

Report

CRADLE to GATE CARBON FOOTPRINT ANALYSIS for CLOTH TAPE

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Prepared for:

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Executive Summary

Incorporated in 2011, GTG Manufacturing Sdn. Bhd. (GTG Manufacturing) is one of the leading manufacturing and supplier of adhesive tapes and stretch films in Malaysia. They strive to offer high quality products marketed worldwide such as in Americas, Africa, Asia, the Caribbean, Europe, the Ocean, and Middle East at competitive prices. The company is interested in assessing carbon emissions associated with its wide range of product as a key step towards a more cohesive environmental sustainability initiative.

GTG Manufacturing Sdn. Bhd has identified one of their products known as cloth tape to undergo carbon emissions assessment related to materials and energy consumption as well as transportation during the production process. The cloth tape or duct tape is made from woven polyester and cotton blended with LDPE which coated with Synthetic Rubber Adhesive which can be used in a variety of applications. The scope of the study is from cradle-to-gate and the production inventory data is collected and provided by GTC Manufacturing.

The Cloth Tape produced by GTG Manufacturing at the Semenyih manufacturing plant with a size of 46mm x 4.8m and weight of 70 gram has a carbon emission of 2.46 KgCO₂/kg based on cradle-to-gate assessment. Most of the carbon emission was emitted from the Winding process, contributing to 87.66% of the total emissions. At the same time, it should be noted that the product has a CFP value of 0.17 kgCO₂e/pc and 12.37 kgCO₂e/carton.

1. Introduction

GTG Manufacturing Sdn. Bhd. (GTG Manufacturing) was established on 15 November 2011 with the aim of supplying superior quality adhesive tape to their customers at competitive prices. Among the various types of self-adhesive tape that they provide to their customers in the form of jumbo rolls, log rolls or finished rolls include single sided tape such as OPP Packing Tape, Masking Tape, PVC Black Protection Tape, PVC Floor Marking Tape, PVC Insulation Tape, PE Protective Film, Cloth Duct Tape, Aluminium Foil Tape, Filament Tape, Teflon Tape, and others. They also supply double sided tape, acrylic foam tape, and protective film for application on various surfaces such as electronic device, injection moulding, automotive, construction glass, carpet, aluminium profiles, ceramic tiles etc.

A product known as cloth tape was identified for carbon emissions measurement as single indicator for environmental performance level of produced over the years. The results related to the designated product is anticipated to provide initial environmental information for potential environmental sustainability strategies, initiatives, and products improvements.

This assessment emphasises on carbon emissions contributed by all components used in making of cloth tape. In the selected cloth tape, the carbon impact associated with utilities such electricity and fuel consumption, transportation and waste generated for production was included. Details on this carbon emissions assessment are described in this report.

It should be noted that the CFP analysis presented in this report is based on the inventory data collected by GTG Manufacturing Sdn. Bhd. at their own factory in Semenyih, Selangor. The details information of the manufacturing plant is provided herewith.

Name of company and address	: GTG MANUFACTURNG SDN. BHD. NO 1, JALAN PLUMBUM 1/1, KAWASAN PERINDUSTRIAN SUNGGAI PURUN, 43500 SEMENYIH, SELANGOR, MALAYSIA
Production site and address	: Same as above
Name of contact person	: Mr. Steve Ong
Contact no	: +603-8725 9988, +6012-3246 908
Regulatory requirements for the operation	: Environment Quality Act 1974 Environmental Quality (Scheduled Wastes) Regulations 2005 Occupational Safety and Health Act (Use and Standards of Exposure of Chemicals Hazardous to Health) Regulations 2000
Information on environmental management system	: ISO 9001:2015 (Quality Management Systems) ISO 14001: 2015 (Environmental Management Systems)

2. General Description of Quantification Methodology

The carbon emissions quantification in this assessment adopts the general principle for product carbon foot-printing approach although it did not cover the complete life cycle phases. This assessment is tailored to the intention of GTG Manufacturing in focusing on the effect of all component used in product manufactured to carbon emissions value.

