Electricity Supply Preferences in Europe: Evidence from Subjective Well-Being Data

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Abstract: We use survey data for 139.517 individuals in 26 European Countries, 2002-2011, to estimate the relationship between subjective well-being (SWB) and production shares of various types of electricity generation. Controlling for individual and macro-level factors, we find that, other things equal, a greater share of (i) fossil-based relative to nuclear electricity, and (ii) fossil-based relative to renewable electricity are significantly correlated with greater SWB, whereas (iii) a greater share of renewable relative to nuclear power (or vice versa) is not significantly correlated with greater SWB. As the estimated SWB equations implicitly capture preference-relevant features of the different technologies (costs, safety, environmental impacts) as perceived by the individuals, the findings (i) – (iii) can be taken to represent a preference ordering. They suggest that fossil-based electricity is the most preferred type of electricity in terms of SWB, whereas there is no clear preference relationship between renewable and nuclear electricity. We also find that the preference orderings in Germany and Switzerland are different than in the rest of Europe, and that the European-wide preference ordering in 2011 is different from that in 2002-2010, with a preference of renewable over nuclear electricity in that year.

Keywords: energy mix; energy transition; preference; subjective well-being; Fukushima
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1. Introduction

Several European countries are currently undertaking fundamental revisions of their energy policy, in particular with regard to the structure of electricity supply. While Switzerland is working on its *Energiestrategie 2050*, Germany has proclaimed the *Energiewende* (energy transition), which entails an accelerated phase-out of nuclear power and an ambitious goal for phasing-in renewable energies. Contrary to this, France has announced to extend the lifetime of its nuclear power stations and the United Kingdom is planning to build new ones.

Different sources of electricity supply all have their specific advantages and drawbacks. Electricity from fossil fuels (in particular coal) is relatively inexpensive but problematic with respect to greenhouse gas emissions and air pollution, whereas electricity from renewable sources (in particular wind and solar power) is more environmentally benign but less reliable and more expensive. Nuclear power is considered to be inexpensive but has unresolved problems of nuclear waste disposal and nuclear safety; the latter concern has recently gained increase attention in the aftermath of the Fukushima nuclear accident.

Against this background, this paper provides an assessment of the structure of the electricity supply system in terms of citizens' experienced utility, operationalized as subjective well-being (SWB). Specifically, this study uses SWB regressions to infer European citizens' preferences and implied willingness to pay for alternative configurations of the electricity supply system. The identified relationship between the electricity mix and SWB implicitly captures the above concerns – costs, safety, and environmental impacts – as perceived by representative individuals, and weighs them according to their significance for SWB.

To perform our analysis, we combine survey data on SWB for 139.517 persons in 26 European countries, 2002-2011, with data on the electricity mix in the respective countries and years. By employing the calendar dates at which surveys were conducted, we are able to investigate whether the Fukushima accident of March 2011 may have affected the relationship between the electricity mix and SWB in Europe.

Our method of preference elicitation by means of SWB data does *not* rely on people's stated assessments of different forms of electricity supply. Instead, by measuring the purely statistical relationship between indicators of the electricity mix and a proxy for experienced utility we derive what may be referred to as experienced preference. In contrast to stated preference methods, the experienced preference approach is not subject to biases stemming from strategic response or "cheap talk".[1] Even though survey data on SWB may be an imperfect approximation of experienced utility, there is no reason to expect that imperfections in the measurement of utility vary systematically with the structure of the electricity system, thus biasing the results.[2]

A main finding from our empirical analysis is that, controlling for individual and macro-level factors, the SWB of citizens of European countries, 2002-2011, varies systematically and significantly with differences in the electricity mix across countries and across time. Specifically, we find that, other things equal, a greater share of (i) fossil-based relative to nuclear electricity, and (ii) fossil-based relative to renewable electricity are significantly correlated with greater SWB, whereas (iii) a greater share of renewable relative to nuclear power (or vice versa) is not significantly correlated with greater SWB. This suggests that fossil-based electricity is the most preferred type of electricity in terms of SWB, whereas there is no clear preference relationship between renewable and nuclear electricity.

By differentiating our analysis with respect to particular countries, we find that the preference orderings in Germany and Switzerland are different from the set of other countries. While the experienced preference of fossil-based over both nuclear and renewable electricity applies to Germany too, we find a clear preference of renewable over nuclear power in this country. In

[1] For instance, Menges et al. (2005) found in a case study that the ex-ante stated willingness to pay for wind energy was twice as high as the amount people actually paid later.

