IMPROVING CONSUMERS' RESPONSIVENESS TO ELECTRICITY DEMAND MANAGEMENT INITIATIVES IN REGIONAL NEW SOUTH WALES: THE POTENTIAL USE OF BEHAVIOURAL-BASED CONSTRUCTS FOR IDENTIFYING MARKET SEGMENTS

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ABSTRACT: The success of demand management initiatives in influencing household electricity consumption has been variable. The lack of focus on the consumer may be an underlying cause. Despite evidence of differentiation in preferences for demand management programs across households, there have been few attempts to segment households. The purpose of this research was therefore to segment the market to facilitate better targeting of demand management programs. The paper reports on a survey of 1074 households. Using three new behaviourally based constructs for segmentation, the analysis revealed that segments differed in program preferences, energy use and the number of past investment and curtailment behaviours engaged in. The analysis also revealed that respondents from lower and higher socio-demographic levels had low and high efficiency behaviours and corresponding energy use. The variance in preferences across segments indicated the potential benefits of a more targeted approach for encouraging participation in demand management programs.

KEY WORDS: Energy, Climate Change, Segmentation, Demand Management

1. INTRODUCTION

There is substantial documented evidence that households are wasteful of energy (Thøgersen and Grønhøj, 2010). Calls to moderate energy demand because of climate change concerns have increased interest in household demand management programs. However, the effectiveness of demand management programs has been variable and not all programs have motivated sufficient consumers to respond, or respond in the desired way (Walsh, 1989; Joskow and Marron, 1992; Stern, 1999). One reason for the lack of success of some programs appears to be a lack of market orientation resulting from insufficient understanding of the different segments within the household consumer market (Walsh, 1989; Ferguson, 1993; Long, 1993; Encinas *et al.*, 2007; Pedersen, 2008). These studies have demonstrated that participation in demand management programs differs according to demographic, situational and, of particular importance to the current paper, geographic variables and that communication with relevant segments has at times been poorly targeted (Ferguson, 1993; Pedersen, 2008). Yet few studies have been undertaken to identify the household segments most interested in alternative demand management programs, including their characteristics, their program preferences, how they might most effectively be reached and how these different factors might change spatially. A similar approach was taken by Pedersen (2008) who addressed these issues in the province of British Columbia, Canada. Moss (2008) identified a number of different uses to which segmentation of consumers has been put in the US power industry but noted that:

> [i]n depth application of market segmentation has only recently emerged within the utility sector as a way to implement demand-side management programs amongst residential and non-residential ratepayers. Greater use of the marketing approach could help the state achieve ambitious energy efficiency and conservation goals (p.8).

To date, similar attempts have not been made in Australia.

This lack of recognition of differing household preferences for demand management programs has persisted despite the fact that such polices have existed since the 1960-70s (Hamidi *et al.,* 2008) and large amounts of money being invested in demand management initiatives, and

government requirements for their use. In the USA, over US$9 billion had been invested in their implementation between the late 1980s and mid 1990s (Eto and Vine, 1996), and by the end of the 1990s, the figure had reached US$18 billion (Eto and Kito, 2000). In Australia, pressure is increasingly being brought to bear on energy suppliers to implement similar strategies. For example, in NSW, the Electricity Supply Act 1995 obliged suppliers to investigate means of implementing demand management strategies (Charles River Associates, 2003). Most other Australian jurisdictions are also reported to have become involved in advocating demand management initiatives (AER, 2008). Further, in Australia, a demand management and planning project was completed under the auspices of a management committee comprising the NSW Department of Planning, EnergyAustralia and TransGrid in 2008 at a cost of $A10 million (DMPP, 2008). In Queensland, Energex has embarked on an ambitious plan to achieve a more sustainable network by 2030 (Energex , 2012). Demand management programs are reported to include conservation and energy efficiency programs, fuel substitution programs, demand response programs, and residential or commercial load management programs (Wong *et al.*, 2010)

Preferences for demand management initiatives across household segments have not previously been widely studied. Feldman and Mast (2001) assessed the use of segmentation in marketing energy efficient lighting. Fritzsche (1981) and Frey and LaBay (1983) examined how electricity consumption and conservation behaviour change over the household lifecycle. The latter two studies provide evidence that changes in consumption are consistent with the stages of the household lifecycle. For example, Fritzsche (1981) found that electricity consumption changed over the lifecycle of the household in an inverted U shape pattern. That is, usage increased until children had been raised and then declined over time. While the use of the household lifecycle provides some useful insights into changes in electricity consumption across households, the approach has been criticized for the frequent failure by researchers to provide an exhaustive segmentation of the population (e.g. Du and Kamakura, 2006). Finally, Pedersen (2008) segmented British Columbia Hydro's residential customers with respect to attitudes and behaviours towards electricity and conservation and profiled the segments with respect to demographics, household characteristics, end uses, electricity consumption and other attitudinal and behavioural characteristics.

In this paper, we report the findings from the quantitative phase of a mixed methods research project. Our focus is on the electricity consumption of regional New South Wales (NSW) households. We employ a motive-based segmentation approach, as it is likely to be effective at identifying specific groups that have poor energy use and efficiency behaviours due to various factors including low efficacy, inadequate knowledge, comfort seeking motives and a lack of concern for price or environmental considerations. In doing so, we empirically compare the veracity of using attitudinally based scales derived from the literature and three new behaviourally based constructs developed as part of this research. Similar to results from previous studies, we find that behaviourally based constructs perform more effectively at predicting energy-efficiency behaviours, and hence we use them for segmentation.

