BUILDING THE ENERGY MAP:
ENCOURAGING RETROFITS IN MULTI-FAMILY HOUSING IN CAMBRIDGE

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Building an interactive map to help prospective renters identify high energy consuming apartments would create social incentives for landlords to upgrade their buildings. Moreover, other interested parties such as government agencies and energy contractors could use the map to target neighborhoods for energy efficiency outreach.

Foundation Research

Previous work conducted by the MIT Energy Efficiency Strategy Project has recognized the power of community-based energy efficiency approaches in making gains in efficiency upgrades. Research completed in 2012 suggested that energy mapping tools would be integral to launching community-based strategies and in making them more effective. Notably, energy mapping could:

- Open the door to new stakeholders in energy efficiency who may bring game-changing ideas to the field;
- Enable more sophisticated geotargeting such as identifying areas of great energy efficiency potential geographically in neighborhoods or programmatically in specific building types or demographic groups;
- Reveal community-level or neighborhood-level energy trends which inform better community-based outreach strategies; and
- Draw attention to energy consumption and catalyze social support for energy efficiency initiatives (Reul and Michaels 2012).

Energy mapping is a relatively new field and mapping applications surveyed were largely confined to academia. However, to achieve maximum impact, energy efficiency mapping tools need to be available to the general public. Previous EESP research also noted that an effective energy map should have three components: 1) An information display that combines energy data with other relevant data sources such as GIS and tax assessor records; 2) Affiliated programs and incentives which inspire users, professionals, or community groups to take action; and 3) A feedback input option which enables energy suppliers to receive augmented data such as age of appliances in homes (Reul and Michaels 2012).

This paper builds on the previous EESP research to explore how an energy map could catalyze energy efficiency upgrades in one of the most difficult sectors to reach – multi-family housing. Focusing specifically on Cambridge, Massachusetts, this work explores mapping precedents, necessary data inputs and data access for a mapping pilot, and how this energy map could potentially change the energy efficiency market.

The Landlord-Tenant Barrier

The landlord-tenant barrier is a significant obstacle to upgrading rental units in Cambridge and in other cities. Especially when tenants pay their own utility bills, neither party has an incentive to invest in efficiency upgrades. Landlords have no financial incentive to do so since they do not pay the energy bills and tenants may not live in the unit long enough to recoup the costs of initial investment in efficiency upgrades. Because of this obstacle, the multi-family rental market is a particularly challenging sector to get to participate in efficiency programs.

Creating more transparent information on energy use and utility bills in rental units could open a door to implementing more efficiency upgrades. For many tenants, utility costs are unknown when they sign leases and can significantly increase their monthly living expenses. If prospective tenants were able to understand their expected utility bills prior to making a housing decision, they would be able to choose apartments within their budget or ones that they perceive to be more “green” if that is something they value. Landlords would realize that tenants were selecting certain apartments over others because of energy performance. This could prod them to invest in efficiency strategies so their rental units would become more desirable. Moreover, if energy information on multi-family rental units is displayed publicly, landlords may feel some social pressure to make their buildings more efficient.

The Energy Map

Energy information transparency should be displayed in an interactive energy map (the Energy Map) where renters can get estimates of monthly electricity and gas bills. Buildings could be color coded for relative energy performance compared to similar buildings in the area (e.g. red is a high energy user, yellow is moderate, and green is low). Users could click on a building to see average monthly electricity and gas bills (in kWh, therms, and dollars) as well as heating fuel type. Other information on the map could include: a benchmark or efficiency potential score, recommended upgrades, available rebates with the appropriate links, and estimates of potential savings.

A map is the optimal energy display tool in this market for many reasons. Renters will likely be looking at a map to determine whether the potential housing location suits them. Other online resources already use maps, so this is a comfortable tool for many people. For example, Yelp - an online public review platform for restaurants, bars, and other places - pairs entries with a Google Maps location. Moreover, using a map could enable city agencies or energy contractors to identify neighborhoods which show the greatest need for energy efficiency upgrades.

Figure 1 – Mock-up of the potential Energy Map. Color-coded pins indicate the energy performance of multi-family buildings. Each pin opens a window where usage information is displayed. Monthly cost could also be displayed here.

