FY2009 CDM/JI Feasibility Study Report – Summary

Title of study:

Feasibility study regarding CDM Programme of Activities for waste heat recovery and utilization for power generation project in cement sector in Shanxi Province, China

Name of company:

Mizuho Information & Research Institute, Inc.

FS implementation structure

Mizuho Corporate Bank, Ltd.

- Evaluation of economic viability of the project, project risk analysis
- Support for preparing PDD

Kyushu Electric Power Co. Inc.

- Support for communication with local counterparts (Shanxi Building Material Industry Administration Office, CPA candidates)
- Support for organizing hearing sessions with stakeholders (governmental agencies, etc.)
- Support for preparing PDD
  - Studies on environmental impacts
  - Studies on comments from stakeholders
  - Studies on financial planning

1. Project overview

This project is a Program of Activity to promote waste heat recovery for power generation to cement plants in Shanxi Province, China, at the initiative of Shanxi Building Material Industry Administration Office, a local private industrial group that administers cement plants in the region, functioning as the coordinating/managing entity.

Each CDM program activity (CPA) will be implemented in geographically distinct area of Shanxi Province. Each CPA will be implemented and managed in cement plants within the area, limited to the entities under the administration of Shanxi Building Material Industry Administration Office, the coordinating/managing entity.

Shanxi Jigang Cement Co., Ltd., a CPA model site for this PoA, introduces 9 MW facilities in total for heat recovery and power generation in the existing 2,500t/d line and in another 2,500t/d line to be installed to generate approx. 53,000 MWh/yr of electricity, of which approx. 49,000 MWh/yr is expected to be supplied to cement production plants. This will contribute to reduce purchase of electricity from a grid and eventually reduce CO2 emissions from the power sector by approx. 44,000t-CO2/yr.

Applied methodology: ACM0012

2. Descriptions of this study

(1) Issues for this study

<Issue 1: Selection of PoA management system and CPA candidate project>

- Capacity building for the coordinating/managing entity is a key factor for successful implementation, because such entity has significant role in a programme of activity. In this PoA, Shanxi Building Material Industry which administers cement operators in the region is assumed as the coordinating/managing entity, and we will help the entity develop their understanding on this activity.
- For CPA candidate, this PoA assumes a cement operator that is located within the project boundary under the administration of Shanxi Building Material Industry, and that plans to construct new production line. For an effective dissemination of this activity, information collection on cement operators is necessary to select appropriate candidates in this study.

<Issue 2: Baseline setting and demonstration of additionality>

- As for ACM0012, the approved methodology this PoA follows, a series of projects have been under review or rejected in the CDM EB's registration procedure. Focusing on waste heat recovery project (using ACM0012) in China, what questioned in many cases were waste heat utilization status in the baseline (a proof of atmospheric discharge) and validity of IRR estimation (credibility of input data, especially for electricity price, etc.).
- In this PoA, with regard to CPA candidate project, it is necessary to prove that waste heat is discharged to the air in the baseline with accompanying sufficient evidences.
- Additionality is necessary to be demonstrated based on investment analysis and common practice analysis. Investment analysis needs to be enhanced by collecting verifiable evidences (FSR, etc.) from CPA candidate operators to make plural comparisons with such as official/governmental data and benchmarks determined within a company. Moreover, in common practice analysis, a fact that cement operators in the region do not (or are unable to) conduct waste heat recovery for power generation is demonstrated by clarifying reasons why this type of power generation has not been disseminated in Shanxi Province, the boundary of this PoA.

<Issue 3: Quantitative evaluation of co-benefit (issue revealed during this study)>

- For quantitative evaluation of co-benefit effect, it is necessary to estimate reduction volume of SO2, NOx and dust in a grid from waste heat recovery for power generation. In a project that uses emission factor (t-SOx/GWh, etc.) as seen in this PoA, we consider that consistency with OM (Operating Margin), BM (Building Margin) and CM (Combined Margin) needs to be ensured, as with the case of the CDM that requires consistency in CO2 emission factor. In this study, one of the issues is to consider possible effects from ensuring consistency as well as project feasibility in case of introducing such consistency in this project.

(2) **Descriptions of this study**

<1st site visit>

The first site visit was conducted in late September, 2009, as outlined in the table below. See the

attached site visit report for details.

Date	Counterpart	Issues discussed/studied
September 28th, 2009	Shanxi Building Material Industry Administration Office: Mr. Dang Chaoxu, Director	Information collection on the notion of this PoA, sales/purchase agreement with the grid, general investment situation, etc.
September 29th, 2009	Shanxi Zhihai Cement Ltd.: Mr. Han, with other one person Shanxi Building Material Industry Administration Office: Mr. Dang Chaoxu, Director	Information collection on detailed project plan, sales/purchase agreement with the grid, a flow of environmental impact assessment, etc.

<2nd site visit>

The second site visit was conducted in mid December, 2009, as outlined in the table below. See the attached site visit report for details.

Date	Counterpart	Issues discussed/studied
December 16th, 2009	Shanxi Building Material Industry Administration Office: Mr. Dang Chaoxu, Director	Re-discussion on structure of this PoA. Information exchange on recent changes in central and municipal governments incl. organizational reform and transfer of authority.
	China Building Material Center: Mr. Zhao jingxun, Shanxi branch Team leader[1]	Request to provide a list of cement plants in Shanxi Province and their support to collect basic information.
December 17th, 2009	Shanxi Jigang Cement: Mr. Chen Muwen, Vice president, Mr. He Wensheng, Production vice-president, with other three people	Information collection on status of facility installation of waste heat recovery for power generation in Shanxi Province, as well as its costs and related info.
	Luliang City Environment Protection Department: Mr. Liu Yuyun, Director, with other four people Consumer division, Luliang City Power Supply Cooperation, State Grid Corporation of China: Mr. Gao Kehu, President	Information collection on the Department's policies on waste heat from cement production and CDM and PoA, implementation of environmental impact assessment, and sales/purchase power price.
December 18th, 2009	Department of Environmental Science and Engineering, Tsinghua University: Ms. Chang Miao, Director	Information collection on co-benefit policies for SO2 and NOx in China, and on statistical data.

[1] Mr. Zhao is one of the members of the panel that administrates construction of cement production line in Shanxi's Development and Reform Commission.

