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The Federal Energy Policy: An Example of Its Potential Impact on Energy Consumption and Expenditures in Minority and Poor Households

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THE FEDERAL ENERGY POLICY: AN EXAMPLE OF ITS POTENTIAL IMPACT ON ENERGY CONSUMPTION AND EXPENDITURES IN MINORITY AND POOR HOUSEHOLDS

by

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ABSTRACT

This report presents an analysis of the relative impacts of the National Energy Strategy on majority and minority households and on non-poor and poor households. (Minority households are defined as those headed by black or Hispanic persons; poor households are defined as those having combined household income less than or equal to 125% of the Office of Management and Budget's poverty-income threshold.) Energy consumption and expenditures, and projected energy expenditures as a share of income, for the period 1987 to 2009 are reported. Projected consumptions of electricity and nonelectric energy over this period are also reported for each group. An analysis of how these projected values are affected under different housing growth scenarios is performed. The analysis in this report presents a preliminary set of projections generated under a set of simplifying assumptions. Future analysis will rigorously assess the sensitivity of the projected values to various changes in a number of these assumptions.

SUMMARY

The *National Energy Strategy (NES), First Edition, 1991/1992* (DOE 1991), issued in February 1991, described and analyzed a number of alternative energy futures. Of the energy futures described, two were major scenarios, referred to as the Current Policy Base case and the National Energy Strategy case (also called the "Strategy scenario"). The comparative analysis of the general/macroeconomic outcomes clearly favored the NES case, which was better by almost every measure: economic growth, per capita real income, energy prices, energy consumption, and level of imported energy.

Not surprisingly, an earlier analysis that made use of the Minority Energy Assessment Model (MEAM)¹ found that all segments of the American population benefited

¹ The Minority Energy Assessment Model has for its theoretical basis (1) the linear expenditure system, which in turn is based on the work of Stone (1954), Geary (1950-51), Samuelson (1947-48), and Klein and Rubin (1947-48); and (2) the theoretical extensions of this system, based on the works of Phillips (1983), Muellbauer (1975), and Pollak and Wales (1981).

under the Strategy scenario. Specifically, the analysis included the impact of the Current Policy Base and NES cases under different sets of background variable assumptions about majority (head of household neither black nor Hispanic), black, and Hispanic households and about nonpoor and poor households (combined income less than or equal to 125% of the Office of Management and Budget's poverty-income threshold in poor households).

The MEAM analysis included consideration of possible effects on the comparative relationship between the NES and the Current Policy Base cases if the new housing growth rate were varied. It was found that changes in the new housing growth rate had little to no effect on the comparative impact between scenarios by population group. Nevertheless, there was some indication that changing the new housing growth rate assumption did affect the comparative effects between groups by scenario.

This study assesses the comparative impact of the NES on majority and minority households and on nonpoor and poor households under different assumptions about the new housing growth rate, exclusively. The issue of how the indicated population groups fare, in comparison with one another, under the same set of assumptions is the major concern of this study. The Current Policy Base case is not the focus of this study.

To study the comparative impact of NES on different population groups, additional assumptions must be made. These assumptions are required to define the socioeconomic and demographic relationships between groups. Rates of change in income, price, and housing stock are assumed to be the same across groups, but the overall growth in household populations is assumed to vary between groups. These assumptions have important consequences. For example, as a result of the assumption of a uniform growth rate in new housing, there is a periodic change in housing patterns that leads to relative growth in the proportion of majority households living in newer homes.

The major findings of the present study are as follows:

- The share of income spent on energy falls slightly for the entire period. Rather large fluctuations in the share of income spent on energy occur over the projected period. During periods of projected rapid price increases for nonelectric energy — particularly the 1995 to 1999 period — the energy-expenditure share of income rises rapidly. The share of income spent on energy rises particularly fast for minority and poor households during this period. Conversely, during the 1999 to 2005 period, when energy prices rise only moderately, the energy-expenditure share values for minority and poor households decline dramatically compared with those for majority and nonpoor households.
- Energy consumption at the point of end-use falls for each population group. The fall in consumption is highest for majority and nonpoor households. A sizable portion of this fall is associated with fuel switching — households moving from nonelectric energy to electricity use.

- As expected, higher rates of new housing growth are associated with larger falls in energy consumption. The higher rates of new housing growth affect majority and nonpoor household energy consumption the most. The differential in the rate of decline in energy consumption between (1) majority and minority and (2) nonpoor and poor households increases as the rate of new housing growth increases.
- Electricity consumption increases at the point of end-use for each population group. The increase is largest for majority and nonpoor households and is only slight for minority and poor households. As a result, the fraction of total energy consumption accounted for by electricity consumption increases for majority and nonpoor households compared with that of minority and poor households.
- Electricity consumption increases with an increase in the rate of new housing growth. Increases in the rate of new housing growth affect majority and nonpoor electricity consumption the most. Consequently, the difference in electricity consumption between majority and minority households, and between nonpoor and poor households, grows with higher rates of new housing growth.
- Real energy expenditures increase slightly for each population group. Expenditures on energy are projected to peak in 1999 and fall between 1999 and 2005, gradually increasing again between 2005 and 2009. Real energy expenditures increase somewhat more for minority than for majority households. The change in expenditures is about the same for poor and nonpoor households.
- The relative change in energy expenditures for majority and nonpoor households compared with those for minority and poor households is explained by differences in electricity and nonelectric energy expenditures. For majority and nonpoor households, the relative fall in nonelectric energy expenditures is considerably offset by a relative increase in electricity expenditures. As a consequence, the net difference in total energy expenditures between poor and nonpoor households and between minority and majority households is very small.
- Total energy expenditures are only slightly affected by changes in the assumed rate of new housing growth. Energy expenditures for majority and nonpoor households decline slightly, while for minority and poor households virtually no change in total energy expenditures occurs as new housing growth rates change.

These preliminary findings are based on a set of rather stringent assumptions, initially made to expedite the analysis. Work is now under way to assess the sensitivity of the projected values to changes in these assumptions. This follow-up study is expected to assess the effects of less stringent assumptions on energy consumption and expenditures and on projected energy expenditures as a share of income.

1 INTRODUCTION

The relative impacts of the National Energy Strategy (NES) on black, Hispanic, and poor households are assessed in this report by means of the Minority Energy Assessment Model (MEAM).² The impact of the NES on black and Hispanic households is compared with its impact on majority households (where the head of the household is neither black nor Hispanic), and the impact of the NES on poor households (those at or below 125% of the Office of Management and Budget's official poverty line) is compared with its impact on non-poor households (those more than 25% above the poverty line).

The analysis described in this report is the outgrowth of an earlier analysis performed for Deputy Under Secretary of Energy Linda Stuntz, for a speech she gave at the Socioeconomic Energy Research Conference, sponsored by the Office of Minority Economic Impact and held in Baltimore, Maryland, on June 27 and 28, 1991.³

In February 1991, under Secretary Stuntz's guidance, the U.S. Department of Energy (DOE) released its long-awaited *National Energy Strategy, First Edition, 1991/1992*. This publication was the culmination of a lengthy process that included a number of public hearings intended to establish a national consensus on energy priorities.

The Bush Administration had initiated the formulation of the National Energy Strategy in July 1989. President Bush (DOE 1991, p. 2) stated that the objective of NES is:

... achieving balance among our increasing need for energy at reasonable prices, our commitment to a safer, healthier environment, our determination to maintain an economy second to none, and our goal to reduce dependence by ourselves and our friends and allies on potentially unreliable energy suppliers.

(The Iraqi invasion of Kuwait illustrated the importance of the last point.)

To achieve the objectives set out by the president, the NES would rely primarily on market mechanisms. For those occasions when markets might not operate efficiently, the

² The Minority Energy Assessment Model has as its theoretical basis (1) the linear expenditure system, based in turn on the work of Stone (1954), Geary (1950-51), Samuelson (1947-48), and Klein and Rubin (1947-48); and (2) the theoretical extensions of this system, based on the works of Phillips (1983), Muellbauer (1975), and Pollak and Wales (1981). The model was estimated with a panel data set constructed from four surveys conducted by the Energy Information Administration (DOE 1982, 1985, 1987, 1989).

³ The analysis presented here and the analysis presented in Secretary Stuntz's speech differ slightly in content and emphasis. The analysis performed for Stuntz used an earlier version of MEAM, which did not include energy end-use share equations, whereas this analysis does (but there is little difference in the projected numbers). In the earlier analysis, differences between the Current Policy Base and NES cases were emphasized, whereas in the analysis presented in this report, the comparative differences among groups under the NES case are the main focus.

NES would incorporate government policy proposals that would remove barriers to an efficiently operating market. However, any government intervention would first have to be justified by rigorous cost-benefit analysis (DOE 1991, p. 2).

Numerous recommendations are made in the NES. These recommendations are a comprehensive set of policy and program prescriptions that would affect both the supply and demand sides of the American economy. The NES also provides energy policy and program guidance for each of the major sectors within the American economy — the industrial, commercial, residential, and transportation sectors.

