Half a Million Homes & Five Data Sets: A Delicious Retrofit Recipe

Affordable Comfort
San Francisco CA
March 31, 2011

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CNT Energy
Session Goal

Explain and demonstrate how large home energy data sets can help accelerate home energy retrofit activity.

- Energy use and housing characteristics of the single family homes in the Chicago metropolitan region

- How these data can be used to provide value to Homeowners, Contractors/Auditors, Program Administrators, Realtors

Qualifier: We understand that every home has unique energy use. These data are not meant to replace analysis at the individual home level. These data are meant to describe a population.
Presentation Contents

- CNT & CNT Energy Approach
- Research Approach and Objectives
- Descriptives of Housing and Energy Use
  - County
  - City
  - Chicago Bungalows
- Operational Energy Use Model
- Why Large Data Sets are Valuable
  - Challenges, Opportunities and Next Steps
Amuse bouche:
Some things that might surprise you

1. Our large data set shows that Chicago homes are twice as energy intensive as the RECs Midwest estimate.

2. Based on a few simple ingredients, our model predicts energy consumption and provides insight into energy efficiency program design.

3. We can see EXACTLY where the clusters of high-energy use are.
Center for Neighborhood Technology is a Think-and-Do Tank

Working to promote livable and sustainable communities through more efficient use of resources
- Research
- Advocacy
- Demonstration projects

Received the 2009 MacArthur Award for Creative and Effective Institutions

5 focus areas and 2 non-profit affiliates
- Energy
- Transportation & Community Development
- Geographic Research and Analysis
- Natural Resources
- Climate Change
Helping consumers, communities and businesses control energy costs and become more energy efficient

- **Energy Planning**
  - Chicago Climate Action Plan
  - Baseline energy analysis for 286 municipalities in the region

- **Dynamic Pricing and Smart Grid**

- **Energy Efficient Buildings**
  - Implement retrofit programs
  - Chicago Region Initiative for Better Buildings
  - US DOE Home Energy Score Pilot
  - USGBC LEED Post-occupancy Performance Evaluation
  - Building America Team
CCAP – Call to Action

• 80% of building stock in 2020 is already existing.

• Most of region’s emissions from energy in buildings
  – Building GHG emissions 6 County region = 61%
  – Building GHG emissions Chicago = 70%

• Ambitious goals:
  – Scale up to 20,000 home retrofits per year!
  – 200,000 single family homes by 2020!
Why Large Data Sets?

• Data used to
  – Inform programs and policy
  – Verify and validate savings
  – Measurement of large scale retrofit impacts
  – Quantify energy efficiency benefits to customers

• Private investment in energy efficiency improvements – accelerate the uptake
  – Access to info, capital, workforce
  – Facilitate the marketplace to value efficiency

• Make housing affordable by reducing energy costs
  – Total Cost of Ownership
Total Cost of Ownership helps consumers make smarter mortgage decisions

Traditional Affordability (PITI)
- Principal
- Interest
- Taxes
- Insurance

Total Cost of Ownership
- PITI+
- Transportation
- Energy
- Maintenance

Which home best suits my family and our budget?
Evaluating CNT’s Total Cost of Ownership Suite

Addresses lessons learned from foreclosure crisis:

– More to affordability that just the mortgage
– Sustainability and affordability are connected
– REALTORS are home ownership advocates
– REALTORS and homebuyers need access to tools that inform the home-buying decision process
Two Views of Affordability

Affordability: Housing Costs as Percent of Income

- 0 to 30%
- Greater than or Equal to 30%

Affordability: Housing and Transportation Costs as Percent of Income

- 0 to 45%
- Greater than or Equal to 45%

http://htaindex.org

http://abogo.org

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Research Approach and Objectives
Research Objectives

• To provide description of housing stock and energy use characteristics in Chicago region

• To produce operational energy use model
  – Can we use available data to find homes with high EUI
  – Benchmark homes in the Chicago region
## Geography/Scope – Cook County

