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Research Report

Impacts of the Split Incentive on Privately Owned Rental Housing

with Implications for an Energy Saving Housing Initiative

Bureau of Business and Economic Research

Labovitz School of Business and Economics

University of Minnesota Duluth

Driven to Discover

Research Team

UMD Labovitz School of Business and Economics (LSBE)
Bureau of Business and Economic Research

Monica Haynes, Director
Gina Chiodi Grensing, Editor/Writer
Christopher McIntosh, LSBE Economics Department Chair
Austin Kuhn, Undergraduate Research Assistant
Michelle Scott, Undergraduate Research Assistant
Travis Eisenbacher, Undergraduate Research Assistant
Andrew Burke, Undergraduate Research Assistant
Karen Haedtke, Executive Administrative Specialist

Bureau of Business and Economic Research
11 East Superior Street, Suite 210
Duluth, MN 55802
(218) 726-7895
www.d.umn.edu/lsbe/bber.php

Project Contact
Monica Haynes, Director
Bureau of Business and Economic Research
11 East Superior Street, Suite 210
Duluth, MN 55802
Direct 218-726-7895
mrhaynes@d.umn.edu

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Executive Summary

Residential housing is a major contributor to energy consumption and waste in our region. The city of Duluth has one of the most extreme climates in the country and an aging housing stock. Plus, Duluth has a large population of college students who rent housing, as there are three major higher education institutions within the city. Since students are less experienced with the rental process, they may be more vulnerable to the costs associated with renting energy inefficient housing.

The Bureau of Business and Economic Research (BBER), a research component of the Labovitz School of Business and Economics at the University of Minnesota Duluth (UMD), in partnership with UMD's Sustainability Office and the local nonprofit agency, Ecolibrium3, conducted a thorough examination of the effects of the split incentive nationally and locally, with a special focus on how the split incentive affects student renters.

A review of empirical research found that the split incentive changes landlord and tenant behavior in various ways depending on who pays for utilities. When landlords pay, properties are typically more energy efficient, but tenants are more likely to overuse energy. When tenants pay, they are more conservative with their energy consumption, but properties tend to have fewer energy efficient features.

Results of the study appear to suggest that students are more prone to the effects of the split incentive for a number of reasons. First, students tend to choose properties that are larger and have more bedrooms than other types of renters. As such, these larger properties typically consume more energy, especially for heating. Second, landlords who rent primarily to students were less likely to report making energy efficient improvements. Therefore, students are apt to be paying more for utilities due to a lack of energy efficiency features in their rental. This goes hand in hand with the findings that students are also more likely to be responsible for monthly utility payments and less likely to have them included in the cost of rent.

The effects of the split incentive on student renters were also observed in a series of linear regressions, comparing various property and tenant characteristics with average monthly electricity and natural gas consumption. The results showed that student residences tend to have higher levels of natural gas consumption than non-student residences but lower levels of electricity consumption. As mentioned previously, students tend to choose properties that are larger and have more bedrooms than other types of renters, and they are more likely to be responsible for their monthly utility payments (especially in the case of natural gas). This would suggest that higher natural gas consumption among students is likely the result of inefficient housing characteristics (e.g. poor insulation, older furnaces) and not behavior. The lower than average electricity consumption, however, is more difficult to explain. If students are paying for their own electricity, perhaps they are more conservative with their consumption in order to save money. Another explanation could be the relationship between income and consumption.

Among Duluth renters, utility costs are an important consideration when determining where to live. More than 70% of landlords indicated that their prospective tenants were likely or very likely to inquire about the unit's average monthly utility costs. However, while utility costs were considered very important to Duluth tenants (89% felt this feature was important or extremely important), energy efficiency in itself was not. In fact, more than half of all respondents said that the energy

efficiency of their rental property was unimportant or not at all important to them when considering where to rent. Clearly, a rental property that is energy efficient is not enough to entice most renters as a stand-alone feature. That efficiency must also translate into cost savings. This piece of evidence is supported by results of the study's willingness to pay analysis, in which roughly half of all tenants revealed they would be willing to pay more in rent to live in an energy efficient unit, but a much larger share (78%) stated they were willing to pay more if they could be guaranteed an equal amount of savings in their monthly utility payments.

One purpose for this study was to gain information from both parties on the types of characteristics that would encourage participation in a program designed to address the split incentive issue. Among landlords, the most enticing characteristics for such a program were "marketing of your properties as 'preferred' for quality renters," with over 53% of landlords responding favorably, followed by "vouchers to cover a portion of the costs of energy-saving investments." Among tenants, the most enticing characteristic for such a program was a "'Rate my Apartment' style website for property and landlord characteristics (e.g. landlord reputation, safety)" and a "monthly energy usage report, including comparisons to similar properties in your neighborhood." Of the program characteristics listed in the survey, both groups rated the "free energy audit" as the third most popular characteristic that would entice them to participate.

Along with the potential energy savings and environmental benefits that could be gained by eliminating the split incentive issue, there are a number of potential economic benefits, the most obvious being reductions in energy bills for tenants and/or landlords. By implementing a variety of energy-saving improvements, such as installation of a programmable thermostat, replacement of an older furnace, or an insulation upgrade, the U.S. Department of Energy (2016) estimates the potential annual energy savings for a Duluth household at 45-50% or $957 annually. Assuming every rental household in the city of Duluth were to achieve the full potential savings annually, the combined savings city-wide would total nearly $14 million in energy expenditures each year. However, a more realistic estimate is nearly $400 in savings per household with a combined city-wide total of $6 million.

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Impacts of the Split Incentive on Privately Owned Rental Housing

With Implications for an Energy Saving Housing Initiative

Project Description

Residential housing is a major contributor to energy consumption and waste in our region. In 2015, the residential sector accounted for 21% of total primary energy consumption and about 20% of carbon dioxide emissions in the United States, according to the U.S. Energy Information Administration (EIA 2016). These numbers are even higher in cold weather climates, like Duluth's, where heating makes up the greatest portion of energy use, according to EIA reports (2012).

The city of Duluth has one of the most extreme climates in the country and an aging housing stock. What's more, Duluth is home to three major colleges and universities, so a large residential portion is composed of college students who are mainly renters. College students are, by nature, a more transient population, more likely to be low-income, younger, and less experienced with the rental process. This puts them at a disadvantage when selecting housing and makes them more vulnerable to the costs associated with renting energy inefficient housing.

In most rental agreements, the landlord is responsible for all energy-related capital investments (e.g. insulation, windows, high-efficiency appliances), while the tenant is responsible for the monthly energy bill. Thus, landlords have little incentive to invest in energy efficient improvements, and tenants are unlikely to invest in a property they don't own. This is called the "split incentive," and it leads to a market failure when it comes to increasing the energy efficiency of rental properties (Gillingham 2010). While much research has focused on the concept of the "split incentive" and how this concept impacts energy consumption in rental housing, little is known about how the split incentive affects student tenants and their energy usage. Our research seeks to examine energy use among student tenants – especially as they compare to regular renters and low-income renters, energy efficiency investments made by landlords in the city of Duluth, and what can be done to correct this important market failure, thereby reducing energy costs for student renters and improving energy efficiency throughout the city of Duluth.

The Bureau of Business and Economic Research (BBER), in partnership with UMD's Sustainability Office and the local nonprofit agency, Ecolibrium3, conducted research for the potential development of a program that would address the Split Incentive issue. The initial premise of the program, with the working title of the "Bulldog Approved Housing" program, would reach out to landlords throughout the city of Duluth, focusing primarily on units commonly occupied by college students. Landlords would be encouraged to schedule a home energy audit and complete the necessary home energy improvements as found from the audit. Properties of participating landlords would be deemed "Bulldog Approved" housing, and their housing units would be marketed to UMD students as energy-efficient options. Therefore, the purpose of this investigation is to help determine the need and scope of the program and to inform the tentative program's sponsors on best practices in addressing the split incentive issue locally.

Specifically, this investigation will help to address the following research questions:

- Does the split incentive issue impact student tenants more severely than it does other renters, including low-income renters? If yes, how?
- Are students less likely to choose energy efficient housing than the average renter or low-income renters? Why or why not?

- Are landlords that primarily serve college students less likely to make energy efficient investments? If yes, why? And what might be done to address this?
- Does more transparency regarding energy efficiency in rental units influence student choices in selecting housing? Why or why not?
- How would addressing the split incentive issue benefit students, low-income individuals, and the city?

This report includes four chapters. Chapter I provides background data on the split incentive issue, the city of Duluth, and the economic impacts that the split incentive issue has on Duluth along with a summary of existing national programs similar to the potential program being investigated for UMD.

Chapter II provides data on Duluth's housing stock, the differences between renter- and owner-occupied properties, rental properties that are student rentals vs. non-student rentals, and energy consumption.

The third chapter provides results from two independent surveys, one on tenants and one on landlords.

The final conclusions resulting from this study can be found in Chapter IV. That chapter also revisits the overarching research questions with a focus on possible answers based on this study's findings.

Chapter I

Chapter I of this report provides a thorough examination of the market failure known as the split incentive. The chapter is divided into four sections. First, related literature was reviewed to provide an in-depth analysis of the split-incentive issue, focusing on how the problem changes tenant and landlord behavior and how it affects energy use among student and low-income renters. The second section, entitled Regional Implications, provides background information on the city of Duluth, including demographic and housing statistics, and focuses on how these characteristics relate to energy consumption in rental housing locally. Section three attempts to quantify the economic impacts that the split incentive issue has on the city of Duluth, using estimates collected from existing literature combined with local and national data sources. The final section includes a summary of existing programs throughout the country and successful characteristics that a potential program may adopt.

Chapter I Key Findings
• **The split incentive changes landlord and tenant behavior in various ways, depending on who pays for utilities.**
• **Home energy costs are felt much more acutely by low-income households, due to the inelasticity of home energy use.**
• **The student population overwhelmingly rents, making them particularly vulnerable to the split incentive issue.**
• **27.5% of Duluth's residents were between 20 and 34 years of age (with more than half of that group falling between ages 20 and 24).**
• **In 2014 nearly 90% of households under age 24 rented in Duluth, and 50% of households between ages 25-34 were renters.**
• **More than 20% of Duluth's residents are below the poverty line compared with only 11% statewide.**
• **Almost half of Duluth's housing stock was built before 1940.**
• **Duluth's large population of young adults, its high poverty rates, and its growing demand for new housing make it more vulnerable to the effects of the split incentive than many other cities.**
• **The potential annual savings for a Duluth household who makes the prescribed improvements is $957, or 45-50% of annual energy costs.**
• **In total, the potential city-wide savings to renters and property owners resulting from the elimination of the split incentive would total between $6 and $14 million.**
• **Program considerations for improving the split incentive issue include subsidizing investments in efficiency, regulations, access to information, green leases, and student participation.**

Literature Review

This study aims to quantify the effects of the split incentive issue on the city of Duluth and to determine whether the issue impacts student renters more than other renters within the city. By providing a thorough review of the existing data and literature on the topic of the split incentive, this chapter highlights how the split incentive issue affects landlord and tenant behaviors and which populations are most impacted by the problem.

Tenant and Landlord Behavior

The split incentive is a common market failure that has been studied extensively by economists, energy experts, and environmental researchers. The problem occurs most frequently between landlords and tenants but can exist whenever two parties have different incentives regarding the consumption of energy.

Table 1. Split Incentives in the Owner-Occupant Relationship

	Occupant Owns	*Occupant Rents*
Occupant pays for energy use	Scenario I: No split incentives	Scenario II: Efficiency problem
Occupant does not pay for energy use	Scenario III: Usage and efficiency problem	Scenario IV: Usage problem

SOURCE: GILLINGHAM 2010

Table 1 shows the four possible scenarios in which the split incentive problem can occur in the owner-occupant relationship. In Scenario I, the occupant owns the property and pays for utilities. There is no split incentive in this situation. In Scenario III, the occupant owns the property but does not pay for his/her energy use. While this rarely occurs in practice, it occasionally happens for residents of townhouses and other attached housing complexes and demonstrates an example of a non-rental split incentive. Scenarios II and IV demonstrate the most common examples of the split incentive problem. Scenario II occurs when the tenant pays the energy bill but is unaware of the energy efficiency of the unit and its features prior to signing the lease. In Scenario IV, the owner (principal) pays the energy bill. In this situation, the tenant has less incentive to conserve energy and, therefore, sets the thermostat higher or uses more electricity than he/she would otherwise. Both scenarios lead to an overconsumption of energy: the first through waste on the part of the tenant (usage problem) and the second through poor insulation or inefficient appliances due to the landlord (efficiency problem).

The theoretical framework shown in Table 1 provides researchers an opportunity to test the existence of the split incentive empirically. If the split incentive changes behavior, we would expect rental properties in which the tenants are directly responsible for utility payments (Scenario II) to be less energy efficient than similar rental properties where utilities are included in rent (Scenario IV) or similar owner-occupied properties (Scenario I). Also, we would expect tenants who do not pay for their utilities (Scenario IV) to use more energy as compared with renters who pay for their own energy use (Scenario II).

Numerous studies have examined the split incentive as it relates to energy efficient investments. Levinson and Niemann (2003) used data from the Residential Energy Consumption Survey (RECS) and American Housing Survey to compare energy efficiency by apartment when landlords paid for utilities, while controlling for other factors, such as climate, heating costs, and other apartment characteristics. They found that apartments and rental units where the heat is included in the cost of rent tend to be more energy efficient than those where the tenant pays. Gillingham and colleagues (2010), using data from the California Statewide

Residential Appliance Saturation Study (RASS),[1] examined how the split incentive affects owner and occupant behavior. They found that owner-occupied homes are significantly more likely to be well-insulated than other types of housing units, which is especially true in older homes. Among homes built before 1940, owner-occupied units consumed 35% less energy per square foot than rented properties (Carliner 2013). This suggests that owners are more likely to invest in energy efficient improvements to their homes than are landlords. It also suggests a great opportunity for increased energy efficiency among older rental properties.

Many of the studies that were reviewed focused on whether the split incentive issue changes tenant behavior. By comparing temperature settings in utility-included apartments with those in units where the renter pays, it is possible to observe whether the split incentive encourages tenants to be more wasteful when they are not directly responsible for the energy costs themselves. A variety of studies looked at this relationship, and all of them came to similar conclusions. Tenants in utility-included apartments tended to keep the temperature higher on average than those who paid for their own heat (Levinson 2003), (Gillingham 2010), (Maruejols 2010). The difference in temperature was largest at night and during times when no one was home, suggesting that tenants who are responsible for their own energy payments were more likely to turn down the thermostat when they left home. Households that paid for heating were 13% more likely to turn down the thermostat at night and more likely to select lower temperature settings (below 65 degrees) in general (Gillingham 2010). Finally, (Levinson 2003) found that tenant sub-metering was one of the most cost-effective energy conservation methods available. Even though these properties tend to be less energy efficient, research shows that tenants used less energy when they paid their own utility bills.

In summary, empirical research has shown that the split incentive changes landlord and tenant behavior in various ways, depending on who pays for utilities. When landlords pay (Scenario IV), properties are typically more energy efficient, but tenants are more likely to overuse. When tenants pay (Scenario II), they are more conservative with their energy consumption, but properties tend to have fewer energy efficient features. Both scenarios lead to higher levels of wasted energy and highlight the difficulties associated with conserving energy in rental properties.

Impacted Populations

In 2014, more than 40 million households (35%) throughout the United States were renter-occupied (U.S. Census Bureau 2014), and it is anticipated that that number will continue to grow in coming years (Joint Center for Housing Studies of Harvard University 2011). Renters are typically younger, more diverse, tend to have lower household incomes, and are more likely to receive welfare benefits than homeowners (Davis 2009). Therefore, while all renters are impacted by the split incentive, through higher utility payments, inefficient housing, or uncomfortable living situations, these impacts can be particularly onerous for low-income households.

According to the Bureau of Labor Statistics 2014 Consumer Expenditure Survey, households in the lowest 20% of the income bracket spent approximately 10% of their household income and 25% of their overall housing expenses on utilities, while households in the highest income bracket spent only 5.6% of their income and 18% of their overall housing expenses on utilities (Bureau of Labor Statistics 2014). Part of the reason for the large burden on low-income households is the inelasticity of home energy use. Energy is a necessity, so consumer demand for it does not increase proportionately with a rise in income. According to results from the American Housing Survey, the median monthly energy payment for the lowest income

[1] The 2003 RASS study was funded by California utility companies and is considered one of the most comprehensive energy surveys with data on a variety of housing characteristics, demographics, and landlord and tenant behaviors.

households was $116 compared with $151 for the highest-income households. [2] This difference is not large, especially when compared with other common household purchases.

Pivo (2012) used data from the RECS to research the relationship between energy efficiency and income among multi-family rentals. He found that multi-family rentals had significantly fewer energy efficient features than other housing types. Additionally, low-income households were less likely to have certain types of energy efficient features, most notably newer appliances, such as washers, driers, refrigerators, and water heaters. While the reason for this is not clear, it could be that low-income households may be selecting units with lower rents, which also come with less efficient features

Much of the research conducted regarding the split incentive issue focused solely on the economic impacts of the problem, but there are also social and health concerns associated with the split incentive. Residents whose homes are highly inefficient often experience discomfort from cold and drafts as a result of poor insulation. Likewise, residents who pay for their own utilities typically set their thermostats lower in the winter months to keep costs down. This can lead to health problems and can be a major stressor (Pivo 2012), (Columbia University's Mailman School of Public Health 2015). In a 2015 Columbia University study on residents in a low-income community in New York City, more than half of the study participants had to cut back on basic household necessities in order to make their utility payments, and many worried that they would not be able to pay their energy bills altogether. Finally, according to a study on Wisconsin's rental characteristics, more than a third of all tenants in the study reported being somewhat uncomfortable or very uncomfortable in their residence during the winter months (Pigg 2005).

Regional Implications

This portion of the report summarizes local demographic, housing, and climate statistics that influence Duluth's rental market and energy consumption. The statistics are collected from a variety of sources, including the American Community Survey, the city of Duluth's Housing Indicator Report, and other regional studies to demonstrate how Duluth's local housing, demographics, and climate make it more susceptible to the impacts of the split incentive problem than other similar communities.

Demographics

The demographics of the city of Duluth make it vulnerable to the impacts of the split incentive problem. As mentioned previously, Duluth has a large population of young adults that attend the city's numerous post-secondary educational institutions. It also has a high population of low-income households. Moreover, while the city's population has declined over time, demand for housing continues to rise. This section details the demographic characteristics of the city of Duluth as they relate to the city's rental market and specifically the split incentive issue.

Duluth is home to a disproprtionately large population of young adults. According to estimates from the 2010-2014 American Community Survey 5-year estimates,[3] 27.5% of Duluth's residents were between 20 and 34 years of age (with more than half of that group falling between 20 and 24) compared with only 20.3% of the state's population. One reason for this larger-than-average population is because the city is home to three major colleges and universities with a total combined enrollment of more than 22,000 (City of Duluth Community Development Division 2015). Research shows that this demographic group (between ages 20-34) is more likely to rent than any other population (U.S. Census Bureau 2014, The Joint Center for Housing Studies 2011). In fact, a 2014 study conducted by Maxfield Research (2014) found that, in Duluth, nearly 90% of households under age 24 rented, and 50% of households between ages 25-34 were renters. This large

[2] Sample includes renters paying all utilities. Source: American Housing Survey, 2011
[3] U.S. Census Bureau, 2010-2014 American Community Survey 5-Year Estimates

population of young adults plays a major role in Duluth's rental market and in understanding how the split incentive affects renters in the city of Duluth.

The city of Duluth also has a significant percentage of low-income households. In 2014, more than 20% of Duluth's residents were below the poverty line compared with only 11% statewide (U.S. Census Bureau 2014). According to a Harvard (2011) study on renter demographics, low-income individuals are more likely to rent. In fact, in 2010, roughly 70% of renter households had incomes below the national median and more than 40% were in the bottom quartile. Low-income households also devoted a much larger share of their monthly household expenses to utility payments (Carliner 2013). Therefore, low-income households are particularly vulnerable to the effects of the split incentive.

Table 2. Duluth's Historical Population

	1950	*1960*	*1970*	*1980*	*1990*	*2000*	*2014*[4]
Population	104,511	106,884	100,578	92,811	85,493	86,319	86,265
Households	30,873	34,491	33,384	35,363	34,646	35,500	38,150

SOURCE: CITY OF DULUTH 2014 HOUSING INDICATOR REPORT (2015), 2010-2014 AMERICAN COMMUNITY SURVEY 5-YEAR ESTIMATES

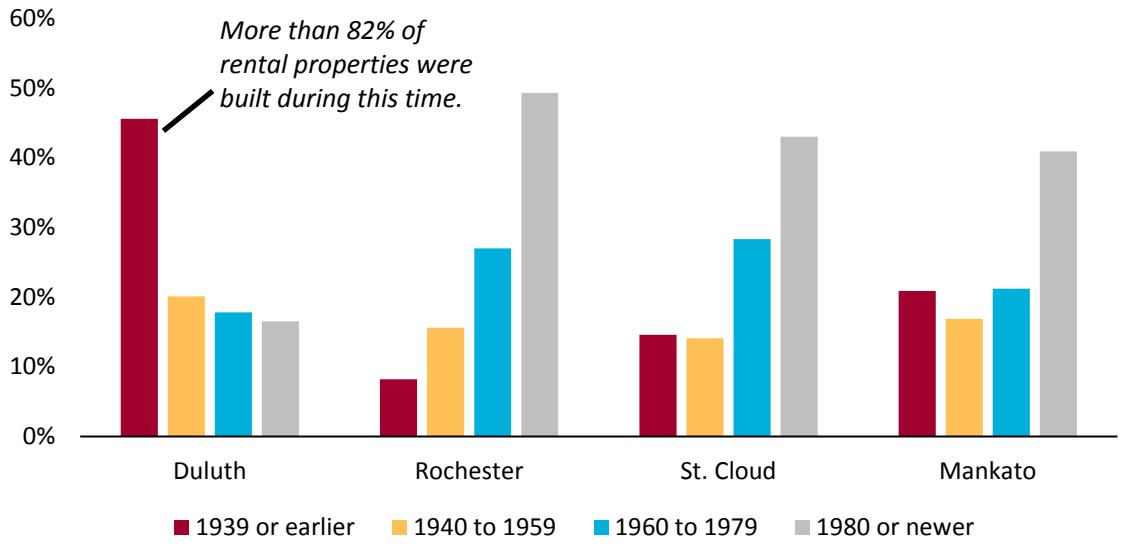
Since the 1950s, Duluth's population has declined from over 100,000 to the current level of 86,265 (see Table 2) (U.S. Census Bureau 2014, City of Duluth Community Development Division 2015). While there has been a drop in population, the city has seen a slight increase in the number of households during that same period. This is likely due to a decrease in average household size. The average household size in Duluth was approximately 2.24 individuals in 2013 compared with 2.9 individuals in 1950 (U.S. Census Bureau 2016). While the overall population in the city of Duluth is not expected to grow signficantly in coming years, the city is expected to continue to see growth in the demand for new housing, particularly new rental housing (Maxfield Research 2014). From 2014-2020, Maxfield Research predicts Duluth will need an additional 180 units per year for market rate rentals, 200 units per year for workforce rentals, and 212 units per year for deep subsidy rentals. This is driven largely by a growth in the number of smaller households, which are comprised of smaller families, an increase in single individuals, and an aging Baby Boomer population.

Housing Statistics

The Duluth rental housing market is unique in many ways, including a very old housing stock and low vacancy rates. This puts tenants at a disadvantage when it comes to finding affordable, energy efficient rental housing. The city's climate also creates an additional burden for renters who pay for utilities, as monthly expenses can spike in winter months. This section looks at how these factors affect renters locally.

[4] Table 2, from the City of Duluth 2014 Housing Indicator Report was updated with 2014 data using the U.S. Census Bureau, 2010-2014 American Community Survey 5-Year Estimates

Figure 1. Age of All Housing Stock: City Comparison



SOURCE: AMERICAN COMMUNITY SURVEY (2014)

Duluth has a housing stock that is older than that found in most Minnesota cities. As shown in Figure 1 above, 45% of Duluth's housing stock (17,255 housing units) was built prior to 1940, and roughly 17% of Duluth homes were built after 1980. By comparison, Rochester, St. Cloud, and Mankato, Minnesota only have a small share of homes built before 1940, with a significant share being built after 1980. Duluth's older housing stock poses a greater challenge when it comes to improving the energy efficiency of the city's rental housing.

