Monitoring Report

Start monitoring period: 1 October 2008
End monitoring period: 11 May 2009

Title: China Guangdong Shenzhen Qianwan LNG generation project

Project developer:

Guangdong Huizhou LNG Power Co., Ltd.

This Monitoring Report is approved by: **Mr Li-Fangji** **General Manager**

Date: 28 July 2009 **Project advisor:Beijing MD Energy Technology Co.,Ltd**	**Management Verifier: Ye-Shanpei**

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1 Introduction

The purpose of this Monitoring Report is to calculate the emission reductions achieved by the project activity in the period covered by this report, and to serve as the basis for the verification of these reductions and issuance of the VCUs.

1.1 Monitoring period

1 October 2008 to 11 May 2009

1.2 Verification standard applied

This Monitoring Report is based on the Voluntary Carbon Standard Version2007.

1.3 Document details

Version: 2

Date: 28 July 2009

2 Project description

2.1 Title

China Guangdong Shenzhen Qianwan LNG generation project

2.2 Project summary

Qianwan LNG Generation Project (QLGP) has constructed a highly efficient Natural Gas (NG) fired Combined-Cycle Gas Turbine (CCGT) power plant. The proposed project has a capacity of 1083.09 MW (3×361.03 MW) with annual electricity generation of 3700 GWh. The annual net electricity generation is 3611GWh. The proposed project will consume 505.6 thousand tons of Liquefied Natural Gas (LNG), which will be regasified at the LNG terminal and transport to the power station via pipeline.

Electricity to be generated by QLGP will be subsequently supplied to the Guangdong Provincial Power Grid (GPPG), which is a part of the China Southern Power Grid (CSPG), consequently displacing power generation from the Southern China Power Grid (CSPG) where more than 50 percent of the power comes from coal fired power plants. The estimated annual greenhouse gas (GHG) emission reductions will be 1, 035,685 tCO_2e. The Project activity has generated the total amount of emission reductions 289,892 tCO_2e in the crediting period (from October 1st 2008 to April 30 st 2009).

2.3 Category of project activity

The project type and category are defined as follows:

· Energy industries. (non-renewable sources)

3 Project timeline

Starting date of the project activity November 15st 2006

Start of monitoring period October 1st 2008

End of monitoring period April 30 st 2009

Table 1 lists the commissioning dates of turbines installed in the Project

Table 1 Commissioning dates of turbines

Turbine	Commissioning date
1#	November 15st 2006
2#	January 11st 2007
3#	May 16st 2007

4 Monitoring methodology and Procedure

4.1 Methodology

Version 01.1 of AM0029: "Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas" (referred as The Methodology). More information about The Methodology can be found on the website:

http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

The version 06 of ACM0002: "Consolidated Methodology for Grid-connected Electricity Generation from Renewable Sources" and Version 05 of "Tool for the Demonstration and Assessment of Additionality".

4.2 Monitored data

The monitored data for the project activity includes electricity supplied to the grid ($EG_{y,}$ MWh) and NG consumption($FC_{,y}$ t).

ID	Variable	Source of data
1	$EG_{y,}$- Net electricity supplied to the grid (MWh)	Electricity meter
2	$FCLNG_{,y}$ -LNG onsumption by the project (t)	Fuel flow mete

4.3 Electricity supplied to the grid and imported from the grid

Electricity supplied to the grid has been monitored with the electricity meter as indicated in 4.2 above and in the PD. The monitoring data was shown in Table 2 below.

Table 2 Electricity supplied to the grid and imported from the grid

Period	Power Generated MWh	Power Consumed MWh	Net Power Supplied MWh
1 Oct 08- 31 Dec 08	641 398	8 618	632 780
1 Jan 09- 11 May 09	1 029 527	10 526	1 019 001
Total	**1 670 925**	**19 144**	**1 651 781**

4.4 Monitoring data NG consumed by the Project

LNG consumption in the project has been monitored with the fuel flow mete as indicated in 4.2 above and in the PD. The monitoring data was shown in Table 3 below.

Table 3 LNG consumed by the Project

Period	FC_{LNG} (tonne)
1 Oct 08- 31 Dec 08	89 732
1 Jan 09- 11 May 09	142 994
Total	**232 726**

5 Quality assurance and quality control measures

5.1 Roles and responsibilities

Overall responsibility for monitoring and carrying out the monitoring following this monitoring procedure lies with the Shenzhen Guangqian Electric Power Co., Ltd. Mr Li-Fangji, Manager of Production and Business, is responsible for the operation and maintenance, which includes the monitoring, of the plant. Mr. Ye shanpei is also responsible for the daily monitoring and reporting.

5.2 Training

The staff who is responsible for electricity and fuel flow meter reading and recording, and who is responsible for auditing these metered data have been trained according to the VER monitoring and management manual for Shenzhen Guangqian Electric Power Co., Ltd.

