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# Tenant-Paid Energy Costs in Multifamily Rental Housing: Effects on Energy Use, Owner Investment, and the Market Value of Energy

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## PREVIEW

The costs of energy used in multifamily rental housing are paid either by the building owner (from tenant rents) or directly by tenants. When tenants are financially responsible for energy costs, they use energy more efficiently. However, energy use is equally affected by the building owner's efforts to maintain and improve the building and equipment. When energy costs are paid by tenants, the owner's economic incentive for efficiency is indirect, coming through increased rents and/or decreased vacancies and turnover rather than directly through lower energy costs. The report examines tenant payment of energy costs from several viewpoints.

**Chapter 1** presents background figures on rental housing, reviews past work, and describes several methods of billing tenants for energy costs.

**Chapter 2** reports comparisons of energy use before and after the introduction of tenant payment in 83 properties in Colorado, California, and elsewhere. RESULT: an average reduction in use of 10-20% in the first year with tenant payment.

**Chapter 3** reports a survey of owners of buildings with and without tenant payment in Atlanta and Portland, Oregon. RESULT: the surveyed owners whose tenants pay for energy did only slightly less to improve efficiency between 1978 and 1982.

**Chapter 4** reports a canvas of advertisements for rental units from 32 cities nationwide. RESULT: energy efficiency and low energy costs are mentioned most frequently--in 5 to 10% of classified advertisements--in Portland, Atlanta, and Charlotte, North Carolina.

**Chapter 4** also presents a study of 69 properties in northeast Atlanta, half of which advertise energy efficiency. RESULT: tenants shopping these properties frequently ask about energy costs, and units in buildings with lower tenant energy costs are commanding higher rents, thereby providing a payback on owner energy investments.

**Chapter 5** presents a model of owner-tenant interactions affecting energy use in multifamily buildings, and a method of estimating the long-term effects of tenant payment on energy use. RESULT: tenant payment should lead to lower energy use if tenants are billed according to their own, individually measured consumption--not according to a formula--and if tenant payment does not depress annual reductions in use by more than 0.5%.

**Chapter 5** also discusses implications of the findings for policies concerning utility payment modes and energy investments in rental housing. RESULT: policy modifications are needed to enable greater use of submetering and heat monitors, and to provide tenants with reliable information on energy costs.

An **Appendix for Property Owners and Managers** is also included.

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# EXECUTIVE SUMMARY

The costs of energy used in multifamily rental housing are generally either paid by the property owner from residents' fixed monthly rents (owner-paid) or paid by tenants (tenant-paid) in one of three ways: directly to a utility company (individual or retail metering), to apartment management for individually metered or monitored consumption, or to apartment management for a share of an entire building's utility bill (formula billing, usually via RUBS, the Resident Utility Billing System). Several characteristics of these payment modes are shown in DISPLAY E1.

DISPLAY E1. UTILITY PAYMENT MODES

| Method | Energy charges and rents are | Quantity measured | Administration handled by |
|---|---|---|---|
| Retail meters | separate | electricity, natural gas, fuel oil | utility co. |
| Submeters | separate | electricity, natural gas | management |
| Monitors | separate | space (or water) heating, via correlates of energy use (thermostat "on" time, room temperature, etc.) | management |
| Formula billing | separate | none | management |
| Rent inclusion | not separated | none | management |

Both logical and empirical analyses suggest that tenants use energy more efficiently when they are themselves financially responsible for energy costs. However, actions of the property owner can be at least as important as those of tenants in determining the net energy use of a multifamily building, and owners of properties with tenant-paid energy costs have a less direct economic incentive for maintaining and improving energy efficiency than do owners who pay for energy costs directly. Therefore, tenant payment may affect energy use in any--or all--of three ways:

- o reducing energy use by giving tenants the economic motivation to use energy more efficiently;
- o increasing energy use by removing the immediate, direct economic benefit to the owner who maintains or improves efficiency;
- o reducing energy use by prompting tenants to pressure owners to improve efficiency. Such pressure might be direct (complaints, threats to withhold rents or move out) or might be characterized as <u>market costs</u> pressure, in which housing units with lower tenant energy costs come to command higher rents.

The full report presents results of a comprehensive examination of tenant payment of energy costs, especially heating costs, in multifamily housing. The emphasis is on space and water heating because there is more variance in payment mode for these functions and because space and water heating account for roughly three-quarters of end-use energy consumption in multifamily housing. DOE figures indicate that the 9 million rental households in multifamily units with owner-paid space and/or water heating consume on the order of 0.8 quadrillion Btu's of natural gas and oil annually.

This summary is organized around 12 questions concerning energy use and tenant payment of energy costs.

## E.1 HOW DOES ENERGY USE CHANGE IN THE YEAR FOLLOWING INTRODUCTION OF TENANT PAYMENT?

Energy use records from one year before the introduction of tenant payment to at least six months after were available for 95 cases representing 83 properties. The cases are distributed as follows:

- o fuel type: 61 gas, 34 electric
- o location: 50 San Diego area, 26 Colorado (mostly Denver), and 19 other, including Wisconsin, Ohio, Pennsylvania, Nevada, Texas, Indiana, Kansas, and Oregon
- o payment mode for
  - space heating: 55 measured consumption, 12 formula

- water heating: 14 measured consumption, 17 included in fixed rents (in these properties tenants pay for use of space heat [measured by monitors] but not for water heating), and 35 formula. In 23 of these properties, tenants are billed for both space and water heating, but only use of space heat is measured, by heat monitors. Water heating is billed according to apartment size, number of occupants, or other factors.

- lights and appliances: 30 measured consumption, 3 formula.

Starting dates for tenant payment in the 83 properties range from January 1979 to November 1981. The properties are predominantly garden apartments and low-rise buildings. Energy use before introduction of tenant payment can be described as follows. The 25 San Diego-area properties with electric lights and appliances (no space cooling) used 110 to 361 KWH/unit/month, median 192, with higher use in high-rent properties. In the 22 San Diego properties using gas for space and water heating, total gas use ranged from 18 to 71 CCF/unit/month, median 41, with an average of 40% of the annual total used for space heating. In the 26 Denver area properties using gas for space and water heating, total use ranged from 48 to 104 CCF/unit/month, median 77, with an average of 54% used for space heating. Greater use was observed in older properties, those with higher rents, and those with fewer units.

The methods used in the current study differ in two important ways from those used in past studies (MRI, 1975; EPRI, 1977; Booz/Allen, 1979). First, every effort was taken to avoid bias in the selection of properties for analysis. For example, when meter firms were contacted to refer properties, data were obtained for <u>all</u> properties meeting explicit criteria (e.g., for start dates, size, fuels used). Second, <u>monthly</u> energy consumption and weather data were obtained for every property. This allowed the energy use-weather relationship to be modeled individually for each property, thereby providing a much more precise weather correction than that available with the annual consumption data used in most past work. This method also enabled the calculation of separate estimates of changes in energy used for lights and appliances, for space heating, and for water heating.

DISPLAY E2 lists results from the 95 cases described above, plus estimates from past work. The last column presents estimates of reductions in energy use to be expected in the first year following introduction of tenant payment in similar situations in the future; these estimates incorporate the results of this study and of those cited above. Reductions for at least half of all similar properties introducing tenant payment should be expected to fall within the specified ranges.

Actual changes for the 95 cases ranged from a drop of 37% to an increase of 9%. Much of the variance over properties is at present unexplainable. However, reductions in energy use are related to characteristics of the properties and billing systems as follows:

DISPLAY E2. UPDATED ESTIMATES OF SHORT-TERM ENERGY REDUCTIONS

| Energy function | | Past work | New data | Current estimate |
|---|---|---|---|---|
| Billing by formula | | | | |
| Space & water heating (usually gas) | median | 5% | 6% | 6% |
| | range | 0-15% | 0-13% | 0-15% |
| | N* | 5 | 12 | |
| Electric lights, appliances, (cooling) | median | 8% | 5% | 6% |
| | range | 0-15% | 0-15% | 0-15% |
| | N | 5 | 3 | |
| All-electric | median | 5% | - | 6% |
| | range | 0-15% | - | 0-15% |
| | N | 8 | 0 | |
| Billing by measured consumption | | | | |
| Space and water heating (usually gas) | median | 5% | 14% | 14% |
| | range | 0-20% | 8-21% | 5-20% |
| | N | 7 | 50 | |
| Electric lights, appliances, (cooling) | median | 22% | 14% | 17% |
| | range | 10-35% | 8-17% | 5-30% |
| | N | 16 | 25 | |
| All-electric | median | 14% | 25% | 17% |
| | range | 5-25% | 15-35% | 10-30% |
| | N | 10 | 5 | |

*Number of properties analyzed.

- Reductions are clearly smaller with formula billing than with billing by measured consumption; this difference is statistically reliable for space heating but not for water heating.

  Reductions in total annual gas use (space plus water heating) averaged 14% in the 50 properties billing for space heating by measured consumption, 6% in the 12 billing by formula. The probability that a difference of this magnitude could occur by chance is less than 1%. Thus, there is clear evidence that the individual monetary incentive associated with measured consumption billing leads to greater changes in energy use than the group incentive offered by formula billing. Still, formula billing is associated with some degree of reduction in total energy use; the probability that the 6% reduction observed with formula billing could have occurred by chance is less than 2%.

- Fuel type, energy function, and property location/climate have little effect on energy reductions. Reductions are similar for properties in Denver, San Diego, and Wisconsin; for space/water heating and lights/appliances; for electricity and gas. Although the results indicate greater reductions in all-electric properties than in those introducing tenant payment for gas space and water heating or electric lights and appliances only, this finding is based on only five all-electric properties, and so could be due simply to chance.

- Reductions in use of gas for space heating are greater than those in use of gas for water heating, median 16% vs. 11%. Partly as a result, greater reductions in total gas use are found in properties with high proportions of space heating for their location.

- The effects of energy prices and costs on reductions in energy use are very weak. The data offer little support for the idea that higher energy prices will lead to greater initial reductions in energy use with the introduction of tenant payment, and offer no evidence whatsoever of an association between reductions in energy use and energy costs paid by tenants, or energy costs in relation to rent. However, variance in price and costs over properties is minimal in this sample, and costs are relatively low, with cost-to-rent ratios under 10% in almost all properties. These considerations suggest that reductions may be expected to fall near the high end of the ranges listed in DISPLAY E2 when the ratio of tenant bills (averaged over a year) to rent exceeds 15-20%. However, reductions should not be expected to increase indefinitely as energy costs increase, and in no case should be expected to exceed 30%.

- Reductions are unrelated to other property characteristics, including property size, rent, starting date of tenant payment, and method of billing for water heating.

## E.2 DO OWNERS OF TENANT-PAYMENT PROPERTIES DO ANYTHING TO IMPROVE ENERGY EFFICIENCY?

Owners and managers of tenant payment properties in Atlanta (N = 20) and Portland, Oregon (N = 24) participated in a written survey designed to answer this question; the survey was administered by the Institute of Real Estate Management (IREM). An additional 17 Atlanta properties with owner-paid space and/or water heating were also surveyed; see section E.3. The properties were located by IREM through membership lists, apartment association lists, and the like; they are not representative of all rental properties in Portland and Atlanta. In particular, all surveyed properties had at least 12 units and were built between 1960 and 1977.

In both Atlanta and Portland, the typical property surveyed was built in 1970, rented two-bedroom units for $275-80 per month in 1982, and is located in the suburbs. Most of the variance in rents across properties can be predicted from property and owner characteristics.

Portland owners have made efficiency improvements in the last four years, even though tenants pay directly for their own energy use in all the properties. Almost two-thirds of the sample properties improved at least one major energy system; one-quarter improved two. The improvements made were aimed at reducing tenant bills as well as reducing costs in common areas; frequent examples include storm windows, hot water tank insulation, and lighting improvements. These data argue against the position that owners of tenant-payment properties will do nothing to maintain or improve energy efficiency.

The Portland data also suggest a reasonable link between tenant and owner actions. Tenant inquiries about energy costs are associated with efficiency improvements and energy maintenance; properties making improvements advertise their efficiency; advertising is associated with tenant inquiries. Thus, there is a feedback loop acting to increase owner awareness of and motivation for energy efficiency. The link between tenant inquiries and owner actions may be enhanced by Portland's high vacancy rate, which could give tenant opinions and actions more power to influence owners.

Although roughly 70% of the variance in energy actions by Portland owners can be accounted for by combinations of demographic variables (e.g., ownership type, location), these combinations are not very theoretically satisfying, and could not be used as a basis for policies to increase the probability of energy action.

The Atlanta properties with total tenant payment have also made improvements to energy systems over the last four years. In addition, tenant-payment properties using expensive electricity for space and water heating are more likely to engage in some energy actions than those using gas. These findings indicate that owners of tenant-payment properties are not completely unwilling to take energy actions, and that their willingness is to some extent affected by "reasonable" factors such as fuel cost.

In sum, owners of tenant-payment properties have made improvements to the energy efficiency of their buildings and equipment. In both Portland and Atlanta, at least 60% of the properties with total tenant payment have improved one or more energy systems in the last four years; 25% in Portland and 35% in Atlanta have improved two or more systems. In Portland, the number of efficiency improvements made is related to the frequency of tenant inquiries about energy costs, indicating that tenant concerns may play a role in motivating owner action. In Atlanta, energy price (electric vs. gas) is related to inclusion of efficiency measures in regular maintenance, indicating that the owners of tenant-payment properties are responding to high tenant energy costs. Thus in both cities there is evidence that the financial concerns of tenants who pay their own energy costs are affecting owner behavior.

## E.3 DO OWNERS OF TENANT-PAYMENT PROPERTIES DO LESS THAN OWNERS WHO PAY DIRECTLY?

This question was addressed by contrasting energy actions in three groups of Atlanta properties surveyed by IREM: tenant-paid gas heat (N = 5), owner-paid gas heat (N = 11), and tenant-paid electric heat (N = 21). The results suggest that tenant payment does depress owner actions to improve energy efficiency, but not to the degree previously expected. In general, less than 10% of the variance in energy actions across properties can be explained by payment mode. However, there is some evidence that the determinants of owner action may be different for owner- and tenant-paid properties. These results cannot be used to conclude that differences between owner- and tenant-payment properties in other cities are as slight as they are in Atlanta, or that as many efficiency improvements have been made to tenant-payment properties in other cities as in Atlanta and Portland. However, the results do indicate that, under certain conditions, owners of properties with tenant-paid energy costs do make investments in energy efficiency, and that the frequency with which they do so is only slightly lower than that for properties with owner-paid costs. For cities with tenants who are concerned about energy costs, this is good news.

## E.4 ARE ENERGY EFFICIENCY AND COSTS MENTIONED IN ADVERTISING FOR RENTAL HOUSING?

If tenants are concerned about energy, rental property owners are likely to mention energy efficiency in their advertising in order to attract tenants. The extent to which this is now occurring was investigated in a sample of 32 cities selected from the 50 largest in the U.S. to represent a broad range of rental markets in all regions of the country. Classified advertisements for residential units for rent were obtained for all 32 cities from the Sunday August 16, 1981 editions of local newspapers. The percentage of entries mentioning energy efficiency, costs, or features was calculated for each city. The items most frequently mentioned include (in order) general energy efficiency, double-glazed and storm windows, insulation and weatherization, heat pumps, other specific features, and solar equipment. (Sample advertisements are shown in Display c of Appendix C.)

Scores for single family homes are consistently higher than multifamily scores, probably because tenant-paid energy costs are more common in single family units than in multifamily, where energy costs are often included in fixed monthly rents.

Based on the multifamily scores, the 32 cities can be divided into four categories:

- o high mention: Atlanta, Charlotte, Portland (Oregon), with scores of 5 to 10%

- medium: Columbus, Jacksonville, Memphis, San Antonio, Seattle, Tampa

- low: Cincinnati, Kansas City, Louisville, Oklahoma City

- no mention: Baltimore, Boston, Chicago, Denver, Detroit, Houston, Indianapolis, Los Angeles, Milwaukee, Minneapolis, New Orleans, Oakland, Omaha, Philadelphia, Phoenix, Pittsburgh, San Diego, San Jose, St. Louis.

The pattern of scores across cities is probably a function of two factors. First, tenants are not likely to be concerned about energy costs if they are included in fixed monthly rents. The proportion of multifamily properties requiring tenant payment of all energy costs (usually electricity plus gas or oil) is highly correlated to the frequency with which energy is mentioned in advertising.

Second, given otherwise favorable conditions, local energy programs can increase awareness of energy costs by both tenants and owners, making advertisements featuring energy efficiency more likely. This seems to have occurred in two high-mention cities. Portland has low energy costs but active city and utility conservation programs, including some programs designed especially for rental property owners. In another high-mention city, Atlanta, the electric utility (Georgia Power) has a program to certify multifamily properties meeting specified efficiency standards. Only properties built since 1979 are eligible to receive the "Good Cents" certification. Electric heat is not required for certification. The Good Cents logo is featured in many Atlanta advertisements, at least partly because qualifying properties receive a one-time advertising subsidy from the utility. The hope of the utility is that Good Cents certification provides a quick, standardized, authoritative way for owners to tell tenants that their properties are efficient. Portland and Atlanta far surpass all other cities in total numbers of multifamily ads mentioning efficiency.

## E.5 DO PROSPECTIVE TENANTS ASK ABOUT ENERGY COSTS?

Data addressing this and the two following questions were collected in Atlanta, the city with the greatest proportion and greatest absolute number of multifamily advertisements mentioning energy.

The sample included all 82 multifamily rental properties in the north-central/northeast area which advertised in the Atlanta Journal-Constitution or in any of five apartment guide magazines during fall 1981. Most of the properties were built after 1970; they typically accept children, have amenities such as swimming pools, and rent two-bedroom units for around $400. Over 80% (N = 69) of the managers surveyed responded to a questionnaire containing items about property and unit size, rents, type of heating fuel, amenities (pools, tennis courts, fireplaces, etc.), age, utility payment patterns, energy costs paid by tenants, and mention of energy in advertising. Over half of these properties mention energy costs or efficiency in their advertising.

Respondents were asked directly "How often do prospective residents ask about energy costs?" and given a 5-point response scale from "never" to "almost always". The percentage distribution for the 69 responding properties is as follows: "half the time" or less, 6%; "often", 18%; "almost always", 76%. Obviously, the leasing agents and resident managers who responded to the survey may have over-reported the incidence of inquiries. However, the consistency of the responses, coupled with comments made by respondents, indicates that a significant number of tenants shopping the north-central/northeast Atlanta market are at least asking about energy costs; what is done with this information when the decision is made is, of course, another matter. The data do not imply that tenant inquiries are equally frequent in other cities, or even elsewhere in Atlanta, because the submarket surveyed was selected for study because of the high frequency with which properties there mention energy efficiency in their advertising.

## E.6 ARE RENTS RELATED TO THE ENERGY COSTS TENANTS MUST PAY?

When tenants are concerned about energy costs (as reflected by inquiries by prospective tenants) and owners are aware of those concerns (as reflected by their use of advertising appeals), housing units with low energy costs should command higher rents than comparable units which have high energy costs or which lack common energy efficiency features. This prediction was tested in a subset of the 69 Atlanta properties described above.

The subset includes all 48 of the 69 properties which have 2-bedroom units and tenant-paid space heating and cooling. The units of all properties in the subset have electric air conditioning, a stove, refrigerator, dishwasher, disposal, patio or balcony, and carpeting. The typical property was built in 1978, has a 5% vacancy rate, and has over 100 two-bedroom units of 1100 square feet, renting for just under $400 per month in 1982. Tenants pay for gas space and water heating in 60%, for electric space and water heating in 23%; all tenants pay for electric lights, appliances, and space cooling.

Four types of information related to energy were collected for each property: heating fuel (electric [35%] or gas; this is important because electricity costs over two times as much per BTU as does gas); mention of energy efficiency in advertising (63%); certification by the Georgia Power Good Cents program (23%); and expected average monthly energy cost for tenants, as reported by the manager or leasing agent. The median tenant energy cost is $55; 73% of the properties have monthly costs averaging between $45 and $75.

The set of variables including unit size in square feet, property age, and presence of fireplaces (considered as luxury amenities rather than as heat sources) explains 77% of the variance in rents over the 48 properties. To estimate the effects of the energy-related factors on rents after the effects of other factors have been controlled or removed, the quantity <u>residual rent</u> = (actual rent - expected rent) was calculated for each property. The average residual rent for the 48-property sample is of course zero; the range is from -$78 to +$60; the average absolute value is $24, or 6% of average rent.

Are differences between actual and expected rents related to differences in energy costs across properties? Properties with higher reported energy costs do have lower residual rents, as would be the case if tenants were unwilling to pay market rents for units with high energy costs. However, each additional $1 in energy costs is associated not with $1 less in rent, but with $.50 less. Thus rents for units with high reported energy costs are being discounted by only half as much as would be necessary to make their total cost (rent plus energy) equal to that of equally desirable units with lower energy costs.

## E.7 ARE RENTS RELATED TO ENERGY EFFICIENCY FEATURES OR ADVERTISING?

Property characteristics are not strongly related to reported energy costs in the 48 Atlanta properties. Property age and unit size each account for only 7% of the variance in costs across properties. Properties with gas heat have energy costs $8 lower (per unit per month) than those with electric heat; properties advertising energy efficiency have costs $9 lower than those which do not; certified properties have costs $6 lower than those without certification. All five property characteristics taken together account for only 16% of the variance in energy costs.

The finding that property age and Good Cents certification are essentially unrelated to reported energy costs is surprising, since it is usually assumed that new construction, especially that meeting the certification standards, is significantly more energy efficient than older construction. This may be due to a compensation phenomena, whereby tenants of less efficient properties (and of those with more costly electric heat) adopt lower comfort levels than do tenants in more efficient properties, bringing actual energy use and costs to a more or less equal level across properties with differing levels of thermal and equipment efficiency.

Even though property features are only weakly related to reported energy costs, they may still affect rents or residual rents. This would happen if tenants concerned about obtaining housing with low energy costs believed these features to relate to and predict energy costs. In fact, differences in residual rent are greater than those in reported energy costs for properties with and without gas heat and with and without energy advertising. For example, gas heat properties have residual rents $23 higher than those with electric heat, compared to a difference of only $8 in reported energy costs. This pattern of results implies that tenants are undervaluing expected energy costs and overvaluing the more easily-determined features of energy advertising and gas heat when making rental decisions; these behaviors by tenants then lead to rent differentials. Good Cents certification has no effect on residual rents.

The fact that management-reported energy costs cannot be readily predicted from property characteristics or advertising suggests that if energy efficiency is to play a stronger role in the Atlanta market, tenants will need improved information. An easy way for current and prospective tenants to obtain believable, comparable information on expected costs at several properties might both eliminate the disparity between rent and cost differentials and increase the role of energy efficiency in the Atlanta market.

## E.8 HOW DO BUILDING OWNERS AND TENANTS INTERACT TO AFFECT ENERGY USE?

The energy consumption of a building (or consumption per unit) is a function of climate, size of apartment units, average household size, the services provided to tenants (e.g., space cooling, swimming pool, washer/dryers) and energy efficiency--thermal insulation, air infiltration, equipment efficiency, and so on. Energy efficiency is in turn a function of the state of the building and its energy-using equipment, operating practices (e.g., thermostat settings on central boilers, maintenance, when space cooling systems are started up in the spring), and the way in which individual tenants use energy. The building owner or manager has primary control over the state of the building and equipment and over operating practices. However, both of these may also be influenced directly or indirectly by tenants. For example, tenants may install plastic window coverings, caulk windows, request that the pool be kept warmer, or complain that halls are overlighted. The energy-using habits of individual tenants are of course under tenant control. However, owner/managers can sometimes exert control in areas traditionally left to tenants--for example, by forcing night thermostat set-backs from a central processing unit.

The way in which tenants and owner/managers interact with one another vis-a-vis energy use is critically affected by payment mode. This interaction, described in detail in Chapter 5, determines how energy use changes in response to price increases and other external influences.

## E.9 WHAT ARE THE LONG-TERM EFFECTS OF TENANT PAYMENT ON ENERGY USE?

The long-term effect of tenant payment on energy use is determined by three independent factors: a) the one-time reduction in energy use which accompanies introduction of tenant payment; b) the ongoing or cumulative changes in energy use which price increases will prompt in tenant-payment properties; and c) the ongoing or cumulative changes in energy use which price increases will prompt in owner-payment properties. This third factor must be considered to yield an estimate of how use will change relative to how it would have changed without tenant payment. These factors were estimated as follows:

- one-time reduction, d
  - range 0 to 30%, depending on billing method and other factors
  - estimates from Chapter 2

- o annual change with tenant payment, t
  - range up 1% to down 2%
  - from Chapter 3, Chapter 4, and estimates of annual change in owner-occupied housing

- o annual change with owner payment, w
  - range up 1% to down 2%, but reductions probably equal or exceed those with tenant payment
  - from Chapter 3, Chapter 4, and estimates of annual change in rental multifamily control properties not introducing tenant payment.

When annual reductions in tenant-payment properties equal or exceed those in owner-payment properties, the benefit of reduced energy use associated with the introduction of tenant payment remains constant or increases over time; this situation presents no problems for policy. In contrast, if annual reductions are greater with owner payment, the initial benefit is eventually lost, overwhelmed by the disadvantage of smaller annual reductions in use in tenant-payment properties. How soon this happens depends upon the size of the initial drop (d) and on the relationship between t and w.

If there is a 0.5% difference between t and w (e.g., a 1% annual reduction with owner payment, 0.5% with tenant payment) and the initial reduction d is at least 8%, cumulative use with tenant payment remains below that with owner payment even after 20 years. With a 1% difference in annual change rates, cumulative tenant payment use over 20 years is below that with owner payment only for initial reductions of over 12%.

## E.10 WHAT ARE IMPLICATIONS FOR POLICIES CONCERNING PAYMENT MODE?

Governmental policies explicitly treating how energy costs are charged to tenants of multifamily housing are expressed in state utility regulations and in federal legislation. In many cases these regulations distinguish among four types of tenant payment: retail meters; submeters measuring use of electricity or natural gas; monitors measuring use of space heating, space cooling, or water heating; and formula billing. These regulations by and large serve to make retail metering more probable, rent inclusion less probable. Their effect on submetering, monitoring, and formula billing is mixed. While the primary goal of most of these policies is reduced energy use, consumer or tenant protection is also a consideration.

Do current policies succeed in their goal of reducing long-term energy use? At least five component questions must be considered in a full policy analysis:

- To what extent do the policies actually encourage tenant payment? Most state regulations are written in terms of types of meters (master, retail, sub), not in terms of who pays the bill. While retail and submetering virtually insure tenant payment, monitors can also be used to charge tenants for energy use according to measured consumption. Submeters, monitors, and formula billing are all compatible with master metering; furthermore, monitors and formula billing are the only possible methods of charging tenants for use of the outputs of central or shared equipment. Thus while recently enacted regulations do promote tenant payment by requiring retail metering (or in some cases submetering) in new construction, regulations already existing in 1974 often serve to discourage tenant payment by prohibiting use of monitors, formula billing, and/or submetering.

