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Household preferences for energy-saving measures: A conjoint analysis

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Abstract

Studies on household energy use generally focus on social and psychological factors influencing the acceptability of energy-saving measures. However, the influence of physical characteristics of energy-saving measures on their acceptability is largely ignored. In this study, preferences for different types of energy-saving measures were examined, by using an additive part-worth function conjoint analysis. Energy-saving measures differed in the domain of energy savings (measures aimed at home energy savings versus measures aimed at transport energy savings), energy-saving strategy (technical improvements, different use of products, and shifts in consumption), and the amount of energy savings (small versus large energy savings). Energy-saving strategy appeared to be the most important characteristic influencing the acceptability of energy-saving measures. In general, technical improvements were preferred over behavioral measures and especially shifts in consumption. Further, home energy-saving measures were more acceptable than transport energy-saving measures. The amount of energy savings was the least important characteristic: there was hardly any difference in the acceptability of measures with small and large energy savings. Except for respondents differing in environmental concern, there were no differences in average acceptability of the energy-saving measures between respondent groups. However, some interesting differences in relative preferences for different types of energy-saving measures were found between respondent groups.

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1. Introduction

In the last three decades, household energy conservation has been an important topic. While in the 1970s the oil crisis and an imminent energy shortage was the main motive for promoting energy conservation, from the late 1980s the negative consequences of fossil energy use for the environment, in particular global warming, became the principal reason for studying household energy use. An impressive amount of research has given insight into factors influencing household energy use and energy conservation. Many studies have focused on social or psychological factors related to energy-saving behavior, for example by examining the influence of cognitive variables, such as values, worldviews or attitudes towards energy conservation (Black, Stern, & Elworth, 1985; De Young, 1993; Gardner & Stern, 1996; Olson, 1981; Stern, 1992). Other studies stressed the importance of social processes (Cook & Berrenberg, 1981; Georg, 1999; Harland & Staats, 1997). Moreover, a large number of studies focused on the effects of information and various types of feedback on energy-saving behavior (Brandon & Lewis, 1999; Geller, Winett, & Everett, 1982; Midden, Meter, Weenig, & Zievering, 1983; Van Houwelingen & Van Raaij, 1989; Weenig, Schmidt, & Midden, 1990). In addition to the above-mentioned factors, characteristics of energy-saving measures themselves may influence the adoption of these measures. Although a distinction between behavioral and technical measures is often made (Gardner & Stern, 1996; Samuelson, 1990), little is known about the effects of these and other characteristics on the success of adopting these measures.

The present study is aimed at examining the influence of the characteristics of various measures on their acceptability by means of a conjoint analysis (e.g. Green & Srinivasan, 1978; Louviere, 1988; Luce & Tukey, 1964; see also the Data Analysis section). Conjoint analysis is a popular statistical technique in consumer research to examine people's preferences for products. However, to the authors' knowledge, it has not been applied to examine preferences for energy-saving measures. Conjoint analysis can be used to determine the importance of various measure characteristics for preferences about such measures.

In this paper, first, several strategies to reduce household energy use will be discussed. Next, results are presented of a study examining various measure characteristics influencing preferences for energy-saving measures.

1.1. Household energy-saving measures

Energy-saving measures may be characterized in various ways. In this study, energy-saving measures are characterized by the *domain* of energy savings (measures aimed at home energy savings versus measures aimed at transport energy saving), the *strategy* of energy-savings (technical improvement, different use of products, and shifts in consumption), and the *amount* of energy savings (small versus large).

