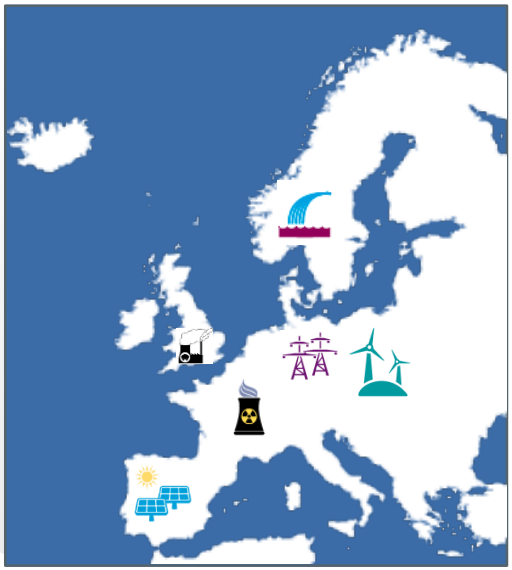
Transformation of the global energy markets is causing chaos in the European power markets



4 key drivers of change

- Shale gas
- Scale deployment of renewable generation
- Energy efficiency
- Regulation

Europe is seeing some of the largest shifts in the energy mix, giving way to some big 'dislocations'

E. Bourbaki

1) **The strange world of European energy**

2) **Resulting trends and implications**

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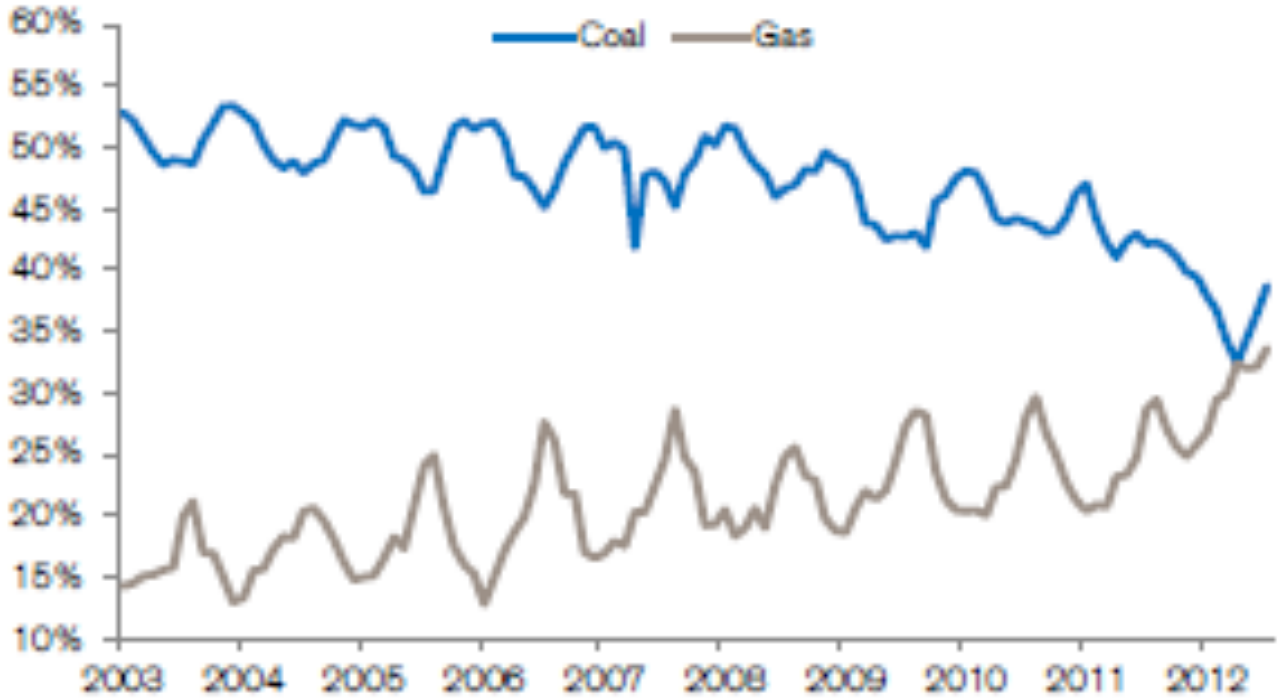
Move to gas across the US – the obvious…

Shift to greater gas usage

% of power generated from coal and gas in the US



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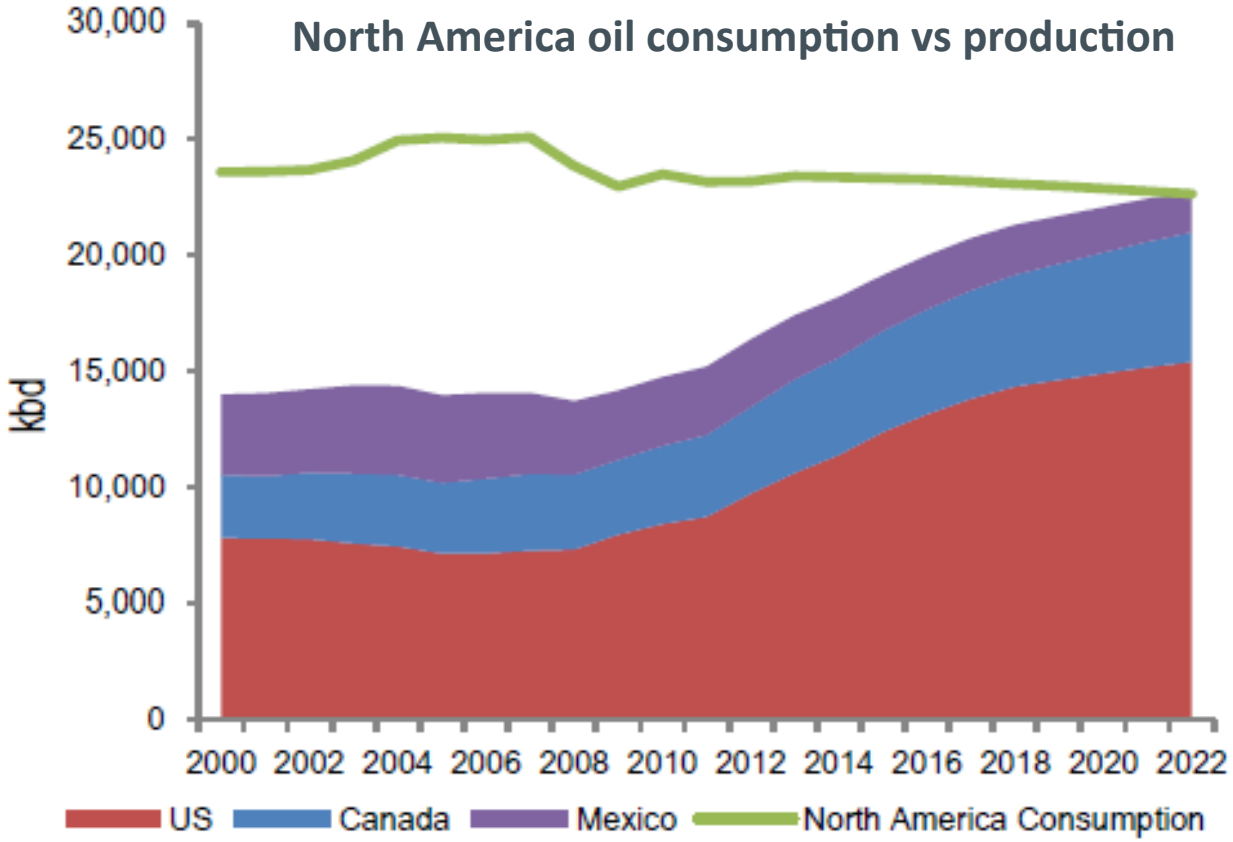
Move to gas across the US – the unexpected…

