Monitoring report form
(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT		
Title of the project activity	LG Chem Naju plant fuel switching project	
UNFCCC reference number of the project activity	2475	
Version number of the monitoring report	1	
Completion date of the monitoring report	21/05/2017	
Monitoring period number and duration of this monitoring period	Monitoring Period 2nd (24/02/2011 - 31/12/2016)	
Project participant(s)	LG Chem, Ltd.(Korea)	
Host Party	Korea	
Sectoral scope(s)	Type III : Other project activities Category B : Switching fossil fuels (Version 12) Sectoral Scope 1 – Energy industries (renewable - / non-renewable sources)	
Selected methodology(ies)	AMS-III.B. ver. 12 - Switching fossil fuels	
Selected standardized baseline(s)	N/A	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	19,635 tCO_2e (Annual, 365 days) **114,905 tCO_2e** **(Monitored, 2,136 days)**	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	23,176	50,054

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

(a) LG Chem produces octanol, plasticizers and acrylic acid at its Naju plant. In the baseline scenario, steam, which is used in the production process of petrochemical products, is mainly produced in a boiler using bunker fuel oil C (Sulphur 0.5%). The Project activity involves retrofitting the boilers to allow fuel switching from bunker fuel oil C to natural gas. Natural gas is less carbon intensive than bunker fuel oil C. Therefore switching fuel from bunker fuel oil C to natural gas reduces GHG emissions.

(b) The existing boiler has been retrofitted by installing special purpose burners for natural gas combustion as well as other necessary minor modifications. For fuel switching from bunker fuel oil C to natural gas, four natural gas burners have been installed for the main boiler. The total capacity of the four natural gas burners installed is 5,353 Nm_3/hr, which is of sufficient capacity for the expected amount of natural gas consumption at Naju plant. The natural gas burners are provided by Hamworthy Combustion.

(c) The start date of the project activity (the purchase date of the natural gas burners) was 21/06/2006. The project boiler retrofit was started on 30/09/2006 and a test-run of the project activity undertaken in November 2006. Project operation began on 20/11/2006. The project was registered on 04/06/2009.

(d) The total emission reductions achieved in this monitoring period (24/02/2011 - 31/12/2016) are 73,230 tCO_2e

A.2. Location of project activity

(a) Country(Host): Republic of Korea

(b) Province: Jeollanam-do

(c) City: Naju, 1, Songwal-dong (520-130)
It is located in Naju city about 20 km southwest of Gwangju International Airport.

(d) The coordinates for the plant site are: 35.023013 N, 126.717460 E.

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Korea (host)	LG Chem, Ltd.	No

Host Country is the Republic of Korea. The Republic of Korea ratified the Kyoto Protocol in November 2002. Mitsubishi UFJ Morgan Stanley Securities Co., Ltd.(Japan) has voluntarily withdrawn from the project participant since 07 January 2016.

A.4. Reference of applied methodology and standardized baseline

In accordance with Appendix B of the simplified modalities and procedures for small-scale clean

development mechanism project activities (“SSC M&P”), the project falls under the following methodology and tools.

(a) Applied methodology: AMS-III.B. Switching fossil fuels (Version12)[1]

(b) Applied methodological tool:

(C) Applied standardized baseline: No standardized baselines are used.

A.5. Crediting period of project activity

Type of the crediting period: Fixed
Start date of the crediting period: 04/06/2009
End date of the crediting period: 03/06/2019
Length of the crediting period: 10 years

A.6. Contact information of responsible persons/entities

Mrs. Lee Do-Kyung
LG Chem, Ltd.
LG Twin Towers, 128, Yeoui-daero, Yeongdeungpo-gu
Seoul 07336, Korea

Manager / Energy·Climate Change Team
Tel.: +82-2-3773-3854
E-mail: donnalee@lgchem.com

LG Chem, Ltd. Is a project participant. For further information, please refer to Appendix 1.

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

(a) Information on the implementation status of the project activity

The starting date of the project activity was 21/06/2006 and commercial operation started on 20/11/2006 following retrofit of the boilers.
The first monitoring period is from 04/06/2009 to 23/02/2011.
The second monitoring period is from 24/02/2011 to 31/12/2016.

The project has been implemented and is operated as per the registered PDD with all physical features (technology, project equipment, monitoring and metering equipment) in place. Monitoring is done according to the applied methodology (AMS-III.B. Ver12.0) and revised monitoring plan.

(b) Description of the installed technology, technical processes and equipment

General description

LG Chem currently produces octanol, plasticizers and acrylic acid at Naju plant. Originally, Naju plant was founded as a fertilizer plant, in 1962 and was modified in 1982 to allow production of

[1] https://cdm.unfccc.int/methodologies/DB/1T8IU3YG99FQOYHN12FM3T0QZFFPBX

octanol. Through subsequent modification and expansion of the plant, current production has reached 190,000 MT/year for octanol, 166,000 MT/year for plasticizers and 26,000 MT/year for acrylic acid.

Project specific description

The existing boiler has been retrofitted by installing special purpose burners for natural gas combustion as well as other necessary minor modifications. There are three boilers in Naju plant. Among the three boilers, one boiler, which is the main boiler in Naju plant and of which specification is described in the following table, is retrofitted. As a result of the Project activity, the capacity of the boiler and the remaining lifetime of the boiler are not changed.

The existing boilers have also combusted purge gas and by-product liquid fuel generated from the processes. However, the combustion of such by-products is not be affected by the Project activity, since only bunker fuel oil C is switched to natural gas.

By-product liquid fuel is generated from EPA Vaporiser, Refine Column, n-Slop Column, Batch Still, VPH Vaporiser and Refine Column.

