NORMALIZATION DOCUMENT AND MONITORING & VERIFICATION GUIDELINES

Pulp and Paper Sector
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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 ESCerts.

Pulp & Paper sector is one of the 8 notified energy intensive sectors under which a total of 31 plants are participating in this program. These plants have been mandated to reduce their Specific Energy Consumption (SEC) from baseline year of 2009-2010. It is expected that these plants may save 0.119 million tons of oil equivalent annually by the end of PAT cycle –I.

The publication of “Normalization Document and M&V Guidelines” for Pulp & Paper 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 Pulp & Paper Sector, chaired by Director, Central Pulp & Paper Research Institute, Shri S.K Khandare, Energy Economist, BEE, Shri Arijit Sengupta, Asst. Energy Economist, BEE, Shri Ishan Jain, Project Engineer, BEE and Dr. B.P Thapliyal, Sector Expert, who worked tirelessly to put together the baseline data, normalization factors and M&V methodology for the sector. I especially want to record my appreciation for Shri S. Vikash Ranjan, Technical Expert, GIZ who has put together the data and methodology associated with normalization.

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

(Ajay Mathur)
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### Special Thanks to Team NMEEE

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2. Introduction

The Indian Paper Industry accounts for about 1.6% of the world’s production of paper and paperboard. There are over 650 paper mills in the country producing different types of paper using various raw materials. The consumption of different grades of paper has been growing in line with the country’s GDP growth. However, the raw material base has been changing significantly over the years. The input consumption in paper and pulp industry is high and the output low compared to other industries like cement, for example. The input-output ratio is 8:1. The quantum of these inputs varies from raw material to raw material and has a direct bearing on the overall efficiency of the paper industry. There is wide variation in the quantity of major inputs is in Indian mills. The power consumption varies between 1200 kWh and 1700 kWh, steam from 10 tonne to 16 tonne, coal 1.5-3.0 tonne, water 60-125 m3, and cooking chemicals 60-400 kg/t paper.

Though the best raw material for pulp and paper manufacturing is derived from soft woods and some of the hard wood species, the Indian pulp and paper industry depends on bamboo and mixed hardwood. This helps conserve the dwindling forest resources. The industry also uses alternative raw material to a large extent along with the farm plantations. Fibrous raw material is the single largest component influencing the manufacturing cost of paper. Any perceptible increase in the cost of fibre from these raw materials has a considerable impact on the manufacturing cost.

For sustained supply of raw materials, the industry has to use renewable sources to the maximum extent. The fibre resources used by the Indian pulp and paper industry come from three sources:

**Forests**

Forests based raw materials include bamboo and mixed hardwoods from forest felling, and eucalyptus wood from plantations (both organised plantations and farmers’ fields/agro forestry plots).

**Agricultural residues**

This includes bagasse, rice and wheat straws and cotton stalks.

**Waste paper**

This includes domestic and imported waste paper.

3. Overview of Manufacturing Process

Pulp and paper are manufactured from raw materials containing cellulose fibres, generally wood, recycled paper, and agricultural residues. The main steps in pulp and paper manufacturing are: Raw material preparation and handling, pulp manufacturing, pulp washing and screening, chemical recovery, bleaching, stock preparation, and papermaking. Pulp mills and paper mills may exist separately or as integrated operations.

An integrated mill is one that conducts pulp manufacturing on site. Non-integrated mills have no capacity for pulping but must bring pulp to the mill from an outside source. Integrated mills have the advantage of using common auxiliary systems for both pulping and papermaking such as steam, electric generation, and wastewater treatment. Transportation cost is also reduced.

A paper mill can house a single paper machine or several machines; each machine can make a single grade of paper or a variety of papers. A dedicated machine usually manufactures a commodity grade paper such as liner board or tissue. Machines designed to make specialty grades typically have more operating flexibility and will manufacture many types of paper. The basic process of paper making remains the same despite the type of paper manufactured or the size of the machine.
Step 1 - Wood preparation
The bark is removed from in-coming logs, and these are then chipped. Sometimes, the wood arrives at the plant already chipped, meaning that this step is unnecessary.

Step 2 - Cooking
The wood chips are heated in a solution of sodium hydroxide (NaOH) and sodium sulphide (Na2S) in a pressure cooker, during which time a lot of the lignin (the reinforcing substance that make tree cells wood hard and ‘woody’ rather than soft like those of other plants) is removed from the wood. The pressure is then released suddenly, causing the chips to fly apart into fibres.

Step 3 - Pulp washing
The pulp is washed with water to wash out the cooking chemicals and lignin from the fibre so that they will not interfere with later process steps.

Step 4 - Pulp screening
A sieve is used to remove from the pulp knots and uncooked fibres clumped together.

Step 5 - Bleaching
This is done in two stages. First, the pulp is treated with NaOH in the presence of oxygen (O2). The NaOH removes hydrogen ions from the lignin and then the O2 breaks down the polymer. The pulp is then treated with chlorine dioxide (ClO2), a mixture of NaOH, O2 and peroxide and finally with ClO2 again to remove the remaining lignin.

Step 6 - Paper making
The fibres are mechanically treated to make them bond well (strengthening the paper), chemicals added to provide special properties such as colour or water resistance, and then the water is squeezed out and the pulp rolled smooth and dried.

Various ancillary processes result in the recovery of calcium oxide (CaO), NaOH and Na2S, the major chemicals used in the process. Various utilities ensure that such conditions as sufficient reaction times and adequate mixing are met.

3.1 Process Flow Diagram
4. Perform, Achieve and Trade (PAT)

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

In almost every sector in India, there is a large variation in energy intensities of different units, ranging from amongst the best in the world to extremely inefficient units. As a result, there is room to improve energy intensity in India with current commercially available technologies and best practices.

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

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

During the first cycle of PAT scheme, i.e. from 2012-13 to 2014-15, eight energy intensive sectors such as thermal power plants, aluminium, cement, chlor-alkali, fertiliser, iron & steel, pulp & paper, and textile have been included. There are 478 designated consumers in these 8 sectors and they account for about 165 million tonnes of oil equivalent of energy consumption annually. Upon implementation of the first cycle of PAT, it is expected that India would save energy to the tune of approximately 6.686 million tonnes of oil (mtoe) equivalent of energy, worth Rs 6,800 crore by the end of 2014-15, equivalent to reduction of greenhouse gas emission by 24 million tonnes per year.

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

5. Indian Paper Industry and PAT

The present PAT cycle has 31 of India’s 653 paper and pulp units. The threshold limit of 30,000 tonnes of oil equivalent (toe) has been defined as the cut-off limit criterion for any unit to be identified as designated consumer (DC).

The pulp & paper sector has been categorised on the basis of raw material usage:

1. Wood based units (17 units)
2. Agro based units (6 units)
3. Recycled fibre based units (7 units)
4. 100% market based pulp (1 unit)
The total energy consumption of these designated consumers is about 2.09 million tonne of oil equivalent (mtoe). By the end of the first PAT cycle, the energy savings of 0.119 mtoe /year is expected to be achieved, which is around 1.77% of total national energy saving targets assessed under PAT.

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<tr>
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<th>Sector</th>
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<td>2</td>
<td>Iron &amp; Steel</td>
<td>67</td>
<td>25.32</td>
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<td>85</td>
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<td>4.67%</td>
<td>0.456</td>
</tr>
<tr>
<td>5</td>
<td>Fertiliser</td>
<td>29</td>
<td>8.20</td>
<td>4.97%</td>
<td>0.478</td>
</tr>
<tr>
<td>6</td>
<td>Paper &amp; Pulp</td>
<td>31</td>
<td>2.09</td>
<td>1.77%</td>
<td>0.119</td>
</tr>
<tr>
<td>7</td>
<td>Textile</td>
<td>90</td>
<td>1.20</td>
<td>0.73%</td>
<td>0.066</td>
</tr>
<tr>
<td>8</td>
<td>Chlor- Alkali</td>
<td>22</td>
<td>0.88</td>
<td>0.53%</td>
<td>0.054</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>478</strong></td>
<td><strong>164.97</strong></td>
<td><strong>100.00%</strong></td>
<td><strong>6.686</strong></td>
</tr>
</tbody>
</table>

6. **Methodology for Baseline and Energy Performance Index (EPI)**

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

Dimensions of PAT mechanism:
- Methodology for establishing the baseline energy consumption
- Methodology for target setting for each sector
- The process of measurement and verification, in particular the verification agencies that need to be appointed by BEE for this purpose.
- The manner in which trading of the energy saving certificates can be encouraged,
particularly instruments that could increase liquidity in the system.

