

Report

CRADLE to GATE CARBON FOOTPRINT ANALYSIS for OPP 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 **OPP Tape** to undergo carbon emissions assessment related to the use of materials and energy consumption as well as transportation during the production process. The **OPP Tape** are manufactured from high quality Polypropylene Random Copolymer resins. Its physical and chemical properties make **OPP Tape** a versatile tape in a wide range of applications in different industries. The scope of the study is from cradle-to-gate and the production inventory data is collected and provided by GTC Manufacturing.

The OPP Tape produced by GTG Manufacturing at the Semenyih manufacturing plant with a 48mm x 58m size holds a carbon footprint (CFP) value of 2.013 kgCO₂e/kg for a cradle-to-gate assessment. Most of the carbon emission are emits from the Winding process which accounts almost 93.67 % of the total emissions which are mostly derived from the use of materials. At the same time, it should be noted that the product has a CFP value of 0.321 kgCO₂e/roll and 30.933 kgCO₂e/CTNS.

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.

SIRIM has been approached by GTG Manufacturing to conduct Carbon Footprint (CFP) analysis for their product namely **OPP Tapes**. The **OPP Tapes** are manufactured from high quality Polypropylene Random Copolymer resins. Its physical and chemical properties make OPP Tape a versatile tape in a wide range of applications in different industries. The CFP assessment for **OPP Tape** has been conducted based on lifecycle inventory data from GTG Manufacturing's product manufactured 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 SUNGAI 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 different types of material used in product components 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 **OPP Tape** manufactured by GTG Manufacturing Sdn. Bhd. At their manufacturing facility 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. Function of the product

The function of this product is to seal heavy -duty cartons, industrial packaging, product packaging and packaging purposes.

3.4. Functional unit

The functional unit for the study is defined as quantity of greenhouse gases (GHGs) generated per kilogram of product (kgCO₂e/kg).

3.5. Product System Assessed

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



Figure 1: Photo of OPP Tape

Table 1: Specification of OPP Tape

Product features	Biaxially oriented Polypropylene film coated with water based acrylic adhesive.
Application	Commonly used for heavy-duty carton sealing, industrial packaging as well as product bundling and wrapping purposes.
Product sizes	48mm x 58m Paper core size: 76mm <i>*contact sales representative for available sizes</i>
Shelf life	12 month storage at 23°C and 65% Relative Humidity.
Weight	160 gram
Size	48mm X 58m
Packing	96 roll/CTNS

3.6. Process Map and System boundary for Quantification

GTG Manufacturing's **OPP Tape** are manufactured through a winding process. The unit processes involved are shown in Figure 2.



Figure 2: Process flow within the manufacturing plant of GTG Manufacturing

The description of the three (3) main unit processes are stated below:

- i. Winding process
The bulk jumbo rolls are wound to form log rolls.
- ii. Cutting process
The log rolls are cut into specific sizes of rolls as per customer requirement.
- iii. Packing process
The specific sized products are wrapped and packed into cartons to be stored in the warehouse

The process map together with its system boundary for the life cycle of **OPP tape** is illustrated in Figure 3 below. Since the scope of the study is from cradle-to-gate, only raw material extraction phase and product manufacturing phase were involved in the CFP study. Whereas, use phase and end-of-life phase were excluded in this study. The process map of the Double-sided tape is summarized and presented in Figure 2. The red dotted indicates the system boundary for this CFP analysis based on cradle-to-gate approach.

