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Public Preferences for Urban and Rural Hydropower Projects in Styria using a Choice Experiment

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Abstract: In this paper we use a choice experiment to estimate public preferences for the construction of two hydropower plants in and near the city of Graz (Austria). One hydropower plant is planned to be built within the city limits of Graz (urban project) and the other one in Gratkorn, a community in the north of Graz (rural project). In order to address differences in public preferences between the rural and urban hydropower projects a split-sample test is conducted. The results of this test show that preferences differ. Generally people have a positive attitude towards new hydropower plants. The provision of green electricity as well as the extension of recreational activities are valued positively and therefore exhibit a positive willingness to pay. However the realisation of a new hydropower plant must come with a small environmental impact in order to gain a significant welfare increasing impact.

Keywords: Choice experiment, scale parameter, willingness to pay, hydropower

JEL Classification: C01, C25, Q42, Q5

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1 Introduction

Hydropower plays a substantial role in the Austrian energy sector. Currently 58.5 percent of total electricity produced in Austria comes from hydroelectric power stations; this corresponds to an amount of annually 41.572 gigawatt hours (GWh; ENERGIE-CONTROL AUSTRIA, 2011a). Gross electric hydropower generation has nearly doubled since 1970 (ENERGIE-CONTROL AUSTRIA, 2011b). The total number of hydropower plants in Austria is 2,598 with an entire installed capacity of 12,920 megawatt (MW). Of these 672 are river and 111 storage power plants. In the case of river power plants there is a strong tendency towards small-scale hydropower. 582 out of the 672 river power plants have a capacity of less than 10 MW. Moreover there exists a large number of small-scale hydropower plants (1,815) with a capacity lower than 1 MW. The important role of river power plants in the Austrian power sector becomes clear by looking at gross electric power generation. The main part of hydropower generated electricity in Austria – 28,000 GWh or 67.4 percent – is produced by river power plants and 13,572 GWh (32.6 percent) by storage power plants (ENERGIE-CONTROL AUSTRIA, 2011c).

Although about 60 percent of the total electricity produced already comes from hydropower installations, there is still substantial potential for new hydropower facilities, especially for small-scale hydropower. According to the hydropower potential study of PÖRY ENERGY GMBH (2008), the techno-economic potential, which is worth being explored is estimated at 56,100 GWh. A large part of this potential has already been opened up (38,200 GWh), but 17,900 GWh are not used yet. Of that, 16,500 GWh can be explored by new hydropower plants, the remaining part (1,400 GWh) by the optimisation of existing facilities. However, these estimates do not consider possible reductions of the techno-economic potential due to environmental and socio-economic restrictions. A first estimate of the reduced techno-economic potential excludes the potentials located in regions with a high degree of sensibility such as national parks and world heritage. This leaves a value of 13,000 GWh, which is effectively exploitable.¹

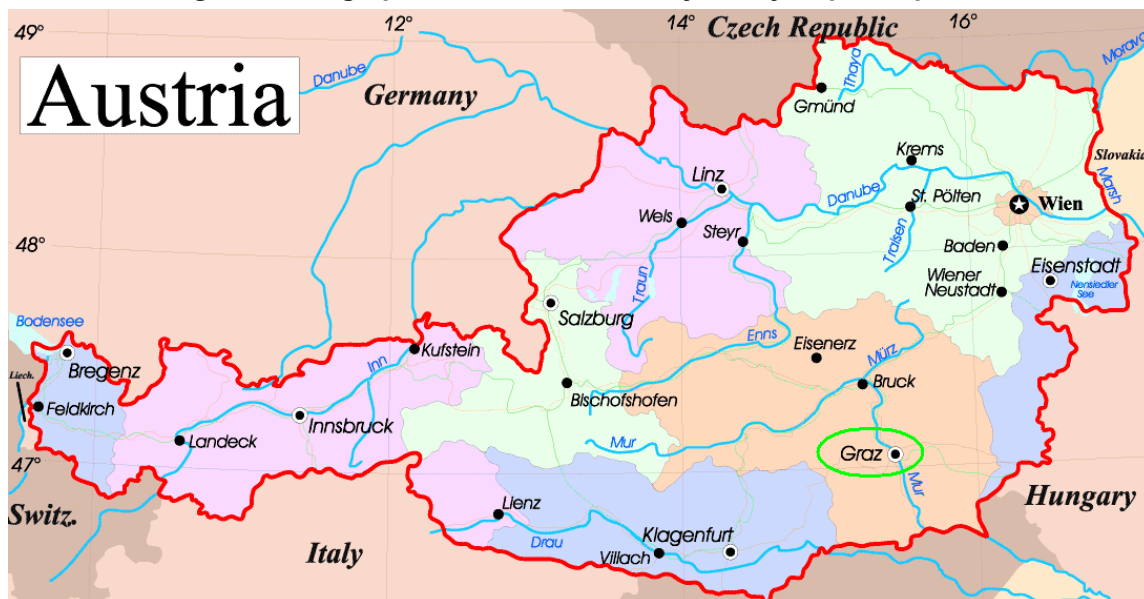
The Austrian master plan for the expansion of hydropower utilisation was presented in 2008 and envisages an increase of hydropower utilisation by 7,000 GWh (VEÖ, 2008). In the Austrian energy strategy hydropower plays a substantial role too. It stipulates a realizable hydropower expansion of 3,500 GWh² and considers the intensified use of renewable energy sources as the core element of a sustainable and future-oriented energy policy (LEBENS-MINISTERIUM, 2010). In total 100 new hydropower plants are currently in the stage of planning, whereas 70 of these projects are small-scaled with a capacity of less than 15 MW. In the province of Styria 22 new hydropower stations are planned to be built, among them the projects “Graz-Puntigam” and “Gratkorn” along the river Mur (UMWELTDACHVERBAND, 2010a

¹ This value does not include reductions due to the possible restrictions imposed by the European Water Framework Directive (WFD).

² This target value considers ecological requirements as well as economic aspects.

and 2010b). The geographical location of these hydropower projects is shown in Figure 1 (by the green circle).

Figure 1: Geographical location of the Styrian hydropower plants



Source: <http://mapsof.net/map/austria-political-map>

The construction of the hydropower station Graz-Puntigam with a total capacity of 16 MW is planned within the city limits of Graz. Graz represents the provincial capital of Styria and is situated around 150 km south-west of Vienna. The number of inhabitants amounts to 262,000; hence Graz is the second largest city in Austria. The overall investment volume is € 87 Mio. The construction works are scheduled to start in autumn 2013 and will be finished by the end of 2015. The power station will be able to generate an electricity amount of 74 GWh per year. Hence about 20,000 households in Graz can be provided with “green” electricity (PISTECKY, 2010; DOBROWOLSKI AND SCHLEICH, 2009; ENERGIE STEIERMARK, 2010). The second hydropower project will be realized in Gratkorn, a community situated in the north of Graz. It is planned to be built between two existing river power plants and therefore represents an important expansion of the already operating power generation capacities along the Mur. Start of construction is planned in 2011; the hydropower station will be finished in 2014 with an installed power plant capacity of 11 MW. Gross electricity production will amount to 57 GWh per year. With this about 13,000 households can be annually provided with “green” electricity (VERBUND AUSTRIAN HYDRO POWER, 2009a; VERBUND AUSTRIAN HYDRO POWER, 2009b). Hence, the main difference between the two hydropower projects concerns the geographical location. While Graz-Puntigam is situated in the urban area of Graz, the location of the hydropower plant Gratkorn can be characterized as a rural area. Additionally, the hydropower plants differ in capacity and in Gratkorn there is already a significant impact on landscape and natural environment due to the existing hydropower facilities.

