ENERGY PRACTICE CLUSTERS OF VIRGINIA LIMITED-RESOURCE HOUSEHOLDS

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Abstract

The purpose of this study was to identify Virginia limited-resource households' current energy cost burdens and energy saving efforts. There were five research objectives related to this limited-resource sample: (1) To examine energy cost burdens and current energy saving efforts; (2) to group households based on their perceived energy cost burdens and current energy saving efforts; (3) to identify demographic and housing characteristics; (4) to examine changes in energy saving efforts; and (5) to investigate their interests in further energy saving information. In 2005, a questionnaire survey was conducted with limited-resource households in Virginia and 941 usable responses were collected. Based on their perceived energy cost burdens and current energy saving efforts, the respondents were clustered into four different Energy Clusters: Energy-Conscious, Motivated, Achieved, and Help-Needed. Households in different clusters showed distinctive demographic and housing characteristics (household income, presence of children, if headed by a single-adult, tenure and home structure type, and residential location), as well as different levels of changes in their energy saving efforts over the last five years and interest in further energy saving information. Findings indicated that having a large energy cost burden was not necessarily related to substantial energy saving efforts or interest in more information on how to save energy.

Introduction

Even among the limited-resource households there can be a substantial variation in the burden caused by high energy costs and the amount of effort taken toward reducing energy use. Households with a perceived high energy burden may or may not be making additional effort to reduce energy. The

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same is true of those with perceived low burden. Other areas of energy related activity that may vary are the extent to which households seek energy information that might help them lower energy use and interest in additional energy management information.

Responses to a series of questions posed to a sample of limited-resource households provided insight into their perceived burden due to current energy costs and actions they have taken to lessen their energy use. Through the use of cluster analysis, these households can be grouped by their perceived burden, effort, and use of energy information. The cluster analysis of this study will help to identify the characteristics of various low to moderate income households that can be used to target policy and educational efforts.

The data for this study were collected in 2005, before hurricane Katrina disrupted energy supplies and prior to the more recent volatile energy markets and worsening recession. Therefore, this research offers an analysis of limited-income households during a time of increasing costs but more stable energy supplies and economic conditions than currently exists.

Review of Literature

Recent energy price increases have affected the budgets of numerous households. Limited-resource households, in particular, have been hit extremely hard. Limited-resource households, as defined to be considered for participation in the Expanded Food and Nutrition Education Program (EFNEP), are households that qualify for federal assistance programs. The term limited-resource is often used interchangeably with low-income. Not only do they pay a disproportionate amount of their income on energy, but may live in housing that is in need of energy efficiency improvements (Pye, 1996; Williams, 2008). This energy inefficient housing has a great amount of energy saving potential, but the low earning power of these households prohibits them from implementing such measures and therefore there is little opportunity to take advantage of the savings such measures can bring.

Household Energy Burden

Energy burden is the amount of annual household income used for annual energy bills (Kalata, 2005). Although all income levels have

experienced higher energy costs – up 50% from 1997 to 2007 (Trisco, 2007), results of a Low Income Home Energy Assistance Program (LIHEAP) study indicated that households with incomes under $10,000 had a home energy burden of 6.3%, compared to 0.9 % for households with incomes above $50,000 (APPRISE, 2005). Another study in 2006 of LIHEAP participants found the home energy burden to be 16% for these low-income households and 7% for all U.S. households (NEADA, 2008). In Virginia, households with incomes that are 50% below the poverty level, paid 55.9% of their annual income on home energy bills in 2008 (Fisher, Sheehan & Colton, 2009). This is a substantial increase from 48.3% in 2005 (Fisher, Sheehan & Colton, 2006). The extent to which these higher prices influence well-being and form a burden for the household depends on a number of other factors including location, education, age, tenure, structure quality, etc. This burden will force households to make choices as to where their budget dollars are spent.

In addition to the low and fixed income households spending a larger proportion of their income on energy (Crites & Haldeman, 1994), previous research indicates that home energy burdens are higher for those in rural areas (Morrison & Gladhart, 1976) and those who live in the South Census Region (APPRISE, 2005). Higher home energy burdens were also found for those with a lower level of education (Morrison & Gladhart, 1976) and for one-person households (APPRISE, 2005). Roper Starch Worldwide (2001) stated that women were more often than men hurt financially by the higher energy prices.

Data from a LIHEAP study showed renters and apartment dwellers to be less likely to have higher home energy burdens than other types of households (APPRISE, 2005). However, in another study, more renters than owners indicated it was necessary to pay less than the entire energy bill or borrow from friends or relatives in order to keep current with their energy bills (National Energy Assistance Director's Association (NEADA), 2004). Renters were also behind on rent due to high energy prices (FRAC, 2009). The non-elderly renters, in particular, were more likely than non-elderly owners to skip electric bill or rent payments, but less likely to suffer health consequences or reduce their medication (NEADA, 2005). In 2008, NEADA reported that around 40% of the LIHEAP participants went without dental or medical care or prescriptions due to high energy costs (NEADA, 2008).

