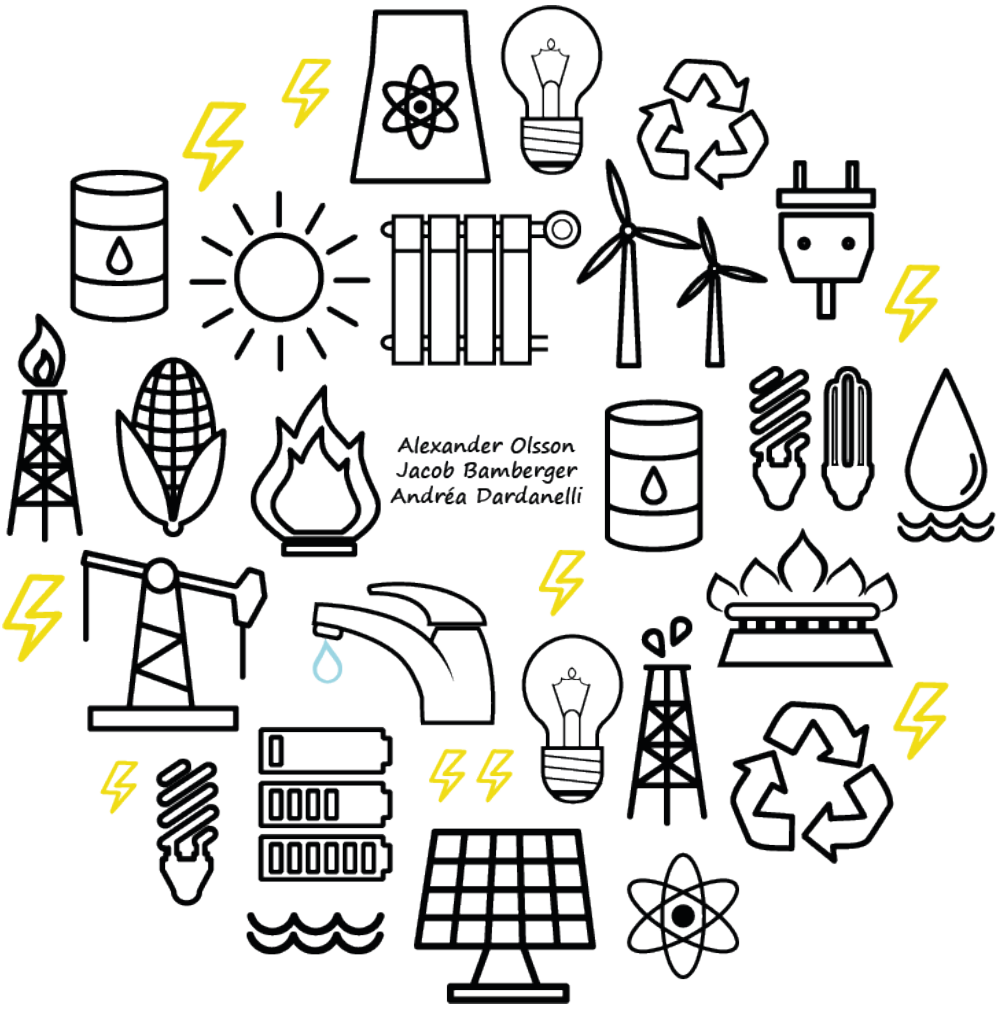
Data Visualization

European Energy Consumption Data

Vizies

June 4, 2021



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1 Introduction

Energy consumption is the main reason behind the flourishing of productivity in the twentieth century. It has permitted the usage of machines, helping us building more, faster and bigger. Thanks to extensive energy usage, we live more comfortably and longer. The thought that energy supply is infinite has encouraged a consumption driven lifestyle. With the rise of climate change evidence and other environmental problems, we are forced to question this lifestyle. It is thus natural to look at how different countries consume energy, and this is precisely what we aim to do in this project.

