



# Summer Fellowship Report

**On**

# A Comprehensive Framework for Scope 3 Data Systems, Event Reporting, and Brightway2 Modeling

*Submitted by*

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## 0.1 Declaration

I, hereby declare that this Report titled "**A Comprehensive Framework for Scope 3 Data Systems, Event Reporting, and Brightway2 Modeling**" is the result of my own work carried out during the Summer Fellowship conducted by the Free/Libre and Open Source Software for Education (FOSSEE) team at IIT Bombay.

No other institution has received this report for the purpose of awarding a degree, diploma, or certificate. In compliance with academic integrity guidelines, all items that were borrowed or referenced from outside sources have been properly acknowledged and attributed.

This declaration is being made fully cognizant of the internship program's terms and conditions as well as the university's academic code of conduct.

**Kunika Dhapodkar**
Date: July 19, 2025

# Acknowledgement

I would like to take this opportunity to sincerely thank everyone who has helped and mentored me during this Fellowship project, which is called **"A Comprehensive Framework for Scope 3 Data Systems, Event Reporting, and Brightway2 Modeling."**

I would like to extend my sincere thanks to my academic guide, **Prof. Kannan M. Moudgalya**, from the Department of Chemical Engineering at IIT Bombay, for his continuous support, expert guidance, and timely feedback. His insights helped me better understand the depth and scope of the project and shaped the quality of this report.

I am especially thankful to my mentors, **Mr. Shubham Sonkusare** and **Mr. Nikhil Sharma**, for their technical mentorship, constant encouragement, and for sharing their knowledge so generously. Their valuable inputs, practical insights, and regular reviews played a critical role in improving the quality and direction of my internship work.

I also wish to express my sincere appreciation to my supervisor, **Mr. Sumanto Kar** (Assistant Project Manager), for his guidance, leadership, and continuous motivation throughout the internship. His coordination and constructive feedback ensured that I remained focused on the goals and timelines of the project.

**Abstract**

Accurate reporting of greenhouse gas (GHG) emissions, particularly Scope 3 emissions, has become a top responsibility for organizations due to the growing emphasis on climate accountability on a worldwide scale. This paper offers a thorough framework that combines advanced life cycle assessment (LCA) with the Brightway2 modeling platform, event-based reporting mechanisms, and Scope 3 data systems. The methodology is intended to improve Scope 3 emission tracking—which covers indirect emissions that take place throughout an organization's value chain—in terms of transparency, traceability, and methodological robustness.

With an emphasis on harmonizing activity data, emission factors, and supplier-specific inputs, the project investigates the architecture and interoperability of emission data systems. Additionally, it presents an event reporting paradigm that allows for more timely and detailed disclosure by dynamically capturing emission-relevant events. Brightway2 is a Python-based life cycle assessment (LCA) program that offers customized workflows and data integration features for modeling complex systems and simulating environmental impacts.

More accurate environmental assessments and decision-making are made possible by the integration of data systems with Brightway2 modeling, which eventually supports sustainable organizational initiatives. By encouraging scalability, automation, and conformity with international reporting standards like the GHG Protocol and Science-Based Targets initiative (SBTi), the suggested framework seeks to close existing gaps in Scope 3 accounting.

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# Chapter 1

# Introduction

## 1.1 About FOSSEE

The **Free/Libre and Open Source Software for Education (FOSSEE)** project is an initiative by the **Indian Institute of Technology (IIT) Bombay**, supported by the **National Mission on Education through Information and Communication Technology (NMEICT)**, Ministry of Education, Government of India.

FOSSEE promotes the use of **open-source software** in education and research to reduce dependency on proprietary tools and to provide high-quality alternatives accessible to all. It supports a variety of open-source platforms including **Python**, **Scilab**, **eSim**, **OpenFOAM**, **R**, and **DWSIM**, among others.

FOSSEE also runs **Semester-Long Internships (SLI)**, **Summer Fellowships**, **Winter Interships Textbook Companions**, and **Lab Migration** projects to provide hands-on learning opportunities for students and educators across the country.

## 1.2 Importance of Open-Source Tools

When it comes to democratizing access to technology, open-source tools are essential. They are reasonably priced, incredibly configurable, and backed by vibrant communities. When working on sustainability and academic projects, Transparency, repeatability, and adaptability are made possible by open-source technologies.

This internship involved the significant use of technologies such as **Python**, **Streamlit**, **SQLite**, and **Brightway2** to construct and visualize emission tracking systems and carry out life cycle assessments.

## 1.3 Overview of Environmental Emissions

Pollutants released into the air, water, and soil as a result of human or natural activity are referred to as environmental emissions. These emissions include air pollutants like sulfur dioxide ($SO_2$) and particulate matter (PM), as well as greenhouse gases (GHGs) like carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$).

