Two Decades of U.S. Household Trends in Energy-Intensity Indicators: A Look at the Underlying Factors

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In 2001 energy consumption in the U.S. household sector was 6 percent higher than in 1980 (13 percent if weather-adjusted). During this same time period, the number of households increased by almost 31 percent. Clearly, U.S. households, on average, seem to be using energy more efficiently than they did in 1980.

This paper looks at two decades of energy–intensity trends. Energy intensity measures are often used as a measure of energy efficiency and its change over time. However, energy-intensity indicators may mask structural and behavioral changes. Energy intensity measurement is often the best we can do with available data. Without a structural and behavioral context, the indicators can be misleading as a measure for energy efficiency.

Using data from the series of Energy Information Administration's Residential Energy Consumption Surveys, this paper first takes a look at the trends for energy intensity using the most aggregated measure, household energy per real dollar of personal disposable income and then looks at trends using three common demand indicators, energy per household, energy per household member, and energy per square foot. If energy intensity is measured using total site energy, each of the three measures listed earlier for total energy, was lower in 2001 than in 1980-even after adjusting for the effects of weather.

Next the paper looks at an example of structural changes, a change in the mix of energy used and its effect on energy-intensity trends. The paper then looks at other underlying factors affecting the trends in energy intensity. These factors include energy-efficiency improvements such as appliance standards and demand-side management programs. Other factors discussed are those leading to structural changes including: changes in housing unit type; household size and location, as well as the behavioral effects of income growth.

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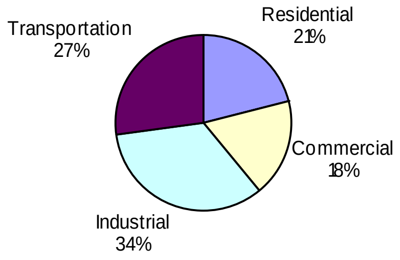
INTRODUCTION

The share of total energy use in the United States devoted to households has remained almost constant between 1980 and 2001, approximately 20 percent in 1980 and 21 percent in 2001 (Figure 1). However, total energy consumption in this sector was 6 percent higher in 2001 than in 1980, 9.3 quadrillion Btu (quads) in 1980 growing to 9.9 quads in 2001. Interestingly, during this same time period the number of households increased by almost 31 percent. Clearly, U.S. households, on average, seem to be using energy more efficiently than they did in 1980.

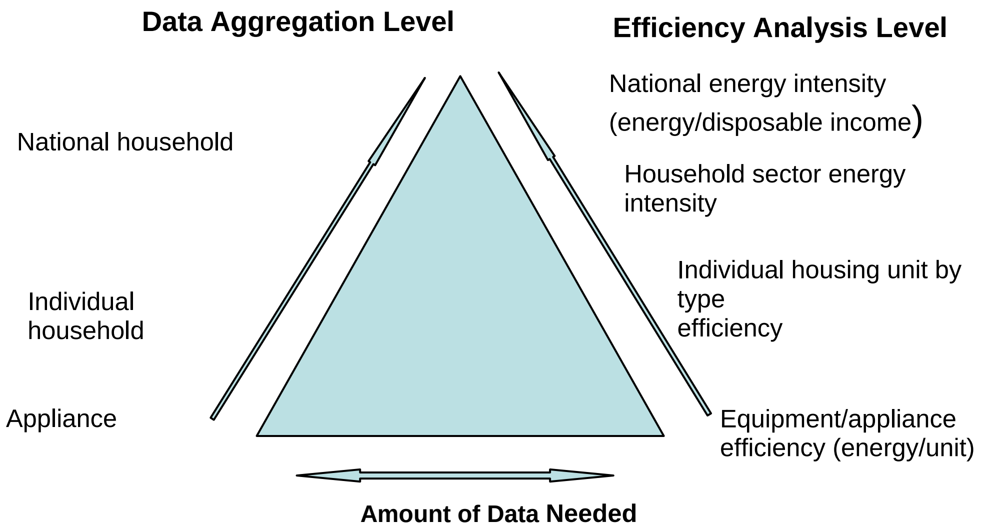
Figure 1. Sector Shares of Total Energy Consumption, 2001



Source: Energy Information Administration, *2003 Annual Energy Review*.

However, energy-efficiency improvement is not the only story. Energy intensity measures are often used in energy-efficiency analysis. The indicators can be misleading as a measure for energy efficiency. The usual definition for energy intensity is the ratio of energy consumption to some measure of demand for energy services—what we call a demand indicator. There doesn't seem to be a single technical definition of energy efficiency—but rather a concept that increases in energy efficiency take place when either energy inputs are reduced for a given level of service or there are increased or enhanced services for a given amount of energy inputs.

Figure 2. Energy Efficiency Indicator Pyramid for the Household Sector



Most often energy-intensity measurement is the best we can do with available data. As shown in the energy-efficiency indicator pyramid (Figure 2), smaller amounts of data are needed as the analysis level is more aggregated (Phylipsen, Blok, and Worrell, 1998). However, as the level of aggregation increases, the aggregated indicators combine energy efficiency, structural, and behavioral effects.

This paper uses energy-intensity measurements not only to show changes in energy use in U.S. households between 1980 and 2001 but also to look at the underlying factors that influenced the energy-intensity measurements. The paper begins with a look at the trends in energy intensity using the most aggregated indicator, household energy consumption per dollar of personal disposable income. Presented next are trends using three common demand indicators, energy per household, energy per household member, and energy per square foot. Next the paper looks at the effects of weather on intensity trends followed by an example of structural change, a change in the mix of energy used. Other underlying factors affecting the trends in energy intensity will be discussed. These factors include energy-efficiency; underlying structural factors such as changes in housing unit type, household size and location; and the behavioral effects of income growth.

