Electricity, a problem market/ markets

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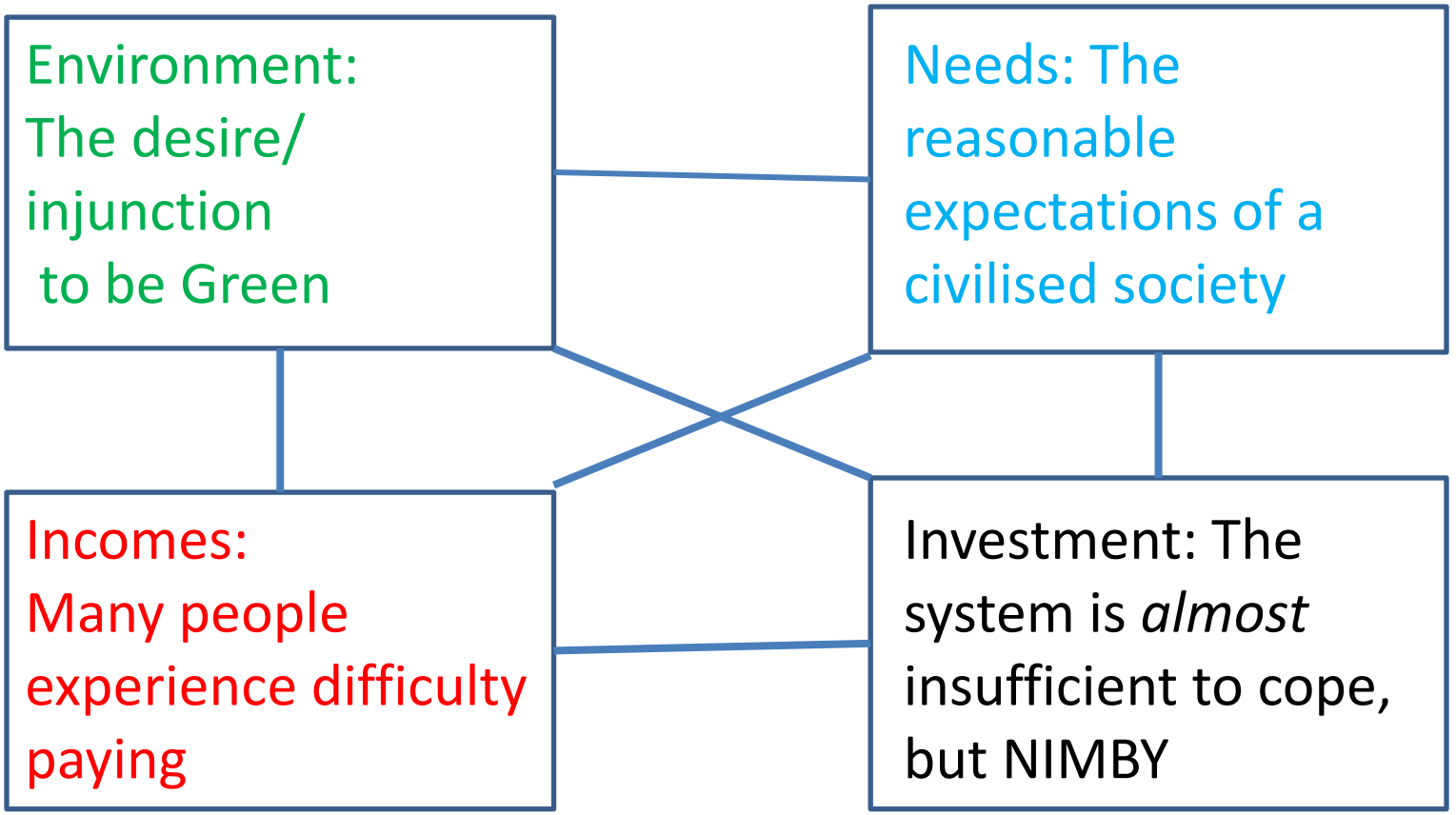
Sources of the problems: a cynical view

- In no particular order:
  - Consumers/ industry
  - Generators
  - Suppliers
  - Traders
  - The public
  - Politicians

The fundamentally conflicting factors here



Plan

- Original blueprint for the electricity industry
- Fixing problems with the strategy
- Market power, vertical integration and NETA/ BETTA
- Incentives for investment
- Policy towards different types of generation
- Concluding remarks

1990: A bright new blueprint for the future (?)

- Vertical disintegration
- Trading through the Pool
- Competition in generation
- Competition in supply planned

- Later: Abandon the Pool for NETA
- Allow vertical integration; all significant suppliers become vertically integrated
- Big Six know they are the Big Six, and behave accordingly
- Disappearance of a single market for electricity

Existing strategy: Fixing problems one at a time

- Increase competition at the generation level: Break up the generators, at the cost of allowing vertical integration
- Looming shortage of baseload capacity: Persuade EdF to build a new nuclear plant
- Increase renewables to reduce emissions: Pay them heavy subsidies
- But in order not to annoy people, build them where it is most expensive and difficult (offshore)
- Resulting increased variability in production: Develop a capacity market because Power-only markets cannot cope with the increased variability
- Lack of liquidity: Force more trading on the wholesale market (?)
- Install Smart meters- purpose?
- Encourage suppliers to get people to install insulation that results in them selling less (?)
- But: Problems/ solutions can interact

