ELECTRIC VS GASOLINE VEHICLES:

Total Cost of Mobility

Prepared by:

Anna Katharina Rausch
Dipl.-Ing.,

Hana Kambur

Mentor:

Professor Amela Ajanovic,

Doctor of Technical Sciences

Table of contents:

1. Abstract

The present research compares the total cost of mobility between Electric Vehicles (EVs) and Internal Combustion Vehicles (ICEVs) in the Czech Republic and Austria. The research focuses on the analysis of Total Cost of Ownerchip (TCO), evaluating aspects such as purchase price, maintenance cost, energy consumption and government incentive policies. Through a Life Cicle Assessment (LCA) and Life Cycle Costing (LCC) approach, are explored the environmental and social burdens associated with both types.

The results indicate that, although EVs have higher initial costs and a significant environmental footprint during production, specially in favorables contexts such as Austria. Furthermore, is examinated the impacts on public health, infrastructure, and social equity, as well as the role of national policies in promoting the adoption of clean technologies.

The comparison reveals that Austria has achieved higher EV penetration as a result of comprehensive policies, while the Czech Republic continues to face structural and economic challenges. The study concludes that EVs represent a viable and increasing competitve solution for advancing sustainable mobility.

2. Introduction

The automotive industry is currently in the process of changing. Electric vehicles (EVs) are starting to become more popular than gasoline vehicles. As the world continues to shift towards sustainable transport, governments are promoting the adoption of EVs to fight climate change and lessen the dependence on fossil fuels. However, this shift is not without its controversies regarding the economic consequences of the transition process.

The comparison between the Total Cost of Ownership (TCO) of EVs and gasoline vehicles is based on the purchase price, service and repair costs, fuel or electricity consumption, and government subsidies. The incentive for writting this paper is the need to determine the total cost of mobility of electric and gasoline vehicles in the Czech Republic and Austria. These two countries are quite different in their policies, infrastructure and market trends and thus perfectly suitable for comparison.

The purpose of this study is to compare the TCO of the two types of vehicles with regard to economic, policy, and infrastructural factors. The key hypothesis that is to be tested in this research is that although electric cars are costly to buy, they are more economical to use and are subsidised by governments, which may make them more economical in the long run.

3. Vehicle Classification and Cost Breakdown for Initial Purchase

There are many ways to classify a vehicle. One of them is based on segment classification which is shown in Figure 1. This classification system is particularly useful for fleet management and market analysis.

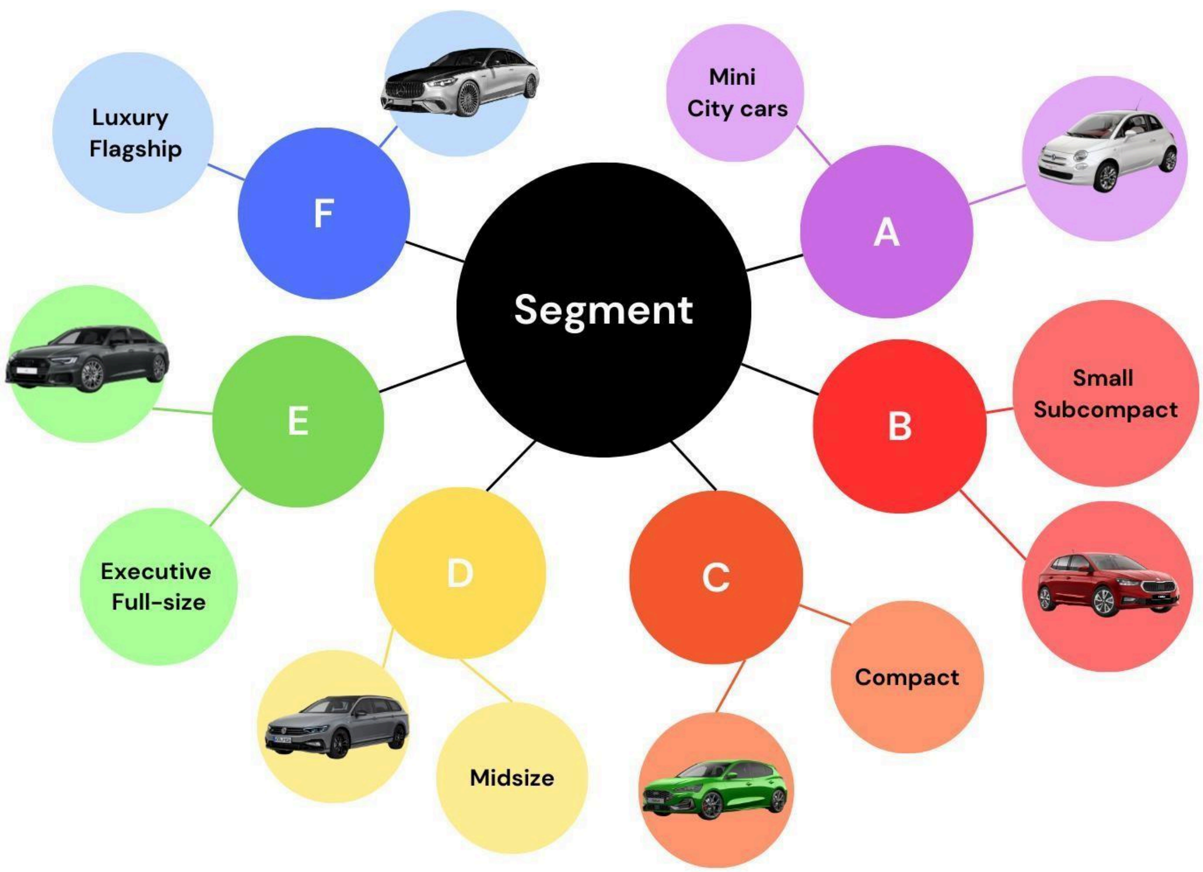


Figure 1: Segment classification of vehicles [5]

Examples of city, subcompact, compact, midsize, full-size and luxury vehicles are Fiat 500, Škoda Fabia, Ford Focus, VW Passat, Audi A6, Mercedes S-Class respectively. [5]

Besides already mentioned segments, there are two more that haven't been mentioned.

Those two segments are MVP and SUV. SUVs account for half (51%) of total EU car sales. Figure 2 showcases a chart that shows the share of the various segments – Small (A+B), Lower medium (C), Upper medium (D), Luxury (E+F), MPV and SUV – of the EU car market per year for the 2012-2023 period, as well as the number of units sold. [3]

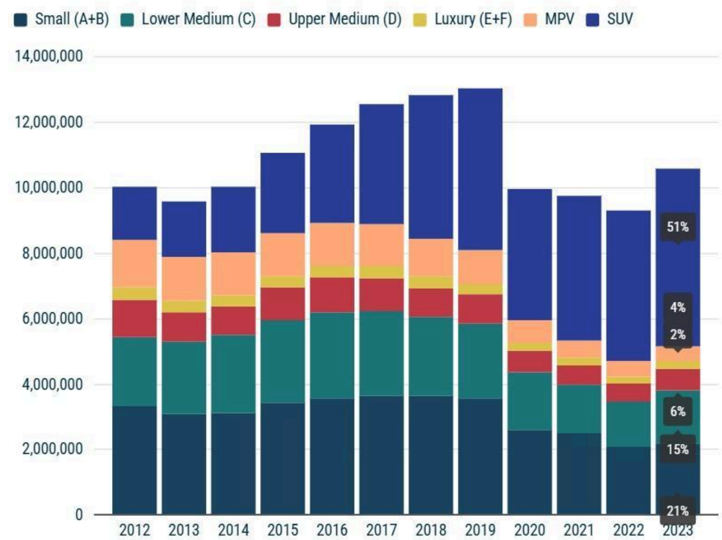


Figure 2: New cars in EU by segment. [3]

In Figure 3, we can see which vehicles were driven the most.

	2018		2019		2020	
1	C1	26%	C1	22%	C1	22%
2	D1	19%	D1	16%	D1	16%
3	D2	10%	D2	13%	D2	13%
4	E2	8%	SUV-C1	12%	SUV-C1	13%
5	SUV-C1	8%	E2	7%	SUV-D2	6%
6	SUV-D2	5%	SUV-D2	5%	E2	5%
7	B1	4%	C2	4%	SUV-C2	4%
8	MPV-C	4%	MPV-C	4%	C2	4%
9	SUV-D1	4%	SUV-D1	4%	SUV-D1	4%
10	C2	3%	B1	4%	MPV-C	3%

Figure 3: Most driven car segments, 2018-2020. [4]

Vehicles can also be classified into three main categories: internal combustion engine vehicles (ICEVs), hybrid electric vehicles (HEVs) and all-electric vehicles (AEVs) or electric vehicles (EVs). Figure 4 illustrates the basic classification of vehicle types. [6]

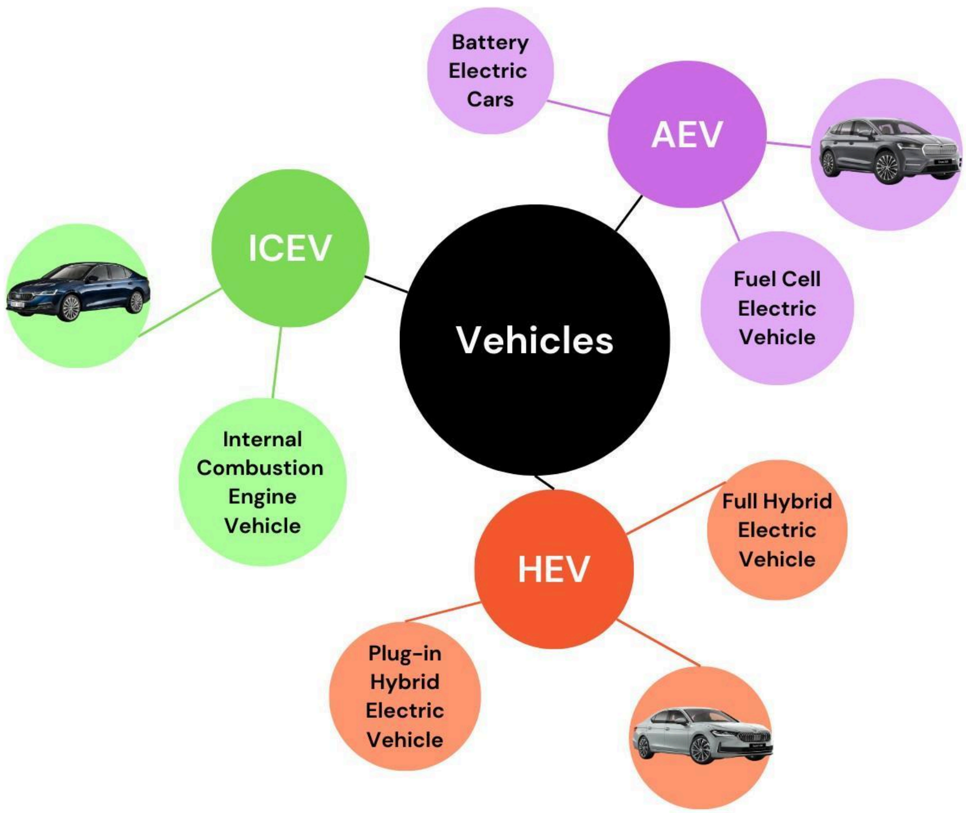


Figure 4: Classification of vehicles into three main categories [6]

Examples of AEVs, HEVs and ICEVs Škoda Enyaq iV, Škoda Superb iV and Škoda Octavia 1.5 TSI respectively.

