

# Greening Housing Research

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# Greening Housing Research



Moderator

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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?*

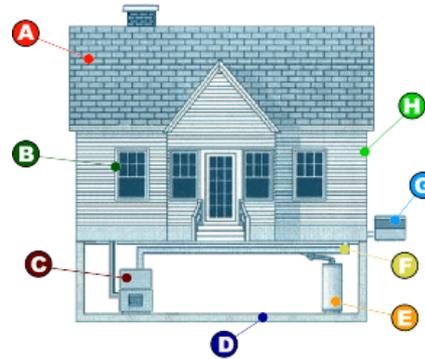
- Defining Green Housing
- Research Findings are Recent
- More Work on Green Housing Practices and Policies than Research in All Areas
- Commercial Building Research Spillover
- Interesting findings, but more to come

# 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

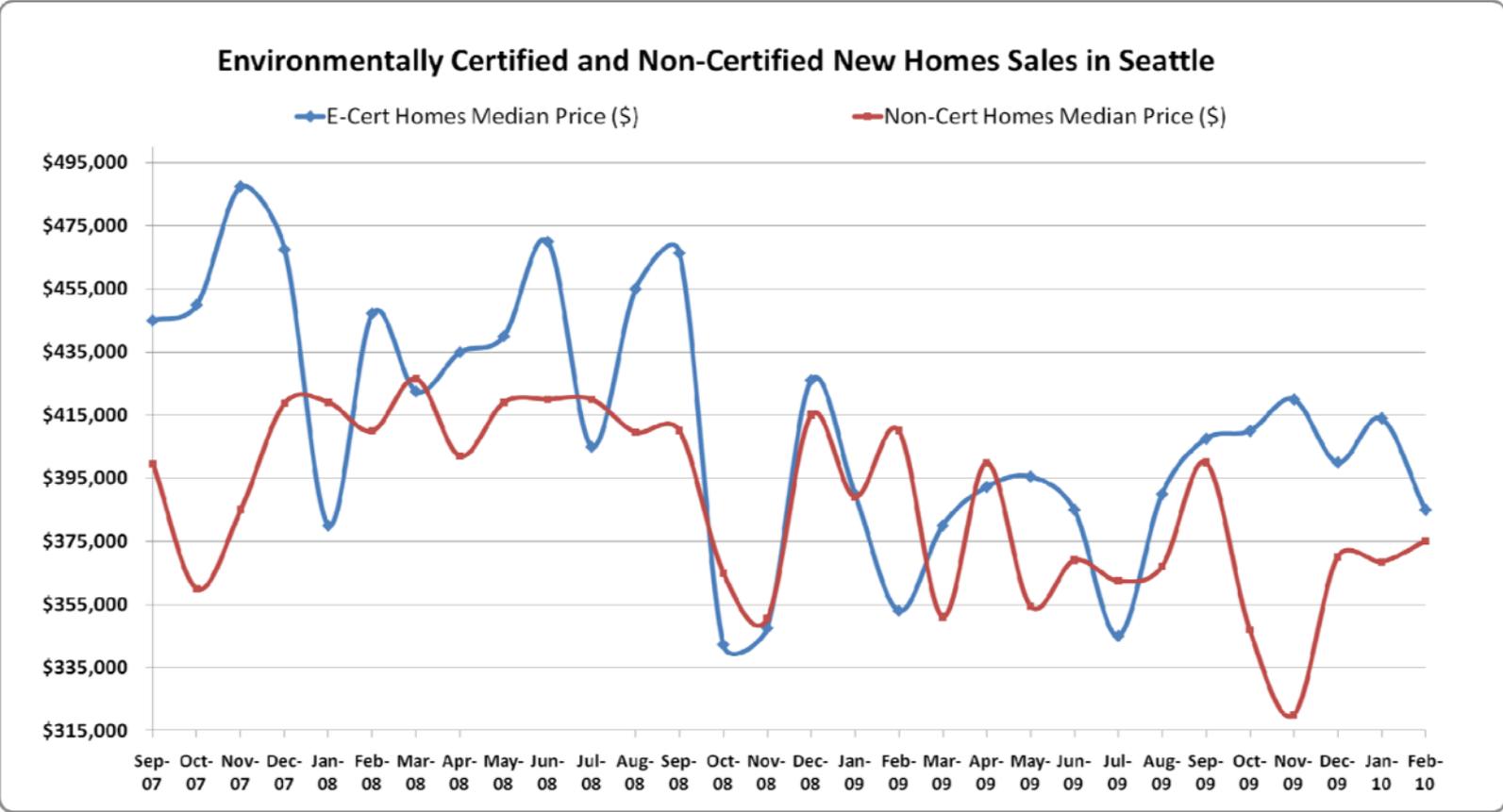
# Green Housing Research: **Policy**

- 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"



