Renewable energies and Power Prices
- Incentives to Invest under Different Support Schemes

Brussels, 02 April 2008

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Overview

- Political Framework

- Power Market

- Green Certificate Markets (RECs / GoO etc...)
Political Framework for Wind Energy

- EU Climate & Energy Package (23 January 2008)
  - 20 % renewables in 2020
    - Transportation
    - Heat
    - Power
- “Pilot Study Renewable Energies 2007” (Federal Ministry for the Environment, Germany)
  - Almost 80 % of power production from renewables in 2050
  - About 50 % of installed capacity = wind

How can we meet such targets in liberalised markets?
- Support schemes (for transitional period)
- Competitiveness in liberalised markets
Investment decision vs. operation decisions

- **Investment decision**
  - Invest if total average costs (TAC) smaller average revenue (=price)
  - As TAC for renewable greater “price”; little incentive for investments
    - Public support schemes in place

- **Operation decision (existing plant)**
  - Offer at marginal costs
  - Supply if marginal costs are smaller / equal price
Different types of “costs” available in economic theory with different relevance for investments

Total average cost = \( \text{Cost / quantity} \)

Marginal cost = additional cost for producing an additional unit

<table>
<thead>
<tr>
<th>Product</th>
<th>Capital cost</th>
<th>O &amp; M (fix)</th>
<th>O &amp; M (var)</th>
<th>Fuel</th>
<th>CO2 cost</th>
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<tbody>
<tr>
<td>Hard coal PP</td>
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<td>Natural gas CCGT</td>
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Price Formation in Competitive Markets (1/3)

Demand = \frac{\text{Supply}}{\text{Price}}

based on marginal costs of production

Energy (MWh)

Costs / Price (Euro / MWh)

nuclear  lignite  Coal  Gas  Oil

renewable energies

Equilibrium

$p^*$

Supply =

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Price Formation in Competitive Markets (2/3)

- Supply (reference)
- Demand
- Supply (additional RE)
- Wholesale price decreases
- Equilibrium

Energy (MWh)

Costs / Price (Euro / MWh)

$p^*$

$p_{RE}^*$

nuclear
lignite
Coal
Gas
Oil

additional renewable energies
Price Formation in Competitive Markets (3/3)

Wholesale price decreases

Energy (MWh)

Costs / Price (Euro / MWh)

Supply (reference)

Demand

Supply (RE)

additional renewable energies

Equilibrium
RE and its impact on power prices (and vice versa)

- With increase in capacity of RE installations (with small marginal costs), the power price decreases:
  - Average annual power price
  - Hourly power price (especially with strong wind)

- Consequently, the average revenue of wind farms also decreases (always) if they produce.
  - Example: strong wind, weak demand $\rightarrow$ power price zero $\rightarrow$ no revenue

- The characteristics of costs and fluctuating supply results in an inherent revenue problem for RE installation (the stronger, the higher the market penetration is)
  - Incentive to invest in additional installations decreases with increasing market penetration in liberalise markets
Support schemes necessary - but which is suitable?

Support schemes discussed by means of income stream types

<table>
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<tr>
<th>Remuneration for:</th>
<th>Power</th>
<th>Greenness of power</th>
<th>Power</th>
<th>Greenness of power</th>
<th>Power</th>
<th>Greenness of power</th>
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<tbody>
<tr>
<td>Scheme type</td>
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<td>fixed</td>
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<tr>
<td>Quota + certificate trade</td>
<td>investment grant</td>
<td>Quota with fixed price for certificate</td>
<td>Feed-in tariff</td>
<td>Tender</td>
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</table>
RE quota and green certificates (RECs, GoO)?

- Power and certificates are joint products
  - Constant relation (1 certificate for 1 MWh electricity fed-in)
- Power is dominant
  - A certificate can only be generated if power is fed-in
- Therefore, rational supply offers at marginal costs on the power market
- If successful s/he gets a green certificate at zero costs “on top”
- All certificate generators supply at zero (marginal) costs
- “Random” price formation on certificate market (next slide)
- Uncertain revenue from sale of certificates
RE quota and green certificates (RECs, GoO)?

Renewable Energy Certificate Market

Willingness-to-pay depends inter alia on buyers expectations on total supply

*) With constant total demand (quota for example 20 % of total demand)
Conclusion

- Market share of RE is to be increased (considerably)
- With increasing market penetration RE installations face reduced power prices at the time of production / sale
- Revenue risk $\rightarrow$ risk premium $\rightarrow$ higher capital costs

- Support schemes necessary even in 2050 if high penetration wanted
- RE quota / green certificates face similar (inherent) problem $\rightarrow$ incentives to invest under this instrument unclear

- Support schemes with fixed remuneration (feed-in tariffs or tender) possibly more suitable to assure higher market penetration
Discussion

More Questions?
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