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ELECTRICITY DEMAND MANAGEMENT POTENTIAL IN THE NEW ZEALAND DOMESTIC SECTOR

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Abstract

The aim of this study was to assess, in advance, the potential success of a range of domestic electricity demand management strategies. Using a sample survey of 413 households, the study specifically identified which types of incentive or education would be required among domestic electricity consumers to modify their demand for domestic electricity services, the energy technologies/products/services they used, and the time of their use/energy usage. The results show that householders already have a predisposition towards achieving improved energy conservation or efficiency. The results clearly demonstrate a potential market for domestic electricity efficiency improvements and conservation. It is crucial however, that the strategies adopted, fulfil specific customer requirements for information regarding the technologies/products/services involved. The research findings have important implications for designing energy efficiency and management strategies for the residential sector.

Introduction

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The study was designed to cover: (1) household profile, including size, composition, household and family type, income, dwelling tenure, length of occupancy of the current dwelling, and main means of home heating, as well as the occupation, age, and education of the person completing the questionnaire; (2) actual and perceived household electricity consumption; (3) current electricity saving practises and reasons for their adoption; (4) likelihood of adoption of electricity saving practises under various

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scenarios of power price increase, incentives, and information provision; (5) likelihood of shifting time of use under peak time price increase scenarios; (6) suitability and perceived credibility of information sources on electricity saving, including perceptions of appliance labelling; and (7) appliance-purchase decision making.

The study sought to build on and complement previous and ongoing domestic sector electricity research into electricity use, including social determinants of use, at the household and appliance level, conducted by Industrial Research Limited and Fitzgerald Applied Sociology – the current research team. This work also sought to contribute to the overall programme of research into domestic energy use in New Zealand being largely funded by the NZ Public Good Science Fund and co-ordinated by the government's Energy Efficiency and Conservation Authority (EECA) under the banner of the Household Energy End-use Project (HEEP).

Character of the Survey Sample

The random sample of 413 households surveyed in this study was generally representative of the overall population and households of the Christchurch urban area. There was some bias however, in favour of home-owning households. Those individuals who filled out the questionnaires on behalf of their households also tended to be a little older, better qualified, and have higher status occupations than the general population.

Matching Household Characteristics With Electricity Consumption

Significant statistical relationships between electricity consumption and the characteristics of the households were identified. The strongest correlation with electricity consumption was, not surprisingly, with the monthly power bill, followed closely by a typical winter monthly power bill. Further down the list of household characteristics, strong correlations were found with income level, household size, and the number of working age adults in each household. This
data is valuable for identifying customer electricity profile groups. It is possible to classify different groupings of customers using the household characteristics identified through the survey and from previous studies of domestic consumers in Christchurch. These customer groupings may be used to identify which to target for special tariff rates and loyalty programmes.

Contribution Of Appliances To Electricity Bills

The most significant contributors to household electricity bills were perceived by householders to be (in descending order): (1) the hot water cylinder; (2) the electric stove/range; (3) fan or bar heaters; and (4) radiators/oil column heaters. The hot water cylinder was clearly considered to be the most significant contributor to household electricity bills. The water/space heating contributions to the household electricity bills, as perceived by different customers, closely matched the real-time contributions made by such devices when they were monitored continuously by IRL, in residential homes.

Relationship Between Household Size And Heating Energy Source

In terms of home heating, there was little difference in average monthly electricity consumption between those using mainly electricity and those using mainly solid fuel (576 units and 589 units respectively). However gas users tended to have higher electricity consumption overall (616 units). This is accounted for by household size (and probably related life-styles) – with high proportions of electricity users among one and two person households, and relatively high proportions of solid fuel and gas users among households with 3 or more members.

Current Uptake Of Energy Saving Measures
Apart from a weak association between home ownership and ceiling insulation, there were no clear relationships between the adoption of any of the energy saving measures investigated, or the total number of measures implemented to date, and the various social characteristics of the respondents. However some groups tended to be bigger overall adopters e.g. those in elementary occupations and agricultural and trades jobs; and those respondents whose highest educational qualification was a trades certificate. As might be expected, those renting their dwellings tended to have lower levels of adoption of the various energy saving measures investigated.