Upon examining age as a demographic variable related to energy cost burdens, findings indicated that 21% of 18 to 49 year olds delayed paying bills compared to 9% for adults over the age of 50 years (Kalata, 2005). In another study by NEADA (2005), which included a comparison of elderly to non-elderly households who took part in the LIHEAP, more elderly low-income households had high energy burdens compared to other low income households. However, non-elderly owners and renters were more likely than the elderly to find it necessary to alter some activities in response to the higher energy payments they experienced. These non-elderly households were more likely to worry about paying their energy bills, borrow money from a friend, and become ill because of being too cold.

The two costs low-income households can reduce more easily are heat and food, but they often must choose between the two. When colder weather arrives, many poor families spend less on food to compensate (FRAC, 2009; Bhattacharya, DeLeire, Haider, & Currie, 2003) or went without food for at least one day (NEADA, 2008). Bhattacharya et al (2003) found that poor families reduce their expenditures on food proportionately to the amount of increase in utility expenses. Low-income elderly and children, in particular, consume fewer calories in the winter, putting them at greater nutritional risk (FRAC, 2009).

Efforts to Save Energy

The effort put forth by households to save energy is a function of various demographic characteristics. Many researchers related the ability to reduce energy to income (Berger & Drennen, 1985; Morrison & Gladhart, 1976; Tienda & Aborampah, 1981), with Morrison and Gladhart (1976) identifying income as the best predictor of energy consumption levels. Although higher energy prices have impacted most households, low-income households have perhaps been affected the most (Morrison & Gladhart, 1976).

The extent to which higher energy prices prompt energy saving behavior is also related to the effect these increases had on the household's feeling of well-being. When higher energy prices were not considered to impact well-being, the household made fewer cuts compared to those who felt a lot worse off (Berger & Drennen, 1985). Income was found to be

directly related to the ability to reduce energy consumption (Tienda & Aborampah, 1981).

Households with a low income were least able to make major energy improvements in the structure, and Tienda and Aborampah (1981) found the physical and structural characteristics of the home to be more important than income in shaping behavioral adaptations. Although low-income households were less able to make major energy improvements in their homes they were found to make more cutbacks in general than the higher income households (Berger & Drennen, 1985), especially no-cost measures such as using fans, keeping curtains closed, using small appliances, and wearing warmer clothing (Crites & Haldeman, 1994). LIHEAP reported that its participants took many measures to help cut energy costs including closing off part of their house, keeping temperatures at unsafe levels, using the kitchen stove or oven to provide heat, and leaving home for part of the day to escape uncomfortable conditions (NEADA, 2008).

Age was also found to be a significant factor related to energy saving practices (Junk, Jones, & Kessel, 1988). Many studies found that the use of conservation practices increased with age (Crites & Haldeman, 1994; Painter, Semenik, & Belk, 1983; Ritchie, McGougall, & Claxton, 1981). Individuals 50 years of age and older were also more concerned about energy use and believed in the benefits of conserving energy compared to younger individuals (Shugoll Research, 2003). However, researchers (Crites & Haldeman, 1994) also found that older people were less likely to install energy saving features in their homes, such as storm windows, insulation and solar devices. Young adults did not share the same energy use beliefs or concerns of the older adults. In a study by Shugoll Research (2003), younger individuals, aged 25 to 34 years, explain their failure to save energy in day to day activities was due to the fact they did not think about energy practices and did not feel they would make a difference. Young adults (under age 35) in this study were less likely to believe that energy conservation is important or feel that saving energy is their responsibility.

Barr, Gilg, and Ford (2005) reported that the most powerful variable distinguishing conservers and non-conservers is homeownership, which also explains a major share of the large capital investments in energy saving

measures (Barr et al., 2005; Black, Sterm, & Elworth, 1985). Homeowners are more likely to have energy saving features installed in their homes (Junk et. al., 1988) and use multiple energy conservations measures (Roper Starch Worldwide, 2001). Renters, on the other had, rely on landlords to make such improvements and therefore may not be able to experience the benefits of such measures.

Clustering as a Means to Understanding Similarities and Differences

Clustering is a means of grouping people that react in a similar manner toward an issue (Hair, Anderson, Tatham, & Black, 1998). Various demographic characteristics may emerge as primary identifiers of individuals in each cluster group. Lee, Goss, and Beamish (2007) utilized the clustering technique to explore lifestyle and its influence on housing preferences of multifamily housing residents. Another example of a clustering technique used the environment as the focus for clustering. Barr et al. (2005) examined how committed individuals were to practices and ideals that protected the environment, including energy efficient actions. The extent to which individuals took part in these practices placed them in a particular type of "environmentalist" cluster.

