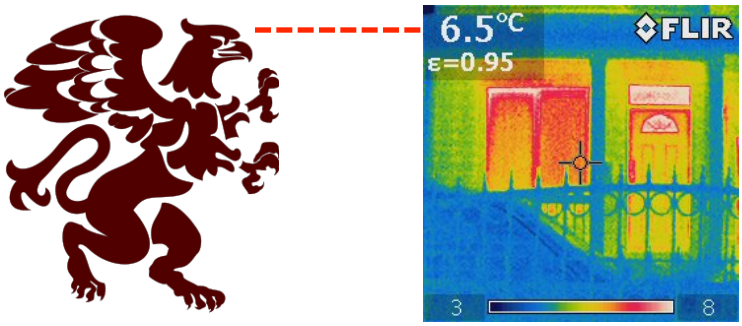
# Bringing negawatts home: A proposed residential weatherization program for the Portland Climate Action Plan




Final Report of the Spring 2013 Environmental Studies Junior Seminar (ES300) at Reed College

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## Executive Summary

Portland has been and continues to be a leader in the combined global effort to mitigate and adapt to climate change. Portland was the first major city in the US to identify and plan for the negative impacts of $CO_2$ in 1993, require LEED gold certification for municipally-owned buildings, and is a national leader in bike and mass transit. Yet for all these leadership positions, Portland and its Climate Action Plan (CAP) lack a weatherization component.

Energy efficiency (coined by Amory Levins as "negawatts") is viewed as a key strategy for both mitigation (less energy generation for heating) and adaptation (homes better resistant to extreme heat) at the federal, state, and local level. Energy efficiency in buildings already occupies a core component of the Portland CAP, particularly as concerns municipally-owned, commercial, or multi-family residential structures. In the U.S., most home weatherization efforts have been targeted at low-income households primarily as a function of the federally funded Weatherization Assistance Program (WAP). Energy efficiency is an inexpensive way to reduce $CO_2$ emissions, yet the challenge for cities is that the population that could benefit from weatherization programs is diffuse and economically diverse. Federal incentives exist for low-income housing while high-income housing can often afford to invest in technologies that have a long-term payoff. The gulf in the current weatherization policy landscape lies in the vast space of middle-income homeowners.

The landscape of potential homes to be targeted by future iterations of the Portland CAP is large, varied, and unwieldy for a one-size-fits-all policy design. In this report, we provide GIS maps and analysis of relevant variables that could be used to identify and prioritize homes for future weatherization efforts.

We conducted a **pilot study** measuring heat loss from homes with a distribution of size (square footage) and year built across four sites in SE Portland. These results, while certainly specific to a particular set of neighborhoods, are generally consistent with the distribution of single family homes in Portland – particularly in terms of build year. We find evidence that targeting **older** homes in Portland might have the largest desirable effect on energy efficiency improvements.

Based on our empirical evidence, we cannot make a clear recommendation on whether targeting **larger** homes would be advantageous. In this case, the data is complicated by the fact

that larger homes are also generally higher-value homes. We do not see a clear trend in energy loss (as measured by thermal imaging) with square footage, perhaps as a result of differing building materials. Certainly more energy must be expended to warm a larger home, and we do observe a qualitative match in the census tracts with larger than average gas usage also being those with larger average square footages. However, we motivate a focus on **middle-income** homes not based on this physical data, but rather on a perceived gap between assistance programs on the low-income side and ability to spend in anticipation of longer-term gains on the higher-income side.

We conclude with recommendations with regard to which homes should be targeted and the methods by which homeowners might be approached to encourage weatherization from a co-benefits perspective: individual homeowners benefit from reduced utility bills while contributing to Portland's efforts to tackle climate change. We proposed a **canvassing** of neighborhoods selected based on **age** and **income** criteria, with City of Portland representatives presenting homeowners with data on their census tract's gas and/or electricity usage relative to others in the city, as well as a brochure advertising a weatherization program facilitated by the city and financed via Energy Trust of Oregon.

The report is organized as follows:

1) An overview of other governmental efforts to encourage weatherization as a part of electricity consumption reduction
2) A description of the methodology for choosing homes and assessing heat loss in four sample sites near Reed College
3) Our proposal for target homes and potential implementation structure

In addition, a USB drive containing an electronic version of this report, the mockup brochure, and complete GIS map files will be provided with this report.

# 1. Overview of Selected Existing Weatherization Strategies: Federal and Local

## 1.1 Summary of Selected Programs

### 1.1.1 Federal Initiatives

In the wake of the 1973 oil crisis, the federal Weatherization Assistance Program (WAP) was created under Title IV of the Energy Conservation and Production Act of 1976.[1] Its purpose was to save imported oil and cut heating bills for low-income households, and it emphasized low cost emergency and temporary measures such as covering windows with plastic sheets and caulking and weather-stripping windows and doors. The 1990s show a trend towards more cost effective measures, most notably auditing homes to comprehensively analyze the best approach for each individual structure.

Today, about 20-30 million households in the U.S. are estimated to be eligible for this federal program. Weatherization, of course, does not lend itself well to federal guidelines: state and local governments, who also determine eligibility criteria, manage applications and allocation of direct aid. Criteria for this federal program, in line with state and local initiatives themselves, target low-income households, along with senior citizens, families that have members with disabilities, and families with children. "Low-income" is defined as within the 200% poverty threshold, and families receiving *Supplemental Security Income* or *Aid to Families with Dependent Children* are automatically eligible. Congress decides funding for the WAP annually, so available resources fluctuate from year to year.

The application process reflects the regional emphasis of this federal program--it entails calling a local agency, filling out the application forms and providing proof of income, as well as an interview. Once determined eligible, applicants are placed on a waiting list until a state-sponsored energy consulting firm audits the home and recommends an action plan which must first be approved by the homeowner before its implementation. Average cost of weatherization per home is $6500 and home values increase an average of $14,300. Renters may apply with landlord permission, as well as owners, single-family homes, multi-family complexes, and mobile homes.

[1] http://www1.eere.energy.gov/wip/wap.html

It is worth noting that weatherization measures have their roots in cost effectiveness—even before climate change was an issue in the public consciousness, the federal government recognized its monetary benefits.

### 1.1.2 Existing Portland Initiatives

In 2001, Portland/Multonomah designs a Local Action Plan on Global Warming with the goal of reducing greenhouse gas emissions to 10 percent below 1990 levels by 2010. Part B of this plan addresses "Energy Efficiency in Buildings," laying out some principles for reducing building energy use that cites the importance of outreach and education in addition to the special attention needed by low-income residents.

The current Portland CAP's weatherization policy[2] reflects much more in depth, information-based approach to weatherization, with an eye towards cost efficiency. It also emphasizes the importance of not just existing structures, but the construction of new homes. Four objectives are under the Buildings and Energy section, the last of which is an adaptation measure (in contrast to the first three mitigation measures).

### 1.1.3 Efforts in Comparable Municipalities: Boulder, Denver, Seattle, and Boston

Looking at other cities is a helpful way of informing our own avenues of local climate change policy. The other three cities CAPs - chosen for roughly similar climates, thus theoretically weatherizing for similar climate conditions - are Boulder, Seattle, and Denver.

All three, in some way, are oriented towards low-income households. However, this manifests into different ways; Seattle focuses one of its two weatherization programs on low-income households (with priority on health and safety issues) *and* provides free weatherization for low income homeowners *and* landlords with low income renters. Boulder's residential weatherization and energy programs target low-income and those slightly above, while also creating a separate program for high-income homes. Denver simply mentions developing and expanding their programs to target low-income housing, instead focusing on the high percentage of old homes in the city.

The methods between the three, cover a large spectrum: Denver and Boulder prioritize provision of materials (Denver has free energy-saving light bulbs, and Boulder provides free or

[2] Portland CAP: http://www.portlandoregon.gov/bps/article/268612, Section "Buildings and Energy," 30-37.

low cost materials),[3] the establishment of standards in Boulder and Denver targeting new homes and remodels, Seattle's low-cost loans (tailored for low-come houses),[4] and endless, more ambiguous and vague language concerning partnering with the private sector (Denver) and educational materials (also Denver).

