Evaluation of Public Preferences for the "Murkraftwerk Graz" Using a Choice Experiment

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1. Introduction

Due to the natural and environmental conditions, Austria is predestined for the use of hydropower. Currently (2012), 65.7 % of total electricity produced in Austria comes from hydroelectric installations; this corresponds to an amount of annually 47,570 gigawatt hours (GWh). The total number of hydropower plants in Austria is 2,795 with an entire installed capacity of 13,350 megawatt (MW). There is a strong tendency towards small-scale hydropower with a capacity less than 10 MW, accounting for a number of 2,637 plants in total. Regarding the type of hydropower technology, 2,684 are run-of-river plants, while the number of storage power plants amounts to merely 111 (Energie-Control Austria, 2013a and 2013b, online).

Although more than half of the total electricity produced already comes from hydropower installations, there is still substantial potential for new hydropower facilities, especially for small-scaled ones. According to the hydropower potential study of Pöyry Energy (2008:64), the potential which is effectively exploitable is 13,000 GWh.[1] The intensified use of renewable energy sources represents the core element of a sustainable and future-oriented energy policy. Beside the utilisation of wind, biomass and photovoltaic potentials, a realizable hydropower expansion of 3,500 GWh is stipulated in the Austrian energy strategy (Bmlfuw, 2010:79ff). Prior to the Austrian energy strategy, the master plan for the expansion of hydropower utilisation was presented in 2008 and envisages an increase of hydropower use by 7,000 GWh until 2020 (Veö, 2008:10ff). Furthermore, the intensified use of hydroelectric power was established by law in 2011. The green electricity act aims to increase hydropower generation by 4,000 GWh in the period 2010 to 2020[2] (Bgbl, 2011, §4). Currently, 16 hydropower projects are nationwide in the construction process with a focus on small-scale hydropower stations and run-of-river technology. Furthermore, 30 concrete hydropower plants are in the stage of planning, again most of them in the form of run-of-river plants. (Oesterreichs Energie, 2012:16f).

One of these projects lies in the province of Styria. The hydropower station, known as "Murkraftwerk Graz" is planned to be built within the city limits of Graz along the river Mur[3], in the part of town called Puntigam. The project is being implemented by "Energie Steiermark AG" in collaboration with "Verbund", Austria's leading electricity company and one of Europe's largest hydropower producers. The overall investment volume of the project is € 95 million. Total installed capacity will be 16.3 megawatt (MW).[4] With this, an electricity amount of 74 GWh per year can be generated. Hence, about 20,000 households can be provided with green electricitiy from the power station (Energie Steiermark, 2010a and 2010c, online; Dobrowolski and Schleich, 2009:10). The construction works are scheduled to start in autumn 2013; the completion and start-up of the power plant is planned for the end of 2015 (Energie-Steiermark, 2010d, online).

On the one hand, the power plant will contribute to the emission-free generation of electricity from domestic hydropower and a sustainable energy supply (Pistecky, 2010:4). On the other hand, the project is criticised due to the environmental impacts that arise from the power plant. Consequently, the hydropower scheme is associated with a trade-off between economic and climate-related advantages and the negative environmental side effects. The aim of this paper is to examine public preferences for the multiple impacts of the planned hydropower station in Graz-Puntigam. The emphasis is placed on public perception of the population living around the project.

2. Methodological basis

The multiple impacts associated with the construction of the new hydropower plant such as the improvement of security of supply, environmental or recreational impacts can be seen as externalities that need to be taken into account

1 This value corresponds to the estimate of reduced techno-economic potential which excludes potentials located in regions with a high degree of sensibility such as national parks and world heritages. However, the indicated hydropower potential does not consider reductions due to the possible restrictions imposed by the European Water Framework Directive (WFD).

2 This target value includes the effect of revitalisation measures and the extension of existing facilities.

3 Graz represents the provincial capital of Styria and is situated about 150 km south-west of Vienna, the capital of Austria. The number of inhabitants amounts to 265,778 (per 1.1.2013). With this, Graz is the second largest city in Austria (Land Steiermark, 2013:1).

4 With this, the planned hydropower station ranks among the large-scale projects. Smale-scale facilities, by contrast, are defined to have a capacity of less than 10 MW.

when investing in new hydropower facilities. However, this is often fraught with difficulties since externalities are usually not reflected in market prices. Hence, it is very difficult to assign a monetary value on something that is not traded and does not affect individual actions in the normal manner (Hausman, 1993:4; Carson, 1999:1). This is why stated preference techniques creating hypothetical markets in which people have the opportunity to buy the non-market good in question gained increasing importance in the past. Beside the contingent valuation (CV) method which has a long tradition in environmental economics, choice experiments (CE) have increasingly been used in the field of environmental valuation. Since CEs involve a broad attribute based perspective (Adamowicz et al., 1998:29), the method appeared to be appropriate to value the multiple impacts associated with the hydropower plant in Graz-Puntigam.

