Exploring residents’ willingness to pay for renewable energy supply:
Evidences from an Italian case study

Gianluca Grilli¹²*, Jessica Balest¹, Giulia Garegnani¹, Alessandro Paletto³

¹* Eurac Research – Institute for renewable energy, Drususallee 1, 39100 Bolzano (Italy); Corresponding author: gianluca.grilli@eurac.edu
² Department of environmental, civil and mechanical engineering, University of Trento, via Mesiano 77, 38123 Trento (Italy)
³ Council for Agricultural Research and Economics, Forest Monitoring and Planning Research Unit (CREA-MPF), p.za Nicolini 6, 38123 Trento (Italy)

Abstract: The present study offers a Contingent Valuation application to explore residents’ willingness to pay for renewable energy supply in a case study in the Italian Alps. Data were originated from onsite personal interviews and were analyzed with a Tobit model. Results show that respondents are willing to pay, on average, 5.1€ per month for a 100% of renewable energy supply, corresponding approximately to a 13% increase in the energy bill. Among the factors positively affecting the answers, the personal knowledge about renewable energy plays a key role in predicting WTP, as well as income and the personal perception of a possible future development of hydropower plants. On the other hand, age and number of household components negatively affect WTP.

Keywords: Renewable energy, willingness to pay, contingent valuation, Tobit model, Italian Alps, recharge.green

Introduction

Renewable energies (REs) are nowadays gaining more and more importance, in order to contrast and mitigate climate change, in particular after the introduction of the Kyoto Protocol in 1997. Through such Protocol, states were obliged to decrease the national greenhouse gases (GHG) emissions and bring them back to the 1990 levels. The energy sector plays an important role within this context, being one of the major sources of air pollution (Prakash and Bhat 2009). A shift towards greener and more sustainable energy is mandatory to fulfill the Kyoto Protocol objectives. Particularly, the European Union (EU) has tried to address to this challenge with the introduction of the so called 20-20-20 Directive...
(Renewable Energy Directive 2009/28/EC), foreseeing some binding target that all the member states should achieve. Renewable Energy Directive obliges the EU member states to reduce by 20% the GHG emissions, enhancing the share of RE up to 20% and increase the energy efficiency by 20% within the year 2020. With regard to the increase in the share of RE, it has to be known that such a strategy will have positive effects for the air pollution, but may also have a negative impact on the environment (Hastik et al. 2015). Different energy sources have different impact on the environment and have to be accurately planned, in order not to damage the ecosystems. In fragile areas, such as the Alpine environment, the drawbacks of producing RE may be even higher, especially due to the uniqueness of the landscape, which is likely to be damaged as new power plants are created (del Río and Burguillo 2009). Usually, local residents are quite skeptical about the enhancement and construction of new power plants and they make opposition to any development project in this sense (Diakoulaki and Karangelis 2007). To help decision-makers and avoid conflicts, it is important to understand stakeholders’ attitude towards RE during the planning phase; within this context it is very useful for decision-makers to collect information about social acceptability of plans and programs (Zoellner, Schweizer-Ries, and Wemheuer 2008). From the perspective of the economics science, people’s willingness to pay (WTP) for a particular program is an important indicator to be explored, because it is thought to be a good proxy of their level of acceptance of the project itself.

