

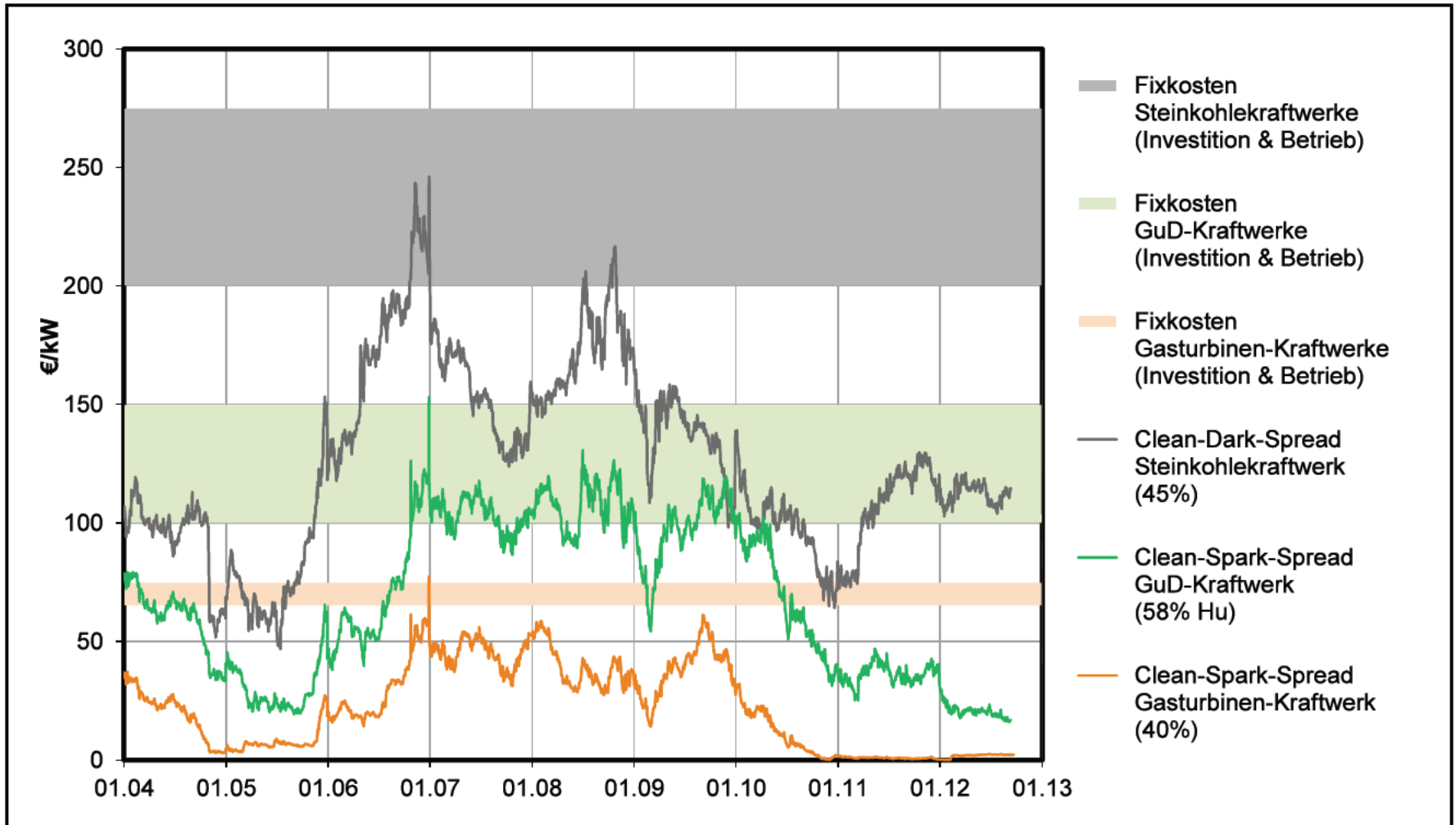
# **SYSTEM EFFECTS DUE TO THE INTRODUCTION OF INTERMITTENT RENEWABLES**

**Conference on Energy Transitions  
Université Paris-Dauphine, 31 May 2013**

