



# NORMALIZATION DOCUMENT AND MONITORING & VERIFICATION GUIDELINES

## Cement Sector



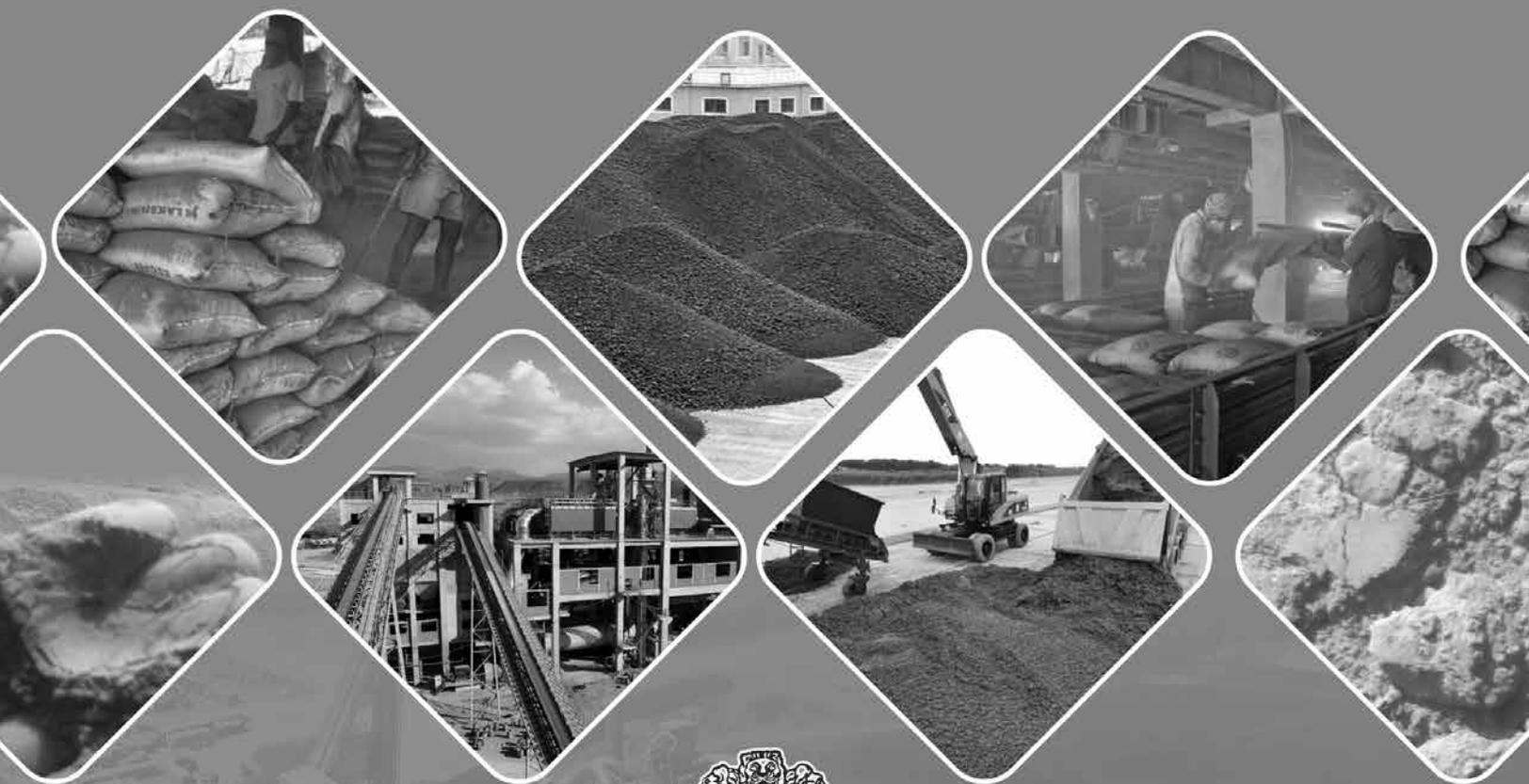
**MINISTRY OF POWER**  
**GOVERNMENT OF INDIA**





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## Cement Sector



**MINISTRY OF POWER**  
**GOVERNMENT OF INDIA**



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Developed specifically for Designated Consumers notified under Perform Achieve and Trade (PAT) Program for National Mission for Energy Efficiency (NMEEE)

## **Disclaimer**

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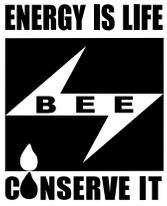
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**BUREAU OF ENERGY EFFICIENCY**

(Government of India, Ministry of Power)

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Director General

## Foreword

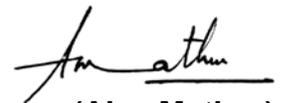
Perform Achieve and Trade (PAT), a flagship initiative under National Mission for Enhanced Energy Efficiency (NMEEE), is a regulatory intervention for reduction of specific energy consumption, with an associated market based mechanism through which additional energy savings can be quantified and traded as ECSerts.

Cement sector is one of the 8 notified energy intensive sectors under which a total of 85 plants are participating in this program. These plants have been mandated to reduce their Specific Energy Consumption (SEC) from baseline year of 2009-2010. It is expected that these plants may save 0.815 million tons of oil equivalent annually by the end of PAT cycle –I.

The publication of “**Normalization Document and M&V Guidelines**” for Cement Sector is an effort to facilitate the DCs to comply with notified PAT rules to participate with the PAT scheme and contribute towards achieving national target of energy savings. This document will also be helpful to all empanelled Accredited Energy Auditors (EmAEAs) and State Designated Agencies (SDAs) in the monitoring and verification process of PAT.

I want to record my appreciation for members of the Sectoral Expert Committee on Cement Sector, chaired by Shri A. Pahuja, Director-General, National Council for Cement and Building Material, Shri K. K. Chakarvarti, Energy Economist, BEE, Dr. K. N. Rao, Director (Energy & Environment) ACC Limited – Chairman, Technical Subcommittee, who worked tirelessly to put together the baseline data, normalization factors and M&V methodology for the sector. I especially want to record my appreciation for Shri S. Vikash Ranjan Technical Expert, GIZ who has put together the data and methodology associated with normalization.

I also compliment the efforts of all participating industrial units towards their endeavor in contributing to the national energy saving targets.

  
(Ajay Mathur)

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# NORMALIZATION METHODOLOGY

## Cement

### 1. Introduction

In the journey towards inclusive growth of a country, the cement sector plays a vital role in its economic advancement and stays one of leading focal points for the construction sector and all infrastructure projects. The industry occupies an important place in the Indian economy because of its strong linkages to other sectors such as construction, transportation, coal and power.

The Indian cement industry is involved in production of several types of cement such as Ordinary Portland Cement (OPC), Portland Pozzolana Cement (PPC), Portland Blast Furnace Slag Cement (PBFS), Oil Well Cement, Rapid Hardening Portland Cement, Sulphate Resisting Portland Cement, White Cement, etc. The Perform, Achieve and Trade (PAT) launched by the Bureau of Energy Efficiency under the Ministry of Power, Government of India, offers an opportunity to the industry to improve its energy efficiency and reduce energy consumption resulting in long term economic benefits in terms of reduced fuel expenditure with trading

### 2 Perform, Achieve and Trade (PAT)

The National Mission for Enhanced Energy Efficiency is one of the eight national missions under the National Action Plan on Climate Change. NMEEE is an integrated approach for climate change mitigation through energy efficiency measures. The mission was considered by the PM's council on Climate Change on 24 August, 2009 and has been approved by the Indian Cabinet in June, 2010.

In almost every sector in India, there is a large variation in energy intensities of different units,

ranging from amongst the best in the world to extremely inefficient units. As a result, there is room to improve energy intensity in India with current commercially available technologies and best practices.

The key goal of the PAT scheme under NMEEE, is to mandate specific energy efficiency improvements for the most energy intensive industries, and further incentivise them to achieve better energy efficiency improvements that are superior to their specified SEC improvement targets.

To facilitate this, the scheme provides the option to industries that achieve superior savings to be rewarded with energy saving certificates for the excess savings, and to trade the additional certified energy savings certificates with other designated consumers who can utilise these certificates to comply with their reduction targets. The Energy Saving Certificates (ESCerts) so issued will be tradable on special trading platforms to be created in the power exchanges.

During the first cycle of PAT scheme, i.e. from 2012-13 to 2014-15, eight energy intensive sectors such as thermal power plants, aluminium, cement, chlor-alkali, fertiliser, iron & steel, pulp & paper, and textile have been included. There are 478 designated consumers in these 8 sectors and they account for about 165 million tonnes of oil equivalent of energy consumption annually. Upon implementation of the first cycle of PAT, it is expected that India would save energy to the tune of approximately 6.686 million tonnes of oil (mtoe) equivalent of energy, worth Rs6,800 crore by the end of 2014-15, equivalent to reduction of greenhouse gas emission by 24 million tonnes per year.



The Bureau of Energy Efficiency is at present focusing on development of normalisation factors so as to normalise the variation of operating parameters in the target year with respect to baseline operating parameters.

### 3. Indian Cement Industry and PAT

The threshold limit of 30,000 tonnes of oil equivalent (toe) has been defined as cut-off limit criterion for any unit in the cement sector to be identified as designated consumer and to be covered in PAT. The scheme has identified 85 designated consumers from the cement sector.

The cement sector has been categorised on the basis of products and process involved into seven sub-sectors – Portland Pozzolana Cement (PPC), Ordinary Portland Cement (OPC), Portland Slag Cement (PPC), Wet Plants, White Plants, Grinding Plants and Clinkerisation Plants. The total reported energy consumption of these designated consumers is about 15.01 mtoe. By the end of the first PAT cycle, the energy savings of 0.815 mtoe /year is expected to be achieved, which is around 12% of the total national energy saving target assessed under PAT.

**Table 1: Sector-wise reduction target under PAT Cycle 1**

S. No.	Sector	No. of Identified DCs	Annual Energy Consumption (Million toe)	Share Consumption (%)	Apportioned Energy Reduction For PAT Cycle-1 (Million toe)
1	Power (Thermal)	144	104.56	63.38%	3.211
2	Iron & Steel	67	25.32	15.35%	1.486
3	Cement	85	15.01	9.10%	0.815
4	Aluminium	10	7.71	4.67%	0.456
5	Fertilizer	29	8.20	4.97%	0.478
6	Paper & Pulp	31	2.09	1.27%	0.119
7	Textile	90	1.20	0.73%	0.066
8	Chlor- Alkali	22	0.88	0.53%	0.054
	Total	478	164.97	100.00%	6.686

The specific energy consumption patterns of most of the plants have a wide bandwidth. This happens mainly because of different product mix based on addition of Pozzolona, Slag and Fly Ash as blending additives. The Ordinary Portland Cement (OPC) has only Gypsum as an additive and consumes the highest energy per tonne. The clinker blends with additives to produce varieties of cement reduces the specific energy consumption per tonne.

### 4. Methodology for Baseline and Energy Performance Index (EPI)

Because of the complexities, it becomes extremely difficult to come to a common

model to arrive at standardised SEC per tonne. Considering all these situations, conversion factors and best possible combination and categorisation have been worked out so that no designated consumer may have any grievance on the targets. While setting targets, the best unit in the group was set as reference and then the targets were worked out for others.

#### Dimensions of PAT mechanism:

- Methodology for establishing the baseline energy consumption
- Methodology for target setting for each sector



- The process of measurement and verification, in particular the verification agencies that need to be appointed by BEE for this purpose.
- The manner in which trading of the energy saving certificates can be encouraged, particularly instruments that could increase liquidity in the system.

#### 4.1 General Rule for Establishing Baseline

Baseline Production ( $P_{base}$ ) : Avg. of 2007-8, 2008-9 & 2009-10  
 Baseline SEC ( $SEC_{base}$ ) : Avg. of 2007-8, 2008-9 & 2009-10  
 Baseline CU% ( $CU_{base}$ ) : Avg. of 2007-8, 2008-9 & 2009-10  
 Target SEC ( $SEC_{target}$ ) : SEC as estimated in 2014-15

**Estimation of Energy Saving (MTOE) :**  $P_{base} (SEC_{base} - SEC_{target})$

#### 4.2 Methodology for Baseline and Energy Performance Index (EPI)

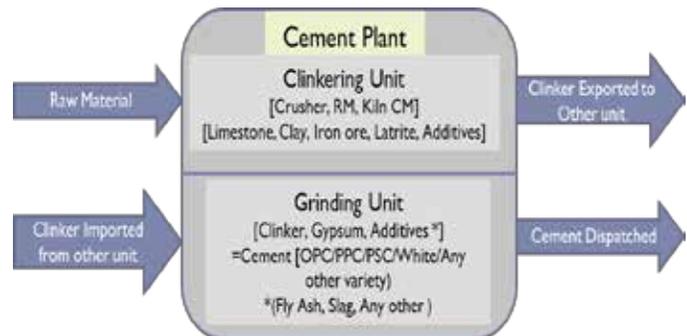
- For each plant, different types of cement products and exported clinker are converted into equivalent major product produced by that plant with the help of conversion factor, reported by the plant concerned.
- Thermal Energy Input is arrived at by taking all types of fuels into account.
- Electricity Purchased is converted into equivalent thermal energy by multiplying it with 860. Whereas the electricity exported to the grid is calculated similarly by multiplying it with 2,717 (national average heat rate).
- Notional energy is also imposed on imported power
- Notional Equivalent Thermal Energy for Imported Power = Electricity purchased

from Grid x (Weighted avg. heat rate of CPP of Cement plants-860).

- Total GtG Energy Consumption is calculated by adding the thermal inputs through all type of fuels, electricity purchased and subtracting the power exported to grid.
- Notional Energy (equivalent thermal energy) for Exported and Imported clinker are calculated based on thermal and electrical SEC reported by the concerned plant, wherein the Electrical kWh is converted into thermal kCal by multiplying the weighted average heat rate of the all form of electricity used in plant
- The notional energy required for exported/ imported clinker is added to the total thermal and electrical energy consumed by the plant only to arrive at the Gate to Gate Specific Energy Consumption.

#### 4.3 Inbuilt Normalisation in EPI Calculation

##### 4.3.1 Product Mix



Conversion of Cement Equivalent to Major grade = (Cement production of a particular grade) X (CF\* of Same grade)/(CF of Major grade)

Total Cement Production Equivalent to major grade = Production of all grades of cement equivalent major grade + (exported clinker equivalent to major grade Cement)\*\*

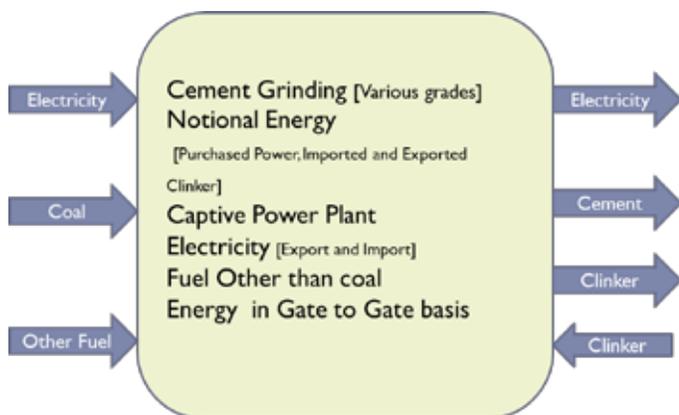
\*CF (Conversion Factor)= Clinker used for x grade/Cement Production of x grade



### 4.3.2 Energy Mix

In this model, all possibilities are considered

1. Cement Grinding of various grades
2. Notional energy required for Import and Export Clinker
3. Captive Power Plant
4. Electricity Import and export
5. Any Fuel other than Coal
6. Energy Accounted on Gate to Gate basis

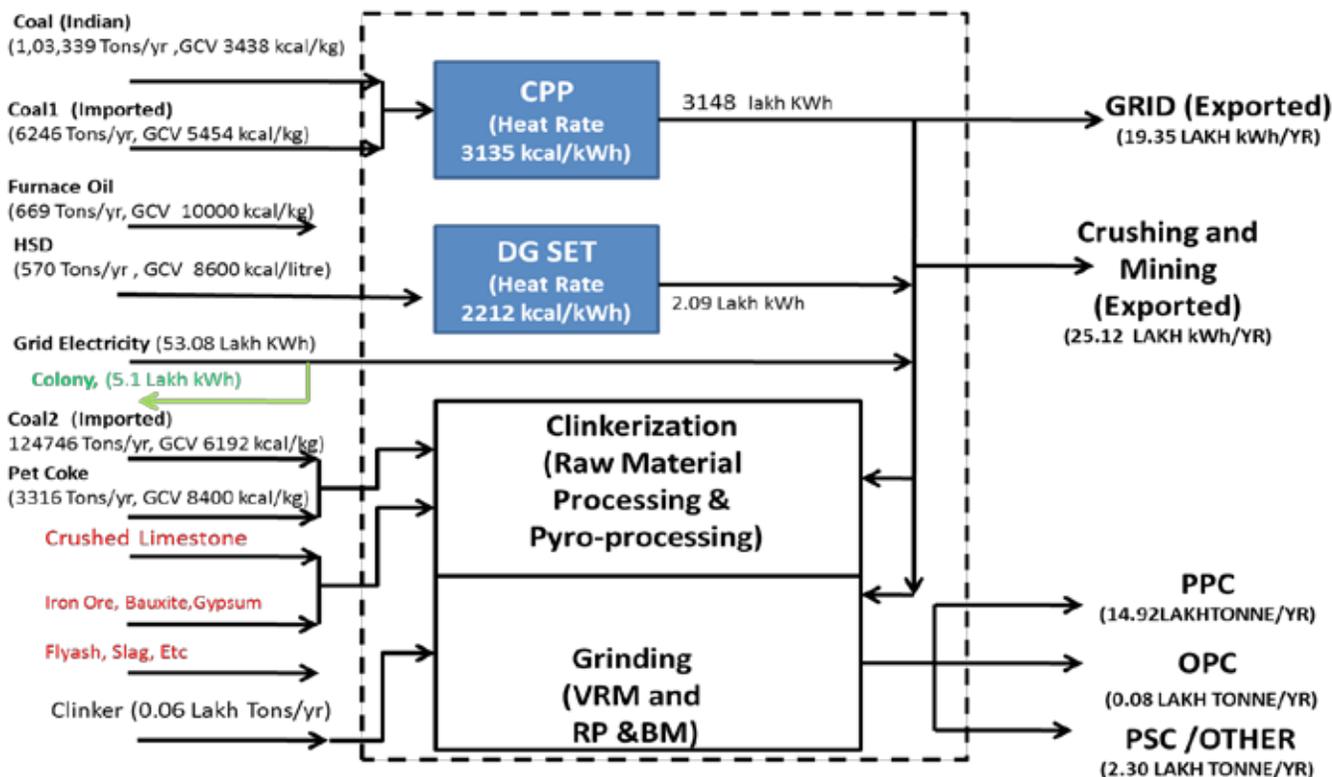


### 4.3.3 Input-Output for a typical Cement Plant

The typical boundary of a cement plant in the gate-to-gate concept under the PAT scheme ranges from input energy and raw material to output energy and product. The boundary depicts the specific energy consumption, which is energy consumed per unit of production. The SEC of an industry is calculated based on the gate-to-gate concept with the following formula:  
Specific Energy Consumption (SEC) =

$$\frac{\text{Net energy input into the designated consumers' boundary}}{\text{Total quantity of output exported from the designated consumers' boundary}}$$

The theory of normalisation flows automatically with the input output concept, wherein change in the power source mix (Grid/CPP/DG/WHR/Co-Gen), product mix (OPC/PPC/PSC/Others) in the assessment year from baseline year could be worked out.



Note: All values presented in the above diagram are average of annual energy consumption of 2007-08, 2008-09, 2009-10



#### 4.3.4 Normalisation Factors considered

The following normalisation factors have been considered

##### 4.3.4.1 Equivalent major grade of cement production

The various product mixes are converted into equivalent major grade of cement product by the plant by using the following formulae:

(i) **Conversion of Ordinary Portland Cement (OPC) production equivalent to major product**

$$\text{Equivalent Major Product} = \frac{\text{OPC Produced (Lakh Tonne)} \times \text{Conversion factor of OPC}}{\text{Conversion Factor of Major Product}} \quad [\text{Lakh Tonne}]$$

(ii) **Conversion of Portland Pozolona (PPC) Production equivalent to major product**

$$\text{Equivalent Major Product} = \frac{\text{PPC Produced (Lakh Tonne)} \times \text{Conversion factor of PPC}}{\text{Conversion Factor of Major Product}} \quad [\text{Lakh Tonne}]$$

(iii) **Conversion of Portland Slag Cement (PSC)/any other variety of Cement Production equivalent to major product**

$$\text{Equivalent Major Product} = \frac{\text{PSC or any other variety Cement Produced (Lakh Tonne)} \times \text{Conversion factor of PSC or any other variety Cement}}{\text{Conversion Factor of Major Product}} \quad [\text{Lakh Tonne}]$$

(iv) **Conversion of Total Exported clinker to major product**

$$\text{Equivalent Major Product} = \frac{\text{Total Exported Clinker (Lakh Tonne)}}{\text{Conversion Factor of Major Product}} \quad [\text{Lakh Tonne}]$$

Where: Total Exported clinker= [Clinker Exported to other plants + clinker exported to clinker stock over and above the opening stock,]

(v) **Conversion of Total Imported clinker to major product**

$$\text{Equivalent Major Product} = \frac{\text{Total Imported clinker (Lakh Tonne)}}{\text{Conversion Factor of Major Product}} \quad \text{Lakh Tonne}]$$

Where: Total Imported clinker= [Clinker Imported from other plants + clinker Imported from clinker stock, equivalent to the quantity by which the clinker opening stock gets reduced]



(vi) **Total Equivalent major product of Cement**

It can be arrived at by summing up all the different grades of cements equivalent to major product calculated above:

$$\text{Total Equivalent major product of Cement} = a(i) + a(ii) + a(iii) + a(iv) \quad [\text{Lakh Tonne}]$$

**Note: S.No. a (v) is already accounted in major product**

**4.3.4.2. Calculation for Gate to Gate Specific Energy Consumption (SEC)**

i. **Total Thermal Energy Consumption (Kiln + power Generation)**

Total Thermal Energy Consumptions to be calculated as:-

$$\text{Total Thermal Energy Consumption} = \{[\text{Fuel consumed (kiln+ power generation) (in Lakh Tonne) X Gross calorific value of respective fuel (kcal/kg) X 100}] - \{(\text{Electricity exported to grid (Lakh kWh) X 2717 (kcal/kWh)} / 10)\}$$

**[Million kcal]**

Where: - 2717 kcal/kWh is the National Average Gross Heat Rate of Thermal Power Stations in the country in 2007.

ii. **Energy for Imported Electricity Consumption**

Total energy for imported Electricity Consumption is to be calculated as:-

$$\text{Total energy for Imported Electricity} = \{[(\text{Total Imported Electricity from grid (Lakh kWh) X 860(kcal/kWh)} / 10)]$$

**[Million kcal]**

iii. **Notional/ Normalisation energy for Imported electricity from Grid**

$$\text{Notional Energy for imported electricity} = \{[\text{Imported Electricity (Lakh kWh) x (3208 - 860) (kcal/kWh)} / 10]$$

**[Million kcal]**

Where: 3208 kcal/kWh is the weighted average heat rate of captive power plants in all DCs in cement sector.

iv. **Notional/ Normalisation energy for grinding of exported Clinker**

It is calculated by using following formula:

$$\text{Notional Energy} = \{[\text{Total Exported clinker to major product (Lakh tonne) x Electrical SEC of cement grinding (kWh/tonne of cement) x Weighted Average Heat Rate (kcal/kWh)} / 10]$$

**[Million kcal]**

Where:- Weighted Average Heat rate (kcal/kWh) =  $\{[\text{Imported Electricity (Lakh kWh)} \times$

$$3208 \text{ (kcal/kWh)} + \{ \text{DG generation (lakh kWh) x DG heat rate (kcal/kWh)} \} +$$

$$\{ \text{Captive Power Plant Generation (lakh kWh) x Captive Power plant heat rate$$

$$\text{(kcal/kWh)} \} / [\text{Imported Electricity (Lakh kWh) + DG generation (Lakh kWh)}$$

$$\text{+Captive power plant generation (Lakh kWh)}]$$

v. **Notional/ Normalisation energy for clinkerisation of imported Clinker**

It is calculated by using following formula:

$$\text{Notional Energy} = \text{Total Clinker imported (Lakh ton) x } \{[(\text{Thermal SEC of Clinkerisation, kcal/kg clinker x 1000}) + \{ \text{electrical SEC of clinkerisation (kWh/ton of clinker)} \} \times \text{Weighted Average Heat Rate (kcal/kWh)}] / 10$$

**[Million kcal]**

vi. **Gate to Gate (GtG) Energy Consumption**

$$\text{GtG Energy Consumption} = b(i) + b(ii) + b(iii) + b(iv) + b(v)$$

**[Million kcal]**



vii. Gate to Gate (GtG) Specific Energy Consumption

$$\text{GtG SEC} = \frac{\text{GtG Energy Consumption (Million kCal)}}{\text{Total Equivalent Major Product of Cement (Lakh Tonne)} \times 100}$$

[kcal/kg of equivalent cement]

Note: - Notional/Normalisation Energy is not to be considered in Total Energy Consumption while deciding whether a plant falls under the designated consumer category or not. Normalisation energy is considered only in the calculation of Gate to Gate Specific Energy Consumption.

#### 4.4. Methodology (Summary)

- i. For each plant, different types of cement products and exported clinker are converted into equivalent major product produced by that plant with the help of clinker factors, reported by the plant concerned.
- ii. Thermal Energy Input is arrived at by taking all types of fuels into account (biomass or waste products energy is not considered if fired in a kiln). Electricity purchased is converted into equivalent thermal energy by multiplying it with 860 and loaded with notional energy (3,208-860 kcal/kWh). Whereas the electricity generated by the captive power plant exported to the grid is calculated similarly by multiplying it with 2,717 (national average of heat rate) and subtracted from the thermal energy used in generating the power.
- iii. Total GtG Energy Consumption is calculated by adding the thermal inputs through all types of fuels, electricity purchased and subtracting the power exported to the grid.
- iv. Notional Energy (equivalent thermal energy) for Exported and Imported clinker are calculated based on thermal and electrical SEC reported by the concerned plant, wherein the Electrical kWh is converted into thermal kcal by multiplying the weighted average heat rate of the plant, which takes into account imported electricity, DG set heat rate and captive

power plant heat rate.

- v. The notional energy required for imported power and exported/imported clinker is added to the total thermal and electrical energy consumed by the plant only to arrive at the GtG Specific Energy Consumption.

#### 5. Target Setting in Cement Plants

##### 5.1 Grouping of Cement plants

For the establishment of energy consumption norms and standards for designated consumers in the cement sector, the designated consumers have been grouped based on similar major product and process for benchmarking of their Specific Energy Consumption performance. The groupings are as under:

- a. PPC Major product (This group contains cement plants producing PPC as a major product in overall production and all other products are converted to equivalent PPC)
- b. OPC Major product (This group contains cement plants producing OPC as a major product in overall production and all other products are converted to equivalent OPC)
- c. PSC Major product (This group contains cement plants producing PSC as a major product in overall production and all other products are converted to equivalent PSC)
- d. White Cement Plant
- e. Wet Cement Process Plant
- f. Clinker Grinding Plant
- g. Clinkerisation Plant



## 5.2 Energy Consumption Range

**DRAFT**  
**ENERGY CONSUMPTION RANGE IN INDIAN CEMENT PLANTS (85 DC's) (2007-10)**

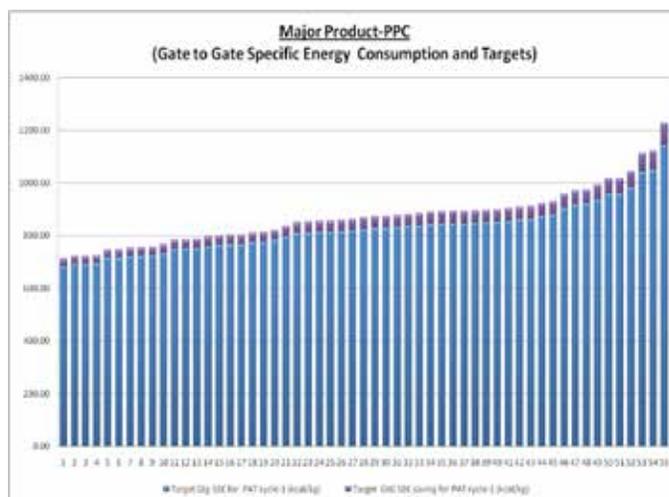
Products/Process (No. of Plants)	Thermal Energy Consumption (kcal/kg of clinker)		Electric Energy Consumption (kWh/Tonne equivalent cement)		Normalized Energy Consumption gtg (kcal/kg equivalent cement)		Total Energy Consumption of Sub-Sector (toe)	% Share of Sub-Sector (%)
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum		
(Major Product)								
PPC (55 Plants)	658	1074.02	64.18	110.24	712.31	1227.1	10292843.975	68.57%
OPC (16 Plants)	727.33	1000.94	75.67	143.48	964.66	1368.43	3295349.387	21.95%
PSC (7 Plants)	701.02	1207.71	71.03	119.69	700.39	968.17	932008.497	6.21%
White Cement (2 Plants)	1093.72	1279.66	108.93	119.81	1452.23	1484.65	105566.281	0.70%
Wet Cement Plants (2 Plants)	1026.67	1415.07	79.75	113.86	1241.4	1244.56	152403.633	1.02%
Grinding Units (2 Plants)	—	—	38.78	40.38	138.73	201.05	88211.169	0.59%
Only Clinkerization (1 Plant)	869.33		87.47		1257.22		143790.367	0.96%
<b>Total</b>							<b>15010173.309</b>	<b>100.00%</b>

The wide bandwidth of specific energy consumption (SEC) within an industrial sector is indicative of the large energy-savings potential in the sector. The wide bandwidth is also a reflection of the differences in the energysaving possibilities among plants because of their varying vintage, production capacity, raw material quality and product-mix. Such wide variation also makes it difficult to specify a single benchmark SEC for the sector as a whole – older plants will find the benchmark impossibly high if it is set at the level of newer plants; newer plants will find it trivial if it is set at the level of older plants.

The broad bandwidth of SEC within a sector, and the inability of all plants to achieve a sectoral benchmark SEC, suggests that SEC improvement norms need to be set for individual plants. These SEC improvement targets can be based on the trend of energy consumption and energysaving potential of the plants. In general, the higher the energy efficiency (or the lower the SEC), the lower the energysaving potential.

Thus, it is evident that it is not feasible to define a single norm/standard unless there is significant homogeneity among units in a sector. Therefore, the energy efficiency improvement targets fixed are “unit specific”. Each DC is mandated to reduce its SEC by a certain value, based on its current SEC (or baseline SEC) within the sectoral bandwidth.

### 5.3 Example: Normalised Baseline Parameters and Target for PPC





85 cement plants covered under PAT have been grouped under 7 Categories; of these 55 cement plants produce Portland Pozzolana Cement (PPC) as a major product. The plants shown in the bar chart have normalised baseline operating parameters. The energy saving targets have been assigned based on their energy efficiency

performance in the baseline year and increases as the inefficiency level increases. The exercise has helped in creating a benchmark for the plants covered in the cement sector. The plant can compare its performance with other plants as all of them have now normalised baseline parameters values.

#### 5.4 Apportionment of Sub-Sector Target of Energy Saving in Cement Sector

S.No.	Sub Sector	NO. OF DCs	Avg. Energy Consumption			Target Energy Reduction for PAT Cycle-1	
			Mkcal	Million toe	%	Million toe	toe
1	PPC	55	102928440	10.293	68.57%	0.559	558865.489
2	OPC	16	32953494	3.295	21.95%	0.179	178925.965
3	PSC	7	9320085	0.932	6.21%	0.051	50604.807
4	White	2	1055663	0.106	0.70%	0.006	5731.880
5	Wet	2	1524036	0.152	1.02%	0.008	8274.985
6	Grinding	2	882112	0.088	0.59%	0.005	4789.558
7	Clinkerization	1	1437904	0.144	0.96%	0.008	7807.315
	<b>Total</b>	<b>85</b>	<b>150101733</b>	<b>15.010</b>	<b>100.00%</b>	<b>0.815</b>	<b>815000.000</b>

The energy saving targets in a group have been calculated on the basis of energy consumption of that particular group and is apportioned accordingly. The saving target of cement sector

was calculated in the table as 0.815 mtoe and is distributed among the group as per the energy consumption.

##### 5.4.1 Apportionment of Target of Energy Saving in individual Cement plant

S.No.	Name of Designated Consumer	Annual GtG Energy Consumption (Mkcal)	Annual GtG SEC (kcal/kg)	Relative SEC	Reduction in SEC Target (%)	Target SEC for PAT cycle-1 (kcal/kg)	Energy Saving With X factor (toe)	Target Energy Savings for PAT cycle-1 (toe)
MAJOR PRODUCT PPC								
1	Plant 1	2721475.76	712.31	1.00	3.9903	683.89	2721.48	10859.50
2	Plant 2	1777311.96	721.49	1.01	4.0418	692.33	1800.24	7183.54
3	Plant 3	1829132.15	721.98	1.01	4.0446	692.78	1854.01	7398.11
4	Plant 4	2740709.49	724.92	1.02	4.0609	695.48	2789.22	11129.75
5	Plant 5	1104943.57	746.17	1.05	4.1798	714.99	1157.43	4618.44
6	Plant 6	1746813.05	746.79	1.05	4.1834	715.55	1831.36	7307.62
7	Plant 7	1288276.78	753.44	1.06	4.2205	721.64	1362.61	5437.17
8	Plant 8	3729606.74	755.01	1.06	4.2297	723.08	3953.38	15775.12
9	Plant 9	1257253.99	756.35	1.06	4.2369	724.30	1334.95	5326.86
10	Plant 10	1557717.77	768.16	1.08	4.3031	735.11	1679.84	6703.02
11	Plant 11	2634424.58	783.29	1.10	4.3877	748.92	2896.81	11559.06



- Total Energy Consumption for the Sector does not include the notional energy required for exported/imported clinker as in case of GtG SEC calculation.
- The sectoral target for cement is allocated on a pro-rata basis of total energy consumption among 7 sectors under PAT scheme; the targets for the thermal power sector have been fixed separately.
- Sub-Sectoral target is allocated on a pro-rata basis of total energy consumption in the grouping among the total cement sector.
- The DC level target is allocated based on a statistical analysis derived from relative SEC concept. This approach will be applicable to all the DCs of a sub-sector.

The individual plant's energy saving targets were calculated on the basis of the group's saving. The example shown is of a plant of the PPC group, wherein the target for this group was calculated as 558,865 tonnes of oil equivalent. This saving needs to be divided by 55 plants in the PPC group by distributing the target as per their existing efficiency level. The same was distributed among the plants with a statistical approach and arrived at the saving target for an individual plant.

## 6. Normalisation

There are several factors that need to be taken into consideration in the assessment year such as change in the product mix, capacity utilisation, change in fuel quality, import/export of power, etc influenced by external factors, i.e., factors beyond the plant's control, in calculating the Specific Energy Consumption (SEC) of the plant within the boundary. This will ensure no undue advantage or disadvantage is imposed on a DC while assessing the performance in the assessment year as compared to the baseline year.

The operating parameters in the assessment year have to be normalised with reference to the baseline year so as to avoid any favourable or adverse impact on the specific energy consumption of the plant. This will also help to gauge accurately the energy efficiency projects implemented by the plant.

### External Factors are:

- **Market Demand**
- **Grid Failure/Breakdown** (Grid not Sync with CPP)
- **Raw Material Unavailability**

- **Natural Disaster** (Flood, Earthquake etc)
- **Major change in Government policy** (Hampering plant's process system)
- **Unforeseen Circumstances** (Labour Strike/ Lockouts/Social Unrest/Riots etc)

Normalisation factors for the following areas have been developed in the cement sector, which will ultimately affect the gate to gate specific energy consumption in the assessment year. A broad categorisation of the factors are presented here:

- **Capacity Utilisation**
  - Availability of Fuel/Raw Material (Effect on Capacity Utilisation)
  - Natural Calamity/Rioting/Social Unrest/Labour Strike/Lockouts (Effect on Capacity Utilisation)
- **Product Mix & Intermediary Product**
- **Fuel Mix** (Pet Coke Utilisation in Kiln)
- **Power Mix** (Imported & Exported from/ to the grid and self-generation from the captive power plant)
- **Fuel Quality in CPP**
- **Low PLF in CPP**
- **Environmental Concern** (Additional Environmental Equipment requirement due to major change in government policy on Environment)



Normalisation will also takes place following some unavoidable circumstances in the assessment year as compared to the baseline year on furnishing authentic documents.

## 6.1 Capacity Utilisation

Variation in plant Capacity utilization in assessment year may take place from baseline year. This will have impact on gate to gate specific energy consumption

With the decrease in capacity utilisation due to any external reason not controlled by plant such as Market demand, Grid Power holiday etc. in the assessment year, the heat rate and specific energy consumption will also get upset and deteriorates the performance of the plant. Thus, this effect will attract the Normalization in assessment year w.r.t. the baseline year.

### 6.1.1 Need for Normalization

The normalization on capacity utilisation factor will be influenced by following external condition

- Market Demand
- Raw Material availability
- Grid Power holiday
- Natural Disaster
- Rioting/Social Unrest/Labour Problem
- Unforeseen Circumstances

The deterioration of Capacity Utilisation due to Internal Factor of plant such as Breakdown of Machine, Power breakdown, Poor maintenance practices, Plants management policy etc. will not be considered.

### 6.1.2 Normalization on Capacity Utilization

The capacity utilization normalization of the plant would be calculated for two different situations

1. Kiln capacity decrease due to external factor i.e., plant has to run at lower capacity as compared to the baseline operating capacity due to fuel, raw material non availability
2. Kiln capacity loss due to market demands/ power cuts/power holiday/setc leading to nos of Kiln Cold startup and Kiln Hot Shutdown due to outages not controlled by plant. The energy for cold startup and Hot stop will be used without significant or no production.

The Plant's kiln capacity and production rate has to be defined by taking hours of operation of kiln for the baseline and Assessment Year. So instead of taking TPD, the kiln capacity is taken as TPH.

#### 6.1.2.1 Normalization on Capacity decrease due to external factor

- The deterioration of Kiln Heat rate with the kiln capacity could only be seen if the production has been decreased from the rated Kiln capacity, hence TPH comparison between baseline and assessment year is done to arrive at proper Normalization Factors.
- However, segregation is required between Internal and External factor, which has influence on Heat rate deterioration.
- The plant capacity in the assessment year will be compared from the baseline year in terms of Ton per Hour (TPH)
- Separate curve of Plant production rate Vs Thermal Energy consumption and Plant production rate Vs Electrical Energy Consumption for nos of plant have been analysed with curves were plotted and curve equation has been drawn. The equation is being used for defining various capacity utilisation factors.



### 6.1.2.2 Normalization due to kiln cold startup and Hot Stop caused due to external factor

#### Thermal Energy

- The Energy loss due to cold startup caused due to external factor defined above has been taken for kiln stabilization period during 24 hours achieving normal production level in 24th hour
- Based on different combination of kiln capacity an equation has been drawn to equate all capacities in mathematical form.
- Plant should maintain the records of the number of outages during the baseline and assessment year
- The Notional Energy due to loss in Productive hours due to external factor [In terms of Nos of Kiln Cold Startup] will be deducted from the assessment year Energy.

#### Electrical Energy

- The difference of Electrical Energy used during the Cold Startup from Baseline year to the Assessment year will be deducted from the Assessment year
- Plant needs to maintain proper Energy Meter Reading Records during Kiln Cold Startup due to external factors for baseline as well as assessment year

### 6.1.2.3 Definition of Cold Startup and Hot Stop of Kiln

Item	Record	Unit
Kiln Hot to Hot start	Annual	Hours
Kiln Hot to Cold stop due to external factor	Annual	Hours
Kiln Hot to Cold stop due to external factor	Annual	Nos
Kiln Hot to Cold stop due to external factor (Electrical Energy Consumption)	Annual	Lakh kWh

Kiln Cold to Hot start due to external factors	Annual	Hours
Kiln Cold to Hot start due to external factors	Annual	Nos
Kiln Cold to Hot start due to external factors (Electrical Energy Consumption)	Annual	Lakh kWh
Kiln Cold to Hot start due to internal factors	Annual	Nos

### 1. Hot to Hot Start in hours

#### Definition

A hot relight is required when a brief interruption of the electrical power supply causes the kiln to shut down. Even though the shut-down may have occurred unexpectedly due to Equipment Breakdown or O&M reasons, the plant should maintain the records in hours from Kiln Light-up to reach the pre-shutdown production level. The duration of such shut down could range from minutes to an hour.

#### Proforma - Data Entry

The DCs are required to fill the data in terms of total nos of hours per annum for Kiln small breakdowns/Shutdown due to internal or external factor in the modified data entry form.  $[\sum (\text{nos of Kiln Hot to Hot Start} \times \text{Nos of hours to reach Normal production level})]$ . The data entry is required for record purpose only.

*Internal factor:* Equipment Breakdown in Kiln Section having direct relation with mass, energy and air balancing equipment kiln, Operational Issues etc

*External Factor:* Factors, which cannot be controlled by Plant such as Grid Failure, Grid Shutdown, Flood, Earth-Quake etc

*Normal Production:* 70% of the Kiln Capacity is termed as Normal Production or the kiln production rates before the kiln stoppage due to external factor



#### Documentation:

The documents maintained by DCs clearly shows the direct reasons of the shutdown along with time and duration in hours and Energy consumed with quantity of Feed to reach the pre-shutdown production level for each such break-down or shutdown.

## 2. Hot to Cold Stop

### Definition

Hot to cold Stop means the cessation of kiln operation. Shutdown begins when feed to the kiln is halted and ends when continuous kiln rotation ceases (Inching Stop). Planned shutdown caused due to internal and external factor of a kiln, consumes only electrical energy during Kiln slowing down. The shutting down of kiln, either occur due to internal factors like Operational issues, major break down of kiln section equipment etc or due to external factor like Unavailability of Grid Power, Raw material un-availability, Storage Full due to Market condition etc. These conditions are to be captured in-terms of Energy record (Electrical) with no of hrs, kiln takes until zero kiln rotation. Proforma - Data Entry

The DCs are required to maintain the duration in hours of Kiln slowing down i.e., when the Feed in the kiln is halted and up to the zero rotation of kiln in a year with Energy consumption during the period caused due to internal and external factors separately. The data in nos are required to be filled up for external factor only. [ $\sum$  (Nos of Kiln Hot to Cold Stop x Nos of hours to reach zero rotation of kiln)].

The reading records for Energy meters are required to be maintained for such Hot to Cold stops. The difference of Electrical energy consumed during baseline as well as in assessment year will be deducted in the assessment year.

*Internal factor:* Equipment Breakdown in Kiln Section having direct relation with mass, energy and air balancing equipment kiln, Operational Issues, Planned Shutdown etc

*External Factor:* Factors, which cannot be controlled by Plant such as Grid Power Availability, Market Condition, Flood, Earth-Quake, Social Unrest, etc

#### Documentation:

The documents maintained by DCs clearly shows the direct reasons of the shutdown along with duration in hours and Energy consumed in each such shutdown.

## 3. Cold to Hot Start

Start-up as the time from when a shutdown Cold kiln first initiates firing fuel until it begins producing clinker at normal production level in a single run. Thus, Cold to Hot Start begins when a shutdown kiln turns on the induced draft fan and begins firing fuel in the main burner. The feed is being continuously introduced into the kiln up to kiln normal production level maintaining Kiln inlet temperature. The duration has been taken as 24 hours with part feed after the end of 16th hour. Thermal Energy will be used during the cold start-up of kiln to reach and maintain Kiln inlet temperature. The Cold start of kiln may take place due to Internal and external factors.

### Proforma- Data Entry - Data Entry

The DCs are required to fill the data in Nos for Cold start caused due to both Internal and External Factors.

### Thermal energy loss due to Cold to hot Start

The DCs are required to enter the data in Nos for cold start caused only due to External Factors. The data to be filled for both Assessment and Baseline year. The nos of cold start then be multiplied with Cold start up Thermal Energy



per cold start-up to get the Extra Energy consumption due to difference in start-up from Baseline and Assessment year. NCCBM has developed the relation between Energy and No of cold starts for all the kiln, which is integrated in one equation for normalization.

### Electrical Energy loss due to Cold to hot Start

The Electrical Energy consumed during such starts should be maintained through proper Energy meter reading records during the Hot Start period for baseline as well as assessment year. The difference will then be normalized by deducting the same in assessment year

*Internal factor:* Equipment Breakdown in Kiln Section having direct relation with mass, energy and air balancing equipment kiln, Operational Issues, Planned Shutdown etc

*External Factor:* Factors, which cannot be controlled by Plant such as Grid Power Availability, Market Condition, Flood, Earth-Quake, Social Unrest, etc

*Normal Production:* 70% of the Kiln Capacity is termed as Normal Production or the kiln production rates before the kiln stoppage due to external factor

Documentation:

The documents maintained by DCs clearly shows the direct reasons of the shutdown for Cold Start-up along with other documents related to both internal and external factors.

### 6.1.3 Normalization Calculation on Capacity decrease due to external factor

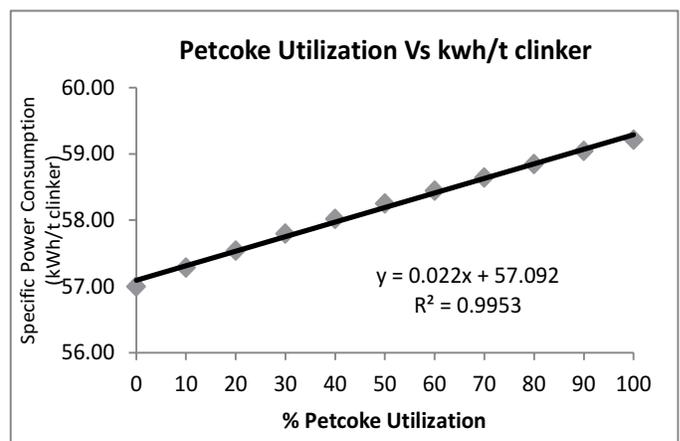
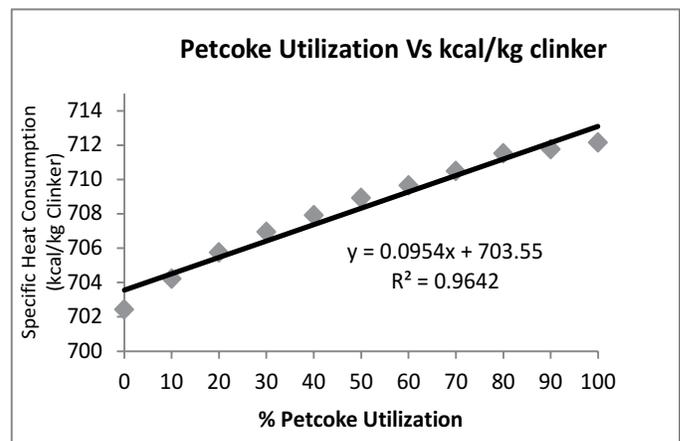
Variation in plant Capacity utilization in TPH in assessment year may take place from baseline year. The same could be normalised as per %age capacity utilisation equation w.r.t. thermal energy of kiln in terms of kiln heat rate and

electrical SPC in terms of kwh/ton of Clinker. This will be applied for comparing the baseline and assessment year TPH derived from annual production and kiln running hours of individual kiln.

NCCBM study for Cement Sector indicates that there is 6 % increase in energy required by clinker when the capacity utilization falls to 55% of the rated value.

#### 6.1.3.1 Pre-Requisites for Capacity Normalization

- The CU Normalization will be utilized if the plant shows deterioration in capacity in terms of Kiln TPH from the Baseline year, the vice versa is not applicable
- Any increase in TPH of Kiln w.r.t. baseline year is classified as efficiency improvement of kiln





## 6.1.4 Normalization Calculation on Capacity Utilisation

### 6.1.4.1 Normalization Calculation on capacity decrease for Kiln Heat Rate due to external factor

- i) Normalization of Thermal SEC (Kiln Heat Rate) up to Clinkerisation

Thermal energy due to loss in kiln TPH, normalized in the assessment year for Kiln Heat Rate is to be calculated as:-

Notional Thermal energy reduction due to loss in Kiln TPH w.r.t. Kiln Heat Rate [Million kcal] = [Kiln Heat Rate in AY (kcal/kg) - Kiln Heat Rate in BY (kcal/kg)] × Clinker Production in AY (Tons) / 1000

Where:- [Kiln Heat rate in AY - Kiln Heat rate in BY] =  $0.4673 \times (TPH_{BY} - TPH_{AY})$

*AY = Assessment year*

*BY = Baseline Year*

*TPH<sub>BY</sub> = Tons per hour of kiln in the baseline year*

*TPH<sub>AY</sub> = Tons per hour of kiln in the assessment year*

*Kiln Heat Rate = Total Thermal Energy consumed in kiln (kcal) / Clinker Production (kg), in kcal/kg*

- ii) **Normalization of Electrical SEC up to Clinkerisation**

Thermal energy due to loss in kiln TPH, normalized in the assessment year for Kiln specific power consumption (SPC) is to be calculated as:-

Notional thermal energy reduction due to loss in kiln TPH w.r.t. kiln SPC [Million kcal] = [Kiln SPC in AY (kwh/Ton) - Kiln SPC in BY (kwh/Ton)] × Clinker Production of Kiln in AY (Tons) × Weighted Heat Rate (kcal/kwh) / 10<sup>6</sup>

Where:- [Kiln SPC in AY - Kiln SPC in BY] =  $0.0943 \times (TPH_{BY} - TPH_{AY})$

*AY = Assessment year*

*BY = Baseline Year*

*TPH = Tons per hour*

*SPC = Specific Power Consumption in kwh/Ton*

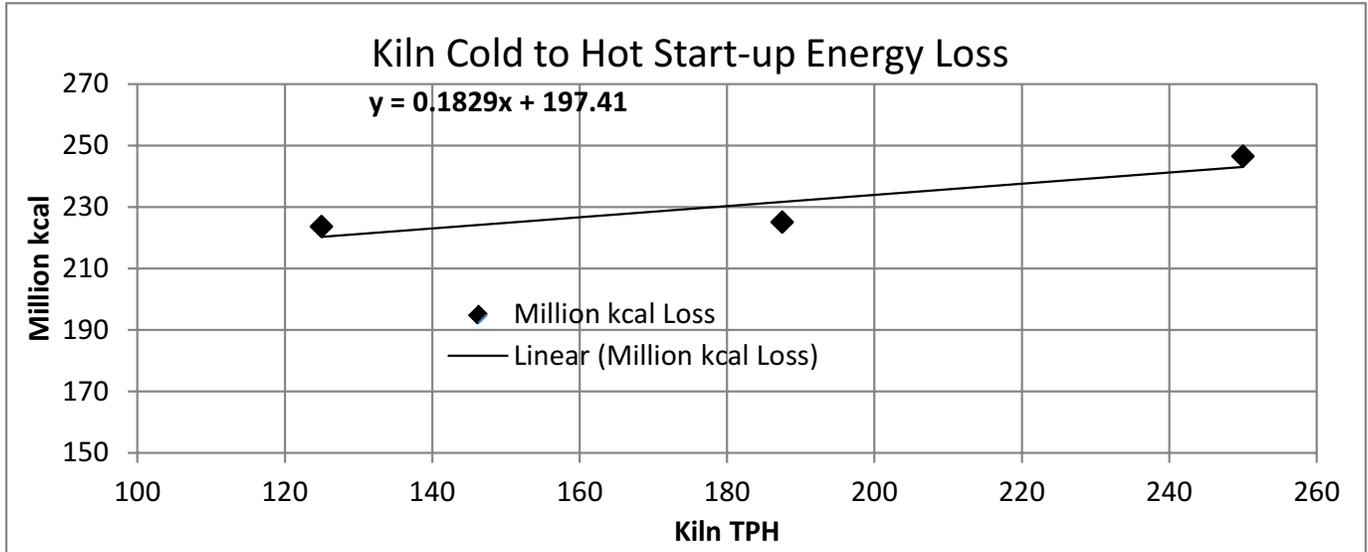
The above formulae stands for individual kiln. However, the notional thermal energy for normalization on Kiln Rate and Kiln SPC will be calculated for all the installed kiln of plant and added to get the Net notional thermal energy reduction figure.

### 6.1.4.2 Normalization Calculation on Kiln Start/Stop caused due to external factor

- (i) Normalization of Kiln Cold Start due to external factor for Thermal energy consumption

Energy is being utilized during kiln cold startup to reach normal production rate for any kiln outage. Due to external factor such as Market demand or Power breakdown, plant may use additional energy in assessment year for increase in kiln outages due to external factor not controlled by plant.

With different combination of Kiln production capacities and with the help of simulation, NCCBM has developed an equation to normalize the same in the assessment year as per following chart.



The graph is based on Energy used in kiln during kiln cold startup w.r.t. Kiln capacity in TPH and shows a linear equation  $Y = 0.1829X + 197.41$  in terms of Million kcal Energy loss.

Thermal energy due to additional Cold Start in assessment year of Kiln w.r.t. the baseline year, normalized in the assessment year for Kiln thermal energy consumption is to be calculated as:-

Notional Energy to be subtracted w.r.t. additional Kiln Cold startup for Thermal Energy Consumption [Million kcal] =  $(0.1829 \times \text{Kiln TPH in AY} + 197.41) \times [\text{Nos of Cold Startup in AY} - \text{Nos of Cold Startup in BY} (\text{Nos})]$

Where:-

AY = Assessment year

BY = Baseline Year

TPH= Tons per hour

(ii) Normalization of Kiln Cold Start due to external factor for Electrical energy consumption

Electrical energy due to additional Cold Start in assessment year of Kiln w.r.t. the baseline year, normalized in the assessment year for Kiln

electrical energy consumption is to be calculated as:-

Notional Energy to be subtracted w.r.t. additional Kiln Cold startup for Electrical Energy Consumption [Million kcal] =  $[\text{Electrical Energy Consumption for Cold start in AY} (\text{Lakh kwh}) - \text{Electrical Energy Consumption for Cold start in BY} (\text{Lakh kwh})] \times \text{Weighted Heat Rate} (\text{kcal/kwh}) / 10$

Where:-

AY = Assessment year

BY = Baseline Year

(iii) Normalization of Kiln Hot to Cold Stop due to external factor for Electrical energy consumption

Electrical energy due to additional Hot to Cold Stop in assessment year of Kiln w.r.t. the baseline year, normalized in the assessment year for Kiln electrical energy consumption is to be calculated as:-

Notional Energy to be subtracted w.r.t. additional Kiln Cold to Cold Stop for Electrical Energy Consumption [Million kcal] =  $[\text{Electrical Energy Consumption for Cold stop in AY} (\text{Lakh kwh}) - \text{Electrical Energy Consumption for Cold stop in BY} (\text{Lakh kwh})] \times \text{Weighted Heat Rate} (\text{kcal/kwh}) / 10$



Where:-

AY = Assessment year

BY = Baseline Year

The above formulae stands for individual kiln. However, the notional thermal energy for normalization on Kiln Start/Stop will be calculated for all the installed kiln of plant and added to get the Net notional thermal energy reduction figure

#### 6.1.4.3 Note on New Line /Production Unit installed after baseline year

In case a DC commissions a new line/production unit before or during the assessment/target year, the production and energy consumption of new unit will be considered in the total plant energy consumption and production volumes once the Capacity Utilisation of that line has touched / increased over 70%. However, the energy consumption and production volume will not be included till it attains 70% of Capacity Utilisation. Energy consumed and production made (if any) during any project activity during the assessment year, needs to be exclusively monitored and will be subtracted from the total energy and production in the Assessment year. Similarly, the same methodology is applied on a new unit installation for power generation (CPP) within the plant boundary.

The Capacity Utilisation will be evaluated based on the OEM document on Rated Capacity or Name plate rating on capacity of New Line/ Production Unit and the production of that line/unit as per DPR/Logsheets.

#### 6.1.5 Documentation

- Documentary proof for unavailability or Raw Material and Fuel
- Power Cut/ Power Holiday documents from respective Boards
- Force Major condition documents: Flood,

Earthquake, Labor Strike, Rioting or Social unrest, Change in Government policy

- Baseline Vs Assessment year Kiln Stop hours (Hot-Hot) Analysis with supporting documents [Ex-Log sheets, DPR. MPR, Lab Report/register/ SAP Data]-For running kiln
- Kiln Stop Hours for i) Cold-Hot and ii) Hot- Cold with supporting documents [Ex-Log sheets, DPR. MPR, Lab Report/register/ SAP Data/CCR trends/Silo Full] with stoppage analysis
- Production documents for Clinker and Cement [MPR/CCR Trend/Lab Report or Register or other supporting documents]
- Clinker and cement (Import and Export) (Excise documents/Internal transfer details)
- The individual kiln wise production, Thermal SEC and run hours data required for the baseline years with supporting documents
- Energy Meter Reading records during Cold Startup and Hot shut down for individual kiln

## 6.2 Product Mix and Intermediary Product

### 6.2.1 Baseline Year Methodology:

In the Cement Sector each plant, having different product mix based on additives like Gypsum, Slag and Fly Ash with different blending ratio. Hence, different types of cement products and exported clinker are converted in to equivalent major product produced by that plant with the help of conversion factor, reported by the concerned plant. The Products are

OPC (Ordinary Portland Cement)

PPC (Portland Pazzolona Cement)

PSC (Portland Slag Cement)/ others



## 6.2.2 Need for Normalization

For all the Product mix change in assessment year with respect to Baseline year, there is a need to develop and impose proper Normalization factors, so that any change in the product mix could be nullified and the concerned plant should not suffer / or gain advantage due to this change only.