1.1.1. Domain: Home and transport energy-saving measures

Households use energy for a wide range of activities. Two different domains of household activities can be distinguished: *indoors* and *outdoors*. According to Van Diepen (2000), this distinction reflects the difference between sojourning in space (indoors) and the bridging of space (outdoors). Generally, activities in both domains require energy. Indoor activities are located at home and include activities such as home heating, lighting and the use of household appliances. Indoor energy use in the Netherlands has significantly increased during the last decades (Noorman & Schoot Uiterkamp, 1998; Steg, 1999). Outdoor activities concern mainly transportation by any means, for example, for commuting, shopping, leisure activities, and holidays. Transport has become increasingly important. Tieleman (1998) even describes (motorized) transport as an inevitable part of modern life. The total energy use for traffic and transport in the Netherlands has increased substantially by about 30% the last decade (CBS, 2001), and accounts for the largest part of the increase of household energy use (Schipper, 1993). Indoor and outdoor energy savings may have different consequences for people's quality of life, and consequently, for the acceptability of such measures.

1.1.2. Strategy: Technical and behavioral energy-saving measures

Several strategies can be used to reduce household energy consumption. First, a distinction can be drawn between behavioral and technical energy-saving measures (Samuelson, 1990; Stern & Gardner, 1981), which have different psychological properties (Gardner & Stern, 1996). Technical measures are generally seen as an expensive way to reduce energy use, because they often require an initial investment. But, in the long term, technical measures may be cost saving. For example, an energy-efficient car may seem quite expensive. However, with an energy-efficient car one can save substantially on fuel costs. Moreover, this energy-saving measure hardly requires behavioral change. One can perform the same travelling behavior, only using less fuel. On the other hand, behavioral measures are often associated with additional effort or decreased comfort. For example, to reduce car use an individual needs to adjust his or her lifestyle, which may require effort and may result in decreases comfort. Therefore, there may be differences in acceptability of technical and behavioral energy-saving measures.

Second, a distinction can be drawn between the reduction of direct and of indirect energy use. Traditionally, measures aimed at reducing direct energy use (i.e., the use of gas, electricity and car fuel) have attracted most attention (Brandon & Lewis, 1999; Gardner & Stern, 1996; Steg, 1999). However, more than half of households' energy use is consumed in an indirect way (Noorman & Schoot Uiterkamp, 1998; Vringer & Blok, 1995a). Substantial energy savings could be achieved via this route. Indirect energy is the energy needed for the manufacturing, transportation and disposal of goods and services, which are consumed by households. Indirect energy use can be reduced by consuming less energy-intensive products, by shifting expenditures to goods with a lower energy intensity, or by shifting expenditures from energy-intensive goods to energy-extensive services. [1] For example, since most flowers are grown in gas-heated greenhouses, flowers are rather energy-intensive products. Giving less energy-intensive presents (such as CDs) instead of flowers will actually save energy. Likewise, contracting out of domestic services, eating no greenhouse vegetables, and eating less meat will reduce indirect energy use, as long as these expenditures are not substituted with other, more energy intensive products (Vringer & Blok, 1995b).

Thus, the following energy-saving strategies can be distinguished:

(1) improving the energy-efficiency of products,
(2) different use of products,
(3) shifts in consumption.

The first two strategies are aimed at reducing direct energy use. Improving the energy efficiency of products implies reducing direct energy use by means of technical improvements. A different use of products refers to behavioral strategies to reduce direct energy use. Generally, this option constitutes a less intensive use of products. The third option, shifts in consumption, implies a reduction of indirect energy use. Shifts in consumption can also be characterized as behavioral change.

1.1.3. Amount: Effectiveness of energy-saving measures

Not all energy-saving measures are equally effective. For example, buying a more energy-efficient heating system saves more energy than applying radiator insulation, and reducing car use is more effective than car pooling (see Poortinga et al., 2001). Cooperation with energy scientists is needed to get data on the amount of energy reduction of specific energy-saving measures. The effectiveness of a measure is determined by calculating the average amount of energy saving (for a more detailed description of the calculations, see Poortinga et al., 2001). Energy figures have been expressed in terms of primary energy use. That is, the energy needed for the production of electricity is taken into account (see Poortinga et al., 2001).

