

# Greening Housing Research

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# Greening Housing Research



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# Speaker: Carlos Martín, PhD



Senior Associate,  
Social and Economic Policy  
Division,  
Abt Associates



# **Green Housing Research: A Review**

- Traditional Housing Topics
- Green Housing Topics
- The State of Green Housing Research
- Highlights in Green Housing Research
- Implications for Residential Architects

# Traditional Housing Topics

***What do residential architects care about?***

- Architectural Form
- Building Performance
- Professional Practice and Practitioners
- Economics (Costs and Benefits)
- Land Use
- Client Needs and Occupant Behaviors
- Finance for Housing
- Housing Policy

# Green Housing Topics

## ***How does “green” change this?***

- Is there a history and theory of green design?
- Is there enough technical performance data?
- What do cost-benefit studies show about green homes?
- How has green changed architectural schools, professional credentials, and practice (liability, scope, etc.)?
- Do we know what green clients want and how they act?



# The State of Green Housing Research

## *Are researchers providing answers?*

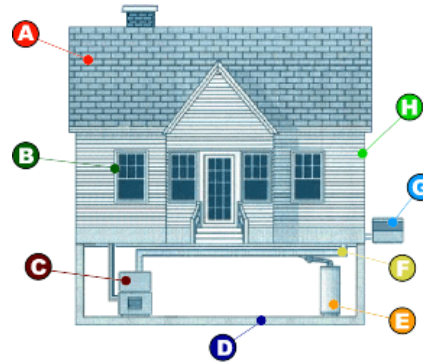
- Defining Green Housing
- Research Findings are Recent
- More Work on Green Housing Practices and Policies than Research in All Areas
- Commercial Building Research Spillover
- Interesting findings, but more to come

# Highlights in Green Housing Research

- Performance
- Land Use
- Policy
- Economics
- Finance
- Behaviors
- Practice and Practitioners
- Form

# Green Housing Research: Performance

- Performance Topics
  - Energy Efficiency
  - Health
  - Materials



- Performance Researchers
  - DOE [Building America](#), Energy Star, Labs
    - BSC, CARB, CNT Energy, NAHB RC, Etc.
  - Non-Profits
    - [National Center for Healthy Housing](#)
  - Building Science Consultants & Manufacturers
  - University-Based Researchers
  - Green Building Programs

# Green Housing Research: Land Use

- Land Use Topics
  - Smart growth
  - TOD
  - Transportation
  - Affordability
- Land Use Researchers
  - Government: EPA, HUD, DOT
  - Non-Profits: ULI, Brookings, CNT, NHC, CTOD
  - Universities: [U MD](#), UT

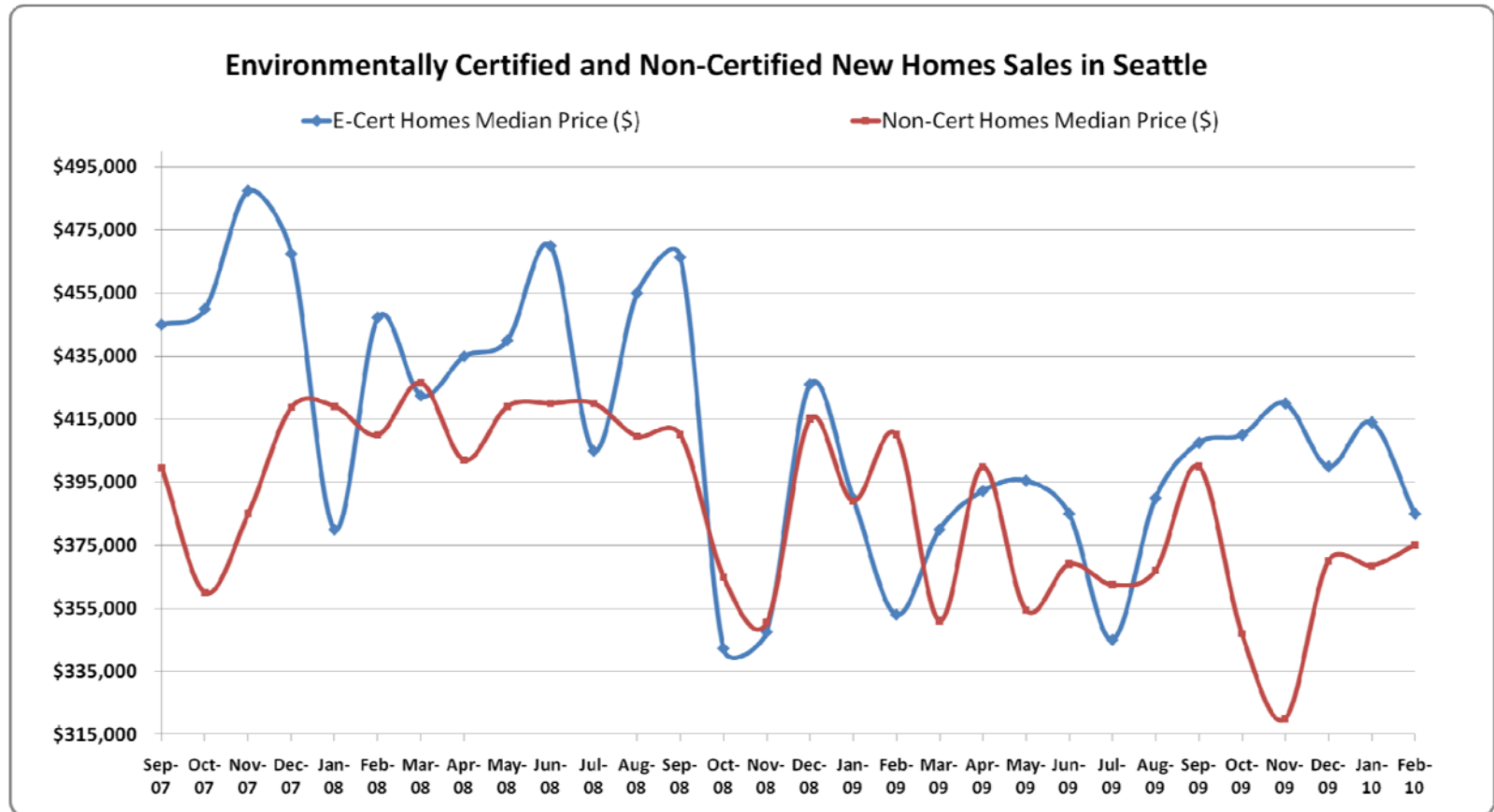
# Green Housing Research: Policy

- Policy Topics
  - Program evaluations (Weatherization, energy block grants, ARRA funding)
  - Public home finance evaluations (Homeowner tax credits, PACE, PowerSavers)
- Policy Researchers
  - Government: DOE, Treasury, OMB
  - Non-Profits: [ACEEE](#)

