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The Preference of Romanian Consumers for Renewable Energy

– Thesis summary –

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Iaşi, April 2014

Introduction

The energy sector makes intensive use of fossil fuels, thus significantly contributing to the deterioration of the environment. However, the academic and journalistic wave of support for the development of ESR seems to only focus on its positive effects, while the disadvantages of ESR, such as the high investment cost and the destabilizing effect that its intermittency has on electricity grids, are minimized or omitted altogether.

Research problem and scope of the study

The principal aim of this doctoral research is to evaluate the target population's willingness to make financial sacrifices in order to encourage the production of electricity from renewable sources. The indirect impact of such sacrifices would be an improvement of the quality of life at an overall society level in several aspects: energy independence, economic development and the reduction of pollution impacts on the environment and human health. Depending on the specific interests shown by the consumers, companies from the field could adapt their marketing policies in order to better address some of the public's preferences or those of a specific market segment.

The research refers exclusively to renewable electric energy – not thermal. In addition, the analysis is focused on industrial scale ESR generation projects and does not take into consideration investments in microgeneration applications.

Research objectives

This study has three main objectives, each of them with a number of corresponding secondary objectives. To these objectives we have associated a series of 13 hypotheses. The research objectives are the following:

O_1 – Identify and present the technological, societal and market context of the production and consumption of electricity.

O_2 – Segment the household electricity consumer market in the county of Iaşi and describe the segments based on consumption preferences and lifestyles.

O_3 – Determine the willingness of household electricity consumers in the county of Iaşi to pay in order to benefit from the positive effects of ESR development and use.

State of knowledge at the time when the research was carried out

At the time when the current doctoral research was carried out, very few academic, journalistic or commercial studies existed that provided an analysis of the Romanian electricity market from the perspective of household consumers. Traditionally, the segmentation of CC was based on socio-demographic classifications. Given the poor explanatory power of socio-demographic traits and ecological behavior, but also the limited practical usefulness of this

approach, we focused mainly on more recent research that uses lifestyle segmentation of consumers.

With regard to the assessment of consumers' WTP, the most recent studies use "choice modelling" techniques and, among these, specialists consider DCE to be the most practically useful and theoretically valid method.

Research methodology

The study was carried out in several stages, using various types of research (secondary, primary-exploratory and primary-descriptive-causal). The secondary research was useful in meeting all of the research objectives, but it played a dominant role in the case of objective O_1. The main data sources used were analysis reports, academic articles, books and other specialized works, but also a large number of laws and regulations applied in the energy industry as well as the annual reports of companies from the field. We used a total of approximately 300 references.

The primary-exploratory research was used in order to meet the secondary objectives $O_{1.2}$ and $O_{3.1}$. Its focus was to establish importance scores for the sustainability indicators of the electricity generation technologies and for the various attributes (or positive effects) of the development of the ESR sector. This part of the study was based on a survey of Romanian higher education specialists from the fields of energy and environmental protection. An online questionnaire containing 7 questions was used, and the respondents were selected using the principles of "judgment sampling". The link to the questionnaire was emailed to 292 academics from faculties and departments specialized in energy and environmental protection from six Romanian universities, insuring a wide geographical coverage. The survey received 62 responses, which have a balanced distribution between the four main university centers in Romania and a nearly uniform spread among the four academic ranks.

The primary-descriptive-causal research represents the focal point of this doctoral thesis, and its design is a result of the entire secondary and exploratory research carried out throughout the rest of the study. As part of this research stage, we sought to meet objectives O_2 and O_3: market segmentation and the assessment of consumers' WTP for the development of ESR. Generally speaking, we used a questionnaire based survey. However, the methodology also includes a DCE, which adds a causal component to this research stage. The questionnaire was administered both in the traditional format (158 valid responses) and online (69 valid responses). We used a convenience sample with the target population consisting of persons above the age of 18 which live in the county of Iaşi. Although this sampling procedure creates a limitation with regard to the representativeness of the sample, other similar studies published in prestigious academic journals make frequent use of this kind of approach. The sample size of 227 respondents is nearly four times larger than the minimum sample size recommended in order to successfully carry out a DCE. The respondents have relatively balanced socio-demographic traits and their residences are proportionally spread among the main urban and rural localities in Iaşi County.