Map Operations and Scalability

The first pilot iteration of the Energy Map should be built for Cambridge since the city has a large proportion of rental units it is housing stock and there are plenty of people in Cambridge with the technology skills needed to build the map. The Energy Map should be operated by either a non-profit or for-profit organization. If it were run by a utility or a government agency, it could be limited by political geography. A third-party would have an easier time of scaling the map from Cambridge to other cities like Chicago and San Francisco. The Energy Map would easily spread to other areas with large multi-family rental markets. This would likely be in urban areas and areas with a large young population (e.g., college towns). These are also demographics more likely to use mapping and other online tools.

Mapping Precedents

Some tools already exist which suggest there is potential for a map geared at displaying rental unit energy performance to be successful. Researchers at the University of Columbia created an interactive map in early 2012 which shows building energy consumption at the block level (see Figure 2). The lead researcher Bianca Howard noted, "The lack of information about building energy use is staggering…We want to start the conversation for the average New Yorker about energy efficiency and conservation by placing their energy consumption in the context of other New Yorkers. Just knowing about your own consumption can change your entire perspective," (Columbia Engineering 2012). One of the stated intentions behind this map was for New York residents to understand the energy consumption of the buildings they live in; however, this map does not display energy use at the building level. A map which could provide the more granular view would enable people to take more specific actions in the buildings they own and occupy.

Walk Score (www.walkscore.com) is map which rates the walkability of different neighborhoods based on metrics like number of nearby restaurants, schools, and the availability of other amenities (see Figure 3). Users can evaluate how walkable a neighborhood is before they decide to live there. Over 10,000 websites that list rental apartments use Walk Score and a year ago the company also developed a new apartment search tool (Coldewey 2011). This suggests there is a user base interested in evaluating things like sustainability and livability using mapping tools to help them make housing decisions.