2. DATA USED

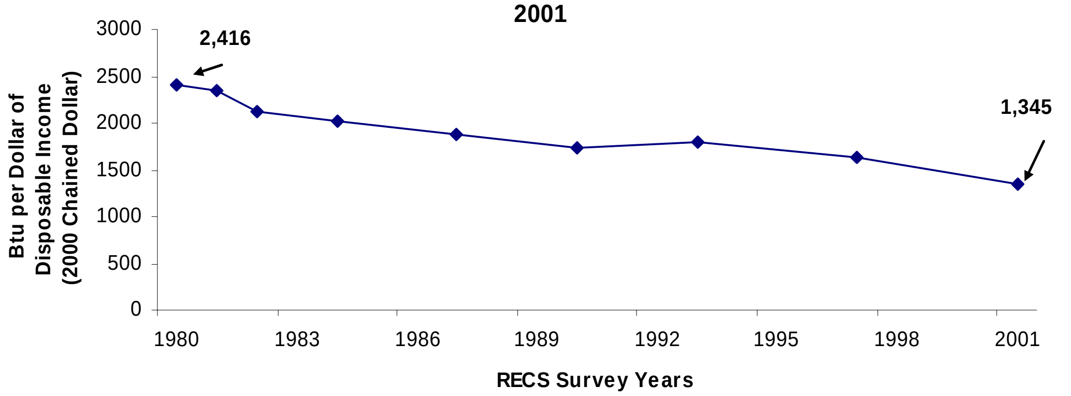
The data used are from the Residential Energy Consumption Survey (RECS). The RECS is conducted every four years by the Energy Information Administration of the U.S. Department of Energy. The RECS collects energy consumption and expenditures data as well as related housing characteristics information from a representative sample of residential housing units. The RECS is a two-part data collection effort. In the first part, in-person interviews are conducted with householders. During these interviews data are collected on characteristics that affect energy consumption and expenditures, including the physical characteristics of the housing unit, demographics of the household, the kinds of energy consuming equipment and appliances used in the home, the types of energy used, and patterns of energy usage. The interviewer also measures the home so that its square footage can be determined. With permission of the householder, billing energy consumption and expenditure data are collected from the energy suppliers. The data available from the RECS are the most comprehensive household energy data available and as such are located close to the base of the energy-efficiency indicator pyramid in Figure 2.

3. ENERGY INTENSITY

3.1 Aggregated Energy Intensity Trends

Usually the highest level of aggregated energy intensity used at the country level is total energy consumption per dollar of gross domestic product. A comparable, aggregate economic measure of energy intensity for the U.S. household sector is energy used per dollar of real disposable income (2000 chained dollars). Figure 3 shows the trend using this energy-intensity measure. The energy intensity was 44 percent lower in 2001 than in 1980. While energy use was 6 percent lower in 2001 than in 1980 (the numerator), the demand indicator (the denominator), disposable real income, was 90 percent higher in 2001 compared to 1980.[1] Although it does seem that energy efficiency increased during this time period, as we shall see in this paper, other structural and behavioral effects were present as well. Many of these were income and technology driven.

Figure 3. Household Energy Use per Dollar of Disposable Income, 1980-2001



Source: Energy Information Administration, Residential Energy Consumption Surveys; Bureau of Economic analysis

3.2 Energy-Intensity Trends Using Three Demand Indicators

When looking at trends in energy intensity it is useful to look at more than one energy intensity measure. Intensities can be developed using different measures of energy such as site energy and primary energy, where primary energy includes the losses due to the generation, transmission, and distribution of electricity. The demand indicators available for use in an energy-intensity measurement for the household sector are many and varied. Demand indicators can include any indicator that drives energy use such as: the number of households; number of household members; amount of floorspace; number of rooms; and household income. This section shows trends in energy intensity using the same site energy and three different demand indicators; the number of households; number of household members, and the amount of floorspace.[2]

Number of Households.[3] In 2001, the number of households was 31 percent higher than in 1980, 81.6 million in 1980 and 107 million in 2001 (Figure 4). The energy intensity, million Btu per household was 19 percent lower in 2001 than in 1980—showing that the number of households grew faster than energy use. In 2001 the energy intensity was 92 million Btu per household compared to 114 million Btu per household in 1980 (Table 1).

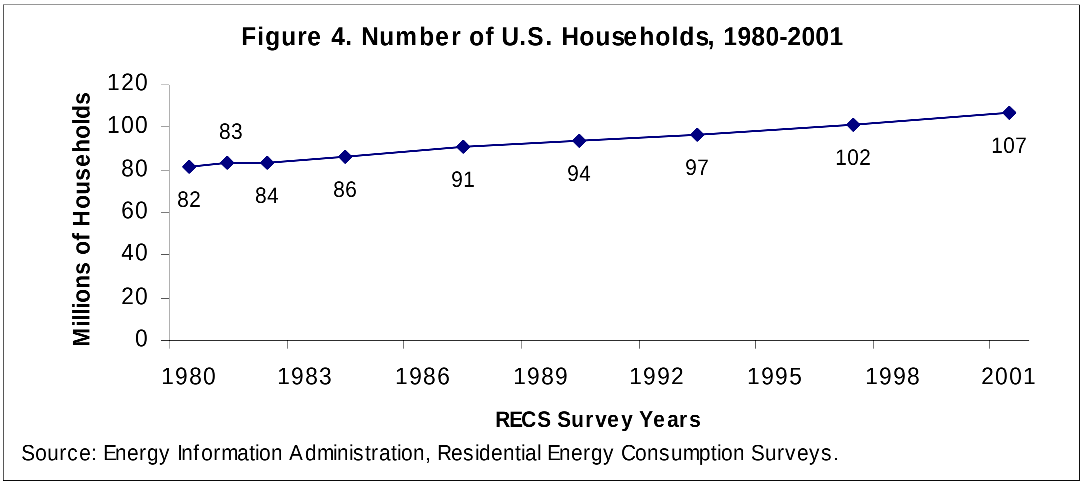
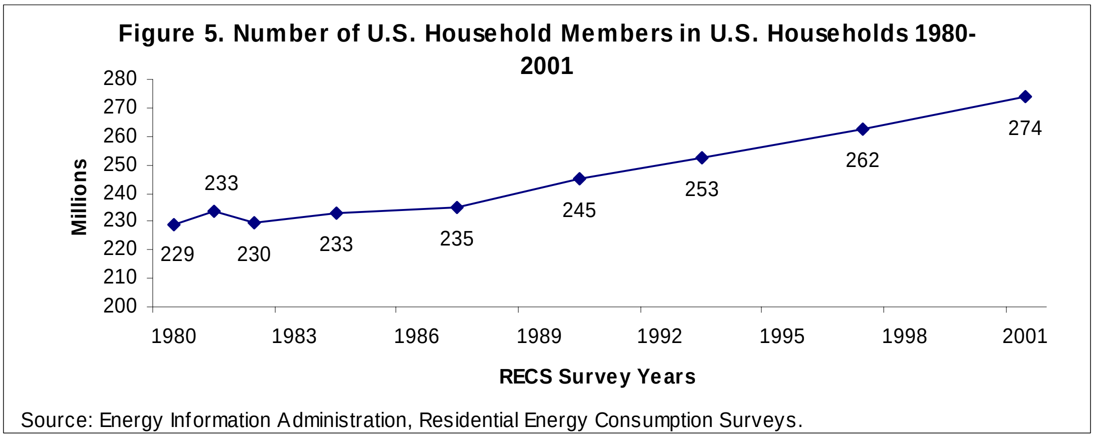


