Dilemma in Estonian Renewable Energy Policy: Do State Subsidies Meet Public Preferences?

Ü. Ehrlich, M. Roodi

***Abstract*—**Estonia has assumed with the EU the obligation to produce by 2020 25% of the electricity from renewable sources. For the achievement of this objective a surcharge has been imposed on electricity generated from renewable sources, which shall be paid by consumers of electricity. In connection with the Estonian electricity market opening in January 2013, the electricity price for end users rose, which has increased discontent with the surcharge on renewable energy based electricity for consumers. The paper attempts to find out the attitude of Estonian consumers toward the electricity produced from renewable sources and demand for electricity produced from renewable sources. Using the Contingent Valuation method the Estonian population's willingness to pay a surcharge on renewable sources based electricity is identified and it is compared to the mandatory renewable energy charge. The study shows that the main criterion for selecting an electricity package under the open energy market has been the electricity price and the willingness to pay of approximately 80% of the consumers for electricity from renewable sources is smaller than the obligatory renewable energy charge.

***Keywords*—**Electricity production, renewable energy, energy policy, renewable electricity state subsidies, contingent valuation.

I. Introduction

Being EU member Estonia has assumed an obligation to produce by 2020 25% of the electricity from renewable sources. To fulfil that obligation the Estonian Parliament in 2007 adopted a law establishing higher obligatory purchase prices for electricity produced from renewable sources compared to oil shale-based electricity, which because of large oil shale reserves has accounted for more than 90% of Estonia's electricity production during more than 60 past years. The more expensive electricity from renewable sources shall be paid by the electricity consumers: an obligatory amount shall be added to their monthly bill for electricity produced from renewable sources. This has caused a lot of protest among the consumers. The situation has grown sharper in connection with the electricity market opening in Estonia from 1 January 2013, which brought a notable rise in electricity prices.

This paper seeks to identify the attitudes of Estonian inhabitants toward different sources of electricity generation on the scale environment-friendly-environmentally hostile; what the consumers reckon with when choosing the electricity producer under the open electricity market and what is the Estonian inhabitants' willingness to pay for electricity produced from renewable sources.

To solve the research task a sample of more than 1000 respondents, being representative for Estonian working-age population, were questioned. The Contingent Valuation method was used to calculate the willingness to pay. The paper provides an overview of the Estonian electricity market, proportion of energy produced from renewable sources in the electricity market, subsidies for renewable energy in Estonia, and presents the results of the research conducted by the authors.

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II. Energy Market in Estonia

Estonia is a country that exports large proportions of energy and is highly independent from foreign energy producers, because of the large natural oil shale reserves. In 2010, 85% of electricity was produced from oil shale [1].

However, depleting of these reserves completely wouldn't be sustainable. Therefore Estonia has started to produce more energy from alternative sources. The sources of energy used for electricity production in 2010 are shown in Table 1.

According to the Estonian Renewable Energy Association and the Estonian Enviromental Communities Association, Estonia could produce 100% of its energy from renewable energy sources by 2030. The renewable energy sources considered in their development plan are wind energy (on- and offshore), biomass and biogas combined power plants, hydro and solar energy. Development of offshore wind farms stands in the focus of the development plan since Estonia has high wind energy potential. The average cost of energy produced according to their plan would be 21% cheaper than the energy produced from oil shale and at nuclear plants [2].

In recent years the amount of energy produced from renewable energy has been increasing notably. The increases in energy produced from renewables over the period of 2002 - 2011 are described on Fig. 1.

66% of renewable energy in 2011 was generated from waste (wood fuel) and biomass, 31% from wind energy and 3% from hydro energy [5].