Research results

In the first part of the thesis we review the main technologies that are presently being used worldwide to generate electricity, looking at the type of fuel they use and the functioning principles on which they are based. Given that using any of these technologies to generate electricity does have a negative impact on the environment and human health, we decided to make a comprehensive comparative assessment of their compatibility with the sustainable development of humanity. We compare 13 technologies based on 10 variables called "sustainability indicators", which are used in order to perform a lifecycle evaluation of the electricity generation units from an economic, technological, ecological and socio-political perspective. The sustainability ranking is constructed using a weighted sum multi-criteria decision analysis. In order to differentiate the sustainability indicators based on their importance for sustainable development, we used the results of the survey among the 62 Romanian academic experts in the field. The results of the research rank large scale hydroelectric projects at the top of the sustainability ranking, followed by small hydroelectric, onshore wind and solar photovoltaic. The lower end of the ranking includes the coal and petroleum based generation units. It is worth mentioning that nuclear and natural gas plants have an overall score that places them in the middle of the ranking, above some ESR technologies such as biomass and geothermal.

Another aspect that we looked at throughout the thesis was the legal environment and the structure of the Romanian electricity market. Based on ample secondary research we created a map showing the evolution of the Romanian electricity sector: starting from the state owned monopoly of RENEL, which controlled all four components of the industry value chain, and arriving at the current semi-privatized industry structure, which includes numerous entities involved in the production and supply of electricity and in which the transmission and distribution maintain a high degree of consolidation. In addition, we note that, although the electricity market has been fully liberalized since 2007, none of the 8.4 million Romanian household consumers had switched electricity suppliers by the end of 2012.

With regard to the legal environment, we first look at the international energy policy context and observe a generalized worldwide tendency to promote the development of low polluting electricity generation. This trend is also promoted at the EU level. We consider that, while some of these measures are truly motivated by the desire to preserve and protect the environment and human health, another major role played by such policy measures is to reduce the EU's dependence on fossil fuel imports.

In the case of Romania, we note a policy approach that is in line with other countries that are very close to reaching the ESR targets set by the EU – using a green certificate based ESR support mechanism, which is aimed at attracting investment mainly in large scale generation projects, thus reducing the need to refurbish the national transmission and distribution networks. However, the recent changes in how the support mechanism functions have created an unpredictable legal environment, which is likely to generate hesitation among several potential investors.

Other relatively recent changes that have taken place on the Romanian electricity market are liberalization and deregulation. These are aimed at aligning the Romanian and European energy legislation, but also at increasing the level of competition on the electricity market. Unfortunately,

after a more detailed assessment of the realities that exist on the market, we conclude that household consumers have limited (mostly theoretical) freedom to choose their supplier, caused by their reduced relevance on the market and by the limited ability to serve and low interest that suppliers have in attracting household consumers into their client portfolios. In addition, it is likely that the current legal framework and the perspectives regarding the evolution of the European and Romanian energy legislation will generate a progressive and significant rise in electricity prices over the medium and long term.

The data for the descriptive-causal research were collected using a survey based on a questionnaire which was administered primarily on paper, but also online. In the end we collected and validated the responses of 227 electricity consumers that live in the county of Iaşi.

In order to better understand the preferences of the household consumers, we decided to perform a market segmentation using psychographic (not socio-demographic) traits. Consumer lifestyles were evaluated through a set of 19 general life practices, ranging from socializing with other persons to non-food shopping and taking part in sports and other physical exercises. The assessment scale was adapted from the one used by Axsen et al. (2012) on a large sample of residents from San Diego, California. By using principal components analysis, we were able to reduce the initial set of 19 variables to six consolidated lifestyle components: "work and relationships", "recreation", "health", "techno-environmental", "family unity" and "volunteering-spirituality".

The actual segmentation of the consumers was performed through a cluster analysis. The solution deemed to be the most useful for the analysis included six market segments: "Introverted" (29 members), "Carpe diem" (23 members), "Modern" (38 members), "Solo-active" (40 members), "Active" (67 members) and "Traditional" (28 members).

The final stage of the study consisted of assessing the preference of consumers for the various positive effects of ESR development. After an extensive literature review regarding the study of WTP, we concluded that the DCE is the most adequate approach for the current research undertaking. The experimental design that was used was a 4^5, balanced, "main effects" model built based on a fractional orthogonal set of profiles or offerings. In order to create the choice sets, we used the "shifting" method to generate 16 sets, each with two profiles that are described through five attributes (including cost) and a "status quo" alternative.

