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Willingness to pay for biodiesel in Spain: a pilot study for diesel consumers

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Abstract

One of the priorities of the European Union is to reduce greenhouse gas emissions in order to contribute significantly to climate change mitigation. The aim of this paper is to analyze consumers' valuation of one type of renewable energy which is important to reach the European emission reduction targets, biodiesel, and to assess the extra price consumers are willing to pay to use biodiesel instead of conventional diesel. In order to achieve these goals, a market survey has been carried out in Aragón (Spain) to collect primary data from diesel consumers. A choice experiment has been used to assess willingness to pay for biodiesel. Results suggest that the consumers' level of knowledge of biodiesel is not very high although consumers' perception of the product is quite favourable because they believe biodiesel is less pollutant and reduces greenhouse gas emissions, compared to conventional diesel. Actual consumption of biodiesel is still very low. However, consumers are willing to pay 5% extra to fill up with biodiesel instead of its conventional counterpart.

Additional key words: biofuel; choice experiment; preferences; valuation.

Resumen

Disposición a pagar por biodiesel en España: un estudio exploratorio para consumidores de diesel

En la actualidad, la Unión Europea pone énfasis en la reducción de la emisión de gases de efecto invernadero para contribuir a la reducción del cambio climático. El objetivo de este artículo es evaluar las preferencias de los consumidores hacia el biodiesel, siendo este una alternativa de carburante importante dentro del escenario europeo. Además, se estima la disposición a pagar por la utilización de biodiesel en lugar de diesel convencional. Para alcanzar este objetivo se llevó a cabo una entrevista personal a usuarios de vehículos diesel en Aragón (España). Un experimento de elección fue diseñado para calcular la disposición al pago por el biodiesel. Los resultados indican que los consumidores poseen un bajo nivel de conocimiento sobre el biodiesel, aunque, en general, la percepción hacia el producto es positiva porque asocian el biodiesel con un carburante no contaminante, y que contribuye a la disminución de las emisiones de los gases efecto invernadero. Sin embargo, el consumo actual es todavía bajo. Además, los consumidores están dispuestos a pagar un 5% más por adquirir biodiesel en lugar de diesel convencional.

Palabra clave adicionales: biocarburantes; experimento de elección; preferencias; valoración.

Introduction

Climate change is foreseen to have very serious impacts on growth and development (Stern, 2007). Because of this, reducing greenhouse gas (GHG) emissions to avoid the worst impacts of climate change has been established as a priority all over the world. One of the main targets in the EU and around the world is the reduction of GHG emissions at their source and as 80% of GHG emissions originate from heating, power pro-

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Abbreviations used: CE (choice experiment), CV (contingent valuation), EU (European Union), GHG (greenhouse gas), WTP (willingness to pay).

duction and transport action is needed in these sectors (Koundouri *et al.,* 2009).

The European Union (EU) committed itself to a reduction in greenhouse gas emissions of 20% by 2020 compared to 1990 (CEPS, 2008). In addition the EU, in its recent Directive on the promotion of the use of energy from renewable sources (EC, 2009), agreed to establish mandatory targets for an overall 20% share of renewable energy and 10% share of renewable (primary biofuels) in transport in the European Union's by 2020[1]. This 10% share for biofuels in transport has been set for three reasons; *i)* the transport sector, which is currently responsible for about one-fourth of European energy-related GHG emissions, presents the most rapid increase in GHG emission out of all sectors of the economy; *ii)* biofuels tackle the oil dependence of the transport sector, which is one of the most serious problems of insecurity in energy supply that the EU faces; *iii)* biofuels are currently more expensive to produce than other forms of renewable energy, which might mean that they would have a limited development without a specific requirement.

Although important advances have been made in the development of renewable energy, and the increase in the supply has been remarkable, market acceptance and demand for renewable energy is still very low.

One of the factors limiting the demand for renewable energy is their higher cost of production[2]. However, as Stern (2007) pointed out, if the overall cost and risks of climate change were taken into account, the benefits of reducing GHG far outweigh the reduction costs. This is due to the fact that conventional energy production has many external costs that are not taken into account. For example, energy production contributes to global warming, increases air pollution and acid deposition, etc., all of which have negative effects on human health and on the environment. If these external costs were taken into account, the total cost of conventional energy production would be higher, thus making renewable energy (which does not face the same external costs) more profitable. Support to promote renewable energy production until now has focused on subsidies and regulatory policies which compensate the higher financial costs of production. However, production costs of renewable energy will remain higher than conventional ones until the technology for renewable energy production improves or fossil fuel prices rise.

