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Eeconomics: BEG/CEE-UT Annual Meeting

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Demand trends in Europe Gas and renewables in Spain Questions on Denmark/Germany

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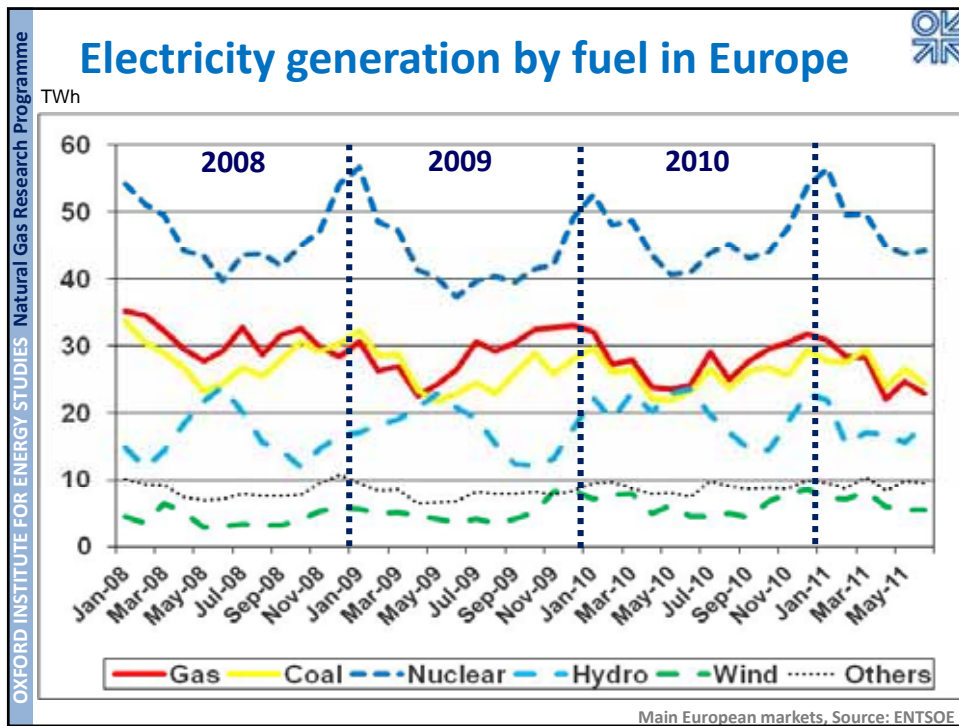


Demand trends in Europe...

- **Slow gas demand recovery**
 - ❖ Possible exceptions: cold winters (+4% in 2010 temp-corr)

	y-o-y	Jan-Aug
2009 vs 08	-5.6 %	-8
2010 vs 09	7.5 %	8
2011 vs 10	-	-5.6
2010 vs 08	1.45 %	-0.5
2011 vs 08	-	-6.2

- **Annual average growth rate: 0.6% (1.5% in power)**
 - ❖ + 50 bcm between 2008 and 2020... maybe !!!
- **Gas for power => many uncertainties**
 - ❖ 20/20/20 targets, LCPD, IED, EU ETS, recovery/new recession, nuclear, CCS... gas as transition or destination fuel ?

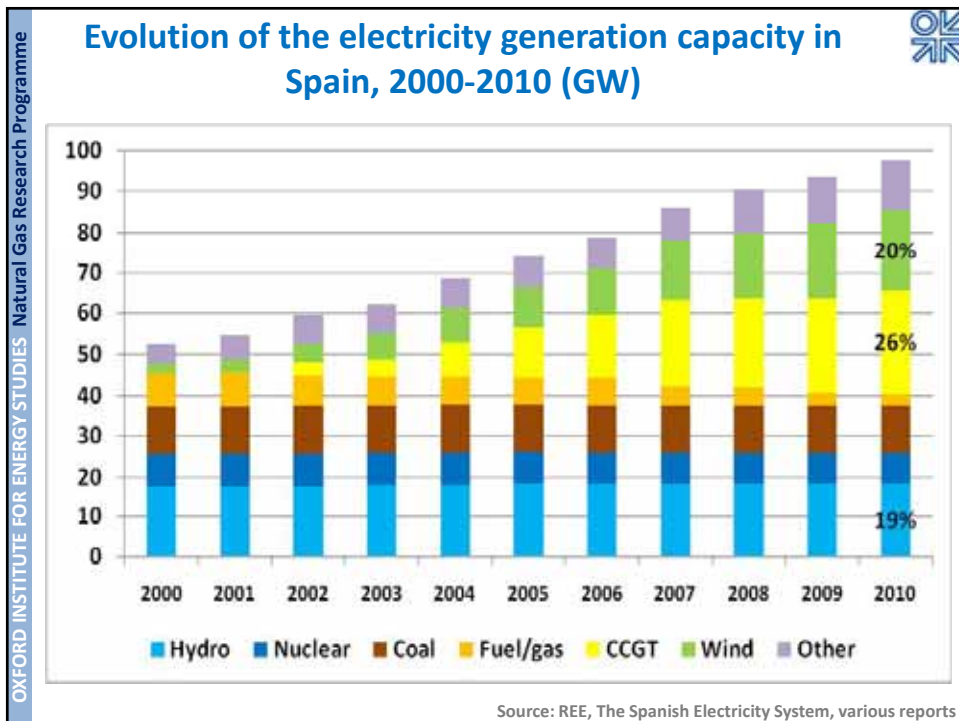
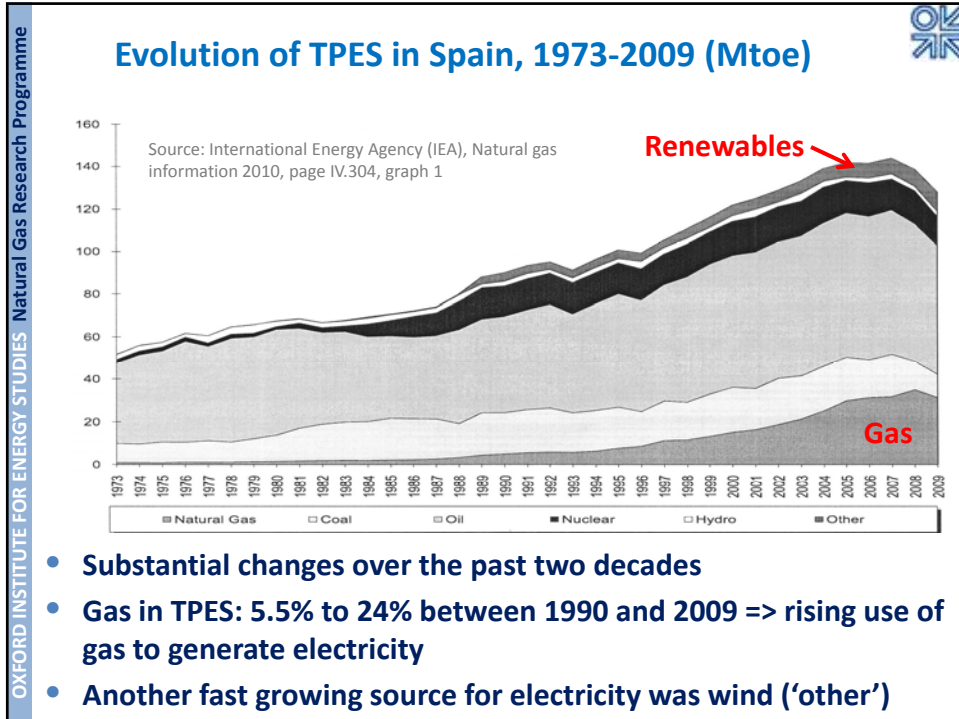


