

The Energy Matrix of the Transport Sector

**INTERNATIONAL SEMINAR
Transport Technologies
<< Energy Policy Scenarios to 2050 >>**

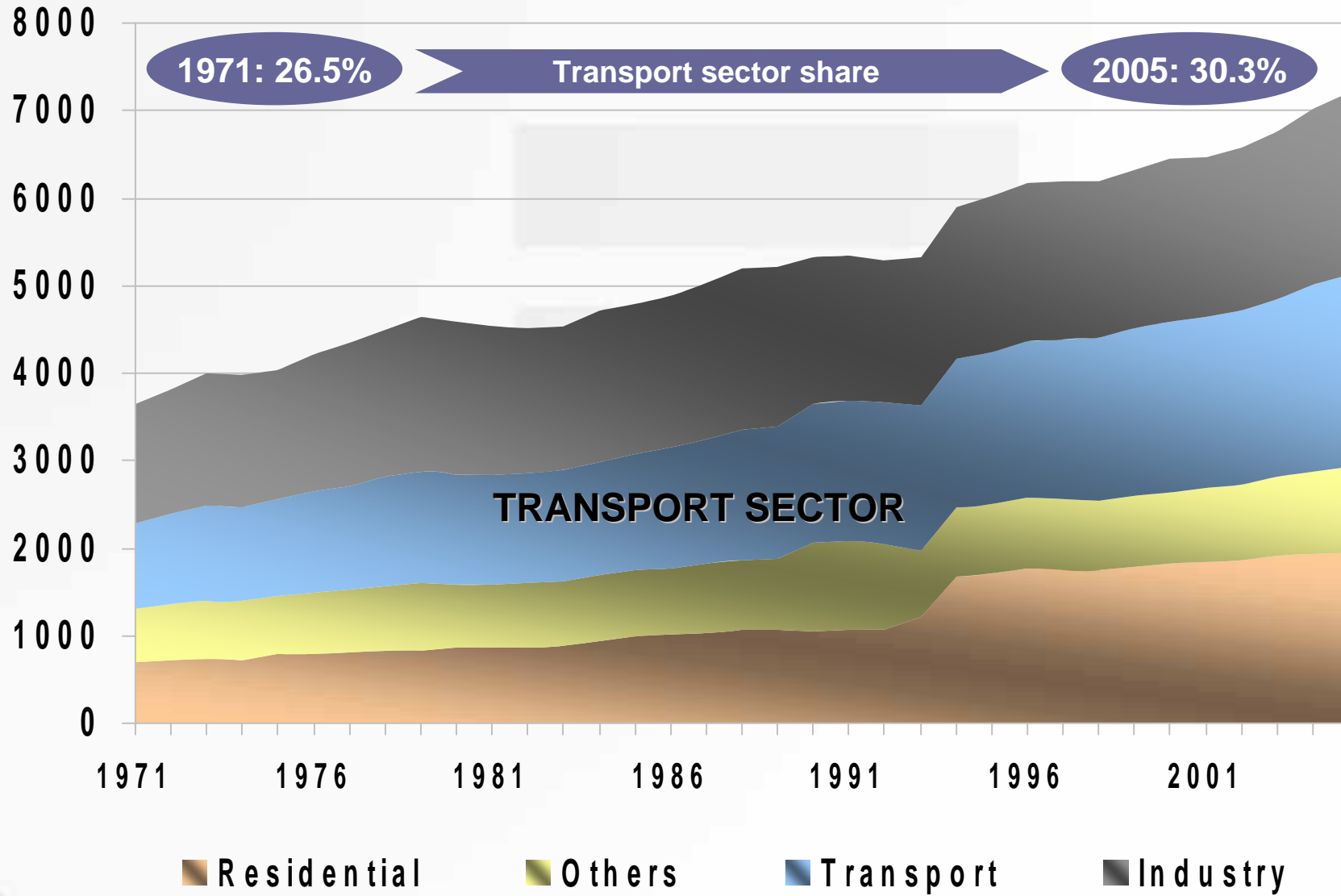


World Energy Council
CONSEIL MONDIAL DE L'ENERGIE

Conselho Mundial da Energia
Comitê Brasileiro

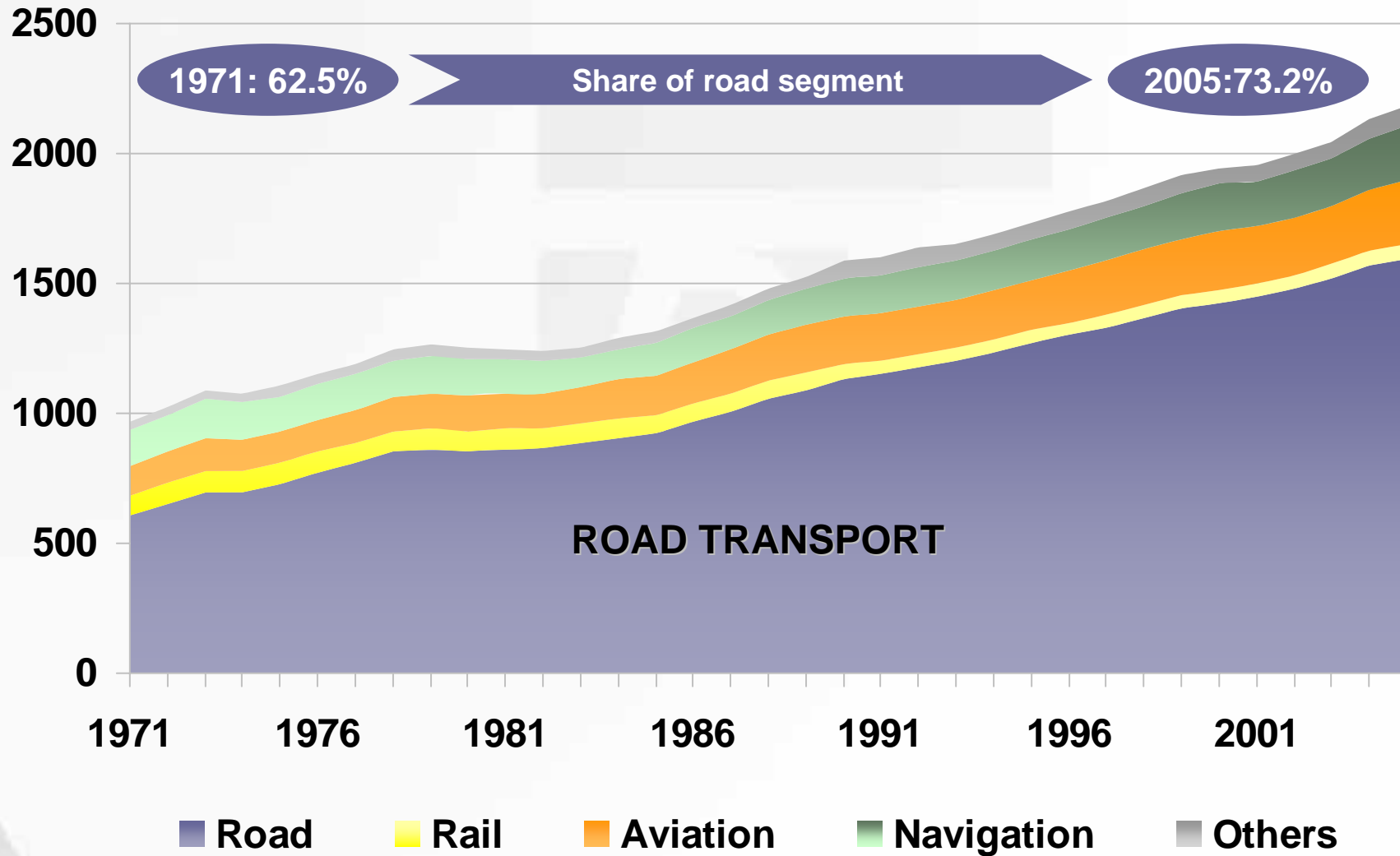
Over the last few decades, the transport sector has become the most important one in the final consumption of energy

Worldwide final consumption of energy per sector*
(10⁶ tep)



