CLEAN DEVELOPMENT MECHANISM
PROPOSED NEW METHODOLOGY: BASELINE (CDM-NMB)
Version 01 - in effect as of: 1 July 2004

Energy Efficiency Improvement in Process and Manufacturing Industries

CONTENTS

SECTION A. Identification of methodology

A.1. Proposed methodology title:

Energy Efficiency Improvement in Process and Manufacturing Industries

A.2. List of category(ies) of project activity to which the methodology may apply:

>>
Sectoral Scope: 3 Energy Demand

This methodology can be applied to the following industry sectors

Sector 4: Manufacturing industries
Sector 5: Chemical industries
Sector 8: Mining/mineral production
Sector 9: Metal production

This methodology will apply to the following types of improvements, individually or together in various combinations, carried out in Process and Manufacturing industries:

- Improvements in electrical energy consumption in manufacturing processes which include inter-alia
  - Change in motors, drives and controls which allow equipment to be operated optimally - time / speed (switching off when not needed)
  - Use of high efficiency equipment and drives – consuming less energy/unit of production
  - Process load reduction leading to lower consumption of electrical power while in operation
  - Better controls which reduce consumption of electricity when production rate is decreased.

- Reducing loss of thermal energy through means which include inter-alia
  - Minimizing thermal losses through radiation by using better insulation
  - Minimizing loss of thermal carriers (ex: leakage of steam, air),
  - Better equipment design, better maintenance practices which reduce leakages and losses and improve heat transfer rates.
  - Recovering thermal energy for a useful application, or replacing fuel used for generation of thermal or electrical energy etc.

- Improving production rates, minimizing waste or recycling of materials which reduce energy consumption (thermal or electrical) for producing a unit quantity of useful product, because of better heat transfers, higher efficiency of usage etc.

- Improving efficiency of generation of electrical power within the plant, using recovered heat, improving boiler efficiency etc.

A.3. Conditions under which the methodology is applicable to CDM project activities:

The methodology is applicable to CDM project activities under following conditions:

- The manufacturing plant is buying electrical energy from the grid and/or generating it in-house, using a mix of fuels.
- The thermal energy is generated within the plant, using a mix of fuels.
- The projects result in demonstrable reduction in consumption of electrical energy/unit of production or fuel consumed/unit of production of useful products
- A single improvement or many improvements implemented simultaneously (implemented within 6months) are considered

This methodology will exclude improvements which

- Result from a change in product-mix produced (this will require a different analysis of markets etc and should be covered by a different methodology)

- Result from a change in fuel mix (will need a separate analysis as fuel-switch)

- This methodology will not apply to Projects that are mandated by law.

For calculating financial feasibility the following impact of process change will be taken into account:

- o Improvement in electrical energy consumption/unit of production
- o Improvement in thermal energy consumption/unit of production
- o Improvement in production, reduction in material waste, sale of useful (new) by-product etc.

A.4. What are the potential strengths and weaknesses of this proposed new methodology?

The key strengths of the proposed methodology are:

- Applies to a wide variety of improvements carried out in manufacturing sector which are difficult to classify as simple improvements in electrical energy consumption or thermal energy consumption or productivity. There are many improvements which may increase one type of energy (say electrical) to significantly reduce another type (say thermal). Therefore one needs to assess overall energy consumption impact and translate to GHG emission abatement.

- Allows aggregation of many improvements carried out simultaneously.

- Limits the benefits accrued by explicit incorporation of plant throughput (as it stands after project implementation) as a limiting factor. This ensures that future improvements in capacity (which are unrelated to the proposed Project) don’t get benefit of improvements in energy consumption/unit.

- Limits the efficiency benefits beyond the ones accruing from the project – excludes the effect of future improvements in efficiency.

- Applies to a variety of energy generation and sourcing strategies such as purchase of electrical energy from grid, supply to surplus energy to grid, generation of thermal energy within the plant, recovery of process heat through in-house generation etc.

Weaknesses of the methodology:

- In some cases it may be difficult to isolate the effect of product-mix changes.

SECTION B. Overall summary description:

The baseline scenario is built by assessing past performance of the plant in terms of emissions, which sets the baseline (excluding emissions in Calcination process.)