Some recommendations made in the NES that are of specific interest and would affect residential energy consumption and expenditures are as follows (DOE 1991, pp.7-8):

- Amend the Public Utility Holding Company Act of 1935 (PUHCA).
- Expand Integrated Resource Planning (IRP).
- Provide tax-free treatment of utility efficiency discounts.
- Continue support of state and utility programs to improve energy efficiency.
- Expand use of mortgage financing incentives for residential energy efficiency.
- Improve the efficiency of public housing.
- Set cost-effective appliance and equipment standards and provide information to consumers through labeling programs.
- Develop and encourage use of building efficiency standards.

The effects of these recommendations are embodied in two major energy-consumption scenarios reported in the NES — the Current Policy Base case and the National Energy Strategy case (the "Strategy scenario"). (For a detailed presentation of these two cases, see DOE 1991, Appendix C; for a detailed description of the underlying energy conservation considerations, see DOE 1990, Chapter 2).

Under the Current Policy Base case, a set of projections to the year 2030 is made under the unlikely assumption that laws and regulations remain unchanged. The case includes the potential effect of laws enacted through the summer of 1990 on energy consumption. Although the Base case is a very unlikely scenario, it does serve as a useful benchmark against which the NES case can be evaluated.

Under the NES case, the effect on the energy future of the United States of potential policies enacted after September 1990 is considered. As was mentioned earlier, the NES includes a wide range of policy choices that affect both the production and consumption of

energy; these choices lead to a very different outcome, in terms of the level of primary energy consumed and its composition, compared with the outcome for the Base case.

The Strategy scenario is analyzed at the level of end-use sectors; this analysis is primarily concerned with the evaluation of the NES case relative to the Current Policy Base case on the basis of changes in overall primary energy consumption, oil imports, and environmental impact. Relative impacts of the NES on the U.S. economy are also taken into account. Potential consequences for the distribution of costs and benefits associated with the NES case among different population groups are not evaluated.

In the NES, residential energy consumption is projected at the aggregate level, with no regional or population-specific detail. This makes it very difficult to determine potential differences in the effect of the NES on different population groups.

Given the varying social circumstances of different population groups — such as blacks, Hispanics, and the poor — policy impacts are likely to be different. As a consequence of differences in their social, economic, demographic, or geographic circumstances (all of which influence energy demand), the effects of public policy in general and energy policy in particular on these groups will probably be dissimilar.

In the sections that follow, a detailed analysis of the effects of the NES on black, Hispanic, and poor households is presented. The analysis is not intended to quantify in any final sense the comparative impacts of the NES, for that is impossible; rather, it is intended to provide some indication of the relative impacts of the NES on these population groups under a variety of assumptions about key background variables (primarily growth in new housing stock). Thus, some plausible range may be established, over which comparisons can be made.

2 THE NATIONAL ENERGY STRATEGY

The National Energy Strategy consists of an amalgam of policy and program actions that are expected to have a dramatic impact on the level of energy consumption and on how energy is provided in the future. The combined effect of these actions relative to the Current Policy Base case is positive overall: energy consumption within each end-use sector declines, domestic energy production increases, oil imports decline, the emission of greenhouse gases and criteria pollutants declines, and the performance of the economy improves.

2.1 MACROECONOMIC PROJECTIONS

In general, the impact of the actions called for by the NES on the U.S. economy is estimated to be positive. On the basis of the DOE-DRI Macroeconomic Model, analysis of the NES indicates that significant improvements in energy security,⁴ the environment, and energy diversity should have a significant positive impact on economic growth (DOE 1991, p. C-29).

In Table 2.1, data on a number of key macroeconomic variables used in the analysis presented in this report — occupied housing stock, disposable income, and disposable income per household — are shown. The rate of change in occupied housing stock declines throughout the projected time horizon,⁵ while the rate of change in real disposable income is projected to increase until the year 2005 and decrease slightly after 2005. As a result of the relative rates of change in housing stock⁶ and real disposable income, the projected annual rate of change in real disposable income per household increases through 2005 and decreases between 2005 and 2010. (In this study, the rate of change in household income is used as a surrogate for the change in disposable income per household.)

2.2 ENERGY-CONSUMPTION PROJECTIONS

Projected fuel consumption, at the point of end-use, is shown in Table 2.2. Over the entire time horizon, electricity consumption increases, although the rate of increase lessens as time passes. Nonelectric-energy consumption is projected to increase slightly through the year 2000 and then to decrease somewhat through the year 2010. The change in nonelectric-energy consumption is not uniform, however; consumption of liquid fuels (distillate fuel and liquified petroleum gas) falls over the entire period, while natural gas consumption increases over the first half of the period and falls slightly over the second half.

⁴ Energy security is represented by reduced dependence on imported oil.

⁵ In this study, the time horizon covers the period between 1987 and 2010.

⁶ Hereafter, occupied housing stock is referred to as "households."

TABLE 2.1 National Energy Strategy: Key Economic Data and Assumptions

Year	Housing Stock	Disposable Income (\$10 ⁹) ^a	Disposable Income per Household (\$10 ³) ^a
1989	92.6	3773	40.75
1990	93.4	3802	40.71
1995	99.5	4280	43.02
2000	105.5	4824	45.73
2005	110.9	5512	49.70
2010	116.2	6167	53.07
<hr/>			
Average Annual Rate of Change (%/yr)			
Time Interval	Housing Stock	Disposable Income	Disposable Income per Household
1989-90	0.86	0.77	-0.09
1991-95	1.27	2.40	1.11
1996-00	1.18	2.42	1.23
2001-05	1.00	2.70	1.68
2006-10	0.94	2.27	1.32

^a 1990 dollars.

Under the NES scenario, reductions in residential energy consumption and changes in the composition of energy consumed are brought about by a combination of conservation actions and integrated resource planning (see DOE 1991, p. C-27).

Some inconsistencies exist between the NES energy-consumption estimates and the MEAM estimates in the interim years (see Section 3 for details). These inconsistencies are related to the way in which the MEAM model was calibrated. It was calibrated so that the rate of change between the initial and terminal periods coincided with the NES value. The calibration procedure essentially assumed a uniform rate of change in residential energy efficiency over the projected time horizon. This uniform-rate-of-change assumption, along with some possible differences in the internal structure of the two models, may explain the variations in some of the projected interim values.

TABLE 2.2 National Energy Strategy: Energy Consumption in the Residential Sector

Year	Consumption by Energy Source (Quads ^a)				
	Distillate Fuel ^b	Liquid Gas ^b	Natural Gas	Nonelectric Energy	Electricity
1989	1.26	0.34	4.9	6.5	3.1
1990	1.26	0.34	4.5	6.1	3.2
1995	1.03	0.27	4.8	6.1	3.5
2000	0.95	0.25	5.1	6.3	3.8
2005	0.79	0.21	5.1	6.1	4.1
2010	0.71	0.19	5.1	6.0	4.3

Time Interval	Average Annual Rate of Change (%/yr)				
	Distillate Fuel ^b	Liquid Gas ^b	Natural Gas	Nonelectric Energy	Electricity
1989-90	0.00	0.00	-8.16	-6.15	3.23
1991-95	-4.07	-4.07	1.30	0.00	1.81
1996-00	-1.59	-1.59	1.22	0.65	1.66
2001-05	-3.58	-3.58	0.00	-0.64	1.53
2006-10	-2.09	-2.09	0.00	-0.33	0.96

^a 1 Quad = 10¹⁵ Btu.

^b It is assumed that the proportional split (obtained from EIA 1990) between distillate fuel and liquid gas remains at 1987 values over the projected time horizon.

2.3 ENERGY PRICE PROJECTIONS

As expected, given the cost structure underlying the production of electricity, the change in electricity prices is relatively moderate when compared with the change in nonelectric-energy prices. Over the first quarter of the projected period, the real price of electricity is projected to fall and then to rise slightly, whereas nonelectric-energy prices are projected to increase over the entire period.

The nonelectric-energy price is a quantity-weighted average of the prices of natural gas, distillate fuel, and liquefied petroleum gas. In the short term (1991-95), the distillate fuel price is projected to fall, while the prices of liquefied petroleum gas and natural gas increase. From 1996 to 2010, the rates of change in these fuel prices move in the same direction, although there are differences in their relative magnitudes (see Table 2.3).

TABLE 2.3 National Energy Strategy: Delivered Prices in the Residential Sector

Price by Energy Source (\$/10 ⁶ Btu) ^a					
Year	Distillate Fuel	Liquid Gas ^a	Natural Gas	Nonelectric Energy ^b	Electricity
1989	6.73	10.60	5.72	6.17	24.10
1990	7.64	9.56	5.69	6.31	23.74
1995	7.32	9.83	6.48	6.77	23.12
2000	8.54	11.10	7.98	8.19	24.59
2005	9.00	11.35	8.31	8.50	25.47
2010	9.62	12.08	9.25	9.38	25.85

Average Annual Rate of Change (%/yr)					
Time Interval	Distillate Fuel	Liquid Gas	Natural Gas	Nonelectric Energy	Electricity
1989-90	13.52	-9.81	-0.52	2.25	-1.49
1991-95	-0.85	0.56	2.63	1.43	-0.53
1996-00	3.13	2.46	4.25	3.88	1.24
2001-05	1.05	0.45	0.81	0.76	0.71
2006-10	1.34	1.25	2.17	1.99	0.30

^a 1990 dollars.

^b Nonelectric-energy price is a quantity-weighted average price of distillate fuel, liquid gas, and natural gas.