Example of problems interacting

- Problem 1: Too little competition in wholesale market
  - Responses:
    - Break up the generators
    - Introduce NETA, to curtail intra-marginal rents
  - But the cost is allowing VI between generators and suppliers
  - Outcome: severe pressure on merchant generators
  - Consequent lack of investment in new generation
  - Lack of competition in supply market
- In my view, it would probably have been OK *either* to introduce NETA, *or* to allow VI, but not both
- Model to illustrate this

Bushnell et al model (variant): Giulietti, Grossi, Waterson: Energy Econ, 2010

- Two stages, generation and supply (may be integrated)
- Two stage game
  - Stage 1: retailers make retail commitments (sign up customers)
  - Stage 2: Generators make production commitments
- Profits for typical firm

$$\pi_{j,t}(q_{j,t}, q_{-j,t}; q^r_{j,t}, q^r_{-j,t}) = p^w_{j,t}(q_{j,t}, q_{-j,t}).(q_{j,t} - q^r_{j,t}) + p^r_{j,t}(q^r_{j,t}, q^r_{-j,t}).q^r_{j,t} - C_{j,t}(q_{j,t})$$

- Solving stage 2:

Integrated firm

$$\frac{\partial \pi_{I,t}}{\partial q_{I,t}} = p^w_{I,t}(q_{I,t}, q_{-I,t}) + \left[q_{I,t} - q^r_{I,t} \right] \frac{\partial p^w_{I,t}}{\partial q_{I,t}} - C'_{I,t}(q_{I,t}) \geq 0$$

Generator (only)

$$\frac{\partial \pi_{G,t}}{\partial q_{G,t}} = p^w_{G,t}(q_{G,t}, q_{-G,t}) + q_{G,t} \frac{\partial p^w_{G,t}}{\partial q_{G,t}} - C'_{G,t}(q_{G,t}) \geq 0$$

Bushnell type model (cont)

- At retail level

Integrated firm

$$\frac{d\pi_{I,t}}{dq^r_{I,t}} = \frac{\partial \pi_{I,t}}{\partial q^r_{I,t}} = -p^w_{I,t} + p^r_{I,t} + q^r_{I,t}\frac{\partial p^r_{I,t}}{\partial q^r_{I,t}} \geq 0$$

Retail supplier

$$\frac{\partial \pi_{R,t}}{\partial q^r_{R,t}} = -p^w_{R,t} + p^r_{R,t} + q^r_{R,t}\frac{\partial p^r_{R,t}}{\partial q^r_{R,t}} \geq 0$$

- Scenario 0: Pool, no integrated firms: double marginalisation
- Scenario 1: No unintegrated firms: wholesale price tends to marginal cost, retail margin

$$\frac{p^r_{I,t} - C'_{I,t}(.)}{p^r_{I,t}} = \frac{1}{N_I \varepsilon_r}$$

- Scenario 2: Unintegrated and integrated coexist, all 4 equations hold, so unintegrated generators and retailers in worse position than integrated firms
- Outcome?

Spark spreads- wholesale level analysis, electricity – gas (gas regime is unchanged)

	t statis-tic	**p.value**	**mean first period**	**mean second period**
BN-BB_Rel. spreads	13.9671	0	0.4382	0.2422
BN-BB_Abs. spreads	13.6238	0	9.7637	4.8603

- Clear indication that wholesale margins fell between the 1999- 2001 (pre-NETA) and 2001-2005, post- NETA, pre-BETTA eras: This part of the policy "worked"
- But what about: (a) Retail market, (b) Long term

