Project design document form for CDM project activities

(Version 05.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	Samsung Electronics SF_6 abatement project
Version number of the PDD	Version 11.0
Completion date of the PDD	09/10/2015
Project participant(s)	Samsung Display Co., Ltd.
Host Party	Republic of Korea
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)	Scope 4 : Manufacturing industries scope 11: Fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride
Estimated amount of annual average GHG emission reductions	768,215 CO2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>> Samsung Electronics SF_6 abatement project (the Project or the Project activity) involves the installation of SF_6 abatement devices at Samsung Display LCD production plant. Samsung Display (SDC) Tangjung plant (the plant) has four LCD production lines (7-1 line, 7-2 line, 8-1 line and 8-2 line). The Project activity installs SF_6 abatement devices at 7-2 lines, which has produced the LCD substrates since January 2006. The installed abatement system will reduce the emission of greenhouse gas through thermal treatment of SF_6 gas.

SF_6 gas destructed by the Project activity is from the etching process where the SF_6 gas is used as etching gas. Though a part of SF_6 gas used in the etching process is decomposed during the process, some part of SF_6 gas is not decomposed and vented into the atmosphere.

Though SF_6 gas is one of the greenhouse gases, SF_6 gas itself is odourless, non-toxic and non-flammable and there is no law or regulation that mandates the decomposition or destruction of SF_6 gas in Korea. Due to these reasons, the undecomposed SF_6 gas from the LCD etching process is now being emitted into the atmosphere. In the absence of the Project activity, the current practice will continue and as described in Section B.4 below, this current practice is the baseline scenario.

To reduce greenhouse gas emissions is one of the most important issues for the sustainable development of Korea against the climate change. Therefore, greenhouse gas emission reductions achieved by the Project activity will contribute to the sustainable development of Korea.

The estimate of annual average and total GHG emission reductions for the crediting period are showed below.

Years	**Annual estimation of emission reductions in tonnes of CO_2e**
Year 1	768,215
Year 2	768,215
Year 3	768,215
Year 4	768,215
Year 5	768,215
Year 6	768,215
Year 7	768,215
Year 8	768,215
Year 9	768,215
Year 10	768,215
Total estimated reductions (tonnes of CO_2e)	7,682,150
Total number of crediting years	10 years
Annual average over the crediting periods of estimated reductions (tonnes of CO2e)	768,215

A.2. Location of project activity

A.2.1. Host Party

>> Republic of Korea

A.2.2. Region/State/Province etc.

>> Chungcheongnam-do

A.2.3. City/Town/Community etc.

>> Asan-si

A.2.4. Physical/Geographical location

>> The Project site is located at 200 Tangjung-Myeon, Asan-si, Chungcheongnam-do, Korea. Its geographical coordinates are 36°48'53.04''N and 127°03'51.23''E.

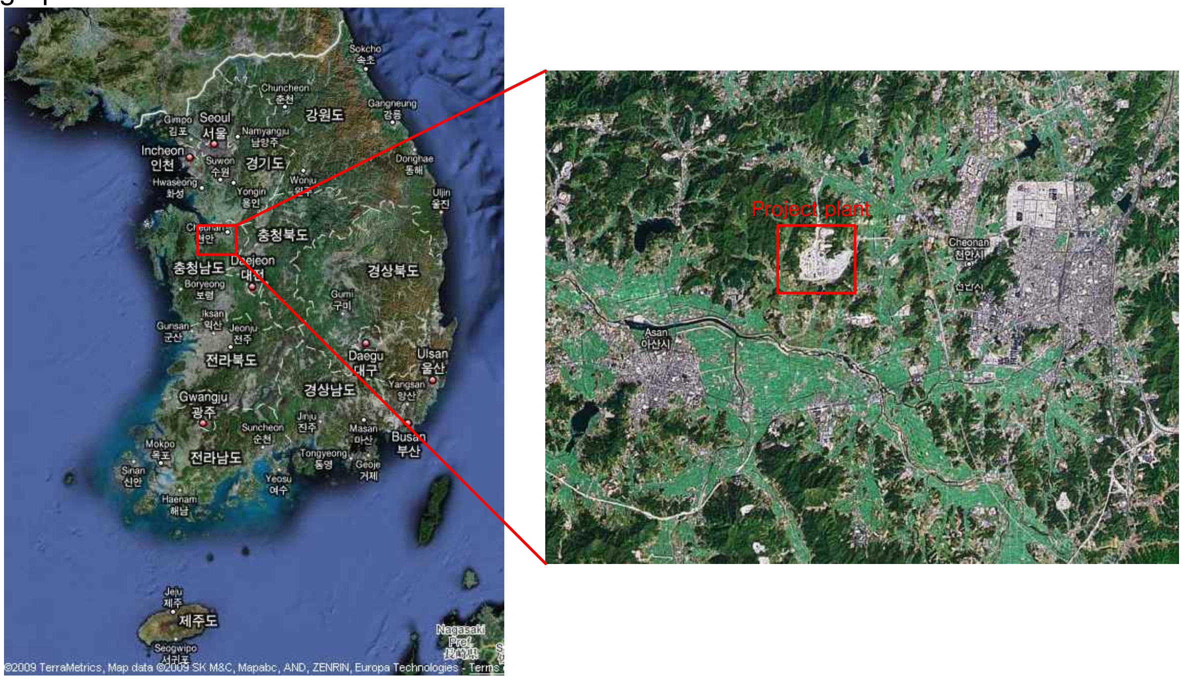


Figure 1. Location of the site for the project activity

A.3. Technologies and/or measures

>> Through the LCD etching process of the 7-2 Line, about 13CMM of exhaust gas, containing a significant amount of SF_6 gas, is being generated. The expected composition of the gas at inlet of the abatement system is as follows:

Table 1. Gas flow rate and composition (INLET)

Description		Expected value
Gas flow rate		13 Nm^3 / min
Gas composition	Nitrogen, N_2	88.190%
	Oxygen, O_2	8.560%
	Moisture, H_2O	2.500%
	Sulfur hexafluoride	0.154%
	Others	0.596%
	Total	100

Table 2. Gas flow rate and composition (OUTLET)

Description		Expected value
Gas flow rate		13 Nm^3 / min
Gas composition	Nitrogen, N_2	87.000%
	Oxygen, O_2	8.000%
	Moisture, H_2O	4.000%
	Sulfur hexafluoride	0.015%
	Others	0.985%
	Total	100%

Table 1 and 2 are based on SDC's estimated calculation, and exact content of the inlet and outlet gas will be accurately measured at the time of Experimental setup, which is required by the Methodology AM0078 version 1.1.

Prior to the implementation of the Project activity, SF_6 gas has been simply released to the atmosphere without any treatment. This is the current practice at the Project site, and is the baseline scenario identified in section B. 4. Since the abatement of SF_6 is carried out with the exhaust gas stream, there is no change in LCD etching process or the LCD production, therefore there is no impact on the types and levels of services provided by the LCD production line.

The aim of the Project is to reduce the SF_6 gas content of the exhaust gas. Key equipment used in the Project is shown in the following table:

Table 3. Summary of Key Equipments

	Number of units	Manufacturer	Q'ty of unit in Operation	Q'ty of Standby	Total Q'ty to be installed
Abatement System	RTO Reactor electrical heater	Clean Systems Korea	4	1	5
	Powder Trap	Clean Systems Korea	4	6	10
	Wet Scrubber	Clean Systems Korea	4	1	5
	Fan	Clean Systems Korea	4	2	6
Monitoring device	Annubar	To be decided	2	0	2
	QMS	To be decided	2	0	2
	FTIR	To be decided	2	0	2

Regenerative Thermal Oxidation Reactor Electrical heating (RTO Reactor)
To abate SF_6 emissions from LCD etching process, the electric thermal abatement system will be installed at the Project site. The electric thermal abatement system destroys SF_6 gases at an operating temperature of 1,200 ~ 1,400 ℃. Specification of the abatement system is given below. Furthermore, in an attempt to enhance the destruction efficiency of the SF6, steam from central boiler may be used in the RTO reactor.

Table 4. Key Parameters for RTO Reactor Electrical Heater

	ITEM DESIGN SPEC	DESIGN SPEC	Remark
1	DIMENSION, mm	1,498L×1,808H×1,560W (INCLUDING HIGH CASTER)	
2	CAPACITY (without standby)	MAX. 3,400 L/min × 4 unites	13.6 CMM
3	TARGET PROCESS	LCD-DRY ETCH	
4	TARGET GAS	SF_6	
5	DESTRUCTION EFFICIENCY OF GAS	ABOVE 90%	
6	MAIN POWER	440V, 3 PHASE	
7	TEMPERATURE CONTROLLER	P.I.D.	
8	HEAT RECOVERY EFFICIENCY	92.2%	OUT/INLET

Powder Trap
A dry type powder trap is installed for pre-treatment, to remove the particles in the flue gas. This is aimed to prevent the deposit of the particles on the walls of the RTO reactor system.

Table 5. Key Parameters for Powder Trap

	ITEM	DESIGN SPEC.	REMARK
1	DIMENSION	745D×1,600H	INCLUDING HIGH CASTER
2	CAPACITY (without standby)	MAX.3.4 CMM × 4 UNITS	13.6 CMM
3	TARGET PROCESS	LCD-DRY ETCH	
4	TARGET GAS	SF_6	
5	REMOVAL EFFICIENCY OF DUST	90%	INLET : 20mg/m3 OUTLET : 2mg/m3
6	MAIN POWER	NO USE	
7	TEMPERATURE CONTROL	NO USE	
8	ENERGY CONSUMPTION	N/A	
9	MAINTENANCE	Every 3 Months	On-site

Wet Scrubber (Pre-treatment)
A wet scrubber is installed as post-treatment system to remove HF, HCl and SiF4 in the flue gas from the main duct.

Table 6. Key Parameters for Pre Treatment Wet Scrubber

	ITEM	REMARK
1	TYPE	VERTICAL WET SCRUBBER
2	SIZE	1,300mm X 2,400mm X 3,110mmH
3	MAT'L	FRP
4	LAYOUT	1,300mmW X 2,400mmL

5	TOTAL Q'TY (without standby)	2 sets (1 set and 1 standby)

Wet Scrubber (Post-treatment)
A wet scrubber is installed as post-treatment system to remove HF, F2 and SOx in the flue gas from the RTO system.

Table 7. Key Parameters for Wet Scrubber

	ITEM	REMARK
1	TYPE	VERTICAL WET SCRUBBER
2	SIZE	650mm X 650mm X 2,500mmH
3	MAT'L	FRP
4	LAYOUT	650mm X 650mm X 2,500mmH
5	TOTAL Q'TY (without standby)	4 units

Fan
FRPs fan are installed to control the total system flow rate and the static pressure through the main inlet duct.

Table 8. Key Parameters for Fan

	ITEM	REMARK
1	Main Inlet Pressure	-150mmAq
2	Max Flow Rate	4 CMM/Unit
3	TOTAL Q'TY (without standby)	4 units

Equipments installed in the Project have expected lifetime of 15years, according to the manufacture. In addition, the Line 7-2 has at least 11 years of lifetime remaining, as described in the Section B.2 below.

Monitoring devices

Annubar
The specification of the Annubar is included in Appendix 5, along with the detailed description of the monitoring plan.

Quadruple Mass Spectrometer (QMS)
The specification of the QMS is included in Appendix 5, along with the detailed description of the monitoring plan.

Fourier Transform infrared (FTIR)
The specification of the FTIR is included in Appendix 5, along with the detailed description of the monitoring plan.

Maintenance schedules for the monitoring devices are described in Section Appendix 5. below.

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Korea (host)	Samsung Display Co., Ltd.	No

A.5. Public funding of project activity

>> Project financing does not involve ODA or public funding from Annex I countries.

SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

>> Approved baseline and monitoring methodology applied to the Project activity is:
"Point of Use Abatement Device to Reduce SF_6 emissions in LCD Manufacturing Operations" (AM0078 Version 01.1)

Also the Project activity refers to the latest version of following tools:
"Combined tool to identify the baseline scenario and demonstrate additionality" (Version 02.2)
"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01);
"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (Version 02)

B.2. Applicability of methodology and standardized baseline

>> The methodology applies to the project activities that involve the installation of a combustion or thermal abatement device that is able to eliminate the SF_6 from an LCD etching plant, which currently is venting the SF_6 to the atmosphere.

At present, SDC is venting the SF_6 gas from the LCD etching plant to the atmosphere. By the project activity, the thermal abatement device will be installed to destroy the SF_6 gas from the etching plant. The Project activity meets all the applicability conditions in AM0078 as follows:

- The methodology only applies to existing production lines with at least 3 years information of SF_6 purchase and consumption and production of LCD substrate by 31 January 2009. The crediting period is limited to the remaining lifetime of the production lines existing at the time of registration;

  → The LCD line 7-2 which is included in the Project activity started the commercial operation in January 2006. There are more than 3 year information of SF_6 purchase and consumption and production of LCD substrate by 31 January 2009.

  → LCD line 1 of SDC started its operation in January 1995 and as of December 2009 (at time of PDD preparation) it has operation time of over 15 years. During this time, the line 1 has been operating continuously and there is no plan to close the line anytime in the near future .

→ Within the LCD production line, SF_6 is consumed at dry etching process. Line 7-2 still uses original equipments for the dry etching and it is manufacture's opinion that these equipments have expected lifetime of 20 years under proper maintenance.

→ Therefore, the LCD line and dry etching equipments have lifetime of at least 15 years, under normal operation. Since the line 7-2 was constructed and started its operation in January 2006, the line has operational time of 4 years at time of the PDD preparation. In addition, internal document confirms that the line 7-2 and dry etching equipments have been operated and maintained according to the recommendations of the manufacturer. With these reasons, remaining lifetime of the 7-2 line and dry etching equipments is at least 11 years, which is longer than the Project's crediting period of 10 years.

- The maximum treatment capacity of the abatement system is sized for the application in correlation to observed historical flow. The maximum SF_6 flow entering the abatement device, from all chambers combined, is below the maximum SF_6 abatement capacity of the abatement device and where the total flow of effluents (SF_6 plus all other by-products and diluents) does not exceed the total flow capacity of the abatement device;

→ The maximum SF_6 flow entering the abatement device, from all chambers combined, will be below the maximum SF_6 abatement capacity of the abatement device and where the total flow of effluents (SF_6 plus all other by-products and diluents) does not exceed the total flow capacity of the abatement device;

- No law or regulation which mandate decomposition, destruction, recycle or substitution of SF_6 or any component of exhaust gases containing SF_6 exist;

→ There are no law or regulation which mandate decomposition, destruction, recycle or substitution of SF_6 or any component of exhaust gases containing SF_6 in Korea.

- The SF_6 destruction should occur at the same industrial site where the SF_6 is used, and SF_6 destroyed is not imported from other facilities;

→ SF_6 destruction occurs at the same industrial site where the SF_6 is used and SF_6 destroyed by the Project activity is not imported from other facilities.

- The measurement with respect to determining SF_6 flow to the abatement device are taken immediately before the abatement device, without any other devices located in between which is capable of changing the SF_6 flow through transformation or decomposition;

→ The measurement with respect to determining SF_6 flow to the abatement device will be taken immediately before the abatement device, without any other devices located in between which is capable of changing the SF_6 flow through transformation or decomposition.

- Where the applicability conditions of US EPA Methods 1 and 2 are satisfied (i.e. the flow is not cyclonic or swirling and the stack has a circular cross section with a diameter greater than 0.3 meter);

→ The flow is not cyclonic or swirling and the stack has a circular cross section with a diameter greater than 0.3 meter. In addition, the Project follows US EPA Methods 1 and 2. Of primary importance for compliance with US EPA requirements, the velocity

measurements will be carried out in portions of the duct which are not located close to bends, expansions, contractions, or other features that can lead to flow disturbance.

- The facility has obtained necessary permits concerning safety and health in order to install and operate the abatement device and monitoring facilities;

→ The Project will change the composition of stack gas from the plant and generates some wastewater. SDC has considered all applicable regulations on safety, health, environmental impact and wastewater issues listed below.

- ➢ Environmental Effect Assessment Act
- ➢ Air Pollution Reservation Act
- ➢ Occupational Safety and Health Act
- ➢ Municipal Gas Business Act
- ➢ Water Pollution Prevention Act

For to Air Pollution Reservation Act, SDC must submit a notice (no need to obtain additional permits or approvals, this is just a notice) of the Project to Chung Cheong Nam-Do Provincial Government as it will change the composition of the Stack gas. Also, while a small amount of additional wastewater will be generated by the project, it is minimal compared to existing wastewater flows from the LCD production line, and is already covered within the scope of existing wastewater permissions.

In conclusion, SDC does not need to obtain new permits to operate the abatement device and monitoring facilities. This has been confirmed by local authority.

- SF_6 is not temporarily stored for subsequent destruction;

→ SF_6 is not temporarily stored for subsequent destruction.

- It is demonstrated by test data by the manufacturer or the project proponent that the abatement technology does not generate known non-CO_2 greenhouse gas such as fluoro-compounds, including non-Kyoto gases, at detection levels.

→ According to the test data by the manufacturer, no non-CO_2 greenhouse gas (GHG), including non-Kyoto gases, is generated as a byproduct from pyrolysis reaction of SF_6 by the abatement system.

→ Although small concentration of CF_4, a non-CO_2 GHG, is expected in the outlet gas of the abatement system, the same CF_4 is also detected in the inlet gas of the abatement system at a higher concentration. Manufacture test data confirms that the abatement system actually reduces CF_4, by an average of 25%. Therefore, the Project will not generate any CF_4, instead, it will reduce CF_4 emission.

The Project activity also meets the applicability conditions included in the tools referred to above as follows:

“Combined tool to identify the baseline scenario and demonstrate additionality” (Version 02.2)

- This tool is applicable if all potential alternative scenarios to the proposed project activity are available options to project participants.

→ SDC owns the LCD production plants. Therefore, the potential alternative scenarios to the Project activity described in section B.4. and B.5. below for the identification of the baseline scenario and demonstration of additionality are available to the project participants.

"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01);

- This tool is applicable if one out of the following three scenarios applied to the sources of electricity consumption:

  Scenario A: Electricity consumption from the grid
  Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s).
  Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s).

→ The source of electricity consumption by the Project activity is the grid. Therefore, it corresponds to the Scenario A of the tool.

"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 02)

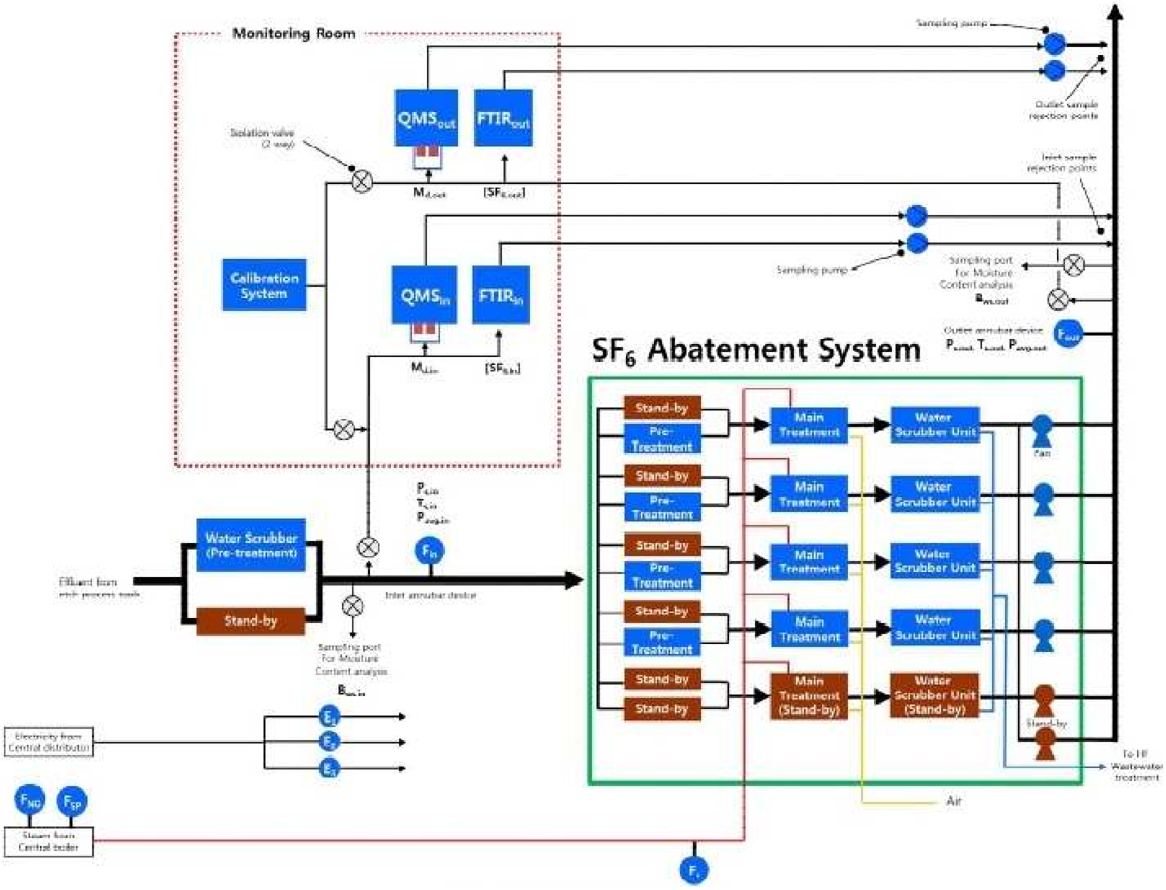
- This tool is applicable to the cases where CO_2 emissions from fossil fuel combustion are calculated based on the quantity of fuel combusted and the CO_2 emission coefficient of the fuel ($COEF_{i,y}$), using one of the following options.

  Option A: The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel
  Option B: The CO_2 emission coefficient $COEF_{i,y}$ is calculated based on the net calorific value
  and CO_2 emission factor of the fuel

→ The Project will consume steam which is generated at central boiler of the Plant. At the central boiler, natural gas is used to generate stream.

→ Although Option A is a preferred option, due to lack of chemical composition of the fuel, option B was chosen. In addition, net calorific value of the fuel was provided by the natural gas supplier, as described in the Section B. 7.1 below.

B.3. Project boundary



Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Use in etching process	CO_2	No	There are no CO_2 emissions related to the project in the baseline scenario.
		SF_6	Yes	This is the primary gas, which will be abated in the project scenario
Project scenario	Unabated SF_6 and CO_2 emissions	CO_2	Yes	Resulting from (1) electricity used to operate the abatement technology (incl. pre wet scrubber)- and (2) steam used to enhance abatement efficiency (if applicable)
		SF_6	Yes	Some small percent of the SF_6 will not be abated via the project

B.4. Establishment and description of baseline scenario

>> As per AM0078 (Version 01.1), identification of the baseline scenario and additionality demonstration is described using the latest version of the “Combined tool to identify the baseline scenario and demonstrate additionality” (“Combined tool”) (Version 02.2) as follows:

Step 1: Identification of alternative scenarios

Sub-step 1a: Define alternative scenarios to the proposed CDM project activity

The potential alternatives to the Project may include:

1. Undertaking this project, using an abatement device without CDM;
2. Continuing the use of SF_6 without any abatement;
3. Using a substitute gas for SF_6;
4. Process modifications/optimization to minimize SF_6 consumption;
5. SF_6 could be captured and recycled at the outlet of the vacuum pump.

Sub-step 1b: Consistency with mandatory applicable laws and regulations

There are no laws and regulations which mandate decomposition, destruction, recycle or substitution of SF_6 in Korea. Therefore, all five scenarios listed below are in compliance with all mandatory applicable legal and regulatory requirements.

1. Undertaking this project, using an abatement device without CDM;
2. Continuing the use of SF_6 without any abatement;
3. Using a substitute gas for SF_6;
4. Process modifications/optimization to minimize SF_6 consumption;
5. SF_6 could be captured and recycled at the outlet of the vacuum pump.

Step 2: Barrier analysis

Sub-step 2a: Identify barriers that would prevent the implementation of alternative scenarios to occur.

From the Step 1a and 1b, there are 5 alternative scenarios.

1. Undertaking this project, using an abatement device without CDM;
2. Continuing the use of SF_6 without any abatement;
3. Using a substitute gas for SF_6;
4. Process modifications/optimization to minimize SF_6 consumption;
5. SF_6 could be captured and recycled at the outlet of the vacuum pump.

For these scenarios, following technological barriers have been identified (there is no financial barriers identified).

