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Increasing Energy Efficiency in Existing Residential Buildings: A Case Study of the Community Home Energy Retrofit Project (CHERP)

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INCREASING ENERGY EFFICIENCY IN EXISTING RESIDENTIAL BUILDINGS: A CASE STUDY OF THE COMMUNITY HOME ENERGY RETROFIT PROJECT (CHERP)

by

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Abstract

This thesis uses a case study of the Community Home Energy Retrofit Project (CHERP) and it analyzes the larger statewide effort in California to increase energy efficiency in existing residential buildings to reduce greenhouse gas emissions. CHERP's primary strategy is to embed itself into a community, educate residents on the multiple benefits of energy efficiency, and inspire them to take energy-saving actions in their own homes. It then builds its own community by connecting like-minded individuals together and provides an opportunity for them to exercise their political agency. This thesis analyzes CHERP's effort in the context of the political, social, and economic climate of California. It identifies three obstacles for widespread energy efficiency adoption: one, CHERP's lack of funding to support permanent staff and pay for collateral materials; two, low access to energy efficiency measures for low-income households and renters; and three, a lack of high quality home performance contractors that perform energy efficiency upgrades utilizing a whole-house energy systems approach. The thesis concludes with five recommendations to overcome these issues.

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Introduction

Average temperatures on Earth have risen by 1.5°F in the last one hundred years (U.S. EPA, n.d.-a). Certain gases trap heat in the Earth's atmosphere, causing a natural "greenhouse effect" that keeps the planet's surface temperatures warm enough to support life (U.S. EPA, n.d.-a). However, according to the Fifth Assessment Report published by the Intergovernmental Panel on Climate Change (IPCC), the leading international authority on climate science, the current concentrations of greenhouse gases "are unprecedented in at least the last 800,000 years" and are "extremely likely" to be the primary cause of "observed warming since the mid-20th century" (p. 4). This observed global rise in temperatures over the past century is a phenomenon commonly known as *global warming* or *climate change*. Ninety-seven percent of climate scientists agree that human activities have caused global warming (Cook et al., 2013; Anderegg, Prall, Harold, & Schneider, 2010). Burning fossil fuels for heat and energy has been the largest contributor to climate change (U.S. EPA, n.d.-a).

Even in the face of such scientific consensus, many governments have been slow to act. In the United States of the early 21st Century, climate change has been one of the most contentious political issues, with Democrats generally agreeing with the scientific consensus and Republicans denying or questioning it, though polls conducted since 2012 suggest a majority of self-described moderate and liberal Republicans agree that global warming is happening ("Not all Republicans think alike about global warming," n.d.). In Congress, however, belief in climate change and support for climate policies are more staunchly split by party lines, generating policy gridlock (Vig & Kraft, 2013; Skocpol, 2013). To illustrate this point, Theda Skocpol (2013) analyzed scores assigned to members of Congress by the League of Conservation Voters (LCV) based on how the

legislators vote on environmental policy. From 1970 to 2004, LCV published summary party scores for Republicans and Democrats in both houses of Congress, but stopped in 2004 (Skocpol, 2013). However, Skocpol (2013) extrapolated the available data to determine party scores through 2011. A score of 100 "designates the maximum possible pattern of voting in accord with LCV priorities and zero designates total opposition" (Skocpol, 2013, p. 60). She found that historically, Republicans and Democrats have always diverged on environmental issues, however the gap started growing significantly between 1990 and 2000, jumping from 29 points in 1990 to 63.5 points over the same period, with Republicans earning the lower score (Skocpol, 2013). In 2010, the gap widened further, reaching 73.5 points (Skocpol, 2013).

Among the general public, Skocpol found that opinion has not been nearly as divided. Using yearly Gallup polls from 1973 to 2006 which asked adults in the United States whether spending to "protect the environment" was "too much," "too little," or "about right," she found that for many years, majorities or near-majorities of self-identified Republicans and Democrats believed too little was spent on environmental protection (Skocpol, 2013, p. 58). There were still the expected partisan differences, but even in their most extreme from the mid-1990s to 2006, gaps were between 10 and 15 percentage points. This is considerably lower than the 73.5-point difference between Congressional Republicans and Democrats shown by the LCV data in 2010.

Disillusioned by federal partisan gridlock, political actors from state governments down to community nonprofits are taking action into their own hands to reduce greenhouse gas emissions. This thesis explores how methods to increase energy efficiency in existing residential buildings, a key strategy for mitigating climate change,

works within the current political framework and drives that framework forward through boundary-pushing efforts such as the Community Home Energy Retrofit Project (CHERP). Founded in Claremont, CA in 2010, CHERP has since spread to several other cities throughout the state. Its primary strategy is to educate residents on the benefits of increasing energy efficiency in their homes and break down barriers that prevent residents from taking action. CHERP employs a grassroots, community-focused model: once established in a city, it maintains a presence by hosting regular energy efficiency workshops and participating in community events, parades, and rallies. Further it creates its own "CHERPer" community comprised of passionate residents who pursue whole home, deep energy retrofits or other energy efficiency measures – some of whom go on to volunteer for the cause. Its methods are grounded in education and one-on-one, personal connections so that people "intuitively and experientially understand the benefits" of increased energy efficiency in their homes (Hartman, 2015a). CHERP believes that through the power of education, a community can reach a tipping point in which residents stop wondering *if* they should increase energy efficiency and start asking *when they can afford to*.

Increasing energy efficiency is an attractive climate change strategy because it produces many tangible benefits for a homeowner, mitigates and adapts to climate change, and effectively addresses environmental justice because of the large relative benefits it provides for low-income residents. Producing electricity still relies heavily on combusting fossil fuels such as coal and natural gas. In 2013, thirty-nine percent of electricity generation came from coal and 27 percent came from natural gas (U.S. EPA, n.d.-b). Overall, electricity production accounted for nearly a third of greenhouse gas

emissions, the largest of all economic sectors (U.S. EPA, n.d.-b). Energy efficiency reduces electricity consumption, which in turn reduces the "need for new power plants and the associated environmental impacts" (Bender et al., 2005). The avoided greenhouse gas emissions mitigate further climate change.

Increasing energy efficiency also serves as a means of climate change adaptation. Making existing buildings more energy efficient through measures like insulation and air sealing makes them more resilient to the more frequent and intense heat waves climate change is expected to bring (Vandentorren et al., 2006; Cayan, 2009). These measures keep indoor air temperature more stable during temperature extremes (International Energy Agency, 2014). As described in the IPCC's Fifth Assessment Report, climate change is likely already contributing to an increased frequency and intensity of heat waves and daily temperature extremes. With harsher weather, people will need to seek refuge indoors. Energy efficiency measures keep indoor temperatures "comfortable and healthy," regardless of season (International Energy Agency, 2014, p. 100).

Energy efficiency interventions also result in improved indoor air quality and health benefits. Ambient air pollutants such as industrial toxins and vehicle exhaust can worsen indoor air quality (U.S. EPA & NIOSH, 1991). Poor indoor air quality is linked to respiratory problems, allergies, skin irritation, headache, and fatigue (U.S. EPA & NIOSH, 1991, p. 11). In a meta-analysis of 36 studies, Maidment, Jones, Webb, Hathaway, and Gilbertson (2014) found that resident health significantly improves following energy efficiency measures.

The same analysis found that low-income households experienced greater improvements in health than the general population (Maidment et al., 2014). This finding

makes energy efficiency a crucial strategy for the environmental justice movement, which "call[s] for fairness, regardless of race, color, national origin or income in the development of laws and regulations that affect every community's natural surroundings, and the places people live, work, play and learn" (California Environmental Protection Agency, n.d.). When directed at low-income and minority residents, energy efficiency can further environmental justice goals by improving a home's thermal and indoor air quality to benefit resident health.

Lower utility bills and increased energy efficiency also help address the "'energy burden,' [which] reflects the disproportionate allocation of financial resources among low-income households on energy expenditures" (Hernández & Bird, 2010). Low-income households spend 10 percent or more of their income on energy, while middle- and upper-income households spend five percent or less (Hernández & Bird, 2010). With the lower utility bills that come from increased energy efficiency, low-income households have greater disposable personal income to pay for other items. According to a CNNMoney analysis of Bureau of Labor Statistics data, low-income households overspend their earnings by 182 percent "on mostly basic needs like housing, food, and transportation" (Luhby, 2015). Confirms Melissa Boteach, vice president of the Poverty to Prosperity Program at the Center for American Progress: these individuals are compelled to make "impossible choices, [turn] to high-cost credit or [go] into debt to meet basic needs" (quoted in Luhby, 2015). The extra money low-income individuals save on utility bills would likely go towards reducing the financial strain of paying for other necessities.

Compared with politically contested measures to reduce greenhouse gas emissions like a carbon tax or national cap-and-trade program, increasing energy efficiency appeals to decision-makers and residents regardless of their opinions on climate change. Even climate change deniers can be persuaded to pursue energy efficiency measures when the argument is framed economically, emphasizing private benefits like reduced energy bills and greater comfort in the home.

Together, the combined effects of increased energy efficiency make it a crucial strategy for climate change mitigation and adaptation. In its five years of operation, CHERP has inspired many residents to take energy-saving action in their homes and educated countless more on the benefits of energy efficiency. However, the effort to increase energy efficiency in existing residential buildings still has a long way to go and must overcome several critical obstacles. As an organization, CHERP must expand its reach and promote energy efficiency access to all socioeconomic segments of the population, while driving forward the political, social, and economic environments in which it operates.