# Green Housing Research: **Economics**

- Economics Topics
  - Valuations and Resale
  - Cost-Benefit Analyses
  - Affordability
- Economics Researchers
  - University-Based Researchers
    - [Journal of Sustainable Real Estate](#), Appraisal Journal
  - Realty, Realty Investor, Energy Investor Groups
    - [GreenWorks Realty](#), Costar Group, Greg Kats
  - Non-Profits
    - Enterprise Communities, IMT

Source: GreenWorks Realty, “Environmental Certification Report  
September 2007 – February 2010”



# Green Housing Research: Finance

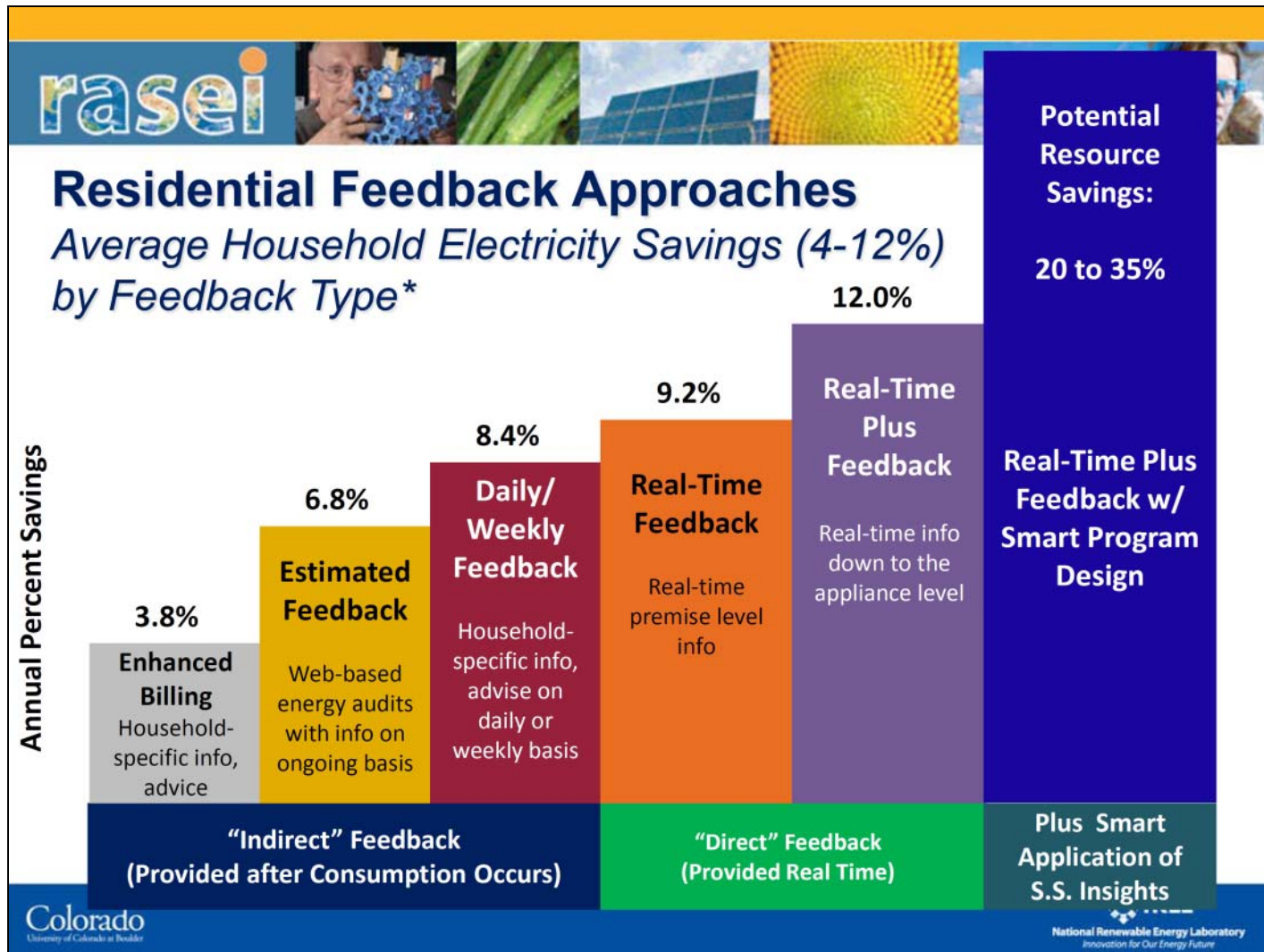
- Finance Topics
  - Green Financial Product Performance
    - energy improvement loans
    - energy-efficient & location-efficient mortgages
  - Alternative Financial Literacy and Product Tools
- Finance Researchers
  - Federal Government
    - HUD, DOE, EPA
    - Fannie Mae/Freddie Mac & Federal Reserve
  - Non-Profits and Academics
    - Blackman & Krupnick (2000)
    - Holtzclaw et al (2002)
    - [Rauterkus, Thrall, & Hangen](#) (2010)



# Green Housing Research: Behavior

- Behavior Topics
  - Homeowner/occupant conservation/efficiency behavior (the “rebound” effect)
  - Effectiveness of information and channels (smart meters and other feedback)
  - Incentives
- Behavior Researchers
  - Non-Profits: [ACEEE](#)
  - Government: DOE, NREL, LBNL, CEC
  - Universities: U CO, Stanford, UC
  - Utilities: O Power, PG&E

Source: Karen Ehrhardt-Martinez, [“Engaging Households and Saving Energy through Smart Feedback Initiatives: Lessons from a Meta-Review”](#) National Renewable Energy Lab July 28, 2011



# Green Housing Research: Practice

- Green Practice and Practitioners Topics
  - Diffusion of green practices
  - Green professional credentials
  - Green professional liability and risk
  - Training and college green design programs
- Researchers
  - Universities: VA Tech, Harvard, Missouri State
  - Non-Profits: ACSA, ASCE

# Green Housing Research: **Form**

- Architectural Form Topics
  - Case studies
  - History and theory of green housing form
- Architectural Form Researchers
  - Firms: Kieran Timberlake; Michelle Kaufman
  - Universities: [John Fernandez MIT](#)



# Implications for Architects

- Direct Use
  - Performance
  - Form
  - Practice and Practitioners
- Indirect Use
  - Behaviors
  - Economics
  - Finance
- Horizon Use
  - Land Use
  - Economics
  - Policy

# Speaker: Marty J. Davey



Program Manager

New Ecology





buildingwell.org

wēgowise



SEARCH

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Water Conservation - Low-Flow Water Fixtures : Sloan AQUUS Greywater and Flush System

Health - VOCs : Low or No VOC Paint Suggestion

Summary

Discussion

Green Building Resources for Existing Affordable Housing



Feedback





Log In:

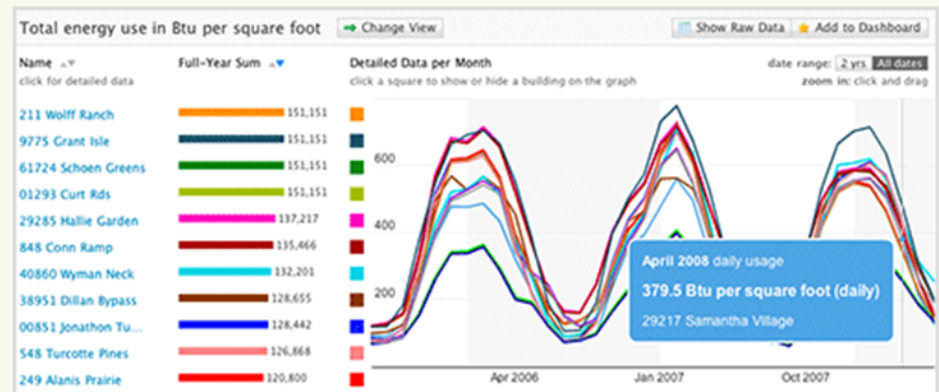
Username Password

## Powerful Utility Analysis

### Wise Decisions

WegoWise allows you to understand your entire portfolio's water and energy usage quickly and easily.