An alternative to support renewable energy would be via higher prices. In this sense, knowing how consumers value renewable energy and their willingness to pay (WTP) an extra price for it is a relevant issue. Several studies have been conducted to assess consumers' willingness to pay for renewable energy. For the assessment of WTP for renewable energy, contingent valuation (CV) has been the most widely used valuation method. Nomura and Akai (2004) and Wiser (2007) estimated consumers' willingness to pay in Japan and US, respectively. Bollino (2009) estimated consumers' WTP to use renewable energy in the electricity production in Italy. A combination of both non-fossil sources of energy and wind-electricity was the focus of the WTP studies by Champ and Bishop (2001) and Whitehead and Cherry (2007). Choice experiments (CE) have also been used to assess WTP for different renewable energy sources. In the US, Roe *et al.* (2001) estimated consumers' WTP for an improved fuel mix containing higher renewable content and lowered emissions while the study by Borchers *et al.* (2007) assessed consumers WTP for green energy electricity in general and for different green sources (solar, wind, biomass, etc.). Last, Longo *et al.* (2008) calculated WTP for a hypothetical program that promotes the production of renewable energy in England.

Studies focusing on biodiesel as a renewable energy source are scarcer. As far as the authors know, only the papers by Jeanty and Hitzhusen (2007) and Jeanty *et al.* (2007) has estimated the WTP for air pollution reduction derived from using biodiesel fuel in engines. This study used a contingent valuation approach to measure Ohio (US) consumers' willingness to pay for biodiesel. This paper follows the approach of these studies and aims to analyze consumers' valuation of biodiesel, and to assess the extra price consumers are willing to pay to use biodiesel instead of conventional diesel. To achieve this goal, a survey was conducted among diesel car' owners in a Spanish city (Zaragoza). The consumption of biodiesel in Spain is still limited. Although total consumption in 2007 reached a total of 281,397 , following a exponential increase since 2005 and 2006 when consumption was limited to only 28,748 and 65,081 tonnes, respectively. However, the share of

[1] The overall 20% target has been translated into individual targets for each Member State (*e.g.* 20% for Spain; 30% for Denmark), but the 10% target for renewable energy in transport has been set at the same level for each Member State, because transport fuels are easily traded.

[2] Production costs refer to financial costs.

biodiesel over total diesel consumption is still very low and it represents only the 0.98% (APPA, 2008).

Material and methods

Data gathering

Data was collected from a survey conducted in Zaragoza, a medium-sized town located in northwest Spain, during April 2008. Target respondents were owners or users of diesel engine vehicles and the questionnaire was delivered face to face throughout the town and its suburbs. Interviewers selected and approached individuals randomly[3], asking them one screening question: whether they owned (or frequently used) a diesel-engine vehicle. In the case of a negative response, interviewers randomly selected another customer belonging to a given age group, until they obtained a positive response.

The questionnaire was designed to assess consumers' acceptance of biodiesel. Consumers were asked questions related to their knowledge regarding and attitudes towards biodiesel, biodiesel consumption (actual use, intention to purchase, place of purchase, etc.), as well as diesel purchasing patterns. The questionnaire also contained questions on socio-demographic characteristics (*i.e.* gender, family size and composition, age, education level, income) and lifestyle. It also contained a set of question to assess consumers' willingness to pay for biodiesel using a choice experiment valuation method. This set of questions is the basis for the results reported in this paper.

Characteristics of the sample

Final sample size accounts for 121 diesel-engine car owners/users. Considering that this sample is extracted from an infinite population and assuming a confidence level of 95.5% ($k = 2$ and $p = 0.5$), the error level associated to the reported estimates is ± 9%. A stratified random sampling procedure was used based on age. Sample summary statistics are presented in Table 1. The majority of respondents were male (69.5%). The respondent's average age was 39, living in a household with three members. Approximately 60% of respondents reported having a monthly income between €1,500 and €3,500, and more than half of the sample has a university degree. Finally, households with children under six years of age are 20% of the total, and those with members above 65 years of age represent 11% of the total.