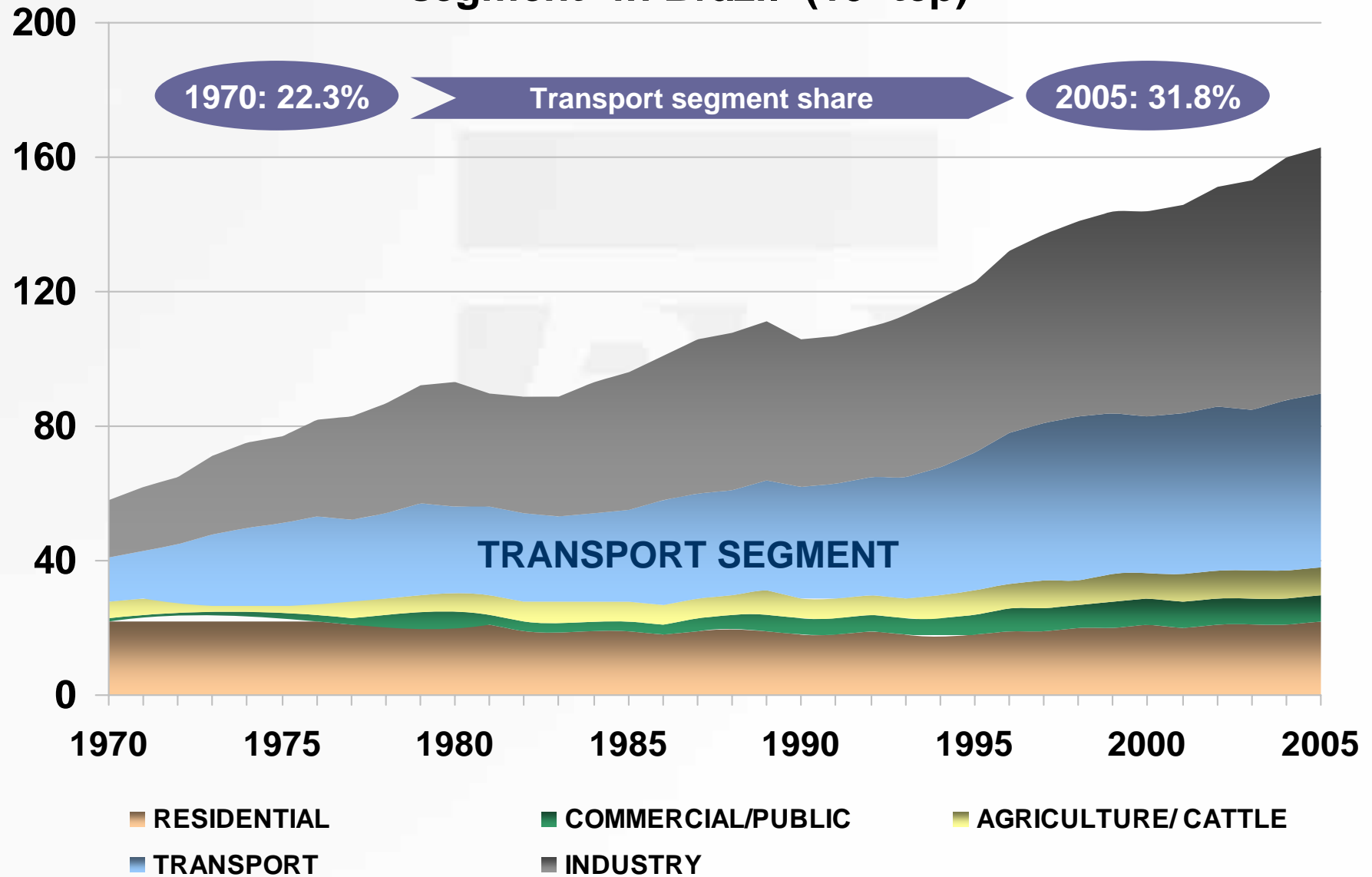
Within the transport sector, road is the dominant mode

Worldwide final consumption of energy in the transport sector per segment (10⁶ tep)

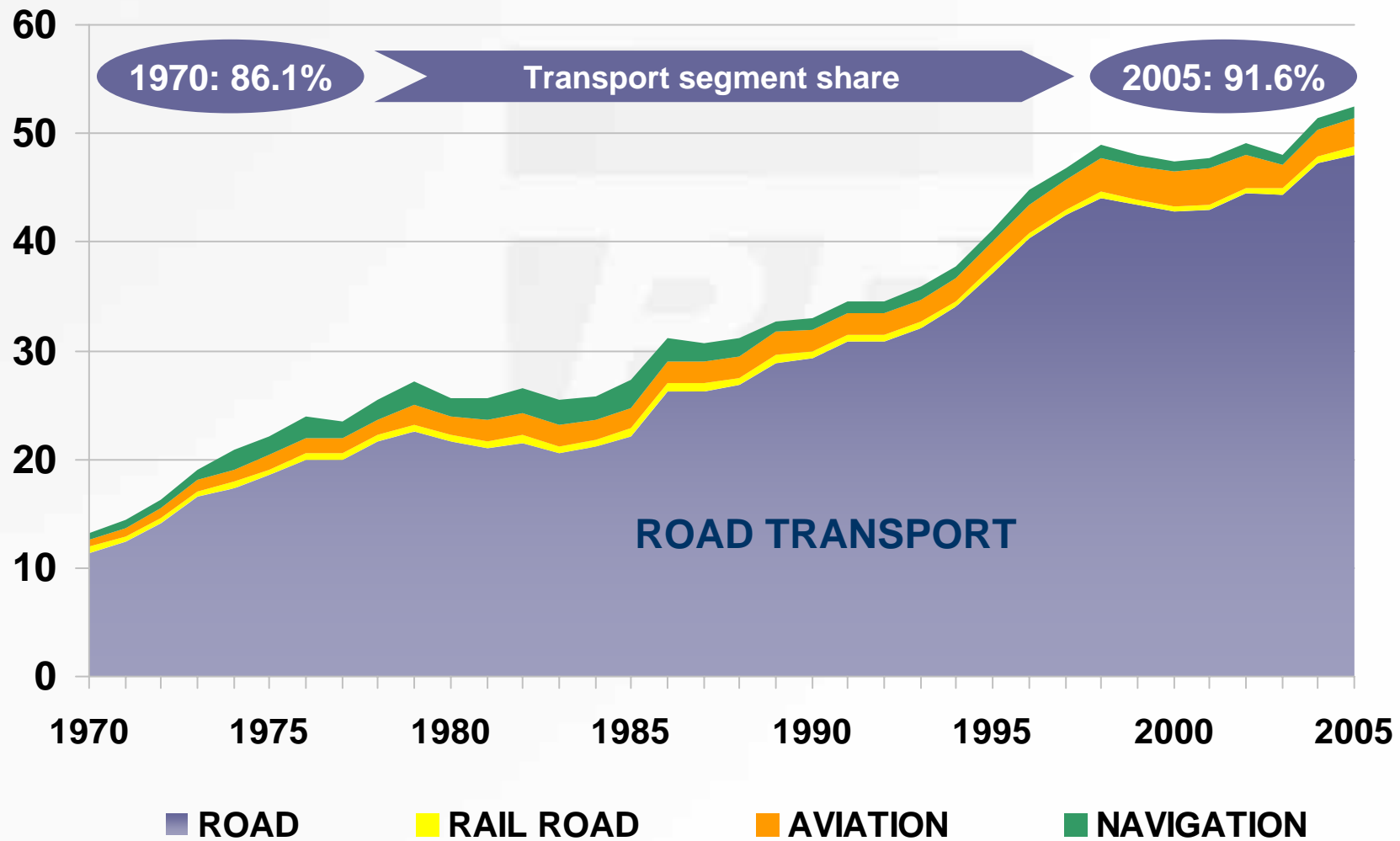


The transport sector has been boosting its participation in final energy consumption in Brazil