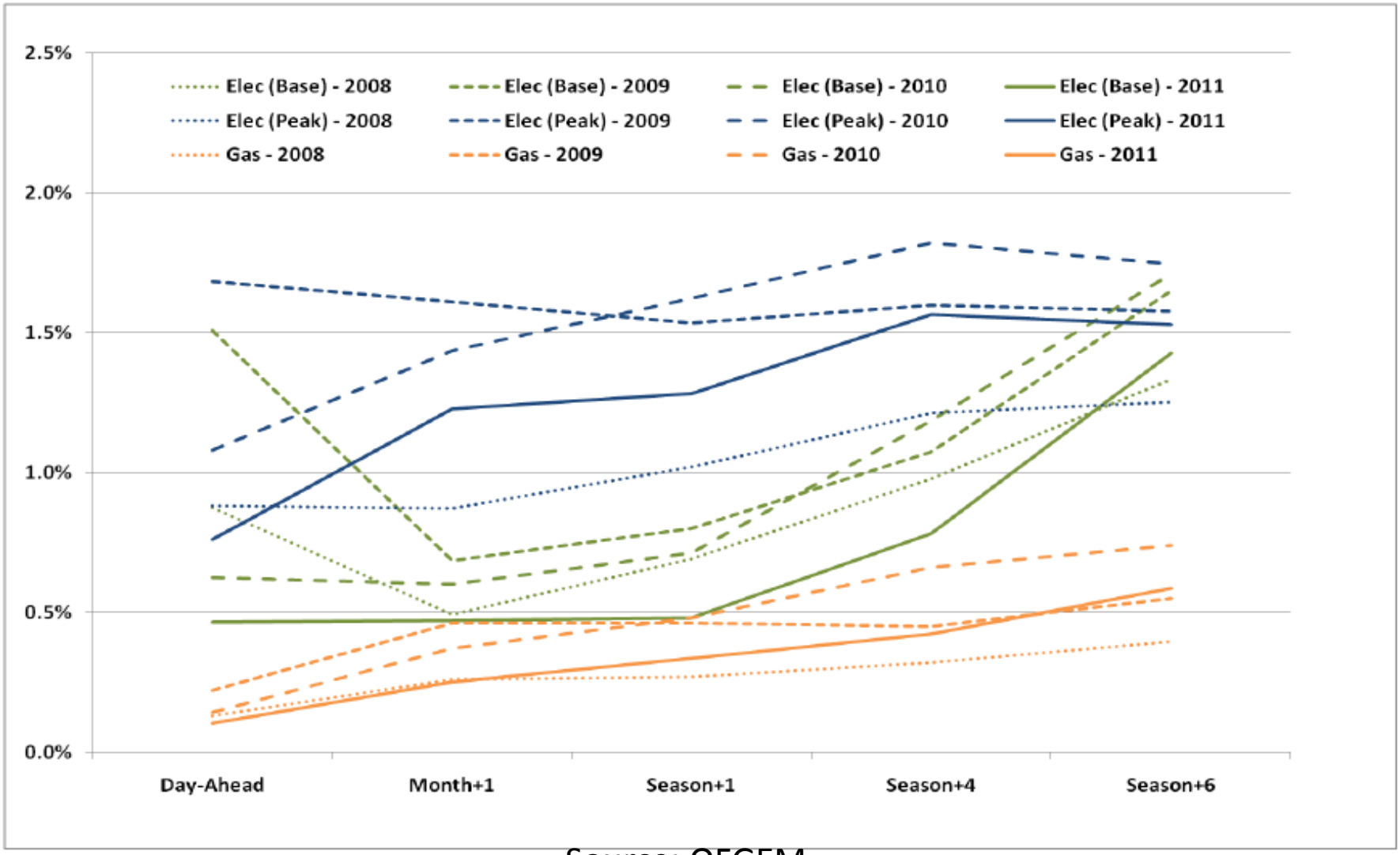
Relative retail margin before/ after NETA (before BETTA)- t tests (example)

	Relative spreads (margin)	t-stat	p- value	mean period1	mean period2	Difference in differences	
						t-stat	p-value
ALL	Engl & Wal	-12.31	0	0.46	0.51		
	Scotland	-7.64	0	0.44	0.47	4.01	0
DD inc	Engl & Wal	-19.99	0	0.46	0.53		
	Scotland	-13.79	0	0.45	0.5	5.85	0
DD noninc	Engl & Wal	-12.89	0	0.43	0.48		
	Scotland	-7.25	0	0.43	0.46	4.73	0

This part didn't!

Trading and liquidity: moves to improve liquidity

Figure 3: Average bid-offer spreads in the GB gas and electricity markets

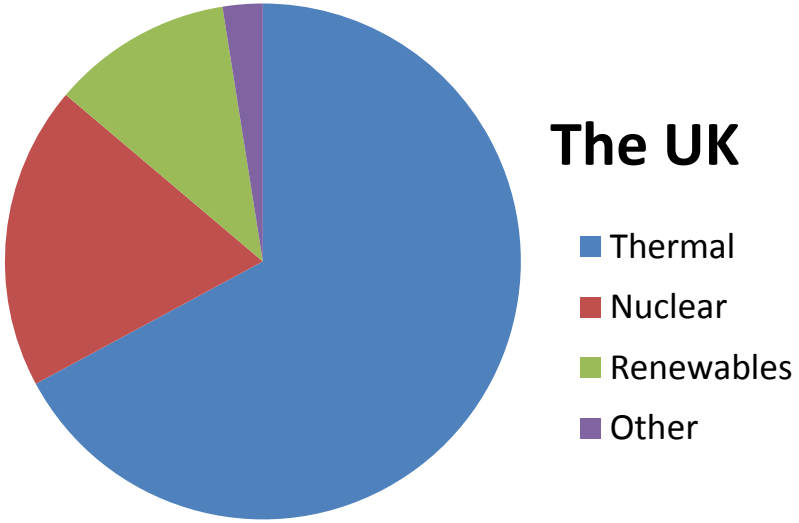


Source: OFGEM

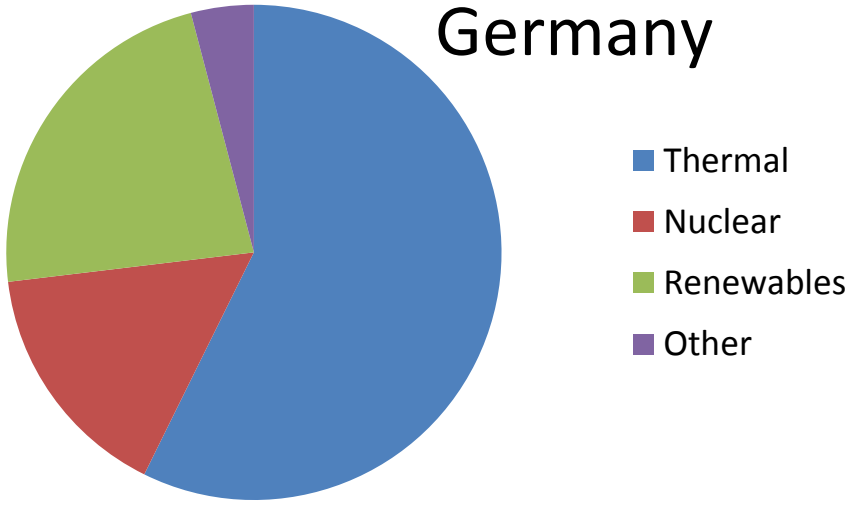
Problems 2 and 3: Lack of investment in new capacity, plus environmental concerns