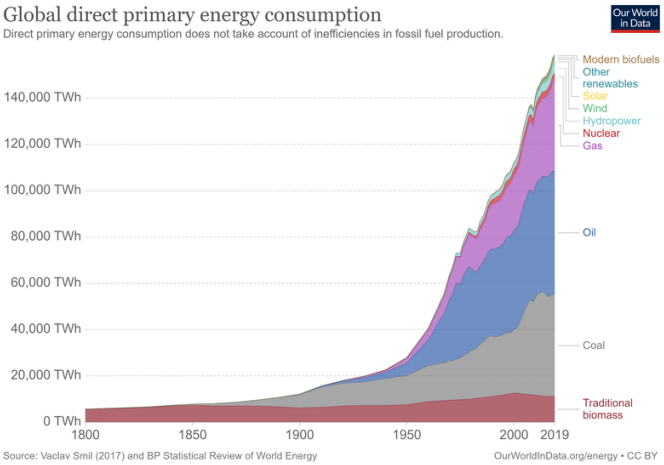


Figure 1: Evolution of world wide energy consumption

In Figure 1, we can see the exponential growth in energy consumption. Unfortunately, this growth will have to stop, or at least change, for two reasons: the earth has a finite energy supply, some types energy production is a main source of green house gaz pollution.

2 Path

The workflow off our project was divided into four stages *Sketch*, *Digital*, *Skeleton* and *Realize*. The reasoning behind this workflow was to start of without limitations, that way we could truly let the creativity flow free and collect as many ideas as possible. At each stage we then pick out the best ideas to implement. We quickly realized as a group that we preferred to have fewer features on our visualization, but that each feature would have a high standard.

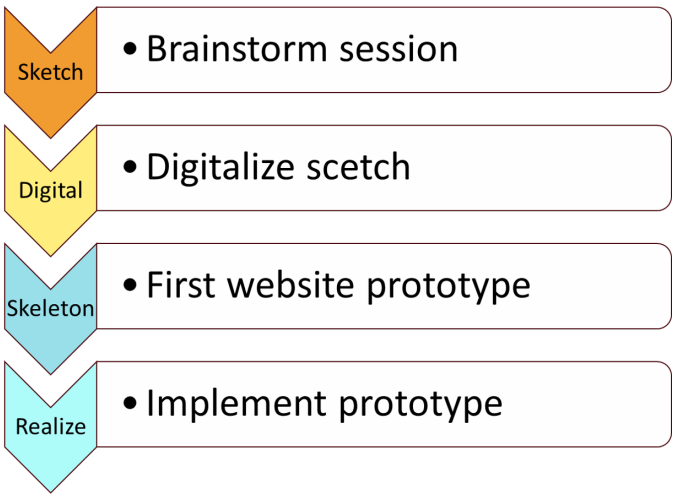


Figure 2: Description regarding the workflow of the implementation

2.1 Sketch

The project started with a brainstorm session where we took turns expressing ideas and writing them down. Then we tried to sketch up the ideas on a *zoom-whiteboard*. As seen in Figure 3 the sketches got quite messy during this first session. However we can already see the central idea of the **Map** and the **Timeline** being a big part of the visualisation. It was however not clear what the the plotting visualization was going to be. Instead we can see from the sketches that there are several different visualization we considered, including bar plots, evolution curves, pie charts, another bar plot showing the % change etc...

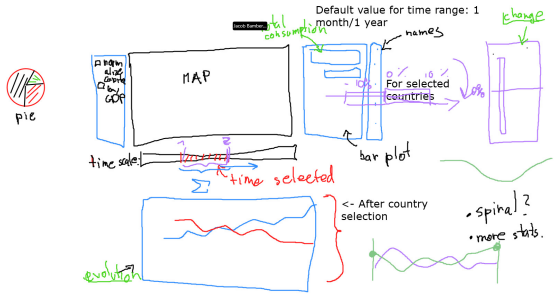


Figure 3: The first sketch after the brain storm session.

2.2 Digital

After the brainstorm session we wanted to digitalize and concretize our main ideas to get a clearer overview of how the end result could look like. We realized that we had several different plots from our initial sketch, so we decided to *start simple*, and then build upon what we had. As observed in Figure 4 we opted for a simple website with three components: a normalization column, a map, and a plot. The plot was at that stage a simple pie chart showing what percentage of energy was consumed by each country. We can also observe at this stage the **Timeline** was removed.

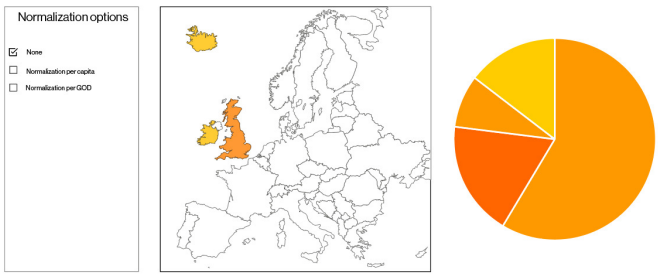


Figure 4: The first digital sketch with three main components.