Table 1. Electricity production in 2010 [1]

	GWh	%
Wood	706	5.45%
Wind	277	2.14%
Gas	304	2.35%
Oil shale gas	407	3.14%
Other	225	1.74%
Oil shale	11043	85.20%

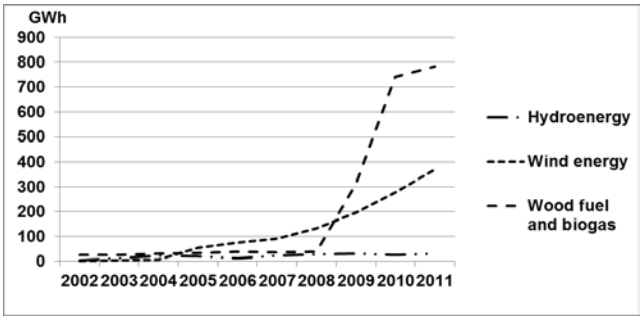

Fig. 1. Electricity production from renewable sources 2002 - 2011 [4]

A. Energy Prices in Estonia

Estonia's energy market opened on 01.01.2013. Private consumers can choose between 10 different providers [6]. Even though after the energy market opening the electricity costs rose noteably for some consumers the prices in Estonia are still cheaper compared to prices in most other European Union countries. Then again, given the different purchasing powers in different European countries, electricity prices are relatively more expensive in Estonia than in countries with high living standards such as Finland, the United Kingdom, Norway, etc. [7].

Furthermore, electricity prices in Estonia are increasing faster than in many other countries. In the European Union (EU) the prices for business consumers in 2010 rose approximately 2%, in Estonia approximately 13%. Only in Lithuania, Malta and Cypros the price increase for business consumers was even higher [7].

Electricity prices consist of several components: energy price, network service and taxes. For an average Estonian consumer the price is combined as follows: electricity 33%; network service 40%; excise tax on electricity 3%; renewable energy charge 6%; VAT 17% [8].

As Estonia's energy market is open since 01.01.2013 the tariffs for consumers vary between producers. Taxes and prices for network services are however equal for all consumers. The latter is determined by the Estonian Competition Authority [9].

In most of the European countries the share of taxes in electricity price is small. Only in some countries it is compareable with Estonia. The share of taxes in the electricity price is the highest in Germany and Denmark [7].

Renewable energy charge is fixed by the government. Its purpose is to support electricity generation from renewable energy sources or in combined heat and power (CHP) plants. The renewable enery charge for ever next year is calculated and published by the main grid company Elering by the 1st of December. The charge is based on the prognosis how much subsidy will be paid for renewable energy and the amount of network service used in the following year.

The main grid company is also responsible for paying the subsidies to the entitled firms after gathering the charges from all active network companies. The subsidies depend on the amount of renewable energy produced [10].

The renewable energy charge for private consumers in 2013 is 1.04 cents €/kWh (includes 20% VAT) [11].

III. Estonian Energy Policy

A. Single Electricity Market in Europe

One of the most important energy goals of the European Union (EU) is the creation of a smoothly functioning single electricity market, based on the EU Third Energy Package. A competitive internal electricity market will give the European consumers the ability to choose between different electricity suppliers, who will offer electricity at a market price. On the other hand, it will allow a wider range of companies to enter the energy market, particularly small companies and those that invest in sustainable energy [12].

The member states of the European Union have taken an obligation to develop the rules for a common energy market by 2014. These will allow the price to be kept as low as possible, while increasing security of supply and the standards of service. The Third Energy Package provides legal basis and institutional framework for developing these rules. All related participants need to contribute in developing the rules for the common energy market. Among others, this includes the Agency for the Cooperation of Energy Regulators (ACER), the European Network of Transmission System Operators (ENTSO), the member states, and the European Commission [12].

B. The Electricity Market Opening Impact on Estonia

Full opening of the electricity market from January 2013 requires the electricity sellers operating in Estonia to exert much more efforts than so far. While so far electricity sellers had enjoyed from many respects their monopolistic position, then in the open energy market they need to work much harder in order to win in competition new clients or keep the existing client base. The main and biggest change the energy market opening brings is the freedom of choice.