*At the same time, one of the side impacts has been **shale oil**!*



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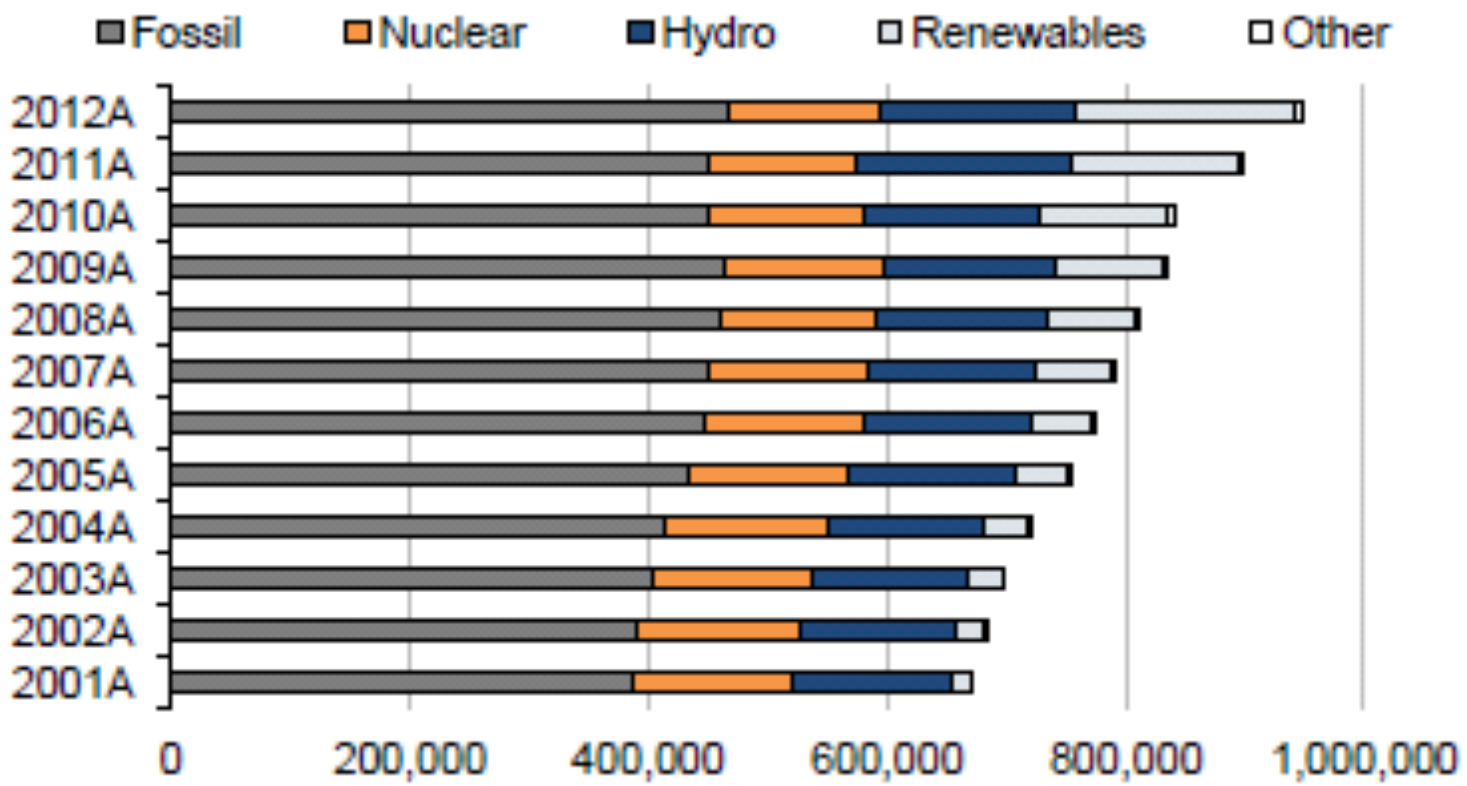
European energy mix – the obvious…

In Europe we have moved to renewables



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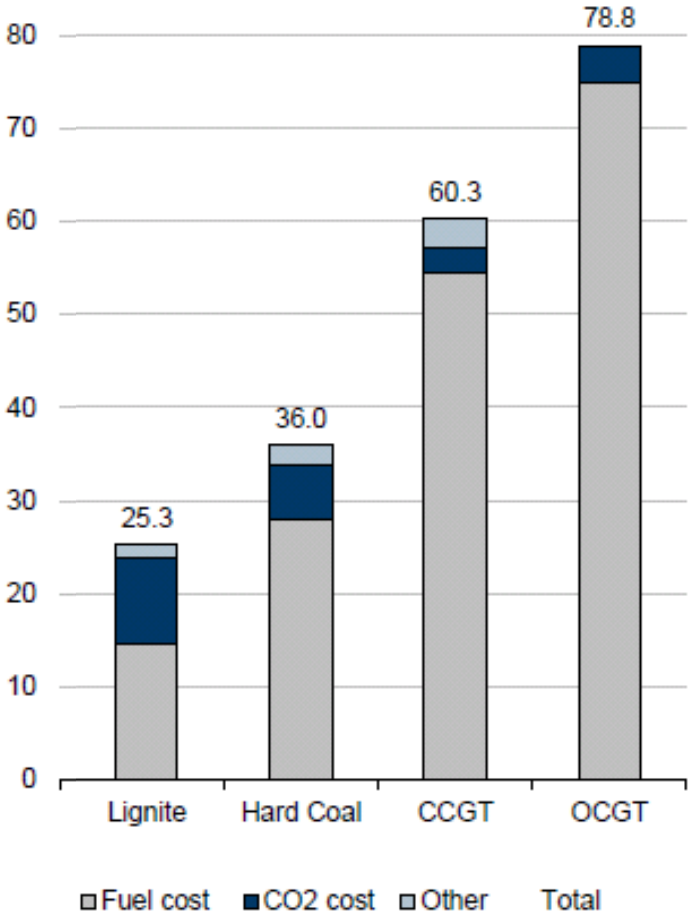
European energy mix – the unexpected

We have moved away from gas and towards coal!



- Coal is the cheapest form of fossil fuel generation in Europe
- Europe unlike the US does not have access to cheap gas
    - European gas contracts are tied to oil prices
- **In 2012 in the EU coal usage was up 3.4% while demand for gas was done 2.3%**

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Renewable generation – the obvious

We are using increasing amounts of "distributed generation"

Solar payback model

	Commercial		
	S. Germany	Spain	Italy
Solar system capactiy (kW)	80.0	80.0	80.0
Capex (EUR/kW)	950	950	950
Total capex (EUR)	76,000	76,000	76,000
Annual depreciation (20 years)	3,800	3,800	3,800
Annual cash opex (3%)	2,280	2,280	2,280
(1) Total annual cost of solar system	6,080	6,080	6,080
Load factor	12.0%	16.0%	15.0%
Solar electricity generation (kWh)	84,096.0	112,128.0	105,120.0
Self consumption ratio	80%	80%	80%
Total electricity demand	200,000	200,000	200,000
In-house solar electricity consumption	67,277	89,702	84,096
Grid electricity tariff (EURct/kWh)	18	14.5	15
(2) Saved annual cost for grid electricity	12,110	13,007	12,614
Net benefit (solar cost less saved cost for grid electricity)	6,030	6,927	6,534
(3) Sale of excess electricity at spot (EUR35/MWh)	1,682	2,243	2,102
(-1)+(2)+(3) Total annual savings (including depreciation)	7,712	9,169	8,637
Total annual savings as % of electricity bill	21.4%	31.6%	28.8%
Total annual cash savings	11,512	12,969	12,437
Payback time on investment (years) assuming price of EUR35/MWh	**7.8**	**6.6**	**6.9**