The price of vehicles varies from country to country. In 2020, Switzerland had the highest price on new passenger cars, whilst Greece had the lowest price, as depicted in Figure 5. Reasons for automobiles being so costly in Switzerland are partly due to tax rates. The only vehicles exempt from taxes in selected cantons were electric cars. [2]

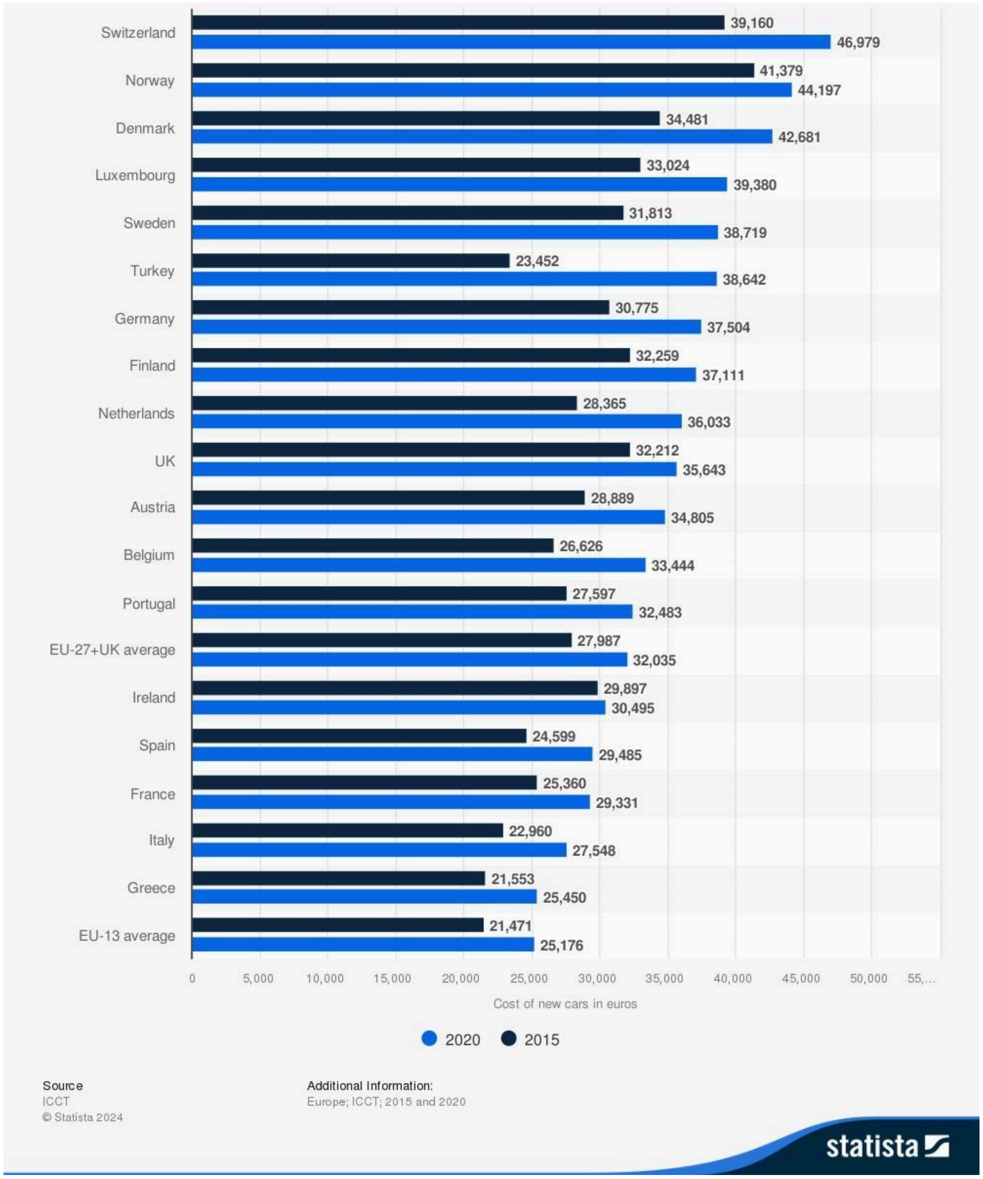


Figure 5: Average price (including tax) of passenger cars in Europe in 2015 and 2020, by country (in euros) [2]

EVs in nearly every segment and in nearly every European country are now at the same price or cheaper than petrol or diesel cars. [1]

Despite energy price inflation, fuel costs remain significantly lower for electric cars than petrol and diesel cars: fuel costs (Electricity for Battery Electric Vehicles**)** represent 15% of the total cost of ownership of an EV, while this is 23% and 28% for petrol and diesel drivers. [1]

Battery Electric cars have a higher initial investment but lower running costs as Figure 6 depicts. Running costs include Road Tax, Fuel/Energy, Insurance, RMT (Repair, Maintenance and Tires) and Interest. [1]

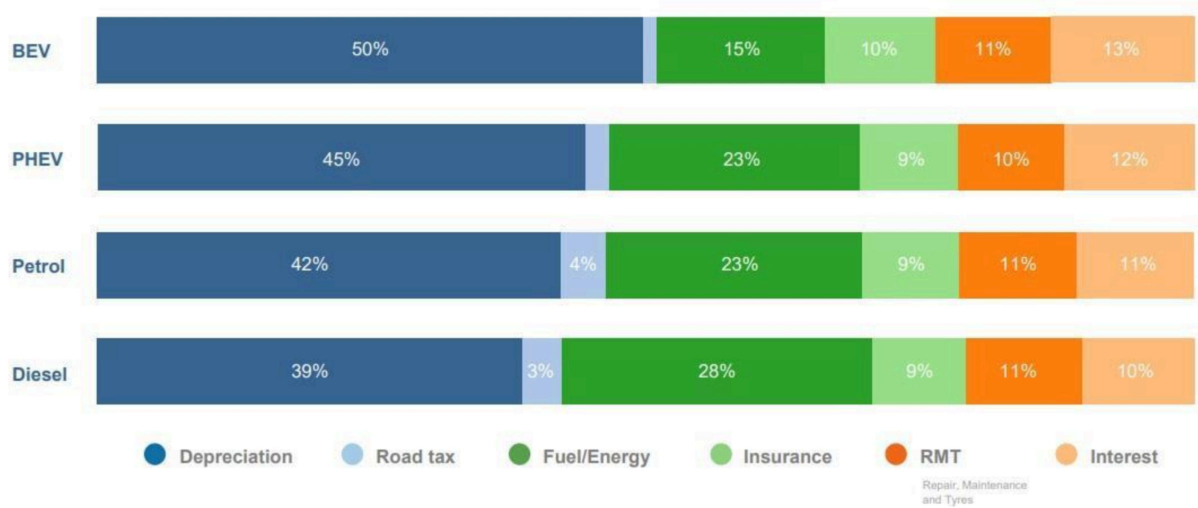


Figure 6: Total Cost of Ownership for Battery Electric Cars, Hybrid cars, Petrol and Diesel cars. [1]

4. Life Cycle Cost (LCC) Assessment

4.1. Life Cycle Assessment (LCA)

Life cycle assessment, or LCA, is a methodology for assessing the environmental impacts associated with the entire life cycle of a particular product or process. [7]

The life cycle stages, as shown on Figure 7, of a manufactured product include:

- Raw materials extraction and processing
- Product manufacturing
- Transportation of the product to its point-of-use
- Product use; and
- Final disposal (or end-of-life recycling) [7]

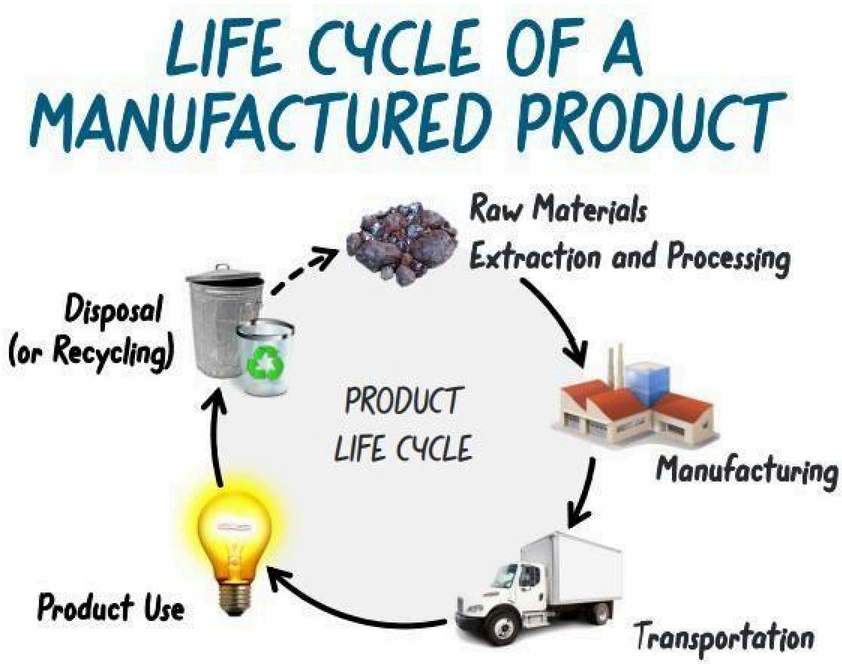


Figure 7: Life cycle of a manufactured product. [7]

4.2. Life cycle cost of Convectional vs. Alternative Vehicles in the Czech Republic

In his definition of Life Cycle Costs (LCC), Woodward refers to the sum of "all the cost factors relating to the asset during its operational life". Life Cycle Cost (LCC) is used by providers and customers to better understand the Product-Service Systems (PSS) costs spanning from design to end-of-life. [9]

Within the Modeling of Life Cycle Cost of Conventional and Alternative Vehicles, scientific methods were used. [8]

Five period phases of the vehicle life cycle were considered:

1. concept and requirement determination,

2. design and development,

3. manufacture,

4. operating state and maintenance

5. disposal [8]

Phases one, two, and three are considered as acquisition costs, phase four is considered as ownership costs, and phase five is considered as liquidation costs.

For the LCC model, the life cycle costs were divided into four categories:

$$LCC = Cp+Cm+Co+Cd$$

$$LCCs = \frac{LCC}{t}$$

Where:

- LCC—the life cycle cost of vehicles,
- LCC_s—the specific life cycle cost of vehicles,
- C_P—the vehicle purchase cost,
- C_M—the maintenance cost,
- C_O—operating state of vehicle cost,
- C_D—the vehicle disposal cost,
- t-the time of vehicle operation. [8]

Into the final calculation of Life Cycle Cost of a vehicle in the Czech Republic, many factors were taken into account, which are showcased in Figure 8.

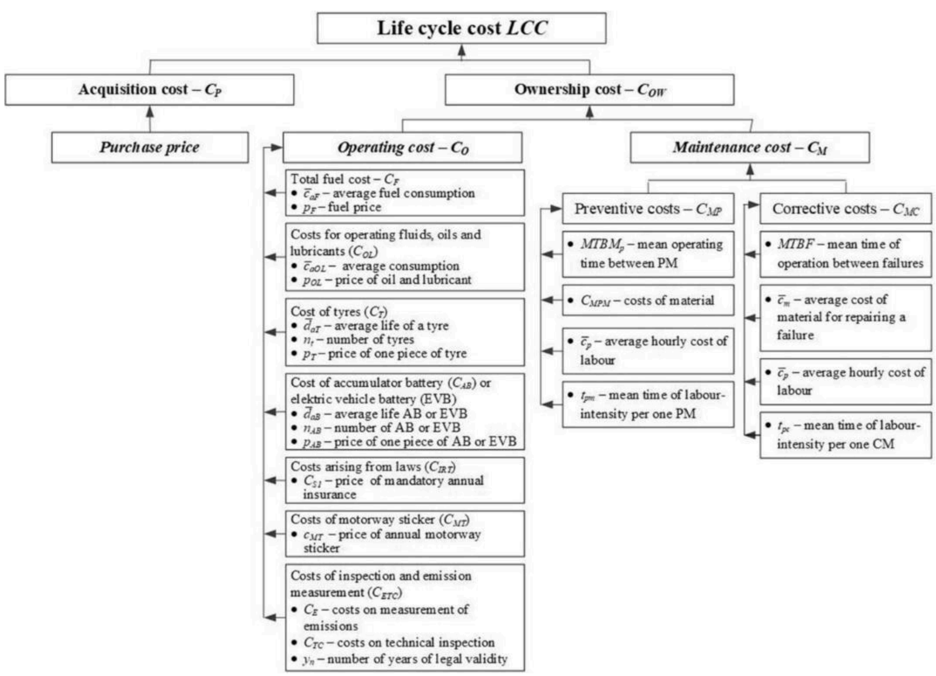
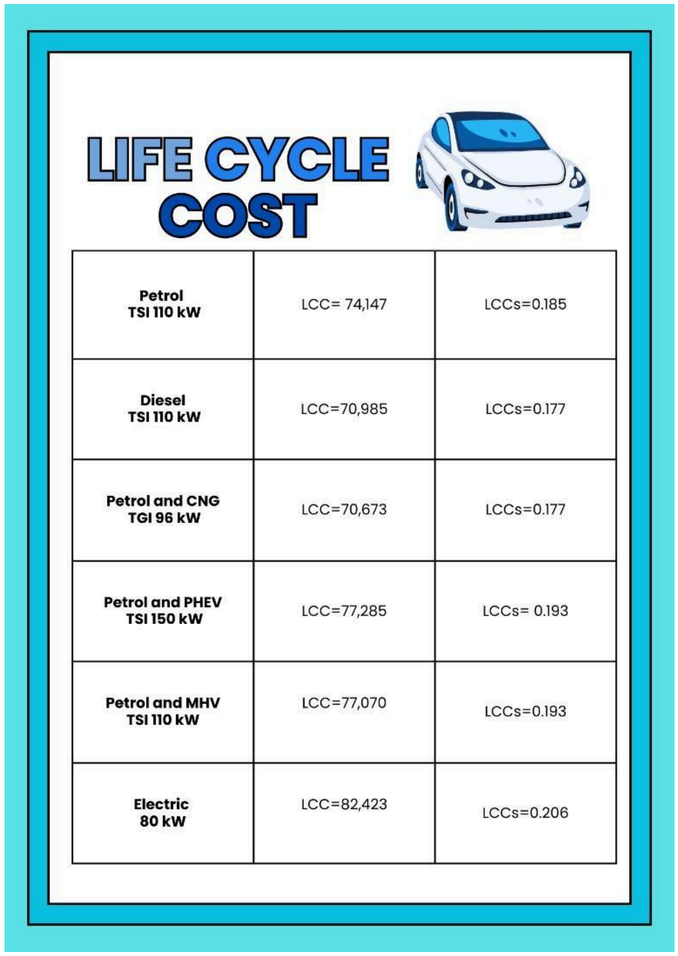


Figure 8: Structure of model input parameters for LCC model calculation. [8]

For calculation of Life Cycle Cost, six different vehicles were considered. In Figure 9, the life cycle cost of vehicles, and the specific life cycle cost of vehicles are showcased.


