

3rd International Workshop on Empirical Methods in Energy Economics (EMEE2010)

Surrey Energy Economics Centre (SEEC)

University of Surrey, UK

24th – 25th June 2010

NOTE:

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Eliciting Public Support for Greening the Electricity Mix

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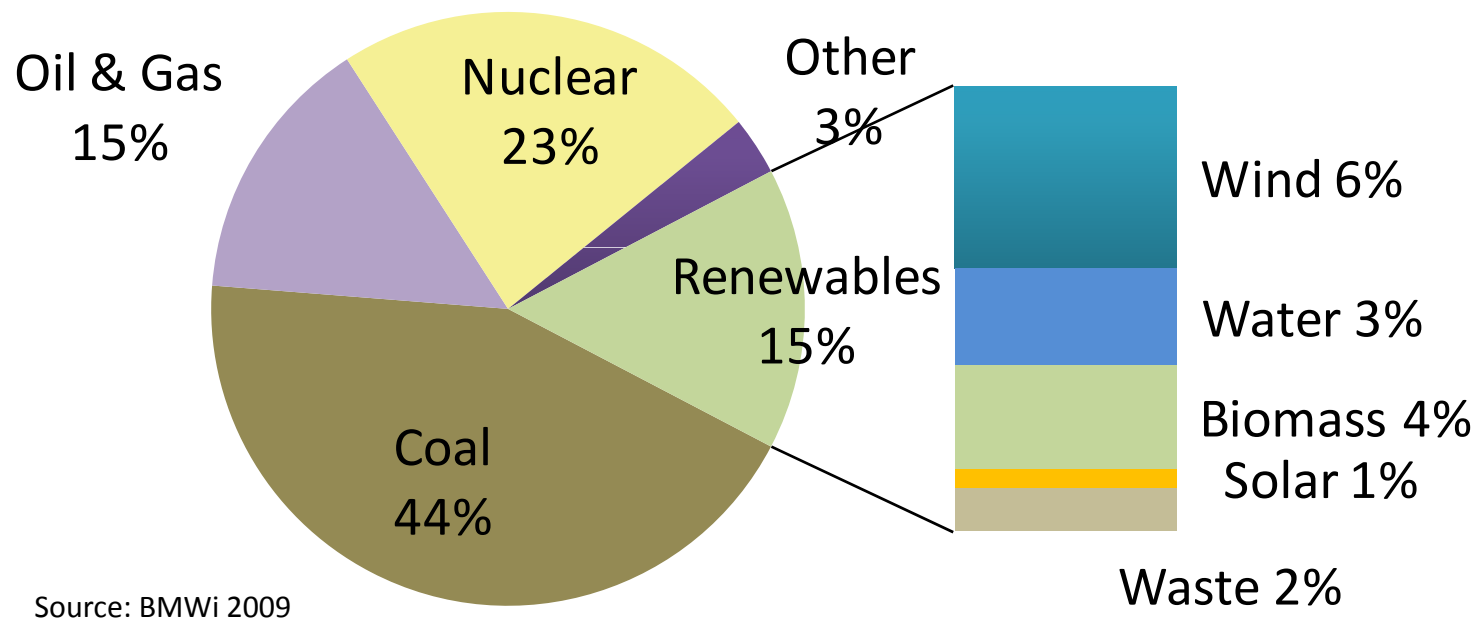
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Background



- Lively discussion wrt future energy system in Germany
 - ❏ nuclear phase-out – or recurrence?
 - ❏ Political target: 30% renewables in electricity mix by 2020