Duluth is also unique in its availability of rental properties, as measured by its rental vacancy rate. According to the 2014 American Community Survey, Duluth had the lowest rental vacancy rate of the four cities, at 3.8%. By comparison, St. Cloud had the highest vacancy rate, measured at 7.1%, followed by Mankato (6.3%), and Rochester (5.8%). Nationally, the rental vacancy rate was 6.9% (U.S. Census Bureau 2014). And there is reason to suggest that 3.8% may actually be an overestimate of the true vacancy rate in Duluth. A 2014 rental survey conducted by the city of Duluth estimated that 3.1% of rental properties were vacant (City of Duluth Community Development Division 2015). It is commonly thought that a vacancy rate of 5% or less favors landlords, while rates above 5% favor renters (Parli 2014), (Hagen 2010). This is an important consideration when developing a program that addresses the split incentive, as it means that landlords will have less incentive to participate in a program if vacancy rates are low. Later, in Chapter III, the results of the tenant and landlord surveys show how low vacancy rates might impact program considerations.

Low vacancy rates tend to correlate with higher monthly rental costs (Belsky 1992). According to 2010-2014 American Community Survey 5-year estimates, Duluth's monthly rent was about average ($726) compared with Mankato ($730), St. Cloud ($708), and Rochester ($801). However, results from the City of Duluth's 2014 Rental Survey show that average monthly rent in the city has risen steadily over the past ten years, from $572 in 2002 to $757 in 2014 (City of Duluth Community Development Division 2015). This could be the result of low vacancy rates during that same time period. Vacancy rates in Duluth were below 5% in nine of the 13 years from 2002 to 2014 (City of Duluth Community Development Division 2015).

Table 3. Rent by Who Pays Utilities

Unit Type	*Utilities Paid By*	*Total Units*	*Average Rent*	*Vacancy Rate*	*Difference in Owner vs. Renter Paid Utilities*
Studio/Efficiency	Owner	179	$512	2.2%	$79
	Renter	4	$433	0.0%	
1 Bedroom	Owner	722	$764	3.9%	$224
	Renter	52	$540	3.8%	
2 Bedroom	Owner	633	$812	3.2%	$182
	Renter	83	$630	7.2%	
3 Bedroom	Owner	56	$980	5.4%	$193
	Renter	48	$791	6.3%	
4 Bedroom	Owner	5	$1,192	0.0%	$292
	Renter	16	$900	12.5%	

SOURCE: CITY OF DULUTH 2014 HOUSING INDICATOR REPORT (2015)

Among renters, there is significant demand for smaller units with owner-paid utilities. Table 3 shows some of the findings from the 2014 City of Duluth rental survey,[5] which highlight the differences in rental costs and vacancy rates by unit size and owner- versus renter-paid utilities. While monthly rent is always higher when utilities are included in the cost of rent (owner-paid utilities), vacancy rates are almost always lower, suggesting that renters prefer to pay the additional cost for utilities in their rent, rather than in direct monthly payments to utility companies. The largest vacancies are in larger residences, particularly those with renter-paid utilities.

Of course, climate is an important consideration in utility costs, as well. According to results from the 2009 RECS, 55% of home energy use in cold/very cold climates went to heating and cooling. Nationally, this percentage is roughly 48% (U.S. Energy Information Administration 2012). This difference is likely due to the extreme winter temperatures in the region, which regularly average single-digit temperatures during the months of January and February (U.S. Climate Data 2016). In fact, over the past three years, Duluth reported 1,000 more heating degree days[6] than St. Cloud, 1,500 more than Mankato, and nearly 2,000 more than Rochester (Weather Underground 2016).

An older housing stock, large rental market, and cold climate all suggest that the split incentive has a larger impact on Duluth's renters than is typical in other parts of the state and country.

[5] Results from the 2014 rental survey are based on responses from property owners and managers. The responses include 1,807 units, accounting for approximately 12% of the total market rate rentals in Duluth. For more details on the survey responses, including the number of responses by type of unit, review the City of Duluth 2014 Housing Indicator Report.

[6] Heating degree days are indicators of household energy consumption for space heating. The measure is computed by averaging the high and low temperatures for each day and comparing that value to a standard temperature (e.g. 65 degrees) typical for indoor comfort

Potential Household Energy Savings

Along with the potential energy savings and environmental benefits that could be gained by eliminating the split incentive issue, there are a number of potential economic benefits, the most obvious being reductions in energy bills for tenants and/or landlords. The purpose of this section is to quantify the potential household energy savings that could result from the elimination of the split incentive. To do so, estimates collected from existing literature combined with local and national data sources were used to calculate the potential cost savings to renters and property owners resulting from eliminating or reducing the split incentive within Duluth's rental properties.

According to the RECS, the average annual energy expenditure per household in the Midwest region was $1,981 in 2009 (U.S. Energy Information Administration 2012). However, this amount varies widely by region, resident type, and ownership. In order to estimate the average amount for Duluth, the average of two values was used: The annual energy expenditure for the "very cold/cold" climate region ($1,986) and the average annual expenditure for rented housing units ($1,429). This gives an estimated value of $1,708 spent annually on energy expenditures among Duluth rental properties. Adjusted to 2016 dollars, the amount is closer to $1,905. Using this estimate ($1,905), the total amount spent on energy expenditures by Duluth renters is calculated to be $27.2 million annually.[7]

Table 4. Potential Energy-saving Improvements

Area of Improvement	*Improvements*	*Potential Savings*
Heating/Cooling	Programmable thermostats Conversion of an older furnace or boiler Adequate tree shading Upgrade insulation	$750
Lighting	Light-emitting diode (LED) lightbulbs	$103
Appliances	Energy Star appliances	$71
Water Heating	1.5 gallon/minute showerheads Tank wrap insulation Water heater temperature of 120°F	$33
Total		$957

SOURCE: PIVO 2012, U.S. DEPARTMENT OF ENERGY 2016

The U.S. Department of Energy has an online tool that allows users to estimate potential yearly energy savings based on their location and various housing characteristics. Using the default values for the city of Duluth,[8] the tool estimates a potential annual savings for a Duluth household at $957, or 45-50% of annual energy costs. The potential savings for each of the categories is shown in Table 4, above, as well as some of the most common recommendations for achieving the savings (U.S. Department of Energy 2016). Pivo (2012) also examines a variety of energy-saving improvements that could reduce energy consumption in rental properties. He finds that the largest savings (21.5% annually) could be earned through the installation of

[7] The average annual expenditure ($1,905) multiplied by the total number of rental households (14,293)
[8] The numbers shown in Table 4 are based on the Duluth zip code of 55812, however other zip codes within the city yielded similar, if not identical, results

programmable thermostats.[9] Other significant savings opportunities include the replacement of older appliances with Energy Star models, conversion of an older furnace or boiler, and adequate tree shading. Combined, his study calculated a potential annual household savings of 48.5%, very close to the estimate given by the U.S. Department of Energy.[10]

Table 5. Potential Savings to Duluth Renters from Eliminating the Effects of the Split Incentive

	Potential Savings Per Household (2016 dollars)	*Savings % (based on annual energy costs of $1905)*	*Total Savings All Renters (2016 dollars)*
Scenario I (Highest potential household savings)	$957	50%	$13,678,401
Scenario II (Lower potential household savings)	$400	21%	$5,717,200

SOURCE: U.S. DEPARTMENT OF ENERGY 2016, PIVO 2012, U.S. CENSUS BUREAU 2014, BUREAU OF LABOR STATISTICS 2016

By extrapolating the average potential energy savings shown in Table 4 to all Duluth rental households, it is possible to approximate the total potential savings that could be achieved were the split incentive eliminated and rental properties were at peak energy efficiency. The city of Duluth contains approximately 35,548 occupied housing units, of which 14,293 (34%) are considered renter-occupied (U.S. Census Bureau 2014).[11] Assuming every rental household in the city of Duluth were to achieve the full potential savings of $957 annually by implementing the recommendations shown in Table 5, the combined savings city-wide would total nearly $14 million annually in energy expenditures (see Scenario I, Table 5).

Of course, this is likely an overstatement of what is actually achievable. The majority of renter-occupied households reside in multi-family units (U.S. Census Bureau 2014), which have lower achievable efficiency potential (Pivo 2012). Therefore, a second scenario, estimating a slightly lower potential household savings was included. Even assuming a low-range estimate of $400 of potential annual savings per household,[12] the potential city-wide savings to renters and property owners resulting from the elimination of the split incentive would total nearly $6 million.[13]

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[9] Programmable thermostats only yield potential savings if used properly. Minnesota's Center for Energy & Environment (2009) recommends setting temperatures back eight degrees overnight and while residents are at work to achieve maximum savings.

[10] The U.S. Department of Energy website estimates $2,053 in annual energy costs, which yields a slightly smaller percentage of annual savings (47%) than what would be expected based on the estimate used in this analysis, assuming $1,905 in annual energy costs and 50% annual savings.

[11] In Chapter 2, the analysis of the St. Louis County Assessor's Office data on residential properties in the City of Duluth yields a slightly different count of properties and rental units. That discrepancy is likely due to how the properties are counted. The Census counts each housing unit (house, apartment, and/or individual living quarters), while the Assessor's Office data file contains a listing of each property or parcel, which can include multiple housing units.

[12] In his 2012 study, Pivo used a low estimate of $376 in potential savings, measured in 2011 dollars. The $400 potential savings per household is based on that estimate, inflated to 2016 levels.

[13] It should be noted that these potential household energy savings calculations do not factor in the costs required to achieve such savings. In many cases, the initial costs may be greater than the initial yearly savings, and the payoff period may be a number of years. For more information on payback time and estimated return on investment, see the U.S. Department of Energy's Home Energy Saver website (http://homeenergysaver.lbl.gov/consumer/).

Program Considerations

Many of the studies reviewed provided suggestions for reducing or eliminating the split incentive. These suggestions ranged from a simple monthly energy usage report for landlords and tenants to government mandated energy efficiency standards. Most of the recommendations fell into one of three categories: subsidies, regulations, or increased access to information. This section summarizes the most common recommendations from the literature. In addition, some alternative local program considerations are discussed, particularly as they relate to student renters.

Subsidize Investments in Efficiency

Many researchers discussed program and policy recommendations that subsidize energy efficient investments for landlords and/or homeowners. Carliner (2013) discussed subsidies in great detail, classifying them into two categories: government and utility-delivered subsidies. He indicated that subsidies can bridge the gap between the value of savings to tenants and the value to property owners who do not pay the energy bills. Government subsidies typically come in the form of tax credits, while utility subsidies tend to promote energy efficiency by offering rebates, providing free energy audits, or subsidizing structural improvements. However, both government- and utility-delivered subsidies tend to focus on single family, owner-occupied homes and commercial buildings. Programs that specifically address the split incentive and energy efficiency in rental properties are limited. In his 2009 study, Davis (2009) suggested a rebate program to incentivize landlords to replace outdated appliances with new, energy efficient models. Such rebates would bring the purchase price of an Energy Star appliance closer to that of a less expensive model.

Regulations

Regulations are another common strategy for improving energy efficiency standards. However, Carliner (2013) discussed some of the challenges with this tool. Building codes are the most common regulation affecting energy efficiency, as they set standards for the construction of new buildings and structural improvements to existing buildings. However, building codes are adopted at the local or state level, which means they vary regionally. The International Code Council was established to provide some universal guidance and consistency to this issue (the International Energy Conservation Code being the model specifically targeting energy requirements). However, in most cases, local governments use the "I-codes," as they are commonly referred to, as guidelines, picking and choosing the aspects that appeal to them rather than the complete set of regulations.

While building codes can be effective, improving energy efficiency through them is a slow and expensive process (Carliner 2013). Since these regulations only apply to new construction or improvements, older homes or homes that haven't been updated after the latest codes were adopted would not be expected to meet the required standards. And higher standards in energy efficiency increase construction costs for new buildings, which typically translates into higher rents.

Another type of housing regulation that could be effective in addressing the split incentive is the disclosure of information about properties that are sold or leased. A program requiring the disclosure of energy efficiency information along with the rental lease agreement could have positive results, by sharing critical information regarding the property's energy efficiency with potential tenants. Gillingham (2010) suggested requiring landlords to disclose information about the quality of the unit's insulation on rental leases. Moreover, in his 2013 study, Carliner described a handful of communities (Austin, Texas; New York; and Seattle among them) that have enacted such regulations, which include requirements for energy audits, benchmarking, and/or disclosure for multifamily rental units.

Figure 2. Austin Energy Guide, 2016

2016

Austin City Code Chapter 6-7, Energy Conservation

ENERGY GUIDE

FOR PROSPECTIVE TENANTS

ESTIMATED MONTHLY ELECTRIC COST **$100**

$40 — Austin Average — $280

THIS PROPERTY

This graph above represents the range of electric costs for Austin properties of a similar type to this one.

This property is:

- all electric
- built before 1985
- 800 sq. ft. average apartment size

Cost information:

- is based on this facility's average size apartment,
- based on a cost of $0.10 per kWh, and
- is updated annually.

1,200 kWh

ESTIMATED MONTHLY ELECTRIC USE

For details, visit the web site austinenergy.com/go/ECAD, call 482-5278 or see QR Code:

YOUR BILL

Your actual bill will depend on many factors:

- Weather (bills are higher in extreme heat and cold – especially if electric heat is used),
- Thermostat settings,
- Number of occupants,
- Lifestyle habits,
- Size and location of unit (upper floors and south and west facing units are generally warmer),
- Energy efficiency measures in place, and
- Age and type of heating/cooling equipment.

ENERGY AUDIT RESULTS FOR THIS PROPERTY:

4321 APARTMENT AVENUE, AUSTIN, TX 78700

STREET ADDRESS

ENERGY EFFICIENCY MEASURES EVALUATED	AUSTIN ENERGY RECOMMENDS	AUDIT RESULTS (AVERAGED)
Air Duct System	Less Than 15%	12% Leakage
Attic or Roof	Between R22–R30	R-26
Solar Screens or Window Film	On all East, South and West Windows	Complete

"Average" values are calculated from results obtained from multiple buildings and systems.

CONSTRUCTION YEAR: 1978, 1982 ENERGY UTILITIES: All Electric ENERGY AUDIT CONDUCTED BY: A Qualified Auditor

NUMBER OF UNITS: 57 DATE OF ENERGY AUDIT: September, 2011 DATE OF DISCLOSURE NOTICE: June 16, 2016

I acknowledge that I have been given an opportunity to review the results of this multi-family property's energy audit conducted in accordance with Austin City Code, Chapter 6-7.

Signature/Date

Owner's Representative

Signature/Date

SOURCE: CITY OF AUSTIN 2016

Access to Information

One low-cost consideration for reducing the effects of the split incentive is simply providing landlords and tenants with more information to help them make informed decisions about their housing choices. As mentioned previously, some communities have enacted regulations that require disclosure statements for multifamily rental units. Austin, Texas, has developed an "Energy Guide" for prospective tenants (see Figure 2) that could be used as a model for a potential rental program (City of Austin 2016). The guide provides tenants with information on the estimated monthly electric cost (and how it compares with the city average), energy audit results, and some general property details. Moreover, some research has shown that customers who receive information on their neighbors' energy consumption were more likely to cut back on their own use, particularly for those households that have the highest levels of use (Ayres 2009).

Green Leases

Green leases provide an opportunity for both landlords and tenants to profit, while also using less energy, thus reducing energy costs. These modified leases are the most commonly examined alternative throughout the literature, particularly in terms of solutions that address the split incentive issue at the individual level. In a green lease agreement, landlords make energy efficient improvements to their rental properties while also raising rent to gradually recover the cost for those improvements. If landlords increase rent by a slightly smaller amount than the energy saving improvements provided, tenants also benefit. Although renters would be paying a higher rent, they would actually be saving money due to not outlaying more money in energy expenses. For example, if an improvement to a dwelling provides $50 of monthly energy savings, landlords could increase the rent amount by $40. This would result in $10 of monthly savings for tenants. In the end, landlords could increase their profits and tenants could increase their savings; a win for both parties.

Green leases have been implemented nationally, primarily in the commercial sector. The difficulty with green leases is that they have not been widely implemented in multi-family units; a property type which offers a great potential for savings. The Natural Resources Defense Council's Energy Efficiency Lease Guidance highlighted three principles that can help guide conversations about green leases.

- The landlord should operate the building and the tenant should operate its premises as efficiently as possible.
- For any given system, installation, or piece of equipment, the responsibility for the capital expense and the benefit of savings should reside with the same entity. Alternatively, all of the savings achieved by virtue of a system improvement should be available to pay for the improvement.
- To the extent feasible, both consumption and demand for resources throughout the building should be measurable and transparent to both the landlord and the tenants.

Student Participation

Many of the suggestions highlighted in the current literature focus on large-scale strategies (policy changes, regulations, city-wide initiatives). However, very little research provided examples of small-scale programs that address the problem or programs designed to serve a specific population, such as college students.

A search for student-focused initiatives did reveal one program, at the University of Oregon, that has attempted to reduce energy use in rental properties. The program, called Student and Community Outreach on Renter Efficiency ($CORE), was enacted in 2012. This student-run initiative focuses on small, easy changes that can help student renters save money. The installation of CFL light bulbs, pipe insulation, and low-flow shower heads are just a few examples of ways that the $CORE program has reduced utility bills for University of Oregon students. To attract student involvement in the program, coupons for free pizza were given out as an incentive for participation in an energy audit (Christie 2013).

Despite the lack of formal research on student-focused programs, many potential program characteristics came up during focus group conversations with landlords and tenants.[14] Some characteristics were not directly related to energy consumption but could serve as a way to attract participants to a potential program. The suggestions are listed below and were used as guidance in survey development:

- Criteria for student renters to participate in program (e.g. GPA, year in school)
- Mandatory training for renters on how to be a responsible tenant
- Monitoring service for property owners (e.g. check-in on property twice per year)
- Free training on tenants' rights, laws, and protections
- A website tool for finding energy efficient properties
- A "Rate my Apartment" style website for property and landlord characteristics (e.g. landlord reputation, safety)
- A third-party service for addressing landlord concerns (e.g. legal services, mediation)
- A third party to discuss energy audit opportunities with landlords

Summary

Empirical research has shown that the split incentive changes landlord and tenant behavior in various ways, depending on who pays for utilities. When landlords pay, properties are typically more energy efficient, but tenants are more likely to overuse. When tenants pay, they are more conservative with their energy consumption, but properties tend to have fewer energy efficient features. Both scenarios lead to higher levels of wasted energy and highlight the difficulties associated with conserving energy in rental properties.

The populations of students and low-income households are the most affected by the split incentive issue. Due to the inelasticity of home energy use, energy is a necessity not affected by increases or decreases in income, low-income households are highly impacted by high energy costs. Moreover, these households typically have lower rents and, thereby, less efficient features. Duluth has almost twice as many residents with income below the poverty line than the state of Minnesota.

With its three large universities, Duluth has a large population of young adults; over one quarter of the city's residents are between the ages of 20 and 34. This population group is typically more likely to rent housing. In fact, <u>only 10% of households under the age of 24 did NOT rent in Duluth</u> in 2014, and Duluth's households in the category of ages 25 to 34 were split between renters and non-renters.

However, Duluth's large contingent of low-income and student renters is faced with a dilemma. Duluth's aged housing stock means, presumably, that many of its rental properties are energy inefficient. Coupled with the area's harsh winters, necessitating that more than half (55%) of a household's energy expenses are for heating and cooling as compared to only 48% nationally, the split incentive causes even more concern.

Therefore, when looking at ways to improve the energy efficiency of a rental property, it was found that seven energy-saving improvements, some of which are not as costly as others, could cut the energy bill for a property in half, when combined. Even if just some of the improvements were made, potential city-wide energy savings resulting from the elimination of the split incentive could be near $6 million.

To assist with making the energy-efficient improvements, options to consider for elimination or reduction of the split incentive issue include subsidies/rebates, disclosure of rentals' energy efficiency, education and access to information, Green Leases, and a joint program for students and landlords.

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[14] Focus groups were conducted prior to administering the landlord and tenant surveys to test the effectiveness of the two survey instruments.

Chapter II

In this chapter, local property and energy consumption data are used to examine the rental housing market within the city of Duluth. Specifically, the purpose of this chapter is to determine which properties Duluth renters are most likely to inhabit, whether those properties tend to use more energy, and whether student renters' consumption habits differ from other types of renters or homeowners. This information can help determine which populations may be most affected by the split incentive and which strategies might best address the problem.

The first section of this chapter, Property Characteristics, provides descriptive statistics for various characteristics of Duluth's housing stock, including the estimated market value (EMV),[15] age, and value per square foot. The section entitled Rental vs. Non-Rental Properties compares differences between renter- and owner-occupied properties and compares the results to findings from previous research. The third section compares properties in which students typically rent to those that serve non-student renters. Finally, the last section of the chapter focuses on energy consumption, with a smaller sample of properties. In addition, the spatial relationship between student housing, rental properties, and energy consumption are shown using a series of maps throughout the chapter.

Data for the study was collected from a variety of sources. The St. Louis County Assessor's office provided a dataset containing property characteristics for all Duluth properties, including property classification, age, and EMV. This dataset was combined with rental license information (City of Duluth Life Safety 2015), student addresses (University of Minnesota - Duluth 2015), and energy consumption (Minnesota Power 2016) (Comfort Systems 2016) to complete a full examination of the city's properties.

Chapter II Key Findings

- **Single family rental properties make up 55% of Duluth's rental housing options.**
- **The average age of Duluth's rental properties is 98 years, compared with 77 years for owner-occupied homes. Rental properties also have a lower average EMV per square foot than owner-occupied homes.**
- **Owner-occupied single family properties have higher average monthly electricity use per square foot, compared with renter-occupied single family properties. This could be the result of higher household income levels among homeowners.**
- **Students tend to choose properties that are larger, have more bedrooms, and have a higher total EMV (the higher market value is due to the larger size of the properties).**
- **In apartments, electricity consumption was lower in student-occupied buildings than in other rentals, possibly the result of students being more likely to reside in apartment buildings that are newer and larger.**
- **Overall, electricity consumption appears to depend more on household size and tenant behavior, while natural gas usage likely depends more on property characteristics, such as insulation, age, and size.**

[15] A property's estimated market value is used by the state to estimate each property's proposed taxes payable for the year. Assessors use property characteristics, historical sales data, and information on the state of the housing market to determine the market value for each property.

Property Characteristics

Real estate data for the city of Duluth is available from the St. Louis County assessor's office. This data contains the property classification (e.g. residential homestead, duplex/triplex), age of structure, and values for all properties within the city. This dataset, in conjunction with rental license and student residence data, was used to identify unique characteristics of Duluth's housing market and to differentiate various residence types including renter-occupied, student-occupied, or owner-occupied properties.

Table 6. Descriptive Statistics of Duluth Properties

	N	*Minimum*	*Maximum*	*Mean*	*Std. Dev.*
Land Estimated Market Value (EMV)	25,583	$1,400	$1,496,000	$31,933	$31,663
Building EMV	25,583	$100	$6,694,900	$134,979	$172,821
Total EMV	25,587	$3,500	$6,791,800	$166,885	$191,599
Above Ground Square Feet	25,584	308	594,048	1840	6502
Age	25,532	1.0	150.0	80.8	30.3
Rental (0=no, 1=yes)	25,587	0.00	1.00	0.18	0.38
Number of bedrooms/units	24,150	1.0	160.0	3.3	0.4
Apartment (0=no, 1=yes)	25,587	0.00	1.00	0.02	0.14
Single family (0=no, 1=yes)	25,587	0.00	1.00	0.90	0.30
Multi-Family (0=no, 1=yes)	25,587	0.00	1.00	0.08	0.26
Student (1=student lived at address in past 3 yrs)	25,587	0.00	1.00	0.09	0.29
Value Per Square Foot (Building EMV / Sq Ft)	25,581	0.02	1,235.4	86.6	34.2
Valid N (listwise)	24,091				

SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, CITY OF DULUTH LIFE SAFETY DEPARTMENT, UMD ITSS

Table 6 provides a look at the variables included in the assessor's data file. The complete list of properties totaled just over 25,000 records (n=25,587). Each record uniquely identifies a parcel of land in the city with a parcel identification number (PIN). In some instances, a parcel[16] may be home to multiple buildings. Similarly, rental license information was only provided at the parcel level (identified by a PIN) Therefore, in situations where there were multiple buildings on one parcel, all values (bedroom count, EMV, square feet) were aggregated to the parcel level. It is worth noting that in Chapter I, data from the U.S. Census Bureau reported more than 35,000 occupied housing units, roughly 14,000 of which were considered rental-occupied. That discrepancy is likely due to how the properties are counted. The census counts each housing unit (house, apartment, and/or individual living quarters), while the Assessor's Office data file contains a listing of each property or parcel, which can include multiple housing units.

Among the variables included in the dataset are the building EMV, the number of bedrooms/units,[17] year built, and square footage. The rental variable indicates whether the property has a rental license, according to Duluth's Life Safety Department. The student variable indicates whether a UMD student has lived at the

[16] Throughout this report, the terms parcel and property are used interchangeably, both indicating a piece of land containing one or more residential structures.