[2] For a discussion of the use of SWB data in economics and pertinent methodological issues, see Frey and Stutzer (2002), Di Tella and MacCulloch (2006), and Kahneman and Krueger (2006).

Switzerland, renewable electricity is the most preferred and fossil-based electricity the least preferred type of electricity, nuclear power taking an intermediate position.

By differentiating with respect to calendar years we find that in the overall set of countries the preference for renewable electricity experienced a boost in 2011, such that it is clearly preferred to nuclear power in that year, even though fossil-based electricity is still the most preferred. We conjecture that this change in preference may be related to the Fukushima accident.

Our approach of using SWB regressions for an assessment of the electricity supply system follows a recent trend in economics of using subjective data for evaluating policies, institutions, and non-market goods. The SWB approach has previously been applied to environmental issues (e.g. Welsch 2002, 2006; Rehdanz and Madison 2005; van Praag and Barsma 2005; Luechinger 2009; Ferreira and Moro 2010; Levinson 2012) and to various societal phenomena, including inflation and unemployment (Di Tella et al. 2001), crime (Powdthavee 2005), civil conflict (Welsch 2008a), corruption (Welsch 2008b) and terrorism (Frey et al. 2009). Though applying the SWB approach to energy issues nicely fits into this line of research, we are unaware of any study in which this has been done as of yet.

The paper is organized as follows. In section 2 we describe our data. Section 3 presents the empirical approach and section 4 the results. Section 5 concludes.

2. Data

We use survey data from the first five waves of the European Social Survey (ESS); see www.europeansocialsurvey.org. The ESS is a repeated cross-sectional, multi-country survey covering over 30 nations. Its first wave was fielded in 2002/2003, the fifth in 2010/2011. ESS data are obtained using random (probability) samples, where the sampling strategies are designed to ensure representativeness and comparability across European countries. The five-wave cumulative dataset used in this paper includes about 240.000 observations from the following countries: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey and the UK. Due to missing observations in some of the variables the final sample for econometric analysis includes 139.517 data points.

The variable used to capture subjective well-being (SWB) is life satisfaction. It is based on the answers to the following question: "All things considered, how satisfied are you with your life as a whole nowadays?" Respondents were shown a card, where 0 means extremely dissatisfied and 10 means extremely satisfied, and we use the answers on the 11-point scale as our dependent variable.

The explanatory variables at the individual level include socio-demographic and socio-economic factors that have been found to have an impact on SWB (sex, age, marital status, household size, employment status and household income), see, e.g., Dolan et al. (2008). In addition, our regressions include macroeconomic control variables (GDP per capita, inflation rate, unemployment rate), taken from the OECD online data base (www.oecd.org).

Our variables of interest are the shares of different electricity generation technologies (fossil-fuel based, nuclear and renewable) in overall electricity supply. The respective data have been taken from the International Energy Agency, see www.iea.org.

Table 1 contains the variable descriptions and Table 2 the descriptive statistics of all the variables.

3. Empirical Approach

We estimate a micro-econometric SWB function in which the self-reported life satisfaction (*LS*) of individual *i*, in country *c* and year *t* depends on a set of individual socio-demographic and socio-economic indicators ($\boldsymbol{micro}_{ict}$), macroeconomic indicators ($\boldsymbol{macro}_{ct}$), the shares of different types of electricity supply by country and year ($\boldsymbol{share}_{ct}$), and country and year dummies ($country_c$, $year_t$, respectively).

The types of electricity generation that we distinguish are fossil (*f*), nuclear (*n*) and renewable (*r*), hence $\boldsymbol{share}_{ct} = (share_{f,ct}, share_{n,ct}, share_{r,ct})$. Due to adding-up, we cannot include all three shares simultaneously in one regression. Therefore, we include the three possible pairs of shares in three separate regressions. The general form of the estimating equations thus reads as follows:

$$LS_{ict} = \boldsymbol{\alpha}'\boldsymbol{micro}_{ict} + \boldsymbol{\beta}'\boldsymbol{macro}_{ct} + \sum_k \gamma_k share_{k,ct} + country_c + year_t + \varepsilon_{ict} \,. \tag{1}$$

where, alternatively, $k \in \{n, r\}$, $k \in \{r, f\}$, and $k \in \{f, n\}$; ε_{ict} denotes the error term. The *micro* indicators are sex, age, marital status, household size, employment status, and household income. The *macro* indicators are GDP per capita, the inflation rate, and the unemployment rate. The *country* dummies account for unobserved time-invariant country characteristics that affect well-being whereas the *year* dummies account for unobserved time-specific well-being factors that are common to all countries.