<3rd site visit>

The third site visit was conducted in late January, 2010, as outlined in the table below. See the attached site visit report for details.

Date	Counterpart	Issues discussed/studied
January 27th, 2010	Tsinghua University: Professor Weizhihong National Development and Reform Commission: Mr. Mi Chuan, Assistant chief	Opinion exchange on the notion of PoA in China.
January 28th, 2010	Shanxi Building Material Industry Administration Office: Mr. Gu junzhong, Assistant chief, with other three people	Re-discussion on structure of this PoA, and on the role of the coordinating/managing entity. Moreover, opinion exchanges on the list of CPA candidate companies and notion of waste heat in the baseline for Shanxi's cement production.
	Shanxi Jigang Cement Co., Ltd. Mr. Chen Muwen, Vice president, Mr. He Wensheng, Production vice president, with some 10 people	Information collection on introduction of facilities for waste heat recovery for power generation, including introduction status in Shanxi and its cost and facility-related info.
January 29th, 2010	Circular Economy Development Research Center, Shanxi Development and Reform Commission: Mr. Yu Fabin, Vice President Environment Department, Lvliang City Development and Reform Commission: Mr. Xin huaiyu, Section chief Jiaocheng County Government: Mr. Shun Shanwen, Mayor, Mr. Zhang Xiaowen, Vice mayor, Mr. Li Zhongyi, Vice mayor. Jiaocheng County's Department of Development and Reform: Mr. Zhang Zhichun, Director	Information collection on CDM with waste heat recovery in cement industry and the PoA.

<Result of Issue 1: Selection of PoA management system and CPA candidate project>

In April 2009, before launching this study, a seminar was held for cement operators in Shanxi Province, which was organized by Shanxi Building Material Industry Administration Office, the

coordinating/managing entity. The seminar was aimed at deepening understanding on the CDM activity implemented by Shanxi Building Material Industry Administration Office, establishing PoA system and strengthening relationship with CPA candidate project operators. Specifically, explanations were given on energy efficiency projects in cement sector including waste heat recovery for power generation, as well as on CDM in general, followed by an opinion exchange session.

In the site visits conducted in September and December 2009 and January 2010, we visited Shanxi Building Material Industry Administration Office to explain and discuss about PoA system and to provide capacity building to them.

CPA candidates are the 45 cement operators that are under the administration of Shanxi Building Material Industry Administration Office and that also have a potential to introduce facilities for waste heat recovery and power generation. In this study, information on candidate operators was collected to prepare a candidate list. According to this study result, this PoA assumes a facility with 330 MW generation capacities, including those at planning stage. Given that introduction of a facility for 9 MW of waste heat recovery and power generation, emission reduction is at a scale of approx. 44,000 t-CO2/yr, this PoA has an emission reduction potential equivalent to approx. 1.6 Mt-CO2/yr.

In the meetings with the Chinese Government (NDRC) and Tsinghua University, we received comments on conditions that should be met by the coordinating/managing entity under the PoA, as well as items to be examined for the PoA. The rules to control CDM projects in China basically assuming private companies (or no governmental agencies are within the coverage) and therefore a governmental agency cannot become a coordinating/managing entity under the PoA[2]. In this regard, after the hearing session, we made an enquiry to Shanxi Building Material Industry Administration Office, the coordinating/managing entity of this project, and received their response that Shanxi Building Material Industry Administration Office is a private company whose financial basis is not on government subsidies but on private capital and that there is no problem with the conditions to work as the coordinating/managing entity.

Key points for the items to be examined in the PoA:

- Clear boundary
- Eligibility for CPA and coordinating/managing entity
- Priority of energy efficiency project (incl. waste heat)
- Clarification on how to allocate profits (from coordinating/managing entity to CPA operator)
- Implementation of EIA
- Clarification of the role of coordinating/managing entity and demonstration of its performance

They also mentioned that IRR and EIA should be described at CPA level while stakeholders' comments at the PoA level in cases of waste heat recovery for power generation, though there may be some variations depending on project types.

<Result of Issue 2: Baseline setting and demonstration of additionality>

<1> Baseline setting

Through hearing sessions with Shanxi Jigang Cement and Shanxi Building Material Industry, both CPA candidate operators, we received their comments saying that in the baseline waste heat is released to the

[2] This is China's own rule.

atmosphere.

- There are no laws and regulations to introduce waste heat recovery for power generation.
- Currently, in Shanxi Province, Shanxi Zhongtiaoshan New Material only introduces and operates waste heat recovery for power generation. The company implements this type of power generation because they are state-owned company and financially stable enough to do so, and they consider it leads to improve its corporate image.
- Among private companies in the province, Shanxi Zhihai Cement Ltd. introduced the facility but does not operate it at this stage. The company introduced the facility because their vice president was inspired by CDM seminars held in China to consider waste heat recovery for power generation and waste-blended cement as potential business, and expected positive effects to improve its O&M costs. However, after the introduction, they recognized the problems on sales price of electricity to the grid and stopped operation of the facility.
- Therefore, for cement sector in Shanxi Province, it is appropriate to consider waste heat is discharged to the atmosphere as the baseline.

Moreover, we also had hearing sessions with the same contents to the Chinese Government (NDRC) and Tsinghua University and received the following responses:

- In the discussions of CDM Executive Board (EB), waste heat recovery for power generation is considered as if it were the baseline in China's cement industry. However, the Chinese Government has no such intention.
- The Chinese Government rather considers it as one of the project types that should be promoted in the context of energy efficiency.

Moreover, we conducted an analysis on how far the precedence that Shanxi Zhihai Cement had already introduced (but not yet operated) facilities for waste heat recovery for power generation could affect demonstration of additionality. Firstly, with regard to the background of introducing the facility and its subsequent developments, several facts were identified through the site visits, as described below:

- Vice president of Shanxi Zhihai Cement was inspired in CDM seminars held in China to consider waste heat recovery for power generation and waste-blended cement as potential business, and expected positive effects to improve its O&M costs.
- However, the company failed to settle down on the sales price of electricity in the negotiations with the grid. Since then, the facility has not been operated.