LIFE CYCLE COST

Petrol TSI 110 kW	LCC= 74,147	LCCs=0.185
Diesel TSI 110 kW	LCC=70,985	LCCs=0.177
Petrol and CNG TGI 96 kW	LCC=70,673	LCCs=0.177
Petrol and PHEV TSI 150 kW	LCC=77,285	LCCs= 0.193
Petrol and MHV TSI 110 kW	LCC=77,070	LCCs=0.193
Electric 80 kW	LCC=82,423	LCCs=0.206

Figure 9: Life cycle cost of vehicles. [8]

The Electric vehicle has the highest life cycle cost, while the Petrol + CNG model has the lowest in this comparison. The reason for electric vehicles having the highest LCC, is that at a certain point (usually after 200000 km), a replacement of a battery is assumed. Figure 10 shows that the life-cycle ownership costs for the operation and maintenance of passenger vehicles are lowest for electric vehicles, but only until the batteries used to power these vehicles are replaced.

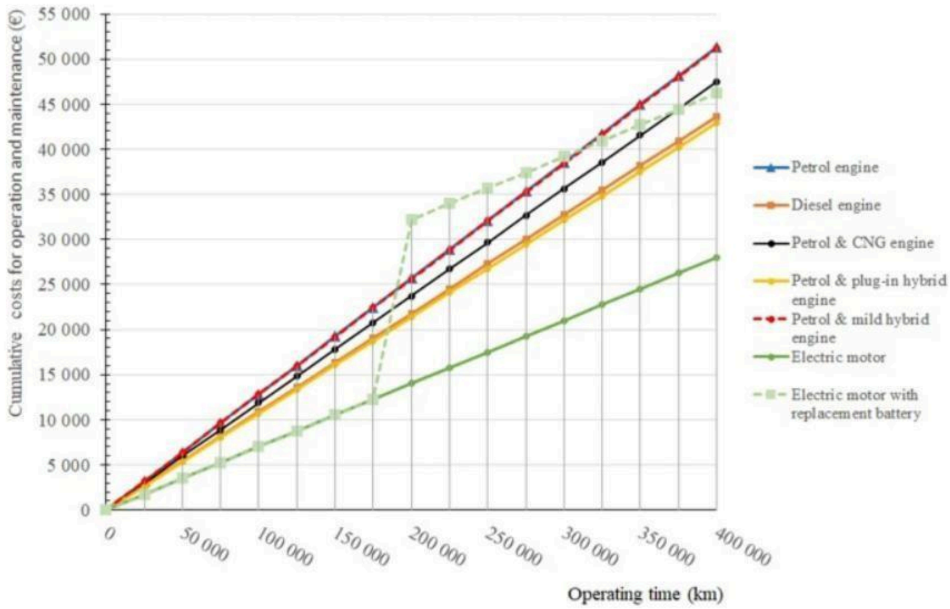


Figure 10: Cumulative life cycle ownership costs for operation and maintenance of selected passenger car powertrains. [8]

4.3. Life Cycle Assessment (LCA) of different types of cars in the Czech Republic

The life cycle assessment method makes it possible to identify, quantify and assess the impact of the entire life cycle in all relevant areas, such as gas emissions, use of natural resources, waste production, etc. [10]

The following factors were considered:

- Vehicle production
- Fuel life cycle
- Vehicle recycling
- The powertrains analyzed were Internal Combustion Engine Vehicle (ICEV), Battery Electric Vehicle (BEV), Fuel Cell Electric Vehicle (FCEV)
- Production, operation and recycling took place in the Czech Republic, including production of fossil fuels, electricity and hydrogen
- Future development of the recycling industry and the expected reduction of the electricity or hydrogen emission factor. [10]

The vehicles selected to represent BEVs and ICEVs were the upper mid-range (D-segment).

BMW i4 eDrive35 was selected to represent a Battery Electric Vehicle and the petrol-powered BMW 430i Gran Coupe was selected to represent an Internal Combustion Engine Vehicle. Due to the low penetration of Fuel Cell Electric Vehicles, the Toyota Mirai MK2 was selected.

The results of Life Cycle Assessment in the Czech Republic for Internal Combustion Engine Vehicle, Battery Electric Vehicle, Fuel Cell Electric Vehicle are shown in Figure 11.

Category	ICEV (Internal Combustion Engine Vehicle)	BEV (Battery Electric Vehicle)	FCEV (Fuel Cell Electric Vehicle)
Total Lifetime GHG Emissions	Highest	33% lower than ICEV	19% lower than ICEV
Production Emissions	Lowest (baseline)	61% higher than ICEV	63% higher than ICEV
Operational Emissions	Highest	Lowest	Medium
Reduction Options (Operation)	Limited: only by changing fuel type	Use of low-emission electricity	Use of low-emission hydrogen production
Lifecycle Phases Considered	Production, use, and recycling	Production, use, and recycling	Production, use, and recycling

Figure 11: Results of Life Cycle Assessment [10]

ICEVs have lower cumulative emissions in the first years of operation, and break-even occurs after approximately five years or 70,000 km of operation in the case the Battery Electric Vehicles, and eight years or 111,000 km of operation in the case of Fuel Cell Electric Vehicles . Figure 12 shows the evolution of Greenhouse Gas emissions over the entire vehicle life cycle, including the production and recycling phases.

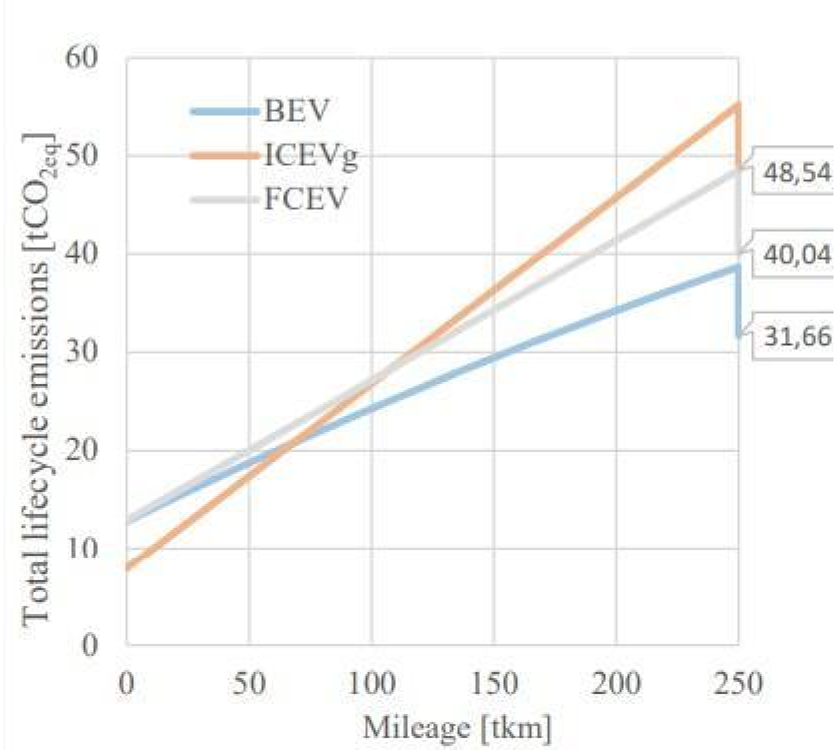


Figure 12: Total life cycle emissions [10]

4.4. Life cycle Assessment (LCA) of Convectional vs. Alternative Vehicles in Austria

The life cycle assessment provides a comprehensive picture of how sustainable different powertrain systems are in climate terms not only in the transport sector but also in the energy and industry sectors, both in Austria and abroad. [11]

Figures 13, 14 and 15 summarize LCA findings from Austria, evaluating BEVs, FCEVs, and ICEVs based on emissions, energy use, and overall environmental impact throughout their life cycles respectively.

Category	Battery Electric Vehicle (BEV)
GHG Emissions (with 100% Renewable Electricity)	50–100 g CO_2-eq/km (depending on vehicle segment)
GHG Emissions (Using Austrian Electricity Mix)	86–157 g CO_2-eq/km
Relative Energy Efficiency	Most energy-efficient baseline
Cumulative Energy Demand (Synthetic E-Fuels)	Lowest overall energy demand
Downsizing Potential for Emission Reduction	High – emissions decrease with smaller batteries and lighter vehicles
Impact of Energy Source on Emissions	Strongly influenced by electricity origin; renewable energy significantly reduces emissions
GHG Emissions Reduction Compared to ICEV	67%–79% lower emissions compared to ICEVs (from luxury to small car segments)
Recommended Application	Best suited for small and medium passenger cars with access to green electricity

Figure 14: LCA findings evaluating Battery Electric Vehicles. [11]

Category	Fuel Cell Electric Vehicle (FCEV)
GHG Emissions (with 100% Renewable Electricity)	Comparable to BEV if powered by hydrogen from 100% renewable sources
GHG Emissions (Using Austrian Electricity Mix)	Higher than BEV due to inefficiencies in hydrogen production
Relative Energy Efficiency	Consumes 39–83% more energy per km than BEVs
Cumulative Energy Demand (Synthetic E-Fuels)	-
Downsizing Potential for Emission Reduction	Limited discussion
Impact of Energy Source on Emissions	Emissions depend on hydrogen production methods
GHG Emissions Reduction Compared to ICEV	Moderate to significant reduction possible depending on hydrogen source and use case
Recommended Application	More suitable for long-range or heavy-duty applications where BEVs are less feasible

Figure 15: LCA findings evaluating Fuel cell Electric Vehicles. [11]

Category	Internal Combustion Engine Vehicle (ICEV)
GHG Emissions (with 100% Renewable Electricity)	-
GHG Emissions (Using Austrian Electricity Mix)	Highest emissions among all powertrains
Relative Energy Efficiency	-
Cumulative Energy Demand (Synthetic E-Fuels)	9–12 times higher energy use than BEVs when using synthetic e-fuels
Downsizing Potential for Emission Reduction	Low potential for further reductions
Impact of Energy Source on Emissions	Fuel characteristics are fixed, limiting emissions improvement options
GHG Emissions Reduction Compared to ICEV	Baseline – used for comparison
Recommended Application	Widespread usage but environmentally outdated for modern sustainability goals

Figure 16: LCA findings evaluating Internal Combustion Engine Vehicles. [11]

When it comes to Greenhouse gas (GHG) emissions alone, Figure 17 depicts GHG emissions per vehicle kilometer in the compact segment.

