

BATTERY VEHICLE FLEET, BRAZIL 2050

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Part I

INTRODUCTION

INTRODUCTION

GLOBAL CONTEXT

- ▶ Growing sales of electric vehicles (EV) as an alternative to internal combustion engine vehicles (ICE).
- ▶ Significant fleet increase in 5 years: 1 million to 10 million.
- ▶ Market share: 14% in 2022, 10x increase in 5 years.
- ▶ Global market in 2022: 14% of car sales (USD 425 billion), a 50% increase compared to 2021, predominantly in China (60%), Europe (15%), USA (8%).
- ▶ Increase in the number of models: 100% growth between 2018-2022
- ▶ Government commitments: legislative advancements to strengthen the market. Example: Inflation Reduction Act, USA.
- ▶ Supply challenges:
 - Demand for Li-ion batteries increased by 65% in 2022.
 - Demand for Li-ion components for EVs in 2022: 60% lithium, 30% cobalt, and 10% nickel (2017: 15%, 10%, and 2%).
 - Manufacturing concentrated in specific regions, especially China.

INTRODUCTION

BRAZILIAN CONTEXT

- ▶ Less significant market: 2.5% of sales in 2022.
- ▶ Regulation does not include electrification targets.
 - Proconve: Reduction of certain types of pollutants
 - Rota 2030: Focus on energy efficiency, reduced IPI for EVs.
 - Possible new round of Rota 2030 with greater focus on electromobility.
- ▶ Biofuels as a possible alternative for net-zero scenarios: domestically produced fuels, with installed capacity, widespread flex-fuel technology.
- ▶ Entry barriers:
 - Raw materials: Availability, high costs, and domestic manufacturing.
 - Regulatory framework
 - Skilled labor
 - Costs and prices
 - Development of internal industry
- ▶ Electric parity achieved between 2029-2035¹

¹ ANFAVEA, BCG (2023)

INTRODUCTION

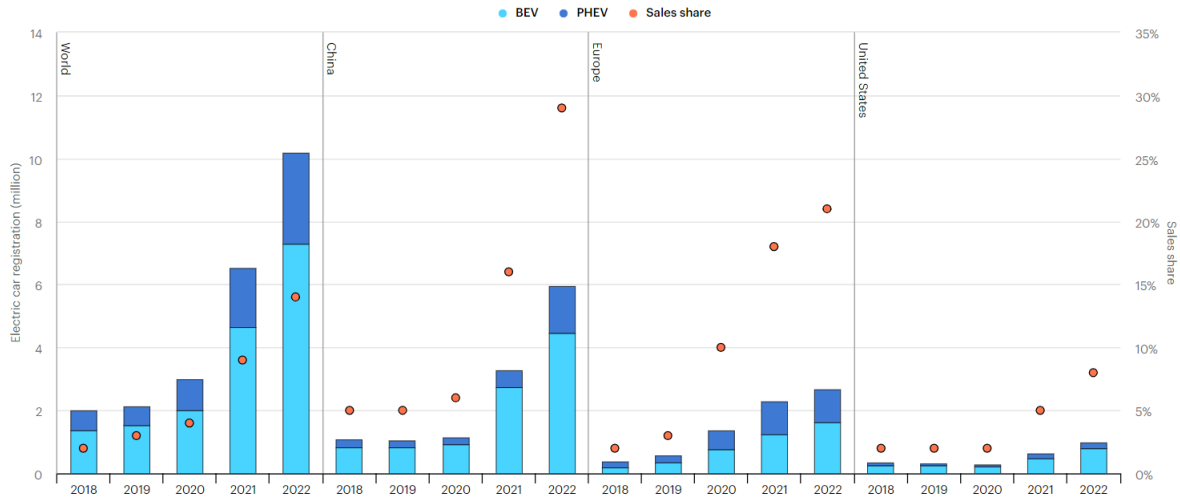
TERMINOLOGY

- ▶ Internal Combustion Engine (ICE): gasoline, alcohol, flex, and diesel.
- ▶ Battery (BEVs): 100% electric vehicles that do not use an internal combustion engine.
- ▶ Hybrids²:
 - Mild Hybrid Electric Vehicle (MHEV): Low-voltage electric motor with limited power
 - Hybrid Electric Vehicle (HEV): Medium power, supporting low speeds.
 - Plug-in Hybrid Electric Vehicle (PHEV): High power, allowing high speeds
- ▶ Electric Vehicles (EV): BEVs and hybrids. Does not include hydrogen fuel cell vehicles.