Partially processed product (Intermediary Product) import by the plant (for which part of the energy is not required to be used by the plant) and export from the plant for which energy has been used but it is not taken into account in the final product. For example, a cement plant can import or export clinker, which is an intermediately product but not the final product i.e., Cement, may alter in the assessment year.

## 6.2.3 Normalization Methodology

- The DC has to get a benefit for using high percentage of additives (Waste Product such as Fly Ash and Slag) in Cement in the assessment year as compared to the Baseline Year
- Higher additives ratio in Cement yield higher efficiency of the plant
- The difference of %age additives from baseline year in assessment year will be converted to Notional clinker produced due to additives
- The Energy consumed to produce the Notional Clinker will then be subtracted from the Total Energy in the Assessment year using year's Weighted Heat Rate of electricity consumed, Heat Rate of Kiln and Electrical SEC up to clinkerisation.

## 6.2.4 Product Mix Case

Product mix (some products consume higher energy whereas other consume comparatively less) may change in Assessment year w.r.t. baseline year

- If major product changed in Assessment Year from baseline year

*Case 1:- OPC to PPC/PSC or Vice-versa*

- If clinker factor changed due to change in additives (Fly ash/Slag/ others) percentage from the baseline year.

*Case 2:- PPC/PSC to PPC/PSC (Clinker Factor change of PPC/PSC)*

*Case 3:- OPC to OPC (Clinker Factor change of PPC/PSC)*

*Case 4:- OPC to PPC /PSC (Clinker Factor change of PPC/PSC)*

*Case 5:- PPC /PSC to OPC (Clinker Factor change of PPC/PSC)*

*Case 6:- PPC /PSC to PPC/PSC (PPC/PSC production increase)*

- Difference in Grinding Energy for Equivalent Cement production (Excluding Exported clinker) and Actual Cement Production

## 6.2.5 Common Normalization formulae for all the above combinations

- Baseline Major Product shall be considered as major product of Assessment year.
- The difference of Energy between Actual Cement production Vs Equivalent Cement production from Baseline year will be added in total energy in the assessment year after negating Clinker Export
- Notional Energy for Clinker produced due to Additive Change or Change in Clinker Factor will be deducted from total energy
- Baseline Clinker Factor shall be considered as Clinker Factor of Assessment year for making equivalent Cement i.e. the baseline clinker factor is to be divided after getting the actual cement (Cement produced will be multiplied by assessment year clinker factor) for making equivalent cement produced



- Notional Energy for Clinker produced due to Additive Change or Change in Clinker Factor will be deducted from total energy. Considering the assessment year's Clinker factor in the same year for converting into the equivalent product is a repetition and leading to dual benefit in terms of additive use. The actual production of PPC/PSC is being used for converting the Notional clinker production. Hence, for Product Mix Normalization, the major product and clinker factor was maintained same as of baseline year in the assessment year.
- If the OPC Clinker factor =0 in the baseline year, then the OPC Clinker factor of assessment year will be used in the baseline year otherwise, baseline year OPC Clinker Factor exist. The vice-versa is applicable in the assessment year
- If the PPC/PSC/Others production in the baseline year or assessment year=0, then PPC/PSC/Others clinker factor will become zero otherwise the existing Clinker factor of respective type of cement persist.

$RCP_{AY}$  = Reported cement production in assessment year in Tons

$CSPC_{AY}$  = Electrical SEC of cement grinding (kWh/Ton of cement) for assessment year

$WHR_{AY}$  = Weighted average CPP Heat/Grid Heat Rate (kcal/kWh) in the assessment year

$ECP_{BY}$  = Equivalent Major Cement production in baseline year in Tons

$RCP_{BY}$  = Reported cement production in baseline year in Tons

$CSPC_{BY}$  = Electrical SEC of cement grinding (kWh/Tone of cement) for baseline year

$WHR_{BY}$  = Weighted average CPP/Grid Heat Rate (kcal/kWh) for baseline year

$ECPExC_{AY}$  = Equivalent major Cement production from Exported Clinker in assessment year in Tons

$ECPExC_{BY}$  = Equivalent major Cement production from Exported Clinker in baseline year in Tons

## 6.2.6 Product Mix Calculation

### 6.2.6.1 Normalisation for Product Mix-Grinding energy

The difference of grinding Energy between Actual Production Vs Equivalent Cement Production of Baseline and Assessment year will be subtracted in total energy in the assessment year considering Clinker Export also as per following equation

$$1. \quad \text{Notional Energy for Grinding (Million kcal)} = \frac{\{(ECP_{BY} - RCP_{BY} - ECPExC_{BY}) \times CSPC_{BY} \times WHR_{BY}\} - \{(ECP_{AY} - RCP_{AY} - ECPExC_{AY}) \times CSPC_{AY} \times WHR_{AY}\}}{10}$$

Where

$ECP_{AY}$  = Equivalent Major Cement production in assessment year in Tons

### 6.2.6.2 Normalisation for Product Mix-Additives

The following formulae will be applied for calculating the Notional Energy for Clinker Produced due to change in Additives/ Clinker Factor. The notional energy corrections calculated will be subtracted from the total energy in the assessment year

$$(i) \quad \text{Notional Thermal Energy for Clinker Produced due to change in Additives/ Clinker Factor [Million kcal]} = CIPcf \times [KTHR_{AY} \times 1000 + KSPC_{AY} \times WHR_{AY} +] / 10$$

$CIPcf$  = Clinker produced due to change in Additives / Clinker Factor (Lakh Ton)

$KSPC_{AY}$  = Kiln Specific Power Consumption (Electrical SEC up to Clinkerisation) (kwh/ton of Clinker) in the assessment year

$WHR_{AY}$  = Weighted average CPP/Grid/DG



Heat Rate (kcal/kWh) in the assessment year

$KTHR_{AY}$  = Thermal SEC of Clinker in the assessment year (kcal/kg of clinker)

Where-  $CIPcf = CIPcf1 + CIPcf2$

(ii)  $CIPcf1$ : Clinker produced due to change in Additives/Clinker Factor (Lakh Ton) for PPC =  $PPCPr_{AY} \times \{(OPCCF_{AY} - PPCCF_{AY}) - (OPCCF_{BY} - PPCCF_{BY})\}$

$PPCPr_{AY}$  = PPC Production in the assessment year (lakh Ton)

$OPCCF_{AY}$  = OPC Clinker factor in the assessment year

$PPCCF_{AY}$  = PPC Clinker Factor in the assessment year

$OPCCF_{BY}$  = OPC Clinker factor in the baseline year

$PPCCF_{BY}$  = PPC Clinker Factor in the baseline year

(iii)  $CIPcf2$ : Clinker produced due to change in Additives/Clinker Factor (Lakh Ton) for PSC/Others =  $PSCOPr_{AY} \times \{(OPCCF_{AY} - PSCOCF_{AY}) - (OPCCF_{BY} - PSCOCF_{BY})\}$

$PSCOPr_{AY}$  = PSC/Others Production in the assessment year (lakh Ton)

$OPCCF_{AY}$  = OPC Clinker factor in the assessment year

$PSCOCF_{AY}$  = PSC/Others Clinker Factor in the assessment year

$OPCCF_{BY}$  = OPC Clinker factor in the baseline year

$PSCOCF_{BY}$  = PSC/Others Clinker Factor in the baseline year

### 6.2.7 Documentation

- Fly Ash/Slag/Additives other than Gypsum-Purchase document
- Additives Stock and consumption

documents [DPR,MPR, SAP data. Store Receipt etc]

- Blended Cement Sale- Excise Documents
- Lab Report of Cement Quality [PPC /PSC/ Others] to prove % additive in Blended Cement
- Cement production documents of Cement Mill [Ex-Log sheets, DPR. MPR, Lab Report/register/ SAP Data]

## 6.3 Power Mix

### 6.3.1 Baseline Year Methodology:

In GtG methodology, the heat rate of power source considered as per following factors

- Electricity Imported from grid @ 3208 kcal/kWh in cement sector [ @ 860 kcal/kWh in other sector]
- CPP generated Electricity @ Actual CPP Heat Rate
- DG generated Electricity @ Actual DG Heat Rate
- Electricity Exported to grid @ 2717 kcal/kWh

### 6.3.2 Need for Normalization

*Power Sources and Import:* The ratio of electricity import/export may change in the assessment year w.r.t. the baseline year. In specific energy consumption calculation, the Electricity import from Grid is taken @3208 kcal/ kWh, whereas heat rate of self- generation could be in the range of 2200-4000 kcal/kWh. Hence, the heat rate of self-generated electricity impact 3-4 times than the Grid Electricity in SEC calculation

There is a possibility that a plant, by increasing the import from grid to meet plant's electricity demand can show savings because of decrease in its own captive power consumption, which has a higher heat rate.



*Power Export:* The heat rate of power export from Plant having CPP as one of the power source has been taken as 2717 kcal/kwh (national average heat rate of all power plants) in the baseline year, while the heat rate of self-generation from CPP stands at 3200-4000 kcal/kwh. Hence, the plant exporting power higher or lower in the assessment year w.r.t. the baseline year will gain or loss in terms of Energy Consumption in the plant.

Therefore, this advantage/ disadvantage attracts Normalization Factors

### 6.3.3 Power Mix Normalization methodology

#### Power Sources and Import

- The baseline year power mix ratio will be maintained for Assessment year for Power Source and import
- The Normalised weighted heat rate calculated from the baseline year Power mix ratio will be compared with the assessment year Weighted Heat Rate and the Notional energy will be deducted from the Total energy assessed
- The Thermal Energy difference of electricity consumed in plant in baseline year and electricity consumed in plant during assessment year shall be subtracted from the total energy, considering the same % of power sources consumed in the baseline year.
- However, any efficiency increase (i.e. reduction in Heat Rate) in Assessment year in any of the power sources will give benefit to the plant

#### Power Sources and Export

- In case of Power export, the plant will be given disadvantage of advantage by comparing the assessment year heat rate of CPP with the baseline year heat rate of CPP and deduct the same by taking the

heat rate of 2717 kcal/kwh

- CPP Actual Net Heat Rate will be considered for the net increase in the export electricity from the baseline.

### 6.3.4 Power Mix Normalization Calculation

#### 6.3.4.1 Power Mix Normalization for Power Sources

Notional Energy to be subtracted from the total Energy of Plant in the assessment year for Power Mix Normalisation is calculated as

$$i. \text{ Energy Correction for all power source in the assessment year [Million kcal]} = \text{TECPS}_{AY} \times (A\text{-WHR}_{AY} - N\text{-WHR}_{AY})$$

Where:-

$\text{TECPS}_{AY}$ : Total energy consumption from all the Power sources (Grid, CPP, DGetc) for AY in Million kwh

$A\text{-WHR}_{AY}$ : Actual Weighted Heat Rate for the Assessment Year in kcal/kwh

$N\text{-WHR}_{AY}$ : Normalised Weighted Heat Rate for the Assessment Year in kcal/kwh

$$ii. \text{ Normalised Weighted Heat Rate for Assessment year (kcal/kwh):}$$

$$N\text{-WHR}_{AY} = A \times (D/G) + B \times (E/G) + C \times (F/G)$$

Where

A: Grid Heat Rate for Assessment year (AY) in kcal/kwh

B: CPP Heat Rate for AY in kcal/kwh

C: DG Heat Rate for AY in kcal/kwh

D: Grid Energy consumption for Base Line Year (BY) in Million kwh

E: CPP Energy consumption for BY in Million kwh



$F$ : DG Energy consumption for BY in Million kwh

$G$ : Energy Consumed from all Power sources (Grid, CPP, DG) for BY in Million kwh

(Note: Any addition in the power source will attract the same fraction to be included in the above equation as  $PSiHR_{AY} \times (PSiEC_{BY}/TEC_{BY})$ )

$PSiHR_{AY}$  = Power Source (ith) Heat rate for AY in kcal/kwh

$PSiEC_{BY}$  = Power Source (ith) Energy Consumption for BY in Million kwh

$TEC_{BY}$  = Total Energy consumption for BY in Million kwh

The Electricity Consumption from WHR is not being considered for Power Mix Normalization

### 6.3.4.2 Power Mix Normalization for Power Export

Net Heat Rate of CPP to be considered for export of Power from CPP instead of 2717 kCal/kWh

The Export power normalization:

- Actual CPP heat rate would be considered for the net increase in the export of power from the baseline.
- The exported Energy will be normalized in the assessment year as following calculation

(i) **Energy to be subtracted in the assessment year in Million kcal:**  

$$=(EXP_{AY}-EXP_{BY})*((GHR_{AY}/(1-APC_{AY}/100))-2717)$$

$GHR_{AY}$ : CPP Gross Heat Rate for AY in kcal/kwh

$EXP_{AY}$ : Exported Electrical Energy in AY in Million kwh

$EXP_{BY}$ : Exported Electrical Energy in BY in Million kwh

$APC_{AY}$ : Auxiliary Power Consumption for AY in %

### 6.3.5 Documentation

- Electricity Bills from Grid
- Energy generation Report from CPP/DG/WHR/CoGen
- Power Export Bills from Grid and ABT meter reading
- Fuel consumption Report [DPR, MPR, Lab Report]
- Fuel GCV test report- Internal and external [As received or As fired basis as per baseline methodology]

### 6.4 Coal Quality for CPP

Coals are extremely heterogeneous, varying widely in their content and properties from country to country, mine to mine and even from seam to seam. The principle impurities are ash-forming minerals and sulphur. Some are interspersed through the coal seam; some are introduced by the mining process, and some principally organic sulphur, nitrogen and some minerals salts.

These impurities affect the properties of the coal and the combustion process, therefore the plant's boiler efficiency & Turbine Efficiency. The generating companies have no control over the quality of coal supplied. The raw coal mainly being supplied to the power stations could have variation in coal quality. Further, imported coal is also being used and blended with Indian coal by large number of stations, which could also lead to variations in coal quality.

The methodology should have provisions to take care of the impact of variations in coal quality. Therefore, average "Ash, Moisture, Hydrogen and GCV" contents in the coal during the baseline period as well as for assessment year is considered



for Normalization and the correction factor has been worked out based on the following boiler efficiency formula:

$$\text{Boiler Efficiency} = 92.5 - \frac{[50 * A + 630 (M + 9 H)]}{G.C.V}$$

Where:

*A= Ash percentage in coal*

*M= Moisture percentage in coal*

*H= Hydrogen percentage in coal*

*G.C.V= Gross calorific value in kcal/kg*

**Station Heat Rate (Kcal/kWh) = Turbine Heat Rate/Boiler efficiency**

#### 6.4.1 Fuel Quality Normalization

- Change in coal GCV, moisture%, Ash% affect the properties of the coal and the combustion process, resulting in loss/gain in the plant's boiler efficiency. To compensate for the change in efficiency of boiler with change in coal quality, the energy loss to be subtracted from the Total Energy consumption
- The plant/generating companies have no control over the quality of coal supplied, with Coal Linkage agreements.
- Further, variation in mix of imported coal with Indian coal could also lead to variations in coal quality. The normalisation factor shall take care of the impact of variations in coal quality
- The Coal quality have impact on Boiler Efficiency of a captive Power Plant, with decrease in coal quality the efficiency of boiler will also decrease and hence the gross heat rate of CPP will also decrease as per above formulae

#### 6.4.2 Pre-Requisite

- The Proximate and Ultimate analysis of coal for baseline should be available to compare the same in assessment year

- In case of unavailability of Ultimate analysis of coal in baseline year, the %H will be taken constant for baseline year as per assessment year data

#### 6.4.3 Coal Quality Normalization Methodology

- The Boiler Efficiency will be calculated for the baseline as well as assessment year with the help of Coal analysis constituents like GCV, %Ash, %Moisture, %H and Boiler Efficiency Equation provided to calculate the Boiler efficiency.
- Hence, by keeping the Turbine heat rate constant for both the years, the CPP heat rate will be calculated for the respective year

#### 6.4.4 Coal Quality Normalization Calculation

The Thermal Energy for the difference in heat rate of CPP will be deducted from the total energy consumption of the plant in the Assessment Year is calculated as

$$(i) \text{ Notional Thermal Energy to be deducted in the assessment year [Million kcal] = [CPP Heat Rate in AY (kcal/kwh) - Actual CPP Heat Rate in BY (kcal/kwh)] \times \text{CPP Generation in AY (Lakh kwh)} / 10$$

$$(ii) \text{ CPP Heat Rate in AY} = \text{CPP Heat Rate in BY} \times (\text{Boiler Efficiency in BY} / \text{Boiler Efficiency in AY})$$

$$(iii) \text{ Boiler Efficiency in BY} = 92.5 - \frac{[50 \times A + 630 (M + 9H)]}{GCV} \text{ (Values are for baseline Year)}$$

$$(iv) \text{ Boiler Efficiency in AY} = 92.5 - \frac{[50 \times A + 630 (M + 9H)]}{GCV} \text{ (Values are for assessment Year)}$$

Where:

*A: Ash in %*

*M= Moisture in %*

*H= Hydrogen in %*

*GCV: Coal Gross Calorific Value in kcal/kwh*



AY = Assessment year

BY = Baseline Year

CPP= Captive Power Plant

THR=Turbine Heat Rate

### 6.4.5 Documentation

- Fuel Linkage Agreement
- Operating Coal Quality- Monthly average of the lots (As Fired Basis), Test Certificate for Coal Analysis including Proximate and Ultimate analysis (Sample Test from Government Lab for cross verification)
- Performance Guarantee Test (PG Test) or Report from Original Equipment Manufacturer (OEM)

Design /PG test Boiler Efficiency documents

Design/PG Test Turbine Heat Rate documents

### 6.4.6 Note on Proximate and Ultimate Analysis of Coal

If the ultimate analysis has not been carried out in the baseline year for getting H% result, following conversion formulae from Proximate to Ultimate analysis of coal could be used for getting elemental chemical constituents like %H

Relationship between Ultimate and Proximate analysis

$$\%C = 0.97C + 0.7(VM + 0.1A) - M(0.6 - 0.01M)$$

$$\%H_2 = 0.036C + 0.086 (VM - 0.1xA) - 0.0035M^2(1 - 0.02M)$$

$$\%N_2 = 2.10 - 0.020 VM$$

Where

C= % of fixed carbon

A=% of ash

VM=% of volatile matter

M=% of moisture

## 6.5 Petcoke Utilisation in Kiln

Petcoke is a by-product obtained during refining of heavy crude oil. Petcoke is characterised as a high grade fuel with high calorific value of more than 8000 Kcal per kg, having low ash content and low volatile matter but high sulphur content, up to 7 per cent.

Petcoke provides scope for manufacturing higher grade of cement with the same raw material or same grade of cement using marginal and low grade limestone contributing to resource conservation. Due to higher calorific value compared to coal, less quantity of petcoke needs to be moved from source to plant site, which reduces the cost of transport. However, as the sulphur content in petcoke is high, its larger use increases the sulphur cycle and aggravates build-up formation in the kiln system.

### 6.5.1 Need for Normalization

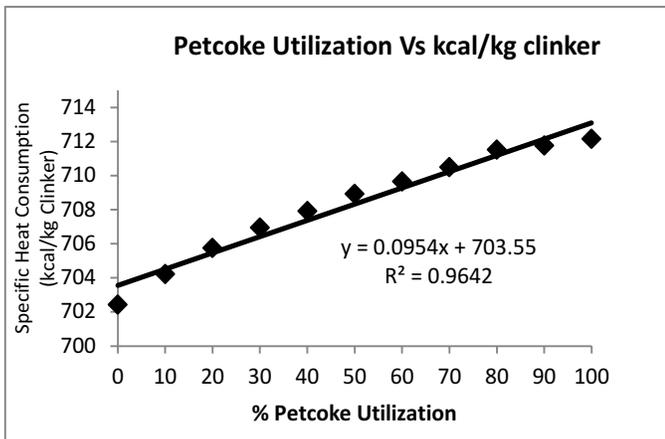
1. Change from Petcoke to Coal or Coal to Petcoke
2. There is a need for changes in raw mix design, fineness of fuel, modifications in burner, calciner and cooler so that a trouble-free and cost effective operation is achieved. With several disadvantages of use of PetCoke in Cement kiln like
  - Difficult to burn
  - Hard to grind
  - High Sulphur Content
  - Can have high metal content

The loss of heat rate and high specific power consumption has been observed with the increasing use of Petcoke after blending with coal. All the above disadvantages is being covered by low price, easy availability and resource conservation as compared to coal



## 6.5.2 Normalization Methodology

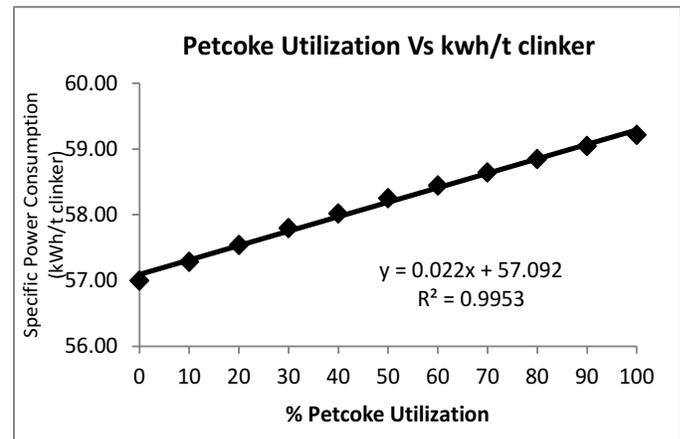
1. Normalization factor for %age PETCOKE usage in cement kilns
2. To compensate for the change in heat rate due to variation in usage of Petcoke in the kiln from the baseline
3. Kiln Heat Rate Normalization for higher or Lower % of PetCoke Consumption in Assessment year w.r.t. Baseline Year
4. The normalisation will be used for Kiln heat rate and kiln Specific Power



Consumption (SPC)

## 6.5.3 Normalization Calculation

1. A graph is plotted between heat rate of kiln, Specific Power Consumption and % use of Petcoke from different plant of different capacity to arrive a linear equation
2. The linear equation generated from the graph will then be computed for baseline as well as for assessment year in terms of Energy loss in Kiln heat rate and Specific Power Consumption



3. The output of curve is an equation and having following relationship w.r.t. kiln heat rate and Kiln SPC w.r.t. % use of Pet coke in kiln

Normalization factor for %age PETCOKE usage in cement kilns is to compensate for the change in heat rate and Electrical SEC (specific power consumption) due to variation in usage of Petcoke in the kiln from the baseline.

Kiln Heat Rate & Electrical SEC Normalization for higher or lower % of PetCoke Consumption will take place in Assessment year w.r.t. Baseline Year.

The normalization will be used for Kiln heat rate and kiln Specific Power Consumption (SPC) is calculated as per following equation

i. Notional Thermal Energy to be deducted in the assessment year due to % use of Petcoke consumption in the kiln [Million kcal] =  $(N-KHR_{AY} - KHR_{BY}) \times \text{Total Clinker Production in Lakh Tons} \times 100 + (N-KSPC_{AY} - KSPC_{BY}) \times \text{Total Clinker Production in Lakh Tons} \times WHR_{AY} / 10$

### 6.5.3.1 Normalization Calculation for Kiln Heat Rate

i. Normalized Kiln Heat rate with Petcoke consumption in assessment year [kcal/kg of clinker]  
 $N-KHR_{AY} = KHR_{BY} + 0.0954 \times (\% PC \text{ Cons}_{AY} - \% PC \text{ Cons}_{BY})$



$N\text{-KHR}_{AY}$  = Normalized Kiln Heat rate with effect of Petcoke consumption in assessment year in kcal/kg of clinker

$KHR_{BY}$  = Total Thermal Energy consumed in kiln/Clinker Production in kg, kcal/kg of clinker in the baseline year

$PC\ Cons_{AY}$  = Petro-coke Consumption in assessment year in %

$PC\ Cons_{BY}$  = Petro-coke Consumption in baseline year in %

AY = Assessment year

BY = Baseline Year

TPH= Tons per hour

$WHR_{AY}$  = Weighted Heat Rate in assessment year

### 6.5.3.2 Normalization Calculation for Electrical SEC (Specific Power Consumption)

i. Normalized Electrical SEC upto clinkering in assessment year [kwh/ton of clinker]  $N\text{-KSPC}_{AY} = KSPC_{BY} + 0.022 \times (\% PC\ Cons_{AY} - \% PC\ Cons_{BY})$

$N\text{-KSPC}_{AY}$  = Normalised Kiln Specific Power Consumption with effect of Petcoke consumption up to clinkerisation in the assessment year in kwh/ton of clinker

$KSPC_{BY}$  = Kiln Specific Power Consumption up to clinkerisation in the baseline year in kwh/ton of clinker

$PC\ Cons_{AY}$  = Petro-coke Consumption in assessment year in %

$PC\ Cons_{BY}$  = Petro-coke Consumption in baseline year in %

AY = Assessment year

BY = Baseline Year

### 6.5.4 Documentation

- Production Report with documents [Ex: Log sheets / SAP / Lab Report DPR/MPR etc]
- Fuel Consumption (Pet Coke and Coal) Documents [Store receipt/DPR]

## 6.6 Low PLF compensation in CPP

### 6.6.1 Need for Normalization

Owing to fuel non-availability, Grid disturbance, Plant load unavailability due to external factor etc, plant forced to reduce the load on turbine leading to low efficiency of units and Station. Due to decreased loading, the Plant load Factor (PLF) will be worsened and affects the unit heat rate. The comparison between baseline year and assessment year will be carried out through characteristics curve of Load Vs Heat rate for correction factor. The increased PLF in the assessment year as compared to baseline year will not be normalized back to the baseline year PLF.

Hence, Normalization is required to compensate for the change in heat rate of CPP due to variation in PLF from the baseline.

### 6.6.2 Normalization Methodology

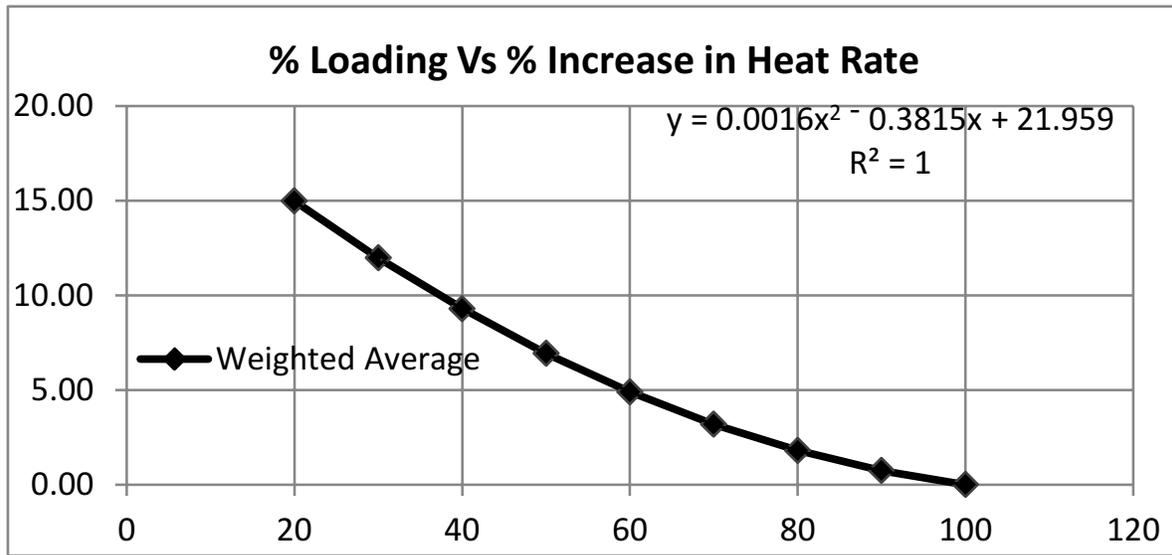
The Heat Mass Balance Diagram (HMBD) of low capacity Power Plant in the range of 20-25 MW installed in Cement Sector have been analyzed at different load

The curve was put into the Ebsilon software and Plant model has been developed for nosof Power plants under study to verify the varying nature of Turbine Heat Rate w.r.t. Loading condition

The graph was plotted after getting the weighted average of % decrease in loading Vs % increase in heat rate



### 6.6.3 Normalization Calculation



Equation: % Increase in Heat Rate due to decrease in Loading=  
 $= 0.0016 \times (\% \text{Loading})^2 - 0.3815 \times \% \text{Loading} + 21.959$

Normalization is required to compensate for the change in heat rate of CPP due to variation in PLF from the baseline.

The Thermal Energy reduction due to low PLF in CPP is calculated as below:-

(i) Notional Thermal Energy deducted in the assessment year from the total energy consumption of the plant [Million kcal] = Gross Generation in Lakh kwh x [Actual Gross Heat Rate in AY (kcal/kwh) - Normalised Gross Heat Rate in AY (kcal/kwh)]

(ii) Normalised Gross Heat Rate in AY [kcal/kwh] = Actual Gross Heat Rate in AY (kcal/kwh) x (1 - % Decrease on % increase in Heat Rate from baseline in AY due to external factor) / 100

(iii) % Decrease on % increase in Heat Rate from baseline in AY due to external factor [%] = [% Increase in Heat Rate in AY - % Increase in Heat Rate in BY] x % Decrease in PLF in Assessment Year due to external factor in %

(iv) % Increase in Heat Rate at PLF of Baseline Year =  $0.0016 \times (\% \text{Loading}_{BY})^2 - 0.3815 \times \% \text{Loading}_{BY} + 21.959$

(v) % Increase in the Heat Rate at PLF of Assessment Year =  $0.0016 \times (\% \text{Loading}_{AY})^2 - 0.3815 \times \% \text{Loading}_{AY} + 21.959$

Where

AY: Assessment Year

BY = Baseline Year

$\% \text{Loading}_{BY}$  = Percentage Loading (PLF) in Baseline Year

$\% \text{Loading}_{AY}$  = Percentage Loading (PLF) in Assessment Year

### 6.7 Normalization others

**6.7.1 Environmental concern (Additional Environmental Equipment requirement due to major change in government policy on Environment)**

#### 6.7.1.1 Need for Normalization

Change in Government policy on Environment Standard can take place after baseline year



leading to the installation of additional equipment by Designated Consumers. The factor is not controlled by plant and termed as external factor. The additional equipment consumes thermal as well as electrical energy and directly or indirectly not contributing to the energy efficiency of the plant.

Hence, the additional equipment installation will be a disadvantageous proposition for the plant and affect the GtG Energy consumption of the plant, which in-turn increases the SEC of the Plant. This needs to be normalized with respect to the baseline year.

### 6.7.1.2 Methodology

The Normalization takes place in the assessment year for additional Equipment's Energy Consumption only if there is major change in government policy on Environment Standard.

- The Energy will be recorded for additional installation through separate Energy meter for the assessment year of from the date of commissioning in the assessment year.
- If separate energy meter installation is not possible due to installation of the equipment such as Additional Field in the ESP or additional bags in the Bag House/ Dust Collector in the existing one, then 80% of rated capacity will be converted in to Energy for Normalization.
- Any additional equipment installed to come back within the Environmental standards as applicable in the baseline, will not qualify for this Normalization i.e., If any Plant after the baseline year has deviated from the Environmental Standards imposed in the baseline year and additional equipment are being installed after the baseline to come back within the Standards, then the plant is not liable to get the Normalization in this regard.
- The Energy will be normalised for

additional Energy consumption details from Energy meters. This is to be excluded from the input energy.

### 6.7.1.3 Normalisation Calculation

The Energy is to be excluded from the input energy as calculated below

$$(i) \text{ Notional Thermal Energy to be deducted in the assessment year due to Environmental Concern [Million kcal] = Additional Electrical Energy Consumed (Lakh kwh) } \times \text{ Weighted Heat Rate (kcal/kwh) } / 10 + \text{ Additional Thermal Energy Consumed (Million kcal)}$$

### 6.7.1.4 Documentation

- Energy Meter Reading records for each additional equipment
- OEM document for Energy Capacity
- Equipment Rating plate
- DPR/MPR/Log Sheet/EMS record

## 6.7.2 Unavailability of Bio-mass/Alternate Fuel w.r.t baseline year

### 6.7.2.1 Need for Normalization

The Plant could have used high amount of Biomass or Alternate Fuel in the process to reduce the usage of fossil fuel in Kiln in the baseline year. By using Biomass or Alternate Fuel the Energy consumption of the plant has come down, since the energy for biomass or alternate fuel were not included as Input Energy to the Plant.

The Biomass availability in the assessment year may decrease and in turn the plant is compelled to use Fossil fuel. Hence, the energy consumption of the plant may go up in the assessment year resulted into higher SEC. Normalization will take place if unavailability



of Biomass or Alternate Fuel is influenced by the external factor not controlled by the Plant.

The external factor for unavailability of Biomass may be Flood, Draught in the region and external factor for Alternate Fuel may be Environmental concern in the region.

### 6.7.2.2 Methodology

The normalization for Unavailability for Biomass or Alternate Fuel takes place only if sufficient evidence in-terms of authentic document is produced

- Plant to furnish the data replacement of fossil fuel from Biomass/ Alternate Fuel (Solid/Liquid) in the assessment year w.r.t. baseline year.
- The energy contained by the fossil fuel replacement will be deducted in the assessment year

### 6.7.2.3 Normalisation Calculation

The normalization for Unavailability for Biomass or Alternate Fuel is applied in the baseline year. The energy contained by the fossil fuel replacement will be deducted in the assessment year

<p>i. Notional Thermal Energy to be deducted in the assessment year due to Biomass/Alternate Fuel Unavailability [Million kcal]= <math>FFB_{AY} \times GCVB_{BY} / 1000 + FFSA_{AY} \times GCVSA_{BY} / 1000 + FFLA_{AY} \times GCVLA_{BY} / 1000</math></p>
--

Where

$FFB_{AY}$  = Biomass replacement with Fossil fuel due to un-availability used in the process in Assessment Year (Tons)

$GCVB_{BY}$ : Gross Calorific Value of Biomass in Baseline Year (kcal/kg)

$FFSA_{AY}$  = Solid Alternate Fuel replacement with Fossil fuel due to un-availability used in

the process in Assessment Year (Tons)

$GCVSA_{BY}$ : Gross Calorific Value of Solid Alternate Fuel in Baseline Year (kcal/kg)

$FFLA_{AY}$  = Liquid Alternate Fuel replacement with Fossil fuel due to un-availability used in the process in Assessment Year (Tons)

$GCVLA_{BY}$ : Gross Calorific Value of Biomass in Baseline Year (kcal/kg)

### 6.7.2.4 Documents

- Authentic Document in relation to Bio-Mass/Alternate Solid Fuel/Alternate Liquid Fuel availability in the region.
- Test Certificate of Bio-mass from Government Accredited Lab for GCV in Baseline and assessment year
- Test Certificate of replaced Fossil Fuel GCV

## 6.7.3 Construction Phase or Project Activities

### 6.7.3.1 Need for Normalization

The energy consumed during construction phase or project activities are non-productive energy and hence will be subtracted in the assessment year.

### 6.7.3.2 Methodology

- The list of equipment with Thermal and Electrical Energy Consumption details need to be maintained for Normalization in the assessment year.
- The energy consumed by the equipment till commissioning will also be deducted in the assessment year

### 6.7.3.3 Normalisation Calculation

The energy consumed by the equipment during construction phase or project activities till commissioning will be deducted in the assessment year



**i. Notional Thermal Energy to be deducted in the assessment year due to Construction Phase or Project Activities [Million kcal]=** Electrical Energy Consumed due to commissioning of Equipment (Lakh kwh) x Weighted Heat Rate (kcal/kwh)/10+ Thermal Energy Consumed due to commissioning of Equipment (Million kcal)

#### 6.7.3.4 Documents

- Energy Meter Readings of each project activity with list of equipment installed under each activity from 1st Apr to 31st March
- Solid/Liquid/Gaseous Fuel consumption of each project activity with list of equipment under each activity installed from 1st Apr to 31st March

#### 6.7.4 Addition of New Line/Unit

##### 6.7.4.1 Need for Normalization

Due to the gate to Gate concept for Specific Energy consumption, the input energy and production needs to be considered for new line/unit if it commissions in the same plant boundary. However, due to the stabilization period of a new line under commissioning, the energy consumption is very high with respect to the production/generation. Hence, following methodology will follow

In case a DC commissions a new line/production unit before or during the assessment/target year, the production and energy consumption of new unit will be considered in the total plant energy consumption and production volumes once the Capacity Utilisation of that line has touched / increased over 70%. However, the energy consumption and production volume will not be included till it attains 70% of Capacity Utilisation. Energy consumed and production made (if any) during any project activity during

the assessment year, needs to be exclusively monitored and will be subtracted from the total energy and production in the Assessment year. Similarly, the same methodology is applied on a new unit installation for power generation (CPP) within the plant boundary.

##### 6.7.4.2 Methodology

- The Capacity Utilisation will be evaluated based on the OEM document on Rated Capacity or Name plate rating on capacity of New Line/ Production Unit and the production of that line/unit as per DPR/ Logsheet.
- The Electrical and thermal energy will be recorded separately for the new line
- The production/generation will have to be recorded separately
- The date of reaching production or generation level at 70% of Capacity Utilisation will have to be monitored
- The Production/generation and Energy consumed will be deducted from the total energy of the assessment year

##### 6.7.4.3 Normalisation Calculation

The Energy reduction will take place in the assessment year for addition of new line/unit normalization as per following calculation

i) Thermal Energy Consumed due to commissioning of New process Line/ Unit till it attains 70% of Capacity Utilization to be subtracted in assessment year (Million kcal) = (Electrical Energy Consumed due to commissioning of New process Line/Unit till it attains 70% of Capacity Utilization (Lakh kWh) x Weighted Average Heat rate in AY (kcal/kwh)/10) + Thermal Energy Consumed due to commissioning of New Process Line/Unit till it attains 70% of Capacity Utilization (Million kcal)



**The Production during commissioning of New Process Line/Unit is to be subtracted from the total production (Clinker) of plant and added in the import of intermediary product (Clinker)**

(ii) **Thermal Energy Consumed from external source due to commissioning of New Line/Unit till it attains 70% of Capacity Utilization in Power generation to be subtracted in the assessment year (Million kcal)=** (Electrical Energy Consumed from external source due to commissioning of New Line/Unit till it attains 70% of Capacity Utilization in Power generation (Lakh kWh) x Weighted Average Heat rate in AY (kcal/kwh)/10) + Thermal Energy Consumed due to commissioning of New Line/Unit till it attains 70% of Capacity Utilization in Power generation (Million kcal)

(iii) **Thermal Energy to be added in the assessment year for Power generation of a line /unit till it attains 70% of Capacity Utilisation (Million kcal)=**Net Electricity Generation till new Line/Unit attains 70% Capacity Utilisation (Lakh kWh) x Weighted Heat Rate (kcal/kwh)/10

*Where*

*AY: Assessment Year*

#### 6.7.4.4 Documents

- Rated Capacity of new Process/line from OEM
- Energy Meter Readings and Power Consumption record of process/line with list of equipment installed from 1st Apr to 31st March
- Thermal Energy Consumption record with list of equipment from DPR/Log book/SAP Entry in PP module
- Production record from DPR/Log book/SAP Entry in PP module

- Energy Meter Readings and Power Consumption record of unit from external source with list of equipment installed from 1st Apr to 31st March

#### 6.7.5 Unforeseen Circumstances

##### 6.7.5.1 Need for Normalization

The Normalization is required for Energy system of a plant, if the situation influences the Energy Consumption, which cannot be controlled by Plant Management and is termed as Unforeseen Circumstances. However, Proper justification in terms of authentic document is required for taking any benefit out of it.

##### 6.7.5.2 Methodology

Any such unforeseen circumstance should be properly analyzed by the plant management before placing for Normalization

- The list of such Unforeseen circumstances should be maintained with proper Energy records
- The plant needs to maintain the Energy Meter reading record to claim any Electrical Energy Normalization for Unforeseen Circumstances.
- For Claiming any normalization towards Thermal energy under this category, the Thermal Energy Consumption records are to maintained

##### 6.7.5.3 Normalisation Calculation

The Energy consumed due to unforeseen circumstances to be deducted in the assessment year

(i) **Thermal Energy consumed due to unforeseen (Million kcal) =** (Electrical Energy to be Normalized in AY x Weighted Average Heat rate in AY (kcal/kWh)/10) + Thermal Energy to be Normalized (Million kcal)



#### 6.7.5.4 Documents

- Relevant document on Unforeseen Circumstances beyond the control of plant
- Energy Meter Readings and Power Consumption during the said period of unforeseen circumstances
- Thermal Energy Consumption record during the said period of unforeseen circumstances from DPR/Log book/SAP Entry

#### 6.7.6 Renewable Energy

Normalization of Export of Power from Renewable Energy Source on which REC Certificates or Preferential Tariff (“the tariff fixed by the Appropriate Commission for sale of energy, from a generating station using renewable energy sources, to a distribution licensee”) partially or fully has been claimed by a DC

##### 6.7.6.1 Need for Normalization

As per Renewable Energy Certificate Mechanism, any plant after meeting Renewable Purchase Obligations (RPOs) can export renewable energy in the form of electrical energy and earn Renewable Energy Certificates (REC) and/ or can opt for preferential tariff for the exported electricity, as the case may be.

However, The DC should not claim dual benefit on same installation from two different Government’s scheme i.e. PAT Scheme and REC Mechanism

In view of the above, a DC covered under PAT scheme and exporting electricity generated from Renewable energy source and earning REC or taking preferential tariff, partially or fully will be treated as per following methodology.

#### 6.7.6.2 Methodology

- The quantity of exported power (partially or fully) on which Renewable Energy Certificates have been earned by Designated Consumer in the assessment year under REC mechanism shall be treated as Exported power and normalization will apply. However, the normalized power export will not qualify for issue of Energy Saving Certificates under PAT Scheme.
- The quantity of exported power (partially or fully) from Renewable energy which has been sold at a preferential tariff by the Designated consumer in the assessment year under REC mechanism shall be treated as Exported power. However, the normalized power export will not qualify for issue of Energy Saving Certificates under PAT Scheme.

##### 6.7.6.3 Normalisation Calculation

- (i) **Target Saving to be achieved (PAT obligation) (Million kcal) =** Equivalent Major Product Output as per PAT scheme Notification (Tons) in BY x Target Saving to be achieved (PAT obligation) (TOE/Te) x 10
- (ii) **Target Saving achieved in assessment year (Million kcal) =** [Gate to Gate Specific Energy Consumption in BY (TOE/Te)-Normalized Gate to Gate Specific Energy Consumption in AY (TOE/Te)] x Equivalent Major Product Output in Tons as per PAT scheme Notification (Tons) x10
- (iii) **Additional Saving achieved (After PAT obligation) (Million kcal) =** Target Saving Achieved in AY (Million kcal) - Target Saving to be achieved (PAT obligation) in BY (Million kcal)

1. Thermal Energy Conversion for REC and Preferential Tariff, if Steam Turbine Heat Rate in assessment year = 0
---



a. **Thermal energy conversion for REC and Preferential tariff (Million kcal)**=[Quantum of Renewable Energy Certificates (REC) obtained as a Renewal Energy Generator (Solar & Non-Solar)(MWh) + Quantum of Energy sold under preferential tariff (MWh)] x 2717 kcal/kwh /1000

2. Thermal Energy Conversion for REC and Preferential Tariff, **if Steam Turbine Heat Rate in assessment year ≠ 0**

a. **Thermal energy conversion for REC and Preferential tariff (Million kcal)**= [Quantum of Renewable Energy Certificates (REC) obtained as a Renewal Energy Generator (Solar & Non-Solar)(MWh) + Quantum of Energy sold under preferential tariff (MWh)] x Steam Turbine Net Heat Rate in AY (kcal/kwh)/1000

energy conversion for REC and Preferential tariff (Million kcal) >Additional Saving achieved (After PAT obligation) (Million kcal) then

a. Thermal Energy to be normalized for REC and preferential tariff power sell under REC mechanism (TOE) =Additional Saving achieved (After PAT obligation) (Million kcal)

(vi) If, Additional Saving achieved (After PAT obligation) (Million kcal) >0, and Thermal energy conversion for REC and Preferential tariff (Million kcal) <Additional Saving achieved (After PAT obligation) (Million kcal) then

a. Thermal Energy to be normalized for REC and preferential tariff power sell under REC mechanism (TOE) =Thermal energy conversion for REC and Preferential tariff (Million kcal)

#### 6.7.6.4 Documentation

- (iv) If, Additional Saving achieved (After PAT obligation) (Million kcal) ≤ 0,
  - a. Thermal Energy to be normalized for REC and preferential tariff power sell under REC mechanism (TOE) = 0,
- (v) If, Additional Saving achieved (After PAT obligation) (Million kcal) >0, and Thermal

- Renewable Energy Certificates
- Power Purchase Agreement (PPA) for the capacity related to such generation to sell electricity at preferential tariff determined by the Appropriate Commission
- Renewal Purchase Obligation document

### 6.8 Gate to Gate Specific Energy Consumption

#### 6.8.1 GtG SEC in Baseline year

$$\text{Gate to Gate Specific Energy Consumption in Baseline year} = \frac{\text{(Total Energy Consumption (Million kcal))}}{\text{(Total Equivalent Production (Tonnes))}}$$

#### 6.8.2 Normalised GtG SEC in Assessment year

$$\text{Normalised Gate to Gate Specific Energy Consumption after REC Compliance in assessment year} = \frac{\text{(Normalised Total Energy Consumption after REC Compliance (Million kcal))}}{\text{(Total Equivalent Production (Tonnes))}}$$



- i. **Normalised Total Energy Consumption in the assessment year (Million kcal) =** Total Energy Consumption in the assessment year- Notional Energy Consumption for low capacity utilization (Million kcal)- Notional Energy Consumption for Product Mix (Million kcal)- Notional Energy Consumption for Petcokeutilisation (Million kcal)- Notional Energy Consumption for Power Mix (Million kcal)- Notional Energy Consumption for Coal Quality (Million kcal)- Notional Energy Consumption for Low CPP PLF(Million kcal)-Notional Energy Consumption for Normalisation others (Environmental Concern+ Biomass/Alternate Fuel Availability+ Project Activiries+ NewLine/ Unit Commissioning+ Unforeseen Circumstances) (Million kcal)+ Energy for Power generation of a line /unit till it attains 70% of Capacity Utilisation (Million kcal)
- ii. **Total Energy Consumption in the assessment year (Million kcal)=** Total Thermal Energy Used in Power Generation (Million kcal) + Total Thermal Energy Used in Process (Million kcal) + {(Total Electricity purchased from grid (Lakh kWh) X 860)-Electricity exported (Lakh kWh) X National Heat Rate- 2717 kcal/kWh}/10]
- iii. **Normalised Total Energy Consumption after REC compliance in the assessment year (Million kcal) =** Normalised Total Energy Consumption in the assessment year (Million kcal) + Renewable Energy Certificates Compliance under PAT Scheme (Million kcal)
- iv. **Normalised Gate to Gate Specific Energy Consumption after REC Compliance (kcal/kg equivalent of Cement)**

$$\text{Normalised Gate to Gate Specific Energy Consumption after REC Compliance in assessment year} = \frac{\text{(Normalised Total Energy Consumption after REC Compliance (Million kcal))}}{\text{(Total Equivalent Production (Tonnes))}}$$

## 7 Conclusion

The target setting methodology elaborated the wide bandwidth of specific energy consumption among the plant. This itself, depicts the potential of Energy saving opportunities. PAT could be instrumental in harnessing the saving potential exist in the plant by employing different management techniques, upgraded technologies, best available practices and technologies through economical viable projects.

Normalization of Plant parameters in the assessment year w.r.t. the baseline year is a process so as to avoid any favorable or negative impact on the specific energy consumption of the plant. This will also assist on evaluating the correct impact of the energy efficiency projects implemented by the plant. Once the Normalization factors are activated, it

automatically brings all the plants under one platform. This will be another big step in terms of benchmarking the Industries as a whole.

## 8 Overriding Clause

**For Normalization factors, which became applicable due to external factors, authentic documents to be produced by DC for the baseline as well for the assessment year. In absence of these authentic documents, no Normalization Factor will be applied/ Considered.**

**Any factor, which has not been considered in this document and Form I, the Empaneled Accredited Energy Auditor will report it separately with possible solution for the same and Annexed to the Form B (Verification Form)**



## 9 Example [Normalization Factor Baseline year]

### 9.1 Production data for the baseline year

Item	Unit	Qty
Clinker Production	Lakh Ton	1.5
Clinker Export	Lakh Ton	0.1
Clinker Import	Lakh Ton	0.2
Clinker Opening Stock	Lakh Ton	0.3
Clinker Closing Stock	Lakh Ton	0.2
OPC Produced	Lakh Ton	0.727
PPC Produced	Lakh Ton	1.142
PSC Produced	Lakh Ton	0.208
Clinker Factor OPC		0.96
Clinker Factor PPC		0.75
Clinker Factor PSC		0.70

### Assumptions:

- I) The Cement is produced in the ratio of OPC:PPC:PSC=0.35:0.55:0.10
- II) The opening stock of clinker is higher than the closing stock, hence the same could be treated as imported clinker
- III) The above table indicates that the major product is PPC

### 9.2 Normalisation Factor considered

The following normalization factors have been considered

#### a. Equivalent major grade of cement production

The various product mixes are converted into equivalent major grade of cement product by the plant by using the following formulae:

#### (i) Conversion of Ordinary Portland Cement (OPC) production equivalent to major product

$$\text{Equivalent Major Product} = \frac{\text{OPC Produced (Lakh Ton)} \times \text{Conversion factor of OPC}}{\text{Conversion Factor of Major Product}} \quad [\text{Lakh Ton}]$$

$$\text{Ex-Equivalent Major Product} = (0.727 \times 0.96) / 0.75 = 0.930 \text{ Lakh Ton}$$

#### (ii) Conversion of Portland Pozolona (PPC) Production equivalent to major product

$$\text{Equivalent Major Product} = \frac{\text{PPC Produced (Lakh Ton)} \times \text{Conversion factor of PPC}}{\text{Conversion Factor of Major Product}} \quad [\text{Lakh Ton}]$$

$$\text{Ex-Equivalent Major Product} = (1.142 \times 0.75) / 0.75 = 1.142 \text{ Lakh Ton}$$

#### (iii) Conversion of Portland Slag Cement (PSC)/any other variety of Cement Production equivalent to major product

$$\text{Equivalent Major Product} = \frac{\text{PSC or any other variety Cement Produced (Lakh Ton)} \times \text{Conversion factor of PSC or any other variety Cement}}{\text{Conversion Factor of Major Product}} \quad [\text{Lakh Ton}]$$

$$\text{Ex-Equivalent Major Product} = (0.208 \times 0.70) / 0.75 = 0.194 \text{ Lakh Ton}$$



**(iv) Conversion of Total Exported clinker to major product**

$$\text{Equivalent Major Product} = \frac{\text{Total Exported Clinker (Lakh Ton)}}{\text{Conversion Factor of Major Product}} \text{ [Lakh Ton]}$$

Where: Total Exported clinker= [Clinker Exported to other plants + clinker exported to clinker stock over and above the opening stock,]

Ex-Equivalent Major Product = 0.1 / 0.75 = 0.133 Lakh Ton

(Note: Clinker exported to clinker stock over and above the opening stock is on negative side, hence not considered in the calculation)

**(v) Conversion of Total Imported clinker to major product**

$$\text{Equivalent Major Product} = \frac{\text{Total Imported clinker (Lakh Ton)}}{\text{Conversion Factor of Major Product}} \text{ [Lakh Ton]}$$

Where: Total Imported clinker= [Clinker Imported from other plants + clinker Imported from clinker stock, equivalent to the quantity by which the clinker opening stock gets reduced]

Ex-Already considered in the cement production

**(vi) Total Equivalent major product of Cement**

It can be arrived at by summing up all the different grades of cements equivalent to major product calculated above:

$$\text{Total Equivalent major product of Cement} = a(i) + a(ii) + a(iii) + a(iv) \text{ [Lakh Ton]}$$

**Note: S.No. a (v) is already accounted in major product**

$$\text{Ex- Total Equivalent major Product} = 0.930 + 1.142 + 0.194 + 0.133 = 2.40 \text{ Lakh Ton}$$

**9.3 Energy Data for the baseline year**

Item	Unit	Value
Coal Consumed Process	Lakh Ton	0.25000
Coal Consumed Power	Lakh Ton	0.09970
Fuel Oil Consumed Power	Lakh Ton	0.00120
GCV of Coal	kcal/kg	4200
GCV of Fuel Oil	kcal/kg	10000
Thermal SEC of Clinker	kcal/kg of Cli	700



Electrical SEC of Clinker	kwh/ton of Cli	55
Electrical SEC of Cement Grinding	kwh/ton of Cement	35
Import from Grid	Lakh Ton	30.0
Exported to Grid	Lakh Ton	10.0
DG power	Lakh Ton	5.0
CPP power	Lakh Ton	110.2

**b. Calculation for Gate to Gate Specific Energy Consumption (SEC)**

**viii. Total Thermal Energy Consumption (Kiln + Power Generation)**

Total Thermal Energy Consumptions to be calculated as:-

Total Thermal Energy Consumption= [{Fuel consumed (kiln+ power generation) (in Lakh Ton) X Gross calorific value of respective fuel (kcal/kg) X 100} - {(Electricity exported to grid (Lakh kWh) X 2717 (kcal/kWh))/10}]

**[Million kcal]**

Where: - 2717 kcal/kWh is the National Average Gross Heat Rate of Thermal Power Stations in the country in 2007

$$\begin{aligned} \text{Ex.-Total Thermal energy Consumption} &= \{(0.25+0.097) \times 4200 \times 100 + 0.00120 \times 10000 \times 100\} - \\ &= 145357 \text{ Million kcal} \end{aligned}$$

**ix. Energy for Imported Electricity Consumption**

Total energy for imported Electricity Consumption is to be calculated as:-

**Total energy for Imported Electricity= [(Total Imported Electricity from grid (Lakh kWh) X 860(kcal/kWh))/10]**

**[Million kcal]**

$$\text{Ex:-Total Energy for Imported Electricity} = 30 \times 860 / 10 = 2580 \text{ Million kcal}$$

**x. Notional/ Normalization energy for Imported electricity from Grid**

**Notional Energy for imported electricity= [(Imported Electricity (Lakh kWh) x (3208 - 860) (kcal/kWh))/10]**

**[Million kcal]**

Where: 3208 kcal/kWh is the weighted average heat rate of captive power plants in all DCs in cement sector.

$$\text{Ex:-Notional Energy for imported Electricity} = 30 \times (3208-860) / 10 = 7044 \text{ Million kcal}$$

**xi. Notional/ Normalization energy for grinding of exported Clinker**

It is calculated by using following formula:



$$\text{Notional Energy} = \left[ \left\{ \text{Total Exported clinker to major product (Lakh ton)} \times \text{Electrical SEC of cement grinding (kWh/ton of cement)} \right\} \right. \\ \left. \times \text{Weighted Average Heat Rate (kcal/kWh)} \right] / 10 \\ \text{[Million kcal]}$$

Where: -Weighted Average Heat rate (kcal/kWh) =  $\left[ \frac{\left\{ \text{Imported Electricity (Lakh kWh)} \times 3208 \text{ (kcal/kWh)} \right\} + \left\{ \text{DG generation (Lakh kWh)} \times \text{DG heat rate (kcal/kWh)} \right\} + \left\{ \text{Captive Power Plant Generation (Lakh kWh)} \times \text{Captive Power plant heat rate (kcal/kWh)} \right\}}{\left[ \text{Imported Electricity (Lakh kWh)} + \text{DG generation (Lakh kWh)} + \text{Captive power plant generation (Lakh kWh)} \right]} \right]$

Ex:- Weighted Average Heat Rate =  $(30 \times 3208 + 5 \times 2400 + 110.2 \times 3800) / (30 + 5 + 110.2) = 3629.5 \text{ kcal/kwh}$

Ex:- Notional Energy for grinding of exported clinker =  $0.133 \times 35 \times 3629.5 = 1693.75 \text{ Million kcal}$

#### xii. Notional/Normalization energy for clinkerization of imported Clinker

It is calculated by using following formula:

Notional Energy = Total Clinker imported (Lakh ton)  $\times$   $\left[ \left( \text{Thermal SEC of Clinkerization, kcal/kg clinker} \times 1000 \right) + \left\{ \text{electrical SEC of clinkerization (kWh/ton of clinker)} \times \text{Weighted Average Heat Rate (kcal/kWh)} \right\} \right] / 10$

[Million kcal]

Ex:-Notional Energy for clinkerisation of imported clinker =  $0.2 \times (700 \times 1000 + 55 \times 3629.5) / 10 = 17992 \text{ Million kcal}$

#### xiii. Gate to Gate (GtG) Energy Consumption

GtG Energy Consumption =  $b(i) + b(ii) + b(iii) + b(iv) + b(v)$  [Million kcal]

Gate to Gate Energy Consumption =  $145357 + 2580 + 7044 + 1693.75 + 17992 = 174667 \text{ Million kcal}$

#### xiv. Gate to Gate (GtG) Specific Energy Consumption

$$\text{GtG SEC} = \frac{\text{GtG Energy Consumption (Million kCal)}}{\text{Total Equivalent Major Product of Cement (Lakh Ton)} \times 100} \\ \text{[kcal/kg of equivalent cement]}$$

Ex: -GtG SEC =  $174667 / 2.40 \times 100 = 727.78 \text{ kcal/kg of equivalent cement}$

**Note:- Notional/Normalization Energy is not to be considered in Total Energy Consumption, while deciding whether a plant falls under the designated consumer category or not. Normalization energy is considered only in the calculation of Gate to Gate Specific Energy Consumption.**



## 10 Example-Normalization Factors

### 10.1 Capacity Utilisation Example

SN	Description	Units	Baseline Year (BY)	Assessment Year (AY)
1	Kiln Production	Tons/year	1485000	1320000
2	No of operative hours (Available in Form I)	Hrs	7920	7920
3	Kiln TPH	TPH	187.5	166.6
4	Weighted Heat Rate	kcal/kwh	3316	3311
5	Kiln Heat Rate	kcal/kg Clinker	670	
6	Kiln SPC	kwh/t Clinker	31.2	
7	Cold to Hot kiln Start due to external factor	Nos	5	7
8	Kiln Cold to Hot Start due to external factor (Electrical Energy Consumption)	Lakh kWh	0.60	0.80
9	Kiln Hot to Cold stop due to external factor (Electrical Energy Consumption)	Lakh kWh	0.05	0.07

#### Normalization due to loss of TPH

##### ❖ Kiln Heat Rate Normalization

Heat rate of AY- Heat rate of BY=  $0.4673 \times (\text{TPH BY} - \text{TPH AY})$

Heat rate in AY=Heat Rate in BY+  $0.4673 \times (\text{TPH BY} - \text{TPH AY})$

$$= 670 + 0.4673 \times (187.5 - 166.6) = 679.76$$

##### ❖ Notional energy reduction due to loss in kiln TPH

= (Heat rate of AY- Heat rate of BY)  $\times$  Clinker Production in AY

$$= (679.76 - 670) \times 1320000 = 12883 \text{ Million kcal}$$

##### ❖ Normalization of Electrical SEC up to Clinkerisation

SPC of AY- SPC of BY=  $0.0943 \times (\text{TPH BY} - \text{TPH AY})$

$$= 31.2 + 0.0943 \times (187.5 - 166.6)$$

$$= 33.17$$

##### ❖ Notional energy reduction due to loss in kiln TPH in Electrical SEC

= (SPC of AY- SPC of BY)  $\times$  Clinker Production in AY  $\times$  Wt. Heat Rate AY

$$= (33.17 - 31.2) \times 1320000 \times 3311 / 10^6 = 8607 \text{ Million kcal}$$

##### ❖ Total notional energy subtracted due loss of TPH

= Notional energy due Kiln heat rate + Notional energy due to Kiln SPC

$$= 12923 \text{ million kcal} + 8607 \text{ million kcal}$$

$$= 21530 \text{ million kcal}$$

#### Normalization due to Kiln Cold Startup and Hot Stop

##### ❖ Notional Energy for Kiln Cold Startup caused due to external factor (Thermal Energy Consumption)

Notional thermal energy reduction due to kiln cold startup

$$= (0.1829 \times \text{TPH in AY} + 197.41) \times (\text{Nos of Cold Startup in AY} - \text{Nos of Cold Startup in BY})$$

$$= (0.1829 \times 166.6 + 197.41) \times (7 - 5)$$

$$= 455.76 \text{ million kcal}$$

##### ❖ Notional Energy for Kiln Cold to Hot Start due to external factor (Electrical Energy Consumption)



= (Electrical Energy Used in Assessment Year for Cold to Hot Start up in Lakh kwh- Electrical Energy Used in Baseline Year for Cold to Hot Start up in Lakh kwh) x Weighted Heat Rate of Assessment Year in kcal/kwh

$$=(0.8-0.6) \times 3311/10 \text{ million kcal}$$

$$= 66.22 \text{ Million kcal}$$

❖ **Notional Energy for Kiln Hot to Cold Stop due to external factor (Electrical Energy Consumption)**

= (Electrical Energy Used in Assessment Year for Hot to Cold Stop in Lakh kwh- Electrical Energy Used in Baseline Year for Hot to Cold Stop in Lakh kwh) x Weighted Heat Rate of Assessment Year in kcal/kwh

$$=(0.07-0.05) \times 3311/10 \text{ million kcal}$$

$$=6.622 \text{ million kcal}$$

❖ **Total Notional energy subtracted due to Kiln Cold Startup and Hot Stop**

=Notional Energy for Kiln Cold Startup (Thermal) + Notional Energy for Kiln Cold Startup (Electrical) +Notional Energy for Kiln Hot stop (Electrical)

$$=455.76 \text{ million kcal} + 66.22 \text{ Million kcal} + 6.622 \text{ million kcal}$$

$$=528.6 \text{ million kcal}$$

❖ **Total Notional energy subtracted from the total energy consumption due to capacity Utilisation**

= Total notional energy subtracted due loss

of TPH + Total Notional energy subtracted due to Kiln Cold Startup and Hot Stop

$$=21530 \text{ million kcal} +528.6 \text{ million kcal}$$

$$=22058 \text{ million kcal}$$

**Note:**

- In the above calculation, installed capacity of kiln/plant is not imminent in the normalization, hence the normalisation is independent of installed capacity
- Weighted average of all the kilns for overall computation of GtG SEC
- Kiln Heat rate calculation will be on GCV basis
- SEC of kiln= Total Thermal Energy consumed kiln/Clinker Production [ In kcal/kg]

**10.1.1 Provision in PAT Rules on Capacity Utilisation (Schedule 1.4)**

- (c) The normalisation procedure is proposed to be applied if the capacity utilization or Plant Load Factor (PLF) has a deviation of more than thirty percent. It shall be applied only if capacity utilisation has deviated due to uncontrollable factors described in rule 4, and duly declared by the designated consumer with authentic proof or self-certifications.