Solar, wind and fuel cells will lead the way

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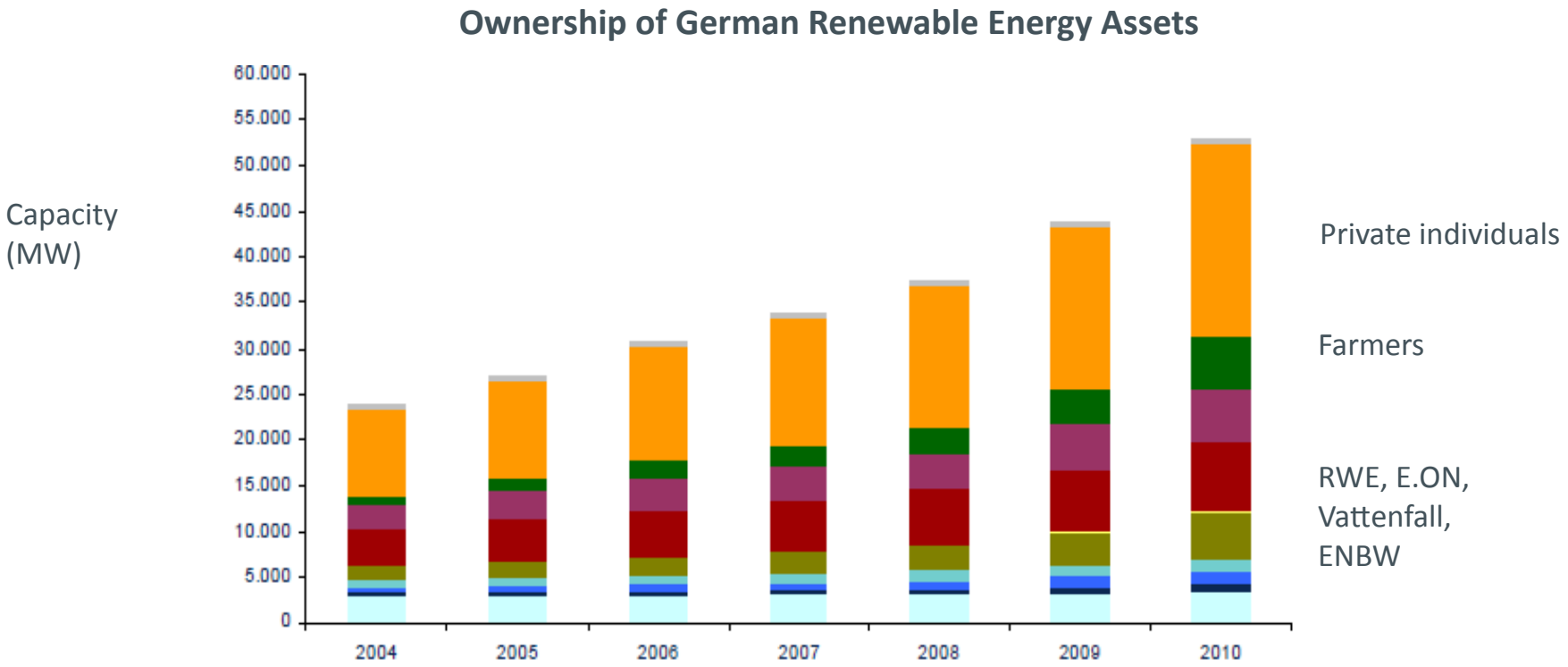
Renewable generation – the unexpected

The utilities are not: E.ON owns a mere 196MW of renewable assets in Germany



Utilities have followed traditional biases toward large-scale power production in committing themselves to expensive and **risky offshore wind**

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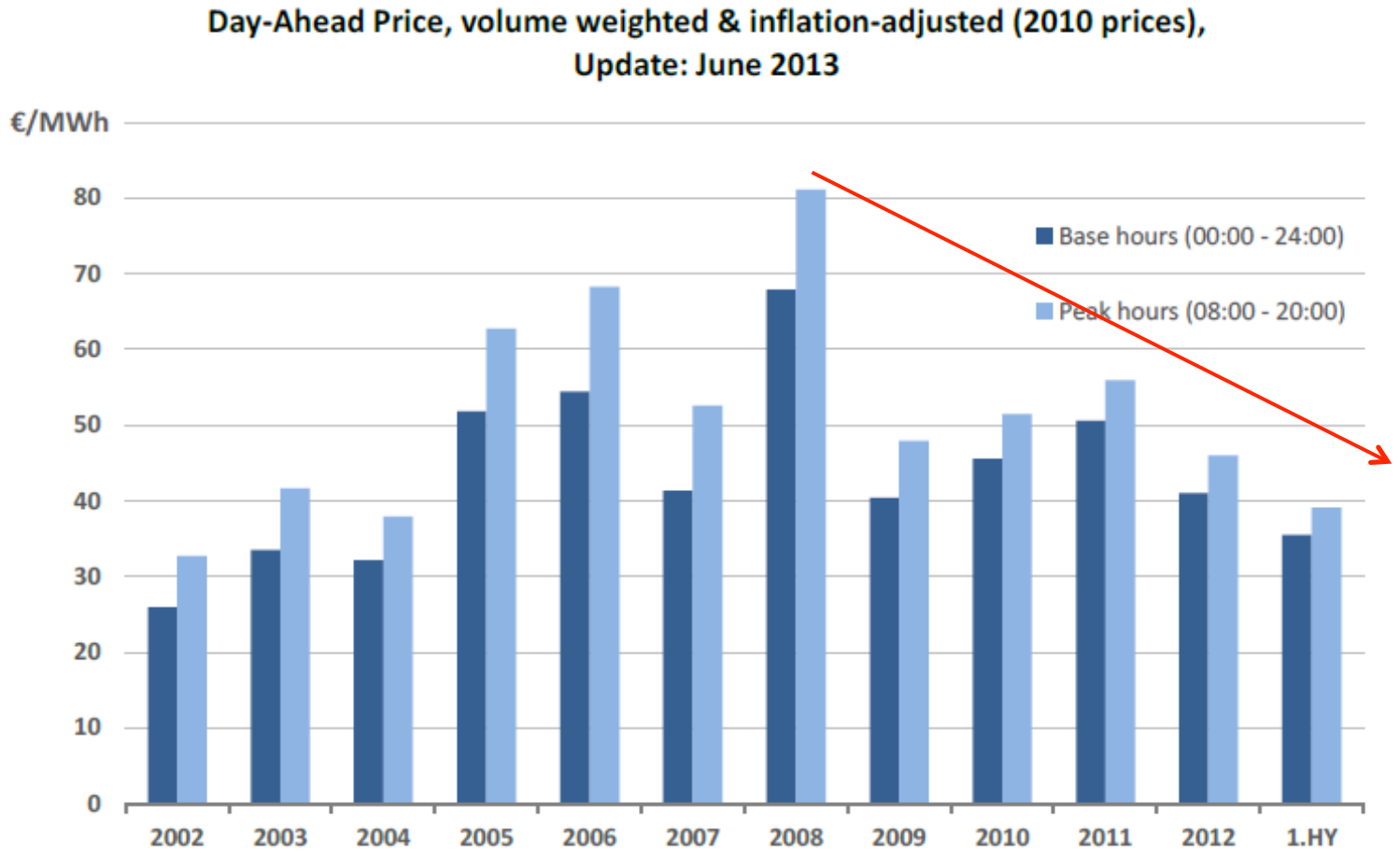
Electricity Prices – the obvious

Have fallen dramatically in recent years due to the renewables build out and weak demand