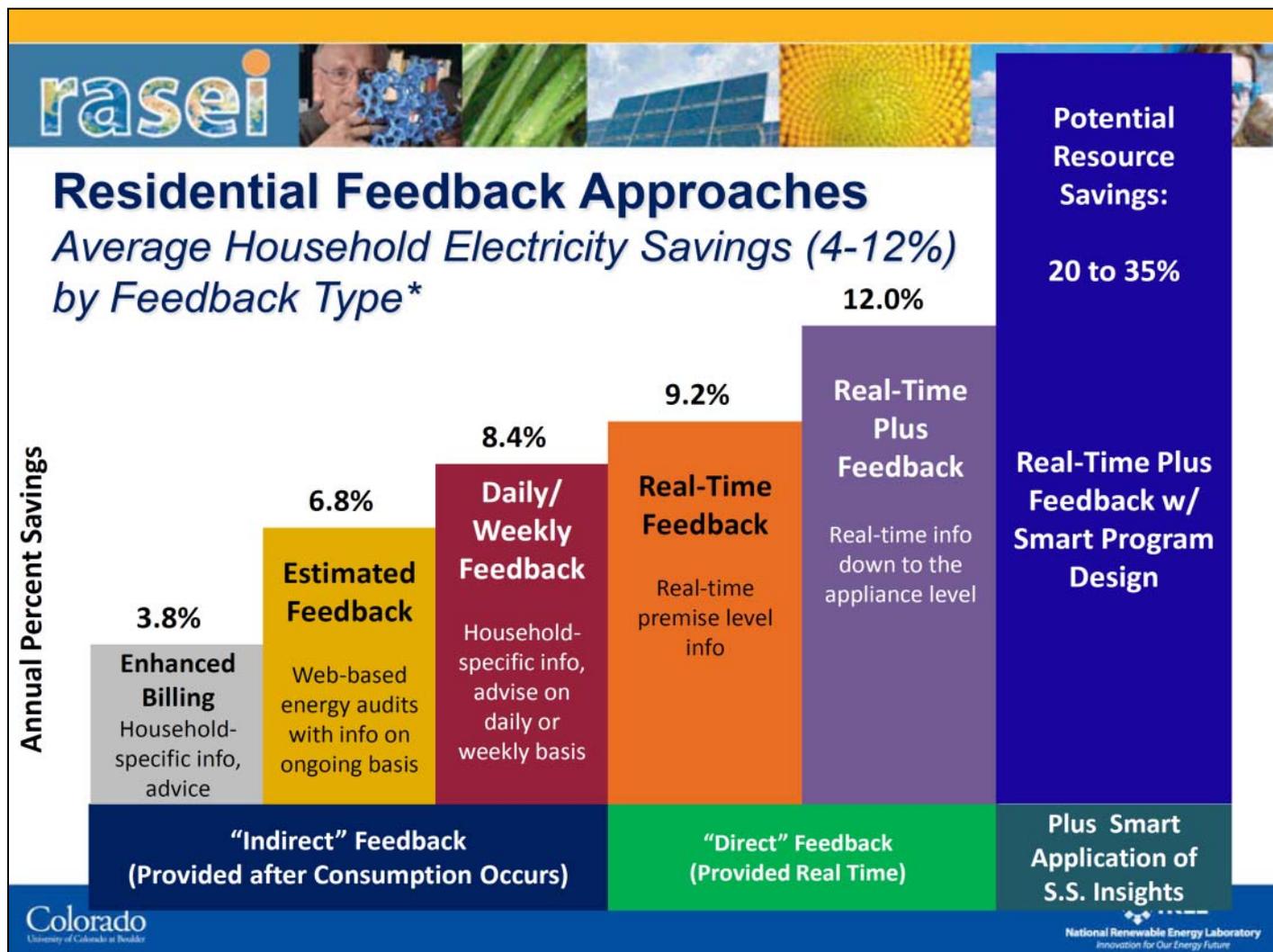
# Green Housing Research: Finance

- 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





Where Do I Start?

<a href="#">Energy Efficiency</a>	<a href="#">Site &amp; Landscaping</a>	<a href="#">Certifications</a>
<a href="#">Water Conservation</a>	<a href="#">Materials</a>	<a href="#">Financing</a>
<a href="#">Health</a>	<a href="#">Operations &amp; Maintenance</a>	<a href="#">Additional Resources</a>

Summary

Discussion

## Green Building Resources for Existing Affordable Housing

### SEARCH

Looking for product or service **recommendations**? Click the **Discussion** tab on each page.