This paper explores residents’ attitudes towards RE by eliciting their WTP for a 100% of energy supply from RE, by means of a Contingent Valuation (CV) application. The study aims at understanding people’s perception about the benefits that the increase in RE may create and their WTP for funding a RE project. CV is a non-market valuation method that tries to derive the value of a non-marketed good by observing the behavior of respondents in a hypothetical scenario (Mitchell and Carson 1989). The application is tested in a study area in the Italian Alps, namely the valleys of Gesso and Vermenagna, which is a pilot area of the recharge.green project (Svadlenak-Gomez et al. 2014), within which this study is carried out. The recharge.green partners are designing a Decision Support System (DSS), called r.green, whose objective is the estimation of the RE potential of the area (Garegnani et al. 2015), focusing on wind power, forest bioenergy, hydropower and ground-mounted solar photovoltaic. Starting from the local energy demand, the DSS shows what is the most effective RE portfolio to supply for such demand. Gesso and Verme nga valleys are low-density populated and characterized by a constant migration of inhabitants towards more productive areas, due to the lack of job opportunities and the remoteness of the location. Local dwellers, nowadays, rely upon tourism and primary sector-related activities, while industry is not developed, as in many mountain areas. The exploitation of natural resources for
producing RE, in such a context, may be extremely beneficial for increasing local income and, at the same time, increase the share of RE. On the other hand, the two valleys already host big hydropower plants, which negatively affect the beauty of the alpine landscape. Enhancing the RE production means creating new power plants, thus increasing the pressure on the ecosystems and lowering even more the visual appeal of the region. In addition, a large part of the study area is under a protection regime, being included in the Marittime Alps Natural Park, so the exploitation of resources is subject to several conservation limits. This is a typical trade-off situation (Burgess et al. 2012), in which on one side the possibility to increase local income through RE seems to be convenient; on the other side, people could be worried about the negative consequences that further exploitation may produce on tourism and the environment. Which of the two phenomenons prevails is uncertain. In the literature, there are some examples in which the possibility of augmenting the number of power plants has been seen in a skeptical way by local inhabitants and others in which stakeholders accommodated such projects, for this reason additional studies in this field may be important and contribute with additional knowledge in such a controversial topic.

Materials and methods

Study area

Gesso-Vermenagna valleys are located in the north-western part of Italy (Piedmont Region), close to the Italian-French border. The study area includes seven municipalities. The land area is approximately 51,500 ha, out of which about 32,000 ha are located in protected areas (Maritime Alps Natural Park or Nature 2000 sites). According to official registers, the total population of the area is 10,000 inhabitants, but in practice the number of people permanently living in the territory is considerably smaller. The main land uses are forests (42 %) and pastures (33 %). Gesso-Vermenagna valley is a mountainous area mainly based on the primary sector (about 22 % of total firms), while the secondary sector (industry) is poorly developed. The services sector is based on tourism with an average of 121,000 visitors per year. The Gesso valley hosts the biggest Italian hydropower plant, with an installed capacity of 1.3 GW, together with other smaller plants all around the valley. Other sources of energy are not developed and forest wood is used for energy only for domestic uses. Concerning consumptions, the thermal energy demand of the households is around 15 MWh/year per household.

Conceptual framework
In order to understand people’s attitude towards RE and to anticipate their behavior in case of new power plants, we investigated citizens’ willingness to pay (WTP) for RE though the Contingent Valuation (CV) method. CV is a famous and broadly applied non-market valuation technique (Gios and Notaro 2001), based on stated preferences, through which it is possible to price goods and services without a market (Bandara and Tisdell 2004; Hanemann 1994; Welsh and Poe 1998). CV method is implemented by creating a hypothetical scenario and a possible policy measure to achieve that scenario. By eliciting respondents’ WTP for the policy, it is possible to foresee respondents’ acceptability of the policy measure provided. From an economic perspective, the stated amount people that are willing to pay represent the compensative variation between the pre and post intervention (Hanley, Barbier, and Barbier 2009). Roughly speaking, the increased utility provided by the hypothesized 100% supply of RE fully compensate the disutility of the payment for the project and make the individual indifferent among the two alternatives (Eugene, Ejike, and Ezebilo 2011). The WTP for the proposed policy is defined by the following indirect utility function:

\[ v(p, y^0, e^0) = v(p, y^1 - WTP, e^1) \]

Where \( v(\cdot) \) is the indirect utility function, \( p \) is the price of all the consumed goods, \( y \) is the personal income and \( e \) is the RE share with (superscript 1) and without (superscript 0) the policy (\( e^1 > e^0 \)).