- Nuclear plants take a long time to build and are controversial: So there is a tendency to put off the decision
- Everyone likes renewables, just not near them!
- Response: Subsidise both (significantly)
- What is the impact of an increased role for renewables and a lesser role for thermal?
- A glimpse into the future:

The future?: A foreign country; they do things differently there

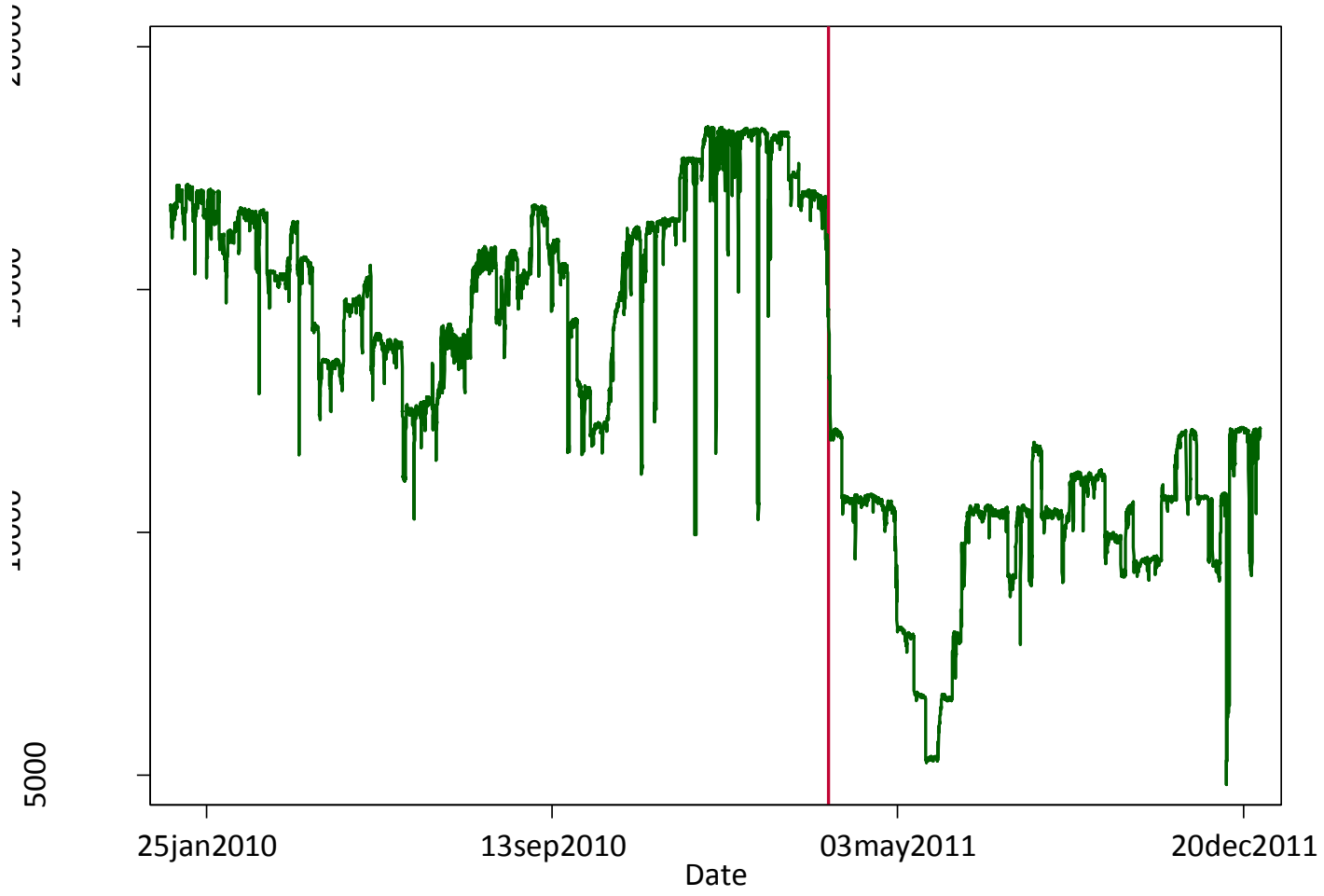


Generation in 2012;
2/3 thermal



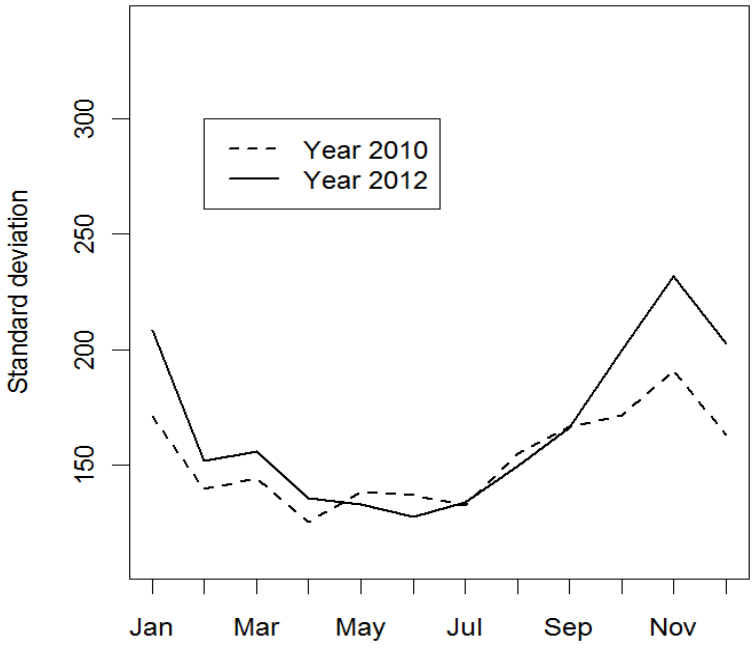
- The future?
