

# Willingness to pay for green electricity

Discrete choice experiment  
in the Czech households

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# Outline

- Motivation
- Green electricity – Czech perspective
- WTP – theoretical background
- Methods
- Data
- Results
- Discussion





## Motivation

*Understand  
consumer preferences  
for green electricity*

# green electricity

## EU initiatives

- EU 2020 target  
20 % renewable energy use
- EU 2030 target  
27 % renewable energy use
  
- CZ 2005 – 6.0 %
- CZ 2014 – **13.4 %**
- CZ 2020 target – 13.0 %  
-> **15.3 %**

## CZ measures

- Investment support  
(ESI funds – since 2007)
- Feed-in tariffs/premiums  
(FIT/FIP – since 2005)
  - Purchase of energy for new RE sources
  - Support base was reduced since 2014

(data: Eurostat)





## green electricity – Czech perspective

- consumer prices include **the payment for RES**
  - **limited** up to 495 CZK/MWh (18.3 EUR/MWh)
  - cca **10 %** of total electricity bill (2015)
  - paid by both **households and companies**
- the rest of the costs on public support of RES is funded directly form the **state budget (0,6 bln. EUR in 2015)**

# willingness to pay for green electricity

- WTP – max price at which consumer will buy a unit of product
- Stated vs. revealed preferences
  - Hypothetical product (attributes)
- Literature review
  - WTP for RES positive, differs across countries
  - WTP urban > WTP rural, WTP N.Am > WTP Asia
  - WTP values increase over time (Soon, Ahmad 2015)



# WTP for green electricity: A Review

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)



## relevant attributes and factors

Attributes		Factors	
RES (increase)	+	Household's income	+
Local air quality (increase)	+	Environmental attitude	+
GHG emissions (decrease)	+	Electricity consumption	-
Decentralization	+	Actual local air quality	?
Regional support	?	Age	?





# Research question

- How much are Czech customers willing to pay for increasing RES share in electricity supply?
  - Is WTP for 10% share (the SQ) larger than the compulsory payment?
  - Does WTP vary across (dirty/cleaner) regions?
  - Is RES from decentralized source more preferred?
  - Is WTP larger when RES will be supplied mainly to a region where respondent lives?



# methods – discrete choice experiment

- choices between discrete alternatives
- attributes of alternatives systematically vary
  - **Share of RES**
  - Costs
    - **Contribution to RES support (total monthly bill) – respondent-specific (pivotal design)**
  - Other effects
    - **AQ – local PM emissions**
    - **GHG emissions**
  - Region-specific attributes
    - **Who is the beneficiary of public support policy**
    - **Where RES will be supplied**

preference parameters of utility function are inferred

# Choice card - Example

Respondent specific

	Status quo	Alternative B	Alternative C
Monthly expenditures for electricity - including RES contribution	1 500 CZK per month	1 650 CZK per month	1 425 CZK per month
RES contribution - absolute	150 CZK per month	300 CZK per month	75 CZK per month
RES contribution - relative	RES contribution about 10%	RES contribution about 20%	RES contribution about 5%
Local emissions (AQ)	Current level	12% reduction	6% increase
GHG emission from powerplants in CZ	Current level	12% reduction	6% increase
Beneficiaries	All subjects	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 ]	[ ]

# DCE attributes

Nested attribute levels

Attribute	Attribute levels
Monthly expenditures for electricity - including RES contribution	10 %, 5 % decrease, Status quo, 5 %, 10 % increase
RES contribution - absolute	10 %, 5 % decrease, Status quo, 5 %, 10 % increase
RES contribution - relative	0 %, 5 %, 10 %, 15 %, 20 %
Local emissions (AQ)	15 %, 12 %, 9 %, 6 %, 3 % decrease Status quo 3 %, 6 %, 9 %, 12 %, 15 % increase
GHG emission from powerplants in CZ	15 %, 12 %, 9 %, 6 %, 3 % decrease Status quo 3 %, 6 %, 9 %, 12 %, 15 % increase
Beneficiaries	Households, Municipalities, Regional companies, National companies, All
RES contribution collected in my region will be provided ..	In whole CR, only in my region

- Nested attribute levels
  - RES share >10% (<10%) → decrease (increase) in emissions
  - RES share >10% (<10%) → increase (decrease) in costs

# preference parameters of utility function

## Utility function

$$U = a_1 * RES + a_2 * AQ + a_3 * GHG + a_4 * Beneficiaries + a_5 * Supplied + b * (y - bill) + e$$

