Contingent Valuation of renewable energy innovations: vegetal biomass in Italy

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Abstract: Warming-up of the planet and scarcity of conventional energy resources has led to aim of reducing the consumption of fossil fuels and the development of innovative renewable technologies for energy production. However, innovations and investments in renewable energy can encounter resistance of local communities. This makes planning for the development of Renewable Energy Source-based power plants often very difficult. Against this background, we investigate the level of social consensus on and support of the development of an energy plant based on the use of vegetal biomass in Central Sardinia, Italy. The method adopted is Contingent Valuation. Estimates of ex-ante household Willingness To Pay are implemented, as they are important indicators of the social endorsement for the project development. Implications concerning consensus/disagreement on innovative technologies for sustainable energy production are discussed as perspectives of future research.

Keywords: Consensus building; Contingent Valuation; Energy planning; Multicriteria Analysis; Participation in planning; Renewable Energy Sources; Vegetal biomass.


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1 Introduction

Many countries are confronted with the crucial issue of translating the principles of sustainable development into actual policies and planning actions. According to the general claims of the well-known declarations renewed at the Johannesburg World Congress (Rio +10) (2002), a number of public and private administrative bodies are engaged in encouraging the adoption of innovative processes aimed at using local resources in the most efficient and reasonable way (Ottinger, 2005).

With reference to energy, a special focus is directed towards the development of processes where the use of traditional natural resources, like fossil fuels, is controlled, especially over their regeneration thresholds, in the perspective of their progressive reduction. In this direction, a variety of statements are undertaken: at the global level, the Kyoto protocol\(^1\) is established, while European green and white papers invite to sharp reduction of fossil fuels consumption.\(^2\) As an important result, research is currently directed to design operative production processes to meet the objective of increasing the endowment of local resources. This is accomplished by adopting alternative sources of energy. Among the Renewable Energy Sources (RES), biomass represents an expanding sector, which presents many advantages. In this perspective, domestic organic residues, a significant part of biomass, usually associated to the rise of management costs, may become an important source of revenues.

During the last 10 years, technological innovation has been tested and introduced gradually into energy conversion and many processes are nowadays available. Furthermore, the adoption of innovation may sometimes be difficult. Citizens, while acquainted with environmental risks stemming from the excessive consumption of fossil fuels, might consider the connected threats not so urgent. As a consequence, they would prefer to postpone the introduction of innovation in energy production. Decision-making concerning building innovative RES-based energy plants could be grounded on technical pre-evaluation, and on the assessment of the social feasibility of a project.

Against this background, we aim at investigating the level of consensus on the development of an energy plant based on the use of vegetal biomass in Central Sardinia, Italy. The method adopted is Contingent Valuation (CV), a stated preference method that allows the estimation of the ex ante Willingness to Pay (WTP) of households. In the case study at hand, the method is used with reference to the hypothetical introduction of an energy plant using vegetal biomass.
The organisation of the remainder of this article is as follows. In Section 2, the principles of biomass-based energy production and policy are introduced. In Section 3, these principles are discussed with respect to social consensus issues. In Section 4, the adopted method of CV is briefly explained. In Section 5, this method is applied to the assessment of the social feasibility of an energy plant in Central Sardinia, Italy and results are presented in Section 6. Section 7 offers a discussion and conclusions.

2 RES, biomass and biomass-based energy production

While in the literature, there is no agreement on a unique definition of RES, in this context the authors adopt the statement of the Second World Conference and Technologic Exhibition of Biomass for Energy, Industry and Climate Defence, held in Rome in 2004: any resources suitable for producing thermal or electric energy, that renovate with at least the same pace at which they are consumed for production (ETA and WIP, 2004). The term biomass, once adopted in biology to indicate the dry weight of the living matter, nowadays refers to a variety of materials. According to recent statements (ETA and WIP, 2004), biomass consists of organic vegetal and animal components mostly obtained from the harvest and processing of agricultural and forestry activities. The biomass most suitable for energy production consists of organic materials, which can be used directly as fuel or transformed into other substances that can be easily combusted in energy plants. The use of biomass for energy production does not imply any net increase of the quantity of CO₂ emitted during its life cycle, except for the emissions connected with other activities, such as transport and treatment. The calorific power of the biomass in weight terms is on average equal to one third of any other traditional energy source (ETA and WIP, 2004). Usually, biomass is divided into organic and energy crops, specifically planted to be converted into electric and thermal energy.