The impact of Project Activity on the emission is estimated, as recorded just after the project activity execution and start of plant operations at higher efficiency level.

The impact of improvements carried our after the Project Activity is excluded by limiting the energy efficiency/improvement in emission level to what was established just after the completion of Project activity.

Any future decline in performance is however penalized.

SECTION C. Choice of and justification as to why one of the baseline approaches listed in paragraph 48 of CDM modalities and procedures is considered to be the most appropriate:

C.1. General baseline approach:

□ **Existing actual or historical emissions of the plant as applicable**

C.2. Justification of why the approach chosen in C.1 above is considered the most appropriate:

Energy efficiency in an ongoing manufacturing business is a combination of many technologies, management practices and ideas and it is difficult to pinpoint a particular technology or practice as being the base case.

Hence the need to construct a baseline based on actual emissions in the past, as in the absence of Project Activity, the plant will deteriorate or remain stagnant in performance.

SECTION D. Explanation and justification of the proposed new baseline methodology:

D.1. Explanation of how the methodology determines the baseline scenario (that is, indicate the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases (GHG) that would occur in the absence of the proposed project activity):

In the absence of Investments in Efficiency Improvement Project, the project proponent would either decline or remain stagnant in performance. Hence the past performance achieved sets the baseline.

The 2 scenarios are:

- Improved energy efficiency and GHG emissions as a result of the Project Activity.
- Continuation of as is scenario – existing level of emissions (past performance)

D.2. Criteria used in developing the proposed baseline methodology:

>>The baseline methodology should:

- *<u>Apply to a variety of Projects which may involve a combination of improvements in electrical energy, thermal energy and productivity</u>*. This flexibility is needed to take care of myriad of ways energy efficiency improvements are carried out by the Industry.

D.3. Explanation of how, through the methodology, it can be demonstrated that a project activity is additional and therefore not the baseline scenario (section B.3 of the CDM-PDD):

The proposed methodology calculates GHG abatement for improvements which are beyond the past performance of Project Proponent.

Additionality should be supported by using the following approach:

- **Test 1 Qualification**:
    - Check if Project Activity Reduces Emissions below the Baseline. If it does move to the next check.
    - Check if the project activity is mandated by a regulation, which is not created specifically for reducing GHG reductions after the signing of Kyoto Protocol.
        - If Project Activity is mandated by such a regulation, it is not additional unless there are enough indications that the regulation is not effectively implemented.
    - If the crediting period is proposed before the Project Registration date, it should be proven that the Activity was undertaken with CDM in mind and CDM benefits were part of management decisions as proved in internal records, minutes of investment decisions taken, project reports etc. If it is so Project is additional or else it is not.

<u>If this test proves Project is additional, move to Test 2:</u>

- **Test 2: Financial Analysis** – analyse the profitability of the proposed changes as follows:
    - Take into account the overall impact of energy consumption, thermal energy consumption and throughput changes and translate them into savings as given in annexure-2.
    - Calculate IRR.
    - If IRR is < average cost of capital adjusted for risks and uncertainties of energy efficiency projects then the project should be considered as financially less attractive than normal projects and therefore not the baseline scenario. Using sensitivity analysis show that project remains less attractive for a range of values of the assumptions which may be expected to occur in normal course of events.

If project is financially unattractive the project is additional and move to **Test 4.**
If project is attractive, move to **Test 3** and prove that Project faces significant barriers and therefore unlikely to be the baseline.

Test 3: Barrier Analysis

- **Investment barrier**: Understand the investment attractiveness of the Project.

- Analyze response from banks for financing similar projects etc, to assess how easy it is to get financing for such projects in the country where Project Activity is being undertaken.

- If it is difficult to arrange finance normally and if CERs have been used as means of financial closure of the project then the Project should be considered as additional.

  Financial closure of equity can be shown if Project CERs helped attract an equity investor or an investor for quasi equity (ex preference capital) or if CERs made the project attractive to get Sanction of Debt.

- **Technological barrier (risk)**: If the technology or improvement concept involved is
  - Complex posing difficulties of management or operation, requiring manpower skills which are not available
  - Not proven at a large scale, has lot of associated risks
  - Not freely available
  - Requires supporting infrastructure which is not readily available in the country

and Carbon Credits have been used as means to attract a technology participant to remove the constraints mentioned above, then the Project should be considered as additional.

