


# IPPU SECTOR

# INVENTORY

## DISCLAIMER



## PREPARED UNDER

The Initiative for Climate Action Transparency (ICAT), supported by Austria, Canada, Germany, Italy, the Children's Investment Fund Foundation and the ClimateWorks Foundation.

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **AD** | Activity Data |
| **CFCs** | Chlorofluorocarbons |
| **CO2** | Carbon dioxide |
| **DEPC** | Department of Environment Protection and Conservation |
| **DOCC** | Department of Climate Change |
| **EF** | Emission Factor |
| **GHG** | Green House Gas |
| **GWP** | Global Warming Potentials |
| **HCFC** | Hydrochlorofluorocarbons |
| **HFCs** | Hydrofluorocarbons |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **IPPU** | Industrial processes and product Use |
| **NACC** | Nations Framework Convention on Climate Change |
| **ODS** | Ozone-depleting substances |
| **OLP** | Ozone Layer Policy |
| **PFCs** | Fluorocarbons |
| **QA/QC** | Quality Assurance/Quality Control |
| **RAC** | Refrigeration and Air-conditioning |
| **RTI** | Right to Information |
| **SF6** | Sulfur hexafluoride |
| **VCIR** | Vanuatu Customs & Inland Revenue |
| **VNSO** | Vanuatu National Statistics Office |

## 2.1 SECTOR OVERVIEW

### 2.1.1. 2.F.1a CATEGORY OVERVIEW

The Refrigeration and stationary air conditioning (RAC) category (2.F.1.a) in the 2006 IPCC methodological Guidelines for national GHG inventories (2006 IPCC)[1] plays a vital role in addressing the ozone-depleting substances (ODS) emitted from the industrial processes and product use sector (IPPU). (RAC) systems may be classified into up to six sub-application domains or categories:

(i) Domestic (i.e., household) refrigeration,

(ii) Commercial refrigeration including different types of equipment, from vending machines to

centralized refrigeration systems in supermarkets,

(iii) Industrial processes including chillers, cold storage, and industrial heat pumps used in the food, petrochemical, and other industries,

(iv) Transport refrigeration including equipment and systems used in refrigerated trucks, containers, reefers, and wagons,

(v) Stationary air conditioning including air-to-air systems, heat pumps, and chillers for building and residential applications,

(vi) Mobile air-conditioning systems used in passenger cars, truck cabins, buses, and trains.

For all these sub-applications, different hydrofluorocarbons (HFCs) are progressively replacing chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). Many blends containing HFCs and/or PFCs are being used in Refrigeration and Air Conditioning applications. The tables with the list of HFCs and the commercial blends used to include their global warming potentials (GWPs) as well as the table with blend composition for the most commonly used blends in Vanuatu are included in Annex 1 to this document.

Regarding Vanuatu, the 2.F.1.a category which covers refrigeration and steady air conditioning, is the most appropriate one based on data availability.

[1] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_7_Ch7_ODS_Substitutes.pdf

### 2.1.2 REFRIGERATION AND AIR CONDITIONING in VANUATU

Refrigeration and air conditioning in Vanuatu mainly focus on residential and commercial applications; examples include conditioning systems in hotels, resorts, and government buildings and refrigeration systems for food storage. A large portion of the sector is run by HCFCs and HFCs, which extend their use in a variety of applications. Regardless of the uses of these ODS, they are categorized as potent greenhouse gases with high global warming potential (GWP). Consequently, there is a need to acquire a sustainable alternative to these substances that can deliver the same but better performance while trying to diminish Environmental impact.

The primary imports into Vanuatu are mixes of R-134A, R404A, R-407C, R-507C, and R-410A. R404A has a composition of (44.0/52.0/4.0) and is made up of HFC-125, HFC-143a, and HFC-134a. Conversely, R-407, which has a composition of (44.0/52.0/4.0), makes up HFC-125/HFC-143a/HFC-134a[1]. Thus, HFC-32, HFC-125, HFC-143a, and HFC-134a are the specific gases that Vanuatu uses the most.

The most often released fluorinated gas in Vanuatu is HFC-134a, a refrigerant. Hydrofluorocarbons (HFCs) like HFC-134a are commonly found in air conditioning and refrigeration systems. When released into the atmosphere, it has a large global warming potential (GWP) and greatly contributes to climate change.

In the year of 2015, Vanuatu completed a project aided by the United Nations and the Multilateral Fund for the implementation of the Montreal Protocol, to replace HCFCs in its air conditioning and refrigeration systems with HFCs (Roberts, 2023).

The transition away from ODS in refrigeration and air conditioning to adopting the use of HFC has proven to be one of the key categories. HFCs lack chlorine which is a primary ozone-depleting component in CFCs and HCFCs (National Research Council, 1996). Though HFCs do not deplete the ozone layer, they are still potent greenhouse gases with a high global warming potential (Ravishankara et al., 2011). Therefore, ongoing research is still on the way to finding alternative HFCs that are friendly and energy efficient. One of the categories that is most significant has shown to be the shift from ODS to HFC in air conditioning and refrigeration. Chlorine, the main ozone-depleting compound in CFCs and HCFCs, is absent in HFCs (National Research Council, 1996). HFCs are strong greenhouse gases with a high potential for global warming even though they do not destroy the ozone layer (Ravishankara et al., 2011). Consequently, continued study is needed to identify safe and energy-efficient replacements for HFCs.

The DEPC currently encourages the importing of environmentally friendly gases like R600 and R290. Vanuatu prohibits the shipment of any regulated substances, including CFCs, due to the Ozone Layer Policy (OLP) Act Regulation Order No. 20 (Roberts, 2023)

The phase-out of ODS in refrigeration and air conditioning systems requires a comprehensive approach that involves not only finding suitable substitutes but also addressing issues related to system design, energy efficiency, leak prevention, and proper disposal of old equipment containing ODS.

## 2.2. REFERENCE MANUAL

### 2.2.1. Data Collection

Data requirement for simplified Tier 1 a/b approach:

- Information on domestic **production, import, and export** of fluorinated agents in the year to be reported. Information should include total mass of agents (e.g., tonnage), where available.
- **Introduction year** of the refrigerant.
- **Growth rate** in sales of new equipment (usually assumed linear across the period of assessment).
- Assumed **equipment lifetime** (IPCC default is 15 years for household equipment)
- **Remaining agent** in retired equipment (set at **0** if unknown)
- **Destruction of agent** in retired equipment (set at 0 if unknown)
- **Release of agent** from retired equipment (set at 0 if unknown)

Minimum Data requirements per agent in Vanuatu's market:

- **Year of introduction** of agent
- **Domestic production** of agent (tonnes) in current year
- **Imports** of agent (tonnes) in current year
- **Export** of agent (tonnes) in current year
- **Growth rate** of equipment sales that uses the agent.

Data needed for baseline and further reporting. For HFCs,

- Data from the GHG inventory, specifically **HFC blends[2] or/and individual chemicals** used in Vanuatu.
- Actual or modeled data for **HFC consumption** (as individual chemicals or blends) for the complete period of 2005 - 2022.
- Data on the **composition of blends imported** in Vanuatu (per blend, if any), otherwise use default values from the blend composition table shown on Table 2.2.1.1 and Table 2.2.1.2. (Refer to Annex).

### 2.2.2. Data Sources (Departments, Stakeholders)

The Country's specific data can be collected from:

- Vanuatu Customs & Inland Revenue (VCIR)
- Vanuatu National Statistics Office
- Department of Environmental Protection and Conservation (DEPC)
- Department of Climate Change (DOCC)

[2] Refrigerant blends contain a mixture of one or more refrigerant type.

Once a data set is selected, a more detailed formal specification of data should be created. A clear clarity of data requirements will allow data that is requested to be delivered upon expectation. The specification should include details such as:

- Definition of the data set (e.g., time series, sectors and sub-sector detail, national coverage, requirements for uncertainty data, emission factors and/or activity data units).
- The format (e.g., spreadsheet) and structure (e.g., what different tables are needed and their structure) of the data set,
- Description of any assumptions made regarding national coverage, the sectors included, representative year, technology/management level, and emission factors or uncertainty parameters.
- Identification of the routines and timescales for data collection activities (e.g., how often is the data set updated and what elements are updated).
- Reference to documentation and QA/QC procedures.
- Contact name and department/ organization.
- Date of availability.

(Goodwin, Woodfield, Ibnoaf, Koch, & Yan, 2006)

**Flowchart 2.2.2.1: Flowchart of sources and access to required data**

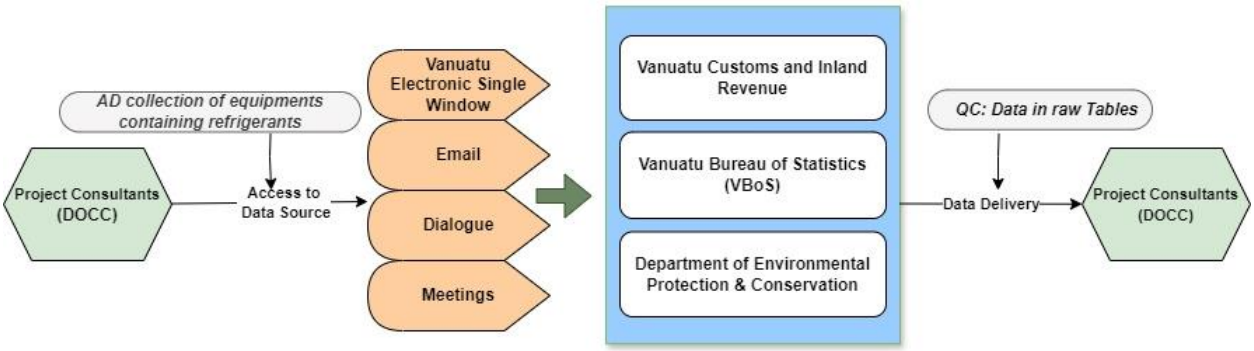


*Table 1: Detailed Information of Collecting Data from Sources.*

| Department/ Organization | Roles and Responsibility | Dates | Relevant Governing Arrangement | Contact Person | Comments |
|---|---|---|---|---|---|
| Vanuatu Customs and inland Revenue (VCIR) | To provide data on imports and exports of F-gases (ODS Substitutes – Refrigerants) to DOCC | 2nd of April every year – 1st week of May | Memorandum of understanding or Right to Information (RTI) between VCIR and DOCC | Customs Revenue Section, Port Vila<br>Email: customsrevenue@vanuatu.gov.vu<br>Tel: +678 33091 | DOCC needs to send a prompt letter to VCIR 1-2 months prior.<br><br>A follow-up email or call is crucial as well. |
| Vanuatu National Statistics Office | Provide statistical data and information on import products containing refrigerants to DOCC | 2nd of April every year – 1st week of May | Memorandum of understanding or Right to Information (RTI) between the Vanuatu National Statistics Office and DOCC | Vanuatu National Statistics Office<br>Tel: (678) 22110 / 22111 / 33040<br>Email: stats@vanuatu.gov.vu<br><br>Name: Mento Susie (Senior Statistician - Disaster & Environment)<br>Email:<br>Tel:<br><br>Leo Charlington (Principal Statistician Social & Environment)<br>Email:<br>Tel: | DOCC needs to send a prompt letter to Vanuatu National Statistics Office 1-2 months prior.<br><br>A follow-up email or call is crucial as well. |
| Department of Environmental Protection & Conservation | Provide information on products containing refrigerants and data related to environmental impact | 2nd of April every year – 1st week of May | Memorandum of understanding or Right to Information (RTI) between the Department of Environmental Protection & | The Environmental Protection Unit.<br><br>Roselyn Bue Senior Officer (Chemical and Ozone) | DOCC needs to send a prompt letter to the Department of Environmental Protection & Conservation 1-2 months prior. |

| | | | | | |
|---|---|---|---|---|---|
| | assessments, regulations, and policies regarding the usage of refrigerants. | | Conservation and DOCC | Email: rbue@vanuatu.gov.vu<br><br>Richard Petterson<br>Ozone Assistant Officer<br>Project (s): IS (Ozone)<br>Email: rpetterson@vanuatu.gov.vu | A follow-up email or call is crucial as well. |
| Department of Climate Change (DOCC) | DOCC is responsible to send a formal letter requesting relevant data to the Vanuatu Customs and Inland Revenue, The National Statistics Office and The Environmental Protection and Conservation. | February – March every year | Provide a Memorandum of understanding or Right to Information (RTI) to the Vanuatu Customs and Inland Revenue, the National Statistics Office and the Environmental Protection and Conservation | Nelson Kalo<br>Director of Climate Change<br>Email: nekalo@vanuatu.gov.vu | DOCC is responsible for doing a follow-up to the departments or organization for the required data to be delivered upon schedule. |

### 2.2.3. Data Assumptions

- A hybrid Tier 1a/b approach can use these assumptions for air conditioning and refrigeration in Vanuatu. The following assumptions were made: (See 2006 IPCC Guidelines, Volume 3 Chapter 7, Emissions of fluorinated substitutes for ozone depleting substances, Section 7.5.2 for discussion on *Methodological issues*)
- HFCs and PFCs are not produced nor exported from Vanuatu.
- Assumed percentage of new equipment exported for Vanuatu is **0%.**
- Assumed percentage of new equipment imported for Vanuatu. (To be determined)
- Emissions from banked refrigerant average is **15%** annually through every RAC application area (Default value from IPCC Guideline).
- Equipment servicing does not commence until **3 years** after installation of equipment.
- In a mature market, **2/3 (67%)** of refrigerant sales are used for servicing while **1/3 (33%)** are used to charge for new equipment. (Default value from IPCC Guideline)
- Across all sub applications, the average equipment lifetime is **15 years.** (Default value from IPCC Guideline).

The HFC emissions from air conditioning and refrigeration did not occur until 2005(Ashford, et al., 2006)

## 2.3 ESTIMATING GREENHOUSE GAS EMISSIONS

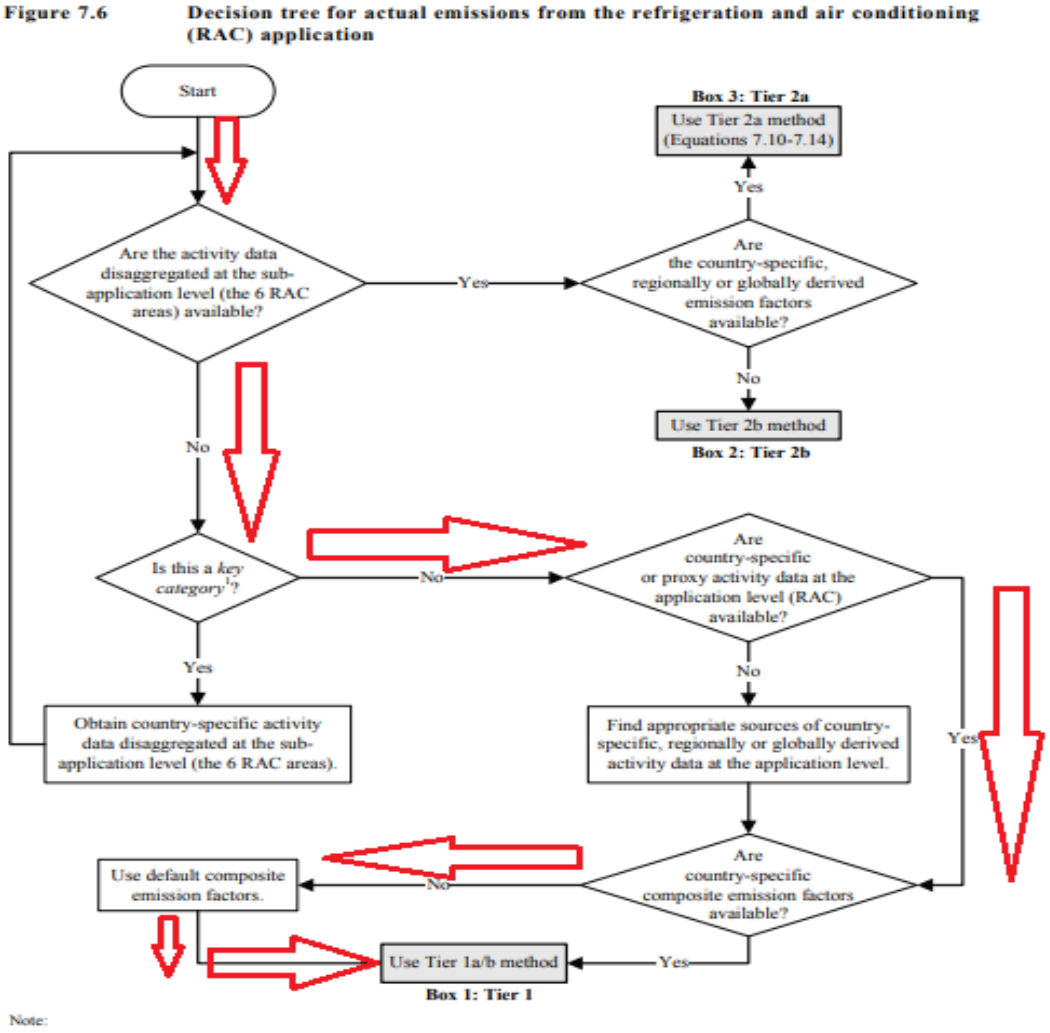



*Figure 1.0: displays the decision tree employed for selecting the method approach for actual emissions from the refrigeration and air conditioning (RAC) application. The decisions implemented during this operation are indicated by the red arrows.*

(See 2006 IPCC Guidelines, Vol. 3, Figure 7.6)

Note: Due to the national circumstances (lack of resources) Vanuatu does not have yet reliable country-specific emission factors and parameters and therefore, is applying the default parameters and Tier 1 methods to estimate emissions from the 2.F.1.a category.

