

WP 5: Consumer Survey
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by

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EU Report: BARENERGY WP5

Acceptability of subsidies of solar panels: The role of demographics, level of knowledge and desire for energy independence

Introduction and analytical model

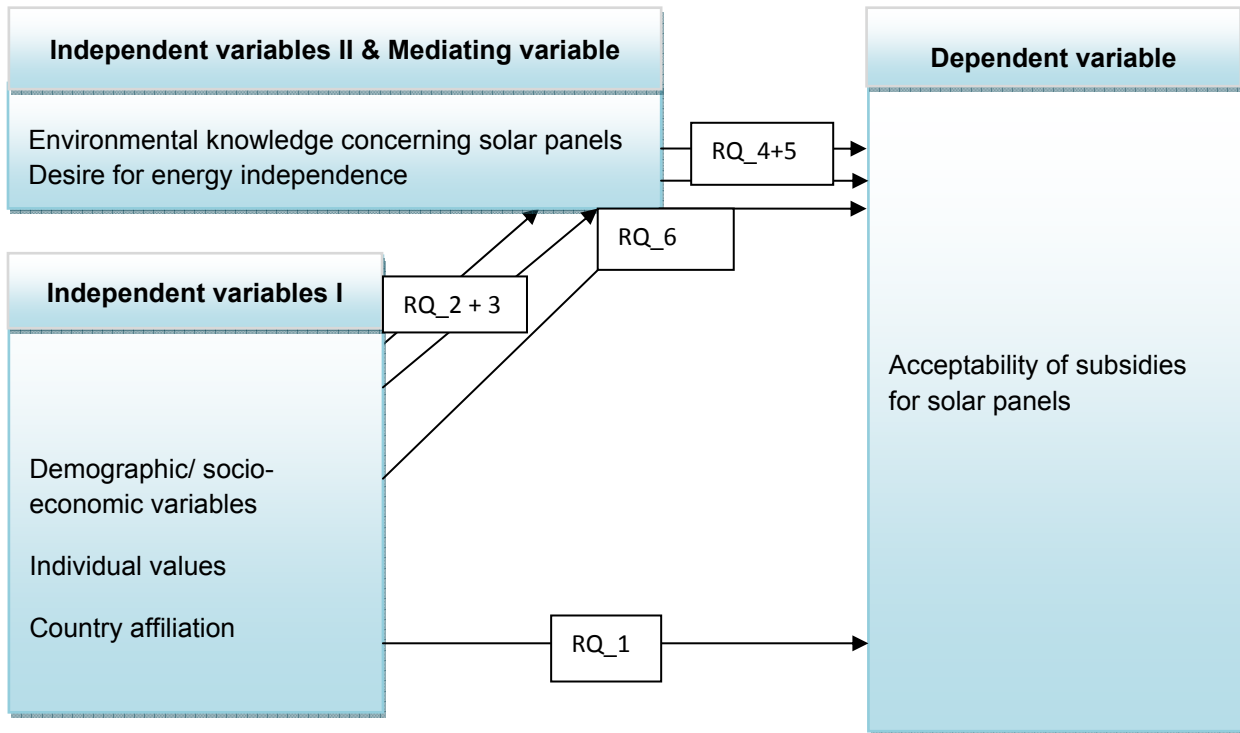
Our world has changed faster than anybody expected: besides the earth's average surface temperature rising, the political landscape has transformed fundamentally, and a growing awareness of the widespread deterioration of the environment has developed (Kärnä et al., 2003). As awareness of these threats to the climate system is increasing, there is also increasing political pressure to deal with the situation. Demand for policy measures to reduce climate change impact is high, and within a democratic society, acceptance of these measures is essential (Nilsson and Biel, 2008). Increasing the share of renewable energy is a top issue on political agendas all over the world and many countries have introduced support schemes aimed at facilitating market implementation of different kinds of renewable energy technologies. In this context, numerous factors in several opinion polls indicate that public acceptance is high for renewable energy technologies and policies in many countries (Eurobarometer, 2006; Simon and Wüstenhagen, 2006). A key factor in successfully implementing these policies is to identify what determines acceptance of particular policies.

This consumer-based study aims to focus on the major drivers behind one specific environmental policy measure: acceptability of subsidies for solar panels. We explicitly tested to what extent demographic and socio-economic factors, respondents' desire for energy independence and their knowledge concerning solar energy influences the level of respondents' acceptability of subsidies for solar panels. A questionnaire was administered to a total sample of 6045 participants in seven countries: Greece, Hungary, France, the United Kingdom, Norway, Switzerland, and the Netherlands. The theoretical framework in Figure 1 has been developed to test the following hypotheses:

- **Research question 1:** What factors (demographic/socio-economic variables, individual values or country affiliation) affect acceptability of subsidies for solar panels the most?
- **Research question 2:** What factors (demographic/socio-economic variables, individual values or country affiliation) affect environmental knowledge concerning solar panels the most?
- **Research question 3:** What factors (demographic variables/socio-economic, individual values or country affiliation) affect desire for energy independence the most?
- **Research question 4:** Does more knowledge about solar panels lead to higher acceptability of subsidies for solar panels?
- **Research question 5:** Does stronger desire for energy independence lead to a higher acceptability of subsidies of solar panels?

- **Research question 6:** Does desire for energy independence have a mediating effect on the relationship between the independent variables and acceptability of subsidies for solar panels?

Figure 1: Illustration of our analytical model



Methodological considerations

Respondents

A questionnaire study was conducted in 2009. In total, 6045 self-administered questionnaires were filled out. The sample consisted of 2973 men and 3072 women and the participants' mean age was 44.0 years (SD = 14.7 years). AMR, a market research company selected the participants from each of the seven countries based on six demographic criteria: gender, age, household income, education level, marital status, and the number of persons in a household. They were chosen to represent the population of each country. Table 1 gives an overview of some background variables of all seven countries included in the study. Demographic variables used in this study are defined in Appendix 1.

Table 1: Background variables (N= 6045; 881;918;758;856;849;940;843)

	All seven countries	France	Greece	The Netherlands	Hungary	United King.	Switzer-land	Norway
Women	50.8%	50.6%	50.9%	50.9%	51.6%	50.8%	50.9%	50.1%
Age mean	44.0	44.8	40.8	45.8	41.9	47.8	44.0	43.5
Higher education	29.9%	30.8%	27.1%	30.9%	22.4%	33.3%	29.7%	35.5%
Income level (1-11)	5.3	5.5	4.6	4.7	2.0	5.1	7.6	7.4
Political left-right (1-10)	5.3	5.2	5.0	5.2	5.5	5.3	5.4	5.5
Persons in households	2.8	2.9	2.9	2.6	3.0	2.7	2.8	2.7

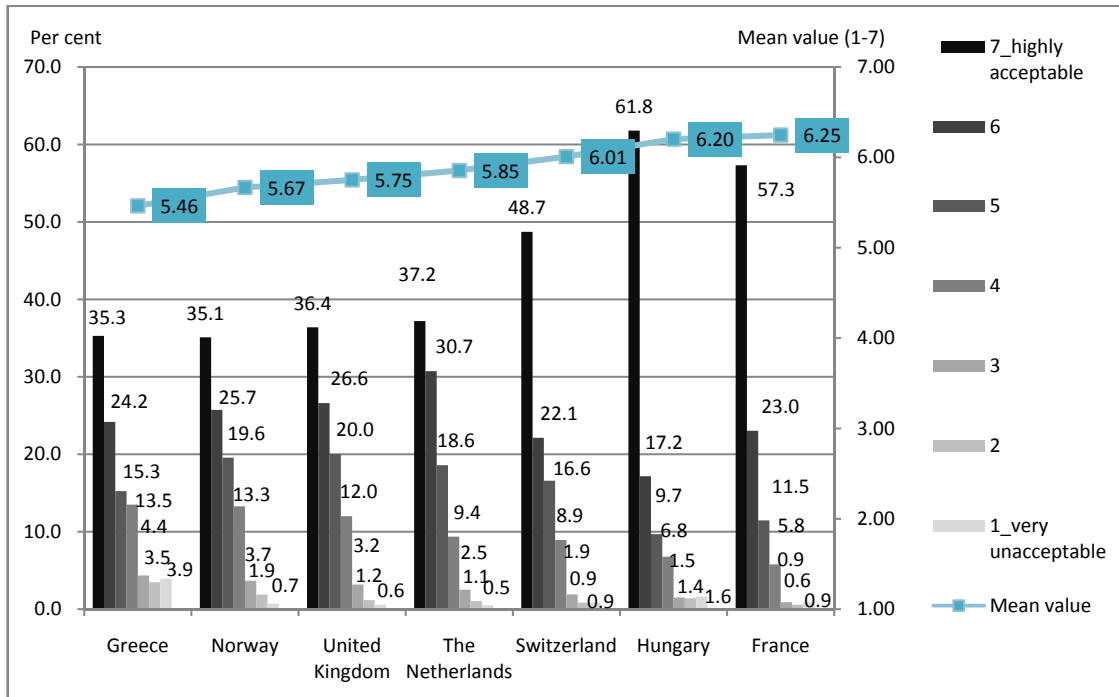
Table 1 shows that the percentage of women in our sample is fairly equal across all countries whereas the average age shows some differences: the mean age of Greek respondents was 40.8 years old whereas the UK respondents' mean age was 47.8 years. The distribution was fairly equal for education (exceptions were Hungary with fairly low levels and Norway with fairly high levels of higher education), political orientation and number of persons in households, whereas the average income revealed large differences, ranging from an average of 2.0 in Hungary to an average of 7.6 in Switzerland. As these countries are characterized by different cost of living, we only included this variable in the regression analyses if we controlled also for country of origin.

