PAT SCHEME
PERFORM, ACHIEVE, TRADE

NORMALIZATION DOCUMENT AND MONITORING & VERIFICATION GUIDELINES

Aluminium Sector

सत्यमेव जयते

MINISTRY OF POWER
GOVERNMENT OF INDIA

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ENERGY IS LIFE

CONSERVE IT

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BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)

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Ajay Mathur, Ph.D.
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.

Aluminium sector is one of the 8 notified energy intensive sectors under which a total of 10 plants are participating in this program. These plants have been mandated to reduce their Specific Energy Consumption (SEC) from baseline year of 2007-2010. It is expected that these plants may save 0.456 million tons of oil equivalent annually by the end of PAT cycle –I.

The publication of **"Normalization Document and M&V Guidelines" for Aluminium 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 Aluminium Sector, chaired by Shri V. Balasubramanyam, Director (Production), NALCO,Co-chairs of sub-Technical committee –Shri Abhijit Pati, Sesa Sterlite Limited, Jharsuguda and Shri S.M. Kulkarni Hindalco Corporate Office, Shri K.K.Chakarvarti, Energy Economist, BEE, Shri A.K. Asthana, Senior Technical Expert, GIZ, Shri Anupam Agnihotri, Director, JNARDDC, Shri K G Sudhan Ramkumar, Project Engineer, BEE.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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14.	Shri Vikash Ranjan	Technical Expert, GIZ

1. Introduction

The National Action Plan on Climate Change (NAPCC), released by the Prime Minister on 30 June, 2008, recognizes the need to maintain high economic growth to raise the living standard of India's vast majority of people and simultaneously reducing their vulnerability to the impacts of climate change.

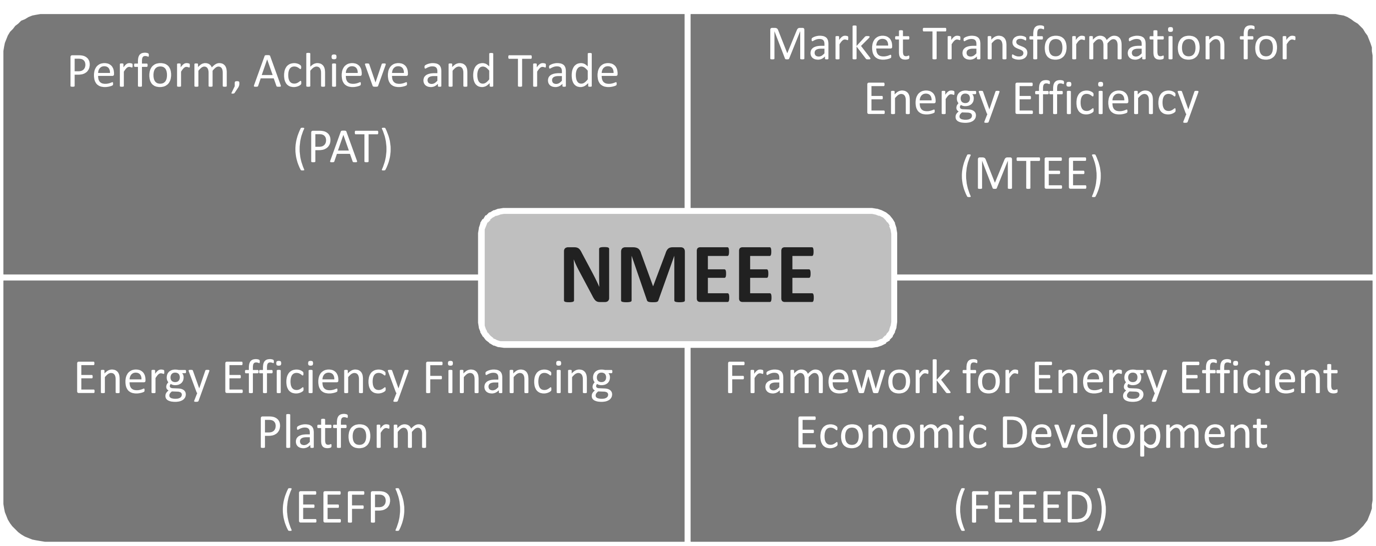
The National Action Plan outlines eight national missions that represent multi-pronged, long-term, and integrated strategies for achieving key goals in mitigating the impact of climate change. These missions are:

- National Solar Mission
- National Mission for Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining the Himalayan Ecosystem
- National Mission for a Green India
- National Mission for Sustainable Agriculture
- National Mission for Strategic Knowledge for Climate Change

1.1 National Mission for Enhanced Energy Efficiency

The National Mission for Enhanced Energy Efficiency (NMEEE) is one of the eight national missions with the objective of promoting innovative policy and regulatory regimes, financing mechanisms, and business models which not only create, but also sustain, markets for energy efficiency in a transparent manner with clear deliverables to be achieved in a time bound manner. It also has inbuilt provisions for monitoring and evaluation so as to ensure transparency, accountability, and responsiveness. The Ministry of Power (MoP) and Bureau of Energy Efficiency (BEE) were tasked to prepare the implementation plan for NMEEE.

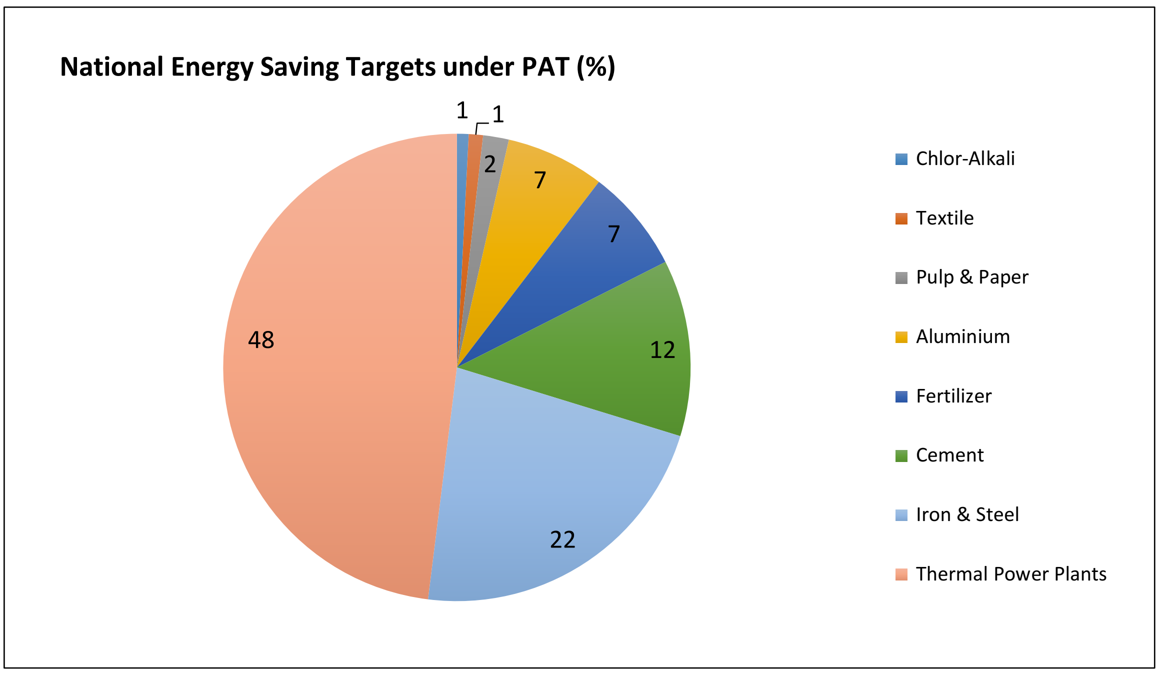
NMEEE spelt out the following four new initiatives to enhance energy efficiency, in addition to the programmes on energy efficiency being pursued. These are:



- **Perform, Achieve and Trade (PAT),** a market based mechanism to make improvements in energy efficiency in energy-intensive large industries and to make facilities more cost – effective by certification of energy saving that can be traded.
- **Market Transformation for Energy Efficiency (MTEE)** accelerates the shift to energy-efficient appliances in designated sectors through innovative measures that make the products more affordable.
- **Energy Efficiency Financing Platform (EEFP),** a mechanism to finance demand side management programmes in all sectors by capturing future energy savings.
- **Framework for Energy Efficiency Economic Development (FEEED),** for developing fiscal instruments to promote energy efficiency.

1.2 Perform, Achieve and Trade (PAT) Scheme

Under the National Mission on Enhanced Energy Efficiency (NMEEE), a market based mechanism known as **Perform, Achieve and Trade (PAT)** has been developed and launched to improve energy efficiency in the large energy intensive industries. It is envisaged that 6.686 million tonnes of oil equivalent will be reduced by 2014-15, which is about 4% of energy consumed by these industries. Under the PAT scheme, targets have been specified for all energy intensive industries notified as designated consumers (DCs) under the Energy Conservation Act, including thermal power stations.



2. Background

The methodology of setting targets for designated consumers is transparent, simple and easy to use.It is based on reduction of specific energy consumption (SEC) on a gate-to-gate (GtG) basis to achieve targeted savings in the first commitment period of 3 years (2012-2015);the reduction in this phase is of about 4.1% which is estimated at 6.686 million tonnes of oil equivalent (mtoe). Of the 23 mtoe set as target

from NMEEE, the PAT scheme is focussed on achieving 6.686 mtoe by 2015.

3. Indian Aluminium Industry and PAT

The threshold limit of 7,000 tonnes of oil equivalent (toe) has been marked as the cut-off limit criterion for any unit in the aluminium sector to be identified as designated consumer under PAT. Ten designated consumers have been identified in India's aluminium sector.

India has the fifth largest reserves of bauxite, the raw material used in production of aluminium, with deposits of about 2.3 billion tonnes (6.76% of the world deposits). The total aluminium production in India is about 3% of the global capacity. Primary aluminium production involves two major steps: one, refining of bauxite to alumina and two, smelting of alumina to aluminium. Smelting is an energy intensive process and consumes electrical energy, accounting for about 85%–90% of the electrical energy consumption.

In aluminium sector, to become a designated consumer the threshold limit is 7500 toe and in PAT cycle-I has identified the 10 designated consumers from Odisha, Karnataka, Jharkhand, Chhattisgarh, Maharashtra and Uttar Pradesh; their targets have already been notified. The aluminium sector has been categorised, on the basis of the processes involved, into four subsectors— Refinery, Smelter, Integrated and Cold sheet mill.

The total average reported energy consumption of these designated consumers is about 7.71 million tonnes of oil equivalent/year in the baseline period (2007-10). By the end of the first PAT cycle, the energy savings of 0.456 million tonnes of oil equivalent/year is expected to be achieved, which is around 7% of the total national energy saving targets assessed under PAT.

To achieve the targeted energy saving and to ensure unbiased implementation of the PAT scheme a technical sub-committee of industry representatives has been formed under the guidance of sector experts of Jawaharlal Nehru Aluminium Research Development and Design Centre (JNARDDC), Nagpur,to finalise normalization factors.

Aluminium sector has been categorized on the basis of their operation in to four subsectors i.e. Refinery, Smelter, Integrated, and Cold Sheet Plants. The Total reported energy consumption of these designated consumers is about 7.71 million ton of oil equivalent (million toe). By the end of the first PAT cycle, the energy saving of 0.456 million ton of oil equivalent/year is expected to be achieved, which is around 7% of total national energy saving target assessed under PAT.

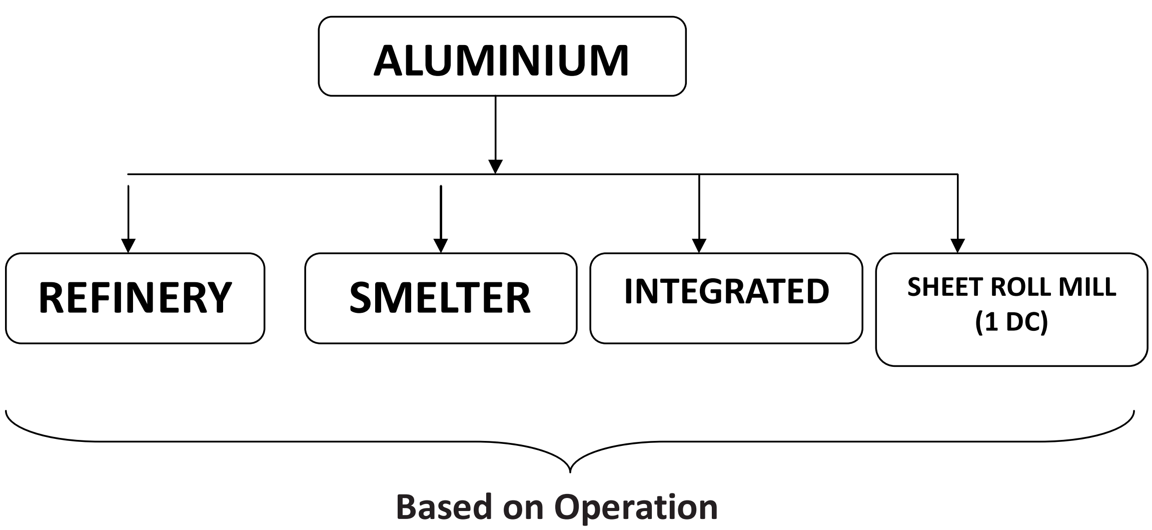


Table 1: Sector-wise reduction target under PAT Cycle 1

	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

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 standardized SEC per ton. Considering all these situations, the conversion factors and best possible combination and categorization have been worked out so that no Designated Consumer may have any grievance on the targets set out. While setting targets, units best in the group set as reference and then worked out targets for others.

Aspect while framing complete mechanism for PAT scheme:

- 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 certificates can be encouraged, in particular instruments that could increase liquidity in the system.

4.1 General Rules for Establishing Baseline Values

4.1.1 Definitions

Baseline Year

Baseline year is defined as 2009-10.

Baseline Production (P_{base})

The arithmetic average of production figures of 2007-08, 2008-09 and 2009-10

Baseline Specific Energy Consumption (SEC_{base})

The arithmetic average of SEC figures of 2007-08, 2008-09 and 2009-10

Baseline Capacity Utilisation in % (CU_{base})

The arithmetic average of CU figures of 2007-08, 2008-09 and 2009-10

4.1.2. Data Consideration

- In case of plants more than 5 years old, data

for the last 3 financial years will be considered, provided the CU is uniform. Normalization will be done in case of abnormality in CU in any of the three years.

- In case of plants more than 5 years old, but has data for less than 3 years, the same will be considered, provided the CU is uniform. If the CU is abnormally low in any of the years, the same will not be considered.
- In case of plants less than 5 years old and has data for less than 3 years, the available year's (or years') data will be considered, provided the CU is uniform. If the CU is abnormally low in any of the years, the same will not be considered.
- In case of new plants, the data would be considered for the years where the CU is greater than 70%. If data exists for only one year data, the same will be considered irrespective of the CU.

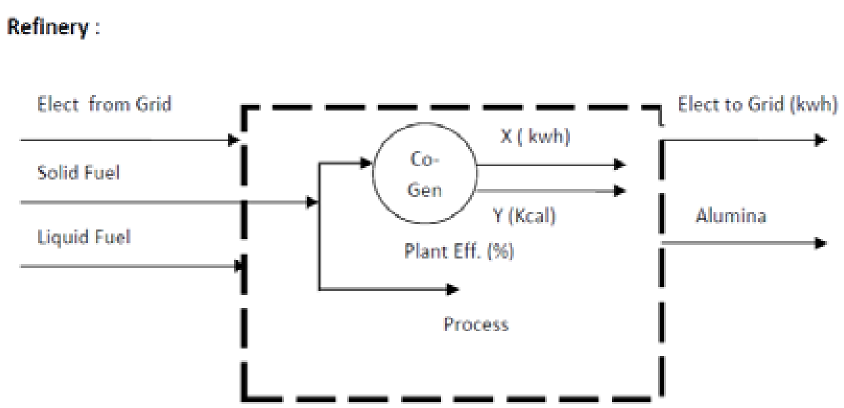
4.1.3 Estimation of Gate-to-Gate Specific Energy Consumption (SEC):

1. The baseline SEC is estimated on a GtG concept.

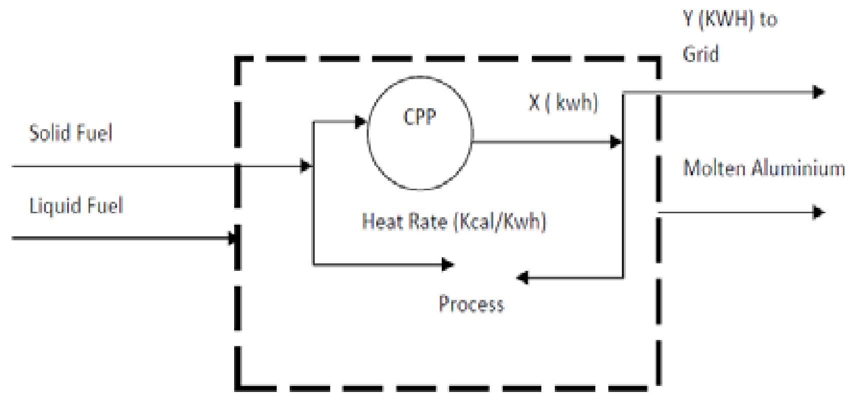
$$\text{GtG SEC} = \frac{\text{All forms of energy converted to tonnes of oil equivalent (toe)}}{\text{Product}}$$

2. The following product definition is considered for the different sub-sectors
   Refinery : Calcined Alumina
   Smelter : Molten Aluminium
   Integrated : Molten Aluminium
   Sheet – Roll Mill : Cold Sheet

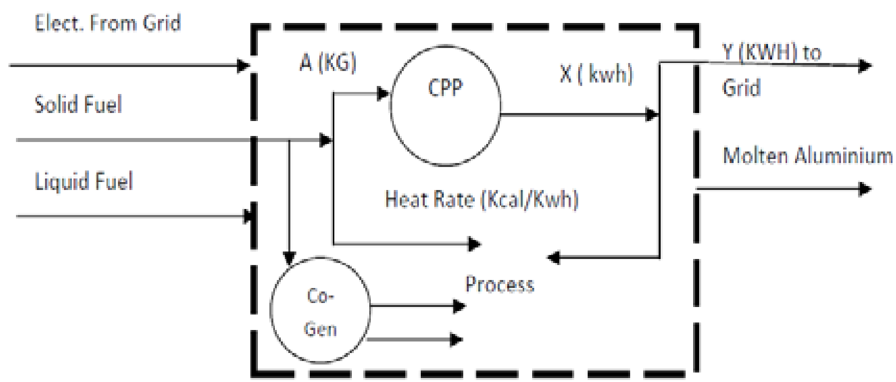
3. The following plant boundaries are considered in the different sub-sectors of this sector as per the data reported by DCs:



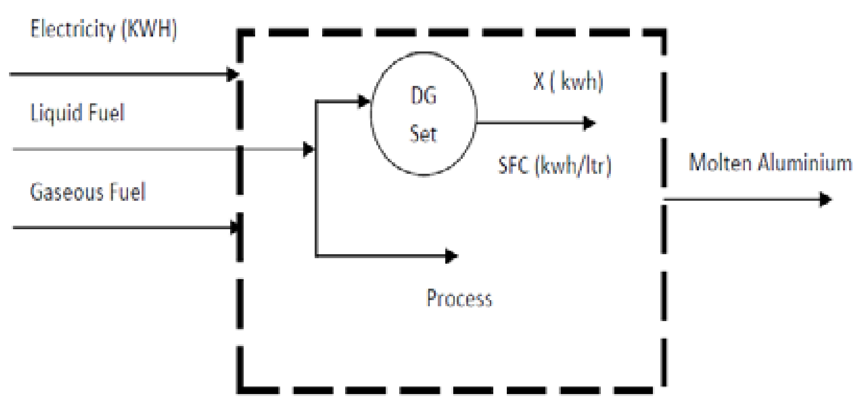
Smelter :



Integrated:



Sheet Roll Mill:



4. The following exclusions are considered:

    - Energy consumed in residential colonies
    - Energy consumed in internal transportation
    - Energy consumed in minor or major construction work

5. The equivalent thermal energy of the electricity supplied to the grid is DEDUCTED from the total energy input to the plant boundary. The following expression is used:

Equiv. Thermal Energy (kCal) = Electricity supplied to Grid (kWh) x 2717 kCal/kWh

6. Correction factors which may be developed for variability during the target period

    - Higher energy consumption due to environmental regulations
    - Energy consumption due to temporary construction works, capacity expansion, etc.

5. Target Setting in Aluminium Plants

1. Sectoral target for the aluminium sector is allocated on a pro-rata basis of total energy consumption among 7 sectors under the PAT scheme; the targets for the thermal power sector have been fixed separately.

2. Sub-sectoral target is allocated on a pro-rata basis of total energy consumption in the sub-sector.

3. The DC level target is allocated based on a statistical analysis derived from relative SEC. This approach will be applicable to all the DCs of only the sub-sector.

Apportionment of Sub-Sector Target of Energy Saving in Aluminium Sector

Sub-Sector	Avg. Energy Cons		Target(Saving)
	Million TOE	%	TOE
Refinery	0.917	11.89	0.054
Smelter	4.505	58.45	0.266
Integrated	2.277	29.54	0.134
Sheet-Roll Mill	0.010	0.13	0.001
TOTAL	7.71	100.00	0.455

4. Calculation of Energy Saving:

Energy Saving = $P_{\text{base year}}(SEC_{\text{base year}} - SEC_{\text{target year}})$

Where Energy Saving is in TOE

$P_{\text{base year}}$ = Production in baseline year (Tonne)

SEC = Specific energy consumption in TOE/Tonne

6. Normalization

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 in calculating the specific energy consumption of the plant within the boundary, so that an undue advantage or disadvantage is not imposed on a DC while gauging 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 assist on evaluating the correct impression of 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, Eartquake,etc)**
- **Major change in Government policy (Hampering plant's process system)**
- **Unforeseen Circu stances (Labour Strike / Lockouts / Social Unrest/Riots)**

The energy performance of any aluminium smelter is affected by various factors (variables) like capacity utilisation, fuel quality, environmental concern, among others. Normalization of these variables is necessary to establish a proper baseline and target.

Normalization factors for the following areas have been developed in the aluminium 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.

- **Fuel Quality in CPP and Co-Gen**
- **Low PLF in CPP**
- **Smelter Capacity Utilisation**
- **Bauxite Quality**
- **Carbon Anode (Import & Export)**
- **Product Mix (Equivalent product)**
- **Power Mix**
- **Environmental Concern (Additional Environmental Equipment requirement due to major change in government policy on Environment)**
- **Biomass/Alternate Fuel Unavailability**
- **Construction Phase or Project Activities**
- **Addition of New Line/Unit (In Process & Power Generation)**
- **Unforeseen Circumstances**
- **Renewable Energy**

6.1 Fuel Quality in CPP and Cogen

Coal is extremelyheterogeneous, 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.

Sr No	Sub-Group	Elements	Reason/ Requirement	Impact	Documents
1	Coal	Use of coal with different calorific value in AY and BY	Coal quality is beyond the control of plant	Boiler Efficiency, Auxiliary Power Consumption	Fuel Quality and Quantity documentation, Energy consumption of mills in AY and BY

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 Design Coal could be considered for Normalization and the correction factor has to be 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

6.1.1 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 normalization 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 decease as per above formulae.

6.1.2 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

6.1.3 Coal Quality Normalization Methodology

- The Boiler Efficiency will be calculated for the baseline as well as assessment year with the help of Coal analysis constituentslike 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 hate will be calculated for the respective year

6.1.4 Normalization Calculation

6.1.4.1 For CPP

Units Boiler efficiency in baseline year = 92.5-[{50xA+630 (M+9H)} / GCV]

Units Boiler efficiency in assessment year = 92.5-[{50xA+630 (M+9H)} / GCV]

Boiler efficiency for Station in BY = Unit #n Capacity (MW) X Unit #n Boiler efficiency (%) in BY / Unit #n Capacity (MW)

Boiler efficiency for Station in AY = Unit #n Capacity (MW) X Unit #n Boiler efficiency (%) in BY / Unit #n Capacity (MW)

The CPP heat rate in assessment year due to fuel quality = CPP heat rate in baseline year x (Boiler Efficiency in baseline year / Boiler Efficiency in assessment year)

Difference in the CPP heat rate of assessment year due to fuel quality = CPP Heat Rate due to Fuel Quality in AY (kcal/kWh)-Actual CPP Heat Rate of BY (kcal/kWh)

Energy to be subtracted w.r.t. fuel quality in CPP (Million kcal) = Difference in the CPP heat rate of AY due to fuel quality (kCal/kWh) X CPP Generation in AY Lakh kWh/10

6.1.4.2 For Co-Gen

Boiler efficiency in baseline year = 92.5-[{50xA+630 (M+9H) } /GCV]

Boiler efficiency in assessment year = 92.5-[{50xA+630 (M+9H)} /GCV]

Weighted Percentage of Coal Energy Used in steam Generation (Process Boiler) in BY = {$\sum_{n=1}^{5}$ (Operating Capacity of all Boilers used for Steam generation in TPH x Percentage of Coal Energy Used in steam Generation in all the boilers for Steam generation in %) / $\sum_{n=1}^{5}$Operating Capacity of all Boilers used for Steam generation}

Weighted Percentage of Coal Energy Used in steam Generation (Process Boiler) in AY = {$\sum_{n=1}^{5}$ (Operating Capacity of all Boilers used for Steam generation in TPH x Percentage of Coal Energy Used in steam Generation in all the boilers for Steam generation in %) /$\sum_{n=1}^{5}$ Operating Capacity of all Boilers used for Steam generation}

Weighted Percentage of Coal Energy Used in steam Generation (Co-Gen Boiler) in BY = {$\sum_{n=6}^{10}$ (Operating Capacity of all Boilers used for Steam generation in TPH x Percentage of Coal Energy Used in steam Generation in all the boilers for Steam generation in %) / $\sum_{n=6}^{10}$ Operating Capacity of all Boilers used for Steam generation}

Weighted Percentage of Coal Energy Used in steam Generation (Co-Gen Boiler) in AY = {$\sum_{n=6}^{10}$ (Operating Capacity of all Boilers used for Steam generation in TPH x Percentage of Coal Energy Used in steam Generation in all the boilers for Steam generation in %) / $\sum_{n=6}^{10}$ Operating Capacity of all Boilers used for Steam generation}

Weighted Average Specific Steam Consumption in BY & AY $_{\text{(kcal/kg of Steam)}}$ = $\sum_{n=1}^{5}$ (Total Steam Generation at Process Boiler x Specific Energy Consumption for Steam Generation in Process Boilers) + $\sum_{n=6}^{10}$ (Total Steam Generation at Co-Gen Boiler x Specific Energy Consumption for Steam Generation in Co-Gen Boiler)} / $\sum_{n=1}^{10}$ Total Steam generation at all the boilers

Normalized Specific Energy Consumption for Steam Generation $_{\text{(kcal/kg of Steam)}}$ = Weighted Average Specific Steam Consumption in BY x (Boiler efficiency at BY/Boiler Efficiency at AY)

Difference Specific Steam from BY to AY $_{\text{(kcal/kg of Steam)}}$ = Normalized Specific Energy Consumption for Steam Generation in AY - Weighted Average Specific Steam Consumption in BY

Energy to be subtracted w.r.t. Fuel Quality in Co-Gen $_{\text{(Million kcal)}}$ **= Difference Specific Steam from BY to AY x {(Total Steam Generation at Process Boiler in AY x Weighted Percentage of Coal Energy Used in steam Generation (Process Boiler) in AY) + (Total Steam Generation at Co-Gen Boiler in AY x Weighted Percentage of Coal Energy Used in steam Generation (Co-Gen Boiler) in AY)} / 1000**

Total Notional energy for Coal Quality deterioration to be subtracted w.r.t fuel quality (Million kcal) = Energy to be subtracted w.r.t.Fuel Quality in CoGen(million kcal) +Energy to be subtracted w.r.t.Fuel Quality in CPP(Million kcal)

Notional Energy for fuel quality in CPP & Co-Gen (toe)= (Total Notional energy for Coal Quality deterioration to be subratced w.r.t fuel quality (Million kcal))/10

6.1.5 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

6.1.6 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

6.2 Low PLF Compensation in CPP

6.2.1 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.

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

Sr No	Sub-Group	Elements	Reason/ Requirement	Impact	Documents
1	Scheduling [External factor] or Backing down	PLF and Station heat rate	• Plant Load backing down due to lower power demand from the grid • Variations in demand from the estimated or forecasted values, which cannot be absorbed by the grid.	Plant Load Factor	i. Scheduling Documents ii. Reference documents are required for deterioration in Plant Load Factor iii. Characteristics curve [Load Vs Heat Rate]
	Unscheduled Power and Outage [External Factor]	PLF and Station heat rate	Transmission outages resulting in reduced power availability.	Plant Load Factor	Characteristics curve-Heat Rate Vs Load

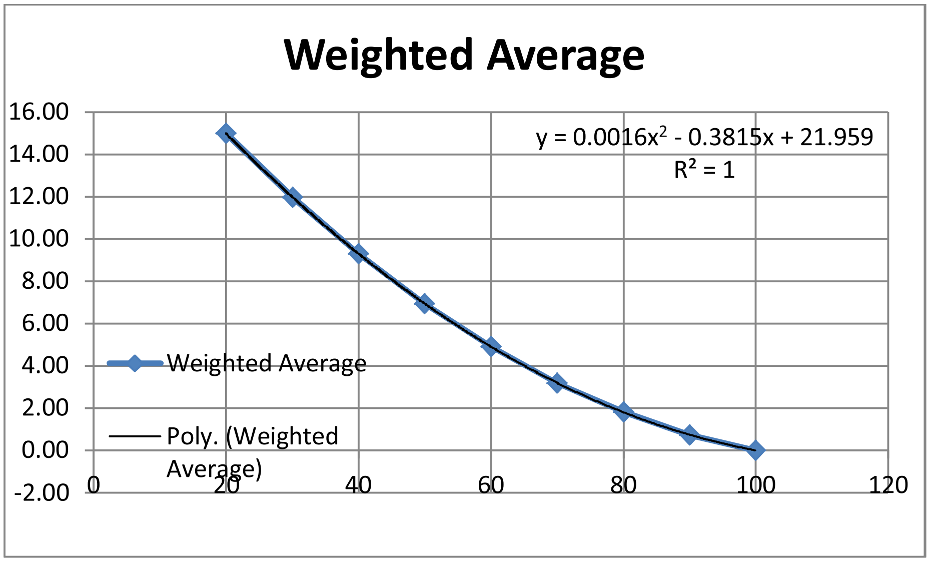
6.2.2 Normalization Methodology

Change in Plant Load Factor (PLF) do affects the plant efficiency and the heat rate. PLF depends on a number of factors. These factors are sometimes under the control of plant operators and sometimes not. Moreover, at different period of times during a year, a plant may not run on a consistent PLF. All such factors which affects the generation, ultimately affects the PLF. It is understood that the plant may not be operating on the same PLF in the Assessment Year as in Baseline Year for internal as well as external reasons. Hence, in PLF normalization,

all such factors which were beyond the control of the plant management, has been taken care of and due advantage has been given. In PLF normalization, like other normalizations, the benefit has been calculated and given in terms of Heat rate which will directly be subtracted from the Net Operating Heat Rate.

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

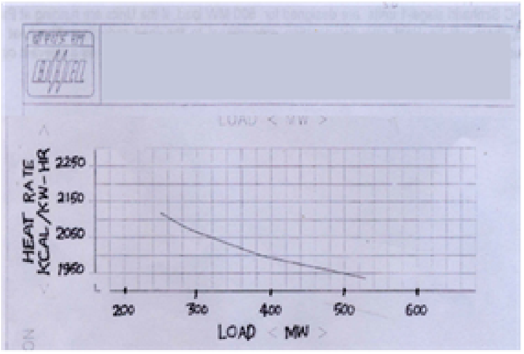
- The decrease in PLF due to external factor in Assessment year w.r.t. Baseline year may deteriorate the CPP heat rate, further increasing/decreasing the SEC
- The Normalization will take place with Plant's respective Turbine Heat Rate Vs Loading curve with the help of Designed HMBD at different loading condition



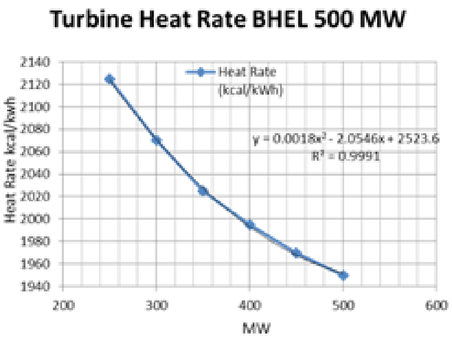
Characteristics Curve

(Load Vs Turbine Heat Rate)

Coal Based Thermal Power Plant Actual Curve



Excel topology of actual curve



- ➢ The polynomial equation of the characteristics curve with accuracy R2=0.9991, will calculate the heat rate on any load
- ➢ The Plant has to submit the documents related to weighted PLF w.r.t. no of hrs (Running time in which the plant desires the Normalisation in loss of PLF influenced by external factor)

- If a plant shuts down due to external reasons, the difference energy consumed during shutdown/restart from Baseline to Assessment year will not be considered in the assessment year Energy Consumption [Proper documents to be provided]
- Curve should be plotted based on HMBD supplied by OEM
- In case of non-availability of HMBD or Curve, data from the similar Unit will be considered
- Curve will be plotted on Unit Basis

6.2.3 Normalization Calculation

Unit wise Plant Availability Factor in BY = (8760-(Forces Outage or Unavailability (hrs)-Planned Maintenance Outage or Planned Unavailability])/8760

Unit wise Plant Availability Factor in AY = (8760-(Forces Outage or Unavailability (hrs)-Planned Maintenance Outage or Planned Unavailability])/8760

Unit wise Total Operating hours in year as per Unit Availability factor = 8760 X Plant Availability Factor

Unit wise Operating hours at full load = Total Operating hours in year as per Unit Availability factor - Average Operating hours at Low ULF

Unit wise Percentage Difference between Design Turbine/Module Heat Rate and Design Curve or HBD Turbine/Module Heat Rate = (Design THR @ 100% Load (OEM) - Design THR @ 100% Load (Curve or HBD) X 100)/(Design THR @ 100% Load (OEM))

Where

THR = Turbine Heat Rate (kcal/kWh)
OEM = Original Equipment Manufacturer
HBD = Heat Balance Diagram

Loading Vs Heat Rate Equation given as y = ax2 - bx + c will be used to calculate the Turbine Heat Rate as per Load Vs Heat Rate Equation due to external factor.

y = ax2 - bx + c (kcal/kWh)
Where
X = Operating Load (MW)
A = Equation Constant 1 =0.0171
b = Equation Constant 2 = 6.6159
c = Equation Constant 3 = 2684.8

Turbine Heat Rate as per Load Vs Heat Rate Equation due to external factor (kcal/kWh) = Equation Constant 1*(Average Operating Load (MW)caused by low ULF,MLF due to external factor)^^ 2-Equation Constant 2* Average Operating Load (MW)caused by low ULF,MLF due to external factor+Equation Constant 3

Design Turbine Heat Rate after Curve correction and difference correction = THR as per Load Vs HR Equation due to external factor X [1 + {% Difference between Design Turbine or Module HR and Design Curve or HBD Turbine or Module HR/ 100}]

Where

THR = Turbine Heat Rate (kcal/kWh)
L Vs HR = Load Vs Heat Rate
HBD = Heat balance Diagram

Normalised Design Turbine Heat rate due to external factor (kcal/kWh) = ((Design Turbine Heat Rate after Curve correction and difference correction (kcal/kwh) X Average Operating

hours at Low ULF) + (Design Turbine Heat Rate @ 100% Load (OEM)(kcal/kwh) X Operating hours at full load))/(Total Operating hours in year as per Unit Availability factor)

Difference of Turbine Heat Rate due to external factor between AY and BY (kcal/kWh) = Normalized Design THR due to external factor in AY - Normalized Design THR due to external factor in BY

Where

THR = Turbine Heat Rate (kcal/kWh)
AY = Assessment Year
BY = Baseline Year

Energy to be subtracted per unit = (Difference of THR between AY and BY (kcal/kWh) X Gross Unit Generation (Lakh Unit))/10

Total Notional Energy to be subtracted due to Low PLF (Million kcal) = Energy to be subtracted in U#1 for AY (Million kcal)+ Energy to be subtracted in U#2 for AY (Million kcal)+ ⋯.

6.3 Smelter Capacity Utilization

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.

As the specific energy consumption (SEC) is calculated on a Gate-to-Gate (GTG) concept, the plant boundary shall be selected in such a manner that the total energy input and the output product be fully captured and the entire designated consumer's plant.

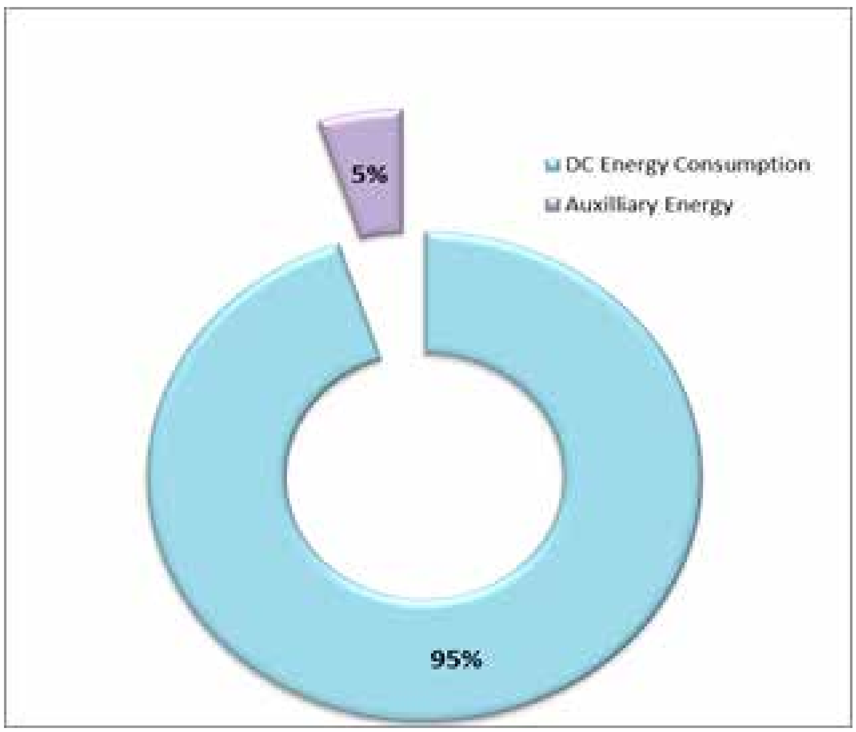
Aluminium smelter's boundary consists of two areas namely Captive Power Plant (CPP) and Smelter plant. The colony, residential complex and transportation system, mining operations of Aluminum sector are not a part of designated consumers' boundary.

