PURCHASE BEHAVIOUR RELATED TO HEATING SYSTEMS IN GERMANY WITH SPECIAL CONSIDERATION OF CONSUMERS' ECOLOGICAL ATTITUDES

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Abstract:
The decision for purchasing a heating system is a long-term one, as many different aspects have an influence on this choice. These different aspects were analyzed in a Germany-wide, written survey. The respondents (only owners of a private house) had to answer questions about their attitude towards e. g. economic, convenience or ecological aspects related to heating systems and the respective combustibles. Using a multinomial logistic regression model the choice of the heating system can mainly be explained by ecological attitudes and the assessment of different combustibles.

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1 Domestic heating system as an example for a long-life consumer good

In Germany nearly 87 % of all residential households have installed their own heating system (Statistisches Bundesamt 2006). However, several reasons urge 2 million owners to replace their old heating system each year. Some of these reasons are:

- new legal regulations (e. g. about respirable dust)
- an excessive fuel consumption
- the old heating system being out of order.

As various kinds of heating systems (e. g. oil-fired heating, gas heating, wood-pellet heating and heat pump) are available on the market nowadays, it is of particular interest for the different market participants (e.g. producers of boilers or fuel traders) to know why consumers choose a certain heating system.

Therefore, based on the theory of purchase behaviour regarding long-life consumer goods a nationwide survey among house owners in Germany was carried out in order to analyze which personal and situational factors (Kupsch et al. 1978) determine the choice of a certain heating system. However, special attention was turned to the consumers` ecological attitudes as they become more and more crucial for the decision-making-process (Knappich 1999; Kuckartz et al 2006).

2 Empirical analysis of the purchase behaviour related to heating systems

In the following the empirical approach used for analyzing the purchase behaviour towards heating systems is described. In a first step the factors which could influence the purchase behaviour of heating systems and which should therefore be considered in the survey are identified. Secondly, details of the data gathering process are provided. Finally, a logistic regression model is developed in order to analyze the influences of different aspects for purchasing a heating system.

2.1 Parameters influencing the purchase behaviour related to heating systems

Based on different literature sources (Hansen 1972; Kupsch et al. 1978; Nieschlag et al. 2002; Frondel et al. 2006; Breidenbach 2008; Hofmann et al. 2008) the reasons for buying a long-life consumer good were identified and – by means of 15 expert interviews (chimney sweepers, members of the heating industry, heating contractors) - adapted on the purchase of a domestic heating system. The four parameters influencing the purchase of a heating system are:

- Characteristics of the combustible
- Socio-demographic characteristics of the consumer
- Individual conditions
- Individual attitudes (“attitudes towards a heating system” and “ecology cluster membership”).

One important reason for the choice of a heating system is the nature of the combustible used in the heating system and its assessment from the individual consumer. Operational reliability, level of prices, availability, environmental emissions, handling and perceived image are some of the aspects which have an impact on the consumers` assessment of a combustible.

Especially the charge for the fuel is an important running cost factor. In order to run the heating system on low costs, the costs of different fuels as well as their future price development are important factors for the decision for or against a certain heating system.