**The normalisation is subjected to the amendments in the Notified Rules G.S.R. 269 (E) dated 30/03/2012**

**10.2 Plant Load(PLF) Factor of Captive Power Plant (CPP)**

Sr No	Description	Unit	Baseline Year (BY)	Assessment Year (AY)
1	Installed capacity	MW	70	70
2	Gross generation of CPP	Lakh kWh	3750	3600
3	Break down hrs due to internal, Planned and external factor	Hrs	1125	625
4	Plant low load hrs due to Internal Factors/ Breakdown in Plant	Hrs	700	300



5	Plant low load hrs due to External Factors like Fuel Unavailability/ Market demand/ External Condition	Hrs	900	700
6	Plant Availability Factor (PAF)	Factor	0.87	0.93
7	Plant Load Factor (PLF)	%	70	63
8	% of loss due to external Factors	%	56.25	70

There are five nos of STG from STG1 to STG 5 are considered in the Form I and consolidated input is taken for PLF calculation. The calculation STG 1-5 was done on weighted basis w.r.t the CPP gross unit generation. Increased no of STG will be filled in the separate Excel Sheet as per format provided for STG data filling in Form I.

### Calculation of PAF, PLF and % of loss due to External factor

#### ❖ Plant Availability Factor (PAF) in Base line year

$$= (\text{Total Available hours in a year in BY} - \text{Internal Planned Shutdown, Breakdown/ Outages hrs in BY} - \text{External Planned Shutdown, Breakdown/ Outages hrs in BY}) / \text{Total Available hours in a year in BY}$$

$$= (8760 - 1125) / 8760$$

$$= 0.87$$

#### ❖ Plant Availability Factor (PAF) in Assessment year

$$= (\text{Total Available hours in a year in AY} - \text{Internal Planned Shutdown, Breakdown/ Outages hrs in AY} - \text{External Planned Shutdown, Breakdown/ Outages hrs in AY}) / \text{Total Available hours in a year in AY}$$

$$= (8760 - 625) / 8760$$

$$= 0.93$$

#### ❖ Plant Load Factor (PLF) in Baseline Year

$$= (\text{Gross Generation in Lakh kwh in BY}) / (\text{Installed capacity in MW in BY} \times \text{Total available hours in a year in BY} \times \text{PAF in BY})$$

$$= (3750 \times 10^5 \times 100 / 70 \times 10^3 \times 8760 \times 0.87)$$

$$= 70.2\%$$

#### ❖ Plant Load Factor (PLF) in Assessment Year

$$= (\text{Gross Generation in Lakh kwh in AY}) / (\text{Installed capacity in MW in AY} \times \text{Total Available Hours in a year in AY} \times \text{PAF in AY})$$

$$= (3600 \times 10^5 \times 100 / 70 \times 10^3 \times 8760 \times 0.93)$$

$$= 63.2\%$$

#### ❖ % loss of PLF due to external factor in Baseline Year

$$= (\text{Plant low load hrs due to External Factors in BY}) / (\text{Plant low load hrs due to External Factors in BY} + \text{Plant low load hrs due to Internal Factors/ Breakdown in Plant in BY})$$

$$= (900 \times 100 / 700 + 900)$$

$$= 56.25\%$$

#### ❖ % loss of PLF due to external factor in Assessment Year

$$= (\text{Plant low load hrs due to External Factors in AY}) / (\text{Plant low load hrs due to External Factors in AY} + \text{Plant low load hrs due to Internal Factors/ Breakdown in Plant in AY})$$

$$= (700 \times 100 / 300 + 700)$$

$$= 70\%$$

Sr No	Description	Unit	Baseline Year (BY)	Assessment Year (AY)
1	Gross generation of CPPs	Lakh kWh	3750	3600
2	Actual Gross Heat Rate	Kcal/kWh	2600	2800
3	Plant Load Factor	%	70	63
4	% of loss due to external Factors	%	56.25	70



- ❖ **Percentage increase in the Heat Rate from Design Heat Rate in Baseline Year**  
 $= 0.0016 \times (\% \text{ PLF})^2 - 0.3815 \times (\% \text{ PLF}) + 21.959$   
 $= (0.0016 \times (70)^2) - (0.3815 \times 70) + 21.959$   
 $= 3.094\%$
- ❖ **Percentage increase in the Heat Rate from Design Heat Rate in Assessment Year**  
 $= 0.0016 \times (\% \text{ PLF})^2 - 0.3815 \times (\% \text{ PLF}) + 21.959$   
 $= (0.0016 \times (63)^2) - (0.3815 \times 63) + 21.959$   
 $= 4.275\%$
- ❖ **Difference of % increase in Heat Rate of Assessment Year and Baseline Year**  
 $= \% \text{ increase in Heat Rate of Assessment Year} - \% \text{ increase in Heat Rate of Baseline Year}$   
 $= 4.275 - 3.094$   
 $= 1.181\%$
- ❖ **% loss in PLF from Assessment Year due to external factor is 70 %**
- ❖ **Percentage increase in Heat Rate from Design Heat Rate in Assessment Year due to external factor**  
 $= 1.181 \times (70 / 100) = 0.82670\%$
- ❖ **The Normalized Gross Heat of Assessment Year**  
 $= \text{Actual Gross Heat Rate} \times (1 - 0.08267\%)$   
 $= 2800 \times [1 - (0.8267 / 100)]$   
 $= 2776.8 \text{ kcal/kWh}$
- ❖ **Total notional energy subtracted from the total energy due to loss of PLF**  
 $= \text{Gross generation of CPP} \times (\text{Actual gross Heat Rate} - \text{Normalized gross Heat Rate}) / 10$   
 $= 3600 \times (2800 - 2776.8) / 10$   
 $= 8352 \text{ Million kcal}$

**Table: Calculation for PLF Normalization**

Sr No	Item	Unit	Baseline Year (BY)	Assessment Year (AY)
1	Loading	%	70	63
2	Actual Gross Heat Rate	kcal/kwh	2600	2800
3	% Increase in Heat rate from Design Heat Rate	%	3.094 ( $= 0.0016 \times (70)^2 - 0.3815 \times 70 + 21.959$ )	4.2749 ( $= 0.0016 \times (63)^2 - 0.3815 \times 63 + 21.959$ )
4	Difference	%		1.1809 ( $= 4.2749 - 3.094$ )
5	Loss in loading due to external factor	%		70
6	% Decrease from baseline	%		0.8267 ( $= 1.1809 \times 70 / 100$ )
7	Normalised Gross Heat Rate	kcal/kwh		2776.8 [ $= 2800 \times (1 - 0.8287 / 100)$ ]
8	Gross generation	Lakh kWh		3600
9	Energy to be subtracted	Million kcal		8352 [ $= 3600 \times (2800 - 2776.8) / 10$ ]



### 10.3 Petcoke utilization in Kiln

Sr No	Description	Units	Baseline Year [BY]	Assessment Year [AY]
1	Clinker Production	Lakh Ton	10	12
2	Thermal SEC of Clinker	Kcal/kg of clinker	700	700
3	Electrical SEC of Clinker	KWh/t	70	70
4	Weighted Heat Rate	Kcal/kWh	3200	3200
5	Petcoke Consumption in kiln	%	10	40

❖ **Normalized Thermal SEC of Clinker due change of Petcoke Consumption**

$$= \text{Baseline thermal SEC of clinker} \times 0.0954 \times (\text{Petcoke Consumption in Assessment Year} - \text{Petcoke Consumption in Baseline Year})$$

$$= 700 \times 0.0954 \times (40-10)$$

$$= 702.86 \text{ kcal/kg of clinker}$$

❖ **Normalized Electrical SEC of Clinker due change of Petcoke Consumption**

$$= \text{Baseline electrical SEC of clinker} \times 0.022 \times (\text{Petcoke Consumption in Assessment Year} - \text{Petcoke Consumption in Baseline Year})$$

$$= 70 \times 0.022 \times (40-10)$$

$$= 70.66 \text{ kWh/ton of clinker}$$

❖ **Thermal energy subtracted from the total energy**

$$= (\text{Normalized thermal SEC of clinker} - \text{Baseline Year thermal SEC}) \times \text{Clinker production of Assessment Year} \times 100$$

$$= (702.86-700) \times 12 \times 100$$

$$= 3434.40 \text{ Million kcal}$$

❖ **Electrical energy subtracted from the total energy**

$$= (\text{Normalized electrical SEC of clinker} - \text{Baseline Year electrical SEC}) \times \text{Clinker production of Assessment Year} / 10$$

$$= (70.66-70) \times 12 / 10$$

$$= 0.79 \text{ Million kWh}$$

❖ **National energy subtracted from the total energy due to the change of Petcoke Consumption**

$$= \text{Total thermal energy} + \text{Total electrical energy} \times \text{weighted Heat Rate}$$

$$= 3434.40 + 0.79 \times 3200$$

$$= 5968.80 \text{ Million kcal}$$

### 10.4 Coal Quality in CPP

Sr No.	Description	Units	Baseline Year [BY]	Assessment Year [AY]
1	CPP Generation	Million kWh	316	320
2	Actual CPP Heat Rate	kcal/kWh	3543	3328
3	Ash	%	30	45
4	Moisture	%	4.4	7
5	Hydrogen	%	2.6	2.6
6	GCV	kcal/kg	3500	3300

❖ **Boiler efficiency in baseline year**

$$= 92.5 - \frac{[50 \times A + 630 (M + 9H)]}{GCV}$$

$$= 92.5 - \frac{[50 \times 30 + 630 \times (4.4 + 9 \times 2.6)]}{3500}$$

$$= 87.1 \%$$

❖ **Boiler efficiency in assessment year**

$$= 92.5 - \frac{[50 \times A + 630 (M + 9H)]}{GCV}$$

$$= 92.5 - \frac{[50 \times 45 + 630 \times (7 + 9 \times 2.6)]}{3300}$$

$$= 86.0 \%$$

❖ **The CPP heat rate in assessment year due to fuel quality**

$$= \text{CPP heat rate in baseline year} \times$$



(Boiler Efficiency in baseline year/Boiler Efficiency in assessment year)

$$=3543 \times (87.1/86)$$

$$=3578.43 \text{ kcal/kWh}$$

❖ **Increase in the CPP heat rate of assessment year due to fuel quality**

$$=3578.43 - 3543$$

$$=35.43 \text{ kcal/kWh}$$

❖ **Notional energy to be subtracted from total energy**

= CPP generation in assessment year X increase in CPP heat rate

$$=320 \times 35.43 = 11337.6 \text{ Million kcal}$$

**Note on Proximate and Ultimate Analysis of Coal**

If the ultimate analysis has not been carried out in the baseline year for getting %H result, following conversion formulae from Proximate to Ultimate analysis of coal could be used for getting elemental chemical constituents like %H

Relationship between Ultimate and Proximate analysis

$$\%C = 0.97C + 0.7(VM + 0.1A) - M(0.6 - 0.01M)$$

$$\%H_2 = 0.036C + 0.086(VM - 0.1xA) - 0.0035M_2(1 - 0.02M)$$

$$\%N_2 = 2.10 - 0.020 VM$$

Where

C= % of fixed carbon

A=% of ash

VM=% of volatile matter

M=% of moisture

**10.5 Power Mix**

The Plant is compared with their operational efficiencies only in the Assessment year, hence keeping the energy consumption same in both the period,

the performance has been assessed by changing the power source mix with change in export quantity from the baseline year

**Table: Production and Performance Indicators**

Sr No	Description	Unit	Baseline Year [BY]	Assessment Year [AY]
1	Clinker Production	Million ton	1.00	1.00
2	Cement Production (OPC)	Million ton	1.04	1.04
3	Thermal SEC upto Clinker	kcal/kg	800	800
4	Electrical SEC upto Clinker	kWh/ton	70.00	70.00
5	Electrical SEC for cement grinding	kWh/ton	28.80	28.80
6	Total Thermal energy used in Process	Million kcal	800000	800000

**Table: Heat Rate of Power sources**

Sr No	Description	Unit	Baseline Year [BY]	Assessment Year [AY]
11	Grid heat rate	kcal/kWh	3208	3208
12	CPP heat rate	kcal/kWh	3400	3400
13	DG heat rate	kcal/kWh	2600	2600
14	Exported Power Heat rate	kcal/kWh	2717	2717

The heat rates from all the power sources remain same in the assessment year for the purpose of developing normalization. However, the normalization calculation should be sensitive enough to accommodate any change in the heat rate w.r.t. the SEC of the Plant.

- The DG Heat Rate in the assessment will be considered equal to baseline year; if the % of DG power consumption is less than



1% of total electricity consumption in the plant in the assessment year

**Table: Energy Data from Power Sources**

Sr No	Description	Unit	Baseline Year [BY]	Assessment Year [AY]
7	Total Electricity Consumption of Plant without WHR generation	Million kWh	100.00	100.00
8	Total Electricity availability without WHR	Million kWh	105.00	110.00
8a	Electricity imported from the grid	Million kWh	15.00	20.00
8b	Electricity generated from CPP	Million kWh	85.00	85.00
8c	Electricity generated from DG	Million kWh	5.00	5.00
8d	Electricity generated from WHR	Million kwh	5.00	5.00
9	Electricity exported to the grid	Million kWh	5.00	10.00
10	CPP generated Electricity Consumption within the plant	Million kWh	80.00	75.00

The normalization calculation is to be developed to cater the change in power import and export. The above table shows the increase in exported power from 5 MU to 10 MU. The additional export power of 5MU is being generated from the CPP. Hence power is generated with heat rate @3400 kcal/kwh, while power export is being taking place @ 2717 kcal/kwh. This difference in heat rate i.e., @683 kcal/kwh will be a disadvantageous proposition for the exporting plant.

Since, the same is contributing in the plant Specific Energy Consumption. In this situation, the plant will consume more thermal energy [5MU @ (3400-2717) kcal /kWh] for same electricity consumption with in plant. Therefore the SEC of plant will increase. This disadvantageous position to be normalized and plant should not suffer with change in export power from the baseline year.

**The electricity generated from WHR is not being considered in the total energy consumption of the plant for power mix normalization.** Hence, it will be excluded from the Power Mix calculation in the Plant's energy consumption itself. The power produced by WHR and exported has been subtracted from the total available electricity of power sources.

The generated electricity consumption in the plant from different power sources is being calculated after taking the exported electricity into account. The exported electricity is being deducted from the major generated electricity automatically.

**Table: Plant Energy Consumption**

Sr No	Description	Unit	Baseline Year [BY]	Assessment Year [AY]
15	Thermal Energy of Electricity Consumed Within Plant	Million kcal	333120	332160
16	Grid Share of electricity consumption of plant	Factor	0.150	0.200
17	CPP Share of electricity consumption of plant	Factor	0.800	0.750
18	DG Share of electricity consumption of plant	Factor	0.050	0.050
19	Weighted Average heat rate of plant	kcal/ kWh	3331.20	3321.60



The share of energy has been taken from the plant electricity consumption excluding WHR generation and Power export. For Example- Grid share factor will be  $15 \text{ MU} / 100 \text{ MU} = 0.15$  or 15% of the total electricity consumption of the plant.

The weighted heat rate is heat rate of different power sources in the baseline as well as in the assessment year. It is the summation of average of the multiplication of heat rate and generation.

### Calculation for Heat Rate in the Baseline Year

#### ❖ Total Energy Consumed in Baseline year

= Energy consumed in process + (Grid Imported electricity X 3208 kcal/kWh) + (CPP generated electricity X CPP heat rate) + (DG generated electricity X DG heat rate) - (Grid exported electricity X 2717 kcal/kwh)

=  $800000 + (15 * 3208) + (85 * 3400) + (5 * 2600) - (5 * 2717)$

= 1136535 million kcal

#### ❖ Gate to Gate SEC in the baseline year

= Total energy consumed in baseline year / (Equivalent Cement production \* 1000)

=  $1136535 / (1.04 * 1000)$

= 1091.07 kcal/kg of eq. Cement

The change in assessment year in the power has been observed as

- Grid import increased from 15 MU to 20 MU
- Grid export increased from 5 MU to 10 MU
- Plant electricity consumption from CPP decreased from 80 MU to 75 MU
- CPP Generation remains constant at 85 MU

If plant decreases the use of electricity from CPP generation (5MU @ 3400kcal/kWh) and increases the import power from grid (5MU @ 3208 kcal/kWh). In this condition, the plant will consume

less thermal energy [5MU @ (3400-3208) kcal / kWh] for same electricity consumption with in plant. Therefore the SEC of plant will decrease.

**Without normalization in the Assessment year, the plant will get undue disadvantage as per following calculation**

#### ❖ Total Energy Consumed in Assessment year would have been without Normalization

= Energy consumed in process + (Grid Imported electricity X 3208 kcal/kWh) + (CPP generated electricity X CPP heat rate) + (DG generated electricity X DG heat rate) - (Grid exported electricity X 2717 kcal/kwh)

=  $800000 + (20 * 3208) + (85 * 3400) + (5 * 2600) - (10 * 2717)$

= 1138990 million kcal

#### ❖ Gate to Gate SEC in the baseline year

= Total energy consumed in baseline year / (Equivalent Cement production \* 1000)

=  $1138990 / (1.04 * 1000)$

= 1093.43 kcal/kg of eq. Cement

It may be concluded that the plant will be on the disadvantageous side and suffer a loss of  $1093.43 - 1091.07 = 2.36$  kcal/kg of eq. cement only by increasing grid import and export power.

This affect will be nullified through normalization in Power source mix and Power exports as per following calculation

1. **For Power Source Mix:** The additional imported electricity in assessment year as compared to baseline year calculated with the CPP heat rate [5MU @ (3400-3208) kcal/kWh = 960 Million kcal] will also be added to total energy of the plant
2. **For Power Export:** The additional exported electricity in assessment year as compared to baseline year calculated with the actual



CPP heat rate [5MU × (3400-2717) kcal/kWh=3215 Million kcal] will also be subtracted from total energy of the plant

The above effect takes place for single power source and power export. There could be multiple power sources in any plant, hence effective calculation could be evaluated through normalizing and maintaining the same share of source in the assessment year, maintained in the baseline year as per following equation

❖ **Normalized Weighted Average heat rate of plant in assessment year**

= Grid Share of electricity consumption in baseline year X Grid heat rate + CPP Share of electricity consumption in baseline year X CPP heat rate + DG Share of electricity Consumption in baseline year X DG heat rate

$$= 0.150 * 3208 + 0.800 * 3400 + 0.050 * 2600 = 3331.20 \text{ kcal/kWh}$$

The Normalised weighted heat rate then subtracted to the weighted heat rate of the plant for assessment year to get the net increase or decrease in combined weighted heat rate. The same would be multiplied with the plant electricity consumption for Normalistaion as per following equation

❖ **Notional energy added in total energy due change in power source mix**

= Total electricity consumed within plant X (Normalized Wt. Average heat rate - Wt. Average heat rate of plant in assessment year)

$$= 100 * (3331.20 - 3215.60) = 960 \text{ million kcal}$$

Similarly, for power export normalization, actual heat rate of the CPP for calculating the exported electricity from the plant, since the same was calculated @2717 kcal/kwh in the baseline year, hence the equation has been derived by taking

into the consideration of baseline export electricity also as per following formulae

❖ **Notional energy for exported electricity to grid subtracted from total energy**

= (Exported electricity in Assessment year - Exported electricity in Baseline year) X (CPP hear rate in Assessment year -2717 kcal/kWh)

$$= (10-5) * (3400-2717) = 3415 \text{ million kcal}$$

**If exported power goes down in the assessment year w.r.t. baseline year:**

In the baseline year; the exported power is taken as 2717 kcal/kwh, which is lower than the CPP heat rate. The difference in the heat rate is then multiplied with the exported power automatically gets added in the total energy consumption of Plant in the base line year.

Now in the assessment year, if the exported power goes down in comparison to the baseline values, the same quantity of energy which was added in the baseline year shall be added in the total energy consumption of the Plant. By doing this, the SEC of Plant remains same for equal condition for all situation.

The situation in terms of SEC of the plant remains unchanged if the energy of exported power would have been subtracted in the baseline year so as in the assessment year. This situation is matched in the assessment year by Power normalizations.

❖ **Total Energy Consumed in Assessment year**

= Energy consumed in process + (Grid Imported electricity X 3208 kcal/kWh) + (CPP generated electricity X CPP heat rate) + (DG generated electricity X DG heat rate) - (Grid exported electricity X 2717 kcal/kWh) + Notional Energy for Power mix - Notional Energy for exported electricity to grid

$$= 800000 + (20 * 3208) + (85 * 3400) + (5 * 2600) - (10 * 2717) + 960 - 3415 = 1136535 \text{ million kcal}$$



- ❖ **Gate to Gate SEC in the assessment year**  
 =Total energy consumed in assessment year/(Equivalent Cement production\*1000)  
 = 1136535/ (1.04 \*1000)  
 =1091.07 kcal/kg of eq. Cement

**Table: SEC in Baseline and Assessment year**

Sr No	Description	Unit	Baseline Year [BY]	Assessment Year [AY]
20	Notional Energy for Power Mix	Mkcal	0.00	960.00
21	Notional Energy for Exported Electricity to Grid	Mkcal	0.00	3415.00
22	Total Energy Consumed	Mkcal	1136535.00	1136535.00
23	SEC	kcal/kg	1091.07	1091.07

After Normalisation in assessment year with power source mix and power export, the Gate-to-Gate Energy stand at 1091.07, which is equivalent to baseline SEC.

### Benefit of increasing efficiency in CPP

If a plant increases its efficiency i.e., decreased its heat rate from 3400 kcal/kwh to 3200 kcal/kwh in the assessment year, the Specific Energy Consumption of the Plant will come down as per the equation discussed above.

**Table: Heat Rate of Power sources- CPP Heat Rate decreased**

Sr No	Description	Unit	Baseline Year [BY]	Assessment Year [AY]
11	Grid heat rate	kcal/kWh	3208	3208
12	CPP heat rate	kcal/kWh	3400	3200
13	DG heat rate	kcal/kWh	2600	2600
14	Exported Power Heat rate	kcal/kWh	2717	2717

**Table: Plant energy Consumption**

Sr No	Description	Unit	Baseline Year [BY]	Assessment Year [AY]
15	Thermal Energy of Electricity Consumed Within Plant	Million kcal	333120	317120
16	Grid Share of electricity consumption of plant	Factor	0.150	0.150
17	CPP Share of electricity consumption of plant	Factor	0.800	0.800
18	DGShareofelectricity consumption of plant	Factor	0.050	0.050
19	Wt. Average heat rate of plant	Kcal/kWh	3331.20	3171.20

**Table: SEC**

Sr No	Description	Unit	Baseline Year [BY]	Assessment Year [AY]
20	Notional Energy for Power Mix	Mkcal	0.00	0.00
21	Notional Energy for Exported Electricity to Grid	Mkcal	0.00	0.00
22	Total Energy Consumed	Mkcal	1136535.00	1119535.00
23	SEC	kcal/kg	1091.07	1074.75

The SEC has been decreased with the decrease in Heat Rate of CPP as stated in the above table.

### 10.6 Product Mix

Case I:

- ❖ Baseline Major Product: PPC & Assessment Year Major Product: PPC
- ❖ Change in clinker factor of major product
- ❖ PSC Production: 0



**Table: Plant Clinker Production Data and their ratio**

Sr No	Item	Unit	Baseline Year	Assessment Year
1	Total Clinker Production	Million Tons	1.0	1.0
2	Total Clinker Export	Million Tons	0.1	0.1
3	Fly Ash used in Cement	%	15	20
4	Gypsum used in Cement	%	4	4
5	OPC in total cement	%	35	35
6	PPC in total cement	%	65	65
7	PSC/Others in total cement	%	0	0
8	Clinker Factor to OPC		0.96	0.96
9	Clinker Factor to PPC		0.81	0.76
10	Clinker Factor to PSC/Others		0	0
11	Average Weighted Clinker Factor		0.8625	0.83
12	Average Weighted Clinker Factor other than OPC		0.81	0.76

The Average Weighted Clinker Factor without OPC factor is the average of PPC and PSC/others factor and will be used to calculate the additional additives in the cement for Normalisation as per following equation

❖ **Average Weighted clinker factor of baseline year excluding OPC**

= (PPC cement production X Clinker factor of PPC + PSC cement production X clinker factor of PSC ) / (PPC cement production + PSC cement production)

$$= 0.678 * 0.81 / 0.678$$

$$= 0.81$$

❖ **Average weighted clinker factor of assessment year excluding OPC**

= (PPC cement production X Clinker factor of PPC + PSC cement production X clinker factor of PSC ) / (PPC cement production + PSC cement production)

$$= 0.705 * 0.76 / 0.705$$

$$= 0.76$$

**Table: Plant Cement Production Data**

Sr No	Item	Unit	Baseline Year	Assessment Year
1	Total combined cement production	Million Tons	1.043	1.084
2	Production of OPC	Million Tons	0.365	0.3795
3	Production of PPC	Million Tons	0.678	0.705
4	Production of PSC	Million Tons	0	0

**Plant Equivalent Cement Production Calculation**

❖ **Major equivalent cement in baseline year ( Major product- PPC cement)**

= (OPC cement production X CF of OPC) / CF of PPC + (PPC cement Production X CF of PPC) + (PSC Cement Production X CF of PSC) / CF of PPC + Clinker exported / CF of PPC

$$= (0.365 * 0.96) / 0.81 + (0.678 * 0.81) / 0.81 + (0 * 0) / 0.81 + 0.1 / 0.81$$

$$= 0.432 + 0.678 + 0.0 + 0.123$$

$$= 1.234 \text{ million ton}$$



**Product Mix: Normalisation 1**

**Normalized Major equivalent cement in assessment year**

$$\begin{aligned}
 &= (\text{OPC cement production of assessment year} \times \text{CF of OPC assessment year}) / \text{CF of PPC baseline year} \\
 &+ (\text{PPC cement Production of the assessment year} \times \text{CF of PPC assessment year}) / \text{CF of PPC baseline year} \\
 &+ \text{Clinker exported in the assessment year} / \text{CF of PPC baseline year} \\
 &= (0.3795 * 0.96) / 0.81 + (0.705 * 0.76) / 0.81 + 0.01 / 0.81 \\
 &= 0.4498 + 0.6614 + 0.123 \\
 &= 1.234 \text{ million ton}
 \end{aligned}$$

The normalized major equivalent cement is to be calculated after applying following normalization

- i. The Major product of assessment year will remain same as of the baseline year, i.e., the Clinker factor of PPC in the baseline year will be used for getting equivalent major product
- ii. The clinker factor of major product of assessment year will remain same as of the baseline year i.e., the Clinker factor of PPC in the baseline year is to be divided for getting equivalent major product

**Table: Plant Equivalent Cement (Example-PPC) Production Data**

Sr No	Item	Unit	Baseline Year	Assessment Year
1	OPC Production equivalent to major product	Million Tons	0.432	0.4498
2	PPC Production equivalent to major product	Million Tons	0.678	0.6614
3	PSC/Others Production equivalent to major product	Million Tons	0	0
4	Exported Clinker to Equivalent Major Product	Million Tons	0.123	0.123
5	Total Equivalent major product of Cement	Million Tons	1.234	1.234

With the increase in Fly Ash %, Slag or any additives % in the Cement, the benefit of utilizing more waste material as compared to the baseline year in the assessment year could be given to the plant similar to the energy efficiency measures. This will be done by taking the difference of %age additives from baseline year in assessment year and converting into Notional equivalent clinker production. Hence, if a plant utilizes more additives (without considering Gypsum in PPC and PSC) in per unit of cement production in the assessment year, the same will be converted into equivalent clinker by below mentioned equation

**Product Mix: Normalisation 2**

**Clinker produced due to change in Additives/Clinker Factor in PPC**

$$\begin{aligned}
 &= \text{Cement production PPC in assessment year} \times [(\text{Clinker factor of OPC in the assessment year} - \text{Clinker factor of PPC in the assessment year}) - (\text{Clinker factor of OPC in the baseline year} - \text{Clinker factor of PPC in the baseline year})] \\
 &= 0.705 * [(0.96 - 0.76) - (0.96 - 0.81)] \\
 &= 0.705 * (0.20 - 0.15) \\
 &= 0.03525 \text{ million ton}
 \end{aligned}$$

**Clinker produced due to change in Additives/Clinker Factor in PSC**

$$\begin{aligned}
 &= \text{Cement production PSC in assessment year} \times [(\text{Clinker factor of OPC in the assessment year} - \text{Clinker factor of PSC in the assessment year}) - (\text{Clinker factor of OPC in the baseline year} - \text{Clinker factor of PSC in the baseline year})] \\
 &= 0 * [(0.96 - 0) - (0.96 - 0)] = 0
 \end{aligned}$$

**Total Clinker Produced due to change in Additives/Clinker factor in PPC and PSC**

$$\begin{aligned}
 &= \text{Clinker produced due to change in Additives/Clinker Factor in PPC} + \text{Clinker produced due to change in Additives/Clinker Factor in PSC} \\
 &= 0.03535 \text{ million ton} + 0 \text{ million ton} \\
 &= 0.03525 \text{ million ton}
 \end{aligned}$$



**Table: Plant's Performance indicators**

Sr No	Item	Unit	Baseline Year	Assessment Year
1	Thermal SEC	kcal/kg of Cli	820.8	820.8
2	Electrical SEC (up to Clinkerisation)	kwh/ ton of Cement	54.43	54.43
3	Electrical SEC (Cement Grinding)	kwh/ ton of Cement	26.95	26.95

Based on the performance indicators, the energy consumption of plant could be calculated in this example. The performance indicators of the plant are also considered while calculating the energy requirement for different normalisation.

**Table: Plant's Power source heat rate**

Sr No	Item	Unit	Baseline Year	Assessment Year
1	Import Power Heat Rate	kcal/kwh	3208.0	3208.0
2	Export Power Heat Rate	kcal/kwh	2717.0	2717.0
3	Power plant Heat Rate	kcal/kwh	3500.0	3500.0
4	Cement plant Combined Heat Rate (Grid heat Rate)	kcal/kwh	3208.0	3208.0
5	Weighted Average Heat Rate	kcal/kwh	3221.98	3221.80

The weighted heat rate has been calculated by taking into consideration the generation and import from grid. The weighted heat rate will be different for baseline as well as for the assessment year due to difference in cement production viz-viz for cement grinding energy.

The clinker produced due to change in clinker factor/additives will be converted to thermal energy

for addition or deletion from the total energy consumption of the plant. It is considered that due to additional Fly ash/slag/additives used per unit of cement, the same amount of clinker is reduced from per unit of cement from the baseline. This could be considered as improvement in energy efficiency by producing less quantity of clinker per unit of cement. The equation will be

**Product Mix: Normalisation 3**

**Notional Energy for Clinker Produced due to change in Additives/Clinker Factor subtracted from total energy**

= Clinker produced due to changes in Additives/ Clinker factor X [Thermal SEC of Clinker X1000 + Electrical SEC upto clinkarization X Wt. Average heat rate of plant in assessment year]

$$= 0.03525 * [820.80 * 1000 + 54.43 * 3221.80]$$

$$= 0.03525 * [820800 + 175362.57]$$

$$= 35114.7 \text{ million kcal}$$

**Grinding Energy consumed due to equivalent cement**

There is a change in equivalent cement production with change in any additives like Ash, Slag etc in the cement i.e., with the same quantity of clinker production, the equivalent cement produced could be more or less in the assessment year as compared to the baseline year with the change in clinker factors or change in additives ratio. The difference in grinding energy between total Equivalent cement made and total Actual cement made is to be added in the baseline year itself and the same method to be followed in the assessment year also.

Hence, the notional grinding energy for the difference in Equivalent cement and Actual Cement Production needs to be calculated for baseline as well as for the assessment year and the difference of notional energy (Baseline-Assessment year) is to be subtracted in the assessment year. Hence, these differences of baseline as well as for the assessment year needs to be adopted as per following equation



#### Product Mix: Normalisation4

Notional Energy for Grinding subtracted in total energy

= [(Eq. Major Cement production – Reported Cement production – Eq. Major cement production of exported Clinker) X Electrical SEC for grinding X Wt. Av. Heat rate] in Baseline year–(Eq. Major Cement production – Reported Cement production – Eq. Major cement production of Exported Clinker) X Electrical SEC for grinding X Wt. Av. Heat rate] in Assessment year

$$[(1.234-1.043-0.123) * 26.95 * 3221.98]-[(1.234-1.084-0.123) * 26.95 * 3221.80]$$

$$= 5904.60-2344.34$$

$$= 3560.25 \text{ Million kcal}$$

#### 10.6.1 Different cases in Cement Plants of Product Mix and use of Normalisation

Sr No	Baseline Year (Major Product)	Assessment Year (Major Product)	Change in Assessment year	Change in Clinker Factor	Assessment Year-Normalisation Factor Required
1	OPC	PPC/PSC	Change in Major	No change	Normalisation 1&4
2	OPC	PPC/PSC	Change in Major	Yes	Normalisation 1-4
3	OPC	OPC	Minor Product (PPC/PSC) CF Change	Yes (Minor)	Normalisation 1-4
4	PPC/PSC	OPC	Change in Major	No Change	Normalisation 1&4
5	PPC/PSC	OPC	Change in Major	Yes	Normalisation 1-4
6	PPC/PSC	PPC/PSC	Clinker Factor Change-Major Product	Yes	Normalisation 1-4 (As per above Ex)
7	PPC/PSC	PPC/PSC	Increase/decrease in PPC/PSC production	No change	Normalisation 1&4

#### 10.7 Normalisation Others

##### 10.7.1 Environmental Concern

**Table: Additional Electrical Energy requirement for Environmental Equipment**

Sr No	Item	Date of Installation	Unit	Baseline Year	Assessment Year
1	Eqp 1	15-May-14	Lakh Unit	NA	20
2	Eqp 2	05-Oct-14	Lakh Unit	NA	5
3	Eqp 3	10-Nov-14	Lakh Unit	NA	10
4	Energy Consumed		Lakh Unit		35
5	Weighted Heat Rate		kcal/kwh	3200	3100



- ❖ Additional Electrical Energy Consumed due to installation of Environmental Equipment

=Total Electrical Energy Consumed for additional Equipment Installed due to Environmental concern in Lakh kWh x Weighted Heat Rate of the Power Sources in kcal/kWh/10

$$=35 \times 3100/10$$

$$=10850 \text{ million kcal}$$

- ❖ Additional Thermal Energy Consumed due to installation of Environmental Equipment

=Total Thermal Energy Consumed for additional Equipment Installed due to Environmental concern in Million kcal

$$=9700 \text{ Million kcal}$$

- ❖ Additional Total Energy Consumed due to installation of Environmental Equipment to be subtracted in the Assessment Year

= Additional Electrical Energy Consumed due to installation of Environmental Equipment + Additional Thermal Energy Consumed due to installation of Environmental Equipment

$$=10850 \text{ Million kcal} + 9700 \text{ Million kcal}$$

$$=20550 \text{ Million kcal}$$

**Table: Additional Thermal Energy requirement for Environmental Equipment**

Sr No	Item	Date of Installation	Unit	Baseline Year	Assessment Year
1	Eqp 4	15-Apr-14	Million kcal	NA	1200
2	Eqp 5	12-Sep-14	Million kcal	NA	5000
3	Eqp 6	15-Jan-15	Million kcal	NA	3500
4	Energy Consumed		Million kcal		9700

**10.7.2 Biomass /Alternate Fuel Unavailability w.r.t. Baseline year(Replacement due to external factor)**

**Table: Fossil Fuel Replacement**

Sr No	Item	Unit	Baseline Year	Assessment Year
1	Biomass replacement with Fossil fuel due to Biomass un-availability (used in the process)	Tonnes	NA	20
2	Alternate Solid Fuel replacement with Fossil fuel due to Alternate Solid Fuel un-availability (used in the process)	Tonnes	NA	15
3	Alternate Liquid Fuel replacement with Fossil fuel due to Alternate Liquid Fuel un-availability (used in the process)	Tonnes	NA	5
4	Biomass Goss Calorific Value	kcal/kg		2100
	Alternate Solid Fuel Goss Calorific Value	kcal/kg		2800
	Alternate Liquid Fuel Goss Calorific Value	kcal/kg		6000



- ❖ **Thermal Energy used due to Biomass replacement by Fossil Fuel in the assessment year due to unavailability (Replacement due to external factor)**

=Biomass replacement with Fossil fuel due to Biomass un-availability (used in the process) in Tonnes x Biomass Gross Heat Rate (kcal/kg)/10<sup>3</sup>

$$=20 \times 2100/1000$$

$$=42 \text{ Million kcal}$$

- ❖ **Thermal Energy used due to Alternate Solid Fuel replacement by Fossil Fuel in the assessment year due to unavailability (Replacement due to external factor)**

= Alternate Solid Fuel replacement with Fossil fuel due to Biomass un-availability (used in the process) inTonnes x Alternate Solid Fuel Gross Heat Rate (kcal/kg)/10<sup>3</sup>

$$=15 \times 2800/1000$$

$$=42 \text{ Million kcal}$$

- ❖ **Thermal Energy used due to Alternate Liquid Fuel replacement by Fossil Fuel in the assessment year due to unavailability (Replacement due to external factor)**

=Alternate Liquid Fuel replacement with Fossil fuel due to Biomass un-availability (used in the process) in Tonnes x Alternate Liquid Fuel Gross Heat Rate (kcal/kg)/10<sup>3</sup>

$$=5 \times 6000/1000$$

$$=30 \text{ Million kcal}$$

- ❖ **Total Thermal Energy to be deducted for Biomass/ Alternate Solid or Liquid Fuel replacement by Fossil Fuel in the assessment year due to unavailability**

=Thermal Energy used due to Biomass + Alternate Solid Fuel +Alternate Liquid Fuel replacement by Fossil Fuel in the assessment year due to unavailability (Replacement due to external factor)

$$=42 + 42 +30 \text{ Million kcal}$$

$$=112 \text{ Million kcal}$$

### 10.7.3 Construction Phase or Project Activities

**Table: Additional Electrical Energy requirement during Construction Phase or Project Activities**

Sr No	Item	Date of Installation	Unit	Baseline Year	Assessment Year
1	Eqp No 7	5-May-14	Lakh Unit	NA	2
2	Eqp No 8	18-Aug-14	Lakh Unit	NA	5
3	Eqp No 9	10-Feb-15	Lakh Unit	NA	1
4	Electrical Energy Consumed		Lakh Unit		8
5	Weighted Heat Rate		kcal/kwh	3200	3100

- ❖ **Additional Electrical Energy Consumed during Construction Phase or Project Activities**

=Total Electrical Energy Consumed for additional Equipment Installed during Construction Phase or Project Activities in Lakh kWh x Weighted Heat Rate of the Power Sources in kcal/kWh/10

$$=8 \times 3100/10$$

$$=2480 \text{ Million kcal}$$

**Table: Additional Thermal Energy requirement during Construction Phase or Project Activities**

Sr No	Item	Date of Installation	Unit	Baseline Year	Assessment Year
1	Eqp No 10	15-June-14	Million kcal	NA	1000
2	Eqp No 11	12-Oct-14	Million kcal	NA	1400
3	Eqp No 12	15-Jan-15	Million kcal	NA	900
4	Energy Consumed		Million kcal		3200



❖ **Additional Thermal Energy Consumed during Construction Phase or Project Activities**

=Total Thermal Energy Consumed for additional Equipment Installed during Construction Phase or Project Activities in Million kcal

=3200 Million kcal

❖ **Additional Total Energy Consumed during Construction Phase or Project**

**Activities to be subtracted in the Assessment Year**

= Additional Electrical Energy Consumed during Construction Phase or Project Activities+ Additional Thermal Energy Consumed during Construction Phase or Project Activities

=2480 Million kcal +3200 Million kcal

=5680 Million kcal

**10.7.4 Addition of New Unit/Line (In Process and Power generation)**

**Table: Energy consumption due to commissioning of new line up to 70% Capacity Utilisation in Process**

Sr No	Item	Unit	Baseline Year	Assessment Year
1	Electrical Energy Consumed due to commissioning of New process Line/Unit till it attains 70% of Capacity Utilisation	Lakh kWh	NA	50
2	Thermal Energy Consumed due to commissioning of New Process Line/Unit till it attains 70% of Capacity Utilisation	Million kcal	NA	1400
3	Clinker Production till new line attains 70% of Capacity utilisation	Tonnes	NA	15000
4	Date of Commissioning (70% Capacity Utilisation)	Date		16-Aug-14
5	Weighted Heat Rate	kcal/kwh	3200	3100

❖ **Electrical Energy Consumed due to commissioning of new line**

=Total Electrical Energy Consumed Lakh kWh x Weighted Heat Rate of the Power Sources in kcal/kWh/10

=50 x 3100/10

=15500 Million kcal

❖ **Thermal Energy Consumed due to commissioning of new line**

=Total Thermal Energy Consumed due to commissioning of new line

=1400Million kcal

❖ **Total Energy to be deducted in the assessment year for Electrical and Thermal**

**Energy consumed due to commissioning of new line in Process**

=Electrical Energy Consumed due to commissioning of new line +Thermal Energy Consumed due to commissioning of new line

=15500 Million kcal + 1400 Million kcal

=16900 Million kcal

Clinker Produced (15000 Tonnes) till new line attains 70% of capacity utilization will be subtracted from the total clinker production and added in the clinker import; so that the energy added for this amount of produced clinker will be equal to the normal energy consumption required to produce the same amount.



**Table: Energy consumption due to commissioning of new line up to 70% Capacity Utilisation in Power Generation**

Sr No	Item	Unit	Baseline Year	Assessment Year
1	Electrical Energy Consumed from external source due to commissioning of New Line/Unit till it attains 70% of Capacity Utilisation in Power generation	Lakh kWh	NA	5
2	Thermal Energy Consumed due to commissioning of New Line/Unit till it attains 70% of Capacity Utilisation in Power generation	Million kcal	NA	15000
3	Net Electricity Generation till new Line/Unit attains 70% Capacity Utilisation	Lakh kWh	NA	40
4	Date of Commissioning (70% Capacity Utilisation) Power Generation	Date		
5	Weighted Heat Rate	Kcal/kWh	3200	3100

❖ **Electrical Energy Consumed due to commissioning of new unit from external source**

=Total Electrical Energy Consumed Lakh kWh x Weighted Heat Rate of the Power Sources in kcal/kWh/10

$$=5 \times 3100/10$$

$$=1550 \text{ Million kcal}$$

❖ **Thermal Energy Consumed due to commissioning of new unit (for generation at higher heat rate of electricity)**

=Total Thermal Energy Consumed due to commissioning of new unit

$$=15000 \text{ Million kcal}$$

❖ **Total Energy to be deducted in the assessment year for Electrical and Thermal Energy consumed due to commissioning of new line in Process**

=Electrical Energy Consumed due to commissioning of new line +Thermal Energy Consumed due to commissioning of new line

$$=1550 \text{ Million kcal} + 15000 \text{ Million kcal}$$

$$=16550 \text{ Million kcal}$$

Electricity generated (40 Lakh kWh @ higher heat rate than Plant's power source heat rate ) till new unit attains 70% of capacity utilization will be added in the total energy consumption of the plant at weighted heat rate of the plant 's power sources.

❖ **Electrical Energy to be added for the generated Electricity at Power sources heat rate**

=Total Electrical generated by new unit till it attain 70 of CU in Lakh kWh x Weighted Heat Rate of the Power Sources in kcal/kWh/10

$$=40 \times 3100/10$$

$$=12400 \text{ Million kcal}$$

Since the unit is generating electricity at higher heat rate due to initial commissioning phase, thus, higher amount of Energy is deducted than the addition in the total energy consumption of the plant.



### 10.7.5 Unforeseen Circumstances (External Factor)

**Table: Additional Electrical Energy requirement due to Unforeseen Circumstances (External Factor)**

Sr No	Item	Unit	Baseline Year	Assessment Year
1	Condition 1	Lakh Unit	NA	5
2	Condition 2	Lakh Unit	NA	5
3	Condition 3	Lakh Unit	NA	10
4	Energy Consumed	Lakh Unit		20
5	Weighted Heat Rate	kcal/kwh	3200	3100

- ❖ Additional Electrical Energy Consumed due to Unforeseen Circumstance (External Factor)  
 =Total Electrical Energy Consumed due to Unforeseen Circumstances in Lakh kWh x Weighted Heat Rate of the Power Sources in kcal/kWh/10  
 =20 x 3100/10  
 =6200 million kcal

**Table: Additional Thermal Energy requirement due to Unforeseen Circumstances (External Factor)**

Sr No	Item	Unit	Baseline Year	Assessment Year
1	Condition 1	Million kcal	NA	2000

2	Condition 4	Million kcal	NA	800
3	Condition 5	Million kcal	NA	3000
4	Energy Consumed	Million kcal		5800

- ❖ Additional Thermal Energy Consumed due to Unforeseen Circumstances (External Factor)  
 =Total Thermal Energy Consumed due to Unforeseen Circumstances in Million kcal  
 =5800 Million kcal
- ❖ Additional Total Energy Consumed due to installation of Environmental Equipment to be subtracted in the Assessment Year  
 = Additional Electrical Energy Consumed due to Unforeseen Circumstances+ Additional Thermal Energy Consumed due to Unforeseen Circumstances  
 =6200 Million kcal +5800 Million kcal  
 =12000 Million kcal

### 10.7.6 Renewable Energy

Case I: Under Achievement of PAT Obligation with REC gain

Case II: Equal Achievement of PAT Obligation with REC gain

Case III: Over Achievement of PAT Obligation with REC gain



**Table: REC and PAT obligation**

Sr No	Descriptions	Basis/ Calculations	Unit	Baseline Year [BY]	Assessment Year [AY]
1	Steam Turbine Net Heat Rate	Form I	kcal/kwh	3900	3800
2	Quantum of Renewable Energy Certificates (REC) obtained as a Renewal Energy Generator (Solar & Non-Solar)	Annual	MWh		1000
3	Quantum of Energy sold under preferential tariff	Annual	MWh		500
4	Saving Target in TOE/ton of product as per PAT scheme Notification		toe/Ton	0.0040	
5	Equivalent Major Product Output in Tons as per PAT scheme Notification		Tons	500000	
6	Baseline Specific Energy Consumption as Per PAT Notification		toe/Ton	0.0850	
7	SEC Target to be achieved	0.0850-0.0040	toe/Ton		0.0810

**Case I: Under Achievement of PAT Obligation with REC gain**

The target SEC for a DC is 0.0810 toe/Ton of equivalent cement against the baseline SEC of 0.0850 toe/Ton of equivalent cement.

- The DC achieves 0.0811 toe/Ton in the assessment year and also obtained REC and Energy sold under preferential tariff to the tune of 1500 MWh.
- The thermal Energy conversion of REC and Energy sold under preferential tariff stands at 5700 Million kcal. The plant has already taken the benefit of exported power in power mix normalization by subtracting 5700 Million kcal from the total energy consumption of plant

Sr No	Descriptions	Basis/ Calculations	Unit	Baseline Year [BY]	Current Year 2013-14
1	Normalized Gate to Gate Specific Energy Consumption	Annual	kcal/Ton	850	811

**In this case, the Energy shall not be normalized w.r.t. REC mechanism, since the DC is not being benefited in dual terms for Renewable Power generated as per following calculation table**

Sr No	Descriptions	Basis	Unit	Baseline Year [BY]	Assessment Year [AY]
<b>Renewable Energy Certificate Normalisation</b>					
1	Target Saving to be achieved (PAT obligation)		kcal/kg equivalent Cement	40.0	
2	Target Saving to be achieved (PAT obligation)		Million kcal	20000	



3	Target Saving Achieved		kcal/kg equivalent Cement		39
4	Target Saving Achieved		Million kcal		19500.0
5	Additional Saving achieved (After PAT obligation)		kcal/kg equivalent Cement		-1
6	Additional Saving achieved (After PAT obligation)		Million kcal		-500.00
7	Thermal energy conversion for REC and Preferential tariff		Million kcal		5700.0
8	Thermal Energy to be Normalised for REC and preferential tariff power sell under REC mechanism	Annual	Million kcal		0.00

### Case II: Equal Achievement of PAT Obligation with REC gain

The target SEC for a DC is 0.0810 toe/Ton of equivalent cement against the baseline SEC of 0.0850 toe/Tons of equivalent cement.

- The DC achieves 0.0810 toe/Ton in the assessment year and also obtained REC and Energy sold under preferential tariff to the tune of 1500 MWh.
- The thermal Energy conversion of REC and Energy sold under preferential tariff stands at 5700 Million kcal.

Sr No	Descriptions	Basis/ Calculations	Unit	Baseline Year [BY]	Current Year 2013-14
1	Normalized Gate to Gate Specific Energy Consumption	Annual	kcal/Ton	850	810

The plant has already taken the benefit of exported power in power mix normalization by subtracting 5700 Million kcal from the total energy consumption of plant

**In this case also, the Energy shall not be normalized w.r.t. REC mechanism, since the DC is not being benefited in dual terms for Renewable Power generated as per following calculation table**

Sr No	Descriptions	Basis	Unit	Baseline Year [BY]	Assessment Year [AY]
<b>Renewable Energy Certificate Normalisation</b>					
1	Target Saving to be achieved (PAT obligation)		kcal/kg equivalent Cement	40.0	
2	Target Saving to be achieved (PAT obligation)		Million kcal	20000	
3	Target Saving Achieved		kcal/kg equivalent Cement		40
4	Target Saving Achieved		Million kcal		20000
5	Additional Saving achieved (After PAT obligation)		kcal/kg equivalent Cement		0.0



6	Additional Saving achieved (After PAT obligation)		Million kcal		0.0
7	Thermal energy conversion for REC and Preferential tariff		Million kcal		5700.0
8	Thermal Energy to be Normalised for REC and preferential tariff power sell under REC mechanism	Annual	Million kcal		0.00

### Case III: Over Achievement of PAT Obligation with REC gain

The target SEC for a DC is 0.0810 toe/Ton of equivalent cement against the baseline SEC of 0.0850 toe/Tons of equivalent cement.

- The DC achieves 0.0809 toe/Ton in the assessment year and also obtained REC and Energy sold under preferential tariff to the tune of 1500 MWh.
- The Thermal Energy conversion of REC and Energy sold under preferential tariff stands at 5700 Million kcal.

Sr No	Descriptions	Basis/ Calculations	Unit	Baseline Year [BY]	Current Year 2013-14
1	Normalized Gate to Gate Specific Energy Consumption	Annual	kcal/Ton	850	809

In this case, the DC is getting benefit of Renewable Power exported in dual terms i.e., by gaining REC or selling it @ preferential tariff and also overachieved PAT obligation to earn ESCerts. The Energy shall be normalized w.r.t. REC mechanism gain, since, the plant has already taken the benefit of exported power in power mix normalization by subtracting 5700 Million kcal from the total energy consumption of plant, hence the additional gain after PAT obligation in terms of energy to be added in the total energy consumption of the plant. Here, the additional gain after PAT obligation stands at 500 Million kcal, thus only the said thermal energy will be normalized as per concluding calculation table. The DC still gains from Renewable Power generated i.e., 5200 Million kcal (5700-500 Million kcal) to achieve PAT obligation apart from getting gain from REC mechanism.

Sr No	Descriptions	Basis	Unit	Baseline Year [BY]	Assessment Year [AY]
<b>Renewable Energy Certificate Normalisation</b>					
1	Target Saving to be achieved (PAT obligation)		kcal/kg equivalent Cement	40.0	
2	Target Saving to be achieved (PAT obligation)		Million kcal	20000	
3	Target Saving Achieved		kcal/kg equivalent Cement		41
4	Target Saving Achieved		Million kcal		20500
5	Additional Saving achieved (After PAT obligation)		kcal/kg equivalent Cement		1.0



6	Additional Saving achieved (After PAT obligation)		Million kcal		500
7	Thermal energy conversion for REC and Preferential tariff		Million kcal		5700.0
8	Thermal Energy to be Normalised for REC and preferential tariff power sell under REC mechanism	Annual	Million kcal		500.00

As per Renewable Energy Certificate Mechanism, any plant after meeting Renewable Purchase Obligations (RPOs) can export (Injection to the grid or deemed injection) renewable energy in the form of electrical energy and earn Renewable Energy Certificates (REC) and/ or can opt for preferential tariff for the exported electricity, as the case may be.