### Cook County Single Family Housing & Demographics

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>1635 square miles</td>
</tr>
<tr>
<td>Households</td>
<td>Nearly 2 million</td>
</tr>
<tr>
<td>Single family Homes (n)</td>
<td>Nearly 1.1 million</td>
</tr>
<tr>
<td>Size of homes (median)</td>
<td>1,629 square feet</td>
</tr>
<tr>
<td>Year built (median)</td>
<td>1956</td>
</tr>
<tr>
<td>Construction type</td>
<td>Masonry 38%</td>
</tr>
<tr>
<td></td>
<td>Frame 58%</td>
</tr>
<tr>
<td></td>
<td>Other 4%</td>
</tr>
<tr>
<td>Household annual income (median)</td>
<td>$59,903</td>
</tr>
<tr>
<td>Heating Systems</td>
<td>85% gas forced air, 15% hot water/steam</td>
</tr>
<tr>
<td>Central Air Conditioning penetration</td>
<td>40%</td>
</tr>
</tbody>
</table>
# Geography/Scope – Chicago

<table>
<thead>
<tr>
<th>Chicago Single Family Housing &amp; Demographics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
</tr>
<tr>
<td><strong>Households</strong></td>
</tr>
<tr>
<td><strong>Single family Homes (n)</strong></td>
</tr>
<tr>
<td><strong>Size of homes (median)</strong></td>
</tr>
<tr>
<td><strong>Year built (median)</strong></td>
</tr>
</tbody>
</table>
| **Construction type** | Masonry 58%  
Frame 38%  
Other 4% |
| **Household annual income (median)** | $46,781 |
| **Heating Systems** | 75% gas forced air, 25% hot water/steam |
| **Central Air Conditioning penetration** | 25% |
Data sets

- Audits
- US Census
- Utilities (Gas, Electric)

Energy Use Intensity
kBtu / sq ft / year

- Daily weather
  - HDD
  - CDD
- Assessor
Cook County
Single Family Housing
and the Common Architectural Styles Represented within Tax Assessor Classifications

- 202: 1 story < 1,000 sf, any age
- 203: 1 story 1,000 - 1,800 sf, any age
- 204: 1 story > 1,801 sf, any age
- 234: Split level w/lower level below grade, any size, any age
- 205: 2 story, up to 2,200 sf, pre-1948
- 206: 2 story, 2,201 - 4,999 sf, pre-1948
- 207: 2 story, up to 2,000 sf, post-1948
- 278: 2 story, 2,001 - 3,800 sf, post-1948
- 208: 2 story, 3,801 - 4,999 sf, post-1948
- 209: 2 story, > 5,000 sf, any age
- 210: Old style row house, pre-1948
- 295: Row house/Townhouse, cost-1948
## Why this data set is unique

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>2005 RECS, National</th>
<th>2005 RECS, East North Central</th>
<th>CNT Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td># Homes</td>
<td>3,102</td>
<td>486</td>
<td>440,204</td>
</tr>
<tr>
<td>kWh</td>
<td>10,757</td>
<td>9,685</td>
<td>9,273</td>
</tr>
<tr>
<td>therms</td>
<td>706</td>
<td>934</td>
<td>1,306</td>
</tr>
<tr>
<td>kBtu - electric</td>
<td>36,703</td>
<td>33,045</td>
<td>31,639</td>
</tr>
<tr>
<td>kBtu - gas</td>
<td>70,589</td>
<td>93,353</td>
<td>130,600</td>
</tr>
<tr>
<td>Square feet</td>
<td>1,889</td>
<td>2,132</td>
<td>1,254</td>
</tr>
<tr>
<td>Year built</td>
<td>Before 1940</td>
<td>Before 1940</td>
<td>1957</td>
</tr>
<tr>
<td>EUI</td>
<td>57</td>
<td>59</td>
<td>129</td>
</tr>
</tbody>
</table>
Housing stock and energy use in the region
Cook County housing stock is old.