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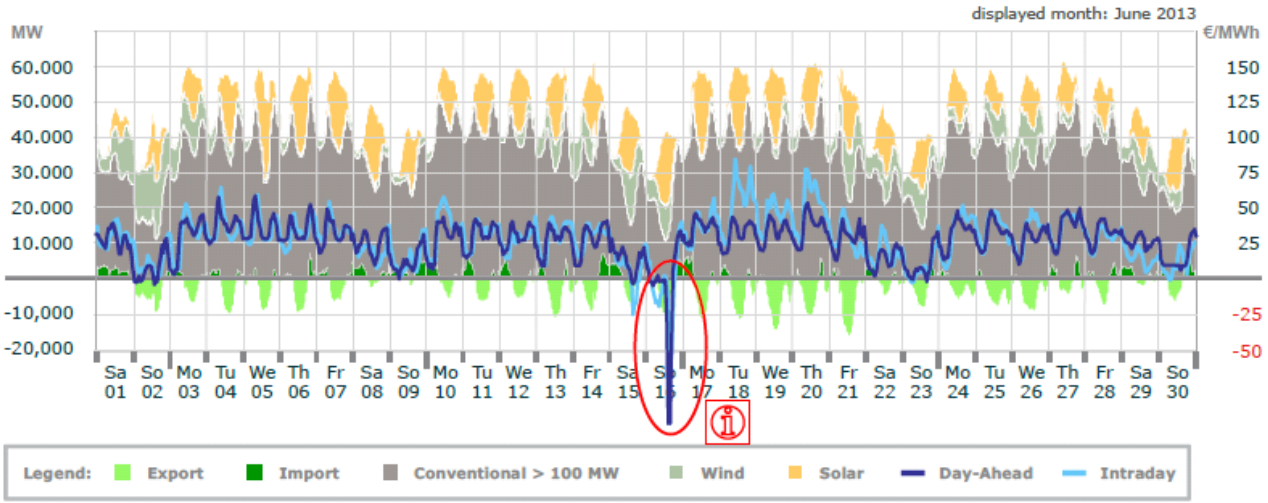
Electricity prices – the unexpected

The German consumer is subsidising heavy power uses and the rest of Europe!

	Heavy Industry	Large Energy	Commercial	Retail
Electricity price (ct/ kWh)	**6.0**	**8.2-11.8**	**19.5**	**27.0**



On big renewable days prices collapse and Germany exports lots of cheap power.

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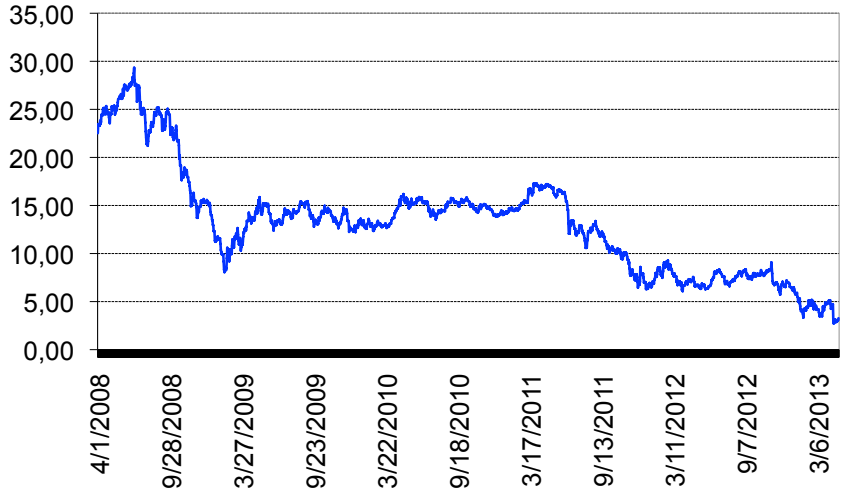
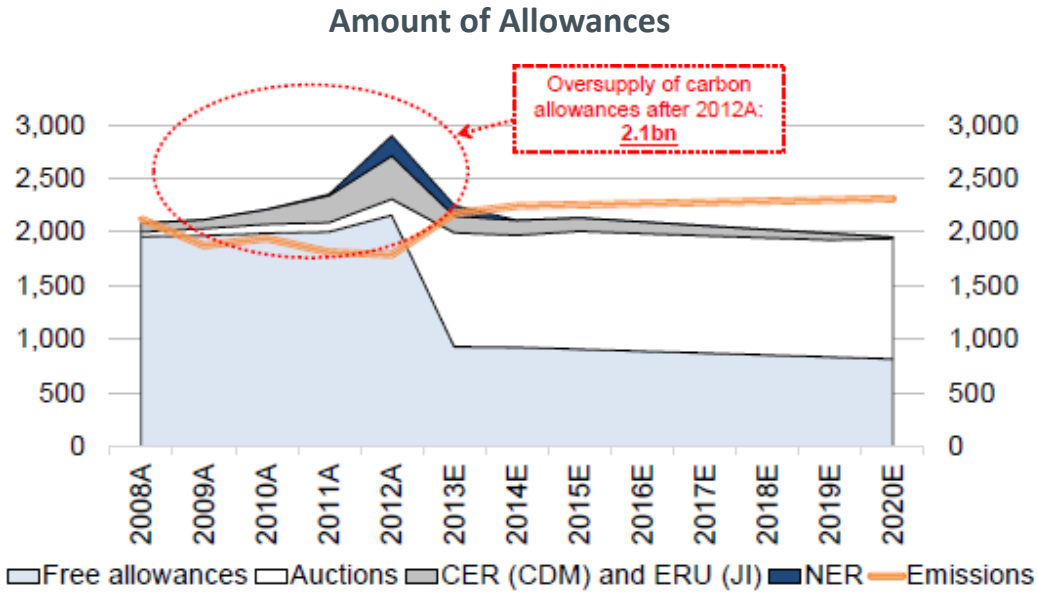
Carbon markets have broken down – obvious

With no real hope of survival





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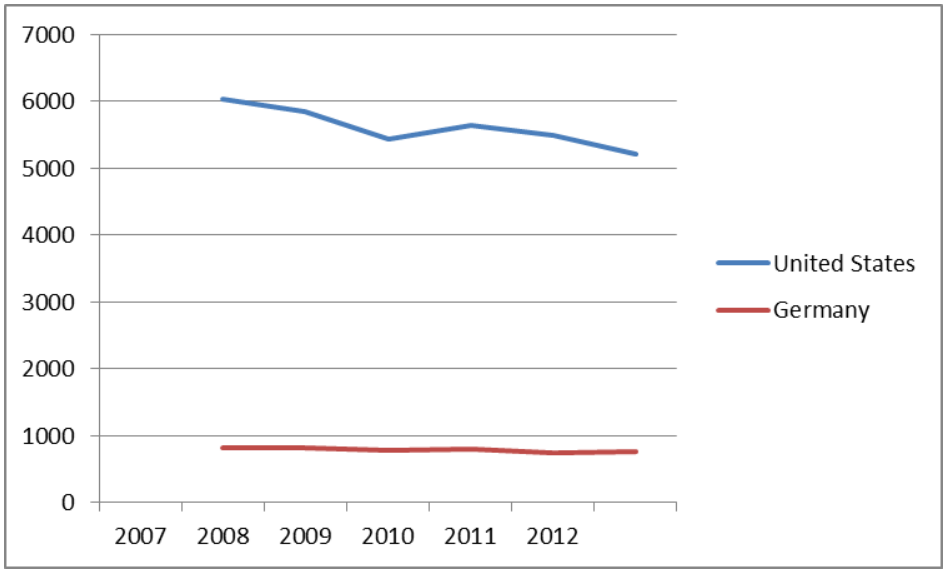
Carbon markets have broken down – the unexpected

US are reducing CO2 emissions by amounts greater than Germany



Germany emissions rose last year by 2% while in the US they fell by 3.9%

All because of a move to coal in Germany and in the US a move to gas and efficiency…