- **Barriers due to prevailing practice**
  If Industry[1] lacks familiarity with state-of-the-art technologies and/or are reluctant to use them; or if the project is the "not of usual kind" involving other risks such as related to market, customer acceptance, supply of materials, (resistance from) regulation, (uncertainty of) operating performance etc and if Carbon Credits attract Project Participants or Additional Support which alleviates the risk perception of Project Proponents, then such projects should be considered additional.

  Energy Efficiency Projects in India and other developing countries are normally not considered for investments unless payback periods are low (<2 yrs) as these countries are growing rapidly and promoters want to invest in capacity expansions to finance their growth rather than expensive energy efficiency projects. Also energy efficiency projects are considered risky because often the intended benefits are not realized.

  Hence if Energy Efficiency Projects are undertaken and/or financed/managed by Energy Services Companies, to counter the hesitation/reluctance of Promoters, such activities should also be considered additional.

The barriers should be shown to be significant based on external or internal assessments, public/ private documentation etc.

[1] Industry is defined as consisting of players who produce similar products, serve similar/same markets and face similar conditions of supply of materials, regulation, labour availability, financing etc.

If the Project qualifies as additional move to **Test 4**.

Test 4: Common Practice Analysis

If Project Activity is a common practice in the Industry
- As evidenced in industry published information, market surveys etc or
- Adoption of technology or similar activity in more than 50% of potential plants (where such practices have been adopted without recourse to CDM benefits)

then the project can't be considered as additional UNLESS the Project Proponent faces unique constraints and is able to remove them due to benefits arising from registration as CDM project :
- Proponent doesn't have financial capability[2] to undertake the project and the project has become feasible due to Carbon Credit supported financing
- Proponent doesn't have management expertise to undertake the project and this constrained is removed by attracting a investor or project participant.
- Proponent has better investment opportunities and is persuaded to support the energy efficiency project when investment and/or management support has come from an outside participant such as an Energy Service Company or equivalent of it.

The project is finally considered as additional if it qualifies to be additional after passing through Test 1→Test 4.

D.4. How national and/or Sectoral policies and circumstances can been taken into account by the methodology:

>>If there is a mandated energy efficiency norm or mandated use of process technology for the industry, this can be accounted for by setting the baseline at

the minimum of mandated norm/norm derived from mandated technology and past (baseline) performance of the Project Proponent

This would ensure that Project Proponent who don't meet the minimum standard don't get benefits of CDM.

In addition the methodology explicitly accounts for external policy driven parameters such as changes in grid emission factors, grid transmission efficiency, fuel quality improvement etc.

D.5. Project boundary (gases and sources included, physical delineation):

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Project boundary would normally include the
- Whole of manufacturing unit where Project is going to be implemented (including all buildings, plants and equipment and local raw material sources if they are owned by the business and can be made part of one geographical boundary, electricity generating station, substation for electricity import and distribution within the plant)
- Electricity supply grid in the Region

[2] Debt: equity ratio > 1.5, EBIDT/Debt <0.25, DSCR for the project <1.5 for developing country context.

The gas emissions considered are:

- Carbon di oxide emissions from burning of fuel (excluding those from burning bio-mass fuel)
- Carbon di-oxide emissions while generating power for the grid, which is consumed by the generating plant.

D.6. Elaborate and justify formulae/algorithms used to determine the baseline scenario. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):

Past emission from the Plant

Q_0 = quantity of production (of the main product) by the plant

eE_0 = total electrical energy consumed in the plant

= $(eEP_0 + eEG_0)$

eEP_0 = total electrical energy purchased from the grid and consumed by the Plant (KWhrs)

= can be –ve if power is exported to grid rather than consuming it for the plant

eEG_0 = total electrical energy generated within the plant using a mix of fuels (KWhr)

reE_0 = ratio of generated electrical power to consumed electrical power

= eEG_0 / eE_0

= can be >1 if generation is more than consumed and it is sold back to the grid.

esE_0 = specific electrical energy consumption KWHr /unit of production

= eE_0 / Q_0

tsE_0 = specific thermal energy consumption KJ/unit of production

= tEG_0 x $teffy_0 / Q_0$

K = conversion factor for converting KWHr to KJ (KJ/KWHr) = 3600

tEG_0 = total thermal energy produced in the plant KJ, by burning fuel in a generation plant