In this regard, we consider that such facts will not affect demonstration of additionality for waste heat recovery for power generation project in Shanxi's cement sector, because of the following reasons:

(a) In the hearing session with Shanxi Jigang Cement, we learned that electricity sales price for power generation from waste heat recovery was originally set at 0.237 yuan/kWh. However, this unit price did not meet the condition offered by the grid. Assuming future negotiation, an acceptable price for both sides can be less profitable for operators.

(b) For reference, the sales price is set at a low level because supply/demand balance in electricity market has been collapsed due to the financial crisis. It is not only to cement operators but also to

cokes producers that such low-level sales price was offered. There is no prospect for the time being in Shanxi Province that electricity demand expands to fall into shortage of supply. Therefore, it is assumed that no project of waste heat recovery for power generation would be conducted without CDM.

(c) The Government of China is expected to issue a "management opinion" (not mandatory) to provincial governments to indicate that "on-site electricity generators do not need to sell the portion of electricity generated for its own use." This is good news for electricity generators using recovered waste heat to realize their project, but not for provincial governments and grids, because this instruction will eventually add electricity surplus. In addition, this is not a mandate regulation and based on a premise of voluntary actions, so as that it is extremely unlikely for provincial governments and grids to follow this "management opinion". If so, the structure will remain the same as it is that electricity generators using recovered waste heat sell electricity to a grid and then buy it back: therefore it will not affect determination on additionality for the time being.

(d) On the other hand, operators who completed capital investment should try to recover their input that have been already invested. Shanxi Zhihai Cement, which plans to do so, is relevant to this situation because they have already paid for the initial investment including bank loans. Operating revenue (excluding initial investment already paid) in case of continuing operation of the facility is evaluated at -54.13 million yuan[3] at NPV, which means they will not promote the project in principle.

(e) However, other than such low-profitable waste heat recovery for power generation project, there are some options to recover capital investment. For the case of Shanxi Zhihai Cement, expansion of cement production can be an alternative.

<2> Demonstration and Assessment of additionality

For Shanxi Jigang Cement, a CPA, Step 2 (investment analysis) is mainly conducted. In the investment analysis, a result in the case of Shanxi Jigang Cement is shown. While situations in the project boundary Shanxi Province is described in the common practice analysis.

The PoA, a CDM category this project follows, assumes to adopt benchmark indicators that are utilized within a company in principle. In the case of this project, Shanxi Jigang Cement do not have a benchmark indicator based on the IRR but has the one on years of investment recovery only[4]. Therefore, in this investment analysis, the benchmark of 11%[5] for project IRR in cement industry published by the Government of China is applied.

<2-1> Investment analysis

Shanxi Jigang Cement, the CPA candidate for this study, provided us the FSR which were prepared by a third party upon Jigang's request. Based on this FSR, this study conducted an investment analysis.

In this study, the following changes have been made on the FSR, in order to reflect the comments

[3] Initial investment is set at 0 yuan and electricity sales price 0 yuan/kWh. Under the current situation, the project is not attractive for the grid to complete a contract with power generators using recovered waste heat. Therefore, electricity sales price is set at 0 yuan/kWh.

[4] When assuming initial investment at 67.85 mil. Yuan with 4-year investment recovery, IRR is 24.9% (power sales price is at 0.444 yuan/kWh)

[5] Source: Economic Assessment method and parameter of Construction Projects by SDPC and MOC, 3/7/2006

received during the second site visit (December 2009) and the third site visit (January 2010) that suggested to modify the assumptions included in the FSR.

Operation hours:	Annual operation of this CPA is set at 300 days per year (7,200 hours), taking into consideration winter (two months) closedown of cement production line. Winter closedown period═depends on weather conditions (temperature etc.), generally for around two months, and therefore this condition is adopted in the calculation of power generation. Meanwhile, this condition is uncertainty factor because of the experience of the maximum four months winter closedown.
Operating Capacity :	Actual temperature of waste heat is around 300 degrees centigrade, which is lower than that assumed in FSR (320℃). Based on the data obtained through hearing sessions, operating capacity was decreased by 10% from 8,203 kW to 7,383 kW.

Table 1 IRR

	Without profit from CER	With profit from CER
IRR	6.50%	11.44%

CDM EB takes up credibility of electricity price in the registration process, and therefore we have worked to make further improvement of the credibility by holding hearing sessions to operators involving electricity trading for both sides, including electricity seller (Lvliang City Power Supply Cooperation of State Grid Corporation of China), and by collecting information from Shanxi's price department that determines and publishes prices for various goods and services in the Province.

<2-2> Common practice analysis

There is a China-specific system with regard to waste heat recovery for power generation, which was learned through hearing sessions to cement company (Shanxi Jigang Cement) and to electricity seller (Lvliang city power supply corporation, State Grid Corporation of China):

- A portion of electricity generated from heat recovery needs to be sold to power grid.
- Sales price of electricity is set at a low level.

This system may hamper to deliver economic benefit for cement operators who implement waste heat recovery for power generation. For example, the prices Shanxi Jigang Cement was offered in the negotiations with State Grid Corporation were 0.237 yuan/kWh for sales and 0.5 yuan/kWh for purchase: compared to sales price of 0.38 yuan/kWh in other province. This fact reveals that the economic benefit is small to promote waste heat recovery for power generation in Shanxi Province.

Such situation is attributed to less urgency in electricity supply within the province (the comment obtained from Lvliang City power Supply Corporation of State Grid Corporation of China). According to the comment from Shanxi Jigang Cement, operators with a plan to introduce waste heat recovery for power generation are unable to launch the project because Lvliang City Power Supply Corporation of State

Grid Corporation of China does not show its intention to reply to enquiries from such operators.

Given such problems in price system as well as in the attitude of Lvliang City Power Supply Corporation of State Grid Corporation of China, it must be said that there has been no common practice in Shanxi Province, while barriers exist to disseminate waste heat recovery for power generation. In order to overcome such situation, utilization of CDM can be an effective option. This status is reflected to investment analysis.

There are no laws and regulations to promote implementation of this PoA.

In Shanxi Province, all cement plants release all waste heat to the air and buy all electricity from the North China Power Grid, except Shanxi Zhongtiaoshan New Material which is the only company that introduces and operates facilities for waste heat recovery and power generation in the province. The company implements waste heat recovery for power generation, because they are state-owned company and financially stable enough to consider this action would improve its corporate image. This is, however, far from feasible for private companies due to the low profitability.