The same boundary shall be considered for entire cycle, and any change in the said boundary such as capacity expansion, merger of two plants, division of operation etc. shall be duly intimated to the Bureau of Energy Efficiency.

Smelter and captive power plant of aluminum sector is highly energy intensive. The production of aluminium consists of three steps: bauxite mining, alumina production and electrolysis. Bauxite - a rock composed of hydrated aluminium oxides - is the main ore of aluminium oxide (Al2O3), commonly known as 'alumina', which is used to make aluminium (Al). Mined bauxite is refined into alumina, which is then converted into metallic aluminium via an electrolytic process when high amperage DC current is passed through from anode to cathode in a pot cell. Aluminium thus dissociated from alumina gets collected at cathode.

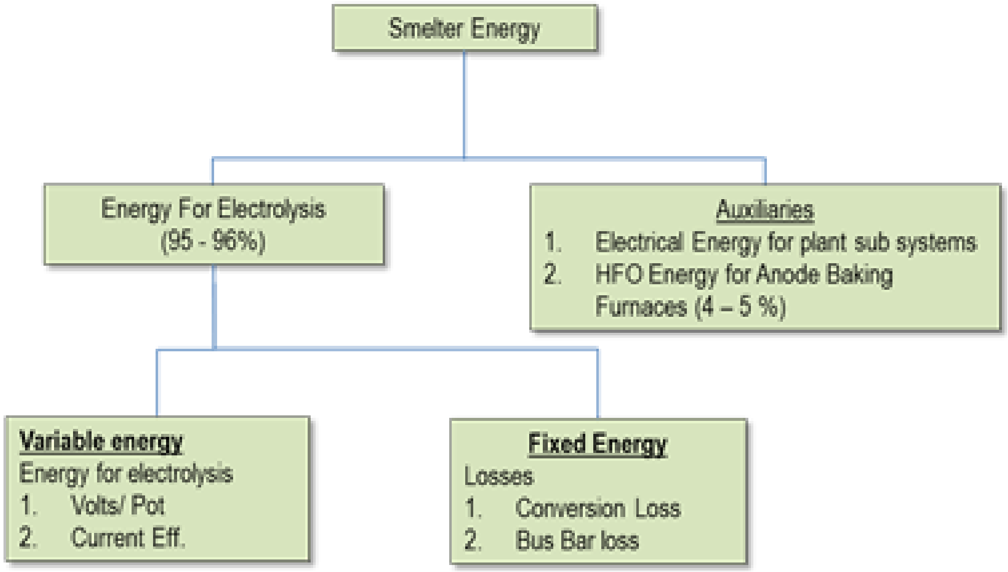
Once aluminium is formed, the hot, molten metal is alloyed with other metals to make a range of primary aluminium products with different properties and suitable for processing in various ways to make end-user products.

A typical aluminum smelter consumes 95% of total energyn Electrolysis process (i.e. DC Electrical energy) and remaining energy is consumed in auxiliary loads of smelter and CPP.



Most of the smelter plants in India operate with coal fired captive power plants and the power plants performance depends on plant load factors and coal quality also.

Hence for normalization of "GTG SEC" in aluminum sectors two major energy performance indicators.



A typical aluminum smelter consumes 95% of total energy in Electrolysis process (i.e. DC Electrical energy) and remaining energy is consumed in auxiliary loads of smelter and CPP.

6.3.1 Terms of Normalization calculation

- Variation in plant Capacity utilization in assessment year may take place from baseline year.
- The variation in capacity utilisation in the assessment year w.r.t. baseline year will be normalised
- Aluminium Smelter's electrolysis process is highly power sensitive and power intensive hence normalization procedure is proposed to be applied due to external factors including power failure factor
- Normalization has been done performing statistical analysis of the specific energy consumption and production data for the industry.
- For smelter plant specific DC energy consumption versus % capacity utilization(for hot metal production) data shall be plotted after collecting design data from all DCs.
- Specific DC energy consumption shall be considered for normalization as it is 95% of total energy consumption in a smelter.

6.3.2 Terms of Normalization

- Aluminium smelter pot line which is commissioning and starting production will not be considered in PAT cycle if capacity utilization is below 50%, as below 50% capacity utilization smelter is in start-up phase and the fixed energy losses are very high and specific DC energy consumption is skewed. Above 50% capacity utilization the smelter energy is mostly variable and fixed energy loss component is marginal.
- Normalization shall not be applicable if there is an enhancement of capacity utilization between baseline period and assessment year and benefit of SEC reduction if any on account of production increase should be given to the DC for achieving higher capacity utilization.

- 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 provided the CU of that Unit/line ≥70% However, the energy consumption and production volume will not be included till it attains 70% CU for calculating SEC in assessment year considering it as project phase. For Pot Line, three months stabilization period may be granted after achievement of 70% CU condition.
- Power failure on account of Grid collapse or due to any other external reason as a factor for SEC normalization if this has caused capacity reduction or plant disturbance for e.g. pot shut down to be applied for the period the plant normal operation is restored. Normalization as per Sr No ii/iii to be considered for smelter and Refinery plant i.e., the energy and production to be deducted from the total energy consumption in the assessment year during stabilization back to equivalent SEC based on normalized curve (CU Vs SEC). Proper documentation is required for Energy and Production data during this period.

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

6.3.4 Capacity Utilization Normalization

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

1. Number of Operating pots(NOP) decrease due to external factor i.e., plant has to run at lower capacity as compared to the baseline operating capacity due to alumina non availability
2. Potline capacity (NOP/NOPP) loss due to market demands/power cuts/power holiday's etc leading to Shutdown of pots due to outages not controlled by plant.

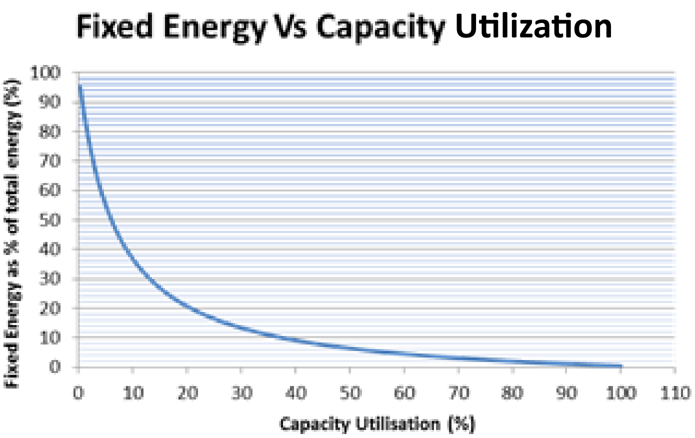
6.3.5 Normalization methodology on Capacity decrease due to external factor

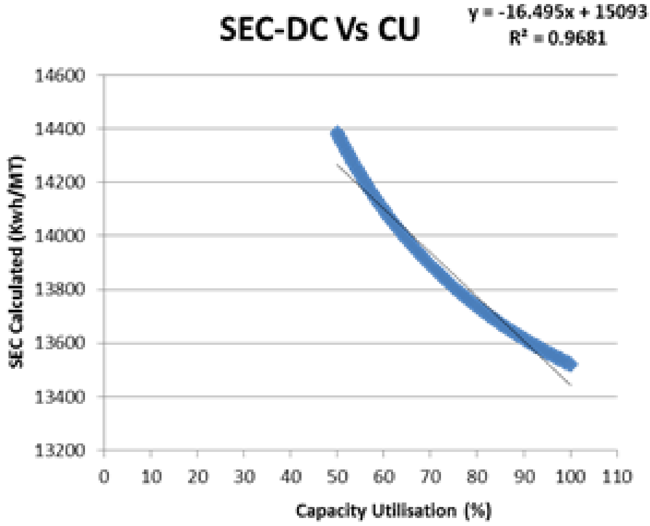
1. Design parameters are considered for plotting normalization curve for smelter capacity utilization.
2. The normalization curve of best fit, may be plant specific based on design data as different plants have different constants (K1 and K2, which are based on No of operating Pots and Nos of Pots/Potline).
3. Normalization in case of capacity utilization may be applicable if there is a decrease in capacity w.r.t baseline period due to external factors as per PAT guideline.
4. The Potline wise plant capacity in the assessment year will be compared from the baseline year in terms of kWh/Tonne design.

JNARDDC study indicates that smelter capacity utilization CU Vs SEC curve of best fit may be derived for each smelter between 50% to 100% capacity utilization as below 50% Capacity Utilisation the fixed energy consumption is high.

- Design parameters for smelters, shall be considered for plotting normalization curve for capacity utilization.
- Curve of best fit shall be derived for each smelter between 50% to 100% capacity utilization as below 50% CU the fixed energy consumption is high
- The normalization curve of best fit, shall be Plant specific based on design data as different Plant has different constants.
- For capacity utilization less then 50%, fixed energy portion of the total energy is increasing drastically
- Below 50% capacity utilization, SEC can not be improved much due to higher portion fixed energy.

VAL Smelter-1 GAMI Design data
1.Stop Pot voltage- 0.25 V / pot
2.Operating Pot Voltage- 4.20 V / pot
3.Potline Bus bar drop- 6 V
4.Current efficiency- 93%
5. No of Pots/ Potline- 304





6.3.6 Normalization Calculation on capacity decrease for Kiln Heat Rate

- **Unit wise K1 – constant 1 in BY & AY=** ((Design Bus Bar Voltage Drop + No of Pots/Potline x Dead pot voltage) x 298000)/ (No of Pots/Potline x Current Efficiency of Pots)
- **Unit wise K2 – constant 1 in BY& AY=** ((Design Pot voltage - Dead pot voltage) x 2980)/ (Current Efficiency of Pots)
- **Unit wise Capacity Utilisation in BY& AY=** ((No of operating pots/No of pots/ potline) x 100)
- **Unit wise SEC Design at CU% (kWh/ tonne) in BY& AY** = (K1/Capacity utilisation) +K2
- **Unit wise Notional Specific Energy Consumption** = Unit wise SEC Design at CU % in AY - Unit wise SEC Design at CU % in BY
- **Unit wise Electrical Energy to be deducted due to lower capacity utilisation (Million kWh)**
If capacity utilization % in AY < capacity utilization % in BY, Electrical energy to be deducted = Notional Specific Energy Consumption forPotline 1 x Production /10^6

If capacity utilization % in AY > capacity utilization % in BY, Electrical energy to be deducted = 0

- **Total Electrical Energy to be deducted due to lower capacity utilisation** = Electrical Energy to be deducted due to lower capacity utilisation for AY of Line 1 + Electrical Energy to be deducted due to lower capacity utilisation for AY of Line 2 + ………………Line 10
- **Electrical Energy to be deducted due to lower capacity utilisation** = Total Electrical Energy to be deducted due to lower capacity utilisation (Milliom kWh) X Weighted Heat Rate (kcal/kWh)
- **Notional Energy for Smelter capacity utilization (toe)** = (Electrical Energy to be deducted due to lower capacity utilisation (Million kcal))/10

6.3.7 Note on New Line /Production Unit installed after baseline year

In case a DC adds capacity within the boundary by commissioning a new Potline after baseline year, the production and energy consumption of new Potline will be considered in the total plant's production volume and energy consumption while calculating SEC provided CU of new pot line is more than 70% and the Pot line has completed at least 90 days of normalization period after commissioning of 70% of pots. If the above condition is not satisfied then the energy consumption & production of the pot line may be excluded for calculating plant's SEC.

In case of addition of new Potline, a DC may submit all relevant design data of new Pot line to JNARDDC and BEE for calculating normalization curve for the newly commissioned Potline.

6.3.8 Documentation

A. Documentary proof for unavailability of Raw Material, Alumina and Fuel
B. Power Cut/ Power Holiday documents from respective Boards
C. Force Major condition documents: Flood, Earthquake, Labor Strike, Rioting or Social unrest, Change in Government policy
D. Production documents for Molten Aluminium [MPR/CCR Trend/Lab Report or Register or other supporting documents]
E. Casting Product (Import and Export) (Excise documents/Internal transfer details)
F. The individual potline wise production, Current efficiency and run hours data required for the baseline years with supporting documents

6.4 Bauxite Quality

Bauxite, the most important ore of aluminium, contains only 30–54% aluminium oxide, (alumina), Al2O3, the rest being a mixture of silica, various iron oxides, and titanium dioxide. The Bayer process is the industrial route to produce alumina, Four Tonne of bauxite required to produce one tonne of alumina.

- Roughly 5,900 kg of earth are mined to produce 5,100 kg of bauxite, which is refined into 1,930 kg of alumina (2.65 t of bxt/t of Alumina).
- The 1,930 kg of alumina are electrolytically processed with 446 kg of carbon to produce one metric ton (1,000 kg) of aluminium (5.1 t of bxt/t of Aluminium)

- Bauxite residue (red mud) is a by product of the Bayer process and contains the insoluble impurities of bauxite.
- The amount of residue generated per kilogram of alumina produced varies greatly depending on the type of bauxite used and impurities present in bauxite, from 0.3 kilograms for high-grade bauxite to 2.5 kilograms for low-grade bauxite.
- Its chemical and physical properties depend primarily on the bauxite used and, to a lesser extent, the manner in which it is processed.

6.4.1 Need for Normalization

- The quality of the bauxite available for manufacturing alumina hydrate is deteriorating over a period of time. This has significant effect on the overall energy consumption of the plant
- Energy consumption will increase with the decrease in TAA% in Bauxite in Evaporation
- The evaporation section helps in Bayer circuit by removing plant dilution caused by wash water and Bauxite Moisture.
- The evaporation of excess moisture w.r.t Baseline year increases Steam consumption so as the energy consumption in the assessment year
- Normalization with respect to bauxite quality (ATH/THA/TAA) and its impact on excess energy requirement in evaporating accompanying bauxite moisture and excess water for red mud washing has been developed
- Change in ATH, THA, TAA affect the quality of the bauxite and the Bayer process, resulting in loss/gain in the plant's energy consumption. To compensate for the change in efficiency of Plant with change in bauxite quality, the energy loss to be subtracted from the Total Energy consumption
- The plant have no control over the quality of bauxite supplied.
- The excess electrical energy consumed because of deviation in bauxite quality is not considered as it is negligible as compared to the thermal energy.

6.4.2 Normalization Calculation

Specific Bauxite Factor (SBC): 1/(TAA% * (100-Moisture) % * Ov'll Recovery %)

Wash Water required in Tonnes (WW) : SBC * (100-Moisture) % * Mud Factor * Wash Water per ton Mud

Excess Steam Consumption (ESC_{AY}) = $((SBC_{AY}-SBC_{BY}) \times M_{AY} + (WW_{AY} - WW_{BY}))/ESE_{AY}$

Notional Energy for Moisture Evaporation = ESCAY x SEAY / (ηAYx10^3)

Where

M_{AY} = *Moisture in Bauxite in Assessment year*

SBC_{AY} = *Specific bauxite factor in Assessment year*

WW_{AY} = *Wash Water requirement in Assessment year*

SBC_{BY} = *Specific bauxite factor in Baseline year*

WW_{BY} = *Wash Water requirement in Baseline year*

ESE_{AY} = *Evaporation Steam Economy in Assessment year*

ESCAY = *Excess Steam Consumption in Assessment year*

SE_{AY} = *Steam Economy in Assessment year*

η_{AY} = *Boiler Efficiency in Assessment year*

Detailed Calculation of Normalization

- **Specific bauxite Factor in BY & AY (tonne of Bauxite/Tonne of Alumina)** = 1/(TAA in Bauxite for BY X (100 – Moisture content in Bauxite for BY) X Overall recovery from Bauxite for BY)
- **Mud Factor in BY & AY (tonne of mud/ Tonne of Bauxite)** = Fe in Bauxite for BY / Fe in Mud for BY
- **Wash Water in BY & AY (Tonns)** = Specific bauxite factor in BY X (100-Moisture content in Bauxite for BY)% X Mud Factor X wash water required for cleaning one Tonne of mud
- **Excess wash water (Tonne)** = Wash water for AY (Tonne) - wash water for BY (Tonne)
- **Excess Moisture (Tonne)** = (Specific bauxite factor in AY - Specific bauxite factor in BY) X Moisture content in AY
- **Excess Steam (tonne)** = Excess Moisture (Tonne) + Excess wash water (Tonne) / Steam economy (tonne/tonne) in AY
- **Notional energy for moisture (kCal/ Tonne)** = Excess steam (Tonne) in AY X Actual steam Enthalpy (kCal/kg) X 1000 / Boiler efficiency (%) in AY
- **Notional energy to be subtracted (Million Kcal) in AY** = notional energy for moisture (kCal/Tonne) X Total Hydrate alumina production (Tonne) / 10^6

6.4.3 Documentation

- Fuel Linkage Agreement
- Operating Bauxite Quality-Monthly average of the lots, Test Certificate for B**auxite** Analysis
- Electrical and Thermal energy consumption for red mud evaporation.
- 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

6.5 Carbon Anode Production

- Carbon anodes are a major requirement for the Hall-Heroult process.
- About 0.5 tons of carbon is used to produce every ton of aluminum.
- There are two main types of carbon anode used
  - Prebaked: Prebaked anodes consist of solid carbon blocks with an electrically conductive rod (e.g. copper) inserted and bonded in position usually with molten iron.
  - Soderberg: A mixture of petroleum coke and pitch is strongly heated causing the pitch to bind the coke particles together
- Both types are made from the same basic materials i.e., Petroleum Coke and react in the same way.
- Anodes used in potlines are produced in house in a separate anode plant by pre-baked technology from a mixture of petroleum coke and coal tar pitch (acting as a binder)

6.5.1 Methodology:

In Smelter plant of Aluminum industries carbon anode is produced and consumed for producing the Molten Aluminum. Considering this fact it may happen that carbon anode product

which they produce in the baseline year may be changed in the assessment year. Also due to market demand of molten aluminium, they export their carbon anode to the market/stock. This import and export may deviate the SEC of the plant in the assessment year.

- ❑ In Pre-bake technology, anode blocks are produced separately in anode baking ovens. The additional thermal energy required for anode baking is met by Furnace Oil
- ❑ Normalization due to Anode import/ export is applicable if the Baseline and Assessment year scenarios are different.
- ❑ The import/export of carbon anode will be treated as Intermediary product normalization
- ❑ In case a DC exports anodes in target year, the energy for the same shall be excluded while calculating SEC in assessment year.
- ❑ Similarly in case a DC imports anodes in addition to own production then energy consumption for the imported anodes shall be factored in Gate to Gate energy calculated based on own anode production SEC
- ❑ Normalization due to Anode import/ export is applicable if the Baseline and Assessment year scenarios are different.

6.5.2 Need for Normalization

Import of carbon anode for production of Molten aluminium is common practice in Aluminum industry along with export of carbon anode also undertaken as per molten aluminium production. The change in the proportion of import or export during baseline year to target year may affect the SEC of the plant.

For carbon anode production 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.

Carbon Anode import by the plant (for which part of the energy is not required to be used by the plant) and Carbon Anode export from the plant for which energy has been used but it is not taken into account in the Molten Aluminum production.

6.5.3 Normalization Methodology

- In case of import of carbon anode product, if import of that product was not present in the baseline year then the amount of product which is being imported in the assessment year will be taken and accordingly the energy consumption for producing the said amount of carbon anode product shall be calculated with the help of SEC of carbon anode product. This energy shall be added to the total energy of the plant. The rationale behind this is the energy consumption for producing imported carbon anode product if carbon anode would have produced within the plant itself.
- In case of export of carbon anode produce: The production and energy consumption for producing that much of amount of product shall be subtracted from the total energy and total production of the plant respectively.

  Note: The stock is also considered as export of carbon anode production

Normalization Calculation:

- **Stock in BY & AY** = Carbon anode Closing Stock in BY & AY – Carbon anode Opening Stock in BY& AY

- **Total Carbon anode Export**
  1. **In Baseline Year**
     a. If, Stock in BY > 0, Total Carbon anode export in BY = Export Carbon anode in BY + Stock in BY
     b. If , Stock in BY < 0, Total Carbon anode export in BY = Export Carbon anode in BY
  2. **In Assessment Year**
     a. If, Stock in AY > 0, Total Carbon anode export in AY = export Carbon anode in AY + Stock in AY
     b. If , Stock in AY < 0, Total Carbon anode export in AY = export Carbon anode in AY

- **Total Carbon anode import**
  1. **In Baseline Year**
     a. If, Stock in BY < 0, Total Carbon anode import in BY = import Carbon anode in BY - Stock in BY
     b. If , Stock in BY > 0, Total Carbon anode import in BY = import Carbon anode in BY
  2. **In Assessment Year**
     a. If, Stock in AY > 0, Total Carbon anode import in AY = import Carbon anode in AY + Stock in AY
     b. If , Stock in AY < 0, Total Carbon anode import in AY = import Carbon anode in AY

- **Notional energy for carbon anode exported**
  1. **In Baseline Year**
     a. Notional energy for carbon anode exported in BY = SEC of carbon anode production in BY X Total Carbon anode exported in BY
  2. **In Assessment Year**
     b. Notional energy for carbon anode exported in AY = SEC of carbon anode production in AY X Total Carbon anode exported in AY

- **Notional energy for carbon anode imported**
  1. **In Baseline Year**
     a. Notional energy for carbon anode imported in BY = SEC of carbon anode production in BY X Total Carbon anode imported in BY
  2. **In Assessment Year**
     b. Notional energy for carbon anode imported in AY = SEC of carbon anode production in AY X Total Carbon anode imported in AY

- **Net energy for carbon anode export and import**
  1. **In Baseline Year**
     a. Net energy for carbon anode export and import in BY= Notional energy for carbon anode exported in BY -Notional energy for carbon anode imported in BY
  2. **In Assessment Year**
     b. Net energy for carbon anode export and import in AY= Notional energy for carbon anode exported in AY -Notional energy for carbon anode imported in AY

- ❖ **Notional energy to be subtracted for carbon anode export and import in AY** = Net energy for carbon anode export and import in AY - Net energy for carbon anode export and import in BY

6.5.5 Documentation

- Purchase and sell document of carbon Anode
- Carbon Anode production documents of Smelter plant
- Carbon Anode – Excise Documents

6.6 Power Mix

6.6.1 Baseline Year Methodology:

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

- Electricity Imported from grid @ 860 kcal/kWh
- CPP generated Electricity @ Actual CPP Heat Rate
- DG generated Electricity @ Actual DG Heat Rate
- Electricity Exported to grid @ 2717 kcal/kWh

6.6.2 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 @ 860 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

6.6.3 Power Mix Normalization methodology

6.6.3.1 *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

6.6.3.2 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.

6.6.4 Power Mix Normalization Calculation

6.6.4.1 Normalization for Power Sources

Normalised Weighted Heat Rate for Assessment year (kcal/kwh):

J = A x (D/G)+B x (E/G)+C x (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 $PSiHR_{AY}$ x ($PSiEC_{BY}$/TEC_{BY})

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

PS_iEC_{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)

Energy Correction in the assessment year Million kcal to be subtracted in the total Energy of Plant,

Energy Correction for all power source =
H x (I-J)

H: Total energy consumption from all the Power sources (Grid, CPP, DGetc) for AY in Million kwh

I: Actual Weighted Heat Rate for the Assessment Year in kcal/kwh

6.6.5 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 would be

- 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

The energy to be subtracted in the assessment year in Mkcal:

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

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 %

6.6.6 Documentation

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

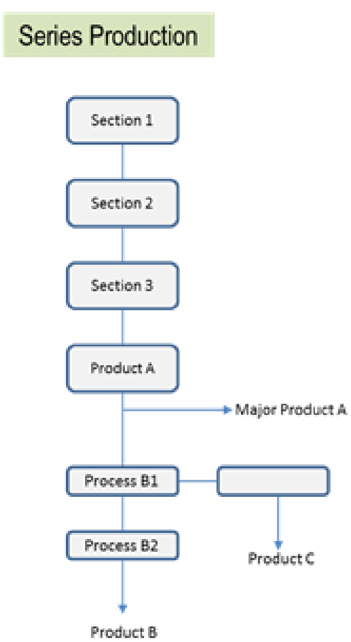
6.7 Product Mix

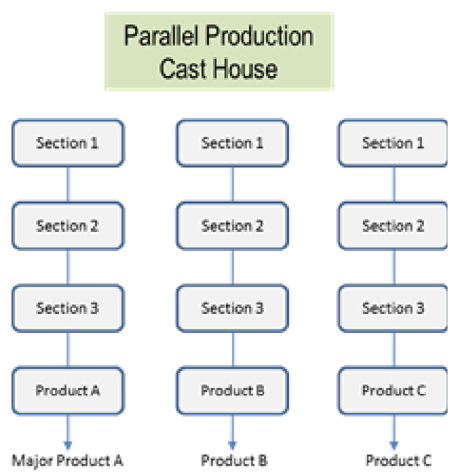
Production quantity is an important relevant variable, but is often difficult to determine; especially for an organization producing various products, since the quantity unit and SEC differs between products

Annual Sales differs in the Assessment years compared to the Baseline Year due to many external factors such as Market Demand, Socio Economic Condition, Government Policy etc. Such external factors sometimes affect the production quantity ratio of the organization

A designated consumer (DC) may have different product mix and the ratio of product mix may vary from baseline period to target year. Hence there has to be right comparison of product mix between base line period and target year. Some product may be more energy intensive and product yield and scrap rate may vary from product to product depending on the finished product.

In product mix (Refinery and Smelter) the baseline year product energy factor (Energy Factor) will be maintained for equivalent major product in the assessment year.





6.7.1 Common Methodology

- ❑ The Specific Energy Consumption (SEC) should be known for each product
- ❑ The methodology will be used for Parallel and Series line production
- ❑ One major product to be chosen among the products for parallel line production, the product which is sold out will be included after conversion into the equivalent product
- ❑ For Series production major product is fixed, all the products or value added product will be converted to the major product with the help of specific energy consumption (SEC) factor
- ❑ The Energy factor of baseline will be used to convert other products to the major product in the Assessment Year
- ❑ The Major product will be kept same in the Assessment Year as of Baseline Year
- ❑ In the Refinery sub-sector, plant may have different product mix based on process like Standard hydrate or special alumina apart from calcined alumina
- ❑ Hence, different types of products needs to be converted in to equivalent major product produced by that plant with the help of energy factor, based on the SEC of the product.

Calcined Alumina Making

- ❑ Calcined Alumina making is a series process plant after the intermediate product of Hydrated Alumina
- ❑ Hydrated Aumina or Calcined Aumina can be exported or imported in Refinery or Integrated Aluminum plant
- ❑ Special or Standard Alumina are being made after after griding or milling
- ❑ Import/Export of product will be covered as Intermediary product normalisation

Aluminium Making

- ❑ Molten Aluminium is the major Product in case of Smelter
- ❑ Other cast house production will be made equivalent to the major product using the Baseline Energy Ratio in the Assessment Year
- ❑ Exclusion methods for plants having series system and inclusion method for plant running in parallel system for product mix normalization have been adopted

6.7.2 Normalization Calculation

(i) **Equivalent production (In Major Product) in the Baseline Year (BY) will be**

$$\mathbf{EqMP_{BY}=PP1_{BY}+(PP2_{BY}*EFP2_{BY})+(PP3_{BY}*EFP3_{BY})}$$

Major Product: Product 1 in the baseline year (Tonnes)

Where

$EqMP_{BY}$ = *Total equivalent product in Major Product in BY (Tonne)*

$PP1_{BY}$ = *Total Product 1 production in BY (Tonne)*

$PP2_{BY}$ = *Total Product 2 production in BY (Tonne)*

$EFP2_{BY}$ = *Product 2 energy factor with respect to Product 1 in BY*

$PP3_{BY}$ = *Total Product 3 production in BY (Tonne)*

$EFP3_{BY}$ = *Product 3 energy factor with respect to Product 1 in BY*

BY= *Baseline Year*

(Note: Any addition in series or parallel product will attract the same fraction and to be included

in the above equation as PPi_{BY} x $EFPi_{BY}$)

The Energy factor for the baseline will be calculated as

$EFP2_{BY} = SECP2_{BY}/SECP1_{BY}$
$EFP3_{BY} = SECP3_{BY}/SECP1_{BY}$
……
$EFPi_{BY} = SECPi_{BY}/SECP1_{BY}$

Where

***$EFP2_{BY}$** = Product 2 energy factor with respect to Product 1 in BY*

***$EFP3_{BY}$** = Product 3 energy factor with respect to Product 1 in BY*

***$EFPi_{BY}$** = Product ith energy factor with respect to Product 1 in BY*

***$SECP1_{BY}$** = Specific Energy Consumption of Product 1 in BY*

***$SECP2_{BY}$** = Specific Energy Consumption of Product 2 in BY*

***$SECP3_{BY}$** = Specific Energy Consumption of Product 3 in BY*

***$SECPi_{BY}$** = Specific Energy Consumption of Product ith in BY*

(ii) **Condition 1, No new product is introduced in the assessment year i.e., if $PPi_{BY\neq}0$ and $PPi_{AY}\neq 0$ then**

Equivalent production (In Major Product) in the Assessment Year (AY) will be

$EqMP_{AY} = PP1_{AY} + (PP2_{AY}*EFP2_{BY}) + (PP3_{AY}*EFP3_{BY})$

Major Product: Product 1 in the baseline year (Tonnes) and will remain same in the assessment year

Where

***$EqMP_{AY}$** = Total equivalent product in Major Product in AY (Tonne)*

***$PP1_{AY}$** = Total Product 1 production in AY (Tonne)*

***$PP2_{AY}$** = Total Product 2 production in AY (Tonne)*

***$EFP2_{BY}$** = Product 2 energy factor with respect to Product 1 in BY*

***$PP3_{AY}$** = Total Product 3 production in AY (Tonne)*

***$EFP3_{BY}$** = Product 3 energy factor with respect to Product 1 in BY*

***AY**= Assessment Year*

(iii) **Condition 2, Due to introduction of new product in the assessment year, the production of new introduced product in the baseline year will be 0 i.e., if $PPi_{BY}=0$ and $PPi_{AY}\neq 0$ then**

Equivalent production (In Major Product) in the Assessment Year (AY) with 4th new introduced product will be

$EqMP_{AY} = PP1_{AY} + (PP2_{AY}*EFP2_{BY}) + (PP3_{AY}*EFP3_{BY}) + (PP3_{AY}*EFP4_{AY})$

Major Product: Product 1 in the baseline year (Tonnes) and will remain same in the assessment year

Where

***$PP4_{AY}$** = Total Product 4 production in AY (Tonne)*

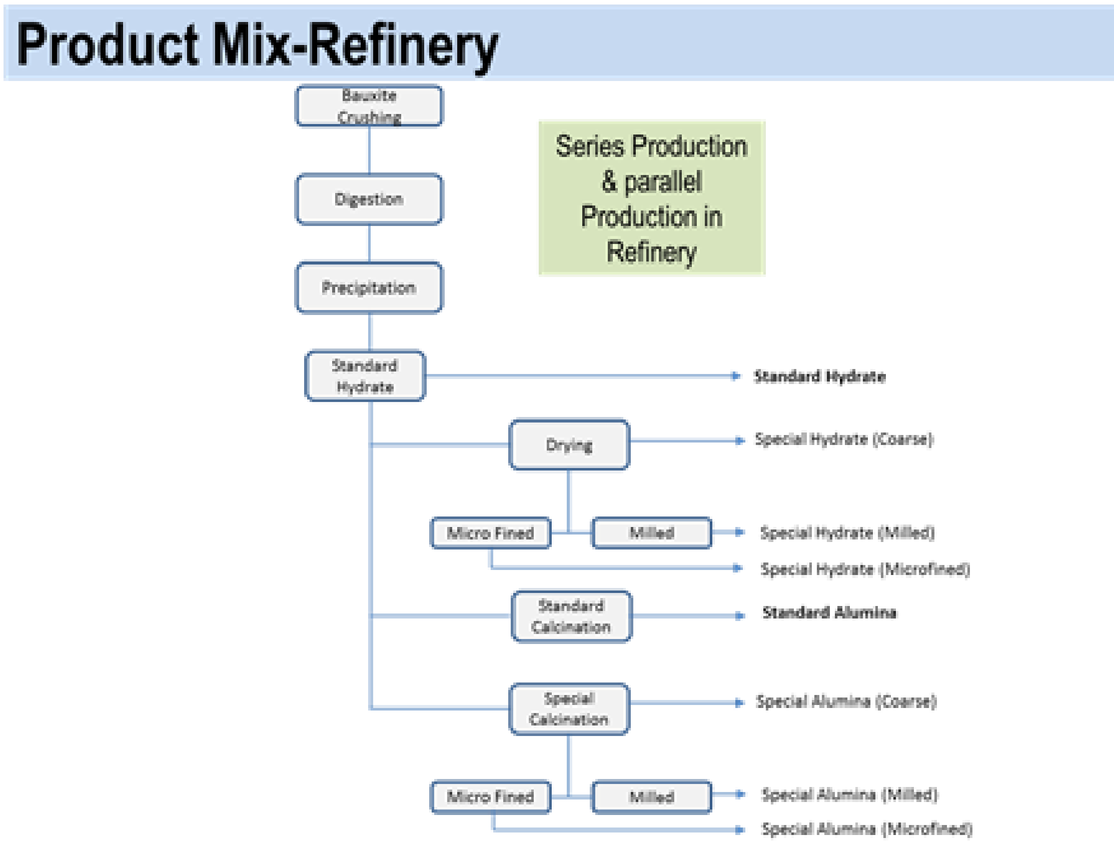
***$EFP4_{AY}$** = Product 4 energy factor with respect to Product 1 in AY*

$EFP4_{AY} = SECP4_{AY}/SECP1_{BY}$

***AY**= Assessment Year*

6.7.3 Refinery Process

In Refinery Industries, many plants do the work of value addition in Calcined Alumina/Hydrate Alumina due to demand of their customers or by their own. These value additions are of different type and sometimes increase the quality of the products. The impact of value addition results increase in the SEC of the plant. A typical Production process of plant is shown below



6.7.3.1 Baseline Year Methodology:

In the refinery plants of aluminium sector there are wide variety of value added products are produced after hydrate alumina/Calcined alumina production. In baseline year, Calcined alumina was considered as major product and the production of value added products were not converted into equivalent major product.

6.7.3.2 Need for Normalization

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

- 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 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 Smelter Plant can import or export Calcined Alumina, which is an intermediately product but not the final product i.e., Molten Alumina may change

If any plant produces a product P and SEC of the product is 'S' in baseline year. But the same plant perform the value addition in assessment year and produce the same quantity of same product, the amount of energy consumption for value addition increases the SEC of the product. For the same amount of product in baseline and assessment year, the SEC will differs. Therefore, value addition normalization shall be applicable in such cases. This normalization factor will accounts for the deviation of SEC from the baseline year due to the factors which are beyond the control of the plant management.

6.7.3.4 Normalization Methodology:

Baseline year Equivalent Molten Aluminium production:

The methodology on value added product normalization is given below

1. The baseline year value added product mix ratio will be maintained for Assessment year.
2. The product mix ratio is given by following equation

   Product mix = Specific Energy Consumption of that product produced in Baseline year/ specific energy consumption of major product produced in Baseline year
3. The Baseline year Equivalent major product is calculated from the baseline year value added product mix ratio will be compared with the baseline year production and theassessment year Equivalent major product is calculated from the baseline year value added product mix ratio will be compared with the assessment year production

6.7.3.4 Normalization calculation:

6.7.3.4.1Energy Factor

D = Specific Energy Consumption of Special Calcined Alumina Milled in Baseline year/ Specific Energy Consumption of Calcined Alumina in Baseline Year

F = Specific Energy Consumption of Special Calcined Alumina Microfined in Baseline year/ Specific Energy Consumption of Calcined Alumina in Baseline Year

H = Specific Energy Consumption of Special Calcined Alumina Course in Baseline year/ Specific Energy Consumption of Calcined Alumina in Baseline Year

J = Specific Energy Consumption of Special Hydrate Alumina Milled in Baseline year/ Specific Energy Consumption of Calcined Alumina in Baseline Year

L = Specific Energy Consumption of Special Hydrate Alumina Microfined in Baseline year/ Specific Energy Consumption of Calcined Alumina in Baseline Year

N = Specific Energy Consumption of Special Hydrate Alumina Course in Baseline year/ Specific Energy Consumption of Calcined Alumina in Baseline Year

P = Specific Energy Consumption of Standard Hydrate Alumina in Baseline year/ Specific Energy Consumption of Calcined Alumina in Baseline Year

(Note: Any addition in the value added product will attract the same conversion fraction)

6.7.3.4.2 Baseline year Equivalent Calcined Alumina production:

A=B+(C*D)+(E*F)+(G*H)+(I*J)+(K*L)+(M*N)+(O*P)

Where

B = Total Calcined Alumina production of Baseline Year in Tonne

C = Total Baseline year Special Calcined Alumina Milled production in Tonne

D = Energy factor of Special Calcined Alumina Milled into Molten Aluminium in Baseline Year

E = Total Baseline year Special Calcined Alumina Microfinedproduction in Tonne

F = Energy factor of Special Calcined Alumina Microfinedinto Molten Aluminium in Baseline Year

G = Total Baseline year Special Calcined Alumina Course production in Tonne

H = Energy factor of Special Calcined Alumina Course into Molten Aluminium in Baseline Year

I = Total Baseline year Special Hydrate Alumina Milled production in Tonne

J = Energy factor of Special Hydrate Alumina Milled into Molten Aluminium in Baseline Year

K = Total Baseline year Special Hydrate Alumina Microfined production in Tonne

L = Energy factor of Special Hydrate Alumina Microfined into Molten Aluminium in Baseline Year

M = Total Baseline year Special Hydrate Alumina Course production in Tonne

N = Energy factor of Special Hydrate Alumina Course into Molten Aluminium in Baseline Year

O = Total Baseline year Standard Hydrate Alumina production in Tonne

P = Energy factor of Standard Hydrate Alumina into Molten Aluminium in Baseline Year

(Note: Any addition in the value added product will attract the same fraction to be included in the above equation as PRi_{AY} x $VAPi_{BY}$)

6.7.3.4.3 Assessment year Equivalent Molten Aluminium production:

For Assessment year, the Energy factor of baseline will be used to calculate the Equivalent product for respective product. However, any introduction of new product in the assessment year will draw the SEC of the newly introduced product into the Energy factor and equivalent product is to be calculated accordingly. Thus, the Numerator SEC of the above calculation of energy factor of baseline will change to SEC of the respective product in the assessment year as **$EFPi_{AY}$ = $SECPi_{AY}$/$SECP1_{BY}$**. Rest of the calculation remain same.