Generally, the use of hydropower implies a considerable conflict potential. On the one hand there are the targets of climate and energy policy (e.g. reduction of greenhouse gas emissions, intensified use of renewable energy sources) and on the other hand the objectives of

nature and water protection as for instance the Water Framework Directive (WFD). Accordingly, the installation of new hydropower stations is associated with external costs and benefits. Positive effects from the use of hydropower especially involve the emission-free generation of electricity and the associated CO₂ avoidance. In addition, other social and economic benefits that can arise from the development of hydropower are positive impulses for the local economy (especially employment effects) as well as the improvement of domestic energy security. Important environmental concerns related to the operation of hydropower plants are the visual impact of a power plant on the surrounding (natural) environment, erosion, sedimentation and oxygen-deficiency problems due to the alteration of the water flow in the river, and correspondingly the impacts of these changes on fish and other water-dependent wildlife. Hence, all these social, economic and environmental impacts have to be taken into consideration if socially-optimal investments are to be made.

The aim of this paper is to examine public perception and preferences for the two hydropower projects in Styria. Thereby we also address differences in public preferences between the planned hydropower stations (rural versus urban project). In particular, we focus on preferences of the same underlying populations³ for two different hydropower projects meaning that we do not distinguish between urban and rural populations. Moreover we estimate willingness to pay (WTP) for increasing the amount of green electricity, the preservation of the natural environment around the power plant as well as the extension of recreational activities. Finally, we will use the model results to calculate total consumer surplus for different policy scenarios.

2 Theoretical background and previous research

The costs and benefits associated with new hydropower plants are estimated conducting a choice experiment study. Choice experiments belong to the family of stated preference techniques. Within the scope of such an experiment respondents are asked to choose between a selection of different alternatives in a hypothetical setting. The alternatives are described by a number of attributes which vary between different alternatives. Usually the respondents are asked to make a sequence of choices. This sequence of choice outcomes enables the analyst to model the probability of an alternative being chosen in terms of the value attached to the attributes used to describe the alternatives. Such models provide information on the willingness of respondents to make trade-offs between the individual attributes and in further consequence it is possible to obtain willingness to pay measures for the different attributes used in the choice experiment (for reviews see ALPIZAR ET AL., 2001; BENNETT AND BLAMEY, 2001; LOUVIERE ET AL., 2000).

There exist only a very limited number of studies using choice experiments to value the costs and benefits of hydropower use. An investigation from SUNDQVIST (2002) provides an attempt to value the environmental impacts arising from hydroelectric production by non-

³ The underlying basic population are people living in Graz and the surrounding communities. More on sample selection can be found later in this text.

residential electricity consumers (small and medium sized firms) using the choice experiment approach. The main objective of the study was to analyse Swedish non-residential attitudes towards green electricity from hydropower. On the one hand the water-related attributes *downstream water level, erosion and vegetation* as well as *impacts on fish life* were included in the choice experiment. In order to obtain willingness to pay measures for these attributes the price attribute was defined as an *increase in electricity price per kilowatt hours (KWh)*. The results show, that respondents are willing to incur extra costs for environmental improvements, like the reduction of erosion and vegetation or the preservation of fish species. The analysis also indicates that environmental improvements must be provided at a low cost since firms are sensitive to price increases. The same choice experiment was applied to a random sample of households (SUNDQVIST, 2002b). This investigation principally yields the same results as in the case of non-residential electricity consumers. KATARIA (2009) examined the willingness to pay of Swedish households for environmental improvements in hydropower regulated rivers. The choice experiment contains the attributes *fish stock, living conditions for birds, species richness, vegetation and erosion* as well as an unspecified *additional annual cost*. The results show that people are principally willing to pay for ecological improvements, for instance for an increased fish stock or an improvement of living conditions for birds. Furthermore there exist a limited number of valuation studies focusing on other renewable energy, mainly wind power (see e.g. ALVAREZ-FARIZO AND HANLEY, 2002; EK, 2005; MEYERHOFF ET AL., 2008). Other choice experiment studies focus on the valuation of costs and benefits of renewable energy investments in general and not especially on hydropower investments (see e.g. BERGMANN ET AL., 2004; BERGMANN ET AL., 2008; LONGO ET AL., 2008).

3 Study design

3.1 The choice experiment

In order to examine public preferences for the two described hydropower facilities in Styria a questionnaire was developed over a 2-3 months time period based on a series of pre-tests and two discussion rounds with external experts in an advisory board.⁴ Special attention was paid to the choice experiment and how understandable the experiment and its design were to lay people. The final questionnaire consisted of 43 questions divided into three main parts. The first section contained questions about the respondent's general perception and attitudes towards renewable energies, electricity and hydropower use. In the second part respondents were asked to state their choices using six different choice sets. The choice experiment was followed up by a number of debriefing questions related to the perceived complexity of the experiment as well as the possible presence of protest responses. The final part of the questionnaire focused on gathering data on respondents' demographic and socio-economic status. The attributes used in the choice experiment are presented in Table 1.

⁴ The group of experts ("Advisory Board") consisted of people from the electricity industry and different federal and provincial government departments.

Table 1: Attributes and attribute levels used in the choice experiment

<i>Attributes</i>	<i>Description</i>	<i>Levels</i>
Market size	Number of households that can be provided with green electricity from the new hydropower plant	5000, 10000, 15000 households
Nature and landscape	Impact of the new hydropower plant on the natural environment and the landscape	small impact, strong impact
Recreational activities	Creation of new possibilities for recreation	yes, no
Cost	Increase in monthly electricity bill	€ 3, 6, 9, 12, 15, 18

The main advantage of the installation of a new hydropower plant is the emission-free generation of electricity for local consumers and the associated greenhouse gas reduction. For the two presented hydropower projects in Styria the amount of households that can be provided with electricity is estimated between 13,000 and 20,000 households (DOBROWOLSKI AND SCHLEICH, 2009; VERBUND AUSTRIAN HYDRO POWER, 2009a). In view of a conservative estimate, the levels for the *household attribute* were fixed between 5,000 and 15,000 households. However, both the construction as well as the operation of a new hydropower plant always come along with a negative impact on the water body and its surrounding environment. Consequently there is a general conflict between emission-free electricity generation from hydropower and nature conservation. Negative effects related to a new hydropower plant are visual impacts on the landscape and negative consequences for the ecosystem state of the water body. These impacts range from the disruption of the consistency of the water stream, the alteration of flow conditions and the associated sedimentation, the increase of the water temperature and the related oxygen-deficiency up to a reduction of the water level downstream of the hydropower plant. Altogether these changes seriously affect fish and other water-dependent wildlife (KNÖDLER ET AL., 2007; MEYERHOFF AND PETSCHOW, 1997; BUNGE ET AL., 2001; WURZEL AND PETERMANN, 2006). In order to minimize these ecological impacts, hydropower plants can be planned in an environmentally friendly way. Thereby measures like the restoration of riverbanks in a near-natural state as well as the preservation of the water body continuity by for instance the installation of fish ladders play an important role (KNÖDLER ET AL., 2007).⁵ We decided to use two levels for the *nature and landscape attribute*, namely a small and strong impact. With a strong impact only the minimum requirements predetermined by the Water Framework Directive are fulfilled.⁶ A small impact implies that higher environmental standards (beyond the given standards of the Water Framework Directive) to minimize the impact of the hydropower plant on the landscape and the natural environment are fulfilled. The third attribute included in the choice experiment

⁵ The Water Framework Directive represents a legal framework to ensure that new hydropower plants do not lead to a deterioration of the water body status. Measures like the installation of fish ladders are obligatory when new hydropower stations are built.