ISO 14044: Life Cycle Assessment (LCA) as the over-arching principle to evaluate the environmental burdens associated with a product, process or activity which includes the identification of energy, raw materials and substances used, emissions and wastes released to the environment over its life cycle. Riding on the principles of LCA, carbon foot-printing is introduced as method to assess single environmental impact category over a product's life cycle stages associating with raw materials used, design, production, transportation, use and its end-of-life (ISO 14067: 2018). Carbon-equivalent emission comprises of greenhouse gases (GHGs) emissions. The GHGs, mainly carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) are accounted to derive the carbon equivalent emission factors using 100-year GWP coefficients, IPCC Fourth Assessment Report: Climate Change 2007.

The carbon quantification considers the first two phases of the LCA concept, i.e., goal and scope definition and life cycle inventory (LCI) analysis and excludes the life cycle impact assessment (LCIA) and results interpretation phases. The quantification coverage is specified through a system boundary from where the assessment indicates whether it is a segmented quantification, a partial-life cycle, or a complete life cycle quantification. This assessment is a segmented carbon emissions measurement based on the system boundary set to meet the intended goal of the assessment. Within the set boundary, there are two (2) different sources of data required, primary data and secondary data. In principle, primary data shall be collected as site specific data or foreground data. Whereas secondary data are data gathered from published sources (LCI databases, LCA journals, web-publication, etc) for related environmental emissions coefficients (emission characterisation factors) as well as measures to fill data gaps in primary data. The quantified carbon value also depends on the availability of the LCI datasets and options available to choose from. Any data gaps, limitations and assumption are reported as quantification barriers.

3. Goal and Scope of Study

3.1. Goal

The goal of this assessment is to quantify the carbon emissions associated with Cloth Tape manufactured by GTG Manufacturing Sdn. Bhd. at their manufacturing facility located in Semenyih, Selangor. The assessment aims to support GTG Manufacturing's initial exercise in product's

environmental performance evaluation. The results will be used for future planning, strategy, and environmental sustainability initiatives in GTG Manufacturing's business activities.

3.2. Scope

The scope of this assessment is determined from cradle-to-gate.

Details of the assessment's scope are described further in each section below.


3.3. Functional Unit

The functional unit (FU) for carbon emission measurement are defined as quantity of greenhouse gases (GHGs) generated per kilogram of product or per one unit of product based on all component consumption for Cloth Tape.

3.4 Product System Assessed

The product system selected by GTG Manufacturing for GHG assessment in this study is Cloth Tape. Brief product information is provided below.

Table 1: Specification of Cloth Tape

Specification	Descriptive Information
Pictorial Impressions (Photo)	
Product features	Made of Woven Polyester and Cotton blended with LDPE & Coated with synthetic rubber adhesive.
Application	Generally, use in patching, bundling, reinforcing taping/ splicing insulation, capping pipe, protecting against light sandblast overspray, packaging, sealing, repairing, carpet joining, marking & labelling.
Product sizes	46mm x 4.8m

	Weight: 70 gram
Shelf life	12-month storage at 23°C and 65% Relative Humidity.

