

Comprehensive Analytical Dashboard of European Countries Carbon Emission

Presentation of Final Project

Advanced Programming in R [2400-DS1APR]

Objective & Functionalities

Objective

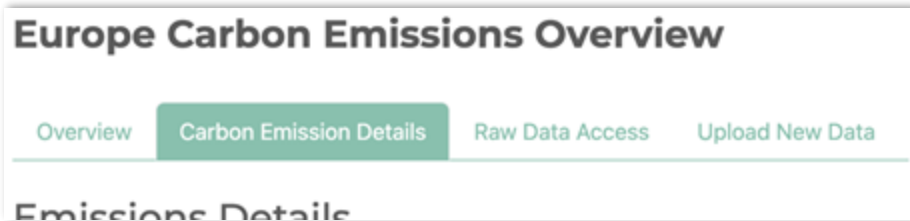
- Europe houses some of the world's largest and most influential economies.
- Analyze Europe's carbon emissions, given the region's economic prominence.
- Explore the environmental, economic, and policy implications of those emissions.

Data obtained from eurostat "Carbon dioxide emission footprints (FIGARO application)"

Required columns: year, countries, sector total emission

Functionalities

- Emission data visualizations to explore trends and carry out comparative analysis (e.g. line plots, bar graphs, pie chart, maps)
- Flexible and reproducible exploration tool:
 - Available for new emission data upload for future analysis
 - Able to filter and export data source used
 - Allowed to save plots / charts if available



Utilisation of Coding Methods

Implementation of Interactive Web Applications using Shiny

Frontend (UI):

- “tabsetPanel” and reactive inputs (sliders, dropdowns)

Backend (Server):

- Reactive programming e.g. “observe”, and integrated with table / plots output like DT
- Data validation workflow for new uploads

Setup (App):

- For preloading necessary components

```
app.R x server.R x ui.R x
1 ui <- fluidPage(
2   theme = bs_theme(version = 5, bootswatch = "minty", "navbar-brand-color" = "#78c6d9"),
3   br(),
4   titlePanel(strong("Europe Carbon Emissions Overview")),
5   br(),
6   tabsetPanel(
7
8     # 1. Overview tab
9     tabPanel("Overview",
10       br(),
11       h2("General Overview"),
12       p(" "),
13       p("This interactive dashboard provides a comprehensive analysis of ca
```

```
fluidRow(
  column(4,
    # no wellPanel here
    selectInput("country_sector_tab", "Select Country:", choices = NULL, width = "100%",
    selectInput("sector_select", "Select Sector:", choices = NULL, width = "100%",
    sliderInput("yearRangeSector", "Year Range:", min = 2010, max = 2022, value = c(2010,

  ),
  column(8,
    plotOutput("linePlotSector")
  )
)
```

```
# 3) Populate second sector-tab country
observe({
  df0 <- emission_data_active()
  updateSelectInput(session, "country_sector_tab_2",
    choices = c("Total", sort(unique(df0$country))),
    selected = "Total")

  available_years <- sort(unique(df0$year))
  min_year <- min(available_years)
  max_year <- max(available_years)
  updateSliderInput(session, "yearRangeSector_2",
    min = min_year,
    max = max_year,
    value = c(min_year, max_year))
})
```

Utilisation of Coding Methods

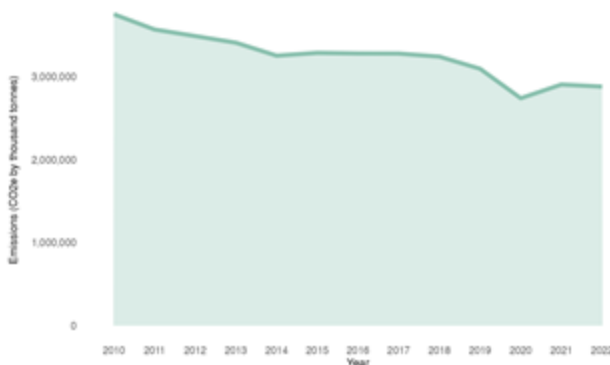
Usage of C++ in Newly-Built Functions

```
# function for sums a vector of emissions
cppFunction('
double total_emission (NumericVector emission) {
  double total = 0;
  for(int i = 0; i < emission.size(); i++) {
    total += emission[i];
  }
  return total;
}
')
```

Select Country or Total:

Total

Development of Total Carbon Emissions



```
if (input$overviewCountry == "Total") {
  yearly <- df0 %>%
    group_by(year) %>%
    summarise(total_emission = total_emission(emission)) # C++ function

  ggplot(yearly, aes(x = year, y = total_emission)) +
    geom_area(fill = "#78c2ad", alpha = 0.3) +
    geom_line(color = "#78c2ad", size = 2) +
    scale_x_continuous(breaks = 2010:2022) +
    scale_y_continuous(labels = scales::comma) +
    labs(title = "Development of Total Carbon Emissions",
         x = "Year", y = "Emissions (CO2e by thousand tonnes)") +
    theme_minimal() +
    theme(
      panel.grid = element_blank(),
      plot.title = element_text(face = "bold", size = 16),
      axis.text.x = element_text(size = 10),
      axis.text.y = element_text(
        size = 10,
        margin = margin(r = 10)
      ),
      axis.title.y = element_text(margin = margin(r = 12)),
      plot.margin = margin(t = 5, r = 5, b = 5, l = 15)
    )
}
```

Utilisation of Coding Methods

Defensive programming methods

- Input validation in each frequent use of req() and validate() functions -> stop render plot if the required inputs are wrong or unavailable
- TryCatch() for error handling when importing file to check for corrupted file or different format, then returns different messages.