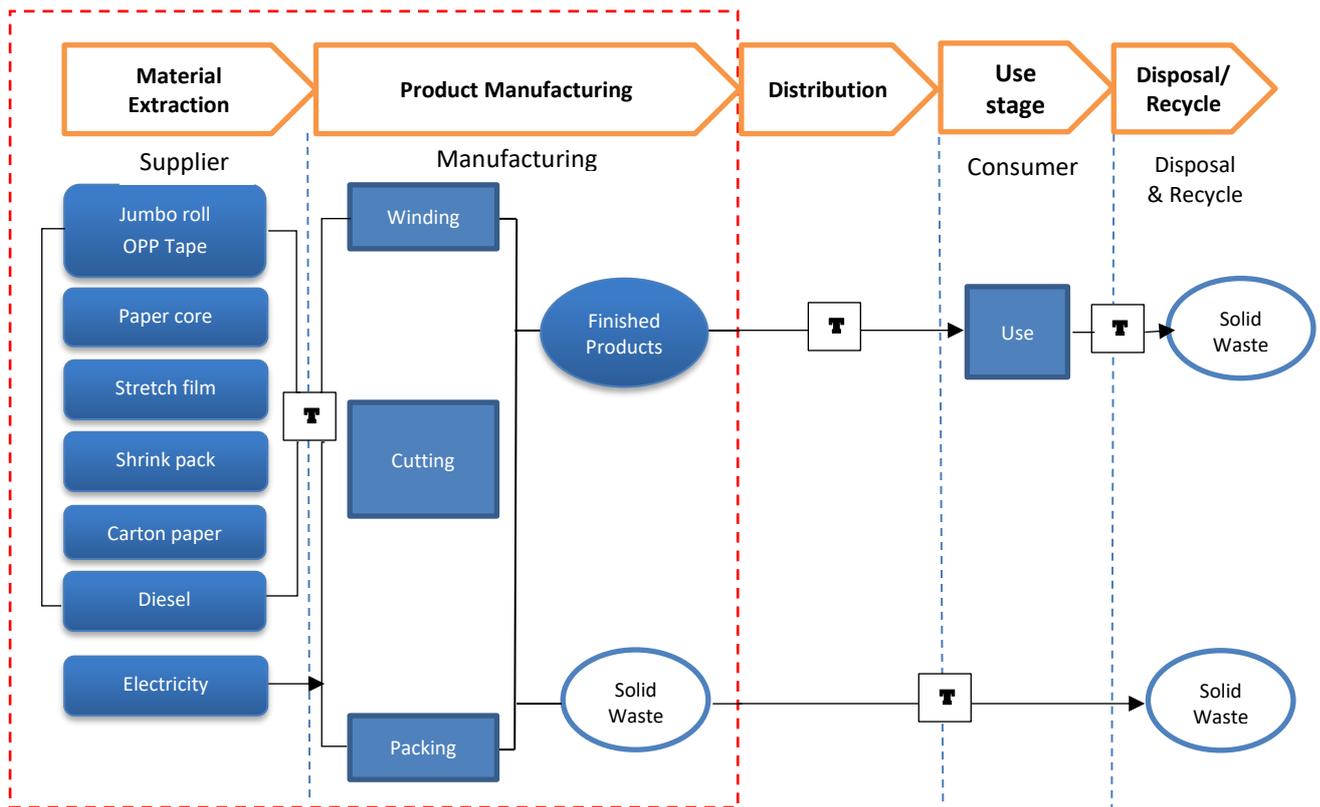


Figure 3: Process map together with its system boundary for OPP Tape

3.7. Data coverage period

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

3.8. Cut-off Rules

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

3.9. Allocation Procedures

According to ISO 14044:2006 I, 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 by sharing the process flow and energy consumption. The energy consumption i.e., electricity and diesel have been partitioned for each model based on product output ratio.

3.10. 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 (kgCO ₂ e per kg item, unless otherwise specified)			
		Value	unit	EF Source	EF Description
Biaxially Oriented Polypropylene Film	Butyl acrylate	4.335	kg	ecoinvent	Butyl acrylate, at plant
	2-hydroxyethyl acrylate	3.092	kg	ecoinvent	Methyl acrylate, at plant
	Ammonium hydroxide	2.682	kg	ecoinvent	Ammonium sulphate, as N, at regional storehouse
	Acrylic acid	2.258	kg	ecoinvent	Acrylic acid, at plant
	2A1 emulsifier (sodium sulphate)	0.095	kg	MYLCID	sodium chloride (rock salt) (mining production mix, at factory)
	Ammonium persulfate	2.682	kg	ecoinvent	Ammonium sulphate, as N, at regional storehouse
	Ammonium bicarbonate	1.546	kg	ecoinvent	Ammonium carbonate, at plant
	Water	0.21	m ³	SIRIM database	Treated water supply
Paper core	Paper core board	0.485	kg	ecoinvent	Paper core board, at plant
Shrink pack	PVC	2.384	kg	GABI	polyvinylchlorides granulate mix (S-PVC)