My knowledge about this topic has been informed by my experience working closely with CHERP and Devon Hartman, the organization's Executive Director, first as a research analyst with the Roberts Environmental Center from January 2015 to May 2015, then as an intern with CHERP from May 2015 to August 2015. During those eight months, I helped coordinate CHERP initiatives to spread energy efficiency education throughout the city of Claremont, managed working partnerships with six regional nonprofit and government partners, and supported office operations. My position provided me with a deep understanding of the inner workings of this organization and the

home performance industry, and served as a jumping off point for my interest in how energy efficiency operates as one of many strategies to combat climate change. This thesis is at once a product of my experiences working with CHERP and my conscious effort to step back from the organization, observe, and objectively analyze how it functions in a larger context. To support my research, I conducted three separate interviews with Hartman in August, October, and November 2015, and one interview with Dan Moncayo, the Director of Operations at Home Performance Matters, an Upland-based home performance contractor, in November 2015. I also draw more generally from my experiences working with CHERP, having attended numerous energy efficiency lectures led by Hartman for the Claremont community and participated in strategy meetings with the CHERP Board of Advisers, other nonprofit organizations, businesses, and local and state government officials.

This thesis aims to contribute to the effort to increase energy efficiency in existing residential buildings by deriving five recommendations for improving CHERP's impact after analyzing CHERP's strategic initiatives within the context of statewide climate politics. In particular, the thesis is structured as follows. In Chapter 1, I explore CHERP's story: how it started, its operational organization, community focus, and educational method. In Chapter 2, I discuss how California's political climate and historical leadership on environmental issues has allowed an organization like CHERP to blossom. Then, I analyze state-level executive orders and key pieces of legislation passed since 2006 that contribute to California's current leadership in energy efficiency and reduction of greenhouse gas emissions. In Chapter 3, I identify three major obstacles that impede scaling up CHERP's model to a broader regional or statewide area: the lack of funding

for staff and programs, the need to increase access to energy efficiency measures to renters and low-income homeowners, and the lack of home performance contractors to execute energy efficiency upgrades utilizing a whole-house energy systems approach. In Chapter 4, I detail four potential funding sources to address lack of operational funding and a solar initiative that, once funded, will allow CHERP to better address low-income homeowner and renter access to improved energy efficiency. I conclude by proposing five recommendations to CHERP and to California state government that will accelerate the rate of energy efficiency adoption in California to supplement other greenhouse gas emissions reduction initiatives and stave off the worst effects of climate change.

Chapter 1: CHERP's Story

The Community Home Energy Retrofit Project (CHERP) is an educational, volunteer-based nonprofit organization; Devon Hartman is its Founder and Executive Director. CHERP launched in Claremont, CA in 2010 and has since expanded to several other cities across California: Carmel, Huntington Beach, Monrovia, Redlands, Sacramento, and San Clemente. At least three other cities have expressed interest in forming a local CHERP chapter: Davis, Upland, and San Diego.

CHERP cities are distinct from one another and from the overarching CHERP "senior leadership" – a term meaning the Board of Advisors, Executive Director, and other individuals who help guide the nonprofit's mission, vision, and operations (Figure 1). Each CHERP city has its own leadership team comprised of passionate volunteers from the community. Each team, also known as a "core group," is usually a mix of business owners, real estate agents, homeowners, retirees, and city council members. Homeowners who participate in the core groups have either completed deep energy retrofits or are passionate about increasing energy efficiency in existing residential buildings. The core group is the major driving force to establish a CHERP chapter in a city. Although CHERP's senior leadership is located in Claremont, the community also has its own core group. Many Claremont core group members do double duty, working in both the CHERP senior leadership and core group. For clarity throughout the thesis, "CHERP" refers to the nonprofit itself and its senior leadership. For CHERP organizations in specific cities, the city name is included in the title. For example, the CHERP chapter in Carmel is referred to as CHERP-Carmel.

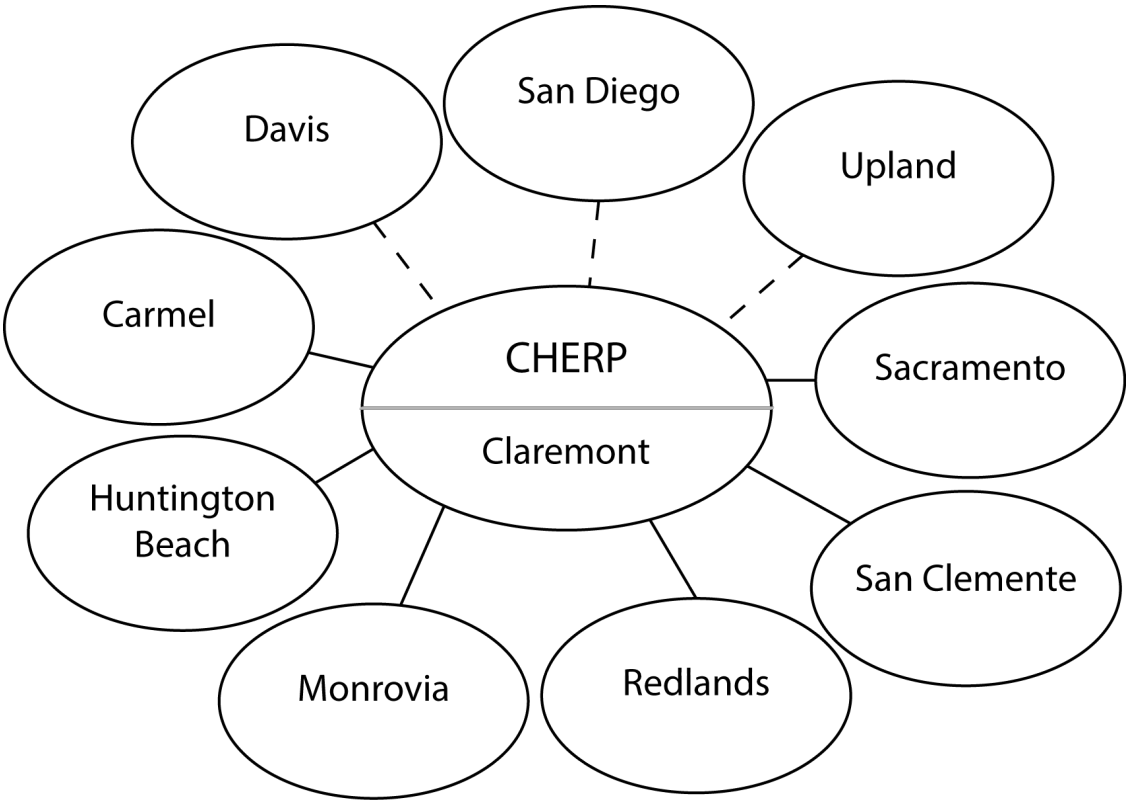

Figure 1. Conceptualized relationship between CHERP and CHERP cities. Solid lines represent cities with established CHERP chapters; dotted lines represent cities that have expressed interest. The gray line in the center oval represents the overlap between CHERP senior leadership and the CHERP-Claremont core group.

A two-way current of information links CHERP to the various CHERP cities. At its headquarters in Claremont, CHERP designs strategic initiatives and collateral materials to reach building owners, then passes them on to CHERP cities. In tangible terms, this vastly reduces the amount of work for a CHERP city core group. For example, in Claremont, the CHERP graphic design intern designs a pamphlet about energy efficiency. She then sends the template to CHERP-Carmel where a local volunteer can replace Claremont-specific language and statistics with Carmel's information, thereby producing a similar, but Carmel-specific pamphlet. In the same way, CHERP provides cities with new strategic initiatives and provides guidance on

how to successfully implement them based on the lessons learned from implementation in Claremont.

Through strategic initiatives, CHERP cities have an opportunity to feed information back to CHERP headquarters. Because CHERP staff is based in Claremont, many initiatives are designed and tested there first before spreading to other cities. As initiatives spread to other cities, core groups inevitably encounter problems that CHERP-Claremont did not. CHERP cities report back to CHERP who can then incorporate the feedback and lessons learned into the initiative's best practices. Essentially, each CHERP city provides another data point to test the strength and success of strategic initiatives. When CHERP cities design their own initiatives, the information flows back to CHERP first before being distributed out as an official CHERP initiative to other CHERP cities.

About Claremont, CA

Before CHERP spread to other towns, the acronym originally stood for the "Claremont Home Energy Retrofit Project." Located on the eastern edge of Los Angeles County, Claremont spans 13.35 square miles and has 36,054 residents with a median household income of $87,324 (U.S. Census Bureau, 2015f). Just over seven percent of its residents live in poverty (U.S. Census Bureau, 2015f). Three of its eight census tracts are designated by the state government as "disadvantaged communities" that are very vulnerable to pollution (Office of Environmental Health Hazard Assessment, n.d.). Unofficially known as the "City of Trees and PhDs," 93 percent of residents over the age of 25 are high school graduates, 55 percent have at least a bachelor's degree and 29 percent have graduate or professional degrees (U.S. Census Bureau, 2015a). These percentages are much higher than the rest of Los Angeles County, where approximately

77 percent of residents are high school graduates, 30 percent have at least a bachelor's degree, and 10 percent have a graduate or professional degree (U.S. Census Bureau, 2015b).

In terms of housing, one of the most pertinent variables for CHERP, Claremont has a total of 12,219 housing units (U.S. Census Bureau, 2015d). Claremont's population density is comparable to the rest of Los Angeles County, averaging 2,617 people per square mile (U.S. Census Bureau, 2015d). Two-thirds of households are occupied by the homeowner (called the "owner-occupied rate") and one-third of households are renters (U.S. Census Bureau, 2015f). This high owner-occupied rate – Los Angeles County's rate is 47 percent – is important because performing retrofit work is much easier when the homeowner inhabits the home and pays the energy bill (U.S. Census Bureau, 2015f) (Gillingham, Harding, & Rapson, 2012). If the scenario is different, there are "split incentives" that hinder investments to increase energy efficiency (Gillingham et al., 2012). Split incentives, also known as principal-agent problems, "[arise] when an agent acts on behalf of a principal, managing resources that are 'owned' by the principal. But the interests of the agent are not aligned with those of the principal" (Wood, Ong, & McMurray, 2012, p. 440). For energy efficiency, the tenant is the agent and the landlord is the principal. Depending on the lease, landlords or tenants can be responsible for paying the utility bill – split incentives exist in either scenario (Gillingham et al., 2012). When the landlord pays the utility bill, tenants have little financial incentive to limit their electricity or heating and cooling use because they will not benefit from reduced utility bills (Gillingham et al., 2012). If the tenant pays the utility bill, they do not have the ability to modify their homes without the landlord's permission and any increases in

property value from energy efficiency investments accrue to the landlord (Wood et al., 2012).