The purpose of our study is to identify appropriate market segments in regional NSW and, where possible, to compare them with findings elsewhere. This has been done in a manner that has subsequently informed, the state owned electricity supplier, Essential Energy's long-term program planning through use in trials and the development of their Intelligent Networks program, which includes a demand management program employing smart meters, remote load control and various incentives. Throughout the paper, we follow the practice established by Stern and Gardner (1981) and define demand management strategies as those which result in either *curtailment* actions (e.g. hanging out washing to dry rather than using the clothes drier) or *investment* actions (the adoption of more energy efficient technologies such as insulation).

The results indicate the existence of both lower and higher socio-demographic segments with poor energy efficiency behaviours. The results also indicate the presence of two segments, one with a lower socio-demographic status and one with a higher socio-demographic status that have relatively low energy use and undertake high numbers of energy efficiency behaviours. The results also indicate that the types of demand management programs that are of most interest differ across segments, with certain programs being more appropriate for targeting those with higher energy use.

The practicality of the findings lies in how they can be leveraged. Pedersen (2008) has suggested four possibilities from his research. First, discriminant analysis could be utilized to predict the segmentation membership of individual subscribers. Communication and program strategies could then be developed with a view to encouraging a greater take-up of conservation strategies. Second, but more complex, segmentation may be of use in direct marketing campaigns if the

segments can be tied to specific geographical areas. Third, the findings can be used as a precursor to qualitative research which endeavours to provide deeper insights into attitudes and behaviours which in turn would feed into more targeted marketing campaigns. Finally, identifying common threads across the segments would provide obvious logistical benefits in the marketing process.

In summary, the need to adopt demand-based management strategies to encourage household consumers to better husband the use of electricity and the resources employed in its generation, has become increasingly accepted. However, demand management strategies have often failed to achieve their objectives because of a failure to tightly target strategies to those household consumers who are most likely to respond favourably. With few exceptions, previous attempts to establish market segments relied upon the use of attitudinally-based scales. However, expressed attitudes can often poorly reflect actual behaviour. In this paper we develop and use behavioural constructs to establish more effective market segments which can then be applied across regions to establish spatially divergent demand-management strategies appropriate to the market segment composition of each region.

2. METHODOLOGY

The identification of segments involved the use of a mixed methods research design. This included a series of focus groups with residential electricity users, as well as a quantitative survey. In brief, the qualitative research phase involved a series of nine focus groups. In total 76 participants were recruited across three locations representing a cross section of regional NSW. This includes one southern and inland town (wagga Wagga), one central and inland town (Bathurst) and one coastal and northern town (Port Macquarie). In each location, three focus groups were conducted with different household types: 1) share houses/young couples with no children, 2) households with children, 3) empty nest/elderly households. Participant reponses were found to differ across household types, but were stable across locations. Of those who attended, 63% were female, ages ranged from 18-77 and respondents were from a variety of occupations and educational backgrounds. The purpose of the focus groups was to provide further information about what influences participation in demand management programs, provide information to

develop scales for several constructs and to assist in refining the quantitative questionnaire.

Sample

A questionnaire was sent out to a proportional stratified sample of 4000 Essential Energy customers across nine areas in regional New South Wales during November 2008 to March 2009. Overall, 1104 responses were received, resulting in a response rate of 27.6%. The sample was split into two groups of 2000, one of which was asked about investment decisions and the other curtailment decisions. The final number of responses used in the analysis after excluding those with excessive item non-responses was 1074. The response rate for the investment sample was marginally higher (n=543 or 27.15%) than the curtailment sample (n=531 or 26.55%).

Prior to conducting the analysis, the respondents in the sample were compared to the state regional population for representativeness (see Table 1). The average age of respondents was somewhat lower than the NSW Regional average (18 years or older) and females were slightly overrepresented in the sample, with only 42% of respondents being male. However, income, education and employment status were similar between the sample and the regional NSW population. This characteristic of the sample is consistent with the respondents in other research projects in the area of environmental issues and household efficiency (e.g. Scott *et al.*, 2000; Parker *et al.*, 2005) and may indicate a level of self-selection bias in the sample. Further, renters were significantly overrepresented in the sample with 43% of respondents reporting that they rented their home versus the regional state average of 28%. In contrast, people who owned their home outright (20%) were underrepresented in the sample (regional stage average 41%).

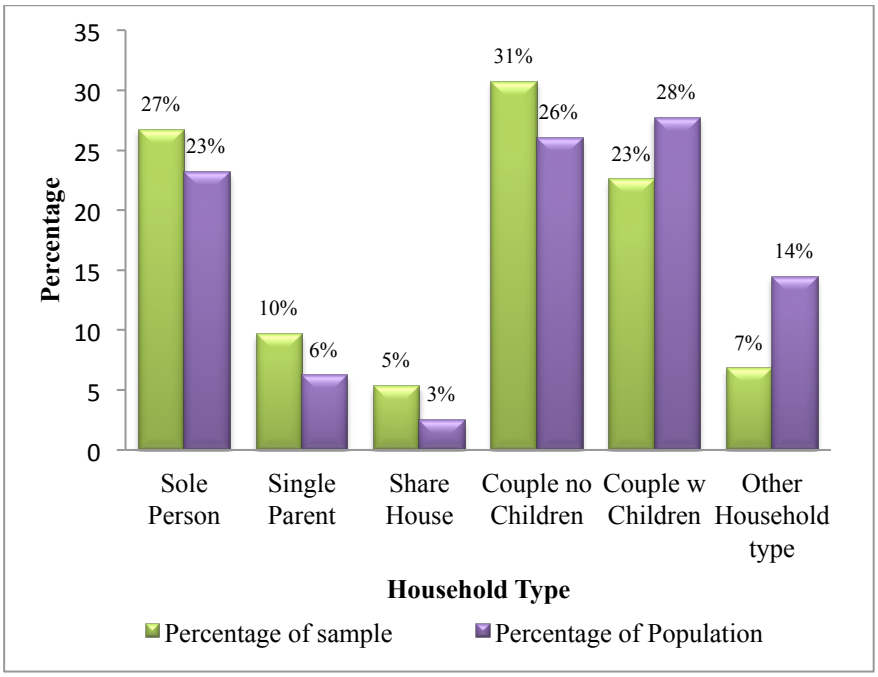
Table 1. Characteristics of the Respondents in the Sample