## Conditional logit model (So and Kuhfeld, 1995)

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

## Log-likelihood function

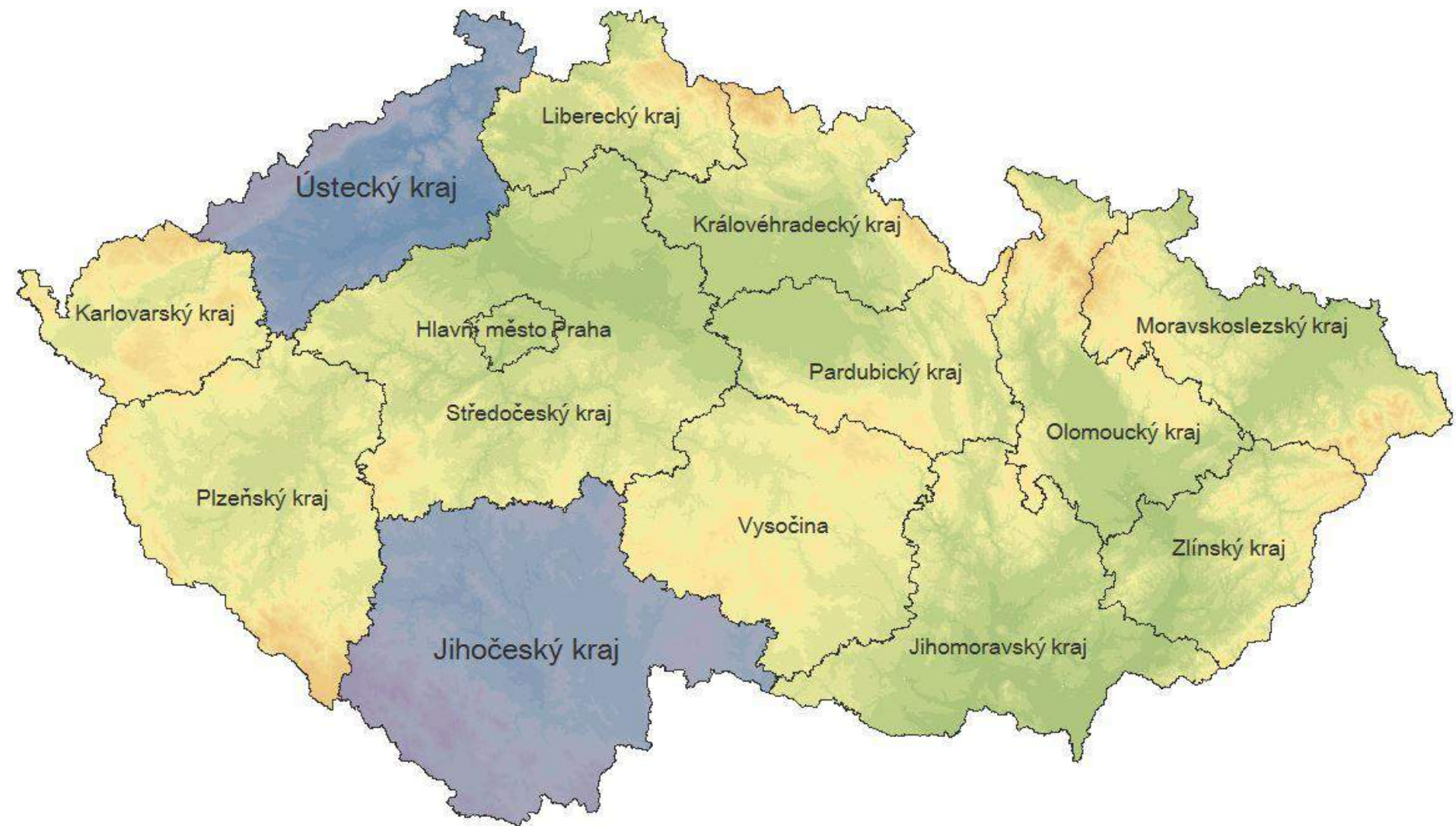
$$L = \sum_{i=1}^N \sum_{j \in c_i} d_{ij} \ln P(y_i = j)$$



# Data

- **pilot survey** – 144 observations -> prior values
  - SW Ngene – **D-efficient design**
- **Data collection** – June 2015, CAWI
- **Quota based sampling in two regions**
  - Ustecky (polluted), Southern Bohemia (cleaner)
- 80 choice sets – **10 blocks**, 8 per respondent
- **404 respondents** gave us **3,232 choice observations**





# Data sample statistics

		Total	Ustecky region	S. Bohemia region	Czech Republic average
<b># respondents</b>		<b>404</b>	<b>207</b>	<b>197</b>	
<b>Gender</b>	Male	32%	28%	35%	49%
	Female	<b>68%</b>	<b>72%</b>	<b>65%</b>	<b>51%</b>
<b>Age</b>	20 - 39	40%	42%	38%	36%
	40 - 59	40%	43%	37%	34%
	60 and older	<b>20%</b>	<b>15%</b>	<b>25%</b>	<b>30%</b>
	<i>average age</i>	45 years	43 years	46 years	49 years
<b>Highest education</b>	Primary school	15%	13%	17%	16%
	Secondary school	55%	60%	50%	70%
	Higher/Bachelor	12%	11%	12%	
	Master/Ph.D.	18%	16%	21%	14%
<b>City/village size (inhabitants)</b>	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%	
<b>Household's net income (CZK/month)</b>		28 354	28 508	28 184	
<b>Electricity bill payment (CZK/month)</b>		1 337	<b>1 203</b>	<b>1 477</b>	
<b>PM10 Emissions - 5 year average (2009 - 2013)</b>		23.47 µg/m <sup>3</sup>	<b>27.33 µg/m<sup>3</sup></b>	<b>19.4 µg/m<sup>3</sup></b>	