Table 1. Sample characteristics (%, unless stated)

Variable definition	Value
Gender	
Male	69.5
Female	30.5
Age (average in years from total sample)	39.2
Education of respondent	
Elementary School	9.3
High School	34.7
University	55.9
Average household income	
< €1,500	14.0
Between €1,501 and 2,500	28.0
Between €2,501 and 3,500	33.3
Between €3,501 and 4,500	14.9
> €4,500	9.7
Household size (average members from total sample)	3.3
Household with kids < 6 years old (1 = Yes)	20.3
Household with adults > 65 years old (1 = Yes)	11.0

As far as respondents' knowledge of biodiesel, most of the respondents (86%) stated that they had at least heard about this fuel. However, when asked for the characteristics of this fuel, only 42% of respondents considered it to be less polluting than the conventional diesel and 35% could identify its vegetal origin. Interviewees where confronted with a series of statements reflecting advantages and disadvantages normally associated with biodiesel. Respondents mostly agreed with some of the advantages associated to biodiesel, in particular, they believed that biodiesel was less pollutant than conventional diesel and that it reduced GHG emissions. However they did not agree with the disadvantages. In particular, their degree of agreement with the fact that biodiesel production will increase food prices was the lowest.

The actual consumption of biodiesel for the sample is very low as only 12% of respondents state that they have used biodiesel at least once. The most important reasons preventing the use of biodiesel are the lack of

[3] Some respondents were approached in some selected petrol stations suggested by a company that produces biodiesel which collaborated in our study.

information about the product (62.8%) and the lack of information about the effect it may have on the car engine (60.3%). Finally, 80.2% of respondents stated that they would buy biodiesel if it was available in the petrol station they normally used, a figure that is reduced to 51.2% if they had to go to a different petrol station in order to do so.

Methodology

To assess consumers' WTP for biodiesel a choice experiment (CE) approach has been selected for three reasons. CE allows valuing multiple attributes simultaneously, its framework is consistent with the random utility theory and the hypothetical choices presented are similar to real market decisions (Adamowicz *et al.*, 1998; Lusk *et al.*, 2003). However, its hypothetical nature makes WTP estimates subject to the possibility of hypothetical bias, an issue that has to be taken into account when interpreting the results.

Choice experiment design

Choice experiments try to reproduce the market choice conditions for a product in the market. The consumer finds in the market different products and selects one of them according to the utility it derives from its specific attributes. In addition the consumer can choose not to purchase the product, and therefore a 'no choice' option could be introduced in the experimental design. This has been the option taken in this study. In a real market conditions, consumers often do not select any product in the market (*i.e.* they do not purchase any fuel). This can be either because they prefer delaying their purchase and waiting for some improvement in the attribute levels (price, brand, package...) or because the products do not satisfy their requirements. In both cases the consumer would not buy any of the fuel options available and just wait for a better opportunity. Therefore, the inclusion of a «no choice» option allows for a better replication of real market conditions (Lawson and Glowa, 2000). The design of the choice experiment requires as a fist step to identify the attributes and levels which will be used to describe the products presented to the consumers.

Since the aim of this study is to estimate consumers' WTP for biodiesel, two attributes are needed: whether the fuel is biodiesel or conventional diesel, and the price. However other relevant attributes can also influence the fuel choice by consumers. To select other important attributes in diesel users' choice, one can use expert opinions or results from a pre-test questionnaire conducted on diesel engine car owners/users. In this study, the latter approach was chosen and carried out using a pre-test questionnaire with multiple open-ended questions delivered to 20 diesel vehicles owners/users. This questionnaire also included an open-ended contingent valuation question to allow obtaining some information on the range of prices to be used in the price attribute.

Results from the pre-test questionnaire showed that the most important characteristics people take into account when choosing diesel for their car were the proximity of the petrol station to buyers' everyday route (*proximity*) and whether the petrol station was owned by a well known company as opposed to being small and independent (*brand*). Moreover, results from the contingent valuation open-ended questions included in the pre-test questionnaire indicate that the maximum premium consumers were willing to pay to use biodiesel, instead of conventional diesel, was around 10%.

Thus, the final selected four diesel attributes were: price, petrol station proximity, type of petrol station and type of diesel (biodiesel or conventional), each of them taking two or more different levels. Table 2 shows the attributes and the levels used. The selection of price vector was conducted as follows. A baseline price scenario was selected corresponding to the average price of a litre of conventional diesel in several petrol stations at the time of the survey (€1.1 L^{-1}). Based on the results of the CV questions in the pre-test questionnaire, a 10% was added to the price to reflect the highest extra price shoppers were willing to pay to use biodiesel instead of conventional diesel and also a 10% discount was included to detect whether non-willing-to-purchase-biodiesel consumers would do it at a discount. The other attributes were entered in the choice set with two levels. Information regarding the meaning of the price,

Table 2. Attributes and levels used in the choice design

Attributes	Levels
Biodiesel (2)	Biodiesel; conventional diesel
Price (3)	€0.99; €1.10; €1.21
Brand (2)	Big brand petrol stations; small or local petrol stations
Proximity (2)	Petrol station is close to everyday route (Yes); otherwise (No)

type of diesel and petrol station characteristics (proximity and well known brand) was presented to participants just before the choice experiment question.

