

温暖化対策クリーン開発メカニズム事業調査

韓国の液晶工場より排出される
代替フロンを対象とした C D M 事業化調査
報告書概要
(英語版)

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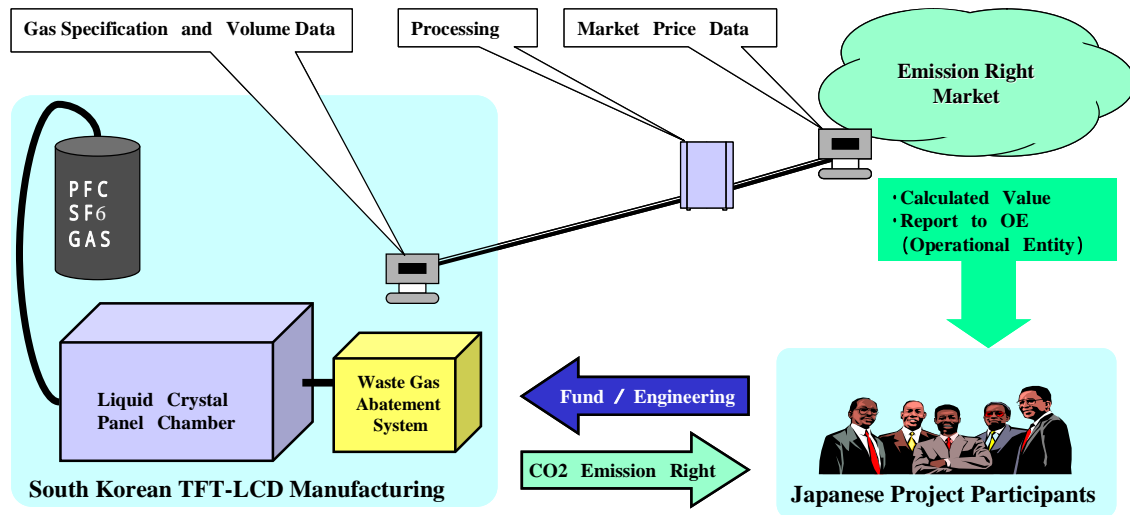
The CDM feasibility study for the chlorofluorocarbon-replacing material discharged from a South Korean liquid crystal factory

- Summary -

1. Description of the project

- In order to restrain emission of the chlorofluorocarbon-replacing material in TFT-LCD manufacturing plants, to install waste gas abatement system that decomposes and makes gas nontoxic is an effective measure, including invention of an alternative chlorofluorocarbon-replacing material or development of new process of TFT-LCD manufacturing.
- The aim of this project is that the Japanese project participants acquire emission rights in terms of setting up waste gas abatement system in a Korean TFT-LCD manufacturing plant.

Figure - 1 Description of the project



2. Background of the survey

- TFT-LCD has an advantage in product cost because it can form a circuit that operates liquid crystal panel on a glass substrate. In addition, the demand of TFT-LCD is increasing in car navigation systems, note type PCs and so on due to high quality display.

- The world TFT-LCD market reached to \$23,240 million in 2003, researched by Display Research (USA). Korea, Taiwan and Japan are major players in the market. In the countries' market shares in the first-quarter of 2003, Korea shared 41%, Taiwan held 39%, and Japan had 20%. Japan was behind Korea and Taiwan on manufacturing.
- Even though PFC gases are indispensable for the process of TFT-LCD manufacturing, these have categorized as greenhouse gas.
- World LCD Industry Cooperation Committee was founded in July 2001 in order to create internationally cooperative scheme for the development of the liquid crystal industry from environmental point of view. In January 2003 the committee approved the target of reduction of PFC gases emission, which was proposed by industry associations among three nations.
- Korea is the most producing country of TFT-LCD and has been on the top share since 1998 for six years. Moreover, Korea has been investing in construction of large manufacturing facilities to enlarge TFT-LCD lot and to increase production. Therefore, Korea is the most appropriate country for the survey because of the below four reasons. Korea;

is the most discharging country of the exhaust chlorofluorocarbon-replacing material in the liquid crystal industry,
 is a less-advanced country of disposal of the exhaust chlorofluorocarbon - replacing material,
 has promoted program for implementation of CDM project, and
 has high possibility of the CDM project due to existence of local partners.