²ANFAVEA (2023)

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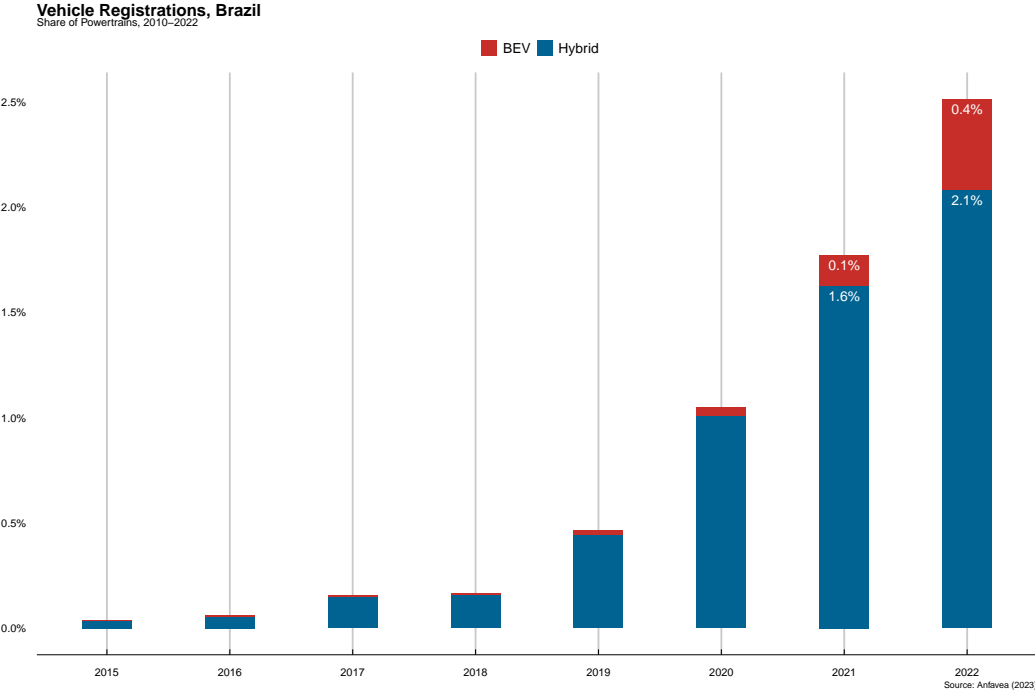
EV SALES SHARE – WORLD AND MAJOR ECONOMIES



Source: IEA (2023)