### 2.3.1 METHODOLOGY CHOICE

Vanuatu mostly imports specific RAC applications as the nation does not manufacture or export refrigeration and air conditioners (RAC). The following justifies the adoption of the IPCC guideline's Tier 1a/b hybrid approach. First off, only fixed air conditioners and refrigeration in domestic and commercial properties will be examined in this analysis. Accordingly, we won't be looking into the other RAC areas, which include transport refrigeration and mobile air conditioning systems. Additionally, government agencies offer country-specific data at the application level (RAC), which can be obtained. Furthermore, Vanuatu does not have a country-specific composite emission factor available, so the IPCC Default composite emission factor will be applied. To aid in the selection process, the decision tree about real emissions from Refrigeration and Air Conditioning (RAC) applications that were extracted from (2006 IPCC Guidelines, Vol. 3, Figure 7.6) is shown in Figure 1.0. The decisions made in this method are shown by the red arrows.

Boxes 1.1 and 1.2, respectively, provide the formulas for calculating the Annual Emissions of a Chemical from an Application with Banks and the Net Consumption of a Chemical in a Specific Application.

***BOX 1.1***

**IPCC (2006) EQUATION 7.2B**

CALCULATION OF EMISSIONS OF A CHEMICAL FROM AN APPLICATION WITH BANKS

Annual Emissions = Net Consumption x Composite $EF_{FY}$ + Total Banked Chemical x Composite $EF_B$

Where:
Net Consumption = Production + Imports – Exports – Destruction (Refer to equation 7.1 below)

Composite $EF_{FY}$ = composite emission factor for the application for the first year (see 2006 IPCC Guidelines, Vol. 3, pg. 7.14, EQUATION 7.2b).

Total Banked Chemical = bank of the chemical for the application (see 2006 IPCC Guidelines, Vol. 3, pg. 7.14, EQUATION 7.2b).

Composite $EF_B$ = composite emission factor for the bank application (see 2006 IPCC Guidelines, Vol. 3, pg. 7.14, EQUATION 7.2b).

***BOX 1.2***

**IPCC (2006) EQUATION 7.1**

CALCULATION OF NET CONSUMPTION OF A CHEMICAL IN A SPECIES APPLICATION

Net Consumption = Production + Imports – Exports - Destruction

(See 2006 IPCC Guidelines, Vol. 3, pg. 7.14, EQUATION 7.1)

## 2.3.2 STEP – BY – STEP CALCULATION, DOCUMENTING RESOURCES USED

*Table 2: a list of steps to perform to calculate the Total Tonne of each agent, starting with activity data obtained.*

| STEPS | | DESCRIPTION | EQUATION OR DEFAULT VALUE | IPCC GUIDELINES TO FIND TABLE OR EQUATION |
|---|---|---|---|---|
| 1 | Activity Data Based on Imports Data (1 of 2) | Collect data from the customs department in Vanuatu on the commodity which includes the Refrigerators, freezers, and other refrigerating or freezing equipment. | | |
| 1.1 | Activity Data Based on Imports Data (2 of 2) | Collect data on the Annual Imports (VT Million) remember to record the source, where the data was collected. | | |
| 1.2 | Refrigerators and Refrigerating Assumptions (1 of 2) | collect data on the Unit price and find the average price per unit (assuming that there is a 2% annual inflation) then Calculate the number of new units imported by using the following equation | Number of new units imported = total import $ / unit $ | |
| 1.3 | Refrigerators and Refrigerating Assumptions (2 of 2) | Calculate the number of new units imported for Air Conditioning and Refrigerators by multiplying the number of new imports by the percentage (%) of applications within Vanuatu. | | |
| 1.4 | Refrigerator and AC Assumptions (1 of 2) | Record the sources of where the following data have been collected from: | | |
| | | - Percentage of households that have an (A/C) system | | |
| | | - Percentage of households that have one or more refrigerators | | |
| 1.5 | Refrigerator and AC Assumptions (2 of 2) | use the information collected from step 6 to find Acquisition Assumption (% of New Units Imported) | Percentage of commercial AC = 100% - percentage of household (domestic) | |
| 1.6 | Total New Units by Equipment Type and End User | Calculate the total new units by equipment type and end-user by: | (Total New units by Equipment Type) X (Acquisition assumption) | |
| | | | Equipment charge Value (Table 1) in manual | (2006 IPCC Defaults (Volume 3, Chapter 7, Table 7.9) |
| 1.7 | Calculated Total Tonnes of HFC | To calculate the total tonnes of HFC we use the following formula | HFC (kg) = Number of Units * Equipment Type charge (KG) | The Equipment Type charge (see 2006 IPCC Defaults (Volume 3, Chapter 7, Table 7.9) |
| 1.8 | Calculating individual chemical kg within a HFC blend | To calculate individual chemicals (Kg) the following equation is used | HFC (kg) = Total HFC Blend (kg) * HFC (% of blend | blends containing HFCs and/or PFCs (see 2006 IPCC Defaults, Volume 3, Chapter 7, Table 7.8) |
| 1.9 | Calculating kg per HFC type | Use the equation in step 1.7 to calculate each HFC type | HFC (kg) = Number of Units * Equipment Type charge (KG) | |
| 2 | TOTAL HFC TONNES | Add up all the blend compositions for each year. | | |

Note: Challenges may arise due to inaccuracies in the unit price and total expenditure figures thus leading to discrepancies in the estimated number of units imported. The uncertainty can be high when dealing with various types of equipment and chemicals that may have fluctuating prices or varying quantities used across the different sectors. Therefore, In the near future

Vanuatu should strive to collect precise data on both the number of equipment item and the specific chemicals used in each application. This should help to minimize uncertainty in the evaluation of imports, as well as in the greenhouse gas (GHG) estimations within the industrial processes and product use (IPPU) sector.

Values for unit price assumptions can be obtained from the statistics single window[3].

*Table 3: Assumptions table with default values of Equipment type and its sub-applications together with their equipment charge in Kg extracted from the IPCC Guide*

| EQUIPMENT TYPE | SUB-APPLICATION | EQUIPMENT CHARGE (KG) |
|---|---|---|
| Air Conditioning | Residential and Commercial AC | 10 |
| Refrigeration | Commercial Refrigeration | 28 |
| | Domestic Refrigeration | 0.5 |

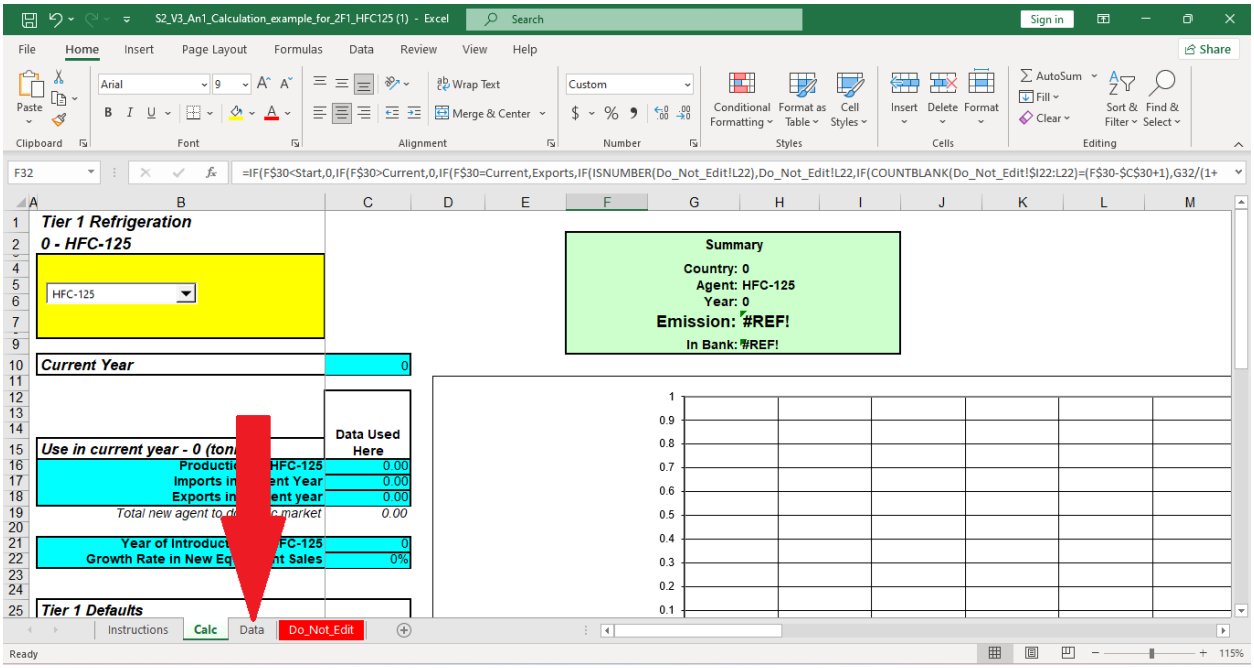
Note: The stand-alone application has a value of 6 and the Medium and large commercial Refrigeration has a lower value of 50, a midpoint of 28 will be used.

(See 2006 IPCC Defaults, Volume 3, Chapter 7, Table 7.9)

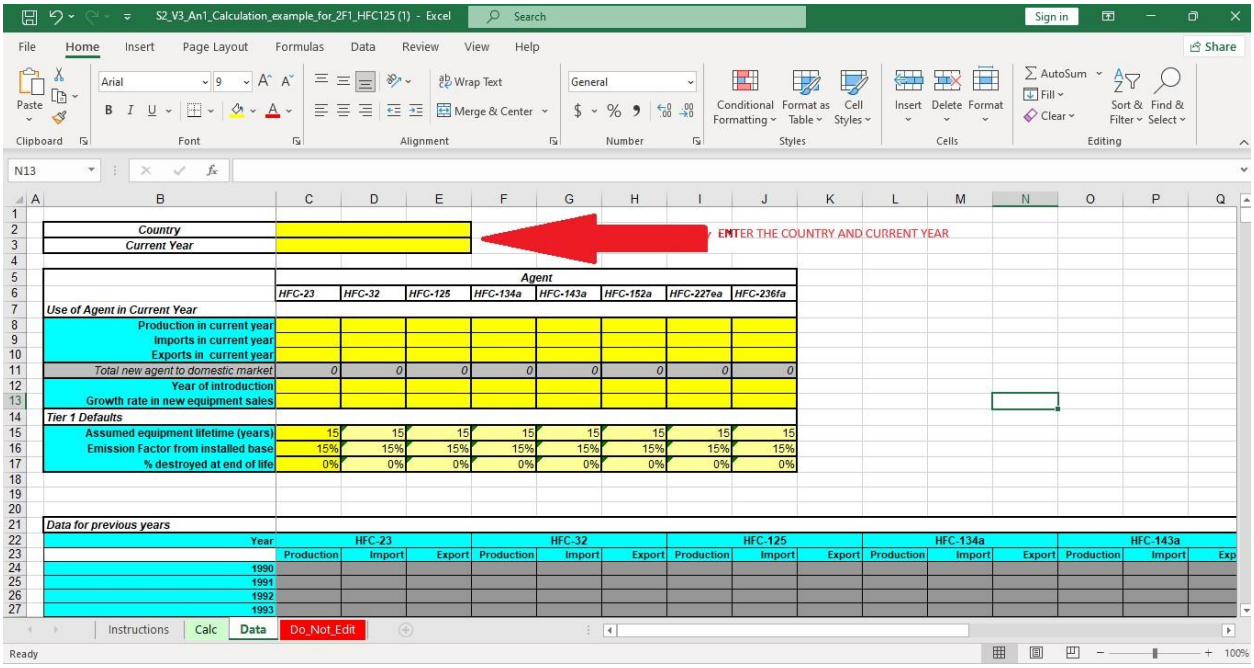
[3] https://singlewindow.gov.vu/portal/services/swApprovedAppliances/appliances.jsf

**USING EXCEL TO CALCULATE THE EMISSIONS FROM THE TOTAL TONNES OF AGENTS using file S2_V3_An1_Calculation_example_for_2F1_HFC125**

1. 1 Select the "DATA" tab (illustrated by the red arrow)