A Lack of reliable and ready-to-use substitute gas for SF_6
B Prevailing practice is to prioritize quality of LCD, over reduction of SF_6 consumption
C Lack of technology to capture and recycle SF_6 gas

Details of each barrier are described in the sub-step 2b below.

Sub-step 2b: Eliminate alternative scenarios which are prevented by the identified barriers

Scenario 1 (Undertaking this project, using an abatement device without CDM):
The Scenario 1 does not face any barriers listed in the Sub-step 2a above. Although it faces a significant investment barrier as further discussed in Step 3, Scenario 1 will remain as a possible scenario on Sub-step 2-b.

Scenario 2 (Continuing the use of SF_6 without any abatement):
This is the continuation of the current practice, and there are no financial or technical barriers associated with this scenario.

Scenario 3 (Using a substitute gas for SF_6):
Use of SF_6 for the LCD etching process is a proven and common practice in the industry. All the LCD producers in Korea use only SF_6 for the process.[1] Looking on an international level, some substitution of the SF_6 has been possible, using CF_4 as an alternative. However, it should be noted that CF_4 is also a greenhouse gas, with a high global warming potential.

In order to explain this properly, it is first necessary to revisit the role of SF_6 in LCD substrate production. SF_6 is used as a cover gas in the etching process, to prevent the electric current that is aimed at the surface of the substrate from shorting, and causing damage to the circuitry etched onto the substrate. It is therefore vital to have a full and even cover of SF_6 over the LCD substrate for the duration of the etching process. Even a small blemish during the etching process renders the entire panel worthless, therefore the failure rate of the cover gas must be as close to zero as possible. Significant research, in terms of both time and money, has been expended on the current SF_6 –based etching process, which represents the cutting edge of today's options for producing LCD substrate.

Before an alternative gas could be utilised, the following kinds of actions would have to be undertaken:

1. Significant research and development work, exploring alternative cover gas options, and ensuring that quality can be maintained after use of any new gas. As the cover gas plays such a crucial role in the production process, any manufacturer will be very cautious about introducing such a major change, and would only act after detailed and convincing research.

2. Assuming that a technically workable alternative can be found, the plant and supply chain would have to be modified in line with any process changes needed by the new cover gas. Until R&D work has reached a more advanced stage, it is difficult to ascertain the precise nature of such changes, but at minimum, it is likely that key features of the etching process, such as gas delivery systems and control systems would have to be modified. This would incur both direct costs, and revenue loss due to downtime for the modification process.

3. It would also be necessary for the switch to an alternative to produce a significant cost saving, when compared to the current cover gas. Given that the change would affect a key process in LCD production, it unlikely that change would be implemented unless the cost saving was extremely persuasive: this is unlikely to be the case when SF_6 procurement represents only a tiny fraction of the overall costs of LCD production.

It can therefore be seen that use of SF_6 is the global standard for LCD production, and that development of an alternative would face technical and financial barriers (barrier A of sub-step 2.a) that make its implementation highly unlikely in the foreseeable future. Scenario 3 cannot be seen as a realistic alternative, and is therefore eliminated from the baseline analysis.

Scenario 4 (Process modifications/optimization to minimize SF_6 consumption):

The etching process is a core process in the production of LCD substrate. Timing is critical in the etching process, with the aim of delivering a charge of electricity to the substrate in a precise location and for a precisely controlled length of time. Injection of the correct dosage of SF_6 into the etching chamber is essential to controlling this process, and is therefore essential to ensuring the quality of the LCD panels. A $4m^2$ LCD panel contains millions of lines of circuitry, and a small blemish on even one of these means that the panel will be rejected by quality control. Therefore

[1] Clarification Letter, "Status of SF6 Abatement technology in LCD Industry", Korea Display Industry Association, Sep. 2009

SDC are constantly striving to optimise the etching process itself. However, this optimisation is for the purpose of quality management, and is not for the purpose of reducing SF_6 consumption per se.

SDC are already running Line 7-2 in a way that maintains the optimum balance between SF_6 dosage and quality if the etching process. SDC are constantly refining and improving the production process, and future developments and research findings may lead to SF_6 doses to be increased or decreased. However, it will be the demands of LCD production that dictate this balance, and consideration of cost-saving from reduction in SF_6 consumption will remain a low priority compared with quality control issues.

It can therefore be seen that the standard, prevailing practice at SDC, and indeed within the Korean LCD industry as a whole, is to focus on the needs of the production process, and to treat SF_6 consumption as an unavoidable necessity (barrier B of sub-step 2.a). This prevailing practice barrier makes it highly improbably that an LCD manufacturer would promote SF_6 optimisation at the expense of production values. Scenario 4 is not therefore a realistic baseline scenario, and is excluded from this analysis.

Scenario 5 (SF_6 could be captured and recycled at the outlet of the vacuum pump):
SDC have researched the possibility of capturing and recycling SF_6 gas. A Japanese company has developed a technology, which has been used in an LCD production facility in Japan for the capture and recycling of CF_4. Confidentiality prevents the naming of the company in the PDD. The company conducted a feasibility study at an SDC plant, but the conclusion of the study was negative. In particular it was found that:

1. The technology is not as suited for SF_6 capture as for CF_4 capture.
2. The technology works well for high concentrations of CF_4, but in SDC's case, the concentration of gas at the outlet was much lower (around 10% of the concentration compared to the example of the Japanese plant where the technology had been successfully used).
3. The technology was expensive.

Given these disadvantages, research into this option was discontinued, and SDC focused more strongly on abatement options.

It can therefore be seen that SDC have investigated the possibility of recycling SF_6, but have concluded that there is no mature technology available for this purpose. Capture and recycling of SF_6 face prohibitive technological barriers (barrier C of sub-step 2.a). Scenario 5 is not therefore a realistic and pursuable baseline scenario for the Project, and is excluded from the baseline analysis.

From step 2, alternatives 3, 4 and 5 have been eliminated. The remaining scenarios are,
1. Undertaking this project, using an abatement device without CDM;
2. Continuing the use of SF_6 without any abatement;

Alternative scenarios 1 and 2 are further considered in step 3 below.

Step 3: Investment analysis

As per the note 6 in the Combined tool, since (a) there are only two alternatives remaining, which include the proposed CDM project activity (alternative 1) and one other alternative (alternative 2), (b) both alternatives do not incur any revenue other than CDM related revenue and (c) project (alternative 1) incurs costs and other remaining alternative (alternative 2) does not incur costs, a simply cost analysis is applied.

As shown below, Project activity incur various costs – equipment costs, construction costs and O&M costs. Therefore, the proposed CDM project activity (alternative 1) is more costly than the other remaining alternative (alternative 2).

1. Equipment costs
   - Abatement device:4,986 million KRW
   - Monitoring device: 1,000 million KRW
2. O&M costs
   - Spare parts: 1,320 million KRW/year
   - Labor costs: 1,000 million KRW/year
   - Electricity cost: 180 million KRW/year
   - Chemical costs: 150 million KRW/year
   - Maintenance of monitoring device: 120 million KRW/year
   - Water cost: 80 million KRW/year
   - Other: 100 million KRW/year

In the case only alternative 1 incurs costs while alternative 2 does not incur any cost, the fact that the alternative 1 is more costly than alternative 2 does not change as a result of the sensitivity analysis.

Therefore, step 4 is conducted below.

Step 4: Common practice analysis

There are more than 10 LCD production lines using SF_6 in etching process in Korea. However, except only one line, the SF_6 from the etching process is emitted to the atmosphere without any SF_6 abatement system. According to the Korea Display Industry Association, LG Display has installed a low-capacity abatement system. However, even this small capacity system is currently not in operation due to high operating cost[2]. In addition, LG Display is currently planning installation of a larger scale abatement system as a CDM project to receive the CER revenue needed to finance their project.[3] Therefore it can be concluded that similar activities are not widespread or commonly seen in Korea.

Therefore, it is clear that installation of the SF_6 abatement system in LCD etching process is not common practice in Korea.
As a result of this analysis, it is concluded that Alternative 2 - Continuing the use of SF_6 without any abatement – is identified as the baseline scenario and that the Project activity is additional.

The Project has a starting date of October 16th 2009, which is the date that SDC made the purchase order for the abatement system to Clean System Korea Inc. This date is over two months after completion of the Global Stakeholder Comment of UNFCCC. Therefore, this Project is considered to be a “New” project activity, and detailed evidence of prior consideration is not required.

B.5. Demonstration of additionality

>> As described in Section B.4. using the Combined tool, it is concluded that the Project activity is additional.

---

[2] Clarification Letter, “Status of SF6 Abatement technology in LCD Industry”, Korea Display Industry Association, Sep. 2009

[3] http://cdm.unfccc.int/Projects/Validation/DB/MTDPC0S9WMPJSSGBJNUPC86RJFBVWY/view.html

B.6. Emission reductions

B.6.1. Explanation of methodological choice

>> **Baseline emissions**

Baseline emissions for a crediting year y are calculated on the basis of mass of SF6 entering the abatement device during the year y. In order to prevent intentional increase in baseline emissions, baseline emissions are limited within a cap derived from historical consumption of SF6. Furthermore, any increase in SF_6 consumption per unit of surface area of LCD substrate processed will be discounted by incorporating an "SF6 consumption factor".

The baseline emissions are calculated as follows:

$$BE_{in,y} = k \cdot E_{SF6,y} \cdot GWP_{SF6}$$

Where:

$BE_{in,y}$	Total baseline emissions in year y (tonnes CO_2)
k	SF_6 consumption factor, defined as the ratio of SF_6 consumption per unit of surface area of LCD substrate processed (in m^2) in the project period with that of the baseline (dimensionless)
$E_{SF6,y}$	SF_6 baseline emissions in year y (tonnes SF_6)
GWP_{SF6}	Global warming potential of SF_6 in tonnes of CO_2 per tonnes of SF_6

$$E_{SF6,y} = \min\left\{E_{SF6,in,y}; 0.48 \times C_{SF6,y}; 0.48 \times C_{SF6,hist}\right\}$$

Where:

$E_{SF6,in,y}$	Mass of SF_6 entering the abatement device in year y (tonnes of SF_6), which is the annual sum of the mass of SF_6 entering the abatement device per unit time ($E_{SF6,in}$ in gram per second)
$C_{SF6,y}$	Annual consumption of SF_6 during the project year y, defined as the total SF_6 purchased in a specific project year y, taking into account the change in inventory in the same year (tonnes SF_6)
$C_{SF6,hist}$	Historical SF_6 consumption, calculated as the three years maximum consumption prior the implementation of the project activity before January 3, 2009. Consumption is defined as the total SF_6 purchased in a year, taking into account the change in inventory in a specific year (tonnes SF_6)
0.48	Ratio of SF_6 consumed but not destroyed or transformed in the process. This is derived from the IPCC 2006 Guideline's default factor on destruction/ decomposition(0.4), and factoring in 20% uncertainty ((1-0.4) * 0.8 = 0.48)

SF_6 consumption ratio

Historical ratio of SF_6 consumption versus LCD production based on previous year (-1, -2 and -3) prior to the implementation of the project activity before January 31, 2009.

$$SF_{6,ratio} = \min\left(C_{SF6,-1} \div SP_{-1}; C_{SF6,-2} \div SP_{-2}; C_{SF6,-3} \div SP_{-3}\right)$$

Where:

$SF_{6,ratio}$ (tonnes/m^2) Ratio of SF_6 consumption to the surface area of LCD substrate processed

$C_{SF6,-i}$ Historical SF_6 consumption in year i, where i = -1, -2, -3, previous to the implementation of the project activity before January 31, 2009 (tonnes)

SP_{-i} Historical production of LCD substrate (in m^2) during year i (where i = -1, -2, -3) prior to the implementation of the project activity before January 31, 2009

SF_6 consumption factor

$$k = \begin{cases} 1 & ; SF_{6,ratio} \geq C_{SF6,y} \div SP_{project,y} \\ \dfrac{SF_{6,ratio}}{C_{SF6,y} \div SP_{project,y}} & ; SF_{6,ratio} < C_{SF6,y} \div SP_{project,y} \end{cases}$$

Where:

$SP_{project,y}$ Production of LCD substrate (in m^2) during the project year y

$C_{SF6,y}$ Annual consumption of SF_6 during the project year y, defined as the total SF_6 purchased in a specific project year y, taking into account the change in inventory in the same year (tonnes SF_6)

$SF_{6,ratio}$ (tonnes/m^2) Ratio of SF_6 consumption to the surface area of LCD substrate processed

Since there is no existing abatement device at the project site, parameter $E_{SF6in,\ adj,y}$ was not considered for the Project activity.

Experimental setup for determination of the baseline and project emissions

The figure below depicts the experimental setup required for the measurement of the SF_6 concentrations and dilution through the abatement system, the monitoring of the inlet and outlet flows, and for the calculation of the SF_6 destruction removal efficiency of the abatement device (DRE). This experimental setup will be used during commissioning of the abatement system (initial evaluation period at project startup) and during annual surveillance tests.

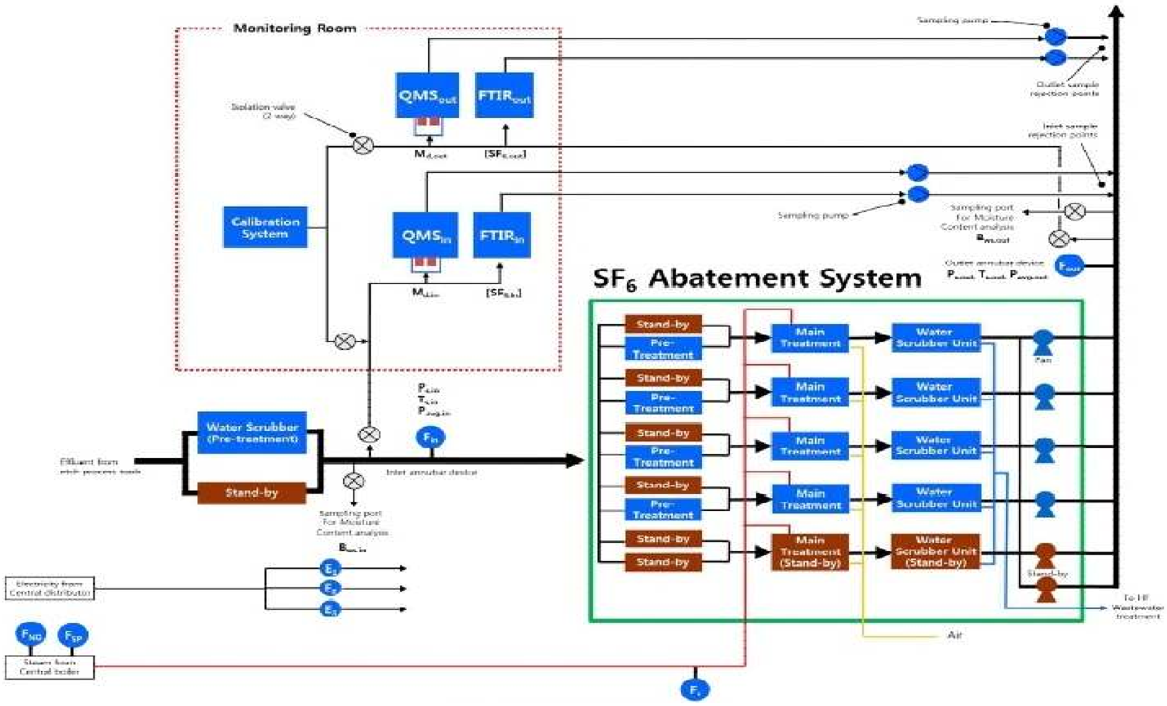


Figure 3. Schematic of the Experimental Setup for Determination of the Baseline and Project Emissions

Calibration of the measuring devices and measurement of the mass of SF_6 entering and exiting the abatement system

The calibration of the measuring devices and measurement of the mass of SF_6 entering and exiting the abatement system will be conducted according to the guideline and requirements of EPA Method 2 and the Methodology.

Following the EPA methodology, the calculation of the averaged volumetric flow rates at the inlet and outlet of the abatement system is based on the measurement and averaging of the pressure differential measured for each gas velocity sampling point across the section of the inlet and outlet stacks. Annubar devices should be used, provided they sample at least 80% of the fluid profile. Method for the calibration and QA/QC procedures for the annubar devices is provided in Annex 1.b of the Methodology.

To convert the concentrations of SF_6 measured at the inlet and outlet of the abatement system into masses of SF_6 entering and exiting the abatement system, measurement of the gas mass densities and of the gas flows shall be conducted. The mass of SF_6 is proportional to the product of the SF_6 concentration and of the total flows at the inlet and outlet. The measurement of the total inlet and outlet flows is derived from a measurement of the inlet and outlet gas velocities, and from a determination of the gas mass densities, taking into account the dry molecular weight of the gases as well as their water content.

The proportion of water vapor in the inlet and outlet gas streams ($B_{ws,in}$ and $B_{ws,out}$) will be determined using US EPA Method 4 and measurement of the moisture content will be done on the basis of percentage volume fraction.

The molecular weight of the inlet gas, on a dry basis ($M_{d,in}$) will be determined by quantifying the

averaged relative concentrations of SF_6, Ar, O_2, CO_2 N_2 and any other gases at concentrations of greater than 100ppmv (mass fraction in percentage) measured by the QMS at the inlet of the abatement system during normal production conditions. The experimental sequence is as follows:

(i) Preliminary sampling of effluents using QMS to identify the effluent components (by determination of the m/e ratios and identification of the IR absorption bands);

(ii) If there is standard gases, calibration the QMS systems with gas standards corresponding to each of the components determined in Step 1 having a concentration of greater than 100ppmv. If there is no standard gases or couldn't be measured exactly by QMS, FTIR will be used. In this case, the average of absolute relative differences should be less than 5% to meet the uncertainty described in Methodology AM0078 ver01.1

(iii) Minimum 6 hours measurement period during standard manufacturing operation.

SDC shall demonstrate that the molecular weight of the inlet stack gas does not vary by more than +/- 5% around the averaged mean value measured during the 6 hours period (using a 95% confidence interval)(if this is not fulfilled, measurement shall be taken again). As a conservative measure, SDC shall record the inlet gas molecular weight ($M_{d,in}$) as the highest value recorded during the 6 hours period . $M_{d,in}$ shall be defined as the highest value of the gas molecular weight measured at the inlet during the 6 hours period.

If gases other than N_2, O_2, Ar, CO_2 and SF_6 are present at the inlet of the abatement system at concentrations of greater than 100ppmv, the project developer shall account for their contribution to the total inlet gas dry molecular weight ($M_{d,in}$) by multiplying their relative concentrations by their individual molecular weights, and adding the result to the calculation. In case there is data measured by FTIR, uncertainty will be considered to calculated $Md,_{in}$

SDC expects that CF_4, CO, HC_1, HF, SO_2F_2 SOF_2 and SiF_4 are likely to be included at concentration of grater than 100ppmv in the outlet gas. If this is the case, $M_{d,in}$ shall be calculated as (gram/mole):

$$M_{d,in} = 1.460[SF_{6in}] + 0.44[CO_{2in}] + 0.399[Ar_{in}] + 0.320[O_{2in}] + 0.280[N_{2in}] + 0.880[CF_4] + 0.280[CO]$$
$$+ 0.365[HC_1] + 0.200[HF] + 1.020[SO_2F_2] + 0.861[SOF_2] + 1.040[SiF_4]$$

Where

$M_{d,in}$ Total inlet stack gas dry molecular weight (gram/mole)

$SF_{6,in}$, ….. SiF_4 Average relative concentration of the gases (mass fraction in percentage)

The QMS and FTIR will be calibrated for any gas detected at the inlet of the abatement device in concentrations greater than 100ppmv, in conformity with the calibration method described in Annex 1.a of the Methodology (replacing SF_6 by the relevant gas).

The molecular weight of the outlet stack gas, on a dry basis ($M_{d,out}$), will be determined by quantifying the relative concentrations of SF_6, Ar, O_2, N_2, CO, CO_2, F_2, HF, SO_2, SOF_2, SO_2F_2 and any other gases at concentrations of greater than 100ppmv (mass fraction in percentage) measured by the QMS at the outlet of the abatement system while running in normal production conditions. This measurement will be performed for a minimum of 6 hours. SDC shall demonstrate

that the molecular weight of the outlet stack gas does not vary by more than +/- 5% around the averaged value measured during the 6 hours period (using a 95% confidence interval) (if this is not fulfilled, measurement shall be taken again). The outlet gas molecular weight ($M_{d,out}$) shall be recorded as the lowest value recorded during the 6 hours period. This is conservative because a low outlet gas molecular weight leads to an overestimation of the project emissions. Thus, $M_{d,out}$ will be defined as the lowest value of the gas mass molecular weight measured at the outlet during the 6 hours period.

If gases other than SF_6, Ar, O_2, N_2, CO, CO_2, F_2, HF, SO_2, SOF_2 and SO_2F_2 are present at the outlet of the abatement system at concentrations of greater than 100ppmv, SDC will account for their contribution to the total outlet gas dry molecular weight ($M_{d,out}$) by multiplying their relative concentrations by their individual molecular weights, and adding to the calculation.

SDC expects that, CF_4, HC_1, and SiF_4 are likely to be included at concentration of grater than 100ppmv in the outlet gas. If this is the case, $M_{d,out}$ shall be calculated as below.

$$M_{d,out} = 1.460[SF_{6,out}] + 0.399[Ar_{out}] + 0.320[O_{2out}] + 0.280[N_{2out}] + 0.28[CO_{out}] + 0.44[CO_{2,out}]$$
$$+ 0.380[F_{2out}] + 0.200[HF_{out}] + 0.641[SO_{2out}] + 0.861[SOF_{2,out}] + 1.021[SO_2F_{2,out}] + 0.880[CF_4]$$
$$0.365[HC_1] + 1.040[SiF_4]$$

Where

$M_{d,in}$ Total inlet stack gas dry molecular weight (gram/mole)

$SF_{6,in}$, ….. SiF_4 Average relative concentration of the gases (mass fraction in percentage)

The QMS will be calibrated for any gas detected at the outlet of the abatement device in concentrations greater than 100ppm, in conformance with the calibration method described in Annex 1.a of the Methodology (replacing SF_6 by the relevant gas).

Following US EPA Method 2, the total (wet) stack gas molecular weights at the inlet and outlet of the abatement system ($M_{s,in}$, $M_{s,out}$) will be calculated using equations

$$M_{s,in} = M_{d,in} \times (100 - B_{ws,in}) \div 100 + 0.18 \times B_{ws,in}$$
$$M_{s,out} = M_{d,out} \times (100 - B_{ws,out}) \div 100 + 0.18 \times B_{ws,out}$$

Where:

$M_{d,in}$ and $M_{d,out}$ Total molecular weights of the inlet and outlet stack gases, dry basis (gram/mole)

$B_{ws,in}$ and $B_{ws,out}$ Water vapor in the inlet and outlet gas streams. (Percentage volume fraction)

Following US EPA Method 2, the averaged inlet and outlet stack gas velocity ($v_{s,in}$, $v_{s,out}$) will be calculated using following equations:

$$v_{s,in} = K_P \times C_{p,in} \sqrt{p_{avg,in}} \sqrt{\frac{T_{s,in}}{P_{s,in} \times M_{s,in}}}$$
$$v_{s,out} = K_P \times C_{p,out} \sqrt{p_{avg,out}} \sqrt{\frac{T_{s,out}}{P_{s,out} \times M_{s,out}}}$$

Where:

$v_{s,in}$ and $v_{s,out}$	Average inlet and outlet stack gas velocities (m/sec)
K_p	Velocity equation constant (=34.97)
$C_{p,in}$ and $C_{p,out}$	Inlet and outlet annubar device coefficients
$p_{avg,in}$ and $p_{avg,in}$	Average inlet and outlet velocity head measurements b, measured across the annubar device (mmH_2O)
$T_{s,in}$ and $T_{s,out}$	Absolute inlet and outlet stack temperatures (K)
$P_{s,in}$ and $P_{s,out}$	Absolute inlet and outlet stack pressures (mmHg)
$M_{s,in}$ and $M_{s,out}$	Stack gas molecular weights at the inlet and outlet of the abatement system

Following US EPA Method 2, the averaged stack dry volumetric total flow rate at the inlet and outlet of the abatement device (Q_{in} and Q_{out} in standard cubic meters per second) will be calculated:

$$Q_{in} = \{(100 - B_{ws,in}) \div 100\} v_{s,in} A_{in} \left[\frac{T_{std} P_{s,in}}{T_{s,in} P_{std}} \right]$$

$$Q_{out} = \{(100 - B_{ws,out}) \div 100\} v_{s,out} A_{out} \left[\frac{T_{std} P_{s,out}}{T_{s,out} P_{std}} \right]$$

Where:

A_{in} and A_{out}	Cross-sectional areas of the inlet and outlet stacks (m^2)
T_{std}	Standard absolute temperature (293°K)
P_{std}	Standard absolute pressure (760 mm Hg)

The mass of SF_6 entering and exiting the abatement device per unit time ($E_{SF6,in}$ and $E_{SF6,out}$ in grams per second) will be calculated by multiplying the volumetric total flow rate (Q_{in} and Q_{out} in standard cubic meters per second) by the concentration of SF_6 at the inlet and outlet (in %) and by the SF_6 molar mass to molar volume ratio:

$$E_{SF6,in} = 65.18 Q_{in} [SF_{6,in}]$$

$$E_{SF6,out} = 65.18 Q_{out} [SF_{6,out}]$$

Where:

SF_{6in} and $SF_{6\ out}$	Concentration of SF_6 at the inlet and outlet (ppm)
$Q_{\ in}$ and Q_{out}	Inlet and Outlet volumetric flow rate (m^3/sec)

Project emissions

Project emissions include emissions due to the incomplete destruction of the SF_6 in the abatement unit and CO_2 emissions from electricity and/or fuel consumption in the abatement device along with any SF_6 entering the abatement device that is not operating within prescribed conditions.