In this article, the authors refer to biomass obtained from vegetal organic matter and, in particular, from products and sub-products of arboreal, herbaceous and forestry cultivations. These are the result of a variety of cultivations (fruit-bearing, vines, olive, etc.); ordinary maintenance of forestry cultivations (dead branches); and of traditional forestry activities, such as periodic cut of the copse wood.

Vegetal biomass can be processed to produce bio-fuels, which can be adopted to produce energy very efficiently. The variety of conversion processes can be divided into three categories: bio-chemical, thermo-chemical and physical.

Biomass and its derivative fuels are used to produce energy according to three main patterns:

- production of thermal energy for heating and tele-heating residential and productive settlements
- production of electric energy through steam and gas turbines or internal combustion engines
- co-generation of thermal and electric energy through a unique integrated system.

Biomass is adopted differently depending upon the region of the Planet (ENEA, 2003). In developing countries, the energy yielded from biomass (around 1,074 million tonnes of oil equivalent per year – Mtoe per year) equals 38% of the total demand. In developed countries, it corresponds only to 3% of the energetic needs and is equal to around
156 Mtoe per year. In the USA, for example, the share of biomass-based energy is equal to 3.2% (70 Mtoe per year); in Europe, it equals on average 3.5% (around 40 Mtoe per year). Even though some European countries are leading examples in the use of biomass for energy production, on average in Europe the use of biomass is negligible with respect to other sources of primary energy.

According to the National Energetic Balance (2002), the ENEA (National Body for Energy and Environment, 2003) Italian biomass-based energy production is estimated to be equal to 1.9 Mtoe: 242 Ktoe of electric energy and 1,655 Ktoe of thermal energy. In Italy, biomass has a share equal to only 2%, which is much below the European average.

In Italy, 35 production plants are currently fuelled by biomass with an installed power, which amounts to 300 MW (ENEA, 2003).

According to a recent survey (Bosser-Peverelli, 2003) in Northern Italy, there are various types of vegetal biomass based energy production plants, ranging from small installations for home heating to big size plants able to deliver energy to entire urban districts or small villages.

The installations using biomass in Italy, belonging to the cluster of big size co-generation energy plants, show technical properties through which they contribute to the satisfaction of the energy demand of a population of around 10,000 people. As Table 1 highlights, big size plants may operate from 4 to 10 months a year, guarantee an electric power from 11 to 30 MWe, and consume an amount of vegetal biomass ranging from 30 to 450 thousand tonnes.

Table 1  Characteristics of big size cogeneration plants

<table>
<thead>
<tr>
<th>Technical characteristics</th>
<th>Values (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power installed</td>
<td>11–30 MWe</td>
</tr>
<tr>
<td>Yearly running time period</td>
<td>120–290 days</td>
</tr>
<tr>
<td>Fuel</td>
<td>Agricultural and forestry wastes, production reject,</td>
</tr>
<tr>
<td></td>
<td>rise chaff, chips and wood</td>
</tr>
<tr>
<td>Yearly fuel consumption</td>
<td>30,000–450,000 m³</td>
</tr>
<tr>
<td>Construction cost</td>
<td>9–13 MEuros</td>
</tr>
<tr>
<td>Yearly fuel cost</td>
<td>0.2–3.7 MEuros</td>
</tr>
<tr>
<td>Yearly fuel transportation cost</td>
<td>0.2–2.0 MEuros</td>
</tr>
<tr>
<td>Yearly average labour cost</td>
<td>0.3 MEuros</td>
</tr>
<tr>
<td>Other yearly operational costs</td>
<td>0.2 MEuros</td>
</tr>
</tbody>
</table>


3 Consensus building and energy policy: a case study in Sardinia, Italy

The technology for processing biomass and converting it into energy is currently available: power plants fuelled by vegetal biomass are installed in many European and Italian areas and are distributing thermal and electric energy for residential and productive settlements (Faaij, 2006).

Recent studies reveal that green-energy strategies have strong connections with the local sustainable development (Midilli, Dincer and Ay, 2006) and that local societies may play a key role in making such enterprises a success (Sinclair, 1998; Upreti, 2004). Local
people may disagree and try to prevent the realisation of these projects, especially when they feel they were not correctly and adequately informed about the advantages and disadvantages of them.