The electricity market opening also increases Estonia's energy security and independence from Russia's electricity. Open electricity market is a precondition for integrating Estonia into the European and Nordic energy systems. Without opening of the electricity market it is not possible to create enough external links with Finland, Latvia and other Europe for transmitting electricity and thanks to investments ensure different electricity generation possibilities in Estonia.

The electricity market opening was agreed upon when Estonia joined the European Union nearly 10 years ago.

Although the European Union electricity market was opened completely in 2007 already, Estonia was enabled in the accession treaty a transition period until 1 January 2013. In case Estonia fails to open the electricity market by that date a considerably more severe punishment than the sugar penalty would be due [13].

C. Estonian Energy Policy Goals

Being EU member Estonia's policy goals are influenced by the goals set by the Union's legislation. The EU's European Strategy on Climate Change has set a common goal for all member states to limit global warming to 2° Celsius. By 2020, EU's energy efficiency should be improved by 20% and the share of renewable energy should be increased also by 20% in the Union [14]. For all member states their targets by 2020 have been set numerical and are shown in table 2.

Table 2. Share of renewable energy in gross final energy consumption % [15]

	2010	TARGET
EU (27 countries)	12,5	20
Belgium	5,1	13
Bulgaria	13,8	16
Czech Republic	9,2	13
Denmark	22,2	30
Germany	11	18
Estonia	24,3	25
Ireland	5,5	16
Greece	9,2	18
Spain	13,8	20
France	12,9	23
Italy	10,1	17
Cyprus	4,8	13
Latvia	32,6	40
Lithuania	19,7	23
Luxembourg	2,8	11
Hungary	8,7	13
Malta	0,4	10
Netherlands	3,8	14
Austria	30,1	34
Poland	9,4	15
Portugal	24,6	31
Romania	23,4	24
Slovenia	19,8	25
Slovakia	9,8	14
Finland	32,2	38
Sweden	47,9	49
United Kingdom	3,2	15
Iceland	:	:
Norway	61,1	67,5
Switzerland	:	:
Croatia	14,6	20

The main goal of Estonian energy policy is also to provide the consumers as many different energy sources at as low prices as possible, thereby minimizing the negative effects on the nature without increasing dependency on imported fuels [16]. This directly implies that it is in the states interest to invest into creating the essential energy network and renewable energy technology, instead of keeping using high proportions of fossil fuels.

Owing to the vast development of renewable energy, especially wind energy in recent years, Estonia has already now reached the goal set for 2020.

D. Subsidies for Renewable Energy in Estonia

Estonia has been supporting energy production from renewables since 1992 [17]. Large investments were made in 2007-2011 in the amount of approximately 500 million euro. 87% of those investments were made by private investors and only 13% by the government owned company *Eesti Energia* [18].

Currently the renewable energy production is supported by the renewable energy charge that is added to the consumers' electricity bill. The subsidies for renewable energy producers are presented in Table 3.

Table 3. Subsidies for renewable energy producers in Estonia [19]

Subsidy, €/kWh	Stipulation
0.0537	for energy produced from renewable energy, except biomass*
0.0537	for combined heat and power production from biomass
0.032	for efficient cogeneration from waste, peat or processing of oil shale retorting gas
0.032	for efficient cogeneration with a production unit with a maximum capacity of 10 MW

* wind energy producers can receive subsidies for up to 600GWh per year

IV. Results of the Questionnaire Survey

A. Sample Size

To find out the attitudes of Estonian population toward the electric energy generated from various resources, people's preferences in choosing electricity packages when the electricity market was opened and their willingness to pay extra for the electricity produced from renewable resources a questionnaire survey with a sample of 1000 individuals was carried out. The sample is representative of the Estonian working-age population and its results are generalizable to the Estonian working-age population. The research results shall be discussed below by individual questions.