The CE method is based on the assumption that consumers derive utility from the properties or characteristics of a good and not from the good per se. This is formally known as the "Characteristics theory of value" first presented by Lancaster (1966:133), and implies that the value of a good, service or policy (e.g. a hydropower station) can be expressed by its characteristics or attributes (Ryan et al., 2001:55; Louviere et al., 2000:2). These attributes have in turn different levels. By varying attribute levels (experimental design of a CE), "packages" or "bundles" of attributes that reflect different states of the good in question are created. Individuals are then asked to choose their preferred alternative from a selection of two or more different "packages", which are described in terms of their attributes and levels (Boxall et al., 1996:244; Bennett and Blamey, 2001:6).[5] Such a selection of "packages" is known as the "choice set" or "choice card" (Boxall et al., 1996:244). Typically, one of the attributes used to describe the good in question is a price or cost factor. Furthermore, respondents are usually asked to make a sequence of choices (Bennett and Blamey, 2001:6).[6]

The sequence of choice outcomes enables the analyst to gain four major pieces of information. First, it can be shown which attributes significantly influence respondent's choice. Second, it is possible to gain information on the implied ranking of the attributes used in the CE. Third, the inclusion of a monetary attribute enables to elicit marginal willingness-to-pay (WTP) for a one unit change in any significant attribute, and finally, attribute-based stated choice methods allow the researcher to value situational changes, i.e. to estimate WTP for a policy which changes more than one attribute simultaneously (Boxall et al., 1996:244f; Adamowicz et al., 1998:65; Lancsar and Savage, 2004:1; Liebe and Meyerhoff, 2005:15ff).

5 For further information see Alriksson and Öberg (2008:245f), Hanley et al. (1998a:2) and (1998b:44) or Liebe and Meyerhoff (2005:15f).

6 See also Boxall et al. (1996:244); Hanley et al. (1998a:2) and (1998b:414).

3. Study design

3.1. Questionnaire & choice experiment

In order to examine public preferences for the Murkraftwerk Graz, a comprehensive questionnaire has been developed over a 2-3 month time period based on a series pre-tests, as well as two discussion rounds with external experts. The final questionnaire consisted of 43 questions divided into three main parts.[7] The first section contained questions about the respondents' general attitude towards renewable energy, hydropower use and the planned hydropower project. In the second part, respondents were asked to state their choices using six different choice sets. The attributes used in the choice experiment are presented in Table 1. The choice experiment was followed up by a number of debriefing questions related to the perceived complexity of the experiment, the relative importance of the attributes, as well as the possible presence of protest responses. The final part of the questionnaire focused on respondents' demographic and socio-economic status like household size, number of children, profession, educational level or household income.

The first attribute used in the CE refers to the emission-free generation of electricity for local consumers and the associated improved security of supply. According to the project operator, the number of households able to be provided with electricity is estimated at approximately 20,000 (Dobrowoski and Schleich, 2009:10; Energie Steiermark, 2010a, online). In view of a conservative estimate the levels of electricity generation were fixed to 5,000, 10,000 and 15,000 households.

Beside that, the development and construction of a new hydropower plant cause impacts on the landscape and the ecosystem. Generally, the damming of a river and the associated loss of vegetation causes adverse effects on the landscape. Moreover, the visual barrier effect that is associated with dams has a negative influence on the appearance of the natural landscape (Pistecky, 2010:28). Other environmental concerns related to the new hydropower project involve biodiversity impacts and a change in water quality. Furthermore, the damming of the river and vegetation clearance will lead to a loss of habitats along the river banks. Additionally, fish will be negatively affected by the hampered ability to pass the dam (Pistecky, 2010:18ff). In view of the requirement to keep attributes as simple as possible, the nature and landscape attribute was included in the CE with two levels, namely a small and a strong impact. With a strong impact, the natural habitats of flora and fauna, as well as the landscape are severely affected. A small environmental impact, by contrast, means that a strong emphasis is put on the preservation and protection of flora, fauna and landscape. By means of a near-natural design of the power plant and the implementation of extensive ecological accompanying measures, the hydropower plant is likely to merge harmoniously with its surroundings.

The third attribute included in the CE describes possible future recreational activities along the riverside. Generally, the power plant is expected to upgrade the urban area of Graz by

7 A full version of the questionnaire is available upon request from the author.

Table 1. Attributes and levels used to describe the hydropower plant

Attribute	*Description*	*Levels*
Households	Number of households that can be provided with green electricity from the new hydropower plant.	5000, 10000, 15000 housholds
Nature and landscape	Impact of new hydropower plant on the natural environment (ecosystem) and the landscape.	small impact, strong impact
Recreational activities	Impact of the new hydropower plant on the possibilities for recreation.	extended, restricted possibilities
Cost	Increase in monthly electricity bill.	€ 3, 6, 9, 12, 15, 18

Source: Author's own elaboration.

creating leisure space and recreational areas. This includes the linking of existing foot and cycling paths, as well as the provision of leisure activities like boating or canoeing. Additionally, the commercial benefit of the hydropower project can be enhanced by the establishment of riverside localities like cafés or restaurants (Dobrowolski and Schleich, 2009:14; Energie Steiermark, 2010b, online; Pistecky, 2010:12).[8] The attribute has two levels. First, the new hydropower plant extends the possibilities for recreation. Second, the hydropower project creates adverse effects on public recreation. In this case no additional measures aiming at improving the possibilities for public recreation are adopted.