- Does tenant payment actually reduce long-term energy use? The figures presented above suggest that tenant payment does lead to long-term reductions in energy use if tenants are billed according to individually measured consumption (not by formula) and if the annual change rates are in accord with certain reasonable assumptions.

- Do the policies encourage use of individual space heating, space cooling, and water heating equipment for each apartment?

- Do the policies encourage use of electricity for space and water heating?

- Do the policies enhance or reduce the ability of utility companies to control electricity loads?

The questions above deal only with the effects of metering and payment mode policies on energy use. Other issues to be considered in policy development concern the effects of payment mode on tenants and on owners. These issues include the equity of tenant charges, accuracy of meters, tenant rights, and financial impacts on owners.

The results presented in this report suggest that requiring tenants to pay for their own, individually measured energy use is effective in producing long-term reductions in direct energy use. Furthermore, tenant payment is looked upon quite favorably by most building owners, since it insures immediate and automatic payment of a cost which is both variable and unpredictable. Many tenants seem to regard tenant-paid energy costs as an inconvenience which is inevitable with rising energy prices; many also welcome the chance to control these costs with their own actions.

Given this view, the obvious shortcoming of current policies is the way in which they act to impede the use of submeters and monitors. These devices are often the least expensive and, in the case of buildings with central equipment, sometimes the only way in which tenant energy consumption can be measured. Their use is prohibited in many states, and in no state is monitor use encouraged. There are no federal and few state standards for testing monitors. True, tenant protection issues are much more critical with owner-administered billing systems such as submeters and monitors than with retail meters. However, these issues are not insurmountable. In short, policy modifications are needed to encourage--or at least avoid discouraging--tenant payment in existing buildings with central heating, cooling, and/or water heating equipment.

## E.11 WHAT ARE IMPLICATIONS FOR POLICIES ON ENERGY INVESTMENT?

State and federal policies, plus some utility company programs, address energy investment in rental housing as well as payment mode. The goal of all such policies is reduced energy use; they fall into four categories: incentive programs, mandatory efficiency standards, information for owners, and information for tenants about the relative energy efficiency of various properties for rent.

The results of this project are relevant to energy investment programs in two regards. First, they indicate that, at least in cities like Portland and Atlanta, building owners have been making some energy investments even when tenants pay all energy costs. With this baseline, incentive and information programs may be useful in spurring further action.

Second, the Atlanta case study and the nation-wide advertising survey indicate that tenant concerns about energy costs can come to play a visible role in the rental market, and that in some instances owners of buildings with tenant payment can expect a payback in increased rental income for lowering tenant energy costs. However, even with cooperative utilities and a well-advertised certification program, Atlanta tenants face great difficulties in obtaining standardized information about energy costs in different properties. (The Georgia Power Good Cents certification covers only new construction and gives only a yes-no rating.) The policy implications are clear: programs to provide current and prospective tenants with an easy way of obtaining believable, comparable information about expected costs could act to increase the role played by energy in the market. This in turn would give owners of properties with tenant payment a more clear-cut economic benefit from energy investment. Such tenant information programs are probably most appropriately run by local governments to insure unbiased assessments and credibility, but could also be run by utilities, tenant groups, or even apartment associations.

## E.12 WHAT IS AN APPROPRIATE ROLE FOR FORMULA BILLING?

The benefit of long-term reductions in energy use is not automatic with formula billing. Given a short-term reduction in energy use of only 5%, the long term benefit is nil if the fact of tenant payment deters owner actions enough to reduce the annual change rate by 0.5%. If it deters owner actions enough to reduce the change rate by a full 1%, the long-term effect of formula billing on energy use is negative--there will be greater use over 10 and 20 years with formula billing than with owner payment.

Formula billing can have benefits other than reduced energy use, especially for property owners who cannot pay for any way of measuring individual energy use. It can also be useful as a first step on the way to billing by measured consumption. On the other hand, tenants are generally not favorable toward formula billing, preferring either rent inclusion or billing according to measured consumption, especially when energy costs are high. In sum, formula billing probably deserves no role in programs designed explicitly to reduce energy use.

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CHAPTER 1

# CHAPTER 1

# BACKGROUND AND GOALS OF THE PROJECT

The costs of energy used in multifamily rental housing are generally either paid by the property owner from residents' fixed monthly rents (owner-paid) or paid by tenants (tenant-paid) in one of three ways: directly to a utility company (individual or retail metering), to apartment management for individually metered or monitored consumption (submetering), or to apartment management for a share of an entire building's utility bill (formula billing, usually via RUBS, the Resident Utility Billing System). These various methods are hereafter referred to as payment modes. Combinations of payment mode are common; e.g., many tenants pay for use of electric lights, appliances, and cooling directly to the utility, but pay for space and water heating in their rents. Various methods used to measure energy consumption and calculate tenant bills are described in section 1.4. Owner-occupants of multifamily housing may pay for energy in similar ways, with homeowner or condominium association payments substituting for rents.

## 1.1 PROJECT RATIONALE, GOALS, AND ORGANIZATION

Both logical and empirical analyses suggest that tenants use energy more efficiently when they are themselves financially responsible for energy costs. However, actions of the property owner can be at least as important as those of tenants in determining the net energy use of a multifamily building, and owners of properties with tenant-paid energy costs have a less direct economic incentive for maintaining and improving energy efficiency than do owners who pay for energy costs directly.

When energy costs are paid directly by tenants rather than included in fixed rents, energy efficiency measures made by the owner will lead to lower energy costs for tenants. This in turn can benefit the owner by allowing higher rents, increasing tenant satisfaction, lowering vacancy and turnover rates, and increasing the sales value of the property. However, none of these effects is as direct or as immediate as the reduction in operating costs which would occur when the owner pays energy costs directly. On the other hand, tenants who pay their own bills may pressure owners into more efficiency improvements than they might otherwise make.

Thus, tenant payment may affect energy use in any--or all--of three ways:

- o reducing energy use by giving tenants the economic motivation to use energy more efficiently;
- o increasing energy use by removing the immediate, direct economic benefit to the owner who improves efficiency;
- o reducing energy use by prompting tenants to pressure owners to improve efficiency. Such pressure might be direct (complaints, threats to withhold rents or move out) or might be characterized as market pressure, in which housing units with lower tenant energy costs come to command higher rents.

This report presents results of a comprehensive examination of tenant payment of energy costs, especially heating costs, in multifamily housing. The emphasis is on space and water heating because there is more variance in payment mode for these functions (see section 1.3) and because space and water heating account for roughly three-quarters of end-use energy consumption in multifamily housing. The report is organized as follows:

- o CHAPTER 2 assesses the effect of tenant payment on tenant behavior by examining changes in energy use in the first year following introduction of tenant payment. Comparisons to similar past work are also made.
- o CHAPTER 3 addresses two questions: Do owners of properties with tenant payment do anything to maintain and improve energy efficiency? Do they do significantly less in this regard than owners of properties with owner-paid energy costs?
- o CHAPTER 4 assesses the degree to which market pressures for efficiency are operating in U.S. rental markets in general and in the Atlanta market in particular.
- o CHAPTER 5 uses the results from Chapters 2, 3, and 4, plus time trends in energy use in properties not introducing tenant payment, to estimate the long-term effects of tenant payment on energy use. Implications of the results for policies regarding energy metering in multifamily housing and for methods of encouraging energy investments in properties with tenant payment are also discussed.

## 1.2 RELATED PAST WORK

Several works dealing primarily or partially with the relationship between energy use and payment mode in rental and/or multifamily housing have been published since 1975. These works can be divided into three groups based on their orientation and date of publication.

1. Early empirical works by Midwest Research Institute (MRI, 1975) and the Electric Power Research Institute (EPRI, 1977) and a review by Real Estate Research Corporation (RERC, 1975) focus exclusively on changes in tenant behavior and short-term energy use associated with tenant payment. There is absolutely no mention of owner motivation or owner investments in efficiency in these works, nor any acknowledgement that owner actions can affect a building's energy use. RERC concludes that conversion to tenant payment "would be the most important single step which could be taken to reduce energy consumption in multifamily dwellings" (p. 75).

2. Booz/Allen (1979) and the Institute of Behavioral Science (IBS, 1980) both present additional data on short-term energy reductions with tenant payment (Booz/Allen for metered natural gas, IBS for formula billing) and review data from MRI and EPRI. While both works focus on tenant actions, both acknowledge a possible negative effect of tenant payment on owner actions. A similar orientation is found in the proceedings of a Federation of American Scientists workshop on energy use in multifamily rental housing (FAS, 1980).

3. Two review/discussion papers published in 1981--Levine and Raab, Counihan and Nemtzow--shifted the focus to owners. Counihan and Nemtzow note that tenant payment "may have a catastrophic effect on the investment behavior of landlords" (p. 1118); Levine and Raab adopt a similar tone. While both discuss the theoretical possibility of market pressures on owners of tenant-payment properties to improve energy efficiency, they conclude that such pressure does not occur in practice in the U.S. Neither paper discusses the effect of tenant payment on tenant behavior.

This view is further developed in two interview studies published in 1982. The Office of Technology Assessment (OTA, 1982) commissioned RERC to conduct interviews of multifamily owners in four cities, and of owners with nation-wide holdings. OTA reports that no owners of tenant-payment properties had made improvements to building or equipment efficiency, and concludes that tenant payment "provides virtually no incentive" (p. 119) for owner investment. Again, however, the possibility of market pressure is raised. Levine et al. (1982) interviewed 35 owners in Boston, Chicago, San Francisco, and Denver; they conclude that tenant payment is "the largest most obvious barrier to energy conservation" (p. 19) in multifamily housing--a total reversal of the conclusion of the 1975 RERC review! Levine does state that owners of very small buildings and those in areas with high tenant energy costs (e.g., Boston, with oil heat) are investing in efficiency improvements in order to appease tenants.

The current project represents an effort to balance the historical emphasis on tenant behavior with more recent concerns about owner behavior, and also to examine market pressures directly for the first time.

## 1.3 THE EXTENT OF TENANT PAYMENT OF ENERGY COSTS

### 1.3.a Current Estimates

Tenant payment of electricity is quite common in the U.S., with approximately 83% of households in buildings with 2-4 units and 69% of those in buildings with 5 or more units paying for their own electricity use. Tenant payment of space and water heating costs is less common. This is because (a) these functions are often supplied by central or shared equipment, precluding retail metering, and (b) the most frequently used heating fuels, natural gas and fuel oil, have historically cost far less than electricity, making building owners less concerned about footing their costs from rental income. Accordingly, tenants pay for space heating in only about 47% of households in buildings with 2 or more units. All estimates are from the Annual Housing Survey (AHS), 1979.

The extent of tenant payment for space and water heating varies with geographical region, as shown in DISPLAY 1.a (page 1-8). While 55% of all rental multifamily (2 or more units per building) households in the south, north-central, and western census regions pay their own space heating costs, only 30% do so in the northeast. As a consequence of this geographic distribution, households with tenant-paid space heating tend to reside in warmer climates: 66% live in areas with less than 4000 annual heating degree days, while 61% of households with owner-paid space heating live in areas with over 5500 annual heating degree days. (Figures are from Annual Housing Survey, 1979, and from DOE, 1981.) Although estimates of energy use vary substantially, figures from the Residential Energy Consumption Survey (DOE, 1981) indicate that the 9 million rental households in multifamily units with owner-paid space and/or water heating consume on the order of 0.8 quadrillion Btu's of natural gas and oil annually.

Regional differences in climate and energy prices also lead to differences in energy costs among households who pay all their own energy costs, as shown in the lower portion of DISPLAY 1.a (page 1-8). Average 1979 cost per household per month ranged from $24 in the west to $50 in the northeast. Cost-to-rent ratios averaged about 12% in the west, 30% in the other three regions. (Figures are from Annual Housing Survey, 1979.)

The extent of tenant payment for space heating also varies with space heating fuel. While less than 10% of multifamily households with oil heat pay for space heating directly, 54% with gas heat do so, and 74% with electric heat (AHS, 1978). This distribution occurs primarily because use of separate heating equipment (vs. central or shared equipment) is most common with electric heat, least common with fuel oil. The distribution of tenant-paid water heating by water heating fuel is virtually identical to that for space heating.

The net effect of the regional and fuel-type differences in payment mode is as follows: of 9 million households with space heating costs included in fixed rents, 35% are in oil-heated buildings in the northeast census region. Another 18% are in gas-heated buildings in the north-central region; 28% are in gas-heated buildings in the other three regions. Thus 81% of all U.S. households with owner-paid space heating reside in buildings with gas heat or in northeastern oil-heated buildings. Overall, 46% of these households reside in the northeast, 21% each in the south and north-central, and 12% in the west. On the other hand, households with tenant-paid space heating reside primarily in buildings with gas heat (61%) or electric heat (34%); they are evenly distributed over census region (19% northeast, 24% north-central, 28% south, 29% west).

### 1.3.b Recent Trends

The rate at which energy prices have increased in recent years has far outdistanced the rate at which rents have increased, especially for natural gas and fuel oil. These differential increases mean that owners of owner-payment properties have been left with a steadily decreasing proportion of income to cover non-utility operating expenses, debt service, and return on investment. One response to this dilemma is disinvestment, with actions ranging from reduced maintenance to non-payment of taxes and outright abandonment. An alternate response is to shift responsibility for utility costs from the owner to tenants through retail metering, submetering, or formula billing.

Tenant payment of utilities holds clear benefit for the property owner: a seasonally variant, unpredictable, rapidly increasing cost is removed from operating expenses and instead covered immediately and automatically by payments from tenants. Accordingly, it is becoming more and more common in both new and existing properties. The Census surveyed privately financed, unfurnished rental multifamily units (5 or more apartments per building) completed in 1973, in 1976, and in 1977 (Census, 1978, 1979). The proportion of newly-constructed units with owner-paid electricity was 27% in 1973, 16% in 1976, 9% in 1977. Similarly, the proportion with owner-paid space heating was 61% in 1973, 45% in 1976, 30% in 1977. No more recent data of this type are available, but it is probable that the trend toward tenant payment in new construction has continued.

Data on conversions to tenant payment in existing properties are available only from metering firms and from owner reports. The number and size of firms distributing electric submeters have grown significantly since 1978; the growth of firms distributing devices which monitor the output of central heating systems to individual apartments (so that tenants can be billed for heat) has been even more dramatic. In the Denver area alone there are now an estimated 100-200 properties billing tenants for monitored heat use, up from a handful in

1979; the number using formula billing for heat has increased similarly. With ever-increasing heating fuel costs and with tenant-paid heat becoming common in the market, these trends will no doubt continue and spread to other markets.

## 1.4 METHODS OF DETERMINING TENANT ENERGY BILLS

Tenants of rental housing can be charged for energy costs in many ways, but the most common payment modes differ on three basic dimensions: Are energy charges separate from or included in fixed rents? Is actual energy use in individual apartments measured, is a stand-in or correlate measured, or are no measurements made? Is administration handled by the owner/manager (or a representative thereof) or by a utility company? DISPLAY 1.b (page 1-9) lists the five major methods of charging tenants for energy and shows their standing on these dimensions. Other features of these payment modes are described below.

- Retail meters, also called utility company or individual meters, measure the electricity, natural gas, or fuel oil used by individual households. A tenant with a retail meter is in basically the same position as the owner of a single family home; all billing safeguards imposed by regulatory agencies automatically apply.

- Submeters measure gas or electricity used in individual apartments; they are placed between the (utility company) master meter serving the property and individual apartments. Meter reading and billing may be handled by the manager directly, or by a meter or billing firm. In some cases the entire reading and billing operation is handled automatically by electronic equipment.

- Monitors measure some correlate of energy use, such as heat or water flow, the amount of time the furnace is used, or room temperature. Monitors are designed for use with shared or central system space heating equipment, for which submeters are useless. Dozens of methods for measuring space heating used in individual apartments exist; they range in cost from about $30 to over $300 per unit (or heat line), plus installation, with cost and accuracy generally correlated. Some firms handling monitors adjust the readings to account for differential heat loss in apartments in various building locations; others do not. Monitor reading and billing are handled in the same ways as they are with submeters. The number of U.S. properties now billing tenants for monitored use of space heating is probably under 1000. In contrast, over 40 million monitors are in use in Europe, and tenant billing is regulated by national or local standards in several countries there.

Although monitors for domestic hot water use exist and are used in Europe in multifamily housing, they have not been used in the U.S. in more than a handful of properties. When monitors are used to measure space heating use, tenants are often charged for water heating also, with charges determined by apartment size, number of occupants, etc.

- With formula billing no measurements of individual use are made; instead, residents are charged for a share of an entire building's energy consumption. The best-known formula billing method is called RUBS, for the Resident Utility Billing System, in which charges are based on apartment size.

- Energy costs may also be included in fixed rents.

Other methods are possible--e.g., fixed rents with an escalation clause--but will not be considered here. Of the five payment modes listed above, only retail meters and rent inclusion are universally legal, although rent inclusion may be prohibited in new construction. The utility regulations of individual states may prohibit use in existing buildings of none, one, two, or all three of submeters, monitors, and formula billing, in virtually every combination possible. These regulations were reviewed in IBS (1980) for formula billing and in Booz/Allen (1979) for submeters; no more recent survey of regulations has been made.

Tenant payment by submeters and by monitors are essentially identical in effect for both tenants and owners; therefore, no distinction is usually made between these two methods in the remainder of this report; both are referred to as "submeters".

## 1.5 DISPLAYS

### 1.5.a DISPLAY 1.a. Energy Payment Modes And Energy Costs In Multifamily Housing, By Census Region

| | Census region | | | |
|---|---|---|---|---|
| | West | South | N-central | Northeast |
| **Multifamily households (buildings with 2+ units)** | | | | |
| Number in thousands | 4316 | 4862 | 4887 | 7088 |
| owner-occupied | 11% | 11% | 16% | 17% |
| in bldgs with 5+ units | 60% | 59% | 16% | 17% |
| With tenant-paid | | | | |
| electricity | 75% | 67% | 78% | 74% |
| space heating | 65% | 55% | 49% | 27% |
| water heating | 65% | 58% | 52% | 34% |
| **Multifamily households with complete tenant payment** | | | | |
| Average energy cost* | $ 24 | $ 44 | $ 43 | $ 50 |
| Average rent* | $193 | $141 | $148 | $159 |
| Cost-rent ratio | 12% | 31% | 28% | 31% |

*Energy costs are per household per month; rents values exclude energy costs.

Figures are from Annual Housing Survey, 1979.

1.5.b DISPLAY 1.b. Five Methods Of Handling Energy Costs In Rental Multifamily Housing

| Method | Energy charges and rents are | Quantity measured | Administration handled by |
|---|---|---|---|
| Retail meters | separate | electricity, natural gas, fuel oil | utility co. |
| Submeters | separate | electricity, natural gas | management |
| Monitors | separate | space (or water) heating, via correlates of energy use (thermostat "on" time, room temperature, etc.) | management |
| Formula billing | separate | none | management |
| Rent inclusion | not separated | none | management |

CHAPTER 2 EFFECT OF TENANT PAYMENT ON SHORT-TERM ENERGY USE

# CHAPTER 2

# EFFECT OF TENANT PAYMENT ON SHORT-TERM ENERGY USE

This chapter reviews past work on and presents new estimates of changes in energy use in the first one to two years following the introduction of tenant payment. These immediate changes in energy use are generally due simply to changes in tenant behaviors such as thermostat settings, and cannot reflect any long-term effects of tenant payment on the owner's efforts to maintain and improve the efficiency of the structure and equipment. Thus, the results reported in this chapter must be balanced against those reported in Chapter 3, on owner investment behavior, and Chapter 4, on market pressures for energy efficiency. This balance is the subject of Chapter 5, on predicting the long-term effects of tenant payment on energy use.

## 2.1 RELATED PAST WORK

Early empirical work on tenant payment was designed to inform utility companies, property owners, and governmental agencies of the change in energy use to be expected with the introduction of tenant payment. Primary data on 30 properties were collected and reported by MRI (1975), EPRI (1977), and Booz/Allen (1979). The comparisons reported by these sources were synthesized by IBS (1980), which also reported data on 14 properties using the formula billing method RUBS (the Resident Utility Billing System), wherein tenants are billed by management for a pro-rata share of an entire building's utility charge.

DISPLAY 2.a (page 2-16) summarizes the results of the IBS synthesis and RUBS analyses; all MRI, EPRI, and Booz/Allen results have been incorporated.

## 2.2 CURRENT WORK: BACKGROUNC

The work reported in this chapter represents an attempt to update the estimates in DISPLAY 2.a (page 2-16), most of which date from 1977 and earlier. Available resources did not allow systematic data collection for every cell of ch2t1. Instead, an effort was made to find a large pool of properties using submeters to charge tenants for gas space and water heating. This focus was adopted because

- less than 50% of U.S. multifamily households now pay for their own gas or oil space and water heating, while a majority do so for electricity;

- previous estimates of the energy reductions to be expected with tenant-paid space and water heating are few in number, methodologically unsound, and inconsistent, while comparable estimates for electric lights, appliances, and cooling are generally consistent and methodologically adequate;

- submetering for space heating will likely be much more common than formula billing (RUBS) in coming years due to legal constraints on and problems with tenant acceptance of RUBS.

The methods used in the current study differ in several ways from those used by MRI, EPRI, and Booz/Allen.

- Every effort was taken to avoid bias in the selection of properties for analysis. Most properties were obtained by contacting owners and managers directly; when meter firms were contacted to refer properties, lists of all properties meeting explicit criteria (e.g., for start dates, size, fuels used) were obtained. In contrast, most of the cases studied previously were selected by utility companies using unstated criteria.

- Monthly energy consumption and weather data from at least one year prior to the introduction of tenant payment and at least six months after were obtained for every property. These data allow the energy use-weather relationship to be modeled individually for each property, thereby providing a much more precise weather correction than that available with the annual consumption data used in most past work.

- Information on average rents and on energy costs was collected whenever possible to allow computation of average tenant-paid energy costs and of these costs in relation to rent, providing a direct check on the effect of the size of the economic incentive on the resulting reduction in energy use.

- Whenever possible, the results for properties introducing tenant payment were compared to those for control properties in the same city in which no change in payment mode was made.

## 2.3 PROPERTY SELECTION

The search for properties began with the meter manufacturers and distributors, utility companies, energy consultants, cities, apartment associations, and property owner/managers who had received information on the IBS project between 1976 and 1981--some 1200 firms and individuals in all. Notices were also placed in publications of the National Apartment Association and the Institute for Real Estate Management, and in Apartment Management Newsletter. Respondents who indicated they were associated with any properties introducing tenant payment in or after 1979 were asked to provide information on property location, size, current payment mode, fuels, and energy functions; this procedure yielded information on over 300 properties.

Cases for analysis were selected from this set by the following criteria:

- o 20 or more rental units (no condominiums or cooperatives);
- o retail meters, submeters, or formula billing introduced in or after 1979;
- o 80% or more of all tenants paying energy costs by May 1981;
- o maximum of three properties owned and/or managed by one firm or individual.

The criteria were relaxed for submetered space and water heating to include properties with as few as 8 units with start dates as late as November 1981. Properties introducing retail meters were not included unless the master meter had been left in place because resources were not available to obtain record release permissions from individual tenants.

Application of these criteria reduced the number of eligible properties to about 100. Data were analyzed for all 45 eligible properties for which energy use records were available from one year before the introduction of tenant payment through April 1982. In addition, the California Edison Utilities Company (CUEC), a submetering firm, provided energy use data on 48 San Diego-area properties introducing electric and/or gas submetering 1979-81, bringing the total to 93 properties. Ten San Diego properties and four in other locations had introduced tenant payment for both gas and electricity, yielding 107 cases for analysis.

## 2.4 ANALYSIS METHOD

The basic method of analysis is outlined below.

### 2.4.a Data Cleaning

All data were checked for obvious meter-reading errors, aberrant use figures, and the like, and the records cleaned up accordingly.

### 2.4.b Correcting For Weather

Linear regression analysis was used to describe the relationship between energy use during the "before" period and heating and/or cooling degree days (HDD, CDD). (Occupancy was also available as a predictor for 90% of the cases outside San Diego, but was significantly related to energy use in only two cases.) The same procedure was then used for the "after" period. When space heating (and not cooling) is involved, this procedure yields two equations of the general form

$$\text{energy use} = \text{base use} + (X * \text{HDD}).$$

The meaning of such equations is illustrated in DISPLAY 2.b (page 2-17), which shows gas use at a 30-unit Colorado Springs property with gas space and water heating. Gas use before (B) and after (A) the introduction of tenant payment is plotted as a function of heating degree days; the two regression lines and equations are shown also. The intercepts of the lines represent monthly gas use when the space heating load (as measured by heating degree days) is zero; they thus approximate monthly gas use for domestic hot water. Conversely, the slopes represent the change in gas use associated with a change in heating load.

In an analysis for a particular property the slope, the intercept, both, or neither may be different in the before and after periods. In this case the after slope (gas used for space heating) is 34% less than that from before while the intercept (gas used for water heating) is 11% less.

### 2.4.c Calculation Of Expected Annual Energy Use

Each regression equation (from before and after introduction of tenant payment) was applied to 12 months of "normal" weather to yield expected annual consumption given normal weather. The percentage reduction in total use is then calculated as

$$\frac{\text{expected annual use, before} \; - \; \text{expected annual use, after}}{\text{expected annual use, before}}$$

For the property shown in DISPLAY 2.b (page 2-17), the reduction in annual gas use is 25%.

### 2.4.d Discarding Unstable Cases

The regression analyses on individual cases revealed that in 12 cases (from 10 properties) the energy use-weather relationship within the before or after period (or both) was so unstable that the change estimates would have been quite unreliable. These 12 cases were discarded. All had a before or after R-squared of .60 or less, or both R-squared's below .70. (R-squared measures the proportion of variance in the dependent variable, energy use, accounted for by variance in the independent variable, weather.) Minimum R-squared's (across the before and after periods) for the remaining 95 cases range from .73 to .99, median .92.

### 2.4.e Secondary Analyses

Once individual analyses were complete for each case, the results were grouped by energy function (space and water heating only, lights and appliances only, other), payment type (tenants billed according to formula or according to measured consumption), and property location for secondary analysis.

### 2.4.f Comparison To Controls

As a final step, results for the 95 cases introducing tenant payment were compared to those for control properties--with payment mode unchanged--in similar locations. These comparisons are reported in Chapter 5 because they represent one way of addressing the question of long-term effects of tenant payment on energy use.

## 2.5 THE PROPERTIES

DISPLAY 2.c (page 2-18) shows a division of the 95 analysis cases by

- fuel type: 61 gas, 34 electric
- location: 50 San Diego area, 26 Colorado (mostly Denver), and 19 other, including Wisconsin, Ohio, Pennsylvania, Nevada, Texas, Indiana, Kansas, and Oregon
- payment mode for
  - space heating: 55 measured consumption, 12 formula
  - water heating: 14 measured consumption, 35 formula, 17 included in fixed rents (in many properties only tenant use of space heating is measured, but tenants are billed for both space and water heating. See section 1.4)

- lights and appliances: 30 measured consumption, 3 formula
- space cooling: 2 measured consumption, 3 formula.