Transportation, energy generation, agriculture, and industrial processes are the main sources of human-induced emissions. Acid rain, smog, global warming, and deterioration of air and water quality are all caused by these pollutants. Emissions are usually divided into three scopes to assess their impact:

- **Scope 1**: Direct emissions from owned or controlled sources
- **Scope 2**: Indirect emissions from the generation of purchased energy
- **Scope 3**: All other indirect emissions occurring in the value chain

## 1.4 Scope 1, 2, and 3 Emissions

**Scope 1:** Direct emissions from owned sources (e.g., company vehicles).

$$\text{Scope 1 Emissions} = \sum_{i=1}^{n} (A_i \times EF_i)$$

where:

- $A_i$ = Activity data (e.g., liters of fuel, tons of waste)
- $EF_i$ = Emission factor for activity $i$ (e.g., kg $CO_2$e per liter of diesel)

**Scope 2:** Indirect emissions from purchased energy (e.g., electricity use).

$$\text{Scope 2 Emissions} = E \times EF$$

where:

- $E$ = Electricity consumption (in kWh)
- $EF$ = Emission factor of electricity (in kg $CO_2$e/kWh)

**Scope 3:** All other indirect emissions (e.g., supply chain activities).

$$\text{Scope 3 Emissions} = \sum_{j=1}^{m} (A_j \times EF_j)$$

where:

- $A_j$ = Activity data for Scope 3 category $j$ (e.g., distance traveled, money spent)
- $EF_j$ = Emission factor for activity $j$

The most complicated and data-intensive type of emissions reporting is scope 3, which includes all indirect greenhouse gas emissions that take place throughout a company's value chain. These emissions come from sources that the reporting entity does not own or have direct control over, like goods and services purchased, business travel, transportation, waste disposal, and product use.

Scope 3 emissions necessitates collecting a broad range of activity data from external stakeholders, suppliers, and third-party databases, in contrast to Scope 1 and 2 emissions, which rely on internal energy and fuel consumption data. Due to uneven data formats, opaque supply chains, and different emission factors based on source, industry, and area, extracting and estimating this data is extremely difficult.

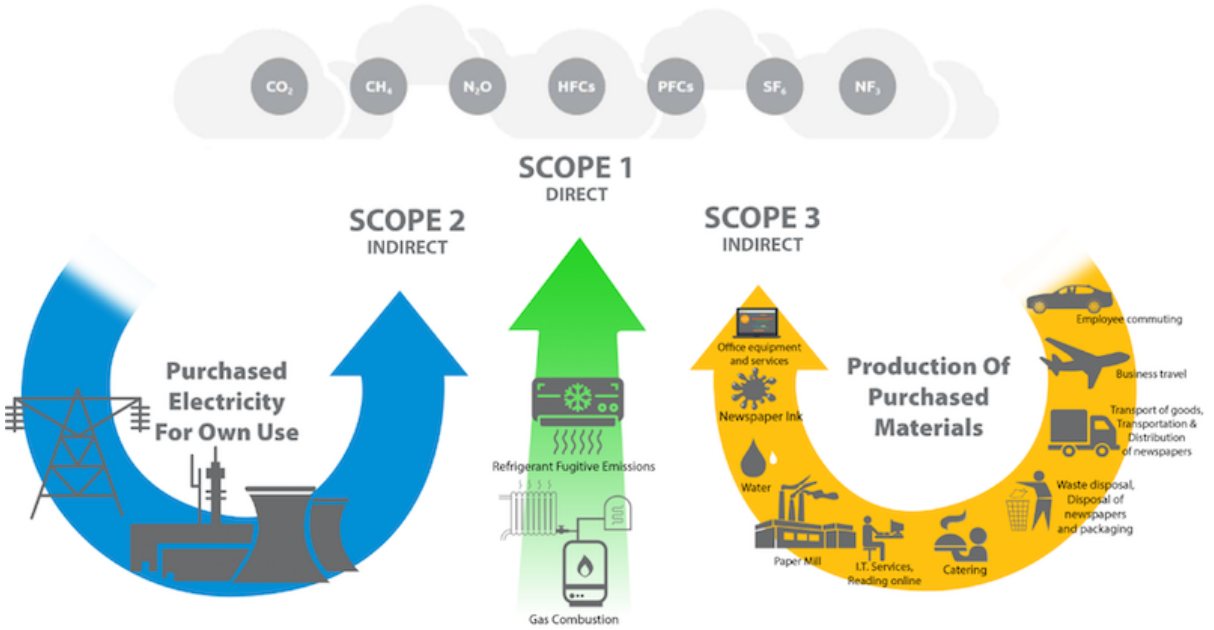



Figure 1.1: GHG emissions by Scope 1, 2, and 3.

# Chapter 2

# Fellowship Overview

## 2.1 Fellowship Title and Domain

Title: **"Scope 3 Emission Data Collection, Analysis, and Dashboard Development using Open Source Tools"**

This internship was provided under **IIT Bombay's FOSSEE** project's **Sustainable Computing sector**. It concentrated on leveraging Python and open-source modules to analyze and visualize greenhouse gas emissions, especially **Scope 3 emissions**. Along with work on **Life Cycle Assessment (LCA)** using **Brightway2**, the project also involved the design and construction of a real-time web dashboard using **Streamlit**.

## 2.2 Selection Process

- **Application Submission:** Interested candidates had to apply through the FOSSEE internship portal.
- **Screening Task:** Applicants were required to complete a screening task focused on **Scope 3 emissions data collection and analysis using Python**.
- **Review and Evaluation:** The FOSSEE team evaluated submissions based on the quality of code, data handling, documentation, and understanding of emission concepts.
- **Final Selection:** Selected students were notified via email and onboarded to begin the internship.

## 2.3 Fellowship Duration and Mode

- **Start Date:** May 2025
- **End Date:** July 2025
- **Mode:** Remote (Online)
- **Type:** Summer Fellowship

## 2.4 Objectives of the Fellowship

- To fully understand the composition and impact of emissions under Scopes 1, 2, and 3.
- to collect data for Scope 3 emission categories in an organized manner.
- to use **Python** for emissions analysis and present the results in a way that is accessible.
- To develop a **Streamlit-based web application** for emission tracking during events.
- To explore **Brightway2**, an open-source Life Cycle Assessment (LCA) tool.
- to support the development of open-source sustainability solutions.