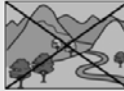


⁶ For new hydropower plants the Water Framework Directive stipulates a mandatory installation of fish ladders as well as a minimum amount of residual water (STIGLER ET AL., 2005).

describes possible future recreational activities along the riverside like biking, boat trips or canoeing that can be created when building a new hydropower plant (DOBROWOLSKI AND SCHLEICH, 2009). Finally, the monetary attribute was specified as an increase in respondents' monthly electricity bill. The payment levels ranged between € 3 and € 18.

In the introduction to the choice experiment respondents were informed that the intensified use of renewable energy sources represents an important goal of future energy policy. In this context it was also mentioned that currently around 60 percent of domestic electricity comes from hydropower installations and that there is still substantial potential for new hydropower plants like the ones in Styria. Furthermore all attributes and their levels were explained in easy terms to the respondents. In order to improve the comprehensibility of the questionnaire various pictograms were used for the explanation of the choice experiment attributes.

Choice sets were created using a D-efficient design in the software package Sawtooth. Each choice set consisted of three alternatives, including an opt-out alternative referred as "none of the two alternatives". This opt-out alternative was included in all choice sets. The design was finally blocked into 30 versions, each containing six choice tasks. An example of a choice card is presented in Figure 2.

Figure 2: Choice card example

	Alternative A	Alternative B	None of the two alternatives
Electricity for...	5,000 households 	15,000 households 	
Impact on nature and landscape	Small impact 	Strong impact 	
Recreational activities	No 	Yes 	
Additional monthly electricity payment	€ 3	€ 9	
	<input type="checkbox"/>	<input type="checkbox"/>	

Respondents who chose six times the opt-out alternative were asked to explain why. They were confronted with a series of statements based on the pretest results (e.g. "I am strictly against the construction of the hydropower station", "The current situation is already satisfying" or "I cannot afford additional monthly payments") in order to identify and categorise protest bidders. Altogether we were able to identify 12 protest votes (5.7 percent) in the sample

referring to Graz-Puntigam and 5 (2.4 percent) in the sample for the hydropower project Gratkorn. These protest votes were excluded from the analysis.

3.2 Sample selection and socio-economic characteristics

In June 2011 two surveys were implemented by a professional survey company using a web-based survey. The only difference between the two surveys is that one sample refers to the urban hydropower plant Graz-Puntigam and the other one to the rural project Gratkorn. In the following we will refer to these samples simply as Graz and Gratkorn. Both samples consist of people living in the area of Graz as well as the surrounding communities. For a pre-test 103 people completed the web-based questionnaire in May 2011. In the first survey (Graz) in total 959 people were invited to participate. The response rate was 22.0 percent meaning that 211 respondents completed the survey. Another 988 people were asked to fill out the questionnaire referring to the rural hydropower plant Gratkorn. The response rate of this second survey amounted to 21.6 percent. Thus the second sample contains in total 213 respondents.⁷ The response rate was calculated as the ratio between filled questionnaires and the overall number of people invited to the online survey.

Table 2 displays the socio-demographic characteristics of the two samples as well as the distribution in the total population from which the samples were drawn. The gender of the respondents in both samples is very close to the Styrian average with 50.6 % men and 49.4 % women. Moreover the gender distribution is statistically not different between the two samples based on the result of the two-sample Wilcoxon rank-sum test ($z=0.451$, $p=0.652$). The age structure corresponds in principle to that of the total population in Styria. However, the age category older than 59 years is proportionally low compared to the total population. The same applies to the age group 18-19 years which is also slightly underrepresented in the sample. In contrast respondents aged between 20 and 29 years are stronger represented in the sample compared to the total population. The mean age is 40.9 years in the Graz sample and 38.3 years in the sample referring to Gratkorn. An independent sample t-test showed that the mean age is significantly different between the two samples ($t=-1.885$, $p=0.061$).

⁷ Due to the exclusion of protest votes (see section 3.1) the sample sizes for further analyses reduced to 199 (Graz) resp. 208 (Gratkorn).

Table 2: Socio-demographic characteristics of respondents

	<i>Graz</i> (n=199)	<i>in %</i>	<i>Gratkorn</i> (n=208)	<i>in %</i>	<i>Total</i> <i>population</i> ^a
GENDER					
Male	103	51.8 %	103	49.5 %	50.6 %
Female	96	48.2 %	105	50.5 %	49.4 %
AGE					
18-19 years	4	2.0 %	2	1.0 %	3.2 %
20-29 years	52	26.1 %	66	31.7 %	17.5 %
30-39 years	38	19.1 %	49	23.6 %	18.3 %
40-49 years	46	23.2 %	43	20.6 %	22.5 %
50-59 years	36	18.1 %	29	13.9 %	17.8 %
60-69 years	19	9.5 %	17	8.2 %	15.1 %
>69 years	4	2.0 %	2	1.0 %	5.6 %
REGION					
Graz	151	75.9 %	155	74.5 %	78.1 %
Surrounding communities	48	24.1 %	53	25.5 %	21.9 %

Source: ^aStatistik Austria (2010), (2011a)

In total, Graz and its surrounding area⁸ have about 330,000 inhabitants. 21.9 % of them are living in one of the surrounding communities and 78.1 % have their residence in the urban area of Graz. This distribution is also reflected in the two samples. The respondents from the area around Graz are thereby equally allocated among all surrounding communities. There is no statistically significant difference between the distribution among regions of the two samples ($z=-0.317$, $p=0.751$).

The distribution of disposable monthly household income is given in Table 3.⁹ 53.0 percent of the respondents in the Graz sample have a household income less than € 2,000. In the Gratkorn sample this applies to 49.3 percent of the survey participants. The income distributions of the two samples are not significantly different from each other ($z=1.321$, $p=0.187$). Furthermore the median monthly household income falls into the income category € 1,501 – 2,000 (Graz), which is slightly below median household income in Austria of approximately € 2,400 (STATISTIK AUSTRIA, 2011b). Consequently, the income distribution in the sample referring to the hydropower project Graz is slightly skewed towards those with lower incomes. In the Gratkorn sample however the median income category is € 2,001 – 2,500 and therefore corresponds better to the median household income in Austria.

⁸ Graz has in total 19 surrounding communities, namely Feldkirchen, Fernitz, Gössendorf, Grambach, Hausmannstätten, Kalsdorf, Raaba and Seiersberg in the south. In the north of Graz are the communities Deutscheitz, Eisbach, Gratkorn, Gratwein, Judendorf-Straßengel, Peggau, Stattegg and Weintzen. Finally in the east and west Graz is surrounded by the communities Hart, Kainbach and Thal.

⁹ In the Graz sample in total 14 and in the Gratkorn sample 11 respondents skipped the income question. Thus the sample sizes in Table 3 differ from those in Table 2.