Generally, the lower cost measures tended to have been adopted mainly as a means of saving on power bills, while more expensive measures were more likely to have been adopted for improved comfort. Reducing harm to the environment was only a significant motivation in the case of heat pumps.

Incentives For Modifying Energy Use
Power price increases were found to be a clear ~~a~~ motivator for adopting each of the efficiency changes in each of the cost brackets, though the level of uptake also appears to be related to the level of initial expenditure required (see Figure 1).

The no investment cost and behavioural changes generally showed high levels of current implementation, and therefore relatively low proportions of likely uptake with increases in the price of power. Most new uptake would occur if the price increased by 10%. Changes which involve loss of personal comfort or enjoyment (such as having a colder house or shorter showers), or produce apparently trivial savings (e.g. turning off TV rather than leaving it on standby) would be the least likely to be implemented.

Influence Of Load Shifting And Peak-Time Pricing Strategies
At the time of the survey only 10 to 20% of households had made an effort to deliberately change the time at which they carry out their main household energy-using activities. The exception changing of the timing of cooking, which, apart from a few households, ~~is~~ was not practised. The most common load-shifting occurred with electric water-heating where nearly 40% had taken up the power company's options for off-peak and night-time switching, and the associated lower tariffs. Use of night store heaters, which are also subject to controlled switching and lower tariffs, was the next most commonly practised load-shifting measure. The initial investment in the heater can be up to $1000.

The majority of the additional uptake of the load shifting measures proposed in the survey, would occur if the peak time price of power increased 50%, with between 25% and 35% additional households making the suggested changes. Relatively little additional uptake (between 5 and 10%) would occur if the price increased by 100%. The levels of adoption in each general category of load shifting measure, and for each level of peak-time power price increase, were not clearly statistically different for the various groups of survey respondents. However there was an overall negative relationship between socio-economic status and willingness to adopt changes in personal or household habits which would reduce electricity consumption at peak times (see Figure 2).