2. Aim of the study

The aim of this study is to examine which characteristics of measures influence household preferences for energy-saving measures. A conjoint analysis was used to examine in what way three characteristics corresponding to strategy, domain and

[1] Energy intensity is a measure of the amount of energy required for producing, transporting and disposing of a product or service, which is bought for a certain amount of money. The energy intensity is expressed in Mega Joules per currency unit (Biesiot & Noorman, 1999; Vringer & Blok, 1995a,b).

amount influence the acceptability of energy-saving measures. A second aim was to examine whether preferences for energy-saving measures are related to various socio-demographic variables (viz. age, sex, household type, income, and level of education) and to environmental concern. The new environmental paradigm scale (Dunlap & Van Liere, 1978; Stern, Dietz, & Guagnano, 1995) is widely used for measuring people's general environmental concern. Although there is some discussion on the dimensionality of the NEP scale (see e.g. Noe & Snow, 1990), in this study the NEP will only be used as a measure to discriminate between people with a "high" and a "low" environmental concern.

3. Method

3.1. Respondents and procedure

A survey study was conducted during October and November 1999. This survey was aimed at evaluating future scenarios with respect to household energy consumption, containing various combinations of energy-saving measures. The scenarios varied systematically on the domain of energy savings (home versus transport), energy-saving strategy (technology, behavior and a combination of the two) and on the amount of energy savings (small versus large reduction of household primary energy use). The energy-saving measures used in the scenarios were also evaluated separately as to their acceptability. Energy scientists provided data on the amount of energy reduction of specific energy-saving measures (see Poortinga et al., 2001). In the present study, only the data with regard to the separate energy-saving measures are used.

Two thousand addresses were randomly selected via the Dutch postal services (PTT). The households were sent a questionnaire along with a cover letter, informing them about the study and inviting them to participate. After three weeks a reminder was sent to the selected households. Of the households invited to participate in this study, 455 (22.8%) returned a completed questionnaire. All respondents were 20 years or older. Compared to a national sample (CBS, 1999a), male respondents and respondents in the category of 40 through 64 years were slightly overrepresented. The level of education of the respondents was higher than the national average. Likewise, high incomes were overrepresented and low incomes were underrepresented (see Poortinga et al., 2001).

3.2. Measures

3.2.1. Energy-saving measures

Respondents were asked to indicate on a 5-point Likert-scale to what extent they found 23 different energy-saving measures acceptable (see Table 1). The scale ranged from 1: "unacceptable" to 5: "very acceptable". The energy-saving measures varied on the three attributes discussed in the Introduction section, as follows:

Table 1
Average acceptability of 23 energy-saving measures and their characteristics

Energy-saving measure	Domain	Strategy	Amount	Mean	SD
Switching off lights in unused rooms	H	2	+	4.6	0.68
Appliances not on stand-by	H	2	+	4.4	0.87
Energy-efficient heating system	H	1	++	4.3	0.94
Walking or cycling short distances (<$2\frac{1}{2}$ km)	T	2	++	4.3	1.00
House insulation	H	1	++	4.3	0.89
Line drying of laundry	H	2	++	4.0	1.13
Compact fluorescent light bulbs (CFLs)	H	1	+	4.0	0.94
Applying radiator insulation (foil)	H	1	+	4.0	0.99
Energy-efficient refrigerator	H	1	+	3.9	1.01
Shorter showers	H	2	++	3.6	1.10
Walking or cycling short distances (<5 km)	T	2	++	3.6	1.18
Econometer in car	T	1	+	3.6	1.16
Energy-efficient car	T	1	++	3.4	1.15
Car-pooling	T	2	+	3.4	1.33
Drive at most 100 km/h on the highway	T	2	+	3.3	1.35
Using public transport	T	2	++	3.2	1.42
No greenhouse vegetables	H	3	+	3.1	1.14
Thermostat maximally 18 °C	H	2	++	3.1	1.27
Energy-extensive presents (no flowers)	H	3	+	2.9	1.19
Rinsing the dishes with cold water	H	2	+	2.9	1.31
Holiday by train	T	3	+	2.8	1.32
Altering food pattern	H	3	+	2.7	1.26
Hiring a housekeeper	H	3	++	2.7	1.31

Note: The scale ranged from 1 "unacceptable" to 5 "very acceptable".
Note: H: home measures, T: transport measures, 1: increasing energy efficiency (technical measures), 2: a different use of products (behavioral measures), 3: shifts in consumption (behavioral measures), +: small energy saving; ++: large energy saving.

