SECTORAL GUIDELINE ON PRODUCT CARBON FOOTPRINT PROCESS

SOLAR PV MANUFACTURING

USAID RFP INVEST 117 - RESEARCH AND ADVISORY SUPPORT TO STRENGTHEN THE INSTITUTIONAL INFRASTRUCTURE FOR CARBON LABELING IN VIETNAM

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CONTENTS

ABBREVIATIONS

AD	Activity data
BOD	Biogenic Oxygen Demand
CFC	Chlorofluorocarbon
CH4	Methane
COD	Chemistry Oxygen demand
EF	Emission factor
GLO	Global
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbons
IPCC	Intergovemental Panel on Climate Change
PCF	Product Carbon footprint
RfC	Request for Certification
ROW	Rest of the World

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DEFINITIONS

Table 1: Terms and definitions

Term	Definition
Activity data	A quantitative measure of a level of activity that results in GHG emissions.
Allocation Emission Co-Products (AEC)	This method refers to the process of allocating the environmental impact to other products that are associated with the production of the main product of interest.
Avoided carbon / Avoided GHG emissions	Avoided emissions are emission reductions that occur outside of a product's life cycle or value chain, but because of the use of that product. Examples of products that avoid emissions include low-temperature detergents, fuel-saving tires, energy-efficient ball bearings, and teleconferencing services.
Biogenic carbon / Carbon dioxide	Biogenic carbon is the carbon stored in biological materials. Biogenic carbon dioxide (CO_2) is emitted from (non-fossil fuel) biological processes, such as combustion of biogas.
Carbon dioxide equivalent (CO_2e)	Unit for comparing the radiative forcing of a greenhouse gas (GHG) to that of carbon dioxide (CO_2).
Co-product	Any of two or more products resulting from the same process or product system which cannot be produced without the other being produced, and which have a market value.
Data quality indicator (DQI)	An assigned indicator of the data quality of each activity data and each Emissions factor.
Global warming potential (GWP)	Factor used to describe the radiative forcing of a greenhouse gas relative to that of CO_2.
Greenhouse gas (GHG)	Gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the earth's surface, the atmosphere, and clouds.
Input allocation	Allocation of inputs (including materials, energy, etc.) to a product level.
Output allocation	Allocation of outputs to a product level, e.g., between co-products.
Primary data	Quantified value of a process or an activity obtained from a direct measurement, or a calculation based on direct measurements at its original source.
Product	A good or a service.
Product consistency criteria (PCC)	Set of specific requirements and guidelines for quantification of and communication on the carbon footprint for one or more product categories. This is also referred to as a 'Product Environmental

	Footprint Category Rule' under the EU's Product Environmental Footprint legislation[1].
Product carbon footprint (PCF)	The sum of greenhouse gas emissions and removals related to a product.
Recycling allocation	Allocation of the benefits of recycling between products using recycled materials and products that are recycled to provide those materials.
Secondary data	Quantified value of a process or an activity obtained from sources other than a direct measurement, or a calculation based on direct measurements at its original source.
Stock keeping unit (SKU)	A distinct sales unit consisting of relevant characteristics of a product (e.g., product type, material, size, packaging, etc.).

[1] In December 2021, EU adopted a recommendation on the use of product environmental footprint category ruel as part of the environmental footprint calculations. More information on this rule can be found here - Environmental Footprint methods - European Commission (europa.eu).

1. INTRODUCTION

This document provides instructions for how to develop a carbon footprint for products within the solar PV manufacturing sector. It is designed to provide step-by-step instructions for Vietnamese organizations that wish to estimate the greenhouse gas (GHG) emissions of a product's value chain, including the production of input materials, manufacture of the product itself, use and transportation of the product, and end-of-life disposal.

The document must be used along with the following product carbon footprint (PCF) calculation tool and PCF technical guidance:

- ***PCF Data Collection and Calculation Toolkit***[2] Organizations can use the toolkit to calculate carbon footprints for products in solar PV manufacturing and other carbon-intensive sectors. Using the tool helps standardize the PCF process and reduce the cost and complexity of carbon footprinting. The Toolkit can be accessed here: http://rcee.org.vn/en/document.
- ***Technical Guidance for Vietnamese Industries on How to Conduct a Product Carbon Footprint (PCF).*** The guidance provides a general framework and instructions for how to collect the appropriate data and calculate a product carbon footprint using internationally recognized GHG accounting standards. The guidance is designed to be sector-agnostic and provide a high-level understanding of terminology, methods, resources, and processes for preparing a PCF. The document can be accessed here http://rcee.org.vn/en/document.

The guidance was commissioned by USAID through the USAID INVEST project and was prepared by a consortium of RCEE-NIRAS and the Carbon Trust. The PCF guidance is part of a compilation of surveys, analytical reports, and other technical documents funded by USAID INVEST to support the Government of Vietnam understand the drivers, methods, and available data for conducting PCF in carbon-intensive and export-oriented industries.

What is a product carbon footprint?

Product carbon footprinting involves the quantification of GHG emissions across the life cycle of a product, which may include production and transportation of material inputs, energy consumption, product use and transport, and disposal or recycling at end-of-life. The specifics of what is included in a product carbon footprint depends on the individual product and its value chain.

By calculating and understanding a product carbon footprint, a company is able to:

- Identify opportunities to improve the GHG emissions performance of their products and systems;
- Inform strategic planning, priority setting, design or re-design of products;
- Improve marketing through participation in carbon labelling schemes or low-carbon product declarations.

The information in this document aligns with internationally recognized PCF protocols, such as the Greenhouse Gas Protocol[3], PAS 2050[4] and ISO 14067[5].

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[2] INVEST 117 – Product Carbon Footprint (PCF) Data Collection and Calculation Toolkit: Electronics Manufacturing, Iron and Steel, Garment and Textiles, and Solar Photovoltaics. June 2024: http://www.rcee.org.vn/en/insights

[3] https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf

[4] https://knowledge.bsigroup.com/products/specification-for-the-assessment-of-the-life-cycle-greenhouse-gas-emissions-of-goods-and-services?version=standard

[5] https://www.iso.org/standard/71206.html

2. GETTING STARTED

Setting up

Proper documentation is fundamental for a successful product carbon footprint. It enables efficient communication between stakeholders and provides a basis for monitoring, evaluation, and updating over time.

The organization developing the PCF should create a data repository for the PCF and ensure that primary activity data is clearly documented, well maintained, and properly saved to act as a clear reference point. Having a data system in place allows for a verifier (internal or external) to cross-check activity data, assumptions, and methods used.

Defining the objective

At the beginning of the PCF, the organization should form a PCF task force and outline the specific objectives and goals for the PCF. This may include, but is not limited to:

- Testing scenarios to explore how altering a product might affect its environmental footprint
- Making comparative assertions between products
- Designing a user dashboard optimized for managing PCF-related objectives
- Achieving certification of the PCF
- Reporting on a corporate scope 1, scope 2 and scope 3 GHG emissions inventory and GHG reduction commitments
- Reviewing key physical, reputational, financial and policy risks of the measured product
- Measuring the circular economy of products footprinted
- Reporting against a science-based or other GHG target

3. PROCESS GUIDANCE

This section briefly describes the steps an organization should take to define the system boundary of the project and calculate GHG emissions from its value chain. For more detail on each step, please refer to the ***Technical Guidance for Vietnamese Industries on How to Conduct a Product Carbon Footprint (PCF)***

To assess greenhouse gas emissions associated with products or services, organizations follow a structured approach. Initially, they define the specific products or services to be evaluated and establish clear boundaries for the assessment, determining which stages of the product lifecycle will be included, such as from production to disposal. Next, a detailed process flow diagram is created, mapping out all stages and subprocesses involved in production or service delivery, while capturing inputs, outputs, co-products, and waste streams at each stage. Data collection follows, where quantities, types, and sources of inputs and outputs are meticulously gathered to ensure accuracy and completeness. Using this data, organizations then calculate greenhouse gas emissions using appropriate methodologies and emission factors, aggregating these emissions across all lifecycle stages to determine the overall product footprint. Throughout these steps, adherence to recognized standards and guidelines ensures consistency and reliability in the assessment process.

Step 1 – Identifying the product system and its system boundary

As described in more detail in Section 2.1 of the ***Technical Guidance for Vietnamese Industries on How to Conduct a Product Carbon Footprint (PCF)***, organizations must clearly define the product and its system boundary by answering the following questions:

- Geographical area of sale/use.
- Which stock-keeping units (SKUs) and geographical areas of sale/use that fall under the definition of this product.
- The unit of analysis (Functional Unit) of the product footprint.
- The system boundary of the product footprint.
- The time period of the activity data collected for the footprint.

Defining the product

If the company has several product SKUs which it wishes to footprint, it may be possible to group these together as one product footprint, if:

- The products are not significantly different e.g., they use the same bill of materials.
- The products can use the same functional unit.
- The company only requires a rough estimation of the average PCF.

The ***PCF Data Collection and Calculation Toolkit*** is designed to simplify footprinting of multiple products or SKUs in a group. This means there should be little difference between the time taken to footprint upstream processes for one product versus for twenty products.

The ***PCF Data Collection and Calculation Toolkit*** prompts users to document each product which should be individually footprinted in the **'SOLAR PV PRODUCTS'** worksheet. The user may insert additional columns as needed to adequately describe the products.