Characteristic of the household	**Sample**	**NSW Regional Average[#]**
Average age of respondents	40	49
Sex of respondent (% Male)	42	49
Household Income ($ per week)	1,096	1022
Education of Respondent (% completed at least 1-2 years at university or TAFE, or completed a degree, trade certificate or apprenticeship)	66	69
Employment Status (Full-time and Part-time)	60	56

Source: Australian Bureau of Statistics (2007)

Household types in the sample and the population were also compared, given our interest in examining energy usage and energy efficiency behaviours across household types. A chi-square analysis revealed a significant difference between the sample and the population (χ^2 = 115.398 p=0.000), though the differences in magnitude for each of the groups was not particularly large, as can be seen in Figure 1. The results indicated that the number of sole persons, single parents, share households and couples with no children in the sample was higher than the NSW average, whereas couples with children and "other" household types were underrepresented.

Figure 1. Household Types.



Data source: * Australian Bureau of Statistics (2007)

Scales

The selection of scales for inclusion in the questionnaire was an important aspect of questionnaire development. The choice of measurement scales was made through the examination of the extant literature and refined through the qualitative research process. Scales were used to measure attitudes, past behaviours and interest in future programs.

Three motivational variables were chosen to differentiate between households – price sensitivity, comfort sensitivity and environmentalconcern – as these have been identified in the literature as the primary drivers of household efficiency decisions. This was also evident in our qualitative findings. Given the ongoing dialogue in the literature about whether past behaviours or attitudes are better predictors of future behaviour (Ouellette and Wood, 1998), it was decided that both attitudinal and behavioural measures would be examined. Following

examination, the measures that were most effective at predicting behaviour would be selected for use in segmenting households.

Price Sensitivity

Price sensitivity refers to the degree to which households were willing to alter their behaviour or make investments to reduce their electricity bill. Numerous studies have found price or savings influence household efficiency (Van Raaij and Verhallen, 1983; Wiener and Doescher, 1994; Osterhus, 1997; Scott *et al.*, 2000; Parker *et al.*, 2005) and this was also reflected in the findings of the focus groups. As noted, two measures of price sensitivity were employed: an attitudinal and a behavioural measure. Following an examination of attitudinal measures of price sensitivity in the efficiency and marketing literature, a scale by Lichteenstein (1993) was chosen to measure this variable, based on its performance (reliability consistently $0.82 < \alpha < 0.86$ and discriminant validity established using confirmatory factor analysis) and the appropriateness of the scale's content.

In contrast to attitudes, few measures of price sensitive behaviour have been used in the efficiency literature, although some scale items referred to behaviours such as monitoring billing (Wiener and Doescher, 1994). In the absence of an appropriate measure, a scale was developed to measure this variable during the focus groups. This scale was based on an aided recall technique, where respondents were provided with a list of behaviours and asked to specify how frequently they engaged in those behaviours (Bradburn and Sudman, 2004). This overcame the problem of forgotten behaviours and allowed for the inclusion of relevant items such as those mentioned in the focus groups. The scale was then tested and refined in the following two rounds of focus groups. The two scales used are shown in Tables 2 and 3.

Comfort Sensitivity

Comfort sensitivity refers to the degree to which households were willing to prioritize comfort in efficiency decisions. As with price sensitivity, many studies have found comfort sensitivity to be a negative driver of efficiency decisions (Seligman *et al.*, 1978; Verhallen and Van Raaij, 1981; Samuelson and Beik, 1991; Scott *et al.*, 2000; Parker *et al.*, 2005). The influence of comfort sensitivity was reinforced during the

focus groups where household members discussed their willingness to pay a little extra to be warm in winter or cool in summer.

One attitudinal measure of comfort sensitivity had been used successfully in the efficiency literature (Seligman *et al.*, 1979; Samuelson and Beik, 1991). Based on the measure's previous performance, it was selected to measure comfort sensitivity in this study (see Table 2). However, a number of additional scale items were added during the focus groups to ensure the scale fully captured the domain of home comfort ("I would prefer our house to be a bearable temperature than to have a low electricity bill" and "I will sacrifice the bill for comfort occasionally"). Again, there was an absence of a behavioural measure of comfort sensitivity in the literature. Hence a scale was developed and tested during the focus groups based on the aided recall technique (Bradburn and Sudman, 2004) mentioned above (see Table 3).

Table 2. Attitudinal Scales, Scale Items and Chronbach Alphas.

Construct	Scale items	Chronbach Alpha
Price Sensitive Attitude	I am not willing to go to extra efforts at home to save money on electricity bills The time it takes to save money on my electricity bill is usually not worth the effort I will shop at more than one store to take advantage of lower prices on home appliances I am willing to change the way I do things at home to save money I would never shop at more than one store to find low prices for home appliances The money saved finding lower prices for appliances is usually not worth the time and effort	0.77
Comfort Sensitive Attitude	I would prefer our house to be a bearable temperature than to have a low electricity bill It's not worth it at all to sweat in the summer/shiver in the winter to save electricity While others might tolerate being too hot/cold, my need for a comfortable temperature at home is high I find I can't relax or work well if the house is too hot/cold We want to be efficient, but we also want to be comfortable I will sacrifice the bill for comfort occasionally	0.79