The four clusters formed by Barr et al. (2005) were: committed environmentalist, mainstream environmentalist, occasional environmentalist, and non-environmentalist. The 'committed environmentalist' was most likely to consider the energy use of appliances, buy energy efficient light bulbs, and reduce heat and turn off lights in unoccupied rooms. Individuals in this group were usually older homeowners living in smaller households; a large number were in the mid-to-low income bracket. The 'mainstream environmentalist' acted similarly to the first group but took part in fewer environmental practices. The main characteristic that stood out for this group was the fact many were from smaller households (households with one or two persons). The third group, the 'occasional environmentalist', had fewer energy saving measures, such as keeping the heat down and had no distinguishing characteristics. Lastly, the 'non-environmentalist' showed little environmental activity. They rarely looked for energy efficient products and only took part in energy saving behaviors that did not affect their comfort or that took minimal effort. This

group was made up of mostly younger males with little education and a lower income. Fewer in this group were homeowners.

In the clusters presented in this paper, low to moderate income households are clustered by their actions or reactions to energy costs. Cluster groups will be based on the burdens perceived by the households, the efforts taken to conserve energy, the extent to which they sought energy related information, and their desire for additional information.

Research Purpose and Objectives

The purpose of this study was to identify Virginia limited-resource households' current energy cost burdens and energy saving efforts. By examining their responses to questions about energy use, energy saving efforts and lifestyle changes due to high energy costs, their overall burden and efforts can be assessed. There were five research objectives pursued as follows:

1. To explore underlying dimensions of perceived energy cost burdens and current energy saving efforts of limited-resource households;
2. To group the limited-resource households into energy clusters based on the relationships between their perceived energy cost burdens and current energy saving efforts;
3. To identify demographic and housing characteristics of the energy clusters;
4. To examine changes in energy saving efforts of the energy clusters over the last five years; and
5. To investigate the energy clusters' interests in further information on energy savings.

Methodology

This research study was designed to assess the impact of rising energy prices on limited-resource families in Virginia. The target audience for this study was households who took part in the Virginia Expanded Food Nutrition Education Program (EFNEP)/Smart Choices Nutrition Education Program (SCNEP) in 2005. This program targets limited-resource families, focusing on but not limited to those with children under the age of 12 years. Households identified as a limited-resource family are those who qualify for public assistance programs. The program is located at 67 sites in Virginia and all sites were given the opportunity to participate in the study. The survey was offered to all EFNEP/SCNEP sites in Virginia and participation was

voluntary. Site programs are managed by a County Family and Consumer Sciences Extension Agent and/or Area Coordinator.

A one-page questionnaire was developed specifically for this study. On the suggestion of the State EFNEP/SCNEP Coordinator, the questionnaire was kept to one page so that it would not be too overwhelming to the participants who would be participating in the survey. The questionnaire asked households about the impact of high energy prices on their household activities and what they were doing to save energy. The questionnaire was sent to three local EFNEP Extension agents who pilot tested it with their participating families. The questionnaire was refined before being distributed to the target audience. One suggestion that surfaced from the pilot testing was to give the respondents fewer choices, thus the use of only three responses for the Likert-type scale. Data were collected in spring 2005 from 55 participating sites. A total of 943 responses were collected and 941 were found usable.

Data Analyses

Energy Variables

There were 12 items to measure perceived energy cost burdens and current energy saving efforts. These items were measured on a three-level scale: "1" = never/seldom, "2" = sometimes, and "3" = usually/almost always. After various attempts, including factor analyses, to identify underlying dimensions of the variables, seven items among these original 12 items were grouped into three composite variables: *Burden, Efficiency-Behavior, and Efficiency-Inquiry.*

The *Burden* variable is the mean of the following three items: "Energy costs are a problem for my family," "We need to borrow money in order to pay our energy bills," and "We cut back on essentials, like food and medicine, in order to pay our energy bills." These items were related to the economic burden a household perceives because of energy costs. The higher the Burden variable, the larger the perceived energy cost burdens of the household. The inter-item reliability (Cronbach's alpha) for this variable was .656. Although the inter-item reliability was low on the selected three items, the items were

considered to have strong connections to each other by the researchers and *Burden* was accepted as a composite variable for further analyses.

The *Efficiency-Behavior* variable was the mean of the following two items: "My family turns off lights when they leave a room" and "My family turns off the TV when no one is watching." These items were related to daily basic behavioral efforts to lower current energy bills without making any big changes. Pearson's bi-variate correlation between those two items was .419 and was significant at $p < .001$ level.

The *Efficiency-Inquiry* variable was the mean score of the following two items: "I try to find information on how I can save energy in my home" and "I check for energy efficiency, like the Energy Star label, when I buy a product that uses energy." These items were related to more active efforts to seek and apply energy saving information so that they could save more energy in the near future. Pearsons' bi-variate correlation between those two items was .375 and was significant at $p < .001$ level. The higher the household was on *Efficiency-Behavior* and *Efficiency-Inquiry,* the greater energy saving efforts the household made.