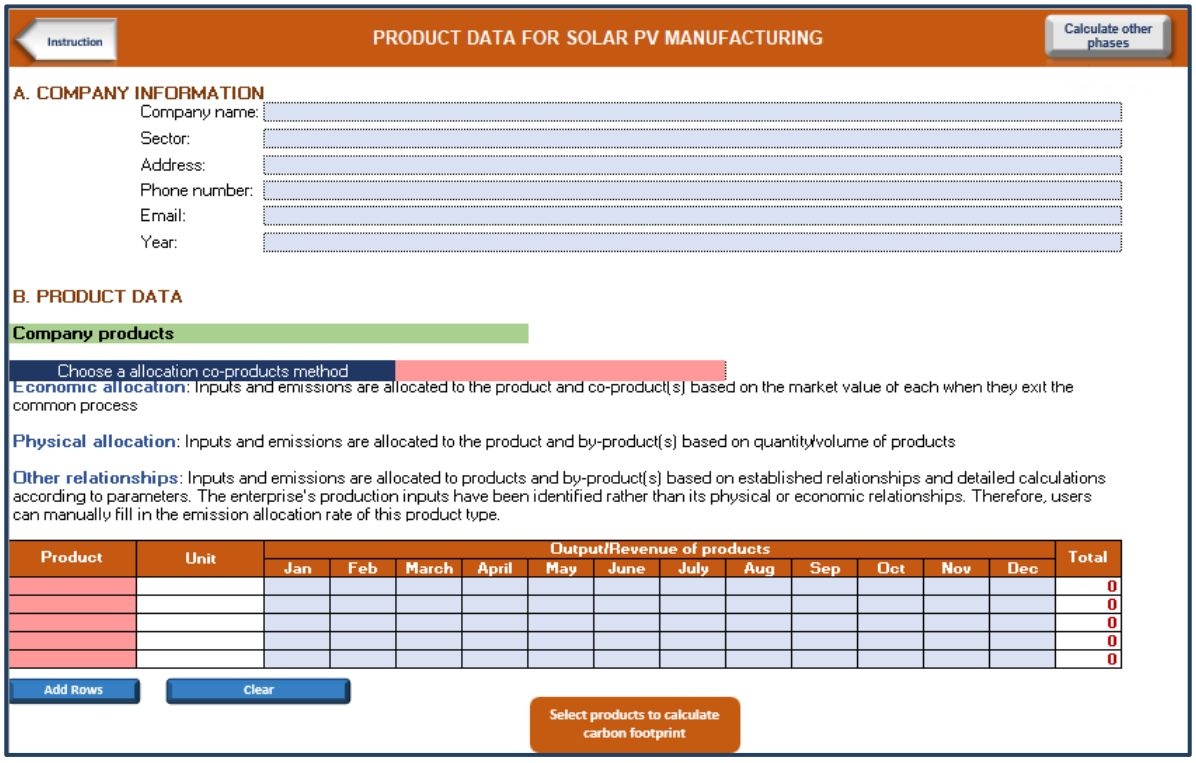


Figure 1: SOLAR PV PRODUCTS worksheet

This worksheet includes data related to information about the business's co-products. Specifically, users need to fill in information such as product names; output/revenue from various types of products. These descriptions are not prescriptive and may be edited as necessary to conform to the product description. Users can add other characteristics of product types by adding other columns/rows. This worksheet also contains information on co-product emissions allocation methods.

Defining the system boundary

It is important to define the product's system boundary so it is explicit what the user has modeled, versus what has been excluded. Not only is this transparency important, but establishing a clear system boundary enables future carbon footprints of similar products to follow the same methodology, and therefore be compared to the first original study.

A product system boundary describes what processes, activities and materials are included within the carbon footprint calculation, and which should be excluded. All processes, services, materials, and energy not directly part of the life cycle of the studied product should be excluded from the footprint.

The system boundary describes all the processes and activities which shall also be captured in the product's process map (see Figure 2 above). The following challenges can arise when defining a system boundary:

- The company wishes to exclude certain processes due to a lack of company data
- The company wishes to exclude certain processes due to assumed immateriality
- The product manufacturing processes create co-products
- The product has complex use phase processes

In general, processes should not be excluded unless absolutely necessary. However, if the company does not require external communication of the footprint to the public then any processes which represent <5% of total GHG emissions or are assumed to be *de minimis* to the footprint may be excluded from the footprint. For more information on how to assess the materiality of a GHG emission source please refer to Annex 2 of the ***Technical Guidance for Vietnamese Industries on How to Conduct a Product Carbon Footprint (PCF)***].

There are two default system boundaries that are generally accepted for a PCF. The company may choose any of these options dependent on the purpose of the PCF. The ***PCF Data Collection and Calculation Toolkit*** can be customized to fit any of the below system boundaries.

- Cradle-to-grave: includes all footprint processes from the acquisition of raw materials through to the end-of-life disposal of the product.
- Cradle-to-gate: includes all footprint processes from the acquisition of raw materials through to the completed manufacturing of the product.

Products sold to consumers should be footprinted cradle-to-grave. Products sold to business customers who are the final user of the product should be footprinted cradle-to-grave. Products sold to business customers who transform the product into another product should be footprinted cradle-to-gate.

Step 2 – Develop the product process map

Process maps are a fundamental component of product carbon footprinting because they provide the user with practical information on each step of the product life cycle. By developing a clear and comprehensive process map, the user can clarify exactly which processes need to be captured in the product footprint, and how the processes relate to one another.

A process map is a clear visualization of the materials, activities, processes and geographies which should be included in the PCF. Note:

- The process map may be created by any method (e.g., a software package, drawn by hand and scanned)
- To save time, the company may include a generic process map which should be amended, if required.

The process map is also useful for communicating to internal and external stakeholders what the footprint covers and what's excluded. This is particularly supportive when conducting quality control and if the company decides to obtain external certification of the PCF at a later stage.

At a minimum, the process map should:

- List the key processes in the life cycle, including the inputs and outputs of these processes

- Include inputs with smaller materiality combined into groups, as they will be modelled
  - Include downstream processes for cradle-to-grave footprints
  - Highlight anything to be excluded from the footprint
  - Highlight processes owned, operated or controlled by the organisation
  - Highlight processes owned, operated or controlled by the organisation's suppliers, if included
  - Define the outputs of each process as:

1. Products – final products being footprinted
2. Interim-products - outputs which become an input to another process
   Co-products - outputs which are sold into other value chains
3. Wastes - outputs with no value

Figure 2 provides an example process map for a company that produces solar photovoltaics (PVs).

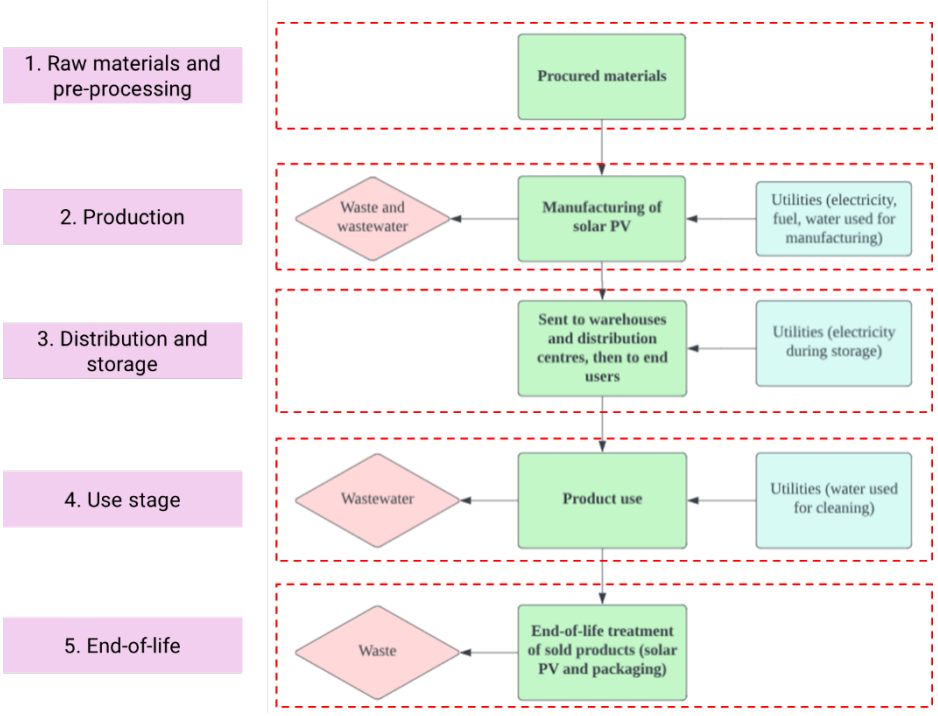


Figure 2: Example process map identified by Company X, producing solar PV panel

Source: RCEE-NIRAS, The Carbon Trust, 2024

The life cycle of a PV module is divided into five different stages, namely (i) raw material acquisition and pre-processing, (ii) production, (iii) distribution and storage, (iv) use stage and (v) end of life.

- Raw material acquisition and pre-processing

This stage comprises emissions related to procurement and pre-processing of the raw materials to manufacture PV modules, such as the front and rear glass, laminate layer, and cadmium telluride. This also includes the transportation of procured items to the company's production facilities.

- Production

Emissions associated with the production stage includes electricity, liquefied petroleum gas, diesel, and water consumed during the processes of transforming procured materials and components into PV modules ready for sale. Emissions from treatment of manufacturing waste is considered in this stage.

- Distribution and storage

Emissions associated with this stage involve outbound transportation from the production site to clients via land and sea transport, and storage of PV modules at the warehouse.

- Use stage

The use stage includes the use of water for cleaning the PV modules during their expected lifetimes and the subsequent treatment of wastewater during.

- End of life

Emissions from end-of-life treatment of the PV modules is considered during this stage.

Step 3 – Identifying input-output and co-products and wastes and collecting relevant data

For solar PV manufacturing, the following main materials should be considered:

- Rear glass
- Laminate layer
- Cadmium telluride
- Chemicals
- Others

Data collection is typically the most resource intensive step of a PCF assessment. After identifying all attributable activities to produce solar PVs, activity data and emissions factors to describe these activities can be collected.

The following assumptions are a starting point for solar PV manufacturers to calculate the PCF:

- Materials with negligible weight (less than 0.01% of the total weight of input materials) are considered to have a negligible impact on the PCF and can be excluded from calculations: (i) label (ii) coating protects product labels (iii) pallet labels (iv) copper foil (v) cadmium arsenide (Cd3As2), and (vi) polymers.
- Materials with incomplete information and not a key component of PV modules are considered to have a negligible impact on the PCF and can be excluded from the calculations: (i) frame tape (ii) double-sided tape, and (iii) connecting bar.

There is no allocation of inputs required if the production site only produces PV modules.

Step 4 – Identify the downstream process

Downstream processes typically encompass (1) distribution and retail, (2) use-phase and (3) end-of-life. Table 2 describes considerations and activities to take into account during the distribution and retail of solar PVs while Table 3 provides example considerations and assumptions for determining GHG emissions during the use and end-of-life disposal phases.

Table 2: Example activities resulting in GHG emissions during transportation and retail of solar PVs

Process	Description	Example considerations
Transportation	All incoming and outgoing transport needs to be taken into account, including different legs of transportation for the same input material or product (e.g., road, sea, air).	• Type of transport • Distribution distance • Vehicle load during return • Load constraint
Transport to regional distribution centers	A weighted average can be used instead of footprinting the transportation routes to each distribution center and each retailer.	
Energy consumption during processing and retail	Energy consumption may be required to support certain operations, such as distribution centers or retail stores.	• Electricity use • Refrigeration • Heating or cooling • Forklift emissions (e.g., for receipt and storage of products)
Waste	Any waste produced during distribution must also be accounted for.	