Source: the Authors

Table 2. (Continued). Attitudinal Scales, Scale Items and Chronbach Alphas

Construct	Scale items	Chronbach Alpha
Environmental Conscious Attitude	Environmental pollution affects my health People who do not take the environment into account try to escape their responsibility Environmental problems have consequences for my life I worry about environmental problems Saving a threatened species is an unnecessary luxury I can see with my own eyes that the environment is deteriorating I am optimistic about the quality of the environment in the future A better environment starts with myself Environmental problems are a risk for the future of my children There is too much attention given to climate change Environmental problems are exaggerated Too much attention is paid to environmental problems	0.86
Perceived Efficiency Knowledge	I don't understand a lot about household energy efficiency My friends consider me an expert on energy efficiency Compared to the average person, I know a lot about household energy efficiency	0.66
Personal Efficacy	I can't do anything about climate change We have little control over the amount of electricity consumed in our household Reducing our electricity use is not going to make a difference to environmental problems Things that I do for the environment can make a difference Environmental problems are so large that there is really no point trying to solve them If my household chose to, we could reduce our electricity consumption by altering our behaviors If we chose to, we could spend some money and increase the efficiency of our house I often feel that we are powerless to deal with electricity consumption issues in our household	0.79

Source: the Authors

Table 3. Behavioural Scales and Scale Items.

Construct	Scale Items
Price Sensitive Behaviour	We check our electricity bill
	We spend money to purchase energy efficient appliances
	We try to lower our electricity bill by changing the things that we do
	We spend money on our home to reduce our electricity bill
Comfort Sensitive Behaviour	We use electricity to keep the temperature in the house about the same all year
	We use our air-conditioner during the summer
	In winter, we run our heater on high as soon as we get up/get home
	We turn our appliances off at the wall
	We use the blinds and curtains to regulated the heat in our house
	We use a clothes dryer
Environmental Conscious Behaviour	I make a conscious effort to reduce our water use
	I try to recycle as much as possible of our household waste
	I compost whatever rubbish I can
	For short trips, I walk/ride the bike instead of taking the car
	I buy environmentally friendly products
	I use recycled paper products
	I buy organic products
	I grow vegetables for our own use
	I take my own bags when shopping

Source: the Authors

Environmental Consciousness

Environmental consciousness refers to the degree to which household members were willing to prioritize environmental concern in efficiency decisions. Much of the efficiency research is from an environmental perspective, and studies have found that environmental concern is a driver for efficiency choices; however, the findings have been less definitive than those for price or comfort sensitivity (Verhallen and Van Raaij, 1981; Scott *et al.*, 2000). As Wallenborn *et al.* (2005, p. 3) observed:

> We have seen that very few people make consumer choices to protect the environment. At best they integrate environmental protection criteria in their choices to select an option among others that meet their primary motivations.

Based on a review of the literature, the New Ecological Paradigm (Dunlap and Van Liere, 2000) was initially chosen as an attitudinal measure of environmental consciousness. However, during the initial focus groups it was found to be problematic as respondents could not see the relevance of the scale to the questionnaire, and it was felt to be too long. Subsequently, a scale developed by Gatersleben and Steg (2002) was substituted. It had a similar reliability and overcame the problems that arose in the focus groups. Unlike the variables discussed above, a number of scales have been used to measure environmentally conscious behaviour (e.g. Roberts, 1996; Straughan and Roberts, 1999; Gatersleben and Steg, 2002). However, the scales were either not suited to an Australian context or did not capture enough of the non-purchase related behaviours that were of interest in this research. Consequently, a new behavioural measure was developed, in a similar fashion to those above (i.e. based on aided recall) but building on the previous scales, in particular the 22-item scale used by Straughan and Roberts (1999).

In addition to the three key drivers of household efficiency in the literature, two other attitudinal scales were included in the survey for profiling the different groups of consumers that emerge. These were perceived efficiency knowledge and personal efficacy.

Perceived Efficiency Knowledge

Perceived efficiency knowledge refers to a respondent's perception of their knowledge of energy efficiency relative to others. Knowledge has been significantly linked to a variety of curtailment based efficiency behaviours (Herberlein and Warriner, 1983; Scott *et al.*, 2000) and hence was considered relevant for characterizing different households. Further, perceived knowledge is of particular interest for retailers attempting to manage demand, as it has been linked to information search behaviours (Bettman, 1993). Perceived knowledge was measured using a three-item scale adapted from Srinivasan and Ratchford (1991), as shown in Table 2.

Personal Efficacy

Personal efficacy relates to a person's perceptions of their ability to control their own actions and control factors that affect their life (Bandura, 1991). This concept has two aspects: the individual's level of confidence that they can perform a behaviour and the degree to which the individual feels that behaviour will make a difference (Azjen and Fishbein, 1980; Ellen and Wiener, 1991). Personal efficacy has been

linked to conservation behaviours (Ellen and Wiener, 1991; Sardianou, 2005) and is of particular interest as it is anticipated that a person's perception of their ability to alter their electricity consumption, and the result of that alteration, will influence their choices. This variable was measured using an adaptation of the Pearlin Mastery scale employed by Meinhold and Malkus (2005).

Demand Management Preferences

In addition to attitudes and past behaviours, it was expected that groups could be differentiated in terms of preference for participation in future demand management programs. Accordingly, households were asked to indicate which of five potential demand management strategies they would be willing to be contacted about (see Table 4). The five demand management strategies outlined were a home energy audit; a home energy use meter; a remote load control program; a subsidy; and a voluntary load reduction program.