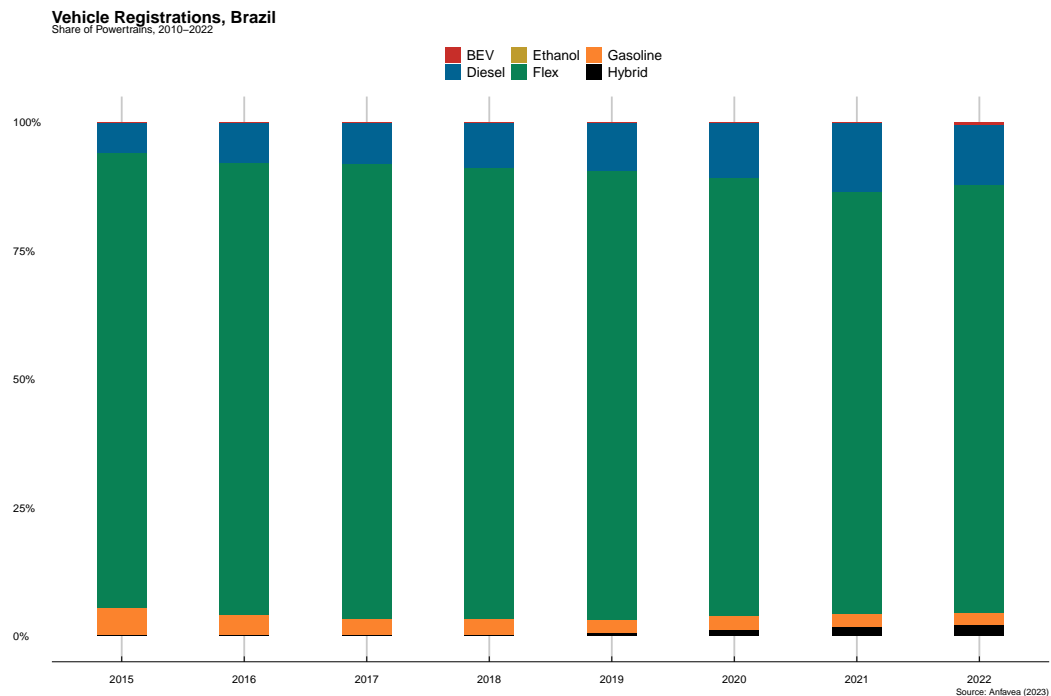
INTRODUCTION

HYBRID AND BEV REGISTRATIONS



INTRODUCTION

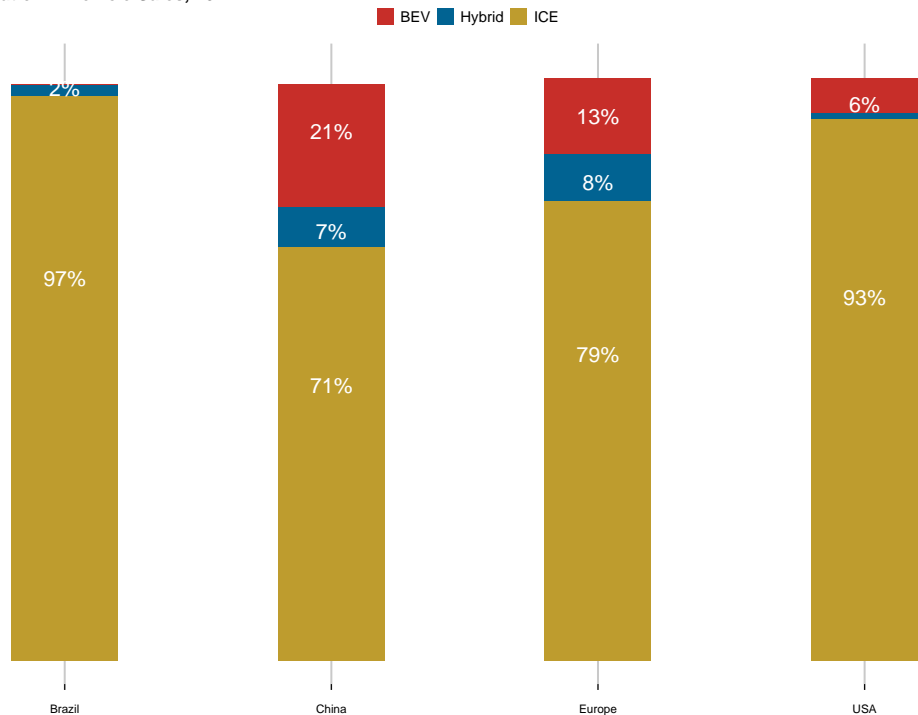
REGISTRATION COMPOSITION – BRAZIL



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LIGHT VEHICLE SALES, 2022

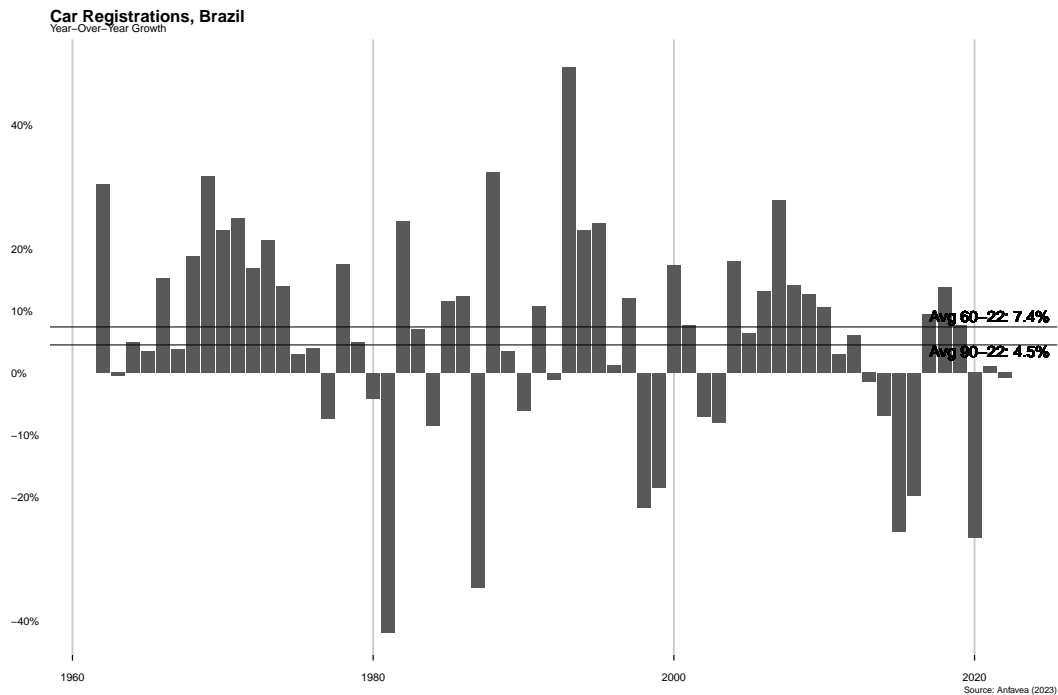
EV Participation in Vehicle Sales, 2022



Source: IEA (2023), Anfavea (2022)

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SALES HISTORY, BRAZIL



Part II

FLEET

BRAZILIAN FLEET

FLEET CALCULATION

Based on licensing data, we can calculate the circulating fleet F at a given moment j considering: (1) new vehicles licensed in the n years prior to j ; (2) the exit of vehicles from the fleet, or the "survival rate" of vehicles with age t , S_t . F_j can be generalized for any fuel.

