

MAIN CONCLUSIONS

ROAD



TRANSPORT COALITION

HOW TO MAKE THE TRANSPORT SECTOR AN ACTIVE
CONTRIBUTOR TO THE REDUCTION OF BRAZILIAN EMISSIONS



CNT / SEST SENAT / ITL
— Sistema Transporte —





CONTEXT AND MOTIVATION

- Brazil's New National Determined Contribution (NDC) and Climate Plan **represent opportunities to position the country as a global decarbonization leader**, especially as it is the host of COP 30 in 2025.
- The transport sector is critical, accounting for **~11% of national gross emissions (260 Mton in 2023, well-to-wheel vision¹)**; **~93% of transport emissions come from the road mode**.
- Given the expected growth for the country, in an inaction scenario, the emissions of the road mode **can reach 398 Mton CO₂e in 2050**.



THE COALITION

- The magnitude of the challenge requires widespread engagement and debate by the transport sector.
- **Led by Motiva, CEBDS, CNT and Insper's Mobility Observatory**, the Coalition mobilized **+50 entities of 6 groups**: urban mobility, road, rail, coastal & inland navigation, airway and infrastructure cross-sectionality.



INITIAL OBJECTIVES

- The effort, started in Nov/2024, developed from the **active contribution of coalition entities and primary data** available until Feb/2025, materialized important deliveries, such as:
 1. Measurement of the emissions baseline in 2050²;
 2. Mapping of 90 decarbonization levers;
 3. Quantification of impacts for decarbonization path.

The conclusions of this study are the result of a collective effort in favor of sustainable decarbonization of the transport sector, based in the technologies and information currently available, and may evolve with new future advances.

1. Emissions from the transport sector calculated based on sources external to SEEG; 2. Baseline 2050 is a projection based on estimates of passenger and cargo growth and inertial vision of the fuel consumption matrix.

ROAD – MEMBER ENTITIES

This document was supported by the following entities from the road transport mode.

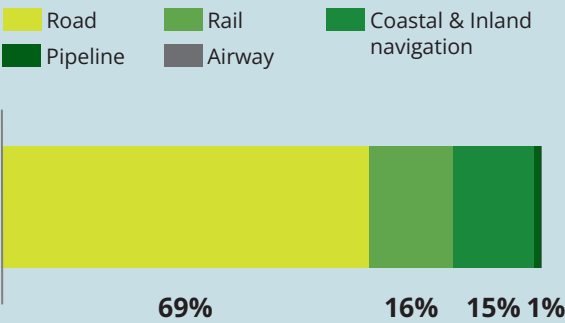


BRAZIL'S TRANSPORT MATRIX IS MAINLY ROAD-BASED

Trucks move ~70% of T-KM, and cars and buses carry over 90% of all passengers in the country.

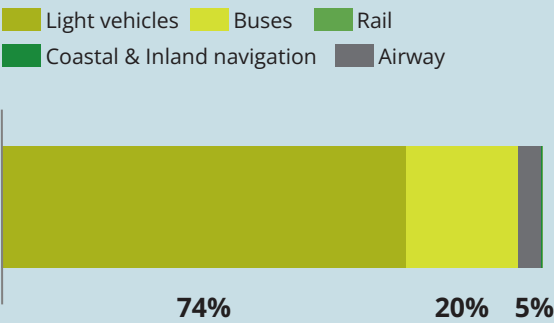
CARGO¹

Billion T-KM, baseline year 2023³

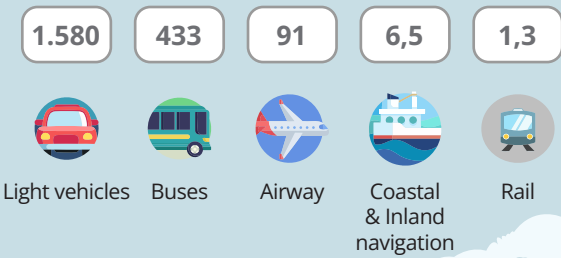
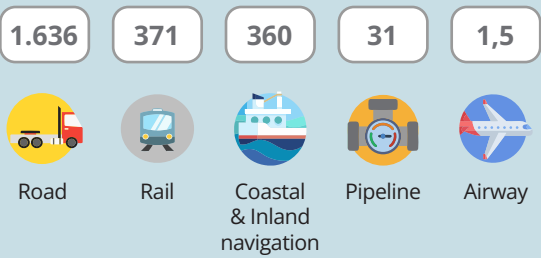


PASSENGERS²

Million PAX, baseline year 2023³



T-KM (B)



1. Road Sector Transport Plan (PSTR); Rail Sector Transport Plan (PSTF); 2. PNL 2035 – National Logistics Plan; 3. Baseline Year 2017 of the PNL projected to the respective CAGRs of the reference scenario. Note: Passengers reported in the PNL only contemplates intermunicipal and interstate routes, and do not consider passengers inside the urban centers. Sources: Infra S.A.; Ministry of Transport; Ministry of Infrastructure.



CONSEQUENTLY, THIS MODE IS EXTREMELY IMPORTANT FOR THE COUNTRY AND HAS SIGNIFICANT NUMBERS



CURRENT OVERVIEW

Relevant indicators help to understand the current state of the road mode

2023

1. Well-to-wheel vision

Road network

~1,7
million (Km)

Vehicle fleet

~48
millions

T-KM (trucks)

~1,7
trillion

PAX (buses and
light vehicles)

~2
billion (people)

Fuel
consumption

~120
billion (liters)