Boston's CAP was updated and released in 2011 by Mayor Menino.[5] Its description on its page of the official website of the city of Boston reflects a particular emphasis on the economic benefits of climate change action, citing solid waste and produce net savings of over $2 billion by 2020 through lower energy bills as well as the jobs resulting from "demand for energy and climate related services." Another emphasis, unique to Boston's building efficiency measures, is a special and extensive focus on municipal resources and systems.

These other plans are, more generally, focusing on weatherization in residential areas with specific regard to disparity in income. They often develop two programs: one for lower income households, and one for higher income. There are often plans for more energy efficient new constructs, and plans for existing houses. Energy standards and benchmarks are common tools. Portland embodies these basics as well - so what is there to learn from Boulder, Denver, Seattle, and Boston?

Policy learning, especially in terms of a field where the science is still advancing quickly, is essential in shaping the most effective policies in climate change, and in weatherization. Looking to other policies has been a common strategy in policymaking for the purpose of building upon previous innovation, but also in determining which tools are effective at reaching programmatic goals – in this case, in increasing weatherization across Portland for the purpose of lowering energy usage. Rather than "reinvent the wheel", we draw upon suggestions from programs that have been attempted in similar jurisdictions. However, it is important to understand that these other contexts are not identical to Portland and should serve as a first look at long-term solutions.

Further details on the federal (A1), Portland's (A2) and these comparator cities' (A3) weatherization programs are provided in list form in the Appendices of this report.

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[3] Boulder CAP: http://www.bouldercolorado.gov/files/LEAD/climate%20and%20energy/cap_final_25sept06.pdf; Denver CAP: http://www.greenprintdenver.org/about/climate-action-plan-reports/
[4] Seattle CAP: http://www.seattle.gov/housing/homewise/
[5] Boston CAP: http://www.cityofboston.gov/climate/

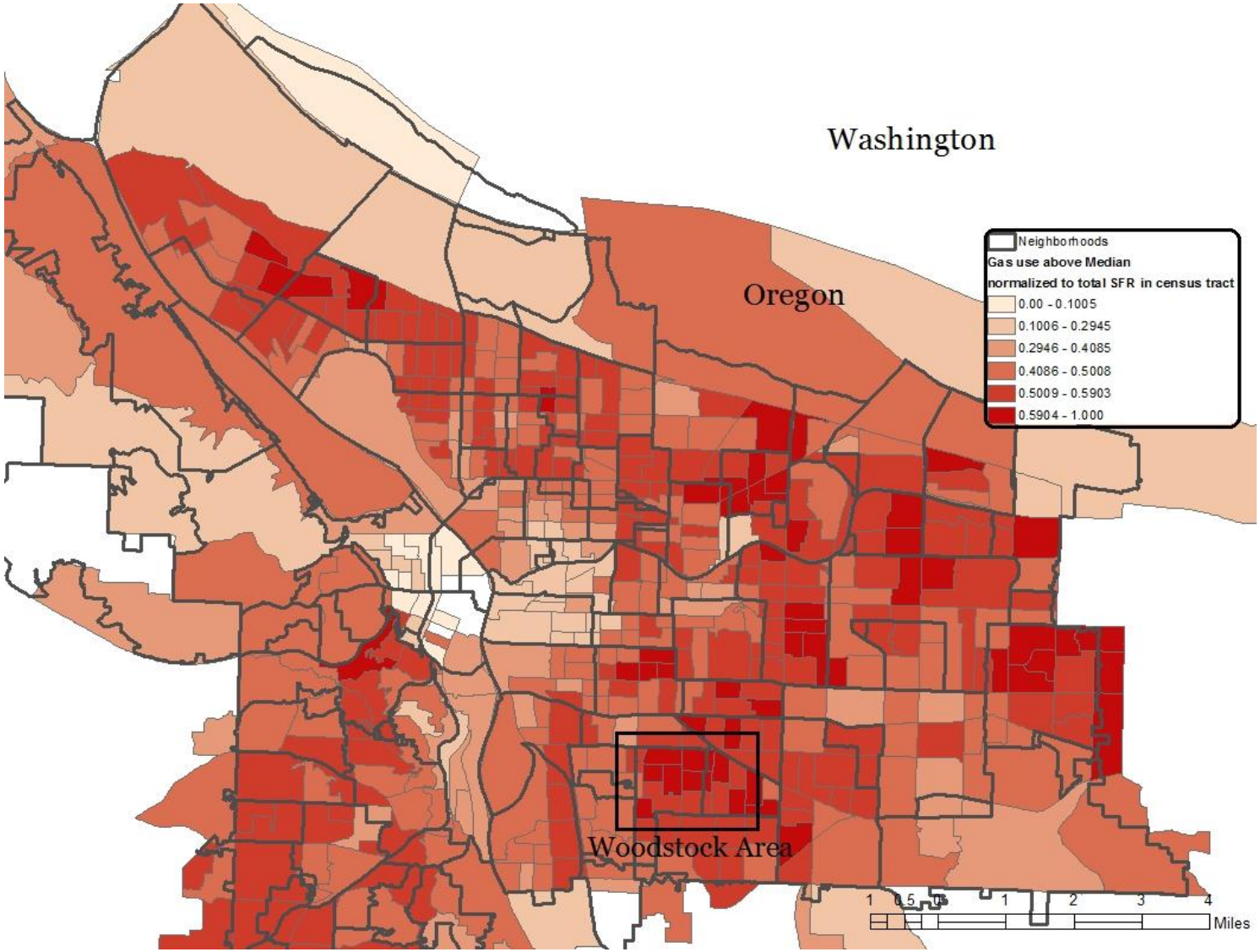



**Figure 1.** Gas use by census block in Portland city. Data are symbolized as number of single-family houses above median gas use (darker color represents more homes above median gas use) by census block, normalized by number of single-family homes in each census block. Data: City of Portland, Bureau of Planning and Sustainability**.** Box indicates area of study for this report.

## 2. Summary of Reed College's pilot SE Portland IR thermometry study

The project proceeded with data-gathering of existing housing stock in Portland. Infrared (IR) thermography data was collected from 110 single-family homes in SE Portland neighborhoods surrounding Reed College (see Figure 1). Individual houses were selected to cover a broad range of both age and square footage. The four age ranges chosen were pre-1975, 1976-1992, 1993-2002, and 2003-2012 to reflect potential differences due to changes in Oregon's building codes enacted in each of the cut-off years (we use 2003 as a cutoff date not because of building codes, but because of the implementation of Oregon's Energy Trust Program). For example, Oregon's first state-wide building code addressing energy conservation went into effect in 1975 and thus houses built before then may be less effectively insulated – to look at one metric.

The range of square footage was selected to capture any trends of heat loss correlated to size of home. It is important to note that house size shows a strong positive correlation with house value ($r = .66$, $p<.001$). The homes we analyzed spanned low and high-use census blocks of gas and electric consumption, which are normalized to the density of residences per block Maps detailing the age of houses analyzed, both overlayed onto gas and electric data, are shown in Figure 2.

