Centre for Energy and Environmental Markets

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THE MERIT ORDER EFFECT OF WIND AND PHOTOVOLTAIC ELECTRICITY GENERATION IN GERMANY 2008-2012

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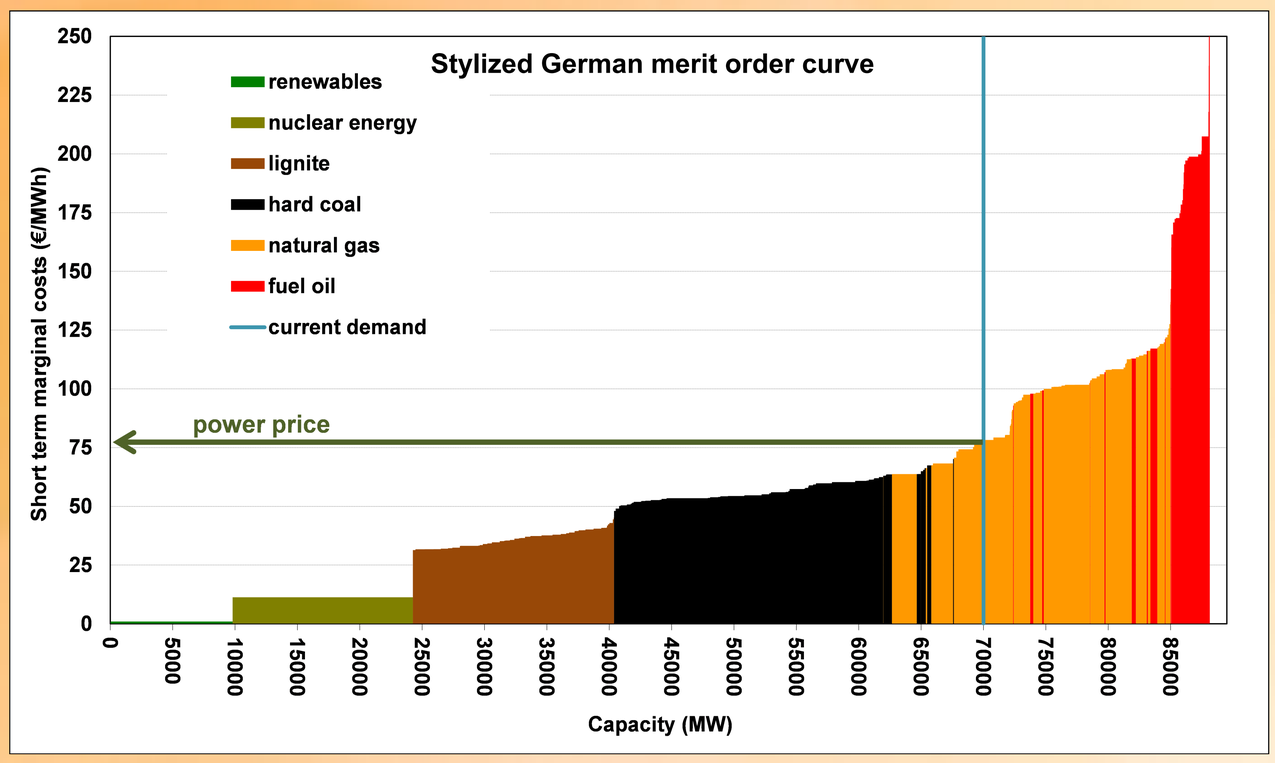
The Merit Order Effect

- **In an ideal competitive electricity market, wholesale spot price set by operating cost of marginal generator**
- **Renewables offer electricity at close to zero marginal cost, thus generally lower wholesale price when high renewable generation**



GER Renewable Energy Support Act (EEG)

- **Provides priority feed-in, purchase guarantee and fixed prices**
- **Cost passed on to consumers in the form of a surcharge**
  - ⇒ Privileged group (mainly energy-intensive industry) pay reduced surcharge of 0.05 ct/kWh
  - ⇒ Non-privileged group (households, small business) pay full surcharge of 1.12 ct/kWh (2008) - 3.59 ct/kWh (2012)
- **Goal: At least 80% renewables in electricity consumption in 2050 (from ~20% in 2012)**

Data and Estimation Method

- **Hourly spot market prices (EPEX), load data (entso-e) and generation by wind and PV (EEX)**
  - ⇒ Data on PV available from mid-2010 (installed capacity > 10 GW)
  - ⇒ All series stationary in levels
  - ⇒ OLS time-series regression with robust standard errors
- **Spot price modelled as dependent on wind and PV generation, total demand and seasonal dummies**

$$Spot_t = \beta_1 wind_t + \beta_2 PV_t + \beta_3 load_t + \sum_{k=1}^{23} \beta_{k+3} dh_{kt} + \sum_{l=1}^{7} \beta_{l+26} dd_{lt} + \sum_{m=1}^{11} \beta_{m+33} dm_{mt} + \sum_{n=1}^{4} \beta_{n+44} dy_{nt} + u_t$$