5.3 Calibrations

The Power Interchange Agreement between Shenzhen Guangqian Electric Power Co., Ltd.and Shenzhen Power Supply Bureau of Guangdong Power Grid Co.Ltd defines the metering arrangements and the required quality control procedures to ensure accuracy. The metering equipments have been calibrated and checked for accuracy based on the local industrial requirement with a permissible limit for the meter of 0.2% accuracy class. The metering equipment has sufficient accuracy so that any error resulting from such equipment shall not exceed local industrial standard. The Electricity supplied to the grid and imported from the grid registered by the meters alone will suffice for the purpose of billing and emission reduction verification as long as the error in the meters is within the agreed limits. Calibration is carried out by Testing Research Academy of Guandong Province Power Industry Bureau with the records being supplied to Shenzhen Guangqian Electric Power Co., Ltd.. These records have been maintained by Testing Research Academy of Guandong Province Power Industry Bureau and Shenzhen Guangqian Electric Power Co., Ltd. Both meters has been jointly inspected and sealed on behalf of the parties concerned and not been interfered with by either party except in the presence of the other party or its accredited representatives. All the meters installed have been tested by Testing Research Academy of Guandong Province Power Industry Bureau within 10 days after:

· the detection of a difference larger than the allowable error in the readings of both meters;

· the repair of all or part of meter caused by the failure of one or more parts to operate in accordance with the specifications; and/or If any errors has been detected the party owning the meter has repaired, recalibrated or replaced the meter giving the other party sufficient notice to allow a representative to attend during any corrective activity. Should any previous months' reading of the main meter be inaccurate by more than the allowable error, or otherwise functioned improperly, The Electricity supplied to the grid and imported from the grid has been determined by an estimate of the correct reading from Shenzhen Power Supply Bureau of Guangdong Power Grid Co.Ltd; and if Shenzhen Power Supply Bureau of Guangdong Power Grid Co.Ltd and Guangdong Shenzhen Guangqian Electric Power Co., Ltd fail to agree then the matter has been referred for arbitration according to agreed procedures. No errors occurred during the operations of the Shenzhen Guangqian Electric Power Co., Ltd. Calibration took place as per schedule. The calibration results show that all meters operate in accordance with the industry standards and are qualified to measure the electricity supplied to the grid and consumed by Shenzhen Guangqian Electric Power Co., Ltd.

The Gas Interchange Agreement between Shenzhen Guangqian Electric Power Co., Ltd and Guangdong Dapeng LNG Co.Ltd defines the metering arrangements and the required quality control procedures to ensure accuracy. The metering equipments have been calibrated and checked for accuracy based on the local industrial requirement. The metering equipment has sufficient accuracy so that any error resulting from such equipment shall not exceed local industrial standard. The gas supplied to Shenzhen Guangqian Electric Power Co., Ltd registered by the meters alone will suffice for the purpose of billing and emission reduction verification as long as the error in the meters is within the agreed limits. Calibration is carried out by National Station of Petroleum Flow Mearsurement with the records being supplied to Shenzhen Guangqian Electric Power Co., Ltd. These records have been maintained by Shenzhen Guangqian Electric Power Co., Ltd. Both meters has been jointly inspected and sealed on behalf of the parties concerned and not been interfered with by either party except in the presence of the other party or its accredited representatives. All the meters installed have been tested by National Station of Petroleum Flow Mearsurement r within 10 days after:

· the detection of a difference larger than the allowable error in the readings of both meters;

· the repair of all or part of meter caused by the failure of one or more parts to operate in accordance with the specifications; and/or If any errors has been detected the party owning the meter has repaired, recalibrated or replaced the meter giving the other party sufficient notice to allow a representative to attend during any corrective activity. Should any previous months' reading of the main meter be inaccurate by more than the allowable error, or otherwise functioned improperly, The LNG consumption has been determined by an estimate of the correct reading from Guangdong Dapeng LNG Co.Ltd; and if Guangdong Dapeng LNG Co.Ltd and Shenzhen Guangqian Electric Power Co., Ltd fail to agree then the matter has been referred for arbitration according to agreed procedures. No errors occurred during the operations of the Shenzhen Guangqian Electric Power Co., Ltd. Calibration took place as per schedule. The calibration results show that meter operate in accordance with the industry standards and are qualified to measure the LNG consumption

5.4 Quality control

The Electricity supplied to the grid and imported from the grid has been approved and signed off by staffs who are responsible for recording meter reading in power station side, and cross checked with receipts from Shenzhen Power Supply Bureau of Guangdong Power Grid Co.Ltd.

The NG consumption has been approved and signed off by staffs who are responsible for recording meter reading in power station side, and cross checked with receipts from Guangdong Dapeng LNG Co.Ltd.

6 Emission reduction calculations

6.1 Project emissions

According to the Methodology, the project activity is on-site combustion of natural gas to generate electricity, then the CO2 emissions from electricity generation are calculated as follows:

$$PE_y = FC_{LNG,y} \times COEF_{LNG,y} + FC_{Diesel,y} \times COEF_{Diesely} \quad (1)$$

Where

$FC_{LNG,y}$: is the total volume of LNG combusted in the project plant (tons) in year y.

$FC_{Diesel,y}$: is the total volume of diesel combusted in the project plant (tons) for start-up fuel in year y. In the proposed project activity, the diesel consumption for start up is zero.

$COEF_{LNG,y}$: is the CO_2 emission coefficient (tCO2/tons) in year y for LNG.

$COEF_{Diesel,y}$: is the CO_2 emission coefficient (tCO2/tons) in year y for diesel.