Table 1. U.S. Residential Energy Intensity Using Site Energy, 1980-2001

	1980	1981	1982	1984	1987	1990	1993	1997	2001
Million Btu per Household	114	114	103	105	101	98	104	101	92
Million Btu per Household Member	41	41	38	39	39	38	40	39	36
Thousand Btu per Square Foot*	65	66	61	63	58	54	55	61	45

Note: * In the 1997 RECS the floor area of the housing unit was not measured. The heated floorspace was estimated using regression analysis. Prior 1997 and 2001 estimates include all the floor area of the housing unit that was enclosed from the weather.
Sources: Energy Information Administration, Residential Energy Consumption Surveys.

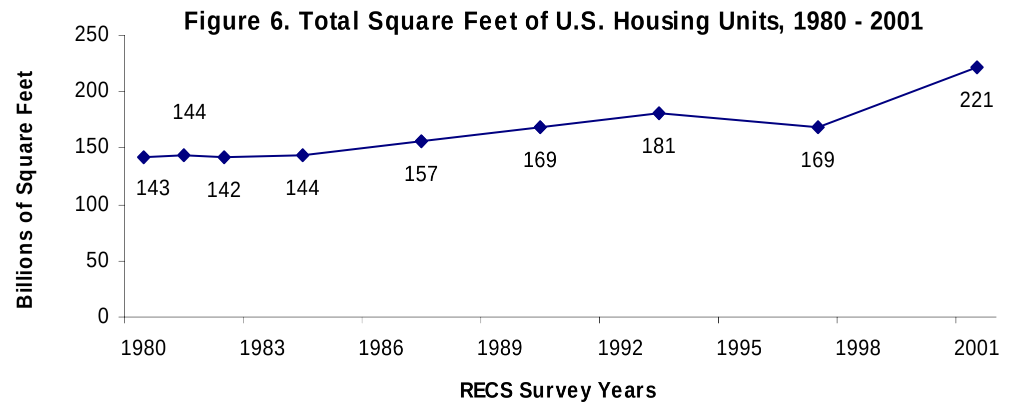


Number of Household Members. Although the number of households was 31 percent higher in 2001 than in 1980, the number of household members was only 20 percent higher in 2001 than in 1980 (Figure 5). The energy measure used in the energy intensity is the same as was used in the energy intensity using households as the demand indicator. The energy intensity, million Btu per household member was 12 percent lower in 2001 than in 1980—showing that the number of household members grew faster than energy used. However, since the number of household members grew slower than the number of households, the energy intensity did not experience as large of a decline. In 2001, the average household member used 36 million Btu of energy compared to 41 million Btu in 1980 (Table 1).

Amount of Floorspace. In 2001 there was 55 percent more total floorspace in U.S. housing units than in 1980, 142.5 billion square feet in 1980 and 221 billion square feet in 2001

(Figure 6). Again using the same energy measure in the calculation, the energy intensity, thousand Btu per square foot was 31 percent lower in 2001 than in 1980—the largest percent decrease of the three types of energy intensity. In 2001 the energy intensity was 45 thousand Btu per square foot compared to 65 thousand Btu per square foot in 1980.

Even though all three measures of energy intensity used the same site energy measure, the different demand indicators, household, household members, and amount of floorspace produced different percent changes in the respective energy intensities. While energy use was growing by only 6 percent, the fastest growing demand indicator, the amount

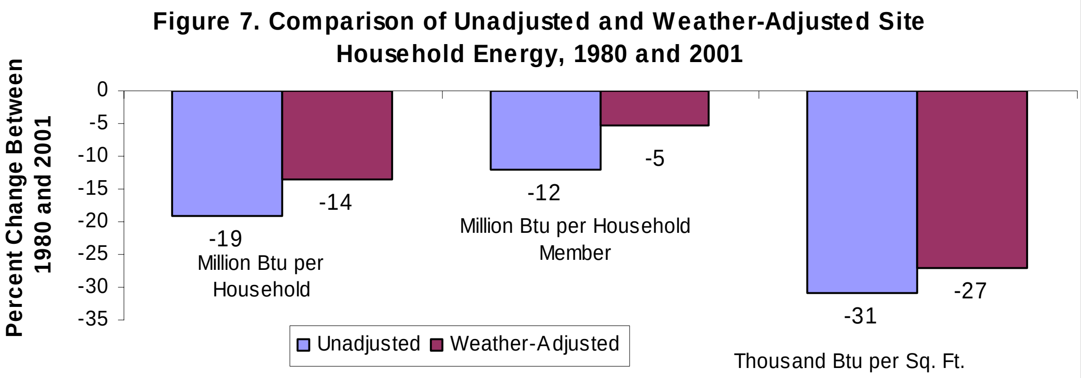


Note: In the 1997 RECS, the floor area w as estimated using regression analysis. In other RECS, the households in the sample w ere actually measured.
Sources: Energy Information Administration, Residential Energy Consumption Surveys.

of floorspace, produced the largest reduction in energy intensity, followed by the number of households and then the number of household members. The implications on energy use of the growth in the number of households, the movement towards fewer household members per household, and the growth in the number of larger homes are explored later in this paper.