6.1 General rule for establishing Baseline
Baseline Production (Pbase): Avg. of 2007-8, 2008-9 & 2009-10
Baseline CU% (CUbase): Avg. of 2007-8, 2008-9 & 2009-10
Target SEC (SECtarget): SEC as estimated in 2014-15

Estimation of Energy Saving (mtoe): Pbase (SECbase – SECtarget)

6.2 Target Setting
- The sectoral target for pulp and paper is allocated on a pro-rata basis of total energy consumption among 7 sectors under PAT scheme; the targets for the thermal power sector have been fixed separately.
- Sub-Sectoral target is allocated on a pro-rata basis of total energy consumption in the grouping among the total paper and pulp sector.
- The DC level target is allocated based on a statistical analysis derived from relative SEC concept. This approach will be applicable to all the DCs of a sub-sector.

Specific Energy Consumption and Targets- Pulp & Paper

6.3 Methodology for Baseline and Energy Performance Index (EPI)
7. Normalisation

The Indian Paper industry produces diverse products using diverse raw materials and processes. Based on the process used for manufacture and their usage, paper products can be categorised into following broad categories.

<table>
<thead>
<tr>
<th>Category</th>
<th>Purpose</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural paper</td>
<td>information and literary purposes</td>
<td>writing Printing paper, fine paper (copier paper) etc</td>
</tr>
<tr>
<td>Packaging paper and paperboard</td>
<td>Commercial (packaging), industrial and constructional use</td>
<td>paperboard and cardboard, kraftliner, sack paper etc.</td>
</tr>
<tr>
<td>Speciality paper</td>
<td>Personal or sanitary purposes</td>
<td>tissue paper, cigarette paper, labels, glassine etc.</td>
</tr>
<tr>
<td>Newsprint</td>
<td>Communication</td>
<td>Newsprint</td>
</tr>
</tbody>
</table>

Normalization factors for the following factors have been developed in Pulp & Paper sector, which will ultimately affect the gate to gate specific energy consumption in the Assessment year. A broad categorization of the factors is as under:

1. **Equivalent Products.**
2. **Intermediary Products.**
3. **Fuel quality in CPP and Cogen.**
4. **Power Mix** (Imported & Exported from/to the grid and self-generation from the captive power plant).
5. **Others**
   5.1 **Environmental concern** (Additional Environmental Equipment requirement due to major changes in government policy on Environment)
   5.2 **Biomass/Alternate Fuel Unavailability**
   5.3 **Construction Phase or Project Activity Phase**
   5.4 **Unforeseen circumstances**
   5.5 **Thermal Energy used in Waste heat recovery**
   5.6 **Renewable Energy Certificate Normalization**

The Normalization will also take place on some unavoidable circumstances in the Assessment year as compared to the Baseline year with proposed authentic base documents.

7.1 **Normalisation of Equivalent Product (Pulp)**

7.1.1 **Need for Normalisation of Equivalent Product**

The Pulp and paper mills produce different varieties of the paper and paperboard by using the wood, agro and/or recycled fibre pulps as well as by using their different ratios. This results in variation of the products. However, another reason for the variation in the product furnish is due to addition of the fillers and some paper additives/chemicals, which increase the ash load in paper without affecting its quality parameters. It results in saving of expensive fiber resources. The pulp produced by some mills is also exported as saleable pulp after drying it in wet lap machine.

For change in the Products mix in Assessment year with respect to Baseline year, there is a need to develop and execute Normalization factors in a proper manner, 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.

Apart from the in-house production of pulp (for making paper and for export as saleable pulp),
mills also import softwood and hardwood pulps to impart certain properties in the paper products. Therefore in case of a pulp and paper mill, as the pulp can be either imported or exported, which is an intermediary product and not the final product, there may be variation in their quantities in the Assessment year to the Baseline years.

For different varieties of the paper, paper board, specialty paper and newsprint as well as the partially processed products (Intermediary Product), i.e., purchased pulp, imported by the plant (for which part of the manufacturing energy is not used by the plant) and exported pulp from the plant (for which energy has been used but it is not taken into account in the final product), different approaches are required to normalise the variations in their products mix during the Assessment year.

i. If major product changed in the Assessment year from baseline in Pulp making

Case 1:- Wood based pulp to Agro based pulp or Vice-versa

Case 2:- Wood based pulp to RCF based pulp or Vice-versa

Case 3:- Agro based pulp to RCF based pulp or Vice-versa ………………

ii. If major product changed in Assessment Year from baseline year in the Paper making

Case 1-: Writing printing to Specialty or Vice-versa

Case 2-: Writing Printing to Board and Kraft paper or Vice-versa

Case 3-: News print to Specialty or Vice-versa  ……………………………

All the above changes with respect to the Baseline Year attracts Normalisation, hence the major product of the baseline year has to be kept same in the assessment year

In case of the product mix it is necessary to convert different types of paper products and exported pulp to be converted in to equivalent major product produced by that plant in the baseline year. Where as in case of import and export of the pulp, as an intermediary product, proper energy accounting (addition or subtraction) is required to compensate the energy. The approach for normalisation of import and export of the pulp and the variation in product quality is discussed below.

7.1.2 Baseline Year Methodology:
The Pulp and Paper mills are different in terms of raw material use, process layouts and product mix based on furnish like pulps used in different blending ratios and the additives such as fillers etc. Some integrated paper mills having excess pulp production capacity, also export pulp as a product apart from the main product, paper, paper board, newsprint, specialty papers etc. Hence, different types of paper products and exported pulp are required to be converted in to equivalent major product produced by that plant with the help of conversion factors. The conversion factors should be based on the data reported by the concerned plant. The products therefore are:

- Exported pulp
- Cultural papers mainly defined as writing printing paper (WPP) and value added coated (chromo and art) papers.
- Packaging paper and paperboard covering the broad sub-categories like paperboard, cardboard, kraftliner, sack paper etc.
- Specialty papers defined as tissue paper, cigarette paper, lables, glassinepaper etc.
- Newsprint.

The mills also import pulp, as purchased softwood and hardwood pulps, and are mixed in a well-defined ratio for product quality. Since in case of imported pulp energy input is not
required for manufacture, therefore any change in its quantity can also affect the specific energy consumption in final paper products.

The baseline year methodology therefore needs to consider the energy inputs in all forms of intermediate and final products in the Baseline year and have relative comparison in the Assessment year, to compensate the effect of changes in the factors which may affect energy consumption.

7.1.3 Normalisation for Equivalent Pulp Product

To find out the Normalisation factor for saleable pulp, it is necessary to determine the specific energy consumption (SEC) for production of pulp from different raw materials, such as wood, agro residues and the recycled fiber. After determination of the SEC for pulp production, the equivalent pulp product may be calculated. Therefore the calculation of the equivalent pulp product is determined in two steps as below.

- Calculation of stocks of exported/imported pulp
- Calculation of its quantities.
- Calculation of Specific Energy Consumption for production of pulp from wood, agro residues and RCF in the Baseline year and the Assessment year.
- Calculation for pulp as equivalent product in the Baseline and Assessment year.

7.1.3.1 Methodology for Output Products

- 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

**Series Production**

- Section 1
- Section 2
- Section 3
- Product A
- Process B
- Product C
- Product B

**Parallel Production Wood/Agro/RCF**

- Section 1
- Section 2
- Section 3
- Product A
- Major Product A
- Product B
- Major Product B
- Product C
- Major Product C
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 Pulp & Paper Sector each plant, having different product mix based on process like Writing Printing Paper, Paper Board and Kraft, Speciality paper or News Print.

Hence, different types of Paper products are converted in to equivalent major product produced by that plant with the help of energy factor, based on the SEC of the product.

### 7.1.3.2 Methodology for Value added Products

i. 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.
7.1.4 SEC Calculation for production of pulp from wood, agro residues and RCF in the Baseline year and the Assessment year.