Age of housing
Year built
- 1821 - 1920
- 1921 - 1940
- 1941 - 1960
- 1961 - 1980
- 1981 - 2005
Cook County homes are energy intensive

Median EUI – 129

25th percentile EUI – 99
75th percentile EUI – 157

444,204 homes
These homes are gas-intensive

Energy Use (kBtu)

- Electricity (kBtu)
- Gas (kBtu)

Therms

- Thermo

kWh

- kWh

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The suburbs surrounding Chicago have the highest median EUI.
Areas of older housing have higher EUIs.
Lower-income areas have higher EUIs.
Chicago homes are old.

Age of housing

- 1821 - 1920
- 1921 - 1940
- 1941 - 1960
- 1961 - 1980
- 1981 - 2005

© CNT Energy 2011
Chicago Homes are Primarily Frame and Brick Construction

Source: Chicago Growth of a Metropolis
The Golden Chance for a Delightful Home in Town

368 RESIDENCE LOTS

To be sold at Auction by WM. A. BUTTERS & CO., on

Thursday, July 9th, 1868

At two o'clock, P.M. Sale to be made on the Ground.

3. Detail of a Plan for a Block of Thirty-Two Frame Houses Built on North LaSalle Street, 1869

Balloon frame construction, whether it had elaborate ornamentation or not, was the most common way builders found to meet the demand for new housing. This rendering shows the facade detail of one of thirty-two houses erected at one time. The builders boasted that “the partition between the houses are all double, with a four inch space between the studs that will enable the proprietors to remove them... in case of fire.” A stream of water could then be directed into the space. (Courtesy Chicago Historical Society.)
Frame and Brick Construction Homes
Market Segmentation and Location

Handsometest Brick Cottages in Chicago

Price, Only $1650 to $1800 each.

EXTRAORDINARY PAYMENTS
Very Small Cash Payments.
Near Cor. Division St. Boulevard & Western Ave.
Six Room Cottages with Lake Water, Go and See Them.

Go and see the HOUSES being built.

OUTSIDE FIRE LIMITS!

S. E. Gross & Co.

S. E. Gross & Co.
Chicago homes are more energy intensive

<table>
<thead>
<tr>
<th></th>
<th>Cook County</th>
<th>Chicago</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>129</td>
<td>141</td>
</tr>
<tr>
<td>25th percentile</td>
<td>99</td>
<td>112</td>
</tr>
<tr>
<td>75th percentile</td>
<td>157</td>
<td>175</td>
</tr>
<tr>
<td>N</td>
<td>444,204</td>
<td>206,681</td>
</tr>
</tbody>
</table>
Areas of older housing have higher EUIs.
Lower-income neighborhoods have higher EUIs.
Large Data Sets

• Common mindset of data development - “all homes are unique”

• Aggregating small numbers of homes doesn’t get to the same point that a large data set does
  – Avoid the outliers

• Measurement of large scale retrofit impacts
Operational Energy Use Model
Model - Inputs

- Age of house
- Basement type
- Frame type
- Heating type
- AC type
- Income
- Square feet
- Number of occupants

Energy Use Intensity (kBtu/sq ft/year)
Model - Inputs

Dependent variable = Energy Use Intensity (EUI)
- Weather normalized

8 independent variables
- Age of home
- Square feet
- Frame type
- Basement type
- Heating type
- AC type
- Income
- Number of occupants

 Doesn’t include behavior and “stuff”
## Model - results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sign of coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square feet</td>
<td>Negative</td>
</tr>
<tr>
<td>Brick</td>
<td>Positive</td>
</tr>
<tr>
<td>Basement type</td>
<td>Positive</td>
</tr>
<tr>
<td>Heating type</td>
<td>Negative</td>
</tr>
<tr>
<td>AC type</td>
<td>Positive</td>
</tr>
<tr>
<td>Number of occupants</td>
<td>Positive</td>
</tr>
<tr>
<td>Income (thousands)</td>
<td>Negative</td>
</tr>
<tr>
<td>Age of house</td>
<td>Positive</td>
</tr>
</tbody>
</table>
Model - results

