EVALUATION OF COSTS ENSUING FROM THE KYOTO PROTOCOL TO ITALY'S ELECTRICITY SECTOR

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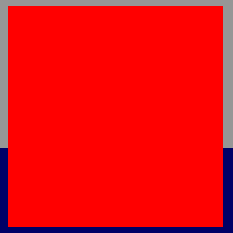

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CESI

Summary

- The EU Emissions Trading System (ETS) and the Italian National Allocation Plan (NAP)
- Simulation of the impact of EU ETS on the Italian electricity sector
- Evaluation of the increment of the system variable costs
- Valorization of the “opportunity costs”
- Conclusions

EU Emissions Trading System (ETS) – *Cap and Trade*

- A "**cap**" is set on the total CO_2 emissions
- An amount of **emission allowances** equal to the "cap" is allocated for free to the plants of the regulated sectors, according to the National Allocation Plan (**NAP**)
- If a plant emits **more** than the allocated allowances the owner must **buy additional allowances** on the market
- If a plant emits **less** than the allocated allowances, the owner can **sell the "saved" allowances** on the market

Italian National Allocation Plan (NAP)

- Total annual average quantity of allowances allocated for 2005÷2007 is **222.2 $MtCO_2$**
- Emissions were **221.54 $MtCO_2$** in 2000 and **210.2 $MtCO_2$** (estimated) in 1990

	2005 [$MtCO_2$]	2006 [$MtCO_2$]	2007 [$MtCO_2$]
Total allocated allowances	221.79	224.87	219.81

Italian NAP – Electricity Sector

- Total annual average quantity of allowances allocated to the **thermoelectric sector** for 2005÷2007 is **131.1 M**[illegible]**t** 59% of all the regulated ETS sectors)

- Emissions were **132.94 $MtCO_2$** in 2000 and **117.7 $MtCO_2$** (estimated) in 1990

0.5 $MtCO_2/MWh$

0.44 $MtCO_2/MWh$

-26%

0.37 $MtCO_2/MWh$

	2005 [$MtCO_2$]	2006 [$MtCO_2$]	2007 [$MtCO_2$]
Total allocated allowances (thermoelectric sector, both CHP and non-CHP)	131.08	133.81	128.41

Italian NAP – Electricity Sector

- **The "thermoelectric sector" includes plants (both CHP and non-CHP) with a combustion power greater than 20 MW (thermal), that deliver to the network at least 51% of the electric energy produced**

- **Allowances allocation to CHP plants** (at least 15% ratio between thermal energy and total energy produced) **is performed on the basis of their average "historical" emissions in 2000÷2003**

- **Allowances allocation to non-CHP plants is performed on the basis of their estimated working hours in 2005÷2007**

- **"Historical" data for non-CHP plants are not meaningful, due to the big changes the Italian generation set is undergoing (dismission of several oil fired units, construction of several CCGT units)**

Allowances allocation to non-CHP plants

- Allocation to each non-CHP plant is carried out according to the following formula:

$$Q_A = P \times h \times \alpha / 1000$$

Q_A is the quantity of allowances [tCO_2]