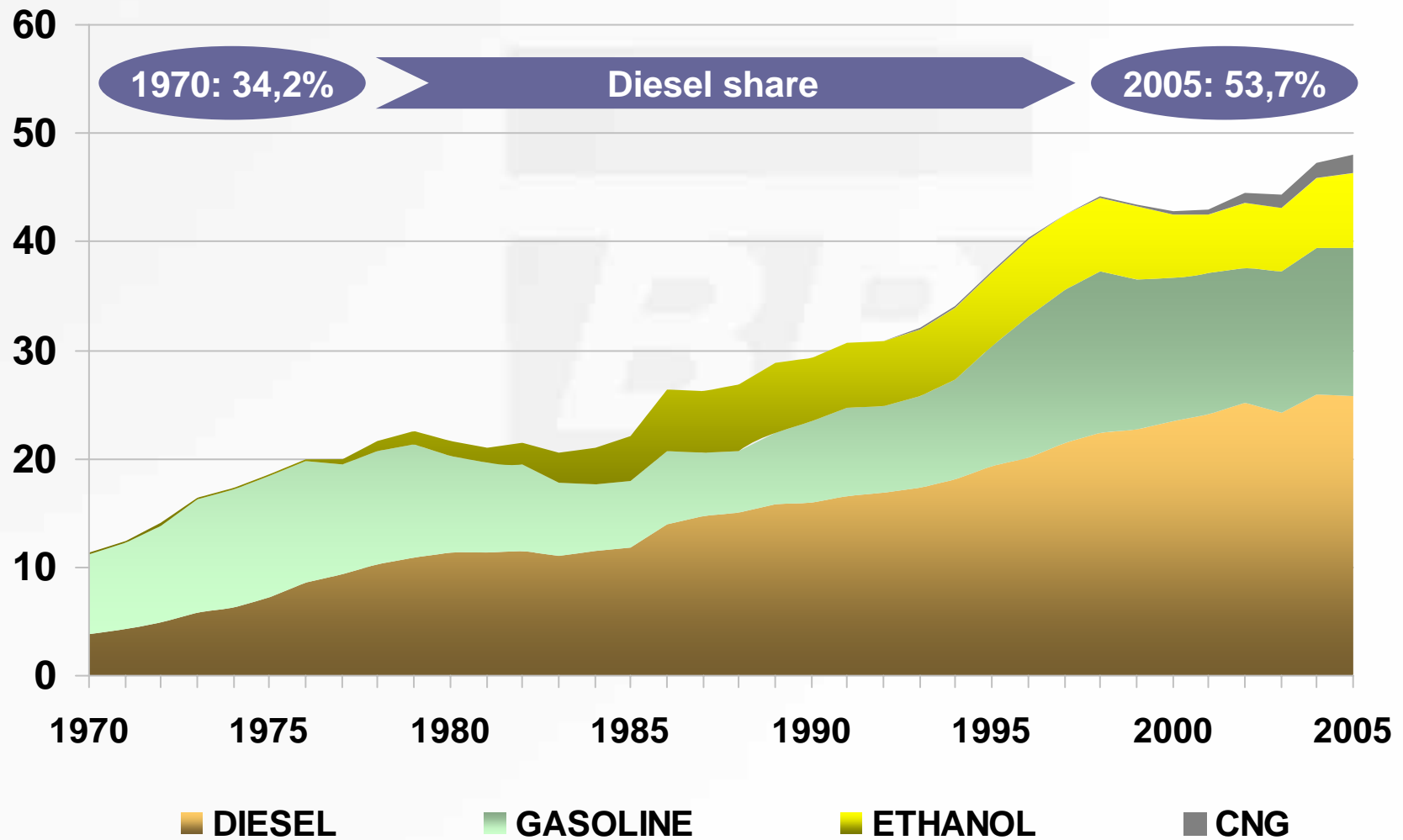
Evolution of the final energy consumption by segment* in Brazil (10^6 tep)



Evolution of the energy final consumption in the transport segment in Brazil (10^6 tep)



Evolution of the automotive fuel final consumption in Brazil (10⁶ tep)



- **Predetermined elements :**

- Strong flex-fuel vehicle penetration in sales and in the Brazilian fleet;
- Sustained sugarcane production increase
- Brazilian market-share growth in global sugar and ethanol exports.

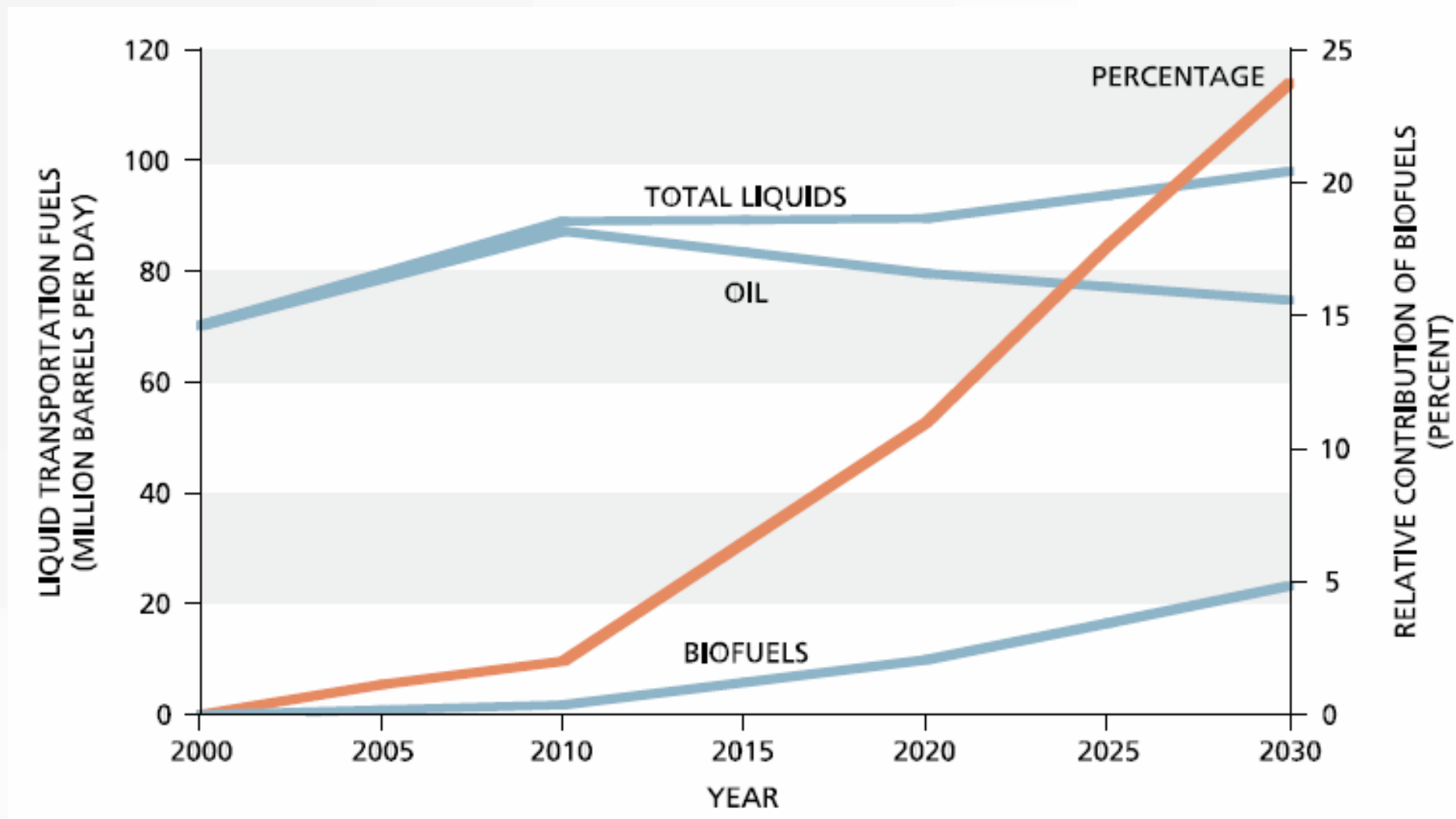
- **Critical uncertainties:**

- Sugar & ethanol export volumes;
- Ethanol availability to the Brazilian market;
- The tax policy and its impacts on automotive fuel prices;
- Oil & natural gas prices;
- Approve the use of diesel for compact, light vehicles;
 - Suitable fuel specification from 2009 on;
 - Self-sufficiency in diesel from 2011 on;
 - Lack of consensus about this use in the American and Chinese markets;
 - Competition in the future with new end-use technologies (Hybrid);
 - High investment required to implement new assembly lines;
- Impact of new technologies (hybrid vehicle, fuel cell, cellulose ethanol production, etc.)