### CONNECT

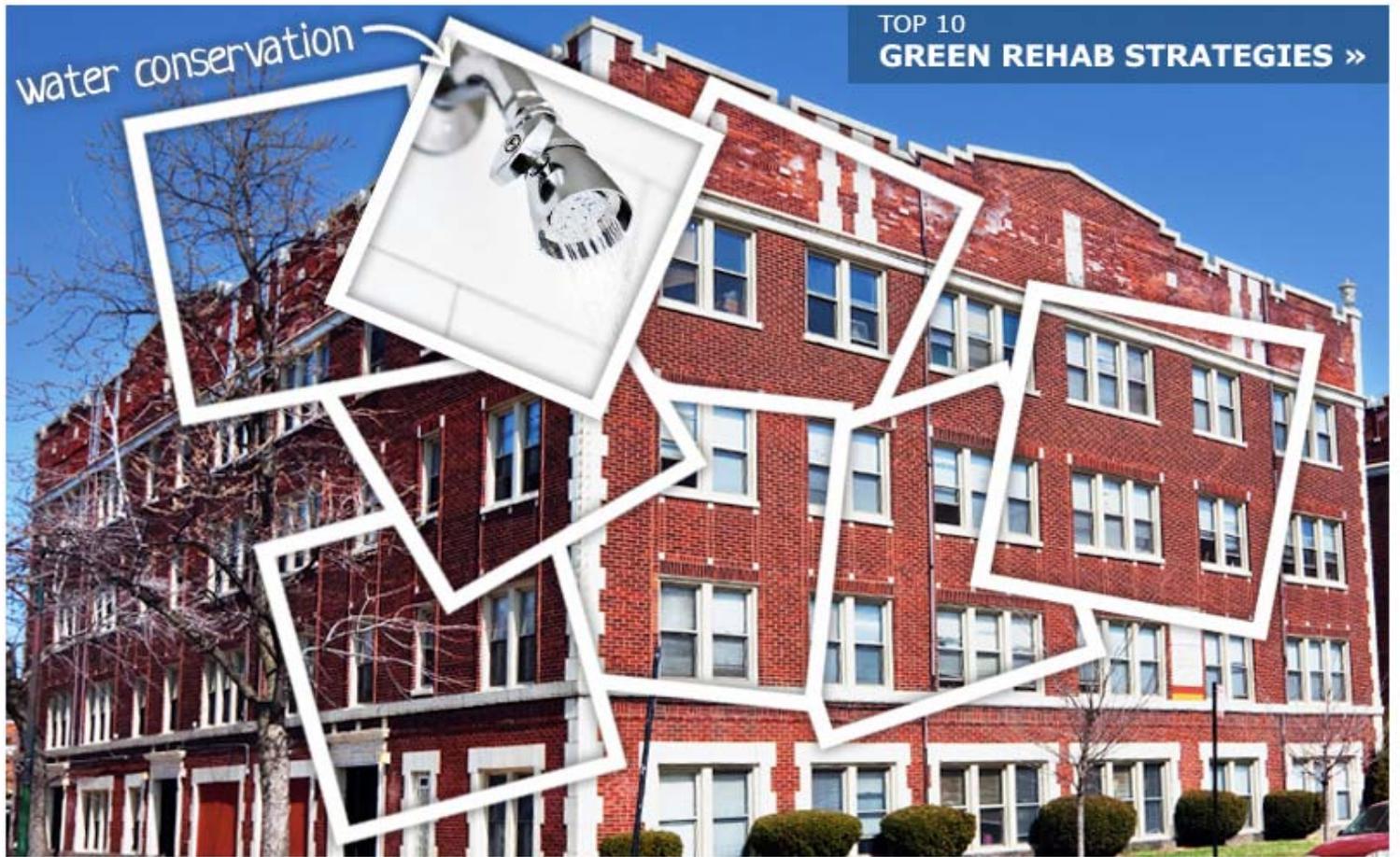
Facebook

Twitter

### LATEST POSTS

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

Health - VOCs : Low or No VOC Paint Suggestion



Feedback

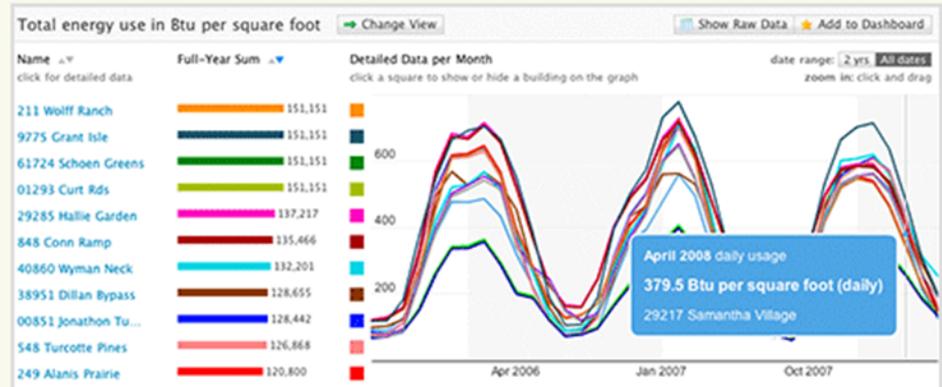


Log In:  Username  Password

## 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

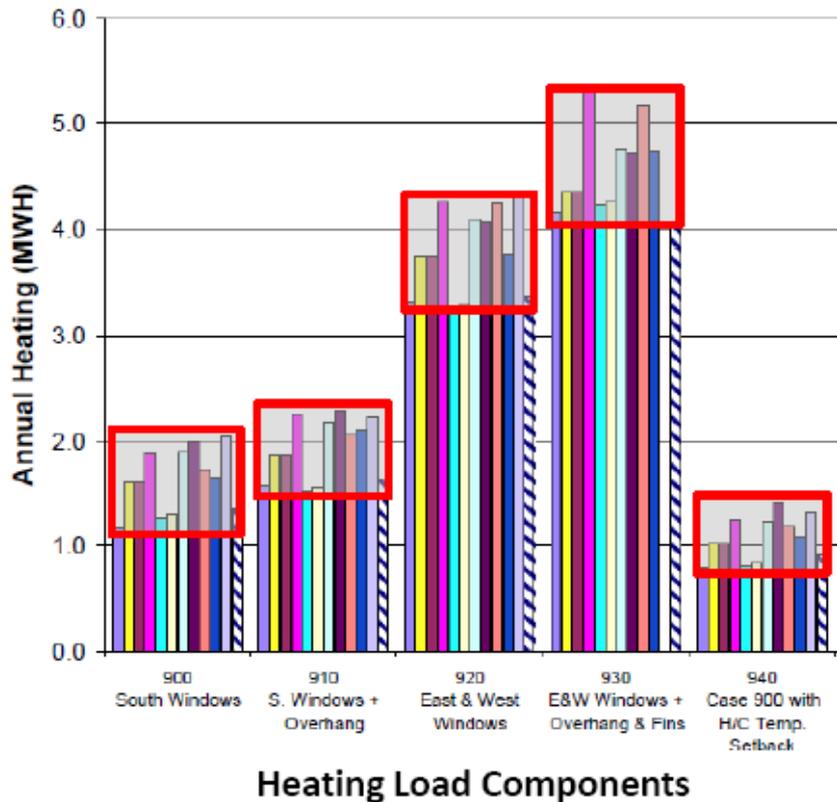
Watch a Demo

[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 dtague · 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 Upgrade](#) [Share](#) [Edit Building](#) [Delete Building](#)

**Edit This Building**

Address:

Age & Type: Year built (or date of last gut rehab):  (in years/decade/forknow)  
 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

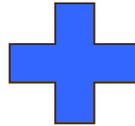
Heating:

Cooling:

Hot Water:

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

Additional Notes:



wēgowise DASHBOARD PROPERTIES REPORTS dtague · 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 This utility account is up-to-date as of 4 days ago [Fetch data now](#)