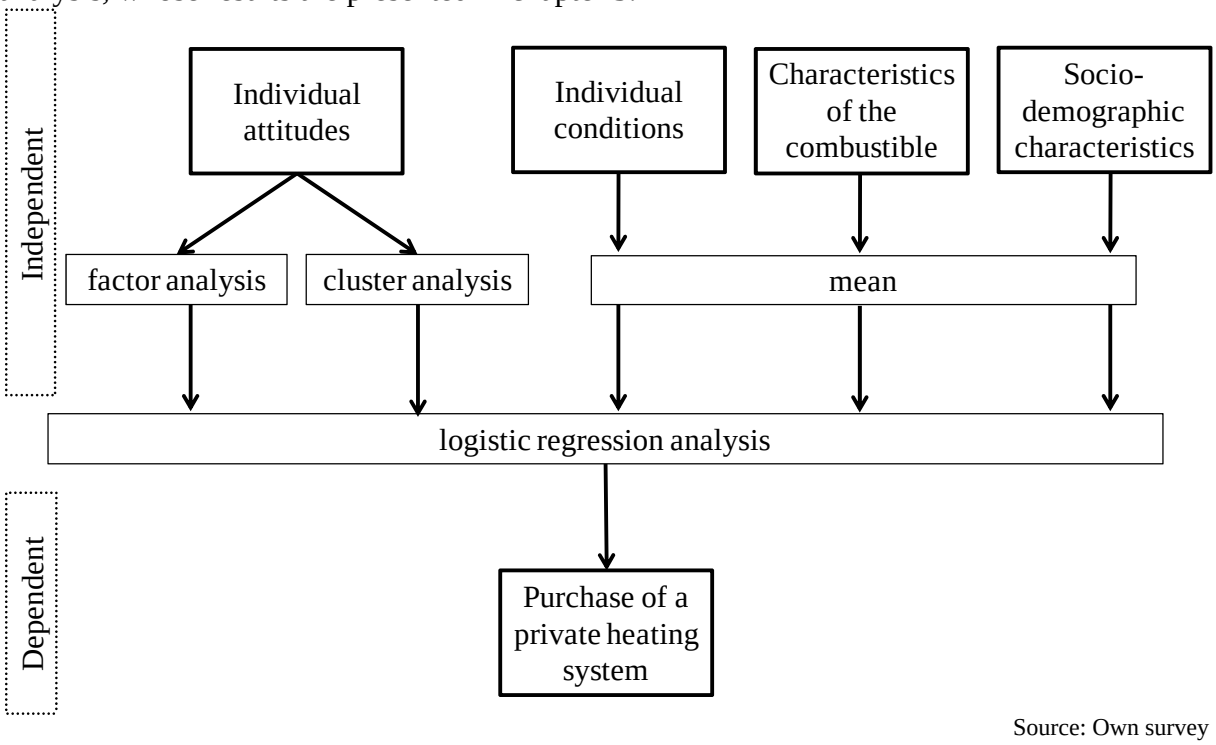
Another important factor represents the socio-demographic characteristics of the consumers. Features like income, household size and age influence the choice of a heating system. If e. g. a household´s average income is quite low, it is very likely that the house owner cannot afford expensive heating systems like e. g. a heat pump.

Other factors influencing the purchase of a heating system are attributed to the conditions which prevail in the individual houses, respectively surroundings. For example “the age of the house” and the corresponding “needed power of the heating system [kW]” are part of this group.

Yet another major influence on the choice of a certain heating system is the house owner`s personality and attitudes. These individual attitudes can be distinguished into several main topics. On the one hand, there are these attitudes which are directly connected to a heating system. In this case, one can differentiate between attitudes which relate to the situation before the purchase of a heating system and the attitudes when operating the new heating system. On the other hand, attitudes towards ecology, environment and sustainability in general influence the decision making process for a new heating system.

2.2 Data gathering and analysis

In spring 2007, 4,500 house owners with different heating systems (oil-fired heating, gas heating, wood-pellet heating and heat pump) were questioned in a nationwide, written survey about the choice of their current heating system, as well as their attitudes towards several combustibles and environmental aspects. With 1,176 returned and applicable questionnaires the survey had a response rate of 26.1 %.
Based on this survey it was analyzed which of the parameters (described in chapter 2.1) best explain the choice of a certain heating system (see figure 1). For that purpose a logistic regression model was defined. The basic idea of this analytical method is the calculation of the probability that a certain event occurs by fitting data to a logistic curve (Urban 1993: 75 ff.; Backhaus et al. 2005: 426 ff.). However, carrying out a logistic regression requires completely filled in questionnaires. Therefore, finally 775 data sets could be used for the analysis, whose results are presented in chapter 3.