Figure 1: Potential uptake of energy saving cganges with power price increases

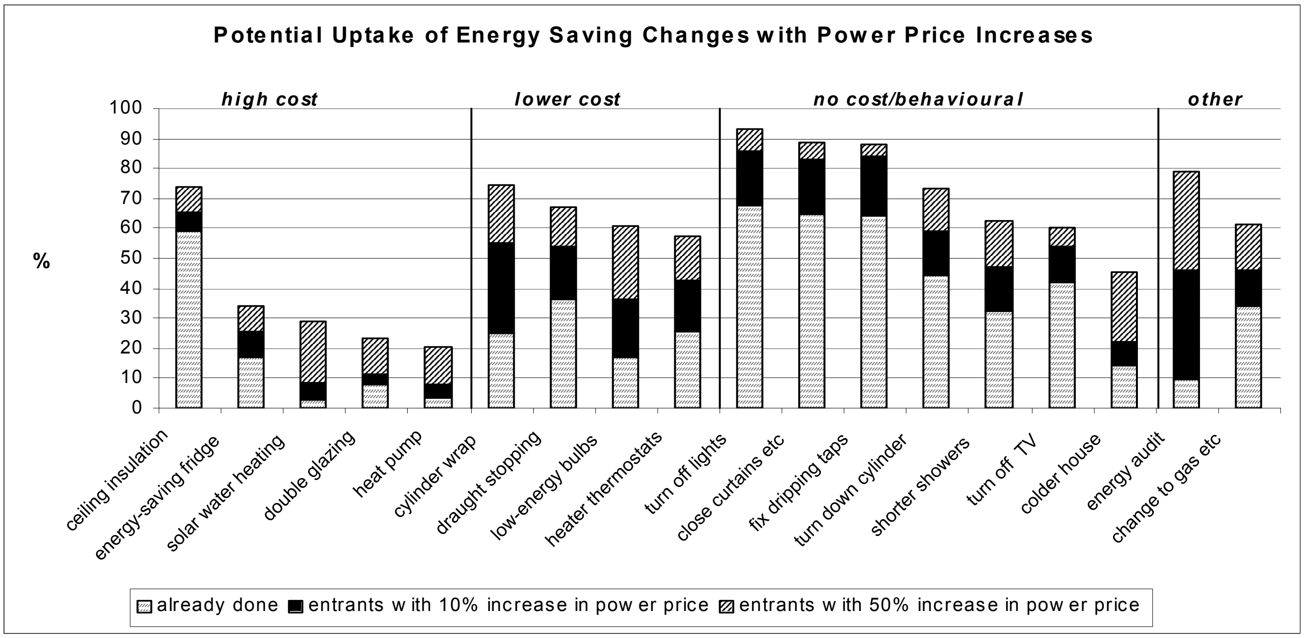
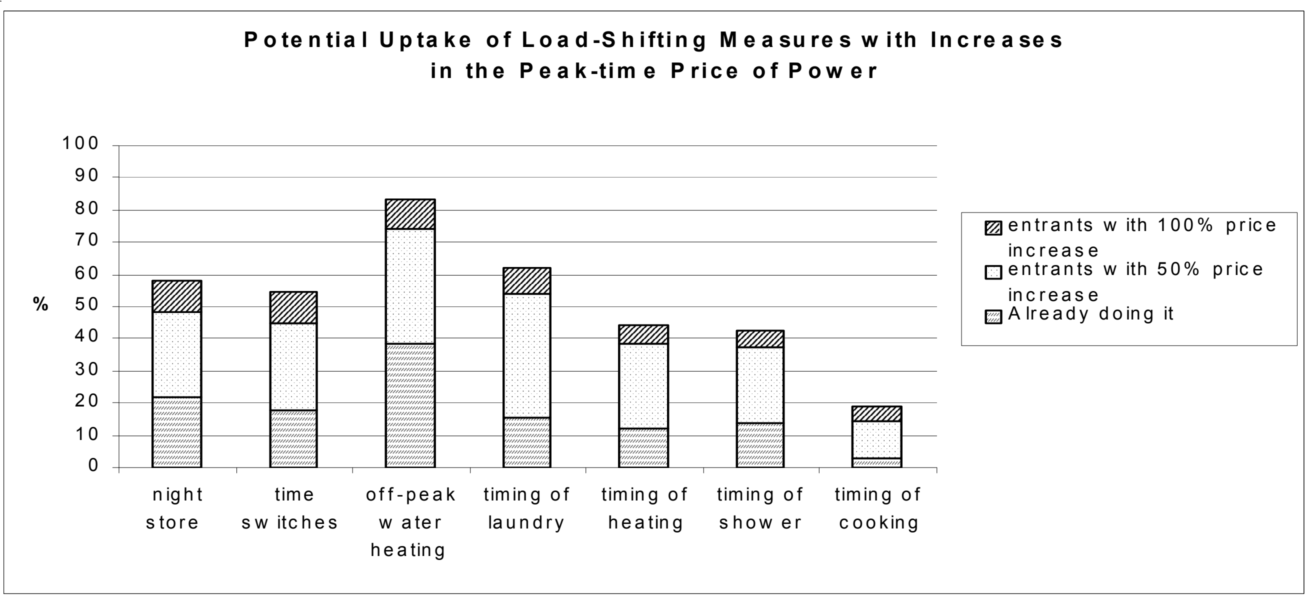


Figure 2: Potential uptake of load-shifting measures with increases in the peak-time price of power