# Power prices in Germany and fixed operating costs – no investment

2

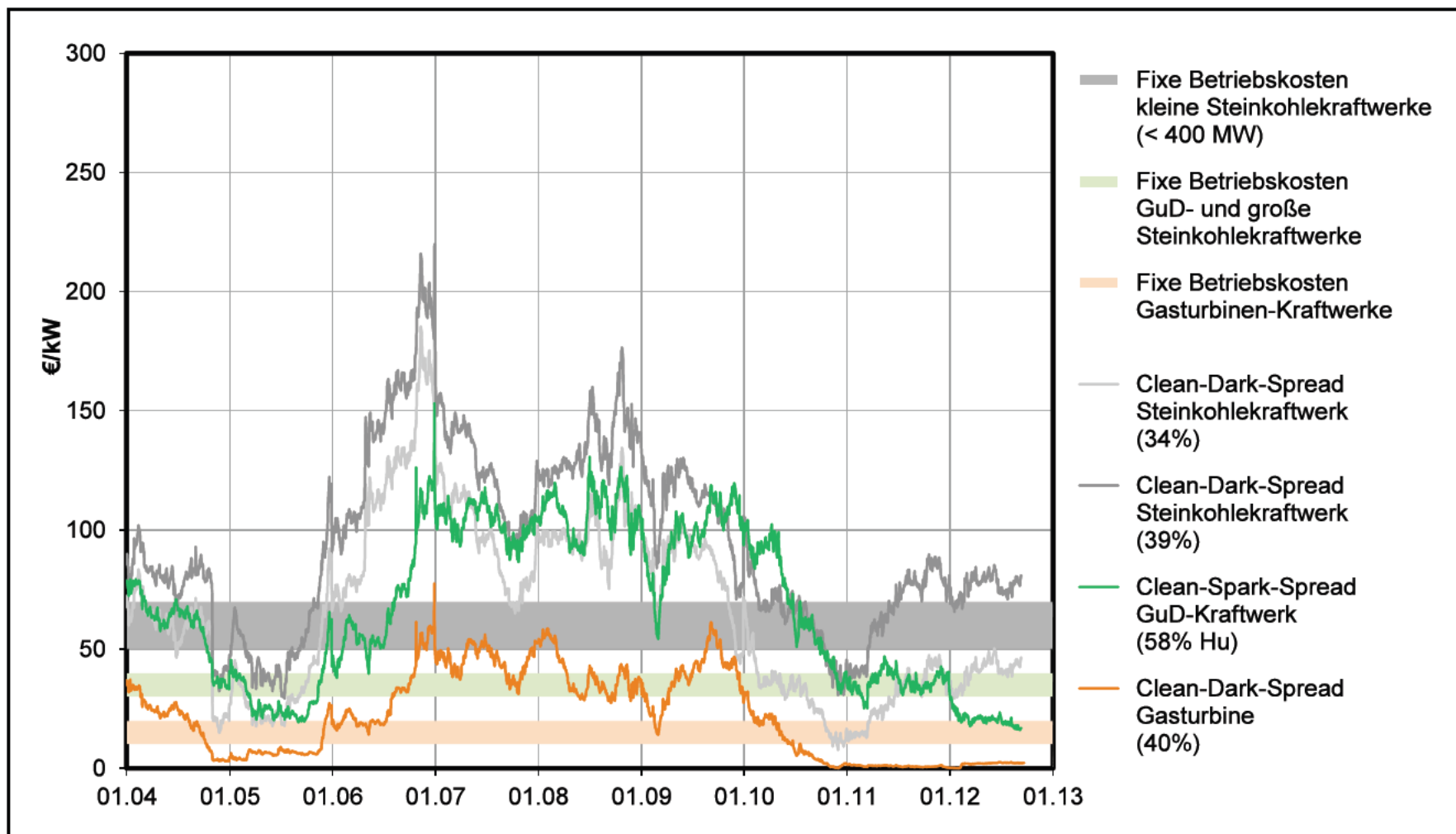
Matthes, Schlemmermeier *et al.* (2012), *Fokussierte Kapazitätsmärkte*, WWF Studie