3.5. Process Map and System boundary for Quantification

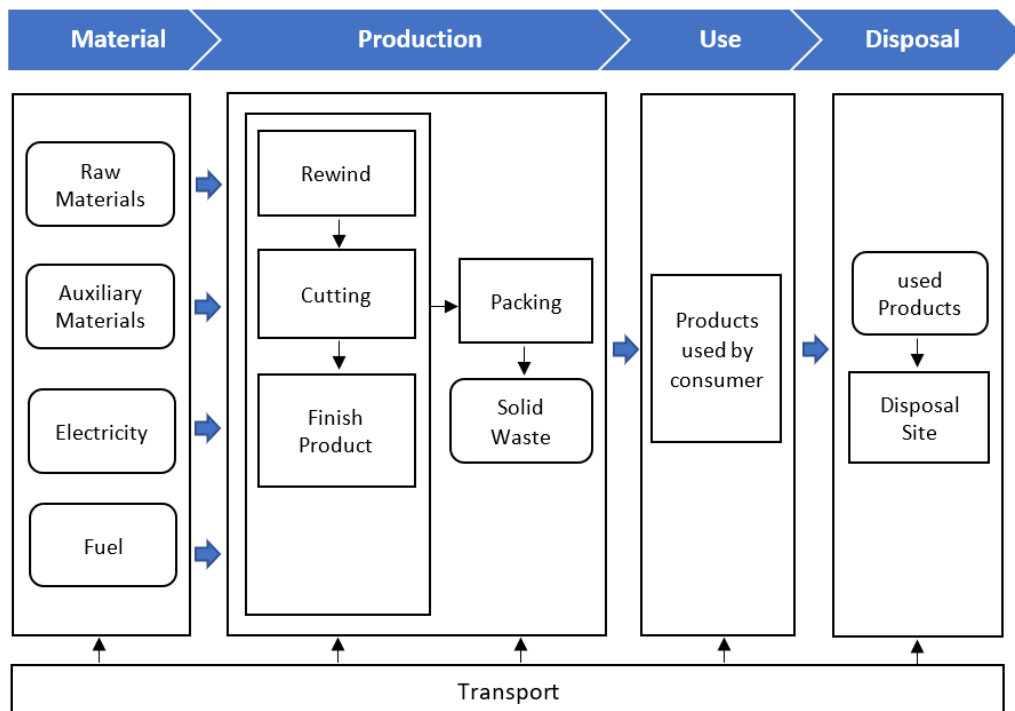


Figure 1: Generic process map for Cloth Tape

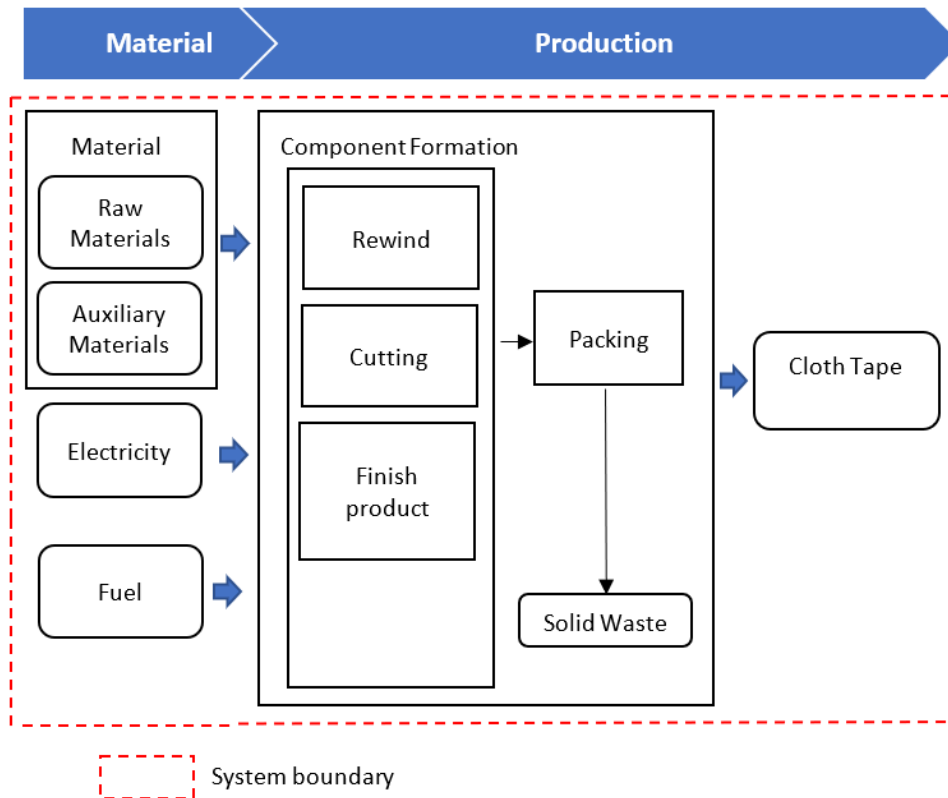


Figure 2: Process map together with its system boundary for Cloth Tape

3.6. Data coverage period.

The site-specific data covers from 1 January 2020 – 31 December 2020 (12 months' reference for the inventory data collection).