However, double benefit being accrued or claimed by a DC from PAT as well as REC mechanism could not be allowed. Keeping the above in view, the proposed normalization clauses are proposed below:

*The quantity of exported (Deemed Injection or injection to the grid) power (partially or fully) on which Renewable Energy Certificates have been earned by Designated Consumer in the assessment year under REC mechanism shall be treated as Exported power and normalization will apply. However, the normalized power export will not qualify for issue of Energy Saving Certificates under PAT Scheme.*

Thus keeping the above normalisation in view, the DCs were asked in the Form I to submit the data pertaining to gain of REC in the baseline as well as for the current year.

To avoid dual benefit from REC and PAT, a normalisation is proposed

Elaborate Example for REC Compliance-

For the year 2014-15,

REC received by DC: 10000 REC = 2717 toe (EScerts)

PAT Target (SEC): 0.0810 toe/Te

Baseline Production: 4591973 Te

- ▶ Case I: SEC achieved: 0.0811 toe/Te

The DC can avail the benefit of REC since it has not achieved the PAT target

- ▶ Case II: SEC achieved: 0.0810 toe/Te

The DC can avail the benefit of REC since it has equaled the PAT target

- ▶ Case III: SEC achieved: 0.0809 toe/Te

Gain of 0.0810-0.0809 = 0.0001 x 4591973 = 459 Escerts



The DC has achieved the target and about to gain 459 ESCerts, the normalisation will take place and the SEC will be made to 0.0810. **Hence there is no gain of ESCerts**

The DC will not gain any ESCerts but can avail the benefit of REC

► Case IV: SEC achieved: 0.0800 toe/Te

Gain of  $0.0810 - 0.0800 = 0.0010 \times 4591973 = 4591$  Escerts

The DC has achieved the target and about to gain 4591 ESCerts, the normalisation will take place.

Here the DC stands to gain  $4591 - 2717 = 1874$  ESCerts

**The DC will gain 1874 ESCerts and also can avail the benefit of 10000 REC**



## 11 Abbreviations

Item	Abbreviations
PAT	Perform, Achieve and Trade
OPC	Ordinary Portland Cement
PPC	Pozzolana Portland Cement
PSC	Pozzolana Slag Cement
NMEEE	National Mission for Enhanced Energy efficiency
SEC	Specific Energy Consumption
SPC	Specific Power consumption
ESCerts	Energy Saving Certificates
GtG	Gate-to-Gate
CPP	Captive Power Plant
PLF	Plant Load Factor
PAF	Plant Availability Factor
TPH	Tons Per Hour
DC	Designated Consumer
CU	Capacity Utilisation
BY	Baseline Year
AY	Assessment Year
Wt.	Weighted
DPR	Daily Production Report
MPR	Monthly Production Report
CCR	Central Control Room
SAP	Systems, Applications, Products in Data Processing
ABT	Availability Base Tariff
WHR	Waste Heat Recovery
DG	Diesel Generator
CoGen	Co-Generation
GCV	Gross Calorific Value
THR	Turbine Heat Rate
Eff	Efficiency
PG	Performance Guarantee
OEM	Original Equipment manufacturer
MM	Materials Management (SAP Module)
PP	Production and Planning (SAP Module)
SD	Sales and Distribution (SAP Module)
FI	Financial Accounting (SAP Module)
PM	Plant Maintenance (SAP Module)
EMS	Energy Management System (SAP Module)
RPO	Renewable Purchase Obligation
REC	Renewable Energy Certificates



## **Part-II**

# **MONITORING & VERIFICATION GUIDELINES**





## 1. Introduction

### 1.1. Background

Ministry of Power and Bureau of Energy Efficiency (BEE) have been implementing several programs for efficient use of energy and its conservation. Their effort are further supplemented by the National Mission for Enhanced Energy Efficiency (NMEEE), which is one of the missions under the National Action Plan on Climate Change (NAPCC), launched by Hon'ble Prime Minister on 30th June 2008 to ensure increase in the living standards of India's vast majority of people while addressing concerns regarding climate change.

The Perform Achieve and Trade (PAT) Scheme is one of the initiatives under NMEEE program, which was notified on 30th March 2012. PAT scheme is a market assisted compliance mechanism, designed to accelerate implementation of cost effective improvements in energy efficiency in large energy-intensive industries, through certification of energy savings that could be traded. PAT flows out Energy Conservation Act, 2001 (Amended in 2010).

The key goal of the PAT scheme is to mandate specific energy efficiency improvements for the most energy intensive industries. The scheme builds on the large variation in energy intensities of different units in almost each notified sector, ranging from amongst the best in the world and some of the most inefficient units. The scheme envisages improvements in the energy intensity of each unit. The energy intensity reduction target, mandated for each unit, depend on its current efficiency: more efficient units have a lower reduction target less efficient units have a higher target.

The Ministry of Power, in consultation with Bureau of Energy Efficiency has prescribed the energy consumption norms and standards,

in the exercise of the power conferred under clause (g) and (n) of section 14 of the Energy conservation Act 2001 (Amended in 2010) for the Designated Consumers- vide S.O. 687 (E) [Energy Conservation (Energy Consumption Norms and Standards for Designated Consumers, Form, Time within which, and Manner of Preparation and Implementation of Scheme, Procedure for Issue of Energy Savings Certificates and Value of per Metric Ton of Oil Equivalent of Energy Consumed) Rules, 2012] dated 30 March, 2012 (Containing Baseline Specific Energy Consumption, Product Output and Target Specific Energy consumption for the Designated Consumers).

The above notification is based on the Rules notified under G.S.R. 269 (E) [Energy Conservation (Energy Consumption Norms and Standards for Designated Consumers, Form, Time within which, and Manner of Preparation and Implementation of Scheme, Procedure for Issue of Energy Savings Certificates and Value of per Metric Ton of Oil Equivalent of Energy Consumed) Rules, 2012] dated 30th March, 2012, herein referred as PAT Rules, 2012

The scheme covers 478 designated consumers (DC) in 8 sectors (thermal power stations, iron and steel plants, cement, fertiliser, textile, pulp and paper, chlor alkali and aluminium) in the first phase. Together these designated consumers used about 36% of the fossil fuel consumed in India in 2010. Each designated consumer has been mandated to achieve a prescribed reduction in its specific energy consumption. The reduction targets were notified in March, 2012. Overall, all the plants together are to achieve a 4.05% reduction in the average energy consumption by 2014-15. This implies a reduction of about 6.686 million tonnes of oil equivalent (mtoe) in their annual energy consumption and a reduction of about 23 million tonnes of carbon dioxide emission, annually.



A robust monitoring, reporting and verification process will ensure effective and credible assessment of energy performance, achieved by industries covered under PAT.

## 1.2. Purpose

A reliable monitoring, reporting and verification (M&V) system forms the backbone of assessment process of the PAT scheme. The objective of the M&V system is to streamline the activities to be carried out for verifying the energy performance achieved by the Designated Consumer in the target year.

The documents sets out the requisite guidelines for M&V in the Monitoring and Verification phase under the PAT Rules. It provides practical guidance and procedures to Designated Consumers (DCs) and Empanelled Accredited Energy Auditors (EmAEA) on verification requirements, and aims to establish a verification process consistent with relevant rules and regulation.

The Assessment of performance verification involves an independent evaluation of each activity undertaken by the DCs for compliance under PAT rules. Verification plays a crucial role in maintaining the integrity of the scheme and ensuring transparent validation.

The verification process will ensure that the information and data in Form 1 and Proforma are free from material omissions, misrepresentations and errors.

The process requires EmAEA to verify the monitoring and verification of energy performance of DCs in accordance with PAT rules while taking into the consideration, Normalization factors and any other relevant conditions as defined PAT Rules

The verification must be completed between 1st April to 30th June of the year, following the assessment year. Submission of final verification

report, verified annual Form 1, Sector Specific Proforma, EmAEA's verification report along with authentic supporting documents shall be done by the DC to the concern State Designated Agency (SDA) and Bureau of Energy Efficiency before 30th June.

### **This document helps develop clarity on the verification process as it:**

- Provides Designated Consumers and EmAEA a set of guidelines to establish methods for assessment of specific energy consumption.
- Defines broad techniques for assessing/determining factors that effects the performance of establishment.
- Provides general terms, which are applicable to all sectors and also includes specific sector term.
- Will be guided as per the provisions conferred under Rule 3 of PAT Rules 2012.
- Provides support to the Designated Consumer to meet its obligation specified in Rule 7 and Rule 15 of the PAT Rules.

## 1.3. Definition of M&V

M&V is the process to verify the Specific Energy Consumption through verifiable means of each Designated Consumer in the baseline year and in the assessment year by an empanelled accredited energy auditor.

The underlying principles for Monitoring and Verification include:

- ▶ **Consistency:** By applying uniform criteria to meet the requirements of the sector specific methodology throughout the assessment period.
- ▶ **Transparency:** Information in the verification reports shall be presented in an open, clear, factual, neutral and coherent manner based on documentary evidence
- ▶ **Acceptability:** The Empanelled Accredited Energy Auditors shall base their findings



and conclusions upon objective evidence, conduct all activities in connection with the validation and verification processes in accordance with the rules and procedures laid down by BEE, and state their validation or verification activities, findings, and conclusions in their reports truthfully and accurately.

- ▶ **Measurability:** Measurement is a fundamental starting point for any kind of data captured for Energy Performance Index.
  - i. Measurement in energy saving projects: The energy saving from any project is determined by comparing measured parameters before and after implementation of a project, making appropriate adjustments for changes in conditions.
  - ii. Measurement of parameters for data captured in Pro-forma: The parameters entered in the pro-forma shall be taken from the measured logs with supporting documentation through Computational documentation from basic measurement at field
  - iii. Measurement activities in the baseline and assessment year consist of the following:
    - meter installation, calibration and maintenance
    - data gathering and screening,
    - development of a computation method and acceptable estimates from the basic measurement at field,
    - computations with measured data, and
    - reporting, quality assurance

A measurement boundary is a notional border drawn around equipment and/or systems that are relevant for determining the savings achieved through implementation of Energy

saving projects.

- ▶ **Traceability:** The documents presented for substantiating the reduction in specific energy consumption or savings from ECM should be verifiable and visible.
- ▶ **Verifiability:** The validation of filled in data in the Pro-forma and savings from Energy Conservation Measures through proper authentic documentation are to be carried out by the EmAEA.

#### 1.4. Empanelled Accredited Energy Auditor or Verifier

The accredited energy auditor firm empanelled with BEE will be the verifier of PAT. Given below are key exercises the verifier will carry out and their meaning.

**Verification:** A thorough and independent evaluation by the accredited energy auditor of the activities undertaken by the designated consumer for compliance with the energy consumption norms and standards in the target year compared to the energy consumption norms and standards in the baseline year and consequent entitlement to energy saving certificates.

**Certification:** It is the process of certifying the verification report or check-verification report by the accredited energy auditor to the effect that the entitlement of energy saving certificate is quantified accurately in relation to compliance of energy consumption norms and standards by the designated consumer during the target year.

**Check-verification:** This is an independent review and ex-post determination by the Bureau through the accredited energy auditor, of the energy consumption norms and standards achieved in any year of the three-year cycle which have resulted from activities undertaken by the designated consumer with regard to compliance of the energy consumption norms and standards.



#### **1.4.1. Qualification of Empanelled Accredited Energy Auditor (EmAEA) for Verification and Check-Verification**

A firm registered under the Indian Partnership Act, 1932 (9 of 1932) or a company incorporated under the Companies Act, 1956 (1 of 1956) or any other legal entity competent to sue or to be sued or enter into contracts shall be entitled to undertake verification and check-verification regarding compliance with the energy consumption norms and standards and issue or purchase of energy savings certificate if it,-

- (a) has at least one accredited energy auditor whose name is included in the list of the accredited energy auditors maintained by the Bureau under regulation 7 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010;
- (b) has at least three energy auditors;
- (c) has adequate expertise of field studies including observations, probing skills, collection and generation of data, depth of technical knowledge and analytical abilities for undertaking verification and check-verification;
- (d) has a minimum turnover of ten lakhs rupees per annum in at least one of the previous three years or in case of a newly formed organisation, a net worth of ten lakhs rupees.

The application shall be accompanied by a certificate of registration or incorporation as the case may be.

#### **1.4.2. Obligation of Empanelled Accredited Energy Auditor**

- (1) For the work of verification or check verification, the accredited energy auditor shall constitute a team comprising of a team head and other members including

Process Experts:

Provided that a person who was in the employment of a designated consumer within the previous four years, shall not be eligible to perform the work of verification or check-verification for such designated consumer;

Provided further that any person or firm or company or other legal entity, who was involved in undertaking energy audit in any of the designated consumer within the previous four years, shall not be eligible to perform the work of verification or check-verification for such designated consumer.

- (2) The accredited energy auditor shall ensure that persons selected as team head and team members must be independent, impartial and free of potential conflict of interest in relation to activities likely to be assigned to them for verification or check-verification.
- (3) The accredited energy auditor shall have formal contractual conditions to ensure that each team member of verification and check-verification teams and technical experts act in an impartial and independent manner and free of potential conflict of interest.
- (4) The accredited energy auditor shall ensure that the team head, team members and experts prior to accepting the assignment inform him about any known, existing, former or envisaged link to the activities likely to be undertaken by them regarding verification and check verification.
- (5) The accredited energy auditor must have documented system for determining the technical or financial competence needed to carry out the functions of verification and check -verification and in determining the capability of the persons, the accredited energy auditor shall consider and record among other things the following aspects, namely:-



- (a) complexity of the activities likely to be undertaken;
  - (b) risks associated with each project activity;
  - (c) technological and regulatory aspects;
  - (d) size and location of the designated consumer;
  - (e) type and amount of field work necessary for the verification or check-verification.
- (6) The accredited energy auditor shall have documented system for preparing the plan for verification or check-verification functions and the said plan shall contain all the tasks required to be carried out in each type of activity, in terms of man days in respect of designated consumers for the purpose of verification and check - verification.
  - (7) The accredited energy auditor shall provide in advance the names of the verification or check-verification team members and their biodata to the designated consumer concerned.
  - (8) The accredited energy auditor shall provide the verification or check-verification team with the relevant working documents indicating their full responsibilities with intimation to the designated consumer.
  - (9) The accredited energy auditor shall have documented procedures for the following:
    - (i) to integrate all aspects of verification or check-verification functions;
    - (ii) for dealing with the situations in which an activity undertaken for the purpose of compliance with the energy consumption norms and standards or issue of energy savings certificate shall not be acceptable as an activity for the said purposes.
  - (10) The accredited energy auditor shall conduct independent review of the opinion

of verification or check-verification team and shall form an independent opinion and give necessary directions to the said team if required.

- (11) In preparing the verification and check-verification reports, the accredited energy auditor shall ensure transparency, independence and safeguard against conflict of interest.
- (12) The accredited energy auditor shall ensure the confidentiality of all information and data obtained or created during the verification or check verification report.
- (13) In assessing the compliance with the energy consumption norms and standards and issue of energy savings certificates, the accredited energy auditor shall follow the provisions of the Act, rules and regulations made thereunder.
- (14) After completion of the verification or check-verification, the accredited energy auditor shall submit the verification (in Form- "B") or check-verification report, together with the certificate in Form-'C', to the Bureau.

### 1.5. Important Documents required for M&V process

- I. Accepted Baseline Audit Report (Available with BEE and DC)<sup>1</sup>

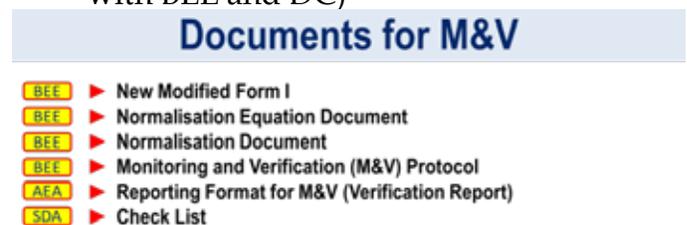


Figure 1: M&V Documents

<sup>1</sup>Baseline Report: Available with BEE and respective DCs. EmAEA to verify the consistency of Report

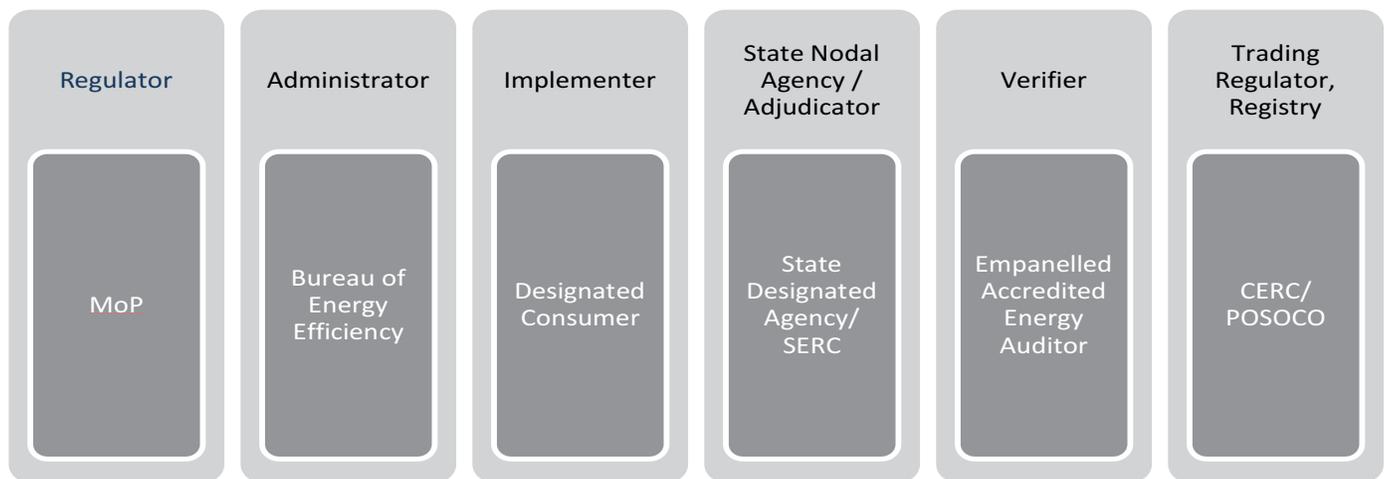


- II. Form 1 & Sector Specific Pro-forma
- III. Form A,B,C,D as covered in PAT rules
- IV. Normalisation Factors Document available with BEE
- V. Normalisation Guidelines Document available with BEE
- VI. Check List to be used by all stakeholders
- VII. Reporting Format for EmAEA

## 1.6. Stakeholders

- I. Ministry of Power, Government of India
- II. Bureau of Energy Efficiency
- III. Designated Consumers
- IV. State Designated Agencies
- V. Empanelled Accredited Energy Auditor
- VI. Adjudicator
- VII. Trading Regulator
- VIII. ESCerts Management Registry

Figure 2: Stakeholders



## 2. Broad Roles and Responsibilities

The various roles to be assessed in the verification process include administration, regulation and services delivery. The key stakeholders are Ministry of Power, Bureau of Energy Efficiency, state designated agencies, adjudicator, designated consumers and empanelled accredited energy auditor.

### 2.1. General

The roles and responsibilities of individuals and designated consumer are set out in Energy Conservation Rules 2012 <sup>2</sup>

The roles and responsibilities of the Designated Consumer (DC), Empanelled Accredited Energy

Auditor (EmAEA), Bureau of Energy Efficiency (BEE), State Designated Agencies (SDA), Adjudicator and Ministry of Power (MoP) can be summed up as under

The designated consumer shall fill the data manually in Excel Sheet Pro-forma and in PATNET in the sector specific Pro-forma and Form 1 stating source of data, of its installation as per gate to gate boundary concept. The filled in forms with the authentic source of data in terms of hard copy document shall have to be kept ready by designated consumer for verification. The designated consumer in consultation with the EmAEA, shall put in place transparent, independent and credible monitoring and verification arrangement. The verifier shall

<sup>2</sup>Energy Conservation Rules 2012: Energy Consumption Norms and Standards for Designated Consumers, Form, Time within which, and Manner of Preparation and Implementation of Scheme, Procedure for Issue of Energy Savings Certificate and Value of Per Metric Ton of Oil Equivalent of Energy Consumed) as per Notification G.S.R.269 (E) dated 30th march 2012



ensure transparency, independence and safeguard against conflict of interest.

As part of the verification process, the EmAEA shall carry out a strategic and statistical analysis, checking of relevant and authentic documents, quarterly, yearly and end of cycle internal data audit reports, performance assessment documents (Form A), Form I and sector specific pro-forma from designated consumers; the EmAEA will also carry out the actual verification and produce an internal verification report, Form B. These verified Forms, documents and reports will then be submitted to the SDA with a copy to the Bureau. The SDA, in turn after proper verification of Form A sent by DC may send its comments to BEE for final verification based on the SDA Check List.

If the accredited energy auditor records a positive opinion in his verification report, the Bureau shall consider that all the requirements with regard to the compliance with energy consumption norms and standards, entitlement about issue or liability to purchase energy savings certificate have been met.

BEE on satisfying itself about the correctness of the verification and check-verification reports, wherever sought by it, will send its recommendations under clause (aa) of sub-section (2) of section 13 to the Central Government, based on the claim raised by the designated consumer in Form 'A', within 10 working days from the last date of its submission, for issuance of energy saving certificates under section 14A.

## 2.2. Designated Consumer

The Designated Consumers have the following responsibilities with respect to EOC or mid cycle verification as per guidelines in Energy Conservation Rules 2012:

1. To monitor and report in accordance with the monitoring plan approved by the BEE.

2. Establish data and information management system as per Sector Specific Supporting Pro-forma for Form 1, Normalization formulae
3. M&V arrangements for energy consumption and production by Designated Consumer
4. Without prejudice to the monitoring plan approved by the BEE, DC must comply with on-going obligations imposed under PAT Rules 2012
5. The monitoring methodology or the Input Data Entry with Normalisation factors shall be changed if this improves the accuracy of the reported data and for taking out any errors reported by DC in the Sector Specific Pro-forma (Linking formulae, error formulae or wrong data entry)
6. The designated consumer in consultation with the accredited energy auditor, shall put in place transparent, independent and credible monitoring and verification arrangements for energy consumption and production based on the Bureau of Energy Efficiency (Manner and Intervals of Time for Conduct of Energy Audit) Regulations, 2010 for compliance with the energy consumption norms and standard, and the said arrangements shall include,-
  - i) Preparation and Maintenance of Quarterly Data Reports to be prepared by DCs from 2012 onwards up to assessment year
    - a. On the performance of plant and production process
    - b. Internal Field Audit Report on Energy and Process
  - ii) Preparation and Maintenance of Yearly Data Reports to be prepared by DCs from 2012 onwards up to assessment year
    - a. On the performance of plant and production process



- b. Outcome of Internal Field Audit
  - c. Measures to reduce energy consumption and improve energy efficiency
  - d. Measures taken to improve the efficiency of the production processes during each year
- iii) Preparation and Maintenance of Yearly Data Reports to be prepared by DCs from 2012 onwards up to assessment year
- a. Report on production achieved, energy consumed
  - b. specific energy consumption achieved, specific energy consumption
  - c. reduction achieved, measures adopted for energy conservation and quantity of energy saved;
- iv) Preparation and Maintenance of Consolidated End of Cycle (EOC) Data Reports to be prepared by DCs from 2012 onwards up to assessment year
- a. Report on production achieved, energy consumed
  - b. specific energy consumption achieved, specific energy consumption
  - c. reduction achieved, measures adopted for energy conservation and quantity of energy saved;
7. The DC has to maintain in set tabulated format and set reports template as per above guidelines for submission to EmAEA
8. The DC has to fill the data in the Sector Specific Pro-forma for the Normalization factors including M&V protocol for its facility in conformity with the Sectoral Normalisation factor guidelines prepared by BEE
9. The data to be filled in the latest version of MS Office Excel sheet and PATNET
10. Designated Consumers shall facilitate verification and check-verification work by the EmAEA and SDA.
11. The designated consumers shall,-
- (a) get their compliance with the energy consumption norms and standards assessed by accredited energy auditors;
  - (b) take all measures, including implementation of energy efficiency projects recommended by the accredited energy auditor and good practices prevalent or in use in the concerned industrial sector so as to achieve the optimum use of energy in their plant;
- furnish the full and complete data, provide necessary documents and other facilities required by the accredited energy auditor for the purpose of performing the function of verification and check-verification.
12. The designated consumer for the purpose of compliance with the energy consumption norms and standards during the target year, in the relevant cycle shall take the following actions and furnish the status of compliance to the state designated agency with a copy to the Bureau in Form D by the end of five months from the last date of submission of Form 'A'-
- (a) practise energy conservation and carry out energy efficiency measures to comply with energy consumption norms, or
  - (b) where the energy efficiency measures implemented are found inadequate for achieving compliance with the energy consumption norms and standards,



the designated consumer shall purchase energy saving certificates to meet the compliance norms in terms of metric tonne of oil equivalent.

### **2.3. Empanelled Accredited Energy Auditor (EmAEA)**

The EmAEA is responsible for verification of compliance with Energy Consumption Norms and Standards for Designated Consumers, Gate to Gate Specific Energy Consumption of baseline and assessment year as per guidelines of PAT Rules 2012 with subsequent attributes

13. To ensure that the verification is carried out by properly trained and competent staff as per Section 1.4.2 are essential
14. The EmAEA is responsible for ensuring that the systems and processes adopted by the DC for determination of GtG SEC from the data in Sector Specific Pro-forma along with Normalisation sheets and information protocol have been maintained in conformity with the various notifications and information provided by BEE/SDA from time to time
15. EmAEA is required to perform various roles such as technical review of manufacturing processes and energy consumption patterns, system variability and its impact on energy consumption; the EmAEA is also required to apply statistical methods of verification and also ensure integrity and authenticity of data.
16. The accredited energy auditor shall independently evaluate each activity undertaken by the designated consumer towards compliance with the energy consumption norms and standards, and entitlement to or requirement of energy saving certificates.
  - (A) The accredited energy auditor, in order to assess the correctness of the information provided by the

designated consumer regarding the compliance with energy consumption norms and standards shall:

- (a) Apply standard auditing techniques;
- (b) Follow the rules and regulation framed under the Act;
- (c) Integrate all aspects of verification, and certification functions;
- (d) Make independent technical review of the opinion and decision of the verification team; also take into consideration, a situation where a particular activity may or may not form part of the activities related to the compliance with the energy consumption norms and standards, and the procedure for the assessment shall include:

Document review, involving

- (i) Review of data and its source, and information to verify the correctness, credibility and interpretation of presented information;
- (ii) Cross checks between information provided in the audit report and, if comparable information is available from sources other than those used in the audit report, the information from those other sources and independent background investigation;

Follow up action, involving-

- (iii) Site visits, interviews with personnel responsible in the designated consumers' plant;
- (iv) Cross-check of information provided by interviewed personnel to ensure that no relevant information has been omitted or, over or under valued;



- (v) Review of the application of formulae and calculations, and reporting of the findings in the verification report.

(B) The accredited energy auditor shall report the results of his assessment in a verification report and the said report shall contain,

- (a) The summary of the verification process, results of assessment and his/her opinion along with the supporting documents;
- (b) The details of verification activities carried out in order to arrive at the conclusion and opinion, including the details captured during the verification process and conclusion relating to compliance with energy consumption norms and standards, increase or decrease in specific energy consumption with reference to the specific energy consumption in the baseline year;
- (c) the record of interaction, if any, between the accredited energy auditor and the designated consumer as well as any change made in his/her assessment because of the clarifications, if any, given by the designated consumer.

- 17. EmAEA to prepare a verification report as per Reporting template to be provided by BEE
- 18. EmAEA to resolve errors, omissions or misrepresentations in the data/records/calculations in consultation with the Designated Consumers (DCs) prior to completing the verification report
- 19. EmAEA to resolve calculation errors in the Sector Specific Pro-forma in consultation

with the BEE prior to completing the verification

#### 2.4. State Designated Agencies (SDA)

All the documents like verified Sector Specific Pro-forma, Form 1, Verification report of EmAEA and related documents will be routed to BEE via SDA.

20. The technical role of SDA are

- i. Inspection & enforcement for M&V related systems
- ii. Assist BEE in information management process
- iii. Review and validation of Sector Specific Pro-forma, Form 1, Verification report of EmAEA and related documents before sending it to BEE
- iv. After submission of duly verified Form 'A' by designated consumer, SDA may convey its comments, if any, on Form 'A' to the Bureau within fifteen days of the last date of submission of Form 'A'.
- v. BEE, in consultation with SDA may decide to undertake review on Check verification
- vi. The EmAEA in-charge of check-verification shall submit the report with due certification Form C to the BEE and the concerned SDA
- vii. The State designated agency may furnish its comments on the report within ten days from the receipt of the report from the EmAEA. In case no comments are received from the concerned state designated agency concerned, it shall be presumed that they have no comments to offer in the matter



viii. The State designated agency within two months from the date of the receipt of the report referred to in sub-rule (9) shall initiate-

- (a) action to recover from the designated consumer the loss to the Central Government by way of unfair gain to the designated consumer;
- (b) penalty proceedings against the persons mentioned in the said report, under intimation to the Bureau;
- (c) register complaint for such fraudulent unfair gain if designated consumer does not pay penalty and loss to the exchequer in the specified time mentioned in the penalty proceedings.

21. The administrative role of SDA is given below

The designated agency may appoint, after 5 years from the date of commencement of this Act, as many inspecting officers as may be necessary for the purpose of ensuring compliance with energy consumption standard specified under clause (a) of section 14 or ensure display of particulars on the label of equipment or appliances specified under clause (b) of section 14 or for the purpose of performing such other functions as may be assigned to them.

Subject to any rules made under this Act, an inspecting officer shall have power to -

- (a) inspect any operation carried on or in connection with the equipment or appliance specified under clause (b) of section 14 or in respect of which energy standards under clause (a) of section 14 have been specified;
- (b) enter any place of designated

consumer at which the energy is used for any activity

- (c) inspect any equipment or appliance as may be required and which may be available at such places where energy is used for any activity;
- (d) inspect any production process to ascertain the energy consumption norms and standards

## 2.5. Adjudicator

Section 27 and Section 28 of the Energy Conservation (EC) Act, 2001 shall be referred to for power to adjudicate.

## 2.6. Bureau of Energy Efficiency

BEE shall co-ordinate with the Designated Consumers, SDA, Sectoral technical committee and other agencies to administer and monitor the Scheme as per PAT Rules and EC Act 2001.

- 22. BEE shall recommend to the Central Government the norms for processes and energy consumption standards required to be notified under clause (a) of section 14 of Energy Conservation Act, 2001.
- 23. It will prepare and finalise sector specific Pro-forma for annual data entry in consultation with the technical committee set up by BEE.
- 24. BEE will prepare and finalise sector specific normalisation factors applicable in assessment year in consultation with the technical committee set up by BEE.
- 25. The Bureau will carry out empanelment of the accredited energy auditor firm as verifier
- 26. It will carry out capacity building of SDA, EmAEA, energy managers of designated consumers
- 27. The Bureau on satisfying itself about the



correctness of verification report, and check-verification report, wherever sought by it, send its recommendation under clause (aa) of sub-section (2) of section 13 to the Central Government, based on the claim raised by the designated consumer in Form `A`, within ten working days from the last date of submission of said Form `A` by the concerned state designated agency, for issuance of energy savings certificates under section 14A

## 2.7. Ministry of Power

28. The roles and responsibilities of the Central Government have been covered under clause 14(chapter V) of EC Act, 2001 and notified under PAT Rules, 2012

## 2.8. Institutional Framework for PAT

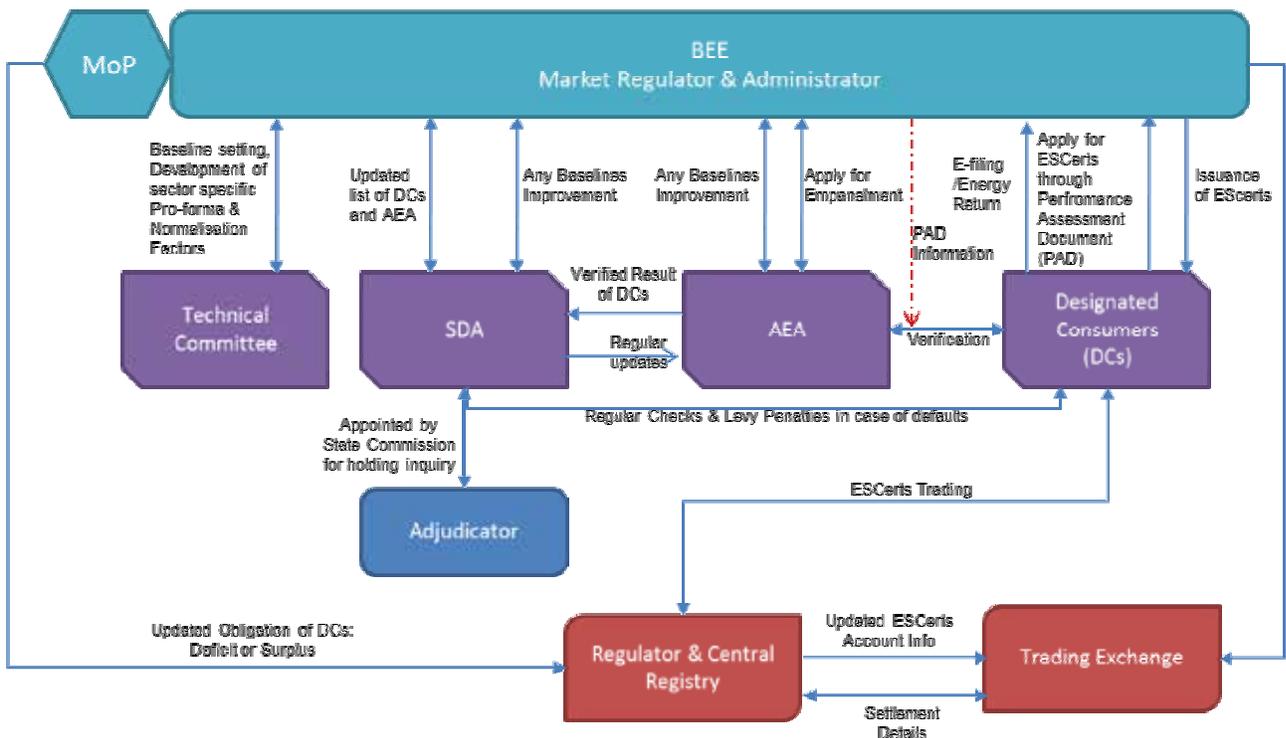
Transparency, flexibility and engagement with

industry players in programme design help ensure effective industrial energy efficiency policy, which even the facilities covered are likely to buy into. PAT's design phase involved extensive consultations with designated consumers; the consultations ensured the design phase was transparent and allowed industry to engage in the process.

Since PAT is largely a federal scheme, involvement of state designated agencies as an extended arm of enforcement ushers outcome in the right direction.

An institutional frame work consisting of State Designated Agencies, Designated Consumers, Accredited Energy Auditors, Trading Exchanges<sup>3</sup> and Financing facilities has been established to implement the scheme. Bureau of Energy Efficiency is leading the process with state level capacity supported by AEA and Sectoral Technical committee constituted for rationalizing the process.

Figure 3: Institutional Framework



<sup>3</sup> Trading Exchanges: IEX & PXIL



### 3. Process & Timelines

#### 3.1. Activities and Responsibilities

The Energy Conservation Rules, 2012 clearly define the timeline of activities and responsibilities to be carried out for accomplishment of PAT scheme. From submitting the action plan to trading of ESCerts by designated consumers, the various steps under PAT need to be executed in a definite time frame.

Constant monitoring of the scheme, through parameters like total ESCerts issued and traded, complying sectors or participants, market liquidity, etc, will be carried out. Delays at any point of the process-chain will be identified and timely action taken by the administrator/regulator.

Automation of processes, wherever feasible, will be carried out for seamless implementation of PAT.

**Table 1: Activities and Responsibilities for PAT Cycle I**

S. No	Name of Form	Submitted by	Time of Submission	Submission authorities
1.	Form A	DCs	Three months from conclusion of target year (end of first, second or third year of relevant cycle) <b>30th June, 2015</b>	SDA & BEE
2.	Form B (Certificate of verification by AEE)	DCs	Three months from conclusion of target year (end of first, second or third year of relevant cycle) <b>30th June, 2015</b>	SDA & BEE
3.	BEE's Recommendation to MoP for issuance of ESCerts	BEE	10 working days from receipt of forms A & B	Ministry of Power
4.	Issuance of ESCerts	Central Government (MoP)	Within 15 days from receipt of recommendations by BEE	BEE
5.	Form D (status of Compliance)	DC	End of 5 months from the last date of submission of Form A	SDA & BEE
6.	Form C (check verification report and certificate)	AEA (Accredited Energy Auditor)	Within 6 months after issuance of ESCerts or within 1 year of submission of compliance report	BEE

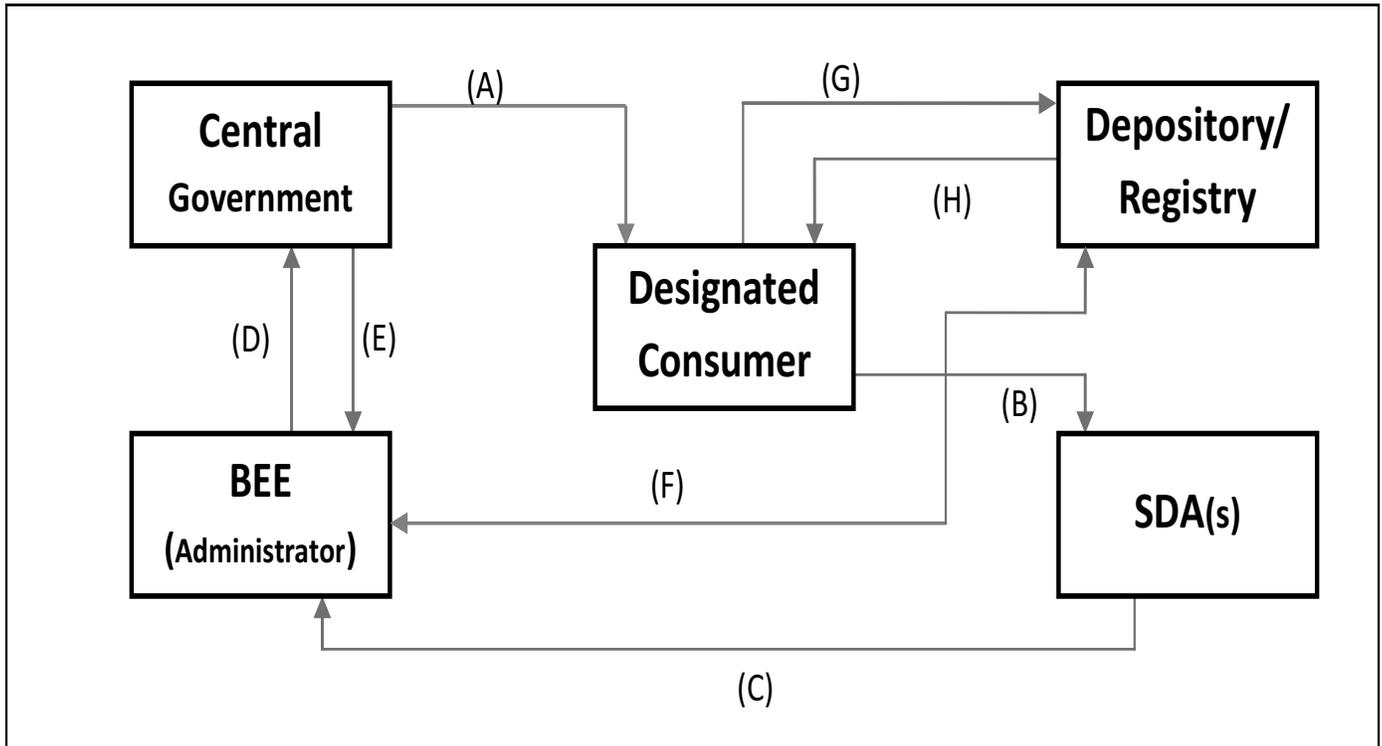


### 3.2. Process Interlinking

The complete process, from notifying the

reduction targets to issuing Escerts, is interlinked among various stakeholders complying to a definite time frame as shown below:

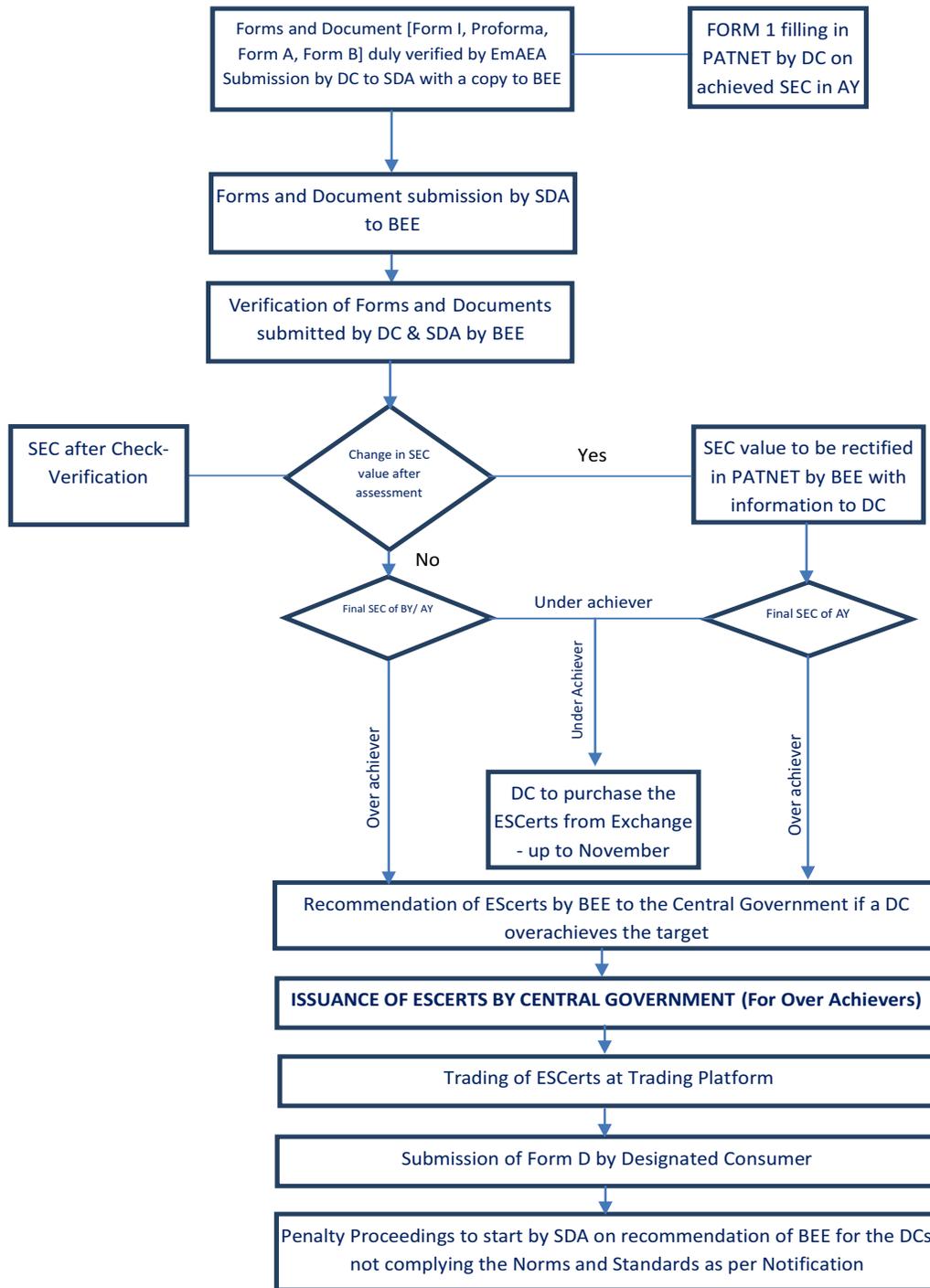
Figure 4: Interlinking Stakeholders



- |   |  |
|---|--|
| (A) Targets from Central Government to DCs  | BEE to Central Government  |
| (B) Performance Assessment Document (Form A) from DC to SDA   | (E) ESCerts Issuance Instruction from Central Government to BEE    |
| (C) Performance Assessment Document (PAD) (Form-A) with recommendation for issuance, if overachieved, from SDA to BEE | (F) Electronic ESCerts Issuance Instruction from BEE to Depository |
| (D) Recommendation of ESCerts Issuance by   | (G) DC Interaction with Depository account                         |
|   | (H) ESCerts credit to DC's account                                 |



### 3.2.1. Issuance of ESCerts



**Figure 5: Flow Chart of ESCerts issuance**

### 29. Penalty for Non-Achievement of Target

- i. Compliance as per Form D of Energy Conservation Rules 2012
  - (a) Energy savings certificates: Enter +ve value if energy savings

certificates issued to designated consumer or enter -ve value in case recommended for purchase of energy savings certificates

- (b) Energy savings certificates



submitted for compliance: If designated consumer is recommended for purchase of energy savings certificates, then enter value of energy savings certificates submitted by designated consumer for compliance of energy consumption norms and standards- saving target of designated consumer.

(c) Balance energy saving certificates: If the balance is ZERO then the designated consumer has complied with its energy saving target and if the balance is -ve then

the consumer will be recommended for penalty.

- ii. For Penalty and Power to adjudicate, refer section 26 and 27 of the EC Act 2001
- iii. As per EC Act, 2001, section 26, the fixed penalty is a maximum 10 lakh rupees and variable penalty is the price of 1 tonne of oil equivalent as specified in Energy Conservation Rules, 2012. Any amount payable under this section, if not paid, will be recovered as if it were an arrear of land revenue.

### 3.3. Flow Chart showing verification process (Rules and Act required dates in *bold Italics*)

Responsibility	Date	Action and Stages of verification process
DC	<i>By June 30 each Year</i>	Submission of Energy Return Form I and Sector Specific Supporting Pro-forma for Form 1
DC	<i>By June 30 [First Year of PAT Cycle]</i>	Submission of Action Plan
DC	<i>Before M&amp;V phase of PAT Cycle</i>	Hiring of Empanelled Accredited energy Auditor
DC/EmAEA	<i>April 1-June 30 [After completion of relevant PAT cycle]</i>	Monitoring and Verification
DC	<i>By June 30 [M&amp;V phase of PAT Cycle]</i>	Submission of Verified Form I and Sector Specific Pro-forma, Form A, Form B and Other Document to SDA & BEE
DC	<i>By June 30 [After end of 1<sup>st</sup> and 2<sup>nd</sup> Year PAT Cycle] For Advance ESCerts</i>	Submission of Verified Form I and Sector Specific Pro-forma, Form A, Form B and Other Document to SDA & BEE
SDA	[15 days of the last date of sub. of Form A]	Submission of Comments on Verified Form I and Sector Specific Pro-forma, Form A, Form B and Other Document to BEE
BEE	[10 working days from last date of submission of Form A by SDA][M&V phase of PAT Cycle]	Recommendation of Energy Saving Certificates to Central Government [10 working days from last date of submission of Form A by SDA]
Central Government	[15 working days from date of receipt of recommendation by BEE][M&V phase of PAT Cycle]	Issue of Energy Saving Certificates [15 working days from date of receipt of recommendation by BEE]
DC	[5 months from date of submission of Form A by DC to SDA][M&V phase of PAT Cycle]	Submission of Form D to SDA and BEE [5 months from date of submission of Form A by DC to SDA]
BEE/Power Exchange	[M&V phase of PAT Cycle]	ESCerts Trading period

Figure 6: Time Line Flow Chart



## 4. Verification requirement

### 4.1. Guidelines for Selection Criteria of EmAEA by Designated Consumer

30. The EmAEA will be selected only from the List of EmAEA as available in the BEE official website
  31. The procedure for selection of EmAEA should be followed from guidelines of PAT Rules 2012
  32. The designated consumer may select EmAEA based on their experience in energy auditing and in the related sector as per information in Form III and Form IV (Register Containing List Of Accredited Energy Auditors ) Submitted by the Accredited Energy Auditor ([www.bee-india.nic.in](http://www.bee-india.nic.in))
  33. The EmAEA has preferably attended at least one training programme on Monitoring and Verification Guidelines organised by the Bureau of Energy Efficiency.
  34. The Designated Consumer needs to verify following during selection of AEA
    - (a) Provided that a person who was in the employment of a designated consumer within the previous four years, shall not be eligible to perform the work of verification or check-verification for such designated consumer;
    - (b) Provided further that any person or firm or company or other legal entity, who was involved in undertaking energy audit in any of the designated consumer within the previous four
35. EmAEA is required to submit the documentation on determining the capability of the team on Technical and financial competence after getting the formal order from Designated Consumer
  36. EmAEA is required to submit the Name and detailed Bio-data on Energy Audit or Verification experiences of the team head, team members and experts to the DC prior to selection
  37. The Designated Consumer to ensure that the EmAEA must have documented system on preparing plan for verification or check-verification along with activities chart defining task in man-days.
  38. The selection process of EmAEA needs to be completed before 31st March of the end of PAT Cycle
  39. The scope of work may cover the period up to check-verification.

years, shall not be eligible to perform the work of verification or check verification for such designated consumer.

### 4.2. Guidelines for Empanelled Accredited Energy Auditor

40. The EmAEA shall constitute a team in accordance with section 10 of Energy Conservation Rules, 2012.
41. Where ever necessary, EmAEA must state any discrepancies in their final verification reports and potential improvements to achieve more accurate reporting in line with the PAT Rules and EC Act.



**Table 2: Team Details (Minimum Team Composition)**

Sr No	Designation	Qualification	Experience
1	Team Head	Accredited Energy Auditor	In the Field of Energy Auditing of PAT Sectors <sup>4</sup>
2	Team Member [Expert]	Graduate Engineer	Process or Technical Expert related to the specific sector, where verification will take place having experience of more than 10 years
3	Team Member	Certified Energy Auditor	In the Field of Energy Auditing
4	Team Member	Graduate/ Diploma Engineer	

42. The EmAEA may constitute any number of verification or check-verification teams to carry out the verification of a number of designated consumers.
43. The EmAEA shall ensure that it has formal contracts with team members, including technical experts, for verification and check-verification so as to act in an impartial and independent manner and free of potential conflict of interest.
44. The EmAEA, has the sole responsibility and signing authority on Form B, Form C
45. The EmAEA should complete the verification for onward submission to SDA and BEE before 30 June in the year following the assessment year.
46. The EmAEA should furnish a time plan and activities chart to the designated consumer after receiving a valid work order.
47. The Designated Consumer shall inform Bureau of Energy Efficiency about the date of start of verification by EmAEA.
48. The verification shall not be carried out by two different EmAEA for the particular DC in a single PAT cycle.
49. The audit report shall be certified by the EmAEA and shall be counter signed by

- the DCs Energy Manager and Competent Authority
50. The EmAEA to submit an undertaking along with Form B indicating that there is no conflict of interest in the team assigned and PAT Rules 2012 and its amendments have been complied with.

#### **4.3. Guidelines for Verification process**

##### **4.3.1. Sector Specific Pro-forma**

The Sector Specific Pro-forma is made with the purpose of capturing the data for Production, Energy and Normalization factors under equivalent condition for the baseline and assessment year. The filled in Pro-forma is used to calculate the Notional Energy for Normalization. Once complete data is filled in the Pro-forma, the SEC after Normalization automatically comes out in the summary sheet enabling the DC to see the actual performance of the plant

51. The Energy Conservation (Form and Manner for submission of Report on the Status of Energy Consumption by the Designated Consumers) Rules, 2007 directs every designated consumers to submit the status of energy consumption in electronic form as well as hard copy, within three

<sup>4</sup> PAT Sectors: Thermal Power Stations, Steel, Cement, Aluminium, Fertiliser, Pulp & Paper, Textile, Chlor-Alkali



months, to the designated agency with a copy to Bureau of Energy Efficiency at the end of the previous financial year in Form-1.

52. The Sector Specific Pro-forma have many sections to cover all the aspects of GtG<sup>5</sup> methodology as follows:

- ▶ Instruction for Form 1 filling
- ▶ General Information Sheet
- ▶ Form 1
- ▶ Sector Specific Pro-forma
  - o Production and Capacity Utilization Details
  - o Section wise details of various products
  - o Electricity and Renewable Energy Consumption
  - o Power Generation (DG/GG/GT/STG/Co-Gen/WHR)
  - o Fuel Consumption (Solid/Liquid/Gas/Biomass & Others)
  - o Heat Rate of different power sources and Coal Quality
  - o Miscellaneous Data for Normalisation
- ▶ Installation of additional equipment to protect the environment
- ▶ Project Activities details
- ▶ Summary Sheet
- ▶ Normalization calculation sheets

53. **Form 1 will be generated automatically after filling in the Pro-forma, which is required to be filled in the PATNET as input for final assessment of gate-to-gate specific energy consumption (GtG SEC) for the baseline and assessment years.**

54. Formulae cells in Pro-forma, Summary

sheet and Normalisation calculation sheets are locked to ensure data security, reliability etc.

55. There are five columns in the Sector Specific Pro-forma. Three columns are used for Baseline years i.e., Year 1, Year 2 and Year 3, the fourth column will be used for computing the average data of the baseline years and the fifth one for entering the data in Year 4 i.e. Assessment year/Target year/Current year.

56. The Sector Specific Pro-forma will be used for mandatory submission of annual Energy return. The data will be filled in the year 3 column as previous year and year 4 as current year after making the others column cells empty.

57. Average of the three baseline years is taken as baseline data for Normalisation

58. For the purpose of taking the average of baseline year, other columns are not to be left blank. However, if a plant's data show only one or two years of operation, then the third year column should be left blank.<sup>59</sup> Cells have been Colour coded and locked for data security purpose in the Pro-forma.

#### 4.3.2. Reporting in Sector Specific Pro-forma

60. Baseline parameter and Plant boundary in Gate to Gate Concept means

- ▶ **Plant Boundary for Energy and Product**
  - Input Raw material
  - Output product
  - Captive Power Plant (CPP) installed within premises or outside the plant demographic boundary
  - Energy inputs and Outputs (Electricity/Gas/Steam etc)

<sup>5</sup> GtG: Gate to Gate



► **Defining Input Energy in Sector Specific Pro-forma**

- Fuel Input to the Captive Power Plants
- Fuel Input to the Process
- Bifurcation of Input Energy for Renewables/Alternate source/Biomass etc in Captive Power Plants
- Not connected with Grid-The energy used from the Renewables/Alternate source/Biomass will not be added in the total input energy
- Connected with Grid-The energy used from Renewables/Alternate source/Biomass will be added in the total input energy
- Waste Heat Recovery
- Co-generation
- Accounting of Energy generation and Energy used inside the plant boundary

► **Raw material input and Product output**

- Intermediary semi-finished Product output for market sale- the energy for making the intermediary product to be deducted from the total energy consumption
- Intermediary semi-finished Product input as raw material in between the process- the energy for making up to the semi-finished intermediate product to be added in the total energy consumption.

61. The baseline Production and Energy related data to be entered in Sector Specific Pro-forma as per Baseline Report by individual DCs. The same will be verified by EmAEA.
62. The DCs are required to fill the data as per instruction sheets in all the relevant

baseline and assessment year data field with source of data

63. The entered baseline data in the Excel Sheets will be locked for data security by BEE. The DC can enter data in all the fields other than locked Cells.
64. The Locked-in Sector Specific Pro-forma is to be sent to DCs for data entry.
65. The primary and secondary source of data should be kept ready in hard copies for verification by EmAEA as per guidelines in the instruction sheet.
66. DCs are advised to fill the data in Excel Sheets only and return the same in Excel form to SDAs with a copy to BEE along with hard copies of Form 1, Sector Specific Pro-forma, Summary and all Normalisation sheets duly signed.

**4.3.3. Verification Process**

As part of the verification process, the EmAEA shall carry out the following steps:

67. The EmAEA after receiving the work order is advised to get the final Baseline report (Accepted by BEE) from the DC.
68. The EmAEA shall conduct a site visit on mutually agreed dates with Designated Consumer, to inspect the monitoring systems, conduct interviews, and collect sufficient information and supporting documentary evidence (vide Sector Specific Pro-forma.)
69. Prior to visiting the site, the EmAEA is advised to study the Baseline reports, Sector Specific Pro-forma and Sector specific Normalisation document
70. For computing gate-to-gate SEC the plant boundary is defined such that the total energy input and the defined product output is fully captured. Typically, it includes the entire plant - excluding



housing colony, residential complex and transportation systems. Similarly, mining operations in the case of iron & steel, aluminium and cement sectors do not fall under the plant boundary.