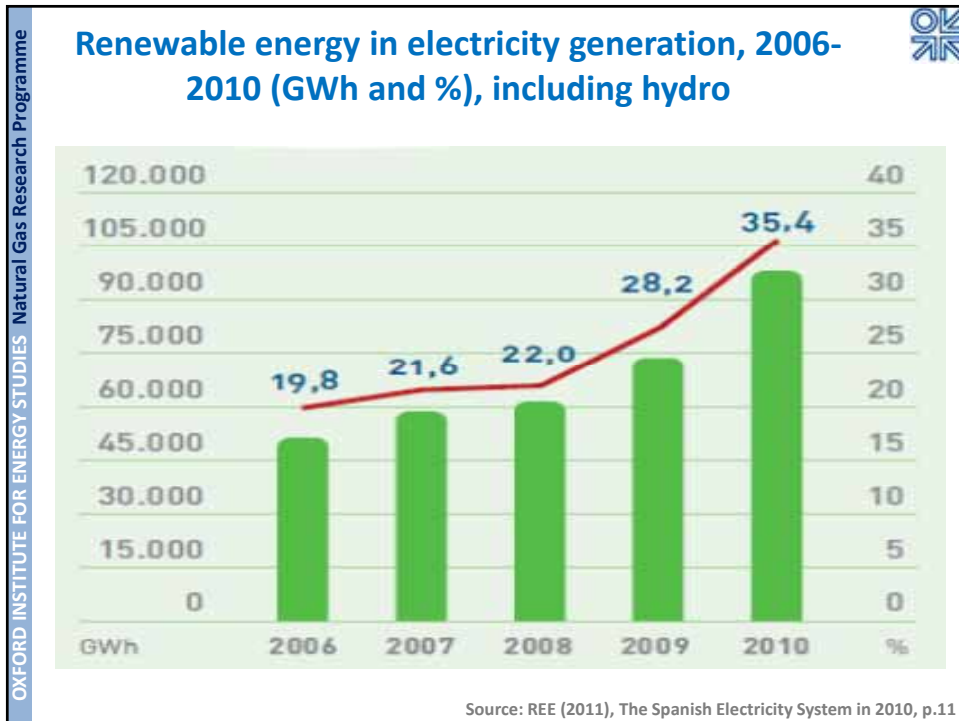
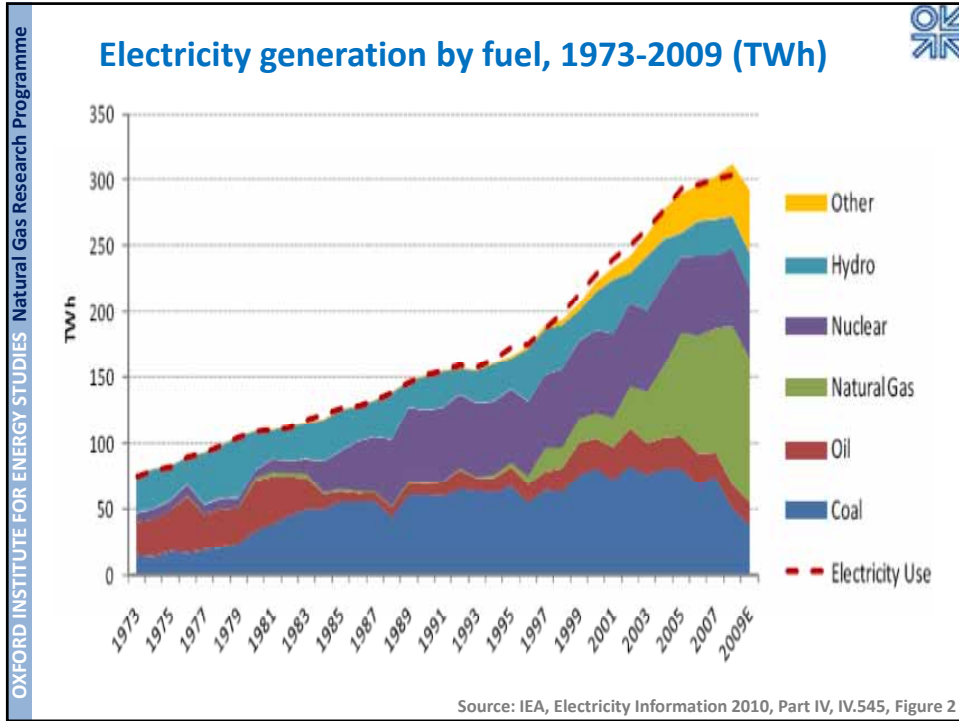
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Gas and renewables in Spain

Outline

- Intro: TPES
- The Spanish electricity market
- Focus on the development of renewables
- Back up of intermittency: impact on the natural gas market
- Conclusions
- Additional questions