The 95 cases come from 83 properties: 22 introduced tenant payment for electricity only, 49 for gas only, 12 for both gas and electricity.

Starting dates for tenant payment in the 83 properties range from January 1979 to November 1981, with 25% in 1979, 47% in 1980, and 28% in 1981. Monthly rents (as of January 1982) were under $250 for 34%, over $325 for 18%, between these values for 48%. (San Diego area properties were rated low-medium-high on rent by CEUC; for all others exact rent figures were available. Figures from the Institute of Real Estate Management's Income/Expense Analysis 1980 were used to estimate median San Diego rent at start of tenant payment as $250.)

The properties are predominantly garden apartments (54%, including most in San Diego), and low-rise buildings (29%, including most in Colorado), but high rises, row houses, and mobile homes are also represented. Number of units at the property ranges from 8 to 424, with the following distribution: 20 or fewer, 23%; 21-40, 19%; 41-80, 16%; 81-120, 12%; 121-250, 11%; over 250, 9%. Annual normal heating degree days range from 691 in San Diego to 7444 in Madison, Wisconsin; annual normal for the Denver area is 6016. (The 30-year average 1940-2070 for San Diego is 1507, but average annual HDD for the 1977-82 heating seasons was 691. In no year 1977-82 did annual HDD exceed 1086.) Gas and electricity prices and costs are discussed in section 2.9.

## 2.6 ENERGY USE

Energy use before introduction of tenant payment can be described for four groups of cases homogeneous in location, fuel type, and energy function: electricity for lights and appliances in San Diego (N = 25), and gas for space and water heating in San Diego (N = 22), in Colorado (N = 26), and in Wisconsin (N = 4). All figures reported here represent energy use per unit per month, in kilowatt hours (KWH) of electricity or hundred cubic feet (CCF) of gas. Energy used in common areas (halls, offices, recreation areas) which flows through the master meter is included in these figures.

The 25 San Diego-area properties with electric lights and appliances (no space cooling) used 110 to 361 KWH/unit/month, median 192. Use was roughly 40% greater in Oceanside (35 miles north of San Diego on the coast) than in other metropolitan areas. Properties with low rents (as rated by CEUC, the submetering firm supplying the data) averaged 160 KWH/unit/month, while high rent properties averaged 340. Electricity use is unrelated to number of units in the property and to the starting date of the reporting period, thus offering no evidence of a general upward or downward trend in use over time.

In the 22 San Diego properties using gas for space and water heating, total gas use ranged from 18 to 71 CCF/unit/month, median 41; from 24 to 59% of total annual use was for space heating (vs. water heating), median 40%. Base use of gas--for water heating but not space heating--was higher in high rent properties; space heating use was higher in Oceanside (which has double the heating degree days of San Diego) and in mobile homes. The number of units in the property and the starting date of the reporting period are unrelated to heat, base, or total use.

In the 26 Colorado properties using gas for space and water heating, total use ranged from 48 to 104 CCF/unit/month, median 77. From 36 to 77% of the total was for space heating, median 54%. Older properties, those with higher rents, and those with fewer units used more gas for space heating; no demographic characteristics are related to the amount of gas used for water heating. Neither heat nor base use is related to gas price or to the starting date of the reporting period.

The four Wisconsin properties all have eight units; three are in Milwaukee, one in Madison. Total gas use ranged from 52 to 73 CCF/unit/month, median 58, with 71% to 82% of this used for space heating, median 70%.

DISPLAY 2.d (page 2-19) compares gas used for space and water heating in the Wisconsin, Colorado, and San Diego properties. Although less gas is used for space heating in San Diego--median 15 CCF/unit/month vs. 42 and 44 in Colorado and Wisconsin--the amount is surprisingly high given that heating degree days for the area total less than 1000 annually. In addition, there is substantial overlap between the San Diego and Colorado distributions. An examination of the weather-gas use relationships for individual properties shows that in many San Diego properties, some space heating is used even when the average monthly temperature exceeds 65 degrees (the base temperature for calculation of standard heating degree days). In contrast, some Colorado and Wisconsin properties do not begin to use space heating until the average monthly temperature falls below 45 degrees. This indicates that, as would be expected, the properties in colder areas are more thermally efficient than those in San Diego.

Base or hot water use should not differ across climate zones unless input water temperatures vary or water heating equipment is in unheated areas. For the properties sampled, median base use in Colorado, 34, is greater than that in Wisconsin (17) or San Diego (23). However, the variance within each group is quite high, so that the distributions for the three groups overlap considerably.

## 2.7 REDUCTIONS IN ENERGY USE COMPONENTS

In this section reductions in energy use are examined separately for each energy function: lights/appliances, space heating, water heating. Section 2.8 then reports results for reductions in total energy use.

All the analyses reported in this section were run on both percentage and absolute reductions in energy use. In general, absolute reductions are greater with greater inital use, yielding uniform percentage reductions across properties. Only percentage reductions are reported here. Absolute reductions can be estimated by applying the percentages to the energy use figures presented in section 2.6.

### 2.7.a Lights And Appliances, San Diego

Electricity used for lights and appliances dropped in all 25 San Diego properties introducing tenant payment (all by submeters). Reductions ranged from 6 to 23%, median 14%. The interquartile range--the values within which 50% of the cases fall--can be used as a "best guess" of reductions to be obtained in similar properties in the future; this range is 8 to 17%. Reductions in use are unrelated to property size, rent, location within the area, or starting date of tenant payment.

### 2.7.b Space Heating

DISPLAY 2.e (page 2-20) shows median values and interquartile ranges for percentage reductions in space heating in 67 properties, stratified by location, method of billing, and fuel type. Reductions are significantly greater in properties billing by measured consumption (median 17%, N = 55) than in those billing by formula (median 0%, N = 12). Reductions tend to be greater in properties using electricity for heat (median 24%, N = 6) than in those using gas (median 14%, N = 61), but the difference is not statistically reliable and may be due simply to chance.

Multiple regression analysis reveals no relationship between reductions in space heating and property size, rent, method of billing for water heating, or location/heating degree days. This is true both for the entire sample of 67 properties and for the 50 with gas heat and billing by measured consumption; it is also true for both the Colorado and San Diego area samples. In both locations, reductions in space heating are greater in properties where space heating is a higher percentage of total annual use. These properties may have greater initial waste of space heating, offering more opportunity for reductions in use. In addition, they certainly have a greater difference between tenant bills in winter and summer, perhaps leading tenants to perceive a greater economic incentive to reduce use of space heating.

For the 50 properties with gas heat and billing by measured consumption, reductions range from nothing (up 5%) to 54%, median 16%; the interquartile range is 9 to 27%. For the 11 properties with gas heat and formula billing, reductions range from nothing (up 18%) to 24%, median 0%, with an interquartile range of up 5% to down 7%.

### 2.7.c Water Heating, Or Base Use

DISPLAY 2.f (page 2-21) shows medians and interquartile ranges for reductions in energy used for water heating and other year-around functions. These functions include lights and appliances for the electric cases, and may include ranges and clothes dryers for gas. The cases are stratified by location, method of tenant billing, and fuel type.

The picture for reductions in water heating is much less clear than that for space heating. In San Diego, there is a slight tendency for greater reductions when tenants are billed according to measured consumption of gas for water heating (median 6%, N = 8) than when charges for water heating are included in fixed rents (median 3%, N = 14), but this may well be due to chance. In Colorado, no properties meter the gas used for water heating by individual tenants, but most charge tenants for this use anyway, using formulae based on number of occupants, square feet occupied, and the like. In these 16 properties reductions are greater than in the 3 which include hot water costs in fixed rents, median reductions 16% vs. 6%. However, the number of cases is so low that this too could be due to chance.

Multiple regression analysis reveals no stable relationships between reductions in base use and billing method, property location, billing method for space heating, property size, or rent.

Why should billing method have such a clear effect on reductions in space heating, and virtually none on reductions in water heating? It may be that many tenants are confused about if and how they pay for hot water, muddying the distinctions among various payment modes. Many managers providing data to IBS were confused about this, so some uncertainty on the part of tenants should not be surprising.

### 2.7.d Comparing Space And Water Heating Reductions

For the 50 properties with gas space heating billed according to measured consumption, percentage reductions in space heating are significantly greater than those in water heating or base use, median 16% vs. 11%. This difference may be associated with any of several factors:

- Tenants do not usually have access to water heater thermostats, and so may be less able to control use of gas for water heating than for space heating. (In virtually all properties outside San Diego, both space and water heating are provided by central or shared equipment not accessible to tenants. In San Diego, space heating equipment is individual, while water heating is central.)

- While tenants were billed for space heating according to individually measured consumption in all properties (in this sample), gas used for water heating was billed by formula in 48%, and was included in fixed rents in 34%.

- In winter months space heating costs exceed water heating costs even in most San Diego properties, and certainly in Colorado and Wisconsin, giving a greater economic incentive to reduce space heating consumption.

## 2.8 REDUCTIONS IN TOTAL ENERGY USE

Multiple regression analysis was used to explore the relationships of payment mode, location, fuel type, energy function, property size, start date, and rents to reductions in total energy use in the 95 cases.

Percentage reduction in total energy use (i.e., in gas or electricity use, not in total use across both fuels) is related to three property characteristics.

1. Reductions are clearly smaller with formula billing than with billing by measured consumption. DISPLAY 2.g (page 2-22) shows distributions of total reductions for 80 properties billing by measured consumption for lights/appliances, space heating, or all functions, and for 15 properties using formula billing only. Reductions with measured consumption billing range from nothing (up 7%) to 37%, median 15%, interquartile range 8 to 19%. For the formula billing cases, reductions range from nothing (up 9%) to 29%, median 6%, interquartile range 0 to 13%. The probability that a difference of this magnitude could occur by chance is less than 1%. Thus, there is clear evidence that the individual monetary incentive associated with measured consumption billing leads to greater changes in energy use than the group incentive offered by formula billing. Still, formula billing is associated with some degree of reduction in total energy use; the probability that the reductions observed with formula billing could have occurred simply by chance is less than 2%.

2. Reductions may be greater in all-electric properties than in those introducing tenant payment for gas space and water heating or electric lights and appliances only. This finding is based on only five all-electric properties, and so could be due simply to chance. In these five total reductions averaged 10 to 15 percentage points greater

than in the remaining 90 cases.

3. In properties introducing tenant payment for space heating, reductions are greater when a greater percentage of annual use is in space heating. In both San Diego and Colorado, properties with a low percentage of annual use in space heating (below 35% in San Diego, 40% in Colorado) have percentage reductions only one-third as great as those in properties with relatively high space heating use (above 45% of total use in San Diego, 60% in Colorado). This effect is in part due to the effect of percentage heat use on reductions in space heating use per se, as discussed in section 2.7. In addition, the fact that percentage reductions for space heating are higher than those for water heating means that properties with relatively high space heating use will automatically record larger percentage reductions in total use.

Percentage reductions in total energy use are unrelated to rents, property location (and thus climate), property size, start date, fuel type, and whether tenant payment was introduced for one or two fuels. For the 80 cases billing by measured consumption, average reductions fall between 13 and 18% for both electricity and gas, for all three location groups (San Diego, Colorado, other), and for all three rent levels.

## 2.9 THE EFFECTS OF ENERGY PRICES AND COSTS

Information on the energy costs paid by tenants in the first year after introduction of tenant billing was available for all cases. This information was used to compute three measures which might relate to reductions in energy use: average tenant-paid cost per unit per month (cost), average price (over the year) per KWH or CCF (price), and cost-to-rent ratio (rent share), which should be roughly proportional to the share of the household's income paid for energy. The rent share measure could not be calculated for San Diego properties. All of these measures pertain to only one energy form, gas or electricity, and so represent total energy costs only in all-electric properties.

### 2.9.a Colorado

In Colorado, gas prices ranged from $.32 to .38 per CCF, median $.36; prices rose steadily, so that price and start date are highly correlated. Gas costs paid by Colorado tenants (averaged over the year) were between $15 and $33/unit/month, median $20. The cost-to-rent ratio ranged from 5 to 10%, median 7%.

For the 23 Colorado properties billing tenants for gas space and water heating by measured consumption, reductions in total energy use are completely unrelated to price and start date, to cost, and to rent share.

### 2.9.b San Diego

In San Diego, gas prices ranged from $.24 to $.41 per CCF, median $.21; as in Colorado, price and start date are highly correlated. Gas costs paid by tenants ranged from $8 to $13, median $10 when tenants were charged for both base and heat use; from $1 to $10, median $3 when tenants paid only for space heating. These costs translate to rent shares of 4 and 1%, respectively, if an average rent of $250 is assumed.

Reductions in both space heating and in total gas use are weakly related to higher prices and, probably as a consequence, later start dates, so that reductions are greater in properties with high prices and late starts; these relationships do not hold at lower price levels, and are so weak that they may well be due simply to chance. Percentage reductions are not related to tenant-paid gas costs. The greater reductions found in electrically heated properties may be due to higher costs--median $20 vs. 3 to $10 for gas. However, the total energy costs paid by tenants of all-electric properties are not significantly higher than those of tenants paying for both gas and electricity.

San Diego electricity prices ranged from $.04 to $.08 per KWH, median $.06, again correlated with start date. Electricity costs (for lights and appliances only) ranged from $6 to $26/unit/month, median $13; this represents a cost-to-rent ratio of 5% assuming a $250 rent. Neither price nor cost is related to reductions in electricity use in San Diego; this is true within groups of low and moderate rent properties as well as for the whole sample.

### 2.9.c Comparison To Results Of Past Work

In 1981 Sam Nelson of Argonne Laboratory published an analysis relating reductions in energy use with tenant payment to energy prices (Argonne, 1981). Only cases from MRI and EPRI were included; in all cases tenant payment was for electricity billed by measured consumption. The price measure was the July 1974 marginal electricity rate, even though the start dates for the cases used ranged from 1972 to 1978; as such, the measure essentially ranks cities on electricity price, rather than tapping changes in price over time. The correlation between this price measure and percentage energy reductions (over 28 cases) is .76, indicating greater reductions in energy use with tenant payment in cities with higher energy prices. In a followup to this work by IBS, electricity rates for each starting date were obtained from utilities in the areas involved. These rates were combined with information about total annual electricity use for each case to derive measures of average electricity price and cost to the tenant. Neither of these measures is related to percentage reductions within the 28 cases used by Nelson.

Winkler and Winett (1982) computed "budget share" (energy cost as a percent of income) for participants in 19 experiments on reducing residential energy consumption. Budget share varied by a factor of 6 over the 19 studies, and correlated .62 with percentage reduction. Correlations with price, cost, and income were lower. All the studies in this sample were performed in single family homes with energy costs paid by the residents.

### 2.9.d Summary

Analyses of data from three sets of cases--Denver gas heat, San Diego gas heat, and San Diego electric lights and appliances--offer very little support for the idea that higher energy prices will lead to greater initial reductions in energy use with the introduction of tenant-paid energy costs. These same analyses offer no evidence of an association between reductions in energy use and energy costs paid by tenants, or energy costs in relation to rent.

Should theories about the effects of price and cost on tenant actions be dismissed based on these results? Probably not, for several reasons. First, variance in price and costs over properties is minimal in these samples: San Diego electricity prices showed the greatest variability, doubling over the period examined. For comparison, the July 1974 electricity prices used by Nelson vary by a factor of four. Second, the costs paid by tenants in these cases represent only a small share of total housing expenses, with the cost-to-rent ratio under 10% in virtually all cases. In the cases examined by Winkler and Winett a similar measure ranged from 6% to over 30%. Thus, it is possible that price, cost, and/or rent share do influence total energy reductions, but only as they vary over location (not over time, as in the current analyses), or only after cost or rent share exceed certain threshold values.

## 2.10 SUMMARY AND CONCLUSIONS

The introduction of tenant payment of energy costs is clearly associated with short-term reductions in energy use, whether tenants are charged according to individually measured consumption or according to a formula allocation of charges for an entire building or property.

DISPLAY 2.h (page 2-23) summarizes the results on reductions in total energy use by billing method and energy function. Results from past work as well as from the 95 cases described in this chapter are listed. The last column estimates reductions to be expected in similar situations in the future; these estimates are based on both current and past work.

Estimates of expected reductions are as follows:

- o formula billing, all functions, 6%, range 0 to 15%
- o billing according to measured consumption
  - space and water heating only, 14%, range 5 to 20%
  - lights, appliances, (cooling), 17%, range 5 to 30%
  - all-electric properties, 17%, range 10 to 30%.

Reductions for at least half of all similar properties introducing tenant payment should be expected to fall within the specified ranges. Several additional factors should be considered in applying the expected ranges to particular properties.

- o Reductions over 30% are very uncommon, and should not be expected even in extreme circumstances. Similarly, the introduction of tenant payment should not be expected to eliminate (or even decrease) differences in energy use per unit across properties in a given location. Other factors--including size of apartment units, average number of occupants, basic equipment and thermal efficiency, amount of common area, and managerial practices--have important effects on energy use, and will not be affected by tenant payment.

- o If tenant payment is being introduced for space and water heating, greater reductions in total energy use should be expected in properties with high proportions of space heating for their location. Such properties may have inefficient equipment and/or thermal shells.

- o Reductions will probably fall near the high end of the range when the ratio of tenant bills (averaged over a year) to rent exceeds 15%. However, reductions should not be expected to increase indefinitely as energy costs increase.

- o The way tenants are billed for space heating is of greater importance than how they are billed for water heating. However, reductions should generally be greatest when hot water use is charged according to measured consumption, least when it is included in fixed rents. This should be especially true if tenants fully understand how their water heating charges are determined. The effect of the billing mode for water heating could also increase as cost-to-rent ratios increase.

- o The variance in reductions across properties is so great that accurate prediction cannot be expected for individual properties.

- The figures listed here represent empirical estimates of reductions in energy use to be expected in the first year following introduction of tenant payment. They do not address the issue of whether and how much energy use could be expected to change if tenant payment were not introduced. This issue involves time trends in both tenant and owner actions affecting energy use, and also involves the effect of tenant payment on actions of the owner or manager to maintain and improve the energy efficiency of the property. Owner actions are discussed in Chapter 3. In Chapter 5 results from this chapter, from control properties which did not introduce tenant payment, and from the examination of owner actions and market pressures are balanced to produce estimates of the long-term effects of tenant payment on energy use.

## 2.11 DISPLAYS

### 2.11.a DISPLAY 2.a. Results Of Past Work Estimating Short-term Energy Reductions Associated With Introduction Of Tenant Payment

| | What tenants started paying for | | |
|---|---|---|---|
| | Lights, appliances, & cooling | Everything (total electric) | Space & water heating |
| **Billing by measured consumption (retail, submeters)** | | | |
| No. of properties | 16 | 10 | 7 |
| Start dates | '72-'77 | '72-'76 | '77-'78 |
| Property size: | | | |
| range; median | 9-260; 50 | 6-208; 60 | 9-120; 18 |
| Estimated reduction: | | | |
| median | 22% | 14% | 0-5% |
| expected range | 10-35% | 5-25% | 0-20% |
| confidence | medium | medium | low |
| **Billing by formula (RUBS, by square feet occupied)** | | | |
| No. of properties | 5 | 8 | 5 |
| Start dates | '75-'78 | '77 | '76-'78 |
| Property size: | | | |
| range; median | 44-300; 120 | 40-377; 220 | 44-300; 120 |
| Estimated reduction: | | | |
| median | 8% | 5% | 5% |
| expected range | 0-15% | 0-15% | 0-15% |
| confidence | high | high | high |

Source: IBS, 1980, Chapter 1.

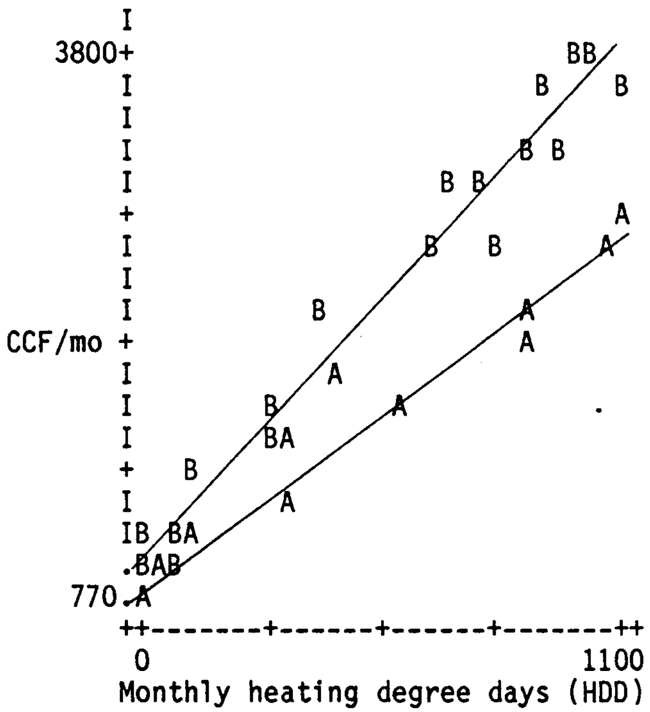
CONCLUSIONS

Reductions in energy use are associated with tenant billing by both measured consumption and formula for all energy functions.

Reductions are lower with billing by formula than with measured consumption.

Reductions are lower for energy used for space and water heating than for energy used for lights, appliances, and cooling for both formula and measured consumption billing.

## 2.11.b DISPLAY 2.b. Illustration Of The Energy Use-weather Relationship In A Colorado Springs Property




Before (B): CCF/month = 858 + (82 * HDD)

After (A): CCF/month = 763 + (55 * HDD)

R-squared for both equations > .95

2.11.c DISPLAY 2.c. Location, Fuel Type, And Payment Mode For The 95 Cases Analyzed

| Fuel type | Location | N | Space heating | Water heating | Lights, appliances | Space cooling |
|---|---|---|---|---|---|---|
| Electric | San Diego | 25* | - | - | measured | - |
| | | 3 | measured | measured | measured | - |
| | Colorado | - | - | - | - | - |
| | other | 2 | measured | measured | measured | measured |
| | | 3** | - | - | formula | formula |
| | | 1 | formula | - | - | - |
| | TOTAL | 34 | | | | |
| Gas | San Diego | 8 | measured | measured | - | - |
| | | 14* | measured | in rent | - | - |
| | Colorado | 20 | measured | formula | - | - |
| | | 3 | measured | in rent | - | - |
| | | 3 | formula | formula | - | - |
| | other | 1 | measured | measured | - | - |
| | | 4 | measured | formula | - | - |
| | | 8** | formula | formula | - | - |
| | TOTAL | 61 | | | | |

*9 properties are in both electric and gas groups
**3 properties are in both electric and gas groups

GRAND TOTAL: 95 cases, 83 properties

## 2.11.d DISPLAY 2.d. Gas Used For Space And Water Heating In Wisconsin, Colorado, And San Diego Properties

```
  0             35            70
  -----------------------------
                                    WISCONSIN  N = 4
                -::*::-                space, median 44
     -::*:-                            water, median 17

                                    COLORADO  N = 26
         --------::*:::--------        space, median 42
          ---:::*::------              water, median 34

                                    SAN DIEGO  N = 22
    --:*:::---                         space, median 15
      ---::*:::--------                water, median 23
   -----------------------------
  0             35            70
     CCF/unit/month before tenant payment
(includes use in common areas on the master meter)


     -----   full range of values
     :::::   interquartile range (middle 50% of cases)
       *     median value
```

## 2.11.e DISPLAY 2.e. Percentage Reductions In Use Of Space Heating, By Location, Billing Method, And Fuel Type

| | | Billing by | | | | |
|---|---|---|---|---|---|---|
| | | measured consumption | | formula | | |
| Location | | gas | electric | gas | electric | N |
| San Diego | median | 16 | 56 | - | - | |
| | Q* | 12 to 30 | - | - | - | |
| | N** | 22 | 3 | - | - | 25 |
| Colorado | median | 17 | - | 0 | | |
| | Q | 9 to 24 | - | - | - | |
| | N | 23 | - | 3 | - | 26 |
| Other | median | 7 | 19 | 0 | 13 | |
| | Q | 5 to 26 | - | <4> to 5 | - | |
| | N | 5 | 2 | 8 | 1 | 16 |
| TOTAL | median | 16 | 37 | 0 | 13 | |
| | Q | 9 to 27 | - | <5> to 7 | - | |
| | N | 50 | 5 | 11 | 1 | 67 |

*Q is the interquartile range (middle 50% of the cases)
**Number of properties analyzed
< > indicates a negative reduction or increase in use

2.11.f DISPLAY 2.f. Percentage Reductions In Use Of Water Heating, By Location, Billing Method, And Fuel Type

| Location | | Billing by measured consumption: gas | Billing by measured consumption: electric | Billing by formula: gas | Costs in rent; gas | N |
|---|---|---|---|---|---|---|
| San Diego | median | 6 | 28 | - | 3 | |
| | Q* | 2 to 11 | - | - | <1> to 15 | |
| | N** | 8 | 3 | - | 14 | 25 |
| Colorado | median | - | - | 16 | 6 | |
| | Q | - | - | 4 to 31 | - | |
| | N | - | - | 22 | 3 | 25 |
| Other | median | 14 | 15 | 19 | - | |
| | Q | - | - | <2> to 23 | - | |
| | N | 1 | 2 | 11 | - | 14 |
| TOTAL | median | 8 | 28 | 19 | 3 | |
| | Q | 3 to 13 | 10 to 33 | 1 to 28 | <1> to 15 | |
| | N | 90 | 5 | 33 | 17 | 66 |

*Q is the interquartile range (middle 50% of the cases)
**Number of properties analyzed
< > indicates a negative reduction or increase in use

## 2.11.g DISPLAY 2.g. Percentage Reductions In Total Energy Use, By Billing Method

| Billing by formula | Percentage reduction | Billing by measured consumption |
|---|---|---|
| | 35-40% | ** |
| | 30-35% | *** |
| * | 25-30% | *** |
| | 20-25% | ********** |
| * | 15-20% | ********************* |
| *** | 10-15% | *************** |
| **** | 5-10% | ********************* |
| **** | 0- 5% | **** |
| ** | <up> | * |

Summary statistics

| | | |
|---|---|---|
| 6% | median | 15% |
| 0 to 13% | Q* | 8 to 19% |
| <9> to 29% | range | <7> to 37% |
| 15 | N | 80 |

*Q is the interquartile range (middle 50% of the cases)
< > indicates a negative reduction or increase in use

2.11.h DISPLAY 2.h. Updated Estimates Of Total Short-term Energy Reductions, By Billing Method And Energy Function

| Energy function | | Past work | New data | Current estimate |
|---|---|---|---|---|
| | | Billing by formula | | |
| Space & water heating | median | 5% | 6% | 6% |
| | range | 0-15% | 0-13% | 0-15% |
| | N* | 5 | 12 | |
| Lights, appliances, (cooling) | median | 8% | 5% | 6% |
| | range | 0-15% | 0-15% | 0-15% |
| | N | 5 | 3 | |
| All-electric | median | 5% | - | 6% |
| | range | 0-15% | - | 0-15% |
| | N | 8 | 0 | |
| | | Billing by measured consumption | | |
| Space and water heating | median | 5% | 14% | 14% |
| | range | 0-20% | 8-21% | 5-20% |
| | N | 7 | 50 | |
| Lights, appliances, (cooling) | median | 22% | 14% | 17% |
| | range | 10-35% | 8-17% | 5-30% |
| | N | 16 | 25 | |
| All-electric | median | 14% | 25% | 17% |
| | range | 5-25% | 15-35% | 10-30% |
| | N | 10 | 5 | |

*Number of properties analyzed.