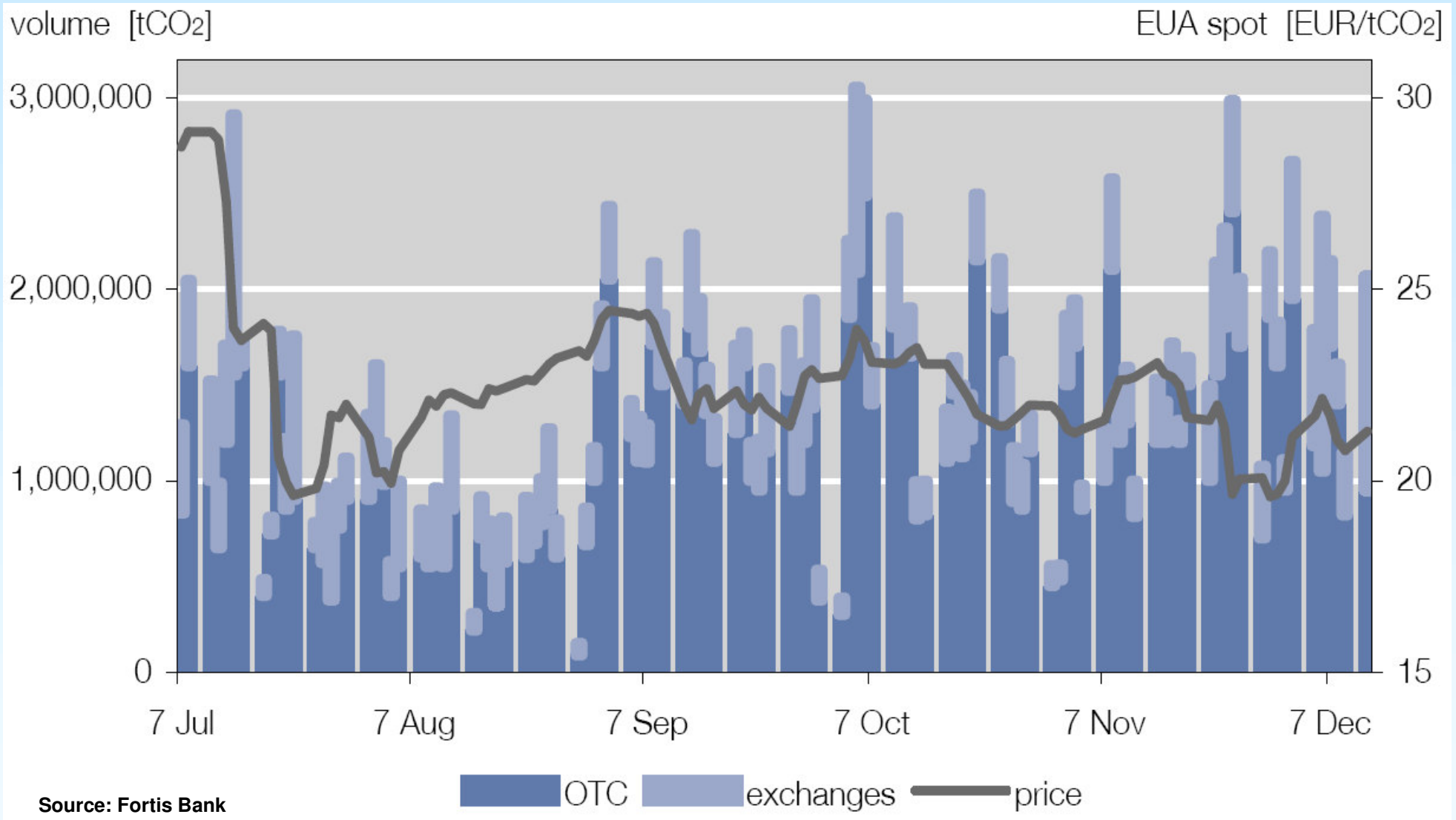
P is the electric power of the plant [MW]

h are the conventional yearly working hours

α is the emission coefficient [$kgCO_2/MWh$]

Plant type	α [$kgCO_2/MWh$]	h (2005)	h (2006)	h (2007)
Coal fired	913	6900	6900	6900
Oil fired	726	1800	900	900
CCGT	396	6600	5900	5500
OCGT	579	50	50	50

EU Allowances (EUA) trades



Source: Fortis Bank

Impact of EU ETS on the electricity sector

- The cost of the CO_2 (price of the EUA) affects the different power plants according to their emission coefficients that, in turn, depend on the "carbon intensity" of the fuel and on the plant efficiency

Fuel	Lower Calorific Power		CO_2 from combustion		[tCO_2/Gcal]
Coal	6,3	[Gcal/t]	2,482	[tCO_2/t]	0,39
Gas	8,25	[Gcal/10^3Sm^3]	1,928	[$tCO_2/10^3Sm^3$]	0,23
Oil	9,8	[Gcal/t]	3,078	[tCO_2/t]	0,31

Impact of EU ETS on the electricity sector

- To assess the impact of EU ETS it is therefore necessary to "internalize" the cost of CO_2 (EUA price) into fuel costs