Electricity generation in Spain

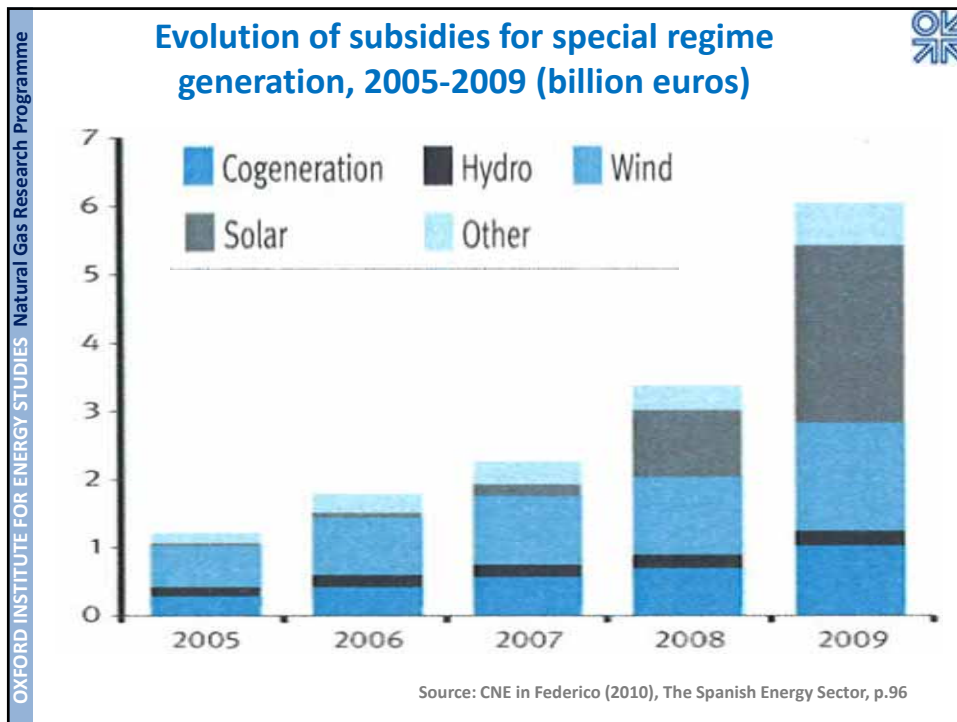


- Much remains to be done in the transition toward a low-carbon electricity generation, but Spain is well under way with increasing renewable capacity, especially wind power
- The share of electricity produced from renewable energy grew from below 20% in 2006 to more than 35% in 2010, while the total output doubled
- The Spanish wind power output reached 42,976 GWh in 2010
 - ❖ Spain took the first place in Europe for the first time, exceeding German output of 36,500 GWh
 - ❖ 2nd wind producer behind US (20 GW capacity)
- In March 2011, wind power was for the first time the technology that brought the most electricity to the system on average for a full month
- 6 November 2011: new record, 59% of electricity generation from wind

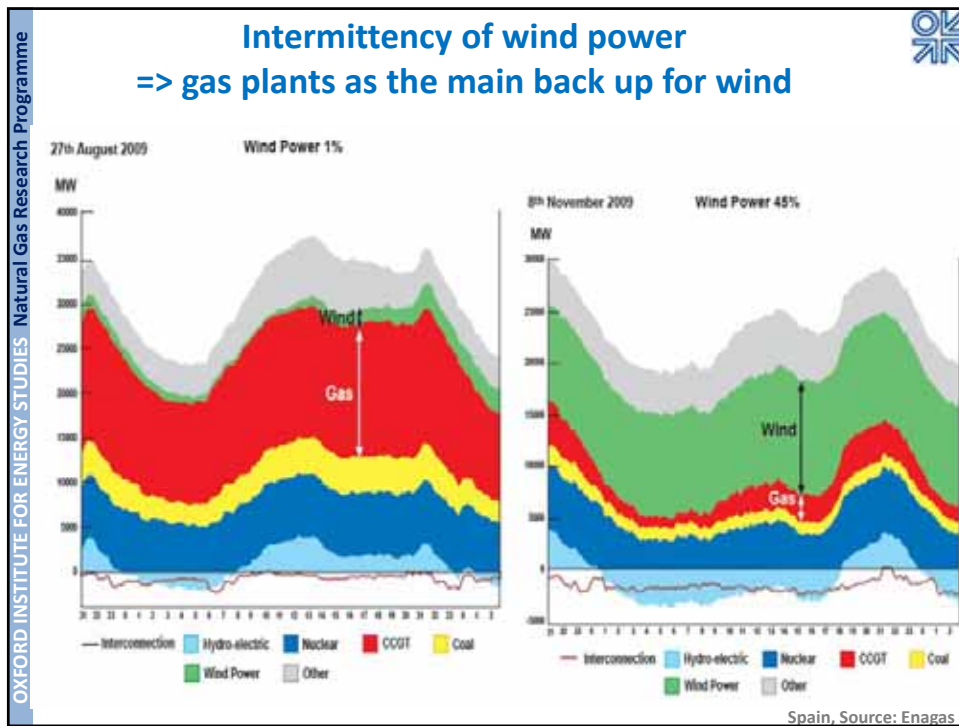
How did renewable energy develop so quickly?



- **Special regime: all generation is subsidised above the market price**
 - ❖ Established in 1994, before the opening of the electricity market to competition
 - ❖ Most renewable sources (with the exception of conventional hydro) and co-generation plants (primarily based on gas)
- **Rapid development of wind and more recently of solar power is a result of:**
 - ❖ this legislative framework + favourable market conditions (rising electricity prices, low interest rates and falling equipment costs)
- **The increase in renewable generation came at a cost:**
 - ❖ Subsidy paid to the special regime was over 6 billion euros in 2009 as a result of the growth of total special regime generation and the rising impact of solar PV
 - ❖ Government had expected 400MW of solar capacity in the country by 2010, but more than seven times that was installed



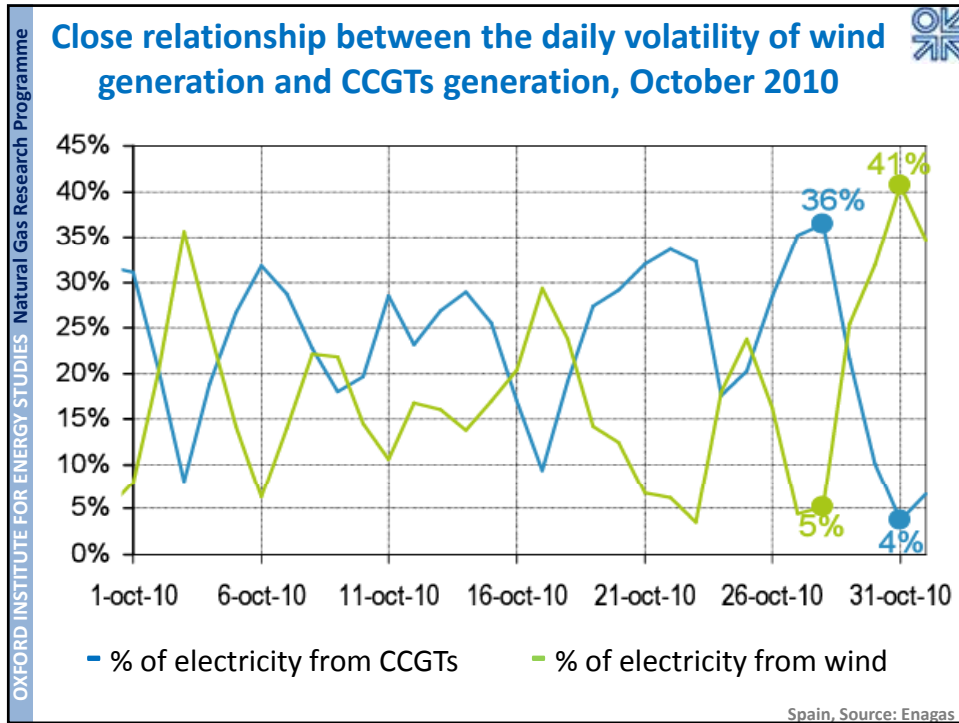
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- ### Development of renewable energy is costly
- **On a bill of 100 Euros:**
 - ❖ 22.5 Euros: renewable premiums
 - ❖ 24.8 Euros: cost of generation
 - ❖ 4.6 Euros: transport
 - ❖ 16.2 Euros: distribution
 - ❖ 18.7 Euros: taxes, 6.1 Euros: previous deficits, 3 Euros: extra-peninsular compensation and 4.1 Euros: other
 - **December 2010: Royal Decree Law 14/2010**
 - ❖ Reduction of solar subsidies by up to 30% + retroactively limiting the hours of production eligible to receive the FIT
 - ❖ Cuts to wind power subsidies by 35% up to 2012 (expected to save 1.1 billion Euros)
 - ❖ Wind support scheme: Royal Decree 661/2007, which expires at the end of 2012
 - **Elections in November 2011: PP elected...**