"Past work" includes Booz/Allen, 1979; EPRI, 1977; IBS, 1980; and MRI, 1975.

CHAPTER 3 OWNER ACTIONS IN PROPERTIES WITH OWNER VS. TENANT PAYMENT

# CHAPTER 3

## OWNER ACTIONS IN PROPERTIES WITH OWNER VS. TENANT PAYMENT

Chapter 2 established that energy consumption generally drops in the year following a shift to tenant-paid energy costs. These reductions are probably due in large part to changes in tenant actions such as thermostat settings and appliance use. In the long run, the actions--or inaction--of the property owner can be at least as important as those of tenants in determining net energy use, for it is the owner who is responsible for maintaining and improving the efficiency of the building's structure and energy-using equipment.

This chapter addresses two questions:

- Do owners of properties with tenant-paid utilities do anything to improve energy efficiency?
- Do owners of properties with tenant-paid utilities do significantly less to improve efficiency than owners of properties with owner-paid energy costs?

The investigation reported here differs from past work primarily in use of a more systematic sampling method and in use of a standard set of questions answered by owners or managers of properties with both payment modes.

### 3.1 THE SAMPLE

#### 3.1.a City Selection

Resources were available to conduct the study in two cities, which were selected according to four criteria:

- no rent control
- a good split between properties with owner- and tenant-paid energy costs (30-70 or 70-30 at worst)

- sufficient lowrise and garden properties accessible for sampling by the Institute of Real Estate Management (IREM), the organization which was to draw the sample and collect the data. Figures reported in IREM's annual Income/Expense Analysis (1980) were used to estimate the number of properties available.

- frequent mention of energy costs and efficiency in rental advertising, as established by the work reported in Chapter 4. In cities with frequent advertising mention market pressures are presumably influencing owners of tenant-payment properties to maintain and improve energy efficiency, thereby decreasing any difference in motivation between owners of owner- and tenant-payment properties. Thus if differences between tenant and owner payment properties are found in these cities, it should be safe to conclude that such differences exist everywhere.

Application of these criteria eliminated many cities with large multifamily stocks, and led directly to selection of Atlanta and Portland, Oregon, as the two study sites.

### 3.1.b Property Selection

The design called for selection of 40 properties in each city, to meet the following criteria:

- minimum size 20 units, relaxed to 12 if necessary to obtain sufficient properties

- without HUD or other governmental regulations on investment and utility payment mode

- minimum age 4 years; age 8 years and over preferred

- within each city, sample properties should be divided equally on tenant vs. owner payment of at least one important energy function (space heating, domestic hot water, or space cooling if significant in the area)

- as far as possible, each important energy function should be supplied by the same energy source (gas, oil, or electricity) in all properties within a city

- as far as possible, all properties within a city should be similar in property size, building style and age, location, type of tenant population, and vacancy rate. In particular, the tenant- and owner-payment groups should not differ systematically on factors which might influence the owner's opportunity, motivation, and ability to invest in energy efficiency improvements (except for payment mode, of course).

o maximum of 2 buildings of each payment type per owner/manager.

The task of applying these criteria to property selection was handled by the Institute of Real Estate Management. IREM first compiled statistical profiles of the multifamily sector in each city to allow specification in advance of the types of properties found most frequently. A screening questionnaire was then sent to IREM members, local apartment association members, and IREM promotional lists; 780 screening questionnaires were sent to Atlanta, 283 to Portland. The questionnaires requested descriptive information on up to six properties with (a) no HUD involvement, (b) at least 12 (Portland) or 20 (Atlanta) units, and (c) no change in utility payment methods in the last four years. Information was requested on property location (city/suburb and metro area quadrant), year of construction, number of units, average monthly rent, vacancy rate for the past year, building type, and fuel and payment modes for space heating, domestic hot water, and space cooling. For some dimensions "preferred profiles" were specified on the screening questionnaire, to guide the respondents as to the types of properties most desired. The Portland preferred profile specified 1960-76 construction, $150-450 monthly rent, 0-12% vacancies, and lowrise or garden construction; that for Atlanta was the same except for a $200-$500 rent range. These profiles were established to insure relative homogeneity of the properties selected.

About 20% of the screening questionnaires were returned undelivered; another large portion presumably went to individuals who do not own or manage any eligible properties. Followup telephone calls were made to those individuals considered most likely to be associated with eligible properties. The 38 questionnaires returned from Atlanta describe 91 properties, with a fair mix of payment modes. The 21 questionnaires returned from Portland describe 69 eligible properties, only 11 of which reported owner payment of space and/or water heating.

The unexpectedly small number of owner-payment properties in Portland came about because most owner-payment properties there are subsidized in some way by federal, state, or local government funds, and were therefore excluded from the sample. This fact was not known to IBS or IREM when Portland was selected as a study site. This necessitated a change in study design. It was decided to collect data on 20 Portland tenant-payment properties, and on 60 properties in Atlanta, divided evenly into those with owner payment of water heating only, owner payment of space and water heating, and tenant payment of all functions. The Portland data were to be used to assess the extent and determinants of owner energy actions in tenant-payment properties, while the Atlanta data were to be used to contrast the actions of owners of tenant-payment and owner-payment properties.

According to IREM figures, the properties on which screening information was received are representative of the Atlanta and Portland markets as far as location, building size, rent and vacancy levels, and fuel types are concerned. Older properties (those built before 1960) were purposely excluded in both cities in an attempt to control for opportunity to upgrade energy efficiency, so the samples are not representative of their markets on this dimension.

### 3.1.c Response Rates

62 surveys were sent to 34 managers in Atlanta. Four managers (who received 7 surveys) were no longer employed by the same firm at the time of the survey. Of those who could respond, 22 (73%) returned 37 completed surveys; 2 refused (4 surveys), and 6 did not respond (14 surveys). The properties for which surveys were not returned are the same as those for which surveys were returned in age, vacancy rate, payment mode, and size; the no-return properties have slightly higher rents and are more frequently in the northern part of the metro area. The final Atlanta sample includes 20 properties with complete tenant payment, 6 with owner-paid domestic hot water only, and 11 with owner-paid space and water heating. Information on 19% of the properties came from the owner; it was provided by the property manager for the remaining 81%.

31 surveys were sent to 18 managers in Portland, one of whom went out of business in the interim. Of those who could respond, 15 (88%) returned 26 completed surveys. One manager refused to participate, and one did not respond. Two of the completed surveys (both from one manager) were from high-rise buildings with very high rents relative to the rest of the sample; these two properties were excluded, leaving 24 for analysis. The properties for which surveys were not returned have slightly higher rents than those for which surveys were returned, but otherwise the two groups of properties are similar. The final Portland sample includes 24 all-electric properties with tenant-paid space and water heating. Information for 33% of the properties was provided by the owner; for 67% information came from the property manager.

## 3.2 THE SURVEY QUESTIONNAIRE

The survey questionnaire was designed to assess owner energy actions and their possible determinants: opportunity for efficiency improvements, financial position, payment mode and fuel type, tenant pressure for energy efficiency, and characteristics of the owner, manager, and property itself. The content of the survey was outlined at IBS, then modified by IREM in consultation with member firms experienced in energy management. The six-page written instrument includes five groups of items:

- property demographics: location, age, size, rent, vacancy and turnover rates, amenities, utility payment modes
- ownership, management, and financial position: type of owner and manager, holding period, cash-flow position

- o energy features and actions: for four major energy systems--space heating, cooling, water heating, and lighting--items on type of fuel used, efficiency features, recent improvements, and other possible improvements known to the respondent

- o energy management: inclusion in regular maintenance, records kept, audits, knowledge of possible improvements with 2-year paybacks

- o tenants and energy use: inquiries about energy costs, requests for improvements, mention of energy in advertising.

## 3.3 PROPERTY CHARACTERISTICS

### 3.3.a Demographics

DISPLAY 3.a (page 3-15) lists characteristics of both the Atlanta and Portland samples. As noted above, the samples are generally representative of the multifamily stock in those cities except in age. Properties in both cities are located predominately in the suburbs, have on-site managers, average 12 years old, have two bedrooms with $275-80 monthly rent (1982), 50% annual turnover, and 5-6% vacancies. Compared to Portland, the Atlanta properties are larger (174 to 33 units, median), with larger units (average 1103 vs. 845 square feet) and more amenities. They are somewhat more frequently owned by a developer, institution, or syndicate (38 to 12%), managed under a fee-management arrangement (40 to 25%), and report a positive cashflow position (81 to 63%).

In Atlanta, rents (per unit per month) range from $210 to $405. 85% of the variance in rents is accounted for by a combination of apartment size, type of owner (syndicates, developers, and institutions own higher-rent properties), location, and whether space &/or water heating are included in the rent. The additional rent for owner-payment properties roughly approximates the average monthly heating bill paid directly by tenants of other (tenant-payment) properties.

In Portland, rents range from $190 to $370, and 71% of the variance in rents is accounted for by a combination of apartment size, number of amenities (e.g., tennis, pool, balconies), whether families with children predominate (in which case rents are lower), and vacancy rates, so that properties with higher vacancy rates have lower rents. This tradeoff is as predicted by traditional economic models of rental markets, and may reflect exceptionally high vacancy rates in Portland in recent years.

### 3.3.b Energy Features

DISPLAY 3.b (page 3-16) summarizes energy efficiency features for the Atlanta and Portland samples, with payment modes combined in Atlanta. The upper portion of the display lists features in three groups: thermal shell, domestic hot water system, and lighting. The percentage of properties rated "good" on individual features ranges from none for fluorescent common area lights in Portland to 89% for timers on common area lights in Atlanta. The patterns in the two cities are generally similar, with frequent use of caulking and timers for common-area lights, moderate use of attic and wall insulation and flow restrictors, and infrequent use of storm windows, fluorescent common-area lights, and insulation for hot water pipes. However, the efficiency features caulking and storm windows are significantly more frequent in Portland (probably due to its colder climate), and there is a huge difference between the cities in use of hot water tank insulation: 79% of the Portland properties report insulated tanks, while only 24% in Atlanta do so. The high incidence of tank insulation in Portland is probably due to tank wrap give-away programs run by the electric utilities there for several years. Flow restrictors are also given away, but less than 30% of Portland properties report having restrictors on all shower heads. The only feature more common in Atlanta than Portland is fluorescent common and outdoor lighting.

The lower portion of DISPLAY 3.b (page 3-16) shows the percentage distribution for each city on scales formed by adding across the features listed in each of the three groups. Few properties--at most 30%--score high; Atlanta has more high-scoring properties for lighting, while Portland has more for thermal efficiency. Portland also has fewer properties scoring very low on domestic hot water features.

### 3.3.c Energy Actions

DISPLAY 3.c (page 3-17) lists the percentage of Atlanta and Portland properties which report taking specified recurring or one-time energy actions. One-third of the properties in both cities have had energy audits, usually from a utility company (especially in Portland) or an energy firm. Of those reporting audits, 20% in Atlanta and 76% in Portland state that some audit recommendations have been implemented.

Only half the properties keep records of energy consumption (units used, not just dollars spent) for owner-paid utilities, while none do so for tenant-paid utilities. Energy is part of regular maintenance procedures in half the properties; two-thirds encourage tenants to conserve, generally by providing "how-to" information.

Some tenant pressure for energy efficiency is apparent in both cities. In Atlanta, prospective tenants ask about energy costs "often" in 41% of the properties; cost information is provided to tenants by 51%; and 41% have received requests from current tenants for improved energy efficiency. The proportion of Portland properties reporting these behaviors is roughly half as great in each case. However, the proportion of properties reporting mention of energy in advertising is lower for Atlanta (11%) than for Portland (30%). Despite their inquiries and requests, neither Atlanta nor Portland tenants are likely to make efficiency improvements on their own (e.g., plastic window covers).

Recent improvements (within four years) were made by at least 20% of the properties in each city for each of the four systems, with space heating equipment in Portland the only exception. The number of systems improved in individual properties ranges from none (for over one-third the properties in each city) to all four by 11% of Atlanta properties, none in Portland. Respondents from 43% of the Atlanta properties and 25% of Portland properties could list additional efficiency improvements with two-year paybacks. The types of improvements already made and the further improvements suggested are similar: insulation (especially in Atlanta) and storm windows (especially in Portland), hot water tank insulation, and new lighting equipment. The single most common improvement already made is tank insulation, which was added by 29% of Portland properties over the last four years, again probably because of utility company give-away programs. In both Portland and Atlanta, the likelihood of recent improvements is essentially unrelated to having had an audit.

### 3.3.d Opportunity For Energy Actions

One purpose of the detailed survey questionnaire was to allow an assessment of opportunity for energy improvements, so that properties without opportunity could be excluded from analysis of the determinants of improvements. As noted above, however, only a small number of properties score in the consistently "good" range on any of the groups of features for thermal efficiency, domestic hot water efficiency, or lighting efficiency. Furthermore, the properties making no improvements in the last four years do not score high on energy features, so that lack of opportunity could not be the reason for their inaction. Controlling for opportunity in further analysis was therefore unnecessary.

### 3.3.e Summary

In both Atlanta and Portland, the typical property surveyed was built in 1970, rents two-bedroom units for $275-80 per month, and is located in the suburbs. Most of the variance in rents across properties can be predicted from property and owner characteristics.

Half the properties in each city include energy efficiency as part of regular maintenance procedures; one-third have had energy audits. Less than one-third in each city report achieving "good" levels of thermal efficiency, domestic hot water efficiency, or lighting efficiency, but over 60% report having made improvements to at least one of these areas in the last four years. Lack of opportunity for improvements (i.e., the prior achievement of "good" levels of all features) does not seem to have been a factor limiting the improvements made.

## 3.4 DETERMINANTS OF ENERGY ACTIONS: PORTLAND

Multiple regression analysis was used to search for determinants of energy actions in Portland. Independent variables included property demographics, financial position, and owner and manager characteristics. As noted above, no correction was made for differential opportunity to make efficiency improvements. Determinants were explored for three sets of actions: (a) mentioning energy in advertising, b) a 0-5 scale with points for recent improvements to heating equipment, thermal efficiency, the domestic hot water system, and lighting equipment, and for including energy in regular maintenance programs, and c) having had an audit. Determinants of the frequency with which prospective tenants ask about energy costs (often, sometimes, seldom) were also explored, and this variable was included in the set of independent predictors. The relationships discovered are shown schematically in DISPLAY 3.d (page 3-18).

Tenants are more likely to ask about energy costs at properties in the north part of the metro area, at properties managed under fee-management arrangements, and at properties which have advertised energy efficiency or low costs (R-squared = .48, indicating that 48% of the variance in the dependent variable is accounted for by this combination of predictors). In turn, mention of energy in advertising is associated with having made recent efficiency improvements and with ownership by an individual or local partnership (rather than by a developer, syndicate, or institution; R-squared = .52).

Properties scoring high on the improvements-energy maintenance scale are likely to a) be owned by a developer, syndicate, or institution, b) be managed by the owner or owner's firm (rather than by a fee-management firm), c) have more frequent inquiries from tenants about energy costs, and d) have families with children predominant. This combination of predictors explains 71% of the variance in the scale.

Having had an audit is unrelated to recent improvements and energy maintenance. Properties reporting audits are small, owner-managed properties in the eastern metro area, again with families with children predominating (R-squared = .68).

The Portland results are of interest in three respects.

- First, Portland owners <u>have</u> made efficiency improvements in the last four years, even though tenants pay directly for their own energy use in all the properties. Almost two-thirds of the sample properties improved at least one major energy system; one-quarter improved two. In sum, these data argue against the position that owners of tenant-payment properties will do nothing to maintain or improve energy efficiency.

- Second, the data link tenant and owner actions in a reasonable way. Tenant inquiries about energy costs are associated with efficiency improvements and energy maintenance; properties making improvements advertise their efficiency; advertising is associated with tenant inquiries. Thus, there is a feedback loop acting to increase owner awareness of and motivation for energy efficiency. The link between tenant inquiries and owner actions may be enhanced by Portland's high vacancy rate, which could give tenant opinions and actions more power to influence owners.

- Third, while roughly 70% of the variance in the various owner energy actions is accounted for by combinations of demographic variables, these combinations are not very satisfying. One problem is that the demographic variables are so interrelated that many different prediction equations could account for similar amounts of variance, so no importance can be attached to the appearance of one predictor rather than another. A second problem is that many of the predictors suggest no obvious mechanism for their operation. For example, why should properties in which families with children predominate be more likely to have audits, make improvements, and include energy in regular maintenance? There may be logical reasons (e.g., children may be associated with high energy use), but they cannot be verified at this point. Clearly, much work remains before the determinants of energy actions are understood even for this sample of properties.

## 3.5 DETERMINANTS OF ENERGY ACTIONS: ATLANTA

The picture in Atlanta is considerably more complicated, because the properties vary on two additional dimensions expected to affect owner energy actions. The first dimension, and the one of primary interest, is payment mode: energy costs are either paid by the owner (to be covered by tenants' fixed monthly rents) or paid directly by the tenants themselves. With owner payment, reductions in consumption directly benefit the owner by reducing operating costs; with tenant payment the owner benefits only if increased rents (or decreased vacancies or turnover) result from the lower energy costs paid by tenants. The second additional source of variance is fuel type and price: space heating and domestic water heating may each be provided by electricity (at roughly $18 per million BTU) or by natural gas (roughly $8 per million BTU). This difference in price should affect owner actions, since reducing consumption by a given percentage will be more valuable with electricity than with gas.

Unfortunately, fuel type and payment mode are closely related in the Atlanta sample, making it difficult to assess their separate effects. For example, there are no properties with owner-paid electric space or water heating; this is because owner payment is used (in Atlanta) only with central space and water heating equipment (i.e., equipment providing service to multiple apartments), which is always gas. There are thus three groups of properties for each of space and water heating: owner-paid gas, tenant-paid gas, and tenant-paid electric. Lights (plus space cooling and appliances) are tenant-paid electric in all 37 properties. Details of the relationship between space and water heating fuels and payment modes are shown in DISPLAY 3.e (page 3-19).

Payment mode is also related to several property characteristics: properties with owner-paid space and/or water heating have more units, larger units, more amenities, and owners more likely to be developers, institutions, or syndicates. The relationships of payment mode to fuel type and demographic characteristics mean that a simple contrasting of energy actions in properties with and without owner payment would be misleading. The remainder of this section describes a three-step process designed to untangle the effects of these variables.

### 3.5.a The Separate Effects Of Payment Mode And Fuel Type

The first step in the analysis was to examine the separate effects of payment mode and fuel type while holding the other constant. The logic of this method is apparent in the diagram below, which shows the three groups of Atlanta properties.

| | Payment mode | | Economic pressure for & benefit from owner energy actions |
|---|---|---|---|
| | Tenant-paid | Owner-paid | |
| Gas | <u>Group A</u><br>heat, N = 5<br>water, N = 7 | <u>Group B</u><br>heat, N = 11<br>water, N = 17 | low |
| Electricity | <u>Group C</u><br>heat, N = 21<br>water, N = 13 | | high |
| Pressure & benefit | low | high | |

Although the A-B-C classifications for space and water heating are not identical, there is substantial overlap. Hypotheses and results for the two classifications are also similar. Therefore, no distinction has been made between space and water heating in the remaining discussion, even though separate analyses were run for the two classifications.

The analyses contrasted groups A and B, then groups A and C, on six dependent variables: space or water heating features and improvements, lighting features and improvements, energy maintenance, and audits. It was expected that group A (tenant-paid gas space and/or water heating) would fall below both groups B and C on efficiency features and improvements for space and water heating, but not on lighting features and improvements, since lighting is always tenant-paid electric. Lighting thus serves as a within-property control for determinants of energy action other than payment mode and fuel type.

In properties using gas (groups A and B), owner payment is associated with a greater number of efficiency features for both space and water heating, with recent improvements to water heating (but not to space heating), and with inclusion of energy in regular maintenance. The groups do not differ in lighting features or improvements, nor in likelihood of an audit.

In tenant payment properties (groups A and C), electric (more expensive) space and water heating are associated with greater numbers of efficiency features for water (but not space) heating, and with a greater chance of recent improvements to both systems. The groups do not differ in lighting features or improvements, in having had an audit, or in energy maintenance.

Thus, both payment mode and fuel type (or fuel price) affect efficiency features and energy actions pretty much as expected: owner payment of and high energy prices for space and water heating are associated with more features and more recent improvements to these systems, but not to features and improvements to lighting, which is always tenant-paid electric.

### 3.5.b Joint Effects Of Payment Mode And Fuel Type

The next step in analysis was to examine the joint effect of payment mode and fuel type. This was done with multiple regression, using index (dummy) variables for each of the three payment mode-fuel type groups as the independent predictors. Group A (tenant-paid gas space and/or water heating) does have fewer water-heating efficiency features than the other two groups combined, and is somewhat less likely to include energy in planned maintenance programs, as expected. However, payment mode-fuel type group is not a significant predictor of any other efficiency feature or improvement measures, nor of other general energy actions. And even for the measures listed here, the proportion of variance accounted for by payment mode and fuel type acting together reaches a maximum of only 23%.

In sum, tenant payment and inexpensive gas fuel are associated with fewer energy features and actions, but their joint effect is very weak, usually accounting for less than 10% of the variance in features and actions over properties.

### 3.5.c Payment Mode, Fuel Type, And Property Characteristics

The third step in analysis was multiple regression analysis similar to that used in Portland, with predictors including property demographics, financial position, owner and manager characteristics, frequency of tenant inquiries about energy costs, and index variables representing the payment mode-fuel type groups. While it is possible to derive combinations of statistically reliable predictors for the dependent variables energy improvements, maintenance, and audits, in no case is more than 40% of the variance accounted for, compared to 70% in Portland. Furthermore, none of the payment mode-fuel type indices appear as significant predictors of any of the action measures. These results suggest that payment mode and fuel type might be interacting with the demographic variables to determine energy actions, rather than simply adding their effects to those of the demographic measures. The analyses were therefore repeated within two separate Atlanta samples: the 20 properties with complete tenant payment, and the 17 properties with owner-paid space and/or water heating. This procedure generally increased the variance accounted for considerably; for example, R-squared for maintenance in the whole sample is .24; in the tenant-payment properties, .70; in the owner-payment properties, .81. This is a strong indication that payment mode and fuel type are in fact interacting with demographics to affect energy actions.

The combinations which best predict improvements, energy maintenance, and audits in the two groups are shown in DISPLAY 3.f (page 3-20). As in Portland, interpretation of the results is made difficult by intercorrelations among the demographic variables and by the association of energy actions with many variables which suggest no mechanism for their operation. With payment mode controlled by division of the sample into two groups, fuel type does enter the equations for both groups. Inclusion of energy in regular maintenance is associated with use of electricity for space and water heating in both tenant-payment and owner-payment properties. This is the only case in which one variable serves to predict an action in both groups in the same way. In contrast, high vacancy rates are associated with more improvements in tenant-payment properties, with fewer improvements in owner-payment properties. Similarly, high rents are associated with having had an audit in the tenant-payment group, but with no audit in the owner-payment group. All other predictors are unique to one group.

These results do not conclusively establish that payment mode and fuel type interact with characteristics of the property, owner, and manager to determine if energy actions are taken. However, the increase in variance explained when separate analyses are performed for owner- and tenant-payment properties, plus the differing combinations of predictors which result, do suggest that the determinants of energy actions are different for properties with and without owner payment.

Payment mode and fuel type are definitely important determinants of mentioning energy efficiency in advertising, even though only 11% of the properties in the sample did so. Only 10% of the properties with owner-paid heat or electric heat advertise energy efficiency, while 40% of those with tenant-paid gas heat do so. This is probably because tenants are not as interested in energy costs when heating costs are included in the rent, and presume that costs are high when heat is electric. Another reason for the low incidence of advertising mention in this sample is the age of the properties. Atlanta has a large number of properties built since 1976, the cut-off date for this sample, and it is primarily these newer properties which advertise energy efficiency (see Chapter 4 for details).

### 3.5.d Summary

The main goal of the Atlanta analysis was to estimate the extent to which payment mode affects owner actions to maintain and improve energy efficiency. The results suggest that while payment mode does generally affect energy actions in the expected direction, this effect is very weak: it is usually statistically reliable but of no practical significance. However, even this qualified statement is perhaps too simple, because the results also suggest that payment mode interacts with property and owner characteristics to determine whether energy actions are taken.

A second aspect of the Atlanta results is also of interest: the properties with total tenant payment have made improvements to energy systems over the last four years, as was the case in Portland. In addition, tenant-payment properties using expensive electricity for space and water heating are more likely to engage in some energy actions than those using gas. These findings indicate that owners of tenant-payment properties are not completely unwilling to take energy actions, and that their willingness is to some extent affected by "reasonable" factors such as fuel cost.

## 3.6 CONCLUSIONS

The two questions posed at the outset of this chapter can now be answered with some confidence. First, owners of tenant-payment properties have made improvements to the energy efficiency of their buildings and equipment. In both Portland and Atlanta, at least 60% of the properties with total tenant payment have improved one or more energy system in the last four years; 25% in Portland and 35% in Atlanta have improved two or more systems. In Portland, the number of efficiency improvements made is related to the frequency of tenant inquiries about energy costs, indicating that tenant concerns may play a role in motivating owner action. In Atlanta, energy price (electric vs. gas) is related to inclusion of efficiency measures in regular maintenance, indicating that the owners of tenant-payment properties are responding to high tenant energy costs. Thus in both cities there is evidence that the financial concerns of tenants who pay their own energy costs are affecting owner behavior.

Second, the Atlanta results suggest that in the properties sampled, tenant payment does depress owner actions to improve energy efficiency, but not to the degree previously expected. In general, less than 10% of the variance in energy actions across properties can be explained by payment mode. However, there is some evidence that the determinants of owner action may be different for owner- and tenant-paid properties.

Can these results be generalized to other cities? Portland is atypical of many cities in having higher vacancy rates, much more active utility company and governmental conservation programs, and lower energy prices. Atlanta is atypical in having a growing market and an electric utility which "certifies" certain new multifamily properties as energy efficient (see Chapter 4). In both cities an unusually high percentage of rental advertisements mention energy costs or efficiency. All these features except Portland's low prices could be expected to increase the likelihood that owners of tenant-payment properties would act to improve energy efficiency. Thus, the results reported in this chapter cannot be used to conclude that differences between owner- and tenant-payment properties in other cities are as slight as they are in Atlanta, or that as many efficiency improvements have been made to tenant-payment properties in other cities as in Atlanta and Portland. However, the results <u>do</u> indicate that, under certain conditions, owners of properties with tenant-paid energy costs do make investments in energy efficiency, and that the frequency with which they do so is only slightly lower than that for properties with owner-paid costs.