3.3 Effects of Weather on Energy-Intensity Trends

Although most often energy-intensity trends are presented without the effects of weather, weather effects may have a substantial affect on the outcome. Figure 7 compares the changes between 1980 and 2001 for each of the three energy-intensity measures described in



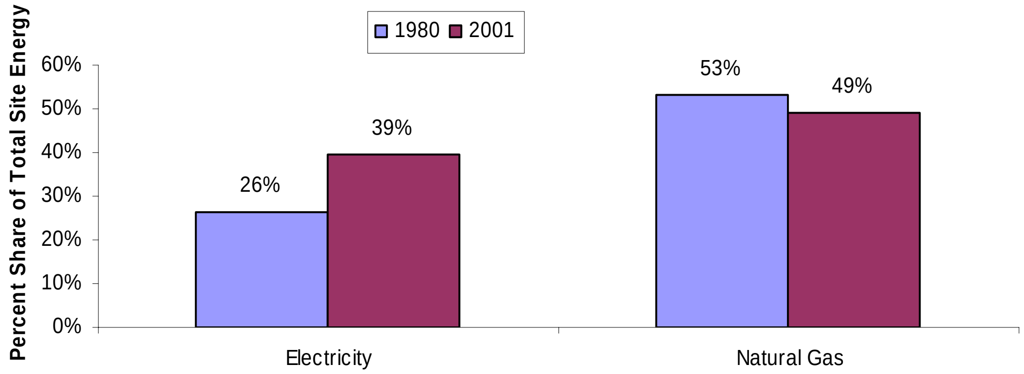
Sources: Energy Information Administration, Residential Energy Consumption Surveys; National Oceanic and Atmospheric Administration.

the preceding section. Additionally, weather-adjusted energy intensities are shown on the graph as well.[4] When the intensities were adjusted for the effects of weather, all three energy-intensity measures between 1980 and 2001 did not experience as large of a decrease, showing the importance of using a weather-adjusted energy measure in the construction of energy intensities.

3.4 Effects of Structural Change on Energy Intensity

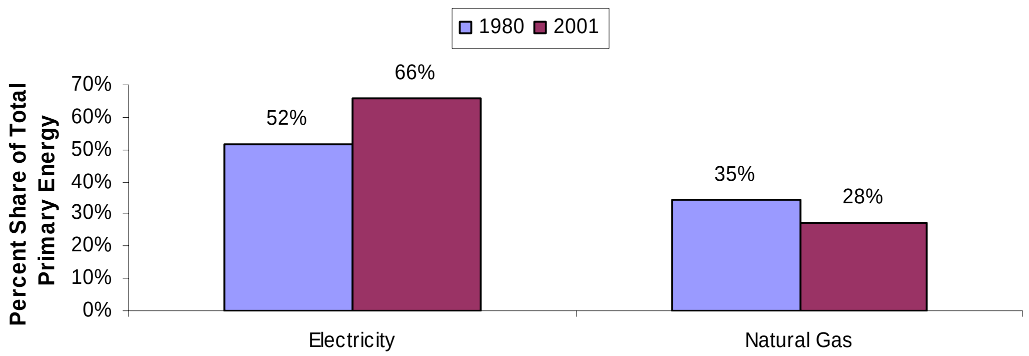
Household Use of Electricity. In addition to weather effects, structural changes can have a major impact on the energy-intensity measure. One major structural change that has been taking place in the household sector is a change in the mix of energy used as demand for electricity steadily climbs. In 1980 site electricity's share of total site energy was 26 percent while natural gas was clearly the majority at 53 percent. In 2001, the share of electricity increased to 39 percent and natural gas's share of total energy was lower at 49 percent (Figure 8). It seems that although the increase in the use of electricity is pronounced, natural gas still represents the largest energy content of the energy sources used in U.S. households.

Figure 8. Major Energy Share of Total Site Energy in U.S. Households, 1980 and 2001



Sources: Energy Information Administration, Residential Energy Consumption Surveys.

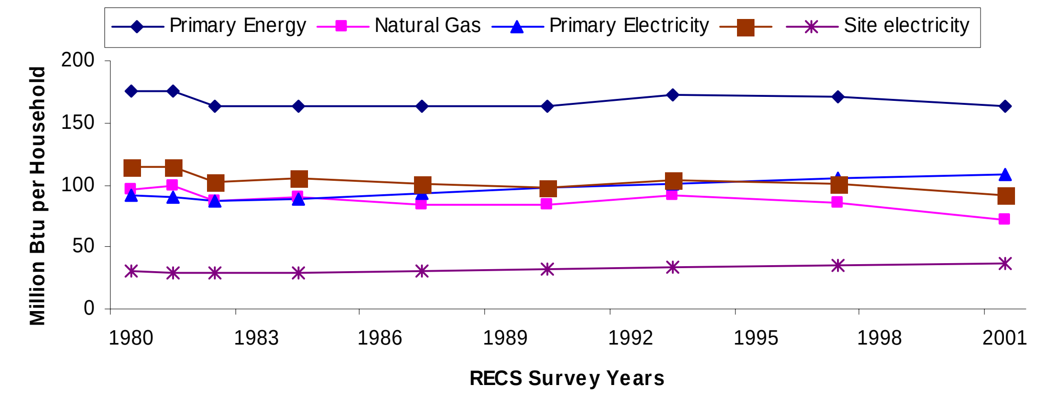
Figure 9. Major Energy Shares of Total Primary Energy in US Households, 1980 and 2001



Sources: Energy Information Administration, Residential Energy Consumption Surveys.

However, the change in the energy mix will affect certain types of energy-intensity analysis such as an analysis pertaining to energy use and global climate change where all of the energy resources required for human activities need to be accounted for. In this analysis resources that are consumed during the generation, transmission, and distribution of electricity (so-called electricity losses) need to be associated with electricity use, causing electricity to be counted at approximately three times the energy value it is given for site energy. Figure 9 shows the effect of this change. It shows the shares of electricity and gas in terms of primary energy; that is, energy values with electricity losses included. By this measure, in 1980, primary electricity was the majority energy source with the share at 52 percent, rising to 66 percent in 2001. Using million Btu per household as the energy-intensity measure, Figure 10 shows that the electricity energy-intensity increases while the natural gas energy intensity falls. In the late 1980's, primary electricity use moved ahead of the use of natural gas. However, both measures of electricity use, site and primary electricity, show increases in use of electricity in the household sector. Later in the paper, the reasons behind this increase are explored.

Figure 10. Trends in Energy Intensity in U.S. Households, 1980 - 2001



Sources: Energy Information Administration, Residential Energy Consumption Surveys.