The attributes that we chose for the experimental design were established based on a literature review, followed by a primary exploratory study among Romanian academic experts in the field. The positive effects of ESR which are included in the research are: Romania's degree of energy independence, the creation of new jobs at the county level, the reduction of pollution effects and additional income for the development of rural areas in the county. The cost variable was defined as additional cost in the monthly electricity bill. The adequate levels for these attributes were established through extensive secondary research.

Based on the two questions associated with each choice set, we decided to analyze WTP from two distinct temporal perspectives: short-term (based on a reduced sample and also considering the possibility of choosing to maintain the current electricity offering) and long-term (using an extended sample and eliminating the "status quo" alternative).

After analyzing the data, we observed that in the case of the main model (short-term), the variable that refers to the development of rural areas was statistically significant only at the 10% level, making its inclusion in the model questionable. Based on the analysis, we concluded that respondents would be willing to pay an additional 17 Lei per month for electricity offering that offered an average improvement of the first three attributes. By including the rural development variable in the analysis, the amount increases to 19 Lei per month. The excellent quality of the predictions based on the current model is demonstrated by the value of the McFadden adjusted-R^2 of 0.30 – specialists from the field state that a value between 0.2 and 0.3 can be translated to an R^2 of 0.7 to 0.9 in the case of linear regression.

One of the assumptions that the CML model uses is that these WTP values are homogenous across the entire sample. However, there are some procedures through which we can study the differences between the preferences of the various respondent categories. Thus, we were able to determine that consumers who have an above average monthly income (at the household level), as well as people who have children, those who are older rather than younger and those who live in an apartment as opposed to a house are willing to pay more than the rest of the sample in order to reduce the effects of pollution. In a surprising contrast, we found that people with a Bachelor's degree or higher are willing to pay less for pollution reduction compared to the rest of the sample. Our results show that: women have a higher preference than men for offerings that increase Romania's level of energy independence, people with a Bachelor's degree or higher are willing to pay more to increase the funds available for rural development, while people who live in apartments are willing to pay less for such improvements. In addition, we found some dissimilarity with regard to the preferences of the various market segments. However, given the low number of observed contrasts, we question whether the psychographic segmentation has sufficient practical usefulness.

Our calculations showed a marginal monthly WTP for an additional local job of 0.04 Lei in South Korea, of 0.12 Lei in Scotland (not statistically significant) and of 0.38 Lei in the case of the population that we assessed in Iaşi County. We feel that this is another surprising result, not just given the direction of the difference, but especially given its magnitude. We can thus conclude that consumers in the county of Iaşi have a much higher preference for job creation compared to the persons interviewed in South Korea. The dissimilarities cannot be explained by a difference in the unemployment rate, which was similar in the two locations at the time when the studies were conducted. Investigating the reasons why the two target populations express such dissimilar preferences can serve as the aim of a future study.

After estimating the secondary preference model, we determined that, on the long-term, the assessed population has a willingness to pay of approximately 26 Lei per month for an average improvement of the socio-ecological attributes (37% higher than in the case of the main model). However, this model remains a hypothetical one, whose validity depends on a series of assumptions. It is possible that, due to a partial violation of these assumptions that the quality of the prediction capacity is somewhat lower than in the case of the main model (McFadden $R^2 = 0.26$).

As part of this thesis, we generated and verified 13 hypotheses which were connected to the primary and secondary objectives of the doctoral research.

Table 7.1 of the thesis: The results of the hypothesis tests

Objective	Hypothesis	Test result
O_1	Hypothesis $H_{1.A.1}$ – The wind and solar PV technologies are not the most sustainable electricity generation alternatives	confirmed
	Hypothesis $H_{1.A.2}$ – Nuclear plants have a higher level of sustainability compared to some conventional thermal technologies and some ESR technologies	confirmed
	Hypothesis $H_{1.B.1}$ – Most household consumers in Iaşi County are not aware of the fact that they can switch electricity suppliers	confirmed
O_2	Hypothesis $H_{2.1}$ – Lifestyle based segmentation produces different results compared to socio-demographic segmentation	partially confirmed
	Hypothesis $H_{2.2}$ – Psychographic based market segments have a different level of knowledge regarding the impact of EE generation on the environment and energy efficiency compared to socio-demographic based segments	valid (could not be tested)
O_3	Hypothesis $H_{3.A.1}$ – Consumers who have children have a higher WTP for the reduction of pollution effects compared to those who do not have children	confirmed
	Hypothesis $H_{3.A.2}$ – Consumers with a higher level of education have a higher WTP for the reduction of pollution effects compared to the rest of the population	not confirmed
	Hypothesis $H_{3.A.3}$ – Women have a higher WTP for the reduction of pollution effects compared to men	partially confirmed
	Hypothesis $H_{3.A.4}$ – People with a higher income have a higher WTP for the reduction of pollution effects	confirmed
	Hypothesis $H_{3.B.1}$ – The "Introvert" segment has a higher WTP for the reduction of pollution effects compared to the "Active" segment	confirmed
	Hypothesis $H_{3.B.2}$ – The "Traditional" segment has a higher WTP for the reduction of pollution effects compared to the "Active" segment	confirmed
	Hypothesis $H_{3.C.1}$ – The impact of various energy policies on the labor market has a significant impact on the choices made by the respondents	confirmed
	Hypothesis $H_{3.C.2}$ – The population of Iaşi County has a lower WTP for the creation of new local jobs compared to that of Scotland or South Korea (countries where similar studies were made)	rejected