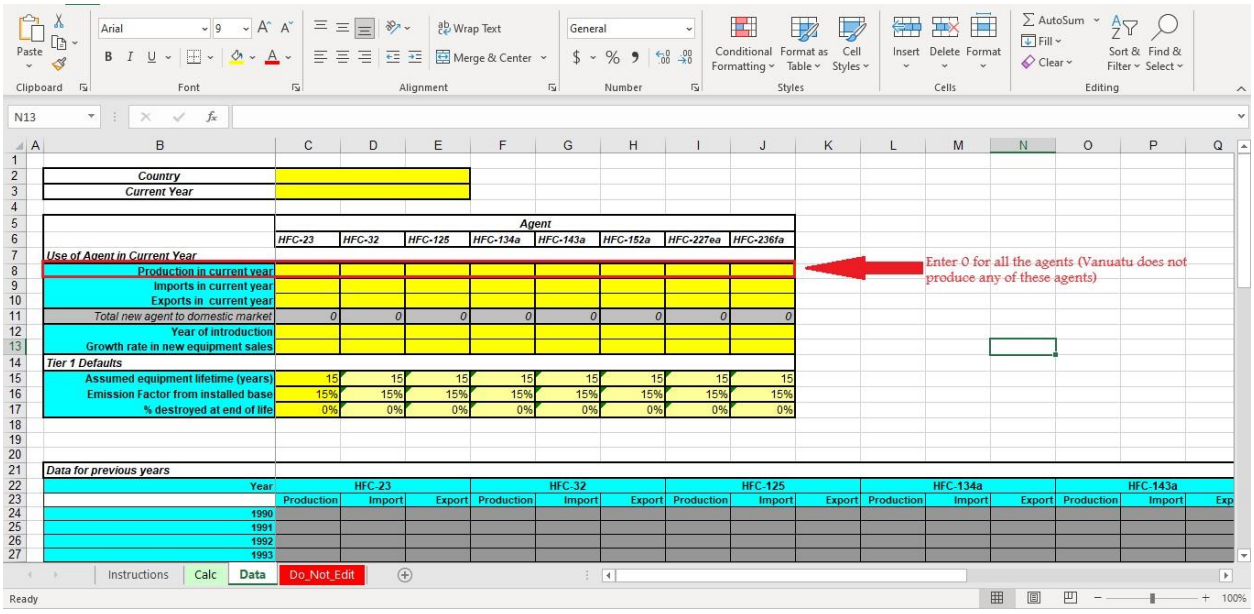



1.2 Enter "VANUATU" as a country in yellow Cell C2 (see red arrow)

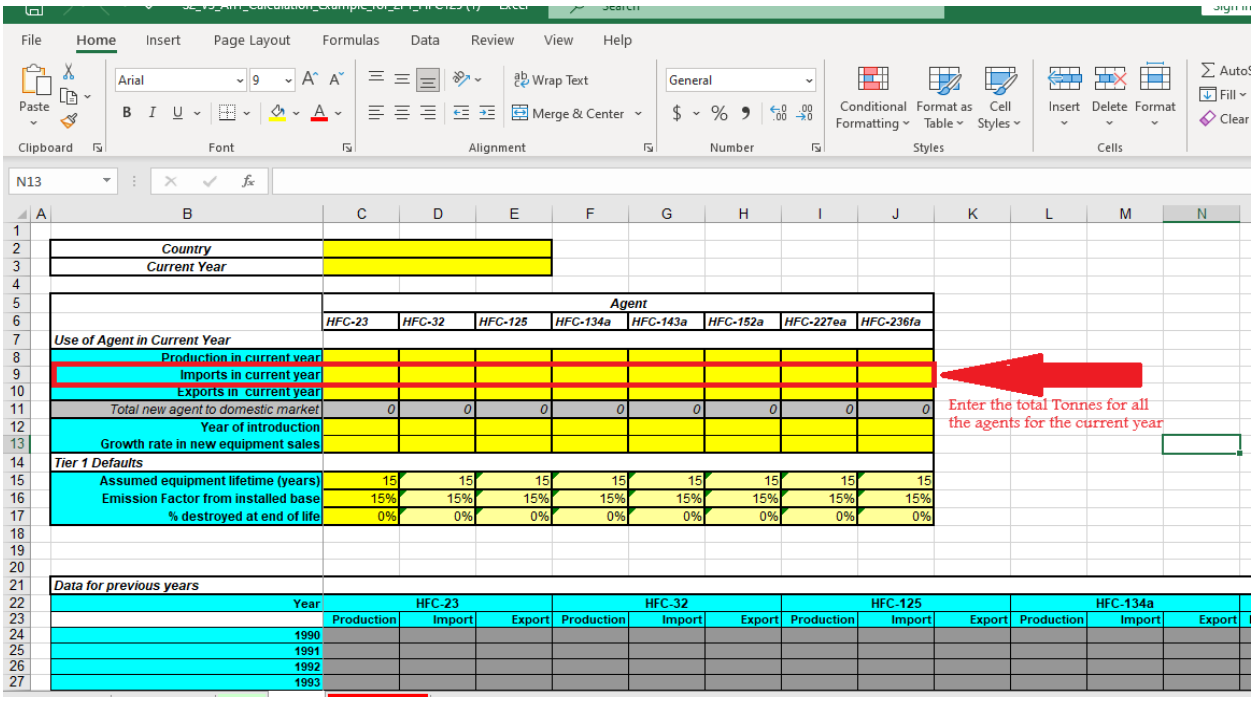


1.3 Enter the relevant year (2023) in yellow cell C3 (see illustration in step 1.2)

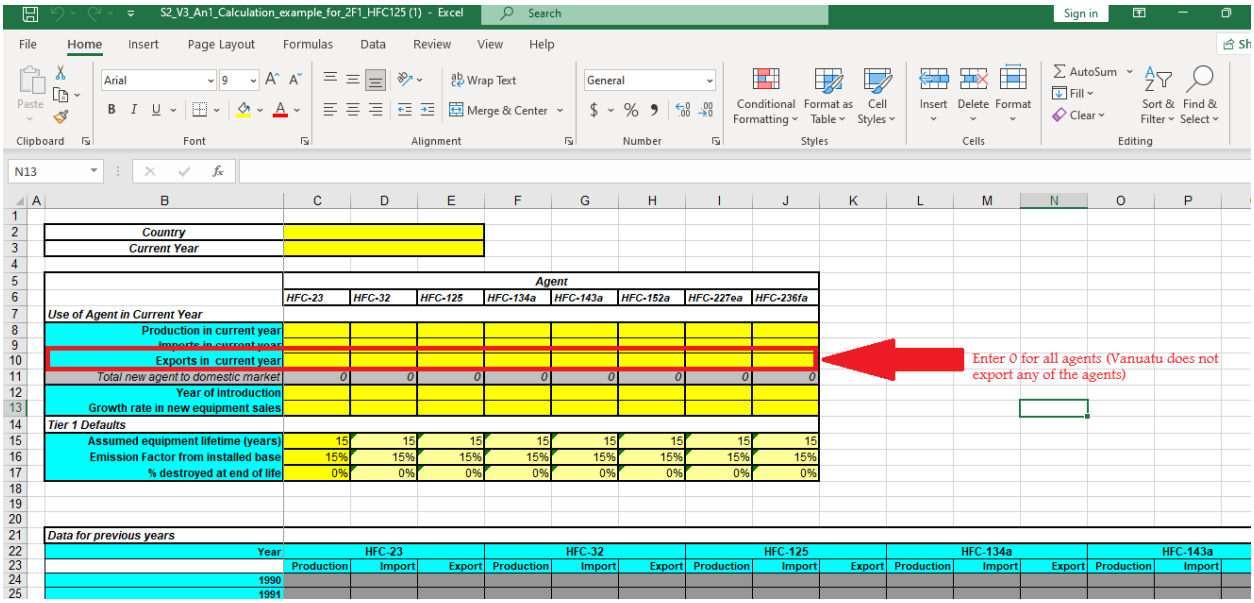
1.4 Enter 0 in yellow cells C8 to J8 as none of the agents are produced in Vanuatu, (see red arrow in the figure below)




1.5 Enter the total imports for each of the individual HFC agents that Vanuatu imported into the yellow cells C9 through J9 (note: ensure that the total HFC agent is in "TONNES"). (See red arrow below illustrated in the figure below)



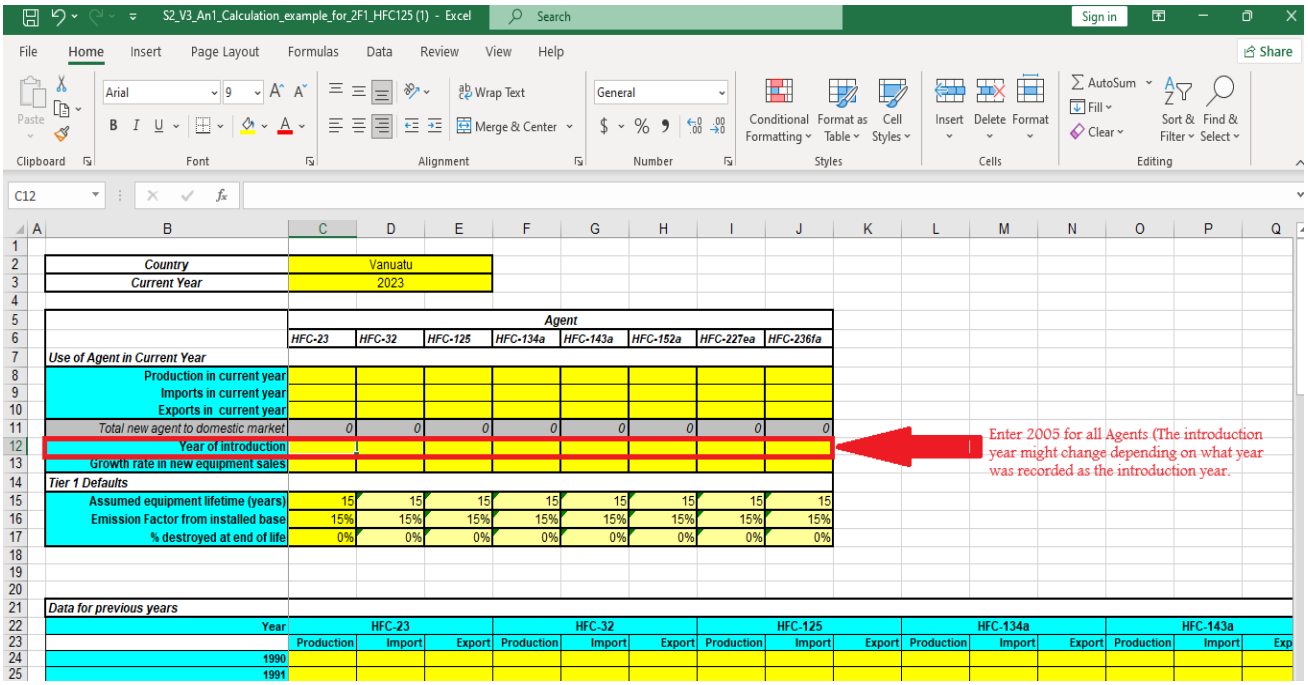
1.6 Enter 0 in yellow cells C10 to J10 as none of the HFC agents are exported from Vanuatu (see red arrow below illustrated in the figure below)




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Country | | | | | | | | |
| | Current Year | | | | | | | | |
| | | Agent | | | | | | | |
| | | HFC-23 | HFC-32 | HFC-125 | HFC-134a | HFC-143a | HFC-152a | HFC-227ea | HFC-236fa |
| | Use of Agent in Current Year | | | | | | | | |
| | Production in current year | | | | | | | | |
| | Imports in current year | | | | | | | | |
| | Exports in current year | | | | | | | | |
| | Total new agent to domestic market | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Year of introduction | | | | | | | | |
| | Growth rate in new equipment sales | | | | | | | | |
| | Tier 1 Defaults | | | | | | | | |
| | Assumed equipment lifetime (years) | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| | Emission Factor from installed base | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% |
| | % destroyed at end of life | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Data for previous years | | | | | | | | | | | | | | |
| | Year | HFC-23 | | | HFC-32 | | | HFC-125 | | | HFC-134a | | | HFC-143a | |
| | | Production | Import | Export | Production | Import | Export | Production | Import | Export | Production | Import | Export | Production | Import |
| | 1990 | | | | | | | | | | | | | | |
| | 1991 | | | | | | | | | | | | | | |

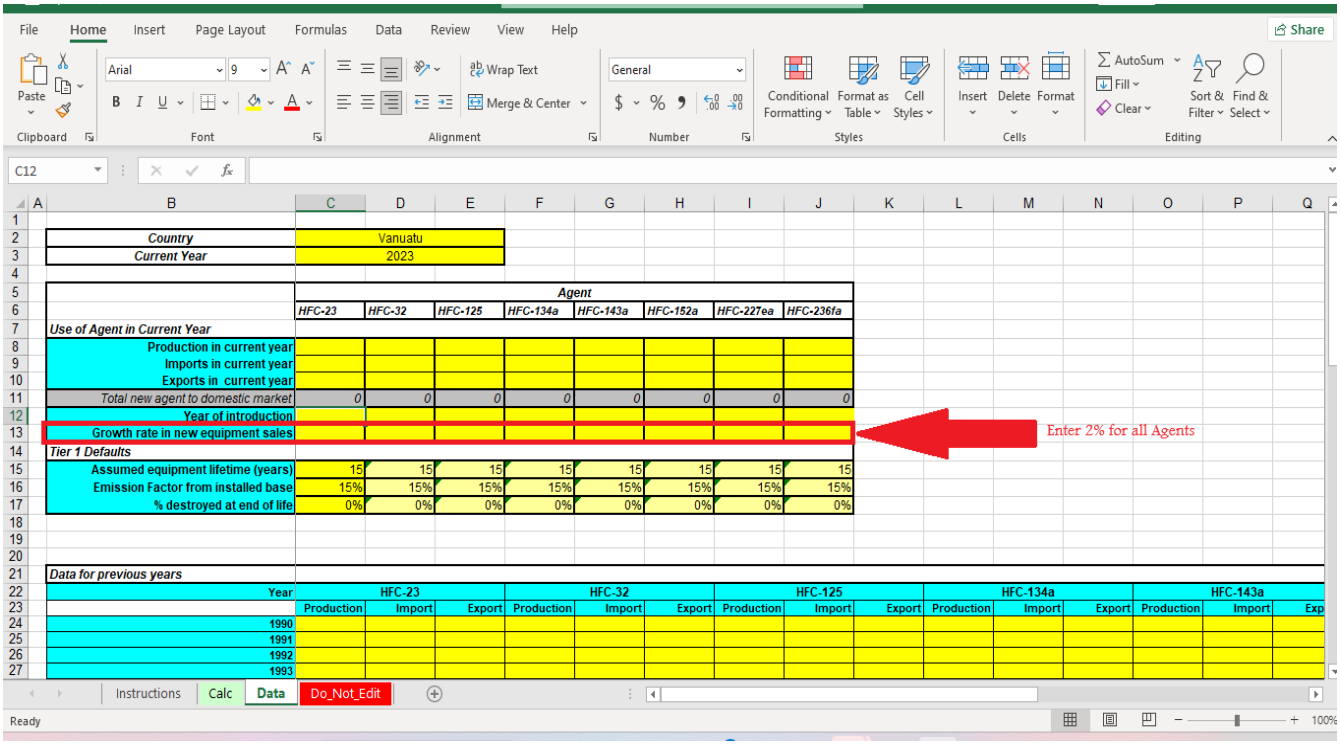
1.7 Enter 2005 yellow cells C12 through J12 (See red arrow illustrated in the figure below). The introduction year might change depending on what year was recorded as the introduction year.



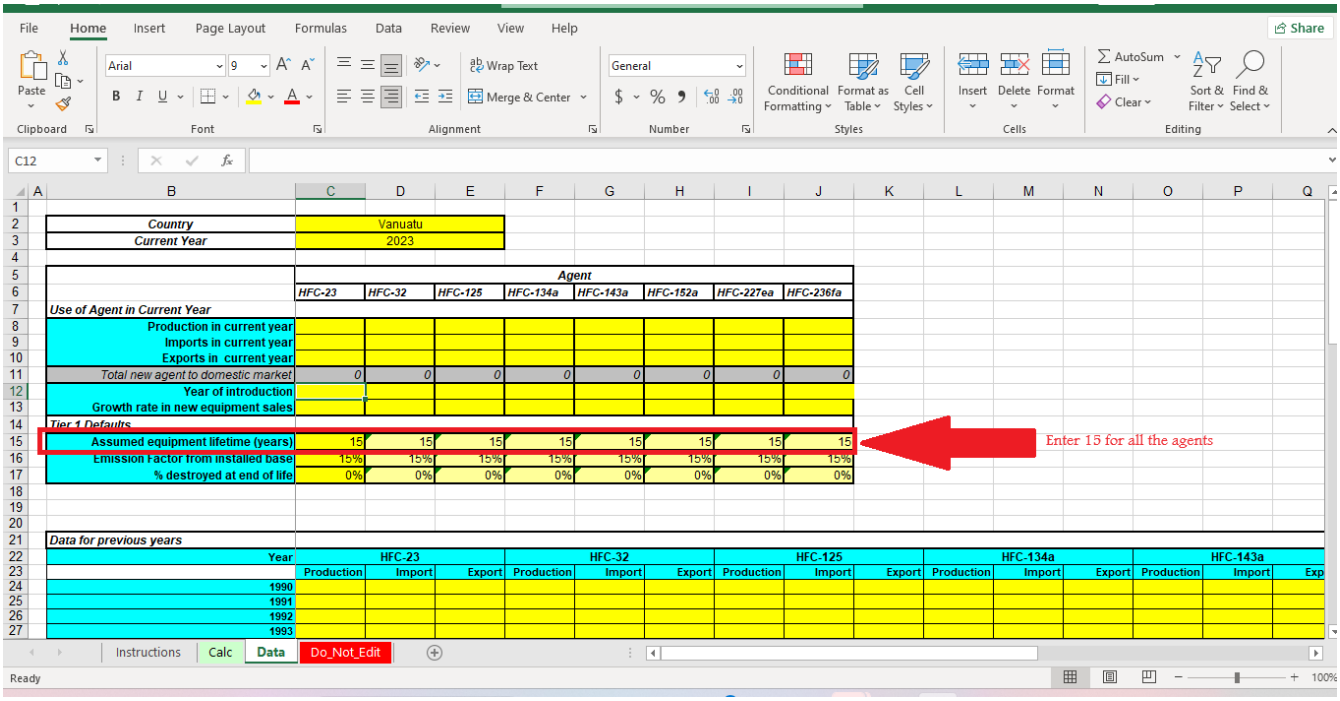

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Country | Vanuatu | | | | | | | |
| | Current Year | 2023 | | | | | | | |
| | | Agent | | | | | | | |
| | | HFC-23 | HFC-32 | HFC-125 | HFC-134a | HFC-143a | HFC-152a | HFC-227ea | HFC-236fa |
| | Use of Agent in Current Year | | | | | | | | |
| | Production in current year | | | | | | | | |
| | Imports in current year | | | | | | | | |
| | Exports in current year | | | | | | | | |
| | Total new agent to domestic market | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Year of introduction | 1 | | | | | | | |
| | Growth rate in new equipment sales | | | | | | | | |
| | Tier 1 Defaults | | | | | | | | |
| | Assumed equipment lifetime (years) | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| | Emission Factor from installed base | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% |
| | % destroyed at end of life | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Data for previous years | | | | | | | | | | | | | | |
| | Year | HFC-23 | | | HFC-32 | | | HFC-125 | | | HFC-134a | | | HFC-143a | |
| | | Production | Import | Export | Production | Import | Export | Production | Import | Export | Production | Import | Export | Production | Import |
| | 1990 | | | | | | | | | | | | | | |
| | 1991 | | | | | | | | | | | | | | |

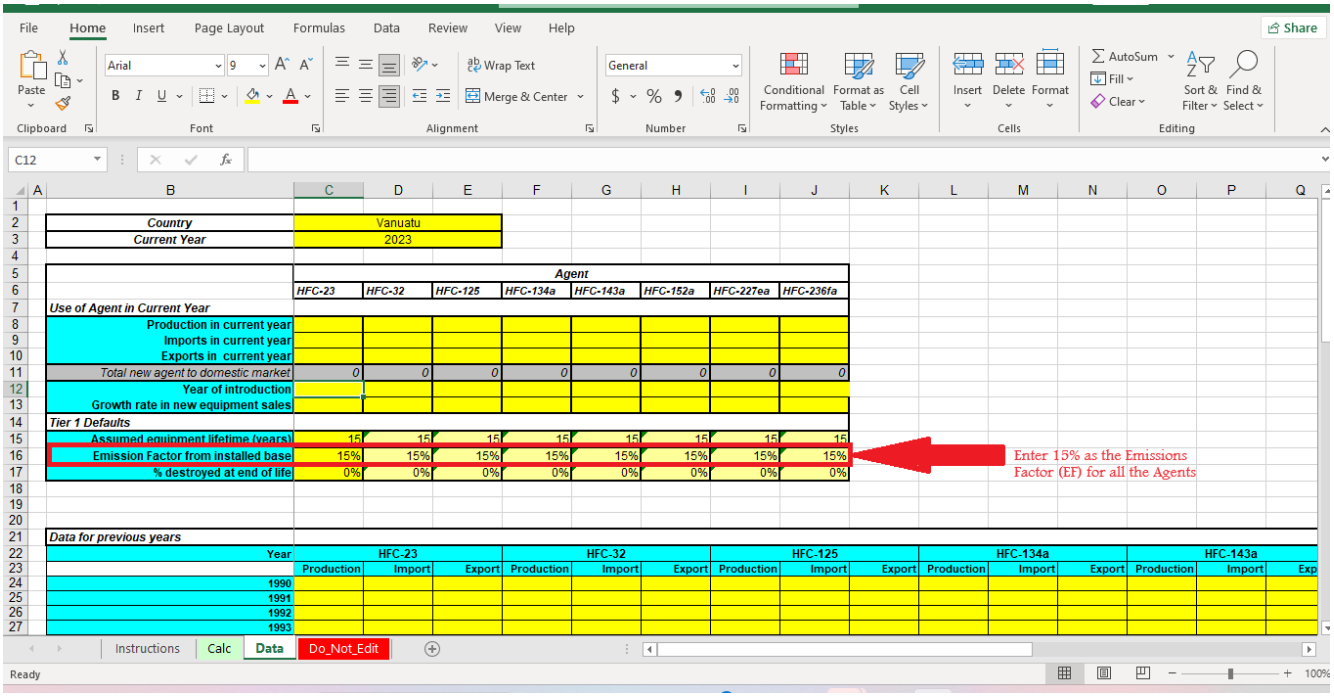
1.8 Add 2% to cells C13 through J13.