The emission coefficients of LNG and diesel are calculated as follows:

$$COEF_{LNG,y} = NCV_{LNG,y} \times EF_{CO_2,Gas,y} \times OXID_{Gas} \quad (2)$$

$$COEF_{Diesel,y} = NCV_{Diesl,y} \times EF_{CO_2,Diesel,y} \times OXID_{Diesel} \quad (3)$$

Where:

$NCV_{LNG,y}$: is the net calorific value of LNG (GJ/ton), which is determined from the fuel supplier.

$NCV_{Diesel,y}$: is the net calorific value of diesel (GJ/ton), which is determined from the most recent "Chinese Energy Statistics Yearbook" available when the verification begins.

$EF_{CO2,Gas,y}$: is the CO_2 emission factor per unit of energy of LNG in year y (tCO_2/GJ),

which is determined from the fuel supplier.
$EF_{CO2,Diesel,y}$: is the CO_2 emission factor per unit of energy of diesel in year y (tCO_2/GJ), the IPCC default value will be used.
$OXID_{Gas}$: is the oxidation factor of LNG, the IPCC default value will be used.
$OXID_{Diesel}$: is the oxidation factor of diesel, the IPCC default value will be used.

For the project, no diesel combusted in the project plant (tons) for start-up, the values of the above parameters and project emission described as Table 4:

Table 4 Project emission

Period	FC_{LNG} (tonne)	NCV_{LNG} (GJ/tonne)	$EF_{CO2,Gas,y}$ (tCO_2/GJ)	OXID	PE (tCO_2e)
1 Oct 08- 31 Dec 08	89 732	49.39	0.0561	1	248 628
1 Jan 09- 11 May 09	142 994	49.39	0.0561	1	396 205
Total	**232 726**				**644 832**

6.2 Baseline emissions

Calculate Baseline Emission (BE_y)

Once the baseline emission factor is determined, the baseline emissions can be calculated by multiplying the electricity generated in the project plant (EGy) with the baseline emission factor $EF_{BL,CO2}$:

$$BE_y = EG_y \times EF_{BL,CO_2} \quad (4)$$

Where,
BE_y is baseline emission(tCO_2)
EG_y is electricity supplied to the grid by the project(MWh)
$EF_{BL,CO2}$ is the baseline emission factor.
According to the version 01.1 of AM0029, the baseline emission factor $EF_{BL,CO2}$, is the lowest emission factor among the following three options:
Option 1. The build margin ($EF_{BL,BM}$), calculated according to ACM0002; and
Option 2. The combined margin ($EF_{BL,CM}$), calculated according to ACM0002, using a 50/50
OM/BM weight, then $EF_{BL,CM}=0.5EF_{BL,BM}+0.5EF_{BL,OM}$, where $EF_{BL,OM}$ is the operational margin calculated according to ACM0002.
Option 3. The emission factor of the technology (and fuel) identified as the most likely baseline scenario under Section 2.4, and calculated as follows:

$$EF_{BL,CO_2,Option3} = \frac{COEF_{BL}}{\eta_{BL}} \times 3.6GJ/MWh \quad (5)$$

Where,
$COEF_{BL}$ is the fuel emission coefficient (tCO_2e/GJ), based on national average fuel data, if available, otherwise IPCC defaults can be used.
η_{BL} is the energy efficiency of the technology, as estimated in the baseline scenario analysis above.
As described in Section 2.4, the 600 MW subcritical coal-fired plant has been identified as the most likely baseline, then emission coefficients of coal can be calculated as follows:

$$COEF_{Coal} = NCV_{Coal} \times EF_{CO_2,Coal,y} \times OXID_{Coal} \quad (6)$$

Where:
$COEF_{Coal}$: is the emission coefficient of coal in tCO_2/tce.
NCV_{Coal}: is the net calorific value of coal (GJ/tce), value from China Energy Statistics Yearbook 2004 has been adopted.

$EF_{CO2,Gas,y}$: is the CO_2 emission factor per unit of energy of coal in year y (tCO_2/GJ), which is determined by IPCC default value.
$OXID_{Coal}$: is the oxidation factor of coal, the IPCC default value will be used.
Then the formula (1) can be translated into the following one:

$$EF_{BL,CO_2,Option3} = COEF_{Coal} \times PGCC_{BL} /(1-\gamma_{selfuse}) \quad (7)$$

$COEF_{Coal}$: is the emission coefficient of coal in tCO2/tce.
$PGCC_{BL}$: is the power generation coal consumption of the most likely baseline technology identified in previous step, 600 MW subcritical coal-fired plant in the PD tce/MWh.
$\gamma_{selfuse}$: is the rate of power generation self-consumed by the power plant.

According to the Methodology and calculation steps described above, the baseline emission reductions can be ex-ante calculated as follows:
$EF_{BL,BM}$=0.5772tCO_2/MWh
$EF_{BL,OM}$=0.9987 tCO_2/MWh
EFBL,CM=0.5×EFBL,BM +0.5×EFBL,OM=0.78795 tCO_2/MWh
$EF_{BL,CO2,Option3} = COEF_{Coal} \times PGCC_{BL}/(1-r_{selfuse})$ =2.769×0.312/(1-5.02%)=0.910 tCO_2/MWh.
Then $EF_{BL,CO2}$ =min($EF_{BL,BM}$, $EF_{BL,CM}$, $EF_{BL,CO2,Option3}$) =0.5772 tCO2/MWh. The build margin (Option 1) is selected as the baseline emission factor.