CHERP's Origins

CHERP's Founder and Executive Director, Devon Hartman, spent the majority of his career as a designer and builder, establishing the Claremont-based firm HartmanBaldwin Design/Build in 1979, a full-service architecture, interior design and construction company (Hartman, 2015a). In 2003, he read an article in *Metropolis Magazine* titled "Turning Down the Global Thermostat" that profiled architect Edward Mazria's forays into energy sector analysis. The U.S. Energy Information Administration (EIA), the federal government agency that gathers and analyzes energy data, traditionally divides nationwide energy consumption into four categories. Since 1949, the earliest year with data available, the EIA reports that industry consumes the most energy, followed by transportation, residential, and commercial energy use (U.S. Energy Information Administration, 2014). Mazria believes this disaggregation is misleading because "when you look at it and ask who the bad guy is – it's industry" (quoted in Hawthorne, 2003). Curious about the role of buildings and architecture in energy use, Mazria rearranged the EIA data by "combining the residential and commercial sectors, and then adding the portion of the industry sector that goes to the operation of industrial buildings and their construction" (Hawthorne, 2003). In 2003, he found that U.S. buildings accounted for 48 percent of energy consumption and 46 percent of carbon dioxide emissions (Hawthorne, 2003). Today's numbers are not much better: buildings still consume 48 percent of energy and are responsible for 45 percent of carbon dioxide emissions nationwide (Figures 2 and 3). For Los Angeles County specifically, the LA Energy Atlas, released in 2015, found that buildings are responsible for 39 percent of greenhouse gas emissions,

the largest of any sector. And within the building category, residential buildings consumed most energy of any building type (LA Energy Atlas, n.d.).

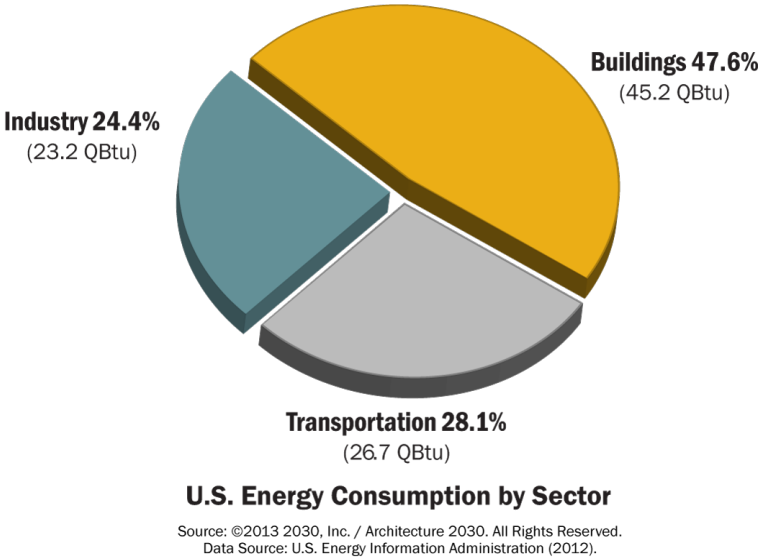

Figure 2. United States energy consumption by sector (reproduced with permission from Architecture 2030)

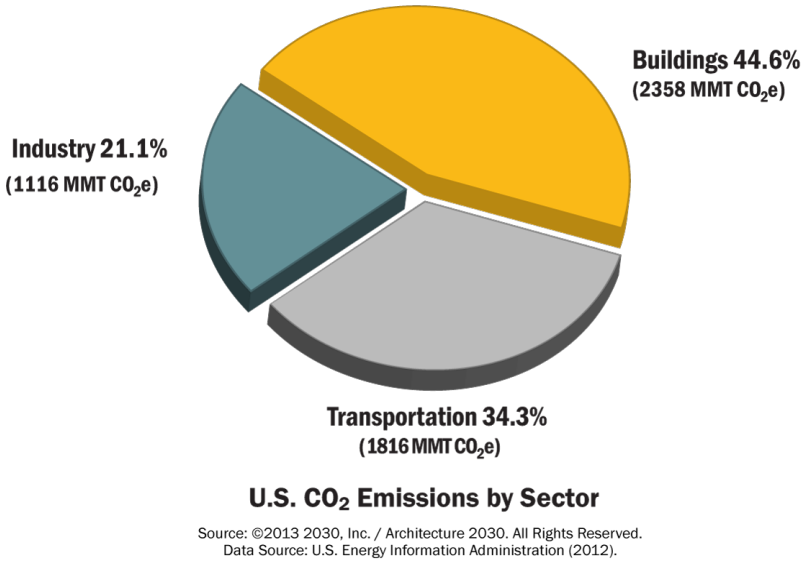

Figure 3. United States carbon dioxide emissions by sector (reproduced with permission from Architecture 2030)

Buildings, then, are this country's greatest climate change obstacle, trumping gas guzzling SUVs and agriculture. Mazria believes that architects can significantly contribute to greenhouse gas emissions reductions using their trade. This problem requires architects to innovate and "design with a capital D" (Mazria quoted in Hawthorne, 2003). The challenge is extensive to be sure, but not impossible: "If you're an architect, just like you solve the functional problem and the budgetary problem, you must solve the environmental problem – and solve it by design" (Mazria quoted in Hawthorne, 2003).

Distraught by his unwitting contribution to global warming, Hartman embraced Mazria's call to action. He began to study energy efficiency and building science in earnest. Energy efficiency not only reduces a building's carbon footprint, he discovered, but also carries a long list of other benefits for the homeowner, including greater comfort in the home, savings on energy bills, higher resale value, better indoor air quality and more ("Home retrofit," n.d.). After several years of personal research and study, Hartman started a home performance division within his design/build firm in 2008. According to Hartman, the central questions floating around California at the time were: "Is there a market [for building retrofits]? What is the market? And, how do we communicate to that market?" (Hartman, 2015a). For Hartman, the answer was obvious: "After studying building science, I was convinced that there was a market for this because of the litany of benefits that accrued to building owners" (Hartman, 2015a). Two years later, Hartman retired from his design/build firm and began the Claremont Home Energy Retrofit Project to prove to the state that the market exists and can most easily be identified at the community level.

Community Focus

As a resident and business owner in Claremont for decades, Hartman already had well-established relationships within the community. These relationships are his "social capital," which in this context, can best be understood as "the sum of resources, actual or virtual, that accrue to an individual or group by virtue of possessing mutual acquaintance and recognition" (Bourdieu & Wacquant quoted King, 2004). For nonprofit organizations and their leaders, social capital allows them to build and maintain trust among various stakeholders, facilitating communication and support for their mission and goals (King, 2004). In CHERP's early days, Hartman leveraged his established social capital to host energy efficiency lectures to friends, family members, and neighbors. When it came time to invite people to his talks, he says, "I just started sending emails and making phone calls to my client database – people I've known for 30 years" (Hartman, 2015a). Hartman's personal network, his social capital, provided the foundation for a CHERP network in Claremont.

CHERP's network benefitted early on by fostering partnerships with the City of Claremont[1] and several civic organizations including Sustainable Claremont (the local, community-led, environmental nonprofit), Pilgrim Place (a retirement community that admits residents who had careers in religious or charitable nonprofit organizations), and the local League of Women Voters. These partnerships allowed CHERP's network to quickly expand by tapping into the organizations' established networks, further developing the nonprofit's social capital.

As part of CHERP's community-oriented approach, it recognizes the different demographic and socioeconomic compositions create different issues and obstacles for

[1] The stylized "City of Claremont" refers to Claremont's city government.

individual cities. To maximize its results, CHERP encourages cities to tailor initiatives and branding to fit their city's unique needs. For example, in January 2015, CHERP-Claremont rebranded itself as the Claremont Energy Challenge (or "the Challenge") because it was accepted into the Georgetown University Energy Prize (GUEP). The GUEP is a two-year competition (January 2015 – December 2016) between fifty cities in the United States to win $5 million by reducing energy use. The competition judges cities on a variety of parameters including measured energy reduction, level of energy efficiency education in K-12 schools, collaboration with the utilities companies, the replicability, scalability, and innovation of their initiatives, likelihood of future performance, and equitable access to the "geographic, demographic, functional, and [economically]" diverse aspects of the population (Georgetown University Energy Prize, 2015). Claremont entered the Georgetown University Energy Prize on the CHERP model: a community-based, educational energy efficiency program, designed to be replicable in other communities. When Claremont's proposal was accepted, the city elected Hartman to serve as the Executive Director of the Claremont Energy Challenge. The Challenge is a prime example of CHERP's belief that cities should adapt the nonprofit's model to their city's particular needs as they evolve over time.

Developing a CHERP chapter is also rooted in community engagement. "CHERP is like a new rotary coming to town," says Hartman (2015a). Importantly, the idea to launch a new CHERP chapter comes from someone within that community. CHERP does not engage in any formal recruitment to multiply its expansion to other cities – the cities that have adopted CHERP have all done so by hearing about CHERP's successes and then reaching out to the organization. In

discussing how CHERP chapters form, Hartman used Upland, CA, one of the cities that expressed interest in 2015, as an example. The interested Upland resident will

> get together and talk to their friends…by the end of two months, we'll probably have some business people, some real estate people, some homeowners, some retired people, maybe a person from the city council, and some owners who have done some retrofits. That will become the core group. We'll take them through some trainings on building science, and we'll move CHERP-Upland forward as a real organization. (Hartman, 2015a)

Gathering these passionate residents of the community from different backgrounds for the core group is the beginning of a CHERP network in Upland.