3 ASSUMPTIONS IN THE MINORITY ENERGY ASSESSMENT MODEL

Within the MEAM framework, energy consumption is determined by variables of two categories: foreground and background variables. Foreground variables are economic variables (prices and income) that are policy-sensitive and affect energy consumption. Background variables are policy-insensitive and are assumed to remain constant between policy cases. In a good policy-assessment model, the relative impacts of a policy should not be substantially affected by changes in background-variable assumptions.

Nevertheless, background-variable assumptions can be important in determining estimated dependent-variable changes within a scenario for a specific population group. Although different assumptions do not affect the relative impacts between policy scenarios, they may affect the relative impacts among population groups. Therefore, the question of what happens to the relative circumstances of different population groups under the same policy regime, given different background-variable assumptions, becomes relevant.

Where the relative impacts of policy among population groups are of particular interest, as in this study, assumptions about changes in background variables are important.

3.1 ASSUMPTIONS ABOUT HOUSING-STOCK GROWTH RATE

The production of household energy services can be characterized as a "putty-clay-type" technology, implying that a household has its greatest flexibility in the choice of end-use technologies when the home is purchased new. Once the home is built and appliances are installed, energy choices and the level of consumption become more or less fixed. Energy consumption and patterns of use do differ with housing vintage. How energy is used and its level of consumption are, therefore, very dependent on the rate of turnover in housing stock.

In this study, variables that identify new homes are assumed to have correlation structures similar to those of homes built after 1974, as given in the 1987 Residential Energy Consumption Survey (EIA 1990). With the exception of those few variables that are projected to change, the correlation structure among variables remains the same. New housing growth is defined as the percent change in the number of homes built after 1974 — the growth occurs from a base value given in the year 1987. To determine the degree of sensitivity of the projected values to changes in the assumption about new housing growth, three growth rates were considered: 4%, 5%, and 6%. The five-percent case is sometimes referred to as the reference case.⁷

From the assumptions made about household population and the growth rate for new housing stock, rates of change in "old" housing (built before 1974) occupancy were derived for each population group. The assumed population growth rates and the derived rates of change

⁷ The five-percent assumption was used in the initial analysis done for Deputy Under Secretary Stuntz for her June 1991 speech in Baltimore, Maryland.

in occupancy of homes built before 1974 are listed in Table 3.1.

3.2 ASSUMPTIONS ABOUT ENERGY EFFICIENCY

Under the NES, substantial improvements in residential energy efficiency are anticipated. Assumed efficiency gains are made through the implementation of integrated resource planning, building standards, and other conservation actions. Along with the policy-induced improvements, energy-efficiency gains due to the turnover in housing stock and appliances are also assumed to occur.

To capture the effect of these energy-efficiency gains, a concept called the energy service ratio (ESR) is used (Cowing and McFadden 1984, p. 32). The ESR is an index number that measures changes in energy efficiency — the ratio of energy coming in to energy going out. The ESR concept is illustrated in Figure 3.1.

The more energy-efficient the household is, the smaller the ESR becomes. Energy is an indirect input in the production of a household service; it is not consumed for its own sake. Therefore, a change in the ESR is equivalent to a change in the energy-out price. The ESR can be used to transform energy-in prices to energy-out prices, as indicated in Equation 3.1:

$$\text{Price}_o = \text{ESR} \times \text{Price}_i \quad (3.1)$$

FIGURE 3.1 Energy Service Ratio

TABLE 3.1 Household Growth Rate Assumptions: Homes Built before 1974

Population Group	Housing Growth Rate (%)	Rate of Change in Occupancy of Old Homes ^a by New Housing Stock Growth Rates (%)		
		4%	5%	6%
Majority	1.09	-0.59	-1.77	-3.87
Black	2.00	1.75	1.56	1.33
Hispanic	3.00	2.70	2.30	1.75
Poor	1.09	0.24	-0.26	-0.98
Nonpoor	1.09	-0.61	-1.82	-3.98

^a Old homes are defined as houses built before 1974.

The projected transformed prices, which are obtained from the projected ESR values, are used as inputs in the MEAM behavioral equations to project energy consumption in terms of energy output. The energy-out values are then transformed back to energy input by using the projected ESRs, as indicated in Equation 3.2:

$$\text{Energy}_i = \text{ESR} \times \text{Energy}_o \quad (3.2)$$

The ESR is set equal to one in the base period.

For the NES case, the ESR is assumed to decline at an annual rate of 0.4%. With this assumption, the effective price change for energy output is the change given in Table 2.3 net the change in the ESR. The ESR change is uniformly applied over all fuel types, home types, housing vintages, and energy end-use categories. This assumption is, of course, unrealistic, because it is expected that energy-efficiency improvements would vary with respect to these variable categories. Future research will investigate the sensitivity of the output to changes in these assumptions.

4 ENERGY-CONSUMPTION PROJECTIONS

Energy consumption, expenditure, and projected income expenditure shares reported for the population groups considered are dependent on the underlying background-variable assumptions (primarily assumptions pertaining to growth in new housing stock) and the estimated income and price elasticities for each population group. Because of differences in the relative numbers of new homes and in elasticities, rates of change in projected energy consumption differ for the various groups. These differences reflect differential rates in the penetration of electricity and nonelectric energy by end-use category and housing vintage. Typically, with all other factors remaining constant, electricity use is higher in newer homes. Therefore, electricity consumption will increase simply as a result of the relative growth in new housing.

Because of differences in housing-vintage distributions, differences in the rate of change in energy consumption and in its composition will emerge among the population groups. On the average, majority and nonpoor persons more often live in newer homes; consequently, these households generally consume relatively more electricity.

Under the NES scenario, the relative price ratio of nonelectric energy and electricity is projected to fall. The majority and nonpoor households' electricity share of total energy consumption is higher, so their projected energy expenditures are expected to increase more slowly than those for minority and poor households.

Another subtle but important implication is associated with the relative consumption of electricity. For the demand system used in this analysis, the price elasticity depends on how electricity is used. The degree of substitution between electricity and nonelectric energy is dependent on the extent of electricity use across household end-use categories — the more extensive the electricity use, the more likely it is that electricity and nonelectric energy are substitutes.

This fact implies a qualitative difference in the relationship between electricity and nonelectric energy for majority and minority households and for nonpoor and poor households. In the case of majority and nonpoor households, electricity and nonelectric energy are more likely to be substitutes. Therefore, differences in energy consumption patterns between groups are expected. The projected increase in the nonelectric and electricity price ratio leads to a more dramatic increase in the relative consumption of electricity by majority and nonpoor households.

4.1 ENERGY CONSUMPTION

4.1.1 Majority and Minority Households

Under the NES case, in each of the three new housing growth scenarios, energy consumption declines for each population group (see Tables 4.1-4.3). The decline is primarily driven by the energy conservation measures assumed to be associated with the NES and by the turnover in housing stock. As expected, nonelectric energy consumption declines significantly, while electricity consumption increases, for each of the population groups.

The general trends projected become more pronounced as the assumed growth rate in new housing increases. The higher the new housing growth rate, the greater is the decline in overall energy consumption and the rise in electricity consumption.

The projected changes, however, vary by population group. In all cases, energy consumption is projected to fall, and electricity consumption to rise, to a greater extent in majority households than in minority households. When a higher growth rate in new housing is assumed, the differential rates of change in energy consumption and electricity consumption for majority and minority households increase.⁸

In Figure 4.1, the influence of different assumptions about new housing growth on the relative changes in energy consumption in majority and minority households is vividly displayed. As the growth rate in new housing increases, the relative decline in majority energy consumption (compared with that of minority households) also increases. As a consequence, the projected level of household energy consumption by black and Hispanic households increases relative to majority household consumption.

In Figures 4.2 and 4.3, changing electricity consumption patterns are shown for the three population groups. As shown in Figure 4.2, the pattern of change in electricity consumption over the projected period is very different for majority, black, and Hispanic households. This difference is primarily due to different price elasticities. For majority households, electricity and nonelectric energy are more readily substitutable, as a result of wider use of electricity by majority households than by minority households.

As expected, given the difference in price elasticities for majority and minority households, the increase in the real price of nonelectric energy results in a relative increase in majority household electricity consumption compared with that for black and Hispanic households.

⁸ In this analysis, it is assumed that the rate of growth in new housing is the same for each population group. If differential rates of growth were assumed, the outcomes would be very different. If there is an interest in considering the effect of differential new housing growth rates on the comparative impact of NES on these groups, projected values associated with these different rates can be compared.