Determination of the SF_6 destruction removal efficiency (DRE) of the abatement device

The SF_6 DRE is calculated as follows:

$$DRE_y = 1 - \frac{E_{SF6,out,y}}{E_{SF6,in,y}}$$

Where:

DRE_y	Destruction removal efficiency of the abatement unit
$E_{SF6,in,y}$	Mass of SF_6 gas entering the abatement device in year y
$E_{SF6,out,y}$	Mass of SF_6 gas exiting the abatement device in year y

Project emissions are calculated as follows:

$$PE_y = BE_y (1 - DRE_y) + C_{CO2,y}$$

$C_{CO2,y} = PE_{CE,y} + PE_{NG,y}$

Where:

PE_y	Project emission during year y
$BE_{,y}$	Baseline emission during year y
$C_{CO2,y}$	Amount of CO_2 produced in a year from the operation of the abatement machine from electricity and/or fuel combustion in year y, calculated using the latest version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" and the "Tool to calculate project or leakage CO_2 emission from fossil fuel combustion"
$PE_{EC,y}$	Project emission from electricity consumption in year y (tCO_2/yr)
$PE_{NG,y}$	Project emission from combustion of natural gas at steam production (tCO_2)

CO_2 emissions from electricity consumption

The Project activity purchases the required electricity from the grid. As per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Electricity consumption tool), CO_2 emissions from electricity consumption are calculated as follows:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{grid,y} \times (1 + TDL_{j,y})$$

Where:

$PE_{EC,y}$	Project emission from electricity consumption in year y (tCO_2/yr)
$EC_{PJ,j,y}$	Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)
$EF_{grid,y}$	Emission factor for electricity generation for source j in year y (tCO_2/MWh)
$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source j in year y
j	Source of electricity consumption in the project

Determination of the emission factor for electricity generation ($EF_{grid,j,y}$)

The Project activity purchases the required electricity from the grid. Therefore, scenario A in the Electricity consumption tool is applied to the Project activity. Among two options, option A1 – Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the "Tool to calculate the emission factor for an electricity system".

Combined Factor

STEP 1. Identify the relevant electric power system

In Korea, there is only one grid, national grid, and the electricity used in the Project will be supplied by the National Grid.

STEP 2. Select an operating margin (OM) method

There are 4 options for calculating the OM, according to the “Tool to calculate the emission factor for an electricity system”.

(a) Simple OM
(b) Simple adjusted OM
(c) Dispatch Data Analysis OM, or
(d) Average OM

In accordance with the “Tool to calculate the emission factor for an electricity system”, any of the four methods can be used, and this PDD selects option (a) the simple OM method; however, option (a) can only be used if low-cost/must-run resources constitute less than 50% of total grid generation in: 1) the average of the five most recent years, or 2) based on long-term averages for hydroelectricity production.

As shown in the table below, low-cost/must-run resources constitute less than 50% of total grid generation, averaged over the five most recent years.

Table 10: The ratio of low cost/must run power generation by year

(Unit: 1,000 MWh)

	2003	2004	2005	2006	2007
Hydro*	6,887	5,861	5,188	5,219	5,042
Coal (anthracite)*	6,960	5,787	5,789	5,709	6,062
Nuclear*	129,672	130,715	146,779	148,749	142,937
Alternative Renewable*	276	350	404	511	831
Total	322,451	342,148	364,639	381,181	403,125
Rate of low cost/must run power generation (%)	44.59%	41.71%	43.37%	42.02%	38.42%

(*:low-operating cost and must-run power plants)
Source: STATISTICS OF ELECTRIC POWER IN KOREA 2005, 2006 and 2007 (by KOREA ELECTRIC POWER CORPORATION)

In calculating the simple OM, the ex-ante option of a 3-year generation-weighted average is chosen, and is based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, thus removing the requirement to monitor and recalculate the emissions factor during the crediting period. For the calculation, data from 2005, 2006 and 2007 is chosen as the data for these years is the most recent available.

STEP 3. Calculate the operating margin emission factor according to the selected method

The simple OM emission factor is calculated as the generation-weighted average of CO_2 emissions per unit of net electricity generation (tCO_2/MWh) of all generation power plants serving the system, not including low-cost/must-run power plants/units. It is calculated based on data for the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system (option C). This option was selected, because the

necessary data for option A or option B is not available, nuclear and renewable power generation are considered as low-cost/ must-run power sources and the quantity of electricity supplied to the grid by these sources is known. Electricity imports are treated as one power plant.

$$EF_{grid,OMsimple,y} = \frac{\sum_i FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{grid,y}}$$

Where:

$EF_{grid,OMsimple,y}$	Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$FC_{i,y}$	Amount of fossil fuel type i consumed in the project electricity system in year y (mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type i in year y (tCO_2/GJ)
$EG_{grid,y}$	Net electricity generated and delivered to the grid by all power sources serving the grid system, not including low-cost/must-run power plants/units in year y (MWh)
i	All fossil fuel types combusted in power sources in the project electricity system in year y
y	The three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option)

STEP 4. Identify the cohort of power units to be included in the build margin

According to "Tool to calculate the emission factor for an electricity system (Ver01.1)", the sample group of power plants for the calculation of $EF_{BM,y}$ can be the larger one of electricity generation of the followings.

(a) The set of five power units that have been built most recently, or
(b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Table 11. Build Margin

	Type (a)	Type (b)	Total (MWh)
Electricity generated (MWh)	34	84,837,781	386,510,193
Ratio to total generation in the grid	0.000009%	21.95%	

Source: STATISTICS OF ELECTRIC POWER IN KOREA 2005, 2006 and 2007 (by KOREA ELECTRIC POWER CORPORATION)

The electricity generation of the "five power plants that have been built most recently" was 34 MWh, which is equivalent to 0.000009% of the total power generation for 2007 (386,510GWh). The result of the calculation of the "Power plants capacity that comprises 20% of the total generation and has been built most recently" is 84,837 GWh, which is equivalent to 21.95% of the total generation. This second case was selected because this one represents the larger annual generation capacity.

In terms of vintage of data, project participants can choose one of the following two options;

Option 1 (ex-ante): For the first crediting period, calculate the build margin emission factor ex-

ante based on the most recent information available on units already built for sample group m at the time of CDM PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2 (ex-post): For the first crediting period, the build margin emission factor shall be updated annually, ex-post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex-ante, as described in option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

For the Project, Option 1 (ex-ante) was selected.

STEP 5. Calculate the build margin emission factor

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$	Build margin CO2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m	Power units included in the build margin
Y	Most recent historical year for which power generation data is available

The CO_2 emission factor of each power unit m ($EF_{EL,m,y}$) was determined by option C of the step 3 (a), using for y the most recent historical year for which power generation data is available, and using for m the power units included in the build margin.

STEP 6. Calculate the combined margin emission factor

The combined margin emission factor is calculated as follows:

$$EF_{grid,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

Where:

$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,OM,y}$	Operating margin CO_2 emission factor in year y (tCO_2/MWh)
w_{OM}	Weighting of operating margin emissions factor (%)
w_{BM}	Weighting of build margin emissions factor (%)

CO_2 emissions from combustion of natural gas to generate steam, which is used to enhance abatement efficiency

The Project activity consumes steam, which was generated by combustion of natural gas (NG) at the central boiler of the plant. As per the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", CO_2 emission from combustion of NG is calculated as follows:

$PE_{NG,y} = FC_{NG,y} \times COEF_{NG,y}$

Where :

PENG,y Project emission from natural gas combustion in the year y (tCO_2)

$FC_{NG,y}$ Quantity of natural gas combusted in the year y (Nm^3)

$COEF_{NG,y}$ CO2 emission coefficient of natural gas (tCO_2/Nm^3)

To calculate $COEF_{NG,y}$ value, the tool provides following two options.

Option A: Calculated based on the chemical composition of the fossil fuel type

Option B: Calculated based on net calorific value and CO2 emission factor

Although Option A is a preferred approach, based on the tool, Option B was selected due to lack of data availability.

$COEF_{NG,y} = NCV_{NG,y} \times EF_{CO2,NG,y}$

Where :

$NCV_{NG,y}$ Net calorific value of natural gas in year y (TJ/Nm^3)

$EF_{CO2,NG,y}$ CO2 emission factor of the natural gas combusted in the Project (tCO2/TJ)

For data source of both $NCV_{NG,y}$ and $EF_{CO2,NG,y}$, the following data source maybe used.

Option a): Value provided by the fuel supplier in invoices (preferred option)

Option b): Measurements by the project participants

Option c): Regional or national default value

Option d): IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 or 1.4 of Chapter 1 of Vol.2 (English) of the 2006 IPCC Guidelines on National GHG Inventories

For $NCV_{NG,}$ option a) was applied as is the preferred option. On the other hand, option d) was applied to $EF_{CO2,NG,y}$ as data needed for option a) is not available from the fuel supplier.

Since the Project utilizes only a small potion of the steam generated at the central boiler, direct measurement of $FC_{NG,y}$ is not possible. Therefore, weighted ratio of steam the Project consumed against the total steam production at the central boiler is used to calculate the $FC_{NG,y}$.

$FC_{NG,y} = C_{NG,plant,y} \times W_{Steam}$

$W_{Steam} = C_{Steam,y} / C_{Steam,plant,y}$

Where

$C_{Steam,y}$ Quantity of steam consumed by the Project year y

$C_{Steam,plant,y}$ Quantity of steam generated by the central boiler in year y
$C_{NG,plant}$ Quantity of natural gas consumed by the central boiler in year y

Quality assurance and quality control (QA/QC) procedures

In addition to the calculation of the standard deviations and R^2 values determined during the calibration procedures for the FTIR and QMS systems (refer to Annex 1.a. of the Methodology), SDC will ensure conformance to the following QA/QC procedures:

Step 1: QA/QC procedure for the calibration and maintenance of the Annubar devices
SDC will follow the QA/QC procedures highlighted in US EPA Methods 1, 2, and 4, including adequate proof that the openings of the Annubar devices have not plugged up during the measurement period. This can be accomplished by comparing the velocity measurement before and after back-purging the Annubar devices with pressurized air to clean them. If the before and after velocity measurements are within 5 percent, then the data is acceptable. If the back-purging methodology is insufficient to ensure the Annubar devices cleanliness (measurements are not within 5%), SDC will determine a minimum maintenance frequency and procedure to manually clean the Annubar devices. For the avoidance of doubt, the minimum additional manual maintenance frequency will be determined to ensure that the before and after purge velocities measured at the inlet and outlet Annubar devices do not drop by more than 5% between the Annubar devices cleaning procedures. SDC will record the maintenance schedule as a non-monitored parameter.

Step 2: QA/QC procedure for maintenance of abatement system
SDC will follow the abatement device manufacturer's recommendations for maintaining the abatement device, including inspection and cleaning procedures and replacement of consumable parts.

Step 3: QA/QC procedure for maintenance of FTIR system
To detect eventual drifts in the FTIR systems' calibration due to coating of the FTIR windows, the operator will perform periodic calibrations of the FTIR systems using the procedure described in Annex 1.a of the Methodology. If a deviation in the slope of the calibration curve of greater than 5% is detected (compared to the reference calibration slope generated during the initial evaluation period), SDC will be required to clean or replace the FTIR windows and to repeat the FTIR calibration procedure described in Annex 1.a of the Methodology. The minimum frequency for the cleaning or replacement of the FTIR windows will be recorded as a non-monitored parameter. Recalibration of the FTIR devices will be required every time the abatement device is brought offline for maintenance or every time the FTIR devices themselves are brought offline for maintenance.

Step 4: Annual surveillance test
For the annual surveillance test, the project will use the guidelines provided in EN14181 (Quality assurance of automated measuring systems). To ensure that the measurement conditions at the inlet and outlet of the abatement system have not changed during the crediting period, SDC will repeat the QMSs, FTIRs and Annubar devices calibration procedures described in Annex 1.a and 1.b on a yearly basis.

Leakage

No leakage is expected from this methodology.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Where:

ERy	Emission reductions in year *y* (t CO2e/yr)
BEy	Baseline emissions in year *y* (t CO2e/yr)
PEy	Project emissions in year *y* (t CO2/yr)

B.6.2. Data and parameters fixed ex ante

<table>
<tr><td>Data / Parameter</td><td>$EF_{grid,y}$</td></tr>
<tr><td>Unit</td><td>tCO_2/MWh</td></tr>
<tr><td>Description</td><td>Emission factor for electricity generation for source j in year y</td></tr>
<tr><td>Source of data</td><td>Tool to calculate baseline, project and/or leakage emissions from electricity consumption</td></tr>
<tr><td>Value(s) applied</td><td>0.5914</td></tr>
<tr><td>Choice of data or Measurement methods and procedures</td><td>Grid emission factor is calculated as a combined margin using ex-ante option. Detailed calculation can be found in Appendix 3 of the PDD. Key information and data used for calculation of $EF_{grid,y}$ is shown below.

Table 12. Parameter used for CM
<table>
<tr><th>Parameter</th><th>Value</th><th>Source</th></tr>
<tr><td>$FC_{i,y}$</td><td>Refer to Appendix 3</td><td>Statistics of Electric Power in Korea</td></tr>
<tr><td>$CV_{i,y}$ (Calorific value)</td><td>Refer to Appendix 3</td><td>Statistics of Electric Power in Korea</td></tr>
<tr><td>Net Calorific Value Conversion Factor</td><td>Solid/Liquid fuel: 0.95
Gaseous fuel: 0.9</td><td>2006 IPCC Guidelines for National Greenhouse Gas Inventories</td></tr>
<tr><td>$NCV_{i,y}$</td><td>Refer to Appendix 3</td><td>Calculated : ($CV_{i,y}$) x (Net Calorific Value Conversion Factor)</td></tr>
<tr><td>$EF_{CO2,i,y}$</td><td>Refer to Appendix 3</td><td>2006 IPCC Guidelines for National Greenhouse Gas Inventories. Applied Upper values of 95% confidence interval.</td></tr>
<tr><td>$EF_{grid,OM,y}$</td><td>0.7509</td><td>Calculated</td></tr>
<tr><td>$EF_{grid,BM,y}$</td><td>0.4319</td><td>Calculated</td></tr>
<tr><td>$EF_{grid,CM,y}$</td><td>0.5914</td><td>Calculated</td></tr>
</table></td></tr>
<tr><td>Purpose of data</td><td></td></tr>
<tr><td>Additional comment</td><td></td></tr>
</table>

Data / Parameter	GWP of SF_6
Unit	$kgCO_2eq/Kg\ SF_6$
Description	Global warming potential of SF_6
Source of data	IPCC
Value(s) applied	23,900
Choice of data or Measurement methods and procedures	Value from IPCC is used. Project participants will keep track of any change by the CDM Executive Board in the assigned GWP of SF_6
Purpose of data	
Additional comment	

Data / Parameter	Historical SF_6 consumption ($C_{SF6,\ hist}$)
Unit	Tonnes
Description	Historical SF_6 consumption, calculated as the three years maximum consumption prior to the implementation of the project activity before 31 January 2009. Consumption is defined as the total SF_6 purchased in a year, taking into account the change in inventory in a specific year
Source of data	Record of purchase and inventory
Value(s) applied	74.48
Choice of data or Measurement methods and procedures	Historical three years consumption data is as follows: Year 2006 (01/01/2006 ~ 31/12/2006): 38.00 tonnes Year 2007 (01/01/2007 ~ 31/12/2007): 69.92 tonnes Year 2008 (01/01/2008 ~ 31/12/2008): 74.48 tonnes
Purpose of data	
Additional comment	

Data / Parameter	Historical production of LCD substrate (SP_{-i})
Unit	m^2
Description	Historical production of LCD substrate (m^2) during year i (where i = -1, -2, -3) prior to the implementation of the project activity before January 31, 2009
Source of data	Production records
Value(s) applied	Year 2006 (01/01/2006 ~ 31/12/2006): 2,455,198 m^2 Year 2007 (01/01/2007 ~ 31/12/2007): 5,126,394 m^2 Year 2008 (01/01/2008 ~ 31/12/2008): 6,485,252 m^2
Choice of data or Measurement methods and procedures	Production records from the project developer are used.
Purpose of data	
Additional comment	

Data / Parameter	Maintenance schedule for abatement device
Unit	Maintenance requirements by the manufacturer
Description	Maintenance schedule for each item required by the manufacturer's instruction
Source of data	Manufacturers specification
Value(s) applied	N/A
Choice of data or Measurement methods and procedures	Manufacturer will provide a schedule for the abatement device and the Developer will conduct the maintenance accordingly.
Purpose of data	
Additional comment	

Data / Parameter	Maintenance schedule for FTIR measurement devices
Unit	Maintenance requirements by the manufacturer
Description	Maintenance schedule for each item required by the manufacturer's instruction
Source of data	Manufacturers specification
Value(s) applied	N/A
Choice of data or Measurement methods and procedures	Manufacturer will provide a schedule for the FTIR and the Developer will conduct the maintenance accordingly.
Purpose of data	
Additional comment	

Data / Parameter	Maintenance schedule for Annubar device
Unit	Maintenance requirements by the manufacturer
Description	Maintenance schedule for each item required by the manufacturer's instruction
Source of data	Manufacturers specification
Value(s) applied	N/A
Choice of data or Measurement methods and procedures	Manufacture will provide a schedule for Annubar and the Developer will conduct the maintenance accordingly.
Purpose of data	
Additional comment	

Data / Parameter	$C_{p,in}$
Unit	Coefficient of the inlet Annubar device (dimensionless)
Description	Inlet annubar device coefficients

Source of data	Korea Research Institute of Standards and Science
Value(s) applied	1.0126
Choice of data or Measurement methods and procedures	Test report of KRISS (Korea Research Institute of Standards and Science - nationally recognized standard organization) was used
Purpose of data	
Additional comment	

Data / Parameter	$C_{p,out}$
Unit	Coefficient of the inlet Annubar device (dimensionless)
Description	Outlet annubar device coefficients
Source of data	Korea Research Institute of Standards and Science
Value(s) applied	1.0126
Choice of data or Measurement methods and procedures	Test report of KRISS(Korea Research Institute of Standards and Science - nationally recognized standard organization) was used
Purpose of data	
Additional comment	

Data / Parameter	Cross sectional area of the inlet stack (A_{in})
Unit	m^2
Description	Cross-sectional areas of the inlet stacks
Source of data	Isometric Drawing
Value(s) applied	0.0755
Choice of data or Measurement methods and procedures	Diameter of inlet stack is 310mm, which equals to 0.0755 m^2
Purpose of data	
Additional comment	

Data / Parameter	Cross sectional area of the outlet stack (A_{out})
Unit	m^2
Description	Cross-sectional areas of the outlet stacks
Source of data	Isometric Drawing
Value(s) applied	0.0755
Choice of data or Measurement methods and procedures	Diameter of outlet stack is 310mm, which equals to 0.0755 m^2
Purpose of data	

Additional comment	

Data / Parameter	$EF_{CO2,NG,y}$
Unit	tCO_2/TJ
Description	CO2 emission factor of the natural gas combusted in the Project
Source of data	IPCC
Value(s) applied	58.3
Choice of data or Measurement methods and procedures	Default value from table 1.4 of Chapter 1 of Vol. 2 of the 2006 IPCC Guidelines for National GHG Inventories is used. 95% upper confidence interval was applied.
Purpose of data	
Additional comment	

B.6.3. Ex ante calculation of emission reductions

>> Mass of SF_6 gas entering the abatement system

$$E_{SF6,y} = \min\{E_{SF6,in,y}; 0.48 \times C_{SF6,y}; 0.48 \times C_{SF6,hist}\}$$

Whereas, value (including expected) for each parameters are,

$E_{SF6,in,y}$ = 53.72 t (refer to section B.7.1)
$C_{SF6,y}$ = 89.103 t (refer to section B.7.1)
$C_{SF6,hist}$ = 74.48 t (refer to section B.6.2)

$$E_{SF6,y} = \min\{53.72; 0.48 \times 89.103; 0.48 \times 74.48\}$$
$$= 35.7504$$

SF_6 consumption ratio

$$SF_{6,ratio} = \min(C_{SF6,-1} \div SP_{-1}; C_{SF6,-2} \div SP_{-2}; C_{SF6,-3} \div SP_{-3})$$

Whereas,

Table 13. Historical data for SF_6 consumption

	$C_{SF6,hist}$ (refer to B.6.2)	SP_{-i} (refer to B.6.2)	$SF6_{ratio}$
2006 (-3)	38	2,455,198	0.000015
2007 (-2)	69.92	5,126,394	0.000014
2008 (-1)	74.48	6,485,252	0.000011

$$SF_{6,ratio} = 0.000011$$

SF_6 consumption factor

$$k = \begin{cases} 1 & ; SF_{6,ratio} \geq C_{SF6,y} \div SP_{project,y} \\ \dfrac{SF_{6,ratio}}{C_{SF6,y} \div SP_{project,y}} & ; SF_{6,ratio} < C_{SF6,y} \div SP_{project,y} \end{cases}$$

For the *ex-ante* calculation, it is assumed that SF_6 consumption factor is 1 (k=1)

Baseline emissions

$$\begin{aligned} BE_{in,y} &= k \cdot E_{SF6,y} \cdot GWP_{SF6} \\ &= 1 \times 35.7504 \times 23{,}900 \\ &= 854{,}434.6 \end{aligned}$$

Determination of the SF_6 destruction removal efficiency (DRE) of the abatement device

$$DRE_y = 1 - \frac{E_{SF6,out,y}}{E_{SF6,in,y}}$$

Whereas, for the *ex-ante* calculation, it is assumed that the destruction efficiency of the abatement system is 90%[4], therefore,

$$DRE_y = 0.9$$

CO_2 emissions from electricity consumption

$$C_{CO2,y} = \sum_j EC_{PJ,j,y} \times EF_{grid,y} \times (1 + TDL_{j,y})$$

Whereas, value for each parameters are,

$EC_{PJ,j,y}$ = 1,261.440 MWh (refer to section B.7.1)
$EF_{grid,j,y}$ = 0.5914 tCO2/MWh (refer to Appendix 3 of the PDD)
$TDL_{j,y}$ = 0.0399 (refer to section B.7.1)

$$PE_{EC,y} = 775.78 tCO_2e$$

CO2 emissions from Combustion of Natural Gas

$PE_{NG,y} = FC_{NG,y} \times COEF_{NG,y}$
$COEF_{NG,y} = NCV_{NG,y} \times EF_{CO2,NG,y}$
$FC_{NG,y} = C_{NG,plant,y} \times W_{Steam}$
$W_{Steam} = C_{Steam,y} / C_{Steam,plant,y}$

Whereas, value for each parameters are,

$NCV_{NG,y} = 39.19 \times 10^{-6}$ TJ/Nm^3
$EF_{CO2,NG,y}$ = 58.3 tCO_2/TJ
$FC_{NG,y}$ = 0 Nm^3

[4] 90% is the guaranteed performance value indicated by the technology provider, so actual destruction rate of SF_6 should be equal to or better than 90%.