Purge gas is non-reaction gas from OXO reactor, OXO recycle loop and VPH loop. Since these processes are not be affected by the fuel type used for the steam generation, the amount of purge gas and by-product liquid fuel is independent from the fuel switching project activity. Moreover, there is no change in the process/equipment for the deliver/combustion of purge gas and by-product liquid fuel before and after the project implementation. Therefore, purge gas and by-product liquid fuel will continue to be combusted in the existing boiler without any change, i.e. the amount of purge gas and by-product liquid fuel to be combusted under the baseline scenario and project scenario would be same and only bunker fuel oil C is switched to natural gas.

For fuel switching from bunker fuel oil C to natural gas, four natural gas burners have been installed for the main boiler. Total capacity of four natural gas burners installed is 5,353 Nm^3/hr, which is of sufficient capacity for the expected amount of natural gas consumption at Naju plant. The natural gas burners are provided by HAMWORTHY COMBUSTION, which is one of the world's largest combustion equipment manufacturers, with the experiences of equipment installation in over 100 countries. The specifications of the current boiler, the Project boiler (after modification) and natural gas burner are as follows:

Table 1. Boiler specification

Description	Baseline scenario	Project scenario
Capacity	70 T/H	70 T/H
Operating pressure	35 kg/cm^2G	35 kg/cm^2G
Steam Temperature	400 ℃	400 ℃
Mail fuel used	Bunker fuel oil C	Natural gas
Efficiency	91 %	91 %

Source: LG Chem, Ltd & Manufacturer

Table 2. Burner specification

Description	Specification
Maker	HAMWORTHY
Model	DF 505
Type	Manifold & Spud

Burning Capacity	Max	1,405 (Nm^3/hr)
	MCR	1,338 (Nm^3/hr)
	Min	267 (Nm^3/hr)

Source: HAMWORTHY COMBUSTION

The natural gas is supplied by Hae Yang City Gas in Gwangju Metropolitan City. The composition of the natural gas sample is described in the following table.

Table 3. Composition of natural gas (sample)

Component		Value
Methane (CH_4)		89.78 %
Ethane (C_2H_6)		7.48 %
Propane (C_3H_3)		2.02 %
Propylene (C_3H_6)		-
Butane	i-C_4H_{10}	0.36 %
	n-C_4H_{10}	0.34 %
Nitrogen (N_2)		0.02 %
Oxygen (O_2)		-

Source: Hae Yang City Gas

(c) Actual operation of the project activity during the covered monitoring period

The plant was offline for 182 days during the second monitoring period. The outages were due to boiler cleaning or turn around (annual plant shutdown for maintenance). The offline outages are described as below:

Table 4. Description of the offline outages

No.	Date	Days	Affected Parameter	Reason
1	05-07/04/2011	3	All(Steam, LNG, PG, LF)	Boiler Cleaning
2	24/09/2011	1	LF	Turn around: Annual plant shut-down for maintenance
3	23-24/09/2011	2	PG	
4	25-30/09/2011	6	All(Steam, LNG, PG, LF)	
5	01-06/10/2011	6	LF	
6	01-05/10/2011	5	PG	
7	07-08/02/2012	2	All(Steam, LNG, PG, LF)	Boiler Cleaning
8	28/08/2012	1	All(Steam, LNG, PG, LF)	Power Failure
9	04-08/09/2012	5	PG	Turn around
10	05-08/09/2012	4	LF	
11	09-16/09/2012	7	All(Steam, LNG, PG, LF)	
12	17-18/09/2012	2	LF	
13	17-19/09/2012	3	PG	
14	08-13/01/2013	6	All(Steam, LNG, PG, LF)	Boiler Cleaning
15	18-20/06/2013	3	All(Steam, LNG, PG, LF)	Boiler Cleaning
16	20/10/2013	1	LF	Turn around & 70T/H Economizer Replacement
17	21/10-11/11/2013	22	All(Steam, LNG, PG, LF)	
18	12-14/11/2013	3	LF, PG	
19	04-05/02/2014	2	All(Steam, LNG, PG, LF)	Boiler Cleaning
20	27-28/05/2014	2	All(Steam, LNG, PG, LF)	Boiler Cleaning
21	08/08/2014	1	PG	OCT plant trouble
22	21/10-03/11/2014	14	All(Steam, LNG, PG, LF)	Turn around

23	04-05/11/2014	2	LF	
24	04-06/11/2014	3	PG	
25	13-15/01/2015	3	All(Steam, LNG, PG, LF)	Boiler Cleaning
26	17-23/04/2015	7	All(Steam, LNG, PG, LF)	Boiler Cleaning
27	11-15/07/2015	5	All(Steam, LNG, PG, LF)	Boiler Cleaning
28	18-21/07/2015	4	All(Steam, LNG, PG, LF)	Boiler Manhole & Castable Repair Work
29	14-18/11/2015	5	All(Steam, LNG, PG, LF)	Boiler Cleaning
30	26-28/01/2016	3	All(Steam, LNG, PG, LF)	Boiler Cleaning
31	12-23/04/2016	12	All(Steam, LNG, PG, LF)	Turn around
32	24-30/04/2016	7	LF	
33	24/04-01/05/2016	8	PG	
34	19-26/05/2016	8	All(Steam, LNG, PG, LF)	55T/H F.D Fan Replacement & Boiler Cleaning
35	30/08-04/09/2016	6	All(Steam, LNG, PG, LF)	Boiler Cleaning
36	12-16/11/2016	5	All(Steam, LNG, PG, LF)	Boiler Cleaning
Total		**182**		

There was no event during the monitoring period that had an impact on the applicability of the methodology.