[17] The number of bedrooms/units variable was created using a combination of the St. Louis County Assessor's Bedroom Count variable and the City of Duluth Life Safety Office's Units variable. Both variables had large numbers of missing cases. In instances where the bedroom count was reported (n=24,150), that number was used. If Bedroom Count was missing, Units was used instead (n=632).

property at some point in the past three years, using data collected from the University of Minnesota-Duluth's student address records. For each variable included in the file, the table shows the minimum value, maximum value, mean, and standard deviation.

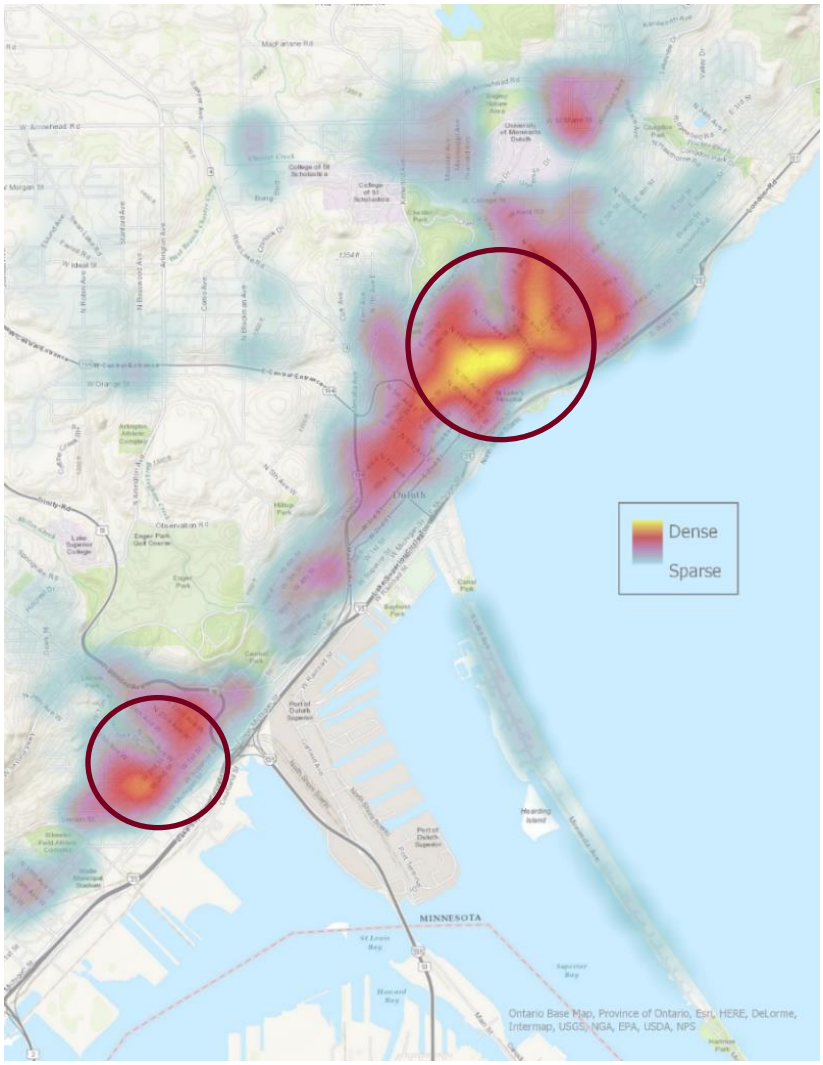
Because the file contains all properties in the city, from small, single family homes to very large apartment buildings, the range of values for many of the properties is, in some cases, very large. For example, the highest total estimated value for any parcel in the city is over $6.7 million, while the lowest value is estimated at $3,500. For the remainder of this analysis, comparisons will be with similar properties (apartments, multi-family homes, single family homes) whenever possible, so as not to skew the results.

Rental vs. Non-Rental Properties

The first step in better understanding the size and scope of the split incentive in Duluth was to examine various characteristics of the city's rental properties, particularly as compared with the city's owner-occupied properties. To accomplish this, a complete listing of rental licenses was collected from Duluth's Life Safety Department.[18] This list was then linked to the county assessor's dataset using the unique PIN.

[18] This listing contained all properties with a rental license, including subsidized rentals (i.e. Section 8 housing)

Figure 3. Rental Licenses, Geocoded



SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, CITY OF DULUTH LIFE SAFETY DEPARTMENT, UMD'S GEOSPATIAL ANALYSIS CENTER

Figure 3 shows all rental licenses, geocoded. The majority of the rental properties in the city are clustered around the Central Hillside and East Hillside areas between Sixth and Twenty-first Avenues East, and south of UMD and the Chester Park neighborhood. However, there is another significant cluster of rental properties in the westerly located Lincoln Park neighborhood, as well. Both clusters are shown in Figure 3, circled in red.

Table 7. Properties by Rental License, Assessor Type

	Non-Rental Properties	*Rental Properties*	*Total*
Apartments[19]	74	472	546
Multi-family (duplex / triplex)	402	1,541	1,943
Single family	20,632	2,466	23,098
Total	21,108	4,479	25,587

SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, CITY OF DULUTH LIFE SAFETY DEPARTMENT

Approximately 18% (n=4,479) of the 25,000 parcels in Duluth have a rental license (see Table 7). Of those 4,479 parcels, 472 are apartments, 1,541 are multi-family units (duplexes or triplexes), and more than 2,400 are single family[20] properties. The term single family, used throughout this study, refers only to the type of property and not its residents, which could be families, unrelated roommates, or some other combination.

Table 8. Results of Independent Sample T-Test for Various Property Characteristics, Rental vs Non-Rental

Property Characteristic	*Type*	*N*	*Mean*	*Statistical Significance*
Age	Non-Rental	21,067	77.2	0.000**
	Rental	4,465	97.7	
Building EMV	Non-Rental	21,108	$164,020	0.000**
	Rental	4,479	$180,388	
Value per square foot	Non-Rental	21,102	$91.17	0.000**
	Rental	4,479	$64.80	
Size (above ground square feet)	Non-Rental	21,105	1,486	0.000**
	Rental	4,479	3,508	
Number of bedrooms / units	Non-Rental	20,308	3.02	0.000**
	Rental	4,474	4.58	

*significant at the 95% level
**significant at the 99% level
SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, CITY OF DULUTH LIFE SAFETY DEPARTMENT

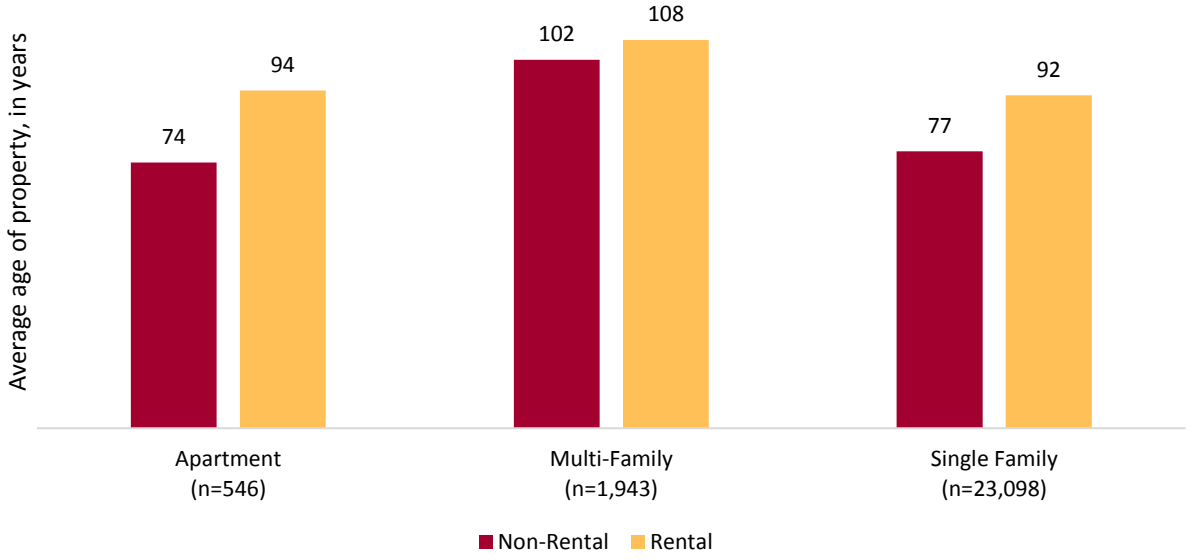
Table 8 shows the results of an independent sample t-test for the selected rental property characteristics. A t-test examines the mean, distribution, and degrees of freedom for both samples (rental and non-rental properties) and determines the probability that the population means differ. The results show that rental properties tend to be older, larger, and have more bedrooms than non-rental properties. Rental properties have, on average, higher estimated market values than non-rentals, but that difference appears to be

[19] According to the data, 74 properties classified as apartments in the assessor's dataset did not have rental licenses. Rather, the majority of these properties have operational permits for supervised living facilities. These permits allow for residents (elder care, disabled, chemical dependency, etc.), but the facilities don't operate as typical rental properties.

[20] In this study, single family properties include both residential homestead (n=18,851) and residential non-homestead (n=4,247) properties. While Minnesota law requires that a residential homestead property must be occupied and used for the purposes of a homestead by its owner, there is also an allowance in the law that states that a property can be considered a residential homestead if it is occupied by a relative of the owner. It is assumed that all of the residential homestead properties that have a valid rental license meet that criteria.

primarily the result of size. After controlling for the value per square foot, rental properties are of lower value. All results are statistically significant at the 99% level.

Figure 4. Mean Age of Housing Stock by Property Type, Rental Status

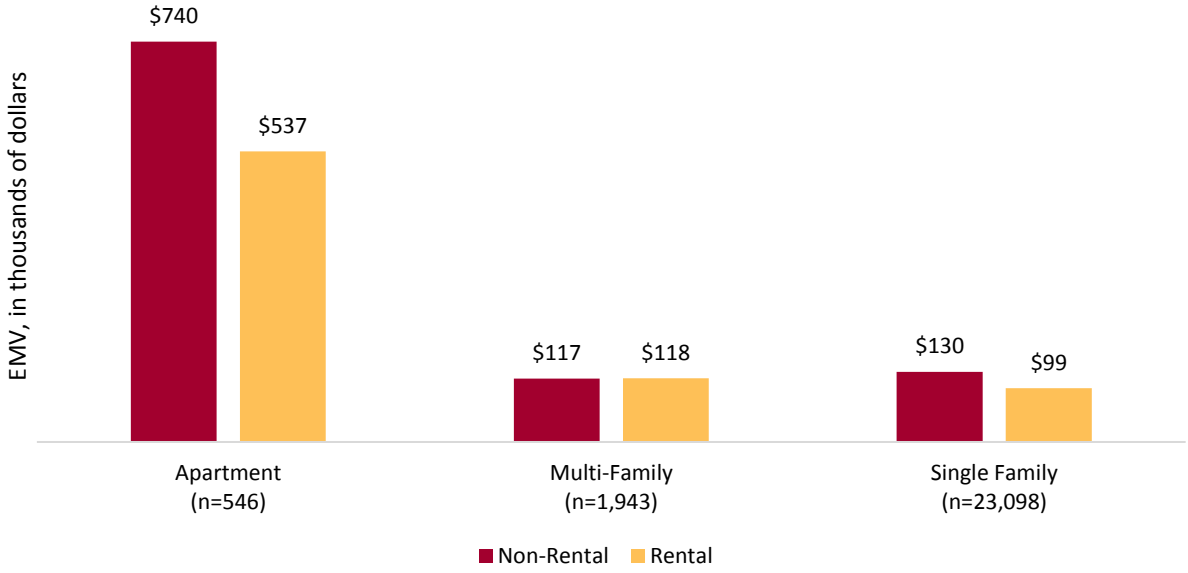


SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, CITY OF DULUTH LIFE SAFETY DEPARTMENT

Figure 4 - Figure 6 show more details for three of the property characteristics, breaking the results out by property type and rental status. Figure 4, above, highlights differences in age. In every case, rental properties tend to be older than similar, owner-occupied properties. Of the three groups, the oldest properties are typically multi-family units (duplexes and triplexes). Overall, the average age of all rental properties in Duluth was 98 years, while non-rentals averaged 77 years, as shown in Table 8, page 20.[21]

[21] This difference is statistically significant at the 99% level.

Figure 5. Mean Building Estimated Market Value (EMV) by Property Type, Rental Status



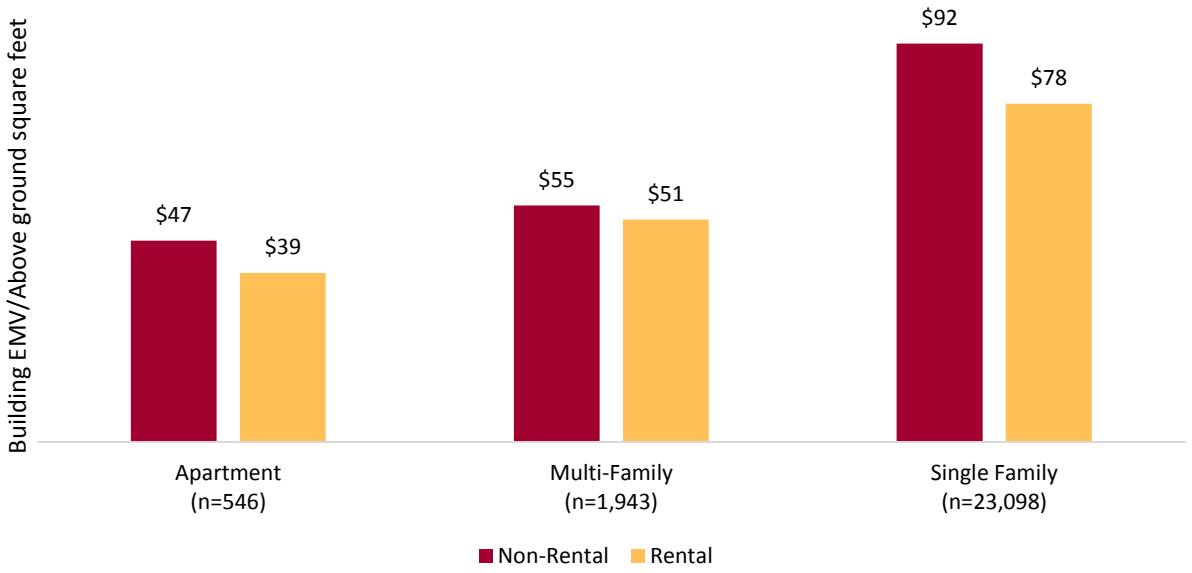
SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, CITY OF DULUTH LIFE SAFETY DEPARTMENT

Figure 5 shows the building EMV for each property type (apartments, duplex/triplex, single family) broken out by the property's rental status. In most cases, the rental property had a lower total EMV, although the results were very similar for duplexes and triplexes.

Not surprisingly, apartments have, on average, a much higher EMV than other residential property types. While average market values for single family properties range from $99,000 and $130,000 for rental and non-rental, respectively, the average value for apartment buildings was between $537,000 and $740,000. Overall, the average building EMV was slightly higher for rental properties ($180,000) than for non-rentals ($164,000) ,[22] although this average is most likely skewed by the higher estimated value of apartments, and the overwhelming majority of single family homes in the non-rental category.

[22] This difference is statistically significant at the 99% level, as shown in Table 8, page 20.

Figure 6. Mean Value Per Square Foot, by Property Type, Rental Status



SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, CITY OF DULUTH LIFE SAFETY DEPARTMENT

Because of the large variation in values depending on the size of the property, it can be helpful to look at the total EMV per square foot, rather than the total value overall. Figure 6 examines the mean value per square foot (Building EMV / Above Ground Square Feet) for the various property types broken out by whether the property has a rental license. After controlling for the size of the building, the graph clearly shows that, in all cases, rental properties have a lower average value per square foot than non-rental or owner-occupied properties. What's more, the figure shows that the property type with the highest average value per square foot is the single family home, followed by multi-family (duplexes and triplexes), and then apartment buildings. Overall, non-rental properties in the city averaged $91 per square foot, while rental properties had a value of only $65 per square foot.[23]

The results show that rental properties are typically older and have lower EMV per square foot than owner-occupied properties. Considering that small single- and multi-family units are the most common rental type in Duluth and typically have the fewest energy efficient features (Pivo 2012), this segment of the rental market could have the greatest opportunities for improvements in efficiency and comfort locally.

In 2005, the Energy Center of Wisconsin (ECW) conducted a comprehensive energy study that characterized 180 rental properties statewide, ranging from single family rental homes to large apartment buildings. The study included an on-site audit, a survey of tenant and owner behavior, and an analysis of historic utility usage for the properties. The level of detail and thorough methodology used in the ECW study provided an excellent framework for this study. Therefore, many of the methods and findings from the Energy Center of Wisconsin's study influenced this analysis, and the results of the ECW study provide a helpful comparison for this study's results.

According to the ECW's findings, Wisconsin's rental housing is categorized into three main types: single family, small multi-family (2-4 units), and large multi-family properties (i.e. five or more units). While the Duluth properties are classified in a slightly different manner (the multi-family classification used in this study

[23] This difference is statistically significant at the 99% level, as shown in Table 8, page 20.

contains duplexes and triplexes with 2-3 units) the findings are similar. The ECW study found that small rental properties (fewer than 5 units) represented a majority of the rental units throughout the state and more than 90% of the physical rental buildings. The situation is much the same in Duluth. As seen in Table 7, apartments represent only about 10% of the rental properties in the city, and the most common rentals in Duluth are single family units, which make up about 55% of the physical rental buildings.

The ECW study also found that single family and small multi-family rental properties tend to be older than similar owner-occupied properties. As mentioned previously, the same is true locally. Our results show that the average age for rental properties in Duluth was 98 years, more than 20 years older than the average age for owner-occupied properties (77 years) in the city.

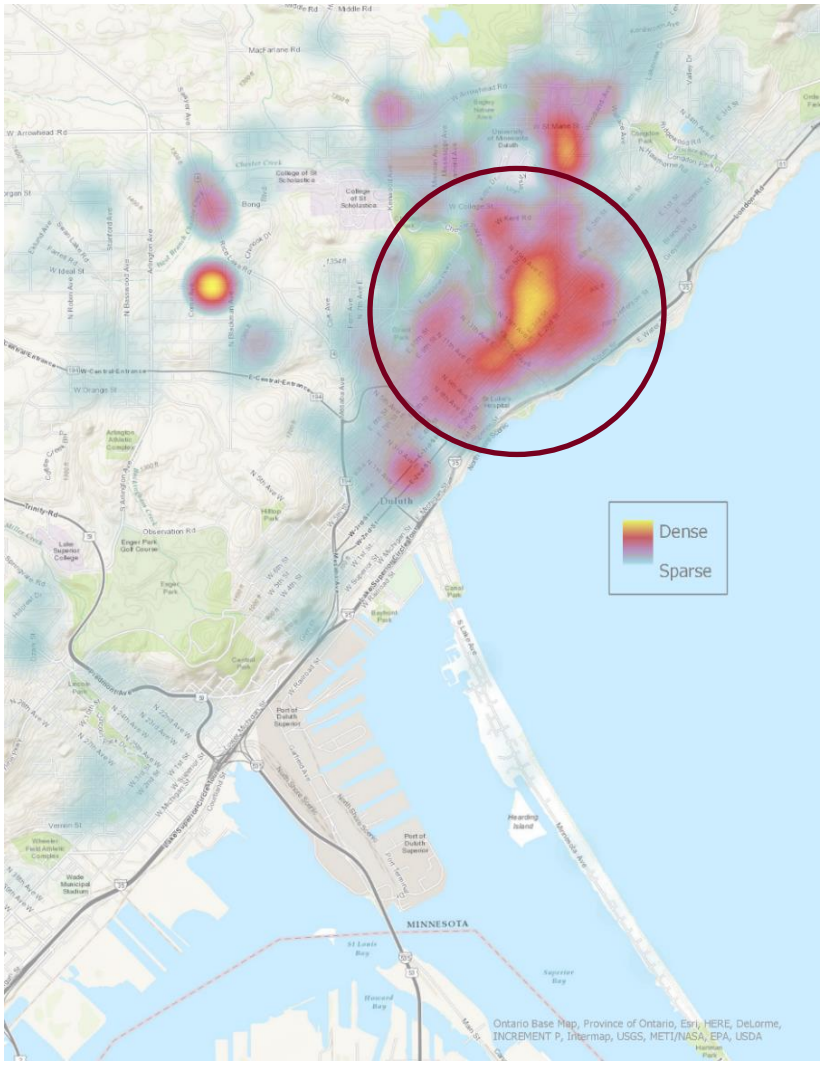
Finally, the ECW study found that single family and small multi-family rental properties tend to be more energy intensive than similar owner-occupied properties. In fact, the study found that small rental properties accounted for approximately 70% of all residential rental energy consumption. Later in the report, we examine the average energy consumption levels for the three property types in Duluth to see how they compare with the results of the ECW study.

Students vs. Non-Students

One of the areas of focus for this study is whether the split incentive issue impacts student tenants more severely than it does other renters, including low-income renters. This section provides a comparison of various attributes between student and non-student occupied rental properties throughout Duluth.

In order to identify typical student rental properties, a list of off-campus student addresses was collected from UMD's Information Technology office. This list was then geocoded and linked to the county assessor's dataset. If any student had lived at the address in the past three years, the property was flagged as a student rental. Of course, there are some problems with this method that should be mentioned. First, many students live with parents while attending school. If the student's parents rent their home or residence, then that property would be flagged as a student rental, even though it may not be a typical student rental property. Second, only UMD student addresses were used, so the sample is more heavily weighted to properties near that University. Third, there may be some unlicensed rental properties that are not included in the sample. Finally, multi-family rental properties (including apartments) would be flagged as a student rental even if the majority of tenants are non-students. Despite these challenges, the final sample of student rentals appeared to be a usable representation of student rental properties.

Figure 7. Student Residences, Geocoded



SOURCE: UMD GEOSPATIAL ANALYSIS CENTER, ST. LOUIS COUNTY ASSESSOR'S OFFICE

Figure 7 shows the physical location of the student residences. Clearly, a large portion of the student addresses are clustered in the same region as seen before, in the Central Hillside and East Hillside neighborhoods. However, it appears that students are less likely to reside in the rental neighborhood of Lincoln Park, perhaps due to its distance from the UMD campus.

Table 9. Rental Properties by Type (Student versus Non-student)

Rental Property Type	*Non-Student Properties*	*Student Properties*	*Total*
Apartments	276	196	472
Multi-family (duplex / triplex)	1,200	341	1,541
Single family	1,682	784	2,466
Total	3,158	1,321	4,479

SOURCE: UMD, ST. LOUIS COUNTY ASSESSOR'S OFFICE, CITY OF DULUTH LIFE SAFETY DEPARTMENT

Approximately 1,300 of the 4,400 rental properties in the city (30%) had at least one student live at the residence in the past three years, as seen in Table 9, previous page. Of these properties, nearly 60% were single family units.

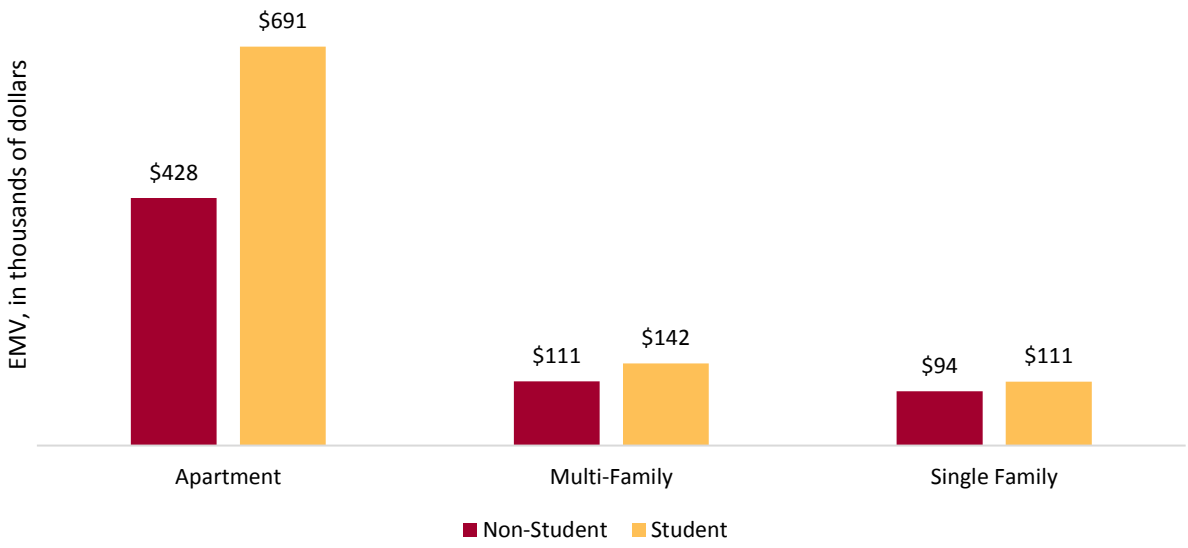
Table 10. Results of Independent Sample T-Test for Various Rental Property Characteristics

Property Characteristic	*Type*	*N*	*Mean*	*Statistical Significance*
Building EMV	Non-Student	3,158	$156,196	0.000**
	Student	1,321	$238,223	
Size (above ground square feet)	Non-Student	3,158	2,946	0.000**
	Student	1,321	4,854	
Value per square foot	Non-Student	3,158	$63.40	0.371
	Student	1,321	$68.16	
Age	Non-Student	3,148	98.7	0.083
	Student	1,317	95.4	
Number of bedrooms / units	Non-Student	2,759	3.56	0.036*
	Student	1,083	4.06	

*significant at the 95% level
**significant at the 99% level
SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, UMD ITSS, CITY OF DULUTH LIFE SAFETY DEPARTMENT

Table 10 shows the results of an independent sample t-test for the selected rental property characteristics. Comparing the mean values for some of the important property characteristics (EMV, size, value per square foot, age, and bedroom count) can help highlight the differences between the two types of rental properties. Rental properties in which students typically rent tend to be of higher value, larger, newer, and have more bedrooms/units. However, the only characteristics where the difference between average values are statistically significant are the total EMV, the size of the building, and the number of bedrooms/units.