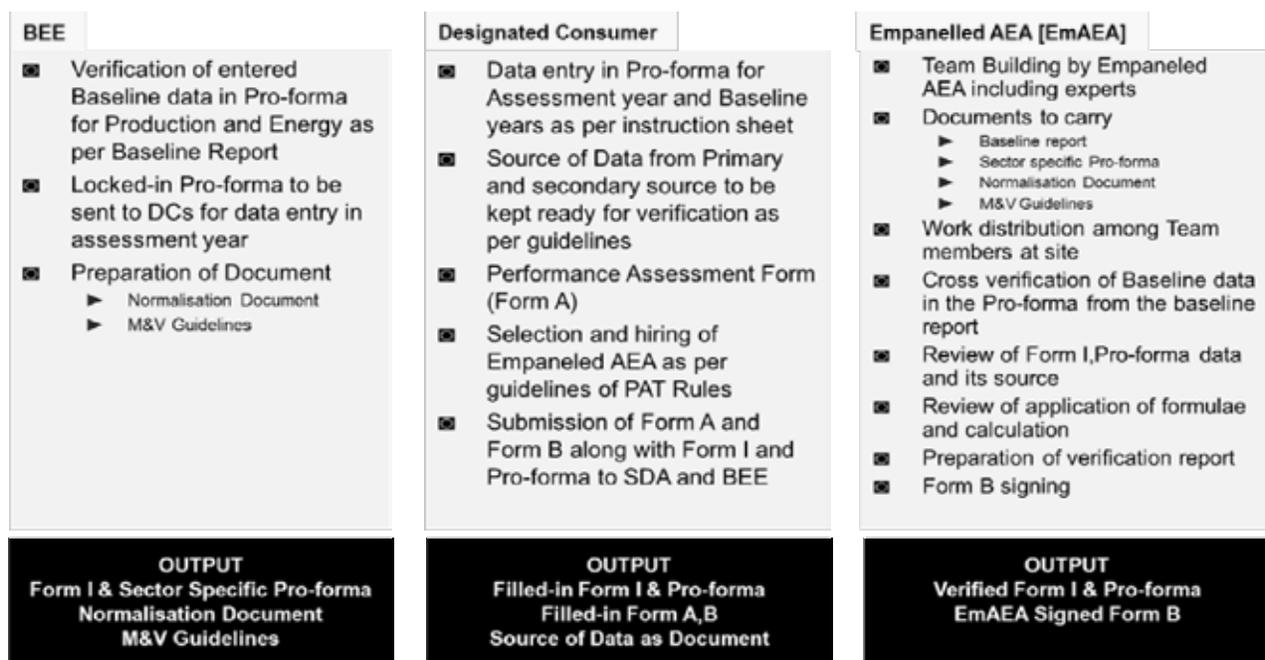
The same boundary should be considered for entire PAT cycle as finalised for the baseline year in the final Baseline Energy Audit Report. Ideally, plant boundary should not change during the entire cycle. Any change in plant boundary limit or merger of two plants, division of operation should be duly reported. The definition of Plant boundary should be considered same as established in the baseline year

- 71. The EmAEA will assign the activities among team members for verifying the data through the Pro-forma, Documented Primary and secondary sources, Field reports, conducting interviews, site visits etc.
- 72. The filled in Baseline data for Production and Energy shall be verified through Baseline Report by EmAEA.
- 73. The additional Baseline data filled by DC needs to be verified based on authentic

documentary evidence.

- 74. The baseline verified data shall be considered as final data to be filled in the sector specific pro-forma. In case of any typographical or factual error, the same shall be taken into account after taking into account corrected during verification process subject to all factual and authentic data source is available by DC. The EmAEA may take into account while preparing the verification form B.
- 75. The SEC calculation methodology as devised in the pro-forma shall be considered.
- 76. In case of any discrepancies observed in baseline data w.r.t. the Baseline reported data, the same should be reported to BEE with proper justification from EmAEA or DC for rectification in the existing Sector Specific Pro-forma. The rectified Pro-forma from BEE will be sent to the DC through e-mail.
- 77. Officials from Bureau of Energy Efficiency may visit Designated Consumers' Plant during the course of verification by EmAEA.

Figure 7: Stakeholders Output





78. Review of assessment year data and its authentic sources:
- i. The verifier shall ask the filled in Sector Specific Pro-forma with Form 1 from the Designated Consumer along with authentic documentary evidence
  - ii. In case DC reports some error; Interlinking or calculation error, these are to be reported back to BEE by the EmAEA with proper justification. BEE will send the rectified Pro-forma to DC through e-mail.
  - iii. EmAEA shall start the verification of Pro-forma referring to the documents provided by DC
  - iv. The guidelines as relevant to the data source are tabulated for different sections in Table 3 to 13 for Designated Consumers of sectors other than Thermal Power Plants. The instruction sheet of Thermal Power Plant sector may be referred for detailed documentation requirement.
  - v. EmAEA may seek other documents relevant to the process of M&V as well apart from the documents mentioned in the guidelines.
  - vi. EmAEA should include a Fuel Analysis report, internally or externally, in the Verification Report
  - vii. Data sampling method could be performed on sources of data, so that Operator's Log book/Log Sheet data/Shift Report (Basic data Entry Point particularly for Lab test/Production/ External reasons etc) could be verified in a loop of verifying the source document. EmAEA is advised to verify random sampling of data up to the primary source for some of the major parameters, affecting SEC of the Plant, which will be included in the Verification Report
- viii. In case of discrepancies between authentic document provided by DC and the Pro-forma, the same to be recorded in the EmAEA's verification report with justification if any from DC's and EmAEA.
79. Review of Energy Savings Projects
- i. In terms of Rule 7 of PAT Rules 2012 on Quarterly, Yearly and EOC<sup>6</sup> internal data reports prepared by the Designated Consumer
  - ii. In terms of Internal Audit reports prepared and maintained by the Designated Consumer
  - iii. In terms of measures adopted for energy conservation and quantity of energy saved and investment made by the Designated Consumer covering the relevant cycle
  - iv. Through Photographs, Screenshots in support of measures implemented in each year, if feasible
  - v. Through Percentage improvement in energy savings achieved in every year following the baseline year until the target year
  - vi. Verification & validation based on evaluation of implemented Energy efficiency projects through commissioning and procurement documents
  - vii. Site visit to some of the implemented Energy efficiency projects for verification and validation
  - viii. Establish linkage of expected results of projects on reduction of GtG SEC

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<sup>6</sup> EOC: End of Cycle



- ix. Identify SEC reduction reasons in the Verification Report
  - 80. Review of Formulae and its application
    - i. EmAEA to review the formulae used in the Pro-forma with Normalisation factor sheets and its applications; Errors are to be reported immediately to BEE.
    - ii. EmAEA to review the formulae and calculation used to arrive certain data filled in the Pro-forma by Designated Consumer and documented properly in the Verification Report
  - 81. Verification through interview of personnel, site visits and cross-checking with the filled in data in sector specific Pro-forma.
- 4.3.4. Primary and Secondary source of Documentation**
- 82. The DC shall provide all the information necessary for the verification process, including supporting documents and access to the plant site. It will be the responsibility of the EmAEA to maintain the confidentiality of the data collected and not to use them for any purpose other than PAT.
  - 83. The data submitted for verification and other figure for SEC calculation of any unit has to be in line with the units' declared production and consumption figures as per the statutory financial audit and declaration in their annual report.
  - 84. EmAEA, while verifying the SEC calculation, should also cross-verify the input figures based on the procurement plans and physical receipts.
  - 85. The transit and handling losses have to be within the standard norms allowable under financial audit.
  - 86. Guidelines on sources of data for Designated Consumer and EmAEA:
    - a. The general guidelines for the sectors other than Thermal Power Plants sector are tabulated in Table 3 to 13 in subsequent pages.
    - b. For the thermal power plant sector, please refer to sector specific pro-forma
    - c. Designated Consumer and EmAEA may also refer the guidelines provided in the instruction sheet attached with the Sector Specific Pro-forma.
  - 87. The general guidelines on sources of data are mentioned below. **In case of any discrepancies, EmAEA may seek additional field documents or equipment/section log sheets for particular data verification**

**Table 3: Production and Capacity Utilisation details**

Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
<b>Production and capacity utilization details</b>					
1	Production Capacity of a Plant/section/line/unit	Tonne	Annual	1) Original equipment manufacturer (OEM) Document of line/unit/equipment capacity 2) Environmental Consent to establish/operate document 3) DoF Communication	1) Equipment/Section wise capacity document from OEM 2) Capacity calculation document submitted for Environmental Consent



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
2	Production of a Plant/ section/line/unit	Tonne	Continuous, Hourly, Daily, Monthly	1) Log Sheet 2) DCS/CCR/ SCADA Report/ Trends 3) DPR 4) MPR 5) SAP Entry in PP/SD module 6) Excise record (ER1) 7) Annual Report 8) TOP	1)Storage Level 2) Feeding Weigh feeders 3) Belt Weigher 4) Solid flow meter 5) Counters
3	Production of Intermediate/ Semifinished Product/Other product	Tonne	Continuous, Hourly, Daily, Monthly	1) Log Sheet 2) DCS/CCR/ SCADA Report/ Trends 3) DPR 4) MPR 5) SAP Entry in PP/SD module 6) Excise record (ER1) 7) Annual Report 8) TOP	1)Storage Level 2) Feeding Weigh-feeders 3) Belt Weigher 4) Solid flow meter 5) Counters
4	Opening stock of Intermediary product	Tonne	Daily, Monthly	1) Inventory Report 2) Excise Document (ER1)3) Stores Entry 4) SAP Entry in MM/ PP/SD module 5) Annual Financial report 6) TOP	1) Field Inventory 2) Storage Level
5	Closing Stock of intermediary product	Tonne	Daily, Monthly	1) Inventory Report 2) Excise Document (ER1)3) Stores Entry 4) SAP Entry in MM/ PP/SD module 5) TOP	1) Field Inventory
6	Export of Intermediary Product	Tonne	Daily, Monthly	1) Excise Document 2) Stores receipt 3) SAP Entry in FI/ SD Module 4) Annual Report 5) TOP	1) Internal material Transfer Records
7	Import of Intermediary Product	Tonne	Daily, Monthly	1) Excise Document 2) Stores receipt 3) SAP Entry in FI/ SD Module 4) Annual Report 5) TOP	1) Internal material Transfer Records
8	Raw material consumption if any	Tonne	Daily, Monthly	1)Lab Product Test Report 2) DPR 3) MPR 4) SAP Entry in MM/PP module 5) Raw material stock entry (Stores) 6) TOP	1) Lab Testing Register 2) Closing and opening stock
9	Thermal Energy Consumption of section/Unit/Product	Tonne	Daily, Monthly	1)Fuel Weigh-feeder 2) Fuel Flow Meter 3) DPR 4) MPR 5) SAP Entry in MM/PP module 6) TOP	1)Storage Level 2) Feeding Weigh feeders 3) Belt Weigher 4) Solid flow meter
10	Electrical Energy Consumption of section/Unit/Product	Tonne	Daily, Monthly	1) Energy Management System 2) Equipment List Major Eqp section 3) DPR 4) SAP Entry in MM/PP module 6) TOP	1)Storage Level 2) Feeding Weigh feeders 3) Belt Weigher 4) Solid flow meter



**Table 4: Major Equipment capacity and Operating SEC**

Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
<b>Major Eqp Capacity and Operating SEC</b>					
1	Major Eqp wise production in Tonne.	Tonne	Continuous, Hourly, Daily, Monthly	1) Log Sheet 2) CCR SCADA Report/ Trends 3) DPR 4) MPR 5) SAP Entry in MM/PP module	1)Storage Level 2) Feeding Weigh feeders 3) Belt Weigher 4) Solid flow meter
2	Operating Major Eqp thermal SEC (Total thermal energy consumed in Major Eqp/ total Major Eqp production) in kcal/ kg Intermediary Product.	Kcal/ kg or kcal/ Tonne	Continuous, Hourly, Daily, Monthly	1)Fuel Weigh-feeder 2) Fuel Flow Meter 3) DPR 4) MPR 5) SAP Entry in MM/PP module	1)Storage Level 2) Feeding Weigh feeders 3) Belt Weigher 4) Solid flow meter
3	Operating Major Eqp electrical SEC (Total electricity consumed in Major Eqp/ total Major Eqp production) in kWh/ kg Intermediary Product.	Kwh/ Tonne	Continuous, Hourly, Daily, Monthly	1) Energy Management System 2) Equipment List Major Eqp section 3) DPR 4) SAP Entry in MM/PP module	1)Electrical Meter Record for Major Eqp section
4	Major Eqp wise annual running hours.	Hrs	Continuous, Hourly, Daily, Monthly	1) Major Eqp Log sheet 2) DPR 3) MPR 4) DCS/CCR/DCS Trends	1)Major Eqp Shift operator's Log Register 2) Breakdown report
5	Annual Hot-Hot start in Nos	Nos	Continuous, Hourly, Daily, Monthly	1) Major Eqp Log sheet 2) DPR 3) MPR 4) DCS/CCR/DCS Trends	1)Major Eqp Shift operator's Log Register 2) Breakdown report
6	Total annual Hot-Cold Stoppage Hours for Major Eqp due to <b>external factor</b> <sup>5</sup>	Hrs	Continuous, Hourly, Daily, Monthly	1) Major Eqp Log sheet 2) DPR 3) MPR 4) DCS/CCR/DCS Trends	1)Major Eqp Shift operator's Log Register 2) Breakdown report
7	Total annual Hot-Cold Stoppage Nos for Major Eqp due to external factor	Nos	Continuous, Hourly, Daily, Monthly	1) Major Eqp Log sheet 2) DPR 3) MPR 4) DCS/CCR/DCS Trends	1)Major Eqp Shift operator's Log Register 2) Breakdown report

<sup>5</sup> External Factor: Market Demand, Grid Failure (Where CPP is not Sync with Grid), Raw material unavailability, Natural Disaster, Rioting or Social unrest, Major change in government policy hampering plant's process system, Any unforeseen circumstances not controlled by plant management



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
8	Total annual Electrical Energy Consumption for Hot-Cold Stoppage for Major Eqp due to external factor in Lakh kWh	Lakh kWh	Continuous, Hourly, Daily, Monthly	1) Energy Meter Reading for Major Eqp Section 2) Major Eqp Log sheet 3) DPR 4) MPR 5) CCR SCADA Trends	1)Major Eqp Shift operator's Log Register 2) Breakdown report
9	Total annual Cold-Hot Start Hours for Major Eqp due to external factor	Hrs	Continuous, Hourly, Daily, Monthly	1) Major Eqp Log sheet 2) Major Eqp Shift operator's Log Register 3) DPR 4) MPR 5) CCR SADA Trends	1)Major Eqp Shift operator's Log Register 2) Breakdown report
10	Total annual Cold-Hot Start Nos for Major Eqp due to external factor	Nos	Continuous, Hourly, Daily, Monthly	1) Major Eqp Log sheet 2) Major Eqp Shift operator's Log Register 3) DPR 4) MPR 5) DCS/CCR/DCS Trends	1)Major Eqp Shift operator's Log Register 2) Breakdown report
11	Total annual Electrical Energy Consumption for Cold-Hot Start for Major Eqp due to external factor in Lakh kWh	Lakh kWh	Continuous, Hourly, Daily, Monthly	1) Energy Meter Reading for Major Eqp Section 2) Major Eqp Log sheet 3) DPR 4) MPR 5) DCS/CCR/DCS Trends	1)Major Eqp Shift operator's Log Register 2) Breakdown report
12	Annual Cold-Hot Start in Nos due to internal factors	Nos	Continuous, Hourly, Daily, Monthly	1) Major Eqp Log sheet 2) Major Eqp Shift operator's Log Register 3) DPR 4) MPR 5) DCS/CCR/DCS Trends	1)Major Eqp Shift operator's Log Register 2) Breakdown report

**Table 5: Boiler Details (Process and Co-Generation)**

Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
<b>Boiler Details (Process/Co-Gen)</b>					
1	Type			1) OEM Document	
2	Rated Capacity	TPH	Annual	1) OEM document on Boiler Capacity 2) Predicted performance Data (PPD) for Boiler 3) Environmental Consent to Operate	1) Capacity calculation submitted for Environmental Consent
3	Total Steam Generation	Ton	Continuous, Hourly, Daily, Monthly	1) Log Sheet 2) DCS/ SCADA Trend 3) DGR 4)MGR 5) SAP Entry in PP/PM Module	1) Steam Flow Meter 2) Process steam Consumption report 3) Log Book



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
4	Running hours	Hrs	Continuous, Hourly, Daily, Monthly	1) Log Sheet 2) DCS/ SCADA Trend 3) DGR 4) MGR 5) SAP Entry in PP/PM Module	1) Hour Meter 2) Log book
5	Coal Consumption	Tonne	Continuous, Hourly, Daily, Monthly	1) Log Sheet 2) DCS/ SCADA Trend 3) DGR 4) MGR 5) SAP Entry in PP/PM Module	1) Weigh Feeder 2) Solid flow Meter 3) Coal Storage register 4) Storage Level
6	GCV of Coal	kcal/kg	Daily, Monthly, Yearly	1) Daily Internal Report from Lab on Fuel Proximate Analysis performed on each lot. 2) Test Certificate from Government Accredited lab. (Plant to maintain minimum 1 sample test in a quarter for Proximate and Ultimate Analysis i.e. 4 test certificates in a year for each fuel in case of CPP/Cogen Fuel, for Process Fuel 1 sample test in a quarter for Proximate Analysis) 3) Purchase Order, where guaranteed GCV range is mentioned	1) Lab Register on Fuel Testing for Proximate Analysis 2) Calibration Record of instrument used for testing
7	Type of Fuel - 2 Name : Consumption	Tonne	Continuous, Hourly, Daily, Monthly	1) DGR 2) MGR 3) CPP/ Cogen Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	1) Belt Weigher before Fuel Bunker
8	GCV of any Fuel -2	kcal/kg	Daily, Monthly, Yearly	1) DGR 2) MGR 3) Lab Test Report	1) Lab Register on Fuel Testing for Proximate Analysis 2) Calibration Record of instrument used for testing
9	Type of Fuel - 3 Name : Consumption	Tonne	Continuous, Hourly, Daily, Monthly	1) DGR 2) MGR 3) CPP/ Cogen Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	1) Belt Weigher before Fuel Bunker
10	GCV of any Fuel -3	kcal/kg	Daily, Monthly, Yearly	1) DGR 2) MGR 3) Lab Test Report	1) Lab Register on Fuel Testing for Proximate Analysis 2) Calibration Record of instrument used for testing
11	Type of Fuel - 4 Name : Consumption	Tonne	Continuous, Hourly, Daily, Monthly	1) DGR 2) MGR 3) CPP/ Cogen Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	1) Belt Weigher before Fuel Bunker



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
12	GCV of any Fuel -4	kcal/kg	Daily, Monthly, Yearly	1) DGR 2) MGR 3) Lab Test Report	1) Lab Register on Fuel Testing for Proximate Analysis 2) Calibration Record of instrument used for testing
13	Feed water Temperature	°C	Continuous, Hourly, Daily, Monthly	1) DGR 2) DCS/SCADA Trends	
14	Operating Efficiency	%	Continuous, Hourly, Daily, Monthly	1) Indirect Method or Direct method calculation	
15	SH Steam outlet Pressure (Operating)	kg/cm <sup>2</sup>	Continuous, Hourly, Daily, Monthly	1) DGR 2) DCS/SCADA Trends	1) Field Pressure Meter
16	SH Steam outlet Temperature (Operating)	°C	Continuous, Hourly, Daily, Monthly	1) DGR 2) DCS/SCADA Trends	1) Field Temperature Meter
17	SH Steam Enthalpy (Operating)	kcal/kg	Continuous, Hourly, Daily, Monthly	1) Steam Table	
18	Design Efficiency	%	Yearly	1) OEM document on Boiler Efficiency 2) Predicted performance Data (PPD) for Boiler	1) Design Calculation

**Table 6: Electricity from Grid/Others, Renewable Purchase Obligation, Notified Figures**

Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
<b>Electricity from Grid / Other (Including Colony and Others) / Renewable Purchase obligation/Notified Figures</b>					
1	Annual electricity purchase from the grid	Lakh kWh	Daily, Monthly	1) Monthly Electricity Bills from Grid 2) Internal Meter reading records for grid incomer	Energy Management System



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
2	Renewable electricity consumption through wheeling	Lakh kWh	Daily, Monthly	1) Open Access records 2) Electricity Bills for Renewable energy 3) Renewable Purchase Obligation document	Energy Management System
3	Electricity consumption from CPP located outside of the plant boundary though wheeling	Lakh kWh	Daily, Monthly	1) Open Access records 2) Electricity Bills (for Wheeling)	Energy Management System
4	Renewable Purchase obligation of plant for the current year in % (Solar and Non-Solar).	%	Yearly	1) Renewable Purchase Obligation document	
5	Renewable Purchase obligation of plant for the current year in Lakh kWh (Solar and Non-Solar).	Lakh kWh	Yearly	1) Renewable Purchase Obligation document	
6	Renewable Purchase obligation of plant for the current year in MW (Solar and Non-Solar).	MW	Yearly	1) Renewable Purchase Obligation document	
7	Renewable Energy Generator Capacity in MW as approved by MNRE	MW	Yearly	1)'Certificate for Registration' to the concerned Applicant as 'Eligible Entity' confirming its entitlement to receive Renewable Energy Certificates for the proposed RE Generation project	
8	Quantum of Renewable Energy Certificates (REC) obtained as a Renewable Energy Generator (Solar & Non-Solar) in terms of REC equivalent to 1 MWh	Nos	Yearly	1) Renewable Energy Certificates	
9	Quantum of Energy sold in terms of preferential tariff under REC Mechanism in MWh	Nos	Lot, Yearly	1)PowerPurchaseAgreement (PPA) for the capacity related to such generation to sell electricity at preferential tariff determined by the Appropriate Commission	



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
10	Plant connected load	kW	Monthly	1) L-Form document 2) Electrical Inspectorate record	1) Total connected Load (TCL) of Plant 2) Equipment List
11	Plant contract demand with utility	kVA	Monthly	1) Monthly Electricity Bills from Utility	
12	DCs Notified Specific Energy Consumption in TOE/T for Baseline Year	TOE/T		1) Notification S.O.687 dated 31/03/2012	
13	DCs Target Specific Energy Consumption in TOE/T for Target year	TOE/T		1) Notification S.O.687 dated 31/03/2012	
14	Equivalent Major Product Output in tonne as per PAT scheme Notification	Tonne		1) Notification S.O.687 dated 31/03/2012	

**Table 7: Own generation through Captive Power Plants**

Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
<b>Own Generation through CPP (STG/GG/GT/WHRB/DG)</b>					
1	Selection is required from the drop down list for grid connectivity with grid (Yes/No)	Yes/No			
2	Installed capacity of all the Units in MW.	MW	Annual	1) OEM document for capacity 2) Rating plate of Generator	1) Capacity Enhancement document 2) R&M document
3	Gross unit generation of all the Units in Lakh kWh.	Lakh kWh	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) CPP main energy meter reading record 4) Energy Management System data	1) Energy Meter
4	Auxiliary power consumption (APC) in %.	%	Continuous, Hourly, daily, Monthly	1) Daily Power Report 2) Monthly Power Report 3) CPP main energy meter reading record 4) Energy Management System data	1) Energy Meter 2) Equipment List



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
5	Design Heat Rate of all the Units in kcal/kWh.	Kcal/kWh	Annual	1) OEM document on designed heat rate	1) PG test document
6	Annual running hours of all the units.	Hrs	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) Energy Management System data	1) Break down report 3) Operators Shift Register
7	Annual available hours of respective unit. Ex. If a unit commissions on 1st Oct, then available hour for the year will be 4380 hours	Hrs	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) Energy Management System data	1) Break down report 3) Operators Shift Register
8	Break down hrs due to internal, Planned and external factor for calculating Plant Availability Factor	Hrs	Hourly, daily, Monthly	1) CPP Log Sheet 2) Operators log Register 3) Daily generation Report 4) Monthly Generation Report 5) Energy Management System data 6) Refer Sr. No: N	1) Operator's Shift Register 2) CPP Break down analysis Report
9	No of hrs per annum during which Plant run on low load due to Internal Factors/ Breakdown in Plant (Average weighted hours of all the units)	Hrs	Hourly, daily, Monthly	1) CPP Log Sheet 2) Operators log Register 3) Daily generation Report 4) Monthly Generation Report 5) Energy Management System data 6) Refer Sr. No: N	1) Operator's Shift Register 2) CPP Break down analysis Report
10	No of hrs per annum during which Plant runs on low load due to Fuel Unavailability/ Market demand/ External Condition (Average weighted hours of all the units)	Hrs	Hourly, daily, Monthly	1) CPP Log Sheet 2) Operators log Register 3) Daily generation Report 4) Monthly Generation Report 5) Energy Management System data 6) Refer Sr. No: N	1) Operator's Shift Register 2) CPP Break down analysis Report
<b>Through Co-Generation</b>					
1	Grid Connected	Yes/ No			
2	Installed Capacity	MW	Annual	1) OEM document for capacity 2) Rating plate of Generator	1) Capacity Enhancement document 2) R&M document
3	Annual Gross Unit generation	Lakh kWh	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) CPP main energy meter reading record 4) Energy Management System data	1) Energy Meter



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
4	Auxiliary Power Consumption	Lakh kWh	Continuous, Hourly, daily, Monthly	1) Daily Power Report 2) Monthly Power Report 3) CPP main energy meter reading record 4) Energy Management System data	1) Energy Meter 2) Equipment List
5	Design Heat Rate	kcal/kWh	Annual	1) OEM document on designed heat rate	1) PG test document
6	Running Hours	Hrs	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) Energy Management System data Inlet Steam	1) Break down report 3) Operators Shift Register
<b>Inlet Steam</b>					
7	Total Steam Flow	Ton	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) DCS/SCADA Records	1) Makeup water Reading 2) Field Steam Flow meter reading
8	Avg. Steam Pressure	Kg/cm <sup>2</sup>	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) DCS/SCADA Records	1) Field Pressure Meter
9	Avg. Steam Temperature	°C	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) DCS/SCADA Records	1) Field Temperature Meter
10	Avg. Steam Enthalpy	kcal/kg	Continuous, Hourly, daily, Monthly	1) Steam Table	
<b>Steam Extraction 1 (MP)</b>					
11	Total Steam Flow (at the Header)	Ton	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) DCS/SCADA Records	1) Makeup water Reading 2) Field Steam Flow meter reading
12	Avg. Steam Pressure (at the Header)	Kg/cm <sup>2</sup>	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) DCS/SCADA Records	1) Field Pressure Meter
13	Avg. Steam Temperature (at the Header)	°C	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) DCS/SCADA Records	1) Field Temperature Meter
14	Avg. Steam Enthalpy (at the Header)	kcal/kg	Continuous, Hourly, daily, Monthly	1) Steam Table	



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
<b>Steam Extraction 2 (LP)</b>					
15	Total Steam Flow (at the Header)	Ton	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) DCS/SCADA Records	1) Makeup water Reading 2) Field Steam Flow meter reading
16	Avg. Steam Pressure (at the Header)	Kg/cm <sup>2</sup>	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) DCS/SCADA Records	1) Field Pressure Meter
17	Avg. Steam Temperature (at the Header)	°C	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) DCS/SCADA Records	1) Field Temperature Meter
18	Avg. Steam Enthalpy (at the Header)	kcal/kg	Continuous, Hourly, daily, Monthly	1) Steam Table	
<b>Steam Condensing</b>					
18	Total Exhaust Steam Flow	Ton	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) DCS/SCADA Records	1) Makeup water Reading 2) Field Steam Flow meter reading
20	Exhaust Steam Vacuum	Kg/cm <sup>2</sup> (a)	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) DCS/SCADA Records	1) Field Pressure Meter
<b>Power from dedicated line</b>					
1	Power wheeled through dedicated line in MW (average for the year)	MW	Hourly, daily, monthly	1) Energy Meter reading for nos of hours, 2) Daily Power Report	Energy Meter
2	Electricity wheeled in a year in lakh kWh	Lakh kWh		1) Separate Energy Meter Reading 2) Daily and Monthly Power Report	
3	Heat Rate of wheeled imported Electricity in kcal/kWh	kcal/kWh	daily, Monthly	1) Power Purchase Agreement 2) DGR of Sister concerned from where the power is wheeled 3)	1) Primary document from the sister concern 2) Excise document of purchase electricity
<b>Power Export and Colony/Others consumption</b>					



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
1	Quantity of electricity sold to the grid in Lakh kWh.	Lakh kWh	Continuous, Hourly, daily, Monthly	1) Daily Power Report 2) Monthly Power Report 3) Export main energy meter reading record 4) Energy Management System data 5) Monthly Export bill receipt sent to utility	Export Energy Meter
2	Quantity of electricity consumed in colony / other in Lakh kWh.	Lakh kWh	Continuous, Hourly, daily, Monthly	1) Daily Power Report 2) Monthly Power Report 3) Colony/other main energy meter reading record 4) Energy Management System data	1) colony/Others meter

**Table 8: Solid Fuel Consumption**

Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
<b>Solid Fuel Consumption</b>					
<b>A. Coal (Indian) / Petcoke/ Coal (Imported) / Coal (Lignite)/Coal 1/Coal 2/Coal 3/ Coal 4 (Other Solid Fuel)/ Dolachar/Coal fines/Met Coke/Coke Breeze /Nut coke/Lump Coke (Imported)</b>					
1	Landed cost of Solid Fuel i.e. Basic Cost+All Taxes + Freight. The landed cost of last purchase order in the financial year	Rs./ MT	Annual	1) Purchase Order for basic rates and taxes 2) Freight document for rates	
2	Gross calorific value (As Fired Basis <sup>6</sup> ) of solid fuel consumed for power generation	kcal/ kg	Lot, Daily, Monthly, Quarterly	1) Daily Internal Report from Lab on Fuel Proximate Analysis performed on each lot. 2) Test Certificate from Government Accredited lab. (Plant to maintain minimum 1 sample test in a quarter for Proximate and Ultimate Analysis i.e. 4 test certificates in a year for each fuel in case of CPP/Cogen/WHRB Fuel, for Process Fuel 1 sample test in a quarter for Proximate Analysis) 3) Purchase Order, where guaranteed GCV range is mentioned	1) Lab Register on Fuel Testing for Proximate Analysis 2) Calibration Record of instrument used for testing

<sup>6</sup> Location of sampling: As fired Fuel after the Grinding Mill



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
3	Gross calorific value (As Fired Basis <sup>7</sup> ) of solid fuel consumed in the process	kcal/kg	Lot, Daily, Monthly, Quarterly	1) Daily Internal Report from Lab on Fuel Proximate Analysis performed on each lot. 2) Test Certificate from Government Accredited lab. (Plant to maintain minimum 1 sample test in a quarter for Proximate and Ultimate Analysis i.e. 4 test certificates in a year for each fuel in case of CPP/Cogen/WHRB Fuel, for Process Fuel 1 sample test in a quarter for Proximate Analysis) 3) Purchase Order, where guaranteed GCV range is mentioned	1) Lab Register on Fuel Testing for Proximate Analysis 2) Calibration Record of instrument used for testing
4	Annual solid fuel quantity purchased	Tonne	Lot, Daily, Monthly, Yearly	1) Purchase Order 2) Stores Receipt 3) SAP Entry in MM/PP/FI module 4) Annual Report	1) Stores Receipt Register
5	Annual solid fuel moisture % (As Received Basis)	%	Lot, Daily, Monthly, Yearly	1) Daily Internal Report from Lab on Fuel Proximate Analysis performed on each lot. 2) Purchase Order, where guaranteed % moisture range is mentioned	1) Lab Register on Fuel Testing for Proximate Analysis 2) Calibration Record of instrument used for testing
6	Annual solid fuel quantity consumed in power generation	Tonne	Hourly, Daily and Monthly	1) DPR 2) MPR 3) CPP/Cogen/WHRB Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	1) Belt Weigher before Coal Bunker
7	Annual solid fuel quantity consumed in process	Tonne	Hourly, Daily and Monthly	1) DPR 2) MPR 3) Major Eqp Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	1) Belt Weigh Feeder 2) Solid Flow Meter
<b>B. Biomass and other renewable solid fuel / Solid waste</b>					
1	Landed cost of Solid Fuel i.e. Basic Cost+All Taxes + Freight. The landed cost of last purchase order in the financial year	Rs./ Tonne	Yearly	1) Purchase Order for basic rates and taxes 2) Freight document for rates	

<sup>7</sup> Location of sampling: As fired Fuel after the Grinding Mill



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
2	Gross calorific value of biomass / solid waste	kcal/kg	Lot, Daily, Monthly, Quarterly	1) Daily Internal Report from Lab on Fuel Proximate Analysis performed on each lot. 2) Test Certificate from Government Accredited lab (NABL). (Plant to maintain minimum 1 sample test in a quarter for Proximate and Ultimate Analysis i.e. 4 test certificates in a year for each fuel in case of CPP Fuel, for Process Fuel 1 sample test in a quarter for Proximate Analysis) 3) Purchase Order, where guaranteed GCV range is mentioned	1) Lab Register on Fuel Testing for Proximate Analysis 2) Calibration Record of instrument used for testing
3	Annual biomass/solid waste quantity purchased	Tonne	Lot, Daily, Monthly, Yearly	1) Purchase Order 2) Stores Receipt 3) SAP Entry in MM/PP/FI module 4) Annual Report	1) Stores Receipt Register
4	Annual solid fuel moisture % (As Received Basis)	%	Lot, Daily, Monthly, Yearly	1) Daily Internal Report from Lab on Fuel Proximate Analysis performed on each lot. 2) Purchase Order, where guaranteed % moisture range is mentioned	1) Lab Register on Fuel Testing for Proximate Analysis 2) Calibration Record of instrument used for testing
5	Annual biomass/solid waste Consumed in power generation	Tonne	Hourly, Daily and Monthly	1) DPR 2) MPR 3) CPP Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	1) Belt Weigher before Coal Bunker
6	Annual biomass/solid waste consumed in processing	Tonne	Hourly, Daily and Monthly	1) DPR 2) MPR 3) Major Eqp Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	1) Belt Weigh Feeder 2) Solid Flow Meter



**Table 9: Liquid Fuel Consumption**

Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
<b>Liquid Fuel Consumption</b>					
<b>A</b>	<b>Furnace Oil</b>				
1	Landed cost of Solid Fuel i.e. Basic Cost+All Taxes + Freight. The landed cost of last purchase order in the financial year	Rs/ Tonne	Annual	1) Purchase Order for basic rates and taxes 2) Freight document for rates	
2	Gross calorific value of furnace oil	kcal/kg	Lot, Monthly, Yearly	1) Test report from Supplier 2) Internal Test Report from lab 3) Test report from Government Accredited (NABL) Lab <sup>8</sup> 4) Standard Value as per Notification	Lab Register
3	Annual furnace oil quantity purchase	kL	Lot, Monthly, Yearly	1) Purchase Order 2) Stores Receipt 3) SAP Entry in MM/PP/FI module 4) Annual Report	Stores Receipt
4	Density of furnace oil	kg/Ltr	Lot, Monthly, Yearly	1) Test report from Supplier 2) Internal Test Report from lab 3) Test report from Government Accredited (NABL) Lab 4) Standard Value as per Notification	Lab Register
5	Furnace oil quantity consumed in DG set for power generation	kL	Daily, Monthly, Yearly	1) Daily Generation Report 2) Monthly Generation Report 3) DG Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	Flow Meter, Dip measurement in day tank
6	Furnace oil quantity consumed in CPP for power generation in kilo liters.	kL	Daily, Monthly, Yearly	1) Daily Generation Report 2) Monthly Generation Report 3) CPP Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	Flow Meter, Dip measurement in day tank
7	Furnace oil quantity used in process heating (including Pyro-processing and Product mill Hot Air Generator) in kilo litres.	kL	Daily, Monthly, Yearly	1) DPR 2) MPR 3) Major Eqp Log Sheet 4) Product Mill Log Sheet 5) SAP Entry in MM/PP/FI module 6) Annual Report	Flow Meter, Dip measurement in day tank

<sup>8</sup> Government Accredited Lab: National Accreditation Board for Testing and Calibration Laboratories(NABL Labs)



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
<b>B</b>	<b>LSHS/HSHS</b>				
1	Landed cost of Solid Fuel i.e. Basic Cost+All Taxes + Freight. The landed cost of last purchase order in the financial year	Rs/ Tonne	Annual	1) Purchase Order for basic rates and taxes 2) Freight document for rates	
2	Gross calorific value of LSHS/HSHS	kcal/ kg	Lot, Monthly, Yearly	1) Test report from Supplier 2) Internal Test Report from lab 3) Test report from Government Accredited Lab 4) Standard Value as per Notification	Lab Register
3	Annual LSHS/HSHS quantity purchase	Tonne	Lot, Monthly, Yearly	1) Purchase Order 2) Stores Receipt 3) SAP Entry in MM/PP/FI module 4) Annual Report	Stores Receipt
4	LSHS/HSHS quantity consumed in DG set for power generation	Tonne	Daily, Monthly, Yearly	1) Daily Generation Report 2) Monthly Generation Report 3) DG Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	Flow Meter, Dip measurement in day tank
5	LSHS/HSHS quantity consumed in CPP for power generation	Tonne	Daily, Monthly, Yearly	1) Daily Generation Report 2) Monthly Generation Report 3) CPP Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	Flow Meter, Dip measurement in day tank
6	LSHS/HSHS quantity consumed in process heating.	Tonne	Daily, Monthly, Yearly	1) DPR 2) MPR 3) Major Eqp Log Sheet 4) Product Mill Log Sheet 5) SAP Entry in MM/PP/FI module 6) Annual Report	Flow Meter, Dip measurement in day tank
<b>C</b>	<b>HSD/LDO</b>				
1	Landed cost of Solid Fuel i.e. Basic Cost+All Taxes + Freight. The landed cost of last purchase order in the financial year	Rs./ Tonne	Annual	1) Purchase Order for basic rates and taxes 2) Freight document for rates	
2	the gross calorific value of HSD/LDO	kcal/ kg	Lot, Monthly, Yearly	1) Test report from Supplier 2) Internal Test Report from lab 3) Test report from Government Accredited Lab 4) Standard Value as per Notification	Lab Register



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
3	Annual HSD/LDO quantity purchase	kL	Lot, Monthly, Yearly	1) Purchase Order 2) Stores Receipt 3) SAP Entry in MM/PP/FI module 4) Annual Report	Stores Receipt
4	Density of HSD/LDO	kg/Ltr	Lot, Monthly, Yearly	1) Test report from Supplier 2) Internal Test Report from lab 3) Test report from Government Accredited Lab 4) Standard Value as per Notification	Lab Register
5	HSD/LDO quantity used in DG set for power generation	kL	Daily, Monthly, Yearly	1) Daily Generation Report 2) Monthly Generation Report 3) DG Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	Flow Meter, Dip measurement in day tank
6	HSD/LDO quantity used in CPP for power generation	kL	Daily, Monthly, Yearly	1) Daily Generation Report 2) Monthly Generation Report 3) CPP Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	Flow Meter, Dip measurement in day tank
7	HSD/LDO quantity used in Transportation, if any	kL	Daily, Monthly, Yearly	1) Vehicle Log book 2) Stores Receipt 3) Fuel Dispenser meter reading 3) Work Order for Internal Transportation	
8	HSD/LDO quantity used in process heating	kL	Daily, Monthly, Yearly	1) DPR 2) MPR 3) Major Eqp Log Sheet 4) Product Mill Log Sheet 5) SAP Entry in MM/PP/FI module 6) Annual Report	Flow Meter, Dip measurement in day tank
<b>D</b>	<b>Liquid Waste</b>				
1	Landed cost of Solid Fuel i.e. Basic Cost+All Taxes + Freight. The landed cost of last purchase order in the financial year	Rs/ Tonne	Annual	1) Purchase Order for basic rates and taxes 2) Freight document for rates	
2	Gross calorific value of liquid waste	kcal/ kg	Lot, Monthly, Yearly	1) Test report from Supplier 2) Internal Test Report from lab 3) Test report from Government Accredited Lab 4) Standard Value as per Notification	Lab Register
3	Annual liquid waste quantity purchase	kL	Lot, Monthly, Yearly	1) Purchase Order 2) Stores Receipt 3) SAP Entry in MM/PP/FI module 4) Annual Report	Stores Receipt



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
4	Density of liquid waste	kg/Ltr	Lot, Monthly, Yearly	1) Test report from Supplier 2) Internal Test Report from lab 3) Test report from Government Accredited Lab 4) Standard Value as per Notification	Lab Register
5	Liquid waste quantity consumed in DG set for power generation	kL	Daily, Monthly, Yearly	1) Daily Generation Report 2) Monthly Generation Report 3) DG Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	Flow Meter, Dip measurement in day tank
6	Liquid waste quantity consumed in CPP for power generation	kL	Daily, Monthly, Yearly	1) Daily Generation Report 2) Monthly Generation Report 3) CPP Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	Flow Meter, Dip measurement in day tank
7	Liquid waste quantity consumed in process heating	kL	Daily, Monthly, Yearly	1) DPR 2) MPR 3) Major Eqp Log Sheet 4) Product Mill Log Sheet 5) SAP Entry in MM/PP/FI module 6) Annual Report	Flow Meter, Dip measurement in day tank

**Table 10: Gaseous Fuel Consumption**

Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
<b>Gaseous Fuel Consumption</b>					
<b>A</b>	<b>Natural Gas (CNG/NG/PNG/LNG)</b>				
1	Landed cost of Solid Fuel i.e. Basic Cost+All Taxes + Freight. The landed cost of last purchase order in the financial year	Rs./ Tonne	Annual	1) Purchase Order for basic rates and taxes 2) Freight document for rates	
2	Gross calorific value of NG	kcal/ SCM	Lot, Monthly, Yearly	1) Test report from Supplier 2) Test report from Government Accredited Lab 3) Standard Value as per Notification	
3	Annual NG quantity purchase	Million SCM	Lot, Daily, Monthly, Yearly	1) Purchase Order 2) Stores Receipt 3) SAP Entry in MM/PP/FI module 4) Annual Report	Gas Meter Reading, Bullet Pressure Reading



Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
4	NG quantity consumed in power generation	Million SCM	Continuous, Daily, Monthly, Yearly	1) Daily Generation Report 2) Monthly Generation Report 3) GG Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	Gas Meter Reading, Bullet Pressure Reading
5	NG quantity consumed in transportation	Million SCM	Daily, Monthly, Yearly	1) Vehicle Log book 2) Stores Receipt 3) Fuel Dispenser meter reading 3) Work Order for Internal Transportation	Gas Meter Reading, Bullet Pressure Reading
6	NG quantity consumed in process heating	Million SCM	Daily, Monthly, Yearly	1) DPR 2) MPR 3) Major Eqp Log Sheet 4) Product Mill Log Sheet 5) SAP Entry in MM/PP/FI module 6) Annual Report	Gas Meter Reading, Bullet Pressure Reading
<b>B</b>	<b>Liquefied Petroleum Gas (LPG)</b>				
1	Landed cost of Solid Fuel i.e. Basic Cost+All Taxes + Freight. The landed cost of last purchase order in the financial year	Rs./ Tonne	Annual	1) Purchase Order for basic rates and taxes 2) Freight document for rates	
2	Gross calorific value of LPG in kcal/kg.	kcal/kg	Lot, Daily, Monthly, Yearly	1) Test report from Supplier 2) Test report from Government Accredited Lab 3) Standard Value as per Notification	
3	Annual LPG quantity purchase	Million kg	Lot, Daily, Monthly, Yearly	1) Purchase Order 2) Stores Receipt 3) SAP Entry in MM/PP/FI module 4) Annual Report	Gas Meter Reading, Bullet Pressure Reading
4	LPG quantity consumed in power generation	Million kg	Daily, Monthly, Yearly	1) DPR 2) MPR 3) GG Log Sheet 4) SAP Entry in MM/PP/FI module 5) Annual Report	Gas Meter Reading, Bullet Pressure Reading
5	LPG quantity consumed in process heating	Million kg	Daily, Monthly, Yearly	1) DPR 2) MPR 3) Major Eqp Log Sheet 4) Product Mill Log Sheet 5) SAP Entry in MM/PP/FI module 6) Annual Report	Gas Meter Reading, Bullet Pressure Reading



**Table 11: Documents for Quality Parameter**

Sr No	Details	Unit	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
<b>Quality Parameters</b>					
<b>A</b>	<b>Raw Material Quality</b>				
1	Raw Material Quality (Sector Specific Raw Material Quality testing)	%	Lot, Monthly	1) Internal Test Certificate 2) External Test Certificate from related Sector Govt Accredited Lab	1) Lab Test Report Register
<b>B</b>	<b>Coal Quality in CPP (As Fired Basis)</b>				
1	the Ash % in coal used in CPP/Cogen/WHRB	%	Lot, Daily, Monthly, Quarterly	1) Daily Internal Report from Lab on Fuel Proximate Analysis performed on each lot. 2) Test Certificate from Government Accredited lab. (Plant to maintain minimum 1 sample test in a quarter for Proximate and Ultimate Analysis i.e. 4 test certificates in a year for each fuel in case of CPP/Cogen/WHRB Fuel, for Process Fuel 1 sample test in a quarter for Proximate Analysis) 3) Purchase Order, where guaranteed GCV range is mentioned	1) Lab Register on Fuel Testing for Proximate Analysis 2) Calibration Record of instrument used for testing
2	the Moisture % in coal used in CPP/Cogen/WHRB				
3	the Hydrogen % in coal used in CPP/Cogen/WHRB				
4	the GCV value of coal used in CPP/Cogen/WHRB				



**Table 12: Documents related to Environmental Concern, Biomass/Alternate Fuel availability, Project Activities, New Line commissioning, Unforeseen Circumstances**

Sr No	Details	Unit	Requirement	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
<b>Miscellaneous Data</b>						
<b>A</b>	<b>Additional Equipment installation after baseline year due to Environmental Concern</b>					
(i)	Electrical Energy Consumption with list of additional Equipment installed due to Environmental Concern after baseline year in Sheet! Addl Eqp List-Env.	Lakh kWh	List of Equipment to be filled up	Daily, Monthly, Annual	Energy Meter Readings and Power consumption details of each additional equipment installed from 1st Apr to 31st March	1) EMS 2) Energy Meter 3) Addition Equipment List with capacity and running load 4) Purchase Order document 5) SAP Data in MM module
(ii)	Thermal Energy Consumption with list of additional Equipment installed due to Environmental Concern after baseline year in Sheet! Addl Eqp List-Env.	Million kcal	List of Equipment to be filled up	Daily, Monthly, Annual	Solid/Liquid/Gaseous Fuel consumption of each additional equipment installed from 1st Apr to 31st March	1) Fuel Flow Meter 2) Weigh Feeder 3) Purchase Order document 4) SAP Data in MM module
<b>B</b>	<b>Biomass/ Alternate Fuel availability</b>					
(i)	Details of replacement of Bio-mass with fossil fuel due to un-availability. This is required in fossil fuel tonnage in terms of equivalent GCV of Bio-mass (Used in Process)	Tonne	Fossil Fuel: Coal/ Lignite/Fuel Oil	Monthly	1) Authentic Document in relation to Bio-Mass/Alternate Solid Fuel/Alternate Liquid Fuel availability in the region. 2) Test Certificate of Bio-mass from Government Accredited Lab for GCV in Baseline and assessment year 3) Test Certificate of replaced Fossil Fuel GCV	
(ii)	Details of replacement of Alternate Solid Fuel with fossil fuel due to un-availability. This is required in fossil fuel tonnage in terms of equivalent GCV of Alternate Solid Fuel (Used in Process)	Tonne		Monthly		



Sr No	Details	Unit	Requirement	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
(iii)	Details of replacement of Alternate Liquid Fuel with fossil fuel due to un-availability. This is required in fossil fuel tonnage in terms of equivalent GCV of Alternate Liquid Fuel (Used in Process)	Tonne		Monthly		
<b>C</b>	<b>Project Activities (Construction Phase)</b>					
(i)	Electrical Energy <sup>9</sup> Consumption with list of Project Activities and energy consumed during project activities treated as Construction phase in Lakh kwh Ref: Sheet Project Activity List	Lakh kWh	List of Equipment to be filled up	Daily, Monthly	Energy Meter Readings of each project activity with list of equipment installed under each activity from 1st Apr to 31st March	1) EMS 2) Energy Meter 3) Addition Equipment List with capacity and running load 3) Purchase Order document 4) SAP Data in MM module
(ii)	Thermal Energy Consumption with list of Project Activities and energy consumed during project activities treated as Construction phase in Million kcal converted from different fuel Ref: Sheet Project Activity List	Million kcal	List of Equipment to be filled up	Daily, Monthly	Solid/Liquid/Gaseous Fuel consumption of each project activity with list of equipment under each activity installed from 1st Apr to 31st March	1) Fuel Flow Meter 2) Weigh Feeder 3) Purchase Order document 4) SAP Data in MM module
<b>D</b>	<b>New Line/Unit Commissioning</b>					
(i)	Electrical energy consumed in Lakh kWh during its commissioning till it attains 70% of the new line capacity utilisation	Lakh kWh		Daily, Monthly	1) Rated Capacity of new Process/line from OEM 2) Energy Meter Readings and Power Consumption record of process/line with list of equipment installed from 1st Apr to 31st March	1) EMS 2) Energy Meter 3) Addition Equipment List with capacity and running load

<sup>9</sup> The Electrical Energy which is not included in colony/others



Sr No	Details	Unit	Requirement	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
(ii)	Thermal energy consumed in Million kcal during its commissioning till it attains 70% of the new line capacity utilisation. The energy is calculated after converting from the different fuel GCV used in the new process/line	Million kcal		Daily, Monthly	1) Rated Capacity of new Process/line from OEM 2) Thermal Energy Consumption record with list of equipment from DPR/Log book/SAP Entry in PP module	1) Fuel Flow Meter 2) Weigh Feeder
(iii)	Final/Intermediary Product production during its commissioning up to 70% of new line/process capacity utilisation in Tonne	Tonne		Daily, Monthly	1) Rated Capacity of new Process/line from OEM 2) Production record from DPR/Log book/SAP Entry in PP module	1) Weigh Feeder
(iv)	Date of achieving 70% capacity utilisation of new process/line	Dates			1) Record/Document from SAP Entry/Log Book Entry/DPR/MPR	Operator's Shift Register
(v)	Electrical Energy consumed in Lakh kWh from external source during its commissioning till it attains 70% of the new unit capacity utilisation in Power generation	Lakh kWh		Daily, Monthly	1) Rated Capacity of new unit from OEM 2) Energy Meter Readings and Power Consumption record of unit from external source with list of equipment installed from 1st Apr to 31st March	1) EMS 2) Energy Meter 3) Addition Equipment List with capacity and running load
(vi)	Thermal energy consumed in Million kcal during its commissioning till it attains 70% of the new unit capacity utilisation. The energy is calculated after converting from the different fuel GCV used in the new unit in Power generation	Million kcal		Daily, Monthly	1) Rated Capacity of new unit from OEM 2) Thermal Energy Consumption record with list of equipment from DPR/Log book/SAP Entry	1) Fuel Flow Meter 2) Weigh Feeder



Sr No	Details	Unit	Requirement	Frequency of record	Primary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor	Secondary Documents from where the information can be sourced and to be kept ready for verification by Accredited Energy Auditor
(vii)	Net generation in Lakh kwh from the new unit in power generation, used in the Product Plant till the new unit achieved 70% of Capacity Utilisation	Lakh kWH		Daily, Monthly	1) Record/Document from SAP Entry/Log Book Entry/DPR/MPR	1) EMS 2) Energy Meter
(viii)	Date of achieving 70% capacity utilisation of new unit in Power generation	Dates			1) Record/Document from SAP Entry/Log Book Entry/DPR/MPR	
<b>E</b>	<b>Unforeseen Circumstances</b>					
(i)	Electrical Energy Consumption with list of unforeseen circumstances consumed in Lakh kWh claimed for Normalisation	Lakh kWH	Unforeseen Circumstances: Situation not under direct or indirect control of plant management		1) Relevant document on Unforeseen Circumstances beyond the control of plant 2) Energy Meter Readings and Power Consumption during the said period of unforeseen circumstances	1) EMS 2) Energy Meter 3) Addition Equipment List with capacity and running load
(ii)	Thermal Energy Consumption with list of unforeseen circumstances consumed in Million kcal claimed for Normalisation	Million kcal			1) Relevant document on Unforeseen Circumstances beyond the control of plant 2) Thermal Energy Consumption record during the said period of unforeseen circumstances from DPR/Log book/SAP Entry	1) Fuel Flow Meter 2) Weigh Feeder



**Table 13: Documents related to External Factor**

Sr No	Details
<b>Document related to external factor</b>	
<b>(i)</b>	<b>Market Demand</b>
	1) Product Storage Full record from Product Mill Log book 2) SAP entry in SD and FI module 3) SAP entry in PP module 4) Document related to sales impact of market
<b>(ii)</b>	<b>Grid Failure</b>
	1) SLDC Reference No. for planned Stoppages from respective Substation 2) Log book record of Main Electrical Substation of Plant 3) DPR 4) MPR 5) SAP entry in PM module of Electrical department
<b>(iii)</b>	<b>Raw Material un-availability</b>
	1) Material Order copy and denial document from Mines owner 2) SAP entry in MM/FI module on raw material order 3) DPR 4) MPR
<b>(iv)</b>	<b>Natural Disaster</b>
	1) Supporting Authentic document from Local district Administration 2) Major Eqp Log Sheet 3) Major Eqp operators Report book 4) DPR 5) MPR
<b>(v)</b>	<b>Major change in government policy hampering plant's process system</b>
	1) Government Notification or Statutory order 2) Authentic document from plant on effect of Major Eqp production due to policy change 3) DPR 4) MPR 5) SAP Entry on production change
<b>(vi)</b>	<b>Unforeseen circumstances/Labour Strike/Lockouts/Social Unrest/Riots</b>
	1) Relevant document on Unforeseen Circumstances beyond the control of plant 2) Energy Meter Readings and Power Consumption during the said period of unforeseen circumstances 3) Thermal Energy Consumption record during the said period of unforeseen circumstances from DPR/Log book/SAP Entry
<b>(vii)</b>	<b>Note</b>
	The hard copy/Printouts is to be signed by Authorised signatory, if SAP data is used as documents
<b>(viii)</b>	<b>Availability of documentation</b>
	1) For Normalisation factors, which became applicable due to external factors, authentic documents to be produced by DC for the baseline as well for the assessment year. In absence of these authentic documents, no Normalisation Factor will be applied/Considered. 2) While selecting "No" from the drop down list, the inbuilt calculation automatic treat the Normalisation for particular factor as zero. However, DC needs to submit an undertaking from the Authorized Signatory on non-availability of document

## 5. Understanding Conditions

“Normalisation” means a process of rationalization of Energy and Production data of Designated Consumer to take into account changes in quantifiable terms that impact energy performance under equivalent conditions.

There are several factors that need to be taken into consideration in the assessment year, such as change in product mix, capacity utilisation, change in fuel quality, import/export of power, etc influenced by externalities i.e., factors beyond the plant's control, while assessing the

specific energy consumption of the plant.

In order to incorporate and address the changes occurring from baseline year to assessment year, the Bureau has formulated sub-technical committees under the technical committee for each sector. The sub-technical committees include representatives from DCs, research associations, ministries concerned, expert bodies from the government and the private sector, among others. The sub-committee identified and prepared the normalisation factors with the consent of DCs.



The operating parameters in the assessment year have to be normalised with reference to the baseline year so as to avoid any favourable or adverse impact on the specific energy consumption of the plant. This will also assist in quantifying and establishing the benefits of the energy efficiency projects the plant implemented.

### 5.1. Specific Issues

88. The complete Normalisation Process with equations and calculations have been dealt separately in sector specific Normalisation documents. EmAEA needs to study the document to carry out the verification process.
89. The details of data furnished in Form 1 shall be drawn from the sector-specific Pro-forma, referred to in the guidelines, relevant to every designated consumer and the said sector-specific Pro-forma, duly filled in, shall also be annexed to Form 1
90. The Sector Specific Pro-forma have built-in calculations of Normalisation with specific Energy Calculation in the summary sheet. The notified Form 1 will be generated automatically from the Pro-forma, once filled in all respect.
91. The normalization will be given to DCs only upon submission of valid/authentic supporting documents, failing which, the DC will not be eligible for normalizations.
92. The DC should submit valid reasons for operating parameters for which normalisation has been provided but not claimed.
93. For the new DCs, which are not covered under PAT scheme shall also fill up the Sector Specific Pro-forma for the verification of their total energy consumption.
94. Notional/Normalized Energy will not to be considered in Total Energy Consumption,

while deciding whether a plant falls under the designated consumer category or not. Normalization energy is considered only in the calculation of Gate to Gate Specific Energy Consumption.