Equivalent Calcined Alumina =Q + (R*D) + (S*F)+(T*H)+(U*J)+(V*L)+(W*N)+(X*P)

Q = Total Calcined Alumina production forAssessment Year in Tonne

R = Total Special Calcined Alumina Milled production for Assessment Year in Tonne

D = Energy factor of Special Calcined Alumina Milled into Molten Aluminium in Baseline Year

S = Total Assessment year Special Calcined Alumina Microfined production in Tonne

F = Energy factor of Special Calcined Alumina Microfined into Molten Aluminium in Baseline Year

G = Total Assessment year Special Calcined Alumina Course production in Tonne

H = Energy factor of Special Calcined Alumina Course into Molten Aluminium in Baseline Year

U = Total Assessment year Special Hydrate Alumina Milled production in Tonne

J = Energy factor of Special Hydrate Alumina Milled into Molten Aluminium in Baseline Year

V = Total Assessment year Special Hydrate Alumina Microfined production in Tonne

L = Energy factor of Special Hydrate Alumina Microfined into Molten Aluminium in Baseline Year

W = Total Assessment year Special Hydrate Alumina Course production in Tonne

N = Energy factor of Special Hydrate Alumina Course into Molten Aluminium in Baseline Year

X = Total Assessment year Standard Hydrate Alumina production in Tonne

P = Energy factor of Standard Hydrate Alumina into Molten Aluminium in Baseline Year

(Note: Any addition in the value added product will attract the same fraction to be included in the above equation as PRi_{AY} x CFi_{BY})

6.7.3.5 Documentation

A. Production documents [Ex-Log sheets, DPR. MPR, Lab Report/register/ SAP Data]
B. Products sale – Excise Documents

6.7.4 Smelter Process

Intermediary product:

Option 1: The energy of any product exported from the plant in between the process will be subtracted from the total energy input from the plant (Applicable if small quantity of intermediate products are being exported)

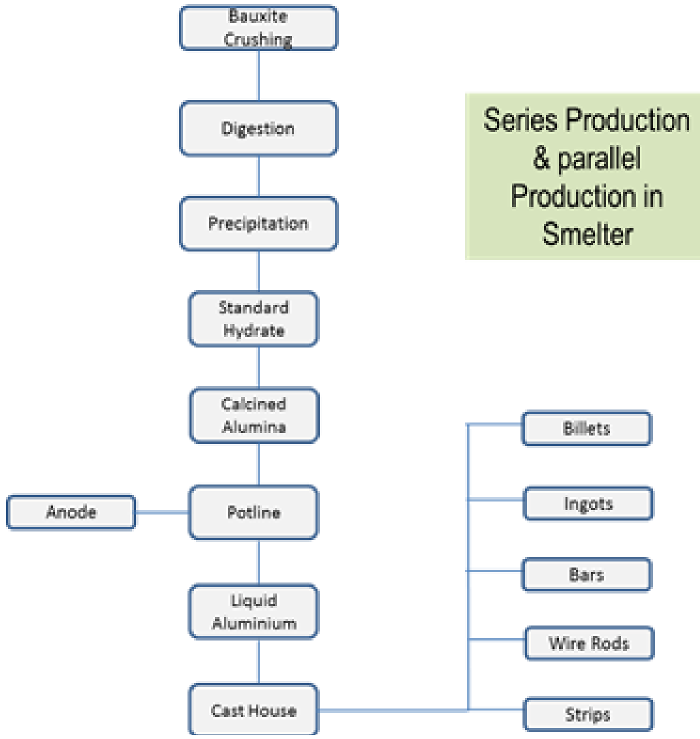
Option 2: The intermediary product exported will be converted to major product and notional energy to be added in the total input energy (Applicable if large quantity of intermediate products are being exported)

Imported Intermediary product: Similarly, For entry of input at intermediate stage, notional energy consumption of previous stages to be added with consideration of recovery/yield of the avoided stages

Exported product after major output product: All the product after major product will be converted to equivalent major output product in energy equivalent terms

Example: in case of Smelter, the cast house product will be converted to Molten Alumina in energy equivalent terms

The series and parallel production is shown below



6.7.4.1 Baseline Year Methodology:

In the smelter plants of aluminium sector there are wide variety of value added products are produced in the cast house after hot metal production. In baseline year, production of value added products in the cast house werenot converted into equivalent major product.

6.7.4.2 Need for Normalization

Due to market demand the product mix(some products consume higher energy whereas other consume comparatively less) of the value added products in the cast house varies during assessment year with respect to Baseline year, there is a need to develop and impose proper Normalization factors, so that any change in thecast house product mix could be nullified and the concerned plant should not suffer / or gain advantage due to this change only.

- ❑ The Import and export of intermediary product
- ❑ The major product remain the same for Baseline as well as the Assessment year
- ❑ True reflection of Energy performance improvement or deterioration in the assessment year w.r.t. baseline year in any of the downstream or specialty product

6.7.4.3 Normalization Methodology:

6.7.4.3.1 Baseline year Equivalent Molten Aluminium production:

The methodology on value added product normalization is given below

1. The baseline year value added product mix ratio will be maintained for Assessment year.
2. The product mix ratio is given by following equation Product mix = Specific Energy Consumption of that product produced in Baseline year/

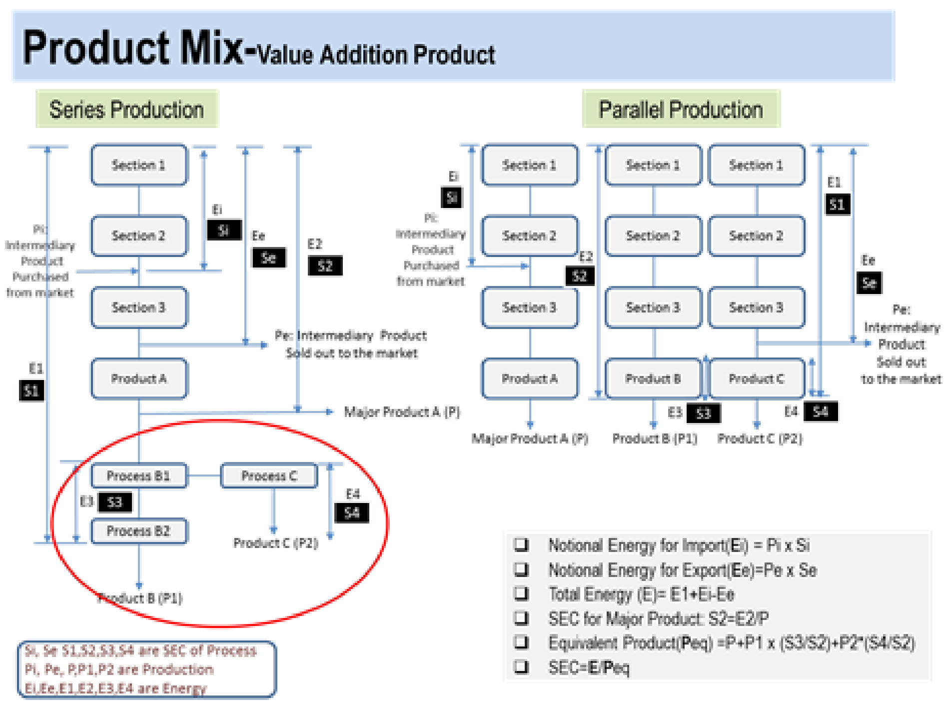
specific energy consumption of major product produced in Baseline year

3. The Baseline year Equivalent major product is calculated from the baseline year value added product mix ratio will be compared with the baseline year production and the assessment year Equivalent major product is calculated from the baseline year value added product mix ratio will be compared with the assessment year production.
4. Integrated Plant may export their intermediary product Alumina to the market and also they imports product from the market which they usually produce within the plant.
5. Smelter Plant may inport/export anode from the market
6. This Import and Export may deviate the SEC of the plant in the assessment year as compare to the baseline year
7.

6.7.4.4 Value Added product

Due to demand of the customers or own innovation, Plant do the work of value addition in the product.
Value addition sometimes also increases the quality of the products and so as the energy. The impact of the value addition results in the increase in the SEC of the plant. The value addition production will be converted to major equivalent product energy terms.

- ❑ If any plant in baseline year produces a product 'X', with SEC of the product 'S' and in assessment year if the same plant perform value addition on their product with same weight 'X' but the amount of energy consumption for value addition increases the SEC of the product. So with same amount of product in baseline and assessment year the SEC differs.
- ❑ This normalization factor accounts for the deviation of SEC from the baseline year due to the factors which are beyond the control of the plant management.



6.7.4.5 Normalization calculation:

6.7.4.5.1 Energy Factor

D = Specific Energy Consumption of Ingots in Baseline year/ Specific Energy Consumption of Molten Aluminium in Baseline Year

F = Specific Energy Consumption of Billets in Baseline year/ Specific Energy Consumption of Molten Aluminium in Baseline Year

(Note: Any addition in the value added product will attract the same conversion fraction)

6.7.4.5.2 Baseline year Equivalent Molten Aluminium production:

A =B + (C*D) + (E*F)

B = Total Molten Aluminium production of Baseline Year in Tonne

C = Total Baseline year Ingots production in Tonne

D = Energy factor of Ingots into Molten Aluminium in Baseline Year

E = Total Baseline year Billets production in Tonne

F = Energy factor of Billets into Molten Aluminium in Baseline Year

(Note: Any addition in the value added product will attract the same fraction to be included in the above equation as PRi_{AY} x $VAPi_{BY}$)

6.7.4.5.3 Assessment year Equivalent Molten Aluminium production:

For Assessment year, the Energy factor of baseline will be used to calculate the Equivalent product for respective product. However, any introduction of new product in the assessment year will draw the SEC of the newly introduced product into the Energy factor and equivalent product is to be calculated accordingly. Thus, the Numerator SEC of the above calculation of energy factor of baseline will change to SEC of the respective product in the assessment year as **$EFPi_{AY}$ = $SECPi_{AY}$/$SECP1_{BY}$**. Rest of the calculation remain same.

J =G + (H*D) + (I*F)

J = Total Molten Aluminium production of Assessment Year in Tonne

G = Total Baseline year Ingots production in Assessment year in Tonne

D = Energy factor of Ingots into Molten Aluminium in Baseline Year

E = Total Baseline year Billets production in Assessment year in Tonne

F = Energy factor of Billets into Molten Aluminium in Baseline Year

(Note: Any addition in the value added product will attract the same fraction to be included in the above equation as PRi_{AY} x CFi_{BY})

6.7.4.6 Documentation

A. Cast House production documents [Ex- Log sheets, DPR. MPR, Lab Report/ register/ SAP Data]
B. Value Added Products sale – Excise Documents
C. Weigh Bridge record

6.8 Import and Export of Intermediary Product (Applicable for Cold Sheet Process)

6.8.1 Baseline Year Methodology:

In the Cold Sheet plant, there are wide variety of Intermediary product due to market demand, they export their intermediary product to the market and also they imports product from the market which they usually produce within the plant. This Import and Export may deviate SEC of the plant in the assessment year.

6.8.2 Need for Normalization

Import of intermediary product for production of final product is common practice in Aluminium cold sheet industry along with export of intermediary product or job work also undertaken as per market demand. The change in the proportion of import or export during baseline year to target year may affect the SEC of the plant.

For all the changes in the ratio of the Import & Export in assessment year w.r.t. baseline year, there is a need to develop and formulate proper Normalization factors, so that any changes in the ratio of imported and exported product could be nullified and the concerned plant should not suffer / or gain advantage due to this variation.

The imported products for which part of the energy is not required to be used by the plant and exported product are converted into equivalent major product. For example, A plant can import or export Rolling Ingot, which is an intermediately product but not the final product. Production of Rolling ingot within the plant and import of same quantity of Rolling Ingot for the production of Cold Sheet affects the SEC of the plant.

6.8.3 Normalization Methodology:

- **In case of import of any intermediary product:**

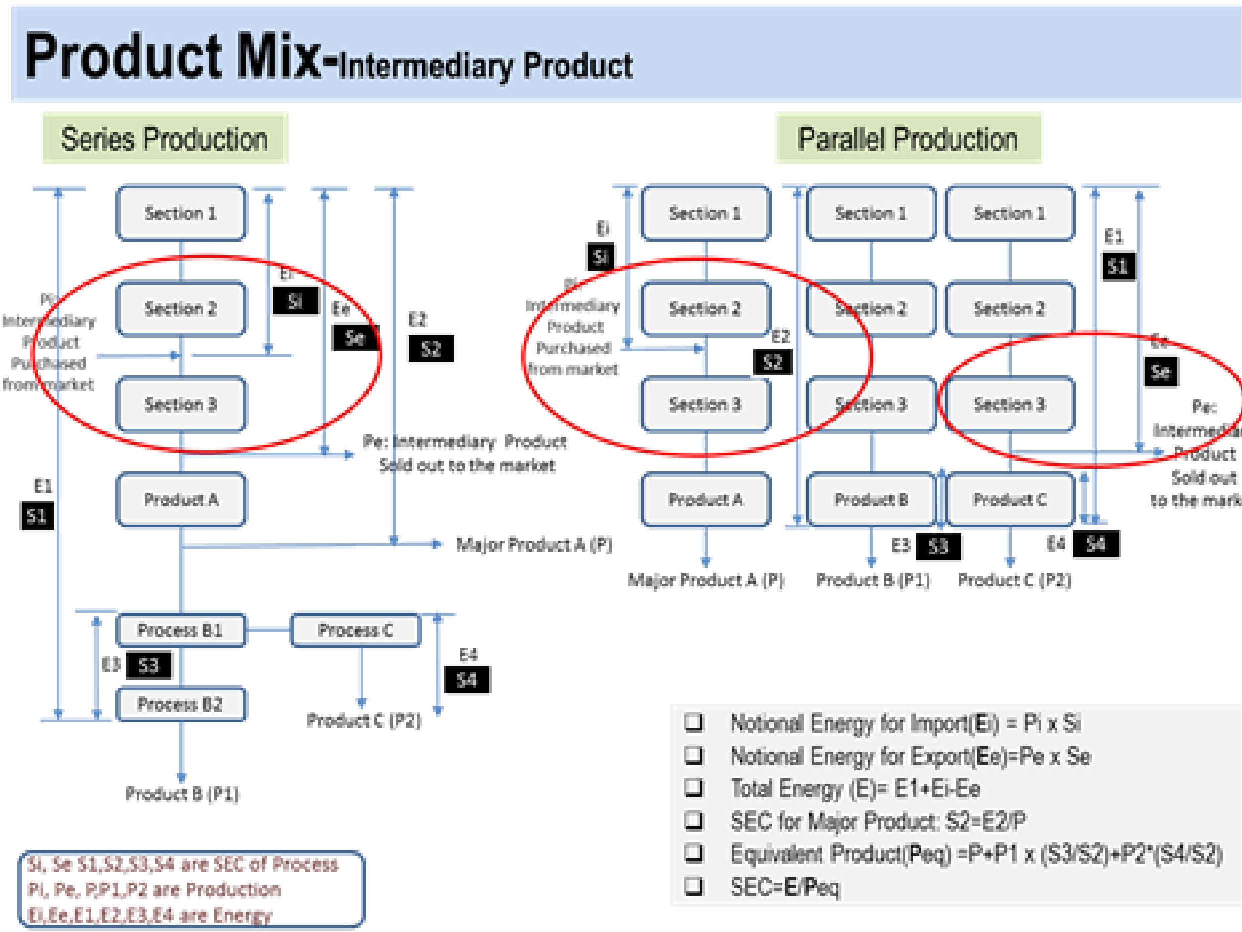
  The amount of product which is being imported in the plant will be taken and accordingly the energy consumption for producing the said amount of the product shall be calculated with the help of SEC of that product. This energy shall be added to the total energy of the plant. The rationale behind this normalization factor is to neutralize the impact of the energy consumption for producing that imported product if that product would have produced within the plant itself.

- **In case of Export of intermediary product:**

  1. The baseline year value added product mix ratio will be maintained for Assessment year.
  2. The product mix ratio is given by following equation

     Product mix = Specific Energy Consumption of that product produced in Baseline year/ specific energy consumption of major product produced in Baseline year

3. The Baseline year Equivalent major product is calculated from the baseline year value added product mix ratio will be compared with the baseline year production and theassessment year Equivalent major product is calculated from the baseline year value added product mix ratio will be compared with the assessment year production



6.8.4 Normalization calculation

6.8.4.1 Product Mix (Equivalent Product)

6.8.4.1.1 Stock and Stock difference

6.8.4.1.1.1 Cold Rolled Coil (CRC)

If Stock Difference>0, Total Cold Rolled Coil (CRC) Export (T)= Export (T)+ Stock Difference (T)

If Stock Difference<0, Total Cold Rolled Coil (CRC) Import (T)= Import (T) -Stock Difference (T)

Stock Difference (T)= Closing Stock (T)- Opening Stock (T)

6.8.4.1.1.2 Hot Rolled Coil (HRC)

If Stock Difference>0, Total Hot Rolled Coil (HRC) Export (T)= Export (T) + Stock Difference (T)

If Stock Difference<0, Total Hot Rolled Coil (HRC) Import (T)= Import (T) -Stock Difference (T)

Stock Difference (T)= Closing Stock (T)- Opening Stock (T)

6.8.4.1.1.3 Rolling Ingot (RI)

If Stock Difference>0, Total Rolling Ingot (RI) Export (T)= Export (T) + Stock Difference (T)

If Stock Difference<0, Total Rolling Ingot (RI) Import (T)= Import (T) -Stock Difference (T)

Stock Difference (T)= Closing Stock (T)- Opening Stock (T)

6.8.4.1.1.4 Alloy Ingot (AI)

If Stock Difference>0, Total Alloy Ingot (AI) Export (T)= Export (T) + Stock Difference (T)

If Stock Difference<0, Total Alloy Ingot (AI) Import (T)= Import (T) -Stock Difference (T)

Stock Difference (T)= Closing Stock (T)- Opening Stock (T)

6.8.4.1.2 Specific Energy Consumption up to per ton of product for BY and BY

6.8.4.1.2.1 Major product (Million kcal/Tonne) CRCSEC= AISP + RISP +HRCSP + CRCSP

Where

AISP =Alloy Ingot -SEC for per tonne of product (Million kcal/Tonne)

RISP =Rolling Ingot- SEC for per tonne of product (Million kcal/Tonne)

HRCSP=Hot Rolled Coil- SEC for per tonne of product (Million kcal/Tonne)

CRCSP=Cold Rolled Coil-SEC for per tonne of product (Million kcal/Tonne)

6.8.4.1.2.2 Hot Rolled Coil (Million kcal/Tonne) HRCSEC= AISP + RISP +HRCSP

Where

AISP =Alloy Ingot -SEC for per tonne of product (Million kcal/Tonne)

RISP =Rolling Ingot- SEC for per tonne of product (Million kcal/Tonne)

HRCSP =Hot Rolled Coil- SEC for per tonne of product (Million kcal/Tonne)

6.8.4.1.2.3 Rolling Ingot (Million kcal/Tonne) RISEC= RISP

Where

RISP =SEC of Rolling Ingot (Recyclinig+ Remelting Furnace) per tonne of product (Million kcal/Tonne)

=[(Thermal Energy for Alloy Ingot + Thermal Energy for Rolling Ingot-Thermal Energy for Alloy Ingot Production)/Rolling Ingot Production]+ [(Electrical Energy for Alloy Ingot + Electrical Energy for Rolling Ingot-Electrical Energy for Alloy Ingot Production)/Rolling Ingot Production]

6.8.4.1.2.4 Alloy Ingot (Million kcal/Tonne) AISEC =AISP

Where

AISP =Alloy Ingot -SEC for per tonne of product (Million kcal/Tonne)

6.8.4.1.3 Major Product

6.8.4.1.3.1 SEC of Major Product =

Where

SECMP =Specific Energy Consumption of Major Product (Million kcal/Tonne)

6.8.4.1.3.2 Major Product = CRC

Where

CRC =Cold Rolled Coil Production (Tonne)

6.8.4.1.4 Conversion Factor for Minor to Major Product

6.8.4.1.4.1 Cold Sheet to major Product Conversion Factor

(a) Cold Sheet to major Product $CSCF_{(BY)}$ = CSSECBY / SECMPBY

Where

CSSECBY=Cold Sheet-Specific Energy Consumption (Million kcal/Tonne) for BY

SECMP BY=Specific Energy Consumption of Major Product (Million kcal/Tonne) for BY

BY = Baseline Year

(b) Cold Sheet to major Product $_{(AY)}$ = CSSECBY / SECMPBY

Where

CSSECBY =Major product-Specific Energy Consumption (Million kcal/Tonne)

SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne)

6.8.4.1.4.2 Hot Rolled Coil to major Product Conversion Factor

(a) Hot Rolled Coil to major Product HRCCF $_{(BY)}$ = HRCCF / SECMPBY

Where

HRCSECBY =Hot Rolled Coil-Specific Energy Consumption (Million kcal/Tonne) in BY

SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY

(b) If Hot Rolled Coil Production in BY= 0, then

Hot Rolled Coil to major Product HRCCF $_{(AY)}$ = HRCSECAY / SECMPBY

(c) If Hot Rolled Coil Production in BY≠ 0, then

Hot Rolled Coil to major Product HRCCF $_{(AY)}$ = HRCSECAY / SECMPBY

Where

HRCSECBY =Hot Rolled Coil-Specific Energy Consumption (Million kcal/Tonne) in BY

HRCSECAY =Hot Rolled Coil-Specific Energy Consumption (Million kcal/Tonne) in AY

SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY

6.8.4.1.4.3 Rolling Ingot to major Product Conversion Factor

(a) Rolling Ingot to major Product RICF$_{(BY)}$ = RISECBY / SECMPBY

Where

RISECBY =Rolling Ingot-Specific Energy Consumption (Million kcal/Tonne) in BY

SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY

(b) If Hot Rolling Ingot Production in BY= 0, then

Rolling Ingot to major Product RICF $_{(AY)}$ = RISECBY / SECMPBY

(c) If Hot Rolling Ingot Production in BY≠ 0, then

Rolling Ingot to major Product RICF $_{(AY)}$ = RISECBY / SECMPBY

Where

RISECBY =Rolling Ingot-Specific Energy Consumption (Million kcal/Tonne) in BY

RISECAY =Rolling Ingot-Specific Energy Consumption (Million kcal/Tonne) in AY

SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY

6.8.4.1.4.4 Alloy Ingot to major Product Conversion Factor

(a) Alloy Ingot to major Product AICF$_{(BY)}$ = AISECAY / SECMPBY

Where

AISECBY =Alloy Ingot-Specific Energy Consumption (Million kcal/Tonne) in BY

SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY

(b) If Alloy Ingot Production in BY= 0, then
Alloy Ingot to major Product $AICF_{(AY)}$ = AISECAY / SECMPBY

(c) If Alloy Ingot Production in BY≠ 0, then
Alloy Ingot to major Product $AICF_{(AY)}$ = AISECAY / SECMPBY

Where

AISECBY =Alloy Ingot-Specific Energy Consumption (Million kcal/Tonne) in BY

AISECAY =Alloy Ingot-Specific Energy Consumption (Million kcal/Tonne) in AY

SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY

AY = Assessment Year

BY = Baseline Year

6.8.4.1.5 Equivalent Product

6.8.4.1.5.1 Cold Sheet to major Product: $CSMP_{(BY/AY)}$ *= CSCFXCRC*

Where

CSCF = Cold Sheet to major Product-Conversion Factor

CRC = Cold Rolled Coil (Tonne)

6.8.4.1.5.2 Hot Rolled Coil to major Product (HRCMP)

(a) Hot Rolled Coil to major Product: $HRCMP_{BY}$ *= HRCCFXTHRCEx*

Where

HRCCF = Hot Rolled Coil to major Product-Conversion Factor

THRCEx = Total Hot Rolled Coil Export (Tonne)

(b) Hot Rolled Coil to major Product $HRCMP_{AY}$ *= HRCCFXTHRCEx*

Where

HRCCF = Hot Rolled Coil to major Product-Conversion Factor

THRCEx = Total Hot Rolled Coil Export (Tonne)

6.8.4.1.53 Rolling Ingot to major Product

(a) Rolling Ingot to major Product $RIMP_{BY}$ *= RICFXTRIEx*

Where

RICF =Rolling Ingot to major Product-Conversion factor

TRIEx =Total Rolling Ingot (RI) Export (Tonne)

(b) Rolling Ingot to major Product $RIMP_{AY}$ *= RICFXTRIEx*

Where

RICF =Rolling Ingot to major Product-Conversion factor

TRIEx =Rolling Ingot Export (Tonne)

6.8.4.1.5.4 Alloy Ingot to major Product

(a) Alloy Ingot to major Product $AIMP_{BY}$ *= AICFXTAIEP*

Where

AICF =Alloy Ingot to major Product-Conversion factor

TAIEEx =Total Alloy Ingot (AI) Export (Tonne)

(b) Alloy Ingot to major Product $AIMP_{AY}$ *= AICFXTAIEP*

Where

AICF =Alloy Ingot to major Product-Conversion factor

TAIEx =Alloy Ingot Export (Tonne)

6.8.4.1.6 Total Equivalent Product Cold Sheet $_{BY}$ (Tonne) = AIMP + RIMP + HRCMP + CSMP

Where

AIMP = Alloy Ingot to Major Product (Tonne)

RIMP = Rolling Ingot to Major Product (Tonne)

HRCMP = Hot Rolled to Major Product (Tonne)

CSMP = Cold Sheet to Major Product (Tonne)

6.8.4.1.7 Total Equivalent Product Cold Sheet $_{AY}$ (Tonne) = AIMP + RIMP + HRCMP + CSMP

Where

AIMP = Alloy Ingot to Major Product (Tonne)

RIMP = Rolling Ingot to Major Product (Tonne)

HRCMP = Hot Rolled to Major Product (Tonne)

CSMP = Cold Sheet to Major Product (Tonne)

6.8.4.2 Import Product Normalization

6.8.4.2.1 Notional Energy for Import

6.8.4.2.1 Import Energy for Cold Rolled Coil (Million kcal) IECRC for BY and AY= CSSEC X TCRCIm

Where

CSSEC =SEC up to Cold Sheet Production (Million kcal/Tonne)

TCRCIm =Total Cold Rolled Coil Import (Tonne)

6.8.4.2.1.2 Import Energy for Hot Rolled Coil (Million kcal) =SECHRC X THRCIm

Where

HRCSEC =SEC up to Hot Rolled Coil Production (Million kcal/Tonne)

THRCIm =Total Hot Rolled Coil Import (Tonne)

6.8.4.2.1.3 Import Energy for Rolling ingot (Million kcal) = SECRI X TRIIm

Where

RISEC =SEC up to Rolling ingot Production (Million kcal/Tonne)

TRIIm =Total Rolling ingot Import (Tonne)

6.8.4.2.1.4 Import Energy for Alloy ingot(Million kcal) = SECAI X TAIIm

Where

AISEC =SEC up to Alloy Ingot Production (Million kcal/Tonne)

TAIIm =Total Alloy Ingot Import (Tonne)

6.8.4.2.2 Notional Energy for Import to be added in the baseline and assessment year

= IEAI + IERI + IEHRC + IECRC

Where

IEAI = Import Energy for Alloy ingot (Million kcal)

IERI = Import Energy for Rolling ingot (Million kcal)

IEHRC = Import Energy for Hot Rolled Coil (Million kcal)

IECRC= Import Energy for Cold Rolled Coil (Million kcal)

6.8.5 Documents

- Purchase and sell document [Log Sheets, DPR, MPR, SAP data. Store Receipt etc.]
- Intermediary Products Sale- Excise Documents

6.9 Others

6.9.1 Environmental concern

6.9.1.1 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.

6.9.1.2 Normalization 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 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 normalized for additional Energy consumption details from Energy meters. This is to be excluded from the input energy.

6.9.1.3 Normalization Formula

14.1.1 Installation due to Environmental concern:

Additional Electrical & Thermal Energy Consumed due to Environmental Concern $_{\text{(Million kcal)}}$ =

(Additional Electrical Energy Consumed $_{\text{(Lakh kWh)}}$ x Weighted Average heat rate in AY/10) + Additional Thermal Energy Consumed

14.1.2 Biomass replacement with Fossil fuel due to un-availability $_{\text{(Million kcal)}}$ =

Biomass replacement with Fossil fuel due to Biomass un-availability (used in the process) x Biomass Gross Calorific Value / 10^3

6.9.1.4 Documentation

Sr No	Sub-Group	Elements	Reason/ Requirement	Impact	Documents
4	Additional Equipment Installation due to Environmental law	Auxiliary Power Consumption	The Energy will be normalized for additional Energy consumption. This is to be excluded from APC	APC	The DC has to maintain the documents for additional installation of Environmental Equipment
5	Flood, Earthquake etc		Proper weightage could be given in SEC in terms of capacity utilization, energy used for re-establishment	Plant Load Factor	The DC has to maintain the authentic documents for natural disaster

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

6.9.2 Fuel replacements

6.9.2.1 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 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.

6.9.2.2 Normalization Methodology

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

6.9.2.3 Normalization Formula

14.2.1 Alternate Solid Fuel replacement with Fossil fuel due to un-availability $_{(Million\ kcal)}$ =
Alternate Solid Fuel replacement with Fossil fuel due to Alternate Solid Fuel un-availability (used in the process) $_{(in\ Tonne)}$ x Solid Alternate Fuel Gross Calorific Value / 10^3

14.2.2 Alternate Liquid Fuel replacement with Fossil fuel due to un-availability $_{(Million\ kcal)}$ =
Alternate Liquid Fuel replacement with Fossil fuel due to Alternate Liquid Fuel un-availability (used in the process) $_{(in\ Tonne)}$ x Liquid Alternate Fuel Gross Calorific Value /10^3

6.9.2.4 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

6.9.3 Construction Phase or Project Activity Phase

6.9.3.1 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.

6.9.3.2 Normalization 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 is deducted in the assessment year.

6.9.3.3 Normalization Formula

14.3 Additional Electrical & Thermal Energy Consumed due to commissioning of Equipment (Construction Phase) $_{(Million\ kcal)}$ = (Electrical Energy Consumed due to commissioning of Equipment x Weighted Average Heat rate in AY/10) + Thermal Energy Consumed due to commissioning of Equipment

6.9.3.4 Documents

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

6.9.4 Addition of New Line/Unit

6.9.4.1 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 Utilization 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 Utilization.

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.

6.9.4.2 Normalization Methodology

- The Capacity Utilization 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/Log sheet.
- 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 Utilization will have to be monitored
- The Production/generation and energy consumed will be deducted from the total energy of the assessment year

6.9.4.3 Normalization Formula

14.4.1 Electrical & Thermal Energy Consumed due to commissioning of New process Line/Unit till it attains 70% of Capacity Utilization $_{\text{(Million kcal)}}$ = (Electrical Energy Consumed due to commissioning of New process Line/Unit till it attains 70% of Capacity Utilization $_{\text{(Lakh kWh)}}$ x Weighted Average Heat rate in AY/10) + Thermal Energy Consumed due to commissioning of New Process Line/ Unit till it attains 70% of Capacity Utilization

The Production during commissioning of New Process Line/Unit will be subtracted from the total production of plant and added in the import of intermediary product.

14.4.2 Electrical & Thermal Energy Consumed from external source due to commissioning of New Line/ Unit till it attains 70% of Capacity Utilization in Power generation $_{\text{(Million kcal)}}$ = (Electrical Energy Consumed from external source due to commissioning of New Line/Unit till it attains 70% of Capacity Utilization in Power generation $_{\text{(Lakh kWh)}}$ x Weighted Average Heat rate in AY/10) + Thermal Energy Consumed due to commissioning of New Line/Unit till it attains 70% of Capacity Utilization in Power generation

14.4.3 Energy to be added for Power generation of a line/unit till it attains 70% of Capacity Utilization (Million $_{\text{kcal)}}$ = (Net Electricity Generation till new line/unit attains 70% Capacity Utilization $_{\text{(Lakh kWh)}}$ x Generation Net Heat Rate in AY/10)

14.4.4 Energy to be added for Steam generation of a line/unit till it attains 70% of Capacity Utilization (Million kcal)= (Steam Generation from Co-Gen till new line/Unit attains 70% of Capacity Utilization $_{\text{(Lakh kWh)}}$ x Steam Specific Energy Consumption in AY/1000)

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 April 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

6.9.5 Unforeseen Circumstances

6.9.5.1 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.

6.9.5.2 Normalization 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

6.9.6.3 Normalization Formula

14.5.1 Electrical & Thermal Energy to be normalized consumed due to unforeseen circumstances $_{(Million\ kcal)}$ = (Electrical Energy to be Normalized in AY x Weighted Average Heat rate in AY/10) + Thermal Energy to be Normalized

6.9.5.4 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.

6.9.6 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.

6.9.6.1 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 duel 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.

Normalization 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.

6.9.6.3 Normalization Formula

14.6.1 Additional Saving achieved (After PAT obligation)$_{(TOE/Ton)}$ = Target Saving Achieved in AY $_{(TOE/Ton)}$ - Target Saving to be achieved (PAT obligation) in BY $_{(TOE/Ton)}$

14.6.2 Additional Saving achieved (After PAT obligation)$_{(TOE)}$ = Target Saving Achieved in AY $_{(TOE)}$ - Target Saving to be achieved (PAT obligation) in BY $_{(TOE)}$

14.6.3 Thermal energy conversion for REC and Preferential tariff $_{(TOE)}$= If Steam Turbine Net Heat Rate in AY =0, then 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 2.717, otherwise 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 Generation Net Heat Rate in AY/ 10^4

14.6.4 Thermal Energy to be normalized for REC and preferential tariff power sell under REC mechanism $_{(TOE)}$= If 14.6.1 <= 0 then 0, Else if, Thermal energy conversion for REC and Preferential tariff $_{(TOE)}$ is greater than Additional Saving achieved (After PAT obligation) $_{(TOE)}$ than Additional Saving achieved (After PAT obligation)$_{(TOE)}$ else Thermal energy conversion for REC and Preferential tariff$_{(TOE)}$

6.9.6.4 Documentation

- 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

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 Factors

9.1 Normalization factor fuel quality in CPP

S. No	Item	Unit	Unit 1		Unit 2	
			BY	AY	BY	AY
1	Unit Capacity	MW	125	125	125	125
2	Total Moisture	%	8	10.35	12	10.35
3	Ash	%	28	41.17	42	41.17
4	GCV	%	4440	3632.7	3700	3632.7
5	Hydrogen	%	2.5	2.5	2.33	2.5

- **Boiler efficiency for unit 1 in BY =** 92.5-[{50xAsh+630 (Moisture+9Hydrogen)} /GCV of fuel] =92.5 – [{50 x 28 + 630 x (8+9x2.5)} / 4440] = 87.86 %

- **Boiler efficiency for unit 2 in BY =** 92.5-[{50xAsh+630 (Moisture+9Hydrogen)} / GCV of fuel] = 92.5 – [{50 x 42 + 630 x (12+9x2.33)} / 3700] = 86.32 %

- **Boiler efficiency for Station in BY = =** Unit #n Capacity (MW) X Unit #n Boiler efficiency (%) in BY / Unit #n Capacity (MW) = ((125*87.86)+(125*86.32))/ (125+125) = 87.09 %

- **Boiler efficiency for unit 1 in AY =** 92.5-[{50xAsh+630 (Moisture+9Hydrogen)} / GCV of fuel] **=** 92.5 – [{50 x 41.17 + 630 x (10.35+9x2.5)} / 3632.7] **= 86.24 %**

- **Boiler efficiency for unit 2 in AY =** 92.5-[{50xAsh+630 (Moisture+9Hydrogen)} / GCV of fuel] **=** 92.5 – [{50 x 41.17 + 630 x (10.35+9x2.5)} / 3632.7] **= 86.24 %**

- **Boiler efficiency for Station in BY = =** Unit #n Capacity (MW) X Unit #n Boiler efficiency (%) in BY / Unit #n Capacity (MW) = ((125*86.24)+(125*86.24))/ (125+125) = 86.24 %

S.No.	Description	Units	Baseline Year [BY]	Assessment Year [AY]
1	CPP Generation	Lakh kWh	19710	17958
2	Actual CPP Heat Rate	kcal/kWh	2426	2518
3	Boiler Efficiency	%	87.09	86.24

- **The CPP heat rate in assessment year due to fuel quality =** CPP heat rate in baseline year x (Boiler Efficiency in baseline year / Boiler Efficiency in assessment year) =2426 x (87.09/86.24) =2450 kcal/kWh

- **Difference in the CPP heat rate of assessment year due to fuel quality =** 2450 – 2426 =24 kcal/kWh

- **Energy to be subtracted w.r.t. fuel quality in CPP (Million kcal)** = Difference in the CPP heat rate of AY due to fuel quality (kCal/kWh) X CPP Generation in AY Lakh kWh/10 = 24 x 17958/10 = 43008 Million kCal

9.2 Normalization factor fuel quality in Cogen

S. No	Item	Unit	Baseline Year [BY]	Assessment Year [AY]
2	Total Moisture	%	4	7
3	Ash	%	30	45
4	GCV	%	3501	3300
5	Hydrogen	%	3	3

- **Boiler efficiency in BY =** 92.5-[{50xAsh+630(Moisture+9Hydrogen)} /GCV of fuel]
  =92.5 – [{50 x 30 + 630 x (4+9x3)} / 3501]
  = 86.50 %
- **Boiler efficiency in AY =** 92.5-[{50xAsh+630(Moisture+9Hydrogen)} /GCV of fuel]
  =92.5 – [{50 x 45 + 630 x (7+9x3)} / 3300]
  = 85.33%

S. No	Item	Unit	Baseline Year [BY]	Assessment Year [AY]
1	Steam Generation at Boiler 1-5	kg	230400000	253440000
2	Steam Generation at Boiler 6-10	kg	0	0
3	Specific Energy Consumption for Steam Generation in Cogen Boiler 1-5	kcal/kg of Steam	583.5	550
4	Specific Energy Consumption for Steam Generation in Process Boiler 6-10	kcal/kg of Steam	0	0
5	Weighted Percentage of Coal Energy Used in steam Generation (Cogen Boiler)	Factor	20	20
6	Weighted Percentage of Coal Energy Used in steam Generation (Process)	Factor	20	20

❖ **Weighted Average Specific Steam Consumption in BY = ((**SEC for Steam Generation in Cogen Boiler 1-5 x Steam Generation at Boiler 1-5) + (SEC for Steam Generation in Process Boiler 6-10 x Steam Generation at Boiler 6-10)) / (Steam Generation at Boiler 1-5 + Steam Generation at Boiler 6-10)
= ((583.5 x 230400000) + (0 x0))/ (583.5 + 0)
= 583.5 kCal/kg

❖ **Weighted Average Specific Steam Consumption in AY = ((**SEC for Steam Generation in Cogen Boiler 1-5 x Steam Generation at Boiler 1-5) + (SEC for Steam Generation in Process Boiler 6-10 x Steam Generation at Boiler 6-10)) / (Steam Generation at Boiler 1-5 + Steam Generation at Boiler 6-10)
= ((550 x 253440000) + (0 x0))/ (550 + 0)
= 550 kCal/kg

❖ **Normalized Specific Energy Consumption for Steam Generation (AY) (kcal/kg of Steam)=**
Specific Energy Consumption for Steam Generation Boiler 6-10(BY)*(Boiler Efficiency (BY)/Boiler Efficiency (AY))
= 583.5 x (86.5/85.3)
= 591.5 kCal/kg

❖ **Difference Specific Steam from (BY) to (AY) (kcal/kg of Steam)=**
(Normalized Specific Energy Consumption for Steam Generation (AY) - Specific Energy Consumption for Steam Generation Boiler 6-10(BY))
= (591.5 – 583.5)
= 7.97 kcal/kg of Steam

❖ **Notional energy to be subtracted w.r.t. Fuel Quality in Steam Generation Boiler (Million kcal)=**
((Difference Specific Steam from (BY) to (AY) (kcal/kg of Steam)* [Steam Generation at Boiler 1-5 (kcal/kg of Steam) * (Weighted Percentage of Coal Energy Used in steam Generation (Cogen Boiler))] = [Steam Generation at Boiler 6-10 (kcal/kg of Steam) * (Weighted Percentage of Coal Energy Used in steam Generation (Process Boiler))])/1000
= (7.97*((253440000*20) +0)/1000
= 40412 Million kcal

9.3 Normalization factor for Low PLF Compensation in CPP

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 based on the following calculation.