B. Electricity Generation Impact on the Environment

A sweeping conclusion from the answers to the question: "What do you think, which source of electricity generation is the most harmful to the environment (1- most hazardous to the environment, 6 -most environment-friendly)?" is provided in Table 3. To verify the dependence of the judgements on the respondents' sociometric indicators the respective regression analyses were performed for all types of energy using the statistical software EViews 7 and the least squares method.

The influence of the sociometric features to respondents' answers is estimated as follows

$$\ln(Q_i) = \alpha + \beta_1 gender_i + \beta_2 \ln(age_i) + \beta_3 \ln(educ_i) + \beta_4 \ln(inc_i) + \varepsilon_i \qquad (1)$$

Nuclear energy is regarded as the most hazardous by 46.5% of the respondents (average score 2.10). This type of energy is ranked second in terms of environmental hostility by 22.4% and third by 17.4% of the respondents, whereas as many as 3.2% regard this energy as the most environment-friendly. The sociometric indicators of the respondents that had an effect on the attitude toward nuclear energy were gender (prob. 0.0005, females considered it the most environmentally hazardous), age (prob. 0.0000; younger respondents regarded nuclear energy as more environmentally hazardous than older people) and education (prob. 0.0388, more educated people regarded nuclear energy as less environment damaging). The second in the ranking in terms of environmental hostility was oil-shale energy, which was regarded as the most hazardous by 41.6% of the respondents. Considering that as many as 42.8% placed oil-shale energy the second by environmental hostility, this type of energy may be regarded as the most hazardous to the environment in the opinion of Estonian population. The statement is confirmed also by the low average score, 1.80 (see Table 4).

Table 4. Answers to the question: "What do you think, which source of electricity generation is the most harmful to the environment?" (1 - most harmful to the environment, 6 - most environment-friendly)

	Response %						Ave-rage score
	1	2	3	4	5	6	
Wind energy	1.2	2.6	6.1	24.5	43.4	22.2	4.73
Nuclear energy	46.5	22.2	17.4	6.1	4.5	3.2	2.10
Hydro-energy	1.8	6.5	17.5	40.1	24.2	10.0	4.09
Oil-shale energy	41.6	42.8	11.7	2.3	1.2	0.4	1.80
Wood energy	9.0	24.5	41.1	16.5	6.0	2.9	2.95
Solar energy	0.2	1.2	6.3	10.5	21.0	60.9	5.34

The sociometric indicators that affected the opinions about oil-shale energy were gender (prob.0.0002) and age (prob.0.0053). The third position by environmental hostility was occupied by energy generated from wood with an average score of 2.94 (Table 4). The most environment-friendly in the opinion of the respondents is solar energy, which was regarded as the most environment-friendly by 60.9% of the respondents. The highest was also the average score for solar energy (5.34). The second came wind energy, which was regarded as the most environment-friendly by 22% of the respondents (average score 4.73). On the whole, the results can be considered logical. While the contact Estonian people have with nuclear energy is only theoretical and negative due to the image created by the media, then an absolute majority of the electricity in Estonia is being produced in oil-share burned power plants and their negative effects on the environment have been witnessed by nearly all Estonian people.

C. Importance of the Electricity Source

Answers to the question „Is it important to you what kind of electricity you consume?" are following. The answers „Fairly important" and „Not important" were mentioned by a nearly equal number of respondents by 42.8 and 46.9%, respectively. Only 10.3% of the respondents regarded the issue as very important. The answer was dependent on gender (prob.0.0005, women regarded it more important) and education (prob. 0.0046, importance increased with education). The fact that for nearly half of the respondents the method of production of electricity they use is not important shows the insufficient environmental awareness of a large part of the population.

D. Preferences in Choosing the Electricity Package

Expressive is the answer to the question „What do you reckon with first of all when choosing the electricity package in the open electricity market?" (Table 5). As many as 77.2% of the respondents regard price as the most important criterion; 13.7% is choosing the package based on patriotic motives (electricity produced by Estonian producer) and only 9.1% prefers electricity produced from renewable sources. As expected the number of those who prefer electricity produced from renewable resources increases with education (prob. 0.0581) and income (prob. 0.0218), whereas, for example, gender and age are not statistically significant determinants here. Preference of cheaper electricity by more than 75% of the respondents indicates primarily that Estonian consumers are extremely price sensitive and consider relative cheapness of electricity much more important than the environment friendliness.

