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Report

CRADLE to GATE CARBON FOOTPRINT ANALYSIS for PVC 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.

The ***PVC tapes*** is featured as a premium grade LLDPE stretch wrap film. The products are to be applied for consolidate the pallet loads boxes or bundling small items for efficient handling and storage to ensure safe and secure delivery of packages. The scope of the study is from cradle-to-gate and the production inventory data is collected and provided by GTG Manufacturing.

GTG Manufacturing has identified one of their products known as ***PVC Tapes*** to undergo carbon emissions assessment related to the use of materials and energy consumption as well as transportation during the production process. The ***PVC Tapes*** is a premium grade polyvinyl chloride film coated with natural rubber adhesive. The application of the product is for insulating, tabbing and wrapping of electric wire or cables under 600V and 80^{o}C. The scope of the study is from cradle-to-gate and the production inventory data is collected and provided by GTG Manufacturing.

The cradle-to-gate carbon footprint (CFP) results for the PVC tapes of four variants namely PVC Black Tape, PVC Insulation Tape, PVC Automotive Wire Tape and PVC Floor Marking Tape manufactured by GTG at their manufacturing facility in Semenyih are 0.294 kgCO_2e/kg, 1.323 kgCO_2e/kg, 0.640 kgCO_2e/kg and 0.600 kgCO_2e/kg respectively.

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 ***PVC tapes***. The ***PVC tapes*** is used for insulating, tabbing, and wrapping the electric wire or cables under 600V and 80^{o}C. The CFP assessment for ***PVC tapes*** 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.

Referring to ISO I4044, 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 (CO_2), methane (CH_4) and nitrous oxide (N_2O) 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 ***PVC tapes*** manufactured by GTG Manufacturing Sdn. Bhd. at their manufacturing facility located at 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 the ***PVC tapes*** is for insulating, tabbing, and wrapping the electric wire or cables under 600V and 80°C.

3.4. Functional unit

The functional unit for the study is defined as quantity of greenhouse gases (GHGs) generated per kilogram of specific-type of ***PVC tapes***.

3.5. Product System Assessed

Four ***PVC tapes*** model have been selected by GTG Manufacturing for this GHG assessment. Brief product information is provided below.

Table 1: Information on the system assessed of PVC Tape

Item	*PVC Tape*	
Photo		
Product variants	1) PVC Black Tape 2) PVC Insulation Tape 3) PVC Automotive Wire Tape 4) PVC Floor Marking Tape	
Materia type	Polyvinyl Chloride (PVC)	
Weight per piece (g)	PVC Black Tape	31
	PVC Insulation Tape	33
	PVC Automotive Wire Tape	107
	PVC Floor Marking Tape	267
Shelf life	12 months storage at 23°C and 65% relative humidity	
Product characteristic	• Good thermal and electrical insulator and well adaption in sudden change of temperature • Well conformable on applications due to strong tack adhesive	

	• Provides high resistance to UV rays, abrasion, moisture, alkalis, acids, corrosion and varying weather conditions • Multicolour properties tend to indicate the voltage level and different phase of the wires

3.6. Process Map and System boundary for Quantification

There three (3) main unit processes involved in PVC tape production as stated below:

i. Winding process

The bulk rolls are winded 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 as indicated in dotted line for the life cycle of PVC tape is illustrated in Figure 1 below. Since the scope of the study is from cradle-to-gate, only emissions assocaited with the raw material acquisition and production stages including the transportation of materials and supplies were involved in the assessment. Whereas, use phase and end-of-life phase were excluded.

