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End-Users Decision Making Factors for Heating and Cooling Systems

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Abstract

This paper aims at showing the results of a survey carried across users of heating and cooling systems, done in order to identify what key decision factors are influencing consumers' behavior when it comes to buying a heating and cooling system. The results are analyzed and presented with a particular focus on the respondents having installed a solar thermal system in the residential sector.

Keywords: *renewable heating and cooling; solar thermal; consumers; decision making factors.*

1. Introduction

The objective of the survey carried out under the European FROnT project (Fair Renewable Heating and Cooling Options and Trade) was to identify end-users' decision making factors for heating and cooling systems in five European countries (NL, PL, PT, ES, UK), in order to understand consumer behavior and to facilitate stakeholders at European and national level to provide better and transparent information to consumers.

Although the survey has been carried out in three different sectors – residential, non-residential, industrial – this paper focuses its analysis on the residential sector, as it is the one in which more data analysis has been carried out.

The paper is structured as follows: it first gives a background on the FROnT project, describing the relation between the survey and the rest of the project areas. It outlines the survey objectives, and then goes into the details of the methodology underpinning the whole exercise, and describes the characteristics of the sample. Then, the paper will present the structure of the survey itself, describing the different steps and their specific aims. Finally, the paper will present the general results of the survey, and then the specific results for solar thermal residential owners, drawing some conclusions at the end.

2. Background of the survey – the FROnT Project

The FROnT project, co-funded by the European Union through the Intelligent Energy Europe programme, aims to develop strategies for a greater deployment and to advance the penetration of renewable energy sources for heating and cooling (RES-HC) technologies by providing a better understanding of how to deploy renewable heating and cooling technologies in the market and of the costs of such technologies[1].

In pursuit of this goal, the project aims at understanding the main barriers that are hampering the deployment of RES-HC installations and analyzes how to possibly overcome them. The project is proposing a set of short and long-term policy recommendations to address these barriers. It analyses both existing support schemes and end user decision factors, in order to help establishing strategic policy priorities for RES-HC.

Specific objectives of the project are:

- To support a better insight of the value of the energy supplied by RES-HC systems, promoting transparency and clarity towards end-users and other stakeholders

[1] More information at www.front-rhc.eu.

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- To improve the understanding of the end-users decision making process with regard to heating and cooling systems in order to develop tailored approaches and facilitate adequate measures enhancing the uptake of RES-HC
- To facilitate the setting-up of improved and sustainable RES-HC integrated support schemes
- To promote the implementation at national and European level of strategic policy priorities that can contribute to efficiently and cost-effectively implement the NREAPs

In order to improve the understanding of how end-users decide which heating and cooling system to use/acquire, and to map this decision making process across different countries and sectors (residential, non-residential, industrial), a survey has been foreseen, as part of an information and data collection exercise which involved all project countries[2].

The project is led by a consortium gathering European industry associations representing the solar thermal, geothermal, aerothermal and biomass technologies, and national energy agencies from Spain, Portugal, The Netherlands, Poland, and UK, assisted by the Austrian Institute of Technology, CREARA (consulting and energy management company), and Quercus (a non-profit environmental organisation based in Portugal).

3. Objectives of the Survey

The main objective of this report is to identify end-users' decision making factors when making choices about heating and cooling systems in the five participating European countries covered by the FROnT project. These countries are: The Netherlands, Poland, Portugal, Spain and the United Kingdom.

Specific objectives of the survey are:

- Identify end-user decision making factors for H/C systems (Renewable and fossil fuels)
- Understanding the decision process when deciding on a H/C system
- Obtain the Key Purchasing Criteria (KPC) which will provide information on "Willingness to Pay"
- Comparison among countries – a list of KPC weighting the criteria will be obtained in each country. Results must be comparable

To achieve these objectives a national survey has been carried out in each country under the coordination of the respective national energy agency and project partner.