Therefore, it is appropriate to consider the baseline as all waste heat is released to the air from cement plants in Shanxi Province and all electricity is purchased from the North China Power Grid.

<Result of Issue 3: Quantitative evaluation of co-benefit (an issue which was revealed during this study)>

For quantification of co-benefit effects in a CDM project, it is preferable to follow the same concept as that of CO2 emission reductions. This is based on a notion that co-benefit effects which quantify improvement of environmental impacts (air pollution, etc.) over decades should be reflected in emission factor, too.

In developing countries where CDM projects are implemented, one of the concerns is physical and temporal coverage and availability of data on environmental impacts (air pollution, etc.). During the site visits conducted in this study (for Lvliang City Environment Protection Department and Lvliang City Power Supply Cooperation of State Grid Corporation of China), we received comments that it was not clear if and where such data would be available.

Considering such actual situations, in this study, we tried to quantify positive effects on how far air pollution was improved from waste heat recovery for power generation, by using an easier method. Quantification is divided into the two stages: the first stage is to quantify air pollutant emissions (and emission reductions), and the second stage is to give monetary value to emission reductions. Giving monetary value aims at creating a uniform indicator: specifically, quantification is conducted based on “OM: actual value, BM: reference value (national standard), CM: average of OM and BM” at the first stage, and by utilizing LIME factors at the second stage.

3. Survey findings for CDM project implementation

(1) Setting baseline scenario and project boundary

The baseline scenario for CPA is in accordance with the approved baseline methodology ACM0012 ("Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects"). In order to demonstrate that no project is implemented without this PoA, the latest version of "Tool for the demonstration and assessment of Additionality" is used, among the UNFCCC additionality tools.

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

Candidates for baseline scenario regarding each CPA are selected in accordance with the section of "Identification of the baseline scenario" in the methodology ACM0012 version 3.2 for each type of facilities listed below.

Sub-Step 1a: Define the most plausible baseline scenario for the generation of heat and electricity using the following baseline options and combinations.

- **Industrial facility where the waste energy is generated**
- **Facility where the energy is produced**
- **Facility where the energy is consumed**

Industrial facility where the waste energy is generated

Suspension preheter (SP) and Air quenching cooler (AQC) are in this category. Among realistic and plausible options provided in ACM0012 Version 3.2, the following W1 (W2) is identified.

W1: WECM (Waste Energy Carrying Medium) is directly vented to atmosphere without incineration or waste heat is released to the atmosphere or waste pressure energy is not utilized.

W2： WECM is released to the atmosphere (for example after incineration) or waste heat is released to the atmosphere or waste pressure energy is not utilized.

Facility where the energy is produced

Steam Turbine Generator is in this category. Among realistic and plausible options provided in ACM0012 Version 3.2, the following P1 and P6 are identified.

P1: Proposed project activity not undertaken as a CDM project activity.

P6: Sourced Grid-connected power plants.

As described below, this project activity is not attractive for operators without profits from CDM, and P1 is excluded from the baseline.

Facility where the energy is consumed

Cement Clinker Production Line(s) is in this category.

(2) Project emissions

Power generation utilizing recovered waste heat in a cement plant uses no additional fossil fuel, because turbine in a generator is driven with steam which was generated from recovered waste heat. Therefore,

there are basically no project emissions and leakage emissions in this PoA.

(3) Monitoring plan

<Monitoring plan for PoA>

The coordinating/managing entity adopts a method with which DOE verifies each CPA.

Each CPA implements monitoring in accordance with ACM0012 "Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects" Version 3.2, and regularly reports the data to the coordinating/managing entity after cross-checking on data validation.

The coordinating/managing entity prepares a monitoring report that integrates the data from all CPA included in the PoA, for allowing DOE to implement verification on each CPA.

Each CPA collects and organizes monitoring data to report to the project database managed by the coordinating/managing entity, and the CERs are then calculated for both individual CPA and entire PoA.

Primary monitoring data are saved in each CPA and in the coordinating/managing entity for a certain period of time. The coordinating/managing entity will also save calculation results for a certain period of time: especially for CERs, feedback will be given to each CPA after a monitoring report is prepared.

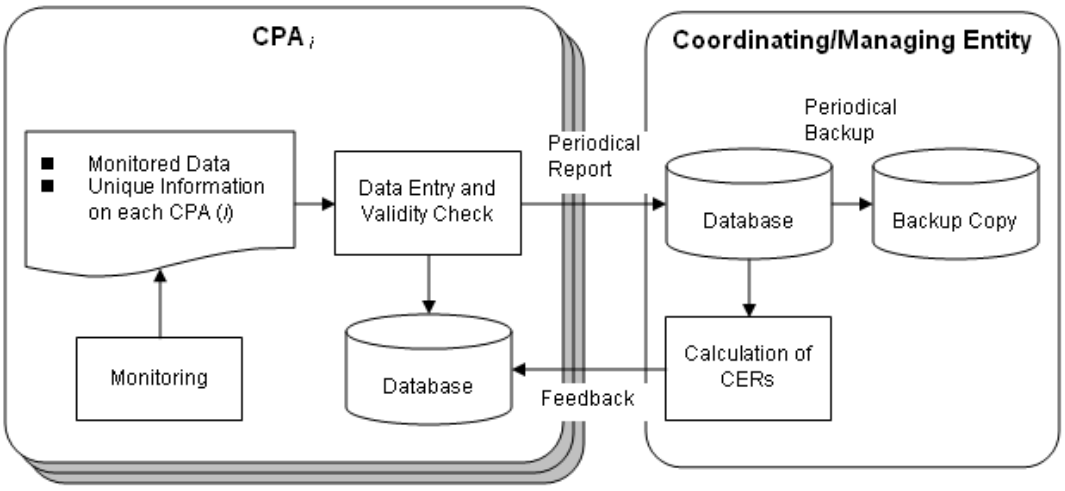


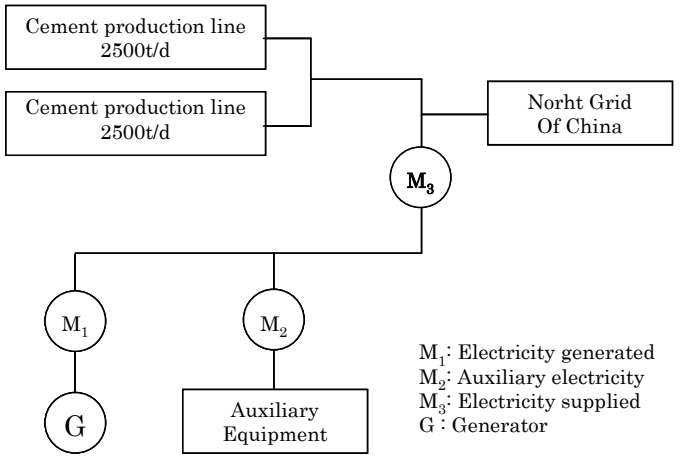
Figure 1 Data collection and record keeping procedure

