Summary of CDM/ JI Feasibility Study Report FY2008

Title of Feasibility Study

CDM Feasibility Study for Waste Electricity Utilization at a Locomotive Plant in China

Implementing Entity

Mitsubishi Research Institute, Inc.

1. Overview of the Project

(1) Location of Project Activity

China

(2) Description of Project Activity

This project aims to make effective use of enormous amount of electricity which is generated for testing newly manufactured or repaired diesel generation units (the electricity is lost by water rheostat) by changing the system in a railway locomotive manufacturing facility in China (Factory A).

In Factory A, locomotives take performance tests before diesel generating unit are installed. At the moment, the electricity at the test stand is lost by friction. Its frequency and output power would be stabilized and this electricity would be retrieved to be utilized in the factories by developing and installing a new inverter (commercially available inverter lacks stability). It would result in saving the electricity imported from the network to consume in the factories, and in reducing CO_2 emission. There are 4 test stands and they are in operation on steady basis.

It is estimated that the amount of electricity retrieved by this project will be 2,700MWh. It will save approximately 16% of the electricity because the total energy consumption in the factories in 2007 is 16,155MWh. Also, we will save energy by supplying steam produced by retrieved waste gas to steam line in the factory, and at the same time, will improve the production line to clean the parts by using waste heat, substituting steam supplied by boilers.

Now, the installation of the system is planned by March. 2010, and the full activation by April. 2010.

2. Contents of the Research

(1) Research Task

Task 1 Application Methodology

ACM0012 (Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects) can be the applicable methodology to make effective use of energy which is to be lost without the project. However, it is for utilizing waste gas, waste heat and waste pressure and the utilization of “waste electricity” is not assumed (revision is required). AMS-III.Q. (Waste Energy Recovery (gas/heat/pressure) Projects), which is for waste energy but for the small project, can be also an option, if the applicability is revised. We set the primary task in this research to apply the revision of ACM0012 or AMS-III.Q. to the CDM council and to consider the expansion of the coverage of waste energy. It should be theoretically no problem to make a request of revision and to include the waster energy in the coverage because it is based on the same idea of utilization of waste energy. In addition, it is also able to use AMS-II.I. (Efficient utilization of waste energy in industrial facilities) as an approved small project methodology.

We will examine the time necessary for the revision of ACM0012 or AMS-III.Q., the applicability of the small project methodology AMS-II.I., the time before approval and the degree of likelihood of registration, and then will consider which methodology to employ.

Task 2 Work scheme with ESCO

It is decided that Energy Service Companies (ESCO) will be the scheme to develop and install the system, and they aim to build "WIN-WIN" relationship between the system developer and installer (ESCO) and the factories.

Task 3 Availability of Waste Gas (Task newly occurred during the research)

At first, it was only aimed to save energy only with regenerative electric power. However, during the field research, there was a request to consider the utilization of other waste energy such as waste gas in addition to waste electricity. So, we decided to consider and examine the amount of reduction, the methodology, the complexity etc.

(2) Research Implementation Structure

Factory A [Counterpart]

- Input of Basic Information

Company B [Cooperative counterpart]

- Input of Basic Information

Company C [Local research consultant]

- Input of Data for establish PDD
- Input of Technical Data
- Input of Data related to Assessment of Business Potency
- Arranging and Attending for Local Research

(3) Content of Research

Firstly, we collected the basic information (Information of the counterpart, technical information, data for estimation of the amount of reduction, data for evaluating profitability) to establish PDD through Company C.

Task 1 Result of Consideration of Applicable Methodology

We considered the three options; (1) the revision of ACM0012, (2) the revision of small scale methodology AMS-III.Q. and (3) the use of small scale methodology AMS.II.I, as applicable methodology.

Option 1: Revision of ACM0012

ACM0012 (Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects) is a methodology for utilizing waste gas, waste heat and waste pressure and the utilization of “waste electricity” is not assumed. It should be theoretically no problem to make a request of revision and to include the waster energy in the coverage because it is based on the same idea of utilization of waste energy.

Option 2: Revision of AMS-III.Q.

Similarly with ACN0012, AMS-III.Q. (Waste Energy Recovery (gas/heat/pressure) Projects) is a methodology for utilizing waste gas, waste heat and waste pressure and the utilization of “waste electricity” is not assumed. The procedure for the small scale CDM is easier than other CDM, so this methodology needs less time and work to establish PDD. It fills the condition; the small scale methodology of Type III is targeted for less than 6Mt-CO_2e of emission reduction.