95. **Definition of External Factors:** The factors over which an individual DC does not have any control but that can impact the SEC are classified as external factors.
  - i. External Factors should be scrutinized carefully for Normalisation applicability
  - ii. The defined external factors in the document are to be supported by external authentic documentary evidences
  - iii. The EmAEA should bring in any other undefined external factor, which may affect production or energy of a DC, in the verification report with authentic documentary evidences
  - iv. The external factors identified are as follows:
    - a. Market Demand
    - b. Grid Failure/Breakdown (Grid not Synchronized with CPP)
    - c. Raw Material Unavailability
    - d. Natural Disaster (Flood, Earthquake etc)
    - e. Major change in Government policy (affect plant's process)
    - f. Unforeseen Circumstances (Labour Strike/Lockouts/Social Unrest/Riots/Others)
96. **Boundary Limit:**
  - a. Establishment of plant GtG boundary is required with clear understanding of raw material input, Energy input, Power Import/Export, Intermediary product Import/Export, housing Colony Power, Construction/Others



Power, Power supplied to other Ancillary unit outside the plant boundary

- b. Inclusion and exclusion from the plant boundary is maintained as established in the baseline year
- c. Section-wise screen-shot of SCADA (supervisory control and data acquisition) system from the central control room (CCR)/distributed control systems (DCS) is to be included in the verification report
- d. Raw material input in the Plant boundary to be recorded for inclusion in the verification report

## 5.2. Fuel

### 97. Fuel Testing

- a. **Validation of Fuel quality testing from external and internal labs for same sample for each solid fuel used**
- b. Test Certificate from Government Accredited Lab (NABL):
  - i. **CPP Fuel:** Plant to maintain minimum 1 sample test certificate in a quarter for Proximate and Ultimate Analysis i.e. 4 test certificates in a year for each fuel
  - ii. **Process Fuel:** 1 sample test certificate in a quarter for Proximate Analysis i.e. 4 test certificates in a year for each fuel
- c. Liquid /Gaseous Fuel Testing: As per Table 9
- d. Reproducibility Limit of same sample
  - i. The means of the result of duplicate determinations carried out in each of two laboratories on representative portions taken from the same sample at the last stage of sample preparation, should

not differ by more than 71.7 kcal/kg as per ISO 1928: 1995 (E)

- ii. If the difference is greater than 71.7 kcal/kg, the difference will be added to the gross calorific value (GCV) value of the test result obtained in DC's Lab for that particular quarter
  - e. Daily Proximate analysis record of all types of Coal to be maintained at Lab for ongoing submission as document related to fuel analysis
98. Note on Proximate and Ultimate Analysis of Coal

If the ultimate analysis has not been carried out in the baseline year for getting H% result, following conversion formulae from Proximate to Ultimate analysis of coal could be used for getting elemental chemical constituents like %H.

Relationship between Ultimate and Proximate analysis

$$\begin{aligned} \%C &= 0.97C + 0.7(VM+0.1A) - M(0.6-0.01M) \\ \%H_2 &= 0.036C + 0.086(VM - 0.1xA) - 0.0035M^2(1-0.02M) \\ \%N_2 &= 2.10 - 0.020 VM \end{aligned}$$

Where  
*C* = % of fixed carbon  
*A* = % of ash  
*VM* = % of volatile matter  
*M* = % of moisture

- 99. The basis of Fuel sample testing i.e., As Received Basis (ARB), As Fired Basis (AFB), As Dried Basis (ADB) for calculating or measuring GCV in assessment year will be same as made during baseline year. However, the location of Fuel sample testing and weight measurement should remain identical. This will be identified in the Pro-forma under Remarks column, if the basis is other than As Fired.
- 100. The status quo to be maintained in the assessment year for the basis of measuring



GCV of Fuel (For Ex. As Received Basis, As Fired Basis, As Dried Basis etc.) as followed in the baseline year i.e., if DC has submitted GCV value on “as received basis”, the basis will be same in the assessment year as well. The DC has to write in the remarks/source of data field on basis of GCV taken in the assessment year. However, the EmAEA is requested to report the Fuel GCV “As fired basis” in the verification report, which may become baseline for subsequent PAT cycles.

101. Standard applicable IS Norms should be followed for Fuel (Solid, Liquid, Gas) sampling for internal or external lab from different location

102. Internal Coal Testing method to be elaborated as per IS Norms and to be included as document in the EmAEA report.

103. Gross Calorific Value or High Heat Value:

a. It is advised to measure the GCV of coal with the help of Bomb Calorimeter only in the assessment year and record the value daily in the LAB register for ongoing submission as document related to Fuel analysis.

b. The method for calculating GCV/ NCV from Proximate and Ultimate Analysis in the assessment year will remain same as that made during the baseline year.

c. In the absence of formulae for calculating GCV, the following Dulong’s formulae may be used for Gross Calorific Value (GCV) or High Heat Value (HHV) calculation

Dulong’s Formulae (Value from Ultimate Analysis) for GCV covers basic principle, that there are only 3 components in a fuel which generate heat i.e., Carbon, Hydrogen and Sulphur as per following expression

$$Q = 81 \times C + 342.5 \times [H - O/8] + 22.5 \times S$$

Where

Q is GCV in kcal/kg

C = % of Carbon by weight

H=% of Hydrogen by weight

O=% of Oxygen by weight

S=% of Sulphur by weight

#### 104. Net Calorific Value (NCV) or Low Heat Value (LHV):

a. The NCV includes the Steam-condensing latent heat, the NCV is defined as the gross calorific value minus the latent heat of condensation of water (at the initial temperature of the fuel), formed by the combustion of hydrogen in the fuel. The latent heat of steam at ordinary temperature may be taken as 587kcal/kg. The NCV could be calculated by the following expression

$$NCV = GCV - 5.87 \times (9 \times H + M)$$

Where

NCV = Net Calorific Value (kcal/kg)

GCV = Gross Calorific Value (kcal/kg)

H= % of Hydrogen by weight

M= % of Moisture by weight

#### 5.3. Normalization Condition and calculation

105. Plant should maintain the records of the number of outages during the baseline and assessment year.

106. Plant needs to maintain proper Energy Meter Reading/Records due to external factors for baseline as well as for assessment year.

107. Section wise Energy metering (Electrical and Thermal) is required for making Equivalent Product in Textile sub-sectors. Proper calculation document should be maintained, if energy figures are arrived by calculation method.



108. The Plant is to maintain Frequency of calibration and records of Energy monitoring equipment.
109. Calibration records of all weighing and measurement system with frequency of calibration to be included in the verification report.
110. The documents maintained by DCs should clearly show the direct reasons of the shutdown along with time and duration in hours and Energy consumed with quantity of Feed to reach the pre-shutdown production level for each such break-down or shutdown.
111. Details of Additional Equipment in Pro-forma:
  - a. **Additional Product/Section detail:** The Designated Consumer may furnish additional Product/Section details as per sectional format in a separate Excel Sheet for insertion in the existing Pro-forma if sectional input data format is full. Otherwise, Total energy of additional section or product could be converted into the last product or section through SEC of both the product/section and feed the same in the last product/section format for baseline as well as for assessment year.
    - b. **Additional Line for Start/Stop Normalization:** If the numbers of line/unit exceeds from the existing numbers, the DCs are advised to insert separate excel sheet of same format for finalization and BEE should insert additional line with normalization calculation.
    - c. Additional Boiler detail (Process/Co-gen): Additional numbers of Process or Co-gen boiler will be annexed in a separate Excel sheet as per the format provided in the Pro-forma for Boilers.
112. Lump CPPs: Information for all parameters of CPP <sup>10</sup> to be provided for all CPPs in Weighted Average terms w.r.t Gross Unit Generation in the CPP section, except for Design Heat Rate DHR (1,2...)= $DHR1 \times C1 + DHR2 \times C2 + \dots / (C1 + C2 + \dots)$ .
113. Lump co-gen (extraction-cum-condensing): The total number of co-gen should be treated as lump power source and details are to be filled accordingly in the Pro-forma separately for extraction-cum-condensing turbine as per the example shown in Table No 14.
114. Lump co-gen (back pressure): The total number of co-gen should be treated as lump power source and accordingly details to be filled in the Pro-forma separately for back pressure turbine as per the example in Table No 14.

**Table 14: Lump Co-Generation Treatment**

Sr No	Description	Formulae	Unit	Remarks
(i)	Install Capacity (C1.....Cn) <sup>11</sup>	$C1 + C2 + \dots + Cn$	MW	Sum of capacity
(ii)	Annual Gross Unit generation (AGG1...AGGn)	$AGG1 + AGG2 + \dots + AGGn$	Lakh kWh	Sum of Generation
(iii)	Auxiliary Power Consumption (APC1....APCn)	$APC1 + APC2 + \dots + APCn$	Lakh kWh	Sum of APC
(iv)	Design Heat Rate	$DHR (1,2...n) = \frac{DHR1 \times C1 + DHR2 \times C2 + \dots}{(C1 + C2 + \dots + Cn)}$	kcal/ kWh	Weighted Average of Design Heat Rate w.r.t to Installed Capacity

<sup>10</sup> CPP: Steam Turbine Generator (STG)/ Gas Turbine (GT)/Gas Generator(GG)/Diesel Generator (DG)

<sup>11</sup> 1,2,3.....n: No of Cogen Sources



Sr No	Description	Formulae	Unit	Remarks
(v)	Running Hours	$(RH1 \times AGG1 + RH2 \times AGG2 + \dots + RHn \times AGGn) / (AGG1 + AGG2 + \dots + AGGn)$	Hrs	Weighted Average of Running Hours w.r.t to Annual Generation
(vi)	Auxiliary Power Consumption	$(ii) \times 100 / (iii)$	%	APC%
(vii)	Total Thermal energy used in Process	$TEPr1 + TEPr2 + \dots + TEPrn$	Million kcal	Sum of Total Thermal Energy used in Process
(viii)	Total Thermal energy used in Power	$TEPo1 + TEPo2 + \dots + TEPon$	Million kcal	Sum of Total Thermal Energy used in Power
(ix)	Heat Rate of Co-Gen	$HR1 \times AGG1 + \dots + HRn \times AGGn / (AGG1 + \dots + AGGn)$	kcal/kwh	Weighted Average of Heat Rate

115. In case a DC commissions a new line/production unit before or during the assessment/target year, the production and energy consumption of new unit will be considered in the total plant energy consumption and production volumes once the capacity utilisation of that line has touched/increased over 70%. However, the energy consumption and production volume will not be included till it attains 70% of capacity utilisation. Energy consumed and produced (if any) in the course of a project activity during the assessment year, need to be monitored exclusively and will be subtracted from the total energy and production in the assessment year. Similarly, the same methodology will be applied to a new unit installation for power generation (CPP) within the plant boundary.

The capacity utilisation will be evaluated based on the original equipment manufacturer (OEM) document on rated capacity or name plate rating on the capacity of new line/production unit and the production of that line/unit as per DPR/log sheet.

#### 5.4. Normalisation General Issue

116. Normalisation Environmental Concern: Any additional equipment installed, to

comply with environmental standards as applicable in the baseline, will not qualify for this normalisation i.e., if any plant has deviated from the environmental standards imposed in the baseline year and additional equipment installed later to comply with these standards, the plant will not be eligible for normalisation.

117. Unavailability of biomass/alternative fuel in assessment year as compared to the baseline year due to external factors. The normalisation for unavailability for biomass or alternative fuel takes place only if sufficient evidence in terms of authentic documents is produced. The plant is to furnish the data on replacement of biomass/alternative fuel (solid/liquid) by fossil fuel in the assessment year with reference to baseline year. The energy consumption resulting from the use of fossil fuel will be deducted in the assessment year.

118. If a captive power or co-generation plant caters to two or more DCs for electricity and/or steam requirements, each DC shall consider that plant as existing within its boundary and the energy consumed by the plant shall be included in the total energy consumption. However, electricity in terms of calorific value (as per actual heat rate) and steam in terms of calorific



value (as per steam enthalpy) exported to other plants shall be subtracted from the total energy consumption.

119. **Normalisation for Start Stop:** The Designated Consumer has to furnish the Electrical and Thermal Energy Consumption by taking into account the saleable or intermediate production made during Hot-Cold Stop and Cold-Hot Start.
  - a. **Hot to Cold Stop:** The Plant ceases to halt after abrupt tripping of main equipment due to external factor.
  - b. **Cold to Hot Start:** The Plant is restarted after a brief halt/stoppages to reach the normal production
120. For the Start/Stop Normalization following factor may be considered:
  - a. At the time of Hot to Cold stop, due to external factors, electric energy consumed in the major section/plant to maintain the essential plant loads of the plant shall be deducted from the total energy consumption.
  - b. At the time of Cold to Hot start after Hot to Cold stop due to external factors, specific energy consumption of the major section/major equipment shall be multiplied with the actual production during this time and added to the total energy consumption.
  - c. The actual equivalent production shall also be added to the total production. For the purpose of clarity, equivalent
121. production means the amount of production of that major section/equipment converted into the major product output.
121. The designated consumer needs to produce authentic documents for normalisation factors, which became applicable due to external factors, for the baseline and assessment years. No normalisation factor will be applied or considered in the absence of these authentic documents. An undertaking from the Authorised Signatory is required on non-availability of document.
122. For investment for year 2010-11, 2012-13, 2013-14 and 2014-15 will be included in the assessment year of sector specific Pro-forma.
123. The empanelled accredited energy auditor will report separately any factor, which has not been considered in the document and Form 1, with possible solution for the same and annexed to Form B (Verification Form)
124. ThesectorsspecificPro-forma,normalisation document and aforementioned guidelines are the major elements of the M&V process; additional sector specific M&V guidelines are provided in Annexures I-VIII.
125. Some of the information sought in these annexures could be considered as supporting information/documents, which may help the EmAEA in submitting Form B.



## 6. Abbreviations

NAPCC	National Action Plan for Climate Change
NMEEE	National Mission on Enhanced Energy Efficiency
PAT	Perform Achieve and Trade
M&V	Monitoring and Verification
MoP	Ministry of Power
BEE	Bureau of Energy Efficiency
SDA	State Designated Agency
EOC	End Of PAT Cycle
DCs	Designated Consumer
EmAEA	Empanelled Accredited Energy Auditor Firm
SEC	Specific Energy Consumption
Pro-forma	Sector Specific Pro-forma for Form 1
ECM	Energy Conservation Measures
GtG	Gate- to- Gate
PAD	Performance Assessment Document
ESCerts	Energy Saving Certificates
AEA	Accredited Energy Auditor
CPP	Captive Power Plant
AY	Assessment Year
BY	Baseline Year
DCS	Distributed Control System
CCR	Central Control Room
SCADA	Supervisory Control and Data Acquisition
SAP	System Application and Product Software
DPR	Daily Production Report
MPR	Monthly Production Report
DGR	Daily Generation Report
MGR	Monthly Generation Report
IEX	Indian Energy Exchange
PXIL	Power Exchange of India Limited
OEM	Original Equipment Manufacturer
GCV	Gross Calorific Value
NCV	Net Calorific Value
NABL	National Accreditation Board for Testing and Calibration Laboratories
TPP	Thermal Power Plant



## 7. Annexure

- (i) Annexure I: Thermal Power Station
- (ii) Annexure II: Steel
- (iii) Annexure III: Cement
- (iv) Annexure IV: Fertilizer
- (v) Annexure V: Aluminium
- (vi) Annexure VI: Pulp & Paper
- (vii) Annexure VII: Textile
- (viii) Annexure VIII: Chlor-Alkali



## 7.1. Annexure I: Thermal Power Plant

### 1. Auxiliary Power Consumption (APC)

EmAEA may verify the section/ equipment wise motor ratings. The sections/ equipment shall include

**Table 15: Auxiliary Power Consumption Details (a,b,c)**

#### a. Boiler and Auxiliaries

S. No.	Equipment	Power Rating (kW)	Current Rating (Amperes)
1.	Coal Grinding Mills		
2.	Coal Feeders		
3.	Boiler Re-Circulation Pump		
4.	Primary Air(PA) Fans		
5.	Secondary Air(SA) Fans		
6.	Induced Draught (ID) Fans		
7.	Seal Air fans		
8.	Scanner air fans		
9.	Air Pre-Heater (APH)		
10.	Miscellaneous/ Missed out equipment		

#### b. Turbine and auxiliaries

S.No.	Equipment	Power Rating (kW)	Current Rating (Amperes)
1.	Condensate Extraction Pump (CEP)		
2.	Boiler Feed Pump (BFP)		
3.	Boiler Feed-booster Pump (BFBP)		
4.	Closed Circuit Cooling Water (CCCW) Pump/ De-Mineralised Cooling Water (DMCW) Pump		
5.	Auxiliary Cooling Water (ACW) Pumps		
6.	Condensate Polishing Unit (CPU)		
7.	Lube Oil Pumps		
8.	Seal Oil Pumps		
9.	Stator Water Cooling Pumps		
10.	Miscellaneous equipment		



**c. Balance of Plant**

S.No.	Equipment	Power Rating (kW)	Current Rating (Amperes)
1.	Compressed Air System		
a)	Instrument Air Compressor		
b)	Service Air Compressors		
2.	Cooling Water (CW) Pumps		
3.	Cooling Tower (CT) Fans		
4.	Water Treatment Plant (WTP)		
a)	Clarifiers		
b)	Filters		
c)	Pumps		
d)	Ion Exchangers		
e)	Miscellaneous/ Missed out equipment		
5.	Coal Handling Plant		
a)	Wagon Unloading System		
b)	Crushers		
c)	Belts Conveyors		
d)	Stacker Reclaimer		
e)	Miscellaneous/ Missed out equipment		
6.	Ash handling System		
a)	Pumps		
b)	Dry Ash Handling System		
c)	Wet Ash Handling System		
d)	Miscellaneous/ Missed out equipment		
7.	Fire Fighting System		
8.	Air Conditioning System		
9.	Lighting		
10.	Transmission System		
11.	Miscellaneous equipment		

This data shall be produced by the DCs for verification of section wise APC. If any item has been missed out in the table above, it shall be inserted by the DC.

The DC shall submit all design documents, manufacturers data sheet, etc. in support of the equipment ratings if required.

**2. Coal Handling Plant**

**a. Coal Input**

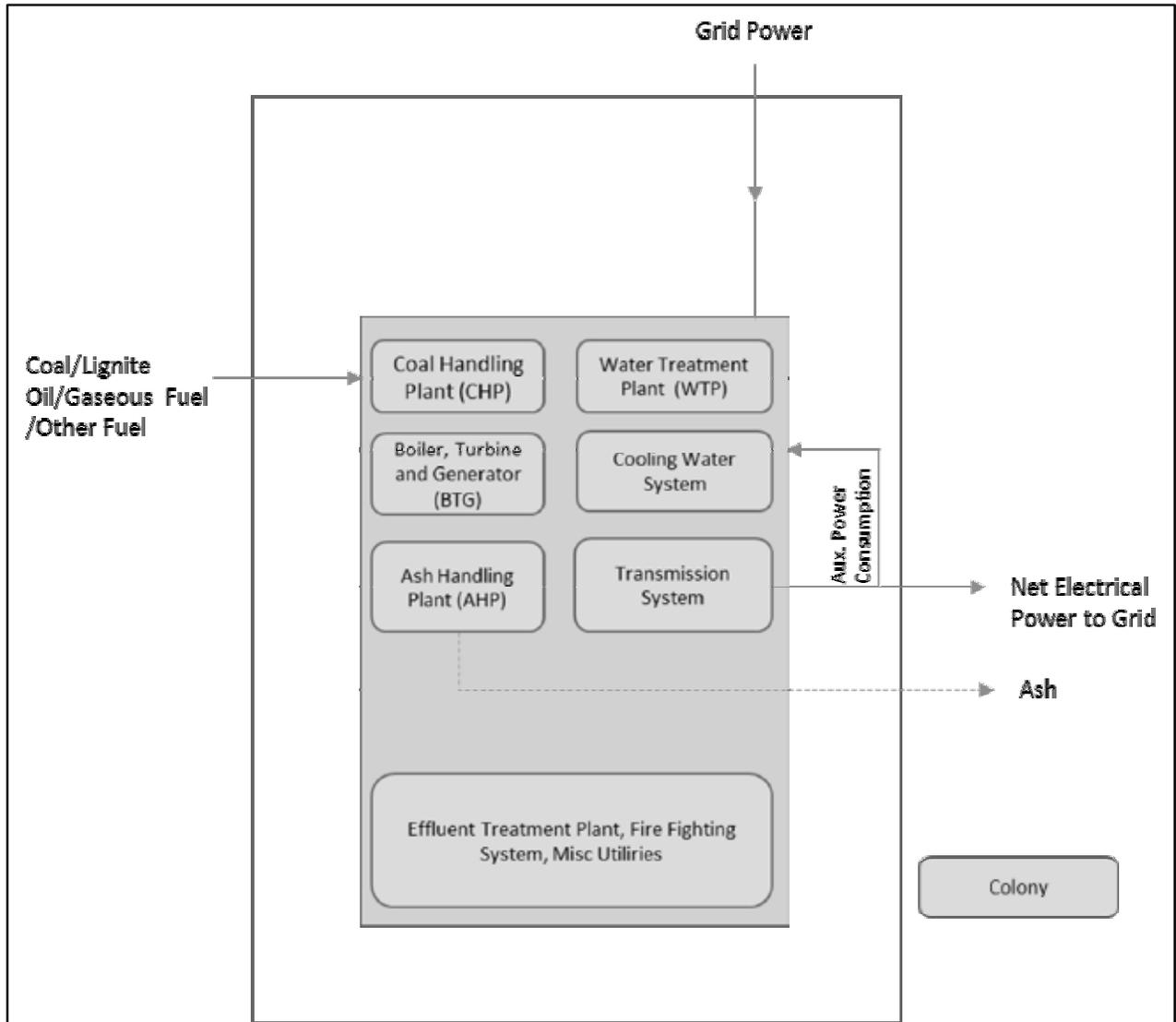
The DC shall submit a copy of Fuel Supply Agreement (FSA) in which the coal quality shall appear. Also, the DC shall submit the transportation agreement/ contract indicating the amount and quality of coal procured.



- b. Scheme  
A schematic representation of the coal handling plant shall be provided by the DC indicating the flow of coal from wagons to boilers. The description shall include hours of operation and number of equipment in running and standby condition.
  - c. Coal Quality  
The ultimate and proximate analysis of coal shall be submitted by the DC. The coal sample shall be taken at coal unloading, stacking and bunker feeding. The lab report in this regard shall be accepted.
3. Heat Rate  
The DC shall give the fully traceable calculation for turbine Heat Rate, Gross Heat Rate and Net Heat Rate. The values taken for heat rate calculation shall be backed by evidences, which can be screen shot of DCS for the particular parameter.
  4. Parameter verification  
The DCs shall make the log books and Daily Generation Report (DGR) available as and when needed.
  5. Fuel Oil  
The DCs shall submit the liquid oil supply contract mentioning the properties of oil. Also, the consumption shall be backed by calculation and pictures/ screen shot of level indicators/ flow counter, etc.
6. Balance diagrams
    - a. The DCs shall submit the Heat Mass Balance Diagrams showing the complete cycle.
    - b. Water Balance Diagram shall also be submitted.
  7. Fuel Mix Normalisation in Gas based Thermal Power Plant  
Due to change in fuel mix i.e., % of consumption of Gas and Oil/other fuel in the assessment year w.r.t. baseline year, the variation in Boiler efficiency is evident. The same needs to be normalized as per total generation from Gas and Oil/other fuel and design boiler efficiency at 100% for gas and Oil/other fuel.
  8. General
    - a. The scheme/ layout diagram of all sub-systems, e.g., CHP, AHP, WTP, etc. shall be submitted by the DCs. This shall facilitate in identifying the boundary condition of systems/ plant.
    - b. The DCs shall submit the maintenance history of systems/ equipment.
  9. Plant Boundary
    - a. The plant boundary shall consist of the BTG island, Water Treatment plant (WTP), Effluent Treatment Plant (ETP), Coal Handling Plant (CHP), Ash Handling Plant, CW System, Compressed Air System, Fire Fighting system, Transmission System, etc. A typical sample of Plant boundary condition is represented below



Figure 8: Ex-GtG Boundary for Thermal Power Plant

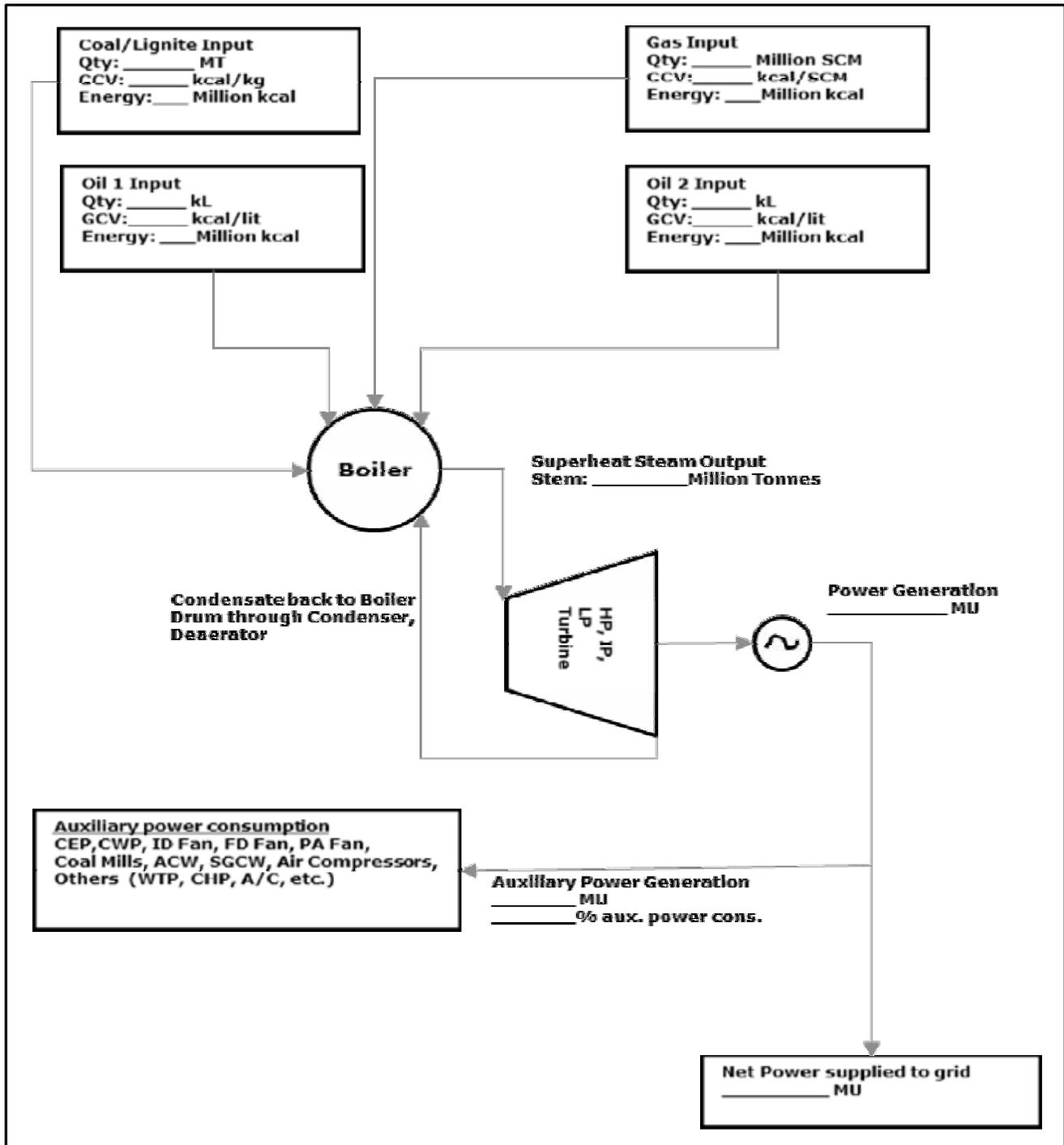


The residential colony does not form a part of the plant boundary and hence it is kept outside. In the figure above. The DC shall submit a latest Plot Plan of the station indicating all the systems/sub-systems.

b. The station energy balance diagram to be included in the Verification report. A typical sample of the diagram is shown below for Coal/Lignite/Oil/Gas based Power Plant and Combined Cycle Gas Turbine

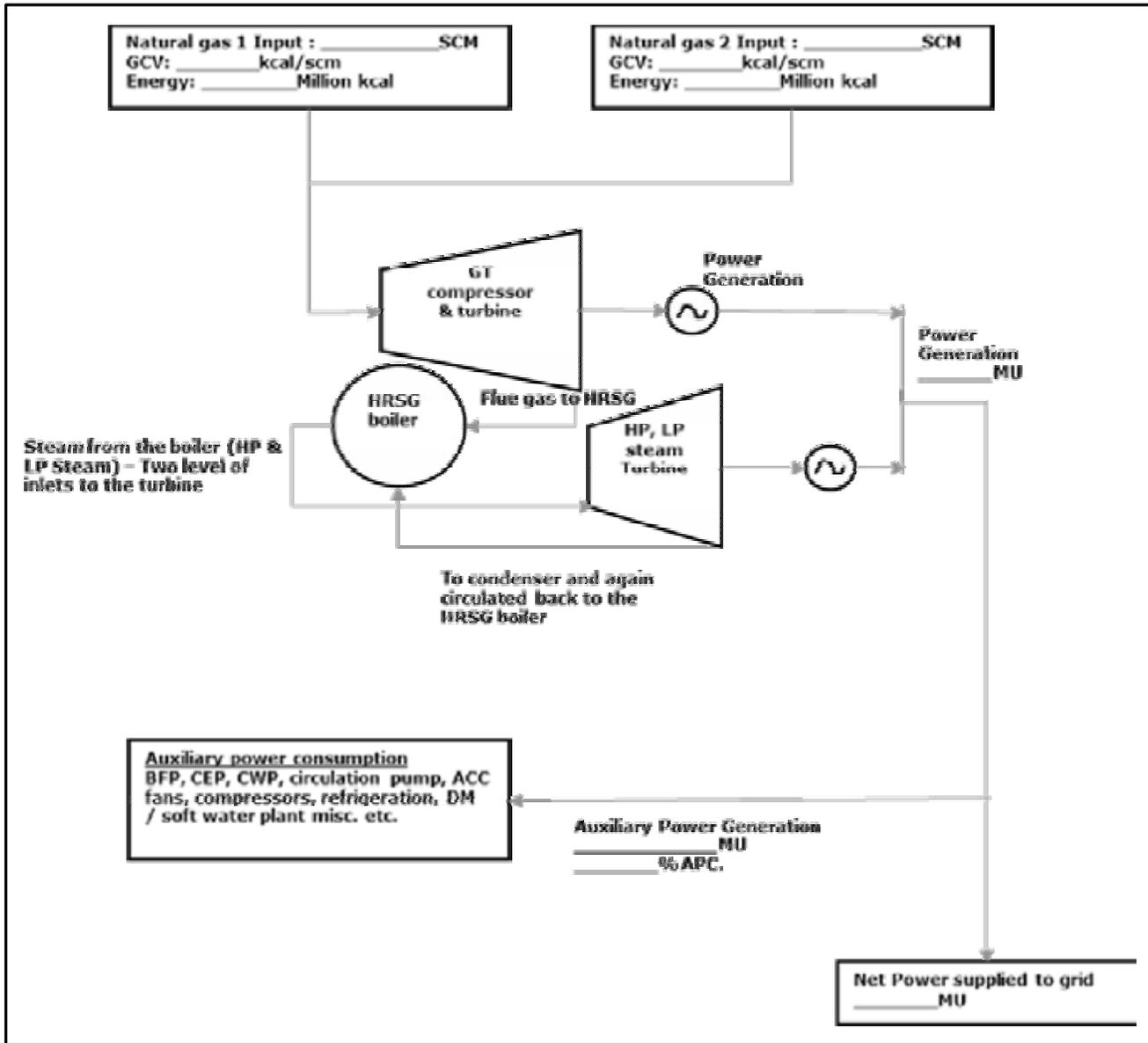


Figure 9: Ex-Coal/Lignite/Oil/Gas based Thermal Power Plant Energy balance diagram





**Figure 10: Ex-CCGT Energy balance diagram**



## 7.2. Annexure II: Steel

### A: Integrated Steel Plant

1. The data submitted for verification and other figure for SEC calculation of any unit has to be in line with the units declared production and consumption figures as per the statutory financial audit and declaration in their annual report.
2. EmAEA, while verifying the SEC calculation should also cross verify the

input figures based on the procurement plans and physical receipts.

3. The transit and handling losses have to be within the standard norms allowable under financial audit.
4. Crude steel is the product output of an Integrated Steel Plant (ISP). The term is internationally used to mean the 1st solid steel product upon solidification of liquid steel. In other words, it includes Ingots (in conventional mills) and Semis (in modern mills)



with continuous casting facility). In PAT Scheme, for ISP, Crude steel is considered as the major product output.

5. The energy impact of any basic input such as Pellet, Sinter, DRI, Oxygen, Nitrogen, Argon, which has been either imported and/ or discontinued during assessment or baseline years, the upstream/notional energy impacts have to be apportioned in SEC as the case may be.
6. Import of any finished or semi-finished fuel input say coking coal vs coke, which has been either imported and/ or discontinued during assessment or baseline years, the upstream/notional energy impacts have to be apportioned in SEC as the case may be
7. For verification process, the DC shall provide all necessary information, supporting documents and access to the Plant site to EmAEA. It will be the responsibility of the EmAEA to maintain the confidentiality of the data collected and not to use for any other purpose except for the PAT scheme.
8. Quality of raw material for the purpose of normalisation needs to be maintained as per the frequency of monitoring of the particular raw material and has to be maintained and submit to EmAEA by the plant, duly signed by the authorized signatory of the Designated Consumer.
9. In case of normalisation benefit, unit has to provide metering and measurement of energy inputs for all the energy parameters, for which normalisation is claimed.
10. All the energy input calorific values for purchased energy and inputs that impact energy performance of unit shall be submitted based on

suppliers documented analysis and contractually agreed and signed documents by competent authority. All these documents are mandatory to be counter signed by auditor. A third party determination of calorific Value of each fuel used in plant to be submitted for each quarter carried out by Government Accredited Laboratory (NABL) of each fuel used in the plant is to be submitted for each quarter.

11. Yield of Mills shall not be greater than 1. EmAEA needs to verify the yield for abnormal changes between baseline year and assessment year. The justification with calculation needs to be incorporated in the verification Report of EmAEA.
12. Coke Nut and Coke breeze is a part of BF grade Coke. EmAEA to take a note for the same in the verification Report of EmAEA.
13. Process route change Normalisation is applicable for change in major process due to external factor.

#### **B:Sponge Iron Sub-Sector**

14. The entire sub-sector is divided into 7 group on similarity of product
15. The major product in 7 group is as per table below
16. The Energy consumption of Pellet Plant shall not be included in the assessment year as well as in the baseline year. The calculation for the same is included in the summary sheet of Pro-forma.
17. For Inclusion of Pellet Plant in GtG Specific Energy Consumption, The DC needs to specify the same so that the Summary sheet needs to be modified.
18. The Electrical and Thermal energy of Pellet Plant should be verified through proper measurement and Energy meters

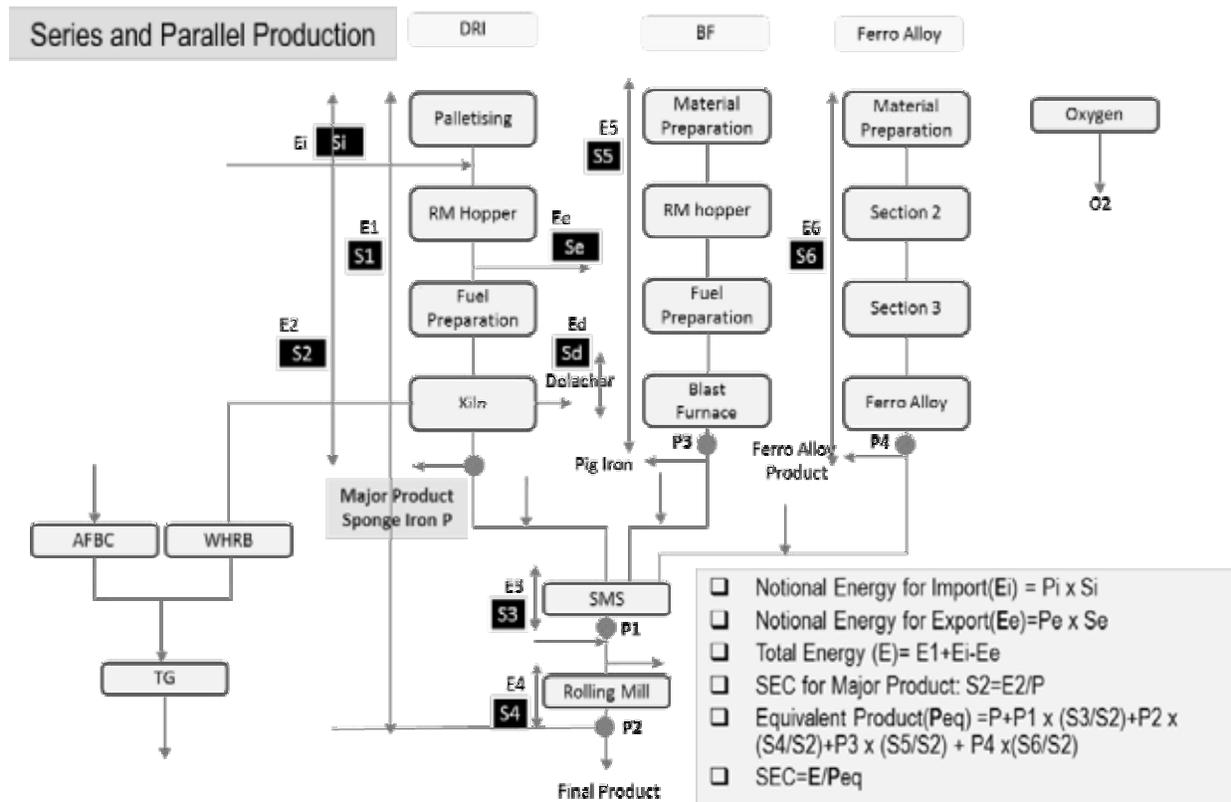


**Table 16: Sponge Iron Subsector- Major Product details**

Sr No	Sub-Sector Group	Major Product	Remarks
1	Sponge Iron	Sponge Iron	
2	Sponge Iron with Steel Melting Shop	Sponge Iron	
3	Sponge Iron with Steel Melting Shop and Others (Ferro Chrome, FeMn, SiMn, Pig Iron, Ferro Silicon, Rolling Mills etc)	Sponge Iron	
4	Ferro Alloy	SiMn	
5	Ferro Chrome	Ferro Chrome	
6	Mini Blast Furnace (MBF)	Pig Iron	
7	Steel Processing Unit (SPU)	Steel	

19. Calibration records of all weighing and measurement system with frequency of calibration to be included in the verification report
20. Section wise SCADA Screen shot if required to be included in the verification report by EmAEA
21. The Energy and Mass balance calculation is required to be included in the verification report.
22. Section wise energy consumption needs to be recorded and included in the verification report.
23. The equivalent product is calculated based on the Product Mix calculation in the pro-forma. A typical process flow along with the location of major product is shown in the diagram. The same shall be included in the verification report for different section of Sponge Iron sub-sector.

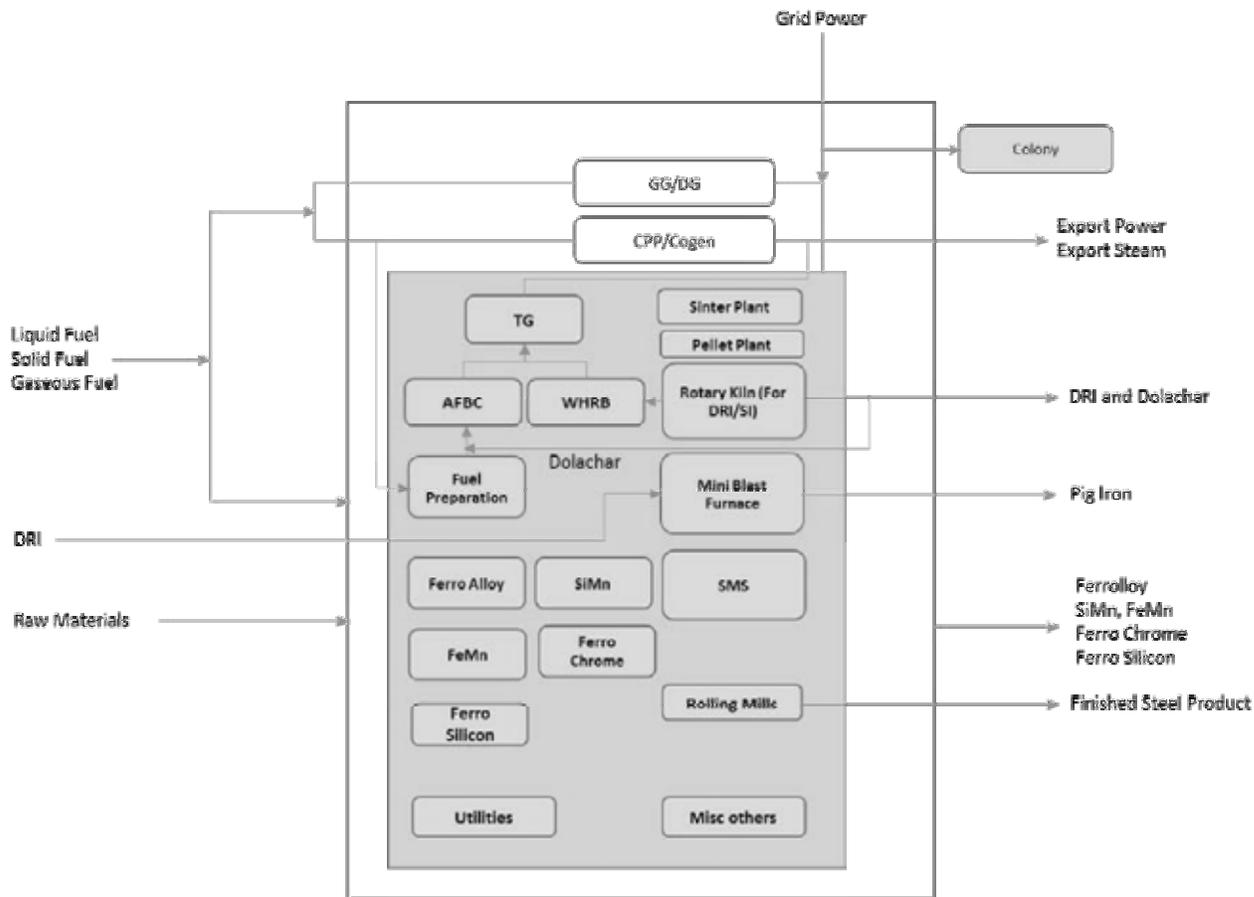
**Figure 11: Product Mix diagram**





24. Demarcation of plant boundary is required with clear understanding of raw material input, Energy input, Power Import/Export, Intermediary product Import/Export, Colony Power, Construction/Others Power, Power supplied to other Ancillary unit outside the plant boundary. A typical sample of Plant boundary condition is represented below

Figure 12: Ex-GtG Boundary boundary for Sponge Iron Sub-sector



25. The energy and mass balance calculation is required to be included in the verification report

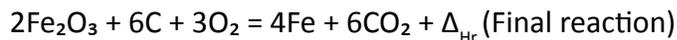
The ideal condition need to be assumed to find out the theoretical mass & heat balance of the kiln and its specific energy requirements. Once this is established, the actual mass & heat balance shall be worked out with SEC.

Comparison of actual SEC V/s. theoretical SEC shall give the kiln efficiency

a. Theoretical Heat Balance (Ideal Case)

To prepare the heat balance, “Hess’s Law of constant Heat summation” is applied, which states “For a given chemical process the net heat charge will be same weather the process occurs in one or several stages.

Adding all reactions



Standard heat of formation of  $\text{Fe}_2\text{O}_3$



& CO<sub>2</sub> are -825.5 & -393.5 KJ/mole respectively. Heat of formation of element is taken zero.

The final reaction after applying thermodynamics principal.

$$\Delta_{Hr} = \sum \Delta_{H \text{ product}} - \sum \Delta_{H \text{ reactants}}$$

Negative sign indicates exothermic reaction or heat release and positive sign indicates requirement of heat

Iron ore	1.43 Kg	Heat Supplied = 2058	Sponge iron	1 Kg.
Coal	0.64 Kg.		Char	0.064 Kg.
Air	5.20 Kg.	-251 Kcal (Excess heat)		6.20 kg.
Total Input			Total Output	
7.270 Kg				

In Heat balance of ideal kiln (100% coal used as reducing agent and no coal is used as fuel)

S.No	Component	Heat Value (Kcal)
1	Sponge iron sensible heat, assuming $\Delta_t 1045^\circ \text{C}$	+124
2	Char sensible heat, assuming $\Delta_t 1045^\circ \text{C}$	+13
3	Flue gas sensible heat, assuming $\Delta_t 1045^\circ \text{C}$	+1555
4	Heat loss due to moisture present in the coal	+66
5	Heat Loss due to vapor formed from Hydrogen of fuel	+49
6	Heat of iron reduction reaction (exothermic)	-758
7	Heat gain from burning of VM of coal	-1300
8	Net heat surplus in overall	-251
9	Total Additional heat/coal requirement to produce 1 Kg Sponge Iron	Nil

b. Sankey diagram of Kiln (Ideal condition)

EmAEA is required to include the heat balance report of Kiln as per actual condition of Plant operation



c. Ideal Mass balance condition

To produce 1 kg of Sponge Iron in ideal condition i.e. with no excess air (flue gas without O<sub>2</sub> & CO).

**Input:** 0.64 kg coal, 1.43 kg Iron Ore, 5.20 Kg of Air

**Output:** 6.206 Kg flue gas, 0.064 Kg (Ash of Coal), 1 kg sponge iron.

7.3. Annexure III: Cement

1. Preservation Power for Stopped Kiln: For kiln which goes under stoppages due to external factors, a certain quantity of power is required for safety and certain operations which needs to be maintained. The normalization for this power will be considered provided the DC has the baseline and assessment year data. This difference of preservation power in the baseline as well as the assessment year shall be subtracted from the total energy consumed.
2. Frequency of Lab Analysis from NABL accredited Laboratories for providing normalization for Raw material Quality in the subsequent cycles:
  - 2.1. Burnability analysis for raw mix – Once in each quarter
  - 2.2. Limestone Bond index – Once in a year
3. Normalisation due to Non availability of fly ash due to external factor: DC to submit support of claim on unavailability of fly ash during Assessment year to the EmAEA with sufficient data and documentation.



EmAEA to establish the facts whether in the vicinity of the particular DC, other Plants/DCs are getting Fly ash or not.

documentation to be provided by DC as per the instructions given in Cement sector Pro-forma.

4. The status quo to be maintained in the assessment year for the basis of measuring GCV of Fuel (For Ex. As Received Basis, As Fired Basis, As Dried Basis etc.) as followed in the baseline year i.e., if DC has submitted GCV value on “as received basis”, the basis will be same in the assessment year as well. The DC has to write in the remarks/source of data field on basis of GCV taken in the assessment year. However, The EmAEA is requested to report the Fuel GCV “As fired basis” in the verification report, which may become baseline for subsequent PAT cycles.
5. Plant Stoppages and Start due to high Clinker stock or Silo Full to be considered as external factor: Necessary
6. Normalisation on Use of Wet Fly Ash due to non-availability of dry Fly Ash: DC has to submit proper authentic documents to establish the increase in energy during AY due to usage of wet fly ash due to external reason. EmAEA to establish the facts whether in the vicinity of the particular DC, other Plants/DCs are getting dry Fly ash or not
7. Some of the information sought under this annexure could be considered as supporting information/documents, which may help EmAEA in submitting the Form B.
8. Review of Section wise specific power consumption (Line wise)

**Table 17: Section wise Specific Power Consumption Details**

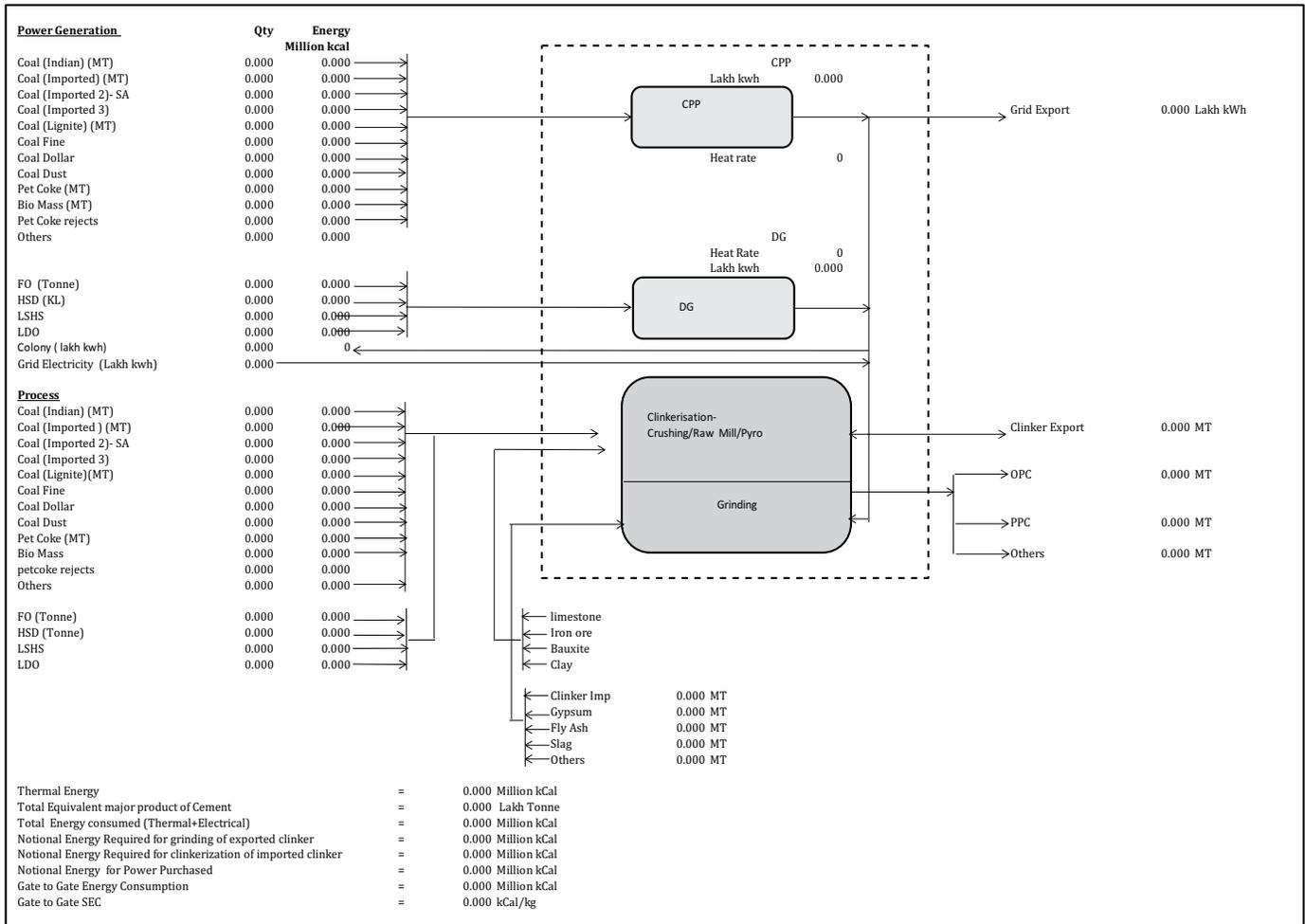
Sr No	Section	kWh/tonne of Material	Conversion Factor to Clinker	kWh/tonne of Clinker	kWh/tonne of Cement	Remarks
1	Crusher					
2	Raw Mill					
3	Kiln					
4	Coal/Petcoke Mill					
5	Cement Mill					
6	Packing					
7	Utilities					
8	Misc					
	<b>Sum</b>					

9. Demarcation of plant boundary is required with clear understanding of raw material input, Energy input, Power Import/Export, Intermediary product Import/Export, Colony Power, Construction/

Others Power, Power supplied to other Ancillary unit outside the plant boundary. A typical sample of Plant boundary condition is represented below



Figure 13: Figure 14: Ex-GtG boundary for Cement Sector



10. Mass and Energy balance verification account the Clinker stock difference and Clinker The clinker balance verification is required Import export. Similarly Energy balance up from Cement produced and Clinker factor to clinkerisation could be verified as per the with actual clinker produced by taking into tabulated formulae

Table 18: Mass and Energy balance

Mass Balance Verification (A=B)							
Clinker Balance							
Sr No	Description	Unit	Year 1, 2007-08	Year 2, 2008-09	Year 3, 2009-10	Year 4, 2014-15	Remarks
A	Equivalent Clinker from total cement produced: [OPC x CFOPC]+[PPC x CFPPC]+[PSC x CFPSC]	Lakh tonnes					
B	Clinker Produced: Total Clinker Produced + (Clinker Imported- Clinker Exported)+(Opening Clinker Stock-Closing Clinker Stock)	Lakh tonnes					



Sr No	Description	Unit	Year 1, 2007-08	Year 2, 2008-09	Year 3, 2009-10	Year 4, 2014-15	Remarks
	% Variation	$(A-B) \times 100/A$					
<b>Energy Balance Verification(C=D)</b>							
C	FinalSEC (Before Normalisation)	kcal/kg equivalent cement					
D	(Thermal SEC for Clinkerization * PPC Clinker Factor) + (Electrical SEC for Clinkerization in thermal equivalent * PPC Clinker Factor) + (Electrical SEC for Cement grinding in thermal equivalent)	kcal/kg equivalent cement					
	% Variation	$(C-D) \times 100/C$					

11. Section wise Screen shot of SCADA from CCR/DCS is to be included in the verification report
12. Raw material input in the Plant boundary to be recorded for inclusion in the verification report
13. Heat balance of Kilns (Kiln wise)for the assessment year is required to be included in the verification report with boundary and understanding on CV basis i.e., NCV or GCV of fuel
14. Calibration records of all weighing and measurement system with frequency of calibration to be included in the verification report
15. Clinker Factor Verification  
The Clinker factor calculation is to be documented and produced in the verification report, the verification could be done by taking following factor into account from the pro-forma A1-A20

**Table 19: Clinker Factor calculation**

Item	Unit	Year1	Year2	Year3	Year 4	Remarks
Gypsum % in Cement	%					
Clinker used for PPC	tonne					
Clinker used for OPC	tonne					
Clinker used for PSC	tonne					
Clinker Used for Cement	tonne					
Gypsum used in OPC	tonne					
Gypsum used in PPC	tonne					
Gypsum used in PSC	tonne					
Clinker factor for PPC	factor					
Clinker Factor for OPC	factor					
Clinker Factor for PSC	factor					

16. Establishment of clear inclusion and exclusion from the plant boundary is maintained as in the baseline year.
17. Some of the factors, which are not covered in the cement sector pro-forma, the EmAEA is required to report it separately



#### 7.4. Annexure IV: Fertilizer

Fertilizer industry is maintaining an elaborate system of measurement and reporting of production and energy data in the form of “Technical Operating Data (TOP)”, as per the guidelines of Fertilizer Industry Coordination Committee (FICC), Department of Fertilizers. The TOP data is also audited by cost accountant. TOP data can be accepted as such. In case of multi-product plants, distribution of raw materials, power, steam and other utilities to be segregated and quantities allocated for urea production are to be brought out distinctly.

##### 1.0 Measurement & recording

In the following table, items have been identified, which are required for calculating material &

energy balance at battery limit of the complex. Against each item, following information is to be furnished :-

- a) Measuring device: Name, tag number, model, location
- b) Accuracy level of measurement or date of last calibration. Correction factors (if any)
- c) Type of record: Data logger/ digital recorder, charts, direct reading/log book/ log sheet etc.
- d) Frequency of reading: Hourly, shift wise, daily, periodically
- e) Whether the quantities are ascertained by material balance?
- f) Stock verification

**Table 20: Material and Energy balance of Fertilizer sector**

Sr. No.	Item	Unit	Measuring device Name/ tag no/model/ location	Accuracy level / correction factors ( if any)	Records Type/ Location	Frequency of reading	Remarks
1.0	<b>Final/ intermediate products</b>						
1.1	<b>Urea production</b>	MT					
1.2	<b>Ammonia</b>						
1.2.1	Production	MT					
1.2.2	Consumption for urea	MT					
1.2.3	Consumption for other products	MT					
1.2.4	Sent to storage	MT					
1.2.5	Received from storage	MT					
1.2.6	Export	MT					
2.0	<b>Input raw materials</b>						
2.1	Natural gas						
2.1.1	Properties						
a	GCV	Kcal/ SCM					
b	NCV	Kcal/ SCM					
2.1.2	Total receipt						
a	Main receiving station	MMSCMD					



Sr. No.	Item	Unit	Measuring device Name/ tag no/model/ location	Accuracy level / correction factors (if any)	Records Type/ Location	Frequency of reading	Remarks
2.1.3	Distribution						
a	Reformer feed	MMSCMD					
b	Reformer fuel	MMSCMD					
c	Gas turbine	MMSCMD					
d	HRU	MMSCMD					
e	Boilers	MMSCMD					
f	Others	MMSCMD					
2.2	<b>Naphtha</b>						
2.2.1	<b>Properties</b>						
a	Sp. Gravity	gm/cc					
b	GCV	Kcal/kg					
c	NCV	Kcal/kg					
2.2.2	<b>Total receipt</b>						
a	Volume	kl					
b	Weight	MT					
2.2.3	<b>Distribution</b>						
a	Reformer feed	MT					
b	Reformer fuel	MT					
c	Others	MT					
2.3	<b>Diesel</b>						
2.3.1	<b>Properties</b>						
a	Sp. Gravity	gm/cc					
b	GCV	Kcal/kg					
c	NCV	Kcal/kg					
2.3.2	<b>Total receipt</b>						
a	Volume	kl					
b	Weight	MT					
3.3	<b>Distribution</b>						
a	DG Sets	kl					
b	Others						
2.4	<b>Furnace oil/LSHS etc.</b>						
2.4.1	<b>Properties</b>						
a	Sp. Gravity	gm/cc					
b	GCV	Kcal/kg					



Sr. No.	Item	Unit	Measuring device Name/ tag no/model/ location	Accuracy level / correction factors (if any)	Records Type/ Location	Frequency of reading	Remarks
c	NCV	Kcal/kg					
2.4.2	<b>Total receipt</b>						
	Volume	kl					
	Weight	MT					
2.4.3	<b>Distribution</b>						
a	Boiler	MT					
b	Other furnaces ( specify)	MT					
c	Misc ( if any)						
2.5	<b>Coal</b>						
2.5.1	<b>Properties</b>						
a	GCV	Kcal/kg					
b	NCV	Kcal/kg					
2.5.2	<b>Total receipt</b>						
a	Weight	MT					
2.5.3	<b>Distribution</b>						
a	Boilers(1+2+3)	MT					
b	Others ( specify)	MT					
c	Stock variation						
2.6	<b>Any other fuel</b>						
3.0	<b>Steam</b>						
3.1	<b>Production</b>						
3.1.1	Boiler ( Individual)						
3.1.2	GTG/HRU						
3.1.3	Service/auxiliary boiler						
3.1.4	Others						
3.2	<b>Consumption</b>						
3.2.1	Steam turbo generator						
3.2.2	Ammonia plant						
3.3.3	Urea plant						
3.3.4	Others						

2. Material balance of all inputs at battery limit of entire complex

Following information is to be filled-in as follows:-

(i) One month having best operation as per TOP.

