Rental Property Energy Efficiency in San Luis Obispo

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Abstract

In the modern era, many people choose to rent homes instead of purchasing a home. College towns have an even more disproportionate number of renters when compared to other cities. The majority of rental properties are much less energy efficient than their owner-occupied counterparts. This project analyzes the energy efficiency issues of rental properties in San Luis Obispo and examines potential ways to remedy these issues. In order to analyze these issues, the guiding principles of building science are first discussed, followed by case studies of rental properties in San Luis Obispo. These case studies examine multiple rental properties and their shortcomings in meeting modern efficiency standards. After discussing potential remedies to these problems there is an examination of possible policies provided that could help to pay for such upgrades.

Introduction

The city of San Luis Obispo, CA has an estimated population of 47,536 people as of the 2016 U.S. Census estimate. The U.S. Census population estimate is based on a person's usual residence. A person's usual residence is defined as the place where a person lives and sleeps most of the time (United States Census Bureau, 2017). Therefore, this statistic includes a significant percentage of the 21,306 students of California Polytechnic State University (Cal Poly Institutional Research, 2017). A student population is typically made up of short-term renters. The significance of the student population becomes clear when looking at the owner-occupied housing rate of 36.5% in the city of San Luis Obispo (United States Census Bureau, 2017). Owner-occupied housing is defined as the housing unit being owned, mortgaged, or leased by someone in the household. We see that 63.5% of housing units in San Luis Obispo are rental properties.

A study of appliance energy efficiency in rental properties indicates that rental unit appliances are much more likely to be less efficient than their owner-occupied counterparts (Davis, 2010). While the information in this study was self-reported, it is not a long jump in logic to say that rental properties are also more likely to have less energy efficient construction. Furthermore, California Title 24 outlines energy efficiency standards for both new construction and remodels of old construction, but seems to leave out upgrades to existing housing stock that is not undergoing a significant remodel. The San Luis Obispo Climate Action plan also lists Efficiency Improvements to Existing Buildings as a major goal (City of San Luis Obispo, 2012), but seems to not address the issue of rental properties.

Rental properties are generally existing construction or buildings not scheduled to undergo major remodels. This leaves them as buildings that will not receive energy efficiency upgrades, despite how many are occupied in the city of San Luis Obispo. Property owners are not likely to pay for these retrofits as they can still find renters, regardless of the dwelling's efficiency. Tenants will not pay for these upgrades as they are predominately students with limited capital and will only be tenants for a short period of time. Thus finding a way to increase rental property efficiency is an excellent means for the city of San Luis Obispo to lower energy use and greenhouse gas emissions.

Technical Background

Residential buildings use energy in many different ways. Natural gas is used in homes for space heating, water heating, and cooking. Electricity can also be used for these purposes, but also has other purposes all its own. Electricity in buildings is primarily used for devices that are plugged in to wall power, lighting, and space heating/cooling.

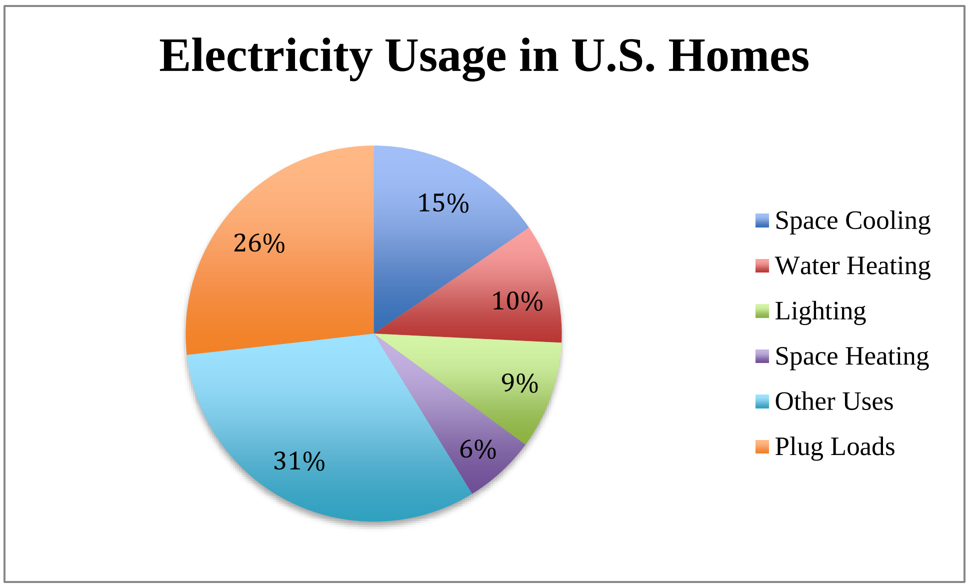

Figure 1. Division of energy usage in United States homes

(U.S. Energy Information Administration, 2017).