Once the attributes and their levels had been selected, the next step is to do the experimental design. The experimental design leads to a combination of attribute level that will be used in the choice questions. Since the focus of this paper is on knowing the preference level of consumers for each attribute independently from the other, but not to valuate the possible interactions among attributes, an orthogonal design was used.

The choice set design was created employing an unlabeled orthogonal design created with SPSS© 14.0, which resulted in a total of 12 choice sets. To avoid an order effect in the replies, the order of choice sets was randomized. The 12 selected choice sets were grouped into three blocks of four choice sets, with each respondent randomly allocated to one of the blocks. Thus, each respondent had to choose four times between three diesel options: two options non-labelled options which described a diesel fuel (option A and option B) and a third option offering consumers the possibility of «not buying» any of the fuel present in the choice set (option C) (see an example of choice set in Appendix).

Discrete choice model

Choice modeling is based on Lancastrian consumer theory of utility maximization (Lancaster, 1966) and consumers' preferences over good attributes are modelled in a random utility framework (McFadden, 1974). For a set of attributes and the respective levels, the individual's utility coming from alternative products j is equal to U_{ij}, $j = 1,\ldots,J$. The individual always chooses the alternative which gives him the highest utility. Thus, the individual i would choose the j alternative if, and only if, $U_{ij} > U_{in}$, *for* $j \neq n$. However, the researcher is able to observe some attributes of the alternative products, while other components of the personal utility are unobservable and remain unknown to him. These unknown utility components are considered as stochastic. As a result U_{ij} is a random variable with a parametric probability distribution with the mean value depending on the observable products and attributes. Therefore, the individual utility U for the j alternative can be represented as (Train, 2003):

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad [1]$$

where V_{ij} is the observable part of the utility function which is modelled by the researcher. V_{ij} is assumed to be linear on the attributes and is specified as $V_{ij} = \beta_j' x_{ij}$, where β_j are unknown parameters which are estimated by econometric methods. The ε_{ij} term reflects the factors not included in V_{ij} which are affecting the utility. It is defined as the difference between the actual utility U_{ij} and the utility the researcher is able to explain, and it is assumed to be random. The density function of the random vector ε_{ij} is $f(\varepsilon_{ij})$. Several discrete choice models can be defined. One of the most used is the Logit model, which works on the assumption that the random part of the utility is distributed as *i.i.d.* (independent and identically distributed) extreme value function; the probability of choosing the j alternative comes from this function (McFadden, 1974).

$$P_{in} = \frac{e^{V_{in}}}{\sum_{j=1}^{J} e^{V_{jn}}} = \frac{e^{\beta' X_{in}}}{\sum_{j=1}^{J} e^{\beta' X_{jn}}} \qquad [2]$$

When only X_{in} are included representing the attributes of the alternative options, this model is referred to in literature as the conditional logit.

Results and discussion

According to the random utility model in [1], utility is taken as a random variable which can be decomposed into separate utilities divided in accordance with the characteristics or attributes of the product. In particular, to specify the random utility model, V_{ij} in [1] has been replaced by the different variables indicating the selected attributes defined in Table 2 ($\beta_j x_{ij}$).

$$U_{ij} = \beta_0 + \beta_1 + \beta_2 Price_j + \beta_3 Biodiesel_j + \\ + \beta_4 Brand_j + \beta_5 Proximity_j + \varepsilon_{ij} \qquad [3]$$

The utility of each consumer i is represented by the sum of the utilities coming from the attributes and the unknown perturbation ε_{ij}, plus two alternative-specific constants (β_0 and β_1). Note that β_0 and β_1 are dummies indicating the selection of option A and option B, respectively, with respect to the no-choice option (option C). The alternative-specific constants are used to measure consumer's utility gain when the consumer chooses option A or option B instead of selecting the «no choice» option and they are expected to be positive. The price attribute was also entered to calculate the consumer's WTP for the rest of the diesel's attributes,

and it is represented by a continuous variable (*price*). Moreover, the estimated price parameter allows checking whether the model complies with economic theory, as it is assumed that it should be negative reflecting a positive marginal utility of income. The other three variables are effect code variables[4]. The five parameters were estimated through a conditional Logit model using STATA 10.0 and results are shown in Table 3. This table shows that all the estimated parameters were statistically different from zero at the 5% significance level. Furthermore, the whole model is significant as indicated the likelihood ratio (350.38).