4. OTHER FACTORS AFFECTING ENERGY-INTENSITY TRENDS

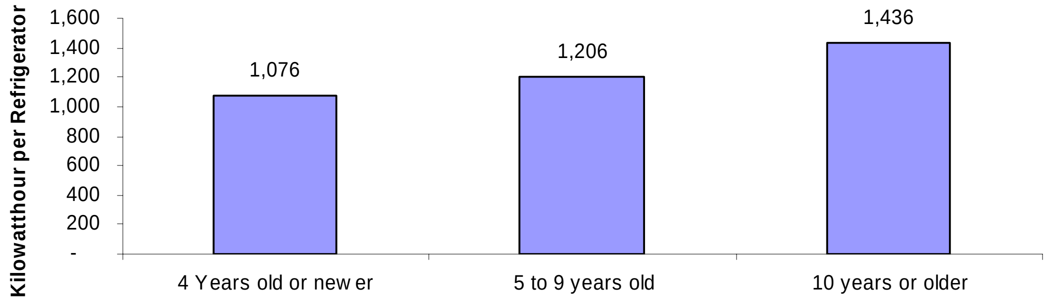
4.1 Energy-Efficiency Improvements

Appliance Standards. In response to various energy-efficiency standards, manufacturers have improved the energy efficiency of household appliances beginning in the 1970s, removing inefficient products from the market (ACEEE, 1995). The National Appliance Energy Conservation Act of 1987 set the minimum standards for several types of household appliances and equipment such as the refrigerator. This followed the earlier voluntary appliance-efficiency targets of the Energy Policy and Conservation Act of 1975 and various State appliance-efficiency standards (EIA 1993).

One of the best success stories of the effect of appliance standards is the story of the household refrigerator (Appliance Standard Awareness Project, 2000). In 2001 refrigerators accounted for about 27 percent of appliance energy use. The effect of gains in refrigerator-appliance efficiency can be measured by comparing the 1990 estimated electricity consumption for refrigerators with 2001 levels of consumption.[5] Using kilowatt-hours (kWh) per refrigerator as the intensity measure, the average refrigerator in the U.S. household stock used an estimated 1,346 kWh in 1990, compared with 1,239 kWh in 2001, an estimated decline of 9 percent.

The data does show that the newer the refrigerator, the more efficient it is, a reflection of the appliance standard. For refrigerators four years old or newer, the average electricity use was lower than for those 10 years or older (Figure 11). The older refrigerator (10 years or older) used 1,436 kWh. The newer refrigerator (four years old or newer) used only 1,076 kWh. Additionally, the efficiency of units declines as they age, due to the effects

Figure 11. Energy Intensity by Age of Refrigerator, 2001

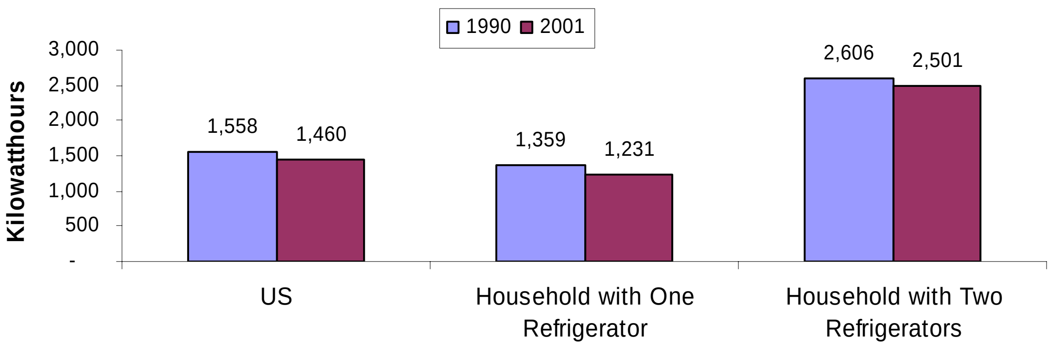


Source: Energy Information Administration, Residential Energy Consumption Survey.

of aging, lack of proper maintenance, or both.

Using the intensity kWh for refrigerators per household, regardless of the number of refrigerators, the intensity declined by 7 percent, from 1,558 kWh in 1990 to 1,460 kWh in 2001—showing the effects of the increase in households having more than one refrigerator, mitigating some gains from the appliance standard.[6] Households do not necessarily remove the old refrigerator when they get a new one. As expected, households with two refrigerators

Figure 12. Refrigerator Electricity Consumption per Household , 2001



Source: Energy Information Administration, Residential Energy Consumption Surveys.

use more electricity. On average, these households used 2,606 kWh for refrigerators in 1990, declining only 4 percent to 2,501 kWh in 2001 (Figure 12).

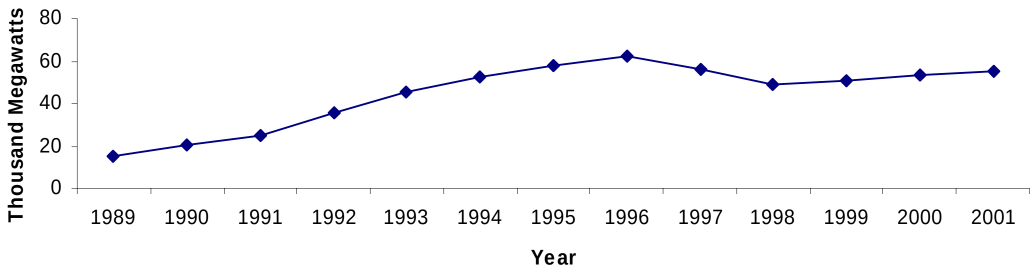
Over this same time period, as the number of households increased, so did the number of refrigerators since the refrigerator is a virtually universal appliance. There were 109 million refrigerators in 1990, increasing to 126 million in 2001, an increase of 34 percent. Although there were efficiency gains per refrigerator, because the number of refrigerators increased, overall electricity use for refrigerators increased in the U.S. That is, demand increase offset the gains in efficiency.

An interesting scenario is to see how much energy would be saved if old refrigerators in 2001 had been replaced by the new efficient units. Using the 2001 RECS data, it is possible to estimate the magnitude of efficiency gains and savings that would have been obtained if all the old refrigerators had been replaced by new units. One hypothetical possibility is to replace the oldest refrigerators (10 years or older) in the 2001 stock with new units. The total electricity savings by replacement of units at least 10 years or older with new units, is not a trivial amount of electricity. If all the older refrigerators were replaced, using 2001 stock numbers, 14,331 megawatthours of electricity or 9 percent of the total amount of electricity used by all refrigerators in 2001 would not have been needed.

Refrigerators are one example of the general effects of appliance efficiency and demand increases in U.S. households. Improvements in household appliances in terms of energy efficiency have affected the energy consumption for many of the appliances used. However, electricity used for appliances in households has increased. In 2001, the largest use of electricity in the average U.S. household was for appliances, which consumed about 51 percent of all the electricity used in the residential sector. Electricity consumed for appliances increased from 5,543 kilowatt-hours per household in 1980 to 6,893 kilowatt-hours per household in 2001, an increase of 24 percent. The increase in appliance energy use, over the 1980 to 2001 time period, is most likely a result of the ever-increasing demand for appliances in U.S. households.

