Charles University in Prague

Faculty of Social Sciences
Institute of Economic Studies

MASTER THESIS

Willingness to pay for green electricity

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Academic Year: **2014/2015**

Declaration of authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature. The author also declares that he has not used this thesis to acquire another academic degree.

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In Prague, July 30th, 2015

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Signature

Acknowledgements

My heartfelt thanks go to Dr. Milan Ščasný, the supervisor of the thesis, for guiding me with endless patience, to Mgr. Martin Kryl for his help with programming on-line version of the instrument questionnaire, to Dr. Mikolaj Czajkowski for his kind support with the experimental design, to Dr. Antonieta Cunha e Sá for her valuable insights into Environmental Economics and especially to my beloved family.

This thesis was financially supported by research grant No. 368715 awarded by Grant Agency of Charles University.

The research leading to these results was supported by the People Programme (Marie Curie Actions) of the European Union's Seventh Framework Programme FP7-PEOPLE-2013-IRSES under REA grant agreement number 609642.

The responsibility for all errors is mine.

Abstract

We estimate the willingness to pay for electricity generated from renewable energy in the Czech Republic. Discrete choice experiment is used to elicit preferences for various attributes of renewable electricity support scheme (PM emission, GHG emission, size of RE power plant, revenue distribution, and costs). Original survey is carried with 404 respondents living in two regions – Ustecky (polluted area) and Southern Bohemia (cleaner area). We find that respondents prefer decentralized renewable electricity sources over centralized, local air quality improvements over reduction in greenhouse gas emissions. Estimated marginal willingness to pay for 1% reduction in emission of particulate matter equals to 49 CZK, respectively 3.7 % of average monthly electricity bill. In total, WTP for green electricity is larger than current compulsory contributions to renewable energy support scheme.

JEL Classification	Q21, Q41, Q42
Keywords	Green electricity, renewable energy, consumer preferences, willingness to pay, stated preferences, discrete choice experiments, choice data, multinomial logit
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Abstrakt

Odhadujeme ochotu platit za elektřinu vyrobenou z obnovitelných zdrojů energie v České republice. Ke zjištění preferencí spotřebitelů pro různé hodnoty atributů (emise prachových částic, emise skleníkových plynů, velikost zdroje elektřiny z OZE, rozdělení příjmů a nákladů) schémat podpory elektřiny z OZE je použit výběrový experiment. Původní výzkum je proveden na vzorku 404 respondentů žijících ve dvou krajích – Ústeckém (znečištěná oblast) a Jihočeském (čistá oblast). Docházíme k závěrům, že respondenti upřednostňují decentralizované OZE oproti centralizovaným OZE, zvýšení kvality ovzduší v místě bydliště oproti snížení emisí skleníkových plynů. Odhadnutá hodnota ochoty platit za 1% snížení emisí prachových částic činí 49 CZK, což odpovídá 3.7 % průměrné měsíční platby za elektřinu. Ochota platit za zelenou elektřinu je vyšší než současný povinný příspěvek na podporu obnovitelných zdrojů.

JEL Klasifikace	Q21, Q41, Q42
Klíčová slova	Zelená elektřina, obnovitelná energie, preference spotřebitelů, ochota platit, stanovené preference, výběrový experiment, výběrová data, multinomial logit

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Master Thesis Proposal

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Proposed Topic:

Willingness to pay for green electricity

Topic Characteristics:

European Union (EU) has made a critical choice to become the world leader in action against the climate change. Current ambitious aim is to stop the increase of global average temperature via decreasing quantity of global greenhouse gas (GHG) emissions. Essential role of the EU is to persuade countries all around the world to engage in the challenge, but this is impossible without exemplary behavior of European countries.
All member countries of the EU have committed themselves to reduce GHG emissions. Individual countries possess freedom in choosing the most effective way of reaching individual targets. Properly evaluate different conceptions is thus the task of great importance.

Energetic sector is one of the main sources of GHG emissions in the Czech Republic. When majority of energy (meaning heat and electricity) is still produced by coal power plants, the commitment to reduce GHG emissions leads necessarily to more "green" energetic mix.
The objective of the thesis is to support the future decision process with the better knowledge of households' preferences about green electricity.
There are several controversial topics, for example whether to produce electricity by centralized or decentralized sources, whether to invest primarily in areas with worse air quality or equally, or whether to finance the investments by taxes that are increasing electricity prices or from the state budget.

The survey will be developed in order to obtain relevant data. Other sources will be databases of Czech Hydrometeorological Institute, Ministry of Trade and Industry of the Czech Republic, Energy Regulatory Office and others.

Hypotheses:

1. Hypothesis #1: Households that are living in areas with worse air quality are willing to pay more for green electricity.
2. Hypothesis #2: Households are willing to pay more for green electricity from small decentralized sources, even though it would be less effective than big centralized sources.
3. Hypothesis #3: Households are willing to pay less to support increase in green electricity share than what is actual contribution in the Czech Republic.

Methodology:

I will start with comprehensive review of relevant literature, focusing on appropriate valuation methods and econometric models for analysing preference of individuals for attributes of residential electricity supply. An instrument, a questionnaire, will be prepared and properly pre-tested. Stated preference method will be applyed in order to obtain willingness to pay for individual categories. The mixed logit model for discerete type data will be employed in order to allow for heterogeneity in unobserved factors and to estimate willingness to pay and test the hypotheses.

Outline:

Introduction
Electricity generation in the Czech Republic – historical background, future alternatives
Literature review
Survey – methodology, and data description
Econometric model
Estimation results
Conclusions

Core Bibliography:

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1 Introduction

The European Union (EU) has made a choice to become the world leader in action against the climate change. Current ambitious aim is to stop the increase of global average temperature via decreasing quantity of global greenhouse gas (GHG) emissions. Essential role of the EU is to persuade countries all around the world to engage in the challenge[1], but this is impossible without exemplary behavior of European countries.

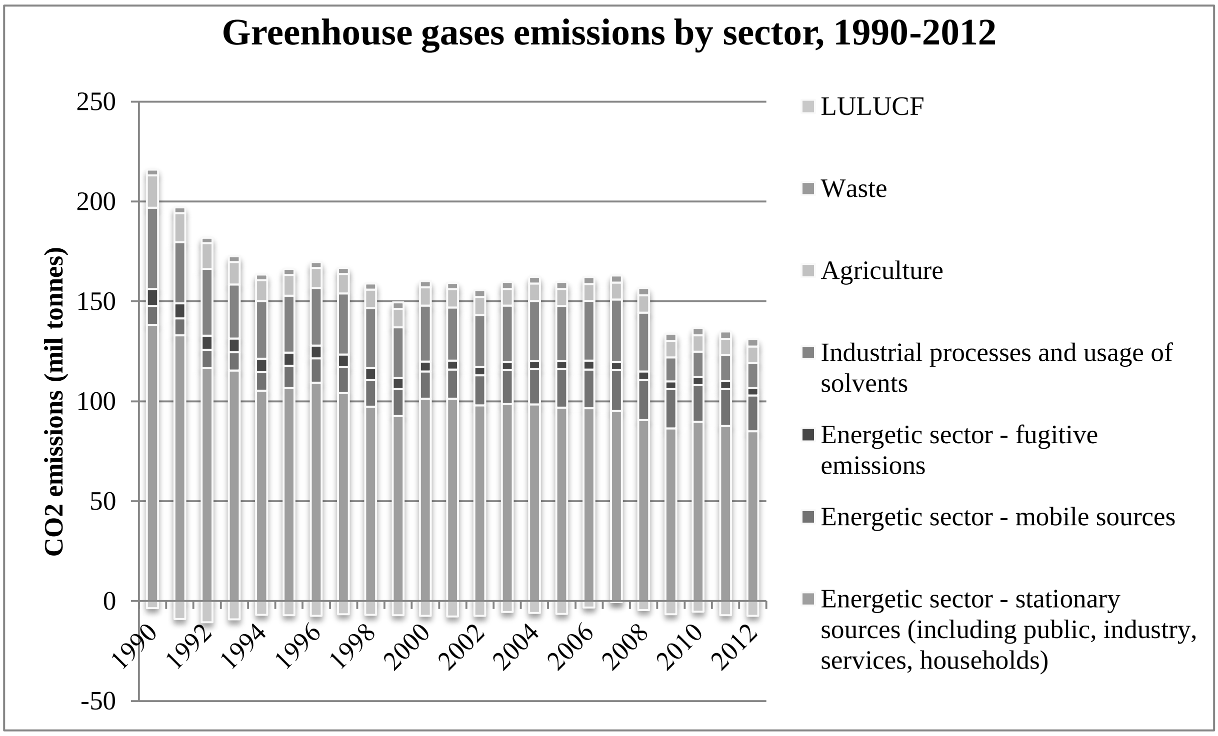
All member countries of the EU have committed themselves to reduce GHG emissions. The EU climate energy policy set the 20-20-20 policy target to be achieved by 2020. This policy has been then updated in 2014 by setting the EU policy commitment to 2030. Individual countries across the EU possess freedom in choosing the most effective way of reaching individual targets. Properly evaluate different conceptions is thus the task of great importance.

The objective of the thesis is to support the future decision making process with the better knowledge of households' preferences about *green energy* and in particular *green electricity*.

Share of Czech GHG emissions out of EU 28 member countries is 2.9%, value of GHG emissions per capita was the fifth highest in the EU, however, there is a substantial decrease of 33% compared to year 1990 (EEA data for 2012). Figure below shows the evolution of GHG emissions in the Czech Republic by sector (CENIA). Power sector is further divided into public power sector (including public electricity and heat production), industrial plants, and energy use in services and by households. Public power sector is generally one of the main sources of GHG emissions in the EU, in EU28 it accounted for 27% of total GHG emissions in 2012, in the Czech Republic it accounted for 40% of all GHG emissions in 2011 (EEA).

[1] This effort is supported by the United Nations that organize the Paris Climate Change Conference in 2015. Major objective of the conference is to achieve a legally binding and universal agreement on climate.

Figure 1 Greenhouse gas emissions in the Czech Republic by sector, 1990-2012 (mil tons of oil equivalents); source: CENIA[2]

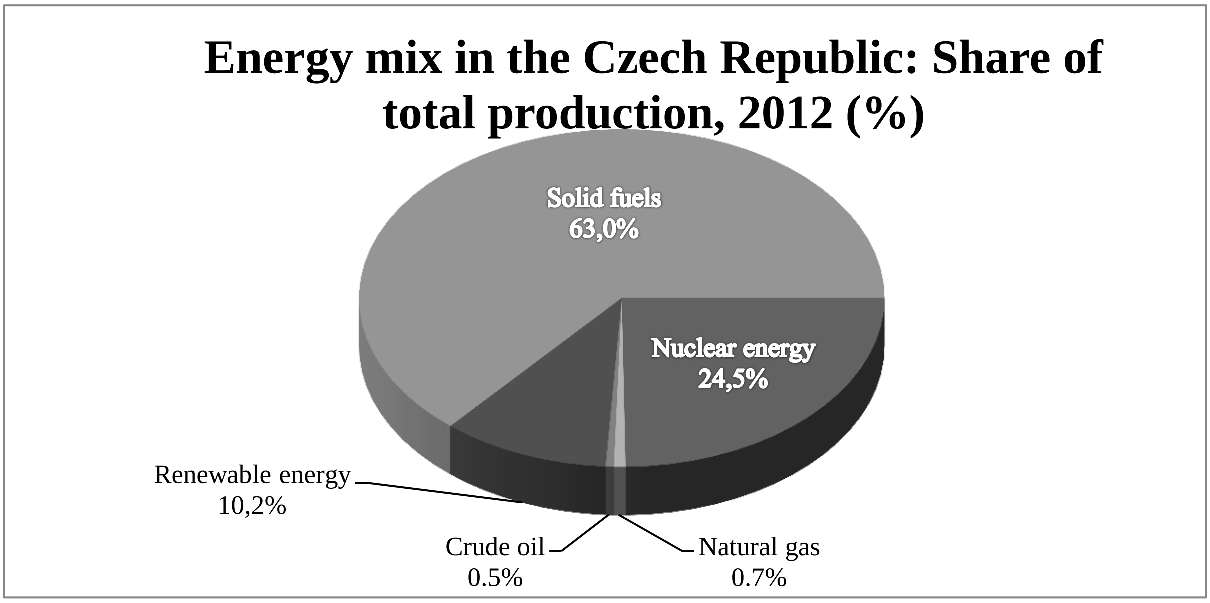


When majority of energy in the Czech Republic is produced from solid fuels (Eurostat), i.e. coal power plants (Figure 2), the commitment to reduce GHG emissions leads necessarily to more "green[3]" energy mix. The second best option is nuclear power energy, which does not produce greenhouse gas emissions either, but its security is currently being discussed after Fukushima nuclear power plant accident (for more see Evangeliou, et al. 2014, Sugiman 2014).

[2] http://issar.cenia.cz/issar/page.php?id=477

[3] We use terms "green energy" and "green electricity" for energy and electricity produced from renewable resources, i.e. wind, solar, water, geothermal, biomass.

Figure 2: Energy mix in the Czech Republic: Share of total production, 2012 (%), Data source: Eurostat



Another important record is that net export of electricity account for 19% of total electricity production of the Czech Republic in 2011 (CSO, 2013). This leads to a simple conclusion that a reduction in electricity generation would lead to significant GHG emissions reduction without affecting energetic security of the Czech Republic.

There are several more controversial topics, for example whether to produce electricity by centralized or decentralized sources in order to achieve highest possible level of energy security, whether to invest primarily in regions with worse air quality, or whether to finance the investment by direct taxes that are increasing electricity prices or from the state budget. We provide answers to those questions from perspective of consumer preferences.

In this paper we analyze potential household demand for electricity generated from renewable resources, i.e. green electricity, based on data from a stated preference type of survey conducted in the Czech Republic. Recall that in the stated preference surveys, respondents are asked to express their preferences for hypothetical products characterized by specific attributes.

Our research is novel in several respects: first, our experimental design allows us to elicit preferences for decentralized vs. centralized production of green electricity and for a reduction in two complementary substances; second, our sample allows to explore whether preferences differ in relatively more polluted region; and third, we contribute to the literature by providing the WTP estimates for a country from CEE region for that such values have not been provided yet.

We find that respondents prefer decentralized renewable electricity sources over centralized, local air quality improvements over reduction in greenhouse gas emissions. Estimated marginal willingness to pay for 1% reduction in emission of particulate matter equals to 3.7 % of average monthly electricity bill. In total, WTP for green electricity is larger than current compulsory contributions to renewable energy support scheme.

Respondents who live in more polluted areas have stronger preference and hence larger WTP for reducing PM emissions (H0 is not rejected). However, effect of actual air quality in respondent's place of residence was not found statistically significant.

Structure of the thesis is as follows. Chapter 2 focuses on electricity markets, from both, European and Czech perspective. Chapter 3 summarizes main results from the review of relevant literature. Methodology, experimental design and main hypotheses are described in chapters 4 and 5. In chapter 6 the econometric model is shown. Chapter 7 contains full description of carried experiment. Final results are provided in chapter 8.

2 Electricity Markets

"Young generation has the impression that the better world is coming along with them, old breed feels that with them the better world is passing away."

Karel Čapek

2.1 European perspective

Recent massive introduction of green electricity in the European Union is natural consequence of European effort of climate change mitigation activities. At first we look at this effort from broader view. As the 5^{th} Intergovernmental Panel on Climate Change (IPCC) report (2013) argues, with 95% level of confidence the global warming is caused by human activities. Deforestation, agriculture and burning of fossil fuels are identified as main causes of global warming.

Global warming has not been considered as a global problem for a long time in history, especially due to the phenomena of negative externalities. Focusing on the process how mankind affects global temperature, in all above-mentioned causes (deforestation, etc.), it is happening mainly via increasing emissions of green-house gases (GHG), predominantly of carbon dioxide (CO_2) and methane.

The 5^{th} IPCC (2013) report indicates that the global warming have an accelerating trend during last 60 years. The report concludes that human activities affect the climate with certain delay and claims that even when human would immediately terminate all activities that are causing GHG emissions, the climate change resp. the global warming has already started and is in irreversible (at least in a horizon of 21^{st} century).

There is vast number of studies calculating the effects of climate change on European countries or on the planet Earth as whole (see e.g. Tol, 2002 or Parry, 2009). Nicholas Stern (2006) claims that the "do nothing" strategy will cost at least 5% of world's GDP annually, and in case of more dramatic evolution even up to 20% of world's GDP annually[4]. By Stern (2006) each ton of emitted carbon dioxide causes damage of $85.

[4] Big effect on final result has the value of discount factor – its correct value is currently broadly discussed, for more information see e.g. Groom, et al. (2005) or Beckerman and Hepburn (2007).

An increase of global average temperature of 2°C, compared to the temperature in pre-industrial times, is commonly seen as the threshold beyond which there is very high risk of dangerous and irreversible changes in the global environment. Expected costs of reducing GHG emissions below the threshold are estimated to be around 1% of world's GDP annually (in 2008 the number was corrected by Stern up to 2% annually). The author also claims that earlier is the reduction achieved, higher are the effects it has on future development.

Following the advice of the IPCC reports the European Union has implemented several measures that aim to decrease GHG emissions of member states in order to mitigate its negative effects on global climate.[5] Part of measures focuses on the evolution of the Kyoto protocol, treaty that the majority of the EU member countries together with other countries worldwide undersigned in 1997. The first commitment period of the Kyoto protocol started in 2008 and ended in 2012. Developed countries agreed in Kyoto to reduce their GHG emissions by 5.2% in total compared to 1990. Each country has set up its specific binding target.