# Power prices in Germany and *fixed operating costs* – plant closures

3

Matthes, Schlemmermeier *et al.* (2012), *Fokussierte Kapazitätsmärkte*, WWF Studie



# System effects in the short run

4

Keppler and Cometto (2012), *Nuclear Energy and Renewables: System Effects*, OECD.

At given capacity, renewables with zero marginal costs replace conventional technologies with higher marginal costs (gas, coal and nuclear):

- Reductions in electricity produced by dispatchable power plants (lower load factors, *compression effect*);
- Reduction in the average electricity price on wholesale power markets, *merit order effect* (up to 33% at 30% penetration);

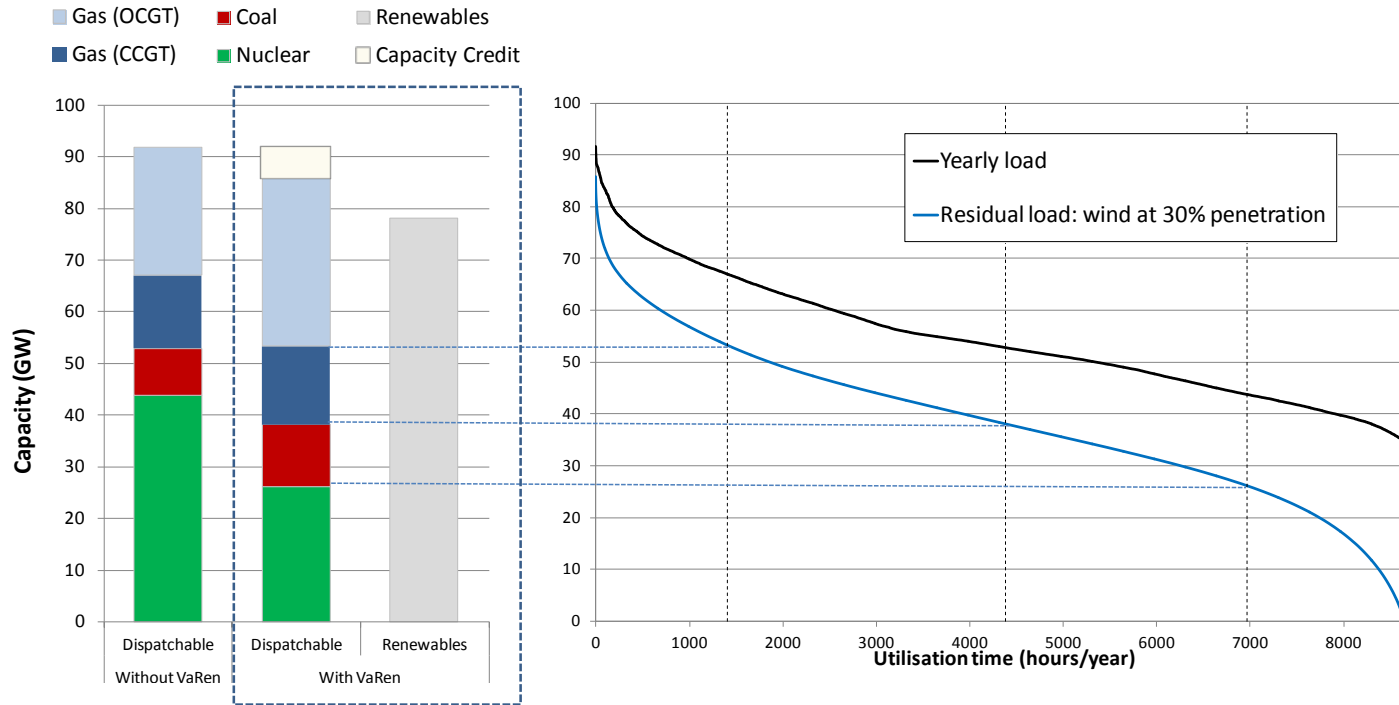

		10% Penetration level		30% Penetration level	
		Wind	Solar	Wind	Solar
Load losses	Gas Turbine (OCGT)	-54%	-40%	-87%	-51%