Table 3: Example assumptions for estimating GHG emissions during downstream phases of solar PVs

Distribution and Storage	<u>Storage</u> The average energy consumption in a warehouse is assumed to be 9 kWh per sqft.	

	Storage of PV modules is assumed to be in Vietnam and the warehouse's electricity is drawn from the local power grid. Distribution Land transportation for outbound transport is assumed to be using HGV (diesel) and it is average laden. The distribution (lorry and ship transport) is assumed to follow the distribution scenario for Asia Pacific production site and destined for transportation to Europe according to PEFCR	United States Department of Energy BEIS PEFCR: Photovoltaic Modules used in Photovoltaic Power Systems for Electricity Generation.
Use Stage	It is assumed that no electricity is consumed in the use stage of PV panels (system startup, maintenance, etc.) It is assumed that wastewater from use stage has the same density as tap water (1 kg/m^3).	
End of Life	The expected lifetime of solar modules is assumed to be 30 years. The end-of-life emission factor that is derived from a study based on the data from First Solar recycling facility in Germany is assumed to be applicable for all sales/use regions of the SKU. The product packaging for PV modules sold is assumed to be negligible.	PEFCR: Photovoltaic Modules used in Photovoltaic Power Systems for Electricity Generation.

If the company wants to expand the scope of the PCF, it can refer to the ***Technical Guidance for Vietnamese Industries on How to Conduct a Product Carbon Footprint (PCF).***

Step 4 – Calculating the product footprint

A PCF calculates the total impact of GHG emissions from a product or product system and is expressed in 'carbon dioxide equivalent' or 'CO2e'. As described further in Table I, CO2e is a common unit which expresses the total global warming impact, or GWP, of GHG emissions. This allows different GHGs to be summed up based on their impact relative to carbon dioxide. CO2e is therefore a standard measurement by which we can compare and aggregate the impact of all GHGs.

Companies should follow the below steps when calculating the GHG impact of a product:

Selecting a GWP value

The methodology for calculating GWPs is evolving and the values are re-evaluated every few years by the Intergovernmental Panel on Climate Change (IPCC). The most updated GWP factors were published by the IPCC in its Sixth Assessment Report.[6] Companies can refer to this IPCC guidance when selecting GWPs or they could use the GWPs used by the Government of Vietnam in the latest version of Vietnam's national GHG emissions inventory.

Calculating CO2e using collected data

Companies should calculate GHG emissions by using the collected activity data and emissions factors as shown in Figure 3.

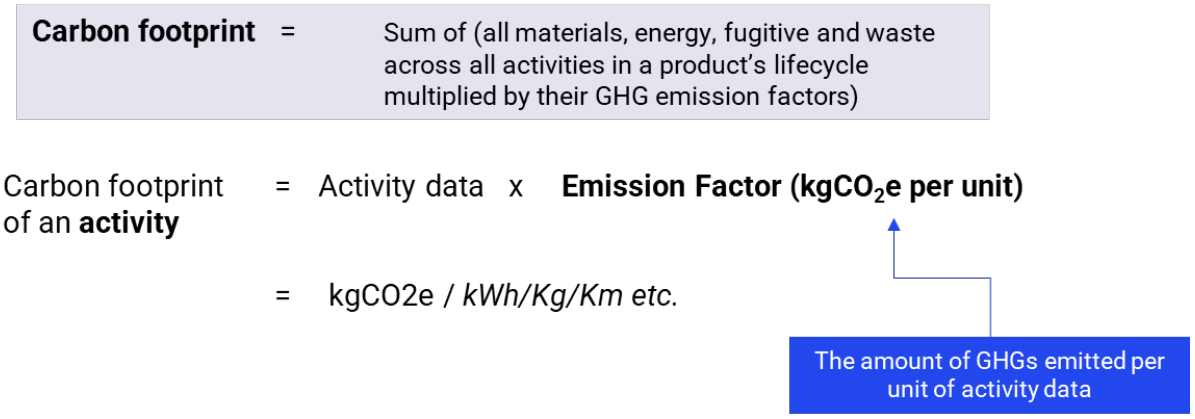


Figure 3: Summary of a product carbon footprint calculation

Activity data

Primary data for input volumes, output and waste volumes for each production stage of the procured materials and components, and manufacturing must be collected with names of suppliers and countries of destination markets to derive the distance travelled in the inbound and outbound transportation.

Example evidence which can be used as primary data includes:

- Quantities of cadmium telluride procured.
- Quantities of electricity/fossil fuel consumed in the production of solar panels.
- Quantities of wood waste disposed of.
- Transportation of input materials, including origin and destination, distance, and transportation type.

The emission factors (EFs) for garments and textiles provided in Table 4 below can serve as a starting point for the PCF calculation. Other sources can be found in the ***Technical Guidance for Vietnamese Industries on How to Conduct a Product Carbon Footprint (PCF)***, – Section 3.

[6] IPCC Sixth Assessment Report, report.ipcc.ch/ar6/wg1/IPCC_AR6_WGI_FullReport.pdf, refer table 7.15 – Emissions metrics for selected species: global warming potential (GWP), global temperature change potential (GTP).

Table 4: Activity data and EF combinations for standard activities across the lifecycle

Life Cycle Stage	Activity Description	Activity Data	Emission Factor
Raw Materials and Pre-processing	Cradle-to-supplier's gate emissions from input materials	Mass of input materials purchased (e.g., front and rear glass, laminate layer, cadmium telluride, etc.)	EFs reflecting emissions from cradle-to-supplier's gate activities, based on $kgCO_2e$ / kg of materials
	Emissions from inbound transport of input materials	Distance travelled between supplier's and company's site, categorized by transport mode (e.g., sea, air or land).	EFs reflecting the full lifecycle emissions from vehicles transporting the input materials, on a $kgCO_2e$ / tonne.km basis
Production	Full lifecycle GHG emissions related to utility energy consumption	Quantity of energy and water used (e.g., electricity in kwh, liquefied petroleum gas in tonnes)	EFs reflecting cradle-to-gate emissions (including all life cycle phases, from the extraction of raw materials to their use), on thebasis of e.g., $kgCO_2e$ / kwh, $kgCO_2e$ / tonne. EFs for electricity reflects average grid emissions in Vietnam.
	Emissions from the treatment and disposal of waste generated from manufacturing PV modules	Mass of waste generated (e.g., scrap metal waste)	EFs reflecting emissions from a specified waste disposal method, on the basis of $kgCO_2e$ / kg of waste recycled, incinerated, landfilled, etc.
Distribution and Storage	Emissions from the transportation and distribution of sold PV modules	Distance travelled between the company and client site, categorized by transportation	EFs reflecting the full lifecycle emissions from vehicles transporting the sold product, on a $kgCO_2e$ / tonne.km basis

Life Cycle Stage	Activity Description	Activity Data	Emission Factor
		mode (e.g.. sea, air, or land_. Mass of PV module transported	
Use Stage	Emissions from the use of PV modules (e.g., water for cleaning, and wastewater treatment)	Quantity of water for cleaning and wastewater treated	EFs reflecting emissions covering cradle-to-supplier's gate emissions on the basis of $kgCO_2e$/ m3 of product
End of Life	Emissions from the disposal of sold PV modules	Mass of sold PV modules	EFs reflecting emissions from a specified waste disposal method, on the basis of $kgCO_2e$/ kg of waste recycled, incinerated, landfilled, etc.

It is usually difficult for solar PV manufacturers to access EFs for input materials from their suppliers. Instead companies can purchase EFs from data service providers, typically by buying a license to access their database. Table 5 below provides sources of where companies can obtain emission factors and a more extensive list of data providers is available in the ***Technical Guidance for Vietnamese Industries on How to Conduct a Product Carbon Footprint (PCF).***

Depending on the needs of the company, the purchase of EFs can be considered at a later stage.

Table 5: Reference sources for emission factors

Emission Factor	Source	Geography specified in the database
Raw materials		
cadmium production, semiconductor-grade	Ecoinvent 3.10[7]	Rest of the world (RoW)
market for cadmium telluride, semiconductor-grade	Ecoinvent 3.10	Global (GLO)

[7] https://ecoinvent.org/ecoinvent-v3-10/

Emission Factor	Source	Geography specified in the database
solar glass production, low iron	Ecoinvent 3.10	RoW
cadmium chloride production, semiconductor-grade	Ecoinvent 3.10	RoW
chemical production, organic	Ecoinvent 3.10	GLO
synthetic rubber production	Ecoinvent 3.10	RoW
primary zinc production from concentrate	Ecoinvent 3.10	RoW
silicon production, electronics grade	Ecoinvent 3.10	RoW
cable production, unspecified	Ecoinvent 3.10	GLO
polyvinylchloride production, bulk polymerisation	Ecoinvent 3.10	RoW
ethylene vinyl acetate copolymer production	Ecoinvent 3.10	RoW
aluminium production, primary, ingot	Ecoinvent 3.10	China (CN)
steel production, electric, low-alloyed	Ecoinvent 3.10	RoW
market for adhesive, for metal	Ecoinvent 3.10	RoW
chemical production, organic	Ecoinvent 3.10	GLO
nitric acid production, product in 50% solution state	Ecoinvent 3.10	CN
hydrogen peroxide production, product in 50% solution state	Ecoinvent 3.10	RoW
market for nitrogen, liquid	Ecoinvent 3.10	RoW
argon production, liquid	Ecoinvent 3.10	RoW
potassium hydroxide production	Ecoinvent 3.10	RoW
sodium hydroxide to generic market for neutralising agent	Ecoinvent 3.10	RoW
chemical production, inorganic	Ecoinvent 3.10	GLO

Emission Factor	Source	Geography specified in the database
carbon dioxide production, liquid	Ecoinvent 3.10	RoW
oxalic acid production	Ecoinvent 3.10	CN
chemical production, organic	Ecoinvent 3.10	GLO
hydrogen peroxide production, product in 50% solution state	Ecoinvent 3.10	RoW
sulfuric acid production	Ecoinvent 3.10	RoW
market for sodium hydroxide, without water, in 50% solution state	Ecoinvent 3.10	RoW
Utilities		
Diesel (100% mineral diesel) - scope 1 + well-to-tank (WTT)	Government decision[8]	Vietnam
LPG - scope 1 + well-to-tank (WTT)	Government decision	Vietnam
Electricity Vietnam - scope 2 + transmission & distribution (T&D) + WTT	Government decision[9]	Vietnam
Water supply (water delivered through a centralized supply network)	BEIS 2022	Not available (NA)
Waste Disposal		
Wastewater disposal (water returned into the sewage system through main drains)	BEIS 2022[10]	NA
Commercial and industrial waste (incineration)	BEIS 2022	NA
Wood (closed loop)	BEIS 2022	NA