## 3.7 DISPLAYS

### 3.7.a DISPLAY 3.a. Property Demographics, Atlanta And Portland

| | Atlanta | | | Portland | | |
|---|---|---|---|---|---|---|
| | Low | Median | High | Low | Median | High |
| Property age (0=1982) | 9.0 | 12.0 | 20.0 | 6.0 | 13.0 | 23.0 |
| Number of units | 44.0 | 174.0 | 611.0 | 15.0 | 33.5 | 388.0 |
| Average number of bedrooms | 1.5 | 2.0 | 2.6 | 1.0 | 1.9 | 2.7 |
| Square feet per unit | 717.0 | 1003.0 | 1400.0 | 600.0 | 845.0 | 1085.0 |
| Average monthly rent | 210.0 | 280.0 | 405.0 | 190.0 | 275.0 | 370.0 |
| Rent per square foot (cents) | 21.7 | 28.0 | 41.3 | 25.3 | 33.6 | 46.6 |
| Annual percent turnover | 2.0 | 50.0 | 80.0 | 10.0 | 50.0 | 100.0 |
| Percent vacant | 0.0 | 6.0 | 20.0 | 1.0 | 5.0 | 30.0 |
| Number of amenities* | 0.0 | 6.0 | 9.0 | 1.0 | 3.5 | 10.0 |
| Years owner has held | 1.0 | 4.0 | 18.0 | 1.0 | 6.5 | 17.0 |

*The ten amenities counted include laundry facilities, balconies or patios, clubhouse-party rooms, tennis courts, pool, playground, dishwashers, exercise rooms, saunas or whirlpool baths, and indoor parking.

| | Percent | |
|---|---|---|
| | Atlanta | Portland |
| In suburb | 78 | 67 |
| In NE quadrant | 35 | 25 |
| In NW quadrant | 22 | 13 |
| In SE quadrant | 22 | 33 |
| In SW quadrant | 22 | 29 |
| Positive cashflow | 81 | 63 |
| Financial position "excellent" | 35 | 38 |
| "good" | 38 | 25 |
| "fair" | 19 | 17 |
| "poor" | 8 | 21 |
| Owned by individual or partnership | 62 | 88 |
| Managed by owner or owner's firm | 60 | 75 |
| Onsite manager | 97 | 92 |
| Families with children predominate | 62 | 38 |
| Cooling in apartments | 100 | 21 |

3.7.b DISPLAY 3.b. Energy Features, Atlanta And Portland

| | Atlanta | | | Portland | | |
|---|---|---|---|---|---|---|
| Feature | Poor* | OK* | Good* | Poor | OK | Good |
| Caulking | 5% | 65% | 30% | 0% | 38% | 62% |
| Storm windows | 89% | 5% | 5% | 54% | 21% | 25% |
| Attic/roof insulation | 5% | 49% | 46% | 13% | 33% | 54% |
| Wall insulation | 0% | 60% | 40% | 8% | 63% | 29% |
| Insulated hot water tanks | 76% | - | 24% | 21% | - | 79% |
| Insulated hot water pipes | 54% | 27% | 19% | 63% | 21% | 17% |
| Hot water temperature** | 48% | 22% | 39% | 29% | 37% | 33% |
| Flow restrictors | 41% | 16% | 43% | 33% | 38% | 29% |
| Timers on common lights | 5% | 5% | 89% | 4% | 21% | 75% |
| Fluorescent common lights | 51% | 30% | 19% | 75% | 25% | 0% |

*Poor = not at all, none; OK = some; good = all, many, completely

**For hot water temperatures, poor = respondent did not know hot water temperature; OK = 140-150 degrees; good = 110-135 degrees

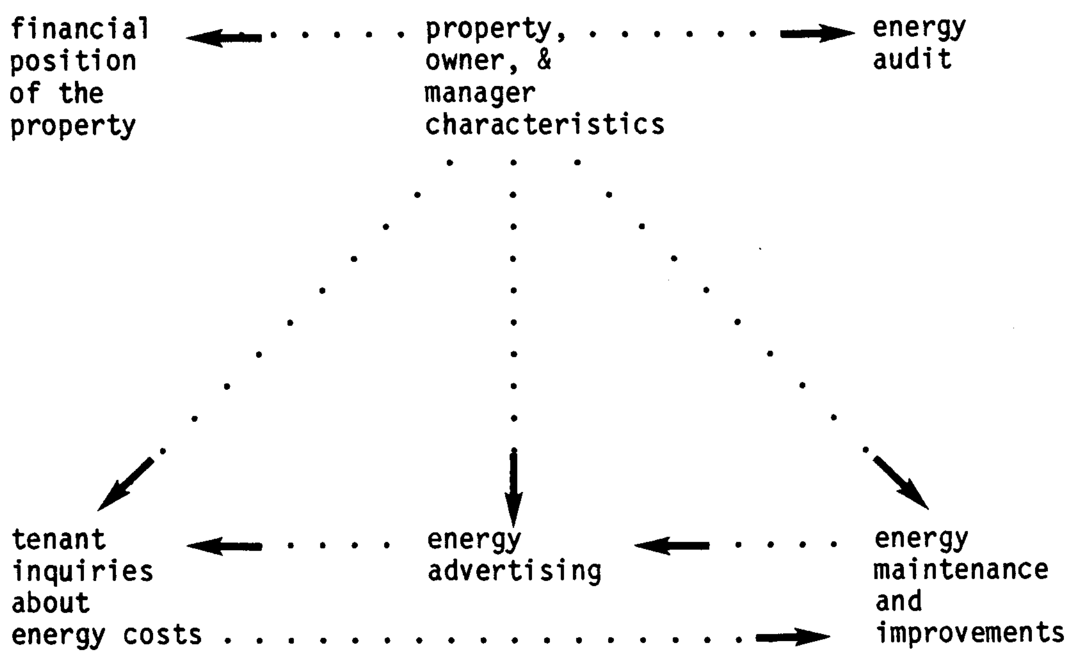
Percentage distribution on efficiency feature scales; high scores indicate more features

| Scale | Score | | | |
|---|---|---|---|---|
| Thermal efficiency | 0-2 | 3-4 | 5-6 | 7-8 |
| Atlanta | 8% | 46% | 43% | 3% |
| Portland | 4% | 50% | 16% | 30% |
| Water heating | 0-2 | 3-4 | 5-6 | 7-8 |
| Atlanta | 41% | 31% | 27% | 0% |
| Portland | 17% | 50% | 24% | 8% |
| Lighting | 0-1 | 2 | 3 | 4 |
| Atlanta | 8% | 49% | 27% | 16% |
| Portland | 17% | 71% | 13% | 0% |

3.7.c DISPLAY 3.c. Energy Actions, Atlanta And Portland

| Action | Percent Atlanta | Percent Portland |
|---|---|---|
| Energy audit | 32 | 33 |
| Consumption records kept | | |
| for owner-paid utilities | 54 | 38 |
| for tenant-paid utilities | 0 | 0 |
| Energy part of regular maintenance | 54 | 42 |
| Tenants encouraged to conserve | 68 | 67 |
| Tenants ask about energy "often" | 41 | 17 |
| Prospective tenants given | | |
| no information on energy | 18 | 37 |
| expected cost per month | 51 | 29 |
| general information only | 30 | 33 |
| Tenants ask for improvements | 41 | 25 |
| Tenants make own improvements | 11 | 13 |
| Energy mentioned in advertising | 11 | 29 |
| Improvements made in last 4 years to | | |
| space heating equipment | 24 | 0 |
| thermal efficiency | 27 | 29 |
| water heating system | 22 | 33 |
| lighting systems | 46 | 25 |
| Total number of improvements made | | |
| 0 | 35 | 38 |
| 1 | 35 | 37 |
| 2 | 16 | 25 |
| 3 | 3 | 0 |
| 4 | 11 | 0 |
| Could list additional improvements with 2-year payback | 43 | 25 |

3.7.d DISPLAY 3.d. Determinants Of Energy Actions, Portland



3.7.e DISPLAY 3.e. Payment Modes And Fuel Types, Atlanta

| | | Space Heating | | | |
|---|---|---|---|---|---|
| | | Tenant-paid gas | Owner-paid gas | Tenant-paid electric | TOTAL |
| Water Heating | Tenant-paid gas | 5 | 0 | 2 | 7 |
| | Owner-paid gas | 0 | 11 | 6 | 17 |
| | Tenant-paid electric | 0 | 0 | 13 | 13 |
| | TOTAL | 5 | 11 | 21 | 37 |

3.7.f DISPLAY 3.f. Determinants Of Energy Actions, Atlanta

| Dependent variable | Complete tenant payment R-sq | Complete tenant payment Predictors | Owner-paid space &/or water heating R-sq | Owner-paid space &/or water heating Predictors |
|---|---|---|---|---|
| Number of efficiency improvements | .74 | low rents<br>few units<br>many amenities<br>high vacancies | .48 | low vacancies<br>in suburbs |
| Energy part of regular maintenance | .75 | in suburbs<br>electric heat/DHW<br>few units | .85 | low vacancies<br>owner-managed<br>negative cash-flow<br>electric tenant-paid heat |
| Energy audit | .35 | high rents | .92 | owner is developer, syndicate, institution<br>new construction<br>fee management<br>low rents |

CHAPTER 4 THE ROLE OF ENERGY IN THE RENTAL HOUSING MARKET

# CHAPTER 4

# THE ROLE OF ENERGY IN THE RENTAL HOUSING MARKET

This chapter examines the role of energy costs or energy efficiency in the market for rental housing. Data from two studies are used to provide an indirect look at how energy costs influence tenant actions. The first study, a survey of rental advertising in 32 cities nationwide, addressed the question

- o Are energy efficiency and costs mentioned in advertising for rental housing?

The second study surveyed 82 multifamily properties in Atlanta, a market with relatively frequent advertising mention of energy. It addressed three more specific questions:

- o Do prospective tenants ask about energy costs?
- o Are rents related to the energy costs tenants must pay?
- o Are rents related to energy efficiency features or advertising?

## 4.1 RELATED PAST WORK

As noted in Chapter 1, several recent reviews of energy problems in rental housing have concluded that tenant concerns about energy costs are not great enough to affect rents or prompt efficiency improvements by owners in most markets (Levine and Raab, 1981; Levine et al., 1982; Office of Technology Assessment [OTA], 1982, pp. 117-121). A 1980 survey of 2115 households which had recently signed apartment leases supports this idea: Kelley (1981) found that for most tenants both energy costs and rent itself are far less important in the selection process than factors such as location, appearance, condition, and layout. No figures for individual cities are reported.

Despite the consensus that tenants are indifferent to high energy costs, there is some evidence that energy costs can influence rental markets under certain conditions: when costs are extraordinarily high, such as oil heating costs in Boston (Levine et al., 1982, p. 14), or when the benefits of energy efficiency are marketed aggressively by a few large owners (OTA, 1982, p. 120). The remainder of this chapter reports on a systematic search for additional evidence concerning the role of energy costs in rental housing markets.

## 4.2 MENTION OF ENERGY EFFICIENCY IN RENTAL ADVERTISING

### 4.2.a Design And Method

If tenants are concerned about energy, rental property owners are likely to mention energy efficiency in their advertising in order to attract tenants. The extent to which this is now occurring was investigated in a sample of 32 cities selected from the 50 largest in the U.S. (1975 population estimates) to represent a broad range of rental markets in all regions of the country. Classified advertisements for residential units for rent were obtained for all 32 cities from the Sunday August 16, 1981 editions of local newspapers. Each unit or property listed separately in the "for rent" section was considered as a separate entry, even if several properties or units were grouped together in one advertisement. The number of entries ranged from 200 in Charlotte to over 1300 in several larger cities.

Each entry was coded on two dimensions:

- o housing style, with categories for a) attached or detached single family homes, including townhouses, and b) units in multifamily buildings--apartments, duplexes, etc. This distinction was made because these two styles may constitute different markets, and because single family tenants almost always pay all energy costs directly while in multifamily units energy costs are more often included in the rent.

- o mention of energy efficiency, including note of specific energy-related features such as weatherization, insulation, storm windows, solar heating, wood stoves, etc., and non-specific mention of energy efficiency, low energy costs, small utility bills, etc.

The "mention score," or percentage of entries which mention energy efficiency, costs, or features, is the measure of interest. The items most frequently mentioned include (in order) general energy efficiency, double-glazed and storm windows, insulation and weatherization, heat pumps, other specific features, and solar equipment.

### 4.2.b Results

The multifamily mention score is essentially zero for 19 cities, and ranges from 1% to 7% for the other 13. DISPLAY 4.a (page 4-12) shows the multifamily and single family scores for these 13 cities, along with a third score for advertisements in apartment guides, which are private or apartment association publications for prospective tenants. Also shown are scores for the same three categories taken from February 1982 publications. The six scores tend to rise and fall together across the 13 cities (minimum correlation, +.23), with the August and February scores for each category most strongly related. For example, the two multifamily scores are correlated +.91.

The scores display three patterns. First, single family scores are consistently higher than multifamily scores (Atlanta and Tampa excepted). This is probably because tenant-paid energy costs are more common in single family units than in multifamily, where energy costs are often included in fixed monthly rents. Second, mention in apartment guides is consistently higher than in newspaper advertisements. This is perhaps because the guides advertise larger, newer, more expensive properties than do newspapers, and it is these properties which are more likely to require tenant payment and to be efficient. In addition, guide advertisements are generally longer, allowing mention of a larger variety of amenities. Third, February scores are consistently higher than August scores.

The pattern of scores across cities is also of interest. Based on the August and February multifamily and guide scores, the 32 cities can be divided into four categories:

- high mention: Atlanta, Charlotte, Portland (Oregon)
- medium: Columbus, Jacksonville, Memphis, San Antonio, Seattle, Tampa
- low: Cincinnati, Kansas City, Louisville, Oklahoma City
- no mention: Baltimore, Boston, Chicago, Denver, Detroit, Houston, Indianapolis, Los Angeles, Milwaukee, Minneapolis, New Orleans, Oakland, Omaha, Philadelphia, Phoenix, Pittsburgh, San Diego, San Jose, St. Louis.

### 4.2.c Interpretation

The pattern of scores across cities invites speculation about the possible importance of five factors in determining the degree to which energy efficiency is mentioned in the rental advertising of a city.

Tenant-paid energy costs. Tenants are not likely to be concerned about energy costs if they are included in fixed monthly rents. Data from the 1980 Institute of Real Estate Management's Income/Expense Analysis (IREM, 1980) were used to identify study cities in which the majority of multifamily properties require tenant payment of all energy costs (usually electricity plus gas or oil). Of the nine cities so identified, seven are in the high and medium-mention groups (New Orleans and Oklahoma City are exceptions). Conversely, Columbus and Seattle are the only high or medium-mention cities without reported high levels of tenant payment.

High energy costs relative to rents should also heighten tenant concerns about energy. However, energy costs as a percentage of rent (as estimated from the Chamber of Commerce's Inter-City Cost of Living Indicators [American Chamber of Commerce, 1981]) are relatively invariant over the 9 tenant-payment cities, and are unrelated to mention scores both within these cities and within the larger sample. This finding may be due to inaccuracy in the cost measure.

Variable energy costs. If tenant-paid energy costs do not vary across properties, owners cannot attract tenants with low costs. Variability in costs should be greatest when a) space heating and/or cooling represent a substantial portion of energy use, b) the fuels used for heating, cooling, and domestic hot water differ across properties (because, for example, all-electric properties generally have higher costs than those with gas heat), and c) many properties in the market have been built since the mid 1970's, when the trend toward energy-efficient construction began. These conditions tend to be true of at least the high-mention cities.

High vacancy rates should lead owners to note more features in their advertising, because shoppers with more properties from which to select can consider more dimensions in their decisions. Vacancy rates vary together with frequency of tenant-paid energy costs in our sample of cities--both are highest in the South, lowest in the Northeast and North Central regions--making it impossible to assess the independent contribution of this factor.

Local programs. Where other conditions are favorable, local energy programs can increase awareness of energy costs by both tenants and owners, making advertisements featuring energy efficiency more likely. This seems to have occurred in two high-mention cities. Portland has low energy costs but active city and utility conservation programs, including some programs designed especially for rental property owners. These include free audits, low-interest loans, and direct subsidies to owners who implement audit recommendations. In another high-mention city, Atlanta, the electric utility (Georgia Power) has a program to certify multifamily properties meeting specified efficiency standards. Only properties built since 1979 are eligible; they receive "Good Cents" certification if they have high-efficiency, properly-sized cooling and heating equipment; R-30 ceilings, R-15 walls, and R-11 floors; double-glazed windows; insulated doors; protected air distribution; and attic ventilation. Electric heat is not required for certification. The Good Cents logo is featured in many Atlanta advertisements, at least partly because qualifying properties receive a one-time advertising subsidy from the utility. The hope of the utility is that Good Cents certification provides a quick, standardized, authoritative way for owners to tell tenants that their properties are efficient. Note in DISPLAY 4.a (page 4-12) that Portland and Atlanta far surpass all other cities in total numbers of multifamily ads mentioning efficiency.

## 4.3 TENANT INQUIRIES ABOUT ENERGY COSTS

The survey of advertising established that in some cities--Atlanta, Portland, Charlotte, and perhaps others--rental property owners think that advertisements featuring low energy costs or energy efficiency can attract prospective tenants. This finding raises two additional questions: Are prospective tenants asking about energy costs when they gather information about the costs and benefits of particular housing units? Are property owners being forced to accept lower rents for units with high energy costs or substandard energy efficiency? Data addressing these questions were collected in Atlanta, the city with the greatest proportion and greatest absolute number of multifamily advertisements mentioning energy, so that equal numbers of properties with and without energy-related advertising could be sampled. Within Atlanta the focus was further narrowed to the north-central/northeast suburbs, which contain the greatest concentration of properties with energy-related advertising.

The sample included all 82 multifamily rental properties in the north-central/northeast area which advertised in the Atlanta Journal-Constitution or in any of five apartment guide magazines during fall 1981. Mail surveys addressed to "Manager" were sent to all properties in June 1982. After telephone followups, 69 (84%) responded. The questionnaire contained items about property and unit size, rents, type of heating fuel, amenities (pools, tennis courts, fireplaces, etc.), age, utility payment patterns, energy costs paid by tenants, and mention of energy in advertising. As far as can be judged from their advertisements, non-responding properties are similar to the rest of the sample on these dimensions.

The first research question was approached directly; respondents were asked "How often do prospective residents ask about energy costs?" and given a 5-point response scale from "never" to "almost always". The percentage distribution for the 69 responding properties is as follows: "half the time" or less, 6%; "often", 18%; "almost always", 76%. Obviously, the leasing agents and resident managers who responded to the survey may have over-reported the incidence of inquiries. However, the consistency of the responses, coupled with comments made by respondents, indicates that a significant number of tenants shopping the north-central/northeast Atlanta market are at least asking about energy costs; what is done with this information when the decision is made is, of course, another matter. The data do not imply that tenant inquiries are equally frequent in other cities, or even elsewhere in Atlanta, because the submarket surveyed was selected for study because of the high frequency with which properties there mention energy efficiency in their advertising.

## 4.4 SENSITIVITY OF RENTS TO ENERGY COSTS AND FEATURES

When tenants are concerned about energy costs (as reflected by inquiries at leasing) and owners are aware of those concerns (as reflected by their use of advertising appeals), housing units with low energy costs should command higher rents than comparable units which have high energy costs or which lack common energy efficiency features. This prediction was tested in the 69 Atlanta properties described above.

### 4.4.a The Properties

The subset includes all 48 of the 69 properties which have 2-bedroom units and tenant-paid space heating and cooling. Of the 21 properties excluded, one has only one-bedroom units, two were still under construction, nine include space heating costs in fixed rents, four did not provide estimates of tenant energy costs, and two reported energy costs at least $50 per month (two standard deviations) above those for any other property. All properties in the subset of 48 provided full information on average rent, apartment size, and tenant-paid energy costs for typical two-bedroom units, plus information on apartment features, recreational facilities, property age, vacancy rate, and fuel types used. The units of all properties in the subset have electric air conditioning, a stove, refrigerator, dishwasher, disposal, patio or balcony, and carpeting; all properties have one or more swimming pools. DISPLAY 4.b (page 4-13) characterizes the 48 properties on a number of other dimensions. The typical property was built in 1978, has a 5% vacancy rate, and has over 100 two-bedroom units of 1100 square feet, renting for just under $400 per month in 1982. Most properties accept children; most have clubhouses and tennis courts; half have fireplaces in each unit. Tenants pay for gas space and water heating in 60%, for electric space and water heating in 23%; all tenants pay for electric lights, appliances, and space cooling.

Four types of information related to energy were collected for each property: heating fuel (electric or gas; this is important because electricity costs over two times as much per BTU as does gas); mention of energy efficiency in advertising; certification by the Georgia Power Good Cents program (for properties built 1979 and after); and expected average monthly energy cost for tenants, as reported by the manager or leasing agent. Manager estimates of costs were used because they duplicate the estimates provided to tenants and because records of actual historical costs were unavailable.

DISPLAY 4.c (page 4-14) shows the distribution of properties by heating fuel type, mention of energy efficiency or costs in advertising, and certification. Of 11 properties with certification, 10 have gas heat; of 19 non-certified properties which advertise energy efficiency, 16 have gas heat. In contrast, 13 of the 18 properties which do not advertise energy efficiency have electric heat. DISPLAY 4.c (page 4-14) also shows the distribution of reported energy costs across the 48 properties. Median cost is $55; 73% of the properties have monthly costs averaging between $45 and $75.

### 4.4.b Analysis Method

The goal of the analysis is an assessment of the relationship of the energy-related factors to rents. As a preliminary step, multiple regression analysis was used to find the set of non-energy factors which best predicts rents. The set of variables including unit size in square feet, property age, and presence of fireplaces (considered as luxury amenities rather than as heat sources) explains 77% of the variance in rents over the 48 properties; no other non-energy property characteristics surveyed significantly increase the amount of variance explained.

To estimate the effects of the energy-related factors on rents after the effects of other factors have been controlled or removed, the quantity residual rent = (actual rent - expected rent) was calculated for each property using the set of variables described above. The average residual rent for the 48-property sample is of course zero; the range is from -$78 to +$60; the average absolute value is $24, or 6% of average rent.

### 4.4.c Rents And Energy Costs

Are differences between actual and expected rents related to differences in energy costs across properties? Properties with higher reported energy costs do have lower residual rents, as would be the case if tenants were unwilling to pay market rents for units with high energy costs. However, each additional $1 in energy costs is associated not with $1 less in rent, but with $.50 less. Thus rents for units with high reported energy costs are being discounted by only half as much as would be necessary to make their total cost (rent plus energy) equal to that of equally desirable units with lower energy costs. This apparent undervaluing of energy costs may be due to inaccuracies in our measure of cost (although the costs reported to us are presumably the same as those reported to prospective tenants), to systematic over-reporting of costs by managers worried about tenants whose costs exceed those promised, to difficulties for tenants in obtaining useable or believable cost information, or to disregard of energy costs by some tenants. Alternately, energy costs may be affecting tenant turnover--the number of times a unit changes hands annually--rather than (or in addition to) rents. Vacancy rates are not related to energy costs or to rents.

If tenants are concerned about energy costs but cannot obtain or do not believe the cost information given out by property staffs, they may be estimating expected energy costs for various properties on the basis of type of heating fuel, mention of energy in advertising, or Good Cents certification. The relationship of these property characteristics to reported energy costs is examined below, followed by an examination of their relationship to residual rents.

### 4.4.d Property Characteristics And Energy Costs

Five property characteristics on which information was collected might be used by tenants to estimate energy costs at a particular property: property age, unit size, type of heating fuel, mention of energy in advertising, and Good Cents certification. Since these factors are not independent in our sample (e.g., all but one of the Good Cents properties have gas heat), their relationships to reported energy costs were explored both one at a time and jointly, and both in the whole sample and within the electric heat and gas heat subsamples. None of the five characteristics is very strongly related to reported costs in the whole sample, either individually or jointly. Property age and unit size are each positively related to reported energy costs, but each accounts for only 7% of the variance in costs across properties. Properties with gas heat have energy costs $8 lower (per unit per month) than those with electric heat; properties advertising energy efficiency have costs $9 lower than those which do not; certified properties have costs $6 lower than those without certification. Taken individually, these differences account for 7, 9, and 4%, respectively, of the total variance in energy costs. All five property characteristics taken together still account for only 16% of the variance in energy costs in the whole sample.

Within the 31 gas heat properties the story is the same, with age, unit size, advertising mention, and certification together explaining only 4% of the variance in reported energy costs. In contrast, unit size accounts for 84% of the variance in reported energy costs within the 17 electric heat properties. However, property age, advertising mention, and certification together account for only 14% of the variance in energy costs, or 18% of the variance in energy costs per square foot for this subsample.

The finding that property age and Good Cents certification are essentially unrelated to reported energy costs is surprising, since it is usually assumed that new construction, especially that meeting the certification standards, is significantly more energy efficient than older construction.

Four explanations can be suggested for this finding. First, the differences between actual energy costs and those reported by the respondents could be large. To account for the pattern found, however, one must hypothesize reporting biases which systematically vary with property age and certification, and which exactly balance the (supposed) true effects of age and certification. Second, significant retrofit activity in this market in the mid 1970's may have increased the efficiency of older properties to a level comparable to that of new construction; however, observers of the Atlanta market agree that this is unlikely. Third, efficiency improvements in newer properties might be cosmetic only, with no significant effect on energy use. Since Good Cents properties are inspected by Georgia Power before certification, this also seems unlikely. Finally, tenants of less efficient properties (and of those with more costly electric heat) might have adopted lower comfort levels than have tenants of more efficient properties, bringing actual energy use and costs to a more or less equal level across properties with differing levels of thermal and equipment efficiency. This explanation, which might be called the "compensating comfort level hypothesis," cannot be fully tested without data on average comfort levels in different properties. The form of the distribution of tenant-paid energy costs reported above neither supports nor counters this idea. Implications of this hypothesis are explored further in section 4.5.

### 4.4.e Energy-related Property Characteristics And Rents

Rents or residual rents may be related to type of heating fuel, mention of energy in advertising, and Good Cents certification even though these factors are only weakly related to reported energy costs; this would happen if tenants concerned about obtaining housing with low energy costs believed these features to relate to and predict energy costs. This possibility was checked by comparing the mean residual rent of properties with and without each of the features.

The relationships of both heating fuel and advertising mention to residual rents are stronger than that of reported energy costs to residual rents. Gas heat properties have residual rents $23 higher than those with electric heat; the probability of a difference of this magnitude occurring by chance is less than 1%. This difference compares to a difference of only $8 in reported energy costs for these two groups of properties.

Residual rents for properties with any advertising mention of energy (including Good Cents certification) are $17 higher than those for properties with no mention, which compares to a difference in reported costs of $9.

Residual rents are the same for properties with and without Good Cents certification; this may reflect a belief that Georgia Power is not a credible source of information, or an incorrect assumption by tenants that all properties certified by the electric company have electric heat, with a consequent belief that these properties will have <u>higher</u> costs.