$teffy_0$ = efficiency of consumption of thermal energy within the plant – could be 1 in cases where energy is directly consumed in a process (such as coal feed to a kiln in a Cement plant) or where it is difficult to measure consumptions; therefore thermal energy generated by fuel combustion is assumed as a measure of total consumption

= total thermal energy consumed in the plant/(Calorific value of fuel burned for thermal energy tCV_0 x fuel quantity tQ_0)

= >1 if the generation plant used energy recovered from process flue gases etc; can reach infinity if no fuel is required to be burnt.

$eeffy_0$ = efficiency of generation of electrical energy within the plant

= total electrical energy produced in the plant (KWhr)●K//(Calorific value of fuel burned for electrical energy generation eCV_0 x fuel quantity eQ_0)

Can be >1 if electrical power generation uses recovered gases; can reach infinity if no fuel is used to generate power everything being produced from recovered energy.

eCF_0 = average effective carbon content of fuel mix for generating Electrical Power within the Plant (T of C/T of fuel mix); bio-mass used taken as carbon content of zero

eCV_0 = wtd average Calorific Value of fuel used for generation of electricity in the plant KJ/kg

$eFEF_0$ = emission factor for fuel mix used for in-house electrical power generation

= $G \bullet eCF_0 / eCV_0$

G = conversion factor for converting carbon to carbon-di-oxide weight =44/12 = 3.667

tCF_0 = average carbon content of fuel mix for Thermal Energy in the plant (T of C/T of fuel mix);

bio-mass used taken as carbon content as zero

tCV_0 = wtd average Calorific Value of fuel used thermal energy generation in the plant KJ/Kg

$tFEF_0$ = emission factor for fuel mix used for thermal power generation

= $G \bullet tCF_0 / tCV_0$

<u>Grid Related Factors</u>

EF_0 = Emission Factor of the grid based on 'approximate operating margin' approach for the region/country where plant is located (Kgs of Carbon di-oxide emission /KWHr of power generated). Most recent available for the region/country.

TD_0 = average transmission and distribution losses for grid power (most recent estimate available for the region/country); can be assumed to be zero if the net power is exported to grid.

TEF_0 = total emission factor of specific energy consumed (Kg of C02/unit Q of products) prior to project implementation
= emission factor for electrical energy supplied from grid + emission factor for electrical energy generated within the plant+ emission factor for thermal energy produced within the plant

$= (esE_0 \bullet ((1-reE_0) \bullet EF_0 / (1-TD_0) + reE_0 / eeffy_0 \bullet eFEF_0 \bullet K) + tsE_0 / teffy_0 \bullet tFEF_0)$ **(1)** [3]

Total emission factor (baseline) for period t

$TEF_{b,t} = TEF_0$ unless there are new mandates for using technology which set a minimum limit on plant performance. In that case work out TEF_t using esE and tsE norms based on regulatory norms.

D.7. Elaborate and justify formulae/algorithms used to determine the emissions from the project activity. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):

Post Project Activity – as validated by DOE in Technical Estimation as well as achieved over a 30 day trial after implementation (for maximum capacity production)

The validation of the energy consumption figures is to be achieved in the following manner:

- Understanding the impact of each improvement/combination of improvements made in a process – in terms of local (process or equipment related) change in energy consumptions (electrical and thermal), increase in local throughput rates.
- Aggregating the improvements in terms of energy consumption and throughput at the plant level.
- Checking measures of energy consumption/generation locally (at each process/equipment involved in the improvement) as well as at plant levels to confirm the actual achievement. This check should be done for operation of the plant for reasonably long period (default level ~ 30 days) and at full capacity.
- Recording the achieved results as part of base data for future calculations.