The EU has increased the effort to reduce GHG emissions in EU member countries. The Climate and Energy Package[6], known as 2020 package, sets several binding targets in order to ensure that the EU meets its goals by year 2020. There are three key objectives included in the Package. First is a 20% reduction in EU GHG emissions compared to 1990. Second target is to raise the share of EU energy consumption produced from renewable resources up to 20%. Third target is a 20% improvement in the EU's energy efficiency. All targets are calculated for the EU as whole and allow less developed countries to achieve lower reductions, while more developed countries[7] such as Germany and Sweden committed themselves to more ambitious restrictions. This policy has been updated by setting the EU policy commitment to 2030 with the objective of i) 40 % reduction of EU's GHG emissions, ii) 27% increase of energy efficiency, both relative to the 1990 level, ii) an increase of the share of renewables on the EU's final energy consumption up to 27 %. These 2030 targets will be accompanied with the reform of the EU Emission Trading System. The 2050 Roadmap is another part of the Climate Energy Package and it sets up the target of 80% GHG emissions reduction in 2050

[5] Those efforts may lead to paradoxical outcome when reduction of GHG emissions in the EU without reducing European consumption of GHG intensive goods may lead to transfer of GHG intensive production to countries with less strict GHG emission policies, e.g. Africa and Asia. However, it is not aim of this study. For more see e.g. Davis and Caldeira (2010).

[6] http://ec.europa.eu/clima/policies/package/

[7] Economic intuition for this approach is given by the Kuznets environmental curve showing that with higher income countries value more environmental goods such as clean air, for more details see Aldy et al. (2005)

compared to 1990 levels. The reduction of GHG emissions shall be reached gradually, year by year, 40% until 2030 and 60% until 2040 (EC, 2011).

To increase the share of EU energy consumption produced from renewable resources up to 20% until 2020 is in view of European history an ambitious, nevertheless, an attainable goal. Energy in Europe has been throughout modern history produced at first mainly by burning of wood and later of solid fuels, i.e. coal (Smil, 1994). Burning of both resources leads to GHG emissions and accounts for big portion of total GHG emissions. The evolution has continued until today with more accents on the production of energy from natural gas, nuclear power plants and from renewable sources, such as solar, wind, water, geothermal and biomass.

Share of renewable energy in gross final energy consumption in the EU was 15% in 2013 (Eurostat). Share of renewables increased between years 2005 and 2013 by 6.3% which represents annual growth of 0.79%. Considering that the average pace remains equal until year 2020, the value of Share of renewable energy would be 20.5%, reaching the official target. Total emissions in EU28 decreased between 1990 and 2012 by 19.2% to 4 548 mil tons of oil equivalent (EEA).

The EU realizes parallel efforts in form of regulatory limitations of maximum allowed air pollutants in member countries, so called *Air quality standards*[8]. Such regulations are transported into national regulations and set maximum daily secure values and average yearly secure values of certain substance. In Czech legislation the *Air Protection Act* No. 201/2012 sets up limit values[9] and maximum allowed yearly amount of the exceeding.

2.2 Czech Republic

2.2.1 Energy mix

Historically the biggest portion of electricity produced in the Czechoslovakia and later on in the Czech Republic has been from carbon-intensive non-renewable resources, i.e. coal, gas and oil, together with non-renewable nuclear power. This situation is recently changing with new technologies arriving to the electricity production market, together with European Union's initiatives that aim to substitute non-renewable sources by renewables. The circumstances in the Czech Republic are slightly atypical in European context due to relatively high participation of nuclear power.

[8] http://ec.europa.eu/environment/air/quality/standards.htm
[9] http://portal.chmi.cz/files/portal/docs/uoco/isko/info/limity_CZ.html

As was mentioned above, each EU member country has set up its internal GHG emissions targets. Directive 2009/28/EC of the European Parliament and of the Council set up the mandatory target for the Czech Republic of 13% share of energy from renewable sources in gross final energy consumption and 10% share of energy from renewable sources in transport by 2020. Indicative interim targets for individual years and individual types of renewable sources of energy are set in the National Renewable Energy Action Plan (NREAP) of the Czech Republic.

Generally the target may be achieved via two different approaches, first is an increase of energy produced by renewable resources, the second is a decrease of overall energy consumption. Combination of both approaches is expected to be an ideal solution; however, the NREAP focuses more on the first approach coming out from the premise that economic growth is only possible with increased consumption of energy. Abovementioned 19 % share of net exported electricity on total production is usually not taken into account as a possibility to decrease consumption of fossil fuels.

In 2010 the final energy consumption in the Czech Republic equaled 26.8 million tons of oil equivalents. Share of individual sectors of economy on final energy consumption is following: Industry 34.4%, Transport 24.6%, Households 25.8% and Services 12.1% (Eurostat). Energy dependency defined as the share of net domestic energy consumption originating from imported energy products was 25.6% in 2010, value decreased from 28.3% in 2005 (Eurostat).

Share of renewable energy in gross final energy consumption was 12.4% in 2013. As was mentioned above, the target for 2020 is 13%.

The overall potential of various renewable energy sources in the Czech Republic (maximum yearly values with current technologies until 2050) was estimated by Pačes, et al. (2008) and it is summed up in table below:

Table 1: Overall potential of renewable energy sources in the Czech Republic: Maximum yearly values with current technologies, 2050; source Pačes, et al. (2008)

Source	**value**	**unit**
Electricity production		
Geothermal energy sources (for electricity)	10	TWh
Electricity from Photovoltaics	18.2	TWh
Hydro power plants	2.5	TWh
Wind power plants	6	TWh
Heat production		
Thermo-solar systems	8.3	PJ
Biomass	276	PJ
Biomass (theoretically when using all arable land)	700	PJ
Geothermal energy sources (for heating)	26.9	TWh
RES overall	**448**	**PJ**

The overall value 448 PJ may be converted to 10.7 million tons of oil equivalents, it equal approx. to 40% of final energy consumption (Eurostat, value of year 2010). We may conclude that the potential of renewable resources is sufficient to reach targets that the Czech Republic has obligated itself to reach.

Evolution of energy consumption should be taken into the account as well. Ministry of Industry and Trade of the Czech Republic estimates in the NREAP that energy consumption shall increase by 9.7% in total between years 2005 and 2020. However, estimated increase of energy consumption did not occur in recent years in reality, most probably as a consequence of economic crisis and lower performance of the economy. Some European countries such as Germany and Denmark (with reference to their NREAPs) plan to decrease resp. preserve same value of gross energy consumption in following years, there is no clear reason for the Czech Republic to plan future increase of energy consumption. From the NREAP it is actually not clear why the experts estimate that the consumption shall increase, when the trend is unequivocal. One of arguments for increase of energy consumption is that to achieve planned growth rates of Gross domestic product, country like the Czech Republic that has historically high proportion of industry on its GDP and industry is traditionally the most energy intensive branch. The positive relation between GDP growth and energy consumption is questionable. Chmelař (2014) however shows that high energy intensity for unit of GDP in the Czech Republic is not mainly caused by a composition of industry but by lower economic development and energy efficiency.

Attainment of the target of 13% share of energy from renewable sources in gross final energy consumption by 2020 thus seems as feasible objective. The Czech Republic may be even more optimistic if the Ministry of Industry and Trade estimates of energy consumption proved to be overestimated.

2.2.2 Support measures for promoting green electricity[10]

In the period 2005-2011, the Czech Republic has been the third largest net electricity exporter in the EU after France and Germany, net export of electricity accounted for 19% of total electricity production (OpenEI; CSO, 2013). Natural gas is mainly used as complementary fuel in multi-fired units and for peaking purposes. Combined heat and power (CHP) constitutes one third of electricity generation and over 40% of overall heat production, making the country the third largest in CHP use after Denmark and Finland (OpenEI).

So far, technologies using alternative energy resources that are producing zero GHG emissions, i.e. renewable energy sources, have not been sufficiently developed to become perfectly market competitive. One reason for this is that current infrastructure on maintenance and fuel supply is exclusively oriented towards conventional energy resources, i.e. coal, gas and nuclear.

Despite the fact that the majority of economists agree that the first best option to reduce GHG emissions (and in general negative external effects of human activities) is proper taxation, for GHG emissions concretely the carbon tax, this option has not yet been transported to households electricity consumption due to political restraints. Some countries thus implemented the feed-in prices (feed-in tariffs and feed-in premiums) that instead of taxing the polluters aim to support renewable sources to become competitive to polluting sources.

In 2005, the Czech Republic introduced legislation to stimulate renewable energy production. The Act on the Promotion of Electricity Generation from Renewable Sources set the legislative framework for the provision of support for renewable electricity generation. Feed-in tariffs (FIT) and feed-in premiums (FIP) were two key support measures for promoting electricity renewable energy sources. The FIT and FIP rates were guaranteed over 20 years, except for hydropower generators (30 years) and sewage gas fired plants (15 years).

[10] Source: EEA 2014 – Case study Czech Republic

As a result of favorable market conditions in the period 2005-2010, in combination with a decline in the prices for solar panels and with slow and inadequate reaction of Czech policy makers, the Czech Republic became the fourth most productive EU country in terms of newly-installed photovoltaic capacity in 2010.[11] However, market conditions deteriorated rapidly. In response to the increase of installed capacity, the political and media debate in the Czech Republic has generally become unfavorable to renewable energy sources. State bodies, using the estimates of the half-state-owned energy company ČEZ, warned of a danger of a significant increase in electricity prices as a result of support for photovoltaic plants (OpenEI). Also in response to these claims several changes were introduced that have significantly deteriorated market conditions for the deployment of renewable energy sources in the Czech Republic. Main changes are as follows:

- A windfall profit tax of 26% on FIT, and 28% on FIP respectively, was imposed on the photovoltaic installations brought in operation between January 2009 and December 2010 for three years until December 2013. The Czech Government and Chamber of Deputies of the Czech Parliament approved an extension of a windfall profit tax of 10% on FIT, and 11% on FIP respectively, from January 2014 onwards, for PV installations that entered into operation during 2010.[12]
- In summer 2013, the Czech Government and Chamber of Deputies of the Czech Parliament adopted a proposal that as of 1 January 2014 public support for new renewable electricity generators being provided through FIT/FIP will not be provided anymore (with an exemption for wind, geothermal, biomass and hydro power if they secure a building permit before entry of the legislation into force and in operation by 31 December 2015). This proposal was approved by the Chamber of Deputies of the Czech Parliament and will be discussed in the Senate in 2013
- Furthermore, CEPS, the Czech Transmission System Operator (TSO) declared a temporary connection moratorium (officially terminated at the end of 2011) for variable renewable electricity plants. Although renewable electricity producers were generally entitled to priority connection to the grid, the TSO argued that the grid capacity was not sufficient for additional renewable electricity installations. The TSO has demanded several amendments of the legal framework, including the introduction

[11] http://www.kinstellar.com/publications/article/developments-in-czech-renewable-energy-regulation-825/
[12] Source: Czech Government - http://www.vlada.cz/cz/media-centrum/aktualne/vlada-omezi-podporu-pro-obnovitelne-zdroje-energie-109181/

of advance payments for grid connection and the abolition of the priority access for electricity from variable RES-E. Currently the power distributors are granting grid connection permits on case by case basis.

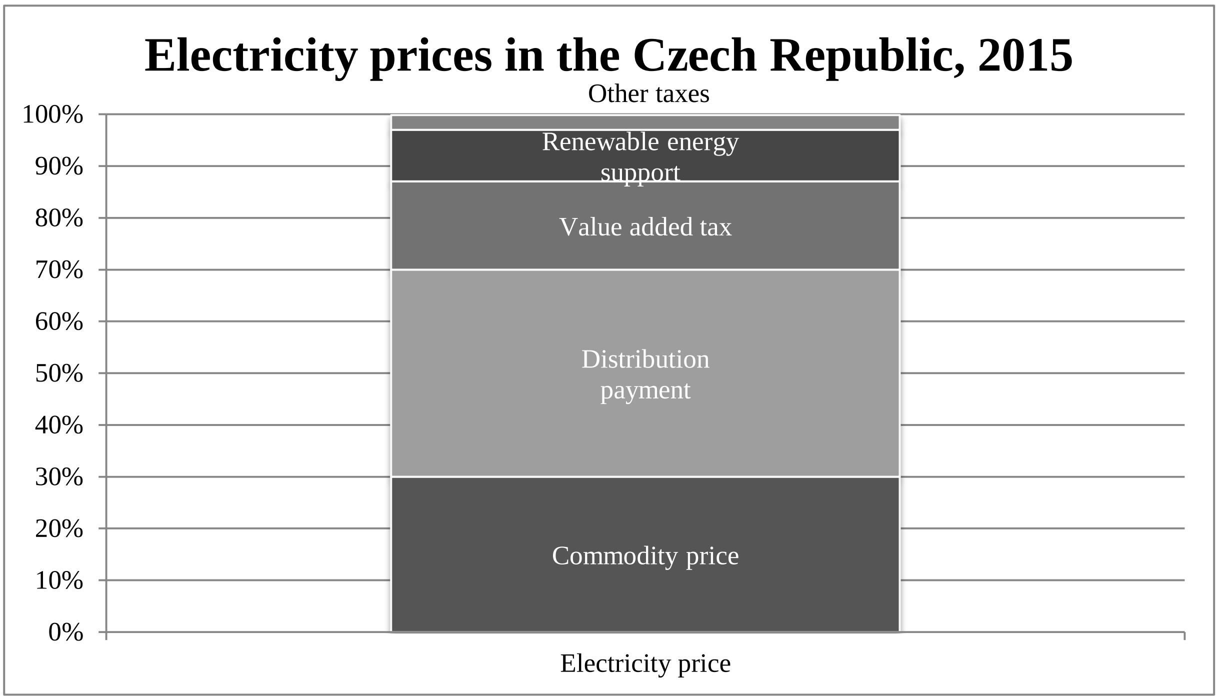
Especially the abolishment of the FIT/FIP deteriorates market conditions for new renewables significantly, as the difference in cost price between fossil fuels and renewables is not compensated anymore. In absence of FIT/FIP, it will be less financially attractive to invest in renewable energy in the Czech Republic, which will have a negative effect on new installed RES capacity. (EEA 2014)

2.2.3 Payments for the electricity

Households in the Czech Republic may choose its electricity provider and may thus influence the proportion of renewable electricity they consume. Some providers guarantee higher proportion of the renewable electricity in their energy mix, since they buy the electricity only/partly from producers of renewable electricity

Final electricity price consists of several components. Part of the price is given by market price regulated by governmental Energy regulatory office and part is given by market price.

Figure 3: Electricity prices in the Czech Republic, 2015; source http://cenyenergie.cz



First component is the payment for the commodity, i.e. the electricity itself. This part is free market price and more-less corresponds to the price of Leipzig commodity exchange price. Commodity price consists approx. 30% of final electricity price. It is paid to the provider.

Second component of the electricity price is regulated by government and altogether it forms approx. 70% of final electricity price. It particularly consists of the payment for the distribution of the electricity and consists approx. 40 % of final electricity price (33% distribution and 7% for the circuit breaker owned by the consumer). The value added tax paid to the government consists approx. 17% of final electricity price. Tax from the electricity equals approx. 0.6%, the payment for the system services equals approx. 2% and the payment for electricity market operator equals approx. 0.2% of final electricity price.

Payment for the support of renewable electricity (from which the feed-in price is paid to producers) is compulsory component of the electricity final price. It is regulated and is computed from actual consumption of electricity (kWh) equally for every consumer. The payment is currently regulated to 495 CZK/MWh. It consists of approx. 10% of final electricity price paid by households. This amount does not cover all sum of feed-in price paid to renewable electricity producers, part of this amount is paid from the governmental budget in order to avoid undesirable social impacts potentially involved by high energy price.[13]

The FIT and FIP has been financed via direct inclusion of total costs for support into electricity prices. With the rapid growth of new RES capacity in 2010 and 2011, the total amount of the contribution increased significantly, in 2005 the contribution to RES was CZK 1.7 billion, in 2013 it was CZK 44.5 billion per year (ERO, 2012).

The payment mechanism of the RES contribution was set up differently than in Germany, since in the Czech Republic not only households but also companies pay the electricity price increased by the contribution. In order to protect electricity consumers before extremely high electricity prices Czech government contributes to the amount paid by consumers, in 2013 it contributed with approximately CZK 12 billion (27% of total amount).

The RES support is not negligible. Therefore the generous support to RES across whole European Union has bear fruit in term of reduced prices. Power electricity price in Europe has

[13] http://www.cenyenergie.cz/

reduced by approximately 50%[14] since 2008 and it should stay low or even continue to decrease in following years. While power electricity price corresponded to 29%[15] of total electricity price in 2013, almost three times more than RES contribution. These two components of electricity price thus have opposite effect and more less clear out.

[14] http://www.kurzy.cz/komodity/
[15] http://www.cenyenergie.cz/cena-elektriny-z-ceho-je-slozena/

3 Literature review

Literature review chapter focuses specifically on the topic by reviewing main results of consumer preferences for electricity and renewable energy.[16]

3.1 Renewable electricity

In this chapter we provide an overview of research in two domains that are essential in order to understand full context of renewable electricity: i) values of the willingness to pay for renewable energy, ii) feasibility of renewable energy and electricity in subsistence volumes.[17]

3.1.1 Willingness to pay for green electricity

The field of study regarding the WTP for renewable energy and more specifically electricity has recently developed in very broad scientific area that offers vast number of different ways and methods how to assess consumers' preferences. In this section we describe more closely results of research and studies that focused on similar area as does this thesis.

At the beginning it is essential to stress the importance of the background of each mentioned study. We may not simply transfer results from one country or region to another, due to specific conditions at each place. However, the results obtained from mentioned studies form the main decisive factor for initial choice of attributes used in our study and set up of initial values used in the pilot of our study.

To summarize the results of literature review, the vast majority of studies conclude that there exists a positive value of willingness to pay of households for renewable energy sources. The attributes with greatest influence on value of WTP are: i) *expected change of air quality*, ii) *type of beneficiary* (decentralization), iii) *location of production,* iv) *environmental attitude of the respondent*, v) *income of the household* and vi) *level of household's electricity consumption*. According to reviewed studies, we expect following effects of attributes on WTP:

[16] In addition Annex IV presents research on feasibility of renewable electricity adoption and on effects of air pollution on human health and the environment.
[17] Overview of the research focusing the effects of GHG and other emissions produced by conventional energy and electricity sources on human health is provided in the Annex IV.