## 4.5 CONCLUSIONS

The national advertising survey and the Atlanta case study shed light on the behavior of both tenants and owners of rental housing. The advertising survey established that in some cities, especially those in which many tenants pay their own heating costs, property owners and managers act as if advertisements mentioning energy efficiency or low energy costs can attract tenants. The case study focused on Atlanta, a city with a utility-run certification program, a growing rental market, and frequent mention of energy costs in rental advertising. In this market tenants frequently ask about energy costs when renting housing units, and rents are related to tenant energy costs, to type of heating fuel, and to whether energy is mentioned in advertisements for the property.

In a rational economic market higher energy costs should be associated on a dollar-for-dollar basis with lower rents--<u>if</u> all tenants have complete information about expected energy costs for different properties; <u>if</u> all tenants incorporate this information into their rental decisions; and <u>if</u> rent adjustments completely compensate for differential vacancy and turnover rates. In the Atlanta market studied, the rent-energy cost tradeoff is not dollar-for-dollar; instead, differences in rents go only half-way toward fully compensating for differences in management-reported energy costs. In contrast, the reported cost differences between properties with electric and gas heat, and between properties with and without advertising mention of energy, are <u>more</u> than compensated by rent differences. This pattern of results implies that tenants are undervaluing expected energy costs and overvaluing the more easily-determined features of energy advertising and gas heat when making rental decisions; these behaviors by tenants then lead to rent differentials. However, this judgment of overvaluation assumes that the energy costs reported by property staffs are good estimates of costs tenants should expect. If tenants in less efficient, electrically-heated properties have adopted lower comfort levels to save money, actual energy costs will <u>not</u> provide good estimates of relative energy costs across properties <u>given equal comfort levels</u>. In this case the rent differences associated with gas heat and energy advertising might actually provide better estimates of the expected difference in energy costs given equal comfort levels than does the difference in management-reported costs. A more parsimonious explanation is that tenants are simply incorrectly perceiving gas heat and energy advertising to be associated with low expected costs.

### 4.5.a The Importance Of Cost Information

The fact that management-reported energy costs cannot be readily predicted from property characteristics such as age, type of heating fuel, utility company certification, or advertising suggests that if energy efficiency is to play a stronger role in the Atlanta market, tenants will need improved information. What is needed is an easy way for current and prospective tenants to obtain believable, comparable information on expected costs at several properties. Currently, cost information can be obtained only by direct inquiry to utility companies or to property staffs. Both Georgia Power and Atlanta Gas will disclose a particular apartment's cost for the last year to prospective tenants, and Georgia Power will provide a cost projection for units in new properties as well. However, collection of this information requires an active effort by the tenant, and the figures obtained will be influenced by the lifestyle of the past tenants as much as by the efficiency of the unit or property. Furthermore, the credibility of utility company information may be low to many tenants. Estimates from property staffs may be given in terms of summer and winter costs, electric and gas costs, high and low costs, or an annual average. Unknown factors influencing the quality of these estimates include reporting biases (low estimates sound good, but high estimates protect the staff from later complaints), the comfort levels adopted by present tenants, and staff ignorance of actual costs in their own and other properties.

### 4.5.b Generalizing From Atlanta

The results of the Atlanta and national studies indicate that energy costs are thought by some owners/managers to play a role in some rental markets with high tenant-paid energy costs. In the Atlanta market selected for intensive study, 1982 energy costs were relatively high: $.60 per hundred cubic feet for gas, $.055 per kilowatt-hour for electricity, rising to almost $.075 with summer rates. Tenants in surveyed properties with tenant-paid heat pay an average of 12% of their total shelter cost (rent plus energy) for energy, with a range of 5 to 20%. Given these costs, a competitive market of over 80 similar properties with 15,000 units, significant construction since 1979, and a formal utility-run certification program, the Atlanta submarket is unique. Even though the relationship among energy costs, energy-related features, and rents is not that predicted for a perfect market, it does indicate that both tenants and owners/managers view a rent discount as appropriate in properties where tenants expect energy costs to be high.

A case study of an unique instance is of course not readily generalizable to other instances. However, it is probable that as energy costs rise relative to rents, as more and more tenants are asked to pay these costs, as the multifamily housing industry recovers, and as property owners and managers nationwide learn that low energy costs can attract tenants, other markets will come to resemble that in Atlanta.

## 4.6 DISPLAYS

### 4.6.a DISPLAY 4.a. Mention Of Energy Efficiency In Rental Advertising In 13 Cities

| City | Percent with mention August MF | August SF | August G | February MF | February SF | February G | Total number MF* |
|---|---|---|---|---|---|---|---|
| Atlanta | 7 | 2 | 10 | 10 | 2 | 19 | 102 |
| Charlotte | 5 | 11 | 14 | 6 | 9 | 12 | 14 |
| Cincinnati | 1 | 3 | 7 | 0 | 5 | 5 | 11 |
| Columbus | 1 | 2 | 8 | 3 | 3 | 9 | 28 |
| Jacksonville | 2 | 2 | 6 | 3 | 4 | 9 | 13 |
| Kansas City | 1 | 0 | 6 | 1 | 2 | 4 | 6 |
| Louisville | 1 | 1 | 1 | 1 | 1 | 3 | 4 |
| Memphis | 3 | 4 | 11 | 3 | 4 | 8 | 24 |
| Oklahoma City | 1 | 0 | 0 | 1 | 2 | 6 | 3 |
| Portland | 4 | 7 | 9 | 5 | 7 | 18 | 88 |
| San Antonio | 1 | 0 | 13 | 0 | 1 | 12 | 1 |
| Seattle | 1 | 2 | 7 | 1 | 3 | 10 | 14 |
| Tampa | 1 | 0 | 9 | 4 | 0 | 12 | 15 |

MF = classified advertisements for multifamily housing
SF = classified advertisements for single family houses
G = apartment guides
*Total number of mentions in August and February multifamily ads

The following cities had scores of less than 1% for August multifamily, and are not included in the display: Baltimore, Boston, Chicago, Denver, Detroit, Houston, Indianapolis, Los Angeles, Milwaukee, Minneapolis, New Orleans, Oakland, Omaha, Philadelphia, Phoenix, Pittsburgh, San Diego, San Jose, St. Louis.

## 4.6.b DISPLAY 4.b. Characteristics Of 48 Atlanta Properties

| Feature | Percent |
|---|---|
| Fireplaces | 46% |
| Clubhouse and tennis courts | 75% |
| Exercise room | 31% |
| Children accepted | 71% |
| Playground | 27% |
| Tenants pay for electric cooling and | |
| Gas heat | 4% |
| Gas heat and hot water | 60% |
| Electric heat | 13% |
| Electric heat and hot water | 23% |

| | | Percentiles* | |
|---|---|---|---|
| Feature | 25th | Median | 75th |
| Number of 2-bedroom units | 78 | 113 | 172 |
| Size in square feet | 1052 | 1119 | 1211 |
| Rent | $349 | $392 | $446 |
| Rent per square foot | $.32 | $.36 | $.38 |
| Total number of units | 136 | 233 | 318 |
| Vacancy rate | 3% | 5% | 10% |
| Year built | 1970 | 1978 | 1981 |

*The 25th and 75th percentiles describe the levels between which 50% of all properties fall.

4.6.c DISPLAY 4.c. Atlanta Properties, By Heating Fuel, Advertising Mention, And Energy Costs

| Advertising mention | Space heating fuel Gas | Electric | TOTAL |
|---|---|---|---|
| Not certified | | | |
| no advertising mention | 5 | 13 | 18 |
| some mention | 16 | 3 | 19 |
| Certified with advertising mention | 10 | 1 | 11 |
| TOTAL | 31 | 17 | 48 |

| Reported monthly energy costs | | |
|---|---|---|
| $25-35 | 6% | |
| $35-45 | 11% | |
| $45-55 | 32% | Median = $55 |
| $55-65 | 25% | Mean = $58 |
| $65-75 | 16% | Standard |
| $75-85 | 4% | deviation = $15 |
| $85-95 | 4% | |
| $95-100 | 2% | |

CHAPTER 5 SYNTHESIS AND IMPLICATIONS

# CHAPTER 5

# SYNTHESIS AND IMPLICATIONS

## 5.1 A MODEL OF ENERGY USE IN MULTIFAMILY RENTAL HOUSING

DISPLAY 5.a (page 5-16) shows in a very simplified fashion the avenues through which building owners and tenants affect a building's overall energy use. Total energy consumption (or consumption per unit) is a function of climate, size of apartment units, average household size, the services provided to tenants (e.g., space cooling, swimming pool, washer/dryers) and energy efficiency--thermal insulation, air infiltration, equipment efficiency, and so on. Energy efficiency is in turn a function of the state of the building and its energy-using equipment, operating practices (e.g., thermostat settings on central boilers, maintenance, when space cooling systems are started up in the spring), and the way in which individual tenants use energy. The building owner or manager has primary control over the state of the building and equipment (although this is also affected by history) and over operating practices. However, both of these may also be influenced directly or indirectly by tenants. For example, tenants may install plastic window coverings, caulk windows, request that the pool be kept warmer, or complain that halls are overlighted. The energy-using habits of individual tenants are of course under tenant control. However, owner/managers can sometimes exert control in areas traditionally left to tenants--for example, by forcing night thermostat set-backs from a central processing unit.

The critical variable affecting how tenants and owner/managers interact with one another vis-a-vis energy use is payment mode. These interactions are most easily understood by examining the effect of increasing energy prices under conditions of owner and tenant payment.

### 5.1.a With Owner Payment Of Energy Costs

DISPLAY 5.b (page 5-17) shows the effects of increasing energy prices under owner payment. As prices increase, the owner's cash flow (rental income minus expenses) drops. The owner may raise rents to increase income; if the new rents are accepted by tenants (i.e., do not cause enough vacancies and turnover to cancel their positive effect on income), cash flow is restored and no further actions are necessary. In this case there is no effect on energy use.

If increased rents lead to significant complaints from tenants, vacancies, turnover, and/or non-payment of rents, the owner may have to lower rents to recover income, leaving unresolved the problem of reduced cash flow. At this point the owner may consider alternative actions. These include simply accepting the lowered cash flow, reducing maintenance or tenant services, selling or abandoning the building, appealing to tenants to reduce their energy use, taking actions to improve energy efficiency, and switching to tenant payment of energy costs. If the appeals to tenants are successful, energy use will drop. Use will also drop if other types of owner actions to improve efficiency (e.g., insulating) are successful. In either case energy costs will drop or stabilize and cash flow will be restored until energy prices rise again.

In general, an "owner's market" (low vacancy rates, high rents in competing properties) will favor the first path described: reduced cash flow > increased rents > increased income > restored cash flow. A "tenant's market" will favor alternative paths, and in extreme cases abandonment may be an economically reasonable option. The presence of local governmental or utility company energy programs for owners should increase the probability of owner investments in efficiency. In any given property multiple paths may be taken simultaneously or at different times.

### 5.1.b With Tenant Payment Of Energy Costs

DISPLAY 5.c (page 5-18) shows the effects of increasing energy prices when tenants pay for energy directly. Increasing prices will lead to tenant concerns about energy costs (or, more precisely, to reduced spending power for other commodities). Tenants may respond with increased care in energy use, employing more moderate thermostat settings, cutting hot water and appliance use, and the like. This will reduce energy use, thereby reducing or stabilizing energy costs for the individual tenants who can improve efficiency. The owner/manager is not involved.

Tenant concerns about energy may also affect the owner. Tenants worried about high costs may appeal to management for improved energy efficiency, using complaints, publicity about management inaction, threats to move out or withhold rent, and so on. They may simply not pay their utility bills. In addition, individual tenants may begin to consider energy costs explicitly when selecting or deciding to retain a housing unit. When many tenants in the same market do this, vacancy and turnover rates will be affected. This effect may be apparent both within properties (e.g., producing consistently higher vacancies or turnover in exterior north-facing units than in interior south-facing ones) and across them, with higher vacancies or turnover in properties with higher energy costs. These differentials will lead in time to rent adjustments, so that units and/or properties with lower energy costs come to command higher rents.

At some point in this process, probably due to tenant complaints, to inquiries about energy costs, to differential vacancy and turnover rates, or to the actions of other owners, the owner/manager should become aware of tenant concerns. Beyond simply adjusting rents to compensate for high energy costs, the owner may attempt to take advantage of tenant concerns about energy to increase the property's competitive position and profitability. Primary actions open to the owner in this regard include a) attempting to persuade tenants, using advertising and information provided at the site, that the rental unit in question is efficient or has low energy costs, and b) attempting to reduce tenant-paid costs by changing operating policies and/or by upgrading the efficiency of the structure and equipment. The economic justification for such improvements would come from the higher rents (or lowered vacancy and turnover rates) presumed to be associated with the reduced energy costs. Any efficiency improvements would be advertised to increase the probability of attracting tenants willing to pay higher rents to obtain lower energy costs. Both the improvements themselves and their effect on rents and cash flow may enhance the sales value of the property.

A final component in this model of owner and tenant interactions, not shown in DISPLAY 5.c (page 5-18), is the presence of local programs to promote or certify energy efficiency in rental properties. Such programs can provide tenants with information about how to find housing with low energy costs, directly increase tenant concerns about costs, increase owner awareness, or even facilitate owner actions with financial incentives or subsidies.

The model just described is clearly a feedback loop. Advertising and other information about energy costs will increase tenant concerns and make it easier for them to consider energy costs in rental decisions. In addition, owner actions to improve efficiency may widen the disparity in energy costs across properties, thereby increasing the competitive pressures on other owners to reduce tenant energy costs.

An owner's market will favor the path not involving owners, in which tenant concerns about energy costs lead to increased care and efficient use by tenants. In a tenant's market, when tenants have more effective power over owners, rent adjustments and efficiency improvements are more likely.

## 5.2 ESTIMATING THE LONG-TERM EFFECTS OF TENANT PAYMENT

The models presented in section 5.1 suggest that the long-term effect of tenant payment on energy use is determined by three independent factors: a) the one-time reduction in energy use which accompanies introduction of tenant payment; b) the ongoing or cumulative changes in energy use which price increases will prompt in tenant-payment properties; and c) the ongoing or cumulative changes in energy use which price increases will prompt in owner-payment properties. This third factor must be considered to yield an estimate of how use will change relative to how it would have changed without tenant payment.

Precise quantitative estimates of the long-term effect of tenant payment on energy use under various conditions would require equally precise estimates of each factor and of how they vary in different conditions--for example, warm and cold climates, type of billing, fuel type, price. Unfortunately, even in the area of most intensive research, Factor A, the best estimates are broad generalizations with bands of possible error ranging from half to double the point estimate. Given this degree of imprecision, a sensitivity analysis is useful to indicate the degree to which the conclusions reached are sensitive to differences in the factor estimates. The following three sections (5.2.a-5.2.c) review evidence relevant to each factor to establish a range of reasonable, probable, or possible quantitative estimates for each. Section 5.2.d then examines how these estimates combine to determine long-term energy use.

### 5.2.a Factor A: One-time Reduction At Introduction Of Tenant Payment

All the data presented in Chapter 2 are relevant to Factor A. Estimates of the one-time reduction in energy use accompanying introduction of tenant payment, synthesized from new data and results of past work, are listed in Display 2.h. These estimates can be summarized as follows: for formula billing, 6%, range 0-15%; for billing by measured consumption, 14% for space and water heating (range 5-20%); 17% for lights, appliances, cooling, and all-electric installations (range 5-30%). Section 2.10 gives guidelines for using these estimates with specific properties, and indicates under what conditions greater and smaller reductions should be expected. Estimates ranging from 0 to 30% should cover all reasonable possibilities since "reductions" of less than zero (i.e., increases in use) and reductions greater than 30% are unlikely to occur.

### 5.2.b Factor B: Ongoing Changes In Tenant-payment Properties

As DISPLAY 5.c (page 5-18) shows, there are two pathways by which increasing energy prices can affect energy use in properties with tenant payment; their effects must be combined to estimate how energy use will change over time in these properties.

Direct actions by tenants. The first path involves tenants alone: increasing prices > tenant concern > increased care and efficiency of use by tenants > reduced energy use. This path is similar to that found in owner-occupied single family housing. However, homeowners are free to make physical modifications to their homes, and can often expect an increased sales value if they do. Tenants usually cannot make any substantial modifications to their units, and receive no reward except the immediate reduction in energy use if they do.

In a private report for Cambridge Energy Research Associates, Meyers and Schipper (1983) recently reported a 20% reduction in residential energy consumption in the 10 years since 1973, or about 2% per year. Since the lion's share of residential consumption occurs in owner-occupied single family homes, this figure can be used to represent the expected annual reduction in energy use in owner-occupied housing; this, of course, assumes that the downward trend in use will continue unchanged, as Meyers and Schipper also assume.

Many of the actions which produced the 2% annual reduction are available to most tenants: changing thermostats, operating windows and doors properly, turning off lights and appliances, using less hot water. What proportion of the drop is due to such actions, and what proportion to modifications such as insulation, water heater wraps, and flow restrictors is open to speculation. It seems safe to assume that some of the drop is due to modifications not available to most tenants, so that the expected annual drop due to tenant action alone would be less than 2%.

Tenant or market pressure on owners. The second path involves the building owner, who may improve efficiency to maintain a competitive market position. As noted in section 5.1, the extent to which this happens depends both on energy prices (or, prices relative to rents) and on the state of the rental market. The results reported in Chapter 3 indicate that owners of tenant-payment properties in Atlanta and Portland have invested in efficiency improvements in the last four years. The Atlanta case study results reported in Chapter 4 further suggest that such improvements may yield increased rental income for the owner if they actually reduce tenant energy costs. Thus the actions of owners of properties with tenant payment, at least under conditions like those in Atlanta and Portland, are probably more likely to reduce consumption over time than to increase it through neglect of needed maintenance and improvements.

The joint effect of tenants and owners. When market pressures prompt owner actions to improve efficiency, the owner-tenant combination can do everything that homeowners can do, including building modifications and so-called "lifestyle changes". In theory, then, consumption changes in tenant-payment properties could duplicate those in single family owner-occupied housing. Given the imperfections which will inevitably flaw rental markets, however, duplication of the 2% reduction discussed above is the maximum that can reasonably be expected; an estimate of 1% seems more prudent. And because increases in use due to owner inaction may occur in markets dissimilar to Atlanta and Portland, an increase in use of 1% per year will also be included in the sensitivity analysis. Thus estimates from +1% to -2% per year will be used.

### 5.2.c Factor C: Ongoing Changes In Owner-payment Properties

As DISPLAY 5.b (page 5-17) shows, energy price increases may also affect energy use in owner-payment properties through owner actions or tenant actions. In this case the owner has the direct incentive to improve efficiency, although the strength of this incentive is affected by the state of the rental market. The results reported in Chapter 3 suggest that owners of Atlanta owner-payment properties may do more to improve efficiency than do owners of tenant-payment properties; in cities where energy efficiency is not marketed as aggressively as in Atlanta, the contrast may be even greater. On the other hand, some owners say that obvious energy waste by tenants makes it pointless for the owner to make any improvements (Levine et al., 1982). Tenants who do not pay for energy directly may take steps to use energy more efficiently as the result of direct appeals by the owner (e.g., a threatened rent increase) and/or as the result of a general climate of concern about energy prices, shortages, etc. As in tenant-payment properties, the actions of owners and tenants work together to determine how energy use changes over time.

Results from control properties. No aggregate data on long-term changes in energy use in owner-payment properties are available to IBS. However, estimates of short-term changes in use are available from a few control properties. The control properties are multifamily, owner-payment properties which did not introduce tenant payment during the period studied. The ideal control property is similar in every regard to the experimental property it is paired with (that is, the property introducing tenant payment); at the minimum, they must be in the same general location, so that control and experimental properties are affected by the same weather and price changes.

Control properties were identified either by the owners of experimental properties or by direct IBS solicitation of owners who responded to the call for experimental properties but did not introduce tenant payment by summer 1982. Matched controls similar in type of construction, tenants, ownership, and energy-using equipment were available for two properties introducing tenant payment by measured consumption for gas space and water heating, one in Pennsylvania, one in Wisconsin. Gas use in the Pennsylvania experimental property fell 22% in the period following January 1980 introduction of retail gas meters. However, gas use in two similar, control, properties fell 17% from baseline in the same period, evidently due to modest physical changes to the buildings and to improved maintenance and operating procedures, but perhaps due to changes in tenant behavior as well.

In Wisconsin, gas use at the experimental property dropped 16% in the year following the October 1980 introduction of tenant payment. In an identical neighboring property which retained owner payment, use dropped 11% in the same period; no information is available on the actions of owner or tenants in the control property.

Four control properties with owner-paid gas space and water heating were available in the Denver area. They range in size from 11 to 196 units and have the same general age, type of construction, rent levels, types of equipment, and gas use as the 23 Colorado properties which introduced tenant payment by measured consumption for gas space and water heating. Gas use dropped an average of 15% in the tenant-payment properties. Gas consumption records for over four years were available for each control. In one control, use (corrected for weather) was relatively constant over time; in a second, it rose by 3-5% per year. In the remaining two properties use fell by an average of 2-5% per year. Managers of the control properties report that no major building or equipment modifications were made in the period examined, except for a new boiler for the building in which use increased over time.

The results for control properties indicate that energy use can drop without the introduction of tenant payment, and that the reductions can be substantial. However, the results are clearly not sufficient for estimating long-term use trends in properties with owner payment.

<u>Summary</u>. The state of knowledge relevant to the ongoing changes in energy use prompted by price increases in owner-payment properties can be summarized as follows. The owner's economic incentive to reduce use is roughly comparable to that for single family homeowners, but the tenant's incentive is weak and indirect. Since tenant behavior as well as owner actions affect consumption, ongoing reductions are unlikely to equal the 2% found in owner-occupied housing. However, the Atlanta data suggest that the reductions are likely to exceed those found in tenant-payment properties. In the absence of more precise information, the same range of estimates will be used for ongoing changes in tenant-payment and owner-payment properties: from up 1% to down 2%.

### 5.2.d Balancing The Factors

The three factors described above, coupled with assumptions about initial use, can be used to calculate energy use in tenant- and owner-payment properties in any particular year following introduction of tenant payment. Let

d = first-year drop in use associated with introduction of tenant payment; e.g., .05, .15, for 5%, 15%.

w = ongoing annual change in use in owner-payment properties; e.g., +.01 indicates an increase in use of 1% annually, while -.015 indicates a drop of 1.5%

t = ongoing annual change in use in tenant-payment properties, in the same terms as w

W(i) = use in owner-payment properties in year i

T(i) = use in tenant-payment properties in year i

p(i) = [T(i)/W(i)] * 100, or tenant-payment use as a proportion of owner-payment use in year i

P(i) = T(i) cumulated over the first i years as a proportion of W(i) cumulated over the same period.

Assume for simplicity that initial use (before tenant payment) is 100 in both tenant- and owner-payment properties. Then

W(i) = 100 * (1 + w)**i

T(i) = [100 * (1 - d)] * [(1 + t)**(i - 1)]

where X**y indicates X raised to the y power.

Certain relationships can be directly derived from the definitions.

- If t = w (if use is projected to drop by the same percentage annually in both tenant- and owner-payment properties), $p \simeq P \simeq (1 - d)$ for all i. In other terms, the relationship between use in the tenant- and owner-payment properties will remain more or less constant over time if use in both is changing at the same annual rate.

- If t < w and d > 0, p and P will always be less than 100 and will become smaller over time. Thus, if there is a larger annual drop or smaller annual increase with tenant payment, and if there is any initial drop in use when tenant payment is introduced, both annual and cumulative use with tenant payment will always be less than with owner payment, with the gap increasing over time.

- When d > 0 and t > w, there exists some i for which p(i) > 100, and some larger i for which P(i) > 100. In other terms, when there is an initial drop with tenant payment but tenant-payment properties exhibit smaller annual reductions (or larger annual increases) in later years, eventually T(i) and W(i) will be equal. Furthermore, cumulative use (starting with introduction of tenant payment) with tenant payment will eventually equal, then exceed, that with owner payment.

In the first two situations, the benefit of reduced energy use associated with the introduction of tenant payment remains constant or increases over time; these situations present no problems for policy. In the third situation, in contrast, the initial benefit is eventually lost, overwhelmed by the disadvantage of smaller annual reductions in use in tenant-payment properties. How soon this happens depends upon the size of the initial drop (d) and on the relationship between t and w.

DISPLAY 5.d (page 5-19) shows cumulative use with tenant payment as a percentage of cumulative use with owner payment after 10 and 20 years [P(10), P(20)] for initial drops of 5, 10, 15, and 20%. Figures less than 100 indicate lower cumulative use with tenant payment, while those greater than 100 indicate greater use with tenant payment. Brackets enclose the figures for situation 1, where t = w. Figures below the brackets describe situation 2, where annual reductions with tenant payment are greater than those with owner payment.

Of greatest interest are the figures above the brackets, where the annual reductions for owner payment are greater (w < t). The results for this situation can be roughly summarized as follows; see DISPLAY 5.d (page 5-19) for details.

- When d = 5%, P(20) exceeds 100 in all cases when consumption in owner-payment properties stays constant or decreases from year to year. P(10) exceeds 100 when the difference between t and w is at least 1%. For example, with t = 0 and w = -1.5%, P(20) = 111 and P(10) = 103.

- When d = 10%, P(20) exceeds 100 when the difference between t and w is at least 1%; P(10) does so with differences of at least 2%.

- When d = 15%, P(20) exceeds 100 when the difference between t and w is at least 1.5%; for P(10) the difference must be at least 3%. Given the values of t and w selected as "reasonable", this means that use in tenant-payment properties over the first 10 years will equal that in owner-payment properties only if annual increases of 1% with tenant payment and annual decreases of 2% with owner payment are recorded.

- When d = 20%, P(20) exceeds 100 only with a t vs. w difference of at least 2.5%; P(10) never exceeds 100 using t and w in the range +1% to -2%.

An alternate way of summarizing the results is by focusing on particular values of t and w as best estimates. If w = -1% (1% annual reduction in owner-payment properties) and t = -0.5% (0.5% annual reduction in tenant-payment properties), then P(10) = 89, P(20) = 91 for an initial reduction in use of 14%, which is the best current estimate for intial reductions for metered space and water heating. Both P(10) and P(20) are still under 100 with an initial reduction of 10%. With an initial drop of 6% (the best estimate for formula billing), both are between 97 and 100. All w, t differences of 0.5% give roughly equivalent results.

With a 1% difference between annual change rates in owner- and tenant-payment properties, P(10) and P(20) range between 90 and 95 for initial reductions of 15%, between 95 and 100 for 10%, and between 100 and 105 for 6%.

## 5.3 IMPLICATIONS FOR POLICIES CONCERNING PAYMENT MODE

### 5.3.a Types Of Regulations And Programs

Governmental policies explicitly treating how energy costs are charged to tenants of multifamily housing are expressed in state utility regulations and in federal legislation. In many cases these regulations distinguish among four types of tenant payment: retail meters; submeters measuring use of electricity or natural gas; monitors measuring use of space heating, space cooling, or water heating; and formula billing. See section 1.4 for a further description. The regulations and programs concerning payment modes and metering fall into four main categories.