3.7. Cut-off Rules.

Cut-off rules are not applied in this assessment because GTG Manufacturing has provided sufficient primary data and the associated background data used for calculation are available in the database.

3.8 Allocation Procedures

According to ISO 14044:2006 (E), allocation is defined as a procedure of partitioning the input or output flows of a process to the product system under study.

GTG Manufacturing plant produces a variety of tape models by sharing the process flow and energy consumption. The energy consumption i.e., electricity and diesel for a model of Double-sided tapes have been partitioned for each model based on the product output mass ratio.

3.9 Data Requirement and Data Quality

Primary / Foreground Data: Site data as primary data source relevant to the products, appropriately collected and compiled by data owner. Site data are actual data obtained from various data owner in the product's life cycle phases. In cases where actual measured data are not available or too complex for collection, substitutes data through theoretical calculation and estimates are acceptable with consideration on their level of accuracy. Details on the site-specific data are further incorporated in the section onwards.

Secondary / Background Data: Secondary data are data information of characterisation factors (carbon emission factors, EFs) as well as product related data deemed appropriate for filling in any possible data gaps found in primary data. For the characterization factors, the data information normally is sourced from the following:

- Malaysia Life Cycle Inventory Database (MYLCID)
- Commercial databases (GaBi, EcoInvent, etc.)
- Published journals and articles

Available EFs used in the carbon quantification are tabulated herein. Wherever there are no EFs listed for data items, it is understood that no carbon emissions being accounted for in association with the respective data items. This data gap(s) therefore would affect the quantified results; i.e reduced carbon value due to data gaps. This data gap situation is further addressed under the 'Limitations and Assumptions' section.

Table 2: Summary of carbon emission factors and sources.

Data Item	Material Type	Emission Factor, EF (kg CO ₂ e per kg item; unless otherwise specified)			
		Value	unit	EF Source	EF Description
Jumbo Cloth Type	Polyethylene film	2.3725	kg	GABI Prof DB	RER: polyethylene film (PE-LD)
	Sealing	1.9477	kg	Ecoinvent	DE, Natural rubber-based sealing, at plant
	PE/PET bico fiber	4.3134	kg	GABI Prof DB	EU-27, Polyethylene terephthalate fibres (PET)
Paper core	Paper core	0.4850	kg	Ecoinvent	Paper core board, at plant
Paper	ECF Wood pulp	0.2677	kg	GABI Prof DB	SE, Sulphate pulp softwood bleached

Fuel	Fuel combustion	3.1863	kg	IPCC	Gas/ diesel oil
	Fuel production	0.3711	kg	MYLCID	MY, diesel (from crude oil consumption mix, at refinery 500 ppm sulphur)
Electricity	Electricity	0.8900	kWh	MYLCID	MY, Electricity grid mix (Peninsular Malaysia)
Lorry 20t	Lorry	0.1845	tkm	Ecoinvent	RER, Lorry 16-32t Euro 3
Ship	Ship	0.0107	tkm	Ecoinvent	OCE, Transoceanic freight ship
Shrink pack	Plastic production	2.3848	kg	GABI Prof DB	DE, polyvinylchloride granulate mix (S-PVC)
Stretch film	Plastic Production	2.6906	kg	Ecoinvent	RER, Packaging film, LDPE, at plant

3.10 Limitations and Assumptions

It is inevitable that some limitations and assumptions need to be made to address data gaps or irregularities (involving both primary and secondary data) to close the quantification process. Listed below are the limitations and assumption observed in the assessment.