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Intermittency of renewable energy

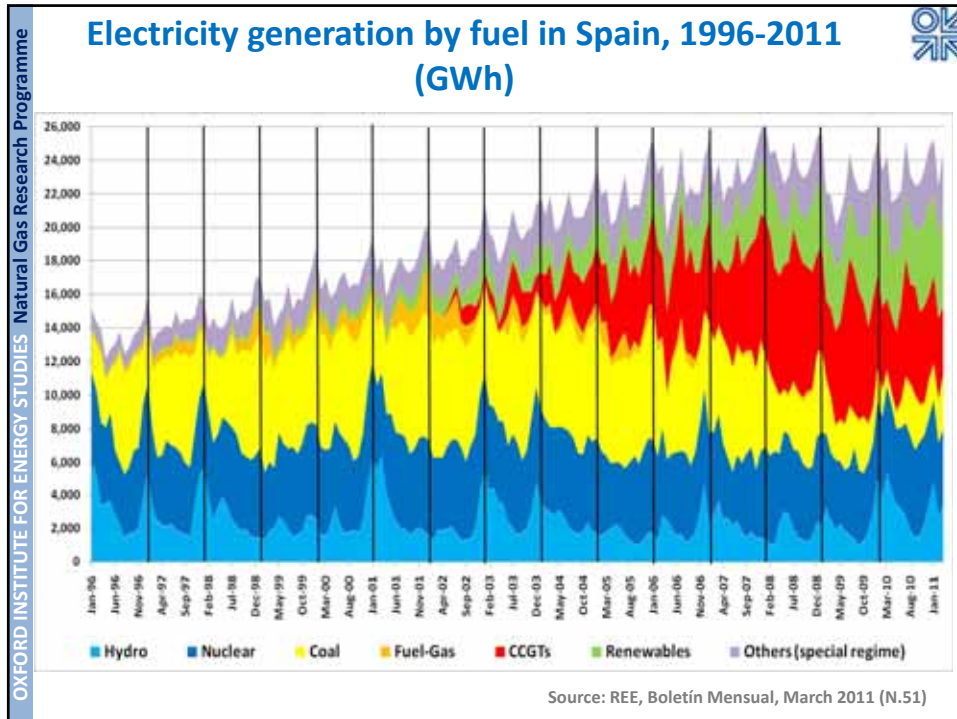
- **Spain has successfully developed wind and solar generation**
 - ❖ More importantly, it has achieved the integration of a large amount of intermittent power into a well-integrated electricity grid to balance the unavoidable variations in intermittent renewable generation, especially wind
 - ❖ With renewables increasing in the mix, conventional power stations that are backing up these plants, run fewer hours
 - ❖ The fewer hours they run, the more economic CCGTs become in comparison to other thermal sources because of lower up-front costs
- **CCGTs being the first choice thanks to low capex and flexibility, and are cleaner & more publicly acceptable than coal & nuclear**
 - ❖ In 2009, special regime generation accounted for 14% of the flexibility requirement, which is defined as the difference between generation in time of peak and low demand
 - ❖ On other hand, thermal and hydro generation provided the largest shares of the flexibility: CCGTs supplied 47%, hydro generation 19% and coal 17%



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CCGTs: important flexibility role, especially during the summer months

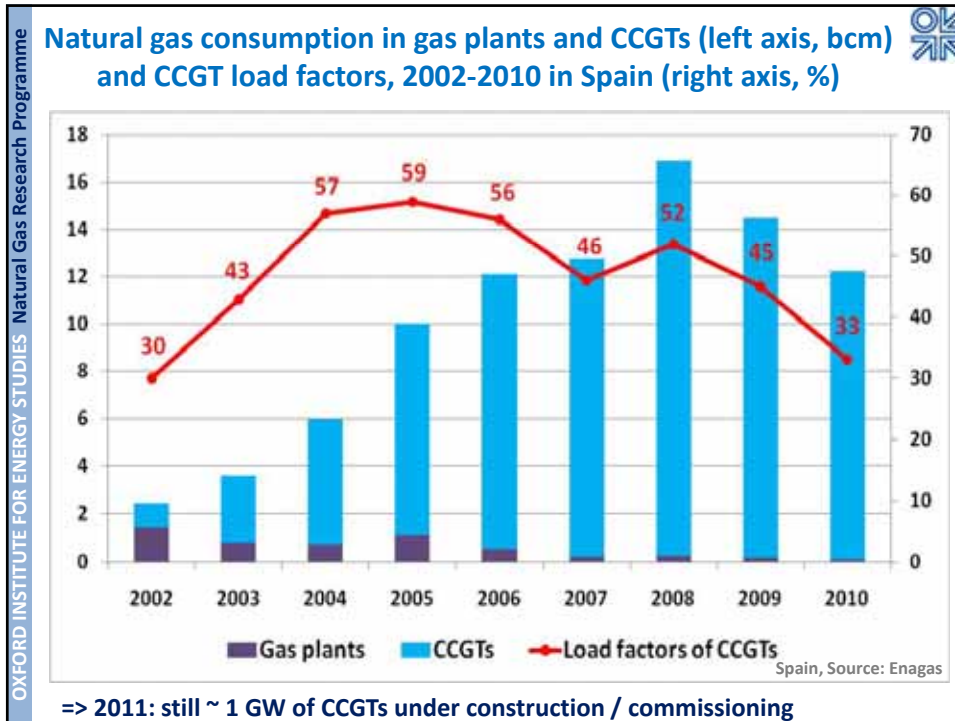
- **Power demand peaks when temperatures rise or drop to their extremes**
 - ❖ This usually happens in times of high pressure, and therefore, when there is little or no wind
 - ❖ As a result, it leads to increased use of air-conditioners or electric heaters
- **Peaks of electricity generation in the winter: production from a wide range of technologies**
 - ❖ January 11th 2010: max peak load demand was 44 GW (7-8 pm)
 - ❖ 36% of which came from CCGTs (19% hydro, 12% nuclear, 11% coal, 1% fuel/gas, 11% wind and 10% other)
- **Peaks in the summer: thermal technology, mostly CCGTs, as hydro and wind energy are less available during July-August**