- Thus, the Korean TFT-LCD manufacturing industry has attempted voluntarily to reduce greenhouse gas for itself. The target of emission reduction will be able to accomplish earlier with promoting the CDM project.
- Since the Korean government has already examined proposal of HFC23 destruction project of Ulsan, the scheme which an officer for industry in Office of the prime minister works this matter has been formed.

3. Outline of host country

Table - 1 Economic Indexes in Korea

Categories	Indexes	Notes
Name of State	Republic of Korea	
Square	99,585k m ²	
Population	47,925 thousand	2003(Estimation)
Capital City	Seoul (Population 10,276,968)	December 3,2003
Languages	Korean	
Religions	Buddhism,Confucianis,Christianity, etc.	
Real Economic Growth Rate	3.1%	*1
Normal GDP	721,345.9 billion Won	*1
US Dollar	605.2 billion US\$	*1
Normal GDP per Capita	12,499 US\$	*7
Consumer Price Increase Rate	3.6 %	*3
Unemployment Rate	3.4 %	*4
Balance of Payments	12,320.7 million US\$	*4
Foreign Currency Reserves	155,284 million US\$	Except Gold *5
Balance of External Foreign Debts	159,808 million US\$	*4
Exchange Rate	100 Won = Approximately 9.4 Yen	End of June2004*5
Financial Deficits per GDP	- 3.5 %	「 - 」 means surplus *6
Amounts of Export	193,817 million US\$	The Customs Basis *1
To Japan	17,276 million US\$	The Customs Basis *1
Amounts of Import	178,826 million US\$	The Customs Basis *1
To Japan	36,313 million US\$	The Customs Basis *1
Income of Foreign Direct Investment	6,467 million US\$	The Contracts Basis *2

Sources) *1 : Monthly Korean Statistics (Korea National Statistical Office)

*2 : Ministry of Commerce, Industry and Energy

*3 : Monthly Economic Outlook (Minister of Finance and Economy)

*4 : Monthly Survey and Statistics (The Bank of Korea)

*5 : I F S

*6 : Economic Outlook(O E C D)

*7 : World Economic Outlook Database (I M F)

4. Trends of the investment in the TFT-LCD producing facilities (Transition of generations)

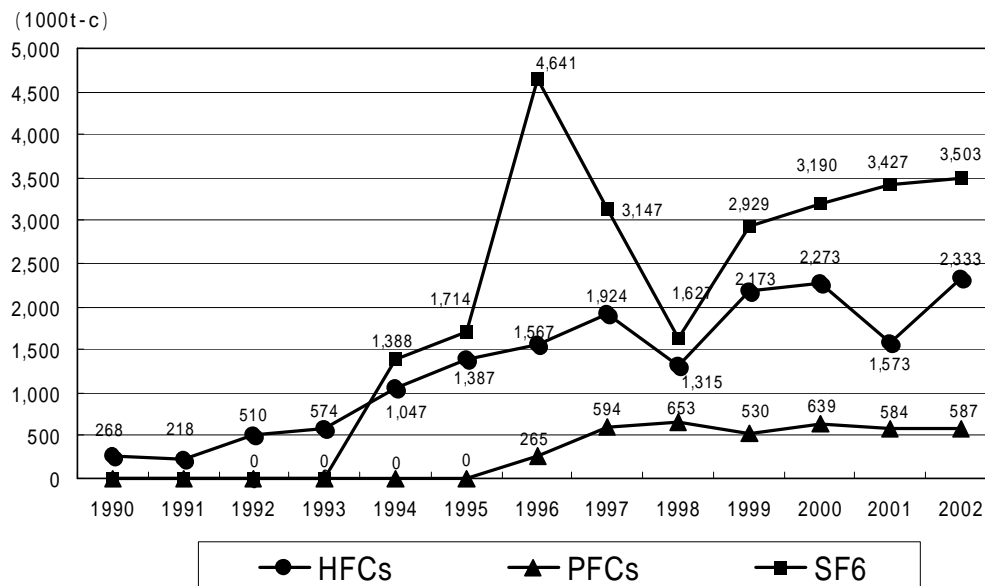
- Construction cost of TFT-LCD manufacturing line is likely to be approximately ¥ 80 billion in the fifth generation although it depends on capacity of production. Product line is categorized by size of a glass substrate, and the size has enlarged since the emergence of the first generation, which size was 320mm×400mm, and the size of the fifth generation was 1,000mm×1,200mm. At present the seventh generation, 1,870mm×2,200mm, is on stream. Samuson and Sony as joint venture plan to start manufacturing the eighth generation (2,300mm×2,600mm) line in 2006 in Korea.
- Thus, the enlargement of the glass substrate aims to maximize panel size of TFT-LCD equipped components and to reduce panel cost in terms of increase on productivity.