## 2.5 Tools and Technologies Used

**Python**

High-level, versatile programming language widely used for data analysis, automation, and application development.

**Pandas and NumPy**

Pandas is a Python library that provides high-performance data structures and tools for data manipulation and analysis.
NumPy is a fundamental Python library for numerical computing, offering support for multi-dimensional arrays and mathematical operations.

**SQLite3**

Without the need for an independent server process, SQLite3 is a lightweight, embedded relational database engine that enables effective data management and storage.

**Streamlit and Seaborn**

Streamlit: A Python tool for building interactive data apps with minimal code.
Seaborn: A Python library for creating clear and elegant statistical plots.

**Brightway2 and Matplotlib**

Brightway2: A Python framework for life cycle assessment (LCA) and environmental impact modeling.
Matplotlib: A Python library for creating static, animated, and interactive visualizations.

# Chapter 3

# Fellowship Project-1 (Realtime Emissions Dashborad for Events)

## 3.1 Overview

Creating a system to monitor and evaluate carbon emissions from physical occurrences was the main goal of my internship's first project. The objective was to create a web-based dashboard that gathers information about attendees, such as their preferred meal and mode of transportation, in order to compute emissions for Scopes 1, 2, and 3. Implementing the reasoning for Scope 1 (direct emissions) and Scope 2 (indirect energy emissions) was my special responsibility. During this stage, environmental research and software development were combined. As the research developed, I also investigated carbon sequestration techniques and gathered data that had been verified by science to calculate possible offsets.

## 3.2 Emission Dashboard Development

### 3.2.1 Objective

The main goal was to provide a user-friendly dashboard where attendees could input their own preferences (such as food and mode of transportation), and the system would compute their carbon footprint automatically. Organizers were also given a visual overview of the overall emissions produced during the event by the dashboard.

### 3.2.2 Dashboard Visualization

The emissions tracking system's main interface, the Main Dashboard, enables interactive visualization, monitoring, and analysis of emission data. It compiles information from different user-submitted forms (such as those for travel or food) and displays it using dynamic visual components including tables, pie charts, and bar charts.

Creating an intuitive, engaging interface that directs the user from event to event was a crucial component of this project registration, followed by the entering of emissions data and, lastly, a graphic depiction of the estimated greenhouse gas (GHG) emissions.

Here are the steps how the dashboard works:

**1. Scope 1 Emission Calculator**

Users can estimate direct greenhouse gas (GHG) emissions by entering fuel types and consumption statistics into the Scope 1 Emissions Calculator shown by this interface. Through an interactive style, it lets users manage multiple fuel sources and dynamically estimates overall CO emissions.

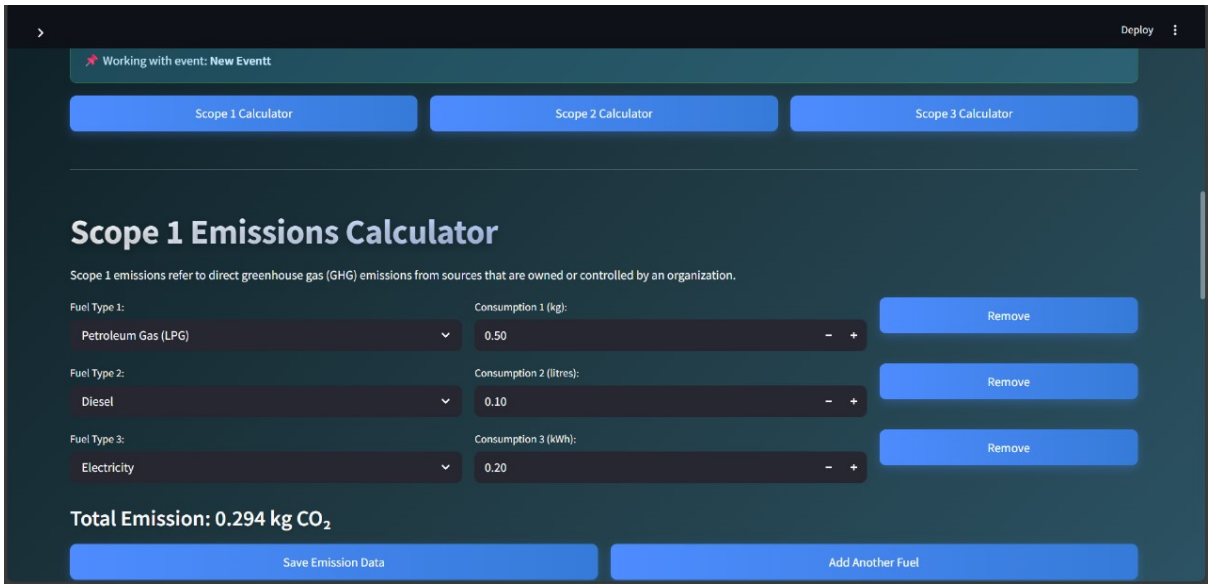



Figure 3.1: User interface for Scope 1 emissions calculation

### 2. Scope 2 Emission Calculator

This interface enables users to calculate Scope 2 emissions by entering electricity usage and HVAC refrigerant data. It supports source selection, leakage input, and visual representation through charts.