Measures

- ***Acceptability of subsidies for installation of solar panels:*** Respondents rated to what extent they would accept one specific kind of policy measure dealing with subsidies on the installation of solar panels, specifically, that the cost associated with the installation of the panels would be recouped within two years. Respondents judged on a 7-point Likert-type scale ranging from 1 (very unacceptable) to 7 (highly acceptable).

In Figure 2 we compared percentages and mean values representing the level of acceptability of subsidies for installation of solar panels in seven selected countries.

Figure 2: Percentages and mean values representing the level of acceptability of subsidies for installation of solar panels (1-7) (N=918;843;849;758;940;856;881)



In general, acceptability of subsidies for installation of solar panels in all countries was fairly high (average mean values of 5.46-6.25 out of a maximum value of 7). According to Figure 2, France and Hungary showed the highest levels of acceptability of subsidies for installation of solar panels whereas Greece and Norway showed the lowest levels of acceptability. In Norway, the electricity sector relies predominantly on hydro power whereas solar is not a commonly discussed topic in the public. Additionally, many residential consumers perceive solar as ineffective as there is not enough sun in this part of the northern hemisphere. Therefore, the added value of solar panels may be unclear and consumers may wonder why government should support an ineffective renewable energy technology if a large portion of the electricity mix in Norway already comes from renewable energy sources, mainly hydropower. This could be an explanation why Norwegians' acceptability of subsidies for solar panels is one of the lowest in Europe. An explanation why Greek consumers show the lowest levels of acceptability might be that in addition to an attractive feed-in-tariff, generous state subsidies are already available. Additionally, Greece has had a number of problems with bureaucracy with these support systems in the past couple of years which may have led to lower public support for future subsidies. The reason behind French consumers' high level of acceptance might be that the French Government has just proposed raising the feed-in tariff for solar PV in the coming year which may have created a buzz in the French population.

- Desire for energy independence:** Desire for energy independence was measured using three questions: examining if the respondents would like to produce their own energy, if they dislike being dependent on big energy companies and if it would be important to them to be independent from the national grid. Participants were asked to indicate to what extent they agreed with these three items. Participants scored all items on a 7-point Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree). The category, desire for energy independence, was created by taking the mean score of the three mentioned items. The mean score represents the overall value of these three questions in the questionnaire. The internal consistency was 0.687 (Cronbach's Alpha).

Figure 3: Percentages and mean value expressing desire for energy independence (1-7). (N=843;758;881;940;849;856;918)

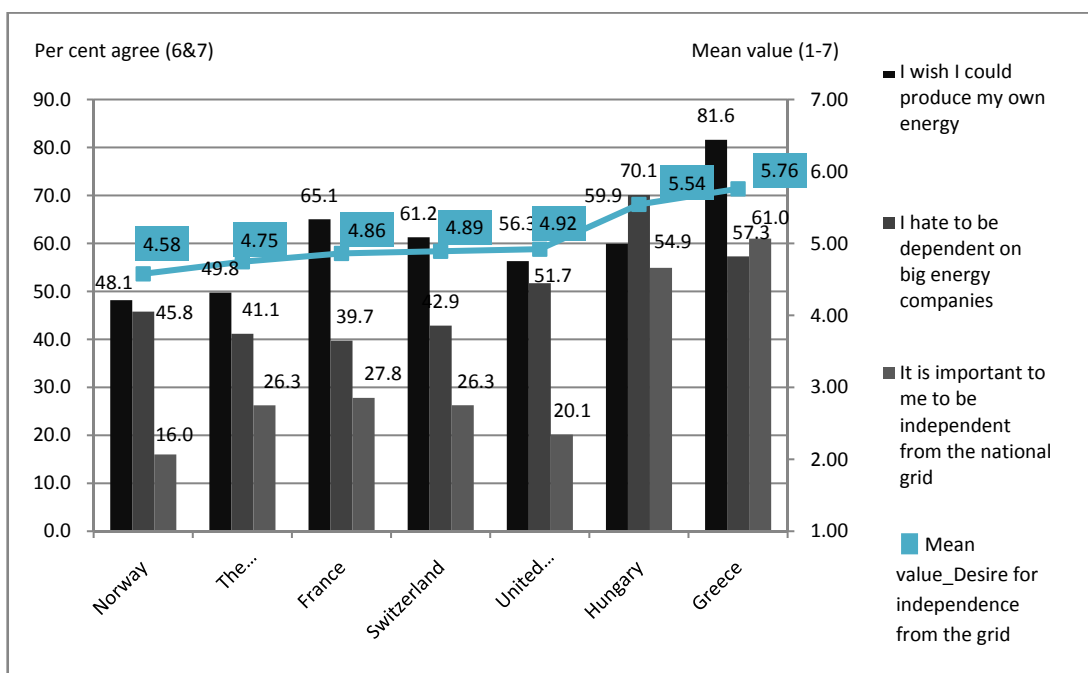


Figure 3 demonstrates that Greek and Hungarian consumers show the highest level of desire for energy independence (mean values 5.76 and 5.54, respectively) whereas Norwegian and Dutch consumers expressed the lowest levels of desire for energy independence (mean values 4.58 and 4.75 respectively). An explanation of why Norwegians and Dutch consumers have the lowest desire for energy independence might be that Norway and the Netherlands are social welfare states and trust in government and in their own energy companies is higher. Therefore, fear of electricity blackouts is lower than in other European countries (e.g. Greece and Hungary which have very high levels of desire for energy independence). Remarkably, over 80% of our Greek respondents agreed that they wished to produce

their own energy. This high result might be traced back to the higher risk of electricity blackouts in Greece.

- **Knowledge concerning solar panels:** Knowledge concerning solar panels was measured using a true/false question: “Energy pay-back time of solar panels is more than five years.” This statement is wrong, as energy pack-back time of solar panels is below five years.