# Results

Variable	Model without interactions				
	B	SE	Approx Pr >  t	Sgn	WTP
Electricity bill expenditures	-0.0006	0.0003	0.0513		
Local air quality - LAQ (% <b>decrease</b> )	-0.0304	0.0070	<.0001	**	<b>-49</b>
Global air quality - GAQ (% <b>decrease</b> )	-0.0055	0.0071	0.4444		-9
<i>Type of supported beneficiary (SQ = all)</i>					
Households	0.4213	0.0673	<.0001	**	685
Municipalities	0.2111	0.0690	0.0022	**	343
Regional companies	0.1607	0.0659	0.0148	*	261
National companies	-0.2453	0.0632	0.0001	**	-399
<i>Location of support scheme (SQ = national)</i>					
Regional	-0.1016	0.0577	0.0782		-165
Number of observations	3232				
Log Likelihood	-3414				
Likelihood Ratio - 2x(LogL - LogL0)	273				

\* - statistically significant at 5 % level

\*\* - statistically significant at 1 % level

# Results

Variable	Final model				
	B	SE	Approx Pr >  t	Sgn	WTP
Electricity bill expenditures	-0.0007	0.0003	0.0482	*	
<i>Type of supported beneficiary (SQ = all)</i>					
Households	0.3905	0.0684	<.0001	**	585
Municipalities	0.1382	0.0713	0.0524		207
Regional companies	0.1046	0.0674	0.1206		157
National companies	-0.2967	0.0646	<.0001	**	-445
<i>Location of support scheme (SQ = national)</i>					
Regional	-0.1002	0.0593	0.0910		-150
<b>Interactions</b>					
Income (thousands of CZK) x LAQ	0.0081	0.0027	0.0028	**	12
Missing Income (dummy) x LAQ	-0.0044	0.0243	0.8577		-7
Environmental attitude - middle (dummy) x LAQ	-0.0458	0.0060	<.0001	**	-69
Environmental attitude - high (dummy) x LAQ	-0.1015	0.0076	<.0001	**	-152
Income (thousands of CZK) x GAQ	-0.0141	0.0031	<.0001	**	-21
Missing Income (dummy) x GAQ	-0.0309	0.0245	0.2070		-46
Ustecky region (dummy) x GAQ	0.0287	0.0079	0.0003	**	43
Southern Bohemia region (dummy) x GAQ	0.0356	0.0081	<.0001	**	53
Number of observations	3232				
Log Likelihood	-3304				
Likelihood Ratio - 2x(LogL - LogL0)	492				

\* - statistically significant at 5 % level

\*\* - statistically significant at 1 % level



# Results

Variable	Full model				
	B	SE	Approx Pr >  t	Sgn	WTP
Electricity bill expenditures	-0.0006	0.0003	0.0647		
<i>Type of supported beneficiary (SQ = all)</i>					
Households	0.3894	0.0686	<.0001	**	617
Municipalities	0.1358	0.0714	0.0572		215
Regional companies	0.1061	0.0674	0.1154		168
National companies	-0.2957	0.0646	<.0001	**	-469
<i>Location of support scheme (SQ = national)</i>					
Regional	-0.1032	0.0594	0.0824		-164
<b>Interactions</b>					
Income (thousands of CZK) x LAQ	0.0119	0.0053	0.0239	*	19
Missing Income (dummy) x LAQ	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	-0.0382	0.0182	0.0364	*	-61
Environmental attitude - high (dummy) x LAQ	-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 GAQ	-0.0178	0.0053	0.0007	**	-28
Missing Income (dummy) x GAQ	-0.0428	0.0291	0.1406		-68
Ustecky region (dummy) x GAQ	0.1409	0.0641	0.0279	*	223
Southern Bohemia region (dummy) x GAQ	0.0959	0.0483	0.0469	*	152
Environmental attitude - middle (dummy) x GAQ	-0.0067	0.0181	0.7120		-11
Environmental attitude - high (dummy) x GAQ	-0.0242	0.0217	0.2659		-38
Actual household's air quality (decrease) x GAQ	-0.0028	0.0022	0.2085		-4
Number of observations	3232				
Log Likelihood	-3299				
Likelihood Ratio - 2x(LogL - LogL0)	503				

\* - statistically significant at 5 % level

\*\* - statistically significant at 1 % level

# Results

- WTP for **local air quality** improvement >  
> WTP for **climate change mitigation**  
(both are positive)
- positive WTP for **decentralization**
- effect of actual local air quality not significant
- respondents are indifferent over **national versus regional support scheme**
- sociodemographic characteristics significant  
(envi. attitude, income..)

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# Thank you for attention

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