Contributions

The current doctoral thesis incorporates several personal contributions such as:

- one of the first studies of the Romanian electricity market from the perspective of the household consumers;
- a review of the most relevant electricity generation technologies and a rigorous comparison of their compatibility with the sustainable development of humanity;
- an additional consumer lifestyle component is identified and the explained variance increases from 42% in the case of Axsen et al. (2012) to 65%;

- two choice experiments are effectively integrated in a single DCE scale, which allowed us to generate two preference models with different temporal perspectives – this is the only WTP study that we have identified which performs such an analysis;
- an original approach in identifying and eliminating the dominated choice sets while maintaining the original research design (orthogonal and balanced);
- the sustainability assessment of the EE generation technologies brings three contributions to the field: we evaluate a practically complete set of technological alternatives, the indicators that were used cover all sustainability dimensions exhaustively, and the technology ranking is based on a weighting of the indicator importance based on the opinions expressed by Romanian academic experts from the field;
- a novel approach is used to compare the electricity suppliers' ability to serve household consumers;
- some practical examples are given on how to select the optimal solution from a set generated through cluster analysis.

Managerial implications and usefulness of the study

We identify five components of the research that can have implications or can aid in the activities of entities such as energy companies, environmental NGOs, governmental authorities, researchers or journalists interested in the field:

- The high level analysis of the Romanian energy sector is useful to industry experts, researchers and journalists.
- The sustainability assessment of the various electricity generation technologies is especially useful for governmental authorities and to people with decisional power with regard to the encouragement of energy investments of a certain type.
- The assessment of the preferences of the various household consumer segments is useful for electricity suppliers.
- Establishing the WTP of household consumers is useful both to the governmental authorities and to the energy companies.
- The detailed description of the DCE methodology and its use on a sample of Romanian consumers can serve as an example to companies or specialists who are interested in the study of any consumer market in Romania (not just electricity).

Implications for fundamental research

The current research provides indirect support to the principles of free market environmentalism, proving that environmental protection could be achieved without having to impose external obligations on the public.

In addition, our results can be used as a reference in performing comparisons between various geographies or populations with regard to the relevant ESR attributes and the WTP.

Finally, the fact that the results are nearly identical between our research (performed in Iaşi County) and that of Axsen et al. (performed in 2012 in San Diego, California) confirms the validity of the scale used in the lifestyle assessment.

Research limitations

One limitation of the current research results from the sampling procedure. In the thesis we offer several arguments in favor of convenience sampling and present the reasons why a probabilistic sampling approach would have been difficult to implement adequately. The main research in this field uses completely random selection of respondents, without considering, as we have done in our study, a separation of consumers based on their ability actually opt for a different electricity offering. However, we admit that a convenience sample cannot guarantee the representativeness of the results at the level of our target population.

Another limitation of the study results from a lack of preliminary validation of the scales used for market segmentation and level of knowledge assessment among the respondents.

Finally, we mention two limitations that result from the use of the DCE: we cannot precisely verify to what extent the respondents have immediately understood how to correctly answer the DCE scale or if they all responded using the same interpretation of the questions. These are discussed in more detail within the thesis.

Possible research extensions

We believe that future extensions of the research should focus on eliminating or the abatement of some of the limitations and issues encountered in the original study. Another important extension, which could increase the practical usefulness of the research, would be to use a "Latent class" model in estimating consumer WTP.

At the end of the thesis we list several other possible research extensions that we have identified throughout the study.