Figure 4: Percentages of respondents with the right answer (N=881;843;849;918;758;856;940)

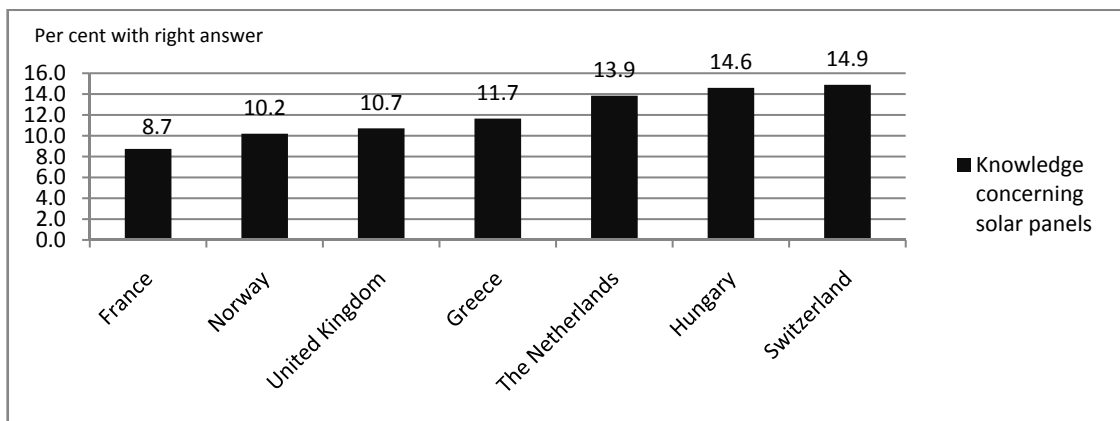
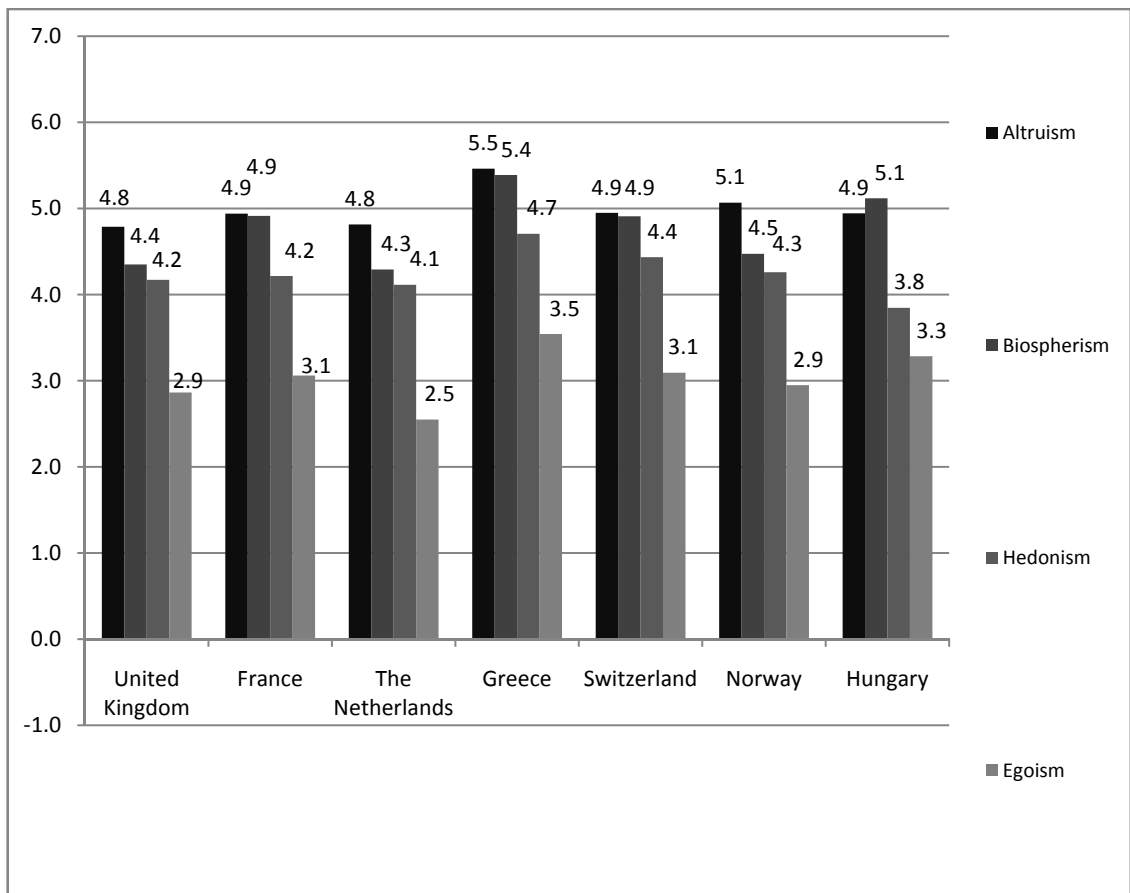


Figure 4 indicates the percentages of respondents with the right answer and shows that Swiss consumers have the most knowledge about the payback time for solar panels, followed by Hungarian and Dutch consumers. According to our survey, French consumers were the least knowledgeable of all countries surveyed. In general, however, knowledge level regarding the payback time of solar panels was low in all countries surveyed.

- **Individual values:** Different studies have pointed out that general values are related to specific values such as environmental concern and behavior; the studies showed that respondents with weaker self-transcendent values are less likely to report environmental concern and behavior (e.g. Stern et al., 1994). Stern et al. suggested the three value orientations, egoism, altruism and biospherism, that cause environmental concern and they found empirical support for this. De Groot and Steg (2007; 2008) have further developed the scale and created a rating scale to test the three value orientations and showed that biospherism, and to some extent altruism, is positively related to environmental concern and behavior. In our study, four value orientations, biospherism, altruism, egoism, and hedonism, were measured using a revised version of the De Groot and Steg's (2008) questionnaire, which has 17 value items. In the survey, biospheric values were described as the following: protecting the

environment, respecting the earth, preventing pollution and unity with nature. Altruistic values were described as the following: helpful, a world at peace, equality and social justice. Egoistic values on the other hand were described as: wealth, authority, ambition, influential, social power. Hedonistic values were described by: a varied life, pleasure, an exciting life and enjoying life. Each value item was accompanied by a short explanation. Participants were asked to rate how important each value was as a guiding principle in their lives, on an 8-point scale from -1 (values which are opposed to their principles) to 7 (values of supreme importance as a guiding principle). Then, four variables were created from the categories of the value scale to represent each of the four values: Altruism, Biospherism, Egoism, and Hedonism. These variables were created by taking the mean score of the categories for each scale, representing an overall value for each of the value orientations in the questionnaire. Cronbach's alpha was then used to check the internal consistency of each value orientation category, which was greater than 0.77 for each category.

Figure 5: Average approval of altruistic, environmental, hedonistic and egoistic values in seven European countries (-1 to 7). (N=849;881;758;918;940;843;856)



In all countries there was higher approval of altruistic and biospheric values than hedonistic and egoistic values. We find the highest level of altruistic values - on average 5.5 - and biospheric - on average 5.4 - among the Greek consumers. However, the Greek consumers also show the highest level of hedonistic and egoistic value orientations.

Preliminary analysis: Correlation analyses

A series of correlational analyses were performed to determine whether environmental knowledge concerning solar panels, desire for energy independence and acceptability of subsidies of solar panels varied according to the participant's demographic and socio-economic characteristics (age, gender, political preference, education, income, number of persons in the household and car ownership), value orientations (egoistic, hedonistic, biospheric and altruistic) and their country affiliation (living in the UK, in France, in the Netherlands, in Greece, in Switzerland, in Norway or in Hungary).

We made use of Spearman's rank correlation coefficient which measures the strength of the relationship between two variables. Values of the correlation coefficient always range between -1 and +1. A correlation coefficient of +1 shows that two variables are perfectly related in a positive linear sense whereas a correlation coefficient of -1 shows that two variables are perfectly related in a negative linear sense. If the correlation coefficient is zero, then there is no linear relationship between the two variables at all.

Table 2 shows the correlation coefficients for the full sample.

Table 2: Spearman's rank correlation coefficients for the full sample (positive correlations are highlighted in blue color and negative correlations in red color)

All countries			
Correlation analysis			
	Environmental knowledge about solar panels	Desire for energy independence	Acceptability of subsidies for solar panels
Age	-0.016	0.031	-0.011
Gender	-0.026	-0.024	0.030
Political preference	0.003	-0.027	-0.024
Education	0.000	-0.046*	0.009
Income	-0.021	-0.131*	-0.037*
Persons in household	0.006	0.045*	0.034*
Car ownership	-0.002	-0.009	-0.050*
Egoism	0.039*	0.094*	-0.053*
Hedonism	0.035*	0.108*	0.028
Biospherism	-0.019	0.366*	0.223*
Altruism	-0.012	0.286*	0.157*
UK	-0.017	-0.043*	-0.062*
France	-0.042*	-0.059*	0.118*
Netherlands	0.020	-0.086*	-0.033*
Greece	-0.006	0.219*	-0.107*
Switzerland	0.037*	-0.054*	0.036*
Norway	-0.023	-0.134*	-0.081*
Hungary	0.031	0.148*	0.126*
Environmental knowledge about solar panels	1	0.000	0.010
Desire for energy independence	0.000	1	0.242*
Acceptability of subsidies for solar panels	0.010	0.242*	1

Note: * = Correlation is significant at the 0.01 level

The correlation analyses of the full sample for environmental knowledge concerning solar panels shows that only the four independent variables egoism and hedonism, living in France and in Switzerland show significant correlations on a 0.01 level although the results confirm only a weak relationship. For all the other variables, the correlation analysis shows that knowledge is not correlated to any of the other variables on a 0.01 level.