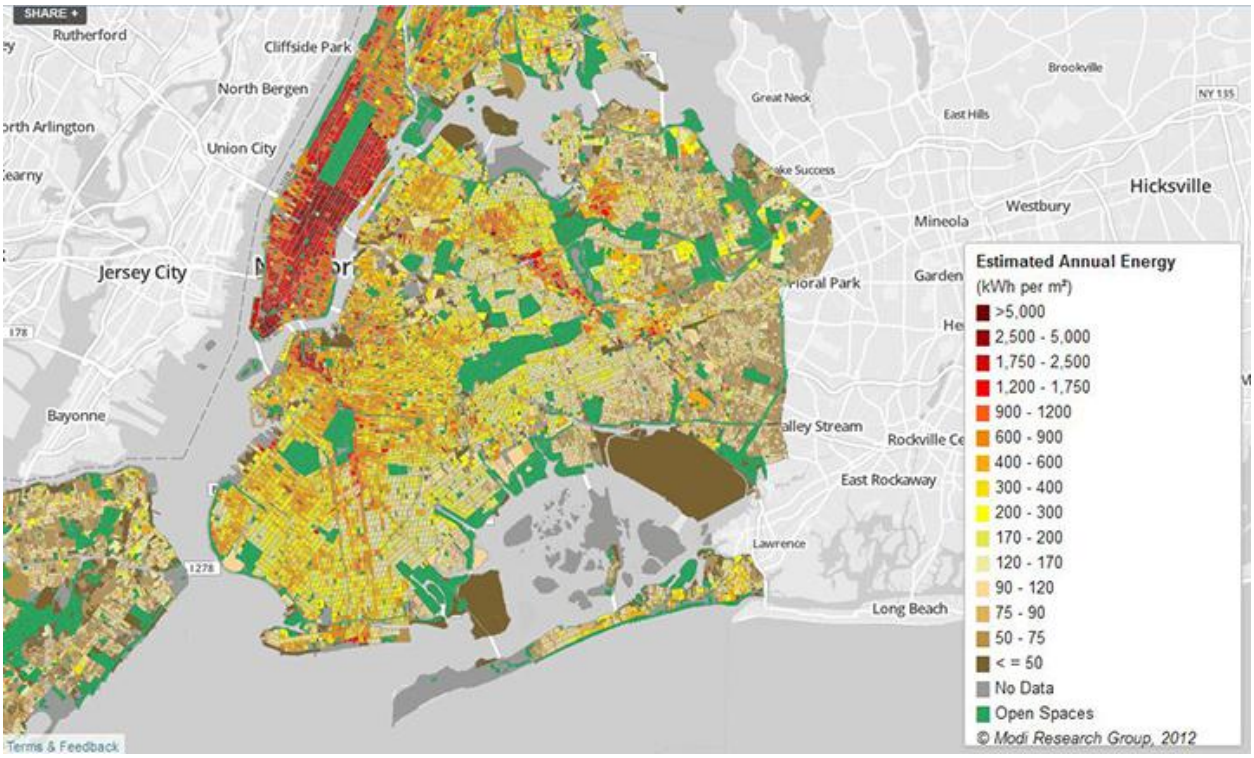

Figure 3 - Screen capture of the energy map built by engineers at Columbia University (modi.mech.columbia.edu/nycenergy/).

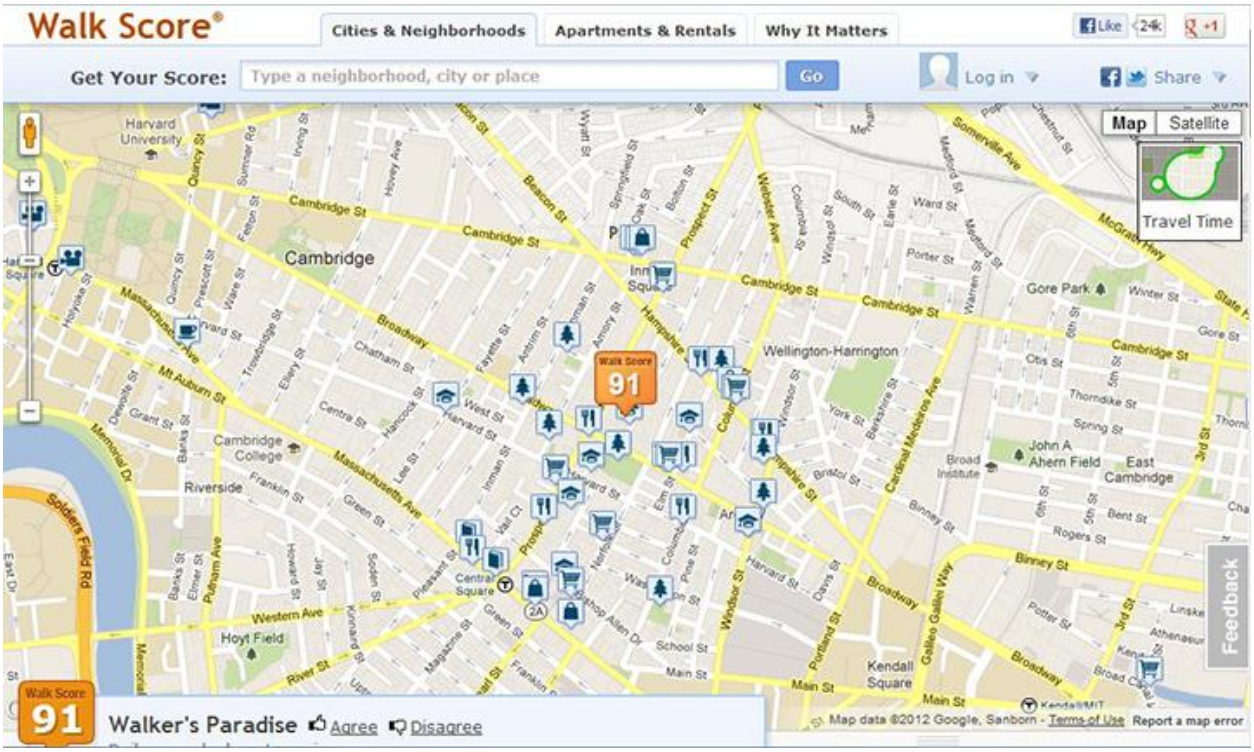

Figure 2 - Walk Score developed algorithms to determine the walkability of different neighborhoods (www.walkscore.com).