Table: Loss of PLF due to non-availability of fuel/schedule/backing down/any external factor/ Unforeseen factors/Internal Factor in BY

S. No	Units	Capacity (MW)	Forced Outage/ Unavailability (Hrs)	Planned Maintenance Outage/Planned Unavailability (Hrs)	Unit Availability Factor
1	Unit-1	125	500	300	0.91
2	Unit-2	125	300	400	0.92
3	Total	250	0.05	0.04	0.914

❖ Plant Availability Factor for unit-1 in BY = (8760-(Forces Outage or Unavailability (hrs)-Planned Maintenance Outage or Planned Unavailability])/8760
= (8760-(500-300))/8760
=0.91

❖ Plant Availability Factor for unit-2 in BY = (8760-(Forces Outage or Unavailability (hrs)-Planned Maintenance Outage or Planned Unavailability])/8760
= (8760-(300-400))/8760
=0.91

Table: Loss of PLF due to non-availability of fuel/schedule/backing down/any external factor/ Unforeseen factors/Internal Factor in AY

S. No	Units	Capacity (MW)	Forced Outage/ Unavailability (Hrs)	Planned Maintenance Outage/Planned Unavailability (Hrs)	Unit Availability Factor
1	Unit-1	125	500	300	0.91
2	Unit-2	125	600	400	0.89
3	Total	250	**0.06**	**0.04**	**0.897**

❖ Plant Availability Factor for unit-1 in AY = (8760-(Forces Outage or Unavailability (hrs)-Planned Maintenance Outage or Planned Unavailability])/8760
= (8760-(500-300))/8760
=0.91

❖ Plant Availability Factor for unit-2 in AY = (8760-(Forces Outage or Unavailability (hrs)-Planned Maintenance Outage or Planned Unavailability])/8760
= (8760-(600-400))/8760
= 0.89

Item	**Unit**	**Unit 1**		**Unit 2**	
		BY	**AY**	**BY**	**AY**
Unit Capacity	MW	125	125	125	125
Gross Unit Generation	Lakh Unit	9636	9198	10074	8760
Design Turbine Heat Rate @ 100% Load (OEM)	kcal/kwh	2045	2045	2045	2045
Design Turbine Heat Rate @ 100% Load (Curve or HBD)	kcal/kwh	2044.44	2044.44	2044.44	2044.44
% Difference between Design Turbine Heat Rate and Design Curve or HBD Turbine Heat rate	%	0.0274	0.0274	0.0274	0.03

Plant Availability Factor		0.9087	0.9087	0.9201	0.8858
Average Operating Load (MW) caused by low ULF due to external factor	MW	110.24	92.68	114.62	110.00
Average Operating hours at Low ULF	Hrs/Annum	2698.51	2714.29	2191.18	1666.67

- **Total Operating hours in year as per Unit Availability factor =** 8760 X Plant Availability Factor

  unit I
  Total Operating hours in year for BY
  = 8760 X 0.91 = 7960 Hrs/Annum

  Total Operating hours in year for AY
  = 8760 X 0.91 = 7960 Hrs/Annum

  unit 2
  Total Operating hours in year for BY
  = 8760 X 0.92 = 8060 Hrs/Annum

  Total Operating hours in year for AY
  = 8760 X 0.89 = 7760 Hrs/Annum

- **Operating hours at full load**=Total Operating hours in year as per Unit Availability factor- Average Operating hours at Low ULF

  unit I
  Total Operating hours in year for BY
  = 7960 - 2698.51 = 5261.49 Hrs/Annum

  Total Operating hours in year for AY
  = 7906 – 2714.29 = 5245.71 Hrs/Annum

  unit 2
  Total Operating hours in year for BY
  = 8060 – 2191.18 = 5868.82 Hrs/Annum

  Total Operating hours in year for AY
  = 7760 – 1666.67 = 6093.33 Hrs/Annum

- **Percentage Difference between Design Turbine/Module Heat Rate and Design Curve or HBD Turbine/Module Heat Rate**

$$= \frac{\text{Design THR @ 100\% Load (OEM)} - \text{Design THR @ 100\% Load (Curve or HBD) X 100}}{\text{Design THR @ 100\% Load (OEM)}}$$

Where
THR = Turbine Heat Rate (kcal/kWh)
OEM = Original Equipment Manufacturer
HBD = Heat Balance Diagram

Unit#1
% Difference between DTHR and Design Curve or HBD THR for BY
= (2045-2044.44)*100/ 2045 = 0.0274

% Difference between DTHR and Design Curve or HBD THR for AY
= (2045-2044.44)*100/ 2045 = 0.0274

Unit#2
% Difference between DTHR and Design Curve or HBD THR for BY
= (2045-2044.44)*100/ 2045 = 0.0274

% Difference between DTHR and Design Curve or HBD THR for AY
= (2045-2044.44)*100/ 2045 = 0.0274

❖ **Loading Vs Heat Rate Equation given as y = ax2 - bx + c will be used to calculate the Turbine Heat Rate as per Load Vs Heat Rate Equation due to external factor.**

y = ax2 - bx + c (kcal/kWh)

Where
X = Operating Load (MW)
A = Equation Constant 1 =0.0171
b = Equation Constant 2 = 6.6159
c = Equation Constant 3 = 2684.8

Turbine Heat Rate as per Load Vs Heat Rate Equation due to external factor (kcal/kWh)
= Equation Constant 1
* (Average Operating Load (MW) caused bylow ULF, MLF due to external factor)^ 2
- Equation Constant 2
* Average Operating Load (MW) caused bylow ULF, MLF due to external factor + EquationConstant 3

Unit #1
THR as per Load Vs HR Equation due to external factor (kcal/kWh) for BY
= 0.0171* 110.24^2 – 6.6159* 110.24 + 2684.8
= 2163.27 kcal/kWh

THR as per Load Vs HR Equation due to external factor (kcal/kWh) for BY
= 0.0171* 92.68 ^{2} – 6.6159* 92.68 + 2684.8
= 2218.51 kcal/kWh

Unit #2
THR as per Load Vs HR Equation due to external factor (kcal/kWh) for BY
= 0.0171* 114.62 ^{2} – 6.6159* 114.62 + 2684.8
= 2151.15 kcal/kWh

THR as per Load Vs HR Equation due to external factor (kcal/kWh) for BY
= 0.0171* 110.00 ^{2} – 6.6159* 110.00 + 2684.8
= 2163.96 kcal/kWh

❖ **Design Turbine Heat Rate after Curve correction and difference correction**
= THR as per Load Vs HR Equation due to external factor X [1 + {% Difference between Design Turbine or Module HR and Design Curve or HBD Turbine or Module HR/ 100}]

Where
THR = Turbine Heat Rate (kcal/kWh)
L Vs HR = Load Vs Heat Rate
HBD = Heat balance Diagram

Unit#1
DTHR after Curve Correction and difference correction for BY
=2163.27*(1+(0.027/100))
= 2163.86 kcal/kWh

DTHR after Curve Correction and difference correction for AY
= 2218.51*(1+(0.027/100))
= 2219.12 kcal/kWh

Unit#2
DTHR after Curve Correction and difference correction for BY
=2151.15*(1+(0.027/100))
= 2151.74 kcal/kWh

DTHR after Curve Correction and difference correction for AY
= 2163.96*(1+(0.027/100))
= 2164.55 kcal/kWh

❖ **Normalised Design Turbine Heat rate due to external factor (kcal/kWh)** =((Design Turbine Heat Rate after Curve correction and difference correction (kcal/kwh) X Average Operating hours at Low ULF) + (Design Turbine Heat Rate @ 100% Load (OEM)(kcal/kwh) X Operating hours at full load))/(Total Operating hours in year as per Unit Availability factor)

Unit#1

Normalized DTHR due to external factor for BY

= ((2163.86*2698.51)+(2045*5261.49))/ 7960 = 2085.29 kcal/kWh

Normalized DTHR due to external factor for AY

= ((2219.12*2714.29)+(2045*5245.71))/ 7960 = 2104.37 kcal/kWh

Unit#2

Normalized DTHR due to external factor for BY

= ((2151.74*2191.18)+(2045*5868.82))/ 8060 = 2074.02 kcal/kWh

Normalized DTHR due to external factor for AY

= ((2164.55*1666.67)+(2045*6093.33))/ 7760 = 2070.68 kcal/kWh

❖ **Difference of Turbine Heat Rate due to external factor between AY and BY (kcal/kWh)**

= Normalized Design THR due to external factor in AY - Normalized Design THR due to external factor in BY

Where

THR = Turbine Heat Rate (kcal/kWh)

AY = Assessment Year

BY = Baseline Year

Difference of THR due to external factor between AY and BY for Unit#1

= 2104.37-2085.29 = 19.08 kcal/kWh

Difference of THR due to external factor between AY and BY for Unit#2

= 2070.68-2074.02 = -3.34 kcal/kWh

❖ **Energy to be subtracted per unit** = (Difference of THR between AY and BY (kcal/kWh) X Gross Unit Generation (Lakh Unit))/10

Energy to be subtracted for Unit#1

= 19.08x 9198/10 = 17548.42 Million kCal

Energy to be subtracted for Unit#2

= -3.34x 8760/10 = -2927.15 Million kCal

❖ **Total Notional Energy to be subtracted due to Low PLF (Million kcal)** =Energy to be subtracted in U#1 for AY (Million kcal)+ Energy to be subtracted in U#2 for AY (Million kcal)+.

Total Notional Energy to be subtracted due to Low PLF (Million kcal)

= 17548.42 + (-2927.15) = 14621.27 Million kCal

9.4 Normalization factor Smelter Capacity Utilisation

Table: Details of Potline 1

S.No.	Description	Units	Baseline Year [BY]	Assessment Year [AY]
1	Production	Tonne	44837.21	44551.11
2	Weighted Heat Rate	kcal/kwh	867.00	867.00
3	No of operating Pot (NOP)	No	290	287
4	No of Pots/Potline (NOPP)	No	304	304
5	Dead pot voltage (DPV)	Volts	0.25	0.25
6	Design Pot Voltage (DnPV)	Volts	4.2	4.2
7	Design Bus Bar Voltage Drop (DnBV)	Volts	6	6
8	Current Efficiency of Pots (CE)	%	0.93	0.93

- **K1 – constant 1 in BY for Potline 1 = ((**Design Bus Bar Voltage Drop + No of Pots/Potline x Dead pot voltage) x 298000)/ (No of Pots/Potline x Current Efficiency of Pots)
= ((6+304 x 0.25) x 298000)/(304 x 0.93)
= 86431.81

- **K2 – constant 1 in BY for Potline 1 = ((**Design Pot voltage - Dead pot voltage) x 2980)/ (Current Efficiency of Pots)
= ((4.2 - 0.25) x 2980)/(0.93)
= 12656.99

- **Capacity Utilisation in BY for Potline 1 = ((**No of operating pots/No of pots/ potline) x 100)
= (290/304) * 100
= 95.39 %

- **SEC Design at CU% (kwh/ton) in BY for Potline 1** = (K1/Capacity utilisation) +K2
= (86431.81 /95.39)+12656.99
= 13563.1 kWh/Tonne

- **K1 – constant 1 in AY for Potline 1 = ((**Design Bus Bar Voltage Drop + No of Pots/Potline x Dead pot voltage) x 298000)/ (No of Pots/Potline x Current Efficiency of Pots)
= ((6+304 x 0.25) x 298000)/(304 x 0.93)
= 86431.81

- **K2 – constant 1 in AY for Potline 1 = ((**Design Pot voltage - Dead pot voltage) x 2980)/ (Current Efficiency of Pots)
= ((4.2 - 0.25) x 2980)/(0.93)
= 12656.99

- **Capacity Utilisation in AY for Potline 1 = ((**No of operating pots/No of pots/ potline) x 100)
= (287/304) * 100
= 94.41%

- **SEC Design at CU% (kwh/ton) in AY for Potline 1** = (K1/Capacity utilisation) +K2
= (86431.81 /94.41)+ 12656.99
= 13572.50kWh/Tonne

- **Notional Specific Energy Consumption for Potline 1 =** SEC Design at CU % in AY for potline 1 - SEC Design at CU % in BY for potline 1
  = 13572.50 - 13563.1
  = 9.47 kWh/Tonne

- **Electrical Energy to be deducted due to lower capacity utilisation (Million kWh) for potline 1**

  a. If capacity utilization % in AY < capacity utilization % in BY, Electrical energy to be deducted = Notional Specific Energy Consumption for Potline 1 x Production /10^6

  b. If capacity utilization % in AY > capacity utilization % in BY, Electrical energy to be deducted = 0

= 9.47* 44551.11/10^6
= 0.42 Million kWh

Table: Details of Potline 2

S. No.	Description	Units	Baseline Year [BY]	Assessment Year [AY]
1	Production	Tonne	28023.26	27844.44
2	Weighted Heat Rate	kcal/kwh	867.00	867.00
3	No of operating Pot (NOP)	No	180	187
4	No of Pots/Potline (NOPP)	No	200	200
5	Dead pot voltage (DPV)	Volts	0.25	0.25
6	Design Pot Voltage (DnPV)	Volts	4.2	4.2
7	Design Bus Bar Voltage Drop (DnBV)	Volts	6	6
8	Current Efficiency of Pots (CE)	%	0.94	0.94

- **K1 – constant 1 in BY for Potline 2 = ((**Design Bus Bar Voltage Drop + No of Pots/Potline x Dead pot voltage) x 298000)/ (No of Pots/Potline x Current Efficiency of Pots)
  = ((6+200 x 0.25) x 298000)/(200 x 0.94)
  = 88765.96

- **K2 – constant 1 in BY for Potline 2 = ((**Design Pot voltage - Dead pot voltage) x 2980)/ (Current Efficiency of Pots)
  = ((4.2 - 0.25) x 2980)/(0.94)
  = 12522.34

- **Capacity Utilisation in BY for Potline 2 = ((**No of operating pots/No of pots/ potline) x 100)
  = (180/200) * 100
  = 90 %

- **SEC Design at CU% (kwh/ton) in BY for Potline 2 =** (K1/Capacity utilisation) +K2
  = (88765.96 /90)+ 12522.34
  = 13508.63 kWh/Tonne

- **K1 – constant 1 in AY for Potline 2 = ((**Design Bus Bar Voltage Drop + No of Pots/Potline x Dead pot voltage) x 298000)/ (No of Pots/Potline x Current Efficiency of Pots)
  = ((6+200 x 0.25) x 298000)/(200 x 0.94)
  = 88765.96

- **K2 – constant 1 in AY for Potline 2 = ((**Design Pot voltage - Dead pot voltage) x 2980)/ (Current Efficiency of Pots)
= ((4.2 - 0.25) x 2980)/(0.94)
= 12522.34

- **Capacity Utilisation in AY for Potline 2 = ((**No of operating pots/No of pots/ potline) x 100)
= (187/200) * 100
= 93.50%

- **SEC Design at CU% (kwh/ton) in AY for Potline 2 =** (K1/Capacity utilisation) +K2
= (88765.96 /93.50)+ 12522.34
= 13471.71 kWh/Tonne

- **Notional Specific Energy Consumption for Potline 2 =** SEC Design at CU % in AY for potline 1 - SEC Design at CU % in BY for potline 1
= 13471.71 - 13508.63
= -36.92 kWh/Tonne

- **Electrical Energy to be deducted due to lower capacity utilisation (Million kWh) for potline 2**

  a. If capacity utilization % in AY < capacity utilization % in BY, Electrical energy to be deducted = Notional Specific Energy Consumption for Potline 1 x Production /10^6

  b. If capacity utilization % in AY > capacity utilization % in BY, Electrical energy to be deducted = 0

  = 0 Million kWh

- **Total Electrical Energy to be deducted due to lower capacity utilisation =** Electrical Energy to be deducted due to lower capacity utilisation for AY of Line 1 + Electrical Energy to be deducted due to lower capacity utilisation for AY of Line 2 +………………Line 10
= 0.42 + 0
= 0.42 Million kWh

- **Electrical Energy to be deducted due to lower capacity utilisation=**Total Electrical Energy to be deducted due to lower capacity utilisation (Milliom kWh) X Weighted Heat Rate (kcal/kWh)
= 0.42 x 867
= 365.8 Million kCal

- **Notional Energy for Smelter capacity utilization (toe**)= (Electrical Energy to be deducted due to lower capacity utilisation (Million kcal))/10
= 365.8/10
= 36.58 TOE

9.5 Bauxite Quality

Sr. No	Description	Unit	Baseline Year (BY)	Assessment Year (AY)
1	Total Hydrate Alumina Production	Tonne	66676.0	92660
2	TAA/THA	%	40	38
3	Moisture	%	10	10
4	Overall Recovery	%	93	93
5	Wash Water	t/t of mud	1.45	1.45
6	Steam Economy	t/t	2.5	2.5
7	Fe in Bxt	%	28	29
8	Fe in Mud	%	54	55
9	Actual Steam Enthalpy	kcal/kg	510	515
10	Boiler Efficiency	%	85	85

- **Specific bauxite Factor in BY (tonne of Bauxite/Tonne of Alumina)** = 1/(TAA in Bauxite for BY X (100 – Moisture content in Bauxite for BY) X Overall recovery from Bauxite for BY)
  = 1/(40 X (100 – 10) X 93)
  =2.987

- **Mud Factor in BY (tonne of mud/Tonne of Bauxite)** = Fe in Bauxite for BY / Fe in Mud for BY
  = 28/54
  =0.519

- **Wash Water in BY (Tonns)** = Specific bauxite factor in BY X (100- Moisture content in Bauxite for BY)% X Mud Factor X wash water required for cleaning one Tonne of mud
  = 2.987 X (100 – 10)% X 0.519 X 1.45
  = 2.02 Tonnes

- **Specific bauxite Factor in AY (tonne of Bauxite/Tonne of Alumina) =** 1/(TAA in Bauxite for AY X (100 – Moisture content in Bauxite for AY) X Overall recovery from Bauxite for AY)
  = 1/(38 X (100 – 10) X 93)
  =3.144

- **Mud Factor in AY (tonne of mud/Tonne of Bauxite)** = Fe in Bauxite for AY / Fe in Mud for AY
  = 29/55
  =0.527

- **Wash Water in AY (Tonns)** = Specific bauxite factor in AY X (100- Moisture content in Bauxite for AY)% X Mud Factor X wash water required for cleaning one Tonne of mud
  = 3.144 X (100 – 10)% X 0.527 X 1.45
  = 2.16 Tonnes

- **Excess wash water (Tonne)** = Wash water for AY (Tonne) - wash water for BY (Tonne)
  = 2.16 – 2.02
  = 0.1423 Tonne

- **Excess Moisture (Tonne)** = (Specific bauxite factor in AY - Specific bauxite factor in BY) X Moisture content in AY
  = (2.987 – 3.144) X 10%
  = 0.0157 Tonne

- **Excess Steam (tonne)** = Excess Moisture (Tonne) + Excess wash water (Tonne) / Steam economy (tonne/tonne) in AY
  = 0.0157 + 0.1423/2.5
  = 0.063

❖ **Notional energy for moisture (kCal/ Tonne)** = Excess steam (Tonne) in AY X Actual steam Enthalpy (kCal/kg) X 1000 / Boiler efficiency (%) in AY
= 0.063 X515 X 85
= 38294.9 kCal/Tonne

❖ **Notional energy to be subtracted (Million Kcal) in AY** = notional energy for moisture (kCal/Tonne) X Total Hydrate alumina production (Tonne) / 10^6
= 38294.9 X 92660/10^6
= 3548.4 Million kCal

Sr. No	Description	Unit	Baseline Year (BY)	Assessment Year (AY)
1	Specific Bauxite Factor (SBC)	t bxt/t Al	2.987	3.144
2	Mud Factor	t mud/t bxt	0.519	0.527
3	Wash Water in tons	t	2.02	2.16
4	Excess Moisture	t		0.0157
5	Excess Wash Water	t		0.1423
6	Excess Steam	t		0.063
7	Notional Energy for moisture	Mcal/t		38294.9
8	Notional Energy to be subtracted	Million kcal		3548.4

9.6 Normalization factor for Carbon Anode (Import & Export)

Sr. No	Description	Units	Baseline Year [BY]	Assessment Year [AY]
1	Carbon Anode production	Tonne	202367	212000
2	Imported Carbon Anode	Tonne	5000.0	2000
3	Exported Carbon Anode	Tonne	1500.0	6000
4	Opening Carbon Anode stock	Tonne	10000.0	8000
5	Closing Carbon Anode stock	Tonne	15000.0	4000
6	SEC of Carbon Anode Production	Million kcal/ Tonne	0.70	0.76

For taking stocks position in the end of year, the opening stock will have to be subtracted from the closing stock. The positive difference will be treated as Export of that product. The negative difference will be treated as import of the product

❖ **Stock in BY = Carbon anode Closing Stock in BY – Carbon anode Opening Stock in BY**
= 10000-15000
= 5000**Tonne**

❖ **Stock in AY = Carbon anode Closing Stock in AY – Carbon anode Opening Stock in AY**
= 8000-4000
= **-4000Tonne**

9.6.1 Total Carbon anode Export

3. **In Baseline Year**

c. If, Stock in BY > 0, Total Carbon anode export in BY = Export Carbon anode in BY + Stock in BY

d. If , Stock in BY < 0, Total Carbon anode export in BY = Export Carbon anode in BY
= 1500 + 5000 (Following case a)
= 6500 Tonne

4. **In Assessment Year**

a. If, Stock in AY > 0, Total Carbon anode export in AY = export Carbon anode in AY + Stock in AY

b. If , Stock in AY < 0, Total Carbon anode export in AY = export Carbon anode in AY
= 6000 Tonne

9.6.2 Total Carbon anode import

1. **In Baseline Year**

a. If, Stock in BY < 0, Total Carbon anode import in BY = import Carbon anode in BY - Stock in BY

b. If , Stock in BY > 0, Total Carbon anode import in BY = import Carbon anode in BY
= 5000 Tonne

2. **In Assessment Year**

c. If, Stock in AY > 0, Total Carbon anode import in AY = import Carbon anode in AY + Stock in AY

d. If , Stock in AY < 0, Total Carbon anode import in AY = import Carbon anode in AY
= 2000 – (-4000)
= 6000 Tonne

9.6.3 Notional energy for carbon anode exported

3. **In Baseline Year**

c. Notional energy for carbon anode exported in BY = SEC of carbon anode production in BY X Total Carbon anode exported in BY
= 6500 * 0.7
= 4550 Million kCal

4. **In Assessment Year**

d. Notional energy for carbon anode exported in AY = SEC of carbon anode production in AY X Total Carbon anode exported in AY
= 6000 * 0.76
= 4560 Million kCal

9.6.4 Notional energy for carbon anode imported

1. **In Baseline Year**

c. Notional energy for carbon anode imported in BY = SEC of carbon anode production in BY X Total Carbon anode imported in BY
= 5000 * 0.7
= 3500 Million kCal

2. **In Assessment Year**

d. Notional energy for carbon anode imported in AY = SEC of carbon anode production in AY X Total Carbon anode imported in AY
= 6000 * 0.76
= 4560 Million kCal

9.6.5 Net energy for carbon anode export and import

3. **In Baseline Year**

   c. Net energy for carbon anode export and import in BY= Notional energy for carbon anode exported in BY -Notional energy for carbon anode imported in BY
   = 4550 – 3500
   = **1050 Million kCal**

4. **In Assessment Year**

   d. Net energy for carbon anode export and import in AY= Notional energy for carbon anode exported in AY -Notional energy for carbon anode imported in AY
   = 4560 – 4560
   = **0 Million kCal**

- **Notional energy to be subtracted for carbon anode export and import in AY = Net energy for carbon anode export and import in AY - Net energy for carbon anode export and import in BY**
  = 0 – 1050
  = - **1050 Million kCal**

9.7 Normalization factor for Product Mix (Refinery)

The normalization of equivalent product from minor product to major product will be taken care by considering the conversion factor for each minor product. Each minor product's conversion factors will be same in Baseline Year (BY) and Assessment Year (AY) will be considered same and is given as:

9.7.1 Calculation of Equivalent product in Baseline year

S. No.	Description	Units	Baseline Year [BY]	Assessment Year [AY]
1	Total Hydrate Alumina Production	Tonne	66676.0	92660
2	Total Calcined Alumina Production	Tonne	174215	40003
3	Total Special Hydrate Course Production	Tonne	18664	24317
4	Total Special Hydrate Microfined Production	Tonne	9098	2932
5	Total Special Hydrate Milled Production	Tonne	1859	2183
6	Total Calcined Alumina Course Production	Tonne	51112	80168
7	Total Calcined Alumina Microfined Production	Tonne	51612	40764
8	Total Calcined Alumina Milled Production	Tonne	8090	9665

S. No.	Description	Units	Baseline Year [BY]	Assessment Year [AY]
1	Standard/Calcined Alumina	TOE/Tonne	2.29	2.31
2	Standard Hydrate Alumina	TOE/Tonne	1.26	1.29
3	Special Hydrate Course	TOE/Tonne	1.58	1.42
4	Special Hydrate Microfined	TOE/Tonne	1.59	1.44
5	Special Hydrate Milled	TOE/Tonne	1.60	1.44
6	Special Calcined Alumina Course	TOE/Tonne	2.99	2.78
7	Special Calcined Alumina Microfined	TOE/Tonne	3.00	2.79
8	Special Calcined Alumina Milled	TOE/Tonne	3.00	2.79

❖ **Conversion factor for Special Calcined Alumina Milled = SEC of Special Calcined Alumina in BY/ SEC of Standard/Calcined Aluminain BY**
= 3.0 / 2.29
=1.312

❖ **Conversion factor for Special Calcined Alumina Microfined = SEC of Special Calcined Alumina Microfined in BY/ SEC of Standard/Calcined Alumina in BY**
= 3.0 / 2.29
=1.312

❖ **Conversion factor for Special Calcined Alumina course = SEC of Special Calcined Alumina course in BY/ SEC of Standard/Calcined Alumina in BY**
= 2.99 / 2.29
=1.308

❖ **Conversion factor for Special Hydrate Milled = SEC of Special Hydrate Milled in BY/ SEC of Standard/Calcined Aluminain BY**
= 1.60 / 2.29
=0.698

❖ **Conversion factor for Special Hydrate Microfined= SEC of Special Hydrate Microfinedin BY/ SEC of Standard/ Calcined Aluminain BY**
= 1.59 / 2.29
=0.695

❖ **Conversion factor for Special Hydrate Course = SEC of Special Hydrate Course in BY/ SEC of Standard/Calcined Aluminain BY**
= 1.58 / 2.29
=0.691

❖ **Conversion factor for Standard Hydrate Alumina = SEC of Standard Hydrate Alumina in BY/ SEC of Standard/ Calcined Aluminain BY**
= 1.26 / 2.29
=0.550

S. No	Description	Units	Baseline Year [BY]	Assessment year [AY]
D.1	Hydrate Alumina into Calcined Alumina	Factor	0.550	0.550
D.2	Special Hydrate Course to Calcined Alumina	Factor	0.691	0.691
D.3	Special Hydrate Microfined to Calcined Alumina	Factor	0.695	0.695
D.4	Special Hydrate Milled to Calcined Alumina	Factor	0.698	0.698
D.5	Special Calcined Alumina course to Calcined Alumina	Factor	1.308	1.308
D.6	Special Calcined Alumina Microfined to Calcined Alumina	Factor	1.312	1.312
D.7	Special Calcined Alumina Milled to Calcined Alumina	Factor	1.312	1.312

❖ **Special Calcined Alumina Milled (Tonne) to Equivalent Major Product- Calcined Alumina =** *Special Calcined Alumina Milled Production (t) x Special Calcined Alumina Milled Production (t)*
= 8090 X 1.312
= 10611.05 Tonne

❖ **Special Calcined Alumina Microfined (Tonne) to Equivalent Major Product- Calcined Alumina=** *Calcined Alumina Microfined Production (t) x Energy Factor Special Calcined Alumina Microfined*
= 51612 X 1.312
= 67694.56 Tonne

❖ **Special Calcined Alumina Course (Tonne) to Equivalent Major Product- Calcined Alumina =** *Calcined Alumina Course Production x Energy Factor Special Calcined Alumina course*
= 51112 X 1.308
= 66858.70 Tonne

❖ **Special Hydrate Milled (Tonne) to Equivalent Major Product- Calcined Alumina =** *Special Hydrate Milled Production x Energy Factor Special Hydrate Milled*
= 1859 X 0.698
= 1297.92 Tonne

❖ **Special Hydrate Micro fined(Tonne) to Equivalent Major Product- Calcined Alumina =** *Special Hydrate Micro fined Production x Energy Factor Special Hydrate Micro fined*
= 9098 X 0.695
= 6323.16 Tonne

❖ **Special Hydrate Course (Tonne) to Equivalent Major Product- Calcined Alumina=** *Special Hydrate Course Production x Energy Factor Special Hydrate Course*
= 0.691 X 18664
= 12888.04 Tonne

❖ **Standard Hydrate Alumina (Tonne) to Equivalent Major Product- Calcined Alumina=** *Standard Hydrate Alumina Production x Energy Factor Standard Hydrate Alumina*
= 0.55 X 66676.0
= 36659.14 Tonne

- **Total Equivalent Standard Calcined Alumina Production (Tonne) in the BY**
  = Standard Calcined Alumina + Equivalent Standard Hydrate Alumina + Equivalent Special Hydrate Course + Equivalent Special Hydrate Microfined + EquivalentSpecial Hydrate Milled + Equivalent Special Calcined Alumina Course + Equivalent Special Calcined Alumina Microfined + Equivalent Special Calcined Alumina Milled
  = 174215.00 + 36659.14 + 12888.04 + 6323.16 + 1297.92 + 66858.70 + 67694.56 + 10611.05
  = 376547.56 Tonne

9.7.2 Calculation of Equivalent product in Assessment year

In Assessment year, the conversion factor for each value added products should be same as that Baseline year.

- **Special Calcined Alumina Milled (Tonne) to Equivalent Major Product- Calcined Alumina =** *Special Calcined Alumina Milled Production (t) x Energy Factor Special Calcined Alumina Milled*
  = 9665 X 1.312
  = 12676.86Tonne

- **Special Calcined Alumina Microfined (Tonne) to Equivalent Major Product- Calcined Alumina=** *Calcined Alumina Microfined Production (t) x Energy Factor Special Calcined Alumina Microfined*
  = 40764 X 1.312
  = 53466.27 Tonne

- **Special Calcined Alumina Course (Tonne) to Equivalent Major Product- Calcined Alumina =** *Calcined Alumina Course Production x Energy Factor Special Calcined Alumina course*
  = 80168 X 1.308
  = 104866.34 Tonne

- **Special Hydrate Milled (Tonne) to Equivalent Major Product- Calcined Alumina =** *Special Hydrate Milled Production x Energy Factor Special Hydrate Milled*
  = 2183X 0.698
  = 1524.13Tonne

- **Special Hydrate Micro fined(Tonne) to Equivalent Major Product- Calcined Alumina =** *Special Hydrate Micro fined Production x Energy Factor Special Hydrate Micro fined*
  = 2932 X 0.695
  = 2037.76 Tonne

- **Special Hydrate Course (Tonne) to Equivalent Major Product- Calcined Alumina=** *Special Hydrate Course Production x Energy Factor Special Hydrate Course*
  = 0.691 X 24317
  = 16791.61 Tonne

- **Standard Hydrate Alumina (Tonne) to Equivalent Major Product- Calcined Alumina=** *Standard Hydrate Alumina Production x Energy Factor Standard Hydrate Alumina*
  = 0.55 X 92660
  = 50945.40 Tonne

- **Total Equivalent Standard Calcined Alumina Production (Tonne) in the AY**
  = Standard Calcined Alumina + Equivalent Standard Hydrate Alumina + Equivalent Special Hydrate Course +

Equivalent Special Hydrate Microfined + EquivalentSpecial Hydrate Milled + Equivalent Special Calcined Alumina Course + Equivalent Special Calcined Alumina Microfined + Equivalent Special Calcined Alumina Milled
= 40003.00 + 50945.40 + 16791.61+ 2037.76+ 1524.13+ 104866.34+ 53466.27+ 12676.86
= **242308.36 Tonne**

9.8 Normalization factor for Product Mix (Smelter)

The normalization of equivalent product from minor product to major product will be taken care by considering the conversion factor for each minor product. Each minor product's conversion factors will be same in Baseline Year (BY) and Assessment Year (AY) will be considered same and is given as:

Calculation of Equivalent product in Baseline year

PRODUCTION DETAILS				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
1	Total Mlt Aluminum Production	Tonne	373649.5	434528
2	Total Cast House production	Tonne	360457	431488
3	Total Billet Production	Tonne	16893	28130
4	Total Ingot Production	Tonne	185047	242938
5	Total Wire rod Production	Tonne	68087	76958
6	Total strips production	Tonne	12152	17050

SPECIFIC ENERGY CONSUMPTION				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
1	SEC TOE of Molten Aluminium	TOE/Tonne	5.35	5.45
2	SEC TOE of Billet	TOE/Tonne	1.305	0.832
3	SEC TOE of Ingot	TOE/Tonne	0.034	0.022
4	SEC TOE of wire Rods	TOE/Tonne	0.058	0.049
5	SEC TOE of Strips	TOE/Tonne	0.382	0.191

- **Conversion factor for Billet = SEC of Billets in BY/ SEC of Molten Aluminium in BY**
  = 1.305 / 5.35
  =0.244

- **Conversion factor for Ingot = SEC of Ingot in BY/ SEC of Molten Aluminium in BY**
  = 0.034 / 5.35
  =0.006

- **Conversion factor for Wire rods = SEC of Wire rods in BY/ SEC of Molten Aluminium in BY**
  = 0.058 / 5.35
  =0.011

- **Conversion factor for Strips = SEC of Strips in BY/ SEC of Molten Aluminium in BY**
  = 0.382 / 5.35
  =0.07

CONVERSION FACTOR				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
12	% Share of billet	Factor	0.244	0.153
13	% share of ingots	Factor	0.006	0.004
14	% share of wire rods	Factor	0.011	0.009
15	% share of strips	Factor	0.07	0.04

- **Billet to Molten Aluminium (EMP) in BY (Tonne) = total billet production in BY * conversion factor of billet in BY**
  = 16893 * 0.244
  = 4121.29 Tonne

- **Ingots to Molten Aluminium (EMP) in BY (Tonne) = Total Ingots production in BY * conversion factor of Ingot in BY**
  = 185047 * 0.006
  = 1188.73 Tonne

- **Wire rods to Molten Aluminium (EMP) in BY (Tonne) = Total Wire rods production in BY * conversion factor of Wire rods in BY**
  = 68087* 0.011
  = 743.91 Tonne

- **Strips to Molten Aluminium (EMP) in BY (Tonne) = Total Strips production in BY * conversion factor of Strips in BY**
  = 12152* 0.07
  = 867.83 Tonne

- **Total Equivalent Molten Aluminium production in BY**
  = Molten Aluminium production + Billet to EMP + Ingots to EMP + Wire rods to EMP + strips to EMP
  = 373649.5 + 4121.29 + 1188.73 + 743.91 + 867.83
  = 380571 Tonne

9.8.2 Calculation of Equivalent product in Assessment year

- **Conversion factor for Billet = SEC of Billets in AY/ SEC of Molten Aluminium in AY**
  = 0.832 / 5.45
  =0.153

- **Conversion factor for Ingot = SEC of Ingot in AY/ SEC of Molten Aluminium in AY**
  = 0.022 / 5.45
  =0.004

- **Conversion factor for Wire rods = SEC of Wire rods in AY/ SEC of Molten Aluminium in AY**
  = 0.049 / 5.45
  =0.009

- **Conversion factor for Strips = SEC of Strips in AY/ SEC of Molten Aluminium in AY**
  = 0.191 / 5.45
  =0.04

CONVERSION FACTOR				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
12	% Share of billet	Factor	0.244	0.153
13	% share of ingots	Factor	0.006	0.004
14	% share of wire rods	Factor	0.011	0.009
15	% share of strips	Factor	0.07	0.04

In Assessment year, the conversion factor for each value added products should be same as that Baseline year.