<Monitoring plan for a CPA (Shanxi Jigang Cement)>

The monitoring plan will be responsibly implemented by the project owner; it will ensure the emission reductions of the project during crediting period.

Table 2 Monitoring plan

(i) Monitoring organization	・The project owner will set up a special CDM group to be in charge of data recordation, collection, supervision and verification. The group director will be trained and supported of technical issues by CDM consultation.
(ii) Data to be Monitored	・For baseline emission factor, emission factor of North China Power Grid for 2009 (released by National Development and Reform Commission) is used. ・Waste heat volume in cement production line is measured in accordance with China's national standards. ・Electricity supplied from electricity plant is measured by monitoring.

(iii) Monitoring equipment and installation	・The electricity meter should be collocated according to the "Technique Management Regulation of Power Measure Equipment" (DL/T448-2000). Before the operation of the proposed project, the project owner and power grid company should check the electricity meter according to "Technique Management Regulation of Power Measure Equipment" (DL/T448-2000). ・Three electricity ammeters shall be installed for the project. The first electricity ammeter (M1) shall be installed to measure electricity generated from the unit; the second electricity ammeter (M2) shall be installed to measure electricity used by the power station; the third electricity ammeter (M3) shall be installed to measure the net electricity supplied to cement production line. So, for the proposed project, the electricity supplied should depend on M3, while data from M1 and M2 shall be used for cross-check. 
(iv) Data collection	・The project owner should read and record the data from M3 on the daily basis in the forms of paper and electronic devices
(v) QC	・The electricity ammeter inspection and on-the-spot check should be implemented according to standard and regulations of Shanxi's electric power industry. After inspection and on-the-spot check, electricity ammeters must be sealed. The project owner and power grid company should inspect and also seal the electricity ammeter, no one can remove seal or modify the electricity ammeter when one party (or its representative) is absent.
(iv) Data management	・Monitoring data which is taken by CDM group should be kept periodically in the paper and electronic devices by oneself. These data are provided periodically to Shanxi Building Material Industry Administration Office, which is coordinating entity, and they make monitoring report periodically based on these data. They also keep backup data of monitoring data provided by all CPA. All of the data shall be saved after 2 years of crediting period.

(4) GHG emission reductions (or sink)

Table 3 GHG emission reductions

Year	Baseline emissions (t-CO2/yr)	Project emissions (t-CO2/yr)	Leakage (t-CO2/yr)	Emission reductions (t-CO2/yr)
2011	37,143[6]	0	0	37,143
2012	43,697	0	0	43,697
…	…	…	…	…
2020	43,697	0	0	43,697
Total	430,418	0	0	430,418

(5) Duration of project activity/crediting period

<PoA>

Period of the PoA: 01/01/2011 – 31/12/2038 (28 years)

In line with the guidance provided in EB 41, this start date has been chosen as the date assuming this PoA is registered by the CDM Executive Board. It is only after registration that implementation of CPAs is considered as the "real action" as defined by the EB's guidance. Hence the date of registration is appropriate to be considered as the start date for the PoA.

<CPA (Shanxi Jigang Cement)>

Period of PoA implementation: 01/01/2011 – 31/12/2031 (21 years)

Crediting period: 1/1/2011～31/12/2020 (10 years), or for 10 years starting from the registration date, whichever is later.

Crediting period is assumed as a fixed ten-year period with no renewal, taking into consideration future development in waste heat recovery and electricity supply/demand balance. The start of actual crediting period is set with flexibility (set to start in the beginning of 2011, for the time being), allowing it to adjust development in project plan and progress in validation process. Moreover, the date of the project start is assumed for the beginning of 2011 for the time being, although it can be affected by dates of formal decision of project implementation as a CDM and publication of such decision, and contract date for main facilities to be used in the project.

(6) Environmental impacts and other indirect impacts

EIA (environmental impact assessment) required for introduction of facilities for waste heat recovery and utilization is as follows:

- PoA level (cement industry in Shanxi Province): no additional analysis is required for existing cement plants as a whole, as an EIA Report has been prepared prior to the launch of its construction and operation.

[6] Assuming 85% of operation capacity in the first operational year based on the FSR.

・ CPA level (introduction of each facility for waste heat recovery and utilization): in line with the classification by the Government of China, it is deemed not as “Type 1” (requiring EIA report) but as a modest “Type 2” under which each CPA needs to prepare an“EI Table.”

The results of environmental effect analysis in the FSR by Shanxi Jigang Cement are as shown in the following paragraphs.

■Standards adopted

The national standards adopted in the FSR are as follows:

・"Environmental Quality Standard for Air" (GB3095-1996)
・"Emission Standard of Air Pollutants for Cement Industry" (GB4915-2004)
・"Emission Standard of Air Pollutants for Coal-burning Oil-burning Gas-fired Boiler" (GB13271-2001)
・"Standard for Noise of Industrial Enterprises" (GB12348-1990)
・"Standard of Environmental Noise in the Urban Area" (GB3096-1993)
・"Integrated Wastewater Discharge Standards" (GB8978-1996)
・"Environmental Quality Standards for Surface Water" (GB3838-2002)

■Pollutants sources and Environmental protection measures

<Air pollution>

Waste gas from cement production line includes pollutants such as dusts, NO2 and SO2 and is one of the reasons to cause air pollution. According to the Standard in China, “Emission Standard of Waste Pollutants in GB13223-200x”, emission standards of dusts, NO2 and SO2 for thermal power plants constructed on or after January 1st, 2010, in Shanxi Province, are as shown below.