Some pre-1974 state regulations classify methods of owner-administered billing for energy as "sale for resale", thereby prohibiting them. Such regulations may be worded so as to rule out submeters only, submeters and monitors only, or any owner-administered billing, including formula billing. They are usually based on historic concerns about threats to the monopolies granted to utility companies in their service areas. In other states tenant protection is the primary concern, and owners are prohibited only from making a profit on tenant billing.

After 1974, regulations concerning new construction began to appear. The federal Public Utilities Regulatory Policies Act of 1978 (PURPA) requires certain utilities to consider (not adopt) a "metering standard" restricting use of master metering for electricity in new construction. A few states have adopted master metering prohibitions in response; some have prohibited master metering for both gas and electricity, even though the PURPA standard refers only to electricity. Several bills were introduced in the U.S. Congress in 1980 and 1981 to prohibit master metering of gas and electricity in new buildings with more than one unit, but none became law. The avowed purpose of PURPA, of resulting state regulations, and of the proposed bills is the reduction of energy use by the assignment of financial responsibility for energy costs to tenants, the end users.

Some post-1974 policies concern existing buildings. The U.S. Department of Housing and Urban Development (HUD) has since 1976 required that Public Housing Authorities consider a conversion to retail meters when any energy efficiency improvements are being considered, and must proceed with conversion if it is cost effective when evaluated using HUD figures on projected energy reductions. The HUD figures, which are loosely based on old engineering standards rather than on empirical comparisons, range as high as 35% for space heating conversions. The HUD policy was challenged in court by a Massachusetts tenant group, and in 1982 the U.S. Court of Appeals (District of Columbia Circuit) found that the HUD meter conversion policy (24 CFR 865.400) "lacked a rational basis" and upheld a lower court order prohibiting HUD from expending federal funds for utility meter conversions by public housing authorities under its jurisdiction.

No federal legislation concerning payment modes in existing housing is in effect, although several bills allowing tax credits for meter installation have been introduced.

California utilities, under pressure from their public utility commission, have adopted several types of programs encouraging owners of master metered buildings to convert to retail or submeters. These programs include direct incentive payments to owners who convert, mail campaigns, and rate differentials which allow owners with submeters to collect more from tenants than they themselves must pay the utility. In some cases these rate differentials are great enough to make cost effective the installation of gas submeters in apartment using gas only for cooking. The programs treat retail and submeters more or less equally; monitors and formula billing are prohibited. The primary goal of all the California programs is reduced energy use.

Regulations allowing submetering, monitors, and/or formula billing have been proposed or adopted in a few states, primarily at the behest of owners who are unable to convert to retail metering due to central space and water heating equipment or to limited capital.

Summary. Proposed, existing, and recently-adopted regulations and programs serve to make retail metering more probable, rent inclusion less probable. Their effect on submetering, monitoring, and formula billing is mixed. While the primary goal of most of these policies is reduced energy use, consumer or tenant protection is also a consideration.

### 5.3.b Meeting Policy Goals

Do metering policies succeed in their goal of reducing long-term energy use? Although this project was not designed to answer this question, its results must be considered in any full analysis. At least five component questions must be considered in a full policy analysis:

- To what extent do the policies actually encourage tenant payment? Most state regulations are written in terms of types of meters (master, retail, sub), not in terms of who pays the bill. While retail and submetering virtually insure tenant payment, monitors can also be used to charge tenants for energy use according to measured consumption. Submeters, monitors, and formula billing are all compatible with master metering; furthermore, monitors and formula billing are the only possible methods of charging tenants for use of the outputs of central or shared equipment. Thus while recently enacted regulations do promote tenant payment by requiring retail metering (or in some cases submetering) in new construction, regulations already existing in 1974 often serve to discourage tenant payment by prohibiting use of monitors, formula billing, and/or submetering.

- Does tenant payment actually reduce long-term energy use? As outlined in section 5.2.d, the answer to this depends both upon the initial drop in use when tenant payment is introduced (or, in new construction, upon an initial difference in use with and without tenant payment) and on the annual rates of change in use in properties with tenant and owner payment. The figures presented in section 5.2.d suggest that tenant payment does lead to long-term reductions in energy use if tenants are billed according to individually measured consumption (not by formula) and if the annual change rates are in accord with certain reasonable assumptions. Policy makers with different assumptions about the initial drop and/or about annual change rates, or with time frames of less than 10 or more than 20 years, should use the formulae presented above to calculate their own answers to this question.

- Do the policies encourage use of individual space heating, space cooling, and water heating equipment for each apartment? Retail metering cannot be used with central or shared equipment. Thus master meter prohibitions will serve to encourage use of individual equipment--which may be less efficient than shared equipment--unless an exemption is allowed for buildings with central equipment. Estimates of how serious a problem this is vary widely.

- Do the policies encourage use of electricity for space and water heating? When retail or submeters are required without exemption for central equipment, two meters per apartment are required if gas is used. Lower first costs may therefore lead some builders and owners to use electric equipment only, which can lead to higher total energy use (counting end use plus generation), to higher bills for tenants, and to increased need for electric generating capacity.

- Do the policies enhance or reduce the ability of utility companies to control electricity loads? Time of day rates, direct control, and other means of load control may be more easily administered with retail meters. However, since the total load generated by a building is more important than individual apartment loads, control over a master metered, total flow may be more useful to a utility in the long run. Such control is lost with retail meters.

The list above deals only with the effects of metering and payment mode policies on energy use. Other issues to be considered in policy development concern the effects of payment mode on tenants and on owners. These issues include

- Are tenant charges equitable? That is, are they related in a reasonable and predictable manner to energy use and prices? Is the way in which charges are calculated fully disclosed to tenants? With formula billing, are charges based on factors generally related to energy use, such as square feet occupied, time spent in the apartment, number of occupants? With submeters and monitors, are measurements sufficiently accurate? Are adjustments made in the billings or in the rents for differences in energy efficiency across apartments?

- Do tenants have rights to inspect billing records, appeal, use a levelized billing program, obtain audits, and the like?

- What are the effects on building owners of required initial costs? of ongoing administrative costs? Do owners with central equipment have any legal way of charging tenants for energy use?

### 5.3.c Policy Shortcomings

The results presented in this report suggest that requiring tenants to pay for their own, individually measured energy use is effective in producing long-term reductions in direct energy use. Furthermore, tenant payment is looked upon quite favorably by most building owners, since it insures immediate and automatic payment of a cost which is both variable and unpredictable. Many tenants seem to regard tenant-paid energy costs as an inconvenience which is inevitable with rising energy prices; many also welcome the chance to control these costs with their own actions.

Given this view, the obvious shortcoming of current policies is the way in which they act to impede the use of submeters and monitors. These devices are often the least expensive and, in the case of buildings with central equipment, sometimes the only way in which tenant energy consumption can be measured. Their use is prohibited in many states, and in no state is monitor use encouraged. There are no federal and few state standards for testing monitors. True, tenant protection issues are much more critical with owner-administered billing systems such as submeters and monitors than with retail meters. However, these issues are not insurmountable. In short, policy modifications are needed to encourage--or at least avoid discouraging--tenant payment in existing buildings with central heating, cooling, and/or water heating equipment.

### 5.3.d The Role Of Formula Billing

The 1980 IBS report on RUBS, the Resident Utility Billing System, established that the initial reduction in energy use associated with this type of formula billing was less than that for billing by measured consumption. The current project replicates and reinforces this result. The results reported in Chapter 2 yield an estimate of a 6% reduction with formula billing for all functions, range 0 to 15%. It is possible that tenants being charged by formula put greater pressures for efficiency on their owners and managers than do tenants charged by measured consumption, because the formula method points up the importance of building and equipment efficiency in determining tenant bills. In addition, the manager billing by formula cannot tell complaining tenants that they alone have high bills, because bills are based on group, not individual, consumption. Still, it is difficult to argue that tenant pressures would prompt more owner action than would occur with complete owner payment; at best, the annual change rates might be equal. Given equal or greater annual reductions in owner-payment properties (compared to those with formula billing), the range of annual change rates used in the sensitivity analysis and in DISPLAY 5.d (page 5-19), and an initial drop of 6% with the introduction of formula billing, 10-year cumulative energy use with formula billing will equal 94 to 110% of that with owner payment. For 20 years, the corresponding figures are 94 to 127%. Thus the benefit of long-term reductions in energy use is not automatic with formula billing. In contrast, if tenant payment deters owner actions enough to reduce the annual change rate by 0.5%, the long-term benefit is nil. If it deters owner actions enough to reduce the change rate by a full 1%, the long-term effect of formula billing on energy use is negative--there will be greater use over 10 and 20 years with formula billing than with owner payment.

Formula billing can have benefits other than reduced energy use, especially for property owners who cannot pay for any way of measuring individual energy use. It can also be useful as a first step toward billing by measured consumption. On the other hand, tenants are generally not in favor of formula billing, preferring either rent inclusion or billing according to measured consumption. In sum, formula billing probably deserves no role in programs designed explicitly to reduce energy use.

## 5.4 IMPLICATIONS FOR POLICIES ON ENERGY INVESTMENT

### 5.4.a Types Of Regulations And Programs

State and federal policies, plus some utility company programs, also address energy investment in rental housing. The goal of all such policies is reduced energy use; they fall into four categories.

Incentive programs provide owners with tax credits, low-interest loans, free or discounted products and labor, etc. The Portland hot-water wrap give-away is an example.

Mandatory efficiency standards, enforced at time of sale or rental licensing, have been proposed by many governmental agencies and adopted by a few, led by Minnesota.

Information programs range from booklets to audits. Utility company audits and federal Commercial and Apartment Conservation Service (CACS) programs are examples.

Information for tenants about the relative energy efficiency of properties for rent is provided by the Georgia Power "Good Cents" program (described in section 4.2.c) and by a certification program directed by several gas utilities in Wisconsin.

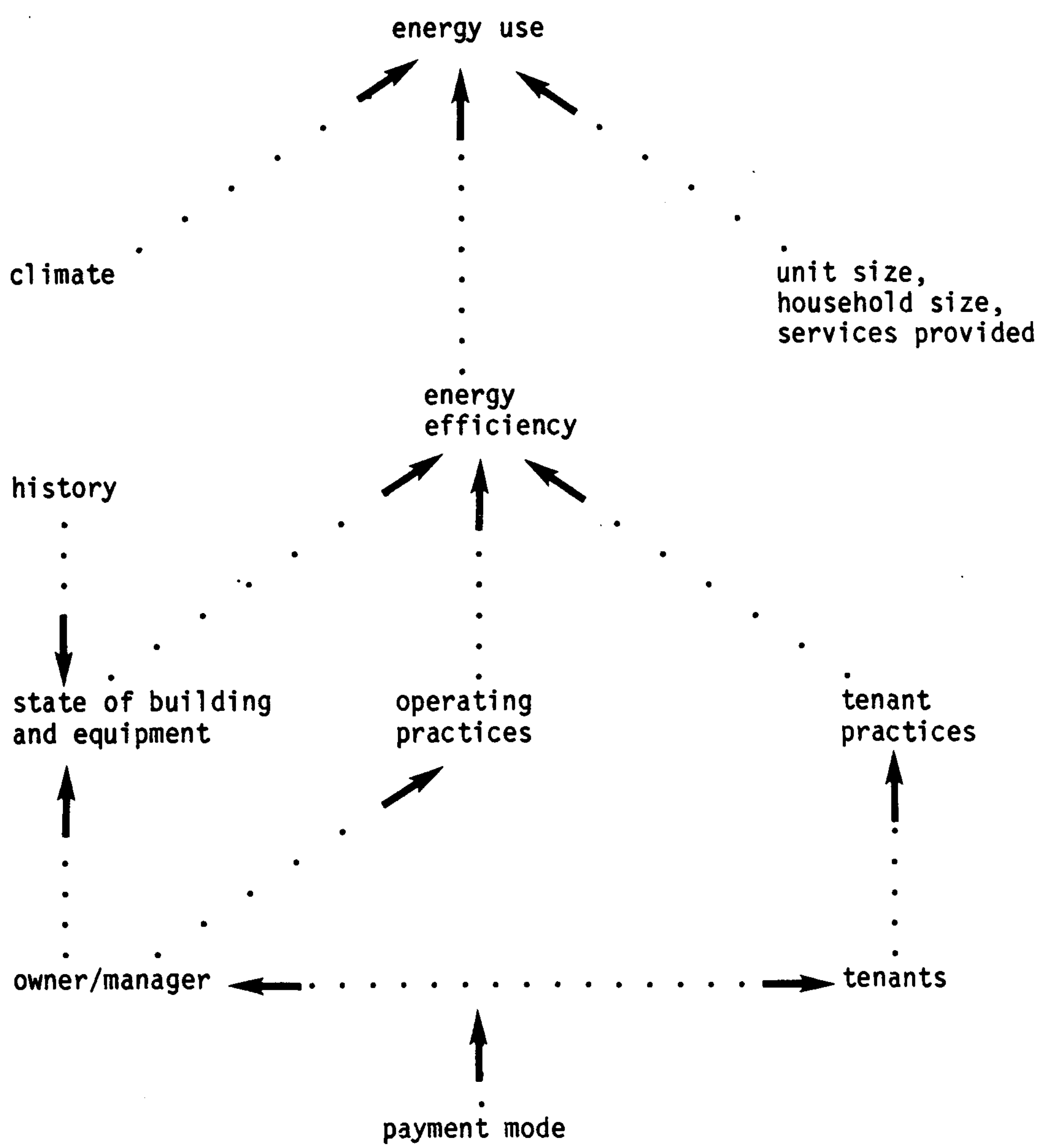
### 5.4.b Meeting Policy Goals

The results of this project are relevant to energy investment programs in two regards. First, they indicate that, at least in cities like Portland and Atlanta, building owners have been making some energy investments even when tenants pay all energy costs. Thus, incentive and information programs may be useful in spurring further action.

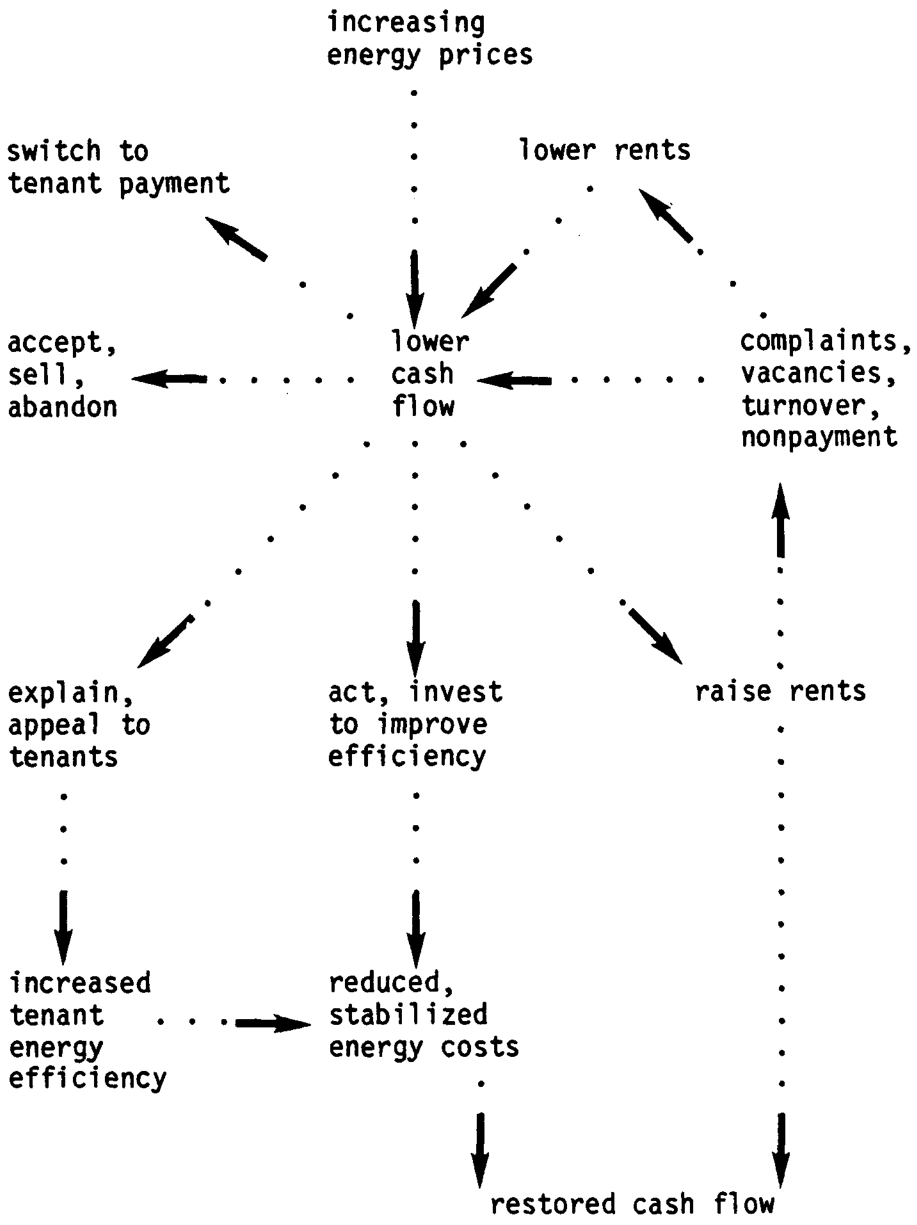
Second, the Atlanta case study and the nation-wide advertising survey indicate that tenant concerns about energy costs can come to play a visible role in the rental market, and that in some instances owners of buildings with tenant payment can expect a payback in increased rental income for lowering tenant energy costs. However, even with cooperative utilities and a well-advertised certification program, Atlanta tenants face great difficulties in obtaining standardized information about energy costs in different properties. (The Good Cents certification covers only new construction and gives only a yes-no rating.) The policy implications are clear: programs to provide current and prospective tenants with an easy way of obtaining believable, comparable information about expected costs could act to increase the role played by energy in the market. This in turn would give owners of properties with tenant payment a more clear-cut economic benefit from energy investment. Information programs are probably most appropriately run by local governments to insure unbiased assessments and credibility, but could also be run by utilities, tenant groups, or even apartment associations.

## 5.5 DISPLAYS

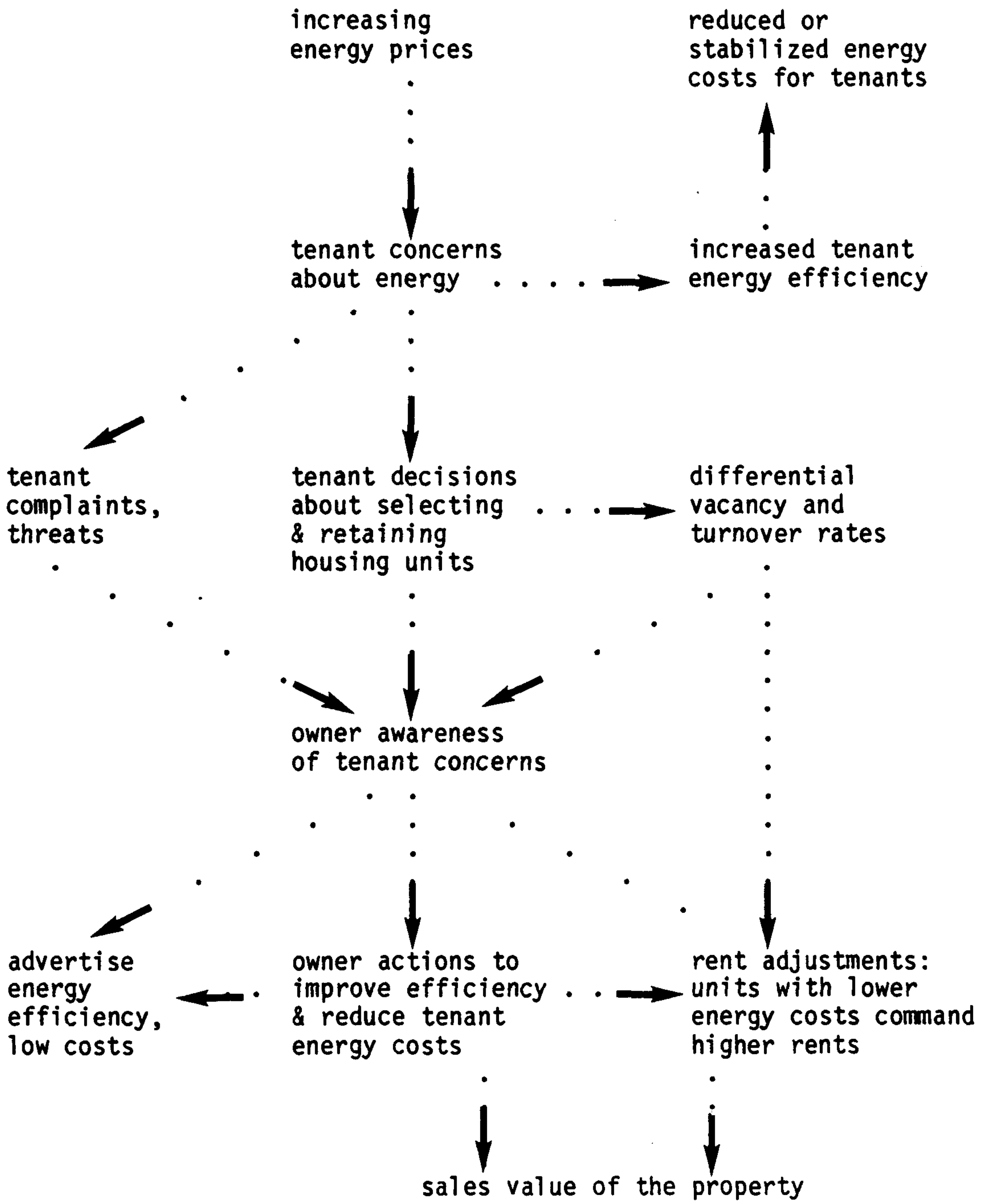
### 5.5.a DISPLAY 5.a. A Model Of Tenant And Owner Effects On Energy Use



5.5.b DISPLAY 5.b. Effect Of Increasing Energy Prices With Owner Payment



5.5.c DISPLAY 5.c. Effect Of Increasing Energy Prices With Tenant Payment



5.5.d DISPLAY 5.d. Cumulative Tenant-payment Energy Use As A Percentage Of Owner-payment Use After 10 & 20 Years, By Initial Drop And Annual Change Rates

| | Annual change in owner-payment properties (w) | | | | | | |
|---|---|---|---|---|---|---|---|
| t* | +1.0% | +0.5% | 0.0 | -0.5% | -1.0% | -1.5% | -2.0% |
| **Initial reduction = 5%** | | | | | | | |
| +1.0% | [94, 94] | 97, 99 | 99,105 | 102,110 | 105,116 | 108,122 | 111,128 |
| +0.5% | 92, 90 | [95, 95] | 97,100 | 100,105 | 103,111 | 105,116 | 108,122 |
| 0.0 | 90, 85 | 92, 90 | [95, 95] | 98,100 | 100,105 | 103,111 | 106,117 |
| -0.5% | 88, 81 | 90, 86 | 93, 91 | [95, 95] | 98,101 | 101,106 | 104,111 |
| -1.0% | 86, 78 | 88, 82 | 91, 86 | 93, 91 | [96, 96] | 99,101 | 101,106 |
| -1.5% | 84, 74 | 86, 78 | 89, 83 | 91, 87 | 94, 92 | [96, 96] | 99,101 |
| -2.0% | 82, 71 | 85, 75 | 87, 79 | 89, 83 | 92, 88 | 94, 92 | [97, 97] |
| **Initial reduction = 10%** | | | | | | | |
| +1.0% | [89, 89] | 92, 94 | 94, 99 | 97,104 | 99,110 | 102,116 | 105,122 |
| +0.5% | 87, 85 | [90, 90] | 92, 94 | 95, 99 | 97,105 | 100,110 | 103,116 |
| 0.0 | 85, 81 | 88, 85 | [90, 90] | 93, 95 | 95,100 | 98,105 | 100,111 |
| -0.5% | 83, 77 | 86, 81 | 88, 86 | [90, 90] | 93, 95 | 96,100 | 98,105 |
| -1.0% | 81, 74 | 84, 78 | 86, 82 | 88, 86 | [91, 91] | 93, 96 | 96,101 |
| -1.5% | 80, 70 | 82, 74 | 84, 78 | 87, 82 | 89, 87 | [91, 91] | 94, 96 |
| -2.0% | 78, 67 | 80, 71 | 82, 75 | 85, 79 | 87, 83 | 89, 87 | [92, 92] |
| **Initial reduction = 15%** | | | | | | | |
| +1.0% | [84, 84] | 87, 89 | 89, 94 | 91, 99 | 94,104 | 97,109 | 99,115 |
| +0.5% | 82, 80 | [85, 85] | 87, 89 | 89, 94 | 92, 99 | 94,104 | 97,109 |
| 0.0 | 80, 76 | 83, 81 | [85, 85] | 87, 90 | 90, 94 | 92, 99 | 95,104 |
| -0.5% | 79, 73 | 81, 77 | 83, 81 | [85, 85] | 88, 90 | 90, 95 | 93,100 |
| -1.0% | 77, 70 | 79, 73 | 81, 77 | 84, 82 | [86, 86] | 88, 90 | 91, 95 |
| -1.5% | 75, 66 | 77, 70 | 79, 74 | 82, 78 | 84, 82 | [86, 86] | 89, 91 |
| -2.0% | 74, 64 | 76, 67 | 78, 71 | 80, 74 | 82, 78 | 84, 82 | [87, 87] |
| **Initial reduction = 20%** | | | | | | | |
| +1.0% | [79, 79] | 81, 84 | 84, 88 | 86, 93 | 88, 98 | 91,103 | 93,108 |
| +0.5% | 77, 75 | [80, 80] | 82, 84 | 84, 88 | 86, 93 | 89, 98 | 91,103 |
| 0.0 | 76, 72 | 78, 76 | [80, 80] | 82, 84 | 85, 89 | 87, 93 | 89, 98 |
| -0.5% | 74, 69 | 76, 72 | 78, 76 | [80, 80] | 83, 85 | 85, 89 | 87, 94 |
| -1.0% | 72, 66 | 74, 69 | 76, 73 | 79, 77 | [81, 81] | 83, 85 | 85, 89 |
| -1.5% | 71, 63 | 73, 66 | 75, 70 | 77, 73 | 79, 77 | [81, 81] | 83, 85 |
| -2.0% | 69, 60 | 71, 63 | 73, 66 | 75, 70 | 77, 74 | 79, 78 | [82, 82] |

*t = annual change in tenant-payment properties

Each pair of entries shows cumulative energy use in tenant-payment properties as a proportion of that in owner-payment properties after 10 and 20 years. Brackets surround the entries where t = w.

APPENDIX A

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APPENDIX B


## ACKNOWLEDGMENTS

The eight-year project which this report culminates got its start from Lynn Collins, formerly of the U.S. Department of Energy, and Stuart Cook of the University of Colorado, both of whom deserve hearty thanks; they never imagined we'd end up in Who's Who in Real Estate! Thanks too to the Department of Energy for the long-term support necessary for a project of this magnitude. Gary McClelland also contributed ideas, analysis help, and a listening ear throughout the eight years.