- As a result, the size of the glass substrate has been rapidly enlarging until the recent seventh generation, comparing with duration from the first generation to the fifth generation.
- The size of the glass substrate was enlarged about 1.8 times per three years from 1991 to 2000. It has been enlarged 1.8 times per two years since 2001.
- The total amount of investment in constructing facilities of three Korean companies, which expand TFT-LCD glass substrate, was \$3,639 million in 2004. A vast amount of investment has been required to alter a generation of manufacturing.
- Although the demand of liquid crystal monitor including note type PCs is stagnating, the future amount of TFT-LCD production, based on square of glass substrate, seems to grow because the trend of enlargement of the size would be continuing.
- In consequence of it, the demand of the chlorofluorocarbon-replacing material on the TFT-LCD manufacturing industry will increase in proportion to the amount of production of TFT-LCD.

5. Activities on reduction of PFC gases

- TFT-LCD and semi-conductor manufacturing industries have heavily discharged the PFC gases in Korea.

Figure - 2 Heavily discharged the PFC gases in Korea



- In the survey of the Ministry of Commerce, Industry and Energy in Korea, PFC gases were spent about 590 thousand ton-C, SF6 was consumed approximately 3.5 million

ton-C in the TFT-LCD manufacturing process. The emission of PFC gases since 1996 and that of SF₆ since 1994 have been increasing, except the economic crisis in 1998.

- Under these circumstances, the Korean government has not tackled to reduction of the chlorofluorocarbon-replacing material emissions because the Government has expected voluntary activity of the industry side. However, the Government has aggressive to reduce greenhouse gas, and has basically promoted research and development of less-energy equipments, implementation of less-energy policy based on its R&D, and employment of new energy.

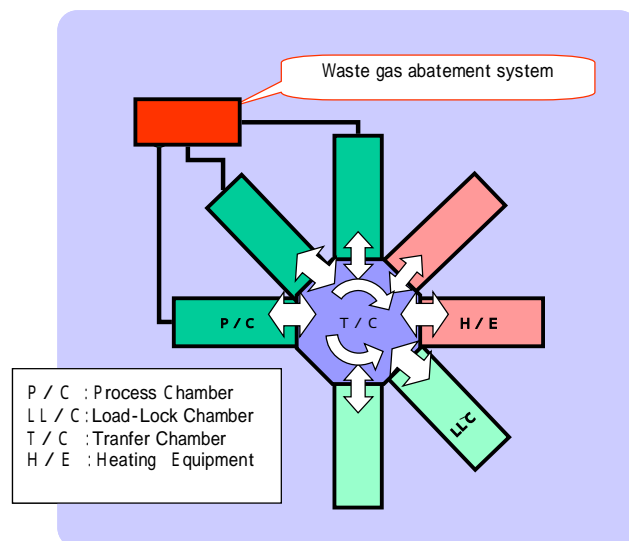
6. Details of the project

- The project aims that the Japanese CDM participants to install waste gas abatement system that decomposes and deconstructs the exhaust chlorofluorocarbon-replacing material in the TFT-LCD manufacturing plants in Korea and to acquire emission rights.

- This project targets to set up waste gas abatement system in every TFT-LCD line in the factory that has two product lines

- Waste gas abatement system should be put in near a chamber in the factory in order to minimize the length of pipe. Due to high corrosion of the exhaust chlorofluorocarbon-replacing material, pipe must be made of stainless. Moreover, so as to avoid the danger of leaking gas from corroded pipe and so on, the pipe should be laid shortest.