The coefficients of interest in this specification are the γ_k's. Because of adding-up of the share variables, a positive relationship between SWB and one of the included share variables (positive coefficient) implicitly indicates a negative relationship between SWB and the respective omitted share variable. Likewise, a negative relationship between SWB and one of the included share variables (negative coefficient) indicates a positive relationship between SWB and the omitted share variable. Thus, the signs of the γ_k's allow us to infer a preference relationship between an included type of electricity and the respective omitted one: A positive and significant coefficient is taken to mean that the corresponding type is preferred to the omitted one, whereas a significant negative coefficient indicates the converse. The size of the coefficients indicates the effect of a 1-percentage point increase in the share of an included type that offsets a 1-percentage point decrease in the respective omitted type.

In order to study the relationship between SWB and the electricity mix in a particular country *h*, we extend equation (1) to include interactions of the respective share variables with the country-specific dummy variable:

$$LS_{ict} = \boldsymbol{\alpha}'\mathbf{micro}_{ict} + \boldsymbol{\beta}'\mathbf{macro}_{ct} + \sum_k \gamma_k share_{k,ct} + \sum_k \delta_{k,h}\, country_h \cdot share_{k,ht} + country_c + year_t + \varepsilon_{ict}\,. \qquad (2)$$

The country-specific SWB gradient for electricity share of type *k* is then

$$\frac{\partial LS_{iht}}{\partial share_{k,ht}} = \gamma_k + \delta_{k,h} \qquad (3)$$

Finally, in order to investigate whether the Fukushima nuclear accident of March 2011 may have altered the relationship between SWB and the electricity mix, we augmented the estimating equation (1) to include interactions of the share variables with a year dummy for 2011.[3] Similar as in equation (3), the year-specific gradient is then the sum of the respective γ coefficient and the coefficient of the corresponding interaction term.

The dependent variable in specification (1), life satisfaction, is an ordinal variable on an 11-point scale, which suggests estimating equation (1) with an estimator for ordered data. However, as shown by Ferrer-i-Carbonell and Frijters (2004) with life satisfaction data and by Angrist and Pischke (2009) more generally, there is little qualitative difference between OLS and ordered-probit or ordered-logit models. We therefore estimate equation (1) using OLS. We checked that the qualitative findings reported below (signs and significance of coefficients) are robust to using

[3] In a more elaborate version of this paper we will use a dummy that specifies more precisely whether a particular observation (survey) was generated before or after the Fukushima accident.

an ordered-probit. The t-statistics we report are based on robust standard errors adjusted for clustering at the county-year level.

4. Results

4.1 Main Results

Table 3 presents the main estimation results for three versions of equation (1).[4] Specification (A) includes the shares of nuclear and renewable electricity while omitting the share of fossil-based electricity. The share of nuclear power enters the regression negatively and significantly, as does the share of renewable power. Thus, switching from fossil-based electricity to nuclear power or to renewable electricity is associated with less life satisfaction. In quantitative terms, a 1-percentage point shift from fossil to nuclear power reduces life satisfaction by 0.012 points on the 11-point scale whereas a 1-percentage point shift from fossil to renewable power reduces it by 0.010 points.[5] A more pronounced shift, by 10 percentage points, say, would thus mean a decrease in average life satisfaction by 0.1 points, provided that the relationship is linear in the

[4] More detailed results concerning the micro and macro controls are presented in Table A1 in the Appendix. These results do not qualitatively differ with respect to the way the electricity mix is included. As is common in data sets for developed countries (see Dolan et al. 2008), life satisfaction is lower for males than for females, u-shaped in age, highest for married and lowest for separated persons, lowest if being unemployed than in any other employment status, and increasing in household income. At the macro level, life satisfaction is negatively related to the inflation and the unemployment rate and insignificantly related to GDP per capita, the latter being in line with the so-called happiness-income paradox (Easterlin et al. 2010).

[5] Note that the shares are entered in our data as decimals. Our discussion of results translates the estimated coefficients in such a way as to refer to 1-percentage point increases in the shares.

relevant range.[6] To illustrate, this is a similar order of magnitude as moving down one step on the 12-point household income scale (see Table A1).