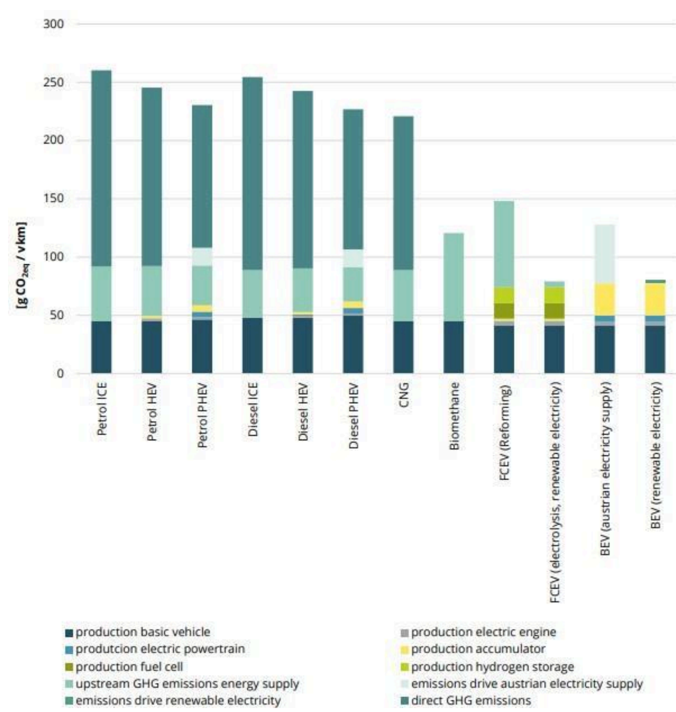


Figure 17: Greenhouse gas emissions [11]

4.5. Reuse of batteries on Electric Vehicles: The Second Life Cicle

Once EVs reach the end of their useful life, one of the biggest enviromental challenges is the management of lithium batteries. Although batteries can degrade until they are no longer useful for mobility, they usually retains up to 70-80% of their original capacity, making then a valuable recource for new applications.

Instead of getting rid of them inmediately, nowadays there are innovative projects that promote Second Life batteries, reusing them as energy storage. This type is suitable for supporting solar and wind energy moreover promoting storage for low production and high demand.

Enviromental and social impact:

- **Waste reduction:** expanding their useful life of batteries, delay recycling processes that could be more expensive and pollutants.
- **Resource optimization:** maximize the use of critical materials as lithium, cobalt or niquel.
- New buissness models: some comapanies like Nissan or Tesla are already working in storage systmes based on reused batteries.

According to the World Economic Forum (2022), the second-life batteries systems could reduce energy storage costs by up to 30% compared to new batteries made up specifically for it. This approach helps accelerate the global energy transition.

This strategy not only represents a great opportunity to close the life cicle of EVs in a sustainable way, but also to reduce energy costs in residential and industrial sectors.

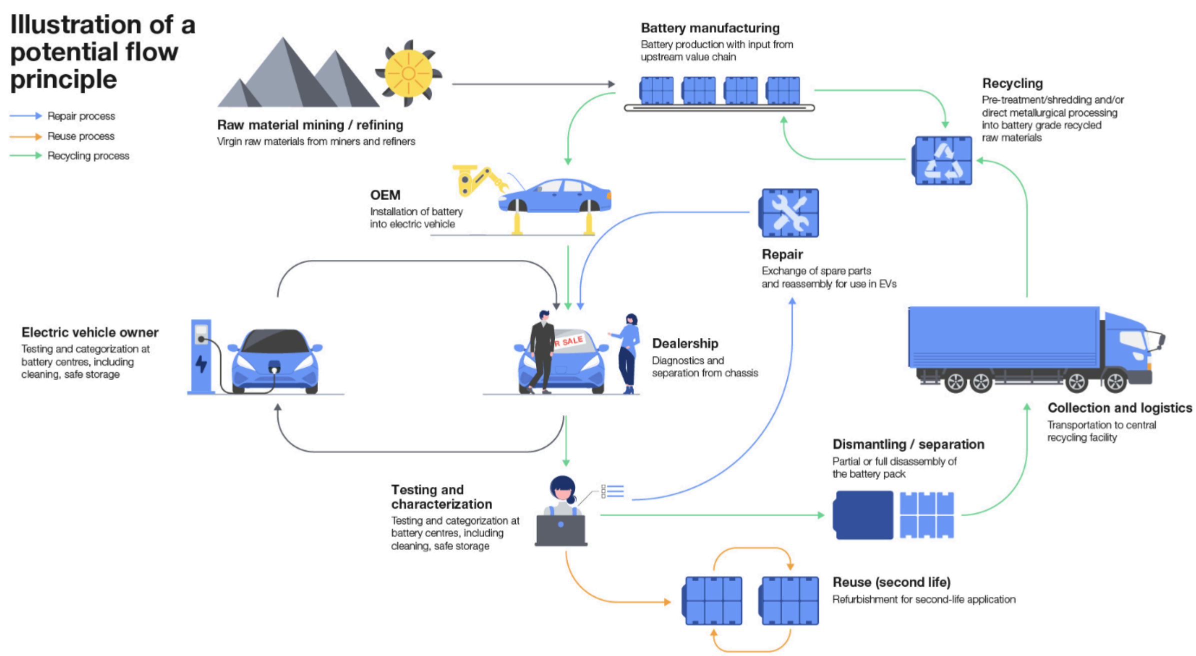


Figure 18. How a functioning EV battery circular value chain should look Image: World Economic Forum [17]

5. Development of clean vehicle registrations and the number of public charging points and charging stations in the Czech Republic and Austria

5.1. Development of clean vehicle registrations and the number of public charging points and charging stations in the Czech Republic

The development of clean vehicle registrations in the Czech Republic from 2013 to 2023, as shown in Figure 18, shows a gradual increase.

Figure 18: Development of clean vehicle registrations. [13]

The highest share of Battery Electric Vehicles are registered in the capital city of Prague compared to other regions, especially the Moravian-Silesian Region, which is probably due to higher purchasing power and a higher number of charging stations.

The development of the number of public charging points and charging stations commissioned in the period 2013-2023, as shown in the graph in Figure 19, shows a significant increase in the number of connected points and stations from 2015 to 2022.

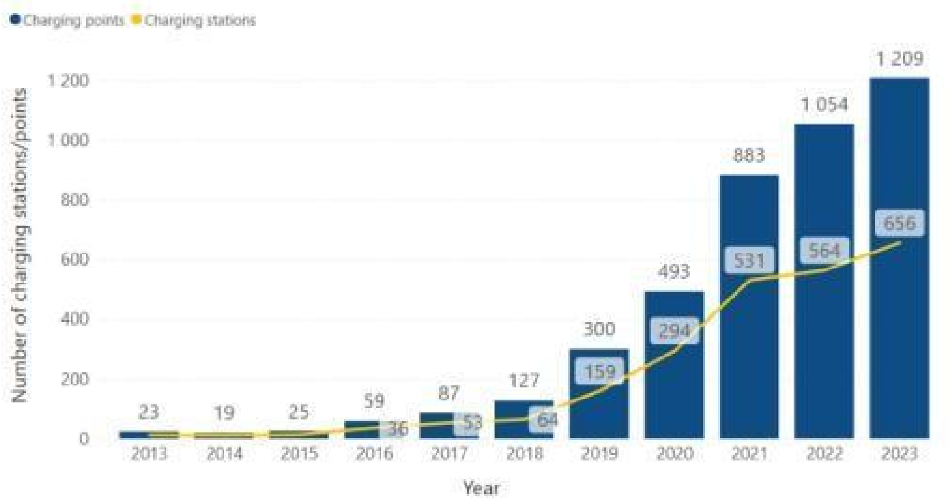


Figure 19: Number of public charging points and charging stations. [13]

5.2. Development of clean vehicle registrations and the number of public charging points and charging stations in Austria

The development of clean vehicle registrations in Austria from 2022 to 2024, is shown in Figure 20.

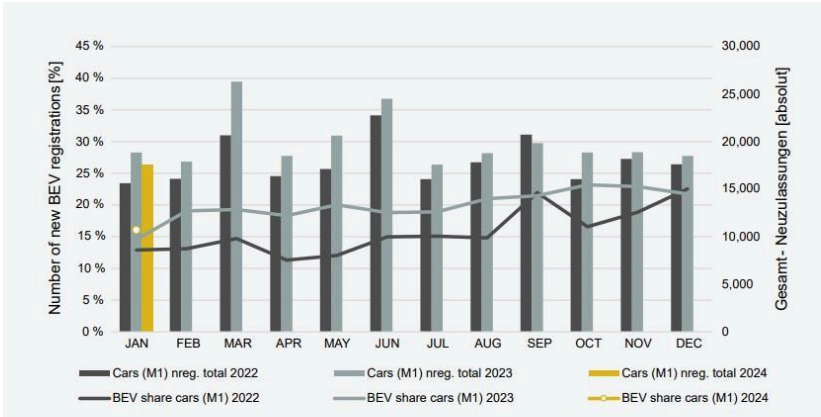


Figure 20: New registrations per month: BEV cars (M1), 2022-2024. [14]

The development of the number of public charging points and charging stations commissioned from February 2023 to January 2024, is shown in Figure 21.

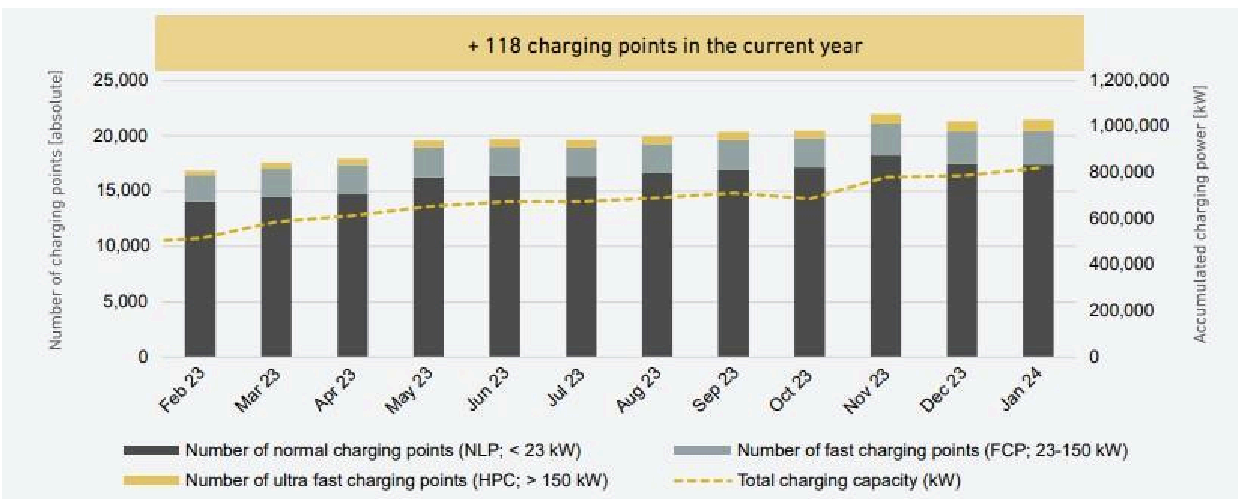


Figure 21: Publicly accessible charging points and total charging capacity per month, 2023-2024. [14]

As of 1st December 2023, the Austrian charging network consists of 17,425 normal charging points, 3,055 fast charging points and 982 ultra-fast charging points, leading 21,462 publicly accessible charging points in total.

Best-selling Battery Electric Vehicles (BEV) passenger cars (M1) by model, 1st to 4th quarter 2023 were: TESLA MODEL Y, ŠKODA ENYAQ, CUPRA BORN, VW ID.4, TESLA MODEL 3, BMW i4, AUDI Q4 E-TRON, BMW iX 1, VW ID.3, BMW iX3 respectively. [14]

6. Comparative Analysis of Total Cost of Ownership (TCO) between the Czech Republic and Austria

TCO is the sum of all the costs associated with acquiring and running a vehicle over its fleet life. These include interest rates on the finance used to fund the vehicle, money lost in depreciation, fuel or electricity costs, insurance premiums, taxes and road tolls, and service and maintenance bills. [12]

In order to compare TCOs of an electric vs. gasoline vehicle, the Volkswagen Golf (petrol and diesel) with the Volkswagen ID.3 (electric) were compared in 22 European countries (including Austria and the Czech Republic). Taken as an overall figure, on average across the 22 countries in scope, the TCOs for the Volkswagen Golf and the Volkswagen ID.3 are similar. However, there are clear differences in the individual cost elements, as illustrated in Figure 22. The cost elements of Golf are set as the baseline, with the ID.3 cost elements compared against them.