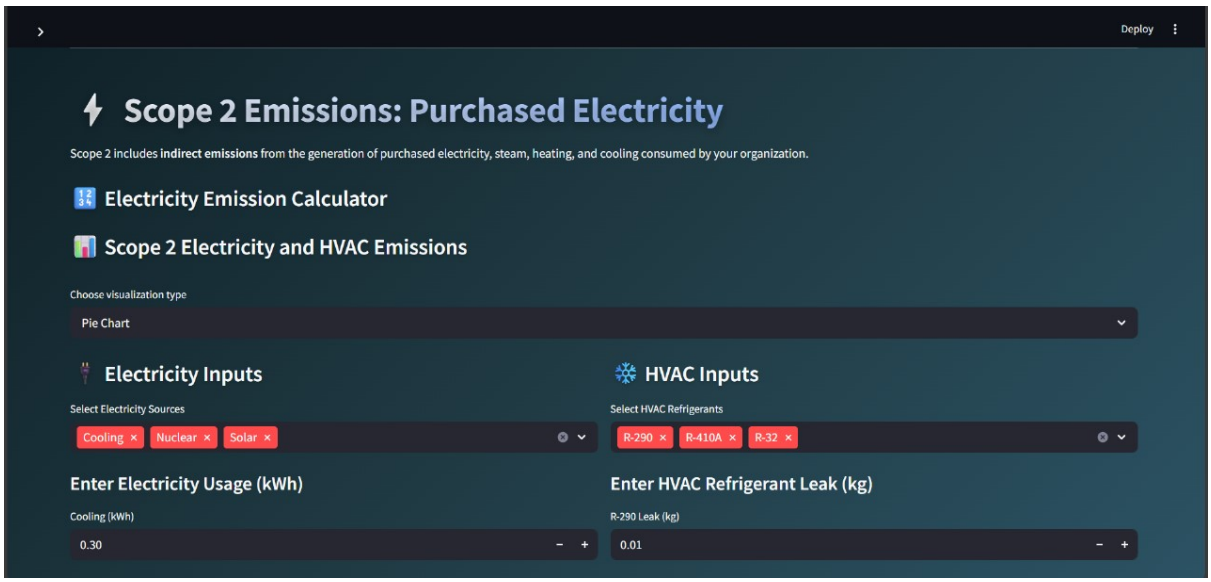



Figure 3.2: User interface for Scope 2 emissions calculation

### 3. Scope 3 Emission Calculator

This interface estimates Scope 3 emissions from purchased goods like custom items (e.g., trophies), even if they're not standard industrial categories. Users can input item type, weight, and quantity to calculate the embodied emissions — meaning the emissions released during raw material extraction, manufacturing, and delivery.

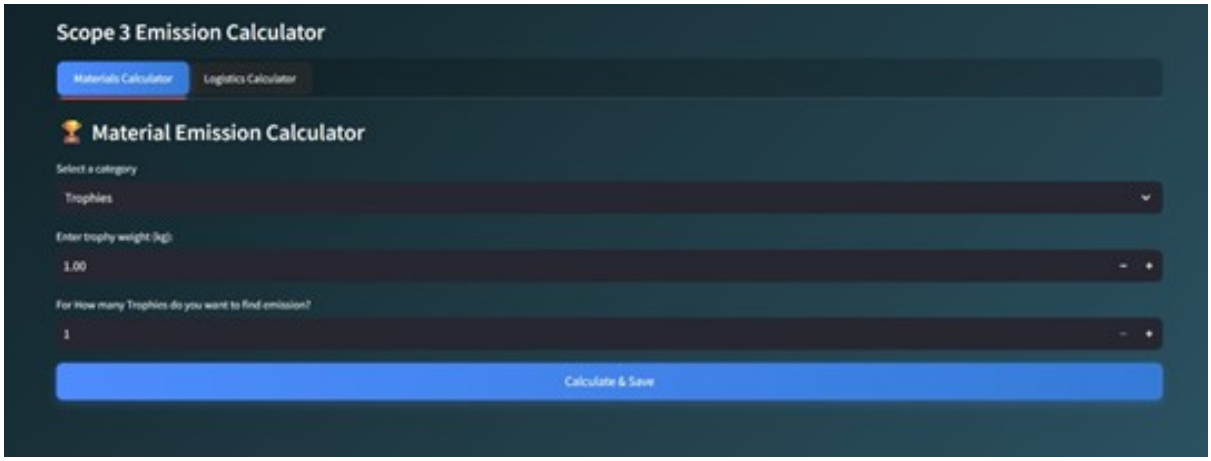



Figure 3.3: User interface for Scope 3 emissions calculation

## 4. User Registration

The application provides an intuitive and user-friendly interface for tracking carbon emissions through categories like Transport, Food, and more. Users can register quickly by inputting basic details such as name and age, enhancing accessibility and ease of use.