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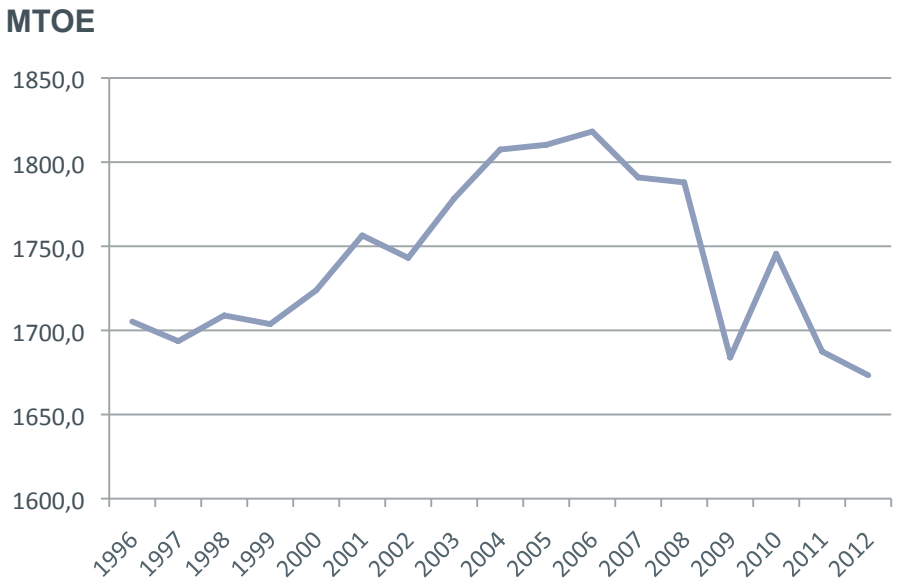
Energy demand – the obvious

Energy demand is set to continue decreasing across Europe



As energy efficiency continues to impact demand!

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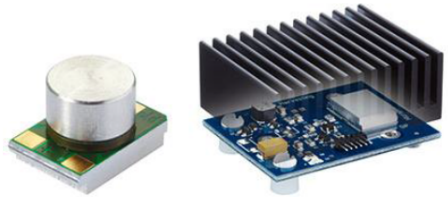
Energy demand – the unexpected

The demand for power is also to remain weak but utilities will not benefit

- We will use energy in much more intelligent and efficient ways
- We will recover more energy than ever thought possible
- Increasingly commercial and industrial users will engage in power trading and self-generation
- The trend to distributed power generation (including mobile phone charging) will continue



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European nuclear – the obvious

Germany is moving away from nuclear as is Switzerland and Japan

- 40 years of anti-nuclear protests and the Green Party
- Fukushima…the game changer

Reactor Name (type, net capacity)	Owner/Operator	End of license (latest closure date)	First Grid Connection
Biblis-A (PWR, 1167 MW)	RWE	6 August 2011	1974
Biblis-B (PWR, 1240 MW)	RWE		1976
Brunsbüttel (BWR, 771 MW)	KKW Brunsbüttel[502]		1976
Isar-1 (BWR, 878 MW)	E.ON		1977
Krümmel (BWR, 1346 MW)	KKW Krümmel[503]		1983
Neckarwestheim-1 (PWR, 785 MW)	EnBW		1976
Philippsburg-1 (BWR, 890 MW)	EnBW		1979
Unterweser (BWR, 1345 MW)	E.ON		1978
Grafenrheinfeld (PWR, 1275 MW)	E.ON	31 December 2015	1981
Gundremmingen-B (BWR, 1284 MW)	KKW Gundremmingen[504]	31 December 2017	1984
Philippsburg-2 (PWR, 1402 MW)	EnBW	31 December 2019	1984
Brokdorf (PWR, 1410 MW)	E.ON/Vattenfall[505]	31 December 2021	1986
Grohnde (PWR, 1360 MW)	E.ON		1984
Gundremmingen-C (BWR, 1288 MW)	KKW Gundremmingen		1984
Isar-2 (PWR, 1410 MW)	E.ON	31 December 2022	1988
Emsland (PWR, 1329 MW)	KKW Lippe-Ems[506]		1988
Neckarwestheim-2 (PWR, 1310 MW)	EnBW		1989

Notes: PWR=Pressurized Water Reactor; BWR=Boiling Water Reactor

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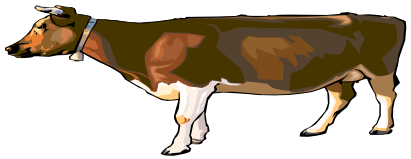
European nuclear – the unexpected

Britain is investing in new nuclear

- And they have put a very expensive price on it
  - £87.50 / MWh starting in 2023 and inflation adjusted for 35 year thereafter!
  - That is three times the continental European power price!



- Why?

- Sacred cow – outdated belief and shocking lack of belief on technology progress

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1) **The strange world of European energy**

2) **Resulting trends and implications**

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Implications are far reaching: (1) US is less strategically interested in the Middle East

China is now the biggest consumer of Middle East oil

- Chinas asked US six weeks ago to remain committed to the region's energy flow
- The question is when will the US start charging us for what is the “biggest energy subsidy” in the world?
  - $225bn per annum?

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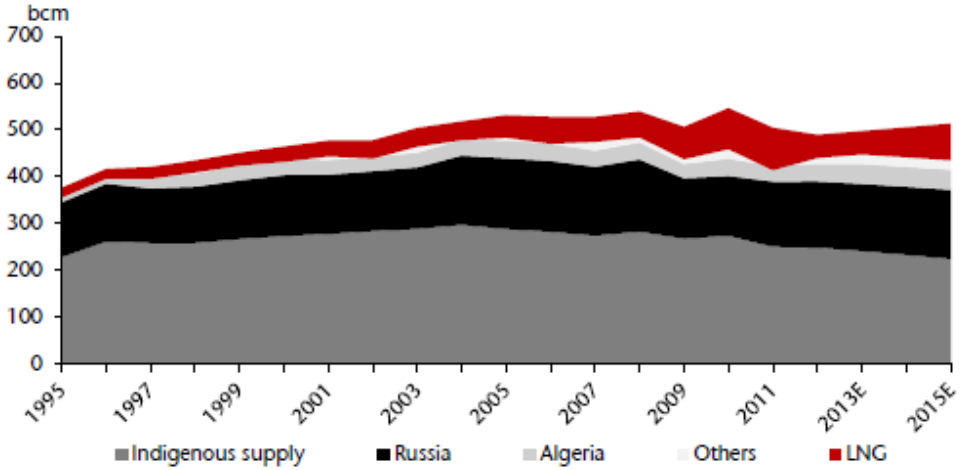
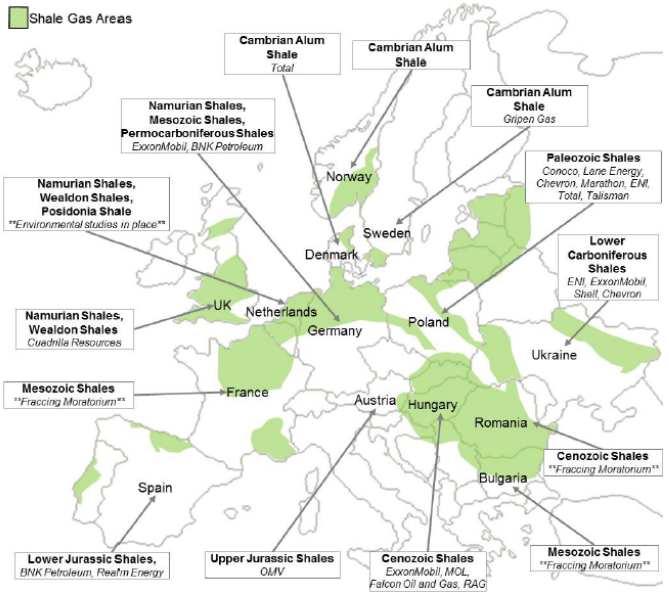
Implications are far reaching: (2) Europe has a gas problem….