Table 3: Distribution of disposable household income

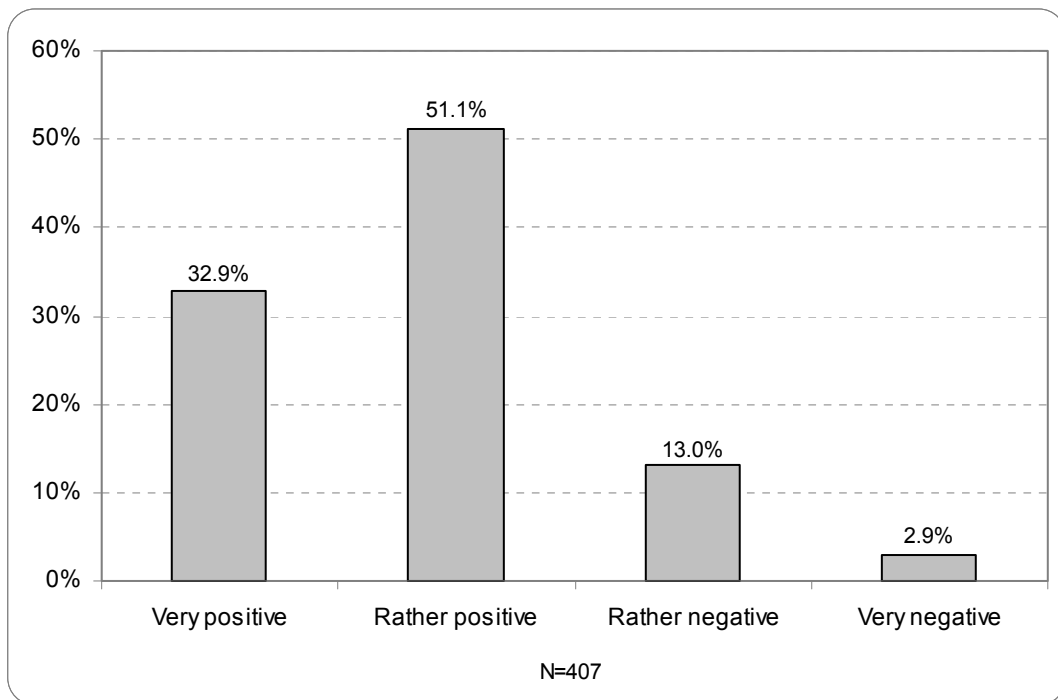
<i>Income category</i>	<i>Graz (n=185)</i>	<i>in %</i>	<i>Gratkorn (n=197)</i>	<i>in %</i>
Up to € 1,000	35	18.9 %	27	13.7 %
€ 1,001 – 1,500	27	14.6 %	34	17.3 %
€ 1,501 – 2,000	36	19.5 %	36	18.3 %
€ 2,001 – 2,500	26	14.1 %	26	13.2 %
€ 2,501 – 3,000	29	15.7 %	22	11.2 %
€ 3,001 – 3,500	12	6.5 %	22	11.2 %
More than € 3,500	20	10.7 %	30	13.2 %
Median category	1,501 – 2,000 €		2,001 – 2.501 €	

3.3 Perceptions of the hydropower projects in Styria

The perceptions of the respondents for renewable energy and hydropower use in Austria resp. Styria were elicited through a series of questions. A majority of respondents (339 or 83.3 percent) answered that the use of renewable energy sources is very important to meet future energy-related targets. Moreover 15.7 percent stated that it is rather important to further increase electricity generation from renewable sources like hydropower, wind power or solar power in the future. The respondents' attitude towards the intensified use of renewable energy does not differ between the two samples ($z=-0.202$, $p=0.840$).

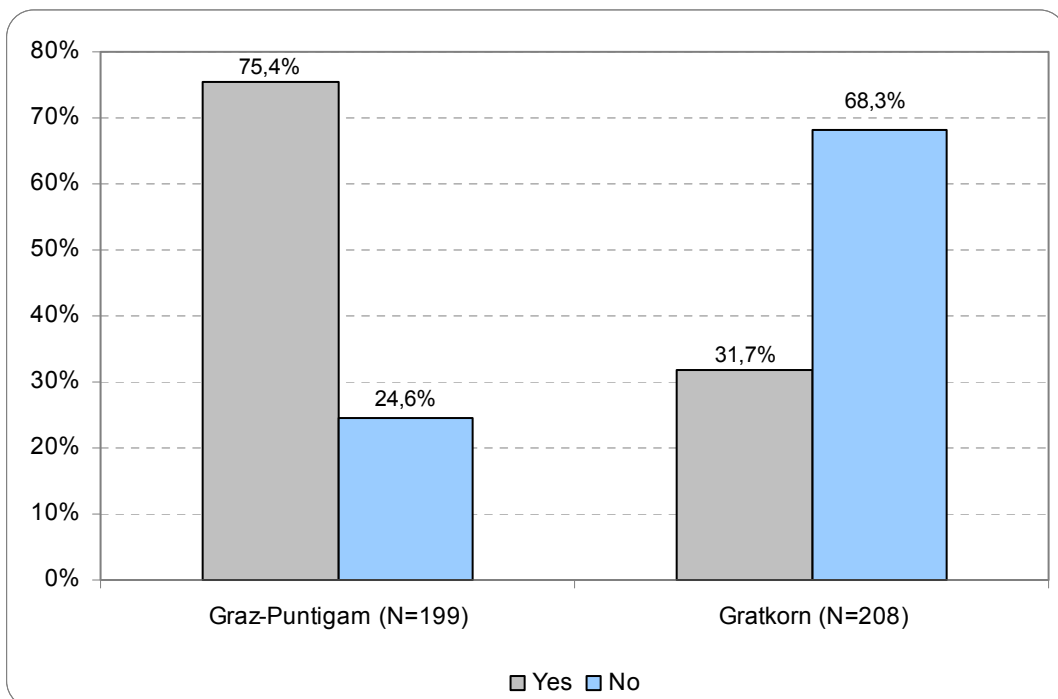
In principle most respondents have a very positive (43.2 percent) or rather positive (51.8 percent) attitude toward hydropower utilization in Austria. Again there is no statistical significant difference between the two samples ($z=0.070$, $p=0.944$). When respondents were asked if they heard about the plan to construct new hydropower plants along the river Mur, 86.0 percent answered this question with "yes". There is no statistical significant difference between the two samples referring to the hydropower projects in Graz and Gratkorn ($z=-0.534$, $p=0.594$). In addition slightly more than half of the respondents (51.1 percent) have a positive attitude toward the construction of new hydropower plants along the Mur. The number of people with a very positive attitude is 32.9 percent. Only a minority of 15.9 percent is in principle against the construction of new hydropower plants along the Mur (see Figure 3). Statistical significant differences between the two samples are not found ($z=-0.279$, $p=0.780$).

Figure 3: Public attitudes towards the expansion of hydropower use along the Mur



Generally, the survey results show that the project Graz-Puntigam is considerably better known than the project Gratkorn. About three quarter (75.4 percent) of respondents in the sample regarding the project Graz know that there are plans to build a new hydropower station. In contrast less than a third of the respondents in the Gratkorn sample are informed about the construction of the hydropower plant (see Figure 4). Statistical significant difference between the two samples is found at the 1 %-level ($z=-8.809$, $p=0.000$).

Figure 4: Share that heard of the hydropower projects



People who heard about the two hydropower projects were asked to state the approximate distance between the location of the hydropower plant and their home. In the sample referring to Graz this distance is on average 10.6 km, in the Gratkorn sample the mean distance is 12.8 km (statistical significant difference in the mean is not found: $t=1.378$, $p=0.170$). Furthermore a relatively high number of respondents (sample A ($n=150$): 63.3 percent, sample B ($n=66$): 77.3 percent) reported not to be affected by the new hydropower projects. At the same time 8.7 percent (Graz) and 6.1 percent (Gratkorn) of the sample population indicated to feel negatively affected. A statistical significant difference between the two samples is found at the 5 %-level ($z=2.019$, $p=0.043$).