Demand-Side Management. During this time period, another factor affecting the energy intensity measure is the use of Demand Side Management (DSM) programs. DSM programs are organized utility-sponsored activities that are intended to affect the amount and timing of

Figure 13. Demand-Side Management Program Total Energy Savings, 1989-2001



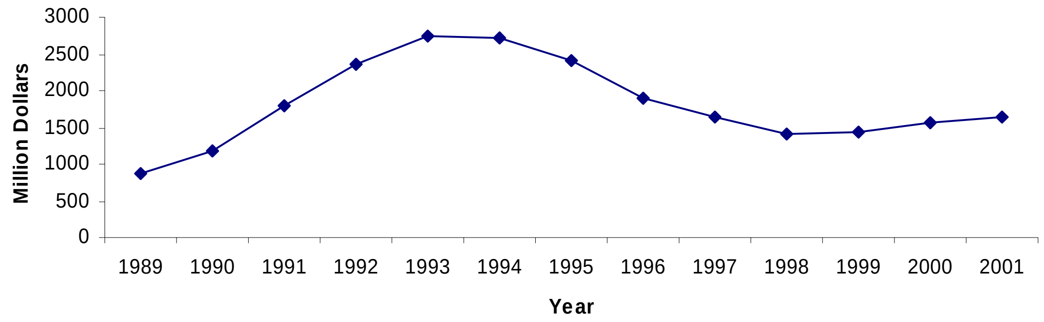
Source: 1989 and 1990 Energy Information Administration, Form EIA-861, "Annual Electric Utility Repot."
1991 forward EIA, "Electric Power Annual 2001" Table 9.6.

customer electricity or natural gas use. Typical DSM programs included load-control programs, energy audits, conservation programs, monetary offers to buy more efficient appliances, fuel-switching programs, and time-of use-programs (EIA 1995). Following the Public Utility Regulatory Policies Act of 1978 (PURPA), State regulators supported and utilities implemented rebates and other DSM programs. Many DSM programs were developed within an integrated resource planning framework in which utilities compared the cost of new generation with the costs and benefits of DSM (EIA 1999).

Data collected by EIA show a steady increase in energy savings from 1989 through 1996 (Figure 13). The total DSM energy savings increased from 14,672 megawatts in 1989 to 61,842 megawatts in 1996. Between 1996 and 1998, total savings fell by about 20 percent, then increased slightly from 1998 through 2001. The savings were 54,762 million megawatts in 2001.

The reduction in the rate of growth in energy savings has been affected by reduction in industry DSM spending (Figure 14). From 1989 through 1993 total DSM expenditure increased sharply from 873 million dollars to 2.7 billion dollars. However, total DSM spending declined significantly from 1993 through 1998. Total investment has slightly increased since 1998; DSM spending was 1.6 billion dollars in 2001. Utility-sponsored DSM programs have declined as the utility sector has become restructured, allowing for competitive markets. In a competitive market there are not the incentives for utilities to offer these types of programs.[7]

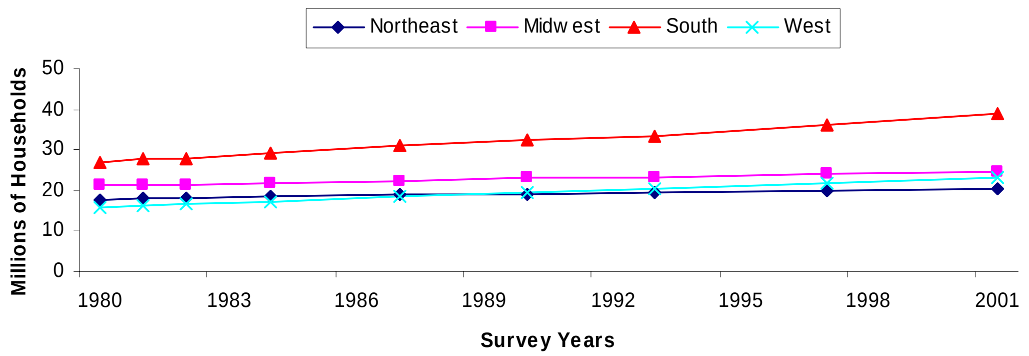
Figure 14. Demand-Side Management Program Total Costs, 1989-2001



Source: 1989 and 1990 Energy Information Administration, Form EIA-861, "Annual Electric Utility Repot."
1991 forward EIA, "Electric Power Annual 2001" Table 9.1.

Regional Growth. The amount and type of energy used in U.S. households is greatly determined on the regional location of the home. During the 1980 to 2001 time period, population growth has shifted to the South and West regions of the United States (Figure 15).

Figue 15 Number of Households by Census Regions, 1980-2001



Source: Energy Information Administration, Residential Energy Consumption Surveys.

This shift in population affected the mix of the energy used in the U.S. as well as what the service the energy provided. Home building was the greatest in the West and the South Census regions. Over this time period, the number of homes in the South increased by 45 percent and in the West by 47 percent, while overall in the U.S. this increase was only 31 percent. The number of homes in the Northeast and Midwest grew slower than the South and the West, 14 percent and 16 percent, respectively. Since the South and West are more temperate climates, space-heating demand is less in those regions and air-conditioning demand greater. As demand for air conditioning increased, especially in the South, a new technology was rapidly penetrating the South, the heat pump. Since the heat pump is also used for space-heating, electricity loads increased at the expense of natural gas.

Energy-intensity trends in the Regions and especially the South can be used to show the upward movement of electricity use. When comparing intensities, million Btu per household is used. The energy measures are both site and primary energy. Between 1980 and 2001, site energy per household decreased by 14 percent, the smallest of any of the Regions. When primary energy is the energy measure in the intensity, the South doesn't show this decline, implying a larger share of electricity in 2001 (Table 2).