Option 3: Application of the approved small scale methodology AMS-II.I.

If AMS-II.I. (Efficient utilization of waste energy in industrial facilities) is applicable, it can be applied without any revision, that will result in saving much time. The scope of Type II of the small scale methodology (Energy saving project) is the project whose amount of emission reduction is less than 60GWh per year on either side of the energy supply or demand. Considering the content of the methodology, on one hand, it is reasonable to understand that this methodology does not exclude waste electricity, but covers it, however, on the other hand, it is possible that it did not assume the utilization of waste electricity when it was create created. So, it is necessary to check with DOE (Designated Operational Entity).

We asked DOE for comments on these options. They answered that Option 3: Application of AMS-II.I. was feasible. So, we tried to apply Option 3 first. However, we thought if the amount of energy per vehicle is appropriate though actually the estimation of the amount of energy per production unit is expected. Even if it is acceptable, it is fount out to be difficult to precisely calculate the amount of energy per production unit including the vehicle’s parts. Thus, we made a suggestion of revising AMS-III.Q. to include wasted electricity to the Small-Scale Working Group. It is going to be discussed in the 20th meeting during 29.April to 2.May in 2009.

Task 2 Result of Consideration of Work scheme with ESCO

About the work scheme with ESCO, a Japanese company (bank), a Chinese company (bank) and a Chinese private investor agreed on developing and installing the system, as well as the investment ratio, which almost established the system. The amount of the initial investment is ¥ 75.94 million, which is enough to start ESCO business, including the initial investment and the maintenance fee (¥ 3.8 million). We then will move on to taking concrete steps such as founding an ESCO company. In addition, ESCO company will work on the utilization of waste hear as well because the local research found out that there is a possibility to utilize waste heat, rather than waste electricity in the factories.

Task 3 Result of Consideration of the Availability of Waste Gas

We considered retrieving waste electricity, waste heat and waste gas by recognizing the energy center as the test stand. It is estimated that the amount of reduction is equivalent with or more than the amount of retrieval of waste electricity. It is possible to make it CDM with the same methodology with the one retrieving waste electricity (AMS-III.Q.). It is more complex to collecting data comparing with retrieving and utilizing waste electricity, but it is thought to be feasible to collect data because of the high expectation from the factories. Besides, the plan of retrieving waste heat and waste gas was suggested when conducting the local research; we consider that it is highly feasible. Therefore, we include retrieving waste heat and waste gas into consideration. There are four testing facilities for diesel power generation units in this plant, and the ESCO project will be introduced to one of them in the immediate future. The annual emissions reduction would be 19,456 tons (the project starts in April 2010, with a total emissions reduction of 53,500 tons between 2010 and 2012). When considering the operating rate of these testing facilities, two more testing facilities could be introduced in the future (in such a case, total emissions reduction would rise to 107,000 tons over the same time period). In China, there are a further four manufacturing plants similar to this plant, and if we can apply the same methodology to those plants as well, the total emissions reduction from 2010 to 2012 would amount to 428,000 tons (need to bear in mind the balance of electricity and heat generated within each plant).

3. Operating the Project

The possibility of applying Clean Development Mechanizm to the project will be examined in this section, according to the amended project proposal of "Waste Energy Recovery (gas/ heat/ electricity/ pressure) Projects", which would add the aspect of waste electricity into AMS-III.Q. waste energy project.

(1) Boundary and Baseline

Applicability

The applicabilities of AMS-III.Q. are as follows. The project can meet all the aspects below.

The methodology is for project activities that utilize waste gas and/ or waste heat and/ or waste electricity at existing facilities as an energy source for:

(a) Generation of electricity; or
(b) Direct use as process heat; or
(c) Direct use as process electricity; or
(d) For generation of heat in elemental process (e.g. steam, hot water, hot oil, hot air).