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CCGTs: important flexibility role and balancing purposes in the day-ahead, secondary and tertiary reserve markets

- CCGTs are the main technology used to relieve technical constraints (often transmission related) in the day-ahead market
 - ❖ => it accounted for 88% of increases in production and 79% of reductions in production in 2010
- There is a 'technical restriction' market in which the CCGTs are chosen to overcome the problems related to the constraints
- In the real time ancillary services market (after the day ahead market and the technical restrictions market are 'closed')
 - ❖ CCGTs are the main technology used to provide tertiary reserve (up within 15 minutes and stay on for 2 hours) and to provide system balancing support
 - ❖ Whereas in the secondary reserve market (up in 15 seconds and stay up for 15 minutes), CCGTs are the second most important technology after hydro

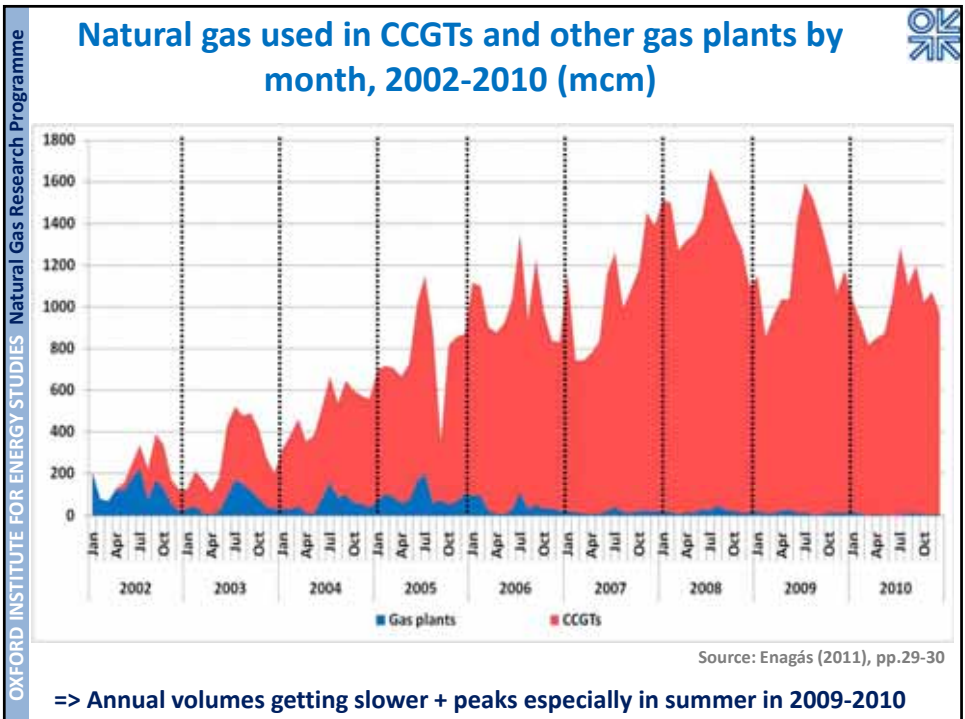
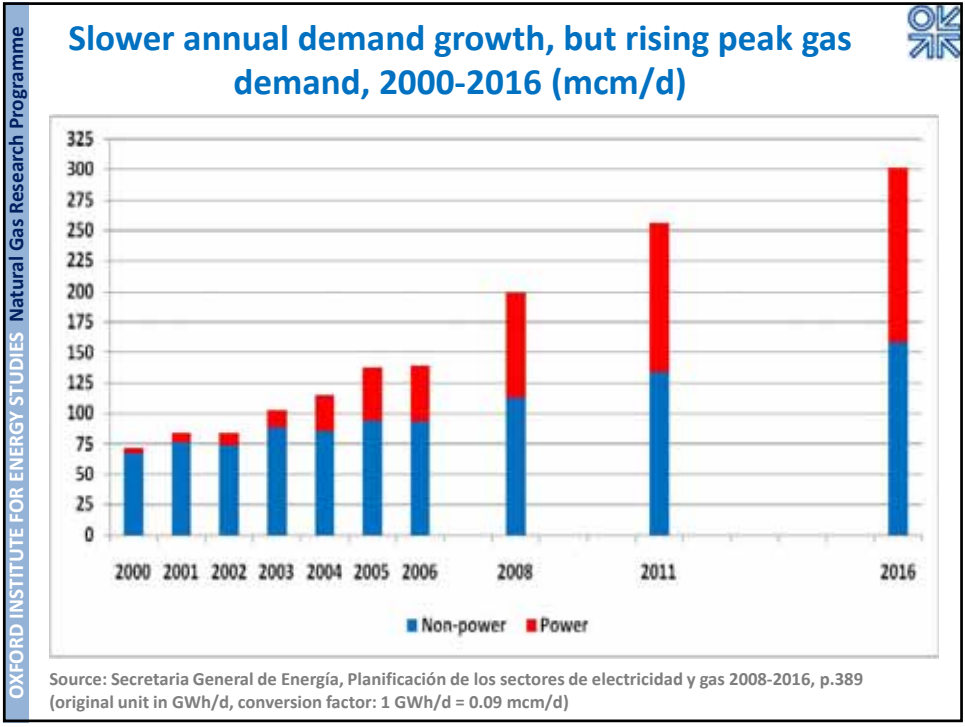


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Impact on the load factors and gas demand

- **CCGTs were expected to provide baseload power, and indeed the load factors were 50-60% for most of 2004-2008**
 - ❖ But CCGT running times have fallen from an average 3,618 hours of output between 2007 and 2009 (already lower than in the 2004-2006 period) to 2,563 hours in 2010 or 33% of capacity
 - ❖ In 2011, the average running time was between 20 and 25%
 - ❖ A CCGT running at 35% load factor consumes about half the amount of gas than a plant running at 75% load factor
- **2011-2020 renewable plan: intermittent energy will increase (wind/solar, not large hydro), even if slower than before**
 - ❖ CCGT back-up will be even more important for balancing the system
 - ❖ The place of gas in the mix is therefore be less and less a factor of economic competitiveness, and more and more a factor of renewable and hydro availability
 - ❖ Peaks are expected to keep on rising