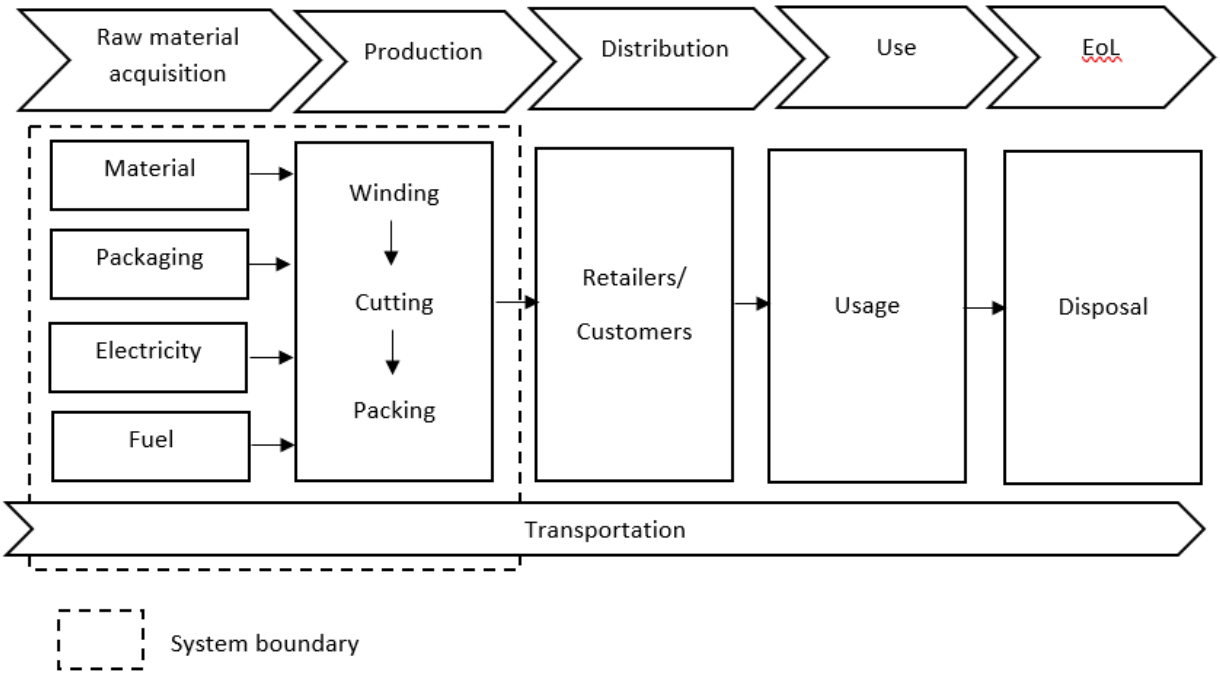

Figure 1: Process map together with its system boundary for PVC Tape.

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 sufficient primary data and the associated background data used for calculation are available in the database.

3.9. Allocation Procedures

Allocation is not applicable in this assessment as the product system involves a single product (not involving multiple products or co-products).

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.)
- Intergovernmental Panel on Climate Change (IPCC)
- 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)*			
		Value	*unit*	*EF Source*	*EF Description*
PVC log/ Shrink pack	Polyvinylchloride	2.3848	$kgCO_2e/kg$	GaBi/SIRIM KK	granulate mix (S-PVC)
Paper core	Paper	0.4850	$kgCO_2e/kg$	ecoinvent/SIRIM KK	core board, at plant
Plastic core/ Stretch film	Plastic	2.6905	$kgCO_2e/kg$	ecoinvent/SIRIM KK	packaging film, LDPE, at plant
Carton	Corrugated paper	1.3832	$kgCO_2e/kg$	MYLCID	technology mix/production mix, at factory | 18% primary fibre, 82% recycled fibre
Electricity	Electricity	0.89	$kgCO_2e/kWh$	MYLCID	grid mix (peninsular Malaysia)
Diesel (production)	Fuel	0.3711	$kgCO_2e/kg$	MYLCID	diesel (from crude oil, consumption mix, at refinery | 500 ppm sulphur)
Diesel (combustion)	Fuel	3.1863	$kgCO_2e/kg$	IPCC	gas/diesel oil
Lorry (3 tonne)	Transportation	0.4833	$kgCO_2e/t.km$	ecoinvent/SIRIM KK	lorry 3.5-7.5t EURO 3/RER
Lorry (20 tonne)	Transportation	0.18450	$kgCO_2e/t.km$	ecoinvent/SIRIM KK	lorry 16-32t EURO 3/RER
Ship	Transportation	0.01068	$kgCO_2e/t.km$	ecoinvent/SIRIM KK	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:

- Input data for rubber adhesive was not provided, hence not accounted in the calculations

Assumptions:

- Transportation:
  - For land transport, lorry 16-32 Tonnage EURO 3 is assumed for transporting of raw materials from its source location to the manufacturing site.
  - For marine transport, transoceanic freight ship/OCE is assumed for transporting of jumbo rolls from China, Singapore and India to Port Klang.