Table 4. Demand Management Programs

Demand Management Program	**Program Description**	**Cost**	**Likely Savings on Average**
Program 1: Home Energy Audit	Customized in home efficiency advice	$250	25% of annual bill
Program 2 Home Energy Use Meter	Installation of home energy meter that provides consumption and price information	No installation cost	$10-$120 per quarter
Program 3: Remote Load Control Program	Households with air-conditioners agree to allow company to cycle appliances remotely during critical peak periods	No cost	Retailer to pay household $10 per quarter, plus resultant reduction in bill
Program 4: Efficiency Subsidy	Subsidy for the installation of insulation or a more efficient hot water system	No cost	Up to $300 on insulation, and up to $1200 on the hot water system
Program 5: Voluntary Load Reduction	Discount for load shedding during critical peak periods when requested	No cost	Retailer to pay household $40 for signing up and $10 for each incident

Source: the Authors

Approach for Defining and Validating Segments

The segments were identified by using both Tobit regression analysis and hierarchical cluster analysis to determine group membership. First, the three attitudinal and behavioural measures identified above (price sensitivity, comfort sensitivity and environmental consciousness) were regressed against two forms of efficiency behaviour: investment (purchase/equipment based efficiency options) and curtailment (behaviour based efficiency options). The purpose of these regression analyses was to determine which type of measure, attitudinal or behavioural, was best able to explain the variance in efficiency behaviours (Punj and Stewart, 1983; Hair *et al.*, 2006).

Then, based on the results of the regression analysis the better performing variables, in this case behavioural variables, were used to segment the data. This segmentation was conducted using a cluster

analysis employing Ward's method. The resultant clusters were then profiled by examining if and how they differed on a variety of demographic, attitudinal, behavioural and situational variables as well as preferences for future demand management options. The responses across groups were then tested for significant differences using ANOVA and Chi square tests. This testing is used in cluster analysis as an indicator of validity (Aldenderfer and Blashfield, 1984).

Lastly, discriminant analysis was used to develop an equation for predicting segment membership.

3. RESULTS

The first step in the segmentation analysis was to assess whether it was more appropriate to segment the sample using attitude or behavioural measures. Initially this involved testing the reliability of the attitude scales. Based on an examination of the Chronbach alphas, which ranged from 0.66 to 0.86, the scales were deemed acceptable. Tobit regressions were then conducted using the attitudinal and then the behavioural measures of price sensitivity, environmental consciousness and comfort sensitivity to predict past investment and curtailment behaviours. As noted, these three variables are the main motives previously used in the literature to explain the uptake of demand management activities by households. The goal of running the regressions was to determine whether behavioural or attitudinal variables better predict investment and curtailment behaviours. As shown in Table 5, the number of significant coefficients and the explanatory power was much greater for the behavioural dependent variables compared to the attitudinal variables, which is consistent with the results of other studies (e.g. Olsen, 1981; Herberlein and Warriner, 1983; Black and Stern, 1985). Therefore, the behavioural variables were used for determining segments in the cluster analysis.

Table 5. Tobit Regressions Showing the Effect of Behaviours and Attitudes on Investment and Curtailment Behaviours.

	Behaviours		**Attitudes**	
Variables	**Investment**	**Curtailment**	**Investment**	**Curtailment**
Price sensitivity	0.380*** (6.88)	0.284*** (8.44)	0.353*** (4.32)	0.080 (1.46)
Environmental concern	0.074** (2.51)	0.053*** (2.91)	0.007 (0.23)	0.017 (0.91)
Comfort sensitivity	-0.098** (-1.98)	-0.056* (-1.7)	-0.117*** (2.73)	-0.070*** (-2.48)
Constant	10.935*** (9.25)	-0.557 (-0.72)	19.632*** (13.03)	4.041*** (3.99)
Summary statistics				
Log-likelihood	-1086.677	-1715.068	-1107.480	-1770.066
X^2	121.29***	151.27***	41.4***	16.37***
Pseudo R^2	0.0529	0.0422	0.0183	0.0046
N	978	747	975	740

Source: the Authors

A six-segment solution resulted from the cluster analysis. Information about each of the segments including their size, sociodemographic characteristics and predominant household types, is shown in Table 6. As can be seen by the significant *P*-values in the final column of the table, chi-square tests and ANOVAs demonstrate that the segments are significantly different across a range of exogenous variables.

Table 6. Sociodemographics Across Segments

	Lower SD Non-Conservers	Lower SD Price & Enviro Conscious	Average Households	Wealthy Price & Enviro Conscious	Wealthy Unempowered	Wealthy Comfort Seeking	Sig.
Proportion of sample	29.1%	16.7%	20.4%	12.9%	15.1%	8.8%	196.28***
Sociodemographics							
Household Income	$54,011	$50,929	$56,754	$60,792	$63,819	$64,800	66.77*
Respondent's Gender (% male)	38%	45%	45%	51%	37%	50%	11.68**
Respondent's Age	36.8	42.4	40.2	42.2	34.7	37.1	6.09***
Education	4.2	4.3	4.7	4.5	4.5	4.6	30.59
Number of People	2.15	2.14	2.35	2.32	2.53	2.55	3.11**
Number of Children	0.51	0.48	0.56	0.60	0.78	0.87	2.10*
Full-time employment	53%	38%	50%	50%	59%	60%	18.42***
Retired or Pensioner	18%	28%	22%	24%	12%	10%	21.97***
Household Types							
Sole Person	34%	28%	23%	23%	20%	23%	14.62**
Single Parent	11%	8%	7%	9%	14%	10%	5.02
Share House	5%	6%	8%	1%	5%	5%	6.87
Married Couple	11%	20%	20%	26%	13%	8%	25.21***
Married Couple with Children	10%	11%	16%	17%	19%	19%	12.48**
Defacto Couple	17%	12%	13%	14%	13%	19%	4.04
Defacto Couple with Children	6%	6%	8%	5%	6%	11%	3.66

Source: the Authors

The first two segments comprise predominantly lower sociodemographic households, and together they represent 45.8% of the sample. The first of these segments, the *Lower Sociodemographic Non-Conservers*, was the largest of the segments, consisting of 29.1% of the sample. This segment had the lowest average level of education, the second youngest age and the smallest proportion of male respondents. It also had the highest number of sole person and single parent households, as well as the second highest proportion of defacto couples. The second segment, the *Lower Sociodemographic Price and Enviro Conscious*, was a smaller segment with 16.7% of the sample. It was characterized by having more retirees and pensioners and a higher average age than any other segment, and the lowest level of income. It also had the smallest average household size and fewest children of any segment. This segment partly parallels the "Devoted Conservation" segment identified by Pedersen (2008), which like this segment was characterized by having the highest age and lowest household income of any segment. However, in our study this segment was price conscious which contrasts with the segment identified by Pedersen (2008).

