

# **CRIEPI's CO2 Emission Permits & Electricity Trading Experiment**

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# Main Characteristics of Trade Experiment

- **Participants to the market**

Virtual generation companies similar to Japanese electricity companies.

CRIEPI's researchers played the roles of nine companies in the experiment

- **Commodities traded in the market**

Virtual company trades both CO<sub>2</sub> emission rights and electricity.

Generators produce both electricity and CO<sub>2</sub> simultaneously. Virtual company tries to maximize its profit by deciding operation and investment of power plants which are also means of reduction of CO<sub>2</sub>.

- **Uncertainty**

The ex-ante demands are reported by game-master but the ex-post demands are determined probabilistically

- **Market clearance mechanism**

Order Driven Method; Orders to buy or sell were collected within a set amount of time, and then the trade volume and price were determined by demand balancing. Electrical trade through the Internet

# Behavior of Virtual Electricity Company

## Given Conditions

Total electricity demand  
CO<sub>2</sub> emissions objective  
Existing generation capacity

Price of fuels for generation  
Capital cost and CO<sub>2</sub>  
emission rate of generation  
Retail electricity price

## strategy

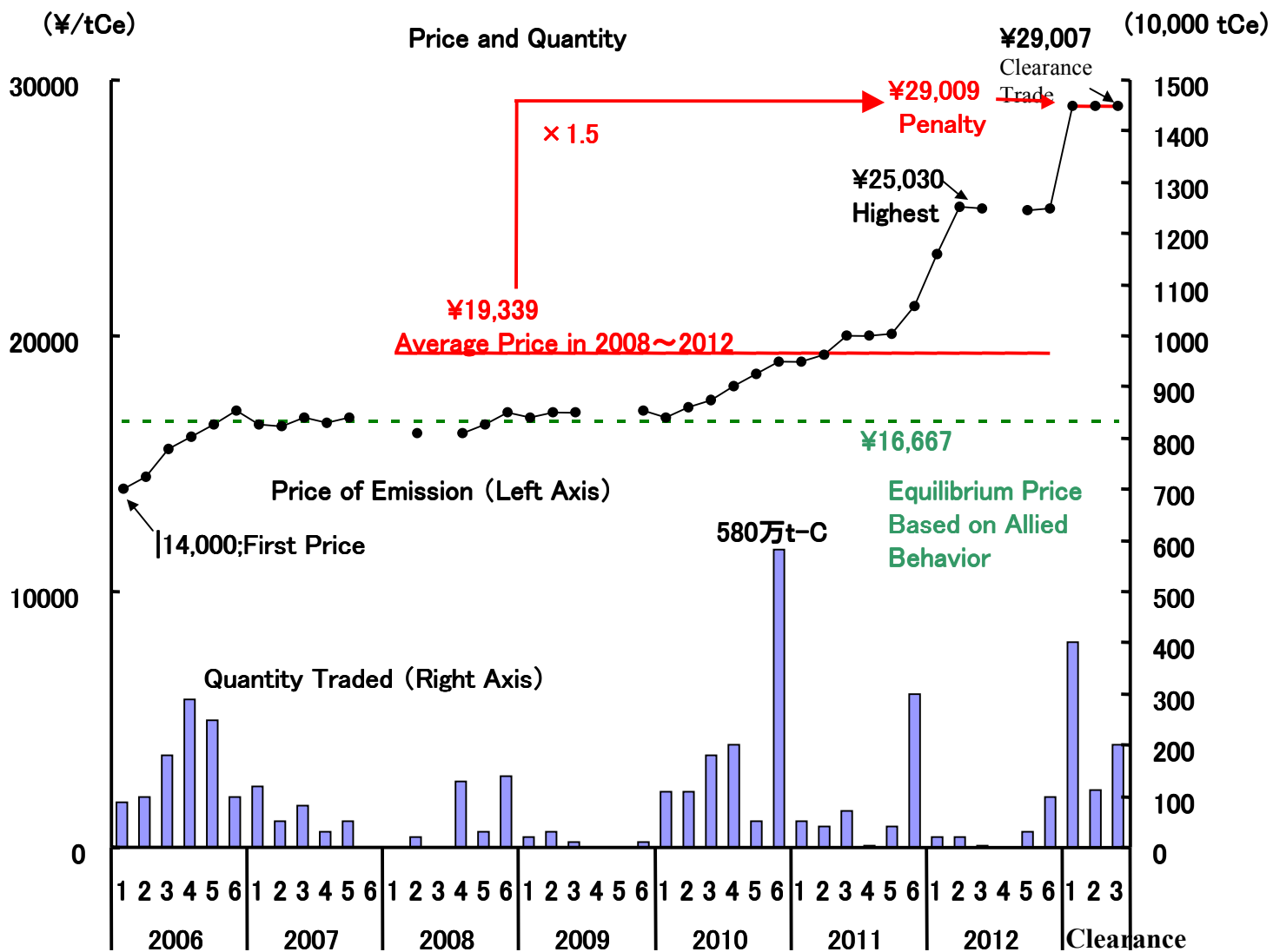
Operation and investment of different types of generation e.g. nuclear, coal, gas and renewable energy.  
Trade of CO<sub>2</sub> emission permits and electricity among companies.