CO₂
emissions

~240¹
MtCO₂e

COMPARED TO OTHER COUNTRIES, BRAZIL'S CARGO MATRIX INDICATES AN OPPORTUNITY FOR BALANCING

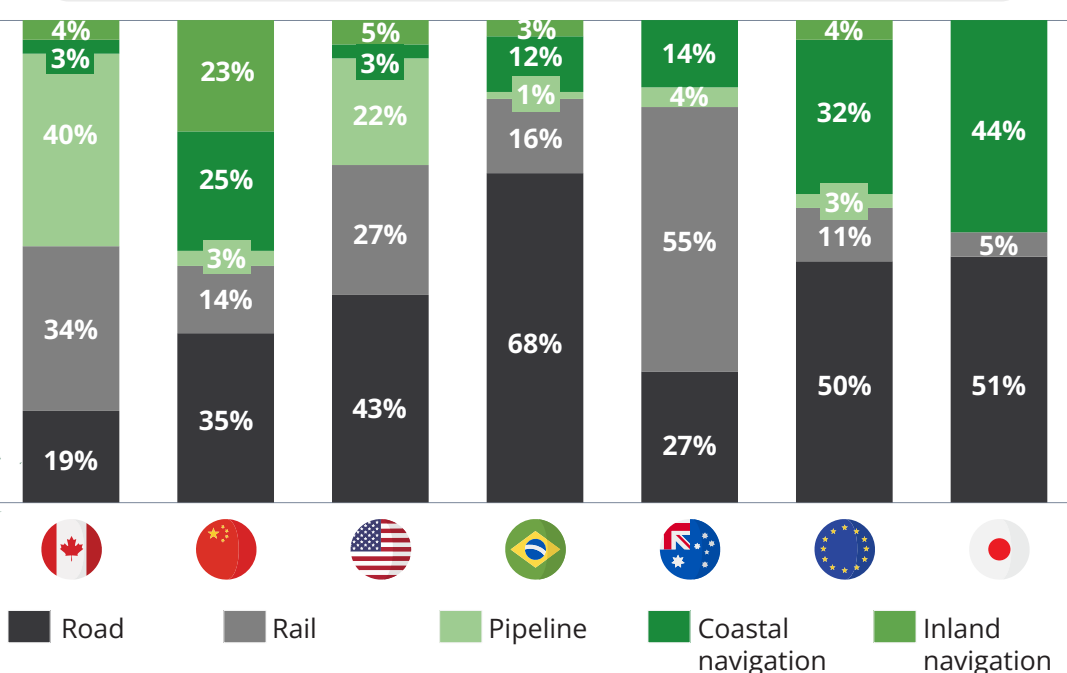
Comparison of Brazil's cargo transport matrix with other countries shows that the current matrix is predominantly road-based. In a continent-sized country like Brazil, there are clear opportunities to develop other modes such as rail and coastal & inland navigation, in addition to road transport.

(% of T-KM)

2023

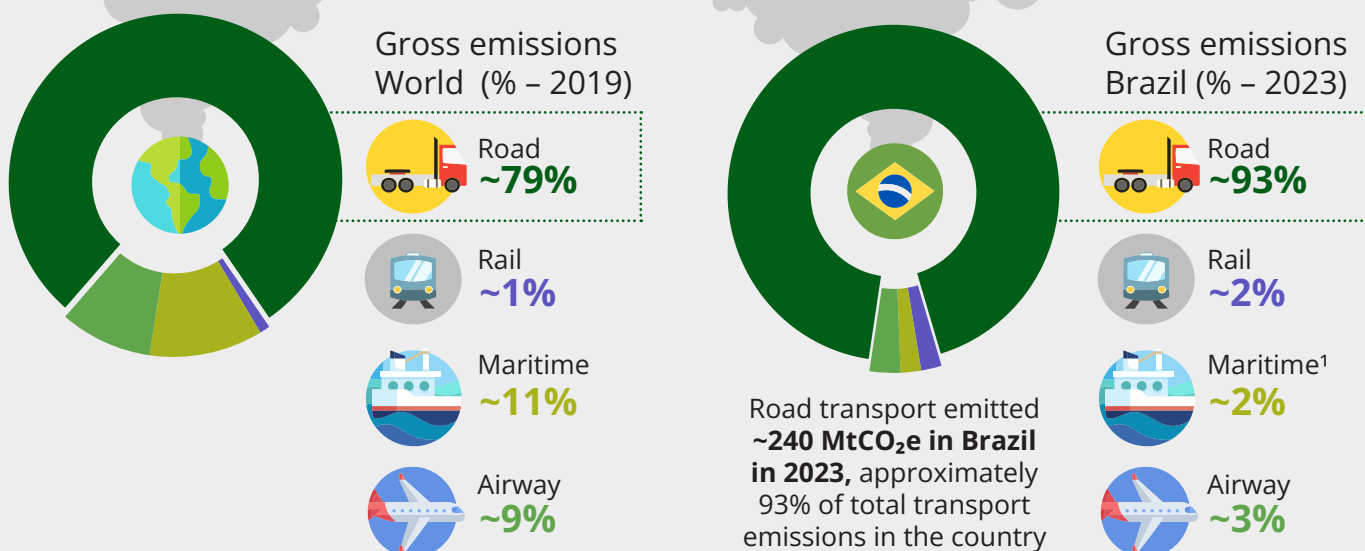


Territorial extension



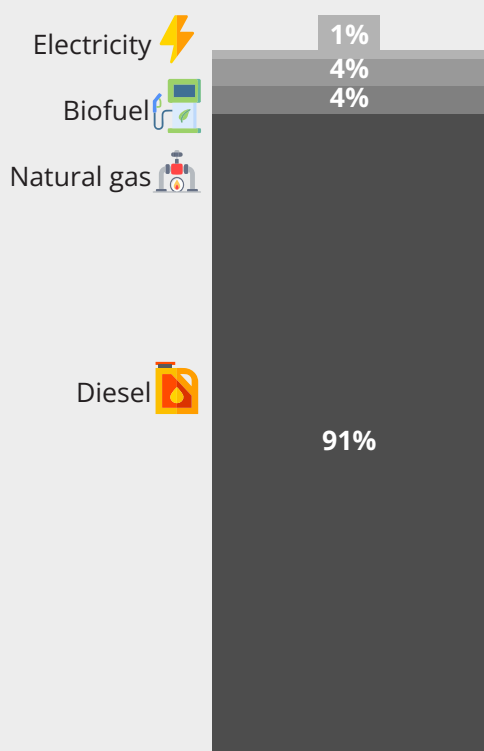
EVEN WITH ~70% SHARE IN BRAZIL (VS. ~40% GLOBALLY), THE ROAD MODE² EMITS LEVELS CLOSE TO THE GLOBAL SCENARIO: ~90% VS. ~80%

The higher concentration of road transport makes its emissions more prominent, despite of 22% of the country's transport energy matrix being generated from biofuels vs. only ~4% worldwide.