(a) *Domain* (two levels): home energy-saving measures versus transport energy-saving measures.
(b) *Strategy* (three levels): increasing energy-efficiency, different use of products, and shift in consumption.
(c) *Amount* (two levels): small versus large energy saving. Respondents were informed about the amount of energy reduction per option.

3.2.2. Environmental concern

The new environmental paradigm scale (NEP; Dunlap & Van Liere, 1978) was used to measure environmental concern. This scale is composed of 12 items. Respondents indicated to what degree they agreed with each statement on a 5-point scale, ranging from 1: "totally disagree" to 5: "totally agree". The environmental-concern variable was calculated by adding up the scores across the 12 items of the NEP scale. The resulting scores could range from 12 (low environmental concern) to 60 (high environmental concern), with a score of 36 at the midpoint. Average environmental concern was high ($M = 47.8$; SD = 6.36). The internal consistency of the NEP scale appeared to be sufficient (Cronbach's alpha = 0.76). The distribution of respondents over the NEP-scale appeared to be quite skewed. The scores of almost all respondents could be found on the right hand side of the midpoint value. A high environmental concern has been found before in the Netherlands (see e.g. Steg, 1999; Vlek, Skolnik, & Gatersleben, 1998).

In order to distinguish between respondents with either high or low environmental concern, respondents were categorized by using a median-split procedure (median = 48). Respondents with a low environmental concern had scores of 48 or less ($N = 245$), and respondents with a high environmental concern had scores on NEP higher than 48 ($N = 206$).

3.3. Data analysis

3.3.1. Conjoint analysis

A conjoint analysis was conducted to examine which characteristics of the 23 energy-saving measures (i.e., strategy, domain, amount) are most influential with respect to their acceptability. Conjoint analysis is a technique to explain consumers' preferences in an indirect way (Acito & Jain, 1980; Green & Srinivasan, 1978; Haaijer, 1999; Louviere, 1988; Luce & Tukey, 1964; Wierenga & Van Raaij, 1987). Conjoint Analysis is a decompositional method that estimates the structure of consumers' preferences (Green & Srinivasan, 1990). The basic idea of a conjoint analysis is that the preference for a particular stimulus is built up by the separate (i.e. independent) contributions of different attributes, each with a limited number of levels. In this study an additive part-worth function model was used, which means that the acceptability of energy-saving measures was taken to be the sum of contributions of *domain*, *strategy* and *amount* of energy saving. [2] These factors had two, three, and two levels, respectively (see Table 1). By varying the combination of attribute levels systematically, the contribution of each attribute can be derived from the overall acceptability judgments. First, conjoint analysis estimates the contribution of the attribute levels to the overall evaluation for each respondent separately. These are called the part-worth scores. Second, the relative importance of an attribute can be calculated from the part-worth scores. The range of part-worth scores of a characteristic gives an indication of the importance of the characteristic: the higher the range, the more important an attribute is for overall acceptability. The relative importance of a characteristic is determined by comparing its range of part-worth scores to the total range of part-worth scores.

