Capacity markets, energy-only markets and security of supply (Using a stochastic investment model)

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In words

- Investments need to be made in an uncertain world
  - exogenous uncertainties (generated out of the EU)
    - fuel price (see preceding presentation)
  - endogenous uncertainties (generated inside the EU)
    - market architecture (see preceding presentation)
    - EU-ETS
      total amount of allowances (we see the trend but still ongoing discussions)
      mode of allocation

- A position: ”nothing to worry about, the industry is used to deal with uncertainties”

- A comment: true but there may be a price to pay for compensating uncertainties
  (and hence a cost that adds to other costs)

Little structured analysis ?

- Sector Inquiry: the remedy (if there is a problem) making the PX competitive will provide the necessary investment incentive

- Directive: write reports on measures for security of supply

- The whole work on capacity markets in the US mentioned neither by ETSO nor by ERGEC

The objective of this analysis (1)

- Construct and use
  - a **very stylized** investment model
  - an equilibrium, not an optimization model (we are in a market economy), that reflects some basis features of price formation in competitive markets (Joskow 2007)

The objective of this analysis (2)

- to capture the impact of
  - market architecture
    capacity market vs energy only
  - uncertainty
    range of uncertainty
    removing uncertainty (by deciding)
  - risk aversion
    a very fine (useful?) lesson of the subprime crisis: assimilating P (the statistical probability) and Q (the risk neutral probability) may be dangerous for the economy. Worse: sometimes there is no Q.

An immensely simple computational set up (1) (that can be made **realistic** while remaining **computable**)

- A two stage problem Decide investment today (2007–2008) that will come on stream after 2012 (on which we know nothing)

- A three technology world

	Coal	CCGT	0GGT
annual capacity and fixed operating cost (k €/Mw)	160	80	60
emission t/Mwh	1	.35	.6

An immensely simple computational set up (2) (that can be made **realistic** while remaining **computable**)

- A fixed (prize insensitive) load duration curve
  - as in Joskow 2007
  - that can be expanded to price sensitive load duration curve at little modelling and computational cost
  - (but there is a lack of economically estimated demand models (not a good subject for Ph.D.!!!))

- Decomposed in 5 time segments (inspired by preceding presentation

MW	86000	83000	80000	60000	40000	20000
duration (1000 hours)	.01	.04	0.31	4.4	3	1

An immensely simple computational set up (3) (that can be made **realistic** while remaining **computable**)

Exogenous uncertainties (non EU made)

Plant operating cost: 2 scenarios (in k€/k hours)

	scenario f1	scenario f2
coal	30	30
CCGT	45	68
OCGT	80	120
Prob.	.5	.5

An immensely simple computational set up (4) (that can be made **realistic** while remaining **computable**)

Endogenous uncertainties (EU made)
The NAPs are unknown at the time of investment (and the Commission did not want to consider any reasoning that involved post 2012 period)

	scenario n1	scenario n2
in million ton	200 000	240 000
Prob	.5	.5

The power system is assumed to operate in a bubble in order to simplify the set up (recall: price of CO2 determined by cost of abatement in power sector) Can be easily extended computationally to demand functions of allowances by the other sectors; but models of other EU-ETS sectors are like demand models: missing!!!

An immensely simple computational set up (5) (that can be made **realistic** while remaining **computable**)

We consider two price cap scenarios of

- 1000 Euro/MWh

- 250 Euro/MWh

A key European debate

- allowances will be allocated/auctionned and we do not know how (even though the trend is clear)

- free allocations have a character (a very imperfect one) of capacity payment

Embed three possible allocation modes (benchmarking to BAT with expected number of running hours, by capacity, full auctioning)

by running hours	scenario b1	scenario b2	scenario b3
coal	6	2.1	0
CCGT	2.1	2.1	0
OCGT	1.2	2.1	0
Prob	0.1	0.3	0.6

An inexisting European debate

- Should one have a capacity market? (We might have to take example in Russia, if not in the US

- Or will an energy only market suffice?

The principle of the model (1)

Basic investment economics

- One invests if gross margin covers the investment cost. One does not invest otherwise.
- Gross margin is revenue minus cost
- Revenues come from selling
  - electricity in the different time segment
    at fuel cost of last operating plant
    or at price of curtailment (regulated)
  - freely granted allowances
  - capacity in a capacity market (if there is one)

- Cost comes form purchasing fuel and needed allowances

The principle of the model (2)

Less basic: in order to account for uncertainty one can

- suppose a risk neutral world and take expectation (that changes little to the math but it looks like a pre subprime crisis approach)

- suppose risk aversion and invoke the financial literature of risk criteria

The risk criterion: the CVaR (Conditional Value at Risk)

- Consider the distribution of revenues
- Look at the lower tail of the distribution
- Consider a VaR: a value of revenue that is exceeded in 1-α% of the cases
- Take the conditional expectation of the revenues lower than the VaR
- And impose that the expected, lower revenue is greater than some minimal target (or that the expected shortfall with respect to the VAR is smaller than some target)

This criterion has an interpretation of Capital at Risk and is directly related to the VaR. It also has an interpretation of risk neutral probability ($P \neq Q$) and hence of risk premium. It assumes that investors are risk avers even if this is not properly reflected in their cost of capital.

Discussion

- We discard questions of market power
  - investment models that account for market power are still more unreliable (sensitive to unverifiable assumptions) than models operating with fixed capacity

- and concentrate on security of supply modelled as (simple criterion of) reliability of system (see Joskow 2007)

Note: Reliability is not an input of the model as in former optimization model) but an output of an equilibrium model.
The whole set-up is a complementarity problem

Results: Investment and security of supply (I)

Price cap: 1000 Euro/MWh

	Coal	CCGT	OCGT	Total	Capacity	Hours
CM/RN	15527	64472	6000	86000	0	0
CM/RA	15527	64472	6000	86000	0	0
EO/RN	15530	64470	3000	83000	3000	10
EO/RA	15546	64454	0	80000	6000	50

Results: Investment and security of supply (II)

Price cap: 250 Euro/MWh

	Coal	CCGT	OCGT	Total	Capacity	Hours
CM/RN	15527	64472	6000	86000	0	0
CM/RA	15214	44942	25844	86000	0	0
EO/RN	15546	64454	0	80000	6000	50
EO/RA	15232	44906	19862	80000	6000	50

Conclusion

Is there really nothing to worry about: Can one just pile up uncertainties because "the industry is used to deal with risk".

Yes the industry is used to deal with risk but this does not mean that there is nothing to worry about.

The industry can act rationally to preserve the value of its assets, and refrain from investing into what could lead to bankrupcy (CVaR $P \neq Q$) (think of the impact on new entrants).

This may reduce investments in an energy only market, more so when energy prices are capped, when demand is peaky or when fuel price uncertainty is rising.