Limitations:

- Transportation used for purchased fuel is modelled within 10 km from petrol station to the factory
- Transoceanic freight ship for transported the raw material from China to Malaysia are modelled from the Shanghai Port of China to North Port of Malaysia
- Transoceanic freight ship for transported the raw material from Singapore to Malaysia are modelled from Port of Singapore to North Port of Malaysia.
- Transoceanic freight ship for transported the raw material from India to Malaysia are modelled from Jawaharlal Nehru Port of India to Northport of Malaysia.
- Land transport for transported the raw material are modelled based on EURO 3 Lorry with 16-32t.
- Transported material only considered for one single trip
- Capacity load of transported material are modelled based on the total weight of material used in the production stage.

- Carbon emission of the paper waste and plastic waste is about 1% are excluded from the study due to the contribution less than 5%

Assumptions:

- Selection of EFs available in the referenced LCI databases is based on their closeness to the description on material types, chemical groupings, processes, etc, of the data items provided by GTC Manufacturing
- Density of diesel was assumed at 0.85 kg/L for the conversion of diesel from L to kg.
- Transoceanic freight ship estimated for every 1 nautical mile is equal to 1.852 km land distance

4. Life Cycle Inventory Analysis

The summary of input output site-specific data for production of Cloth Tape by GTG Manufacturing plant is shown in Table 3.

Table 3: Input-Output Flow of Cloth Tape

Input – Output Flow					
Input			Output		
Material	Quantity	Unit	Material	Quantity	Unit
Jumbo Cloth Tape	100.3	Roll	Cloth Tape	5932	Ctns
Paper Core	20480	Roll	Paper waste	146.8	kg
Shrink Pack	31	Roll	Plastic waste	240.1	kg
Stretch film	203	Roll			
Paper	6544	Ctns			
Electricity	7359.31	kWh			
Fuel	393.03	L			

Information on the transportation of materials from the source location to the manufacturing site or disposal location is shown in Table 4.

Table 4: Site-specific data for Transportation of Cloth Tape production by GTG Manufacturing

Material	Source location	Transport mode	Manufacturing/ disposal location
Jumbo Cloth Tape	China	Ship and Lorry	Manufacturing in Semenyih
	Singapore		
	India		

Paper core	Sungai Buloh, Malaysia	Lorry	
Shrink pack	China	Ship and Lorry	
Stretch film	Batu Pahat, Malaysia	Lorry	
paper	Kajang, Malaysia		
Paper waste	Semenyih, Malaysia	Lorry	Disposal Facility in Kajang
Plastic waste			

5. Results and discussion

The details of CFP profiles for one-year Cloth Tape production are shown in Table 5.

Table 5: Carbon emission for Cloth Tape Production

<i>Item</i>	<i>Carbon Emission (kgCO₂e/year)</i>	<i>Percentage (%)</i>
Winding process	64,312.93	87.66
Cutting process	1,571.95	2.14
Packing process	7,480.70	10.20
Total of carbon Emission of Cloth Tape	73,365.58	100

Based on the result shown in the table 5 above, the Winding process with a carbon emission of 64312.93 kg CO₂e which is equivalent to about 88% is the major contributor to the total carbon emissions, followed by the Packing process which emit about 7480.70 kg CO₂e representing about 10% as the second higher and lastly the Cutting process is about 1571.95 kg CO₂e which is equivalent about 2%.

The results of total carbon emissions to produce Cloth Tape are illustrated in Figure 3.