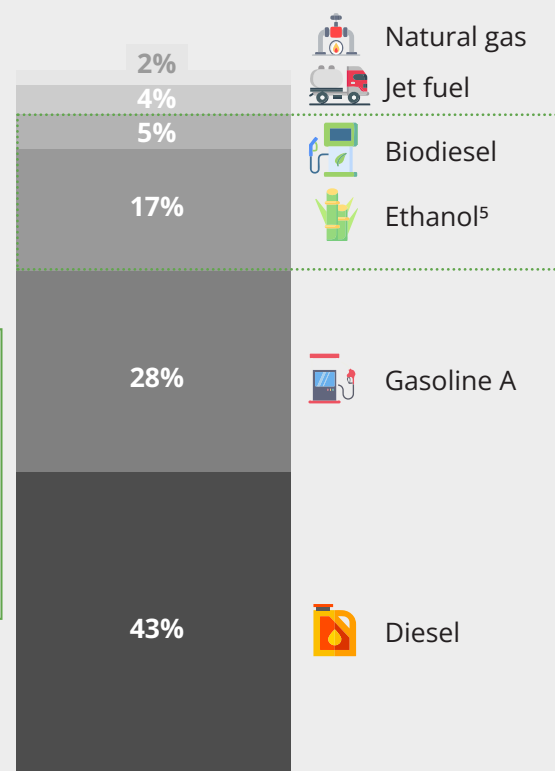


1. Considers coastal and inland navigation, without long-haul.

WORLD TRANSPORT ENERGY MATRIX (IEA⁴ 2023)



BRAZIL TRANSPORT ENERGY MATRIX (BEN³ 2024)



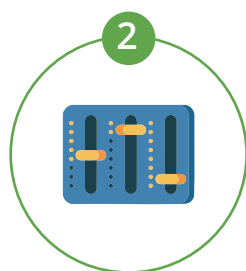
Ethanol emits **80% less CO₂** than gasoline A, and biodiesel emits **70% less** than fossil diesel (well-to-wheel vision).

2. Refers to road freight transport; 3. National Energy Balance 2024 – Summary Report, baseline year 2023; 4. Energy consumption in transport by fuel; 5. Includes anhydrous and hydrated ethanol; Source: EPE, MME, IEA.

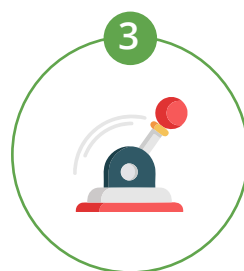
APPROACH | FOUR STEPS FOR DECARBONIZATION OF THE ROAD MODE



Definition of projections for the total emissions of the sector, **WITHOUT changes in the participation of different modes in the transport matrix;**



Definition of projections for the total emissions of the sector, **WITH changes in the participation of different modes in the transport matrix;**



Mapping levers for **reducing emissions applicable to the road mode;**



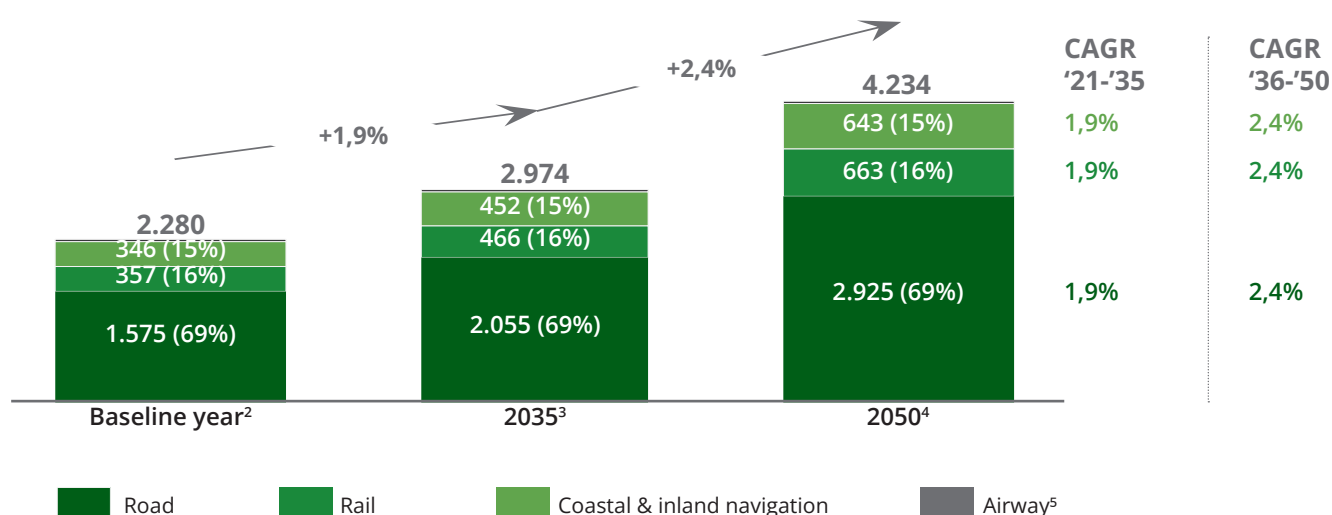
Proposition of possible **sensitivities based on levers mapped.**

1 DEFINITION OF BAU1 DE EMISSÕES WITHOUT CHANGES IN THE TRANSPORT MATRIX

In an inaction scenario, the total transport emissions would reach **~424 2050 Mton CO₂e in 2050**; in this context, the representativeness of the transport mode in the national transport matrix would remain unchanged (road would remain ~70%).

EVOLUTION OF THE CARGO¹ MATRIX (BILLIONS OF T-KM, %)

Inaction scenario



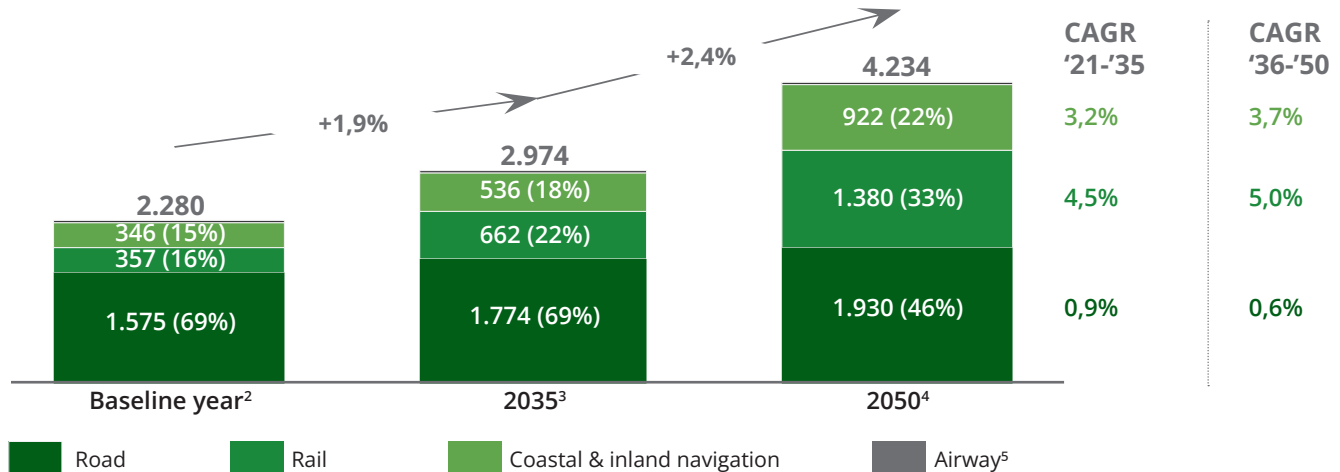
1. Projections based on the Sectoral Transport Plans (PSTR and PSTF) and the PNL 2035 – National Logistics Plan; 2. 2021 was the year the PNL/PSTF were carried out, in addition to presenting more comprehensive historical parameters; 3. T-KM values refer to scenario PSR1 from PSTR; 4. T-KM projected in line with GDP, with distribution of scenario PSR3 from PSTR; 5. Emissions from the airway mode are not related to cargo transportation, only to passenger transportation; Sources: Infra S.A.; Ministry of Transport; Ministry of Infrastructure.