Table 5. Answers to the question „What do you reckon with first of all when choosing the electricity package in the open electricity market?"

Answers	Response %
Price (prefer cheaper electricity)	77.2
Electricity is produced by Estonian producer	13.7
Electricity is produced from renewable resources (green electricity)	9.1

E. Extra Willingness to Pay (WTP) for the Electricity Produced from Renewable Resources

The demand for environmental goods can be determined via asking individuals to directly or indirectly state their preferences to different commodities. The demand for environmental goods can be derived from the stated preferences. The demand approaches for investigating the value of environmental goods are divided into two categories: revealed preference and expressed preference techniques.

Expressed or also called stated preference techniques are commonly used to evaluate externalities of specific renewable energy projects. These techniques include contingent valuation methods and discrete choice [20]. In these studies people are asked to clearly state their preferences from a choice set or in prices. Undertaking these studies is time consuming due to conducting questionnaire surveys, but results are case-specific and thereby highly reliable.

Contingent valuation methods ask people to state in monetary terms how much they are either WTP for a specific scenario to be harnessed or how much they would need to be paid in order to be willing to accept (WTA) the scenario. Questionnaires can either be open ended, offer specific values (a payment card) or compose of a bidding game [20].

The contingent valuation method is used in the current study in order to identify WTP for the electricity produced from renewable resources.

The first application of the contingent valuation method took place in 1963 when Davis [21] tried to estimate the value hunters and tourists placed on a wilderness area. In the mid-1970s, the contingent valuation method started to spread rapidly. Since then the method has grown increasingly more popular and is widely used in all advanced democracies, serving as an instrument for adopting informed decisions.

Comprehensive accounts of the method may be found in Mitchell and Carson [22], Hanley and Spash [23] and Bateman and Willis [24].

Most of the contingent valuation method applications are related to environmental objects and other nonmarket goods which have the characteristics of use value [25].

In current study in addition to asking the contingent valuation question „How much are you willing to pay extra for the electricity produced from renewable resources compared to fossil fuel (e.g. oil shale and natural gas)?" an explanation was provided that when the survey was conducted the client was paying a compulsory 1.16 sents for electricity produced from renewable resources, or approximately 10% more compared to ordinary electricity. The answers are provided in Table 6. The answers demonstrate that 41.0% of the respondents are not willing to pay a higher price for the electricity produced from renewable resources. And only slightly more than 20% of the respondents are willing to pay the obligatory or higher than obligatory price applicable in the period of the survey. Regarding the obligatory higher price of electricity produced from renewable resources the preferences of Estonian inhabitants are in sharp conflict with the official national policy. The answers to the question evidence that Estonian electricity consumers are not willing to pay the obligatory 10% higher price of electricity from renewable resources compared to ordinary electricity. Higher willingness to pay for electricity produced from renewable resources is positively correlated to higher income (prob.0.0196) and negatively to age (prob. 0.0000). Also, women's willingness to pay extra is higher (prob. 0.0042).

Table 6. The answers to the question „ How much are you willing to pay extra for the electricity produced from renewable resources compared to fossil fuel (e.g. oil shale and natural gas)", %

Answers	Response %
I am not willing to pay extra	41.0
I am willing to pay extra 3%	19.5
I am willing to pay extra 5%	17.8
I am willing to pay extra 10%	15.5
I am willing to pay extra 20%	5.1
I am willing to pay extra 30%	0.8
I am willing to pay extra 50%	0.3

The input data for the total willingness to pay calculation is the willingness to pay questionnaire survey of a representative sample of Estonian adult population for the electricity produced from renewable sources. On the basis of that an aggregate demand function for electricity produced from renewable sources is cleared up and the respective demand curve is constructed.