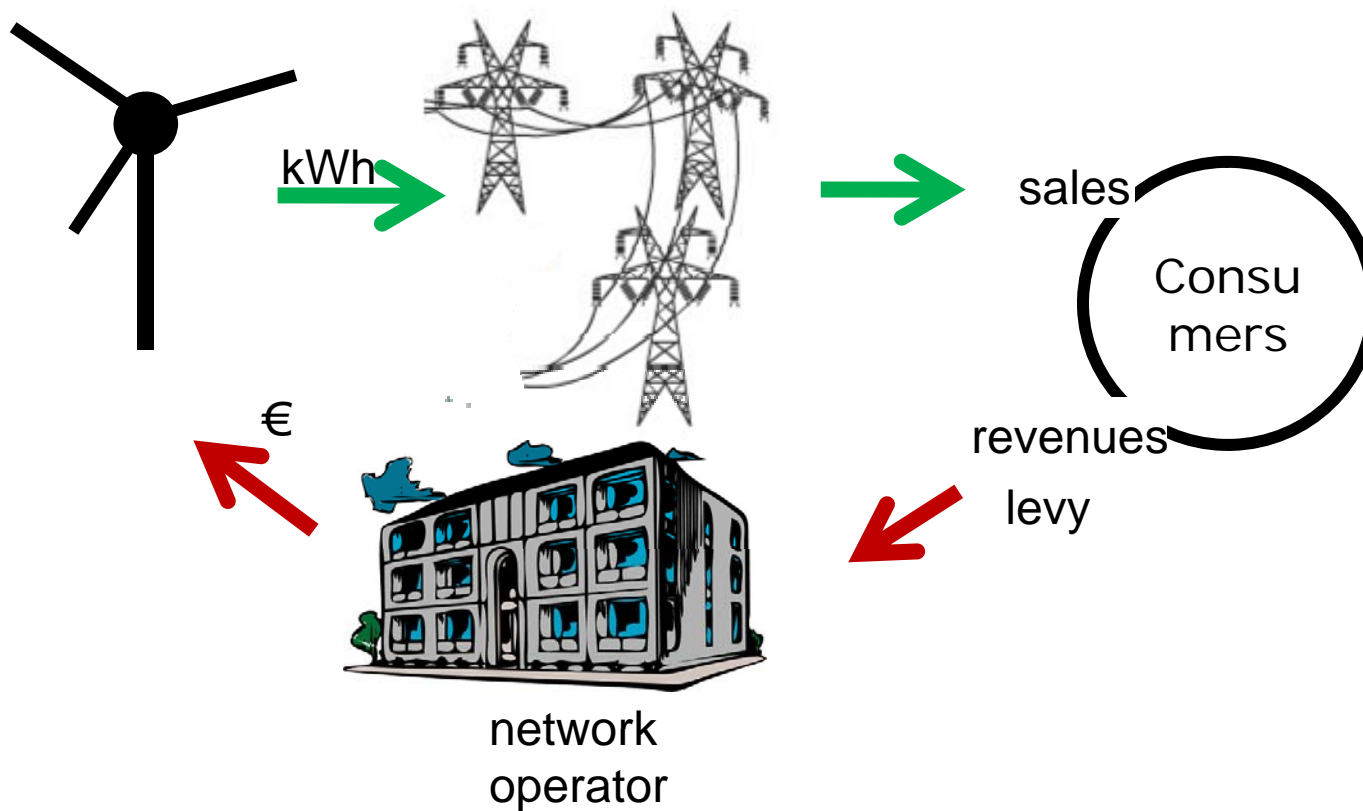
Fuel mix in electricity generation 2008



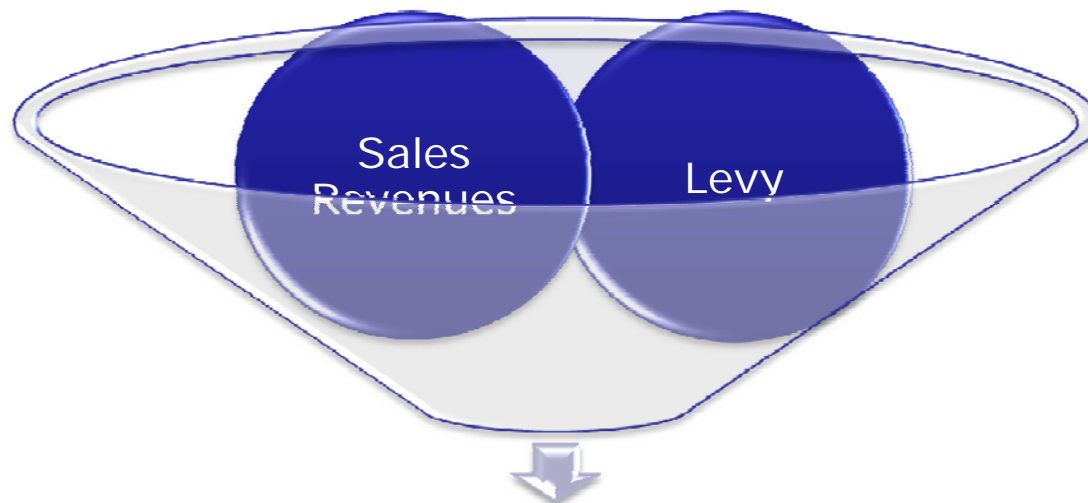
Background



- Political commitment: Double the share of renewables until 2020
- Providing a subsidy via feed-in tariff scheme