- **Billet to Molten Aluminium (EMP) in BY (Tonne) = total billet production in BY * conversion factor of billet in BY**
  = 28130* 0.244
  = 6863.72 Tonne

- **Ingots to Molten Aluminium (EMP) in BY (Tonne) = Total Ingots production in BY * conversion factor of Ingot in BY**
  = 242938* 0.006
  = 1457.628 Tonne

- **Wire rods to Molten Aluminium (EMP) in BY (Tonne) = Total Wire rods production in BY * conversion factor of Wire rods in BY**
  = 76958* 0.011
  = 846.538 Tonne

- **Strips to Molten Aluminium (EMP) in BY (Tonne) = Total Strips production in BY * conversion factor of Strips in BY**
  = 17050* 0.07
  = 1193.5 Tonne

- **Total Equivalent Molten Aluminium production in BY**
  = Molten Aluminium production + Billet to EMP + Ingots to EMP + Wire rods to EMP + strips to EMP
  = 434528 + 6863.72 + 1457.628 + 846.538 + 1193.5
  = 445010 Tonne

9.8.2.1 Case 1: Different Product mix ratio in Assessment year

PRODUCTION DETAILS				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
1	Total Mlt Aluminum Production	Tonne	373649.5	373649.5
2	Total Cast House production	Tonne	360457	360457
3	Total Billet Production	Tonne	16893	185000
4	Total Ingot Production	Tonne	185047	13000
5	Total Wire rod Production	Tonne	68087	17000
6	Total strips production	Tonne	12152	68000

SPECIFIC ENERGY CONSUMPTION				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
1	SEC TOE of Molten Aluminium	TOE/Tonne	5.35	5.35
2	SEC TOE of Billet	TOE/Tonne	1.305	2.17
3	SEC TOE of Ingot	TOE/Tonne	0.034	0.0045
4	SEC TOE of wire Rods	TOE/Tonne	0.058	0.036
5	SEC TOE of Strips	TOE/Tonne	0.382	0.89

CONVERSION FACTOR				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
1	% Share of billet	Factor	0.244	0.406
2	% share of ingots	Factor	0.006	0.001
3	% share of wire rods	Factor	0.011	0.007
4	% share of strips	Factor	0.07	0.17

Calculation of Equivalent molten aluminium for each value added products

- **Billet to Equivalent molten aluminum product =** BiP_{AY}x $EFBi_{AY}$
  Where
  BiP_{AY} = *Billet Production (t)*
  $CFBi_{AY}$ =*Conversion factor of Billet*=$CFBi_{BY}$
  = 185000* 0.244
  = 45133.45Tonne

- **Ingot to Equivalent molten aluminum product** = InP_{AY} x $EFIn_{AY}$
  Where
  InP_{AY} = *Ingot Production (t)*
  $EFIn_{AY}$=*Energy factor of ingots* = $EFIn_{BY}$
  = 13000* 0.006
  = 83.51Tonne

- **Wire rods to Equivalent molten aluminum product** = $WiRP_{AY}$ x $EFWiR_{AY}$
  Where
  $WiRP_{AY}$ = *Total Wire rod Production (t)*
  $EFWiR_{AY}$ =*Energy factor of wire rods*= $EFWiR_{BY}$
  = 17000* 0.011
  = 185.74Tonne

- **Strips to Equivalent molten aluminum product =** StP_{AY}x$EFSt_{AY}$
  Where
  StP_{AY} =*strips production(t)*
  $EFSt_{AY}$=*Energy factor of Strips* =$EFSt_{BY}$
  = 68000* 0.07
  = 4856.20Tonne

- **Total Equivalent Molten Aluminium production** = MA_{AY} +$EqBi_{AY}$ +$EqIn_{AY}$ +$EqBa_{AY}$ +$EqPF_{AY}$+ $EqWiR_{AY}$+ $EqSt_{AY}$ + $EqOp_{AY}$
  = 373649.5 + 45133.45 + 83.51 + 185.74 + 4856.20
  = 423908Tonne

9.8.2.2 *Case 2: Calculation of Equivalent Molten Aluminum product in assessment year when production of Billet is zero.*

PRODUCTION DETAILS				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
1	Total Mlt Aluminum Production	Tonne	373649.5	373649.5
2	Total Cast House production	Tonne	360457	360457
3	Total Billet Production	Tonne	16893	0
4	Total Ingot Production	Tonne	185047	185047
5	Total Wire rod Production	Tonne	68087	68087
6	Total strips production	Tonne	12152	29045

SPECIFIC ENERGY CONSUMPTION				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
1	SEC TOE of Molten Aluminum	TOE/Tonne	5.35	5.35
2	SEC TOE of Billet	TOE/Tonne	1.305	0
3	SEC TOE of Ingot	TOE/Tonne	0.034	0.034
4	SEC TOE of wire Rods	TOE/Tonne	0.058	0.058
5	SEC TOE of Strips	TOE/Tonne	0.382	0.540

CONVERSION FACTOR				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
1	% Share of billet	Factor	0.244	0.000
2	% share of ingots	Factor	0.006	0.006
3	% share of wire rods	Factor	0.011	0.011
4	% share of strips	Factor	0.07	0.10

Calculation of Equivalent molten aluminium for each value added products

- **Billet to Equivalent molten aluminum product =** BiP_{AY} x $EFBi_{AY}$
  Where
  BiP_{AY} = *Billet Production (t)*
  $CFBi_{AY}$ =*Conversion factor of Billet*=$CFBi_{BY}$
  = 0* 0.244
  = 0Tonne

- **Ingot to Equivalent molten aluminum product** = InP_{AY} x $EFIn_{AY}$
  Where
  InP_{AY} = *Ingot Production (t)*
  $EFIn_{AY}$=*Energy factor of ingots* = $EFIn_{BY}$
  = 185047* 0.006
  = 1188.73Tonne

- **Wire rods to Equivalent molten aluminum product** = $WiRP_{AY}$ x $EFWiR_{AY}$
  Where
  $WiRP_{AY}$ = *Total Wire rod Production (t)*
  $EFWiR_{AY}$ =*Energy factor of wire rods*= $EFWiR_{BY}$
  = 68087* 0.011
  = 743.91Tonne

- **Strips to Equivalent molten aluminum product =** $StP_{AY} x EFSt_{AY}$
  Where
  StP_{AY} =*strips production(t)*
  $EFSt_{AY}$ =*Energy factor of Strips* =$EFSt_{BY}$
  = 29045* 0.07
  = 2074.24Tonne

- **Total Equivalent Molten Aluminum production** = MA_{AY} +$EqBi_{AY}$ +$EqIn_{AY}$ +$EqBa_{AY}$ +$EqPF_{AY}$+ $EqWiR_{AY}$+ $EqSt_{AY}$ + $EqOp_{AY}$
  = 373649.5 + 0+ 1188.73 + 743.91 + 2074.24
  = 377656Tonne

9.8.2.3 Case 3: Calculation of Equivalent Molten Aluminum product in assessment year when addition of new product

PRODUCTION DETAILS				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
1	Total Mlt Aluminum Production	Tonne	373649.5	373649.5
2	Total Cast House production	Tonne	360457	360457
3	Total Billet Production	Tonne	16893	16893
4	Total Ingot Production	Tonne	185047	185047
5	Total Wire rod Production	Tonne	68087	68087
6	Total strips production	Tonne	12152	12152
7	Total Bars production	Tonne	0	17821

SPECIFIC ENERGY CONSUMPTION				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
1	SEC TOE of Molten Aluminum	TOE/Tonne	5.35	5.35
2	SEC TOE of Billet	TOE/Tonne	1.305	1.305
3	SEC TOE of Ingot	TOE/Tonne	0.034	0.034
4	SEC TOE of wire Rods	TOE/Tonne	0.058	0.058
5	SEC TOE of Strips	TOE/Tonne	0.382	0.382
6	SEC TOE of Bars	TOE/Tonne	0	0.320

CONVERSION FACTOR				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment year [AY]**
1	% Share of billet	Factor	0.244	0.244
2	% share of ingots	Factor	0.006	0.006
3	% share of wire rods	Factor	0.011	0.011
4	% share of strips	Factor	0.07	0.07
5	% share of Bars	Factor	0	0.06

- **Billet to Equivalent molten aluminum product =** BiP_{AY}x $EFBi_{AY}$
  Where
  BiP_{AY} = *Billet Production (t)*
  $CFBi_{AY}$ =*Conversion factor of Billet*=$CFBi_{BY}$
  = 16893* 0.244
  = 4121.29Tonne

- **Ingot to Equivalent molten aluminum product** = InP_{AY} x $EFIn_{AY}$
  Where
  InP_{AY} = *Ingot Production (t)*
  $EFIn_{AY}$=*Energy factor of ingots* = $EFIn_{BY}$
  = 185047* 0.006
  = 1188.73Tonne

- **Wire rods to Equivalent molten aluminum product** = $WiRP_{AY}$ x $EFWiR_{AY}$
  Where
  $WiRP_{AY}$ = *Total Wire rod Production (t)*
  $EFWiR_{AY}$ =*Energy factor of wire rods*= $EFWiR_{BY}$
  = 68087* 0.011
  = 743.91Tonne

- **Strips to Equivalent molten aluminum product =** StP_{AY}x$EFSt_{AY}$
  Where
  StP_{AY} =*strips production(t)*
  $EFSt_{AY}$ =*Energy factor of Strips* =$EFSt_{BY}$
  = 12152* 0.07
  = 867.83Tonne

- **Bars to Equivalent molten aluminum product =** BrP_{AY}x$EFBr_{AY}$
  Where
  BrP_{AY} =*Bars production (t)*
  $EFBr_{AY}$ =*Energy factor of Bars* =$EFBr_{BY}$
  = 17821*0.06
  = 1065.93Tonne

- **Total Equivalent Molten Aluminum production** = MA_{AY} +$EqBi_{AY}$ +$EqIn_{AY}$ +$EqBa_{AY}$ +$EqPF_{AY}$+ $EqWiR_{AY}$+ $EqSt_{AY}$ + $EqOp_{AY}$
  = 373649.5 + 4121.29+ 1188.73 + 743.91 + 867.83 + 1065.93
  = 381637Tonne

9.9 Normalization factor for Cold Sheet Process

9.9.1 Product mix Normalization

9.9.1.1 *Yearly Stock Calculation*

9.9.1.1.1 Alloy Ingot

Alloy Ingot (AI)				
S.No.	**Description**	**Units**	**Baseline Year [BY]**	**Assessment Year [AY]**
1	Alloy Ingot (AI)	Tonne	6864.72	10699.00
2	Import	Tonne	0.00	0.00
3	Export	Tonne	0.00	0.00
4	Opening Stock	Tonne	0.00	0.00
5	Closing Stock	Tonne	1187.04	0.00
6	Stock Difference	Tonne	1187.04	0.00

For taking stocks position in the end of year, the opening stock will have to be subtracted from the closing stock. The positive difference will be treated as Export of that product. The negative difference will be treated as import of the product

- **Stock in BY = Alloy Ingot Closing Stock in BY – Alloy Ingot Opening Stock in BY**
  = 0-1187.04
  = 1187.04**Tonne**

- **Total Alloy Ingot Export**
  5. **In Baseline Year**
     e. If, Stock in BY > 0, Total Alloy Ingot export in BY = Export Alloy Ingot in BY + Stock in BY
     f. If , Stock in BY < 0, Total Alloy Ingot export in BY = Export Alloy Ingot in BY
     = 1187.04 + 0 (Following case a)
     = 1187.04 Tonne

- **Total Alloy Ingot import**
  1. **In Baseline Year**
     a. If, Stock in BY < 0, Total Alloy Ingot import in BY = import Alloy Ingot in BY - Stock in BY
     b. If , Stock in BY > 0, Total Alloy Ingot import in BY = import Alloy Ingot in BY
     = 0 Tonne

- **Stock in AY = Alloy Ingot Closing Stock in AY – Alloy Ingot Opening Stock in AY**
  = 0**Tonne**

- **Total Alloy Ingot Export**
  1. **In Assessment Year**
     g. If, Stock in AY > 0, Total Alloy Ingot export in AY = Export Alloy Ingot in AY + Stock in AY
     h. If , Stock in AY < 0, Total Alloy Ingot export in AY = Export Alloy Ingot in AY
     = 0 Tonne

- **Total Alloy Ingot import**
  2. **In Assessment Year**
     a. If, Stock in AY < 0, Total Alloy Ingot import in AY = import Alloy Ingot in AY - Stock in AY
     b. If , Stock in AY > 0, Total Alloy Ingot import in AY = import Alloy Ingot in AY
     = 0 Tonne

9.9.1.1.2 Rolling Ingot

Rolling Ingot (RI)				
S.No.	**Description**	**Units**	**Baseline Year [BY]**	**Assessment Year [AY]**
1	Rolling Ingot (RI)	Tonne	38523.91	24931.28
2	Import	Tonne	0.00	19255.73
3	Export	Tonne	0.00	0.00
4	Opening Stock	Tonne	37825.99	0.00
5	Closing Stock	Tonne	0.00	0.00
6	Stock Difference	Tonne	-37825.99	0.00

❖ **Stock in BY = Rolling Ingot Closing Stock in BY – Rolling Ingot Opening Stock in BY**

= 37825.99 -0
= - 37825.99 **Tonne**

❖ **Total Rolling Ingot Export**

1. **In Baseline Year**
   a. If, Stock in BY > 0, Total Rolling Ingot export in BY = Export Rolling Ingot in BY + Stock in BY
   b. If , Stock in BY < 0, Total Rolling Ingot export in BY = Export Rolling Ingot in BY
   = 0 Tonne

❖ **Total Rolling Ingot import**

2. **In Baseline Year**
   a. If, Stock in BY < 0, Total Rolling Ingot import in BY = import Rolling Ingot in BY - Stock in BY
   b. If , Stock in BY > 0, Total Rolling Ingot import in BY = import Rolling Ingot in BY
   = 0-37825.99 Tonne
   = - 37825.99 Tonne

Assessment Year

❖ **Stock in AY = Rolling Ingot Closing Stock in AY – Rolling Ingot Opening Stock in AY**
= 0 **Tonne**

❖ **Total Rolling Ingot Export**

1. **In Assessment Year**
   a. If, Stock in AY > 0, Total Rolling Ingot export in AY = Export Rolling Ingot in AY + Stock in AY
   b. If , Stock in AY < 0, Total Rolling Ingot export in AY = Export Rolling Ingot in AY
   = 0 Tonne

❖ **Total Rolling Ingot import**

2. **In Assessment Year**
   a. If, Stock in AY < 0, Total Rolling Ingot import in AY = import Rolling Ingot in AY - Stock in AY
   b. If , Stock in AY > 0, Total Rolling Ingot import in AY = import Rolling Ingot in AY
   = 0 Tonne

9.9.1.1.3 Hot Rolled Coil

Hot Rolled Coil (HRC)				
S.No.	**Description**	**Units**	**Baseline Year [BY]**	**Assessment Year [AY]**
1	Hot Rolled Coil (HRC)	Tonne	75592.67	42689.97
2	Import	Tonne	583.67	2570.42
3	Export	Tonne	4737.50	0.00
4	Opening Stock	Tonne	0.00	0.00
5	Closing Stock	Tonne	0.00	0.00
6	Stock Difference	Tonne	0.00	0.00

- **Stock in BY = HRC Closing Stock in BY – HRC Opening Stock in BY**
  = 0 Tonne

- **Total HRC Export**
  1. **In Baseline Year**
     a. If, Stock in BY > 0, Total HRC export in BY = Export HRC in BY + Stock in BY
     b. If , Stock in BY < 0, Total HRC export in BY = Export HRC in BY = 4737.50 **Tonne (following case b)**

- **Total HRC import**
  2. **In Baseline Year**
     a. If, Stock in BY < 0, Total HRC import in BY = import HRC in BY - Stock in BY
     b. If , Stock in BY > 0, Total HRC import in BY = import HRC in BY **= 583.67 Tonne (following case b)**

Assessment Year

- **Stock in AY = HRC Closing Stock in AY – HRC Opening Stock in AY**
  = 0 **Tonne**

- **Total HRC Export**
  1. **In Assessment Year**
     a. If, Stock in AY > 0, Total HRC export in AY = Export HRC in AY + Stock in AY
     b. If , Stock in AY < 0, Total HRC export in AY = Export HRC in AY **= 0 Tonne**

- **Total HRC import**
  2. **In Assessment Year**
     a. If, Stock in AY < 0, Total HRC import in AY = import HRC in AY - Stock in AY
     b. If , Stock in AY > 0, Total HRC import in AY = import HRC in AY = 2570.42 Tonne (following case b)

9.9.1.1.4 Cold Rolled Coil

Cold Rolled Coil (CRC)				
S.No.	**Description**	**Units**	**Baseline Year [BY]**	**Assessment Year [AY]**
1	Cold Rolled Coil (CRC)	Tonne	48830.07	30306.00
2	Import	Tonne	600.00	0.00
3	Export	Tonne	0.00	0.00
4	Opening Stock	Tonne	0.00	0.00
5	Closing Stock	Tonne	0.00	0.00
6	Stock Difference	Tonne	0.00	0.00

- **Stock in BY = CRC Closing Stock in BY – CRC Opening Stock in BY**
  = 0 Tonne

- **Total CRC Export**

  1. **In Baseline Year**
     a. If, Stock in BY > 0, Total CRC export in BY = Export CRC in BY + Stock in BY
     b. If , Stock in BY < 0, Total CRC export in BY = Export CRC in BY = 0 **Tonne (following case b)**

- **Total CRC import**

  2. **In Baseline Year**
     a. If, Stock in BY < 0, Total CRC import in BY = import CRC in BY - Stock in BY
     b. If , Stock in BY > 0, Total CRC import in BY = import CRC in BY **= 600 Tonne (following case b)**

Assessment Year

- **Stock in AY = CRC Closing Stock in AY – CRC Opening Stock in AY**
  = 0 **Tonne**

- **Total CRC Export**

  1. **In Assessment Year**
     a. If, Stock in AY > 0, Total CRC export in AY = Export CRC in AY + Stock in AY
     b. If , Stock in AY < 0, Total CRC export in AY = Export CRC in AY **= 0 Tonne**

- **Total CRC import**

  2. **In Assessment Year**
     a. If, Stock in AY < 0, Total CRC import in AY = import CRC in AY - Stock in AY
     b. If , Stock in AY > 0, Total CRC import in AY = import CRC in AY = 0 Tonne (following case b)

9.9.1.2 Specific Energy Consumption up to per ton of product for BY and AY

	Specific Energy Consumption for per tonne of product			
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment Year [AY]**
1	Alloy Ingot	Million kCal/Tonne	0.62	1.01
2	Rolling Ingot (Remelting furnace)	Million kCal/Tonne	0.61	0.68
3	Hot Rolled Coil	Million kCal/Tonne	0.32	0.32
4	Cold Rolled Coil	Million kCal/Tonne	0.64	0.56

- **In Baseline year**
  1. Alloy Ingot (Million kcal/Tonne)
     AISEC =AISP
     Where
     AISP = Alloy Ingot -SEC for per tonne of product (Million kcal/ Tonne)
     = 0.62 Million kCal/Tonne

  2. Rolling Ingot (Million kcal/Tonne)
     RISEC= RISP
     Where
     RISP =SEC of Rolling Ingot (Recyclinig+ Remelting Furnace) per tonne of product(Million kcal/Tonne) =[(Thermal Energy for Alloy Ingot + Thermal Energy for Rolling Ingot-Thermal Energy for Alloy Ingot Production)/Rolling Ingot Production]+ [(Electrical Energy for Alloy Ingot + Electrical Energy for Rolling Ingot-Electrical Energy for Alloy IngotProduction)/Rolling Ingot Production]

S.No	Description	Unit	Baseline Year [BY]	Assessment Year [AY]
1	Alloy ingot Production	Tonne	**2653**	0
2	Thermal Energy consumption for producing Alloy Ingot (Recycling Furnace)	Million kcal	1190.19	10487.62031
3	Electrical Energy consumption for producing Alloy Ingot (Recycling Furnace)	kWh	885872.00	332773
4	Thermal SEC	kcal/tonne	584308.31	980243.04
5	Electrical SEC	kwh/tonne	45.00	31.10
6	Total Rolling Ingot Production	Tonne	38523.91	24931.28
7	Thermal Energy consumption for producing Rolling Ingot (Re-Melting Furnace)	Million kcal	23518.62	15975.14726
8	Electrical Energy consumption for producing Rolling Ingot (Re-Melting Furnace)	kWh	0.00	1062430
9	Thermal SEC	kcal/tonne	608109.74	640767.23
10	Electrical SEC	kwh/tonne	0.00	42.61
11	Weighted Average Heat Rate	Kcal/kWh	860	860

- **Thermal SEC of Rolling Ingot (kCal/Tonne)**
  =((1190.91+ 23518.62 – (2653*584308.31/10^6))/38523.91)*10^6
  = 601150 kCal/Tonne

- **Electrical SEC of Rolling Ingot (kWh/Tonne)**
  =((885872.00 + 0 – (2653*45.00))/38523.91)
  = 19.9 kWh/Tonne

- **Rolling Ingot SEC (Million kCal/Tonne)**
  = (601150 + (19.9 *860))/10^6
  = 0.62 Million kCal/Tonne

3. Hot Rolled Coil (Million kcal/Tonne)
   HRCSEC= = AISP + RISP +HRCSP
   Where
   AISP =Alloy Ingot -SEC for per tonne of product (Million kcal/Tonne)
   RISP =Rolling Ingot- SEC for per tonne of product (Million kcal/Tonne)
   HRCSP =Hot Rolled Coil- SEC for per tonne of product (Million kcal/Tonne)
   = (0.62 + 0.61 + 0.32)
   = 1.55 Million kCal/Tonne

4. Cold Rolled Coil (Million kcal/Tonne) CRCSEC= = AISP + RISP +HRCSP + CRCSP
   Where
   AISP =Alloy Ingot -SEC for per tonne of product (Million kcal/Tonne)
   RISP =Rolling Ingot- SEC for per tonne of product (Million kcal/Tonne)
   HRCSP =Hot Rolled Coil- SEC for per tonne of product (Million kcal/Tonne)
   CRCSP =Cold Rolled Coil- SEC for per tonne of product (Million kcal/Tonne)
   = (0.62 + 0.61 + 0.32 + 0.64)
   = 2.20 Million kCal/Tonne

❖ **In Assessment year**

1. Alloy Ingot (Million kcal/Tonne) AISEC =AISP
   Where
   AISP =Alloy Ingot -SEC for per tonne of product (Million kcal/Tonne) for AY
   = 1.01 Million kCal/Tonne

2. Rolling Ingot (Million kcal/Tonne) RISEC= RISP
   Where
   RISP =SEC of Rolling Ingot (Recyclinig+ Remelting Furnace) per tonne of product(Million kcal/Tonne)
   =[(Thermal Energy for Alloy Ingot + Thermal Energy for Rolling Ingot-Thermal Energy for Alloy Ingot Production)/Rolling Ingot Production]+ [(Electrical Energy for Alloy Ingot + Electrical Energy for Rolling Ingot-Electrical Energy for Alloy IngotProduction)/Rolling Ingot Production]

❖ **Thermal SEC of Rolling Ingot (kCal/Tonne)**
=((10487.62+ 15975.15 – (0*980243.04/10^6))/24931.28)*10^6
= 1061428.4 kCal/Tonne

❖ **Electrical SEC of Rolling Ingot (kWh/Tonne)**
=((332773+1062430–(0*31.10))/24931.28)
= 55.96 kWh/Tonne

❖ **Rolling Ingot SEC (Million kCal/Tonne)**
= (1061428.4 + (55.96 *860))/10^6
= 1.11 Million kCal/Tonne

3. Hot Rolled Coil (Million kcal/Tonne)
   HRCSEC= = AISP + RISP +HRCSP
   Where
   AISP =Alloy Ingot -SEC for per tonne of product (Million kcal/Tonne)
   RISP =Rolling Ingot- SEC for per tonne of product (Million kcal/Tonne)
   HRCSP =Hot Rolled Coil- SEC for per tonne of product (Million kcal/Tonne)
   = (1.01 + 0.68 + 0.32)
   = 2.01 Million kCal/Tonne

4. Cold Rolled Coil (Million kcal/Tonne) CRCSEC= = AISP + RISP +HRCSP + CRCSP
   Where
   AISP =Alloy Ingot -SEC for per tonne of product (Million kcal/Tonne)
   RISP =Rolling Ingot- SEC for per tonne of product (Million kcal/Tonne)
   HRCSP =Hot Rolled Coil- SEC for per tonne of product (Million kcal/Tonne)
   CRCSP =Cold Rolled Coil- SEC for per tonne of product (Million kcal/Tonne)
   = (1.01 + 0.68 + 0.32 + 0.56)
   = 2.57 Million kCal/Tonne

9.9.1.3 Major Product

In Aluminium Cold Sheet plant major product is Cold Rolled Coil. So for calculating conversion factor for minor to major product, we can consider SEC of Cold Rolled Coil.

❖ **SEC of Major Product (Cold Rolled Coil) Million kCal/Tonne**
= 2.20 Million kcal/Tonne

9.9.1.4 *Conversion factor for minor to major product*

Specific Energy Consumption up to per ton of product				
S.No	**Description**	**Unit**	**Baseline year [BY]**	**Assessment year [AY]**
1	Alloy Ingot	Million kCal/ Tonne	0.62	1.01
2	Rolling Ingot	Million kCal/ Tonne	0.62	1.11
3	Hot Rolled Coil	Million kCal/ Tonne	1.55	2.01
4	Major product (Cold Rolled Coil)	Million kCal/ Tonne	2.20	2.57

❖ **In Baseline Year**

1) Alloy Ingot to major Product Conversion Factor
Alloy Ingot to major Product $AICF_{(BY)}$ =
Where
AISECBY =Alloy Ingot-Specific Energy Consumption (Million kcal/ Tonne) in BY
SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY
= 0.62/2.20
= 0.28

2) Rolling Ingot to major Product conversion factor
Rolling Ingot to major Product $RICF_{(BY)}$ = RISECBY/SECMPBY
Where
RISECBY =Rolling Ingot-Specific Energy Consumption (Million kcal/ Tonne) in BY
SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY
= 0.62/2.20
= 0.28

3) HRC to major product conversion factor
Hot Rolled Coil to major Product $HRCCF(_{BY})$ = HRCSECBY/SECMPBY
Where
HRCSECBY =Hot Rolled Coil-Specific Energy Consumption (Million kcal/ Tonne) in BY
SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY
= 1.55/2.20
= 0.71

4) CRC to major product conversion factor
- Cold Rolled Coil to major Product $CRCCF(_{BY})$= CRCSECBY/ SECMPBY
Where
CRCSECBY =Cold Rolled Coil-Specific Energy Consumption (Million kcal/Tonne) in BY
SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY
= 2.20/2.20
= 1

❖ In Assessment Year

1) Alloy Ingot to major product conversion factor

   d) If Alloy Ingot Production in BY= 0, then Alloy Ingot to major Product $AICF_{(AY)}$ = AISECAY / SECMPBY

   e) If Alloy Ingot Production in BY≠ 0, then Alloy Ingot to major Product $AICF_{(AY)}$ = AISECAY / SECMPBY

   Where
   AISECBY =Alloy Ingot-Specific Energy Consumption (Million kcal/Tonne) in BY
   AISECAY=Alloy Ingot-Specific Energy Consumption (Million kcal/Tonne) in AY
   SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY
   AY = Assessment Year
   BY = Baseline Year
   = 0.62/2.20 (following case b)
   = 0.28

2) Rolling Ingot to major product conversion factor

   a) If Hot Rolling Ingot Production in BY= 0, then Rolling Ingot to major Product $RICF(_{AY})$ =RISECAY/ SECMPBY

   b) If Hot Rolling Ingot Production in BY≠ 0, then Rolling Ingot to major Product RICF $(_{AY})$ =RISECBY/ SECMPBY
   Where
   RISECBY =Rolling Ingot-Specific Energy Consumption (Million kcal/Tonne) in BY
   RISECAY =Rolling Ingot-Specific Energy Consumption (Million kcal/Tonne) in AY
   SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY
   AY = Assessment Year
   BY = Baseline Year
   = 0.62/2.20 (following case b)
   = 0.28

3) Hot Rolled Coil to major product conversion factor

   a) If Hot Rolled Coil Production in BY= 0, then Hot Rolled Coil to major Product HRCCF $(_{AY})$ =HRCSECAY/SECMPBY

   b) If Hot Rolled Coil Production in BY≠ 0, then Hot Rolled Coil to major Product HRCCF $(_{AY})$ =HRCSECBY/SECMPBY
   Where
   HRCSECBY =Hot Rolled Coil-Specific Energy Consumption (Million kcal/Tonne) in BY
   HRCSECAY =Hot Rolled Coil-Specific Energy Consumption (Million kcal/Tonne) in AY
   SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne) in BY
   AY = Assessment Year
   BY = Baseline Year
   = 1.55/2.20 (following case b)
   = 0.71

4) Cold Rolled Coil to major product conversion factor

   1) Cold Sheet to major Product (AY) =CSSECBY / SECMPBY
   Where
   CSSECBY =Major product-Specific Energy Consumption (Million kcal/Tonne)
   SECMPBY =Specific Energy Consumption of Major Product (Million kcal/Tonne)
   AY = Assessment Year
   BY = Baseline Year
   = 2.20/2.20
   = 1

9.9.1.5 Equivalent Product

Conversion Factor for Minor to Major Product				
S.No	**Description**	**Units**	**Baseline Year [BY]**	**Assessment Year [AY]**
1	Alloy Ingot to major Product	Factor	0.28	0.28
2	Rolling Ingot to major Product	Factor	0.30	0.30
3	Hot Rolled Coil to major Product	Factor	0.71	0.71
4	Cold Sheet to major Product	Factor	1.00	1.00

- **In Baseline year**

1) Alloy Ingot to major Product $AIMP_{BY}$ =AICF X TAIEP
Where
AICF = Alloy Ingot to major Product-Conversion factor for BY
TAIEEx = Total Alloy Ingot (AI) Export (Tonne) in BY
= 0.28 x 1187.04
= 336.2 Tonne

2) Rolling Ingot to major product $RIMP_{BY}$ =RICF X TRIEx
Where
RICF = Rolling Ingot to major Product-Conversion factor for BY
TRIEx =Total Rolling Ingot (RI) Export (Tonne) in BY
= 0.30 x 0
= 0 Tonne

3) Hot Rolling Coil to major product $HRCMP_{BY}$ = HRCCF X THRCEx
Where
HRCCF=Hot Rolling coil to major Product-Conversion factor for BY
THRCEx=Total Hot Rolling coil (HRC) Export (Tonne) in BY
=0.71 x 4737.50
= 3348.3 Tonnes

4) Cold Rolling coil to major product $CSMP_{(BY)}$ = CSCF X CRC
Where
CSCF=Cold Sheet to major Product-Conversion Factor
CRC=Cold Rolled Coil (Tonne) in BY
=1.00 x 48830.1
= 48830.1 Tonne

- **In Assessment year**

1) Alloy Ingot to major Product $AIMP_{AY}$ =AICF X TAIEP
Where
AICF=Alloy Ingot to major Product-Conversion factor for AY
TAIEEx=Total Alloy Ingot (AI) Export (Tonne) in AY
= 0.28 x 0
= 0Tonne

2) Rolling Ingot to major product $RIMP_{AY}$ =RICF X TRIEx
Where
RICF=Rolling Ingot to major Product-Conversion factor for AY
TRIEx=Total Rolling Ingot (RI) Export (Tonne) in AY
= 0.30 x 0
= 0 Tonne

3) Hot Rolling Coil to major product $HRCMP_{AY}$ = HRCCF X THRCEx
Where
HRCCF=Hot Rolling coil to major Product-Conversion factor for AY
THRCEx=Total Hot Rolling coil (HRC) Export (Tonne) in AY
=0.71 x 0
= 0 Tonnes

4) Cold Rolling coil to major product $CSMP_{(AY)}$ = CSCF X CRC
   Where
   CSCF= Cold Sheet to major Product-Conversion Factor
   CRC= Cold Rolled Coil (Tonne)
   =1.00 x 30306.0
   = 30306.0 Tonne

9.9.1.6 Total Equivalent Product Cold Sheet

❖ **In Baseline Year**

- Total Equivalent Product Cold $Sheet_{BY}$ (Tonne) = AIMP + RIMP + HRCMP + CSMP
  Where
  AIMP = Alloy Ingot to Major Product (Tonne)
  RIMP = Rolling Ingot to Major Product (Tonne)
  HRCMP = Hot Rolled to Major Product (Tonne)
  = 336.2 + 0.0+3348.3+ 48830.1
  = 52514.6 Tonne

❖ **In Assessment Year**

- Total Equivalent Product Cold $Sheet_{AY}$ (Tonne) =AIMP + RIMP + HRCMP + CSMP
  Where
  AIMP = Alloy Ingot to Major Product (Tonne)
  RIMP = Rolling Ingot to Major Product (Tonne)
  HRCMP = Hot Rolled to Major Product (Tonne)
  = 0 + 0.0+0+ 30306.0
  = 30306.0 Tonne

9.9.2 Input Normalization

9.9.2.1 Notional Energy for Import

- **In Baseline Year**
  1. Import Energy for Alloy ingot(Million kcal) for BY = SECAI X TAIIm
     Where
     AISEC=SEC up to Alloy Ingot Production (Million kcal/Tonne) for BY
     TAIIm=Total Alloy Ingot Import (Tonne) in BY
     = 0.62 x 0
     = 0 Million kcal

  2. Import Energy for Rolling ingot (Million kcal) for BY = SECRI X TRIIm
     Where
     RISEC =SEC up to Rolling ingot Production (Million kcal/Tonne) for BY
     TRIIm =Total Rolling ingot Import (Tonne) in BY
     = 0.62 x 37825.99
     = 23452.11 Million kcal

  3. Import Energy for Hot Rolled Coil (Million kcal) for BY =SECHRC X THRCIm
     Where
     HRCSEC =SEC up to Hot Rolled Coil Production (Million kcal/Tonne) for BY
     THRCIm =Total Hot Rolled Coil Import (Tonne) in BY
     = 1.55 x 583.67
     = 907.32 Million kcal

4. Import Energy for Cold Rolled Coil (Million kcal) IECRC for BY = CSSEC X TCRCIm
   Where
   CSSEC =SEC up to Cold Sheet Production (Million kcal/Tonne) for BY
   TCRCIm =Total Cold Rolled Coil Import (Tonne) in BY
   = 2.20 x 600
   = 1319.69 Million kcal

- **In Assessment Year**

1. Import Energy for Alloy ingot(Million kcal) for AY = SECAI X TAIIm
   Where
   AISEC=SEC up to Alloy Ingot Production (Million kcal/Tonne) for AY
   TAIIm=Total Alloy Ingot Import (Tonne) in AY
   = 1.01 x 0
   = 0 Million kcal

2. Import Energy for Rolling ingot (Million kcal) for AY = SECRI X TRIIm
   Where
   RISEC =SEC up to Rolling ingot Production (Million kcal/Tonne) for AY
   TRIIm =Total Rolling ingot Import (Tonne) in AY
   = 1.11 x 19255.73
   = 21365.31 Million kcal

3. Import Energy for Hot Rolled Coil (Million kcal) for AY=SECHRC X THRCIm
   Where
   HRCSEC =SEC up to Hot Rolled Coil Production (Million kcal/Tonne) for AY
   THRCIm =Total Hot Rolled Coil Import (Tonne) in AY
   = 2.01 x 2570.42
   = 5159.96 Million kcal

4. Import Energy for Cold Rolled Coil (Million kcal) IECRC for AY= CSSEC X TCRCIm
   Where
   CSSEC =SEC up to Cold Sheet Production (Million kcal/Tonne) for AY
   TCRCIm =Total Cold Rolled Coil Import (Tonne) in AY
   = 2.20 x 0
   = 0 Million kcal

9.9.2.2 ***Notional Energy for Import to be added in the baseline year(Million kcal)***
=IEAI+IERI+IEHRC+IECRC
= 0 + 23452.11 + 907.32 + 1319.69
= 25679.12 Million kcal

9.9.2.3 ***Notional Energy for Import to be added in the assessment year(Million kcal)***
=IEAI+IERI+IEHRC+IECRC
= 0+ 21365.31+5159.96+0.00
= 26525.26 Million kcal

9.10 Normalization factor for 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

Table: Heat Rate of Power sources

S.No	Description	Unit	Baseline Year (BY)	Assessment Year (AY)
1	Aluminum Production	ton	100000	100000
2	Thermal SEC Molten Aluminum	Mkcal/ton	0.08	0.08
3	Electrical SEC Molten Aluminum	kWh/ton	15500	15500
4	Total Thermal Used in Process	Mkcal	8000	8000
S.No	Description	Unit	Baseline Year (BY)	Assessment Year (AY)
5	Grid heat rate	kcal/kWh	860	860
6	Actual CPP heat rate	kcal/kWh	3000	3000
7	DG heat rate	kcal/kWh	2200	2200
8	Export 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.

Table: Energy Data from Power Sources

S.No	Description	Unit	Baseline Year (BY)	Assessment Year (AY)
9	Total Electrical Consumption of Plant without WHR Generation	MWh	1550000	1550000
10	Total Electricity availability without WHR from all Power Sources	MWh	1625000	1555000
11	Electricity Imported from Grid	MWh	200000	200000
12	Electricity generated from CPP	MWh	1350000	1290000
13	Electricity generated from CPP-consumption with in Plant	MWh	1275000	1285000
14	Electricity generated from DG	MWh	75000	65000
15	Electricity Exported to grid	MWh	75000	5000

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.