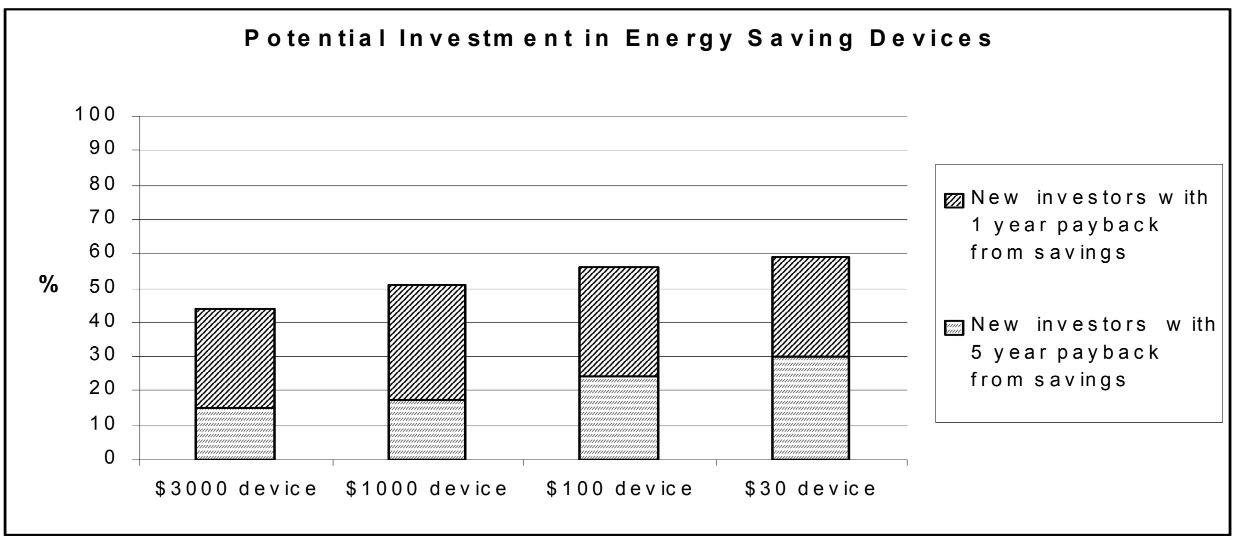


Potential Investment In Energy Saving Devices

For consumers to capture significant benefits of energy saving-measures and technologies they may have to make a sizeable investment. Two factors appear to influence the extent to which households might be willing to make this investment – the initial cost, and the potential savings. The initial size of this investment can clearly be a disincentive, especially to those without access to capital. The return on this investment may in the form of savings on power bills, enhancement or maintenance of property values, increased comfort for the same expenditure on power (itself a form of saving), or reduced exposure to loss of electricity supply.

The likely extent of investment in a generic or unspecified energy-saving devices was found to be lower than for specific devices (see Figure 3). When the responses on likely uptake of generic and specific devices were compared, just under half the respondents were found to have consistent views on investing. The overall proportion of those who had inconsistent responses increased according to the size of the investment called for. These inconsistencies may be due to the unspecified, and therefore uncertain, nature of the investment concerned, and/or the inability of a section of respondents to evaluate the investment scenarios presented.

Figure 3: Potential investment in energy saving devices



Those in the financial position to invest, and/or who own their homes, and/or who have previous experience of the benefits of such investment would be significantly more likely to adopt measures which require an outlay of capital. However this investment would only really be made if the benefits could be fully realised in 1 year – that is, with the minimum level of risk.

Impact Of Information Provision On Changing Energy Consumption

Provision of accurate information on how to save electricity would be more likely to result in expenditure on devices for saving power or shifting time of use by households with higher incomes, greater numbers of working aged adults, and whose respondents have better jobs and higher educational levels – in other words those with the material means to afford such changes. Households with elderly members would generally be less likely to be convinced to adopt any of these changes. Most households would be equally willing to change their electricity-using habits if they could receive accurate information on how to do so (see Table 1).