(d) Situations with impact on the applicability of the methodology

No such situations occurred during the covered monitoring period.

B.2. Post-registration changes

B.2.1. Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline

No deviation has been applied to the monitoring period.

B.2.2. Corrections

No such corrections have been applied during this monitoring period, neither to any previous monitoring period.

B.2.3. Changes to start date of crediting period

No such changes have applied to this monitoring period neither to previous monitoring period in the crediting period.

B.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

No such inclusion has applied to this monitoring period.

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

No such permanent changes have applied to this monitoring period.

B.2.6. Changes to project design of registered project activity

No such changes have applied to this monitoring period neither to any previous monitoring period.

B.2.7. Types of changes specific to afforestation or reforestation project activity

N/A

SECTION C. Description of monitoring system

LG Chem has organized an Operating and Monitoring Team, as per the PDD, which composes a manager and operators. The manager is responsible for monitoring and archiving all data associated with items depicted in the PDD monitoring plan. Operators working under the manager are assigned to the task of monitoring the different parameters on a timely basis as well as recording and archiving data in an orderly manner. All data collected as part of the monitoring plan will be archived electronically and be kept at least two (2) years after the end of the crediting period. Monitoring reports are reviewed by the manager on a monthly basis in order to ensure that the Project activity meets all requirements.

1. Allocation of Project management responsibilities

The management and operation of the Project is the responsibility of LG Chem, the Project operator. Ensuring the environmental credibility of the Project through accurate and systematic monitoring of the Project's implementation and operation for the purpose of achieving trustworthy CERs is the key responsibility and accountability of the operator.

2. Management and operational systems

The project developers have implemented a management and operational system that meets the requirements of the Project. This includes:

2.1 Data handling

– The establishment of a transparent system for the collection, computation and storage of data, including adequate record keeping and data monitoring systems.

2.2 Quality assurance

– LG Chem has designated a manager to be accountable for the generation of CERs including monitoring, record keeping, computation of CERs, audits and verification. The manager officially sign-offs on all GHG Emission worksheets.
– The manager follows well-defined protocols and routine procedures, with good, professional data entry, extraction and reporting are undertaken to maximize transparency of data archiving.
– Proper management processes and recording of all official data is undertaken.

2.3 Training

– Internal training is made available to operational staff to enable them to undertake the tasks required by the MP.

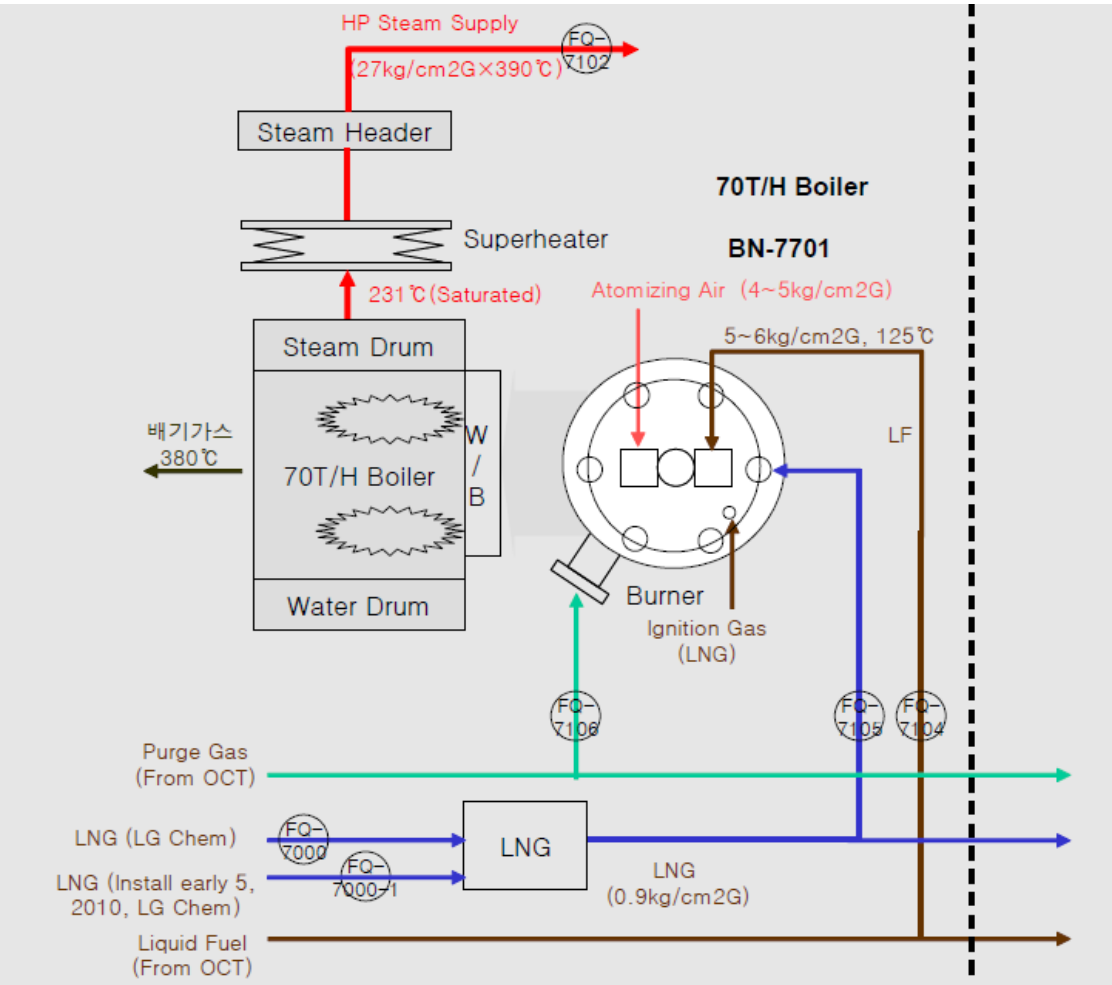

Figure 1. All relevant project monitoring points

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data/parameter:	**$EF_{NG,CO2}$**
Unit	tCO_2/TJ
Description	CO_2 emission factor of the natural gas combusted
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	56.1
Choice of data or measurement methods and procedures	N/A
Purpose of data	Project emission calculations
Additional comments	The value is set ex-ante