The management of processes affecting innovation-averse societies has been recently considered a major challenge in policy making and planning. Current communicative and negotiative planning practices can possibly help local communities to build consensus and solve conflicts (Healey, 1997; Innes, 1998; Forester, 1999). The local communities may show an attitude towards the prevention of innovative strategies as a kind of a NIMBY (the well-known Not In My Back Yard syndrome) barrier.

The case study presented in this article aims to illustrate some of the above mentioned problems. A recent study indicates that Sardinia, an insular region of Italy, shows a relevant endowment of vegetal biomass (De Montis et al., 2005). In the same study, spatial distribution of vegetal biomass is investigated: according to Geographic Information System-based calculations, the annual production of each municipality ranges from 3,600–300,000 m³ per year. This implies that a number of internal regions produce currently an amount of agricultural and forestry biomass that would satisfy the fuel demand of big size energy power plants.

This study examines the social feasibility analysis of an energy plant located in a Sardinian union of municipalities named ‘Comunità Montana del Barigadu-Alto Oristanese,’ which includes the following towns: Abbasanta, Aidomaggiore, Allai, Ardauli, Bidoni, Boroneddu, Busachi, Fordongianus, Ghilarza, Neoneli, Norbello, Nughedu SantaVittoria, Samugheo, Soddi and Ula Tirso. The details of the region are shown in Figure 1.

**Figure 1** Location of the union of municipalities named ‘Comunità Montana del Barigadu-Alto Oristanese’ in the region of Sardinia, Italy (see online version for colours)
The plant designed belongs to the set of big size co-generation plants, whose technical characteristics are described in Table 1. According to De Montis et al. (2005) the union of municipalities shows a total annual production of vegetal biomass approximately equal to 230,000 m$^3$. Nowadays, agricultural and forestry residuals produced in the region are not projected to enter into any permanent recycling process and represent a relevant environmental management problem. The development of the proposed project implies activities for biomass management that can be articulated into five main phases: harvesting, transporting and stocking, pre-treatment, conversion and distribution. Each phase implies a positive impact on direct and indirect employment and income, as shown in Table 2.

<table>
<thead>
<tr>
<th>Phases</th>
<th>Direct income (thousand Euros)</th>
<th>Indirect income (thousand Euros)</th>
<th>Direct employment</th>
<th>Indirect employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvesting</td>
<td>1,500</td>
<td>1,500</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Stocking</td>
<td>600</td>
<td>600</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Pre-treatment</td>
<td>300</td>
<td>300</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Conversion</td>
<td>300</td>
<td>300</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Distribution</td>
<td>300</td>
<td>300</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>2,700</td>
<td>2,700</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

4 Methodology

The CV method is a favourite tool of regional and urban economists. CV case studies, which are based on people’s expressed thoughts and convictions, quantitatively assess the degree of consensus in terms of people’s WTP for some public good. It is commonly used in the context of environmental goods. Bishop’s and Heberlein’s (1979) article is among the earliest and most important ones in this area. Other important articles in this area are Sellar et al. (1985), León (1995) and Kerr (2000). In these articles, standard statistical and sampling techniques are used to infer the probability that a representative consumer be willing to pay some nominated amount to ensure that an environmental good be made available.

Generally, the CV approach is preferred over the hedonic approach for evaluating people’s WTP for public goods. As Cropper and Oates (1992) point out, the CV approach has been mainly designed to estimate the values of amenities in terms of expressed WTP, while the hedonic methodologies aim at estimating the values of amenities through the housing and labour markets. According to León (1995), an important reason why the CV approach is generally more attractive is that it relies on responses to a questionnaire, and thus does not require data on housing and labour markets. This is a solid argument for preferring CV to hedonic approach for evaluating benefits from environmental goods in Italy, since detailed and standardised territorial information systems and databases regarding the housing and labour markets are not available.
In this essay, a CV case study is presented based on the method of Dichotomous Choice (DC). The implementation of the DC technique requires that people included in a random sample first be asked if they would be willing to pay a fixed monetary sum typically in the form of a lump-sum tax for the outcomes associated with a particular planning policy.