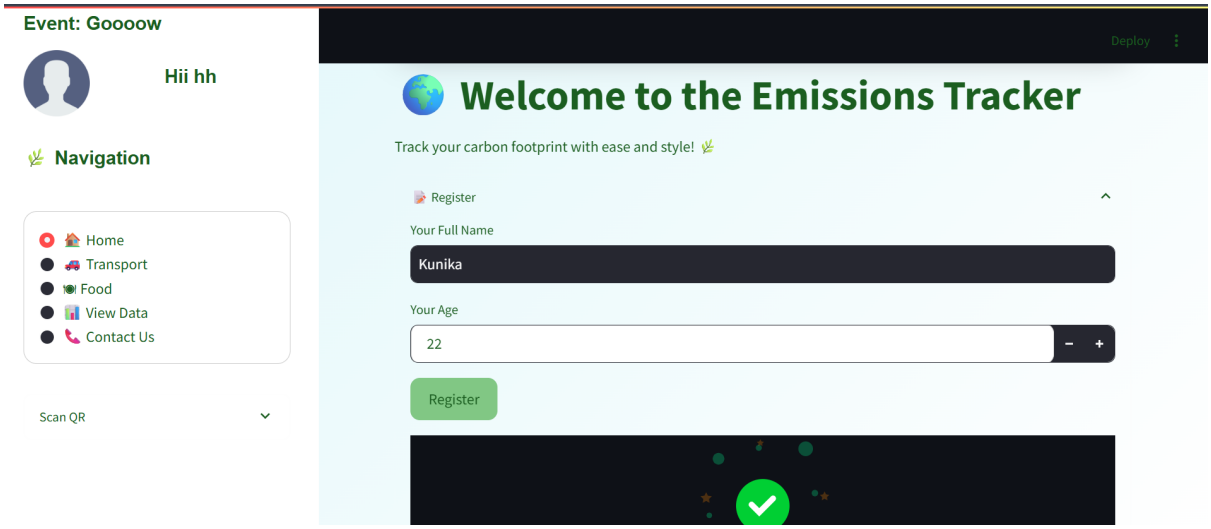



Figure 3.4: User registration screen of the Emissions Tracker application

## 5. Transport Data Calcultor

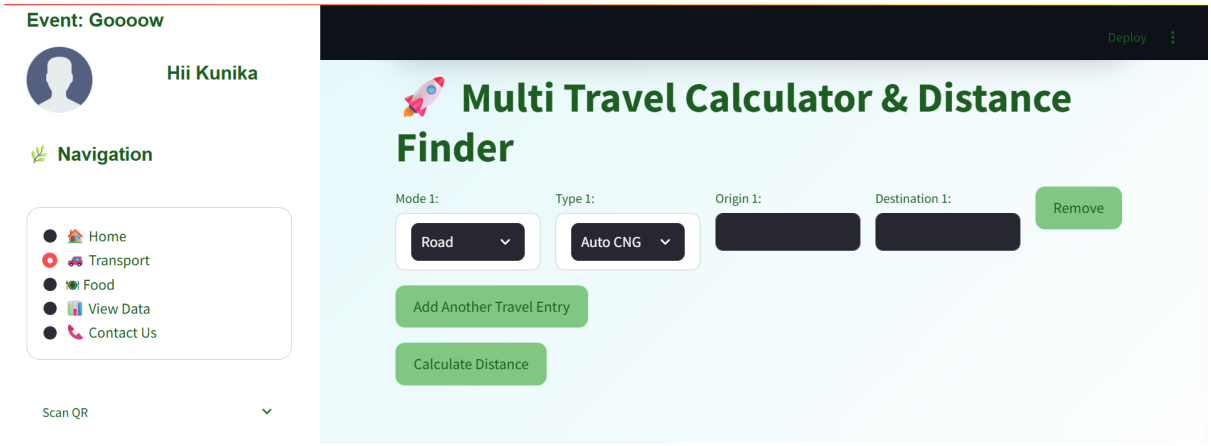



Figure 3.5: Transport Data Calculation Interface

### 6. Food Preferences

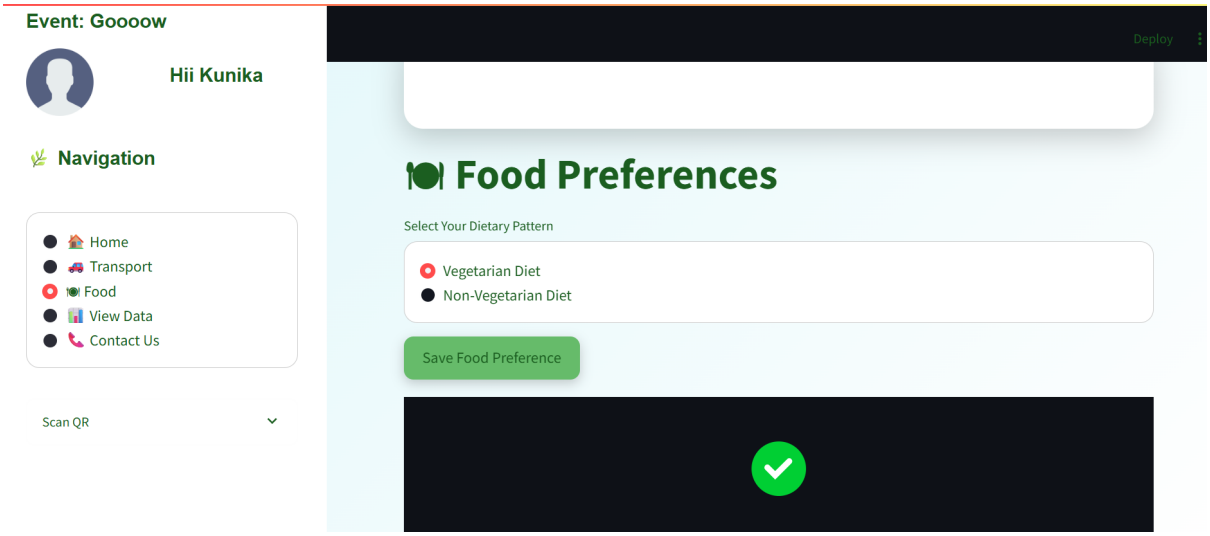



Figure 3.6: Emission Calculation from Food Preferences

### 7. Emissions(Carbon) Footprint Tracker

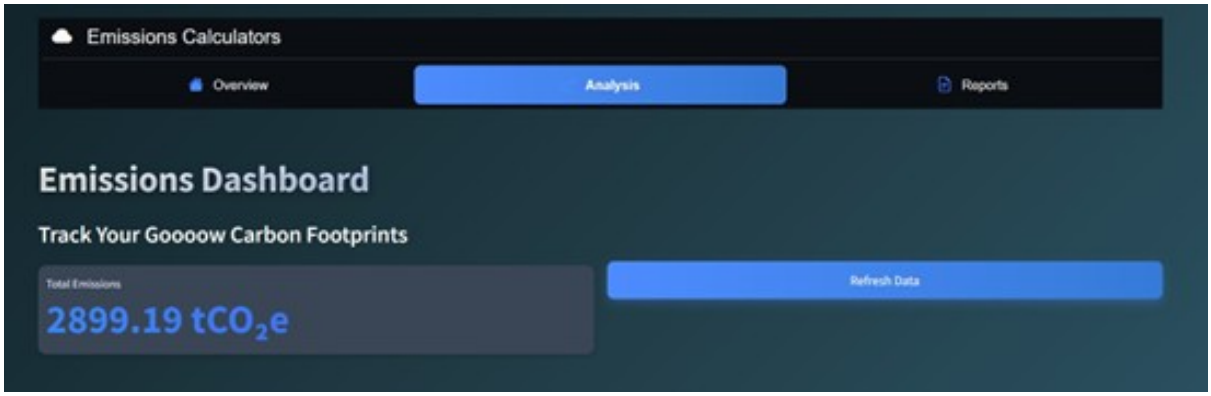



Figure 3.7: Carbon Footprint calculation

After data is entered, the dashboard provides instant feedback. Visualizations include:

- A real-time carbon footprint summary
- Category-wise emission breakdown (e.g., pie charts, bar graphs)
- Scope-wise contribution (Scope 1, 2, 3)
- Progress indicators showing emissions vs. reduction targets

### 3.2.3 Tools and Technologies Used

- **Python** for scripting and backend logic
- **Streamlit** for UI development
- **SQLite** for storing user and event data
- **Matplotlib / Plotly** for visualization
- **Qrcode / UUID / Time libraries** for session handling and access features

### 3.2.4 Outcome

By the end of this phase, I had developed a **fully functional form-driven dashboard** that could:

- Accept real-time user data
- Calculate emissions instantly
- Store and visualize results
- Scale across multiple events

This was my first time building something that combined data science with real-world environmental impact, and it was a rewarding experience.

# Chapter 4

# Fellowship project 2 - Scope 3 Data Categorization and Collection

## 4.1 Scope 3 Emission Categories

Indirect greenhouse gas emissions that happen both upstream and downstream in a company's value chain are referred to as scope 3 emissions. Scope 3 encompasses 15 areas, including purchased products, transportation, trash disposal, business travel, employee commuting, product use, and end-of-life treatment, in contrast to Scope 1 (direct) and Scope 2 (purchased electricity). Since these emissions frequently account for the majority of a business's overall carbon footprint, monitoring them is crucial to achieving sustainability and climate action objectives.

The 15 Categories include:

**Upstream Emissions (Activities before the company's direct operations):**

- **Category 1** – Purchased Goods and Services
- **Category 2** – Capital Goods
- **Category 3** – Fuel- and Energy-Related Activities