Stretch film	LDPE	2.690	kg	ecoinvent	Packaging film, LDPE, at plant
Carton paper	Paper board	0.485	kg	ecoinvent	Corrugated board (technology mix production mix, at factory 18% primary fibre, 82% recycled fibre)
Electricity	-	0.89	kWh	MYLCID	Electricity grid mix (Peninsular Malaysia)
Diesel	Diesel	0.3711	kg	MYLCID	Diesel (from crude oil consumption mix, at refinery 500 ppm sulphur)
Diesel	Diesel	3.186	kg	IPCC	Gas/ diesel oil
Lorry	-	0.184	t.km	ecoinvent	Lorry 16-32t EURO 3/RER
Lorry	-	0.483	t.km	ecoinvent	Lorry 3.5-7.5t EURO 3/RER
Ship	-	0.0106	t.km	ecoinvent	Transoceanic freight ship/OCE

3.11. 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:

- The carbon emissions from the manufacturing of OPP jumbo roll at the supplier factory are not considered in the calculation due to the difficulty of obtaining the inventory data of the process.

Assumptions:

- Density of diesel was assumed at 0.85 kg/L for the conversion of diesel from L to kg.
- Mode of marine transport were assumed as transoceanic freight ship/OCE for the marine transportations of jumbo rolls from China, Singapore, and India to Port Klang.
- Port of departure in China, Singapore and India were assumed as Port of China (Shanghai), Port of Singapore (Jurong) and Port of India (Calcutta) for the marine transportations of jumbo rolls to Port Klang. Port distances are measured in nautical miles (nm), where 1nm equals to 1.852km.
- Carton paper is sourced from a supplier in Semenyih, the same location as the factory, the distance for transportation is assumed as 10km.

4. Life Cycle Inventory Analysis

The site-specific inventory data for CFP quantification purposes are provided in this section. All on-site data is collected and compiled by GTG Manufacturing using a Product data sheet (PDS) template provided by SIRIM. The summary of input output data for production of OPP Tape is shown in Table 3.

Table 3: Input-output flow of OPP Tape.

Input – Output Flow					
Input			Output		
Material	Quantity	Unit	Material	Quantity	Unit
Butyl acrylate	112726.60	kg	OPP Tape	18254	CTNS
2-hydroxyethyl acrylate	2552.30	kg	Plastic waste	705	Kg
Ammonium hydroxide	2126.91	kg	Paper waste	383	kg
Acrylic acid	1276.15	kg			
2A1 emulsifier (sodium sulphate)	1276.15	kg			
Ammonium persulfate	425.38	kg			
Ammonium bicarbonate	212.69	kg			
Water	92095.50	kg			
Paper core	73818	pcs			
Electricity	18449.95	kWh			
Shrink pack (PVC)	327	roll			
Stretch film (LDPE)	970	roll			
Carton paper	19994	CTNS			
Diesel	1115.21	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: Information on the transportation of materials.

Material	Source location	Transport mode	Manufacturing/ disposal location
Biaxially Oriented Polypropylene Film	China	Ship 30-tonne lorry	GTG Manufacturing
Paper core	Sungai Buloh	20-tonne lorry	GTG Manufacturing
Diesel	Semenyih	3-tonne lorry	GTG Manufacturing
Stretch film	Batu Pahat	30-tonne lorry	
Shrink pack	China	Ship 30-tonne lorry	GTG Manufacturing
Carton paper	Kajang	30-tonne lorry	GTG Manufacturing
Plastic waste	GTG Manufacturing	26-tonne lorry	Kajang
Paper waste	GTG Manufacturing	26tonne lorry	Kajang

5. Results and discussion

The detailed of CFP profiles for OPP Tape manufactured in GTG Manufacturing plant in Semenyih are summarized in Table 5.