The next segment has been named *Average Households* and represents 20.4% of the sample. It was the second largest of all segments. It was named *Average Households* because it had average values for almost every reported measure, thus few distinguishing characteristics. However, members of this segment had the highest level of education. This segment also had the second highest proportion of retirees and pensioners, as well as the highest proportion of share households.

The next three segments were all higher sociodemographic segments and together represent 36.8% of the sample. They all had relatively high incomes. The last two segments, the *Wealthy Unempowered* and the *Wealthy Comfort Seeking* consisted primarily of relatively young respondents with large families. They had the highest proportion of full-time employed people. The *Wealthy Comfort Seeking* group had the highest proportion of defacto couples (including those with and without children), as well as on average the second highest level of education. A similar segment to the *Wealthy Comfort Seeking* called "Comfort Seekers" was identified by Pedersen (2008) which primarily consisted of relatively young respondents with children. Pedersen (2008) also identified a segment similar to the *Wealthy Unempowered* that he called the "Tuned-Out & Carefree". Similar to the *Wealthy Unempowered*, Pedersen's segment tended to be younger and have the highest household income of any of the segments. They had the highest energy usage of any segment and also shared the characteristic of being the most disengaged

or apathetic in the way they thought about and used electricity. One difference to the segment we identified was that Pedersen's segment is predominantly male (65%) whereas the segment identified in our study was predominantly female (63%). The remaining higher sociodemographic segment, the *Wealthy Price and Environment Conscious* has the highest proportion of married couples. The smallest of the three higher sociodemographic segments is the *Wealthy Comfort Seeking*, with only 8.8% of the sample.

Next, in Table 7 data about electricity consumption, behaviours, attitudes and house characteristics are presented for each of the segments. The two lower sociodemographic segments had the lowest electricity usage overall, and the lowest and third lowest electricity usage per person and per appliance. Their electricity usage per room was, however, higher than the *Wealthy Price and Environmentally Conscious* Segment. As might be expected, the two lower sociodemographic segments had the fewest appliances and the smallest average house size. The *Lower Sociodemographic Non-Conservers* had the highest proportion of renters and had undertaken the smallest number of curtailment and investment behaviours. In contrast, the *Lower Sociodemographic Price and Environmentally Conscious* had undertaken the equal highest number of curtailment behaviours and the second highest number of investment behaviours (including the second highest percentage of energy efficient hot water systems).

Respondents from the *Wealthy Price and Environmentally Conscious* segment had the third lowest level of electricity consumption despite having the largest house size and the third highest number of appliances. This group had the second lowest electricity consumption per person and per appliance and the lowest electricity consumption per room. It contains the smallest percentage of renters and respondents owning units/flats/apartments.

The remaining two wealthy segments, the *Wealthy Unempowered* and the *Wealthy Comfort Seeking* had the highest electricity usage, the highest usage per person and per room, and the third and first highest usage per appliance respectively. These two segments had the largest number of appliances and among the largest houses on average of any of the segments. The *Wealthy Unempowered* had undertaken the fewest curtailment and investment behaviours to reduce electricity usage. The proportion of households renting was also relatively high among members of this segment.

Table 7. Electricity Consumption, Efficiency Behaviours, Other Behaviours and Attitudes Across Segments.

	Lower SD Non-Conservers	Lower SD Price & Enviro Conscious	Average Households	Wealthy Price & Enviro Conscious	Wealthy Unempowered	Wealthy Comfort Seeking	Sig.
			Electricity Consumption				
Avgkwph[1]	5095	5151	6006	5532	6980	7411	10.00***
Avgkwph/person	2373	2408	2559	2388	2758	2908	5.35***
Avgkwph/appliance	420	454	475	422	469	531	2.21**
Avgkwph/room	925	909	1025	868	1148	1197	3.31***
			Behaviours				
Curtailment	14.8	17.3	15.9	17.3	12.9	15.6	31.52***
Investment	3.1	5.4	3.7	5.5	2.5	3.5	34.65***
Price Sensitivity	2.57	4.18	2.97	4.09	2.25	3.68	408.73***
Enviro Conscious	2.53	4.01	3.23	3.10	2.11	2.48	391.43***
Comfort Sensitivity	1.85	1.58	2.26	1.98	2.88	2.94	325.83***
			Attitudes				
Price Sensitivity	3.54	3.83	3.66	3.67	3.40	3.59	18.05***
Enviro Conscious	3.62	4.01	3.84	3.79	3.53	3.52	16.05***
Comfort Sensitivity	3.17	2.84	3.15	3.14	3.72	3.61	36.10***
Perceived Knowledge	2.91	3.55	2.99	3.22	2.50	2.94	49.14***
Perceived Efficacy	3.74	4.04	3.88	3.89	3.60	3.67	339.23***
			House characteristics				
No Appliances	12.1	11.4	12.6	13.1	14.9	14.0	15.38***
Electric Hot Water	70%	65%	73%	69%	71%	58%	1.364
Energy Efficient Hot Water System (Solar/on demand)	14%	34%	18%	38%	11%	19%	13.21***
House size	5.5	5.7	5.9	6.4	6.1	6.2	5.35***
Unit /Flat/Apartment	27%	14%	15%	13%	19%	10%	25.90***
Home fully paid off	16%	28%	21%	25%	17%	11%	17.26***
Own home paying off	31%	33%	33%	43%	33%	42%	8.70
Renting	51%	34%	42%	27%	48%	40%	30.62***

[1] AVGKWPH is average kilowatts per hour. This was supplied by the electricity supplier and is not self reported.