Table 4 “Emission standard of waste pollutants in the new GB” [mg/m3]

Air pollutant	Emission standard
Dust	30
NO2	200
SO2	400

<Water pollution>

In this PoA, waste water discharged from each CPA site includes mainly facility cooling water with some domestic waste water. The pollution standard for such waste water is as shown in the table below. For the standard, “Integrated Wastewater Discharge Standards” (GB8978-1996) is applied.

Table 5 1st class standard of “Integrated Wastewater Discharge Standards” (GB8978-1996)

Evaluation item	Scope	1st class standard
PH	All emission pollutants	6～9
Degree of colour (dilution rate)	All emission pollutants	50
Petroleum	All emission pollutants	5.0 mg/l

SS	Other emissions pollutants	70 mg/l
BOD_5	Other emissions pollutants	20 mg/l
COD_{cr}	Other emissions pollutants	100 mg/l

In each CPA, domestic water is well recycled and only a small volume of wastewater is discharged. For reference, wastewater is discharged at different timings: after receiving treatment approval for facility cooling water, and after satisfying standards of biochemical treatment for domestic wastewater.

<Noise >

Noise standard for this PoA is as shown below. For handling noise in this project activity, the Category III standard of "Standard for Noise of Industrial Enterprises" (GB12348-1990) is applied.

Table 6 Category III standard of "Standard for Noise of Industrial Enterprises" (GB12348-1990)

Category	Scope	dB – Daytime (A)	dB – Nighttime (A)
Ⅲ	Industrial areas	65	55

<Greening>

Greening has positive effects in such as preventing pollution, controlling temperature/humidity, improving climate and mitigating noise pollution. In this PoA, greening will be implemented in plants and its neighbourhood at construction stage at each CPA site.

<Environmental management>

After launching each CPA, environmental managers in plants will grasp facilities for environmental protection and occupational safety management. Some personnel to be in charge with environment protection (concurrent) will be placed in production sites to work with the environmental managers.

(7) Stakeholders' comments

In the host country, provincial governments (or municipal/county government, depending on its size) hold the authority to oversee project activities. Provincial Development and Reform Commission administers CDM projects while environmental department in local government controls environmental impacts: the structure is exactly the same as China's central government.

All comments we received were for promotion of this project as a CDM. No request for correction or review was received from government officials.

Seminar on the environment (April 23rd, 2009)

- A lot of cement business operators gave comments that they expect waste heat recovery for power generation to be registered as a CDM in order to promote projects which are under tough situation to proceed.
- Shanxi Building Material Industry Administration Office gave comment that they will work together toward CDM registration and work as coordinating/managing entity under the PoA.

View-exchange meeting in Lvliang City (December 17th, 2009)

- Several CDM projects are at development stage in Lvliang City: no project has been registered by the CDM EB.
- Under the initiative of National Development and Reform Committee, CDM Exchange Centre has recently been established in Beijing. No actual trading has been made. Lvliang City is expected to develop the CDM projects.
- Environment Protection Department of Lvliang City supports this PoA and is willing to provide information as necessary.

View-exchange meeting with NDRC (January 27th, 2010)

- Chinese government promotes the energy-efficiency projects. The waste heat recovery for power generation considered in this PoA is coincident with this concept.
- There are no PoA within China so far, therefore the government expects that this PoA will be the first of its kind.

View-exchange meeting with DRC in Shanxi Province (January 29th, 2010)

- The government of Shanxi Province promotes positively the energy-efficiency within the province, and considers the waste heat recovery for power generation is one of its project types. The government supports this project that promotes the waste heat recovery for power generation within Shanxi province by using the PoA scheme. (Mr. Yu Fabin, Vice President, Development and Reform Commission of Shanxi Province,)
- The government promotes positively the waste heat recovery for power generation and also supports CDM based on national policy. (Mr. Xin huaiyu, Section chief, Development and Reform Commission of Lvliang City)
- The government supports this waste heat recovery for power generation project that should be promoted by using CDM scheme. Relevant authorities such as Environment Protection Department and Development and Reform Commission participate in this meeting, so we expect this meeting creates a momentum to proceed this project as well. (Mayor Shun Shanwen, Vice-mayor Zhang Xiaowen and Vice-mayor Li Zhongyi, the government of Jiaocheng County)
- The government supports and cooperates aggressively. (Mr. Zhang Zhichun, Director, Development and Reform Commission of Jiaocheng County)

(8) Project implementation system

The responsibilities of coordinating/managing entity and CPA are shown below.