4 The econometric model

Choice experiments belong to the family of stated preference techniques and are based on traditional microeconomic theory. They combine Lancaster's characteristics theory of value as well as random utility theory (RUT). First, Lancaster's theory states that consumers derive utility from the properties or characteristics of a good (LANCASTER, 1966). Thus the value of a new hydropower station can be expressed by its characteristics like the number of households able to be provided with electricity or the impact on the landscape and the natural environment (see section 3.1). Moreover choice theory is based on the assumption that individuals are acting rationally, meaning that they compare alternatives and choose the one which gives the highest level of utility (HENSHER ET AL., 2005).

"RUT postulates 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, p. 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. That is:

$$U_{in} = V_{in} + \varepsilon_{in} \quad (1)$$

V_{in} represents the systematic or observable component of the utility held by consumer n for choice alternative i and ε_{in} is the random or unobservable component of utility (BENNETT AND BLAMEY, 2001). For the unobserved component of utility we have to make assumptions. Usually the random part is assumed to be independently and identically distributed (IID) with an extreme value type 1 (EV1) distribution (LOUVIERE ET AL., 2000).¹⁰ In the mixed logit model, also referred to as random parameter logit model, preference heterogeneity is accounted for in the unobserved portion of utility.

Furthermore, the independence from irrelevant alternatives (IIA) property states that the relative probabilities of two options being selected are unaffected by the introduction or removal of additional alternatives. The IIA property represents a consequence of the initial assumption that the unobserved part of the utility function (ε) is independently and identically distrib-

¹⁰ This distribution is also referred to as Gumbel distribution.

uted (LOUVIERE ET AL., 2000). Consequently, violation of IIA requires more complex statistical models like nested or mixed logit models that relax some of the assumptions regarding the unobserved part of utility (ϵ).¹¹

In the classical multinomial or conditional logit (MNL) model the observed component of utility V_{in} from equation (1) is assumed to be linear additive in the attributes and parameters. Thus each parameter is a single fixed parameter (HENSHER ET AL., 2005). However, the MNL model has two substantial disadvantages. First, the statistical model is based on the IID and in further consequence on the IIA property. Second, the MNL model cannot capture preference heterogeneity not embodied in the individual characteristics of respondents (GREENE AND HENSHER, 2005; HENSHER AND GREENE, 2002). Therefore we draw on more complex choice models, namely mixed logit. In the mixed logit model parameters are not fixed but random, meaning that they are allowed to vary across individual respondents. Formally this can be described in the following way:

$$\beta_{in} = \beta_i + \sigma_i v_{in} \quad (2)$$

In this equation β_i represents the population mean and v_{in} the individual specific heterogeneity (with zero mean and a standard deviation of one). σ_i is the standard deviation of the distribution β_{in} around β_i . The components estimated by the analyst are β_i (mean) and σ_i (standard deviation; BEVILLE AND KERR, 2009). In order to get a better understanding of sources of preference heterogeneity within a sampled population the mixed or random parameter logit model can be extended to allow for variance heterogeneity (GREENE ET AL., 2005). With variance heterogeneity in the random parameters the σ_i in equation (2) becomes a heteroscedastic term (σ_{in} ; BEVILLE AND KERR, 2009). This heteroscedastic standard deviation of a random parameter can simply be treated as an additional error component. Therefore such models are called random parameter or mixed logit error component models (HENSHER AND GREENE, 2002).

5 Results

5.1 The role of the scale parameter for the comparison of two datasets

As mentioned in section 4 of this paper, a rationally acting individual will choose the alternative which yields the highest utility. The decision maker will choose the same alternative with $U_{in} > U_{jn}$ as with $\lambda U_{in} > \lambda U_{jn}$. This means that the alternative with the highest utility remains the same no matter how utility is scaled (λ = scale parameter; TRAIN, 2003, p. 27). However, a comparison of two datasets requires revealing the scale parameter in order to make the results comparable (HENSHER ET AL., 2005, p. 75). The problem is that the scale parameter

¹¹ The most widely used test for violation of the IIA assumption is the so-called Hausman test, developed by Hausman and McFadden in 1984 (LOUVIERE ET AL., 2000).

cannot be identified directly because the scale parameter and preference parameters are jointly estimated and therefore confounded (SWAIT AND LOUVIERE, 1993, p. 305). In principle observed parameter estimate differences between two samples, say A and B, occur due to three reasons:

- (1) First, the parameter differences are simply the result of sampling error. The true underlying preference parameters and scale factors do not differ between the two samples, i.e. $\beta_A = \beta_B$, $\lambda_A = \lambda_B$ (where β_A is the preference parameter vector of sample A and β_B the parameter vector of sample B; λ_A represents the scale parameter of sample A and λ_B the scale factor of sample B).
- (2) Second, the true underlying parameters are the same but the scale parameters differ between the two samples, i.e. $\beta_A = \beta_B$, $\lambda_A \neq \lambda_B$.
- (3) Third, there are real differences between preference and scale parameters of the two samples, i.e. $\lambda_A\beta_A \neq \lambda_B\beta_B$ (SWAIT AND LOUVIERE, 1993, p. 307).

To identify potential differences in preferences for the urban (A = Graz) and rural hydropower project (B = Gratkorn), a sequential testing procedure is applied in line with SWAIT AND LOUVIERE (1993). In the first step, we test for differences in the preference parameter vector β by allowing for varying scale parameters λ between the two samples. Second, a test for scale parameter equality is performed. The latter test can only be conducted if the preference parameters are equal between the two samples, because the confoundedness of preference and scale parameters prevents the attribution of observed differences to parameter vector inequality and scale equality ($\beta_A \neq \beta_B$, $\lambda_A = \lambda_B$) or to both parameter and scale inequality ($\beta_A \neq \beta_B$, $\lambda_A \neq \lambda_B$; SWAIT AND LOUVIERE, 1993). We illustrate this test by comparing the two samples of this study.

In the first step, we start by estimating a separate mixed logit error component model for the two samples, which provides us with efficient estimates for $\lambda_A\beta_A$ and $\lambda_B\beta_B$ and a likelihood value for both samples. The scale parameter cannot be identified in any particular dataset, but the ratio of the scale parameter of one dataset relative to another can be identified. Due to this fact the scale parameter of sample A is normalized to $\lambda_A = 1$. This normalization implies that estimates of scale should be interpreted as relative scale parameters to sample A (i.e. λ_B/λ_A). A pooled model is then estimated across the two samples, which has the effect of imposing preference parameter equality ($\beta_{iA} = \beta_{iB}$).¹² A search procedure over a range of relative scale parameters is applied to estimate the combination of scale and (pooled) preference parameters providing the best model fit. At each possible relative scale parameter the data for sample B are rescaled such that a mixed logit model with error components can be estimated to obtain an estimate for β_i and an associated log likelihood value. After the best model fit has been identified, a chi-square test using the log likelihood (LL) of each estimated model can be used to test the difference in preference parameters for the attributes under the null hypothesis of equality between the two samples. The standard chi-square distributed Likelihood Ratio (LR) test is as follows:

¹² Strictly speaking parameter equality also means that the alternative specific constants (ASC) are the same, i.e. $ASC_A = ASC_B$.

$$-2(LL^{pooled} - (LL^{Graz} + LL^{Gratkorn})) \text{ with d.f. } |\beta| - 1 \quad (3)$$

$|\beta|$ is thereby the number of imposed parameter restrictions. If the LR test concludes that preference parameters are equal across the two samples, it is then possible to test for differences in scale parameters. This second step of the test procedure requires the estimation of a mixed logit error component model for the same pooled sample as in step 1, but with equality imposed on both preference and scale parameters this time ($\beta_{iA} = \beta_{iB}$ and $\lambda_A = \lambda_B$). Again a LR test can be applied to compare the log likelihood of the estimated model to the log likelihood of the pooled model with varying scale parameters:

$$-2(LL^{equalscale} - (LL^{pooled})) \text{ with d.f. } 1 \quad (4)$$

A rejection of the null hypothesis would imply that the scale parameters of the two samples are different (BROUWER ET AL., 2010, p. 97 f). Due to the fact that the scale parameter is inversely related to the variance of the error term¹³ (SWAIT AND LOUVIERE, 1993, p. 305), an increasing scale would indicate that choice behaviour becomes less random because of reductions in preference uncertainty.