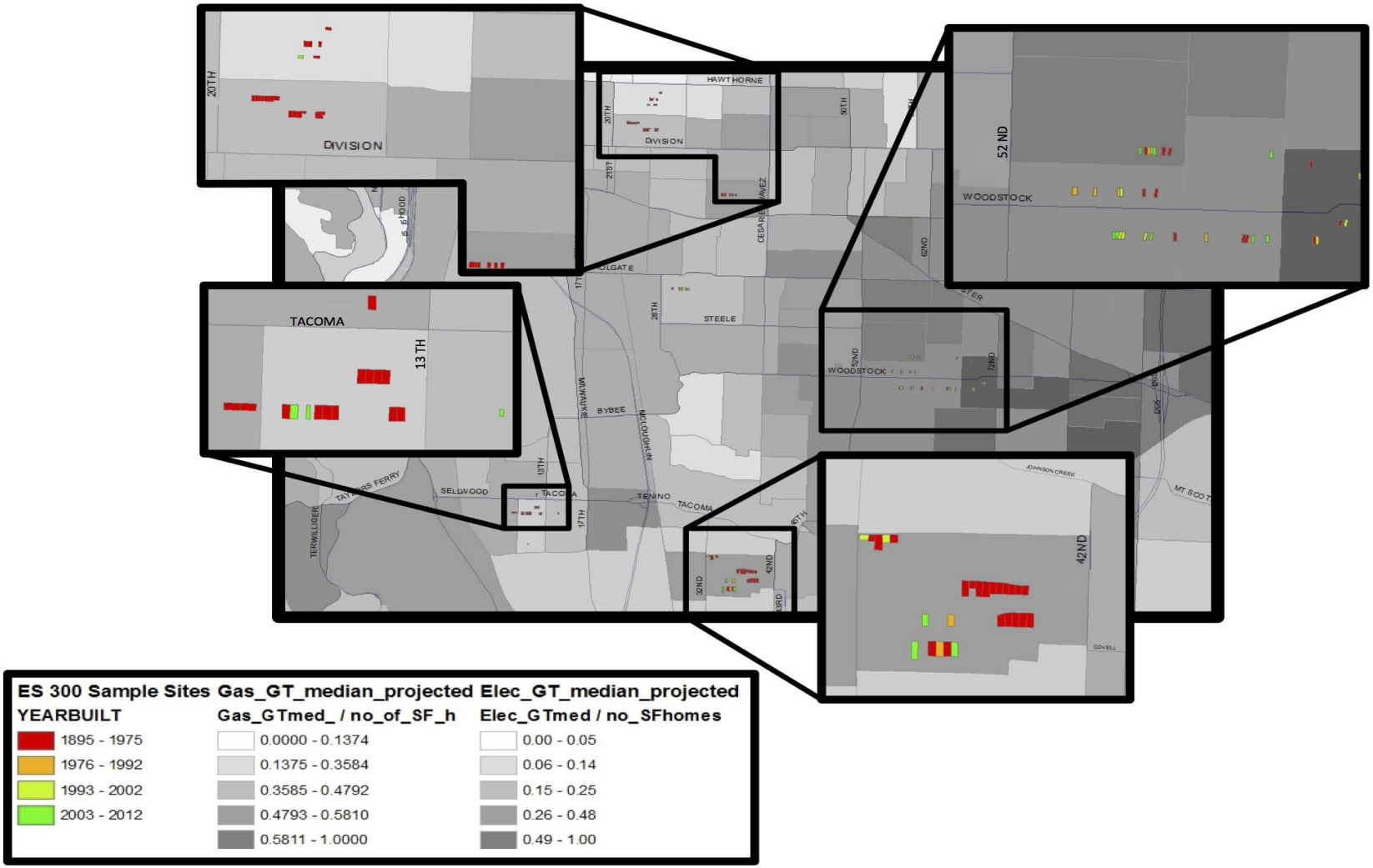



**Figure 2.** Map of SE Portland with zoomed in regions showing sampled houses layered onto gas/electric data (same source and normalization as in Fig. 1), colored by house age.

To best capture heat losses from homes, thermography images were taken using a FLIR b60 IR camera between the hours of 8:00 PM and 10:00 PM February 8-10, 2013, when the nighttime temperature dropped below 40 °F, which is typical for Portland winter. The evening sampling times minimized heat contributions from the sun during the day. For consistency, images were taken of the north-facing wall of each house, and images were captured perpendicular to the surface of the wall to maximize accuracy of the temperature readings. An example IR image of a house is shown in Figure 3.

FLIR QuickReport software was used to record the spot temperatures of walls, windows, and doors, and "background" features such as trees or concrete to assess heat loss from each house. Temperature differences (ΔT) were calculated for each non-background element by subtracting the ambient background temperature from the temperature of the home element, (e.g. a window). Because this temperature difference is proportional to heat loss (2009 American Society of Heating, Refrigerating and Air-Conditioning Engineers Handbook Chap. 4), we use this ΔT as a metric for home energy loss.

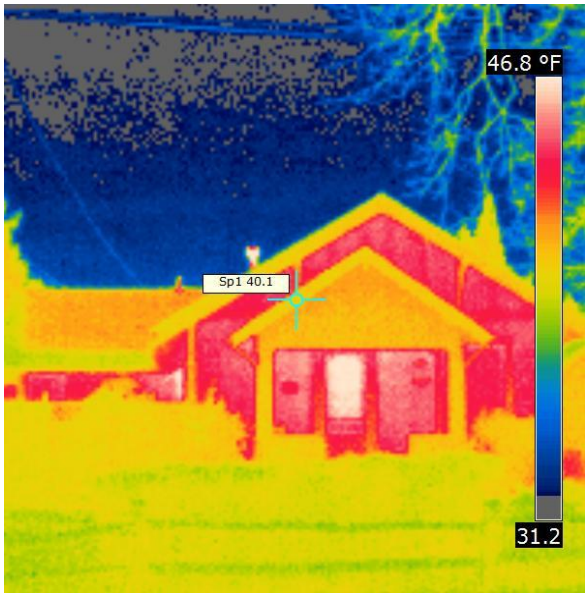



**Figure 3.** Sample IR image of home.

Correlation plots were generated relating various ΔT values to both age and size of homes. The strongest correlation to age was observed from ΔT values calculated using the maximum wall temperature. Figure 4 shows this negative correlation, indicating that newer houses have better insulated walls. The strongest correlation to size was observed from ΔT values calculated using the door temperature. Figure 5 shows this relationship and suggests that larger houses lose less heat through the front door, possibly due to the fact that larger houses have many other points of heat loss in comparison to smaller houses, or that larger homes tend to have more substantial doors.

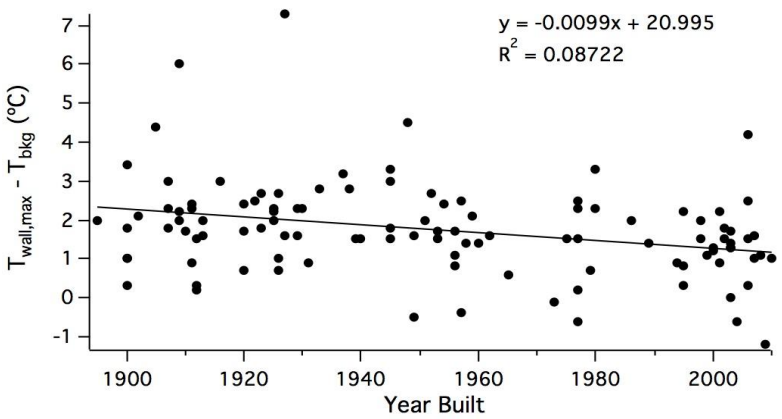



**Figure 4.** Correlation plot of ΔT from the maximum wall temperature with respect to house age.

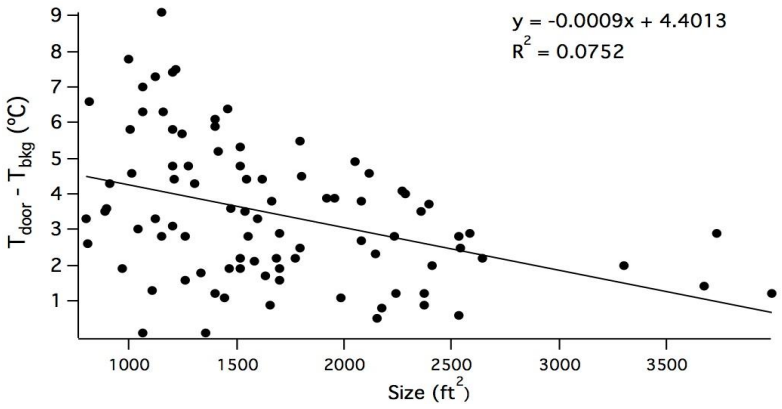



**Figure 5.** Correlation plot of ΔT from the front door temperature with respect to house size.

In addition, thermography data was collected from a single house both before and after windows were reinsulated and reset. Figure 6 shows before and after IR images of this house which is typical in size and value to our mean home.