Table: Plant Energy Consumption

S.No	Description	Unit	Baseline Year (BY)	Assessment Year (AY)
16	Total Electrical Consumption of Plant without WHR Generation	MWh	1550000	1550000
17	Grid Share	%/ratio	0.129	0.129
18	CPP Share-Plant	%/ratio	0.823	0.829
19	DG Share	%/ratio	0.048	0.042
20	Weighted Heat Rate	kcal/kWh	2685.16	2690.32

Calculation of Specific Energy Consumption in Baseline Year

- **Calculation of Total energy consumption**
  = Total Thermal energy consumption + total Electricity Imported from Grid * Grid heat rate + electricity generated from CPP * CPP Heat Rate + electricity generated from DG * DG Heat Rate – electricity exported to grid * 2717 kcal/ kwh
  = 8000 + 200000*860 + 1350000*3000 + 75000*2200 - 75000*2717
  = 4191225 Million kcal
  =419122.5 TOE

- **Specific Energy Consumption in Baseline Year:**
  = Total Energy consumption in TOE / Total Aluminum Production in Tonne
  = 419122.5 / 100000
  = 4.19 TOE/ Tonne of Molten Aluminum
  The change in assessment year in the power has been observed as
  - Grid import remains constantat 200000 MWh
  - Grid export decreased from 75000 MWh to 5000MWh
  - Plant electricity consumption from CPP increased from 1275000 MWh to 1285000 MWh
  - CPP Generation decreases from 1350000 MWh at 1290000 MWh
  - DG Generation decreases from 75000 MWh to 65000 MWh

Without normalization in the Assessment year, the plant will get advantage as per following calculation

- **Calculation of Total energy consumption:**
  = Total Thermal energy consumption + total Electricity Imported from Grid * Grid heat rate + electricity generated from CPP * CPP Heat Rate + electricity generated from DG * DG Heat Rate – electricity exported to grid * 2717 kcal/ kwh
  = 8000 + 200000*860 + 1290000*3000 + 65000*2200 - 5000*2717
  = 4179415 Million kcal
  = 417941.5 TOE

- **Specific Energy Consumption in Assessment Year:**
  = Total Energy consumption in TOE / Total Aluminum Production in Tonne
  = 417941.5 / 100000
  = 4.18 TOE/ Tonne of Molten Aluminum

It is concluded that the plant will be on the advantageous side and gain of 4.18 -4.19=-0.012 TOE/Tonne of Molten Aluminum only by increasing Plant electricity consumption from CPP.
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 additionalexported electricity in assessment year as compared to baseline year calculated with the actual CPP heat rate [5MU x (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

Power Source normalization:

- **Calculation of Normalized Weighted Heat Rate**

  = Grid Heat Rate in Assessment year*Grid share of electricity consumption in baseline year+ CPP heat rate in Assessment year*CPP share of electricity consumption in baseline year + DG heat rate inin Assessment year*DG share of electricity consumption in baseline year

  = 860*0.129 + 3000*0.823 + 0.048*2200 kcal/kwh

  = 2685.16 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 subtracted in total energy due change in power source mix**

  = Total Energy consumption * (Normalized wt. Heat rate – Weighted Heat rate)

  = 1550000 * (2685.16 - 2690.32) / 1000

  =8000.00 Million kcal

Power Export Normalization

Similar to Power source normalization, normalization for power export is to be done in assessment year based on the following equation

- **Notional energy subtracted in total energy due change in power export mix**

  =(Exported Electrical energy in Assessment year - Exported Electrical energy in Baseline year)*(CPP Heat in Assessment year -2717)

  = (5000 – 75000)*(3000 - 2717) / 1000

  = -19810.00

- **Total Energy consumed in Assessment year with normalization**

  = Total Thermal energy consumption + total Electricity Imported from Grid * Grid heat rate + electricity generated from CPP * CPP Heat Rate + electricity generated from DG * DG Heat Rate – electricity exported to grid * 2717 kcal/kwh–Notional energy subtracted in total energy due change in power source mix - Notional energy subtracted in total energy due change in power export mix

  = 8000 + 200000*860 + 1290000*3000 + 65000*2200 - 5000*2717 - 8000.00 – (-19810.00)

  = 4191225 Million kcal

  = 419122.5 TOE

- **Gate to Gate SEC in the assessment year**

  = Total energy consumed in assessment year/ (Equivalent Aluminum production)

  = 419122.5 / 100000

  = 4.191 TOE/Tonne

Table: SEC in Baseline and Assessment year

S.No	Description	Unit	Baseline Year	Assessment Year
1	Notional Energy for Power source	Mkcal	0	8000.00
2	Notional Energy for Power export to grid	Mkcal	0	-19810.00
3	Total Energy Consumed	TOE	419122.5	419122.5
4	GTG SEC	TOE/Ton	4.191	4.191

After Normalization in assessment year with power source mix and power export, the Gate-to-Gate Energy stand at 4.191 which is equivalent to baseline SEC.

CPP Heat Rate Deteriorates

If efficiency of a CPP decreases i.e., increased its heat rate from 3000 kcal/kwh to 3200 kcal/kwh in the assessment year, the specific energy consumption is increases

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

S.No	Description	Unit	Baseline Year (BY)	Assessment Year (AY)
5	Grid heat rate	kcal/kWh	860	860
6	Actual CPP heat rate	kcal/kWh	3000	3200
7	DG heat rate	kcal/kWh	2200	2200
8	Export Power Heat rate	kcal/kWh	2717	2717

Table: Plant energy Consumption

S.No	Description	Unit	Baseline Year (BY)	Assessment Year (AY)
16	Total Electrical Consumption of Plant without WHR Generation	MWh	1550000	1550000
17	Grid Share	%/ratio	0.129	0.129
18	CPP Share-Plant	%/ratio	0.823	0.832
19	DG Share	%/ratio	0.048	0.823
20	Weighted Heat Rate	kcal/ kWh	2685.16	2849.68

Table: SEC

S.No	Description	Unit	Baseline Year	Assessment Year
1	Notional Energy for Power source	Mkcal	0	0
2	Notional Energy for Power export to grid	Mkcal	0	-28980.00
3	Total Energy Consumed	TOE	419122.5	446122.5
4	GTG SEC	TOE/ Ton	4.191	4.461

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

CPP Heat Rate Improves

If a plant increases its efficiency i.e., decreased its heat rate from 3000 kcal/kwh to 2800 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

S.No	Description	Unit	Baseline Year (BY)	Assessment Year (AY)
5	Grid heat rate	kcal/kWh	860	860
6	Actual CPP heat rate	kcal/kWh	3000	2800
7	DG heat rate	kcal/kWh	2200	2200
8	Export Power Heat rate	kcal/kWh	2717	2717

Table: Plant energy Consumption

S.No	Description	Unit	Baseline Year (BY)	Assessment Year (AY)
16	Total Electrical Consumption of Plant without WHR Generation	MWh	1550000	1550000
17	Grid Share	%/ratio	0.129	0.129
18	CPP Share-Plant	%/ratio	0.823	0.832
19	DG Share	%/ratio	0.048	0.823
20	Weighted Heat Rate	kcal/ kWh	2685.16	2849.68

Table: SEC

S.No	Description	Unit	Baseline Year	Assessment Year
1	Notional Energy for Power source	Mkcal	0	0
2	Notional Energy for Power export to grid	Mkcal	0	-4980.00
3	Total Energy Consumed	TOE	419122.5	392122.5
4	GTG SEC	TOE/Ton	4.191	3.921

9.11 Normalization Others

i. Environmental Concern

Table: Additional Electrical Energy requirement for Environmental Equipment

Sr No	Item	Date of Commissioning	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 x 3100/10
  =10850 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

- **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 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 Million kcal +9700 Million kcal
  =20550 Million kcal

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

Table: Fossil Fuel Replacement

Sr No	Item	Unit	Baseline Year	Assess-ment Year
1	Biomass replacement with Fossil fuel due to Biomass un-availability (used in the process)	Tonne	NA	20
2	Alternate Solid Fuel replacement with Fossil fuel due to Alternate Solid Fuel un-availability (used in the process)	Tonne	NA	15
3	Alternate Liquid Fuel replacement with Fossil fuel due to Alternate Liquid Fuel un-availability (used in the process)	Tonne	NA	5
4	Biomass Goss Calorific Value	kcal/kg		2100
6	Alternate Solid Fuel Goss Calorific Value	kcal/kg		2800
7	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 Tonne x Biomass Gross Heat Rate (kcal/kg)/10^3
=20 x 2100/1000
=42 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) in Tonne x Alternate Solid Fuel Gross Heat Rate (kcal/kg)/10^3
=15 x 2800/1000
=42 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 Tonne x Alternate Liquid Fuel Gross Heat Rate (kcal/kg)/10^3
=5 x 6000/1000
=30 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 Million kcal
=112 Million kcal

iii. 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 x 3100/10
=2480 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

iv. 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	Calcined Alumina Production till new line attains 70% of Capacity utilisatiion (Refinery)	Tonne	NA	15000
4	Molten Aluminum Production till new line attains 70% of Capacity utilisatiion (Smelter & Integrated)	Tonne	NA	NA
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
=1400 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
=15500 Million kcal + 1400 Million kcal
=16900 Million kcal

Calcined Alumina Produced (15000 Tonne) till new line attains 70% of capacity utilization will be subtracted from the total Calcined Alumina production and added in the Calcined Alumina import; so that the energy added for this amount of produced Calcined Alumina 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 Utilization in Power generation	Lakh kWh	NA	5
2	Thermal Energy Consumed due to commissioning of New Line/Unit till it attains 70% of Capacity Utilization in Power generation	Million kcal	NA	15000
3	Steam Generation From Co-Gen till New Line / Unit attains 70% of Capacity Utilization	Tonne	NA	300
4	Net Electricity Generation till new Line/Unit attains 70% Capacity Utilization	Lakh kWh	NA	40
5	Date of Commissioning (70% Capacity Utilization) Power Generation	Date		
6	Weighted Heat Rate	Kcal/kWh	3200	3100
7	Specific Steam energy consumption	Kcal/kg	583	550

- **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 x 3100/10
  =1550 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 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 Million kcal + 15000 Million kcal
  =16550 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 x 3100/10
  =12400 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.

  Steam generated (300 Tonne) 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.

- **Energy to be addedd for Steam Generation From Co-Gen**
  =Total Steam generated by new unit till it attain 70% of CU in Tonne x Steam Specific Energy Consumption (kCal/kg)/1000
  =300 x 550/1000
  =165 Million kcal

v. 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

- **Total energy to be subtracted (Other Normalization factors) =** Additional Electrical & Thermal Energy Consumed due to Environmental Concern + v .... Total Thermal Energy to be deducted for Biomass/ Alternate Solid or Liquid Fuel replacement by Fossil Fuel in the assessment year due to unavailability + Additional Electrical & Thermal Energy Consumed due to commissioning of Equipment (Construction Phase) + Electrical & Thermal Energy Consumed due to commissioning of New process Line/Unit till it attains 70% of Capacity Utilisation + Electrical & Thermal Energy Consumed from external source due to commissioning of New Line/Unit till it attains 70% of Capacity Utilisation in Power generation (CPP/Cogen) - Energy to be addedd for Steam Generation From Co-Gen till New Line /Unit attains 70% of Capacity Utilisation - Energy to be addedd for Net Electricity Genration till new line/ Unit attains 70% Capacity Utilisation from CPP/Cogen + Electrical & Thermal Energy to be Normalised due to unforeseen circumstances
  = 20550+112+5680+16900+16550-165-12400+12000
  = 59227 Million kCal

vi. 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/Tonne of product as per PAT scheme Notification		Toe/Tonne	0.040	
5	Equivalent Major Product Output in Tonne as per PAT scheme Notification		Tonne	50000	
6	Baseline Specific Energy Consumption as Per PAT Notification		Toe/Tonne	0.861	
7	SEC Target to be achieved	0.861-0.040	Toe/Tonne		0.821

Case I: Under Achievement of PAT Obligation with REC gain

The target SEC for a DC is 0.821 Toe/Tonne of equivalent Calcined Alumina against the baseline SEC of 0.861Toe/Tonne of equivalent Calcined alumina.

- The DC achieves 0.822 Toe/Tonne 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	Toe/Tonne	0.861	0.822

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

Sr No	Descriptions	Basis	Unit	Baseline Year [BY]	Assessment Year [AY]
Renewable Energy Certificate Normalization					
1	Target Saving to be achieved (PAT obligation)		Toe/Tonne equivalent Calcined alumina	0.04	
2	Target Saving to be achieved (PAT obligation)		Toe	2000	
3	Target Saving Achieved		Toe/Tonne equivalent Calcined alumina		0.039
4	Target Saving Achieved		Toe		1950
5	Additional Saving achieved (After PAT obligation)		Toe/Tonne equivalent Calcined alumina		-0.001
6	Additional Saving achieved (After PAT obligation)		Toe		-50.00
7	Thermal energy conversion for REC and Preferential tariff		Toe		570.0
8	Thermal Energy to be Normalized 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 0.821Toe/Tonne of equivalent Calcined alumina against the baseline SEC of 0.861Toe/Tonne of equivalent Calcined alumina.

- The DC achieves 0.821Toe/Tonne 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	Toe/ Tonne	0.861	0.821

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 duel terms for Renewable Power generated as per following calculation table

Sr No	Descriptions	Basis	Unit	Baseline Year [BY]	Assessment Year [AY]
Renewable Energy Certificate Normalization					
1	Target Saving to be achieved (PAT obligation)		Toe/Tonne equivalent Calcined alumina	0.04	
2	Target Saving to be achieved (PAT obligation)		Toe	2000	
3	Target Saving Achieved		Toe/Tonne equivalent Calcined alumina		0.04
4	Target Saving Achieved		Toe		2000
5	Additional Saving achieved (After PAT obligation)		Toe/Tonne equivalent Calcined alumina		0.0
6	Additional Saving achieved (After PAT obligation)		Toe		0.0
7	Thermal energy conversion for REC and Preferential tariff		Toe		570.0
8	Thermal Energy to be Normalized for REC and preferential tariff power sell under REC mechanism	Annual	Toe		0.00

Case III: Over Achievement of PAT Obligation with REC gain

The target SEC for a DC is 0.821Toe/Tonne of equivalent Calcined alumina against the baseline SEC of 0.861Toe/Tonne of equivalent Calcined alumina.

- The DC achieves 0.820Toe/Tonne 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	Toe/ Tonne	0.861	0.82

In this case, the DC is getting benefit of Renewable Power exported in duel 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]
Renewable Energy Certificate Normalization					
1	Target Saving to be achieved (PAT obligation)		Toe/Tonne equivalent Calcined alumina	0.04	
2	Target Saving to be achieved (PAT obligation)		Toe	2000	
3	Target Saving Achieved		Toe/Tonne equivalent Calcined alumina		0.041
4	Target Saving Achieved		Toe		2050
5	Additional Saving achieved (After PAT obligation)		Toe/Tonne equivalent Calcined alumina		0.001
6	Additional Saving achieved (After PAT obligation)		Toe		50
7	Thermal energy conversion for REC and Preferential tariff		Toe		570.0
8	Thermal Energy to be Normalized for REC and preferential tariff power sell under REC mechanism	Annual	Toe		50.00

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 normalization 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 duel benefit from REC and PAT, a normalization 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 normalization 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 x 4591973 = 4591 Escerts

The DC has achieved the target and about to gain 4591 EScerts, the normalization 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

10 Abbreviations

Item	Abbreviations
PAT	Perform, Achieve and Trade
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	Plat Load Factor
PAF	Plant Availability Factor
TPH	Tonnes 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**
AI	**Alloy Ingot**
RI	**Rolling Ingot**
HRC	**Hot Rolling Coil**
CRC	**Cold Rolling Coil**

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 performanceachieved by the Designated Consumer in the target year.

> The documents sets out the requisite guidelines forM&V in the Monitoring and Verification phase under thePAT Rules. It provides practical guidance and proceduresto Designated Consumers (DCs) and Empanelled Accredited Energy Auditors (EmAEA) on verification requirements, and aims to establisha 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 1and Pro-forma are free from material omissions, misrepresentations and errors.

The process requires EmAEA to verify the monitoring and verification of energy performance of DCsin 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 Pro-forma, 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 EmAEAaset of guidelines to establish methods for assessment ofspecific 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-formaand 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 incorporationas the case may be.

1.4.2. Obligation of Empanelled Accreditor 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)[1]

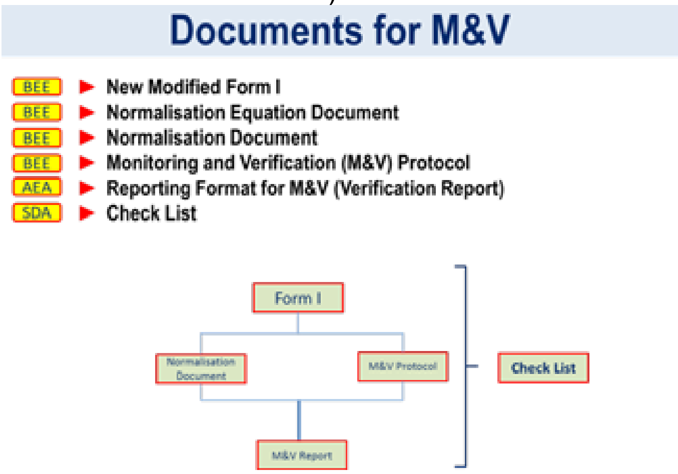


Figure 1: M&V Documents

[1]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

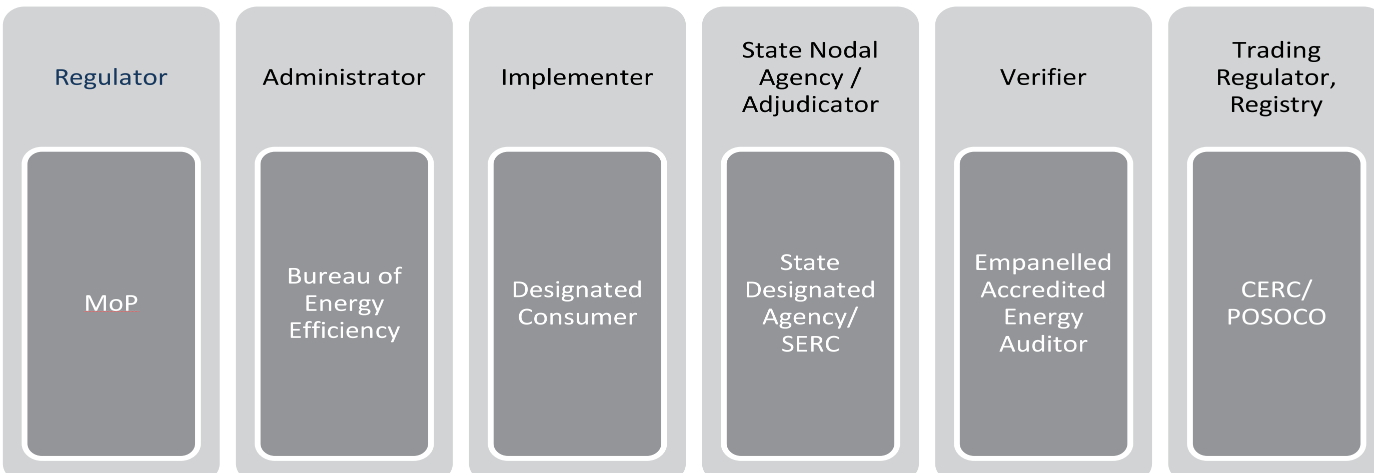
V. Empanelled Accredited Energy Auditor

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 [2]

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

[2]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 designed 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

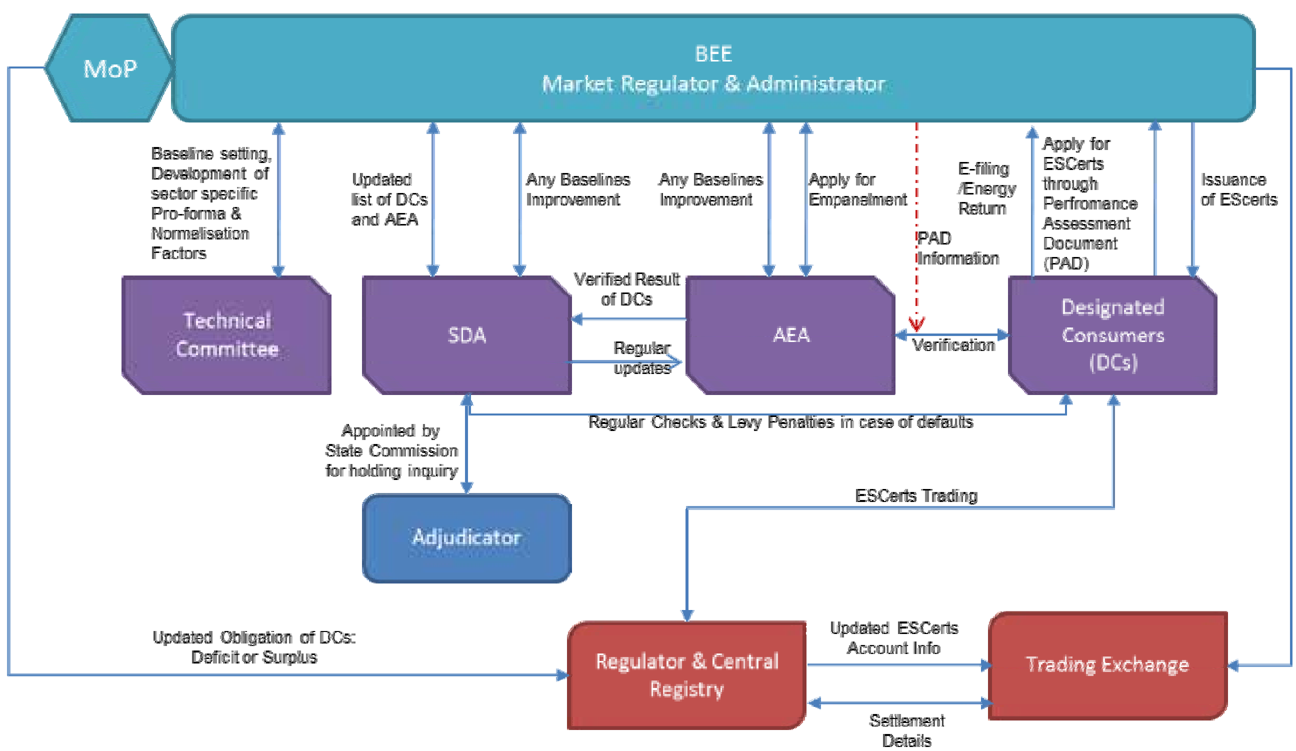
2.8. Institutional Framework for PAT

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[3] 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



[3] 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.

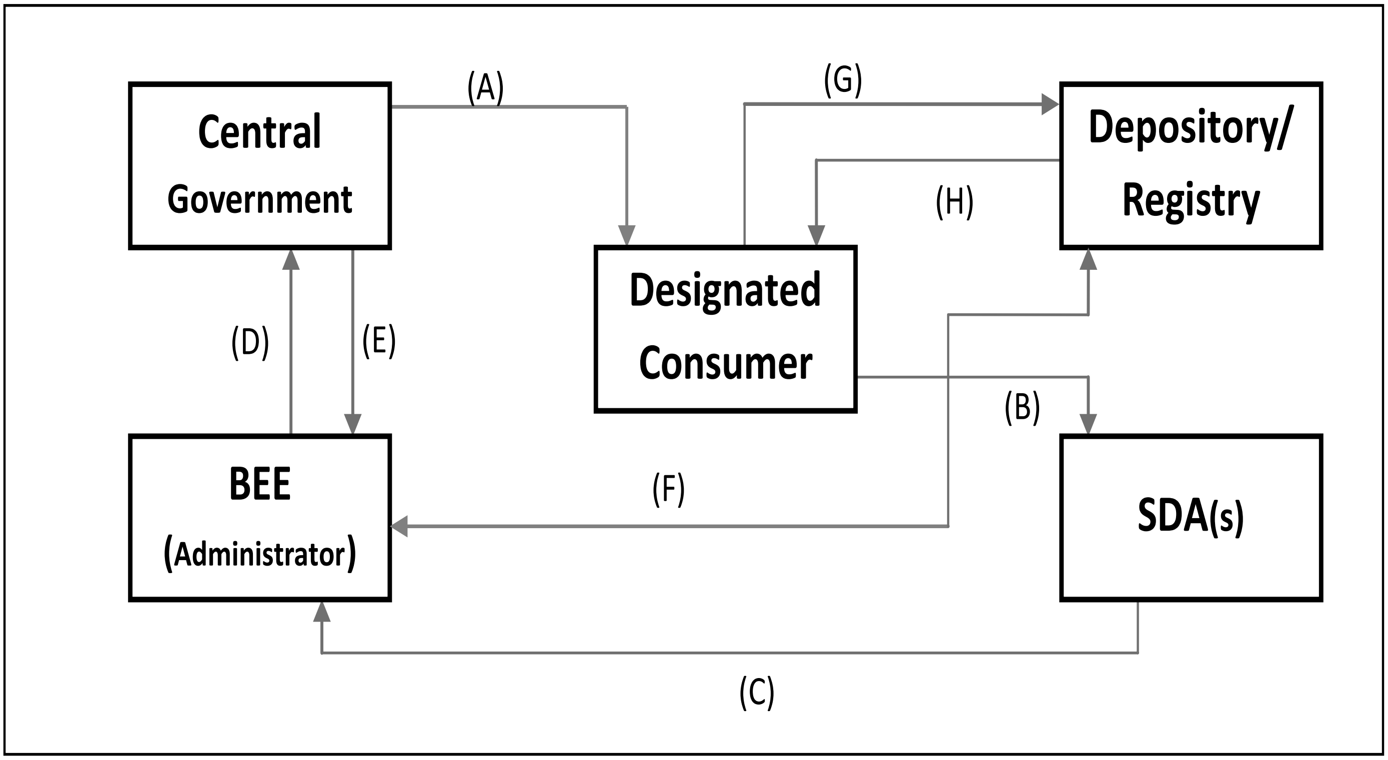
Table 1: Activities and Responsibilities for PAT Cycle I

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) **30th June, 2015**	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) **30th June, 2015**	SDA & BEE
3.	BEE's Recommendation to MoP for issuance of ESCerts	BEE	10 working days from receipt of forms A & B by SDA	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

(B) Performance Assessment Document (Form A) from DC to SDA

(C) Performance Assessment Document (PAD) (Form-A) with recommendation for issuance, if overachieved, from SDA to BEE

(D) Recommendation of ESCerts Issuance by BEE to Central Government

(E) ESCerts Issuance Instruction from Central Government to BEE

(F) Electronic ESCerts Issuance Instruction from BEE to Depository

(G) DC Interaction with Depository account

(H) ESCerts credit to DC's account

3.2.1. Issuance of ESCerts

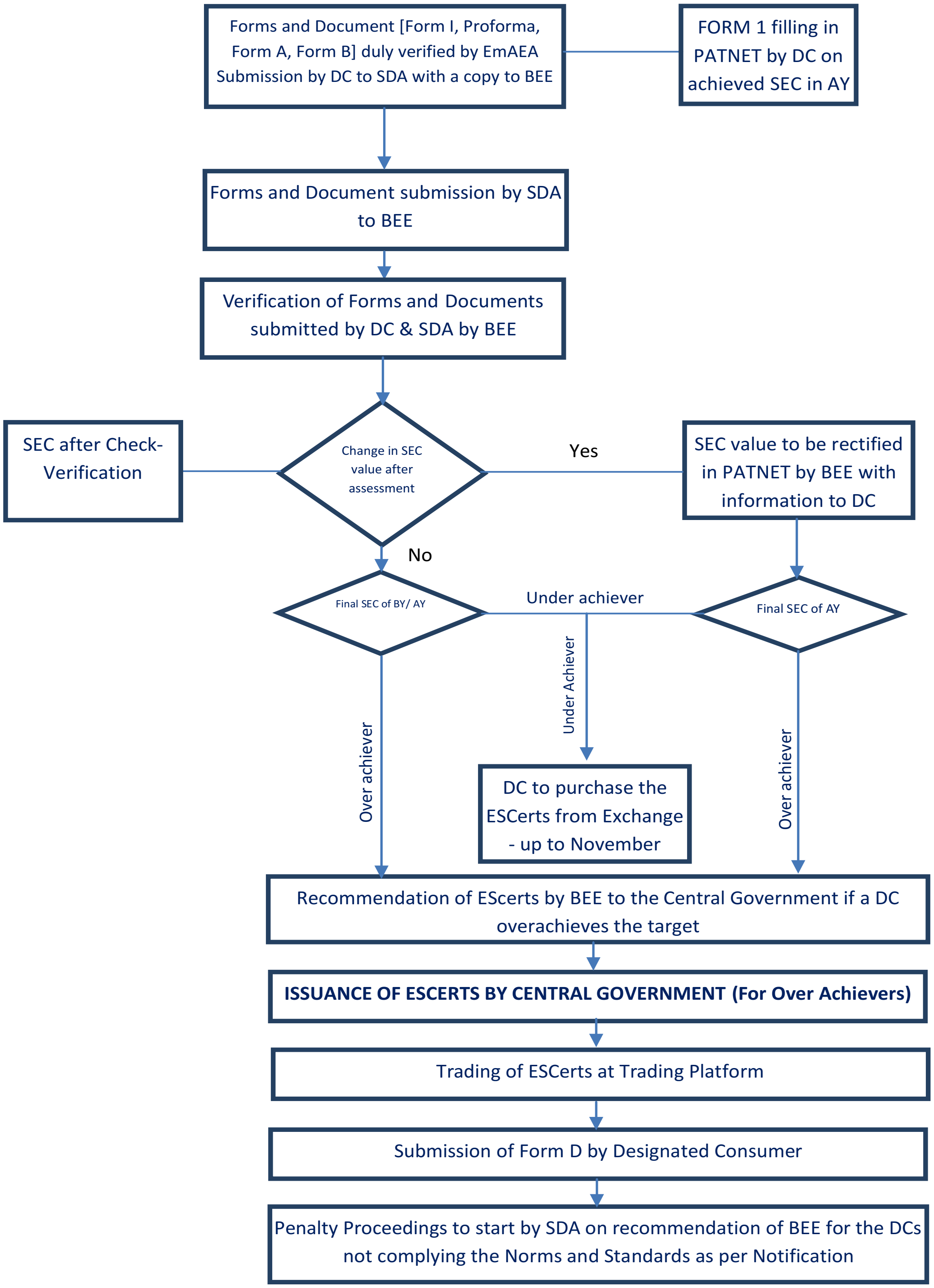


Figure 5: Flow Chart of ESCerts issuance

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	***By June 30 each Year***	Submission of Energy Return Form I and Sector Specific Supporting Pro-forma for Form 1
DC	***By June 30 [First Year of PAT Cycle]***	Submission of Action Plan
DC	***Before M&V phase of PAT Cycle***	Hiring of Empanelled Accredited energy Auditor
DC/EmAEA	***April 1-June 30 [After completion of relevant PAT cycle]***	Monitoring and Verification
DC	***By June 30 [M&V phase of PAT Cycle]***	Submission of Verified Form I and Sector Specific Pro-forma, Form A, Form B and Other Document to SDA & BEE
DC	***By June 30 [After end of 1st and 2nd Year PAT Cycle]For Advance ESCerts***	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)

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 years, shall not be eligible to perform the work of verification or check verification for such designated consumer.

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.

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 [4]
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

[4] 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[5] 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.59. 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)

[5] 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 byindividual 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. 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 PATcycle 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.

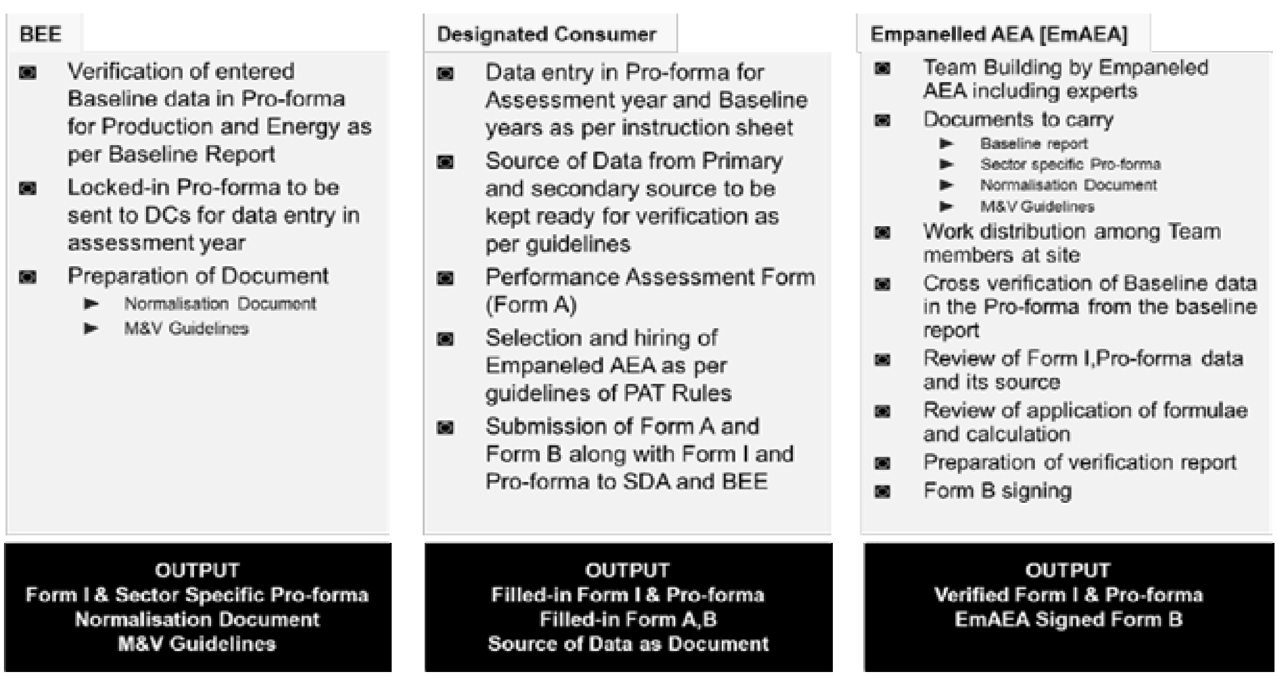
74. The baseline verified data shall be considered as final data to be filled in the sector specific pro-forma. In case of any typographical or factual error, the same shall be taken into account after taking into account corrected during verification process subject to all factual and authentic data 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. Incase 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 sectormay 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[6] 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

[6] 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
Production and capacity utilization details					
1	Production Capacity of a Plant/section/ line/unit	Tonne	Annual	1) Original equipment manufacturer (OEM) Document of line/unit/ equipment capacity 2) Enviromental Consent to establish/operate document 3) DoF Communication	1) Equipment/Section wise capacity document from OEM 2) Capacity calculation document submitted for Enviromental 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
Major Eqp Capacity and Operating SEC					
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 **external factor** [5]	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

[5] 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
Boiler Details (Process/Co-Gen)					
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/cm2	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
Electricity from Grid / Other (Including Colony and Others) / Renewable Purchase obligation/Notified Figures					
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 interms of preferential tariff under REC Mechanism in MWh	Nos	Lot, Yearly	1)Power Purchase Agreement (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
Own Generation through CPP (STG/GG/GT/WHRB/DG)					
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
Through Co-Generation					
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
Inlet Steam					
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/ cm2	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	
Steam Extraction 1 (MP)					
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/ cm2	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
Steam Extraction 2 (LP)					
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/ cm2	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	
Steam Condensing					
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/ cm2 (a)	Continuous, Hourly, daily, Monthly	1) Daily Generation Report 2) Monthly Generation Report 3) DCS/SCADA Records	1) Field Pressure Meter
Power from dedicated line					
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
Power Export and Colony/Others 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
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
Solid Fuel Consumption					
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)					
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[6]) 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

[6] 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 [7]) 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. Biomass and other renewable solid fuel / Solid waste					
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	

[7] 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
Liquid Fuel Consumption					
A	**Furnace Oil**				
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[8] 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, Montly, 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

[8] 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	**LSHS/HSHS**				
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
C	**HSD/LDO**				
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
D	**Liquid Waste**				
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
			Gaseous Fuel Consumption		
A	**Natural Gas (CNG/NG/PNG/LNG)**				
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	**Liquefied Petroleum Gas (LPG)**				
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
Quality Parameters					
A	**Raw Material Quality**				
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	**Coal Quality in CPP (As Fired Basis)**				
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
			Miscellaneous Data			
A	**Additional Equipment installation after baseline year due to Environmental Concern**					
(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	**Biomass/ Alternate Fuel availability**					
(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		
C	**Project Activities (Construction Phase)**					
(i)	Electrical Energy[9] 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
D	**New Line/Unit Commissioning**					
(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

[9] 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	
E	**Unforeseen Circumstances**					
(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
Document related to external factor	
(i)	**Market Demand**
	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
(ii)	**Grid Failure**
	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
(iii)	**Raw Material un-availability**
	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
(iv)	**Natural Disaster**
	1) Supporting Authentic document from Local district Administration 2) Major Eqp Log Sheet 3) Major Eqp operators Report book 4) DPR 5) MPR
(v)	**Major change in government policy hampering plant's process system**
	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
(vi)	**Unforeseen circumstances/Labour Strike/Lockouts/Social Unrest/Riots**
	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
(vii)	**Note**
	The hard copy/Printouts is to be signed by Authorised signatory, if SAP data is used as documents
(viii)	**Availability of documentation**
	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 Analysisi.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

$$\%C = 0.97C + 0.7(VM+0.1A) - M(0.6-0.01M)$$
$$\%H2 = 0.036C + 0.086\ (VM - 0.1xA) - 0.0035M2(1-0.02M)$$
$$\%N2 = 2.10 - 0.020\ VM$$

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 [10] 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 x C1+DHR2 x C2+…./(C1+C2….).