[Add data](#) [Download Data \(.csv\)](#)

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
2009-03-16	2009-02-16 (30 days)	43,000,000 Btu	430 Therms				\$204.50

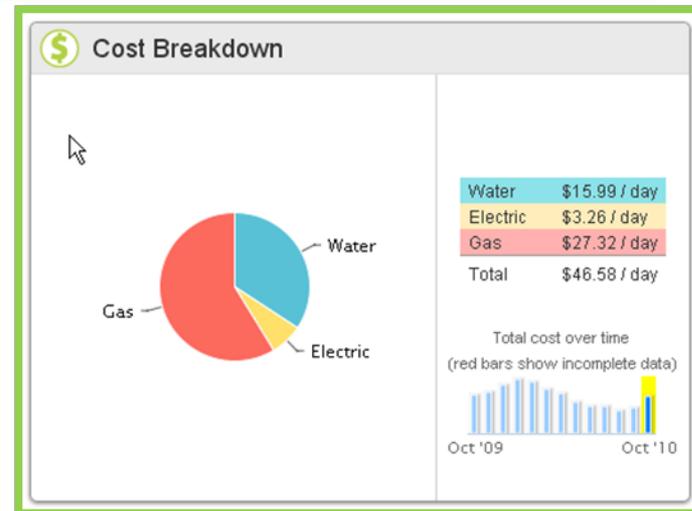
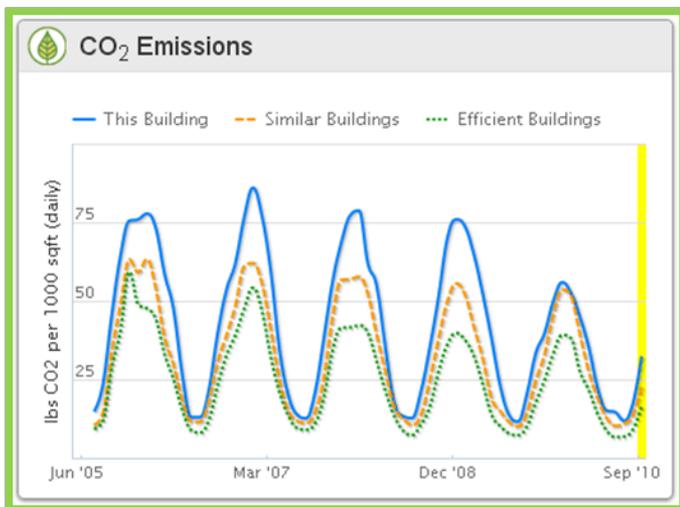
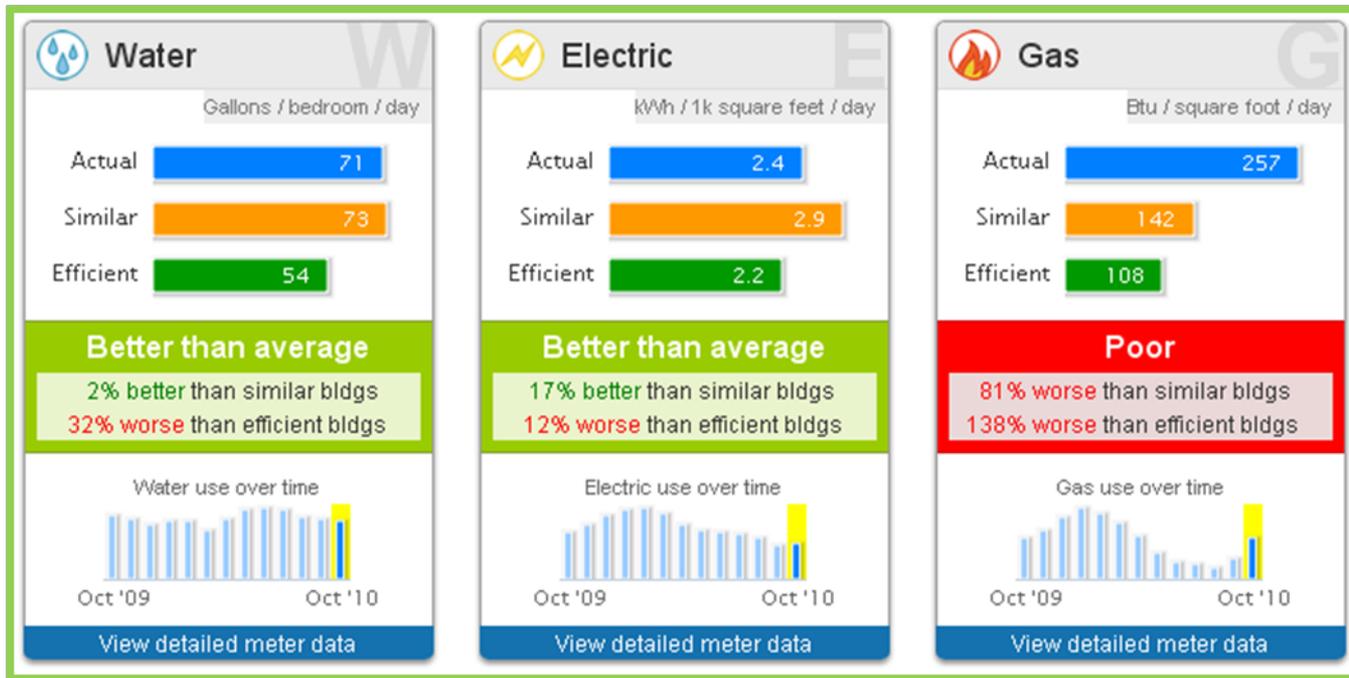
Physical  
Attributes

Utility Data

# Portfolio Summary



## Instant Overview



# Building Monthly Summary

Heating energy in Btu per square foot (conditioned)