For the project, the values of the above parameters and baseline emission described as Table 5:

Table 5 Baseline emission

Period	Power Generated MWh	Power Consumed MWh	Net Power Supplied MWh	Load factor %	Baseline Emission (tCO_2e)
1 Oct 08- 31 Dec 08	641 398	8 618	632 780	26.46%	365 241
1 Jan 09- 11 May 09	1 029 527	10 526	1 019 001	32.40%	588 168
Total	**1 670 925**	**19 144**	**1 651 781**		**953 408**

6.3 Leakage emissions

Thus the leakage can be calculated as follows:

$$LE_y = LE_{CH4} + LE_{LNG,CO_2,y} \quad (8)$$

Where:
LE_y: leakage emission during the year y in tCO_2e.
$LE_{CH4,y}$: leakage emission due to fugitive upstream CH_4 emissions in year y in tCO2e.
$LE_{LNG,CO2,y}$: leakage emission due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year y in tCO_2e.

Calculate Fugitive Methane Emissions ($LE_{CH4,y}$)
To estimated the fugitive methane emissions, one can multiply the quantity of LNG consumed by the project in year y with an emission factor for fugitive CH_4 emissions ($EF_{Gas,upstream,CH4}$) for LNG consumption and subtract the emissions occurring from fossil fuels used in the absence of the project activity, as follows:

$$LE_{CH4,y} = \left[FC_{LNG,y} \times NCV_{LNG,y} \times EF_{Gas,upstream,CH_4} - EG \times EF_{BL,upstream,CH_4}\right] \times GWP_{CH4} \quad (9)$$

Where:

$LE_{CH4,y}$: Leakage emissions due to fugitive upstream CH4 emissions in the year y in tCO2e.
$FC_{LNG,y}$: Total volume of LNG combusted in the project plant (tons) in year y.
$NCV_{LNG,y}$: Net calorific value of LNG (GJ/ton), which is determined from the fuel supplier.
$EF_{Gas,upstream,CH4}$: Emission factor for upstream fugitive methane emissions from production of gas in tCH_4/GJ. The Methodology suggested several default fugitive CH4 associated with different regions. In this PD, the default value for other oil exporting countries/rest of world is adopted.
EG_y: Electricity generation in the project plant during year y in MWh.
$EF_{BL,upstream,CH4}$: is the emission factor determined in sub step 3a for upstream fugitive methane emissions occurring in the absence of the project activity in tCH_4/MWh.
GWP_{CH4}: Global warming potential of methane valid for the relevant commitment period.
Calculate CO_2 emissions from LNG ($LE_{LNG,CO2,y}$)
CO_2 emission from LNG combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system is estimated by multiplying the quantity of natural gas combusted in the project with an appropriate emission factor, as follows:

$$LE_{LNG,CO_2,y} = FC_{LNG,y} \times NCV_{LNG,y} \times EF_{Gas,upstream,CH_4} \quad (10)$$

Where,
$LE_{LNG,CO2,y}$: Leakage emissions due to LNG combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system in tCO_2e.
$FC_{LNG,y}$: Total volume of LNG combusted in the project plant (tons) in year y.
$NCV_{LNG,y}$: Net calorific value of LNG (GJ/ton), which is determined from the fuel supplier.
$EF_{CO2,upstream,LNG}$: Emission factor for upstream CO_2 emission due to LNG combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system in tCO_2/GJ. Because such data is unavailable in this project, the default value of 6 tCO_2/TJ suggested in the Methodology is adopted as a rough approximation.

According to the Methodology, the emission factor for upstream fugitive CH_4 emissions occurring in the absence of the project activity should be consistent with the baseline emission factor ($EF_{BL,CO2}$). the BM will be selected as the baseline emission factor, then the corresponding upstream fugitive CH_4 emission factor can be calculated as follows:

$$EF_{BL,upsream,CH4} = \frac{FF_{Coal} \times EF_{Coal,upstream,y} + FF_{Gas} \times EF_{Gas,upstream,y} + FF_{Oil} \times EF_{Oil,upstream,y}}{GEN_y} \quad (11)$$

Where:
$EF_{BL,upstream,CH4}$: is the emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in tCH_4/MWh
FF_{Coal}: Total quantity of coal type fuel combusted (tons raw coal) in power plants included in the build margin.
FF_{Gas}: Total quantity of gas type fuel combusted (GJ) in power plants included in the build margin.
FF_{Diesel}: Total quantity of diesel type fuel combusted (GJ) in power plants included in the build margin.
$EF_{Coal,upstream,CH4}$: Emission factor for upstream fugitive methane emissions from

production of coal in tCH_4/t coal. The Methodology suggested two default fugitive CH_4 associated with different source: underground mining and surface mining. Because 95% of the coal production in China are produced by underground mining, so the default value for underground mining 13.4 tCH_4/kt coal is used in this PD.

$EF_{Gas,upstream,CH4}$: Emission factor for upstream fugitive methane emissions from production of gas in tCH_4/GJ. The Methodology suggested several default fugitive CH_4 associated with different regions. In this PD, the default value for other oil exporting countries/rest of world is adopted, which is higher than the value for USA and Canada, resulting in an upward estimate of the leakage. Thus it is conservative.