(ii) For financial year, as per TOP.



**Table 21: Material balance of all inputs in Fertilizer sector**

Sr. No.	Item	Unit	Received at plant battery limit	Allocated for urea production	Allocated for other products	Difference if any	Remarks
1.0	<b>Purchased items</b>						
1.1	Purchased power	MWh					
1.2	Natural gas	MMSCMD					
1.3	Naphtha						
a	Volume	Kl					
b	Weight	MT					
1.4	Diesel	Kl					
1.5	Furnace oil /LSHS etc.						
a	Volume	Kl					
b	Weight	MT					
1.6	Coal	MT					
1.7	Any other fuel						
2.0	Steam						
2.1	Production						
2.1.1	Boiler ( Individual)	MT					
2.1.2	GTG/HRU	MT					
2.1.3	Service/auxiliary boiler	MT					
2.1.4	Others	MT					
2.2	Consumption	MT					
2.2.1	Steam turbo generator	MT					
2.2.2	Ammonia plant	MT					
2.2.3	Urea plant	MT					
2.2.4	Others	MT					
3.0	<b>Power</b>						
3.1	<b>Generation</b>	MWh					
3.1.1	GTG	MWh					
3.1.2	Others	MWh					
3.2	<b>Consumption</b>						
3.2.1	Ammonia plant	MWh					
3.2.2	Urea plant	MWh					
3.2.3	Others	MWh					

**3. Pro-forma**

**a. Pro-forma**

Under the PAT scheme, all DCs are required to fill-in and submit to BEE, Pro-forma, which is mandatory, with following salient features:

**i. Plant capacity, production & capacity utilization**

- Installed capacity
- Production
- Capacity utilization



- ii. Purchased electricity – Purchased quantity, cost, consumption
- iii. Generated electricity through DG/ turbo gen/ gas turbine/ co-generation
- iv. Fuels – Gaseous (NG, LNG), Liquid (Naphtha, fuel oil, diesel) solid (coal, coke) – Purchased quantity, calorific value (GCV).
- v. Consumption of energy input for
  - Power generation
  - Process raw material
  - Process heating
- vi. Using waste as fuel
- vii. Use of non-conventional energy (Solar, wind, etc)
- ix. Total energy input at BL

#### b. Sector Specific Pro-forma

Keeping in view the special requirements in fertilizer sector, the Pro-forma has been modified with following changes:-

- i. Plant capacity is reported in following formats:-
  1. **Name plate capacity:** The original name plate capacity at the time of installation of plant.
  2. **Re-assessed capacity:** As revised by “Fertilizer Industry Coordination Committee (FICC) “ in the year 2002.
  3. **Baseline production:** As worked out (for urea product only) under PAT scheme. It is an average of production for three baseline years viz 2007-08, 08-09, 09-10.
  4. **Re-vamp capacity:** Subsequent to baseline period i.e. 2007-10, some plants carried out major revamp to enhance capacity further. The capacity is as reported by DCs to Department of Fertilizers.

#### ii. Calorific value of fuel

In fertilizer sector, all the energy calculations are based on net calorific value (NCV) of fuel. NCV will also be furnished along with GCV.

#### iii. Total inputs at plant battery limit

In the existing Pro-forma, only the inputs, which are allocated for urea production, are furnished. Modified Pro-forma, provides for furnishing total inputs at plant battery limit in addition to the inputs allocated for urea product.

#### iv. Quantity of natural gas

Presently, natural gas is being received from a number of sources. Instead of giving quantity of natural gas received from different sources separately, total quantity shall be furnished at one place only. However break up of this quantity may be furnished for Feed and fuel along with respective NCV. Other fuels which are not in use in fertilizer sector have been removed.

#### 4. Annexure to Pro-forma

The Pro-forma being of generic nature does not contain information specific to fertilizer sector. Therefore, additional technical information is furnished through “Annexure to Pro-forma. Information furnished in Annexure to Pro-forma is as following:

- A. Installed capacity, production, CU, on-steam days for ammonia / urea for base 5 years.
- B. Installed capacity has been substituted with re-assessed capacity.
- C. Inputs to Ammonia Plant
  - NG/RLNG/LNG/PMT ( Feed, fuel) – Quantity, NCV
  - Naphtha ( Feed, fuel) – Quantity, NCV



- Steam / power - Quantity, conversion factor
- Credits / debits - DM Water heating, LP steam export etc.
- Ammonia production

#### D. Inputs to Urea Plant

- Ammonia consumption for urea
- Power/steam

- Credits/debits- DM Water heating, LP steam export etc.

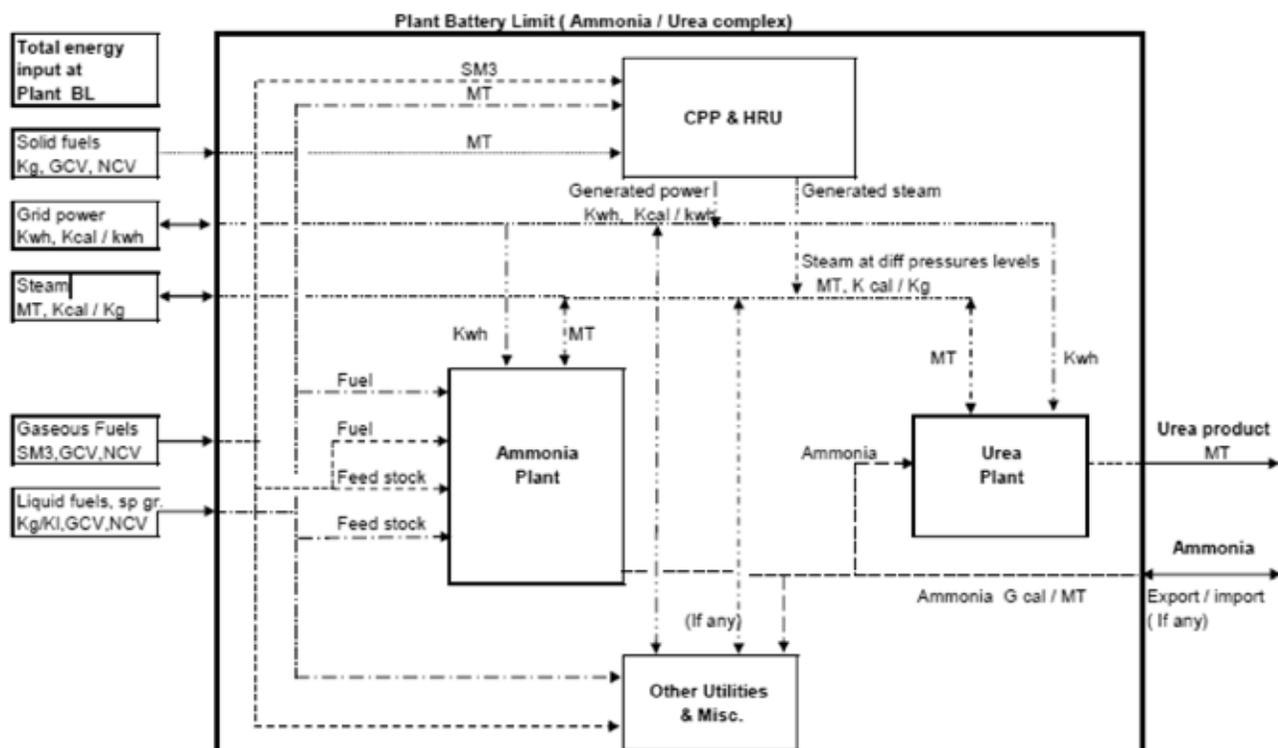
E. Conversion factor for power generated.

F. Heat value of steam generated.

G. Information available in log sheets, log books, data logger print outs and other plant documents need to be verified with appropriate references.

### 5. Plant battery limit block diagram

Block diagram showing total energy input at Plant BL as well as credit / debit of energy at intermediate stages for establishment of "Base Line SEC"  
To be filled-in by Designated Consumers (DC's)



### 6. Data not available in Pro-forma and Annexure - 1

- Fuel input to boilers
- Waste gases available from ammonia/ urea plants and fed to boilers.
- Quantity of steam produced.
- Other energy inputs like pre-heated DM water

- Calculations for conversion factors of steam/power.

a. Additional information in Block diagram

The illustrative block diagram in sections - 5 above, when, filled adequately, incorporates missing information.

i. It depicts all inputs at plant battery limit, which may be



- consumed for production of urea as well as other products.
- ii. It also depicts all inputs allocated for urea production.
- iii. Gives details on various imports/exports, debit/credit etc.
- iv. One set of sample calculations of gate-to-gate energy balance to be furnished by DC.
- v. Basis of calculations, conversion factors, assumptions, import/export, credit/debit etc; to be mentioned specifically.

### 7. Procedure for calculation of specific energy consumption (SEC)

In general specific energy consumption (SEC) is calculated by dividing total energy input at battery limit by final product. However, in case of ammonia / urea complex, part of the input energy is utilized for manufacturing ammonia wherein Carbon-di-oxide (CO<sub>2</sub>) is also produced as by-product. Ammonia and CO<sub>2</sub> are then reacted to produce urea. Part of the steam/power energy is consumed in urea plant. Further, full quantity of ammonia produced is not necessarily consumed for urea manufacture. Part of ammonia may go to storage or export. Similarly, part of steam / power may be either exported or imported. Therefore, in fertilizer sector, SEC of urea cannot be calculated directly by dividing total energy input by urea product. Following procedure is to be adopted for calculating SEC:-

- a. Allocation of fuel for production of ammonia, power/steam and other products/facilities (wherever applicable).
- b. Calculation of conversion factor for power generated (Kcal/Kwh) and its distribution.
- c. Conversion factor for purchased power (taken as 2860 Kcal/Kwh).
- d. Calculation of heat value of steam produced (Kcal/Kg) and its distribution.
- e. Calculation of SEC for ammonia by considering the following:-
  - i. Feed & fuel energy input to ammonia plant directly
  - ii. Allocation of steam/power to ammonia plant along with conversion factors.
  - iii. Credit/debit of energy at ammonia plant battery limit like pre-heating of DM water, burning 'Off gases' in boiler furnace etc.
- f. Calculation of SEC for urea by considering the following:-
  - i. Allocation of ammonia, separately as manufactured or purchased, for urea production.
  - ii. Allocation of steam/power to ammonia plant along with conversion factors.
  - iii. Credit/debit of energy by way of export of steam, burning vent gases etc.

Sr. No.	Description	Unit	Illustrative figures	Actual for 2014-15	Remarks
1.0	<b>Overall plant battery limit</b>				
1.1	<b>Inputs</b>				
1.1.1	Natural gas ( NG)				
a	Quantity	MMSCM			
b	NCV of NG	Kcal/SCM			
1.1.2	Naphtha				
a	Quantity	kl			



Sr. No.	Description	Unit	Illustrative figures	Actual for 2014-15	Remarks
b	NCV of naphtha	Kcal/lit Kcal/kg			
c	Density of naphtha	gm/cc			
1.1.3	Grid power	MWh			
1.1.4	Steam	MT			
1.1.5	Ammonia	MT			
1.2	Output				
	Urea	MT			
	Power export	kWh			
2.0	<b>CPP/HRU</b>				
2.1	<b>Input</b>				
2.1.1	Natural gas	MMSCM			
2.2	Output				
2.2.1	Power	MkWh			
	Heat rate	Kcal/kWh			
2.2.2	Steam	MT			
	Heat content	Kcal/kg			
3.0	<b>Ammonia Plant</b>				
3.1	<b>Input</b>				
3.1.1	NG feed	MMSCM			
3.1.2	NG fuel	MMSCM			
3.1.3	Naphtha feed	kl			
3.1.4	Naphtha fuel	kl			
3.1.5	Steam	MT			
3.1.6	Power	MkWh			
3.2	<b>Output</b>				
3.2.1	Ammonia product	MT			
4.0	<b>Urea Plant</b>				
4.1	<b>Input</b>				
4.1.1	Ammonia	MT			
4.1.2	Steam	MT			
4.1.3	Power	MkWh			
4.2	<b>Output</b>				
4.2.1	Urea product	MT			
5.0	<b>Service boiler / Utilities</b>				
5.1	<b>Input</b>				
5.1.1	NG Fuel	MMSCM			
5.1.2	Naphtha fuel	kl			



## 8. Gate to Gate specific energy consumption (SEC)

### i. Overall material & energy balance

An illustrative material & energy flow diagram of an ammonia/urea fertilizer complex is given below

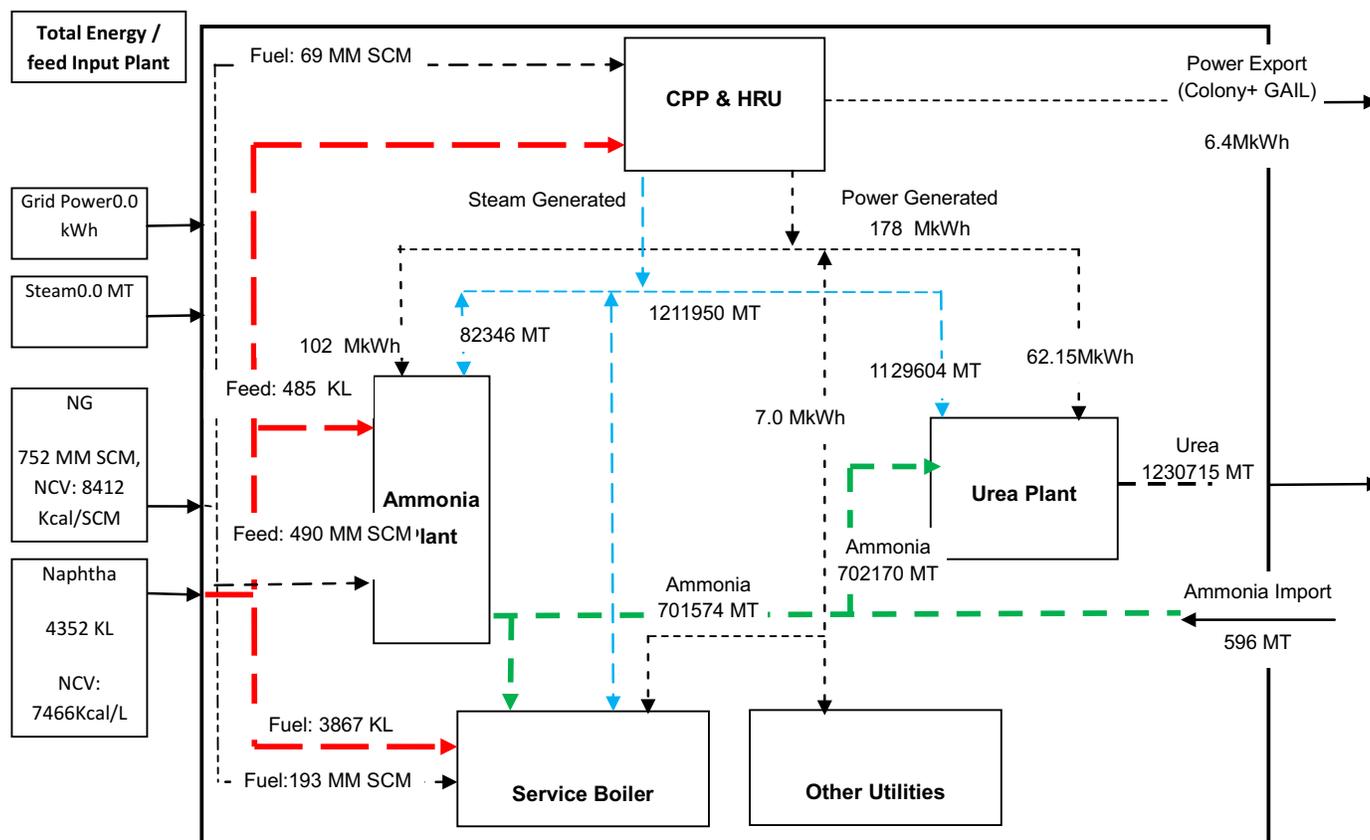


Figure 16: Overall Material and Energy balance. Figures mentioned above are indicative and used for representational purpose only . The actual data will vary from unit to unit .

## II. CALCULATION OF SPECIFIC ENERGY CONSUMPTION (SEC) OF AMMONIA

### (a) Material balance of Natural Gas

Description	Quantity (MM SCM)	NCV ( Kcal/SCM)	Heat content (Gcal) 2 x 3	Remarks
1	2	3	4	
Total input				
	752	8412	6325824	
Distribution				
CPP/HRU	69	8412	580428	
Reformer feed	490	8412	4121880	
Reformer fuel	193	8412	1623516	



(b) Material balance of Naphtha

Description	Quantity (KL)	NCV (Kcal/ L)	Heat content (Gcal) 2 x 3	Remarks
1	3	2	4	5
Total input				
	4352	7466	32492	
Distribution				
Reformer feed	485	7466	3621	
Service boiler	3867	7466	28871	

c) Energy balance in Ammonia Plant

Item	Unit	Quantity	NCV/ Heat value	Heat content Gcal	Specific energy consumption
Ammonia production	MT				
NG feed	MM SCM				
NG fuel	MM SCM				
Naphtha feed	MT				
Naphtha fuel	MT				
Steam	MT				
Power	MkWh				
Total feed energy	Gcal				
Total fuel energy	Gcal				
Power + steam	Gcal				
Total SEC	Gcal/MT				
Non plant energy	Gcal/MT				
SEC including non-plant energy	Gcal/MT				

(d) Energy balance in Urea Plant

Item	Unit	Quantity	NCV/ Heat value	Heat content Gcal	Specific energy consumption
Urea production	MT	1230715			
Ammonia feed	MT	701574	7.691	5395806	4.384
Steam	MT	1129604	743	839295	0.682
Power	MkWh	62150	511	31759	0.026
Total energy	Gcal			6266860	
Total SEC	Gcal/MT				5.092
Non plant energy	Gcal/MT				0.079
SEC including non plant energy	Gcal/MT				5.171



## 9. Computing Baseline data

Under first cycle of PAT scheme, the baseline period constitutes the years 2007-08, 08-09 and 2009-10. Urea product has been taken as basis for calculating Specific energy consumption “SEC”.

### a. Production

Baseline production of urea is obtained by averaging urea production for three baseline years i.e. 2007-08, 08-09, 09-10. Production during target year (2014-15) is reported in the following table.

Sr. No.	Description	Unit	Baseline data				Assessment year
			2007-08	2008-09	2009-10	Average	2014-15
1.0	Urea product						
1.1	Installed capacity	MT				n.a.	
1.2	Actual production	MT					
1.3	Capacity Utilization	%				n.a.	

### b. Specific energy consumption (SEC)

Baseline specific energy consumption (SEC) of urea is obtained by weighted average

for three baseline years i.e. 2007-08, 08-09, 09-10. Specific energy consumption (SEC) during target year (2014-15) is reported in the following table.

Sr. No.	Description	Unit	Baseline data				Assessment year
			2007-08	2008-09	2009-10	Total	2014-15
1.0	Urea production	Tonnes				n.a.	
1.1	SEC	Gcal/ MT				n.a.	
1.2	Total energy	Gcal					
1.3	Weighted average	Gcal/MT	n.a	n.a	n.a		

## 10. Normalization factors

PAT procedure provides for “Normalization” of reported data based on capacity utilization factor, when plant load factor (PLF) has a deviation of more than 30%. The PAT procedure also provides for normalization by statistical analysis methods. In fertilizer sector, apart from capacity utilization, there are some other important factors viz. number of forced shut down of the plant, use of naphtha due to unavailability of natural gas, quality of coal and commissioning period after major revamp of the plant, which also affect specific energy consumption of product. Identified causes of un-productive energy consumption on account of factors, which are beyond the control of the plant are as follows:

- (i) Forced shut down of the plant and subsequent Cold start up
- (ii) List of critical equipment, which on failure, cause forced shut down.
- (iii) Plant operation at low load
- (iv) Reduction of ammonia synthesis and CO shift catalyst
- (vi) Use of naphtha due to non-availability of gas
- (vi) Deterioration in quality of coal

For calculating the unproductive energy consumption against individual factor, formats were developed showing illustrative calculations.



**a. Low capacity utilization**

In addition to the reasons for lower capacity as given in PAT document, lower capacity utilization due to following reasons has also been considered for normalization (i) shortage of raw material including feed, fuel, water, electricity etc. (ii) high cost of inputs leading to unviable urea production beyond certain capacity (iii) major equipment failure (iv) force majeure.

Factors like shortage of raw materials (mainly the gas), decline in market demand, change in Govt. policy etc. are beyond the control of DCs. These factors may force the plant to be operated at lower capacity, thus causing adverse effect on energy consumption. In such cases, normalization shall be allowed as follows.

**i. Pre-requisites for Normalization**

1. A DC shall furnish detailed and convincing reasons with supporting documents for reduction in capacity utilization, due to factors, beyond their control.
2. Following criteria shall be adopted:-
  - a) No compensation shall be allowed if the capacity utilization of urea plant on annual basis is 95% or above.
  - b) Compensation shall be allowed for capacity utilization between 70-95%.
  - c) Below 70%, the data shall be discarded.
3. The claim will be based on Technical operating data (TOP), which is being reported to Fertilizer Industry Coordination Committee (FICC) of Department of Fertilizers, Govt. of India.
4. Normalization due to low capacity

utilization will be considered only in one of the plants i.e. either ammonia or urea.

5. Subsequent to the baseline year i.e. 2007-10, some DCs have carried out major revamp of their plant for capacity enhancement in line with New Investment Policy for urea notified by the Govt. in 2008. Govt. recognized enhanced capacity, while reimbursing cost of production under the pricing policy. The enhanced capacity shall be considered, while calculating capacity utilization for normalization, subject to confirmation from DoF, Government of India and also verification certificate issued by an Accredited Energy Auditor to DC which seek to declare their enhanced installed capacities, production and energy use. Cost of this audit will be borne by the DC. Check tests of such verification could be carried out by BEE, if needed.
  6. Some plants are having ammonia plant capacity higher than the quantity of ammonia required for urea production and thus, diverting surplus ammonia for production of other products or direct sales. In such cases, due to Govt. policy and/or market conditions, consumption of surplus ammonia for production of other products becomes unviable and under these circumstances, ammonia plant is operated at lower capacity, thus resulting in higher energy consumption per MT of ammonia, which also get transferred to urea, even if the urea plant is operated at full load; Normalization shall be allowed.
  7. In case of ammonia / urea complex having ammonia capacity matching with urea production, capacity utilization of urea plant shall be considered.
- ii. Calculation of normalization factor**
1. Based on the operating data collected from plants at 100%, 85% and 70% plant load, average normalization



factor works out to be 0.02 Gcal per MT of urea per percentage reduction in plant load below 95% up to 70%.

2. Impact of Lower Capacity utilization shall be worked out as follows:-

- a. Maximum permissible value (Gcal/ MT urea) = (95 - % Capacity utilization) \* 0.02.
- b. Actual unproductive energy (Gcal/ MT urea) = Annual Energy, Gcal/MT of Urea - Weighted Average of Monthly Energy Consumptions for the months with Capacity Utilization of 100% or more
- c. Lowest of the either (a) or (c) shall be considered for allowing the impact of lower capacity utilization.

3. Impact of Lower Capacity utilization of plants where ammonia is surplus than required for urea production, shall be worked out as follows:

- a. Maximum permissible value ( Gcal/ MT ammonia) = (95 - % Capacity utilization of ammonia plant) \* 0.02 Gcal.
  - b. Actual unproductive energy (Gcal/ MT urea) = Annual Energy, Gcal/ MT of ammonia - Weighted Average of Monthly Energy Consumptions for the months with ammonia plant Capacity Utilization of 100% or more
  - c. Lowest of the above two shall be considered for allowing the impact of lower capacity utilization. In such cases, normalization due to low capacity utilization (i.e. <95%) will be allowed only in one of the plants i.e. either ammonia or urea.
4. Capacity utilization for urea plant will be calculated based on "Baseline urea Production".
- iii. Supporting data / documentation Data shall be maintained in the following formats:-

#### A. Month-wise production & energy consumption during the year

Sr. No.	Month	Ammonia				Urea			
		On stream	production	CU	SEC	On stream	production	CU	SEC
		days	MT	%	Gcal/MT	days	MT	%	Gcal/MT
1	April								
2	May								
3	June								
4	July								
5	August								
6	September								
7	October								
8	November								
9	December								
10	January								
11	February								
12	March								



B. Data for best operating months

Sr. No.	Best operating month	Ammonia production	CU	Urea production	CU	SEC Ammonia	SEC Urea	Reference
		MT	%	MT	%	Gcal/ MT	Gcal/ MT	

- (i) Take the month in which , plants have run for all the calendar days.
- (ii) Capacity utilization during the month should be equal to or above 100%.

**b. Cold startup of the plant after forced shut down**

In case of sudden failure of a critical equipment as per the list below, or external factors (as notified), ammonia plant undergoes a forced shut down. Restarting the plant from cold conditions (Cold start up) , consumes unproductive energy and shall be normalized.

**i. Pre-requisites for Normalization**

A. The list of critical equipment failure of which leads to complete shutdown of plant and consequent cold start up, allowed under this normalization factor is given below :-

1. Primary Reformer
2. Secondary Reformer
3. Heat Exchange Reformer
4. Reformed Gas Boiler
5. Carbon dioxide absorber and stripper
6. Air, Refrigeration and synthesis compressors
7. Synthesis converters
8. Synthesis Gas Waste Heat Boilers
9. High pressure urea reactor, stripper and carbamate condenser
10. Carbon dioxide compressor

11. Utility boiler furnace
12. Gas turbine/HRSG
13. Cooling Tower
14. Major Fire leading to complete shutdown of plant and cold startup
15. Turbo generator along with GTG
16. Purifier
17. CO Shift Converter

B. The Designated Consumer (DC) shall furnished a detailed report on failure of such equipment and its impact on energy consumption.

C. The Designated Consumer shall declare with back up documentation, what portion of such unproductive consumption during the month is due to cold shutdown and startup activity.

D. This actual energy loss due to shut down and cold startup in Gcal/MT of Urea shall be compensated, subject to maximum of 0.03 Gcal/MT of Urea.

**ii. Calculation of normalization factor**

A. Energy loss during the month(s) for which additional cold startup is being claimed shall be calculated as follows:-

- (i) (Monthly Energy per MT of Ammonia during the month-Weighted Average Monthly Energy Consumption for the months with 100% on-stream days) X Monthly Ammonia production for the month of Startup.



- (ii) This Energy Loss shall be divided by Annual Urea Production to identify total unproductive loss in a month.
- (iii) The Designated Consumer shall declare what portion of such unproductive consumption during the month is due to cold shutdown and startup activity.
- (iv) This actual energy loss due to shut down and cold startup in Gcal/ MT of Urea shall be compensated, subject to maximum of 0.03 Gcal/ MT of Urea.
- (v) The failure of critical equipment leading to complete shutdown of plant and consequent cold start up, allowed under this normalization factor is given at Annexure -

### iii. Documentation

Sr. No.	Description	Unit	2007-08	2008-09	2009-10	2014-15
1	Ammonia production	MT				
2	Urea production	MT				
3	Total no of cold start up	Nos				
4	Cold start up due to failure of major equipment	Nos				
5	For each start up					
a	Duration	hours				
b	Energy consumed	Gcal				

Note: For each shut down / cold start up, information to be filled-in separately.

#### c. Use of naphtha

A. Using part naphtha involves additional energy consumption as follows:-

- a) For each startup of facilities to use naphtha as feed including pre-reformer
- b) For the period of use of naphtha as feed
- c) For the period of use of naphtha as fuel

B. DCs shall furnish detailed and convincing reasons with supporting documents for use of naphtha due to non-availability of gas on account of factors, beyond their control.

#### i. Pre-requisites for Normalization

A. As per directives from Department of Fertilizers, Govt. of India, use of naphtha is to be discontinued in phased manner. As such, use of naphtha is not foreseen. However, provision is being made, in case naphtha has to be used due to shortage of natural gas in future, with permission from DoF.

B. In case of use of naphtha, DC will furnish details regarding non-availability of gas, leading to use of naphtha.

#### ii. Calculation of normalization factor

A. Following formula shall be used

$$\text{Energy loss (Gcal/MT Urea)} = (185 * S + 0.625 * N_{\text{feed}} + 0.443 * N_{\text{fuel}}) / \text{urea production in MT}$$



- S= 1 if naphtha is used as feed in startup  
 S= 0 if naphtha is not used as feed in startup  
 $N_{Feedc}$  = quantity of naphtha used as feed in MT.  
 $N_{Fuelc}$  = quantity of naphtha/LSHS/FO used as fuel in MT.

### iii. Documentation

Sr. No.	Description	Unit	2007-08	2008-09	2009-10	2014-15
1	Ammonia production	MT				
2	Urea production	MT				
3	NG consumption	MMSCMD				
4	Shortfall in NG	MMSCMD				
5	Equivalent naphtha	kl				
6	Actual naphtha used	kl				

#### d. Catalyst reduction

Fresh catalyst is in oxidized form and needs to be reduced with synthesis gas, wherein hydrogen reacts with oxygen and gets converted into water. Whole plant is operated at 60-80% load for around 48 to 120 hours, depending upon type and quantity of catalyst. Thus, replacement / reduction of **ammonia synthesis and CO shift catalysts** consumes large amount of unproductive energy. Therefore, normalization due to replacement / reduction of these catalysts will be allowed.

#### i. Pre-requisites for Normalization

A. In case of ammonia synthesis catalyst, in the older plants, oxidized form of the catalyst is used which takes around 4-5 days for reduction, causing corresponding un-productive energy consumption. Presently, "Pre-reduced catalyst" is also available, which is expensive but takes around 48 hours for reduction, thus consuming lesser un-productive energy. This aspect will be taken care, while calculating normalization factor.

B. This will be considered subject to certification by DCs and furnishing to BEE information as follows:

- (i) Year in which the catalyst were last changed along with copies of purchase order, last placed with the vendor, time taken in commissioning of catalyst, facts and figures clearly indicating and quantifying rise in the energy consumption of plant due to the replacement of this catalyst.
- (ii) Copies of purchase orders placed by units with the vendors for supply of fresh catalysts.

#### ii. Calculation of normalization factor

Adjustment shall be allowed on the basis of actual plant data, subject to a maximum of 0.04 Gcal/MT of Urea.

#### e. Deterioration in quality of coal

The quality of indigenous coal has been deteriorating gradually, thus affecting boiler efficiency adversely. The reduction in boiler efficiency due to poor quality of coal shall be compensated.

#### i. Pre-Requisites for Normalization



Weighted average of three years data shall be worked out. In case there is significant variation, then normalization factor shall be applied based on the actual impact due to the variation.

**ii. Calculation of normalization factor**

A. Quality of coal affects boiler efficiency, which shall be calculated by following empirical formula:-

$$\text{Boiler Efficiency} = 92.5 - ((50 \times A + 630(M + 9H)) / \text{GCV})$$

Where

**iii. Documentation**

**A. Coal consumption and analysis**

Sr. No.	Parameters	Unit	2007-08	2008-09	2009-10	2014-15
1	Quantity of coal used	MT				
2	GCV (Weighted average)	Kcal/kg				
3	NCV (Weighted average)	Kcal/kg				
4	<b>Proximate analysis</b>					
A	Fixed carbon	%				
B	Volatile matter	%				
C	Moisture	%				
D	Ash	%				
5	<b>Ultimate analysis</b>					
A	Carbon	%				
B	Hydrogen	%				
C	Sulphur	%				
D	Nitrogen	%				
E	Oxygen	%				

**f. Additional provisions**

i. Normalization factors to be applied during assessment year, shall also be applied on baseline data for 2007-10.

B. Provision of normalization factors is intended solely to save plants from penalties for non-achieving the saving targets, for reasons which are beyond the control of DCs. However, availing of any of the normalization factors shall render the DC ineligible for issuance of E-certificates

A = Ash content of coal (%)

M = Moisture (%)

H = Hydrogen (%)

GCV = Kcal/Kg

B. Boiler efficiency shall be converted into specific energy consumption, as follows:

Additional Energy Consumption, Gcal/MT of Urea = Energy of Coal per MT of Urea in Target Year, Gcal/MT of Urea \* (Boiler Efficiency in Base Year - Boiler Efficiency in Target Year)/Boiler Efficiency in Target Year.

under PAT scheme. Therefore DC should seek normalization only when specified energy saving target is not met due to reasons beyond control of DCs.

C. DC's claim will be examined based on Technical operating data (TOP), which is being reported to Fertilizer Industry Coordination Committee ( FICC) of Department of Fertilizers, Govt. of India as well as by auditors designated by Bureau of Energy Efficiency ( BEE).



## 7.5. Annexure V: Aluminium

1. The energy required to transport mined bauxite to refining operations within the plant boundary, alumina to smelting operations, ingots to metal processors, and scrap from collection to melting is accounted as inside transportation and considered as energy used in plant.
  2. Plant stoppages and start due to external factor: Necessary documents have to be provided by DC
  3. Proper documents on Bauxite Quality for the purpose of normalization have to be maintained and submitted to EmAEA.
  4. Refinery Mass Balance (Bauxite to alumina ratio): The DC has to provide necessary calculation document to EmAEA during M&V for verification of alumina product ratio.
  5. Smelter Mass Balance (Alumina to Molten Aluminium ratio): The DC has to provide necessary calculation document to EmAEA during M & V for verification of Molten Aluminium product ratio
  6. In Smelter Plant EmAEA has to verify BusBar Voltage drop and Anode-Cathode Distance in reduction cell.
  7. DC needs to submit HMBD of Turbine system or characteristics curve between Load and Turbine Heat Rate PLF normalization. Equivalent capacity HMBD or characteristics curve shall be used, if OEM data is not available with the DC
  8. In case of addition of new Potline, a DC shall submit all relevant design data of new Pot line to EmAEA for inclusion in the verification report
  9. The baseline SEC factor used for product equivalent will be used for assessment year product equivalent. The major product of the baseline period will be considered in the assessment year. In case if any new product is introduced in the assessment year the SEC factor of assessment year will be used for converting to equivalent major product for the assessment period.
  10. For Import or Export of Carbon Anode, DC shall be required to fill the Pro-forma the type of anode (i.e., Green Anode, Baked Anode or Rodded Anode) exported or imported in the Remarks Column. The SEC shall be for the type of Carbon Anode i.e., SEC up to the type of Carbon Anode produced. Generally for importing or exporting anodes, the energy shall be booked till the energy of baked anodes
1. Refinery
  11. Review of Section wise Specific Energy Consumption

**Table 22: Section wise Energy Consumption details**

S. No	Section	Thermal energy Consumption	Electrical Energy Consumption	kWh/tonne of Alumina	kWh/tonne of Aluminium	Remarks
1	Grinding					
2	Digestion					
3	Clarification					
4	Precipitation					
5	Calcination					



12. Plant Boundary

Demarcation of plant boundary is required with clear understanding of raw material input, energy input, power import/export, Intermediary product import/

export, Colony power, Construction power, power supplied to other ancillary unit outside of the plant boundary. Typical plant boundary conditions are produced below.

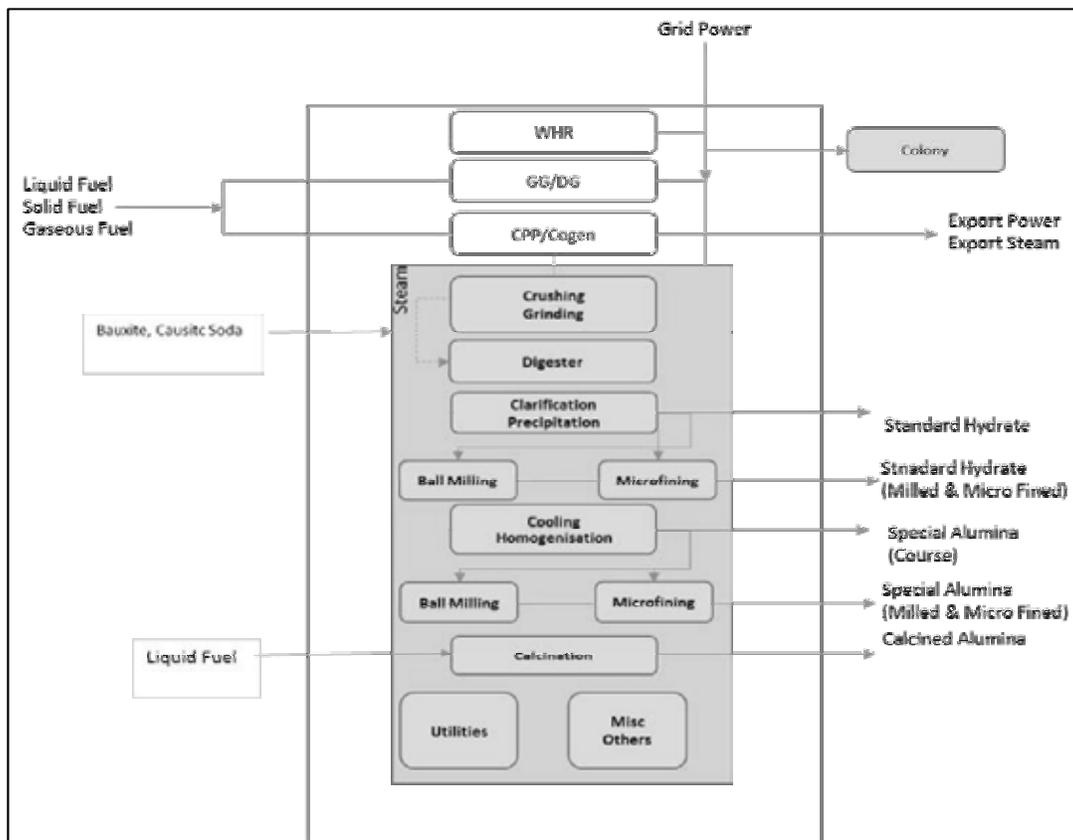


Figure 17: Ex- GtG boundary for Aluminium (Refinery sub sector)

**B. Smelter**

- 13. Carbon Anode to Molten Aluminium ratio: The DC has to provide necessary document to EmAEA during M & V. Approximately 0.45 kilograms of carbon anode were needed to produce one kilogram of aluminum
- 14. The smelter Energy consumption shall be taken up to Molten Alumina in the pro-

forma

- 15. The additional cast house product shall be converted into one product and inserted in the Product "other" details in pro-forma
- 16. The energy used in smelter for imported scrap/ cold metal for production of finished products shall be considered for product equivalent hot metal SEC calculation

**Table 23: Section wise Energy Consumption details**

S.No	Section	Thermal Energy Consumption	Electrical Energy Consumption	kWh/tonne of Anode	kWh/tonne of Aluminium	Remarks
1	Pitch					
2	Coke					
3	Baking					



**17. Electrolytic reduction energy consumption:**

**Table 24: Voltage Distribution**

S.No	Reduction Cell (Section wise)	Voltage Distribution
1	External	
2	Anode	
3	Polarization	
4	Bath	
5	Reaction	
6	Cathode	
7	Other	

**18. Plant Boundary**

Demarcation of plant boundary is required with clear understanding of raw material input, energy input, power import/export, Intermediary product import/

export, Colony power, Construction power, power supplied to other ancillary unit outside of the plant boundary. Typical plant boundary conditions are produced below

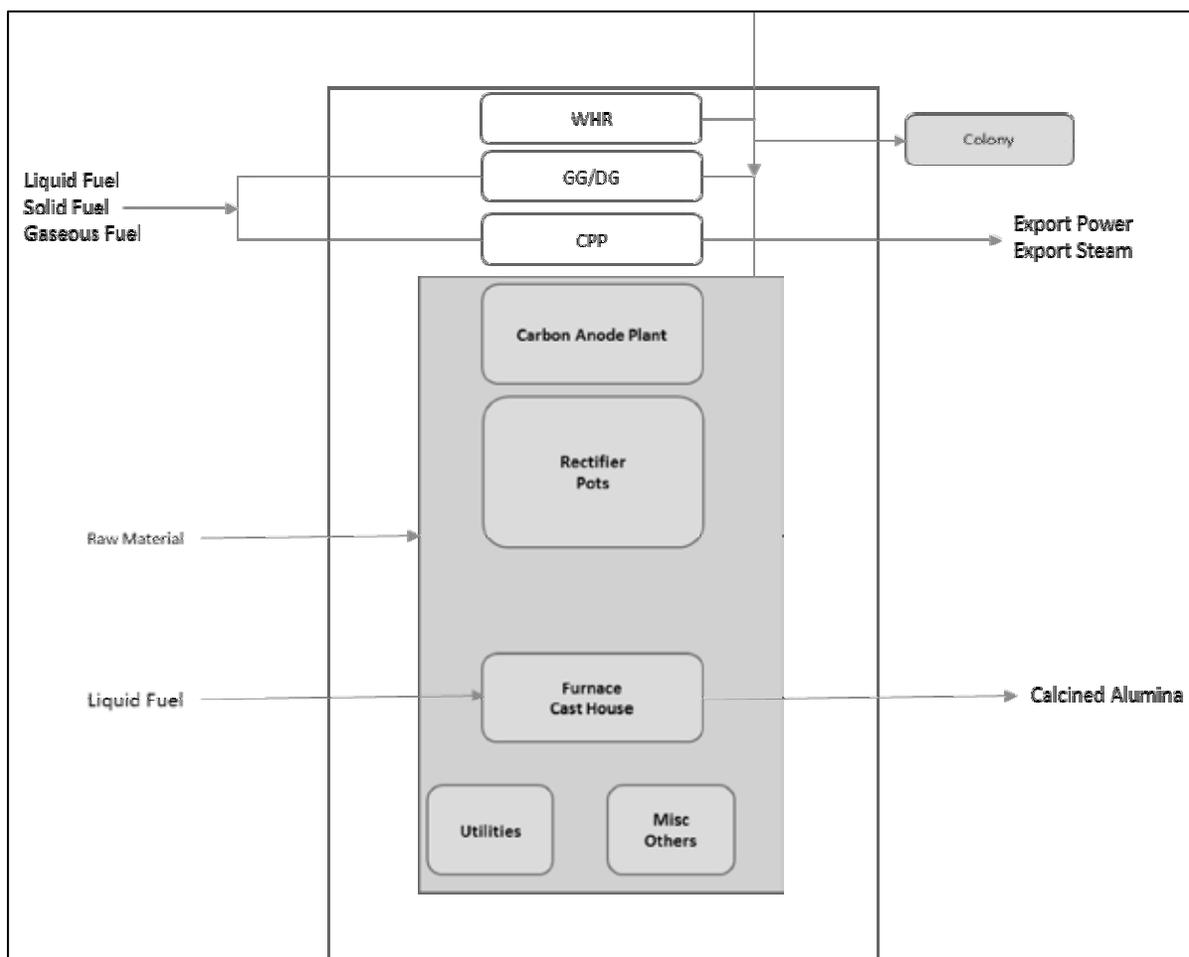


Figure 18: Ex- GtG boundary for Aluminium (Smelter sub sector)



### C. Cold Sheet

19. Necessary documents as per the instruction in Form 1 need to be provided by DC to EmAEA for verification of section wise energy consumption and Specific Energy Consumption.
20. Product equivalent of other cold rolled products shall be calculated offline to to single cold rolled product through conversion from SEC of different cold rolled product.

### 21. Plant Boundary

Demarcation of plant boundary is required with clear understanding of raw material input, energy input, power import/export, Intermediary product import/export, Colony power, Construction power, power supplied to other ancillary unit outside of the plant boundary. Typical plant boundary conditions are produced below

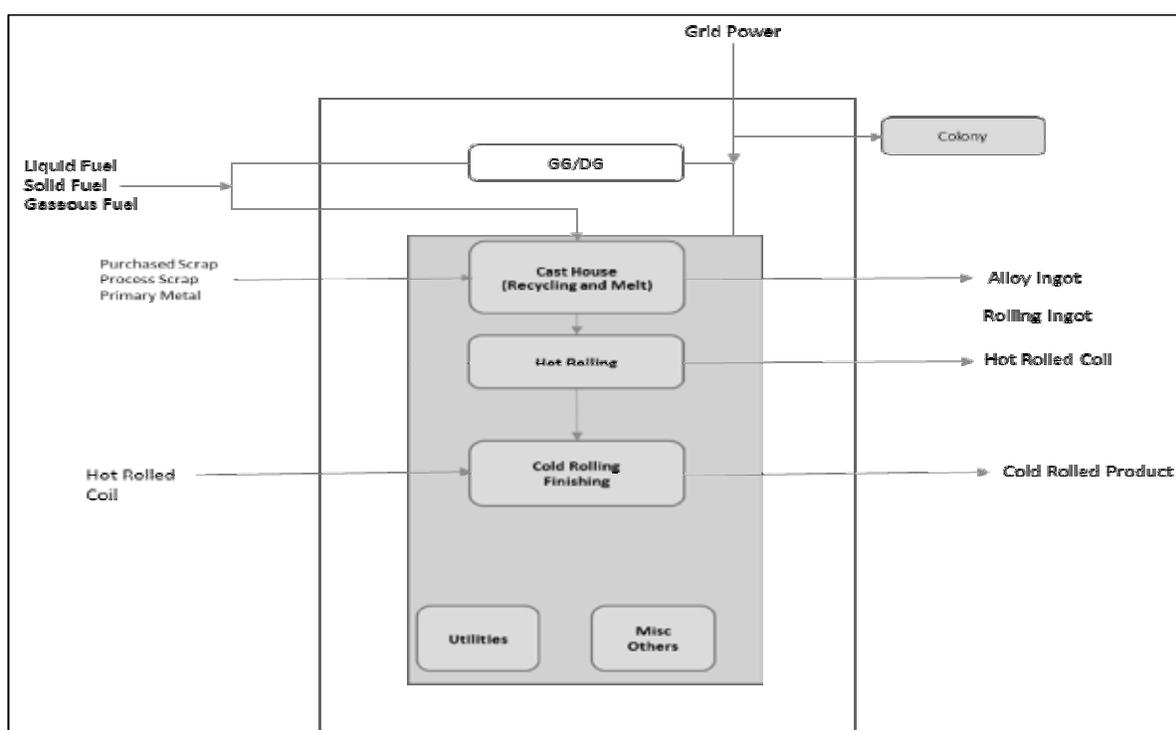


Figure 19: Ex- GtG boundary for Aluminium (Cold Sheet sub sector)

### 7.6. Annexure VI: Pulp & Paper

1. The boundary can be drawn virtually by including CPP or Cogen in the boundary limit of DCs, if nos DCs exist in a same boundary limit.
2. The captive power plant (CPP) or cogen will be taken into the virtual boundary of each DCs and accordingly import and export of power and steam will be treated as per Pro-forma data entry system.
3. If a captive power plant or cogeneration

plant caters to two or more DCs for the electricity and/or steam requirements. In such scenario, each DC shall consider such captive power plant or cogeneration plant in its boundary and energy consumed by such captive power plant or cogeneration plant shall be included in the total energy consumption. However, electricity in terms of calorific value (as per actual heat rate) and steam in terms of calorific value (as per steam enthalpy) exported to other plants shall be subtracted from the total energy consumption.



4. It is to be noted that the same fuel input needs to be considered in case CPP is being taken into the boundary limit. By import and export of energy, the energy consumption from the CPP is automatically left out for the particular DC for SEC calculation.
  5. Mill wise verification data are required to be included in the verification report
- a. The information required is shown in the flow chart for wood based pulp and paper mill
  - b. List of documents required for monitoring and verification
- in M&V format by mentioning the source and document from where data is collected. Subsequently the data may be verified from the, data provided by the DC in sector specific Pro-forma for normalization.

#### A. Wood Based Mills:-

- a. The auditors may collect details required

**Table 25: General details required in wood based Pulp and Paper Mills**

##### A.1 Raw Material Details

Type of Wood:-

Sr No	Name of the raw material	Moisture, %	Quantity, tonne/annum	Source/ document
1				
2				
3				
4				
5				

##### A.2 Wood Pulp Mill (Including Raw material, Chipper , Digester , WSC, ODL , Bleach Plant, Recovery , WTP, and ETP)

###### i) Pulping Processes Used

Sr No	Type of pulping	Capacity tonne/annum	Production tonne/annum	Total Yield (Including screening losses)	Source / Document
1	Chemical				
2	Semi Chemical				
3	Chemi Thermo Mechanical				
4	Other				

###### ii) Extended Delignification (ODL)

Sr No	Item	Unit	Value	Source / Document
1	Capacity	tonne/ annum		
2	Date of Installation of ODL Plant	Date		



iii) Bleaching

Sr No	Item	Chemical Pulp	Semi Chemical	Chemical Thermo Mechanical Pulp
1	Type of Bleaching	ECF/conv.	ECF/conv.	ECF/conv.
2	Sequence Used			
3	Bleaching Losses %			
4	Bleached Pulp Yield %			
5	Brightness of pulp, %			

Sr No	Item	Unit	Value	Source / Document
1	Capacity	Tonne/ annum		
2	Date of Installation of ECL Plant	Date		

iv) Energy Consumption in Pulp Mill

Sr No	Item	Qty	Source/ Document
1	Steam Consumption, LP/a		
2	Steam Consumption, MP/a		
3	Power Consumption, kWh/a		

v) Pulp Dryer

Sr No	Item	Unit	Qty	Source / Document
1	Capacity	Tonne/annum		
2	Production of salable pulp, t/a	Tonne/annum		
3	Energy Consumption in pulp dryer	kcal		
4	LP Steam Consumption	Tonne/annum		
5	MP Steam Consumption	Tonne/annum		
6	Power Consumption	kWh/annum		

vi) Chemical Recovery

Sr No	Item	Unit	Data	Source / Document
1	Type of chemical recovery	Conventional/Non-Conventional		
2	Total Black liquor Solids generated	Tonnes		
3	In Lime Kiln Installed	Yes/No		
4	Date of Installation of Lime Kiln I	Date		
5	Date of Installation of Lime Kiln II	Date		
6	Date of Installation of Lime Kiln III	Date		



vii) Over-all Energy consumption in pulp mill

Sr No	Item	Qty	Source / Document
1	LP Steam consumption, t/a		
2	MP Steam consumption, t/a		
3	Power consumption, kWh/a		

**A.3 Paper Machine (including stock preparation, chemical preparation / addition plant, finishing house)**

(i) Paper Machine Details

Number of Paper Machines

Item	PM-1	PM-2	PM-3	PM-4	PM-5	Source/ document
Type of paper machine						
Capacity,t/a						
Type of paper produced						
Production, t/a						
Annual weight average GSM						
<b>Energy Consumption in paper machine (including Stock Preparation, chemical addition and finishing house)</b>						
LP Steam consumption t/a						
MP Steam consumption, t/a						
Power consumption, kWh/a						

(ii) Coating / Value addition

Coating If any

Yes / No

Type of coating

online / offline

Item	Qty	Source/ document
Capacity of offline coating plant, t/a		
Production of coated paper/board, t/a		
LP Steam consumption,t/a		
MP Steam consumption, t/a		
Power consumption, kWh/a		



(iii) Over-all Energy consumption in paper machine, stock preparation, chemical preparation and addition plant, finishing house and offline coating plant add (i+ii)

	Qty	Source/ document
LP Steam consumption,t/a		
MP Steam consumption, t/a		
Power consumption, kWh/a		

**A.3 The Information required is shown in the Flow Chart for Wood Based Pulp and Paper Mill**

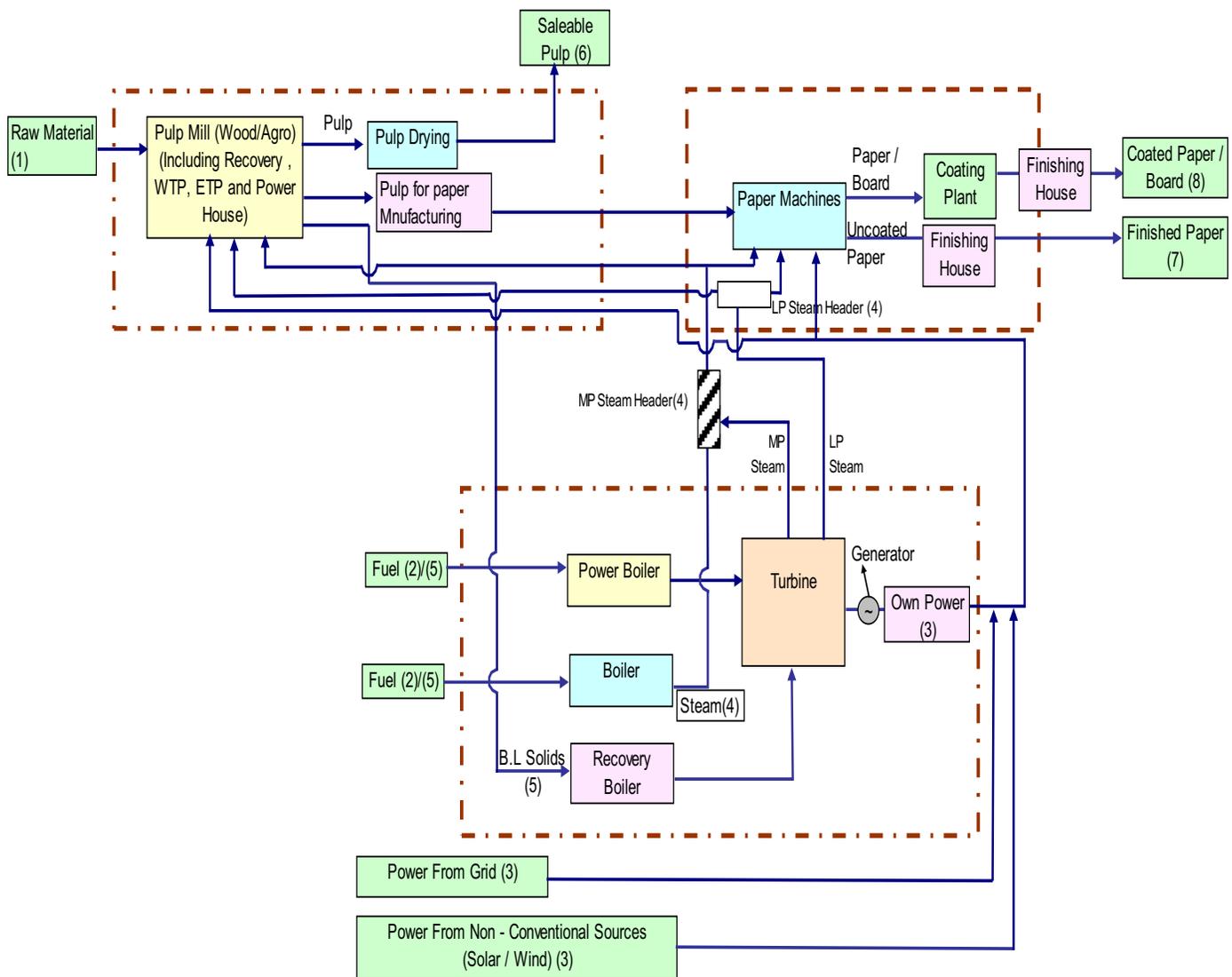


Figure 20: Ex- GtG boundary and metering details for Wood based Pulp and Paper Mill



**Table 26: Documents required wood based Pulp and Paper Mills**

S.No.	Details of input and output	Source / Type of document required	Details of the Source / document and frequency
1	Raw Materials	Lab Report	Report on moisture(%), Ash (%) and other analysis of the raw materials used by the mill  Frequency: Daily/ weekly/ monthly/ annual lab reports may be produced for different types of raw materials used by the mills.
		Purchase Document From Purchase Department	Purchase documents providing details of raw material purchased by the mill  Frequency: Daily/ weekly/ monthly/ annual purchase documents may be produced for purchase of different types of raw materials used by the mills
		Raw Material Consumption Reports	Consumption reports giving details of raw material consumed by the mill. The report may be for raw material chip production, digester loading etc. from the concerned department.  Frequency: Daily/ weekly/ monthly/ annual consumption documents may be produced for different types of raw materials used by the mill in chipper / digesters house..
		Annual Report	Annual report showing details of raw materials consumed on annual basis by the mill.  Frequency: Annual consumption of raw materials by the mill.
2	Purchased Fuels	Fuel Purchase report/ documents	Purchase documents providing details of fuel purchased by the mill.  Frequency: Daily/ weekly/ monthly/ annual purchase documents may be produced for purchase of different types of fuels used by the mills.
		Lab report for moisture and Ash GCV	Lab report on GCV, moisture(%), Ash (%) and other analysis (proximate and ultimate) density etc, of the fuel used by mill.  Frequency: Daily/ weekly/ monthly/ annual lab reports may be produced for different types of fuels used by the mills.
		Fuel Consumption Report	Consumption reports giving details of fuel consumed by the mill in boilers, DG sets etc. The consumption report may be from the concerned department showing details of fuel consumption.  Frequency: Daily/ weekly/ monthly/ annual fuel consumption documents may be produced for different types of fuels used by the mill in boiler/DG sets etc.
		Annual Report	Annual report showing details of fuels consumed on annual basis by the mill.  Frequency: Annual consumption of fuels by the mill.