• Model results are highly significant
• Allows us to explain variability in EUI based on 8 structural variables
• Can be improved over time – doesn’t control for individual characteristics of homes
• R-squared – .43
  • ~43% of the variation in EUI is explained by this model
  • Remember – the model doesn’t include behavior
Frame cottage

- 1500 sq ft
- Frame construction
- Unfinished basement
- Furnace
- Window AC
- Built in 1893
- 4 occupants
- Income ~$50,000

EUI = 135
Model result - bungalow

Bungalow
- 1200 sq ft
- Brick
- Unfinished basement
- Boiler
- Window AC
- Built in 1920
- 4 occupants
- Income ~$50,000

EUI = 162
Historic Chicago Bungalow

Credit: www.historicchicagobungalow.info
Vernacular Architecture: Chicago Bungalow

- Ubiquitous. Over 80,000 bungalows built in the region between 1910-1940
- Represents nearly 1/3 of single family housing stock in Chicago
- Influenced by Arts and Crafts movement emphasizing simplicity and craftsmanship
- Six historic Chicago Bungalow Districts that are on the National Register of Historic Places

Credit: www.historicchicagobungalow.info © CNT Energy 2011
WHAT IS A HISTORIC CHICAGO BUNGALOW?

TEN DEFINING CHARACTERISTICS

FLOWER BOXES, VRNS & OTHER "NATURAL" OR BUILT-IN ELEMENTS

INTRICATE WOOD-, MASON-, AND/OR METAL-WORK

GENEROUS WINDOWS, OFTEN LEADED - OR STAINED-GLASS

RECTANGULAR SHAPE, BUILT BETWEEN 1910-1940

BRICK EXTERIOR WITH STONE ACCENTS

COVERED ENTRANCE

ONE-AND-ONE-HALF STORIES TALL

PROTRUDING FRONT BAY

FRONT DORMER AT CENTER OF PEAK LOW-PITCHED HIP ROOF WITH OVERHANG

PLAY AGAIN

Credit: www.historicchicagobungalow.info
About the HCBI

Launched by Mayor Richard M. Daley in September of 2000, the Historic Chicago Bungalow Initiative is designed to foster an appreciation of the Chicago Bungalow as a distinctive housing type, encourage sympathetic rehabilitation of Chicago bungalows, and assist bungalow owners with adapting their homes to current needs, which in turn helps to strengthen Chicago bungalow neighborhoods.

The Historic Chicago Bungalow Association is the non-profit organization that administers the Initiative. The program offers a variety of financial resources, from grants to loans, and technical resources, from special permit assistance to "how-to" seminars. Certifying your bungalow with the Historic Chicago Bungalow Association is the first step in accessing these financial incentives and benefits.

Staff
Click here to contact any member of the staff of the Historic Chicago Bungalow Association to get your questions answered.

Online Forms
Engaged Owners

Chicago Bungalow Owners are:
- Organized
- Motivated
- Engaged
- Proud of their homes

Prime audience for retrofit engagement
Welcome to the first web site devoted exclusively to buying and selling historic Chicago bungalows. You will find me as passionate as you are about preserving these historic bungalows in ways that is as true and authentic as the Arts & Crafts movement that inspired them, while sincerely devoted to helping you upgrade them in ways that meet a modern lifestyle.

For buyers, my goal is to help you find, buy, and if desired transform Chicago’s most common form of residential architecture into certified historic treasures. For sellers, I’ll help you understand how your bungalow compares to others on the market, find the craftsmen who can make any necessary repairs, target market to an audience who most care about preserving them, and ultimately, get you top dollar for your bungalow.

In both cases it is my knowledge of the market, bungalow certification process, and relationships with honest and competent contractors that sets me apart from other realtors. As a buyer’s agent, I preview literally hundreds of homes a year, and that view from the inside out helps my bungalow buyers and sellers truly understand a bungalow’s real value.

I look forward to helping you buy or sell your own historic Chicago bungalow. In the pages that follow, I offer a bit of bungalow history, a graphical depiction of how a historic Chicago bungalow is defined, a direct link to my friends at the Chicago Bungalow Association, a little color on the Historic Chicago Bungalow Initiative, and a way to search for bungalows only (without having to sift through hundreds of irrelevant properties).