2 PARTICIPATION OF RAIL AND COASTAL & INLAND NAVIGATION MODES COULD BE EXPANDED

In the second stage, an alternative scenario was explored in which the share of the rail in the transport matrix could be expanded, which would already be able to generate impacts of emission reduction due to the lower relative emission factor (gCO₂/T-KM) in this mode vs other more emitters.

EVOLUTION OF THE CARGO¹ MATRIX (BILLIONS OF T-KM, %)

With change in matrix

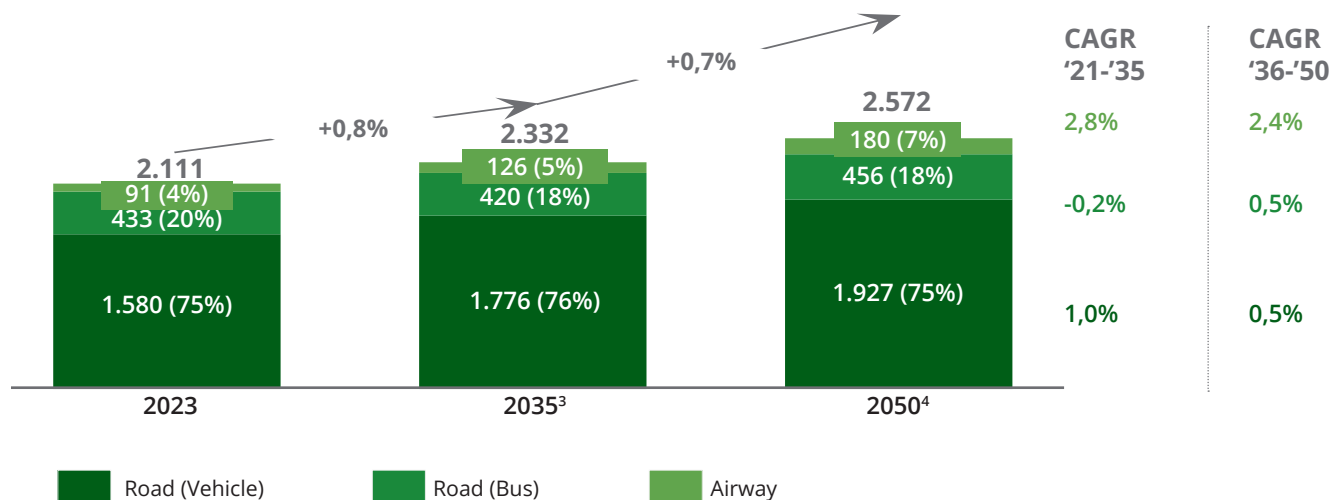


It is important to highlight that the **projected CAGR of 0,6% per year for road transport** reflects the **growth in T-KM demand** across the **1.7 million km** of the existing brazilian road network. However, **growth in the concession sector** is expected to be **higher, around 3%–4% per year** – currently, there are ~30 thousand km under concession.

Regarding passenger transport (chart below), sectoral plans and the PNL do not foresee changes in transport modes shares. The **road sector is expected to continue accounting for over 90% of total passenger transport**.

PASSENGERS¹ (PASSENGERS, %)

Millions of PAX, baseline year 2023



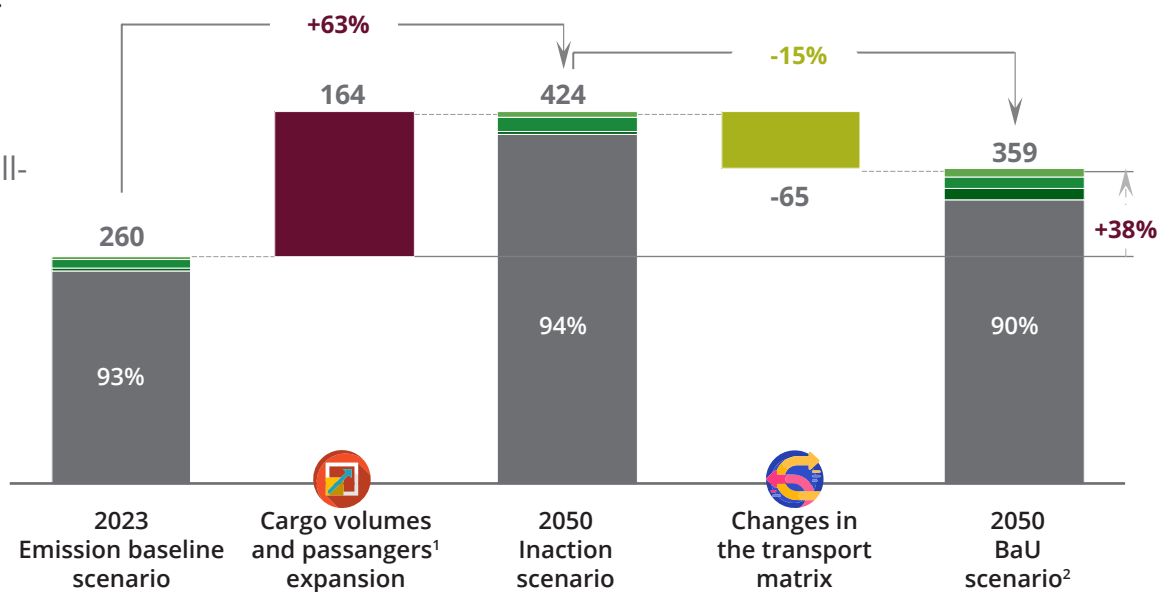
The numbers show that the demand for road passenger transport across Brazil's **entire network is expected to grow modestly**, with a projected CAGR of 0,5% per year. However, **roads under concession are expected to expand much more rapidly**, with a growth forecast of over 3% per year.