Q_T	=	quantity of production (of the main product) by the plant – capacity production
eE_T	=	total electrical energy consumed in the plant
	=	$(eEP_T + eEG_T)$
eEP_T	=	total electrical energy purchased from the grid and consumed by the Plant (KWhrs)
	=	can be –ve if power is exported to grid rather than consuming it for the plant
eEG_T	=	total electrical energy generated within the plant using a mix of fuels (KWhr)
reE_T	=	ratio of generated electrical power to consumed electrical power
	=	eEG_T / eE_T
	=	can be >1 if generation is more than consumed and it is sold back to the grid.
esE_T	=	specific electrical energy consumption KWHr /unit of production
	=	eE_T / Q_T
tsE_T	=	specific thermal energy consumption KJ/unit of production
	=	tEG_T x $teffy_T / Q_T$

[3] ● = denotes multiplication

K = conversion factor for converting KWHr to KJ (KJ/KWHr) = 3600

tEG_T = total thermal energy produced in the plant KJ, by burning fuel in a generation plant

$teffy_T$ = efficiency of consumption of thermal energy within the plant – could be 1 in cases where energy is directly consumed in a process (such as coal feed to a kiln in a Cement plant) or where it is difficult to measure consumptions; therefore thermal energy generated by fuel combustion is assumed as a measure of total consumption

= total thermal energy consumed in the plant/(Calorific value of fuel burned for thermal energy tCV_T x fuel quantity tQ_T)

= >1 if the generation plant used energy recovered from process flue gases etc; can reach infinity if no fuel is required to be burnt.

$eeffy_T$ = efficiency of generation of electrical energy within the plant
= total electrical energy produced in the plant (KWhr)●K//(Calorific value of fuel burned for electrical energy generation eCV_T x fuel quantity eQ_T)

Can be >1 if electrical power generation uses recovered gases; can reach infinity if no fuel is used to generate power everything being produced from recovered energy.

$eFEF_T$ = emission factor for fuel mix used for in-house electrical power generation
= $eFEF_0$ (as fuel mix changes are not part of the analysis)
$tFEF_T$ = emission factor for fuel mix used for thermal power generation
= $tFEF_0$ (as fuel mix changes are not part of the analysis)

EF_T = Emission factor of the grid (Kgs of Carbon di-oxide emission /KWHr of power generated)
= will be same as EF_0 (as the project doesn't impact change of grid)

TD_T = average transmission and distribution losses for grid power
= will be same as TD_0 (as the project doesn't impact change of grid)

Hence

$TEF_{T,0}$ = total emission factor of specific energy consumed as tested post project implementation (kg of co2/unit of production)

$$= (esE_T \bullet ((1-reE_T)\bullet EF_0 / (1-TD_0) + reE_T/ eeffy_T \bullet eFEF_0 \bullet K) + tsE_T/ teffy_T\ tFEF_0) \quad \textbf{(2)}$$

Actual performance for a period t after project implementation

t = period
Q_t = quantity of production (of the main product) by the plant – capacity production
eE_t = total electrical energy consumed in the plant
= $(eEP_t + eEG_t)$
eEP_t = total electrical energy purchased from the grid and consumed by the Plant (KWhrs)
= can be –ve if power is exported to grid rather than consuming it for the plant

eEG_t = total electrical energy generated within the plant using a mix of fuels (KWhr)
reE_t = ratio of generated electrical power to consumed electrical power
= eEG_t / eE_t
= can be >1 if generation is more than consumed and it is sold back to the grid.
esE_t = specific electrical energy consumption KWHr /unit of production
= eE_t / Q_t
tsE_t = specific thermal energy consumption KJ/unit of production
= tEG_t x $teffy_t / Q_t$
K = conversion factor for converting KWHr to KJ (KJ/KWHr) = 3600

tEG_t = total thermal energy produced in the plant KJ, by burning fuel in a generation plant

$teffy_t$ = efficiency of consumption of thermal energy within the plant – could be 1 in cases where energy is directly consumed in a process (such as coal feed to a kiln in a Cement plant) or where it is difficult to measure consumptions; therefore thermal energy generated by fuel combustion is assumed as a measure of total consumption

= total thermal energy consumed in the plant/(Calorific value of fuel burned for thermal energy tCV_t x fuel quantity tQ_t)

= >1 if the generation plant used energy recovered from process flue gases etc; can reach infinity if no fuel is required to be burnt.

$eeffy_t$ = efficiency of generation of electrical energy within the plant
= total electrical energy produced in the plant (KWhr)●K//(Calorific value of fuel burned for electrical energy generation eCV_t x fuel quantity eQ_t)

Can be >1 if electrical power generation uses recovered gases; can reach infinity if no fuel is used to generate power everything being produced from recovered energy.