[8] https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Quyet-dinh-2626-QD-BTNMT-2022-cong-bo-he-so-phat-thai-phuc-vu-kiem-ke-khi-nha-kinh-532253.aspx

[9] http://www.dcc.gov.vn/van-ban-phap-luat/1110/He-so-phat-thai-luoi-dien-Viet-Nam-2022.html

[10] https://www.gov.uk/government/publications/beis-annual-report-and-accounts-2022-to-2023

Emission Factor	Source	Geography specified in the database
Plastics: average plastics (closed loop)	BEIS 2022	NA
Metal: scrap metal (open loop)	BEIS 2022	NA
Glass (open loop)	BEIS 2022	NA
Waste from electrical and electronic equipment (also call e-waste) WEEE - mixed (open loop)	BEIS 2022	NA
Mineral oil (closed loop)	BEIS 2022	NA
Batteries (open loop)	BEIS 2022	NA
Paper and board: mixed (closed loop)	BEIS 2022	NA
CdTe PV module EoL disposal	IEA PVPS[11]	NA
Transport		
HGV (diesel) - articulated - average laden - full life cycle	BEIS 2022	NA
Container ship (average) - Full life cycle	BEIS 2022	NA

[11] https://iea-pvps.org/

ANNEX 1 - PRACTICAL SKILLS

The user guide for this tool provides comprehensive instructions on how to effectively utilize its features and functionalities. It includes step-by-step procedures for setting up the tool, navigating its interface, and utilizing various tools and options. Users will learn how to input data, interpret results, and customize settings to suit specific needs. Additionally, troubleshooting tips and frequently asked questions are included to assist users in overcoming common challenges. The guide aims to empower users with the knowledge and skills necessary to maximize the tool's capabilities and achieve optimal outcomes efficiently.

STRUCTURE OF THE TOOL

The tool includes 9 worksheets with the following functions:

Worksheet	Function
INTRODUCE	Provides general introduction to the tool. Available tool functions and methods used to calculate the carbon footprint of products
INSTRUCTIONS	Explains the structure and steps to use the tool
PRODUCT	Data entry to define the products and their system boundary
PHASE 1	Data entry and calculation of GHG emissions from production and transportation of raw materials used in products
PHASE 2	Data entry and calculation of GHG emissions from the product manufacturing stage
PHASE 3	Data entry and calculation of GHG emissions from product distribution and retail stages
PHASE 4	Data entry and calculation of GHG emissions from the product use stage
PHASE 5	Data entry and calculation of GHG emissions from post-use product treatment and recycling stages

RESULTS	Summarizes the results of calculating the product's carbon footprint

Toolbar

On top of each worksheet there is a toolbar including buttons to help users navigate and move to the next calculation step.

**Navigation buttons, move to other sheets*

Color symbol

The data cells are color-coded so that they can provide users with clear visual instructions on how to use the tool. Specifically, the cells in the tool will include the colors in Table 6.

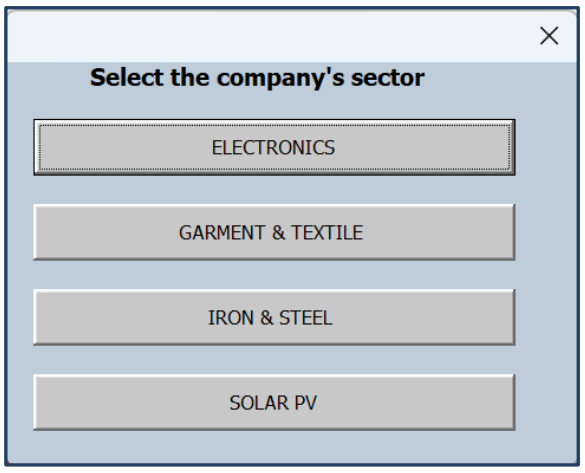
Table 6: Cell color definitions

Color	Regulations
	User data boxes must be filled in automatically
	The data cell has an automatic formula, which does not encourage users to edit it themselves. However, users can change the value of the cell to match the business's input data
	The data cell has an automatic formula and cannot be edited
	The data box requires the user to select information from a drop-down list.

STEPS TO USING THE TOOL

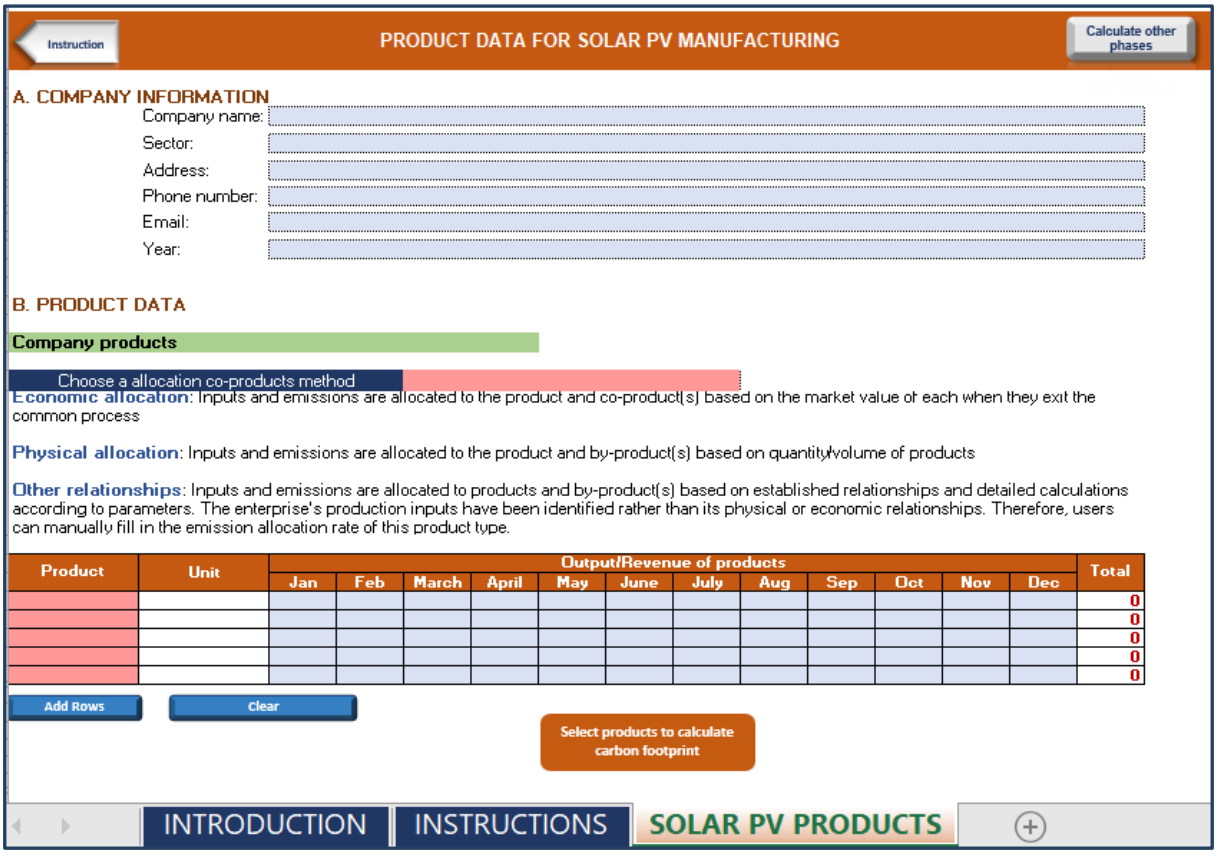
Step 1: Enter product data

After reading the **INTRODUCTION** and **INSTRUCTIONS** worksheets for using the tool, the user should select the "Calculate" button above the toolbar on the INSTRUCTIONS worksheet to move to the **SOLAR PV PRODUCTS** worksheet.



Select the field "SOLAR PV"

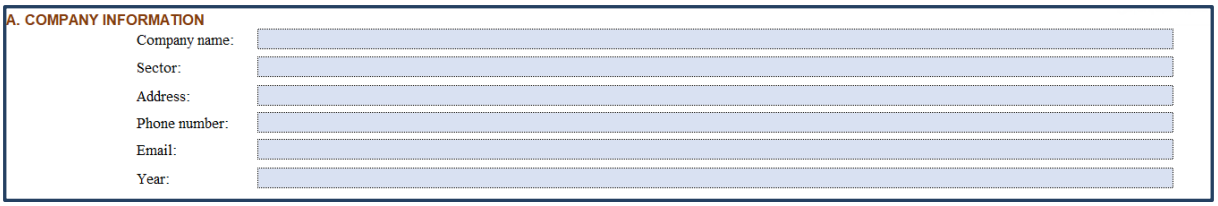
Products worksheet



The **SOLAR PV PRODUCTS** worksheet has two major sections for data entry:

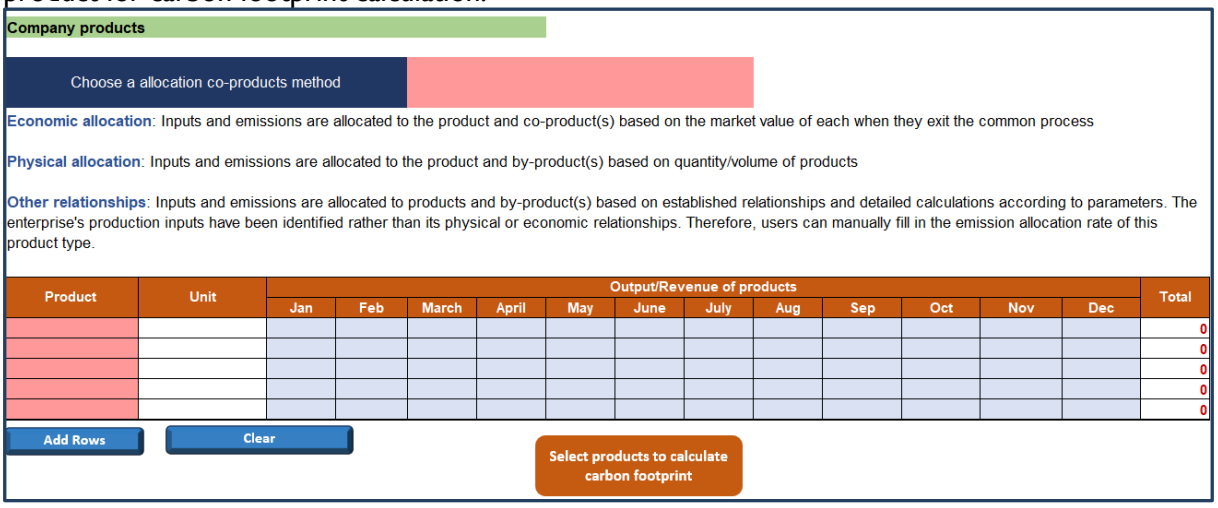
A. *General information on the business*
Users need to enter information about:

Facility name	Phone number
Sector	Email
Address	Year of calculation



B. *Company products*

For this section, users can enter information related to the products manufactured by the business and select a product for carbon footprint calculation.