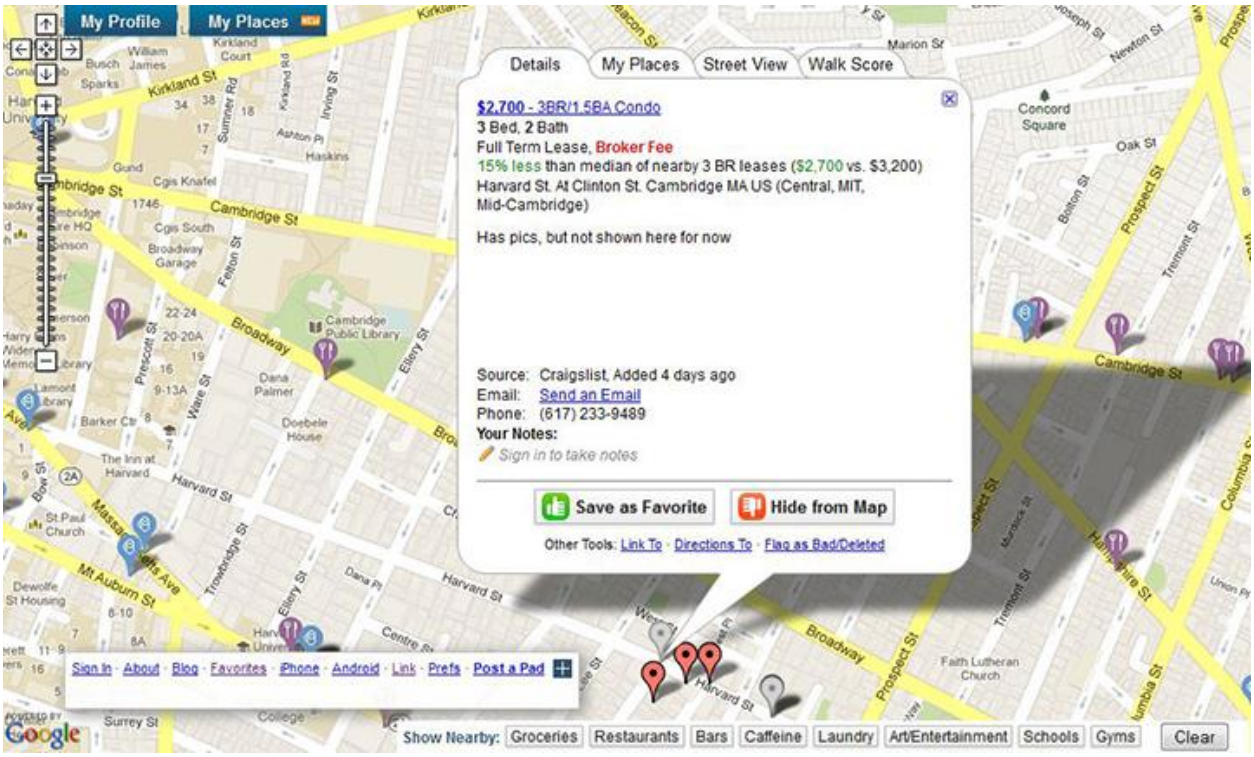

Figure 5 - PadMapper sources apartment listings from other sites and then adds other geographical information such as nearby restaurants, bars, schools, and more. It also incorporates Walk Score information with each apartment listing profile (www.padmapper.com).