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)[11]	C1+C2+…Cn	MW	Sum of capacity
(ii)	Annual Gross Unit generation (AGG1…AGGn)	AGG1+AGG2+…AGGn	Lakh kWh	Sum of Generation
(iii)	Auxiliary Power Consumption (APC1…. APCn)	APC1 +APC2…APCn	Lakh kWh	Sum of APC
(iv)	Design Heat Rate	DHR (1,2…n)= DHR1 x C1+DHR2 x C2+…./(C1+C2….Cn)	kcal/ kWh	Weighted Average of Design Heat Rate w.r.t to Installed Capacity

[10] CPP: Steam Turbine Generator (STG)/ Gas Turbine (GT)/Gas Generator(GG)/Diesel Generator (DG)
[11] 1,2,3….n: No of Cogen Sources

Sr No	Description	Formulae	Unit	Remarks
(v)	Running Hours	(RH1xAGG1+RH2xAGG2+ ……… RHnx AGGn)/ (AGG1+AGG2+… AGGn)	Hrs	Weighted Average of Running Hours w.r.t to Annual Generation
(vi)	Auxiliary Power Consumption	(ii) x 100/(iii)	%	APC%
(vii)	Total Thermal energy used in Process	TEPr1+TEPr2+…TEPrn	Million kcal	Sum of Total Thermal Energy used in Process
(viii)	Total Thermal energy used in Power	TEPo1+TEPo2+…TEPon	Million kcal	Sum of Total Thermal Energy used in Power
(ix)	Heat Rate of Co-Gen	HR1xAGG1+…..+HRn x AGGn/ (AGG1+…+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 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. The sector specific Pro-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.	Miscellaneousequipment		

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

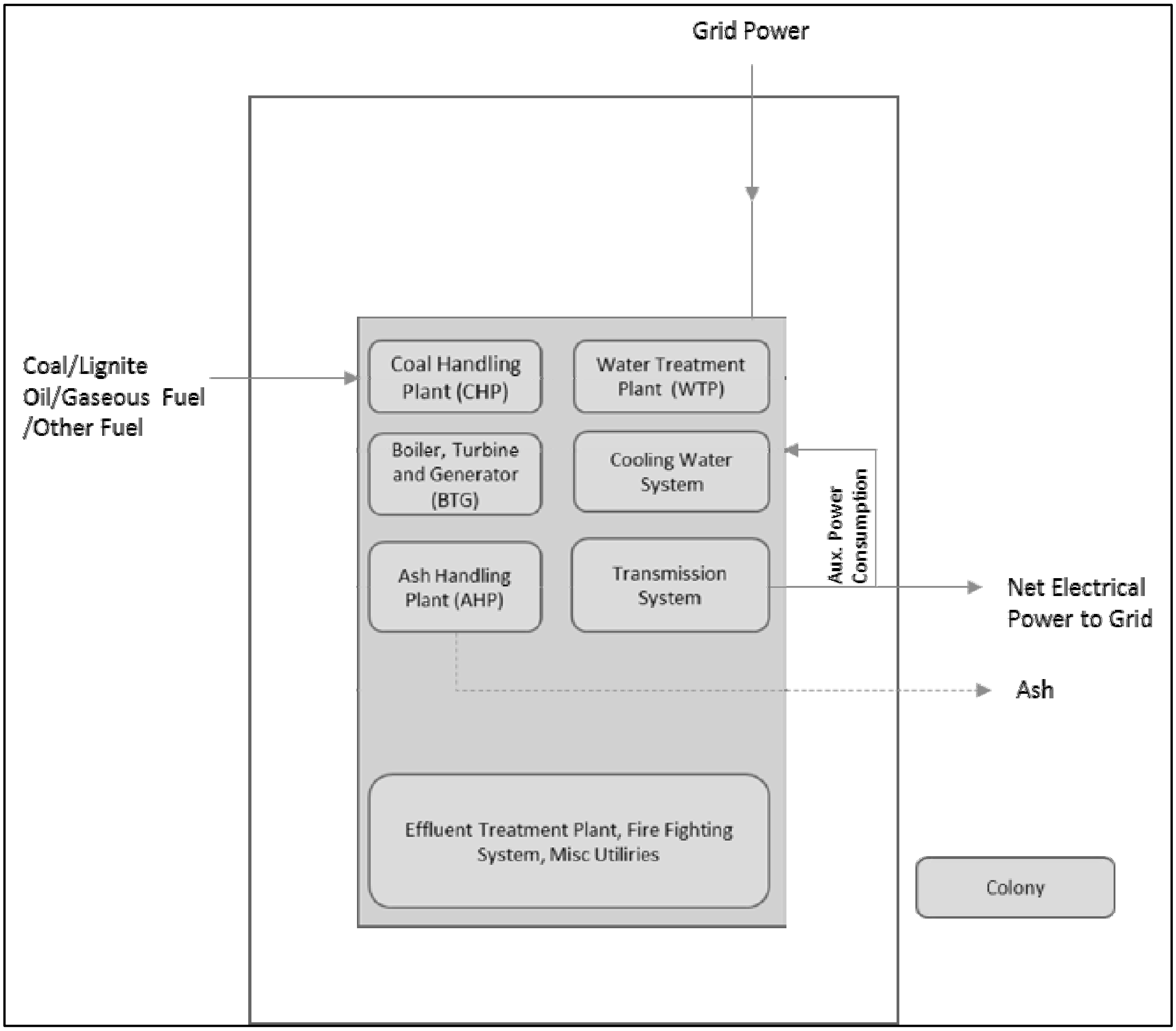
a. The scheme/ layout diagram of all sub-systems, e.g., CHP, AHP, WTP, etc. shall be submitted by the DCs. This shall facilitate in identifying the boundary condition of systems/ plant.

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

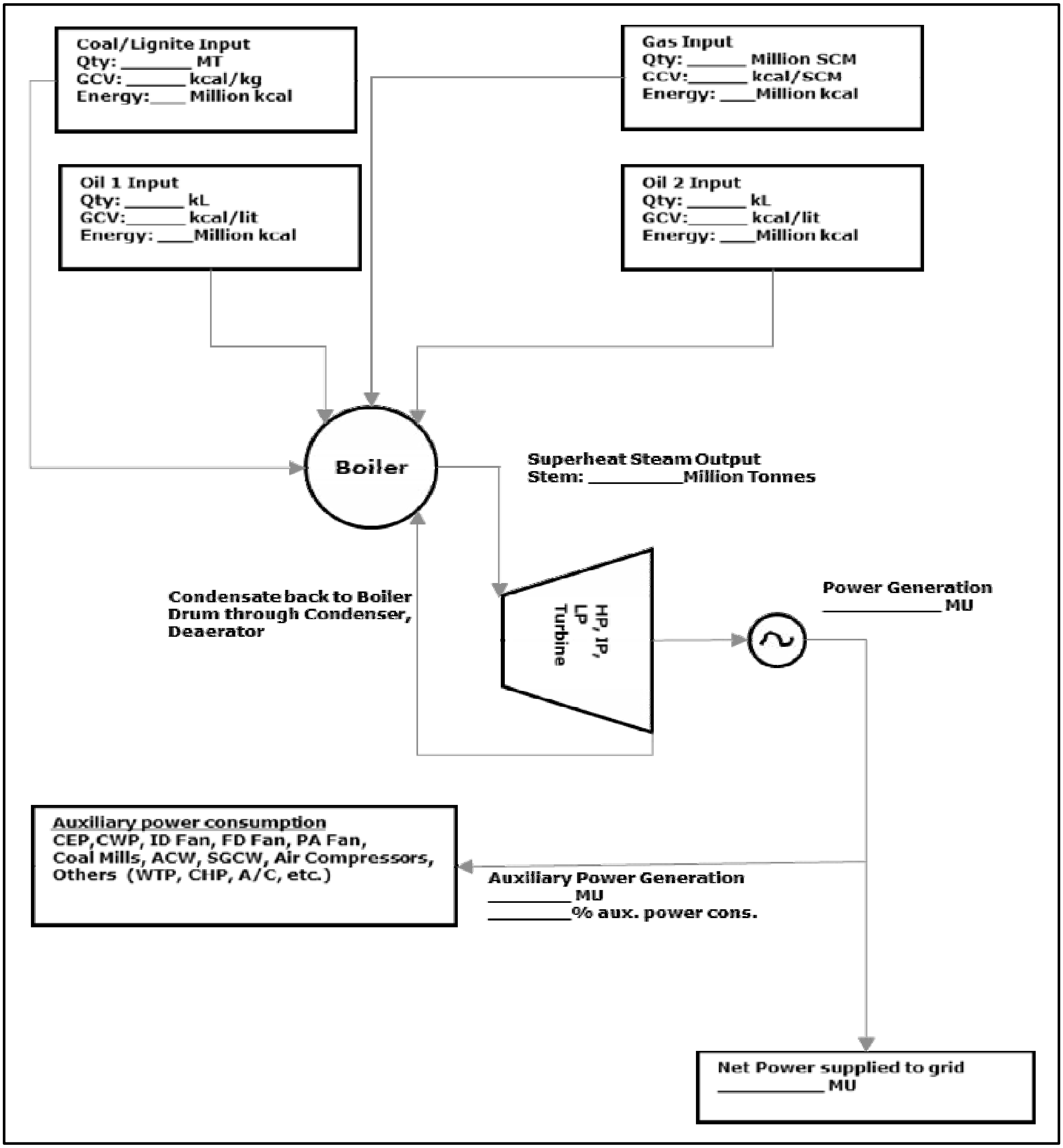
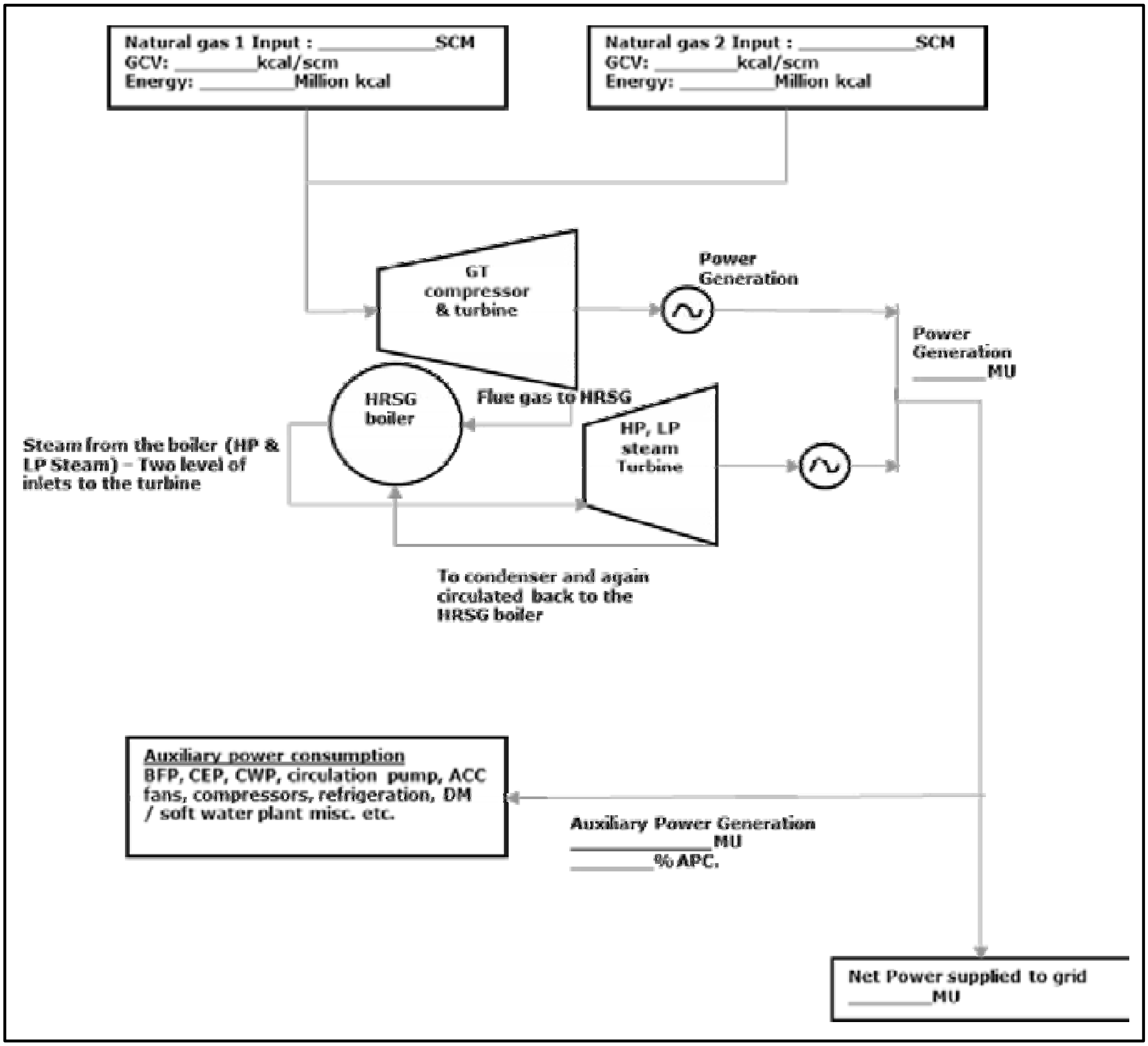


Figure 10: Ex-CCGT Energy balance diagram



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

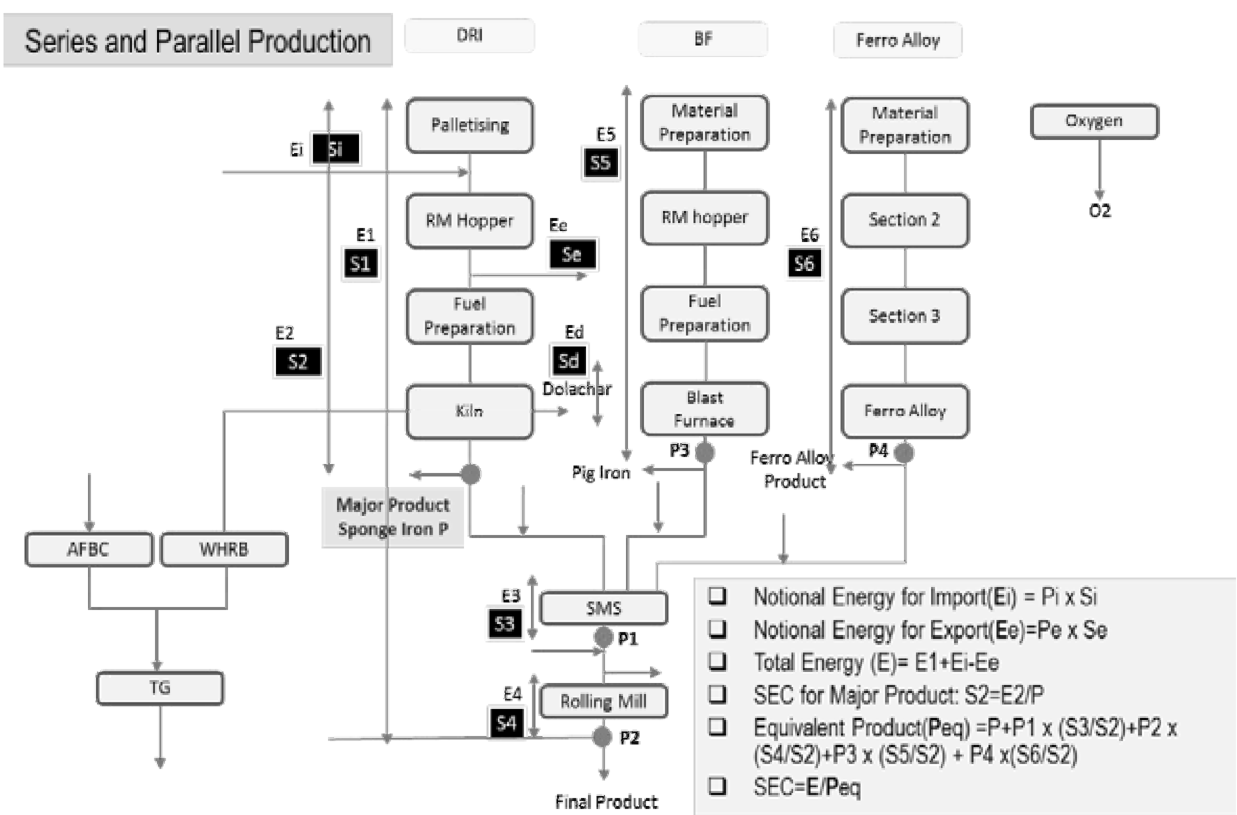
14. The entire sub-sector is divided into 7 group on similarity of product
15. The major product in 7 group is as per table below
16. The Energy consumption of Pellet Plant shall not be included in the assessment year as well as in the baseline year. The calculation for the same is included in the summary 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	

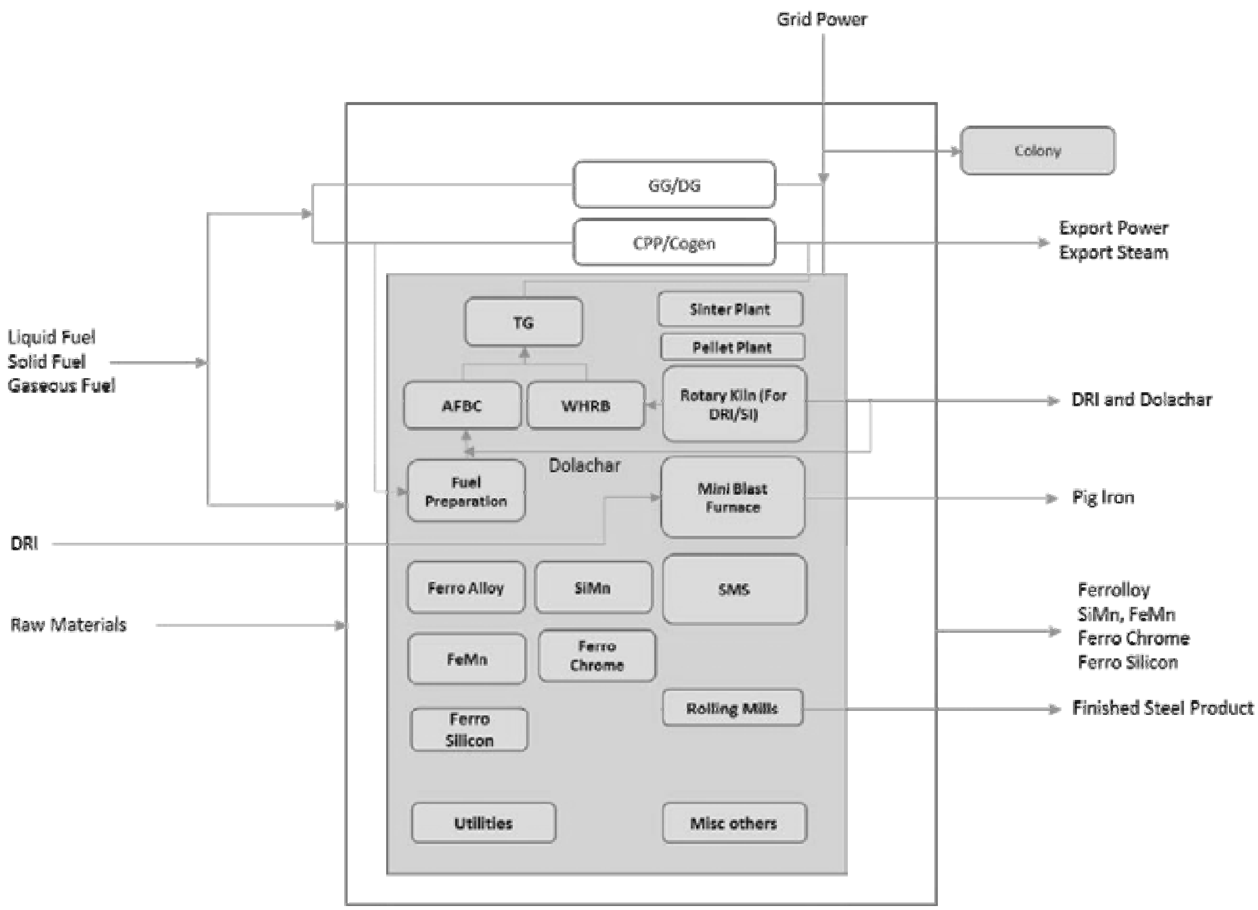
19. Calibration records of all weighing and measurement system with frequency of calibration to be included in the verification report
20. Section wise SCADA Screen shot if required to be included in the verification report by EmAEA
21. The Energy and Mass balance calculation is required to be included 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

$$2Fe_2O_3 + 6C + 3O_2 = 4Fe + 6CO_2 + \Delta_{Hr} \text{ (Final reaction)}$$

Standard heat of formation of Fe_2O_3

& CO_2 are -825.5 & -393.5 KJ/mole respectively. Heat of formation of element is taken zero.

The final reaction after applying thermodynamics principal.

$\Delta_{Hr} = \sum \Delta_{H\ product} - \sum \Delta_{H\ reactants}$

Negative sign indicates exothermic reaction or heat release and positive sign indicates requirement of heat

Iron ore 1.43 Kg

Coal 0.64 Kg.

Air 5.20 Kg.

Heat Supplied = 2058 →

← -251 Kcal (Excess heat)

Sponge iron 1 Kg.

Char 0.064 Kg.

6.20 kg.

Total Input 7.270 Kg

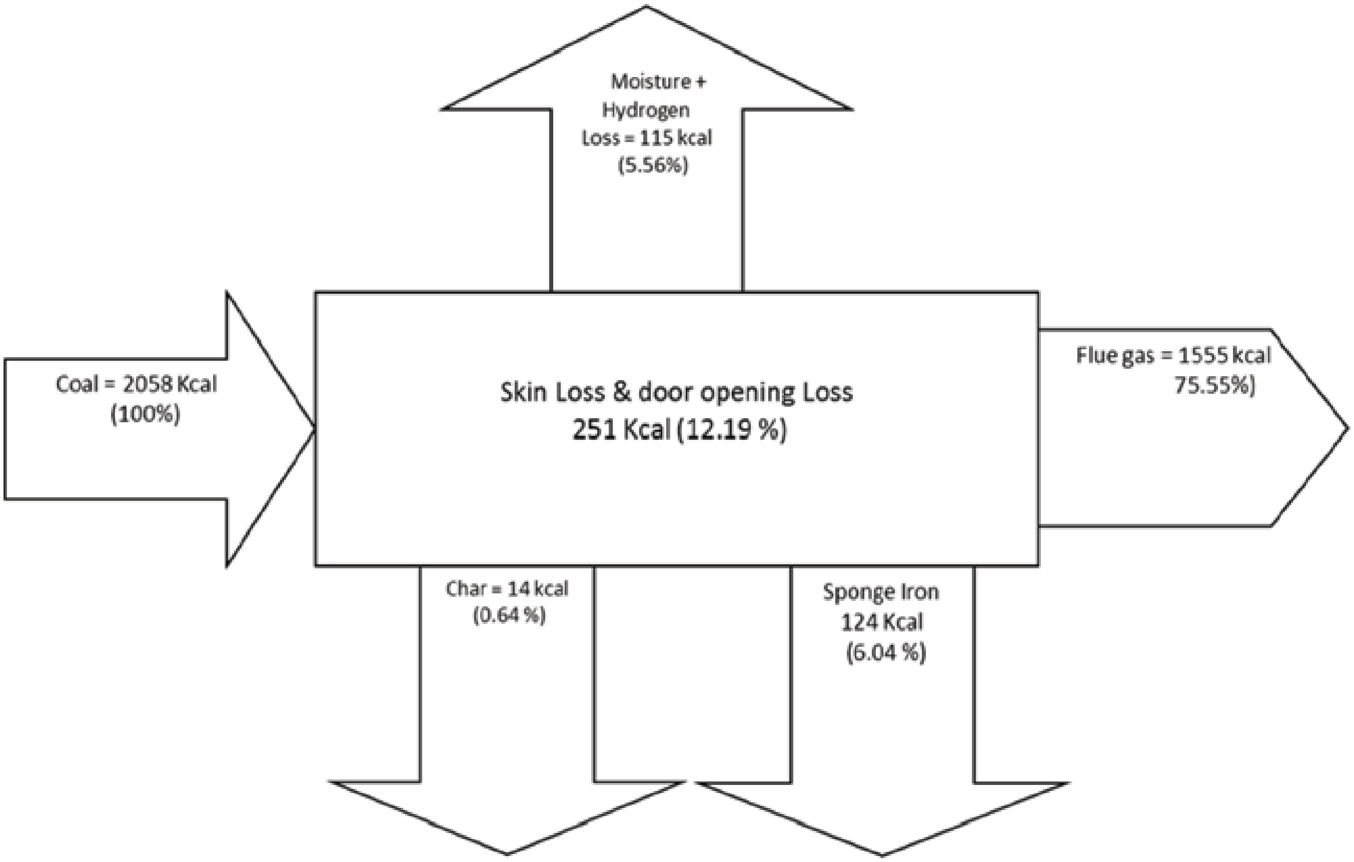
Total Output

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 Δ_t 1045° C	+124
2	Char sensible heat, assuming Δ_t 1045° C	+13
3	Flue gas sensible heat, assuming Δ_t 1045° 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_2 & 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. Thisdifference 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 submitin 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.

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 documentation to be provided by DC as per the instructionsgiven in Cement sector Pro-forma.

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.

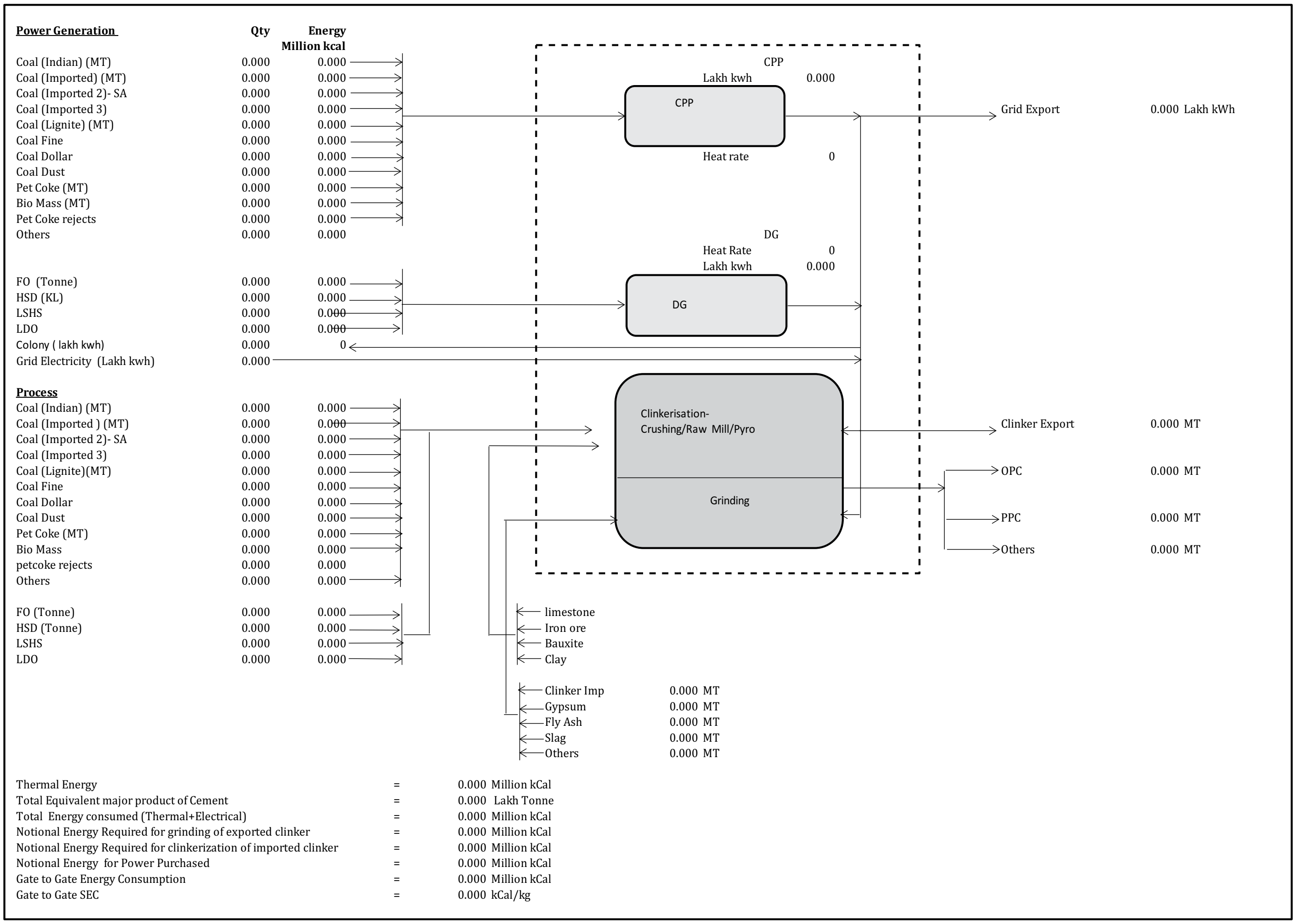
8. Review of Section wise specific power consumption (Line wise)

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					
	Sum					

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

The clinker balance verification is required from Cement produced and Clinker factor with actual clinker produced by taking into account the Clinker stock difference and Clinker Import export. Similarly Energy balance up to clinkerisation could be verified as per the 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) x 100/A					
Energy Balance Verification(C=D)							
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) x 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	**Final/ intermediate products**						
1.1	**Urea production**	MT					
1.2	**Ammonia**						
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	**Input raw materials**						
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	**Naphtha**						
2.2.1	**Properties**						
a	Sp. Gravity	gm/cc					
b	GCV	Kcal/kg					
c	NCV	Kcal/kg					
2.2.2	**Total receipt**						
a	Volume	kl					
b	Weight	MT					
2.2.3	**Distribution**						
a	Reformer feed	MT					
b	Reformer fuel	MT					
c	Others	MT					
2.3	**Diesel**						
2.3.1	**Properties**						
a	Sp. Gravity	gm/cc					
b	GCV	Kcal/kg					
c	NCV	Kcal/kg					
2.3.2	**Total receipt**						
a	Volume	kl					
b	Weight	MT					
3.3	**Distribution**						
a	DG Sets	kl					
b	Others						
2.4	**Furnace oil /LSHS etc.**						
2.4.1	**Properties**						
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	**Total receipt**						
	Volume	kl					
	Weight	MT					
2.4.3	**Distribution**						
a	Boiler	MT					
b	Other furnaces (specify)	MT					
c	Misc (if any)						
2.5	**Coal**						
2.5.1	**Properties**						
a	GCV	Kcal/kg					
b	NCV	Kcal/kg					
2.5.2	**Total receipt**						
a	Weight	MT					
2.5.3	**Distribution**						
a	Boilers(1+2+3)	MT					
b	Others (specify)	MT					
c	Stock variation						
2.6	**Any other fuel**						
3.0	**Steam**						
3.1	**Production**						
3.1.1	Boiler (Individual)						
3.1.2	GTG/HRU						
3.1.3	Service/auxiliary boiler						
3.1.4	Others						
3.2	**Consumption**						
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 Fertilzer sector

Sr. No.	Item	Unit	Received at plant battery limit	Allocated for urea production	Allocated for other products	Difference if any	Remarks
1.0	**Purchased items**						
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	**Power**						
3.1	**Generation**	MWh					
3.1.1	GTG	MWh					
3.1.2	Others	MWh					
3.2	**Consumption**						
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.

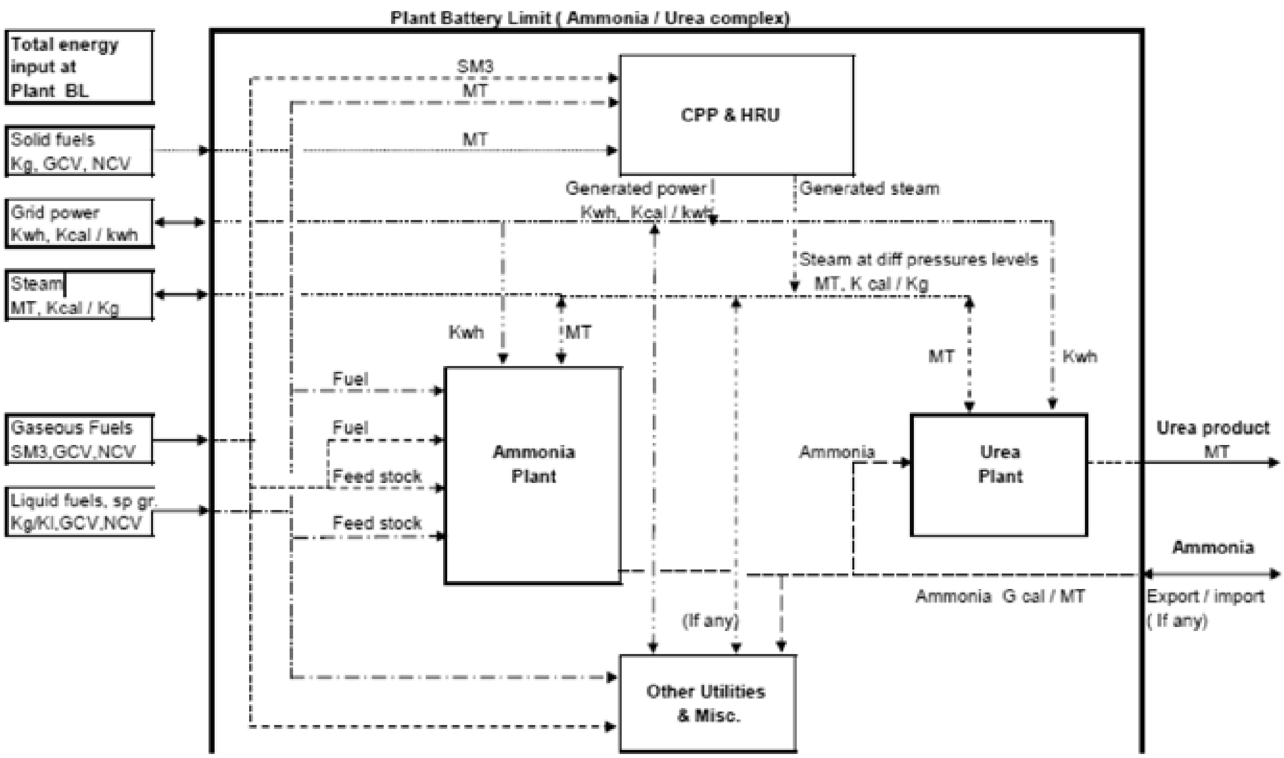
E. Conversion factor for power generated.

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 (CO2) is also produced as by-product. Ammonia and CO2 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	**Overall plant battery limit**				
1.1	**Inputs**				
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	**CPP/HRU**				
2.1	**Input**				
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	**Ammonia Plant**				
3.1	**Input**				
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	**Output**				
3.2.1	Ammonia product	MT			
4.0	**Urea Plant**				
4.1	**Input**				
4.1.1	Ammonia	MT			
4.1.2	Steam	MT			
4.1.3	Power	MkWh			
4.2	**Output**				
4.2.1	Urea product	MT			
5.0	**Service boiler / Utilities**				
5.1	**Input**				
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

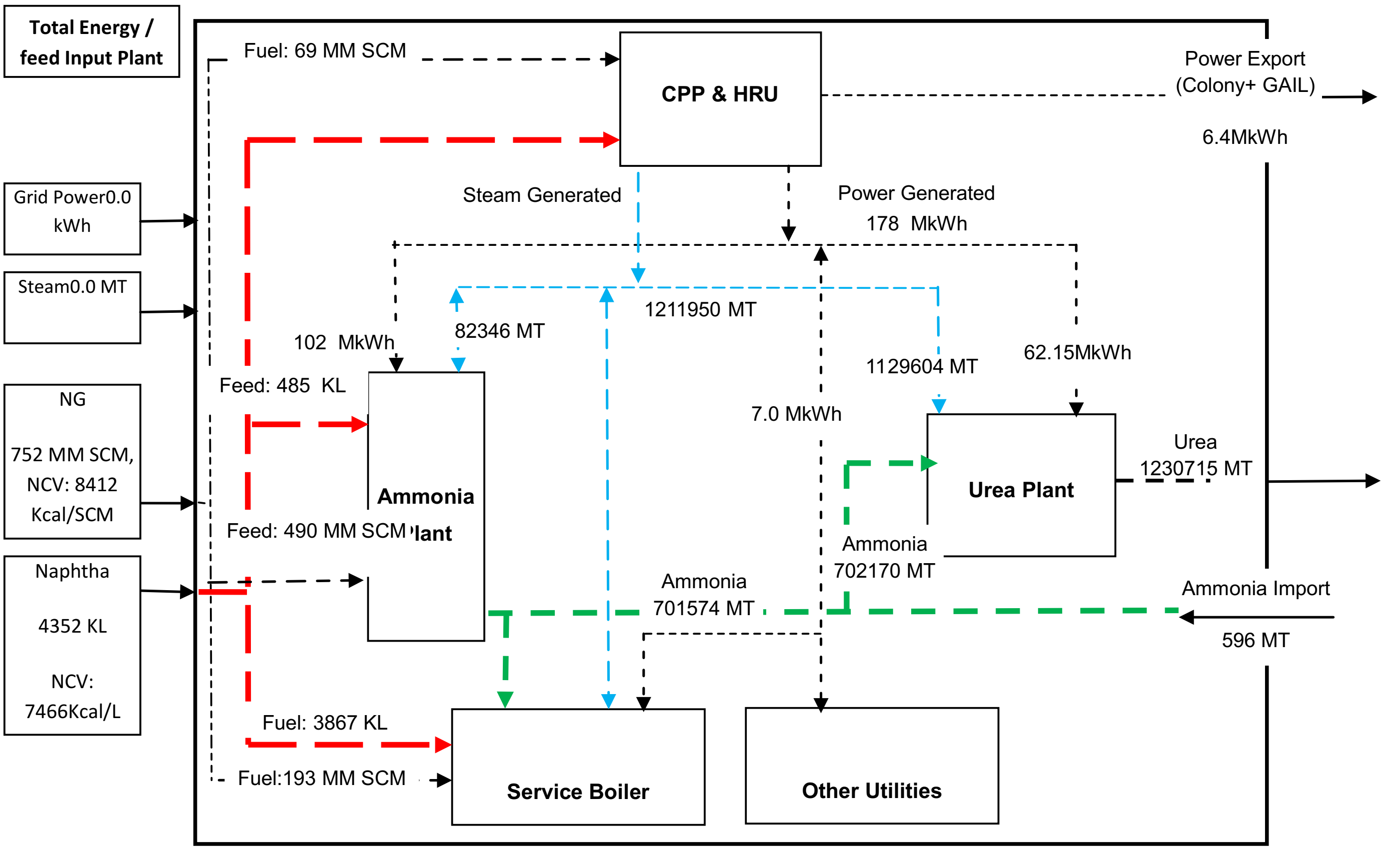


Figure 16: Overall Material and Energy balance. Figures mentioned above are indicative and used for representational purpose only . The actual data will vary from unit to unit .

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

Energy loss (Gcal/MT Urea) = (185*S + 0.625 * Nfeed + 0.443 * Nfuel) / urea production in MT

S= 1 if naphtha is used as feed in startup

S= 0 if naphta is not used as feed in startup

N_{Feedc}= quantity of naphtha used as feed in MT.

N_{Fuelc}= quanity 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 expansive 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:-

Boiler Efficiency = 92.5 – ((50*A+630 (M+9H)) / GCV.

Where

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.