Specification (B) includes the shares of renewable and fossil-based electricity and omits the share of nuclear power. The share of renewable electricity enters positively but insignificantly whereas the share of fossil-based electricity enters positively and significantly. The latter result mirrors, of course, the result from specification (A) concerning the fossil-nuclear comparison. Switching from nuclear power to fossil-based electricity is thus associated with greater life satisfaction whereas switching to renewable power has no such effect. Quantitatively, a 1-percentage point shift from nuclear to fossil-based electricity raises life satisfaction by 0.012 points.

Finally, specification (C) includes the shares of fossil-based electricity and nuclear power and omits the share of renewable electricity. The results from this specification confirm those from specifications (A) and (B); actually, they are mirror images of what was found above: The share of nuclear power enters the regression insignificantly, whereas the share of fossil-based electricity enters the regression positively and significantly, meaning that a switch from renewable electricity to fossil-based power enhances life satisfaction.

In summary, we obtain the following

Proposition 1: Other things equal, greater shares of (i) fossil-based relative to nuclear electricity and (ii) fossil-based relative to renewable electricity are correlated with greater SWB (life satisfaction), whereas a greater share of renewable relative to nuclear electricity (or vice versa) is not significantly correlated with SWB.

[6] Including squared values of the supply shares yielded insignificant coefficients for the associated coefficients (results not shown).

If, as discussed in section 3, we take the correlation with SWB as an indicator of preference, we get the following

Proposition 2: In the set of countries under study, 2002-2011, fossil-based electricity is the most preferred type of electricity in terms of SWB, whereas there is no clear preference between renewable and nuclear electricity.

4.2 Results Differentiated By Country and Year

We augmented the specifications presented in Table 3 to include interactions with country dummies for Germany and Switzerland, respectively, see equation (2).[7]

Table 4 reports the results for the case of Germany. The results for the un-interacted share variables are qualitatively the same as in Table 3. With respect to the interaction terms, only the renewable share in regression B and the nuclear share in regression C of Table 4 are significant. Due to the "mechanics" of regressions B and C, they are of the same magnitude but opposite in sign. They indicate that in Germany a switch from nuclear to renewable electricity by 1 percentage point is associated with an increase in life satisfaction by 0.019 points (cf. equation (3), where the corresponding γ coefficient is set to zero due to insignificance). Nevertheless, since the interaction terms in regression A are insignificant, the preference of fossil-based over renewable electricity found for the overall set of countries applies to Germany as well. Overall, fossil-based electricity is the most preferred and nuclear power the least preferred type of electricity in Germany, while renewable electricity takes an intermediate position.

The results for Switzerland are shown in Table 5. Here, all interaction terms are significant at least at the 10 percent level. On the basis of the estimated coefficients and equation (3),

[7] We chose Germany and Switzerland because the issue of restructuring the electricity supply system is particularly salient in these countries. Similar tests will be conducted for other countries in a future version of the paper.

following the same logic as in the case of Germany, it can be concluded that renewable electricity is the most preferred and fossil-based electricity the least preferred, nuclear power taking the intermediate position.[8]

Finally, Table 6 presents the results of including interactions of the shares with a year dummy for 2011. It is seen that the 2011-renewable interaction is significantly positive in regressions A and B, indicating a boost in the preference for renewable electricity relative to both fossil-based and nuclear power. Quantitatively, this boost is too weak to place renewable electricity ahead of fossil-based electricity, but it clearly places renewable electricity ahead of nuclear power.

Thus, while European citizens seem to have been indifferent between renewable and nuclear electricity over the overall time horizon, 2002-2011, there is a clear experienced preference for renewable electricity in 2011. We conjecture that this may be related to the Fukushima accident, which may have changed the relationship between SWB and the energy mix by altering people's perceptions of damage potentials and damage probabilities associated with alternative electricity generation technologies.

4.3 Summary of Results

Table 7 presents a summary of the effects on life satisfaction of changes in the energy mix. The effects shown are based on the estimated coefficients reported in Tables 3-6 and refer to a 1-percentage point shift.