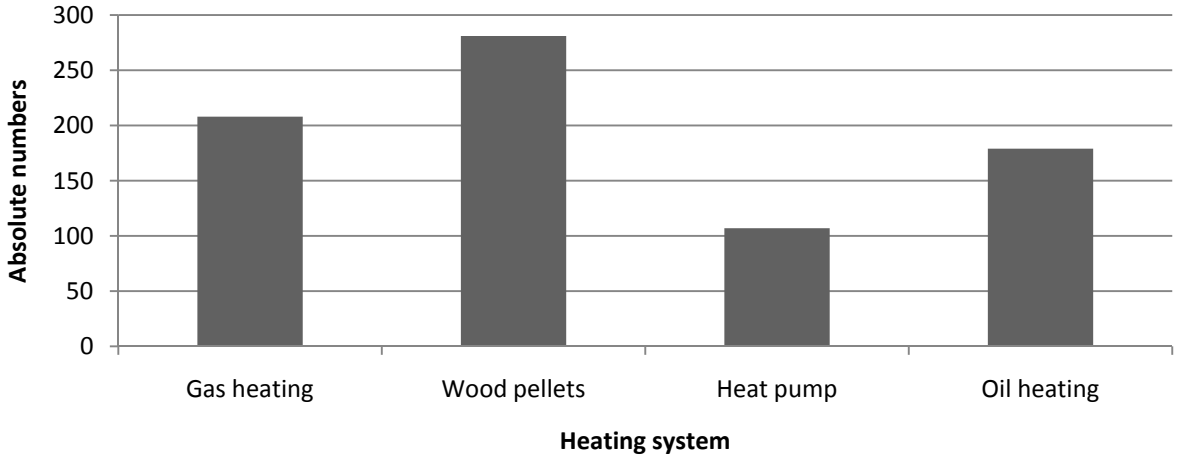


Source: Own survey

Figure 1: Elements of the applied model

3 Purchase behaviour related to heating systems

The distribution of the respondents with respect to their choice of a heating system was quite uniform. The group using heat pumps merely has a minor share of 13.8 % (figure 2). But this fact does not affect the quality of the logistic regression´s result (Backhaus et al. 2005: 426ff).



Source: Own survey

Figure 2: Distribution of the respondents according to their heating system (n =775)

The logistic regression was carried out with 27 variables of the four groups of parameters described in chapter 2.1.
All data for the variables of the categories “characteristics of the combustible”, “individual conditions” and “socio-demographic characteristics of the consumers” were directly taken from the survey (with average determination; see figure 1). By contrary, results for the variables of the category “individual attitudes” were condensed, either by using factor analysis (attitudes towards a heating system) or cluster analysis (ecology cluster membership).

3.1 Attitudes towards a heating system

In the survey the respondents had to answer two statement listing regarding their individual attitudes towards different aspects influencing the purchase of a heating system (see chapter 2.1). In the first one the importance of 23 different aspects related to the time before the purchase decision should be evaluated on a five point scale ranging from “very important” to “very unimportant”. Using factor analysis (KMO = 0.845 / Total variance = 60.798 / Bartlett significance = 0.000) it was feasible to identify seven significant factors (see table 1).

Table 1: Rotated Component Score Coefficient Matrix: Before the purchase of the heating system (Principal Component Analysis; Varimax Rotation); (n=775)

		Factors						
		Economy	Ecology	Questions about the fuel	Comfort	Questions about the delivery of the fuel	Information about the heating system	Public subsidies for the purchase of a heating system
Statements	Costs for replacements	0.711						
	Amortization time	0.668						
	Low capital expenditure	0.642						
	Operating costs	0.641						
	Spatial conditions	0.536						
	Longevity of the system	0.482						
	Health aspects		0.772					
	Low dust emmissions		0.731					
	Climate protection		0.7					
	Transportation risk of the fuel		0.579					
	Low fuel price			0.731				
	Price security of the fuel			0.73				
	Wood as renewable resource			0.638				
	Regionally available heating material			0.529				
	Failure-free operation of the system				0.755			
	Low maintenance requirements				0.723			
	Personal controllability of the system				0.547			
	Uncomplicated delivery of the fuel					0.816		
	Supply security of the fuel					0.802		
	Competent consultancy						0.826	
	Competent heating contractor						0.786	
	Image of the heating system						0.559	
	Public subsidies for the purchase of a heating system							0.775

Source: Own survey

In the second statement battery the respondents were asked to assess the importance of eight different statements dealing with the operation of the heating system (using the same scale as for the first statement battery). Out of these eight statements (see table 2) three significant factors were identified using a factor analysis (KMO = 0.745 / Total variance = 62.524 / Bartlett significance = 0.000)