The pulp is produced from wood, agro residues and recycled fiber, therefore separate SEC for production of pulp from these raw materials must be known.

Pulp mills based on the production process, will have different specific energy consumption to produce the pulp. For wood, agro and RCF pulp production the energy (thermal and electrical) used in following processes is taken into consideration.

- Wood (chipper + digester+WSC+ bleachplant + Chemical recovery + utilities + ETP)
- Agro (depither, cutter + digester+WSC+ bleach plant + Chemical recovery + utilities + ETP)
- RCF (hydrapulper+deinking+bleach plant + utilities + ETP)

Following formulae are used for calculation of the SEC for wood pulp (SECWP), SEC for agro pulp (SECAP) and SEC of recycled fiber pulp (SECRP).
a. SEC of Wood Pulp

\[
\text{SECWP} = \text{SEC of Wood Pulp (kcal/Tonne)} = \text{Specific Steam Consumption -MP for Wood Pulp (kcal/Tonne)} + \text{Specific Steam Consumption -LP for Wood Pulp (kcal/Tonne)} + \text{Specific Energy Consumption (Power) for Wood Pulp (kcal/Tonne)}
\] ----(7.4.1 a)

Where,

\[
\text{Specific Steam Consumption -MP for Wood Pulp (kcal/Tonne)} = \left[\frac{\text{MP-Steam Consumption for Wood Pulp (Tonne)}}{\text{Wood Pulp Production (Tonnes)}}\right] \times \text{Enthalpy of MP-Steam (kcal/kg)} \times 1000
\]

\[
\text{Specific Steam Consumption -LP for Wood Pulp (kcal/Tonne)} = \left[\frac{\text{LP-Steam Consumption for Wood Pulp (Tonne)}}{\text{Wood Pulp Production (Tonnes)}}\right] \times \text{Enthalpy of LP-Steam (kcal/kg)} \times 1000
\]

\[
\text{Specific Energy Consumption (Power) for Wood Pulp (kcal/Tonne)} = \left[\frac{\text{Power Consumption for Wood Pulp (kwh)}}{\text{Wood Pulp Production (Tonnes)}}\right] \times \text{Heat Rate (kcal/kwh)}
\]

b. SEC of Agro Residue Pulp

\[
\text{SECAP} = \text{SEC of Agro (kcal/Tonne)} = \text{Specific Steam Consumption -MP for Agro (kcal/Tonne)} + \text{Specific Steam Consumption -LP for Agro (kcal/Tonne)} + \text{Specific Energy Consumption (Power) for Agro (kcal/Tonne)}
\] ----(7.4.1 b)

Where,

\[
\text{Specific Steam Consumption -MP for Agro (kcal/Tonne)} = \left[\frac{\text{MP-Steam Consumption for Agro (Tonne)}}{\text{Agro Production (Tonnes)}}\right] \times \text{Enthalpy of MP-Steam (kcal/kg)} \times 1000
\]

\[
\text{Specific Steam Consumption -LP for Agro (kcal/Tonne)} = \left[\frac{\text{LP-Steam Consumption for Agro (Tonne)}}{\text{Agro Production (Tonnes)}}\right] \times \text{Enthalpy of LP-Steam (kcal/kg)} \times 1000
\]

\[
\text{Specific Energy Consumption (Power) for Agro (kcal/Tonne)} = \left[\frac{\text{Power Consumption for Agro (kwh)}}{\text{Agro Production (Tonnes)}}\right] \times \text{Heat Rate (kcal/kwh)}
\]


**c. SEC of RCF Pulp**

\[
\text{SECRP} = \text{SEC of RCF (kcal/Tonne)} = \text{Specific Steam Consumption –MP for RCF (kcal/Tonne)} + \text{Specific Steam Consumption –LP for RCF (kcal/Tonne)} + \text{Specific Energy Consumption (Power) for RCF (kcal/Tonne)}
\]

Where,

\[
\text{Specific Steam Consumption –MP for RCF (kcal/Tonne)} = \frac{\text{MP- Steam Consumption for RCF (Tonne)}}{\text{RCF Production (Tonnes)}} \times \text{Enthalpy of MP- Steam (kcal/kg)} \times 1000.
\]

\[
\text{Specific Steam Consumption –LP for RCF (kcal/Tonne)} = \frac{\text{LP- Steam Consumption for RCF (Tonne)}}{\text{RCF Production (Tonnes)}} \times \text{Enthalpy of LP- Steam (kcal/kg)} \times 1000.
\]

\[
\text{Specific Energy Consumption (Power) for RCF (kcal/Tonne)} = \frac{\text{Power Consumption for RCF (kwh)}}{\text{Agro Production (Tonnes)}} \times \text{Heat Rate (kcal/kwh)}.
\]

7.1.5 Calculation for pulp as equivalent product in the Baseline and Assessment year

The calculations used for Normalisation of Pulp as Equivalent Product in the Baseline year and Assessment year is presented below.

**A. Calculation of the equivalent pulp product in baseline year.**

\[
\text{Equivalent Product (Pulp) for BY [Tonnes]} = \text{WP}_m \times (\text{CFWBY} \times \text{PPWBY}) + \text{AP}_m \times (\text{CFABY} \times \text{PPABY}) + \text{RCF}_m \times (\text{CFRBY} \times \text{PPRBY})
\]

Where;

\(\text{WP}_m\) = wood pulp to main product

\(\text{AP}_m\) = Agro pulp to main product

\(\text{RCF}_m\) = RCF pulp to main product

\(\text{CFWBY}\) = Conversion factor for wood pulp in Baseline Year

\(\text{CFABY}\) = Conversion factor for Agro pulp in Baseline Year

\(\text{CFRBY}\) = Conversion factor for RCF pulp in Baseline Year

\(\text{PPWBY}\) = Pulp production of Wood Pulp (Tonne) in BY

\(\text{PPABY}\) = Pulp production of Agro Pulp (Tonne) in BY

\(\text{PPRBY}\) = Pulp production of RCF Pulp (Tonne) in BY
The conversion factors CFW, CFA and CFR for Baseline Year in Eq. 1.4 will be calculated as shown below.

\[
CFW_{BY} = \frac{\text{SEC for Wood pulp (BY)}}{\text{SEC of Major Product (BY)}} \quad (7.5.2 \text{ A})
\]

\[
CFA_{BY} = \frac{\text{SEC for Agro pulp (BY)}}{\text{SEC of Major Product (BY)}} \quad (7.5.2 \text{ B})
\]

\[
CFR_{BY} = \frac{\text{SEC for RCF pulp (BY)}}{\text{SEC of Major Product (BY)}} \quad (7.5.2 \text{ C})
\]

**B. Calculation of the equivalent pulp product in Assessment year**

\[
\text{Equivalent Product (Pulp) for AY[Tonnes]} = WP_m \times (CFW_{AY} \times PPW_{AY}) + AP_m \times (CFA_{AY} \times PPA_{AY}) + RCF_m \times CFR_{AY} \times PPR_{AY} \quad -----(7.5.3)
\]

Where

CFWAY = Conversion factor for wood pulp in Assessment Year

CFAAY = Conversion factor for Agro pulp in Assessment Year

CFRAY = Conversion factor for RCF pulp in Assessment Year

PPWAY = Pulp production of Wood Pulp (Tonne) in Assessment Year

PPAAY = Pulp production of Agro Pulp (Tonne) in Assessment Year

PPRAY = Pulp production of RCF Pulp (Tonne) in Assessment Year

**Condition#1-** When baseline saleable pulp production is zero in the Baseline Year.

The Eq. No. 7.5.2.A, 7.5.2.B and 7.5.3.C for Assessment Year, given below, are applicable in case when baseline production = 0 for the concerned product (saleable pulp), otherwise the baseline conversion factor will be considered.

\[
CFW_{BY} = \frac{\text{SEC for Wood pulp (BY)}}{\text{SEC of Major Product (BY)}} \quad (7.5.4 \text{ A})
\]

\[
CFA_{BY} = \frac{\text{SEC for Agro pulp (BY)}}{\text{SEC of Major Product (BY)}} \quad (7.5.4 \text{ B})
\]

\[
CFR_{BY} = \frac{\text{SEC for RCF pulp (BY)}}{\text{SEC of Major Product (BY)}} \quad (7.5.4 \text{ C})
\]
Condition#2 – When baseline saleable pulp production is not zero in the Baseline year.