Educational Strategy

At its core, CHERP is an educational enterprise that aims to embed itself into the community. Hartman (2015a) says:

> It's a very simple, classic strategy: a hyper-local education program that [connects] people to people [so they can] understand intuitively and experientially the benefits around this conversation…[At CHERP, we're] going one person to one person to one person, waiting for that tipping point to happen when so many people in the community understand this, it's not even a question about whether we should do this anymore, it's just when can I afford to.

To implement this strategy, CHERP hosts through regular 90-minute energy efficiency workshops for community residents in which a building science expert presents on energy efficiency for an hour, and allows 30 minutes to answer audience questions afterwards.

Hartman developed the workshop lectures in a mindful way: "The talks are designed to inspire and to give people a next possible action step" (Hartman, 2015a). While most lectures are not filmed and made publicly available, one that Hartman gave to members of the League of Women Voters, the Sierra Club, and San Clemente Green on November 13, 2014 is available online (Hoffman, 2014). I will use this 58-minute lecture as an example throughout this section so readers may access it. Throughout my time working with CHERP, I attended at least six of Hartman's energy efficiency lectures given to the Claremont community, all of which followed a similar rhetorical style as the one available online.

In his lectures, Hartman opens with a brief discussion of energy and then quickly identifies buildings as the main source of carbon emissions, weaving in how the *Metropolis Magazine* article deeply affected him. This rhetorical choice humbles him. By admitting his own decades-long complacency in climate change, he establishes a bond between himself and the audience. If he was able to change, they think, then they will be able to change too. In the filmed lecture, Hartman spends just over 10 minutes telling his story, and dedicates the next 47 minutes discussing ways residents can take action in their home. Instead of spending lots of time on the frightening and dire consequences of climate change, he spends the majority of the lecture on actionable steps each individual could theoretically take tomorrow. This keeps the lecture atmosphere positive and inspirational. The talks I have seen have been designed in a way that appeals to a climate change believer – this one included – though Hartman notes that he can change the talk to appeal to a more conservative audience by replacing references to climate change with

how energy conservation promotes U.S. energy independence and additional information on the personal benefits a homeowner experiences after an energy efficiency retrofit.

After telling his personal story, Hartman transitions to a larger overview of modern energy efficiency measures and their implications. He screens examples of buildings that have utilized these techniques to visually represent what is possible with today's technology. He then looks at the issue with an even wider lens, depicting a graph of U.S. building operations that demonstrates that overall energy use has decreased since 2005. The goal of this slide is to let the audience know that their work will not be in vain; in fact, they will be contributing to a larger, nationwide trend. "We can make a difference," says Hartman in earnest. "There are hundreds of people in every community who are sick and tired of going to meetings, not doing anything, and just talking about the problems. There are things that we can do" (Hartman quoted in Hoffman, 2014).

Next, he examines the benefits homeowners experience when they pursue retrofits: reduced energy bills, quieter and more comfortable homes, better indoor air quality, increased home property value, better resilience to the increased frequency and intensity of high temperature days that are expected to occur in Southern California as a result of climate change, and money from state rebates (Hoffman, 2014). He also touches on how retrofits carry spillover benefits to the community at-large by helping cities reach their sustainability goals and creating jobs for local contractors (Hoffman, 2014). He spends a full 15 minutes discussing the multiple benefits that result from increased energy efficiency. And for good reason: it draws the audience in. "Everybody who owns a house connects with one or more of those [benefits]," says Hartman (2015a).

For the final third of the lecture, Hartman scales down to the individual house. He starts with cringe-worthy pictures taken during a home energy assessment: infrared photographs of the high temperatures that leak out of light fixtures and attics, large quantities of debris in attics, animal skeletons found in crawl spaces, rat feces found on grates, and many others (Hoffman, 2014). With these images, Hartman conveys how poorly homes have historically been designed from an energy efficiency and health perspective. Yet slide after slide, the message remains positive. According to Hartman (2015a), these problems are "amazingly easy things to fix that we call 'low-hanging fruit.'" Furthermore, when he describes what was found during the assessments, he uses the personal plural "we" (Hoffman, 2014). This pronoun choice rhetorically links him to the energy contractors, signaling to the audience that he has significant professional experience working on energy efficiency in homes. Rather than talking about these issues from a podium, detached from the work on the ground, his rhetoric further establishes his authority on this topic.

His goal is to persuade the audience that they want to be part of the CHERP community. He shows colorful photos of CHERP supporters walking in the Fourth of July parade and talking with other community members at the Earth Day celebration, the Claremont city planner holding a CHERP sign, and the Claremont City Council waving flags and smiling in bright blue CHERP shirts (Hoffman, 2014). The photographs are fun, warm, and inviting and, most importantly, they exemplify how CHERP provides an opportunity for individuals to exercise their political agency alongside other like-minded individuals.

In closing, Hartman highlights the importance of taking action wherever possible: "Working locally is the only way we're going to solve the global problem" (quoted in Hoffman, 2014). The ultimate goal, according to Hartman, is to set up CHERP chapters in a "demand-constrained area," or an area that is using more power than available. By linking all the houses together, "we can reduce energy demand and offset the need to build a new power plant" (Hartman, 2015a). For Hartman and for CHERP, this benefit – reducing greenhouse gas emissions from power plants, is "absolutely, the entire reason" and driving force for CHERP's existence; the private benefits like increased comfort and air quality are secondary (Hartman, 2015c).

Supporting CHERP's chosen educational strategy is a 2015 report by the Canadian Centre for Policy Alternatives: it argues that personal, positive, and community-oriented climate news stories are most conducive to building public engagement. In the study, researchers conducted seven focus groups with 53 Canadian residents who are classified as "alarmed"[2] or "concerned"[3] about climate change by the Yale Project on Climate Change Communication's 2011 report *Global Warming's Six Americas*, but exhibit low levels of political engagement on the issue. The study found

[2] "The alarmed are certain that global warming is happening, believe that people (including those in the United States) are currently being harmed by it and worry that their families and future generations are at risk. Three-quarters of this segment see climate change as potentially solvable. Close to two-thirds report having thought 'a lot' about global warming; 80 percent follow environmental news (compared with the national average of 38 percent) and 55 percent report paying 'a lot' of attention to news stories about global warming (more than four times the level of any other segment)" (Cross, Gunster, Piotrowski, & Daub, 2015, p. 8).

[3] "Levels of involvement for the concerned are not as high as the alarmed, but they are significantly higher than all other segments. A substantial majority sees global warming as a risk to their families and future generations, and more than two-thirds see climate change as a problem that humans could solve. Three-quarters pay at least 'some' attention to information about global warming, though a much smaller proportion (18 percent) than the alarmed pay 'a lot' of attention" (Cross et al., 2015, p. 8).

that participants were most motivated by stories of "entrepreneurial activism and everyday heroism – that is, tales of people who, through their own initiative and creativity, open up new spaces for political engagement for themselves and others" (Cross, Gunster, Piotrowski, & Daub, 2015, p. 5). Further, they found "people engage more strongly with localized information about the causes and consequences of climate change, as well as the solutions" and that information explaining how to engage politically and how political engagement effects change is as important as information about climate change science (Cross et al., 2015, p. 5).

CHERP exemplifies many characteristics described by Cross, Gunster, Piotrowski, and Daub: it is a local, community-based and community-building campaign started by one "everyday hero" with an "entrepreneurial spirit." Rather than solely promoting an individualistic action (i.e. a building retrofit or other measure to reduce individual energy consumption), CHERP weaves these individual actions together through its community-building nature and open-arm invitation to exercise political power through public demonstrations about saving energy. Importantly, CHERP's educational strategy and numerous initiatives have achieved substantial progress in increasing energy efficiency of existing buildings. As of December 2015, five years since CHERP launched in Claremont, there were 287 homes citywide, or 2.3 percent of the residential building stock, that have undergone deep energy retrofits, commonly understood as reducing a building's overall energy consumption by 30 percent (City of Claremont, 2015). To fully understand how CHERP has achieved this success, it is crucial to understand how these local actions are nested within a statewide political framework of environmental laws and greenhouse gas reduction strategies.

Chapter 2: Background on California Climate Change Politics

Since 2003, California has followed a four-step "loading order" to prioritize its energy resources: energy efficiency, demand response, renewable energy, and finally, distributed generation. By conserving and reducing demand for energy first through energy efficiency, the state can decrease the overall amount of electricity needed. The California Energy Commission (CEC) defines energy efficiency as "programs that require buildings and appliances to be constructed in a manner that uses less energy, that provide incentives for purchasing energy efficient equipment, and that provide information and education to encourage people to save energy" (Bender et al., 2005, p. E-1). According to the CEC, the state's energy efficiency programs have saved Californians $75 billion on their electricity bills since energy efficiency standards for new buildings were codified in Title 24, Part 6 of the California Code of Regulations in 1978 (California Energy Commission, 2012; California Energy Commission, 2013). However, more than 55 percent of existing residential buildings and more than 40 percent of existing nonresidential buildings in California were built before 1978 (California Energy Commission, 2013). In total, residential and commercial buildings accounts for approximately 20 percent of greenhouse gas emissions in California (California Energy Commission, 2015). Clearly, a huge opportunity exists in the existing building stock to reduce carbon emissions through energy efficiency. This is the arena in which CHERP operates.

In California, there is a diverse and complicated array of interlocking executive orders, laws, and action plans to implement laws that comprise the state's overall strategy to tackle climate change. To understand how a small, community-based nonprofit like

CHERP functions within the state, it is necessary to look at the political climate nurturing energy efficiency programs.