The surveys, conducted in three different sub-sectors: residential, non-residential and industrial, allows the project to identify key purchasing criteria (KPC) across the whole sector. These surveys have addressed the heating and cooling sector as whole, not only renewable energy solutions.

4. Methodology and sample characterization

Questionnaires for each analyzed sector (residential, non-residential and industrial) were developed by all the partners, under the supervision of Quercus, in order to use a homogenous tool and get comparable results. The execution time for this activity, excluding subcontracting launch period, was around 2 months.

The number of interviews conducted at European level was: 4,195 in the residential sector, 896 in the non-residential sector and 585 in the industrial sector.

The details per country, and related representativeness of each group is described in the Figure 1 below. The overall confidence level on the representativeness of the sample is 95%.

[2] The full results of the survey, as well as detailed analyses per country, are available in the project portal http://www.front-rhc.eu/library/.

SECTOR	COUNTRY	NUMBER OF QUERIES	CONFIDENCE LEVEL	SAMPLE ERROR
RESIDENTIAL	NETHERLANDS (NL)	560	95%	4.14%
	POLAND (PL)	960	95%	3.16%
	PORTUGAL (PT)	900	95%	3.27%
	SPAIN (ES)	1,250	95%	2.77%
	UNITED KINGDOM (UK)	525	95%	4.28%
NON-RESIDENTIAL	NETHERLANDS (NL)	15	95%	25.29%
	POLAND (PL)	150	95%	7.97%
	PORTUGAL (PT)	250	95%	6.16%
	SPAIN (ES)	300	95%	5.62%
	UNITED KINGDOM (UK)	181	95%	7.25%
INDUSTRY	NETHERLANDS (NL)	35	95%	16.55%
	POLAND (PL)	100	95%	9.78%
	PORTUGAL (PT)	100	95%	9.78%
	SPAIN (ES)	250	95%	5.62%
	UNITED KINGDOM (UK)	100	95%	9.78%

Figure 1 Sample confidence level per country, per sector

A common methodology among partners has been agreed, concerning sample definition and size: error, confidence level, balance of the sample, timing of the application, form of application: by phone, on line, etc. Questions have been based on studies on consumer behavior, external influences, energy labelling, Building Performance Certificates, etc.

The main features of the sample interviewed in the residential sector are shown in Figure 2. This sample is balanced compared with the relative figures of the participating countries (in terms of age, gender, level of education, etc.). Additionally, the sample is balanced in each Member State.