Funding the Feed-In Tarif

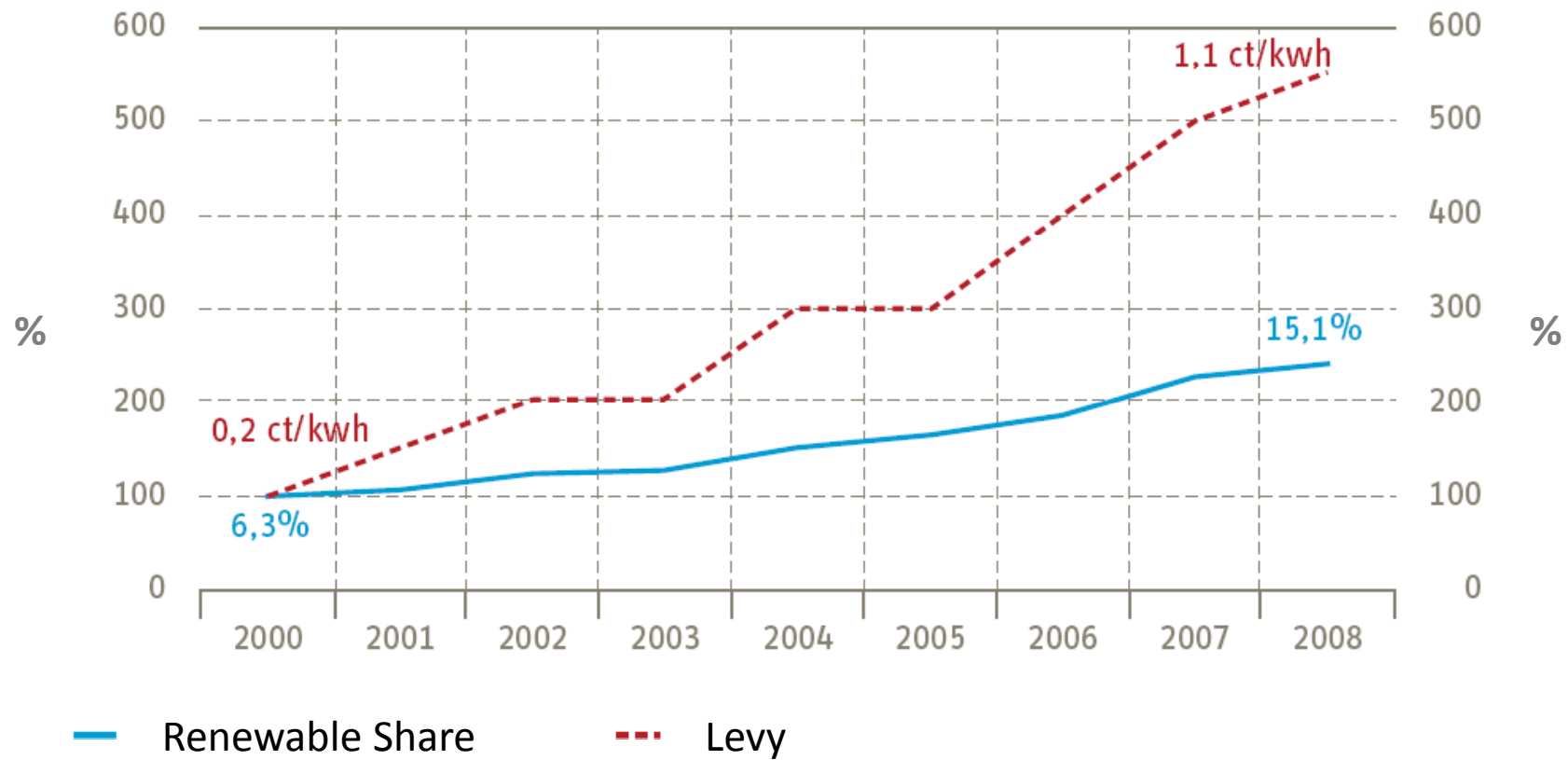


Subsidy for Renewables

10 bn. € (2009) ⇒ 12.7 bn. € (2010)

Sales revenues: ~ 4.5 bn. €

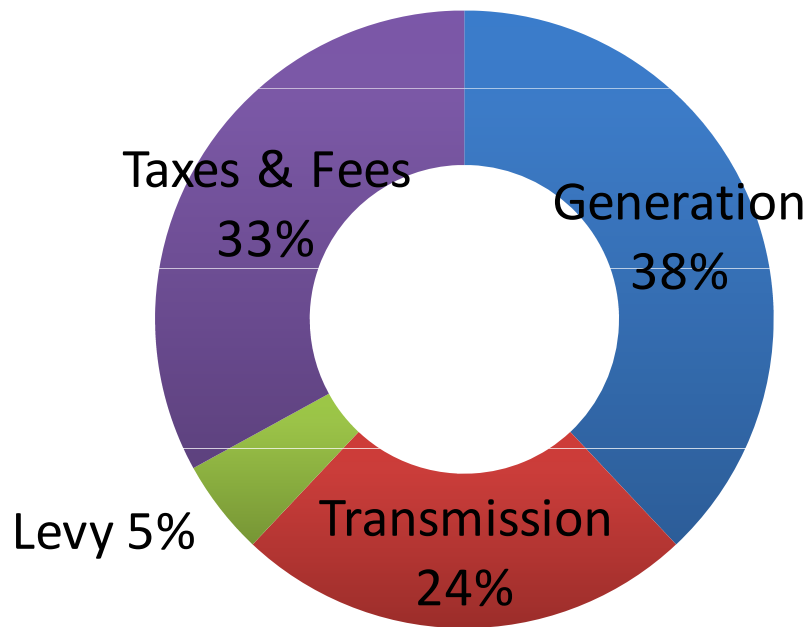
Levy: ~ 8.2 bn. €



Quelle: BMU 2009

Levy 2010: 2.047 ct/kWh

Consumer's Electricity Price 2008



Source: BDEW

Net-Price
(generation + transmission)