Table 2: Effects of attributes on WTP for renewable electricity (according to literature review)

Attribute	Effect on WTP for renewable electricity
Air quality (increase)	positive
Decentralization	positive
Location of production (distance)	negative
Environmental attitude	positive
Household's income	positive
Household's electricity consumption	negative

3.1.1.1 Country-specific differences

Soon and Ahmad (2015) realized the meta-analysis of research studies concerning WTP for renewable energy sources (including electricity and heat). The results of included studies vary considerably due to differences in, among others, sampling designs, valuation techniques, and types of renewable energy. Authors used a random-effect meta-analytic approach and obtained a summary WTP estimate of 7.16 USD (in 2013 prices). On average, households are willing to pay an increase of this amount per month over the price of energy they are currently paying for, to shift to RES use. The authors find that metropolitan residents and North American households have higher WTP than their rural and Asian counterparts. Important result is the evidence of genuine underlying empirical effects that more and more households are increasingly willing to pay for RES use. The types of RES do not appear to have any impact on WTP.

Huge variability may be in elicitation formats used across studies in order to estimate WTP for renewable electricity. Most frequently used elicitation format is contingent valuation.

Table 3: Stated preference studies on WTP for renewable electricity

Study	Elicitation format	Survey year	Survey country	Sample size	Mean WTP*
Bigerna & Polinori (2011)	Payment card	2007	Italy	1019	10.29
Guo et al. (2014)	SBDC	2010	China	571	3.31
Kim et al. (2013)	DBDC	2010	S. Korea	490	1.44
Kontogianni et al. (2013)	Open-Ended question	2010	Greece	312	17.1
Oliver et al. (2011)	Dichotomous Choice	2008	S. Africa	380	17.06
Soliño et al. (2012)	SBDC	2006	Spain	581	4.18
Solino et al. (2009)	SBDC	2006	Spain	572	6.5
Zhang et al. (2012)	Payment card	2010	China	1139	1.61
Zografakis et al. (2010)	DBDC	2007	Greece	1440	8.27
Zorić et al. (2012)	Dichotomous Choice	2008	Slovenia	450	7.14

DBDC = Double-Bounded Dichotomous Choice; SBDC = Single-Bounded Dichotomous Choice
* USD - 2013 base year. Data source: Soon and Ahmad (2015)

Another insight into country-specific differences was added into discussion by Alló and Loureiro (2014). The authors provided a review of existing assessments of preferences for climate change mitigation and adaptation policies through a worldwide meta-analysis. Authors found that mitigation actions were preferred over adaptation actions, and that preferences towards climate change policies are affected by attitudes towards time and social norms. In particular, societies with a long-term orientation display greater support towards climate change policies. These results therefore reveal the role of social factors as being crucial in order to understand the acceptability of climate change policies at a worldwide level. In this sense we shall be able to roughly estimate consumers' preferences at specific country relatively to another country according to long/short-term orientation of its societies.

Important aspect is the form of demand for electricity as such. Fell, Li and Paul (2010) estimated residential electricity demand for different regions in the US. The authors found that price elasticity estimates vary across the four census regions, the most price-elastic region with -1.02 and the least with -0.82, and are essentially equivalent across income quartiles. Krishnamurthy and Kriström (2015) estimated price and income elasticity for residential electricity demand in 11 OECD countries and found strong price responsiveness, with elasticities varying (in absolute value) between 2 and 4%. In contrast with very weak income responsiveness, authors found income elasticities varying from 0.07 to 0.16 and no evidence for heterogeneity across the countries.

However, there are other effects that shall be considered. One of them is the level of development of the country. Majority of the work in the field focused only on developed countries and it is not clear whether the results may be transferable to developing countries as-well. Oliver, et al. (2011) estimated WTP for renewable electricity in emerging economy context, South Africa's Cape Peninsula. The study found a significant positive link between household income and WTP for green electricity similar to results typical for developed countries. Regarding the magnitude of WTP the strong counter fact stating that results from developed and developing countries should differ is based on the *environmental Kuznets curve* (more in Aldy et al. 2005). This theory proposes that people in country with higher average income value more environmental goods when other, basic, needs are already satisfied, rising from similar assumptions as the Maslow's hierarchy of needs theory (Maslow 1943).

3.1.1.2 Household's income and electricity consumption

The vast majority of studies conclude that the value of household's income is the most significant variable that affects the WTP for renewable electricity. Other common variables affecting WTP in positive way are the level of education, the amount of consumed electricity, the age. As mentioned above, by Soon and Ahmad (2015) the values of WTP differ significantly among countries, results of several studies are mentioned below.

Train (2000) found out that customers' willingness to pay for non-price attributes depended on the level of prices. For example, customers were willing to pay more for a desirable attribute when the price was 10 cents per kWh than when price was 4 cents per kWh. This behavior, while contradicting economic rationality, is intuitively meaningful and conforms to many analysts' view of how customers commonly make decisions. Thus in the used model price enters both linearly and in log form. Train (2000) defines the coefficients of the non-price attributes to be normally distributed. Since the normal distribution has support on each side of zero, this specification implies that, for each attribute, there are some customers who like the attribute and others who dislike it.

Kriström (2009) used data from the OECD 10 country web survey exploring the WTP to use only renewable energy and how do general attitudes towards the environment (environmental awareness, membership in environmental organization, etc.) influence demand for renewable energy. On average, the respondents display a price premium of less than 4% of their current electricity bill, if those who do not wish to pay are excluded the average is about 7%. There is a stronger statistical link between income and the decision to enter the market, compared to the link between income and the level of the price premium. The author also found that there were country-specific differences between households that cannot be attributed to explanatory variables.

3.1.1.3 Environmental attitude

Another universal attribute that positively affects the value of WTP is the level of environmental attitude of the respondent. An inclusion of an environmental attitude as an explanatory variable usually verifies its positive effect. Kotchen and Moore (2007), Hansla, et al. (2008), Kriström (2009), Zografakis, et al. (2010), Guo, et al. (2014), Sapci and Considine (2014), Kriström and Kiran (2014) found environmental attitude affecting positively the WTP. In more detail, according to Hansla, et al. (2008) the attitude towards green electricity is related to awareness of consequences of environmental problems for oneself, others, and the biosphere, concerns for these consequences, and self-transcendent value types.

Sapci and Considine (2014) examined the connection between household environmental attitudes and real energy consumption behavior using a data set of electricity use by households in Wyoming, USA. The results suggest that attitudes about environmental issues are associated with lower energy consumption. Environmentally concerned households tend to be more conservative on energy use.

Hansla, et al. (2008) studied WTP of Swedish households for green electricity. Authors showed that WTP for green electricity increased with a positive attitude towards green electricity and decreased with electricity costs.

More detailed analysis of consumer attitudes was provided by Klöckner (2013) who studied how humans make decisions about environmentally relevant behavior. Intentions to act, perceived behavioral control and habits were identified as direct predictors of behavior. Intentions are predicted by attitudes, personal and social norms, and perceived behavioral control. Personal norms are predicted by social norms, perceived behavioral control, awareness to consequences, ascription of responsibility, an ecological world view and self-transcendence values. Self-enhancement values have a negative impact on personal norms. Based on the model, interventions to change behavior need not only to include attitude campaigns but also a focus on de-habitualizing behavior, strengthening the social support and increasing self-efficacy by concrete information about how to act. Value base interventions have only an indirect effect.

Hanimann, Vinterbäck and Mark-Herbert (2015) studied the motivations behind the WTP for renewable electricity. The concept of identity signalizing has proven to play a significant role in consumer behavior for green products. However, (renewable) electricity in the Swedish residential market typically lacks two important drivers for identity signaling: visibility and product involvement. The results show a positive effect of identity signaling on the demand for renewable electricity and yield suggestions for increasing the share of renewable electricity without market distorting measures.

3.1.1.4 Decentralization

The ownership of the (renewable) electricity source may become influential variable when included in the experiment. Sagebiel, et al. (2014) estimated the WTP for electricity from cooperatives in Germany. Based on Transaction Cost Economics, the authors developed a theoretical framework seeking to explain preferences for electricity supplied by cooperatives from a consumer perspective. The authors found slightly higher WTP for electricity produced by cooperatives.

Solino, Vazquez and Prada (2009) analyzed the WTP for local renewable energy. Moreover, the authors discussed two methodological goals concerning the contingent valuation method. First result shows that WTP estimates from single- and double-bounded format significantly differ. Moreover, results show that periodicity of the payment vehicle influences upon the probability to favor the proposed change.

Van Putten, et al. (2014) studied the valuation of preferences for small scale initiatives in renewable electricity generation, analyzing the results of a stated choice experiment in The Netherlands. Respondents prefer installing the capacity in small to medium sized groups and their preferred location for the generation capacity is at sea, followed by their own roofs. People that already consume green electricity, as well as those that have indicated to be willing to generate energy locally, are less price sensitive than others.

In addition to what was mentioned above Kriström (2009) suggests based on data from Sweden that there an “urban/rural” asymmetry may occur regarding reported price premium (WTP) for renewable electricity. Urban groups typically display higher price premium, all else equal.

3.1.1.5 Specific technology or source of energy

Results of WTP may differ according to the definition of renewable energy source in the experiment. Reyes-Mercado (2014) focused only on one good that was specific for the study region. The author asked specifically on WTP for purchase of water solar boilers.

Solino, et al. (2012) presented a choice experiment analyzing the consumers’ preferences towards a policy for replacing conventional electricity with electricity generated from forest biomass. The results show that consumers specially prefer the effects related to the lower risk of forest fires and to the decrease in pressure on non-renewable resources. Moreover the article presents methodological test in relation on the payment timeframe. The most frequent and realistic payments are associated with lower presence of inconsistent responses. The author cannot reject the null hypothesis of no effects of payment timeframe on marginal WTP.

Woo, et al. (2014) analyzed WTP for emissions reduction via natural-gas-fired electricity in Hong Kong. Authors estimated that the WTP for a 30% emissions reduction via natural-gas-fired generation is an 18% annual electricity bill increase, twice the estimate for nuclear power. Author compared the WTP with projected bill increase required to achieve the government's emissions reduction target.

Gracia, et al. (2012) estimated WTP for renewable electricity using a discrete choice experiment survey conducted in Spain in 2010. Two main categories of power supply attributes were explored: source of renewable power (wind, solar and biomass) and the origin of such power. The findings suggest that most consumers are not willing to pay a premium for increase in the shares of renewable in their electricity mix. For wind and biomass an increase of the renewable mix would require a discount, however, preferences are found to be heterogeneous. On contrary authors record positive WTP for increases in the share of both solar power and locally generate power. 20% of respondents show WTP higher than the current feed-in tariffs.

Kim, et al. (2013) examined the WTP for Korean consumers for renewable electricity under a differentiated good framework. Korean consumers recognize renewable electricity as a differentiated good from traditional electricity generated from fossil fuels or nuclear energy. The mean WTP to use renewable electricity is 1.26 USD per month. Authors confirmed the existence of perfect substitution relationships among variant renewable technologies. Thus, the imposition of the cost of renewable electricity on consumers in the form of increased electricity charges would be acceptable to consumers.

On contrary Borchers, Duke and Parsons (2007) presented the findings of a choice experiment for voluntary participation in renewable electricity programs. The model estimated WTP for a generic "green energy" source and compared it to WTP for green energy form specific sources. The results show a positive WTP for renewable electricity and further that individuals have a preference for solar over a generic green and wind. Biomass and farm methane were found to be the least preferred sources.

Kontogianni, Tourkolias and Skourtos (2013) investigated individual preferences and social values towards specific technologies of renewables in Lesvos Island, Greece. Authors applied an open-ended contingent valuation survey in order to analyze main factors shaping public attitudes and estimate WTP of preferred technologies.

3.1.1.6 Policy-making

Zoric and Hrovation (2012) analyzed WTP to renewable electricity in Slovenia. The results confirm that age, income, education and environmental awareness are the most important factors. WTP predominantly depends on household income, while the willingness to participate in green electricity programs is influenced by education and environmental awareness. The results imply that awareness-raising campaigns in Slovenia should target younger, university educated and high-income households. The expressed median WTP is found to exceed the current level of mandatory charges for green electricity.

Zhang and Wu (2012) studied residents' WTP for green electricity in Jiangsu Province in China for the large-scale promotion of energy projects from renewable sources that do not rely solely on energy policies. The average WTP ranges from 1.15 to 1.51 USD monthly. There are significant differences in demographic variables, such as level of education, household income and location of residence.

Yoo and Kwak (2009) provided respondents with hypothetical scenario of green electricity share on the total electricity supply increased from 0.2% to 7.0% by 2011. Monthly mean WTP estimates for renewable electricity were 1.8 USD for parametric and 2.2 USD for non-parametric methods. The estimates of the annual benefits to relevant residents amounted to 157 mil USD and 194 mil USD, respectively.

Kriström and Kiran (2014) showed on 2011 OECD EPIC data that the level of WTP for renewable energy is driven primarily by non-economic factors, such as membership in an environmental organization. Authors conclude that because policy impacts are typically heterogeneous across households, policy targeting may sometimes be useful.Shin, et al. (2014) analyzed WTP for the Renewable portfolio standard with specific attributes in South Korea. Households consider the creation of new jobs as the most important policy attribute, followed by increase in electricity prices, damage to forests, reduction in CO_2 emissions, and length of power outages. Median WTP for renewable portfolio standard is 0.67 USD per month.

Streimikiené and Mikalauskiene (2014) estimated WTP for renewable electricity of Lithuanian households and compare the value with support provided for renewable by the government in terms of Feed-in prices. The results indicate that WTP is significantly lower than subsidies for renewable electricity provided by the government. The average WTP of Lithuanian households for 10% of electricity produced from renewables makes 0.25 EUR/kWh, the average Feed-in price for electricity produced from renewables makes about 0.47 EUR/kWh.

3.1.1.7 Providers and payment vehicles

Kaenzig, et al. (2013) focused on the consumers' possibility to switch from standard electricity provider, who offers electricity corresponding to standard electricity mix, to a provider who offers more environmentally friendly default electricity mix. Authors investigated the relative importance of different product attributes in creating customer value when choosing their green electricity provider, and find that price and electricity mix are two most important attributes. Data shows an implicit WTP a premium of about 16% for electricity from renewable sources.

Guo, et al. (2014) showed that the definition of payment vehicle (compulsory or voluntary) may have an important impact on consumers' decisions. The authors found out that most (54%) of respondents in Beijing have positive WTP for renewable electricity. The average WTP for renewable electricity ranges from 2.7 to 3.3 USD monthly. The main factors affecting WTP include income, electricity consumption, bid and payment vehicle. The proportion of respondents replying "yes" to WTP questions using a mandatory payment vehicle was slightly higher than that for questions using a voluntary vehicle. Knowledge of and a positive attitude towards renewable energy also resulted in the relatively higher WTP for renewable electricity. Deployment of renewable electricity can cause considerable benefit.

Bigerna and Polinori (2011) estimated the consumer's WTP for green electricity in Italy using stochastic payment card. Results shows that there is a substantial willingness among consumers to partially cover the cost of achieving the RES goal in Italy of 17% share in electricity production from renewable energy sources by 2020.

3.1.1.8 Voluntary programs

Kotchen and Moore (2007) analyzed "green-electricity programs" in the US, households' decisions about voluntary participation in programs and empirical investigation of actual participation decisions. Authors provide models that show how participation in programs depends on income and heterogeneous tastes. Contributions are increasing in household income, environmental concern, and altruistic attitudes, yet they are decreasing in the number of people living in the household and whether a male name is on the electricity billing statement. All variables affect the decision of whether to contribute, but only household income affects the decision of how much to contribute.

Roe, et al. (2001) analyzed US consumers' demand for environmental attributes of deregulated residential electricity services using results from consumers' WTP and using results from a hedonic analysis of actual price premiums charged for green electricity. Among other features, fuel mix from newly created renewable generation capacity helps explain real price premiums.

3.1.1.9 Other categories

Zografakis, et al. (2010) analyzed and evaluate public acceptance and WTP for renewable energy sources in Crete, using a double bound dichotomous choice format on sample of 1440 households. Mean WTP per household was found to be 16.3 EUR to be paid quarterly. WTP was positively affected by income and residence size, environmental attitudes and frequent experience with electricity shortages.

Yang, Solgaard and Haider (2015) examined the heterogeneous consumer preference for electricity products in the residential electricity retailing market in Denmark. The authors identified three consumer segments: the value seeking, the price sensitive consumers, and the green consumers. The authors concluded that consumers are willing to pay extra for the increasing share of renewable energy and that the socio-demographic characteristics had influence on their choices. The authors implied that policy makers should enable consumers to make a choice among various products.

MacPherson and Lange (2013) showed that in the UK the individuals in the highest income quartile, those with higher qualifications, those supporting the Green political party, and those exhibiting strong environmental behavior were all more likely to have purchased green tariffs. Significant to a lesser degree were strong environmental attitudes and those households with some form of renewable energy technology installed.

Not only positive effects of renewable energy sources shall be studied and included in the valuation. Typical negative effects are dis-amenities, e.g. increased noise or visual change of landscape. Ladenburg and Dubgaard (2007) studied WTP for reducing the visual dis-amenities from future offshore wind farms in Denmark. The data were elicited using the choice experiment method. The results show positive WTP amounts for having the wind farms located further from the coast. WTP values deviated significantly depending on the age of respondents and their experience with offshore wind farms.

3.1.1.10 WTP for the Czech Republic in previous research

Shi, Zhou and Kriström (2013) studied the residential WTP for renewable energy in six OECD countries, including Czech Republic. Authors elicit value of "green electricity" as the maximum percentage of the current electricity bill the person is willing to pay to "re-mix" electricity supply such that it is based only on renewable energy. Authors find that environmental concern/attitude consistently drives the decision to enter the (hypothetical) market for "green electricity", while membership in environmental organizations typically affects how much a person wants to pay, economic variables are less important. Authors used variables heating degree days and cooling degree days as proxies for the amount of energy consumed by households. WTP for Czech Republic are in relative values (WTP as a % increase of electricity bill) similar as in Canada and higher than in France, Australian and Norway.