Let \( j \) be a discrete variable that equals 1 if the outcomes of a particular planning policy are realised and equals 0 otherwise. Let \( Y \) be the household income of an individual and let \( S \) be vector of social characteristics of that individual. Let \( U \) denote an individual’s actual utility and \( V \) denote the individual’s expected utility. Then, an individual’s utility over a given outcome with household income \( Y \) and social characteristics \( S \) equals his expected utility associated with that outcome plus an error term. Namely,

\[
U(j, Y; S) = V(j, Y; S) + \epsilon_j, \quad j = 0, 1.
\]  

(1)

If a person answers affirmatively to the first question, then it must be that

\[
U(1, Y - \Phi; S) \geq U(0, Y; S)
\]  

(2)

and

\[
V(1, Y - \Phi; S) + \epsilon_1 \geq V(0, Y; S) + \epsilon_0,
\]  

(3)

where \( \Phi \) is the lump-sum tax.

Denote the probability that an individual answers ‘yes’ to the first question by \( P_1 \). Then

\[
P_1 = \text{prob}[V(1, Y - \Phi; S) + \epsilon_1 \geq V(0, Y; S) + \epsilon_0] = \text{prob}(\epsilon_0 - \epsilon_1 \leq \Delta V) = F_r(\Delta V),
\]  

(4)

where \( \tau = \epsilon_0 - \epsilon_1 \) and \( \Delta V = V(1, Y - \Phi; S) - V(0, Y; S) \). The term \( F_r(\Delta V) \) is the probability that the difference in the errors is less than or equal to a number, the value of which is the difference in expected utility.

The literature assumes that the probability distribution is either normal, logistic or Weibull and that the derived model is either Probit, Logit or Weibit. Estimates implemented in this article assume the normal distribution and use a bivariate Probit model. Following León (1995), we specify the functional form for the difference in the expected utilities \( \Delta V \) as

\[
\Delta V(B) = \beta B + \alpha C.
\]  

(5)

In Equation (5), \( B \) is the bid or monetary amount, an interviewed person said that he would pay if he had answered yes. The bid, \( B \), is the vector of monetary fees from the first and second part of the interview. The vector of variables \( C \) is the income of the respondent’s household as well as the vector of social characteristics, \( S \). Finally, \( \beta \) and \( \alpha \) are the (vectors of) parameters whose values are to be determined in the CV method. The parameter \( \beta \) determines the elasticity of an individual’s expected utility given a lump-sum fee. In other words, 1% increase in the lump-sum fee, would decrease an individual’s expected utility by \( \beta \) percent.
Let $E$ denote an interviewed person’s WTP. A person’s WTP is the monetary amount for which $U(1, Y - E; s) = U(0, Y; s)$ and a person will answer yes in the questionnaire if and only if $E \geq B$. Let $G_E(B)$ be the probability that a person’s WTP is less than or equal to $B$. The probability that a person’s WTP is less than or equal to $B$ is one minus the probability that the individual will say yes to the questionnaire for a monetary fee of $B$, namely $1 - P_{1}$, or

\[ G_E(B) = 1 - F_E[\Delta V(B)] = 1 - \text{prob}(\Delta V \geq \tau). \]  

(6)

An individual’s WTP can be calculated as either the mean ($M$) of the probability density of $E$, denoted by $g_E$, or as the mean (MT) or median (MEDT) of the normalised probability density of $E$ truncated at $B=B_M$, denoted by $g_{EN}$. The mean of the probability density function is influenced more by the tails than the median. Both the mean and median of the normalised truncated distribution at $B=B_M$ are calculated with respect to the probability density function truncated at the maximum value that $E$ can take.\(^7\) The mean of the probability distribution of $E$, $M$ and the mean of the truncated distribution, MT, can be calculated directly from the following equations.

\[ M = \int_{-\infty}^{\infty} B g_E(B) dB = \int_{0}^{B_M} [1 - G_E(B)] dB - \int_{-\infty}^{0} G_E(B) dB, \]  

(7)

\[ \text{MT} = \int_{-\infty}^{B_M} B g_{EN}(B) dB = \int_{0}^{B_M} [1 - G_{EN}(B)] dB - \int_{-\infty}^{0} G_{EN}(B) dB \]

\[ = \int_{0}^{B_M} \left[ 1 - \frac{G_E(B)}{G_E(B_M)} \right] dB - \int_{-\infty}^{0} \frac{G_E(B)}{G_E(B_M)} dB \]

\[ = \int_{0}^{B_M} \frac{F_E[\Delta V(B)] - F_E[\Delta V(B_M)]}{1 - F_E[\Delta V(B_M)]} dB - \int_{-\infty}^{0} \frac{1 - F_E[\Delta V(B_M)]}{1 - F_E[\Delta V(B_M)]} dB. \]

(8)

In Equations (6)–(8), the variables of vector $C$ of model (5) take their sample mean values.