1.9 Insert 15 in the yellow cells C15 to J15.



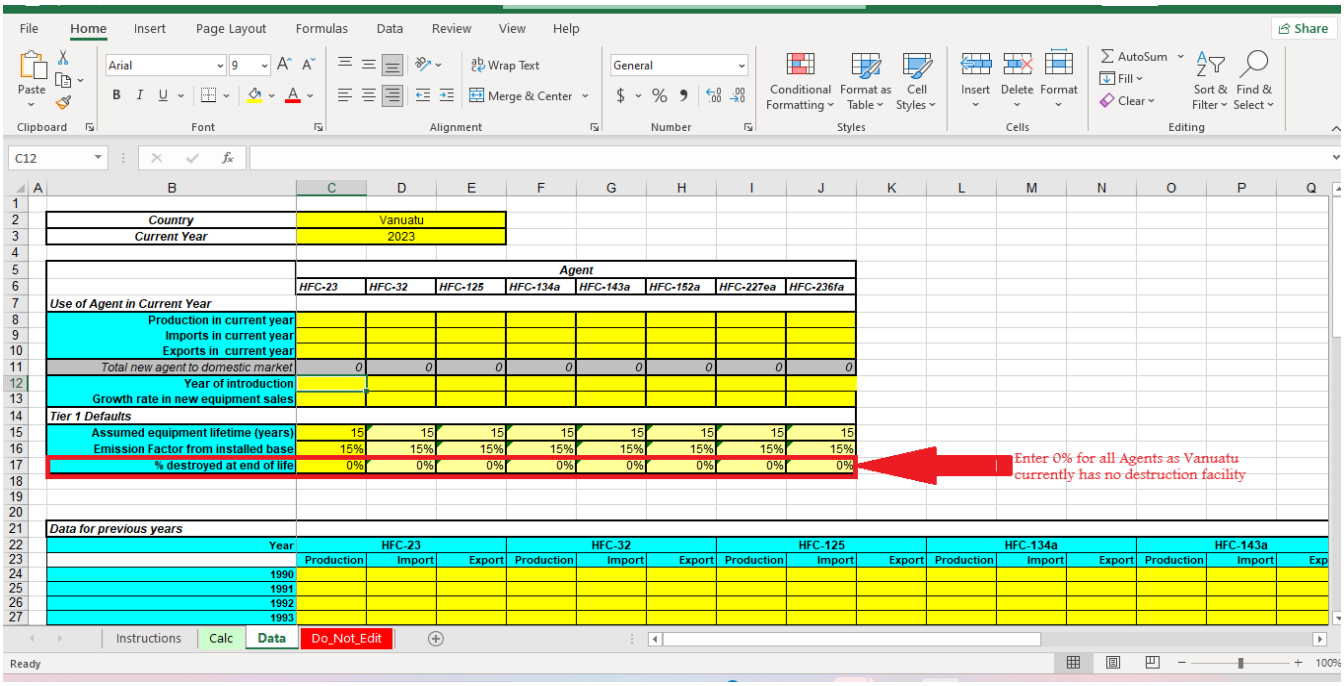
2.0 Insert 15 in the yellow cells C16 to J16 (See red arrows in the illustration below)




| | | Agent | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | HFC-23 | HFC-32 | HFC-125 | HFC-134a | HFC-143a | HFC-152a | HFC-227ea | HFC-236fa |
| Use of Agent in Current Year | | | | | | | | | |
| Production in current year | | | | | | | | | |
| Imports in current year | | | | | | | | | |
| Exports in current year | | | | | | | | | |
| Total new agent to domestic market | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Year of introduction | | | | | | | | | |
| Growth rate in new equipment sales | | | | | | | | | |
| Tier 1 Defaults | | | | | | | | | |
| Assumed equipment lifetime (years) | | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Emission Factor from installed base | | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% |
| % destroyed at end of life | | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |

| Data for previous years | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | HFC-23 | | | HFC-32 | | | HFC-125 | | | HFC-134a | | | HFC-143a | | | | |
| | Production | Import | Export | Production | Import | Export | Production | Import | Export | Production | Import | Export | Production | Import | Exp | | |
| 1990 | | | | | | | | | | | | | | | | | |
| 1991 | | | | | | | | | | | | | | | | | |
| 1992 | | | | | | | | | | | | | | | | | |
| 1993 | | | | | | | | | | | | | | | | | |

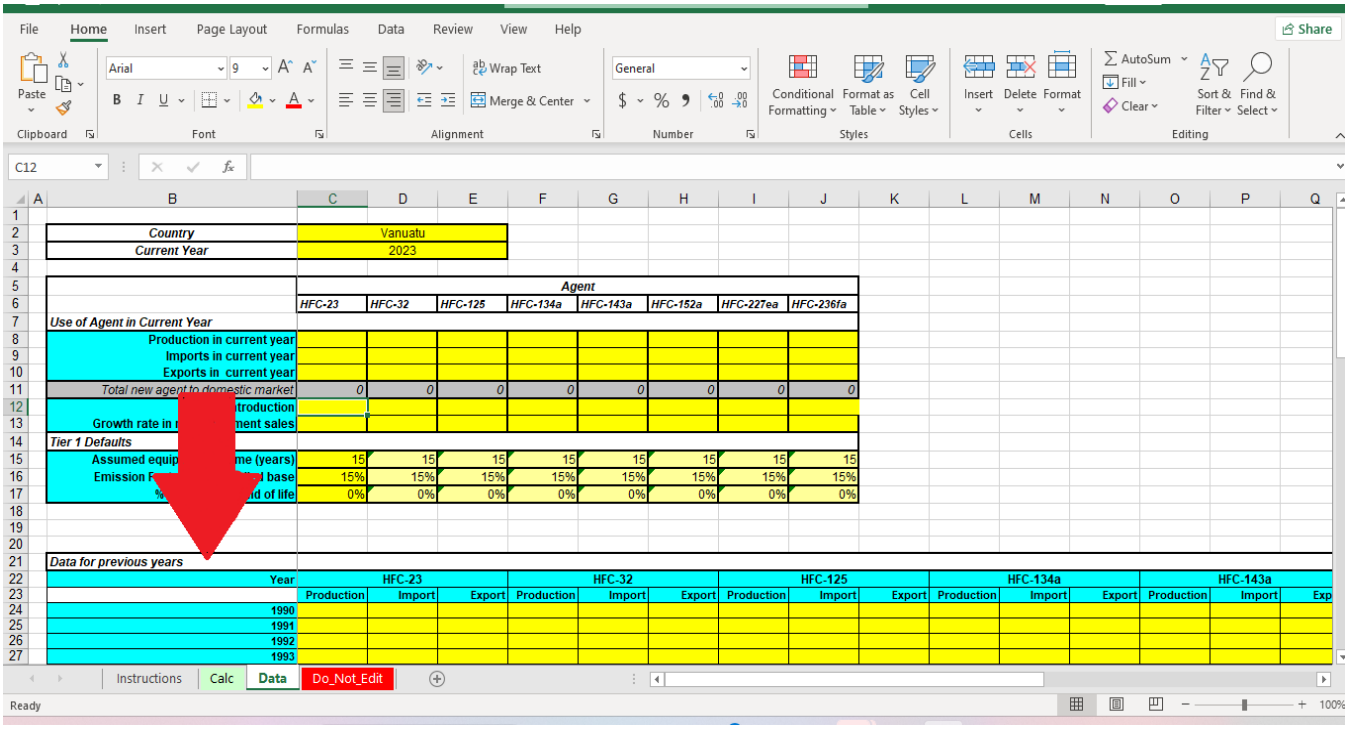
2.1 Enter 0 in the yellow cells C17 through J17 (See red arrow below illustrated in Figure 7) reason being that Vanuatu does not have any destruction facility.



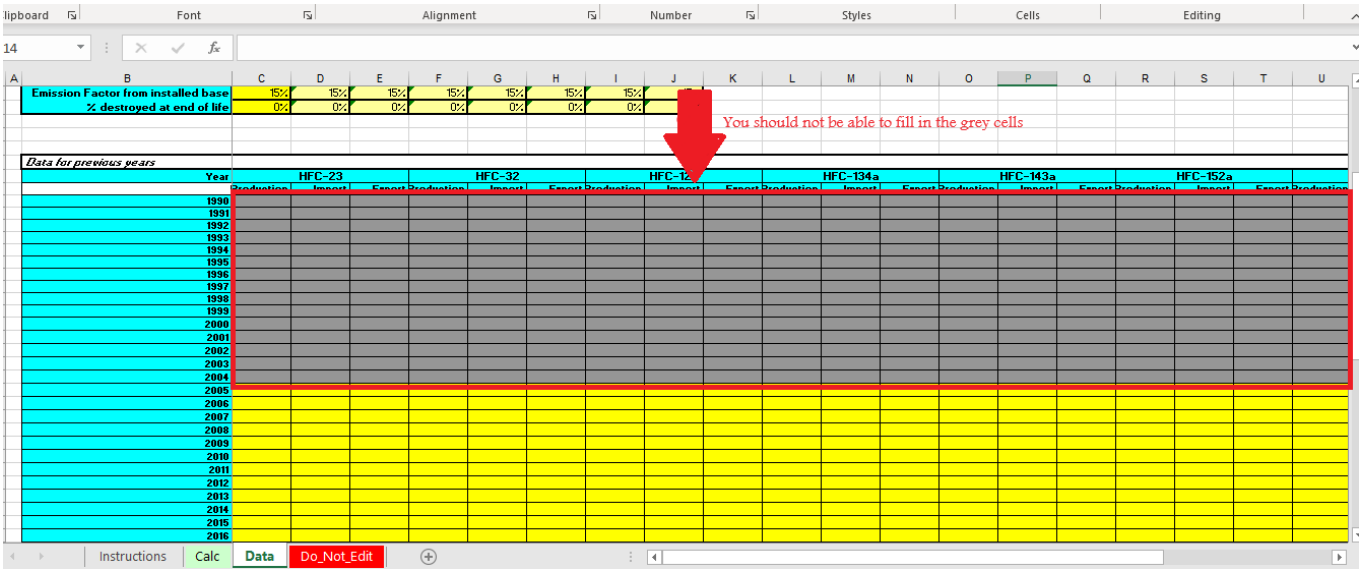

| | | Agent | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | HFC-23 | HFC-32 | HFC-125 | HFC-134a | HFC-143a | HFC-152a | HFC-227ea | HFC-236fa |
| Use of Agent in Current Year | | | | | | | | | |
| Production in current year | | | | | | | | | |
| Imports in current year | | | | | | | | | |
| Exports in current year | | | | | | | | | |
| Total new agent to domestic market | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Year of introduction | | | | | | | | | |
| Growth rate in new equipment sales | | | | | | | | | |
| Tier 1 Defaults | | | | | | | | | |
| Assumed equipment lifetime (years) | | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Emission Factor from installed base | | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% |
| % destroyed at end of life | | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |

| Data for previous years | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | HFC-23 | | | HFC-32 | | | HFC-125 | | | HFC-134a | | | HFC-143a | | | | |
| | Production | Import | Export | Production | Import | Export | Production | Import | Export | Production | Import | Export | Production | Import | Exp | | |
| 1990 | | | | | | | | | | | | | | | | | |
| 1991 | | | | | | | | | | | | | | | | | |
| 1992 | | | | | | | | | | | | | | | | | |
| 1993 | | | | | | | | | | | | | | | | | |

2.2 Locate the table with the title "Data for previous years" by scrolling down on the "Data for previous years" tab (see red arrow illustrated below).



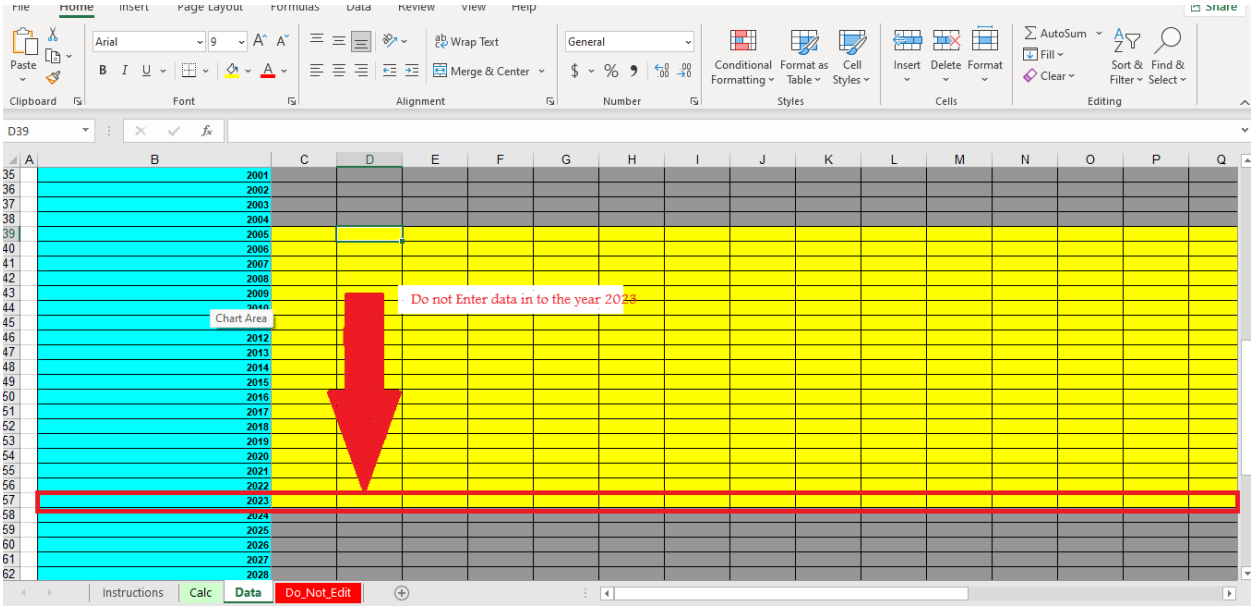

2.3 that the cells that cross over to rows Z24 to Z38 and that descend from C24 to C38 are gray (i.e., cannot be filled in).