- Distance travelled for transporting PVC log rolls to Port Klang, Malaysia using transoceanic freight ship:
  - From China (unspecified port): 4348.05 km
  - From Singapore (unspecified port): 315.07 km
  - From India (unspecified port): 3839.16 km
- Distance travelled for transporting log rolls from Port Klang is estimated at 70 km.
- Distance travelled for transporting carton (paper) sourcing location from Kajang is estimated at 27.7 km.
- Distance travelled for transporting stretch film (LDPE) from Batu Pahat, Johor is estimated at 208.6 km.
- Diesel is sourced from a supplier in Semenyih, the same district as the factory, the distance for transportation is assumed as 10 km.

- Density of diesel is taken at 0.849kg/L
- Due to a very minimal contribution, waste input is not considered in this assessment

4. Life Cycle Inventory Analysis

The site-specific inventory data for quantification purposes are provided in this section. The summary of input output data for production of PVC Tape by GTG Manufacturing plant is shown in Table 3 below.

Table 3: Input-Output Data for the Production of PVC Tape.

Input		
Process 1: Winding		
Data Item	*Quantity*	*Unit*
PVC tape (Log roll)	29843	kg
Paper core	1321	kg
Plastic core	27.90	kg
Electricity	647.91	kWh
Process 2: Cutting		
Data Item	*Quantity*	*Unit*
Electricity	647.91	kWh
Process 3: Packing		
Data Item	*Quantity*	*Unit*
Carton (paper)	826	kg
Shrink pack	87	kg
Stretch film	244	kg
Electricity	1404	kWh
Diesel	130	L

Output		
Product		
Data Item	*Quantity*	*Unit*
PVC Black Tape	2842	kg
PVC Insulation Tape	12788	kg
PVC Automotive Wire Tape	6188	kg
PVC Floor Marking Tape	5799	kg

Information on the transportation of production materials from the source location to the transit site/ factory site are shown in Table 4.

Table 4: Transportation of Production Materials

Material	*Source location*	*Transport mode*	*Transit site/factory site*
Paper core	Sg. Buloh	20 tonne lorry	Factory site
PVC log **Ratio from sourcing location:* *China (80%)* *Singapore (10%)* *India (10%)*	Port of China	Marine transport mode, Transoceanic freight ship/OCE	Port Klang
	Port of India	Marine transport mode, Transoceanic freight ship/OCE	Port Klang
	Port of Singapore	Marine transport mode, Transoceanic freight ship/OCE	Port Klang
	Port Klang	30 tonne lorry	Factory site
Carton	Kajang	30 tonne lorry	Factory site
Diesel	Semenyih	3 tonne lorry	Factory site
Shrink pack	Port of China	Marine transport mode, Transoceanic freight ship/OCE	Port Klang
	Port Klang	30 tonne lorry	Factory site
Stretch Film	Batu Pahat	30 tonne lorry	Factory site

5. Results and discussion

The carbon emission profiles for CFP analysis of the ***PVC tapes*** are tabulated in Table 5 below.

Table 1: Profiles of CO_2 Emissions for the Production of stretch films

Model/ Unit Process		*kgCO_2e/ctns*	*KgCO_2e/roll*	*KgCO_2e/kg*
PVC Black Tape		**1.948**	**0.081**	**0.294**
	Raw material	*1.829*	*0.076*	*0.276*
	Packaging material	*0.050*	*0.002*	*0.008*
	Electricity	*0.059*	*0.002*	*0.009*
	Fuel	*0.010*	*0.0004*	*0.001*
PVC Insulation Tape		**20.511**	**0.041**	**1.323**
	Raw material	*19.259*	*0.039*	*1.242*
	Packaging material	*0.526*	*0.001*	*0.034*

	Electricity	*0.624*	*0.001*	*0.040*
	Fuel	*0.102*	*0.0002*	*0.007*
PVC Automotive Wire Tape		**10.565**	**0.021**	**0.640**
	Raw material	*9.920*	*0.020*	*0.601*
	Packaging material	*0.271*	*0.001*	*0.016*
	Electricity	*0.322*	*0.001*	*0.019*
	Fuel	*0.053*	*0.0001*	*0.003*
PVC Floor Marking Tape		**3.082**	**0.064**	**0.600**
	Raw material	*2.894*	*0.060*	*0.563*
	Packaging material	*0.079*	*0.002*	*0.015*
	Electricity	*0.094*	*0.002*	*0.018*
	Fuel	*0.015*	*0.0003*	*0.003*

**Note: Results includes emission from transportation*

Based on the functional unit identified in this CFP study, it is noticeable that PVC Insulation Tape has the highest CFP value with 1.323 $kgCO_2e/kg$, followed by PVC Automotive Wire Tape, PVC Floor Marking Tape, and PVC Black Tape with carbon emission of 0.640 $kgCO_2e/kg$, 0.600 $kgCO_2e/kg$, and 0.294 $kgCO_2e/kg$, respectively.