- 10 percentage points less thermal
- Somewhat less nuclear
- Doubling of renewables

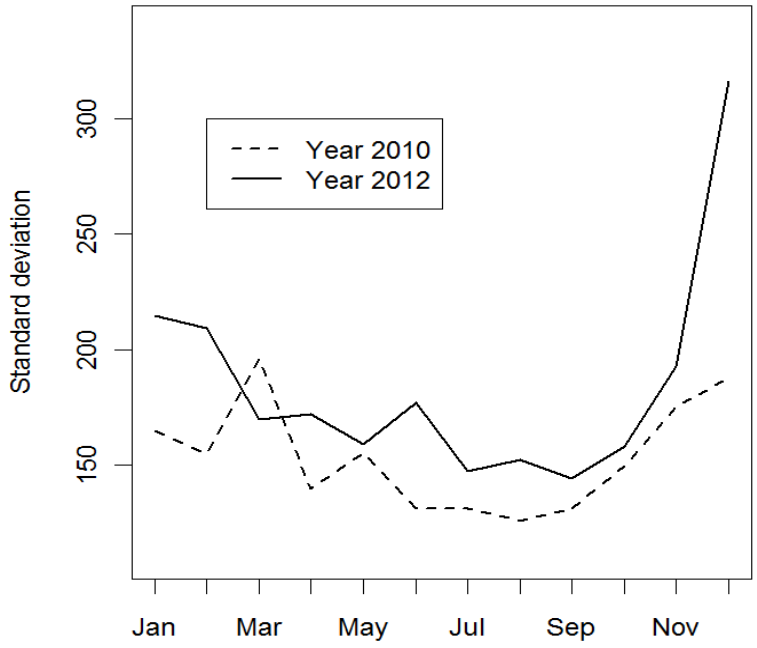
Nuclear plant production in Germany



Germany actually added more capacity in renewables than it removed in the Ausstieg between 2010 and 2012

- But there is a significant impact on variability
- Load variability across hours within the day (left) and days within the month (right)





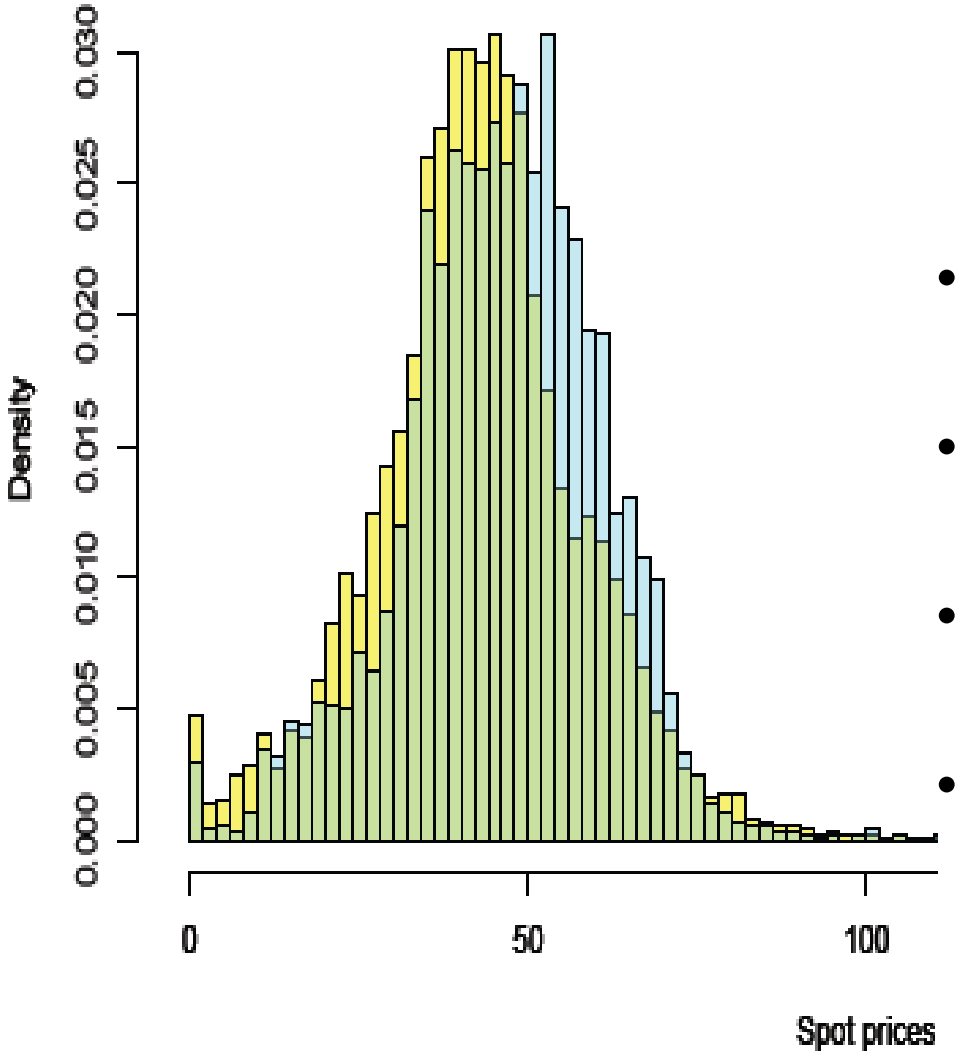
Impact of the German decision on day-ahead wholesale prices (Grossi, Heim, Waterson, 2014)