1. Projections based on the Sectoral Transport Plans (PSTR and PSTF) and the PNL 2035 – National Logistics Plan; 2. 2021 was the year the PNL/PSTF were carried out, in addition to presenting more comprehensive historical parameters; 3. T-KM values refer to scenario PSR1 from PSTR; 4. T-KM projected in line with GDP, with distribution of scenario PSR3 from PSTR; 5. Emissions from the airway mode are not related to cargo transportation, only to passenger transportation; Sources: Infra S.A.; Ministry of Transport; Ministry of Infrastructure.

In summary, the balance in the Brazilian transport matrix would mitigate about 15% (considering the change of matrix foreseen in the rail and coastal & inland navigation modes) of the expected volume of CO₂ emissions by 2050:

TRANSPORT SECTOR EMISSIONS

(Mton CO₂ – well-to-wheel vision – by mode)



T-KM (%)

	2023 Emission baseline scenario	Cargo volumes and passengers ¹ expansion	2050 Inaction scenario	Changes in the transport matrix	2050 BaU scenario ²
Road	69%	=	69%	⬆	46%
Rail	16%	=	16%	⬆	33%
Coastal & inland navigation	15%	=	15%	⬆	22%

Despite the reduction in its share of the matrix, road transport is projected to see an absolute freight demand growth of **+18% by 2050 (+150 billion T-KM)**.

■ Road ■ Rail ■ Airway³ ■ Coastal & inland navigation

1. Increased emissions due to expected growth in T-KM and passenger demand until 2050; 2. Business-as-usual; 3. Emissions from airway transport are not related to cargo transportation, only passenger transportation.

3 LEVER MAPPING FOR EMISSION REDUCTION

After the presentation of the transport matrix, levers with potential to reduce emissions in the road mode were identified by the working group.

Such levers were mapped into three large blocks as described below. For each of them, a qualitative feasibility analysis¹ was performed and local and global references were presented that illustrate the respective application.

Although there are different sources of emissions in the road transport chain, this document focused on levers with the potential to reduce emissions from the combustion of fuel by vehicles (well-to-wheel vision).

LEVERS BLOCKS FOR REDUCING EMISSIONS in road mode



EFFICIENCY



BIOFUELS



ELECTRIFICATION AND POWER-TO-X

1. The complete details of the viabilities and references can be found in the complete document of the road mode, which can be accessed via QR Code at the end of material.



EFFICIENCY

Levers	Vehicle application
1 Driver behavior optimization – short-term actions (e.g.: Increased use of telematics in fleets for driver guidance/training) and long-term actions (e.g.: Ongoing education).	  
2 Traffic flow technologies - reduce stop time on roads to lower average travel time and CO ₂ emissions (e.g., Free flow, HS-WIM).	  
3 Smart route and fleet optimization - use of technologies like IoT, Big Data, and Artificial Intelligence to improve freight transport routing and reduce emissions.	  
4 Vehicles conformity - ensure compliance with emissions standards – reduce circulating vehicles that do not meet these established standards.	  
5 Road pavement improvement - expand the granted road network via new auctions and public-private investments in the public road network.	  
6 Tire energy efficiency - encourage the use of more efficient tires, resulting in lower fuel consumption.	  
7 Modernization and accelerated fleet renewal - replace old vehicles with new, more efficient vehicles with better fuel consumption and lower CO ₂ /L emissions.	  



BIOFUELS

Levers	Vehicle application
1 Biodiesel – increase biodiesel blend in fossil diesel - currently blended at 14%, target should achieve 20% by 2030 and 25% from 2031 onward.	  
2 Green Diesel – enable alternatives like HVO and others - viability and potential are currently being studied by CNPE.	  
3 Biomethane – increase biomethane blend in vehicle gas - 1% target should come into effect in 2026 and could reach up to 10%.	  
4 Ethanol – increase ethanol blend in gasoline A - currently between 22% and 27%, there is potential to reach 35%.	  
5 Pump preference – encourage ethanol fueling - currently 80% of the fleet is flex, but the preference for ethanol at the pump is less than 30%.	  

Potential intensification of biofuels to reduce the carbon footprint can be applied provided that: the technical, mechanical, operational and laboratory viability of the said energy input is verified, as well as respecting the diversity of matrices and regional specificities



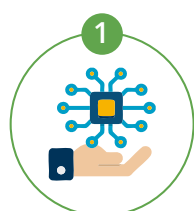
ELECTRIFICATION & POWER-TO-X

Levers	Vehicle application
1 Hybrids – increase electrification - reduce dependence on fossil fuels through the use of hybrid vehicles (e.g.: PHEV, HEV, MHEV).	
2 Fully electric vehicles (BEV) – expand the share of 100% electric vehicles in the fleet - a clean energy source for recharging is a critical element.	
3 Fuel cell electric vehicles (Hydrogen) – expand H₂-powered vehicle alternatives through electrolysis - leading to energy production with lower CO ₂ emissions.	

Levers can be applied since the technical and operational viability of the respective solutions are verified.

4 PROPOSITION OF SENSITIVITIES BASED ON THE MAPPED LEVERS

Finally, sensitivities were proposed to evaluate the impact of different decarbonization paths:



Current technologies

Restricted to the application of efficiency levers and compliance with regulatory requirements;



Intensification of biofuels

Predominance of the application of levers for intensification of the use of biofuels;



Acceleration of Electrification / Power-to-X

Predominance of electrification/power-to-x levers of the vehicles fleet;



Transformational

Combination of efforts considering the levers of sensitivities 1, 2 and 3 for closer reach of zero net emissions.

For the purposes of this material, we will only analyze the impact range between the most conservative (1) and the most ambitious (4) sensitivities — the detailed breakdown of the other sensitivities can be found in the full document, accessible via the QR Code at the end of this material.

Sensitivities varied some critical assumptions regarding the blending of biofuels in fossil fuels, preference for ethanol at the pump vs. gasoline C, as well as the acceleration of the electrification of the light and heavy vehicle fleet.



CURRENT TECHNOLOGIES

Increase in the share of biofuels in current fuels.

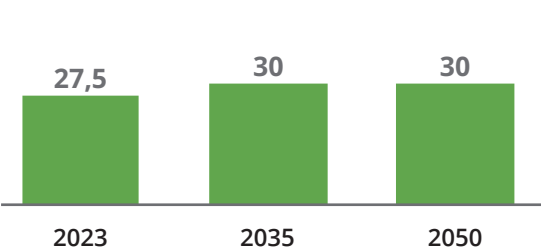
Key sensitivity variables

Pump preference for ethanol¹ (%)
 - Recover to 35% level (vs. 26% in 2023).