California's Historical Leadership on Climate Change

Due to its large population and economy, California wields considerable political power, particularly on the issue of climate change. Since the late 19th Century, with the creation of national forests and parks through congressional and presidential actions, federal government has spearheaded most environmental legislation. In the 1960s and 1970s, the "golden era" of environmental legislation, the federal government passed 22 major laws to protect the environment, including the Endangered Species Act, Clean Air Act, and Clean Water Act (Klyza & Sousa, 2013). States were then required to implement programs that met the federal conditions, a relationship known as "cooperative federalism" (Engel, 2006). However, with climate change, most legislative action has been generated on the state and local levels first before going national (Engel, 2006). California has emerged as a prominent leader in the state-level push for climate change policy.

California's two most recent governors, Arnold Schwarzenegger (2003-2010) and Jerry Brown (2010-present), have helped propel the state's leadership in climate change policy. In 2006, in a rare instance of bipartisanship amid the time's divided environmental politics, Governor Schwarzenegger, a Republican, partnered with the Democratically controlled legislature to pass the historic California Global Warming Act of 2006 (AB 32). His successor, Democratic Governor Jerry Brown, has built on Schwarzenegger's environmental legacy by aggressively pursuing climate change policies. Since his third gubernatorial term began in 2011, Governor Brown has signed nine climate-related bills into law: SB 2: Energy: Renewable Energy Resources

(Simitian, 2011); AB 1532: Greenhouse Gas Reduction Fund in the Budget (Pérez, 2012); SB 535: California Global Warming Solutions Act of 2006: Greenhouse Gas Reduction Fund and Disadvantaged Communities (de Léon, 2012); AB 1092: Building Standards: Electrical Vehicle Charging Infrastructure (Levine, 2013); AB 8: Alternative Fuel and Vehicle Technologies: Funding Programs (Perea, 2013); SB 1204: California Clean Truck, Bus, and Off-Road Vehicle and Equipment Technology Program (Lara, 2014); SB 1275: Charge Ahead California Initiative (de Léon, 2014); SB 605: Short-lived Climate Pollutants (Lara, 2014); and SB 350: Clean Energy and Pollution Reduction Act of 2015 (de Léon, 2015) ("California climate change legislation," n.d.).

Scholars have identified numerous factors that have motivated California and other states to pursue aggressive climate policy. First, state leaders may see climate change as "an opportunity to align themselves with a more progressive energy agenda and against big oil and gas interests," which enhances their public image among a pro-environment voter base (Engel, 2006, p. 1024). Moreover, pursuing state-level action in the context of federal inaction further increases their image (Engel, 2006). By passing AB 32, Schwarzenegger characterized himself as a moderate, pro-environment Republican at a time when environmentalists were frustrated with the George W. Bush administration's non-regulatory, voluntarism environmental approach to environmental issues (Klyza & Sousa, 2013).

Second, environmental issues have historically been a major concern for Californians, and global warming is no exception (Mazmanian, Jurewitz, & Nelson, 2008). According to the 2015 Public Policy Institute of California's poll *Californians and the Environment*, 62 percent of Californians believe that the effects of global warming

have already begun. Only 10 percent believe that the effects of global warming will never happen (Baldassare, Bonner, Kordus, & Lopes, 2015). Furthermore, 64 percent of respondents favor the state "making its own policies, separate from the federal government, to address the issue of global warming" (Baldassare et al., 2015, p. 9). California voters demand progress on climate change policy, even in the face of the federal gridlock in Congress.

In terms of legislation, California has led the nation in climate change policy to such an extent that political scientist David Vogel (1995) coined the term the "California Effect," which "refers to the critical role of powerful and wealthy 'green' political jurisdictions in promoting a regulatory 'race to the top' among their trading partners" (p. 6). For decades, California has had the strictest motor vehicle emission standards in the United States, spurred by the historically heavy air pollution and smog in the Los Angeles metropolitan area (Vogel, 1995). When revisions to the Clean Air Act passed in 1970, the law permitted California – and only California – to pursue stricter standards than other states (Vogel, 1995). The state seized this opportunity and chose to impose stricter motor vehicle emission standards (Vogel, 1995). Then, in 1990, Congress brought the federal government standards up to the bar set by California in the 1970s at the same time the state pursued even stricter standards (Vogel, 1995).

As the Clean Air Act has morphed into the primary legislation used in the fight against climate change,[4] this clause has proved crucial to California's leadership in reducing greenhouse gas emissions. In 2002, California passed Assembly Bill 1493:

[4] This is due in large part to the 2006 Supreme Court decision in *Massachusetts v. Environmental Protection Agency* that carbon dioxide, nitrous oxide, methane, and hydrofluorocarbons fall under the definition of air pollutants in the Clean Air Act. This ruling gave the EPA authority to regulate greenhouse gas emissions.

Clean Car Standards (Pavley, 2012) to reduce greenhouse gas emissions in new passenger cars. By 2006, ten other states had adopted these regulations (Engel, 2006). Despite the multistate embrace to curb tailpipe emissions, the George W. Bush administration delayed and eventually denied issuing the waiver (Mazmanian et al., 2008; Klyza & Sousa, 2013). When the Obama administration entered office, the California Air Resources Board (ARB) immediately asked EPA to reconsider and it granted the waiver in June 2009 (Klyza & Sousa, 2013). In 2010, the Obama administration announced the first national fuel standards, which were modeled after the 2002 Pavley standards (Hoffman, 2010). The California Effect had struck again.

Assembly Bill 32: California Global Warming Solutions Act of 2006

California's commitment to the environment is enshrined in a suite of laws and executive orders. The cornerstone of climate change legislation in California is Assembly Bill 32: California Global Warming Solution Act of 2006 (AB 32) (Nunez & Pavley, 2006), a landmark bill that required the state to reduce its greenhouse gas emissions to 1990 levels by 2020. This amounts to "a reduction of approximately 15 percent below emissions expected under a 'business as usual' scenario" ("Assembly bill 32 overview," n.d.). Though some other states had emissions targets in 2006, most were not legally binding. The only other binding target was the Regional Greenhouse Gas Initiative (RGGI), a 2005 greenhouse gas cap-and-trade agreement between seven[5] east coast states, but California's AB 32 was stricter and broader in scope (Hanemann, 2007). For Hartman, the passage of AB 32 put California at the forefront of climate change

[5] As of December 2015, there were nine states participating: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont (Regional Greenhouse Gas Initiative, Inc., 2015).

mitigation and adaptation. Once the bill passed, "it was no longer a debate in California to mitigate global warming. It was the law" (Hartman, 2015a).

Given the ARB's successful experience implementing the Clean Car Standards from 2002, the agency was tasked with implementing AB 32's greenhouse gas reduction goals (Hanemann, 2007). The agency created four primary programs to implement the legislation: Advanced Clean Cars, Renewable Portfolio Standard, Low Carbon Fuel Standard, and Cap-and-Trade (Air Resources Board, 2014). I will discuss how cap-and-trade revenue may be a useful funding source for CHERP in Chapter 4. Importantly, AB 32 has not simply been an aspirational nicety to appease environmentalists. Its numerous programs have actually worked: California is on track to meet and perhaps exceed its 2020 emissions reduction goal (Air Resources Board, 2014).

In 2010, the ballot measure Proposition 23 threatened to suspend AB 32 for the foreseeable future. If passed, AB 32 would have become active only once unemployment fell below 5.5 percent for four consecutive quarters, which had only occurred five times since 1976, the earliest year of data available (U.S. Bureau of Labor Statistics, 2015). Voters defeated the measure by a margin of 23 percent, further proving the California public's commitment to environmental protection.

Executive Orders

Governors Schwarzenegger and Brown also pushed for strong climate change policies through a series of executive orders. These executive orders usually predate and are wider in scope than state legislation. Though executive orders are not legally binding, they still have tangible benefits because they direct agency action. The downside to executive orders is that they can be overturned by a new administration.

In June 2005, Governor Arnold Schwarzenegger issued Executive Order S-3-05 to reduce greenhouse gas emissions to 80 percent below 1990 levels by 2050. Ten years later, Governor Brown issued an interim goal (Executive Order B-30-15) to reduce emissions to 40 percent below 1990 levels by 2030. Senate Bill 32, introduced by Senator Fran Pavley in March 2015, attempted to codify these two goals into law, but was pulled from consideration in early September 2015 after facing intense opposition from the oil industry (Willon, 2015). After the bill endured several revisions, Brown pulled his support as well because he was nervous that the language contained additional legislative oversight of the ARB that would weaken his administration's ability to pursue aggressive greenhouse gas reductions (Willon, 2015). The interim and future goals set forth by executive orders are important because they signify to businesses and governments of all levels around the globe that California is serious about climate change. In the long timelines of business and politics, groups could attempt to evade emissions reductions by delaying action until legislation or programs expire. These executive orders head off this kind of sneaky behavior.

For the objectives of this thesis, Governor Brown issued a third relevant executive order in 2012 (Executive Order B-18-12). It mandated government buildings embrace the latest energy efficiency technologies to promote leadership in the state's green building future. Some of the order's many requirements include LEED certifications for new and existing buildings, an increase in solar photovoltaic systems on state facilities and public university campuses, more electric vehicle charging stations to support an electric vehicle infrastructure, and a reduction in the state's overall water usage ("Green building action

plan - For implementation of Executive Order B-18-12," 2012; Air Resources Board, 2014).