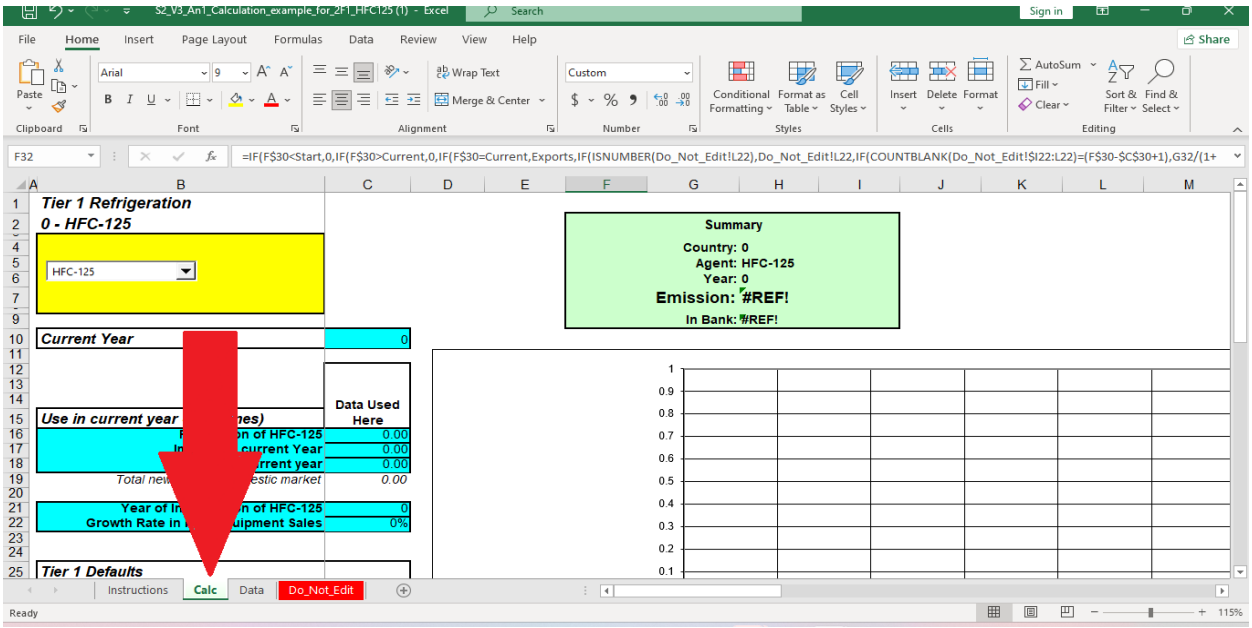
2.4 Enter value Zero in the yellow cells C39, F39, I39, L39, O39, R39, U39, and X39 (HFC agents are not produced in Vanuatu).

2.5: Enter the total number of agents in Tonnes in yellow cells D39, G39, J39, M39, P39, S39, V39, and Y39.

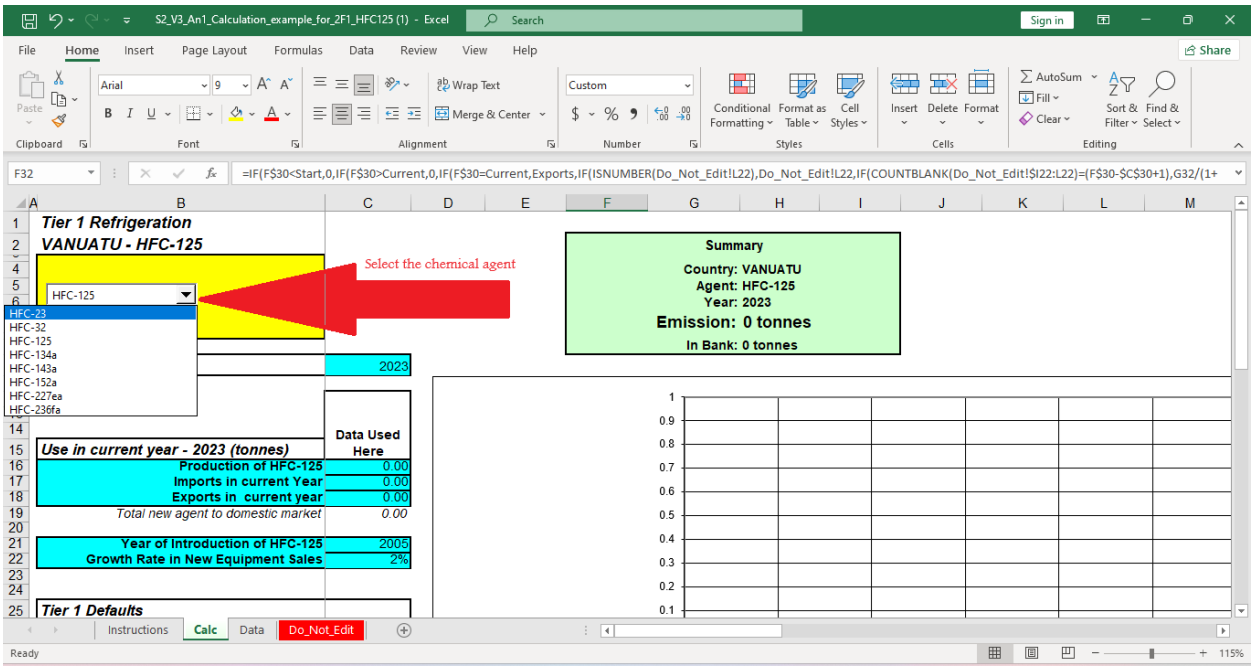
2.6: Complete the following procedures for the remaining years starting from 2006 to 2022, leaving out the current year 2023 given that you have previously inputted each agent's total tonnes (See red arrow illustrated below)




2.7 - Select the "Calc" tab located at the bottom of the Excel sheet (See red arrow in illustration below)

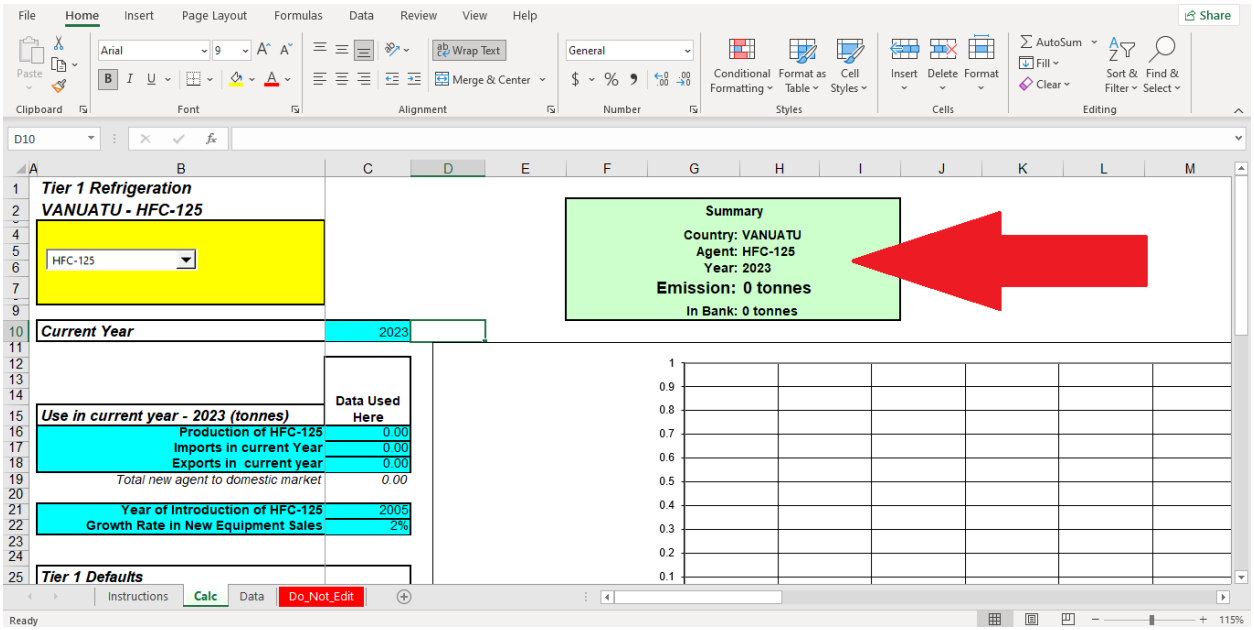


2.8 - Select the preferred chemical agent by clicking on cell B7 (See red arrow in illustration below)

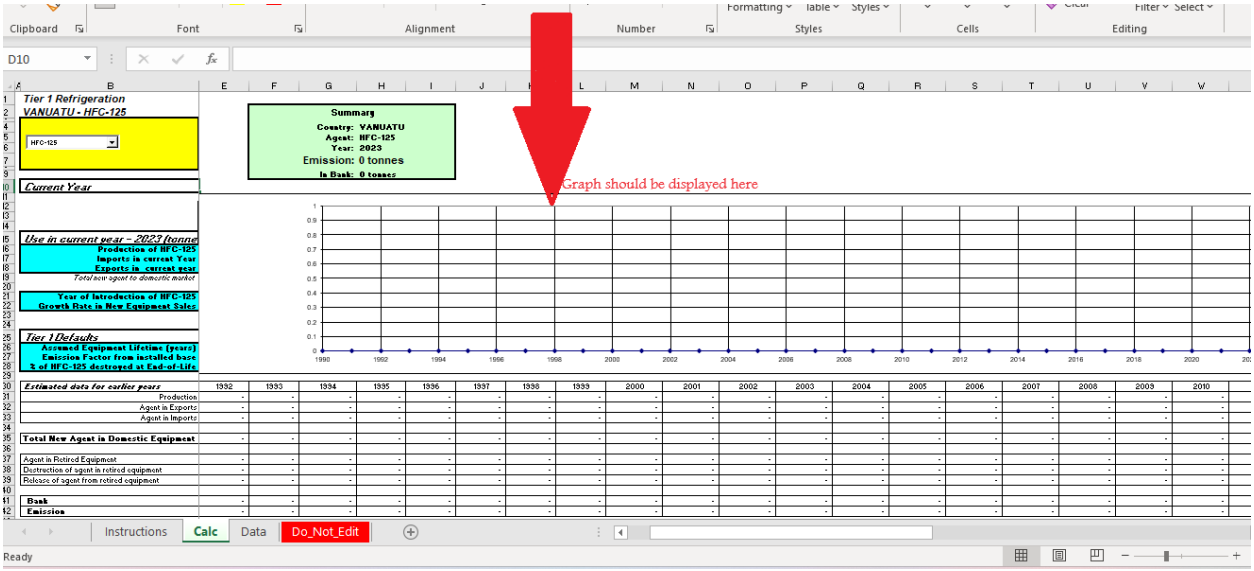



2.9 - Select the required year by clicking on cell C10.

3.0-Go to cell F7, where a green summary box displays the total emission of the specified chemical agent in tones over the chosen year (See red arrow in illustration below).



3.1 Continue scrolling down to see a graph that displays trends related to emissions. A back-calculation of emissions from prior years is also displayed (See red arrow in illustration below).



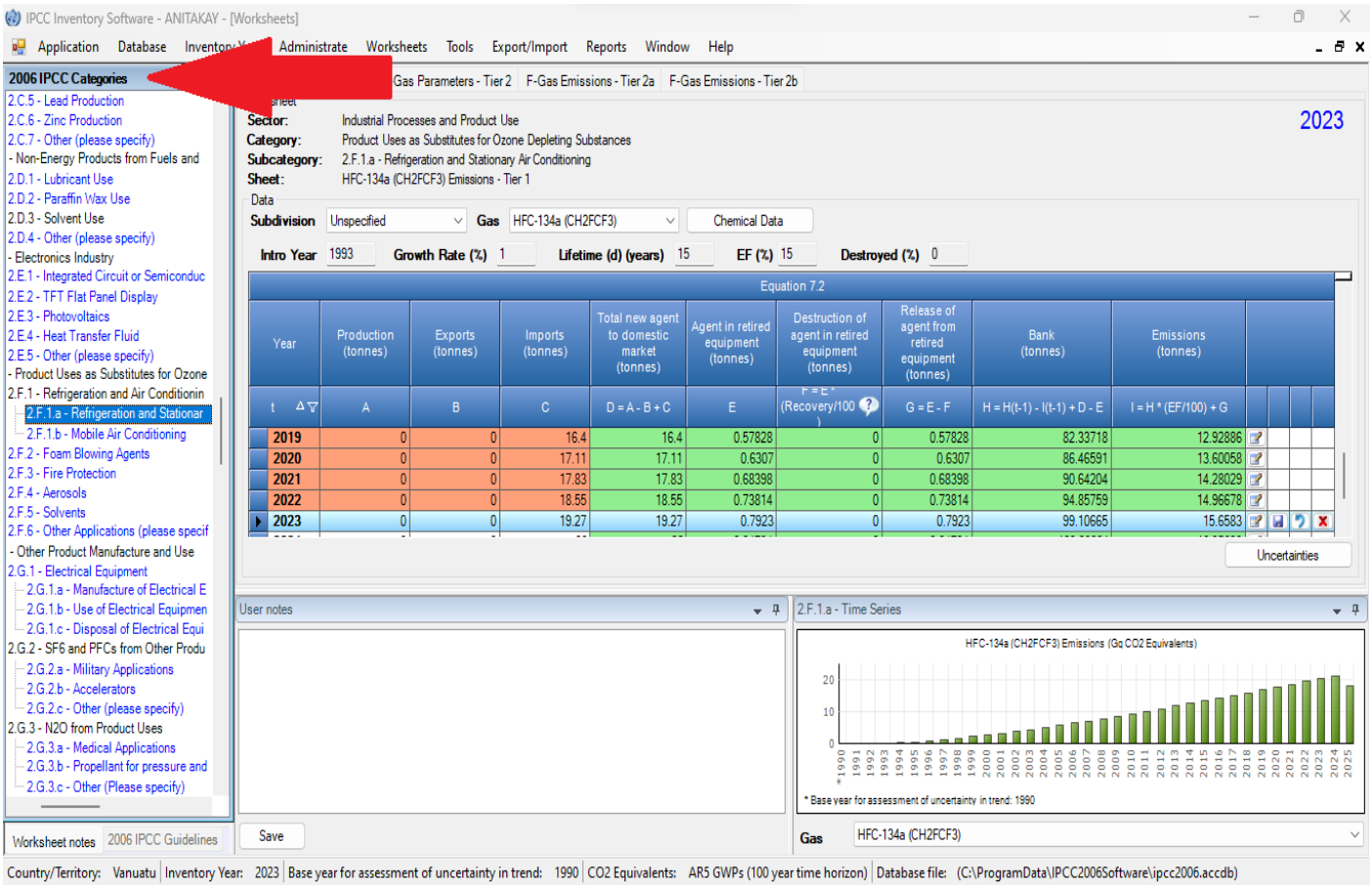

**ALTERNATIVE METHOD TO CALCULATING EMISSIONS FROM EACH AGENT OF HFC USING THE VER. 2.901 IPCC INVENTORY SOFTWARE - 32BIT**

1.1 Launch the IPCC software ver. 2.901 IPCC Inventory software - 32bit for national GHG inventories.

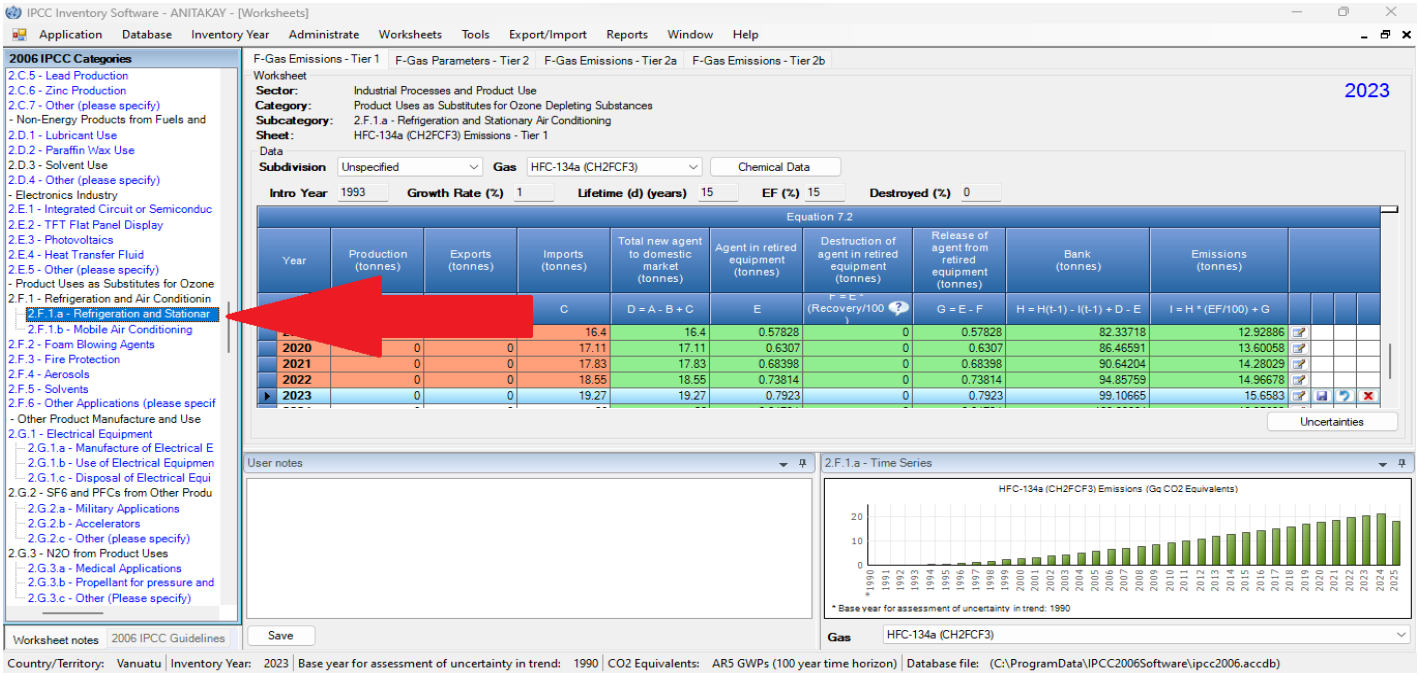
1.2 Type in your password and username.