$$F_j = \sum_{n=1}^j V_n \times (1 - S(t))$$

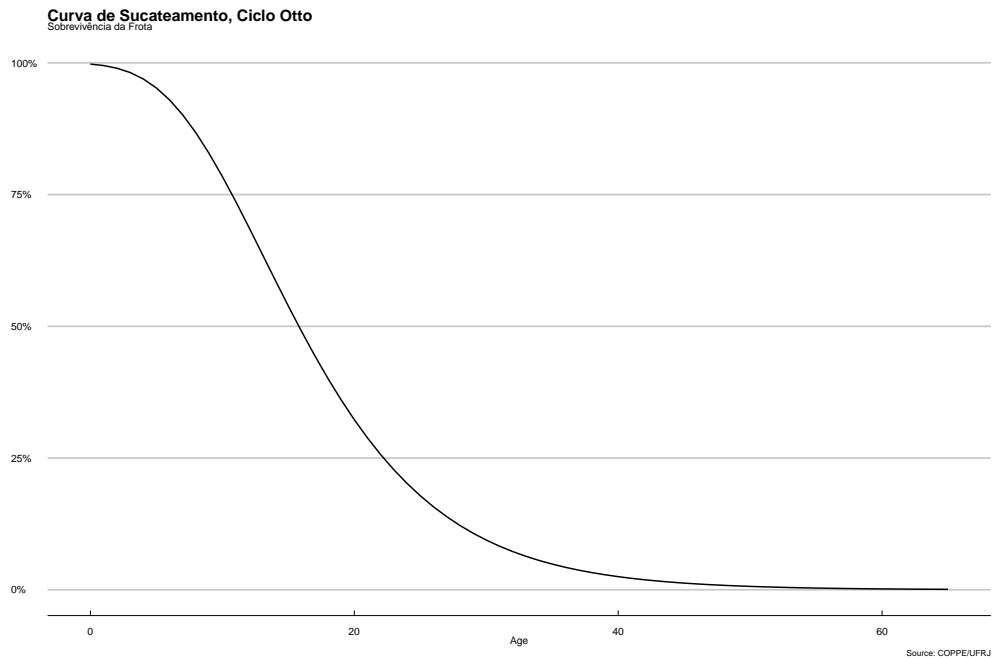
S_t follows the following formulations:

- ▶ Otto Cycle: $S(t) = e^{-e^{\alpha+\beta(a)}}$
- ▶ Diesel Cycle: $S(t) = \frac{1}{1+e^{\alpha(a-a_0)}} + \frac{1}{1+e^{\alpha(a+a_0)}}$

Constants: $\alpha = 1.798$ for automobiles; $\alpha = 0.17$ for light commercial vehicles with Diesel cycle; $\beta = -0.137$ for automobiles; $\beta = -0.141$ for light commercial vehicles (except those with Diesel cycle); $a_0 = 15.3$ for light commercial vehicles with Diesel cycle.

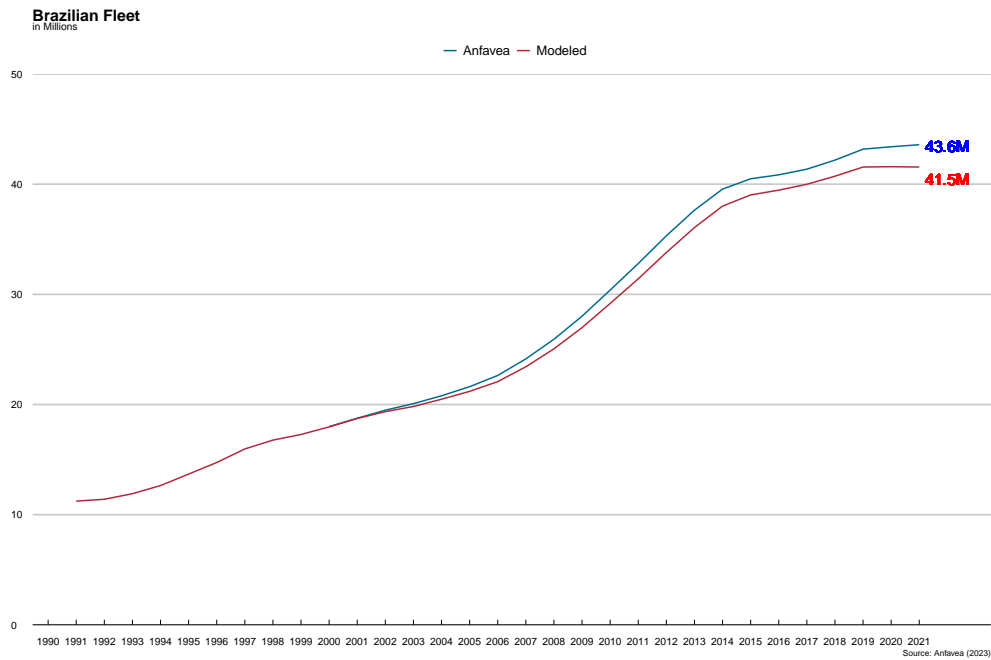
BRAZILIAN FLEET

SURVIVAL FUNCTION (SCRAPPING)



