Spatio-temporal carbon emission estimation: User Guide and Technical Overview

This repository contains Python code developed for the research paper: "Spatio-temporal estimation of electricity-related carbon emission intensity: a case study of the Tokyo Metropolitan Area."

Citation

If you use this code, please cite our paper:

[Reza Nadimi, Mika Goto, "Spatio-temporal estimation of electricity-related carbon emission intensity: a case study of the Tokyo Metropolitan Area", Sustainable Cities and Society, Volume ***, year:***, doi: ***]

Implementation Procedure

Figure 1 presents the structure of the carbon emission modeling, comprising three Python scripts and the Input_Data folder containing 5 Excel files. Users can modify these input files to customize modeling cases.

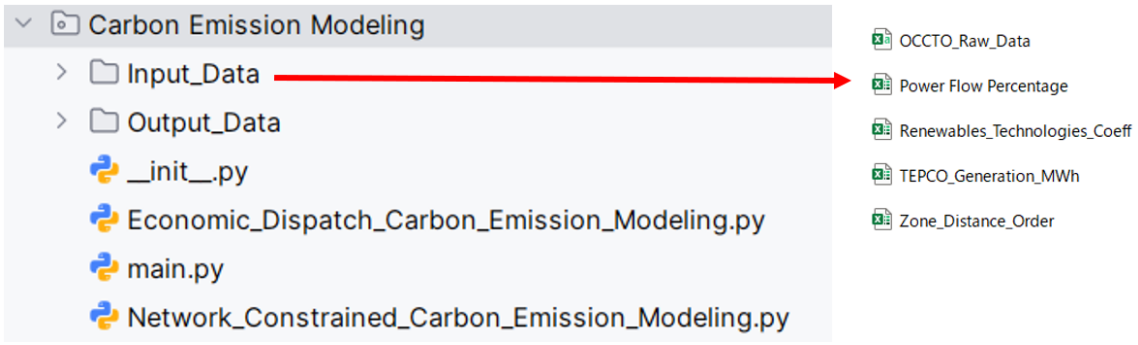


Figure 1: Tree Structure of carbon emission modeling with descriptions

To utilize the carbon emission modeling tool, the following steps are required:

1. Install Dependencies

Ensure that all required Python libraries are installed. Use the following command:

pip install -r requirements.txt

2. Prepare Input Data

Download the ZIP archive from the repository's Code section. After extraction, verify that the "Input_Data" folder contains 5 Excel (.xlsx, .csv) files. These files provide the necessary configuration and input datasets for modeling.

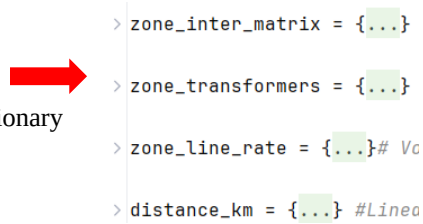
3. Execute the carbon emission model

Run the main script "main.py". This script serves as the entry point and coordinates the execution of all other modules.

User Configuration

Within "main.py", users can change the modeling parameters, including:

- Zonal high voltage (HV) data via zone_inter_matrix dictionary
- Zonal transformers data via zone_transformers dictionary
- Voltage-level line capacity per zone (MW) via zone_line_rate dictionary
- Linear distance matrix for 14 zones via distance_km dictionary



Upon execution, the application creates:

- All files inside the output folder, as shown in Figure 1, are updated for the last run.
- Inside the output folder there are 11 excel files, two png files, and two gif files (Figure 2).

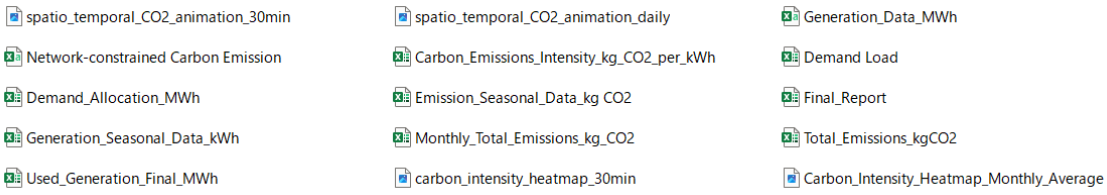


Figure 2: Output files of the carbon emission modeling

However, the main file is the Final_Report worksheet which consists of the following sheets:

- **NC_CE** and **ED_CE**: these sheets' data are used to plot Figure 2(a) of the paper,

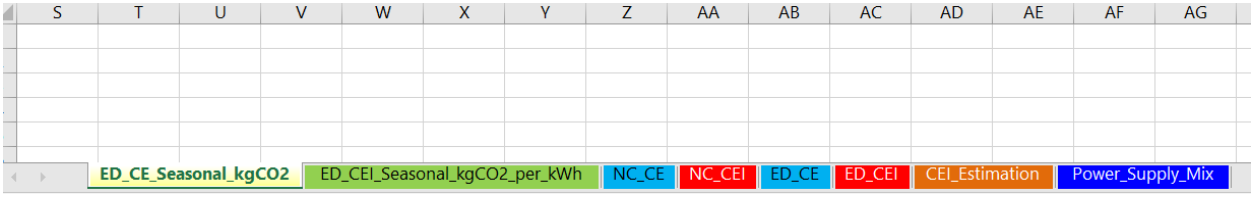
- **Power_Supply_Mix**: this sheet's data are used to plot Figure 2(b) of the paper,

- **ED_CE_Seasonal_kgCO2**: this sheet's data are used to plot Figure 3 of the paper,

- **NC_CEI** and **ED_CEI**: these sheets' data are used to plot Figure 6 of the paper,

- **ED_CEI_Seasonal_kgCO2_per_kWh**: this sheet's data are used to plot Figure 7 of the paper,

- **CEI_Estimation**: this sheet's data are used to plot Figure 8 of the paper (without historical data),



Two png files inside the Output_Data folder belong to figures 4 and 5 as follows:

- **carbon_intensity_heatmap_30min.png** is corresponding to Figure 4, and

- **Carbon_Intensity_Heatmap_Monthly_Average.png** is corresponding to Figure 5.