ROLE OF CDM PROJECT on Municipal Solid Waste to Energy Project in Sidoarjo, Indonesia 21 Feb. 2005

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APPLIED THERMAL CONVERTER TECHNOLOGY on WASTE PROCESSING PLANT IN SIDOARJO
WHAT IS THE THERMAL CONVERTER

The Thermal Converter is Waste Processing Plant which combust various waste at high temperature 1700 °C, in order to reduce emission of air pollutants including dioxin. The heating will be changed as superheated steam by boiler. It will generate turbine and generator which produce the electricity power.

Also Thermal Converter destroys 97% of waste leaving only 2 – 3% residue as marble which is suitable for cement additives as well as ceramic production.
SCOPE OF WORK

- The Local Government only provide land at no cost and waste on the TPS
- Waste Energy System Ltd England will supply and install the Thermal Converter.
- PT. Imam Manunggal Wijaya (IMW) will build and Operate the plant
- PT. PLN will buy the electric energy which be product by plant
Technical Data of Thermal Converter

- **Type**: 2 @ 350 S
- **Plant Capacity**: 2 @ 204 Ton / day (Dry Condition)
- **Minimum MSW**: 360 Ton/day (dry Condition) or 659 Ton/day (wet Condition)
- **Gros Calori Value**: 3.459 kCal/kg.
- **Moisture Content**: 45.3 %.
- **Power Output**: 18.9 MW.
- **Inhouse Power**: 0.9 MW.
- **Power sale**: 18.9 MW.
- **Life time**: 20 Tahun.
Works Flow of Thermal Converter

TPS 1 > TPS 2 > TPS 3

COMPACTING TRUCK

WEIGHT BRIDGE

MSW PIT AREA

OVERHEAD CRANE

THERMAL CONVERTER
Temp. : 1700 °C

Residu : 2 s/d 3%

Steam Drum (Boiler)

Steam Turbine

Generator

Net Work 20 KV PLN

Power
Total MSW

: 18.9 MW
: 360 Ton / Day
Thermal Converter

Air

Flue Gas
Cross Section of Thermal Converter

- Bagian Atas
- Bagian Tengah
- Bagian Pembakaran
- Bagian Setelah Pembakaran
RESIDUE
Emission Control equipment

Emission Monitoring

SET 01
Pollutant Gasses
O₂, Temp., Opacity
Flow

SET 02
Pollutant Gasses
O₂, Temp., Opacity
Flow

Modem Link
The Thermal Converter

- Most known wastes destroyed.
- Economic recycling if required.
- Operating temperature 1700°C.
- Process-Pyro Thermic Reaction
- Very low refractory use
- Waste reduction 97%
- Residue - Inert / sterile granules
- Reduce CH4 due Combustion.
- Supplying electricity to JAMALI Grid (reduce CO2).

Other Methods

- Only solids and combustibles.
- Recycling necessary
- Usually 680°C to 1200°C
- Simple combustion
- High refractory use, high cost
- Waste reduction generally 70%
- Requires post treatment
CDM PROJECT
ON
Waste Processing Plant
In Sidoarjo
General Description of Project Activity

Background
- MSW is increasing due to high population growth
- MSW is currently open-dumped at final disposal sites
- LFG is emitted without any control

Project activity
- Incinerating MSW at 1,700 °C (reduce CH4)
- Supplying electricity to JAMALI grid (reduce CO2)

Categories of project activity
- Grid-connected electricity generation from renewable sources
- Landfill methane avoidance
General Description of Project Activity…
Cont…

- Contribution to SD
  - Provide job opportunity to local people,
  - Hire scavengers and providing steady income
  - Reduce current environmental/health impacts at the final MSW disposal sites
  - Reduce its operation cost borne by the government of Sidoarjo
**Project location**

- **Physical location**
  - DesaBlurukidul
  - Kec. Sidoarjo
  - Kab. Sidoarjo (East Jawa)

- **Project participants**
  - PT. IMW (host) Surabaya
  - PCI (donor) Japan
Technology Description (Flow diagram)

MSW transported from dumping sites

- Recyclable materials
- Unrecyclable materials
- Electric shredder
  - Shredded wastes
  - Heat
  - Electricity 0.9 MW
  - Clinkers

Incenerator (Thermal converter)

- Steam boiler
  - Steam
- Steam turbine generator
  - Electricity 18.0 MW
  - JAMALI grid

Internal use of the project plant 0.9 MW

GHG Emission reduction in crediting period (14 years) = 1,869,714 t -eCO2
Application of baseline methodology

Baseline scenario:

1. MSW treatment

2. Electricity
**Baseline scenario (MSW treatment)**

Q1: Is there any regulation/law or agreement requiring the effective utilization of MSW to be landfilled and/or landfill gases in the country/area?

A1: No. In Sidoarjo city, there is no regulation/law requiring the Project. There is currently neither regulation requiring MSW incinerator nor landfill gas recovery. In addition, there is currently no plan to establish them in the near future.