## Object

**Profit maximization**

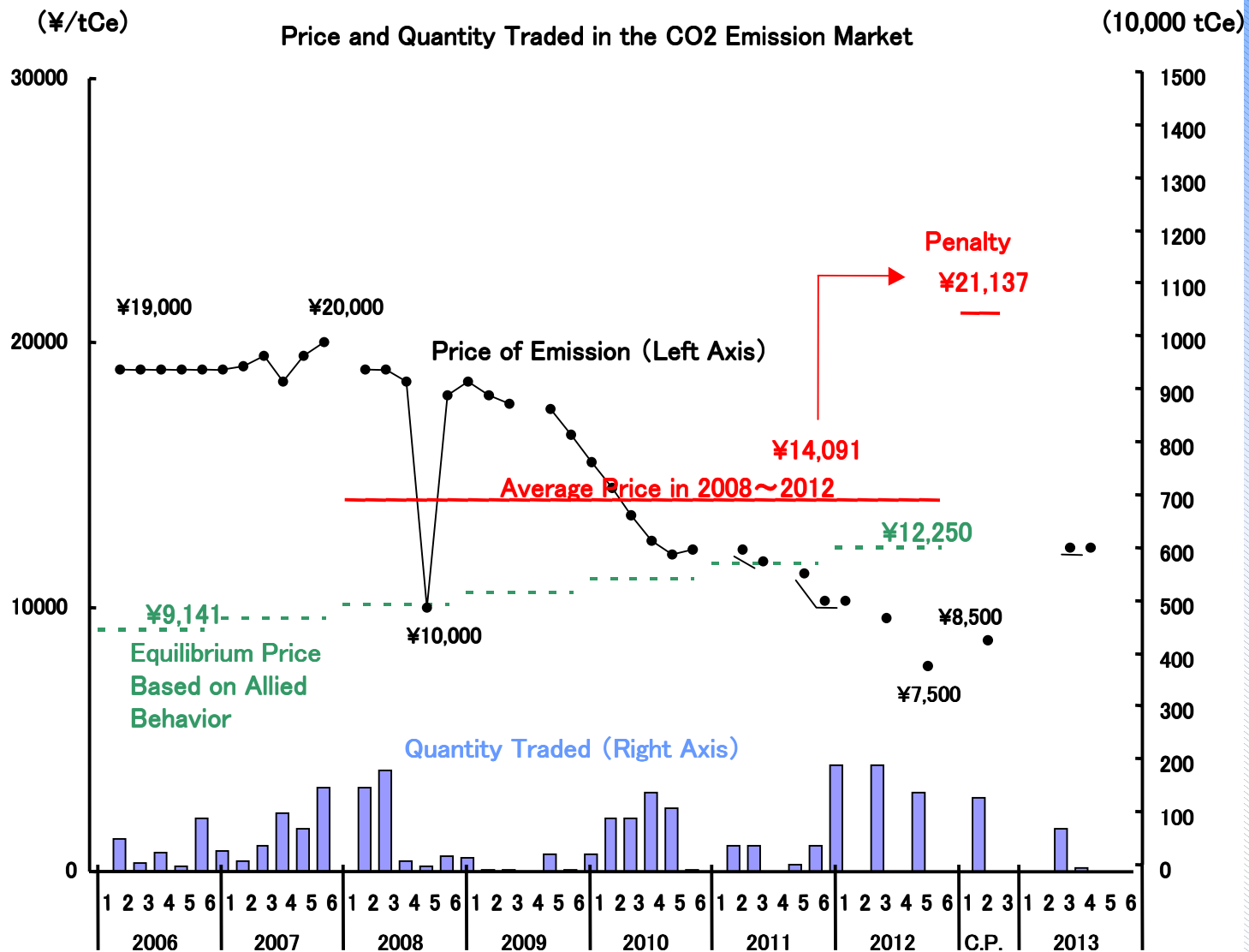
# 1st Experiment: Ends in 2012

## CO2 Emission Trade



2nd Experiment: Ends in 2013

CO2 Emission Trade



## Summary

In the 1st simulation, insufficient investment of power plant and unexpected growth of power demand created rise in the prices of emissions permits and power.

In the 2nd simulation, since several large companies invested excessively in power plant despite of relatively lower demand for power, the price of emissions permits fell gradually, so did price of power.

These confirmed that the price of emissions permits was greatly affected by the uncertainty in the demand for power and by investment of power plants.

The price of emissions permits was affected by their demand throughout the entire periods of the simulation, not just by the current year.

## Summary

The rules of fine system may explain the price fluctuations in the later half of two simulations (when the demand and supply condition of market was gradually getting known).

In case of non-compliance of CO<sub>2</sub> emission reduction, the company should pay fine. The fine is set at 150% level compared to the average market price.

During the first simulation, this fine system affected the increase of emissions price. Since the fine is varied according to the market price, the rule of fine itself might affect the market price. Some of the participants tries to hold emission permit because they can sell it in the grace period at the high price which is nearly equal to fine level. Thus, the market power to rise the price is observed.

If an emissions permits trading system is to be established in Japan in future, it will need to be investigated along the lines of the Danish system, in which the fine is a fixed amount.