Data were collected by means of a semi-structured questionnaire, administrated face-to-face to a sample of inhabitants, randomly selected in the Gesso and Verrenagna valleys\(^1\). The pre-test highlighted the necessity of some small changes, mainly wordings and minor other adjustments. The questions did not change in the substance after the pre-test, so the answers collected in this step were included in the final computation. The questionnaire contained 27 questions organized in 4 thematic sections. The first section contained warm-up questions, to get respondents familiar with topic and help them focusing on their experience with RE and power plants (Chiabai 2001). The second section was aimed at gathering information about the perceived impacts that four RE sources have on ecosystem services: ground-mounted solar photovoltaic, wind power, hydro power and forest biomass for energy. Such sources were chosen because they are the focus of investigation of the cited recharge.green project. The third section contained the description of the hypothetical scenario and the WTP question,

\(^1\) The questionnaire was administrated by the authors of this paper. Particularly, Gianluca Grilli pre-tested the questionnaire to a small sample of respondents, while Jessica Balest administrated it to the final sample of respondents.
described in detail in the next sub-section. The forth section was aimed at collection the socio-demographic information of the respondents.

WTP question

In the present work, we hypothesized an energy supply at 100% coming from renewable sources. We asked people if they were willing to pay (and how much) something more in the energy bill for such new supply. We included cheap talk in order to provide respondents with as much information as possible about how to reach such RE supply (Fox and Hudson 2003; Mahieu, Riera, and Giergiczny 2012; Morrison and Brown 2009); in addition, cheap talks were useful to encourage respondents stating the real WTP level and obtaining reliable answers. The question format was a ladder of values (Horton et al. 2003; Meyerhoff and Liebe 2006), in which respondents had to think the amount they were willing to pay. The justification of the payment was the necessity of the municipalities to have new funds for increasing RE. Subsequently, the selected amounts were subdivided by the stated energy bill they are currently paying. This was made in order to derive a percentage of increase of the energy bill. Such a question is important for understanding the perceived importance of RE and, at the same time; investigate a system of compensation for the loss of environmental quality due to RE increase. Such compensation will be discussed later.

Econometric analysis

In CV method studies, ordinary least square (OLS) and Tobit (Tobin 1958) regressions are the most implemented models to explore WTP with open-ended or ladder format (Ezebilo et al. 2015). Our analyses started with both models, and then the Tobit model was chosen to continue the statistical modeling of the WTP. Censored regression, such as Tobit, is capable to better address the CV method data with many zeros, which are typical in such studies (Yoo, Kim, and Lee 2001). Tobit is an econometric model in which the dependent variable is censored, i.e. there is an upper or lower limit. In the case of WTP the model is usually censored at 0. WTP for the individual \(i\) can be expressed, assuming a continuous and quasi-concave utility function, as a function of individuals’ characteristics:

\[
WTP_i = \beta x_i + \epsilon_i
\]

Where \(x_i\) is a vector of personal characteristics, beta the parameters to be estimated and \(\epsilon_i\) the error component. The Tobit model can be defined as:

\[
y^* = \beta x_i + \epsilon_i
\]
Where \( y^* \) is the latent (unobservable) variable for WTP\( i \), \( x_i \) a vector of individual characteristics and \( \varepsilon_i \sim N(0, \sigma^2) \). The observed counterpart for \( y_i^* \), called \( y_i \), is:

\[
\begin{align*}
  y_i = y_i^* & \quad \text{if } y_i^* > 0 \\
  y_i = 0 & \quad \text{otherwise}
\end{align*}
\]

The Tobit model is estimated through the maximum likelihood. The dependent variables used for the estimation of the model, together with some descriptive statistics and expected signs, are listed in Table 1. The variable labeled “know” represents the personal knowledge on RE. In order to elicit such knowledge, we asked respondents to state whether they did or not one or more activities connected with RE in the past two years. The activities were: participation to public meetings, education connected with RE, readings on magazines or newspapers, participation to meetings of environmental associations, work in the field of RE, watching television documentaries or newscasts, discussion with relatives or friends on RE. Each activity had a score based on the importance of the activity for information; the individual score was given by the sum of the scores obtained in each activity. The expected sign of such variable is positive, because it is assumed that the more a person is interested in RE and the more he is willing to increase the share of renewable production. “Hydro_fut” and “bio_fut” represent the personal perception about the possibility to further develop hydropower and forest biomass for energy, respectively. We decided to focus on these two sources of RE because they are the ones most likely to be developed in the area. Other sources, such as wind power or solar photovoltaic, are subject to many constrains for the protection regimes and the landscape constrains. As already stated in the introduction, the expected sign for these two variables is ambiguous, because it is not certain a priori if the environmental or economic considerations prevail.