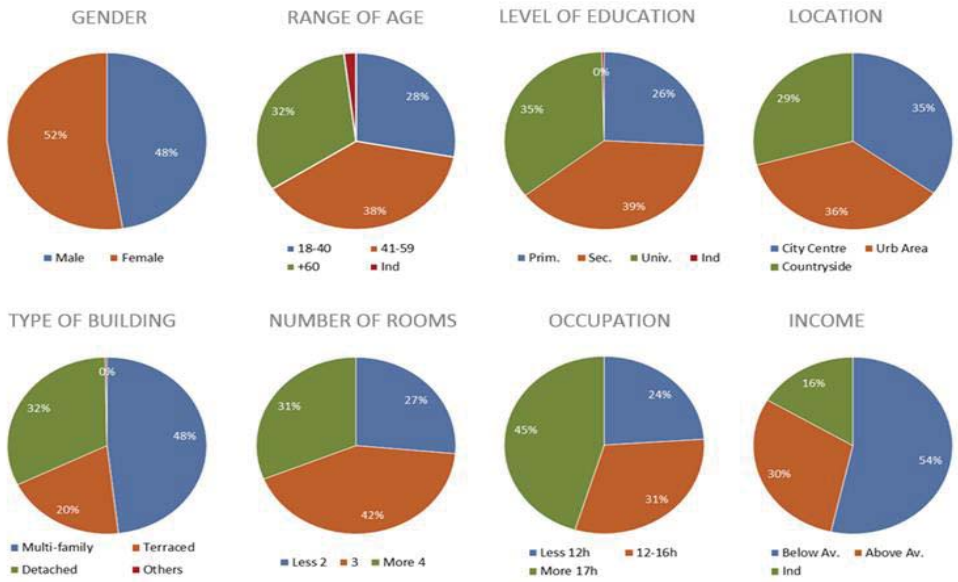

Figure 2 Sample characterisation

5. Structure of the Survey

The survey on the residential sector has addressed consumers on the heating and cooling sector, not only renewable energy solutions. The survey foresees a filter question on ownership of the house. Negative responses lead to the termination of the survey. Results are thus only including residential owners, in order to

simplify analysis.

The survey includes a first part on general information in order to characterize the sample (age, gender, education level, occupation, household income), a second part on the description of the building (location, type of building, number of bedrooms), a third part on heating and cooling system description and, the level of satisfaction with the systems, the main information source, awareness about renewable heating and cooling, adequacy of RES-HC and identification key purchasing criteria and provided information about "willingness to pay", including environmental and social parameters.

The flow diagram in Figure 3 below summarizes the structure of the survey.

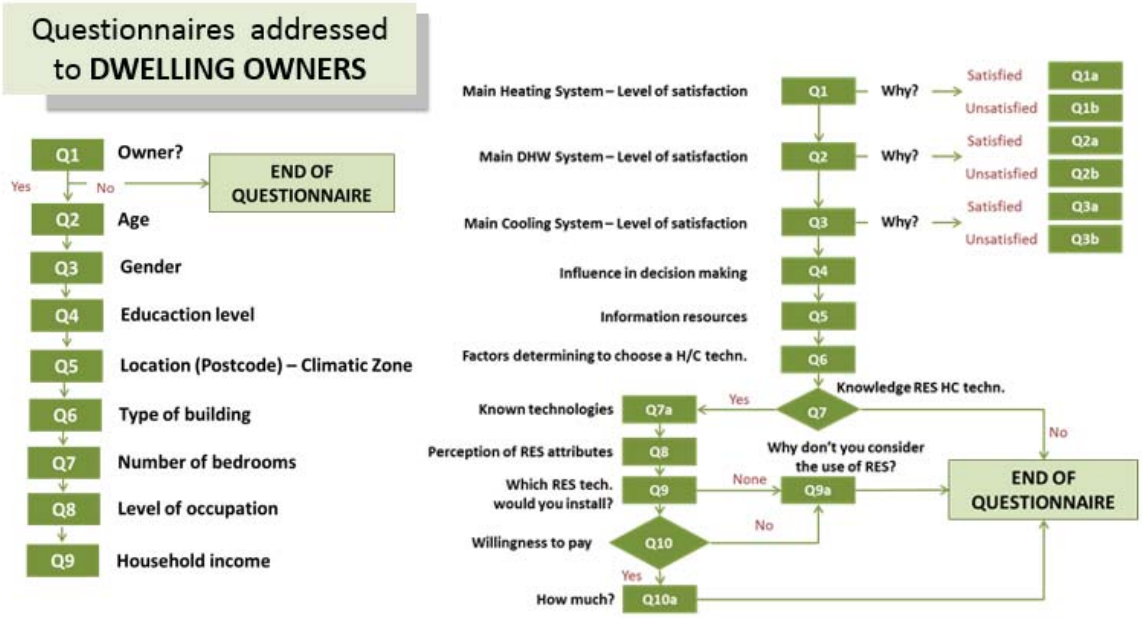

Figure 3 Flow Diagram of the questionnaire in the residential sector

6. General results of the survey

According to the results of the surveys[2], the main energy source employed in all sectors is natural gas followed by electricity. There is also a considerable variability in the industrial sector.

In general, the main information source is professionals' opinions. However, its influence is more relevant in the non-residential and industrial sectors than in the residential sector, where there are other important information sources such as the Internet or relatives.

