5. Energy file

I/ Energy calculations

The Segmobyl, as an innovative electric vehicle concept, stands at the forefront of energy-efficient urban commuting. With a sustainable design aimed at optimizing energy consumption, this two-in-one mobility solution reflects a forward-thinking approach to urban transportation. The vehicle efficiently covers the initial kilometers from a commuter's home to the city's periphery, and upon arrival, seamlessly transitions to a smaller and lighter means of transportation – the Segway. This transition not only reduces energy usage but also helps alleviate traffic congestion in city centers. Powered by electricity, the Segmobyl operates at a maximum speed of 45 km/h and is designed with a commitment to sustainability, making it a promising solution for environmentally conscious urban commuters. There are two 7.4 kWh batteries in the front part of the vehicle, and a third battery found in the Segway. The energy stored in these batteries will power the electric motor found in the Segway, which is used to propel the vehicle forward. We may need a second electric motor to help the Segway in the propulsion; the final decision will be taken after testing. With a focus on eco-friendly travel, the Segmobyl pioneers a new era of energy-efficient and environmentally responsible commuting within cities.

- Energy consumption:
  The ESTACA students who did their project around the Segmobyl did a simulation to calculate the energy needed for a 56 km trip with the vehicle.
  They found that the Segmobyl would consume 4.58 kWh to complete the 56 km trip.
  This means we will have an energy consumption of **0.082 kWh/km** for our vehicle, which is 42% less than the average energy consumption km of existing EVs[1] (0.195 kWh/km).

- Charging costs:
  To calculate the charging costs, we took the average between the costs of public AC charging (0.4 €/ kWh) and domestic charging in France (0.27 €/ kWh), which gives **0.33 €/kWh**.[2,3]

- Maintenance costs:

  This includes both routine maintenance costs (*e.g.*, tire replacements, brake pads) and potential battery replacement costs over the vehicle's lifetime. In the literature, it says that on average, maintenance costs are around 4600 USD over an EV's lifetime. But we will assume **2000 €** for our vehicle since it is much smaller than the average, and much more frugal with a minimum of components.

- Total energy costs calculation:
  - Calculate the annual energy consumption by multiplying the kilometrage by the energy consumption per kilometer assuming 20 km traveled per day:

0.082 kWh/ km x 20 x 365 km = 599 kWh per year

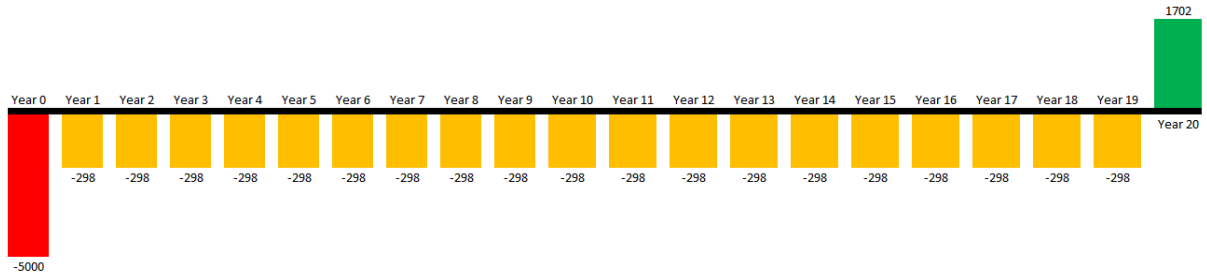
- Calculate the annual energy cost by multiplying the annual energy consumption by the cost of electricity per unit (*e.g.*, kWh):

0.33 €/ kWh x 599 kWh = 198 €/ year

Assuming a productlife of 20 years, we can assume that the maintenance costs will be 2000/ 20 which means 100 €/ year. So, adding the energy cost to the maintenance cost, we obtain a total cost of **298 €/ year.**

Also, we can assume a salvage value at the end of the useful life equal to 40% of its initial value (which we are setting to be 5000 €.)

With this information, we can calculate the NPV using the discounted energy flow (DEF), assuming a discount rate of 5%. The DEF diagram is found in the figure below, giving an NPV of -7 960 €.



NPV = - 7960 €

The NPV is obviously negative since people will not win revenue from owning a car. But it would be interesting to compare it to the NPV of owning an ICE vehicle or even a larger EV existing on the market. The value we found is guaranteed to be higher since the vehicle has a lower price and lower operating costs. This means that if we consider a differential NPV that includes the savings we make by having our vehicle instead of another, the NPV will be positive, and hence we “gain” money from owning the Segmobyl instead of another vehicle.

II/ Bibliography

(1) *EV Database*. EV Database. https://ev-database.org/cheatsheet/energy-consumption-electric-car (accessed 2023-10-19).
(2) *Here is the real cost of charging an electric car in France - Gearrice*. https://www.gearrice.com/update/here-is-the-real-cost-of-charging-an-electric-car-in-france/#The_real_cost_of_charging_a_car (accessed 2023-10-19).
(3) *These European countries have the lowest and highest energy prices*. euronews. https://www.euronews.com/next/2023/03/29/energy-crisis-in-europe-which-countries-have-the-cheapest-and-most-expensive-electricity-a (accessed 2023-10-19).