It is not possible to derive the reduced form equation for MEDT. However, MEDT is determined by the following equation.

\[ \frac{F_E[\Delta V(MEDT)]}{[1 - F_E(\Delta V(B_M))]^2} = 0.5. \]

(9)

The key to solving these moments is determining $\Delta V(B)$. Namely, it is first necessary to obtain estimates for the vector of parameters $\beta$ and $\alpha$ in Equation (5). For DC CV, this is done by solving the first order maximisation problem of the following likelihood function, $\log(L)$:

\[ \log(L) = \sum_{i} \left[ I_i \log[F_i(\Delta V(B_i))] + (1 - I_i) \log[1 - F_i(\Delta V(B_i))] \right]. \]

(10)

In Equation (10), $I_i = 1$ if $\Delta V(B) \geq \tau; I_i = 0$ if $\Delta V(B) < \tau$.

Empirical findings must be qualified with regard to potential distortions. Beyond the usual problems associated with the implementation of econometric models, there is the
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additional problem associated with the interview and questionnaires. Particular attention must be paid to the interviewed person’s disposition and attitude, and the nature of the interaction between the interviewer and the respondent (Carson, 1991).

5 Sampling method and questionnaires

A random sample of residents of the towns of Abbasanta, Aidomaggiore, Allai, Ardauli, Bidoni, Boroneddu, Busachi, Fordongianus, Ghilarza, Neoneli, Norbello, Nughedu Santa Vittoria, Samugheo, Soddi and Ula Tirso, was chosen by associating a random number to each name listed in the phone directory. This sample covered 150 people, of which 88 people were willing to cooperate. This means that the rate of cooperation was about 1 out of 1.7, which is an indication of a fairly good social reaction with respect to other analogous cases. Only 50 people explicitly refused to cooperate, while 12 people refused to cooperate when they were asked to answer a questionnaire during a second phone call, once they had accepted to cooperate in the first place. The original phone calls, which simply asked if the resident would be willing to participate in the survey, were made at different times of the day. One third were made between 7.30 and 9.00 a.m.; one third between 1.30 and 3.00 p.m.; the last third between 7.00 and 8.30 p.m. The rate of participation was almost constant in the three periods.

If the randomly selected person answered in the first phone call that he was willing to participate, then he or she was sent an envelope containing information on the energy plant project. The person was asked to read the report carefully. The report was the informational basis for answering the questionnaire that would have been administered through a second call, approximately two weeks after the first call. The report contained an informative note on the planning proposal. The report also contained a map showing the location of the most important planning actions entailed by the energy plant. The questionnaire was administered through a second call, instead of being sent through the mail for two reasons. Firstly, this procedure ensured that there would be separation in the time a person received the information and responded. Secondly, the interview allowed a person to clarify his doubts and misunderstandings that he may possibly have had on the information sent to him in the report. In this way, the procedure ensured that people who interviewed were informed on the goals of the planning proposal before responding to the questions.

Following the method proposed by Cooper (1993) a pre-test was implemented in order to establish the most suitable bids to be asked in the WTP question of the questionnaire. The pre-test was administered to a sample of 50 randomly selected people through two phone calls, with the same procedure described above. The pre-test results for the optimal number of bids was found to Equation (3), and the monetary values (in Euros) and the number of respondents associated with each of the three bids, were also determined. The bids are: 10–30. The corresponding per-bid number of people are: 20, 46 and 22.