Data/parameter:	**$FF_{baseline}$**
Unit	Liter
Description	Quantity of bunker fuel oil C combusted in the baseline situation

Source of data	LG Chem.
Value(s) applied)	70,730,291
Choice of data or measurement methods and procedures	N/A
Purpose of data	Baseline emission calculations
Additional comments	The value is set ex-ante. 3 years data prior to the project implementation (from 1st, November 2003 to 31st, October 2006) is used.

Data/parameter:	**$NCV_{baseline}$**
Unit	TJ/liter
Description	Net calorific value of bunker fuel oil C
Source of data	Standard Manual for Calorific Value (the most recent version revised in 30th, December 2011) approved by Ministry of Trade, Industry and Energy / Korea Energy Agency
Value(s) applied)	39.2×10^{-6}
Choice of data or measurement methods and procedures	N/A
Purpose of data	Baseline emission calculations
Additional comments	The value is set ex-ante

Data/parameter:	**$EF_{baseline,CO2}$**
Unit	tCO_2/TJ
Description	CO_2 emission factor of bunker fuel oil C
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	77.4
Choice of data or measurement methods and procedures	N/A
Purpose of data	Baseline emission calculations
Additional comments	The value is set ex-ante

Data/parameter:	**$Q_{total,baseline}$**
Unit	TJ
Description	Total quantity of steam generated by bunker fuel oil C, purge gas and by-product liquid fuel in the baseline situation
Source of data	LG Chem.
Value(s) applied)	3,701.09
Choice of data or measurement methods and procedures	N/A

Purpose of data	Baseline emission calculations
Additional comments	The value is set ex-ante. 3 years data prior to the project implementation (from 1st, November 2003 to 31st, October 2006) is used. LG Chem produces superheated steam at 27 atm, 390°C. The enthalpy of the superheated steam is 767.7kcal/kg of steam according to the steam table (Spirax Sarco: http://www.spiraxsarco.com/resources/steam-tables.asp). The temperature of the feed water is 104℃.

Data/parameter:	**$PG_{baseline}$**
Unit	Nm^3
Description	Quantity of purge gas combusted in the boiler in the baseline situation
Source of data	LG Chem.
Value(s) applied)	13,203,959
Choice of data or measurement methods and procedures	N/A
Purpose of data	Baseline emission calculations
Additional comments	The value is set ex-ante. 3 years data prior to the project implementation (from 1st, November 2003 to 31st, October 2006) is used.

Data/parameter:	**$LF_{baseline}$**
Unit	Liter
Description	Quantity of by-product liquid fuel combusted in the boiler in the baseline situation
Source of data	LG Chem.
Value(s) applied)	26,397,017
Choice of data or measurement methods and procedures	N/A
Purpose of data	Baseline emission calculations
Additional comments	The value is set ex-ante. 3 years data prior to the project implementation (from 1st, November 2003 to 31st, October 2006) is used.

Data/parameter:	**$NCV_{PG,baseline}$**
Unit	TJ/Nm^3
Description	Net calorific value of purge gas
Source of data	LG Chem
Value(s) applied)	52.15×10^{-6}
Choice of data or measurement methods and procedures	N/A
Purpose of data	Baseline emission calculations
Additional comments	The value is set ex-ante. 3 years data prior to the project implementation (from 1st, November 2003 to 31st, October 2006) is used.

Data/parameter:	$NCV_{LF,baseline}$
Unit	TJ/Nm^3
Description	Net calorific value of by-product liquid fuel
Source of data	LG Chem
Value(s) applied)	30.576×10^{-6}
Choice of data or measurement methods and procedures	N/A
Purpose of data	Baseline emission calculations
Additional comments	The value is set ex-ante. Due to the absence of the reliable data for the period of 3 year prior to the project implementation (from 1st, November 2003 to 31st, October 2006) does not exist, the data recently measured by the independent laboratory is used.

D.2. Data and parameters monitored

Data/parameter:	$FF_{projcet,y}$	
Unit	Nm^3	
Description	Quantity of natural gas combusted in the project boiler during the year, y	
Measured/calculated/default	Measured	
Source of data	On-site measurement	
Value(s) of monitored parameter	106,174,861.560	
Monitoring equipment	Type	Vortex
	Accuracy Class	±1.0%
	Name	FQ_7105
	Serial Number	15-S0728HN
	Calibration frequency	At lease every 3 years
	Date and validity of the meter`s the most recent calibration during the monitoring period	4-Nov-2013 (4-Nov-2013 to 3-Nov-2016)
	Date and validity of the meter`s the 2_{nd} rec ent calibration during the monitoring period	5-Nov-2010 (5-Nov-2010 to 4-Nov-2013)
Measuring/reading/recording frequency:	Continuous	
Calculation method (if applicable):	N/A	