S.No.	Details of input and output	Source / Type of document required	Details of the Source / document and frequency
3	Power	Electricity Purchased from Grid	Purchased electricity bill from state electricity board providing details of the electricity purchased by the mill. Frequency: monthly/ annual purchased electricity bills may be produced by the mills.
		Own power generation	Details of own power generation from different sources such as turbines(gas, steam etc), DG sets. Frequency: Daily/ weekly/ monthly/ annual own generation reports may be produced by the mills. These reports may be the log sheets/ production reports from power house.
		Production of power from Non Conventional sources, e.g. Solar / wind power	Details of power generation from different Non-conventional sources such as Solar / wind turbines, bio gas etc. Frequency: Daily/ weekly/ monthly/ annual Power generation reports may be produced by the mills. These reports may be the log sheets/ production reports from concerned power houses / departments
		Annual Report	Annual report showing details of Power purchased from grid, own power generation, power from non-conventional sources etc. Frequency: Annual report of power purchased , own generation, generation from non- conventional sources etc.by the mill.
4	Steam	Steam generation by the mill	Details of Steam generation from different boilers, extraction of steam from turbines, steam generation from waste heat recovery and non-conventional sources(Solar steam generators) Frequency: Daily/ weekly/ monthly/ annual steam generation reports may be produced by the mills. These reports may be the log sheets/ production reports for steam generation from boiler house etc.
		Steam consumption by the mill	Details of Steam consumption in different sections of the mill such as pulp mill, chemical recovery, paper machine, power house and other plants of the mill. Frequency: Daily/ weekly/ monthly/ annual steam consumption reports may be produced by the mills. These reports may be the log sheets/ consumption reports for steam consumption by individual section of the mill or power boiler house.
		Annual Reports	Annual report showing details of Steam Generation and consumption from various sources. The generation and consumption of steam may be in individual departments as well as for the whole mill, boilers, extraction steam, steam from non-conventional sources etc. Frequency: Annual report of steam generation and consumption by the mill.



S.No.	Details of input and output	Source / Type of document required	Details of the Source / document and frequency
5	Internally Generated Fuels (Black liquor solids, pith, chipper dust)	Generation report of Black liquor, pith, chipper dust, etc	<p>Details of generation of black liquor , pith , chipper dust or any other combustible waste by the mill from different sections such as chipper house, pulp mill, other plants.</p> <p>Frequency: Daily/ weekly/ monthly/ annual Black liquor, dust etc generation reports may be produced by the mills. These reports may be the log sheets/ production reports for Black liquor and pith generation from boiler house etc.</p>
		Lab reports for GCV, solids, moisture, ash etc.	<p>Lab report on GCV, solids (%) moisture(%), Ash (%) and other analysis (proximate) of the Black liquor, pith, dust etc. used by the mill.</p> <p>Frequency: Daily/ weekly/ monthly/ annual lab reports may be produced for different types of Black liquor, pith, dust etc. used by the mill.</p>
		Annual Report	<p>Annual report showing details of Black liquor generation, dust and pith generation, from various sources such as pulp mill, chippers, etc.</p> <p>Frequency: Annual report of Black liquor, pith and dust generation by the mill.</p>
6	Saleable Pulp	Opening and closing stock of saleable pulp	<p>Documents providing details of opening and closing of saleable pulp records by the mill.</p> <p>Frequency: Daily/ weekly/ monthly/ annual opening and closing records of the saleable pulp stock may be produced for different types of pulps produced by the mill.</p>
		Saleable pulp production	<p>Documents providing details of production of saleable pulp from different raw materials by the mill.</p> <p>Frequency: Daily/ weekly/ monthly/ annual production records/ documents providing details of saleable pulp from different types of raw materials produced by the mill.</p>
		Annual Report	<p>Annual report showing details of saleable pulp production from different raw materials and its consumption etc. Also the annual stock closing and opening of the saleable pulp from annual report may be produced</p> <p>Frequency: Annual report of saleable pulp production, consumption and stock (opening/ closing) by the mill.</p>
7	Uncoated paper/ board, Newsprint, Specialty grade	Opening and closing stock reports	<p>Documents/ records providing details of opening and closing of Uncoated paper / board, Newsprint, Specialty grade paper products by the mill.</p> <p>Frequency: Daily/ weekly/ monthly/ annual opening and closing records of Uncoated paper / board, Newsprint, Specialty grade paper products, produced by the mill.</p>



S.No.	Details of input and output	Source / Type of document required	Details of the Source / document and frequency
		Paper production report / documents	Documents providing details of production of Uncoated paper/board, Newsprint, Specialty grade paper products, produced by the mill  Frequency: Daily/weekly/ monthly/ annual production records/documents providing details of Uncoated paper/board, Newsprint, Specialty grade paper products, produced by the mill.
		Annual Report	Annual report showing details of Uncoated paper / board, Newsprint, Specialty grade paper products, produced by the mill.  Also the annual stock closing and opening of the Uncoated paper / board, Newsprint, Specialty grade paper products, produced by the mill from annual report may be produced  Frequency: Annual report of Uncoated paper / board, Newsprint , Specialty grade paper products, produced and stock (opening/ closing) by the mill.
8	Coated Paper / board	Opening and closing stock reports	Documents/ records providing details of opening and closing of Coated Paper / board by the mill.  Frequency: Daily/ weekly/ monthly/ annual opening and closing records of Coated Paper / board, produced by the mill.
		Paper production report / documents	Documents providing details of production of Coated Paper / board produced by the mill  Frequency: Daily/ weekly/ monthly/ annual production records/ documents providing details of Coated Paper / board produced by the mill.
		Annual Report	Annual report showing details of Coated Paper / board, produced by the mill.  Also the annual stock closing and opening of the Coated Paper / board, produced by the mill from annual report may be produced  Frequency: Annual report of Coated Paper / board, produced and stock (opening/ closing) by the mill.

**B. Agro Based Mills:-**

a. The auditor may collect details required in M&V by mentioning the source and document from where data is collected. Subsequently the data may be verified from the data provided by the DC in pro-forma for

normalization.

- b. The information required is shown in the flow chart for Agro based pulp and paper mill.
- c. List of documents required for various monitoring and verification



**Table 27: General details required in Agro based Pulp and Paper Mills**

**B.1 Raw Material Details**

Type of Agro Paper

Name of the raw material	Moisture, %	Quantity, t/a	Source/ document

Whether Depithing at Mill Site                      Yes / No

**B.2 Depither Details**

Item	Unit	Qty	Source/ document
No. of Depithers	Nos		
Capacity	Tonne/ annum		
Type of depithing,	Wet/ dry		
Moisture	%		
Pith removal	%		

**B.3 AgroPulp Mill (Including Raw material, Pulper, Digester ,WSC, ODL , Recovery, Bleach Plant, WTP, and ETP)**

**i) Pulping Process Used**

Type of pulping	Capacity t/a	Production t/a	Total Yield (Including screening losses)	Source / Document
Chemical				
Semi Chemical				
Chemi Thermo Mechanical				
Other				

**ii) Refining Details**

Items	Unit	Qty	Source / Document
Type of refiners			
Capacity of Refiner, t/a	Tonne/ annum		
Pulp Yield, %	%		



### iii) Extended Delignification (ODL)

Item	Unit	Qty.	Source / Document
Extended Delignification (ODL)	Yes/No		
Capacity	Tonne/annum		
Date of Installation of ODL Plant	Date		

### v) Bleaching

Item	Chemical Pulp	Semi Chemical	Chemical Thermo Mechanical Pulp
Type of Bleaching	ECF/conv.	ECF/conv.	ECF/conv.
Sequence Used			
Bleaching Losses %			
Bleached Pulp Yield %			
Brightness of pulp, %			

Item	Date	Source / Document
Date of Installation of ECF Bleach Plant		

### vi) Energy Consumption in Pulp Mill

Item	Qty	Source/ Document
LP Steam Consumption, t/a		
MP Steam Consumption, t/a		
Power Consumption, kWh/a		

### v) Pulp Dryer

Sr No	Item	Unit	Qty	Source / Document
1	Capacity	Tonne/annum		
2	Production of salable pulp	Tonne/annum		
3	Energy Consumption in pulp dryer	kcal		
4	LP Steam Consumption	Tonne/annum		
5	MP Steam Consumption	Tonne/annum		
6	Power Consumption	kWh/annum		



vi) **Chemical Recovery**

Sr No	Item	Unit	Data	Source / Document
1	Type of chemical recovery	Conventional/ Non-Conventional		
2	Total Black liquor Solids generated	Tonnes		
3	In Lime Kiln Installed	Yes/No		
4	Date of Installation of Lime Kiln I	Date		
5	Date of Installation of Lime Kiln II	Date		
6	Date of Installation of Lime Kiln III	Date		

vii) **Over-all Energy consumption in pulp mill**

Item	Qty	Source / Document
LP Steam consumption, t/a		
MP Steam consumption, t/a		
Power consumption, kWh/a		

**B.4 Paper Machine (including stock preparation, chemical preparation/addition plant, finishing house)**

(i) **Paper Machine Details**

Number of Paper Machines

Item	PM-1	PM-2	PM-3	PM-4	PM-5	Source/ document
Type of paper machine						
Capacity, t/a						
Type of paper produced						
Production, t/a						
Annual weight average GSM						
<b>Energy Consumption in paper machine (including Stock Preparation , chemical addition and finishing house)</b>						
LP Steam consumption t/a						
MP Steam consumption, t/a						
Power consumption, kWh/a						



(ii) Coating / Value addition

Coating If any

Yes /No

Type of coating

online / offline

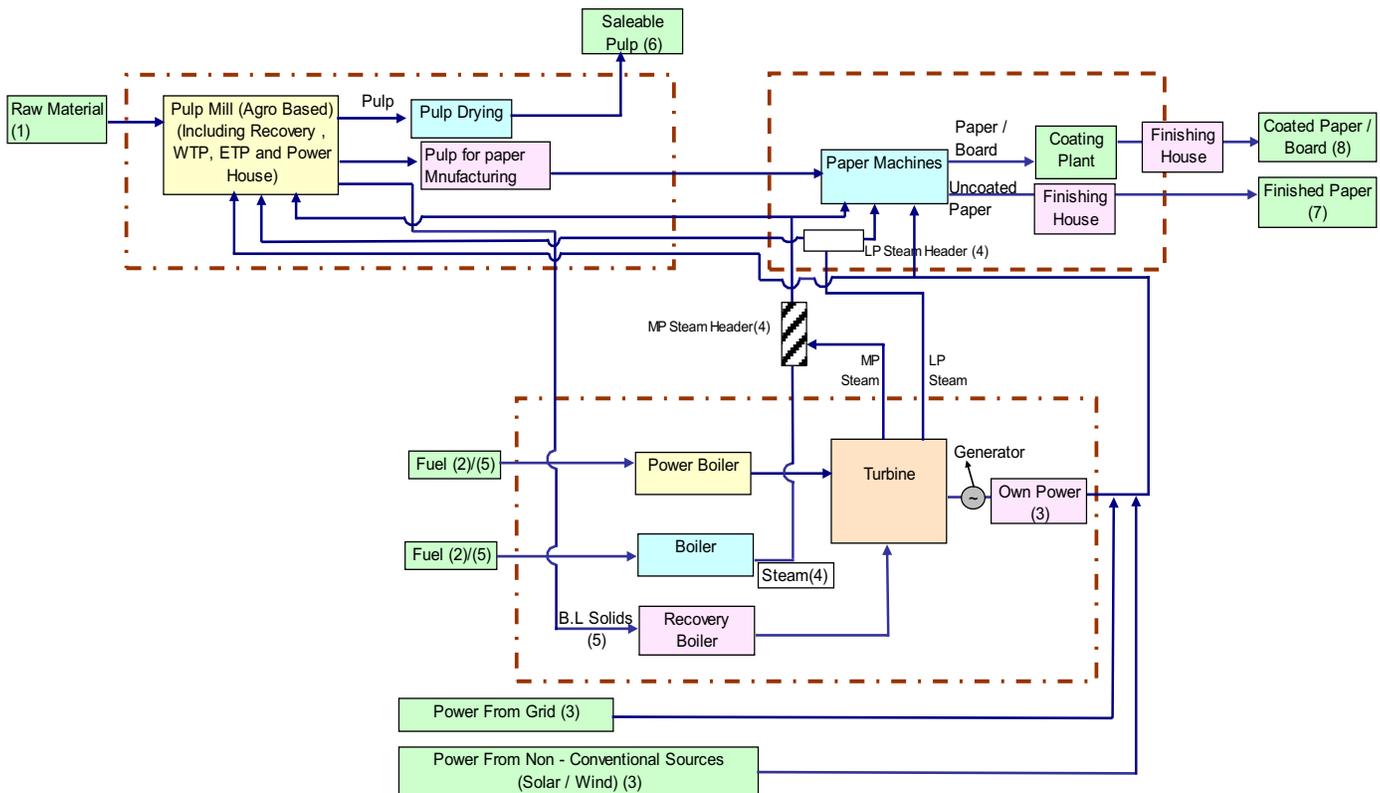
Item	Qty	Source/ document
Capacity of offline coating plant, t/a		
Production of coated paper/board, t/a		
LP Steam consumption, t/a		
MP Steam consumption, t/a		
Power consumption, kWh/a		

(iii) Over-all Energy consumption in paper machine, stock preparation, chemical preparation and addition plant, finishing house and offline coating plant add (i+ii)

	Qty	Source/ document
LP Steam consumption, t/a		
MP Steam consumption, t/a		
Power consumption, kWh/a		

**B.5 The Information required is shown in the Flow Chart for Agro Based Pulp and Paper Mill**

Figure 21: Ex- GtG boundary and metering details for Agro based Pulp and Paper Mill





**Table 28: Document required for Agro based Pulp and Paper Mills**

S.No.	Details of input and output	Source / Type of document required	Details of the Source / document and frequency
1	Raw Materials	Lab Report	Report on moisture(%), Ash (%) and other analysis of the raw materials used by the mill  Frequency: Daily/ weekly/ monthly/ annual lab reports may be produced for different types of raw materials used by the mills.
		Purchase Document From Purchase Department	Purchase documents providing details of raw material purchased by the mill  Frequency: Daily/ weekly/ monthly/ annual purchase documents may be produced for purchase of different types of raw materials used by the mills
		Raw Material Consumption Reports	Consumption reports giving details of raw material consumed by the mill. The report may be for raw material chip production, digester loading etc. from the concerned department.  Frequency: Daily/ weekly/ monthly/ annual consumption documents may be produced for different types of raw materials used by the mill in chipper / digesters house..
		Annual Report	Annual report showing details of raw materials consumed on annual basis by the mill.  Frequency: Annual consumption of raw materials by the mill.
2	Purchased Fuels	Fuel Purchase report / documents	Purchase documents providing details of fuel purchased by the mill.  Frequency: Daily/ weekly/ monthly/ annual purchase documents may be produced for purchase of different types of fuels used by the mills.
		Lab report for GCV moisture and Ash	Lab report on GCV, moisture(%), Ash (%) and other analysis (proximate and ultimate) density etc, of the fuel used by mill.  Frequency: Daily/ weekly/ monthly/ annual lab reports may be produced for different types of fuels used by the mills.
		Fuel Consumption Report	Consumption reports giving details of fuel consumed by the mill in boilers, DG sets etc. The consumption report may be from the concerned department showing details of fuel consumption.  Frequency: Daily/ weekly/ monthly/ annual fuel consumption documents may be produced for different types of fuels used by the mill in boiler/DG sets etc.
		Annual Report	Annual report showing details of fuels consumed on annual basis by the mill.  Frequency: Annual consumption of fuels by the mill.



S.No.	Details of input and output	Source / Type of document required	Details of the Source / document and frequency
3	Power	Electricity Purchased from Grid	Purchased electricity bill from state electricity board providing details of the electricity purchased by the mill. Frequency: monthly/ annual purchased electricity bills may be produced by the mills.
		Own power generation	Details of own power generation from different sources such as turbines(gas, steam etc), DG sets. Frequency: Daily/ weekly/ monthly/ annual own generation reports may be produced by the mills. These reports may be the log sheets/ production reports from power house.
		Production of power from Non Conventional sources, e.g. Solar / wind power	Details of power generation from different Non-conventional sources such as Solar / wind turbines, bio gas etc. Frequency: Daily/ weekly/ monthly/ annual Power generation reports may be produced by the mills. These reports may be the log sheets/ production reports from concerned power houses / departments
		Annual Report	Annual report showing details of Power purchased from grid, own power generation, power from non-conventional sources etc. Frequency: Annual report of power purchased , own generation, generation from non- conventional sources etc.by the mill.
4	Steam	Steam generation by the mill	Details of Steam generation from different boilers, extraction of steam from turbines, steam generation from waste heat recovery and non-conventional sources(Solar steam generators) Frequency: Daily/ weekly/ monthly/ annual steam generation reports may be produced by the mills. These reports may be the log sheets/ production reports for steam generation from boiler house etc.
		Steam consumption by the mill	Details of Steam consumption in different sections of the mill such as pulp mill, chemical recovery, paper machine, power house and other plants of the mill. Frequency: Daily/ weekly/ monthly/ annual steam consumption reports may be produced by the mills. These reports may be the log sheets/consumption reports for steam consumption by individual section of the mill or power boiler house.
		Annual Reports	Annual report showing details of Steam Generation and consumption from various sources. The generation and consumption of steam may be in individual departments as well as for the whole mill, boilers, extraction steam, steam from non-conventional sources etc. Frequency: Annual report of steam generation and consumption by the mill



S.No.	Details of input and output	Source / Type of document required	Details of the Source / document and frequency
5	Internally Generated Fuels (Black liquor solids, pith , chipper dust)	Generation report of Black liquor, pith, chipper dust, etc	<p>Details of generation of black liquor , pith , chipper dust or any other combustible waste by the mill from different sections such as chipper house, pulp mill, other plants.</p> <p>Frequency: Daily/ weekly/ monthly/ annual Black liquor, dust etc generation reports may be produced by the mills. These reports may be the log sheets/ production reports for Black liquor and pith generation from boiler house etc.</p>
		Lab reports for GCV, solids, moisture, ash etc.	<p>Lab report on GCV, solids (%) moisture(%), Ash (%) and other analysis (proximate) of the Black liquor, pith, dust etc. used by the mill.</p> <p>Frequency: Daily/ weekly/ monthly/ annual lab reports may be produced for different types of Black liquor, pith, dust etc. used by the mill.</p>
		Annual Report	<p>Annual report showing details of Black liquor generation, dust and pith generation, from various sources such as pulp mill, chippers, etc.</p> <p>Frequency: Annual report of Black liquor, pith and dust generation by the mill.</p>
6	Saleable Pulp	Opening and closing stock of saleable pulp	<p>Documents providing details of opening and closing of saleable pulp records by the mill.</p> <p>Frequency: Daily/ weekly/ monthly/ annual opening and closing records of the saleable pulp stock may be produced for different types of pulps produced by the mill.</p>
		Saleable pulp production	<p>Documents providing details of production of saleable pulp from different raw materials by the mill.</p> <p>Frequency: Daily/ weekly/ monthly/ annual production records/ documents providing details of saleable pulp from different types of raw materials produced by the mill.</p>
		Annual Report	<p>Annual report showing details of saleable pulp production from different raw materials and its consumption etc. Also the annual stock closing and opening of the saleable pulp from annual report may be produced</p> <p>Frequency: Annual report of saleable pulp production, consumption and stock (opening/ closing) by the mill.</p>
7	Uncoated paper / board, Newsprint , Specialty grade	Opening and closing stock reports	<p>Documents/ records providing details of opening and closing of Uncoated paper / board, Newsprint , Specialty grade paper products by the mill.</p> <p>Frequency: Daily/ weekly/ monthly/ annual opening and closing records of Uncoated paper / board, Newsprint , Specialty grade paper products, produced by the mill.</p>



S.No.	Details of input and output	Source / Type of document required	Details of the Source / document and frequency
		Paper production report / documents	Documents providing details of production of Uncoated paper/board, Newsprint, Specialty grade paper products, produced by the mill  Frequency: Daily/ weekly/ monthly/ annual production records/ documents providing details of Uncoated paper / board, Newsprint , Specialty grade paper products, produced by the mill.
		Annual Report	Annual report showing details of Uncoated paper / board, Newsprint, Specialty grade paper products, produced by the mill.  Also the annual stock closing and opening of the Uncoated paper/board, Newsprint, Specialty grade paper products, produced by the mill from annual report may be produced  Frequency: Annual report of Uncoated paper / board, Newsprint , Specialty grade paper products, produced and stock (opening/ closing) by the mill.
8	Coated Paper / board	Opening and closing stock reports	Documents/ records providing details of opening and closing of Coated Paper / board by the mill.  Frequency: Daily/ weekly/ monthly/ annual opening and closing records of Coated Paper / board, produced by the mill.
		Paper production report / documents	Documents providing details of production of Coated Paper / board produced by the mill  Frequency: Daily/ weekly/ monthly/ annual production records/ documents providing details of Coated Paper / board produced by the mill.
		Annual Report	Annual report showing details of Coated Paper / board, produced by the mill.  Also the annual stock closing and opening of the Coated Paper / board, produced by the mill from annual report may be produced  Frequency: Annual report of Coated Paper / board, produced and stock (opening/ closing) by the mill.

### C. RCF Based Mills:-

- a. The auditor may collect details required in M&V format) by mentioning the source and document from where data is collected. Subsequently the data may be verified from the, data provided by the DC in pro-forma for normalization.
- b. The information required is shown in the flow chart for RCF based pulp and paper mill.
- c. List of documents required for various monitoring and verification



**Table 29: General details required in RCF based Pulp and Paper Mills**

**A.1 Material Details**

Type of Waste Paper

Name of the raw material	Moisture, %	Quantity, t/a	Source/ document

**A.2 RCF Pulp Mill (Including Pulper, Pulp Cleaning and Screening, Deinking, Bleaching, WTP, and ETP)**

**i) Pulper / Pulp Cleaning and Screening Process Used**

No. of Unit	Capacity t/a	Production t/a	Source / Document
Pulper			
HD Cleaner			
Screening			
Cleaning and screening rejects, t/a			
No. of Deinking loops			

**ii) Deinking / Bleach Process**

Item	Qty.	Source / Document
Capacity, t/a		
Pulp yield, %		
Fibre Loss, %		
Ink removal Efficiency, %		
Bleaching Stages Yes/No		
Bleaching losses, t/a		

**iii) Refining**

Item	1	2	3	Source / Document
Type of Refiners				
No. of Refiners				
Initial Pulp Freeness oSR /CSF				
Final Freeness oSR /CSF				



iv) **Energy Consumption in Pulp Mill**

Item	Qty	Source / Document
LP Steam consumption, t/a		
MP Steam consumption, t/a		
Power consumption, kWh/a		

v) **Pulp Dryer**

Sr No	Item	Unit	Qty	Source / Document
1	Capacity	Tonne/annum		
2	Production of salable pulp, t/a	Tonne/annum		
3	Energy Consumption in pulp dryer	kcal		
4	LP Steam Consumption	Tonne/annum		
5	MP Steam Consumption	Tonne/annum		
6	Power Consumption	kWh/annum		

vi) **Over-all Energy consumption in pulp mill**

Item	Qty	Source / Document
LP Steam consumption, t/a		
MP Steam consumption, t/a		
Power consumption, kWh/a		

**A.3 Paper Machine (including stock preparation, chemical preparation / addition plant, finishing house)**

(i) **Paper Machine Details**

Number of Paper Machines

Item	PM-1	PM-2	PM-3	PM-4	PM-5	Source/ document
Type of paper machine						
Capacity, t/a						
Type of paper produced						
Production, t/a						
Annual weight average GSM						
<b>Energy Consumption in paper machine (including Stock Preparation , chemical addition and finishing house)</b>						
LP Steam consumption t/a						
MP Steam consumption, t/a						
Power consumption, kWh/a						



**(ii) Coating/ Value addition**

Coating If any  
Type of coating

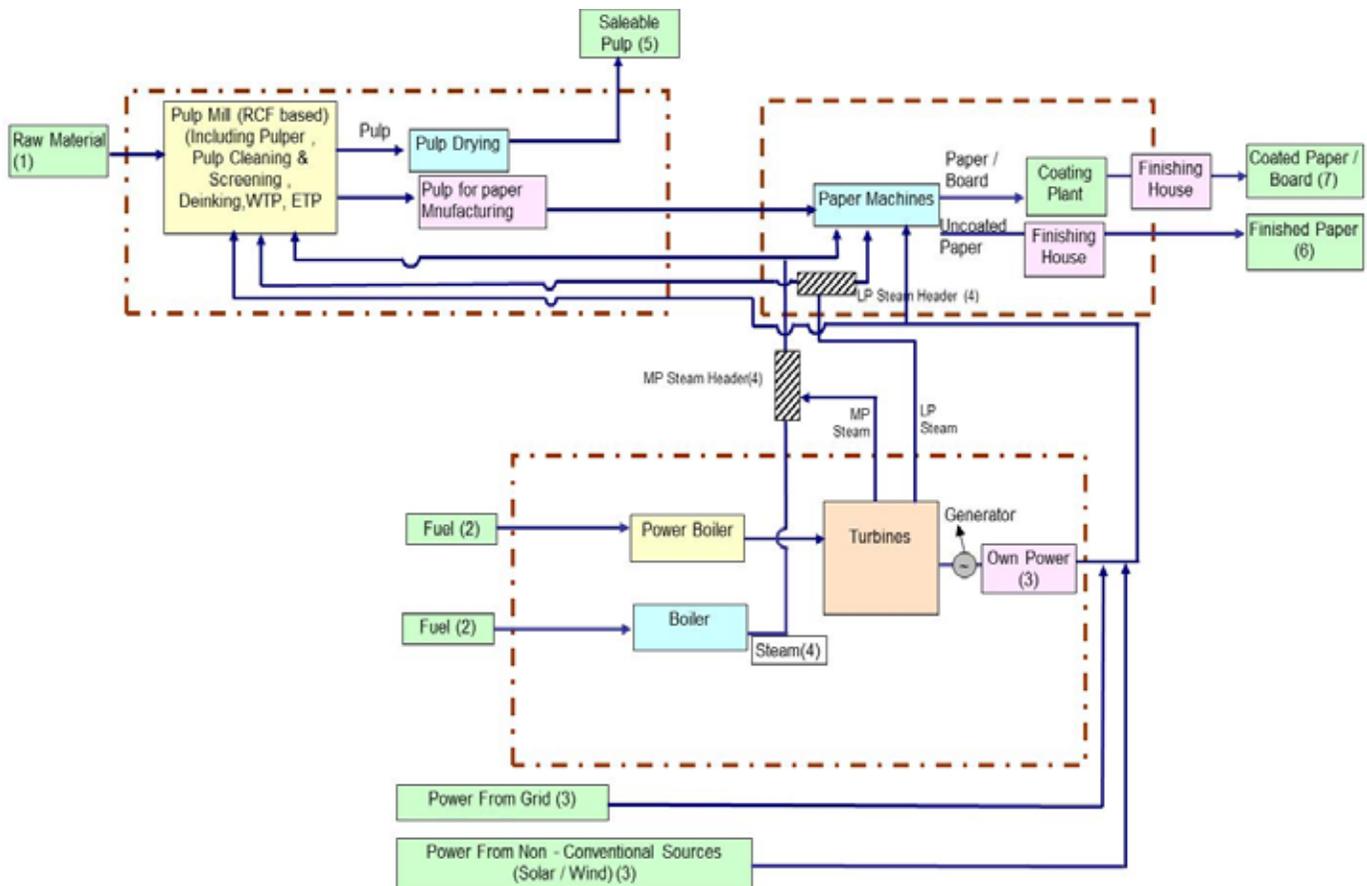
Yes /No  
online / offline

Item	Qty	Source/ document
Capacity of offline coating plant, t/a		
Production of coated paper/board, t/a		
LP Steam consumption, t/a		
MP Steam consumption, t/a		
Power consumption, kWh/a		

**(iii) Over-all Energy consumption in paper machine,stock preparation, chemical preparation and addition plant, finishing house and offline coating plant add (i+ii)**

	Qty	Source/ document
LP Steam consumption, t/a		
MP Steam consumption, t/a		
Power consumption, kWh/a		

A.4 The Information required is shown in the Flow Chart for RCF Based Pulp and Paper Mill





**Table 30: Documents required in RCF based Pulp and Paper**

S.No.	Details of input and output	Source / Type of document required	Details of the Source / document and frequency
1	Raw Materials	Lab Report	Report on moisture(%), Ash (%) and other analysis of the raw materials used by the mill Frequency: Daily/ weekly/ monthly/ annual lab reports may be produced for different types of raw materials used by the mills.
		Purchase Document From Purchase Department	Purchase documents providing details of raw material purchased by the mill Frequency: Daily/ weekly/ monthly/ annual purchase documents may be produced for purchase of different types of raw materials used by the mills
		Raw Material Consumption Reports	Consumption reports giving details of raw material consumed by the mill. The report may be for raw material chip production, digester loading etc. from the concerned department. Frequency: Daily/ weekly/ monthly/ annual consumption documents may be produced for different types of raw materials used by the mill in chipper / digesters house..
		Annual Report	Annual report showing details of raw materials consumed on annual basis by the mill. Frequency: Annual consumption of raw materials by the mill.
2	Purchased Fuels	Fuel Purchase report / documents	Purchase documents providing details of fuel purchased by the mill. Frequency: Daily/ weekly/ monthly/ annual purchase documents may be produced for purchase of different types of fuels used by the mills.
		Lab report for moisture and Ash GCV	Lab report on GCV, moisture(%), Ash (%) and other analysis (proximate and ultimate) density etc, of the fuel used by mill. Frequency: Daily/ weekly/ monthly/ annual lab reports may be produced for different types of fuels used by the mills.
		Fuel Consumption Report	Consumption reports giving details of fuel consumed by the mill in boilers, DG sets etc. The consumption report may be from the concerned department showing details of fuel consumption. Frequency: Daily/ weekly/ monthly/ annual fuel consumption documents may be produced for different types of fuels used by the mill in boiler/DG sets etc.
		Annual Report	Annual report showing details of fuels consumed on annual basis by the mill. Frequency: Annual consumption of fuels by the mill.



S.No.	Details of input and output	Source / Type of document required	Details of the Source / document and frequency
3	Power	Electricity Purchased from Grid	Purchased electricity bill from state electricity board providing details of the electricity purchased by the mill. Frequency: monthly/ annual purchased electricity bills may be produced by the mills.
		Own power generation	Details of own power generation from different sources such as turbines(gas, steam etc), DG sets. Frequency: Daily/ weekly/ monthly/ annual own generation reports may be produced by the mills. These reports may be the log sheets/ production reports from power house.
		Production of power from Non Conventional sources, e.g. Solar / wind power	Details of power generation from different Non-conventional sources such as Solar / wind turbines, bio gas etc. Frequency: Daily/ weekly/ monthly/ annual Power generation reports may be produced by the mills. These reports may be the log sheets/ production reports from concerned power houses / departments
		Annual Report	Annual report showing details of Power purchased from grid, own power generation, power from non-conventional sources etc. Frequency: Annual report of power purchased , own generation, generation from non- conventional sources etc.by the mill.
4	Steam	Steam generation by the mill	Details of Steam generation from different boilers, extraction of steam from turbines, steam generation from waste heat recovery and non-conventional sources(Solar steam generators) Frequency: Daily/ weekly/ monthly/ annual steam generation reports may be produced by the mills. These reports may be the log sheets/ production reports for steam generation from boiler house etc.
		Steam consumption by the mill	Details of Steam consumption in different sections of the mill such as pulp mill, chemical recovery , paper machine, power house and other plants of the mill. Frequency: Daily/ weekly/ monthly/ annual steam consumption reports may be produced by the mills. These reports may be the log sheets/ consumption reports for steam consumption by individual section of the mill or power boiler house.
		Annual Reports	Annual report showing details of Steam Generation and consumption from various sources. The generation and consumption of steam may be in individual departments as well as for the whole mill, boilers, extraction steam, steam from non-conventional sources etc. Frequency: Annual report of steam generation and consumption by the mill



S.No.	Details of input and output	Source / Type of document required	Details of the Source / document and frequency
5	Saleable Pulp	Opening and closing stock of saleable pulp	Documents providing details of opening and closing of saleable pulp records by the mill. Frequency: Daily/ weekly/ monthly/ annual opening and closing records of the saleable pulp stock may be produced for different types of pulps produced by the mill.
		Saleable pulp production	Documents providing details of production of saleable pulp from different raw materials by the mill. Frequency: Daily/ weekly/ monthly/ annual production records/ documents providing details of saleable pulp from different types of raw materials produced by the mill.
		Annual Report	Annual report showing details of saleable pulp production from different raw materials and its consumption etc. Also the annual stock closing and opening of the saleable pulp from annual report may be produced Frequency: Annual report of saleable pulp production, consumption and stock (opening/ closing) by the mill.
6	Uncoated paper / board, Newsprint, Specialty grade	Opening and closing stock reports	Documents/ records providing details of opening and closing of Uncoated paper / board, Newsprint , Specialty grade paper products by the mill. Frequency: Daily/ weekly/ monthly/ annual opening and closing records of Uncoated paper / board, Newsprint, Specialty grade paper products, produced by the mill.
		Paper production report / documents	Documents providing details of production of Uncoated paper/board, Newsprint, Specialty grade paper products, produced by the mill Frequency: Daily/ weekly/ monthly/ annual production records/ documents providing details of Uncoated paper / board, Newsprint , Specialty grade paper products, produced by the mill.
		Annual Report	Annual report showing details of Uncoated paper / board, Newsprint, Specialty grade paper products, produced by the mill. Also the annual stock closing and opening of the Uncoated paper / board, Newsprint , Specialty grade paper products, produced by the mill from annual report may be produced Frequency: Annual report of Uncoated paper / board, Newsprint , Specialty grade paper products, produced and stock (opening/ closing) by the mill.



S.No.	Details of input and output	Source / Type of document required	Details of the Source / document and frequency
7	Coated Paper / board	Opening and closing stock reports	Documents/ records providing details of opening and closing of Coated Paper / board by the mill. Frequency: Daily/ weekly/ monthly/ annual opening and closing records of Coated Paper / board, produced by the mill.
		Paper production report / documents	Documents providing details of production of Coated Paper / board produced by the mill Frequency: Daily/ weekly/ monthly/ annual production records/ documents providing details of Coated Paper / board produced by the mill.
		Annual Report	Annual report showing details of Coated Paper / board, produced by the mill. Also the annual stock closing and opening of the Coated Paper / board, produced by the mill from annual report may be produced Frequency: Annual report of Coated Paper / board, produced and stock (opening/ closing) by the mill.

### 7.7. Annexure VII: Textile

1. Section wise Energy metering (Electrical and Thermal) is required for making Equivalent Product in Textile sub-sectors. Proper calculation document should be maintained, if energy figures are arrived by calculation method.
2. SCADA Screen shot is required for Major and Auxilliary systems.
3. Inclusions and Exclusion should be clearly marked in the Gate to Gate Boundary Diagram.
4. It is essential to express quantities of different product types in a single unit for calculation of specific energy consumption from Gram per Linear Meter (GLM) or Gram per Square Meter (GSM). DC to furnish back up calculation of conversion to EmAEA.
5. Mass balance is required to be furnished in the verification report.
6. EmAEA is advised to convert other special

product or value added product in to the major equivalent product through Energy Consumption and the calculation is to be included in the verification report

#### 7. Spinning Sub-Sector

- a. Count of Yarn is one of the important parameter. Change in the count of the yarn may result in the change in the UKG of the plant. So normalization for count of yarn is important. Hence, all the product needs to be converted to 40s count s per SITRA guidelines for UKG calculation at TFO - AutoConer output. The calculation for conversion shall be an integral part of the verification report.
- b. The open end yarn to be converted to 10s count for UKG calculation.
- c. Section wise energy consumption to be provided for backup calculation as per sample table. EmAEA is required to insert or delete the section as per the requirement



**Table 31: Section wise Energy Consumption**

Sr No	Item	Electrical SEC (kwh/kg)	Thermal SEC (kcal/kg)	Remarks
1	Blow Room			
2	Carding			
3	Combing			
4	Draw Frame			
5	Speed Frame			
6	Ring Frame			
7	Winding			
8	TFO			
9	AutoConer			
10	Doubling			
11	Singing and Sizing			
12	Humidification			
13	Lighting			
14	Utilities			
15	Misc Others			

- d. The calculation used to convert other type of yarn (Like PV, Worsted etc) into the singular yarn in the baseline year will remain same in the assessment year. EmAEA is advised to use the same formulae as per Baseline Year Report.
- e. All special product yarn (Melange/ Fibre dyed Yarns, High value blended yarns mixed with Wool, Silk, Modal, Nylon, etc, Slub Yarns, Compact yarns, TFO doubled yarns, Jaspe yarns, Jaspe slub yarns, Nep effect yarns) needs

to be converted in to single major product. The conversion formulae for baseline and assessment year will be same.

- f. Production and capacity to be equated w.r.t. the Nos, speed, weight and running hours of Ring Frame and Autoconer.
- g. Mention clear bifurcation of energy in Major Product (GtG boundary as per PAT) and other products as per Boundary Limit Example.

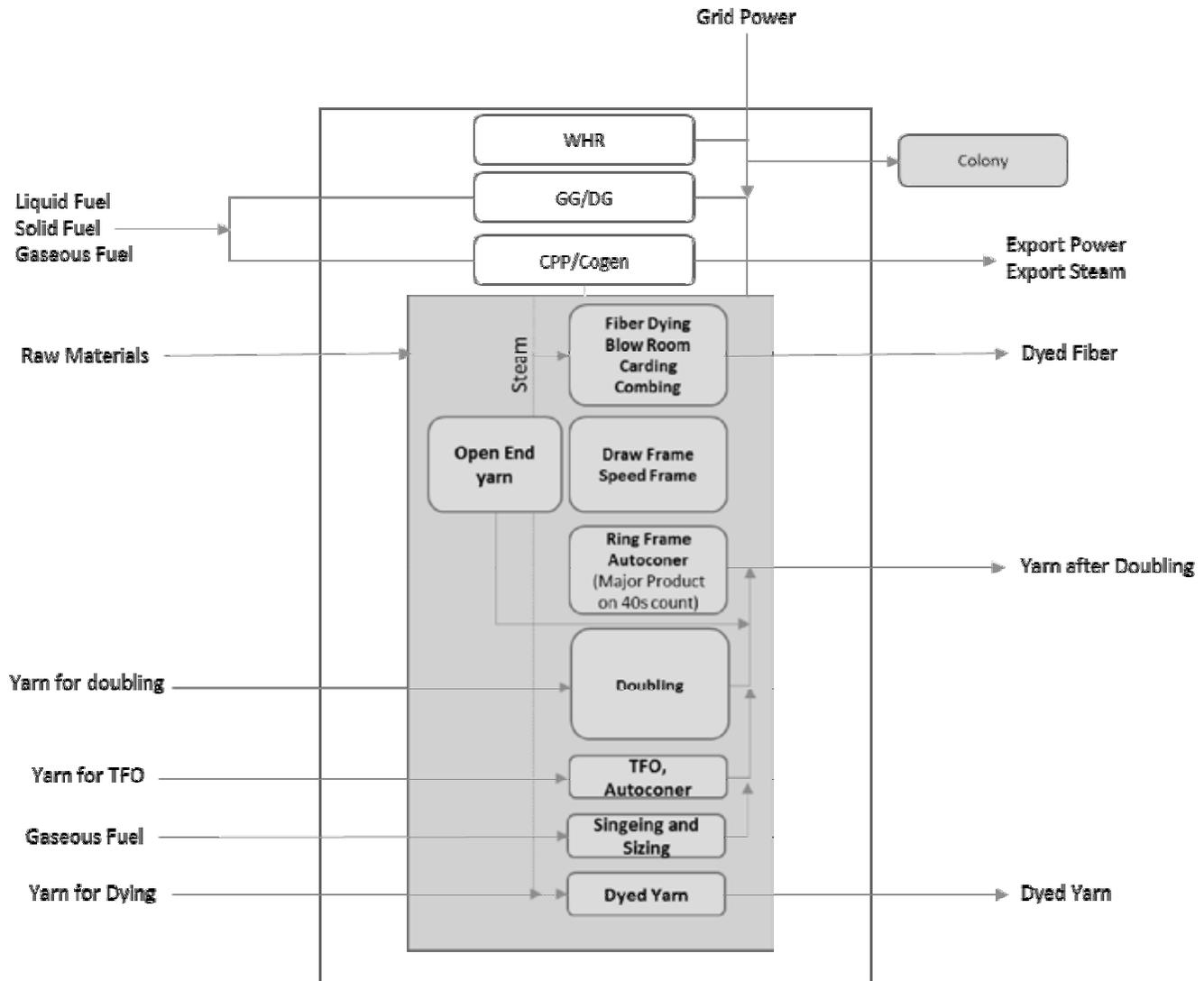


Figure 22: Ex- GtG boundary for Textile (Spinning sub sector)

8. Composite and Processing Sub sector

a. There are five finished product defined in the Composite sub-group, all other special or value added product shall be converted into either of these five major products through energy consumption of making those special or value added product. The calculation of conversion is to be included in the verification report of EmAEA.

The final five finished products in the Composite sub group are:

- i. Cotton
  - ii. Polyester Cotton
  - iii. Lycra
  - iv. Non Cellulosic Product (100% Synthetic)
  - v. Wool based product
- b. Picks as standard for taking production in case of Weaving. In case of weaving, in order to streamline products of all the DCs 60 PPI (Picks per Inch) as standard value and DCs should



- convert their weaving production at different picks to production at 60 PPI. EmAEA to include the conversion calculation in the verification report.
- c. Similarly for Knitting, conversion factors shall be in terms of Wales on weight basis.
  - d. Mass and Energy balance calculation is required to be included in the verification report by EmAEA
  - e. Steam balance diagram is required to be included in the verification report by EmAEA
  - f. Section wise Specific Energy Consumption is required to be specified as per table below

**Table 32: Section wise Energy Consumption**

Sr No	Item	Electrical SEC (kwh/kg)	Thermal SEC (kcal/kg)	Remarks
<b>Spinning</b>				
1	Blow Room			
2	Carding			
3	Combing			
4	Draw Frame			
5	Speed Frame			
6	Ring Frame			
7	Winding			
8	TFO			
9	AutoConer			
10	Doubling			
11	Singing and Sizing			
<b>Knitting/Weaving</b>				
1	Wrapping			
2	Sizing			
3	Knotting			
4	Weaving			
<b>Processing</b>				
1	Singeing			
2	Desizing			
3	Mercerizing			
4	Bleaching			
5	Sueding			
6	Dying			
7	Printing			
<b>Misc and Others</b>				
1	Humidification			
2	Lighting			
3	Utilities			
4	Others			

EmAEA is required to add the section as per the requirement and need



- g. Demarcation of plant boundary is required with clear understanding of raw material input, Energy input, Power Import/Export, Intermediary product Import/Export, Colony

Power, Construction/Others Power, Power supplied to other Ancillary unit outside the plant boundary. A typical sample of Plant boundary condition is represented below

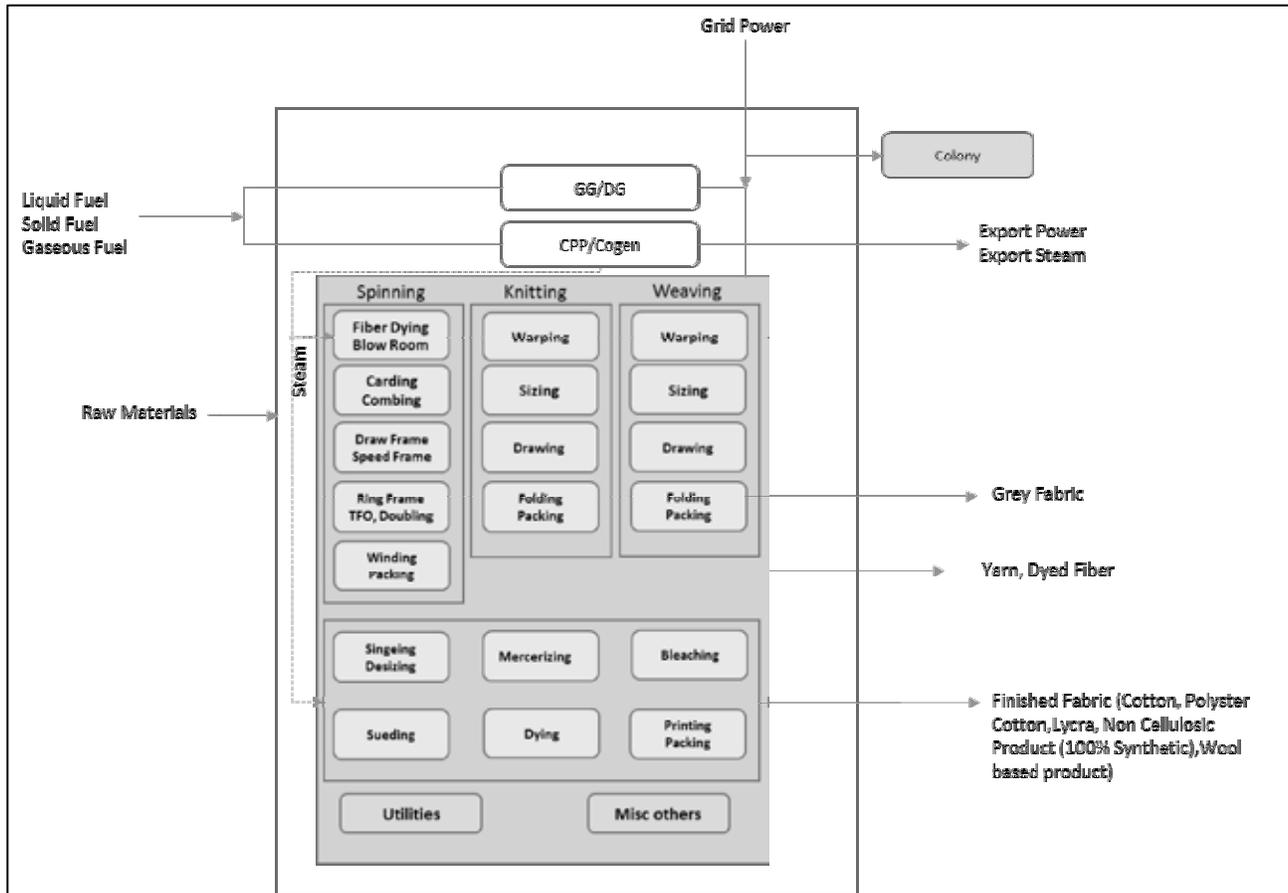


Figure 23: Ex- GtG boundary for Textile ( Composite/ Processing sub sector)

9. Fiber Sub-Sector
  - a. Section wise production and Energy performance is required for each Fiber Product
  - b. The Products and sections are different in Fiber sub-sector, hence the Pro-forma of the subsector specify the major product and other Products from 1-5.
  - c. EmAEA to specify the product details with sectional Process Flow Diagram in the verification report.
  - d. Mass balance calculation w.r.t. input raw material and output product with conversion factor is required to be produced
  - e. Fuel used as raw material should not be considered from the input energy and reported in the verification report by EmAEA
  - f. DC has to submit weighted average denier value for their products. Plant has to submit production value in single denier by converting all the denier value



- g. DCs have to convert all of their products in single major product equivalent by taking ratio of the SEC of the other products to the main product
- h. EmAEA to include the details of major products and other products as mentioned in Pro-forma as per following table

**Table 33: Product Name in Fiber Sun-sector**

Sr No	Item	Name	Unit	Remarks
1	Raw Material			
2	Major Product			
3	Product 1			
4	Product 2			
5	Product 3			
6	Product 4			
7	Product 5			
8	Denier			

- i. Steam Balance Diagram of the Plant from Steam generation to Steam consumption is required to be included in the verification report
- j. Product wise, sectional (Sub Process) yearly Thermal and Electrical Energy details is required as per following sample table for Product 1

**Table 34: Section wise Energy Consumption**

Sr No	Item	Electrical SEC (kwh/kg)	Thermal SEC (kcal/kg)	Remarks
1	Polymerisation Process			
2	Spinning Process			
3	Draw line Process			
4	Utilities			
5	Misc Others			

- k. Boundary Condition  
Mention clear bifurcation of energy in Major Product (GtG boundary as per PAT) and other products as per Boundary Limit Example

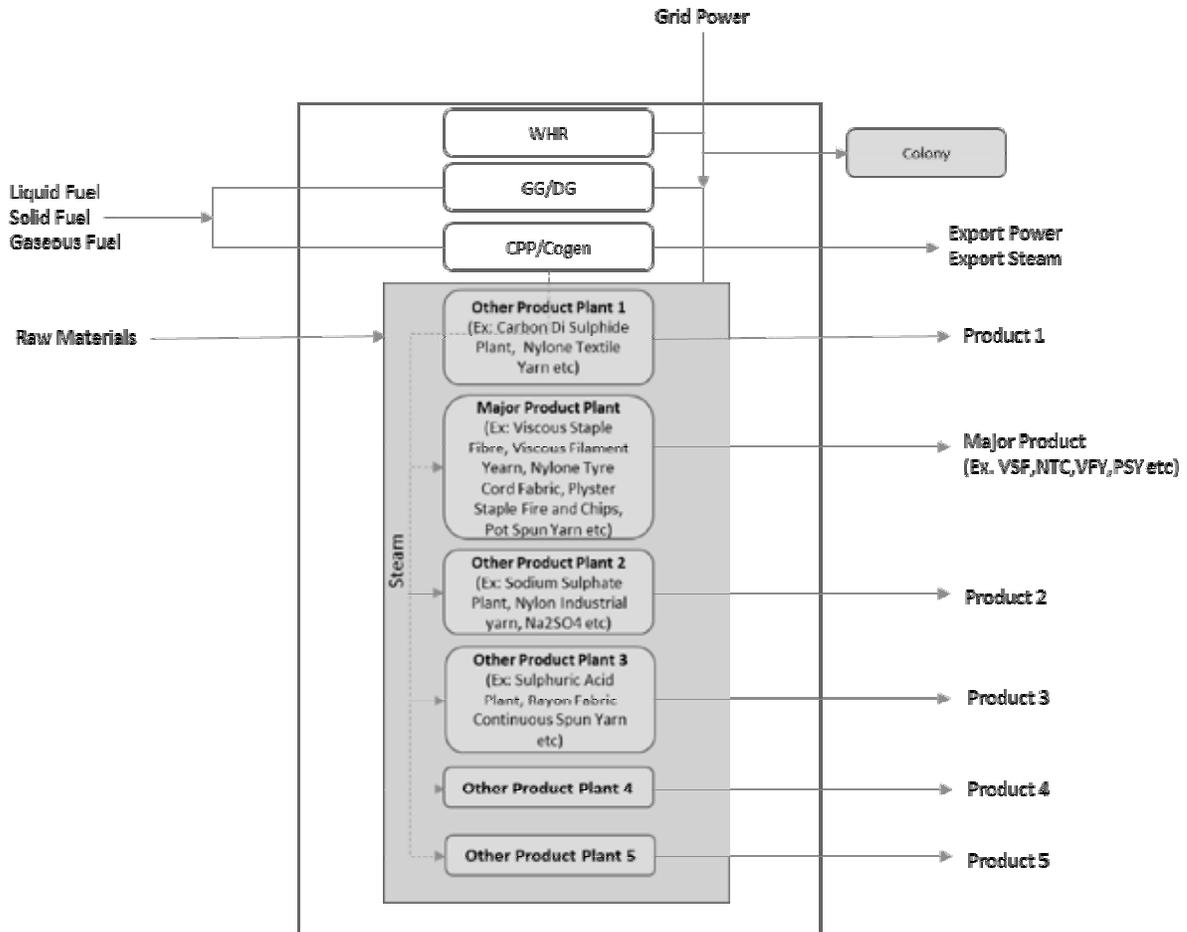


Figure 24: Ex- GtG boundary for Textile (Fiber) Sub- sector

## 7.8. Annexure VIII: Chlor Alkali

### 1. Section wise Details

Section wise Specific Power consumption

and Specific Thermal consumption shall be specified and provided to EmAEA as per following format. EmAEA can add section if required

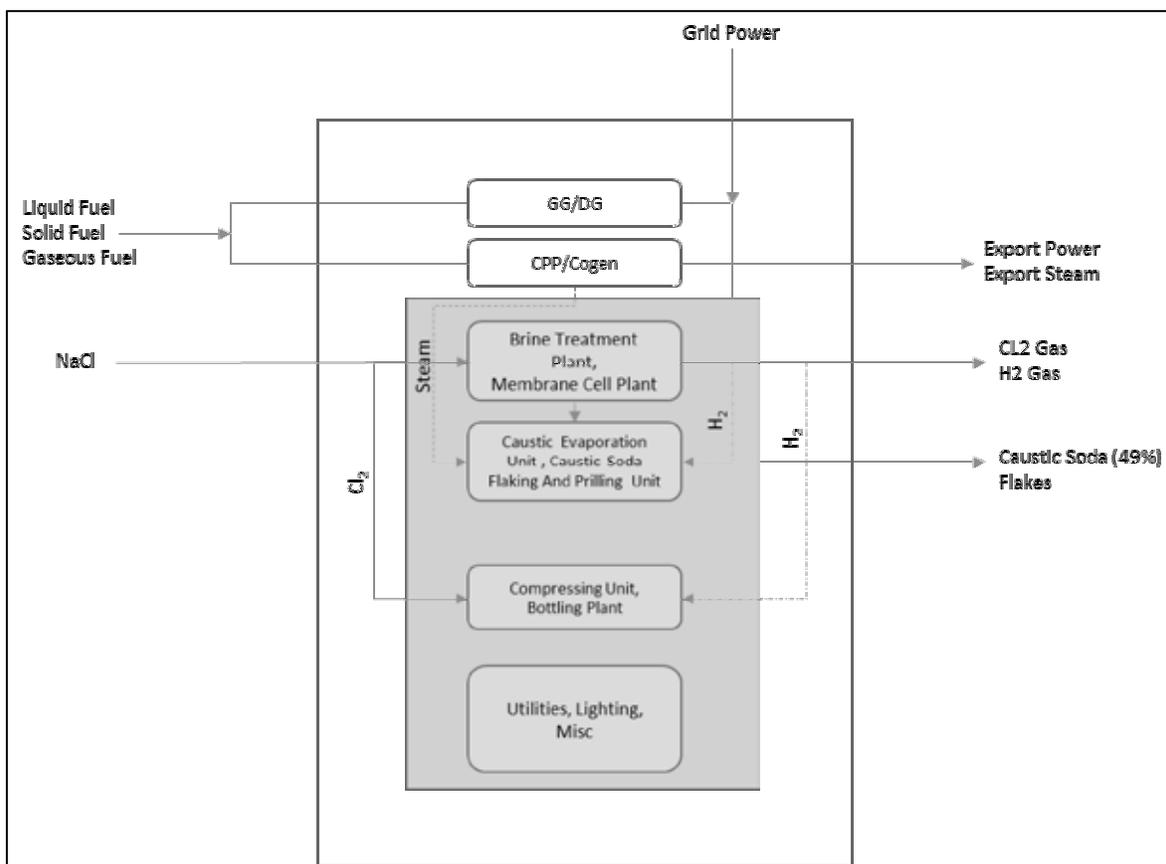
Table 35: Section wise Energy details

Sr No	Section	SPC kwh/tonne	SEC kcal/kg	Remarks
1	Primary Brine Plant.			
2	Secondary Brine Plant.			
3	Membrane Cell Plant.			
4	Chlorine / Hydrogen Treatment Plant			
5	HCl / Sodium Hypo Plants.			
6	Caustic Concentration and evaporation units.			
7	Utilities Plant.			
8	Waste Water Treatment Plant.			



2. Membrane Change verification: Details regarding membrane change for each cell shall be provided along with the membrane configuration
3. Maximum allowable capacity of chlorine storage in the DC shall be specified and provided to the EmAEA
4. Cathode- Anode coating verification: Details regarding Cathode- Anode coating shall be provided along with the membrane configuration
5. EmAEA shall ensure and verify production of Caustic Soda lye (49% concentration) and Hydrogen as per quantity of Chlorine produced during the electrolysis process. EmAEA shall also ensure that these productions should not exceed the stoichiometric limit
6. If a captive power plant or cogeneration plant caters to two or more DCs for the electricity and/or steam requirements. In such scenario, each DC shall consider such captive power plant or cogeneration plant in its boundary and energy consumed by such captive power plant or cogeneration plant shall be included in the total energy consumption. However, electricity in terms of calorific value (as per actual heat rate) and steam in terms of calorific value (as per steam enthalpy) exported to other plants shall be subtracted from the total energy consumption.
7. Boundary Condition  
Mention clear bifurcation of energy in Caustic Soda plant (GtG boundary as per PAT) and other products as per Boundary Limit Example

Figure 25: Ex- GtG boundary for Chlor-Alkali sector



For all practical and legal purposes in connection with M&V guidelines, the English version of the notified PAT rules 2012 and EC Act 2001 will be considered as final.





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