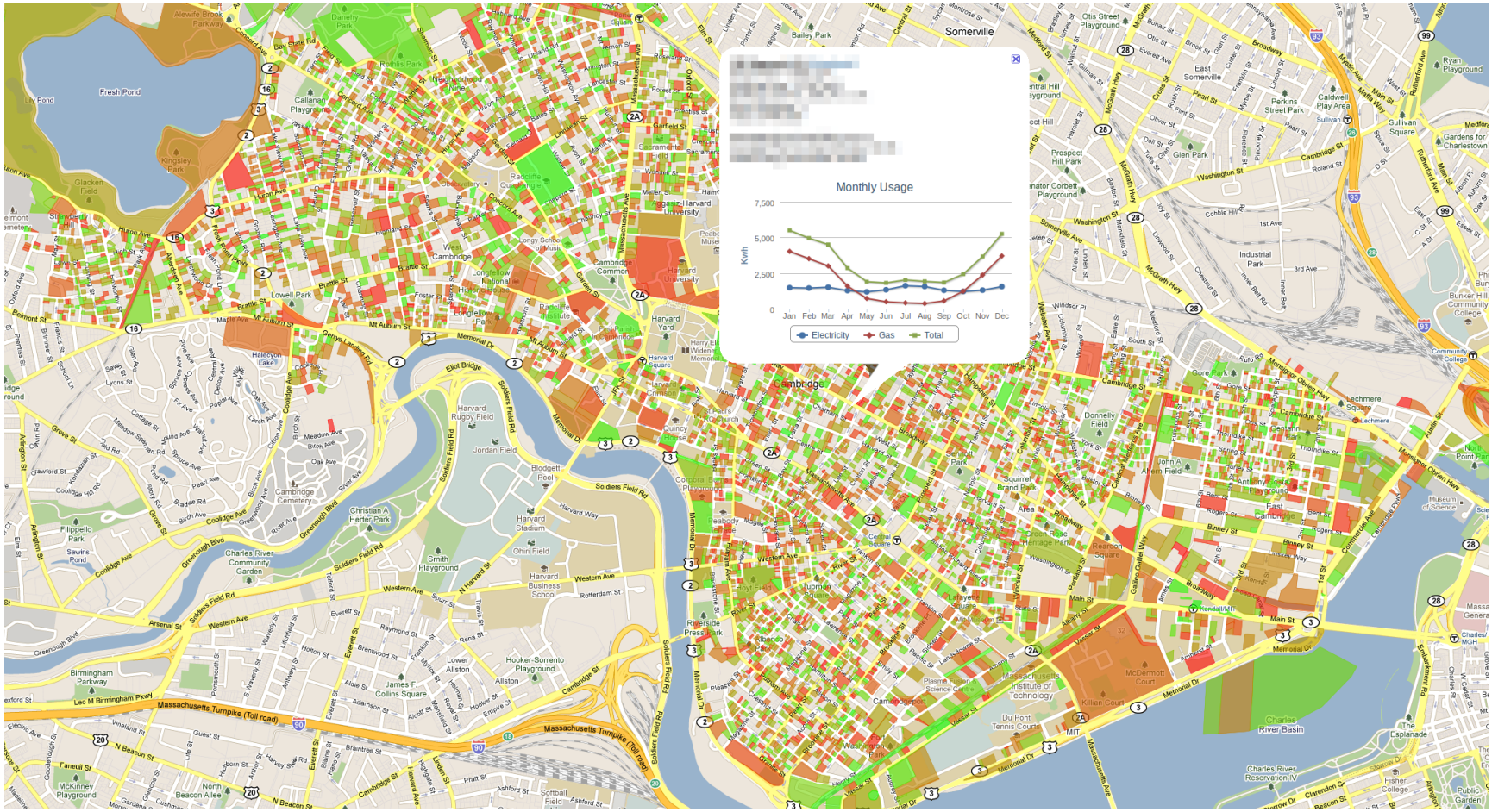
Lessons from Community Energy Services

Partnering with Communities



Data- and Information-Enabled Efficiency

Data- and Information-Enabled Efficiency

Democratizing Efficiency Delivery Through Disclosure

Machine Learning Approaches to Predicting Energy Consumption

Quantitative IR Thermography for Large-Scale, Targeted Retrofit

Using Information to Drive Efficient Operations and Behavior

Assessing MA Green Communities Program for Municipal Building Retrofits

Democratizing Efficiency Delivery Through Disclosure

Jeffrey S. Mekler

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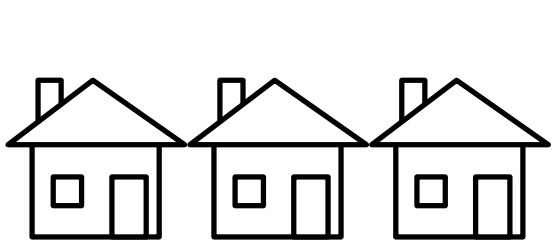
MIT Engineering Systems Division

Key Resources for Community EE Planning

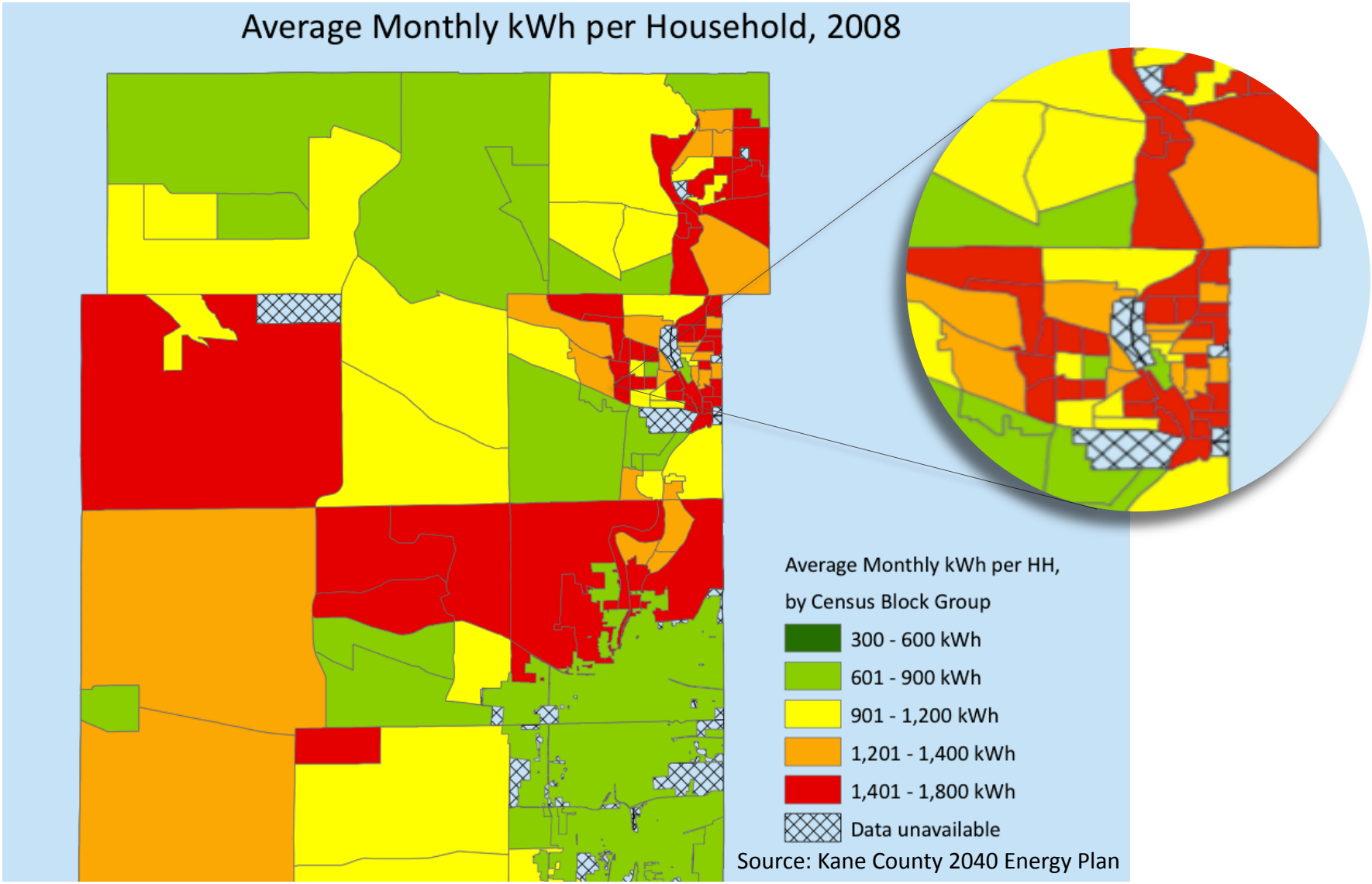
- Observation:
  Communities seen as a key element of residential/small business efficiency programs

- Question:
  What **tools** and **information** do communities need to *plan*, *deliver*, and *evaluate* **effective programs**?

Efficiency Information Systems (EIS)

	w/o EIS	w/ EIS
Plan		
Deliver		
Evaluate		

Data- and Information-Enabled Efficiency



Barriers to Realization

- ***Getting*** **end-use energy data**
  - Consumer privacy laws/concerns
  - Misalignment of public & utility incentives

- **Turning raw data into *useful* information**
  - Communities often don't have the personnel/ resources to extract useful insights from raw data

Implications for the EE Marketplace

\+ publicly-disclosed (aggregated) EE information

policy mechanisms to monetize negawatts

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democratized market for EE services

Future research:

What effect would *democratizing* efficiency have on **market innovation**, **participation rates**, and **energy savings**?