In this case, the calculations in eq. 7.5.2 and 7.5.4 are applicable when the baseline production ≠ 0 for a product i.e., wood, agro and RCF pulps. Thus following baseline conversion factor will be considered.

\[
CF_{\text{BY}}^{\text{W}} = \frac{\text{SEC for Wood pulp (BY)}}{\text{SEC of Major Product (BY)}} \quad (7.5.2.A)
\]

\[
CF_{\text{BY}}^{\text{A}} = \frac{\text{SEC for Agro pulp (BY)}}{\text{SEC of Major Product (BY)}} \quad (7.5.2.B)
\]

\[
CF_{\text{BY}}^{\text{R}} = \frac{\text{SEC for RCF pulp (BY)}}{\text{SEC of Major Product (BY)}} \quad (7.5.2.C)
\]

7.1.6 Documentation

- Pulp sales Documents
- Pulp production documents [for e.g. Log sheets, DPR, MPR, Lab Report/register/SAP Data]

7.2 Normalisation for Intermediary Product (Pulp)

7.2.1 Normalisation of Intermediary Products

In Indian Pulp & Paper Sector, pulp can be produced by using the following raw materials:

- From wood (Hardwoods) using chippers, digesters, washing, screening & centricleaning (WSC), and bleaching using different bleach chemicals.
- From agro residues (wheat straw, bagasse, reeds and other annual plants) using cutters, depithers, digesters, washing, screening & centricleaning (WSC), and bleaching using different bleach chemicals.
- From recycled fibers (RCF) and market pulp using hydrapulpers, cleaning and screening of the stock, deinking and bleaching of the pulp.
- Apart from the above pulp manufacturing from different raw materials, mills also import 100% market pulp which is used for paper production.

Since pulp mills based on the above raw materials have different unit operations to produce and process the pulp, hence, these are designated as distinct wood pulp street; agro pulp street and RCF pulp streets. Power and steam consumption in all above streets are different and thus there will be variation in the specific energy consumption for process specific pulp production. Many mills use variety of raw materials using wood, agro and RCF pulp streets and further the pulp production also varies according to the variation in product quality and market demand. The variation in pulp production in Assessment year with respect to Baseline year, therefore needs to develop and impose proper Normalization factors, so that any change in the process to prepare pulp and final product produced could be nullified and the concerned plant should not suffer / or gain advantage due to this change in pulp production.

For this the major product of baseline year would be considered for the assessment year for calculating Equivalent product in
the assessment year. Major product could be from Wood, Agro or RCF pulp depending on Maximum production. The terminologies used for calculation are:

- AY: Assessment Year
- BY: Baseline Year
- SEC: Specific Energy Consumption

### 7.2.1.1 Methodology for Intermediary Product

Import of intermediary product for production of final product can happen along with export of intermediary product 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 with respect to Baseline year, there is a need to develop and formulate proper Normalization factors, so that any change in the ratio of imported and exported product could be nullified and the concerned plant should not suffer / or gain advantage due to this changes.

---

**Product Mix - Intermediary Product**

- **Series Production**
  - Section 1
  - Section 2
  - Section 3
  - Product A
  - Process B1
  - Process B2
  - Product B (P1)
  - Process C
  - E1, E2, E3, E4 are Energy
  - S1, S2, S3, S4 are SEC of Process
  - Pi, Pe, P1, P2 are Production

- **Parallel Production**
  - Section 1
  - Section 2
  - Section 3
  - Product A
  - Product B (P1)
  - Product C (P2)

- Notional Energy for Import(Ei) = Pi x Si
- Notional Energy for Export(Ee) = Pe x Se
- Total Energy (E) = E1 + Ei + Ee
- SEC for Major Product: S2 = E2 / P
- Equivalent Product (P_{eq}) = P x (S3/S2) + P2 x (S4/S2)
- SEC = E / P_{eq}
**7.2.1.2 Pulp Stock (Assessment Year)**

The calculation of the bleached pulp stock is shown below

\[
BS_{\text{WP}} = \text{Wood bleached pulp stock [Tonnes]} = \text{Closing Stock of Total wood Bleached saleable Pulp (Tonnes)} - \text{Opening Stock of Total wood Bleached saleable Pulp (Tonnes)} \tag{8.1.a}
\]

\[
BS_{\text{AP}} = \text{Agro bleached pulp stock [Tonnes]} = \text{Closing Stock of Total Agro Bleached saleable Pulp (Tonnes)} - \text{Opening Stock of Total Agro Bleached saleable Pulp (Tonnes)} \tag{8.1.b}
\]

\[
BS_{\text{RP}} = \text{RCF bleached pulp stock [Tonnes]} = \text{Closing Stock of Total RCF Bleached saleable Pulp (Tonnes)} - \text{Opening Stock of Total RCF Bleached saleable Pulp (Tonnes)} \tag{8.1.c}
\]

**7.2.1.3 Pulp Export Quantities (Assessment Year)**

Calculations are made according to following conditions.

**Condition#1** - If BSWP > 0, following calculation will be used for Total Wood bleached Export

\[
P_{\text{EWP}} = \text{Total Wood bleached Export [Tonnes]} = \text{Export Wood Bleached Pulp (Tonnes)} + \text{Wood bleached pulp stock (Tonnes)} \tag{8.1.d}
\]

**Condition#2** - If BSWP < 0, following calculation will be used for Total Wood bleached Export

\[
P_{\text{EWP}} = \text{Total Wood bleached Export [Tonnes]} = \text{Export Wood Bleached Pulp (Tonnes)} \tag{8.1.e}
\]

**Condition#3** - If BSAP > 0, following calculation will be used for Total Agro bleached Export

\[
P_{\text{EAP}} = \text{Total Agro bleached Export [Tonnes]} = \text{Export Agro Bleached Pulp (Tonnes)} \tag{8.1.f}
\]

**Condition#4** - If BSAP < 0, following calculation will be used for Total Agro bleached Export

\[
P_{\text{EAP}} = \text{Total Agro bleached Export [Tonnes]} = \text{Export Agro Bleached Pulp} \tag{8.1.g}
\]

**Condition#5** - If BSRP > 0, following calculation will be used for Total RCF bleached Export

\[
P_{\text{ERP}} = \text{Total RCF bleached Export [Tonnes]} = \text{Export RCF Bleached Pulp (Tonnes)} + \text{RCF bleached pulp stock (Tonnes)} \tag{8.1.h}
\]

**Condition#6** - If BSRP < 0, following calculation will be used for Total RCF bleached Export

\[
P_{\text{ERP}} = \text{Total RCF bleached Export [Tonnes]} = \text{Export RCF Bleached Pulp} \tag{8.1.i}
\]

**7.2.1.4 Pulp Import Quantities for Baseline Year (BY)**

**Condition#1** - If BSWP > 0, following calculation will be used for Total Wood bleached Import

\[
P_{\text{IWP}} = \text{Total Wood bleached Import [Tonnes]} = \text{Import Wood Bleached Pulp (Tonnes)} \tag{8.1.j}
\]

**Condition#2** - If BSWP < 0, following calculation will be used for Total Wood bleached Import

\[
P_{\text{IWP}} = \text{Total Wood bleached Import [Tonnes]} = \text{Import Wood Bleached Pulp (Tonnes)} - \text{Wood bleached pulp stock (Tonnes)} \tag{8.1.k}
\]

**Condition#3** - If BSAP > 0, following calculation will be used for Total Agro bleached Import
Normalisation Methodology for Pulp & Paper Sector

7.2.1.5 Pulp Import Quantities for Assessment Year (AY)

**Condition#1** - If BSWP > 0, following calculation will be used for Total Wood bleached Import

\[ P_{IWP} = \text{Total Wood bleached Import [Tonnes]} = \text{Import Wood Bleached Pulp (Tonnes)} + \text{Wood Pulp Production till new line attains 70\% of Capacity utilisation} \]  

----(8.1.p)