$C_{NG,plant}$ = 53,000,000Nm^3
$C_{Steam,y}$ = 0 t
$C_{Steam,plant,y}$ = 800,000t

$PE_{NG,y}$ = 0tCO_2e
39.19 × 10^{-6}

Project emissions

$$PE_y = BE_y (1 - DRE_y) + C_{CO2,y}$$

$C_{CO2,y}$ = $PE_{EC,y}$ + $PE_{NG,y}$

Whereas, value for each parameters are,
BE_y = 854,434.6 t (eCO_2)
DRE_y = 0.9
$C_{CO2,y}$ = 775.78tCO_2
$PE_{EC,y}$ = 775.78tCO2
$PE_{NG,y}$ = 0tCO2

$$PE_y = 86{,}219.2 tCO_2e$$

Emission reductions

$$ER_y = BE_y - PE_y$$
$$= 854{,}434.6 - 86{,}219.2$$
$$= 768{,}215 tCO_2e$$

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
Year 1	854,434.6	**86,219.2**	0	768,215
Year 2	854,434.6	**86,219.2**	0	768,215
Year 3	854,434.6	**86,219.2**	0	768,215
Year 4	854,434.6	**86,219.2**	0	768,215
Year 5	854,434.6	**86,219.2**	0	768,215
Year 6	854,434.6	**86,219.2**	0	768,215
Year 7	854,434.6	**86,219.2**	0	768,215
Year 8	854,434.6	**86,219.2**	0	768,215
Year 9	854,434.6	**86,219.2**	0	768,215
Year 10	854,434.6	**86,219.2**	0	768,215
Total	8,544,346	**862,192**	0	7,682,150
Total number of crediting years	10 Years			

Annual average over the crediting period	854,434.6	**86,219.2**	0	768,215

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	$EC_{PJ,j,y}$
Unit	MWh/yr
Description	Quantity of electricity consumed by the project electricity consumption source j in year y
Source of data	On-site measurement
Value(s) applied	Total electricity consumption of project equipment: 144 kW Annual hours of operation assumed: 8,760 h Total annual electricity consumption = 1,261,440 KWh / year **Name of Equipment** / **Power Consumption/ unit (KW)** / **Number of unit*** / **Total power consumption (KW)** RTO Reactor / 5.5 / 4 / 22.0 Water Scrubber / 2.2 / 4 / 8.8 Fan / 28.3 / 4 / 113.2 **TOTAL** / 144.0 * Since there is no power consumption from standby units, power consumption of RTO Reactor, Water Scrubber and Fan were calculated based on number of unit actually in operation and not considering standby units.
Measurement methods and procedures	It will be measured continuously using electricity meters and aggregated at least annually.
Monitoring frequency	It will be monitored annually.
QA/QC procedures	The meters will be periodically calibrated according to the manufacturer's instruction and/or national standard.
Purpose of data	
Additional comment	

Data / Parameter	$TDL_{j,y}$
Unit	%
Description	Average technical transmission and distribution losses for providing electricity to source j in year y
Source of data	STATISTICS OF ELECTRIC POWER IN KOREA 2007 (by KOREA ELECTRIC POWER CORPORATION)
Value(s) applied	3.99
Measurement methods and procedures	The value is most recent, accurate and reliable data for Korea. During the crediting period, the latest value at the time of each verification will be used.

Monitoring frequency	It will be monitored annually.
QA/QC procedures	
Purpose of data	
Additional comment	

Data / Parameter	$E_{SF6,in,y}$
Unit	tonnes
Description	Mass of SF_6 gas entering the abatement device in year y
Source of data	From inlet FRIT and inlet Annubar device
Value(s) applied	53.72
Measurement methods and procedures	Annual sum of the mass of SF_6 entering the abatement device per unit time ($E_{SF6,\ in}$ in grams per second). This parameter is monitored annually. For the purpose of calculating expected emission reductions, value was calculated using $E_{SF6,in,}$ (1.7033 g/sec) and operating hour (8,760 h =31,536,000 sec).
Monitoring frequency	
QA/QC procedures	All of the manufacturer's maintenance and calibration procedures and timetables will be followed.
Purpose of data	
Additional comment	

Data / Parameter	$C_{SF6,y}$
Unit	tonnes
Description	Annual consumption of SF_6 during the year y, defined as the total SF_6 purchase in a specific project year y taking into account the change in inventory in the same year
Source of data	Record of purchase and inventory
Value(s) applied	89.103
Measurement methods and procedures	This parameter will be monitored annually.
Monitoring frequency	It will be monitored annually
QA/QC procedures	The value will be cross checked with the purchase records.
Purpose of data	
Additional comment	

Data / Parameter	$SP_{project,y}$
Unit	m^2
Description	Production of LCD substrate during the project year y
Source of data	Production, sales and inventory records
Value(s) applied	

Measurement methods and procedures	Production record will be used. This parameter will be monitored annually.
Monitoring frequency	It will be monitored annually
QA/QC procedures	
Purpose of data	
Additional comment	

Data / Parameter	$E_{SF6,in}$
Unit	Gram/second
Description	Amount of SF_6 gas measured at the inlet of the SF_6 abatement system
Source of data	Inlet QMS, FTIR and Annubar device
Value(s) applied	1.7033
Measurement methods and procedures	This parameter is calculated by multiplying the volumetric total flow rate by the concentration of SF_6 at the inlet (in %) and by the SF_6 molar mass to molar volume ratio (6,518 gram/ standard cubic meter). This parameter will be monitored continuously.
Monitoring frequency	
QA/QC procedures	All of the manufacturer's maintenance and calibration procedures and timetables will be followed.
Purpose of data	
Additional comment	Only the values obtained when QMS, FTIR systems, Annubar devices or calibration are operating within required parameters are taken into account for the purpose of calculating $E_{SF6,in,y}$

Data / Parameter	$E_{SF6,out}$
Unit	Gram/second
Description	Amount of SF_6 gas measured at the outlet of the SF_6 abatement system
Source of data	Outlet QMS, FTIR and Annubar device
Value(s) applied	0.1687
Measurement methods and procedures	This parameter is calculated by multiplying the volumetric total flow rate by the concentration of SF_6 at the outlet (in %) and by the SF_6 molar mass to molar volume ratio (6,518 gram/ standard cubic meter). This parameter will be monitored continuously.
Monitoring frequency	
QA/QC procedures	All of the manufacturer's maintenance and calibration procedures and timetables will be followed.
Purpose of data	
Additional comment	Only the values obtained when QMS, FTIR systems, Annubar devices or calibration are operating within required parameters are taken into account for the purpose of calculating $E_{SF6,out,y}$

Data / Parameter	$M_{d,in}$
Unit	Gram/mole

Description	Total dry molecular weight of inlet stack gas
Source of data	QMS and FTIR
Value(s) applied	28.6752
Measurement methods and procedures	Quantifying the averaged relative concentrations of SF_6, Ar, O_2, CO_2, N_2 and other gases with concentration of greater than 100ppmv, such as CF_4, CO, HC_1, HF, SO_2F_2 SOF_2 and SiF_4 (percentage mass fraction) measured by the QMS and FTIR at the inlet of the abatement system during normal production conditions. If there is no standard gases or couldn't be measured exactly by QMS, FTIR will be used. In this case, FTIR will take a calibration for its reliability. According to methodology AM0078 ver01.1, Md,in will be calculated applying uncertainty to molecular weight measured by FTIR for conservative manner. $M_{d,in}$ will be defined as the highest value of the gas molecular weight measured at the inlet during the 6 hours period per year. This parameter is measured once per year
Monitoring frequency	
QA/QC procedures	Guideline in Annex 1.a in the methodology will be followed.
Purpose of data	
Additional comment	

Data / Parameter	$M_{d,out}$
Unit	Gram/mole
Description	Total dry molecular weight of outlet stack gas
Source of data	QMS
Value(s) applied	28.4943
Measurement methods and procedures	Quantifying the averaged relative concentrations of SF_6, Ar, O_2, N_2, CO, CO_2, F_2, HF, SO_2, SOF_2, SO_2F_2 and other gases with concentration of greater than 100ppmv, such as CF_4, HC_1, and SiF_4 (percentage mass fraction) measured by the QMS at the inlet of the abatement system during normal production conditions. $M_{d,out}$ will be defined as the highest value of the gas molecular weight measured at the inlet during the 6 hours period per year. This parameter is measured once per year
Monitoring frequency	
QA/QC procedures	Guideline in Annex 1.a in the methodology will be followed.
Purpose of data	
Additional comment	

Data / Parameter	$B_{ws,\ in}$
Unit	Dimensionless (percentage volume fraction)
Description	The proportion of water in the inlet gas stream measured using EPA Method 4, and used to calculate the inlet gas molecular weight.
Source of data	EPA Method 4
Value(s) applied	2.5

Measurement methods and procedures	This measurement will be done for a minimum of 6 hours during normal manufacturing conditions. The averaged proportion of water during the 6 hours period will be used to calculate the inlet gas stream total (wet) molecular weight. This parameter is measured once per year.
Monitoring frequency	
QA/QC procedures	QA.QC will follow US EPA method. This will be calibrated and maintained per the manufacturer's instructions
Purpose of data	
Additional comment	

Data / Parameter	$B_{ws, out}$
Unit	Dimensionless (percentage volume fraction)
Description	The proportion of water in the inlet gas stream measured using EPA Method 4, and used to calculate the inlet gas molecular weight.
Source of data	EPA Method 4
Value(s) applied	4.0
Measurement methods and procedures	This measurement will be done for a minimum of 6 hours during normal manufacturing conditions. The averaged proportion of water during the 6 hours period will be used to calculate the outlet gas stream total (wet) molecular weight. This parameter is measured once per year.
Monitoring frequency	
QA/QC procedures	QA.QC will follow US EPA method. This will be calibrated and maintained per the manufacturer's instructions
Purpose of data	
Additional comment	

Data / Parameter	$P_{s,in}$
Unit	mmHg
Description	The inlet stack pressure measured during manufacturing operations
Source of data	Pressure gauge
Value(s) applied	754.116
Measurement methods and procedures	Followed by US EPA Method. This parameter will be continuously measured.
Monitoring frequency	
QA/QC procedures	Followed by US EPA Method. The inlet pressure gauge will be calibrated and maintained per the manufacturer's instructions.
Purpose of data	
Additional comment	

Data / Parameter	$P_{s,out}$
Unit	mmHg
Description	The outlet stack pressure measured during manufacturing operations

Source of data	Pressure gauge
Value(s) applied	752.645
Measurement methods and procedures	Followed by US EPA Method. This parameter will be continuously measured.
Monitoring frequency	
QA/QC procedures	Followed by US EPA Method. The outlet pressure gauge will be calibrated and maintained per the manufacturer’s instructions.
Purpose of data	
Additional comment	

Data / Parameter	$T_{s,in}$
Unit	K
Description	The inlet stack temperature measured during manufacturing operations
Source of data	Thermocouple
Value(s) applied	301
Measurement methods and procedures	Followed by US EPA Method. This parameter will be continuously measured.
Monitoring frequency	
QA/QC procedures	Followed by US EPA Method. The inlet temperature gauge will be calibrated and maintained per the manufacturer’s instructions.
Purpose of data	
Additional comment	

Data / Parameter	$T_{s,out}$
Unit	K
Description	The outlet stack temperature measured during manufacturing operations
Source of data	Thermocouple
Value(s) applied	297
Measurement methods and procedures	Followed by US EPA Method. This parameter will be continuously measured.
Monitoring frequency	
QA/QC procedures	Followed by US EPA Method. The outlet temperature gauge will be calibrated and maintained per the manufacturer’s instructions.
Purpose of data	
Additional comment	

Data / Parameter	$p_{avg,in}$
Unit	mmH_2O
Description	The averaged velocity head measurement used to calculate the inlet gas velocity

Source of data	Differential pressure gauge
Value(s) applied	0.3452
Measurement methods and procedures	Followed by US EPA Method. This parameter will be continuously measured.
Monitoring frequency	
QA/QC procedures	Followed by US EPA Method. The project proponents will completely discount from the baseline any SF6 emitted during periods of times where the gas velocity measured at the inlet decreases by more than 5%, compared to the averaged velocity
Purpose of data	
Additional comment	

Data / Parameter	$p_{avg,out}$
Unit	mmH_2O
Description	The averaged velocity head measurement used to calculate the inlet gas velocity
Source of data	Differential pressure gauge
Value(s) applied	0.3414
Measurement methods and procedures	Followed by US EPA Method. This parameter will be continuously measured.
Monitoring frequency	
QA/QC procedures	Followed by US EPA Method. The project proponents will completely discount from the baseline any SF6 emitted during periods of times where the gas velocity measured at the outlet increases by more than 5%, compared to the averaged velocity
Purpose of data	
Additional comment	

Data / Parameter	$v_{s,in}$
Unit	m/sec
Description	Inlet gas velocity
Source of data	Measurement of inlet gas velocity corrected for pressure and temperature variations
Value(s) applied	2.4661
Measurement methods and procedures	Followed by US EPA Method. This parameter will be continuously measured.
Monitoring frequency	
QA/QC procedures	Followed by US EPA Method.
Purpose of data	
Additional comment	

Data / Parameter	$v_{s,out}$
Unit	m/sec
Description	Outlet gas velocity
Source of data	Measurement of outlet gas velocity corrected for pressure and temperature variations
Value(s) applied	2.4530
Measurement methods and procedures	Followed by US EPA Method. This parameter will be continuously measured.
Monitoring frequency	
QA/QC procedures	Followed by US EPA Method.
Purpose of data	
Additional comment	

Data / Parameter	Q_{in}
Unit	m^3/s
Description	Inlet volumetric flow rate
Source of data	Measurement of inlet gas velocity corrected for pressure and temperature variations
Value(s) applied	0.1633
Measurement methods and procedures	Followed by US EPA Method. This parameter will be continuously measured.
Monitoring frequency	
QA/QC procedures	Followed by US EPA Method.
Purpose of data	
Additional comment	

Data / Parameter	Q_{out}
Unit	m^3/s
Description	Outlet volumetric flow rate
Source of data	Measurement of outlet gas velocity corrected for pressure and temperature variations
Value(s) applied	0.1618
Measurement methods and procedures	Followed by US EPA Method. This parameter will be continuously measured.
Monitoring frequency	
QA/QC procedures	Followed by US EPA Method.
Purpose of data	
Additional comment	

Data / Parameter	**Inlet SF_6 concentration**

Unit	ppm
Description	Inlet SF_6 concentration measured by FTIR
Source of data	Inlet FTIR system
Value(s) applied	1,600
Measurement methods and procedures	Conversion of FTIR absorbance measurement into concentration. This parameter will be monitored continuously.
Monitoring frequency	
QA/QC procedures	The inlet FTIR unit will be calibrated and maintained per the manufacturer's instructions.
Purpose of data	
Additional comment	

Data / Parameter	**Outlet SF_6 concentration**
Unit	ppm
Description	Outlet SF_6 concentration measured by FTIR
Source of data	Outlet FTIR system
Value(s) applied	160
Measurement methods and procedures	Conversion of FTIR absorbance measurement into concentration. This parameter will be monitored continuously.
Monitoring frequency	
QA/QC procedures	The outlet FTIR unit will be calibrated and maintained per the manufacturer's instructions.
Purpose of data	
Additional comment	

Data / Parameter	$\mathbf{C_{Steam,y}}$
Unit	ton
Description	Quantity of steam consumed by the Project year y
Source of data	On-site measurement
Value(s) applied	0 t
Measurement methods and procedures	Monitored Continuously using meters located at the site. The monitored data will be recorded on daily basis.
Monitoring frequency	
QA/QC procedures	The meters will be calibrated and maintained per the manufacturer's instructions and/or national standard.
Purpose of data	
Additional comment	Steam maybe consumed by the Project to enhance the destruction efficiency of the RTO reactor. However, there is no plan to consume the steam in the foreseeable future; therefore the value of zero was used in the ex-ante calculation.

Data / Parameter	$C_{Steam,plant,y}$
Unit	ton
Description	Quantity of steam generated by the central boiler in year y
Source of data	On-site measurement
Value(s) applied	800,000 t
Measurement methods and procedures	Monitored Continuously using steam meters located in the central boilers. The monitored data will be recorded on daily basis.
Monitoring frequency	
QA/QC procedures	The meters will be calibrated and maintained per the manufacturer's instructions and/or national standard.
Purpose of data	
Additional comment	

Data / Parameter	$C_{NG,plant}$
Unit	Nm^3
Description	Quantity of natural gas consumed by the central boiler in year y
Source of data	On-site measurement
Value(s) applied	53,000,000 Nm_3
Measurement methods and procedures	Monitored Continuously using natural gas meters located in the central boilers. The monitored data will be recorded on daily basis.
Monitoring frequency	
QA/QC procedures	The meters will be calibrated and maintained per the manufacturer's instructions and/or national standard.
Purpose of data	
Additional comment	

Data / Parameter	$NCV_{NG,y}$
Unit	TJ/Nm3
Description	Net calorific value of natural gas
Source of data	Korea Gas Cooperation data
Value(s) applied	39.19 x 10-6 43.54 x 10-6 (GCV) x (1-10%)

Measurement methods and procedures	For the NCV, value provided by the fuel supplier, Korea Gas Cooperation (KOGAS), will be applied as the primary data. However, in case that NCV from the KOGAS is not available for whatever reason, then IPCC default value will be applied as the backup value. Since KOGAS only releases Gross Calorific Value (GCV), it will be converted to NCV by discounting 10%, which is inline with the IPCC Guideline for National Greenhouse Gas Inventories. The GCV will be recorded on monthly bases, from which weighted average annual value will be calculated.
Monitoring frequency	
QA/QC procedures	
Purpose of data	
Additional comment	

B.7.2. Sampling plan

>> The section is left blank intentionally

B.7.3. Other elements of monitoring plan

>> The objective of the monitoring plan is to ensure the calculation of the actual emission reduction achieved by the Project. The project owner will manage directly or hire a third party to manage normally monitoring activity. Monitoring procedures may be adjusted, if necessary, but will not deviate from the principles described in the monitoring plan.

Operational Procedures:
The methodology provides detailed instruction on how to design and undertake monitoring activities. The steps required for the monitoring of the baseline and project emissions as well as the measures required to quantify uncertainties, ensure data quality, and conservativeness are as follows:

Step 1: Experimental setup for the monitoring methodology
The monitoring methodology will require SDC to continuously measure several parameters concerning the operation of the abatement tool and the measurement devices, the gas flow velocities at the inlet and outlet, and the concentration of SF_6 at the inlet and outlet of the SF_6 abatement device as shown in the Figure 7.

Under the monitoring procedure, two FTIR systems will be used to continuously monitor the concentration of SF_6 at the inlet and outlet of the SF_6 abatement system, while annubar devices will be used to continuously monitor the velocity of the gas entering and exiting the SF_6 abatement system. A calibration system will be used periodically to ensure that the calibration of the FTIR systems has not drifted, and to recalibrate the FTIR units whenever the abatement device is brought offline for maintenance or whenever the FTIR monitor itself is brought offline for maintenance.

The mass of the SF_6 entering and exiting the abatement device, the SF_6 DRE and the inlet and outlet flows will be calculated on a continuous basis, according to equations 12,13,14,15,and 16. All other parameters necessary to calculate the emissions baseline and the project emissions (fuel

and electricity usage) will be monitored on a continuous basis. Continuous monitoring of the fuel flow will be used to ensure that the SF_6 abatement process conditions do not significantly vary during the monitoring period, and to ensure that the molecular weight of the outlet gas stream does not significantly change, compared to the molecular weight of the outlet gas measured during the 6 hours initial evaluation period (at project startup). The project proponents will ensure that the abatement system's fuel flow is regulated and will discount from the baseline any SF_6 entering the abatement system if the fuel flow deviates by more than +/- 5%, compared to the nominal flow rate determined during the initial evaluation period.

Step 2: Quality assurance, quality control, and conservativeness of the monitoring methodology

The proposed methodology relies on direct and continuous monitoring of all key parameters necessary to quantify the baseline and project emissions. As such, the method does not require projection of the baseline or of the project emissions and does not lead to an overestimation of emission reductions attributable to the project activity. In addition to following the QA/QC and uncertainty assessment procedures highlighted in the baseline section for the measurement of SF_6 concentration, and to following the QA/QC procedures of the US EPA Methods for measuring the flow, SDC will ensure conformance to the following steps, throughout the entire monitoring period.

Step 2a: QA/QC procedure and conservativeness for monitoring of the inlet flow

SDC will ensure that maintenance of the inlet annubar device is performed at least as frequently as determined in Step 1 of the baseline methodology procedure. By continuously monitoring the flow at the inlet of the abatement system (Q_{in}), SDC will ensure that the flow conditions at the inlet of the abatement system do not drift, compared to the measurement performed during determination of the baseline (i.e. . Q_{in} measured in Step 2.2.). As mentioned in Step 2.2, the method provides a conservative measure to estimate the baseline emissions by taking the highest value of the gas molecular weight measured at the inlet to calculate the inlet flow. As an additional conservative measure, SDC will discount from the crediting period any SF_6 emissions measured when the value of the gas flow measured at the inlet of the abatement system during the monitoring period decreases by more than 5%, compared to the baseline flow rate measured during Step 2.2 (i.e. if .$Q_{in,\ monitoring} < 0.95$.$Q_{in,\ baseline}$). Indeed, a decrease of the total inlet flow would result in an increase in the SF_6 concentration, which could artificially increase the baseline if no flow compensation is accounted for. Should the gas flow measured at the inlet of the SF_6 abatement system drop below 0.95 . $Q_{in,\ baseline}$, SDC will identify the source of the issue (annubar device clogging or real decrease in inlet flow) and restore the nominal flow condition prior to resuming normal operation and measurements for emission reductions.

Step 2b: QA/QC procedure and conservativeness for monitoring of the outlet flow

SDC will ensure that maintenance of the outlet annubar device is performed at least as frequently as determined in Step 1 of the baseline methodology procedure. By continuously monitoring the gas flow at the outlet of the abatement system ($Q_{,out}$), SDC will ensure that the flow conditions at the outlet of the abatement system do not drift, compared to the measurement performed during determination of the baseline (i.e. .Qout measured in Step 2.2). As mentioned in Step 2.2, the method provides a conservative measure to estimate the project emissions by taking the lowest value of the gas molecular weight measured at the outlet to calculate the outlet flow. As an additional conservative measure, SDC will discount from the crediting period any SF_6 emissions measured when the value of the gas flow measured at the outlet of the abatement system during the monitoring period increases by more than 5%, compared to the averaged velocity measured during Step 2.2 (i.e. if .$Q_{out,monitoring} > 1.05$.,$Q_{out,\ baseline}$). Indeed, an increase in the total outlet flow would result in a decrease in the SF_6 concentration measured at the outlet, which could artificially increase the measurement of the DRE if no flow compensation is accounted for. Should the gas flow measured at the outlet of the SF_6 abatement system increase above 1.05 $Q_{out,\ baseline}$, SDC will

identify the source of the issue (Annubar device clogging or real increase in inlet flow) and restore the nominal flow condition prior to resuming normal operation and measurements for emission reductions.

Step 2c: QA/QC procedure for maintenance and calibration of the FTIR systems

SDC will ensure that the maintenance procedures of the FTIR systems are followed at least as often as the manufacturer's recommendation. SDC will document very clearly to the DOE what the maintenance requirements of the FTIR devices are and will ensure that they have been followed in at least as rigorous a manner as required. SDC will also ensure that the FTIR systems windows are maintained in conformance with the maintenance procedure determined in Step 3"QA/QC procedure for maintenance of FTIR system" of the project emission section Recalibration of the FTIR devices will be required every time the abatement device is brought offline for maintenance or every time the FTIR devices themselves are brought offline for maintenance, following the calibration procedure. Obviously, SDC will discount from the crediting period any emissions of SF6 that could occur while any FTIR system is being maintained or calibrated.

Step 2d: QA/QC procedure for the maintenance of the abatement system

SDC will ensure that the maintenance procedures of the SF_6 abatement system are followed at least as often as the manufacturer's recommendation. SDC will document very clearly to the DOE what the maintenance requirements of the abatement device are and will ensure that they have been followed in at least as rigorous a manner as required.