2.3 Skeleton

After the digital sketch it was time to create a base skeleton in *HTML*, with limited functionality but still providing a clear overview of how the finished product would look like. In order to create a useful code skeleton we again went back to discussing what data we actually wanted to display and how to control the said data. In Figure 5 we can see that the discussions gave two new important conclusions that in order to choose what data we wanted to display we needed to bring back the **Time Line**, and that in order to observe patterns in time on the data we needed to display the data in cycles. So we switched the pie chart into a **circular plot**. On top of that we kept the map but realised that a **color scale** would be needed to display the map properly.

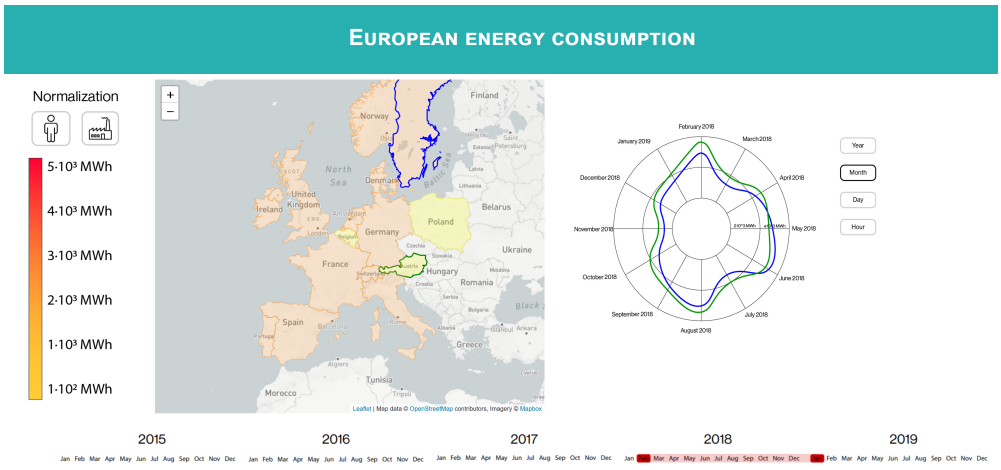


Figure 5: The skeleton of how the final website would look like.

2.4 Realize

The final part in the workflow was to implement the actual website, to take the now finalized skeleton and implement an actual functional website of it. To leverage the fact that we were three people working we organized a plan of how we would implement the website. The reasoning behind this plan was to maximize the amount of work that could be done in parallel. In Figure 6 the main idea of the workflow is described.

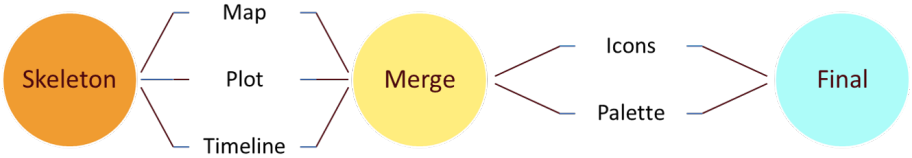


Figure 6: Workflow of realization, to maximize parallelization.

From the skeleton we saw that each team member could start working on one of the three main components each in parallel. Then as soon as one component was completed, it could be connected to other components, and to the real data. After all components were completed and connected together we started polishing the final product to make sure the website ran smoothly and appeared user friendly. That was done by refactoring for better performance but also by finding icons that were intuitive and deciding as a team on a color palette that suits the website.

3 The Data

The data we visualize is the energy consumption data of 15 Western European countries, over the period of January 2015 to August 2020. The data is measured in MegaWatts. This data has been retrieved by François Raucent and is available on Kaggle [6], but it originally comes from the ENTSO-E transparency platform [2]. For a more in depth country comparison, we then decided to enrich the dataset with economical (GDP), demographical (population) and environmental (green house gaz emission for the energy sector) statistics for each country.

4 Implementation

4.1 Map

The map is generated with the Leaflet Package [3]. The background image is taken from Open Street Map [4] and Carto.com [1]. The idea is to build a choropleth map displaying the mean value of per-hour energy consumption within the selected timeline. The colors are selected from a linearly-scaled shade between the maximum and minimum values.

Figure 7: Example of color scaling in the legend

The map has two different interactive actions with the website users. First, there is a mouse hover interaction: placing your mouse over a country will display the mean value computed. Secondly, users can select and unselect countries with a clicking action to plot their mean-energy consumption on the right. The color of the border will change and match with the line on the circular plot. This way, we avoid creating a new legend for the circular plot.