Applying these results to large-scale shifts in the electricity supply structure as implied by, e.g., the German *Energiewende*, it is seen that well-being effects are non-negligible: a shift from nuclear power to renewable electricity by 10 percentage points, say, would correspond to an

[8] It should be noted that the big coefficient sizes arising when the fossil share is (explicitly or implicitly) involved are due to the small share of fossil-based electricity in Switzerland. The small values of the shares imply that a hypothetical 1-unit change is a big one.

increase in the life satisfaction of German citizens by almost 0.2 on the 11-point scale.[9] This is more than the effect of being lifted one category in the 12-point income scale (see Table A1).

5. Conclusions

This paper has used survey data for 139.517 individuals in 26 European Countries, 2002-2011, to estimate the relationship between subjective well-being (SWB) and the shares of fossil-based, nuclear and renewable electricity in total electricity generation. Controlling for an array of individual and macro-level factors, we found that SWB varies systematically and significantly with differences in the electricity mix across countries and across time. Specifically, we found that, other things equal, a greater share of (i) fossil-based relative to nuclear electricity, and (ii) fossil-based relative to renewable electricity are, significantly correlated with greater SWB, whereas (iii) a greater share of renewable relative to nuclear power (or vice versa) is not significantly correlated with greater SWB.

These estimation results can be taken to represent a preference ordering over the technologies considered. They suggest that in Europe overall fossil-based electricity is the most preferred type of electricity in terms of SWB, whereas there is no clear preference relationship between renewable and nuclear electricity. Additional regressions suggest that the preference orderings in Germany and Switzerland are different than in the rest of Europe, and that the European-wide preference ordering in 2011 is different from that in 2002-2010, with a preference of renewable over nuclear electricity in that year.

The estimated relationships between SWB and the electricity mix capture the preference-relevant features of the various technologies (costs, safety, environmental impacts), as perceived by the individuals, in an *implicit* fashion. Being of a purely statistical nature, they are not affected by concerns about strategic responses or "cheap talk" that may arise when people are explicitly *asked* about their opinions and preferences.

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[9] See footnote 5 concerning the linearity assumption implicit in this statement.

In interpreting our results it should be clear that the preference relationships identified are only of a local nature, that is, they are valid only for configurations of the electricity supply system sufficiently close to the energy mix observed. Nevertheless, our results for 2011 provide support in terms of SWB for restructuring the supply system towards more renewable electricity and less nuclear power.

The present version of this paper is preliminary. In a more elaborate version we will check the robustness of our results to using capacity shares instead of output shares and to including additional control variables such as per capita electricity consumption. In addition, we will extend our analysis in the following ways:

- Including interactions of supply shares with household income. This will allow us to investigate whether electricity supply preferences are income-dependent.
- Including the electricity price level, indicators of air pollution and stated environmental preferences as controls. This will allow us to infer electricity supply preferences at given costs and to separate cost-related preference factors from safety and environment-related ones.
- Including the electricity mix in more detail (splitting fossil-based generation into coal, gas, oil, and renewable electricity into hydro, wind, solar). This will allow us to perform a more in-depth analysis of electricity supply preferences.
- Including interactions with a dummy variable for the post-Fukushima period, rather than the whole year 2011. This will allow us to more specifically check whether the Fukushima accident has altered experienced electricity supply preferences.

We believe that these are promising and policy-relevant next steps for extending the work presented above.

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Table 1. List of Variables

VARIABLE	SOURCE	DESCRIPTION
Socio-demographic Indicators	ESS	
Subjective Well-Being ("How satisfied with life as a whole?")		0 (extremely dissatisfied) - 10 (extremely satisfied)
Sex		Dummy: 1= male
Age		Age of respondent in years
Marital Status		4 categories: married or in civil partnership; separated, divorced; widowed; never married nor in civil partnership (reference)
Household Income		Household's total net income (all sources). Discrete: 1 (low income) - 12 (high income)
Employment Status		8 categories: paid work; in education; unemployed and actively looking for job; unemployed and not actively looking for job; permanently sick or disabled; retired; housework; other (reference).
Household size		Number of people living regularly as member of household
Macroeconomic Indicators	OECD (http://www.oecd.org)	
GDP per capita		Measured in 2005 PPP$ per capita
Inflation rate		Measured as the percentage increase of price index compared with the previous year.
Unemployment rate		Measured as the percentage of total civilian labor force
Electricity Supply Indicators	IEA (http://iea.org/)	
Fossil share		The share of electricity output relative to total electricity generated by electricity plants and CHP-plants using fossil energy input.
Nuclear share		The share of electricity output relative to total electricity generated by nuclear power plants.
Renewable share		The share of electricity output relative to total electricity generated by electricity plants and CHP-plants using renewable energy sources.