In a full factorial design, all combinations of attribute levels are evaluated (three attributes, two having two levels, and one with three levels yield $2 \times 2 \times 3 = 12$ stimulus combinations). However, it is not always necessary to present all combinations. If only main effects are required, a fractional factorial design can be used, in which only a limited number of combinations are evaluated (Louviere, 1988). In the present

[2] There are three conjoint analysis models, which assume different composition rules. That is, a part-worth function, an ideal point, and a vector model. For an overview, see Green and Srinivasan (1978).

study, a fractional factorial design with 11 types of combinations of characteristics was used. A fractional design may disturb the orthogonality of the design, which may lead to collinearity problems. However, in this case, collinearity is not a problem. [3]

Respondents were asked to indicate the acceptability of 23 energy-saving measures (see Table 1). Note that some measures had the same combination of attribute levels. All measures were used in the conjoint analysis. The average acceptability scores of measures with the same combination of attribute levels were used in the analysis.

3.3.2. Analyses of variance

In order to examine whether various respondent groups differed in their acceptability ratings for the different types of energy-saving measures, several analyses of variance (ANOVAs) were conducted, with the constant (reflecting the average acceptability of the energy-saving measures) and the part-worth scores of the three attributes (reflecting the contributions of the different attribute levels to the overall acceptability) as dependent variables. Note that the part-worth scores of attributes with two levels (domain and amount) are perfectly negatively correlated, and that therefore the results of the ANOVAs will be exactly the same for both levels. So, for the domain and amount attributes only an ANOVA on one level will be conducted. For the attribute with three levels (strategy), ANOVAs will be conducted on all levels. [4] The analyses were conducted for socio-demographic variables, that is, age, sex, income, level of education, and household type, and for environmental concern (Dunlap & Van Liere, 1978; Stern et al., 1995).

[3] Collinearity is the situation in which the correlations between the factors used are too high. High correlations between the factors make it difficult to determine the importance of these factors, because they are confounded due to the intercorrelations (see Stevens, 1992). Correlations between the factors used are expressed by means of Cramer's V. The value can range from 0 to 1, with 0 indicating that there is no association between the row and column variables, and with 1 indicating that there is a perfect association between the variables. Cramer's V statistics revealed the following association between the factors domain, strategy, and amount.

	Domain	Strategy	Amount
Domain	1		
Strategy	0.224	1	
Amount	0.096	0.270	1

Although the factors are not completely orthogonal, the correlations between the three characteristics are not disturbingly high. So, in this case, collinearity is not a problem.

[4] The results of the ANOVAs for the three levels of strategy should be treated with some caution, because they are not independent of one another: the part-worth score of one level is perfectly negatively correlated with the linear combination of the part-worth scores of the two other levels.

4. Results

4.1. Acceptability of energy-saving measures

Table 1 shows the average acceptability judgments of the 23 energy-saving measures. The measures are ordered from most to least acceptable. Overall, most measures were evaluated as (quite) acceptable. Switching off lights in unused rooms, keeping appliances not on stand-by and an energy-efficient heating system were evaluated as the most acceptable, while respondents thought that holidays by train, altering food patterns and hiring a housekeeper were not very acceptable.

Table 2 shows the results of the conjoint analysis. It appeared that the model had a reasonably good fit (Pearson's $R = 0.72$).

The average acceptability of the energy-saving measures, as represented by the constant, was 3.43, on the 5-point scale. Table 2 shows that Strategy was the most important characteristic to explain the variation in acceptability of energy-saving measures across all respondents. [5] Part-worth scores reveal that technical energy-saving measures were evaluated most positively. Shifts in consumption (behavioral measures aimed at reducing indirect energy use) were evaluated most negatively. Behavioral measures aimed at reducing direct energy use took a middle position. Domain of energy savings was evaluated moderately. On the average, home energy-saving measures were more acceptable than transport energy-saving measures. It appeared that amount was the least important. Part-worth scores reveal that there is hardly any difference between the acceptability of measures with small and large energy savings.

4.2. Differences between respondent groups

Table 3 presents the constant and the average part-worth scores of the characteristic levels for various respondent groups. It was found that various socio-demographic groups and people differing in environmental concern preferred different types of energy-saving measures. The average acceptability of the energy-saving measures only differed between people differing in environmental concern. People with high environmental concern evaluated the energy-saving measures on average as more acceptable than did people with low environmental concern.