	Base Fuel Cost (beginning 2005)		Extra Fuel Cost [€/Gcal] with an EUA price of:			
			10 [€/tCO$_2$]	20 [€/tCO$_2$]	30 [€/tCO$_2$]	40 [€/tCO$_2$]
Coal	54 [€/t]	8,64 [€/Gcal]	3,94	7,88	11,82	15,76
Gas	213 [€/10^{3}Sm^3]	25,81 [€/Gcal]	2,34	4,67	7,01	9,35
Oil	198 [€/t]	20,62 [€/Gcal]	3,21	6,41	9,62	12,83

Impact of EU ETS on the electricity sector

- Starting from the fuel costs with "internalized" CO_2 costs, the impact of EU ETS on the electricity sector can be evaluated, under various assumptions, using an **electricity market simulator**

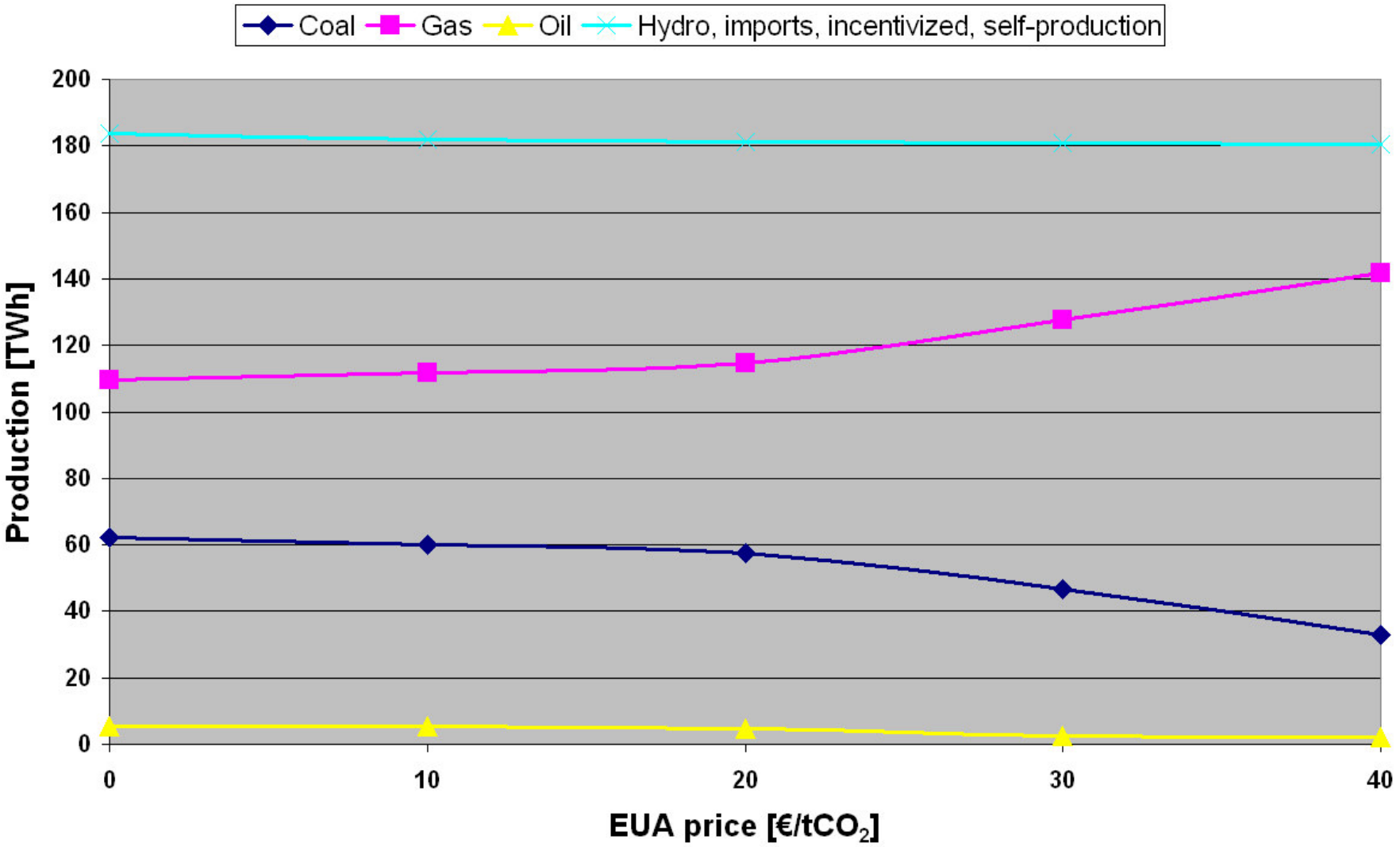
- We used **PROMED**, developed by **CESI**, that simulates the Italian electricity market on a **yearly time horizon** with an **hourly detail** and calculates energy prices and productions on the basis of different scenario parameters:
  - fuel costs
  - zonal demand
  - hydro resources available during the year
  - hydro and thermal plants characteristics (fuel mix, consumption curves, minimum and maximum power, start-up / shut-down flexibility, etc.)
  - market zonal topology
  - market players bidding strategy on the power exchange
  - electric energy imports
  - etc.