The results of the test procedure described above are illustrated in Table 4. NLOGIT 4.0 econometric software was used to perform the test. As already mentioned before, sample A refers to the urban hydropower project Graz-Puntigam and sample B to the rural project Gratkorn. In the first step we tested whether preference parameters β are equal between the two samples. The likelihood ratio test revealed that the preference parameters of sample A (Graz) and B (Gratkorn) are statistically significant different from each other, i.e. the null hypothesis (H_0) of preference parameter equality can be rejected at the 1 %-level. The second step of the sequential testing procedure, namely the test for scale parameter equality cannot be performed due to the rejection of the null hypothesis in step 1. Thus we can conclude that the models are different but we cannot attribute this difference to preference or scale parameter inequality. As a consequence the two samples are considered separately in the following remarks. It would not be appropriate to estimate the model on the pooled data set.

¹³ This relation is given by the following equation: $\sigma^2 = \frac{\pi^2}{6(\lambda)^2}$

Table 4: Procedural test results for preference and scale parameter equality

<i>Test procedure</i>	<i>Result</i>
LL Graz (sample A)	-876.465
LL Gratkorn (sample B)	-873.625
LL pooled sample ¹⁴	-1761.993
LR-test – test-statistic (9 df)	23.805
LR-test – <i>p-value</i> (9 df)	0.005
Relative scale (λ_B/λ_A)	1.030
Relative variance (σ_B^2/σ_A^2)	0.943
Reject $H_0: \beta_A = \beta_B?$	Yes

Source: Own calculations

5.2 Estimation results

The final best fit econometric model of this study has the following indirect utility form:

$$V_{in} = \alpha + \beta_1 \text{Households}_{in} + \beta_2 \text{Nature}_{in} + \beta_3 \text{Leisure}_{in} + \beta_4 \text{Cost}_{in} + \beta_5 \text{Payment} * \text{Cost} + \beta_6 \text{Donator} * \text{Nature} + \beta_7 \text{Age} + \varepsilon_{in} \quad (5)$$

In equation (5) α represents the alternative specific constant (ASC) and β_1 to β_4 refer to the coefficients related to the attributes of the choice model, namely the number of households that can be provided with electricity from the new power station (Households), the impact on landscape and natural environment (Nature), the impact on recreational activities (Leisure) as well as the additional electricity payment per month (Cost). The attributes Households and Cost represent linear effects, while Nature and Leisure are dummy coded. The baseline category of Nature is small impact. In case of Leisure the base consists of no recreational activities. Furthermore two interaction terms were included in the choice model. The dummy variable payment indicates whether the electricity bill in the respondent's household is paid by another person¹⁵ and was interacted with the cost attribute. The variable Donator is also dummy coded and shows whether the respondent (or someone else in his or her household) is a donator to environmental organisations.¹⁶ Together with the nature attribute this variable represents the second interaction term. Finally Age was included in the econometric model as the only socio-demographic characteristic. No other socio-economic characteristics were found to be statistically significant. This includes household income which is usually a strong predictor of stated willingness to pay. A detailed description of the variables used in the econometric analysis can be found in the appendix.

¹⁴ Pooled mixed logit error component model allowing scale parameters to vary.

¹⁵ More precisely, the variable Payment takes the value 1 if another person in the respondent's household pays the electricity bill and 0 if the respondent pays.

¹⁶ The variable Donator equals 1 if the respondent or someone else in his household is a donator to environmental organisations and 0 if this is not the case.

First in a set of models not presented here a variety of variables including sociodemographic characteristics like sex, income or education level as well as interaction terms between these characteristics and choice attributes were included in the model specification. However, these variables did not show up to be statistically significant in the estimated models. The statistically best fit models are presented in Table 5.¹⁷ For each sample the results of a standard multinomial logit model as well as the model estimates of a mixed logit with error components are reported below. Looking at the multinomial logit estimates all coefficients are indeed significant at least at the 5 % confidence level and have the expected signs but ignore so-called taste differences, which are captured by the mixed logit model. As can be seen from Table 5 the derived standard deviations of random parameter distributions are all statistically significant at least at the 10 %-level. The presence of significant parameter standard deviations indicates the presence of preference heterogeneity in the sampled population (HENSHER AND GREENE, 2002). Hence the mixed logit error components model is more appropriate than a standard multinomial logit model in both samples.

Looking at the mixed logit model estimates it can be seen that the coefficients of the four choice attributes, the interaction terms and age have the expected signs and are all statistically significant. The alternative specific constant (ASC) can be interpreted similarly to the constant in a regression model and represents on average the effect of all factors that are not included in the model (HENSHER ET AL., 2005; TRAIN, 2003). Thus the positive ASC in both samples indicates 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 attributes *households* and *leisure* have positive signs which imply that respondents have preferences for alternatives where more households can be supplied with electricity by the new hydropower stations and where leisure activities are possible. In contrast, alternatives with a strong impact on landscape and natural environment are less preferred compared to those with only a small or no impact. This relationship is captured by the negative sign of the coefficient on the attribute nature. Furthermore 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. The negative sign of the cost attribute indicates that respondents prefer lower electricity bills. However, if the electricity bill is not paid by the respondent himself but instead by another household member the negative effect of cost diminishes suggesting lower price sensitivity. Finally, older people are less willing to choose one of the hydropower plant options. Instead they rather tend to choose the opt-out alternative.

Although we know from the split sample test in the previous section that preferences differ, the estimated coefficients in Table 5 cannot be compared directly because preference and scale parameters are confounded.

¹⁷ NLOGIT 4.0 econometric software was used to estimate the models.