Finally, the monetary attribute was specified as an increase in respondent's monthly electricity bill with six payment levels ranging between € 3 and € 18. Here, it is extremely important that people are familiar with the payment vehicle. This is usually the case when referring to utility bills (Carson, 1999:13).

In the questionnaire, the CE was introduced by an explanatory text, familiarizing respondents with the relevant attributes. Attribute levels were communicated via pictograms. The visual (non-textual) representation of attribute levels may contribute to a more homogeneous perception of the levels (Adamowicz et al., 1998:13; Carson, 1999:11). However, photographs can give very different impressions of an impact, depending for instance on the angle from which a photo is taken (Meyerhoff et al., 2010:87). In order not to influence people's perception of one attribute or level compared to another caused by the attractiveness of a picture, simple pictograms in black and white colour shades have been used to communicate the levels of the attributes. These pictograms were included in the choice cards as well, so as to improve the comprehensibility of the decision situations.

Choice sets were created using an efficient, randomized experimental design in the software package Sawtooth. Each choice set consisted of three alternatives, including an opt-out alternative referred to as "none of the two alternatives". This opt-out alternative was included in all choice sets avoiding that people are forced to (hypothetically) buy electricity from the hydropower plant (Dimitroupoulos and Kontoleon, 2009:1846). The design was finally blocked into 30 versions, each containing six choice tasks. An example of a choice set is given in Figure 1.

3.2. Sampling

In July 2011 the survey was implemented by a professional market research institute[9] using a web-based survey. Yet, the programming of the online survey was carried out with the help of the software package Sawtooth. The survey agency only delivered the address data and was responsible for the distribution of the survey across respondents. With the help of the demographically balanced online panel of the survey agency it was possible to obtain a representative sample. The survey was distributed to 959 people living in Graz and its directly surrounding communities.[10] The response rate was 22.0 % meaning that 211 respondents completed the survey. Due to incompletely filled questionnaires and protest responses[11] the sample size available for data analysis reduced to 199 observations.

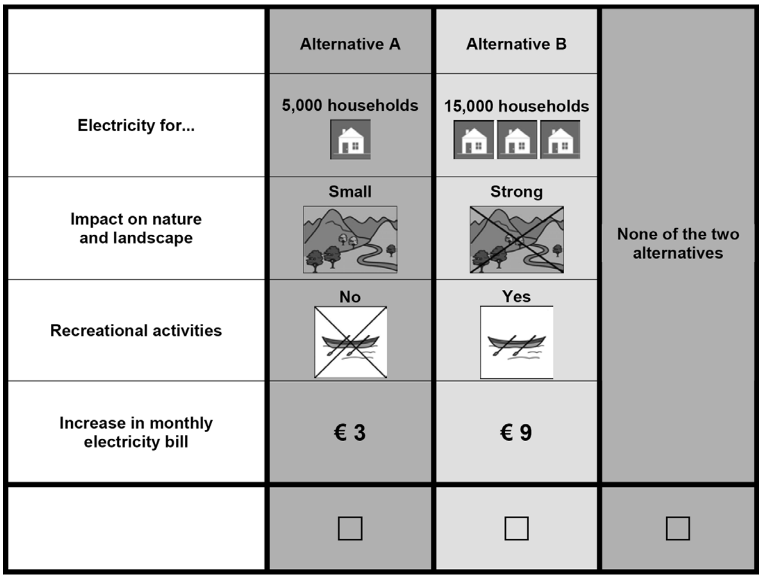
In order to illustrate the representativeness of the sample, the main characteristics of the survey sample have been compared with the total Styrian population from which the sample was drawn. First, Table 2 shows that representativeness is in principle given with respect to gender. There is a slight

8 Generally, there are ambiguous empirical results regarding the impact of hydro-electric power plants on recreational activities. See for instance Getzner (2012).

9 For more information see *http://www.marketagent.com*.

10 In total, Graz and its surrounding area (19 directly surrounding communities) have about 338,000 inhabitants. 21.6 % of them are living in one of the surrounding communities and 78.4 % have their residence in the city of Graz. This distribution is roughly reflected in the sample with 75.2 % of the respondents living within the city limits of Graz and 24.8 % living in one of the surrounding communities. The respondents from the area around Graz are thereby equally allocated among all surrounding communities.

11 Based on a debriefing question of the CE, 12 respondents were able to be categorised as protest responses. These observations were excluded from the subsequent analysis.



Source: Author's own elaboration.