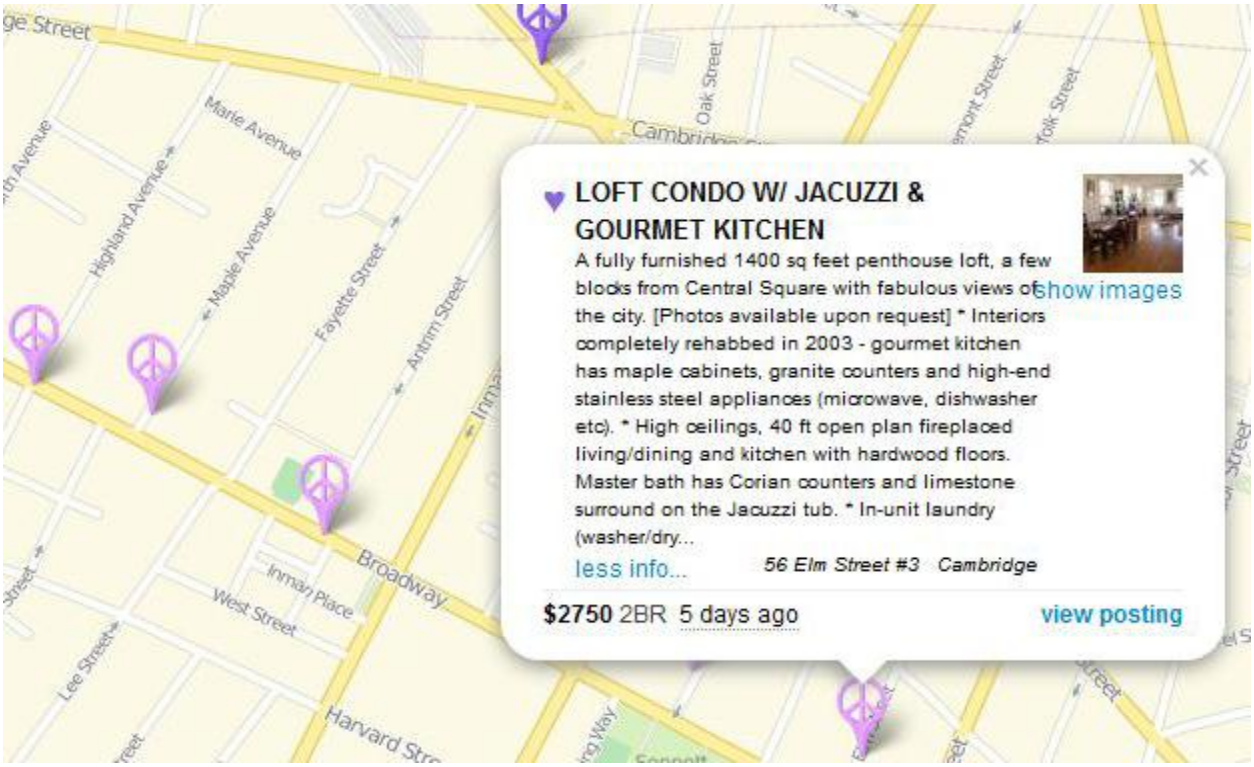

Figure 4 – Craigslist.org now includes a map for viewing apartment listings. Including energy information on this map could prove helpful to apartment seekers and could help convince landlords to invest in upgrades (http://boston.craigslist.org/aap/).

One of the over 10,000 websites which uses the Walk Score plug-in is PadMapper (www.padmapper.com). PadMapper pulls apartment listings from Craigslist.org – a popular site where people post apartment listings among other things – and displays them geographically using Google Maps. One of their included information tabs is Walk Score (see Figure 3). It could be feasible for sites like PadMapper to also include energy information from the proposed Energy Map, thus dispersing energy knowledge even further.

Craigslist itself recently launched an apartment mapping tool where users searching for apartments can display results on a map (see Figure 4). Since rental seekers already frequently turn to Craigslist to find an apartment, this map could become a popular tool. Perhaps the Craiglist map could incorporate Energy Map information which would help apartment seekers make leasing decisions. If a popular site likes Craigslist.com included the Energy Map information, this could have potential to influence landlords to improve their buildings.

Energy Data Access and Privacy

To build the Energy Map, monthly energy use is needed from rental units. Energy data is increasingly available, though still difficult to access, especially in the residential sector.

Federal recognition of the importance of energy data galvanized the creation of the Green Button Initiative, an industry-led effort to improve availability of energy data. Sparked by a challenge in September 2011 from U.S. Chief Technology Officer Aneesh Chopra to give customers greater access to their energy data, industry stakeholders worked together to officially launch the program in January 2012 (White House Office of Science and Technology Policy 2012). This voluntary program encourages utilities to release personal energy data to customers in a standard format as an XML file (EnerNex n.d.). To date, 20 utilities have committed to the Green Button Initiative. This amounts to 36 million residential customers gaining digital access to their energy data (Innovation Electricity Efficiency 2012).

NSTAR has implemented Green Button functionality and information can be downloaded as a CSV or XML file. The file includes the associated address, the start and end dates of 12 previous billing periods, the KWH usage for each period, and the cost ($) for each period.