Among the original 941 usable responses, 120 responses had missing values in Burden, *Efficiency-Behavio*r or *Efficiency-Inquiry* and were not used in the analyses. Thus, 823 responses were included in further data analyses.

Energy Clusters

We utilized a statistical technique that combined hierarchical cluster analyses and K-mean cluster analyses to group respondents based on their energy practices. In the first step, hierarchical cluster analyses with a partial samples (247 cases, 30% random samples from the 823 cases) were used to produce cluster seeds. *Burden, Efficiency-Behavior* and *Efficiency-Inquiry* were independent variables and Wald's method using standardized z-scores was used to produce the cluster seeds. Three to five cluster solutions were examined by comparing group means of the independent variables and four group solutions were selected. In the next step, K-mean cluster analyses were then used to group the entire 823 cases into four clusters using the cluster seeds produced from the hierarchical cluster analyses in the previous step. As a result, four energy-saving behavior clusters were retrieved: Energy-Conscious, Motivated, Achieved, and Help-Needed.

Means of Burden, *Efficiency-Behavior* and *Efficiency-Inquiry* were compared across the clusters using one-way analyses of variance (ANOVA). One of the critical assumptions of a one-way ANOVA is homogeneity of variance among groups and violation of this assumption can influence hypothesis testing (Hair, Anderson, Tatham, & Black, 1998). Levene's homogeneity of variance test is one of the techniques used to test the equal variance assumption (Howell, 2002). When the equal variance assumption is violated, either Welch's method or Brown-Forsythe's method is recommended as an alternative way to measure mean differences among groups (Howell, 2002). It was found that all variables violated the equal variance assumptions. Thus, Brown-Forsythe's method was used as the alternative. As a result, the four energy clusters showed significant differences in all three energy variables at $p < .001$. Table 1 compares means of the energy variables across the energy clusters. Tukey's tests were used to identify which pairs of clusters showed significant mean differences with each of the energy practice variables.

Table 1. Means of Original and Composite Variables

Variables	Mean
Burden[a]	1.52
Energy costs are a problem for my family.[b]	1.88
We need to borrow money in order to pay our energy bills.[b]	1.33
We cut back on essentials, like food and medicine, in order to pay our energy bills.[b]	1.36
Efficiency-Behavior[a]	2.35
My family turns off lights when they leave a room.[b]	2.38
My family turns off the TV when no one is watching.[b]	2.31
Efficiency-Inquiry[a]	1.93
I try to find information on how I can save energy in my home.[b]	2.07
I check for energy efficiency, like the Energy Star label, when I buy product that uses energy.[b]	1.78

[a] Composite variables are calculated as the mean of the ratings on the items included in the composite variable.
[b] Responses of the original items were made on a 3-level scale: never/seldom = "1"; sometimes = "2"; and usually/almost always = "3".

Cluster 1 seldom perceived energy cost burdens, but showed great efforts to save energy in both daily energy saving practices and efforts to seek and apply energy saving information for energy saving in the near future. Thus, Cluster 1 was named the Energy-Conscious Cluster. Cluster 2 perceived the greatest energy cost burdens among the four energy clusters and was making more than average energy saving efforts. Thus, Cluster 2 was named the Motivated Cluster. Like Cluster 1, Cluster 3 was characterized by least perceived energy cost burdens. However, because Cluster 3 was making less than average efforts to save energy it was named the Achieved Cluster. Cluster 4 showed more than average perceived energy cost burdens, but was making the least effort to perform daily practices to save energy. This cluster was also making about average efforts to seek and apply information to save energy in the near future. Considering great energy cost burdens and little energy saving efforts, Cluster 4 was named the Help-Needed Cluster.

Findings

Overview of Respondents

Among the final 823 respondents, 51% were homeowners and 49% were renters. Fifty-two% of the respondents were living in single-family homes, 28% in multifamily units, and 14% in manufactured (mobile) homes or other types of dwelling. Fifty-six percent lived in city or town locations and 44% lived in rural locations. Fifty-three percent had a monthly household income of $1,000 or less and only 20% had a monthly income of more than $2,000. In these households, 87% of the respondents lived with one or more children at home, however, about half of the respondents did not answer the question on the number of children at home. Forty-nine percent of respondents were the only adult in the households. Seventy-three percent reported that they felt electricity bills had increased a lot over the past year. Fifty-six percent had electric heating systems and 58% had central air-conditioning systems.

Means of the Burden, Efficiency-Behavior and Efficiency-Inquiry variables were 1.52, 2.35, and 1.93, respectively. See Table 2 for means of the three composite variables and their original items.