Table 2: Rotated Component Score Coefficient Matrix: During the operation of the heating system (Principal Component Analysis; Varimax Rotation); (n=775)

		Factors		
		Personal contact to the craftsman etc.	Questions about the fuel	Comfort
Statements	Personal contact to the producer	0.784		
	Personal contact to the retailer	0.749		
	Personal contact to the craftsman	0.715		
	Price of the fuel		0.86	
	Quality of the fuel		0.797	
	Low operating stress			0.837
	Convenient supply of the fuel			0.573
	Compliance with the service interval by the craftsman			0.525

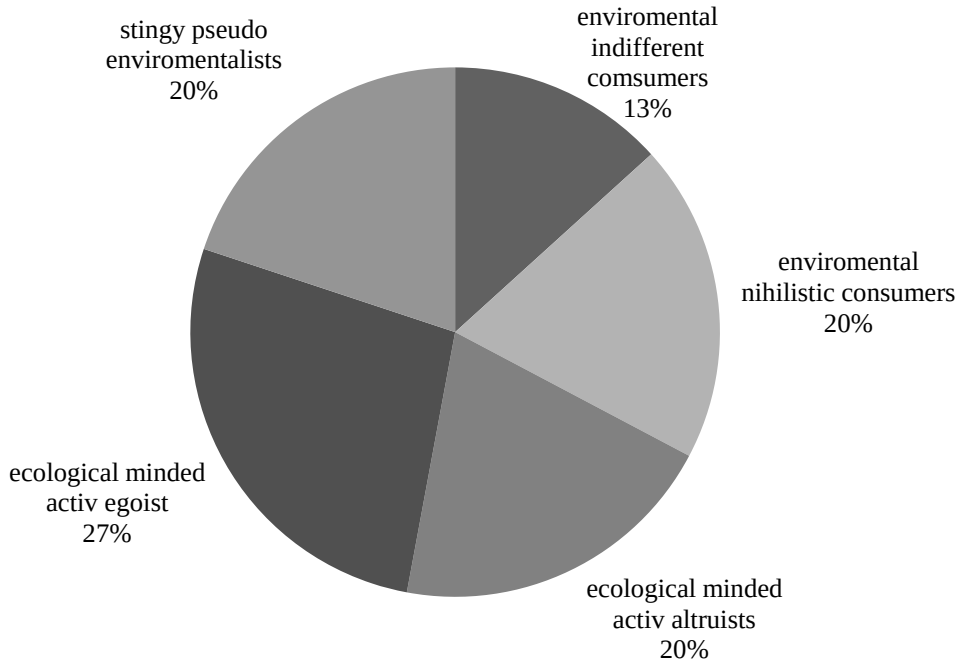
Source: Own survey

3.2 Ecology cluster membership

Furthermore - again on a five point scale (“I strongly agree” until “I do not agree”) - the respondents had to evaluate several statements dealing with environmental aspects. The statements deal e. g. with climate warming, sustainability, pollution or species extinction. Due to the high amount of respondents a hierarchical cluster analysis was impossible. Thus, in order to determine the “right” number of clusters, a two-step cluster analysis was applied revealing five different clusters. Following a K-Means cluster analysis was run in order to achieve a detailed description of the groups. According to their ecological attitudes the ”environmental indifferent consumers”, “environmental nihilistic consumers”, “ecological-minded, active altruists”, “ecological-minded, active egoists” and the “stingy pseudo environmentalists” can be distinguished.).

The ANOVA-table shows, that every statement has high F-values and a very low sig.-level. Therefore it seems that the results of the cluster analysis are quite good.