Show Raw Data Bookmark This Report

Name  
Click for detailed data

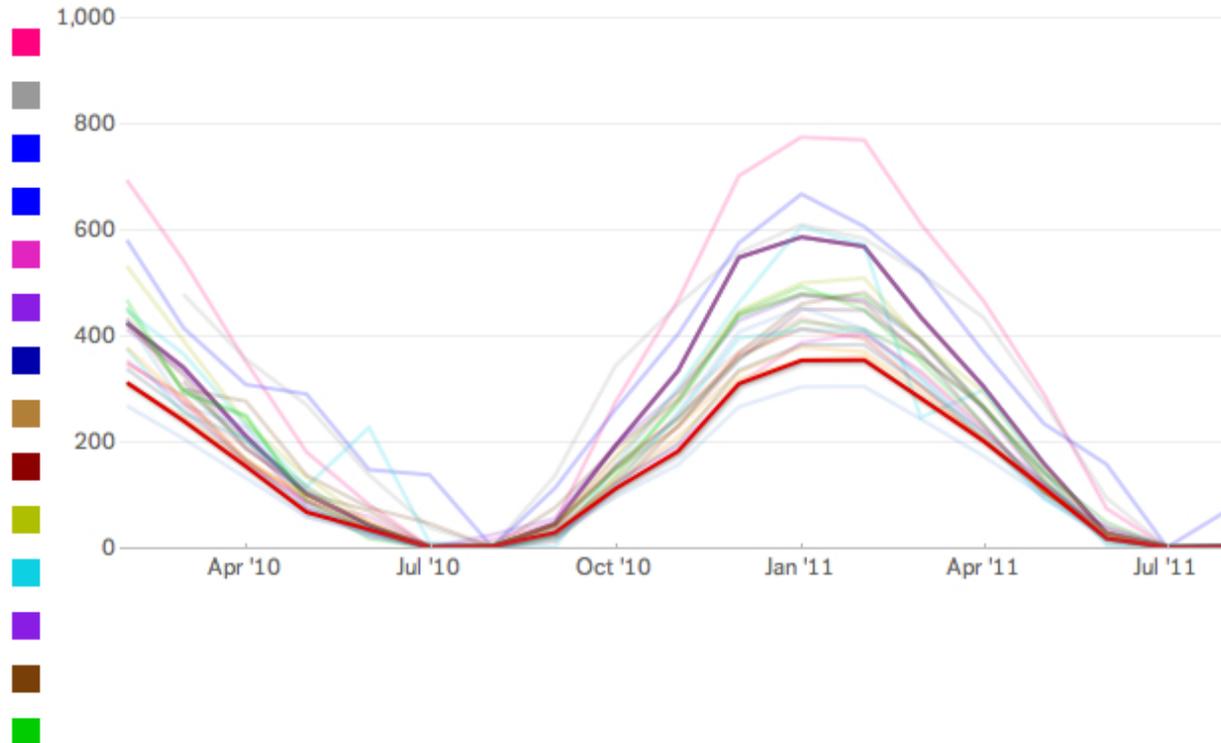
Full-Year Sum

Detailed Data per Month

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](#)

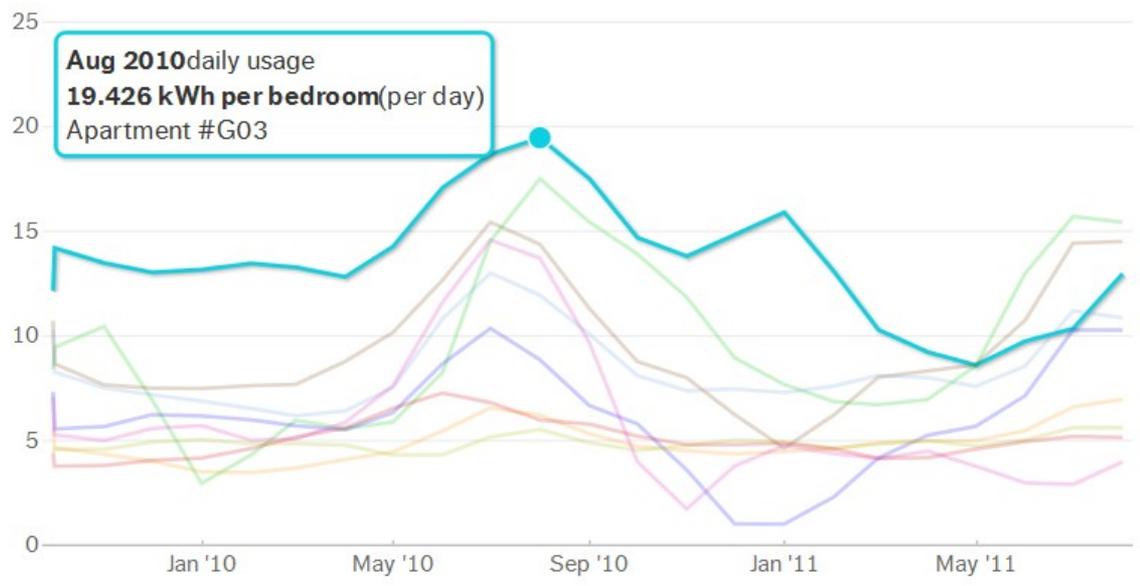
[Show Raw Data](#) [Add Benchmark](#) [Bookmark This Report](#)

Electricity use in kWh per bedroom

Name Full-Year Sum   
Click for detailed data

Detailed Data per Month  
Click a square to show or hide an item on the graph Click and drag to zoom

Name	Full-Year Sum
Apartment #G03	4,578
Apartment #G01	3,981
Apartment #G02	3,333
Apartment #202	3,098
Apartment #101	1,915
Apartment #103	1,871
Apartment #102	1,800
Apartment #201	1,759
Apartment #203	1,522