We teamed with Lewis & Clark College's Digital Field Scholarship program for this study. As a result, the complete "digital field notebook" from this pilot IR thermometry study, including all housing data and thermometry images, can be accessed at https://sge.lclark.edu/dfs/weatherization/.

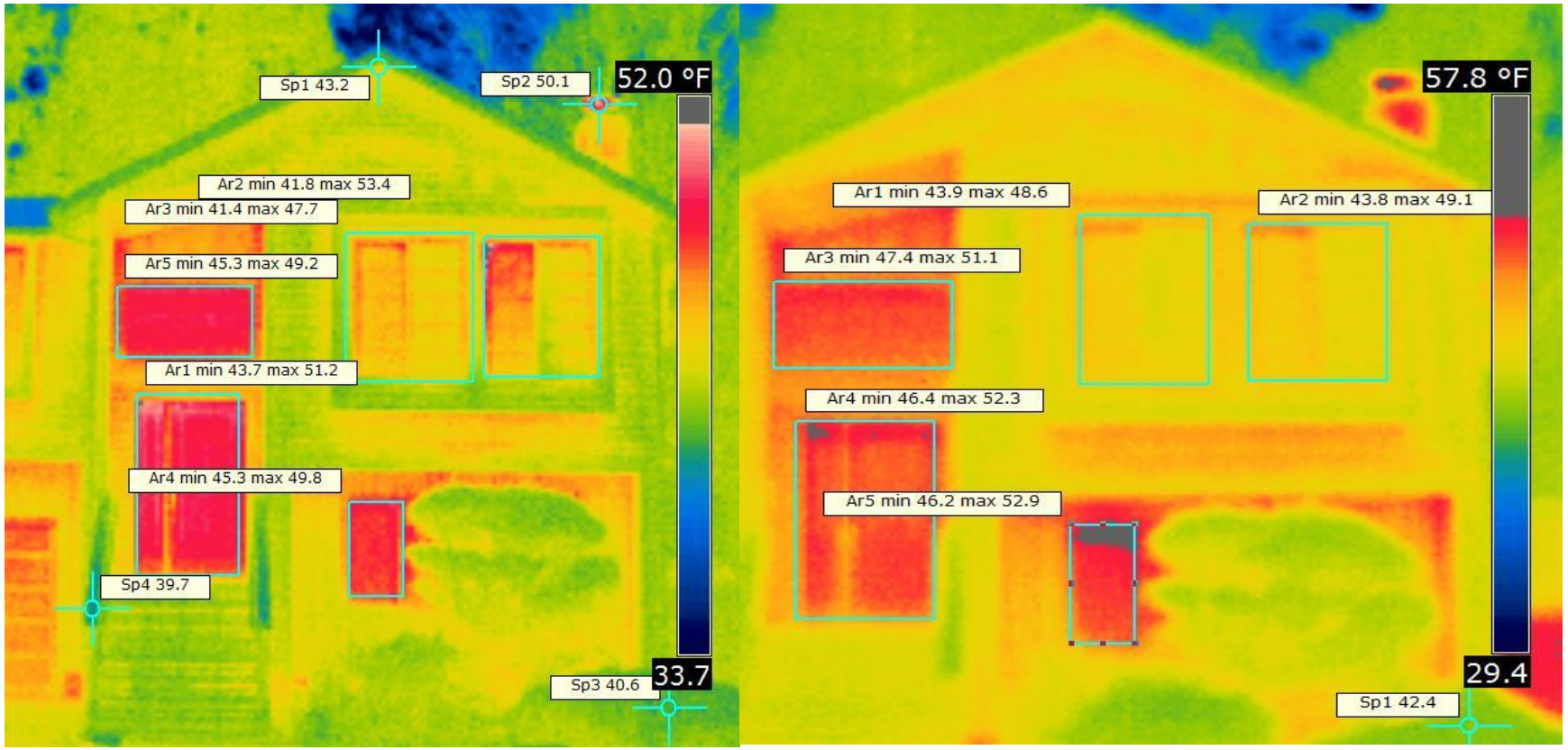



**Figure 6.** IR images taken of a single home before and after implementation of weatherization improvements. The left image is prior to weatherization actions; the right image is post-weatherization. The two windows in the upper right hand corner of the image were weatherized; the result is a reduced heat loss differential between the siding of the home and the windows.

## 3. Policy Design and Implementation

### 3.1 Overview of Proposed Design

We propose targeting Portland neighborhoods contained both by the census blocks with the highest average gas consumption per residence, and by the census tracts with the highest median incomes.[6] We have identified four neighborhoods with high gas use that we can immediately address: Bridlemile, Crestwood, Woodstock, and Beaumont-Wilshire. These four earn incomes one standard deviation above the mean of the median Portland income and have the top 20% of gas users by percent of residences consuming above the median across the City. Our next targets are sixteen additional neighborhoods that are constrained by the same gas use parameter but include incomes within the top half highest median income, as opposed to just those above one standard deviation from the tract median. These features represent a demographic most likely willing to weatherize their homes if presented information regarding annual utility savings, upfront costs and approximate decreases in greenhouse gas (GHG) output.

Based on our infrared image analysis, as represented in Section 2, we find a stronger correlation between heat loss from walls and house age than we do between heat loss from doors and house size (Figures 4 and 5) from collected IR data from southeast Portland homes (sample size 110 single family residences). With this in mind, we are interested in canvassing and distributing brochures to single-family residences built before 1975 that are located in the neighborhoods constrained by the gas and income parameters. Wilson and Dowlatabadi (2007)[7] outline the following variable behaviors determining choice when faced with decisions regarding changes:

a) aversion to risk and uncertainty

b) the use of high short-term discount rates

c) heterogeneity of preferences within a population

d) transaction costs of searching for and processing information

e) sensitivity to changes in the attributes of the "energy services"

[6] The data available to us dictated this pattern. Ideally, census blocks would be used as the smallest common unit of measure, but we did not have access to income data by census block.

[7] Wilson, Charles and Dowlatabadi, Hadi. 2007. Models of Decision Making and Residential Energy Use. Annual Review of Environment and Resources. 32:169-203.

f) the relative importance of energy costs as a proportion of total expenditure

In effort to address all six of facets of decision making, our implementation strategy combines social and economic sensitivity with technical assessment. Utility is an economic construct that tries to understand decision outcomes in terms of preference, and is sometimes used to represent well-being or personal benefit. Short-term discount rate according to Wilson and Dowlatabadi (2007) is a measurement indicative of willingness to pay more in the short term to save money in the long term. This same review also suggests that when it comes to energy, short-term discount rates are highly dependent upon the energy saving appliance or system. The *Target Attributes* portion of this proposal lays out how we will address the aforementioned decision making rationales - **by targeting homeowners making above the mean income, with 20% above mean of the median gas usage and making at or over one standard deviation above the mean income within the city of Portland.**

Once target neighborhoods/homeowners have been identified, we propose a canvassing campaign where homeowners are presented with a brief comparison of their census tract's gas use relative to the normative gas user, and with a brochure describing Portland's future energy goals (see Section 3.3).

## 3.2 Target Attributes

### 3.2.1 House Age

We propose first targeting neighborhoods with houses built before 1975. The first city-wide energy conservation requirements for residential buildings were developed in 1975. By targeting homeowners with homes built before the enforcement of the conservation requirements, who also are high gas users, we increase our confidence that these homes have not yet been renovated for energy savings. Homeowners who have not recently invested in energy savings may be more willing to consider renovations as proposed by us. While some homeowners might adversely react to the prospect of renovating their older homes, alterations such as new windows are a less invasive processes than new walls, and also have added safety benefits. Newer windows are often double paned for heat conservation and boast more advanced locking mechanisms. While often the most expensive components of weatherization programs, windows also may be eligible for federal support related to lead paint removal in older homes. The intention of heat-retaining renovations is to lessen gas use, not change energy services (point

(e)), and therefore the only disruptive portion of the weatherization process to daily life is the actual renovation process. This disturbance and potential discomfort is further alleviated by our seasonal canvas-renovation approach (see Figure 7). Sacrificing short-term funds could be seen as a trade-off for increased safety in the long run for many homeowners, and the need for new windows is reinforced by abnormally high gas use, especially in neighborhoods with older homes (Table 1 and Figure 8).