Differences in the acceptability of home and transport energy saving were found between groups differing in age ($F(2,442) = 13.51$, $p < 0.001$), household type ($F(2,440) = 8.59$, $p < 0.001$), and income ($F(2,433) = 7.08$, $p < 0.001$). All respondent groups evaluated home measures as more acceptable than transport measures. However, home measures were relatively more acceptable for respondents aged

[5] The contribution of energy-saving strategy might be slightly overestimated, for this characteristic had a higher number of levels than the other two characteristics. This is called the number-of-levels effect (Haaijer, 1999). The exact impact of the number-of-level effect on the results is not known. Also, there seems not to be a clear-cut solution for this problem (other than simply assigning the same number of level to all the attributes beforehand).

Table 2
The average importance of the characteristics for the acceptability of the energy-saving measures and the average part-worth scores

Characteristic	Average importance	Level	Average part-worth scores
Domain	25.2	Home	0.15
		Transport	−0.15
Strategy	58.4	Efficiency	0.43
		Different use	0.24
		Consumption shift	−0.66
Amount	16.4	Small	0.01
		Large	−0.01
		Constant	3.43

Table 3
Average part-worth scores of various respondent groups

	Constant	Domain		Strategy			Amount	
		H	T	1	2	3	+	++
Age								
20–39	3.32	0.26**	−0.26**	0.49*	0.20	−0.69	0.00	−0.00
40–64	3.45	0.13**	−0.13**	0.44*	0.24	−0.67	0.01	−0.01
65+	3.54	0.02**	−0.02**	0.28*	0.29	−0.58	−0.01	0.01
Sex								
Male	3.39	0.14	−0.14	0.45	0.22	−0.67	−0.01	0.01
Female	3.49	0.16	−0.16	0.40	0.26	−0.66	0.03	−0.03
Household type								
Single	3.50	0.05*	−0.05*	0.31*	0.26	−0.57	−0.02	0.02
Couple	3.44	0.15*	−0.15*	0.45*	0.23	−0.68	0.01	−0.01
Family	3.38	0.22*	−0.22*	0.48*	0.23	−0.71	0.02	−0.02
Income								
Low	3.48	0.04**	−0.04**	0.28**	0.39**	−0.67	0.01	−0.01
Average	3.43	0.14**	−0.14**	0.38**	0.28**	−0.66	0.03	−0.03
High	3.41	0.21**	−0.21**	0.56**	0.12**	−0.68	−0.02	0.02
Level of education								
Low	3.28	0.12	−0.12	0.32	0.47**	−0.79	0.01	−0.01
Intermediate	3.39	0.18	−0.18	0.43	0.25**	−0.68	0.01	−0.01
High	3.49	0.14	−0.14	0.46	0.16**	−0.62	0.00	−0.00
Environmental concern								
Low	3.30**	0.18	−0.18	0.45	0.21	−0.66	−0.02*	0.02*
High	3.57**	0.12	−0.12	0.40	0.26	−0.66	0.04*	−0.04*

Note: H: home measures, T: transport measures, 1: increasing energy efficiency (technical measures), 2: a different use of products (behavioral measures), 3: shifts in consumption (behavioral measures), +: small energy saving, ++: large energy saving.

$^{*}p < 0.01$.

$^{**}p < 0.001$.