**Condition#2** - If BSWP < 0, following calculation will be used for Total Wood bleached Export

\[ P_{IWP} = \text{Total Wood bleached Import [Tonnes]} = \text{Import Wood Bleached Pulp (Tonnes)} + \text{Wood Pulp Production till new line attains 70\% of Capacity utilisation - Wood bleached pulp stock (Tonnes)} \]  

----(8.1.q)

**Condition#3** - If BSAP > 0, following calculation will be used for Total Agro bleached Import

\[ P_{IAP} = \text{Total Agro bleached Import [Tonnes]} = \text{Import Agro Bleached Pulp (Tonnes)} + \text{Agro Pulp Production till new line attains 70\% of Capacity utilisation (Tonnes)} \]  

----(8.1.r)

**Condition#4** - If BSAP < 0, following calculation will be used for Total Agro bleached Export

\[ P_{IAP} = \text{Total Agro bleached Import [Tonnes]} = \text{Import Agro Bleached Pulp (Tonnes)} - \text{Agro bleached pulp stock (Tonnes)} \]  

----(8.1.m)

**Condition#5** - If BSRP > 0, following calculation will be used for Total RCF bleached Import

\[ P_{IRP} = \text{Total RCF bleached Import [Tonnes]} = \text{Import RCF Bleached Pulp (Tonnes)} \]  

----(8.1.n)

**Condition#6** - If BSRP < 0, following calculation will be used for Total RCF bleached Export

\[ P_{IRP} = \text{Total RCF bleached Import [Tonnes]} = \text{Import RCF Bleached Pulp (Tonnes)} - \text{RCF bleached pulp stock (Tonnes)} \]  

----(8.1.o)

7.2.2 The Net Import Energy to be deducted in the Assessment Year

The net import energy to be deduced in the assessment year is calculated as shown in the below equation
Net Import/Export Energy for bleached pulp to be deducted in the assessment year [Million kcal] = \[\frac{\text{SEC}_{WP} \times \text{PE}_{WP}}{10^6} - \frac{\text{SEC}_{WP} \times \text{PI}_{WP}}{10^6}\] + \[\frac{\text{SEC}_{AP} \times \text{PE}_{AP}}{10^6} - \frac{\text{SEC}_{AP} \times \text{PI}_{AP}}{10^6}\] + \[\frac{\text{SEC}_{RP} \times \text{PE}_{RP}}{10^6} - \frac{\text{SEC}_{RP} \times \text{PI}_{RP}}{10^6}\]

Where,

- \(\text{PE}_{WP}\) is Total Export of the Wood Pulp (Tonne)
- \(\text{PI}_{WP}\) is Total Import of the Wood Pulp (Tonne)
- \(\text{PE}_{AP}\) is Total Export of the Agro Pulp (Tonne)
- \(\text{PI}_{AP}\) is Total Import of the Agro Pulp (Tonne)
- \(\text{PE}_{RP}\) is Total Export of the RCF Pulp (Tonne)
- \(\text{PI}_{RP}\) is Total Import of the RCF Pulp (Tonne)
- \(\text{SEC}_{WP}\) Total Specific Energy Consumption of saleable Wood Pulp in kcal/tonne
- \(\text{SEC}_{AP}\) Total Specific Energy Consumption of saleable Agro Pulp in kcal/tonne
- \(\text{SEC}_{RP}\) Total Specific Energy Consumption of saleable RCF Pulp in kcal/tonne

\(\text{SEC}_{WP}\), \(\text{SEC}_{AP}\) & \(\text{SEC}_{RP}\) will be calculated as per Sr. No 7.4 for Assessment and Baseline year.

### 7.2.3 Documentation
- Pulp sales Documents
- Pulp production documents [for e.g. Log sheets, DPR, MPR, Lab Report/register/ SAP Data]

### 7.3 Normalisation of Equivalent Product (Paper)

The pulp is further processed to prepare the paper. Various types of paper can be manufactured using the pulp and the specific energy consumption varies with product specific. The products considered for normalisation are:

- Writing Printing Paper
- Paper Board &kraft Paper
- Speciality Paper
- Newsprint
- Writing Printing Coated Paper
- Coated Board

#### 7.3.1 Normalization Methodology

Product mix, i.e., production of different grades of paper, where some products consume higher energy whereas other consume comparatively less, due to change in their quantities and ratios may change SEC in Assessment year with respect to Baseline year.

Normalisation will be done for all products mix manufactured by the DC in Assessment year. This will be based on the conversion of all products into the major product manufactured in the Baseline year.

The DC has to get a benefit for using high percentage of fillers and additives (precipitated calcium carbonate, PCC, or china clay etc.) in paper in the Assessment year as compared to the Baseline Year. Since increase in filler loading will result in higher production without addition of energy, therefore plant will get a benefit.

However in case of reduction in filler loading due to market demand for certain grades, and qualities, mill will have to bear and compensate the addition of energy itself.

i. Import of intermediary product for production of final product can happen along with export of intermediary product 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

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

The details of the calculations for equivalent product in the Baseline and Assessment year are given below.

7.3.2 Common Normalization formulae for all the product mix case combinations

- Baseline Major Product shall be considered as major product of Assessment year.

- The calculation of SEC of different grades of paper produced by a mill will consider the power and steam consumption in stock preparation, additives, paper machine, finishing house, and utilities.

- It will be assumed that there is no variation in specific energy of paper production in above unit operations, by using different types of pulps or their blends in different ratios.

7.3.3 Product Mix Calculation

To find out the Normalisation factor for product mix, it is necessary to determine the specific energy consumption (SEC) for production of different varieties of paper. After determination of the SEC for paper production, the equivalent paper product will be calculated. Therefore the calculation of the equivalent pulp product is determined in following steps as below.

- Calculation of Specific Energy Consumption for production of paper in the Baseline year and the Assessment year.

- Calculation product mix as equivalent major product in the Baseline and Assessment year.

7.3.4 SEC calculation for Baseline and Assessment Year

The calculation of SEC for WPP, paper board, specialty, newsprint, coated paper and board is presented in this section.

The SEC calculations for Writing Printing paper (WPP) (in terms of total kcal/tonne for steam–MP, LP and power consumption) will be calculated as below.

(a) SEC Calculation for Writing and Printing Paper Grades


\[ \text{Writing Printing Grade Paper Specific Steam Consumption-MP (kcal/Tonne)} = \left[ \frac{\text{MP-Steam Consumption for Writing Printing Grade (Tonne)}}{\text{Writing Printing Grade Production (Tonnes)}} \right] \times \text{Enthalpy of MP-Steam (kcal/kg)} \times 1000 \]

\[ \text{Writing Printing Grade Paper Specific Steam Consumption-LP (kcal/Tonne)} = \left[ \frac{\text{LP-Steam Consumption for Writing Printing Grade (Tonne)}}{\text{Writing Printing Grade Production (Tonnes)}} \right] \times \text{Enthalpy of LP-Steam (kcal/kg)} \times 1000 \]
Writing Printing Grade Paper Specific Energy Consumption for Power (kcal/Tonne) = \[\frac{\text{Power Consumption for Writing Printing Grade (kwh)}}{\text{Writing Printing Grade Production (Tonnes)}}\] \times \text{Heat Rate (kcal/kwh)}

(b) **SEC Calculation for Paper Board Grades**

\[
\text{SEC for Paper Board Grade (}\text{kcal/Tonne}) = \text{Paper Board Grade Paper Specific Steam Consumption-MP (kcal/Tonne) + Paper Board Grade Paper Specific Steam Consumption-LP + Paper Board Grade Paper Specific Energy Consumption for Power (kcal/Tonne)} \]

\[ (9.4.1 \text{ b}) \]

Where,

\[
\text{Paper Board Grade Paper Specific Steam Consumption-MP (kcal/Tonne) = } \frac{\text{MP-Steam Consumption for Paper Board Grade (Tonne)}}{\text{Paper Board Grade Production (Tonnes)}} \times \text{Enthalpy of MP-Steam (kcal/kg)} \times 1000
\]

\[
\text{Paper Board Grade Paper Specific Steam Consumption-LP (kcal/Tonne) = } \frac{\text{LP-Steam Consumption for Paper Board Grade (Tonne)}}{\text{Paper Board Grade Production (Tonnes)}} \times \text{Enthalpy of LP-Steam (kcal/kg)} \times 1000
\]

\[
\text{Paper Board Grade Paper Specific Energy Consumption for Power (kcal/Tonne) = } \frac{\text{Power Consumption for Paper Board Grade (kwh)}}{\text{Paper Board Grade Production (Tonnes)}} \times \text{Heat Rate (kcal/kwh)}
\]