+ levy

Price off taxes

+ taxes & fees

consumer price



Ø 21.43 ct/kWh

Political decision:
Redesign of energy system
(double the share of renewables)



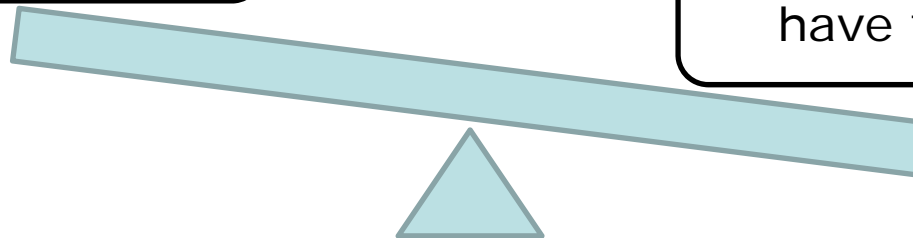
Committing people to pay for it
(raising a levy)



Scope of the financial obligation
approved by the people?

what are people
willing-to-pay

what people
have to pay





General Question:

What levy can be charged for a specific fuel mix, such that the majority of people ($\geq 50\%$) supports the policy?

Gain insights into peoples preferences!

Research Steps



- (1) Surveying the max. willingness-to-pay (WTP)
 - ❏ for a specific mix of fossil, renewable and nuclear fuels
- (2) Find functional relationship between WTP and fuel mix
 - ❏ Hedonic Regression with random parameters
 - ❏ accounting for unobserved heterogeneity
- (3) Scenario Analysis

Survey

Econometrics

Scenario



Digital questionnaire via TV



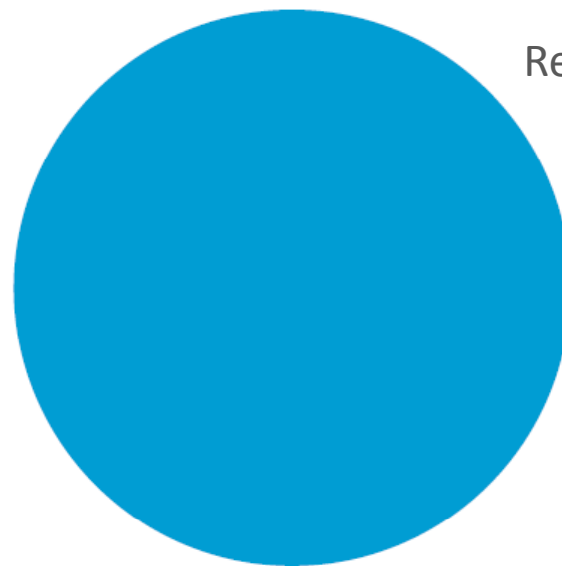
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Scenario

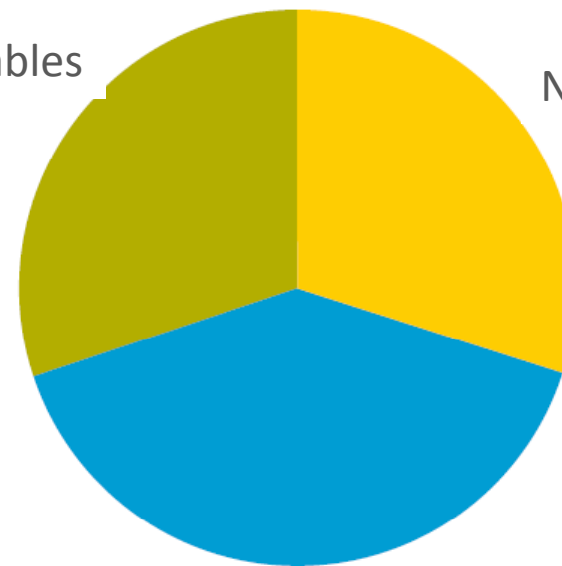


What is the monetary amount that you would be willing to pay at most for the contract shown on the right hand side, given that electricity generated entirely from fossil fuels costs €100?



Fossil
Price = 100

Renewables



Nuclear

Fossil
Price = ???

