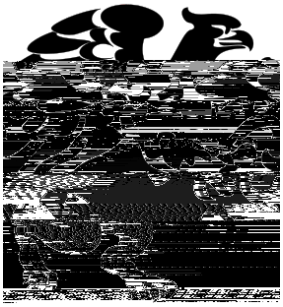

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Portland has been and continues to be a leader in the combined global effort to mitigate and adapt to climate change. Portland was the first major city in the US to identify and plan for the negative impacts of CO_2 in 1993, require LEED gold certification 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

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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-

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.

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

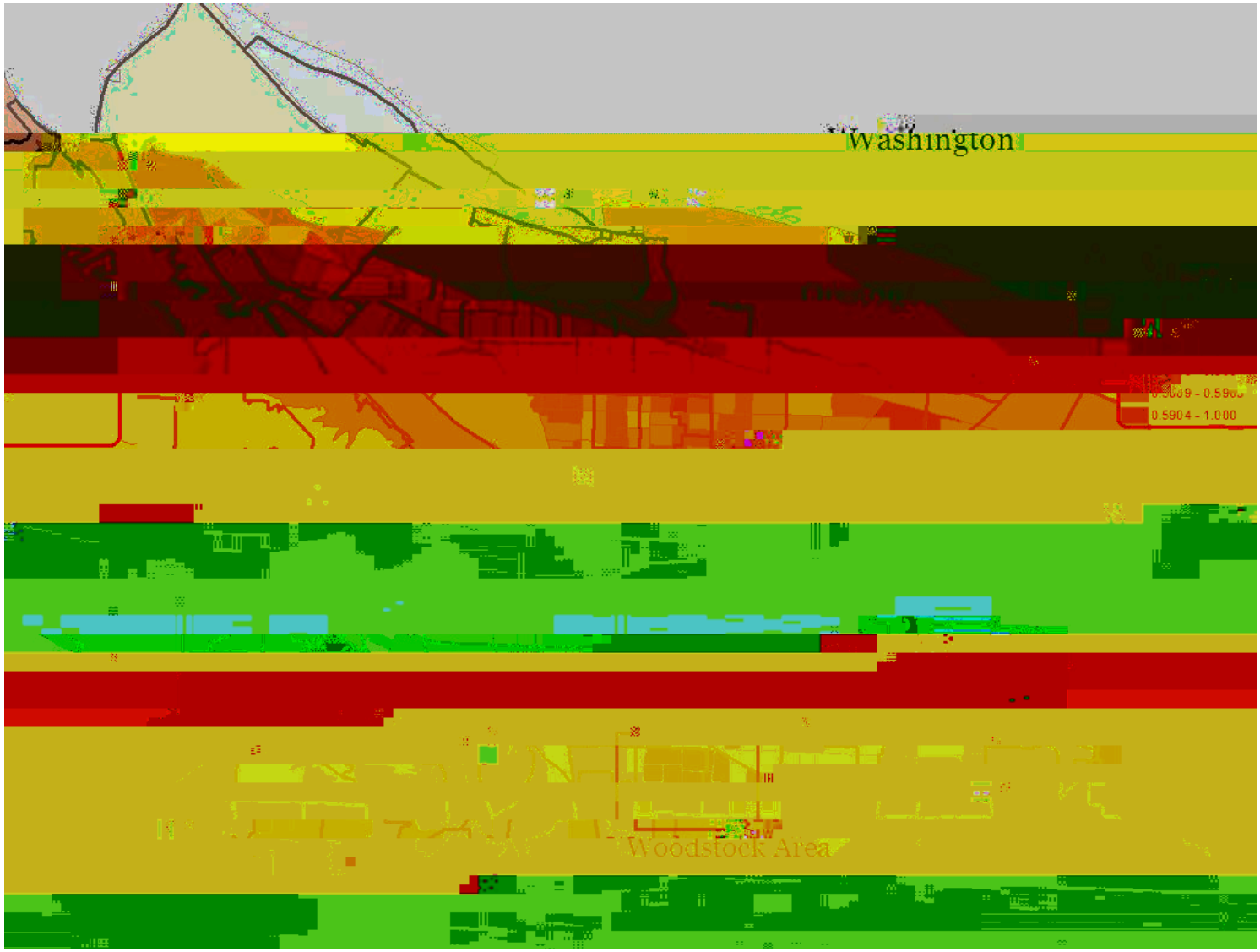

Figure 1. Gas use by census block in Portland city. Data are symbolized as number of single-family houses above median gas use (darker color represents more homes above median gas use) by census block, normalized by number of single-family homes in each census block. Data: City of Portland, Bureau of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