Senate Bill 350: Clean Energy and Pollution Reduction Act of 2015

During Governor Brown's fourth inauguration in January 2015, he announced three new goals for climate policy. Brown called for California to slash vehicle gasoline consumption by 50 percent by 2030, double the efficiency savings achieved in existing buildings, and produce 50 percent of its energy from renewable sources – an increase from the previous target of 33 percent by 2020 (Megerian, 2015; Nagourney, 2015; Roberts, 2015). Soon after, Senate President pro Tempore Kevin de León wrote these three mandates into Senate Bill 350: Clean Energy and Pollution Reduction Act of 2015 (SB 350). After a fierce attack from the oil industry, the petroleum component was removed and the rest of the bill passed. Despite the absence of a legally binding petroleum reduction, Brown insists "[the Air Resources Board] is committed to that 50 percent goal, and I am committed to backing them up" (quoted in Galbraith, 2015).

However, the two new codified goals are still a substantial step forward for California. For CHERP, doubling energy efficiency savings from existing buildings is particularly important because it provides further legal support for CHERP's mission. "What this means," Hartman (2015b) stressed, "is the Governor and the Legislature are underscoring, once again, the state's commitment to [energy efficiency]." With a legislative mandate to promote energy efficiency, Hartman hopes that the state's "commitment" will translate into funds to support energy efficiency nonprofit efforts like CHERP.

Assembly Bill 758

Perhaps the most important piece of legislation passed in recent years related to energy efficiency in existing buildings is Assembly Bill 758 (AB 758) (Skinner, 2009). This bill, passed in 2009, "directs the California Energy Commission to develop and implement a permanent and ongoing, comprehensive program to achieve cost-effective energy savings" in existing buildings (California Energy Commission, 2013, p. 29). In September 2015, the CEC adopted the *Existing Buildings Energy Efficiency Action Plan* to implement the law. The Action Plan lays out a 10-year roadmap for energy reductions to achieve California's climate action goals. The importance of this bill will be discussed in further detail in Chapter 4.

Chapter 3: Obstacles

As with any organization, CHERP has encountered obstacles that impede its growth. To capture all potential energy reductions in existing residential buildings, CHERP must overcome the three remaining critical obstacles to success: lack of operational funding, low access to energy efficiency measures for low-income and renter populations, and a lack of home performance contractors to execute deep energy retrofits utilizing a whole-house energy systems approach.

Obstacle 1: Operational Funding

When asked to identify CHERP's biggest obstacle, without hesitation Hartman pointed to the lack of funds available to pay for the organization's overhead, operations, and collateral materials. He says:

> We could be a lot bigger and more effective if we had more money…If I had enough money to hire three full-time people, we could very quickly get to a place where we're leveraging more and more cities, because right now it basically depends on me…If I had an office manager and staff, I could be doing more strategic work full time. (Hartman, 2015a)

Because CHERP is a nonprofit, volunteer-based organization, most of its labor is donated by community members who are passionate about the problems associated with climate change. In fact, Hartman is the only person who receives direct monetary compensation. Everybody else – from the CHERP supporters walking the streets for a few hours for the Fourth of July parade to the CHERP-Huntington Beach regional director – donates their time. According to Hartman (2015a), this volunteer model is part of what makes CHERP more effective than other programs: "The difference is that the

money that we raise to support CHERP has farther reaching effects than the money raised in other programs because we leverage all of those volunteers." However, the service CHERP provides certainly is not free: it is a labor-intensive endeavor in coordination, public-private partnerships, and community engagement. CHERP operates on small amounts of funding acquired through grants and partnerships, and sometimes relies on what Hartman can contribute "from [his] own pocket" (Hartman, 2015a).

For the one-year period between October 2014 and October 2015, Hartman received a grant from the Energy Network, a program run by the County of Los Angeles and authorized by the California Public Utilities Commission (CPUC), to fund his position as the Executive Director of the Claremont Energy Challenge. At the time of our first interview in August 2015, Hartman (2015a) expressed urgency in the search for more funds: "We have nothing else past October…we are now actively engaged in securing more funding."

Aside from Hartman, all other workers either donate their time or receive funding through another institution. Hartman estimates this contribution has totaled perhaps hundreds of thousands of dollars over CHERP's five-year existence. Take the summer of 2015, for example. In those 10 weeks, nine Claremont College students worked a total of 1,600 hours at no cost to CHERP (most were funded through their various schools' internship grant programs). Had these students been hired employees earning minimum wage, currently at $9 an hour in California, CHERP would have spent $14,400 on labor costs in those two and half months alone. Over the course of CHERP's history, there have been dozens of others who have helped CHERP's operations, doing everything from

delivering signs, hosting community gatherings, managing social media, and designing graphics to organizing entire initiatives.

Though the volunteer-based model has its upsides and is critical to establishing a grassroots community presence, it also has important disadvantages. Hartman (2015a) is hesitant to critique the volunteer model, but acknowledges that problems exist: "People come and go. It's very fluid…It's been an interesting thing for me to be able to go with the flow and see what arises week to week, in terms of interest and who is there to help." CHERP's cause may be noble, but many volunteers and interns operate on a short-term basis or have only a few hours to dedicate each month. For mundane tasks like sign delivery, there is a risk of volunteers becoming bored and opting out of the organization all together. For more complex and strategic tasks, like graphic design and initiative management, volunteers may be unwilling or unable to commit the time necessary to perform adequately without some sort of compensation. This was true of the 2015 summer interns, who expressed that they would not have engaged in either type of task for such a length of time without the resume-building benefits or monetary compensation they received. Moreover, without the organizational support in place, training and managing volunteers as they come and go can be more time-consuming than productive, negating the benefits of volunteer labor.

This is one of the central obstacles CHERP faces. Without the funds to hire full-time staff for organizational continuity, CHERP's growth risks stalling. Hartman and his team of volunteer staff are doing all they can to keep up with the major initiatives that are already in operation, never mind implementing new ones to expand energy efficiency

access and education. There are, quite simply, not enough "spare" work hours in the week.

Obstacle 2: Renters and Low-Income Households

A second obstacle for CHERP has been reaching the renter and low-income populations. With renters, CHERP encounters split incentives between tenants and landlords, which complicate either party's desire to pursue energy efficiency measures. Moreover, the deep energy whole-house retrofits that CHERP promotes are expensive. Even with financing options and rebates, deep energy retrofits are often too expensive for low-income homeowners.

To contextualize the home retrofit market in Claremont, Table 1 provides home characteristics and cost data collected from 287 homes that have undergone retrofits (City of Claremont, 2015). To estimate the total cost of a retrofit for an individual home, home performance contractors must conduct an energy audit, collecting extensive data on how well the house creates, absorbs, and retains heat. Contractors consider a number of factors including the age and number of HVAC systems, air-leakage levels of the whole house and ducting system, existing insulation quality, the year the house was built, its size, construction materials, and presence of an attic, crawl space, or pool. After the audit, contractors present the homeowner with a list of recommendations to choose from to improve their home's energy performance. Summing up the chosen measures equals the total cost of the retrofit. Due to all these variables, including the subjective human element, no two retrofits are the same. Even if the houses were architecturally identical, homeowners would likely pursue different combinations of audit recommendations based on their budget and priorities, resulting in different total costs.

Retrofit costs depend on a number of different factors including the size of the home, year it was built, architectural design, previous remodeling work, and regional climate. Claremont's ranch-style, one-story houses built in the 1960s and its sunny, warm, and dry Mediterranean climate (Köppen-Geiger classification Csa) make retrofit costs here very different from the costs of retrofitting, for example, the 100-year-old three-story brownstones popular in the humid continental climate (Köppen-Geiger classification Dfb) of New York City (Kottek, Grieser, Beck, Rudolf, & Rubel, 2006). The measures and associated costs required to make ranch homes and brownstones more energy efficient will therefore be different. The table provides cost data for Claremont to reflect the unique regional challenges for deep energy retrofits in this area.

Table 1

Summary of retrofitted home characteristics in Claremont

	Data			
Characteristic	Mean	Median	Minimum	Maximum
Total Cost of job ($)	14,546	12,197	1,590	67,693
Rebate Amount ($)	5,355	5,000	1,500	8,000
Home Size (ft^2)	1,849	1,788	637	4,807
Year Built	1957	1957	1896	2007
Percent modeled reduction	27%	26%	7%	57%
Percent homes built before 1978		87%		

Note. In 1978, California adopted the first Building Energy Efficiency Standards (Title 24, Part 6), which established a minimum level of energy efficiency for all new buildings (California Energy Commission, 2012).

As demonstrated in the table, the average total cost of energy retrofits is $14,546. Rebates cover one-third of the cost, still leaving an average bill of $9,191 to the

homeowner. It is reasonable to assume that there are many people in Claremont and beyond who want to save energy and make their homes more comfortable, but do not have the disposable income for a retrofit, even with rebates coming a few weeks after the job is completed. Eventually, the market will reach a saturation point where there are no energy-minded homeowners left who are able to pay for a retrofit, while still not exhausting the full theoretical potential of cost-effective energy retrofits.

This problem will only grow more acute with time. When CHERP started in 2010, the country faced a severe recession and relatively few people could afford a retrofit. At the time, Hartman (2015a) thought: "We're at the beginning of a revolution here. For the moment, we don't need to worry about the people who aren't interested. We have a lot of work to do to communicate to the people who are." Now, five years later, many of the people with that kind of wealth have already heard about energy efficiency. While the economy has improved, and numerous energy retrofit financing options and rebates have sprouted up, the problem of how to address the lowest income households and renters still remains a significant obstacle to CHERP's and the state's energy efficiency and greenhouse gas reduction goals.

Obstacle 3: Lack of Contractors

Securing operational funding and expanding energy efficiency affordability and access are only two-thirds of the battle that CHERP confronts statewide. In addition to making existing buildings more resilient and energy efficient, the organization must also develop enough home performance contractors to execute the building retrofits that will produce the necessary greenhouse gas reductions.