Survey

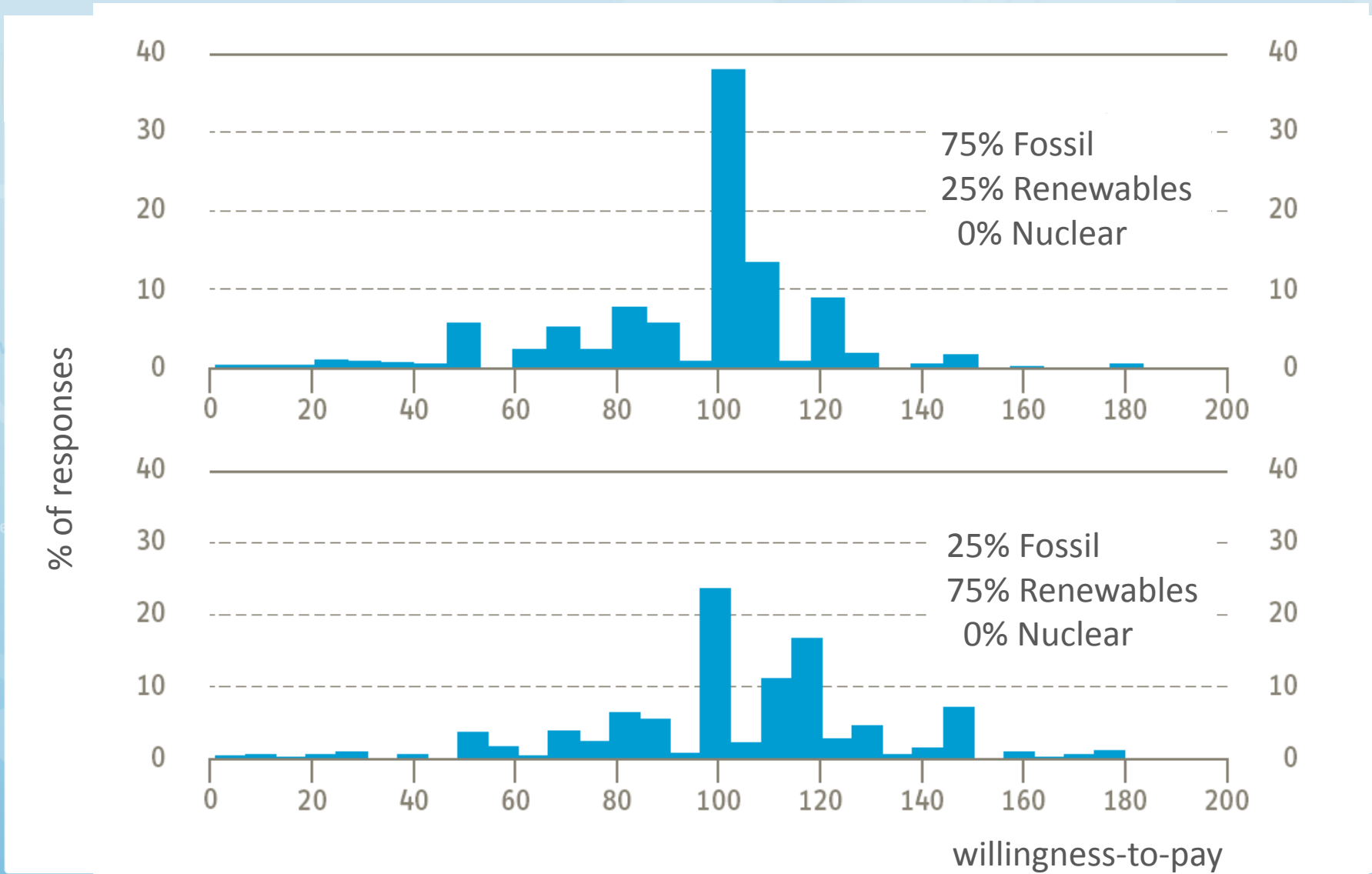
Econometrics

Scenario



		Renewables				
		0%	25%	50%	75%	100%
Nuclear	0%	Ref.				
	25%					
	50%					
	75%					

- 5 fuel mixes to evaluate for every participant
- Random draws from choice set ⇒ **avoid ordering effects**
- Total 13 647 responses from 2 948 households



Research Steps



- (1) Surveying the max. willingness-to-pay (WTP)
 - ❏ for a specific mix of fossil, renewable and nuclear fuels
- (2) Find functional relationship between WTP and fuel mix
 - ❏ Hedonic Regression with random parameters
 - ❏ accounting for unobserved heterogeneity
- (3) Scenario Analysis
 - ❏ *what levy can be charged s.t. the majority of people ($\geq 50\%$) supports the policy?*

Survey

Econometrics

Scenario



- Hedonic approach
 - ❏ WTP triggered by inherent characteristics of contract
 - ❏ functional relationship between WTP and fuel mix

$$WTP = f(\text{fossil}, \text{renewables}, \text{nuclear})$$

- Green „conviction“ is an unobserved individual effect
- **Linear Mixed Model** provides random parameters
 - ❏ gives rise to individual-specific coefficients
 - ❏ capturing large parts of taste heterogeneity
 - ❏ able to handle panel structure of data set

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Scenario



$$WTP_{ij} = \alpha + \sum_k (\bar{\beta}_k + u_{ki}) x_{ij}^k + \sum_l \delta_l z_i + v_i + \epsilon_{ij}$$

$$x_{ij}^k = (\%Green, \%Nuclear, \%Green \times \%Nuclear)$$

$$z_i = (East, HHsize, Income)$$

■ Individual-specific parameter $\beta_{ki} = (\bar{\beta}_k + u_{ki})$

■ with distribution $\beta_k \sim N(\bar{\beta}_k, \sigma)$

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Scenario



Complexity versus Flexibility

$$\textcircled{1} \quad WTP_{ij} = \alpha + \sum_k (\bar{\beta}_k + u_{ki}) x_{ij}^k + \sum_l \delta_l z_i + v_i + \epsilon_{ij}$$

$$\textcircled{2} \quad WTP_{ij} = \alpha + \sum_k \beta_k x_{ij}^k + \sum_l \delta_l z_i + v_i + \epsilon_{ij}$$

$$\textcircled{3} \quad WTP_{ij} = \alpha + \sum_k \beta_k x_{ij}^k + v_i + \epsilon_{ij}$$