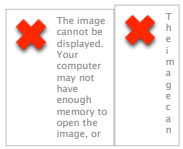
Machine Learning Approaches to Predicting Energy Consumption

J. Zico Kolter, PhD

MIT Computer Science and
Artificial Intelligence Laboratory

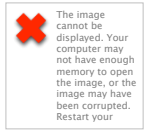
Predicting Energy Consumption

- Goal: Predict monthly electricity and gas consumption for a building

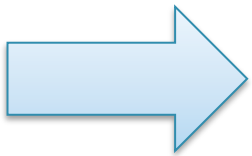


Monthly electricity and gas bills for Cambridge buildings

Cambridge GIS (Geographical Information System) database

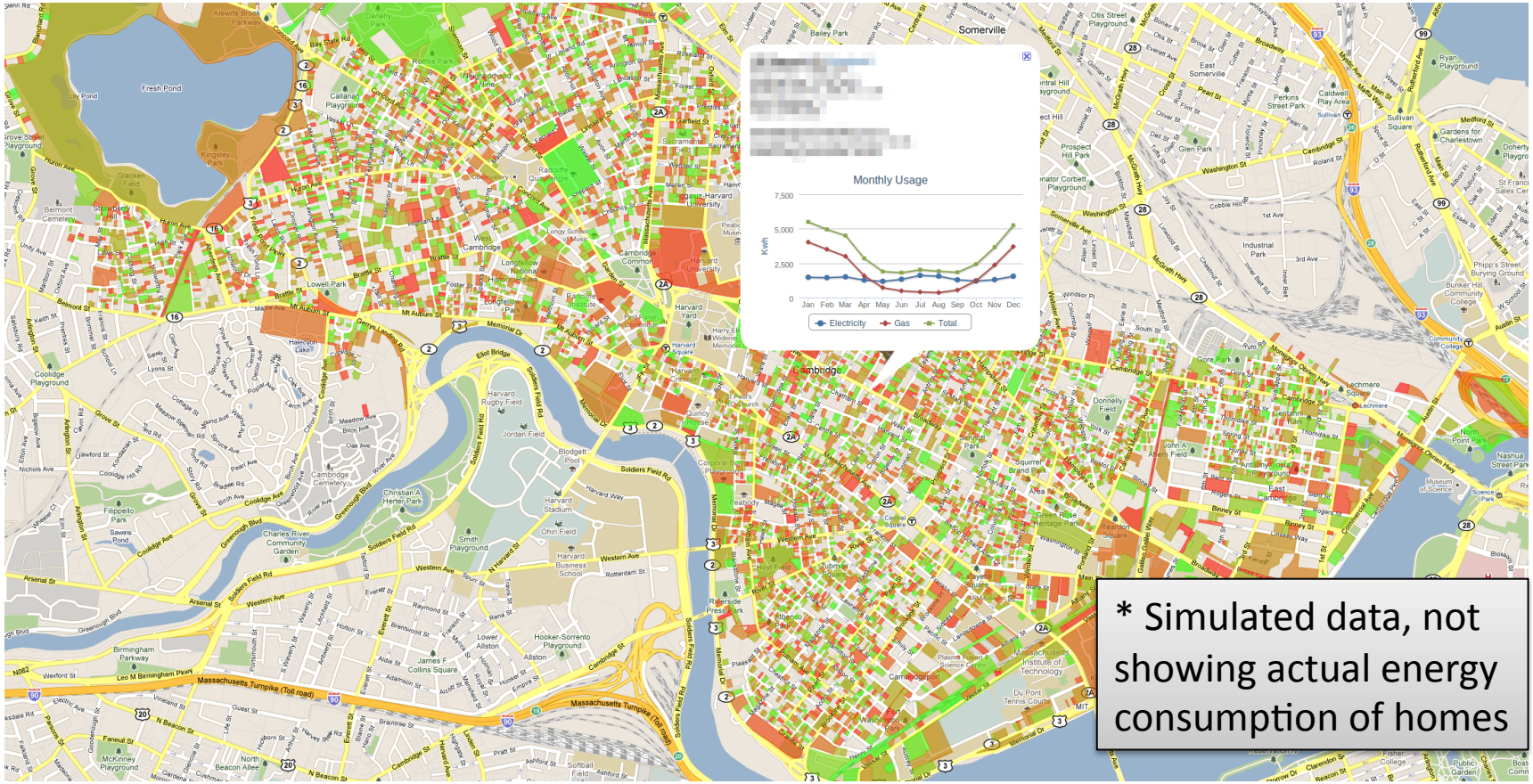


Tax assessor records

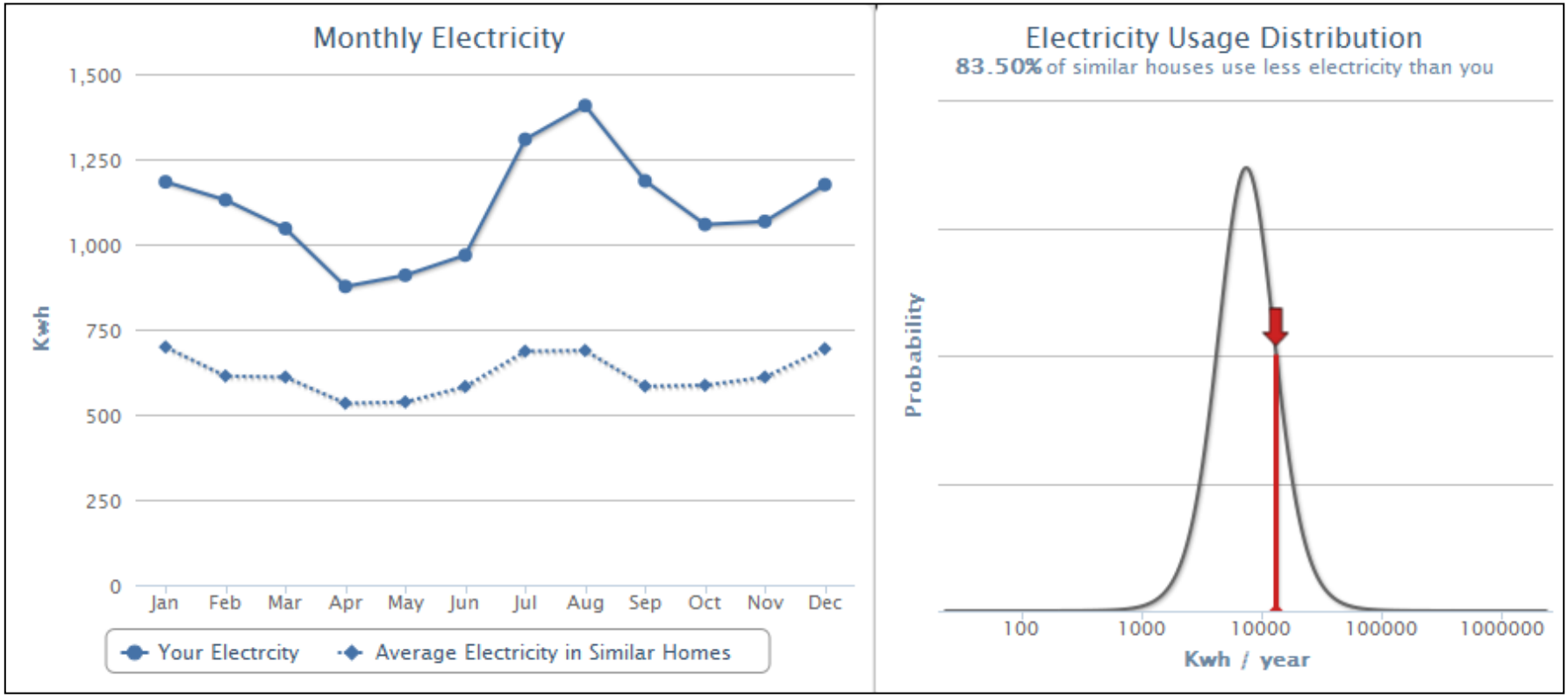


Build model that explains 75% of the variance in building energy consumption

Visualizing Consumption



Visualizing Consumption



J. Zico Kolter

Predicting Energy Consumption

- All data sources except monthly utility bills are publicly available
- Opportunity to quantitatively evaluate different modeling / prediction algorithms
- Serves as a starting point for incorporating more complex features for energy prediction

Quantitative Infrared Thermography for Large-Scale, Targeted Retrofit of Res. Homes

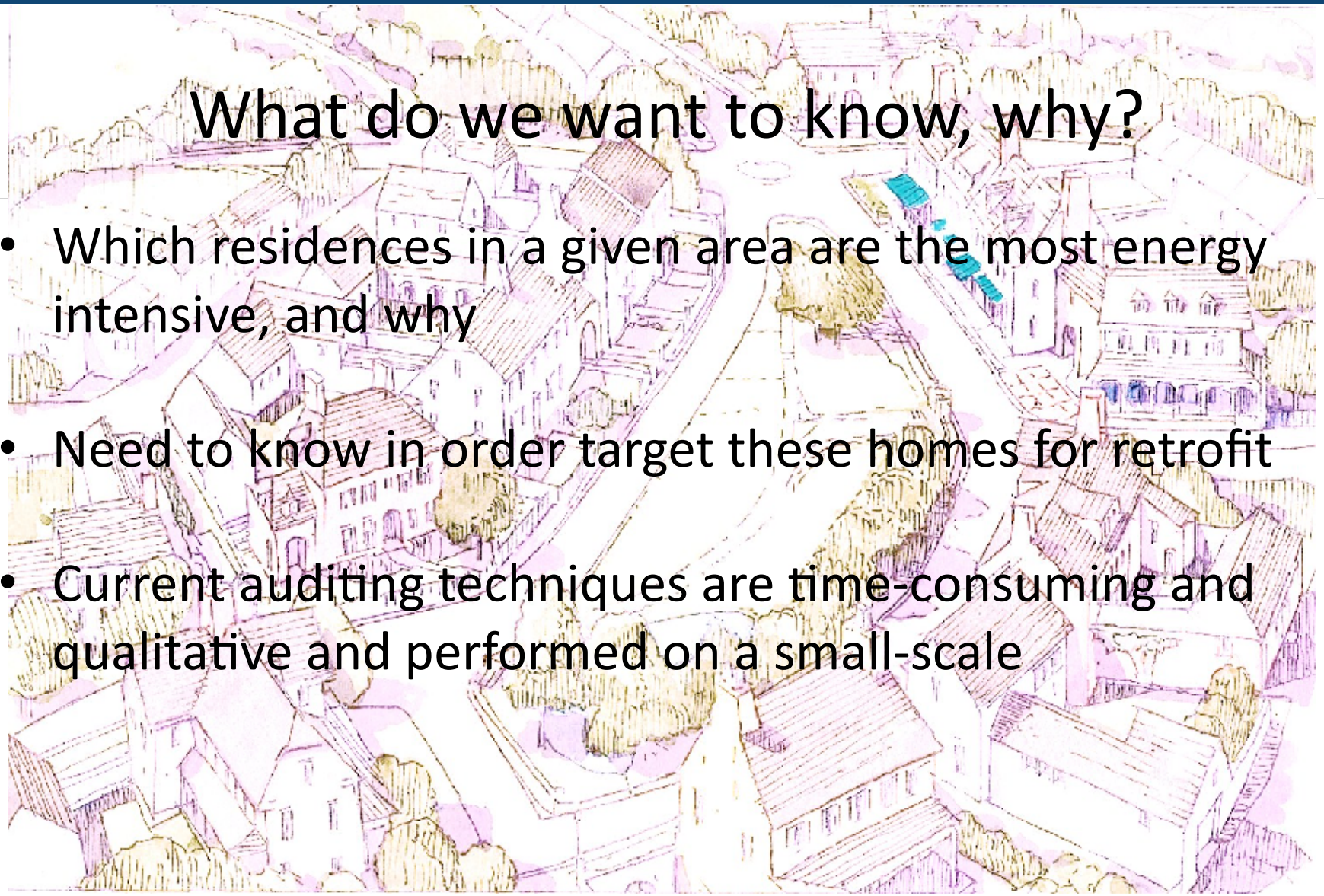
Kaitlin Goldstein

PhD Candidate

MIT Building Technology Program

Quantitative Infrared Thermography for Large Scale Targeted Retrofit of Residential Homes

Kate Goldstein



What do we want to know, why?

- Which residences in a given area are the most energy intensive, and why
- Need to know in order target these homes for retrofit
- Current auditing techniques are time-consuming and qualitative and performed on a small-scale

How do we obtain this information?

- Drive-by infrared scan of homes
  - Augmented with data about external conditions
- Information then used to develop an R-value map
  - Map telling us how well insulated the home is in different areas
- Most difficult part getting data sufficiently accurate to be predictive
- Need not only good model of heat transfer at building surface
  - Understand why building looks the way it does through the lens

How do we use this information?