Regarding key purchasing criteria, total economic savings is the most important criterion for the residential sector while for the non-residential sector it is reliability, followed by total economic savings. The industrial sector presents the same pattern as the non-residential sector.

In particular, in the residential sector, total economic savings is the most important criterion to choose H&C systems (84% of respondents) followed by comfort level (78%). Initial investment is also important (75% of respondents). Total economic savings is the most important criterion in Poland. Comfort level is the most important factor in Spain, the Netherlands and Portugal (followed in these three countries by total economic savings). Reliability and safety is the major factor in the United Kingdom. In general, architectural integration and environmental reasons are more relevant for women than for men. Economic savings, investment and maintenance are more important for people between 41 and 59 years-old than for young people. The importance of savings and recommendations from relatives for those who have primary education (higher than the average) is remarkable.

[2] To access the full results of the survey and the dataset, as well as detailed analyses per country, see http://www.front-rhc.eu/library/.

The non-residential sector presents the greatest level of RES technology awareness followed by the industrial sector, making the residential sector the least aware. In the residential sector, 65% of respondents declared being aware of RES-HC options, of those 96% quoted solar thermal as a familiar technology (against 49% for biomass, 40% for heat pumps, 42% for geothermal)[3]. Women, people over 60 years-old, those with primary education, people from countryside and income below the average know less about RES than the rest. The perception of RES-HC technologies is very similar in all sectors: it is considered to require high investment costs and to deliver high economic savings.

The main rejection reason for RES technologies in the residential sector is the high investment required, followed by structural changes involved and the need of approval by neighbors or superiors. In the non-residential sector, the latter has less weight than the two former. The main rejection factor in the industrial sector is, by far, the high investment required.

Considering the total sample of the respondents in the residential sector who are familiarised with RES-HC (65%), 50% of them would be willing to make a higher initial investment, 39% would not, and 11% did not answer this question. According to the results, 12% of respondents would pay up to 5% more for an RES-HC system, 15% would pay between 5 and 10%, 12% would pay between 10-25%, 6% would pay between 25-40% and 5% did not answer this question.

In general, men, young people and those with university a university level education are more willing to pay more for a RES-HC system than the rest. This is also the case for people who live in the countryside. The willingness to pay is lower in Portugal than in the rest of countries (28%).

The industrial sector is most willing to pay for RES-HC, compared to residential and non-residential sectors.

7. Specific results of the survey – Solar Thermal

By analysing the dataset of the survey results, it is possible to isolate the answers originating from people using solar thermal systems, and assess their answering patterns, as opposed to the general ones. A specific analysis of the solar thermal results per country is more difficult, as the difference in available data across countries is quite considerable (see paragraph 7.1). As for the non-residential and industrial sectors, further data analysis is required in order to process the dataset and draw some specific solar thermal conclusions there too.

For this reason, this section focuses on the residential sector, analyzing the sum of solar thermal users across the five project countries.

7.1. Solar Thermal sample

Out of the 4195 people surveyed in the residential sector, a total of 94 people declared using solar thermal as their heating and cooling system, that is 2.25% of the total sample. In particular solar thermal users are distributed as follows across countries: 16 in Spain, 48 in Portugal, 20 in the UK, 1 in Poland, 9 in the Netherlands.

Out of the 94 solar thermal users, 16 declared using it for space heating, 69 for domestic hot water (DHW), 9 for both. None was using solar thermal for cooling application. Auxiliary system for users of solar thermal for space heating is as follows: 5 electric heater, 2 gas boilers, 1 biomass, 1 heat pump, 1 geothermal, 6 ‘other’. Auxiliary system for users of solar thermal for domestic hot water is as follows: 21 gas boiler, 12 electric heaters, 5 biomass, 5 heat pumps, 5 oil boilers, 2 coal, 1 LPG, 18 none.