Several correlations were found between demographic characteristics of the complete sample (from all seven countries) and desire for energy independence. They show significant positive correlations with number of persons in households, egoistic values, hedonistic values, biospheric values, altruistic values, and living in Greece or Hungary. There were significant negative correlations with education, income, and living in the the UK, France, the Netherlands, Switzerland and Norway. Although significant, however, most correlations were very small. Only for biospheric and altruistic value orientations, for living in Hungary and Norway could a moderate correlation be found. The results show that respondents with higher biospheric and altruistic values indicate a higher desire for energy independence.

Additionally, these results once again confirm the descriptive results from Figure 3 which showed that Greek and Hungarian consumers indicated a higher desire for energy independence whereas Norwegians indicated a lower desire for energy independence.

The correlation analyses of the full sample for acceptability of subsidies for solar panels showed significant positive correlations with number of persons in household, biospherism, altruism, and living in France, Switzerland and Hungary and significant negative correlations with income, car ownership, egoism, and living in the United Kingdom, in the Netherlands, in Greece or Norway. However, most of these results showed only a weak relationship. Only for biospherism, for altruism, for living in France or Hungary a moderate correlation could be found. Here the results indicate that respondents with higher biospheric and altruistic values report a higher acceptability of subsidies. The results from the descriptive part were also confirmed showing that France and Hungary have the highest levels and Greece the lowest levels of acceptability of subsidies for solar panels.

Finally, the analyses of the correlations between acceptability of subsidies for solar panels and environmental knowledge concerning solar panels reveals that there is no significant correlation between subsidy acceptance and knowledge, whereas desire for energy independence and acceptability of subsidies of solar panels correlate significantly. We did not find any significant correlation between environmental knowledge concerning solar panels and desire for energy independence.

Next, we analyze the country specific correlations between the acceptability of subsidies for solar panels and the different independent variables.

Table 3: Spearman's rank correlation coefficients split by countries for acceptability of subsidies of solar panels

Acceptability of subsidies for solar panels	Correlation analysis						
	UK	France	NL	Greece	Switzerland	Norway	Hungary
Age	0.055	-0.018	0.005	0.038	-0.058	-0.040	-.074
Gender	0.025	0.030	-0.017	-.118*	.115*	.121*	0.044
Political preferences	-0.060	0.012	-.133*	0.043	-.069	-0.034	0.013
Number of Persons	-0.011	.074	-0.044	0.062	0.061	0.003	0.025
Car ownership	-0.037	-0.019	-0.066	-0.012	-0.048	-0.061	-0.025
Education level	.091*	-0.007	0.042	-0.004	-0.004	0.043	-0.048
Income	0.014	-0.040	0.063	0.047	0.016	-0.006	0.043
Hedonism	0.046	0.052	0.026	.066*	0.055	.108*	0.000
Altruism	.216*	.214*	.156*	0.044	.241*	.233*	.148*
Biospherism	.249*	.256*	.199*	.099*	.302*	.278*	.181*
Egoism	-0.043	-0.053	-.149*	-.073*	-.073*	-0.032	0.003
Environmental knowledge concerning solar panel	-0.004	-0.032	-0.012	0.064	-0.018	0.015	0.021
Desire for energy independence	.404*	.287*	.105*	.206*	.291*	.198*	.295*

Note: * = Correlation is significant at the 0.01 level

There are several significant correlations in acceptability of subsidies for solar panels according to some demographic/socio-economic variables and value orientations in different countries. Regarding gender, women showed significantly lower levels of acceptability of subsidies for solar panels in Greece, whereas in Switzerland and Norway women showed significantly higher levels of acceptability of subsidies. Political preferences correlated significantly with subsidy acceptability only in the Netherlands: the more right-wing the respondent was, the weaker his or her acceptability of subsidies of solar panels.

Spearman's rank correlation analyses were also conducted to examine the relationships between the four values - altruism, biospherism, egoism, and hedonism - and the acceptability of subsidies for solar panels. For all samples (with the exception of altruism in Greece), there was a positive correlation between acceptability of subsidies and the two value orientations altruism and biospherism. This indicates that people with biospheric and/or altruistic values are more likely to accept subsidies for solar panels. There were negative correlations between egoism and acceptability of subsidies in the Netherlands, indicating that people with higher egoistic values are less likely to accept subsidies for solar panels.

We did not find any correlation between environmental knowledge about solar panels and subsidy acceptance in any country. Finally, we found significant correlations between acceptability of subsidies and desire for energy independence in all analyzed countries. We found moderate strong effects in all countries, ranging from 0.083 in the Netherlands to

0.320 in the United Kingdom.

Next, we analyze the country specific correlations between desire for energy independence and the different independent variables.

Table 4: Spearman's rank correlation coefficients split by countries for strive for energy independence

Desire for energy independence	Correlation analysis						
	UK	France	NL	Greece	Switzerland	Norway	Hungary
Age	0.019	0.029	.145*	0.023	.091*	0.061	.082
Gender	0.035	-0.025	-.115*	-.066*	0.005	-0.002	-0.024
Political preferences	-0.025	-0.054	-0.012	-0.022	-0.027	-0.028	0.064
Number of Persons	-0.066	.068	0.019	0.001	0.050	0.052	0.022
Car ownership	-.074	0.059	0.030	-0.011	-0.037	-.068	0.045
Education level	0.056	-0.049	-0.029	-0.018	0.030	-0.034	-0.024
Income	-0.056	-0.028	0.019	-0.004	0.016	-.076	0.027
Hedonism	.125*	.101*	.093	.130*	.101*	.117*	0.031
Altruism	.307*	.264*	.282*	.301*	.288*	.216*	.171*
Biospherism	.376*	.348*	.365*	.268*	.340*	.307*	.262*
Egoism	0.013	0.026	.181*	0.010	.084	-0.006	-0.010
Environmental knowledge concerning solar panels	0.005	-0.061	-0.025	0.024	0.001	0.015	0.012
Acceptability of subsidies for solar panels	.404*	.287*	.105*	.206*	.291*	.198*	.295*

Note: * = Correlation is significant at the 0.01 level

There are several significant correlations in desire for energy independence with some demographic/socio-economic variables and value orientations in different countries. In the Netherlands and in Switzerland, there were moderately strong effects for age, showing that the older the respondents, the higher their desire for energy independence. In the Netherlands, women had significantly lower levels of desire for energy independence than men.

Spearman's rank correlation analyses were also conducted to examine the relationships between the four values - altruism, biospherism, egoism, and hedonism - and desire for energy independence. In every country there was a positive correlation between desire for energy independence and the two value orientations altruism and biospherism; this indicated that as the level of reported biospherism and altruism increased, the desire for energy independence increased too. There were positive correlations between egoism and desire for energy independence in the Netherlands, indicating that as the level of reported egoism increased, the desire for energy independence increased too. There were also positive

correlations between hedonism and desire for energy independence at the 0.01 level in all countries except Hungary and the Netherlands, indicating that as the level of reported hedonism increased, the desire for energy independence increased too.

Finally, we did not find any significant correlations in environmental knowledge concerning solar panels and desire for energy independence in different countries.

Next, we analyze the country specific correlations between environmental knowledge concerning solar panels and the different independent variables.