QA/QC procedures:	The meter (Tag No. 7105) has been calibrated at least every 3 years and calibration certificates have been issued. However, the calibration frequency did not meet every 3 yearly calibration requirement specified in the revised monitoring plan for this meter after the expiry of meter calibration on 3 November 2016. The meter was only calibrated on 4 November 2013. Therefore, error corrections were carried out according to EB's relevant guidelines for the period from November 2016 to December 2016 as a conservative measure. According to the revised monitoring plan, the amount measured by this meter was cross-checked monthly with the purchased amount which was measured by trading meter and stated on receipts, and the amount consumed by another point which was measured by the meter FQ-5105. The result of cross-checking shows that the average difference between total natural gas consumption and the purchased total amount of natural gas is only 2%, within a reasonable and acceptable range. The meter FQ-5105 was also calibrated periodically as per the revised monitoring plan of the Project.
Purpose of data:	Project emission calculations
Additional comments:	N/A

Data/parameter:	**$NCV_{NG,y}$**
Unit	TJ/Nm^3
Description	Net calorific value of natural gas in year, y
Measured/calculated/default	Measured
Source of data	Standard Manual for Calorific Value
Value(s) of monitored parameter	39.4×10^{-6}
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Yearly
Calculation method (if applicable):	N/A
QA/QC procedures:	Standard Manual for Calorific Value (the most recent version revised in 30th, December 2011) approved by Ministry of Trade, Industry and Energy / Korea Energy Agency
Purpose of data:	Project emission calculations
Additional comments:	

Data/parameter:	**$Q_{total,y}$**
Unit	TJ
Description	Total quantity of steam generated by natural gas, purge gas and by-product liquid fuel in the project boiler during the year, y
Measured/calculated/default	Measured
Source of data	On-site measurement
Value(s) of monitored parameter	6,609.000

Monitoring equipment	<table><tr><td>Type</td><td>Differential pressure</td></tr><tr><td>Accuracy Class</td><td>±0.10%</td></tr><tr><td>Name</td><td>FQ_7102</td></tr><tr><td>Serial Number</td><td>91M642405</td></tr><tr><td>Calibration frequency</td><td>At lease every year</td></tr><tr><td>Date and validity of the meter`s the most recent calibration during the monitoring period</td><td>16-Apr-2016 (16-Apr-2016 to 15-Apr-2017)</td></tr><tr><td>Date and validity of the meter`s the 2_{nd} rec ent calibration during the monitoring period</td><td>3-Nov-2013 (3-Nov-2013 to 2-Nov-2014)</td></tr><tr><td>Date and validity of the meter`s the 3_{rd} rec ent calibration during the monitoring period</td><td>6-Nov-2010 (6-Nov-2010 to 5-Nov-2011)</td></tr></table>
Measuring/reading/recording frequency:	Continuous
Calculation method (if applicable):	The total quantity of steam generated from the combustion of natural gas, purge gas, and by-product liquid fuel (the difference in the energy of the feedwater going into the system and the steam leaving the system) was calculated via steam tables. The most conservative values identified during the monitoring period were used in the calculation. For steam, 26.6 kgf/cm^2 and 374 °C measured on 18 December 2013 and for feedwater, 112 °C measured on 3 December 2013 are identified as the most conservative conditions during this monitoring period. The enthalpy of the superheated steam is 758.9 kcal/kg of steam according to the steam table. The enthalpy of the feedwater is 112 kcal/kg. (Spirax Sarco: http://www.spiraxsarco.com/resources/steam-tables.asp).
QA/QC procedures:	The meter (Tag No. 7102) has been calibrated at least yearly and calibration certificates have been issued. The PDD monitoring plan does not specify a calibration frequency, but the calibration frequency did not meet the yearly calibration requirement specified in internal documents for this meter. The meter was calibrated on 6 November 2010, on 3 November 2013 and on 16 April 2016. To take its validity into consideration, therefore, error corrections were carried out according to EB's relevant guidelines for each period from 6 November 2011 to 2 November 2013 and from 3 November 2014 to 15 April 2016 as a conservative measure. The last calibration of the meter on 16 April 2016 was a replacement of its transmitter. Serial number was changed from 4100404001 to 91M642405.
Purpose of data:	Project emission calculations
Additional comments:	

Data/parameter:	**PG_y**
Unit	Nm^3
Description	Quantity of purge gas combusted in the project boiler during the year, y
Measured/calculated/default	Measured
Source of data	On-site measurement
Value(s) of monitored parameter	50,533,707.795

