GHG emissions estimation from paper production

Report

Marcal Paper
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Executive summary

1. Objective

- Estimate GHG emissions per ton of paper manufactured using the New Tissue Technology (NTT) paper production process deployed at Marcal Paper facility in Natchez, Mississippi
- Compare results with GHG emissions from Through Air Drying (TAD) paper production process

2. Procedures Performed

- GHG emissions calculations were done based on GHG Protocol's principles, and the paper manufacturing machine was considered for the boundary.
- Actual plant data from Marcal's plant in Natchez as well as engineering data from the OEM were available for NTT, which were compared with the engineering data provided by the OEM for TAD.

3. Assumptions

- Data collected by Marcal's team for fuel and electricity usage is internally sourced and accurately reported to the best of their team's ability.
- Data shared by the original equipment manufacturer (OEM) is based on engineering test results and is accurate to the OEM's best ability.
- TAD data provided by the OEM is based on using virgin fiber as input, whereas the Natchez NTT plant uses 100% recycled fiber. Use of recycled fiber in TAD production would further increase its energy consumption due to its lower freeness value that impacts dewatering and offers greater resistance to air for drying.
- Emission factors considered for the TAD data are specific to the Natchez region to facilitate a meaningful comparison.
- Engineering results assume machines to be operating at 100% efficiency with continuous stock preparation and auxiliary systems; therefore, real-world energy consumption would be higher. Realistically, for towel grades, the average efficiency range of TAD machines is between 90-92% in the best case based on consultation with OEM. This study assumes an overall TAD machine efficiency of 92% in real-world.
- Efficiency of natural gas boiler is assumed to be 85%.
- The paper manufacturing machine was considered as the boundary for this comparison. Any processes upstream or downstream of this boundary have not been considered.
- It is assumed that the steam generated is from natural gas-fired boilers.
- Any form of waste heat recovery has not been considered for this analysis.

4. Relevant Documents

- Calculations – [Natchez Energy Consumption April 2023 to June 2023], [Natchez Energy Consumption April 3 through Current], [Utility Metrics for 2022 & Q1 2023], [2022 05 27 Soundview Technology Update], [2023 07 14 Energy figures KPMG]
- EPA GHG Emissions Factors Hub 2021
- eGRID 2020 Emissions Factors (released in January 2021)
- Global warming potentials – IPCC Sixth Assessment Report (AR6)

5. Guidance

- Product Life Cycle Accounting and Reporting Standard
- GHG Protocol Corporate Accounting and Reporting Standard
- GHG Protocol Scope 2 Guidance

6. Results

Analysis revealed that in comparison to the TAD process, the NTT process generates significantly fewer GHG emissions. **This difference in GHG emissions is in the range of 41-46% per ton of paper, with respect to the TAD process.** Refer pages 8-12 for complete details.

NTT and TAD process

NTT (New Textured Technology) and TAD (Through-Air Dried) are two paper production processes that differ in the way they achieve the desired texture and softness of the paper.

Aspect	NTT	TAD
Process	NTT process involves using a textured belt and a shoe press to create a higher density web, and remove water from the sheet	TAD process uses a textured fabric and a through air drying method to produce a paper product
Emissions Efficiency	Typically produces lower air/ GHG emissions because it uses less energy compared to traditional papermaking processes	Requires more energy for drying than other papermaking processes, which may contribute to higher GHG emissions and energy use.
Product Suitability	NTT paper has a smoother and less textured product	TAD has a more textured, higher bulk, and more absorption product