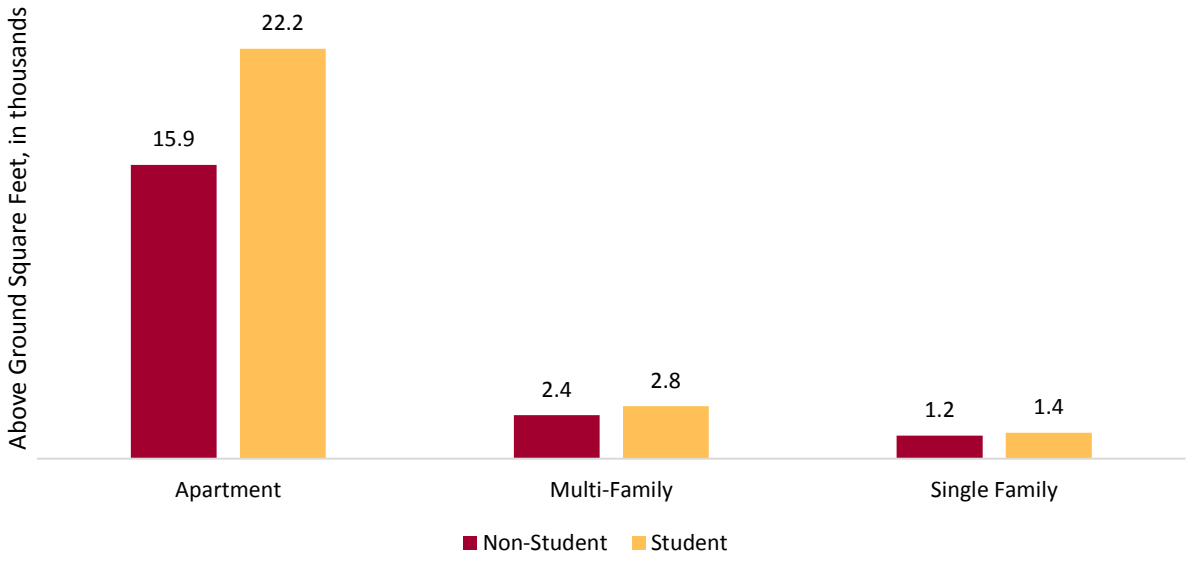
Figure 8. Building EMV by Property Type, Student Rental Status



SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, UMD ITSS, CITY OF DULUTH LIFE SAFETY DEPARTMENT

Figure 8 - Figure 10 show more details for three of the property characteristics, specifically those in which there was a statistically significant difference between the two populations. Figure 8, on the previous page, highlights differences in the building's EMV by property type and student rental status. In every case, student rental properties are of higher value than properties in which students don't typically reside.[24] Of the three groups, apartment buildings have the highest average value and exhibit the largest difference in means (student versus non-student properties). Multi-family and single family rental properties have much lower average values but still demonstrate the same results: properties in which students typically rent tend to have higher EMVs.

Figure 9. Above Ground Square Feet by Property Type, Student Rental Status

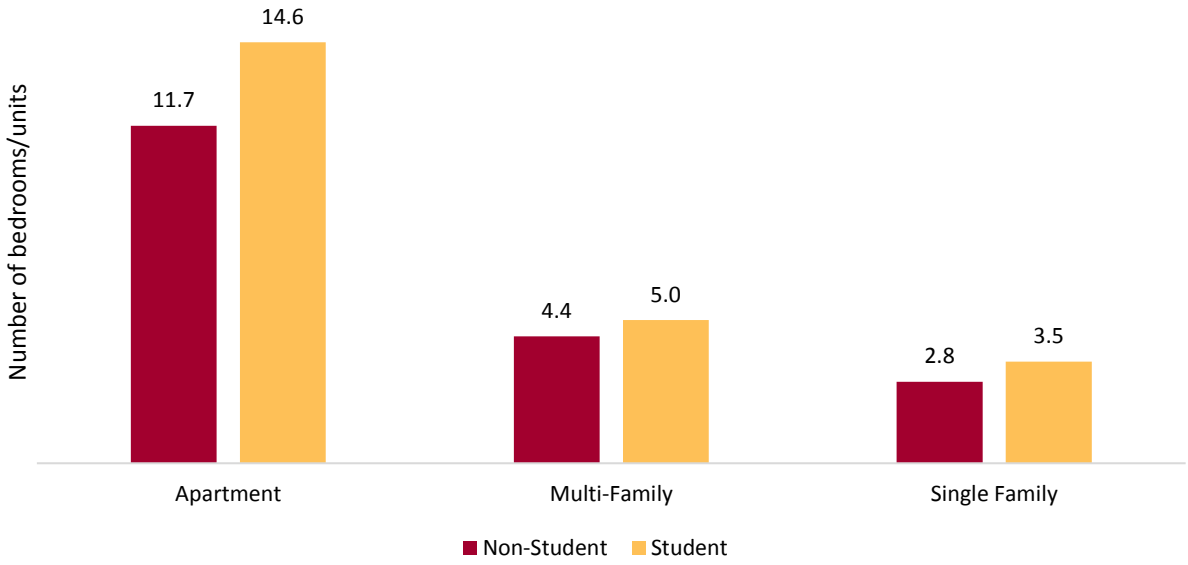


SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, UMD ITSS, CITY OF DULUTH LIFE SAFETY DEPARTMENT

Figure 9 provides more insight into the types of properties in which students are more likely to reside. In all cases, properties that typically house students tend to be larger, and the difference is statistically significant. This factor is also likely contributing to the difference in building EMV. Larger buildings tend to have higher EMV, which might explain some of the large differences seen in Figure 8.

[24] This difference is statistically significant at the 99% level.

Figure 10. Number of Bedrooms / Units by Property Type, Student Rental Status



SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, UMD ITSS, CITY OF DULUTH LIFE SAFETY DEPARTMENT

Finally, Figure 10 (previous page) shows the average number of bedrooms/units by property type and student rental status. Again, students tend to reside in properties that have more bedrooms and/or units, and the difference is statistically significant.

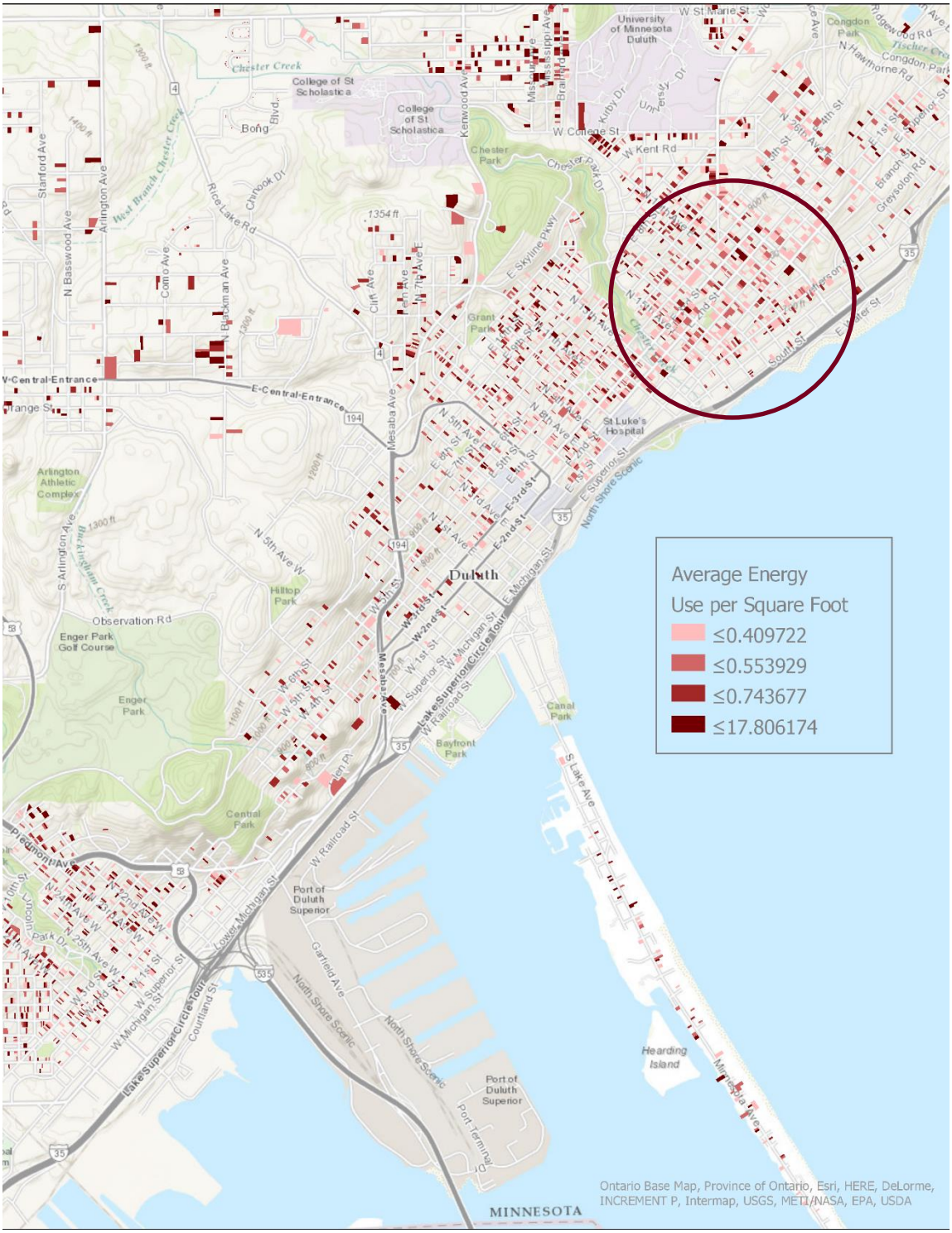
The results show that students tend to reside in properties that are larger, have more bedrooms, and have a higher total EMV. However, one interesting point to note is that once the EMV of the building is adjusted based on the size of the property (value per square foot), the difference between the two property types (student vs. non-student) is no longer statistically significant (see Table 10). This suggests that it may not be that students are necessarily residing in properties that are of higher value but are simply selecting larger properties. This is supported by the fact that students are also more likely to reside in properties with more bedrooms/units.

Energy Consumption

Data on monthly household energy usage was collected from local utilities and linked to the dataset containing property characteristics. To determine the sample used for analysis, our team selected the full population of rental properties (n=4,479) as well as a random sample of non-rental (i.e. single family, owner-occupied) properties for comparison (n=2,413). That population was then submitted to local utility providers Minnesota Power (electricity provider) and Comfort Systems (natural gas provider) for matching.

In some cases, data was geocoded to the correct address using the assessor pin, and in other cases, the data was linked by the property address. In the end, 3,891 properties were successfully linked with energy usage data, which contained monthly energy consumption for the three-year period from May 2012 to April 2015. This sample represents approximately 15% of all Duluth properties but is more heavily weighted toward rental properties.

Figure 11. Energy Use Per Square Foot



SOURCE:UMD GEOSPATIAL ANALYSIS CENTER, ST. LOUIS COUNTY ASSESSOR'S OFFICE, MINNESOTA POWER, COMFORT SYSTEMS, DULUTH LIFE SAFETY DEPARTMENT

Figure 11, on the previous page, shows the new sample, mapped by location. Lighter shades represent lower energy consumption per square foot, while darker shades represent higher energy consumption.[25] Interestingly, the area with the highest concentration of rental properties (circled) has lower average energy consumption per square foot. Many of the properties with higher energy consumption per square foot are clustered in more residential neighborhoods. For example, the area north of Hartley Park has a number of properties with higher than average energy consumption, as does the Lester Park neighborhood, located further north along Lake Superior.

Table 11. Descriptive Statistics, Duluth Properties with Energy Consumption

	N	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Land Estimated Market Value (EMV)	3,891	$0	$515,800	$27,041	$22,244
Building EMV	3,891	$5,400	$4,906,300	$133,225	$171,974
Total EMV	3,891	$19,200	$5,422,100	$160,266	$187,248
Above ground square feet	3,891	402	161,936	2,465	7,188
Age	3,883	3	145	91.5	27.1
Rental (0=no, 1=yes)	3,891	0	1	0.59	0.49
Number of bedrooms/units	3,849	0	152	3.84	4.63
Apartment (0=no, 1=yes)	3,891	0	1	0.07	0.25
Single family (0=no, 1=yes)	3,891	0	1	0.74	0.44
Multi-family (0=no, 1=yes)	3,891	0	1	0.20	0.40
Monthly electricity usage (kWh)	3,891	20.8	63,232.1	922.5	2,010.3
Monthly natural gas usage (CCF)	3,891	0.0	4,934.0	120.2	175.2
Monthly electricity usage per sq ft (kWh/SqFt)	3,891	0.0	17.26	0.51	0.40
Monthly natural gas usage per sq ft (CCF/SqFt)	3,891	0.0	0.67	0.064	.030
Valid N (listwise)	2,285				

SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, CITY OF DULUTH LIFE SAFETY DEPARTMENT, MINNESOTA POWER, COMFORT SYSTEMS

Table 11 shows the descriptive statistics for the sample of properties containing energy consumption data. Of note in the table are three key points: the sample size is much smaller than the original sample of Duluth properties, there is a much larger share of rental properties in the sample (59%), and it contains four variables (highlighted in orange) that are related to monthly energy consumption. The four energy consumption variables include the average monthly electricity usage in kilowatt hours (kWh), the average monthly natural gas usage in one hundred cubic feet (CCF), and the average monthly electricity and natural gas usage per square foot (kWh and CCF divided by the above ground square feet). [26]

[25] Units reflect the sum of monthly natural gas and electricity consumption.

[26] It should be noted that fuel oil consumption was not included in the energy consumption analysis, as no data source was available for that utility. This means that homes which rely on fuel oil for their primary heating source (roughly 6% of the city) will appear to have lower levels of energy consumption than homes heated by natural gas or electricity.

Table 12. Results of Independent Sample T-Test for Energy Consumption in Single Family Properties by Rental Status

Energy Consumption Measure	*Type*	*N*	*Mean*	*Statistical Significance*
Electricity Consumption (kWh/ Square Foot)	Owner-occupied	1,600	0.566	0.009**
	Rental	1,270	0.544	
Natural Gas Consumption (CCF/Square Foot)	Owner-occupied	1,600	0.064	0.554
	Rental	1,270	0.069	
Electricity Consumption (Sept-May)	Owner-occupied	1,600	0.585	0.008**
	Rental	1,270	0.578	
Natural Gas Consumption (Sept-May)	Owner-occupied	1,600	0.081	0.747
	Rental	1,270	0.088	

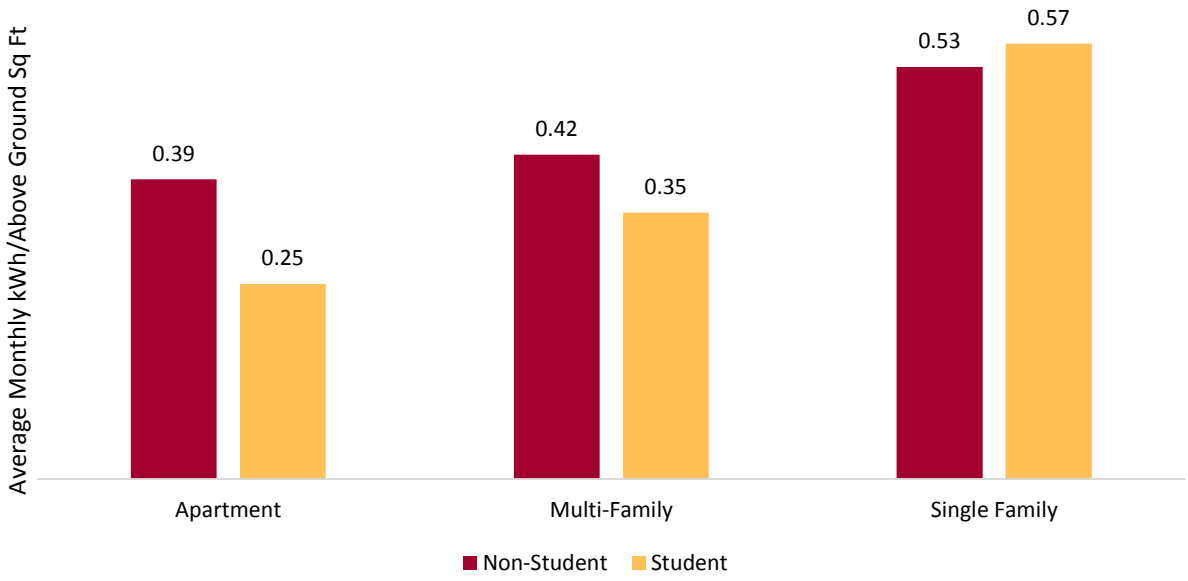
*significant at the 95% level
**significant at the 99% level
SOURCE: ST. LOUIS COUNTY ASSESSOR'S OFFICE, UMD ITSS, CITY OF DULUTH LIFE SAFETY DEPARTMENT

As mentioned previously, the sample used for this analysis included mostly rental properties, but it also included a small selection of owner-occupied single family homes to use as a comparison population. This allowed us to compare energy consumption in single family homes that are renter-occupied versus those that are owner-occupied. Results of this comparison are shown in Table 12. Comparing only this sample (single family properties), electricity consumption per square foot was higher in owner-occupied properties than rented properties, and the results were found to be statistically significant at the 99% level.

This is surprising, as it seems to contradict previous findings, which indicated that energy expenditures per square foot were highest in rented single- and multi-family units, while owner-occupied, single family units generally had the lowest energy expenditures per square foot (U.S. Energy Information Administration 2012). However, previous research also indicates that, for renters paying all utilities, median monthly energy payment for the lowest income households was $116 compared with $151 for the highest-income households (Carliner 2013). Therefore, the difference in usage may be an indication of the relative incomes and consumption habits of the occupants, rather than the energy efficiency of the property itself. Natural gas consumption, on the other hand, was lower in owner-occupied residences, which is in line with findings from previous research. The results, however, were not statistically significant.

One potential explanation for the significant difference in electricity use between owner-occupied and rental properties, specifically student rental properties, could be that many student rentals are vacant for the summer months, resulting in lower average monthly electricity consumption. To test this theory, average electricity consumption was calculated using only the months from September through May of each year. The third and fourth energy consumption measures in Table 12 show the average monthly electricity and natural gas consumption levels for the months September through May. As expected, the average usage is higher for both property types (owner-occupied, rental) when selecting only the months of September through May. And although the rental properties saw the largest increase, on average, between the two averages (0.03 kWh/Sq Ft more in electricity consumption, as compared with 0.02 for owner-occupied), the overall results are generally the same. Owner-occupied properties tend to use more electricity, while rental properties use significantly less. This suggests that the difference in energy consumption is not the result of students being gone for the summer but rather a characteristic of the property itself or the occupants' consumption habits. As mentioned previously, household incomes are likely a factor, as owner-occupied homes tend to have more appliances, such as dishwashers, air conditioning, DVRs, and dehumidifiers, that use a lot of electricity.

Figure 12. Electricity Use per Square Foot, by Property Type



SOURCE: MINNESOTA POWER, ST. LOUIS COUNTY ASSESSOR'S OFFICE, UMD ITSS, CITY OF DULUTH LIFE SAFETY DEPARTMENT

Focusing solely on the rental properties in the sample, consumption levels in both student and non-student rental properties were evaluated. Overall, the difference between the two groups was small, and results were not statistically significant. Student rental properties, on average, consumed 0.45 kWh/Sq Ft of electricity per month, compared with 0.48 kWh/Sq Ft in other rental properties. Natural gas consumption was, on average, 0.065 CCF/Sq Ft per month at both residences.

There were, however, some differences when breaking out the results by property type. In apartments, consumption was lower per square foot in student rentals than in other rentals. Electricity consumption, in particular, was much larger in apartment buildings that don't typically have student residents (see Figure 12).[27] This is likely due to differences between the two types of apartments. It appears that students are more likely to live in apartment buildings that are bigger and newer. Apartments that commonly have student tenants are, on average, ten years newer and about 3,000 square feet larger than those without.[28] Differences in consumption in multi-family and single family rental units were not statistically significant.

Linear Regression Results

To better understand which factors most influence energy consumption levels, two linear regressions were performed using monthly energy consumption as the dependent variables and various property and occupant characteristics as the predictive variables. Monthly price and weather data were also included

[27] And the difference was statistically significant at the 99% level.

[28] This is likely the result of several new apartment buildings constructed in Duluth in recent years, including the BlueStone, Summit Ridge, Boulder Ridge, and Campus Park developments, all of which are marketed to student renters.

along with annual and seasonal dummy variables to control for external factors that influence energy consumption. The results of these regressions are described here.

Table 13. Linear Regression Results - Avg Monthly Natural Gas Consumption (CCF) as Dependent Variable

Predictive Variable	Coefficient (B)	*Interpretation*
Constant	-130.73	
Building EMV ($1K USD)	0.45**	For every $1,000 increase in a building's estimated market value, a 0.45 increase in monthly CCF is predicted, holding all other variables constant. ***Higher value buildings have higher natural gas usage***
Age	0.55**	For every one-year increase in the age of a building, a 0.55 increase in monthly CCF is predicted, holding all other variables constant. ***Older buildings have higher levels of natural gas consumption***
Above Ground Sq Ft (hundreds)	0.13**	For every additional 100 square feet on a property, a 0.13 increase in monthly CCF is predicted, holding all other variables constant. ***Larger buildings are more likely to have higher levels of natural gas consumption***
Duplex/Triplex (0=no, 1=yes)	24.59**	Properties classified as duplexes or triplexes consume natural gas at a rate of 25 CCFs more per month, as compared with single family properties, holding all other variables constant. ***Multi-family properties have higher levels of natural gas consumption***
Apartment (0=no, 1=yes)	174.35**	Properties classified as apartments consume natural gas at a rate of 174 CCFs more per month, as compared with single family properties, holding all other variables constant. ***Apartments have higher levels of natural gas consumption***
Student Residence (0=no, 1=yes)	10.23**	Student residences consume natural gas at a rate of 10 CCFs more per month, as compared with non-student residences, holding all other variables constant. ***Student residences tend to have higher levels of natural gas consumption than non-student residences***
Heating Degree Days	0.10**	For every one additional heating degree day per month, a 0.10 increase in monthly CCF is predicted, holding all other variables constant ***Colder months require more natural gas consumption***
Winter (0=no, 1=yes)	77.25**	Properties consume natural gas at a rate of 77 CCFs more per month during winter months (Dec – Feb) as compared with summer and fall, holding all else constant. ***Winter months have higher levels of natural gas consumption than summer and fall***
Spring (0=no, 1=yes)	48.33**	Properties consume natural gas at a rate of 48 CCFs more per month during spring months (Mar – May) as compared with summer and fall, holding all else constant. ***Spring months have higher levels of natural gas consumption than summer and fall***
Year of 2013-2014 (0=no, 1=yes)	10.23**	Properties consumed natural gas at a rate of 10 CCFs more per month during the 2013-2014 year (May – Apr) as compared with 2012-2013, holding all else constant. ***The year 2013-2014 had higher natural gas consumption than the year 2012-2013***
Year of 2014-2015 (0=no, 1=yes)	5.93**	Properties consumed natural gas at a rate of 6 CCFs more per month during the 2014-2015 year (May – Apr) as compared with 2012-2013, holding all else constant. ***The year 2014-2015 had higher natural gas consumption than the year 2012-2013***
Rental (0=no, 1=yes)	--	
Adjusted R-Squared	0.420	
Standard error of the estimate	171.7	

*significant at the 95% level
**significant at the 99% level

SOURCE: COMFORT SYSTEMS, ST. LOUIS COUNTY ASSESSOR'S OFFICE, UMD, CITY OF DULUTH LIFE SAFETY DEPARTMENT

Table 13, on the previous page, shows the results of the regression with the average monthly natural gas consumption as the dependent variable. Independent, or explanatory, variables are shown in the left column. These include the building's estimated market value in thousands of dollars, the number of heating degree days for the month, the age of the building, and the size in square feet. Also included in the analysis were dummy variables for multi-family, apartment, and student residences. These variables were coded 1 if the property was classified within this category and 0 otherwise. Finally, seasonal and annual dummy variables were included.[29] The variable indicating whether the property was classified as a rental was dropped from the model as its coefficient proved not to be statistically significant.[30]

All of the variables shown in Table 13 are significant predictors of average monthly natural gas consumption. The results show that older residences, larger residences, and buildings with higher estimated market value tend to have higher levels of natural gas consumption. Multi-family residences and apartments tend to have higher levels of natural gas consumption than single family residences. Not surprisingly, some of the weather-related variables were statistically significant as well. Winter and spring months tend to have higher natural gas consumption than do summer and fall, and as the number of heating degree days increases, so does monthly natural gas consumption. Finally, student residences tend to have higher levels of natural gas consumption than non-student residences. These results are generally in line with national statistics, which indicate that multi-family units and renter-occupied units tend to have higher average energy expenditures than owner-occupied, single family units (RECS, 2009).