Fig. 1. Choice set example

Table 2. Gender and age of respondents compared to total population

	Sample (n=199)	in %	Total population*
GENDER			
Male	103	51.8 %	48.9 %
Female	96	48.2 %	51.1 %
AGE			
18-19 years	4	2.0 %	3.3 %
20-29 years	52	26.1 %	17.5 %
30-39 years	38	19.1 %	17.8 %
40-49 years	46	23.1 %	22.4 %
50-59 years	36	18.1 %	18.2 %
60-69 years	19	9.5 %	14.6 %
70-75 years	4	2.0 %	6.2 %

Source: *STATISTIK AUSTRIA (2011a:48 and 2011b:72)

surplus of male respondents compared to the total Styrian population.[12]

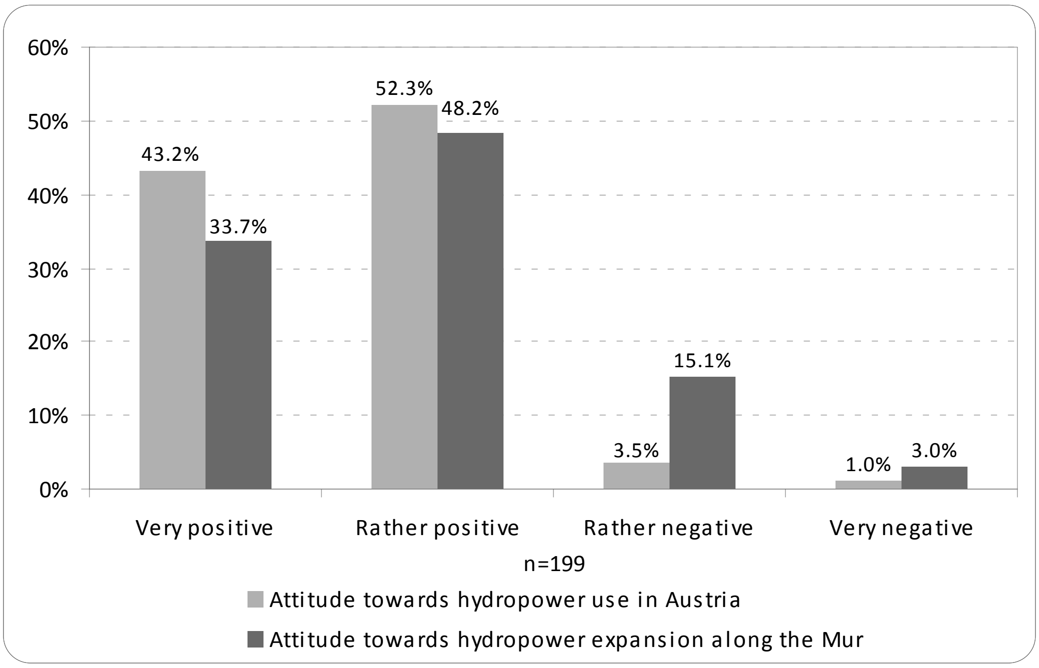
The age structure corresponds in principle to that of the total population in Styria (see Table 2). However, the age category older than 59 years is proportionally low compared to the total Styrian population.[13] The same applies to the age group 18-19 years which is also slightly underrepresented in the sample. In contrast, respondents aged between 20-29 years are stronger represented with a proportion of 26.1 % in the sample compared to 17.5 % in the total population. The mean age in the regional sample is 40.9 years (standard deviation: 14.2 years; median: 41 years).

With respect to the educational situation, the sample is somewhat higher educated than the total population.[14]

12 Due to a lack of reliable data for the area of Graz and surroundings, the sample is compared to the whole province of Styria.

13 This underrepresentation may be due to the data collection method, since the older population is usually less familiar with online surveys or the internet in general.

14 As an aside, sample characteristics were here compared with the population of the district "Graz-Stadt".



Source: Author's calulation.

Fig. 2. Attitude towards hydropower and its expansion along the Mur

Respondents with a higher school certificate are considerably overrepresented while lower educated people (compulsory school, apprenticeship and professional school) are significantly underrepresented compared to the total population of Graz. Finally, the distribution of disposable monthly household income shows that the sample is slightly skewed towards those with lower incomes. The median income category corresponds to € 1,501-2,000 which is considerably below median household income in Austria of approximately € 2,490 (Statistik Austria, 2011a:248).

4. General attitude towards the planned hydropower project

Before we go deeper into public preferences for the multiple impacts associated with the hydropower project in Graz-Puntigam, people's general attitude and knowledge towards the hydropower project is analysed. First, there is a general agreement upon the importance of renewable energy use. The majority of the respondents (82.9 %) regard the intensified use of renewable energy sources in the future as very important. Further 16.1 % state that it is rather important. Only a minority of 1.0 % consider the prospective expansion of renewable energy as unimportant.