Table 5: Time and date varying impact of the earthquake.

	(1) Basic (Est. (3) in Tab. 4)	(2) Low & High D.	(3) Seasons	(4) Low/High D. & Seas.
Demand	0.229***	0.229***	0.228***	0.229***
	(-0.022)	(-0.023)	(-0.022)	(-0.022)
Earthquake	3.263***			
	(-0.944)			
Earthqu. × Low		5.116***		
		(-0.998)		
Earthqu. × High		-0.251		
		(-1.306)		
Earthqu. × Spring			2.208**	
			(-1.081)	
Earthqu. × Summer			2.418**	
			(-1.181)	
Earthqu. × Autumn			2.646**	
			(-1.035)	
Earthqu. × Winter			5.073***	
			(-1.614)	

Lessons from the German experiment

Pre- and post- earthquake



- A system with excess generation capacity and/ or *good interconnection* survives a major shock
- But it is expensive- 7% rise in average wholesale price
- The effect *doesn't necessarily* come at peak
- In Germany it reduces diurnal arbitrage possibilities
- The increased renewables do imply increased subsidies paid by consumers (EEG)

Renewables are *very* variable: German example

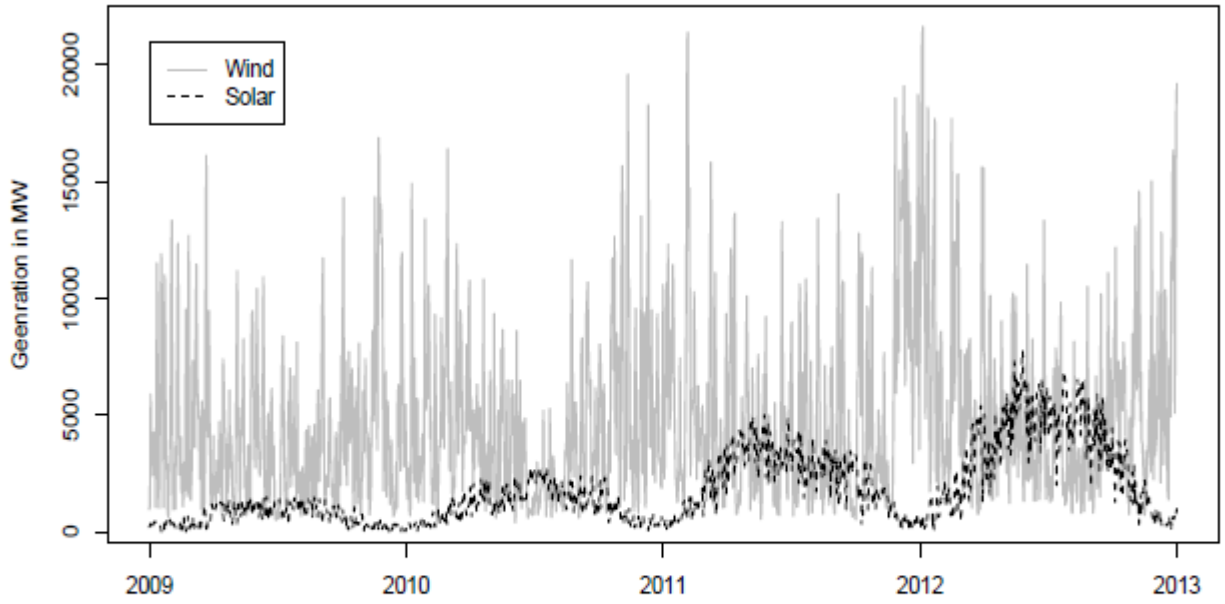


Figure 5: (Forecasted) Generation from Wind and Solar between 2009 and 2012

What policy move to take in response to this?

Germany- interconnection

The UK

Greater capability to store electricity is crucial for [renewable] power sources to be viable. It promises savings on UK energy spend of up to £10bn a year by 2050 as extra capacity for peak load is less necessary.

George Osborne, 9 November 2012

So: subsidies for storage?