**Automatic and intuitive**, WegoWise will help you focus your investments and save money.



Create a New Account



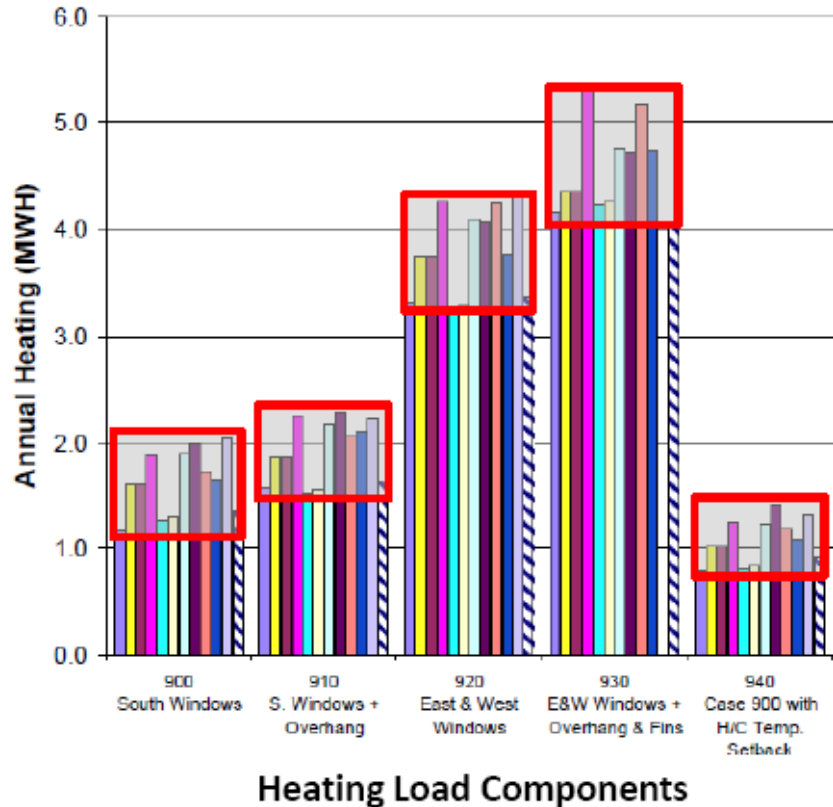
Watch a Demo

[www.wegowise.com](http://www.wegowise.com)

# Current Status

- Currently tracking 4400 buildings, and ~65,000 units
  - Tracking 1300 Low Income Buildings with 25,00 units
  - Many types of housing types and tenants
- Expect to add all affordable housing in Mass:
  - Projected up to 144,000 additional units by 2013  
(Including 85,000 units of public housing)
- Measurement and Verification for LEAN Multifamily
- Required for USGBC Multifamily Certification (2013)
- Web based – available for any user
  - Low Cost: \$5/building/month (free version also available)
  - Auto data uploading of usage data
  - Weather normalization nationally

# The Unhappy Truth About Forward Modeling Accuracy



Identical inputs produce wildly different outputs among even the best tools.

Annual heating load components vary up to 100% depending on the tool.

Modeling tools work best at making comparisons between hypothetical cases.

Source: EnergyPlus Validation 2004

## Models Vary. A lot.

wēgowise DASHBOARD PROPERTIES REPORTS [dteague - demouser1](#)  
[Edit Profile](#) [Log Out](#)

Building D This is a 2,000 sq ft, 3-story multi-family home.  
 All Developments > Spruce Village > Building D > Edit [View building characteristics](#)

[View Data](#) [Utility Accounts](#) [Building Upgrades](#) [Share](#) [Edit Building](#) [Delete Building](#)

### Edit This Building

Address      
Street Address City State Zip Code

Age & Type Year built (or date of last gut rehab)  (in increments of 10 years)  
 Single-family residence? ☐ Yes ☒ No

Housing Category Low-income housing? ☒ Yes ☐ No  
 Predominant resident category

Structure Type of construction   
 Is there a basement? ☐ Yes ☒ No

Size Gross building size  sq. ft.  Number of stories tall  
 Total size of apartments  sq. ft.  Number of apartments  
 Number of bedrooms

Energy Efficiency Has this building received "Green Building" certification? ☐ Yes ☒ No

Utilities & Fuels Which utilities will you be tracking for this building? (Check all that apply)  
☒ Electricity ☒ Natural gas ☐ Fuel oil ☐ Water

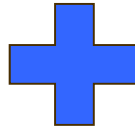
Heating    
Heating fuel Heating system

Cooling   
Type of cooling system

Hot Water    
Heating fuel Heating system

Facilities Does this building contain any of the following facilities?  
 Laundry room ☐ Yes ☒ No  
 Elevator ☐ Yes ☒ No  
 Ventilated parking garages ☐ Yes ☒ No  
 Swimming pool ☐ Yes ☒ No

Additional Notes You may specify notes for yourself related to the building (optional, e.g. "fill using single pane window")



wēgowise DASHBOARD PROPERTIES REPORTS [dteague - demouser1](#)  
[Edit Profile](#) [Log Out](#)

Gas #52156-10360  
 All Developments > Spruce Village > Building D > Gas #52156-10360

[View Data](#) [Import Data](#) [Edit Data](#) [Edit Utility Account](#) [Delete Utility Account](#)

### Data in this gas account

[Add data](#) [Download Data \(.csv\)](#) This utility account is up-to-date as of 4 days ago [Fetch data now](#)