Furthermore, most respondents have a very positive (43.2 %) or rather positive (52.3 %) attitude towards hydropower utilisation in Austria. The share of people with a negative attitude is considerably low with 3.5 % being rather negative and 1.0 % very negative towards hydropower use (see Figure 2). Regarding people's attitude towards the construction of new hydropower plants along the river Mur[15], a quite different picture is provided. The proportion of people exhibiting a very positive attitude towards hydropower expansion along the Mur amounts to 33.7 %, a significantly lower value as compared to the very positive attitude towards hydropower use in general. A similar result is given for the category "rather positive" whereas the difference is not as large as before (48.2 % versus 52.3 %). In contrast, the share of respondents having a rather negative attitude towards the construction of new hydropower plants along the Mur is with 15.1 % significantly higher as before. The same applies to the category "very negative". In total, 3.0 % of the respondents are very negative towards hydropower expansion along the Mur (see Figure 2). Consequently, people are in general pro hydropower. However, if hydropower plants are to be built along a nearby river people's acceptance will diminish. This provides confirmation of the famous "Not in my backyard" phenomenon.

Regarding the specific hydropower project in Graz-Puntigam, it was found that the degree of recognition is pretty high. Accordingly, about three quarters (75.4 %) of the respondents explicitly know that there will be built a new hydropower station. These people were asked about the degree to which they feel affected by the new hydropower plant. A relatively high number of respondents (63.3 %) reported not to be affected by the new hydropower project. At the same time, 8.7 % of the sample population indicated to feel negatively

15 As an aside, the main part of the respondents (86.9 %) is already in knowledge about the plan to expand hydropower utilisation along the Mur. By contrast, 13.1 % of the respondents have never heard about the fact that new hydropower plants are to be constructed.

affected. The share of people feeling positively affected by the hydropower project is 28.0 %. Moreover, 39.7 % of the respondents think that the planned hydropower station would improve the possibilities for recreation, while 14.6 % hold the opinion that the construction of the hydropower plant would deteriorate recreational activities. A rather large part of the sampled population (45.7 %) was unable to assess the impact of the new hydropower station on leisure opportunities.

5. The econometric model

In order to quantify the multiple impacts associated with the new hydropower station, an econometric model has been estimated. Generally, choice models are based on traditional microeconomic considerations. More precisely, it is assumed that individuals act as if they are maximizing utility, meaning that they compare the alternatives in the choice set and choose the one which gives them the highest level of utility (Hensher et al., 2005:80). Hence, alternative *i* is chosen over alternative *j* only if:

$$U_{in} > U_{jn} \qquad (1)$$

The problem is, however, "that utility is a latent construct that exists (if at all) in the mind of the consumer, but cannot be observed directly by the researcher" (Bennett and Blamey, 2001:15). Instead, it is possible to explain a significant proportion of the unobservable consumer utility, but some part of the utility will always remain unobserved (Random Utility Theory). That is:

$$U_{in} = V_{in} + \varepsilon_{in} \qquad (2)$$

In order to estimate V_{in}, we have to make assumptions about the distribution of the random component of utility ε_{in}. Usually, the random part of utility is assumed to be independently and identically distributed (IID) (Hensher et al., 2005:84; Louviere et al., 2000:45). IID means that the unobserved components of utility have no cross-correlated terms and exactly the same distributions (Hensher et al., 2005:77).[16] Generally, the IID assumption is associated with the popular multinomial logit (MNL) model. However, IID and in further consequence IIA may often be violated, especially due to repeated choices causing correlation across observations (Hensher et al., 2005). In this case the standard MNL model represents an improper approach and more complex choice models are required. Another disadvantage of the MNL model is the inability to capture preference heterogeneity not embodied in the individual characteristics of the respondent (Greene and Hensher, 2005:2; Hensher and Greene, 2002:5).[17] In the presence of unobserved preference heterogeneity, therefore, more complex choice models are required. Such a model would be the Mixed Logit (MXL) model. In the MXL model unobserved preference heterogeneity is captured by estimating random parameters which have a mean β_k and a standard deviation σ_k (Hensher et al., 2005:76; Beville and Kerr, 2009:7). Hence, the estimated parameters are not fixed for each individual as in the MNL model but fluctuate around a mean. In order to get a better understanding of the sources of preference heterogeneity within a sampled population the MXL model can be extended to allow for variance heterogeneity (Greene et al., 2005:2). Such models are called error component (EC) models (Hensher and Greene, 2002:5; Train, 2003:143).

The model parameters are estimated by maximum likelihood. The maximum likelihood estimation is an iterative search procedure, searching for a single value of the parameter vector β_k that will maximize the likelihood function L (Hensher et al., 2005:318).

The econometric model estimated within the scope of this paper has the following indirect utility form (equation 3) where β_0 represents the intercept term of the equation and X_{ink} the vector of $k=1,\dots,K$ attributes that pertain to the choice options. In addition, indirect utility may depend on socio-economic characteristics (Z_{inp}), as well as possible combinations between choice option attributes and individual characteristics ($X_{ink}Z_{inp}$).

$$V_{in} = \beta_0 + \sum_{k=1}^{K}\beta_k X_{ink} + \sum_{p=1}^{P}\theta_p Z_{inp} + \sum_{k,p=1}^{K,P}\phi_{kp} X_{ink} Z_{inp} \qquad (3)$$

A detailed description of the attributes and their corresponding coding, socio-economic characteristics and interaction terms that were included in the final model is given in Table 3. For the attributes households and cost a cardinal-linear coding was used, while nature and recreation were coded as dummy variables with "small impact" and "restricted recreational opportunities" as the baseline categories.