Table 5: Model estimates

<i>Variable</i>	Graz-Puntigam		Gratkorn	
	<i>Multinomial Logit</i>	<i>Mixed Logit Error Comps.</i>	<i>Multinomial Logit</i>	<i>Mixed Logit Error Comps.</i>
ASC	1.972*** (0.000)	3.537*** (0.000)	1.931*** (0.000)	3.265*** (0.000)
Households	0.035*** (0.002)	0.055*** (0.001)	0.074*** (0.000)	0.106*** (0.000)
Nature impact strong	-1.339*** (0.000)	-2.405*** (0.000)	-1.722*** (0.000)	-3.494*** (0.000)
Leisure activities extended	0.646*** (0.000)	1.040*** (0.000)	0.574*** (0.000)	0.929*** (0.000)
Cost	-0.150*** (0.000)	-0.253*** (0.000)	-0.137*** (0.000)	-0.219*** (0.000)
Donator*Nature	-0.529*** (0.007)	-1.445*** (0.004)	-0.930*** (0.000)	-1.349*** (0.007)
Payment*Cost	0.027** (0.045)	0.059** (0.029)	0.035** (0.010)	0.083*** (0.000)
Age	-0.017*** (0.000)	-0.026* (0.070)	-0.027*** (0.000)	-0.042*** (0.003)
Std. dev. Households		0.087*** (0.001)		0.054* (0.099)
Std. dev. Nature		3.772*** (0.000)		4.261*** (0.000)
Std. dev. Leisure		1.767*** (0.000)		0.953** (0.021)
Std. dev. random effects (error component)		2.309*** (0.000)		2.186*** (0.000)
Log likelihood	-1,038.690	-868.042	-1,013.284	-859.802
McFadden Pseudo R ²		0.338		0.373
AIC	1.753	1.474	1.637	1.397
BIC	1.787	1.525	1.670	1.446
Number of respondents	199	199	208	208
Number of observations	1,194	1,194	1,248	1,248
p-values in parentheses				
***significant at 1% level	**significant at 5% level		*significant at 10% level	

5.3 Willingness to pay

In the next step we calculated for both samples implicit prices respectively willingness to pay estimates and the corresponding standard deviations (see Table 6).¹⁸ These values are based on a ceteris paribus assumption, that is, all other parameters are held constant except

¹⁸ In order to account for the given preference heterogeneity, implicit prices and the corresponding standard deviations have been estimated by calculating the implicit price for each respondent and taking the mean and standard deviation of these simulations. This approach is in line with HENSHER ET AL., 2005, p. 686 ff.

the attribute for which the implicit price is being calculated. As can be seen from Table 6, the willingness to pay estimates for the three choice attributes differ substantially between the two samples except for leisure activities. First, respondents of the Graz sample are willing to pay around € 0.25 on top of their monthly electricity bill for the supply of 1,000 additional households with electricity from the hydropower plant. In the other sample by contrast the willingness to pay is much higher and amounts to € 0.42 per 1,000 households.

The implicit price for the nature attribute is negative, reflecting the fact that people do not desire alternatives with a strong environmental impact. Negative values of WTP imply a reduction in utility. So, WTP decreases with a strong impact on the landscape and natural environment. Negative WTP is much lower in one sample compared to the other. Thus when referring to the urban hydropower project Graz peoples' WTP amounts to € -9.8 per month. Conversely in the other sample which regards to the planned hydropower station Gratkorn, WTP decreases by € 15.4 per month with a strong environmental impact. Moreover it can be seen, that in both samples the negative willingness to pay for a strong impact on the environment fluctuates substantially around its mean with a standard deviation of 3.9 resp. 6.3.

However, we cannot say anything with certainty about the reasons for these WTP differences. No significant indications were found in respondents' attitudes towards the new hydropower plants that can help to explain the considerable WTP differences. Instead we can only make assumptions about the significant difference in WTP for the nature and landscape attribute. First, the high negative WTP in the sample referring to the Gratkorn project may reflect the fact that due to the already existing hydropower plants people value a further environmental intervention more negatively compared to the location of Graz where there are no existing hydropower plants. Second, we can argue the other way round. In the city centre of Graz, where the project Graz-Puntigam is planned to be built, the river Mur is already heavily modified. Thus, the strong environmental impact is not valued as negatively as in the case of the hydropower project Gratkorn, which is planned in a rural area where the Mur is still less modified and in a near-natural state. However, there may be other confounding and uncontrollable factors playing a role in explaining the differences in respondents' preferences.

Finally respondents' willingness to pay for the creation of new possibilities for recreational activities does not differ between the two samples. It amounts to € 4.2 per month, whereas the standard deviation of the sample referring to Graz is slightly higher compared to the other sample.¹⁹

¹⁹ Statistically significant differences between WTP estimates can be tested by looking at the confidence intervals. For the household and nature attributes the corresponding 95 % confidence intervals do not overlap. So WTP is significantly different between the two samples. In contrast, the confidence intervals of leisure activities overlap underpinning our conclusion that WTP for recreational activities does not differ.

Table 6: Estimates of implicit prices (willingness to pay)

Variable	Measurement	Graz-Puntigam	Gratkorn
Households	per 1,000 households	€ 0.246 (€ 0.088)	€ 0.415 (€ 0.180)
Nature impact	from small to strong	€ -9.811 (€ 3.896)	€ -15.432 (€ 6.297)
Leisure activities	from no recreation to recreation	€ 4.200 (€ 0.971)	€ 4.206 (€ 0.787)

Standard deviations in parentheses

5.4 Welfare analysis

Although implicit prices (i.e. marginal willingness to pay) are useful to policy makers, they do not represent valid welfare measures to be used for instance in Cost-Benefit-Analysis (CBA). In order to estimate overall willingness to pay for different combinations of attribute levels (policy scenarios) we included the alternative specific constant (ASC). The ASC captures systematic but unobserved information of not choosing the opt-out alternative and is therefore unrelated to the choice set attributes (BENNETT AND BLAMEY, 2001).²⁰

Based on the statistically best fit models presented in section 5.2, a number of policy scenarios were simulated and their welfare implications estimated, changing the attribute levels simultaneously. Generally, the assessment of economic welfare involves the investigation of utility differences associated with a baseline alternative compared to some other alternative. Accordingly, the economic or compensating surplus (CS) can be written as follows (BENNETT AND BLAMEY, 2001):

$$CS = -\frac{1}{\beta_{cost}}(V_1 - V_0) \quad (6)$$

where β_{cost} is interpreted as the marginal utility of income. V_0 and V_1 represent observed utility associated with linear combinations of attribute levels in the current situation and a new policy scenario respectively. Welfare values and the results of CS comparisons are therefore contingent on the scenarios chosen. Based on the statistically best fit models presented before, welfare measures for four different policy scenarios were calculated for each of the two hydropower projects.²¹ The outcomes are presented in Table 7.

²⁰ However, there is a lot of discussion whether the ASC should be included or not since it may represent a yea-saying problematic (KATARIA, 2009).

²¹ Similar to the calculation of implicit prices, the welfare measures were simulated for each respondent in order to account for random parameters, i.e. preference heterogeneity. Then means, standard deviations and the corresponding confidence intervals were drawn from these simulations.

Table 7: Estimates of welfare measures for different policy scenarios (per respondent/month)

Project Graz-Puntigam				
	Households	Nature/landscape	Recreation	Welfare (CS)
(1)	5,000	strong impact	no	€ 1.008 (0.117, 1.899)
(2)	20,000	small impact	yes	€ 18.173 (17.580, 18.765)
(3)	20,000	strong impact	yes	€ 8.520 (7.459, 9.581)
(4)	20,000	small impact	no	€ 14.013 (13.577, 14.449)
Project Gratkorn				
(1)	5,000	strong impact	no	€ -6.110 (-7.186, -5.033)
(2)	13,000	small impact	yes	€ 17.813 (17.622, 18.004)
(3)	13,000	strong impact	yes	€ 1.953 (0.867, 3.038)
(4)	13,000	small impact	no	€ 13.609 (13.468, 13.751)
95 % confidence intervals in parentheses				

Scenario (1) represents the “worst case scenario” with the same attribute levels in both samples and yields very low welfare measures amounting to € 1.0 per respondent and month in the Graz sample. In the sample referring to Gratkorn CS is even negative with a monthly value of € -6.1. The remaining policy scenarios differ by the number of households. According to the project plans, the hydropower plant Graz-Puntigam will be able to supply 20,000 households and the project in Gratkorn 13,000 households with green electricity. In order to generate realistic scenarios, these values were used in welfare analysis. Hence, the second scenario, which is an improvement of all attributes, is associated with an economic welfare of € 18.2 (Graz) respectively € 17.8 (Gratkorn). Starting from this scenario, a change of the environmental impact from small to strong is associated with a significant decrease in total economic welfare in both samples, whereas the welfare loss is significantly higher in the Gratkorn sample reflecting the fact that the loss of nature and landscape is valued more negatively. The effect of the creation of leisure activities can be shown by looking at scenarios (2) and (4) which indicate that CS increases by approximately € 4.2 when recreational activities are possible.