1.3 Type in the year of your choosing or the current inventory year.

1.4 Locate the long, rectangular bar labeled "IPCC categories" on the left side of the page.

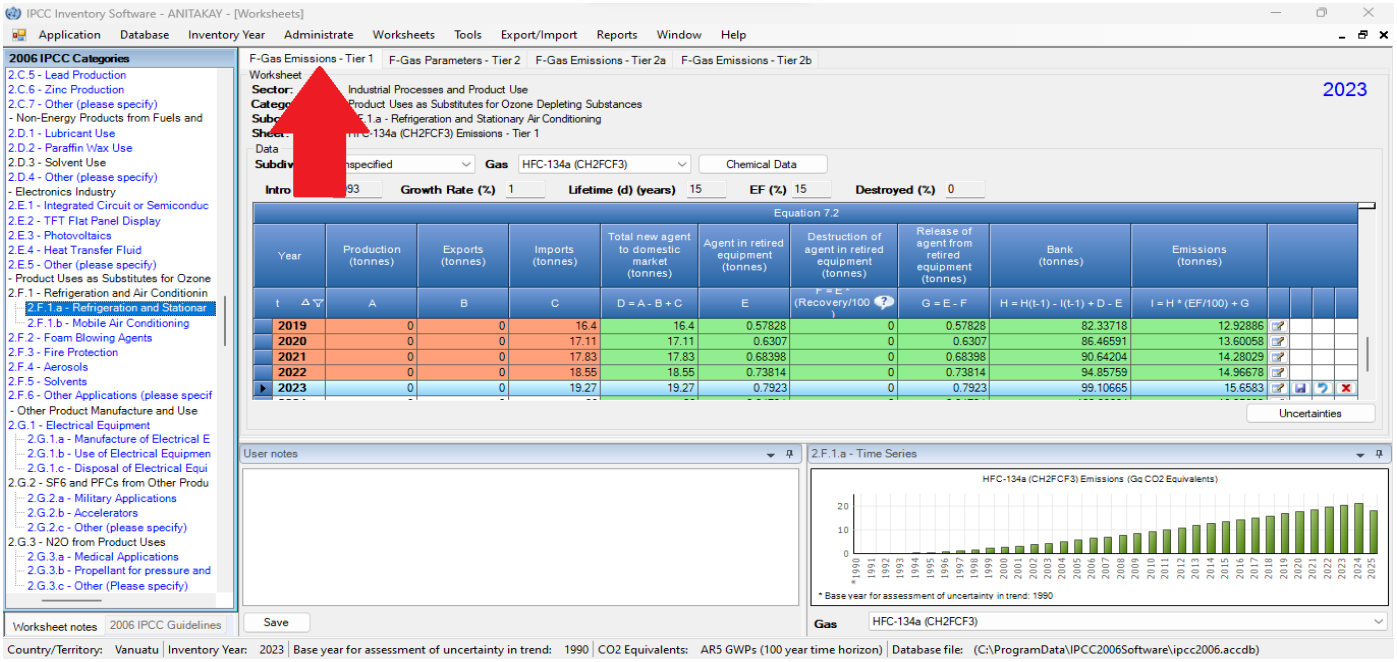



1. 5 Scroll Down the category list till you get to 2. F: Product Uses as Substitutes for Ozone Depleting Substances (See red arrow illustrated below)

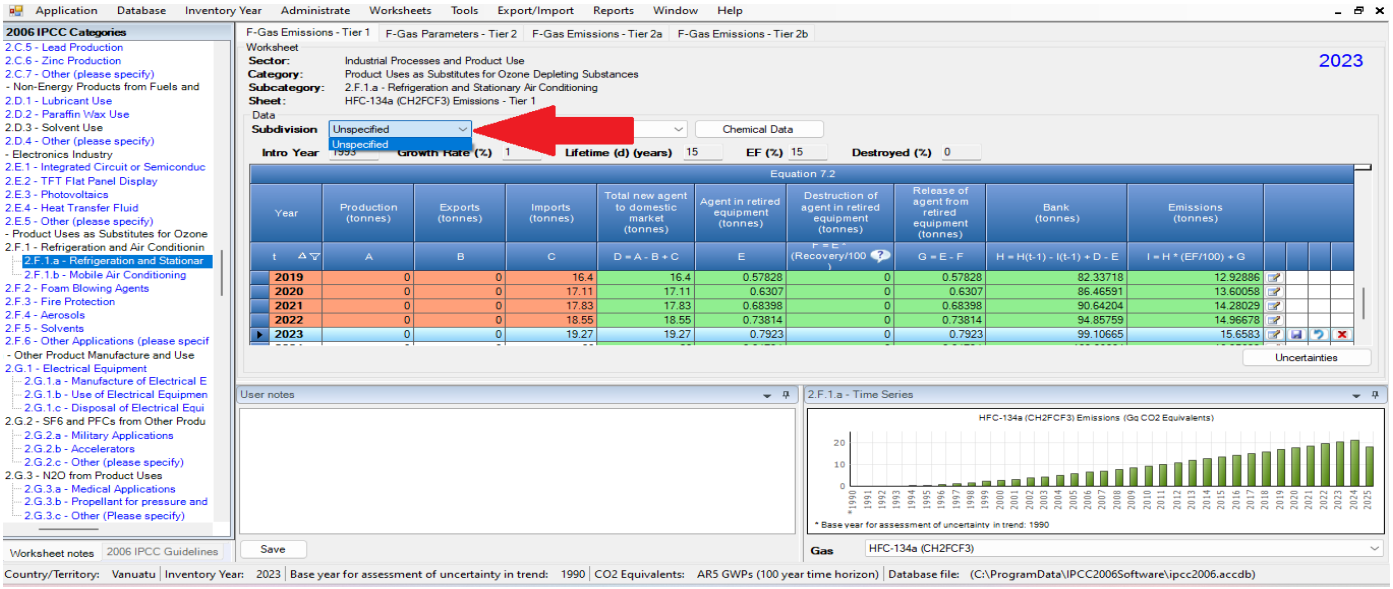


1.6 Click on Refrigeration and stationary Air Conditioner. (2.F.1.a) (See red arrow illustrated above)

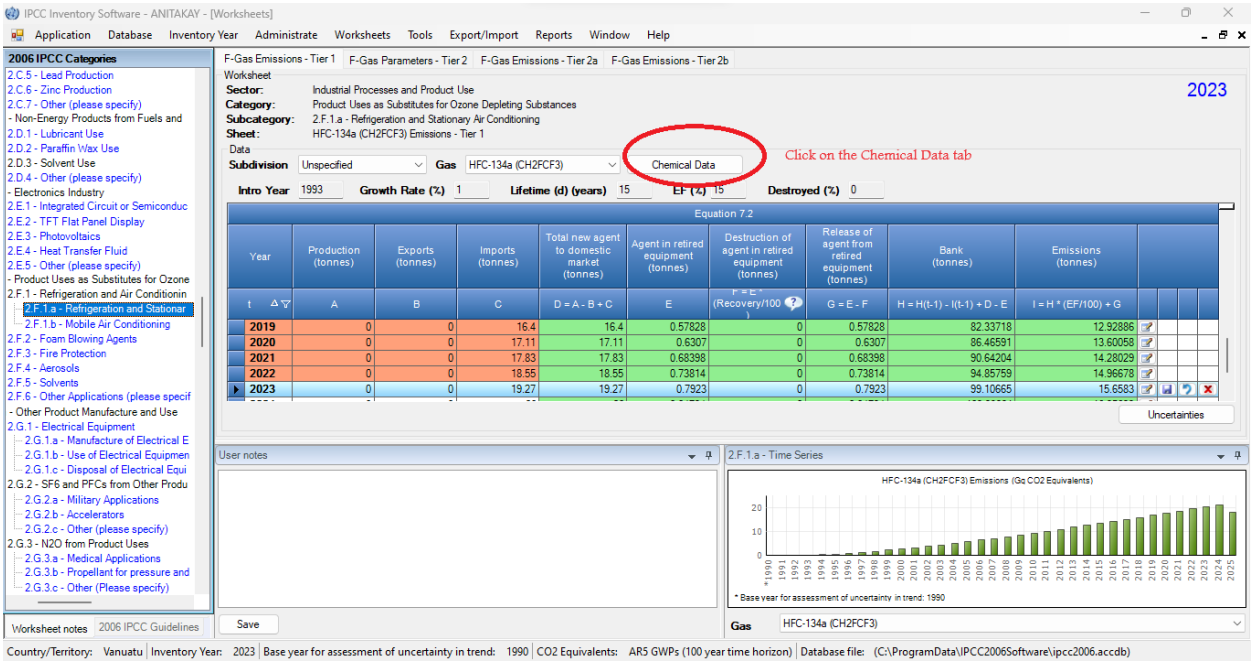
1.7 To make sure you are utilizing the Tier 1 approach, click the F-Gas Emission-Tier 1 tab in the upper right corner (See red arrow in illustration below).




1.8 Select Unspecified by clicking on the empty button next to the Subdivision tab (See red arrow in illustration below)



1.9 Click on the “Chemical Data” tab (see illustration below)




2.0 In the Chemical data table Enter:

**Country / Territory**: Vanuatu

**Subdivision**: Unspecified

**Gas**: Choose the Gas imported by the Country (Vanuatu)

**Data Year of Introduction**: select the year of introduction of the particular agent selected in the "Gas" section.

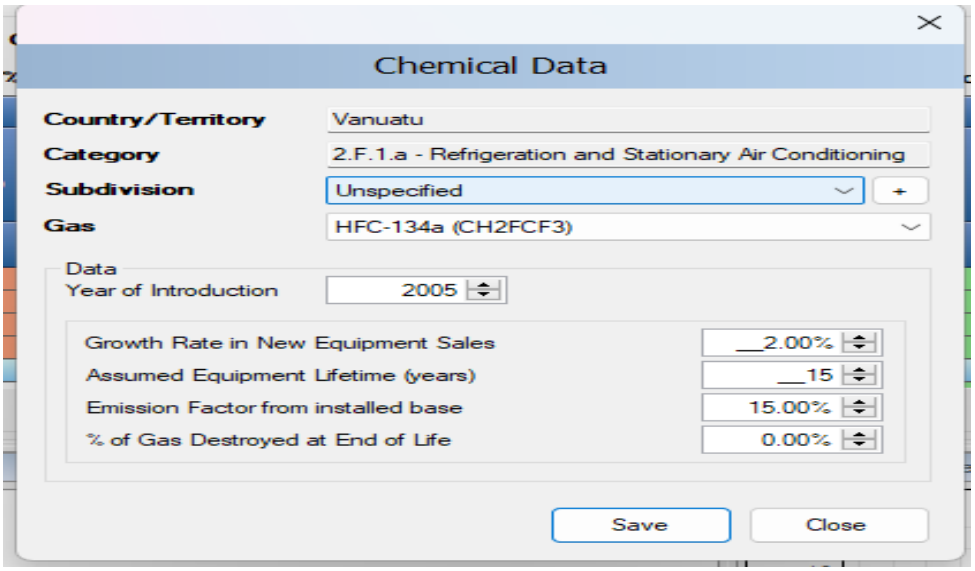
**Growth rate in New Equipment Sales**: 2%

**Assumed Equipment Lifetime** (years): 15

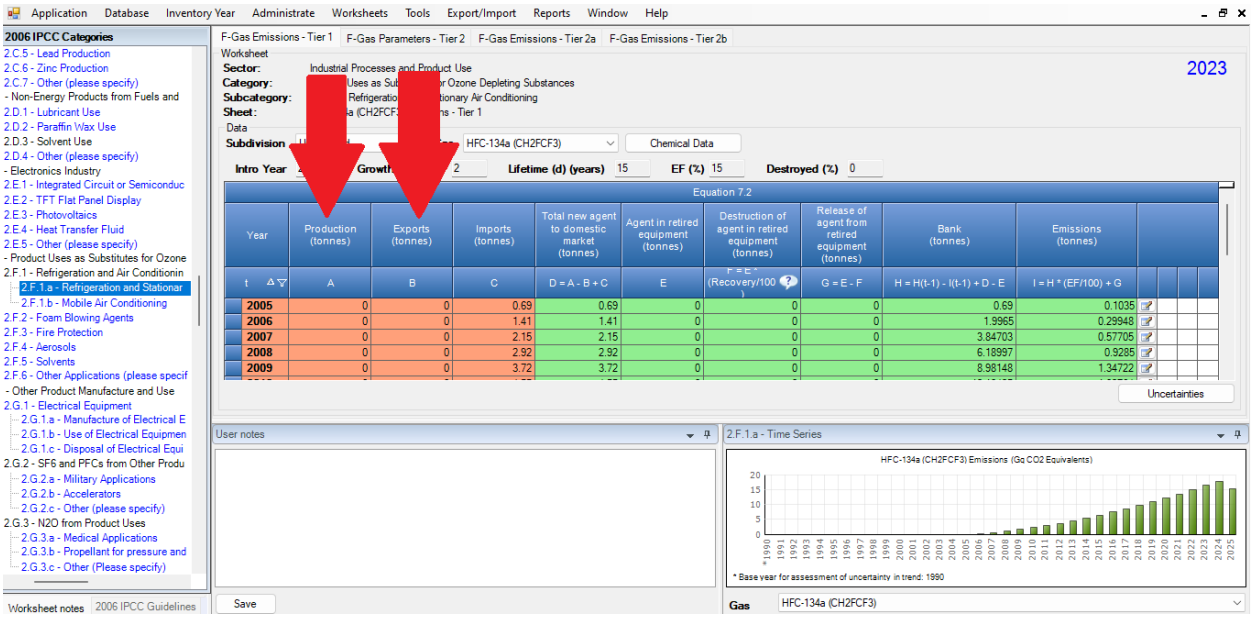
**Emission Factor from installed base**: 15%

**% of Gas Destroyed at End of Life**: 0

(See illustration below)




2.1 Refer to the table and enter 0 for each year in the Production (tonnes) and Export(tonnes) column (see red arrow in illustration below).