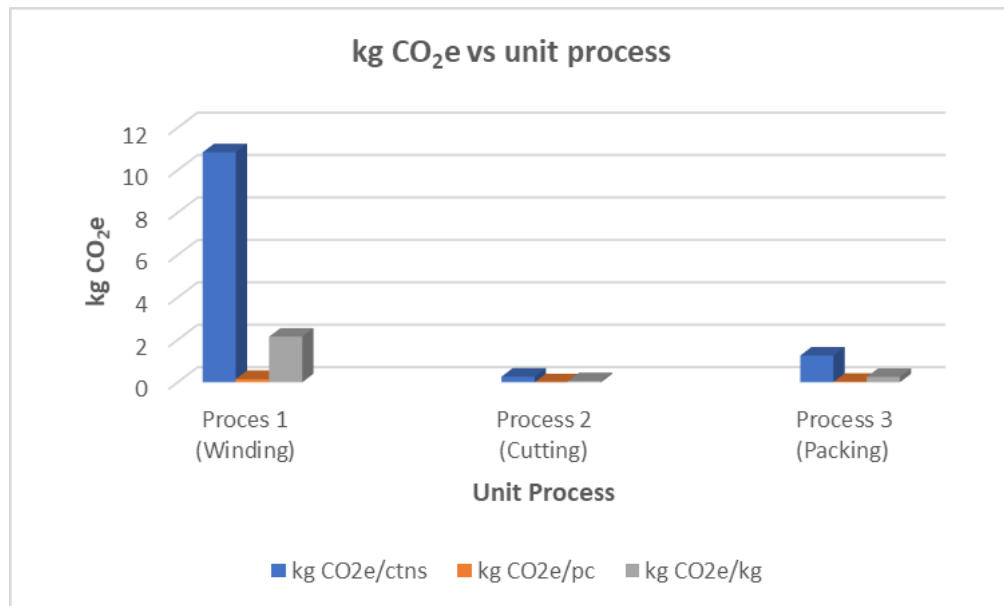


Figure 3: Contribution of carbon emissions for each unit process

The total one-year production of Cloth Tape by GTG Manufacturing are shown in Table 6.

Table 6: Total production of one-year Cloth Tape

Item	Unit	Value
Total Cotton of Cloth Tape	Carton (ctns)	5932
Total piece of Cloth Tape	Piece (pc)	427,104
Total weight of Cloth Tape	kg	29897.28

Based on the information of one-year total production of Cloth Tape, the carbon emissions of the product have been calculated according to their relevant units as shown in Table 7.

Table 7: final carbon emission quantification for Cloth Tape production

Item	kgCO ₂ e/ctns	kgCO ₂ e/pc	kgCO ₂ e/kg
Carbon Emission of Cloth Tape	12.37	0.17	2.46

The total carbon emissions of the product are calculated further in terms of its materials and energy consumption for each unit process as summarized in Table 8. The summarized table shows that the Winding process is a major contributor to the total carbon emissions which mostly come from

consumption of raw materials with only a small portion of electricity consumption and transportation of raw materials.