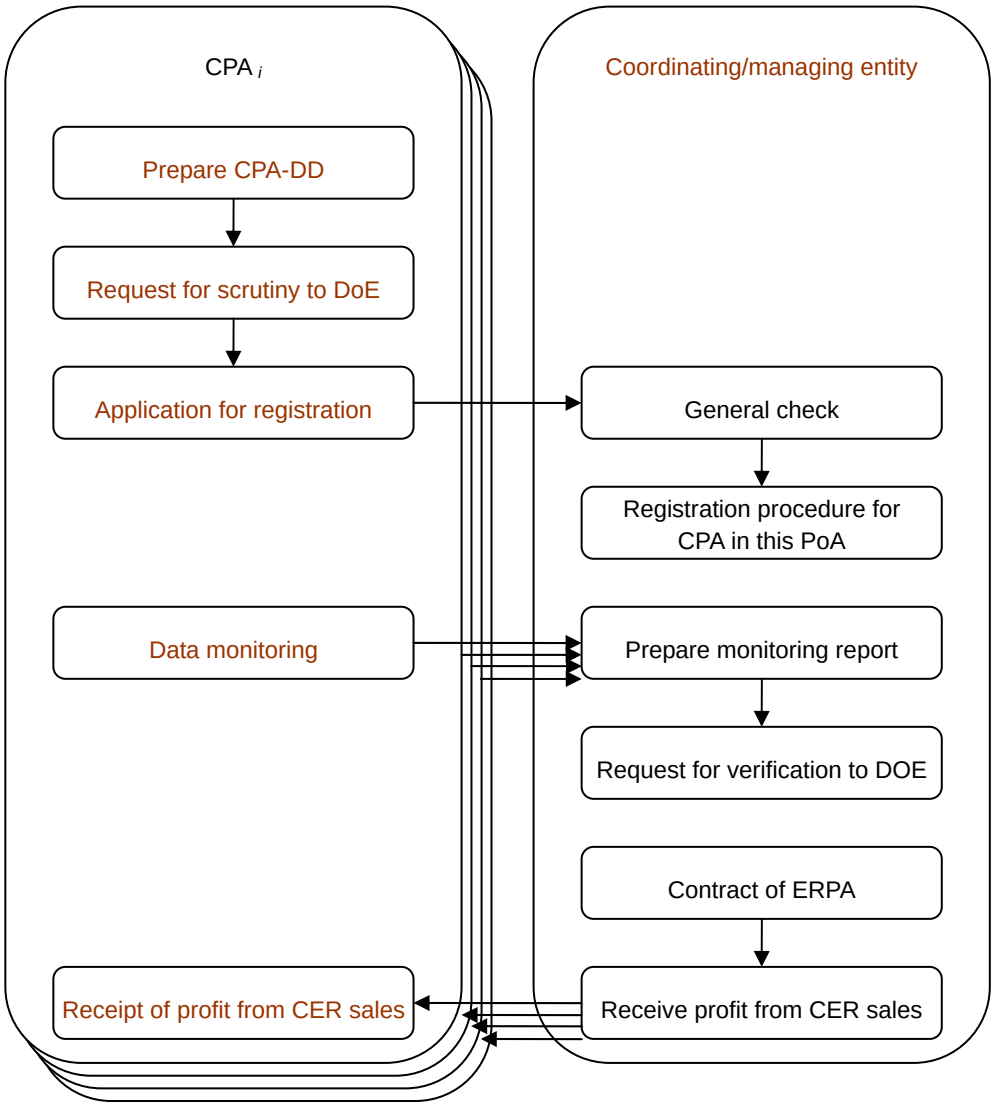


Figure 2 Responsibilities in PoA and CPA

(9) Investment Plan

The total amount necessary for this project is approx. 67.85 million yuan which is to be covered with own fund.

(10) Economic analysis

The financial data for this PoA is as follows:

Table 7 Financial indicators

Installed capacity	9 MW
Net electricity supply	48,903 MWh
Lifetime of the Project	21 years
Total investment	67.85 million Yuan
Annual O&M cost	5.25 million Yuan
Expected tariff	RMB 0.237 Yuan/KWh (excluding VAT) - If the power generated from waste heat recovery in cement sector is captive-consumed in Shanxi Province, the company sells the power to the power grid once and purchases the stable power from the power grid for stabilizing power system. - The price of being sold to power grid is 0.237 yuan/kWh, and the price of being purchased from Power Grid is 0.41 yuan/kWh (excluding VAT). - It is due to the state of excess-supply of power generation in Shanxi Province. If the generated power is captive-consumed, it may cause further demand deficiency. So the power grid does not accept the captive consumption of power generation.
Income tax rate	25%
Tax rate of city construction	7%
Tax rate of education	3%
Crediting period	10 years
Expected price of CERs	8.5 Euro/tCO2e (exchange rate of Euro and RMB is 1:10)

As a result of calculation under the above-mentioned condition, the project IRR is 6.50% in the case of without profit from CER while 11.40% with profit from CER.

Table 8 (repetition) IRR

	Without profit from CER	With profit from CER
IRR	6.50%	11.44%

(11) Demonstration of additionality

Additionality is demonstrated and assessed by using the "Tool for the Demonstration and Assessment of Addititonality".

Investment analysis of Shanxi Jigang Cement is demonstrated and common practice analysis of Shanxi Province, which is the project boundary, is shown in this section.

Step 2: Investment analysis

Sub-step 2a: Determine appropriate analysis method

For investment analysis, "benchmark analysis (Option III)" of the additionality tool is applied.

Sub-step 2b: Option Ⅲ. Apply benchmark analysis

The PoA, a CDM category this project follows, assumes to adopt benchmark indicators that are utilized within a company in principle. In the case of this project, Shanxi Jigang Cement does not have a benchmark indicator based on the IRR but has the one based on years of investment recovery only. Therefore, in this investment analysis, the benchmark of 11% for project IRR in cement industry, published by the Government of China, is applied.

Sub-step 2c: Calculation and comparison of financial indicators (only applicable to option 2 and 3)

Table 9 (repetition) IRR

	Without profit from CER	With profit from CER
IRR	6.50%	11.44%

Sub-step 2d: Sensitivity analysis (only applicable to option 2 and 3)

In this Project, the financial indicators shown below are used as uncertainty.

- Initial investment
- Annual operational & management cost
- Electricity price

In case that total investment, annual &M cost, tariff of the project varies from -10% to +10%, IRRs are analyzed in below table.

Table 10 Sensitivity analysis of IRR

Financial Indicators	-10%	-5%	0%	5%	10%
Initial investment	7.82%	7.13%	6.50%	5.92%	5.38%
Annual O&M cost	7.48%	6.99%	6.50%	5.98%	5.46%
Electricity price	4.16%	5.36%	6.50%	7.60%	8.66%

Step 4: Common practice analysis

Sub-step 4a: Analyze other activities similar to the proposed project activity

Common option for electric power supply for cement production facilities in Shanxi Province is from the public electricity grid (the North China Power Grid). Activities similar to the project activity are considered to be any project at a cement production facility that utilizes waste heat from either the pre-heater stage or clinker cooling stage for generation of electric power.

The Chinese power grid is divided into a few large regional power grids, and therefore conditions of power plant to connect a relevant grid are different. China's DNA reviews CO2 emission factors by grid on a regular basis and releases them in both forms of operation margin and build margin, allowing operators for preparing CDM PDD. All cement plants in Shanxi Province purchase their electricity from North China Power Grid, a major grid in the country, which means that all cement plants in the province shares the same characteristics such as emission factor.

So far, several cement plants in Shanxi Province implement electricity generation using waste heat recovered in the plants, as with each CPA assumed in this PoA, which could be a similar activity to each CPA proposed under this PoA. Among them, a CPA site or a CDM site is not included in any other PoA than this PoA.