Figure - 3 Position of Waste gas abatement system



7. Project boundary, Setting up baseline, demonstration of supplement

- The chlorofluorocarbon-replacing material is used on the etching process and the cleaning process in a TFT-LCD plant. The exhaust chlorofluorocarbon-replacing material is in a closed chamber of both etching and cleaning processes, so it seems to be difficult to leak out on the processes.
- In Japan, pipe jointed to waste gas abatement system is made of stainless that resists rust. Additionally, the pipe between a chamber and waste gas abatement system is constructed to minimize its length in case gas leaks out from the erosion pipe.
- If waste gas abatement system is installed and pipe is laid like the Japanese way, it would be less hazard of erosion of pipe and leaking gas in joint.
- Baseline is grounded on the amount of emission at present and in the past, and the amount of emission reduction is defined as the destruction amount of the chlorofluorocarbon-replacing material.

8. Quantity of GHG reduction and leakage in terms of the operation of the project

- The presumptive result of annual total emission amount is, as below, approximately 240 thousand ton-c per year.
- Quantitative method will utilize a calculation formula for the chlorofluorocarbon-replacing material emissions that was established by Japan Electronics and Information Technology Industries Association.
- That is able to estimate the amount of the chlorofluorocarbon-replacing material emission as GWP, based on the amount of input of the chlorofluorocarbon-replacing material, and considering the transforming quality of gas among processes.

Table 2 The chlorofluorocarbon-replacing material

Gas	Calculation formula	GWP (ton)
C F ₄	$170 \times 0.9 \times \{(1 - 0.2) \times 5,700\}$	698
S F ₆	$17,300 \times 0.9 \times \{(1 - 0.5) \times 22,200\}$	172,827
N F ₃	$34,500 \times 0.9 \times \{(1 - 0.8) \times 10,800\}$	67,068
Total		240,593

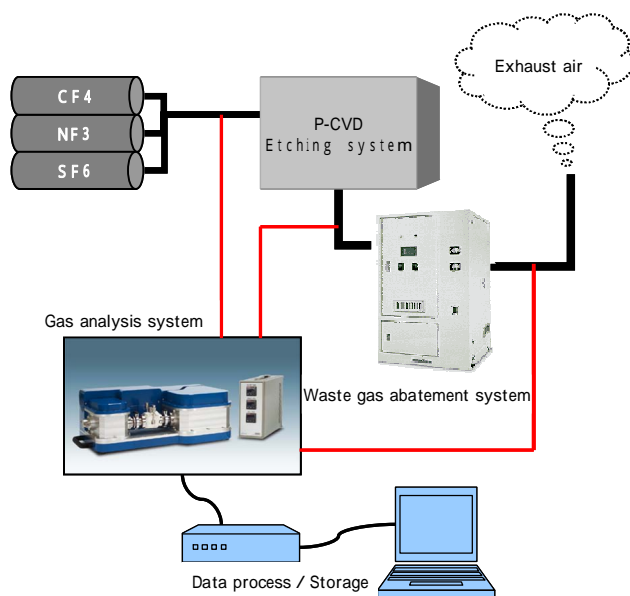
9. Monitoring plan

- Basically, it is to measure the amount of the exhaust chlorofluorocarbon-replacing material emission from a chamber and the amount of the deconstruction gas in waste gas abatement system, in the process of TFT-LCD manufacturing
- In order to grasp the reduction amount of the chlorofluorocarbon replacing material emission as correct as possible, it is necessary to collect data at the point indicated

below the chart.

- The method of measurement is FT-IR, which is applied to a sort of Intel Protocol, and it reinforces Intel Protocol.

Figure - 4 Monitoring plan



10. Environmental impacts

- Disposition of filth water that goes the exhaust chlorofluorocarbon-replacing material through a scrubber in waste gas abatement system would become an issue. Nevertheless, it will be possible to flow it out with other water in a TFT-LCD plant.

11. Stakeholders comments

- The Korean Government: it is highly concerned with this project as a result HFC23 destruction project in the past.
- EDIRAK: Korean liquid crystal industry is concerned with the project, and expects to discuss directly with the Japanese investors. In the meantime, the recent survey revealed difference of the way of setting up waste gas abatement system while he has recognized the CDM project.