	Model 1		Model 2		Model 3	
	Coefficient	<i>s.e.</i>	Coefficient	<i>s.e.</i>	Coefficient	<i>s.e.</i>
Constant	87.978**	1.869	88.561**	1.904	90.263**	0.771
Renewable	22.234**	1.025	22.142**	0.973	22.163**	0.973
Nuclear	-20.101**	1.283	-19.870**	1.265	-19.851**	1.265
Renewable×Nuclear	0.047	2.903	0.271	3.102	0.212	3.102
Household Size	-0.429	0.480	-0.496	0.479	-	-
East	-2.349	1.265	-3.054*	1.267	-	-
Income	0.003**	0.001	0.002**	0.001	-	-
Log-Likelihood	-63,306		-63,989		-63,999	

Standard deviation for random parameters

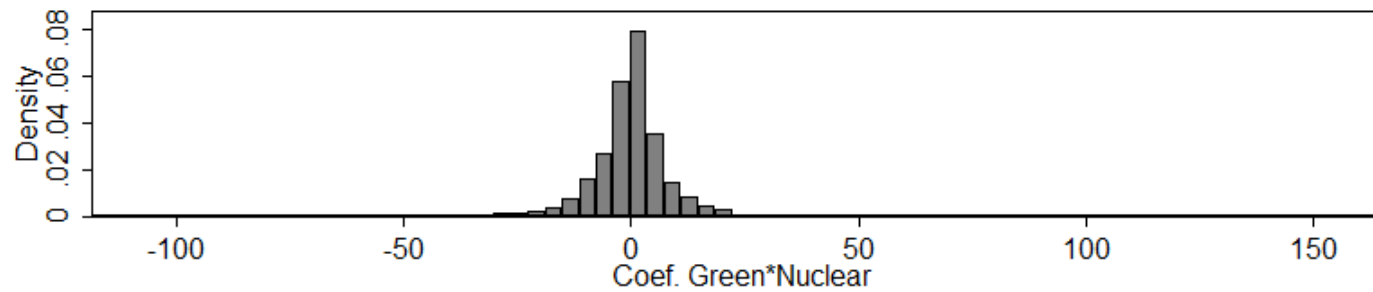
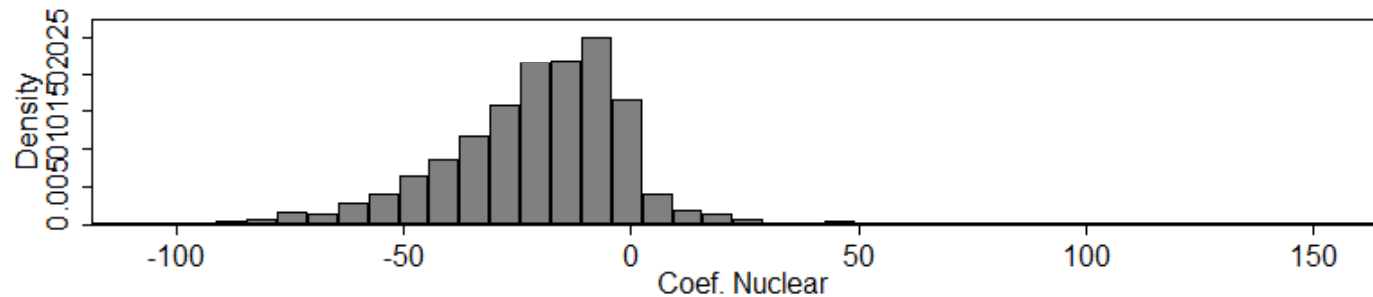
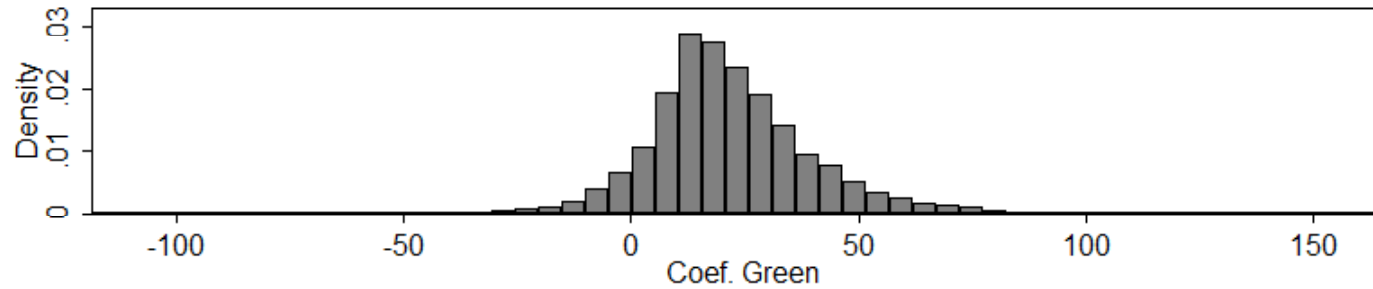
	Std.Dev		<i>s.e.</i>		Std.Dev		<i>s.e.</i>	
	Std.Dev	<i>s.e.</i>	Std.Dev	<i>s.e.</i>	Std.Dev	<i>s.e.</i>	Std.Dev	<i>s.e.</i>
Constant	32.389**	0.994	25.526**	0.405	25.628**	0.407		
Renewable	28.497**	0.774	-	-	-	-		
Nuclear	22.356**	0.373	-	-	-	-		
Renewable×Nuclear	33.677**	5.418	-	-	-	-		