In general, raw material is the major contribution (93.89%) to the total CFP profile for the manufacturing of all models of ***PVC tapes***, followed with electricity (3.04%), packaging material (2.57%), and fuel (0.50%).

Based on the tabulated figures above, the CFP value information can also be translated as:

- 1.948 $kgCO_2e$/ctns and 0.081 $kgCO_2e$/roll for PVC Black Tape.
- 20.511 $kgCO_2e$/ctns and 0.041 $kgCO_2e$/roll for PVC Insulation Tape.
- 10.565 $kgCO_2e$/ctns and 0.021 $kgCO_2e$/roll for PVC Automotive Wire Tape.
- 3.082 kgCO2e/ctns and 0.064 $kgCO_2e$/roll for PVC Floor Marking Tape.

Based on the tabulated figures above, the CFP value information can also be translated as:

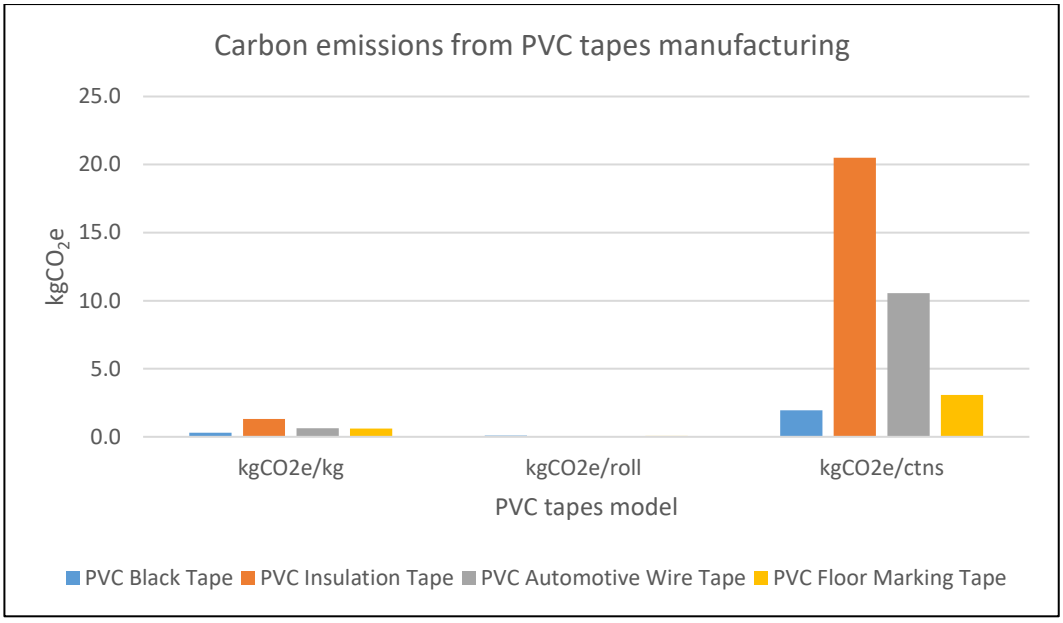

Figure 2: CFP profiles for PVC tapes model

6. Conclusion

The cradle-to-gate carbon footprint (CFP) results for the PVC tapes of four variants namely PVC Black Tape, PVC Insulation Tape, PVC Automotive Wire Tape and PVC Floor Marking Tape manufactured by GTG Manufacturing at their manufacturing facility in Semenyih are 0.294 $kgCO_2e/kg$, 1.323 $kgCO_2e/kg$, 0.640 $kgCO_2e/kg$ and 0.600 $kgCO_2e/kg$ respectively.

At the same time, it should be noted that the product has a CFP value of 1.948 $kgCO_2e/ctns$ and 0.081 $kgCO_2e/roll$ for PVC Black Tape, 20.511 $kgCO_2e/ctns$ and 0.041 $kgCO_2e/roll$ for PVC Insulation Tape, 10.565 $kgCO_2e/ctns$ and 0.021 $kgCO_2e/roll$ for PVC Automotive Wire Tape, and 3.082 $kgCO_2e/ctns$ and 0.064 $kgCO_2e/roll$ for PVC Floor Marking Tape.

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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