Table 4: Proportion of respondents willing to pay for renewable energy (Shi, Zhou and Kriström 2013)

Country	**Region**	**Relative increase to current electricity bill (%)**						
		Zero	**< 5%**	**5-15%**	**16-30%**	**>30%**	**Don't know**	**Total**
Czech Republic	North West	30%	26%	19%	3%	1%	21%	100%
	North East	33%	30%	11%	3%	0%	23%	100%
	South	28%	27%	20%	1%	1%	22%	100%

Three regions were included in the experiment, North West, North East and South. About one third of respondents report a zero WTP and there is no substantial difference of WTP between regions in any bracket. Main positive determinants of WTP were environmental attitude, membership in environmental organization and employment status, main negative determinants were residence type of an apartment in a building with more than 12 apartments and age between 18 and 24 years. Main positive determinants of the entry decision were income and environmental attitude, main negative if the residence construction time was more than 50 years ago and if the respondent was female.

3.1.1.11 Conclusions

All the results mentioned in the chapter are important input into the decision making process of policy makers. Since some of the results give us antagonistic answers it shall be in any case essential to come out from country-specific assumptions and characterizations.

The overview shows that there are many forces that have an influence on consumer preferences in the area of green electricity. Apart from those most commonly mentioned in the literature, such as the effect in air quality, household's income and electricity consumption, type of supported beneficiaries and location of production (its distance from consumer's house), there are many others.

Social norms may have strong influence, similarly environmental attitudes of consumers. Some technologies may be more popular by consumers due to different reasons, e.g. their expected effect on employment or appearance in the nature.

It may be concluded that accurate magnitudes of all variables are always region specific, however, directions may be more-less easily estimated from previous experience.

This thesis seeks to find answers for questions in specific background of the Czech Republic. Some of the answers were already studied in different countries with different historical, political and economic background. As was mentioned above, in the Czech Republic there already exists a compulsory scheme of support for renewable electricity. It is compulsory not only for households (as in Germany) but also for companies, using regular payments as a part of electricity bills.

The problematic part, in our opinion, is the fact that policy makers are/were not able to explain to broad public, what are real economic consequences of introduction of renewable electricity into Czech energy mix. The media tend to evaluate the support to renewable electricity as an unnecessary regulation from the European Union. Public discussion usually ends up with scandal cases of illegal abuse of governmental support for renewable electricity. The support to renewable electricity is also only one of few governmental supports that are not paid indirectly from the governmental budget but directly by consumers in their electricity bills. It is by all means the right way how to indirectly internalize external costs when an introduction of the carbon tax is not politically feasible, but from consumers' perspective it is sending the opposite signal that the introduction of renewable sources is increasing the final price of electricity and thus decreasing their total welfare.

The serious scientific research and the public oriented campaign shall be done in order to provide consumers enough information for their further rational choices. The results of consumer preference research may provide useful insights for policy makers. With strong sound background policy makers may target specific population with campaigns in locations where the awareness is weak or using economic instruments in locations where the WTP is high. **Policy makers may focus on specific target groups and potentially allow such groups to contribute more with certainty that the share of renewable electricity in their consumption is high.**

3.1.2 Feasibility of renewable electricity

In this section some of the relations and consequences of renewable electricity adoption are explained.

The usual counter argument against renewable energy is its capability to supply sufficient amount of energy without massive fluctuations over day/year when it shall substitute present sources of energy. Arent, et al. (2014) confirmed that in the US the renewable energy could supply 80% of electricity demand in 2050 at the hourly level. Transitioning to high renewable electricity supply would lead to significant reductions in greenhouse gas emissions and water use, with only modest land-use implications. No insurmountable long-term constraints to renewable electricity technology manufacturing capacity or materials supply were identified.

Pazheri, Othman and Malik (2014) showed that if the current developments in renewable industry continue, then a major share of global electricity production in the future could be supplied by renewable energy technologies. The analysis further shows that a significant amount of fuel cost and pollutants emission can be reduced by the increased use of RES based electrical power production technologies.

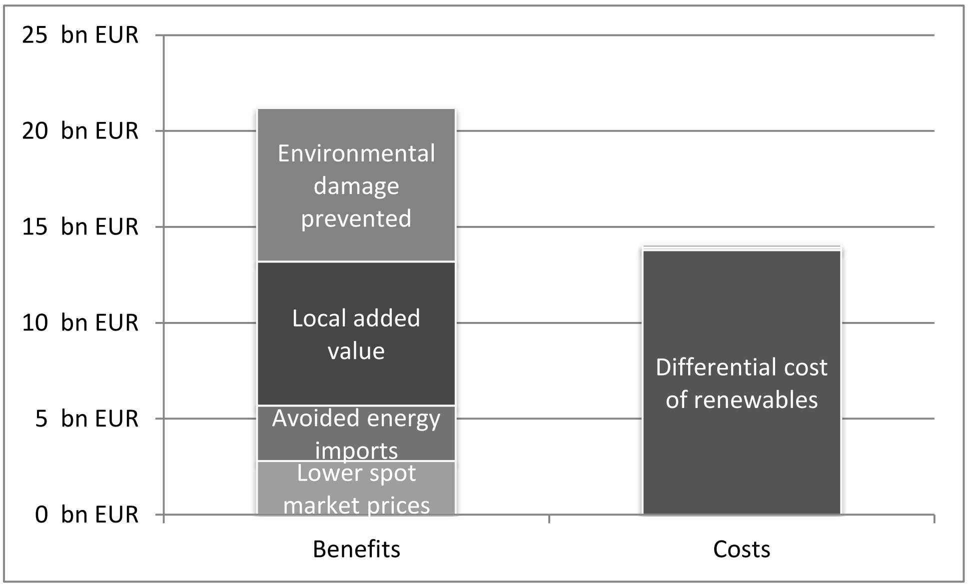
Another counter argument against renewable electricity is an ineffectiveness of feed-in prices scheme. Smith and Urpelainen (2013) estimated the casual effect of feed-in tariffs on renewable electricity generation in 26 industrialized countries, 1979-2005. The authors found that the increasing FIT by one US cent per kilowatt hour increases the percentage change in renewable electricity's share of the total by 0.11% points.

Ortega, del Río and Montero (2013) provided an assessment of the benefits and costs of the deployment of renewable electricity in Spain between 2002 and 2011. The benefits refer to reductions of CO2 emissions and fossil-fuel imports. These are compared to the costs of public support for renewable electricity deployment granted through the feed-in-tariff system. The results show that the benefits of renewable electricity promotion have outweighed the overall costs of its deployment, although significant variations can be observed across technologies. Benefits have been higher than the costs for on-shore wind and small hydro, on contrary lower in case of solar photovoltaics and slightly lower in case of solar thermoelectric. Probably similar results would be ascertained for the Czech Republic during past decade. Prices of renewable technologies do not significantly differ across European common market and the support mechanism in Spain was similar to the one implemented in the Czech Republic.

There are several leading countries in renewable energy adoption in the EU and the most visible is without doubts Germany. The "Energiewende" (German for "energy transition") is the ambitious program of German government with aim to substitute all non-renewable energy sources by renewable ones. According to Renewable Energies Agency[18] (Agentur für Erneuerbare Energien), renewables saved Germany more than 7 billion EUR in 2011 (see Figure 4). The costs of 13.8 bn EUR, of its absolute majority consists of differential cost of renewables, were over-weighted by 21.2 bn EUR of benefits. The estimated benefits consisted of 2,8 bn EUR of lower spot market prices, 2.9 bn EUR of avoided energy imports, 7.5 bn EUR of local added value and 8 bn EUR of environmental damage prevented.

[18] Source: http://www.unendlich-viel-energie.de/

Figure 4: Costs and benefits of renewables in energy use, Germany, 2011; source: Renewable Energies Agency



4 Methodology

4.1 Stated preferences

"Valuing the services derived from the environment is important because it 'works' – i.e. it helps make the case for protecting the environment in an effective way. Indeed it can be, in many cases, a more effective instrument than other methods of protecting the environment – such as lobbying, undertaking direct action and so on."

Anil Markandya[19]

By valuing environmental services, such as air quality or biodiversity, economists are trying to solve market failures.

The *monetary value* of an environmental good is usually based on the monetary value that individuals place on it, their *willingness to pay* and *willingness to accept compensation*. According to Markandya (2002) the maximum willingness to pay (WTP) can be considered an expression of the individual's values, analogously the minimum willingness to accept (WTA) which is an amount of money considered as compensation for foregoing a benefit or for incurring a loss and this reflects the value of such a benefit or loss.

In normal situation at market with set prices of goods, all consumers reveal part of information on their WTP and WTA every time they buy or sell. When individual is buying the price equals to the lower bound of the WTP, when individual is selling the price equals to the upper bound of the WTA. When there is no market for the good, there is no market price that would reveal consumer's WTP or WTA (Markandya 2002).

Usual way how to obtain WTP or WTA is to measure consumer's reaction to the price change of a good or to the change in quantity consumed. First way of the evaluation is examining the actual behavior of the consumer in moment of price or quantity change. This approach is called the *revealed preferences* method. Another way is asking consumers their willingness to pay or WTA for proposed (hypothetical) change of price or quantity, this is called *stated preferences* method.

[19] Markandya, A., Harou, P., Bellu, L. G., & Cistulli, V. (2002). *Environmental economics for sustainable growth: A handbook for practitioners*. Edward Elgar Publishing Ltd.

In this thesis we focus primarily on the stated preferences methods because we present to consumers the hypothetical market situations and we ask them to state their preferences. Revealed preference data from market behavior tied to the environmental good is frequently unavailable or of limited usefulness due to a limited range of observed variation in the key variables of interest (Carson and Czajkowski 2013).

“Stated preference (SP) is a widely used term that encompasses many different methods that can be used in several different contexts. Stated preference survey is a survey that asks agents questions that embody information about preferences. Information about preferences can be elicited in many forms in SP surveys, but links between elicited information about preferences and preference parameters of an indirect utility function are at best ill-defined without more specificity.”

Carson and Louviere[20]

Contingent valuation is generally used term in meaning of a survey approach to place an economic value on a public good (Mitchell and Carson 1989). It consists of asking people (via a questionnaire or by experimental techniques) what they are willing to pay or willing to accept for hypothetical change it the quantity of the good. In fact, the questionnaire simulates a hypothetical (contingent) market of a particular good (in our example environmental good, e.g. air quality) and individuals are asked to reveal their willingness to pay for a change in the supply of the good in question. The major advantage of this approach is that it may (in theory) be applicable to value all goods and services and it is the only possible technique for the evaluation of non-use values. Comparing to other techniques it does not require the huge amount of data. On the other hand the main criticism concerns the biases inherent in the techniques (Markandya 2004).

Usage of stated preference data has roots in the marketing and transportation for situations when estimating value of a product for which there is no historical experience and we are thus not able to estimate the demand function. In the marketing stated preference data are commonly used when new products or brands are to be introduced (for more see Ben-Akiva et al. 1994). In transportation the stated preference data are used to elicit information on new transportation modes and transportation routes. Relatively new area is “health economics”

[20] Carson, R. T., & Louviere, J. J. (2011). A common nomenclature for stated preference elicitation approaches. *Environmental and Resource Economics*,*49*(4), 539-559.

where stated preference data are used for new treatments or drugs, again to estimate its potential future value.

Stated preferences are usually put in a broader context by *auxiliary questions* given to respondents in a survey. Three categories of auxiliary questions are typically used. *Demographic questions* ask on age of respondent, education, income, etc., *knowledge questions* seek to find out if the respondent understands the context of the questions, and third, *attitudinal questions* are related to the good, competing goods, or their method of provision, including general questions about the role of government.

In addition there are three basic types of "debriefing" questions, *motivation assessment, scenario assessment* and *certainty assessment.* Example of motivation assessment questions are those designed to identify protest zeros. Scenario assessment questions focus on specific aspects of a scenario, e.g. asking respondent if he believed that the good would actually be provided. Certainty assessment questions are intended to elicit respondent's certainty about their respond (Carson and Louviere 2011).

4.2 Biases in stated preference research

Serious distortion of the stated preference data from real behavior may be caused by biased answers. Tietenberg (2012) describes five types of potential bias: *strategic bias, information bias, starting-point bias, hypothetical bias* and the *observed discrepancy between willingness to pay and willingness to accept*. It is important to emphasize that the scope of effect of all the biases differs for every individual survey according to its proper settings.

Strategic bias arises when the respondent from strategic reasons states higher or lower values than real ones because he does not expect that he would ever have to actually pay proposed values and he thinks that his opinion will be in future used for policy, or any other, decision.

Information bias occurs when the respondent has little or no experience with the good or the attributes of the good. Lack on information does not necessarily mean that respondent's WTP is going to be lower. Generally it is common for all kinds of goods, not only environmental, that the consumer must have certain knowledge about a good, the context and consequences of its purchase to be able to value it correctly.

Starting-point bias arises when there are predefined levels of attributes that the respondent answers, this is most certainly caused the respondents' natural perception that the first value mentioned in the survey is close or equal to market value, estimated total economic value or value proposed by politicians.

Hypothetical bias occurs when the respondent is being asked to value goods or attributes that do not exist at the moment. Hypothetical choices that are typical for stated preference surveys may not reflect constraints on behavior of respondents (e.g. budget constraint) because respondent is not acting in a real context. It refers to misspecifications of the true WTP or WTA. To mitigate the bias it is possible to combine stated preference data with revealed preference data in order to detect prospective distortions.

The fifth source of bias is the *gap between values obtained from WTP and WTA compensation* surveys. Respondents tend to report significantly higher values when they are asked to express their willingness to accept compensation for a specified loss of some good than if asked for their willingness to pay for a specified increased of that same good. Economic theory suggests the two should be equal. Some economists have attributed the discrepancy to a psychological endowment effect, saying that the psychological value of something that you own is greater than something that you do not own (Tietenberg 2012).

There are more types of the biases over those defined by Tietenberg (2012). *Protest bias* occurs when respondent gives a zero or extremely large bid because he does not accept the hypothetical situation or valuation method. *Contingent bias* means that the respondent is trying to please the interviewer instead of expressing real WTP or WTA. *Sensitivity to scope* tests whether WTP values are sensitive to the size of environmental change being offered. (Hanley, Mourato and Wright 2001).

4.3 Discrete choice questions

There are two main methods how to elicit stated preference from consumers: *discrete choice* and *matching methods.* By Carson and Czajkowski (2013) those approaches are the only two that result in data consistent with neoclassical welfare economics.

The *matching approach* uses direct questions (open ended or supported by a payment ladder) given to respondents in order to provide a number that will make them indifferent in some sense (WTP or WTA), typically between status quo and an alternative.

The *discrete choice* technique asks respondents to pick their most preferred alternative from a set of options. It is a general preference elicitation approach that asks agents to make choice(s) between two or more discrete alternatives where at least one attribute of the alternative is systematically varied across respondents in such a way that information related to preference parameters of an indirect utility function can be inferred (Carson and Louviere 2011). Traditionally, a contingent valuation questions did not vary the attributes of a program and offered one program and a status quo only. Such contingent valuation with single- or double-bounded discrete choice question belongs to this category of techniques as discrete choice experiments that usually consists of more than two alternatives presented in a sequence (*ibid.*).

There are two basic types of DCE questions – a *single binary choice* (SBC) question and a *single multinomial choice* (SMC) question. The difference is that in SMC the number of alternatives is equal to three or higher. To obtain welfare measurements, an attribute (typically cost or price) must be varied in some systematical way. Thus with a sample of sufficient size, the full set of information about preferences for particular attributes recoverable may be obtained from any DCE.

When policy makers want to elicit value of more than one possible change from the status quo, the SBC must be enhanced. According to Carson and Czajkowski (2013) there are at least two possible ways how to do it. The first is to extend the SBC by a question on a second cost amount, that conditions on the first response, i.e. *double bounded binary choice*. The second way is to ask for the choice to be made from a larger set of alternatives, abovementioned *single multinomial choice*. In principle, an enormous amount of preference information could be obtained from a single agent (consumer) by using a choice set with an extremely large number of alternatives.

In *single multinomial choice* respondents may be asked to exercise a complete ranking over all alternatives presented. In complete ranking the respondent provides information about all possible pair-wise comparisons. The problem is that with increase of the number of alternatives the question becomes more difficult to evaluate for the respondent. There is certain limit to the maximum number of choice alternatives that agents will seriously entertain at one moment.

As mentioned above one of the alternatives offer to the respondent may be the current *status quo*, which is from respondent's perspective always feasible choice. Correct specification of status quo alternatives is critical to defining appropriate property rights situations in DCEs, and by extension, the types of welfare measures obtained.

There are different elicitation formats in CV studies, and by the belief, different elicitation formats should yield statistically equivalent estimates of WTP. Mentioning once again the biases connected with stated preference methods, these biases are expected to be the reason why previous statement does not hold in reality. Surveys shall meet two conditions to ensure that respondents behave as rational agents. There must be (a) positive probability of influencing policy maker's actions and (b) agents must care about the outcomes (Carson and Czajkowski 2013).

There are three piece of evidence confirming the statement that different elicitation formats yield different estimates of WTP according to Carson and Czajkowski (2013). First is that the differences appear to be systematic not random. Second is that their existence was seen by psychologists as a function of framing not as a survey artifact. Third is that if respondents are standard rational maximizing economic agents, then they should exploit all of the incentive and information characteristics of the particular elicitation format used.

In an SMC, the fundamental problem with pure public goods is that only one level can be supplied and it is the same for all agents. Truthful preference revelation is often not optimal, e.g. if the agent has non-uniform priorities over the two alternatives most likely to be chosen by other people, then it is generally optimal for the agent to choose the most preferred of these two alternatives, even though their true preferences may be for another alternative. Another problematic point occurs when respondents have no preference among possible alternatives. In such case the choice among alternatives is more-less random and does not provide necessary information (Carson and Czajkowski 2013). It is not uncommon to see respondents get more price sensitive over time (between different choice sets) or become more likely to choose the status quo level when the price offered does not seem like a good deal relative to alternatives seen earlier (Day, et al. 2012).

Policy makers are interested in exploring options that differ from each other along one or more well defined dimensions or attributes. The question is how to elicit the value for the good changes as one or more of the attributes of the good are varied in either a continuous or discrete manner. The *monetary value of the marginal change* in one of the good's attributes corresponds to an *implicit price* of the attribute.

CV critics often claimed (e.g. Hausman 1993) that environmental goods are luxury goods and as such the income elasticity for such goods should be above one. According to Carson and Czajkowski (2013) there are the empirical reasons why environmental goods are not luxury goods. Income elasticity of demand and the income elasticity of WTP can differ significantly in magnitude and even sign and the income elasticity of WTP is likely to be considerably smaller. In reality we may see that the society (or nation) tends to display more environmental concerns with relatively higher gross domestic product (e.g Aldy 2005). On the other hand, from the situation of individual, the very wealthy are usually able to isolate themselves from negative environmental impacts and it affects the lowest income groups.