Up to 30 new gas power stations will be needed by 2030

George Osborne, 5 December 2012

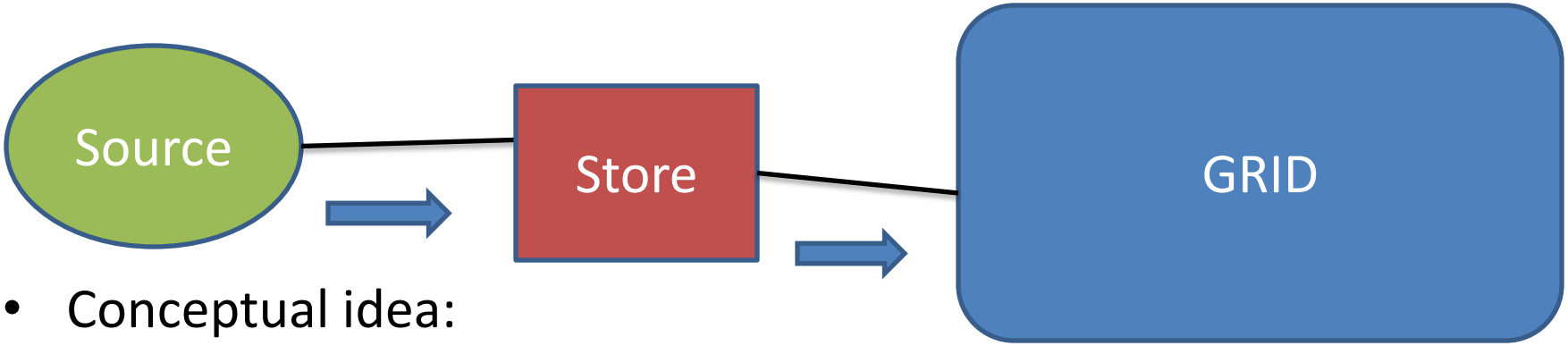
Or payments for holding capacity?

Slide from a presentation by Philipp Grunewald

The role of storage: Some preliminary work (Flatley, MacKay, Waterson, 2014)

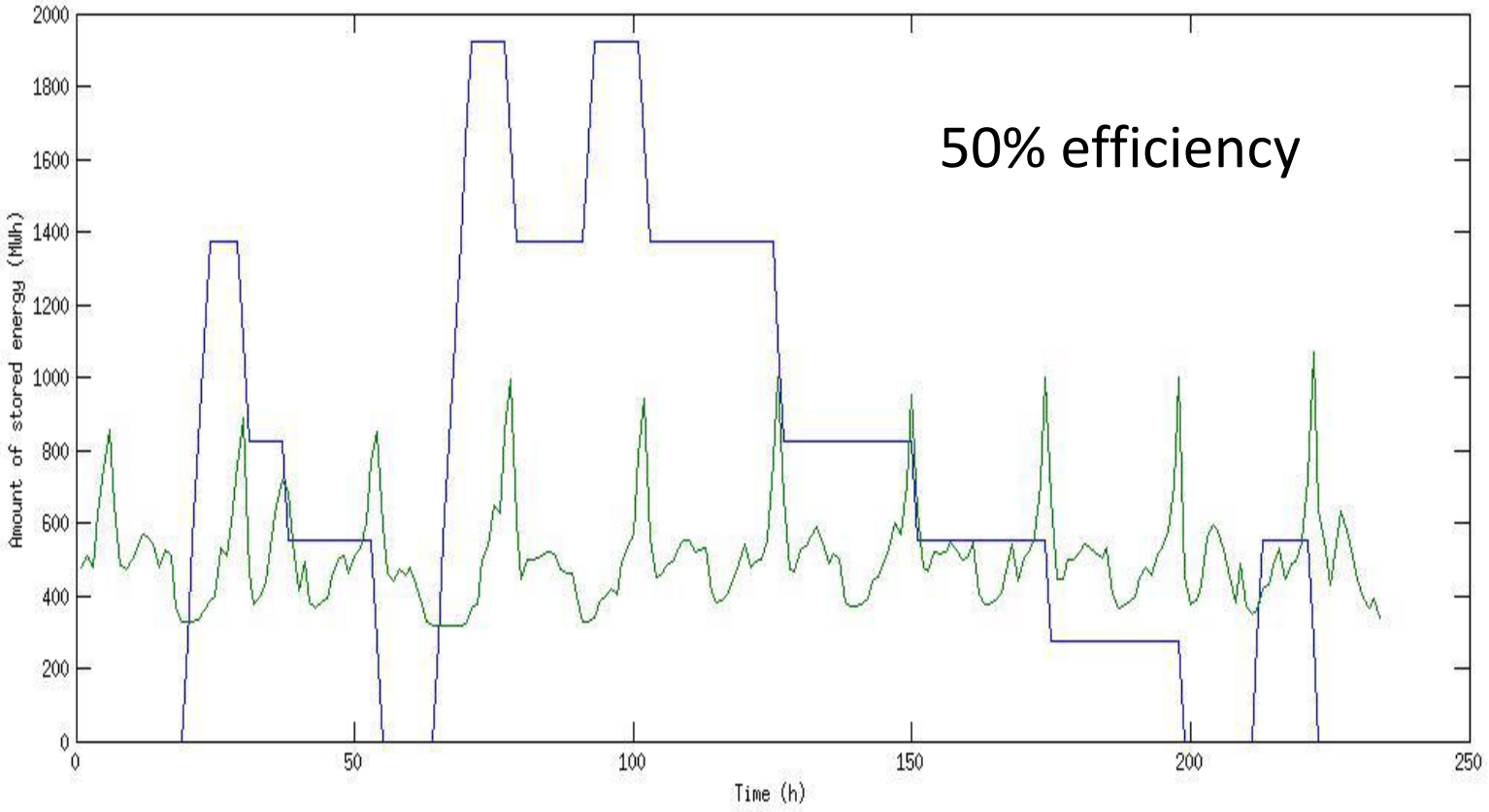
- How does storage earn money?
- Most obviously, through arbitrage, storing when prices are low, releasing where prices are high
- Although this clearly depends on the effect of renewable output variance on prices