End Date YYYY-MM-DD	Start Date YYYY-MM-DD	Usage Btu	Usage Therms	Total Charge	Supply Charge	Delivery Charge	Service Charges
2010-06-11	2010-05-15 (28 days)	9,600,000 Btu	96 Therms			\$59.45	
2010-05-14	2010-04-16 (29 days)	23,600,000 Btu	236 Therms			\$124.32	
2010-04-15	2010-03-18 (29 days)	31,700,000 Btu	317 Therms			\$170.80	
2010-03-17	2010-02-16 (30 days)	30,600,000 Btu	306 Therms			\$165.30	
2010-02-15	2010-01-21 (26 days)	39,900,000 Btu	399 Therms			\$201.01	
2010-01-20	2009-12-16 (36 days)	55,900,000 Btu	559 Therms			\$281.11	
2009-12-15	2009-11-16 (30 days)	35,500,000 Btu	355 Therms			\$185.35	
2009-11-15	2009-10-18 (29 days)	31,900,000 Btu	319 Therms			\$146.04	
2009-10-17	2009-09-17 (31 days)	30,700,000 Btu	307 Therms			\$120.78	
2009-09-16	2009-08-20 (28 days)	8,000,000 Btu	80 Therms			\$50.39	
2009-08-19	2009-07-21 (30 days)	7,000,000 Btu	70 Therms			\$49.32	
2009-07-20	2009-06-18 (33 days)	9,800,000 Btu	98 Therms			\$60.50	
2009-06-17	2009-05-19 (30 days)	23,500,000 Btu	235 Therms			\$98.41	
2009-05-18	2009-04-17 (32 days)	28,700,000 Btu	287 Therms			\$132.19	
2009-04-16	2009-03-19 (29 days)	38,700,000 Btu	387 Therms			\$186.83	
2009-03-15	2009-02-16 (30 days)	42,000,000 Btu	420 Therms			\$204.50	

Physical  
Attributes

Utility Data

## Portfolio Summary

Showing:

All Energy

Water

Electricity

Gas

Oil



This graph shows the performance of all of your buildings, relative to one another.

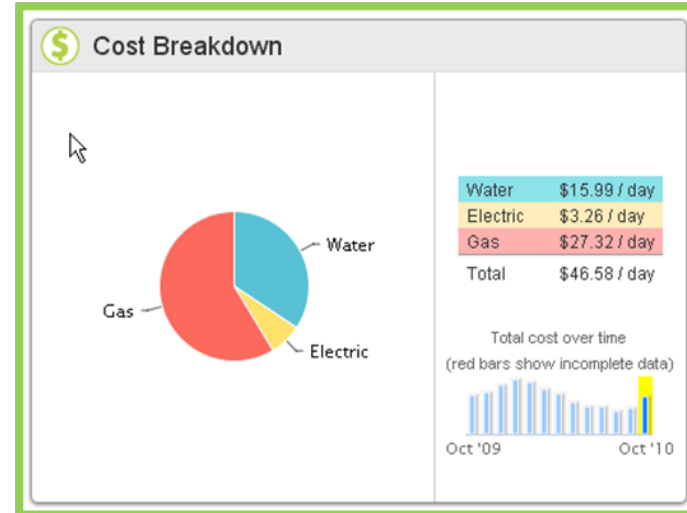
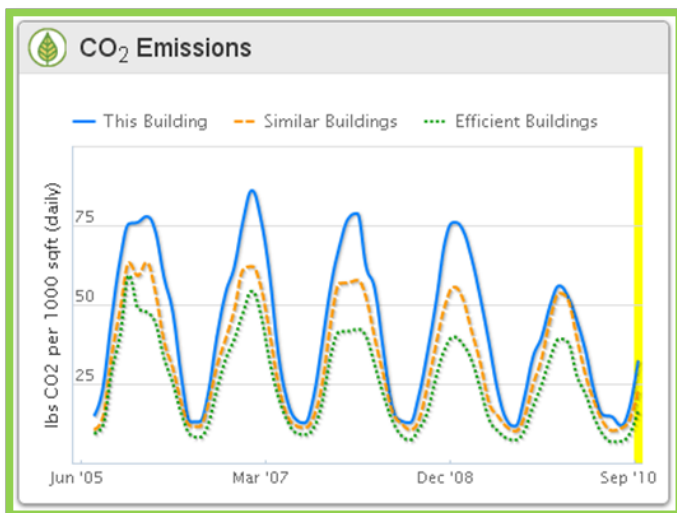
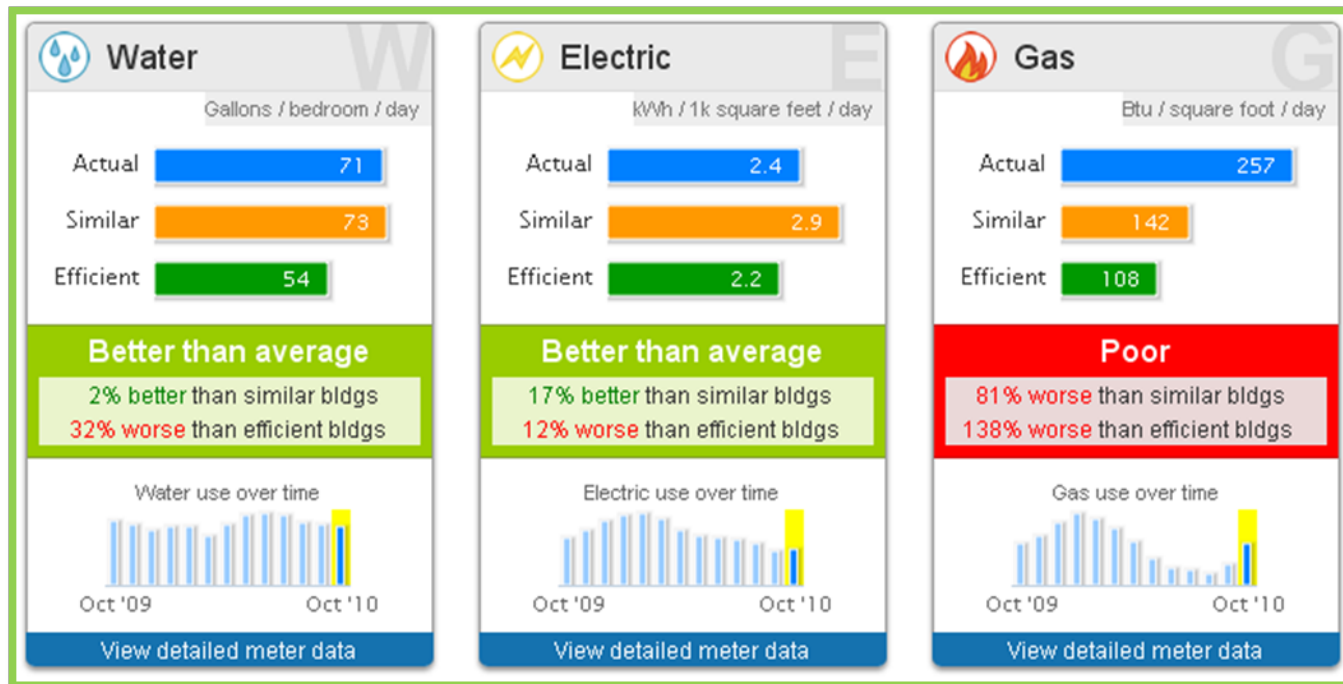
- Buildings in the top right quadrant need the most attention — they are the most inefficient and expensive ones in your portfolio.
- Use the buttons at the top to switch between different utilities.