The final row in Table 13 shows the model's adjusted R-squared value (0.420). The R-squared value measures the proportion of the variation in the dependent variable (energy consumption) explained by the independent variables in the model. Adjusted R-squared adjusts the statistic based on the number of independent variables in the model. In this case, roughly 40% of the variation in natural gas consumption is explained by the variables shown in Table 13.

Table 14. Linear Regression Results - Average Monthly Electricity Consumption (kWh) as Dependent Variable

Predictive Variable	Coefficient (B)	*Interpretation*
Constant	-225.50	
Number of bedrooms/units	329.61**	For every additional bedroom or unit in residence, a 330 increase in monthly kWh is predicted, holding all other variables constant. ***Residences with more bedrooms/units have higher electricity usage***
Age	-2.35**	For every one-year increase in the age of a building, a 2.35 decrease in monthly kWh is predicted, holding all other variables constant. ***Older buildings have lower levels of electricity consumption***

[29] Prior to modeling, variables were tested for multicollinearity, and in some cases, collinearity was present. For example, the building's EMV was highly correlated with the number of bedrooms or units (correlation = 0.888). Some of the seasonal variables, particularly the summer and winter dummy variables, were correlated with heating degree days (summer = -0.662, winter = 0.690). Finally, the price of natural gas was correlated with the yearly dummy variables, as price per CCF was mostly constant during the three-year period. Variables were selectively removed to reduce collinearity effects and maintain a maximum adjusted R-square value.

[30] Both regressions were modeled using the stepwise linear regression method in SPSS. Stepwise linear regression is a method of regressing multiple variables while simultaneously removing those that aren't statistically significant, leaving those variables that best explain the distribution. Source: http://www.geog.leeds.ac.uk/courses/other/statistics/spss/stepwise/

Above ground sq ft (hundreds)	3.00**	For every additional 100 square feet on a property, a 3.00 increase in monthly kWh is predicted, holding all other variables constant. ***Larger buildings are more likely to have higher levels of electricity usage***
Duplex/triplex (0=no, 1=yes)	-371.99**	Properties classified as duplexes or triplexes consume electricity at a rate of 372 kWh less per month, as compared with single family properties, holding all other variables constant. ***Multi-family buildings tend to have lower levels of electricity consumption than single family properties***
Apartment (0=no, 1=yes)	115.48**	Properties classified as apartments consume electricity at a rate of 115 kWhs more per month, as compared with single family properties, holding all other variables constant. ***Apartments have higher levels of electricity consumption***
Student residence (0=no, 1=yes)	-233.33**	Student residences consume natural gas at a rate of 233 kWh less per month, as compared with non-student residences, holding all other variables constant. ***Student residences tend to have lower levels of electricity consumption than non-student residences***
Heating Degree Days	0.14**	For every one additional heating degree day per month, a 0.14 increase in monthly kWh is predicted, holding all other variables constant ***Colder months require more electricity consumption***
Winter (0=no, 1=yes)	124.30**	Properties consume natural gas at a rate of 124 kWhs more per month during winter months (Dec – Feb) as compared with summer and fall, holding all else constant. ***Winter months have higher levels of electricity consumption than summer and fall***
Year of 2014-2015 (0=no, 1 = yes)	-40.60**	Properties consumed electricity at a rate of 40 kWhs less per month during the 2014-2015 year (May – Apr) as compared with 2012-2013, holding all else constant. ***The year 2014-2015 had lower electricity consumption than the year 2012-2013***
Rental (0=no, 1=yes)	--	
Spring (0=no, 1=yes)	--	
Year of 2013-2014 (0=no, 1=yes)	--	
Adjusted R-Squared	0.633	
Standard error of the estimate	1,434.6	

*significant at the 95% level
**significant at the 99% level
SOURCE: MINNESOTA POWER, ST. LOUIS COUNTY ASSESSOR'S OFFICE, UMD, CITY OF DULUTH LIFE SAFETY DEPARTMENT

Table 14 shows the results of a similar regression, using the average monthly electricity consumption in kilowatt hours as the dependent variable. The same twelve independent variables were included to estimate the amount by which they predict electricity consumption. Whether the property was classified as a rental, the spring seasonal variable, and the 2013-2014 dummy variable were all dropped from the model as they proved not to be statistically significant.

As with the previous regression, larger properties tend to have higher levels of electricity consumption. Interestingly, the number of bedrooms and/or units was shown to be a better predictor of electricity

consumption while the building's EMV was a better predictor of natural gas consumption.[31] The reason for this could be that the number of bedrooms or units is acting as a proxy for household size (or resident count). If so, one hypothesis might be that electricity consumption is more susceptible to household size, while natural gas usage likely depends more on property characteristics, such as insulation, age, and size. The adjusted R-squared value for this model is slightly higher than for the other model, suggesting that nearly 70% of the variation in electricity consumption is explained by the variables shown in Table 14. However, the standard error of the estimate (SEE) is very large, suggesting that the model is not very precise in predicting energy consumption levels. This is not surprising, considering the sample of properties in the analysis, which includes everything from small residential homes to large apartment buildings. However, it does indicate that there may be predictor variables that are missing from the regression

It is interesting to note that the age of the property actually had an inverse relationship with electricity consumption, suggesting that older properties actually tend to consume less electricity than newer ones. Similarly, multi-family (duplex/triplex) and student residence indicators also showed inverse relationships with electricity consumption, suggesting that these properties have lower levels of electricity use than single family properties and non-student residences, respectively. These results are exactly the opposite of what was shown in the previous regression model. In other words, older properties, duplex/triplexes, and student residences tend to have higher levels of natural gas consumption but lower levels of electricity consumption, even after controlling for other property characteristics like size and estimated market value. This is unusual and could suggest that these indicators are acting as a proxy for some other, unmeasured variable.

To compare effects for the three property types, both regressions were run again using the same dependent and predictive variables, but limiting the sample to only apartments, multi-family, or single family properties. The results were mixed. Natural gas consumption results were very similar for all three property types: all predictor variables had consistent signs and the models had similar R-square values. The model with only single family properties had a smaller SEE value, which is to be expected, as amount of variation in consumption is smaller in single family homes than it would be in apartments or multi-family. Otherwise, the three regressions looked very similar.

The models predicting electricity consumption, however, showed different results. In general, the number of bedrooms/units, the size of the property, the number of heating degree days, and the winter seasonal variable tended to have positively predict electricity consumption, while the age of the building, and the 2014-15 annual variable tended to negatively predict electricity consumption. However, results were not identical for all property types. The model with only apartments exhibited results very similar to the original, but among single- and multi-family homes coefficients' signs were not consistent and R-squared values were very low.

These findings seem to support the idea that natural gas consumption is more directly tied to property characteristics, while electricity consumption is more difficult to predict, especially in single- and multi-family properties. There are clearly some unmeasured factors, such as tenant behavior, household income, and who pays for utilities that appear to be more important to understanding electricity consumption. Hence, strategies for eliminating the split incentive will be different for the two utilities. For example, efforts to reduce natural gas consumption should focus on energy efficient improvements (insulation, windows, etc) while efforts to reduce electricity consumption should focus on behavioral changes. Also, there might be more potential electrical savings in owner-occupied homes.

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[31] Only one of the two predictors (EMV and number of bedrooms/units) was included in each model due to the high level of correlation between the two variables.

Summary

The most common type of rental in Duluth is single family properties, which make up about 55% of the physical rental buildings. On average, rentals tend to be older, larger, and have more bedrooms than owner-occupied properties. The average age of all rental properties in Duluth was 98 years, while non-rentals averaged 77 years. After controlling for the value per square foot, rental properties are of lower value than owner-occupied households.

Approximately 1,300 of the 4,400 rental properties in the city (30%) had at least one student live at the residence in the past three years. Of these properties, nearly 60% were single family units. Students tend to reside in properties that are larger, have more bedrooms, and have a higher total estimated market value. However, once the EMV of the building is adjusted (value per square foot), the difference is no longer statistically significant. This suggests that students are not necessarily residing in properties of higher value but are simply selecting larger properties. This is supported by the fact that students are also more likely to reside in properties with more bedrooms/units.

Interestingly, owner-occupied single family residences tend to have higher average monthly electricity use per square foot than similar renter-occupied single family properties. This is surprising, as it appears to contradict previous findings which indicated that single family units generally had the lowest energy expenditures per square foot (U.S. Energy Information Administration 2012). However, research also indicates that, for renters paying all utilities, median monthly energy payment for the lowest income households was $116 compared with $151 for the highest-income households (Carliner 2013). Therefore, the difference in usage may be an indication of the relative incomes of the occupants, rather than the energy efficiency of the property itself. Another potential explanation could be an inverse relationship between the age of the property and the electricity plug load. Older homes may simply have less capacity for electrical appliances than newer homes.

After controlling for various property and tenant characteristics using a linear regression model, many interesting findings came to light. For example, the number of bedrooms and/or units was shown to be a significant predictor of electricity consumption while the building's EMV was a better predictor of natural gas consumption. What's more, age was found to have a positive relationship with natural gas consumption but negatively predicted electricity consumption. Lastly, the student residence and the duplex/triplex indicators had opposite relationships with electricity consumption and natural gas consumption: duplexes/triplexes and student residences tended to have higher levels of natural gas consumption but lower levels of electricity consumption, even after controlling for other property characteristics like size and estimated market value.

Based on regression results, it seems that natural gas consumption is more directly tied to property characteristics, while electricity consumption is more difficult to predict, especially in single- and multi-family properties. There are clearly some unmeasured factors, such as tenant behavior, household income, and who pays for utilities that appear to be important to understanding electricity consumption. Literature summarized in Chapter I showed that energy use depends greatly on whether the owner pays utilities. And while the data used in this analysis did not include information on who is paying utilities, the 2013 American Housing Survey results indicate that tenants are more than twice as likely to pay electricity costs as heating costs[32] (U.S. Census Bureau 2013). This could explain why the results of the two regressions have slightly different results. Hence, strategies for eliminating the split incentive will be different for the two utilities.

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[32] 30% of households that use piped gas or fuel oil have those expenses included in their rent, while only 13% of households that use electricity have the cost included in rent.

Chapter III

This chapter presents the results from surveys conducted of tenants and landlords about a potential UMD program encouraging energy efficiency in rental properties. The two surveys gathered data regarding the split incentive. The goal for the landlord survey was to gather insight on landlords' potential willingness to make energy improvements in their rental properties. The objective for the tenant survey was to see how student and non-student renters view energy usage and energy efficiency in rental properties. In addition, the surveys attempted to answer the question of whether or not landlords and tenants would be interested in participating in a future program designed to lessen the impact of the split incentive issue.

Chapter III Key Findings

- **Surveyed landlords own about 20-25% of the rental properties in Duluth and 16-36% of the rental households**
- **Tenants are typically responsible for utilities, particularly electricity.**
- **Fewer than 5% of surveyed landlords reported difficulties finding tenants, while 28% of student tenants and 59% of non-students stated that it was difficult or very difficult for them to find rental housing.**
- **Of the characteristics listed in the survey, those deemed most important to landlords were that tenants be respectful of their property and timely with payments.**
- **Among tenants, the most important housing features included the cost of rent, location, utility costs, number of bedrooms, parking availability, and laundry options.**
- **89% of tenants responded that their property's utility costs were an important or extremely important factor. Energy efficiency in itself was not nearly as important.**
- **Of the program characteristics listed in the survey, both groups rated the "free energy audit" as a feature that would entice them to participate.**
- **On average, tenants responded with a higher desire for participating in a program than landlords.**
- **47% of tenants indicated that they would be willing to pay more in rent to ensure an energy efficient or "green" property. A larger portion of tenants were willing to pay more in rent for some amount of savings in utility costs.**

Landlord Survey Results

The results of the landlord survey are provided in this section. A total of 355 survey responses were used. Details on survey methodology can be found in Appendix A, Survey Distribution Methods.

Table 15. How many properties of each type (by number of units) do you currently own?

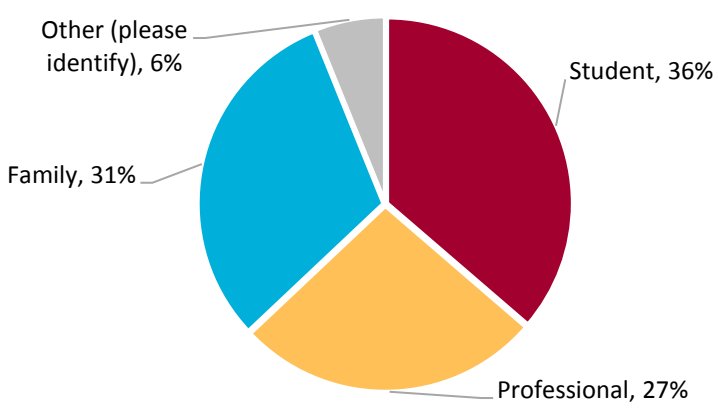
Units per property	*Number of properties owned*				
	1	**2-3**	**4-7**	**8+**	**Total**
1 Unit	174	63	28	12	277
2-4 Units	97	34	20	4	155
5-19 Units	14	5	4	4	27
20+ Units	2	1	3	4	10

SOURCE: BBER LANDLORD RENTAL SURVEY, QUALTRICS

Question 1 asked landlords what types of property they own (e.g. 1 unit, 2-4 unit) and how many. Table 15 shows a summary of the responses. Keep in mind that many respondents own multiple properties, so the total will not sum to 355. According to the survey results, 277 landlords (78% of respondents) own at least one 1-unit property. On the other hand, 10 landlords surveyed indicated that they own at least one property with 20+ units, and four indicated that they own more than eight of that type.

Using the ranges given for the number of properties owned, it is estimated that the 355 surveyed landlords own between 900 and 1,200 properties in total, representing at least 2,380 units and upwards of 5,000 units. These numbers equate to about 20-25% of the rental properties in Duluth and 16-36% of the rental households, based on counts from the St. Louis County Assessor's Office and the American Community Survey.[33]

Figure 13. Approximately what percentage of your tenants are represented by the following groups?

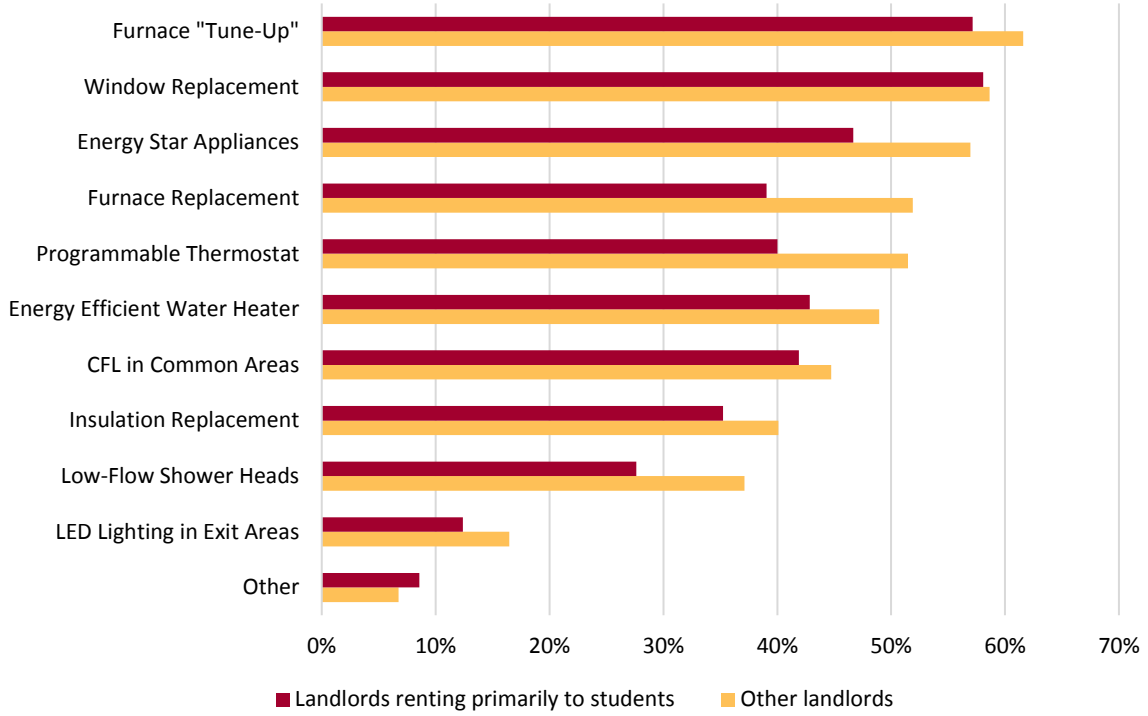


SOURCE: BBER LANDLORD RENTAL SURVEY, QUALTRICS

On average, respondents indicated that 36% of rental tenants are students, 31% are families, and 27% are professionals. Roughly 6% responded other, which included responses of adults, retirees, and tourists.

[33] The city of Duluth Life Safety Department's database included 4,479 rental licenses and the 2010-2014 American Community Survey 5-year estimates reported 14,293 rental households for the city.

Figure 14. Which of the following energy efficient improvements have you made to <u>the majority</u> of your properties? (click all that apply)



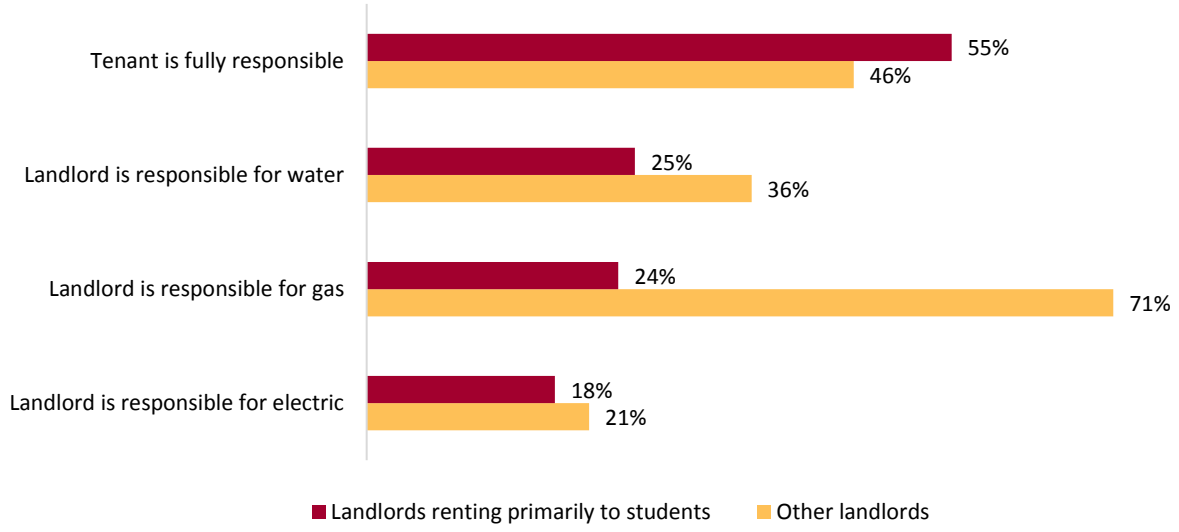
SOURCE: BBER LANDLORD RENTAL SURVEY, QUALTRICS

Landlords were also asked to describe some of the energy efficient improvements they have made to their properties. Figure 14 shows all improvements, ordered from most common to least. The results show that furnace tune-ups were the most common improvement, followed by window replacement, Energy Star appliances, and furnace replacement. Less common improvements include insulation replacement, low-flow shower heads, and LED lighting. It is notable that fewer than half of the landlord respondents indicated that they have installed programmable thermostats, which, according to the literature (Pivo 2012, U.S. Department of Energy 2016), has the highest potential for cost savings.

In order to determine whether landlords who rent primarily to students are less likely to make energy efficient investments, landlords were separated into two groups: those who indicated that they rent primarily to students[34] (n=106) and those who do not (n=248). Using these populations, the differences between the two groups was evident. Landlords who rent primarily to college students were less likely, in all instances, to have made energy efficient investments in their units. Programmable thermostats, furnace replacements, and Energy Star appliances were the investments that had the largest differences in adoption rates between the two groups.

[34] 106 landlords indicated that more than 50% of their tenants are students. These respondents were grouped into the category "Landlords renting primarily to students." All other landlords were included in the "Other landlords" category.

Figure 15. What percentage of your units are you responsible for the monthly utilities (gas, electric, etc.)?

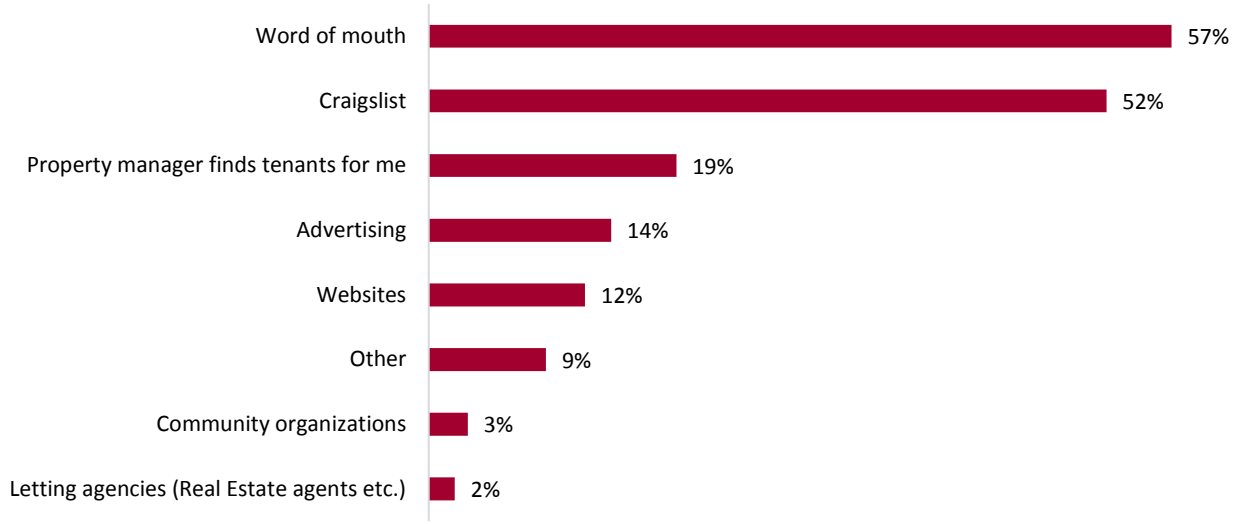


SOURCE: BBER LANDLORD RENTAL SURVEY, QUALTRICS

Landlords were asked who pays for monthly utilities in their units. This shows where the burden of these expenses lie. The split incentive issue between tenants and landlords means that landlords are less likely to implement energy efficient improvements if they are not paying for utilities. On the other hand, tenants have no incentive to save energy if the landlord pays for the utilities. About half of all landlords stated that their tenants were fully responsible for utility payments, with a slightly higher share (55%) of landlords renting primarily to students indicating tenants pay all utilities, compared with slightly less than half of other landlords (46%).

One notable difference between the two populations is in who pays for natural gas. While only 24% of landlords who rent primarily to students pay for natural gas, more than 70% of the other landlords pay for natural gas in their tenants' units. This difference is striking, and it raises the question of its cause. Are landlords more likely to pass these payments on to tenants because of some common property characteristic (e.g. older furnace, poor insulation)? For example, the number of meters and how meters are split between units often determines who is responsible for payments. Further future investigation might help explain the reasons behind this large discrepancy.