	Gas Turbine (CCGT)	-34%	-26%	-71%	-43%
	Coal	-27%	-28%	-62%	-44%
	Nuclear	-4%	-5%	-20%	-23%
Profitability losses	Gas Turbine (OCGT)	-54%	-40%	-87%	-51%
	Gas Turbine (CCGT)	-42%	-31%	-79%	-46%
	Coal	-35%	-30%	-69%	-46%
	Nuclear	-24%	-23%	-55%	-39%
Electricity price variation		-14%	-13%	-33%	-23%

- Declining profitability especially for OCGTs and CCGTs;
- Insufficient incentives for new investment;
- Security of supply risks as gas plants close; HIS CERA estimate 110 GW no longer cover AC and 23 GW will close until end 2014.

# System effects in the long-run

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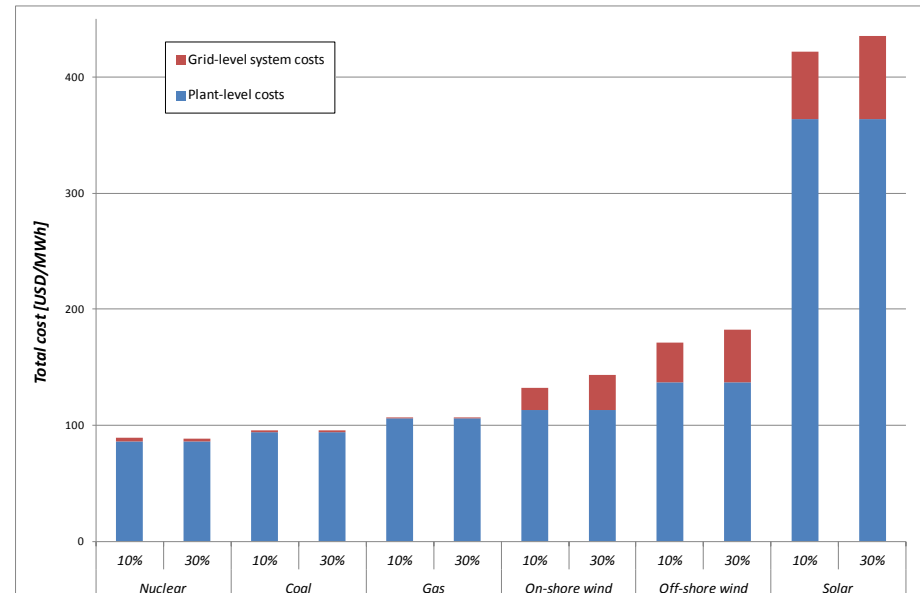
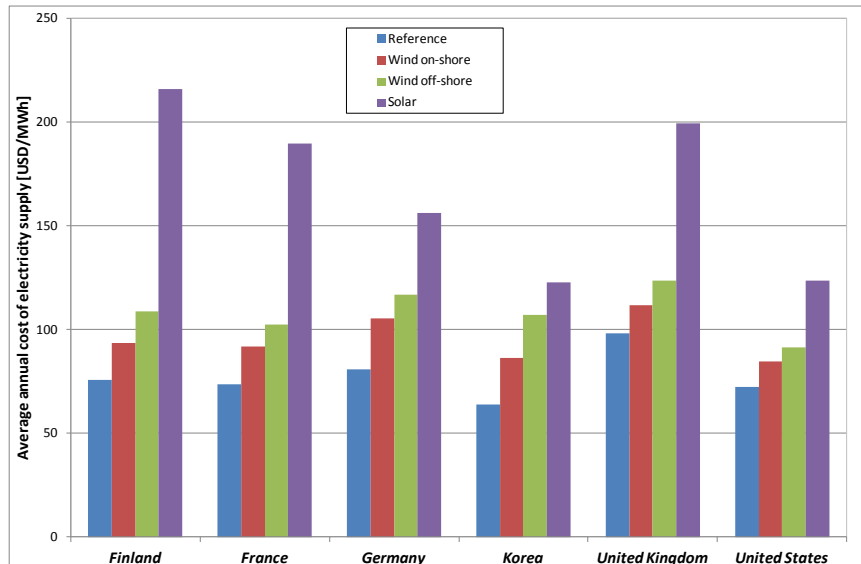
Kepler and Cometto (2012), *Nuclear Energy and Renewables: System Effects*, OECD.