NTT machine

*Image sourced from Valmet's marketing materials

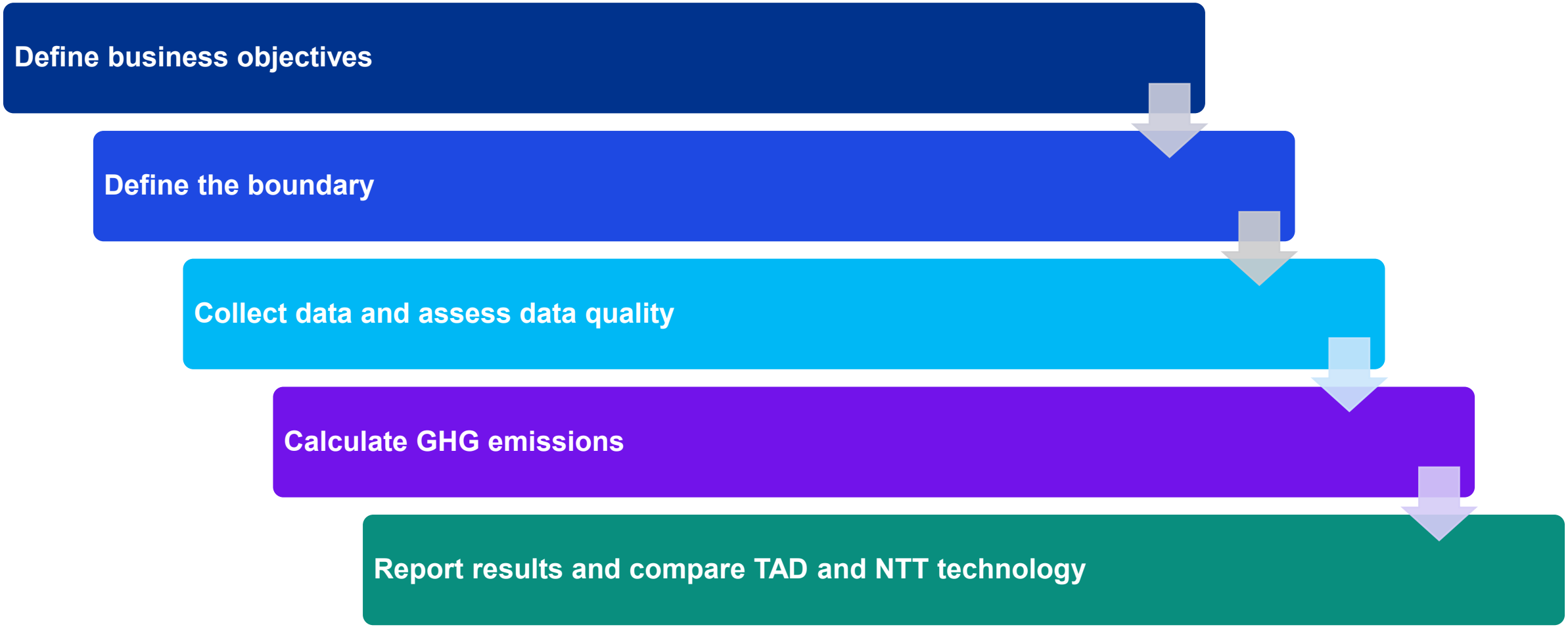
GHG Protocol is the primary guide for this assignment (1/2)

GHG emissions estimations have been informed by the GHG Protocol's guiding principles

GHG Principle	Definition	Application for this study
Relevance	**Use data, methods, criteria, and assumptions that are appropriate for the intended use of reported information**	Since the paper production process is responsible for a majority of emissions throughout the lifecycle of a paper product, and its drying process is the most energy-intensive stage, thus the **paper production process is considered as the boundary** for analysis. This includes emissions from the NTT and TAD machine process.
Completeness	**Consider all relevant information that may affect the accounting and quantification of GHG reductions and complete all requirements**	To align with this principle, this analysis **includes all emissions sources** within the boundary i.e., electricity, natural gas, and steam usage in the paper production process.
Consistency	**Use data methods, criteria, and assumptions that allow meaningful and valid comparisons**	For a consistent comparison, **similar boundary** has been considered for both the NTT and TAD processes. Additionally, **same source of supply and GHG emission factors** have been considered for consumption of electricity and fuels in the two processes.
Transparency	**Provide clear and sufficient information for reviewers to assess the credibility and reliability of GHG reduction claims**	Clear boundary conditions, assumptions, methodology, data sources, and emission factors have been disclosed to make the report transparent.
Accuracy	**Reduce uncertainties as much as is practical**	To reduce uncertainties and reflect seasonal variations, the NTT data for nine months (Jul'23 to March'24) has been extrapolated using last year's plant data. This was necessary because the NTT machine with diamond belt has only been operational since April '23 and plant data for a full year was not available.

GHG Protocol is the primary guide for this assignment (2/2)

Following steps have been adopted to undertake this project which are in line with the GHG Protocol on Product Life Cycle Accounting Reporting Standards



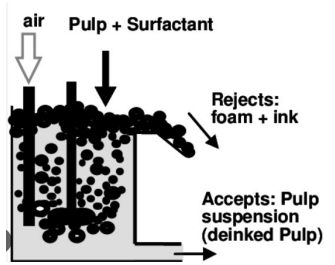
Boundary setting

Following is the papermaking process at Marcal's Natchez plant. **For this analysis, only the emissions associated with the paper machine process in both the NTT and TAD technologies are compared.** It is assumed that the other processes are similar for the two technologies.