$eFEF_t$ = emission factor for fuel mix used for in-house electrical power generation
= $eFEF_0$ (as fuel mix changes are not part of the analysis)
$tFEF_t$ = emission factor for fuel mix used for thermal power generation
= $tFEF_0$ (as fuel mix changes are not part of the analysis)

EF_t = emission factor of the grid (Kgs of Carbon di-oxide emission /KWHr of power generated); based on most recent available information about the grid for the region/country

TD_t = average transmission and distribution losses for grid power;
based on most recent available information about the grid for the region/country

$TEF_{,t}$ = total emission factor based on actual performance of the plant in period t (Kg of Co2/unit of production)

$$= (esE_t \bullet ((1-reE_t)\bullet EF_t / (1-TD_t) + reE_t/ eeffy_t \bullet eFEF_0 \bullet K) + tsE_t/ teffy_t \bullet tFEF_0) \quad \textbf{(3)}$$

Total emission factor based on tested specific energy consumption just after project implementation, but all other factors changing to those relating to period t:

$$TEF_{T,t} = (esE_T \bullet ((1-reE_t)\bullet EF_t / (1-TD_t) + reE_t/ eeffy_t \bullet eFEF_0 \bullet K)+ tsE_T/ teffy_t \bullet tFEF_0) \quad \textbf{(4)}$$

Adjustment for Product Mix Changes

If product mix has changed substantially from period 0 to t and if product mix has a substantial impact on energy consumption, the specific electrical energy consumption and specific thermal energy consumptions need to be adjusted as given in Section E1.

The same approach has to be used for adjusting tsE_t, esE_T, tsE_T, $iesE_t$, $itsE_t$

Specific carbon emission attributable to the Project, in period t
This will be maximum of the estimates based on performance just after project implementation and those based on the actual performance in period t

$$\mathbf{TEF_{a,t} = ((MAX(TEF_{T,t}\ ,\ TEF_t)} \quad \textbf{(5)}$$

This formulation ensures that specific energy consumption improvements beyond those that were validated after Project Implementation are excluded as well as any deterioration in performance thereafter is penalized.

D.8. Description of how the baseline methodology addresses any potential leakage of the project activity:

>>
The project boundary is defined as physical boundary of the manufacturing plant, even if the proposed improvement is in a specific section.

The methodology analyzes total system impact of the proposed change (translated finally in total energy consumption or thermal energy consumption in the plant). Thus it avoids potential leakage which may arise due to local analysis (Ex: energy reduction in one place resulting in increased energy consumption in another part of the plant).

D.9. Elaborate and justify formulae/algorithms used to determine the emissions reductions from the project activity. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):

aQ_t = Quantity of production which should be accounted for as the effect of the Project Activity
= $MIN(Q_T, Q_t)$

Specific Emission reduction

$\Delta sE_t = MIN((\mathbf{TEF_{b,t}} - \mathbf{TEF_{a,t}}), 0)$	**(6)**

Total GHG Emission reduction

ΔGE_t = Total GHG émission reduction = $aQ_t \bullet \Delta sE_t$	**(7)**

SECTION E. Data sources and assumptions:

E.1. Describe parameters and or assumptions (including emission factors and activity levels):

Most of the data elements are directly measurable except the following:

- EF - Emission factor of the grid
- TD - Transmission and distribution losses of the grid.
- eCF - Average effective carbon content of the fuel mix for generating electricity in the plant
- eCV - Average calorific value of fuel mix for generating electricity

- tCF - Average effective carbon content of the fuel mix for generating thermal energy
- tCV - Average calorific value of fuel mix for generating thermal energy

These need to be estimated.