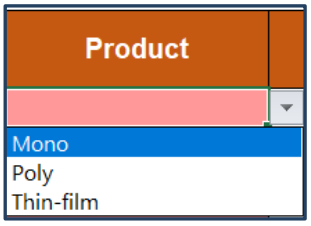


Before entering information about product types, users need to **Choose an Allocation Emission Co-Products (AEC) method:** The Allocation Emission Co-Products (AEC) method is used in life cycle assessments to account for environmental impacts from co-products produced alongside a primary product. It involves dividing these impacts between the primary product and its co-products based on criteria like economic value or mass. By separately assessing the environmental burdens of both the primary product and its co-products, this method aims to provide a fair representation of their combined environmental footprint. This approach is crucial for accurately understanding and managing the environmental impacts of manufacturing processes that yield multiple outputs. A pull-down list includes three methods for users to choose from:

- Economic allocation: Inputs and emissions are allocated to the product and co-product(s) based on the market value of each.

- Physical allocation: Inputs and emissions are allocated to the product and by-product(s) based on quantity/volume of products.
- Other relationships: Inputs and emissions are allocated to products and by-product(s) based on established relationships and detailed calculations according to parameters. The enterprise's production inputs have been identified rather than its physical or economic relationships. Therefore, users can manually fill in the emission allocation rate of this product type.

After choosing the emission allocation method, users must enter the **Output/Revenue information of products** in the table with the core information as follows:



- Product: The name of the product is suggested by a drop-down list
- Unit: If the user has selected the allocation method "According to economic value", the unit will be automatically displayed as "Million VND". If the user chooses the remaining 2 allocation methods, the unit column will be left blank and the user will have to manually fill in the corresponding units for each product type.
- Output/Revenue of the product:

If users need to add rows to the table, please click on the button "Add Rows" at the bottom of the table. If the user wants to delete information about the product types, please click on the button "Clear". The data in the collection table will automatically be deleted and the user will start re-filling information from the step **Choose a product allocation method.**

After entering all the information above, users click on the button "Select products to calculate carbon footprint" at the bottom to continue. Two cases will occur:

Case 1: If the user chooses the allocation co-product method as economic allocation or physical allocation (must include the condition that the products share a consistent statistical unit), the tool will support the calculation of the emissions rate allocation for each type of product. The users only need to **select a product for life cycle GHG calculations** among the products listed.

Product	Unit	Output/Revenue of products												Total
		Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	
Mono	Million VND	100	100	100	100	100	100	100	100	100	100	100	100	1200
Poly	Million VND	200	200	200	200	200	200	200	200	200	200	200	200	2400
														0
														0
														0

Add Rows | Clear | Select products to calculate carbon footprint

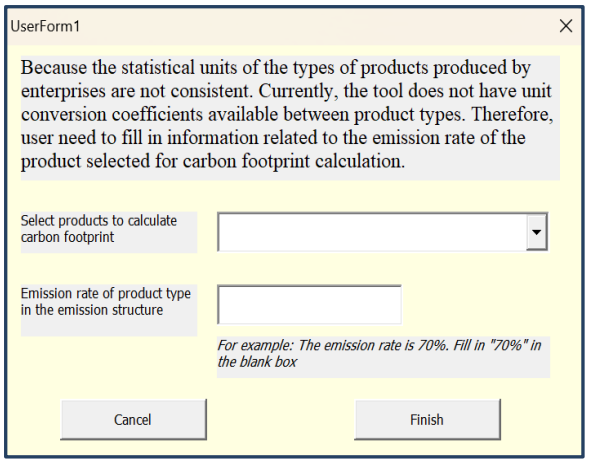
Product	Rate											
	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Mono	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%
Poly	67%	67%	67%	67%	67%	67%	67%	67%	67%	67%	67%	67%
	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Select a product for life cycle GHG calculations: Mono / Poly

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
GHG Emission rate	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Enter data for product inputs

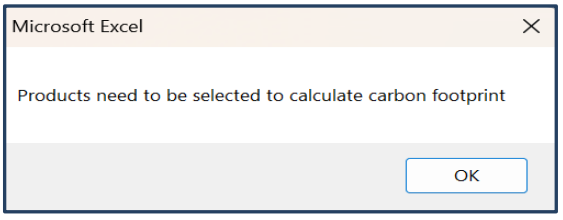
Case 2: If the user chooses the method "Other relationships" or if each product has a different statistical unit, a user form will appear requesting the following information:

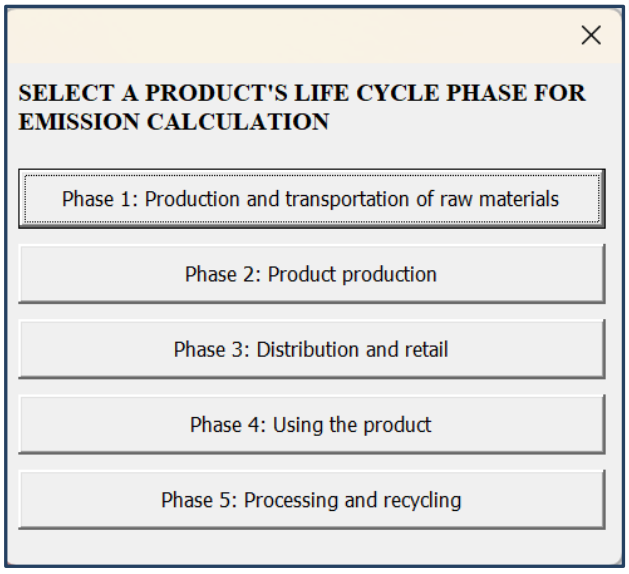


- Select Products: choose the products for calculation of carbon footprint
- Emission rate of the product: Using available data, adjust the emission rate of that product in the enterprise's emission structure. For example: If the emission rate is 70%, fill in the text box as "70%"
- Click on the Finish button

After entering all the requested information for each product type and selecting the product for calculation of the carbon footprint, the user should click on the button "Calculate other phases" on the toolbar or "Enter data for product inputs" at the bottom of the worksheet.

If the user forgets to select a product type, a notification will appear

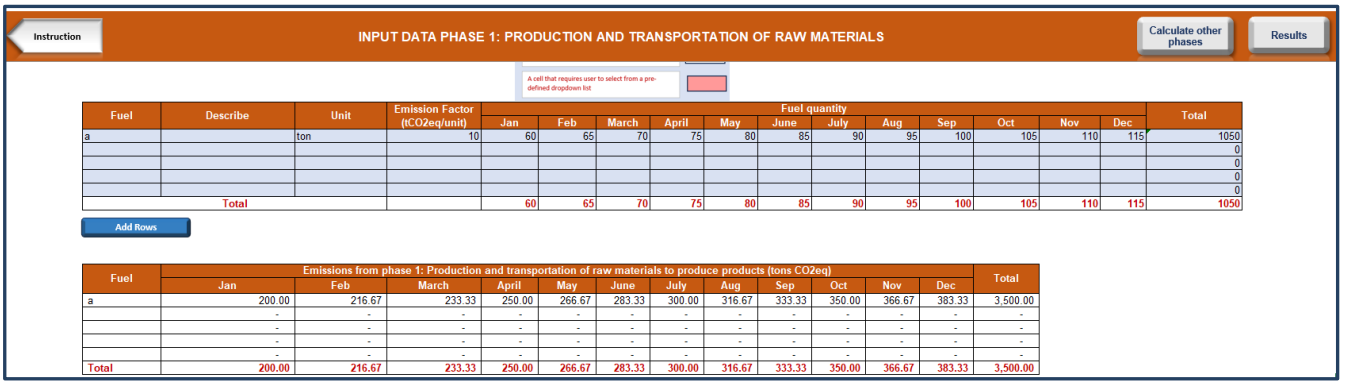




If all information has been filled in, a user form appears, allowing the user to select the emission stages in the product life cycle.

Step 2: Enter data and calculate emissions for phase 1: Production and transportation of raw materials

After selecting Phase 1: Production and transportation of raw materials in the user form, the **SOLAR PV PHASE 1** worksheet will appear.



Users will need to fill in the information for the first table including

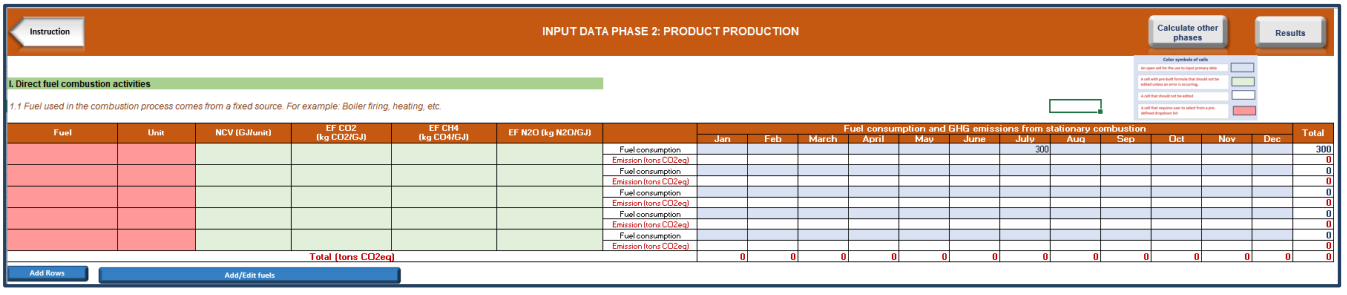
- Fuel: Fossil fuels which were used for phase 1
- Description: A more detailed description of the fuel
- Unit: Statistical unit of the fuels. For example: tons, thousand liters, TOE, million VND.
- Emission factor: tCO2eq/unit
- Quantity of fuel used

After entering the requested information in Table 1, the GHG emission results will be presented in the table below.