There is much more on these pages, so I invite you to linger, to learn, and if and when you are ready, contact me for specific information or services.
Bungalows are even MORE energy intensive

<table>
<thead>
<tr>
<th></th>
<th>Cook County</th>
<th>Chicago</th>
<th>Bungalows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>129</td>
<td>141</td>
<td>158</td>
</tr>
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<td>25th percentile</td>
<td>99</td>
<td>112</td>
<td>132</td>
</tr>
<tr>
<td>75th percentile</td>
<td>157</td>
<td>175</td>
<td>188</td>
</tr>
<tr>
<td>N</td>
<td>444,204</td>
<td>206,681</td>
<td>7,157</td>
</tr>
</tbody>
</table>

© CNT Energy 2011
Energy use intensity of bungalows

Median EUI = 158
25th percentile EUI = 132
75th percentile EUI = 188
Bungalows Are More Energy Intensive than Chicago and County Homes

County of Cook
Median EUI = 129
Median Year Built 1956

City of Chicago
Median EUI = 141
Median Year Built 1926

Bungalows in Chicago
Median EUI = 158
Median Year Built 1919
Bungalow Owners Span Socio-Economic Groups

Median Income
- Less than $30,000
- $30,001 - $40,000
- $40,001 - $50,000
- $50,001 - $60,000
- More than $60,000

© CNT Energy 2011
Lower-income areas have higher EUIs.
How can these data be used to drive retrofit demand?

- Homeowners
- Auditors and contractors
- Program managers and policymakers
- Drive program design/influence and increase retrofit demand
Program managers / policymakers

- Set priorities for energy efficiency investment – city could look at this and decide to prioritize bungalows
- Design financing options for different ownership types and geographies (TIF districts, etc)
- Informs neighborhood-based marketing strategies
- Geographic targeting allows you to align multiple program goals like energy efficiency, equity, neighborhood preservation and economic development

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Auditors / Contractors

• Market services based on aggregated data
• Workforce development is faster – can know the distribution of energy use in a given home type, instead of learning through field experience
• Target home types with high energy use – specialization of services
Homeowners

• Empower Homeowners with Information
  – Compare to neighbors/similar homes – there’s significant opportunities to save on energy bills
  – Total cost of ownership info before purchasing
  – Incorporate efficiency improvements into MLS before time of sale

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Realtors and Appraisers

• Appraisers need lots of data points to value efficiency improvements
• Realtors need third party verification and comparables
Challenges

• Data sharing and privacy concerns
• Quality of data across the nation
• How relevant is this to other cities? Is there the equivalent of the bungalow belt?
Next steps

- Describing the energy characteristics of other common architectural styles

- Bungalow
- Colonial
- Frame Cottage
- Georgian
- Newer Luxury
- Raised Ranch
- Ranch
- Split level
- Townhome
- Tudor
- Victorian

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Cook County
Single Family Housing
and the Common Architectural Styles Represented within Tax Assessor Classifications

- Townhome: 7%
- Colonial Georgian Tudor: 10%
- Bungalow Cottage (frame): 15%
- Raised ranch: 15%
- Ranch: 15%
- Split level: 11%
- Newer luxury: 5%
- Victorian Georgian: 5%
- Victorian: 5%
- Ranch: 5%
- Bungalow: 5%
- Townhomes: 7%
- Newer luxury: 5%
- Victorian Tudor: 1%

Legend:
- 202: 1 story < 1,000 sf, any age
- 203: 1 story 1,000 - 1,800 sf, any age
- 204: 1 story > 1,801 sf, any age
- 234: Split level w/lower level below grade, any size, any age
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- 210: Old style row house, pre-1948
- 295: Row house/Townhouse, oost-1948
Next steps

• Use model to create EUI distributions of other home types
• Measuring the impact of retrofit programs on a large scale
• Formalizing real estate partnerships
  – Total Cost of Ownership calculator
  – Energy data into MLS
We have a lot on our plate…

Mangia!
Contact Us

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