SN	Parameter	Process of estimation
1	EF	Chose regional grid which transmits electricity to the plant. Depending on the data availability select a state, region or country (in declining order of preference as the farther we move from the location, the greater is the likelihood that estimate will not represent the emission impact accurately.) The method chosen for emission factor estimation is ‘approximated operating margin method’ For the region: ➢ List all power plants, fuels used and their performance (auxiliary power consumed, despatch of power, plant efficiency/fuel consumption, etc) ➢ Exclude Hydro Power, Wind Power, Geothermal Power, Nuclear Power plants as being least operating cost plants, they will always run and efficiency improvement from the Project will not displace their generation. ➢ Estimate fuel consumption (for each fuel type)

		Emission factor = heat rate(Kcal/KWhr)* emission factor for the fuel (Kg of Co2/Kg)—IPCC values/ (Calorific value Kcal/kg for the fuel—IPCC value/as measured)/(1-auxililary power) Total emission from the plant = emission factor X total KWHr exported by the plant/1000 (Tonne) Total emission for the region = ∑ (plant emissions) Emission factor for the grid = Total emission/Total power exported by power plants. Most of this data may be available with National Electricity Authorities in countries.
2	TD	Transmission and Distribution Losses = (1 - (Total power metered at the consumer end/Total power supplied to the grid by the generating stations) National Electricity Authorities may be monitoring this data in most countries.
3	eCF	Carbon Content of Fuel mix: ∑ (fuel qty consumed x average value of carbon content %) / ∑ fuel qty Carbon content values can be as measured in labs of the plant or as given in supplier certificates or as per IPCC guidelines. Carbon content for bio-fuels assumed to be zero.
4	tCF	-same as above-
5	eCV	Calorific Value of Fuel Mix ∑ (fuel qty consumed x average value of carbon content %) / ∑ fuel qty Calorific values can be as measured in labs of the plant or as given in supplier certificates or as per IPCC guidelines.
6	tCV	- same as above-

E.2. List of data used indicating sources (e.g. official statistics, expert judgement, proprietary data, IPCC, commercial and scientific literature) and precise references and justify the appropriateness of the choice of such data:

>>Most of the data elements to be used are as per Official Statistics of Industry Association or IPCC default values for fuel carbon factors and calorific values.

SN	Data Element	Source
1	esE, tsE	As measured in the plant; energy audit reports.
2	Q	Quantity of production as well as mix, as given in plant log

		books/production records/Management Information Reports
3	reE	Log books/reports of power generating/receiving stations within the plant
4	eeffy, teffy	Calculated based on fuel qty consumed in generating stations, their calorific values and the electrical/thermal power consumed.
5	eCF, tCF	Carbon wt/wt of fuel consumed as validated from sample testing in plant labs or certificates of the supplier. In absence of such data IPCC default values can be taken
6	eCV, tCV	Calorific values (KJ/Kg) of fuels consumed as verified from sample testing in plant labs, certificates from supplier. In absence default IPCC values can be taken.
7	EF	Emission Factor of the grid estimated from published data, government reports, independent baselines established by reputed and qualified energy consultants etc. This data may not be of the same vintage as rest of the data (as such studies take time), but this approximation may be allowed
8	TD	This data will be available from National Electricity Authorities or such bodies as the performance of utilities is tracked in most of the countries. In absence of such data however IPCC default value (20%) may be taken.

E.3. Vintage of data (e.g. relative to starting date of the project activity):

>> In some countries electricity grid data of the most recent origin is not available. In such cases the latest available data will need to be used.

E.4. Spatial level of data (local, regional, national):

>> Need to take regional grid data for grid emission factor and transmission losses.

SECTION F. Assessment of uncertainties (sensitivity to key factors and assumptions):

>>The key uncertainties in the methodology are:

- Adjustment for impact of product-mix differences

To the extent possible, if separate analysis of energy consumption is possible product-wise, this should be done, to eliminate estimation errors.

SECTION G. Explanation of how the baseline methodology allows for the development of baselines in a transparent and conservative manner:

>>
The baseline is based on

- Past performance (of the equipment/process, as well as impact on plant level performance) which can be validated and measured. This makes the baseline transparent.

- The actual performance improvements made after project implementation are excluded (because the actual emission levels are estimated as max of what was initially observed after project implementation, and what is actually observed in period t).

- The emission of other gases such as Nitrous Oxide and Methane, which are produced while burning in energy equipment is omitted. *Also the reduction in energy consumption due to less quantity of fuel mined and transported to the plant is also ignored, which can be substantial in some cases.*

Glossary:

Project	A single improvement or a combination of improvement projects which impact electrical energy consumption, thermal energy consumption and productivity of a manufacturing plant and which together reduce energy consumption/unit of production.
Industry	Industry is defined as consisting of players who produce similar products, serve similar/same markets and face similar conditions of supply of materials, regulation, labour availability, financing etc.
Bio-mass	As defined in revised IPCC 1996 guidelines. Includes wood waste, agricultural waste, bagasse, waste derived fuels (such as municipal waste, industrial waste, bio-gas, tires, plastics etc)
Emission factor EF	Emission Factor of the grid based on 'approximate operating margin' of the grid.