What if California committed to performing deep energy retrofits on its entire residential building stock? In late 2015, there were close to 13.8 million housing units in

California (U.S. Census Bureau, 2015e). Retrofitting all of these residential buildings would substantially reduce greenhouse gas emissions by greatly diminishing the quantity of electricity generated. Potentially no new fossil fuel power plants would need to be built; some could probably even be retired. California residents would be more comfortable in their homes, breathe better quality air indoors, save money on their electricity bills, and see their property values increase. But to accomplish these lofty outcomes, the state needs enough high quality home performance contractors to meet the demand CHERP generates through its educational strategy.

Table 2 shows how many contractors would be needed to retrofit all homes in California. As new technologies become available, California makes its building energy efficiency standards more stringent; a home built today is required to be more energy efficient than a home built 15 years ago (California Energy Commission, 2012). Undoubtedly, many recently built homes would require more minor retrofits that would result in a smaller percentage of energy reduced. For this reason, I base my calculations on the number of contractors needed to retrofit the 12.2 million housing units that existed in California in 2000 (U.S. Census Bureau, 2015c).

Table 2

Number of home performance contractors needed to retrofit all housing units built before 2000

	Contractors Needed to Retrofit 12.2 Million Homes by		
Jobs Completed Per Week	2025	2030	2050
3	8,143	5,429	2,327
4	6,107	4,072	1,745
5	4,886	3,257	1,396

According to Energy Upgrade California, a statewide initiative committed to saving energy and conserving natural resources, there were 1,913 licensed contractors throughout the state in December 2015. As demonstrated in Table 2, California needs a much larger contracting force to achieve maximum greenhouse gas reductions from existing buildings within the timeframes set by state laws and executive orders. As Hartman puts it: "We can spend all this time and money going out and talking to homeowners, but if we don't have the contracting force to enact the work, then we are fooling ourselves. And that's what we've been doing in California so far" (Hartman, 2015b).

Dan Moncayo (2015), Director of Operations at Home Performance Matters, estimates that most of the 1,913 licensed Energy Upgrade California contractors perform the simpler, less energy efficient Home Upgrades, which achieve a minimum of 10 percent reductions in energy use, instead of the Advanced Home Upgrades, which reduce energy use by up to 45 percent ("Get a home upgrade and increase comfort," n.d.). Advanced Home Upgrade requires using the complicated modeling software EnergyPro, which Dan Moncayo (2015) speculates has too steep of a learning curve, and therefore too high of an opportunity cost, for many contractors to use.[6] He acknowledges that the home performance industry is a complicated business, more complex than single-trade contracting like insulation and HVAC, which may contribute to the lack of firms in the market (Moncayo, 2015). In economic terms, opportunity costs exist with learning EnergyPro, keeping up with the latest energy efficiency developments, and shifting

[6] In January 2016, the EnergyPro software will become easier to use, which may increase the number of Advanced Home Upgrade projects executed (Moncayo, 2015).

existing business practices that prevent new firms from entering and for existing contractors to transition into the home performance industry.

Hartman (2015b), who also sits on the board of Efficiency First California (formerly the California Building Performance Contractors Association), estimates that there are fewer than 30 contractors statewide who perform high quality, deep energy retrofits based on an understanding of the whole-house energy system, and these contractors perform *at most* an average of three jobs a week. Affirming Hartman's approximation, Moncayo (2015) agreed that his company averages three jobs each week. He noted that this is slightly under their capacity, saying that in 2016, he will focus more on "marketing to sustain our business, keep up growth, and generate more and more leads" (Moncayo, 2015). This comment reveals that, from the supplier perspective, they are able and willing to handle greater demand for retrofits. Through its educational strategy to inspire homeowners to move forward with energy-saving retrofits, CHERP aims to fill that demand.

Exploring this issue will take further research that is beyond the scope of this thesis. However, California must foster and grow this industry if it wishes to increase the number of people pursuing home energy retrofits. A healthy and robust contracting industry is the last, indispensable piece to making existing buildings more energy efficient, affordable, and effective.

Chapter 4: Potential Solutions

These three obstacles impede CHERP's growth and the widespread adoption of energy efficiency measures in California. However, the organization is actively pursuing strategies to overcome these obstacles; at the same time, California is strengthening its commitment to financially support increased energy efficiency throughout the state. To surmount these issues, the coming months look promising.

The California Energy Commission's 2015 Draft Integrated Energy Policy Report recognizes that Governor Brown's executive order to reduce greenhouse gas emissions by 40 percent by 2030 compared to 1990 levels (Executive Order B-30-15) "cannot be met within the building sector unless private capital and market forces are brought to bear; current ratepayer- and taxpayer-funded efficiency efforts will not be sufficient on their own" (p. 36). The CEC estimates that $10 billion in private capital[7] will need to be invested annually in California's existing buildings to reach the target (California Energy Commission, 2015a). With this stated government commitment to support a growing industry, reliable operational funding (Obstacle 1) seems to be on the horizon, but has not yet been distributed. Coupled with the state's urgency to invest in energy efficiency is Senate Bill 535's legislative mandate to focus the benefits of greenhouse gas emission reductions in disadvantaged communities (Obstacle 2). The solutions to both obstacles, then, are linked. CHERP must become an active champion for energy efficiency in low-income neighborhoods to attract government funding to sustain its operations.

As of December 2015, CHERP was exploring four potential sources of funding. The first is an ambiguous offer from the County of Los Angeles. On August 28, 2015,

[7] The report does not specify where private capital will come from or what type of investments must be made.

Hartman received positive news from Howard Choy, the program administrator for the Energy Network and the General Administrator of the County of Los Angeles Office of Sustainability. Choy "committed to putting CHERP on solid financial footing for [the next several years]" after Choy's office's funding was approved from the CPUC (personal text communication with Devon Hartman, 28 Aug 2015). Choy indicated that this funding could be used to hire full-time staff, addressing Obstacle 1. As of December 2015, it remains unclear what "solid financial footing" means in real terms.

On a national level, the Department of Energy's *Existing Buildings Energy Efficiency Action Plan* (2015), written to implement Assembly Bill 758, aims to address the lack of available funding to make existing buildings more energy efficient. The plan recognizes the importance of local government leadership in energy efficiency, but "the lack of consistent funding sources" inhibits their progress (California Energy Commission, 2015a, p. 37). To meet some of the financing need, which the plan acknowledges is not sufficient to cover all financial needs, the plan recommends implementing a Local Government Challenge, which is set to launch in 2016 (California Energy Commission, 2015b). Grants will be awarded through a competitive application process, and will be based on "actions and adoption of policies for aggressive energy efficiency, disclosure, compliance and permitting" (California Energy Commission, 2015b, p. 57). The plan states that roughly $13 million from leftover "administration funds" and American Recovery and Reinvestment Act funds will be available to finance the challenge, but that $20 million annually "would allow this effort to flourish" (California Energy Commission, 2015b, p. 56). The Commission will look for "scalable, transferable" programs that can be "replicated and expanded" (California Energy

Commission, 2015a, p. 51). Tackling the cost-prohibitive nature of retrofits and focusing on disadvantaged communities will earn CHERP higher marks in these categories, making it a more attractive applicant for the Local Government Challenge.

A third, if distant, possibility is the $5 million award from the Georgetown University Energy Prize. The semi-finalist competition Claremont is in now closes in December 2016, and the finalists will be announced in June 2017 (Georgetown University Energy Prize, 2015). The GUEP website states that the $5 million prize "must be spent on energy efficiency programs that reward the community as a whole and provide for the long-term implementation of those plans" ("FAQs," n.d.). If Claremont were to win first place, it is feasible that some of the prize money would go to support CHERP's operations since it is one of the primary implementers of energy efficiency programs in Claremont.

The state's cap-and-trade revenue is a fourth, less certain funding source. The state earns money every year from the auction of carbon permits and, per state law, allocates that money to reduce greenhouse gas emissions. Forty percent of the funds are appropriated each year; the other 60 percent are designated for ongoing, specific programs like the Low-Income Weatherization Program. SB 535 mandates that 25 percent of the revenue earned by cap-and-trade must provide benefits to disadvantaged communities (de Léon, 2012). At minimum, 10 percent of that revenue must fund projects located within these communities (de Léon, 2012). To identify the disadvantaged communities, the Office of Environmental Health Hazard Assessment created a screening tool called the California Communities Environmental Health Screening Tool (CalEnviroScreen). The second version of the tool, CalEnviroScreen 2.0, released in

October 2014, ranked the state's census tracts by pollution vulnerability scores and, per SB 535 mandate, labeled the top 25 percent as disadvantaged communities. In Claremont, three of its eight census tracts are designated as disadvantaged communities (Office of Environmental Health Hazard Assessment, n.d.).

To further energy efficiency efforts in this area, Claremont could apply for cap-and-trade revenue allocated for the Low-Income Weatherization Program, to be implemented by the Department of Community Services and Development (CSD). The Air Resources Board allocated $75 million of cap-and-trade revenue for this program in fiscal year 2014-15 (Air Resources Board, 2015).[8] This program tackles the same structural and appliance problems as CHERP: insulation, caulking, refrigerators, windows, heating and cooling systems, and photovoltaic systems, but with an explicitly low-income market ("Low-Income Weatherization Program," n.d.). In addition to living in a disadvantaged census tract, households must meet income qualifications of 60 percent of the state's median income ("Low-Income Weatherization Program," n.d.) Funds are distributed in competitive grants and through existing service providers, which in this case, are the utilities (Air Resources Board, 2015). To access the competitive grant funds, CHERP would need to partner with the City of Claremont to access these government funds. Once again, the potential funding source is linked to the issue of equitable access to energy efficiency measures. As of December 2015, the Low-Income Weatherization Program has yet to launch ("Low-Income Weatherization Program," n.d.).

[8] "By design, this program will also leverage CSD's Low-Income Home Energy Assistance Program funds, [and the federal low-income energy efficiency program] Weatherization Assistance Program funds" ("Low-Income Weatherization Program," n.d.).