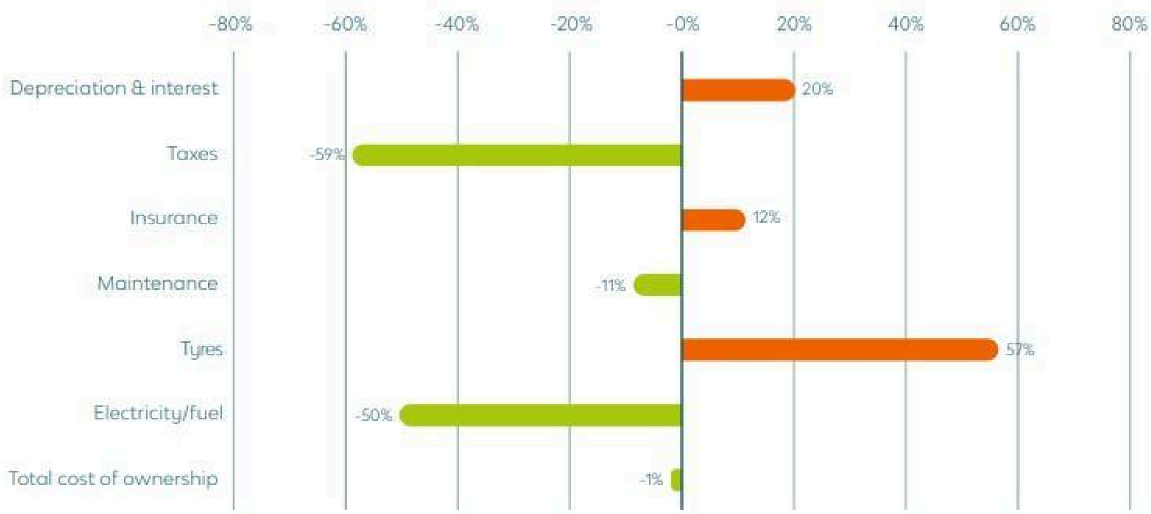


Figure 22: Difference in EV cost compared to ICE vehicles. [15]

Depreciation, insurance and tires are more expensive for Electric Vehicles, but taxes, maintenance and energy are cheaper.

Total Cost of Ownership between EVs and ICE vehicles is shown in Figure 23.

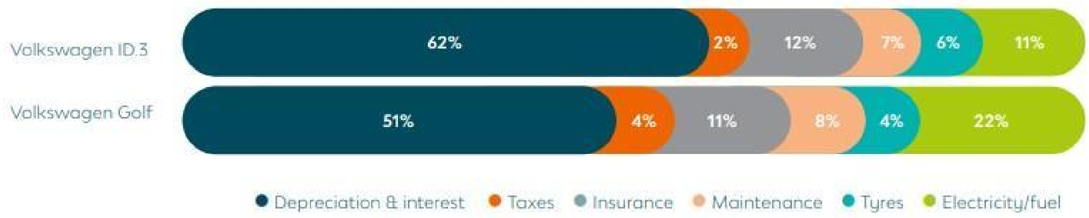


Figure 23: TCO breakdown [15]

An increase in the price of electricity has a different impact from an increase in the price of petrol/diesel. For example, when the price of both electricity and fuel increases by 50%, this results in a TCO increase of 6% for the Volkswagen ID.3, but a TCO increase of 11% for the Volkswagen Golf. This shows that the ID.3 is more resilient to energy price fluctuations than the Golf. Also, if for example, home owned solar panels are used to charge electrical vehicles then that electricity isn't prone to price fluctuations. [15]

By comparing two annual driving distances of electric vs. petrol vehicles, it was concluded that for the annual driving distance of 10000 km/year, cumulative annual ownership and operating costs are higher for electric vehicles than they are for petrol vehicles, as shown in Figure 24.

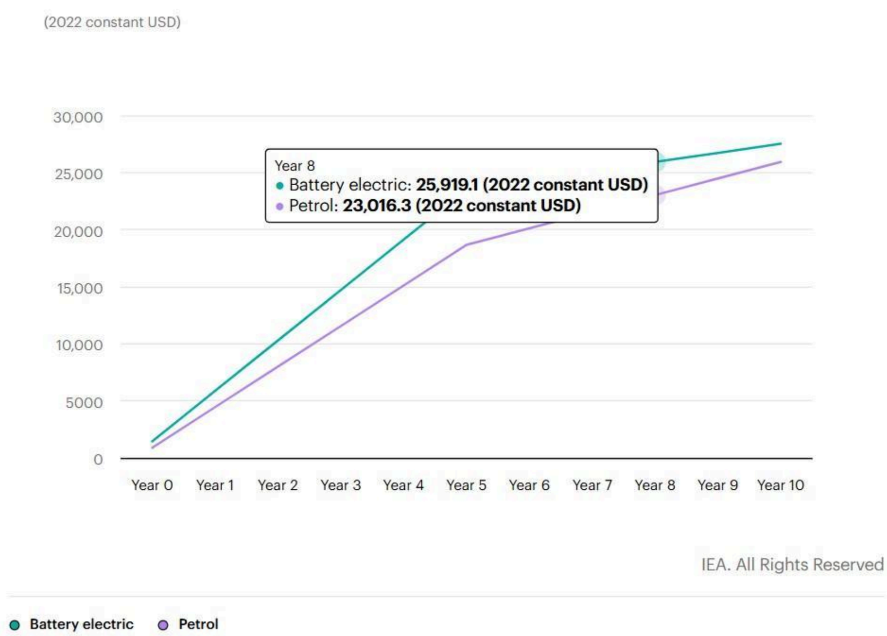


Figure 24: Cumulative annual ownership and operating costs for the annual driving distance of 10000 km/year. [16]

For the annual driving distance of 10000 km/year, Total Cost of Ownership of an Electric Vehicle is slightly higher than that of a Petrol Vehicle as shown in Figure 25.

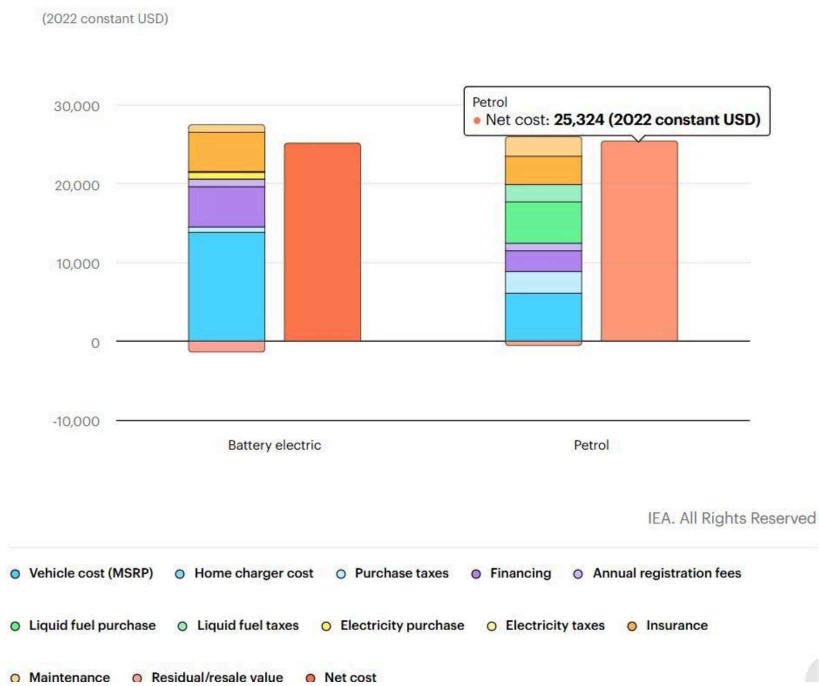


Figure 25: Breakdown of total cost of ownership for the annual driving distance of 10000 km/year. [16]

For the annual driving distance of 30000 km/year, cumulative annual ownership and operating costs are mostly lower for electric vehicles than they are for petrol vehicles, as shown in Figure 26.

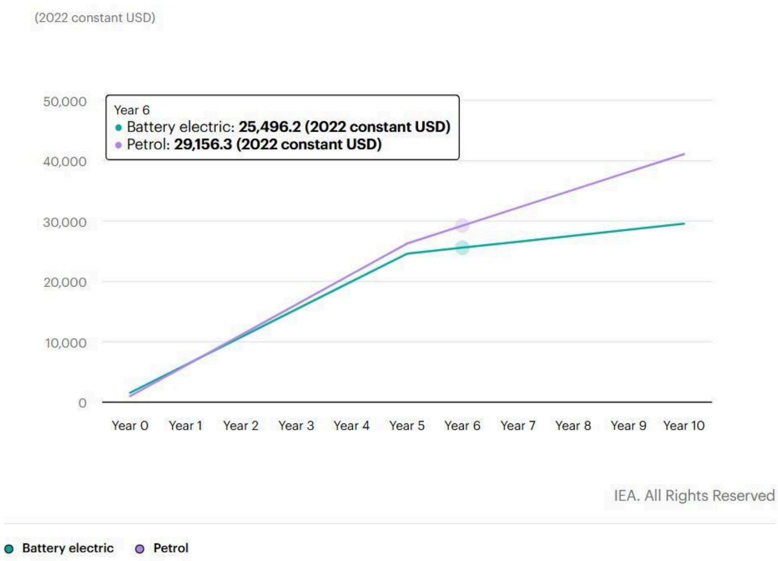


Figure 26: Cumulative annual ownership and operating costs for the annual driving distance of 30000 km/year. [16]

For the annual driving distance of 30000 km/year, Total Cost of Ownership of an Electric Vehicle is significantly lower than that of a Petrol Vehicle as shown in Figure 27.

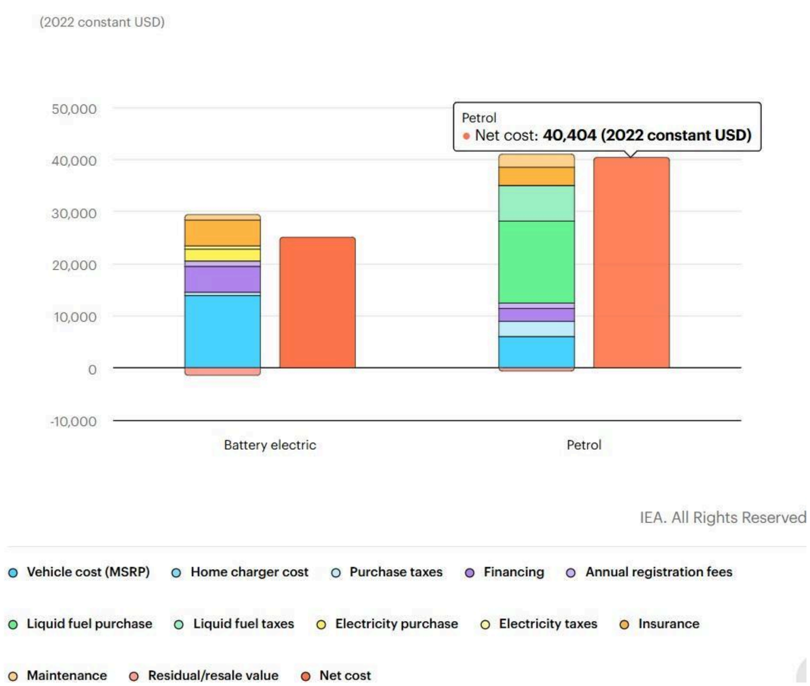


Figure 27: Breakdown of total cost of ownership for the annual driving distance of 30000 km/year. [16]

6.1. Comparison between the Czech Republic and Austria

Sub-compact segment (B1 & SUV-B1)

Examples of sub-compact segment models: Volkswagen Polo, Peugeot 208, Opel Mokka, Volkswagen T-Cross. Electric cars are steadily becoming more competitive in the sub-compact segment (9/22 countries) as can be seen in Figure 28. [1]

Figure 28: EV Cost Competitiveness in the Sub-Compact Car Segment. [1]

As shown in Figure 28, in the Czech Republic and in Austria, this segment of Electric Vehicles is not cost competitive with Gasoline Vehicles.

Compact (C1 & SUV-C1)

Examples of compact segment models: Renault Mégane, Peugeot 308, Ford Puma, Kia Niro. In the popular C-segment, electric cars are more affordable in most European countries (18/22) as can be seen in Figure 29. [1]

Figure 29: EV Cost Competitiveness in the Compact Car Segment. [1]

As shown in Figure 29, in Austria this segment of Electric Vehicles is cost competitive, but in the Czech Republic this segment of Electric Vehicles is not cost competitive with Gasoline Vehicles.