In terms of general sample characterization, solar thermal users are depicted in the Figure 4 below. Overall, if

[3] Data should be interpreted as the 96% of the respondents familiarised with RHC (65%) would be familiarised with solar thermal energy for heating uses. It means that 62% (0.65 x 0.96) of the total sample would be familiarised with solar thermal energy. Behavioral biases and confusion with solar photovoltaic might need to be taken into account in explaining this result vis-á-vis the other technologies.

compared with the general sample (4195 respondents), they result distributed in more rural areas (+6% countryside, -14% city centre), mostly on detached buildings (+35% detached buildings), and with a slightly higher level of income (-7% below average) and education (+5% university) than the overall average.

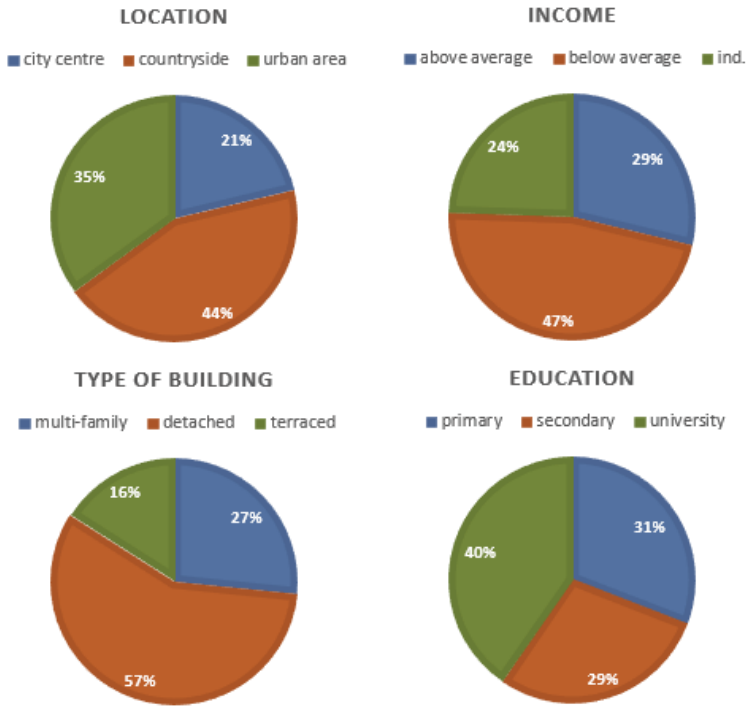

Figure 4 Sample characterisation for solar thermal users

7.2. Satisfaction with Solar Thermal

Satisfaction levels related to the use of solar thermal are relatively high, with 15 out if 16 solar thermal space heating users being satisfied of their systems, 61 out of 69 for domestic hot water users, and 7 out of 9 combi-systems users.

When asked about the reasons of their satisfaction with the solar thermal system, top four respondents answers were comfort, environmental friendliness, fuel price and reliability and safety for both space heating and DHW users (though the order slightly varies). The detailed answers to this open question (multiple choices possible) are depicted in the Figure 5 below.

Satisfaction of solar thermal users is consistent with the general answers of the full sample, as the general satisfaction level is high (satisfied – 90%; no answer – 9%; dissatisfied: 1%) and the main satisfaction reasons are: comfort levels (54%) and easy use, reliability and safety (39%). The different features of the sample (age, gender, etc.) are not really influential.