(c) **SEC for Speciality Paper Grade**

\[

\[ (9.4.1 \text{ c}) \]

Where,

\[
\text{Speciality Paper Grade Paper Specific Steam Consumption-MP (kcal/Tonne) = } \frac{\text{MP-Steam Consumption for Speciality Paper Grade (Tonne)}}{\text{Speciality Paper Grade Production (Tonnes)}} \times \text{Enthalpy of MP-Steam (kcal/kg)} \times 1000
\]

\[
\text{Speciality Paper Grade Paper Specific Steam Consumption-LP (kcal/Tonne) = } \frac{\text{LP-Steam Consumption for Speciality Paper Grade (Tonne)}}{\text{Speciality Paper Grade Production (Tonnes)}} \times \text{Enthalpy of LP-Steam (kcal/kg)} \times 1000
\]

\[
\text{Speciality Paper Grade Paper Specific Energy Consumption for Power (kcal/Tonne) = } \frac{\text{Power Consumption for Speciality Paper Grade (kwh)}}{\text{Speciality Paper Grade Production (Tonnes)}} \times \text{Heat Rate (kcal/kwh)}
\]
(d) **SEC for News Print Grade**

\[
\text{SEC for News Print Grade (kcal/Tonne)} = \text{News Print Grade Paper Specific Steam Consumption-MP (kcal/Tonne)} + \text{News Print Grade Paper Specific Steam Consumption-LP} + \text{News Print Grade Paper Specific Energy Consumption for Power (kcal/Tonne)} \tag{9.4.1 d}
\]

Where,

\[
\text{News Print Grade Paper Specific Steam Consumption-MP (kcal/Tonne)} = \left[\frac{\text{MP-Steam Consumption for News Print Grade (Tonne)}}{\text{News Print Grade Production (Tonnes)}}\right] \times \text{Enthalpy of MP-Steam (kcal/kg)} \times 1000
\]

\[
\text{News Print Grade Paper Specific Steam Consumption-LP (kcal/Tonne)} = \left[\frac{\text{LP-Steam Consumption for News Print Grade (Tonne)}}{\text{News Print Grade Production (Tonnes)}}\right] \times \text{Enthalpy of LP-Steam (kcal/kg)} \times 1000
\]

\[
\text{News Print Grade Paper Specific Energy Consumption for Power (kcal/Tonne)} = \frac{\text{Power Consumption for News Print Grade (kwh)}}{\text{Paper Board Grade Production (Tonnes)}} \times \text{Heat Rate (kcal/kwh)}
\]

(e) **SEC for Writing Printing Coated Grade**

\[
\text{SEC for Writing Printing Coated Grade (kcal/Tonne)} = \text{Writing Printing Coated Grade Paper Specific Steam Consumption-MP (kcal/Tonne)} + \text{Writing Printing Coated Grade Paper Specific Steam Consumption-LP} + \text{Writing Printing Coated Grade Paper Specific Energy Consumption for Power (kcal/Tonne)} \tag{9.4.1 e}
\]

Where,

\[
\text{Writing Printing Coated Grade Paper Specific Steam Consumption-MP (kcal/Tonne)} = \left[\frac{\text{MP-Steam Consumption for Writing Printing Coated Grade (Tonne)}}{\text{Writing Printing Coated Grade Production (Tonnes)}}\right] \times \text{Enthalpy of MP-Steam (kcal/kg)} \times 1000
\]

\[
\text{Writing Printing Coated Grade Paper Specific Steam Consumption-LP (kcal/Tonne)} = \left[\frac{\text{LP-Steam Consumption for Writing Printing Coated Grade (Tonne)}}{\text{Writing Printing Coated Grade Production (Tonnes)}}\right] \times \text{Enthalpy of LP-Steam (kcal/kg)} \times 1000
\]

\[
\text{Writing Printing Coated Grade Paper Specific Energy Consumption for Power (kcal/Tonne)} = \frac{\text{Power Consumption for Writing Printing Coated Grade (kwh)}}{\text{Writing Printing Coated Grade Production (Tonnes)}} \times \text{Heat Rate (kcal/kwh)}
\]
(f) **SEC for Coated Board Grade**

\[
\text{SEC for Coated Board Grade (kcal/Tonne)} = \text{Coated Board Grade Paper Specific Steam Consumption-MP (kcal/Tonne)} + \text{Coated Board Grade Paper Specific Steam Consumption-LP} + \text{Coated Board Grade Paper Specific Energy Consumption for Power (kcal/Tonne)} \quad \text{---- (9.4.1 f)}
\]

Where,

\[
\text{Coated Board Grade Paper Specific Steam Consumption-MP (kcal/Tonne)} = \left(\frac{\text{MP-Steam Consumption for Coated Board Grade (Tonne)}}{\text{Coated Board Grade Production (Tonnes)}}\right) \times \text{Enthalpy of MP-Steam (kcal/kg)} \times 1000
\]

\[
\text{Coated Board Grade Paper Specific Steam Consumption-LP (kcal/Tonne)} = \left(\frac{\text{LP-Steam Consumption for Coated Board Grade (Tonne)}}{\text{Coated Board Grade Production (Tonnes)}}\right) \times \text{Enthalpy of LP-Steam (kcal/kg)} \times 1000
\]

\[
\text{Coated Board Grade Paper Specific Energy Consumption for Power (kcal/Tonne)} = \left(\frac{\text{Power Consumption for Coated Board Grade (kwh)}}{\text{Coated Board Grade Production (Tonnes)}}\right) \times \text{Heat Rate (kcal/kwh)}
\]

7.3.5 **Equivalent Product Calculations in Baseline Year**

Calculations of the equivalent product in Baseline and Assessment year will be as below.

a) **Equivalent product (paper) for baseline year will be calculated as below.**

\[
\text{Equivalent Product (Paper) for BY (Tonnes)} = \text{FPWP (CFWPBY x PWPBY)} + \text{FPPB (CFPBBY x PPBBY)} + \text{FPSP (CFSPBY x PSPBY)} + \text{FPNP (CFNPBY x PNPBY)} + \text{FPWPC (CFWPCBY x PWPCBY)} + \text{FPBC (CFCBBY x PCBBY)} \quad \text{---- (9.5.1)}
\]

Where,

\[
\begin{align*}
\text{FPWP} & = \text{Writing Printing Paper to Final Product} \\
\text{FPPB} & = \text{Paper Board to Final Product} \\
\text{FPSP} & = \text{Speciality Paper to Final Product} \\
\text{FPNP} & = \text{Newsprint to Final Product} \\
\text{FPWPC} & = \text{Writing Printing Coated paper to Final Product} \\
\text{FPBC} & = \text{Coated Board to Final Product} \\
\text{CFWPBY} & = \text{Conversion factor for writing printing paper in Baseline Year} \\
\text{CFPBBY} & = \text{Conversion factor for Paper Board & Kraft Paper in Baseline Year} \\
\text{CFSPBY} & = \text{Conversion factor for Speciality Paper in Baseline Year} \\
\text{CFNPBY} & = \text{Conversion factor for News Print in Baseline Year} \\
\text{CFWPCBY} & = \text{Conversion factor for Writing Printing Coated paper in Baseline Year} \\
\text{CFCBBY} & = \text{Conversion factor for Coated Board in Baseline Year} \\
\text{PWPBY} & = \text{Total Writing Printing Paper production}
\end{align*}
\]
in Baseline Year (Tonnes)

\[ PPBY = \text{Total Paper Board Paper production in Baseline Year (Tonnes)} \]

\[ PSPBY = \text{Total Speciality Paper production in Baseline Year (Tonnes)} \]

\[ PNPBY = \text{Total Newsprint paper production in Baseline Year (Tonnes)} \]

\[ PWPCBY = \text{Total Writing Printing Coated Paper production in Baseline Year (Tonnes)} \]

\[ PCBBY = \text{Total Coated Board Paper production in Baseline Year (Tonnes)} \]