Carson (1997) shows that so called *scope insensitivity,* a situation when respondent does not differentiate among different quantities of environmental goods, is not caused by CV survey as such but due to vague and imprecise definition from perspective of the respondent. People usually cannot differentiate among very small probabilities. There is also behavioral logic for the case of voluntary payments, suggesting that in such case respondents do not care about different scope. Reason is also scepticism, i.e. if the respondent does not believe that the public body would be ever able to achieve proposed value of an alternative.

According to Carson's "user's guide to contingent valuation" (2000) good CV survey usually contains: (a) an introductory section that helps set the general context, (b) a detailed description of the good to be offered to respondent, (c) the institutional setting in which the good will be provided, (d) the manner in which the good will be paid for, (e) a method by which the survey elicits the respondent's preference, (f) debriefing questions about why respondents answered certain questions the way that they did, and (g) a set of questions regarding respondents characteristics including attitudes, and demographic information.

The particular population sample should be the relevant one for evaluating the benefits and costs of the proposed project. For a pure public good, the economic value of a good is simply the sum of the WTP of all agents in the relevant population. CV results can be by Carson (2000) quite sensitive to the treatment of potential outliers. However, a carefully done CV study can provide much useful information to policymakers.

When setting the experimental design the correct proposition of attributes and attribute levels is crucial. According to Carson and Louviere (in McIntosh 2010) if one believes that the true relation between utility and attribute (e.g. cost) is linear, the proper way to design the experiment is to only use two levels for the attribute. On the other hand, if one does not know the true relationship, and it is likely that it is non-linear, then one needs to assign at least three levels of the attribute. Typically, one would assign four levels to the attribute to be able to visualize relationships between utility and attribute and rule out a quadratic polynomial if it is inappropriate.

5 Our Study: Experimental Design and Hypotheses

5.1 Hypotheses

The study inter alia attempts to confirm or reject following hypotheses.

Hypothesis #1: "Households that are living in areas with worse air quality are willing to pay more for green electricity."

We expect that household that is living in area with worse air quality ceteris paribus, shall have higher marginal utility from decrease of local emissions of particular matter and global GHG emissions. When the portion in energy mix of electricity generated from renewable resources increases, electricity generated from conventional resources may decrease and so do both local particular matter emissions and global GHG emissions.

Hypothesis #2: "Households are willing to pay more for green electricity from small decentralized sources, even though it would be less effective than big centralized sources."

The reasoning for second hypothesis is that households have higher utility from decentralized sources of energy when the companies are locally owned and profits of those companies remain in areas where the electricity is produced and consumed. Another argument is the energy security, when electricity is produced by multiple sources failure of single producer does not cause black out for large number of households, similarly with potential failure of grids.

Hypothesis #3: "Households are willing to pay less to support increase in green electricity share than what is actual contribution in the Czech Republic."

Third hypothesis is more intuitive, recent opinion polls held in the Czech Republic indicate that two thirds of consumers would support energy generated from renewable resources (SC&C, 2012), but the half of consumers does not exactly know, how high is their actual contribution (Bohemian energy, 2012). If the contribution for renewable resources was voluntary 44% of respondents would certainly not contribute and 32% of respondents would probably not contribute.

5.2 Experimental design

In this section we define choice attributes and attribute levels that we used within the experiment. Findings from the literature review show that monetary costs, air quality (both local and global), type of beneficiary, location of the source of electricity, are all variables that may affect willingness to pay for green electricity.

Moreover, other explanatory variables typically affect WTP value. From wide list we have chosen level of environmental attitude, household's air quality and income.

<u>Economic model</u>

According to the literature review we initially considered following economic model:

$$U_i = a_1 * EBILL_i + b_1 * PM_i * INCOME_i + c_1 * PM_i * REGION_i + d_1 * PM_i * ATTITUDE_i + e_1 * PM_i * AIRpoll_i + b_2 * CC_i * INCOME_i + c_2 * CC_i * REGION_i + d_2 * CC_i * ATTITUDE_i + e_2 * CC_i * AIRpoll_i + f_1 * HH_i + f_2 * MUN_i + f_3 * REG_i + f_4 * NAT_i + g_1 * ALLOC_i$$

This model was developed from a simple model that was initially used for pilot experiment in accordance with results of pilot experiment outcomes of literature. Description of attributes and its levels is shown below.

<u>Monetary costs (EBILL)</u>

Monetary costs were defined as average monthly electricity bill expenditures of household including renewable electricity support. In order to achieve attribute levels provided to respondents in choice sets to be realistic, we set up values of monetary costs respondent specific. Respondents were asked to state their average monthly electricity bill expenditures, including commodity price, distribution payment, VAT and renewable energy support. This value was taken as a status quo value, considering that approx. 10% of this value equals to real actual compulsory contribution for renewable electricity production .

Five attribute levels of households' monetary costs were defined including status quo, ranging from 10 % reduction to 10 % increase. For respondents who were not able to specify their actual monetary costs the status quo value was estimated according to services for which they use electricity, i.e. heating and hot water. Values used in the experiment are shown in table below.

Table 5: Calculation of monetary costs

Type of activity	Estimated monthly electricity bill (CZK per month)
Only work and cooking	1100
Plus heating	2500
Plus hot water	1500
Plus heating and hot water	3000

Air quality (PM, CC)

We defined two dimensions of air quality, local and global. Reason for this is common expectation that consumers are able to value more precisely goods and services that they actually consume.

Local air quality (PM) is defined as % change of annual average concentration of particulate matter, PM_{10} at respondent's permanent address. Local air quality is expected to be directly linked to change in proportion of electricity generated from renewable resources.

Climate change (CC) is defined as % change of greenhouse gas emissions emitted from all power plants in the Czech Republic. Willingness to pay for global effects of green electricity is expected to be lower than in case of local air quality, however, both attributes are expected to have negative value.

Both attributes are defined as the % compared to status quo and we expect them to be correlated. Levels of both attributes that we used within the experiment were nested according to expected proposed monetary costs, e.g. 10 % reduction in monetary costs is expected to cause 12 % increase of local air quality with deviation of +/- 3 %. Complete nesting set up is shown in table below.

Table 6: Nesting of attribute levels

Attribute	Specification	Unit	Attribute levels				
Monetary costs	Electricity bill price	% change	-10	-5	0	5	10
Local air quality	PM10 concentration	% change	9, 12, 15	3, 6, 9	0	-3 -6 -9	-9 -12 -15
Climate change	GHG emissions from power plants	% change	9, 12, 15	3, 6, 9	0	-3 -6 -9	-9 -12 -15

Type of supported producer (beneficiary) (HH, MUN, REG, NAT)

This attribute defines type of beneficiaries that receive support paid by the respondent and by whole support scheme. It expresses relative preference of decentralized electricity sources over centralized electricity sources.

We define following types of beneficiaries: a) *households*, b) *municipalities* c) *regional* and d) *national*. We test hypothesis that households have positive value of WTP for decentralized electricity sources renewable. Attribute level of status quo is specific because there is currently no differentiation among beneficiaries, everyone may receive a support

Location of the renewable electricity source (ALLOC)

This attribute have two levels, *regional* and *national*. Respondents are asked whether they prefer to be a part of regional or national support scheme. Regional scheme ensures that all money collected from consumers in specific region will be used for renewable electricity support in same region.

Environmental attitude (ATTITUDE)

In order to derive environmental attitude of respondents we used the environmental concern model of Stern, Dietz and Kalof (1993). The model states that environmental concern consists of three value orientations that are further correlated: a) *social-altruistic value*, b*) biospheric value*, and c) *egoism* or *self-interest orientation*. Coming out from the model we asked respondents 10 question defined by Alibeli and White (2011) to obtain their environmental attitude (Table 7). The 10 questions were in Likert scale format, answers ranged from 1 (lowest concern) to 5 (highest concern), a sum for each respondent ranged between 10 and 50. Sum of all variables defined 3 levels of respondents' environmental attitude: a) *low environmental attitude* (10 - 30), b) *middle environmental attitude* (31 - 40), and c) *high environmental attitude* (41 – 50).

Table 7: Environmental attitude – List of questions (source: Alibeli and White 2011)

No	Question
1	Change in nature makes things worse
2	Modern Life harms the Environment
3	Animals have the same moral rights as humans
4	Pay higher prices to protect the environment
5	Pay higher taxes to protect the environment
6	Accept a cut in living standards to protect the environment
7	In general, how dangerous do you think air pollution by industry is for you and your family?
8	In general, how dangerous do you think pesticide in farming is for you and your family?
9	In general, how dangerous do you think that the pollution of rivers, lakes, and streams in for you and your family?
10	In general, how dangerous do you think that rise world temperature is for you and your family?

Household's Income (INCOME)

Respondents were asked to state average "take-home wage" of the whole household. Provided values were cleared from taxes.

Actual households' air quality (AIRpoll)

We derived this variable from real data of CHMI's database. We used annual average concentration of particular matter PM_{10} for years 2009 – 2013, which are the most actual data available. The data are provided at 1x1 km resolution and we may thus differentiate respondents not only on city level but in more detail. It is necessary to mention that those data are modelled, because there are 202 measuring devices in whole territory of the Czech Republic (amount of 2012).

5.3 Frequencies

Each choice set presented to respondents in the experiment includes three alternatives from which a respondent was asked to choose one alternative that by his/her expectation would bring him/her highest level of utility. The status quo alternative (that is respondent-specific) was presented in each choice set. The levels of attributes in the alternatives varied according to the choice set that was randomly chosen from a block that was attributed to each respondent (at random).

In table below see frequencies of chosen alternatives according to value of RES support relative to status quo value.

Table 8: Frequencies of chosen alternatives according to change of OZE support relative to status quo value (source: dataset)

Change of OZE support relative to status quo value	**Full sample**	
	Count	**Percent**
10 % decrease	393	12%
5 % decrease	383	12%
decrease total	*776*	*24%*
0 % (status quo)	982	30%
5 % increase	795	25%
10 % increase	679	21%
increase total	*1474*	*46%*
Total	**3232**	**100%**

In order to set up an efficient design of a questionnaire 80 choice sets were defined. Choice sets were divided 8 in 10 blocks. Blocks were randomly distributed among respondents,

The design was optimized for D-efficiency (Sándor and Wedel 2001; Ferrini and Scarpa 2007) of the MNL model using Bayesian priors (Huber and Zwerina, 1996; Scarpa and Rose, 2008). The efficiency was evaluated by simulation (a median of 1000 Sobol draws, see Rose and Bliemer, 2008) à 80 choice-tasks, blocked into 80/10 questionnaire versions with 10 choice tasks per ID.

The order of choice tasks in each version, as well as the order of alternatives was randomized for each respondent, to mitigate potential anchoring or framing effects. Frequencies of the distribution into blocks in presented in table below. In ideal case block would be evenly distributed, however, this did not happen due to number of questionnaires that were screened out or excluded.

Since our respondents aimed at purchasing different volume of electricity we used pivotal designs (Rose et al. 2008), i.e. the levels for additional costs are made individual specific after eliciting information about respondents' bill paid last year. Similarly, the bill in the status quo is respondent-specific.

Table 9: Frequencies of blocks of choice sets (source: dataset)

Block	Full sample	
	Count	**Percent**
1	46	11%
2	40	10%
3	31	8%
4	49	12%
5	43	11%
6	39	10%
7	35	9%
8	48	12%
9	37	9%
10	36	9%
Total	**404**	**100%**

6 Econometric model

In this section we describe the model that was used for econometric analysis of data.

Forecasting the demand for new products or market innovations requires information about consumers' preferences for products or services that do not exist in the current marketplace.

Researchers have overcome this problem by designing stated preference (SP) experiments to measure consumers' preferences over hypothetical alternatives including new products. SP data have been subject to considerable criticism by economists and other researchers because of a belief that consumers react differently to hypothetical experiments than when they would face the same alternatives in a real live. One problem is that some attributes for totally new products might be novel enough that respondents do not completely understand them. This would introduce components related to both uncertainty and perceived risk that would affect the outcome of choice modeling efforts. Another problem that could be particularly severe arises when new products incorporate "politically correct" public good attributes such as "zero-pollution" or green electricity.

Stated preference methods are used to elicit an individual's preferences for *alternatives* (whether goods, services, or courses of action) expressed in a survey context. Thus, this class of methods for preference elicitation differs from traditional economic approaches which are based on revealed preference (RP) data obtained by observing individual behavior in real markets.

When a sample of respondents is presented with a series of experiments (such as the experiment series analyzed below) the problem of memory effect, and/or taste persistence arises. This means that stated preferences of respondent may be correlated across different choice sets even if the corresponding (observable) attributes differ. A psychological reason for this may be that an respondent's state of mind and his perception capacities vary over time, i.e. across choice sets, and consequently, preference evaluations in two consecutive choice sets may tend to be more strongly correlated than preference evaluations in choice sets that are more remote in "time".

6.1 Multinomial logit model

Multinomial (MNL) models are used to model relationships between a polytomous (i.e. more than two-) response variable and a set of regressor variables.

There are two basic types of MNL models used in discrete choice experiments data evaluation, *generalized logit* and *conditional logit.* In a conditional logit model, a choice among alternatives is treated as a function of the characteristics of the alternatives (e.g. level of air quality or level of centralization), whereas in a generalized logit model, the choice is a function of the characteristics of the individual making the choice (e.g. age or education) (So and Kuhfeld 1995).

Consider a respondent choosing among *i* alternatives in each of *t* choice set. The generalized logit model focuses on the individual as the unit of analysis and uses individual characteristics as explanatory variables. The explanatory variables are constant over alternatives.

In the conditional logit model, the explanatory variables assume different values for each alternative and the impact of a unit of explanatory variables is assumed to be constant across alternatives (ibid.). When explanatory variables contain only individual characteristics, the multinomial model is defined as

$$P(y_i = j) = P_{ij} = \left[\exp\left(x_i'\beta_j\right) / \sum\nolimits_{k=0}^{J} \exp(\, x_i'\beta_k)\right] for\ j = 0, \dots, J$$

Where y_i is a random variable that indicates the choice made, x_i is a vector of characteristics specific to the individual and βj is a vector of coefficients specific to the *j*th alternative. Thus, this model involves choice-specific coefficients and only individual specific regressors.

The ratio of the choice probabilities for alternatives *j* and *i* or the odds ratio of alternatives *j* and *i*. The log-likelihood function of the MNL model is

$$L = \sum_{i=1}^{N} \sum_{j \epsilon c_i} d_{ij} ln P(y_i = j)$$

Where d_{ij} = 1 if individual i chooses alternative j, d_{ij} = 0 otherwise.

The conditional logit model can be used to predict the probability that an individual will choose a previously unavailable alternative, given knowledge of β and the vector x_{ij} of choice-specific characteristics.

According to Louviere et al. (2000) Multinomial logit model provides following advantages compared to other choice modelling framework i) its simple estimation – there is only one set of globally optimal parameters, ii) it enables easy implementation of predictive test of changing market shares in response to scenarios of changing levels of attributes without complex evaluation of integrals.

On contrary the problematic aspects of the multinomial logit model is i) it has too many parameters (the number of individual characteristics times *J*, ii) and the property of independence from irrelevant alternatives.

The variety in the parameters at the individual level may be demonstrated using the maximum simulated likelihood (MSL) method for estimation with a set of 100 Halton draws (Louviere et al., 2000; Bhat, 2001). Since each respondent completes same amount of discrete choice questions, the data form a panel, and we can apply standard random effect estimation.

When we expect that variables are linear in parameters, we may express the utility function as

$$U_{nit} = \gamma\,' x_{nit} + \beta_n' z_{nit} + \varepsilon_{nit}$$

where γ denotes a fixed parameter vector, β_n denotes a random parameter vector, x_{nit} and z_{nit} denote observable variables, and ε_{nit} denotes an independently and identically distributed extreme value term.

7 Experiment

Based on the experience presented in the literature review we run a discrete choice experiment in order to elicit willingness to pay for renewable electricity of households in the Czech Republic. In this chapter we describe in detail, the structure of the questionnaire, outcomes from the pilot survey and the dataset that we obtained from the experiment, i.e. both respondents' characteristics and obtained data.

7.1 Pilot survey

We ran a pilot survey before final set up of the questionnaire using computer-assisted web interviews (CAWI) method. We obtained responses from 18 respondents all living in Ustecky region, each respondent expressed preference in 8 choice sets and we thus obtained in total 144 choice sets. Prior values of parameters were obtained and reflected in final set up of the experimental design. Texting of whole questionnaire was updated, especially in parts which were not fully understandable from the view of respondents.

7.2 Structure of the Questionnaire

The questionnaire[21] was divided into four sections. In the first part, we asked respondents on their region, size of household, size of apartment and on their electricity consumption patterns.

Second part was explanatory. General background of Czech energy market was described, together with main effects of future adoption of renewable electricity, e.g. that the contribution for building new capacity of renewable electricity sources, that is added to original electricity price, should bring lower proportion of carbon intensive electricity sources and better air quality in near future. Or that the support and investing in centralized sources of electricity should bring economies of scale but on contrary higher cost of long-track transition grids and also accumulation of profits into few big national or international companies instead of small local companies. Money invested via the green electricity contribution into local companies may be seen as positive externality since it will stay in the village or city where the respondent lives.

[21] Complete questionnaire is in Annex I.

Third part was the choice experiment. Each respondent was asked to state his first best option among three alternatives (one of them status quo) in eight different choice tasks. Value of monthly electricity expenses was made respondent-specific according to his/her actual expenses and presented in absolute value. For respondents who did not provide the value of monthly electricity expenses it was calculated according to activities for which electricity is used in the household (for more details see Table 5). Values on air quality were not respondent specific and described expected percentage change compared to status quo.

We used statistical software Ngene in order to achieve an efficient experimental design. In total 80 choice sets were used in the experiment, divided into 10 blocks by 8 choice sets. For each respondent the block was chosen randomly, order of individual choice sets within blocks was random as well. We aimed to manage that the status quo would not be chosen too often among all alternatives due to wrong specification of attribute levels. The parameters obtained in the experiment shall thus be realistic.