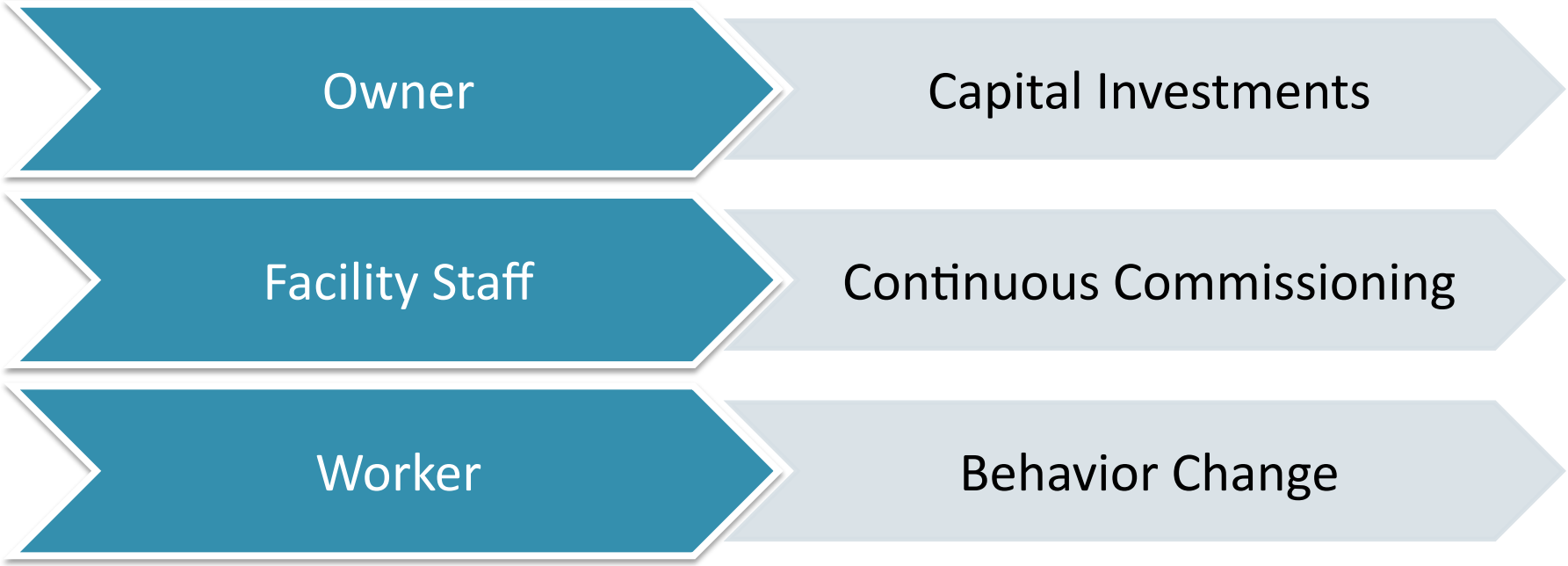
- Could be used in many different ways by many different parties
- First and foremost, informational tool
  - Help us to understand what we already have
- Can also help inform those willing to support/subsidize

Using Information to Drive Efficient Operations and Behavior

Elena Alschuler, Masters Candidate
MIT Department of Urban Studies and Planning

Kat Donnelly, PhD Candidate
MIT Engineering Systems Division

Why Real-Time Data for Office Buildings?



Elena Alschuler & Kat Donnelly

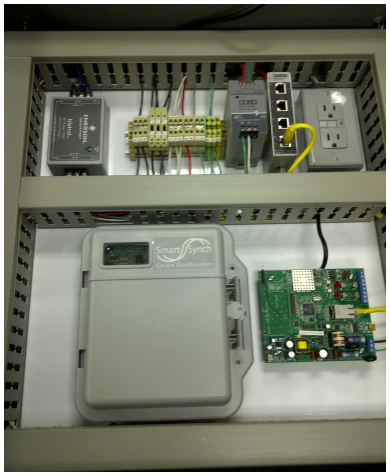
Smart Energy Now Pilot, Charlotte

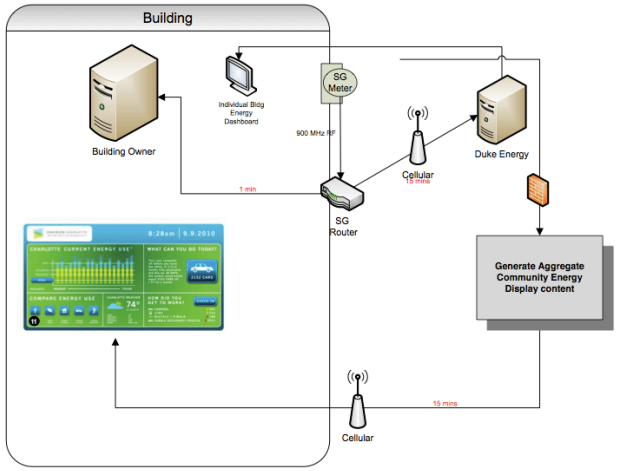
- Propose a new strategic approach to achieving cost-effective energy efficiency
- Reduce energy use in office buildings by 20%, 5% via behavior change
- Deliver a first-of-its-kind behavioral efficiency program with regulator approval
- Increase participation in capital incentive programs

Elena Alschuler & Kat Donnelly

Installing Meters & Obtaining Data

- Installing interval "shadow" meters in all 70+ office buildings downtown
  - Buildings host 75,000 workers
  - Bank of America, Wells Fargo, Duke Energy, Public buildings = 80% SF
- >200 meters and >150 routers (Cisco), wireless 4G LTE technology (Verizon)





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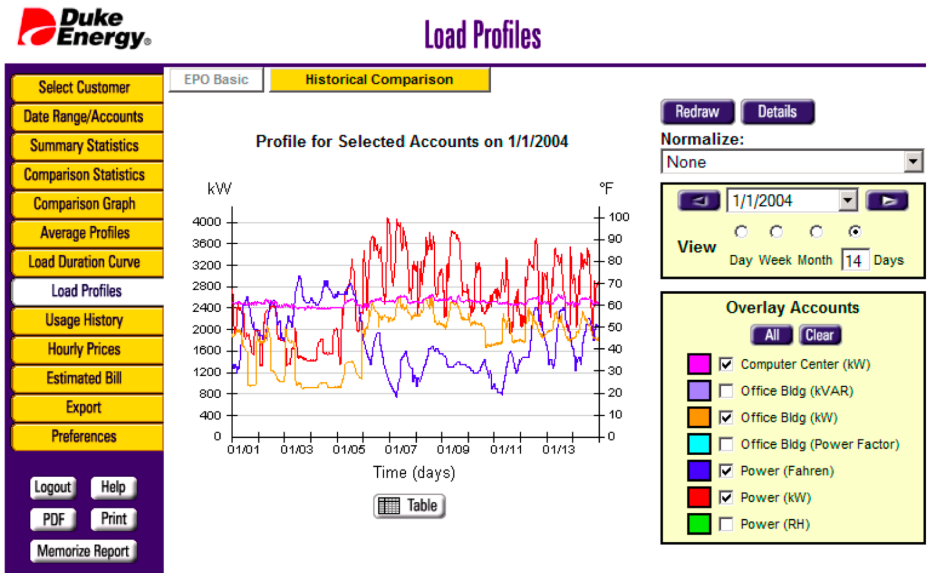
Translating Data into Usable Information

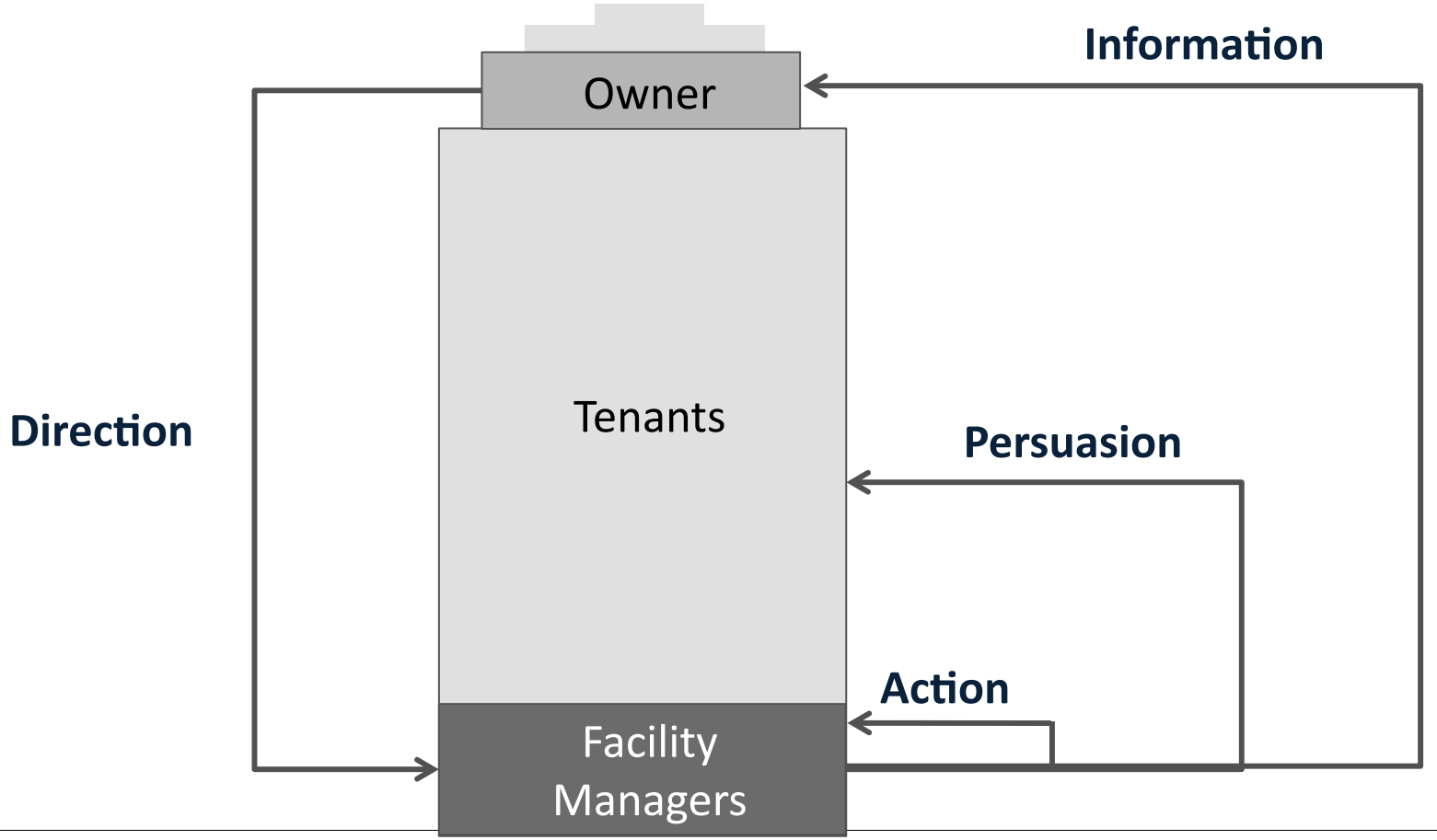
Real Time Feedback	Clearly Presented	Actionable Tips
Fault Detection	Technical support	Training