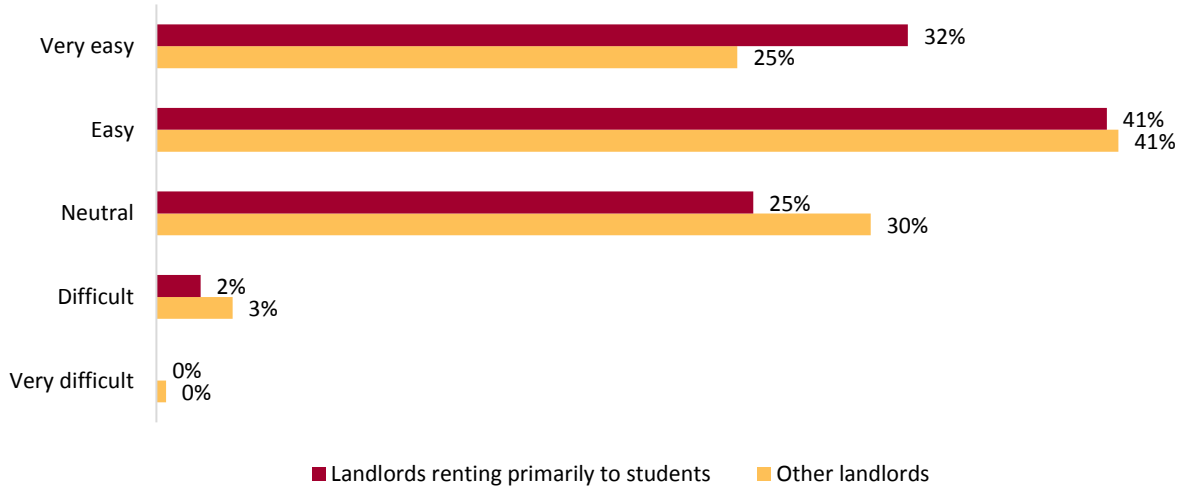
Figure 16. How do you find new tenants? (check all that apply)



SOURCE: BBER LANDLORD RENTAL SURVEY, QUALTRICS

Landlords were asked which methods they most commonly use to find new tenants. Word of mouth and Craigslist were, by far, the most common responses, with more than half of all landlords using these methods. Other methods, such as letting agencies, community organizations, advertising, and websites, were fairly uncommon.

Figure 17. Typically, how difficult is it for you to find tenants in general?



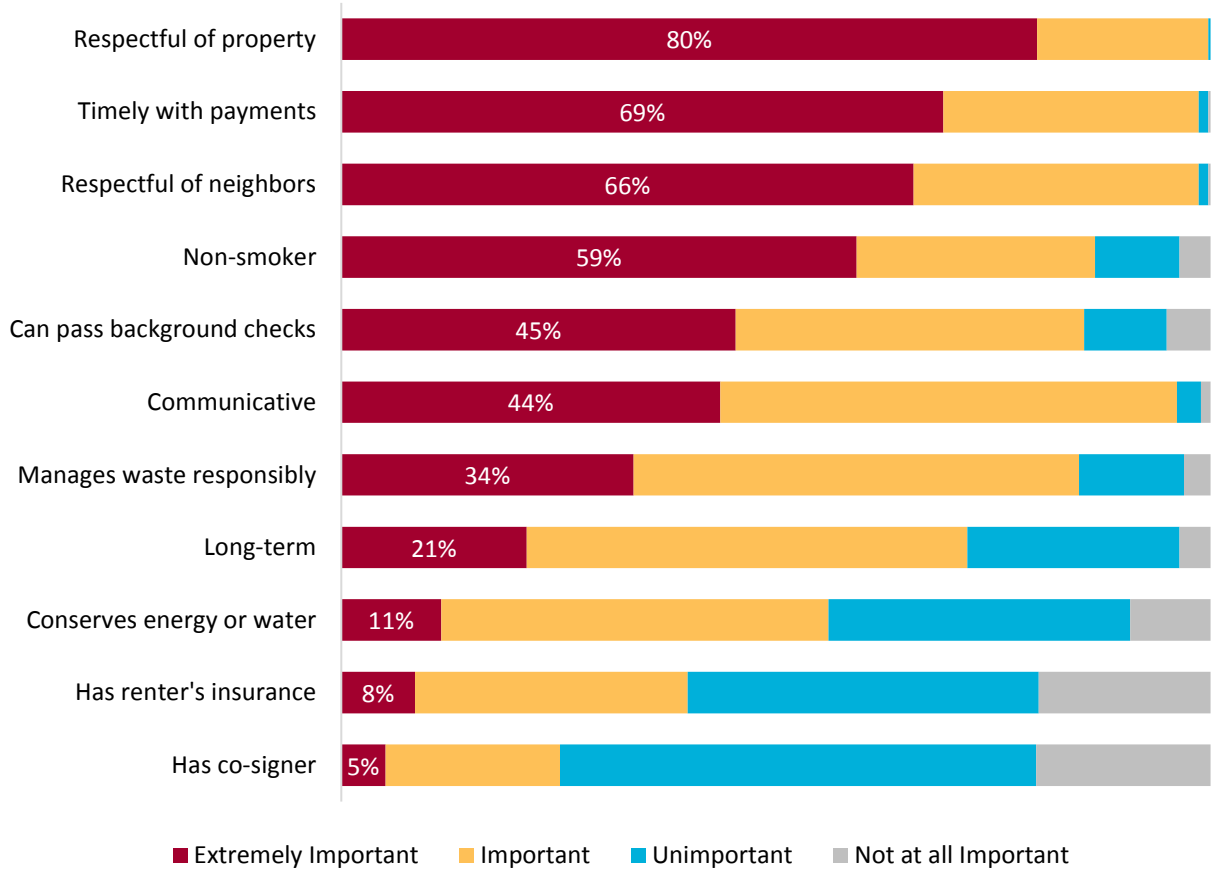
SOURCE: BBER LANDLORD RENTAL SURVEY, QUALTRICS

A program designed to connect tenants and landlords with the goal of reducing the split incentive must be appealing to both parties to be successful. As mentioned in Chapter I, Duluth's rental vacancy rate is fairly low, reported at 3.8% in the 2010-2014 American Community Survey (U.S. Census Bureau 2014). A low

vacancy rate tends to favor landlords, as it means that they have more demand for their properties. To gauge the effects of the low vacancy rate on landlords, the survey asked respondents to indicate how difficult it is for them to find tenants. Responses are shown in Figure 17, on the previous page.

Clearly, landlords do not appear to have difficulties finding tenants. More than 70% of all respondents said it is easy or very easy to find tenants. Landlords that rent primarily to students have an easier time finding tenants, with 32% indicating that it is very easy to find tenants, while other landlords have a slightly harder time, with only 25% stating that it is very easy to find tenants.

Figure 18. When selecting tenants, how important are the following characteristics? (Please consider each answer separately)



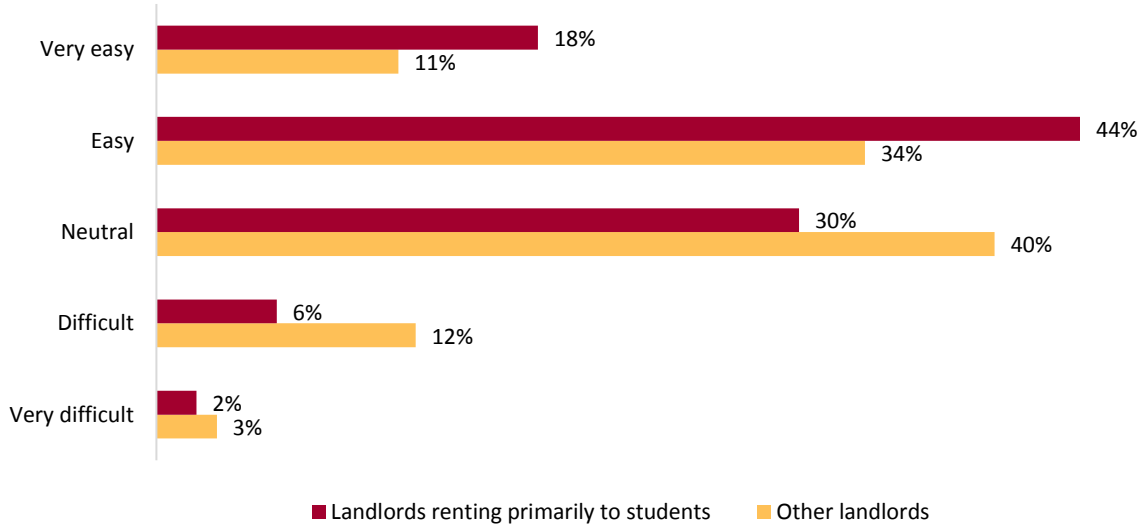
SOURCE: BBER LANDLORD RENTAL SURVEY, QUALTRICS

Landlords were also asked how important different characteristics are when choosing tenants. They were asked to rate various characteristics as being extremely important, important, unimportant, or not at all important. Figure 18 shows all of these characteristics, ranked from most important to least. The most important characteristic to landlords was that tenants be respectful of their property with 99% of landlords indicating that this was important or extremely important. The next most important characteristic was "timely with payments," with 97% of landlords indicating that this was important or extremely important.

Other important characteristics included being respectful of neighbors, a non-smoker, and the ability to pass background checks.

Based on landlord responses, characteristics that are considered less important include having a co-signer, having renter's insurance, conserving energy or water, staying at the property long-term (i.e. more than one year), and managing waste responsibly.

Figure 19. How difficult is it for you to find tenants with the qualities that are most important to you?

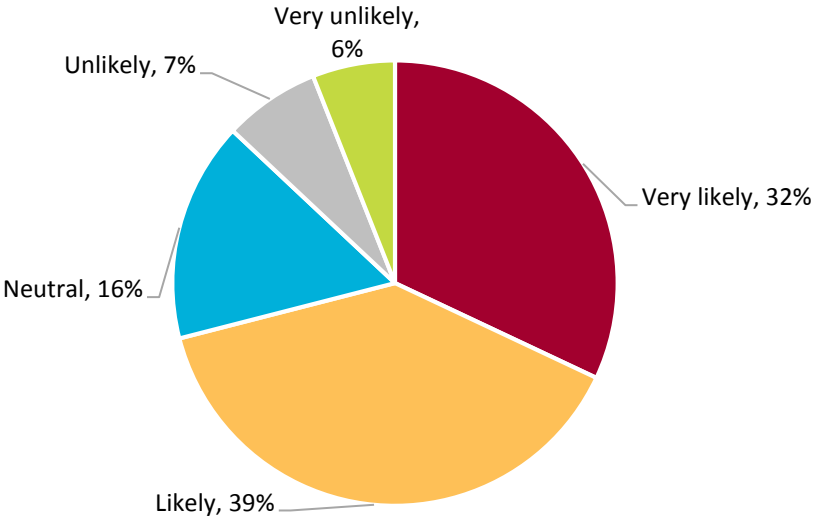


SOURCE: BBER LANDLORD RENTAL SURVEY, QUALTRICS

After indicating which tenant characteristics were most important, landlords were then asked to rate their difficulty finding tenants with those specific qualities. This question was included after hearing from landlords in our focus group conversations that, while they had no trouble finding tenants, they did have difficulty finding what they considered to be "high-quality" tenants: renters who had the characteristics they valued most.

Upon comparing the responses to this question (shown in Figure 19) with the responses from the previous question about difficulties finding tenants (Figure 17) it can be seen that, while most landlords still report having an easy or very easy time finding tenants with desirable qualities, a larger share of landlords do report difficulties finding tenants with the qualities that are most important to them. Of landlords renting primarily to students, 8% indicated that it was difficult or very difficult to find tenants with the characteristics they valued, compared with 15% of other landlords. These findings suggest that, if a program designed to address the split incentive wants to appeal to landlords, it should ensure that tenants who participate in the program have the characteristics that are most important to property owners.

Figure 20. When looking at one of your properties, how likely is it that a potential tenant inquires about the unit's average monthly utility payments?

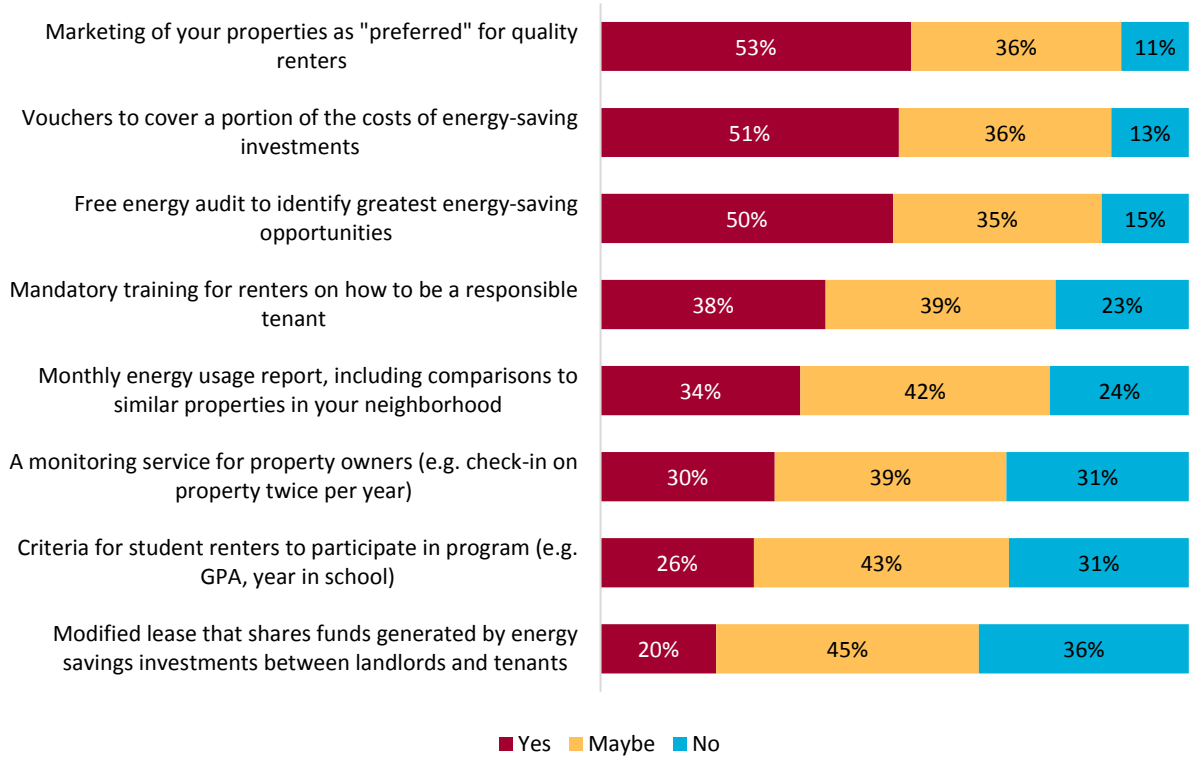


SOURCE: BBER LANDLORD RENTAL SURVEY, QUALTRICS

Landlords were asked, "When looking at one of your properties, how likely is it that a potential tenant inquires about the unit's average monthly utility payments?" More than 70% of survey respondents indicated that their prospective tenants were likely or very likely to inquire about the unit's average monthly utility costs (see Figure 20). A follow-up question then asked landlords, "Are student renters more or less likely to inquire about average monthly utility payments than non-student renters?" Of those that responded, the majority (59%) indicated that both groups were about equally likely to inquire. However, 24% said students were more likely or slightly more likely to inquire about utility payments, while a smaller share (17%) said the opposite was true, that students were less likely to inquire.

Interestingly, the 2005 Energy Center of Wisconsin questionnaire for owners and operators found that most tenants did not request information regarding energy costs when searching for a rental unit to lease, even though energy costs are viewed as an important factor when choosing where to rent (Pigg 2005). This difference may be due to Duluth's colder and longer winter heating season or a change in attitudes among consumers over the past decade.

Figure 21. If a program existed to connect responsible tenants with high-quality, energy-efficient rental properties, would any of the following program characteristics entice you to participate in such a program?



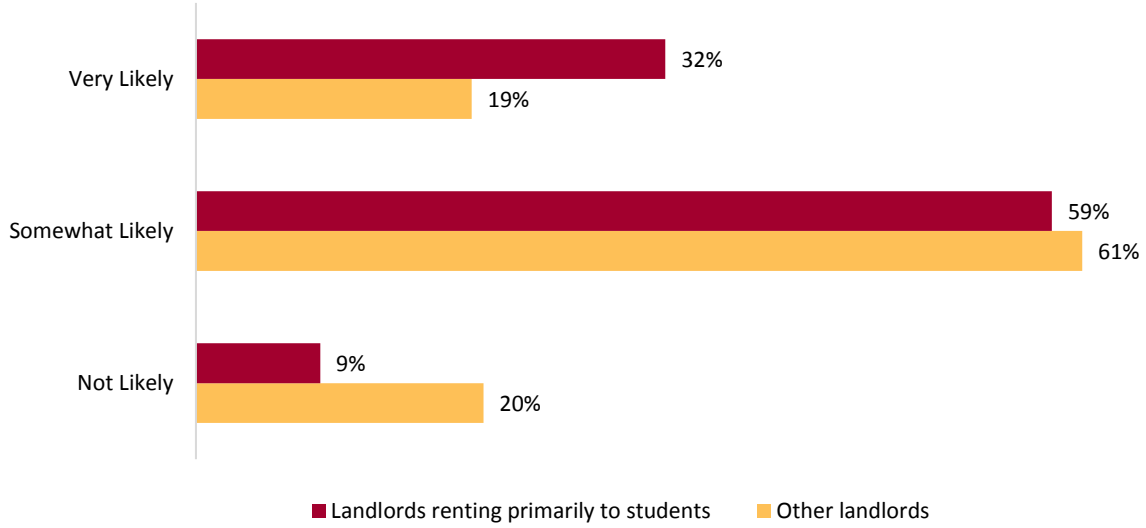
SOURCE: BBER LANDLORD RENTAL SURVEY, QUALTRICS

Next, landlords were asked whether they would be interested in a program that would help bridge the gap between tenants seeking energy efficient properties and landlords seeking quality renters. As shown in Figure 21, the top three most enticing characteristics for such a program were "marketing of your properties as 'preferred' for quality renters," with over 53% of landlords responding yes; just over 51% of landlords responded that they would participate if given "vouchers to cover a portion of the costs of energy-saving investments;" and 50% of landlords would participate if they were offered a "free energy audit to identify greatest energy-saving opportunities."

Green leases, which were discussed in Chapter I and would alleviate the split incentive issue, was the idea that landlords were least excited about as a program characteristic with over 36% of landlords saying they would not want a "modified lease that shares funds generated by energy savings investments between landlords and tenants."

A small fraction of participants (n=13) chose to answer no to all of these options for a program; if that was the case, we asked them to tell us why they selected no to the previous options. Of the few people that said they would not be enticed by any program characteristics, most said their reason was because they do not need help finding responsible tenants (n=9).

Figure 22. If such a program existed, how likely would you be to participate?



SOURCE: BBER LANDLORD RENTAL SURVEY, QUALTRICS

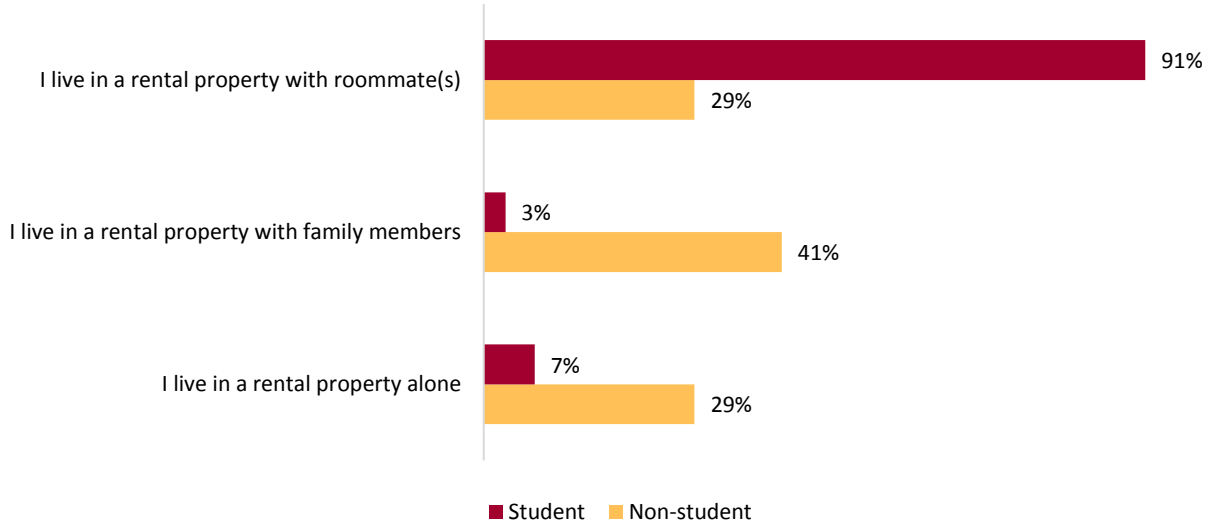
After being shown the list of potential program characteristics, survey respondents were asked, "if such a program existed, how likely would you be to participate?" The results of this question are displayed in Figure 22, where most landlords answered "somewhat likely" with approximately 60% of both landlord types answering with this option. Interestingly, about 32% of landlords who rent primarily to students indicated that they would be very likely to participate in a program like the one described in the previous question. Only 19% of other landlords indicated that they would be very likely to participate in that type of program.

For the landlords who chose to answer "not likely" to participate in the program (n=58), they were asked an additional question to determine why they would choose to not participate. Of the responses, over half indicated "I don't need help finding responsible tenants" as the reason why they are not willing to participate in a program. A smaller share (n=7) chose the option "energy efficiency in my rental properties is not a priority" as the reason why they did not want to participate. A number of respondents (n=13) chose the option "other," where they were given the opportunity to describe their reasoning. Some of the responses included; "not convenient," "we do our own interview and checks," and "not applicable to my situation."

Tenant Survey Results

The results of the tenant survey are provided in this section. A total of 804 survey responses were collected, more than 90% from student renters.

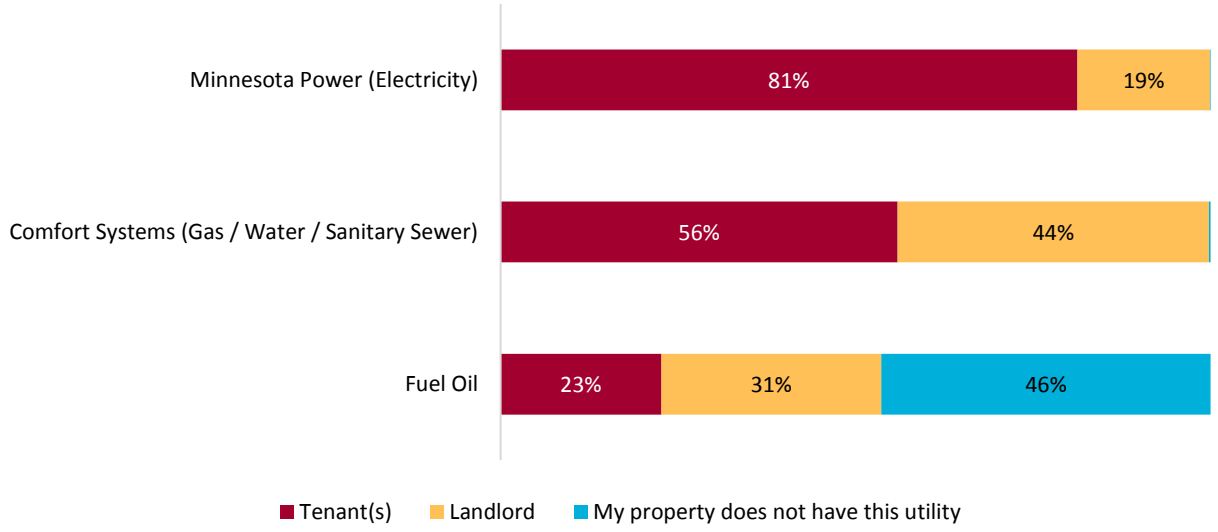
Figure 23. Please select the option that most accurately describes your current living situation.



SOURCE: BBER TENANT RENTAL SURVEY, QUALTRICS

Upon beginning the survey, tenants were asked a series of questions to determine their eligibility. For example, respondents had to live in the city of Duluth and be responsible for some portion of their monthly living expenses. In addition, the respondent had to be a renter, living either with roommates, family members, or alone. Figure 23 shows the three options that tenants could select as their current living situation and still be eligible to complete the survey, along with the percentage of respondents who selected each option. The graph has been broken out by whether the respondent indicated that they were currently enrolled at a college or university. The results indicate that 91% of student respondents stated that they live with roommates, whereas non-student renters are more likely to live with family members (41%) or alone (29%).