7.3.5.1 Conversion Factors for Baseline Year will be calculated as below

(i) \[ CFWP_{BY} = \frac{\text{SEC for Writing Paper (BY)}}{\text{SEC of Major Product (BY)}} \] \hspace{1cm} (9.5.1 a)

(ii) \[ CFPB_{BY} = \frac{\text{SEC for Paper Board (BY)}}{\text{SEC of Major Product (BY)}} \] \hspace{1cm} (9.5.1 b)

(iii) \[ CFSP_{BY} = \frac{\text{SEC for Speciality Paper (BY)}}{\text{SEC of Major Product (BY)}} \] \hspace{1cm} (9.5.1 c)

(iv) \[ CFNP_{BY} = \frac{\text{SEC for News Print (BY)}}{\text{SEC of Major Product (BY)}} \] \hspace{1cm} (9.5.1 d)

(v) \[ CFWPC_{BY} = \frac{(\text{SEC of Major Product (BY)})}{\text{SEC for Writing Printing Coated Paper (BY)}} \] \hspace{1cm} (9.5.1 e)

(vi) \[ CFCB_{BY} = \frac{(\text{SEC for Coated Board (BY)})}{(\text{SEC of Major Product (BY)})} \] \hspace{1cm} (9.5.1 f)

7.3.6 Equivalent Product Calculations in Assessment Year (AY)

\[ \text{Equivalent Product (Paper) for AY (Tonnes)} = FP_{WP} \times (CFWP_{AY} \times PWP_{AY}) + FP_{PB} \times (CFPB_{AY} \times PPB_{AY}) + FP_{SP} \times (CFSP_{AY} \times PSP_{AY}) + FP_{NP} \times (CFNP_{AY} \times PNP_{AY}) + FP_{WPC} \times (CFWPC_{AY} \times PWPC_{AY}) + FP_{BC} \times (CFCB_{AY} \times PCB_{AY}) \] \hspace{1cm} (9.6.1)

Where,

\[ CFWP_{AY} = \text{Conversion factor for writing printing paper in Assessment Year} \]

\[ CFPB_{AY} = \text{Conversion factor for Paper Board & Kraft Paper in Assessment Year} \]

\[ CFSP_{AY} = \text{Conversion factor for Speciality Paper in Assessment Year} \]

\[ CFNP_{AY} = \text{Conversion factor for News Print in Assessment Year} \]

\[ CFWPC_{AY} = \text{Conversion factor for Writing Printing Coated paper in Assessment Year} \]

\[ CFCB_{AY} = \text{Conversion factor for Coated Board in Assessment Year} \]

\[ PWP_{AY} = \text{Total Writing Printing Paper production in Assessment Year (Tonnes)} \]
PPB_{AY} = \text{Total Paper Board Paper production in Assessment Year (Tonnes)}

PSP_{AY} = \text{Total Speciality Paper production in Assessment Year (Tonnes)}

PNP_{AY} = \text{Total Newsprint paper production in Assessment Year (Tonnes)}

PWPC_{AY} = \text{Total Writing Printing Coated Paper production in Assessment Year (Tonnes)}

PCB_{AY} = \text{Total Coated Board Paper production in Assessment Year (Tonnes)}

\textbf{7.3.6.1 Conversion Factors for Assessment Year}

The conversion factors for writing & printing paper, paperboard, specialty grades and newsprint in Assessment Year in Eq. 9.6.a will be calculated as shown below. Based on the product mix variation, there are two conditions for the calculations. These are 1) when the baseline production of the concerned product is zero and 2) when it is not zero.

\textbf{Condition\#1}– Applicable only in case concern production = 0, in this case the following conversion factors are considered. Otherwise the baseline conversion factor will be considered.

\( CFWP_{AY} = \frac{\text{SEC for Writing Paper (AY)}}{\text{SEC of Major Product (BY)}} \) \text{------(9.6.1 a)}

\( CFPB_{AY} = \frac{\text{SEC for Paper Board (AY)}}{\text{SEC of Major Product (BY)}} \) \text{------(9.6.1 b)}

\( CFSP_{AY} = \frac{\text{SEC for Speciality Paper (AY)}}{\text{SEC of Major Product (BY)}} \) \text{------(9.6.1 c)}

\( CFNP_{AY} = \frac{\text{SEC for News Print (AY)}}{\text{SEC of Major Product (BY)}} \) \text{------(9.6.1 d)}

\( CFWPC_{AY} = \frac{\text{SEC for Writing Printing Coated Paper (AY)}}{\text{SEC of Major Product (BY)}} \) \text{------(9.6.1 e)}

\( CFPC_{AY} = \frac{\text{SEC for Coated Board (AY)}}{\text{SEC of Major Product (BY)}} \) \text{------(9.6.1 f)}

\textbf{Condition\#2}– Applicable only in case baseline production of concern product \(\neq 0\). In this case baseline conversion factor will be considered.

\( CFWP_{AY} = \frac{\text{SEC for Writing Paper (BY)}}{\text{SEC of Major Product (BY)}} \) \text{------(9.6.1 g)}

\( CFPB_{AY} = \frac{\text{SEC for Paper Board (BY)}}{\text{SEC of Major Product (BY)}} \) \text{------(9.6.1 h)}

\( CFSP_{AY} = \frac{\text{SEC for Speciality Paper (BY)}}{\text{SEC of Major Product (BY)}} \) \text{------(9.6.1 i)}
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(vi) \[ CF_{CFCB}^{AY} = \frac{SEC \text{ for Coated Board (BY)}}{SEC \text{ of Major Product (BY)}} \] -----(9.6.1 l)

Major Product of Baseline year would be considered in the Assessment year for calculating Equivalent product in the assessment year. Major product could be from Wood, Agro or RCF pulp depending on Maximum production

AY: Assessment Year
BY: Baseline Year
SEC: Specific Energy Consumption

7.3.7 Documentation

• PCC/China clay /Additives -Purchase documents
• Filler and Additives stock and consumption documents [DPR, MPR, SAP data. Store Receipt etc.]
• Paper and paper board, Newsprint and specialty papers sale- Excise Documents
• Lab Report of Paper Quality testing [Ash contents/ GSM /Other parameters] to prove % filler addition and GSM variation in paper qualities.
• Paper production documents [for e.g. Log sheets, DPR. MPR, Lab Report/register/ SAP Data]

7.4 Fuel Quality of Coal in CPP & Co-Gen

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

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

The methodology should have provisions to take care of the impact of variations in coal quality. Therefore, average “Ash, Moisture, Hydrogen and GCV” contents in the coal during the baseline period as well as for assessment year is considered for Normalization and the correction factor has been worked out.

7.4.1 Coal Quality for CPP

The Boiler Efficiency will be calculated for the baseline as well as assessment year with the help of Coal analysis constituents like GCV, %Ash, %Moisture, %H and Boiler Efficiency Equation provided to calculate the Boiler efficiency.

Hence, by keeping the Turbine heat rate constant for both the years, the CPP heat rate will be calculated for the respective year. The Thermal Energy for the difference in heat rate of CPP will be deducted from the total energy consumption of the plant.
(i) Notional Thermal Energy to be deducted in the assessment year [Million kcal] = \([\text{CPP Heat Rate in AY (kcal/kwh)} - \text{Actual CPP Heat Rate in BY (kcal/kwh)}] \times \frac{\text{CPP Generation in AY (Lakh kwh)}}{10}\) \hspace{1cm} (10.1.1)

(ii) CPP Heat Rate in AY = CPP Heat Rate in BY x (Boiler Efficiency in BY / Boiler Efficiency in AY) \hspace{1cm} (10.1.1 a)

(iii) Boiler Efficiency in BY = 92.5 - \(\left\{\frac{50A+630 (M+9H)}{\text{GCV}}\right\}\) (Values are for baseline Year) \hspace{1cm} (10.1.1 b)

(iv) Boiler Efficiency in AY = 92.5 - \(\left\{\frac{50A+630 (M+9H)}{\text{GCV}}\right\}\) (Values are for assessment Year) \hspace{1cm} (10.1.1 c)

Where:

- CPP = Captive Power Plant
- THR = Turbine Heat Rate

\(A\): Ash in 
\(M\): Moisture in 
\(H\): Hydrogen in 
\(GCV\): Coal Gross Calorific Value in kcal/kwh

\(AY\): Assessment year
\(BY\): Baseline Year

7.4.2 Coal Quality for Cogen

The Boiler Efficiency will be calculated for the baseline as well as assessment year with the help of Coal analysis constituents like GCV, %Ash, %Moisture, %H and Boiler Efficiency Equation provided to calculate the Boiler efficiency.