**Table 1.** Composition of neighborhood by percentage of houses between five age ranges. We suggest targeting neighborhoods composed primarily of older houses, because it would not only save money from decreased gas but also in many cases increase property value.

| Target Neighborhood | 1885-1915 | | 1916-1930 | | 1931-1945 | | 1946-1960 | | 1961-1975 | | Total houses |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | taxlot | % | | | | | | | | | |
| Bridlemile | 5 | 1% | 11 | 2.5% | 52 | 12% | 223 | 52% | 138 | 32% | 429 |
| Crestwood | 1 | 0.01% | 3 | 0.05% | 62 | 10% | 323 | 56% | 186 | 32% | 575 |
| Woodstock | 31 | 14% | 86 | 40% | 38 | 17% | 43 | 20% | 16 | 7% | 214 |
| Beaumont-Wilshire | 66 | 16% | 295 | 74% | 27 | 6% | 5 | 1% | 2 | 0.05% | 395 |

### 3.2.2 Gas Use per Census Block

We propose targeting neighborhoods with high overall gas use because it is likely that they either a) use high amounts of gas because they can afford it, or b) use more gas than the median of Portland residences because they lose more heat from poorly insulated walls and windows. In our analysis, we assume both a and b are the case, so we choose to target most immediately the single-family residences earning more than one standard deviation above the mean income (of the census tracts' medians). These single-family residences also fall in census blocks with a very high percent of single-family residences that consume more gas than the median Portland residence. Looking into neighborhoods with high gas use reveals a usage pattern in conflict with current values surrounding resources; high gas usage does not align with contemporary progressive mentality in regards to resource consumption. While as mentioned above (point (c)) that different preferences within a population do exist, we acknowledge that in Portland the current frame of mind focuses on using less resources, and not more. Portland represents itself as a "green" and environmentally motivated city. Therefore, weatherizing homes in order to use less has an inherent "green" value. We propose that by targeting neighborhoods

with high gas use, weatherization will be an attractive option not only because of the "green" value, but because of the increases in home value and the decrease in utility bills.

#### 3.2.3 Housing Value and Savings Incentives

"Greening" a home through weatherization increases home value, benefiting homeowners in multiple ways. Increasing the value of homes through our proposed weatherization plan allows homeowners to experience the monetary benefits of their reduced gas use, increased home value, and avoidance of short term discount rates. In a study cited by Popescu *et al.* (2012)[8], "greened" homes (homes meeting energy-star standards) had 9.8% fewer utility expenses. When it comes time to sell, market value for energy-star rated homes is 13.5% greater than non-energy-star rated homes (Popescu *et al.* 2012). These values are reassuring for homeowners uncertain about the direct benefits of weatherization (point (a)). If the home is rented out, tenants may also absorb some of the cost as they receive direct benefits in the form of energy savings, and the homeowners benefit still from the raised property value (see Section 3.3.1: payment structure). As noted by Wilson and Dowlatabadi (2007), priorities for spending may deter some homeowners from renovating because raising home market value or spending less on gas is a low priority. For this reason, we target those making above the mean income, who have flexible capital and whose priorities feasibly lie in home improvement or home efficiency.

#### 3.2.4 Income Target Rationale

Preferences are often limited by monetary resources. For this reason, we propose targeting census blocks one standard deviation above the average of the median income in Portland. High-income homeowners using more gas than the median user might not see adjusting gas use as a financial priority. To put excessive use in perspective for heavy gas users, we propose presenting them with a brief comparison of their census tract's gas use relative to the normative gas user and with a brochure describing Portland's future energy goals. A comparative approach informs homeowners jointly about potential savings and the extent of their relative resource use. This comparative tactic in effort with the brochure works to collectively entice the city residents to lower gas use. The brochure focuses primarily on GHG output as a product of resource use, which points to the individual and high gas use, tying GHG output and home

[8] Popescu D, Bienert S, Schützenhofer C, Boazu R. 2012. Impact of energy efficiency measures on the economic value of buildings. 2012. Applied Energy. 89:454-463.

renovation together. By reframing the focus of the weatherization project from individual homes to city-wide and global, those who can easily pay for higher gas use may recognize the inherent value in weatherization for lowering resource use. This "group mentality" reestablishes the importance of gas use as a proportion of total expenditure on an individual level (point (f)).

In summary, our proposed first target neighborhoods are shown in Table 1 and Figure 7.

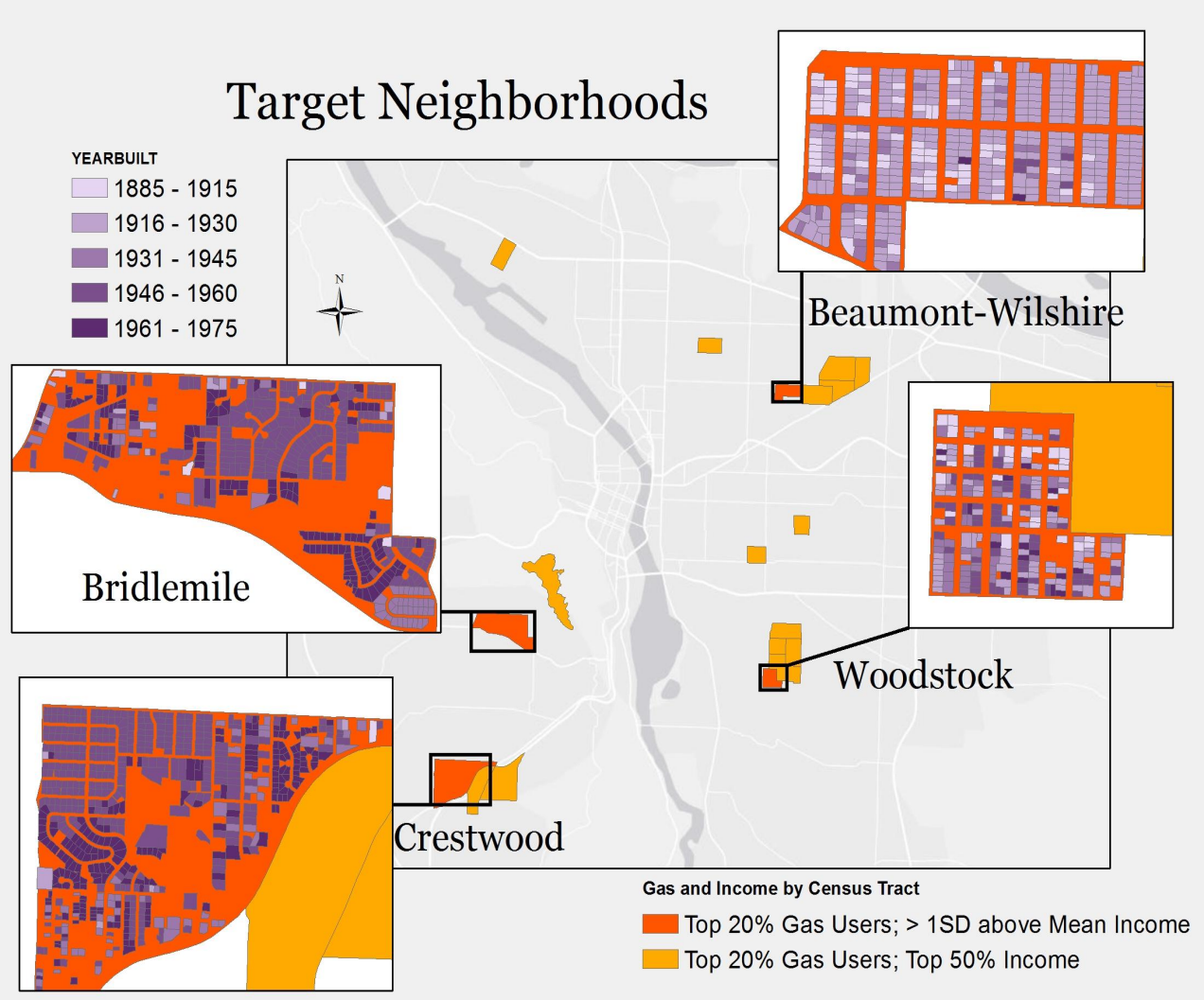



**Figure 7**. Target neighborhoods for initial weatherization efforts based on the findings in this report.

## 3.3 Implementation: Information Disclosure and Pricing

### 3.3.1 Payment Structures

The greatest hindrance for individuals considering retrofitting a house for efficiency is the high initial investment in time, money, and effort, even considering long-term savings. This is a phenomenon known at an "efficiency gap." This is further compounded by the principal-agent problem in which the payments to engineers and architects that weatherize houses are a percentage of the capital costs of the projects. This kind of pay structure renders the already high up-front costs of weatherization arbitrarily more expensive. Similarly, for renters, the principal-agent problem exists where landlords have no incentive to install either renewable energy or energy efficiency projects when they bear the costs and their tenants reap the benefits of lower heating and cooling costs.