Co-location: the straightforward case

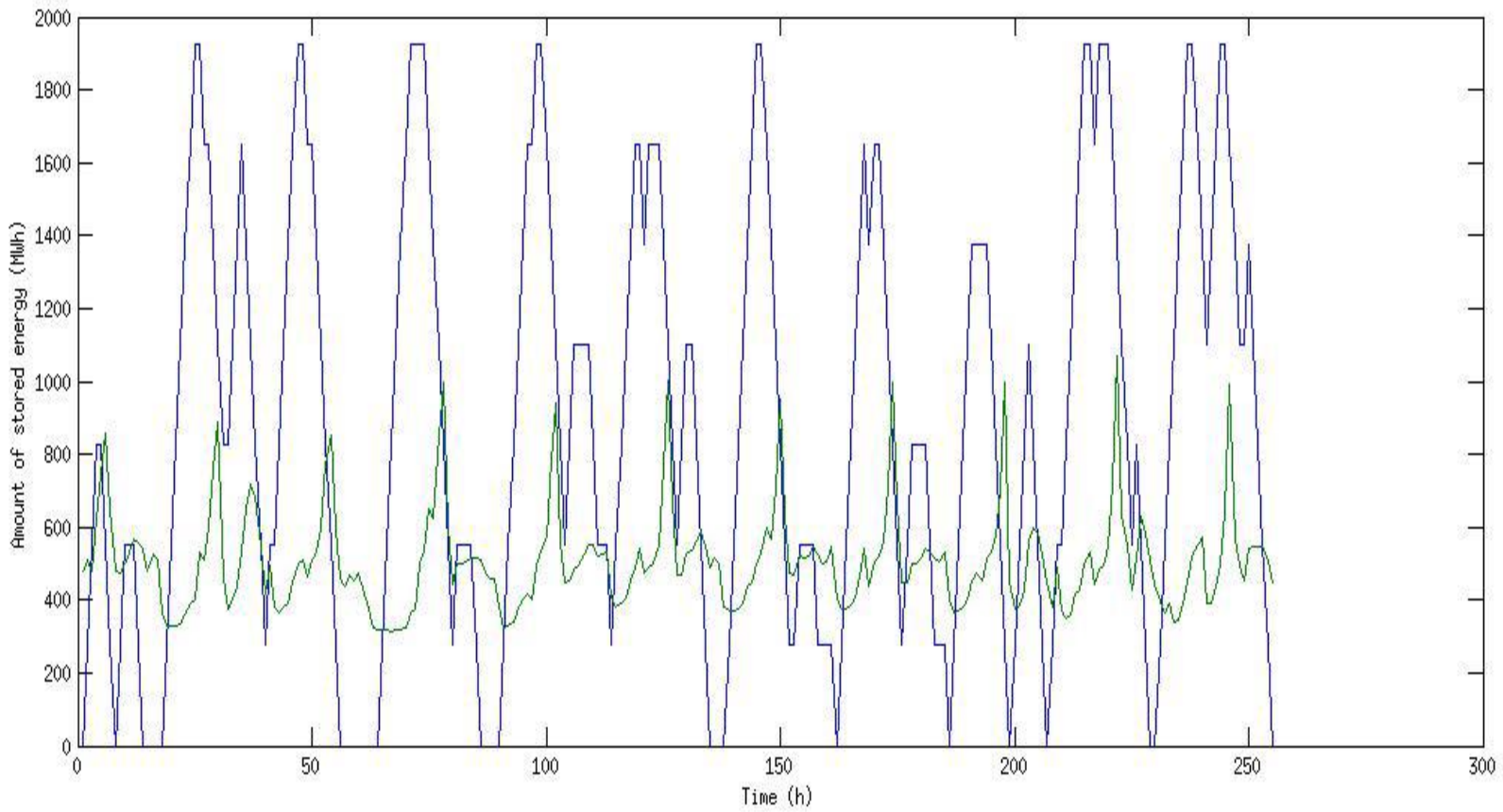


- Conceptual idea:
  - The value of the power generated fluctuates
  - So store when value low and release when value high
- We can (and plan to) calculate these magnitudes, under some assumptions
- But, the renewable source currently doesn't face the price signal, nor does nuclear
- In other words, FiT destroys the economics of co-location storage as an earner from arbitrage through direct connection to a renewable source!

The earnings from storage depend delicately on its efficiency



Storage 90% efficiency



Conclusions

- Elements of the electricity system are very much interconnected;
- Trying to fix problems in it on a piecemeal basis are likely to have unexpected and possibly adverse consequences
- Recognising that generation requires an optimisation across the whole market, rather than a series of solutions for individual fuels, would be welcome
- Private investment will come forth if existing generators are seeing supernormal returns, and there is some policy certainty
- It does not make sense for an industry that produces significant negative externalities to be subsidised!
- So politicians need to “come clean”- energy will be expensive