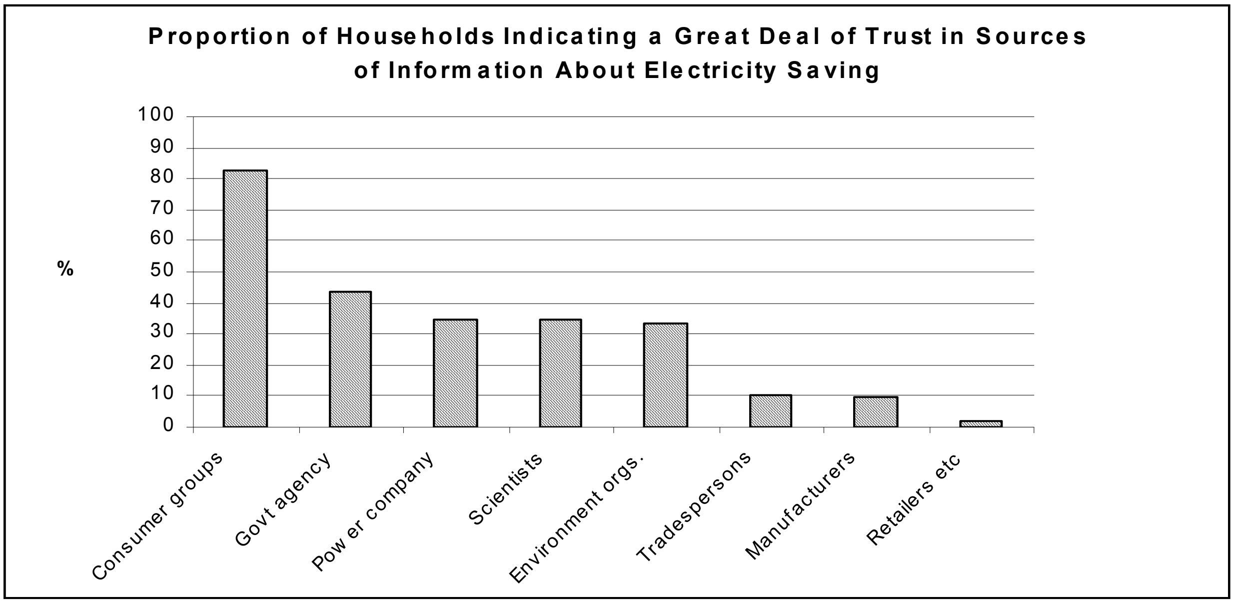
Credibility Of Information Suppliers

Survey respondents were asked about their trust of information from various potential sources on how to save electricity. Across all the listed sources of information or advice, there were no clear patterns of differences in levels of trust among different types of households or respondents. However some trends were evident, e.g. level of trust of information from “expert” sources (especially environmental groups, scientists, and government agencies) tends to increase with the educational level and occupational status of the respondent, and the related income level of the household. At the same time, level of trust in these sources decreases according to the number of elderly people in the household. Trust in information from “vested interests”, especially trades-persons, tends to be greater among non-nuclear family households, especially one-person households. Information from independent sources, such as the Consumers Institute, is trusted equally among all groups and types of respondents (see Figure 4).

Table 1: Likely levels of adoption of DSM measures with provision of accurate information on saving power.

	Number likely to do it	**% of total**
Purchase and use inexpensive devices which would save a moderate amount of electricity	270	65.4
The consumer changing their electricity using habits and practises themselves	215	52.1
Purchase and use devices which change the use of electricity or appliances to off-peak times	211	51.1
The consumer changing the time when they use electricity or appliances	157	38.0
Purchase and use appliances or devices which would save a lot of electricity over time, but would be expensive to buy and install -	72	17.4

Figure 4: Proportion of households indicating a great deal of trust in sources of information about electricity saving



Means Of Obtaining Energy Saving Information

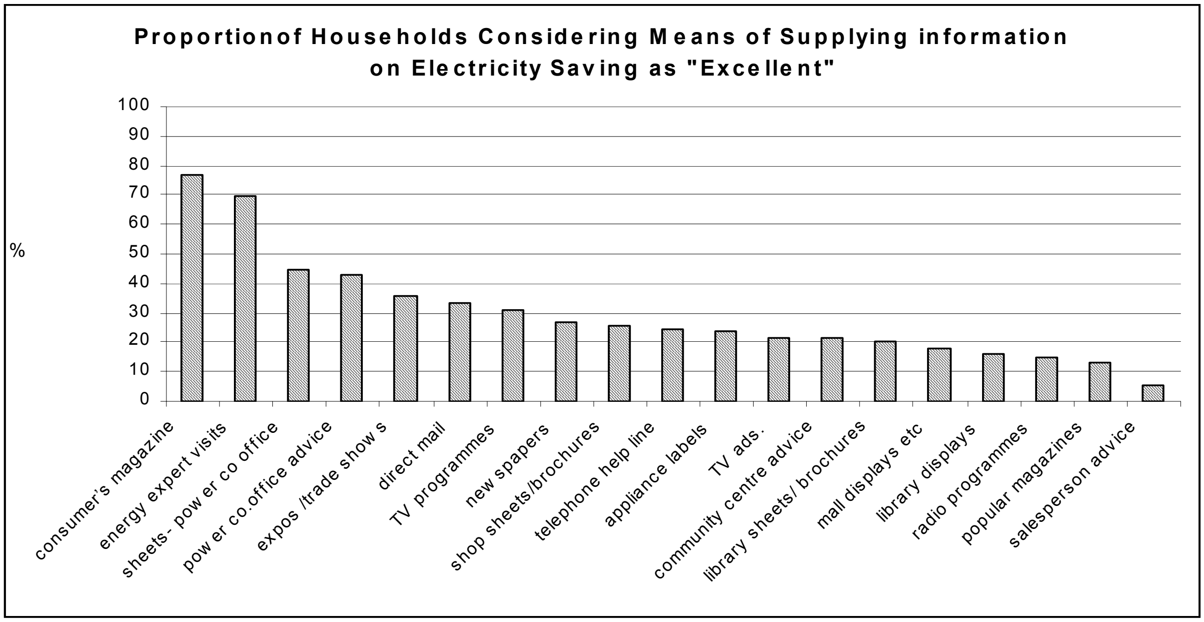
In keeping with the degree of trust in the information source itself, respondents considered Consumer Magazine to be by far the best way, among the methods examined, to get information on electricity saving. A home visit by an energy professional was also considered a particularly good way to get information. For most of the remaining methods, except television advertising, over half of the respondents felt that the method was "okay", and in no case did the majority feel the method was "not good" (see Figure 5).