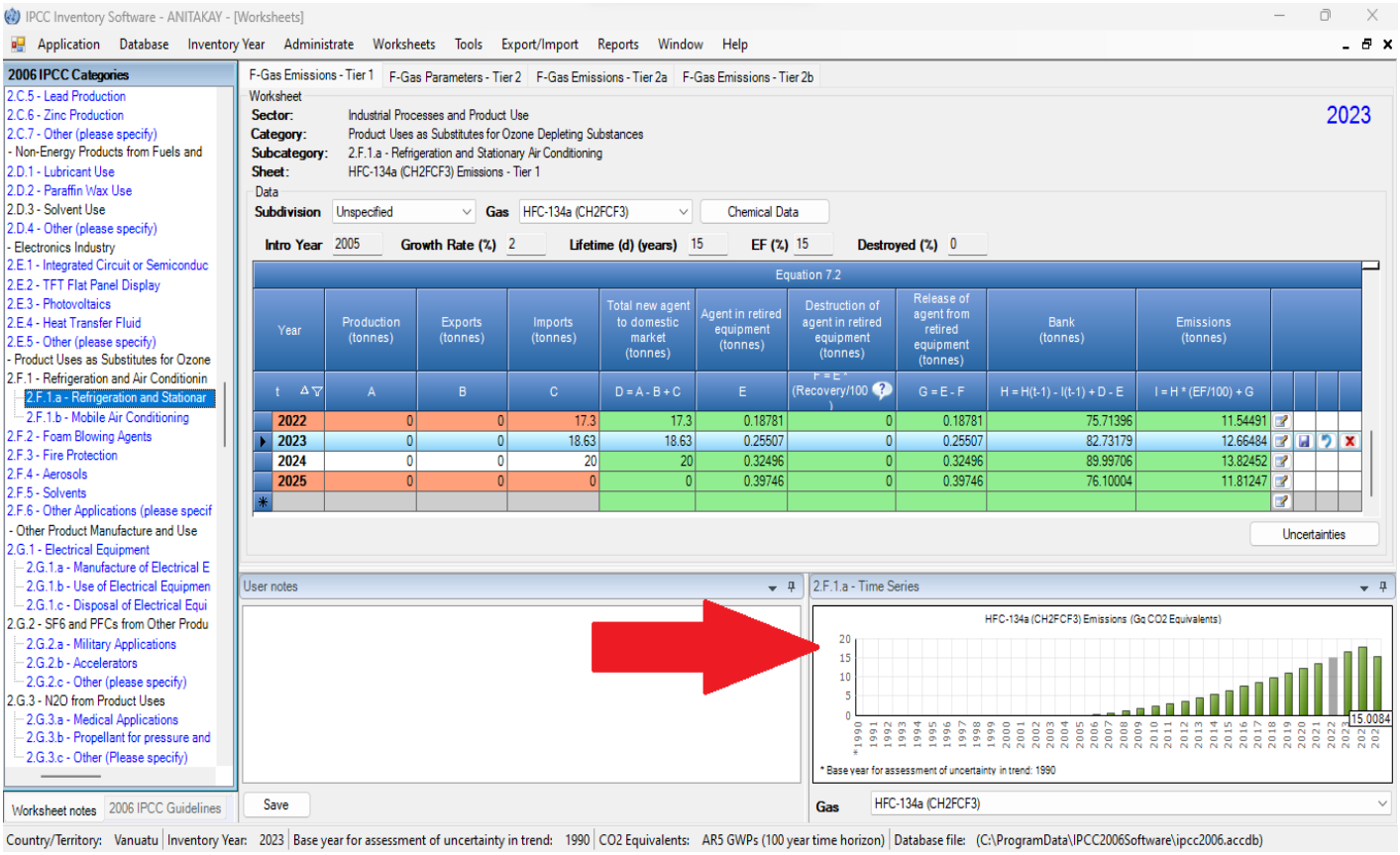



2.3 Select the Imports column and enter the data that was gathered for the total HFC agent (gas selected in step 2.0) in tones for every year.

2.4 Select each of the green cells adjacent until you get to the Emissions cell.

Banked and Emissions have now been calculated for you and you can record the data

2.5 Locate the graph labeled 2.F.1a - time series at the bottom of the table. The graph depicts the emissions in Gg of CO2 equivalent (Gg CO2 Equivalent) (see red arrow in illustration below)




2.6 Depending on which year you selected, move the cursor over the green bars in the graph to determine their (Gg CO2 Equivalent).

2.7 Repeat step 1.9 to 2.6 for the other Specific agents Imported by Vanuatu.

### 2.3.3 TIME SERIES

**Note On Consistency (Method, EF, Data Collection Method)**

According to the Vanuatu National Communication to the Conference of the Parties to the United Nations Framework Convention on Climate Change (1998), page 11, the NACC has designated 1994 as the baseline year for Vanuatu concerning the Green House Gas Inventory and COP.

So far, three reports on national communication have been produced. Because activity data documentation is lacking in all three reports, no estimations of emissions from the IPPU sector have been provided. Thus, no methodology, Emission factor (EF), or techniques for collecting data have been specified.

Following the (2006 IPCC guideline, Vol.3, Figure 7.6), Tier 1a/b will be used for this inventory.

Regarding the EF, the sub-application equipment charge (kg) will be calculated using the default value found in the 2006 IPCC Defaults (Volume 3, Chapter 7, Table 7.9). The methodology for gathering data will only concentrate on the ozone-depleting replacements found in imported refrigerants and in stationary air conditioning and domestic and commercial refrigeration.

The Vanuatu Customs and Inland Revenue is responsible for clearance, tariffs, and revenue collection for imported goods therefore the department may have import records and specific information on items or products containing refrigerants. Therefore, the Director of the Department of Customs and Inland Revenue and the Information Management Team. Additionally, The Department of Environmental Protection & Conservation oversees environmental protection and regulation. The department can have information on products containing refrigerants and data related to environmental impact assessments, regulations, and policies regarding the usage of refrigerants. Hence communications will be extended to the Director of the Department of Environmental Protection & Conservation Environmental Protection Unit upon request for Activity data. Last but not least The Vanuatu Statistics Office oversees collecting, analyzing, and issuing statistical data and information on import products thus the office can provide information on items containing refrigerants. As a result, the Social and Environment Statistics Section will be requested to provide the information and data needed.

The channels for requesting activity data meetings are the Electronic Single Window, emails, dialogues, and interviews. Consultants may ask the Prime Minister's Office for a Confidential Agreement or Right to Information (RTI) in specific situations where data is unavailable.

Emissions for the entire time series will be estimated using the Tier Hybrid Tier 1a/b approach, the IPCC default EF (which was addressed above), and the new data collection technique. Historical data, if any, and the current year 2023 will also be used.

**Table Of the Time-Series**

Table 2.3.3.1. i Time series HFC- 143a (Trifluoroethane): 1994 - 2003

| Item | Units | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | kt CO2-e | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| EF | % | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% |
| Method | NA | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b |

Table .3.3.1. ii Time series HFC- 143a (Trifluoroethane): 2004 - 2013

| Item | Units | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | kt CO2-e | NO | 0.1455 | 0.27218 | 0.38285 | 0.47992 | 0.56543 | 0.64112 | 0.70845 | 0.76868 | 0.88888 |
| EF | % | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Method | NA | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b |

Table 2.3.3.1.iii HFC- 143a (Trifluoroethane): 2014 - 2023

| Item | Units | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | kt CO2-e | 1.13654 | 1.23606 | 1.34915 | 1.35378 | 1.39671 | 2.2142 | 2.0184 | 1.88447 | 1.87872 | 1.87872 |
| EF | % | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| METHOD | NA | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b |

NO = not occurring – this notation key was used for all years before the chemical was introduced in Vanuatu

The year of chemical introduction was not recorded and from 2005 to 2023 the emissions were calculated using T1/b IPCC methodology with default IPCC parameters and EF.

Table 2.3.3.2.i Time Series HFC – 32 (Difluoromethylene): 1994 - 2003

| Item | Units | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | kt CO2-e | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| EF | % | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% |
| METHOD | NA | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b |

Table 2.3.3.2.ii HFC – 32 (Difluoromethylene): 2004 - 2013

| Item | Units | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | kt CO2-e | NO | 0.0405 | 0.07643 | 0.10696 | 0.13442 | 0.15775 | 0.17909 | 0.19723 | 0.21414 | 0.24802 |
| EF | % | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| METHOD | NA | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b |

Table 2.3.3.2.iii HFC – 32 (Difluoromethylene): 2014 - 2023

| Item | Units | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | kt CO2-e | 0.26182 | 0.31555 | 0.34321 | 0.37432 | 0.3751 | 0.38633 | 0.61338 | 0.56145 | 0.5202 | 0.52221 |
| EF | % | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| METHOD | NA | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b |

NO = not occurring – this notation key was used for all years before the chemical was introduced in Vanuatu

The Year of Chemical introduction was not recorded and from 2005 to 2023 the emissions were calculated using T1/b IPCC methodology with default IPCC parameters and EF.

Table 2.3.3.3.i HFC – 125 (Pentafluoroethane): Year 1994 - 2003

| Item | Units | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | kt CO2-e | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| EF | % | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% |
| METHOD | NA | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b |

Table 2.3.3.3.ii HFC – 125 (Pentafluoroethane): Year 1994 - 2003

| Item | Units | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | kt CO2-e | NO | 0.1665 | 0.31103 | 0.43687 | 0.54834 | 0.64609 | 0.73218 | 0.80985 | 0.87887 | 1.01704 |
| EF | % | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| METHOD | NA | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b |

Table 2.3.3.3.iii HFC – 125 (Pentafluoroethane): Year 2014 - 2023

| Item | Units | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | kt CO2-e | 1.07599 | 1.30159 | 1.41685 | 1.54632 | 1.55137 | 1.60067 | 2.53657 | 2.31056 | 2.15663 | 2.15666 |
| EF | % | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| METHOD | NA | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b |

NO = not occurring – this notation key was used for all years before the chemical was introduced in Vanuatu

The year of chemical Introduction was not recorded and from 2005 to 2023 the emissions were calculated using T1/b IPCC methodology with default IPCC parameters and EF.

Table 2.3.3.4.i HFC – 134a (Tetrafluoroethane): 1994 - 2003

| Item | Units | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | kt CO2-e | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| EF | % | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% | 15% |
| METHOD | NA | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b |

Table 2.3.3.4.ii HFC – 134a (Tetrafluoroethane): 2004 - 2013

| Item | Units | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | kt CO2-e | NO | 0.1065 | 0.19853 | 0.27975 | 0.35028 | 0.41174 | 0.46698 | 0.51543 | 0.55962 | 0.64818 |
| EF | % | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| METHOD | NA | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b |

Table 2.3.3.4.iii HFC – 134a (Tetrafluoroethane): 2014 - 2023

| Item | Units | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Emissions | kt CO2-e | 0.68595 | 0.82906 | 0.9027 | 0.98479 | 0.98707 | 1.01751 | 1.61539 | 1.46805 | 1.37562 | 1.36824 |
| EF | % | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| METHOD | NA | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b | T1a/b |

NO = not occurring – this notation key was used for all years before the chemical was introduced in Vanuatu

The year of chemical introduction was not recorded and from 2005 to 2023 the emissions were calculated using T1/b IPCC methodology with default IPCC parameters and EF.

When it comes to identifying trends and outliers, as previously explained, no previous estimations of F-gases have been calculated, hence no graphs were produced.

However, we may anticipate a steady rise in F-gases utilized in air conditioners from the year of introduction in 2005 to the present inventory year of 2023. F-gas emissions may have increased as a result of Vanuatu's growing population, influx of investors, and development of businesses. The only anomaly in the trend could be the absence of data from 2022 because of a hack in the government system that resulted in the loss of all the data and information for that year. Another outlier might result from COVID-19, a ban on imports, and the lockdown-related closure of companies.

### 2.3.3. QUALITY CONTROL/ QUALITY CHECK

#### QUALITY CONTROL METHOD

*Table 4: The QC activities and procedures that will be followed are indicated in the table below. The three consultants will handle the QC and Procedures based on the color in the table, Anita-Pink, Florencza- Green and Zechariah Bani- Blue.*

| QC activity | Procedures |
|---|---|
| Check the Assumptions and criteria for the selection of activity data, emissions factor and other estimation parameters | • Confirm that estimates are reported for all categories and for all years from the appropriate base year to the period of the current inventory. |
| | • For subcategories, confirm that entire category is being covered. |
| | • Provide clear definition of 'Other' type categories. |
| | • Check that known data gaps that result in incomplete estimates are documented, including a qualitative evaluation of the importance of the estimate in relation to total emissions (e.g., subcategories classified as 'not estimated', see Chapter 8, Reporting Guidance and Tables). |
| Check for transcriptions Errors in the data input and references | • Confirm that bibliographical data references are properly cited in the internal documentation. |
| | • Cross-check a sample of input data from each category (either measurements or parameters used in calculations) for transcription errors. |
| Check that emissions and removals are calculated correctly | • Reproduce a set of emissions and removals calculations. |
| | • Use a simple approximation method that gives similar results to the original and more complex calculation to ensure that there is no data input error or calculation error. |

| | |
|---|---|
| Check that parameters and units are correctly recorded and that appropriate conversion factors are used. | • Check that units are properly labelled in calculation sheets. |
| | • Check that units are correctly carried through from beginning to end of calculations. |
| | • Check that conversion factors are correct. |
| | • Check that temporal and spatial adjustment factors are used correctly. |
| Check the integrity of database files | • Examine the included intrinsic documentation (see also Box 6.4) to: |
| | 1. Confirm that the appropriate data processing steps are correctly represented in the database. |
| | 2. Confirm that data relationships are correctly represented in the database. |
| | 3. Ensure that data fields are properly labelled and have the correct design specifications. |
| | 4. Ensure that adequate documentation of database and model structure and operation are archived. |
| Check for consistency in data between categories. | Identify parameters (e.g., activity data, constants) that are common to multiple categories and confirm that there is consistency in the values used for these parameters in the emission/removal calculations. |
| Check that the movement of inventory data among processing steps is correct. | • Check that emissions and removals data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. |
| | • Check that emissions and removals data are correctly transcribed between different intermediate products. |
| Check that uncertainties in emissions and removals are estimated and calculated correctly. | • Check that the qualifications of individuals providing expert judgement for uncertainty estimates are appropriate. |
| | • Check that the qualifications, assumptions and expert judgements are recorded. |
| | • Check that calculated uncertainties are complete and calculated correctly. |
| | • If necessary, duplicate uncertainty calculations on a small sample of the probability distributions used by Monte Carlo analyses (for example, using uncertainty calculations according to Approach 1). |
| Check time series consistency. | • Check for temporal consistency in time series input data for each category. |

| | |
|---|---|
| | • Check for consistency in the algorithm/method used for calculations throughout the time series. |
| | • Check methodological and data changes resulting in recalculations. |
| | • Check that the effects of mitigation activities have been appropriately reflected in time series calculations. |
| Check Completeness | • Confirm that estimates are reported for all categories and for all years from the appropriate base year to the period of the current inventory. |
| | For subcategories, confirm that entire category is being covered. |
| | • Provide clear definition of 'Other' type categories. |
| | • Check that known data gaps that result in incomplete estimates are documented, including a qualitative evaluation of the importance of the estimate in relation to total emissions (e.g., subcategories classified as 'not estimated', see Chapter 8, Reporting Guidance and Tables) |

| | |
|---|---|
| Trend Check | • Confirm that estimates are reported for all categories and for all years from the appropriate base year to the period of the current inventory. |
| | • Check value of implied emission factors (aggregate emissions divided by activity data) across time series. |
| | 1. Do any of the year's<br>2. show outliers that are not explained? |
| | 2. If they remain static across time series, are changes in emissions or removals being captured? |
| | • Check if there are any unusual and unexplained trends noticed for activity data or other parameters across the time series. |
| Review of internal documentation and archiving. | • Check that there is detailed internal documentation to support the estimates and enable reproduction of the emission, removal and uncertainty estimates. |
| | • Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. |
| | • Check that the archive is closed and retained in secure place following completion of the inventory. |
| | • Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation |

(TABLE 6.1 GENERAL INVENTORY QC PROCEDURES, volume 1, 2006 IPCC Guidelines for National Greenhouse Gas Inventories).

*Table 5: Quality control method, the Responsibilities carried out by which particular party, and the timeline stating how long it would take for the party to complete the task.*

| Quality Control Method | | Timeline for Completion |
|---|---|---|
| GHG Inventory Team Members (Consultants) | 1. Check the Assumptions and criteria for the selection of activity data, emissions factor and other estimation parameters | 2 months |
| | 2. Check for transcriptions Errors in the data input and references | |
| | 3. Check that emissions and removals are calculated correctly | |
| | 4. Check that parameters and units are correctly recorded and that appropriate conversion factors are used. | |
| | 5. Check that parameters and units are correctly recorded and that appropriate conversion factors are used. | |
| | 6. Check the integrity of database files | |
| | 7. Check for consistency in data between categories. | |
| | 8. Check that the movement of inventory data among processing steps is correct | |
| | 9. Check that uncertainties in emissions and removals are estimated and calculated correctly. | |
| | 10. Check time series consistency. | |
| | 11. Check Completeness | |
| | 12. Trend Check | |
| | 13. Review of internal documentation and archiving. | |
| TWGs (Technical Working Groups): specialized groups consisting of experts and professionals | 1. Technical review of sub-category activity data, emission factors, estimation parameters, and calculations method. | 2 - 3 weeks |
| | 2. Final Check of report | |
| The Department of Environmental Protection & Conservation | The department for environmental Protection & Conservation oversees environmental protection and regulations. The department should have information on products containing refrigerants and data related to environmental impact | 2 weeks upon request for Data |

| | | |
|---|---|---|
| | assessments, regulations and policies regarding the usage of refrigerants | |
| Vanuatu Customs and Inland Revenue | The Vanuatu Customs and Inland Revenue is responsible for clearance, tariffs and revenue collection for imported goods therefore the department may have imported records and specific information of items or products containing refrigerants | 2 weeks upon request for Data |

Note: Detailed explanations of the GHG Inventory team member's tasks are stated in the Quality control method.