As expected, the alternative-specific constants are positive and statistically significant, showing that consumers derive more utility from the purchase alternatives than from the non-purchase option. Increased prices have a negative effect on individual's utility, thus complying with the economic theory. The attribute most valued by consumers was proximity of the petrol station to their daily routes indicating that consumers prefer to use petrol stations which are closer to their everyday route. The second attribute in importance affecting consumer choice is *biodiesel*. Its positive sign means that renewable fuels (*i.e.* biodiesel) provide a higher level of utility to consumers that fossil fuels (*i.e.* diesel). In addition, whether the petrol station has a well known brand has a positive impact on consumers' utility. However, interpretation of direct estimate parameters is not enough to fully understand consumers' valuation. Therefore, the marginal values or WTP for the effects of the attributes has been calculated for each non-monetary attribute. WTP estimates are calculated as the ratio of the partial derivative of the utility function with respect to the attribute of interest, divided by the derivative of the utility function with respect to the *price* variable [see Burton *et al.* (2001) and James and Burton (2003) for different applications]. Thus, WTP for each attribute is calculated as the ratio between the parameter estimated for the attribute and the price parameter, multiplied by minus one.

The WTP values for the different attributes are also shown in Table 3. Results indicate that all the considered attributes carry a positive premium, with the highest WTP associated with the proximity (€0.06 per litre of diesel). This implies that, on average, the WTP for the proximity of the petrol stations to buyers' everyday route is €0.06 per litre of diesel. Slightly behind, €0.05 per litre of diesel is the premium that makes diesel buyers indifferent between the two levels of utility associated with conventional diesel and biodiesel. So, consumers are willing to pay five eurocents more to purchase one litre of biodiesel instead of a litre of conventional diesel. Finally, consumers are willing to pay about half that price, €0.03 extra, for a litre of diesel purchased at a petrol station associated to a big and well known oil company.

Conclusions

This study presents the first analysis of consumers' WTP for biodiesel in Spain. In order to comply with the objective, a market survey directed to diesel vehicles owners/users was carried out in Aragón.

Results indicated that most people have heard about the existence of biodiesel but only less than half are know what are the characteristics of biodiesel. However, respondents show a positive perception toward biodiesel because they mostly agree that biodiesel has milder environmental consequences (it is less polluting

Table 3. Conditional Logit estimates

Parameter	Estimate	Error[1]	t-value	Approx. Pr >|t|	WTP (€)
β_0	10.087	0.8776	11.49	0.000	
β_1	9.966	0.8764	11.37	0.000	—
Price	–7.645	0.7699	–9.93	0.000	—
Biodiesel	0.4102	0.0700	5.86	0.000	0.05
Brand	0.2033	0.0674	3.02	0.003	0.03
Proximity	0.4330	0.0726	5.96	0.000	0.06

R^2 McFadden's LRI = 0.3378; Likelihood Ratio: 350.38 (df = 4). [1] Clustered standard errors were calculated to account for correlation among the ε_{ij} for a given *j*.

[4] Taking the value +1 value when *«biodiesel», «big and branded petrol station»* and *«close to the every-day route»* respectively and –1 otherwise.

and it reduces GHG emissions) than traditional diesel. Actual consumption is still low but the intention to purchase biodiesel is of considerable importance, mainly if it is available in the petrol stations people use frequently. The most important reasons preventing the use of biodiesel are the lack of information about the product and lack of information about the effect it may or may not have on the car engine.

Findings indicate that the *biodiesel* attribute has a positive effect on consumers' utility. Thus, consumers are willing to pay a premium price for it. In particular, consumers are willing to pay a premium for biodiesel of 5% of the current price for conventional diesel. This premium is only slightly lower than the extra-price they are willing to pay for diesel, should it be available in a petrol station closer to their everyday route. This means that filling up convenience and environmental aspects of the fuel are of equal value to consumers.

Results confirm that consumers are willing to purchase biodiesel and also to pay a small extra-price for it, but the factors limiting demand are mainly the lack of information about the product and the possible consequences on the car engine, and the lack of availability in petrol stations.

However, the findings shown in this paper must be considered as exploratory because of the small sample size and the limited geographical coverage of the study.