- The recovery of waste gas/ heat/ electricity may be a new initiative or an incremental gain in an existing practice.
- In cases where the project activity is an incremental gain, the difference between the technology used before project activity implementation and the project technology should be clearly shown. It should be demonstrated why there are barriers for the project activity that did not prevent the implementation of the technology used before the project activity implementation.
- Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually. Where ever the measures lead to waste heat recovery which is incremental to an existing practice of waste heat recovery, only the incremental gains in GHG

mitigation should be taken into account and such incremental gains shall result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

- The category is applicable under the following conditions:
    - (a) The energy produced with the recovered waste gas/ heat/ electricity should be measurable.
    - (b) Energy generated in the project activity shall be used within the facility where the waste gas/ heat/ electricity is produced. An exception is made for the electricity generated by the project activity which may be exported to the grid.
    - (c) The waste gas/ heat/ electricity utilized in the project activity would have been flared or released into the atmosphere/ water in the absence of the project activity. This shall be proven by one of the following options:
- For the purpose of this category waste energy is defined as: a by-product gas/ heat/ electricity from machines and industrial processes having potential to provide usable energy, for which it can be demonstrated that it was wasted. For example gas flared or released into the atmosphere, the heat/ electricity not recovered (therefore wasted). Gases that have intrinsic value in a spot market as energy carrier or chemical (e.g. natural gas, hydrogen, liquefied petroleum gas, or their substitutes) are not eligible under this category.

Project Boundary

The physical, geographical site of the facility where the waste gas/ heat/ electricity is produced and transformed into useful energy, i.e. the locomotive plant delineates the project boundary.

Baseline Scenario

The most reasonable baseline scenario for the project activities will be evaluated by examining alternative scenarios, using steps one to three of the latest version of “Combined tool to identify the baseline scenario and demonstrate additionality”. If the baseline scenario identified by this tool is the same as the one used by the methodology proposed, and also it is possible to demonstrate that it is not common practice in this area to implement project activities “without registering CDM”, then the methodology is applicable.

The alternative scenarios are as follows:

- Continuation of the current practice – the locomotive plant continues to be operated without recovering waste gas/ heat/ electricity;
- All or part of the project activity is implemented without CDM (e.g. implemented by ESCO on its own) ;
- Energy-saving equipment with a higher efficiency than the one introduced by the project activity is installed;

In CDM, it is necessary to demonstrate that this project won’t be implemented by the commercial sector unless credit income for the project is taken in account. In this case, it should be proven that the IRR is less than the regular business standard.

It is unlikely for ESCO to implement the project on their own due to this lower IRR and also due to their lack of knowledge and experience in energy saving technologies, although it has been 12 years since

they first set up their test facilities, and as a result there is only a slight chance that energy saving facilities with higher efficiency ratings than the proposed project will be introduced. Hence, the baseline scenario without the project should most likely be the continuation of the existing system.
In addition, there is no similar project like this undertaken before in China and so this would set a precedent in experimentation work for utilizing waste electricity/ heat from a testing process in an vehicle manufacturing plant.

Baseline emissions
In the situation where the electricity is obtained from the grid and heat from a fossil fuel based element process (e.g. steam boiler, hot water generator, hot air generator, hot oil generator), baseline emissions can be calculated as follows:

(a) Waste electricity
Waste electricity will replace the electricity from the existing grid. Baseline emissions ($BE_{elec,y}$) will be calculated as follows:

$$BE_{elec,y} = f_{cap} * f_{wcm} * \sum_{j}\sum_{i}(EG_{i,j,y} * EF_{Elec,i,j,y})$$

Where:

$BE_{elec,y}$	=	Baseline emissions due to the electricity replaced by waste electricity during the year y in tons of CO_2
$EG_{i,j,y}$	=	The quantity of electricity supplied by grid (i=gr) in the absence of the project activity during the year y in MWh
$EF_{Elec,i,j,y}$	=	The CO_2 emission factor for the electricity source i (i=gr (grid)) in tons CO_2/ MWh
f_{wcm}	=	1 (All $EG_{i,j,y}$will be generated by the waste electricity)
f_{cap}	=	1 (Assuming the amount of waste electricity production remains the same as before implementation of the project)

(b) Waste gas/ heat
Waste gas/ heat will replace the heat supplied by existing steam from boiler in plant. Baseline emissions ($BE_{heat,y}$) will be calculated as follows:

$$BE_{heat,y} = f_{cap} * f_{wcm} * \sum_{j}\sum_{i}(HG_{i,j,y} * EF_{Heat,i,j,y})$$

Where:

$BE_{heat,y}$	=	Baseline emissions due to waste steam (heat) replaced by waste gas/ heat during the year y in tons of CO_2
$HG_{i,j,y}$	=	The quantity of heat supplied by boilers (i=$Boiler$) in the absence of the project activity during the year y in TJ
$EF_{Heat,i,j,y}$	=	The CO_2 emission factor for the heat source i (i=$Boiler$) in tons CO_2/ TJ
f_{wcm}	=	1 (All $HG_{i,j,y}$ will be generated by waste gas/ heat)

f_{cap} = 1 (assuming the amount of waste gas/ heat productions stays the same as before implementation of the project.)