BRAZILIAN FLEET

MODELING



Part III

PROJECTIONS

ASSUMPTIONS

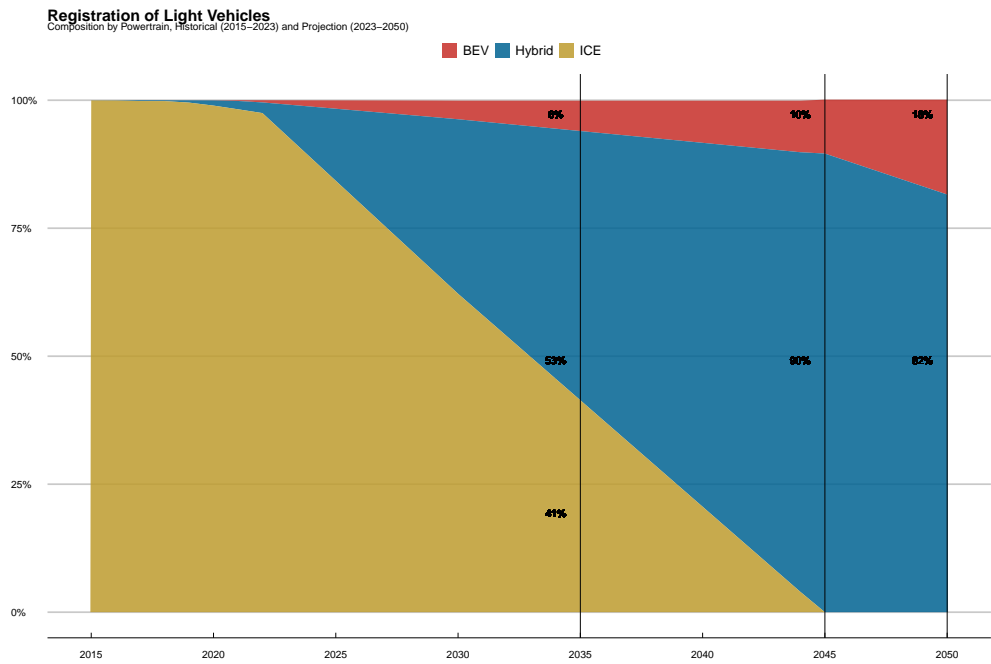
SCENARIOS

- ▶ Base Scenario: Follows the assumptions of the Climate Center of COPPE/UFRJ. Linear decline of ICE vehicle commercialization until the end of commercialization in 2045, making way for electric vehicles. Hybrids are initially favored until 2045 when BEV participation accelerates.
- ▶ Global Convergence Scenario: Similar to the base scenario but with accelerated BEV expansion in line with the penetration of this segment in major markets until the 2030s (adaptation of ANFAVEA/BCG studies).
- ▶ Biofuels Scenario: Based on EPE studies. Even with the entry of EVs in Brazil, the premise of biofuel resilience due to installed capacity and already widespread flex-fuel technology.

In all scenarios, the commercialization of gasoline-only vehicles ends in 2035.