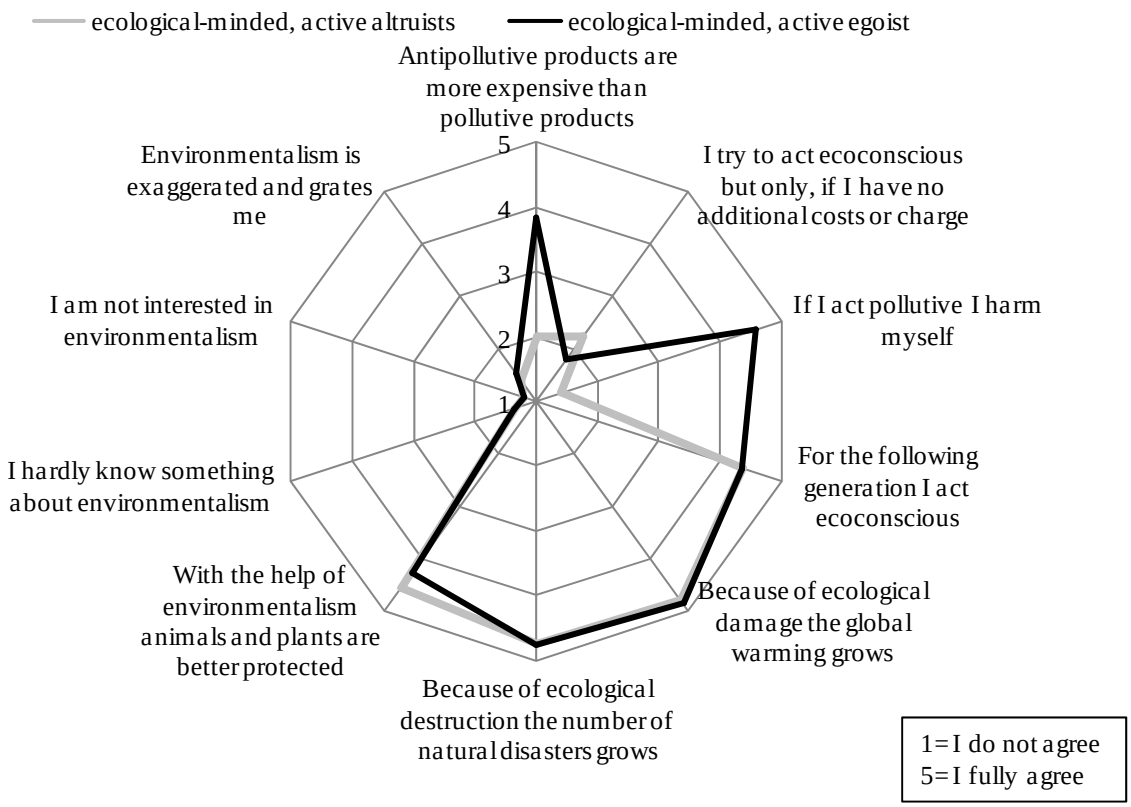
The distribution of the numbers within the clusters is very evenly (see figure 3). More than 100 members every cluster has.



Source: Own survey

Figure 3: Distribution of the respondents in the different clusters (n =775)

In the following the groups “ecological-minded, active altruists” and “ecological-minded, active egoists” will be described in more detail as these two clusters will pose a very significant influence on the choice of a heating system.
The difference between these two groups appears mainly in the completely different way of estimating two statements. While the “ecological-minded, active altruists” do not think that they harm themselves by acting pollutive, the “ecological minded, active egoists” estimate antipollutive products to be more expensive than pollutive products (see figure 4).



Source: Own survey

Figure 4: Comparison of the cluster “ecological-minded, active altruists” and “ecological-minded, active egoist” (n =775)

3.3 Influencing parameters on the purchase of a domestic heating system

By means of the statistical program SPSS it is possible to run a multinomial logistic regression in order to find those variables which describe the model optimally. The variables were successively included in the model using the method “forward entry”. With this procedure, 17 (out of 27) variables were identified having a significant influence on the choice of the heating system (see table 3). The other 10 variables have only a minor influence and therefore do not appear in the model. Different information sites for example have no influence on the purchase of a heating system. Thus, it does not matter where and how often the consumer gets information about a heating system. Additionally the respondents´ monthly income has no influence on the choice of the heating system. The two variables dealing with wood log have a minor influence, too. This is not surprising as no respondent has a wood log heating system.