**TABLE 4.1 Energy-Consumption Projections for Majority, Black, and Hispanic Households:
4% New Housing Growth**

Energy Consumption per Household (10 ⁶ Btu)									
Majority			Black			Hispanic			
Year	Electricity	Non-electric Energy	Total	Electricity	Non-electric Energy	Total	Electricity	Non-electric Energy	Total
1987	31.85	68.60	100.45	27.64	82.91	110.56	26.39	60.92	87.31
1991	33.59	68.08	101.68	29.47	81.85	111.32	27.00	59.24	86.24
1995	33.95	64.65	98.60	28.79	79.40	108.18	27.96	58.83	86.79
1999	35.19	59.43	94.62	30.11	74.99	105.11	27.27	57.75	85.02
2005	34.47	57.31	91.79	27.48	76.04	103.52	25.89	57.32	83.21
2009	36.44	51.42	87.86	29.00	69.89	98.88	27.35	53.62	80.98

Average Annual Rate of Change (%/yr)									
Majority			Black			Hispanic			
Time Interval	Electricity	Non-electric Energy	Total	Electricity	Non-electric Energy	Total	Electricity	Non-electric Energy	Total
1987-91	1.34	-0.19	0.30	1.62	-0.32	0.17	0.57	-0.70	-0.31
1991-95	0.27	-1.28	-0.77	-0.58	-0.76	-0.71	0.88	-0.17	0.16
1995-99	0.90	-2.08	-1.02	1.13	-1.42	-0.72	-0.62	-0.46	-0.51
1999-2005	-0.34	-0.60	-0.50	-1.51	0.23	-0.25	-0.86	-0.12	-0.36
2005-09	1.40	-2.67	-1.09	1.36	-2.09	-1.14	1.38	-1.65	-0.68
1987-2009	0.61	-1.30	-0.61	0.22	-0.77	-0.51	0.16	-0.58	-0.34

**TABLE 4.2 Energy-Consumption Projections for Majority, Black, and Hispanic Households:
5% New Housing Growth**

Energy Consumption per Household (10 ⁶ Btu)									
Majority			Black			Hispanic			
Year	Electricity	Non-electric Energy	Total	Electricity	Non-electric Energy	Total	Electricity	Non-electric Energy	Total
1987	31.85	68.60	100.45	27.64	82.91	110.56	26.39	60.92	87.31
1991	33.81	67.41	101.22	29.54	81.59	111.13	27.02	58.97	86.24
1995	34.42	63.22	97.64	28.92	78.85	107.77	28.08	58.39	86.47
1999	35.93	57.23	93.16	30.36	74.11	104.46	27.38	57.07	84.45
2005	35.64	53.82	89.46	27.86	74.56	102.42	26.14	56.32	82.46
2009	37.86	47.21	85.06	29.41	67.96	97.37	27.48	52.35	79.82

Average Annual Rate of Change (%/yr)									
Majority			Black			Hispanic			
Time Interval	Electricity	Non-electric Energy	Total	Electricity	Non-electric Energy	Total	Electricity	Non-electric Energy	Total
1987-91	1.50	-0.44	0.19	1.68	-0.40	0.13	0.59	-0.81	-0.38
1991-95	0.45	-1.59	-0.90	-0.53	-0.85	-0.76	0.97	-0.25	0.14
1995-99	1.08	-2.46	-1.17	1.22	-1.54	-0.78	-0.63	-0.57	-0.59
1999-2005	-0.13	-1.02	-0.67	-1.42	0.10	-0.33	-0.77	-0.22	-0.40
2005-09	1.52	-3.22	-1.25	1.36	-2.29	-1.26	1.26	-1.81	-0.81
1987-2009	0.79	-1.68	-0.75	0.28	-0.90	-0.58	0.18	-0.69	-0.41

**TABLE 4.3 Energy-Consumption Projections for Majority, Black, and Hispanic Households:
6% New Housing Growth**

Energy Consumption per Household (10 ⁶ Btu)									
Majority			Black			Hispanic			
Year	Electricity	Non-electric Energy	Total	Electricity	Non-electric Energy	Total	Electricity	Non-electric Energy	Total
1987	31.85	68.6	100.45	27.64	82.91	110.56	26.39	60.92	87.31
1991	34.14	66.39	100.53	29.62	81.31	110.93	27.04	58.67	85.71
1995	35.13	61.04	96.17	29.07	78.24	107.31	28.22	57.87	86.09
1999	37.04	53.94	90.98	30.63	73.1	103.73	27.5	56.26	83.76
2005	37.25	48.98	86.23	28.29	72.83	101.13	26.45	55.09	81.54
2009	39.67	41.84	81.51	29.91	65.66	95.57	27.63	50.76	78.39

Average Annual Rate of Change (%/yr)									
Majority			Black			Hispanic			
Time Interval	Electricity	Non-electric Energy	Total	Electricity	Non-electric Energy	Total	Electricity	Non-electric Energy	Total
1987-91	1.75	-0.82	0.02	1.74	-0.49	0.08	0.61	-0.94	-0.46
1991-95	0.72	-2.08	-1.10	-0.47	-0.96	-0.83	1.07	-0.34	0.11
1995-99	1.33	-3.04	-1.38	1.32	-1.68	-0.84	-0.64	-0.70	-0.68
1999-2005	0.09	-1.59	-0.89	-1.32	-0.06	-0.42	-0.65	-0.35	-0.45
2005-09	1.59	-3.86	-1.40	1.40	-2.56	-1.40	1.10	-2.03	-0.98
1987-2009	1.00	-2.22	-0.95	0.36	-1.05	-0.66	0.21	-0.83	-0.49

a. 4% Growth Rate

b. 5% Growth Rate

FIGURE 4.1 Patterns of Energy Consumption for Majority, Black, and Hispanic Households, New Housing Stock Growth Rate at Three Different Values

c. 6% Growth Rate

FIGURE 4.1 (Cont.)

FIGURE 4.2 Electricity-Consumption Patterns for Majority, Black, and Hispanic Households, New Housing Stock Growth Rate at 5%

a. Majority Households

b. Black Households

FIGURE 4.3 Electricity-Consumption Patterns for Majority, Black, and Hispanic Households, New Housing Stock Growth Rate at Three Different Values

c. Hispanic Households

FIGURE 4.3 (Cont.)

The assumed growth in new housing plays an important role in determining the pattern of change in electricity use. The difference in electricity use between newer and older homes is analogous to the difference in use between majority and minority households. In newer homes, electricity is more widely used and serves more as a substitute for nonelectric energy. As a result, growth in electricity consumption over the projected period is higher for the scenarios that incorporate higher rates of new housing growth.

The impact of different housing growth scenarios on the pattern of energy use differs for majority and minority households. This phenomenon is illustrated in Figure 4.3.

The impact of a higher new housing growth rate is more pronounced for majority households. For the three rates considered in this study, the increase in electricity consumption is larger for majority households than for minority households with each successively higher new housing growth rate. For minority households, increased electricity consumption is also associated with higher new housing growth rates. These increases in consumption are, however, very small.

The impact of the NES on nonelectric-energy consumption is of particular importance because of its national security implications. In this regard, the effects of the NES seem to be most positive in the case of majority households, where nonelectric-energy consumption declines the most. This outcome is, of course, implied by the fact that overall energy consumption declines, and electricity consumption increases, more for majority households

than for others. The relative decline in nonelectric-energy consumption is higher for majority households in each of the three scenarios.

4.1.2 Nonpoor and Poor Households

The comparative changes in energy consumption by nonpoor and poor households are very similar to the changes in energy consumption by majority and minority households. Energy consumption declines for both nonpoor and poor households. The overall change in energy consumption, over the projected time period, is slightly higher for nonpoor households in the 5% new housing stock reference case. The differential in the growth rate, however, widens as the new housing growth rate increases. The widening margin in the decline of energy consumption between nonpoor and poor households is illustrated in Figure 4.4. The widening in the rate between the 5% and 6% growth rate scenarios is dramatic.

The change in the patterns of energy consumption for nonpoor and poor households is also different. For both nonpoor and poor households, electricity consumption increases and nonelectric-energy consumption falls. As a consequence (as in the case of majority and minority households), the electricity share of total energy consumption increases for both the nonpoor and poor, but relatively more for the nonpoor, households.

The nature of electricity demand in nonpoor and poor households is different. The analogy with majority and minority households is again appropriate, in that the relative ability of nonpoor and poor households to substitute electricity for nonelectric energy varies. Electricity and nonelectric energy may be substituted interchangeably for each other to a greater degree in nonpoor households than in poor ones.

Figure 4.5, which shows projected electricity consumption for the 5% reference case, illustrates how projected electricity consumption differs for nonpoor and poor households. Nonpoor households' electricity consumption increases, for the most part, over the entire period in response to the relative decline in real electricity price. For poor households, electricity consumption remains relatively flat, fluctuating up and down over the projected period.

Figure 4.6 shows projected electricity consumption for the three new housing growth rates for nonpoor and poor households, respectively. These figures show how changes in the assumptions about new housing growth affect electricity consumption. In every case, for both nonpoor and poor households, higher rates of new housing growth are associated with higher rates of electricity consumption.

The shift in electricity consumption in response to changes in new housing growth rates varies. For nonpoor households, the change in the rate of growth in electricity consumption is increasing. For poor households, it remains about the same. Thus, the difference between nonpoor and poor households' electricity consumption increases at an accelerated rate. This means that not only is the gap in electricity consumption growing, but

a. 4% Growth Rate

b. 5% Growth Rate

FIGURE 4.4 Patterns of Energy Consumption for Nonpoor Households, New Housing Stock Growth Rate at Three Different Values

c. 6% Growth Rate

FIGURE 4.4 (Cont.)

FIGURE 4.5 Electricity-Consumption Patterns for Nonpoor and Poor Households, New Housing Stock Growth Rate at 5%

a. Nonpoor Households

b. Poor Households

FIGURE 4.6 Electricity-Consumption Patterns for Nonpoor and Poor Households, New Housing Stock Growth Rate at Three Different Values

so is the relative level of nonpoor households' electricity consumption compared with that of poor households.

