Effects of Feedback on Residential Electricity Demand: Results from a Field Trial in Austria

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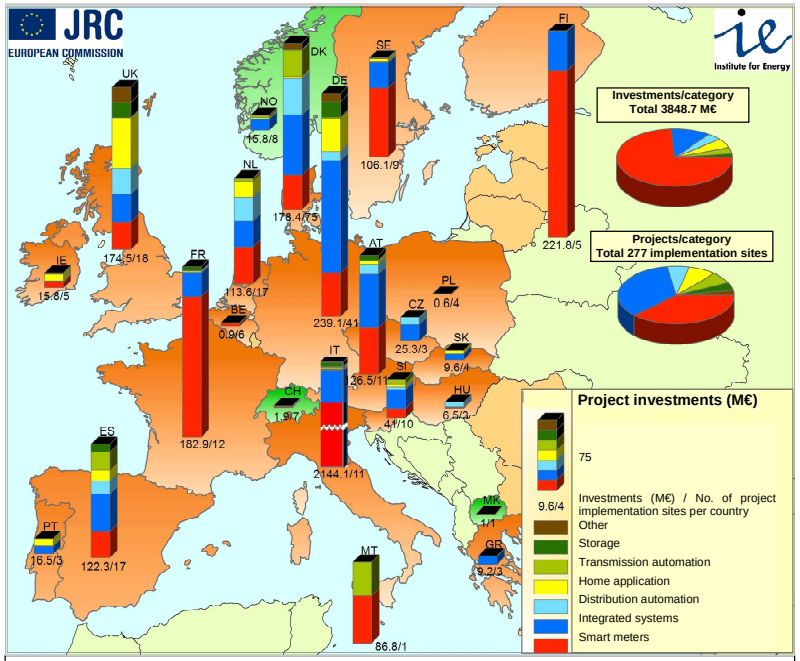
Introduction: EU Regulation

- Energy Service Directive 2006/32/EC
  - Smart meters must be installed in new buildings or when existing buildings undergo major renovations – if technically feasible and economically reasonable
  - Final customers need to receive information on actual energy consumption and costs
- Electricity Directive 2009/72/EC
  - Roll out of smart meters to 80% of consumers in EU Member States by 2020 – MS decide on national strategy

Introduction: Current situation in EU

- In Europe, over € 5.5 billion have been invested in about 300 Smart Grid projects during the last decade.
- Around 10 % of EU households have some sort of smart meter installed
- Countries differ



Picture 1: Overview of Smart Grid investment and implementation across the EU (source: JRC, IE). Projects represented can span over more than one country and can include more than one category. Three projects are not represented in this Picture: Kriegers Flak project, a Super Grid between Germany and Denmark, total investment of 507 M€; Smart Meter Roll-out and AMI in UK, estimated investment of 11897 M€; and Smart Meter Roll-out in Sweden, spanning in approx. 150 projects and amounting a total investment of approx.1500 M€.

The field trial Intelliekon (for Linz, Austria)

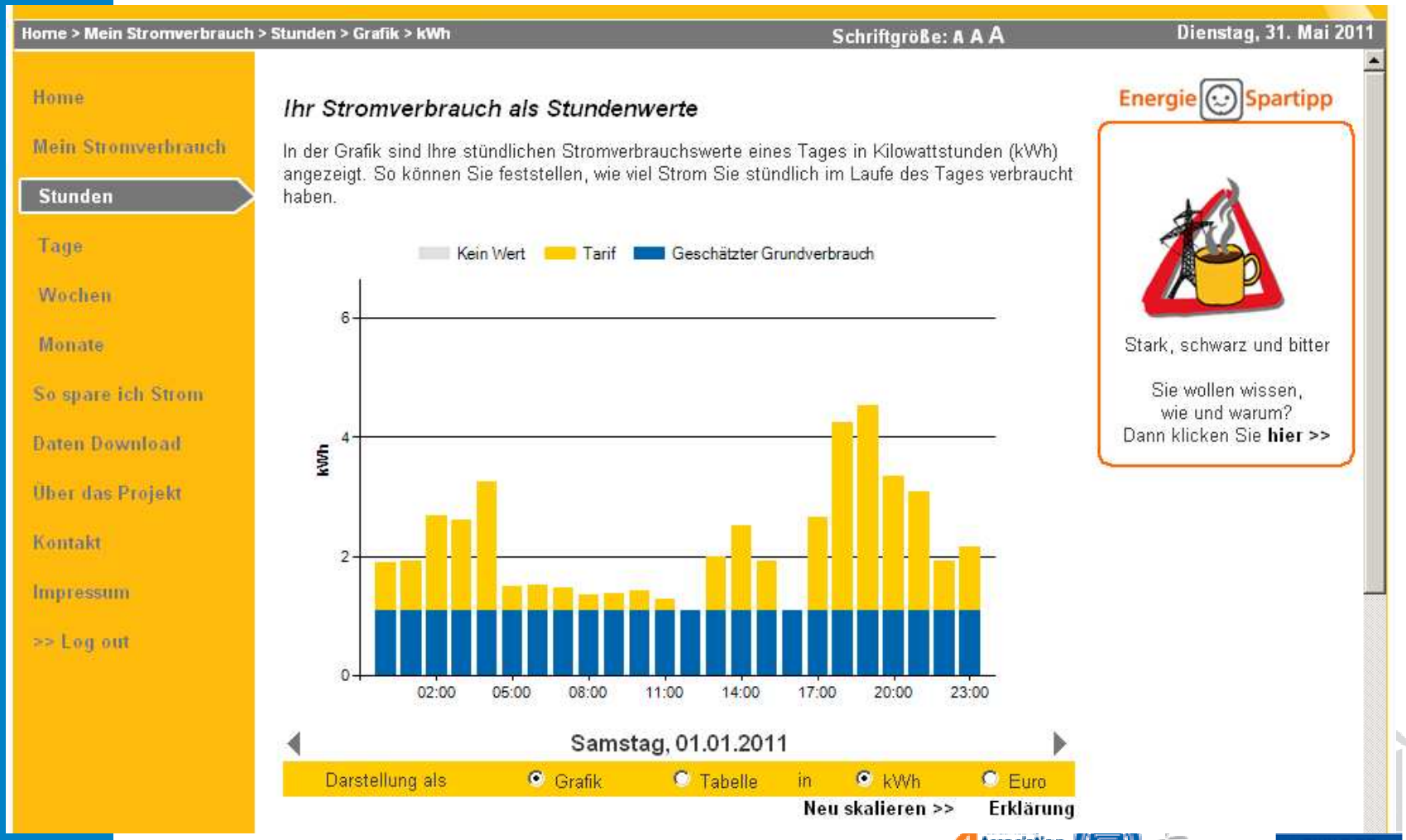
- Sponsored by German Federal Ministry of Education (www.intelliekon.de)
- Carried out by Fraunhofer ISE (lead), Fraunhofer ISI, ISOE
- Involved two types of feedback: web portal, postal mail