Gas Supply in Europe





- The issue with European shale gas is that it is expensive to take out of the ground and we will not see any meaningful amounts till 2020
  - [EU flag] has circa 20 drilling drigs capable of fracking, [US flag] has 2,000
- LNG to Europe is not an alternative as it is still expensive: $4 gas, $3 conversion $2 transport

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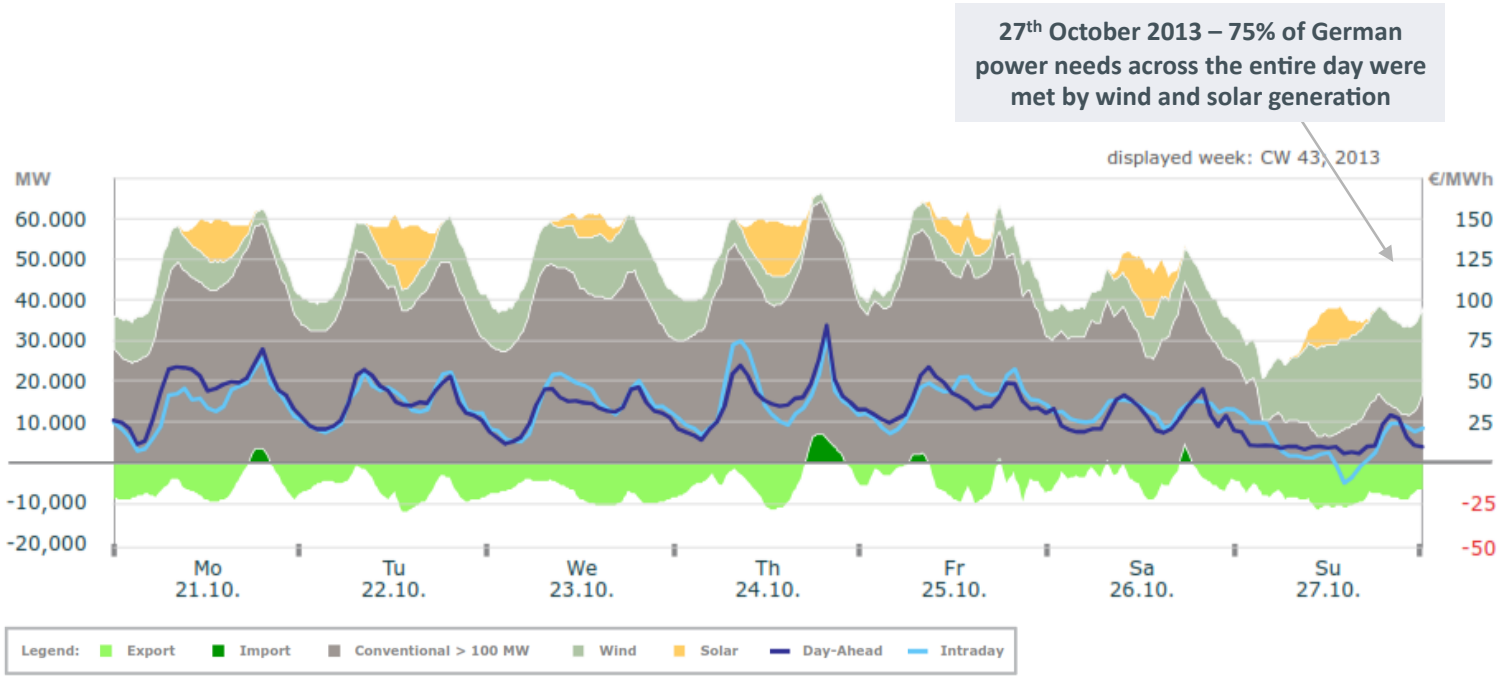
Implications are far reaching: (3) increasing build out of renewable and energy efficiency mean that wholesale prices are likely to stay low and volatile



- **Who is going to invest in this mess?**

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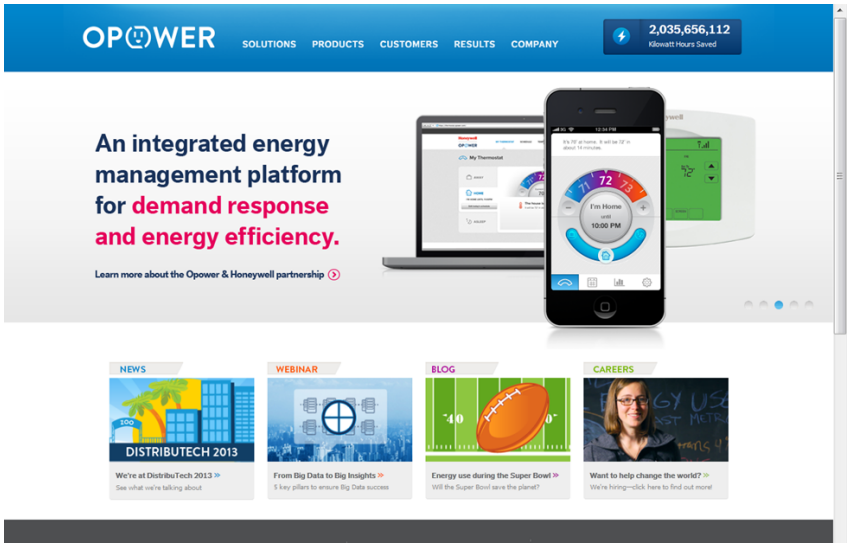
Implications are far reaching: (4) Exciting new business models are coming our way



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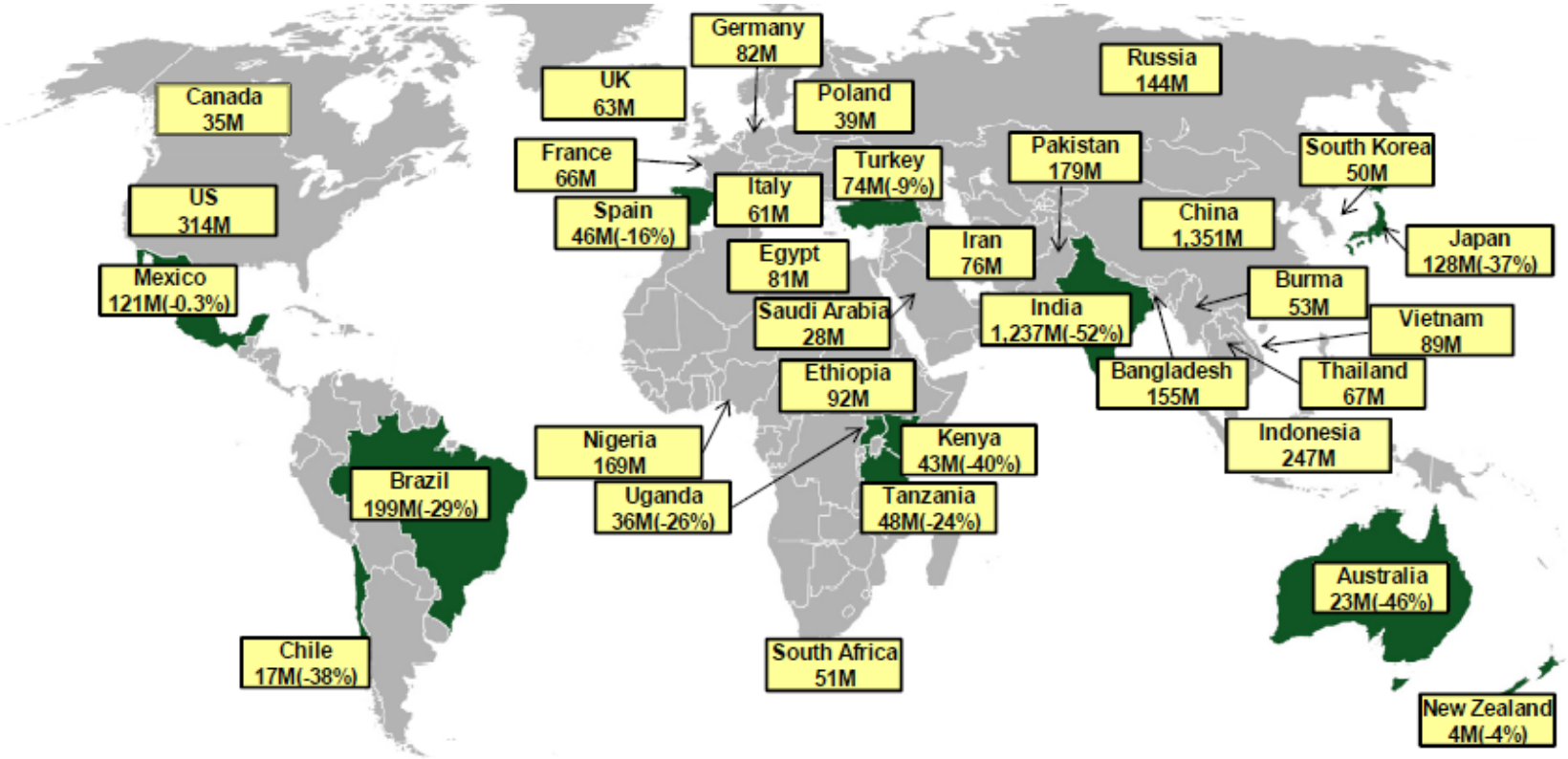
Implications are far reaching: (5) the whole way we look at producing power has been called into question