Table 5: Summary of CFP profiles for OPP Tape.

Unit Process/ Component	kgCO ₂ e/CTNS	KgCO ₂ e/roll	KgCO ₂ e/kg	%
Winding	28.974	0.301	1.886	93.67
Material	28.746	0.299	1.871	92.93
Electricity	0.216	0.002	0.014	0.70
Transport	0.012	0.0001	0.0008	0.04
Cutting	0.216	0.002	0.014	0.70
Electricity	0.216	0.002	0.014	0.70
Packing	1.743	0.018	0.113	5.64
Material	1.079	0.011	0.07	3.49
Electricity	0.468	0.005	0.03	1.51
Transport	0.012	0.0001	0.0008	0.04
Fuel	0.185	0.002	0.012	0.60
TOTAL	30.933	0.321	2.013	100

*Note: All processes have accounted the transportation data.

It is noticeable that winding process (93.67 %) contributes the main contribution to the total CFP profile during the manufacturing stage, followed with packing (5.64 %) and cutting (0.70 %) respectively. Referring to the winding process, most of the CFP value is contributed by material consumption, and only a small part of the CFP value is contributed by electricity and transport.

Based on the tabulated figures above, the CFP value information can be translated as 30.933 kgCO₂e/CTNS, 0.321 kgCO₂e/roll, and 2.013 kgCO₂e/kg. The summary of the CFP profiles for OPP Tape is illustrated in Figure 4.