To move to the next stage, the user presses the button "Calculate other phases" and the stage selection user form will be displayed.

Step 3: Enter data and calculate emissions for phase 2: Product manufacturing

After selecting Phase 2: Product Production in the user form, the **SOLAR PV PHASE 2** worksheet will appear.

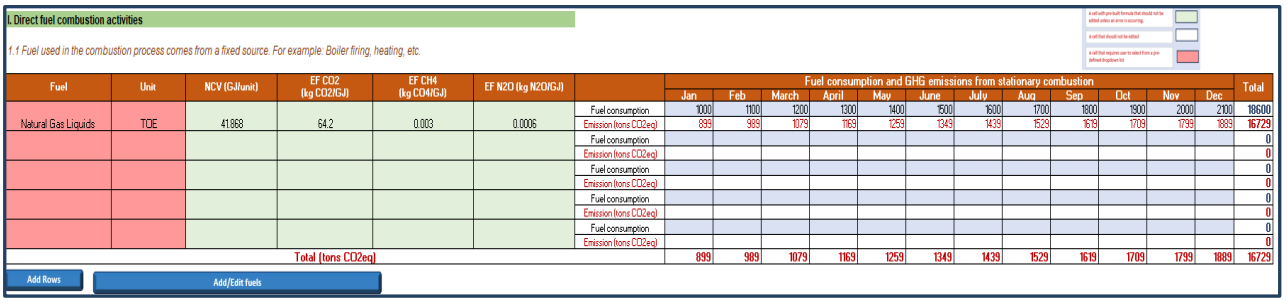


The user must enter the requested information on GHG emission sources, including:

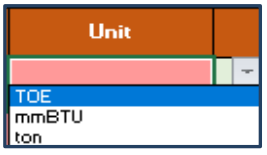
- Direct fossil fuel combustion
  - Stationary fossil fuel combustion
  - Mobile fossil fuel combustion
- Leaking refrigerants from refrigeration equipment
- Industrial processes
- Wastewater treatment activities

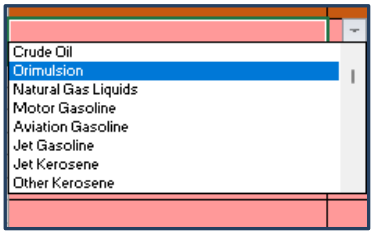
- Purchased steam, cooling, heat, and electricity
- Other activities

Step 3.1: Direct fossil fuel combustion – Stationary fossil fuel combustion



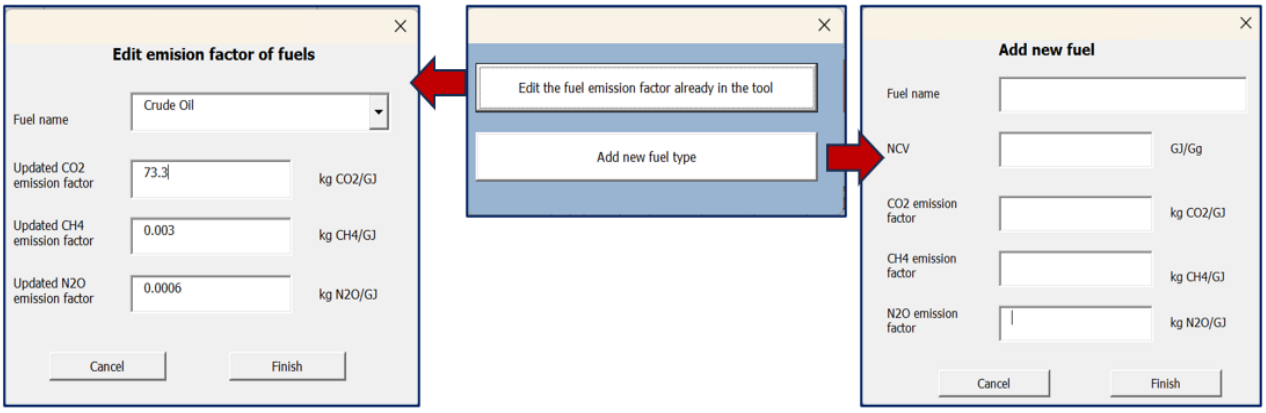
The user fills in the following information:





- Fuel: Select fuel types from the drop-down list
- Unit: Select unit from the drop-down list
- Heating value, emission factors: The tool automatically shows the heating value associated with the selected fuel type

If the tool does not have all the relevant fossil fuel types which the business is using or the user wants to edit the fossil fuel emission factors, the user can select the "Add/Edit fuel types" button. A user form will appear as follows:

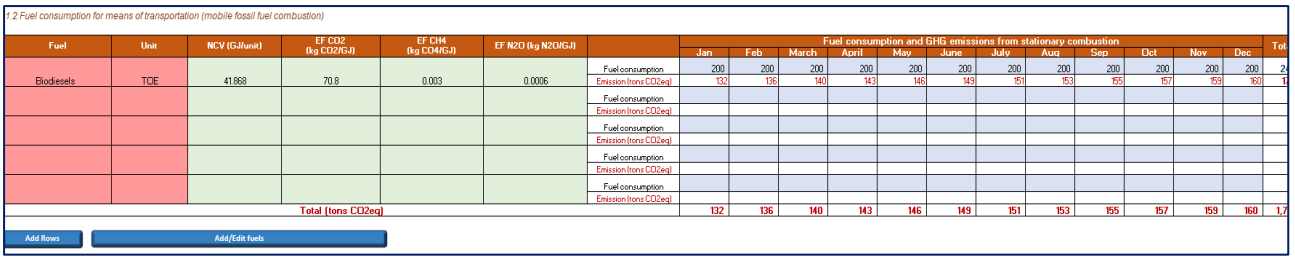


Users can then edit the emission factors of the fuel types or add new fuel types that suit the company's fossil fuel burning activities.

- Fuel consumption: Enter fossil fuel consumed each month. The emissions results will appear below.

Step 3.2: Direct fossil fuel combustion – Mobile fossil fuel combustion

Repeat the steps implemented above



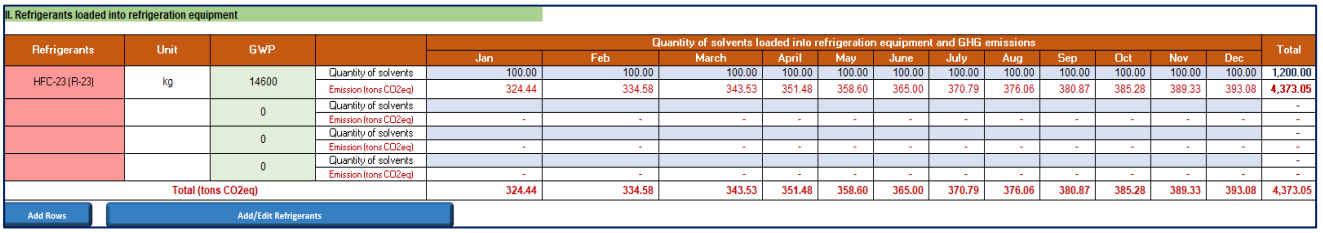
1.2 Fuel consumption for means of transportation (mobile fossil fuel combustion)

Fuel	Unit	NCV (GJ/unit)	EF CO2 (kg CO2/GJ)	EF CH4 (kg CO4/GJ)	EF N2O (kg N2O/GJ)		Fuel consumption and GHG emissions from stationary combustion												Tot
							Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	
Biodiesels	TOE	41.868	70.8	0.003	0.0006	Fuel consumption	200	200	200	200	200	200	200	200	200	200	200	200	2
						Emission (tons CO2eq)	132	136	140	143	146	149	151	153	155	157	159	160	1
						Fuel consumption													
						Emission (tons CO2eq)													
						Fuel consumption													
						Emission (tons CO2eq)													
						Fuel consumption													
						Emission (tons CO2eq)													
						Fuel consumption													
						Emission (tons CO2eq)													
Total (tons CO2eq)							132	136	140	143	146	149	151	153	155	157	159	160	1,7

Add Rows | Add/Edit fuels

Step 3.3: Refrigerants used in refrigeration equipment

Refrigerants are chemical compounds used in cooling systems to absorb and release heat, enabling refrigeration and air conditioning. Common types include Chlorofluorocarbon (CFCs), Hydrochlorofluorocarbons (HCFCs), and Hydrofluorocarbons (HFCs), each with varying environmental impacts, particularly concerning ozone depletion and greenhouse gas effects.

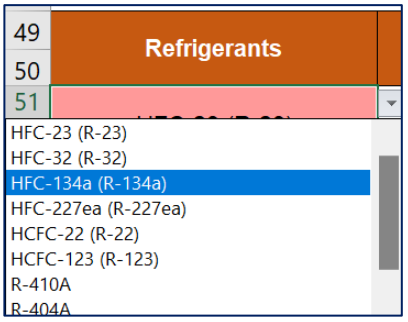


II. Refrigerants loaded into refrigeration equipment

Refrigerants	Unit	GWP		Quantity of solvents loaded into refrigeration equipment and GHG emissions												Total
				Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	
HFC-23 (R-23)	kg	14600	Quantity of solvents	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	1,200.00
			Emission (tons CO2eq)	324.44	334.58	343.53	351.48	358.60	365.00	370.79	376.06	380.87	385.28	389.33	393.08	4,373.05
		0	Quantity of solvents													-
			Emission (tons CO2eq)	-	-	-	-	-	-	-	-	-	-	-	-	-
		0	Quantity of solvents													-
			Emission (tons CO2eq)	-	-	-	-	-	-	-	-	-	-	-	-	-
		0	Quantity of solvents													-
			Emission (tons CO2eq)	-	-	-	-	-	-	-	-	-	-	-	-	-
Total (tons CO2eq)				324.44	334.58	343.53	351.48	358.60	365.00	370.79	376.06	380.87	385.28	389.33	393.08	4,373.05

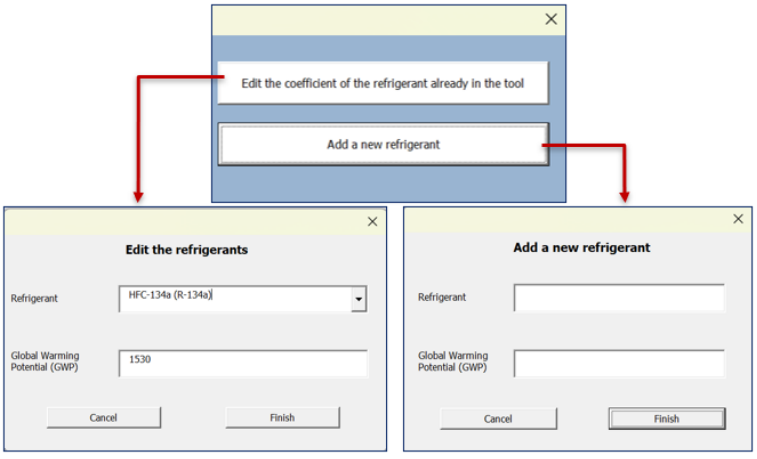
Add Rows | Add/Edit Refrigerants

The user fills in the following information:



- Refrigerants: Select refrigerant type from the drop-down list
- Unit: The default unit is kg
- GWP: The tool automatically shows the GWP associated with the selected refrigerant.