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References

ADAMOWICZ W., BOXALL P., WILLIAMS M., LOUVIERE J., 1998. Stated preference approaches for measuring passive use values: choice experiments and contingent caluation. Am J Agr Econ 80(1), 64-75.

APPA, 2008. Capacidad, producción y consumo de biocarburantes en España. Situación y perspectivas. Asociación de Productores de Energías Renovables. Available in http://www.appa.es/descargas/Informe_Capacidad_produccion_consumo_biocarburantes.pdf [25 March, 2010]. [In Spanish].

BOLLINO C.A., 2009. The willingness to pay for renewable energy sources: the case of Italy with socio-demographic determinants. The Energy J 30(2), 81-96.

BORCHERS A.M., DUKE J.M., PARSONS G.R., 2007. Does willingness to pay for green energy differ by source? Energ Policy 35, 3327-3334.

BURTON M., RIGBY D., YOUNG T., JAMES S., 2001. Consumer attitudes to genetically modified organisms in food in the UK. Eur Rev Agric Econ 28(4), 479-498.

CEPS, 2008. The future of european electricity. Choices before 2020. Centre for European Policy Studies Policy brief, 164. Available in http://www.ceps.be/ceps/download/1512 [22 March, 2010].

CHAMP P.A., BISHOP R.C., 2001. Donation payment mechanisms and contingent valuation: an empirical study of hypothetical bias. Environ Resour Econ 19, 383-402.

EUROPEAN COMMISSION, 2009. Directive 2009/28/ec of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing. Directives 2001/77/EC and 2003/30/EC.

JAMES S., BURTON M., 2003. Consumer preferences for GM food and other attributes of the food system. Aust J Agr Resour Ec 47(4), 501-518.

JEANTY P.W., HITZHUSEN F., 2007. Using stated preferences to estimate the environmental benefits of using biodiesel fuel in diesel engines. Bio-fuels, Food and Feed Tradeoffs Conference. St Louis, Missouri, USA.

JEANTY P.W., HAAB T., HITZHUSEN F., 2007. Willingness to pay for biodiesel in diesel engines: a stochastic double bounded contingent valuation survey. American Agricultural Economics Association Annual Meeting. Portland, Oregon, USA.

KOUNDOURI P., KOUNTOURIS Y., REMOUNDOU K., 2009. Valuing a wind farm construction: a contingent valuation study in Greece. Energ Policy 37, 1939-1944.

LANCASTER K., 1966. A new approach to consumer theory. J Polit Econ 74(2), 132-157.

LAWSON S., GLOWA T., 2000. Discrete choice experiments and traditional conjoint analysis. Quirk's Marketing Research Review, ID 20000508.

LONGO A., MARKANDYA A., PETRUCCI M., 2008. The internalization of externalities in the production of electricity: willingness to pay for the attributes of a policy for renewable energy. Ecol Econ 67, 140-152.

LUSK J., ROOSEN J., FOX J.A., 2003. Demand for beef from cattle administered growth hormones or fed genetically modified corn: a comparison of consumers in France, Germany, the United Kingdom, and the United States. Am J Agr Econ 85(1), 16-29.

MCFADDEN D., 1974. Conditional logit analysis of qualitative choice behavior. Frontiers in econometrics (Zarembka P., ed). Academic Press, NY (USA). pp. 105-142.

NOMURA N., AKAI M., 2004. Willingness to pay for green electricity in Japan as estimated through contingent valuation method. Appl Energ 78, 453-463.

ROE B., TEISL M.R., LEVY A., RUSSELL M., 2001. US consumers' willingness to pay for green electricity. Energ Policy 29, 917-925.

STERN N., 2007. The economics of climate change: the Stern review. Cambridge University Press, Cambridge, UK. 673 pp.
TRAIN K., 2003. Discrete choice methods with simulation. Cambridge University Press, Cambridge, UK. 334 pp.
WHITEHEAD J.C., CHERRY T.L., 2007. Willingness to pay for a green energy program: a comparison of ex-ante and ex-post hypothetical bias mitigation approaches. Resour Energy Econ 29, 247-261.
WISER R.H., 2007. Using contingent valuation to explore willingness to pay for renewable energy: a comparison of collective and voluntary payment vehicles. Ecol Econ 62, 419-432.

Appendix. Example of choice set

18.1A	**Option A**	**Option B**	**Option C**
Diesel type	Conventonal diesel	Biodiesel	Neither A nor B
Price/litre	€1.10	€1.10	
Brand	Big brand petrol stations	Small or local petrol stations	
Proximity	No	No	
Select: ⟶ (mark one only, please)	☐	☐	☐