Table 2. Brown-Forsythe's Method and Tukey's Tests: Energy Clusters and Burden, Efficiency-Behavior and Efficiency-Inquiry

	Engergy Cluster				
Variable	1	2	3	4	Total
Burden*	1.24a	2.17b	1.26a	1.82c	1.52
Efficiency-Behavior**	2.68a	2.81b	2.33c	1.61d	2.35
Efficiency-Inquiry***	2.51a	2.09b	1.27c	2.08b	1.93

* $F(3, 529.453) = 239.913$, $p = .000$ ($p < .001$)
** $F(3, 797.091) = 338.807$, $p = .000$ ($p < .001$)
*** $F(3, 556.448) = 318.539$, $p = .000$ ($p < .001$)
Note. Variables used are composite variables that have mean scores of items included. Responses of the original items were made on a 3-level scale: never/seldom (= 1), sometimes (= 2), and usually/almost always (= 3). Means in the same row that do not share subscripts differ at $p < .05$ in the Tukey's tests.

A majority of the respondents (92%) reported that they were making the same or less effort to save energy than they did five years ago. About 67% of the respondents indicated they were not interested in further energy saving information.

Demographic and Housing Characteristics of the Energy Clusters

To identify demographic and housing characteristics of the energy clusters, three demographic characteristics (household income, presence of children, whether or not headed by a single adult) and three housing-related characteristics (tenure and home structure type, residential location) were compared across four energy clusters using chi-square tests of independence. As a result, it was found that the energy clusters showed significant distinctions in all six demographic and housing characteristics.

Table 3 displays the comparisons of demographic characteristics across the energy clusters. There were more households with monthly incomes over $1,000 in the Energy-Conscious Cluster and in the Help-Needed Cluster and more households with monthly incomes of $1,000 or less in the Motivated Cluster and Achieved Cluster. There were more households with one or more children at home in the Motivated Cluster and the Help-Needed Cluster. However, because the sampling of this study focused on limited-resource households with children, more than 80% of the households in each energy cluster had one or more children at home. In addition, there were many respondents who did not answer the question

Table 3. Contingency Table: Energy Clusters and Demographic Characteristics

Demographic Characteristics	Engergy Cluster				Total
	Energy-Conscious	Motivated	Achieved	Help-Needed	
Household Monthly Income[A]					
$1,000 or less					
Observed *n*	98	82	146	79	405
[Expected *n*]	[108]	[69]	[136]	[92]	
(Valid %)	(50)	(66)	(59)	(47)	(55)
More than $1,000					
Observed *n*	98	43	100	88	329
[Expected *n*]	[88]	[56]	(110)	[75]	
(Valid %)	(50)	(34)	(41)	(53)	(45)
Total	196	125	246	167	734
Existence of a Child[B]					
Yes					
Observed *n*	17	2	33	6	48
[Expected *n*]	[14]	[8]	[22]	[14]	
(Valid %)	(16)	(3)	(20)	(6)	(13)
No					
Observed *n*	87	58	134	99	378
[Expected *n*]	[90]	[52]	[145]	[91]	
(Valid %)	(84)	(97)	(80)	(94)	(87)
Total	104	60	167	105	436
Headed by Single-adult[C]					
Yes					
Observed *n*	111	55	124	102	392
[Expected *n*]	[109]	[61]	[136]	[86]	
(Valid %)	(52)	(46)	(47)	(60)	(51)
No					
Observed *n*	102	64	142	67	375
[Expected *n*]	[104]	[58]	[130]	[83]	
(Valid %)	48	(54)	(53)	(40)	(49)
Total	213	119	266	169	767

[A] x^2 (3, N = 734) = 13.531, p = .004 (p < .01)
[B] x^2 (3, N = 436) = 17.287, p = .001 (p < .01)
[C] x^2 (3, N = 767) = 9.155, p = .027 (p < .05)
Note. Percentages are valid percents of observed frequencies within each energy cluster. Percentage totals of may not be 100 due to rounding.

about the number of children at home. There were more single-adult headed households in the Motivated Cluster and Achieved Cluster compared to the other two clusters.

Table 4 contains comparisons of three housing characteristics across the energy clusters. It was found that there were more homeowners in the Energy-Conscious Cluster and the Motivated Cluster and more renters in the Achieved Cluster and Help-Needed Cluster than expected when tenure type and the energy clusters were independent of each other. As for home structure types, more households in the Energy-Conscious Cluster and the Help-Needed Cluster lived in single-family homes and more households in the Achieved Cluster lived in multifamily units than expected when home structure types and the energy clusters were independent of each other. In the Motivated Cluster, more households lived in a single-family home or home structure type other than multifamily units. More households in the Energy-Conscious Cluster and in the Help-Needed Cluster lived in rural locations while more households in the Motivated Cluster and the Achieved Cluster lived in city or town locations than expected when home locations and the energy clusters were independent of each other.