Likelihood-Ratio Tests

parameter restrictions	Model 2 nested in Model 1	Model 3 nested in Model 2
	$2 \times \Delta\text{Log-Likelihood}$	3 1366

**significant at the 1% level, *significant at the 5% level. Critical value for model comparison:
 $\chi^2_{0.99}(df = 3) = 11.35$.

Individual-Specific Coefficients: Empirical Distribution



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Scenario



- (1) Surveying the max. willingness-to-pay (WTP)
- (2) Find functional relationship between WTP and fuel mix
 - ❏ provides individual-specific coefficients
- (3) **Scenario Analysis**
 - ❏ Political Goal: Double the share of renewables
 - ❏ 15,1% (2008) \Rightarrow at least 30% (2020)
 - ❏ **what levy can be charged s.t. the majority of people ($\geq 50\%$) supports the policy?**



Scenario A

15% Renewables

+1% Renewables
-0.5% Fossil
-0.5% Nuclear

30% Renewables

Scenario B

15% Renewables

+1% Renewables
-1% Nuclear

30% Renewables

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Scenario



- Using individual-specific coefficients, calculate individual WTP
 - for every %point step in every scenario
- A household would approve if consumer price will rise less than individual WTP (Assumption)

$$\frac{WTP^s}{WTP^0} \geq \frac{p^0 + t^s}{p^0}$$

- Increase t^s until equality is achieved
- What t^s is accepted by the median voter?

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Scenario



- Assumption: a household would approve if consumer price rises less than WTP

$$\frac{WTP^s}{WTP^0} \geq \frac{p^0 + t^s}{p^0}$$

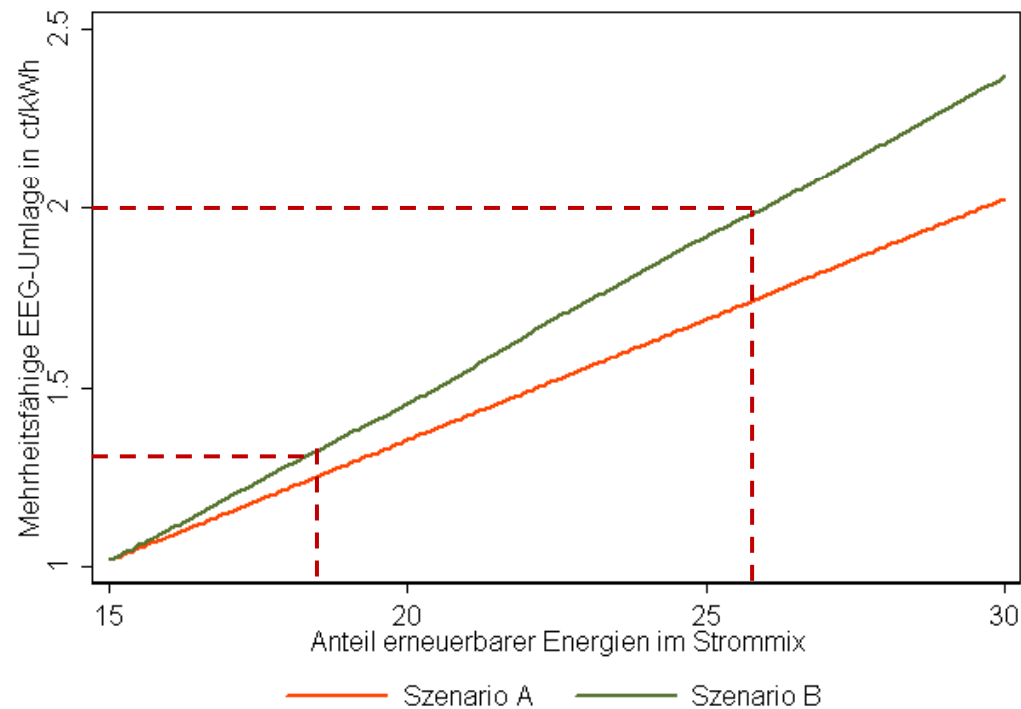
- What t^s is accepted by the median voter?