Outlook of international agencies for the penetration of biofuels in the transport sector

International Energy Agency	2004	2030
WORLD		
Share of biofuels in the transport sector worldwide (Basic scenario)	1%	3%
Share of biofuels in the transport sector worldwide (Alternative scenario)	1%	5%
BRAZIL		
Share of biofuels in the Brazilian transport sector (Basic scenario)	12%	20%
Share of biofuels in the Brazilian transport sector (Alternative scenario)	12%	25%

Outlook of international agencies for the penetration of biofuels in the transport sector

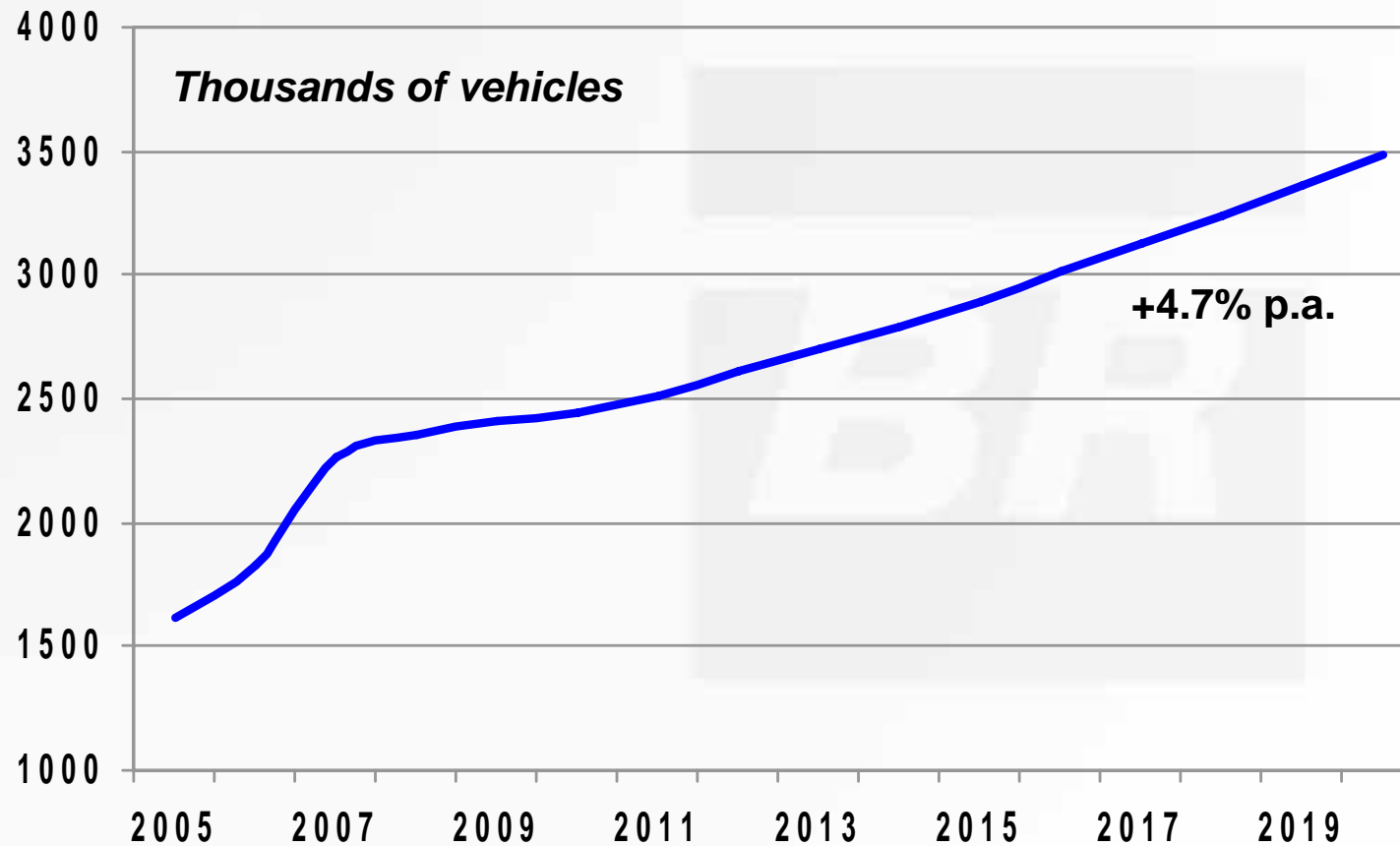


Source: NPC Global Oil & Gas Study, June 29, 2007

Petrobras Strategic Plan

Main Assumptions and Forecasts for Automotive and Fuel Domestic Markets Evolution