## 2.3.4 UNCERTAINTIES

### UNCERTAINTIES

Vanuatu does not have the capacity to provide quantitative assessment of uncertainty and will there for be implemented into the improvement plan. Tier 1a/b will be used this leading to high Uncertainties. The contributing factors to the high uncertainty would stem from the following

1. Default Emission factor of 15%: Emission factors are used to estimate GHG emissions from a specific activity or process. Tier 1a/b methods rely on default emission factors provided by the IPCC. However, these default emission factors may not accurately represent the actual emissions from a particular process or activity. This discrepancy can lead to uncertainties in the estimated GHG emissions.

2. Assumptions used in the calculations may also lead to uncertainties within the estimated Emission values. For instance:

- HFCs and PFCs are not produced nor exported from Vanuatu.
- Assumed percentage of new equipment exported for Vanuatu is 0%
- Assumed percentage of new equipment imported for Vanuatu can be collected from the single window[4]
- Emissions from banked refrigerant average is 15% annually through every RAC application area.
- Equipment charge using the default values
  - Residential and Commercial AC is 10kg
  - Commercial Refrigeration is 28kg
  - Domestic refrigeration is 0.5kg
- Equipment servicing does not commence until 3 years after installation of equipment.
- In a mature market, 2/3 (67%) of refrigerant sales are used for servicing while 1/3 (33%) are used to charge for new equipment.
- Across all sub applications, the average equipment lifetime is 15 years.
- The HFC emissions from air conditioning and refrigeration did not occur until 2005.
- The complete transition to a new refrigerant technology will take place over a 10-year period. From experiences to date, this assumption is believed to be valid for a single chemical in a single country.

[4] https://singlewindow.gov.vu/portal/services/swApprovedAppliances/appliances.jsf

## 2.4 IMPROVEMENT PLAN

### 2.4.1: Vanuatu's Current Inventory Process.

The national Greenhouse Gas (GHG) inventory of anthropogenic (human- caused) GHG emissions and removals were estimated for the Republic of Vanuatu under the first, second, and third (draft) National Communications for 1994, 2000, and 2015 (Srikanth Subbarao, Subbarao Consulting Services, Naveen Pawar, Subbarao Consulting Services, 2020). However, according to these reports, emissions from IPPU sector and fluorocarbons (PFCs), Hydro fluorocarbons (HFCs) and Sulfur hexafluoride (SF6) were not estimated and considered negligible, as the products containing these gases are not produced in the country (Ministry of Climate Change, 2020).

### 2.4.2: Areas Identified for Improvement and Identified Gaps.

Since there is no record of any Inventory processes regarding IPPU sector, improvements will mean taking into account the construction of the whole inventory process for the very first time. This will be the only identified gap that is to be addressed.

### 2.4.3: Proposed Improvement Actions

From the year 1994 to 2023, there is no record of estimation calculated thus there is no report to base improvement actions on. However, in constructing the whole inventory process this table shows detailed information on the data sources, how to access it, who is responsible and the relevant time it needs to collect data sets. These are the improvement actions that the consultants should take into consideration while constructing the inventory. There is also a great need to collect data on tonnage of each gas that will make reporting more accurate and transparent. Currently Vanuatu's data is based on VT data of equipment imported which leads to substantially high uncertainty in our Inventory.

*Table 6: Improvement Actions for Consultants.*

| Department/ Organization | Roles and Responsibility | Dates | Relevant Governing Arrangement | Contact Person | Comments |
|---|---|---|---|---|---|
| Vanuatu Customs and inland Revenue (VCIR) | To provide data on imports and exports of F-gases (ODS Substitutes – Refrigerants) to DOCC | 2nd of April every year – 1st week of May | Memorandum of understanding or Right to Information (RTI) between VCIR and DOCC | Customs Revenue Section, Port Vila<br>Email: customsrevenue@vanuatu.gov.vu<br>Tel: +678 33091 | DOCC needs to send a prompt letter to VCIR 1-2 months prior.<br><br>A follow-up email or call is crucial as well. |

| | | | | | |
|---|---|---|---|---|---|
| Vanuatu National Statistics Office | Provide statistical data and information on import products containing refrigerants to DOCC | 2nd of April every year – 1st week of May | Memorandum of understanding or Right to Information (RTI) between the Vanuatu National Statistics Office and DOCC | Vanuatu National Statistics Office<br>Tel: (678) 22110 / 22111 / 33040<br>Email: stats@vanuatu.gov.vu<br><br>Name: Mento Susie (Senior Statistician - Disaster & Environment)<br>Email:<br>Tel:<br><br>Leo Charlington (Principal Statistician Social & Environment)<br>Email:<br>Tel: | DOCC needs to send a prompt letter to Vanuatu National Statistics Office 1-2 months prior.<br><br>A follow-up email or call is crucial as well. |
| Department of Environmental Protection & Conservation | Provide information on products containing refrigerants and data related to environmental impact assessments, regulations, and policies regarding the usage of refrigerants. | 2nd of April every year – 1st week of May | Memorandum of understanding or Right to Information (RTI) between the Department of Environmental Protection & Conservation and DOCC | The Environmental Protection Unit.<br><br>Roselyn Bue<br>Senior Officer (Chemical and Ozone)<br>Email: rbue@vanuatu.gov.vu<br><br>Richard Petterson<br>Ozone Assistant Officer<br>Project (s): IS (Ozone)<br>Email: rpetterson@vanuatu.gov.vu | DOCC needs to send a prompt letter to the Department of Environmental Protection & Conservation 1-2 months prior.<br><br>A follow-up email or call is crucial as well. |

| | | | | | |
|---|---|---|---|---|---|
| Department of Climate Change (DOCC) | DOCC is responsible to send a formal letter requesting relevant data to the Vanuatu Customs and Inland Revenue, The National Statistics Office and The Environmental Protection and Conservation. | February – March every year | Provide a Memorandum of understanding or Right to Information (RTI) to the Vanuatu Customs and Inland Revenue, the National Statistics Office and the Environmental Protection and Conservation | Nelson Kalo Director of Climate Change Email: nekalo@vanuatu.gov.vu | DOCC is responsible for doing a follow-up to the departments or organization for the required data to be delivered upon schedule. |

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## ANNEX

TABLE 1: showing blends, their Constituents and their Composition (%)

**TABLE 7.8**
**BLENDS (MANY CONTAINING HFCS AND/OR PFCS)**

| Blend | Constituents | Composition (%) |
|---|---|---|
| R-400 | CFC-12/CFC-114 | Should be specified[1] |
| R-401A | HCFC-22/HFC-152a/HCFC-124 | (53.0/13.0/34.0) |
| R-401B | HCFC-22/HFC-152a/HCFC-124 | (61.0/11.0/28.0) |
| R-401C | HCFC-22/HFC-152a/HCFC-124 | (33.0/15.0/52.0) |
| R-402A | HFC-125/HC-290/HCFC-22 | (60.0/2.0/38.0) |
| R-402B | HFC-125/HC-290/HCFC-22 | (38.0/2.0/60.0) |
| R-403A | HC-290/HCFC-22/PFC-218 | (5.0/75.0/20.0) |
| R-403B | HC-290/HCFC-22/PFC-218 | (5.0/56.0/39.0) |
| R-404A | HFC-125/HFC-143a/HFC-134a | (44.0/52.0/4.0) |
| R-405A | HCFC-22/ HFC-152a/ HCFC-142b/PFC-318 | (45.0/7.0/5.5/42.5) |
| R-406A | HCFC-22/HC-600a/HCFC-142b | (55.0/14.0/41.0) |
| R-407A | HFC-32/HFC-125/HFC-134a | (20.0/40.0/40.0) |
| R-407B | HFC-32/HFC-125/HFC-134a | (10.0/70.0/20.0) |
| R-407C | HFC-32/HFC-125/HFC-134a | (23.0/25.0/52.0) |
| R-407D | HFC-32/HFC-125/HFC-134a | (15.0/15.0/70.0) |
| R-407E | HFC-32/HFC-125/HFC-134a | (25.0/15.0/60.0) |
| R-408A | HFC-125/HFC-143a/HCFC-22 | (7.0/46.0/47.0) |
| R-409A | HCFC-22/HCFC-124/HCFC-142b | (60.0/25.0/15.0) |
| R-409B | HCFC-22/HCFC-124/HCFC-142b | (65.0/25.0/10.0) |
| R-410A | HFC-32/HFC-125 | (50.0/50.0) |
| R-410B | HFC-32/HFC-125 | (45.0/55.0) |
| R-411A | HC-1270/HCFC-22/HFC-152a | (1.5/87.5/11.0) |
| R-411B | HC-1270/HCFC-22/HFC-152a | (3.0/94.0/3.0) |
| R-411C | HC-1270/HCFC-22/HFC-152a | (3.0/95.5/1.5) |
| R-412A | HCFC-22/PFC-218/HCFC-142b | (70.0/5.0/25.0) |
| R-413A | PFC-218/HFC-134a/HC-600a | (9.0/88.0/3.0) |
| R-414A | HCFC-22/HCFC-124/HC-600a/HCFC-142b | (51.0/28.5/4.0/16.5) |
| R-414B | HCFC-22/HCFC-124/HC-600a/HCFC-142b | (50.0/39.0/1.5/9.5) |
| R-415A | HCFC-22/HFC-152a | (82.0/18.0) |
| R-415B | HCFC-22/HFC-152a | (25.0/75.0) |
| R-416A | HFC-134a/HCFC-124/HC-600 | (59.0/39.5/1.5) |
| R-417A | HFC-125/HFC-134a/HC-600 | (46.6/50.0/3.4) |
| R-418A | HC-290/HCFC-22/HFC-152a | (1.5/96.0/2.5) |
| R-419A | HFC-125/HFC-134a/HE-E170 | (77.0/19.0/4.0) |
| R-420A | HFC-134a/HCFC-142b | (88.0/12.0) |
| R-421A | HFC-125/HFC-134a | (58.0/42.0) |
| R-421B | HFC-125/HFC-134a | (85.0/15.0) |
| R-422A | HFC-125/HFC-134a/HC-600a | (85.1/11.5/3.4) |
| R-422B | HFC-125/HFC-134a/HC-600a | (55.0/42.0/3.0) |
| R-422C | HFC-125/HFC-134a/HC-600a | (82.0/15.0/3.0) |
| R-500 | CFC-12/HFC-152a | (73.8/26.2) |
| R-501 | HCFC-22/CFC-12 | (75.0/25.0) |
| R-502 | HCFC-22/CFC-115 | (48.8/51.2) |
| R-503 | HFC-23/CFC-13 | (40.1/59.9) |
| R-504 | HFC-32/CFC-115 | (48.2/51.8) |
| R-505 | CFC-12/HCFC-31 | (78.0/22.0) |
| R-506 | CFC-31/CFC-114 | (55.1/44.9) |
| R-507A | HFC-125/HFC-143a | (50.0/50.0) |
| R-508A | HFC-23/PFC-116 | (39.0/61.0) |

| | | |
|---|---|---|
| R-508B | HFC-23/PFC-116 | (46.0/54.0) |
| R-509A | HCFC-22/PFC-218 | (44.0/56.0) |
| [1] R-400 can have various proportions of CFC-12 and CFC-114. The exact composition needs to be specified, e.g., R-400 (60/40). | | |

TABLE 2: showing the different HFCs, their chemical name, Chemical Formula and their Global Warming Potential

| ***Reference sheet: GWPs for HFCs and HFC blends according to the IPCC AR4, 100 years horizon*** | | | | |
|---|---|---|---|---|
| **Code** | **Substance Name** | **Chemical Name** | **Chemical Formula** | **GWP (AR4)** |
| R-125 | HFC-125 | Pentafluoroethane | $CHF_2CF_3$ | **3,500** |
| R-134A | HFC-134a | Tetrafluoroethane | $CH_2FCF_3$ | **1,430** |
| R-143A | HFC-143a | Trifluoroethane | $CF_3CH_3$ | **4,470** |
| R-152A | HFC-152a | Difluoroethane | $CH_3CHF_2$ | **124** |
| R-227EA | HFC-227EA | Heptafluoropropane | $CF_3CHFCF_3$ | **3,220** |
| R-23 | HFC-23 | Trifluoromethane / Fluoroform | $CHF_3$ | **14,800** |
| R-236CB | HFC-236CB | | $CH_2FCF_2CF_3$ | **1,340** |
| R-236EA | HFC-236EA | | $CHF_2CHFCF_3$ | **1,370** |
| R-236FA | HFC-236FA | Hexafluoropropane | $CF_3CH_2CF_3$ | **9,810** |
| R-245CA | HFC-245CA | | $CH_2FCF_2CHF_2$ | **693** |
| R-245FA | HFC-245FA | Pentafluoropropane | $CHF_2CH_2CF_3$ | **1,030** |
| R-32 | HFC-32 | Difluoromethane | $CH_2F_2$ | **675** |
| R-365MFC | HFC-365MFC | Pentafluorobutane | $CF_3CH_2CF_2CH_3$ | **794** |
| R-41 | HFC-41 | Fluoromethane (or Methyl fluoride) | $CH_3F$ | **92** |
| R-43-10MEE | HFC-43-10MEE | Decafluoropentane | $CF_3CHFCHFCF_2CF_3$ | **1,640** |

TABLE 3: showing the different HFC Blends and their Global Warming Potential (GWP).

| Code | HFC Blend Name | GWP (AR4) |
|---|---|---|
| R-32 | HFC-32 | **675** |
| R-404A | HFC-404A | **3,922** |
| R-407A | HFC-407A | **2,107** |
| R-407B | HFC-407B | **2,804** |
| R-407C | HFC-407C | **1,774** |
| R-407D | HFC-407D | **1,627** |
| R-407E | HFC-407E | **1,552** |
| R-407F | HFC-407F | **1,825** |
| R-407G | HFC-407G | **1,463** |
| R-410A | HFC-410A | **2,088** |
| R-410B | HFC-410B | **2,229** |
| R-413A | HFC-413A | **2,053** |
| R-417A | HFC-417A | **2,346** |
| R-417B | HFC-417B | **3,027** |
| R-417C | HFC-417C | **1,809** |
| R-419A | HFC-419A | **2,967** |
| R-419B | HFC-419B | **2,384** |
| R-421A | HFC-421A | **2,631** |
| R-421B | HFC-421B | **3,190** |
| R-422A | HFC-422A | **3,143** |
| R-422B | HFC-422B | **2,526** |
| R-422C | HFC-422C | **3,085** |
| R-422D | HFC-422D | **2,729** |
| R-422E | HFC-422E | **2,592** |
| R-423A | HFC-423A | **2,280** |
| R-424A | HFC-424A | **2,440** |
| R-425A | HFC-425A | **1,505** |
| R-426A | HFC-426A | **1,508** |
| R-427A | HFC-427A | **2,138** |
| R-428A | HFC-428A | **3,607** |
| R-429A | HFC-429A | **13** |
| R-430A | HFC-430A | **94** |
| R-431A | HFC-431A | **36** |
| R-434A | HFC-434A | **3,245** |
| R-435A | HFC-435A | **26** |
| R-437A | HFC-437A | **1,805** |
| R-438A | HFC-438A | **2,264** |
| R-439A | HFC-439A | **1,983** |
| R-440A | HFC-440A | **144** |

| | | |
|---|---|---|
| R-442A | HFC-442A | **1,888** |
| R-444A | HFC-444A | **87** |
| R-444B | HFC-444B | **293** |
| R-445A | HFC-445A | **129** |
| R-446A | HFC-446A | **459** |
| R-447A | HFC-447A | **582** |
| R-447B | HFC-447B | **739** |
| R-448A | HFC-448A | **1,386** |
| R-449A | HFC-449A | **1,396** |
| R-449B | HFC-449B | **1,411** |
| R-449C | HFC-449C | **1,250** |
| R-450A | HFC-450A | **601** |
| R-451A | HFC-451A | **146** |
| R-451B | HFC-451B | **160** |
| R-452A | HFC-452A | **2,139** |
| R-452B | HFC-452B | **697** |
| R-452C | HFC-452C | **2,219** |
| R-453A | HFC-453A | **1,765** |
| R-454A | HFC-454A | **236** |
| R-454B | HFC-454B | **465** |
| R-454C | HFC-454C | **145** |
| R-455A | HFC-455A | **145** |
| R-456A | HFC-456A | **684** |
| R-457A | HFC-457A | **136** |
| R-458A | HFC-458A | **1,650** |
| R-500 | HFC-500 | **8,077** |
| R-503 | HFC-503 | **14,560** |
| R-507A | HFC-507A | **3,985** |
| R-508A | HFC-508A | **13,214** |
| R-508B | HFC-508B | **13,396** |
| R-512A | HFC-512A | **189** |
| R-513A | HFC-513A | **629** |
| R-513B | HFC-513B | **593** |
| R-515A | HFC-515A | **386** |