Table 5: Spearman's rank correlation coefficients split by countries for environmental knowledge concerning solar panels

Environmental knowledge concerning solar panels	Correlation analysis						
	UK	France	NL	Greece	Switzerland	Norway	Hungary
Age	-0.018	-0.040	-0.038	0.003	0.046	-0.017	-0.037
Gender	-0.024	-0.016	-0.034	-0.017	-.073	-0.047	0.029
Political preferences	-0.017	-0.037	-0.002	-0.061	0.000	0.015	.101*
Persons	-0.011	-0.024	0.048	0.035	-0.025	-0.008	0.025
Car ownership	-0.032	0.005	0.010	0.021	0.026	0.026	-0.008
Education level	-0.043	0.035	0.002	-0.020	.073	-0.016	-0.032
Income	-0.007	-0.016	-0.026	-0.029	-0.015	0.030	-.074
Hedonism	.070	-0.044	0.020	-0.034	.070	0.037	.121*
Altruism	-0.020	-0.055	-0.018	-.100*	0.012	0.061	0.049
Biospherism	0.015	-.068	-0.027	-.090*	-0.017	0.015	0.023
Egoism	0.065	0.008	0.042	-0.035	.070	0.051	.074
Desire for energy independence	0.005	-0.061	-0.025	0.024	0.001	0.015	0.012
Acceptability of subsidies	-0.004	-0.032	-0.012	0.064	-0.018	0.015	0.021

Note: * = Correlation is significant at the 0.01 level

There are only a couple of significant correlations between knowledge about solar panels according to some demographic/socio-economic variables and value orientations in the analyzed countries. We found in Hungary that political preferences have a moderate effect on environmental knowledge about solar panels (the more right-wing the respondent, the more knowledgeable).

Spearman's rank correlation analyses were also conducted to examine the relationships between the four values - altruism, biospherism, egoism, and hedonism - and knowledge about solar panels. There was only one negative significant correlation between knowledge and the two value orientations altruism and biospherism in Greece, indicating that as the level of reported biospherism and altruism increased, the level of knowledge about solar panels decreased. There was only one positive significant correlation between hedonism and

knowledge concerning solar panels in Hungary, indicating that as the level of reported hedonism increased, the level of knowledge about solar panels also increased.

Finally, we did not find any significant correlations between environmental knowledge about solar panels and desire for energy independence in different countries, nor with acceptability of subsidies for solar panels.

Last but not least, we analyze the country specific correlations between individual value orientations (hedonistic, egoistic, altruistic and biospheric) and demographic/socio-economic factors.

Table 6: Spearman's rank correlation coefficients split by countries for hedonistic value orientation

	Hedonistic value orientations					Correlation analysis		
	All	UK	France	NL	Greece	Switzerl and	Norway	Hungar y
Age	-.180*	-.270*	-.196*	-.266*	-0.044	-.116*	-.100*	-.238*
Gender	-0.041*	-0.034	0.001	-.093	0.032	-.137*	-0.026	-0.028
Political preferences	0.056*	-0.028	.086	0.043	0.033	.098*	.156*	0.057
Persons	0.012	0.052	0.024	0.008	-.090*	0.050	0.014	0.001
Car ownership	0.059*	0.022	0.000	-0.023	0.004	.113*	-0.011	0.059
Education level	0.030	0.060	0.036	0.066	0.039	0.040	0.014	-.089*
Income	.088*	.118*	0.042	0.007	-0.039	0.052	.100*	0.002

Note: * = Correlation is significant at the 0.01 level

The relationship between demographic characteristics and hedonistic value orientation revealed that respondents with higher hedonistic values tend to be younger. Gender was unrelated to hedonistic value orientation in this context, with the exception of our Swiss sample where women reported relatively lower perceptions of hedonistic values. Income was correlated to hedonistic orientation in the United Kingdom and in Norway.

Table 7: Spearman's rank correlation coefficients split by country for egoistic value orientation

	Egoistic value orientations					Correlation analysis		
	All	UK	France	NL	Greece	Switzerlan d	Norway	Hungar y
Age	-0.046*	-.136*	-0.010	-0.070	0.019	.138*	-0.030	-.077
Gender	-0.085*	-.080	-.071	-.203*	-.105*	-.121*	-0.050	0.013
Political preferences	0.132*	.101*	.200*	.159*	.147*	.176*	.217*	-0.025
Persons	0.060	.083	0.023	0.027	-0.004	.122*	-0.015	0.035
Car ownership	0.094*	0.055	0.030	.086	0.054	.194*	0.047	.087
Education level	0.002	-0.020	-0.003	0.067	0.057	.072	-0.028	0.006
Income	0.029*	.115*	.079	.108*	0.033	.132*	.082*	0.017

Note: * = Correlation is significant at the 0.01 level

The relationship between demographic characteristics and egoistic value orientation revealed that respondents with higher egoistic values tend to have rather right-wing political preferences. In Switzerland, car ownership correlated on a moderate level with egoistic value orientations (the more cars are present in a household the higher a respondent's egoistic value orientation). Gender was related to egoistic values; we found a moderate correlation between gender and egoistic value orientation in our Dutch and Swiss subsamples, showing that women in these countries tend to have lower values of egoistic value orientations.

Table 8: Spearman's rank correlation coefficients split by country for biospheric value orientation

Biospheric value orientations	Correlation analysis							
	All	UK	France	NL	Greece	Switzerland	Norway	Hungary
Age	0.085*	0.021	.145*	.156*	.082	.193*	.132*	.131*
Gender	0.091*	.144*	.120*	0.015	0.045	.071	.151*	.077
Political preferences	-0.087*	-.094*	-0.064	-.121*	-0.048	-.093*	-.134*	-0.009
Persons	0.016	-0.039	-0.039	-0.029	0.016	0.048	-0.020	-0.010
Car ownership	-0.023	-.090*	-0.043	-0.067	-0.034	-0.036	-.084	0.033
Education level	-0.067*	-0.034	-.081	-.081	-.074	-0.036	-0.019	0.028
Income	-0.082*	-0.052	-.089*	-.089	-0.030	0.053	-0.034	-.086

Note: * = Correlation is significant at the 0.01 level

The relationship between demographic characteristics and biospheric value orientation revealed that respondents with higher biospheric values tend to be rather older, female, with a lower income and education level and with rather left-wing political preferences.

Table 9: Spearman's rank correlation coefficients split by country for altruistic value orientations

Altruistic value orientations	Correlation analysis							
	All	UK	France	NL	Greece	Switzerland	Norway	Hungary
Age	0.068*	0.067	.104*	.106*	0.022	.083	.162*	.097*
Gender	0.142*	.134*	.186*	0.067	.134*	.136*	.204*	.141*
Political preferences	-0.134*	-.139*	-.140*	-.176*	-.083	-.168*	-.135*	-0.047
Persons	0.002	-0.065	-.087*	-0.035	0.018	.107*	-0.001	-0.003
Car ownership	-0.027	-.105*	-0.063	-.078	-0.009	-0.010	-0.064	-0.016
Education level	-0.048*	-0.056	-.068	-.078	-.070	0.017	-0.026	0.032
Income	-0.039*	-.093*	-.114*	-0.055	-0.051	0.056	-0.017	-.102*

Note: * = Correlation is significant at the 0.01 level

The relationship between demographic characteristics and altruistic value orientation revealed that respondents with higher altruistic values tend to be rather older, female, with a lower income and education level and rather left-wing political preferences.

Research question 1: Which factors affect acceptability of subsidies for solar panels most?

In order to answer our first research question, in Table 10 we include stepwise social background variables, individual value orientations, and country of origin.

We applied a multiple regression analysis, which is a useful way to look for relationships between different constructs. The concept of multiple regression analysis is identical to that of simple regression analysis except that two or more independent variables are used simultaneously to explain variations in the dependent variable.