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Life Satisfaction	238975	6.763159	2.366564	0	10
Sex					
Male	240145	0.4594682	0.4983555	0	1
Female	240145	0.5405318	0.4983555	0	1
Age	239124	47.37294	18.52812	13	123
Age squared	239124	2587.485	1844.433	169	15129
Household Size	240173	2.800964	1.475175	1	22
Marital Status					
Single	232066	0.281351	0.4496593	0	1
Married	232066	0.5258418	0.4993328	0	1
Divorced	232066	0.077241	0.266974	0	1
Separated	232066	0.0143106	0.1187681	0	1
Widowed	232066	0.1012557	0.3016676	0	1
Employment Status					
Paid Work	238885	0.4849865	0.4997756	0	1
Student	238885	0.0854386	0.2795338	0	1
Unemployed seeking	238885	0.2795338	0.1923695	0	1
Unemployed not seeking	238885	0.0170835	0.129583	0	1
Sick	238885	0.0229734	0.1498189	0	1
Retired	238885	0.2367876	0.4251117	0	1
Civil Military	238885	0.0019047	0.0436012	0	1
Housework	238885	0.0997928	0.2997241	0	1
Other	238885	0.0125458	0.1113034	0	1
Income	171818	5.694706	2.738729	1	12
Country Dummies					
Austria	240429	0.0287736	0.1671699	0	1
Belgium	240429	0.0371794	0.1892015	0	1
Czech Republic	240429	0.0365596	0.1876784	0	1
Denmark	240429	0.0319595	0.1758927	0	1
Estonia	240429	0.0289483	0.1676615	0	1
Finland	240429	0.0415549	0.1995701	0	1
France	240429	0.0378324	0.1907911	0	1
Germany	240429	0.0289483	0.1676615	0	1
Greece	240429	0.0405899	0.1973387	0	1
Hungary	240429	0.0130309	0.1134069	0	1
Iceland	240429	0.0024082	0.0490143	0	1
Ireland	240429	0.0435555	0.2041043	0	1
Israel	240429	0.0302917	0.1713891	0	1
Italy	240429	0.0050202	0.0706754	0	1
Luxembourg	240429	0.0132555	0.114367	0	1
Netherlands	240429	0.0405151	0.1971643	0	1
Norway	240429	0.0359482	0.1861615	0	1
Poland	240429	0.0370879	0.1889775	0	1

Portugal	240429	0.0428484	0.2025157	0	1
Slovak Republic	240429	0.0288817	0.1674744	0	1
Slovenia	240429	0.0296387	0.1695888	0	1
Spain	240429	0.0404652	0.197048	0	1
Sweden	240429	0.0382691	0.1918456	0	1
Switzerland	240429	0.0387225	0.1929331	0	1
Turkey	240429	0.0177682	0.1321083	0	1
United Kingdom	240429	0.0462382	0.2100009	0	1
Time Dummies (Year)					
2002	240429	0.1109184	0.3140317	0	1
2003	240429	0.064622	0.2458582	0	1
2004	240429	0.1226183	0.3279993	0	1
2005	240429	0.0679951	0.2517381	0	1
2006	240429	0.1350128	0.341738	0	1
2007	240429	0.0436595	0.2043367	0	1
2008	240429	0.1243694	0.3300031	0	1
2009	240429	0.1099077	0.3127753	0	1
2010	240429	0.0871234	0.2820164	0	1
2011	240429	0.1076077	0.3098849	0	1
GDP(per capita)	209291	28718.62	9439.162	11394.04	68210.83
Inflation	209291	2.82585	2.253715	-4.479938	14.10775
Unemployment	201477	7.771362	3.740002	2.538279	21.72335
Nuclear Share	203872	0.2127605	0.2256884	0	0.7936616
Renewable Share	203872	0.2234688	0.2386849	0.0004386	0.9994244
Fossil Share	203872	0.5637707	0.3137406	0.0005756	0.9995614

Table 3: Main Estimation Results

	A	B	C
Nuclear share	-1,19515 (-3,79)***		-0,2088906 (-0,60)
Renewable share	-0,9862595 (-3,99)***	0,2088906 (0,60)	
Fossil share		1,19515 (3,79)***	0,9862595 (3,99)***
Socio-demographics	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Observations	139517	139517	139517
R2	0,1946	0,1946	0,1946

Dependent variable: Life satisfaction (0-11). Method: OLS. t-values in parentheses are based on standard errors corrected for clustering at the country-year level.