20 through 39 years, while respondents aged 65 years and older found home measures the least acceptable. Because there is a perfect negative correlation between the two levels of the domain attribute, the opposite applied to the acceptability of the transport measures. Couples and families found home measures relatively more acceptable than singles did, while transport measures were more acceptable for singles than for couples and families. Home measures were also relatively more acceptable (and transport measures less acceptable) for respondents with a high and average income than for respondents with a low income. Differences in acceptability of measures differing in energy-saving strategy were found between groups differing in age, household type, income, and level of education. Couples and families found technical improvements more acceptable than singles did ($F(2, 440) = 6.22$, $p < 0.01$), while respondents aged 65 years and older found technical improvements relatively less acceptable than did the other age groups ($F(2, 442) = 6.04$, $p < 0.01$). Technical improvements were most acceptable for respondents with a high income ($F(2, 433) = 16.85$, $p < 0.001$), while behavioral measures aimed at reducing direct energy were the least acceptable for high incomes ($F(2, 433) = 16.19$, $p < 0.001$). Moreover, behavioral measures were relatively more acceptable for respondents with a low level of education than for respondents with an average or high level of education ($F(2, 433) = 17.60$, $p < 0.001$). Only respondents differing in environmental concern differed in their acceptability judgments of small and large energy-saving measures. Respondents with a high environmental concern found measures with small energy savings relatively more acceptable than measures with large energy savings, while the reverse applied to respondents with a low environmental concern ($F(1, 444) = 9.14$, $p < 0.01$).

5. Discussion

The aim of this study was to examine the influence of characteristics of energy-saving measures on their acceptability. Further, the relationships between preferences for different types of energy-saving measures and various socio-demographic variables and environmental concerns of the respondents were examined.

It appeared that the strategy of energy saving was the most important characteristic contributing to the acceptability of energy-saving measures across all respondents. In general, technical measures were more acceptable than behavioral measures, and measures aimed at reducing direct energy use were more acceptable than were measures aimed at reducing indirect energy use. Shifts in consumption (i.e., behavioral measures aimed at reducing indirect energy use) appeared to be the least acceptable. This may be due to the fact that people may not understand that this type of measure saves energy, because they do not take into account indirect energy use. Moreover, shifts in consumption may be less acceptable because they are generally not very economical. Most indirect energy-saving measures are relatively expensive and imply a considerable change in consumption patterns, while the amount of energy savings is often relatively small. Whether the energy was saved indoors or outdoors appeared to be moderately important. Home energy-saving measures were more acceptable than transport energy-saving measures. It would be interesting to examine why transport measures evoke more resistance. An explanation might be that transport is being used for many purposes, and that, consequently, energy saving transport measures will have consequences for (many) highly valued activities, such as going to work, maintaining social relations and recreation. Interestingly, the amount of energy saving appeared not to be an important factor. Apparently, consumers consider other factors than the effectiveness of energy saving to determine whether an energy-saving measure is acceptable or not. In this study, the average amount of energy that would be saved by adopting the measures was determined, as it was not possible to calculate individualized energy savings with the available data. In point of fact, the effectiveness of a measure is dependent on many factors. For example, an energy-efficient heating system is more effective in a badly insulated house than in a well-insulated house. Individualized calculations of energy savings may give better insight into the relationship between the amount of energy saved and the acceptability of the energy-saving measures.

An interesting result was that, except for respondents differing in environmental concern, there were no differences in average acceptability of the energy-saving measures between (socio-demographic) respondent groups. However, some interesting differences in relative preferences for different types of energy-saving measures were found between various respondent groups.

Older individuals evaluated transport measures as relatively more acceptable (and home measures as relatively less acceptable) than did younger individuals. This result is not surprising, since in general older respondents are less mobile (CBS, 1999b; Poortinga et al., 2001). Likewise, families and couples evaluated transport measures as less acceptable (and home measures as more acceptable) than singles did, and high-income respondents evaluated transport measures as less acceptable (and home measures as more acceptable) than low and average-income respondents did. Probably, this follows from the fact that families and couples travel more by car than singles do (CBS, 1998), and respondents with a higher income travel more by car than do respondents with a low income (see CBS, 1999b; Poortinga et al., 2001). So, these results indicate that energy-saving measures are less acceptable when they have more palpable impacts.