- **Category 4** – Upstream Transportation and Distribution
- **Category 5** – Waste Generated in Operations
- **Category 6** – Business Travel
- **Category 7** – Employee Commuting
- **Category 8** – Upstream Leased Assets

**Downstream Emissions (Activities after the company's direct operations):**

- **Category 9** – Downstream Transportation and Distribution
- **Category 10** – Processing of Sold Products
- **Category 11** – Use of Sold Products
- **Category 12** – End-of-Life Treatment of Sold Products
- **Category 13** – Downstream Leased Assets
- **Category 14** – Franchises
- **Category 15** – Investments

## 4.2 Scope of Work and Category-wise Approach

**Category 1 Purchased Goods and Services**
Emissions from the production of goods and services the company buys (e.g., raw materials, office supplies)

**Category 2 Capital Goods**
Emissions from manufacturing equipment, buildings, or infrastructure purchased by the company

**Category 3 Fuel- and Energy-Related Activities (not in Scope 1 or 2)**
Emissions from the production of fuels and energy the company purchases (e.g., extraction, refining, and transport)

**Category 4 Upstream Transportation and Distribution**
Emissions from transporting products the company buys, from the supplier to its location

**Category 5 Waste Generated in Operations**
Emissions from third-party treatment and disposal of waste generated by the company

**Category 6 Business Travel**
Emissions from employee travel for work (e.g., flights, hotel stays, rental cars)

**Category 7 Employee Commuting**
Emissions from daily employee travel between home and the workplace

**Category 8 Upstream Leased Assets**
Emissions from assets leased by the company but not included in Scope 1 or 2 (e.g., leased office buildings or vehicles)

**Category 9 Downstream Transportation and Distribution**
Emissions from distributing the company's sold products to customers

**Category 10 Processing of Sold Products**
Emissions from third parties processing intermediate products sold by the company

**Category 11 Use of Sold Products**
Emissions generated when customers use the company's products (e.g., fuel in cars, electricity in appliances)

**Category 12 End-of-Life Treatment of Sold Products**
Emissions from waste disposal (recycling, landfilling, incineration) after the product's use