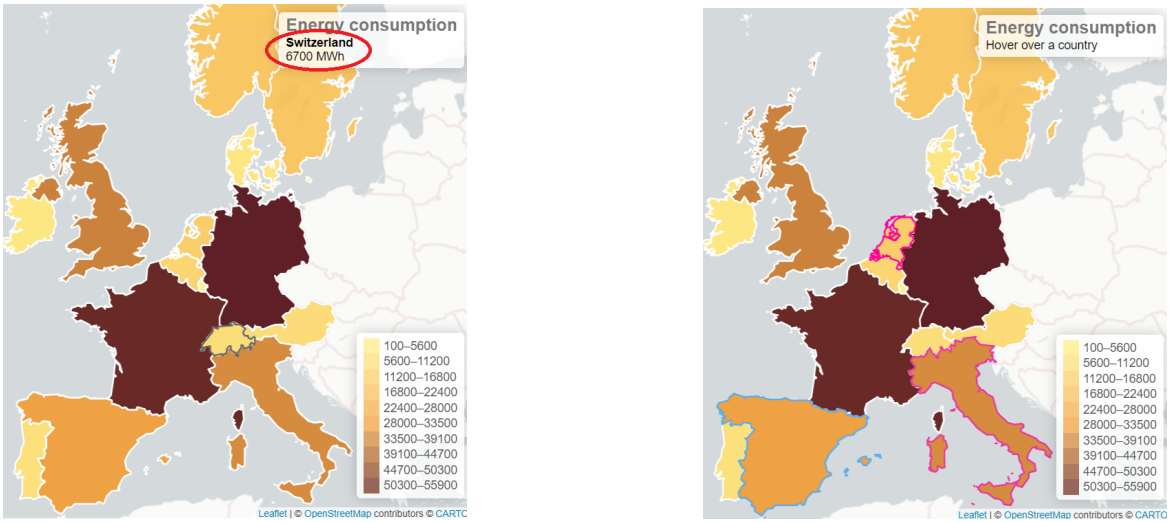


Figure 8: User interactions on the map

4.2 Timeline

We wanted to implement an intuitive way of filtering what data that was shown in the map and plot. Since all our data was dependent on dates, we decided that the best way of displaying that data was with a timeline. On the timeline it would not only be clear what period of time we are currently displaying, but also simple to move the selected period, expand or shrink the whole period. The way to achieve this was to add a "selected" area above the timeline.

Figure 9: The final timeline.

The timeline was implemented using *D3.js axis*. In order to achieve the desired result based on are early sketches three axes were created (year label, month label, ticks), which were are overlapping to give a clear view of which month belonged to which year. Then the selected area was created by a *d3.js brush*. The brush was implemented to overlay the month labels, and added to be discrete over the actual months. Then also in order to actually be able to filter data with the timeline, the brush sent the start and end date of the selected area to the main function after the area had been altered with.

4.3 Periodic Plot

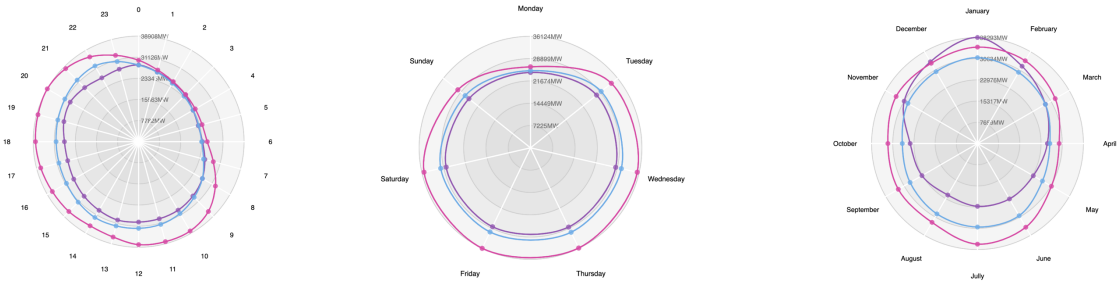


Figure 10: Periodic Plot

At first, we wanted a plotting section to visualize the data 'across time', as usually done when visualizing a time series. However, after the exploratory data analysis, we realized that our data was highly periodic, and we further realized different countries had different energy consumption pattern across time. To use this periodicity to further get insight on energy consumption patterns, we thought that it would be nice to visualize the data as a function around a circle. After trying different ideas, we decided to plot the hourly average of the data over the time selected by the user, thus reducing the variance of the data. For the periodicity, we decided to have three options being the main periods in our data, namely month, day and hour as seen in Figure 10. The implementation was based on implementations of the well known "spider chart" [5]. On the technical side, we had to decide on how to process the data to turn it into the desired format.