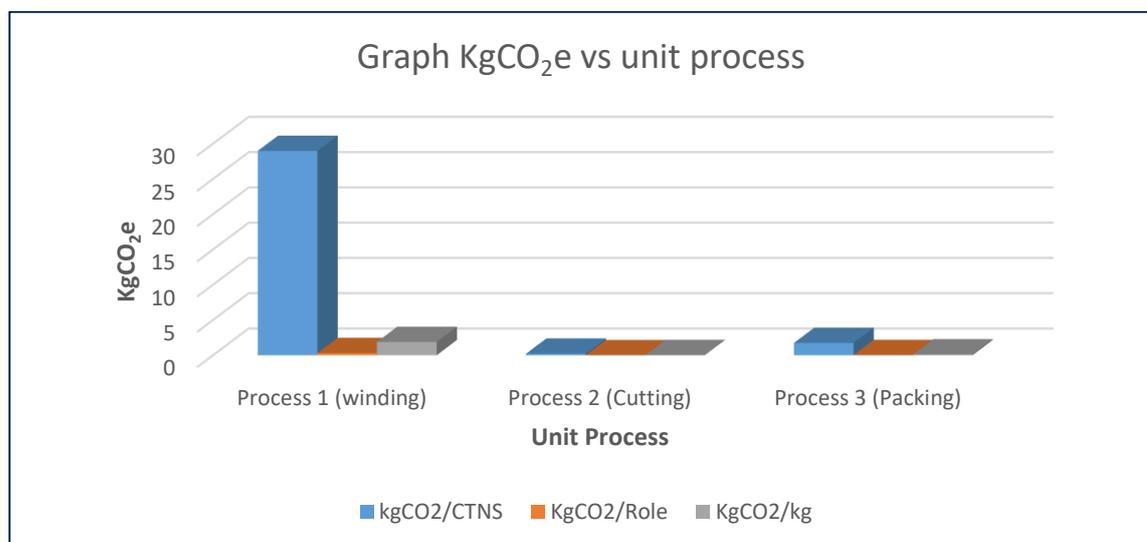


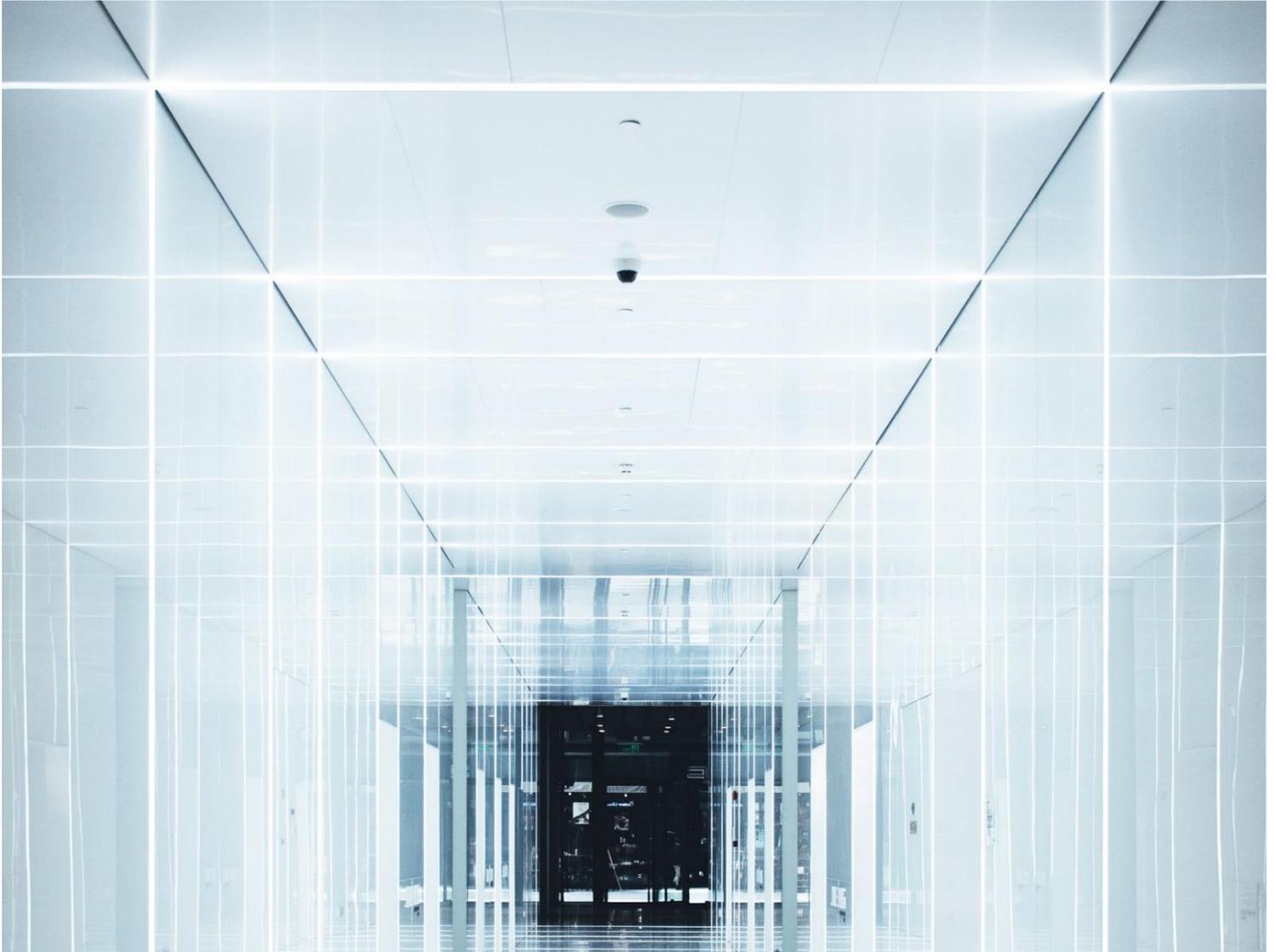
Figure 4: Contribution of carbon emissions for each unit process.

6. Conclusion

The OPP Tape produced by GTG Manufacturing at the Semenyih manufacturing plant with a 48mm x 58m size holds a carbon footprint (CFP) value of 2.013 kgCO₂e/kg for a cradle-to-gate assessment. Most of the carbon emission are emits from the Winding process which accounts almost 93.67 % of the total emissions which are mostly derived from the use of materials. At the same time, it should be noted that the product has a CFP value of 0.321 kgCO₂e /roll and 30.933 kgCO₂e/CTNS.

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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