Sub-step 4b: Discuss any similar option that are occurring

As shown in Sub-step 4a, activities similar to the CPA under this PoA exist. However, no general practice exists to implement same kind of project and, as mentioned above, there are no laws and regulations to promote implementation of this PoA[7].

With regard to existing projects similar to this project activity, investment has been determined based on various conditions that are different from current ones. Therefore, whether to implement similar project will be determined by each CPA based on Step 2 (investment analysis). Conditions for investment analysis change at any time. Today, the conditions that North China Power Grid offers to cement plants for electricity sales & purchase agreement are rather stricter than they used to be to cement plants, making them difficult in comparison with the existing similar activities.

With regard to sales & purchase agreement with the grid, which could give considerable impacts on investment analysis, it should be noted that conditions and unit prices are determined after negotiations on contracts between the public electricity grid (the North China Power Grid) and cement companies, using the information by National Development and Reform Commission. Therefore, general practice analysis should be implemented within Shanxi Province as the boundary, not in supplying area of a single grid.

(12) Probability of commercialization

Shanxi Jigang Cement, CPA model site, considers positively the commercialization of this project in the case that the PoA is promising, taking into consideration the result of this feasibility study.

However, due to the current state of excess-supply of power generation in Shanxi Province, North China

[7] Based on comments Shanxi Building Material Industry Administration Office

Power Grid does not want to purchase the power generated from waste heat recovery and actually they are often back away from proceeding negotiations to complete a contract with those companies. Completion of such sales/purchase contract at an early stage is a need to make progress of this project on a commercial basis.

Meanwhile, there is a skepticism that the CDM EB may consider the waste heat recovery for power generation in cement sector as the Baseline in China in terms of IRR. Small-scale project (below 2,500t/d, for example) typically has not good IRR, so it may be necessary to select small scale at first as an option to formulate the project.

4. Realization of co-benefit in host country

(1) Assessment of pollution prevention effect in host country

When we suppose Tier 2 or Tier3 method in the evaluation of air quality improvement, we need the data of fuel consumption and air pollutant density in the fuel in the baseline and project scenarios, according to "Co-benefit Quantitative Evaluation Manual".

In fact, we evaluate the air pollution reduction in the following equations.

<Baseline emissions>

$BE_i = PELE \times EU_i$

Where:

BE_i: Baseline emissions of air pollutant i [t-emission volume/yr]

PELE: Project power generation [GWh/yr]

EU_i: Emission factor of air pollutant i [t-emission volume/GWh]

<Project emissions>

$PE_i = 0$

Where:

PE_i: Project emissions of air pollutant i [t-emission volume/yr]

<Emission reductions>

$RE_i = BE_i - PE_i$

Where:

RE_i: Project emissions of air pollutant i [t-emission volume/yr]

We need some data from North China Power Grid, which emits some air pollutants, in the case of reducing air pollutants indirectly as planned in this PoA. While, according to the meeting with Lvliang City Power Supply Corporation of State Grid Corporation of China, they do not have any such data. In this co-benefit evaluation, we estimate the emission factor of SO2, NOx, and dust at first, as with the case of evaluating CO2 emission reduction, and then evaluate these pollutants reductions by using power generation from waste heat recovery.

Table 11 Emission factor of air pollutants from coal-fired power plant [t/GWh]

	1996	2000	2002	2005	2007
SO2	10.4	8.15	6.11	8.03	**4.67**
NOx	5.77	4.21	3.87	6.90	**3.11**
Dust	8.21	2.84	2.01	3.35	**1.10**

Table 12 Emission factor of air pollutants [t/GWh]

	OM	BM	CM
SO2	4.67 t/GWh	200 mg/m3 ⇒ 0.25 t/GWh	2.46 t/GWh
NOx	3.11 t/GWh	400 mg/m3	1.81 t/GWh

	OM	BM	CM
		⇒ 0.50 t/GWh	
Dust	1.10 t/GWh	30 mg/m3 ⇒ 0.04 t/GWh	0.57 t/GWh

Emission reductions of air pollutants are able to be evaluated by multiplying the power generation from waste heat recovery in Shanxi Jigang by above emission factors.

(2) Suggestion for co-benefit indicator

Mitigation of environmental burden is a pollution prevention effect by itself. In addition, by doing so, external environmental cost can be reduced, which can be a co-benefit indicator. In this section, mitigation of damage is estimated in monetary value to express willingness-to-pay (WTP) for avoiding environmental burden, by using the Life-cycle Impact assessment Method based on Endpoint modeling (LIME: publicized in cooperation of Japan's Advanced Industrial Science and Technology (AIST) and the national LCA project).

The monetary conversion integrated factor of LIME is used as monetary conversion factor. These conversion factors means the price to be willingly paid, whicn is an indicator to express values of reducing unit weight (1kg) of pollutant emissions for the residents who are exposed to such pollutants.

Table 13 The monetary conversion integrated factor of LIME

Pollutant	Conversion factor (yen/kg)
CO2	1.74
NOx	141.22
SO2	1,014.73

As a co-benefit indicator of this project, external environmental costs from reducing air pollutants (SO2, NO2) are evaluated at 122 million yen/yr for SO2, 13 million yen/yr for NOx, and 76 million yen/yr for CO2. With environmental costs from reducing SO2 and NOx, the total cost becomes three times of external cost of CO2 only. The effect of reducing SO2 is large especially in Shanxi Province where coal is consumed heavily.

These costs mean the extent of willingness to reduce the pollutants considered by the residents exposed to them. Therefore, it can be interpreted that reducing SO2 and CO2 also reduces the residents' struggles or fulfill their sense of environmental safety.

However, the conversion factors used as above are assumed for those who live in the Japanese community. It should be noted that the host country of this project is China where monetary value of residents who receives benefits from emission reductions would not be the same as the one we presented in this study.

Table 14 Environmental external cost in this project

Pollutant	Power generation with waste heat recovery (GWh/yr)	Emission factor (t/GWh)	Air pollutant emission reduction (t/yr)	Conversion factor (yen/kg)	Environmental external cost (mil. yen/yr)
SO2	48.903	2.46	120.30	1,014.73	122.07
NOx		1.81	88.51	141.22	12.50
Dust		0.57	27.87	-	-
CO2		893.55	43,697.28	1.74	76.03
Total					210.61