Table 10: What affects respondents' acceptability of subsidies for solar panels (1-7) the most: individual social background variables, individual values or country of origin. Standardised regression coefficients (beta). N=6045

Acceptability of subsidies			
	Model I	Model II	Model III
Explained variance	r ² =0.007	r ² =0.052	r ² =0.094
Age	0.009	-0.017	-0.031
Gender	0.028	-0.004	-0.002
Political preference	-0.017	0.018	0.010
Education	0.023	0.033*	0.019
Income			0.050*
Persons in household	0.048*	0.042*	0.024
Car ownership	-0.068*	-0.054*	-0.044*
Egoism		-0.120*	-0.124*
Hedonism		0.024	0.044*
Biospherism		0.197*	0.178*
Altruism		0.028	0.062*
UK			-0.027
France			0.080*
Netherlands			-0.009
Greece			-0.144*
Switzerland			0.00
Norway			-0.073*
Hungary			0.079*

Note: * = Correlation is significant at the 0.01 level

In this section, the regression analysis aims to analyze the sensitivity of explanatory variables of acceptability of subsidies of solar panels. Model 1 includes important demographic and socio-economic variables (age, gender, political preference, education, number of persons in households, car ownership). Variation in demographic variables explains only 0.7% variation. Model 2 includes all variables included in Model 1 and all four value orientations. Variation between demographic/socio-economic variables and value

orientations in Model 2 explains 5.2% percent of total variation. Model 3 includes all variables included in Models 1 and 2 and income and country affiliation (living in the UK, France, the Netherlands, Greece, Switzerland, Norway or Hungary). Variation on all variables included in this model explains 9.4% of total variation.

The explained variances (r^2) from the three models presented in Table 10 show that among the analyzed variables, the consumers' value orientation and country of origin explain acceptability of subsidies the most. According to these calculations, biospherism had the highest impact on acceptability of subsidies. Regarding the countries, the multivariate approach reflects the main results from the correlation analysis presented in Table 2.

Only two socio-economic variables turned out to be statistically significant in the final model: income and car ownership.

The most important observation that emerges from this analysis is that value orientations and country affiliation explain desire for energy independence the most while demographic and socio-economic factors do not explain the effect very well. However, the additional variance explained by values and country affiliation is still quite small.

Research question 2: Which factors affect strive for energy independence the most?

In order to answer our second research question, in Table 11 we include stepwise social background variables, individual value orientations, and country of origin.

Table 11: What affects respondents' desire for energy independence (1-7) the most: individual social background variables, individual values or country of origin. Standardised regression coefficients (beta). N=6045

Desire for energy independence			
	Model I	Model II	Model III
Explained variance	r ² =0.008	r ² =0.138	r ² =0.190
Age	0.038*	-0.004	0.026
Gender	-0.026	-0.068*	-0.067*
Political preference	-0.028	0.008	0.016
Education	-0.043*	-0.024	0.005
Income			-0.042*
Persons in household	0.065*	0.047*	0.042*
Car ownership	-0.031	-0.020	0.000
Ego		-0.003	-0.044*
Hedo		0.005	0.033
Bio		0.318*	0.269*
Altruistic		0.068*	0.080*
UK			0.034
France			-0.016
Netherlands			-0.009
Greece			0.171*
Switzerland			0.000
Norway			-0.054*
Hungary			0.131

Note: * = Correlation is significant at the 0.01 level

In this section, the regression analysis aims to analyze the sensitivity of explanatory variables of desire for energy independence. Model 1 includes important demographic and socio-economic variables (age, gender, political preference, education, number of persons in a household, car ownership). Variation in demographic variables explains only 0.8% variation. Model 2 includes all variables included in Model 1 and all four value orientations. Variation between demographic/socio-economic variables and value orientations in Model 2 explains 13.8% percent of total variation. Model 3 includes all variables included in Models 1 and 2 and income and country affiliation (living in the UK, France, the Netherlands, Greece, Switzerland, Norway or Hungary). Variation between all variables included in this model explains 19.0% of total variation.

The explained variances (r^2) from the three models presented in Table 7 show that it is consumers' value orientation and country of origin that best explain consumers' desire for energy independence. In this model biospherism had the highest impact on desire for energy independence. The multivariate approach confirms once again the main results from the correlation analysis presented in Table 2.

Only three socio-economic variables turned out to be statistically significant in the third model: Gender, income and number of persons in a household.

The most important observation that emerges from this analysis is that value orientations explain desire for energy independence the most while socio-economic factors do not explain the effect very well.

Research question 3: Which factors affect environmental knowledge concerning solar panels the most?

In order to answer our third research question, Table 12 includes stepwise social background variables, individual value orientations, and country of origin.

We applied logistic regression analyses, which is similar to a linear regression model but suits models with a dichotomous dependent variable (as in our case with knowledge concerning solar panels: yes=1/ no=0). Logistic regression coefficients can be used to predict a dichotomous dependent variable on basis of continuous and/or categorical independents and to determine the percent variance in the dependent variable that can be explained by the independent variables. The proportion of explained variance can be calculated with the following formula:
$$\frac{\text{Chi-square}}{(\text{Chi-square} + -2\text{Log-likelihood})}$$

Table 12: What affects respondents' environmental knowledge about solar panels the most: individual social background variables, individual values or country of origin; b coefficients in the logistic regression equation; N=6045

Sustainable energy knowledge about solar panels			
	Model I	Model II	Model III
Explained variance	r ² =0.002	r ² =0.004	r ² =0.011
Age	-0.004	-0.002	-0.001
Gender	-0.177	-0.143	-0.155
Political preference	0.013	0.004	0.001
Education	-0.005	-0.010	0.000
Income			-0.029
Persons in household	0.0013	0.017	0.019
Car ownership	-0.034	0.051	0.017
Ego		0.075	0.073
Hedo		0.045	0.055
Bio		-0.064	-0.079
Altruistic		0.016	0.029
UK			-0.304
France			-0.503*
Netherlands			0.001
Greece			-0.256
Switzerland			0.144
Norway			-0.308
Hungary			0.000

Note: * = Correlation is significant at the 0.01 level

In this section, the regression analysis aims to analyze the sensitivity of explanatory variables of environmental knowledge concerning solar panels. Model 1 includes important demographic and socio-economic variables (age, gender, marital status, political preference, education, home ownership, number of persons in a household, car ownership). Variation in

these variables explains only 0.3% variation. Model 2 includes all variables included in model 1 and all four value orientations. Variation between demographic/socio-economic variables and value orientations in Model 2 explains only 0.6% percent of total variation. Model 3 includes all variables included in Models 1 and 2 and in addition income and country affiliation (living in the UK, France, the Netherlands, Greece, Switzerland, Norway or Hungary). Variation between all variables included in this model explains only 1.3% of total variation.

The explained variances (r^2) from the three models presented in Table 6 are extremely low, which suggest that the independent variables do not explain variation in knowledge for solar panels well. The percentage of explained variance in Model 3 is less than 1.5%. Therefore we draw a general conclusion that the independent variables do not predict whether or not someone is knowledgeable about the payback time of solar panels. This result also supports the correlation analysis which we performed in the preliminary analysis showing that knowledge was not correlated to most of the other variables. Therefore one can assume that the logistic regression analysis which used knowledge as the dependent variable was unlikely to yield clear results.

Research question 4: Does more knowledge about solar panels lead to higher acceptability of subsidies for solar panels?

Table 13: Impact of more knowledge concerning solar panels on acceptability of subsidies for solar panels. Standardised regression coefficients (beta). N=6045;84981;758;918;940;843;856

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
All countries	0.059	0.053	0.014	1.115	0.265
1=United Kingdom	-0.017	0.141	-0.004	-0.121	0.904
2=France	-0.129	0.134	-0.032	-0.962	0.336
3=The Netherlands	-0.019	0.126	-0.006	-0.154	0.877
4=Greece	0.321	0.169	0.063	1.905	0.057
5=Switzerland	-0.027	0.114	-0.008	-0.236	0.813
6=Norway	0.046	0.152	0.010	0.304	0.761
7=Hungary	0.129	0.127	0.035	1.015	0.311

In this section, the regression analysis aims to show whether or not more knowledge about solar panels leads to higher acceptability of subsidies for solar panels. The results clearly indicate that knowledge does not explain acceptability of. Neither in the results of the regression analysis for all countries nor in the results for each individual country could we find significant values.

Research question 5: Does higher desire for energy independence lead to higher acceptability of subsidies for solar panels?