The question for a person’s WTP is (two possible answers: ‘yes’ or ‘no’):

“In case the city administration needed funds for managing the project and realisation of a big size vegetal biomass-based energy plant, would you be willing to pay a contribution of 10/20/30 Euros in the form of an annual tax?”
6 Results

The responses from the questionnaire are the basis for the explanatory variables corresponding to the vector $C$ of model (5). The explanatory variables are defined in Table 3. The mean and SDs of the social characteristics are listed in Table 4, next to each explanatory variable name. The social characteristics of the sample are not significantly different from the social characteristics of the population of Arbus, as described in the 2001 census data.

Table 3 Variables used in the model

<table>
<thead>
<tr>
<th>Code</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>BID</td>
<td>Monetary bid, Euros</td>
</tr>
<tr>
<td>AGE</td>
<td>Age of the interviewed person</td>
</tr>
<tr>
<td>SEX</td>
<td>Dummy – sex of the interviewed person (1 if it is male)</td>
</tr>
<tr>
<td>FAM3</td>
<td>Dummy – three-people family</td>
</tr>
<tr>
<td>FAM4</td>
<td>Dummy – four-people family</td>
</tr>
<tr>
<td>FAM5</td>
<td>Dummy – five-or-more-people family</td>
</tr>
<tr>
<td>FAM-14</td>
<td>Dummy – people under the age of 14</td>
</tr>
<tr>
<td>EMPL</td>
<td>Dummy – white or blue collar, retailer, craftsman</td>
</tr>
<tr>
<td>PROF</td>
<td>Dummy – university professor, practitioner, executive, manager</td>
</tr>
<tr>
<td>RETIR</td>
<td>Dummy – retired person</td>
</tr>
<tr>
<td>GRAD</td>
<td>Dummy – university graduate</td>
</tr>
<tr>
<td>HISCH</td>
<td>Dummy – high school graduate</td>
</tr>
<tr>
<td>CONOSC</td>
<td>Dummy – people know about the problems the project addresses</td>
</tr>
<tr>
<td>INC2030</td>
<td>Dummy – annual household disposable income between 20,000 and 30,000 Euros</td>
</tr>
<tr>
<td>INC3050</td>
<td>Dummy – annual household disposable income between 30,000 and 50,000 Euros</td>
</tr>
<tr>
<td>INCNO</td>
<td>Dummy – no information about household disposable income</td>
</tr>
</tbody>
</table>

Table 4 Descriptive statistics on variables used in the probit model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>BID</td>
<td>20.22</td>
<td>10.22</td>
</tr>
<tr>
<td>AGE</td>
<td>51.95</td>
<td>3.78</td>
</tr>
<tr>
<td>SEX</td>
<td>0.40</td>
<td>0.35</td>
</tr>
<tr>
<td>FAM3</td>
<td>0.17</td>
<td>0.34</td>
</tr>
<tr>
<td>FAM4</td>
<td>0.43</td>
<td>0.46</td>
</tr>
<tr>
<td>FAM5</td>
<td>0.14</td>
<td>0.46</td>
</tr>
<tr>
<td>FAM-14</td>
<td>0.31</td>
<td>0.23</td>
</tr>
<tr>
<td>EMPL</td>
<td>0.22</td>
<td>0.41</td>
</tr>
<tr>
<td>PROF</td>
<td>0.19</td>
<td>0.46</td>
</tr>
<tr>
<td>RETIR</td>
<td>0.22</td>
<td>0.35</td>
</tr>
<tr>
<td>GRAD</td>
<td>0.06</td>
<td>0.40</td>
</tr>
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<td>HISCH</td>
<td>0.31</td>
<td>0.42</td>
</tr>
<tr>
<td>CONOSC</td>
<td>0.70</td>
<td>0.30</td>
</tr>
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<td>INC2030</td>
<td>0.14</td>
<td>0.35</td>
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<td>INC3050</td>
<td>0.10</td>
<td>0.49</td>
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<tr>
<td>INCNO</td>
<td>0.14</td>
<td>0.38</td>
</tr>
</tbody>
</table>
WTP for the energy plant were estimated through the CV DC methodology discussed in Section 3. The explanatory variable of model (5), \( B \), is the bid derived from the pre-test. Estimates for the mean and median WTP are based on the ‘Probit’ procedure in the econometric program ‘Limdep’ developed by Greene (1995).