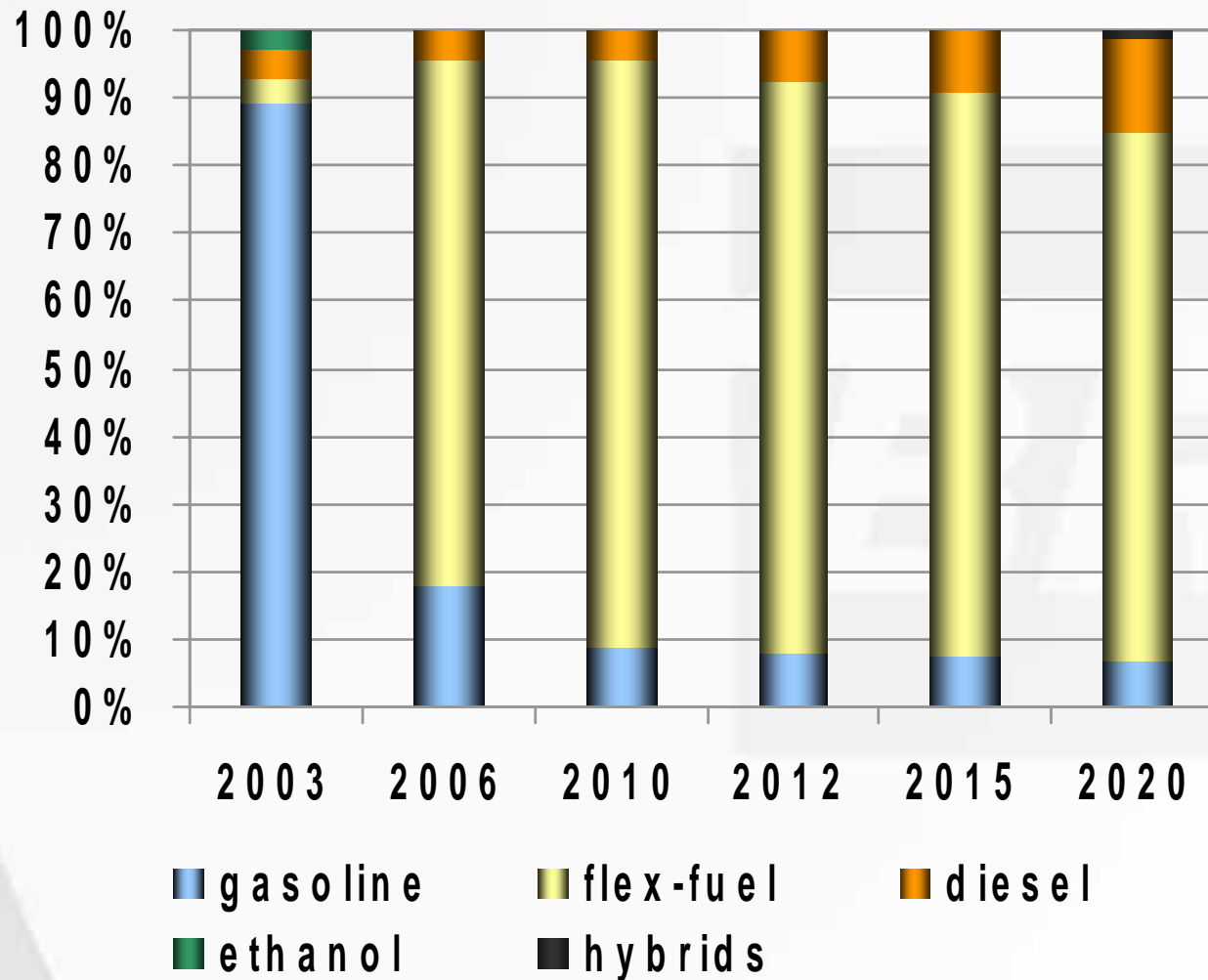
Evolution of the Light Vehicle Sales



Note: growth rate 2007- 2020

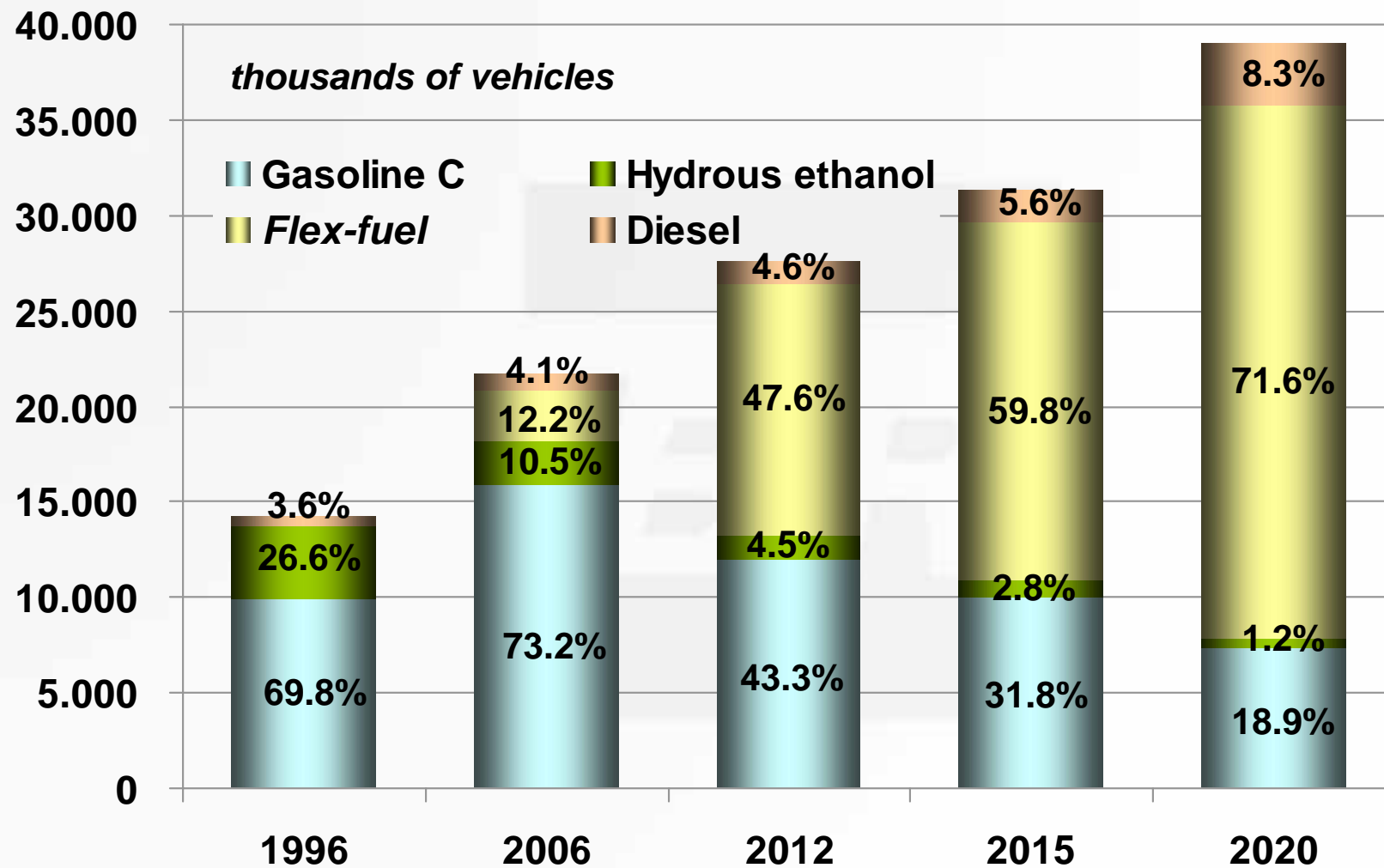
- Average elasticity- income of 1.2 in the period, leading to an annual average growth of 3.5% in the motorization rate (vehicle fleet/inhabitant), compatible with the per capita income growth (2.8% p.a.).

Brazilian Light Vehicle Sale Profile



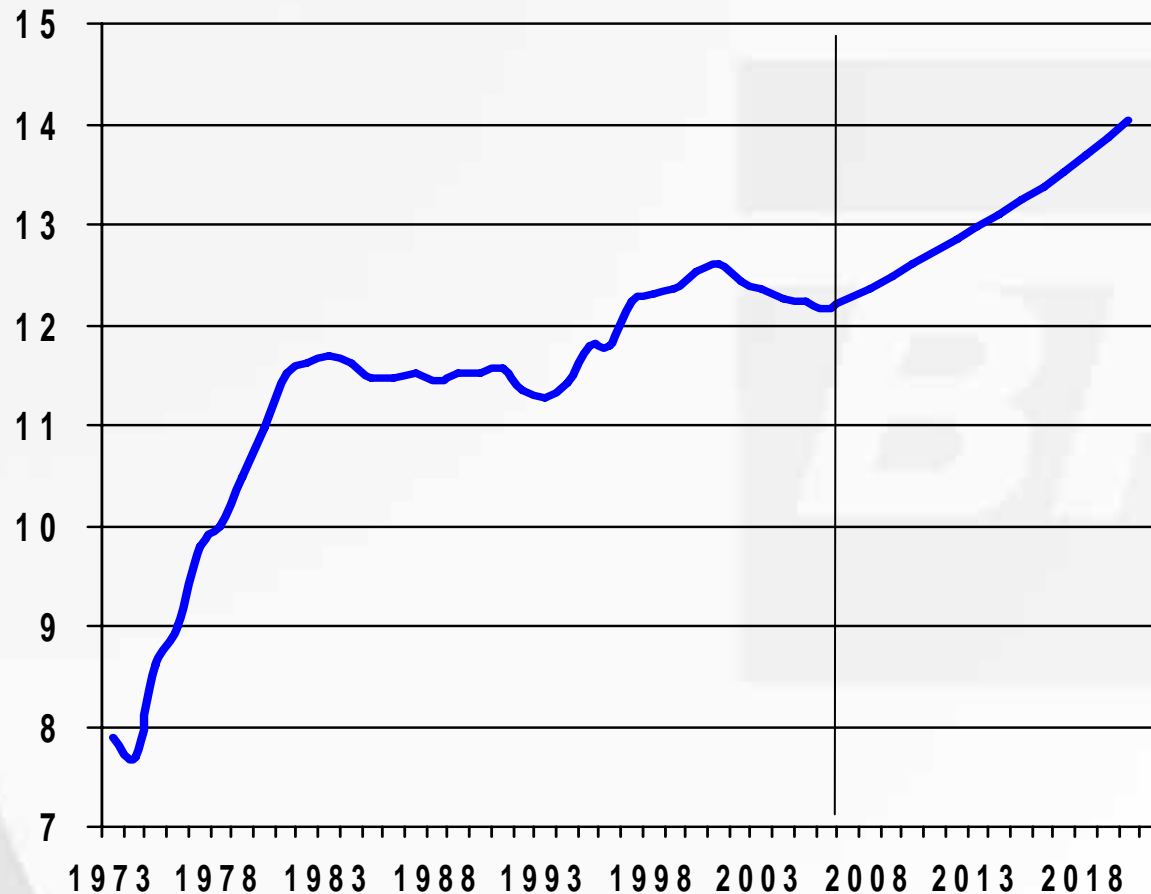
- Dominance of flex-fuel vehicles in the sales, with the emergence of diesel vehicles when this fuel's use for compact vehicles is approved;
- Hybrid vehicles (mainly flex/electric) will still have very limited space in 2020.