Changes in energy consumption and patterns of energy consumption are summarized in Tables 4.4-4.6. In the 4% and 5% new housing growth cases, the relative increase in nonpoor households' electricity consumption is offset by the relative decline in their consumption of nonelectric energy compared with that of poor households. As a result, in these two cases, the overall change in energy consumption is about the same for both population groups. In the 6% new housing growth case, however, spurred by the rapid declines in nonelectric-energy consumption, the fall in nonpoor households' energy consumption is substantially greater than that of poor households.

In this section, the effects of changing prices, income, and energy efficiencies on household energy consumption and patterns of use have been discussed. As was already mentioned, energy is not consumed for its own sake; rather, it is consumed in the process of

**TABLE 4.4 Energy-Consumption Projections for Nonpoor and Poor Households:
4% New Housing Growth**

Energy Consumption by Household (10^6 Btu)						
Year	Nonpoor			Poor		
	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987	32.09	71.30	103.39	26.59	64.6	91.19
1991	34.50	69.64	104.14	28.72	63.06	91.78
1995	34.54	67.30	101.84	28.02	61.41	89.43
1999	36.03	60.96	96.99	29.05	58.02	87.07
2005	35.63	58.95	94.58	26.39	57.87	84.26
2009	37.90	53.46	91.36	28.13	53.20	81.32
Average Annual Rate of Change (%/yr)						
Time Interval	Nonpoor			Poor		
	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987-91	1.83	-0.59	0.18	1.95	-0.60	0.16
1991-95	0.03	-0.85	-0.56	-0.61	-0.66	-0.65
1995-99	1.06	-2.44	-1.21	0.91	-1.41	-0.67
1999-2005	-0.19	-0.56	-0.42	-1.56	-0.04	-0.55
2005-09	1.56	-2.41	-0.86	1.61	-2.08	-0.88
1987-2009	0.76	-1.30	-0.56	0.26	-0.88	-0.52

TABLE 4.5 Energy-Consumption Projections for Nonpoor and Poor Households: 5% New Housing Growth

Energy Consumption by Household (10 ⁶ Btu)						
Year	Nonpoor			Poor		
	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987	32.09	71.3	103.39	26.59	64.6	91.19
1991	34.67	69.16	103.82	28.76	62.77	91.53
1995	34.89	66.31	101.2	28.1	60.75	88.85
1999	36.62	59.31	95.93	29.17	56.91	86.08
2005	36.52	56.45	92.96	26.68	56.06	82.74
2009	39.07	50.43	89.49	28.5	51.07	79.56

Average Annual Rate of Change (%/yr)						
Time Interval	Nonpoor			Poor		
	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987-91	1.95	-0.76	0.10	1.98	-0.72	0.09
1991-95	0.16	-1.05	-0.64	-0.58	-0.81	-0.74
1995-99	1.22	-2.75	-1.33	0.94	-1.62	-0.79
1999-2005	-0.05	-0.82	-0.52	-1.48	-0.25	-0.66
2005-09	1.70	-2.78	-0.95	1.66	-2.30	-0.98
1987-2009	0.90	-1.56	-0.65	0.32	-1.06	-0.62

producing household services. From the point of view of the individual household, it is not the amount or type of energy consumed that is important, but the real cost or value associated with the level of energy consumption required to maintain some given measure of service.

In the next two sections, the impact of the NES case on energy expenditures and energy expenditure as a share of income (given different assumptions about the rate of new housing growth) is addressed. The results presented here should give a better, if not an exact, measure of the economic welfare implications associated with the NES under the three new housing growth rate scenarios.

TABLE 4.6 Energy-Consumption Projections for Nonpoor and Poor Households: 6% New Housing Growth

Energy Consumption by Household (10 ⁶ Btu)						
Year	Nonpoor			Poor		
	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987	32.09	71.3	103.39	26.59	64.6	91.19
1991	35.14	67.78	102.92	28.81	62.42	91.23
1995	35.91	63.45	99.37	28.2	59.94	88.15
1999	38.29	54.63	92.92	29.32	55.53	84.85
2005	38.85	49.84	88.68	27.06	53.78	80.84
2009	41.89	43.06	84.95	28.96	48.39	77.35
Average Annual Rate of Change (%/yr)						
Time Interval	Nonpoor			Poor		
	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987-91	2.30	-1.26	-0.11	2.02	-0.85	0.01
1991-95	0.54	-1.64	-0.87	-0.53	-1.01	-0.85
1995-99	1.62	-3.67	-1.66	0.98	-1.89	-0.95
1999-2005	0.24	-1.52	-0.78	-1.33	-0.53	-0.80
2005-09	1.90	-3.59	-1.07	1.71	-2.61	-1.10
1987-2009	1.22	-2.27	-0.89	0.39	-1.30	-0.75

4.2 ENERGY EXPENDITURES

In each of the three scenarios for rate of new housing growth, the change in energy expenditures can be considered in terms of three phases over the projected period:

- The first phase (1987-1999) can be viewed as a transition phase, in which NES policies and programs are being put into place. During this phase, trends that predate the NES still dominate, and the initial costs associated with the implementation of the NES are being absorbed by the economy; as a result, real energy expenditures increase.
- The second phase (1999-2005) represents the period in which the NES takes hold. During this phase, NES measures that tend to augment the energy supply and encourage conservation rapidly penetrate the American market; as a result, real energy expenditures decline.

- The third phase (2005-2009) represents the emergence of a long-term trend in energy markets, reflecting the increasing scarcity of petroleum-based energy. The effect of this trend is a gradual increase in real energy expenditures.

Changes in expenditures depend primarily on changes in price, housing stock, and energy efficiency (assumed change in energy service ratio), as well as on the responsiveness of energy consumption to those changes. The fluctuations in energy expenditures noted here, however, reflect energy price changes alone; improvements in energy efficiency and housing-stock changes are applied uniformly over time in this analysis.⁹

Energy expenditures increase in every period, with the exception of the 1999-2005 period, when increases in real energy prices do not keep pace with energy-efficiency improvements; during this period, energy expenditures actually decline for all groups. Energy expenditure projections for each group are summarized in Tables 4.7-4.12 and depicted in Figures 4.7-4.9.

With the exception of Hispanic households during the 1987-1991 period, the general movement in energy expenditures is the same for each population group. Between 1987 and 1991, expenditures for Hispanic households are projected to decrease slightly, whereas expenditures for all other groups increase slightly.

For each group, the pattern of change in energy expenditures is the same, for the most part. Very little difference is projected between the three new housing growth scenarios in terms of patterns of change in energy expenditures. However, some difference is anticipated in the relative movement in expenditures among the groups.

4.2.1 Majority and Minority Households

The elasticities in the model used in this assessment work are variable; they depend on initial consumption and price levels and on the composition of energy use. A further complication is associated with the hierarchical structure of the demand system. With this structure, even though all households are assumed to face the same price changes, the effective change in the *overall* price or cost of energy is different for majority and minority households. The cost of energy differs because of differences in the composition of energy used by minority and majority households. Thus, the elasticities for minority and majority households are different, as is the effect of price changes on the overall level of energy expenditures.

⁹ These assumptions of uniformity, made to expedite the analysis, represent this study's greatest shortcoming. Future work is planned, however, to investigate the impact of these assumptions on various socioeconomic groups by considering other scenarios for improved energy efficiency and housing-stock growth.

TABLE 4.7 Energy-Expenditure Projections for Majority, Black, and Hispanic Households: 4% New Housing Growth

Expenditures per Household (1989 dollars)									
Majority			Black			Hispanic			
Year	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987	704.42	471.42	1175.84	646.79	606.39	1253.18	654.36	447.01	1101.37
1991	711.79	496.11	1207.9	661.51	640.89	1302.40	643.94	456.64	1100.58
1995	769.64	490.99	1260.63	690.05	647.02	1337.07	708.98	472.93	1181.91
1999	896.13	639.48	1535.61	817.00	869.71	1686.71	787.57	675.33	1462.9
2005	822.84	443.17	1266.01	700.38	640.67	1341.05	698.37	478.37	1176.74
2009	848.84	538.88	1387.72	719.40	808.73	1528.13	721.47	600.48	1321.95

Average Annual Percentage Rate of Change (%/yr)									
Majority			Black			Hispanic			
Time Interval	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987-91	0.26	1.28	0.67	0.56	1.39	0.97	-0.40	0.53	-0.02
1991-95	1.97	-0.26	1.07	1.06	0.24	0.66	2.43	0.88	1.80
1995-99	3.88	6.83	5.06	4.31	7.67	5.98	2.66	9.32	5.48
1999-2005	-1.41	-5.93	-3.17	-2.53	-4.97	-3.75	-1.98	-5.58	-3.56
2005-09	0.78	5.01	2.32	0.67	6.00	3.32	0.82	5.85	2.95
1987-2009	0.85	0.61	0.76	0.48	1.32	0.91	0.44	1.35	0.83

TABLE 4.8 Energy-Expenditure Projections for Majority, Black, and Hispanic Households: 5% New Housing Growth