Translating Information into Action

- Downtown-wide data displayed ***to public*** on touch screens in building lobbies
- Meter-level information for ***owners and staff***

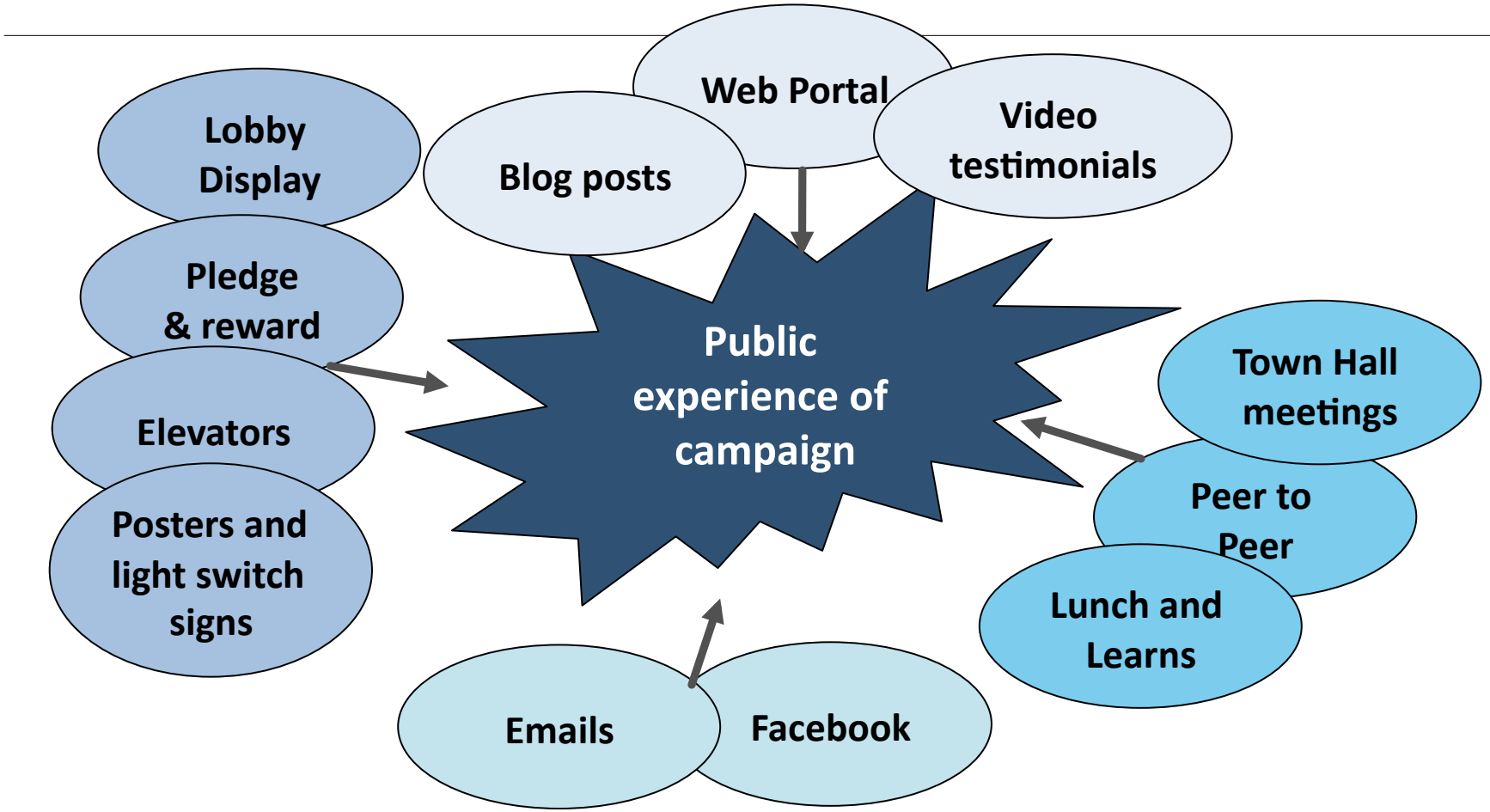


Creating a Feedback Loop for Management



Elena Alschuler & Kat Donnelly

Media Channels to Engage Worker Bees

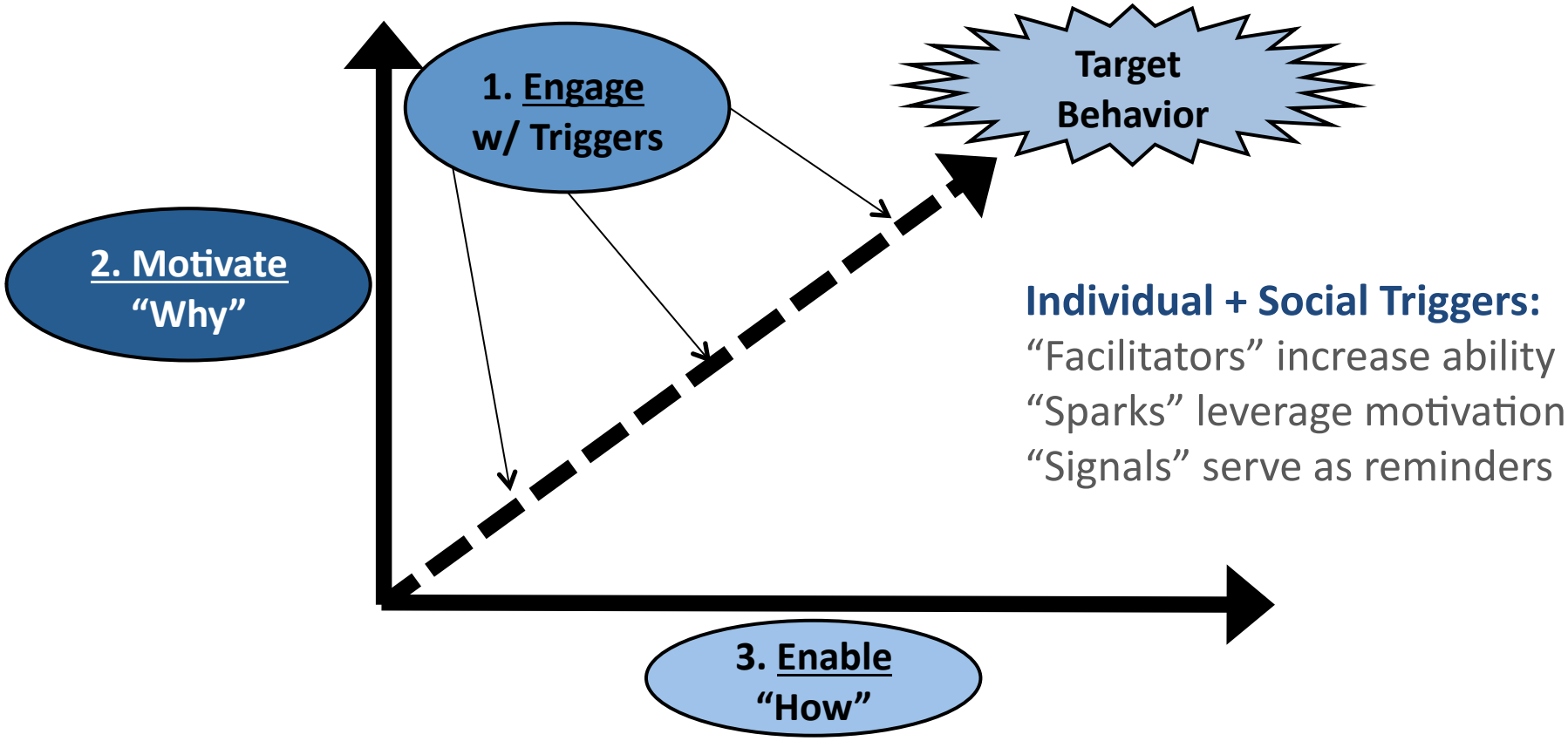


Source: O'Neill, Kerry (Earth Markets) and Donnelly, Kat A. (EMpower Devices) (2011)

Kat A. Donnelly

Data- and Information-Enabled Efficiency

Psychological Framework for Behavior Change



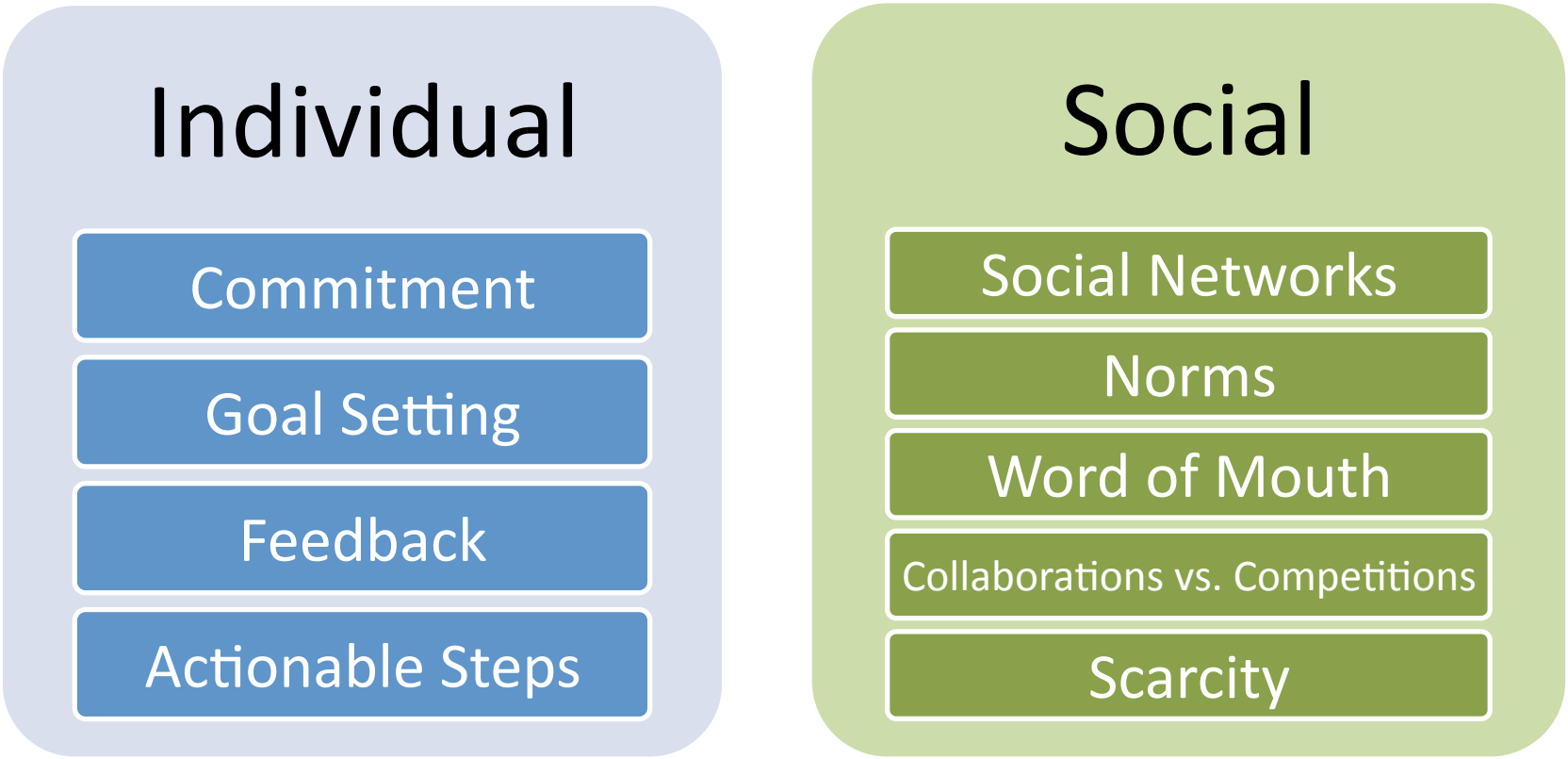
Individual + Social Triggers:
"Facilitators" increase ability
"Sparks" leverage motivation
"Signals" serve as reminders

Sources: Donnelly, K. A. (2010); Ehrhardt-Martinez, K., Donnelly, K.A., and Laitner, J.A. 2010; Armel, K. Carrie, 2010.