The simplest solution to these related problems is to change the pricing scheme of households receiving weatherization. Since the biggest problem for an individual considering weatherization is the initial investment, a city-wide weatherization project could easily shape the implementation to ease this initial burden by:

1) Taking the responsibility of finding an installation specialist and coordinating schedules with the household.
2) Changing the pricing structure of the household receiving weatherization to incremental payments over time instead of simply paying the entire initial cost of installation (formerly paid directly to the installer).

The second component could be done two ways: either the payment structures of the installers themselves would change to incremental payments (i.e. the recipients pay the installers directly in increments over time), or the city pays the upfront cost to the installer and the homeowner pays the city incrementally over time. The latter is likely easier to implement. The size and frequency of increments could be adjusted to household income where higher earning households pay larger and less frequent increments, while low-income households pay lower more frequent payments (perhaps, for example, the difference in energy savings over time such that the cost would be net neutral to the homeowner). These payments could even be built into the tax code.

These solutions do not, however, solve the principal-agent problem for landlords and tenants. Some mechanism that enables landlords to collect the difference in energy savings from

their tenants is necessary. This should be relatively easy to implement, however, since the energy savings experienced by tenants would be net neutral (and eventually net positive) if they paid the difference to landlords until the initial cost of installation is completely paid off (after which tenants reap the benefits of lower energy bills once their rent is lowered to its initial value).

#### 3.3.2 Canvassing

An effective and perhaps overlooked venue of information dissemination (that can effectively inform households of the benefits to weatherization) is the act of canvassing. This can be done door to door, at events like farmers markets and festivals, and at storefronts. We propose what seems like an obvious tactic because experience at Green Mountain Energy has shown us that this will be an extremely effective way of getting residents of Portland on board with the weatherization program. The model used by Green Mountain Energy was very successful in getting PGE customers to pay *more* to have a higher percentage of renewable energy going to the grid (a benefit from which they never profited). We are therefore confident that canvassing efforts to inform people of a program that is *directly profitable to them,* requires no effort, and reduces fossil fuel consumption, will be effective.

The implementation mechanism utilized by Green Mountain was simple. A canvasser would either go door to door or set up tables at festivals, farmers markets, and storefronts. The canvasser's job would be to get attention with lines like "do you want to improve your home value and reduce your electricity bills with Portland's building efficiency program?" Interested recipients would fill out a short form involving their name, phone number, and address, which is entered into a database. Given the success of Green Mountain in getting customers to sign on to a program that was a direct cost to them, it is likely that these sort of information disseminating efforts would be wildly effective for the city of Portland in getting residents to agree to weatherization.

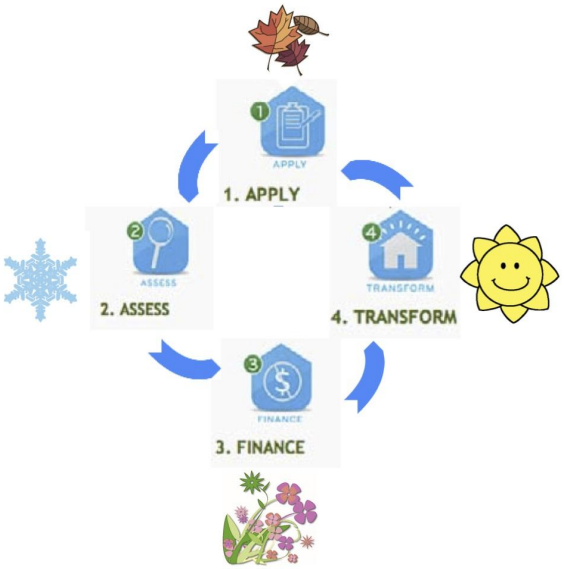



**Figure 8.** A breakdown of the approach our proposal takes by season (graphic: Clean Energy Works Oregon).

Extensively, we propose canvassing our information seasonally. By approaching residents in the fall when gas use is high, after having signed up we can assess their homes in the winter when the heat loss is highest. Potential winter discomfort is avoided when homes are then renovated in the spring and summer months. Information is presented to neighbors in the form of a brochure advertising the following four steps: apply, assess, finance and transform (see Figure 8). By using canvassing as a distributive tactic, and by utilizing services connected to the city, we eliminate concerns regarding information hassle (point (d)) by delivering information to the homeowner's doorstep. A sample brochure we propose for use in this canvassing campaign is shown in Appendix A4, and the data needed to present homeowners with energy-use data relevant to their properties is found in the GIS maps we will also provide electronically with this report.

## 4. Conclusions

The work we have presented in this report offers information with regard to prioritization techniques for a Portland-specific weatherization program in addition to some policy suggestions regarding design and implementation. We find that the most likely beneficiaries for weatherization programs are likely to be older homes, and argue that additional targeting should be based on homeowners who fall in the "gap" between federal assistance and the ability to finance upfront costs individually in anticipation of long-term gains. We provide GIS mapping tools to aid in targeting, and provide a sample brochure that might be used to inform residents about the goals of weatherization. These will be provided to the city electronically and we invite the use of any portion of this study deemed useful.

## Appendices: Specific Components of Comparison Weatherization Initiatives

**Note:** the text below was taken / adapted from the DOE EERE program website and these cities' published online Climate Action Plans (websites cited above in the report body).

### A1. US Federal Program

U.S. Department of Energy (DOE) Energy Efficiency and Renewable Energy (EERE) Weatherization and Intergovernmental Program (WIP)
http://www1.eere.energy.gov/wip/wap_apply.html

- estimated 20-30 million U.S. families eligible for program
- Criteria for eligibility state dependant but:
    - automatically eligible if receive Supplemental Security Income (people who are low-income **and** old or disabled) or Aid to Families with Dependent Children*. "Low-income" is described as income within the 200% poverty threshold, which is to say household income is 0-2 times some defined "poverty" level of income. Some states may alternatively use 60% of the median state resident income as a poverty benchmark.
    - States often prefer: age > 60 years, families with one or more members with a disability, families with children

Process:

- Call local agency
- Fill out application form/provide proof of income for the previous year/go through an interview process
- If the agency determines you are eligible they place you on a waiting list
- Eventually a state-sponsored energy consulting firm will audit your home and recommend an action plan stressing costing-effectiveness, if said plan is approved by the homeowner then they will weatherize your house

Interesting facts:

- Started in 1976
- The average weatherization cost per home is $6500. On average the program increases home values by $14,300
- Program open to: renters (with written landlord permission), owners, single-family homes, multi-family complexes, mobile homes
- Available resources subject to fluctuations as Congress decides funding for the program on a yearly basis
- Applications for the program and direct allocation of aid to individuals is managed by State and local governments. Guidelines in the U.S. constitution discourage the federal government from providing aid directly to individuals

### A2 Portland Program

#### A. First weatherization push

- 1989 marks the Oregon legislatures' first carbon reduction goal. In 1993 Portland became the first local government in the U.S. to adopt a greenhouse gas-reduction plan.