Financial analysis of Project Profitability

Based on proposed Investments: I

Throughput improvement ΔQ $= Q_T - Q_0$ (T)
Specific electrical energy consumption improvement ΔesE $= esE_0 - esE_T$ (KWHr/T)
Specific thermal energy consumption improvement ΔesE $= tsE_0 - tsE_T$ (Kcal/T)
Improvement in generation efficiency of electrical energy $\Delta eeffy$ $= eeffy_T - eeffy_0$ %
Improvement in generation efficiency of thermal energy $\Delta teffy$ $= teffy_T - teffy_0$ %

Average Price Realization for increased throughput = P Rs/T
Expected EBIDTA margin (based on last 3 yrs average or estimate) = m %
Average cost of fuel/unit qty for electricity generation = eFP Rs/T
Average calorific value for fuel for electricity generation = eFCV Kcal/T
Average cost of fuel/unit qty for thermal energy generation = tFP Rs/T
Average calorific value for fuel for thermal energy generation = tFCV Kcal/T

Coefficient to convert KWHr to Kcal = 3600

Marginal tax rate = t
Depreciation rate = reinvestment rate = depr

Operating Cash Flow (Pre-tax) Savings in a year (OCF) =

$= \Delta Q \bullet P \bullet m$

$+ \Delta esE \bullet Q_T / eeffy_0 \bullet K/eFCV \bullet eFP$

$+ \Delta tsE \bullet Q_T / teffy_0 /tFCV \bullet tFP$

$+ esE_T \bullet Q_T (\Delta eeffy / (eeffy_0 \bullet eeffy_T)) \bullet K/eFCV \bullet eFP$

$+ tsE_T \bullet Q_T (\Delta teffy / (teffy_0 \bullet teffy_T))/tFCV \bullet tFP$

Free Cash Flow (FCF) $= OCF \bullet (1-t) + depr \bullet I \bullet t - depr \bullet I$

= (OCF-depr) ●(1-t)

In the beginning of cash-flow stream deduct the initial investment I.

Cash flow stream could be created for 10 yrs by assuming appropriate price trends for fuels and and the product. IRR of these cash flows could be compared to normally acceptable IRRs of similar Projects or Cost of Capital for the Project Proponent.

In developing country context, energy efficiency projects are considered risky as often the technical estimates of possible efficiencies are higher than actual realized. It is recommended that a 4% margin over and above average cost of capital of the proponent should be allowed for such projects. << basis for 4% ??

If project IRR is less than adjusted cost of capital, the project may be presumed to be financially un-attractive and therefore NOT the BAU scenario. Thus qualifying for additionality criteria from the point of view of CDM.

Calculation of weighted average cost of capital for the project proponent:

Debt Cost (i) = average interest cost as it stands in the latest balance sheet of the Project proponent; to be modified if the Project is likely to result in significant worsening of debt: equity ratio and debt coverage (EBIDTA/Debt)

Equity cost (e) = risk free return (10 yr yield on Government Bonds) + equity premium over risk free return % x beta of the Project Proponent

To minimize complexity of the estimation, it is recommended to consider 10% as the equity premium[4] and

beta = 1 for steady businesses (such as power, FMCG, pharmaceuticals, specialty chemicals….)<< justification >>
beta = 1.5 for highly cyclical businesses such as sugar, cement, fertilizer, steel, aluminium, textiles, bulk chemicals, petrochemicals, coal etc.

D:E ratio (d) = for simplification it could be assumed as actual balance sheet based ratio (total debt/ equity (net-worth).

Deferred tax liability/asset to be excluded from both debt and equity
All capital revaluation reserves to be excluded from net worth.

Tax rate (t) = tax rate = marginal income tax rate on the company (after taking into account income tax exemptions if any).

Cost of capital (COC) = i*d/(d+1)*(1-t) + e*1/(1+d)

[4] Valid for developing markets such as India.