Q2: Is there an alternative plan for the effective utilization of MSW to be landfilled and/or landfill gases, in case the proposed project, which is electricity generation by incineration of MSW to be land-filled, was not implemented?

A2: No. According to the waste management department of the Sidoarjo government, no plan exists for a utilization of MSW or landfill gases in the near future. Their budget for MSW treatment is not sufficient to manage MSW completely and too limited to invest for such an effective utilization.
Baseline scenario (MSW treatment)...

Cont.

Q3: Is there any possibility for implementation of the proposed project, considering barriers such as investment barrier, technological barrier, barrier due to prevailing practice?

A3: No, due to Investment barrier, Technological barrier and Barrier due to prevailing practice.

Baseline scenario of MSW treatment:

The MSW would continue to be open-dumped without treatment.
Q1: Comparing to the electricity generated by the grid connected by the project, is it possible to logically prove that the electricity generated by the project are small enough to be ignored?
A1: The project generation capacity is negligible comparing with the grid because the Project plant will generate and supply electricity to the JAMALI grid. The Project will supply electricity 140 GWh far less than 1 % of total generation 83,576 GWh in JAMALI grid. Therefore, it logically proves that the electricity generated by the Project are small enough to be ignored.

Baseline scenario of MSW treatment:

Among those power plants whose operation would be affected by the project (current situations), the baseline scenario is the case that plant(s) that play the same role as the project would operate in the absence of this project
Duration of the project activity/Crediting period

- Starting date of the project activity
  - 2007

- Expected operational lifetime of the project activity
  - 20 years

- Choice of the crediting period and related information
  - Renewable crediting period:

- Starting date of the first crediting period
  - 2007

- Length of the first crediting period
  - 14 years
Estimation of GHG emissions by sources

Project Case:
\[ PE_y = PE_{by} + PE_{fy} \]

Where:
- **PEy**: Total project activity emissions (t-CO2e / yr).
- **PEby**: Project emissions from burning fossil origin product in the Power Plant (t-CO2e / yr).
- **PEfy**: Project emissions from fossil fuel consumption for the Project (t-CO2e / yr).

\[ PE_{by} = MSW_y * FP_{fy} * CCFP * EFC * 44/12 \]

Where:
- **MSW_y**: Total amount of MSW burned in the project plant (T/yr)
- **FP_{fy}**: Fraction of plastics in the MSW (%)
- **CCFP**: Fraction of carbon content in the plastics (%) 
- **EFC**: Burn out efficiency of combustion
Estimation of GHG emissions by sources (Cont)

\[
PEby = 131,400 \text{ (ton/yr)} \times 4.8(\%) \times 85(\%) \times 99(\%) \times \frac{44}{12} \\
= 19,461 \text{ (t-CO2e /yr)}
\]

\[
PEfy = FFy \times VEFCO2
\]

Where:

- \( FFy \): Diesel oil used for the Project (Lt./yr).
- \( VEFCO2 \): CO2e emission factor for the diesel oil used for the Project (t-CO2e /Lt.)

\[
PEfy = 154,460 \text{ (Lt./yr)} \times 0.00268 \text{ (t-CO2e /Lt.)} \\
= 414 \text{ (t-CO2e /year)}
\]

\[
PEy = PEby + PEfy \\
= 19,461 \text{ (t-CO2e /yr)} + 414 \text{ (t-CO2e /yr)} \\
= 19,875 \text{ (t-CO2e /year)}
\]
Estimation of GHG emissions by sources (Cont)

**Baseline Case:**

\[ BEy = BEdy + BEgy \]

- **BEy**: Total baseline emissions (t-CO2e / yr)
- **BEdy**: Baseline emissions from avoided MSW disposal (t-CO2e / yr)
- **BEgy**: Baseline emissions of grid-electricity (t-CO2e / yr)

\[ BEdy = k \times L0 \times \sum_{t=1,y} \text{MSW}_t \times e^{-k(y-t)} \times (16/12) \times (1-OX) \times \text{GWP\_CH4} \]

where:

- \( k \): Methane generation rate
- \( L0 \): Decay rate (= DOCy \times DOCF \times MCF \times Fy \times 16/12)
- \( t \): Year in which MSW is disposed
- \( \text{MSW}_t \): Total dry amount of MSW burned in the Power Plant (ton/yr)
- \( \text{DOCy} \): Degradable carbon fraction in the MSW (\%)
- \( \text{DOCF} \): Fraction of DOC that actually degrades (\%)
- \( \text{MCF} \): Methane correction factor for landfill (default value used).
- \( Fy \): Fraction of methane in the project’s landfill gas (\%)
- \( \text{OX} \): Oxidization factor (\%)
- \( \text{GWP\_CH4} \): Global Warming Potential of methane (21) specified in the IPCC Second Assessment Report
Estimation of GHG emissions by sources
(Cont)

\[ BEd1 = 0.05 \times (0.19 \times 0.88 \times 0.4 \times 0.5 \times 16/12) \times 131,400 \times e(0) \times (1-0) \times 21 \]
\[ = 6,152 \text{ (t-CO2e /yr)} \]
(for y=1, on the year of the Project start)