The results of the final model are given in Table 4. Due to violation of IID and the inability of the standard MNL model to capture unobserved preference heterogeneity, an error component (EC) model has been estimated treating all non-monetary attributes as random parameters. The estimates are based on 1,194 observations, that is, each of the 199 respondents answering six choice tasks.

As can be seen from Table 4, the model is highly significant as shown by the Chi² statistic calculated for the entire set of variables. The coefficients of the four choice attributes, the interaction terms and the remaining variables have the expected signs and are all statistically significant at least at the 10 % level. The alternative specific constant (ASC) is highly significant and positive indicating that the respondents have some inherent propensity to choose for one of the power plant alternatives over the opt-out (none of the two alternatives) for reasons that are not captured in the estimated model.

The household attribute affects indirect utility positively meaning that respondents prefer alternatives where more

16 Another assumption that is closely related to IID is the independence from irrelevant alternatives (IIA) property. "This states that the ratio of the probabilities of choosing one alternative over another (given that both alternatives have a non-zero probability of choice) is unaffected by the presence or absence of any additional alternatives in the choice set" (Louviere et al., 2000:44). The IIA property, in turn, implies that the unobserved parts of the utility function (the ε_js) are independently and identically distributed (Louviere et al., 2000:45).

17 In the classical MNL model each parameter in the indirect utility specification V_{in} is assumed to be a fixed estimate, i.e. equal for each individual (Hensher et al., 2005).

Table 3. Description of the variables used in the econometric model

Variable	*Description*	*Coding/relative frequency*
	Attributes (X)	
Households	Number of households that can be provided with green electricity from the new hydropower plant (in 1,000).	5, 10, 15 households
Nature	Impact of the new hydropower plant on the landscape and natural environment.	1 = strong impact 0 = small impact
Recreation	Impact of the new hydropower plant on the possibilities for recreation.	1 = extended possibilities 0 = restricted possibilities
Cost	Increase in respondent’s monthly electricity bill.	€ 3, 6, 9, 12, 15, 18
	Socio-economic characteristics & other variables (Z)	
Electricity payment *(interacted with cost attribute)*	1 = Electricity bill is paid by another household member. 0 = Electricity bill is paid by the respondent him-/herself.	1 = 19.6 % 0 = 80.4 %
Donator *(interacted with nature attribute)*	1 = Respondent gives regular donations to environmental organisations. 0 = Otherwise	1 = 33.2 % 0 = 66.8 %
Recreation impact *(interacted with recreation attribute)*	1 = New hydropower plant is expected to improve recreational activities. 0 = Otherwise	1 = 39.7 % 0 = 60.3 %
Children *(interacted with nature attribute)*	1 = Respondent has children living in his or her household. 0 = No children in household.	1 = 29.1 % 0 = 70.9 %
Age	Age of the respondent in years.	Mean = 40.9
Hydropower	1= Hydropower first preferred energy source for future expansion. 0 = Other renewable energy source	1 = 35.2 % 0 = 64.8 %
Bad information	1 = Respondent feels badly informed about hydropower use in Austria. 0 = Respondent feels well informed.	1 = 48.7 % 0 = 51.3 %

Source: Author’s calculation.

households can be supplied with green electricity from the new hydropower station. The impact of the new hydropower plant on recreational opportunities is positive as well. This means that people are more likely to choose an alternative when the possibilities for recreation are extended as compared to an alternative with restricted leisure activities. Furthermore, people holding the opinion that the planned hydropower station would improve leisure opportunities pay increasing attention to the recreation attribute. This relationship is captured by the positive sign of the coefficient attached to the interaction term between the attribute recreation and the dummy variable “impact recreation”.

In contrast to these positive outcomes, environmental impacts appeared to have a negative effect on choice, providing confirmation of the trade-off between positive consequences and negative environmental side effects. More precisely, alternatives with a strong environmental impact are less preferred as compared to power plant alternatives exhibiting only a small impact. This relationship is captured by the negative sign of the coefficient on the attribute nature. In addition, the effect of the strong nature impact is enhanced if the respondent (or someone else in his or her household) is a donator to environmental organisations; regular donations reflect affinity with environmental issues. Another important result of the model refers to the impact of children on people’s perception of a strong environmental impact. Particularly, the strong environmental impact shows a greater impact on choice or utility when children are living in respondent’s household. This result implies the presence of bequest values. Consequently, respondents with children are more inclined to preserve a natural river landscape for the sake of future generations (Koundouri et al., 2009:1949).