12. Implementation scheme of the project

- As regards the implementation scheme of the project, the Japanese side will decide it on the implementation process, and the attitude of the Korean side has not been clarified. Therefore, it has not been decided yet.

13. Financial plan for the project

- Finance in the project could not be to some extent difficult in terms of provided equipments and components by participants, which are abatement or gas-analysis equipment companies.

14. Cost and benefit

(1) Duration of the project activity · duration of credit

- Duration of the project activity is fixed for seven years, and that of credit is also set for seven years, considering renewal of TFT-LCD manufacturing equipment due to crystal cycle of liquid crystal products and durable years of waste gas abatement system.

(2) Conditions of feasibility study simulation

- The prices of emission rights were estimated three patterns, which are \$5/t-Co2 as minimum cost, \$7/t-Co2 and \$9/t-Co2.

- The corporation tax was set as 30%. The corporation residence tax was set as 20.7%. The benefits after taxes were calculated as that pre tax deduction benefits multiple 0.3621.

- The following expenses of pre-project has excluded.

- | |
|--|
| <ul style="list-style-type: none">• PDD product cost• Examination cost by appointed operational organizations (which is appointed by CDM council and the Korean side).• Verification and approval costs for greenhouse gas reduction |
|--|

- The way of finance in the project has not decided yet at this moment. Some waste gas abatement system and gas analysis components would be probably provided by some manufacturing companies. Furthermore, local offices could support maintenance fees of abatement system and engineering staff fees.

- Total cost is financed by investors, and then cash-in-flow will be principally distributed among them. Moreover, TFT-LCD manufacturing companies in Japan could compensate the shortage of star-up finance.

(3) Results of feasibly study

- In the case of that the price of emission rights was \$5, IRR (Internal Rate Return) for seven years was 7%, so it is slightly difficult to realize it.

- In the case of \$7, IRR for seven years was 20%, so it could be profitable. In the case of

\$9, the project could be realized even for five years.

- Thus, in the case of \$5, it would be difficult to realize the project if some expenses noted before are deducted. In the cases of \$7 to \$9, the project could be realized even if expenses are deducted.

Table - 3 Internal Rate Return

	Cases1 . (\$ 5)	Cases2. (\$ 7)	Cases3. (\$ 9)
3 years	-	- 28%	- 12%
5 years	- 11%	8 %	24%
7 years	3 %	20%	34%

15. Issues for business of the project

(1) Difference in notion of waste gas abatement system

- Korean companies tend to establish a single large waste gas abatement system in each plant. That is concentration system that collects and disposes the exhaust chlorofluorocarbon-replacing material at one point.
- It is different from dispersion system of which a couple of waste gas abatement system are placed in every chamber, conducted by Japanese or Taiwanese companies.
- The reason why Korean makers adopt the different type of abatement system could not be clarified in this survey. However, the Korean companies are going on their way, and they have not changed their method although they have understood the project.

(2) Response to rapid renewal of manufacturing facilities

- The speed of enlargement of glass substrate has been accelerating. The square of the first generation was at least 0.128 m², meanwhile that of the eighth generation in 2006 will be 5.98 m². Thus, it is 46.7 times of the first generation. As a result, the amount of consumption of the chlorofluorocarbon-replacing material has increased corresponding to the growth of TFT-LCD production.
- This research focused on the fifth generation (1,200 m²) plant, which was most popular at present. However, when the project will be started, it is necessary to predict that renewal of manufacturing facilities will greatly transform for seven years when is duration of the project.
- Furthermore, as mentioned already that there was difference in notion of waste gas abatement system, it is necessary to confirm capacity of the waste gas abatement system because the Korean side would plan the future enlargement of manufacturing facilities.

(3) Distribution of emission rights

- A Korean interviewee stated that benefits from acquisition of emission rights should not be occupied by solely Japanese participants but should be shared with a half of benefits with the Korean side.
- According to stakeholders of Korean TFT-LCD manufacturing industry, they have a plan to spend benefits from the CDM project to environmental preservation such as planting in their own factories. In addition, they also expect to invest them in environment-oriented projects when they construct TFT-LCD factories in other countries.
- Although these notions seem to be preferable, the Japanese side should recognize the situation because the benefits of the Japanese side as investors will be halved.