Energy Usage Information			
For location:	15 TREMONT STREET CAMBRIDGE MA 02139		
Data for period starting/ending:	11/25/2011	12/22/2012	
Current billing period as of:	12/22/2012		
Time period (start)	Time period (end)	Usage (KWH)	Cost of Usage
11/26/2012	12/22/2012	185	$31.93
10/25/2012	11/26/2012	210	$35.34
9/25/2012	10/25/2012	148	$26.93
8/24/2012	9/25/2012	165	$29.22
7/26/2012	8/24/2012	228	$37.77
6/23/2012	7/26/2012	243	$40.28
5/25/2012	6/23/2012	121	$24.38
4/25/2012	5/25/2012	123	$24.71
3/24/2012	4/25/2012	159	$29.93
2/27/2012	3/24/2012	146	$28.04
1/26/2012	2/27/2012	209	$37.17
12/27/2011	1/26/2012	212	$37.44
11/25/2011	12/27/2011	178	$31.45

Figure 6 - Sample of information in CSV file from NSTAR's Green Button download.

NSTAR Electric Account Number: [illegible] Logout
Service Address: 15 TREMONT STREET, CAMBRIDGE

Summary of Electric Power Usage	
Last Billing Date	12/22/2012
Total Usage	2327 kWh
Total Cost of Usage	$414.59
Total Billing Period	11/25/2011 - 12/22/2012

Energy Billing Period	Usage (kWh)	Cost of Usage
11/26/2012 - 12/22/2012	185	$31.93
10/25/2012 - 11/26/2012	210	$35.34
09/25/2012 - 10/25/2012	148	$26.93
08/24/2012 - 09/25/2012	165	$29.22
07/26/2012 - 08/24/2012	228	$37.77
06/23/2012 - 07/26/2012	243	$40.28
05/25/2012 - 06/23/2012	121	$24.38
04/25/2012 - 05/25/2012	123	$24.71
03/24/2012 - 04/25/2012	159	$29.93
02/27/2012 - 03/24/2012	146	$28.04
01/26/2012 - 02/27/2012	209	$37.17
12/27/2011 - 01/26/2012	212	$37.44
11/25/2011 - 12/27/2011	178	$31.45

Usage and cost information is available up to your most recent meter reading.

You can choose to download your data in two different formats. Comma Separated Value (CSV) can be opened by most spreadsheet programs, and will let you use your data in a way that is familiar to you. XML is the format required by the government's Green Button Initiative. It is intended to be used by computer applications provided by third parties to help you understand and manage your energy usage.

File Format: CSV XML

Green Button Download My Data ®

Figure 7 - Screen capture of NSTAR's Green Button access. Clients must be logged into their eBill account to access the information and they can choose between a CSV or XML file.

Some utilities have already implemented Green Button data downloads. But even without Green Button measures, non-utility organizations are developing new efficiency tools and technology using alternative data sources. Some companies have already developed tools to screen scrape customer's energy data from e-bills, although this takes customization for each utility area serviced. Other companies are exploring how to facilitate getting asset data, which can often be a time consuming process and thus a barrier for potential customers. Some organizations have explored using tax assessor data, which is publically available and in many instances online and easy to access. Others are building databases of historic energy assessments so they can compare non-audited buildings to the performance of buildings with similar characteristics. Some companies are also using these databases and tax assessor records to create energy efficiency maps which identify homes and neighborhoods with the greatest efficiency potential. [Appendix A gives a few examples of innovative groups in the energy data sector.]

For the Energy Map, two different approaches could be used to collect data - either from the utility or from the tenants.

Due to privacy concerns (among other reasons), utilities have been reluctant to release ratepayer consumption data. Recently in New York, ConEd has agreed to release data for buildings with three or more tenants because end users cannot connect the energy usage to a specific tenant. Perhaps this precedent could pave the way for other utilities to release energy consumption data for multi-family homes in Cambridge, especially if energy data is presented as an average representing a typical unit in the building. Utility-provided data would be ideal because it would be up-to-date and access to data would not change as tenants come and go.

A way to enable the Energy Map and other groups to access data would be for states or the federal government to mandate public disclosure of energy data. Some building owner may protest due to privacy or safety concerns. One common safety concern is that if real-time data is publicly disclosed then it may be possible to tell when buildings are unoccupied leaving them vulnerable to theft. Other concerns include individuals or organizations simply wanting to keep their energy data private. Legislation could address the safety issue by requiring disclosure only on a monthly basis so that real-time information remains private. And initial disclosure requirements could focus on multi-tenant buildings where information could be aggregated to protect privacy and where there may be support among tenant's rights groups to give renters more information about units they lease.