# 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

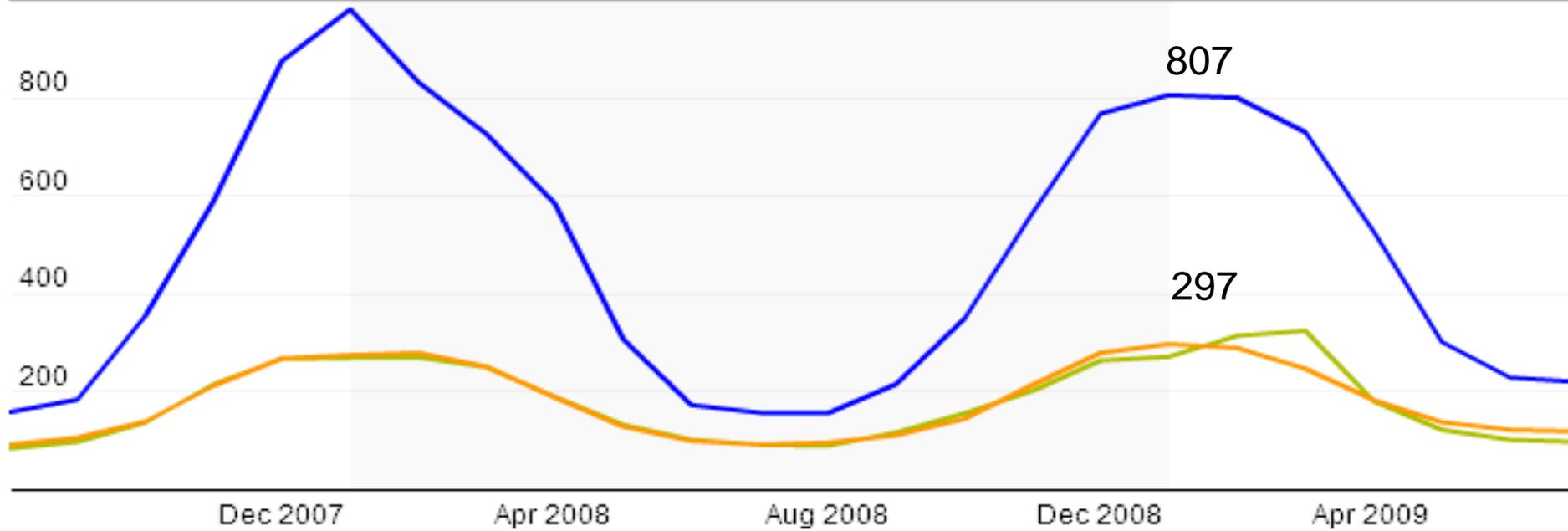


Public Housing in Jamaica  
Plain

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

View:  in units of  per  for

[change display mode](#) [filter displayed buildings](#) [add to dashboard](#) [click and drag to zoom in](#)



Legend (click labels to toggle display)

- 10-18 Plant Ct (Buildi...
- 42 Horan Way (Building...
- 42 Horan Way (Building...
- 42 Horan Way (Building...