- In the long-run high prices will adequately remunerate sufficient capacity levels even in the face of renewables with low capacity values;
- Yet, when does the short-run become the long-run? Not in the foreseeable future. That is why we need CRMs

# Quantitative estimation of system effects for different technologies

- Grid-level costs large for intermittent renewables
  - Depend strongly on country, technology and penetration level
  - Grid-level costs are in the range of 15-80 USD/MWh for renewables.
  - Among renewables, wind-on shore has the lowest grid-level costs, solar the highest.
  - Average grid-level costs for Europe are about 50% of total production cost of base-load technology (33% in USA)
- GL costs of dispatchable technologies order of magnitude lower (1-3€/MWh)



# New Markets for New Challenges

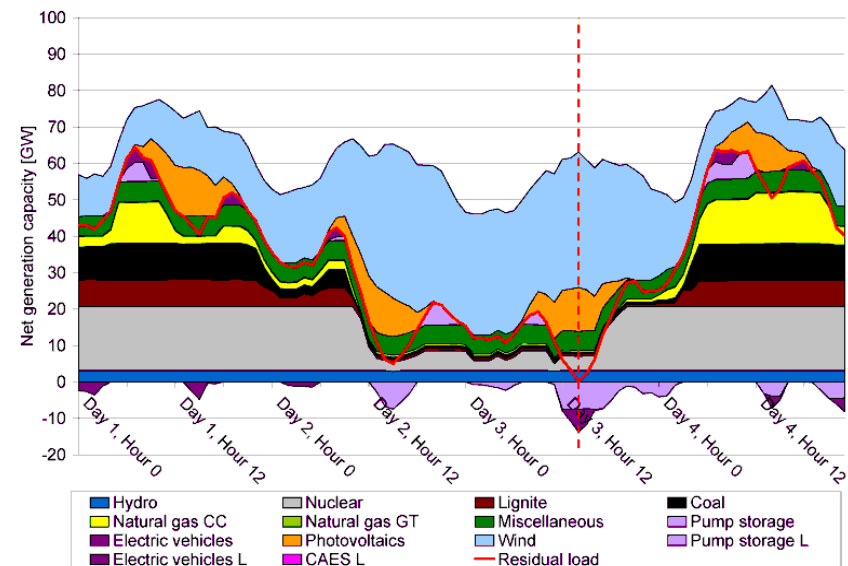
## *Nuclear Energy and Renewables (OECD NEA, Dec. 2012)*

The integration of large amounts of variable generation and the dislocation it creates in electricity markets requires new institutional and regulatory responses

### A. Markets for flexibility provision

For greater flexibility to guarantee continuous matching of demand and supply exist in principle four options that should compete on cost:

1. Dispatchable back-up and load-following
2. Electricity storage
3. Interconnections and market integration
4. Demand side management



### B. Mechanisms for the long-term provision of capacity

When the wind does not blow or the sun does not shine. Capacity mechanisms will need to finance dispatchable back-up through:

1. Capacity mechanisms
2. Strategic reserves
3. Markets for controlled curtailment in times of need