Kat A. Donnelly

Data- and Information-Enabled Efficiency

Four Individual and Four Social Triggers



Sources: Donnelly, K. A. (2010); Ehrhardt-Martinez, K., Donnelly, K.A., and Laitner, J.A. 2010; Armel, K. Carrie, 2008, Cialdini, 2008.

Kat A. Donnelly

Resources

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Assessing Massachusetts Green Communities Program for Municipal Building Retrofits

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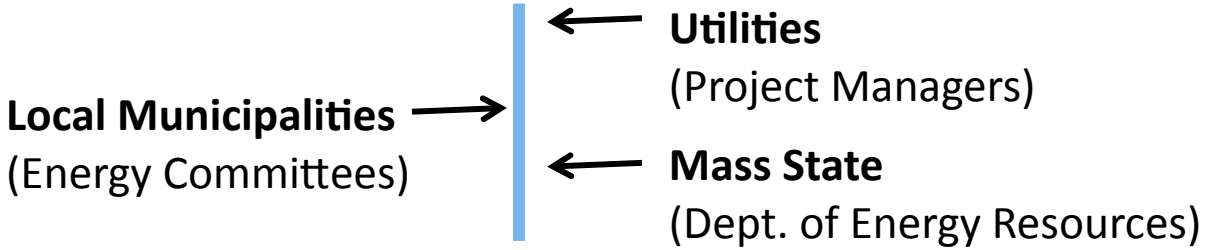
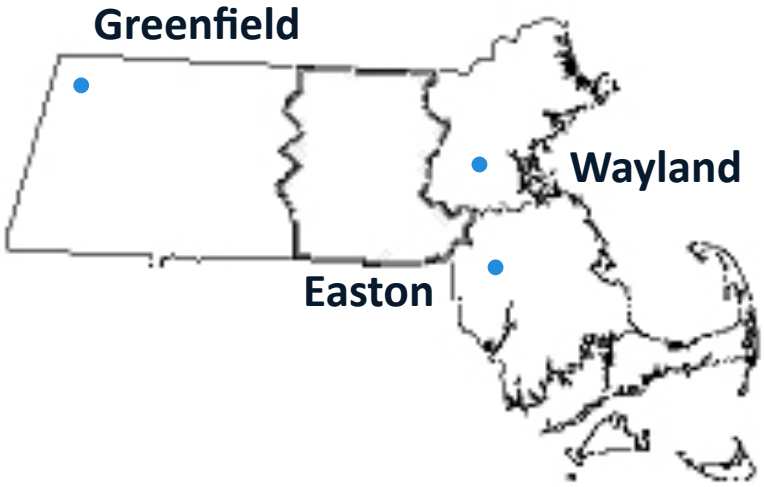
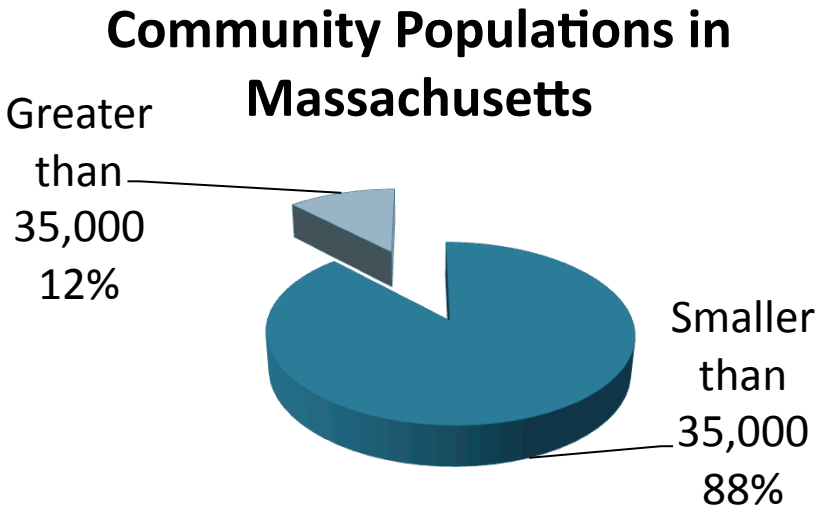
Will MA Green Communities Enable Energy Efficiency?



1. What **enables** communities to achieving energy efficiency?
2. What aspects of the MGC Program are **barriers** to its success?
3. Are **small communities a threshold** for a more fortified program?

Community Factors





Town	Population	Median HH Income	Volunteer or Staff Lead	Region	Type of Government	Champion Present
Wayland	13,219	130,643	Volunteer	Northeast	Open	Yes
Easton	22,913	84,375	Staff	Southeast	Open	Yes
Greenfield	17,862	45,188	Staff	Western	City Council	Yes

Preliminary Conclusions

1 ENABLERS

MassEnergyInsight
POWERING EFFICIENCY

Web-Based Tool

2 BARRIERS

Lack of easy information to:

- Restructure local political mobility
- Benchmark proposed projects
- Financing tools
- Know how to leverage other grants & programs

3 SMALL COMMUNITIES A THRESHOLD?

No

Additional Observations

COMMUNITY SIDE

- **Small communities** are generally showing more interest than larger communities.
- The most successful communities have had a **champion** – an individual with pre-existing expertise or values for energy efficiency.

UTILITY SIDE

- The utilities do not have enough **personnel** to run the collaborative process well.
- Program Planning and Administration **(PPA) is limited**, but to reach deeper energy efficiency, increasingly more PPA intensive projects are required.

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Data- and Information-Enabled Efficiency

Image Source: http://scheuring.wordpress.com/category/energy-saving-home-products/

Equity and Efficiency

Panel Preview

- Efforts to Integrate Equity and Energy Efficiency

- Policies and Programs to Deliver Benefits Beyond EE and to Communities often Overlooked

Job Quality and Outcomes in Residential Energy Efficiency

Ryan Hammond

PhD Candidate

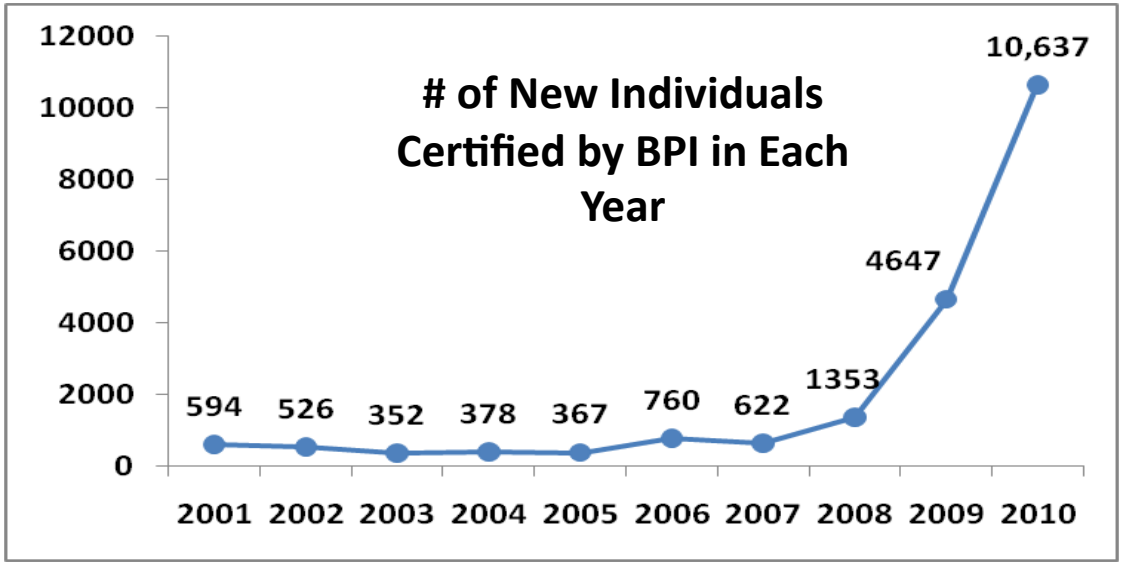
MIT Sloan School of Management

Residential Retrofits as Job Creators

- Policy Aim under ARRA to create not only many jobs but "good" and "sustainable" jobs
- Pace of job creation has been slower than hoped due to administrative needs
- Training has been ramping up rapidly and money just now beginning to be deployed
- Are the jobs being created "good" jobs?

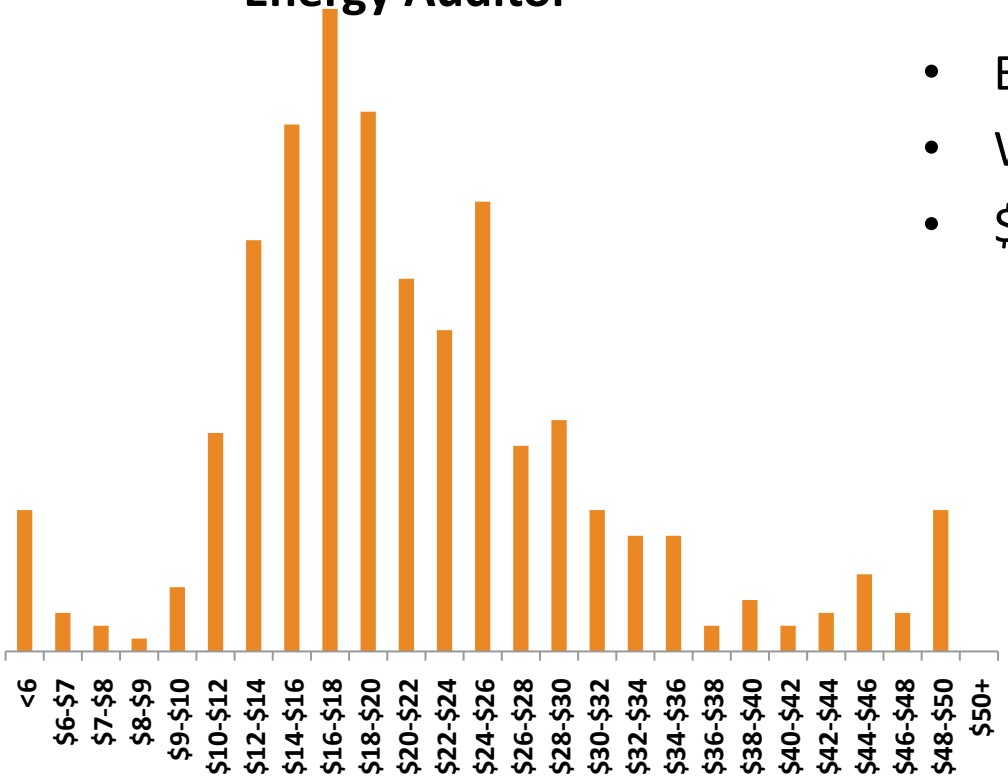
Residential Retrofits as Job Creators

- Data from survey sent to all individuals who took a Building Performance Institute certification exam in 2010