### Legend

Click label to toggle graph items

- Blue Mountain
- ◆ Boston Bay Apartments
- Hope Bay
- ▲ Marrant Bay Apartments
- ▼ New Port Antonio

# Instant Overview



# Building Monthly Summary

Heating energy ▾ in Btu ▾ per square foot (conditioned) ▾

Show Raw Data

★ Bookmark This Report

Name ▾

Full-Year Sum ▾

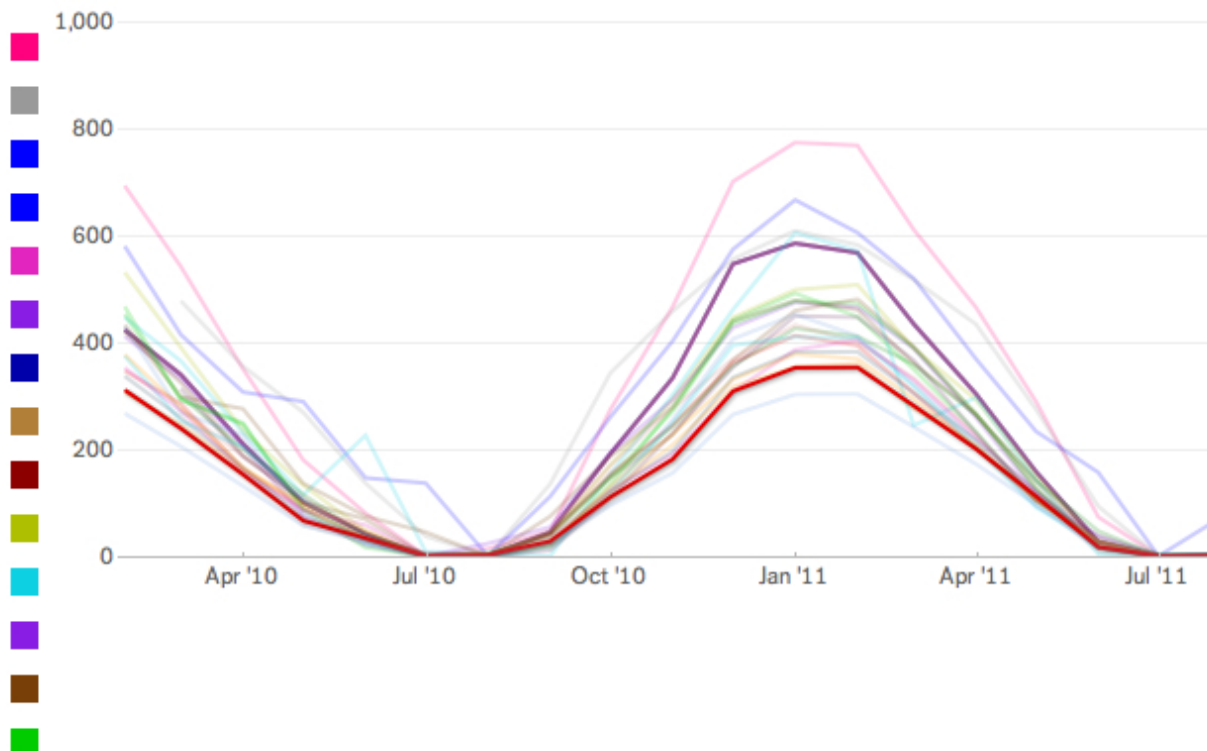
Detailed Data per Month

Click for detailed data

Click a square to show or hide an item on the graph

Zoom out

58 Cheney	21.05
52-54-56 Brunswick	18.87
14 Irwin	18.72
6 Wellington	15.03
7 Wellington	15.03
8 Wellington	15.03
4 Wellington	15.03
5 Wellington	15.03
515 Warren	15.03
181 Ruthven	13.24
26 Irwin	13.09
28 Wyoming	12.78
8 Irwin	12.68
20 Irwin	12.43



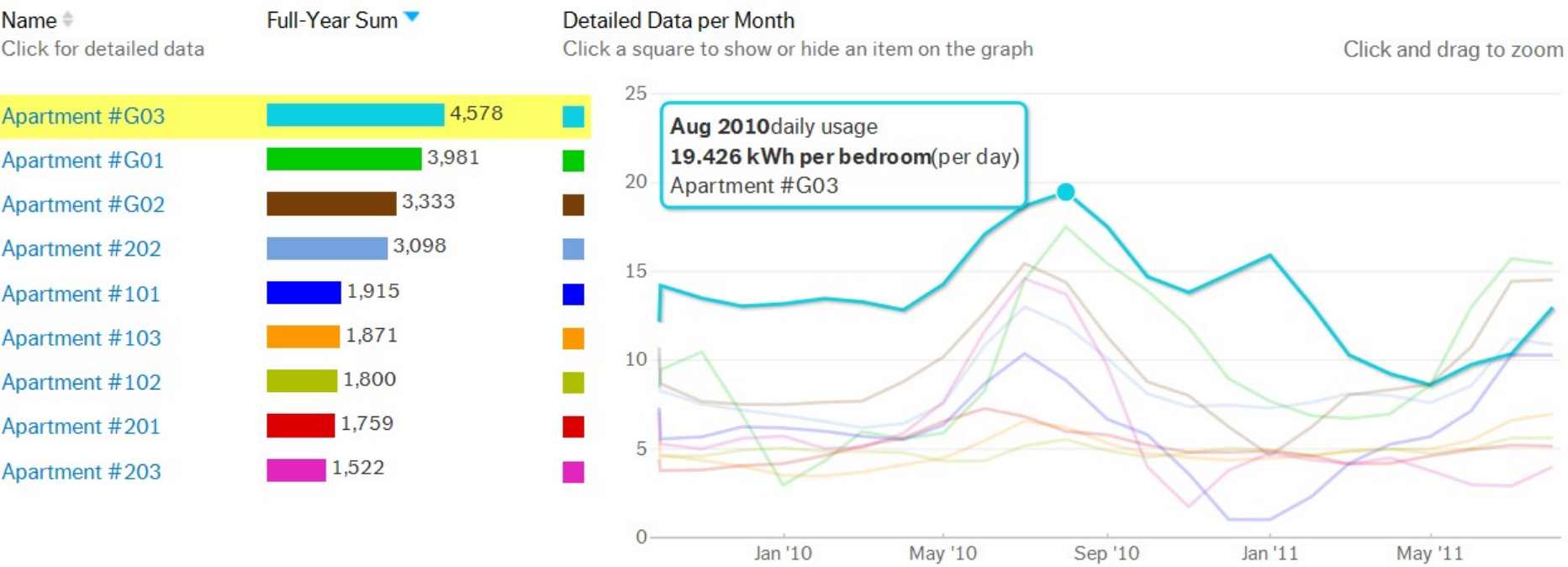
# Heating Energy

# Apartment Electric Use

Custom Reports » Apartment Electric Use

[View Report](#) [Edit Report](#) [Delete Report](#)

Electricity use in kWh per bedroom [Show Raw Data](#) [Add Benchmark](#) [Bookmark This Report](#)