4.4 Combining everything

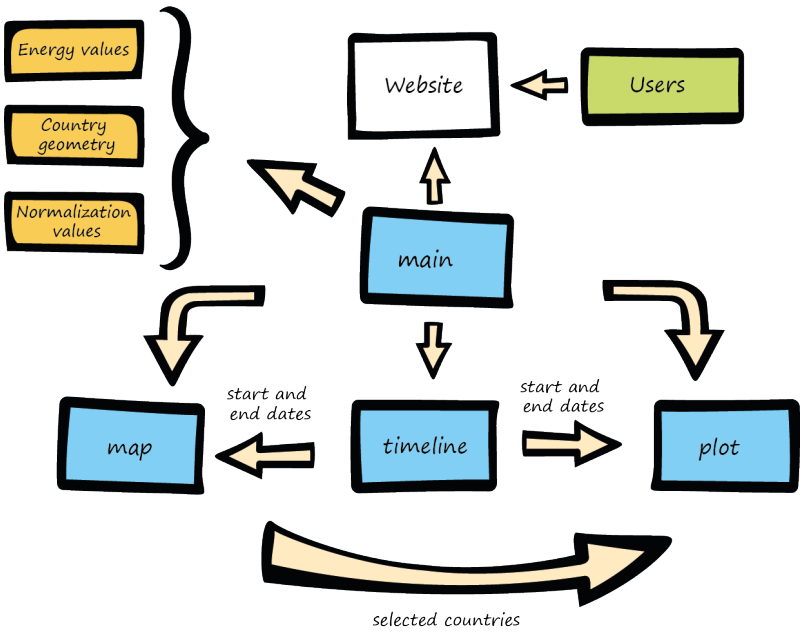


Figure 11: Dependence relation between files

Each of the previous elements were combined to minimize duplicate work in data processing. We therefore decided that the central functionality of the main file was to handle the data and send it to other different files. The overall dependencies can be seen in Figure 11. The timeline filters the data on time values, then sends it over to the map and plot section, then the map's interactive component sends user selected countries to add, or remove from the plot section.

5 Challenges and design decisions

During the progress of this project several challenges emerged, some harder some easier. In Figure 12 below is listed our main challenges during we as a team had regarding this project. Throughout this project a lot of design choices were made. In Figure 13 is a list of the main non-technical design choices that were made during the project, and the reasoning for why we deemed such decisions necessary.