Table 3: Primary and chosen (marked) variables for the multinomial logistic regression

Characteristics of the combustible	Individual attitudes	Individual conditions	Socio-demographic characteristics
Evaluation of natural gas	**Crucial economic aspects – at the time of buying**	Amount of different information sites	**Size of the household**
Evaluation of fuel oil	**Crucial ecological aspects – at the time of buying**	**Power/m²**	Age
Evaluation of electric power	**Needs towards the combustible - at the time of buying**		**Educational status**
Evaluation of wood log	**Convenience aspects - at the time of buying**		Monthly income
Evaluation of wood pellet	**Information about the delivery of the combustible - at the time of buying**		
Price development of natural gas	Advisory service - at the time of buying		
Price development of fuel oil	**Subsidies for the heating system**		
Price development of electric power	Contact to the heating craftsman – at the time of operation		
Price development of wood log	Questions about the fuel – at the time of operation		
Price development of wood pellets	**Convenience aspects – at the time of operation**		
	Ecology cluster membership		

Source: Own survey

The adaption of the multinomial logistic regression with the 17 variables shows a very good adaption. The significance of the likelihood-ratio-test is 0.00. This implies that the null hypothesis can be rejected and that the model separates the consumers very well in accordance to their heating system (oil-fired heating system, gas-fired heating system, wood-pellet heating system, heat pump). Other figures for the quality of the model are also excellent with the factor of McFadden being 0.663 and the "Nagelkerke-factor" being 0.891.

In the following the results of the multinomial logistic regression are described using the Exp (B)-level as "an indicator of the change in the odds resulting from a unit change in the predictor" (Field 2005: 225).

The results for the respective reference category "oil-fired heating system", "gas-fired heating system" and "heat pump" are quite similar. Thus, in the following not the results of all four different reference groups are presented but the two most interesting ones ("oil-fired heating system" and "wood pellet heating system"). Also, only the three most interacting variables of each comparison regarding content are shown in the following figures (the level of significance of all chosen variables is lower than 0.05).

Comparing firstly the reference group "owners of an oil-fired heating" with the other three groups it is shown that the membership in the cluster "ecological-minded, active altruists" has a big influence on the choice of a certain heating system (see table 4) and that it separates the different groups very well. The members of this cluster think and behave ecologically (independent of higher costs for e. g. environmentally-friendly products). Furthermore, this cluster is a very homogeneous one, as more than 96 % of the "ecological-minded, active altruists" have a wood pellet heating system at home. Thus, it is very unlikely to be

concurrently e. g. owner of an oil-fired heating system and to be member of this cluster. Consequently, the Exp (B)-level in table 4 for the variable “ecological-minded, active altruists” is very high.
The estimation of the own fuel plays an important role for every reference group. For example: comparing the owners of an oil-fired heating system with the users of a gas heating system the “evaluation of fuel oil” is very important (Exp (B) = 35.237). Thus, it is much more likely to own an oil-fired heating than to have e. g. a gas heating system if different aspects of oil are favourably assessed by the respondent. In comparison to users of a pellet heating system, economic aspects (e. g. amount of investments, amortization time) are more important for the owners of an oil- fired heating.

Table 4: Comparison of owners of an oil-fired heating with owners of the other three heating systems (n =775)

								95% Cl for Exp(B)	
		B	Standard Error	Wald	Degrees of Freedom	Significance	Exp(B)	Lower Limit	Upper Limit
Users of a gas heating system	Evaluation of fuel oil	3.562	0.342	108.348	1	0	35.237	18.018	68.91
	Evaluation of electric power	0.651	0.241	7.297	1	0.004	1.917	1.196	3.074
	Cluster: Ecological-minded, active altruists	0.574	1.305	0.193	1	0.66	1.775	0.137	22.922
Users of a heat pump	Evaluation of fuel oil	3.149	0.36	76.68	1	0	23.31	11.52	47.167
	Cluster: Ecological-minded, active altruists	1.285	1.448	0.787	1	0.040	3.615	0.211	61.779
	Size of household	0.756	0.197	14.783	1	0	2.13	1.449	3.131
Users of a pellet heating system	Cluster: Ecological-minded, active altruists	5.827	1.226	22.606	1	0	339.432	30.727	3749.647
	Evaluation of fuel oil	2.405	0.36	44.571	1	0	11.078	5.468	22.445
	Crucial economic aspects – at the time of buying	1.456	0.277	27.67	1	0	4.289	2.493	7.379