Evaluation criteria

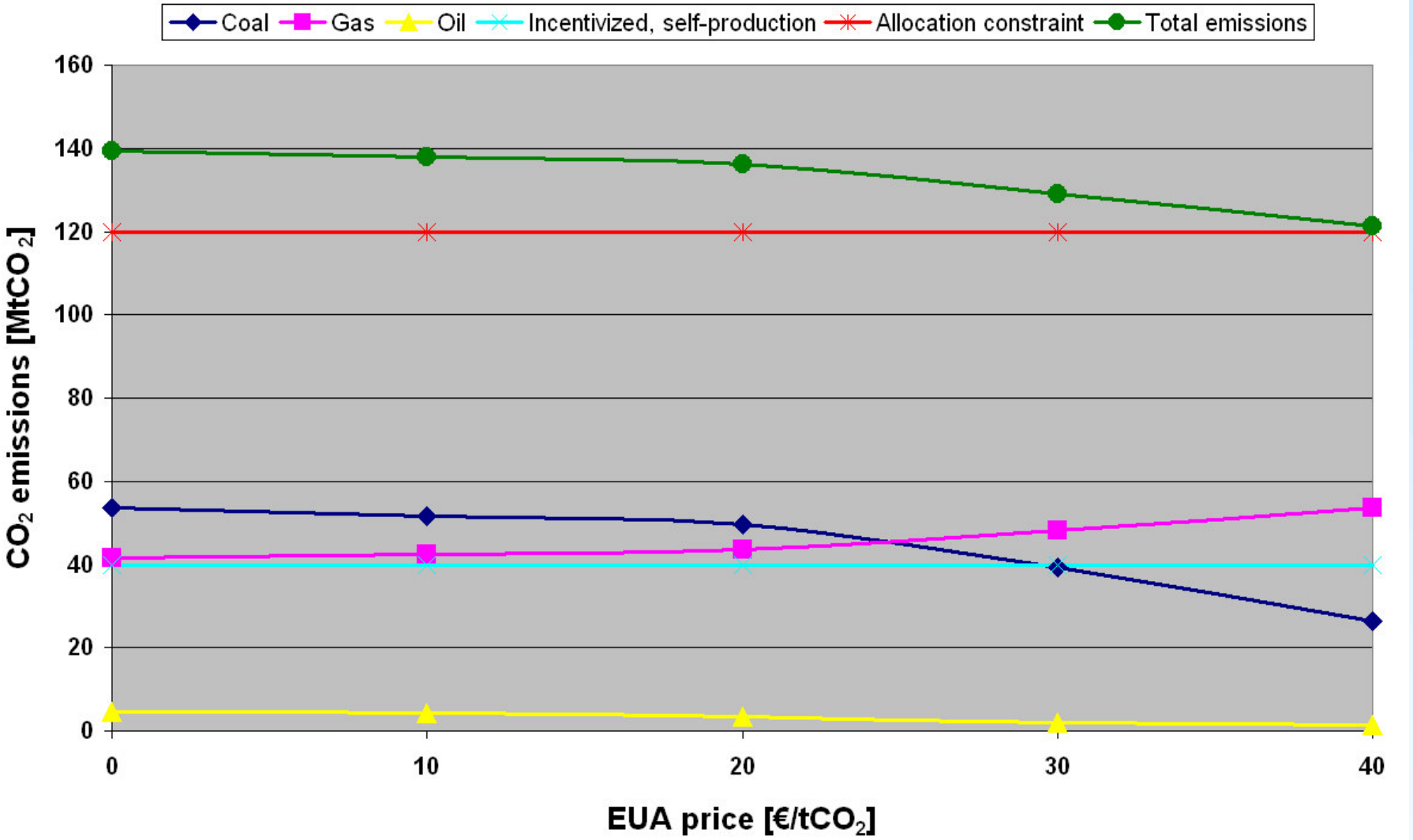
- Simulations have been performed on the reference year **2008**, assuming the same fuel prices of beginning 2005 and an amount of allocated allowances of **120 $MtCO_2$** (w.r.t. an amount of **128.41 $MtCO_2$** allocated for 2007)