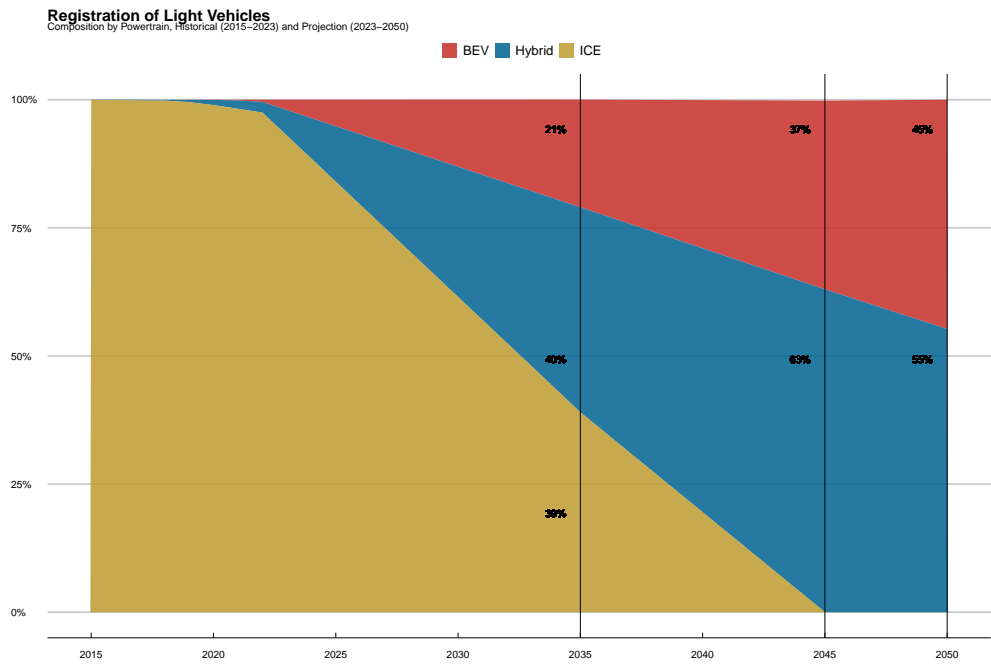
ASSUMPTIONS

BASE SCENARIO



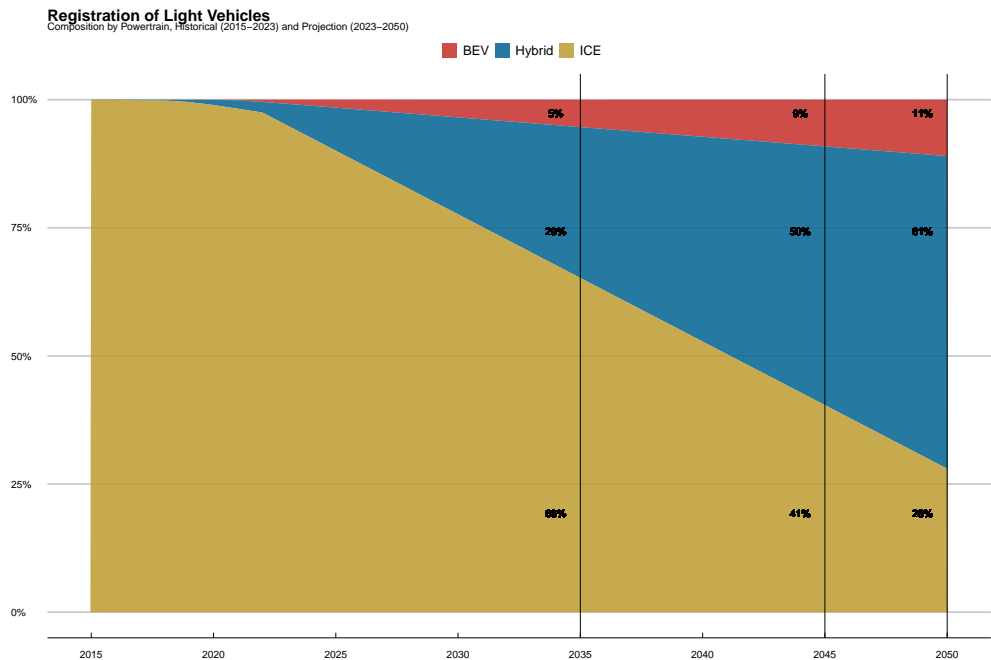
ASSUMPTIONS

GLOBAL CONVERGENCE SCENARIO



ASSUMPTIONS

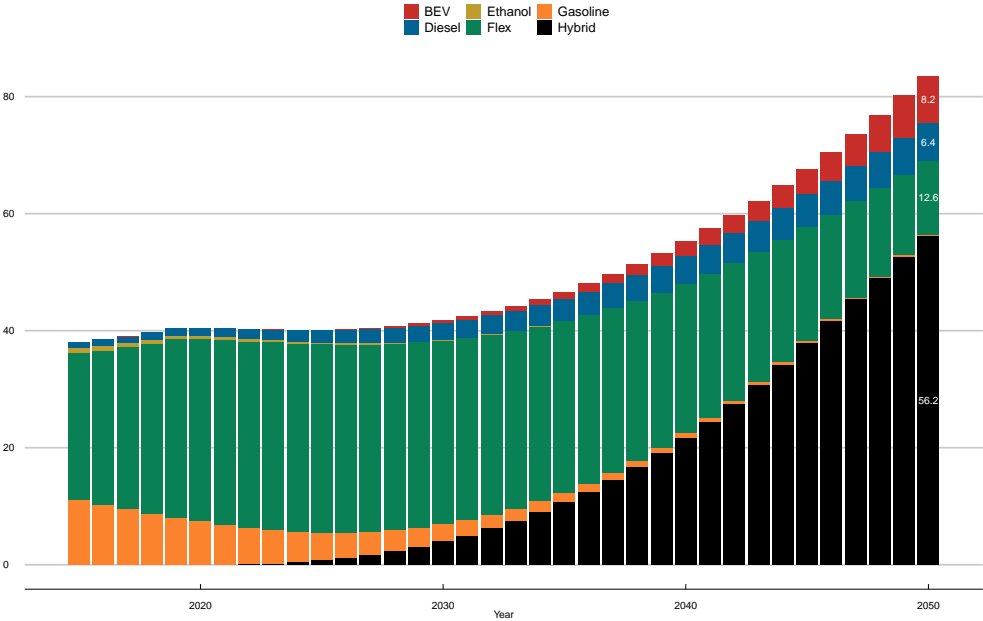
BIOFUELS SCENARIO



FLEET 2050

BASE SCENARIO

Fleet Composition, Base Scenario
Brazil, in Millions

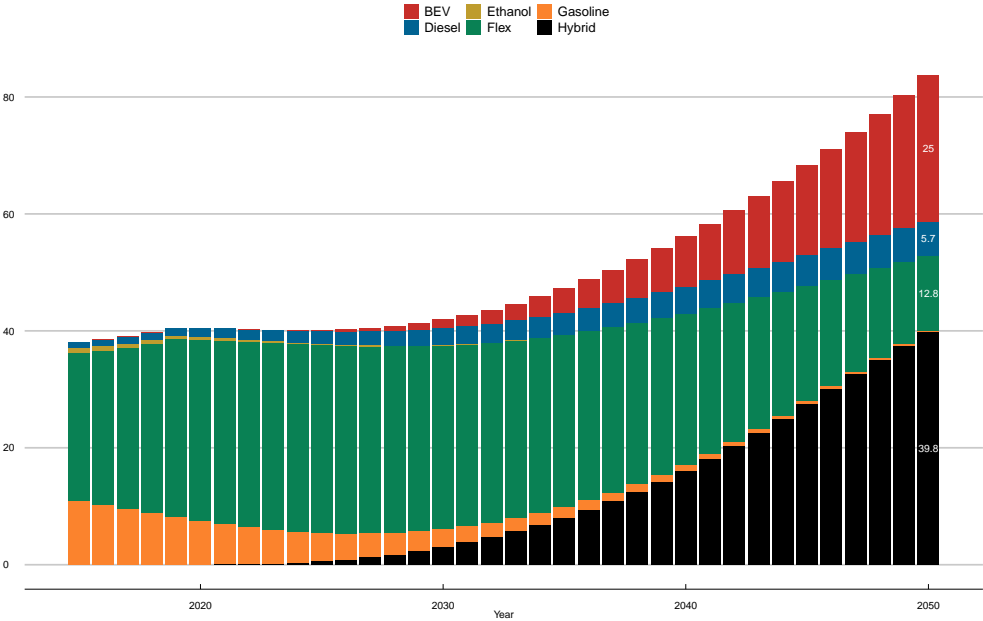


FLEET 2050

GLOBAL CONVERGENCE SCENARIO