Methodology: Field trial, econometric models

Field Trial

- Participating households were **assigned randomly** into two groups
  - Pilot group
  - Control group
- Pilot group households could **chose** between two types of feedback
  - Web portal
  - Postal mail

Feedback instrument : WEB Portal



Feedback instrument : Mail - info

- Monthly
- Two pages
- Information includes
  - Daily consumption
  - Weekly consumption
  - Monthly consumption
  - Energy saving tips

Data

- Hourly data for household electricity consumption
- December 2009 to November 2010
- Survey on socio-economic and technological characteristics
- 1525 observations
- 775 in pilot group
- Cross section data available only

Econometric models

- **Feedback model** (pilot and control group)
  - Estimates effects of providing feedback

$$Y = X\beta + I_p\delta + \varepsilon \qquad (1)$$

  - Y: annual electricity demand
  - X: Vector of household and technology characteristics
  - I_p: Dummy = 1 if household belongs to pilot group
  - OLS to get average effects (δ)
  - Quantile regression to allow differences by electricity consumption levels (δ and β may vary)

Econometric models

- **Feedback types** model (only pilot group)
  - Allows for differences in effectiveness of feedback types
  - Allows for treatment bias
  - Estimate Heckman-type two stage model
    - Stage 1: Probit Model to estimate choice of feedback type
    - Stage 2: Estimate electricity consumption equation with feedback choice directly included
    - Endogeneity test involves testing significance of covariance

Results: Feedback Model OLS

Smart	-154.47	**
	(69.90)	
Age6	118.05	
	(77.99)	
Age17	276.95	***
	(63.08)	
Age30	356.76	***
	(71.59)	
Age45	531.02	***
	(82.75)	
Age60	506.49	***
	(79.82)	
Age60plus	557.04	***
	(74.27)	
Floorsize	5.81	***
	(1.04)	
Income	103.19	**
	(52.11)	
Education	-89.11	
	(72.22)	

Fridge	328.14	***
	(101.90)	
Dryer	434.89	***
	(75.56)	
Freezer	217.57	***
	(68.42)	
Dishwash	44.74	
	(105.29)	
Boiler	304.14	***
	(61.79)	
TV	159.20	***
	(49.06)	
Computertime	39.00	***
	(11.40)	
Appliances	65.29	***
	(19.35)	
Constant	-53.17	
	(164.55)	
R^2 (adjusted)	0.4330	
Sample size	1070	
Smart in % of consumption	4.51%	

Results: Quantile Regression

	q5		q10		q20		q30		q40		q50	
Smart	-60.74		-15.19		-24.97		-149.43	***	-174.27	**	-125.38	**
	(84.27)		(72.89)		(54.44)		(56.28)		(68.98)		(62.29)	
Smart in % of percentile consumption	-4.85%		-0.90%		-1.18%		-5.75%	***	-5.97%	**	-3.86%	**

	q60		q70		q80		q90		q95
Smart	-107.37	*	-134.01	*	-69.73		-123.05		-230.17
	(59.22)		(71.07)		(75.09)		(176.33)		(235.23)
Smart in % of percentile consumption	-3.03%	*	-3.37%	*	-1.59%		-2.36%		-3.67%

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Results: Feedback type model

- No empirical support for endogeneity hypothesis
  - May treat feedback choice as random *conditional on observed characteristics*
- Estimate as weighted OLS (using P-Scores from Probit model as weights)
  - No empirical support for differences in effects of web versus mail-based feedback on electricity use

Conclusions

Effects of feedback on electricity consumption

- Estimated average savings per household correspond to 4.5%
  - Literature usually gives higher figures (Darby 2006, Ehrhardt et al. 2010)
  - 4.5% are not peanuts
- Households with very low and very high consumption do not respond to feedback
  - Limiting smart metering deployment to high electricity users may be ineffective
  - Need more research to corroborate this finding and explore underlying reasons

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