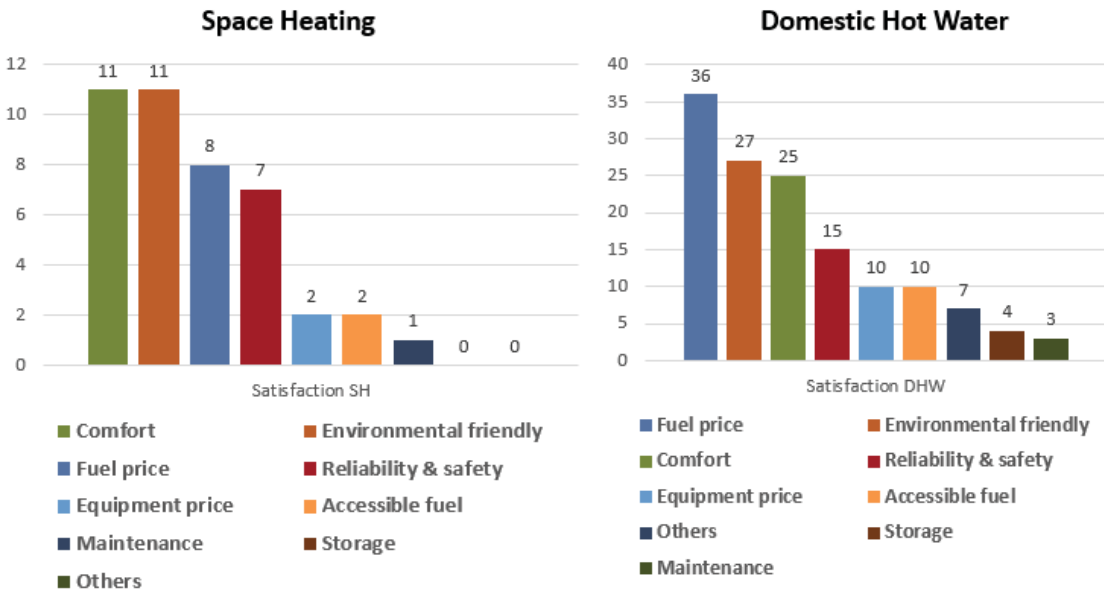

Figure 5 Satisfacion reasons for solar thermal users

7.3. Influence in decision making and information resources

Solar thermal owners did opt for those solutions for space heating or DHW because the system was already existing, because of incentives, because of the cheap cost of the system or of the fuel. Detailed answers are shown in Figure 6 below.

This is again more or less in line with the average response of the full sample, where the main reason to use current heating and DHW systems in dwellings is because they already exist there (52% and 50%, respectively). Other reasons given by respondents are: access and fuel costs (18% – 15% in the case of DHW systems) and equipment price (11% in both cases). Legal obligation is not a predominant reason to support the installation of heating and DHW systems.