Table 2. Residential Energy Intensity by Census Region, 1980-2001
(Million Btu per Household)

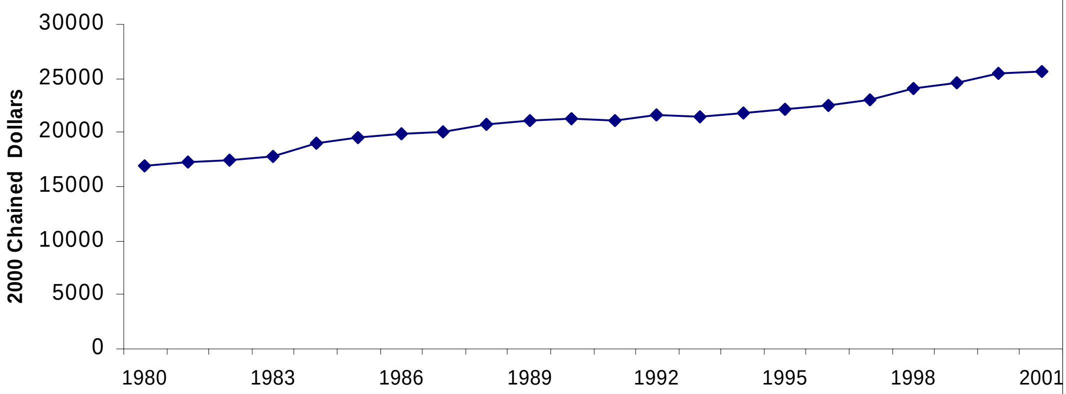
	Survey Years								
Northeast	**1980**	**1981**	**1982**	**1984**	**1987**	**1990**	**1993**	**1997**	**2001**
Site	137	138	121	125	125	120	122	121	107
Primary	183	186	165	171	173	170	171	171	158
Midwest									
Site	139	147	122	130	122	122	134	134	117
Primary	197	203	178	181	178	180	199	197	182
South									
Site	96	89	88	85	84	81	88	84	83
Primary	177	165	165	160	165	167	179	178	179
West									
Site	87	90	84	85	78	78	76	75	70
Primary	140	148	136	141	132	135	132	134	126

Note: Primary energy includes losses due to the generation, transmission, and distribution of electricity. Site energy does not include the losses.
Source: Energy Information Administration, Residential Energy Consumption Surveys.

4.2 Effects of Income growth

An important factor affecting the demand for energy is household disposable income. Per capita disposable income (2000 chained dollars) increased from $16,940 in 1980 to $25,698 in 2001, an increase of 52 percent (Figure 16). Although increased disposable

Figure 16. Per Capita Disposable Income, 1980-2001

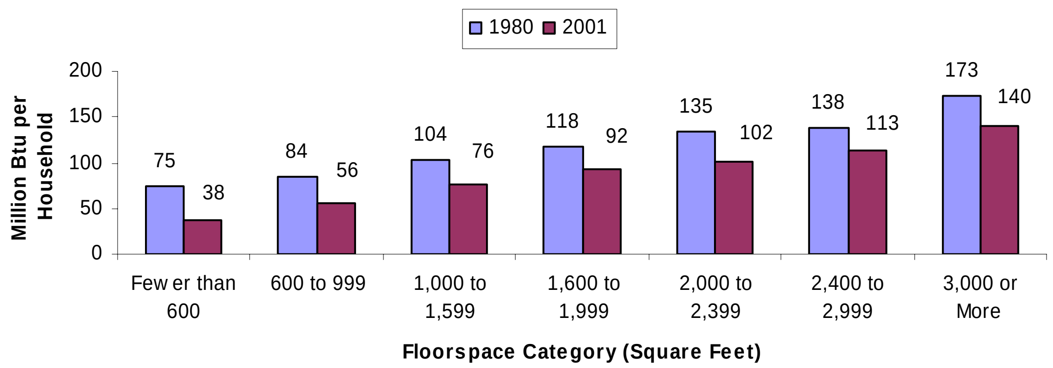


Bureau of Economic Analysis, January 2005, Personal Income and its Desposition. Table 2.1.

incomes affect living conditions in many ways, three major affects in the U.S. household sector are that more people are purchasing larger homes, more people are living alone[8], and more appliances are being purchased for use in the homes.

Housing Unit Size. The average size of a home has become larger over the years. Most U.S homes are single-family detached. The average size of a single-family detached home in 2001 was 2,553 square feet. This is a 17 percent increase above the average square footage of 2,131 square feet in 1980. The increase in housing unit size partially offsets the substantial improvements in building codes as well as the energy efficiency of the necessary systems and appliances within the homes—affecting any measurement of energy intensity. Figure 17 shows that the measure of energy intensity increases along with housing unit size. In 2001, an average household in a 1,000 to 1,599 square feet unit used 76 million Btu of energy. This is 33 percent less than household living in a 2,000 to 2,399 square feet home. For the same size

Figure 17. Energy Intensity by Size of Housing Units

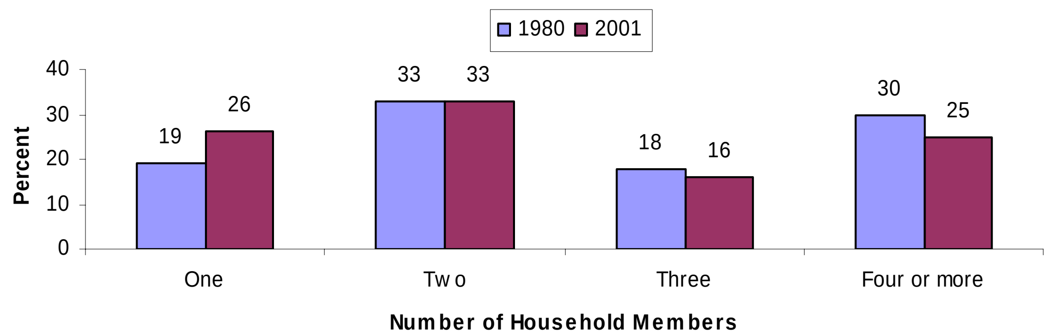


Source: Energy Information Administration, Residential Energy Consumption Surveys.

home the intensity for each floor-space category is higher in 1980, compared with 2001. If the growth in housing size continues, it is most likely that the demand for energy will tend to increase with it, irrespective of the effects of other factors.