Energy Auditor Wages

Distribution of Reported Wages for Energy Auditor



- Exempt from Davis Bacon
- Wide Range
- $18-20/hr average

Health and Pension Benefits

By Job Category

% who receive through employer	Health Benefits	Retirement Benefits	Union Member
All job categories	54%	41%	6%
Insulation Installatio	44%	37%	8%
Crew Chief	46%	28%	8%
Energy Auditor	48%	38%	3%
HVAC Specialist	75%	55%	7%
Other - Misc	69%	56%	9%
Sales and Marketing	55%	37%	2%
Senior Manager/ Owner	48%	34%	4%
Trainer	65%	59%	15%

By Organization Type

% who receive through employer	Health Benefits	Retiremenet Benefits	Union Member
All Organizations	54%	41%	6%
CC/University	66%	60%	27%
Gvt. Program	78%	63%	10%
Non-Profit	83%	63%	4%
Other - Non-REE related	81%	69%	31%
Other - REE related	62%	53%	11%
Other-For Profit	85%	59%	9%
Contractor NOT spec. REE	58%	46%	4%
Contractor spec. REE	41%	25%	2%
Self-employed	20%	14%	1%
Utility	84%	80%	4%

Other Job Quality Attributes

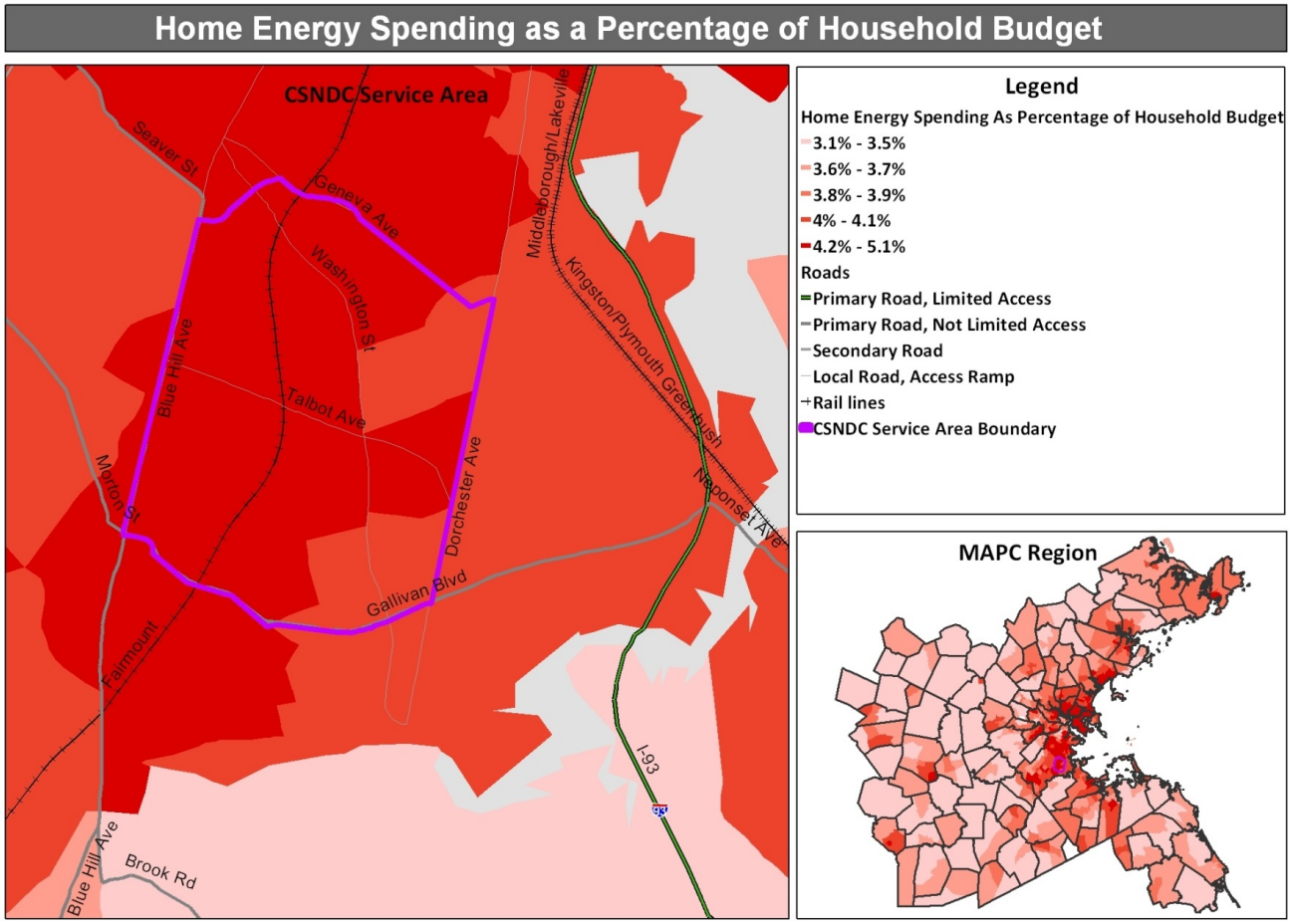
% Very or Somewhat Satisfied	Training and Skill Development	Control Over Work	Career Advancement Opportunties
All job categories	75%	83%	59%
Insulation Installation	65%	68%	45%
Crew Chief	60%	84%	48%
Energy Auditor	73%	80%	54%
HVAC Specialist	72%	82%	59%
Other - Misc	75%	79%	59%
Sales and Marketing	72%	78%	62%
Senior Manager/Owner	80%	90%	71%
Trainer	83%	90%	62%

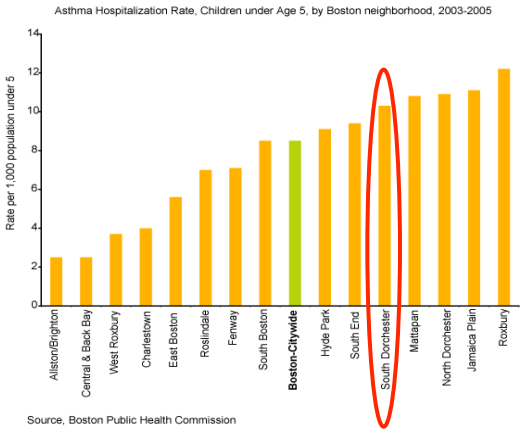
Healthy, Energy Efficient Homes:
Part of a Neighborhood Sustainability Plan for Codman Square

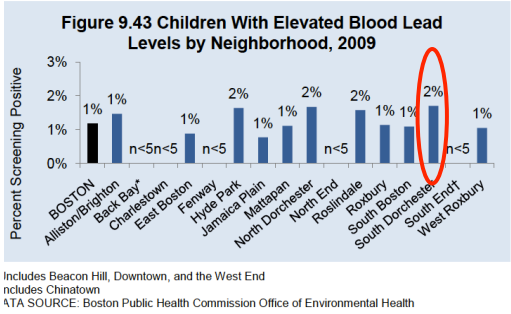
Brendan McEwen & Rosie Sherman

Equity and Efficiency

Health & Energy - Bridging Opportunities in Codman Square & the Boston Metro Region



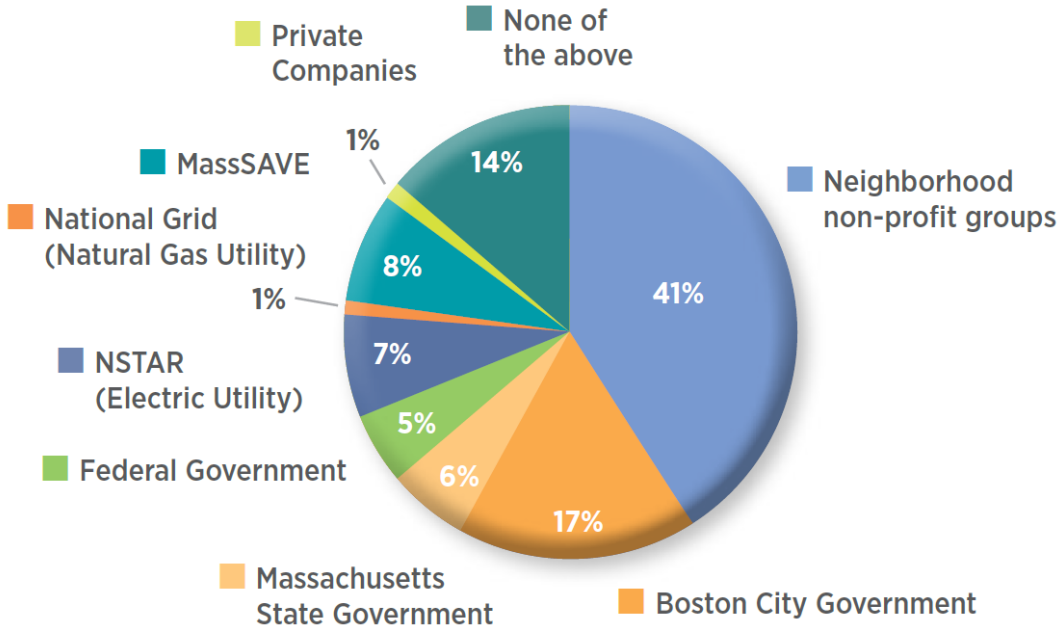




Brendan McEwen & Rosie Sherman

Building on Community-Based Energy Efficiency

Whom do you trust most about getting information on energy efficiency program?