In fourth part of experiment we asked respondents about their socio-demographic characteristics. This phase is the last part of the experiment, such that the responses did not affect the respondents when answering choice tasks.

7.3 Data collection

The survey was administered in term June 18th – June 22th 2015in 2 regions of the Czech Republic, in accordance with demographic distribution of the population. The CAWI method was used. Respondents were contacted via commercial internet panel data provider and received remuneration for completing the survey from data provider.

In total 588 questionnaires were send to respondents from which we received back 442 complete responds. Overview of non-complete questionnaires is shown in table below.

Table 10: Survey - Respond rates (absolute and relative)

Status of questionnaire	Amount of questionnaires	% of total
Complete	441	75%
Unfinished	60	10%
Screen-out	17	3%
Quota-full - region	39	7%
Quota-full - age	31	5%
total	588	100%

We further excluded results of 24 questionnaires that were filled-in too quickly (less than 48 % of the mean value, i.e. 6:01 minutes) and of 13 questionnaires when respondents presented too low monthly electricity price was, i.e. lower than 300 CZK. We obtained 404 complete questionnaires, specifically 207 from Ustecky region and 197 from Southern Bohemia region. Each respondent was asked to express his/her preference in 8 choice sets, we obtained 3232 consumer choices.

All questionnaires were administered within specific time period, specific region and under specific socioeconomic circumstances. When comparing with results from other studies we should always take this into account. Moreover if there occurs some either positive or negative information about renewable electricity in national-wide media it may in short term significantly affect the respondents' willingness to pay for green electricity, we may call this a kind of population's current mood. It remains open question if this effect is short time or long lasting and if it affects whole population or only certain groups. We shall thus take as more predicative the relative values of WTPs between different socio-demographic groups.

Focusing on the sample we put special accent on necessary variation in values of respondents' home air quality in order to test the hypothesis staying that households living in areas with worse air quality are willing to pay more for green electricity. Ustecky region is the one with relatively high local air pollution compared to other regions. There is clear causal relation between amount of electricity generated from coal power plants and emissions of PM_{10}, because majority of coal power plants in the Czech Republic are located in the region. On the other hand, Southern Bohemia region is known for relatively low local air pollution. However, local air pollution is relatively variable in the region and it is mainly caused by traffic exhaust.

7.4 Sample characteristics

Sociodemographic characterization is specified in more detail in table below.

Table 11: Background sociodemographic characteristics for respondents 1

Variable	Experiment			Czech Republic average
	Total 404	Ustecky region 207	Southern Bohemia region 197	
	% share	% share	% share	% share
Gender				
Male	32	28	35	49
Female	68	72	65	51
Age category (0 - 19 excluded)				
20 – 39	40	42	38	36
40 – 59	40	43	37	34
60 and older	20	15	25	30
average age (years)	45 y	43 y	46 y	49 y
Household size				
1 person	12	14	11	25
2 persons	36	35	35	27
3 persons	25	28	22	20
4 persons and more	27	23	32	28
Highest education				
Primary school	15	13	17	16
Secondary school	55	60	50	70
Higher/Bachelor	12	11	12	
Master/Ph.D.	18	16	21	14
City/village size (inhabitants)				
less than 1000	13	12	15	
1000 – 9999	31	21	40	
10 000 - 99 999	51	62	41	
more than 100 000	5	5	4	

According to values of age distribution in the Czech Republic, three age categories were set in the questionnaire: i) 20 – 39 years old, ii) 40 – 59 years old and iii) 60 years and older. For each category we set up a quota. General rule is that the final value may be maximally 5 %

higher than real value. Final sample is slightly younger than real population. Expressed in average value, final sample is 4 years younger than real population.

Regarding household size, there is a slight shortage on single person households and slight surplus of two-people households in the sample.

Table 12: Background sociodemographic characteristics for respondents 2 (source: data sample and Czech Statistical Office)

Variable	**Total**	**Ustecky region**	**Southern Bohemia region**
Average Net income of the household (CZK)	28 354	28 508	28 184
Average Monthly electricity bill payment (CZK)	1 337	1 203	1 477
PM10 Emissions - 5 year average (2009 - 2013) (μg/m3)	23.47	27.33	19.40
Average Environmental attitude (10 = lowest, 50 = highest)	36.24	36.53	35.93

Average net income of the household is by 1 % higher in Ustecky region than in Southern Bohemia region. On the other hand Average monthly electricity bill payment is by 23 % higher in Southern Bohemia region than in Ustecky region. This difference may be explained two ways, first that in Ustecky region central heating system running on cheap coal is more frequently used by citizens, second possible explanation are colder weather conditions in Southern Bohemia region.

Average annual emissions of particular matter were by 41 % higher in Ustecky region during 2009 – 2013 period. Values of PM_{10} emissions are relatively variable in both regions, ranging from 9.5 to 23.5 $\mu g/m_3$ in Southern Bohemia region and from 9.5 to 31.5 μg/m3 in Ustecky region. Average environmental attitude is relatively similar in both regions.

8 Results

Final outcomes of the study are presented in this chapter. SAS 9.4 software was used in order to evaluate the data and for modelling values of parameters and WTP values.

In the basic MNL model, we find there is a positive WTP for both, local air quality improvement and climate change mitigation. WTP for local air quality improvement (represented by emissions of particular matter) is relatively higher than WTP for climate change mitigation (represented by greenhouse gases emissions).

As expected **respondents have positive WTP for decentralization of renewable electricity production.** The highest WTP value was stated for supporting renewable electricity production in households, second highest WTP for support focusing on municipalities, third regional companies, fourth if the support would be distributed among all types of beneficiaries and the lowest WTP value is for large national or international companies.

Respondents who live in more polluted areas have stronger preference and hence larger WTP for reducing PM emissions (H0 is not rejected). However, effect of actual air quality in respondent’s place of residence was not found statistically significant.

Respondents living in Ustecky region have on average higher WTP for both local air quality improvement and climate change mitigation. Level of environmental attitude and household’s net income were found to have a positive effect on WTP for local air quality improvement and climate change mitigation. Respondents prefer national support scheme over regional support scheme.

Effects of respondents’ sociodemographic characteristics on WTP for change of air quality were studied as well, e.g. on average women have higher WTP for local air quality improvement than men. WTP for climate change mitigation decreases with increase of household’s size.

Overall MNL results are presented in tables below. Parameters of most variables are statistically significant at 5 % level. Both environmental variables were defined as negative – i.e. an increase in the value of given variable represents a decrease in air quality (due to PM increase), or an increase in climate change impacts (due to GHG increase), respectively. Hence, positive values of the coefficients would indicate (positive) marginal utility for worsening air quality (i.e. increase in PM), or increasing global warming (i.e. increase in GHGs). Negative coefficients for "local air quality" or "global warming" show on respondents' disutility with respect to worsening the state and are associated with positive WTP values for emission reduction in respective substance. Definition of all variables are presented in Chapter 5.2.

Results of basic model [M1]

For a 1 % increase of local air quality the respondents are, on average, willing to pay 49 CZK per month. In relative terms for an average electricity bill that amounts 1,337 CZK a month, the respondents are willing to pay 3.7 % higher payments for electricity if this amount would be transferred in 1 % increase of local air quality, that is in this study represented by emissions of particular matter.

WTP for climate change mitigation is also positive but about 4 times lower than WTP for local air quality improvements; however, the coefficient is not statistically significant at any convenient level. Both results for local air quality and climate change are in line with the literature; including stronger preference for local air quality improvements since pollution causes directly adverse health effects.

Results of full model [M3]

Model 3 is a full model that contains all possible interaction – on income, region, environmental attitudes and actual household's air quality. Statistical significance of dependent variable (electricity bill expenditures) is less statistically significant than in the basic model. The coefficients of two dummy variables representing type of supported beneficiary, i.e. municipalities and regional companies, are in all models with interactions (M2 – M9) less statistically significant, however of similar value and same sign as in the basic model.

Results of final model [M2]

Considering the model with the interactions on income with both environmental variables (LAQ and CC), environmental attitudes with local air quality, region with climate change effects (model 2), the statistical significance of the parameter for electricity bill is higher compared to model 1 and model 3.With 1000 CZK increase of household's monthly income

WTP for local air quality decreases by 12 CZK/month and WTP for climate change mitigation increases by 21 CZK/month. The effect for local air quality is partly balanced because "richer" households pay on average more on their electricity bills due to higher electricity consumption and thus relative value of WTP for RES support is only slightly higher in households with lower income.

We find, in line with our prior expectations that respondent's environmental attitudes positively affect his/her WTP for local air quality improvement; WTP values for climate change mitigation are not statistically significant in full model, hence interactions of CC with environmental attitudes are excluded in final model.

Respondents living in Ustecky region express higher WTP values for local air quality improvement than those living in Southern Bohemia region; this result is logical because majority of Czech coal power-plants are situated in Ustecky region. On contrary Southern Bohemians express higher WTP for climate change mitigation. The coefficients for interactions of regional variables with climate change mitigation variable are not statistically significant in the full model hence these interactions are excluded in final model.

Results of models [M4] – [M9]

Compared to full model [M3] models [M4] – [M9] do not include full set of interactions.

Model 4 includes interactions of environmental variables with income. Model 5 includes interactions of environmental variables with income and regional variables. Model 6 includes interactions of environmental variables with income, regional variables and environmental attitudes. Model 7 includes interaction of environmental variables with income and actual household's air quality. Model 8 includes interactions of environmental variables with income, environmental attitudes and actual household's air quality. Model 9 includes interactions of environmental variables with income and environmental attitude.

As expected, in models that do not include full set of interactions the coefficients of included variables tend to be more statistically significant in comparison to the full model due to possible correlations among variables.

In models M7, M8 and M9 the coefficient of electricity bill the statistical significance is substantially higher than in full and final model.

Important fact is that values of the coefficients of identical variables are similar and with the same sign across different models. The exemption is the dummy variable Missing income. This variable was added in order to control for a difference in preferences between those respondents who did not provide information about total net income of their household and the rest of sample. However, the coefficient of this variable is not statistically significant across all models, where it was included.

Compared to full model [M3] and final model [M2] both income variables in model 4 have negative WTP value, representing higher WTP for environmental variables of respondents with higher income. WTP for local air quality improvement is higher than for climate change mitigation.

In comparison with full model and final model where the coefficient of actual household's air quality is not statistically significant, it is statistically significant in model 7 at 1 % for local air quality and at 5 % at climate change mitigation.

Table 13: Model estimation results 1 (monthly costs in CZK, income in thousands of CZK)

	[M1] Model without interactions					[M2] Final model					[M3] Full model				
Variable	**B**	**SE**	**Approx Pr > |t|**	**Sgn**	**WTP**	**B**	**SE**	**Approx Pr > |t|**	**Sgn**	**WTP**	**B**	**SE**	**Approx Pr > ItI**	**Sgn**	**WTP**
Electricity bill expenditures	-0.0006	0.0003	0.0513	*		-0.0007	0.0003	0.0482	**		-0.0006	0.0003	0.0647	*	
Local air quality - LAQ (% decrease)	-0.0304	0.0070	<.0001	***	-49										
Climate change - CC (% decrease)	-0.0055	0.0071	0.4444		-9										
Type of supported beneficiary (SQ = all)															
Households	0.4213	0.0673	<.0001	***	685	0.3905	0.0684	<.0001	***	585	0.3894	0.0686	<.0001	***	617
Municipalities	0.2111	0.0690	0.0022	***	343	0.1382	0.0713	0.0524	*	207	0.1358	0.0714	0.0572	*	215
Regional companies	0.1607	0.0659	0.0148	**	261	0.1046	0.0674	0.1206		157	0.1061	0.0674	0.1154		168
National companies	-0.2453	0.0632	0.0001	***	-399	-0.2967	0.0646	<.0001	***	-445	-0.2957	0.0646	<.0001	***	-469
Location of support scheme (SQ = national)															
Regional	-0.1016	0.0577	0.0782	*	-165	-0.1002	0.0593	0.0910	*	-150	-0.1032	0.0594	0.0824	*	-164
Interactions															
Income (thousands of CZK) x LAQ						0.0081	0.0027	0.0028	***	12	0.0119	0.0053	0.0239	**	19
Missing Income (dummy) x LAQ						-0.0044	0.0243	0.8577		-7	0.0075	0.0295	0.7980		12
Ustecky region (dummy) x LAQ											-0.0885	0.0648	0.1722		-140
Southern Bohemia region (dummy) x LAQ											-0.0419	0.0489	0.3907		-66
Environmental attitude - middle (dummy) x LAQ						-0.0458	0.0060	<.0001	***	-69	-0.0382	0.0182	0.0364	**	-61
Environmental attitude - high (dummy) x LAQ						-0.1015	0.0076	<.0001	***	-152	-0.0769	0.0220	0.0005	***	-122
Actual household's air quality (decrease) x LAQ											0.0018	0.0022	0.4117		3
Income (thousands of CZK) x CC						-0.0141	0.0031	<.0001	***	-21	-0.0178	0.0053	0.0007	***	-28
Missing Income (dummy) x CC						-0.0309	0.0245	0.2070		-46	-0.0428	0.0291	0.1406		-68
Ustecky region (dummy) x CC						0.0287	0.0079	0.0003	***	43	0.1409	0.0641	0.0279	**	223
Southern Bohemia region (dummy) x CC						0.0356	0.0081	<.0001	***	53	0.0959	0.0483	0.0469	**	152
Environmental attitude - middle (dummy) x CC											-0.0067	0.0181	0.7120		-11
Environmental attitude - high (dummy) x CC											-0.0242	0.0217	0.2659		-38
Actual household's air quality (decrease) x CC											-0.0028	0.0022	0.2085		-4
Number of observations	3232					3232					3232				
Log Likelihood	-3414					-3304					-3299				
Likelihood Ratio - 2x(LogL - LogL0)	273					492					503				

* - statistically significant at 10 % level
** - statistically significant at 5 % level
*** - statistically significant at 1 % level

Table 14: Model estimation results 2 (monthly costs in CZK, income in thousands of CZK)

Variable	[M4]					[M5]					[M6]				
	B	SE	Approx Pr > |t|	Sgn	WTP	B	SE	Approx Pr > |t|	Sgn	WTP	B	SE	Approx Pr > |t|	Sgn	WTP
Electricity bill expenditures	-0.0005	0.0003	0.1105			-0.0007	0.0003	0.0234	**		-0.0007	0.0003	0.0448	**	
Local air quality - LAQ (% decrease)															
Climate change - CC (% decrease)															
Type of supported beneficiary (SQ = all)															
Households	0.4372	0.0670	<.0001	***	948	0.4099	0.0675	<.0001	***	555	0.3894	0.0686	<.0001	***	573
Municipalities	0.2161	0.0691	0.0018	***	469	0.2036	0.0693	0.0033	***	276	0.1371	0.0714	0.0548	*	202
Regional companies	0.1709	0.0655	0.0091	***	371	0.1574	0.0661	0.0172	**	213	0.1072	0.0674	0.1117		158
National companies	-0.2454	0.0628	<.0001	***	-532	-0.2525	0.0634	<.0001	***	-342	-0.2947	0.0646	<.0001	***	-433
Location of support scheme (SQ = national)															
Regional	-0.1224	0.0568	0.0312	**	-266	-0.1005	0.0579	0.0828	*	-136	-0.1033	0.0594	0.0820	*	-152
Interactions															
Income (thousands of CZK) x LAQ	-0.0061	0.0023	0.0072	***	-13	0.0095	0.0051	0.0626	*	13	0.0117	0.0053	0.0271	**	17
Missing Income (dummy) x LAQ	-0.0458	0.0233	0.0491	**	-99	0.0050	0.0285	0.8610		7	0.0072	0.0294	0.8077		11
Ustecky region (dummy) x LAQ						-0.0706	0.0179	<.0001	***	-96	0.0072	0.0294	0.8077		11
Southern Bohemia region (dummy) x LAQ						-0.0426	0.0179	0.0170	**	-58	-0.0075	0.0232	0.7455		-11
Environmental attitude - middle (dummy) x LAQ											-0.0372	0.0182	0.0410	**	-55
Environmental attitude - high (dummy) x LAQ											-0.0744	0.0219	0.0007	***	-109
Actual household's air quality (decrease) x LAQ															
Income (thousands of CZK) x CC	-0.0046	0.0023	0.0467	**	-10	-0.0167	0.0051	0.0010	***	-23	-0.0175	0.0053	0.0009	***	-26
Missing Income (dummy) x CC	0.0048	0.0230	0.8357		10	-0.0356	0.0281	0.2058		-48	-0.0424	0.0291	0.1446		-62
Ustecky region (dummy) x CC						0.0502	0.0177	0.0046	***	68	0.066	0.0236	0.0052	***	97
Southern Bohemia region (dummy) x CC						0.0319	0.0178	0.0735	*	43	0.043	0.0235	0.0673	*	63
Environmental attitude - middle (dummy) x CC											-0.0078	0.0181	0.6682		-11
Environmental attitude - high (dummy) x CC											-0.0078	0.0181	0.6682		-11
Actual household's air quality (decrease) x CC															
Number of observations	3232					3232					3232				
Log Likelihood	-3409					-3398					-3301				
Likelihood Ratio - 2x(LogL - LogL0)	283					306					500				

* - statistically significant at 10 % level
** - statistically significant at 5 % level
*** - statistically significant at 1 % level

Table 15: Model estimation results 3 (monthly costs in CZK, income in thousands of CZK)