- In 2001, Portland/Multonomah designs a Local Action Plan on Global Warming with the goal of reducing greenhouse gas emissions to 10 percent below 1990 levels by 2010. Part B of this plan addresses "Energy Efficiency in Buildings," and Part D addresses "Renewable Energy Resources."
- Part B, "Energy Efficiency in Buildings," notes that "Greenhouse gas emissions from energy use in buildings accounted for 55 percent of all Portland greenhouse gas emissions in 1999."
- The section lays out these ***Principles for Reducing Building Energy Use***
    - Benefit all neighborhoods and socioeconomic groups, with particular attention to low-income residents.
    - Promote energy, economic, environmental, and social benefits, including developing active, healthy neighborhoods.
    - Consider community values along with a broad definition of cost effectiveness that includes total costs to
    - individuals and all resource savings.
    - Minimize lost opportunities, such as new residential and commercial construction.
    - Emphasize education and outreach value.
    - Support local businesses and expand local infrastructure for delivering energy-efficiency services.
- Part B also lays out 3 Objectives, and under each is listed government and community initiatives to be taken in 2003 and 2010 to realize these goals.
    - Objective 1: Reduce greenhouse gas emissions from City of Portland and Multnomah County facilities to 10 percent below 1990 levels by 2010 through energy-efficiency measures.
    - Objective 2: Reduce forecast greenhouse gas emissions in the residential sector by 10 percent by 2010. (One community initiative under this is to "Weatherize 250 homes occupied by low-income households through the City's Block-By-Block program and 500 homes through the County's weatherization program.")
    - Objective 3 Cut forecast greenhouse gas emission in the commercial, industrial, public, and non-profit sectors by 10 percent by 2010.

**B. CAP weatherization policy**

- The Portland CAP's weatherization policy relies upon a mix of information-based policy tools (public energy performance ratings for homes), incentive-based tools (investment fund to increase access to low-cost financing for energy performance improvements, "resources and incentives" to decrease carbon-emitting home practices, city tax for ecoroof and solar combination), regulatory tools (energy performance benchmarks for multi-family and commercial buildings), and some more vauge tools (working with partner organizations to "promote improvement" in operations and maintenance practices in commercial buildings).

Buildings and Energy section:

- Buildings last for many decades, thus efforts to reduce emissions from buildings needs to address both existing structures and new construction (30)
- Objective 1: Reduce the total energy use of all buildings built before 2010 by 25% (34).

    - **GOAL:** "By 2030, many new and highly efficient buildings will have been built that will consume less than half the energy of today's buildings ... over two-thirds of the buildings that will exist in 2030 are in place today, existing buildings must be retrofitted with energy-saving measures to achieve the necessary aggregate building efficiency improvements."
    - Establish investment fund in public and private capital --> increase ease of access to low-cost financing to residents/businesses for energy performance improvements
    - Require energy performance ratings for all homes - informed decisions, etc.
    - Require energy performance benchmarks for all multi-family and commercial buildings.
    - Provide resources and incentives to make carbon-reducing choices for their homes.
    - Work with partner organizations to promote improvement in operations and maintenance practices in commercial buildings.
    - Establish a City business tax credit for installing solar panels and ecoroofs in combination.
- Objective 2: Achieve zero net greenhouse gas emissions in all new buildings and homes (34)
    - **GOAL:** Newer buildings built with energy performance in mind "significantly outperforming similar, previously built buildings that have been retrofitted for efficiency." It is "critical" that buildings constructed after 2030 "generate more energy from clean sources than they consume, resulting in a net emissions reduction."
    - Participate actively in revision of Oregon building code to work in CAP goals.
    - Adopt incentives for high performance new construction projects that "consider life-cycle carbon emission impacts."
    - Accelerate existing efforts to provide green building design assistance, resources, etc.
- Objective 3: Produce 10% of total energy used within Mult. Co. from on-site renewable sources and clean district energy systems (35).
    - **GOAL:** Population of Mult. Co. projected to increase by ~30% by 2030; State law requires that by 2025, 25% all electricity sold in Oregon is clean and renewable.
    - Investment fund, from Obj. 1 for district energy systems/distributed generation.
    - Establish at least one new district heating and cooling system.
    - Facilitate the installation of at least 10 MW of on-site renewable.
    - Collaborate to reduce the role of coal in Portland's electricity mix.
- Objective 4: Ensure that new buildings can adapt to a changing climate (35).
    - **GOAL:** Climate will change in a building's life, buildings need to anticipate and be able to adapt to physical changes.
    - Participate actively in state of Oregon code-development processes.

## A3. Other Cities

### A. BOULDER

Similar to the federal program, boulder targets energy cost savings for lower income residents, with a slightly higher income qualification threshold. . However, Boulder's program adds incentives for homes that exceed this threshold.

*Residential Weatherization/Energy Programs:*

- Weatherization is available to low-income households and households slightly above the low income qualification. It is estimated that weatherized homes will save the residents 20-25% on annual energy costs. In 2005, the five homes that received new, 90+% efficient furnaces are saving an average of 50% on their heating costs
- HPwES (Home Performance with Energy Star) can also be considered a weatherization program, but it is intended for higher income households.
- Gives out free fluorescent light bulbs during October Energy Awareness Month and throughout the year - each lightbulb saves about $5 on electricity costs.
- The Green Points Program is the residential building ordinance and was conceived as a mechanism for encouraging the overall social, economic and environmental good of constructing new and remodeled homes with minimal negative environmental consequences over the life of the structures. Green Points are awarded when beyond-code improvements are implemented.
- Kits (Energy Efficiency Starter Kits / Conservation Kits) - to interested individuals (potential option) - items such as showerheads, etc.

### B. Seattle

The city of Seattle Office of Housing has two separate programs revolving around government subsidies to home repairs, designed to work in tandem:

(1) Home Repair Loan Program

- Targets low- to moderate-income households, prioritizing health and safety related repairs.
- Funding comes both local and federally programs
- Loans start at $3000. For households at or below 50% total gross area median income ($2,500-4200 per month, depending on size of household) loans will have 0% interest. For households earning between 50 and 80% total gross area median income (that is to say, earning more than the 50% bracket but no more than $3800-6200 per month, depending on the size of household) loans will have 3% interest.
- While these loans are designed to assist households with health and safety related concerns, some of the things they cover could have the co-benefit of reducing energy usage: replacing old appliances, door/window repair/replacement, etc. The HomeWise program website recommends the use of these more general home improvement loans for repair concerns beyond the scope of the weatherization program.

(2) Home Wise: Weatherization Services

- Provides free weatherization services for low income homeowners and landlords with low income renters (households with a total gross monthly income no greater than $2000-7000, depending on the number of persons in the household and whether they have gas/oil or electric heat). Eligibility is restricted to households within the city limits of

Seattle, but an exception is made for non-Seattle residents who are still customers of Seattle City Light (Seattle's public energy utility).

- The application process involves-
  - Mailing a completed application form along with documentation of all income sources for the past three months to the City of Seattle- Office of Housing.
  - After a period of 1-2 weeks in which your application is processed and approved, you will receive a call to schedule an energy audit of your home
  - Based on the energy audit a weatherization plan for your home will be drawn up, and if approved by the homeowner the weatherization services will be scheduled and enacted.