Monitoring equipment	<table><tr><td>Type</td><td>Differential pressure</td></tr><tr><td>Accuracy Class</td><td>±0.25%</td></tr><tr><td>Name</td><td>FQ_7106</td></tr><tr><td>Serial Number</td><td>91L751790</td></tr><tr><td>Calibration frequency</td><td>At lease every year</td></tr><tr><td>Date and validity of the meter`s the most recent calibration during the monitoring period</td><td>16-Apr-2016 (16-Apr-2016 to 15-Apr-2017)</td></tr><tr><td>Date and validity of the meter`s the 2nd rec ent calibration during the monitoring period</td><td>4-Nov-2013 (4-Nov-2013 to 3-Nov-2014)</td></tr><tr><td>Date and validity of the meter`s the 3rd rec ent calibration during the monitoring period</td><td>6-Nov-2010 (6-Nov-2010 to 5-Nov-2011)</td></tr></table>
Measuring/reading/recording frequency:	Continous
Calculation method (if applicable):	N/A
QA/QC procedures:	The meter (Tag No. 7106) has been calibrated periodically and a calibration certificate has been issued. Although the PDD monitoring plan does not specify a calibration frequency, the meter was calibrated on 6 November 2010, 4 November 2013, and 16 April 2016. However, according to internal guidelines for meter calibration the meter should be calibrated at least yearly. Therefore the calibration frequency did not meet the yearly calibration requirement specified in internal documents for this meter after the expiry of meter calibration on 6 November 2011 until the new calibration on 4 November 2013 and on 3 November 2014 until the new calibration on 16 April 2016. Accordingly, error corrections were carried out according the EB 52 Annex 60 Guidelines for the period from 6 November 2011 to 3 November 2013 and from 4 November 2014 to 15 April 2016. Additionally, from November 2011 to November 2013 and from November 2014 to April 2016 (complied calibration periods) a variation beyond the rated meter accuracy was nonetheless identified at each yearly calibration. Therefore as a conservative measure, the data was corrected according to the maximum identified variation during the monitoring period. As the temperature meter for normalization of the quantity/volume of the combusted purge gas was calibrated after the end of the monitoring period, a correction using the maximum error identified by the calibration to correct the measured quantity/volume of the combusted purge gas was applied. The last calibration of the meter on 16 April 2016 was a replacement of its transmitter. Serial number was changed from 4100404001 to 91M642405.
Purpose of data:	Project emission calculations
Additional comments:	

Data/parameter:	**LF_y**
Unit	Liter
Description	Quantity of by-product liquid fuel combusted in the project boiler during the year, y
Measured/calculated/default	Measured
Source of data	On-site measurement
Value(s) of monitored parameter	57,220,587.135

<table>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td>Type</td><td>Positive displacement</td></tr>
<tr><td>Accuracy Class</td><td>±0.5%</td></tr>
<tr><td>Name</td><td>FQ_7104</td></tr>
<tr><td>Serial Number</td><td>B-153-6985</td></tr>
<tr><td>Calibration frequency</td><td>At lease every 3 years</td></tr>
<tr><td>Date and validity of the meter`s the most recent calibration during the monitoring period</td><td>22-Oct-2014
(22-Oct-2014 to 21-Oct-2017)</td></tr>
<tr><td>Date and validity of the meter`s the 2$_{nd}$ rec ent calibration during the monitoring period</td><td>27-Sep-2011
(27-Sep-2011 to 26-Sep-2014)</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency:</td><td>Continuous</td></tr>
<tr><td>Calculation method
(if applicable):</td><td>N/A</td></tr>
<tr><td>QA/QC procedures:</td><td>The meters (Tag No. FQ-7104) has been calibrated and a calibration certificate has been issued. The calibration frequency did not meet the yearly calibration requirement specified in internal documents for this meter after the expiry of meter calibration on 26 September 2014 until the new calibration on 22 October 2014.

Accordingly, error corrections were carried out according the EB 52 Annex 60 Guidelines for the period from September 2014 to October 2014 as a conservative measure.</td></tr>
<tr><td>Purpose of data:</td><td>Project emission calculations</td></tr>
<tr><td>Additional comments:</td><td></td></tr>
</table>

<table>
<tr><td>Data/parameter:</td><td>$NCV_{WG,y}$</td></tr>
<tr><td>Unit</td><td>TJ/Nm^3</td></tr>
<tr><td>Description</td><td>Net calorific value of purge gas</td></tr>
<tr><td>Measured/calculated/default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>On-site measurement</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Weighted average: 43.67 X 10^{-6}
<table>
<tr><th>Year</th><th>Net calorific Value(TJ/Nm^3)</th></tr>
<tr><td>2011</td><td>61.50 X 10^{-6}</td></tr>
<tr><td>2012</td><td>53.99 X 10^{-6}</td></tr>
<tr><td>2013</td><td>51.41 X 10^{-6}</td></tr>
<tr><td>2014</td><td>38.80 X 10^{-6}</td></tr>
<tr><td>2015</td><td>34.84 X 10^{-6}</td></tr>
<tr><td>2016</td><td>35.03 X 10^{-6}</td></tr>
</table>
</td></tr>
</table>

Monitoring equipment	Type	Agilent 7890A Network Gas Chromatograph
	Accuracy Class	· Inlet modules: Pressure sensors: Accuracy: <±2% full scale, Repeatability: <±0.05 psi, Temperature coefficient: <±0.01 psi/°C, Drift: <±0.1 psi/6 months Flow sensors: Accuracy <±5% depending on carrier gas, Repeatability: <±0.35% of setpoint, normalized temperature and pressure (NTP, 25°C, 1atm) per °C for He or H_2, <0.05mL/min NTP per °C for N_2 or Ar/CH_4. · Detector modules: Accuracy: <± 3mL/min NTP or 7% of setpoint Repeatability: <±0.35% of setpoint
	Calibration frequency	At lease every 6 months
	Date and validity of the gas chromatograph in 2011	10-May-2011 (10-May-2011 to 9-Nov-2011) 9-Nov-2011 (9-Nov-2011 to 8-May-2012)
	Date and validity of the gas chromatograph in 2012	10-May-2012 (10-May-2012 to 9-Nov-2012) 8-Nov-2012 (8-Nov-2012 to 7-May-2013)
	Date and validity of the gas chromatograph in 2013	9-May-2013 (9-May-2013 to 8-Nov-2013) 9-Nov-2013 (9-Nov-2013 to 8-May-2014)
	Date and validity of the gas chromatograph in 2014	9-May-2014 (9-May-2014 to 8-Nov-2014) 10-Nov-2014 (10-Nov-2014 to 9-May-2015)
	Date and validity of the gas chromatograph in 2015	11-May-2015 (11-May-2015 to 10-Nov-2015) 9-Nov-2015 (9-Nov-2015 to 8-May-2016)
	Date and validity of the gas chromatograph in 2016	5-Nov-2016 (5-Nov-2016 to 4-May-2017)
Measuring/reading/recording frequency:	Monitored quarterly and yearly average value used	
Calculation method (if applicable):	Weighted average calculated based on quarterly NCV values and amount of purge gas used each quarter.	
QA/QC procedures:	The GC has been calibrated according to the internal monitoring manual procedures. No erroneous measurement or malfunction was detected during the monitoring period.	
Purpose of data:	Project emission calculations	
Additional comments:		