Mid-sized standard segment (D1 & SUV-D1)

Examples of mid-sized standard segment models: Volkswagen Passat, Hyundai Ioniq 5, Ford Kuga, Škoda Enyaq. BEV is cost competitive in the D1 segment in all countries (19/22), except for Poland, Italy and the Czech Republic. [1]

Figure 30: EV Cost Competitiveness in the mid-sized standard Car Segment. [1]

As shown in Figure 30, in Austria this segment of Electric Vehicles is cost competitive, but in the Czech Republic this segment of Electric Vehicles is not cost competitive with Gasoline Vehicles.

Mid-sized premium segment (D2 & SUV-D2)

Examples of mid-sized premium segment models: Polestar 2, BMW 3 Series, Mercedes-Benz GLC Class, Audi Q4 E-tron. EVs are the most affordable option in virtually all countries researched for the D2 segment (18/22 countries) as can be seen in Figure 31. [1]

Figure 31: EV Cost Competitiveness in the mid-sized premium Car Segment. [1]

As shown in Figure 31, in Austria this segment of Electric Vehicles is cost competitive, but in the Czech Republic this segment of Electric Vehicles is not cost competitive with Gasoline Vehicles.

7. Policy Impact Assessment in Austria and the Czech Republic

Some policies for promoting Electromobility include financial and tax incentives, charging infrastructure and Impact of policies

7.1. Austria

- Direct subsides: The Austrian government offers subsidies of up to 5.000€ for the purchase of Electric Vehicles. [18]

- Tax benefits: Exemption from registration tax (NoVa) and annual road tax for electric vehicles. [19]
- Deduction for companies: Companies can deduct VAT on the purchase of EVs and their employees who use these vehicles as company cars can enjoy the additional financial benefits.

Related to charge infrastructure, Austria has stablisehd a national network, with more than 15.000 public charge stations in 2022. Projects as „panther" has contributed to the growth of the infrastructure. [19]

The impact on the policies shows that in 2022, the 13,9% of new vehicles registered in Austria were electrics. Total of electric vehicles in circulation are more than 100.000, which represent 2% of the global vehicles.

The "EV Policy Impact Quantification Tool" from the NewClimate Institute, Project that with the actual policies, Austria will achieve a significant participation on them electric vehicles fleet to 2030.

7.2. Czech Republic

The Czech Republic has limited incentives such as:

- Subsides for PYMES: since march 2024, The National Bank of Development offer subsides until 300.000€ for the purchase of electric vehicles for small and medium companies. [21]
- Exemption from driving tax: the electric vehicles used for buissness manners
- Lack of incentives for particulars: It does not exist tax incentives or subsides for individuals who want electric vehicles.

In 2022, on the Czech Republic has 465 public charge stations, considerable lower figure in comparition with Austria.

The impact of policies, in 2022 only 4% of the registered vehicles were electric or plugabble hybrids, it represent barely 0.1% of the total of vehicles. Studies shows, besides the price, factors like the fuel efficiency, autonomy and charging time is a determining factor in Czech consumers for buying EVs. [22]

In the following table the comparison between Austria and the Czech Republic is shown:

Aspect	*Austria*	*Czech Republic*
Subsides for EVs	Up to 5.000€ for individuals and businesses	Up tp 300.000 CZK for Pymes
Tax benefits	NoVA and road tax exemption	Road tax exemption for companies

Charging Infrastructure	**15.000** public stations in 2022	**465** public stations in 2022
Share of Evs in new registrations (2022)	13.9%	4%
Share of EVS in the total vehicle fleet (2022)	2%	0.1%

Figure 32: Comparision of Policies and Results

The comparison between Austria and the Czech Republic reveals how public policies can directly influence the adoption of EVs.

On one hand, Austria combines financial incentives, tax benefits, and a large charging infrastructure, which have achieved significant electric vehicles penetration.

On the other hand, the Czech Republic faces challenges due to the limited access to incentives for particulars and a less developed infrastructure.

8. Enviromental Burden and Societal Costs

The transition from internal combustion vehicles (ICVs) to electric vehicles (EVs) brings some significant implications, not only economic or tecnical, also environmental and social. To evaluate the environmental charge and socials costs associated to both types of esential mobility is essential to understand the total impact on society.

8.1. Enviromental Burden: Life Cicle Emissions

An analysis os the Life Cicle Assessment, LCA, shows that Evs despite of having a higher greenhause emission on the production phase (mainly due to batteries manufacturers), present lowest total of greenhause emissions throughout its useful life, particullary in countries with a electric network dependen on fossil fuels.

In the case of Austria, where a big part of electricity comes from renewables, the BEVs present a significant reduction in GEI emissions compared to ICEVs [23]. On the contrary, in the Czech Republic, the electric network include a large carbon proportion, the Benefit of BEVs benefits occur after 70.000km traveled.

Recent studies shows that ICEVs have a lowest envornmental load at the begining of their useful life, but this advantage lost with time due to the continous emissions during the operation. For example, the BMW i4 overcome the BMW 430i (ICEV) on sostenebility terms after 5 years of use or 70.000km traveled in czech conditions.

8.2. Societal Costs: Health and Infrastructure Impacts

Internal combustión vehicles impact negatively public health by contributing to respiratory and cardiovascular diseases, so increases healthcare costs emitting pollutants gases like NOx and PM2.5. [23]

Road transport represent up to 39% of urban NOx emissions, and electrifying the vehicle fleet can improve air quality. While ICEVs create hidden infrastructure costs due to fuel logistics and road wear, electric vehicles require an initial inversion on charging networks that are more sustainable and cost-effective in long terms, especially. [24]

8.3. Social Equity Considerations

Electrification of transport give social challenges. An unequal distribution of charging infrastructure can lead to a social inequality, leaving rural or low-income communities with limited access to the benefits of EVs. Moreover, the high initial cost of EVs can be a barrier for the most vulnerable households. [1]

In this context, public policies as targeted subsides, inversions in community charging stations and educational programs are essential for assuring that the transition to the electric mobility is inclusive and equitative.

9. Interview at “Klokočka” – certified Škoda dealership

An interview at a certified Škoda dealership in Prague called “Klokočka” was conducted. Interviewee was Ing. David Rohla, Škoda New Car Sales Manager at Autosalon Klokočka Centrum. The questions and answers go as follows:

The interview was constructed out of 10 questions, and those questions go as follows:

1. **Could you please briefly introduce yourself and describe your role at Autosalon Klokočka Centrum and how it relates to the sale and customer support of Škoda vehicles?**

-I serve as the Head of New Škoda Vehicle Sales and lead a team of eight people responsible for both retail and fleet sales.

2. From your experience, how does the total cost of ownership (TCO) of a Škoda electric vehicle compare to a gasoline model over a 5–10 year period in the Czech Republic?

-If you’re not expecting specific calculations, I’d generally say it depends heavily on the customer and how the car is used. If you live near the capital in a family house with solar panels on the roof and commute 40 km to work, your daily operating costs will be minimal. Service costs for electric vehicles are also significantly lower than for conventional cars, and the initial cost of an EV has now approached that of traditional cars. However, if you’re a sales rep driving 30,000 km annually and using high-speed highway chargers, then operating costs could be much higher than, say, a fuel-efficient diesel engine.

3. Could you share any internal insights or data about differences in maintenance and service costs between Škoda EVs and gasoline models?

-I can share a comparison of prepaid service costs as stated by the manufacturer.

Prepaid Standard Service (everything prescribed by the manufacturer during regular maintenance checks); prices in CZK including VAT:

Model	Prepaid Service	Price (CZK incl. VAT)
Elroq	5 years, up to 60,000 km	10000
Elroq	5 years, up to 100,000 km	10000
Elroq	5 years, up to 150,000 km	10000
Karoq	5 years, up to 60,000 km	23000
Karoq	5 years, up to 100,000 km	34000
Karoq	5 years, up to 150,000 km	51000

Škoda Elroq is a fully electric compact SUV (BEV – Battery Electric Vehicle), where as Škoda Karoq is an Internal combustion engine compact SUV.

4. Are there any significant government subsidies, tax reliefs, or other incentives in the Czech Republic that impact the affordability of Škoda electric vehicles?

Last year, legal entities could receive a subsidy of up to CZK 200,000 from the Ministry of Industry and Trade for purchasing an EV under certain conditions. This incentive was quickly exhausted and temporarily boosted the demand for EVs.

Currently, the only benefits are:
- Free parking in blue zones in Prague and some other cities
- Free motorway vignette
- Exemption from road tax

5. What role do infrastructure factors like charging station availability or electricity prices play in customer decisions regarding electric vehicle purchases?

The most crucial questions potential buyers ask are:

What is the range on a single charge, where can I charge the vehicle, and how much will it cost? Electricity prices are currently very volatile. When e-mobility first gained traction here a few years ago, electricity was significantly cheaper, making it one of the main incentives to switch to an EV. Today, the situation is more complex — the cost per kilometer varies greatly depending on where you charge: whether it's at home using off-peak rates, with your own solar panels, or at high-speed highway charging stations. In some cases, the cost can be much lower than gasoline, while in others it can be considerably higher. Electricity prices are expected to continue rising — but so are the prices of gasoline and diesel.

Infrastructure, on the other hand, is improving significantly each year. Today we have about 2,700 charging stations in the Czech Republic, or roughly 6,000 charging points. That puts us among the best in Europe – about 22 charging stations per 100 EVs, while the EU average is 15 per 100.

6. Do you have access to any data or case studies from Škoda dealerships that show the real long-term costs for EV versus gasoline vehicle owners?

There are likely some publicly available user comparisons, but I don't have any specific data on hand.

7. Do you think Škoda's current EV offering brings real economic advantages over gasoline models? Why or why not?

Currently, Škoda Auto offers only two electric vehicles (not counting derivatives like the Coupé). That means competition only in two segments. Within two years, about three more models should be added: Epiq (similar to Kamiq), a Combi version (like Octavia Combi – still under consideration for production), and a 7-seater (larger than Enyaq – for 7 passengers). Only then will our offering be complete and we'll be able to provide EVs to everyone. What we currently lack most is a smaller vehicle – that's what the Epiq should be.

8. What everyday mobility or user comfort differences do Škoda customers typically mention between EVs and gasoline vehicles?

Again, it depends on the customer type. Some don't notice a difference – they're happy with a quiet, smooth, zippy car at a similar price that they can charge at home, possibly with surplus solar power. Others prefer the sound of an engine and being able to refuel in 5 minutes. The main difference is how the car is used. For example, in companies, sales reps with high mileage typically drive conventional cars, while "pool cars" (used for short trips or as loaners after accidents) are often EVs. Range also matters – some EVs now exceed 500 km per charge and can function similarly to conventional vehicles; others, with about 250 km range, serve better as city cars or second family vehicles.

9. What do you see as the biggest future challenge for EVs in terms of affordability and mass adoption in Central Europe?

The EV market is very specific. It doesn't operate fully on market principles. Most vehicles are bought by companies for ESG compliance or at least to appear environmentally friendly – often due to decisions by parent companies based outside CZ. These aren't economic decisions.

Technology will have a major influence – in China, batteries are being developed that will allow 1,000 km range per charge. Alongside lower production costs (economies of scale), this will impact the market. EV sales are already growing almost exponentially year-on-year and that trend will likely continue.

10. If you were advising someone in the Czech Republic buying their first car today, what would be your main arguments for and against choosing an electric vehicle over a gasoline car?

Pros of EVs:
- Environmental benefits
- Quiet operation
- Acceleration
- Sustainability
- Low service costs
- Potentially low operating costs with cheap charging
- Modern technologies (e.g., remote heating)
- It's the future

Cons of EVs:
- Different usage style – requires route planning
- Still relatively underdeveloped and unreliable charging infrastructure
- Conventional cars have longer range and faster refueling
- Conventional cars are usually lighter
- Better for long-distance travel and countries with poor charging networks

10. Conclusion

This comparitive analysis reveals that Electric Vehicles, despite of their higher purchase Price, can offer significant economic and environmental benefits the long term, especially for those who dirve long distances throughout the year.

Austria represents a favorable enviroment for adopting EVs due to its solid infrastructure and beneficial policies, while Czech Republic they still shows competitive gaps in some vehicle segments. However, the increasing implementation of charge stations and second-life bettery systems points to a promising future for sustainable mobility. As energy markets evolve and technology matures, it seems that electric vehicles would become more affordable and efficient in larger markets, leading to a strong role n the transition toward descarbonized transport.

11. International Survey on Consumer Preferences Between Electric and Gasoline Vehicles

A short survey was conducted among 59 people from all around the globe, in order to gain insight into global perspectives on energy renovation.

The survey was constructed out of four questions. The first question was designed as an open question, questions two, three and four were constructed as multiple-choice questions.