The project might adopt the lower default value for USA and Canada because the new gas terminal and transmission and distribution network of this project is construed and operated by advance technology.

$EF_{Oil,upstream,CH4}$: Emission factor for upstream fugitive methane emissions from production of oil in tCH_4/GJ. The default value suggested in the Methodology is used in this PD.

GEN_y: Electricity generation in the plants included in the build margin in MWh/a.

For the BM is calculated based on a conservative way, we also use the following formula to estimate the upstream fugitive methane emissions as follows:

$$
\begin{aligned}
EF_{BL,upsream,CH4} &= \frac{FF_{Coal} \times EF_{Coal,upstream,y} + FF_{Gas} \times EF_{Gas,upstream,y} + FF_{Oil} \times EF_{Oil,upstream,y}}{GEN_y} \\
&= \frac{CAP_{Thermal}}{CAP_{Total}} \times EF_{ThermalupstreaCHCH4} \\
&= \frac{CAP_{Thermal}}{CAP_{Total}} \times (\lambda_{Coal} \times EF_{Coal,adv,upstreamCH4} + \lambda_{Gas} \times EF_{Gas,adv,upstreamCH4} + \lambda_{Oil} \times EF_{Oil,adv,upstreamCH4_{Coal,BM}}) \\
&> \frac{CAP_{Thermal}}{CAP_{Total}} \times \lambda_{Coal} \times EF_{Coal,adv,upstreamCH4} \\
&= \lambda_{Coal} \times \frac{CAP_{Thermal}}{CAP_{Total}} \times PGCC_{Adv} \times EF_{Coal,upstream,CH4} \times \frac{NCV_{Coal}}{NCV_{Rawcoal}}
\end{aligned}
\qquad (12)
$$

Where,

$\lambda_{Coal,BM}$: is the share of coal-fired generation in BM generation.

$PGCC_{Adv}$: is the power supply coal consumption of the most advance coal-fired generation technology within the grid boundary, which is estimated as 343.33 gce/kWh in this PD.

NCV_{Coal}: is the net caloric value of standard coal equivalent in GJ/tce.

$NCV_{Rawcoal}$: is the net caloric value of raw coal which is used for power generation in GJ/tce.

For the project, the values of the above parameters and leakage emission described as Table 6-Table 8:

Table 6 Leakage emission

Period	LE_{CH4} (tCO_2e)	$LE_{LNG,CO2}$ (tCO_2e)	LE (tCO_2e)
1 Oct 08- 31 Dec 08	-29 787	26 591	-3 196
1 Jan 09- 11 May 09	-48 431	42 375	-6 056
Total			0

6.4 Summary of emission reductions during the monitoring period

Table 9 Emission reduction calculation (tCO_2e)

Period	Baseline Emission (tCO_2e)	Project Emission (tCO_2e)	Leakage (tCO_2e)	Emission Reduction (tCO_2e)
1 Oct 08- 31 Dec 08	365 241	248 628	0	116 613
1 Jan 09- 11 May 09	588 168	396 205	0	191 963
Total (tCO_2e)	**953 408**	**644 832**	**0**	**308 576**

Annex 1: Contact details

Project developer

Organization:	Shenzhen Guangqian Electric Power Co., Ltd.
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Annex 2: Baseline information

Data recommended in the *Notification on Determining Baseline Emission Factors of China power Grid*（issued by Chinese DNA on July. 2th 2009）for CSPG are adopted for the Project. Table A1~A3 show the thermal power generation supplied to CSPG in 2005, 2006 and 2007.

Table A1. Thermal power generation data within CSPG in 2005

	Electricity generation (MWh)	**Auxiliary electricity consumption (%)**	**Electricity delivered to the grid (MWh)**
Guangdong	176,453,000	5.58	166,606,923
Guangxi	25,023,000	7.95	23,033,672
Guizhou	58,430,000	7.34	54,141,238
Yunnan	27,281,000	6.94	25,387,699
Total			269,169,531

Data source: China Electric Power Yearbook 2006 Edition.

Table A2. Thermal power generation data within CSPG in 2006

	Electricity generation (MWh)	**Auxiliary electricity consumption (%)**	**Electricity delivered to the grid (MWh)**
Guangdong	188,429,000	5.27	178,498,792
Guangxi	27,967,000	4.45	26,722,469
Guizhou	76,039,000	6.06	71,431,037
Yunnan	39,791,000	4.12	38,151,611
Total			314,803,908

Data source: China Electric Power Yearbook 2007 Edition.

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Table A3. Thermal power generation data within CSPG in 2007

	Electricity generation (MWh)	**Auxiliary electricity consumption (%)**	**Electricity delivered to the grid (MWh)**
Guangdong	215,700,000	6.01	202,736,430
Guangxi	36,100,000	7.42	33,421,380
Guizhou	84,300,000	6.62	78,719,340
Yunnan	47,400,000	7.23	43,972,980
Total			358,850,130

Data source: China Electric Power Yearbook 2008 Edition.

With reference to the *on Determining Baseline Emission Factors of China Power Grid* published by Chinese DNA on July. 2th 2009, Table A4 shows the low calorific values, emission factors and oxidation rates of fuels consumed for electricity generation that are to be used in the following OM emission factor calculation and BM emission factor calculation.