Rooftop solar is already cheaper than retail power prices in a large part of the world

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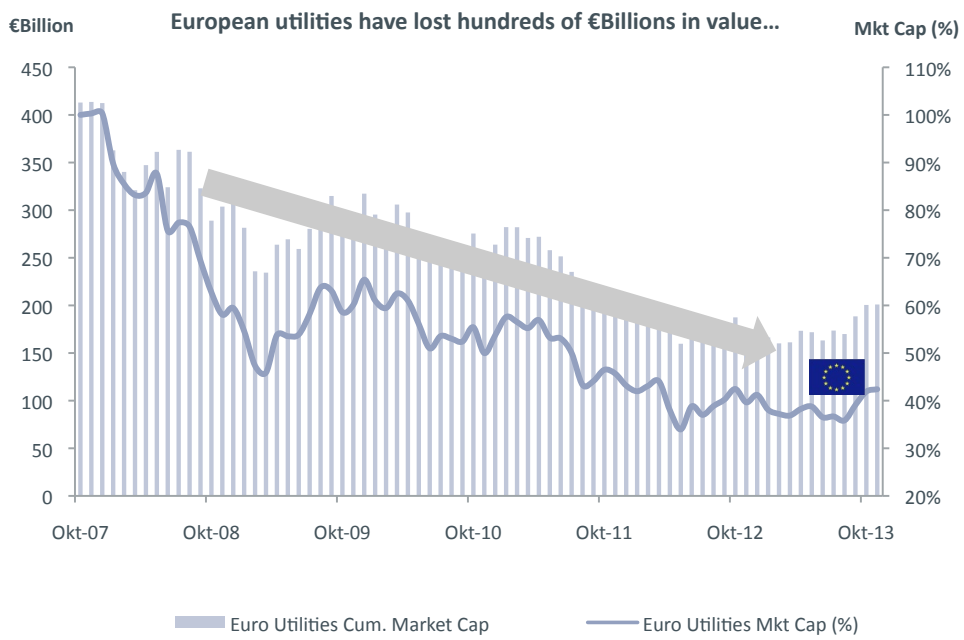
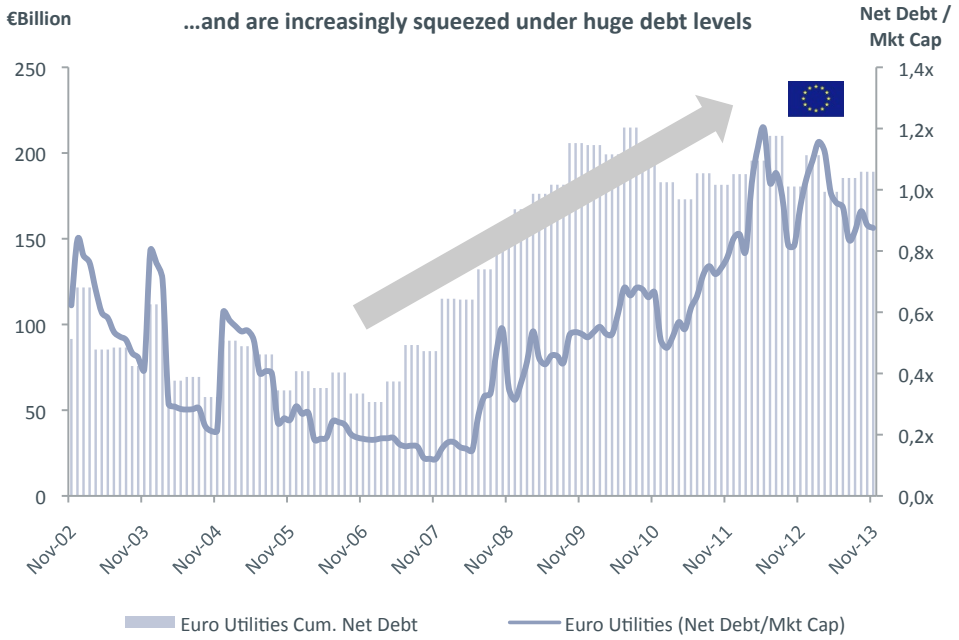
Implications are far reaching: (6) profitability and utility business models are coming under massive pressure





Question marks over their whole business models

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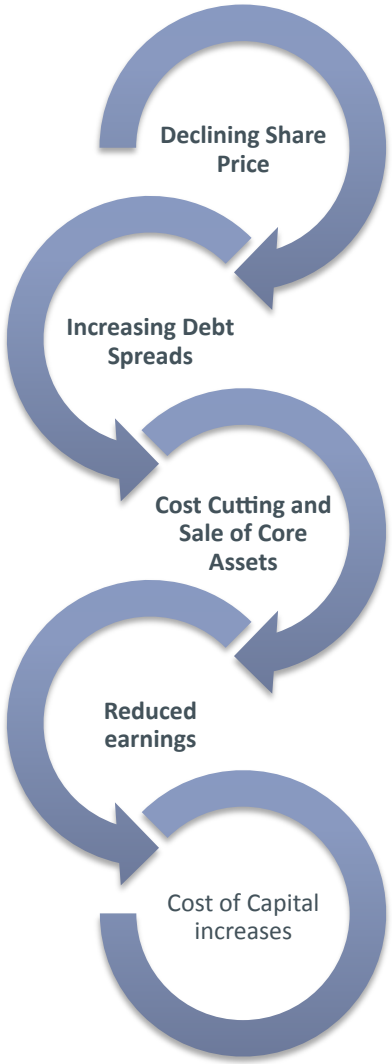
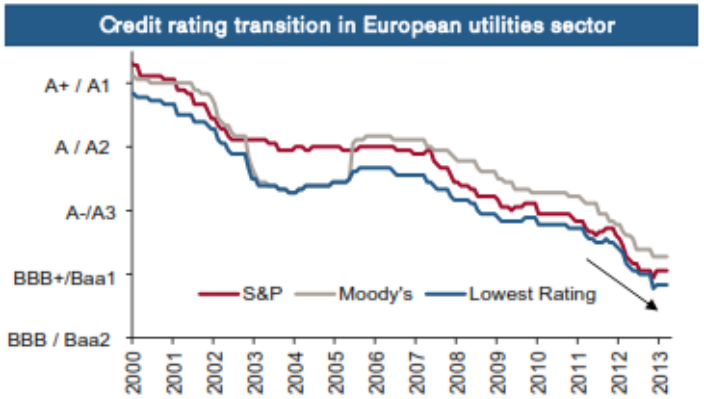
Implications are far reaching: (7) many utilities are in a negative cost of capital spiral