Electricity used by devices plugged into wall outlets are called plug loads. The amount of energy used in a home by plug loads is highly dependent on the occupants. Regardless of the energy efficiency measures in place on a building, there is little that can be done from a construction standpoint to change plug loads. Efficiency measures like Energy Star rating for appliances and other systems that rate energy usages of devices already focus on reducing the amount of energy consumed by plug loads.

Lighting is another major consumer of energy for residential buildings. When a new home is being designed, there are many ways of maximizing the light brought into a building during daylight hours. Even armed with this knowledge, many existing homes were designed and built before the benefits of these lighting designs were realized. Even with new construction that takes advantage of these new lighting designs, lighting also needs to be provided on dark days and at night. There are many solutions available to reduce electricity usage from lighting. California Title 24 Part 6 requires the use of occupancy sensors in rooms as well as high efficiency lighting fixtures. The regulations outlined in Title 24 Part 6 apply to new construction and areas of existing buildings that are being remodeled. Title 24 Part 6 leaves out existing building stock in many respects, yet existing buildings are where the vast majority of people live.

Space heating and cooling are very complex consumers of energy in residential applications. Traditionally, the air is heated in a central furnace and then run through ducts around the house. After the air has been distributed through the house, the warm air is introduced into the living spaces.

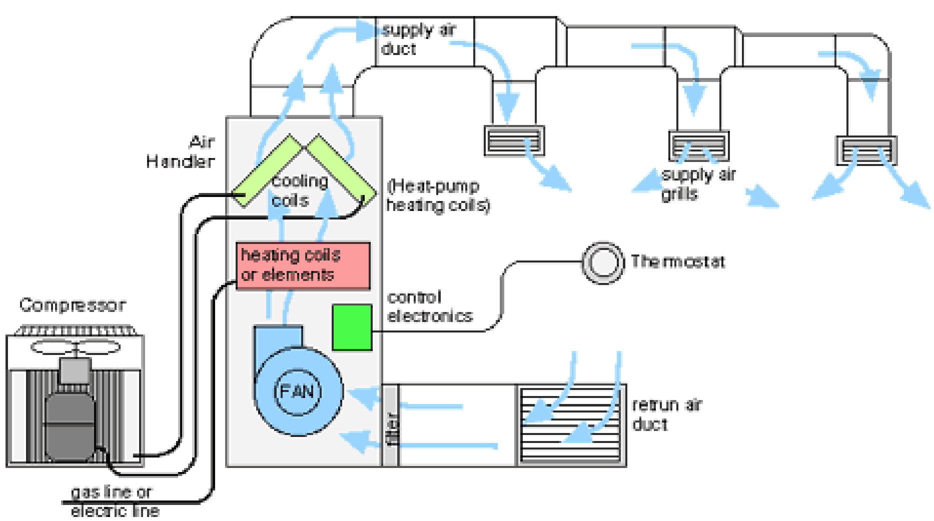

Figure 2. Building HVAC system diagram (Smart Home Ideas, 2011).

Figure 2 shows how a simplified central heating system works. The obvious solution is to replace old, inefficient heating and air conditioning units with newer, high efficiency models. While this can lead to more efficient heat generation, it only addresses one part of the issue. The actual heating unit is only one part of a complex system of interacting parts that heat or cool the living space in a home. Often, maximizing the efficiency of the existing system can be done without replacing the entire HVAC unit. A high performing building envelope is critical to the efficiency of the HVAC system. If the room being heated or cooled is not insulated and sealed properly from the outside environment, then maintaining a comfortable temperature inside the room is difficult and consumes large amounts of energy.

Heat in a building is transferred by radiation, conduction, and convection. The methods of heat transfer in a building are the same as in any other system, but heat transfer in a building is between conditioned and unconditioned spaces. Insulation is used in walls to prevent the transfer of heat by all three methods. A typical wall assembly contains vertical boards with open voids of air between them. These voids are typically filled with an insulation material in newer buildings. In older buildings, these voids allow air to effectively move thermal energy through conduction. Wood transfers heat much more easily than insulation and creates a thermal bridging effect. In turn this effectively lowers the R-value of the entire wall assembly. High performance wall assemblies use specific materials and techniques to limit the amount of heat that is transferred through them and to lessen this thermal bridging effect.