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Map of SE Portland with zoomed in regions showing sampled houses layered onto gas/electric data

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

Figure 5. Correlation plot of ! T 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

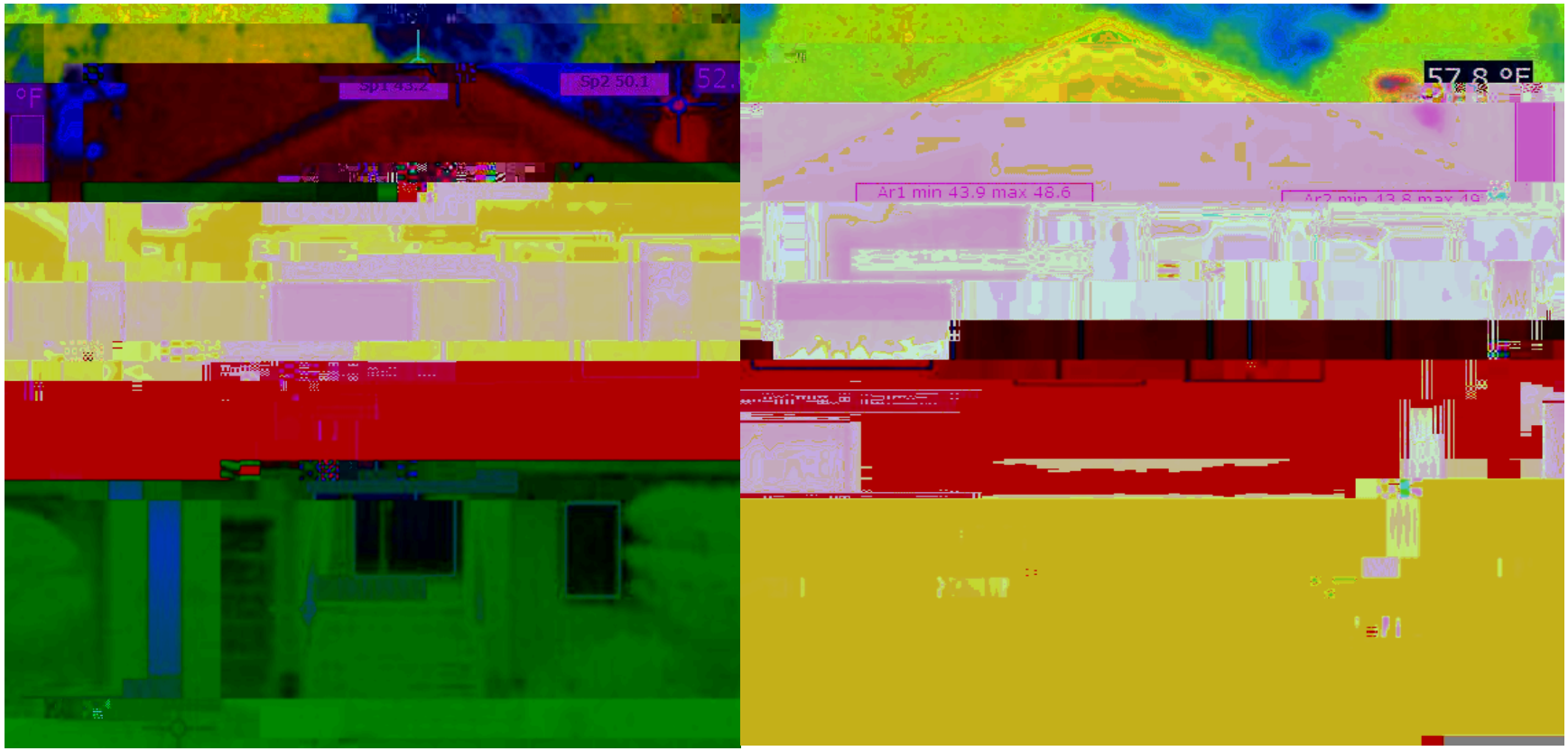

Figure 6.

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