

Principal Research Results

Availability of CO₂ Emissions and Electricity Trading Markets and Their Impacts on CO₂ Abatement Costs: Based on Market Trading Experiments among Virtual Utility Firms

Background

CO₂ emissions trade is one of the flexible mechanisms in the Kyoto Protocol, and the European Union decided to introduce emissions trading as of January 2004 imposing emission permits to large companies who produce electric power, steel, paper and pulp and so forth. In Japan, Ministry of Environment is strengthening global warming measures and emission trading is one of the policy alternatives. Since power sector is responsible for more than 30% of Japan's CO₂ emissions, it is important to clarify effects, defects and merits of emissions trading to power sector in advance.

Objectives

To verify the meanings of accessibility to emissions and electricity trades, we will execute economic experiments that describe various circumstances power companies face. In some experiments, access to both CO₂ emission and electricity trades is possible, other cases only access to one market is possible, and extreme case access to both markets is impossible. To do such conditional experiments, we will quantitatively present the cost effectiveness of availability of trading markets for power companies under the managerial constraints such as power supply obligation, attainment of emission reduction target, cash flow constraint on investment of power plants, and power transmission capacity constraints, and so on.

Principal Results

The results of our trading experiments are summarized as follows: (1) The total supply cost of ten virtual power companies is minimized under the condition that access to both CO₂ emission and electricity trades is possible. The cost then increases when access to CO₂ emission market is limited, and then when electricity market is restricted respectively. The cost is highest when access to both markets is prohibited. (2) CO₂ emission reduction target of the electricity industry is easily achieved by utilizing market trade either of electricity or emission allowance. When both markets are available the target is more easily achieved. (3) Since two markets are complementary to each other, the prices of electricity and allowance are stabilized.

Thus market trades are generally considered to achieve greater efficiency in a sense of total supply costs, however it is not generally observed that the gain from trade increases at every virtual firm level. Through our experiments, averagely, more than 90 percent of firms gain from trades when CO₂ emission allowances are tradable in addition to electricity trade. The fact that some firms cannot enjoy gains from trades may be due to the fact that players are unskilled in dealing trades, they have to face bounded rationality and more fundamentally they cannot collect all information of markets and other players' actions.

Main Researcher: Toru Ohkawara, Ph.D.,
Senior Economist, Socio-economic Research Center

Reference

- M. Wakabayashi, H. Fujii, Toru Ohkawara and Ken-ichi Tokoro, Availability of Trading Markets and Their Impacts on CO₂ Abatement Costs: Based on Market Trading Experiments among Virtual Utility Firms, CRIEPI Report Y03009, 2004.
- T. Ohkawara and M. Wakabayashi "Utility's Challenges to Global Warming: Some Experimental Evidences from Trading Simulations of CO₂ Emission Permits & Electricity Among Virtual Japanese Utilities," Preceding in the 19th World Energy Congress, 2004.
- T. Ohkawara, M. Wakabayashi, and C. Matsuya, "Market Trading Experiments of CO₂ Emission Permits and Electric Power Among Virtual Japanese Utilities," CRIEPI Report Y02004, 2002

Mitigation of Climate Change: Tasks and Measures

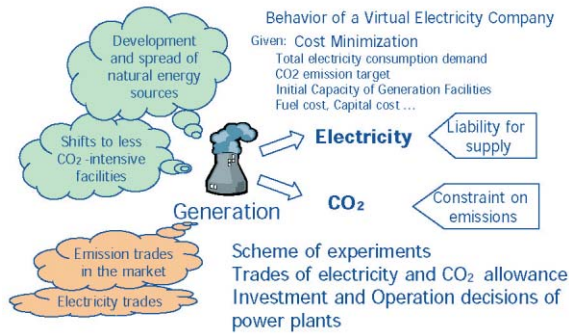


Fig.1 Behavior of Utility Firm

System of Market Trading

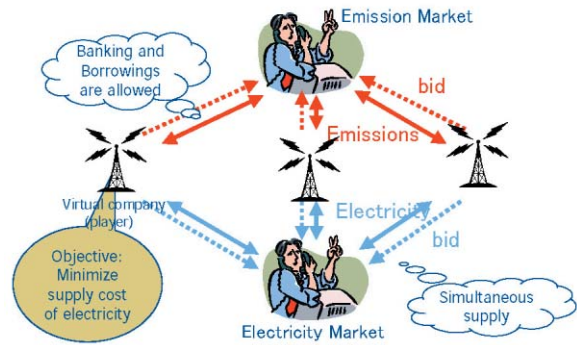


Fig.2 System of Trading Markets

Virtual companies trade both electricity and CO₂ emission permit

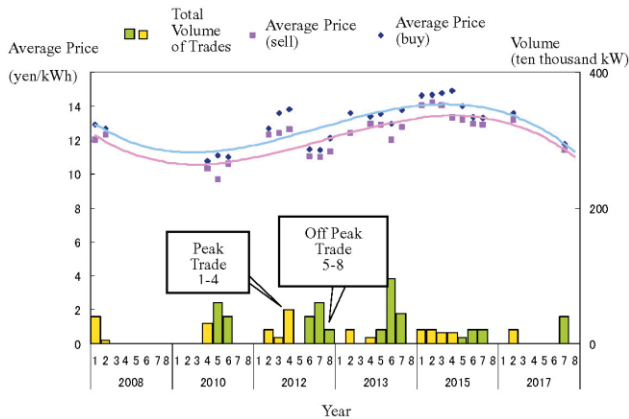
Table 1 Cost Reduction Effects Based on Market Availability

Unit: 100 Million Yen

	No trade	Electricity	Emission	Both
Mean	16,103	16,012	15,227	15,155
Max	67,122	69,444	64,478	65,264
Min	2,810	2,032	1,461	995
Std. Ver	20,359	20,924	18,942	19,664

Cost in this table refers to average supply costs of 10 virtual companies. Since the total supply costs differ in every experiment, thus we show descriptive statistics.

Transition of Electric Trade



Transition of Emission Trades