Household Size. The number of people living in a home affects the amount of energy used in the home. If the average number of persons living in a home shows a systematic change, this also will affect any measure of energy intensity. Indeed, this is what has happened. More people are living by themselves and family sizes are declining. Over the 1980 to 2001 time period the number of people living in the average U.S. household has fallen from 2.8 in 1980 and 2.6 in 2001. Although this statistic is insignificant, the story lies with the one-person household. During the same period, the share of households with one person has increased

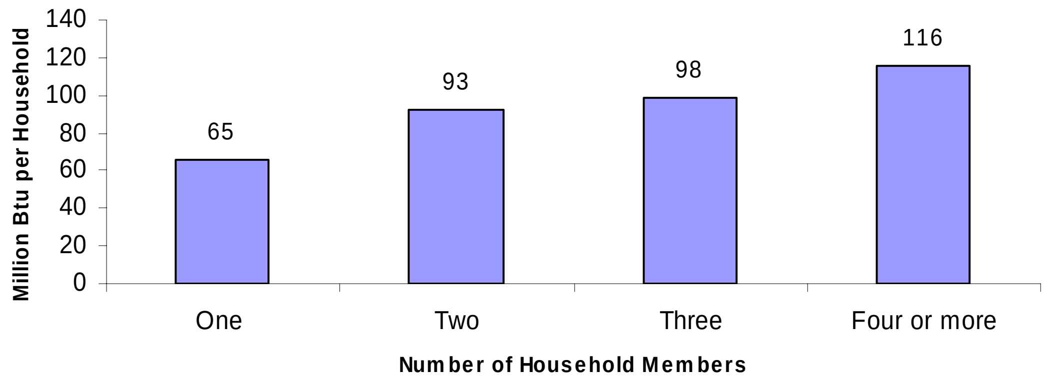
Figure 18. Distribution of Household Size, 1980-2001



Source: Energy Information Administration, Residential Energy Consumption Surveys.

from 19 percent to 26 percent (Figure 18) while, the share of households with 3 or more people has declined. Energy per person is increasing as household size become smaller. Figure 19 shows the average energy intensity per household by size of household members. The intensity per member decreases as the number of household members increases. For example, the intensity is 65 million Btu in a one-person household and 98 million Btu in a three-person household. That is, each person in a three- member household uses about 33 million Btu, not 65 million Btu. Thus, the growth in smaller household size places upward pressures on the demand for energy—as seen in energy-intensity measurements.

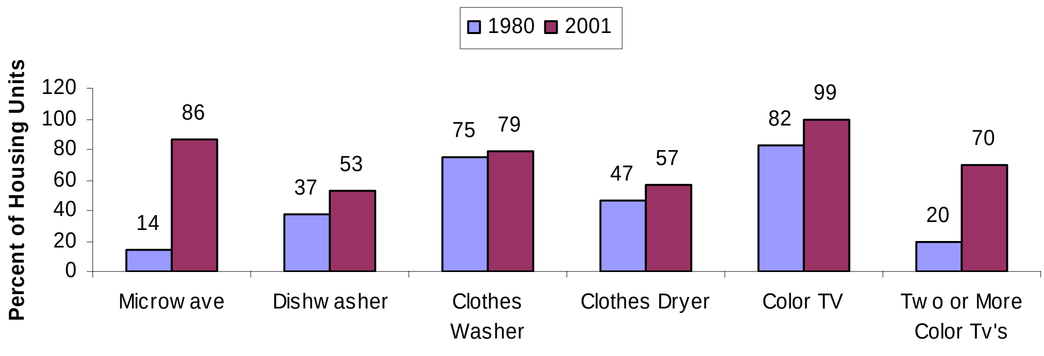
Figure 19. Energy Intensity by Size of Household, 2001



Source: Energy Information Administration, Residential Energy Consumption Survey.

Appliance Growth. Larger homes are generally associated with more appliances. With income growth, even smaller homes use more appliances. However, there are some appliances such as clothes washers, where demand doesn't change, but energy efficiency has changed. So, depending on the nature of purchase the income growth may have an increasing or decreasing effect on the energy intensity. For example, if a household replaces an existing old clothes washer with a new and more efficient unit, everything else the same, the demand for energy reduces (decreasing effect). However, as income increases a household may decide to purchase an additional large screen TV. In this case, the demand for energy increases (increasing effect). The data show that there has been a continual penetration of appliances over the 1980 to 2001 time period as seen in Figure 20. Microwave ovens, dishwashers,

Figure 20. Selected Electrical Appliances Used in U.S. Housing Units, 1980-2001



Source: Energy Information Administration, Residential Energy Consumption Surveys.

clothes washers, clothes dryers and color televisions are some of the most commonly-used major household appliances. In 1980 only 14 percent of households used microwave compared with 86 percent of households in 2001. The use of a dishwasher has increased from 37 percent in 1980 to 53 percent in 2001. Householders are not only getting different appliances but multiple numbers of some such as the computer and televisions. For example, the share of households having two or more color TV increased from 20 percent in 1980 to 70 percent in 2001. As mentioned earlier, the share of energy used in appliances is the fastest component in total energy use. As household incomes continue to grow, the demand for all types of appliances is pushing up electricity use and will continue to affect energy-intensity measurements.

5. SUMMARY

Using the best available data from the Residential Energy Consumption Survey, the paper shows how important it is to include several different types of energy-intensity indicators to show intensity changes overtime. Shown also was the fact that energy intensity measurement may not be a substitute measure for changes in energy efficiency. Using three different demand indicators, energy-intensity has declined between 1980 and 2001. However, the magnitude of declines are not as pronounced when the energy is first adjusted for weather and then adjusted for the losses in the generation, transmission, and generation of electricity. However, all of the energy-intensity measures show a decline between 1980 and 2001.

Factors that affected the intensity measure were discussed such as the increased use of electricity, appliance standards, and utility and government-sponsored efficiency programs. Additionally the paper included the effects of Regional household growth, especially in the South. Income growth has been rapid over the two decades pushing up demand for housing as well as demand for the appliances to use in the homes.

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ENDNOTES

[1] An assumption is made that all disposable income is spent. However, a small portion of disposable income goes to savings.
[2] The site energy used for this section is 9.3 quads in 1980 and 9.9 quads in 2001.
[3] In the RECS, the number of households is the same as the number of housing units. All of these units are primary residences and occupied. Vacation and vacant housing units are not included.
[4] The methodology for degree-day adjustments may be found online at http://www.eia.doe.gov/emeu/efficiency/ee_app_a.htm.
[5] In earlier RECS, separate data for the energy used for refrigerators were not estimated.
[6] The averages are estimated by dividing total electricity consumption for refrigerators by total number of refrigerators.
[7] Recognizing this, many of the states have passed legislation for the provision of DSM-like services called "Public Utility Funds (PBFs)." The funds are typically collected as a proportion of each kWh

used by electricity consumers. Some states may charge a fixed monthly fee. These funds ensure guaranteed public funds to support programs such as energy efficiency (Apollo Alliance, 2003).

[8] Higher income presents the choice to live alone but is only one reason for living alone. Death of a spouse or partner would be another.