Change in Energy Saving Effort Over the Last Five Years

A survey question asked respondent households if they were making more energy saving efforts in comparison with the household's efforts five years ago using a 3-point scale: less effort, same effort, and more efforts. More than half of the respondents reported that they were making less energy saving efforts compared to their efforts five years ago and only 8% were making more efforts. Changes in energy saving effort over the last five years were compared across the energy clusters using the chi-square test of independence to see if the changes in energy saving efforts were the same regardless of energy clusters. Significantly more households in the Achieved Cluster were found to make the same energy saving efforts than expected when the changes in energy saving efforts and the energy cluster were independent of each other. Fifty-two percent of the households in the Achieved Cluster were making the same efforts and 40% were making less effort than five years ago. On the other hand, 69% of the households in the

Table 4. Contingency Table: Energy Clusters and Housing-Related Characteristics

Housing-related Characteristics	Engergy Cluster				
	Energy-Conscious	Motivated	Achieved	Help-Needed	Total
Tenure Type[A]					
Own					
Observed *n*	73	56	153	89	371
[Expected *n*]	[103]	[60]	[125]	[84]	
(Valid %)	(36)	(47)	(62)	(54)	(51)
Rent					
Observed *n*	130	63	93	76	362
[Expected *n*]	[100]	[59]	[122]	[82]	
(Valid %)	(64)	(53)	(38)	(46)	(49)
Total	203	119	246	165	733
Home Structure Type[B]					
Single-family home					
Observed *n*	132	72	115	111	430
[Expected *n*]	[118]	[69]	[149]	[94]	
(Valid %)	(62)	(58)	(43)	(66)	(56)
Multifamily unit					
Observed *n*	54	25	115	32	226
[Expected *n*]	[62]	[36]	[79]	[49]	
(Valid %)	(26)	(20)	(43)	(19)	(29)
Other					
Observed *n*	26	27	39	26	118
[Expected *n*]	[32]	[19]	[41]	[26]	
(Valid %)	(12)	(22)	(15)	(15)	(15)
Total	212	124	269	169	774
Home Location[C]					
Rural					
Observed *n*	105	53	98	89	345
[Expected *n*]	[96]	[55]	[116]	[78]	
(Valid %)	(48)	(43)	(37)	(51)	(44)
City/Town					
Observed *n*	113	71	165	87	436
[Expected *n*]	[122]	[69]	[147]	[98]	
(Valid %)	(52)	(57)	(63)	(49)	(56)
Total	218	124	263	176	781

[A] x^2 (3, N = 733) = 31.969, p = .000 (p < .001)
[B] x^2 (6, N = 774) = 45.213, p = .000 (p < .001)
[C] x^2 (3, N = 781) = 9.524, p = .023 (p < .05)
Note. Percents are valid percents of observed frequencies within each energy cluster. Total of percents may not be 100 due to rounding.

Table 5. Contingency Table: Energy Clusters and Change in Energy Saving Efforts over the Last 5 Years

Change in Energy Saving Effort	Engergy Cluster				
	Energy-Conscious	Motivated	Achieved	Help-Needed	Total
Less Effort					
Observed *n*	148	79	102	94	423
[Expected *n*]	[118]	[69]	[139]	[97]	
(Valid %)	(69)	(62)	(40)	(53)	(55)
Same Effort					
Observed *n*	54	36	132	69	291
[Expected *n*]	[81]	[48]	[96]	[67]	
(Valid %)	(25)	(28)	(52)	(39)	(38)
More Effort					
Observed *n*	14	12	20	14	60
[Expected *n*]	[17]	[10]	[20]	[14]	
(Valid %)	(7)	(9)	(8)	(8)	(8)
Total	216	127	254	177	774

x^2 (6, N = 774) = 47.750, p = .000 (p < .001)

Note. Percents are valid percents of observed frequencies within each energy cluster. Total of percents may not be 100 due to rounding.

Table 6. Contingency Table: Energy Clusters and Interest in Further Energy Saving Information

Interest in Further Information	Engergy Cluster				
	Energy-Conscious	Motivated	Achieved	Help-Needed	Total
No					
Observed *n*	167	113	156	152	558
[Expected *n*]	[165]	[94]	[197]	[132]	
(Valid %)	(74)	(88)	(58)	(85)	(74)
Maybe					
Observed *n*	36	10	72	20	138
[Expected *n*]	[39]	[22]	[46]	[31]	
(Valid %)	(16)	(8)	(27)	(11)	(17)
Yes					
Observed *n*	22	5	40	7	74
[Expected *n*]	[21]	[12]	[25]	[17]	
(Valid %)	(10)	(4)	(15)	(4)	(9)
Total	225	128	268	179	800

x^2 (6, N = 800) = 59.398, p = .000 (p < .001)

Note. Percents are valid percents of observed frequencies within each energy cluster.

Energy-Conscious Cluster, 62% in the Motivated Cluster, and 53% of the Help-Needed Cluster were making less energy saving efforts than they did five years ago. Table 5 shows the comparisons of change in energy saving efforts in each of energy saving clusters.