Expenditures per Household (1989 dollars)									
Majority			Black			Hispanic			
Year	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987	704.42	471.42	1175.84	646.79	606.39	1253.18	654.36	447.01	1101.37
1991	715.42	491.08	1206.50	662.67	638.58	1301.25	643.86	454.51	1098.37
1995	778.08	479.98	1258.06	692.16	641.59	1333.75	710.92	468.68	1179.6
1999	911.02	615.51	1526.53	821.49	857.56	1679.05	788.34	666.98	1455.32
2005	845.06	415.24	1260.30	706.90	625.57	1332.47	702.14	469.37	1171.51
2009	875.42	493.61	1369.03	725.75	783.34	1509.09	721.15	584.48	1305.63

Average Annual Rate of Change (%/yr)									
Majority			Black			Hispanic			
Time Interval	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987-91	0.39	1.03	0.65	0.61	1.30	0.95	-0.40	0.42	-0.07
1991-95	2.12	-0.57	1.05	1.09	0.12	0.62	2.51	0.77	1.80
1995-99	4.02	6.42	4.95	4.38	7.52	5.92	2.62	9.22	5.39
1999-2005	-1.24	-6.35	-3.14	-2.47	-5.12	-3.78	-1.91	-5.69	-3.55
2005-09	0.89	4.42	2.09	0.66	5.78	3.16	0.67	5.64	2.75
1987-2009	0.99	0.21	0.69	0.52	1.17	0.85	0.44	1.23	0.78

TABLE 4.9 Energy-Expenditure Projections for Majority, Black, and Hispanic Households: 6% New Housing Growth

Expenditures per Household (1989 dollars)									
Majority			Black			Hispanic			
Year	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987	704.42	471.42	1175.84	646.79	606.39	1253.18	654.36	447.01	1101.37
1991	720.86	483.52	1204.38	663.91	636.11	1300.02	643.77	452.09	1095.86
1995	790.9	463.25	1254.15	694.5	692.16	1330.09	713.2	463.68	1176.88
1999	933.29	579.65	1512.94	826.58	843.79	1670.37	789.26	656.96	1446.22
2005	875.84	376.56	1252.4	714.52	607.93	1322.45	706.79	458.28	1165.07
2009	909.22	436.02	1345.24	733.29	753.1	1486.39	720.75	564.57	1285.32

Average Annual Percentage Rate of Change (%/yr)									
Majority			Black			Hispanic			
Time Interval	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987-91	0.58	0.64	0.60	0.66	1.20	0.92	-0.41	0.28	-0.13
1991-95	2.35	-1.06	1.02	1.13	2.13	0.57	2.59	0.63	1.80
1995-99	4.23	5.76	4.80	4.45	5.08	5.86	2.57	9.10	5.29
1999-2005	-1.05	-6.94	-3.10	-2.40	-5.32	-3.82	-1.86	-5.83	-3.54
2005-09	0.94	3.73	1.80	0.65	5.50	2.96	0.49	5.35	2.49
1987-2009	1.17	-0.35	0.61	0.57	0.99	0.78	0.44	1.07	0.70

TABLE 4.10 Energy-Expenditure Projections for Nonpoor and Poor Households: 4% New Housing Growth

Expenditures per Household (1989 dollars)						
Year	Nonpoor			Poor		
	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987	716.9	499.25	1216.15	598.83	436.46	1035.29
1991	737.36	511.39	1248.75	619.31	450.27	1069.58
1995	788.2	516.54	1304.74	645.97	451.33	1097.3
1999	924.8	663.04	1587.84	755.49	627.89	1383.38
2005	858.51	454.95	1313.46	641.6	455.97	1097.57
2009	890.3	563.73	1454.03	667.22	577.93	1245.15
Average Annual Percentage Rate of Change (%/yr)						
Time Interval	Nonpoor			Poor		
	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987-91	0.71	0.60	0.66	0.84	0.78	0.82
1991-95	1.68	0.25	1.10	1.06	0.06	0.64
1995-99	4.08	6.44	5.03	3.99	8.60	5.96
1999-2005	-1.23	-6.08	-3.11	-2.69	-5.19	-3.78
2005-09	0.91	5.51	2.57	0.98	6.10	3.20
1987-2009	0.99	0.55	0.82	0.49	1.28	0.84

The direction of energy expenditures is, for the most part, the same for majority and minority households; however, the relative movement is different for the two groups. The relative difference in energy expenditures between Hispanic and majority households is not the same as the difference in energy expenditures between black and majority households. The difference is due to variations in the geographic location of and in the composition of energy use by black and Hispanic households.

In general, energy expenditures by black households are more sensitive to changes in nonelectric-energy prices than are those by majority households. Conversely, energy expenditures by majority households are more sensitive to changes in electricity prices than are those by black households. The changes in energy expenditures depicted in Figure 4.7 reflect the net effect on expenditures of changes in electricity and nonelectric-energy prices. As expected, given the relative increase in the nonelectric-energy price, energy expenditures by black households increase at a slightly faster rate than those by majority households. The differential rate in energy expenditures for majority and black households is not as large as the differential rate in energy consumption might indicate, because electricity consumption by majority households undergoes a sizeable increase.

**TABLE 4.11 Energy-Expenditure Projections for Nonpoor and Poor Households:
5% New Housing Growth**

Expenditures per Household (1989 dollars)						
Year	Nonpoor			Poor		
	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987	716.9	499.25	1216.15	598.83	436.46	1035.29
1991	740.15	507.52	1247.67	619.72	448.47	1068.19
1995	794.54	508.32	1302.86	646.54	446.84	1093.38
1999	936.71	643.58	1580.29	756.34	617.66	1374
2005	875.56	433.3	1308.86	645.78	442.76	1088.54
2009	912.69	528.79	1441.48	671.43	555.62	1227.05
Average Annual Percentage Rate of Change (%/yr)						
Time Interval	Nonpoor			Poor		
	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987-91	0.80	0.41	0.64	0.86	0.68	0.79
1991-95	1.79	0.04	1.09	1.06	-0.09	0.58
1995-99	4.20	6.08	4.94	4.00	8.43	5.88
1999-2005	-1.12	-6.38	-3.09	-2.60	-5.40	-3.81
2005-09	1.04	5.11	2.44	0.98	5.84	3.04
1987-2009	1.10	0.26	0.78	0.52	1.10	0.78

The relationship between Hispanic household energy expenditures and those by majority households is similar to that found in the case of black households. The movement of energy expenditures by Hispanic households relative to that by majority households is, however, different from the movement of energy expenditures by black households in the early part of the projected period. Between 1987 and 1991, the level of energy expenditures by Hispanic households declines, with both electricity and nonelectric-energy expenditures declining relative to those by majority households. During the 1991-1995 period, these relative trends are reversed, with energy expenditures by Hispanic households increasing relative to those by majority households. In each of the succeeding periods, the trend in energy expenditures by Hispanic households relative to those by majority households is the same as that by black households. Overall, the rate of increase in energy expenditures by Hispanic households, like that of black households, is somewhat higher than the rate for majority households.

The pattern of changes in energy expenditures among scenarios for growth in new housing is very similar. As the assumed rate of growth in new housing increases, energy expenditures decline very slightly. The decline is larger for majority households than it is for minority households.

**TABLE 4.12 Energy-Expenditure Projections for Nonpoor and Poor Households:
6% New Housing Growth**

Expenditures per Household (1989 dollars)						
Year	Nonpoor			Poor		
	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987	716.9	499.25	1216.15	598.83	436.46	1035.29
1991	748.14	496.45	1244.59	620.19	446.36	1066.55
1995	812.9	484.53	1297.43	647.24	441.36	1088.6
1999	970.6	588.19	1558.79	757.39	604.91	1362.3
2005	920.68	376.01	1296.69	651.04	426.13	1077.17
2009	967.11	443.88	1410.99	676.74	527.65	1204.39

Average Annual Percentage Rate of Change (%/yr)						
Time Interval	Nonpoor			Poor		
	Electricity	Nonelectric Energy	Total	Electricity	Nonelectric Energy	Total
1987-91	1.07	-0.14	0.58	0.88	0.56	0.75
1991-95	2.10	-0.61	1.04	1.07	-0.28	0.51
1995-99	4.53	4.97	4.69	4.01	8.20	5.77
1999-2005	-0.88	-7.19	-3.02	-2.49	-5.67	-3.84
2005-09	1.24	4.24	2.13	0.97	5.49	2.83
1987-2009	1.37	-0.53	0.68	0.56	0.87	0.69

FIGURE 4.7 Total Energy Expenditures for Majority, Black, and Hispanic Households, New Housing Stock Growth Rate at 5%

a. Majority Households

b. Black Households

FIGURE 4.8 Total Energy Expenditures for Majority, Black, and Hispanic Households, New Housing Stock Growth Rate at Three Different Values

c. Hispanic Households

FIGURE 4.8 (Cont.)

The fact that energy expenditures change little and electricity consumption increases significantly (particularly for majority households) as the rate of growth in new housing increases indicates that changes in energy composition do not necessarily coincide with a change in the valuation of energy services. The shift from nonelectric energy to electricity in newer homes does not, by itself, imply a more efficient use of energy; energy prices reflect the true social value of energy.

During the first phase of changing energy expenditures, electricity expenditures, like total energy expenditures, are projected to increase, peaking around the year 1999. They are projected to fall during the 1999-2005 period and then rise in the latter part of the projected period. Electricity expenditures by Hispanic households over the 1987-1991 period are an exception to this pattern; during this early period, electricity expenditures by Hispanic households fall slightly.