Furthermore, during the lifecycle of paper products, the majority of environmental burdens can be attributed to the paper production process, with emissions ranging from 75.65% to 86.31% of total emissions.*

Boundary

Pulping and Screening → Flotation and Washing → Deinking of fiber → Paper production from pulp in the paper Machine → Converting → Finished goods to customer



Source: Marcal's internal documents

* Ta Thi, Y. & Thi Anh, T. (2020). Determination of life cycle GHG emission factor for paper products of Vietnam. Green Processing and Synthesis, 9(1), 586-594. https://doi.org/10.1515/gps-2020-0061

Methodology

Following is the methodology used to calculate the GHG emissions intensity

Calculation formula

GHG emissions intensity = $\sum_{i=1}^{n} Consumption\ intensity\ (i) * Emission\ factor\ (i)$

where:

Consumption intensity is amount of electricity, natural gas or any other fuel consumption per ton of production
Emission factor is the mass of CO_2, CH_4, or N_2O emitted per unit of consumption

Consumption intensity

- Electricity, steam, and natural gas consumption values have been taken from data provided by Marcal and OEM (Valmet).
- Steam is assumed to be produced from natural gas-fired boilers with an efficiency of 85% (no waste-heat recovery has been considered)

Emission factor for electricity

- Emission factor for electricity is sourced from the EPA eGRID2021.
- Emission factor of the Mississippi Valley / Eastern Power Grid (SMRV) has been used.
- Emission factor used is **772.7 lb CO_2eq / MWh.**

Emission factor for natural gas

- Emission factor for natural gas is sourced from US EPA Emission Factors Database
- Emission factor used is **53.12 kg CO_2eq / mmBtu** and **0.0545 kg CO_2eq / scf**

Data collected from the Natchez plant

April to June 2023 (Plant data)

Energy consumption from April 2023 to June 2023 was obtained from actual records of electricity and gas consumption in the boiler and hoods at the plant site.

		Plant data		
NTT Machine	**Units**	Apr-23	May-23	Jun-23
Electricity consumption intensity	kWh per ton	792	813	806
Gas consumption intensity	scf per ton	7,529	7,105	7,604

July 2023 to March 2024 (Estimated)

Energy consumption from July 2023 to March 2024 was estimated through extrapolation of April to June 2023 plant data using the previous year's trend to account for any potential seasonal variations.

		Estimated from historical data								
NTT Machine	**Units**	**Jul-23**	**Aug-23**	**Sep-23**	**Oct-23**	**Nov-23**	**Dec-23**	**Jan-24**	**Feb-24**	**Mar-24**
Electricity consumption intensity	kWh per ton	725	840	796	746	759	901	736	802	668
Gas consumption intensity	scf per ton	7,477	7,568	6,887	7,096	7,064	8,103	7,393	7,345	7,394

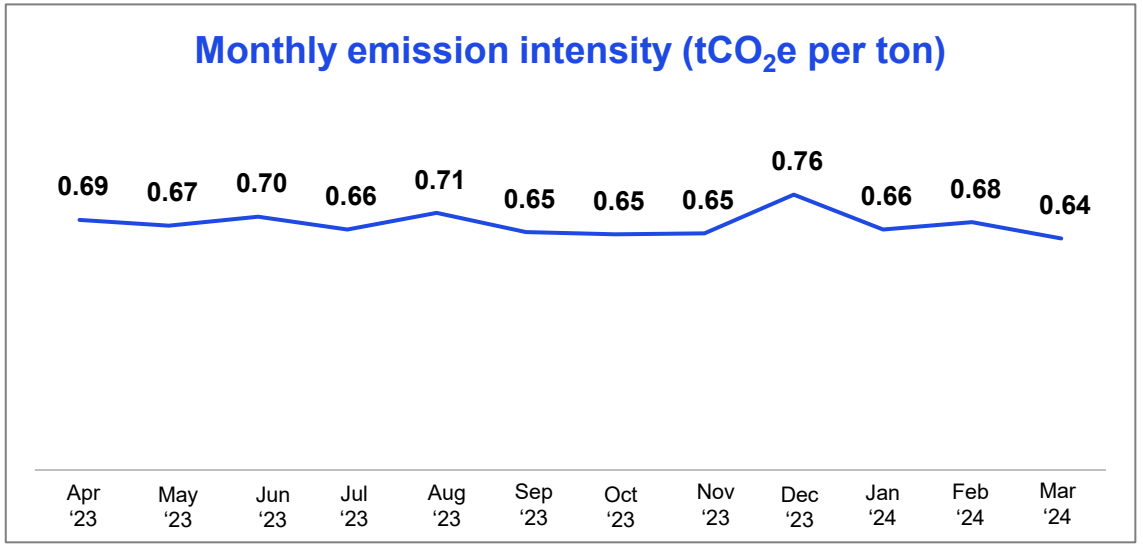
Source: Marcal's plant data records

GHG emissions from the paper production process at Natchez plant

Following is the monthly GHG emission intensity based on the data received from the plant and data that is extrapolated using the historical one-year data.