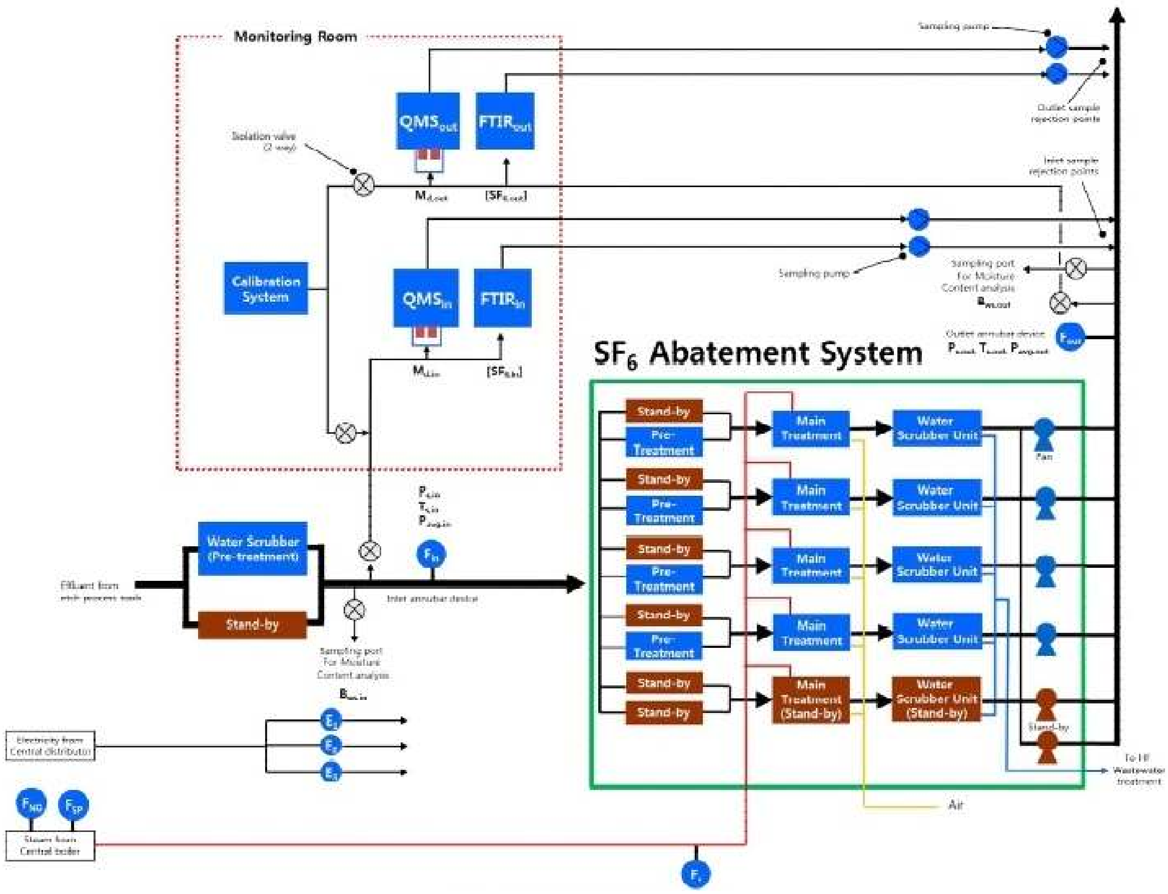


Figure 7. Project diagram

Figure 7 provides a roadmap for the design of critical metering instruments that will be used in the monitoring of emission reductions. The abatement device monitoring system in the SDC project is based on these specifications. The key elements of the monitoring plan will be to ensure compliance of the design of the abatement monitoring system with the methodology.

Management and Operational Systems

SDC plans to organize a qualified management organization to undertake the main monitoring functions. Within the Management Organization, SDC will form 4 teams of 3 people (3 shifts/day and 1 team on holiday). Management organization will be composed of managers and operators, which will execute monitoring and database tasks. Monitoring task will be the task of the monitoring all data associated with items depicted in the monitoring plan as well as the maintenance, repair and calibration of measuring instruments. Database task will perform the recording and archiving of data in an orderly manner. Management organization will report collected data to SDC monthly.

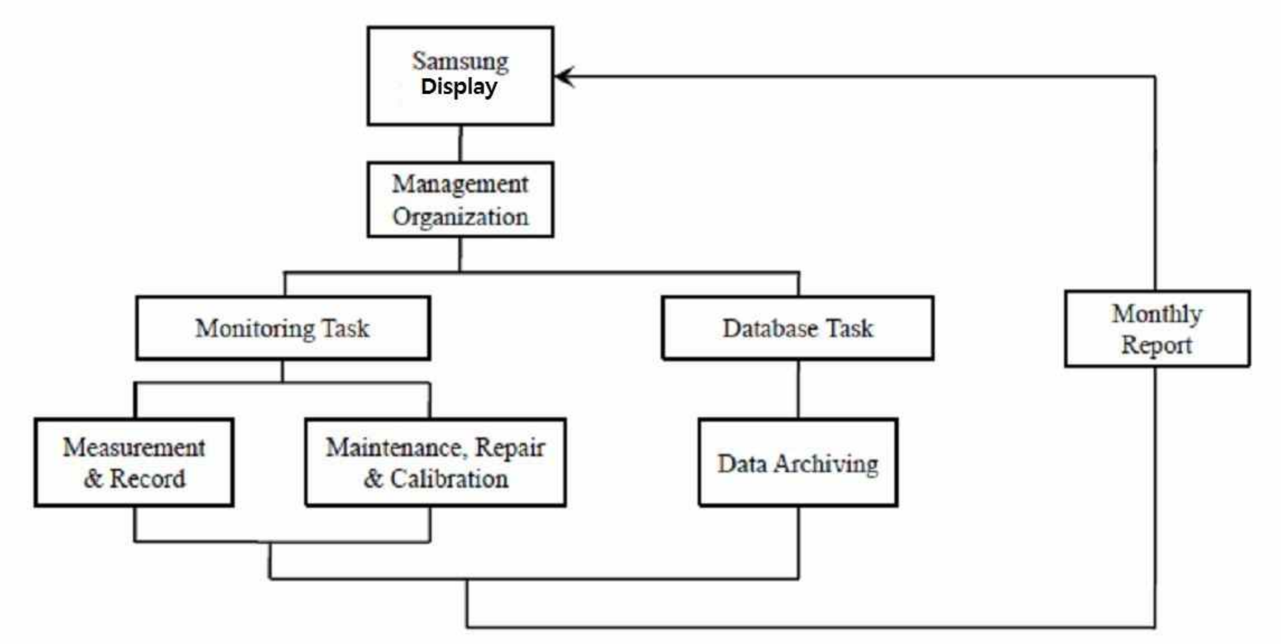


Figure 8. Management and Operational Systems

The organization and tasks of this Project will likely be organized as follows:

Management Organization, organized by a 3rd party entity– This organization will be responsible for coordinating the overall monitoring plan implementation. They will perform monitoring and database tasks, and will also coordinate all other logistics, including for example:

- Ensuring compliance with CDM methodology,
- Ensuring manpower needs are met,
- Evaluating training needs and carrying out training programs,
- Liaising with SDC to ensure a smooth implementation of the monitoring function.

Monitoring Task – As data collection and monitoring is one of the most critical components of the methodology, it is important to gather the data in the manner detailed in the approved methodology. For the sake of the task, they will ensure the monitoring system is operation properly and the meters are calibrated as per the methodology. They are the focal point for the data gathering. They

will use the raw collected to make monthly reports of the results including any irregularities and remedies.

Database Task – This task is to document the data and ensure that it is correctly entered into a database. They will prepare an appropriate database format prior to the start of the project implementation phase. Once the project commences, the required data will be entered on a daily basis.

Calibration of Equipment

The methodology required for gaining CERs rests on numerous measurements being undertaken on a continuous basis on a variety of parameters. The measurement tools required for this process need to be calibrated using a variety of different methods. The necessary calibration will be performed according to the manufacturer's guidelines, or according to the applicable regulations. The Management Organization will establish a single person responsible for overseeing the calibration process. This person will ensure that the calibrations take place as scheduled under the conditions required in the methodology.

The monitoring personnel will maintain a calibration schedule and log for each meter to be used as part of the program. A master schedule will establish the responsible personnel for each meter and provide the required dates for each calibration activity. As the calibration is undertaken, the responsible person for that meter will sign the log attesting to the accurate completion of the calibration and date the calibration.

Any irregularities are to be reported in the log and an explanation for the steps undertaken to rectify the problem documented in the log.

Data Flow, Storage and Management

Quality Control, Discrepancies, and Data Security

After the monthly data collection, the Management Organization reviews the data and checks that it has been recorded correctly.

- Any discrepancies between the purchase records and actual inventories will be recorded.
- A description of cause of deviation will be recorded.
- Any clear errors will be documented and corrected. With evidence backing up the correction.
- For any discrepancy that is not cured, the more conservative (resulting in fewer CERs being generated) will be chosen as the actual data.

The data is backed up on a weekly basis and the collated data placed on an excel spreadsheet on a monthly basis, where it will be retained as well to ensure long-term electronic storage in several separate locations. All electronic and hard copy records of the metering devices, relevant documentation and the results of calibration will be collected in a central place by the project entity. Data record will be archived for a period of 2 years after the crediting period to which the records pertain.

Monitoring Report

A monitoring report in line with CDM regulations and the requirements of this monitoring methodology will be issued by the general manager.

The monitoring report will contain a summary of the whole monitoring plan, and will describe the implementation of the monitoring plan in that particular period, present the relevant results and data, and calculate emission reductions for the period.

The report will include:

- Calibration reports for the monitoring equipment (including relevant standards and regulations);
- Any maintenance and repair of monitoring equipment;
- The qualifications of the persons responsible for the monitoring and calculations;
- The tests performed and data obtained;
- Emission reduction calculations;
- A summary of the monitoring plan in that particular year;
- Any other information relevant to the monitoring plan.

Monitoring Equipments

The monitoring equipments are Annubar, FTIR and QMS. The detail description of each equipment is as follows;

The FTIR and QMS are to analyze and monitor the concentrations of SF_6 gas, which flows between inlet and outlet of abatement system.

As it will be necessary to monitor the concentrations of inlet and outlet simultaneously, two sets of FTIR and QMS systems will be installed at the sampling ports of inlet and outlet exhausts.

The dynamic calibration system will be used for more than 8 points calibration by accurate dilution.

Table 17. Annubar Specification

Contents	Spec.
Measuring Principal	Multi-points Pitot-Fechheimer flow element
Measuring Range	
Material of sensor & station	All Hastelloy-C construction
Accuracy	≤ 2% (AMCA 610 certificated)
Sensor Coefficient	1(Compensation is not required.)
Temperature sensor/transmitter	
Auto Calibration	Auto-zero cal. By internally. Auto-span cal. By internally or externally
Auto-Purge	
Flow computer(Mass-tron Ⅱ/CEM)	
Sensing parameter in Mass-tron/CEM	
Power Supply	
Instrument Air Requirement	100 psi. for both Auto-Purge & Cal.

Table 18. Maintenance schedule (Annubar)

	Maintenance Contents / Month (After start-up)	1	2	3	4	5	6	7	8	9	10	11	12
1	Physical & Function test												
2	Zero verification												
3	Auto-Span Verification												

Table 19. FTIR specification

NO	ITEM	CONTENT
	Monitoring and analysis	Fast continuous real-time gas analysis
1	Spectral range	5000 - 650 cm^{-1}
2	Wavenumber accuracy	0.01cm^{-1}
3	Resolution	0.5cm^{-1} to 32cm^{-1} (step selectable)
4	Ordinate precision	0.1%T
5	Interferometer	Michelson type with dual mechanical bearing
6	Beam splitter	Ge on ZnSe
7	Detector	DTGS Detector
8	Source	1650K, high energy SiC, air cooled
9	Mirror control	HeNe Laser with quadrature phase detectors
10	Reflector	gold coated, diamond turned
11	Gas cells (pathlength)	1 cm for Inlet gas and 10 cm for Outlet gas
12	CPU	Pentium IV
13	HDD	160 GB or more
14	RAM	2 GB
15	ODD	Combo
16	Monitor	19" LCD
17	CPU for Server	Intel Dual Core 945 (3.4GHz)
18	HDD for Server	300G SATA
19	RAM for Server	4GHz

Table 20. Maintenance schedule (FTIR)

	Maintenance Contents / Month (After start-up)	1	2	3	4	5	6	7	8	9	10	11	12
1	Check FTIR Performance	■	■	■									
2	Standard Calibration		■			■			■			■	
3	Check the Clogging of Sampling line	■	■	■		■		■			■		
4	Check / Clean the filtration unit	■	■		■		■		■		■		■
5	Check / Clean the Cell windows	■	■		■		■		■		■		■
6	Check Fittings / Valbes / Unions	■			■		■		■		■		■

Table 21. QMS specification

NO	Contents	Q'ty	Spec.
1	QMS	1 ea	Mass range : 1 ~ 200 amu
			Detector type : Faraday & SEM
			Max. operation pressure : 1 x 10^{-6} mbar
			Detection limits : 100% to 10 ppb
2	Scroll Pump	1 ea	Ultimate pressure : 2.5 x 10^{-1} torr (3.3 x 10^{-1} mbar, 33 Pa)
			Ambient operating temp : 5 to 40 ℃ (41 to 104 ℉)
			Storage temperature : -20 to 60 ℃ (-4 to 140 ℉)
3	TMP Station	2 set	Base pressure : 1-9 x 10 mbar
			Operating Ambiebt Temperature : 5 to 35 ℃
			Bakeout temperature : 120 ℃ at inlet
4	1000 mbar Capacitance Diaphragm Gauge	1 ea	Measurement range : 1 x 10^{-1} to 1100 mbar
			Accuracy : 0.2% of reading
			Operation temperature : +5 ~ +50 ℃
5	1 mbar Capacitance Diaphragm Gauge	1 ea	Measurement range : 1 x 10-4 to 1.1 mbar
			Accuracy : 0.2% of reading
			Operation temperature : +5 ~ +50 ℃
6	Full Range Gauge	1 ea	Measurement range : 5 x 10-9 to 1000 mbar
			Accuracy : 1 x 10-8 ~ 1 x 102 mbar : +/- 30%
			Operation temperature : +5 ~ +55 ℃
7	Gauge Controller	1 ea	Filter time constant : 1.2 / 0.4 / 0.02 s
			Measurement rate : 50 1/s
			Connections for transmitter : 2
8	Gas Sampler	1 ea	Batch inlet system (Volume extension method)
9	Sample Injector	1 ea	Batch inlet system (Volume extension method)

Table 22. Maintenance schedule (QMS)

	Maintenance Contents / Month (After start-up)	1	2	3	4	5	6	7	8	9	10	11	12
1	Check QMS Performance	■	■	■									
2	Standard Calibration		■										
3	Check the Clogging of Sampling line	■	■	■		■		■			■		
4	Check the Sample Injection Valve unit	■	■		■		■		■		■		■
5	Check Rotary Pump/ Turbo Pump	■			■			■			■		
6	Check Electronics Modules	■			■		■		■		■		■

Training

Comprehensive training programs have been designed by SDC and will be provided to staff involved in operation and monitoring of the abatement system, including FTIR, QMS and Annubar. Details of the training programs are shown below. These programs will be given by the instrument manufacturer or the authorized distributor of the instrument, to insure proper operation and monitoring of the Project.

Table 23: Training Schedule for Abatement System

	Training Contents	**D-10**	**D-9**	**D-8**	**D-7**	**D-6**	**D-5**	**D-4**	**D-3**	**D-2**	**D-1**
1	What is SF6 abatement system										
2	Principle of RTO Reactor										
3	Principle of SF6 reaction mechanism										
4	Principle of Power Trap										
5	Principle of Scrubber										
6	Operation of Hardwar										
7	Operation of Software										
8	Management of emergency state										
9	Maintenance										

Table 24: Training Schedule for QMS

	Training Contents	D-10	D-9	D-8	D-7	D-6	D-5	D-4	D-3	D-2	D-1
1	Basic Theary Mass Spec.	■									
2	Qualitative Analysis (I)								■		
3	Quantitative Analysis (II)									■	
4	QMS Operation		■			■					■
5	How to back up data								■		
6	Calibration			■				■			
7	Sampling , Valving , Fitting									■	
8	Software				■		■				
9	Maintenance								■		■

Table 25: Training Schedule for Annubar

	Training Contents	D-10	D-9	D-8	D-7	D-6	D-5	D-4	D-3	D-2	D-1
1	Installation									■	
2	Operation									■	
3	Test method										■
4	Maintenance.										■

Table 26: Training Schedule for FTIR

	Training Contents	D-10	D-9	D-8	D-7	D-6	D-5	D-4	D-3	D-2	D-1
1	What is FTIR Spectroscopy	■									
2	Principle of FTIR (I)	■								■	
3	Principle of FTIR (II)							■			
4	Principle of FTIR (III)				■						
5	Qualitative Analysis (I)								■		
6	Qualitative Analysis (II)									■	
7	FTIR Operation		■			■					■
8	How to make the method						■		■		
9	Calibration			■				■			
10	Sampling , Valving , Fitting									■	
11	Software				■		■				
12	Maintenance								■		■

Each content is two to three hours long, and can be combined or shorten depending on qualification and prior experience of the trainees.

B.7.4. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

>> The section is left blank intentionally.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>> 16/10/2009

This is the date of equipment purchased order of the abatement system to Clean System Korea Inc.. This is the first significant investment made for the Project, and is considered as the Starting date of the Project.

C.1.2. Expected operational lifetime of project activity

>> 11 years 00 month

As been explained in the section B.2 above, the line 7-2 and dry etching equipments have remaining lifetime of at least 11 years, whereas, the abatement system has expected lifetime of 15 years. Therefore, 11 years has been selected as the expected operational lifetime of the Project activity.

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>>Fixed

C.2.2. Start date of crediting period

>> 01/05/2010 or the date of registration, whichever is later

C.2.3. Length of crediting period

>> 10 years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>> "Enforcement Decree of the Act on Assessment of Impacts of Works on Environment, Traffic, Disasters, etc." describes projects for which an Environment Impact Assessment (EIA) is required. Under the Act, the Project activity, which installs additional abatement system to the existing facility, is not required to conduct an EIA.

The Project activity consumes electricity to operate the SF6 abatement system. Since electricity is imported from the grid, there will be no significant direct environmental impacts caused at the project site. As background, it should be noted that the equipment for the Project will be installed on the roof of the line 7-2 building, which already has a variety of devices for treatment and control of exhaust gases. The exhaust gas from the Project will be emitted from the same gas stacks used by the untreated gas in the baseline.

The wastewater containing HF flows from the wet scrubber of the SF_6 abatement system. However the volume is under 30m^3/day. This will be treated in the existing wastewater treatment plant of which the overall capacity is 63,800m^3/day, with current treatment of wastewater containing HF at around 10,200m^3 / day. The effect on the existing wastewater treatment facility is negligible because this addition is less than 0.5% of the current wastewater containing HF.

D.2. Environmental impact assessment

>> As mentioned above, it is expected that there will be no negative environmental impacts associated with the Project activity.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>> A local stakeholder's meeting has been conducted by SEC LCD Division on July 9, 2009 at K-room of SEC LCD plant to collect local stakeholders' comments on SEC CDM project. 17 persons are presented at the local stakeholders' meeting, including Environmental Quality Management Division of Chung Cheong Nam-do Provincial Government, Environmental Protection Division of A-San City Hall, , Chung Cheong Regional Energy & Climate Change Center of Korea Energy Management Cooperation, local residents, industrial neighbours and employees of SEC. These attendees were seen as a reasonable representation of the key stakeholders. It should be kept in mind that the Project equipment will be installed on the roof of Line 7-2, which is part of a major complex of Samsung Electronics LCD Division. The roof of line 7-2 already holds a number of items of equipment for treatment of exhaust gases from the LCD production process. The exhaust gas from the Project will be emitted from the same gas stacks used by the untreated exhaust gas in the baseline. Therefore in terms of public perception, the project would only be a small incremental change in existing process, with little in the way of noticeable change or new structures that would be visible to the general public. The meeting was announced publicly, but public uptake was low, probably due to the type of perception outlined above.

Figure 4. Local stakeholder meeting (July 9, 2009)

SEC made an announcement the public meeting for this SF_6 abatement CDM project on web-site of A-San City Hall (posted on 26/06/2009) as the following and through an official invitation letter to the key stakeholders (issued on 26/06/2009).
The purpose of this announcement was:

- To inform the stakeholders of the outline of the project
- To invite the stakeholders to comment directly, through electronic mails, regular mails, or ph one calls
- To invite the stakeholders to attend the public meeting in SEC LCD Plant

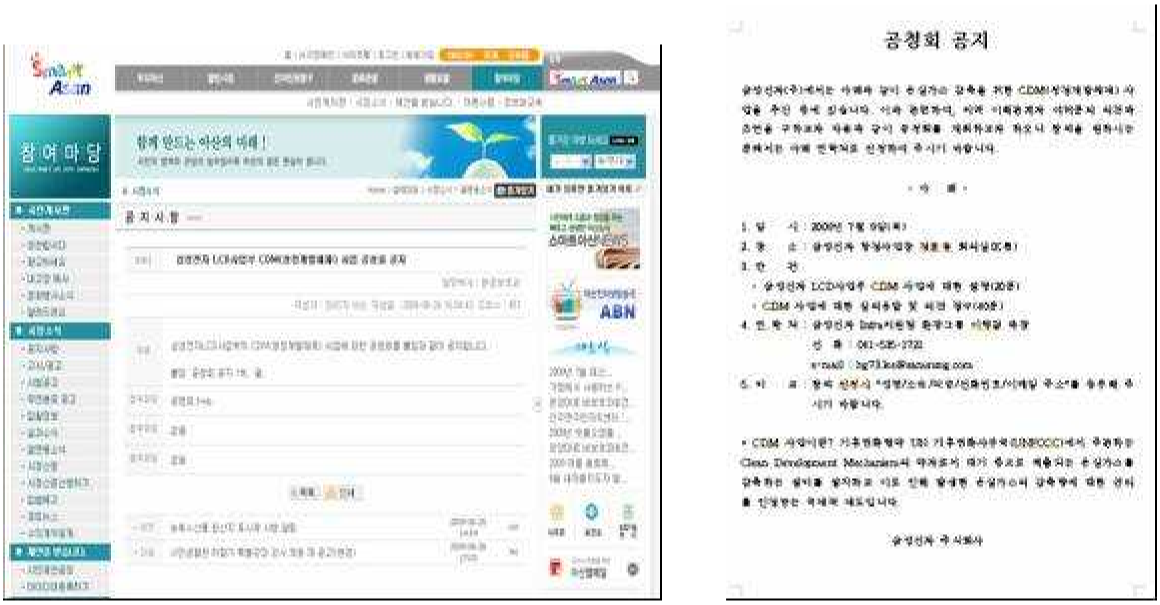


Figure 5. The public announcement on A-San City Hall web-site

The announcement in Figure E-2 is translated as follows:

Public Announcement of Local Stakeholder's Meeting

Public Announcement of local stakeholder's meeting for Samsung's CDM project will be held as follows

We invite you to attend the local stakeholder's meeting as followings.

- Followings -

1. Date : Jul. 9th, 2009(Thu.)
2. Place : Samsung Electronics Tangjeong Plant Conference Room (Room "K")
3. Agenda

- Presentation of Samsung's CDM Project
- Question and answer for Samsung's CDM Project

4. Contact Person

Hyeong Geol, Lee / Manager
Samsung Electronics Environment Group
Telephone: 041-535-1721
e-mail:hg73.lee@Samsung.com

5. Remarks: Please give us your personal information of attendant, such as name, position, telephone number and e-mail address.

Samsung Electronics Co., Ltd.

SEC introduced the major business of SEC LCD Division, and environmental policy including greenhouse gas reduction to achieve the sustainable growth. It also explained the greenhouse effect and Kyoto Protocol, UNFCCC, CDM, LCD manufacturing process, SF_6 abatement technology in detail for all attendants to have good grasp of this CDM project. At the same time, it welcomed the comments and suggestions from all stakeholders. The participants expressed their

strong interests and supports on this CDM project, and raised some questions about CDM and the project.

Furthermore, the opinions of the attendants were collected in the form of questionnaires.

Figure 6. The contents of presentation

Following table shows the contents of the questionnaires;

Table 15. Summary of Questionnaires

Questions to the stakeholders	Yes	No
1. Have you ever heard of CDM (Clean Development Mechanism)?	17	0
2. Do you know that SF_6 (Six fluoride sulfur) is one of the greenhouse gas?	16	1
3. Do you or does your organization has a role in this project?	6	11
4. Do you think that SEC explains this project in detail?	17	0
5. Do you think that this project will be positive effect on the global environment as a whole?	17	0
6. Do you think that this project will contribute to improve the air quality of A-San city?	15	2
7. Do you or does your organization have a possibility to have a bad effect due to this project?	0	17
8. If you have any other comments or opinion, please describe.		

Most comments or opinion on question 8 are to encourage this CDM project. The other comment is to monitor SOx and NOx, appropriate control before emission.