Claremont Locally Grown Power

Recognizing the need to address low-income households and renters, CHERP has expanded its initiatives to promote behavioral adaptations and less expensive energy efficiency measures on the front side of a whole-house upgrade, and is actively pursuing a new model to provide solar photovoltaic renewable energy to low-income households and renters. The Claremont Energy Challenge embraces dozens of ways that residents can contribute to the city's energy reduction effort apart from pursuing a deep energy retrofit. Taken together, these measures create a complete energy efficiency roadmap to becoming a net-zero home that includes a wide variety of income levels (Figure 4). A new CHERP initiative, Claremont Locally Grown Power (CLGP) is designed specifically to address the environmental and economic justice issues for renters and low-income households in the areas of distributed energy generation and energy efficiency.

Once funded, the initiative will provide six thousand 5.4 kW solar arrays to Claremont households at very low cost in its first year of operation, starting with the lowest income households first (Hartman & Kernahan, 2015). It will also provide 800 retrofits to low-income residents and renters for a price of approximately $500 (Hartman & Kernahan, 2015). This initiative addresses Step Three: Solar Power of the Energy Efficiency Roadmap (Figure 4). CHERP has partnered with San Jose solar company idealPV, whose patented technology (U.S. Patent 8,952,672) eliminates reverse conduction in solar panels, which causes extreme heat that leads to early failure and reduced efficiency (Hartman & Kernahan, 2015).

Figure 4. Energy efficiency road map for Claremont Energy Challenge (reproduced with permission from CHERP).

By licensing this technology, CHERP can manufacture solar panels using cells made of cheaper materials that traditional manufacturers cannot, which drastically reduces the price consumers pay for the solar array (Hartman & Kernahan, 2015).

For context, as of November 24, 2015, there were 394 residential solar arrays installed in Claremont (California Solar Statistics, 2015), which represents 3.2 percent of the 12,219 housing units in Claremont. In Phase I, CLGP will blanket just under half of the homes in Claremont with solar panels, increasing the number of homes with solar panels sixteen-fold.

Most importantly, because of idealPV's patented technology and the proposed state funding mechanism, the installed 5.4 kW systems will be much less expensive for homeowners or renters to purchase, paying a total of approximately $800 for purchase and installation (Hartman & Kernahan, 2015). In the first year of CLGP solar installation, the average customer will earn back their initial investment by saving $860 on their energy bill, found by multiplying the average annual energy use (5400kWh) by the cost of Tier 1 electricity ($0.16 per kWh) (Hartman & Kernahan, 2015).

To put this in perspective, even though the cost of solar power has dropped dramatically in the last few years, the National Renewable Energy Laboratory of the U.S. Department of Energy estimates that in 2014, a 5-kilowatt solar array cost an average of $26,000 (Schlanger, 2015). In 1998, the same solar array would have cost $86,000 (Schlanger, 2015). Even with the ongoing drop in solar prices, purchasing panels remains a challenge for low-income households because panels are still too expensive to purchase (Shahan, 2015).

Moreover, CHERP claims that providing solar to the lowest income residents first will benefit the local Claremont economy. Recall that lower utility bills provide residents with greater disposable income. To understand how increased disposable income affects the larger economy, two basic economic concepts must be understood. The first is the multiplier effect, which states that "a change in spending will bring about an *even larger* change in GDP [Gross Domestic Product]" (Baumol & Blinder, 2012, p. 563). The second concept is the marginal propensity to consume (MPC), which determines how consumer spending, or consumption, changes as disposable income changes (Baumol & Blinder, 2012). Low-income individuals have a higher MPC than people that earn more, which means that when their disposable income changes, they will spend a greater portion of it than high-income individuals (Carroll, Slacalek, & Tokuoka, 2014). So, combining the concepts of the multiplier effect and MPC, having greater disposable income increases consumer spending – and the low-income households targeted by CLGP will spend a higher portion of their disposable income than higher-income households – which has a multiplier effect on GDP. Using these economic ideas as a foundation, CHERP calculates that the 6,000 solar arrays will increase residents' disposable income by $6.5 million per year through reduced energy bills, which, because of the multiplier effect, generates an increase in local economic activity by $29.3 million annually, or a 12 percent growth per year (Hartman & Kernahan, 2015).

Further, CLGP solves the split incentive problem that occurs in rental homes. Renters are incentivized to purchase solar panels because they will earn back their initial investment through savings on their utility bill after one year. The homeowner is also incentivized to purchase panels for a rental home because the home's property value will

dramatically increase. A 2015 Lawrence Berkeley National Laboratory study estimates that solar adds an average $4 per watt premium to the home – for these 5.4kW systems, that equals a $21,600 increase in the home's value (Hoen et al., 2015).

To get Claremont Locally Grown Power up and running, Hartman needs to raise $300,000 to build and test the solar panels and another $700,000 to open the manufacturing plant. To begin Phase I, Hartman is requesting $25.5 million from the state government. In the first six years of the program, the project is revenue neutral; afterwards, the program generates $5.4 million in surplus state revenue for at least the next 19 years (Hartman & Kernahan, 2015). And because of the importance of retrofits for quality of life, health, and safety, $5.3 million of the $25.5 million request is set aside to retrofit 800 low-income homes in conjunction with solar panel installation, at a price of approximately $500 to the consumer (Hartman & Kernahan, 2015). Like all other CHERP initiatives, Claremont Locally Grown Power is designed to be replicable in other CHERP cities.

Recommendations

Energy efficiency is a complex issue under the broad umbrella of climate change strategies. It is one way to reduce greenhouse gas emissions and make our human environments more resilient to the effects of climate change and offers multiple benefits that can be framed in both climate and economic terms. This thesis examined how CHERP educates the community on the benefits of energy efficiency. The organization's ultimate goal is to reduce energy demand so substantially as to avoid the need to build additional polluting power plants. California's robust package of global warming related laws and its history of pro-sustainability leaders and environmentally conscious public provide the political, social, and economic climate in which CHERP flourishes. Though CHERP has achieved success, retrofitting dozens of homes and educating thousands of residents in its seven established CHERP chapters, three critical obstacles impede its growth: the lack of operational funding, low access to energy efficiency measures to low-income households and renters, and lack of home performance contractors to execute existing building retrofits.

There are several steps that CHERP and all levels of government can take to increase the rate of adoption of energy efficiency in existing residential buildings. Based on my research and experience working within CHERP, I provide five recommendations to expand energy efficiency and overcome the obstacles described in Chapter 3. Because this thesis extended only as far as state policies, its recommendations are also state-based. However, these recommendations are likely relevant for federal and multistate coalitions as well.

For CHERP:

- **Secure funding to hire staff, but maintain a list of tasks for individuals who wish to volunteer.** To ease Hartman's responsibilities, CHERP needs paid staff. Employees can help with volunteer management, grant writing, graphic design, strategic initiative development, and organizational partnerships. However, to maintain a community, grassroots presence, CHERP should keep opportunities available for individuals who wish to volunteer. These opportunities can vary depending on the volunteer's interests, but can include office tasks like organization and phone banking to community tasks like sign delivery and representing CHERP at public community events.
- **Closely monitor a community's energy usage following retrofits.** Previous scholarship documents that more energy efficient technology can cause a "rebound effect" in which individuals actually consume more energy, partially offsetting the carbon reduction benefits of increased efficiency (Greening, Greene, & Difiglio, 2000). Monitoring energy usage is important to see how much energy efficiency interventions actually reduce overall energy usage.
- **Continue to link energy usage and climate change to encourage more eco-friendly behaviors.** This recommendation is directly related to the previous recommendation. Understanding how energy production and consumption contribute to climate change will help diminish the rebound effect. If residents understand that heating, regardless of the system's energy efficiency, still contributes to climate change, they may instead choose energy-saving behaviors like putting on a sweater to feel warmer. For an audience of climate change

deniers or skeptics, this recommendation can be re-framed into an economic argument.

For California state government:

- **Invest in skills training and energy efficiency education for contractors.** To address the lack of home performance contractors (Obstacle 3), there needs to be a concerted effort to grow the home performance industry. One way to increase the number of home performance contractors is to educate current single-trade HVAC or insulation contractors in the whole-house energy systems approach so that they can transition into the home performance industry. Undoubtedly, transforming these industries will be difficult and slow as people may be reticent to change their operations. However, as contractors come to understand the science behind and profitability of the home performance industry, firms will begin to enter the industry. A good entry point to communicating with these single-trade contractors is through the professional associations. Further, apprenticeships, associate degree programs and certificate programs should embed whole-house systems approach education into their programs so that future contractors are prepared to enter the home performance industry.

For CHERP and state government:

- **Continue to focus efforts and funding on access to energy efficiency for low- to moderate-income households.** As demonstrated throughout this thesis, widespread greenhouse gas emissions reductions cannot be realized without the

inclusion of low- to moderate-income households. For CHERP to scale up its operations to cities with lower median household incomes, it must continue to promote initiatives like Claremont Locally Grown Power that focus on these populations. State government can aid this process by providing funds to implement CLGP and support other Locally Grown Power initiatives in other CHERP cities.

These policy recommendations offer a brief outline of what can be done to expand the effort to increase energy efficiency in existing residential buildings. Though this thesis and policy recommendations were specific to CHERP and to California, the lessons can be extrapolated to other communities, states, and regions seeking to increase energy efficiency in existing buildings. As one of the numerous strategies to reduce greenhouse gas emissions, increasing energy efficiency in existing buildings is an invaluable energy resource because, as Commissioner of the California Energy Commission Andrew McAllister writes, "at sufficient scale, it can mitigate the need for both fossil and renewable generation, thus increasing system flexibility and lowering costs of all potential scenarios" towards a low-carbon future (California Energy Commission, 2015b). Increasing the rate of adoption and expanding access to energy efficiency measures will greatly assist the statewide effort to reduce greenhouse gas emissions.

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