Figure 24. In your rental property, who pays for the following monthly utility payments?



SOURCE: BBER TENANT RENTAL SURVEY, QUALTRICS

Tenants were also asked who pays for monthly utilities in their units. Their responses are shown in Figure 24. More than 80% of tenants reported that they were responsible for their Minnesota Power (electricity) payment, and 56% indicated that they were responsible for their Comfort Systems payments (gas, water, and sanitary sewer). A smaller share (23%) claimed responsibility for fuel oil payments, although nearly half of respondents stated that their property did not have that type of utility.[35]

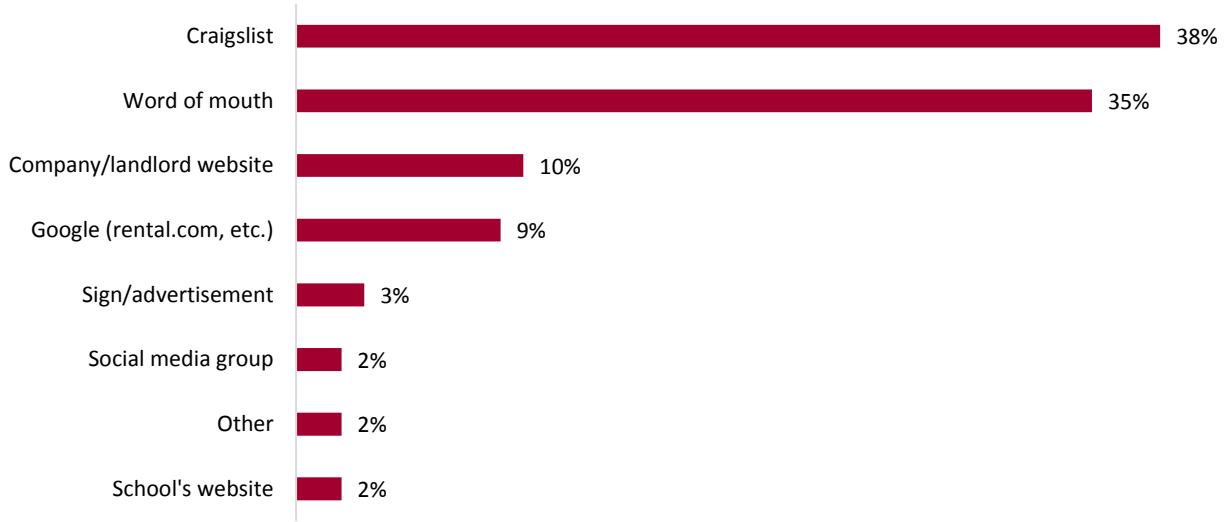
These results are not directly comparable to the findings from the landlord survey, as landlords may own multiple properties and/or units, each with an unknown number of tenants, while each tenant response reflects a single individual. However, the results do not contradict one another. In both cases, tenants are more likely to be responsible for monthly utility payments. In addition, while water and heat are occasionally included in the cost of rent, it is uncommon for electricity to be.

Interestingly, student tenants were more likely to indicate that they (the tenant) were responsible for utility payments than were non-student renters. This was true for all types of utilities. 82% of student tenants reported being responsible for Minnesota Power payments, compared with 66% of non-students; 57% of students indicated that they were responsible for Comfort Systems payments, compared with 40% of non-students; and 24% of students stated that they were responsible for fuel oil payments, compared with only 5% of non-students. Students were also more likely to report having fuel oil as a utility than were non-students.

[35] According to the 2010-2014 American Community Survey, only 6.3% of renter-occupied housing units are heated by fuel oil, while 53% use utility gas, 29% use electric heat, and the remaining 12% use some other source. This would suggest that either our sample of renters (primarily students) are significantly more likely to reside in properties heated by fuel oil than is typical, or they are mistakenly reporting that their property uses fuel oil when it does not.

These results might help to explain some of the unusual findings from the regression models in Chapter II, where student residences appeared to have lower levels of electricity consumption and higher levels of natural gas consumption. According to previous literature, if student renters are more likely to pay utilities, then their residences would be more prone to efficiency problems (Table 1, page 4). However, evidence suggests that electricity consumption depends more on tenant behavior than property characteristics, while the opposite is true for natural gas consumption. Therefore, one might conclude that appliances and insulation in student residences (and multi-family units) are probably older and less efficient, leading to higher levels of natural gas usage, while the residents of those units are perhaps more conservative with their electricity consumption than other types of renters.

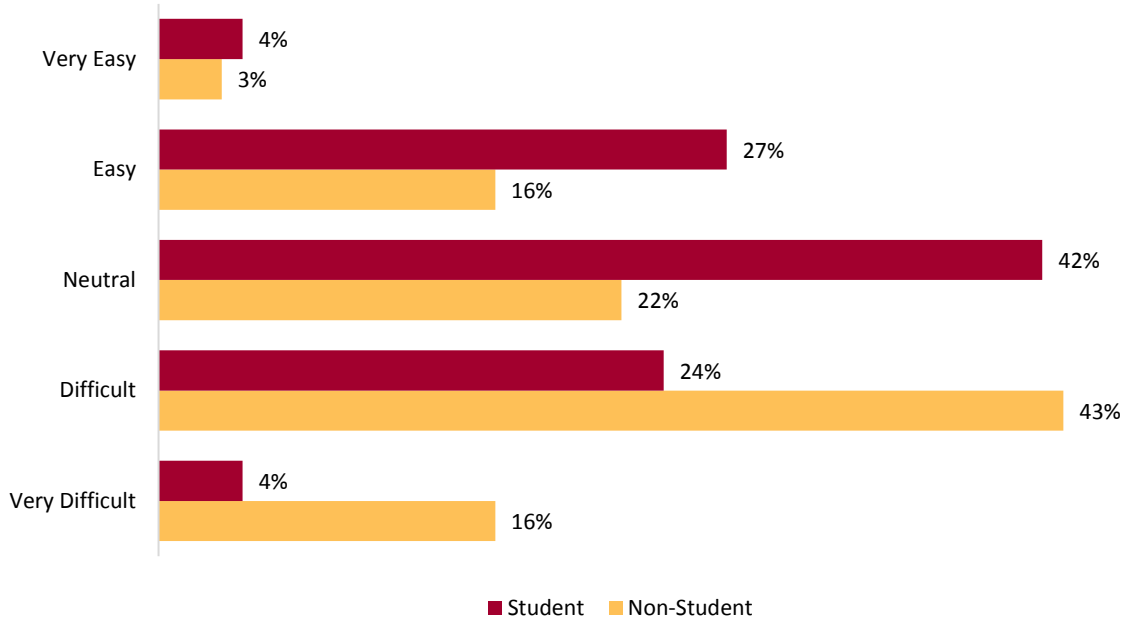
Figure 25. How did you find your rental property?



SOURCE: BBER TENANT RENTAL SURVEY, QUALTRICS

Similar to the results from the landlord survey, the primary means of renters finding property was by word of mouth and Craigslist. Craigslist was a more popular option for renters than for landlords. One explanation for this discrepancy could be that landlords are more likely to have personal and business connections in the city of Duluth, whereas tenants, particularly student tenants, are less likely to be native to Duluth and might lack those local connections. These results also show how much renters are relying on the internet for finding vacant properties. Combined, 61% of tenant respondents used the web in some format (i.e. Craigslist, website, google, social media, or college's website) to locate their residence. Only 2% of tenants reported finding their rental property on their school's website. This is important to consider when determining how to reach potential program participants.

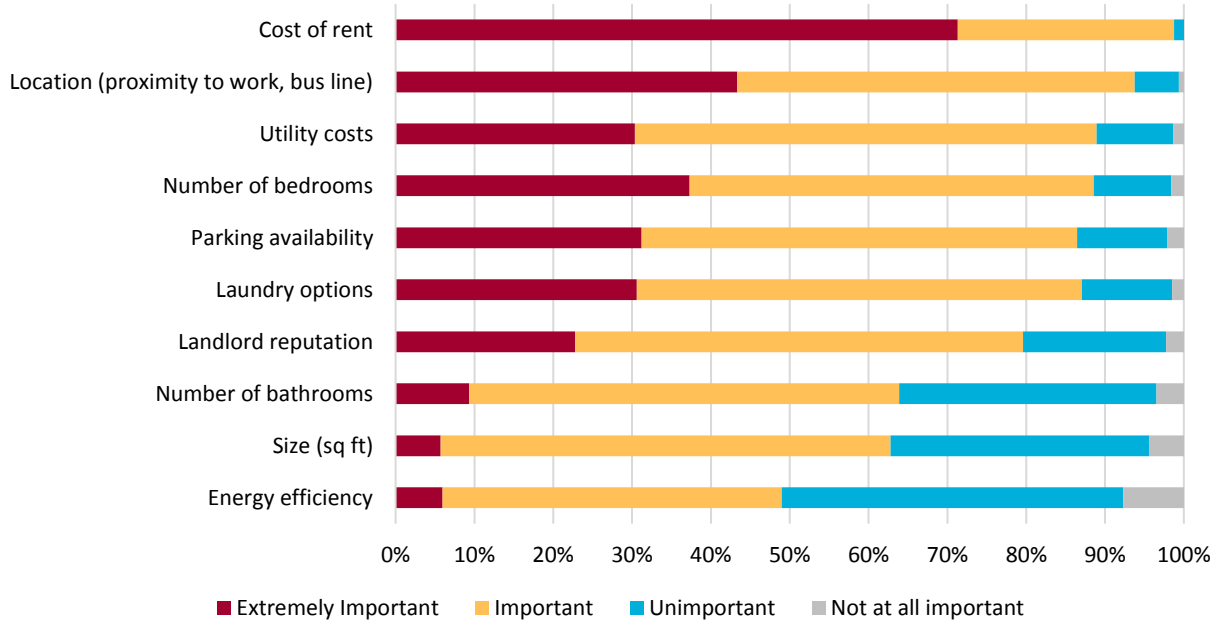
Figure 26. Typically, how difficult is it for you to find rental housing?



SOURCE: BBER TENANT RENTAL SURVEY, QUALTRICS

A low vacancy rate would likely indicate that tenants have more difficulty finding rental housing than landlords have finding tenants. The results shown in Figure 26 show that this is, in fact, the case locally. More than a quarter (28%) of student tenants and 59% of non-students stated that it was difficult or very difficult for them to find rental housing. That number is significantly higher than what landlords reported. The results highlight the need for a potential program that would appeal to landlords in particular, as they have less incentive to participate due to the city's low vacancy rates.

Figure 27. How important were the following features when considering your current rental property?

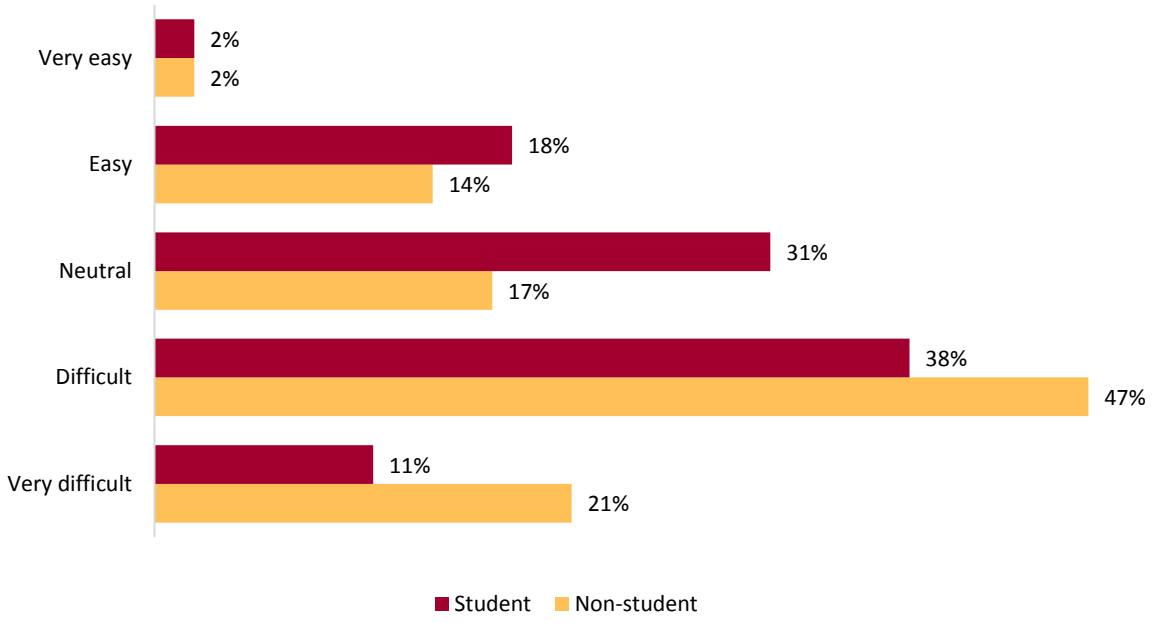


SOURCE: BBER TENANT RENTAL SURVEY, QUALTRICS

Tenants were also asked how important various characteristics were when selecting their current rental property, rating each as being extremely important, important, unimportant, or not at all important. Figure 27 shows all of these characteristics, ranked from most important to least. The most important feature, by far, was the cost of rent, with 99% of all tenants stating that this was either important or extremely important. Other important features included location, utility costs, number of bedrooms, parking availability, and laundry options. These factors were generally in line with the results from the Energy Center of Wisconsin's 2005 study, in which tenants listed rent, location, size, and number of bedrooms as the four most important factors influencing their decision to rent (Pigg 2005).

While utility costs were considered very important to Duluth tenants (89% felt this feature was important or extremely important), energy efficiency in itself was not. In fact, more than half of all respondents said that the energy efficiency of their rental property was unimportant or not at all important to them when considering where to rent. This distinction between energy efficiency and energy costs is very important to keep in mind if designing a program that will appeal to tenants. Clearly, the energy efficiency of a property alone is not enough to entice most renters. That efficiency must also translate into cost savings. The Energy Center of Wisconsin's study showed Energy costs as fifth in importance.

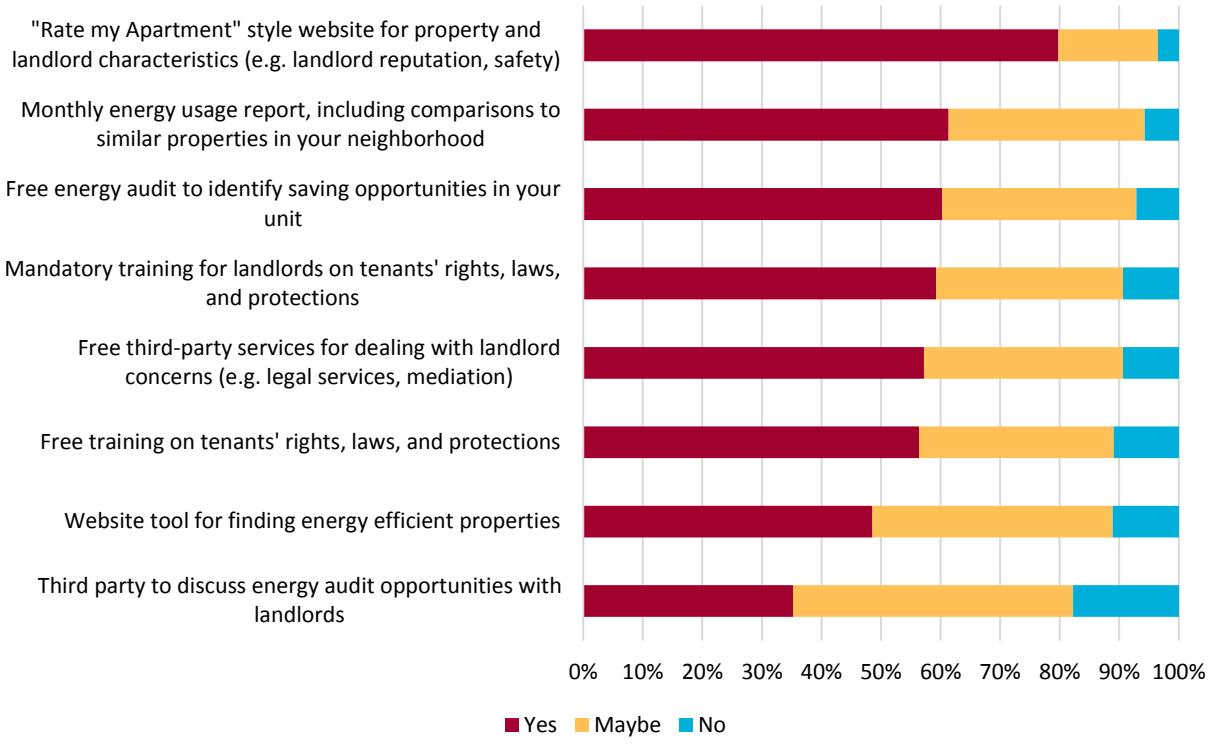
Figure 28. How hard is it for you to find rental housing with the qualities that are most important to you?



SOURCE: BBER TENANT RENTAL SURVEY, QUALTRICS

After indicating which property features were most important, tenants were then asked to rate their difficulty finding properties with those features. Comparing the responses to this question (shown in Figure 28) with the responses from the previous question (Figure 26) it can be seen that renters have an even harder time finding rental housing with the qualities that are most important to them (i.e. cost, location, size, monthly utility payments). Nearly 70% of non-student tenants report difficulties finding suitable rental housing. A smaller, but still significant, share of student renters (49%) report difficulties finding rental housing that fits their criteria.

Figure 29. If a program existed to assist renters by supplying them with information about rental properties, landlords, and other available services, would any of the following features entice you to participate?



SOURCE: BBER TENANT RENTAL SURVEY, QUALTRICS

Next, tenants were asked whether they would be interested in a program that would provide renters with information about rental properties, landlords, and other available services. As shown in Figure 29, the top three most enticing characteristics for such a program were a "'Rate my Apartment' style website for property and landlord characteristics (e.g. landlord reputation, safety), with 80% of tenants indicating that they would be interested in a program with this type of service. Other popular features included a "monthly energy usage report, including comparisons to similar properties in your neighborhood," and a "free energy audit to identify saving opportunities in your unit."

Program characteristics that were less popular among tenants included "Third party to discuss energy audit opportunities with landlords" and "website tool for finding energy efficient properties."

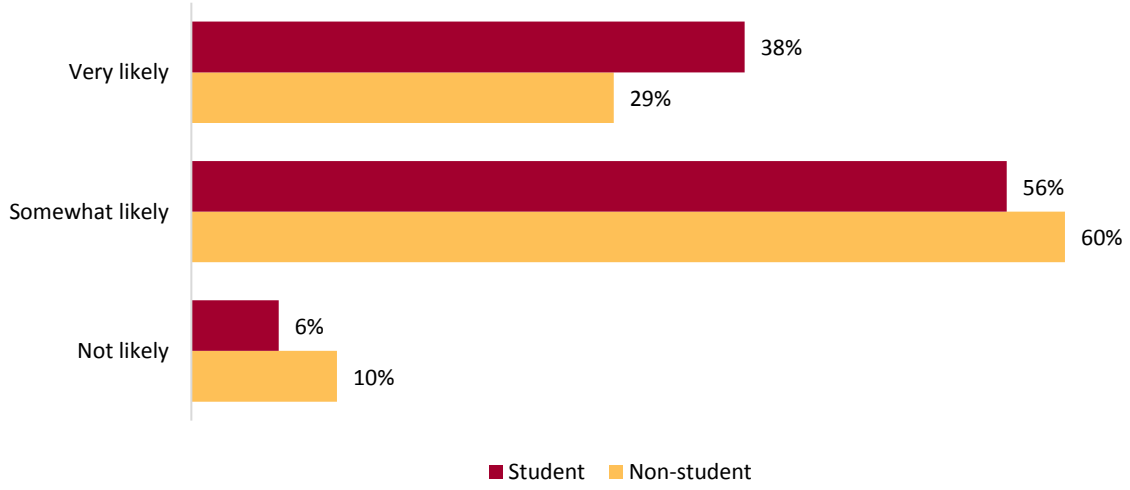
Table 16. Top Three Program Characteristics Among Tenants and Landlords

Tenants	Landlords
"Rate my Apartment" style website for property and landlord characteristics (e.g. landlord reputation, safety)	Marketing of your properties as "preferred" for quality renters
Monthly energy usage report, including comparisons to similar properties in your neighborhood	Vouchers to cover a portion of the costs of energy-saving investments
Free energy audit to identify saving opportunities in your unit	**Free energy audit to identify greatest energy-saving opportunities**

SOURCE: BBER TENANT RENTAL SURVEY, BBER LANDLORD RENTAL SURVEY, QUALTRICS

A small fraction of participates chose to answer no to all of these options for a program; if that was the case, we asked them to tell us why they selected no to the previous options. Of the few people (n=10) that said they would not be enticed by any program characteristics, most cited that they do not need help finding information on rental properties, landlords, or other services (n=3). The other most common option (n=3) was "energy efficiency in my rental properties is not a priority."

Figure 30. If such a program existed, how likely would you be to participate?



SOURCE: BBER TENANT RENTAL SURVEY, *QUALTRICS*

On average, tenants responded with a higher desire for participating in a program than landlords. Of student renters, 38% indicated that they were very likely to participate as did 29% of non-student renters. One reason for this could be that the Duluth rental market tends to favor landlords, as shown by the low vacancy rate and the ease by which landlords can find new tenants (see Figure 17 and Figure 19). There is more incentive for tenants to participate in a program that will help them find high-quality rental properties with the characteristics that they value, considering the difficult time many tenants appear to have securing suitable rental housing (Figure 28).

Another reason for the difference in interest among landlords and tenants could be that landlords are not as easily convinced to put effort into starting in a new program because they have a history of property rental behavior that fits their needs, and a change may seem counterproductive. Implementing change in the

process, for example, of how the contract is altered for the green lease, could be seen as an additional labor for an unforeseen benefit. Also, the payoff for landlords to participate in this program could be viewed as taking too long. Purchasing Energy Star appliances would be costly in the short-run, and even if rent is increased, landlords may still be leery to start a long-run investment.

However, there are some areas of commonality between the two groups that could be built upon. For example, of the program characteristics listed in the survey, both groups rated the free energy audit as a feature that would entice them to participate. In addition, 82 landlords indicated that they were interested in participating in the type of program described in the survey. Even if that number is fairly small as a percentage of respondents (23%), it represents between 230 and 300 properties throughout Duluth and an estimated 650-1,700 individual units, based on those individual respondents' answers to question 1 from the survey, about the number and types of units they own. This shows how participation by even a relatively small number of landlords can have a large impact in terms of the number of properties and/or tenants that would be affected.

Willingness to Pay

In addition to questions about renter preferences and interest in a potential program, the tenant survey asked a series of questions about their willingness to pay for improved efficiency and/or energy cost savings. The results of that analysis are included in this section.

Table 17. Descriptive Statistics, Willingness to Pay Analysis

	N	*Minimum*	*Maximum*	*Mean*	*Std. Dev*
Household Size	735	1.0	13.0	4.0	1.5
Household members paying monthly expenses	736	0.0	13.0	3.9	1.6
Monthly rent per person	787	$50	$1,200	$432.30	$136.51
Monthly utility payment per person	637	$5	$418	$64.46	$56.05
Monthly Comfort Systems payment per person	431	$5	$280	$47.04	$35.84
Monthly Minnesota Power payment per person	643	$0	$208	$26.96	$22.84
Monthly fuel oil payment per person	113	$2	$300	$31.59	$40.63
Monthly household utility payment	619	$0	$3,575	$257.02	$288.25
Willingness to pay (energy efficient, green property)	802	$0	$40	$9.55	$11.56
Willingness to pay (savings in utility costs)	657	$0	$45	$17.95	$10.03
Student	802	0.0	1.0	0.9	0.3
Age	802	19.0	75.0	23.5	6.1
Valid N (listwise)	99				

SOURCE: BBER TENANT RENTAL SURVEY, QUALTRICS

Table 17 shows the descriptive statistics used in analyzing the willingness to pay portion of the tenant survey. Household size, monthly rent and utility payments, and willingness to pay are all shown in the table along with the age of the respondent and whether he/she indicated that he/she was enrolled at a college or university. With a sample that was very much weighted toward students (more than 90% of respondents indicated they were enrolled at a college or university), it is not surprising that the average age is relatively low (23.5 years), and the household size (4.0) is larger than the city average (2.24) (U.S. Census Bureau 2014).