Cluster analysis indicated that the various forms of information access tend to group around type of access point, rather than the form of delivery (e.g. print etc). Five general types of access were identified:

- householder- focused (consumer magazine and home visit by an energy expert),
- specialists (power company office and home expositions),
- community (libraries, community centres, help lines),
- mass media (print and electronic)
- promotions (retail facilities, and direct mail)

There was a significant correlation between the respondent's average rating of trust of information sources (e.g. environmental groups, scientists, and government agencies) and average rating of the form of provision of that information. In other words, the more a person felt able to trust a source of information, the more likely they were to feel positive about the place or form of access.

Figure 5: Proportion of households considering means of supplying information on electricity saving as ”excellent”



Understanding Appliance Energy Labels

There was generally poor understanding of appliance energy efficiency “star” labels. Just under one fifth of the respondents indicated an understanding of the purpose of the sample label provided and where a particular appliance featuring the label fell in terms of its relative energy efficiency. It was evident from the responses that the star scale/system of rating appliance energy efficiency is, at best, not well understood, and at worst, seriously confusing. People on higher incomes, in better jobs, and in households with other working aged people were found to be more likely than their counterparts to have seen and know the meaning of appliance energy rating labels, whereas elderly people were significantly less likely to have seen and know the meaning of these labels (see Table 2).

Table 2: Understanding Of Sample Appliance Energy Efficiency Label

	Number	% of respondents
full understanding	15	3.9
general understanding	58	15.2
partial understanding	127	33.2
limited understanding	70	18.3
incorrect	53	13.9
didn’t know	59	15.4
Total valid responses	382	100.0

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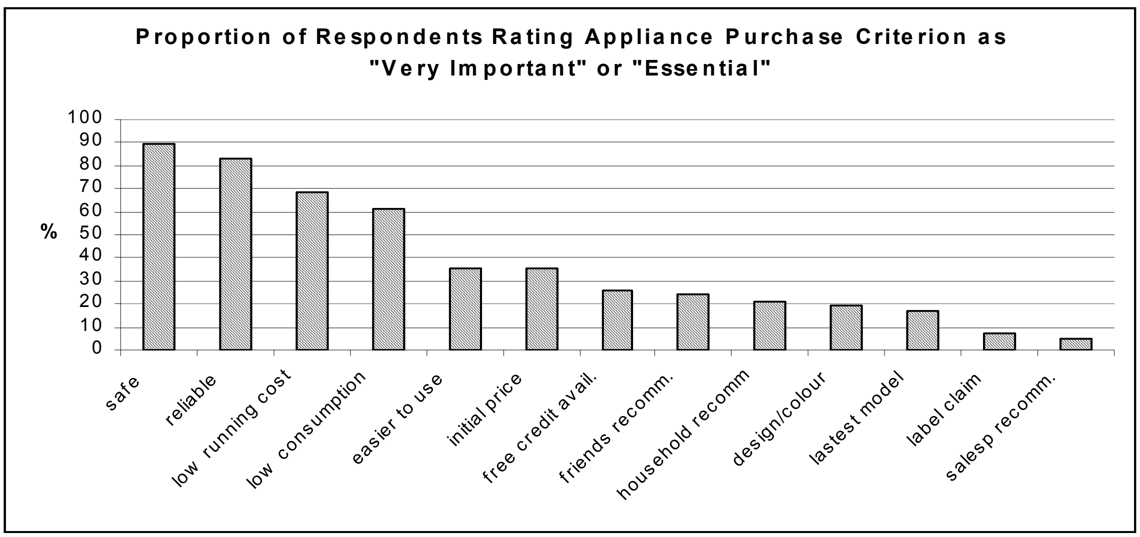
Appliance Purchase Decision-making