To construct the demand curve let's find the best approach (which also is the general equation for aggregate demand function):

$$WTP = ae^{-bX} \quad (2)$$

where WTP is total willingness to pay, x is the number of people who are willing to pay at least that sum, and α, β are the parameters assessed. 1 answer corresponds to 1031 adult Estonian people.

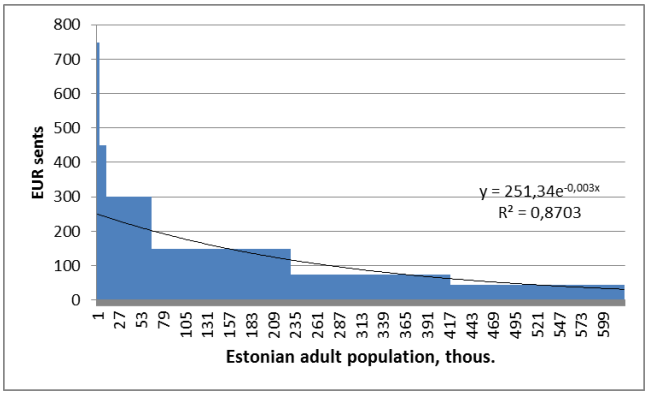

Fig. 2. Willingness to pay of Estonian adult population for electricity produced from renewable sources of energy, monthly

Aggregate demand of Estonian population for electricity produced from renewable sources is mathematically equal to the space under the demand curve on the graph. Aggregate demand is calculated by integrating the demand curve on the graph based on the equation:

$$WTP_T \int_{x_1}^{x_2} \alpha e^{-\beta x} = -\frac{\alpha}{\beta}\left(e^{-\beta x_2} - e^{-\beta x_1}\right) \cong \frac{\alpha}{\beta} \quad (3)$$

where $x_1=0$ and x_2 are the number of people with positive willingness to pay.

$$WTP=\alpha e^{-\beta x} \quad (4)$$

$$WTP = 251.34e^{-0.003x} \quad (5)$$

$$WTP_T = \frac{\alpha}{\beta} = \frac{251.34}{0.003} \approx 83.780 \quad (6)$$

Given the above, Estonian adult population's total willingness to pay for electricity produced from renewable sources of energy is 83.780 million euro sent = 837,800 euro.

1,581,442 euro are actually paid monthly by Estonian adult people for electricity from renewable sources.

Consequently the amount of the charge established by the government that is to be additionally paid for electricity produced from renewable resources exceeds nearly twofold the consumers' actual willingness to pay.

V. Conclusions

The sample survey that is representative for the Estonian working-age population showed that nuclear and oil-shale electricity are regarded as equally the most environmentally hostile and solar panels produced electricity as the most environment-friendly. Roughly half of the Estonian electricity consumers attach no importance to the source and technology of electricity production. Production from renewable energy sources is the primary criterion for choosing the electricity package for only approximately 10% of the population. For more than three quarters of the consumers the most important criterion when choosing the electricity package under the open electricity market is the price, showing that Estonian electricity consumers are extremely price sensitive, receding the criterion of environment-friendliness quite to the background.

The additional total willingness to pay of Estonian electricity consumers for electricity from renewable resources is approximately half the obligatory amount established by the state with (and factually paid) extra charge. Hence the research results confirm the discontent of electricity consumers with the established obligatory extra charge for the electricity from renewable sources of energy. Approximately half of the consumers completely disagree to pay a higher price for renewable energy in comparison with ordinary electricity.

The surcharge on electricity produced from renewable sources has rapidly increased the share of electricity produced from renewable sources, but it does not conform to the consumers' willingness to pay. A reason for this is, on the one hand, Estonian consumers price sensitivity, but, on the other hand, probably also consumers' doubts about the environment friendliness of wind and hydro energy, which is confirmed by earlier studies by the authors [26]-[29].

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