The bivariate probit model generates estimates for:

- coefficients of variables that maximise the likelihood function (10) given the cumulative probability distribution \( F_2(\Delta V) \) given by Equation (5)
- the differential marginal effect of \( B \) on a respondent’s WTP and the differential marginal effects of income and social characteristics \( C \) on a respondent’s WTP given by Equation (5).\(^8\)

In most cases, the marginal effects of \( B \) and \( C \) on a respondent’s WTP were significant at the 5% level (Table 5). The marginal effect of the bid is 0.023. Thus, if the respondent is told that he must pay one more Euro for the outcome of the energy plant to be realised, his WTP decreases by only 0.023 Euros. These numbers reveal that WTP is fairly inelastic with respect to the bid.

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Results of the probit model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
<td><strong>Marginal effect</strong></td>
</tr>
<tr>
<td>BID</td>
<td>0.023</td>
</tr>
<tr>
<td>AGE</td>
<td>0.001</td>
</tr>
<tr>
<td>SEX</td>
<td>0.611</td>
</tr>
<tr>
<td>FAM3</td>
<td>0.216</td>
</tr>
<tr>
<td>FAM4</td>
<td>0.580</td>
</tr>
<tr>
<td>FAM5</td>
<td>0.251</td>
</tr>
<tr>
<td>FAM-14</td>
<td>0.089</td>
</tr>
<tr>
<td>EMPL</td>
<td>0.763</td>
</tr>
<tr>
<td>PROF</td>
<td>1.020</td>
</tr>
<tr>
<td>RETIR</td>
<td>0.420</td>
</tr>
<tr>
<td>GRAD</td>
<td>-0.538</td>
</tr>
<tr>
<td>HISCH</td>
<td>0.307</td>
</tr>
<tr>
<td>CONOSC</td>
<td>0.491</td>
</tr>
<tr>
<td>INC2030</td>
<td>0.001</td>
</tr>
<tr>
<td>INC3050</td>
<td>0.122</td>
</tr>
<tr>
<td>INCNO</td>
<td>0.260</td>
</tr>
</tbody>
</table>

The estimates to the probit model imply that there is consensus among the planning proposal, since the mean and median values of WTP are greater than zero. More specifically, the per-household average or median WTP is roughly 47 Euros. As a consequence, total WTP for the union of municipalities, (which in 2001 had 7,041 households) is 330,350 Euros. Using an interest rate of 2.5%, the community’s WTP in present value terms calculated over a 50 year useful life period is 9.35 MEuros.
The generalised DC CV model estimated in this essay allows inferring information on the average WTP of the local communities about the potential effectiveness of the proposed energy planning policy. Indeed, it provides important insights on the policy implementation, by showing the influence of social key variables on the degree of consensus. The analysis developed indicates that the quality of information plays a key role in implementing precise assessments of communities’ attitudes towards projected planning policy, and in favouring public participation in the decisional processes.

This is entirely consistent with the observations of O’Doherty (1996) regarding the case of Northavon District, Bristol, UK. According to O’Doherty, the considerable potential of CV methods must be recognised both in the opportunity of policy assessments before implementation, and in the qualitative improvement of public participation in the decisional processes. However, a trade-off exists between CV performance and cost, since the greater the public participation in CV studies and the consequent qualitative improvement of the planning process, the more expensive the experiment in logistic, informational and financial incentive terms.

7 Discussion and conclusions

The community’s WTP constitutes a remarkable result, with respect to a total cost equal to a maximum of 13 M€uro: more than the 70% of the construction costs would be covered. It is worth discussing some issues, which imply open questions for future research.

Firstly, the calculated values of mean and median WTP indicate that the citizens of the 16 Sardinian towns are definitely in favour of the implementation of the project. However, the calculated use value may not be sufficient to cover the estimated costs; this means that the financial resources from the national and regional governments should integrate the potential financial flow generated by the use value of the local residents. Precise projections on these financial flows have not been implemented yet, but they should provide funds sufficient to cover the administrative and management costs.

Secondly, the estimated degree of consensus of the communities is significantly influenced by their household incomes: the upper limit of the average WTP is almost deterministically conditioned by the average household disposable income. An increase of income may occur especially in the long run, through a more suitable and efficient organisation of the energy production system.