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Estimation of GHG emissions by sources (Cont)

\[ BEgy = E Gy \times (WOM \times EF_{OMy} + WBM \times EF_{BMy}), \]

where:

- \( E Gy \) : electricity supplied to the grid
- \( WOM \) : weight factor for operating margin (OM)
- \( WBM \) : weight factor for build margin (BM)
- \( EF_{OMy} \) : emission factor for OM
- \( EF_{BMy} \) : emission factor for BM
- \( y \) : a given year

\[ \begin{align*}
BEgy &= 139,968 \text{ (MWh/yr)} \times 0.827 \text{ (t-CO2e /MWh)} \\
&= 115,754 \text{ t-CO2e /yr}
\end{align*} \]

\[ BEy = BEdy + BEgy \]
\[ = 6,152 \text{ (t-CO2e /yr)} + 115,754 \text{ (t-CO2e /yr)} \]
\[ = 121,906 \text{ (t-CO2e /yr)} \] (for \( y=1 \), on the year of the Project start)
Estimation of GHG emissions by sources (Cont)

GHGs Emission reduction for the year of y (t-CO2e/yr)

\[ \text{BE}_y \text{ (t-CO}_2\text{e/yr)} - \text{PE}_y \text{ (t-CO}_2\text{e/yr)} \]

\[ = 121,906 \text{ (t-CO}_2\text{e/yr)} - 19,875 \text{ (t-CO}_2\text{e/yr)} \]

\[ = 102,031 \text{ (t-CO}_2\text{e/yr)} \]

(for y=1, on the year of the Project start)
## Annual GHGs Emission Reduction Table

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<th>Year</th>
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<th>Project Emissions</th>
<th>Emission Reductions</th>
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**Total** 1,869,714
Financial Analysis (Without CER) (100% Capacity Factor)

- **Investment Cost**: Rp. 213 M

- **Income**:
  - Sale of Electric Power: Rp 56.4 M
  - Sale of Recycle Material: Rp 1.6 M
  - Total Income: Rp 58 M

- **Expenditure**:
  - Operation Cost: Rp 18.8 M
  - Depreciation (10 th): Rp 21.3 M
  - Cost of Finance: Rp 10.9 M
  - Total Expenditure: Rp 51 M

- **Profit**: Rp 7 M

- **Pay Back Period**: 6 Tahun.

- **IRR**: 12 %
Financial Analysis (With CER) (100 % Capacity Factor)

- **Investment Cost**: Rp. 215 M
- **Income**:
  - Sale of Electric Power: Rp. 56.4 M
  - Sale of Recycle Material: Rp. 1.6 M
  - Sale CER: Rp. 4.6 M
  - **Total Income**: Rp. 62.6 M
- **Expenditure**:
  - Operation Cost: Rp. 18.8 M
  - Depreciation (10 th): Rp. 21.5 M
  - Cost of Finance: Rp. 10.9 M
  - **Total Expenditure**: Rp. 52 M
- **Profit**: Rp. 10.6 M
- **Payback Period**: 5 Tahun
- **IRR**: 14 %
Financial Assumption

- **Price of Electricity**: Rp. 400 / kWh.
  - $ 0.045 / kWh.
- **Price of CERs**: $ 5 / t eCO2/y
- **Working hour/y**: 7,776 hour/y.
- **Interest / y**: 5 % / y flat.
- **CDM Cost**:
  - PDD: $ 150,000
  - Registration, Validation and Monitoring: $ 50,000
- **Income CERs for 14 years**: Rp. 84.2 M
Project Schedule
## CDM PROJECT SCHEDULE

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Barriers

- Waste Powered - Power Plant < 36 MW, authority of contract will be under PLN Regional Office
- According to PLN Regional Office Regulation, buying contract limited only for 1 year although the MoU state that PLN will buy for 10 years
- Financiers expectations: > 10 years
- Average selling price to PLN: Rp. 400 / kWh or $ 0.045
- Financiers expectations: $ 0.05.
- Difficult to find the location for waste processing (conflict with local community).
Conclusion

- Municipal Waste Potency in Indonesia: 48,000 Ton / day.
- Expected Power produced: 1.428 MW.
- With Sidoarjo waste reference, emission reduction will:
  \[ 1.869.714 \times 80 = 149.577.120 \text{ t-eCO}_2 \text{ for } 14 \text{ years} \]
- Income of CER: $747,885,600.
- Labour involved: 16,000 Orang.
- Policy required from Government:
  1. Electricity Buying Contract (for Waste-Powered Power Plant)
     > 10 years,
  2. Price > $5 / kWh.
Photograph Of TPS Sepanjang and Wadung Asri
Photograph Of TPS Tulangan and Porong
Photograph of TPS Bengkel J in (Nearly Centre of Sidoarja City)
Photograph of Final Disposal of Sidoarjo
Other the final disposal site
Other The Environmental Pollution
MATURNUWUN