The negative sign of the cost attribute reflects standard economic theory and indicates that green electricity must be provided at a low cost in order to accept the construction of the new hydropower plant. In simple terms, people prefer

Table 4. Results of the estimated error component (EC) model

Variable	*Coefficient*	*Variable*	*Coefficient*
Dependent variable	Choice: Alternative A, B or none of the two		
Alternative specific constant (ASC)	4.300*** (0.000)	Impact recreation*Recreation	0.842*** (0.005)
Households	0.057*** (0.001)	Age	-0.034** (0.018)
Nature (strong impact)	-2.161*** (0.000)	Hydropower	0.754* (0.077)
Recreation (extended)	0.682*** (0.001)	Bad information	-1.163*** (0.005)
Cost	-0.255*** (0.000)	Std. Dev. Households	0.087*** (0.002)
Electricity payment*Cost	0.067** (0.016)	Std. Dev. Nature	3.666*** (0.000)
Donator*Nature	-1.320*** (0.007)	Std. Dev. Recreation	1.693*** (0.000)
Children*Nature	-0.791* (0.055)	Std. Dev. Random effect (error component)	2.218*** (0.000)
Log likelihood	-855.999		
McFadden Pseudo R^2	0.347		
χ^2 (p-value)	911.5 (0.000)		
Number of respondents	199		
Number of observations	1,194		
p-values in parentheses			
Significance: *** 1 % level	** 5 % level	* 10 % level	

Source: Author's calculation.

cheaper alternatives. However, price sensitivity will diminish if the electricity bill is not paid by the respondent but instead by another household member.

Regarding socio-demographic characteristics, the model outcomes reveal that elder people are less likely to vote for the construction of the new hydropower plant. Instead, they rather tend to choose the opt-out alternative. No other socio-demographics were found to exhibit a statistically significant impact on choice. However, two additional attitudinal variables appeared to represent significant determinants of people's choice. First, respondents who ranked hydropower first when asked for the two most preferred renewable energy sources for the purpose of future electricity generation are more likely to choose one of the hydropower scenarios over the opt-out. Finally, the level of information has a significant effect on choice as derived from the positive coefficient on "bad information". Specifically, people feeling badly informed about hydropower in general are less likely to accept the new hydropower plant.

6. Willingness to pay

The estimated parameters presented above can be used to calculate the rate at which respondents are willing to trade-off one attribute for another. This relationship is usually referred to as "marginal rate of substitution" (MRS). If one of the attributes is measured in monetary units (e.g. electricity price increase) the MRS will correspond to the marginal willingness to pay (MWTP) of the consumer (Bennett and Blamey, 2001:63). This is given by equation 4. Due to the presence of unobserved preference heterogeneity, measures of MWTP have been simulated for each respondent $n=1,\ldots,N$ and each attribute $k=1,\ldots,K$ using the conditional and constrained parameter estimates for β_{kn} (Hensher et al., 2005:691f). Then the means, standard deviations and confidence intervals were taken from these simulations.

$$MWTP_{kn} = -\frac{\beta_{kn}}{\beta_{monetary}} \quad \forall\, n = 1,\ldots,N \;\; and \;\; k = 1,\ldots,K \qquad (4)$$

The outcomes are shown in Table 5. The estimated meas-

Table 5. Estimates of marginal WTP

Variable	*Measurement*	*MWTP*
Hydropower plant	effect of the ASC	€ 16.882 [11.544, 22.219]
Households	per 1,000 households	€ 0.258 [0.225, 0.292]
Impact on nature and landscape	from small to strong	€ -9.430 [-10.019, -8.841]
Recreational activities	from restricted to extended recreational activities	€ 3.078 [2.839, 3.318]
95 % confidence intervals in parentheses		

Source: Author's calculation.

ures of MWTP are based on a "ceteris paribus" assumption, that is, MWTP is calculated for a change in the attribute of concern, given that all other parameters are held constant (Bennett and Blamey, 2001:63). First, people generally exhibit a positive MWTP for the construction of the new hydropower station independent from the attribute levels. This general MWTP, which represents the positive ASC, is € 16.9 per household and month. Additionally, respondents are willing to pay around € 0.3 on top of their monthly electricity bill for the supply of 1,000 additional households with green electricity from the hydropower plant.

The implicit price for the nature attribute is negative since stated choices are negatively affected by the adverse environmental effects associated with the new hydropower plant. Negative values of MWTP imply a reduction of respondents' utility. According to that, the disutility associated with a strong environmental impact is estimated at € 9.4 per household and month. Conversely, the negative implicit price can be interpreted as a demand for compensation required for the loss of nature and landscape when the new hydropower station is built.

Another important factor for respondents is the creation of leisure activities. Since the survey participants are living near the Mur, recreational activities along the river are suspected to play an important role. Hence, an improvement of the possibilities for recreation is valued positively. More specifically, respondents are willing to pay € 3.1 on top of their monthly electricity bill if the hydropower station opens up new opportunities for leisure activities (such as a cycle paths or canoeing).