Table 8: Summary of CFP profiles for Cloth Tape

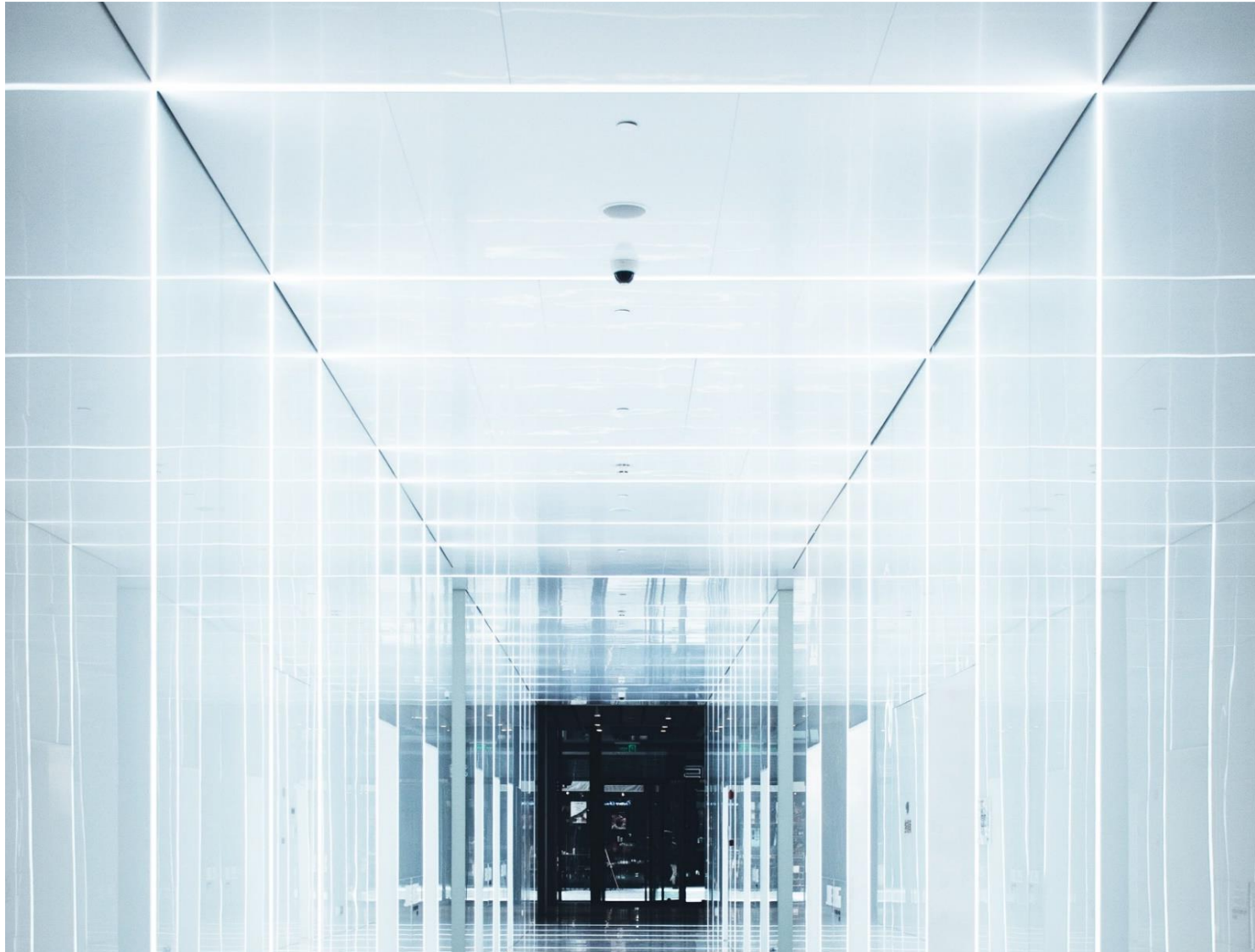
Unit Process/ Component	kgCO ₂ /CTNS	KgCO ₂ /pc	KgCO ₂ /kg	%
Winding	10.842	0.151	2.152	87.66
Material	10.261	0.143	2.036	82.96
Electricity	0.265	0.004	0.053	2.14
Transportation	0.316	0.004	0.063	2.55
Cutting	0.265	0.004	0.053	2.14
Electricity	0.265	0.004	0.053	2.14
Packing	1.260	0.018	0.251	10.19
Material	0.479	0.007	0.095	3.87
Electricity	0.574	0.008	0.114	4.64
Transportation	0.200	0.003	0.040	1.62
Fuel	0.007	0.0001	0.002	0.06
TOTAL	12.367	0.173	2.456	100

6. Conclusion

The Cloth Tape produced by GTG Manufacturing at the Semenyih manufacturing plant with a size of 46mm x 4.8m and weight of 70 gram has a carbon emission at 2.46 KgCO₂e per kg of calculated product based on cradle-to-gate assessment. Most of the carbon emission was emitted from the Winding process, contributing approximately 88% of the total emissions. Simultaneously, it should be noted that the calculated product has a CFP value of 0.17 kgCO₂e per pc and 12.37 kgCO₂e per carton.

7. References

- [1] International Standard ISO 14067: 2018; Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification-Principles and Framework.
- [2] Intergovernmental Panel on Climate Change, 2006 IPCC Guidelines for National Greenhouse Gas Inventories.



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