Fleet Composition, Convergence Scenario

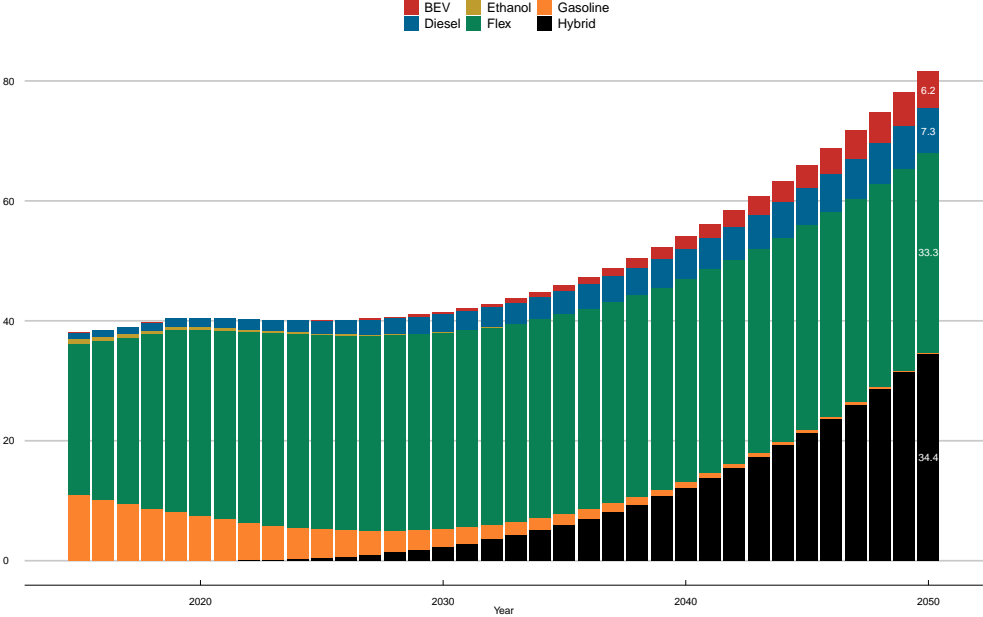
Brazil, in Millions



FLEET 2050

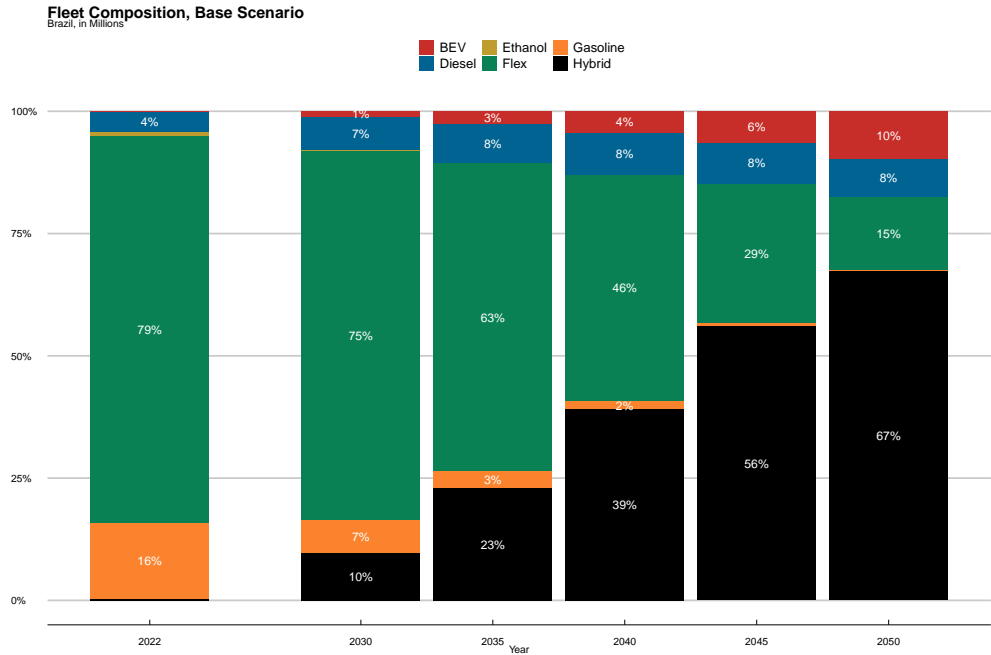
BIOFUELS SCENARIO

Fleet Composition, biofuels Scenario
Brazil, in Millions



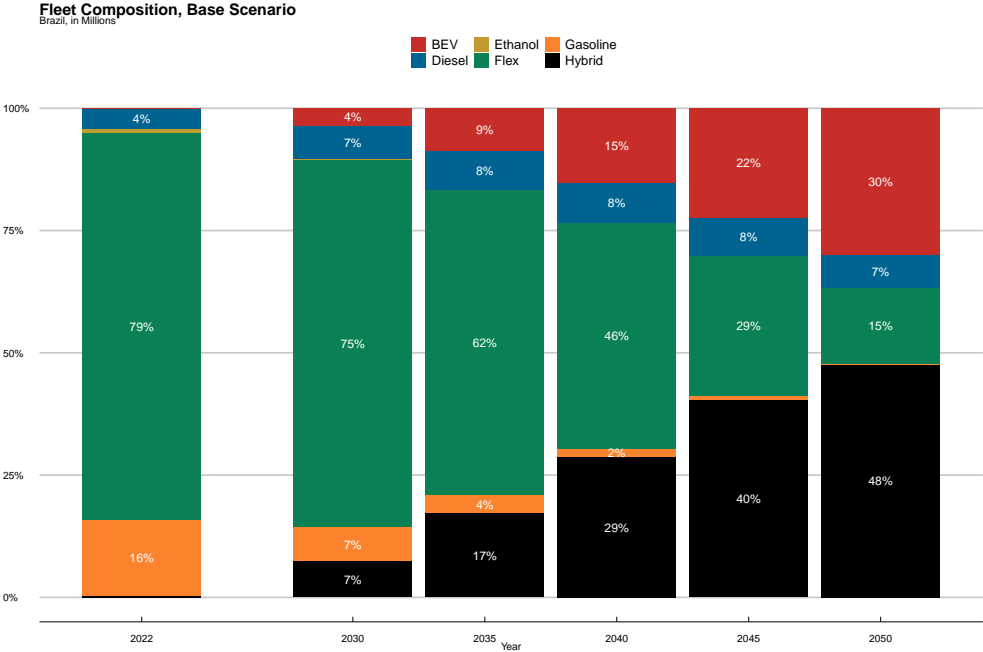
FLEET 2050

BASE SCENARIO, FLEET SHARE



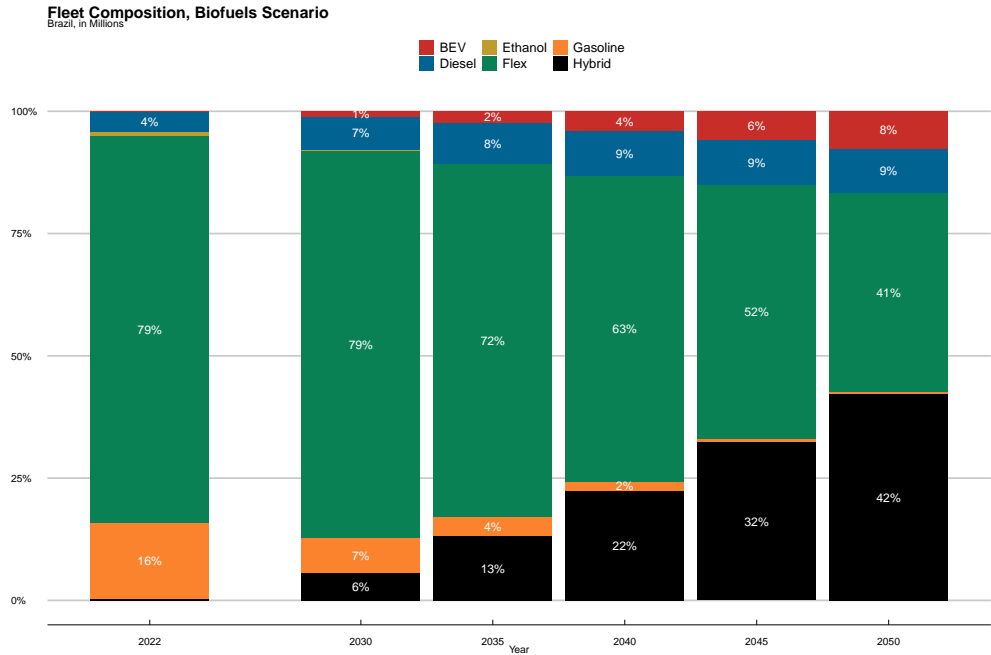
FLEET 2050

GLOBAL CONVERGENCE SCENARIO, FLEET SHARE



FLEET 2050

BIOFUELS SCENARIO, FLEET SHARE



CONCLUSION

- ▶ Fleet for 2050 is calculated at 81.5 million passenger and light commercial vehicles
- ▶ BEV Fleet is calculated between 6 million and 25 million depending on the scenario chosen.
- ▶ Fleet share in 2050 can vary between 8% and 30%, depending on policy choices favoring higher participation of biofuels or higher participation of electric vehicles.