**Category 13 Downstream Leased Assets**
Emissions from assets the company owns but leases out to others

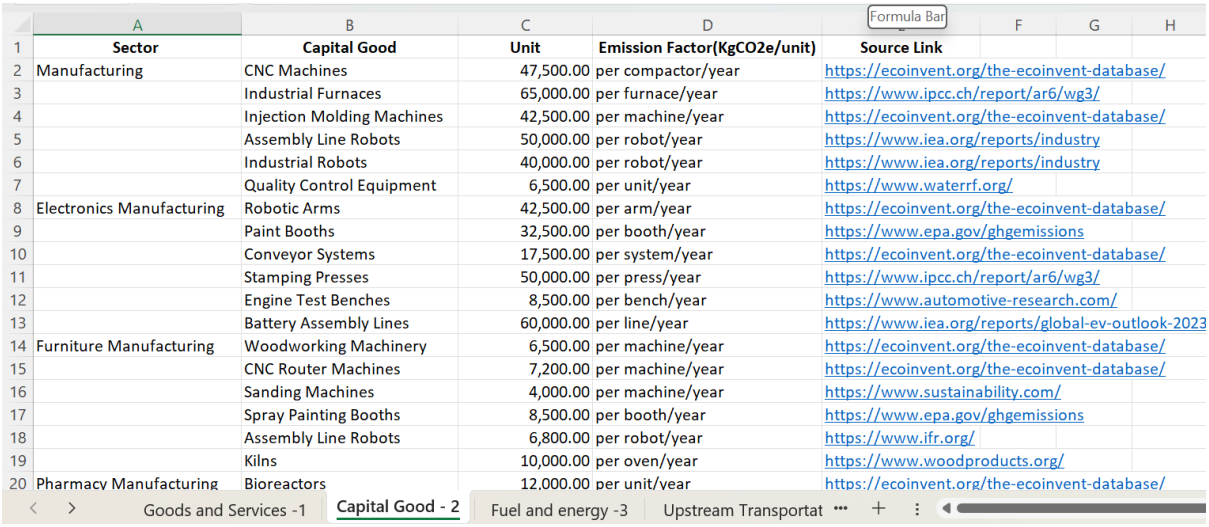
**Category 14 Franchises**
Emissions from the operation of franchises not directly owned but under the company's brand

**Category 15 Investments**
Emissions associated with investments the company makes (e.g., equity, debt, project finance)

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 1 | Goods | | | | | | |
| 2 | **Industry** | | **Goods Category** | **Sub category** | **Unit** | **Emission Factor** | **Source** |
| 3 | **Manufacturing** | **Goods** | Steel | Steel | Kg | 1.77 | Winnipeg Report |
| 4 | | | | Reinforced steel | Kg | 1.49 | Winnipeg Report |
| 5 | | | | Stainless steel | Kg | 6.15 | Winnipeg Report |
| 6 | | | Iron metal | Cast iron | Kg | 1.51 | https://www.gov.uk/governm |
| 7 | | | | Iron | Kg | 1.91 | https://www.gov.uk/governm |
| 8 | | | Metals | Aluminium | kg | 4.1 | Climatiq |
| 9 | | | | Copper | kg | 1.3 | Climatiq |
| 10 | | | plastic | ABS | kg | 3.46 | Winnipeg Report |
| 11 | | | | EVAC | kg | 2.11 | Winnipeg Report |
| 12 | | | | HDPE r. | kg | 1.10 | Winnipeg Report |
| 13 | | | | HDPE v. | kg | 1.90 | Winnipeg Report |
| 14 | | | | LDPE r. | kg | 1.01 | Winnipeg Report |
| 15 | | | | LDPE v. | kg | 2.06 | Winnipeg Report |
| 16 | | | | Nylon | kg | 7.90 | Winnipeg Report |
| 17 | | | | PET r. | kg | 1.76 | Winnipeg Report |
| 18 | | | | PET v. | kg | 5.44 | Winnipeg Report |
| 19 | | | | Polystyrene | kg | 3.07 | Winnipeg Report |
| 20 | | | | Polyethylene (PE) | kg | 1.9 | Climatiq |
| 21 | | | | Polypropylene (PP) | kg | 1.586 | PMC Article |
| 22 | | | Glass | Glass | kg | 0.85 | https://www.gov.uk/governm |
| 23 | | | | Flat glass | m² | 6.25 | Climatiq |

Goods and Services -1 | Capital Good - 2 | Fuel and energy -3 | Upstream Transportat

Figure 4.1: Data Collection of Categories-1



| | A | B | C | D | Source Link |
|---|---|---|---|---|---|
| 1 | Sector | Capital Good | Unit | Emission Factor(KgCO2e/unit) | |
| 2 | Manufacturing | CNC Machines | 47,500.00 | per compactor/year | https://ecoinvent.org/the-ecoinvent-database/ |
| 3 | | Industrial Furnaces | 65,000.00 | per furnace/year | https://www.ipcc.ch/report/ar6/wg3/ |
| 4 | | Injection Molding Machines | 42,500.00 | per machine/year | https://ecoinvent.org/the-ecoinvent-database/ |
| 5 | | Assembly Line Robots | 50,000.00 | per robot/year | https://www.iea.org/reports/industry |
| 6 | | Industrial Robots | 40,000.00 | per robot/year | https://www.iea.org/reports/industry |
| 7 | | Quality Control Equipment | 6,500.00 | per unit/year | https://www.waterrf.org/ |
| 8 | Electronics Manufacturing | Robotic Arms | 42,500.00 | per arm/year | https://ecoinvent.org/the-ecoinvent-database/ |
| 9 | | Paint Booths | 32,500.00 | per booth/year | https://www.epa.gov/ghgemissions |
| 10 | | Conveyor Systems | 17,500.00 | per system/year | https://ecoinvent.org/the-ecoinvent-database/ |
| 11 | | Stamping Presses | 50,000.00 | per press/year | https://www.ipcc.ch/report/ar6/wg3/ |
| 12 | | Engine Test Benches | 8,500.00 | per bench/year | https://www.automotive-research.com/ |
| 13 | | Battery Assembly Lines | 60,000.00 | per line/year | https://www.iea.org/reports/global-ev-outlook-2023 |
| 14 | Furniture Manufacturing | Woodworking Machinery | 6,500.00 | per machine/year | https://ecoinvent.org/the-ecoinvent-database/ |
| 15 | | CNC Router Machines | 7,200.00 | per machine/year | https://ecoinvent.org/the-ecoinvent-database/ |
| 16 | | Sanding Machines | 4,000.00 | per machine/year | https://www.sustainability.com/ |
| 17 | | Spray Painting Booths | 8,500.00 | per booth/year | https://www.epa.gov/ghgemissions |
| 18 | | Assembly Line Robots | 6,800.00 | per robot/year | https://www.ifr.org/ |
| 19 | | Kilns | 10,000.00 | per oven/year | https://www.woodproducts.org/ |
| 20 | Pharmacy Manufacturing | Bioreactors | 12,000.00 | per unit/year | https://ecoinvent.org/the-ecoinvent-database/ |