Apartment Electricity Use



# 85 Russel Expressway

[All Developments](#) » [Burke Mountain](#) » 85 Russel Expressway



View Data



Building Upgrades

## Effect of Water Retrofit (April 1, 2009)

[← Back to the list of all building upgrades](#)

Water consumption  in  Gallons  per bedroom



Show Raw Data



Bookmark This Report

Name

Full-Year Sum

Detailed Data per Month

Click for detailed data

Click a square to show or hide an item on the graph

Click and drag to zoom

Apr 08 - Mar 09



62,090



Apr 09 - Mar 10



31,150



### Description of Upgrade

Before: leaking toilets, no low flow fixtures

After: new toilets low flow fixtures

Cost: \$2,000.00

### Annual Savings

Expected: 35%

Actual: 50% (30,941 Gallons per bedroom)

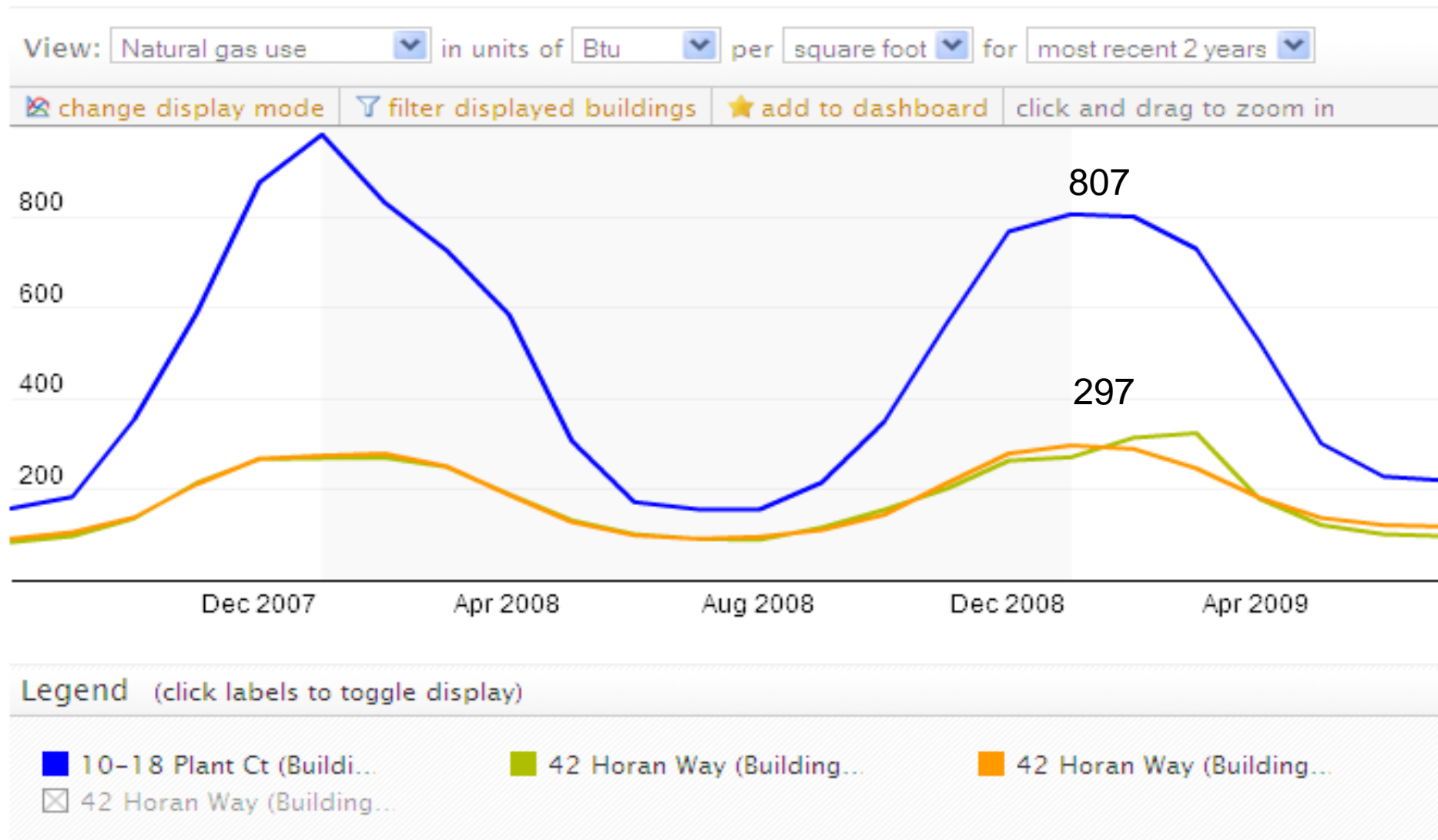


# Measure Impact of Decisions



Public Housing in Jamaica  
Plain

## Natural gas use in Btu per square foot (daily)



# Verifying Effectiveness

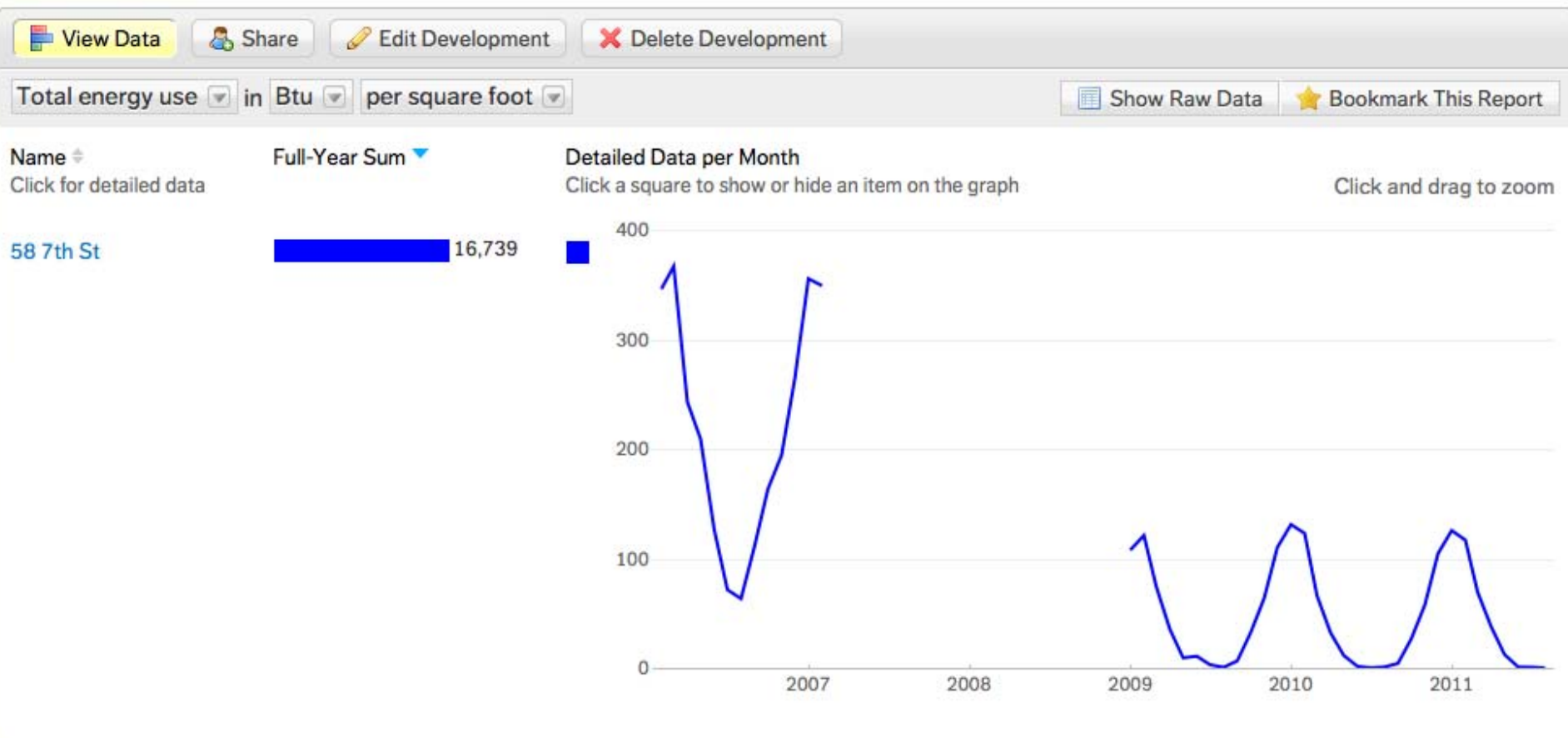
# Deep Retrofit



Extensive Insulation and Air Sealing  
Solar PV  
Solar DHW pre-heat  
95% efficient Boilers  
Energy Star Appliances  
Low-flow water fixtures