Utilisation of Coding Methods

Code vectorisation

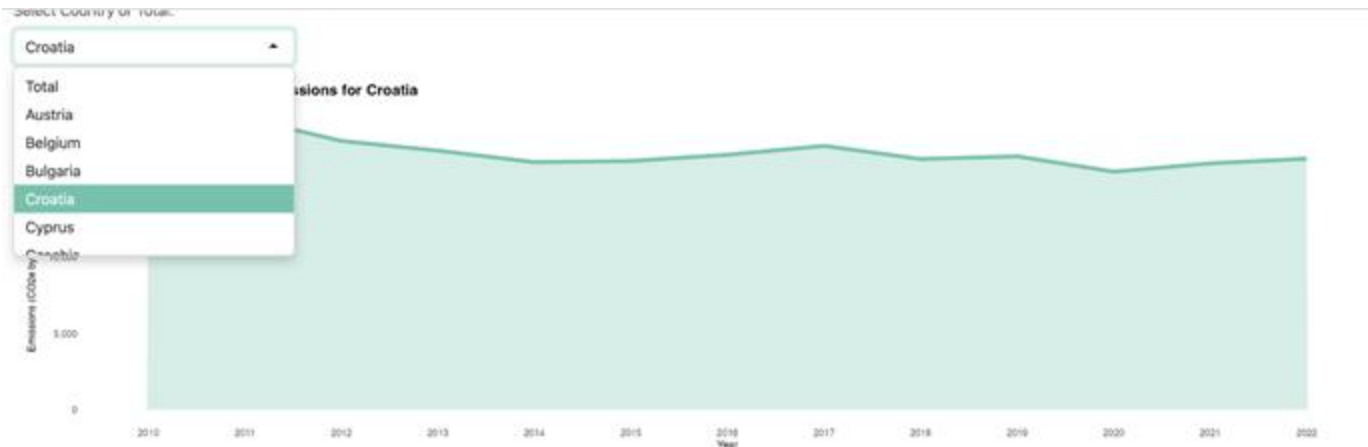
- Most of the code are vectorised as tibble using dplyr to filter each columns according to certain conditions
- Minimal for-loop function for (except in C++) function

```
map_data_active <- reactive({  
  df0 <- emission_data_active()  
  total_by_country <- df0 %>%  
    group_by(country) %>%  
    summarise(  
      total_emission = total_emission(emission),  
      .groups = "drop"  
    )  
  
  data_filtered <- df0 %>%  
    filter(  
      (input$country_sector_tab_2 == "Total" | country == input$country_sector_tab_2),  
      year %in% c(year_start, year_end)  
    )  
  
  df_wide <- data_filtered %>%  
    group_by(sector, year) %>%  
    summarise(total = sum(emission, na.rm = TRUE), .groups = "drop") %>%  
    tidyr::pivot_wider(  
      | names_from = year,  
      | values_from = total,  
      | values_fill = list(total = 0)  
    )  
})
```

Short Demo

Comprehensive Dashboard of European Countries Carbon Emission

Advanced Programming in R [2400-DS1APR]

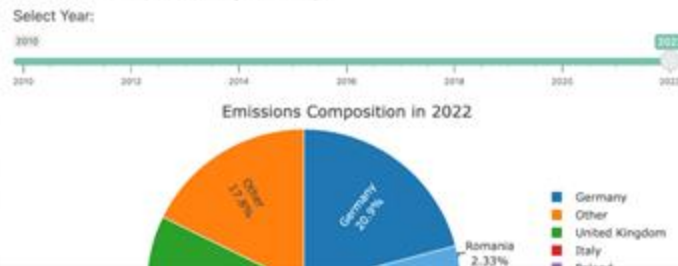


Sometimes, each country has different major contributors to carbon emissions in a given year, and each of them contributes relatively to the others. Therefore, it is especially crucial to aware the composition of emissions by country for a selected year. It is also beneficial to get a clear geographical distribution of carbon emission intensity.