(i) Boiler efficiency in baseline year (BY) = 92.5 - \(\left\{\frac{50A+630 (M+9H)}{\text{GCV}}\right\}\) \hspace{1cm} (10.2.1)

(ii) Boiler efficiency in assessment year (AY) = 92.5 - \(\left\{\frac{50A+630 (M+9H)}{\text{GCV}}\right\}\) \hspace{1cm} (10.2.2)

(iii) Weighted Percentage of Coal Energy Used in steam Generation (Process Boiler) in BY (Factor) = \(\frac{\sum_{n=1}^{16} \left\{\text{Operating Capacity of Process Boilers used for Steam generation in TPH} \times \text{Percentage of Coal Energy Used in steam Generation in all the boilers for Steam generation in %}\right\}}{\sum_{n=1}^{16} \text{Operating Capacity of Process Boilers used for Steam generation (TPH)}}\) \hspace{1cm} (10.2.3 a)

(iv) Weighted Percentage of Coal Energy Used in steam Generation (Process Boiler) in AY (Factor) = \(\frac{\sum_{n=1}^{16} \left\{\text{Operating Capacity of Boilers used for Steam generation in TPH} \times \text{Percentage of Coal Energy Used in steam Generation in all the boilers for Steam generation in %}\right\}}{\sum_{n=1}^{16} \text{Operating Capacity of Process Boilers used for Steam generation (TPH)}}\) \hspace{1cm} (10.2.3 b)

(v) Weighted Percentage of Coal Energy Used in steam Generation (Co-Gen Boiler) in BY = \(\sum_{n=1}^{12} \left\{\text{Operating Capacity of Boilers used for Steam generation in TPH} \times \text{Percentage of Coal Energy Used in steam Generation in all the boilers for Steam generation in %}\right\}\) / \(\sum_{n=1}^{12} \text{Operating Capacity of Boilers used for Steam generation (TPH)}\) \hspace{1cm} (10.2.4 a)
(vi) Weighted Percentage of Coal Energy Used in steam Generation (Co-Gen Boiler) in AY = \[\frac{\sum_{n=1}^{12} (\text{Operating Capacity of Boilers used for Steam generation in TPH} \times \text{Percentage of Coal Energy Used in steam Generation in all the boilers for Steam generation in } \%)}{\sum_{n=1}^{12} \text{Operating Capacity of Boilers used for Steam generation (TPH)}}\] ----(10.2.4 b)

(vii) Weighted Average Specific Steam Consumption in BY & AY (kCal/kg of Steam) = \[\frac{\sum_{n=13}^{16} (\text{Total Steam Generation in Process Boiler (Tonnes}) \times \text{Specific Energy Consumption for Steam Generation in Process Boilers (kcal/kg of steam}) + \sum_{n=1}^{12} (\text{Total Steam Generation in Co-Gen Boiler (Tonnes}) \times \text{Specific Energy Consumption for Steam Generation in Co-Gen Boiler (kcal/kg of steam})}{\sum_{n=1}^{16} \text{Steam generation in Co-gen + process boilers}}\] ----(10.2.5)

(viii) Normalized Specific Energy Consumption for Steam Generation (kCal/kg of Steam) = Weighted Average Specific Steam Consumption in BY \times (\text{Boiler efficiency in BY } \%)/\text{Boiler Efficiency in AY (\%)}) ----(10.2.6)

(ix) Difference in Specific Steam from BY to AY (kCal/kg of Steam) = Normalized Specific Energy Consumption for Steam Generation in AY (kcal/kg of steam) - Weighted Average Specific Steam Consumption in BY (kcal/kg of steam) ----(10.2.7)

(x) Energy to be subtracted w.r.t. Fuel Quality in Co-Gen (Million kCal) = Difference in Specific Steam from BY to AY (kcal/kg of steam) \times (\text{Total Steam Generation of all Process Boilers in AY (Tonnes}) \times \text{Weighted Percentage of Coal Energy Used in steam Generation (Process Boiler) in AY}) + (\text{Total Steam Generation at Co-Gen Boiler in AY (Tonnes}) \times \text{Weighted Percentage of Coal Energy Used in steam Generation (Co-Gen Boiler) in AY})/1000 ----(10.2.8)

Where:

A: Ash in %
M= Moisture in %
H= Hydrogen in %
GCV: Coal Gross Calorific Value in kcal/kwh
AY = Assessment year
BY = Baseline Year
CPP= Captive Power Plant
TPH=Tonnes Per Hour

7.4.3 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

7.4.4 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

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

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

\[
\%N_2 = 2.10 - 0.020VM
\]

Where

\(C\) = % of fixed carbon

\(A\) = % of ash

\(VM\) = % of volatile matter

\(M\) = % of moisture

### 7.5 Power Mix

#### 7.5.1 Power Mix Normalization for Power Sources

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.

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

\[
\text{TECPS}_{AY} x (A-\text{WHR}_{AY} - N-\text{WHR}_{AY})
\]

Where:-

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

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

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

\[
\text{N-WHR}_{AY} = \frac{A}{D/G} + \frac{B}{E/G} + \frac{C}{F/G}
\]

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 \(\text{PSiHR}_{AY} x (\text{PSiEC}_{BY/TEC}_{BY})\))
Normalisation Methodology for Pulp & Paper Sector

7.5.2 Power Mix Normalization for Power Export

Net Heat Rate of CPP to be considered for export of Power from CPP instead of 2717 kCal/kWh. Actual Generation Net 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 per following calculation.

(i) Notional energy for Power export to be subtracted in the assessment year [Million kcal] = \[\frac{(\text{EXP}_{\text{AY}} - \text{EXP}_{\text{BY}}) \times ([\text{GnNHR}_{\text{AY}}] - 2717)}{10}\]

Where:

- \(\text{GnNHR}_{\text{AY}}\): Generation Net Heat Rate for AY in kcal/kwh
- \(\text{EXP}_{\text{AY}}\): Exported Electrical Energy in AY in Lakh kwh
- \(\text{EXP}_{\text{BY}}\): Exported Electrical Energy in BY in Lakh kwh

7.5.3 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]

7.6 Normalisation Others

7.6.1 Environmental Concern ((Additional Environmental Equipment requirement due to major change in government policy on Environment)

7.6.1.1 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.

7.6.1.2 Methodology

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

- The Energy will be recorded for additional installation through separate Energy meter for the assessment year of from the date of commissioning in the assessment year.
- If separate energy meter installation is
not possible due to installation of the equipment such as Additional Field in the ESP or additional bags in the Bag House/Dust Collector in the existing one, then 80% of rated capacity will be converted in to Energy for Normalization.

- **Any additional equipment installed to come back within the Environmental standards as applicable in the baseline, will not qualify for this Normalization i.e., If any Plant after the baseline year has deviated from the Environmental Standards imposed in the baseline year and additional equipment are being installed after the baseline to come back within the Standards, then the plant is not liable to get the Normalization in this regard.**

- The Energy will be normalised for additional Energy consumption details from Energy meters. This is to be excluded from the input energy.

### 7.6.1.3 Notional Energy to be deducted to Environmental Concern

Additional Environmental Equipment requirement due to major change in government policy on Environment

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 normalized for additional Energy consumption details from Energy meters. This is to be excluded from the input energy as calculated below.

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

### 7.6.1.4 Documentation

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

### 7.6.2 Biomass/ Alternate Fuel Unavailability w.r.t Baseline Year

#### 7.6.2.1 Need for Normalization

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

The Biomass availability in the assessment year may decrease and in turn the plant is compelled to use Fossil fuel. Hence, the energy consumption of the plant may go up in the assessment year resulted into higher SEC. Normalization will take place if unavailability of Biomass or Alternate Fuel is influenced by the external factor not controlled by the Plant.

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

#### 7.6.2.2 Methodology

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