E.2. Summary of comments received

>> The questions raised by the stakeholders attending the public meeting and SEC's responses are briefly summarized as followings;

1. Does SEC have enough information for SF_6 baseline emission calculation?
   - ➔ Yes, SEC has accumulated the information for SF_6 baseline emission calculation.

2. Are the emissions from the use of energy/ fossil fuel used for SF_6 decomposition excluded f rom the emission reductions calculation?

➔ Yes, they are excluded.

3. Is CDM proceeded into only for 7-2 line?
   ➔ After the successful implementation and CDM registration of 7-2 line, SEC will implement the abatement technology in the other lines as CDM project activities.

4. What is the expected amount of CERs?
   ➔ Approximately 750,000 ~ 780,000 CERs/yr

5. Will the information used for emission reductions be published?
   ➔ Yes

6. Will SEC acquire the national approval?
   ➔ Yes, it will acquire the Korean DNA approval as required.

7. Why does the monitoring start from May 2010?
   ➔ It is the expected date of CDM registration.

8. When does SEC acquire CERs?
   ➔ After the registration of the Project activity as a CDM project activity.

9. Are other pollutants, such as SOx and NOx, generated by the Project activity?
   ➔ Yes, they are generated. However, SEC will treat those pollutants and keep the environmental requirements. Its target is to reduce such pollutants below 50% level required by the environmental regulations.

10. What is the purpose of this Project activity?
    ➔ The purpose of the Project activity is the sustainable development. SEC is now trying to reduce the greenhouse gases emissions as well as to acquire CERs for its future use.

11. Is there any plan to reduce other pollutants less than 50% required by the environmental re gulations?
    ➔ SEC targets the less than 50% of emission for other pollutants required by the environment regulation considering the current available technology. However, if required, it will further reduce such emission in the future.

12. What is the plan for the other lines, which is not included in the Project activity?
    ➔ The abatement technology will be installed to the lines which can apply CDM. Afterward, SEC will install the abatement technology for the other lines. If there is any other available technology, such as recycle in the future, it will consider such technology.

13. Does only etching process emit SF_6?
    ➔ Yes, and $_6$emission gases from the other processes are very minimal, usually less than 0.1% of the total emissions.

14. How about the other companies' situation for SF_6 abatement CDM project activities?
    ➔ LG Display is also now preparing the CDM registration using direct thermal abatement technology, which use massive amount of fossil fuels.

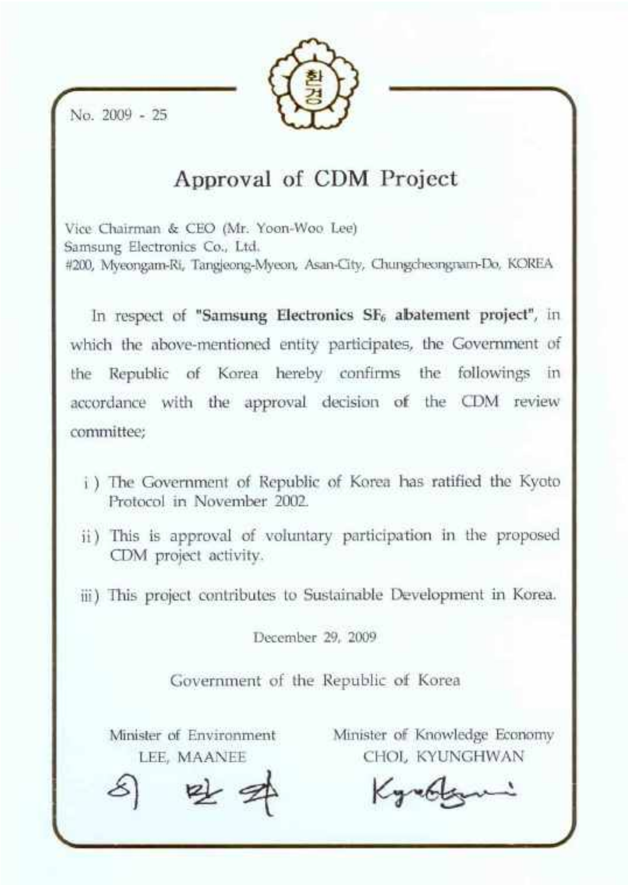
15. Is there any plan to hold a stakeholders' meeting for the results of the monitoring in the futu re?
    - ➔ Up to now, there is no such plan, however, the results can be checked by anybody on the UNFCCC website.

E.3. Report on consideration of comments received

>> There were some concerns raised by the attendees, as outlined above. However, the attendees were satisfied with the response given by SEC and there were no further negative comments or concerns raised by local stakeholders.

SECTION F. Approval and authorization

>> Approval of CDM project for the project activity is issued by Korea Ministry of environment and Ministry of trade, industry & energy(It was called of Ministry of Knowledge Economy) at December 29, 2009.



No. 2009 - 25

Approval of CDM Project

Vice Chairman & CEO (Mr. Yoon-Woo Lee)
Samsung Electronics Co., Ltd.
#200, Myeongam-Ri, Tangjeong-Myeon, Asan-City, Chungcheongnam-Do, KOREA

In respect of **"Samsung Electronics SF_6 abatement project"**, in which the above-mentioned entity participates, the Government of the Republic of Korea hereby confirms the followings in accordance with the approval decision of the CDM review committee;

i) The Government of Republic of Korea has ratified the Kyoto Protocol in November 2002.

ii) This is approval of voluntary participation in the proposed CDM project activity.

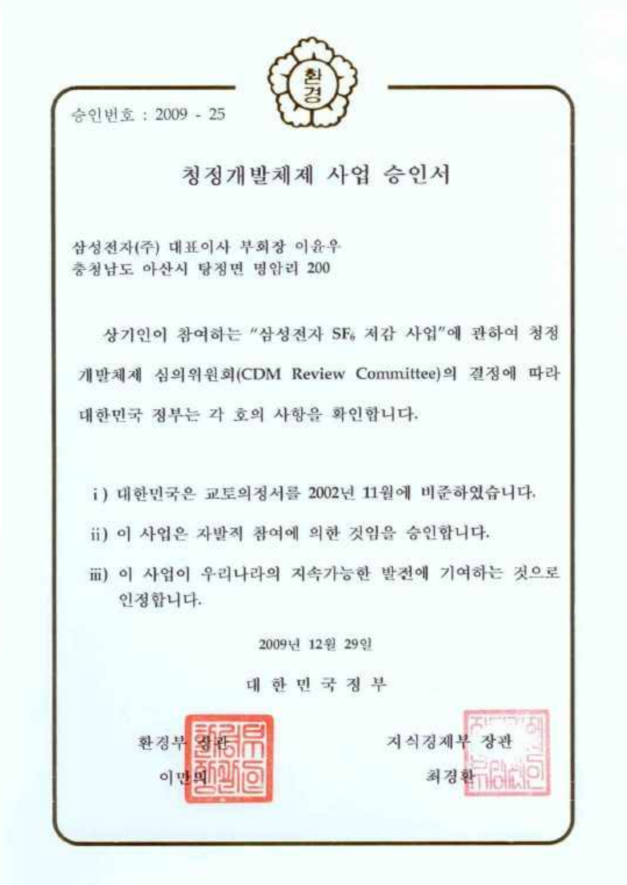
iii) This project contributes to Sustainable Development in Korea.

December 29, 2009

Government of the Republic of Korea

Minister of Environment
LEE, MAANEE

Minister of Knowledge Economy
CHOI, KYUNGHWAN



승인번호 : 2009 - 25

청정개발체제 사업 승인서

삼성전자(주) 대표이사 부회장 이윤우
충청남도 아산시 탕정면 명암리 200

상기인이 참여하는 "삼성전자 SF_6 저감 사업"에 관하여 청정개발체제 심의위원회(CDM Review Committee)의 결정에 따라 대한민국 정부는 각 호의 사항을 확인합니다.

i) 대한민국은 교토의정서를 2002년 11월에 비준하였습니다.

ii) 이 사업은 자발적 참여에 의한 것임을 승인합니다.

iii) 이 사업이 우리나라의 지속가능한 발전에 기여하는 것으로 인정합니다.

2009년 12월 29일

대 한 민 국 정 부

환경부 장관
이만의

지식경제부 장관
최경환

- -

Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	☐ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	SAMSUNG DISPLAY CO., LTD.
Street/P.O. Box	#200, MYEONGAM-RI, TANGJEONG-MYEON
Building	
City	ASAN CITY
State/Region	CHUNGCHEONGNAM-DO
Postcode	336-841
Country	SOUTH KOREA
Telephone	82-41-535-1699
Fax	82-41-535-1111
E-mail	miri.chung@samsung.com
Website	
Contact person	
Title	
Salutation	
Last name	Jung
Middle name	
First name	MI-RI
Department	ENVIRONMENT&SECURITY GROUP
Mobile	82-01-2642-5359
Direct fax	
Direct tel.	
Personal e-mail	

Appendix 2. Affirmation regarding public funding

Project financing does not involve ODA or public funding from Annex I countries

Appendix 3. Applicability of methodology and standardized baseline

Applicability of methodology and standardized baseline is described in B.2 above

Appendix 4. Further background information on ex ante calculation of emission reductions

BASELINE INFORMATION

OM (Operating Margin)_2005

Plant name	Unit number	Electricity delivered (MWh)	fuel consumption				Calorific value	Net caloric value	Calorific value	Net caloric value	Calorific value	Net caloric value	Calorific value	Net caloric value	Calorific Value				EF_CO2				CO2 emission (t CO2)
			Coal (t)	Heavy oil (kl)	Diesel oil (kl)	LNG (t)	Coal (kcal/kg)		Heavy oil (kcal/l)		Diesel oil (kcal/l)		LNG (kcal/kg)		Coal (TJ/t)	Heavy oil (TJ/kl)	Diesel oil (TJ/kl)	LNG (TJ/t)	Coal (t/TJ)	Heavy oil (t/TJ)	Diesel oil (t/TJ)	Natural gas (t/TJ)	
Honam	#1	1,787,715	870,214	961	278	-	5,392	5,122	9,835	9,343	8,809	8,368	-	-	0.02144	0.03912	0.03504	-	99.7	78.8	74.8	58.3	1,864,262
	#2	1,875,790	912,497	338	185	-	5,376	5,107	9,854	9,362	8,804	8,364	-	-	0.02138	0.03920	0.03502	-	99.7	78.8	74.8	58.3	1,946,917
Samchonpo	#1	3,810,079	1,534,223	-	1,220	-	5,913	5,618	-	-	8,841	8,399	-	-	0.02352	-	0.03516	-	99.7	78.8	74.8	58.3	3,600,807
	#2	4,323,618	1,731,265	-	626	-	5,924	5,628	-	-	8,883	8,439	-	-	0.02356	-	0.03533	-	99.7	78.8	74.8	58.3	4,068,776
	#3	4,343,666	1,723,152	-	377	-	5,897	5,602	-	-	9,000	8,550	-	-	0.02345	-	0.03580	-	99.7	78.8	74.8	58.3	4,030,457
	#4	4,112,297	1,632,334	-	1,029	-	5,898	5,603	-	-	8,943	8,496	-	-	0.02346	-	0.03557	-	99.7	78.8	74.8	58.3	3,820,529
	#5	3,542,728	1,516,654	-	1,415	-	5,347	5,079	-	-	8,614	8,183	-	-	0.02127	-	0.03426	-	99.7	78.8	74.8	58.3	3,219,192
	#6	3,643,969	1,546,663	-	1,001	-	5,376	5,107	-	-	9,000	8,550	-	-	0.02138	-	0.03580	-	99.7	78.8	74.8	58.3	3,299,954
Yonghung	#1	5,623,299	2,081,972	-	4,541	-	6,131	5,824	-	-	8,935	8,488	-	-	0.02439	-	0.03554	-	99.7	78.8	74.8	58.3	5,073,763
	#2	4,658,862	1,761,395	-	2,903	-	6,053	5,750	-	-	8,947	8,500	-	-	0.02408	-	0.03559	-	99.7	78.8	74.8	58.3	4,235,693
Boryeong	#1	3,547,140	1,440,343	-	761	-	5,830	5,539	-	-	8,943	8,496	-	-	0.02319	-	0.03557	-	99.7	78.8	74.8	58.3	3,331,957
	#2	3,433,608	1,388,532	-	551	-	5,816	5,525	-	-	8,943	8,496	-	-	0.02313	-	0.03557	-	99.7	78.8	74.8	58.3	3,203,908
	#3	4,124,745	1,589,150	-	90	-	5,882	5,588	-	-	8,740	8,303	-	-	0.02340	-	0.03476	-	99.7	78.8	74.8	58.3	3,706,963
	#4	3,698,705	1,421,343	-	603	-	5,890	5,596	-	-	8,748	8,311	-	-	0.02343	-	0.03479	-	99.7	78.8	74.8	58.3	3,321,394
	#5	4,121,314	1,587,999	-	156	-	5,882	5,588	-	-	8,749	8,312	-	-	0.02340	-	0.03480	-	99.7	78.8	74.8	58.3	3,704,451
	#6	3,283,477	1,260,305	-	627	-	5,901	5,606	-	-	8,749	8,312	-	-	0.02347	-	0.03480	-	99.7	78.8	74.8	58.3	2,950,819
Taean	#1	3,992,112	1,508,570	-	621	-	6,000	5,700	-	-	8,692	8,257	-	-	0.02386	-	0.03457	-	99.7	78.8	74.8	58.3	3,590,748
	#2	3,484,251	1,323,078	-	395	-	6,009	5,708	-	-	8,684	8,249	-	-	0.02390	-	0.03454	-	99.7	78.8	74.8	58.3	3,153,731
	#3	3,957,054	1,494,175	-	650	-	6,007	5,707	-	-	8,676	8,242	-	-	0.02389	-	0.03451	-	99.7	78.8	74.8	58.3	3,561,037
	#4	3,653,534	1,383,297	-	365	-	5,999	5,699	-	-	8,705	8,270	-	-	0.02386	-	0.03462	-	99.7	78.8	74.8	58.3	3,291,750
	#5	3,744,413	1,411,398	-	742	-	6,032	5,730	-	-	8,676	8,242	-	-	0.02399	-	0.03451	-	99.7	78.8	74.8	58.3	3,377,930
	#6	3,999,847	1,504,962	-	417	-	6,017	5,716	-	-	8,691	8,256	-	-	0.02393	-	0.03457	-	99.7	78.8	74.8	58.3	3,592,158
Hadong	#1	3,997,914	1,513,930	-	284	-	6,003	5,703	-	-	8,940	8,493	-	-	0.02388	-	0.03556	-	99.7	78.8	74.8	58.3	3,604,774
	#2	3,732,583	1,410,099	-	792	-	5,997	5,697	-	-	8,928	8,481	-	-	0.02385	-	0.03551	-	99.7	78.8	74.8	58.3	3,355,450
	#3	3,769,077	1,422,196	-	472	-	5,998	5,698	-	-	8,982	8,533	-	-	0.02386	-	0.03573	-	99.7	78.8	74.8	58.3	3,383,876
	#4	3,989,315	1,511,054	-	567	-	5,999	5,699	-	-	8,938	8,491	-	-	0.02386	-	0.03555	-	99.7	78.8	74.8	58.3	3,596,117
	#5	3,553,901	1,345,648	-	614	-	5,995	5,695	-	-	8,975	8,526	-	-	0.02385	-	0.03570	-	99.7	78.8	74.8	58.3	3,200,740
	#6	4,037,763	1,520,774	-	331	-	5,995	5,695	-	-	8,928	8,481	-	-	0.02384	-	0.03551	-	99.7	78.8	74.8	58.3	3,616,172
Dangjin	#1	3,797,307	1,438,702	-	637	-	5,962	5,664	-	-	8,834	8,392	-	-	0.02371	-	0.03514	-	99.7	78.8	74.8	58.3	3,403,005
	#2	3,798,078	1,437,473	-	632	-	5,962	5,664	-	-	8,915	8,469	-	-	0.02371	-	0.03546	-	99.7	78.8	74.8	58.3	3,400,358
	#3	4,081,017	1,549,041	-	141	-	5,935	5,638	-	-	8,844	8,402	-	-	0.02361	-	0.03518	-	99.7	78.8	74.8	58.3	3,646,112
	#4	4,079,557	1,544,010	-	134	-	5,941	5,644	-	-	8,828	8,387	-	-	0.02363	-	0.03511	-	99.7	78.8	74.8	58.3	3,638,036
	#5	1,318,670	499,714	-	5,701	-	6,115	5,809	-	-	8,904	8,458	-	-	0.02432	-	0.03541	-	99.7	78.8	74.8	58.3	1,226,855
	#6	96,365	38,671	-	1,779	-	6,221	5,910	-	-	11,095	10,540	-	-	0.02474	-	0.04413	-	99.7	78.8	74.8	58.3	101,268
Ulsan	#1	262,393	-	70,183	750	-	-	-	9,900	9,405	9,116	8,660	-	-	-	0.03938	0.03626	-	99.7	78.8	74.8	58.3	219,795
	#2	255,812	-	67,296	585	-	-	-	9,903	9,408	9,113	8,657	-	-	-	0.03939	0.03625	-	99.7	78.8	74.8	58.3	210,457
	#3	200,518	-	53,085	662	-	-	-	9,908	9,413	9,119	8,663	-	-	-	0.03941	0.03627	-	99.7	78.8	74.8	58.3	166,654
	#4	1,549,091	-	375,417	1,971	-	-	-	10,001	9,501	9,122	8,666	-	-	-	0.03978	0.03628	-	99.7	78.8	74.8	58.3	1,182,057
	#5	1,500,935	-	363,992	1,676	-	-	-	9,993	9,494	9,122	8,666	-	-	-	0.03975	0.03628	-	99.7	78.8	74.8	58.3	1,144,631
	#6	1,454,644	-	352,776	1,708	-	-	-	9,979	9,480	9,118	8,662	-	-	-	0.03969	0.03627	-	99.7	78.8	74.8	58.3	1,108,027
Youngnam	#1	1,022,470	-	359,910	844	-	-	-	7,482	7,108	8,942	8,495	-	-	-	0.02976	0.03556	-	99.7	78.8	74.8	58.3	846,284
	#2	531,006	-	190,085	584	-	-	-	7,729	7,342	8,943	8,496	-	-	-	0.03074	0.03557	-	99.7	78.8	74.8	58.3	462,011
Yosu	#1	430,310	-	106,919	434	-	-	-	9,960	9,462	8,887	8,442	-	-	-	0.03962	0.03535	-	99.7	78.8	74.8	58.3	334,929
	#2	904,597	-	218,356	346	-	-	-	9,944	9,447	8,886	8,441	-	-	-	0.03955	0.03534	-	99.7	78.8	74.8	58.3	681,475

Pyongtaek	#1	1,258,662	-	293,214	118	3,553	-	-	9,903	9,407	8,943	8,496	12,898	11,608	-	0.03939	0.03557	0.04860	99.7	78.8	74.8	58.3	920,437
	#2	1,376,342	-	321,188	140	2,641	-	-	9,905	9,409	8,961	8,513	12,872	11,585	-	0.03940	0.03564	0.04850	99.7	78.8	74.8	58.3	1,004,928
	#3	1,321,167	-	308,042	132	1,784	-	-	9,907	9,412	8,949	8,502	12,942	11,647	-	0.03941	0.03559	0.04877	99.7	78.8	74.8	58.3	961,960
	#4	1,338,204	-	311,245	138	2,047	-	-	9,909	9,413	8,949	8,502	12,893	11,604	-	0.03941	0.03559	0.04858	99.7	78.8	74.8	58.3	972,796
Namjeju	#1	44,602	-	14,628	15	-	-	-	9,878	9,384	9,318	8,853	-	-	-	0.03929	0.03706	-	99.7	78.8	74.8	58.3	45,332
	#2	44,654	-	15,031	12	-	-	-	9,879	9,385	9,307	8,842	-	-	-	0.03929	0.03702	-	99.7	78.8	74.8	58.3	46,575
Jeju	#1	36,266	-	12,564	12	-	-	-	9,932	9,435	8,885	8,441	-	-	-	0.03950	0.03534	-	99.7	78.8	74.8	58.3	39,143
	#2	532,700	-	129,516	-	-	-	-	9,929	9,433	-	-	-	-	-	0.03949	-	-	99.7	78.8	74.8	58.3	403,052
	#3	502,189	-	122,866	48	-	-	-	9,925	9,429	8,938	8,491	-	-	-	0.03948	0.03555	-	99.7	78.8	74.8	58.3	382,331
Seoul	#4	207,498	-	-	-	49,143	-	-	-	-	-	-	13,002	11,702	-	-	-	0.04899	99.7	78.8	74.8	58.3	140,367
	#5	444,324	-	-	1	108,761	-	-	-	-	9,070	8,617	13,008	11,707	-	-	0.03608	0.04902	99.7	78.8	74.8	58.3	310,800
Incheon	#1	16,450	-	-	-	4,365	-	-	-	-	-	-	13,032	11,729	-	-	-	0.04911	99.7	78.8	74.8	58.3	12,497
	#2	37,727	-	-	-	8,505	-	-	-	-	-	-	13,025	11,723	-	-	-	0.04908	99.7	78.8	74.8	58.3	24,336
	#3	-	-	-	372	746	-	-	-	-	8,964	8,516	13,030	11,727	-	-	0.03565	0.04910	99.7	78.8	74.8	58.3	3,127
	#4	29,202	-	-	400	6,620	-	-	-	-	8,954	8,506	13,026	11,723	-	-	0.03561	0.04908	99.7	78.8	74.8	58.3	20,009
Pyongtaek C/C	C/C	659,932	-	-	1	110,953	-	-	-	-	8,950	8,503	13,030	11,727	-	-	0.03560	0.04910	99.7	78.8	74.8	58.3	317,601
Ilsan	C/C	2,873,958	-	-	-	533,188	-	-	-	-	-	-	13,011	11,710	-	-	-	0.04903	99.7	78.8	74.8	58.3	1,524,035
Bundang	C/C	3,742,073	-	-	-	671,944	-	-	-	-	-	-	13,025	11,723	-	-	-	0.04908	99.7	78.8	74.8	58.3	1,922,685
Ulsan	C/C	3,131,075	-	-	-	470,131	-	-	-	-	-	-	12,750	11,475	-	-	-	0.04804	99.7	78.8	74.8	58.3	1,316,811
Seoincheon	C/C	7,001,031	-	-	335	989,645	-	-	-	-	9,200	8,740	13,009	11,709	-	-	0.03659	0.04902	99.7	78.8	74.8	58.3	2,829,259
Shinincheon	C/C	10,543,280	-	-	-	1,458,763	-	-	-	-	-	-	13,013	11,712	-	-	-	0.04904	99.7	78.8	74.8	58.3	4,170,335
Boryeong	C/C	8,221,926	-	-	-	1,161,510	-	-	-	-	-	-	13,030	11,727	-	-	-	0.04910	99.7	78.8	74.8	58.3	3,324,763
Incheon	C/C	2,055,016	-	-	-	281,813	-	-	-	-	-	-	13,012	11,711	-	-	-	0.04903	99.7	78.8	74.8	58.3	805,561
Busan	C/C	9,076,327	-	-	-	1,211,144	-	-	-	-	-	-	13,000	11,700	-	-	-	0.04898	99.7	78.8	74.8	58.3	3,458,777
Hallim	C/C	100,346	-	-	29,686	-	-	-	-	-	8,973	8,524	-	-	-	-	0.03569	-	99.7	78.8	74.8	58.3	79,247
Anyang	C/C	1,433,978	-	-	-	261,202	-	-	-	-	-	-	13,025	11,723	-	-	-	0.04908	99.7	78.8	74.8	58.3	747,397
Bucheon	C/C	1,404,160	-	-	-	261,705	-	-	-	-	-	-	13,003	11,702	-	-	-	0.04900	99.7	78.8	74.8	58.3	747,545
POSCO POWER	C/C	2,571,095	-	-	-	445,253	-	-	-	-	-	-	13,024	11,721	-	-	-	0.04907	99.7	78.8	74.8	58.3	1,273,901
G S Bugog	C/C	2,189,808	-	-	-	297,976	-	-	-	-	-	-	13,756	12,381	-	-	-	0.05183	99.7	78.8	74.8	58.3	900,476
Yulchon	C/C	1,300,627	-	-	159	194,534	-	-	-	-	10,930	10,384	13,023	11,721	-	-	0.04347	0.04907	99.7	78.8	74.8	58.3	557,054
Namjeju	D/P	268,073	-	56,727	37	-	-	-	9,877	9,383	8,975	8,526	-	-	-	0.03929	0.03570	-	99.7	78.8	74.8	58.3	175,711
Jeju	G/T	5,069	-	-	2,869	-	-	-	-	-	8,919	8,473	-	-	-	-	0.03547	-	99.7	78.8	74.8	58.3	7,613
Jeju	D/P	151,759	-	31,808	72	-	-	-	9,932	9,435	8,954	8,506	-	-	-	0.03950	0.03561	-	99.7	78.8	74.8	58.3	99,209
TOTAL		**195,045,065**																					**148,021,949**
																				OM2005		**0.7589 tCO2/MWh**	