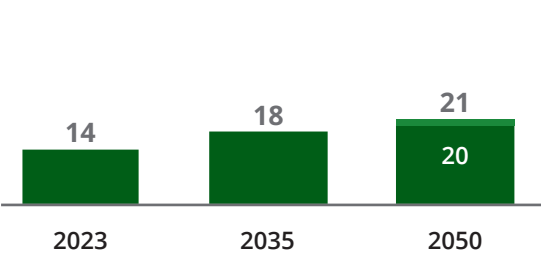
LIGHT VEHICLES

% of Ethanol in the blend with gasoline

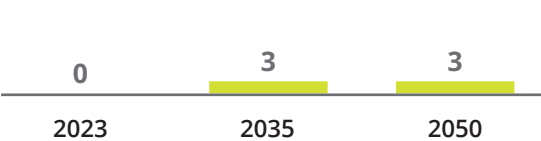


HEAVY VEHICLES

% of Biofuels in the blend with diesel



% of biomethane in the blend with vehicle gas



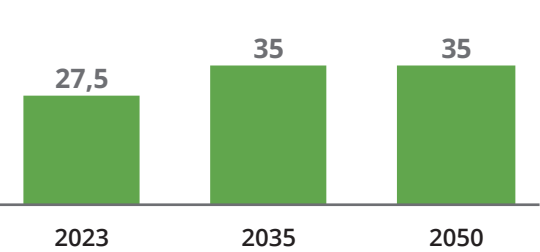
BIOFUELS INTENSIFICATION

Development of new technologies enabling broader use of biofuels.

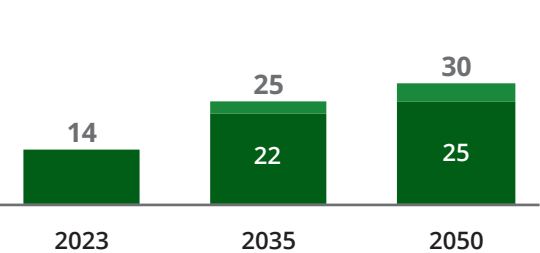
Key sensitivity variables

Pump preference for ethanol¹ (%)
 - Assumes flex-fuel vehicles always refuel with ethanol.

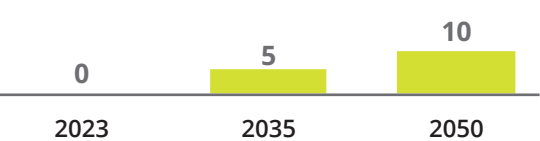
% of Ethanol in the blend with gasoline



% of Biofuels in the blend with diesel



% of biomethane in the blend with vehicle gas



Ethanol
 Biodiesel
 Green diesel
 Biomethane



CURRENT TECHNOLOGIES

Gradual growth in the adoption of new engine technologies.



ELECTRIFICATION ACCELERATION

Rapid convergence toward fleet electrification, with BEVs taking over in sales.

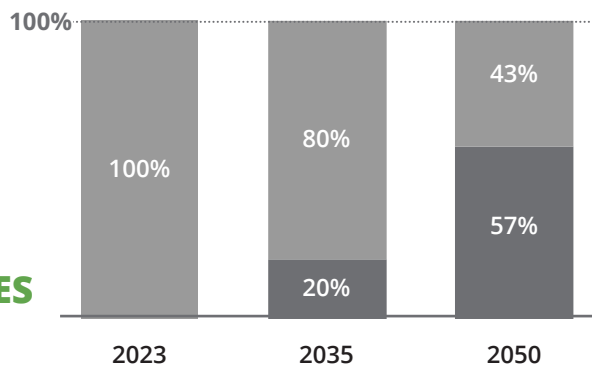
Key sensitivity variables

Fleet mix (%)

– Maintaining the sales mix from 2040 to 2050.



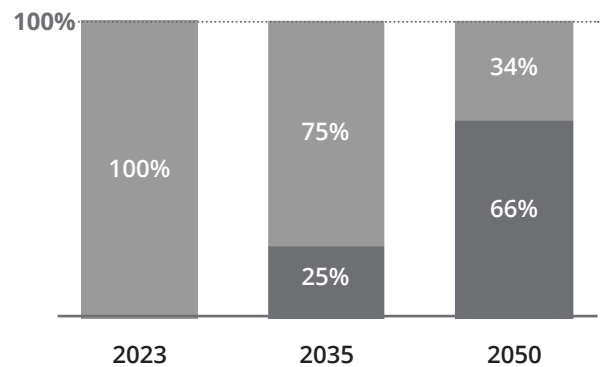
LIGHT VEHICLES



Key sensitivity variables

Fleet mix (%)

– All vehicles sold are BEVs from 2040 to 2050.

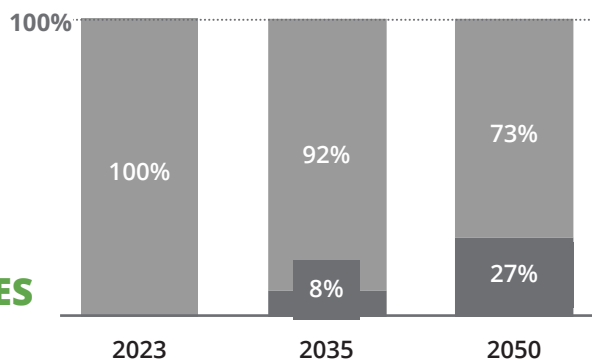


Fleet mix (%)

– Maintaining the sales mix from 2040 to 2050.

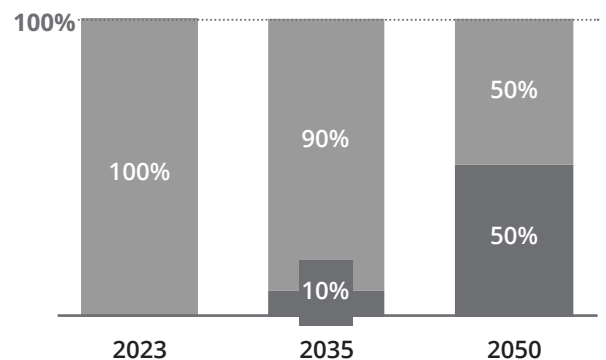


HEAVY VEHICLES



Fleet mix (%)

– All vehicles sold are BEVs from 2040 to 2050.