The quality of urban living space and its components, which include energy production facilities, are intrinsically public goods, and, being so, the different levels of the public administration, and the national community, must cooperate to their production through their human and financial resources. In particular, public intervention should exploit a share of the national fiscal revenues to mitigate social and economic disparities, and to insure equity in development opportunities across the national territory. From this point of view, Sardinia and its regional urban structure need the implementation of economic and territorial planning policies directed towards compensation for their historical structural slowness of economic and social development, with respect to the fast-growing Northern and Central Italian regions. One of the main reasons of this slowness must certainly be recognised in the historical lack of adequate public investments in favour of the realignment of the productive capacity and standard of living with respect to the average national levels.
Thirdly, consensus assessment must take into account that the investment choices aimed at producing public goods must be primarily based on the political recognition of their implementation opportunity, and, secondarily, on the quantitative evaluation of average WTP of the local communities. Consensus evaluation techniques, such as the DC case study implemented in this article, are very effective to increase the level and quality of information of the local communities, and of the different levels of the public administration, on the impacts of the projected energy planning policies, and to favour feed-backs between the recognition of the political opportunity of such policies and the potential reaction of the affected population. Therefore, these techniques must be utilised as a suggestion and not to draw final decisions in deterministic terms.

Finally, the definition and implementation of the proposed energy plant are based on the principle, according to which the local communities have the right to enjoy an adequate urban standard of living, which is decisive in catalysing the local social and economic development. The historically built relationship between the local communities and environment in Central Sardinia has always allowed these communities to develop their urban organisation, so that it can express a peculiar structural harmony between human activities and active environmental protection. A sustainable energy production system helps significantly to maintain and strengthen this harmony. Evaluation methods of the local communities’ attitude towards environmental planning policies, such as CV methods, can help improving communication between planners and citizens. If discussion is made possible, agreement on some common goals, or at least on some common starting points, could be easier, and the economic value attributed to environmental resources by the local communities could be considered as a known condition of the game. Consensus evaluation should allow planners and policy-makers to forecast public participation and opposition, and, as a consequence, to estimate the probability of the effectiveness of the energy policies at stake.

Agreement on goals must help building a common strategy with the aim of finding resources to finance the implementation of urban and territorial projects and processes, which are particularly referred to energy production in the case study discussed so far.

As a consequence, an open planning process can be conceived as a patient construction of a space where a well-informed discussion can freely develop between the social territorial characters involved in a local context. This promising discussion is based on a common knowledge of the possible decisional alternatives and connected scenarios, and on the common goal of defining field agreements, that is, rules which are established to implement effectively planning policies through the spatial organisation of local contexts.

Acknowledgements

The authors are enormously grateful to Giuditta Depau who helped to administer the survey. This research activity has been partially funded by the Autonomous Region of Sardinia under the project ‘COMBALOS’.
References


**Notes**


5 For a basic discussion of these models, see Greene (1993).

6 Both Logit and Weibit models were investigated, and no differences in findings were found.

7 The maximum value for $E$ is first set at the highest value declared in the pre-test. One needs to check how the mean and median in the exercises change as the maximum value of $E$ asymptotically is increased to infinity. The truncation value does not matter to the results.

8 The differential marginal effect of $B$ on a respondent’s WTP and the differential marginal effects of income and social characteristics $C$ on a respondent’s WTP are calculated, using $\alpha$ and $\beta$, through the procedure described by Greene (1993, p.639, pp.643–647).
ANNEX 1

Questionnaire

1. Age________
2. Sex M F
3. How many people live in your family?
   3a. How many people are there younger than 14?
4. Job:
   blue collar employee;
   white collar employee;
   executive;
   retailer;
   craftsman;
   practitioner;
   manager;
   university professor;
   retired person.
5. Which is your education degree (university, college, high school, etc.)?
6. Did you think of the planning issues concerning the establishment of an energy plant
   using vegetal biomass in the Barigadu Area of Central Sardinia before receiving the
   informative note connected to this questionnaire?
   YES NO
7. Are you in favour of the establishment of an energy plant using vegetal biomass in the
   Barigadu Area of Central Sardinia?
   YES NO I DO NOT KNOW
8. In case the regional administration needed funds for managing the project and
   realisation of a big size vegetal biomass-based energy plant, would you be willing to
   pay a contribution of 10/20/30 Euros in the form of an annual tax?
9. Which is you family disposable income (thousand Euros)?
   Less than 10.
   20–30.
   30–50.
   More than 50.