Overview Map of Carbon Emission in European Countries



Emission Composition by Country



Select Country:

Total

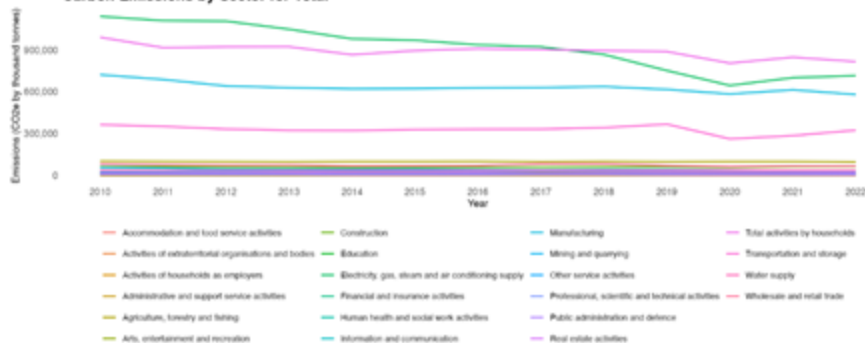
Select Sector:

All sectors

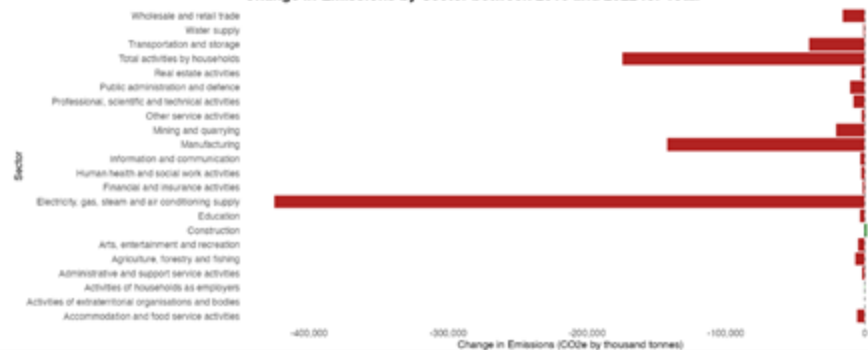
Year Range:



Carbon Emissions by Sector for Total



Change in Emissions by Sector between 2010 and 2022 for Total



Select Country:

Total

Year Range:



Europe Carbon Emissions Overview

[Overview](#)[Carbon Emission Details](#)[Raw Data Access](#)[Upload New Data](#)

Explore & Download Filtered Emissions Data

Please use the sidebar to filter and download the raw dataset that powers the dashboard. It is able to filter the dataset by selecting specific or interested sector(s), country(ies), and year(s). The matching data can be downloaded as CSV file. It is important to note that the unit measure for carbon emission is by **thousand tonnes**.

Select Sector(s):

Accommodation and food service activities

Select Country(ies):

Austria Croatia

Select Year(s):

2010

Filename to save:

Save CSV

Filtered Data Preview

Show 15 entries

Search:

	sector	country	year	emission
1	Accommodation and food service activities	Austria	2010	341.232
2	Accommodation and food service activities	Croatia	2010	0.013
3	Accommodation and food service activities	Austria	2010	1.167
4	Accommodation and food service activities	Croatia	2010	0.01
5	Accommodation and food service activities	Austria	2010	0.213
6	Accommodation and food service activities	Croatia	2010	0.001
7	Accommodation and food service activities	Austria	2010	3.563
8	Accommodation and food service activities	Croatia	2010	0.012
9	Accommodation and food service activities	Austria	2010	0.027
10	Accommodation and food service activities	Croatia	2010	0
11	Accommodation and food service activities	Austria	2010	1.177
12	Accommodation and food service activities	Croatia	2010	0.003

Europe Carbon Emissions Overview

[Overview](#)[Carbon Emission Details](#)[Raw Data Access](#)[Upload New Data](#)

New Emissions Data Upload

It is able to upload new carbon emissions dataset and explore it interactively using this dashboard. The data **must** be downloaded from Eurostat database called [Carbon Dioxide Emission Footprints](#). To ensure the data works correctly and successfully with the dashboard, there are several requirements **must** be satisfied:

1. The file must be a CSV file (maximum 70 MB);
2. There are 5 columns must be included in the data: "National accounts indicator (ESA 2010)", "Statistical classification of economic activities in the European Community (NACE Rev. 2)", "Country of origin", "TIME_PERIOD", and "OBS_VALUE";
3. The European countries are limited to Austria, Belgium, Bulgaria, Switzerland, Cyprus, Czechia, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia, and the United Kingdom.

After selecting the CSV file using the upload field, please click "Validate & Preview" to check the format and contents. If the data passes validation check, please click "Apply Data" to load it into the dashboard and ultimately all charts, maps, and filters will be reflected.

Select CSV File

Browse...

ds_salaries_filtered_clea

Upload complete

✓ Validate & Preview

Error: Missing required column(s): National.accounts.indicator..ESA.2010., Statistical.classification.of.economic.activities.in.the.European.Community..NACE.Rev..2., Country.of.origin, TIME_PERIOD, OBS_VALUE

Thank you!

Questions?