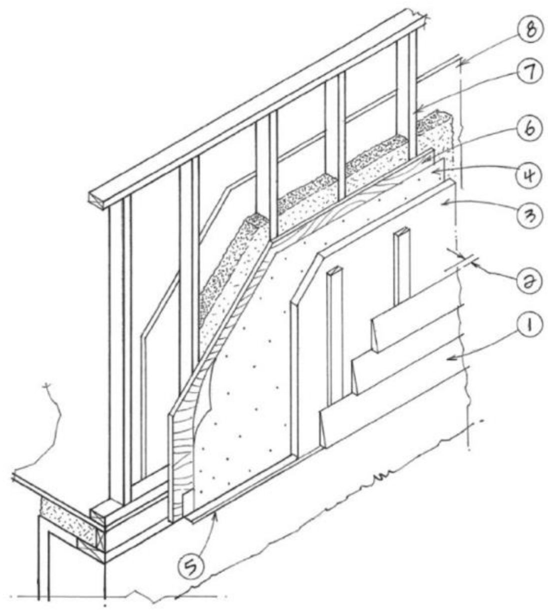

Figure 3. Example high performance wall assembly. (1) exterior siding material, (2) air gap that allows the wall to dry, (3) rigid foam insulation layer, (4) Tyvek or similar house wrap, (5) metal flashing, (6) exterior Oriented Stand Board (OSB) sheathing, (7) wood framing with batt insulation, (8) interior drywall (Racusin, 2016).

A wall assembly such as this has a much higher effective wall value than simple batt insulation in the wall cavities. The rigid foam on the exterior creates a barrier preventing the conductive flow of heat through the wall. In addition, the wall cavity is completely filled thus preventing the movement of air and convective heat loss. These techniques and materials are relatively easy to implement into a new home, but have a higher material and labor cost when compared to traditional framing methods. Wall assemblies such as this can be much harder and more expensive if not impossible to use in a retrofit application. High performance wall assemblies are fairly new in the building industry and therefore are not used in many existing homes.

Preexisting rental properties may not have any of these high performance assemblies. In fact, many older homes lack insulation of any kind.

Older homes lacking insulation or any kind of advanced framing, transfer heat outside the building envelope through all methods of heat transfer. The lack of insulation leads to the inside, conditioned spaces to be in direct thermal contact with the outside air. In the best-case scenario, only a thin layer of air is between the inside and outside spaces. Thermal contact between materials with low R values lead to heating units or air conditioners having to work much harder to maintain the same temperature inside the building. These systems running more frequently and for longer durations lead to increased energy usage.

In addition to not having adequate insulation, older homes do not have the same air sealing standards as new construction. Improper air sealing of the building envelope leads to air infiltration between conditioned and non-conditioned spaces in a building. Inside of a building there is pressure, with more air pressure near the floor and less air pressure near the-top. The pressure gradient is a result of more air being “stacked” on top of air at the bottom of the building. The “stacking” effect causes the most active air leaks to be at the top and bottom of the walls. The walls of a building are where many of the mechanical, electrical, and plumbing systems are contained. These ducts, wires, and pipes need holes in the top or bottom plate of the wall to be run through. The penetrations for these systems lead to holes in the walls near the most active air leaks in a building. If these penetrations are not properly sealed, there can be a flow of air inside the walls, under the floor, or in the attic which lead to convective heat-loses.

Conductive and convective heat transfer leads to the majority of the heat lost or gained from the building envelope. Older houses and buildings are much more likely to not have insulation or proper air sealing. In addition, older homes are more often used as rental properties.

Simple measures such as adequate insulation and air sealing can remedy many of these problems in new and older homes.

Issues in Homes

Each part of a building when viewed individually is made up of simple components such as drywall, framing, and plumbing/electrical penetrations. These simple components are hidden in the complete building, making it difficult to identify efficiency loss mechanisms. Both attics and crawl spaces are areas of a home where many of these problems can be found. Almost all mechanical, electrical, and plumbing in a house is routed through these unconditioned spaces and then penetrates into the conditioned space. Figure 4 shows the heat vents through the ceiling of a rental property in San Luis Obispo.