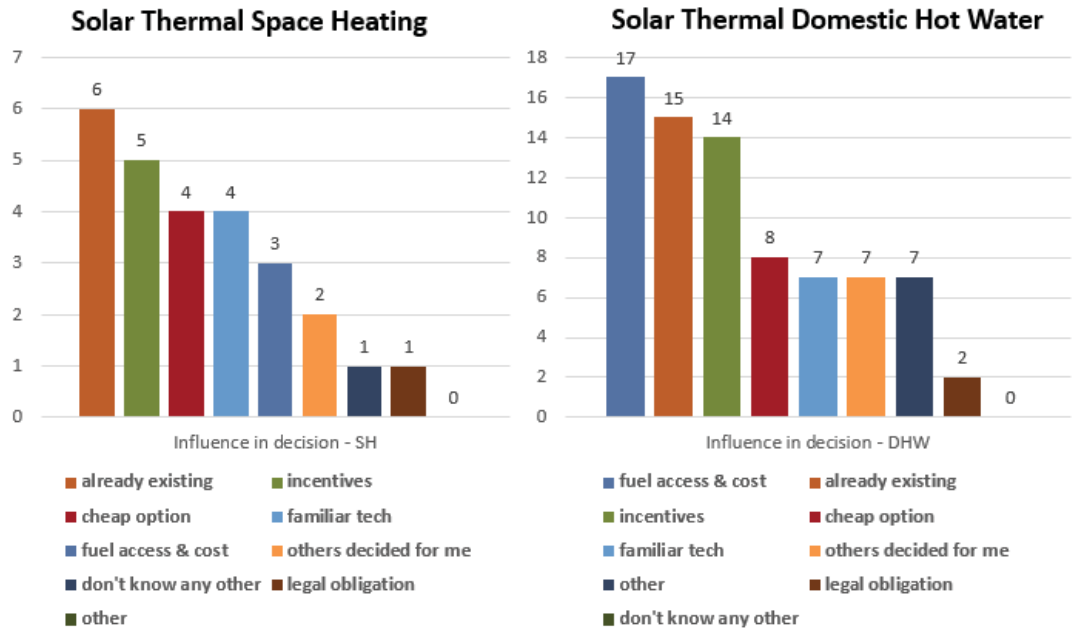

Figure 6 Influence in decision making for solar thermal users

In order to decide which system to opt for, solar thermal users used predominantly professionals as source of information, distanced by sales agents, internet, and family or friends' advices. The predominant role of installers in channeling information to consumers seems therefore confirmed.

Comparing those results with the general sample, it is to be observed an increased relevance of sales agents (+12%), and of consumers/ environmental NGOs (+9%). The detailed preferences in terms of sources of information are displayed in Figure 7 below.

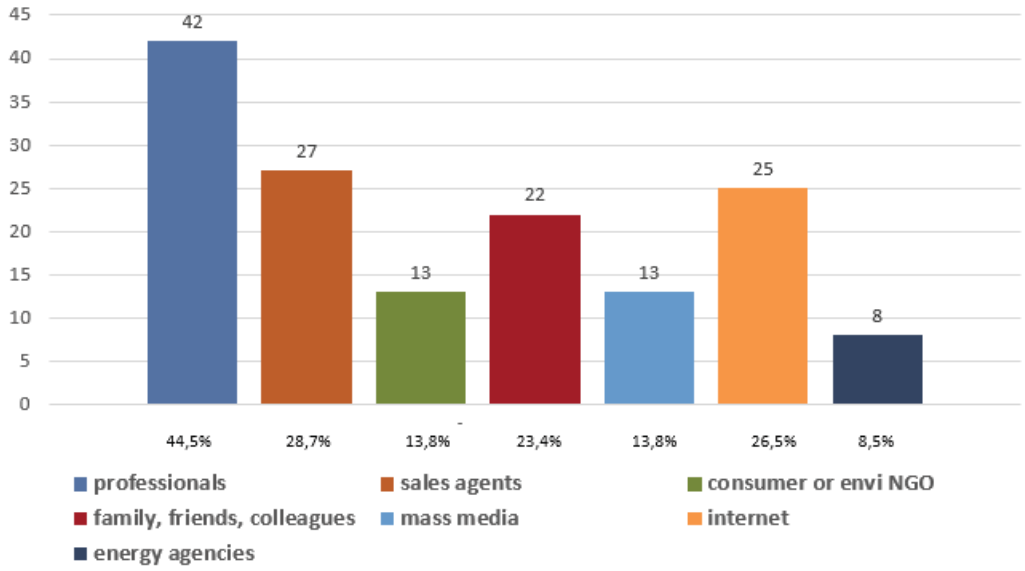

Figure 7 Information sources for solar thermal users

7.4. Key decision factors for Solar Thermal

When asked 'Which factors do you take into account when you buy new heating/cooling/DHW equipment?', solar thermal users did mention savings and comfort as their top two decision factors, with initial investment, reliability and safety, environmental reasons and reliable brand following afterwards.