Table A4. Data of fuels consumed for electricity generation

Fuel type	Low calorific value	Emission factor ($kgCO_2/TJ$)	Oxidation rate
Raw coal	20,908 kJ/kg	87,300	1
Clean coal	26,344 kJ/kg	87,300	1
Other washed coal	8,363 kJ/kg	25.80	1
Shape coal	20,908 kJ/kg	25.80	1
Coke	28,435 kJ/kg	95,700	1
Crude oil	41,816 kJ/kg	71,100	1
Gasoline	43,070 kJ/kg	67,500	1
Diesel	42,652 kJ/kg	75,500	1
Fuel oil	41,816 kJ/kg	75,500	1
Other petroleum products	41,816kJ/kg	71,100	1
Natural gas	38,931 kJ/m^3	54,300	1
Coke oven gas	16,726 kJ/m^3	37,300	1
Other coal gas	5,227 kJ/m^3	37,300	1
LPG	50,179 kJ/m^3	61,600	1
Refinery gas	46,055 kJ/m^3	48,200	1

Data sources: *China Energy Statistical Yearbook 2008 edition, P283*

Notification on Determining Baseline Emission Factors of China Power Grid issued by Chinese DNA published on July. 2^{th} 2009

Table 1.3 and Table 1.4, Volume 2, "2006 IPCC Guidelines for National Greenhouse Gas Inventories"

Table A5. Emission and Power Supply Data of CSPG in 2005

Energy	**Unit**	**Guangdong**	**Guangxi**	**Guizhou**	**Yunnan**	**Total Fuel**	**Carbon content (tC/TJ)**	**Oxidation rate (%)**	**Emission factor (tCO_2/TJ)**	**NCV (MJ/t or $1000m^3$)**	**Emission (tCO_2e)**
		A	**B**	**C**	**D**	**E=A+B+C+D**	**F**	**G**	H	**I**	**J**
Raw Coal	10^4t	6696.47	1435	3212.31	1975.55	13319.33	25.8	100	87,300	20908	263442601.85
Clean Coal	10^4t				0.15	0.15	25.8	100	87,300	26344	3738.21
Other washed coal	10^4t			10.39	33.88	44.27	25.8	100	87,300	8363	350237.59
Coke	10^4t	4.79			8.05	12.84	29.2	100	95,700	28435	390906.18
Coke oven gas	10^8m^3				0.79	0.79	12.1	100	37,300	16726	58624.07
Other coal gas	10^8m^3	1.87			15.96	17.83	12.1	100	37,300	5227	413485.84
Crude oil	10^4t	10.91				10.91	20	100	71,100	41816	334555.88
Gasoline	10^4t	0.68				0.68	18.9	100	67,500	43070	20296.31
Diesel	10^4t	31.96	2.02		1.81	35.79	20.2	100	72,600	42652	1130638.84
Fuel oil	10^4t	887.21				887.21	21.1	100	75,500	41816	28702703.26
LPG	10^4t					0	17.2	100	61,600	50179	0.00
Refinery gas	10^4t	4.92				4.92	15.7	100	48,200	46055	130440.66
Natural gas	10^8m^3	0.93				0.93	15.3	100	54,300	38931	203114.71
Other petroleum products	10^4t	1.7				1.7	20	100	75,500	38369	47833.35
Other Coke products	10^4t					0	25.8	100	95,700	2835	0.00
Other energy	10^4tce	104.66	133.15		59.72	297.53	0		0	0	0.00
Net electricity import from the Central China Grid (MWh)						202,64,000					
OM emission factor of the Central China Grid (tCO_2e/MWh)						1.16148					
Total emission of CSPG (tCO_2e)						297,544,857					
Fossil power supply of CSPG (MWh)						289,433,531					

Data sources: China Energy Statistical Yearbook 2006 Edition

Table A6. Emission and Power Supply Data of CSPG in 2006

Energy	Unit	Guangdong A	Guangxi B	Guizhou C	Yunnan D	Total Fuel E=A+B+C+D	Carbon content (tC/TJ) F	Oxidation rate (%) G	Emission factor (tCO_2/TJ) H	NCV (MJ/t or $1000m^3$) I	Emission[1] (tCO_2e) J
Raw Coal	10^4t	7303.19	1490.01	4001.54	2735.88	15530.26	25.8	100	87,300	20908	307,179,636
Cleaned coal	10^4t	0	0	0	0	0	25.8	100	87,300	26344	0
Other washed coal	10^4t	0	0	19.53	45.8	65.33	25.8	100	87,300	8363	516,852
Shape coal	10^4t	133.75	0	0	0	133.75	26.6	100	87,300	20908	2,767,466
Coke	10^4t	0	0	0	1.31	1.31	29.2	100	95,700	28435	39,882
Coke oven gas	10^8m^3	0	0.84	0	2.06	2.9	12.1	100	37,300	16726	215,202
Other coal gas	10^8m^3	0.89	0	0	19.15	20.04	12.1	100	37,300	5227	464,737
Crude oil	10^4t	0.87	0	0	0	0.87	20	100	71,100	41816	26,679
Gasoline	10^4t	0	0	0	0	0	18.9	100	67,500	43070	0
Diesel	10^4t	29.92	1.26	0	3	34.18	20.2	100	72,600	42652	1,079,777
Fuel oil	10^4t	685.85	0.09	0	0	685.94	21.1	100	75,500	41816	22,191,288
LPG	10^4t	0	0	0	0	0	17.2	100	61,600	50179	0
Refinery gas	10^4t	0	0	0	0	0	15.7	100	48,200	46055	0
Natural gas	10^8m^3	7.92	0	0	0	7.92	15.3	100	54,300	38931	1,729,151
Other petroleum products	10^4t	0.67	0	0	0	0.67	20	100	75,500	38369	18,852
Other coke products	10^4tce	0	0	0	0	0	25.8	100	95,700	28435	0.00
Other energy	10^4tce	93.54	189.68	0	20.29	115.56	0	0	0	0	0.00