Importance of supply flexibility



- **Increasing need for back-up technology to balance the electricity system**
 - ❖ => Gas demand is expected to continue to display large fluctuations in the future
 - ❖ => Low annual gas volumes for power but high volatility of gas demand
- **Peak demands for gas in the non power sector coincide with higher demand for electricity and therefore, potentially higher demand for gas in the power sector**
 - ❖ => As a result, the gas market needs to be able to supply simultaneous peak demands in both the non-power and the power sectors
- **High demand volatility means high supply flexibility**
 - ❖ The system needs to be able to cope with instantaneous requirements of additional gas
 - ❖ Rather isolated market with limited gas and electricity interconnections

Flexible supply: points of entry to the Spanish gas market



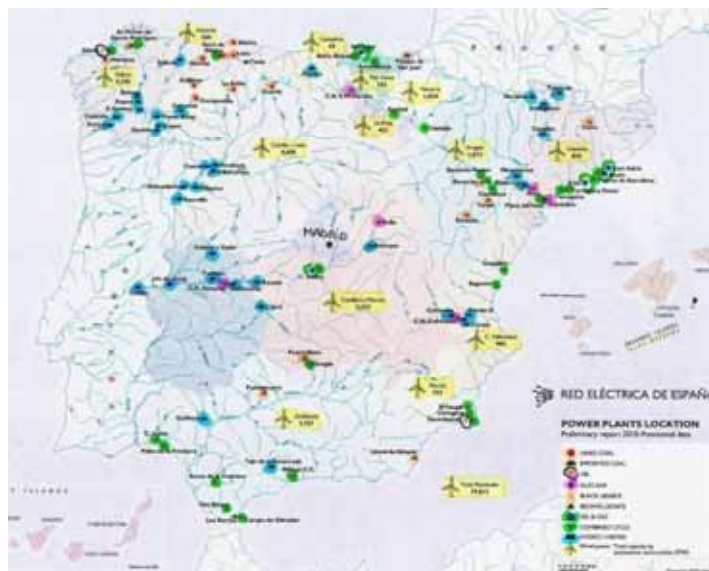
Source: Enagás website, September 2010

Spanish gas supply: a model of flexibility

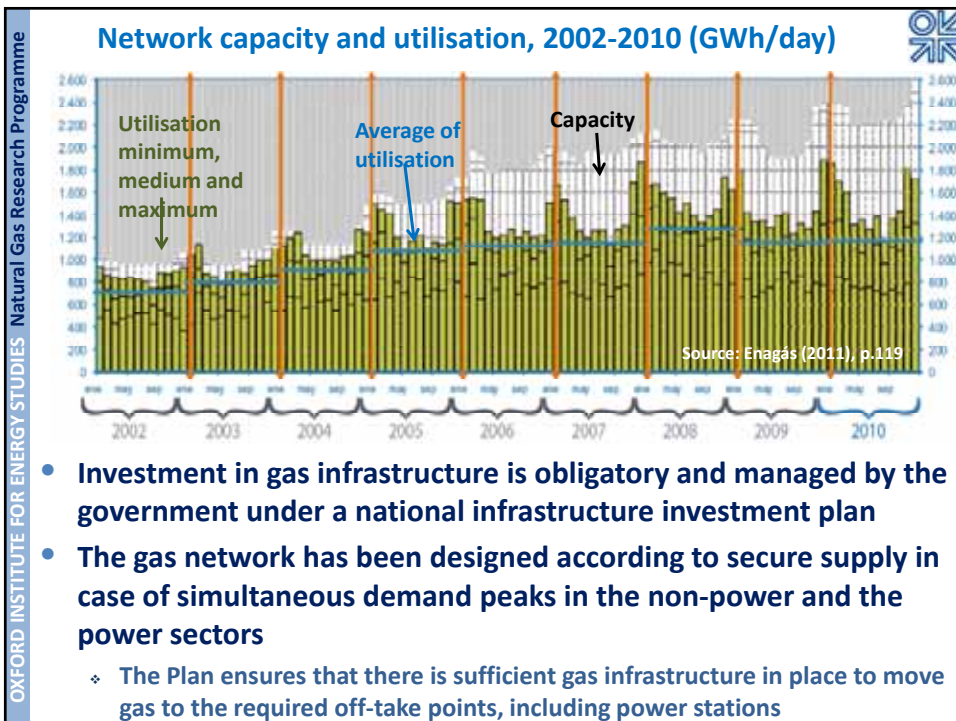
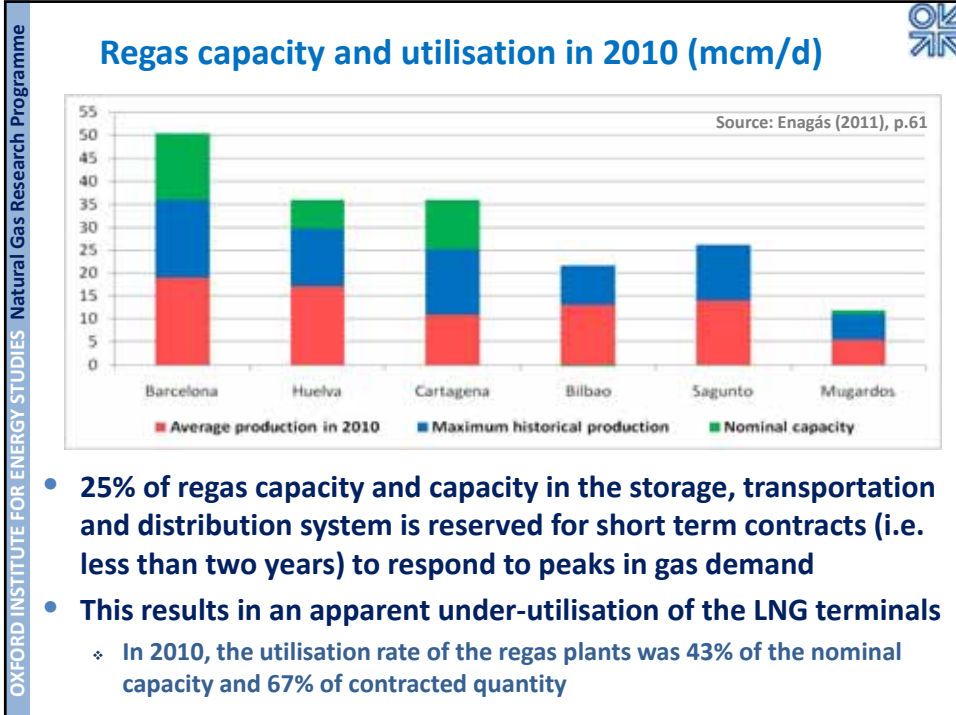