Since the baseline generation source is the identified existing boilers, the CO_2 emission factor shall be determined as follows:

$$EF_{Heat,i,j,y} = \frac{EF_{CO2,i,j}}{\eta_{Boiler,j}}$$

Where:

$EF_{CO2,i,j}$ = The CO_2 emission factor per unit of energy of the fossil fuel used in the heat source *i* (*i=Boiler*) in (tCO_2/ TJ)

$\eta_{Boiler,j}$ = The efficiency of the boilers that would be used in the absence of the project activity

Project emissions

There would be no emissions from this project.

Emissions reductions

The parameters used in the calculations for emission reductions are as follows:

	Waste Electricity	
$EG_{i,j,y}$	2,700	MWh
$EF_{Elec,i,j,y}$	0.9928	tCO_2/ MWh
$\boldsymbol{BE_{elec,y}}$	**2,681**	**tCO_2/ year**
$\boldsymbol{PE_{elec,y}}$	**0**	**tCO_2/ year**

	Waste Gas	**Waste Heat**	
Steam	1,670	16,460	Ton
$HG_{i,j,y}$	12	114	TJ
$EF_{CO2,i,j}$	106.5		tCO_2/ TJ
$\eta_{Boiler,j}$	80		%
$EF_{Heat,i,j,y}$	133.1		tCO_2/ TJ
$\boldsymbol{BE_{heat,y}}$	**1,545**	**15,231**	**tCO_2/ year**
$\boldsymbol{PE_{heat,y}}$	**0**	**0**	**tCO_2/ year**

(2) Monitoring Plan

For baseline emissions determination, monitoring shall consist of:

- Metering the thermal and/ or electrical energy produced. In case of thermal energy the enthalpy of the thermal energy output stream like hot water/ steam should be monitored.
- Metering the amount of waste gas/ electricity or the amount of energy contained in the waste heat.

(3) GHG emissions reductions

Recovery and Utilization of	Year 2010	Year 2011	Year 2012	Total
Waste electricity	2,010 t	2,681 t	2,681 t	7,372 t
Waste gas	1,159 t	1,545 t	1,545 t	4,249 t
Waste heat	11,423 t	15,231 t	15,231 t	41,884 t
Total	14,592 t	19,456 t	19,456 t	**53,505 t**

(4) Duration of Project Activity/ Crediting Period

Duration of Project Activity

The project period is based on the system's working life time.

The project starting date is the day when the contract of the facility is signed. At the moment, it is the contract is expected to be signed by June.2009, and the project period is 20 years after the installation. Therefore, the project period is from June.2009 to December.2030.

Crediting Period

We set credit acquisition period as 10 years. It is expected that the system will be installed by March.2010, so the full activation will start in April.2010. Therefore, the credit acquisition period is from 1.April.2010 to 31.March.2020. The working life time of the facility is much longer than the credit acquisition period.