Data/parameter:	**$NCV_{LF,y}$**
Unit	TJ/Liter
Description	Net calorific value of by-product liquid fuel
Measured/calculated/default	Measured
Source of data	On-site measurement

Value(s) of monitored parameter	Weighted average: 28.3 X 10^{-6}

Year	Net calorific Value(TJ/Liter)
2011	29.10 X 10^{-6}
2012	29.45 X 10^{-6}
2013	27.64 X 10^{-6}
2014	26.74 X 10^{-6}
2015	28.11 X 10^{-6}
2016	28.86 X 10^{-6}

Monitoring equipment	N/A
Measuring/reading/recording frequency:	Monitored quarterly and yearly average value used
Calculation method (if applicable):	Weighted average calculated based on quarterly NCV values and amount of LF used each quarter.
QA/QC procedures:	The measurement was carried out by a qualified third party.
Purpose of data:	Project emission calculations
Additional comments:	

Data/parameter:	$\varepsilon_{projcet,y}$
Unit	%
Description	Energy efficiency of the boiler during the year, y
Measured/calculated/default	Calculated
Source of data	Calculated using measured data
Value(s) of monitored parameter	

Year	Quarter	Quarterly	Yearly
2011	1Q 2Q 3Q 4Q	81.94 % 83.05 % 84.81 % 85.98 %	83.94 %
2012	1Q 2Q 3Q 4Q	87.25 % 84.47 % 86.85 % 85.46 %	86.01 %
2013	1Q 2Q 3Q 4Q	87.06 % 85.21 % 83.76 % 86.74 %	85.69 %
2014	1Q 2Q 3Q 4Q	86.21 % 78.43 % 77.18 % 79.06 %	80.22 %
2015	1Q 2Q 3Q 4Q	79.81 % 78.02 % 75.00 % 79.23 %	78.01 %
2016	1Q 2Q 3Q 4Q	80.18 % 82.09 % 79.34 % 83.71 %	81.33 %
Weighted Average			82.52 %

Monitoring equipment	N/A
Measuring/reading/recording frequency:	Quarterly

Calculation method (if applicable):	The energy efficiency of the boiler will be calculated by the direct method (dividing the net heat generation by the energy content of the fuels fired).
QA/QC procedures:	The meters used for monitoring of the relevant parameters (steam generation, fuel consumption) will be calibrated periodically. Once the erroneous measurement or malfunction is detected, corrective actions will be taken by LG Chem.
Purpose of data:	Project emission calculations
Additional comments:	

D.3. Implementation of sampling plan

A sampling approach was not employed.

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

Baseline emission factor for the baseline situation, $EF_{baseline}$

$$EF_{baseline} = FF_{baseline} \times EF_{baseline,CO2} \times NCV_{baseline} / Q_{baseline}$$

$$= 70,730,291(liter) \times 77.4(tCO_2/TJ) \times 39.2 \times 10^{-6}(TJ/liter) / 2,405.88(TJ)$$

$$= 89.20\ tCO_2e/TJ$$

Where:

$FF_{baseline}$	Quantity of bunker fuel oil C combusted in the baseline situation (liter)
$EF_{baseline,CO2}$	CO_2 emission factor of bunker fuel oil C (tCO_2/TJ)
$NCV_{baseline}$	Net calorific value of bunker fuel oil C (TJ/liter)
$Q_{baseline}$	Quantity of steam generated by bunker fuel oil C in the baseline situation (TJ)

For quantity of bunker fuel oil C combusted, $FF_{baseline}$, and quantity of steam generated by bunker fuel oil C, $Q_{baseline}$, 3 years data prior to project implementation (from 1_{st}, November, 2003 to 31_{st}, October 2006) is used.

$$Q_{baseline} = Q_{total,baseline} \times \frac{FF_{baseline} \times NCV_{baseline}}{(FF_{baseline} \times NCV_{baseline} + PG_{baseline} \times NCV_{PG,baseline} + LF_{baseline} \times NCV_{LF,baseline})}$$

$$Q_{baseline} = Q_{total,baseline} \times (FF_{baseline} \times NCV_{baseline}) / (FF_{baseline} \times NCV_{baseline} + PG_{baseline} \times NCV_{PG,baseline} + LF_{baseline} \times NCV_{LF,baseline})$$

$$= 3,701.09(TJ) \times [70,730,291(liter) \times 39.2 \times 10^{-6}(TJ/liter)] / [70,730,291(liter) \times 39.2 \times 10^{-6}(TJ/liter) \times$$

$$13{,}203{,}959(Nm^3) \times 52.15(TJ/liter) \times 26{,}297{,}017(liter) \times 30.576 \times 10^{-6}(TJ/liter)]$$

$$= 2{,}405.88\ TJ$$

Where:

$Q_{total,baseline}$	Total quantity of steam generated by bunker fuel oil C, waste gas and by-product liquid fuel in the baseline situation (TJ)
$PG_{baseline}$	Quantity of purge gas combusted in the boiler in the baseline situation (Nm^3)
$NCV_{PG,baseline}$	Net calorific value of purge gas (TJ/Nm^3)
$LF_{baseline}$	Quantity of by-product liquid fuel combusted in the boiler in the baseline situation (liter)
$NCV_{LF,baseline}$	Net calorific value of by-product liquid fuel (TJ/liter)

Quantity of steam generated by natural gas, Q_y

Since purge gas and by-product liquid fuel are also combusted in the boiler, the quantity of steam generated by natural gas, Q_y, is calculated based on the proportion of fuel used as follows:

$$Q_y = Q_{total,y} \times \frac{FF_{project,y} \times NCV_{NG,y}}{(FF_{project,y} \times NCV_{NG,y} + PG_y \times NCV_{WG,y} + LF_y \times NCV_{LF,y})}$$

$$Q_y = Q_{total,y} \times (FF_{project,y} \times NCV_{NG,y}) / (FF_{project,y} \times NCV_{NG,y} + PG_y \times NCV_{WG,y} + LF_y \times NCV_{LF,y})$$

$$= 6{,}609(TJ) \times [106{,}174{,}861.56(Nm^3) \times 39.4 \times 10^{-6}(TJ/Nm^3)] / [106{,}174{,}861.56(Nm^3) \times 39.4 \times 10^{-6}(TJ/Nm^3)$$

$$+ 50{,}533{,}707.80(Nm^3) \times 43.67 \times 10^{-6}(TJ/Nm^3) + 57{,}220{,}587.14(liter) \times 28.30 \times 10^{-6}(TJ/liter)]$$

$$= 3{,}451.99\ TJ$$

Where:

$Q_{total,y}$	Total quantity of steam generated by natural gas, purge gas and by-product liquid fuel during year, y (TJ)
$FF_{project,y}$	Quantity of natural gas combusted in the project boiler during the year, y (Nm^3)
PG_y	Quantity of purge gas combusted in the boiler during year, y (Nm^3)
$NCV_{PG,y}$	Net calorific value of purge gas (TJ/Nm^3)
LF_y	Quantity of by-product liquid fuel combusted in the boiler during year, y (liter)
$NCV_{LF,y}$	Net calorific value of by-product liquid fuel (TJ/liter)

Baseline emission, BE_y

$$BE_y = EF_{baseline} \times Q_y$$

$BE_y = EF_{baseline} \times Q_y$

$= 89.20(tCO_2e/TJ) \times 3,451.99(TJ)$

$= 307,912.90\ tCO_2e$

Where:

BE_y	Baseline emission during the year y (tCO_2e)
$EF_{baseline}$	Baseline emission factor for the baseline situation (tCO_2/TJ)
Q_y	Quantity of steam generated by natural gas (TJ)

E.2. Calculation of project emissions or actual net GHG removals by sinks

Project emissions consist of those emissions related with the use of fossil fuel after the fuel switch. Project emissions are calculated as follows:

$$PE_y = FF_{project,y} \times NCV_{NG,y} \times EF_{NG,CO2}$$

$PE_y = FF_{project,y} \times NCV_{NG,y} \times EF_{NG,CO2}$

$= 106,174,862(Nm^3) \times 39.4 \times 10^{-6}(TJ/Nm^3) \times 56.10(tCO_2/TJ)$

$= 234,682.54\ tCO_2e$

Where:

PE_y	Project emissions during the year, y (tCO_2e)
$FF_{project,y}$	Quantity of natural gas combusted in the project boiler during the year, y (Nm^3)
$NCV_{NG,y}$	Net calorific value of the natural gas combusted in year, y (TJ/Nm^3)
$EF_{NG,CO2}$	CO_2 emission factor of the natural gas combusted in the project boiler (tCO_2/TJ)

E.3. Calculation of leakage

As described in AMS-III.B, no leakage calculation is required.

E.4. Summary of calculation of emission reductions or net GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	GHG emission reductions or net GHG removals by sinks (t CO_2e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total	307,912	234,682	0	23,176	50,054	73,230

E.5. Comparison of actual emission reductions or net GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	19,635 tCO_2e (Annual, 365 days) **114,905 tCO_2e** **(Monitored, 2,136 days)**	12,514 tCO_2e (Annual, 365 days) **73,230 t CO_2e** **(Monitored, 2,136 days)**

E.6. Remarks on difference from estimated value in registered PDD

The actual emission reductions achieved during the monitoring period is only 40% of the value calculated ex ante in the PDD due to following reasons:

1. Fuel mix of $FF_{project,y}$, PG_y and LF_y was changed. Compared with the ex-ante estimation, the share of PG_y and LF_y have increased, resulting in a change to the baseline as well as the project emission.

2. Steam generation (Q_y) from the system has decreased, due to lower demand of steam at the factory.

3. Increase of down time. Due to various reasons, the boiler was down for 182 days, during the total 2,136 days monitoring period, as indicated in Section B.1 above.

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

Project participant and/or responsible person/ entity	■ Project participant ☐ Person/entity responsible for completing the CDM-MR-FORM
Organization name	LG Chem, Ltd.
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City	Seoul
State/region	-
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Country	Republic of Korea
Telephone	+82-2-3773-3854
Fax	+82-2-3773-7983
E-mail	donnalee@lgchem.com
Website	www.lgchem.com
Contact person	Do-Kyung Lee
Title	Manager
Salutation	-
Last name	Lee
Middle name	-
First name	Do-Kyung
Department	Energy·Climate Team
Mobile	+82-10-8879-1926
Direct fax	+82-2-3773-7983
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Personal e-mail	-

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Document information

Version	*Date*	*Description*
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.

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