Net-Price (generation + transmission)	20.33 ct/kWh
+ levy (@15%)	1.1 ct/kWh
<hr/>	
<i>Price off taxes</i>	
+ taxes & fees	
<hr/>	
consumer price	21.43 ct/kWh

Survey

Econometrics

Scenario

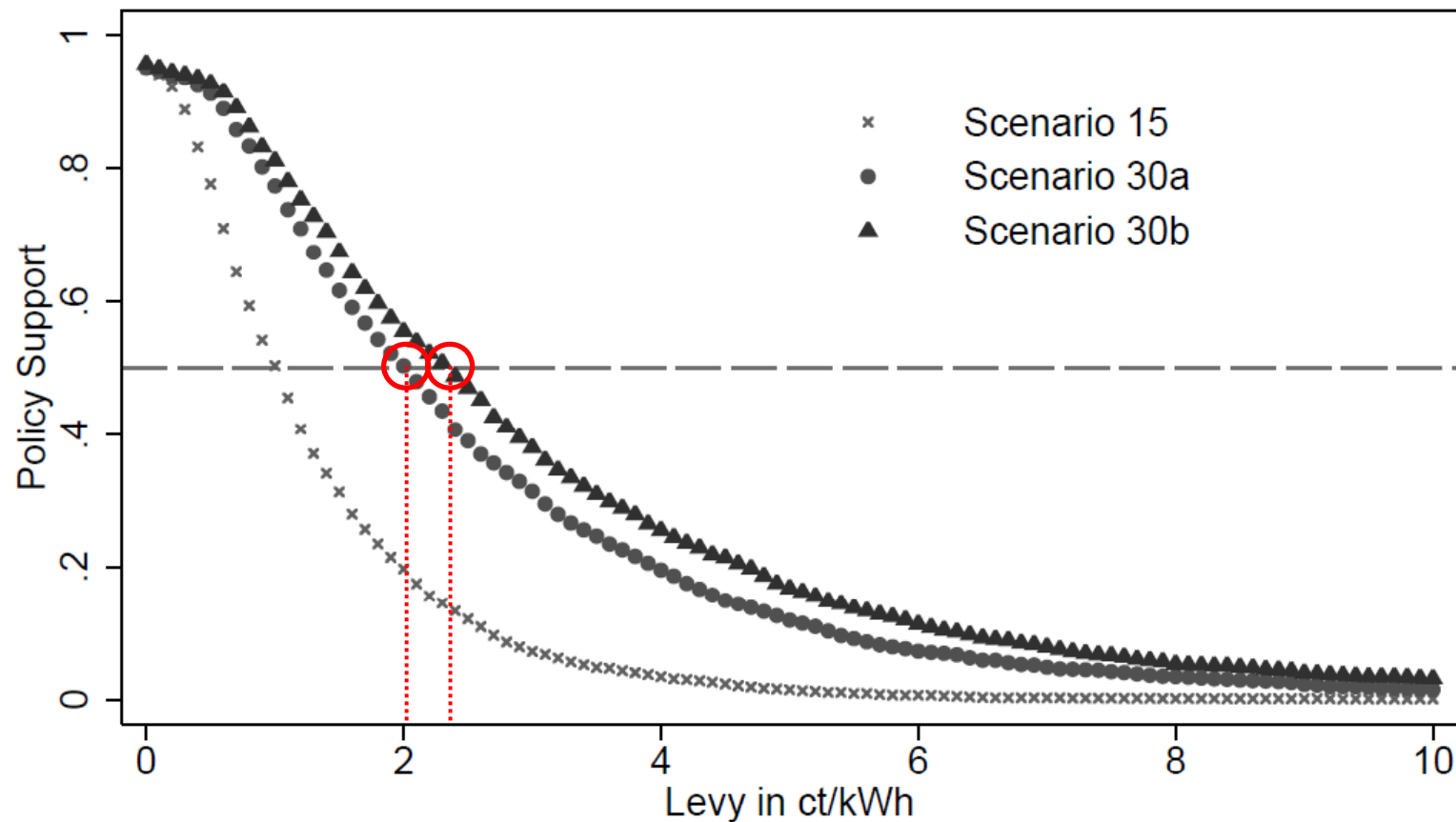


- Year 2008:
 - ❏ 15.1% renewables
 - ❏ Levy: 1.1 ct/kWh
 - ❏ Median Voter: 1.02 ct/kWh

- Year 2010:
 - ❏ Levy 2.047 ct/kWh
 - ❏ Median Voter requires 26.5% renewables

 - ❏ Renewables 2010: ~18%

 - ❏ Median Voter: max. 1.27 ct/kWh



- Scenario 30a = fossil and nuclear fuels are substituted
 - median voter: 2.03 ct/kWh

- Scenario 30b = only nuclear fuels are substituted
 - median voter: 2.37 ct/kWh

Political Implications



- If society must pay for the redesign of the energy system
- ... policy should at least keep consider social preferences
- Paper provide guidance what cost might be assigned to people for redesign of energy system
- People **are** willing-to-pay for promoting renewables
 - ❏ within certain limits
 - ❏ in 2010 these limits are exceeded