7. Welfare analysis

Implicit prices (MWTP) for the individual attributes are in fact useful for policy makers. However, these values do not represent valid welfare measures. This is why overall economic welfare (EWF) was estimated for different policy scenarios. Similar to the calculation of implicit prices, the welfare measures were simulated for each respondent based on the statistically best fit model presented above. With this approach, unobserved preference heterogeneity is accounted for. Then means, standard deviations and the corresponding confidence intervals were drawn from the simulations.

The outcomes for four different policy scenarios are presented in Table 6.[18] The first scenario corresponds to the worst case, meaning that a small hydropower plant is built with a strong impact on landscape and natural environment and no additional possibilities for recreation. This attribute level combination is associated with a very low level of EWF amounting to merely € 0.2 per household and month. Additionally, we cannot conclude that EWF attached to the worst case scenario is significantly positive since the 95 % confidence interval includes the value zero. Improving all attributes leads to a substantial increase of welfare to € 20.0 per household and month. This value is associated with 20,000 households able to be provided with electricity from the hydropower plant, a small environmental impact and the presence of new recreational activities. Starting from this scenario, a deterioration of environmental conditions, that is, a change from small to strong impact is associated with a significant decrease in total EWF. In particular, EWF goes substantially down from € 20.0 in scenario (2) to € 8.0 in scenario (3). The effect of additionally available recreational activities can be shown by the comparison of scenarios (2) and (4). The creation of additional leisure opportunities is associated with an increase of EWF from € 15.8 to € 20.0.

The welfare measures presented above describe the mean of the respondents included in the sample of the study. However, the mean of the sample may not be policy relevant, but rather the mean of the relevant population. For that reason, the estimated measures of economic welfare have been aggregated from the sample to the population. Usually, this can be done by simply multiplying the estimated economic welfare by the number of people or households in the population (Pearce et al., 2002:89f). This is a valid approach as long as a representative sample was drawn from the entire population (Bateman et al., 2006:3). Accordingly, the monthly measures of EWF have been converted into yearly values and aggregated with the number of households in the area of investigation, arriving at a reliable estimate of overall

18 The hydropower station Graz-Puntigam is expected to provide 20,000 households with green electricity. Therefore, this value was used in the subsequent welfare analysis although it is outside the predetermined range of the attribute levels.

Table 6. Economic welfare (EWF) for different policy scenarios

No.	*Households*	*Nature/landscape*	*Recreation*	*EWF (per household/month)*	*Aggregated value/year*
(1)	5,000	strong impact	restricted	€ 0.190 [-0.927, 1.306]	€ 0.3 mill.
(2)	20,000	small impact	extended	€ 19.992 [19.022, 20.963]	€ 36.0 mill.
(3)	20,000	strong impact	extended	€ 8.039 [6.700, 9.378]	€ 14.5 mill.
(4)	20,000	small impact	restricted	€ 15.750 [14.972, 16.528]	€ 28.3 mill.
95 % confidence intervals in parentheses					

Source: Author's calculation.

economic welfare.[19] The outcomes are shown in the last column of Table 6.

First, the worst case scenario is associated with a very low value of total EWF amounting to solely € 0.3 million. Going to the best case (scenario 2) welfare rises substantially to € 36.0 million. A strong environmental impact is associated with a welfare loss of € 21.5 million, as can be seen from the comparison of scenarios (2) and (4). In contrast, the creation of new possibilities for leisure activities is totally worth € 13.8 million.

8. Conclusion

Hydropower plays a substantial role in the Austrian energy sector and it is planned to open up the remaining potentials, i.e. building new hydropower stations along Austrian rivers. One of these projects is the hydropower station in Graz-Puntigam, known as "Murkraftwerk Graz". Although the hydropower plant is expected to improve the security of supply, reduce CO_2 emissions and improve recreational possibilities, the project is associated with negative environmental impacts. This trade-off between economic and climate-related advantages and the negative environmental side effects was identified and quantified by means of an econometric model. While people exhibit a positive WTP for the provision of households with green electricity and the improvement of recreational possibilities, they wish to be compensated for the loss of nature and landscape the new hydropower plant is associated with. More precisely, strong environmental impacts lead to a significant welfare loss indicating that it is extremely important to hold the environmental impact as small as possible when new hydropower stations are built.

19 Due to a lack of data, the number of households used to aggregate EWF was calculated manually. The average household size in Graz and surroundings is 2.26 persons. This value is a weighted average of the household sizes in the districts of "Graz" and "Graz-Umgebung". Then the number of inhabitants living in the city area of Graz and the directly surrounding communities was divided by the average household size yielding a number of 149,903 households.

All together, this paper provides an important insight into public attitude towards a concrete hydropower project in Austria. By means of an econometric model it was possible to quantify the positive and negative externalities the hydropower project is associated with. These external effects need to be taken into account when investment decisions are to be made. Hence, this work makes an important contribution to broaden the strategic basis of decision making for the construction of new hydropower plants.

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