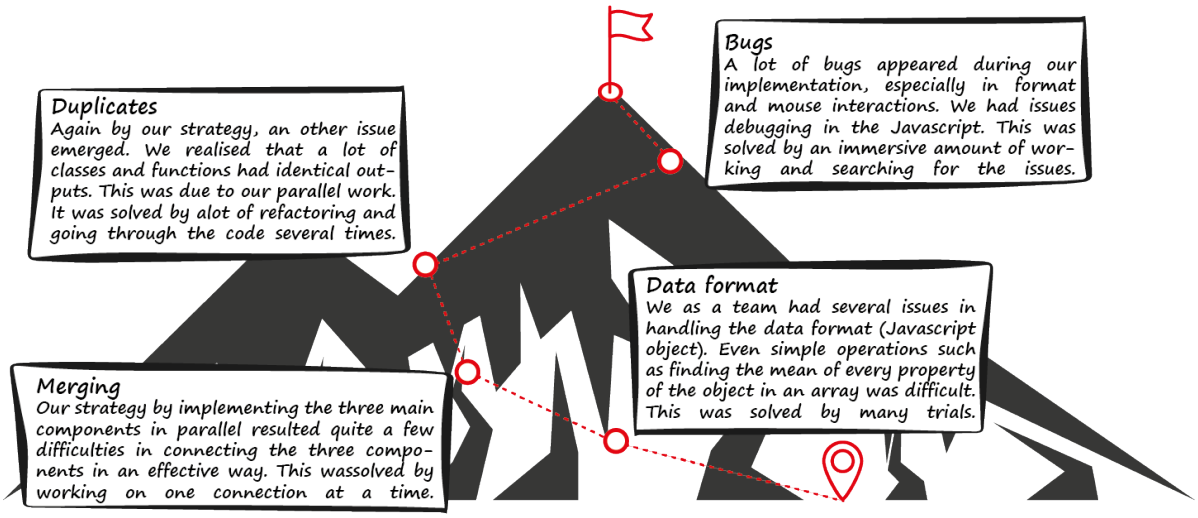
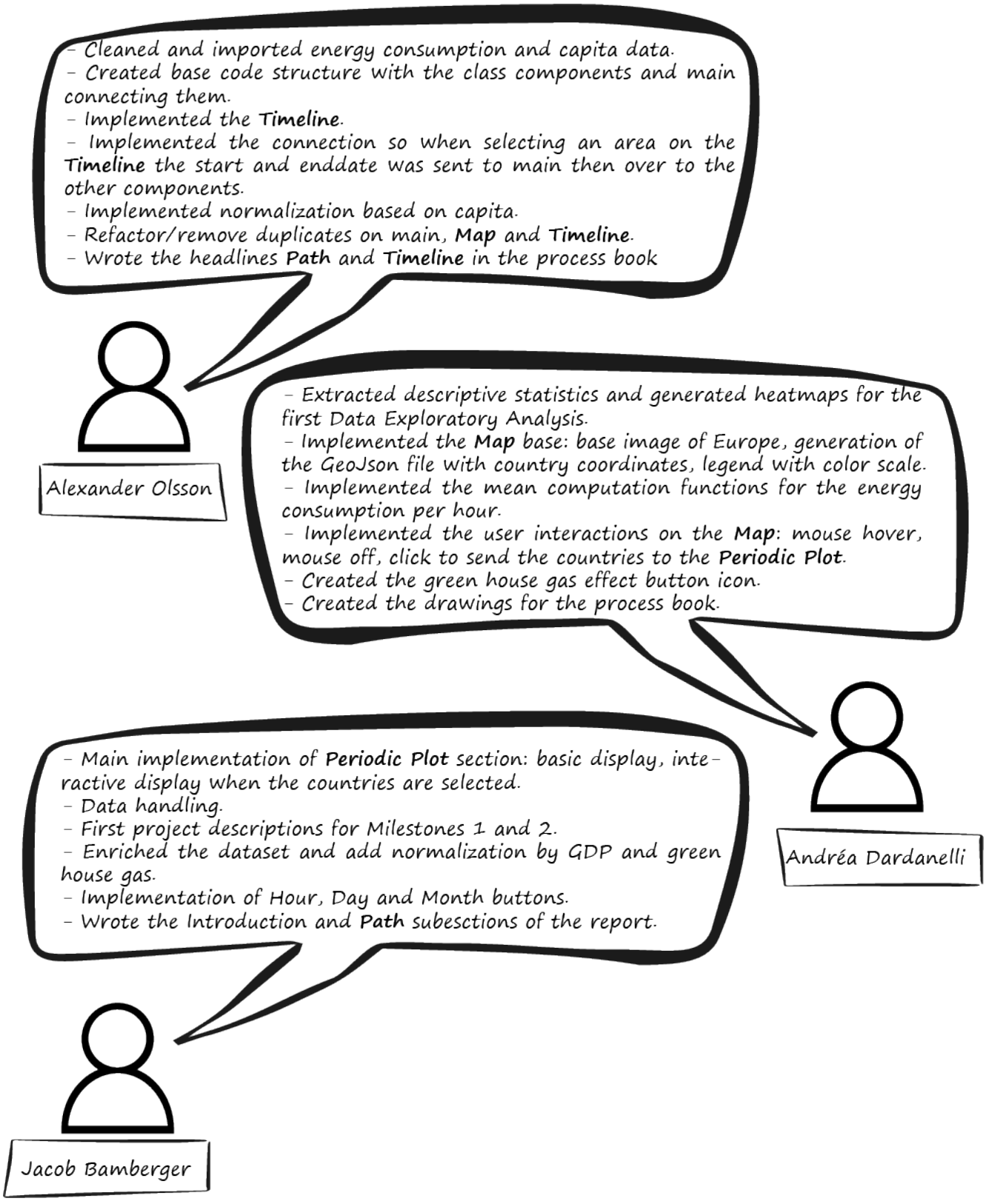


Figure 12: Challenges

Figure 13: Design decisions

6 Peer Assessment

Below is listed what each team member worked on on the project.



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[6] Western europe power consumption. https://www.kaggle.com/francoisraucent/western-europe-power-consumption. Accessed: 2020-02-01.