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	**Proximate analysis**					
A	Fixed carbon	%				
B	Volatile matter	%				
C	Moisture	%				
D	Ash	%				
5	**Ultimate analysis**					
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 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 with inthe plant boundary, alumina to smelting operations, ingots to metal processors, and scrap from collection to melting is accounted as inside transportation and consider as energy used in plant.
2. Plant stoppages and start due to external factor: Necessary documents has 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 Carbone 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/tone of Alumina	kWh/tone 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.

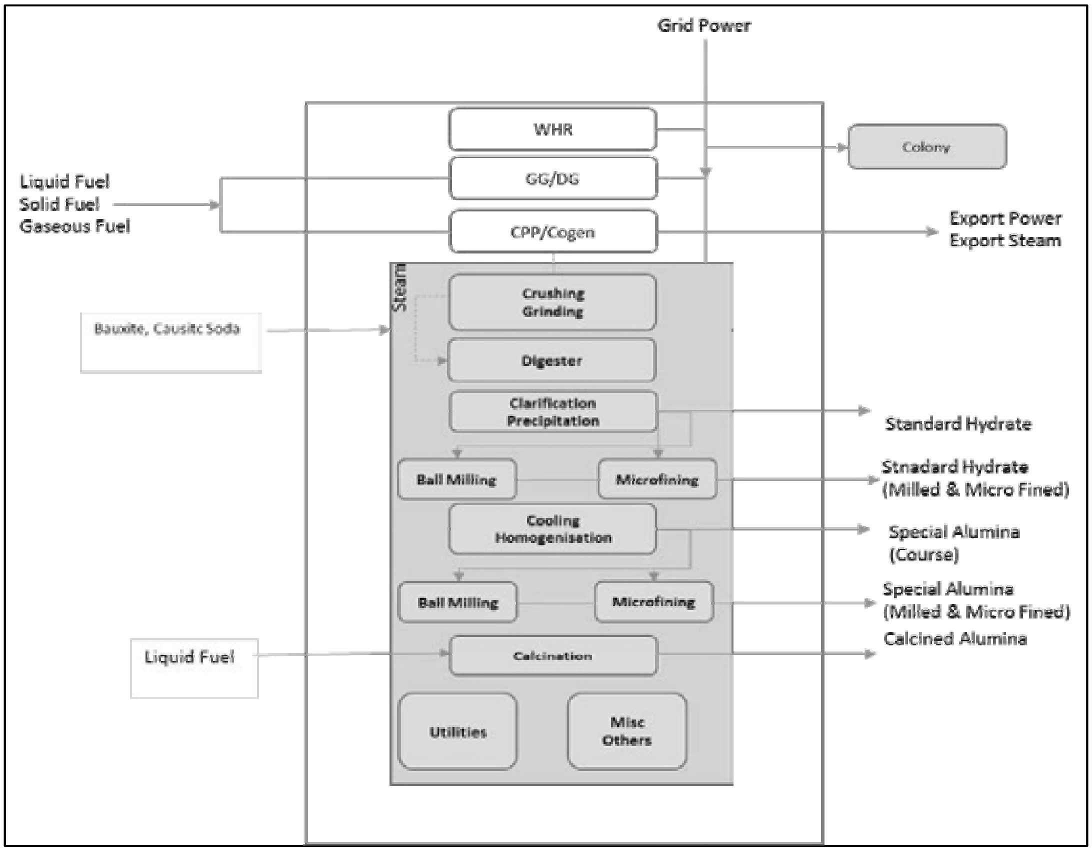


Figure 17: Ex- GtG boundary for Aluminium (Refinery sub sector)

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/tone of Anode	kWh/tone 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

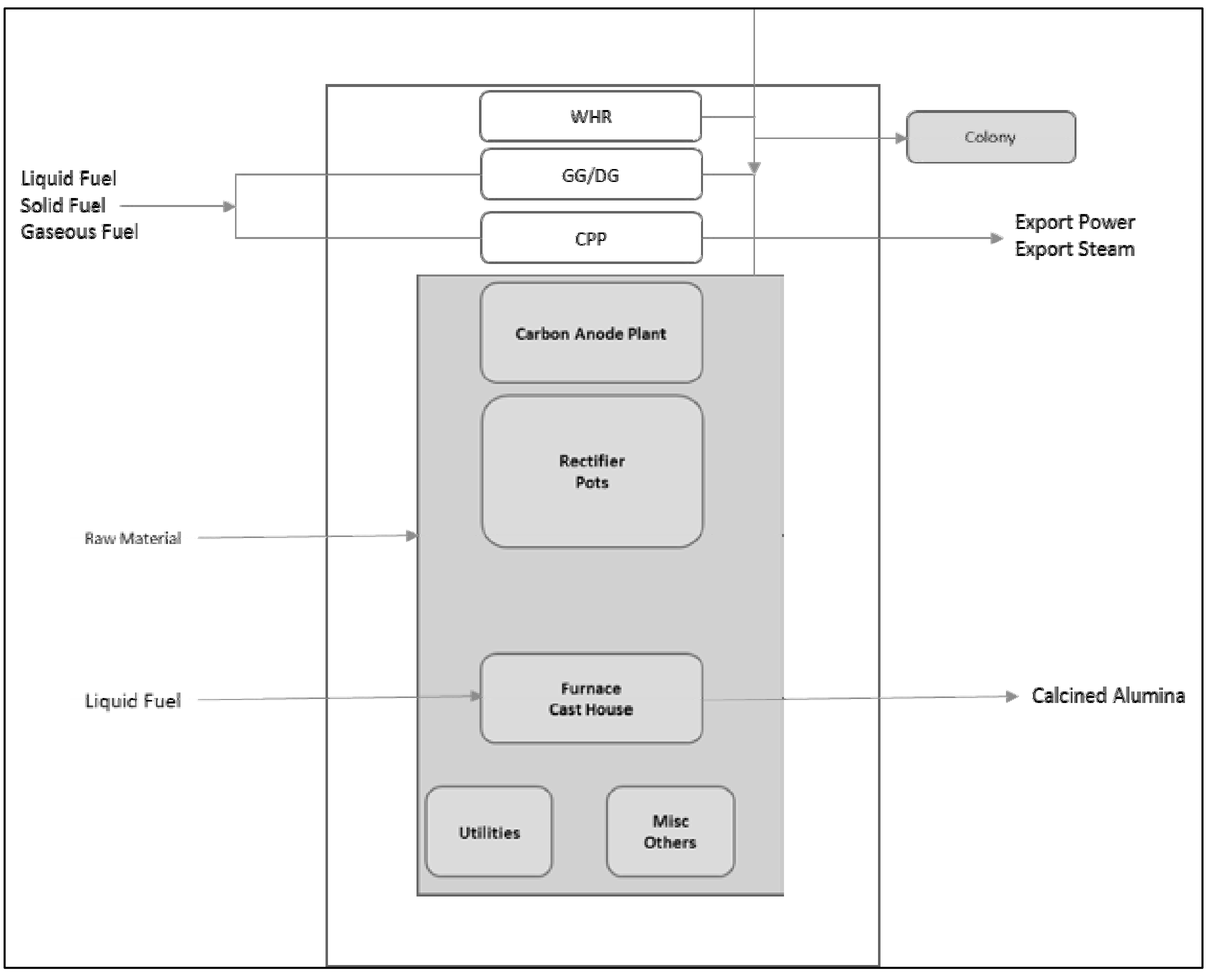


Figure 18: Ex- GtG boundary for Aluminium (Smelter sub sector)

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

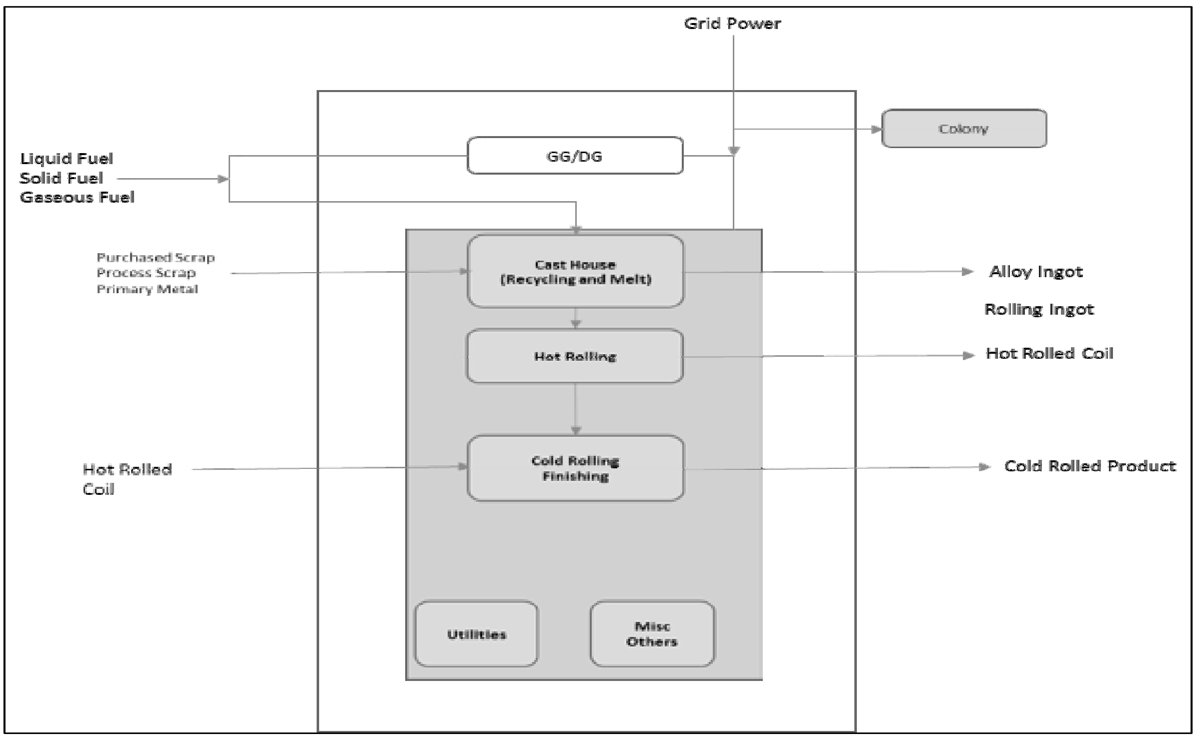


Figure 19: Ex- GtG boundary for Aluminium (Cold Sheet sub sector)

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. Wood Based Mills:-

a. The auditors 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 sector specific Pro-forma for normalization.

b. The information required is shown in the flow chart for wood based pulp and paper mill

c. List of documents required for monitoring and verification

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						
Energy Consumption in paper machine (including Stock Preparation, chemical addition and finishing house)						
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

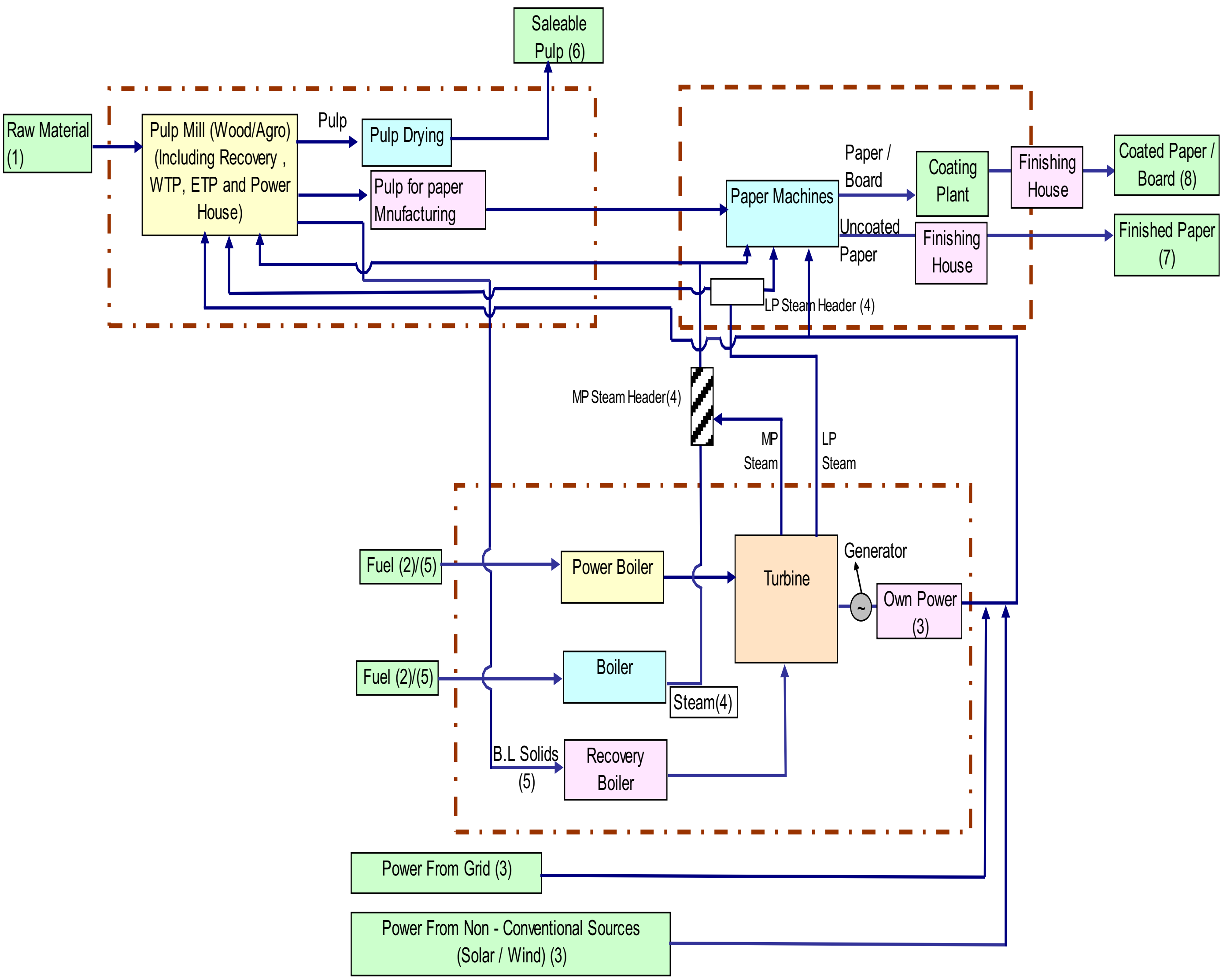


Figure 20: Ex- GtG boundary and metering details for Wood based Pulp and Paper Mill

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 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	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. 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.
		Lab reports for GCV, solids, moisture, ash etc.	Lab report on GCV, solids (%) moisture(%), Ash (%) and other analysis (proximate) of the Black liquor, pith, dust etc. used by the mill. Frequency: Daily/ weekly/ monthly/ annual lab reports may be produced for different types of Black liquor, pith, dust etc. used by the mill.
		Annual Report	Annual report showing details of Black liquor generation, dust and pith generation, from various sources such as pulp mill, chippers, etc. Frequency: Annual report of Black liquor, pith and dust generation by the mill.
6	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.
7	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.

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.1Raw 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						
Energy Consumption in paper machine (including Stock Preparation , chemical addition and finishing house)						
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

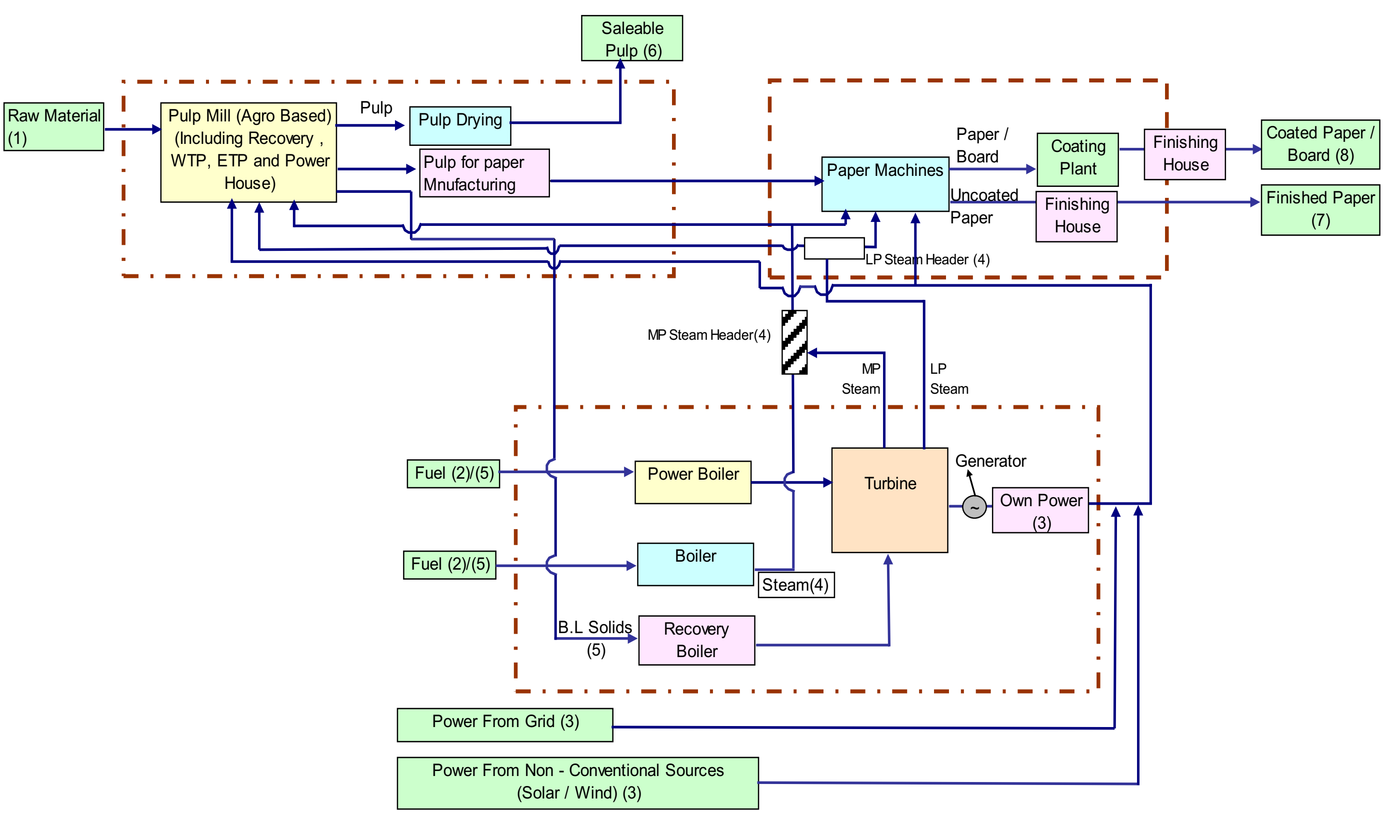


Table 28: Document required for Agro based Pulp and Paper Mills

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	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. 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.
		Lab reports for GCV, solids, moisture, ash etc.	Lab report on GCV, solids (%) moisture(%), Ash (%) and other analysis (proximate) of the Black liquor, pith, dust etc. used by the mill. Frequency: Daily/ weekly/ monthly/ annual lab reports may be produced for different types of Black liquor, pith, dust etc. used by the mill.
		Annual Report	Annual report showing details of Black liquor generation, dust and pith generation, from various sources such as pulp mill, chippers, etc. Frequency: Annual report of Black liquor, pith and dust generation by the mill.
6	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.
7	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.

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-froma 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						
Energy Consumption in paper machine (including Stock Preparation , chemical addition and finishing house)						
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.4 The Information required is shown in the Flow Chart for RCF Based Pulp and Paper Mill

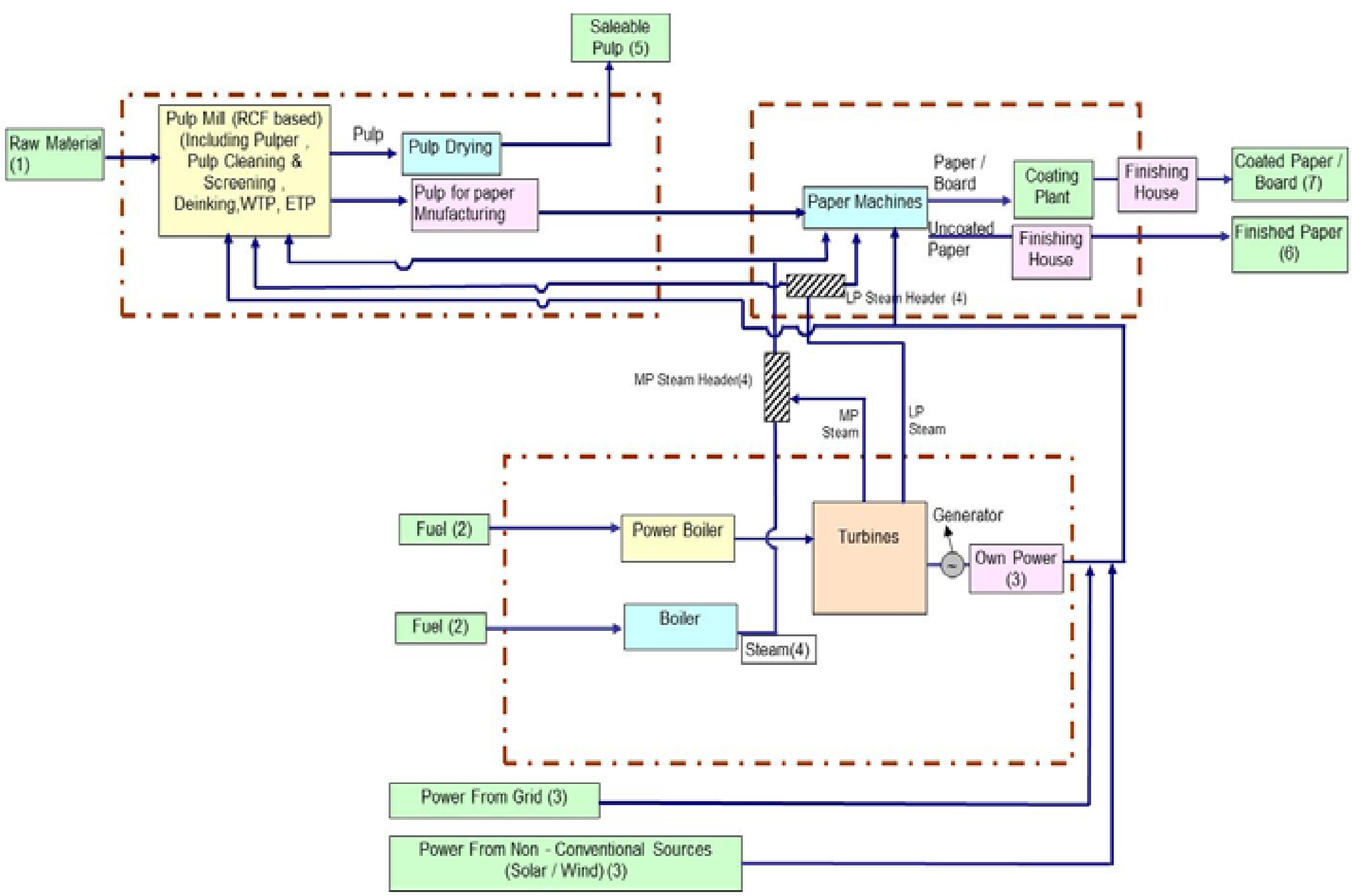


Table 30: Documents required in RCF based Pulp and Paper

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 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	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.

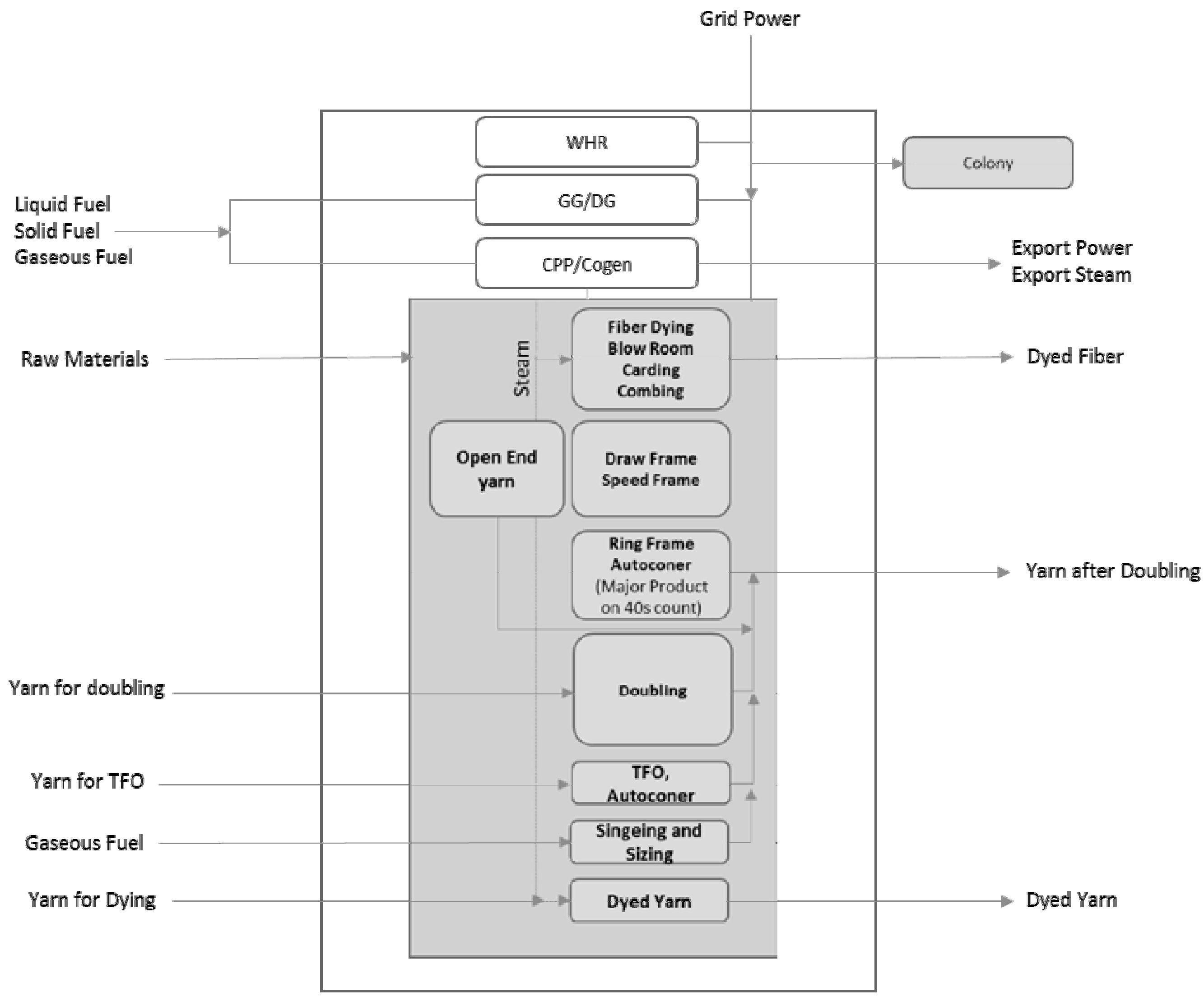


Figure 22: Ex- GtG boundary for Textile (Spinning sub sector)

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. Polyster 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
Spinning				
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			
Knitting /Weaving				
1	Wraping			
2	Sizing			
3	Knotting			
4	Weaving			
Processing				
1	Singeing			
2	Desizing			
3	Mercerizing			
4	Bleaching			
5	Sueding			
6	Dying			
7	Printing			
Misc and Others				
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

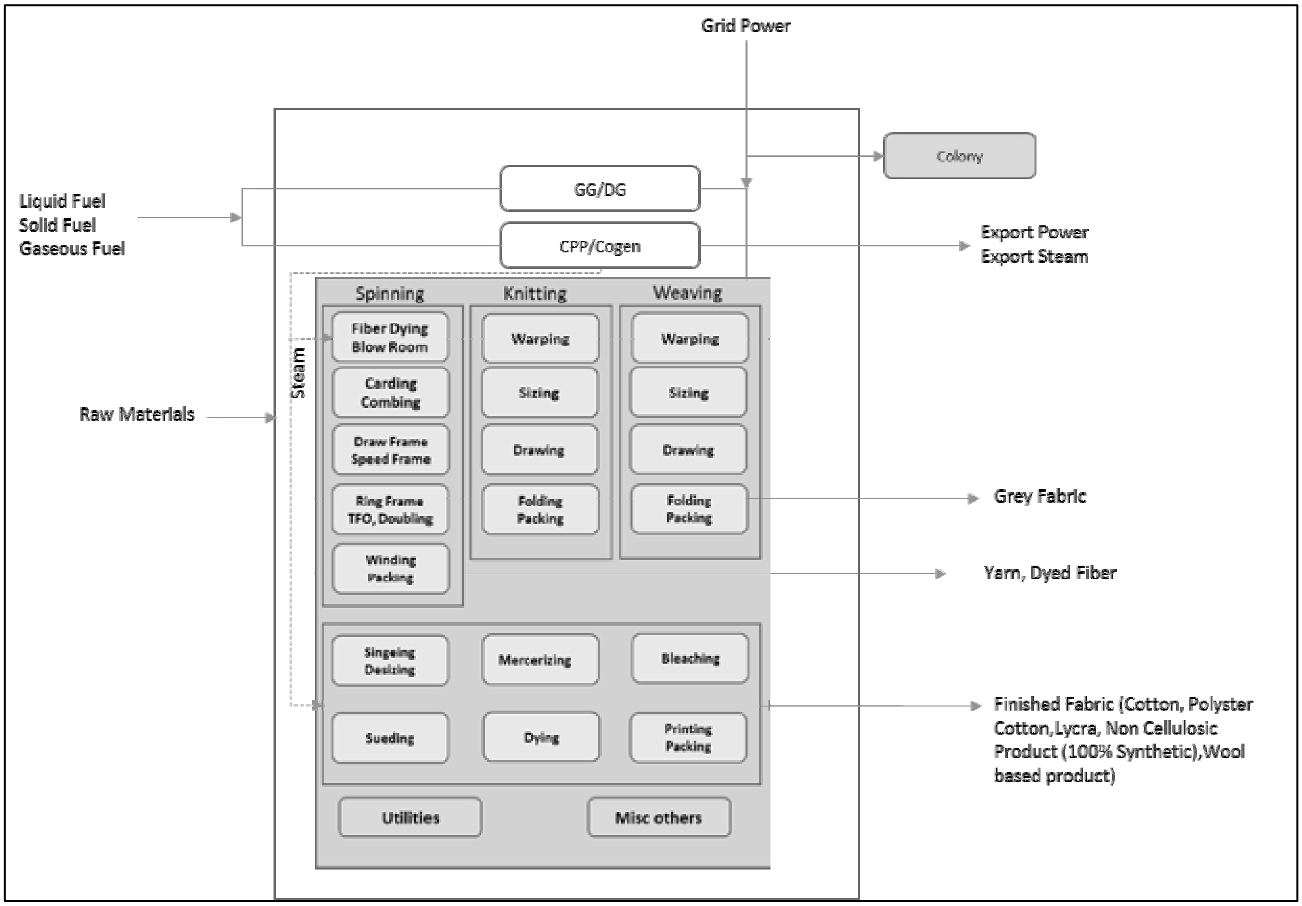


Figure 23: Ex- GtG boundary for Textile (Composite/ Processing sub sector)

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) yearlyThermal 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

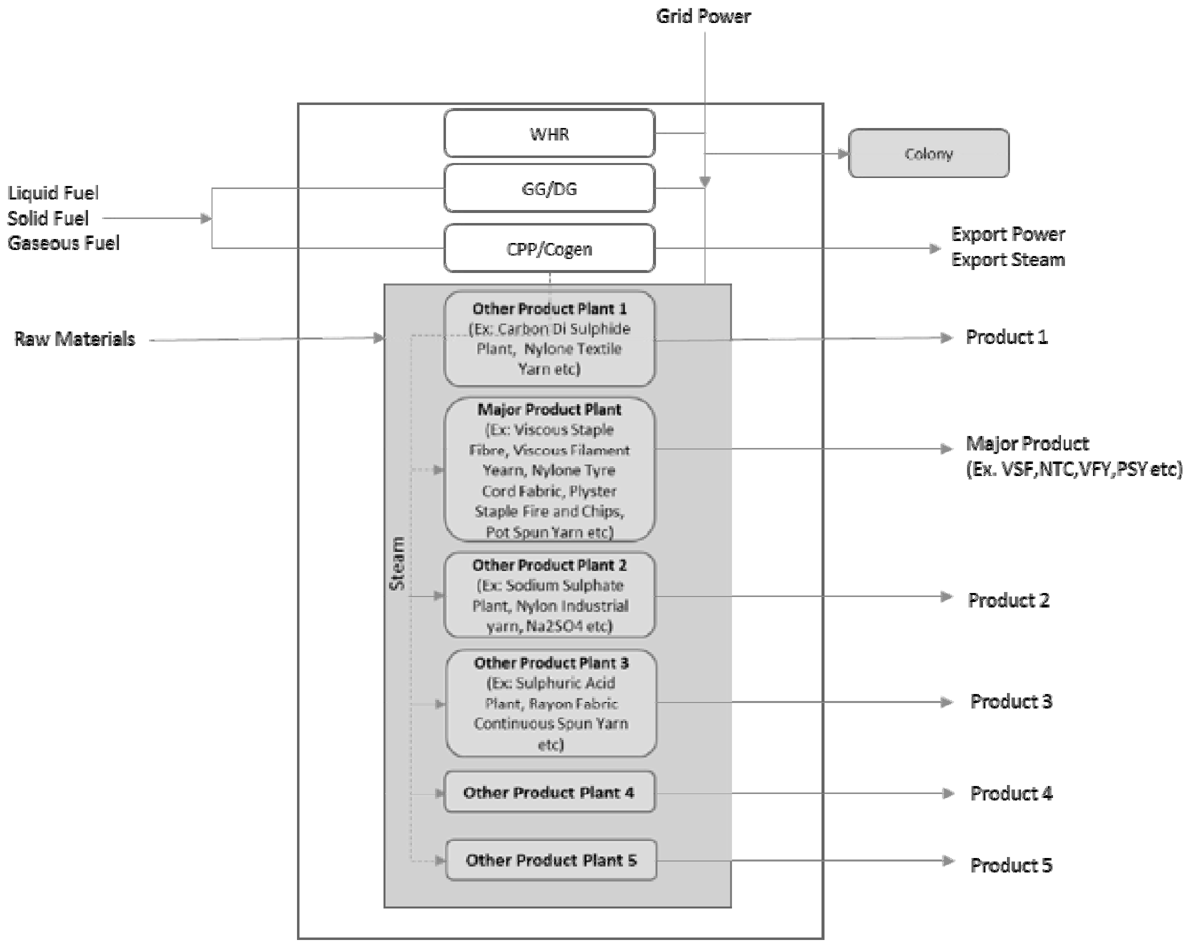


Figure 24: Ex- GtG boundary for Textile (Fiber) Sub- sector

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

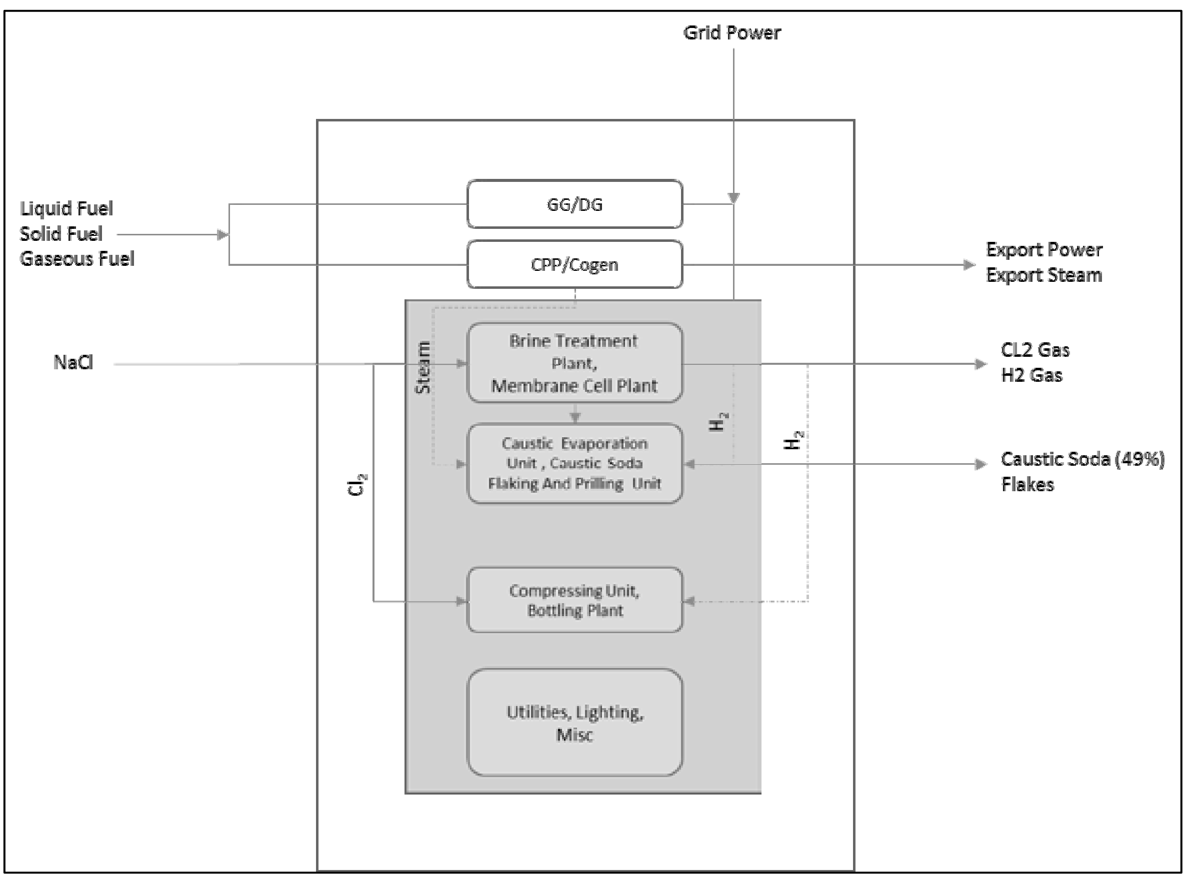
5. EmAEA shall ensure and verify production of Caustic Soda lye (49% concentration) and Hydrogen as per quantity of Chlorine produced during the electrolysis process. EmAEA shall also ensure that these productions should not exceed the stoichiometric limit

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.

ENERGY IS LIFE

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