The average monthly rent per person, according to surveyed tenants, was $432. Combined monthly utility payments per person averaged about $65, with the largest payment going to Comfort Systems ($47), followed by fuel oil ($32) and then to Minnesota Power ($27). Based on tenant responses, it is estimated that the average household paid $257 per month in utility payments, which translates to an average annual payment of $3,084. This is significantly higher than what was given as the average in Chapter II ($1,905) and could mean one of two things. First, survey respondents might be over-estimating their monthly payments. The survey was sent to tenants in early Spring (February and March), so it is possible that respondents would be influenced by a recency bias, in which they would be more likely to consider their most recent bill (e.g. February) as the average monthly payment, not considering the average over the full calendar year. The other possibility is that this population of survey respondents (which includes primarily student tenants) is actually faced with higher than average monthly utility payments. And when comparing student responses with non-students, it is true that student tenants report higher monthly household utility payments. In fact, students reported paying, on average $263 per month in utilities (as a household) while non-students reported only $123 per month.[36] This suggests that this population may actually experience higher monthly payments than other groups, although more research would need to be conducted to verify whether that is, in fact, the case.

To determine willingness to pay, respondents were first asked about their monthly rental payment. Each respondent could answer either individually (amount paid per person) or on behalf of their household (the total amount paid for all members).[37] Then, respondents were asked if they would be willing to pay between $20 and $40 more per month in rent[38] to ensure that they were living in an energy efficient or "green" property. This question was included to estimate the non-market value[39] of having an energy efficient unit, which may or may not directly translate into cost savings. Respondents were evenly split on whether they would pay more in rent to ensure an energy efficient property, with 47% of tenants indicating that they would be willing to pay more and 53% unwilling. According to the survey, tenants were willing to pay about $10 more per month in rent to ensure that they were living in an energy efficient or "green" residence (see Table 17).

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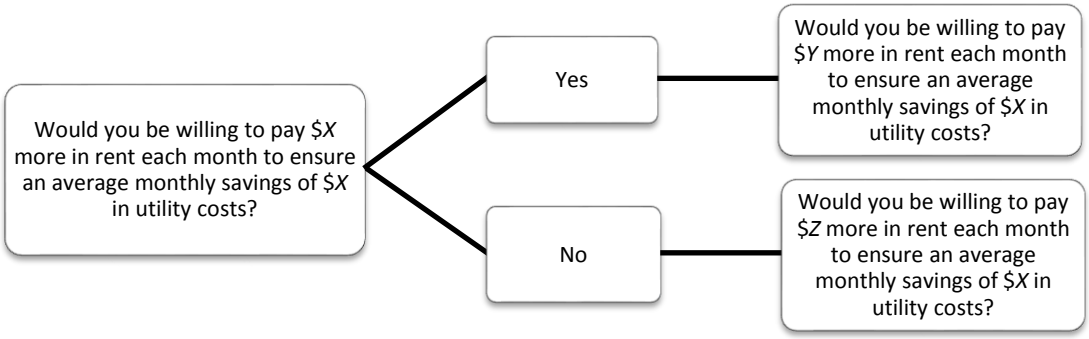
[36] Results are not statistically significant, due to the small sample size of non-student renters reporting utility payments.

[37] For simplicity, all responses in this section are shown per household member. To achieve this result, household responses were divided by the number of household members that contribute financially to the household's monthly expenses.

[38] The amount shown was randomly generated for each survey respondent.

[39] Non-market value attempts to place an economic value to goods or services that are not traded in the market, such as clean air and water.

Figure 31. Willingness to Pay Question Logic

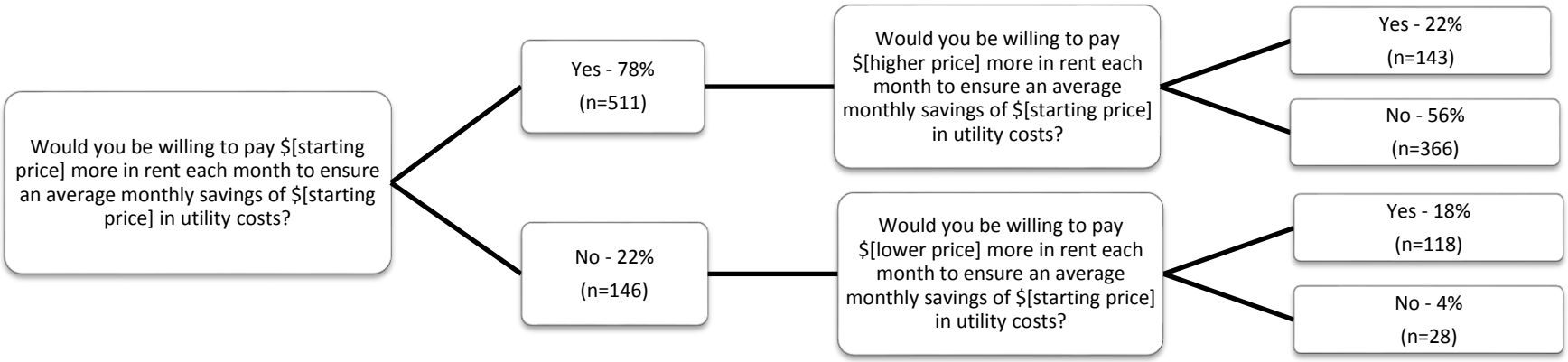


SOURCE: BBER TENANT RENTAL SURVEY, QUALTRICS

Next, the survey asked tenants a series of questions about their monthly utility payments and whether they would be willing to pay more in rent each month to ensure a savings in monthly utility costs. Figure 31, above, shows the series of questions regarding monthly utility payments. The initial starting price ($X) was based on their reported monthly utility payments[40] and ranged from $10 to $30. Depending on their response to that question, they were then faced with a randomly generated higher or lower price point for the same amount of savings. If tenants answered yes to the first question, they were then shown a randomly selected higher price ($Y), ranging from $15 to $45, in $5 increments. Respondents who answered no to the first question were shown a randomly selected lower price ($Z), ranging between $5 and $25 in $5 increments. Tenants were willing to pay nearly $18 more per month in rent for a similar amount of savings in utility payments (see Table 17).

[40] Tenants who paid less than $50 per month in utility payments were shown an initial value of $X = $10, with higher payments ($Y) ranging between $15-$25 and lower payments ($Z) equal to $5. Tenants who paid between $50 and $125 per month were shown an initial value of $X = $20, with higher payments ranging from $25-$35 and lower payments ranging from $5-$15. Finally, tenants who paid $125 or more on utilities each month were shown an initial payment value of $30 with higher payments ranging from $35-$45 and lower payments ranging from $15-$25.

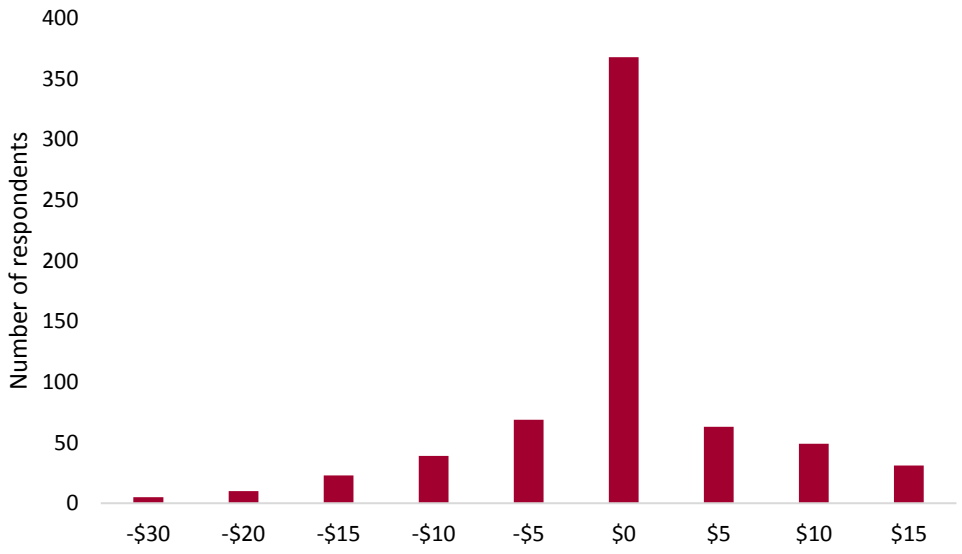
Figure 32. Willingness to Pay Question Logic with Responses



SOURCE: BBER TENANT RENTAL SURVEY, QUALTRICS

As mentioned previously, tenants were equally divided on whether they would pay more for an energy-efficient or "green" unit. By comparison, a larger portion of tenants were willing to pay more in rent for some amount of savings in utility costs, at 78% (see Figure 32). Most commonly, tenants were willing to pay some larger amount in rent to ensure an equal amount in energy cost savings but no more. More than half of all respondents (56%) selected this series of options. Only 4% of respondents (n=28) indicated that they would not be willing to pay any amount more in rent, even if they were ensured an equal or greater amount of savings in utility costs.

Figure 33. Respondents' Net Willingness to Pay



SOURCE: BBER TENANT RENTAL SURVEY, QUALTRICS

Figure 33 shows the distribution of tenants' net willingness to pay for reductions in utility costs. For each respondent, the highest amount that they said they would be willing to pay was compared with the amount of savings they would receive. The difference, or the respondents' net willingness to pay, is shown in the figure with the highest possible value being $15 and the lowest being -$30.[41] As mentioned earlier, the majority of respondents are only willing to pay more in exchange for an equal amount of savings in utility costs. Therefore, their net willingness to pay would be $0.

The scenario in which a tenant is willing to pay some amount more in rent for an equal amount of savings in utility payments is very logical. However, a sizable portion of respondents (22%) indicated that they were willing to pay more in rent (between $5 and $15) than the amount of savings they would be ensured in utility costs. Either these individuals place some value on energy savings over and above their out-of-pocket payment or they value the convenience of having a consistent increase in rent to offset energy payments, which are more likely to fluctuate from month to month. On the other hand, a number of respondents indicated that they were not willing to pay more in rent, even to ensure a greater savings in utilities. One theory behind these respondents' negative net willingness to pay could be that they don't trust that savings would actually materialize or understand how payments would be reimbursed.

To determine tenants' true willingness to pay for utility savings, results were analyzed using a bivariate probit model, which allows for jointly modeling two binary outcomes. In this case, the binary outcomes were the tenants' responses (yes/no) to the two willingness to pay questions in the survey. Respondents were analyzed in two separate groups: the first included tenants who reported paying $60 or more for utilities

[41] Five individuals stated that they would not be willing to pay any amount more in rent, even for a savings of $30 in utility costs. Hence, their net willingness to pay is -$30.

each month, and the second included those who paid less than $60.[42] Results of modeling found that respondents with utility payments higher than $60 were willing to pay an estimated average of $22 more per month in rent in exchange for a $20 savings in monthly utilities,[43] while respondents with utility payments of less than $60 had an estimated willingness to pay of essentially $0 on average.[44] In both cases, estimates were based on the second series of willingness to pay questions, as results from the first question were inconsistent.[45] The significant difference in results between the two groups could reflect the amount of savings relative to the respondent's current utility payments. Individuals paying less than $60 in monthly utilities might be more skeptical that significant savings in utilities could actually materialize and may have responded no for that reason. Further statistical testing, including whether willingness to pay varies based on respondent characteristics, is possible for future study.

Summary

The results of two surveys, targeting Duluth tenants and landlords, revealed many interesting insights into Duluth's rental market and how the split incentive impacts landlord and tenant behaviors. More than 350 landlord responses were collected, or about 27% of the 1,273 landlords in the city's database. Based on their responses, it is estimated that the landlords who took the BBER survey own between 900 and 1,200 properties and between 2,380 and 5,000 units. In addition, a total of 804 tenant survey responses were collected, more than 90% from student renters.

In both cases, respondents indicated that tenants were typically responsible for utilities, particularly electricity. More than 80% of tenants reported that they were responsible for their Minnesota Power (electricity) payment, and 56% indicated that they were responsible for their Comfort Systems payments (i.e. gas, water, and sanitary sewer). A smaller share (23%) claimed responsibility for fuel oil payments, although nearly half of respondents stated that their property did not have that type of utility.

Landlords seem to have an easier time finding tenants than renters do finding housing. Fewer than 5% of surveyed landlords reported difficulties finding tenants, while 28% of student tenants and 59% of non-students stated that it was difficult or very difficult for them to find rental housing.

Utility costs were considered very important to Duluth tenants. More than 70% of surveyed landlords indicated that their prospective tenants were likely or very likely to inquire about the unit's average monthly utility costs, and 89% of tenants responded that their property's utility costs were an important or extremely important factor in determining where to live. However, energy efficiency in itself was not nearly as important. In fact, more than half of all respondents said that the energy efficiency of their rental property

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[42] $60 was the median utility payment for all surveyed tenants.

[43] For this population, coefficient estimates for both questions demonstrated the proper signs (as bids got higher, respondents were less willing to pay). The 95% confidence interval for this group was between $9 and $35.

[44] The actual estimate was $3.64, but the result was not statistically significant, and the confidence interval ranged from -$14 to more than $20, indicating that the true value could very easily be $0.

[45] One reason for the inconsistent results from the first question was the lack of variation in the bid amounts. Only three bids were given in the initial question ($10, $20, and $30) and bids were dependent on the respondents' current monthly utility payment. The second question had greater variability (bids ranged from $5 to $45, in $5 intervals)

was unimportant or not at all important to them when considering where to rent. This distinction, between energy efficiency and energy costs, is notable if designing a program that will appeal to tenants. Clearly, the energy efficiency of a property alone is not enough to entice most renters. That efficiency must also translate into cost savings.

One purpose for this study was to gain information from both parties on the types of characteristics that would encourage participation in a program designed to address the split incentive issue. Among landlords, the most enticing characteristics for such a program were "marketing of your properties as 'preferred' for quality renters," with over 53% of landlords responding favorably, followed by "vouchers to cover a portion of the costs of energy-saving investments." Among tenants, the most enticing characteristic for such a program was a "'Rate my Apartment' style website for property and landlord characteristics (e.g. landlord reputation, safety)" and a "monthly energy usage report, including comparisons to similar properties in your neighborhood."

On average, tenants responded with a higher desire for participating in a program than landlords. Of student renters, 38% indicated that they were very likely to participate, as did 29% of non-student renters, compared with less than 25% of landlords. However, there are some areas of commonality between the two groups that could be built upon. For example, of the program characteristics listed in the survey, both groups rated the free energy audit as a feature that would entice them to participate. In addition, 82 landlords indicated that they were interested in participating in the type of program described in the survey. Even if that number is fairly small as a percentage of respondents (23%), it represents between 230 and 300 properties throughout Duluth and an estimated 650-1,700 individual units, based on those individual respondents' answers to Question 1 from the survey. This shows how participation by even a relatively small number of landlords can have a large impact in terms of the number of properties and/or tenants affected.

In addition to questions about renter preferences and interest in a potential program, the tenant survey asked a series of questions about their willingness to pay for improved efficiency and/or energy cost savings. Respondents were evenly split on whether they would pay more in rent to ensure an energy efficient or "green" property, with 47% of tenants indicating that they would be willing to pay more and 53% unwilling. By comparison, a larger portion of tenants were willing to pay more in rent for some amount of savings in utility costs, at 78%. Most commonly, tenants were willing to pay more in rent to ensure some amount of savings in their monthly utilities but no more. Results of modeling found that respondents with utility payments higher than $60 were willing to pay an estimated $22 more per month in rent in exchange for a $20 savings in monthly utilities, while respondents with utility payments of less than $60 had an estimated willingness to pay of essentially $0.

Chapter IV

This investigation addressed the following overarching research questions:

Does the split incentive issue impact student tenants more severely than other renters, including low-income renters? If yes, how?

Results appear to suggest that students are more prone to the effects of the split incentive for a number of reasons. First, students tend to choose properties that are larger and have more bedrooms than other types of renters. They are also more likely to be responsible for monthly utility payments and less likely to have them included in the cost of rent. This difference is especially large for natural gas payments, where landlords who rent primarily to students were significantly more likely to report that their tenants pay for natural gas.

These two factors would suggest that students are more susceptible to the efficiency problem associated with the split incentive in which the occupant pays for energy use and so the landlord has less incentive to make energy efficient updates, such as proper insulation, energy efficient appliances, or a new furnace.

Are students less likely to choose energy efficient housing than the average renter or low-income renters?[46] Why or why not?

To better understand which factors most influence energy consumption levels, two linear regressions were performed using the average monthly energy consumption (electricity and natural gas) as the dependent variables and various property and occupant characteristics as the predictive variables. The results of these regressions suggest that student residences tend to have higher levels of natural gas consumption than non-student residences but lower levels of electricity consumption.

Consumption levels don't necessarily correlate with energy efficiency, however. Higher consumption could be the result of building efficiency (e.g. poor insulation, old furnaces, drafty windows) or behavioral energy use (e.g. setting the thermostat high, leaving lights on). Also, in winter months, there is a minimum threshold for natural gas consumption. Therefore, it is difficult to say with certainty why students are consuming more natural gas but less electricity. However, other findings from the study offer evidence that can help explain these unusual results.

As mentioned previously, students tend to choose properties that are larger and have more bedrooms than other types of renters, and they are more likely to be responsible for their monthly utility payments (especially in the case of natural gas). This would suggest that higher natural gas consumption among students is likely the result of inefficient housing characteristics (e.g. poor insulation, older furnaces), and not behavior. The lower than average electricity consumption, however, is more difficult to explain. If students are paying for their own electricity, perhaps they are more conservative with their consumption in order to save money. Another explanation could be the relationship between income and consumption, where

[46] While the survey asked tenants to indicate household income, there were not enough responses from non-student tenants to compare the relationship between income level and rental preferences. Therefore, all non-student renters were examined as a whole.

higher-income households tend to consume more electricity as a result of owning additional appliances, DVRs, air conditioning, and other luxury household items.

While the survey asked tenants to indicate household income, there were not enough responses from non-student tenants to compare the relationship between income level and rental preferences. Therefore, all non-student renters were examined as a whole.

Are landlords that primarily serve college students less likely to make energy efficient investments? If yes, why? And what might be done to address this?

The BBER survey asked landlords to describe some of the energy efficient improvements that they have made to their properties. Landlords were then separated into two groups: those who rent primarily to students[47] (n=106) and those who do not (n=248). Using these populations, the differences between the two groups were evident. Landlords who rent primarily to college students were less likely, in all instances, to have made energy efficient investments in their units. Programmable thermostats, furnace replacements, and Energy Star appliances were the investments that had the largest differences in adoption rates between the two groups. However, there are many reasons why this might be the case. For example, properties where students tend to reside might have older furnaces that are costlier to replace. Also, some landlords indicated in their comments that their property already had some of these features (e.g. programmable thermostat, Energy Star appliances, quality insulation) when they purchased it. However, the results still suggest that student residences may have fewer energy efficient investments than other properties. This could be an opportunity that a potential program might address.

Does more transparency regarding energy efficiency in rental units influence student choices in selecting housing? Why or why not?

Among Duluth renters, utility costs are an important consideration when determining where to live. More than 70% of landlords indicated that their prospective tenants were likely or very likely to inquire about the unit's average monthly utility costs. However, while utility costs were considered very important to Duluth tenants (89% felt this feature was important or extremely important), energy efficiency in itself was not. In fact, more than half of all respondents said that the energy efficiency of their rental property was unimportant or not at all important to them when considering where to rent. Clearly, a rental property that is energy efficient is not enough to entice most renters as a stand-alone feature. That efficiency must also translate into cost savings.

Some research has shown that customers who receive information on their neighbors' energy consumption were more likely to cut back on their own use, particularly for those households that have the highest levels of use (Ayres 2009). Moreover, surveyed renters reported being very interested in a program that included a monthly energy usage report with comparisons to similar properties in their neighborhood.

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[47] 106 landlords indicated that more than 50% of their tenants are students. These respondents were grouped into the category "Landlords renting primarily to students". All other landlords were included in the "Other landlords" category.

How would addressing the split incentive issue benefit students, low-income individuals, and the city?

Along with the potential energy savings and environmental benefits that could be gained by eliminating the split incentive issue, there are a number of potential economic benefits, the most obvious being reductions in energy bills for tenants and/or landlords. Using estimates from the 2009 Residential Energy Consumption Survey (RECS), it was estimated that renter-occupied Duluth households spend $1,905 annually on energy expenditures. What's more, this estimate may actually be higher based on the results of the BBER tenant rental survey. On average, tenant survey respondents estimated that they spent $257 per month on utility payments, or $3,084 annually, and students reported paying more for utilities than non-students (although the non-student sample size was very small).

By implementing a variety of energy-saving improvements, such as installation of a programmable thermostat, replacement of an older furnace, or an upgrade of insulation, the U.S. Department of Energy (2016) estimates the potential annual energy savings for a Duluth household at 45-50%, or $957 annually. Assuming every rental household in the city of Duluth were to achieve the full potential savings annually the combined savings city-wide would total nearly $14 million annually in energy expenditures. However, a more realistic estimate is nearly $400 in savings per household with a combined city-wide total of $6 million.

Future Research

The purpose of this study was to conduct research informing the potential development of a program that would address the Split Incentive issue. Of course, there are some limitations to this investigation that should be noted. First, the sample of non-student renters that responded to the BBER Tenant Survey was very small. If more research were conducted on this topic, a broader response from tenants, particularly non-student tenants, would help clarify some of the findings and allow the research to be more applicable to a broader population. Similarly, the student tenants surveyed were primarily UMD students. This was intentional, as the program in consideration would be designed specifically for UMD students. However, students from some of the other local universities may report different experiences related to rental housing.

A broader distribution of the tenant survey would allow for a broader interpretation of the results of the study, including a more thorough examination of how income affects housing choice and the split incentive. It would also provide an opportunity to improve some of the survey questions. For example, the willingness to pay questions provided inconsistent results, due largely to a lack of variation in the initial bids. In addition, a fairly large portion of respondents (especially those with higher monthly utility payments) responded "yes/yes" to WTP questions, suggesting that the bids we used might be too low. A redesigned survey would increase variation in both bids and would increase the upper bound of the willingness to pay options. Lastly, some questions generated responses that were surprising or contradictory. In a revised survey, these could be reworded or clarified to see if results differ.

Another limitation of this study was the level of detail available from the energy consumption data. Consumption data was collected for Comfort Systems (natural gas) and Minnesota Power (electricity), but fuel oil data was not collected. Also, limited information was available on energy-related property features. Therefore, it was not possible to connect energy consumption to a particular property feature, such as whether the tenant paid utilities, the fuel source used for heating, or the efficiency of the property overall.

The initial premise of a program to address the split incentive, the “Bulldog Approved Housing” program, was conceived by UMD’s Sustainability Office. One important area of future research would be the development and evaluation of this program utilizing some of the characteristics discussed in this report. Ideally, the initial pilot would incorporate some form of experimental design, in which half of the participants were placed in a program with very limited interventions (or no interventions at all), while the other half receives a more intrusive program model including some of the characteristics identified in this study (e.g. free energy audits, monthly energy usage reports, a website for rating properties). Monthly energy consumption would be measured for both groups. The most effective program elements would be selected based on effectiveness and participant satisfaction. A successful program would not only decrease energy consumption but also be appealing to both landlords and tenants. If successful, the program could potentially be expanded city-wide.

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Appendix A - Survey Distribution Methods

The landlord survey targeted landlords who own at least one rental property in Duluth, while the tenant survey targeted residents of rental units.[48]

Both surveys were submitted to the Institutional Review Board (IRB) to comply with research regulations regarding the use of human subjects. This assures that subjects are not at risk and that they give consent to participate.

Prior to distribution, each survey was tested on a small sample of participants to gather information regarding the ease of completion and any troublesome questions. For the landlord survey, a focus group was conducted to test the survey for any areas that may have seemed confusing or ambiguous. The BBER randomly selected 200 landlords who reside in Duluth and owned at least one property in the city. Based on the sample, postcards were sent to each landlord and offered him/her the opportunity to participate in the focus group. Subjects who participated in the landlord focus group were compensated $50. The focus group had 11 participants.

Similarly, a focus group of student renters was conducted to test the tenant survey for any areas that may have seemed confusing or ambiguous. Subjects who chose to participate in the tenant survey focus group (hosted on UMD campus) received a free lunch. Following both focus groups, changes were made to improve the quality of the surveys based on feedback from participants.

The landlord survey was administered using 1,274 email addresses of landlords who owned rental properties in Duluth, supplied by the City of Duluth's Life Safety Department. Administered through Qualtrics, the

[48] Survey instruments are available upon request.

survey produced 397 respondents with 355 of those surveys completed in entirety. For the results in this report, only the 355 completed surveys were used.

The tenant survey was administered by email and postcards. Email addresses of those students living off campus were provided by UMD. Postcards were distributed to randomly selected rental units, using the St. Louis County Assessor's Office database to reach non-student renters. Unfortunately, the postcards had a low response rate due to a printing error. As a result, additional distribution emails were sent to the landlord email listserv, with a request for landlords to forward the survey link to their tenants. In total, the tenant survey had 954 respondents with 804 of those surveys completed in entirety. For the results in this report, only the 804 completed surveys were used.

After both survey periods closed, participants were entered into a drawing to win a $500 Visa gift card with one winner selected from each survey group (landlord and tenant).