The questions, and possible answers, that were taken into account in this short survey are as follows:

1. Where are you from? (Country/City)
2. When considering a new vehicle, which factor is *most important* to you?
   a) Purchase Price
   b) Running costs (fuel/electricity, maintenance, insurance)
   c) Environmental impact (greenhouse gas emissions, resource use)
   d) Government subsidies and incentives
   e) Vehicle performance and features

3. Which type of vehicle would you prefer to buy today, assuming similar prices?
   a) Gasoline or diesel vehicle
   b) Hybrid electric vehicle (HEV)
   c) Battery electric vehicle (BEV)
   d) Fuel cell electric vehicle (FCEV)

4. Do you think electric vehicles (EVs) are already more economical *over their lifetime* than gasoline vehicles in your country?
   a) Yes
   b) No
   c) Not sure

11.1. Results

The results of the survey conducted are given in Figure 33.

Spain	a) Purchase price	b) Hybrid electric vehicle (HEV)	b) No
Spain/Lugo	a) Purchase price	b) Hybrid electric vehicle (HEV)	a) Yes
Spain	b) Running costs (fuel/electricity, maintenance, in:	a) Gasoline or diesel vehicle	b) No
Spain	e) Vehicle performance and features	a) Gasoline or diesel vehicle	b) No
Spain	a) Purchase price	a) Gasoline or diesel vehicle	b) No
Spain	b) Running costs (fuel/electricity, maintenance, in:	a) Gasoline or diesel vehicle	c) Not sure
Zaragoza España	b) Running costs (fuel/electricity, maintenance, in:	a) Gasoline or diesel vehicle	b) No
Spain	a) Purchase price	a) Gasoline or diesel vehicle	b) No
Praha, Czech Republic	a) Purchase price	b) Hybrid electric vehicle (HEV)	a) Yes
Barcelona	a) Purchase price	b) Hybrid electric vehicle (HEV)	c) Not sure
Spain	b) Running costs (fuel/electricity, maintenance, in:	b) Hybrid electric vehicle (HEV)	a) Yes
Spain	a) Purchase price	b) Hybrid electric vehicle (HEV)	b) No
Spain	b) Running costs (fuel/electricity, maintenance, in:	b) Hybrid electric vehicle (HEV)	c) Not sure
Cambodia	d) Government subsidies and incentives	b) Hybrid electric vehicle (HEV)	a) Yes
Cambodia/Phnom Penh	b) Running costs (fuel/electricity, maintenance, in:	b) Hybrid electric vehicle (HEV)	a) Yes
Spain, A Coruña	e) Vehicle performance and features	b) Hybrid electric vehicle (HEV)	b) No
Prage, Czechia	a) Purchase price	c) Battery electric vehicle (BEV)	b) No
Prague, the Czech Republic	a) Purchase price	c) Battery electric vehicle (BEV)	c) Not sure
Prague, Czechia	b) Running costs (fuel/electricity, maintenance, in:	b) Hybrid electric vehicle (HEV)	b) No
Vienna, Austria	e) Vehicle performance and features	a) Gasoline or diesel vehicle	c) Not sure
Graz, Austria	e) Vehicle performance and features	b) Hybrid electric vehicle (HEV)	c) Not sure
Lugo	b) Running costs (fuel/electricity, maintenance, in:	a) Gasoline or diesel vehicle	b) No
Austria/ Vienna	a) Purchase price	d) Fuel cell electric vehicle (FCEV)	a) Yes
Finland	e) Vehicle performance and features	c) Battery electric vehicle (BEV)	a) Yes
Ukraine	b) Running costs (fuel/electricity, maintenance, in:	a) Gasoline or diesel vehicle	b) No
Vienna, Austria	b) Running costs (fuel/electricity, maintenance, in:	c) Battery electric vehicle (BEV)	a) Yes
France	b) Running costs (fuel/electricity, maintenance, in:	b) Hybrid electric vehicle (HEV)	c) Not sure
Austria	e) Vehicle performance and features	c) Battery electric vehicle (BEV)	a) Yes
Austria	b) Running costs (fuel/electricity, maintenance, in:	b) Hybrid electric vehicle (HEV)	c) Not sure
Spain/Córdoba	e) Vehicle performance and features	a) Gasoline or diesel vehicle	b) No
Austria	e) Vehicle performance and features	b) Hybrid electric vehicle (HEV)	a) Yes
Bosnia/ Sarajevo	a) Purchase price	b) Hybrid electric vehicle (HEV)	c) Not sure
Germany	b) Running costs (fuel/electricity, maintenance, in:	b) Hybrid electric vehicle (HEV)	a) Yes
Vienna	c) Environmental impact (greenhouse gas emissic	d) Fuel cell electric vehicle (FCEV)	a) Yes
Vienna		c) Battery electric vehicle (BEV)	a) Yes
Germany/Obertshausen	b) Running costs (fuel/electricity, maintenance, in:	a) Gasoline or diesel vehicle	b) No
Germany/Marktheidenfeld	b) Running costs (fuel/electricity, maintenance, in:	a) Gasoline or diesel vehicle	c) Not sure
Spain/Zaragoza	e) Vehicle performance and features	a) Gasoline or diesel vehicle	b) No
Vienna	e) Vehicle performance and features	a) Gasoline or diesel vehicle	b) No
Spain	a) Purchase price	a) Gasoline or diesel vehicle	c) Not sure

Figure 33: Results of the survey.

When it comes to the second question, the second option for an answer "Running costs (fuel/electricity, maintenance, insurance)" was the most popular, with 39% of participants choosing this option. The second most popular answers were "Purchase price" and "Vehicle performance and features", both with 27,1% of the participants opting for this option. The fourth answer “Enviromental impact (greenhaus gas emissions…)” with 5,1% of participants and finally the “Government subsidies and incentives” was the least popular with only 1.7% of participants choosing this option.

Figure 34 presents a visual summary of respondents’ answers to the question “When considering a new vehicle, which factor is most important to you?”

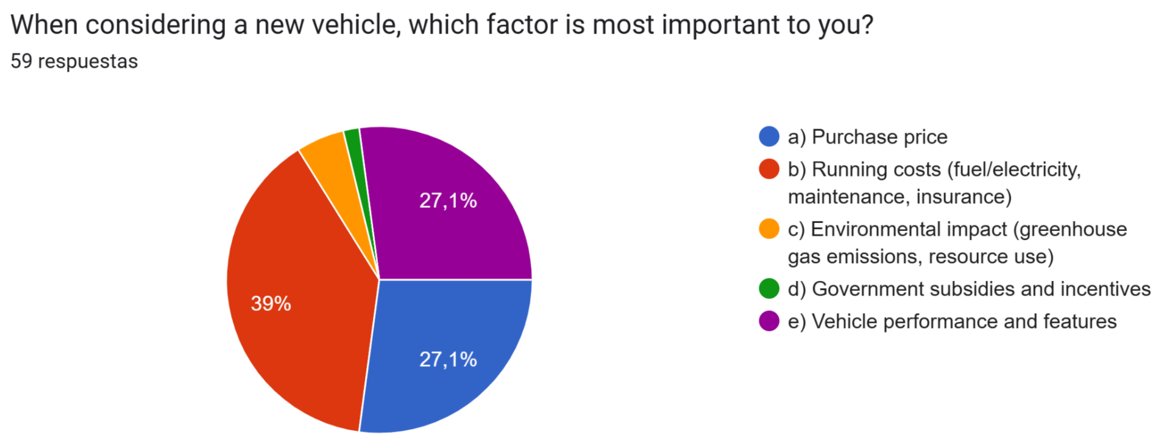


Figure 34: Responses to Survey - Question 2.

When it comes to the third question, the second option for an answer “Hybrid Electric Vehicle (HEV)” was the most popular, with 45,8% of participants choosing this option. The second most popular answer was the first option “Gasoline or diesel vehicle”, with 39% of the participants opting for this option. Moreover 11,9% of participants choose “Battery electric vehicle (HEV)”. The last answer “Fuel cell Electric Vehicle (FCEV)” was the least popular with only 3,4% of participants choosing this option.

Figure 35 presents a visual summary of respondents’ answers to the question “Which type of vehicle would you prefer to buy today, assuming similar prices?”

Which type of vehicle would you prefer to buy today, assuming similar prices?
59 respuestas

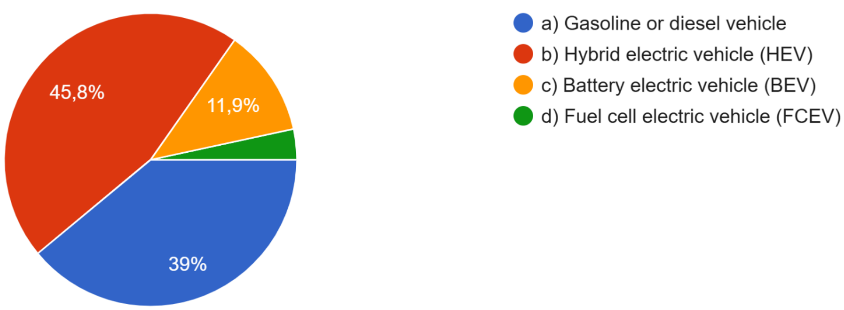


Figure 35: Responses to Survey - Question 3.

When it comes to the fourth question, the third option for an answer "Not sure" was the most popular, with 39% of participants choosing this option. The second most popular answer was the second option "Yes", with 32,2% of the participants opting for this option, and the first answer "No" with 28.8%% of participants choosing this option.

Figure 36 presents a visual summary of respondents' answers to the question "Do you think electric vehicles (EVs) are already more economical *over their lifetime* than gasoline vehicles in your country?"

Do you think electric vehicles (EVs) are already more economical over their lifetime than gasoline vehicles in your country?
42 odgovora

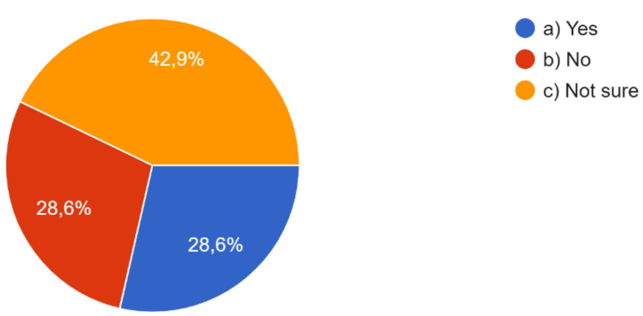


Figure 36: Responses to Survey - Question 4.

From a total of 59 participants, the distribution of respondents by country is as follows:

- Austria: 10 participants
- Czech Republic: 6 participants
- Bosnia and Herzegovina: 4 participants
- Kazakhstan: 1 participant
- France: 2 participants
- Spain: 27 participants
- Ukraine: 2 participants
- Cambodia: 2 participants
- Turkey: 1 participant
- USA: 4 participants
- Finland: 1 participant
- Germany: 3 participants

11.1.1. Comparison between Austria and the Czech Republic

Among the 59 participants in this survey, 6 were from the Czech Republic and 10 from Austria.

For the second question "When considering a new vehicle, which factor is *most important* to you?" The comparison between Austria and the Czech Republic is shown in Figure 37 and Figure 38.

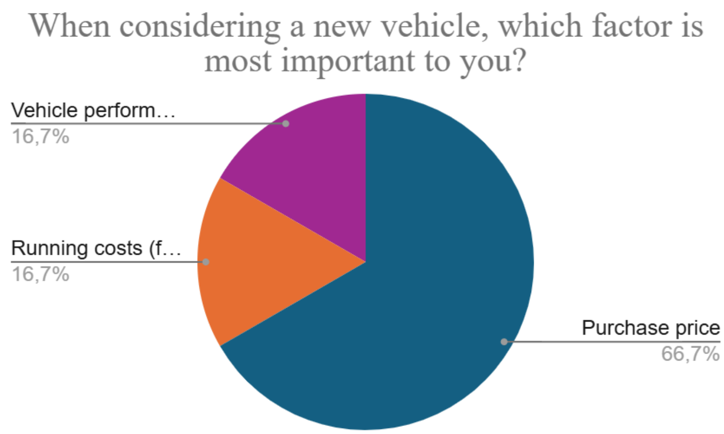


Figure 37: Responses to Survey - Question 2 – the Czech Republic.