If the tool does not have all the relevant refrigerant types which the business is using or the user wants to edit the GWP, the user can select the "**Add/Edit refrigerants**" button. A user form will appear as follows:



The user can edit the refrigerant GWP or add other refrigerants suitable for the business.

- Quantity of refrigerants used in refrigeration equipment and GHG emissions: Users enter information about the monthly amount of refrigerant used in the business' refrigeration equipment. The results of calculating greenhouse gas emissions from refrigerant leaks will be shown in the white cells below.

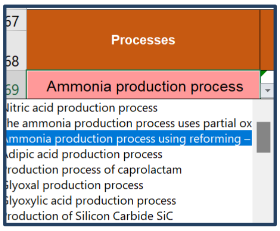
Step 3.4: Industrial processes

III. Emissions from industrial production processes

Processes	Unit of output from the process	EF CO2 (kg CO2/unit)	EF CH4 (kg CO4/unit)	EF N2O (kg N2O/unit)		Output of production processes and GHG emissions from those processes												Total
						Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	
Ammonia production process using reforming – natural gas	ton	1147.50	-	-	Quantity of Outputs	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	1,200
					Emission (tons CO2eq)	25.50	26.30	27.00	27.63	28.18	28.69	29.14	29.56	29.93	30.28	30.60	30.89	344
					Quantity of Outputs													-
					Emission (tons CO2eq)													-
					Quantity of Outputs													-
					Emission (tons CO2eq)													-
					Quantity of Outputs													-
					Emission (tons CO2eq)													-
					Quantity of Outputs													-
					Emission (tons CO2eq)													-
					Quantity of Outputs													-
					Emission (tons CO2eq)													-
Total (tons CO2eq)						26	26	27	28	28	29	29	30	30	30	31	31	344

Add Rows | Add/Edit industrial processes

The user fills in the following information:



- Processes: Select industrial processes from the drop-down list
- Unit: The tool will automatically provide statistical units for output products from industrial processes available in the tool
- Emission factor: The tool automatically shows EFs associated with the selected industrial process

If the tool does not have all the relevant industrial processes of the business, or the user wants to edit the EF, the user can select the "Add/Edit industrial processes" button.

- Output of production processes and GHG emissions from those processes: Enter the output corresponding to each selected industrial process. The results of greenhouse gas emissions resulting from these processes will be calculated and shown in the white cells below.

Step 3.5: Wastewater treatment activities

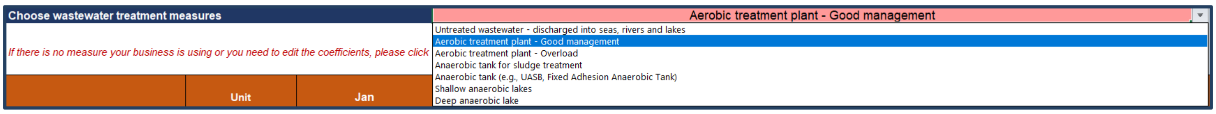
IV. Wastewater treatment activities

Choose wastewater treatment measures: Aerobic treatment plant - Good management

If there is no measure your business is using or you need to edit the coefficients, please click Add/Edit measures

	Unit	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Amount of wastewater	m3	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	12000
Chemical Oxygen Demand (COD)	kgCOD/m3	100	100	100	100	100	100	100	100	100	100	100	100	
CH4 is recovered in the treatment system	kg													
MCF		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Maximum methane production capacity	(kg CH4/kg COD)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
Sludge is removed	kg COD/month													
Emission	tons CO2eq	555.56	572.92	588.24	601.85	614.04	625.00	634.92	643.94	652.17	659.72	666.67	673.08	7,488.09

- Choose wastewater treatment measures: Users select the wastewater treatment method employed by their business. If the tool does not include the specific wastewater treatment method used by the business, or if users wish to modify the indicators of the available methods, they can use the button "**Add/Edit measures**".



- Amount of wastewater treated: Users enter monthly data on the amount of wastewater treated at the enterprise

- Chemical Oxygen Demand (COD): COD is a measure of the amount of organic compounds in water that can be oxidized by strong chemical oxidants. It is commonly used as an indicator of the amount of organic pollution in water. COD is determined through a chemical reaction that oxidizes the organic matter present, producing a measurable amount of oxygen consumed during the process. High COD levels indicate a larger amount of organic pollutants present in the water, which can affect water quality and the health of aquatic ecosystems if discharged untreated. Users need to enter the COD of the treated wastewater of the business.
- Methane (CH4) recovered by the treatment system: CH4 recovered by the treatment system refers to methane gas that is captured and extracted during a wastewater treatment process. CH4 can be produced through anaerobic digestion of organic matter in wastewater treatment facilities. Recovering CH4 involves capturing it before it is released into the atmosphere. Users need to fill in the amount of CH4 recovered during wastewater treatment
- Methane correction factor - MCF; Maximum methane production capacity and Sludge removed: The tool will automatically provide the corresponding wastewater treatment method selected.

Step 3.6: Purchased steam, cooling, heat, and electricity

IV. Amount of steam purchased from outside and electricity purchased from the grid

	Unit	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Generation	kWh	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	96,000
Emission Factor	tCO2/MWh	0.6766	0.6766	0.6766	0.6766	0.6766	0.6766	0.6766	0.6766	0.6766	0.6766	0.6766	0.6766	
Emission	tons CO2eq	1.20	1.24	1.27	1.30	1.33	1.35	1.37	1.39	1.41	1.43	1.44	1.46	16

Add/Edit Fuels

Type of fuel for the boiler	Crude Oil	
Steam pressure	0.04	bar
Boiler efficiency	40	%
Emission Factor CO2	73.3	kgCO2/GJ
Emission Factor CH4	0.003	kgCH4/GJ
Emission Factor N2O	0.0006	kgN2O/GJ

	Unit	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Amount of steam	m3	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	120,000
Amount of converted heat	KJ	1835031.03	1835031.03	1835031.03	1835031.03	1835031.03	1835031.03	1835031.03	1835031.03	1835031.03	1835031.03	1835031.03	1835031.03	22,020,372
Emission	tons CO2eq	29.99	30.93	31.76	32.49	33.15	33.74	34.28	34.76	35.21	35.61	35.99	36.34	404

Purchased Electric

- Generation: Users fill in the monthly amount of electricity purchased from the grid
- Emission factor: The EF of the electricity grid will automatically be provided by the tool corresponding to the enterprise's inventory year entered in the **SOLAR PV PRODUCTS** sheet.

Steam

- Type of fuel for the boiler: The user selects the type of fossil fuel used to produce steam from the drop-down list
- Steam pressure: The user selects the pressure of the produced steam from the drop-down list
- Boiler efficiency: The user enters the boiler's efficiency
- Emission factor: EFs are automatically updated relative to the fossil fuel used to produce the steam
- Amount of steam: The user fills in the monthly amount of produced steam
- Amount of converted heat: The amount of heat converted is automatically calculated

Step 3.7: Other activities

Repeat step 2, adding emission sources not available in the tool

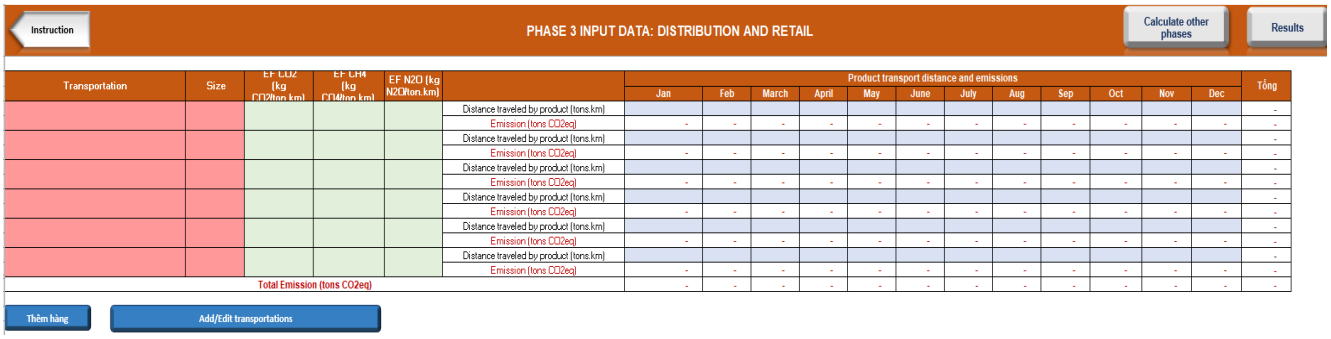
V. Other emission sources

Fuel/Process	Unit	CO2 emission factor (kgCO2/unit)	CH4 emission factor (kgCH4/unit)	N2O emission factor (kgN2O/unit)		Quantity of fuel used												Total
						Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	
					Fuel consumption													0
					Emission (tons CO2eq)													0
					Fuel consumption													0
					Emission (tons CO2eq)													0
					Fuel consumption													0
					Emission (tons CO2eq)													0
					Fuel consumption													0
					Emission (tons CO2eq)													0
					Fuel consumption													0
					Emission (tons CO2eq)													0
Total (tons CO2eq)						0	0	0	0	0	0	0	0	0	0	0	0	0