Interest in Further Energy Saving Information and Energy Clusters

Interest in further energy saving information was measured on a 3-point scale: no, maybe, and yes. About three-quarters of the respondents were not interested in further energy saving information. Interests in further information were compared across the four energy clusters using the chi-square test of independence. Significantly more households in the Achieved Cluster showed an interest in further energy saving information Forty-three percent of the households in the Achieved Cluster answered "maybe" or "yes" to the question while only 12% to 26% of households in each of the other three clusters did so. However, still more than half of the households in the Achieved Cluster were not interested in further information. Table 6 contains comparisons of interest in further information across the energy clusters.

Summary of Energy Clusters

This study focused on identifying the energy cost burden and energy saving efforts of limited-resource households in Virginia. Survey participants were grouped into four energy clusters (Energy-Conscious, Motivated, Achieved, and Help-Needed) based on their perceived energy cost burdens and current energy saving efforts and they showed distinctive demographic and housing characteristics. Households in different clusters showed a different level of change in their energy saving efforts over the last five years and interest in further energy saving information. The energy clusters and their characteristics are summarized below and in Table 7.

Energy-Conscious Cluster. Households in Energy-Conscious Cluster comprised about 28% of the total respondents. They perceived the least energy cost burdens but were making lots of efforts to save energy. More than two-thirds of the households in this cluster reported that they were making less effort to save energy when compared with their efforts five years ago, and 74% were not interested in further energy saving information. Compared to the total and other clusters, a higher percentage of households

Table 7. Summary of Energy Clusters

	Engergy Cluster			
Characteristics	Energy-Conscious	Motivated	Achieved	Help-Needed
Size (% of total respondents)	28%	16%	34%	22%
Perceived energy cost burdens	Least among energy clusters	Greatest among energy clusters	Little	Great
Basic energy saving behaviors	Great	Greatest among energy clusters	Average	Least among energy clusters
Inquiry for more energy saving	Greatest among energy clusters	Average	Least among energy clusters	Average
Energy saving efforts compared to past efforts	Less effort	Less effort	Less or same effort	Less effort
Interest in more energy saving information	Very low	Very low	Slightly low	Very low
Demographics				
Monthly household income less than $1,000	50%	66%	59%	47%
One or more children	84%	97%	80%	94%
Headed by single-adult	48%	54%	53%	40%
Housing				
Tenure type	64% homeowners	53% homeowners	62% renters	54% renters
Home structure type	62% in single-family home	58% in single-family homes, 22% in mobile home or other types of home	43% in single-family homes, 43% in multifamily units	65% in single-family homes
Home location	52% in city/town locations	57% in city/ town locations	63% in city/ town locations	51% in rural locations

in this cluster had a monthly income over $1,000. In addition, this cluster had a higher percentage of households with one or more children at home and households headed by a single-adult than other clusters. Sixty-four percent of the households were homeowners and 62% lived in single-family homes. Fifty-two percent of households lived in rural locations.

Motivated Cluster. Households in the Motivated Cluster comprised 16% of the total respondents. Households in this cluster were characterized with large perceived energy cost burdens and great energy saving efforts. Their current energy saving efforts seemed to be driven by their current deficiency. Interestingly, 62% of households in this cluster, however, reported that they were making less energy saving effort than five years ago and 88% were not interested in additional energy saving information. Sixty-four percent of households in this cluster had monthly incomes $1,000 or less, 96% lived with one or more children, and 54% were headed by a single-adult. Sixty-two percent of the households in this cluster were renters and 58% lived in single-family homes. About 22% of households lived in a mobile home or other types of housing while only 12% to 15% of households in each of other energy clusters lived in mobile home or other types of homes. Fifty-seven percent lived in city or town locations.

Achieved Cluster. Households in the Achieved Cluster comprised 34% of the total respondents. Households in this cluster perceived the least energy cost burden and were making fewer efforts to save energy. Compared with households in other energy clusters, more households in this cluster reported that they were making at least the same energy saving effort as they had made five years ago. Also, more households were interested in further energy saving information. About 59% of households in this cluster had a monthly income of $1,000 or less and 53% were headed by a single-adult. Compared with the total, a higher percent of the households lived with one or more children. Sixty-two percent of the households were renters, and 51% lived in rural locations. Interestingly, a higher percentage of the households in this cluster (43%) lived in multifamily units than those in other energy clusters (19% to 26%). Except for one household, all households living in multifamily units were renters which comprised half of the multifamily renters of the study.