| Variable  | Description                                    | Mean | Max | Min | Expected sign |
|-----------|------------------------------------------------|------|-----|-----|---------------|
| Know      | Personal knowledge on RE (continuous)          | 8.65 | 22  | 0   | +             |
| Hydro_fut | Perceived possibility to further develop hydropower | 2.28 | 4   | 0   | +/-           |
| Bio_fut   | Perceived possibility to further develop forest biomass for energy | 2.94 | 4   | 0   | +/-           |
| gender    | 0 = female 1 = male                            | .26  | 1   | 0   | +             |
| age       | 0 = <30                                        | 3.1  | 4   | 0   | -             |

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The other variables included in the model were related to the personal characteristics of the respondents, such as gender, age, number of people in the household, membership of an environmental association and personal income.

During the statistical analysis, we controlled for the subsistence of the basic assumption of the Tobit model, in particular we investigated whether the residuals were normally distributed and homoscedastic (Greene 2003). The normality of the residuals was investigated graphically by the kernel density distribution. Due to the presence of some heteroscedasticity, it was used the sandwich estimator to derive robust standard errors (Angrist and Pischke 2008). The adoption of robust standard errors contributed to a better fit and a higher significance of the estimated parameters. It was also checked the presence of multicollinearity (i.e. linearly dependent variables), which may lead to biased parameter estimates (Farrar and Glauber 1967), by calculating the variance inflation factor (VIF). Typically, a VIF higher than 10 require further investigation, being an index of severe multicollinearity. The VIF for the included independent variables did not exceed 4.71, meaning that multicollinearity is not a serious problem for the model.

**Results and discussions**

Out of the 83 collected questionnaires, only 74 were compiled enough to be useful for the analysis. Despite the number of respondents is not so big, the valleys are very low-density populated and it is difficult to achieve higher number of respondents. We then had to eliminate 6 protesters who declared 0 WTP because they did not want other power plants in their territories. These respondents were assumed to be lead by a sort of NIMBY syndrome (Bell et al. 2005, Van der Horst 2007) during their decision-making process, so they were excluded from the sample. The final number of observations was...
Respondents declared an average WTP of 5.2€ per month (13% more, on average, in their energy bill) for receiving an energy provision from renewable sources. Among the personal characteristics that influenced this result, it can be seen that the personal knowledge and interest towards renewables positively affects WTP. This is reasonable because people who actively acquire information in the RE field should be more sensitive towards the topic and, in general, towards environmental consciousness. The expected possibility to further develop hydropower plants in the valleys is positively correlated to the WTP as well. The expected possibility to develop forest biomass for energy purposes has also a positive coefficient, but it is not statistically significant at 95% confidence level. On the other hand, the older people are and the less likely would be willing to pay for RE; in fact, age is negatively correlated to WTP. Similarly, the bigger the household and the less likely people would pay. This is maybe because as the number of people in the household increase, the energy bill increases, thus making people less positive towards additional expenses. Gender of the respondents seems to be not important for describing WTP, since the coefficient is not statistically different from 0. This result suggest equality of preferences for RE between male and female. Finally, income is positively correlated to WTP, as expected. The positive relationship between income and WTP is highlighted in the literature, because the more people earn and the more are willing to pay for enhancing the environmental quality.