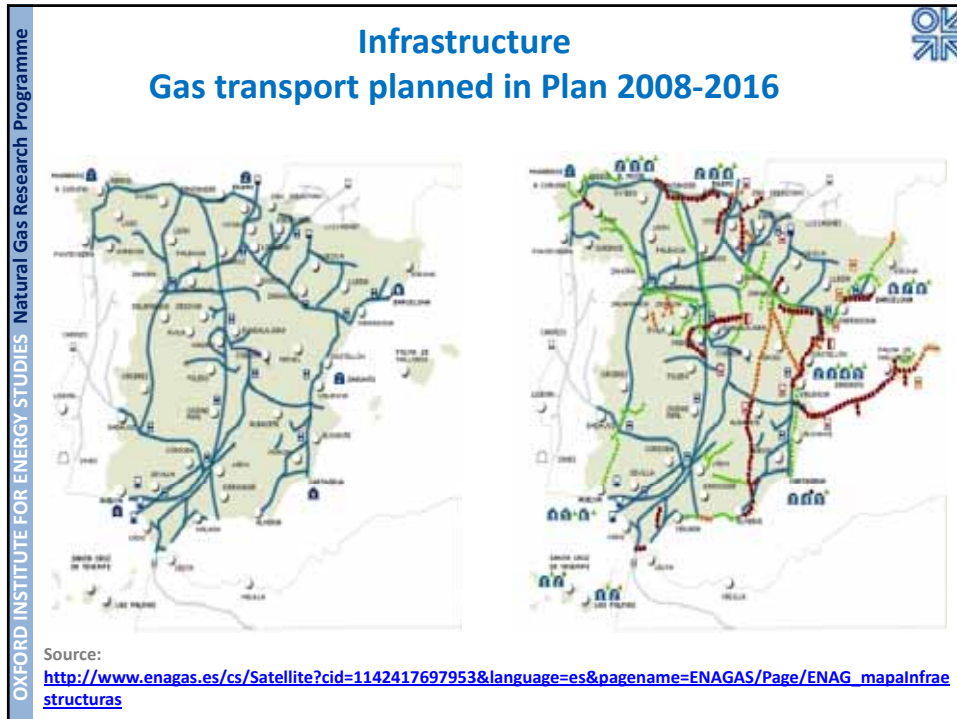
- Spain coped well in meeting gas (and electricity) needs thanks to successful development of its energy infrastructure despite exceptionally strong growth in the 1990s and 2000s and development of intermittent renewables in the 2000s
- The country also led the way in diversifying gas transportation routes and entry points, sources of gas and LNG development (76% of imports in 2010)
 - ❖ 86 bcm of import capacity for 36 bcm of gas demand
 - ❖ Additional projects already under construction
- => There is no lack of physical entry points for gas imports
- LNG is providing most of the flexibility in supply, mirroring the fluctuations of gas demand
 - ❖ Most of the CCGTs are located near LNG terminals => these CCGTs can be ramped up quickly to react to drops in wind power generation by regasifying stored LNG in the rapid-cycle LNG tanks

Map of the location of the power plants location in Spain (2010)



Source: Red Electrica, preliminary report 2010 and author's updates





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Conclusions

- **Gas generation is and will continue to be a key tool to balance the system...**
- **... but more and more uncertainty on baseload generation**
- **Political pressure to slow-down the growth of renewable capacity**
 - ❖ Financial burden of renewable energy on the system
 - ❖ Economic downturn and the existence of excess generation capacity
 - ❖ => Revision of subsidies for solar and to a lesser extent wind may be the first signs of such trends
- **Uncertainties on coal and nuclear capacity**
 - ❖ Environmental targets could reduce coal-fired capacity, but between 2011 and 2014, 23 TWh of electricity produced by plants using domestic coal will have to be included in the generation mix
 - ❖ Post-Fukushima: "40 years useful life" => phase out in 2028
- **=> Gas for power: less and less a factor of economic decision**

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Conclusions


- Spain has copped well in providing flexible supply
- Variable sendout from regasification plants provides most of the flexibility in supply, mirroring the fluctuations of gas demand
- In the future, Spain will not only have to cope with periods of peak demand and tight supply for gas, but also most probably with increasingly frequent periods of low gas demand (period of high renewable and hydro availability)
 - ❖ Problems when LT contracts (Spain: 50 bcm in 2010)
- During these periods, new forms of flexibility will be required to balance the system
 - ❖ The development of gas and electricity interconnections with France in 2013 and 2015 will add some flexibility + Portugal
 - ❖ Re-export LNG



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Additional questions

Wind in Denmark
Solar in Germany





Additional questions: Denmark

- How much power from wind is actually “consumed” in Denmark? (versus being exported)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Wind capacity (MW)	2,390	2,497	2,890	3,116	3,123	3,127	3,135	3,124	3,163	3,482	3,752
Electricity generated (TWh)	4.22	4.31	4.86	5.56	6.58	6.61	6.11	7.14	6.98	6.72	7.81
Wind power share in the electricity supply (%)	12.1	12.2	13.9	15.8	18.5	18.5	16.8	19.7	19.1	19.3	21.9

- ❖ It is basically not possible to quantify how much wind energy that ends being consumed in Denmark
- ❖ All power production is bid and sold at the Nord Pool power exchange (now called NASDAQ OMX Commodities Europe)
- ❖ => wind power production and other power production are pooled and matched with total consumption in the whole Nord Pool area (Sweden, Norway, Denmark, Finland) and potential excess supply is exported (ex. Germany)
- ❖ => it is not possible, in hours of net export to Denmark's neighbouring countries, to assess whether such export origins from wind production or other



Additional questions: Germany

- How much did Germany spend on solar FITs? And what did they get in exchange? Share in total consumption? Is there a \$/kWh number on this?