If utilities are unwilling to provide data, tenants could voluntarily contribute their own data. Tenants could manually enter usage from historic utility bills. Or tenants could provide their e-bill account information and the mapping application could automatically screen scrape their data each month. The drawbacks to tenant provided data are that not all tenants in a building may participate; manually entering data is tedious and users may stop doing it eventually; as users move to new apartments e-bill accounts may change or deactivate, making it difficult to keep up-to-date records; and there would need to be a marketing campaign encouraging renters to contribute their data to reach a threshold participation rate that would make the map useful.

The preferable way to access energy data would be through a legislated mandate requiring utilities to release data for multi-tenant buildings in a standardized format on a monthly basis.

Energy Map Data Structure and Efficiency Ratings

As seen above, Green Button downloads provide information on billing period start and end dates, KWH usage, and cost in dollars of the usage. The building address is also provided. Depending on the area, publicly available tax assessor records could provide other information such as heat type, living area, and whether there is central AC. GIS databases could provide information on parcel size and building height (see Figure 8).

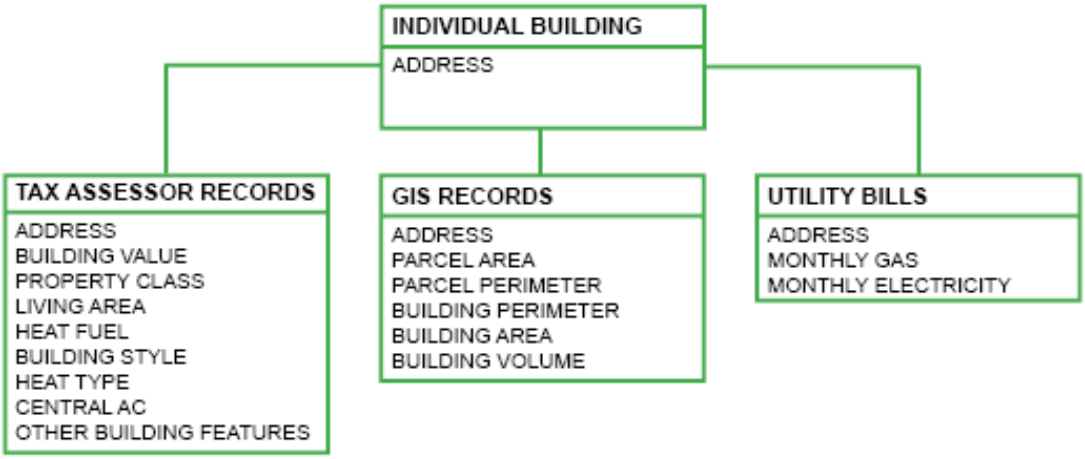

Figure 8 - Tax Assessor records, GIS records, and utility information could be linked by address.

Using these inputs, it could be possible to develop operational and asset performance ratings. Each building on the map could potentially receive a score for assets (e.g., relative to similar buildings, this building scores an 89/100). But each building could also receive an operational score (e.g., this building has an asset score of 89/100 but over the past 12 months has an operational score of 65/100). By having an operational score and an asset score, this could alleviate concerns of landlords that even if they upgrade their buildings, tenants would make poor energy decisions and negatively impact their building's rating.

Potential Impact

The Energy Map has the potential to influence the housing decisions of renters. Mapping tools for other types of information are already commonly used, so there would be a very short learning curve for users. Presuming that energy data is readily available through a government mandate, the next biggest obstacle may be creating awareness of the map so that it becomes popularly used. Integrating social media could help to address this issue and Walk Score could prove to be a model for diffusing rental information to other websites.

The Energy Map could be used to enable other community based social marketing campaigns. The visual display of building performance in colors (e.g., green, yellow, red) may establish new social norms which encourage landlords to upgrade their buildings. City agencies or utility departments responsible for implementing residential efficiency programs could use the map to more effectively target their programs at buildings and communities most in need.

The map may also be used to develop other creative outreach strategies. For example, the Energy Map could be used in an energy efficiency competition. Blocks, neighborhoods, or even friends living in disparate buildings could form teams to compete against each other to save the most energy. The Energy map could be used in a dynamic web platform to monitor building performance and show how different teams are faring against each other.

By revealing the energy performance of buildings on the public Energy Map renters can make more informed decisions about their housing decisions and this may ultimately encourage landlords to upgrade their buildings. Moreover, the map could also provide the opportunity for more geo-targeted efficiency outreach and the opportunity to develop other creative community-based social marketing programs.

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