Figure 4.2: Data Collection of Categories-2

## 4.3 Data Structuring and Formats

All collected data was structured into standardized **CSV and Excel files**, with the following fields:

- Category Name
- Activity Description
- Emission Factor (kg $CO_2e$/unit)
- Unit Type (km, kWh, item, etc.)
- Data Source

## 4.4 Python Scripts For Data Processing

Python scripts were created to:

- **Ingest raw data** from different formats
- **Normalize values** to a common base unit
- **Map activity data** to the correct Scope 3 category
- **Compute total emissions** by multiplying quantity × emission factor

# Chapter 5

# Key Learnings

## 5.1 Technical Skills Gained

During this internship, I enhanced my skills in Python programming, data analysis, and backend logic implementation. I developed interactive dashboards using Streamlit, managed structured data with SQLite, and visualized results using Matplotlib and Plotly. Pandas to clean, preprocess, and standardize raw datasets for emission calculations.

## 5.2 Domain Knowledge Acquired (Climate Science and Emission)

This internship provided in-depth exposure to the domain of climate science, carbon emissions, and sustainable computing:

- **Understanding of Scope 1, 2, and 3 Emissions**
- **Life Cycle Assessment (LCA)**
- **product lifecycles**
- **Emission Factors and Reporting**

– Gained familiarity with open-source tools and principles through FOSSEE's workflow.
– Contributed to an open-source aligned dashboard tool for emission tracking.
– Followed reproducible and transparent coding practices suitable for public sharing.

## 5.3 Communication and Team Collaboration

1. Participated in regular progress check-ins and coordinated with mentors and peers.
2. Maintained task documentation and version control to stay aligned with shared goals.
3. Improved clarity in reporting technical and environmental data for both technical and non-technical audiences.
4.Collaborated on data-driven insights to support sustainable decision-making within the project framework.
5.Engaged in constructive feedback sessions to refine methodologies and enhance project outcomes.

# Chapter 6

# Conclusion

## 6.1 Overall Experience

I was able to close the gap between technology and environmental impact thanks to my FOSSEE internship. It gave me the opportunity to use my programming abilities in a useful way by using data systems and models to address actual climate concerns.

Every stage improved my comprehension of sustainability in action, from learning about emission types to putting tracking and analytic tools into place.

## 6.2 What Worked Well

- Building a working **dashboard from scratch** using open tools
- Creating a **user-friendly form system** that functioned both online and on mobile
- Mapping real data to **emission factor models**
- Exploring the potential of **carbon sequestration** in future tools
- Independently managing code, research, and reporting.
- Predictions and visualizations.

## 6.3 Scope for Future Work

• Add **user login system** and allow attendee profile editing• Fetch emission factors from **real-time APIs**
• Use carbon sequestration offsets to calculate **net emissions**• Expand dashboard to include **more Scope 3 categories**
• Incorporate national policy targets (e.g., India's National Electricity Plan or Net Zero targets) to replace or supplement SSP projections.
•Provide error bars or distributions instead of point estimates to improve decision robustness
•Design the dashboard to act as a learning tool for students and policymakers to understand the role of lifecycle assessment in energy planning.

# Chapter 7

# References


**Data Sources**

1. Intergovernmental Panel on Climate Change (IPCC) Emission Factor Guidelines
2. Food and Agriculture Organization (FAO) – Global Emission Statistics
3. UK Department for Environment, Food & Rural Affairs (DEFRA) – GHG Conversion Factors
4. Government of India – Ministry of Road Transport and Highways (MoRTH) Reports
5. Indian Railways Passenger Emission Estimations
6. Ecoinvent Database Documentation (as applicable)
7. National Renewable Energy Laboratory (NREL) – LCA Data Sources
8. Brightway2 and OpenLCA Toolkits
9. Academic Journals on Carbon Sequestration (Elsevier, Springer)

**Libraries / Tools**

1. Python 3.10
2. Streamlit
3. Pandas, NumPy, Matplotlib, Plotly
4. SQLite
5. OpenLCA (optional reference)

**Research Papers and Links**

1. GHG Protocol Corporate Standard: **Click Here**
2. IPCC Reports Archive: **Click Here**
3. Brightway2 Documentation: **Click Here**
4. Activity Browser: **Click Here**
5. OpenLCA Software: **Click Here**
6. Ecoinvent: **Click Here**
7. Life Cycle Assessments **Click Here**
6. FOSSEE Resource Portal**Click Here**