Changes in the rate of growth in new housing, like total energy expenditures, have little influence on electricity expenditures. If higher rates of growth in new housing are assumed, the level of electricity expenditures falls slightly. As in the case of total energy expenditures, the level of electricity expenditures by majority households is more sensitive to the assumed rate of growth in new housing than is that by minority households.

a. Majority Households

b. Black Households

FIGURE 4.9 Electricity Expenditures for Majority, Black, and Hispanic Households, New Housing Stock Growth Rate at Three Different Values

c. Hispanic Households

FIGURE 4.9 (Cont.)

For each population group, the electricity expenditure as a share of total energy expenditures rises during periods of moderate growth in overall energy prices. Figure 4.10 indicates that the share of electricity expenditure increases in the 1991-1995 and 1999-2005 periods. In the 1995-1999 and 2005-2009 periods, electricity expenditure as a share of total energy expenditures declines. In the latter periods, the increase in the price of nonelectric energy is relatively rapid.

The trends in energy expenditure composition discussed above hold for each of the population groups. However, the change in expenditure composition between groups is somewhat different. The electricity expenditure share varies more widely for majority households than it does for minority households. The trend in electricity expenditure as a share of total energy expenditures also differs for majority and minority households. In general, the electricity share of total energy expenditures is increasing for majority households, in contrast to minority households. This trend is particularly noticeable in the case of Hispanic households, which in the base year spent approximately the same share of their total energy expenditures on electricity as did majority households. In each succeeding period, the electricity expenditure share for Hispanic households declines dramatically compared with that for majority households.

FIGURE 4.10 Electric Percentage Share of Energy Expenditures for Majority, Black, and Hispanic Households, New Housing Stock Growth Rate at 5%

For each of the population groups, the electricity expenditure as a share of total energy expenditures increases with a larger assumed value in the growth of new housing. This trend is illustrated in Figure 4.11. The variation in electricity share among the three population groups is different for the different scenarios of new housing growth.

In the case of black and Hispanic households, the variation in electricity share is not great when compared with that of majority households. The electricity share for minority households remains relatively stable between scenarios of new housing growth. This stability is especially marked in the case of Hispanic households, where virtually no change in electricity expenditure share occurs over the various scenarios of new housing growth over the entire projected period. A major reason for the differences observed among groups is the difference in the base-year housing composition among these groups. In the base year, a larger fraction of the majority lives in newer homes. As a consequence, the proportion of majority households living in newer homes grows faster.

4.2.2 Poor and Nonpoor Households

The overall pattern of energy expenditure change for poor and nonpoor households is almost identical, as shown in Figure 4.12. Poor households, like minority households, are relatively sensitive to changes in nonelectric-energy prices. The greatest increase in energy expenditures for the poor occurs during the 1995-1999 period, when nonelectric-energy price increases are largest. Conversely, during the 1999-2005 period, energy expenditures by the poor decline very steeply; during this period, it is projected that the rise in nonelectric-energy prices will be minimal.

a. Majority Households

b. Black Households

FIGURE 4.11 Electric Percentage Share of Energy Expenditures for Majority, Black, and Hispanic Households, New Housing Stock Growth Rate at Three Different Values

c. Hispanic Households

FIGURE 4.11 (Cont.)

FIGURE 4.12 Total Energy Expenditures for Nonpoor and Poor Households, New Housing Stock Growth Rate at 5%

As was the case for majority and minority households, the effect on total energy expenditures of changing the new housing growth assumption is small (see Figure 4.13). Again, there is a slight decline in total energy expenditures as the assumed new housing growth rate increases, reflecting the base-year difference in energy efficiency between newer and older homes.

Underlying the similar changes in overall energy expenditures, over the projected time period, are dissimilar changes in nonelectric-energy and electricity expenditures. For poor and nonpoor households, the difference in electricity expenditures increases with time, with electricity expenditures increasing for the nonpoor more than for the poor. As was the case for majority and minority households, electricity expenditures increase for poor and nonpoor households during the 1987-1999 and 2005-2009 periods and decline during the 1999-2005 period (Figure 4.14). Also, as indicated in Figure 4.15, the gap in electricity expenditures between the two groups widens as the assumed growth in new housing increases. For nonpoor households, electricity expenditures increase as the rate of growth in new housing increases, whereas these expenditures remain relatively constant for poor households.

During the first half of the projected period, the electricity expenditure as a share of total energy expenditures remains relatively constant. However, during the 1999-2005 period, when overall energy prices are projected to rise only moderately, the electricity share increases for both groups. Over the last five-year period, 2005-2009, the electricity expenditure as a share of total energy expenditures again declines in the face of faster-rising overall energy prices.

The growing gap in electricity expenditures between nonpoor and poor households, together with relatively equal changes in their total energy expenditures, implies the growing importance of electricity in nonpoor households compared with poor households. This trend is seen in Figure 4.16, particularly in the latter half of the projected period. During that period, the electricity expenditure as a share of total energy expenditures rises for nonpoor households compared with that for poor households (Figure 4.17).

4.3 ENERGY EXPENDITURE AS SHARE OF INCOME

The energy expenditure as a share of income is equal to energy expenditure as a percentage of combined household income. The purpose of determining the energy expenditure as a share of income is to provide a measure, albeit a nonrigorous one, of the relative change in the burden associated with energy expenditures.¹⁰ In a simple world of fixed proportions, a one-dollar increase in energy expenditures would mean a one-dollar loss

¹⁰ A better measure would be the change in energy expenditures derived from the expenditure function obtained by minimizing energy cost subject to a constant level of utility (see Deaton and Muellbauer 1980, Chapter 7).

a. Nonpoor Households

b. Poor Households

FIGURE 4.13 Total Energy Expenditures for Nonpoor and Poor Households, New Housing Stock Growth Rate at Three Different Values

FIGURE 4.14 Electricity Expenditure Patterns for Nonpoor and Poor Households, New Housing Stock Growth Rate at 5%

in economic well-being. This idea, coupled with the normative notion that a dollar loss by those with lower incomes means more than the same loss by those with higher incomes, gives relevance to the expenditure share measure.

In this section, the projected impact of the NES on the energy expenditure as a share of income is assessed for each group, under the three new housing growth scenarios. In general, the share of income spent on energy is projected to decline over the first part of the projected time period, with a rather steep increase between 1995 and 1999. This increase, in turn, is followed by a large decline in energy expenditure share during the 1999-2005 period. From 2005 to 2009, the energy expenditure share is projected to increase gradually. Projected changes in energy expenditure as a share of income for each group under the three new housing growth scenarios are summarized in Tables 4.13 and 4.14.

4.3.1 Majority and Minority Households

Changes in the energy expenditure share of income serve to measure the degree to which changing energy prices are an economic burden on a household (although this measure is not a rigorous one). The changes in the energy expenditure share of income by group over the projected period are shown in Figure 4.18.

As expected, the percent of income spent on energy increases during periods in which energy prices rise rapidly. In particular, during the 1995-1999 period, the rise in energy expenditure share is projected to be largest. Over that period, energy prices are projected to increase significantly.

a. Nonpoor Households

b. Poor Households

FIGURE 4.15 Electricity Expenditure Patterns for Nonpoor and Poor Households, New Housing Stock Growth Rate at Three Different Values

FIGURE 4.16 Electric Percentage Share of Energy Expenditures for Nonpoor and Poor Households, New Housing Stock Growth Rate at 5%

The change in the percent of income spent on energy by blacks is projected to be more than twice the change for majority households during the 1995-1999 period. For Hispanic households, the change in the percent of income spent on energy is projected to increase by more than 25% during this period, compared with the change in the majority household value.

For the 1999-2005 period, the trend is opposite that of the 1995-1999 period. A sizeable decrease in the energy expenditure share of income for each of the groups is projected. The biggest decline occurs for minority households. For black households, the decline in energy expenditure share of income is almost twice as large as it is for majority households. For Hispanic households, the decline in energy expenditure share of income is projected to be about 20% as large as it is for majority households.