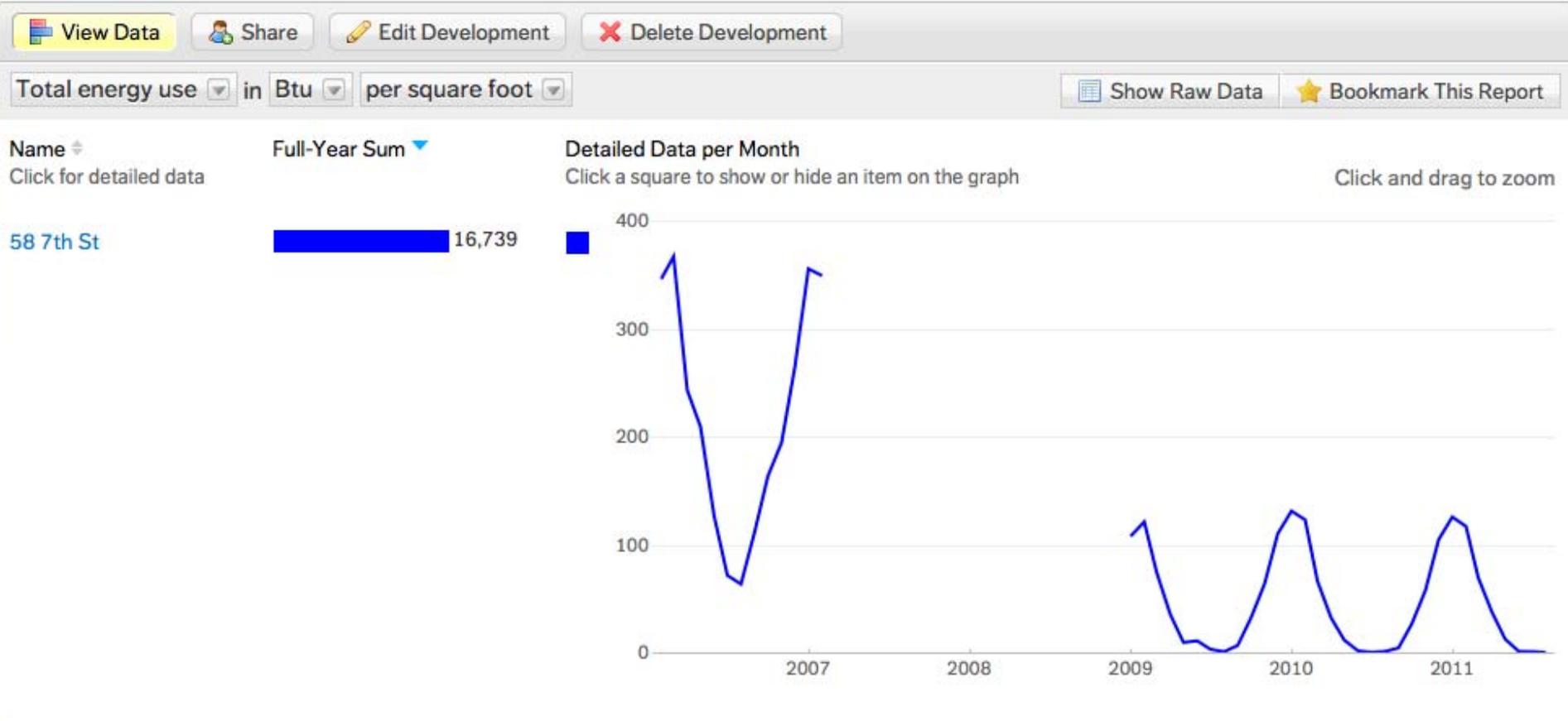
## Verifying Effectiveness



# Deep Retrofit

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

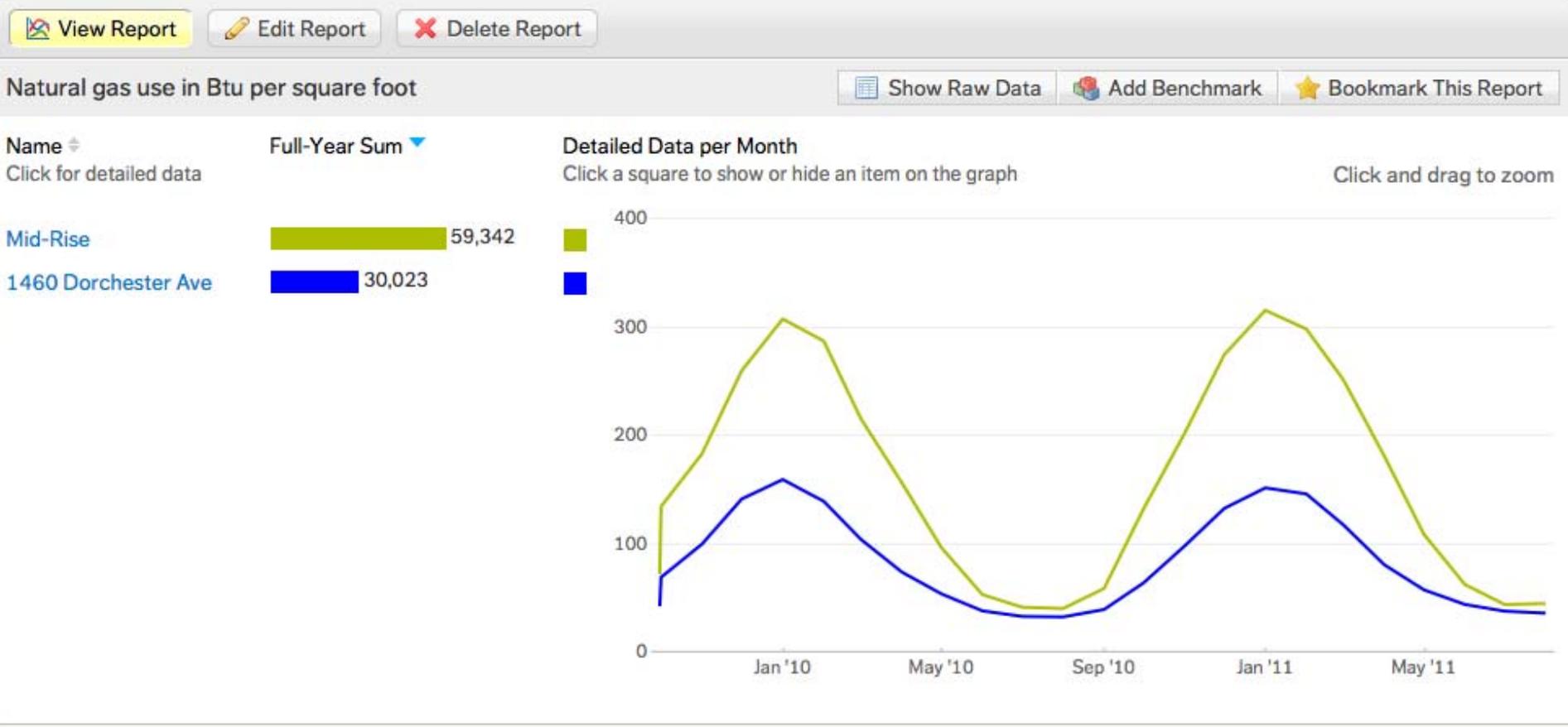




Compare: Before and After



## New Construction in Dorchester



Compare: Energy Star Homes; Enterprise GC



## New Construction in Somerville

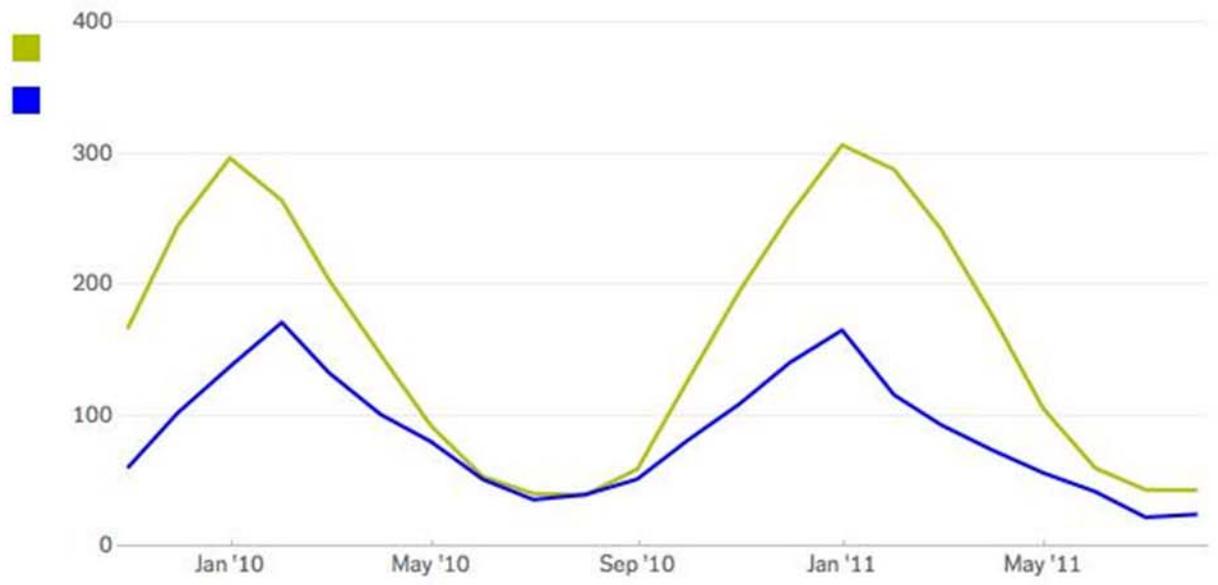
[View Report](#) [Edit Report](#) [Delete Report](#)