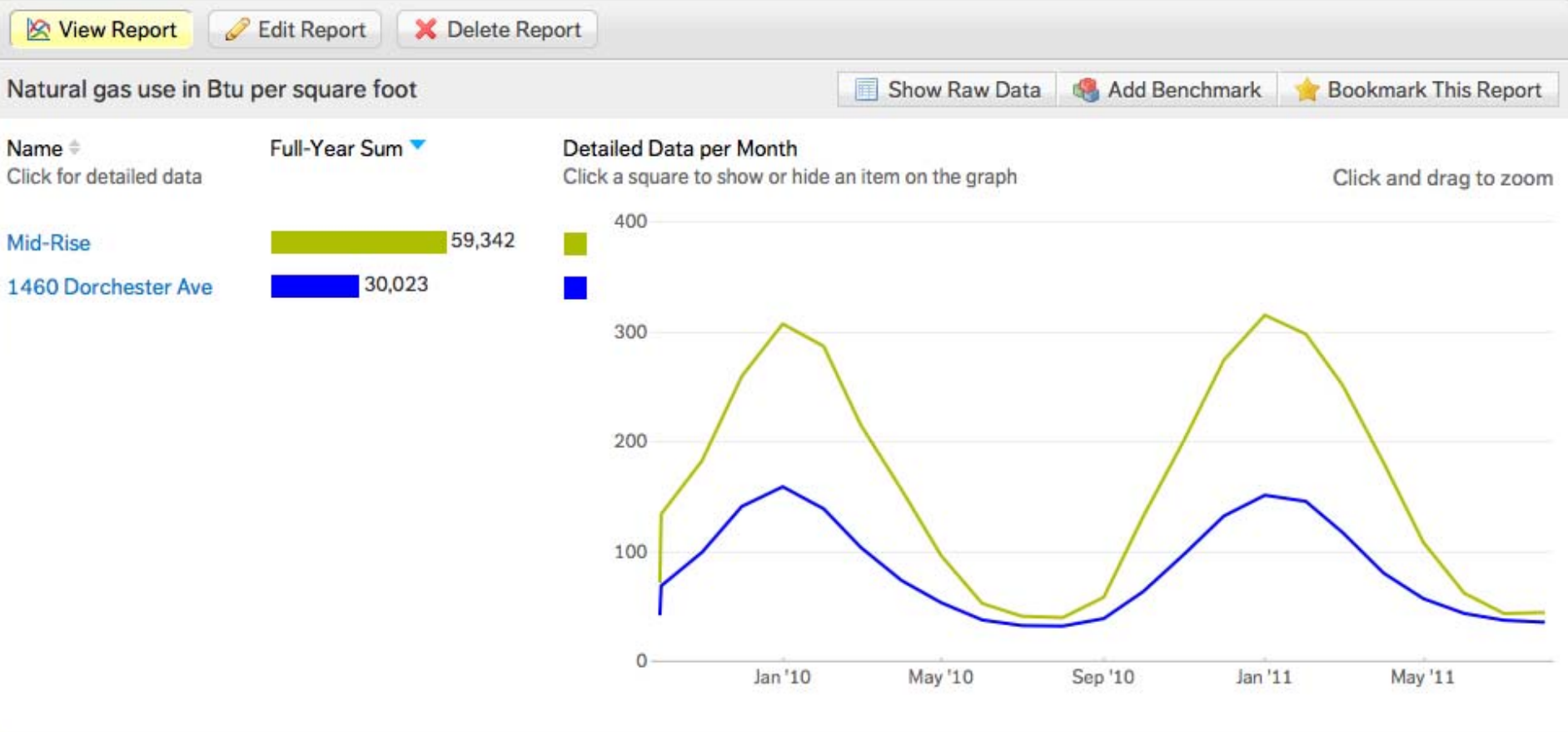




Compare: Before and After



## New Construction in Dorchester

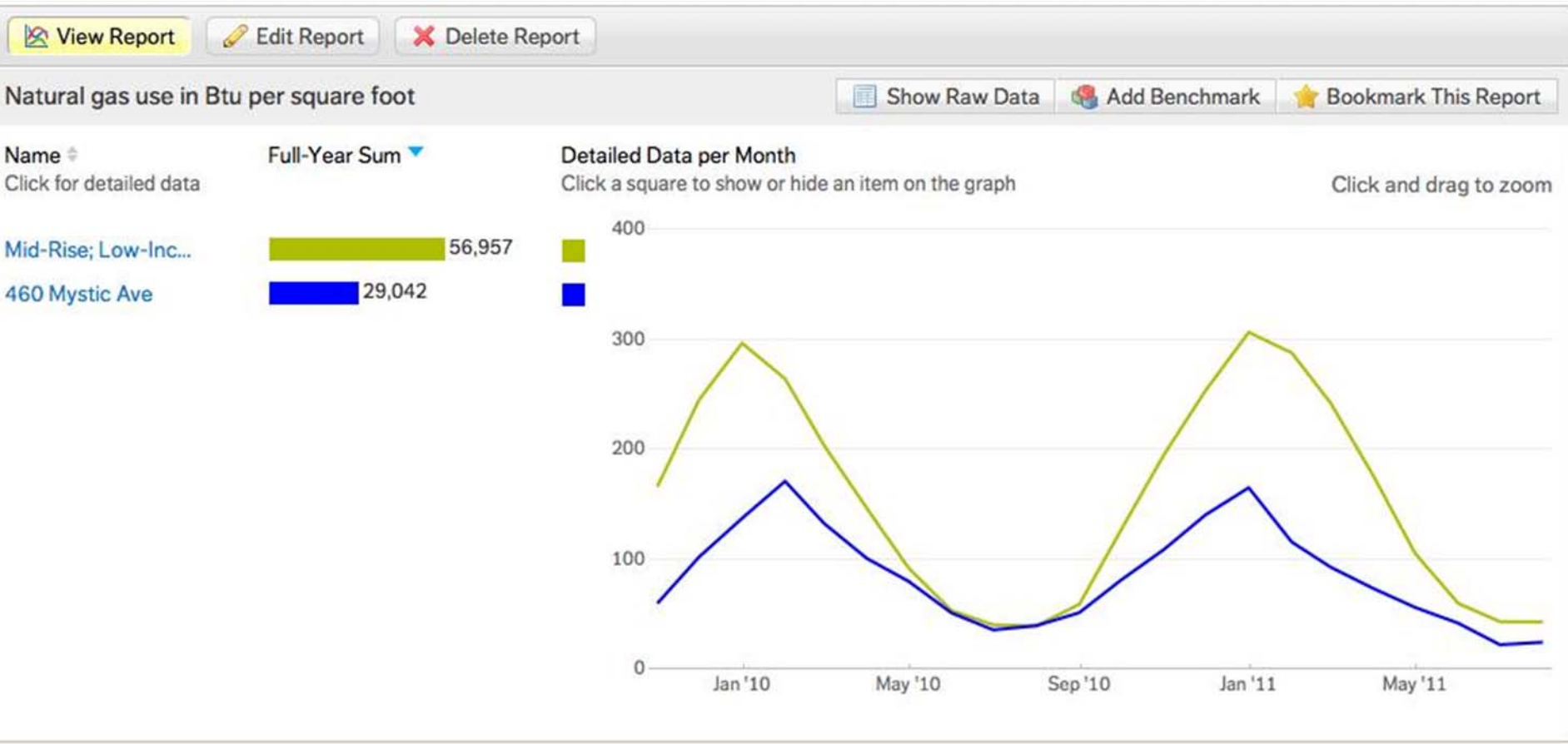


Compare: Energy Star Homes; Enterprise GC



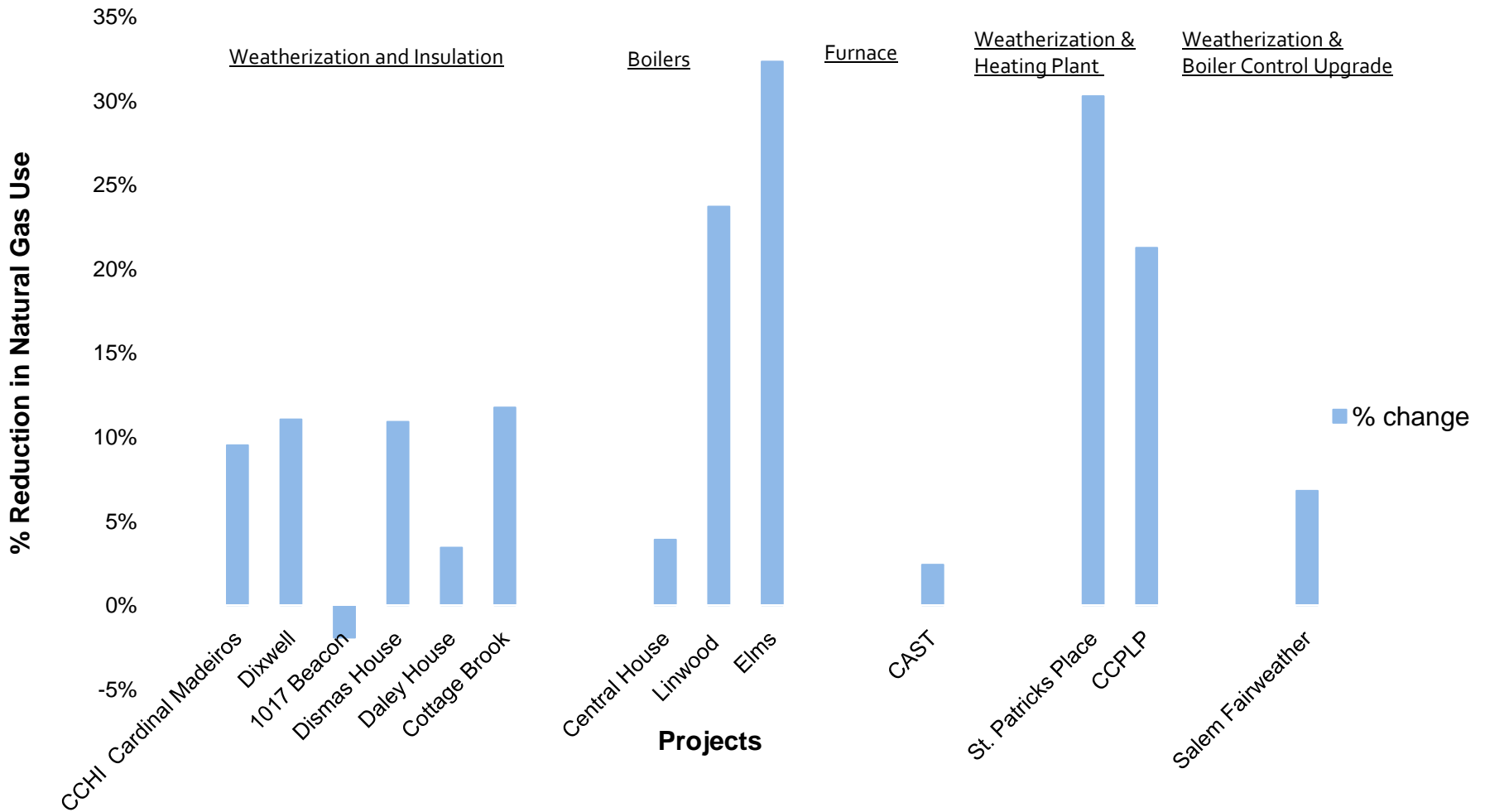
New Construction in  
Somerville





Compare: LEED NC

# Change in Natural Gas Usage



# Benchmarks-Massachusetts Multifamily Housing

Type	Benchmark	Range
Water- Gal/BR/Day:	50	40-250
Space Heating-BTU/SF/HDD	9	6-22
Electric (apts) kWh/SF/YR	4-5	1.28-14
Electric (common) kWh/SF/YR	1	.6-2.5
Domestic hot water Btu/BR/Day	25,000	12,000-85,000

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Submit a question to the moderator via the “chat” box. They will be answered as time allows.