Variable	[M7]					[M8]					[M9]				
	B	SE	Approx Pr > |t|	Sgn	WTP	B	SE	Approx Pr > |t|	Sgn	WTP	B	SE	Approx Pr > |t|	Sgn	WTP
Electricity bill expenditures	-0.0008	0.0003	0.0067	***		-0.0011	0.0003	0.0007	***		-0.0012	0.0003	0.0001	***	
Local air quality - LAQ (% decrease)															
Climate change - CC (% decrease)															
Type of supported beneficiary (SQ = all)															
Households	0.4048	0.0674	<.0001	***	491	0.3784	0.0684	<.0001	***	348	0.3687	0.0681	<.0001	***	306
Municipalities	0.1997	0.0693	0.0040	***	242	0.1386	0.0711	0.0513	*	128	0.1351	0.0709	0.0567	*	112
Regional companies	0.1499	0.0660	0.0231	**	182	0.0957	0.0672	0.1544		88	0.0873	0.0671	0.1932		72
National companies	-0.2565	0.0633	<.0001	***	-311	-0.3032	0.0646	<.0001	***	-279	-0.3116	0.0645	<.0001	***	-259
Location of support scheme (SQ = national)															
Regional	-0.0908	0.0576	0.1149		-110	-0.0812	0.0589	0.1685		-75	-0.0649	0.0583	0.2655		-54
Interactions															
Income (thousands of CZK) x LAQ	0.0078	0.0046	0.0897	*	9	0.0116	0.0048	0.0154	**	11	0.0073	0.0038	0.0541	*	6
Missing Income (dummy) x LAQ	0.0014	0.0271	0.9601		2	0.0110	0.0279	0.6947		10	-0.0060	0.0256	0.8134		-5
Ustecky region (dummy) x LAQ															
Southern Bohemia region (dummy) x LAQ															
Environmental attitude - middle (dummy) x LAQ						-0.0373	0.0172	0.0298	**	-34	-0.0526	0.0141	0.0002	***	-44
Environmental attitude - high (dummy) x LAQ						-0.0717	0.0214	0.0008	***	-66	-0.0868	0.0191	<.0001	***	-72
Actual household's air quality (decrease) x LAQ	-0.0022	0.0006	0.0004	***	-3	-0.0012	0.0008	0.1414		-1					
Income (thousands of CZK) x CC	-0.0143	0.0046	0.0018	***	-17	-0.0151	0.0047	0.0014	***	-14	-0.0093	0.0037	0.0128	**	-8
Missing Income (dummy) x CC	-0.0287	0.0268	0.2837		-35	-0.0366	0.0276	0.1842		-34	-0.0138	0.0251	0.5819		-11
Ustecky region (dummy) x CC															
Southern Bohemia region (dummy) x CC															
Environmental attitude - middle (dummy) x CC						-0.0002	0.017	0.9894		0	0.0207	0.0137	0.1323		17
Environmental attitude - high (dummy) x CC						-0.0231	0.0212	0.2750		-21	-0.002	0.0187	0.9128		-2
Actual household's air quality (decrease) x CC	0.00136	0.00061	0.0263	**	2	0.00166	0.00079	0.0358	**	2					
Number of observations	3232					3232					3232				
Log Likelihood	-3398					-3309					-3313				
Likelihood Ratio - 2x(LogL - LogL0)	306					483					476				

* - statistically significant at 10 % level
** - statistically significant at 5 % level
*** - statistically significant at 1 % level

Hypothesis #1: "Households that are living in areas with worse air quality are willing to pay more for green electricity."

We found positive WTP for local air quality improvement that would be reached through support scheme for renewable electricity production. However this effect is not statistically significant in models where other variables were included. Willingness to pay values for local air quality improvements climate change mitigation are both more strongly affected by variables such as household's income, environmental attitude and region of residence.

Hypothesis #2: "Households are willing to pay more for green electricity from small decentralized sources, even though it would be less effective than big centralized sources."

This hypothesis is proven by the data. Respondents are willing to pay more for decentralized sources of renewable electricity. The highest WTP value was found for the support scheme that would support strictly renewable electricity sources owned by households, the value is more than twice higher than for other sources of renewable electricity. The second highest WTP value is for the support scheme that would advance renewable electricity sources owned by municipalities, slightly lower WTP value is for RES sources owned by regional companies. If the support scheme would be open for all types of beneficiaries (which is current status quo) WTP for contribute into such scheme would be lower than for schemes focusing on decentralized RES. The lowest WTP value was found for contribution in the support scheme that would support only big national or international companies WTP

Hypothesis #3: "Households are willing to pay less to support increase in green electricity share than what is actual contribution in the Czech Republic."

We may reject the hypothesis that households are willing to pay less to support increase in green/renewable electricity share than what is actual contribution in the Czech Republic. However, this result has to be interpreted with caution.

As stated by respondents in the questionnaire many of them are very distrustful in a way whether the government would be able to implement such support scheme effectively and achieve proposed levels of air quality improvements. Proposed local air quality improvement may be also seen by respondents as too optimistic because particular matter emissions do not occur solely as a by-product of energy generation but also from industry, transportation, agriculture, etc. and that a reduction in power production emissions may not be sufficient for proposed air quality improvements.

Proper interpretation of the results is that respondents are willing to pay on average 3.7 % higher price of electricity bills per month in form of contribution to a support scheme that promises to increase local air quality by 1 %

If such support scheme improved local air quality by 12 % (which is expected effect of current renewable electricity production on local air quality) respondents would be willing to pay monthly contribution to such scheme that equals 44 % of their electricity bill payment. That is 4 times higher value that what is currently paid by households in the Czech Republic.

Sociodemographic characteristics

None of following sociodemographic characteristics was confirmed to be statistically significant in any of designed models. However, on average presented values of WTP were derived in order to show expected differences among sociodemographic groups.

Women have higher WTP values for both local quality improvements and climate change mitigation. Respondents older than 60 years have higher WTP for local air quality improvement than respondents up to 40 years and lower WTP than middle age group (40 – 59 years). Oldest respondents have the highest WTP for climate change mitigation among age groups, followed by young respondents and middle age group with the lowest WTP value. With increased household members WTP for climate change mitigation increases.

9 Conclusions

Results of the study may be relevant when setting up policy measures in future. In this chapter we provide main recommendations for policy makers.

Willingness to pay for green electricity was not confirmed to be affected by actual air quality in the area of residence (represented by particular matter emissions). On the other hand, it was confirmed that people living in Ustecky region where the air quality is in general worse than in Southern Bohemia region have higher WTP for green electricity. The difference between two regions was not examined more deeply, however, environmental attitudes of respondents in both regions are nearly equal, similarly the level of education, households' income and other sociodemographic categories, with exception of average air quality which is higher in Southern Bohemia region. Introducing sort of voluntary support scheme in addition to national-wide scheme in regions with lower air quality would make sense.

Results show that WTP for decentralized sources of green electricity is significantly higher than for centralized sources. Proceeds of possible voluntary support scheme should be used in order to support green electricity sources owned by households or municipalities.

The result may be distinct if a sample of respondents would consist of representatives of big companies from energy-intensive industries. This topic was not a part of the study, however, relatively higher WTP for centralized green electricity sources would understandable, since it would be expected to be relatively cheaper due to economies of scale.

It was not proven in the study that households would be willing to pay less for green electricity support than what is their actual contribution. Concerning this result, the limit price of electricity bill should be set up accordingly, i.e. higher than current, and the governmental payment to green electricity support scheme would decrease.

Soon and Ahmad (2015) in their meta-analysis estimated the average WTP of 7.16 USD (193.32 CZK) per household and month. This value would in our sample represent 4 % improvement of local air quality. Our results are in line with the results found in other countries.

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10 Bibliography

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Annex I – Questionnaire

Part A

Thank you for participating in research that is realized by Charles University in Prague. Aim of the research is to find out what is the willingness of Czech households to pay higher prices of electricity, in order to increase air quality via support for renewable sources of energy.

Duration of the questionnaire +/- 25 minutes

We will later ask you what are your expenditures on electricity that you consume. Please have prepared your last electricity bill.

There are no correct or incorrect answers.

All information that we will obtain from the questionnaire will be used solely for purpose this research.

Part B: Electricity consumption

Part B.1: Basic information

Q1. Are you:
[1] man or
[2] woman?

Q2. Please fill in your age

Q3. Please fill in your region
[1] Jihočeský (Southern Bohemia)
[2] Jihomoravský
[3] Královehradecký
[4] Karlovarský
[5] Liberecký
[6] Moravskoslezský
[7] Olomoucký
[8] Pardubický
[9] Praha
[10] Plzeňský
[11] Středočeský
[12] Ústecký
[13] Vysočina
[14] Zlínský

Q4. How many citizens live in your city/village?

[1] up to 199
[2] 200 - 499
[3] 500 - 999
[4] 1 000 - 1 999
[5] 2 000 - 4 999
[6] 5 000 - 9 999
[7] 10 000 - 19 999
[8] 20 000 - 49 999
[9] 50 000 - 99 999
[10] 100 000 - 999 999
[11] 1 million and more

Q6. Please fill in your postal code

Q7. What is your highest education?

[1] Primary
[2] Primary technical
[3] Secondary without graduation
[4] Secondary with graduation
[5] Secondary technical with graduation
[6] grammar school
[7] Higher technical
[8] bachelor degree
[9] master degree
[10] Ph.D. and higher

Part B.2.1: Information on household

Q8. How many people live in your household?

[1] 1
[2] 2
[3] 3
[4] 4
[5] 5
[6] 6
[7] 7 and more

Q9. How many members of your household are employed?

[1] 1
[2] 2
[3] 3
[4] 4
[5] 5

[6] 6
[7] 7 and more

Part B.2.2: Electricity consumption

Q10. What type of accommodation you live in?
[1] Family house
[2] Apartment in villa
[3] Apartment in residential building
[4] Other

Q11. Can you affect your regular expenditures for electricity?
[1] yes.
[2] no, it is fixed.
[3] no, it is proportional according to total consumption of the building.
[4] i don't know.

Q12. What is the size of your apartment/house?
[1] up to 40 m2
[2] 40-59 m2
[3] 60-79 m2
[4] 80-99 m2
[5] 100-119 m2
[6] 120-149 m2
[7] 150-179 m2
[8] 180 m2 and more
[9] I don't know

Q41. What does your household use electricity for?

Heating	yes/no
Water heating	yes/no

Q13. What is the energy class of your home appliances?

	I don't know	A++ and higher	A+	A	B	C	D	I don't possess this appliance
Fridge								
Washing machine								
Dishwasher								

Q14. How much you paid for electricity in last period?
Please fill in one on following options

a) .. CZK per year
b) .. CZK per quarter
c) .. CZK per month
d) .. I don't know

IF Q42=d)
Q45. Calculated according to average value in the Czech Republic.

IF Q42 > 6000 CZK per month
Q46. You stated relatively high value of payment for electricity, please fill in once again.

a) .. CZK per year
b) .. CZK per quarter
c) .. CZK per month

Q15. Did you look at your electricity bill when answering previous question?
[1] Yes, because I don't know exactly how much I pay.
[2] Yes, because I know how much I pay, but I wanted to check it.
[3] Yes, I know how much I pay, however, I could not find it on the electricity bill.
[4] No, because I know exactly how much I pay.
[5] No, because I don't understand information on the electricity bill.
[7] No, my electricity bills are at different place.
[8] No, because someone else takes care for electricity bills
[6] Other: ………………………..

Q43. Have you ever consumed „green electricity"?
[1] No
[2] Yes

Q16. Do you think that in following 10 years electricity prices will..
[1] .. certainly increase.
[2] .. probably increase.
[3] .. stay same as today.
[4] .. probably decrease.
[5] .. certainly decrease.
[6] .. I don't know.

Part C: Information on renewable electricity

Part C.1

Electricity may be produced two ways, from renewable or non-renewable energy sources. Renewable energy sources common in the Czech Republic are water, wind, solar, biomass and geothermal energy. Non-renewable energy sources are coal, nuclear, gas and oil.

Renewable sources cause less negative effects to the environment compared to non-renewable sources. Electricity produced from coal and gas cause emissions of particular matter and greenhouse gases into the atmosphere. Emissions of particular matter cause health problems of citizens (lung disease, heart disease, asthma, etc.

Greenhouse gas emissions are main cause of climatic change. Climate change causes in the Czech Republic higher probability of extreme weather, intensive storms and floods.

Q17. Have you ever heard about climate change?

[1] Yes
[2] No

<u>Part C.2</u>

There are two ways how to reduce emissions of particular matter and greenhouse gases. First is reduced electricity consumption. This is possible without reduction of residents‘ quality of life via higher energy efficiency. Second way is to increase proportion of renewable energy sources on the energy mix. Consequently old coal power plants with highest emissions may be closed. Both ways lead to lower dependence on imports of fuels (natural gas and uranium).

In the Czech Republic 12.8 % of the electricity was produced from renewable energy sources in 2013, 3.6 % in 2004. In the EU 25.4 % of electricity was produced from renewable energy sources in 2013.

<u>Part C.3</u>

Electricity produced from renewable sources is currently more expensive, because it is relatively new technology. It is expected that the price will decrease in future due to technological progress.

	Renewable energy sources	Non-renewable energy sources
Amount	Unlimited	Limited
Example	Wind, water, solar	Nuclear, coal, gas
Price of electricity	Currently higher, expected to decrease	Currently lower
Effect on health and the environment	Almost no negative impact, relatively low emissions during building-up	High negative impact – emissions caused by combustion, nuclear fuel storage
Self-sufficiency	Possible full	Import of gases and nuclear fuel. Enough coal in the Czech Republic

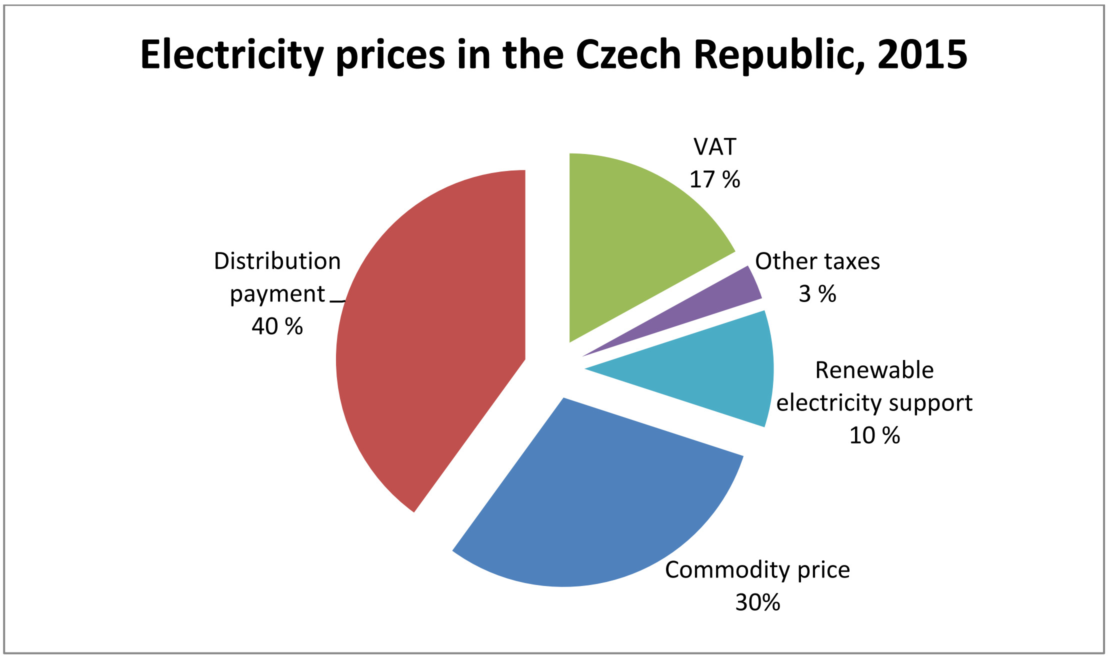
Q18. Do you think that in following 10 years prices of renewable electricity will..

[1] .. certainly increase.
[2] .. probably increase.
[3] .. stay same as today.
[4] .. probably decrease.
[5] .. certainly decrease.
[6] .. I don’t know.

<u>Part C.4</u>

Renewable electricity is in the Czech Republic supported in form of feed-in tariffs and feed-in premium. Producers have guaranteed electricity prices. This guaranteed price is higher than market price of electricity. This support is currently being restricted due to excessive values in preceding years, in particular for solar.

Feed-in tariffs and premium are partly paid from governmental budget and partly by consumers as a part of final electricity price. Renewable energy sources support currently forms approximately 10 % of final price of electricity. Final price of electricity consists of spot price (30 %), distribution payment (40 %) and taxes (20 %).



Part C.5

Electricity produced from centralized (bigger) sources usually causes lower costs (economies of scale). On the other hand, small (decentralized) sources produce local value added, the support thus have positive effect on the employment in the region.

	Centralized sources	Decentralized sources
Examples	Nuclear power plant, coal power plant, big solar power plant	Roof solar, small water power plant
Costs	Lower average costs of production, higher costs of distribution	Higher average costs of production, lower costs of distribution
Employment	Lower amount of jobs, jobs are concentrated	Higher amount of jobs, jobs are not concentrated

Part D: Discrete choice experiment

Q19 – Q26 8x choice set

We will now introduce you 8 hypothetical situations. In each situation you may choose one of three different options. Please choose the one that is the most suitable for you.

Support for renewable electricity is imposed into your average monthly electricity bill. Please expect that chosen level of support is binding for all households.

All money collected for renewable electricity support will be provided in the area that you choose.

Please consider that higher payment for electricity would decrease your wherewithal for purchases of other goods.

Example of choice set: (status quo and two alternatives)

	Status quo	**Alternative B**	Alternative C
Your average **monthly expenditures** for electricity **Contribution** to renewable energy sources (RES) **Proportion of contribution** to RES compared to your total expenditures for electricity	1 500 CZK per month ____________ **150 CZK per month** ____________ RES contribution about 10%	**1 650 CZK per month** ____________ **300 CZK per month** ____________ **RES contribution about 20%**	1 425 CZK per month ____________ **75 CZK per month** ____________ RES contribution about 5%
Emissions of particular matter emitted in your region	Keeping current	**12% reduction**	6% increase
Emissions of greenhouse gases emitted from power plants in the Czech Republic	Keeping current	**12% reduction**	6% increase
Beneficiaries	All	**Municipalities**	Region, big companies
RES contribution collected in my region will be provided ..	In whole CR	**In whole CR**	In my region
Preferred alternative	[ ]	[**X**]	[ ]

We chose alternative B in the example. You will pay 1650 CZK monthly for electricity, which is 10 % more than what you are paying currently. Your contribution to renewable energy is 300 CZK monthly, which is 150 CZK more than what you are currently paying.