Source: the Authors

When each group was examined, the energy use outcomes observed reflected the behaviours and attitudes of the segments. The *Lower Sociodemographic Price and Environmentally Conscious* and the *Wealthy Price and Environmentally Conscious* segments had the highest price sensitivity, the highest values for perceived knowledge and perceived efficacy. The *Lower Sociodemographic Price and Environmentally Conscious* also had the highest average values for environmentally conscious behaviours and attitudes, and the lowest values for comfort sensitivity behaviours and attitudes. Interestingly, the *Average Households* segment had marginally higher values than the *Wealthy Price and Environmentally Conscious* for environmentally conscious behaviours and attitudes, and similar values for perceived efficacy. However, in contrast to the *Wealthy Price and Environmentally Conscious* segment, the *Average Households* exhibited much higher average comfort sensitivity behaviours though their average value for comfort sensitivity attitude was similar.

The link between attitudes and behaviours and energy usage was also evident for the two remaining segments. The *Wealthy Unempowered* and the *Wealthy Comfort Seeking* had the lowest average values for environmentally conscious behaviours, attitudes and perceived efficacy. They also had the lowest and third lowest average values for price sensitive behaviours and attitudes respectively, as well as the highest average values for comfort sensitive behaviours and attitudes, all of which would be expected to lead to higher energy usage.

Thus in summary, it is apparent that energy usage was related to sociodemographic status. Primarily because the differences in house size and number of appliances meant that average and higher income households used more energy than lower income households. Yet within the higher and lower income segments, price and environmentally conscious segments had a much higher uptake of curtailment and investment behaviours and, correspondingly, a much lower relative energy use than other segments with equivalent incomes. Within the higher income segments, there were also two high usage segments that differed subtly, unlike the lower income segments where there was only one high use segment. Both of these groups were characterized by high comfort behaviours, low efficacy and perceived knowledge.

The segments also differed in their interest in being contacted about the five demand management programs. As shown in Table 8, overall interest in being contacted across the segments was highest for the home energy

use meter and the voluntary reduction program, and lowest for the home energy audit and remote load control program. Again, there is heterogeneity of preferences across segments. The *Lower Sociodemographic Non-Conservers* were least interested of all segments in being contacted about all programs though, consistent with the other segments, they were more interested in being contacted about a meter or voluntary reductions. However, two other segments – the *Wealthy Unempowered* and *Wealthy Comfort Seeking* – had relatively high interest in some of the available programs. The *Wealthy Unempowered* had the highest percentage of respondents interested in being contacted about remote load control while the *Wealthy Comfort Seeking* had the second highest percentage of respondents wanting to be contacted about undertaking an audit. The segments most interested in being contacted about a subsidy were the two price and environmentally conscious segments, while the segment most interested in being contacted about an audit was the *Lower Sociodemographic Price and Environmentally Conscious*.

Table 8. Interest in Being Contacted About Various Demand Management Programs Across Segments

	Lower SD Non-Conservers	Lower SD Price & Enviro Conscious	Average Households	Wealthy Price & Enviro Conscious	Wealthy Unempowered	Wealthy Comfort Seeking	Sig.
Program 1: Home Energy Audit	23%	39%	26%	30%	29%	36%	14.27**
Program 2 Home Energy Use Meter	60%	63%	68%	72%	68%	74%	8.22
Program 3: Remote Load Control Program	19%	21%	28%	29%	37%	28%	20.28***
Program 4: Efficiency Subsidy	39%	55%	43%	56%	40%	45%	19.00***
Program 5: Voluntary Load Reduction	64%	69%	68%	70%	69%	60%	3.02

Source: the authors

Next we turn to spatial issues. As recommended by Pedersen (2008), we analysed the distribution of segments across regions within New South Wales in order to identify if different approaches to the marketing of demand management programs in different regions would be necessary. Several observations can be made about the results in Table 9. Firstly, the *Lower Sociodemographic Non-Conservers* made up a large proportion of respondents across all regions, ranging in size from 19.2% (Riverina) to 38.7% (Far West Region). Secondly, the *Wealthy Comfort Seeking* respondents were common in only two regions, the South Western (10.4%) and Far West Region (16.1%). Third, the price and environmentally conscious segments respondents were unevenly distributed. Specifically, the *Lower Sociodemographic Price and Environmentally Conscious* respondents were much less common in the three western regions. In contrast, the *Wealthy Price and Environmentally Conscious* respondents were common in each of these regions as well as in the Riverina and Northern Regions. Lastly, the *Wealthy Unempowered* respondents were most common in the southern regions (South Western, South Eastern and Riverina), but represent a reasonable proportion of households in all locations (from 16.1% to 27.4%). We therefore conclude that in considering the implementation of demand management initiatives in regional NSW, significant differences in approach will be needed across regions.

Table 9. Distribution of Segments Across Regions.