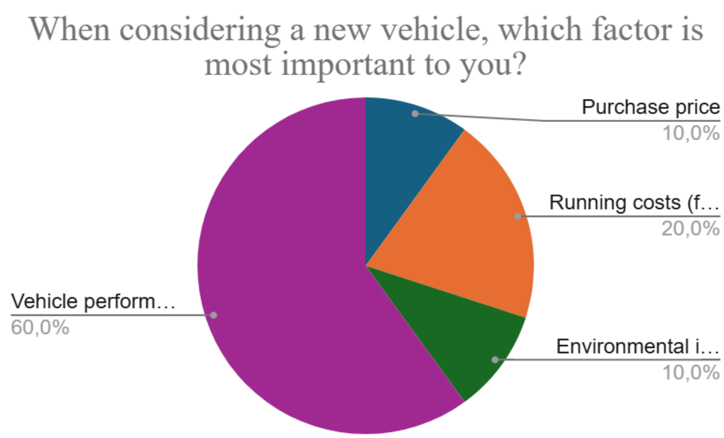


Figure 38: Responses to Survey - Question 2 – Austria.

When it comes to the second question, 66,7% of participants in the Czech Republic said that the most important factor when purchasing a vehicle is the Purchase Price, and the rest in equal parts, with 16,7% each of participants said that the most important factors are running costs and vehicle performance and features. In Austria, 60% of the participants opted for the fourth option for the most important factor when purchasing a vehicle which was vehicle performance and features. Also 20% go for running costs, and two minorities with 10% each voted for Environmental Impact and Purchase Price.

For the third question “Which type of vehicle would you prefer to buy today, assuming similar prices?” The comparison between Austria and the Czech Republic is shown in Figure 40 and Figure 41.

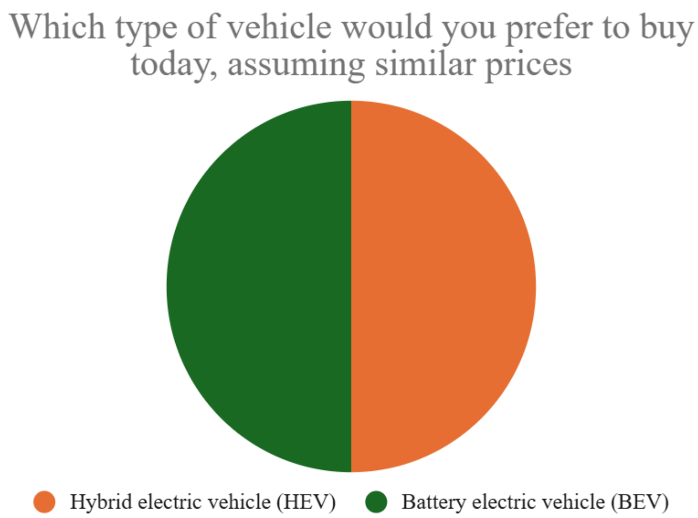


Figure 40: Responses to Survey - Question 3 – the Czech Republic.

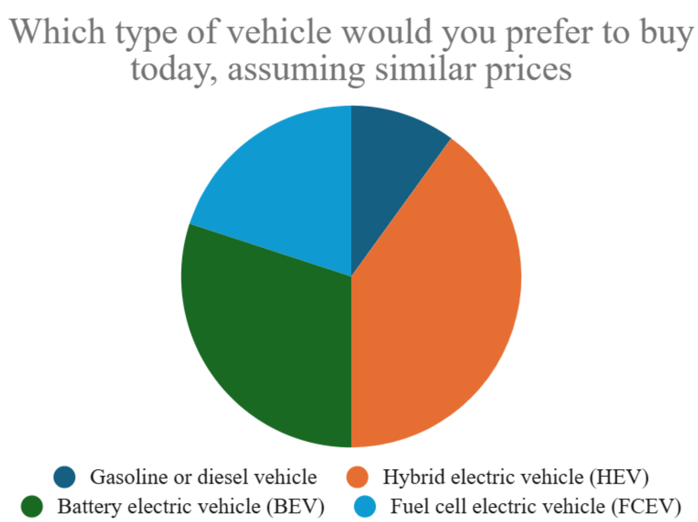


Figure 41: Responses to Survey - Question 3 – Austria.

When it comes to the third question, 50% of participants in the Czech Republic said that they would prefer a HEV, and 50% of participants said that they would prefer a BEV. In Austria, we can see a wide variety of responses, 40% of the participants would opt for a HEV, 30% for BEV, 20% for FCEV and a small group, 10%, opt for Gasoline or diesel vehicle.

For the fourth and final question "Do you think electric vehicles (EVs) are already more economical *over their lifetime* than gasoline vehicles in your country?" the comparison between Austria and the Czech Republic is shown in Figure 42 and Figure 43.

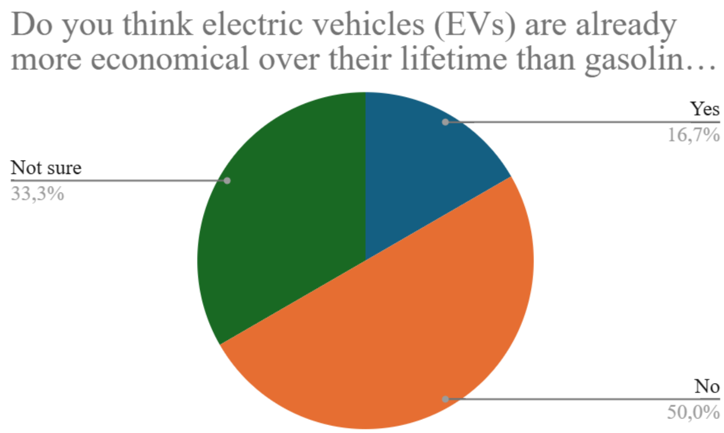


Figure 42: Responses to Survey - Question 4 – the Czech Republic.

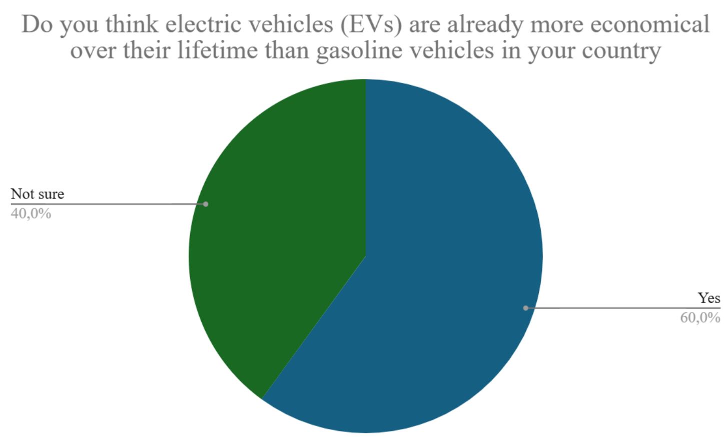


Figure 41: Responses to Survey - Question 3 – Austria.

When it comes to the third question, 50% of participants in the Czech Republic said that they don't think that EVs are more economical over lifetime, and 33,3% said that they were not sure if EVs were more economical, and 16,7% of participants said that they don't think EVs are more economical over their lifetime. In Austria, 60% of the participants were sure about EVs being more economical over their lifetime, compared to the remaining 40%. This may indicate that Austrian citizens are more confident in a sustainable transition compared to Czechs.

References:

[1] LeasePlan International Consultancy Services, *Car Cost Index 2022*, 7th ed. LeasePlan Corporation N.V., 2022.

[2] Statista, "Average prices for new cars in the EU in 2015, by country," *Statista*, 2024. [Online]. Available: https://www.statista.com/statistics/425095/eu-car-sales-average-prices-inby-country/. [Accessed: Apr. 2, 2025].

[3] European Automobile Manufacturers' Association (ACEA), "New passenger cars by segment in the EU," *ACEA*, Apr. 2024. [Online]. Available: https://www.acea.auto/figure/new-passengercars-by-segment-in-eu/. [Accessed: Apr. 2, 2025].

[4] LeasePlan International Consultancy Services, *Industrial Industry Benchmark: Fleet Trends in the European Industrial Industry 2018–2020*, LeasePlan Corporation N.V., Amsterdam, Netherlands, Jun. 2021.

[5] European Alternative Fuels Observatory (EAFO), "Vehicle types," *EAFO*, 2024. [Online]. Available: https://alternative-fuels-observatory.ec.europa.eu/general-information/vehicle-types. [Accessed: Apr. 2, 2025].

[6] S. J. Rind, Y. Ren, Y. Hu, J. Wang, and L. Jiang, "Configurations and control of traction motors for electric vehicles: A review," *Chinese Journal of Electrical Engineering*, vol. 3, no. 3, pp. 1–18, Dec. 2017.

[7] U.S. Department of Energy, *Introduction to Life Cycle Assessment*, 1st ed. Washington, DC: DOE Advanced Manufacturing Office, Jul. 2022.

[8] J. Furch, V. Konečný, and Z. Krobot, "Modelling of life cycle cost of conventional and alternative vehicles," *Scientific Reports*, vol. 12, no. 10661, pp. 1–14, 2022.

[9] M. L. Kambanou and M. Lindahl, "A literature review of life cycle costing in the productservice system context," *Procedia CIRP*, vol. 47, pp. 186–191, 2016.

[10] V. Kutnar and K. Jaššo, "LCA of different types of cars in Czech Republic," in *Proceedings of the 30th Conference STUDENT EEICT 2024*, Brno University of Technology, Brno, Czech Republic, 2024, pp. 124–128.

[11] D. Fritz, H. Heinfellner, and S. Lambert, *Die Ökobilanz von Personenkraftwagen: Bewertung alternativer Antriebskonzepte hinsichtlich CO_2-Reduktionspotential und Energieeinsparung*, 1st ed. Vienna, Austria: Umweltbundesamt, 2021. REP-0763.

[12] J. Armitage, "Assessing EV vs ICE TCO," *Fleet Europe*, May 24, 2023. [Online]. Available: https://www.fleeteurope.com/en/financial-models/others/features/assessing-ev-vs-icetco?a=JMA06&t%5B0%5D=TCO&t%5B1%5D=BEVs&t%5B2%5D=ICE&curl=1. [Accessed: Apr. 11, 2025].

[13] M. Turek, B. Kalupová, V. Cempírek, K. Tůmová, and B. Abramović, "Electromobility and the Environment in the Czech Republic," *LOGI – Scientific Journal on Transport and Logistics*, vol. 15, no. 1, pp. 201–212, 2024.

[14] AustriaTech, *E-Mobility in Austria – Facts & Figures*, OLÉ – National Competence Center for E-Mobility, Vienna, Austria, Jan. 2024.

[15] J. Wetterhahn, *Total Cost of Ownership: How Electric Vehicles and ICE Vehicles Compare*, LeasePlan Corporation N.V., Amsterdam, Netherlands, Feb. 2022.

[16] International Energy Agency (IEA), "Electric Vehicles Total Cost of Ownership Tool," *IEA*, 2023. [Online]. Available: https://www.iea.org/data-and-statistics/data-tools/electricvehicles-total-cost-of-ownership-tool. [Accessed: Apr. 21, 2025].

[17] World Economic Forum. (2022, December). *How second-life batteries could transform the electric vehicle industry and support a circular economy*. https://www.weforum.org/stories/2022/12/electric-vehicle-battery-circular-economy/

[18] *Plug-in electric vehicles in Austria*. Wikipedia. Retrieved April 30, 2025, from https://en.wikipedia.org/wiki/Plug-in_electric_vehicles_in_Austria

[19] European Alternative Fuels Observatory. (2022). *National Policy Framework: Austria (EN)*. https://alternative-fuels-observatory.ec.europa.eu/system/files/documents/2022-12/Austria%20NPF%20%28EN%29_0.pdf

[20] NewClimate Institute. (2022). *EVs Tool Technical Documentation – Update CATPSRII*. https://newclimate.org/sites/default/files/2022/02/EVs-Tool-Technical-Documentation_update-CATPSRII.pdf

[21] *Government incentives for plug-in electric vehicles*. Wikipedia. Retrieved April 30, 2025, from https://en.wikipedia.org/wiki/Government_incentives_for_plug-in_electric_vehicles

[22] Turek, M., Kalupová, B., Cempírek, V., Tůmová, K., & Abramović, B. (2024). *Electromobility and the environment in the Czech Republic*. ResearchGate. https://www.researchgate.net/publication/387520594_Electromobility_and_the_Environment_in_the_Czech_Republic

[23] European Environment Agency. (2022). *Air quality in Europe – 2022 report*. https://www.eea.europa.eu/publications/air-quality-in-europe-2022

[24] World Health Organization. (2021). *Health effects of air pollution*. https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health