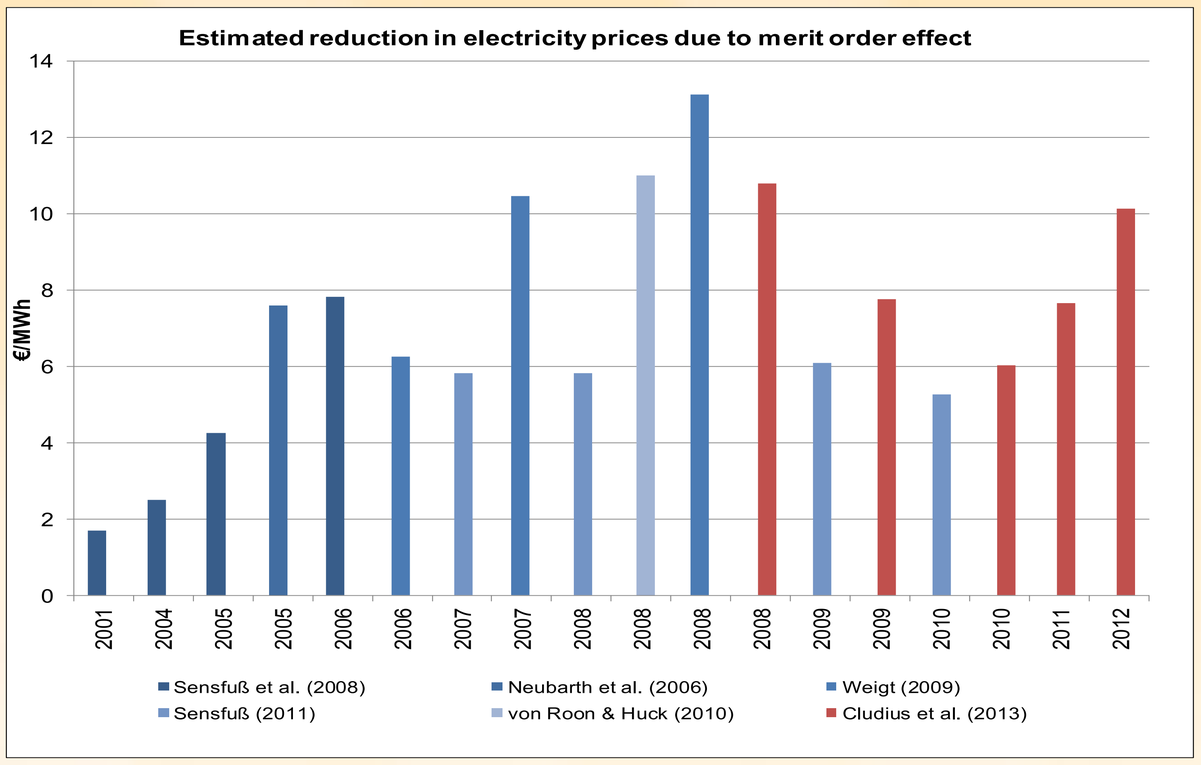
- **Assumption: inelastic demand (in the short-run)**

Results

	2008	2009	2010 (first half)	2011	2012	2010-12
Specific merit order effect: Reduction of spot price (€/MWh) per additional GW of wind / PV generation						
Wind (GW)	-2.27***	-1.72***	-1.15***	-0.97***	-1.07***	-1.12***
	(0.09)	(0.18)	(0.07)	(0.05)	(0.06)	(0.04)
PV (GW)			-0.84***	-0.90***	-1.29***	-1.09***
			(0.16)	(0.07)	(0.11)	(0.05)
Load (GW)	2.58***	1.36***	1.27***	1.13***	1.65***	1.43***
	(0.07)	(0.06)	(0.06)	(0.05)	(0.15)	(0.09)
Total merit order effect: Reduction of spot price (€/MWh) due to total generation of wind / PV (GW)						
	-10.80	**-7.76**	**-6.04**	**-7.67**	**-10.13**	
Observations	8,783	8,760	3,983	8,760	8,784	21,527

Newey-West standard errors in parentheses, robust to heteroskedasticity and autocorrelation
*** significant at the 99% confidence level

- **High specific effects (€/MWh per GW of wind or PV) in years with high fuel / carbon prices (merit order curve steeper)**
- **Volume-weighted total effects rise in recent years due to additional renewable capacity**



Implications

Benefits and costs of EEG in 2012	Estimated merit order effect (ct/kWh)	Surcharge (ct/kWh)
	-1.01	
Privileged group (energy-intensive companies)		0.05
Non-privileged group (households)		3.59

- **Benefits and costs of EEG could be distributed more equally**
  - ⇒ Merit order effect likely overcompensates energy-intensive industry for contribution to cost of EEG
  - ⇒ Surcharge for households would be reduced if surcharge for industry closer to merit order effect
  - ⇒ Results for 2012 imply reduced surcharge could be set at 1 ct/kWh instead of 0.05 ct/kWh
  - ⇒ Importance of considering distributional effects ex-ante and including review mechanism when designing renewable energy policies
- **Limitations: Long-term effects, e.g. environmental and energy security benefits, investment in generation / network capacity**

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