Appliance purchase decision criteria were examined in order to assess the relative importance to householders of energy efficiency. These criteria, grouped by cluster analysis (see Figure 6), were:

- essential features – including running cost/energy consumption, safety, and reliability
- the availability of free credit,
- references – including recommendations of friends, and opinions of other household members – and initial price,
- design features – which includes being the latest model with all the modern features, design & colour, and ease of use compared to other models,
- sales claims – such as the sales person's recommendation and comparative claims made on the appliance label.

Figure 6: Proportion of respondents rating appliance purchase criterion as "very important" or "essential"



It was difficult to discern an overall pattern here other than that, when considering an appliance purchase, the higher the household's income and the educational achievement of the respondent (representing the household), the less likely they would be to emphasise the running cost or efficiency of the appliance. Households with children appeared more likely to consider the availability of free credit as important, while elderly people tended to de-emphasise it.

Implications for Decision-makers

It appears, from our findings, clear, credible, and well delivered information would produce similar levels of uptake of energy efficiency measures that require expenditure by the household as would taking the unpopular step of putting up the overall price of electricity by up to 50%. The same applies to load shifting measures and putting up the peak time price of power. However in the case of "no-cost" or behavioural energy saving measures, electricity price increases would induce significantly higher uptake than would an information campaign. At the same time, there is much lower potential for such uptake due the high level of existing adoption. Measures producing apparently trivial savings, or which compromise basic comfort, are of no interest to householders.

Information campaigns and peak time price increases designed to get householders to change their electricity-using routines are likely to be equally unsuccessful. Doing the laundry is the only household activity apparently amenable to change in terms of timing. Inducements such as lower rates for off-peak water heating, are much more likely to work, and appear to have been quite successful to date.

For broad information campaigns promoting energy efficiency to be successful, program designers and deliverers need to:

- present accurate and clear information on costs and benefits of specific measures (rather than energy saving in general);
- focus mainly on the lower cost measures, for which a quick payback is possible and demonstrable, and which most of the population can afford (e.g. cylinder wraps, low energy bulbs);
- ensure that the information is from a credible source – in particular sources which are independent of the energy efficiency product e.g. consumers organisations. Retailers, manufacturers and trades-persons have low public credibility;
- ensure that the information is provided to the consumer appropriately. Independent credible publications such as Consumer Magazine, or home visits by an independent energy expert or advisor (who is not trying to sell something) are best. Energy efficiency promoters should not rely on providing information through retail facilities and salespeople.
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We found that most appliance shoppers want energy efficient appliances and consider energy efficiency when they are deciding on a purchase. But clear independent information, in the form of comparative running costs over time, is not easily available. The current "star" energy labelling of appliances currently used in New Zealand appears ineffective in providing such information about appliances. Such labels are confusing, poorly understood, and provided in the least credible location – the retail store. Information on appliance efficiency needs to meet the same standards as outlined above for energy efficiency measures.

Strategic Significance

This survey shows that the potential benefits from implementing different energy efficiency and management strategies, varies with the level of cost, convenience, incentive and savings involved. This data can be used to:

- create loyalty programmes that target the most profitable customers, e.g. to keep from a competitor
- target the most valuable customers, e.g. to acquire from a competitor
- market energy efficiency and management devices
- promote energy efficient building design
- evaluate potential energy savings by groups of different customers
- target new market sectors for energy saving technologies
- design the optimum electricity tariffs
- identify products and services to invest in

From these results it is possible to classify the dominant customer electricity profile groups according to the different characteristics of the households. These characteristics can also be used to classify each customer's potential for reducing/shifting a sizeable part of his/her electricity load.

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