OM (Operating Margin) 2006

Plant name	Unit number	Electricity delivered (MWh)	fuel consumption				Calorific value	Net caloric value	Calorific value	Net caloric value	Calorific value	Net caloric value	Calorific value	Net caloric value	Calorific Value				EF_CO2				CO2 emission (t CO2)
			Coal (t)	Heavy oil (kl)	Diesel oil (kl)	LNG (t)	Coal (kcal/kg)		Heavy oil (kcal/l)		Diesel oil (kcal/l)		LNG (kcal/kg)		Coal (TJ/t)	Heavy oil (TJ/kl)	Diesel oil (TJ/kl)	LNG (TJ/t)	Coal (t/TJ)	Heavy oil (t/TJ)	Diesel oil (t/TJ)	Natural gas (t/TJ)	
Honam	#1	1,622,639	781,139	1,113	279	-	5,436	5,164	9,809	9,318	8,917	8,472	-	-	0.02162	0.03901	0.03547	-	99.7	78.8	74.8	58.3	1,687,919
	#2	1,782,016	859,736	1,251	359	-	5,407	5,137	9,823	9,332	8,870	8,426	-	-	0.02151	0.03907	0.03528	-	99.7	78.8	74.8	58.3	1,848,348
Samchonpo	#1	4,161,219	1,696,271	-	860	-	5,937	5,640	-	-	8,814	8,373	-	-	0.02361	-	0.03506	-	99.7	78.8	74.8	58.3	3,995,615
	#2	3,703,880	1,508,082	-	1,362	-	5,942	5,645	-	-	8,814	8,373	-	-	0.02364	-	0.03506	-	99.7	78.8	74.8	58.3	3,557,350
	#3	3,779,585	1,519,385	-	457	-	5,858	5,565	-	-	8,814	8,373	-	-	0.02330	-	0.03506	-	99.7	78.8	74.8	58.3	3,530,944
	#4	3,816,997	1,521,263	-	1,818	-	5,861	5,568	-	-	8,803	8,363	-	-	0.02331	-	0.03501	-	99.7	78.8	74.8	58.3	3,540,702
	#5	3,761,205	1,665,339	-	977	-	5,236	4,974	-	-	9,000	8,550	-	-	0.02083	-	0.03580	-	99.7	78.8	74.8	58.3	3,460,391
	#6	4,065,091	1,770,348	-	428	-	5,255	4,993	-	-	9,000	8,550	-	-	0.02090	-	0.03580	-	99.7	78.8	74.8	58.3	3,690,608
Yonghung	#1	5,337,432	2,004,193	-	2,548	-	6,072	5,768	-	-	8,891	8,447	-	-	0.02415	-	0.03537	-	99.7	78.8	74.8	58.3	4,832,492
	#2	5,727,937	2,129,118	-	2,545	-	6,086	5,782	-	-	8,899	8,454	-	-	0.02421	-	0.03540	-	99.7	78.8	74.8	58.3	5,145,415
Boryeong	#1	3,988,848	1,638,140	-	306	-	5,768	5,479	-	-	8,855	8,412	-	-	0.02294	-	0.03522	-	99.7	78.8	74.8	58.3	3,747,559
	#2	3,423,101	1,389,425	-	1,137	-	5,766	5,478	-	-	8,943	8,496	-	-	0.02294	-	0.03557	-	99.7	78.8	74.8	58.3	3,180,183
	#3	3,409,486	1,323,779	-	514	-	5,845	5,552	-	-	8,943	8,496	-	-	0.02325	-	0.03557	-	99.7	78.8	74.8	58.3	3,069,450
	#4	4,133,946	1,610,928	-	82	-	5,824	5,533	-	-	8,943	8,496	-	-	0.02316	-	0.03557	-	99.7	78.8	74.8	58.3	3,720,722
	#5	3,364,148	1,296,455	-	541	-	5,845	5,552	-	-	8,749	8,312	-	-	0.02325	-	0.03480	-	99.7	78.8	74.8	58.3	3,006,196
	#6	3,987,488	1,553,273	-	518	-	5,834	5,542	-	-	8,749	8,312	-	-	0.02320	-	0.03480	-	99.7	78.8	74.8	58.3	3,594,567
Taean	#1	3,556,797	1,354,832	-	514	-	5,982	5,683	-	-	8,749	8,312	-	-	0.02380	-	0.03480	-	99.7	78.8	74.8	58.3	3,215,498
	#2	4,035,753	1,532,209	-	162	-	5,978	5,679	-	-	8,371	7,952	-	-	0.02378	-	0.03329	-	99.7	78.8	74.8	58.3	3,632,792
	#3	3,528,613	1,338,967	-	575	-	5,983	5,684	-	-	8,649	8,216	-	-	0.02380	-	0.03440	-	99.7	78.8	74.8	58.3	3,178,189
	#4	4,069,820	1,548,909	-	133	-	5,979	5,680	-	-	8,665	8,232	-	-	0.02378	-	0.03446	-	99.7	78.8	74.8	58.3	3,672,841
	#5	4,013,235	1,542,775	-	544	-	5,934	5,638	-	-	8,665	8,232	-	-	0.02360	-	0.03446	-	99.7	78.8	74.8	58.3	3,632,047
	#6	3,381,867	1,294,577	-	1,113	-	5,960	5,662	-	-	8,665	8,232	-	-	0.02371	-	0.03446	-	99.7	78.8	74.8	58.3	3,062,768
	#7	159,677	61,910	-	4,799	-	5,965	5,667	-	-	8,558	8,130	-	-	0.02373	-	0.03404	-	99.7	78.8	74.8	58.3	158,664
Hadong	#1	3,607,063	1,373,049	-	515	-	5,969	5,670	-	-	8,838	8,396	-	-	0.02374	-	0.03515	-	99.7	78.8	74.8	58.3	3,251,249
	#2	4,068,036	1,543,074	-	293	-	5,959	5,662	-	-	8,928	8,482	-	-	0.02370	-	0.03551	-	99.7	78.8	74.8	58.3	3,647,446
	#3	4,079,158	1,549,094	-	153	-	5,958	5,660	-	-	8,928	8,481	-	-	0.02370	-	0.03551	-	99.7	78.8	74.8	58.3	3,660,500
	#4	3,631,374	1,376,612	-	796	-	5,969	5,671	-	-	8,825	8,384	-	-	0.02374	-	0.03510	-	99.7	78.8	74.8	58.3	3,260,642
	#5	4,092,625	1,554,524	-	242	-	5,963	5,665	-	-	8,911	8,466	-	-	0.02372	-	0.03545	-	99.7	78.8	74.8	58.3	3,676,820
	#6	3,610,222	1,371,801	-	690	-	5,967	5,669	-	-	8,901	8,456	-	-	0.02373	-	0.03540	-	99.7	78.8	74.8	58.3	3,247,978
Dangjin	#1	3,598,820	1,380,527	-	966	-	5,882	5,588	-	-	8,975	8,526	-	-	0.02340	-	0.03570	-	99.7	78.8	74.8	58.3	3,222,901
	#2	4,115,891	1,570,077	-	161	-	5,906	5,611	-	-	8,978	8,529	-	-	0.02349	-	0.03571	-	99.7	78.8	74.8	58.3	3,677,721
	#3	3,666,490	1,402,916	-	433	-	5,886	5,592	-	-	9,007	8,556	-	-	0.02341	-	0.03582	-	99.7	78.8	74.8	58.3	3,275,646
	#4	3,610,984	1,386,317	-	1,549	-	5,875	5,581	-	-	9,015	8,564	-	-	0.02337	-	0.03586	-	99.7	78.8	74.8	58.3	3,233,968
	#5	3,946,931	1,456,458	-	745	-	6,046	5,743	-	-	8,955	8,507	-	-	0.02405	-	0.03562	-	99.7	78.8	74.8	58.3	3,493,792
	#6	3,392,395	1,216,582	-	3,051	-	6,120	5,814	-	-	8,895	8,450	-	-	0.02434	-	0.03538	-	99.7	78.8	74.8	58.3	2,960,392
	#7	1,474	1,008	-	505	-	5,818	5,527	-	-	8,984	8,535	-	-	0.02314	-	0.03573	-	99.7	78.8	74.8	58.3	3,675
Ulsan	#1	275,016	-	72,243	605	-	-	-	9,915	9,419	9,120	8,664	-	-	-	0.03944	0.03627	-	99.7	78.8	74.8	58.3	226,138
	#2	306,668	-	80,187	469	-	-	-	9,923	9,427	9,120	8,664	-	-	-	0.03947	0.03627	-	99.7	78.8	74.8	58.3	250,655
	#3	376,132	-	96,459	518	-	-	-	9,919	9,423	9,120	8,664	-	-	-	0.03945	0.03627	-	99.7	78.8	74.8	58.3	301,284
	#4	1,511,557	-	360,919	3,729	-	-	-	10,030	9,529	9,120	8,664	-	-	-	0.03989	0.03627	-	99.7	78.8	74.8	58.3	1,144,748
	#5	1,583,846	-	375,985	3,678	-	-	-	10,033	9,531	9,120	8,664	-	-	-	0.03991	0.03627	-	99.7	78.8	74.8	58.3	1,192,301
	#6	1,589,838	-	378,331	3,694	-	-	-	10,035	9,533	9,120	8,664	-	-	-	0.03991	0.03627	-	99.7	78.8	74.8	58.3	1,199,917
Youngnam	#1	359,205	-	107,090	1,016	-	-	-	10,138	9,631	8,845	8,403	-	-	-	0.04032	0.03518	-	99.7	78.8	74.8	58.3	342,952
	#2	323,595	-	95,127	1,494	-	-	-	10,110	9,605	8,862	8,419	-	-	-	0.04021	0.03525	-	99.7	78.8	74.8	58.3	305,368
Yosu	#1	403,547	-	99,129	281	-	-	-	9,963	9,465	8,798	8,358	-	-	-	0.03963	0.03499	-	99.7	78.8	74.8	58.3	310,280
	#2	906,849	-	215,957	291	-	-	-	9,954	9,456	8,796	8,356	-	-	-	0.03959	0.03499	-	99.7	78.8	74.8	58.3	674,484

Pyongtaek	#1	1,123,948	-	261,458	141	3,997	-	-	9,707	9,222	8,943	8,496	12,941	11,647	-	0.03861	0.03557	0.04876	99.7	78.8	74.8	58.3	807,225
	#2	1,198,620	-	277,025	166	5,687	-	-	9,719	9,233	8,943	8,496	12,941	11,647	-	0.03866	0.03557	0.04876	99.7	78.8	74.8	58.3	860,500
	#3	1,304,568	-	303,858	134	3,891	-	-	9,747	9,260	8,949	8,501	12,859	11,573	-	0.03877	0.03559	0.04845	99.7	78.8	74.8	58.3	939,621
	#4	1,052,228	-	245,602	103	3,473	-	-	9,693	9,208	8,949	8,501	12,963	11,667	-	0.03855	0.03559	0.04885	99.7	78.8	74.8	58.3	756,311
Namjeju	#1	34,448	-	11,406	17	-	-	-	9,908	9,413	8,974	8,525	-	-	-	0.03941	0.03569	-	99.7	78.8	74.8	58.3	35,464
	#2	28,686	-	9,772	14	-	-	-	9,908	9,412	8,952	8,504	-	-	-	0.03941	0.03561	-	99.7	78.8	74.8	58.3	30,382
	#3	179,033	-	46,504	2,509	-	-	-	9,898	9,403	8,938	8,491	-	-	-	0.03937	0.03555	-	99.7	78.8	74.8	58.3	150,938
Jeju	#1	24,748	-	8,603	23	-	-	-	9,870	9,377	8,873	8,429	-	-	-	0.03926	0.03529	-	99.7	78.8	74.8	58.3	26,676
	#2	462,023	-	113,679	64	-	-	-	9,952	9,454	8,973	8,524	-	-	-	0.03958	0.03569	-	99.7	78.8	74.8	58.3	354,757
	#3	479,676	-	117,464	67	-	-	-	9,953	9,455	8,973	8,524	-	-	-	0.03959	0.03569	-	99.7	78.8	74.8	58.3	366,594
Seoul	#4	306,558	-	-	1	69,383	-	-	-	-	9,070	8,617	13,018	11,716	-	-	0.03608	0.04905	99.7	78.8	74.8	58.3	198,421
	#5	685,011	-	-	1	152,891	-	-	-	-	9,070	8,617	12,882	11,594	-	-	0.03608	0.04854	99.7	78.8	74.8	58.3	432,688
Incheon	#1	32,932	-	-	-	6,945	-	-	-	-	-	-	13,036	11,733	-	-	-	0.04912	99.7	78.8	74.8	58.3	19,888
	#2	24,366	-	-	-	5,223	-	-	-	-	-	-	13,028	11,725	-	-	-	0.04909	99.7	78.8	74.8	58.3	14,948
	#3	78,669	-	-	311	15,426	-	-	-	-	8,982	8,533	13,018	11,716	-	-	0.03573	0.04905	99.7	78.8	74.8	58.3	44,945
	#4	62,414	-	-	311	12,454	-	-	-	-	8,981	8,532	13,024	11,722	-	-	0.03572	0.04908	99.7	78.8	74.8	58.3	36,462
Pyongtaek C/C	C/C	497,441	-	-	45	84,054	-	-	-	-	8,950	8,503	13,030	11,727	-	-	0.03560	0.04910	99.7	78.8	74.8	58.3	240,710
Ilsan	C/C	3,038,165	-	-	1,384	556,504	-	-	-	-	8,989	8,540	13,017	11,715	-	-	0.03575	0.04905	99.7	78.8	74.8	58.3	1,595,041
Bundang	C/C	4,059,300	-	-	-	720,381	-	-	-	-	-	-	13,025	11,723	-	-	-	0.04908	99.7	78.8	74.8	58.3	2,061,292
Ulsan	C/C	3,608,435	-	-	-	536,196	-	-	-	-	-	-	12,646	11,381	-	-	-	0.04765	99.7	78.8	74.8	58.3	1,489,587
Seoincheon	C/C	8,726,521	-	-	1,066	1,199,196	-	-	-	-	9,200	8,740	13,025	11,723	-	-	0.03659	0.04908	99.7	78.8	74.8	58.3	3,434,336
Shinincheon	C/C	11,797,500	-	-	-	1,641,038	-	-	-	-	-	-	13,025	11,723	-	-	-	0.04908	99.7	78.8	74.8	58.3	4,695,664
Boryeong	C/C	7,089,662	-	-	-	998,683	-	-	-	-	-	-	13,034	11,730	-	-	-	0.04911	99.7	78.8	74.8	58.3	2,859,509
Incheon	C/C	3,648,288	-	-	-	484,606	-	-	-	-	-	-	12,998	11,698	-	-	-	0.04898	99.7	78.8	74.8	58.3	1,383,767
Busan	C/C	10,455,401	-	-		1,396,417	-	-	-	-	-	-	13,017	11,716	-	-	-	0.04905	99.7	78.8	74.8	58.3	3,993,312
Hallim	C/C	175,356	-	-	48,475	-	-	-	-	-	8,954	8,506	-	-	-	-	0.03561	-	99.7	78.8	74.8	58.3	129,127
Anyang	C/C	1,286,480	-	-	-	230,969	-	-	-	-	-	-	13,028	11,726	-	-	-	0.04909	99.7	78.8	74.8	58.3	661,054
Bucheon	C/C	1,241,795	-	-	215	225,713	-	-	-	-	10,927	10,381	13,013	11,711	-	-	0.04346	0.04903	99.7	78.8	74.8	58.3	645,937
POSCO POWER	C/C	2,338,128	-	-	-	408,018	-	-	-	-	-	-	13,031	11,728	-	-	-	0.04910	99.7	78.8	74.8	58.3	1,167,987
G S Bugog	C/C	2,911,683	-	-	-	389,811	-	-	-	-	-	-	13,030	11,727	-	-	-	0.04910	99.7	78.8	74.8	58.3	1,115,802
Yulchon	C/C	2,276,276	-	-	-	315,132	-	-	-	-	-	-	13,376	12,039	-	-	-	0.05040	99.7	78.8	74.8	58.3	926,015
Namjeju	D/P	239,690	-	51,347	111	-	-	-	10,246	9,734	8,907	8,462	-	-	-	0.04075	0.03543	-	99.7	78.8	74.8	58.3	165,184
Jeju	G/T	15,986	-	-	8,264	-	-	-	-	-	8,792	8,352	-	-	-	-	0.03497	-	99.7	78.8	74.8	58.3	21,614
Jeju	D/P	252,764	-	52,907	-	-	-	-	9,617	9,136	-	-	-	-	-	0.03825	-	-	99.7	78.8	74.8	58.3	159,476
TOTAL		**206,605,293**																					**154,543,353**
																					OM2006	**0.7480 tCO2/MWh**	

OM (Operating Margin) 2007

Plant name	Unit number	Electricity delivered (MWh)	fuel consumption				Calorific value	Net caloric value	Calorific value	Net caloric value	Calorific value	Net caloric value	Calorific value	Net caloric value	Calorific Value				EF_CO2				CO2 emission (t CO2)
			Coal (t)	Heavy oil (kl)	Diesel oil (kl)	LNG (t)	Coal (kcal/kg)		Heavy oil (kcal/l)		Diesel oil (kcal/l)		LNG (kcal/kg)		Coal (TJ/t)	Heavy oil (TJ/kl)	Diesel oil (TJ/kl)	LNG (TJ/t)	Coal (t/TJ)	Heavy oil (t/TJ)	Diesel oil (t/TJ)	Natural gas (t/TJ)	
Honam	#1	1,806,765	866,853	889	281	-	5,459	5,186	9,801	9,311	8,944	8,497	-	-	0.02171	0.03898	0.03557	-	99.7	78.8	74.8	58.3	1,880,026
	#2	1,773,852	846,931	811	262	-	5,463	5,190	9,801	9,311	8,940	8,493	-	-	0.02173	0.03898	0.03556	-	99.7	78.8	74.8	58.3	1,837,952
Samchonpo	#1	3,903,591	1,631,706	-	296	-	5,837	5,545	-	-	8,814	8,373	-	-	0.02322	-	0.03506	-	99.7	78.8	74.8	58.3	3,777,651
	#2	4,398,382	1,804,695	-	384	-	5,828	5,537	-	-	8,814	8,373	-	-	0.02318	-	0.03506	-	99.7	78.8	74.8	58.3	4,171,855
	#3	4,311,704	1,755,374	-	434	-	5,816	5,525	-	-	8,788	8,349	-	-	0.02313	-	0.03495	-	99.7	78.8	74.8	58.3	4,049,643
	#4	3,840,729	1,543,140	-	677	-	5,831	5,539	-	-	8,788	8,349	-	-	0.02319	-	0.03495	-	99.7	78.8	74.8	58.3	3,569,971
	#5	4,074,103	1,850,764	-	315	-	5,122	4,866	-	-	9,000	8,550	-	-	0.02037	-	0.03580	-	99.7	78.8	74.8	58.3	3,760,010
	#6	3,823,174	1,714,320	-	619	-	5,120	4,864	-	-	9,000	8,550	-	-	0.02036	-	0.03580	-	99.7	78.8	74.8	58.3	3,482,327
Yonghung	#1	5,020,901	1,902,557	-	3,320	-	6,047	5,745	-	-	8,832	8,390	-	-	0.02405	-	0.03513	-	99.7	78.8	74.8	58.3	4,570,969
	#2	6,081,490	2,296,289	-	1,779	-	6,041	5,739	-	-	8,902	8,457	-	-	0.02403	-	0.03541	-	99.7	78.8	74.8	58.3	5,505,645
	#3	320,502	119,883		3,964		6,129	5,823			8,292	7,877			0.02438		0.03298		99.7	78.8	74.8	58.3	301,151
Boryeong	#1	3,604,642	1,466,761	-	811	-	5,809	5,519	-	-	8,943	8,496	-	-	0.02311	-	0.03557	-	99.7	78.8	74.8	58.3	3,380,952
	#2	4,120,511	1,655,488	-	169	-	5,805	5,515	-	-	8,943	8,496	-	-	0.02309	-	0.03557	-	99.7	78.8	74.8	58.3	3,811,364
	#3	4,214,892	1,648,008	-	187	-	5,809	5,519	-	-	9,111	8,655	-	-	0.02311	-	0.03624	-	99.7	78.8	74.8	58.3	3,796,817
	#4	3,438,773	1,347,303	-	646	-	5,804	5,514	-	-	9,414	8,943	-	-	0.02309	-	0.03744	-	99.7	78.8	74.8	58.3	3,102,751
	#5	4,162,530	1,629,904	-	195	-	5,811	5,520	-	-	9,111	8,655	-	-	0.02311	-	0.03624	-	99.7	78.8	74.8	58.3	3,756,427
	#6	3,817,024	1,490,809	-	387	-	5,808	5,518	-	-	9,111	8,655	-	-	0.02310	-	0.03624	-	99.7	78.8	74.8	58.3	3,434,648
Taean	#1	4,055,394	1,524,391	-	410	-	6,035	5,733	-	-	8,604	8,174	-	-	0.02400	-	0.03422	-	99.7	78.8	74.8	58.3	3,649,216
	#2	3,796,670	1,434,221	-	374	-	6,035	5,733	-	-	8,828	8,387	-	-	0.02400	-	0.03511	-	99.7	78.8	74.8	58.3	3,433,354
	#3	4,039,811	1,521,349	-	350	-	6,036	5,734	-	-	8,829	8,388	-	-	0.02401	-	0.03512	-	99.7	78.8	74.8	58.3	3,642,409
	#4	3,504,214	1,320,380	-	422	-	6,028	5,727	-	-	8,382	7,963	-	-	0.02398	-	0.03334	-	99.7	78.8	74.8	58.3	3,157,315
	#5	3,523,988	1,342,358	-	676	-	5,985	5,686	-	-	8,801	8,361	-	-	0.02381	-	0.03501	-	99.7	78.8	74.8	58.3	3,187,680
	#6	4,036,733	1,535,931	-	491	-	5,995	5,695	-	-	8,786	8,347	-	-	0.02384	-	0.03495	-	99.7	78.8	74.8	58.3	3,652,704
	#7	3,868,817	1,430,171	-	2,321	-	6,018	5,717	-	-	8,467	8,044	-	-	0.02394	-	0.03368	-	99.7	78.8	74.8	58.3	3,418,885
	#8	2,528,587	919,055		3,636		6,023	5,722			7,638	7,256			0.02396		0.03038		99.7	78.8	74.8	58.3	2,203,368
Hadong	#1	4,140,667	1,582,726	-	178	-	5,944	5,647	-	-	8,939	8,492	-	-	0.02364	-	0.03555	-	99.7	78.8	74.8	58.3	3,731,132
	#2	3,681,670	1,396,830	-	637	-	5,942	5,645	-	-	8,901	8,456	-	-	0.02363	-	0.03540	-	99.7	78.8	74.8	58.3	3,293,060
	#3	3,727,907	1,424,033	-	375	-	5,923	5,627	-	-	8,914	8,468	-	-	0.02356	-	0.03546	-	99.7	78.8	74.8	58.3	3,345,738
	#4	4,115,014	1,572,409	-	292	-	5,935	5,638	-	-	8,967	8,519	-	-	0.02361	-	0.03567	-	99.7	78.8	74.8	58.3	3,701,507
	#5	3,905,190	1,486,776	-	452	-	5,950	5,653	-	-	8,939	8,492	-	-	0.02367	-	0.03555	-	99.7	78.8	74.8	58.3	3,509,234
	#6	4,158,791	1,585,307	-	109	-	5,937	5,640	-	-	8,942	8,495	-	-	0.02361	-	0.03557	-	99.7	78.8	74.8	58.3	3,732,632
Dangjin	#1	3,968,103	1,512,904	-	269	-	5,958	5,660	-	-	9,063	8,610	-	-	0.02370	-	0.03605	-	99.7	78.8	74.8	58.3	3,575,205
	#2	3,595,927	1,358,316	-	543	-	5,961	5,663	-	-	9,059	8,606	-	-	0.02371	-	0.03603	-	99.7	78.8	74.8	58.3	3,212,320
	#3	4,010,715	1,516,065	-	119	-	5,955	5,657	-	-	9,070	8,617	-	-	0.02369	-	0.03608	-	99.7	78.8	74.8	58.3	3,580,466
	#4	4,009,178	1,519,231	-	342	-	5,956	5,658	-	-	9,090	8,636	-	-	0.02369	-	0.03616	-	99.7	78.8	74.8	58.3	3,589,148
	#5	3,443,482	1,279,796	-	1,038	-	6,014	5,713	-	-	9,074	8,620	-	-	0.02392	-	0.03609	-	99.7	78.8	74.8	58.3	3,054,947
	#6	3,497,359	1,281,318	-	878	-	6,039	5,737	-	-	9,066	8,613	-	-	0.02402	-	0.03606	-	99.7	78.8	74.8	58.3	3,070,846
	#7	2,904,680	1,059,612	-	6,681	-	6,026	5,725	-	-	9,075	8,621	-	-	0.02397	-	0.03610	-	99.7	78.8	74.8	58.3	2,550,116
	#8	1,297,925	467,807		4,873		6,044	5,742			9,048	8,596			0.02404		0.03599		99.7	78.8	74.8	58.3	1,134,341
Ulsan	#1	406,685	-	107,844	406	-	-	-	9,908	9,413	9,120	8,664	-	-	-	0.03941	0.03627	-	99.7	78.8	74.8	58.3	336,001
	#2	407,321	-	108,381	483	-	-	-	9,916	9,420	9,120	8,664	-	-	-	0.03944	0.03627	-	99.7	78.8	74.8	58.3	338,149
	#3	458,584	-	120,571	576	-	-	-	9,853	9,360	9,120	8,664	-	-	-	0.03919	0.03627	-	99.7	78.8	74.8	58.3	373,906
	#4	1,418,034	-	341,170	3,525	-	-	-	10,008	9,508	9,120	8,664	-	-	-	0.03981	0.03627	-	99.7	78.8	74.8	58.3	1,079,728
	#5	1,540,400	-	370,712	4,711	-	-	-	10,011	9,510	9,120	8,664	-	-	-	0.03982	0.03627	-	99.7	78.8	74.8	58.3	1,175,960
	#6	899,604	-	216,409	3,021	-	-	-	10,002	9,502	9,120	8,664	-	-	-	0.03978	0.03627	-	99.7	78.8	74.8	58.3	686,610
Youngnam	#1	688,935	-	174,082	1,232	-	-	-	10,150	9,643	8,844	8,402	-	-	-	0.04037	0.03518	-	99.7	78.8	74.8	58.3	557,040
	#2	474,475	-	122,249	796	-	-	-	10,150	9,643	8,846	8,404	-	-	-	0.04037	0.03518	-	99.7	78.8	74.8	58.3	391,000
Yosu	#1	497,053	-	121,572	332	-	-	-	9,962	9,464	8,808	8,368	-	-	-	0.03962	0.03503	-	99.7	78.8	74.8	58.3	380,458
	#2	1,071,405	-	257,420	367	-	-	-	9,960	9,462	8,811	8,370	-	-	-	0.03962	0.03505	-	99.7	78.8	74.8	58.3	804,550