Profile of the Light Vehicle Brazilian Fleet



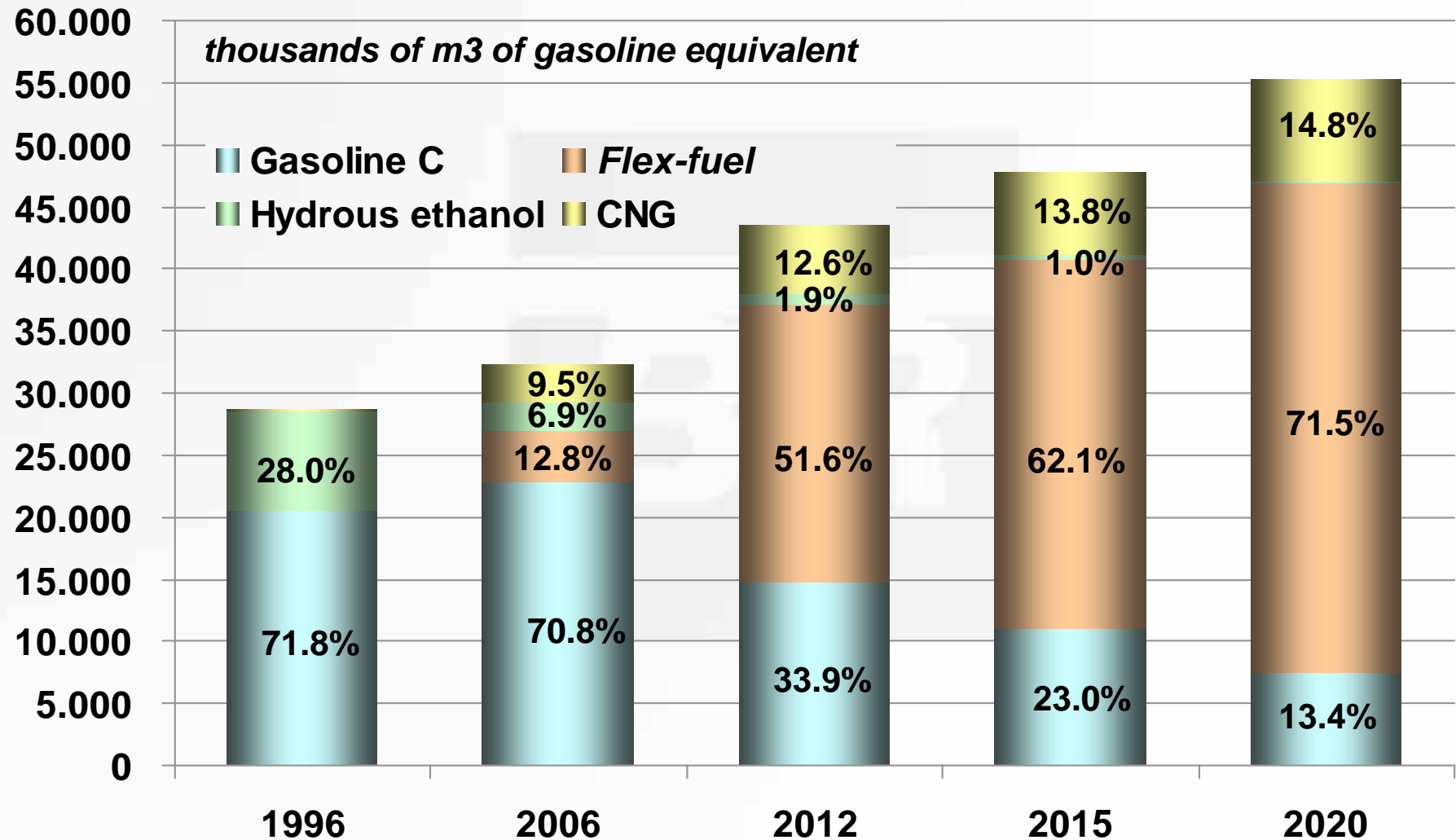
- NG vehicles (bi-fuel) included in the gasoline and flex-fuel fleets
- Hybrid vehicles would account for 0.30% of the 2020 fleet.

Efficiency of the new gasoline and flex vehicles (using gasoline) (km/liter)



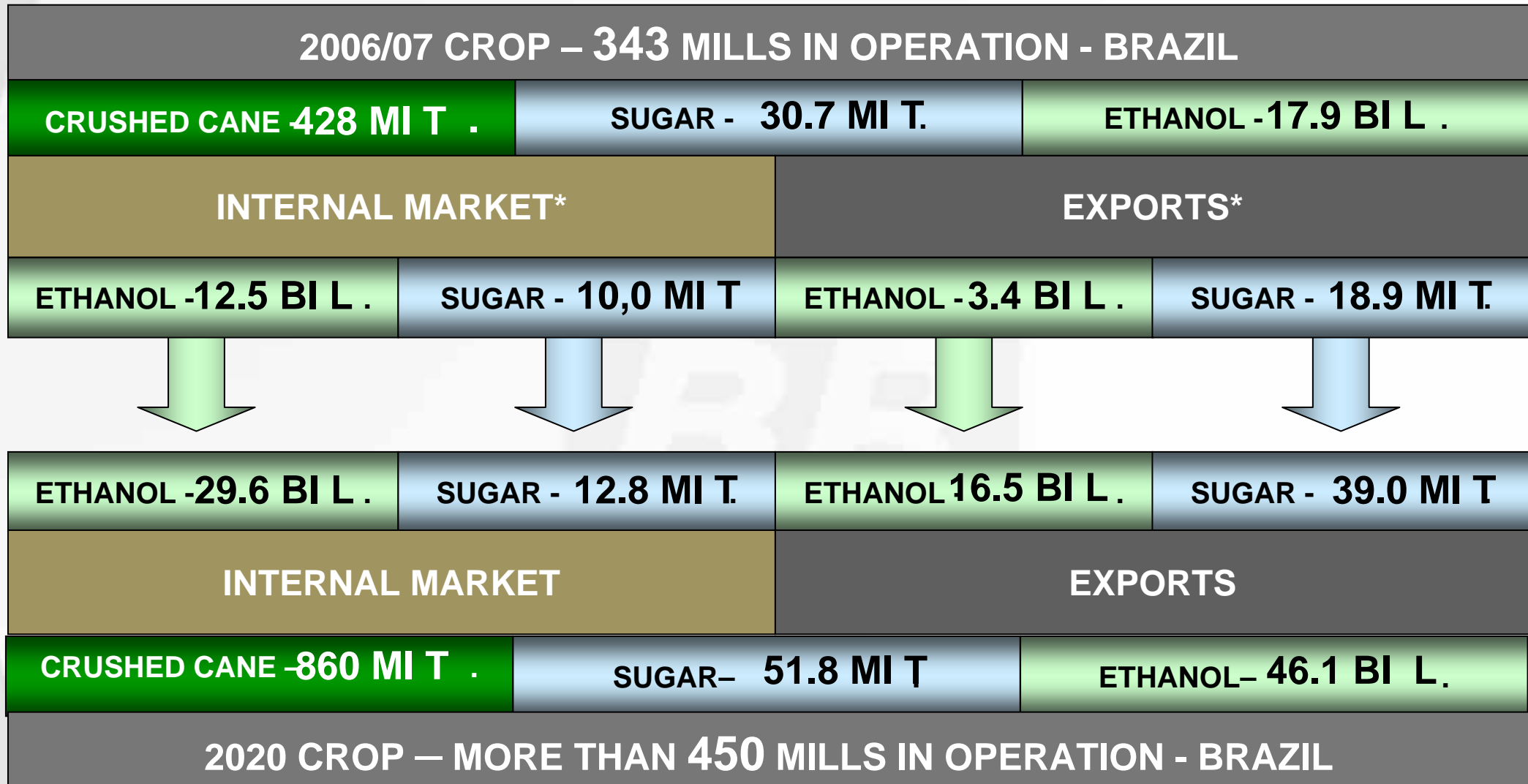
- Engine technological evolution (direct injection, etc.), increased flex-fuel efficiency and small increase in the 1.0 vehicle participation in the sales allowed efficiency gain pick-up for vehicles sold in the domestic market;
- The introduction, even if still marginal in the period, of the hybrid vehicles, also contributes to higher average vehicle efficiency.