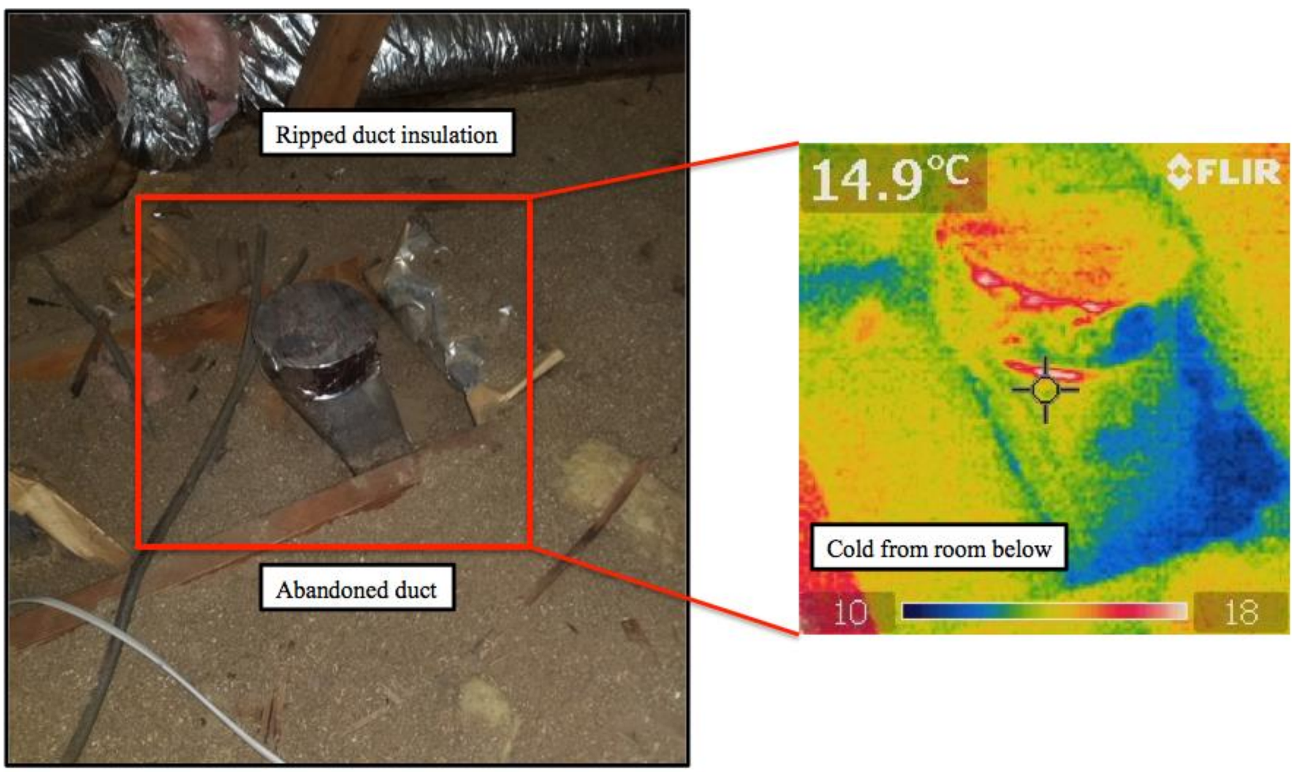

Figure 4: Abandoned duct in rental property ceiling.

The heat vent viewed in figure 4 was abandoned when a new furnace was installed, but left in place and sealed with tape. The image also shows that when this vent was installed, the insulation was peeled back and never replaced. The image on the right of figure 4 shows a thermal camera image of the heat vent. The thermal camera image was taken on a day when the temperature in the attic was higher than the temperature in the building. The dark blue area of this image shows where cold air is seeping up from the non-insulated penetration into the building envelope. Not only is the heating vent not connected to any ducting, but it is also not properly sealed. By having this penetration in the ceiling, the building is losing heat any time the heating or air conditioning is turned on.

Even though buildings may have insulation in the walls and ceilings, the insulation is only as good as the installation. Improperly installed insulation can be almost as bad as not having insulation in the first place. Figure 5 shows improper installation of insulation around an electrical penetration.