	Lower SD Non-Conservers	Lower SD Price & Enviro Conscious	Average Households	Wealthy Price & Enviro Conscious	Wealthy Unempowered	Wealthy Comfort Seeking
Mid North Coast	34.2%	16.7%	16.2%	10.3%	20.1%	2.6%
Northern Region	23.8%	17.9%	13.1%	21.4%	16.7%	7.1%
Far North Coast	30.8%	23.4%	16.4%	7.5%	18.9%	3.0%
North Western Region	28.6%	11.1%	11.1%	23.8%	17.5%	7.9%
South Western Region	21.7%	12.3%	9.4%	25.5%	20.8%	10.4%
Far West Region	38.7%	3.2%	6.5%	19.4%	16.1%	16.1%
South Eastern Region	24.8%	19.1%	10.8%	12.1%	27.4%	5.7%
Riverina Region	19.2%	15.4%	9.6%	26.9%	23.1%	5.8%

Source: the Authors

Finally, again as recommended by Pedersen (2008), we applied discriminant analysis to predict segment membership. Using the three new behavioural constructs (price sensitive behaviour, comfort sensitive behaviour and environmental conscious behaviour) as independent variables, we found that the discriminant analysis correctly predicted segment membership 87.3% of the time. An output of a discriminant analysis is Fisher's Classification Function Coefficients (see Table 10) which is used in a manner analogous to prediction with regression, but with some additional transformations and calculations to predict segment membership[1]. Thus if a household completes a short questionnaire that includes the 19 items that make up these three constructs, the data from the questionnaire can be applied to a spreadsheet to predict segment membership.

[1] A spreadsheet that does this is available from the corresponding author.

Table 10. Fisher's Classification Function Coefficients.

Segment	Lower SD Non-Conservers	Lower SD Price & Enviro Conscious	Average Households	Wealthy Price & Enviro Conscious	Wealthy Unempowered	Wealthy Comfort Seeking
ComfortBI	2.604	2.411	3.173	2.852	3.866	4.014
EnviroBI	1.487	2.303	1.889	1.826	1.296	1.526
PriceBI	2.491	3.980	2.904	3.880	2.252	3.543
(Constant)	-45.419	-88.096	-67.800	-76.164	-57.713	-81.337

Source: the Authors

4. DISCUSSION AND IMPLICATIONS

Despite the increasing interest in the use of household demand management programs for moderating energy usage, relatively little is known about the behaviours, attitudes and preferences of alternative household segments. A few studies have mapped segments in terms of preferences for energy efficient lighting or examined how energy use changes across the household lifecycle, but their scope has been relatively limited. For this reason, we have reported information about household segments and the nature of household energy use, efficiency behaviours and interest in future demand management programs. In doing so, we have developed three new behavioural constructs, price sensitive behaviour, comfort sensitive behaviour and environmental conscious behaviour. As expected given the ongoing dialogue in the literature about the greater effectiveness of using behavioural rather than attitudinal measures to predict future behaviours, we found that these three new behavioural constructs were more effective than existing attitudinal scales in the literature for predicting past investment decisions and curtailment behaviours. Consequently these three behavioural constructs were used for segmenting households and were found to be effective segmenting variables. Their use is therefore recommended for other case studies including uptake of demand management initiatives.

The motivational segmentation of households provided various insights into household energy use, efficiency behaviours and program preferences. The segmentation allowed the identification of three higher sociodemographic segments, two lower sociodemographic segments and one "average" segment. This indicated that uptake of energy efficiency was not simply related to sociodemographic status, but that within

sociodemographic classes there were groups that have differential behaviours and attitudes that influenced energy efficiency.

Within this segmentation both lower and higher sociodemographic segments were identified that had relatively poor efficiency behaviours, which had a corresponding effect on energy usage. All three of the segments with poor efficiency behaviours had similar behaviours and attitudes, including few environmentally conscious behaviours, low perceived efficiency knowledge and low perceived efficacy. The two higher income groups also had high values for comfort seeking behaviours. These features across these high usage and poor efficiency behaviour segments suggest a role for education and communication programs to address the low perceived knowledge and low efficacy of these segments. Consideration should also be given to developing advertising programs to stimulate the development of curtailment behaviours. Strategies to address efficiency behaviours of these three segments are likely to be particularly important for the future given the relatively young age of the respondents – they had the lowest average ages of all segments.

The results from this study provide further insights into the types of programs of most interest to these three high energy use/low efficiency behaviour segments. The lower sociodemographic non-conservers had the greatest interest in voluntary reductions, then in home meters and then the subsidy, and relatively low interest in audits or remote load control. Both higher sociodemographic groups could be reached by various programs. They had high interest in home meters and voluntary reductions, as well as remote load control and audit, so various types of programs appealed to these two segments.

In contrast to the segments with high energy usage and few efficiency behaviours, there were low and high sociodemographic segments that exhibited low energy use and numerous efficiency behaviours. The respondents in these groups undertook high numbers of curtailment and investment behaviours. They were distinguished by relatively high home ownership but they also had the two highest percentages of retirees and pensioners and consequently the highest average ages of any segment. Together with the finding that the three segments with the highest energy usage and fewest energy efficiency behaviours were segments with the lowest average age, this is potentially concerning if it means that environmental concern and the desire to undertake energy efficiency behaviours is generational. It is possible that the lower number of efficiency behaviours undertaken by some of the segments may reflect stage of life factors which may change over time (e.g. home ownership);

however, it is also possible that it reflects that the younger generation has not grown up in a period where the need to control energy usage was such a concern. However, even if the latter is the reason for higher energy usage among certain segments, the good news is that there are certain demand management programs that interest members of all segments.

The industry partner for this research, Essential Energy, was able to use the findings from our research to confirm the findings of earlier exploratory research conducted in a Home Energy Efficiency Trial (HEET) about the likely usefulness of smart meters. This research found Smart meters to be the most popular demand management tool across all segments. In addition, the results from this study were used to inform the design of the consumer stage of Essential Energy's Intelligent Network trial in the Bega Valley, which involved the installation of home energy use meters as well as the provision of energy management advice and use of incentives (Essential Energy, 2012). The use of meters as well as incentives is consistent with the findings of this study that indicate that across all segments these were consistently two of the three most popular demand management programs.

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