### Natural gas use in Btu per square foot

[Show Raw Data](#) [Add Benchmark](#) [Bookmark This Report](#)

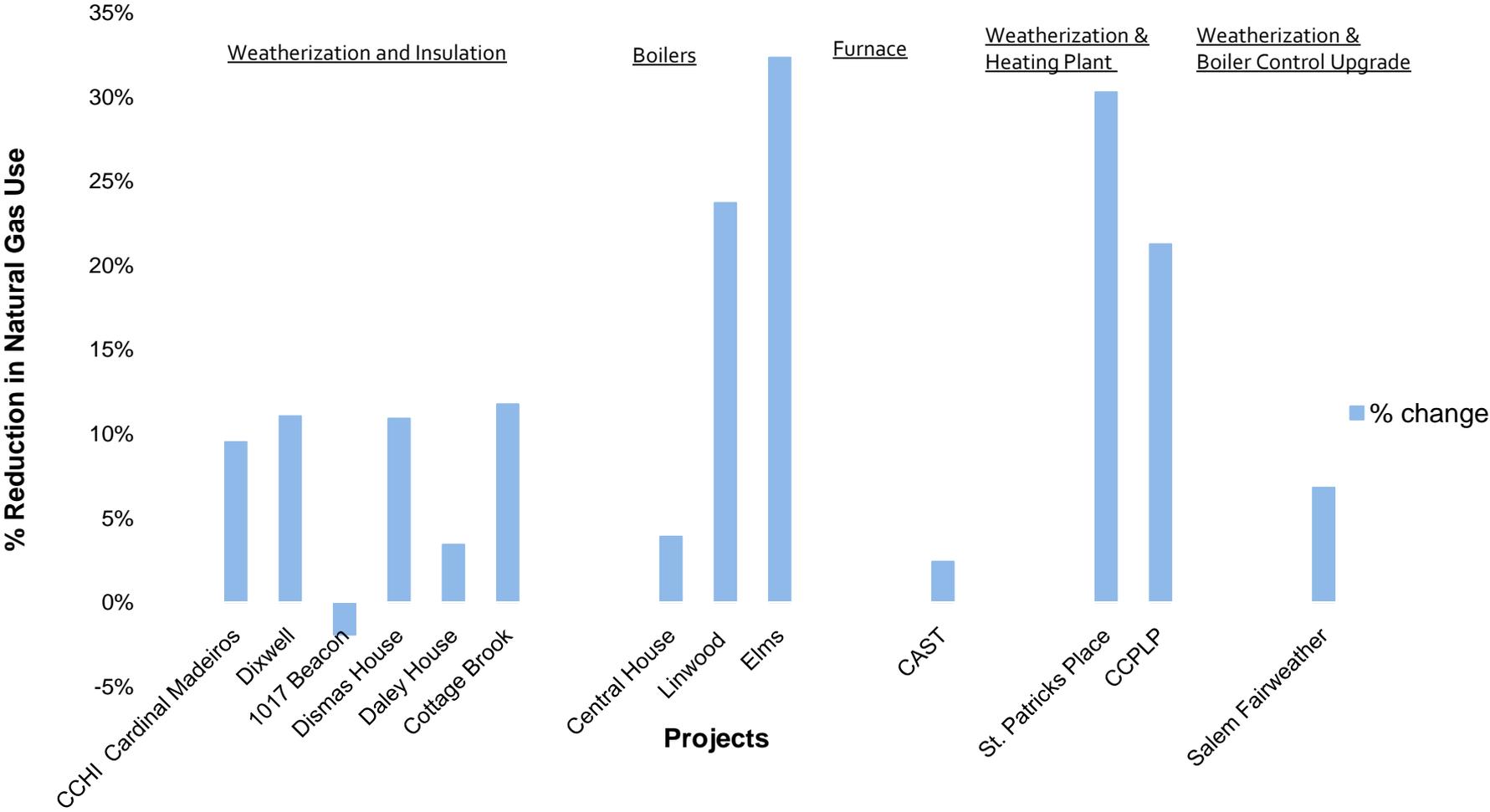
Name	Full-Year Sum
Mid-Rise; Low-Inc...	56,957
460 Mystic Ave	29,042

**Detailed Data per Month**  
Click a square to show or hide an item on the graph Click and drag to zoom



# 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

# Greening Housing Research



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Speaker

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