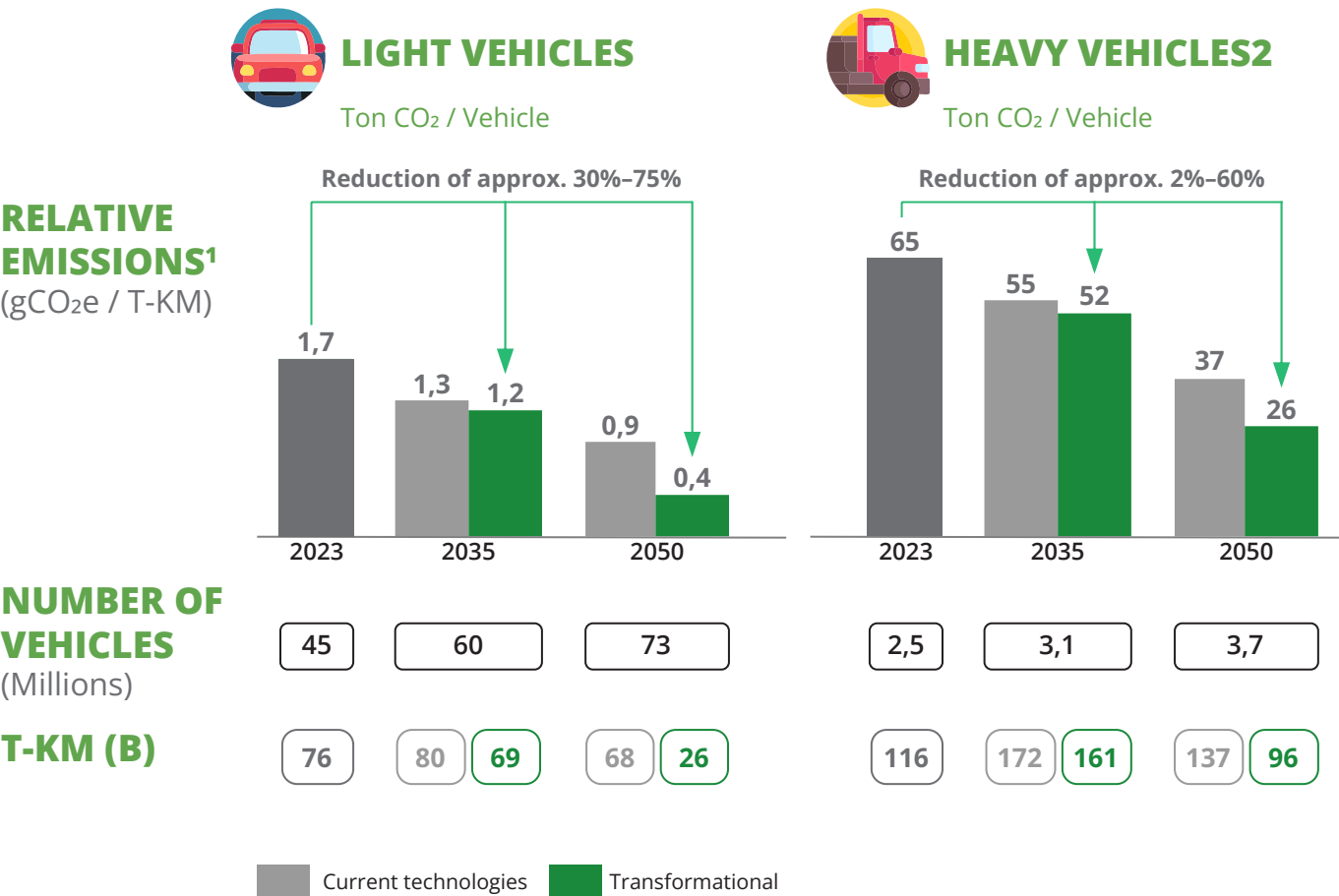
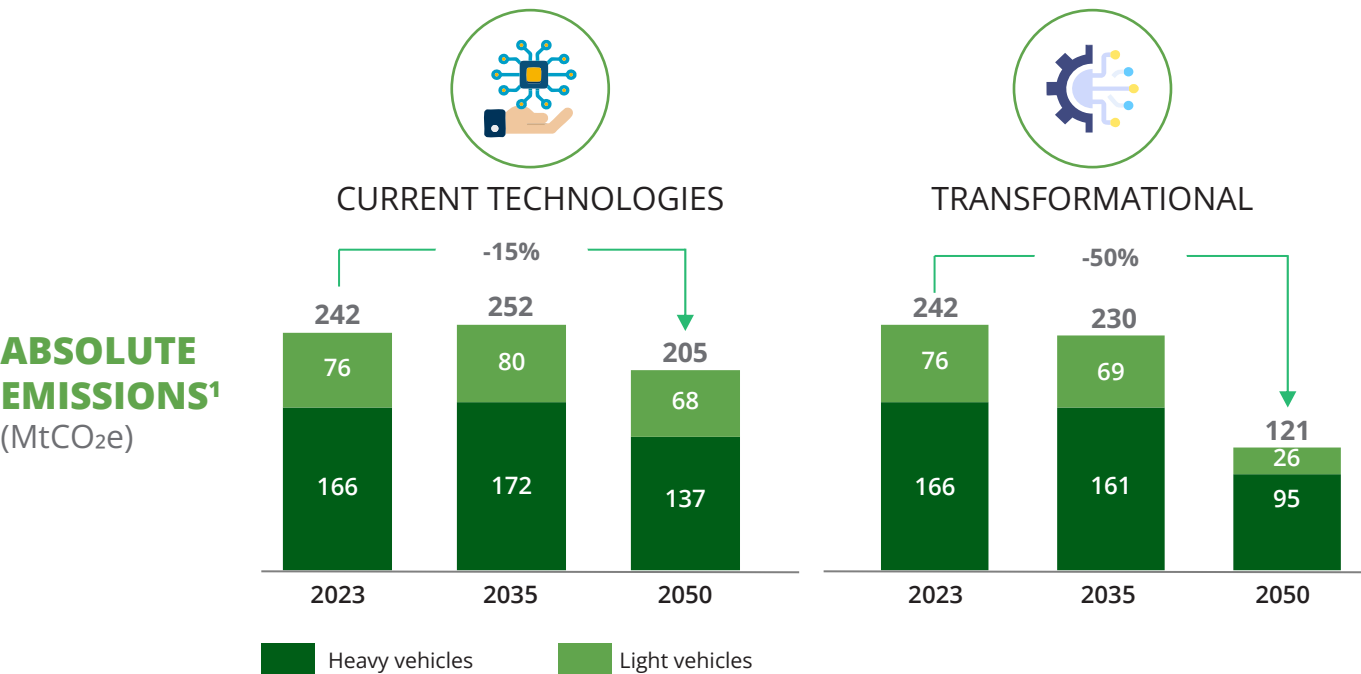


ICE (Internal Combustion Engine Vehicles).