Pyongtaek	#1	1,147,515	-	269,284	114	3,316	-	-	9,942	9,445	8,983	8,534	12,945	11,651	-	0.03954	0.03573	0.04878	99.7	78.8	74.8	58.3	848,840
	#2	1,553,162	-	359,870	140	6,339	-	-	9,946	9,449	8,979	8,530	12,947	11,652	-	0.03956	0.03571	0.04879	99.7	78.8	74.8	58.3	1,140,231
	#3	1,502,099	-	349,481	157	7,874	-	-	9,944	9,447	8,966	8,518	14,945	13,451	-	0.03955	0.03566	0.05631	99.7	78.8	74.8	58.3	1,115,493
	#4	1,095,986	-	255,443	117	4,047	-	-	9,958	9,460	8,965	8,517	12,946	11,651	-	0.03961	0.03566	0.04878	99.7	78.8	74.8	58.3	809,078
Namjeju	#3	484,459	-	124,559	225	-	-	-	9,907	9,412	8,632	8,200	-	-	-	0.03940	0.03433	-	99.7	78.8	74.8	58.3	387,345
	#4	500,222		127,900	341	-	-	-	9,905	9,410	8,963	8,515			-	0.03940	0.03565		99.7	78.8	74.8	58.3	397,970
Jeju	#1	3,019	-	1,049	4	-	-	-	9,908	9,413	8,903	8,458	-	-	-	0.03941	0.03541	-	99.7	78.8	74.8	58.3	3,268
	#2	280,454	-	70,122	112	-	-	-	9,916	9,420	8,323	7,907	-	-	-	0.03944	0.03310	-	99.7	78.8	74.8	58.3	218,210
	#3	396,186	-	98,846	34	-	-	-	9,914	9,418	8,937	8,490	-	-	-	0.03943	0.03555	-	99.7	78.8	74.8	58.3	307,233
Seoul	#4	357,572	-	-	1	75,080	-	-	-	-	7,801	7,411	13,030	11,727	-	-	0.03103	0.04910	99.7	78.8	74.8	58.3	214,914
	#5	962,861	-	-	1	206,908	-	-	-	-	9,070	8,617	13,030	11,727	-	-	0.03608	0.04910	99.7	78.8	74.8	58.3	592,266
Incheon	#1	148,821	-	-	-	30,402	-	-	-	-	-	-	13,030	11,727	-	-	-	0.04910	99.7	78.8	74.8	58.3	87,024
	#2	157,042	-	-	-	31,528	-	-	-	-	-	-	13,033	11,730	-	-	-	0.04911	99.7	78.8	74.8	58.3	90,268
	#3	205,530	-	-	354	41,270	-	-	-	-	8,962	8,514	13,034	11,731	-	-	0.03565	0.04911	99.7	78.8	74.8	58.3	119,113
	#4	95,143	-	-	201	18,892	-	-	-	-	8,929	8,483	13,034	11,731	-	-	0.03551	0.04911	99.7	78.8	74.8	58.3	54,628
Pyongtaek C/C	C/C	909,449	-	-	67	151,414	-	-	-	-	8,950	8,503	13,044	11,740	-	-	0.03560	0.04915	99.7	78.8	74.8	58.3	434,059
Ilsan	C/C	3,506,350	-	-	-	635,260	-	-	-	-	-	-	13,028	11,725	-	-	-	0.04909	99.7	78.8	74.8	58.3	1,818,120
Bundang	C/C	3,741,296	-	-	3	660,899	-	-	-	-	9,175	8,716	13,031	11,728	-	-	0.03649	0.04910	99.7	78.8	74.8	58.3	1,891,943
Ulsan	C/C	4,383,453	-	-	-	649,494	-	-	-	-	-	-	12,900	11,610	-	-	-	0.04861	99.7	78.8	74.8	58.3	1,840,595
Seoincheon	C/C	10,895,505	-	-	-	1,495,687	-	-	-	-	-	-	13,043	11,739	-	-	-	0.04915	99.7	78.8	74.8	58.3	4,285,599
Shinincheon	C/C	12,533,994	-	-	-	1,761,001	-	-	-	-	-	-	13,039	11,735	-	-	-	0.04913	99.7	78.8	74.8	58.3	5,044,257
Boryeong	C/C	7,839,371	-	-	-	1,121,251	-	-	-	-	-	-	13,029	11,726	-	-	-	0.04909	99.7	78.8	74.8	58.3	3,209,277
Incheon	C/C	3,696,784	-	-	-	494,690	-	-	-	-	-	-	13,030	11,727	-	-	-	0.04910	99.7	78.8	74.8	58.3	1,416,025
Busan	C/C	11,616,221	-	-		1,552,997	-	-	-	-	-	-	13,030	11,727	-	-	-	0.04910	99.7	78.8	74.8	58.3	4,445,374
Hallim	C/C	61,752	-	-	17,753	-	-	-	-	-	8,982	8,533	13,025	11,723	-	-	0.03573	0.04908	99.7	78.8	74.8	58.3	47,441
Anyang	C/C	1,615,090	-	-	-	289,384	-	-	-	-	-	-	13,046	11,741	-	-	-	0.04916	99.7	78.8	74.8	58.3	829,364
Bucheon	C/C	1,523,068	-	-	-	269,651	-	-	-	-	-	-	13,220	11,898	-	-	-	0.04981	99.7	78.8	74.8	58.3	783,117
POSCO POWER	C/C	3,788,598	-	-	-	660,445	-	-	-	-	-	-	13,063	11,757	-	-	-	0.04922	99.7	78.8	74.8	58.3	1,895,278
G S Bugog	C/C	2,767,811	-	-	-	371,586	-	-	-	-	-	-	13,038	11,734	-	-	-	0.04913	99.7	78.8	74.8	58.3	1,064,299
Yulchon	C/C	2,083,451	-	-	-	292,336	-	-	-	-	-	-	13,036	11,732	-	-	-	0.04912	99.7	78.8	74.8	58.3	837,182
Namjeju	D/P	164,390	-	35,297	238	-	-	-	9,915	9,419	8,761	8,323	-	-	-	0.03944	0.03485	-	99.7	78.8	74.8	58.3	110,309
Jeju	G/T	1,294	-	-	850	-	-	-	-	-	8,892	8,447	-	-	-	-	0.03537	-	99.7	78.8	74.8	58.3	2,249
Jeju	D/P	235,626	-	49,613	-	-	-	-	9,890	9,396	-	-	-	-	-	0.03934	-	-	99.7	78.8	74.8	58.3	153,788
TOTAL		**230,640,457**																					**172,233,342**
																					OM2007	**0.7468 tCO2/MWh**	

BM(Build Marg)

No.	Plant name	Type	Commissioning date	Net generation	fuel consumption Coal (t)	fuel consumption Heavy oil (kl)	fuel consumption Diesel oil (kl)	fuel consumption LNG (t)	Coal (kcal/kg) Calorific value	Coal (kcal/kg) Net caloric value	Heavy oil (kcal/l) Calorific value	Heavy oil (kcal/l) Net caloric value	Diesel oil (kcal/l) Calorific value	Diesel oil (kcal/l) Net caloric value	LNG (kcal/kg) Calorific value	LNG (kcal/kg) Net caloric value	Calorific Value Coal (TJ/t)	Calorific Value Heavy oil (TJ/kl)	Calorific Value Diesel oil (TJ/kl)	Calorific Value LNG (TJ/t)	EF_CO2 Coal (t/TJ)	EF_CO2 Heavy oil (t/TJ)	EF_CO2 Diesel oil (t/TJ)	EF_CO2 Natural gas (t/TJ)	CO2 emission (t CO2)
1	Hanbit Sungsan solar #2	Renewable	`07.12	-																	99.7	78.8	74.8	58.3	-
2	Taein Kangjin solar	Renewable	`07.12	6																	99.7	78.8	74.8	58.3	-
3	Suneye Kangjin solar	Renewable	`07.12	11																	99.7	78.8	74.8	58.3	-
4	Korea Youngchun solar	Renewable	`07.12	17																	99.7	78.8	74.8	58.3	-
5	Solar Youngam solar	Renewable	`07.12	-																	99.7	78.8	74.8	58.3	-
6	Changhwan Youngduk solar	Renewable	`07.12	5																	99.7	78.8	74.8	58.3	-
7	Samsung Jindo solar	Renewable	`07.12	9																	99.7	78.8	74.8	58.3	-
8	Hankyung wind	Renewable	`07.12	18,416																	99.7	78.8	74.8	58.3	-
9	Dangjin #8	Renewable	`07.12	1,297,925	467,807	-	4,873	-	6,044	5,742	-	-	9,048	8,596		-	0.02404	-	0.03599	-	99.7	78.8	74.8	58.3	1,134,341
10	SP solar younggwang	Renewable	`07.11	38																	99.7	78.8	74.8	58.3	-
11	Dongyang energy sinan	Renewable	`07.11	268																	99.7	78.8	74.8	58.3	-
12	EF Youngam solar	Renewable	`07.11	40																	99.7	78.8	74.8	58.3	-
13	Dongwon Kangjin solar	Renewable	`07.11	214																	99.7	78.8	74.8	58.3	-
14	Solec Younggwang solar	Renewable	`07.11	120																	99.7	78.8	74.8	58.3	-
15	Solar Jungeum solar	Renewable	`07.11	92																	99.7	78.8	74.8	58.3	-
16	Shinbuk Youngam solar	Renewable	`07.11	178																	99.7	78.8	74.8	58.3	-
17	Hyein Haenam solar	Renewable	`07.11	364																	99.7	78.8	74.8	58.3	-
18	Samrangjin solar	Renewable	`07.11	646																	99.7	78.8	74.8	58.3	-
19	Hyosung Daegiwind	Renewable	`07.11	42																	99.7	78.8	74.8	58.3	-
20	UriYoungam solar	Renewable	`07.08	267																	99.7	78.8	74.8	58.3	-
21	Hwasung solar	Renewable	`07.08	309																	99.7	78.8	74.8	58.3	-
22	Taean #8	Fossil fuel	`07.08	2,528,587	919,055	-	3,636	-	6,023	5,722	-	-	7,638	7,256	-	-	0.02396	-	0.03038	-	99.7	78.8	74.8	58.3	2,203,368
23	Youngju solar #1	Renewable	`07.08	230																	99.7	78.8	74.8	58.3	-
24	Dangjin #7	Fossil fuel	`07.06	2,904,680	1,059,612	-	6,681	-	6,026	5,725	-	-	9,075	8,621	-	-	0.02397	-	0.03610	-	99.7	78.8	74.8	58.3	2,550,116
25	Muan solar	Renewable	`07.08	622																	99.7	78.8	74.8	58.3	-
26	Youngam solar	Renewable	`07.06	770																	99.7	78.8	74.8	58.3	-
27	Jangheum solar	Renewable	`07.08	125																	99.7	78.8	74.8	58.3	-
28	Gomun smallhydro	Renewable	`07.08	2,996						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
29	Wonjungsu smallhydro	Renewable	`07.05	1,321						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
30	Baekgok smallhydro	Renewable	`07.05	1,001						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
31	Damyangho smallhydro	Renewable	`07.05	1,771						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
32	Juam hydro	Renewable	`07.05	714						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
33	Namjeju #4	Fossil fuel	`07.03	500,222	-	127,900	341	-	-	-	9,905	9,410	8,963	8,515	-	-	-	0.03940	0.03565	-	99.7	78.8	74.8	58.3	397,970
34	Ecoenergy	Renewable	`07.03	231,029																	99.7	78.8	74.8	58.3	-
35	Junju incineration	Renewable	`07.02	13,059																	99.7	78.8	74.8	58.3	-
36	Mungyung SP solar	Renewable	`07.02	2,563																	99.7	78.8	74.8	58.3	-
37	SeoulMarine (Sunchen)	Renewable	`07.02	1,223																	99.7	78.8	74.8	58.3	-
38	Mirae energy	Renewable	`07.02	165																	99.7	78.8	74.8	58.3	-
39	Hapcheon smallhydro	Renewable	`07.02	6,777						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
40	Samcheonpo haeyang hydro	Renewable	`07.02	23,290						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
41	Dabang	Renewable	`07.02	933						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
42	Taean #7	Fossil fuel	`07.02	3,868,817	1,430,171		2,321		6,018	5,717	-	-	8,467	8,044	-	-	0.02394	-	0.03368	-	99.7	78.8	74.8	58.3	3,418,885
43	Youngju solar #2	Renewable	`07.01	646																	99.7	78.8	74.8	58.3	-
44	Chungsu hydro	Renewable	`06.12	145,042						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
45	Bundang fuelcell	Renewable	`06.10	1,959																	99.7	78.8	74.8	58.3	-
46	SNP solar	Renewable	`06.10	995																	99.7	78.8	74.8	58.3	-
47	Namhae solar	Renewable	`06.10	1,462																	99.7	78.8	74.8	58.3	-
48	Hanra junggon solar	Renewable	`06.10	1,292																	99.7	78.8	74.8	58.3	-
49	Enerpark	Renewable	`06.09	416																	99.7	78.8	74.8	58.3	-
50	Youngheum solar	Renewable	`06.09	1,214																	99.7	78.8	74.8	58.3	-
51	Chungsong hydro	Renewable	`06.09	164,069						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
52	Namjeju #3	Fossil fuel	`06.09	484,459	-	124,559	225	-	-	-	9,907	9,412	8,632	8,200	-	-	-	0.03940	0.03433	-	99.7	78.8	74.8	58.3	387,345
53	Kangwon wind	Renewable	`06.09	232,377																	99.7	78.8	74.8	58.3	-
54	Yangyang hydro #4	Renewable	`06.08	91,270						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
55	Donghae solar	Renewable	`06.08	1,118																	99.7	78.8	74.8	58.3	-
56	Yangyang hydro and wind	Renewable	`06.06	1,907																	99.7	78.8	74.8	58.3	-
57	Hadongho smallhydro	Renewable	`06.06	1,832						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
58	Yangyang hydro #3	Renewable	`06.06	56,495						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
59	Goheum solar	Renewable	`06.06	1,233																	99.7	78.8	74.8	58.3	-
60	Jangsung smllhydro	Renewable	`06.05	648						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-

61	Yangyang small hydro #2	Renewable	`06.04	103,698						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
62	Dangjin #6	Fossil fuel	`06.04	3,497,359	1,281,318	-	878	-	6,039	5,737	-	-	9,066	8,613	-	-	0.02402	-	0.03606	-	99.7	78.8	74.8	58.3	3,070,846
63	Shinchang wind	Renewable	`06.03	3,572																	99.7	78.8	74.8	58.3	-
64	Yangyang hydro #1	Renewable	`06.02	106,973						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
65	Sunchun solar	Renewable	`05.12	1,259																	99.7	78.8	74.8	58.3	-
66	Jangheum dam small hydro	Renewable	`05.12	5,430						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
67	Samcheonpo solar	Renewable	`05.12	131																	99.7	78.8	74.8	58.3	-
68	Dangjin #5	Fossil fuel	`05.10	3,443,482	1,279,796	-	1,038	-	6,014	5,713	-	-	9,074	8,620	-	-	0.02392	-	0.03609	-	99.7	78.8	74.8	58.3	3,054,947
69	Yangyang small hydro	Renewable	`05.10	5,587						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
70	Taean solar	Renewable	`05.10	118																	99.7	78.8	74.8	58.3	-
71	Incheon C/C	Fossil fuel	`05.07	3,696,784	-	-	-	494,690	-	-	-	-	-	-	13,029	11,726	-	-	-	0.04909	99.7	78.8	74.8	58.3	1,415,916
72	Daegok small hydro	Renewable	`05.07	1,278						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
73	Donghwa small hydro	Renewable	`05.07	2,481						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
74	Uljin #6	PWR	`05.04	7,911,305						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
75	Hanryo LFG	Renewable	`05.04	5,102																	99.7	78.8	74.8	58.3	-
76	Yungduk wind	Renewable	`05.03	74,280																	99.7	78.8	74.8	58.3	-
77	Busan biogas	Renewable	`05.03	1,551																	99.7	78.8	74.8	58.3	-
78	Sungnam small hydro	Renewable	`04.12	1,794						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
79	Maebongsan wind	Renewable	`04.12	11,058																	99.7	78.8	74.8	58.3	-
80	Daegwanryung wind	Renewable	`04.12	4,288																	99.7	78.8	74.8	58.3	-
81	Yonghung #2	Fossil fuel	`04.11	6,081,490	2,296,289	-	1,779	-	6,041	5,739	-	-	8,902	8,457	-	-	0.02403	-	0.03541	-	99.7	78.8	74.8	58.3	5,505,645
82	Uljin #5	PWR	`04.07	8,025,928						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
83	Yonghung #1	Fossil fuel	`04.07	5,020,901	1,902,557	-	3,320	-	6,047	5,745	-	-	8,832	8,390	-	-	0.02405	-	0.03513	-	99.7	78.8	74.8	58.3	4,570,969
84	Ulchon C/C	Fossil fuel	`04.07	2,083,451	-	-	-	292,336	-	-	-	-	-	-	13,036	11,732	-	-	-	0.04912	99.7	78.8	74.8	58.3	837,182
85	Cheonsang small hydro	Renewable	`04.02	240						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
86	Chungju LFG	Renewable	`04.02	5,808																	99.7	78.8	74.8	58.3	-
87	Unjung LFG	Renewable	`03.12	11,415																	99.7	78.8	74.8	58.3	-
88	Andong samll hydro	Renewable	`03.09	6,259																	99.7	78.8	74.8	58.3	-
89	Daejeon Gumgodong LFG	Renewable	`03.06	9,160																	99.7	78.8	74.8	58.3	-
90	Busan C/C	Fossil fuel	`03.05	11,616,221	-	-	-	########	-	-	-	-	-	-	13,030	11,727	-	-	-	0.04910	99.7	78.8	74.8	58.3	4,445,374
91	Muju small hydro	Renewable	`03.04	637						-		-		-		-	-	-	-	-	99.7	78.8	74.8	58.3	-
92	Sangwon ENC	Renewable	`03.03	2,752																	99.7	78.8	74.8	58.3	-
93	Younggwang #6	PWR	`02.12	7,859,224																	99.7	78.8	74.8	58.3	-
94	Taean #6	Fossil fuel	`02.05	4,036,733	1,535,931	-	491	-	5,995	5,695	-	-	8,786	8,347	-	-	0.02384	-	0.03495	-	99.7	78.8	74.8	58.3	3,652,704
95	Younggwang #5	PWR	`02.05	8,601,736						-		-		-	-	-	-	-	-	-	99.7	78.8	74.8	58.3	-
			Total	**84,837,781**																					**36,645,607**
			Total Generation	**386,510,193**																					
				21.95%																			**BM**	**0.4319 tCO2/MWh**	

Baseline CEF(Carbon Emission Factor)

	CO2 emission	Electricity generation
	ton CO_2e	MWh
OM factor_2005	148,021,949	195,045,065
OM_factor_2006	154,543,353	206,605,293
OM_factor_2007	172,233,342	230,640,457
Sum OM factor	474,798,645	632,290,815
Average OM factor	**0.7509 tCO_2/MWh**	
BM factor	**0.4319 tCO_2/MWh**	
CM factor (50:50)	**0.5914 tCO_2/MWh**	

Appendix 5. Further background information on monitoring plan

Appendix 6. Summary of post registration changes

- Addition of FTIR as a measure equipment for Md,in(SO2F2)

In second monitoring period, SO2F2 gas is detected in inlet stack gas as 1st monitoring period. Therefore, registered monitoring plan needs to be changed this monitoring period.

Md,in is defined as total dry molecular weight of inlet stack gas. The averaged relative concentrations of SF6, Ar, He, O2, CO2, N2 and other gases with concentration of greater than 100ppmv, such as CF4, CO, HC, HF, SO2F2 SOF2 and SiF4 should be quantified with measurement by the QMS as per the methodology and registered PDD.
In the project activity, SF6, Ar, He, O2, CO2, and N2 are scanned as over 100ppmv gases in inlet stack and additionally only SO2F2 among other gases is scanned as over 100ppmv gas in inlet stack gas. Thus, SO2F2 also need to be measure by the QMS.
However, there is no certified standard gas for SO2F2 available because this gas is problematic with the stability of gases.(This is confirmed by Dr. Jin Seong Kim, a research scientist working in KRISS<Korea Research Institute of Standards and Science>) If there is no standard gas, the QMS system could not measure the gas because QMS need to use calibration with standard gas for quantitative analysis.
Instead, SO2F2 can be analysed with FTIR and library information provided by the FTIR manufacturer.
The FTIR system has equal accuracy with QMS and it is suitable for gas analysis. The absorption intensity for FTIR follows the 'Lambert Beer law' which details the coefficient, path length, and number of molecules of a selected component. Using this law, without gas standards, it can be quantify certain components by FTIR with their known absorption coefficients. And many FTIR manufacturers provide a library which contains most useful infrared absorption wave-numbers with corresponding absorption coefficients for many gas chemicals, such as SiF4, and SO2F2.

- Change of FTIR and QMS calibration frequency

According to the annual surveillance test in the methodology AM0078, calibration frequency of the QMS should be implemented once per year. However, as the annex 4 in the QMS calibration frequency is recorded once per 2 or 3 months unlike annual surveillance test in the methodology and PDD. In addition, QMS equipment is used only one time, 6hours, in a year to determinate Md,in and Md,out. So, it is inefficient to calibration every three months.