Add Rows

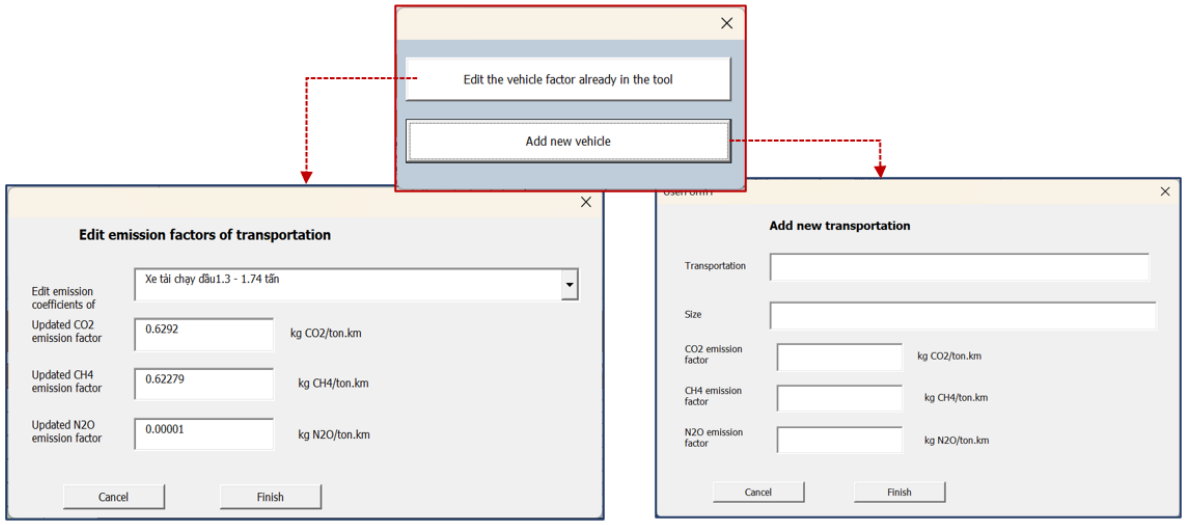
Step 4: Enter data and calculate emissions for phase 3: Distribution and retail

After selecting Phase 3: Distribution and retail in the user form, the **SOLAR PV PHASE 3** worksheet will appear.



- Transportation: Select vehicle types from the drop-down list
- Size: Select the size of the corresponding vehicle type from the drop-down list
- Emission factors: The EFs of the selected vehicle will load automatically
- Distance transported: Fill in the volume of goods movement for each type of vehicle

If the user wants to edit emission factors or add other types of transportation, the user can click on the "Add/Edit transportation" button.



Step 5: Fill information and calculate emissions for phase 4: Using the product

Do the same as step 2

Step 6: Fill information and calculate emissions for phase 5: Processing and Recycling

Do the same as step 2

Step 7: View the carbon footprint calculation results

Select the "Results" button on the toolbar, the **RESULTS** worksheet will appear.

Product's Data | Calculate other phases | RESULTS OF CALCULATION OF PRODUCT'S CARBON FOOTPRINT | Export results

REPORT ON PRODUCT CARBON FOOTPRINT CALCULATION RESULTS

A. General information

Company name:	0
Sector:	0
Address:	0
Phone number:	0
Email:	0
Year:	0

B. Carbon footprint calculation results

Product name Yarns

Product	Unit	Product output/revenue												Total
		Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	
Yarns	Million VND	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	12000

EMISSIONS OF PRODUCT LIFE CYCLE PHASES

Unit: tons CO2eq

Stages in the product emissions life cycle		Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Phase 1	Production and transportation of raw materials	80	120	160	200	240	280	320	360	400	440	480	520	3600
Phase 2	Product manufacturing	123	185	246	308	370	431	493	554	616	677	739	801	5543
Phase 3	Distribution and retail	123	148	172	197	222	246	271	295	320	345	369	394	3102
Phase 4	Using product	86	92	98	104	110	116	122	128	134	140	146	152	1428
Phase 5	Processing and Recyling	111	120	129	138	147	156	165	174	183	192	201	210	1926
Total (Tons CO2eq)		523	664	806	947	1088	1229	1370	1512	1653	1794	1935	2076	15598

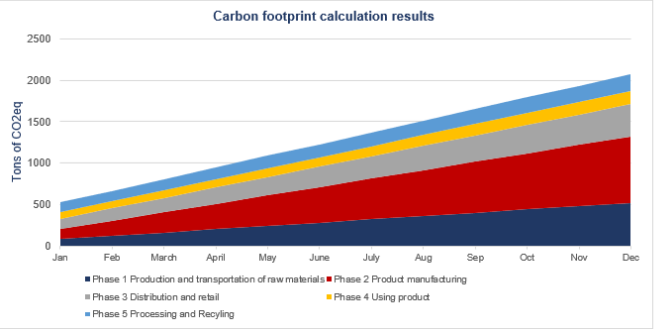
EMISSIONS STRUCTURE BY PRODUCT LIFE CYCLE PHASES

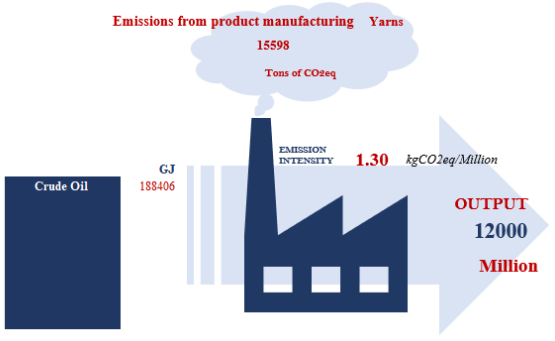
Unit: %

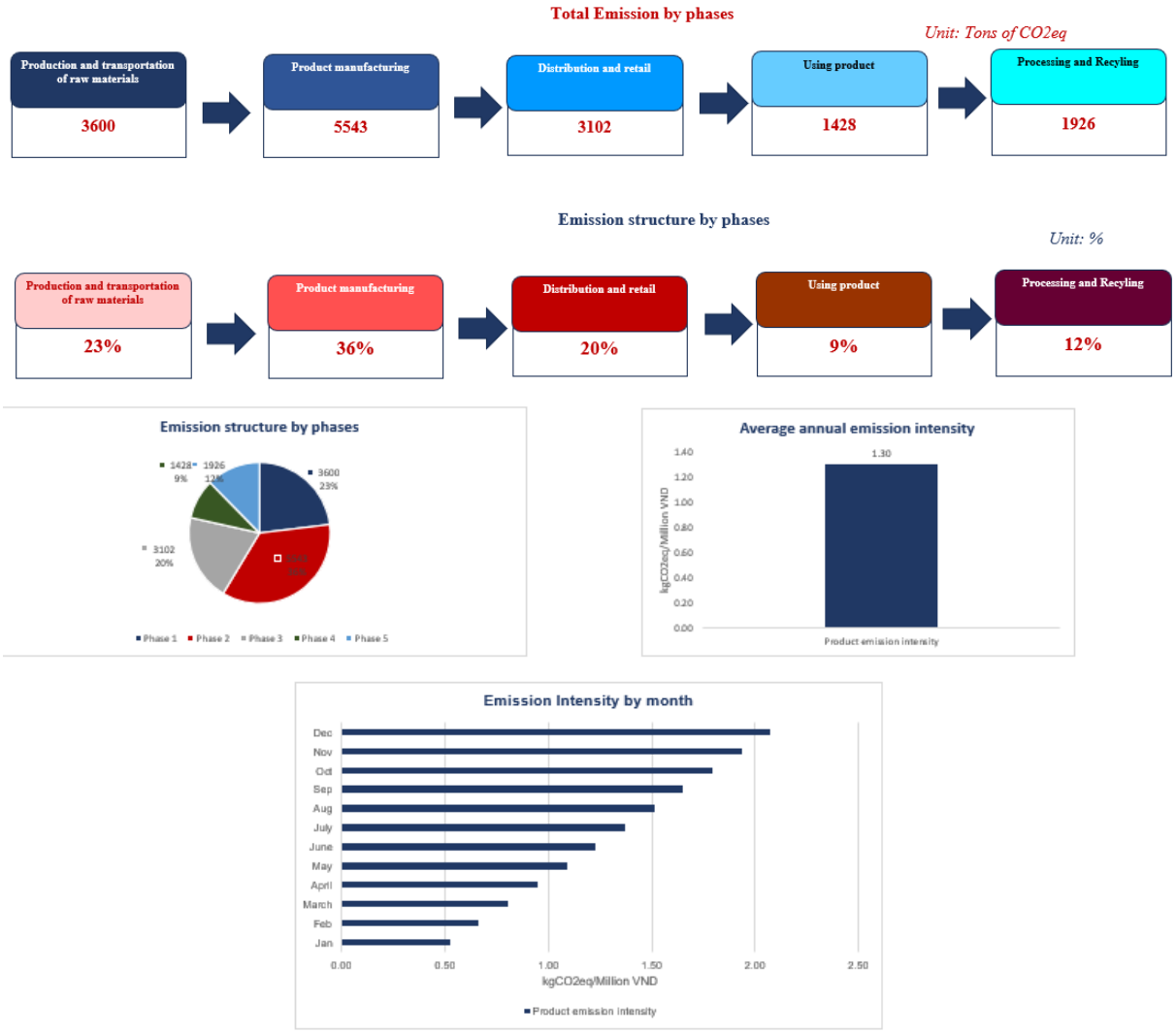
Stages in the product emissions life cycle		Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Phase 1	Production and transportation of raw materials	15%	18%	20%	21%	22%	23%	23%	24%	24%	25%	25%	25%	23%
Phase 2	Product manufacturing	24%	28%	31%	33%	34%	35%	36%	37%	37%	38%	38%	39%	36%
Phase 3	Distribution and retail	24%	22%	21%	21%	20%	20%	20%	20%	19%	19%	19%	19%	20%
Phase 4	Using product	16%	14%	12%	11%	10%	9%	9%	8%	8%	8%	8%	7%	9%
Phase 5	Processing and Recyling	21%	18%	16%	15%	14%	13%	12%	12%	11%	11%	10%	10%	12%
Total (Tons CO2eq)		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

EMISSIONS INTENSITY

kgCO2eq/Million VND	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Average annual emission intensity
Product emission intensity	0.52	0.66	0.81	0.95	1.09	1.23	1.37	1.51	1.65	1.79	1.94	2.08	1.30







To export the results as PDF, the user can click on "**Export results**".