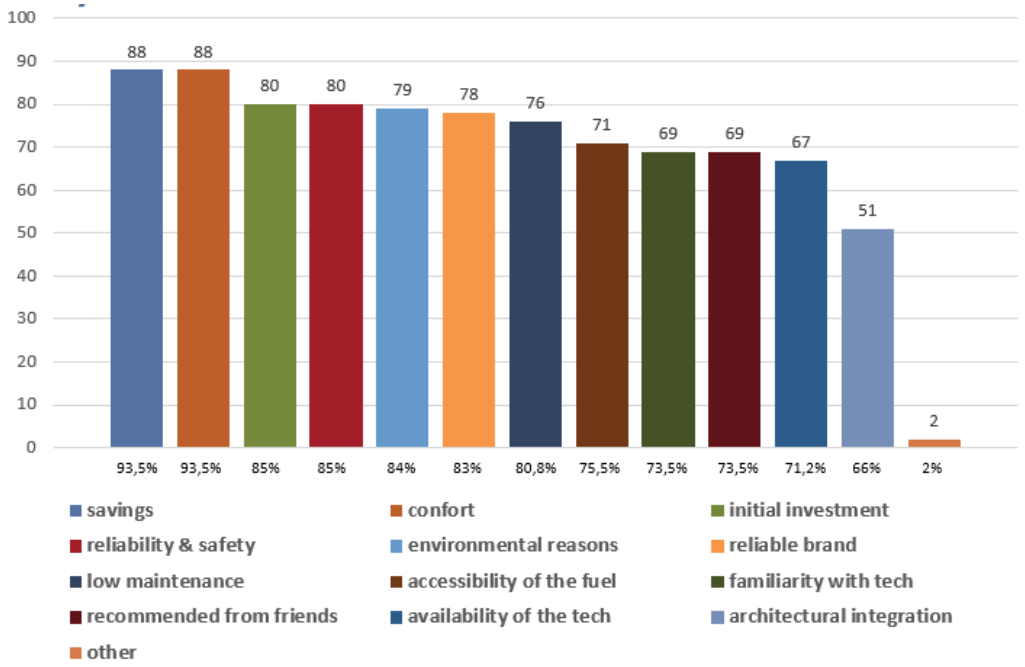

Figure 8 Key Decision Factors for solar thermal users

The detailed preferences in terms of key decision factors are displayed in Figure 8 above. In this case it is interesting to notice the differences between those results, and the overall results from the full sample. Several decision factors seem to be more relevant for solar thermal users, than the average respondents. Most notably, environmental reasons are quoted +23% than the average of the full sample, and reliable brand +26%.

8. Conclusions

The survey shows very interesting results when it comes to identify the end-users' decision making factors. Several key observations can be made both analyzing the general results of the survey, and the specific results from solar thermal users.

For the general results:

- ✓ There is an overall positive satisfaction with current heating systems in Europe;
- ✓ Professionals, sale agents and the Internet are the preferred sources of information;
- ✓ Guarantee of comfort and savings are the main key decision factors in all the participating countries;
- ✓ The awareness about RES-HC is high in Europe (63-79%). RES technologies are more familiar for heating than cooling uses. Solar Thermal the most known technology;
- ✓ Surveyed consider that RES-HC technologies are more expensive, but they provide more savings;
- ✓ Around 60% of the surveyed in Europe considered RES suitable for their heating systems.

For the solar thermal results:

- ✓ Solar thermal is less deployed in city centers and in non-detached houses;
- ✓ Solar thermal is bought by slightly higher income and higher education people;
- ✓ Solar thermal is bought mostly for domestic hot water, with gas as auxiliary space heater;
- ✓ Professionals and sales agents are the main information sources;
- ✓ Vast majority of solar thermal owners unaware of solar thermal cooling;
- ✓ Solar thermal is perceived as reliable, safe technology, providing high level of comfort and with a reasonable initial investment;
- ✓ Comfort, fuel price, environmental friendliness and reliability & safety top reasons for consumers' satisfaction with their solar thermal systems; savings and comfort also being the top two key decision factors for buying solar thermal;
- ✓ Environmental matters are very important for solar thermal buyers. Incentives do also play an important role;
- ✓ Brand reliability does matter for solar thermal buyers!

More interesting results could be extracted from the dataset, as time and resources limited the scope of the FROnT project in this area. However, the dataset will be made publicly available, and more research can be carried on by interested stakeholders. Most important areas of further analysis would be to compare results across different countries, and to cross results according to sample characteristics (gender, age, income...). Such analysis could provide additional information on consumers' behaviour on heating and cooling appliances choices, as well as important marketing and social considerations.