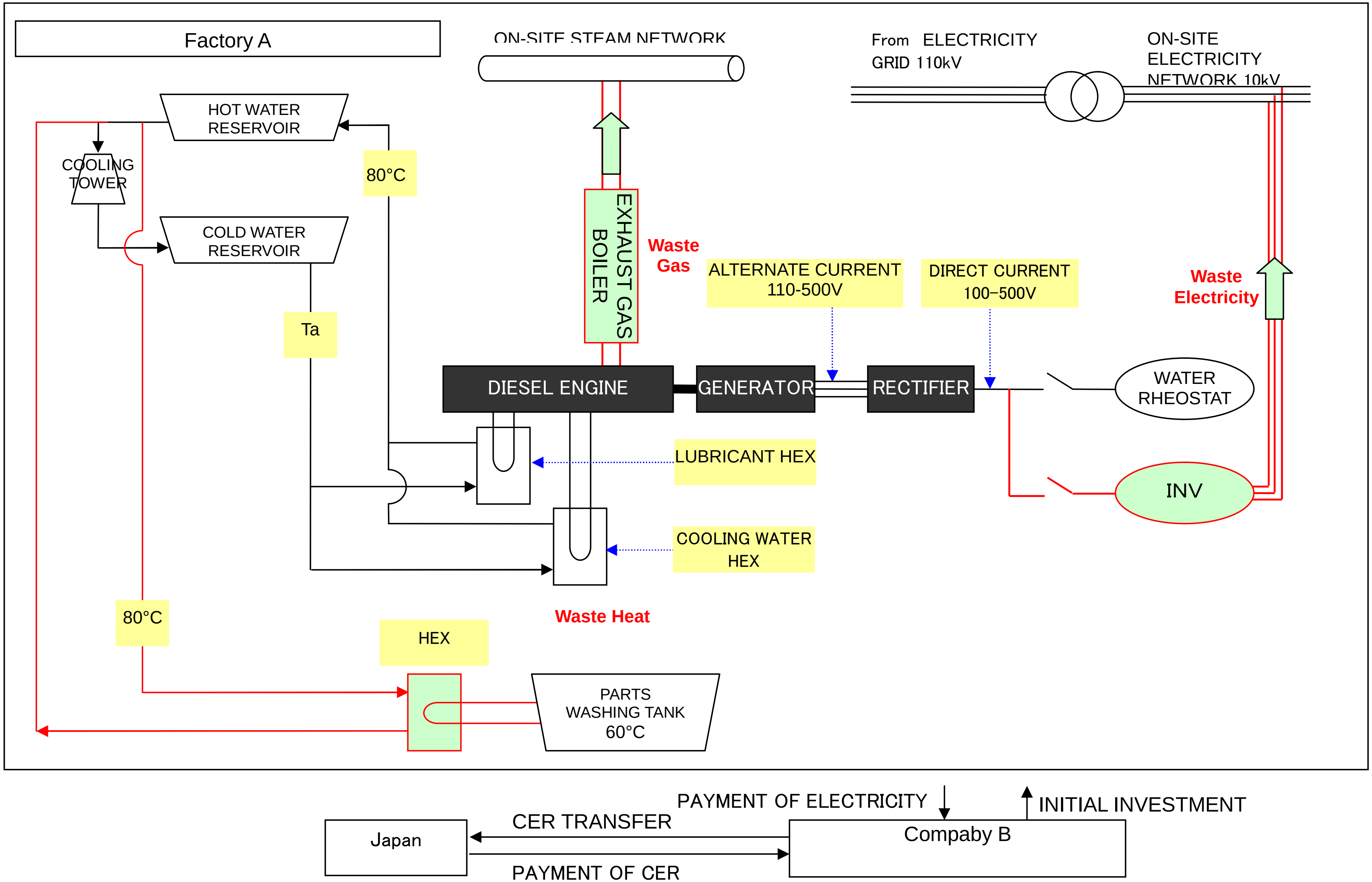
(5) Environmental Impact/ Other Indirect Effect

It is thought that there is no negative environmental effect or that it is avoidable because this project set the energy saving system inside the factories. By contrast, this project will promote environment protection in the area because it reduces the emission SO_2 and NO_X in the power grid and the emission of coal ash.

(6) Stakeholders' Comments

We will arrange a briefing session for the residents in the area and the stock holders before the operation. It is expected to be hold around May.2009; after the major issues about the facility is determined.

(7) Implementation structure



(8) Financial Plan

It will be carried on with ESCO company's own resource. A Japanese company and a Chinese company agreed on investing their own resources enough for this project to start the business. There will be no borrowing from a bank.

(9) Economical considerations

The following information is the pre-supposed data and IRR applied.

- Operation starts from: April 2010
- System set-up cost: 75.94M yen
- Income: 13.38M yen (Income in the first year would be its 75%)
- Tax rate: 30％
- CO_2 Reduction 19,456 ton/ year
- Credit Unit Price 8 EUR/ t-CO_2
- Exchange Rate 1 EUR=120 yen

	Without Credit	With Credit
IRR (10years)	-1.07%	10.83%

Above are the economic aspects of the whole project scheme which sells steam generated from waste gas/ heat as well as electricity generated from a testing facility to the plant.

(10) Demonstration of Additionality

In this section, additionality will be demonstrated by using "Combined tool to identify the baseline scenario and demonstrate additionality".