NEVs (Vehicles with new energy powertrains (e.g., BEV, PHEV)).

RESULTS OF SENSITIVITIES ON EMISSION IMPACT

As a result of the implementation of the mapped levers, road transport emissions could reach **121 MtCO₂e** (a **50% reduction compared to 242 MtCO₂e in 2023**). Additionally, relative emissions (Ton CO₂/vehicle) could be reduced **by up to 60% in heavy vehicles and 75% in light vehicles**.



1. Emission factors consider the WTW (well-to-wheel) vision.



EXAMPLES ILLUSTRATE HOW ENABLERS HELP THE APPLICATION OF DECARBONIZATION LEVERS

PUBLIC AND PRIVATE INCENTIVES TO ENABLE EMISSIONS REDUCTION IN ROAD INFRASTRUCTURE

Concessions Law¹

Allows private entities to operate highways by making structural investments in the modernization and improvement of road pavement and traffic flow technologies (e.g., Free Flow, HW-WIM), reducing emissions.

Incentives for concrete corporate sustainability commitments

ANTT's Sustainability Program² offers regulatory benefits to companies, conditional on sustainability initiatives.

Public investments in road infrastructure modernization

Commitment to invest €2.3B by 2030 in the modernization and construction of transport infrastructure, including roads.

PUBLIC AND PRIVATE MECHANISMS TO ENABLE ELECTRIFICATION

Regulation to support electrification infrastructure and recharging availability

Regulatory packages and commitments boosting electrification, such as Euro VI/ VII, the EU Green Deal, Fit for 55, and the ICE³ ban by 2035.

Tangible mechanisms to increase the attractiveness of electric and hybrid vehicle adoption

US\$ 1B in subsidies for local manufacturers⁴ investing in domestic production of EV batteries⁵, strengthening supply chain safety.

Concrete investment moves from the private sector toward electrification

Private investments⁶ in electric chargers in Brazil, contributing to infrastructure readiness.

1. Law no 8.987/1995; 2. ANTT Resolution 6.057 (2024); 3. ICE = Internal Combustion Engine (vehicles powered by fossil combustion); 4. Toyota and Honda; 5. Electric = electric vehicles; 6. Volvo; Sources: Gov.br; ANTT; European Commission; Época Business; Volvo Trucks; Brazil Agency.

**PUBLIC AND PRIVATE
MECHANISMS TO ENABLE
THE EXPANSION OF
BIOFUEL PRODUCTION
AND ITS USE IN THE
ENERGY MATRIX**

Regulation that encourages expansion of biofuel production/use, ensuring quality and preserving performance

"Combustível do Futuro" and "RenovaBio" programs aim to expand the production and use of biofuels, contributing to increase participation of cleaner fuels in the matrix. 

Stricter specifications, such as ANP Resolution 920/2023 for biodiesel, and tests executions, both combined with concrete mechanisms to ensure compliance with quality criteria (e.g. 2BSVS¹ from EU) will be essential to enable the advancement of biofuels while preserving engine performance.  

Tangible mechanisms to encourage private financing for R&D²

"MOVER" program offers tax incentives to automotive players investing at least 0,5% of revenue per year in R&D².

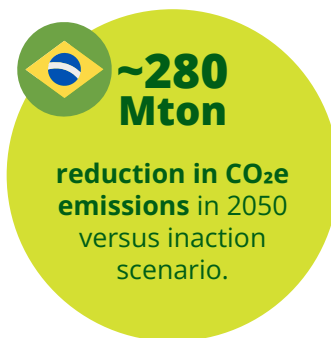
Concrete private sector investment movements in favor of development of cleaner fuels

Agreements for joint exploration³ of the production, purchase and sale of biomethane, a clean fuel with applicability in the road transport mode.

Note: The use of biodiesel blended into diesel requires adjustments in the production chain and assurance of product quality, in addition to technical and economic feasibility analyses; 1. Biomass Biofuels Sustainability voluntary scheme: a scheme recognized by the EU that ensures, through independent audits, the compliance of biofuels with the criteria of the Renewable Energy Directive (REDII); 2. Research and Development; 3. Petrobras and Raizen; Source: Gov.br; ANTT; European Commission website; Brazil Agency; Petrobras.

WE AIM FOR SUSTAINABLE GROWTH FOR THE ROAD MODE

Mapped decarbonization levers have the potential to reduce up to **~280 million tons of CO₂e from road transport by 2050**, depending on decarbonization efforts. This reduction is greater than the current volume of emissions from the transport mode, however the growth of the country and consequently of the road transport magnifies the challenge of achieving scenarios of net zero emissions.



Conclusions sought by the work toward the road mode in Brazil in 2050:

CURRENT ROAD¹



~1,6 TRILLION T-KM

transported annually by road mode in Brazil.



~25 BI LITERS OF ETHANOL

used by light vehicles in both hydrated and anhydrous forms.



~8 BI LITERS OF RENEWABLE DIESEL

used by heavy vehicles in the form of biodiesel³.



~200 THOUSAND M³/DAY OF CNG

consumed as vehicular gas for heavy fleets.



<1% OF THE FLEET POWERED BY H₂

operating with Power-to-X (PtX) solutions.



<1% OF THE FLEET ARE xEVs

in circulation in Brazil, including light and heavy electric vehicles.



~200 GWH/YEAR

supplied for charging 100% electric and plug-in hybrid vehicles.

FUTURE ROAD²



~1,9 TRILLION T-KM

transported, an increase of +18% vs '23 (0,8% per year 2024–2050).



+40 BI LITERS OF ETHANOL

required to fuel light vehicles with hydrated ethanol.



+10 BI LITERS OF RENEWABLE DIESEL

needed for heavy vehicles, including biodiesel³ and green diesel³.



~8 MILLION M³/DAY OF CNG

demand, with 10% biomethane³ in its composition.



+230 THOUSAND TONS/YEAR OF H₂

applied as a solution for the operation of heavy-duty fleets.



+40% OF THE xEV FLEET

in circulation, with ~40% of the heavy-duty fleet and +50% of the light fleet electrified.



+170 THOUSAND GWH/YEAR

required for charging BEV and PHEV light and heavy vehicles.

1. 2023; 2. 2050 Transformational; 3. Intensification of the use of biofuels should be encouraged provided that: technical, mechanical, operational and laboratory feasibility of the referred energy input is verified, as well as the diversity of matrices and regional specificities are respected

ROAD MODE

Scan the QR Code to access the full document