Source: Own survey

If the reference group consists of the owners of a wood pellet heating system, a completely different picture is painted as one can observe in table 5. In this case the membership to an ecological-orientated cluster has a much lower influence on the decision for a certain heating system. In analogy to the other reference groups, the consumers` assessment of wood pellets is a very important factor for owners of a wood pellet heating system. They assess “their” fuel better than other fuels like oil, gas or electric power and thus it is more likely that they choose a wood pellet heating system. Another very important distinguishing variable describes the importance of the needs towards the combustible. Before a consumer buys a heating system, he has to think about the requirements regarding the fuel. The delivery of the combustible should be quite easy or one needs enough storage capacity for oil or wood pellets. The importance of these questions is merged into the variable “needs towards the combustible – at the time of buying”. For owners of a pellet heating system this variable is more important than for the other groups. With reference to the delivery or the storage of wood pellets it is not that easy as with oil. Thus, if one wants to buy a wood pellet heating system, he has to satisfy these needs towards wood pellets.

Table 5: Comparison of owners of a wood pellet heating with owners of the other three heating systems (n =775)

								95% Cl for Exp(B)	
		B	Standard Error	Wald	Degrees of Freedom	Significance	Exp(B)	Lower Limit	Upper Limit
Users of a gas heating system	Needs towards the combustible - at the time of buying	1.958	0.273	51.31	1	0	7.087	4.147	12.110
	Evaluation of wood pellet	1.231	0.256	23.188	1	0	3.425	2.075	5.654
	Evaluation of fuel oil	1.157	0.333	12.081	1	0.001	3.181	1.656	6.108
Users of a heat pump	Needs towards the combustible - at the time of buying	1.516	0.279	29.476	1	0	4.552	2.634	7.868
	Cluster: Ecological-minded, active egoist	1.159	0.637	3.307	1	0.049	3.186	0.914	11.105
	Evaluation of wood pellet	1.099	0.263	17.514	1	0	3.000	1.793	5.018
Users of an oil-fired heating system	Needs towards the combustible - at the time of buying	1.616	0.286	32.012	1	0	5.033	2.875	8.810
	Evaluation of wood pellet	1.572	0.264	35.476	1	0	4.814	2.870	8.075
	Subsidies for the heating system	1.158	0.264	19.285	1	0	3.182	1.898	5.335

Source: Own survey

The described variables show the highest influence on the choice of a heating system. Besides that, each of the 17 independent variables included in the model has a more or less impact, but to describe all of them would go beyond the scope of this article.
As already shown, the results of the multinomial logistic regression model are significant. Using the logistic regression model 83.0 % of the respondents (see table 6) are correctly classified in terms of their heating system. The mathematical expectation of the dependent variable ("choice of the heating system") was 27.6 % (see figure 2). Thus, by means of the logistic regression there is a gain in explanation of more than 55 %.

Table 6: Classification

		Predicted				
		Gas heating	Wood pellets	Heat pump	Oil-fired heating	Correct percentage
Observed	Gas heating	170	8	13	17	81.7%
	Wood pellets	8	257	9	7	91.5%
	Heat pump	16	6	73	12	68.2%
	Oil-fired heating	23	5	8	143	79.9%
	Overall percentage	28.0%	35.6%	13.3%	23.1%	83.0%

Source: Own survey

4 Conclusion

With the help of a developed multinomial logistic regression model including 17 independent variables explaining the choice of a heating system, it was possible to correctly allocate 83.0 % of the respondents in accordance to their choice of a heating system, which documents the high quality of the applied model. Mainly the membership to different ecological clusters influences the choice of a certain heating system. Also the assessment of the different combustibles plays a major role for the decision.
For producers of heating systems the results can supportively influence their marketing activities, like for instance their product policy. They understand e. g. the reasons why consumer buys an oil-fired heating and not a wood-pellet heating system. Therefore, it is feasible for them to diversify their product portfolio or to tailor their marketing activities towards the needs of the consumer. For example: Producers of a wood-pellet heating system should focus their marketing activities on ecological aspects.

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