Help-Needed Cluster. Households in Help-Needed Cluster were characterized by great energy cost burdens and little efforts to save energy. Households in this cluster comprised 22% of the total respondents. More than half of them were making less energy saving effort than they had made five years ago and were not interested in further energy saving information. Fifty-three percent of households in this cluster had an income more than $1,000 per month, 94% had one or more children at home, and 60% were

headed by a single-adult. About 54% were renters, 66% lived in single-family homes, and about 51% lived in rural locations. Households in this cluster showed the second lowest interest in further energy saving information. Table 7 includes a summary of the four energy clusters.

Implications

When relationships between energy cost burdens and current energy saving efforts within each cluster were examined, a large energy cost burden was not necessarily related to substantial energy saving efforts. For example, households in the Energy-Conscious Cluster perceived the least energy cost burden but they were making great efforts to save even more. On the other hand, households in the Help-Needed Cluster perceived a great energy burden, but they were not making big efforts to save energy.

Some findings of this study need to be acknowledged. First, although the study sample included limited-resource households and 80% of the respondents had monthly household incomes of less than $2,000, their perceptions of energy cost burden were not reported to be as serious as might be expected. The Average Burden score was 1.52 which was between "never/seldom" and "sometimes" on the rating scale of original items. Only households in the Motivated Cluster perceived economic burden because of their energy bills more frequently than "sometimes." This unexpected lack of perceived burden could be due to a number of factors. One contributing factor may be the fact that in 2005 Virginia had low energy rates compared to many parts of the nation so the extent of the burden isn't as severe for these respondents compared to other low to moderate income households in other parts of the nation. The weather in Virginia is also a temperate climate so households do not experience as much extreme weather, especially during the winter months, as other parts of the nation. Lastly, these respondents may have learned to adjust their style of living to use less energy, keeping energy costs at a manageable level. We do not know what the comfort level is for these families, but keeping home temperatures at less than optimal temperatures or doing without certain energy use activities may be a normal part of life.

Secondly, a majority of the households reported that they were making less effort to save energy compared to their efforts five years before, and a

majority was not interested in any further energy saving information. Until households feel that they are making extreme sacrifices because of energy costs, they may not feel that they need to make more efforts to save energy. As stated above, most of the households did not see energy costs as a burden. Feeling a need to seek out more information would also seem unnecessary to them. This response is similar to that of people facing foreclosure where the situation created so much stress that many people did not actually focus on the problem until the filing of the foreclosure. These homeowners reacted by avoiding help and were reluctant to talk about their problem (Collins, 2009). Many households may also feel they are doing all they can to save on energy costs, and see no other viable energy saving options, especially if they involve a large capital investment. With energy costs rising in recent years, households may feel that they are not making any progress in the fight against energy costs because costs continue to rise even with the efforts already taken.

Third, half of the multifamily unit renters of this study sample were classified as members of Achieved Cluster which had the least energy cost burden and little energy saving efforts. Also, households in the Achieved Cluster showed relatively less decrease in energy saving efforts over last five years and greater interests in further information to save energy among the energy clusters. These renters' lack of energy burden may be attributed to an energy efficient rental unit with fewer square feet than a house, and therefore little effort was necessary to keep energy costs low. Many of these renters did not have heating bill in addition to their rent, which make energy costs more affordable. According to the U.S. Census Bureau, only slightly over 10% of the American renters do not have any utility payment (U.S. Census Bureau, 2008). And, because they were in a situation where they did not have control of structural or equipment measures to save additional energy, interest in more information was not necessary.

Clearly, the Help-Needed Cluster should be the first target of energy education programming and energy policy efforts. With more perceived burden, yet little effort to save energy, these households could greatly benefit. Finding ways to identify and reach these households will be the challenge, as well as developing innovative ways to increase their interest in making more effort toward reducing their perceived burden.

This Virginia sample, overall, did not find energy costs to be a critical problem as other studies have found. This situation may now have changed in Virginia, however, because energy price increases after this research was conducted, along with the impact of the current recession, may have altered households' perception of their energy burden. More research is necessary to assess how households with average and above average incomes compare to this limited-resource sample, as well as how the Virginia limited-resource households have changed and how they compare to those across the nation. Additional information is also needed on why certain households make more efforts than others. What additional characteristics separate the Motivated Cluster from the others?

Lastly, it appears, at least with this sample, that consumers are making less effort than in the past and have little interest in learning more about energy saving measures. This could be an additional challenge when developing and implementing energy education programs. Directors of energy programs that promote education may need to consider non-traditional ways to reach these consumers. Once contacted, these limited-resource households could be made aware of low-cost/no-cost energy measures they were perhaps not aware of or weatherization assistance for which they might qualify. A lack of information can keep many people from measures that could be very helpful. They may also need to team with other organizations and program, like EFNEP, to reach those who need the information the most. Lastly, it is clear from this study that just this one segment of the population, limited-resource households, varies a great deal in their thoughts and actions related to high energy costs, and this group may not react to the high costs as we might typically think they would or should. Policy makers must be aware of this variation and evaluate energy assistance policies so they might more accurately address the issues people face, as well as their attitudes.

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