Months	Electricity consumption intensity (kWh per ton)	Gas consumption intensity (scf per ton)	GHG emissions intensity (tCO_2e per ton)
Apr-23	792	7,529	**0.69**
May-23	813	7,105	**0.67**
Jun-23	806	7,604	**0.70**
Jul-23	725	7,477	**0.66**
Aug-23	840	7,568	**0.71**
Sep-23	796	6,887	**0.65**
Oct-23	746	7,096	**0.65**
Nov-23	759	7,064	**0.65**
Dec-23	901	8,103	**0.76**
Jan-24	736	7,393	**0.66**
Feb-24	802	7,345	**0.68**
Mar-24	668	7,394	**0.64**
Annual Average	**782**	**7,380**	**0.68**

*blue highlighted cells indicate actual plant data



- The emission intensity observed over a period of 12 months ranges from 0.64 tCO_2e per ton to 0.76 tCO_2e per ton, with an **average of 0.68 tCO_2e per ton.**

Data received from OEM

Following are the emission intensities calculated for the NTT textured process and TAD process using the data provided by OEM (Valmet) based on engineering results, specifically for a 22-gram towel at 97% dryness.

NTT textured			
	Electricity	**Steam***	**Natural gas**
Consumption intensity	791 kWh per ton	624 kWh per ton	904 kWh per ton
Emission factor	772.7 lb/MWh	53.12 kg / mmBtu	53.12 kg / mmBtu
GHG emissions intensity		**0.57 tCO_2e per ton**	

TAD			
	Electricity	**Steam***	**Natural gas**
Consumption intensity	1,277 kWh per ton	391 kWh per ton	2,902 kWh per ton
Emission factor	772.7 lb/MWh	53.12 kg / mmBtu	53.12 kg / mmBtu
GHG emissions intensity		**1.06 tCO_2e per ton**	

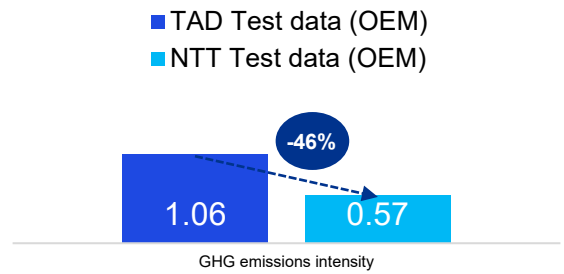
* When estimating the natural gas consumed to produce steam, an efficiency of 85% is assumed for natural gas boilers.

GHG emissions comparison | NTT vs TAD

Actual plant data from Marcal's plant in Natchez as well as engineering test data from OEM were available for NTT and were compared with the engineering test data provided by OEM for TAD. Results are as follows:

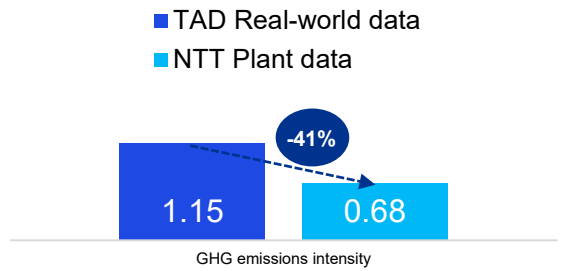
Scenario 1: NTT (test data) savings as % of TAD (test data)

Parameter	Units	NTT Test data (OEM)	TAD Test data (OEM)	NTT savings as % of TAD
Electricity consumption intensity	kWh per ton	791	1,277	38%
Gas consumption intensity	kWh per ton	1,638	3,362	51%
GHG emissions intensity	**tCO_2e per ton**	**0.57**	**1.06**	**46%**



Scenario 2: NTT (plant data) savings as % of TAD (real-world data*)

Parameter	Units	NTT Plant data	TAD Real-world data*	NTT savings as % of TAD
Electricity consumption intensity	kWh per ton	782	1,388	44%
Gas consumption intensity	kWh per ton	2,219	3,654	39%
GHG emissions intensity	**tCO_2e per ton**	**0.68**	**1.15**	**41%**



Analysis indicates that the NTT process produces fewer GHG emissions compared to the TAD process. This is primarily due to the need for less energy in NTT's drying process.

*Real-world data has been estimated by applying an average machine efficiency of 92% to the test data provided by the OEM (Valmet)