Others contributed ideas and comments on individual chapters of the report: Cody Engle of First Property Management Corp, Debby Bleviss of the Federation of American Scientists, Daniel Stram of Princeton University, E. Robert Miller of The Robert A. McNeil Corporation, Chuck Sapper and Nancy Birkeland of the Atlanta Apartment Owners and Managers Association, and Ray Spratlin of Georgia Power.

The entire report was kindly reviewed by Debby Bleviss of the Federation of American Scientists and Frans Verhagen of Sociological Energy Services International.

Energy consumption data were contributed by dozens of property owners, plus several meter companies: ZDC of Boulder; Energy Billing Systems of Colorado Springs; Energy Control Systems, Fontana, Wisconsin; and especially California Edison Utilities Company.

The Institute of Real Estate Management's Ken Anderson handled the owner survey reported in Chapter 3 with creativity, efficiency, and professionalism. Thanks also go to the owners participating in the survey and to the Atlanta managers who participated in the rent sensitivity study.

Secretaries Liz Farrell and Laura Osborn were responsible for much of the data collection and organization.

The final thank you goes to CLIPR, the University of Colorado Department of Psychology Computer Laboratory for Instruction in Psychological Research. Their VAX computer handled correspondence, data management, analysis, mailing lists, editing, report production, and myriad other tasks with patience, good cheer, and attention to detail no person could ever muster.

# APPENDIX C

# INFORMATION FOR PROPERTY OWNERS AND MANAGERS

NOTE: This appendix is designed as a self-contained document, and thus repeats information presented in the full report.

The University of Colorado, Boulder, recently completed a three-year investigation for the U.S. Department of Energy focusing on the implications of tenant payment of energy costs in multifamily rental housing. This document incorporates results from that project and from the 1980 Colorado report on RUBS, the Resident Utility Billing System. It is divided into two sections: one for owners and managers who currently pay some or all of their buildings' energy costs directly from rental income; one for owners and managers whose tenants are now or will soon be paying some portion of building energy costs themselves.

## C.1 IF THE OWNER PAYS FOR ENERGY COSTS

If you now pay for energy costs from rental income, you may be having trouble maintaining an adequate cash flow in the face of rising energy costs. Possible solutions to this problem include improving the efficiency of your building and equipment, raising rents more frequently, asking residents to conserve, and shifting the responsibility for energy costs to tenants.

### C.1.a Benefits Of Tenant Payment

Tenant payment, the only option covered here, has several benefits for owners. First, increases in energy costs are paid by tenants automatically, without a rent increase. Second, cash flow will be more stable from month to month, since seasonal variations in energy costs are absorbed by tenants. Third, quoted rents can be lower, with smaller and less frequent increases. Finally, energy use may drop up to 20%, depending on the billing method and other factors.

### C.1.b Methods Of Billing Tenants

There are four basic methods of assigning energy costs to tenants. With retail meters for electricity and/or gas, all administration is handled by the utility company. With submeters for electricity and/or gas, administration is by apartment management. Neither retail nor submeters can be used to bill tenants for the energy used by central or shared space heating, water heating, or space cooling equipment. In contrast, monitors are designed to measure each tenant's use of the output of central equipment, usually space heating. Monitors measure such quantities as the amount of time the thermostat calls for heat or the zone valve is open, volume of flow in hydronic systems, or room vs. outside temperature. The costs of the energy used by the central equipment are then apportioned among tenants according to these measurements. With formula billing no measurements are made. Instead, a formula, usually based on square feet occupied, is used to allocate the cost of building energy use among tenants. The most common formula is called RUBS, for the Resident Utility Billing System.

Use of retail and submeters, including gas submeters, is quite common in the U.S. Monitors are used frequently in Europe, but were virtually unknown in the U.S. before 1978. They are now handled by several firms here (see DISPLAY C.a, page C-11), and are used to bill tenants for gas (rarely oil) in as many as 500 properties nationwide. RUBS was introduced in Atlanta in 1975, and is now in use in approximately 400 properties nationwide. In some cities RUBS services are available to handle set-up and monthly billing.

### C.1.c Special Problems Of The Methods

Each method has its own special problems. Retail and submeters are not useful with central equipment. Monitors may be inaccurate, and tenants have great difficulty checking billings because the bill for each unit is based not only on the monitor reading for that unit, but on readings for all other units as well. Tampering can also be a problem with monitors. When monitors, submeters, or retail meters are used to bill tenants for space heating, the bills will be affected by differences across apartments in thermal efficiency or heat loss (e.g, top vs. middle floor), in solar gain, and in the temperature of adjoining units. With some monitors, there are also differences in the amount of heat delivered per hour of "on" time, due to different baseboard lengths, stuck zone valves, and the like. These effects can be substantial; for example, average bills of $6 and $28 were registered by two sets of identical apartments on different floors of a Denver four-story building in November 1979. Such differences must either be accepted (with eventual compensating rent adjustments) or corrected in billing; many monitor firms estimate and automatically correct for differences in heat output and thermal efficiency.

The special problem of RUBS is that tenant bills reflect group (building) consumption, not individual consumption, so tenants who use less than average pay too much; these tenants may complain, especially as costs rise to 15-20% of rent. An associated problem is that RUBS yields smaller reductions in energy use than do monitors, submeters, or retail meters.

### C.1.d Before Considering Tenant Payment

Tenant payment by any method should be introduced only if tenants actually control energy use within their apartments, only if the building is sufficiently energy efficient, and only if average tenancy exceeds three months. There are also legal considerations. A state's utility regulations may explicitly or implicitly prohibit any one, two, or three of submeters, monitors, and RUBS; sometimes the same regulations do not apply to gas as to electricity. Since the regulations are usually ambiguous and change with some frequency, it is best to check with both the state utility regulatory body (e.g., public utility commission) and the utility supplying your building before introducing any form of tenant payment administered by management. Additional or different regulations may apply to condominiums, properties with HUD connections, and buildings under rent control.

### C.1.e Calculating The Payback On Tenant Payment

The switch to tenant payment is an investment with an initial cost, ongoing costs, and ongoing benefits, so it is useful to calculate the payback period, or the time required to recover the inital cost from the (hoped-for) increase in cash flow, or in monthly income minus utility costs. The payback period is a function of the five quantities defined below; see DISPLAY C.b (page C-14) for a sample calculation.

1. The <u>initial investment</u> includes two components. The first is the <u>set-up cost</u>, for lease change-overs, publicity, staff training, setting up the billing and record keeping, purchase and installation of monitors or meters. These costs generally range from $1 to $20 per unit with RUBS, $50 to $400 per unit (or point metered) with monitors or submeters.

   The second component of the initial investment is any temporary income loss due to introduction of tenant payment. This cost, calculated as the product of the number of vacancies, their duration in months, and rent per unit (where all values are over and above normal vacancy figures), can range from nothing to several thousand dollars, primarily depending on how well the introduction is handled.

2. Energy costs should be lower with tenant payment than with owner payment, because tenants become more careful about energy use when they pay for it. New data from 83 properties in Denver, San Diego, and other locations, plus the data summarized in the 1980 report, have been used to make the following estimates:

   - formula billing (RUBS), all energy functions, 6% expected reduction in energy use, range 0 to 15%

   - billing with monitors, submeters, or retail meters

     - for space and water heating only, 14% reduction, range 5 to 20%

     - for electric lights and appliances, 17% reduction, range 5 to 30%

     - for all-electric properties, 17%, range 10 to 30%.

   Reductions for at least half of all similar properties introducing tenant payment should be expected to fall within the specified ranges. Reductions will probably fall nearer the high end of the range when the ratio of tenant bills (averaged over a year) to rent exceeds 15%.

   The expected percentage reduction can be converted to dollar savings by multiplying the quantities average energy cost per month over the last year, expected price over the next year as a percentage of last year's price (e.g., 1.20), normal annual heating degree days as a percentage of last year's total heating degree days (for space heating only), and the expected percentage reduction in energy use. This calculation is shown in DISPLAY C.b (page C-14).

3. Ongoing administrative costs include meter reading, maintenance, billing, collection, and record keeping. These costs might run from $.10 to $1.00 per unit per month with RUBS, $.50 to $2.00 per unit (or point) with monitors or submeters. With retail meters the costs should be nil. Uncollected utility charges are a possibility too; leases should treat utility charges in the same fashion as rent to provide sanctions for nonpayment.

4. Probably the most important factor in the payback analysis is the change in income per rented unit, where income equals rent plus utility payments. Calculating this change involves comparing two figures: a) income (per unit per month) expected with tenant payment; this equals the expected average rent level plus the expected average utility payment; and b) income (rent only) expected if tenant payment is not introduced. Current or last year's rents should be used to estimate b only if you would not be raising rents instead of

starting tenant payment.

5. Long-term changes in occupancy due to tenant payment will also affect cash flow. As above, you must compare expected occupancy with tenant payment to that expected in the same period without tenant payment; the first may be greater than, less than, or equal to the latter, depending on how rents change, the market, and other factors.

DISPLAY C.b (page C-14) shows how these five factors determine payback period. As the example demonstrates, payback cannot be calculated with precision because it depends upon several factors which are very difficult to estimate, such as assumptions about the number and duration of vacancies, the percentage reduction in energy costs, and changes in rents and occupancy.

### C.1.f Other Factors In The Decision

Several factors in addition to payback period should affect your decision about whether and what type of tenant payment to introduce. These include the size of the initial investment (larger with meters or monitors than with RUBS); availability and cost of financing; the effect on property value at sale (meters and monitors are preferred to RUBS and rent inclusion, especially by condominium buyers); the feelings of the owner, manager, and tenants about group vs. individual billing and about differences in bills across apartments due to apartment location, exposure, etc.; and the importance of stabilizing cash flow.

### C.1.g Further Information

More details on the topics presented above are included in the "Cost Allocation Decision Guide" published by the University of Colorado in 1980. The guide is part of the full RUBS report, Encouraging energy conservation in multifamily housing: RUBS and other methods of allocating energy costs to residents (Report number DOE/CS/20050-T2, available in government document libraries and from the DOE Technical Information Center, Oak Ridge National Laboratory, Oak Ridge TN 37830 [free of charge] or from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield VA 22161, for a printing fee) Instructions on calculating the life-cycle costs and savings-to-investment ratio for introduction of tenant payment are included in Alternatives to Master Metering in Multifamily Housing, published by the Institute of Real Estate Management in 1981 (available from IREM, 430 North Michigan Avenue, Chicago IL 60611 for $8.95 plus $2.75 handling).

### C.1.h Getting Started With Tenant Payment

Details on introducing RUBS, monitors, submetering, or retail metering are also included in the RUBS report. The necessary steps include selecting, purchasing, installing, and testing monitors or meters; selecting a starting date which allows adequate time for preparation and notice to tenants; changing leases; developing billing procedures; and planning ways to insure tenant acceptance of the billing method selected. Tenant acceptance will generally be greater with ample notice, clearly explained billing procedures, smaller increases in total shelter cost, apparent equity across tenants, an effort by the owner to improve energy efficiency, and accurate meters.

## C.2 IF TENANTS PAY FOR ENERGY COSTS (OR WILL SOON)

Once your tenants are paying their own energy costs, you as owner or manager still have the responsibility for and ability to benefit from energy efficiency. The responsibility stems from the fact that energy consumption--and tenant bills--are as greatly affected by the efficiency of the building and equipment as by tenant actions such as thermostat settings. And in most multifamily buildings, maintenance and modifications of the building and equipment are the owner's sole responsibility. The ability to benefit from energy efficiency comes from the opportunity to improve your competitive position by "selling" existing or new efficiency features to tenants for higher rents. This can be done only if tenants are to some degree concerned about the energy costs they pay.

Much of the recently completed Colorado project was aimed at finding out if and under what circumstances owners can improve their competitive positions by selling energy efficiency. The remainder of this section reports the lessons learned from this investigation.

### C.2.a Current Situation: Advertising For Rental Housing

If tenants are concerned about energy, rental property owners are likely to mention energy efficiency in their advertising in order to attract tenants. (The converse is probably true also.) The extent to which this is now occurring was investigated in a sample of 32 cities selected from the 50 largest in the U.S. to represent a broad range of rental markets in all regions of the country. Classified advertisements for residential units for rent were obtained for all 32 cities from the Sunday August 16, 1981 editions of local newspapers. The percentage of entries mentioning energy efficiency, costs, or features was calculated for each city. The items most frequently mentioned include (in order) general energy efficiency, thermopane and storm windows, insulation and weatherization, heat pumps, other specific features, and solar equipment. An example is shown in DISPLAY C.c (page C-15).

Cities with the highest percentage of multifamily advertisements mentioning energy are Atlanta, Charlotte, and Portland (Oregon), followed by Columbus (Ohio), Jacksonville, Memphis, San Antonio, Seattle, and Tampa. These are all cities in which the majority of tenants pay all their own energy costs. Between 9% and 18% of the multifamily advertisements in these cities mentioned efficiency or low energy costs. In some cities, especially Atlanta and Portland, the presence of local utility company programs may have increased the role of efficiency in the market.

## C.2.b Current Situation: Atlanta Rents And Energy Costs

The advertising study showed Atlanta, especially the northeast/north-central suburbs, to be the geographic area with the greatest number of properties mentioning energy in advertising. This is a desirable part of the metro area, with generally high rents and a competitive market. It has over 80 large rental properties, with most built since 1970. As such, it presents a picture of what other U.S. rental markets are likely to look like in the future. Managers of properties in this part of Atlanta were surveyed by mail in summer 1982. There are three results of interest to owners and managers elsewhere.

First, over 75% of the 69 properties responding said that prospective residents "almost always" ask about energy costs, indicating a high degree of concern among Atlanta tenants.

Second, in 48 properties with two-bedroom units and tenant-paid space heating and cooling, median tenant energy costs were $55 per month (vs. rents of $392). Properties with higher energy costs did have lower rents than expected on the basis of unit size, amenities, and age, so that each $10 less in energy costs paid by tenants was associated with $5 more in rent. Thus Atlanta owners were "selling" low energy costs to tenants for higher rents.

Third, neither property age nor certification by the local utility was strongly related to energy costs, and some new, certified properties with (supposedly cheap) gas heat were among those with the highest energy costs. Even so, properties with tenant-paid gas heat were getting a $23 premium in rents (per unit per month), despite total tenant energy costs only $8 lower than those for all-electric properties. Similarly, properties which advertise energy efficiency (63% of those in the sample) were getting a $17 premium in rents, with tenant energy costs only $9 less than those in properties not mentioning energy in their advertising.

## C.2.c Current Situation: Energy Improvements Made By Owners

Owners and managers of 20 tenant payment properties in Atlanta and 24 in Portland were surveyed in 1982 by the Institute of Real Estate Management. In both cities, the typical property surveyed was built in 1970, rented two-bedroom units for $275-80 per month in 1982, and is located in the suburbs.

In both cities, at least 60% of the properties (all with total tenant utility payment) have improved the efficiency of one or more energy systems (heat, water, cooling, lighting) in the last four years; 25% in Portland and 35% in Atlanta have improved two or more systems. In Portland, the number of efficiency improvements made is related to the frequency of tenant inquiries about energy costs, indicating that tenant concerns are playing a role in owner decisions to invest in energy efficiency. In Atlanta, owners of all-electric properties, where tenant bills are higher, have made more improvements, also indicating that owners are considering tenant energy bills in their investment decisions.

## C.2.d Current Situation: Summary

The advertising study, the examination of rents in Atlanta, and the survey of Atlanta and Portland owners all suggest that in some cities--probably those with a high frequency of tenant payment, with local energy programs for rental properties, and perhaps with high energy costs--tenant concerns about energy costs are already great enough give a competitive advantage to properties with efficiency features and low energy costs, and to play a role in the investment decisions of owners.

## C.2.e Future Trends

Tenant pressure for low energy costs will only increase in the future. This is because energy costs are rising faster than rents, because rental housing is becoming a more common target for utility and governmental programs, and because the proportion of tenants paying all their own energy costs is increasing. The proportion of new multifamily buildings with tenant-paid energy costs was up to 91% for electricity and 70% for gas by 1977, and increasing every year. New properties are also more energy efficient, thereby putting existing properties under even greater market pressure. Conversions to tenant payment in existing properties with master meters have also been growing at an ever-increasing rate; in Denver, the number of properties using monitors or RUBS (formula billing) to bill for space and water heating has gone from a handful in 1979 to an estimated 200 to 400 now. All these trends will serve to increase pressure for low energy costs from both prospective and in-residence tenants.

C.2.f Suggested Responses

How can a property owner or manager whose tenants pay for energy take advantage of current and coming market pressures for efficiency? The Atlanta and Portland data suggest five possible actions.

- If your property is more efficient than competing properties--that is, has lower tenant energy costs than those for other properties with similar size units--advertise this fact, and/or mention it in information available on-site. If possible, use numbers that tenants can easily compare with those from other properties. Or list efficiency features of your building and equipment.

- Explore ways of sharing the first cost of efficiency improvements with tenants, since they will benefit from lowered energy costs. For example, owner and tenants might share the cost of overhead fans, storm doors, clock thermostats, or other items which provide an immediate, visible benefit to individual tenants but also enhance the building itself.

- Any efficiency improvements you make to the property should be made visible to tenants either literally or through advertising.

- When considering an investment in efficiency, don't forget to include in your analysis anticipated effects on rents (e.g., in Atlanta a $10 reduction in tenant bills should allow a rent increase of $5), on vacancy and turnover rates, and on the sales value of the property.

  For example, assume clock thermostats cost $40 each and will reduce tenant energy costs by an average of $3 per month. If the owner foots the entire first cost, the market might allow collection of an addition $1 to $2 in rent per unit per month, with no change in occupancy or turnover rates. If rents increase by $2 (as a direct result of the $3 reduction in tenant energy costs), the payback to the owner is $40/$2 = 20 months. The sales value of the property should increase accordingly, too.

  In considering energy investments, also remember that condominium buyers are usually more interested in efficiency than are rental property buyers.

- Tenants should be more willing to pay a rent premium for low energy costs if they have good information about what energy costs to expect. Such information must be believable, easy to understand, and readily compared across different properties. Once tenants have reliable information and are willing to pay premium rents for low energy costs, owners of properties with tenant payment would gain a more clear-cut economic benefit from energy investments: eventually, the trade-off between rents and energy costs should be approximately one-to-one. Information programs are probably most appropriately run by local governments to insure unbiased judgments and credibility, but could also be run by utilities, tenant groups, or even apartment associations.

## C.3 DISPLAYS

### C.3.a DISPLAY C.a. Firms Handling Submeters And Monitors

Listed on the next two pages are firms handling submeters and/or monitors for space (or water) heating which responded to an IBS survey in September 1983. Neither IBS nor the U.S. Department of Energy endorse or recommend these firms.

The first item in each listing is a contact person designated by the firm; this individual is usually the president or sales manager.

The listings include specification of the types of energy use the firm's products measure, with

ELEC = electricity
GAS = natural gas
HEAT = space heating
COOL = space cooling
DHW = domestic hot water.

These specifications were provided by the firms themselves, and IBS does not attest to their accuracy. In some cases product brand names are also listed.

The firms are ordered by <u>zip code</u>.

Ralph Beckman
Aeolian Kinetics Inc.
PO Box 100
Providence RI 02901
401-421-5033
HEAT COOL DHW ELEC GAS
"682 Precision BTU meter"

Anders Albertsen
Brunata USA
Box 4280, 59 Bow Street
Portsmouth NH 03801
603-431-3700
HEAT COOL DHW

Michael Schuit
Quadlogic Controls
15 E. 26th Street
New York NY 10010
212-696-5891
ELEC GAS

Reiner Clode
The Comfort-Meter Co.
742 Ridge Road
Kinnelon NJ 07405
201-838-5731
HEAT COOL

Hal Goodman
Cosmostatic,Ldt.,
Cosmo-Comp Division
32-02 Queens Blvd.
Long Island City NY 11101
212-937-4970
ELEC

Ted First
TDM, Inc.
PO Box 47
State College PA 16801
814-237-6944
HEAT COOL
"Total Degree Day Meter"

Joe Stefan
ADEC, Inc.
6178 Oxon Hill Rd.
Oxon Hill MD 20745
301-567-7000
ELEC HEAT COOL DHW
"EMS-8000"

M.D. Renner
Amer. Submeter & Power Co.
Box 272
Garrett Pk MD 20766
301-933-4550
ELEC GAS (distributor)

Paul Estrada
Separate Metering Systems
PO Box 15242
Arlington VA 22215
703-892-0172
HEAT COOL ELEC

Donald Keeth
S.E.C., Inc.
406 N. Main
Plymouth MI 48170
313-455-4500
HEAT COOL
"Meter-All"

Robert Maher
Energy Control Systems
846 Main
Lake Geneva WI 53147
414-248-7035
HEAT COOL
"Accumeter"

Walter Bohrer
Hastings Air-Energy Controls
1718 North First Street
Milwaukee WI 53212
414-265-3600
HEAT DHW
(Clorius products)

J.E. Graves
Econo-Meter
5321 Old Middleton Road
Madison WI 53705
608-238-2100
HEAT

Richard McNary
Minnesota Metering Inc
10740 Lyndale Ave S,
Suite 14E
Bloomington MN 55420
612-881-7885
HEAT COOL DHW ELEC GAS
(ZDC distributor)

Cary Anderson
Anderson Technology
428 E. Chapel
Rockton IL 61072
815-624-2559
HEAT COOL
"Antech BTU meter"

Duane Toft
8500 College Blvd
Overland Park KS 66210
913-341-0610
ELEC GAS

Tony Rapson
Time Mark Corporation
11440 E Pine
Tulsa OK 74116
918-438-1220
HEAT COOL DHW ELEC GAS

Bryant Craig
TEPCOR, INC.
412 Northview
Richardson TX 75080
214-231-0972
HEAT COOL ELEC

Nelson Knight
Planned Energy Systems
949 W. Kearney, Suite 105
Mesquite TX 75149
214-288-5428
ELEC HEAT COOL
"CAPS" for unmetered heat

Ken Adler
Amphel Industries
2888 Bluff 353
Boulder CO 80301
303-440-0411
HEAT COOL
"Energy Monitor Meters"

Gary Schulz
Energy Monitoring Technologies
(EMT)
3905 Pinon Drive
Boulder CO 80303
303-494-6096
HEAT COOL DHW
"Conserve-a-Therm"

Howard Scaman
Energy Cost Allocation Systems
PO Box 12444, 2030 Newton Str.
Denver CO 80212
303-477-6736
HEAT COOL (distributor)

Craig Pulliam
Magna Energy Group
1105 South Cherry Street,
Bldg. 1-108
Denver CO 80222
303-759-8780
HEAT COOL DHW ELEC

Landmark Energy Systems
425 S. Cherry, 4th floor
Denver CO 80222
303-399-5290
HEAT COOL DHW ELEC GAS

Clydeen Huck
Heater Meter Inc.
5805 W 6th Ave #1-B
Lakewood CO 80214
303-234-0256
HEAT COOL

Rik Roberts
ZDC Corp
2450 Central Ave #C
Boulder CO 80301
303-449-9949
ELEC HEAT COOL DHW GAS
"Fareshare"

Roger Freischlag
Energy Billing Systems Inc
20 E. Mountview Lane #E
Colorado Springs CO 80907
303-620-9099
HEAT COOL ELEC
"Compubill"

Alan Kilborn
California Edison Utilities Co.
7250 Engineer Rd, Suite H
San Diego CA 92111
619-292-8001
HEAT COOL DWH ELEC GAS

C.3.b DISPLAY C.b. Calculating The Payback Period For A Switch To Tenant Payment

See section C.1.e of the text for definitions. Sample property has 100 units and is introducing RUBS. All figures are per month.

INITIAL INVESTMENT of $3040 = $400 + $2640, where
$400 = administrative start-up cost, 100 units @ $4.00
$2640 = temporary rental loss from
4 units vacant for 3 months @ $220 unrealized rent

CHANGE IN MONTHLY CASH FLOW (INCOME AFTER UTILITIES)

$163 GAS COST SAVINGS of $163 = ($2670 * 1.22 * .05), where
$2670 = average monthly cost for the previous year
1.22 = adjustment for expected price rise and colder weather
.05 = expected savings due to tenant conservation (5%)

These figures also give the expected tenant bill as
$2940 = $30/unit/month = ($3258 - $163) * .95, where
$3258 = expected mo. bill w/o tenant payment, $2670 * 1.22
$163 = savings due to tenant payment
.95 = portion of total costs paid by tenants (95%)

$104 ONGOING ADMINISTRATIVE COSTS of $104 = $75 + $29, where
$75 = routine administration, 100 units @ $.75
$29 = collection losses, 1% of expected monthly charges

$576 CHANGE IN INCOME of $576 = $6 * 96, where
$6 = increase (allowed by the market) in monthly rent per unit
96 = number of occupied units expected with RUBS

These figures assume that WITH RUBS rents will average $220, utility payments $30, for total income of $250 per occupied unit with 96 units occupied. WITHOUT RUBS rents (and income) per occupied unit will be $244 with 98 units occupied.

$440 LOSS DUE TO LONG-TERM VACANCIES of $440 = $220 * 2, where
$220 = unrealized rent per vacant unit
2 = long-term vacancies anticipated as a result of RUBS

NET CHANGE IN MONTHLY CASH FLOW of $195 = $163 - $104 + $576 - $440

An additional $195 per month is available, after energy-related expenses, with RUBS.

PAYBACK PERIOD of 16 months = $3040/$195, or

initial investment / change in cash flow

C.3.c DISPLAY C.c. Example Of Advertising For Energy Efficiency

**NEW**
**Energy Efficient Construction**

- North Atlanta's new sophisticated, all adult community.
- 1 & 2 BR garden and 2 BR town homes, with exceptional luxury appointment.
- Sunrooms, screened porches, private patios . . . California contemporary architecture set about a running brook . . . streamside living.
- Economical gas cooking and hot water, W/D connections, and many more luxury amenities.
- Prestige location, just off Georgia 400 and just north of I-285.

**Post Creek now introduces a new attitude in adult apartment living, featuring . . . Six Spacious Apartment Styles . . . Proven Energy Saving Construction Methods*. . . Screened Porches . . . Careful Attention to Interior and Exterior Design . . . Gas Heat and Hot Water . . . Washer-Dryer Connections in Every Apartment . . . Excellent Location Close to I-285, Marta Park-Ride Station, Perimeter Mall and Major Employment Centers . . . Luxuriously Landscaped Grounds . . . Superb Recreational Facilities Including Six Lighted Tennis Courts and Pool with Large Sundeck . . . Quiet Adult Atmosphere.**

*Post Properties pioneered energy efficient construction methods in Atlanta apartments. Included are such innovations as double pane windows, thicker outer walls for more insulation, more attic insulation, steel clad foam core doors with adjustable thresholds, and insulation between foundations and the bases of all outer walls.

COBB/Marietta energy efficent apts. 1,2 & 3 BR. 424-7854.