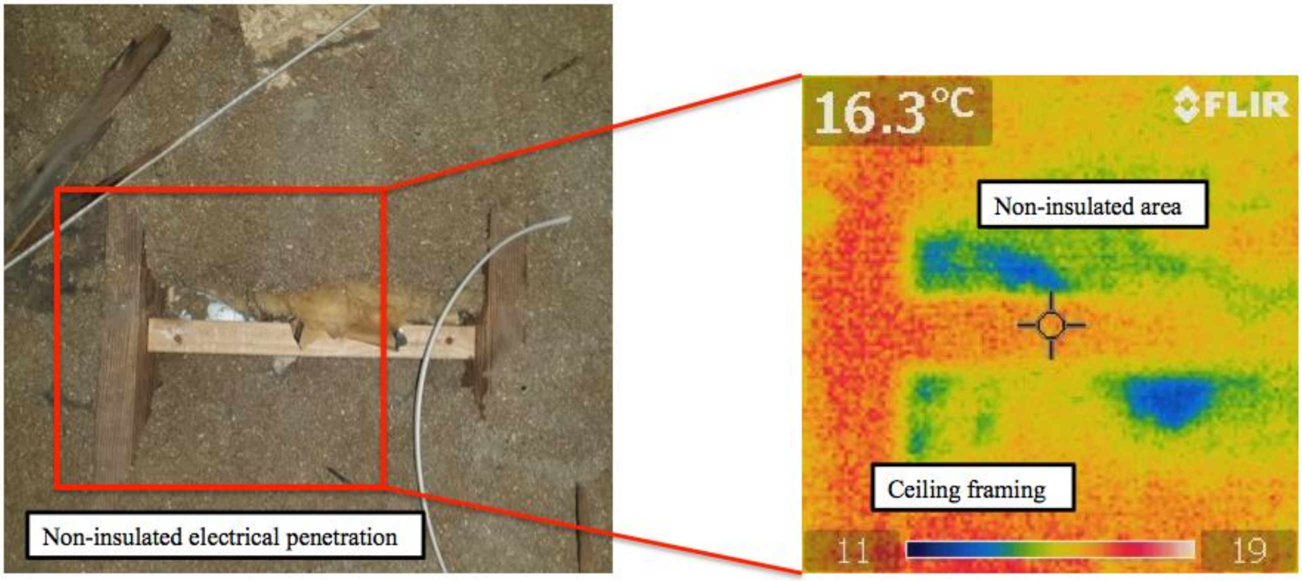

Figure 5. Insulation pulled back from recessed light fixture

In this image, it can be seen that the insulation was pulled back to expose the electrical box so work could be performed. After the work was done, the insulation was not properly put back in place. The image on the right shows the result of not reinstalling the insulation properly. This image shows the temperature difference between the areas with the insulation working properly and where the insulation is not functioning. The temperature difference between these two areas becomes more pronounced with more extreme outside temperatures.

Improper remodels or additions also lead to building inefficiency. Many of the rental properties in San Luis Obispo have been remodeled or have additions. Additions are common in rental units to convert living rooms to extra bedrooms, or to add bedrooms by sacrificing yard space. “Heat leaks” are introduced when these additions and remodels are not properly done with best building practices in mind. Figure 6 shows an improperly added skylight.

Figure 6. Skylight in home viewed from attic

When this skylight was added to the home, a hole was cut through the existing ceiling and roof in order to add the skylight to the kitchen. While there is no evidence of water damage from the roof penetration, there is also no insulation around the new framing. The implications of this are that the unconditioned space of the attic is almost in direct thermal contact with the conditioned space of the kitchen ceiling. There are also penetrations in the sheet rock for electrical boxes that are not sealed; meaning air is free to flow between the kitchen and attic. These air leaks at the top of the building envelope are not only active because of the building's pressure differential, but are also causing the dirty air of the attic to be directly circulated through the house.

Figure 7 shows an example of a poorly constructed addition. In this home, an existing detached garage was connected to the home and a bedroom was added behind the garage.

Figure 7. Framing of existing home to garage addition

The framing of this addition is similar to the skylight addition. The new space was framed to the desired shape and then sheet rocked. No insulation was added at the new interface between the attic and the conditioned space. In this addition, there is also a ¾” gap in the sheet rock, which causes the interior space to be completely open to the attic.

While these problems are present in both rental homes and owner-occupied housing, rental properties are more prone to having these problems persist. It is relatively easy to avoid these heat leaks. Most of the fixes are simple things like ensuring that existing insulation was installed correctly, applying small amounts of insulation to spaces that are lacking insulation, or ensuring penetrations into the conditioned space are properly sealed. These tasks can be performed by many people as a DIY project, but should be performed by a professional to ensure proper handling of hazardous materials and to ensure proper installation and maximum return from upgrades.