| Variable  | Coefficient | t-statistic |
|-----------|-------------|-------------|
| Know      | 0.011       | 2.19**      |
|           | (0.005)     |             |
| Hydro_fut | 0.042       | 1.88*       |
|           | (0.022)     |             |
| Bio_fut   | 0.021       | 0.75        |
|           | (0.027)     |             |
| gender    | 0.017       | 0.27        |
|           | (0.064)     |             |
| age       | -0.044      | -2.53***    |
|           | (0.017)     |             |
| household | -0.047      | -2.37**     |
|           | (0.020)     |             |
| Env_ass   | -0.036      | -0.52       |
|           | (0.068)     |             |
| income    | 0.046       | 1.72*       |
|           | (0.026)     |             |

N 68
-Log-Likelihood 10.37
F(8, 60) 3.64
In general, the positive WTP is an index of a positive public acceptance of RE (Zografakis et al. 2010). Such positive attitude could be explained by the fact that nowadays there are several limits to the exploitation of natural resources, because of the conservation regime affecting approximately one third of the territory. People may have the intuition that the use of natural resources for energy is one of the few opportunities they have to increase incomes and attenuate the tendency to emigrate from the valleys. Evidences of positive attitudes towards RE and positive WTP are available in other studies. As an example, Longo, Markandya and Petrucci (2008) carried out a study in the city of Bath, finding that people were willing to pay for reducing GHG emissions and internalizing the externalities of electricity production. Similarly, United States consumers show positive WTP for green electricity (Roe et al. 2001).

In some cases, WTP for RE was found to be different based on the RE source, as highlighted by Borchers et al. (2007). Estimating the total welfare effect of the present study is quite difficult, because assessing the total affected population is a hard task. In fact, according to the official local registers, local population is around 10,000 inhabitants but, in practice, the number of people living in the area is considerably smaller. Even considering the total inhabitants from the national registers, and assuming an energy contract per household, we will have around 4,000 users, thus obtaining a total WTP for the area of around 20,800 €. Such figure is not enough to assure the construction of new power plants at regional scale, even in the present of incentives. The provided results are in line with Scarpa and Willis (2010), who investigated the WTP of British households for micro-generation technologies, finding a positive WTP but not enough for funding the capital costs of the project.

**Conclusion**

The present paper has investigated the public acceptance of RE development in an Italian case study, the Gesso and Vermenagna valleys, located in the Italian Alps. Results show that, although the topic seems to be controversial, people in the study area have a positive WTP for RE, thus indicating that a further development of power plants may be seen as an opportunity, rather than a menace to the environment. Probably, the fact that nowadays the population is decreasing and local opportunities for jobs are scarce are key factors for understanding the local acceptance of RE. The exploitation of resources for energy may represent a good strategy for the local development. Hydro power is currently exploited through big power plants, so a good strategy for limiting the negative visual impacts could be
to focus on small and micro power plants. Concerning the use of forest biomass for energy, the possibilities for further exploitation are manifold. In fact, most of the public forest is quite old and managed with the coppice treatment. Coppice is not good for high quality timber but, on the other hand, the yield for bioenergy is considerable. For this reason, managing forest with the aim of maximizing the energy output could be an effective strategy for the valorization of the local woodlands. The conservation regime of the Marittime Alps Natural Park may represent a limit to such development, because hydropower and harvesting biomass has a negative effect on local biodiversity and soil fertility. Hydropower should be effectively located to minimize the negative impact on the environment. At the same time, wood extraction should be accurately planned, in order not to run the risk of depleting local flora and fauna and maintaining the ecosystem resilience. A problem with the study is that the WTP of the target population, although being positive, is not enough to cover the investment costs of new power plants. This means that a hypothetical program of RE development could be partially funded by an increase in the energy bill; nevertheless public administration should be able to cover the expenses with different funding sources.

Acknowledgements

This study was conducted in the frame of the recharge.green project “Balancing Alpine Energy and Nature” (http://www.recharge-green.eu), which is carried out within the Alpine Space Programme, and is co-financed by the European Regional Development Fund. The author would like to thank Giorgio Curetti and the Alpi Marittime natural park for the help in the questionnaire administration.

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