Given the rather small differences in energy expenditures between the different new housing growth scenarios, it is not surprising to find little difference among the values of the energy expenditure share of income between these scenarios. Not only are energy expenditure share values for the new housing growth scenarios about the same, but these values are also about the same for the three population groups (Figure 4.19). The difference between the share values is smallest for Hispanic households. However, it should be noted that the differences do become progressively larger with time and larger expenditure share values. This implies that a larger growth rate in new housing helps to buffer the economic impact of rising energy prices.

a. Nonpoor Households

b. Poor Households

FIGURE 4.17 Electric Percentage Share of Energy Expenditures for Nonpoor and Poor Households, New Housing Stock Growth Rate at Three Different Values

TABLE 4.13 Energy Expenditure Share of Income and Percentage-Point Change for Majority, Black, and Hispanic Households

Energy Expenditures per Household as Share of Income, by Housing Growth Rate (%)									
Year	Majority			Black			Hispanic		
	4%	5%	6%	4%	5%	6%	4%	5%	6%
1987	3.80	3.80	3.80	6.66	6.66	6.66	4.21	4.21	4.21
1991	3.79	3.77	3.74	6.75	6.73	6.71	4.11	4.09	4.07
1995	3.67	3.63	3.58	6.46	6.42	6.37	4.12	4.09	4.06
1999	4.18	4.10	3.99	7.66	7.58	7.48	4.80	4.74	4.67
2005	2.92	2.85	2.76	5.19	5.11	5.01	3.30	3.25	3.18
2009	3.21	3.09	2.95	5.96	5.81	5.63	3.74	3.64	3.52

Percentage-Point Change (%)									
Time Interval	Majority			Black			Hispanic		
	4%	5%	6%	4%	5%	6%	4%	5%	6%
1987-91	-0.01	-0.032	-0.06	0.09	0.07	0.05	-0.10	-0.12	-0.14
1991-95	-0.12	-0.14	-0.16	-0.29	-0.31	-0.34	0.01	0.00	-0.01
1995-99	0.51	0.47	0.41	1.20	1.16	1.11	0.68	0.65	0.61
1999-2005	-1.26	-1.26	-1.23	-2.47	-2.47	-2.48	-1.50	-1.49	-1.48
2005-09	0.29	0.24	0.19	0.77	0.70	0.62	0.44	0.39	0.33
1987-2009	-0.59	-0.71	-0.85	-0.70	-0.85	-1.03	-0.47	-0.57	-0.69

TABLE 4.14 Energy Expenditure Share of Income for Nonpoor and Poor Households

Expenditures per Household (1989 dollars)						
Year	Nonpoor			Poor		
	4%	5%	6%	4%	5%	6%
1987	3.49	3.49	3.49	14.71	14.71	14.71
1991	3.49	3.48	3.45	14.86	14.84	14.81
1995	3.39	3.37	3.31	14.26	14.20	14.13
1999	3.86	3.82	3.70	16.95	16.82	16.66
2005	2.71	2.68	2.58	11.53	11.42	11.28
2009	3.02	2.95	2.81	13.22	13.01	12.75

Average Annual Percentage Rate of Change (%/yr)						
Time Interval	Nonpoor			Poor		
	4%	5%	6%	4%	5%	6%
1987-91	-0.01	-0.02	-0.04	0.15	0.13	0.10
1991-95	-0.10	-0.11	-0.14	-0.60	-0.63	-0.68
1995-99	0.47	0.45	0.38	2.69	2.62	2.53
1999-2005	-1.15	-1.14	-1.12	-5.42	-5.40	-5.38
2005-09	0.30	0.28	0.22	1.69	1.59	1.46
1987-2009	-0.48	-0.54	-0.69	-1.49	-1.70	-1.96

FIGURE 4.18 Percentage Share of Income Spent on Majority, Black, and Hispanic Households' Energy Consumption, New Housing Stock Growth Rate at 5%

a. Majority Households

b. Black Households

FIGURE 4.19 Percentage Share of Majority, Black, and Hispanic Households' Income Spent on Energy Consumption, New Housing Stock Growth Rate at Three Different Values

c. Hispanic Households

FIGURE 4.19 (Cont.)

4.3.2 Nonpoor and Poor Households

As would be expected, the share of income spent on energy by poor households is subject to wider fluctuations than that spent by nonpoor households as energy prices rise and fall (Figure 4.20). During the 1995-1999 period, when energy prices rise dramatically, the change in the percent of income spent on energy by poor households rises by about 2.6%, compared with about 0.45% for the nonpoor. On the other hand, during the 1999-2005 period, when energy price rises are projected to be moderate, the share of income spent on energy by poor households falls by about 5.4%, compared with only approximately 1.15% for the nonpoor.

Again, although the change is not dramatic, the energy expenditure share of income falls with an increase in the assumed rate of growth in new housing. The impact of changing growth rates in new housing increases with time and higher energy prices. The higher the energy expenditure share of income is to begin with, the farther it falls in value as the growth in new housing increases. This phenomenon is illustrated in Figure 4.21 and indicated in Table 4.14.

As was the case for majority and minority households, because of differences in new housing stock values in the base year, faster new housing growth insulates the nonpoor from higher energy prices better than it does the poor. For example, in 1999, the decline in energy expenditure share for the nonpoor between the 4% and 5% cases is a paltry 0.04%, but this value increases to 0.12% between the 5% and 6% scenarios — a 200% increase! For poor

households, the comparative numbers are 0.13% and 0.16%, respectively — only a 23% increase.¹¹

FIGURE 4.20 Percentage Share of Nonpoor and Poor Households' Income Spent on Energy Consumption, New Housing Stock Growth Rate at 5%

¹¹ Of course, this is not to say that higher rates of new housing growth are not desirable; on the contrary, everyone benefits, especially from an energy expenditure share perspective. In fact, the absolute benefit is larger for poor households, but it declines with higher rates of new housing growth.

a. Nonpoor Households

b. Poor Households

FIGURE 4.21 Percentage Share of Nonpoor and Poor Households' Income Spent on Energy Consumption, New Housing Growth Rate at Three Different Values

5 CONCLUSIONS

The overall impact of the NES is positive for all households. However, the effect of the NES across different population groups is not uniform. This is particularly true with respect to its impact on the composition of energy use across different population categories. The picture is further complicated by new housing growth. It was found that energy composition is particularly sensitive to changes in the assumptions made about new housing growth rates.

Under the NES, total energy consumption declines for each population group, with the biggest decline occurring for majority and nonpoor households. With higher new housing growth rates, the difference in the rate of decline in energy consumption between majority and minority households, and between nonpoor and poor households, grows. The decline in energy consumption for majority and nonpoor households takes the form of a sizable decline in nonelectric-energy use. On the other hand, a large increase in electricity consumption by majority and nonpoor households is projected. For minority and poor households, the decline in nonelectric-energy consumption is projected to be less than that for majority and nonpoor households, respectively, and electricity consumption is not projected to change substantially.

In the cases involving higher new housing growth rates, the compositional differences in energy consumption between majority and minority households are exacerbated, with the electricity share of total energy consumption becoming relatively larger for majority and nonpoor households. With each increase in the new housing growth rate, the difference between majority and minority households, and nonpoor and poor households, with respect to the electricity share of total energy consumption becomes larger.

The demand for energy is price-inelastic for each of the population groups. As a result, during periods with rising energy prices, energy expenditures go up; during periods with falling energy prices, these expenditures go down. Over the projected time period, energy prices rise the fastest during the 1995-1999 period, and they rise most slowly during the 1999-2005 period. Consequently, energy expenditures peak in 1999 for each of the population groups.

Despite the differences in energy consumption and patterns of use, the overall difference in energy expenditures between groups is small. The reason for this small overall difference is that the smaller decline in nonelectric-energy consumption on the part of minority and nonpoor households is offset by the larger increase in electricity consumption by majority and nonpoor households. Similar changes in energy expenditures obscure very different changes in the pattern of energy consumption.

The sensitivity of minority and poor households' energy expenditures to changes in nonelectric-energy and electricity prices is different from that of majority and nonpoor households' energy expenditures. For minority and poor households, the rate of change in energy expenditures is projected to be higher during periods in which the increase in the nonelectric-energy price is relatively high. Therefore, during the 1995-1999 period, the rise

in minority and poor households' energy expenditures is high compared with that of majority and nonpoor households. Conversely, during the 1999-2005 period, when the rise in nonelectric-energy prices is moderate, the fall in energy expenditures for minority and poor households is large compared with that of majority and nonpoor households.

The effect on energy expenditures of changing the assumptions about new housing growth is small, indicating little to no additional value in the incremental increase in electricity use and decrease in nonelectric-energy consumption associated with higher levels of new housing growth. Energy expenditures decline slightly as the growth in new housing increases, with a larger decline for majority and nonpoor households.

The impact of the NES on the percent of income spent on energy moves in step with its impact on energy expenditures. As is the case for expenditures, the share of income spent on energy peaks in 1999, rising dramatically over the 1995-1999 period and then falling between 1999 and 2005. The comparative shift in the percent of income spent on energy depends on the change in the price of energy. Since minorities and the poor spend a larger share of their income on energy, their percentage share of income will increase by a larger amount during periods when the price of energy is rising. This is the case over the 1995-1999 period. Conversely, when energy prices are declining, the minority and poor households' energy expenditure share falls by a larger amount. This is the case during the 1999-2005 period, when the percentage share of income spent on energy by minority and poor households falls by a substantial amount compared with majority and nonpoor households' expenditure share.

Simply using the expenditure share numbers provides no clear indication whether any particular group has a comparative advantage under the NES. As was mentioned in the Introduction, each of the population groups benefits with respect to the Current Policy Base case, but no clear beneficiary emerges under the NES case.

Over the entire period, the percentage share of income spent on energy by black and poor households falls in comparison with majority and nonpoor households, respectively, whereas this share increases slightly for Hispanic households relative to majority households.

If the projected time period is split into two periods around the year in which energy expenditures and the energy expenditure share of income are projected to peak, the rise in energy expenditure share is higher for minority and poor households during the first period. In the second period, the fall in energy expenditure share is larger for minority and poor households.

Future research will seek to determine how robust these results are under a number of different assumptions. As mentioned earlier, the change in energy service ratio was applied uniformly over time, by housing type, end-use category, and fuel type. What might happen if this simplifying assumption of uniformity were lifted? Also, what might happen if a more rigorous measure of economic welfare were used and its present value were calculated at different discount rates? These questions remain to be answered.

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