Brazilian Otto Cycle Carburant Market



- Consumption per motorization for each fuel

Expansion Scenario for the Brazilian Sugar & Ethanol Sector

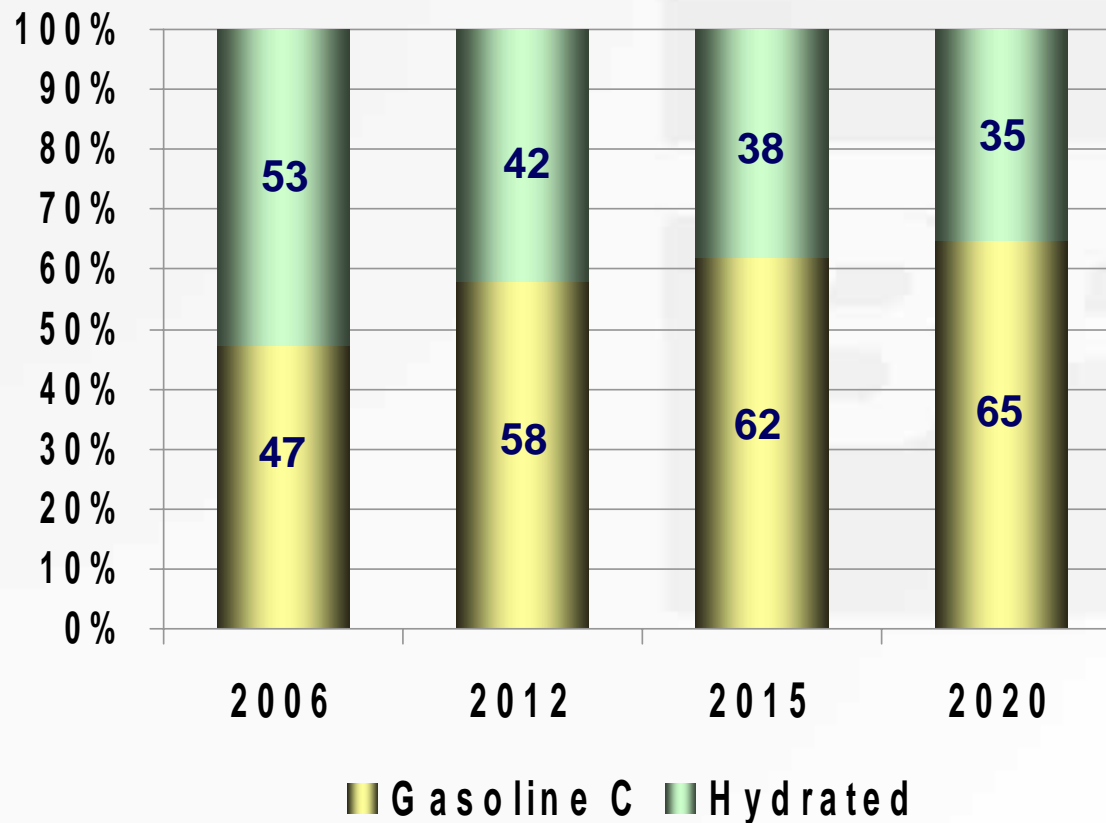


SOURCE: MAPA and PETROBRAS/STRATEGY

* 2006 markets

Flex-fuel Supply

% of total consumption in gasoline equivalent

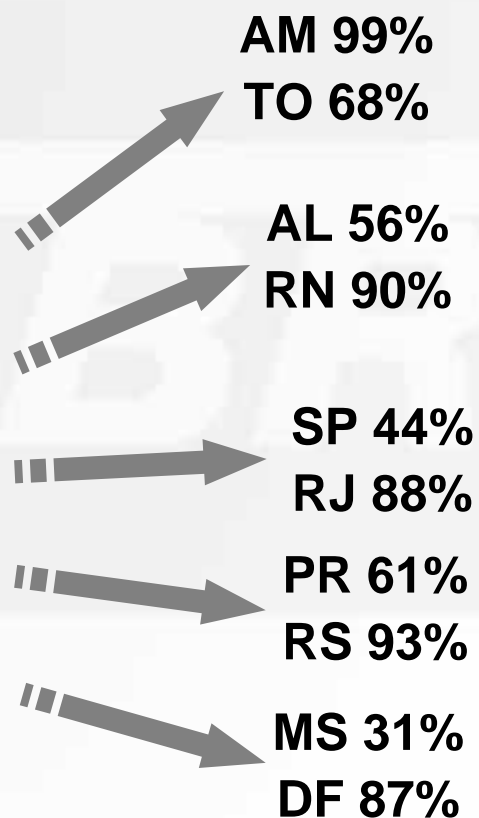


- The logistics structure (transportation costs); the local tax policy; ethanol production and its costs per region define regional competitiveness between ethanol and gasoline
- In 2020, 35% of the energy consumed by the flex-fuel vehicles will be hydrous ethanol (44% in volume), with total ethanol (including anhydrous) accounting for 57% of the total consumption volume of the flex vehicles.

Reference Scenario

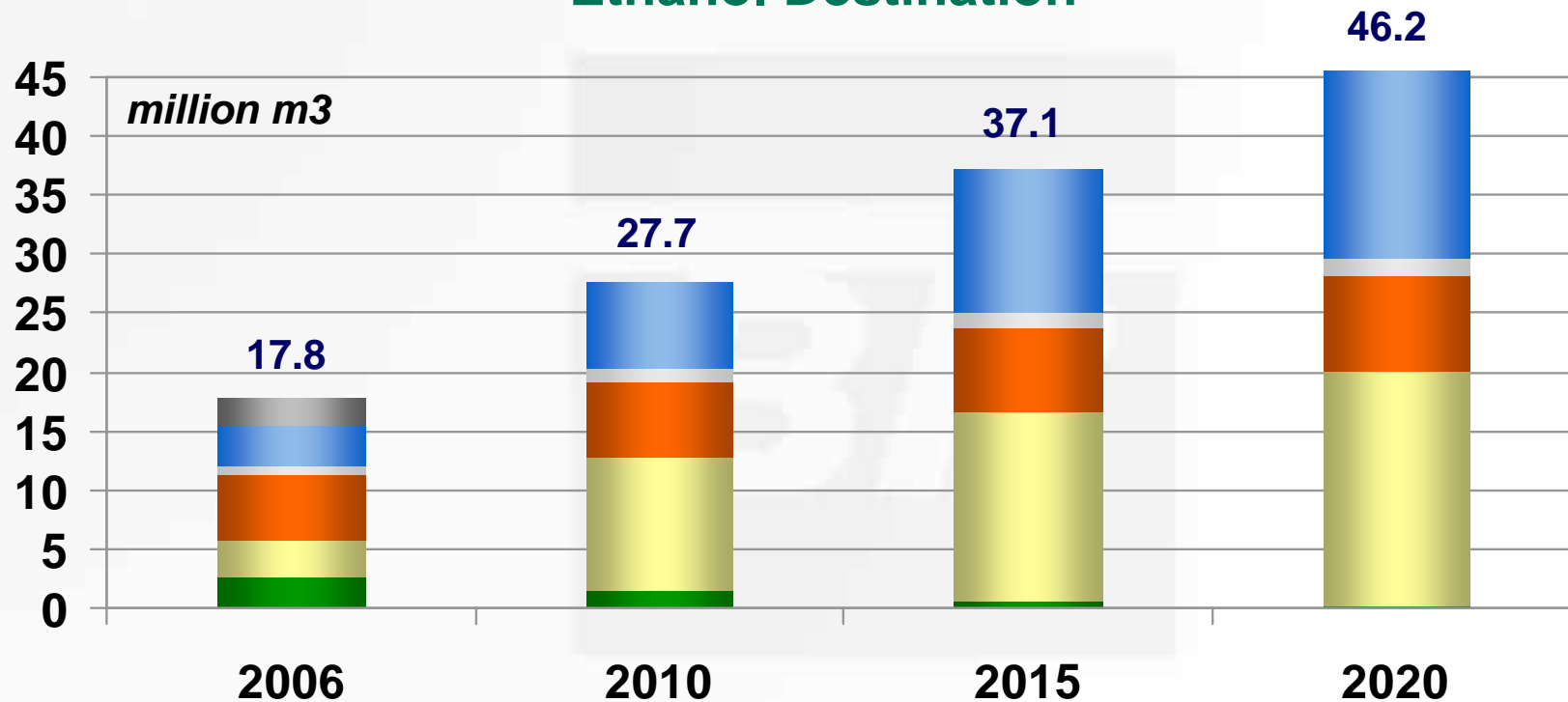
Flex-fuel supply by gasoline C in 2020 (in gasoline equivalent)

Region	%
North	95%
Northeast	82%
Southeast	54%
South	80%
Mid-West	46%



- Major regional differences and variations among the states in a same region reflect the great supply cost and taxation differences in each state;
- In volume, gasoline type C supply in SP would be equivalent to 35% of the total (only 27% in volume is considered pure gasoline, without anhydrous).