**C. Denver**

- In addition to a short section that outlines the creation of new energy standards for new homes, Denver also has a short section on the establishment of "programs to ensure that older homes have basic energy- and water-efficiency features (for example, weatherization, roof insulation, pipe wrap, low-flow showerheads)."
- Plan states that "Working with the local real estate community, consideration is being given as to how best to design and implement tools and activities that would result in increased energy efficiency while not unduly impeding the home sale process."
  - Following is a list of approaches such as: simple checklists of energy efficiency items, free or very low cost materials, additional educational materials, and certain higher cost efficiency recommendations, in-home energy display systems for energy conservation and the planting of shade trees at strategic locations to further minimize summer heat in homes.
- The plan mentions targeting low-income housing and states that programs already exist to aid certain income levels with energy efficiency improvements and that these aid programs should be expanded or more should be developed.
- Also mentions the high percentage of old homes in Denver (70% before 1970), and how weatherization may be the best way to reach this section as well. It also notes water conservation as a helpful side benefit from upgrades (through changing fixtures to those with the best available technology).
- The rest of the section lists some figures:
  - contribution to Denver's Greenhouse Gas Reduction Goal: 1 – 4%
  - Initial Cost per Metric Ton of $CO_2e$ Mitigated: $58/mt$CO_2e$
  - Total Participant Cost or Investment: Investment of up to $1,000 per home with a payback of 4 – 6 years
  - Expected 2012 Participation Rate: 25% of homes

On average, about 5 percent of Denver's existing homes are resold each year. Expected 2020 Impact: 8%

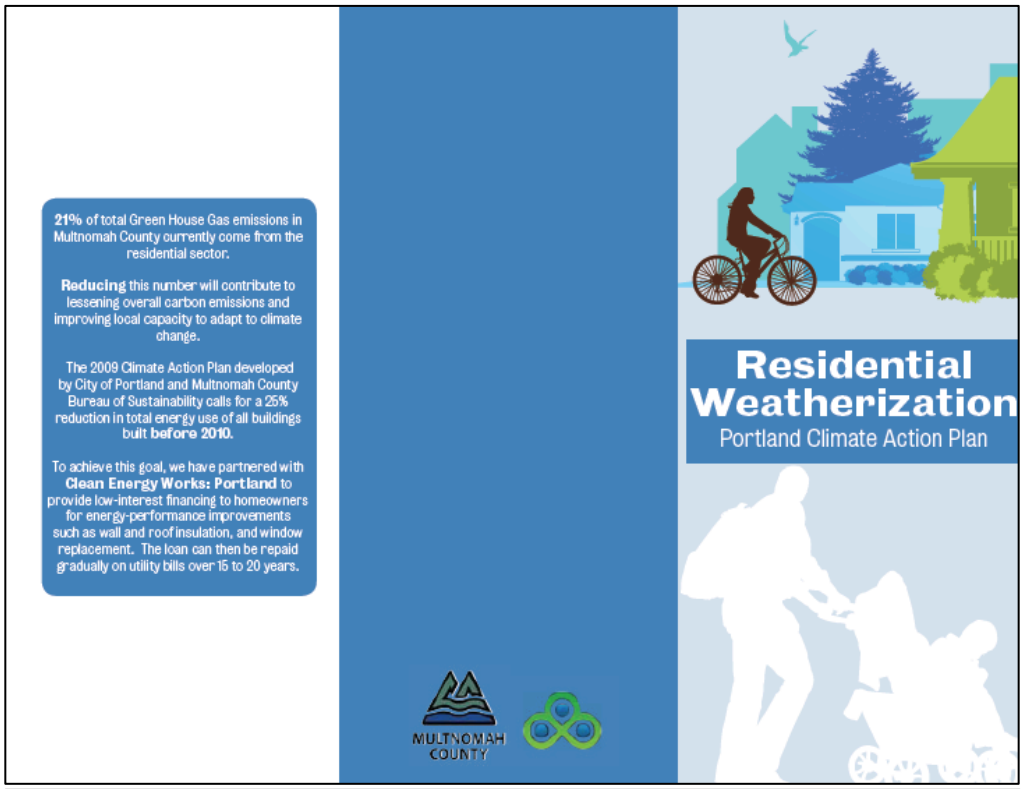
**D. Boston**

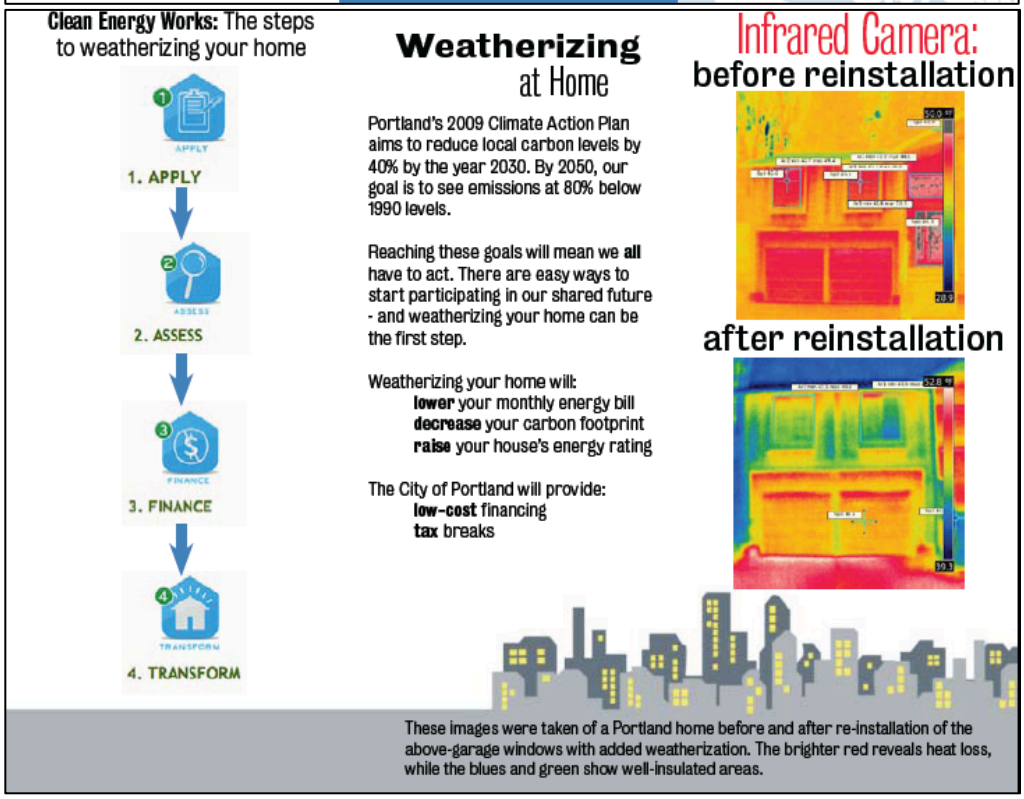
- Boston has used municipal zoning requirements to require a green building standard—it is the first city in the nation to do so.
- As the "Green Buildings" section of the Environmental & Energy Services page states, "By amending Article 37 of the municipal zoning code, the city requires that all large-scale projects meet the U.S. Green Building Council's LEED certification standards."
  - As of 2011, "large-scale" constitutes any structure over 50,000 square feet.

- Additionally, the “Renew Boston” program draws on municipal resources to “develop measures and partnerships that assist Boston residents, businesses, and institutions in taking full advantage of the utility programs.”
    - 13 community-based organizations (as of Fall 2010), under this program, have been working to connect Boston households with no-cost weatherization services.
    - Renew Boston’s weatherization component focuses on households whose income is between 60 to 120 percent of the median.
- Two-thirds of the 2020 goal for GHG reductions from buildings Energy-efficiency retrofits of existing buildings. However, Boston’s climate action has an eye to the future, stating that “Better energy performance in new buildings is essential in looking beyond 2020 to the 2050 goal.” The statement is reflected by their extensive new building codes for energy efficiency.
- The plan divides its energy-efficiency measures into three main types: incentives, markets, and requirements.

## A4. Sample brochure advertising weatherization campaign

Hard copies and an electronic version of this mock-up brochure will be provided with our report. Many of these images are taken from CleanEnergyWorksOregon.org, so this should be seen as a sample only.



The Spring 2013 Environmental Studies Junior Seminar (ES300) at Reed College (Pictured atop Boardman PGE power plant, April 5, 2013)

Back (L-R): Alan Tuan, Boardman Manager, James Bianconi, Julie Fry, Maya Jarrad, Alma Siulagi, Erin McAllester, Mia Reback, Allison Giffin, Dove Henry, PGE guest
Front (L-R): Malia McCollister, Danielle Draper, Taylor Stinchcomb, Chris Koski

Contact: J. Fry (fry@reed.edu) or C. Koski (ckoski@reed.edu)