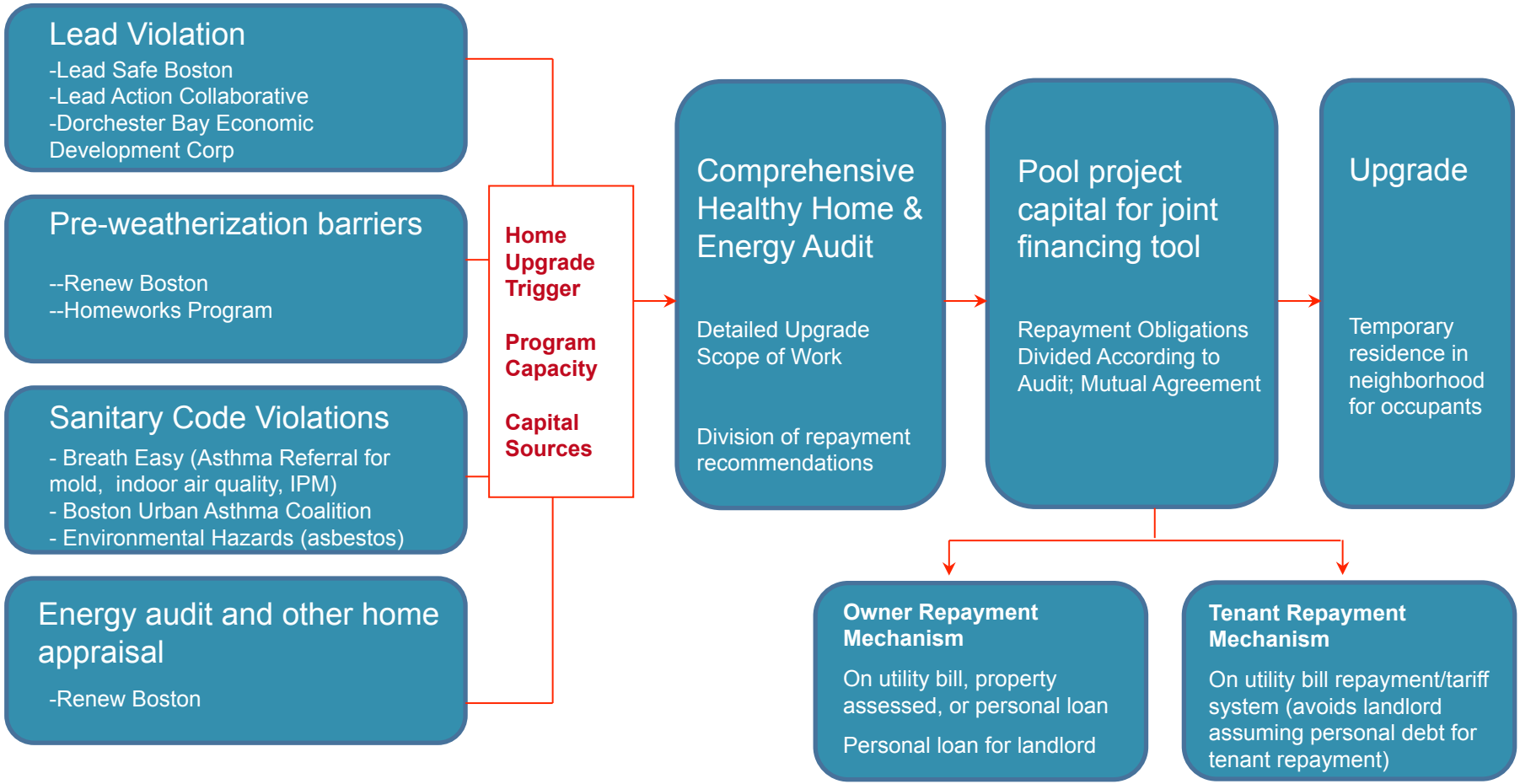


Source: City of Boston. 2010. Polling at climate action planning engagement processes.

- Draft energy efficient and healthy home management strategy for CSNDC's existing portfolio
- Outline comprehensive energy efficient and healthy home upgrade process
- Incorporate energy & healthy homes into existing community engagement

Equity and Efficiency

Comprehensive Home Upgrade Strategy



Brendan McEwen & Rosie Sherman

Program Outreach During CDC Engagement

Existing Community Engagement

- 10 year Neighborhood Plan
- Family Plans
- Individual Financial Fitness

Energy Efficiency & Healthy Homes Outreach

- Promote programs at community events; CBSM
- Incorporate EE into financial fitness
- Outreach to landlords ('Good Landlord' program?)

Energy Efficiency and Moderate-Income Households

Marcus Rozbitsky

Masters Candidate

Urban and Environmental Policy and Planning

Tufts University

To what extent are Moderate-Income Households Participating in Energy Efficiency?

- Discretionary Income
  - Do moderate-income households have the discretionary income to participate?
- Programs
  - Are there specific programs targeting moderate-income households?
- Potential
  - What is the potential in moderate-income households?
- Participation
  - Are moderate-income households participating?

Results

- Do have discretionary income, but limited for many
- Perceived need by industry to target
- 25% of MA's Residential energy use
- Weak correlation between income and participation on Cape Cod

Energy Efficiency Ordinances Targeting Rental Housing

Pat Coleman

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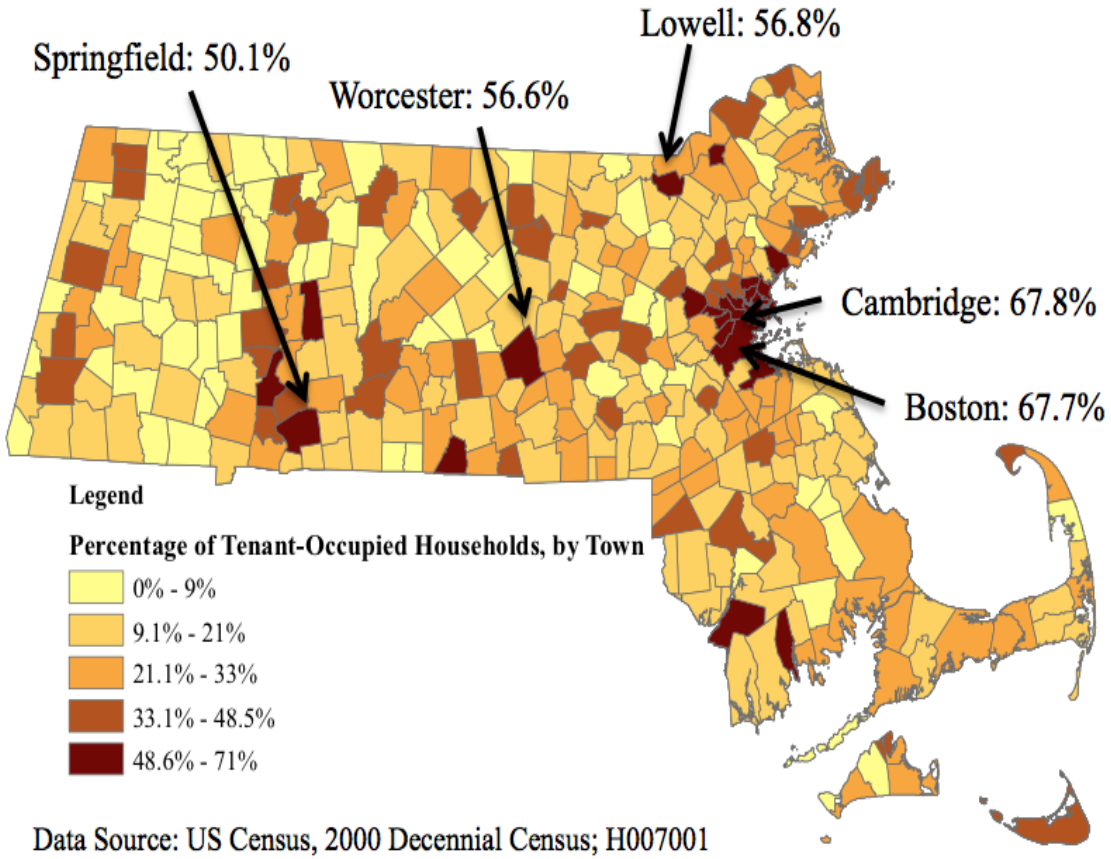
MIT Department of Urban Studies and Planning

Tenants and Energy Efficiency

- Income / Spatial Disparities
- Barriers / Strategies
  - "Hard to Reach"



Increase in Public Interest

Image Source: City of Boston, "Sparking Boston's Climate Revolution, 2010"

- $3.2 billion EECBG
- Municipal Actions: Renew Boston

State and Local Policies to Enable EE in Rental Properties

- Mandatory EE Standards
  - San Francisco & Berkeley, CA, Wisconsin, Burlington, VT
- Information and Upgrade Ordinance
  - Austin, TX

Ordinance Outcomes and Recommendations

- Lack of formal evaluation
- Ordinances deliver EE floor, facilitate valuation of EE, and enable focus on deeper EE

- Considerations for municipalities
  - Mandate upgrades at time of sale at little incremental cost
  - Targeting of municipal efforts

Image Sources:
http://affordablehousinginstitute.org/blogs/us/2005/04/triple_deckers.html
http://www.allatticinsulation.com/attic-insulation-spring-texas