Step 1: Identification of alternative scenarios

Identified baseline scenarios are as follows:

Scenario 1: Continuation of the current practice – the locomotive plant continues to be operated without recovering waste gas/ heat/ electricity;

Scenario 2: All or part of the project activity is implemented without CDM (e.g. implemented by ESCO on its own);

Scenario 3: Energy-saving equipment with a higher efficiency than the one introduced by the project activity is installed;

Although the Chinese regulations for energy saving are becoming more stringent as epitomized in "the five-year plan", it is not mandatory to introduce a level of energy saving technology that this project activities can deliver, or even a higher standard than this project. It still remains up to the individual companies to decide what project activities and how much higher level of energy saving standards above the mandatory minimum they want to strive for.

Step 2: Barrier analysis

- Investment barriers, other than insufficient financial returns as analyzed in Step 3
- Technological barriers
- Lack of prevailing practice
- Other barriers

Scenario 3 will be excluded due to existing technical barriers.

Step 3: Investment analysis

In CDM, it is necessary to demonstrate that this project won't be implemented by the commercial sector unless credit income for the project is taken in account. In this case, it should be proven that the IRR is less than the regular business standard.

(11) Potentials and Tasks of Project Materialisation

It has high feasibility because the counterpart shows motivation and the government expressed its will to support. Now, the details of the ESCO business is being discussed between Factory A, Japanese investor (bank) and Chinese investors (bank and a private investor). We should pay attention to that CDM is operated in response to the results of the discussion.

4. Co-benefits Effects in the Host Country

(1) Evaluation of Pollution Prevention in the Host Country

By conducting this project, (1) the amount of consumed system power and coal used in the power plant are reduced because of efficient use of electricity which has been wasted, and (2) the amount of coal consumed in steam generators in the factories is reduced because of utilization of waste heat and waste gas. Considering SO_2 and NO_X as the major air pollutants, literature review gives us the conclusion that emission factor of coal in Chinese power sector (SO_2: 833.6g/ GJ, NO_X: 298.8g/ GJ) corresponds to (1), and that emission factor of coal in the industry sector (SO_2: 934.2g/ GJ, NO_X: 241.8g/ GJ) corresponds to (2). Multiplying the appropriate reduction amount of coal consumption ((1) 9,720GJ, (2)126,014GJ) gives the reduction of 126 t- SO_2/ year SO_2 and 33t-NO_X / year.

(2) Suggestion of Co-benefit index

By introducing the concept of negative externality, we suggest co-benefit index through in integrating environment pollutants and each benefit.

Co-benefit Index 1 (Index of Contribution to Co-benefit)

Contribution Index --- Climate Change vs. Air Pollution = Amount of reduction of Negative Externality (Air Pollution)/ Amount of reduction of Negative Externality (Climate Change) ------ (1)

Both climate change measures and air pollution measures reduce negative externality. We set formula (1), considering Co-benefit index evaluating the effect in case of regarding the climate change issue as subject, and the air pollution as object.

We employ the case evaluating negative externality based on the damage cost which theoretically approved by IPCC1955; CO_2: $ 26/ t, SO_2: $ 7,425/ t, NO_x: $ 14,483/ t., to calculate the amount of reduction of each gas in this project. In result, for example, the amount of reduction for ten years and the amount of reduction of negative externality is as follows. It gives 2.8 as Co-benefit index based on the definition here. Therefore, the degree of contribution of this project against pollution issue means 2.8 times of the one against climate change issue. The benefit of measures to be taken for air pollution can be regarded as the good index for the host country to recognize the contribution of CDM by Japan.

CO_2:	194,560 t	¥ 456.750 million
SO_2:	1,260 t	¥ 843.530 million
NO_x:	330 t	¥ 436.430 million

Co-benefit Index 2 (Index of Co-benefit Investment Efficiency)

Index of Co-benefit Investment Efficiency
= Negative Externality (Climate change＋Air Pollution)/ Investment Amount ------ (2)

Formula (2) calculates the degree of avoided negative externality against the amount of investment. For the host country, the bigger the reduction of negative externality against the amount of investment, the more efficient for improvement of climate change and air pollution.

For this project, formula (2) gives 22.8 as co-benefit index (index of investment efficiency). This means the total amount of negative externality of $CO_{2,}$ SO_2 and NO_X (Total of ten years: ¥ 1,736.71 million) divided by the amount of investment to energy saving system (¥ 75.96 million). The formula can take environmental merit into consideration of investment decision-making in addition to economic merit of the investment. Setting aside of private investment, ODA has environment-friendliness in mind, so it should be explicitly employed for investment decision-making or choice of the project.