The estimated welfare measures shown in Table 7 were aggregated across the area of investigation (Graz and surrounding communities) using the number of households living in this area.²² Furthermore, CS measures were converted to yearly values. Due to the fact that we do not have any information about the preferences of non-responses, this part of the

²² Due to a lack of data, the number of households used to aggregate CS was calculated manually. The average household size in Graz and surroundings is 2.25 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 148,447 households.

population was assumed to have zero WTP in order not to overestimate economic welfare. First, the worst case scenarios yield a very low or even negative value of total economic surplus amounting to € 0.4 million (Graz) respectively € -2.4 million (Gratkorn). Going to the best case (scenario 2) welfare rises substantially in both samples. A strong environmental impact is associated with a welfare burden in the amount of € 3.8 million when referring to the hydropower project in Graz-Puntigam. In the Gratkorn sample, by contrast, a strong environmental impact causes a welfare loss of € 6.1 million. This can be seen from the comparison of scenarios (2) and (3). Finally, the creation of new possibilities for leisure activities is totally worth about € 1.6 million in both samples.

Table 8: Aggregation of welfare measures

Policy scenario	Graz	Gratkorn
(1) 5,000 households / strong impact / no recreation	€ 0.4 mill.	-
(2) 20,000 households / small impact / recreation	€ 7.1 mill.	-
(3) 20,000 households / strong impact / recreation	€ 3.3 mill.	-
(4) 20,000 households / small impact / no recreation	€ 5.5 mill.	-
(1) 5,000 households / strong impact / no recreation	-	€ -2.4 mill.
(2) 13,000 households / small impact / recreation	-	€ 6.9 mill.
(3) 13,000 households / strong impact / recreation	-	€ 0.8 mill.
(4) 13,000 households / small impact / no recreation	-	€ 5.2 mill.

The simple aggregation of the estimated CS across the population is often critical to arrive at a valid and reliable estimation of total economic surplus. As BATEMAN ET AL. (2006) points out, the aggregated total economic surplus can differ enormously depending on area size and population density. However, in this paper we consider a quite small geographical area consisting of only one city (Graz) and its suburbs. Furthermore we were not able to detect a distance decay effect in the econometrical model. This may also be due to the fact that just a very limited geographical area is regarded. Hence, the aggregated CS estimates of this paper may represent a good approximation of overall economic surplus in the region of Graz.

6 Conclusions

The aim of this paper was to explore the various costs and benefits of new hydropower installations in Styria (Austria). Thereby an important issue was to examine preference differences between an urban hydropower project (Graz) and a rural one (Gratkorn). The main question to answer was whether people have in general a positive attitude towards the construction of the new hydropower plants and how they value the costs and benefits of the new hydropower projects. Moreover it was tested for preference differences between the two projects. To answer these questions two random samples of people living in Graz and its surrounding communities were surveyed using a choice experiment.

First of all, in order to compare preferences between the two random samples it was necessary to reveal the scale parameter of one sample relative to the other. A two-stage test was used in accordance with SWAIT AND LOUVIERE (1993), which enabled us to detect differences in preference and/or scale parameters. According to the results of this test we concluded that peoples' preferences for the urban hydropower project differ from the individual preferences for the planned rural hydropower station. We therefore estimated two separate choice models. To account for given preference heterogeneity, we draw on the complex mixed logit error component estimation procedure. The main findings are as follows:

- All variables (choice attributes, interactions and sociodemographic characteristics) have a statistically significant impact on choice with the expected signs.
- Respondents have some propensity to vote for the construction of the new hydropower plant over the opt-out alternative (no hydropower plant). This propensity is approximately of the same magnitude in both samples.
- The supply of additional households with "green" electricity from the new hydropower plant is valued positively, although the marginal willingness to pay for the provision of 1,000 extra households is quite low and amounts to merely € 0.25 resp. € 0.42 monthly.
- Alternatives which create new possibilities for recreational activities are preferred over alternatives where leisure activities are not possible. Hence, people have a positive willingness to pay for power plant constructions with new possibilities for recreation. WTP amounts to € 4.2 and does not differ between the two samples.
- In principle people don't want the construction of hydropower stations which cause a strong impact on nature and landscape. Therefore WTP is negative in the amount of monthly € 9.8 when referring to the hydropower project Graz and € 15.4 for the project Gratkorn.

Finally we estimated overall willingness to pay (compensating surplus) for different combinations of attribute levels and aggregated these values across the population in the area of investigation, i.e. Graz and suburbs. Total economic surplus ranges between € -2.4 and € 7.1 million contingent on the policy scenario chosen. The effect of the environmental impact associated with a new hydropower plant on overall economic surplus is considerable. In combination with a quite low number of households able to be provided with green electricity and a restriction of recreational activities a strong environmental impact can even cause a negative economic surplus. Thus it is very important to hold the environmental impact of a new hydropower plant as small as possible.

To conclude, the results of this study can improve policy by reflecting what is important for the residents when building a new hydropower plant and what they want to avoid. Moreover the results provide information on the total economic surplus of different power plant alternatives. For further analysis it would be interesting to incorporate the results of this study in a comprehensive cost-benefit analysis in order to conclude if the benefits of the new hydropower plant exceed the associated costs. A comprehensive cost-benefit analysis must comprise in addition to the non-use values, which were subject of this study, also the sum of use values. Use values are for instance regional economic effects (e.g. employment effects) or

the value of the sold electricity from the new hydropower plant. Only such a broad consideration of costs and benefits can ensure to arrive at a valid conclusion whether a hydropower project is beneficial.

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Appendix

Variable	Description	Levels
Households	Number of households that can be provided with “green” electricity from the new hydropower plant.	5000, 10000, 15000 households
Nature and landscape	Impact of the new hydropower plant on the landscape and the natural environment.	<p><i>Small impact:</i> The new hydropower station will be built in a way that the landscape and the habitats of water-dependent flora and fauna are only slightly affected. All necessary measures (beyond the given standards of the WFD) in order to minimize the impact on landscape and environment are adopted.</p> <p><i>Strong impact:</i> The new hydropower plant strongly affects the landscape and the habitats of water-dependent flora and fauna. Only the minimum requirements predetermined by the WFD are fulfilled.</p>
Recreational activities	Creation of new possibilities for recreation.	<p><i>Yes:</i> As part of the power plant construction a recreational area providing a lot of opportunities for various leisure activities like biking, boat trips or canoeing is created.</p> <p><i>No:</i> The altered riverscape caused by the construction of the new hydropower station cannot be used as a recreational area for the people living near the power plant location.</p>
Cost	Increase in the respondent’s monthly electricity bill.	€ 3, 6, 9, 12, 15, 18
Donator	The respondent or someone else in his or her household is a donator to environmental organisations.	1 = yes, 0 = no
Payment	The respondent’s electricity bill is paid by another household member.	1 = yes, 0 = no
Age	Age of the respondent in years	metric scaled variable