EXPLORING THE IECC 2009 ENERGY CODE IN KENTUCKY

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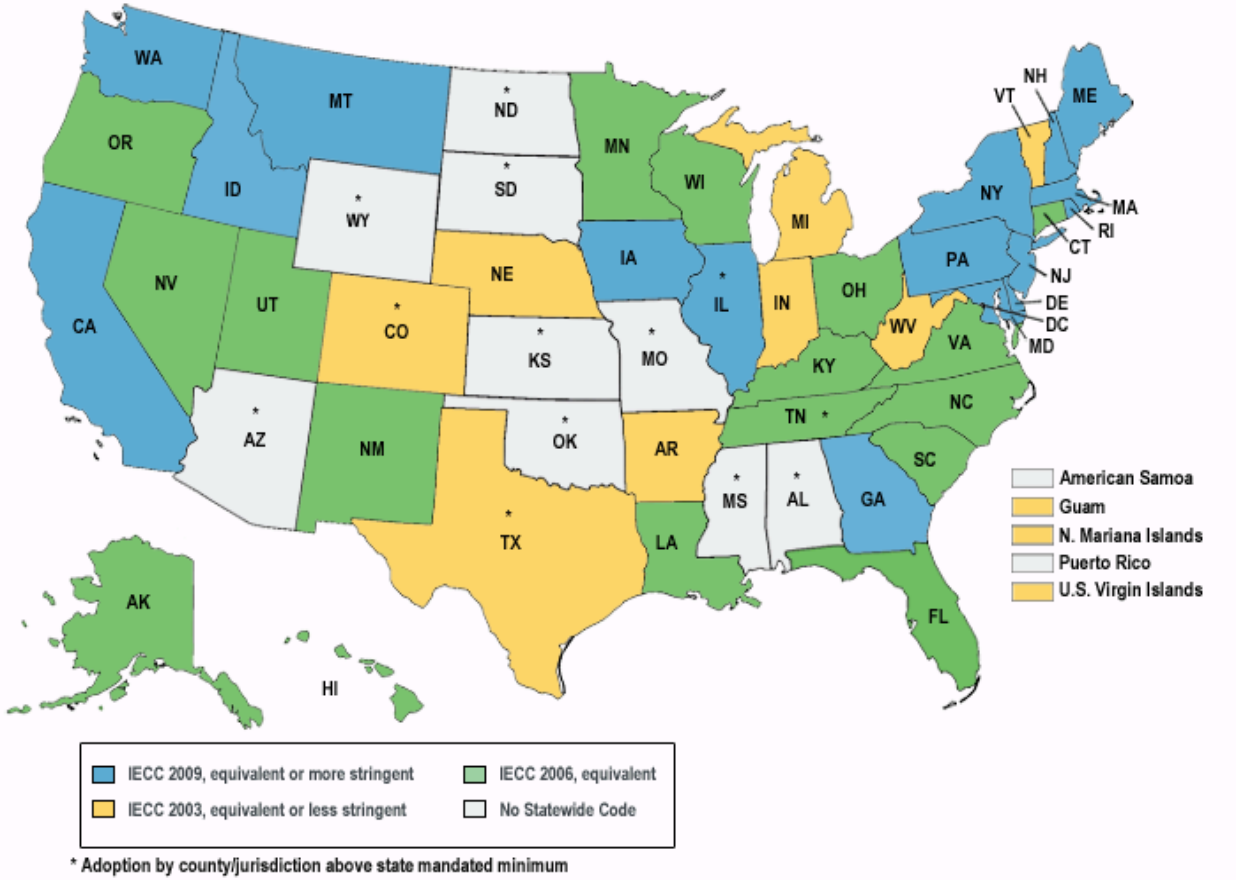
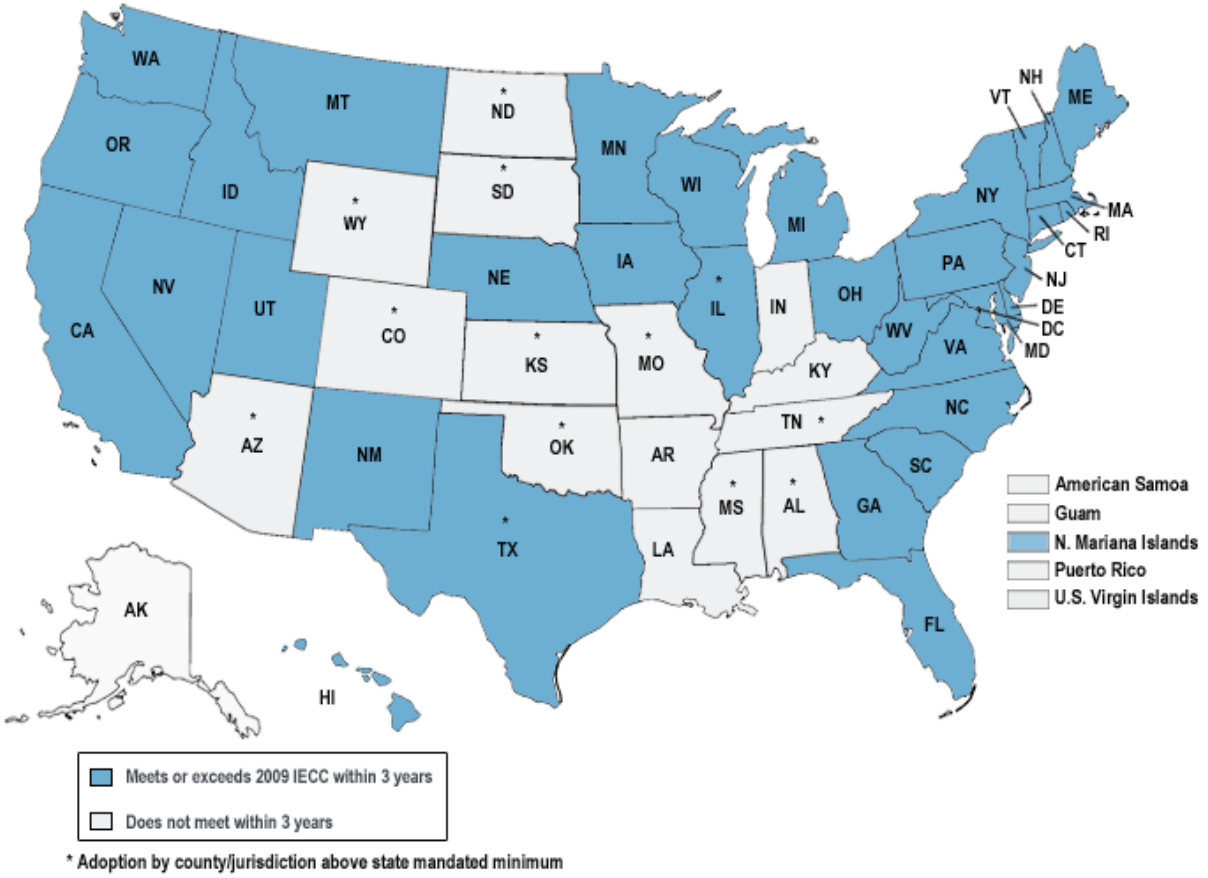
Energy Code Status Now



Energy Code Status by 2013



Areas of Study

- Adoption
- Implementation
- Enforcement

Future Research

With low energy prices, low residential building rates, and little energy efficiency infrastructure…

- Incentive to fully fund enforcement efforts?
- Simplify enforcement to ensure equal efficiency at less cost?
- What is the role of utilities?

Greening HBCU's

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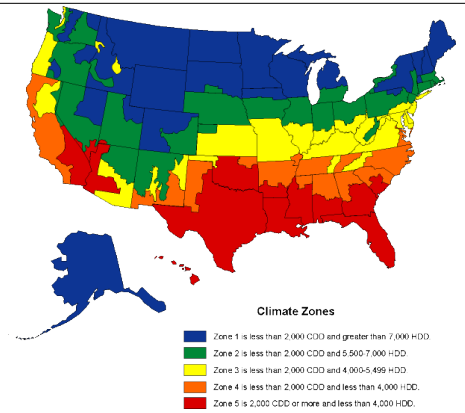
The University Context and *HBCU's*



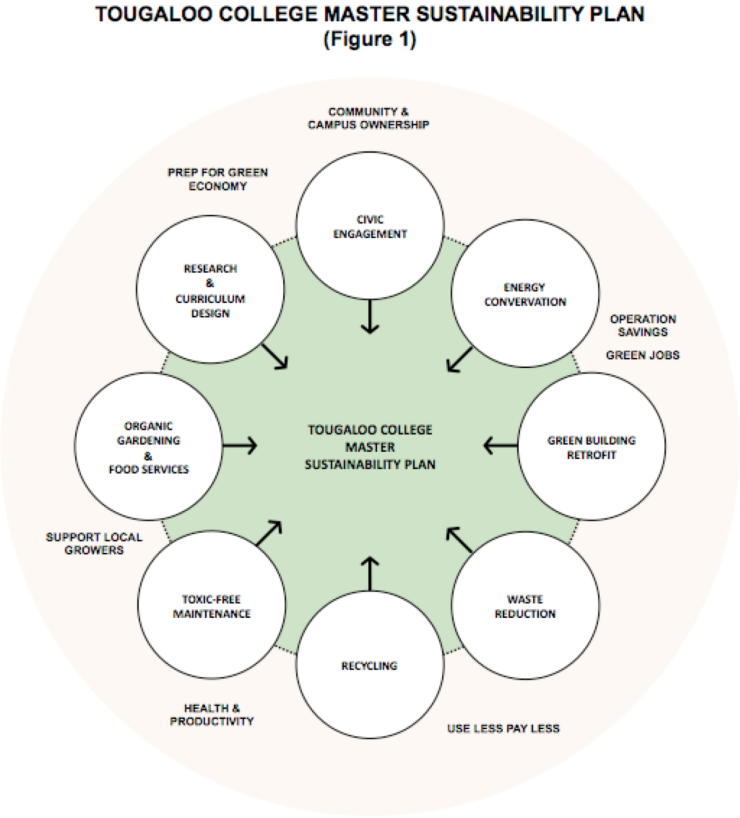
27 Billion kWh/yr

- Size and nature of building stock
- Curriculum development
- Savings to universities in financial trouble (**15% reduction = $300 Million/yr)**
- Influence on communities in the South/midwest
- *Centers of intellectual thought*
- *Equity and justice*
- *Broad influence of alumni*

On the ground

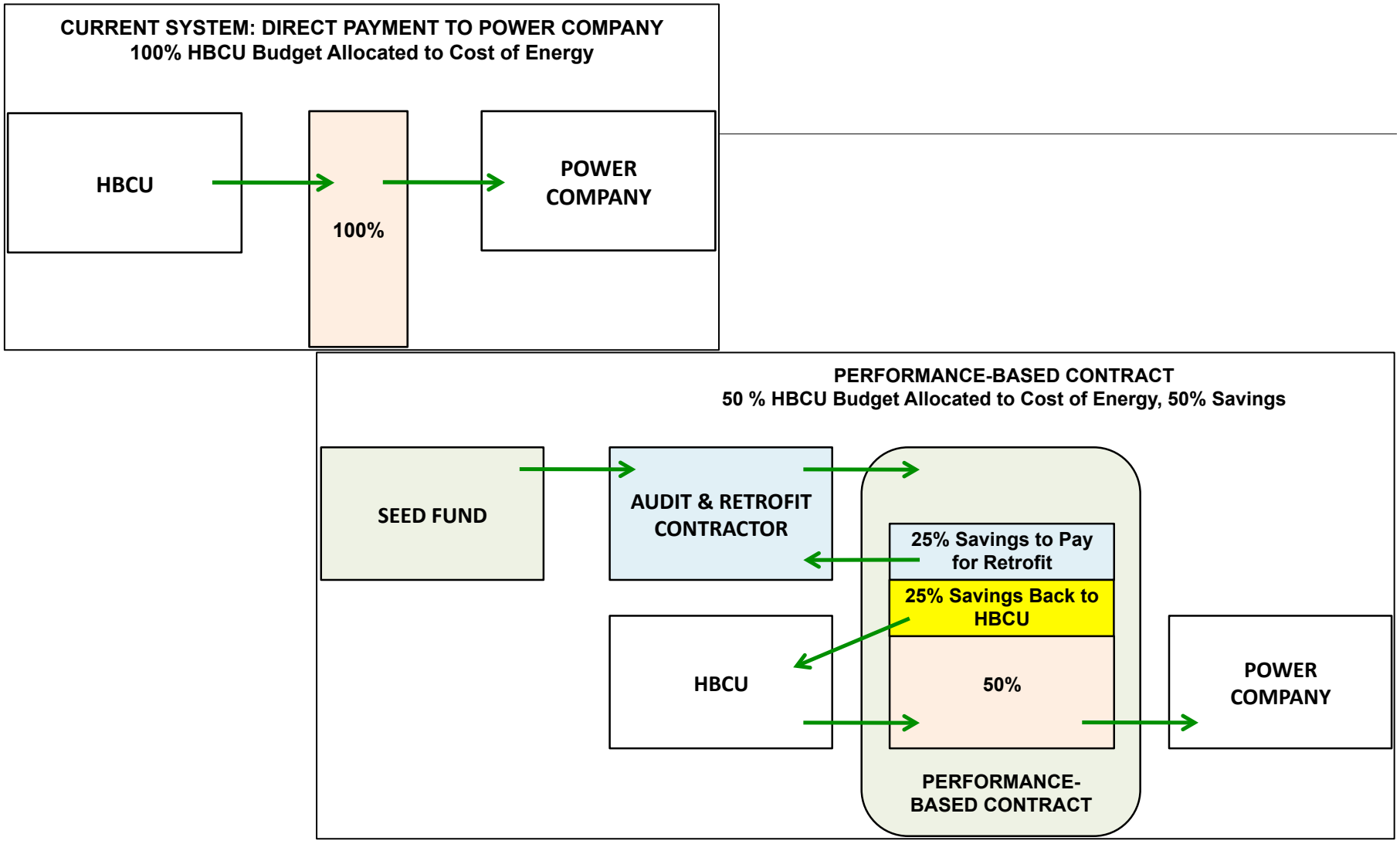
TOUGALOO 1869 COLLEGE — *Where History Meets the Future*

- Founded in 1869 in Tougaloo, MS
- Enrollment = 856
- 100 acres of land, 450,000 sqft of building space
- 7,200,000 kWh electricity usage
- $540K/yr spent
- **15% savings = $80K**



Equity and Efficiency

OPPORTUNITIES AROUND ENERGY EFFICIENCY RETROFIT



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