Table 14: Impact of higher desire for energy independence on acceptability of subsidies for solar panels. Standardised regression coefficients (beta). N=6045;84981;758;918;940;843;856

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
All countries	0.368	0.031	0.377	11.850	0.000
1=United Kingdom	0.368	0.031	0.377	11.850	0.000
2=France	0.214	0.026	0.264	8.120	0.000
3=The Netherlands	0.060	0.031	0.071	1.946	0.052
4=Greece	0.237	0.047	0.166	5.089	0.000
5=Switzerland	0.238	0.029	0.259	8.215	0.000
6=Norway	0.177	0.032	0.187	5.518	0.000
7=Hungary	0.292	0.033	0.289	8.837	0.000

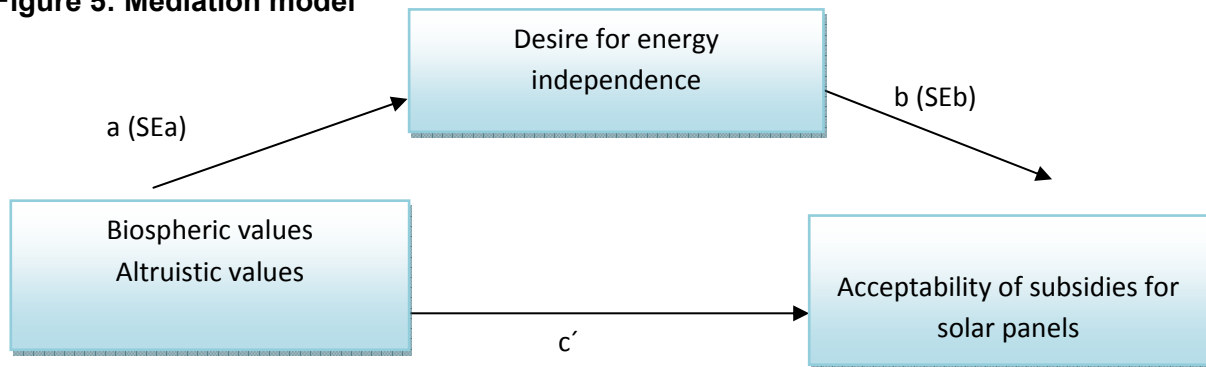
In this section, the regression analysis aims to show whether or not higher desire for energy independence leads to higher acceptability of subsidies for solar panels. The results clearly indicate that higher desire for energy independence does explain acceptability of subsidies on a moderate level in most countries.

Research question 6: Does a mediation effect exist?

Mediation is said to occur when a causal effect of some variable X on an outcome Y is explained by some intervening variable M . Statistical approaches to the analysis of mediation have been discussed extensively in the psychological literature. This study makes use of the approach to mediation analysis by Baron & Kenny (1986).

We investigated to what extent desire for energy independence can be explained as a mediator model when examining the relationships between biospheric and altruistic values and acceptability of subsidies for solar panels. As knowledge concerning payback time of solar panels did not explain acceptability of subsidies, we did not include this variable in the mediation analysis. To test the mediator model, we followed R.M. Baron and Kenny's (1986) approach to mediation analyses using regression analyses.

Figure 5: Mediation model



a... raw (unstandardized) regression coefficients for the association between independent variables (biospheric and altruistic values) and mediator (desire for energy independence)
SEa... standard error of a

b... raw (unstandardized) coefficient for the association between the mediator (desire for energy independence) and the dependent variable (acceptability of subsidies for solar panels), when the independent variable (biospheric, altruistic or egoistic value) is also a predictor of the dependent variable

SEb... standard error of b

c'... total effect

When the direct effect, $a \times b$, equals the total effect, c , we say the effect of X on Y is completely mediated by M . In this case, there is no direct effect of X on Y , and the path c' in figure 5 is equal to zero. When the indirect effect does not equal the total effect but is smaller and of the same sign, we say the effect of X on Y is partially mediated by M . In this case, the path c' is a value other than zero.

In order to consider a variable as a mediator, the following four criteria must be met: 1) the independent variable significantly affects the mediator, 2) the independent variable significantly affects the dependent variable in the absence of a mediator, 3) the mediator has significant effect on the dependent variable and 4) the effect of the independent variable on the dependent variable shrinks when the mediator is included in the model. If even one of these three correlations is not significant, then one cannot find significant mediation (see Baron & Kenny, 1986). This study makes use of the Goodman version of the Sobel test (Preacher & Leonardelli, 2006) in order to test the significance of the mediation effects.

- **Step 1: Show that the independent variable (biospherism, altruism) significantly affects the mediator (desire for energy independence).**

Table 11: Regression analysis (independent values on mediator)

	Unstandardized Coefficients		Standardized Coefficients					
	B	St. Error	Beta	t	Sig.	Adj. R2	F	Sig.
Biospheric values	0.341	0.011	0.360	29.978	.000	0.129	898.695	0.000
Altruistic values	0.308	0.014	0.272	21.962	.000	0.074	482.332	0.000

We found a moderate positive relation between the two variables. In short, respondents with high levels of biospherism and altruism report a higher desire for energy independence.

- **Step 2: Show that the independent variable (biospheric and altruistic values) significantly affects the dependent variable (acceptability of subsidies on solar panels) in the absence of a mediator**

Table 12: Regression analysis: Independent values on dependent values

	Unstandardized Coefficients		Standardized Coefficients					
	B	St. Error	Beta	t	Sig.	Adj. R2	F	Sig.
Biospheric values	0.173	0.012	0.189	14.993	.000	0.036	224.793	0.000
Altruistic	0.147	0.014	0.135	10.589	.000	0.018	112.124	0.000

values								
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We found a moderate positive relation between the two variables. In short, respondents with high levels of biospherism and altruism report a higher acceptability of subsidies of solar panels.

- **Step 3: Show that the mediator (desire for energy independence) has significant effect on the dependent variable (acceptability of subsidies of solar panels).**

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Adj. R2	F	Sig.
	B	St. Error	Beta					
Desire for energy independence	0.210	0.013	0.202	16.048	.000	0.041	257.549	0.000

We found a moderate positive relation between the two variables. In short, respondents with high levels of desire for energy independence report a higher acceptability of subsidies of policy measures.

- **Step 4: Show that the effect of the independent variable (biospherism or altruism) on the dependent variable (acceptability of subsidies for solar panels) shrinks when the mediator (desire for energy independence) is included**

Table 13: Regression analysis: Biospheric values and strive for energy dependence on acceptability of subsidies of solar panels

a)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Adj. R2	F	Sig.
	B	St. Error	Beta					
Biospheric values	0.123	0.012	0.134	10.003	.000			
Strive Ind	0.149	0.013	0.154	11.496	.000			

The inclusion of a mediator attempts to explicate the basic relationship presented above. We argue that desire for energy independence may mediate the basic relationship. We think that biospherism leads to higher desire for energy independence, and subsequently higher desire for energy independence leads to a higher acceptability of subsidies for solar panels.

We showed the effect of a partial mediation (standardized coefficient of biospheric values drop from 0.173 to 0.123). Partial mediation is the case in which the path from X to Y is reduced in absolute size but is still different from zero when the mediator is controlled. In order for either partial or complete mediation to be established, the reduction in variance explained by the independent variable must be significant as determined by one of several tests, such as the Sobel (1982) test. In our case, this direct effect is still significantly different from zero and the Goodman Sobel's z-value is significant (z-value 10.75) telling us that a significant mediation has occurred.