Economic Viability

The construction work required to perform these energy upgrades is not exceptionally difficult. The more difficult task is determining how they will be paid for within the tenant/landlord dynamic. The issue stems from the fact that neither of the parties will benefit directly from the money spent in the way a traditional homeowner would. The majority of landlords in San Luis Obispo have multiple properties and tenants pay for their own utilities. A landlord not paying the utilities on their properties has no incentive to pay for energy efficiency upgrades because the renters are unaware of the utility costs when they choose a place to rent. Similarly, most people renting a home or apartment only plan on living there for a short amount of time. Energy efficiency upgrades only make financial sense when the savings per month on an energy bill will end up offsetting the cost of performing the upgrades. Therefore, in order to effectively perform upgrades on rental properties, a program needs to be in place to help pay for such retrofits.

A study (Burfurd, Gangadharan, & Nemes, 2011) examining the relationship between energy efficiency and rental markets discovered that information regarding efficiency for potential tenants was one of the most important factors when determining how effectively energy policies would be introduced into the market. The study analyzes four treatments of the rental market and how efficiency measures can be introduced in a way that benefits both tenants and landlords. The four cases were: (1) landlords providing voluntary energy efficiency information to their tenants, (2) landlords being required to provide energy efficiency information to their tenants, (3) landlords being required to have a minimum level of efficiency upgrades on their property, and (4) landlords paying a fixed percentage of the tenant's energy bill.

The treatments where landlords provided information regarding the energy efficiency of their properties were similar in their effectiveness. Providing this information to tenants resulted in little additional cost to the landlord, but tenants were willing to pay slightly higher rents for units that had a higher efficiency. Tenants willing to pay more for efficient units also provided an incentive for landlords to invest in their properties in order to receive the higher rent values. By simply providing information voluntarily, properties with displayed information were 71% more likely to be rented and tenants paid 5% more on average for these properties (Burfurd, Gangadharan, & Nemes, 2011). The results for the case requiring landlords to provide a minimum level of energy upgrades on their properties had a very similar effect on the market as in the cases where tenants were provided with additional information. It can be inferred that the tenants were aware of the upgrade requirements and therefore had access to similar amounts of information as the prior two cases, regardless of the amount of upgrades performed. The case that performed the worst was the cost-sharing case. In most cases, the landlords were not willing to upgrade the property. Unless the percentage of the utility bill was very large, it made more financial sense for the landlords to continue paying the bill instead of investing in upgrades for their property. When the bill percentage increased enough that landlords began to invest, they simply raised rent prices in order to cover the uncertainty.

In the study, the rental market was treated as a perfectly functioning market. In reality, the rental market does not function perfectly and all information provided to tenants is not perfect. Even if landlords were required to provide information regarding building efficiency to potential tenants, it would need to be vetted in order to ensure tenants were receiving accurate information. The easiest way to provide this information is through the use of energy bills (natural gas and electricity). These metrics can provide useful baseline information, but the numbers are so highly dependent on the end user that this is not an accurate means for comparison.

Information needs to be provided for tenants through a third party that is more comprehensive than simply comparing energy bills. A way to provide tenants with this information is to mandate a basic energy inspection of rental properties before a new tenant can occupy the space. In new construction and remodels, this already is the case. Almost all municipalities require a final occupancy inspection before the property owner is allowed to move in. Implementing such an inspection for rental properties would take advantage of previously observed rental market trends to provide more energy efficient rental properties.

Future Outlook

The next step for this project would be to develop a relationship with property management companies and work collaboratively with them. By involving these companies early in the process it would lessen the amount of push back from potential new mandates. Throughout the course of this project, getting in contact with property management companies to even do basic background research was difficult. A relationship with these companies would be critical to the success of any future policy.

Implementing a rental inspection program that provides renters with information regarding the efficiency of properties is critical for the city of San Luis Obispo to continue towards their climate action plan goals. Not only do energy efficient homes benefit the planet, they also benefit individuals by providing better indoor air quality and less expensive energy bills. All prospective tenants should have the right to be aware of the future energy costs and indoor air quality of a rental property. California Polytechnic State University, San Luis Obispo is also in the process of developing a “House Doctor” lab. The goal of this program is to provide students and collaborators with the tools, techniques, and education necessary to critically analyze how buildings use energy. This is a crucial step towards improving building efficiency in the city of San Luis Obispo and state of California. In addition, California’s Energy Efficiency Strategic Plan mandates zero net energy construction for all new homes in 2020 (California Public Utilities Commission, 2015). By investing in upgrades to existing properties now, landlords can save money in the long term if mandates are put in place regarding existing properties. Legislation needs to be adapted to include rental properties in order for the city of San Luis Obispo and the state of California to achieve their climate action goals.

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