Net electricity import from the Central China Grid (MWh)	21,730,840
OM emission factor of the Central China Grid (tCO_2e/MWh)	1.12157
Total emission of CSPG (tCO_2e)	335,809,186
Fossil power supply of CSPG (MWh)	336,534,768

Data sources: China Energy Statistical Yearbook 2007 Edition

[1] If the unit of the fuel is 10^4 t, then I=E× H×I /10^4; if the unit of the fuel is 10^8 m^3, then I= E× H×I /10^3. The same about the calculation of I in Table A5,Table A6 and Table A7.

Table A7. Emission and Power Supply Data of CSPG in 2007

Energy	**Unit**	**Guangdong** **A**	**Guangxi** **B**	**Guizhou** **C**	**Yunnan** **D**	**Total Fuel** **E=A+B+C+D**	**Carbon content (tC/TJ)** **F**	**Oxidation rate (%)** **G**	**Emission factor (tCO_2/TJ)** H	**NCV (MJ/t or $1000m^3$)** **I**	**Emission (tCO_2e)** **J**
Coal	10^4t	8214.78	1750.63	4298.8	3170.79	17435	25.8	100	87,300	20,908	318,235,546
Cleaned coal	10^4t	3.46				3.46	25.8	100	87,300	26,344	79,574
Other washed coal	10^4t		0.65	21.58	14.64	36.87	25.8	100	87,300	8,363	269,184
Shape coal	10^4t	271.25				271.25	26.6	100	87,300	20,908	4,951,041
Coke	10^4t	0.04	1.69		2.15	3.88	29.2	100	95,700	28,435	105,584
Coke oven gas	10^8m^3		0.96	3.19	1.8	5.95	12.1	100	37,300	16,726	371,208
Other coal gas	10^8m^3		30.77		21.63	52.4	12.1	100	37,300	5,227	1,021,628
Crude oil	10^4t					0	20	100	71,100	41,816	0
Gasoline	10^4t					0	18.9	100	67,500	43,070	0
Diesel	10^4t	21.37	2.13		2.29	25.79	20.2	100	72,600	42,652	798,596
Fuel oil	10^4t	467.97	0.41			468.38	21.1	100	75,500	41,816	14,787,262
LPG	10^4t					0	17.2	100	61,600	50,179	0
Refinery gas	10^4t	0.37				0.37	15.7	100	48,200	46,055	8,213
Natural gas	10^8m^3	32.17				32.17	15.3	100	54,300	38,931	6,800,588
Other petroleum products	10^4t	8.47				8.47	20	100	75,500	41,816	267,407
Other coke products	10^4tce					0	25.8	100	95,700	28,435	0
Other energy	10^4tce	118.04	81.89	44.1	50.3	294.33	0	0	0	0	0
Net electricity import from the Central China Grid (MWh)						24,237,240					
OM emission factor of the Central China Grid (tCO_2e/MWh)						1.10197					
Total emission of CSPG (tCO_2e)						374,404,628					
Fossil power supply of CSPG (MWh)						383,087,370					

Data sources: China Energy Statistical Yearbook 2008 Edition

The simple OM emission factor is weighted average value of simple OM emission factors of CSPG in 2004,2005,2006 as fellows:

$$EF_{OM,y} = (297544857 + 335809106 + 374404628)/(289433531 + 336534768 + 383087370)$$
$$= 0.99871\ tCO_2e/MWh$$

Table A8. The data of efficiency level of the best electricity generation technologies commercially available in China and the corresponding emission factors

	Parameter	Best efficiency of supplying electricity (%)	Fuel emission factor (tco_2/TJ)	Oxidation rate	Emission factor (tCO_2e/MWh)
		A	B	C	D=3.6/A/1000*B *C*44/12
Coal-fired power plant	$EF_{Coal,Adv}$	38.10	25.8	1	0.8249
Gas-fired power plant	$EF_{Gas,Adv}$	48.81	15.3	1	0.5437
Oil-fired power plant	$EF_{Oil,Adv}$	48.81	21.1	1	0.3910

Data sources: Notification on Determining Baseline Emission Factors of China Power Grid issued by Chinese DNA on July 2th , 2009
Table 1.3 and Table 1.4, Volume 2, "2006 IPCC Guidelines for National Greenhouse Gas Inventories"