Table 4: Estimation Results with Interactions for Germany

	A	B	C
Nuclear share	-0,81631 (-2,45)**		0,33486 (0,89)
Nuclear share * Dummy (Germany)	0,65517 (0,24)		-1,94032 (-1,95)*
Renewable share	-1,15116 (-4,60)***	-0,33486 (-0,89)	
Renewable share * Dummy (Germany)	2,59549 (1,25)	1,94032 (1,95)*	
Fossil share		0,81631 (2,45)**	1,15116 (4,60)***
Fossil share * Dummy (Germany)		-0,65519 (-0,24)	-2,59549 (-1,25)
Socio-demographics	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Observations	139517	139517	139517
R2	0,1947	0,1947	0,1947

Dependent variable: Life satisfaction (0-11). Method: OLS. Dummy (Germany) is a dummy variable that takes the value 1 if life satisfaction was measured in Germany and 0 otherwise. t-values in parentheses are based on standard errors corrected for clustering at the country-year level.

Table 5: Estimation Results with Interactions for Switzerland

	A	B	C
Nuclear share	-1,10695 (-3,48)***		-0,09823 (-0,28)
Nuclear share * Dummy(Switzerland)	19,60280 (1,97)**		-2,58920 (-1,80)*
Renewable share	-1,00872 (-4,08)***	0,09823 (0,28)	
Renewable share * Dummy(Switzerland)	22,19200 (2,32)**	2,58920 (1,80)*	
Fossil share		1,10695 (3,48)***	1,00872 (4,08)***
Fossil share * Dummy(Switzerland)		-19,60284 (-1,97)**	-22,19200 (-2,32)**
Socio-demographics	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Observations	139517	139517	139517
R2	0,1947	0,1947	0,1947

Dependent variable: Life satisfaction (0-11). Method: OLS. Dummy (Switzerland) is a dummy variable that takes the value 1 if life satisfaction was measured in Switzerland and 0 otherwise. t-values in parentheses are based on standard errors corrected for clustering at the country-year level.

Table 6: Estimation Results with 2011 Interaction

	A	B	C
Nuclear share	-0,99617 (-4,28)***		0,05820 (0,17)
Nuclear share * Dummy (2011)	-0,09713 (-0,83)		-0,83638 (-5,23)***
Renewable share	-1,05437 (-3,14)***	-0,05820 (-0,17)	
Renewable share * Dummy (2011)	0,73925 (6,74)***	0,83638 (5,23)***	
Fossil share		0,99617 (3,14)***	1,05437 (3,14)***
Fossil share * Dummy (2011)		0,09713 (0,83)	-0,73925 (-6,74)***
Socio-demographics	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Observations	139517	139517	139517
R2	0,1948	0,1948	0,1948

Dependent variable: Life satisfaction (0-11). Method: OLS. Dummy (2011) is a dummy variable that takes the value 1 if life satisfaction was measured in the year 2011 and 0 otherwise. t-values in parentheses are based on standard errors corrected for clustering at the country-year level.

Table 7: Summary of Electricity Mix-SWB Relationships

	Nuclear Share	Renewable Share	Fossil Share	Model
Nuclear Share		0.0000	-0.0120	Overall Europe (Table 3)
Renewable Share	0.0000		-0.0099	
Fossil Share	0.0120	0.0099		
Nuclear Share		-0.0194	-0.0082	Germany (Table 4)
Renewable Share	0.0194		-0.0115	
Fossil Share	0.0082	0.0115		
Nuclear Share		-0.0259	0.1850	Switzerland (Table 5)
Renewable Share	0.0259		0.2118	
Fossil Share	-0.1850	-0.2118		
Nuclear Share		-0.0084	-0.0100	2011 (Table 6)
Renewable Share	0.0084		-0.0032	
Fossil Share	0.0100	0.0032		

Note: Entries x_{ij} denote the effect on life satisfaction (11-point scale) of a 1-percentage point shift from electricity type j to type i. Entries are based on the estimated coefficients presented in Tables 3 – 6. Coefficients that are not significant at least at the 10 percent level have been set to zero.