- Two different evaluation criteria:
  - **increment of the system variable costs**
  - **valorization of the "opportunity costs"**

Simulation results – year 2008



Simulation results – year 2008



Increment of the system variable costs

- **The increment of the system variable costs is due to:**
  - **the variation of the overall fuel mix used by the thermal generation set, due to the "internalization" of CO_2 costs into fuel costs** (the higher is EUA price, the less competitive are coal plants w.r.t. CCGTs, the less "cheap" coal is used w.r.t. "expensive" gas)
  - **the cost of additional EUA the electric system could bear in case the free allowances allocated by the NAP are not sufficient**

Increment of the system variable costs

EUA price	€ / tCO_2	10	20	30	40

Increment of the system variable costs					
Cost due to the variation of the overall fuel mix	M€	25	62	293	603
Cost of additional EUA	M€	179	327	274	53
Increment of the system variable costs	**M€**	**204**	**389**	**567**	**656**

Average increase of the energy price (demand = 353 TWh)					
Average price increase (100% costs pass-through)	€/MWh	0,58	1,10	1,60	1,86

Valorization of the "opportunity costs"

- When a producer "saves" an allowance, he/she can sell it on the market and gain the EUA price
- When a producer "burns" an allowance, even if it was allocated for free, he/she "burns" the opportunity to sell it on the market and gain the EUA price (it is an "opportunity cost", since it is a lost profit)
- The producer could try to "extract" the market value of the "burned" allowance by passing-through its "opportunity cost" on the electric energy price
- The "opportunity cost" is equal to the EUA price, "internalized" in the fuel costs

Valorization of the "opportunity costs"

EUA price	€ / tCO_2	10	20	30	40
Average increase of the energy price due to the valorization of the "opportunity costs" (demand = 353 TWh)					
Average price increase (100% pass-through)	€/MWh	3,53	7,88	13,29	17,78

Conclusions

- **The application of the Kyoto protocol to the Italian electricity sector can increase the electricity prices**

- **Price increases justified by the increment of the system variable costs ("real" costs) range from 0.58 to 1.86 • /MWh in 2008** (fuel prices of beginning 2005, 120 $MtCO_2$ freely allocated, EUA price 10÷40 • /tCO_2)

- **Price increases due to the valorization of the "opportunity costs" can be much higher (from 3.53 to 17.78 • /MWh)**

- **Anyway, producers can hardly pass-through 100% of the "opportunity costs" on the price without causing the intervention of the regulatory bodies …**

Conclusions

- Moreover, **additional costs** could derive from a possible "wrong" allocation of allowances, due to a **wrong estimation of plants yearly working hours**

- A correct allocation is the one proportional to each plant working hours corresponding to the **optimal dispatching that minimizes system costs** (perfectly competitive market); this can easily be calculated with a market simulator like **PROMED**

- In the simulated 2008 scenario, CO_2 emissions decrease significantly only when the EUA price is **over 20 •/tCO_2**, due to the high "carbon efficiency" of the Italian generation set, composed by several CCGTs

Thank you!

Thank you for your attention!