- ❖ 2010: Germany installed 7.4 GW of new solar power capacity (nearly half of the world's total of 16.6 GW installed)
- ❖ 2011: 5.2GW expected despite cuts in solar power incentives

- ❖ 2010: renewable electricity penetration: 17% incl hydro (> 30% on Feb. 2010)
- ❖ Solar PV: 2%
- ❖ 1H2011: renewable: 20.8% (source: BDEW)

	TWh	%
Nuclear	133	22
Natural gas	84	14
Brown coal	145	24
Hard coal	115	19
Other	30	5
Wind	37.5	6.2
Biomass	33.5	5.6
Hydro	19.5	3.2
Solar PV	12	2
Total	603	

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Economic indicators for the development of renewable energy sources in Germany

- ❖ Renewable Energy Sources Act (EEG), introduced 11 years ago, guarantees each provider a fixed price for the electricity it feeds into the grid (FIT) paid for by consumers
- ❖ Total subsidies for renewables in 2010 : 26.6 bln (x2.5 in 5 years)

	2005	2006	2007	2008	2009	2010 ⁴	Difference 2010/2005	
							In percent	
	In billion euros (current prices)						Total	Annual
Investment in Germany	10.3	11.1	11.6	16.8	20.2	26.6	158	21
Sales of complete facilities ¹	7.9	10.6	11.8	15.5	16.8	19.7	149	20
Export of components ²	0.7	0.7	3.4	4.1	4.6	5.6	67	52
Demand for operation and maintenance ³	2.5	2.6	3.9	4.3	4.7	5.2	110	16
Demand for biomass and biofuels ³	2.6	3.6	5.6	6.1	5.6	4.9	94	14
Total demand impulse from RES	13.7	17.6	24.8	30.1	31.7	35.5	160	21
	In 1,000 persons							
Employment	194	236	277	322	340	367	89	14

1 From manufacturers based in Germany, including the export of complete facilities.
 2 Change in calculation basis in 2007, thus change shown for period 2007 to 2010.
 3 Increase in demand in Germany.
 4 Preliminary figures.

Sources: DIW Berlin; DLR; GSW; ZSW

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Solar: investments and sales

- ❖ $\frac{3}{4}$ of investments in renewable (19.5 bln)
- ❖ 48% of sales (9.5 bln)
- ❖ Up to end of 2010, electricity consumers paid €81.5 billion for the expansion of photovoltaic technology alone (source: RWI)
- ❖ Cuts in 2010 to 28.74 cents per kWh
- ❖ Cut again by -15% on January 2012

2010, in percent

Investment in renewable energy sources

Sales of installation manufacturers (including export of systems and components)

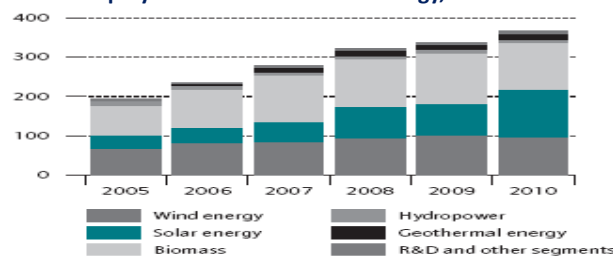
Source: O'Sullivan, M., Edler, D., van Mark, K., Nieder, T., Lehr, U, March 2011

Additional questions: Germany



- How many local jobs did they create with all of this support? And how are these jobs faring now that Chinese companies among others are grabbing market share?
 - ❖ Jobs in renewable energy industry: 367 400 persons in 2010
 - ❖ 33% in production of solar, 33% biomass, 26% wind

Gross employment from renewable energy, in thousands



Sources: DIW Berlin; DLR; GSW; ZSW

Share of global PV sales



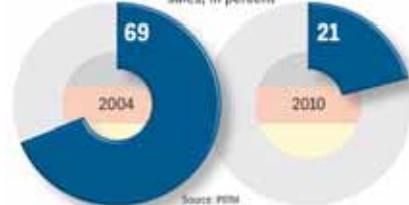
Sunrise ...

China's share of global photovoltaic sales, in percent



... and Sunset

Germany's share of global photovoltaic sales, in percent



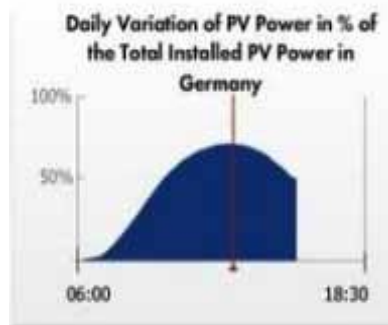
Source: Spiegel, 9/07/11

- ❖ Many German manufacturers can hardly keep up, now that Chinese suppliers are flooding the world market with solar panels
- ❖ Only about six months ago, it cost about €28,000 to cover a 100-square meter (1,076-square-foot) roof with brand-name solar modules, says Asbeck. Today the price is down to about €22,000 (source: Spiegel, 9/07/11)

Additional questions: Germany



- Impact of renewables on system reliability? Use of other fuels (especially natural gas)?
 - ❖ Solar power production varies with the weather and the time of day



Reliability of the system / back up generation



- ❖ Impact on other fuels ("back up"): 2/3 from coal, 1/3 from natural gas and hydro, on certain days, renewables force lignite production down, but not my much
- ❖ System reliability:
 - Export/import to balance the market
 - 2011: exports still more important than imports, although lower than in 2010 due to nuclear close down
 - Export of surplus to neighboring markets (ex. Switzerland)
 - Bottlenecks, need additional lines (solar production in the South, wind production in the North)
 - Project: production of methane from surplus renewable electricity => way to store green power
 - Project in Lower Saxony, 6.3 MW, 3,900cm/d
 - Impact power spot prices because renewable energy has priority grid access and near-zero marginal cost => investment in back up capacity as renewable capacity grows?

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Thank you !

“The Spanish gas market: demand trends post recession and consequences for the industry”, OIES website


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Back up slides

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Evolution of the load factors of the power plants by fuel in Spain, 2003-2010 (%)

	Load factors								Capacity	Generation
	2003	2004	2005	2006	2007	2008	2009	2010	2010	2010
Hydro	26.6	20.4	13.1	17.4	18.1	14.7	16.4	25.1	17.7	13.8
Nuclear	89.7	92.2	83.4	89.0	81.5	87.2	78.1	91.0	7.9	22.1
Coal	71.3	75.4	77.3	66.0	72.2	46.5	34.0	22.2	11.5	7.9
Fuel/gas	13.2	12.7	17.2	10.1	5.7	6.1	7.9	7.3	2.9	0.7
CCGTs	38.9	39.9	45.6	46.8	37.1	48.1	38.7	29.2	25.5	23.1
SR hydro	37.6	32.4	23.7	25.1	23.7	25.5	31.7	39.1	2.0	2.4
SR wind	25.1	21.3	23.7	23.2	22.1	22.6	22.3	24.7	20.3	15.5
SR other REN	54.6	50.1	48.7	42.4	36.9	20.2	29.1	25.7	5.2	4.2
SR other non-REN	36.1	39.0	38.4	33.0	34.2	37.3	46.3	47.4	7.1	10.4

Source: Load factors calculated from REE, The Spanish Electricity System (various issues)