Figure 6: Results of mediation model 1

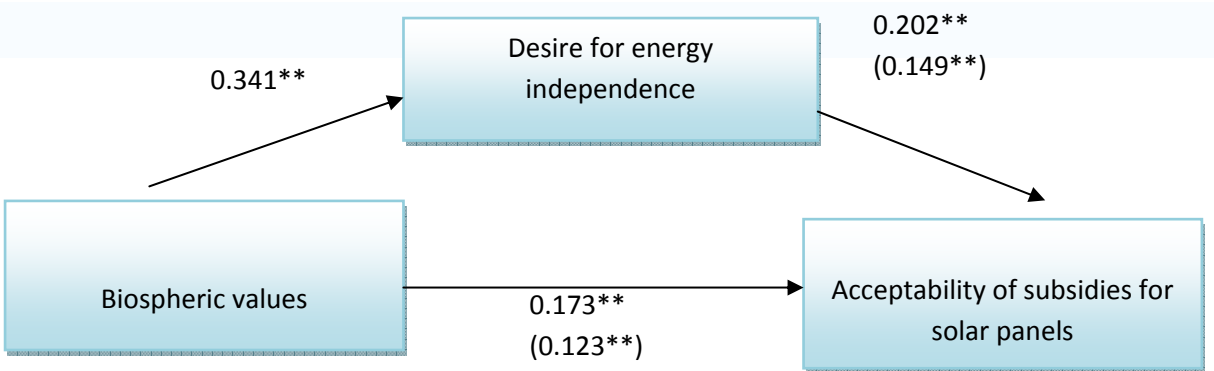


Table 14: Regression analysis: Altruistic values and desire for energy independence on acceptability of subsidies for solar panels

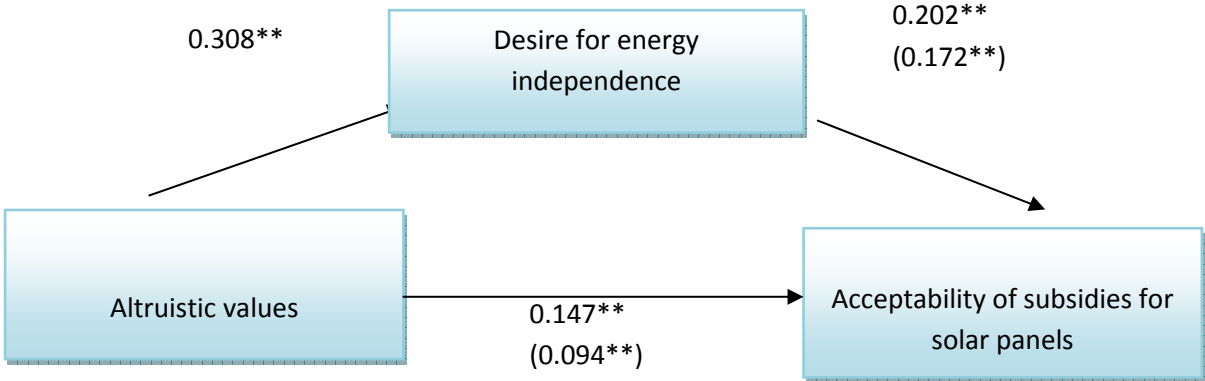
b)	Unstandardized Coefficients		Standardized Coefficients			Adj. R2	F	Sig.
	B	St. Error	Beta	t	Sig.	0.047	151.613	0.000
Altruistic values	0.094	0.014	.086	6.622	0.000			
Strive Ind	.172	.013	.179	13.698	0.000			

The inclusion of a mediator attempts to explicate the basic relationship presented above. We argue that desire for energy independence may mediate the basic relationship. We think that

altruism leads to a higher desire for energy independence, and subsequently higher desire for energy independence leads to higher acceptability of subsidies for solar panels.

We showed the effect of a partial mediation (standardized coefficient of altruistic values drop from 0.147 to 0.094). This direct effect is still significantly different from zero and the Goodman Sobel's z-value is significant (z-value 11.35) telling that a significant mediation has occurred.

Figure 7: Results of mediation Model 2



We have indeed found partial mediation - we showed that the relationship between altruistic and biospheric value-orientations and acceptability become weaker when we include the mediator in the model. What we conclude is that striving for energy independence partially mediates the relationship between altruistic and biospheric values and acceptability.

Conclusions

This report aimed to identify key factors which influence consumers' acceptability of subsidies for solar panels. More specifically, we tested to what extent demographic and socio-economic factors, value orientation, country affiliation, respondents' desire for energy independence and their knowledge concerning solar energy influences the level of acceptability of subsidies. To our knowledge, there has been no empirical research which has tested a theoretical model integrating consumer values, knowledge and desire for energy independence on acceptance of environmental policy measures. The study presented in this paper provides a deeper understanding of that interrelation.

The country analysis revealed that acceptability of subsidies for the installation of solar panels in all countries was fairly high (5.46-6.25 out of 7). French and Hungarian respondents showed the highest levels of acceptability of subsidies for installation of solar panels whereas Greek and Norwegians showed the lowest levels of acceptability. This high acceptability is not surprising. Many studies (European Commission, 2007; European Renewable Energy Centres Agency, 2008; Alpiq, 2009) have shown that many people are in favor of renewable energies and especially solar power. Solar power is however not yet self-sufficient and as a result dependent on policy and regulation. This is in line with the outcomes of the qualitative interviews of WP4 where respondents mentioned that consumers expected the government to support photovoltaics in a more substantial way than at present. The high acceptability for such measures in France and Hungary support the current initiatives of these countries' governments to enhance solar power production. In Norway, solar power is not seen as an important source to invest in because of the countries geographical location and also the current power mix low on CO₂.

Concerning desire for energy independence, our analysis demonstrates that Greek and Hungarian consumers showed the highest level of desire for energy independence whereas Norwegians and Dutch consumers expressed the lowest levels of desire for energy independence. A possible explanation for these results, that Norwegians and Dutch consumers have the lowest levels for desire for energy independence, might be explained by the fact that Norway and the Netherlands are social welfare states and trust in government and in the own energy companies is higher and therefore fear of electricity blackouts is lower than in other European countries such as Greece and Hungary which show very high levels for desire for energy independence.

In general, knowledge levels concerning the payback time of solar panels was low in all countries surveyed. Our result indicated that it was highest for Swiss consumers, followed by

Hungarian and Dutch consumers whereas French consumers showed the least knowledge of all countries surveyed. The low knowledge regarding the payback time indicates that the preconception that the production of solar panels uses more energy than the systems produce over their lifespan is probably still quite popular among the population in the surveyed countries. This indicates a lack of trust in the solar photovoltaic technology which, together with the fact that PV technology is still being improved, leads to a wait-and-see attitude towards photovoltaics by many people. Governments can counter this attitude by awareness raising and spreading accurate information. Here schools, the media, solar industry associations and other platforms such as the "European Solar Days" and construction industry fairs play an important role.

As our country analysis showed that the acceptability of subsidies for the installation of solar panels is already quite high, we must bear this in mind when interpreting our results from the quantitative analyses. Therefore, the following suggestions propose ways of further increasing the acceptability rates to an even higher level.

The most important observation that emerged from the analysis is that value orientations and country affiliation explained acceptability of subsidies for solar panels and desire for energy independence the most, while demographic and socio-economic factors did not explain the effect very well. The reason behind the significance of value orientations might be the fact that subsidies of solar panels requires individuals to pay higher taxes or even to take political actions through voting and therefore restrain from egoistic tendencies (such as paying more taxes) in order to benefit collective interests (diffusion of a renewable energy technology). Support for solar subsidies may be therefore enhanced by emphasizing biospheric values in politicians' communication messages. In addition, several possible ways for the development of prosocial (e.g. biospheric and altruistic) values have been discussed in the literature. Kelley (1983), for instance, argued that social values result from extensive social learning experiences in which cooperative behavior is reinforced. Therefore social learning interventions promoting prosocial values might be an approach for further exploration.

To enhance further diffusion of solar power and the acceptability of measures among the population, it would be useful to show the population the personal profit of solar investments (so that also people with higher egoistic value orientations could be addressed). The present findings suggest using communication messages that emphasize the individual benefit of solar energy. This assumption is supported by the country specific results. In France, subsidies available for solar panels allow a profitable investment in solar power. This could be the reason why this country's affiliation correlates positively with the acceptability of subsidies.

The present findings suggest that a policy measure targeting the introduction of a support scheme for solar energy may profit from using persuading messages that highlight the benefits of increased energy independence. For example, efforts to increase public support for subsidies for solar energy may find that messages emphasizing being independent from foreign countries or big corporations may be an effective way.

By applying a mediator analysis we showed that desire for energy independence partially mediates the relationship between altruistic and biospheric values and acceptability of subsidies on solar panels.

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Income level: In which category does your total monthly household income *after taxes* fit?

Income level	Category
< €500	1
€500-€1000	2
€1000-€1500	3
€1500-€2000	4
€2000-€2500	5
€2500-€3000	6
€3000-€3500	7
€3500-€4000	8
€4000-€4500	9
€4500-€5000	10
> €5000	11

Car ownership: How many cars are present in your household?

Car ownership	Category
0 cars in your household	0
1	1
2	2
3	3
4	4
5 or more cars in your household	5

Persons in household: How many persons are present in your household?

... persons