People with a high income found technical measures relatively more acceptable than did people with a low or average income. This might be explained by the fact that technical measures often require an initial investment, which might be less problematic for the higher-income groups. Also, respondents aged 20 through 39 and respondents aged 40 through 64 thought that technical improvements were relatively more acceptable than respondents aged 65 years and older, and families and couples found technical measures relatively more acceptable than singles did. An analysis of covariance revealed that these differences could be largely attributed to differences in income. After correcting for the influence of income, no significant differences in acceptability of technical measures between age groups and different household types were found. On the other hand, behavioral measures aimed at reducing direct energy use were more acceptable to respondents with a low income and to respondents with a low level of education. Possibly, behavioral measures are more acceptable to people with a low income and to people with a low level of education, because these measures are generally cost saving. Moreover, seeing that behavioral measures often constitute a less intensive use of products, and considering that low-income and low-education groups generally have fewer appliances, behavioral measures may be less far-reaching for these groups.

Conspicuously, people with a high environmental concern evaluated measures with small energy savings as being relatively more acceptable than measures with a large amount of energy savings. The opposite applied to respondents with a low environmental concern. Although this is only a very small effect, these results seem counter-intuitive. One would expect that individuals with a high environmental concern would favor measures with large energy savings. These results might be explained by using the distinction between environmentally significant behavior that is defined by its impact and environmentally significant behavior that is undertaken by the actor with the intention to improve the environment (Stern, 2000). The amount of energy saving is an indicator that is most interesting from an environmental impact point of view. However, people probably undertake energy saving actions that are based on more popular notions of pro-environmental behavior. Measures with small energy savings, such as switching off lights in unused rooms and appliances not on stand-by, can be highly symbolic. Especially people with a high environmental concern may feel that at least these energy-saving measures should be adopted.

Conjoint analysis appeared to be a useful method for examining which measure-characteristics influence people's preferences for energy savings. That is, it reveals some interesting findings regarding the acceptability of energy-saving measures with respect to *where* the energy saving is achieved, *how* it is achieved, and *how much* energy is saved. However, one should consider that the results of the conjoint analysis might be affected by the modest response rate, whereby the sample was not completely representative for the Dutch population. Since high incomes, people with a high level of education, and people aged 40–64 were overrepresented, the contributions of technological and transport measures to the overall acceptability may be somewhat overestimated and the contributions of behavioral and home measures underestimated. Moreover, conjoint analysis appeared to be a suitable method for revealing differences in the acceptability of various types of energy-saving measures between various respondents groups.

This study focused mainly on differences in acceptability of energy-saving measures, and less on the reasons why different types of energy-saving measures are acceptable. Future research should examine more closely what psychological, social, physical and financial characteristics are of importance for judgments of the acceptability of various types of energy-saving measures. Future research could focus on factors that influence the difficulty to adopt energy-saving measures (cf. Bagozzi, Yi, & Baumgartner, 1990; Green-Demers, Pelletier, & Menard, 1997; Schultz & Oskamp, 1996). The present study suggests some factors that may be of importance. First, measures that are not far-reaching (i.e., which do not constitute a change in lifestyle) may be the most acceptable. For example, it appeared that technical measures were more acceptable than behavioral measures and shifts in consumption.

According to Gardner and Stern (1996), technical measures are easier to apply, because they often only constitute a one-time action (i.e., the purchase), while behavioral measures require continuous effort. Second, an energy-saving measure may only be acceptable if one can afford it. This study also showed that technical measures were relatively less acceptable for low-income respondents. As discussed before, technical measures often require an initial investment, which may be a burden for respondents with a low income. In other words: technical measures are more difficult to achieve for people with low incomes. Third, energy-saving measures may be more acceptable if it seems apparent that they are beneficial for the environment. Because the relation between indirect energy-saving measures and the environment is less clear, they may be less acceptable than direct energy-saving measures. The acceptability of indirect energy-saving measures may be increased by implementing complementary policy measures aimed at increasing knowledge about this type of energy use. From a policy point of view, this might be an interesting route to follow, since more than half of the total household energy use is consumed in an indirect way (Noorman & Schoot Uiterkamp, 1998; Vringer & Blok, 1995a; VROM, 1999).

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