Table A9. Data for calculating the thermal power emission factors

Energy	Unit	Guangdong A	Guangxi B	Guizhou C	Yunnan D	Total E=A+B+C+D	NCV (MJ/t or 1000m^3) F	Emission factor (tC/TJ) G	Oxidation Rate H	Emission (tCO_2e) I =E*F*G*H *44/12/100
Raw coal	10^4t	8,214.78	1,750.63	4,298.8	3,170.79	17,435	20,908	87,300	1	318,235,546
Cleaned coal	10^4t	3.46	0	0	0	3.46	26,344	87,300	1	79,574
Other washed coal	10^4t	0	0.65	21.58	14.64	36.87	8,363	87,300	1	269,184
Shape coal	10^4t	271.25	0	0	0	271.25	20,908	87,300	1	4,951,041
Coke	10^4t	0.04	1.69	0	2.15	3.88	28,435	95,700	1	105,584
Other coke products	10^4t	0	0	0	0	0	28,435	95,700	1	0
Sub-total										**323,640,928**
Crude oil	10^4t	0	0	0	0	0	41,816	71,100	1	0
Gasoline	10^4t	0	0	0	0	0	43,070	67,500	1	0
Diesel	10^4t	467.97	0.41	0	0	468.38	41,816	75,500	1	14,787,262
Fuel oil	10^4t	8.47	0	0	0	8.47	41,816	75,500	1	267,407
Other oil products	10^4t	0	0	0	0	0	41,816	71,100	1	0
Sub-total										15,853,266
Natural gas	10^7m^3	321.7	0	0	0	321.7	38,931	54,300	1	6,800,588
Coke oven gas	10^7m^3	0	9.6	31.9	18	59.5	16,726	37,300	1	371,208
Other coal gas	10^7m3	0	307.7	0	216.3	524	5,227	37,300	1	1,021,628
LPG	10^4t	0	0	0	0	0	50,179	61,600	1	0
Refinery gas	10^4t	0.37	0	0	0	0.37	46,055	48200	1	8,213
Sub-total										**8,201,637**
Total										**347,695,831**

Data sources: China Energy Statistical Yearbook 2008

Calculate with data provided in Table A8, A9 and formula (4)~(6), the value for

$$\lambda_{Coal} = 93.08\% ,$$

$$\lambda_{Oil} = 4.56\% ,$$

$$\lambda_{Gas} = 2.36\% ,$$

Then $$EF_{Thermal} = \lambda_{Coal} \times EF_{Coal,Adv} + \lambda_{Oil} \times EF_{Oil,Adv} + \lambda_{Gas} \times EF_{Gas,Adv}$$

$$= 0.8018 \text{ tCO}_2\text{e/MWh}$$

Table A10. Installed capacity of the CSPG in 2005

	Guangdong	Guangxi	Yunnan	Guizhou	Total
Thermal power (MW)	44,710	9,310	10,630	15,960	80,610
Hydro power (MW)	10,110	10,440	11,580	8,210	40,340
Nuclear power (MW)	3,780	0	0	0	3,780
Wind power and Other (MW)	250	0	0	0	250
Total (MW)	58,850	19,750	22,210	24,170	124,980

Data source: China Electric Power Yearbook 2006.

Table A11. Installed capacity of the CSPG in 2006

	Guangdong	Guangxi	Yunnan	Guizhou	Total
Thermal power (MW)	40,615	5,434	8,564	14,350	68,963
Hydro power (MW)	9,320	7,624	9,698	7,534	34,176
Nuclear power (MW)	3,780	0	0	0	3,780
Wind power and Other (MW)	183	0	0	0	183
Total (MW)	53,898	13,058	18,262	21,884	107,102

Data source: China Electric Power Yearbook 2007.

Table A12 Installed capacity of the CSPG in 2007

	Guangdong	Guangxi	Yunnan	Guizhou	Total
Thermal power (MW)	44,710	9,310	10,630	15,960	80,610

Hydro power (MW)	10,110	10,440	11,580	8,210	40,340
Nuclear power (MW)	3,780	0	0	0	3,780
Wind power and Other (MW)	250	0	0	0	250
Total (MW)	58,850	19,750	22,210	24,170	124,980

Data source: China Electric Power Yearbook 2008.

Table A13. Capacity increase data of CSPG from 2005 to 2007

	Installed capacity in 2005 (MW) B	**Installed capacity in 2006 (MW) C**	**Installed capacity in 2007 (MW) A**	**Capacity additions from 2005 to 2007 (MW) D=C-A**	**Share in total capacity additions**
Thermal power	54,507	68,963	80,610	26,103	71.98%
Hydro power	30,347.1	34,176	40,340	9,992.9	27.56%
Nuclear power	3,780	3,780	3,780	0	0.00%
Wind power and Other	83.4	183	250	166.6	0.46%
Total	**88,717.5**	**107,102**	**124,980**	**36,262.5**	**100.00%**
Share in total installed capacity of 2005	70.99%	85.70%	100%		

Data source: China Electric Power Yearbook 2006 ,2007, 2008 Edition.

$$EF_{BM,y} = 0.8018 \times 0.7198 = 0.5772 \quad \text{tCO2e/MW}$$

$$\lambda_{Coal} = \lambda_{Coal} \times CAP_{Thermal} / CAP_{Total} = 0.9308 \times 0.7198 = 0.66999$$