If we chose alternative C, your contribution to renewable energy would be 75 CZK monthly which is 5 % less than what you are currently paying.

Contribution to renewable energy in alternative B will cause 12 % reduction of emissions of particular matter in the region where you are living and 12 % reduction of emissions of greenhouse gases from power plants in the Czech Republic.

Contribution to renewable energy will be used to support construction of renewable electricity sources owned by municipalities and small companies. Contribution collected in your region will be combined with as a part of national program and will be provided to support construction of renewable electricity sources in whole are of Czech Republic.

Control question if status quo alternative was chosen six times and more.

Q27. You chose status quo alternative six times and more. What was the reason for your decision?

[1] Emissions reductions were too low.
[2] Electricity prices were too high.
[3] I am against any regulations.
[4] I don't believe information that I received in the questionnaire.
[5] Alternatives were too similar.
[6] I think that electricity prices will increase but proposed results will not be achieved.
[7] I don't believe that proposed measures would be implemented.
[8] I don't believe that proposed RES contribution would lead to proposed emissions reduction.
[9] Proposed measures should be provided by the government.
[10] I did not receive enough information in order to make relevant decision.

<u>Part E: Environmental attitudes</u>

Q28. Does your household own and use some of renewable energy sources (photovoltaic panel, solar collector, heat pump, microgeneration unit etc.)?

[1] no
[2] yes
  [2a] yes, photovoltaic panel
  [2b] yes, solar collector
  [2c] yes, heat pump
  [2d] yes, microgeneration unit
  [2e] other, please specify: ____

Q44. What kind of energy does your microgeneration unit utilize?

[1] Natural gas
[2] Biogas
[3] LPG
[4] Biomass
[5] Solar energy
[6] other, please specify: ____

Q29. Please evaluate each of following statements on 1 to 5 scale.

(1= certainly do not agree, 5= certainly agree)

	1	2	3	4	5
Current changes in the environment lead to worse.					
Modern life harms the environment.					
Animal has same rights as human.					
People should pay higher prices in order to better prevent the environment.					
People should pay higher taxes in order to better prevent the environment.					

People should reduce their standards of life in order to better prevent the environment.					
Industrial pollution is dangerous for me and my family.					
Utilization of pesticides in agriculture is dangerous for me and my family.					
Pollution of river, lakes and streams is dangerous for me and my family.					
Global warming is dangerous for me and my family.					

Q30. Please evaluate each of following statements on 1 to 5 scale.
(1= certainly do not agree, 5= certainly agree)

As a result of climate change .. :	1	2	3	4	5
.. there will be extreme fluctuations of the weather and more natural disasters in the Czech Republic (e.g. droughts and floods) which will cause increase of costs for the government and municipalities.					
.. there will be higher temperatures during winter in the Czech Republic which will cause decrease of my costs for heating.					
.. there will be less people sick during winter in the Czech Republic which will reduce costs for the health system.					
.. there will be more infection diseases, long warm weather periods, which will cause negative effects to my health and quality of life and I will pay more for my health.					

<u>Part F.1: Sociodemographic questions</u>

Q31. What is your current family status?

[1] Married

[2] Registered partnership

[3] I have a partner but we are not married or in registered partnership

[4] I do not live with my partner in a single household

[5] Divorced

[6] Widow

[7] Never married or in registered partnership

[999] No answer

Q32. What kind of job or rent do you have?

[100] Job
[1] 30 hours per week or more
[2] less than 30 hours per week
[3] entrepreneur
[200] Rent
[4] army service
[5] pension
[6] housewife/househusband
[7] maternal/paternal leave
[8] student
[9] unemployed

[10] invalid pension
[11] other

Q33. What are your net earnings per month?
Please include all earnings, e.g. parental subsidies, governmental subsidies, etc.

[1] Less than 7 500 CZK
[2] 7 500 – 9 500 CZK
[3] 9 501 – 11 500 CZK
[4] 11 501 – 13 500 CZK
[5] 13 501 – 15 500 CZK
[6] 15 501 – 18 500 CZK
[7] 18 501 – 22 000 CZK
[8] 22 001 – 27 000 CZK
[9] 27 001 – 35 000 CZK
[10] 35 001 – 40 000 CZK
[11] 40 001 – 50 000 CZK
[12] More than 50 000 CZK
[999] I don't want to answer

Q34. What are net earnings of your household per month?
[1] Less than 7 500 CZK
[2] 7 500 – 9 500 CZK
[3] 9 501 – 11 500 CZK
[4] 11 501 – 13 500 CZK
[5] 13 501 – 15 500 CZK
[6] 15 501 – 18 500 CZK
[7] 18 501 – 22 000 CZK
[8] 22 001 – 27 000 CZK
[9] 27 001 – 35 000 CZK
[10] 35 001 – 40 000 CZK
[11] 40 001 – 50 000 CZK
[12] More than 50 000 CZK
[999] I don't want to answer

Q35. In your opinion, should be the results of this questionnaire used for set up of new governmental program?
Please rate on 1 to 5 scale**.**

Certainly no				**Certainly yes**

Q46. Now feel free to express your opinion on the questionnaire.

END OF QUESTIONNAIRE

Annex II – Experimental design

Choice set	alt1.a	alt1.b	alt1.c	alt1.d	alt1.e	alt2.a	alt2.b	alt2.c	alt2.d	alt2.e	alt3.a	alt3.b	alt3.c	alt3.d	alt3.e	Block	Order
1	0	15	15	4	0	5	12	9	2	1	-10	24	24	3	0	1	1
2	0	15	15	4	0	5	12	12	2	0	-10	27	24	3	0	1	2
3	0	15	15	4	0	5	9	6	2	1	5	6	12	0	0	1	3
4	0	15	15	4	0	5	12	12	0	0	-10	27	24	2	1	1	4
5	0	15	15	4	0	-10	27	30	1	1	10	3	0	0	1	1	5
6	0	15	15	4	0	10	6	3	3	1	-5	18	21	2	0	1	6
7	0	15	15	4	0	5	9	9	1	1	-10	27	24	3	0	1	7
8	0	15	15	4	0	-5	24	24	0	1	10	0	0	2	0	1	8
9	0	15	15	4	0	-5	24	21	2	1	5	9	9	1	1	2	1
10	0	15	15	4	0	-5	21	21	1	1	-5	18	18	3	0	2	2
11	0	15	15	4	0	-5	18	18	3	0	5	12	9	0	1	2	3
12	0	15	15	4	0	-5	21	21	1	1	10	3	6	2	0	2	4
13	0	15	15	4	0	5	9	12	0	1	-5	24	18	3	0	2	5
14	0	15	15	4	0	10	0	6	3	0	-10	30	27	1	1	2	6
15	0	15	15	4	0	5	9	12	2	1	-5	21	18	3	0	2	7
16	0	15	15	4	0	10	3	0	1	0	-5	21	24	0	1	2	8
17	0	15	15	4	0	-10	24	24	3	0	5	12	12	2	0	3	1
18	0	15	15	4	0	10	3	3	1	0	-10	30	24	0	1	3	2
19	0	15	15	4	0	-5	24	18	3	0	5	9	12	0	1	3	3
20	0	15	15	4	0	-5	21	18	3	0	5	6	9	1	0	3	4
21	0	15	15	4	0	-10	24	27	2	1	10	6	3	0	0	3	5
22	0	15	15	4	0	5	9	6	2	1	-5	21	24	1	1	3	6
23	0	15	15	4	0	-10	27	24	2	0	5	6	9	1	0	3	7
24	0	15	15	4	0	-10	24	30	0	1	10	3	0	1	0	3	8
25	0	15	15	4	0	-10	30	24	2	0	10	0	6	3	1	4	1

Choice set	alt1.a	alt1.b	alt1.c	alt1.d	alt1.e	alt2.a	alt2.b	alt2.c	alt2.d	alt2.e	alt3.a	alt3.b	alt3.c	alt3.d	alt3.e	Block	Order
26	0	15	15	4	0	-10	27	30	1	1	10	6	0	3	1	4	2
27	0	15	15	4	0	10	0	0	0	0	-5	24	24	2	1	4	3
28	0	15	15	4	0	10	6	3	3	1	-10	27	27	1	1	4	4
29	0	15	15	4	0	5	12	6	0	0	-5	18	24	2	1	4	5
30	0	15	15	4	0	-10	27	24	2	0	10	3	3	1	0	4	6
31	0	15	15	4	0	5	12	6	0	0	-10	24	30	2	1	4	7
32	0	15	15	4	0	5	6	6	0	0	5	12	12	2	0	4	8
33	0	15	15	4	0	-10	30	30	1	1	10	0	0	3	0	5	1
34	0	15	15	4	0	5	9	9	1	1	-10	24	24	3	0	5	2
35	0	15	15	4	0	-10	27	27	1	1	10	6	6	3	0	5	3
36	0	15	15	4	0	10	3	0	1	0	-10	24	30	0	1	5	4
37	0	15	15	4	0	5	6	12	2	0	-5	24	18	3	0	5	5
38	0	15	15	4	0	10	0	3	1	0	-5	24	21	2	1	5	6
39	0	15	15	4	0	-5	18	18	3	0	5	12	9	2	1	5	7
40	0	15	15	4	0	-10	27	27	1	1	10	3	0	2	1	5	8
41	0	15	15	4	0	5	6	12	2	0	-5	21	21	1	1	6	1
42	0	15	15	4	0	5	9	12	0	1	-5	21	18	3	0	6	2
43	0	15	15	4	0	5	12	9	0	1	-5	18	18	3	0	6	3
44	0	15	15	4	0	-5	21	18	3	0	5	9	9	1	1	6	4
45	0	15	15	4	0	-10	30	30	1	1	10	0	0	0	0	6	5
46	0	15	15	4	0	-10	27	27	1	1	10	3	6	0	0	6	6
47	0	15	15	4	0	10	0	0	3	1	-10	27	30	1	1	6	7
48	0	15	15	4	0	-10	30	27	1	1	5	6	6	0	0	6	8
49	0	15	15	4	0	-10	30	27	1	1	10	0	6	3	0	7	1
50	0	15	15	4	0	-5	18	21	2	0	5	9	6	1	0	7	2
51	0	15	15	4	0	10	3	0	2	1	-10	27	30	1	1	7	3
52	0	15	15	4	0	-5	21	24	1	1	5	12	6	0	0	7	4
53	0	15	15	4	0	5	6	9	0	1	-5	24	21	2	1	7	5

Choice set	alt1.a	alt1.b	alt1.c	alt1.d	alt1.e	alt2.a	alt2.b	alt2.c	alt2.d	alt2.e	alt3.a	alt3.b	alt3.c	alt3.d	alt3.e	Block	Order
54	0	15	15	4	0	-5	24	21	0	1	5	6	12	2	0	7	6
55	0	15	15	4	0	-10	24	24	3	0	5	12	12	0	0	7	7
56	0	15	15	4	0	10	6	6	3	0	-10	24	27	0	1	7	8
57	0	15	15	4	0	5	12	12	0	0	-5	18	21	2	1	8	1
58	0	15	15	4	0	5	6	6	2	0	-5	24	24	0	1	8	2
59	0	15	15	4	0	-5	18	24	2	1	5	12	6	0	0	8	3
60	0	15	15	4	0	-5	21	18	3	0	5	9	12	0	1	8	4
61	0	15	15	4	0	-5	24	18	3	0	10	0	3	0	1	8	5
62	0	15	15	4	0	-5	24	24	0	1	5	6	6	2	0	8	6
63	0	15	15	4	0	-10	30	27	1	1	10	0	3	3	1	8	7
64	0	15	15	4	0	10	3	6	2	0	-10	30	27	1	1	8	8
65	0	15	15	4	0	-10	24	30	0	1	10	6	0	3	0	9	1
66	0	15	15	4	0	-10	24	27	0	1	10	6	6	3	0	9	2
67	0	15	15	4	0	-5	18	21	0	1	10	6	3	2	0	9	3
68	0	15	15	4	0	10	3	6	0	0	-10	30	24	2	1	9	4
69	0	15	15	4	0	10	0	3	2	0	-10	30	30	1	1	9	5
70	0	15	15	4	0	10	0	6	3	0	-10	30	24	2	1	9	6
71	0	15	15	4	0	10	6	6	3	0	-10	27	27	1	1	9	7
72	0	15	15	4	0	-10	30	24	2	0	10	3	3	1	0	9	8
73	0	15	15	4	0	10	6	0	2	0	-5	18	24	3	0	10	1
74	0	15	15	4	0	5	6	9	0	1	-5	21	21	1	1	10	2
75	0	15	15	4	0	-5	21	24	0	1	-5	21	18	3	0	10	3
76	0	15	15	4	0	10	0	0	3	1	-10	30	30	1	1	10	4
77	0	15	15	4	0	10	6	0	3	0	-5	18	24	0	1	10	5
78	0	15	15	4	0	-5	18	24	3	0	5	9	6	1	0	10	6
79	0	15	15	4	0	10	3	3	1	0	-10	24	27	0	1	10	7
80	0	15	15	4	0	-5	18	24	3	0	5	9	6	2	1	10	8

Annex III – Attribute levels

	Attributes	Attribute levels - design										
a1	Your average monthly expenditures for electricity	-10	-5	0	5	10						
a2	Contribution to renewable energy sources	-10	-5	0	5	10						
a3	Proportion of contribution to renewable energy sources compared to your total expenditures for electricity	-10	-5	0	5	10						
b	Emissions of particular matter emitted in your region	0	3	6	9	12	15	18	21	24	26	30
c	Emissions of greenhouse gases emitted from power plants in the Czech Republic	0	3	6	9	12	15	18	21	24	26	30
d	Beneficiaries	0	1	2	3	4						
e	RES contribution collected in my region will be provided ..	0	1									

	Attributes	Attribute levels - questionnaire										
a1	Your average monthly expenditures for electricity	Q42* (1-0,1) CZK per month	Q42* (1-0,05) CZK per month	Q42 CZK per month	Q42* (1+0,05) CZK per month	Q42* (1+0,1) CZK per month						
a2	Contribution to renewable energy sources	Q42* (0,1-0,1) CZK per month	Q42* (0,1-0,05) CZK per month	Q42*0,1 CZK per month	Q42* (0,1+0,05) CZK per month	Q42* (0,1+0,1) CZK per month						
a3	Proportion of contribution to renewable energy sources compared to your total expenditures for electricity	RES support 0%	RES support 5%	RES support 10%	RES support 15%	RES support 20%						
b	Emissions of particular matter emitted in your region	15% decrease	12% decrease	9% decrease	6% decrease	3% decrease	Status quo	3% increase	6% increase	9% increase	12% increase	15% increase
c	Emissions of greenhouse gases emitted from power plants in the Czech Republic	15% decrease	12% decrease	9% decrease	6% decrease	3% decrease	Status quo	3% increase	6% increase	9% increase	12% increase	15% increase
d	Beneficiaries	Households	Municipalities, small companies	Regions, middle companies	National and big companies	All						
e	RES contribution collected in my region will be provided ..	in whole Czech Republic	only in my region									

Annex IV – External effects of air pollution

According to Kampa and Castanas (2008) anthropogenic activities that cause chemical escape to the environment may cause adverse effects on human health. Air pollutants, such as carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO_X), volatile organic compounds (VOCs), ozone (O_3), heavy metals, and respirable particular matter ($PM_{2,5}$ and PM_{10}), differ in their chemical composition, reaction properties, emission, time of disintegration and ability to diffuse in long or short distances.

Air pollution has both acute and chronic effects on human health, affecting a number of different systems and organs. It ranges from minor upper respiratory irritation to chronic respiratory and hearth disease, lung cancer, acute respiratory infections in children, adverse effect on lung development in children (Gauderman, et al. (2004) and chronic bronchitis in adults, aggravating pre-existing heart and lung disease, or asthmatic attacks. In addition, short- and long-term exposures have also been linked with premature mortality and reduced life expectancy.

Power plants that combust fossil fuels are one of major sources of *gaseous pollutants*, namely NO_X, VOCs, SO_2[22] and *particulate matter*. The size of the particles determines the site in the respiratory tract that they will deposit: PM_{10} particles deposit mainly in the upper respiratory tract while fine and ultra-fine particles are able to reach lung alveoli. There is strong evidence to support opinion that ultra-fine and fine particles are more hazardous than larger ones, in terms of mortality and cardiovascular and respiratory effects (Kampa and Castanas 2008).

In order to quantify correct values of air pollution effects on human it is essential to properly derive the *value of statistical life (VSL)*. Ščasný and Alberini (2012) estimated the monetary value of VSL in the Czech Republic being approx. 2.4 mil EUR. With knowledge of the value it is possible to monetize external effect of air pollution, e.g. decrease of the average life expectancy.

In addition to human health effects air pollution has negative effects in form of ecosystem degradation due to acidification and eutrophication (Bobbink, Hornung and Roelofs 1998);

[22] Even though the majority of gaseous pollutants are inhaled and mainly affect respiratory system they can also induce haematological problem and cancer (for more see Kampa and Castanas 2008).

damage caused to crops (Emberson 2003) and building materials (corrosion); and impacts of climate change attributable to the emissions of greenhouse gases, e.g. in form of intensified storm activities, droughts, etc. (IPCC 2013).

According to Máca, Melichar and Ščasný (2012), who quantified air pollution externalities from electricity generation in six central and eastern European countries, including Czech Republic, market-based instruments are not very effective in internalizing external costs. The authors found that the level of internalization by economic instruments (imposition of command-and-control measures, air emission charges and taxes on electricity) is fairly low for existing fossil-fired power plants ranging from 3% for coal- and lignite-fueled plants to 31% for gas-fueled plants. The picture improves if cross-subsidies for renewable electricity are accounted for but the internalization level is still below air pollution-related external costs, between 9% and 55% for coal- and oil-fired power plants. A substantial overinternalization by these three instruments is however encountered in the case of gas-fired power plants.

Melichar, Máca and Ščasný (2012) quantified external (health and environmental) costs of the 17 biggest coal-fired power plants in the Czech Republic. The authors estimated total external costs of 51 bn CZK and marginal external costs per kWh of produced electricity for each power plant. The results indicate that the biggest part of external costs was caused on human health, including mortality and morbidity, between 60 and 79% of total, second biggest in form of climate change effects, between 11 and 30% of total external costs.