Appendix

Table A1: Detailed Estimation Results

	(A)		(B)		(C)	
Variable	*Coeff.*	*SE*	*Coeff.*	*SE*	*Coeff.*	*SE*
Sex (male)	-0.119	0.011	-0.119	0.011	-0.119	0.011
Age	-0.063	0.002	-0.063	0.002	-0.063	0.002
Age-squared	0.001	0.000	0.001	0.000	0.001	0.000
HH-Size	-0.011	0.005	-0.011	0.005	-0.011	0.005
Single	0.479	0.052	0.479	0.052	0.479	0.052
Married	0.829	0.051	0.829	0.051	0.829	0.051
Divorced	0.323	0.054	0.323	0.054	0.323	0.054
Widowed	0.329	0.055	0.329	0.055	0.329	0.055
Paid Work	-0.176	0.128	-0.176	0.128	-0.176	0.128
Education	0.022	0.128	0.022	0.128	0.022	0.128
Unemployment (voluntary)	-0.990	0.138	-0.990	0.138	-0.990	0.138
Sick	-1.332	0.135	-1.332	0.135	-1.332	0.135
Retired	-0.189	0.129	-0.189	0.129	-0.189	0.129
Household	-0.252	0.129	-0.252	0.129	-0.252	0.129
Other	-0.402	0.140	-0.402	0.140	-0.402	0.140
Unemployment (involuntary)	-1.269	0.132	-1.269	0.132	-1.269	0.132
Income Scale	0.132	0.003	0.132	0.003	0.132	0.003
Austria	1.777	0.244	1.777	0.244	1.777	0.244
Belgium	1.872	0.259	1.872	0.259	1.872	0.259
Switzerland	2.537	0.298	2.537	0.298	2.537	0.298
Czech Republic	0.826	0.150	0.826	0.150	0.826	0.150
Germany	1.107	0.213	1.107	0.213	1.107	0.213
Denmark	2.309	0.200	2.309	0.200	2.309	0.200
Spain	1.768	0.177	1.768	0.177	1.768	0.177
Finland	2.372	0.215	2.372	0.215	2.372	0.215
France	1.108	0.298	1.108	0.298	1.108	0.298
United Kingdom	1.127	0.205	1.127	0.205	1.127	0.205

Greece	0.178	0.134	0.178	0.134	0.178	0.134
Variable	Coeff.	SE	Coeff.	SE	Coeff.	SE
Hungary	0.033	0.155	0.033	0.155	0.033	0.155
Ireland	1.345	0.251	1.345	0.251	1.345	0.251
Israel	0.825	0.144	0.825	0.144	0.825	0.144
Iceland	2.845	0.309	2.845	0.309	2.845	0.309
Italy	0.914	0.196	0.914	0.196	0.914	0.196
Luxembourg	1.391	0.494	1.391	0.494	1.391	0.494
Netherlands	1.382	0.222	1.382	0.222	1.382	0.222
Norway	2.369	0.382	2.369	0.382	2.369	0.382
Poland	0.604	0.093	0.604	0.093	0.604	0.093
Portugal	-0.308	0.121	-0.308	0.121	-0.308	0.121
Sweden	2.569	0.271	2.569	0.271	2.569	0.271
Slovenia	1.414	0.179	1.414	0.179	1.414	0.179
Slovak Republic	1.041	0.203	1.041	0.203	1.041	0.203
2002	-0.148	0.046	-0.148	0.046	-0.148	0.046
2003	-0.030	0.048	-0.030	0.048	-0.030	0.048
2004	-0.063	0.039	-0.063	0.039	-0.063	0.039
2005	0.042	0.039	0.042	0.039	0.042	0.039
2006	-0.031	0.032	-0.031	0.032	-0.031	0.032
2008	0.114	0.032	0.114	0.032	0.114	0.032
2009	0.040	0.039	0.040	0.039	0.040	0.039
2010	0.309	0.033	0.309	0.033	0.309	0.033
2011	0.195	0.036	0.195	0.036	0.195	0.036
GDP(in 1000 PPP05 $) per capita	-0.006	0.009	-0.006	0.009	-0.006	0.009
Inflation rate	-0.026	0.006	-0.026	0.006	-0.026	0.006
Unemployment rate	-0.034	0.004	-0.034	0.004	-0.034	0.004
Nuclear Share	-0.012	0.003			-0.002	0.003
Renewable Share	-0.010	0.002	0.002	0.003		
Fossil Share			0.012	0.003	0.010	0.002