Cost of debt stabilisation

Nuclear decommissioning, fall off in power hedges, increased competition

Cost of equity rises and then debt

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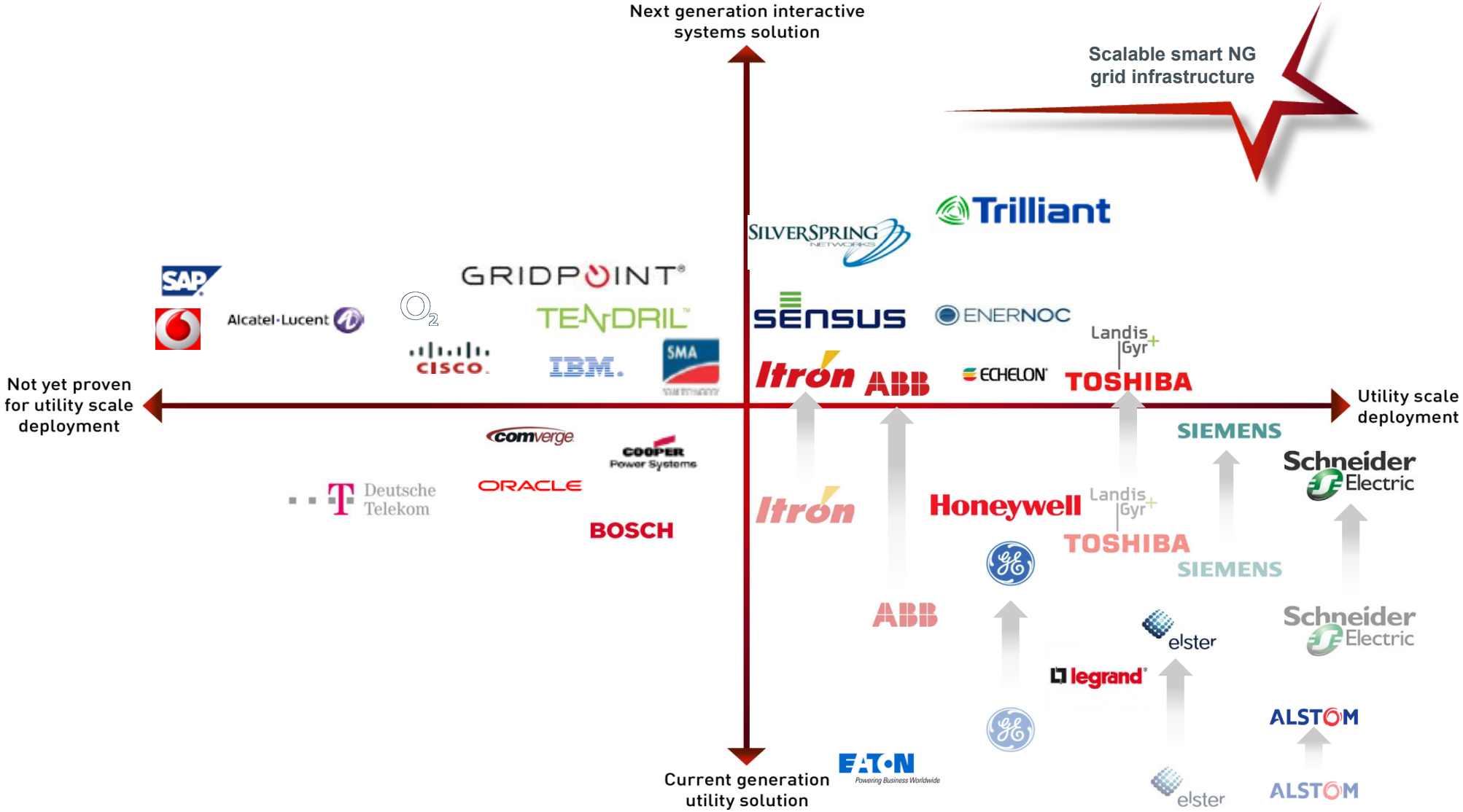
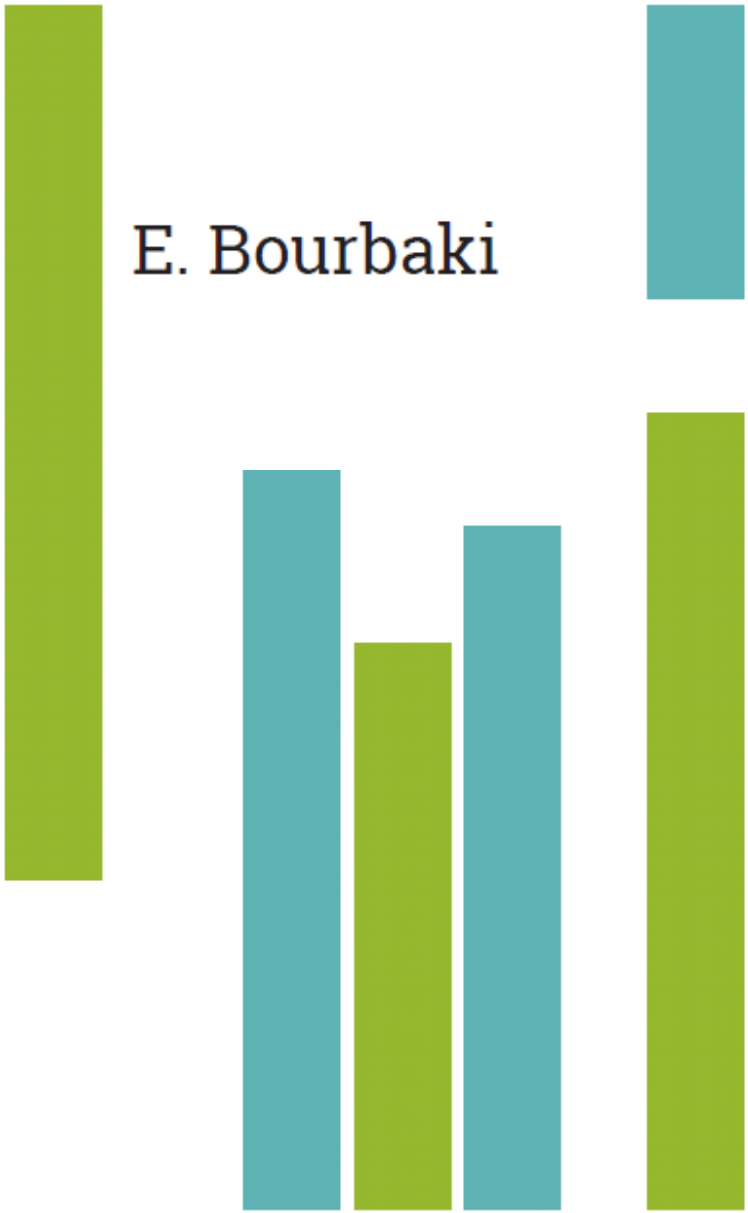
Implications are far reaching: (8) And the supply chain is also in flux…with many traditional European suppliers badly positioned



So what should be done



To be continued…