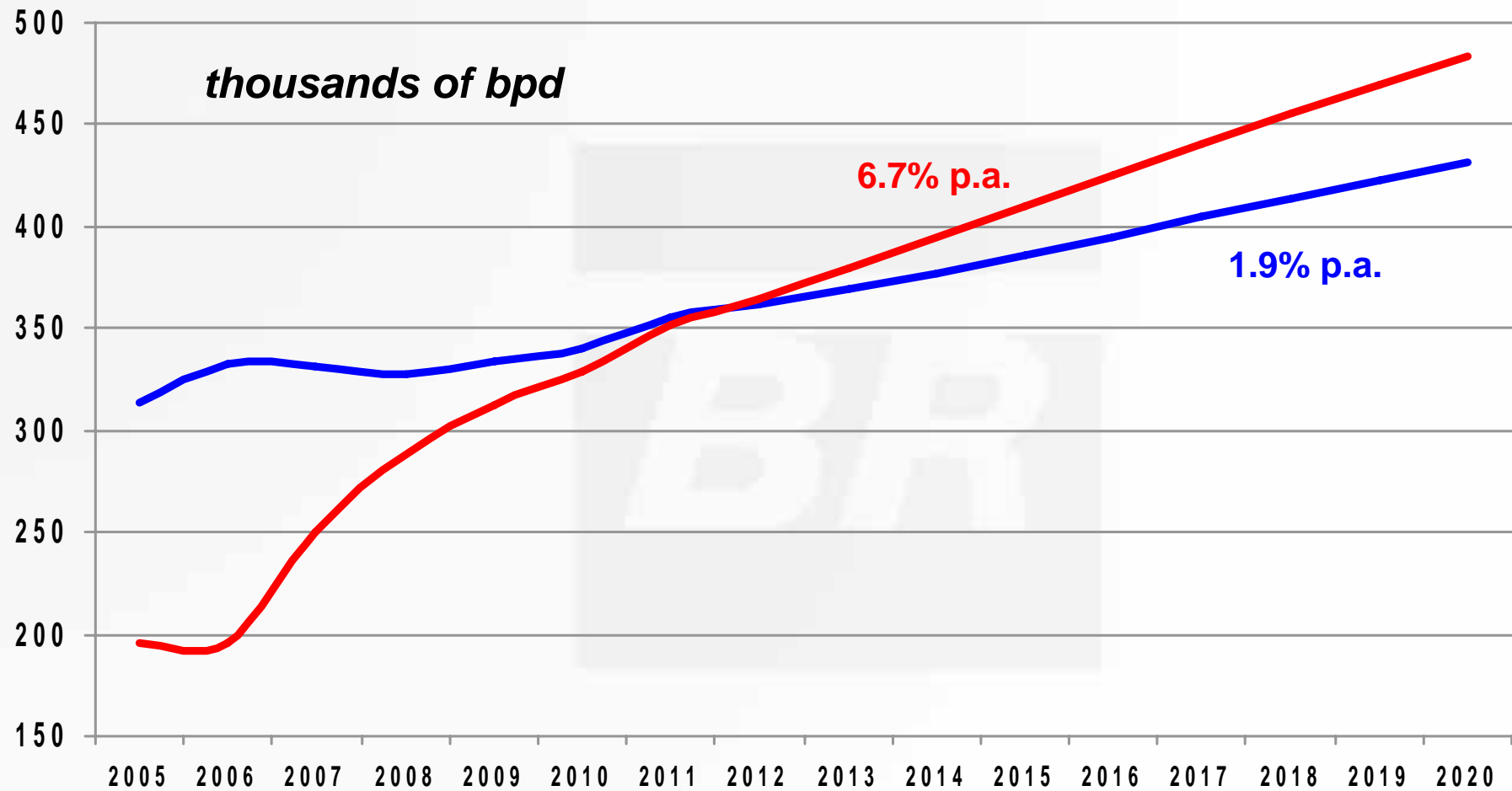
Ethanol Destination



- ethanol vehicles
- anhydrous in gasoline
- exports

- flexfuel
- non energ. use
- inventories changes

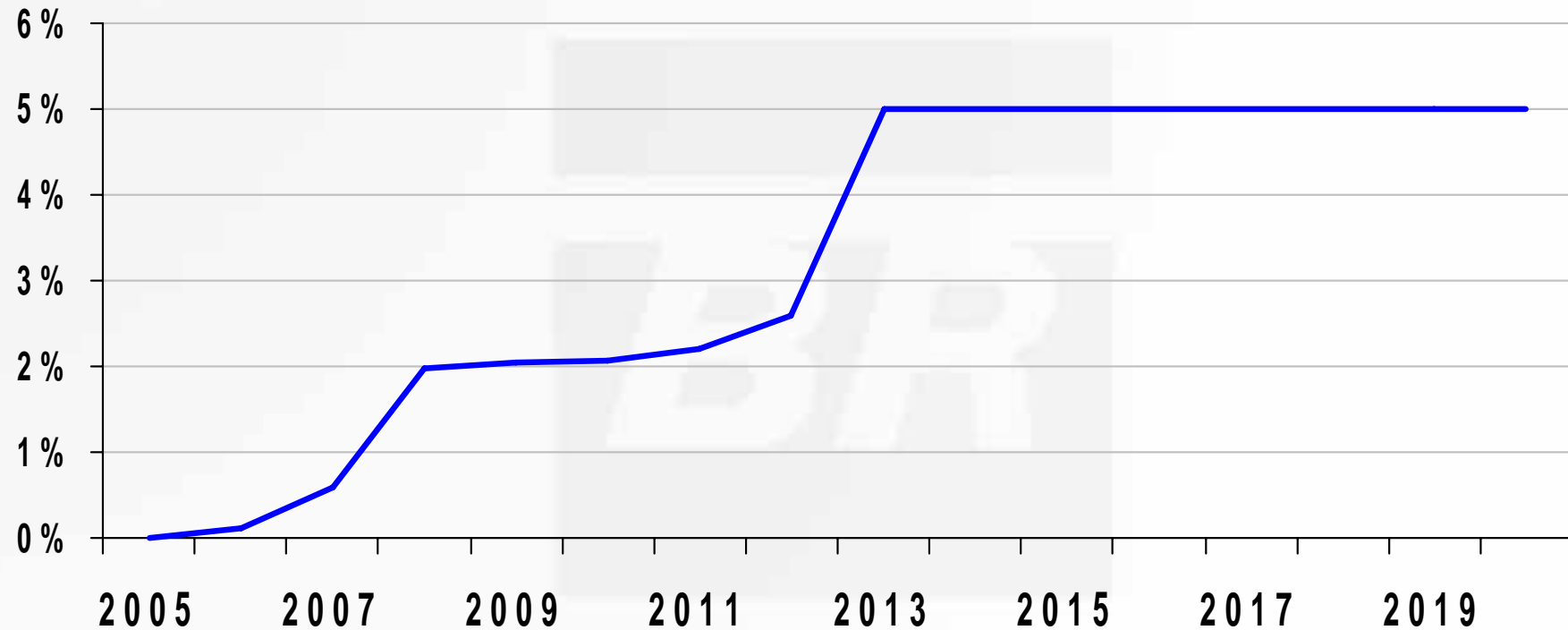
Brazilian Gasoline and Ethanol Market



Note: 2007- 2020 growth rate

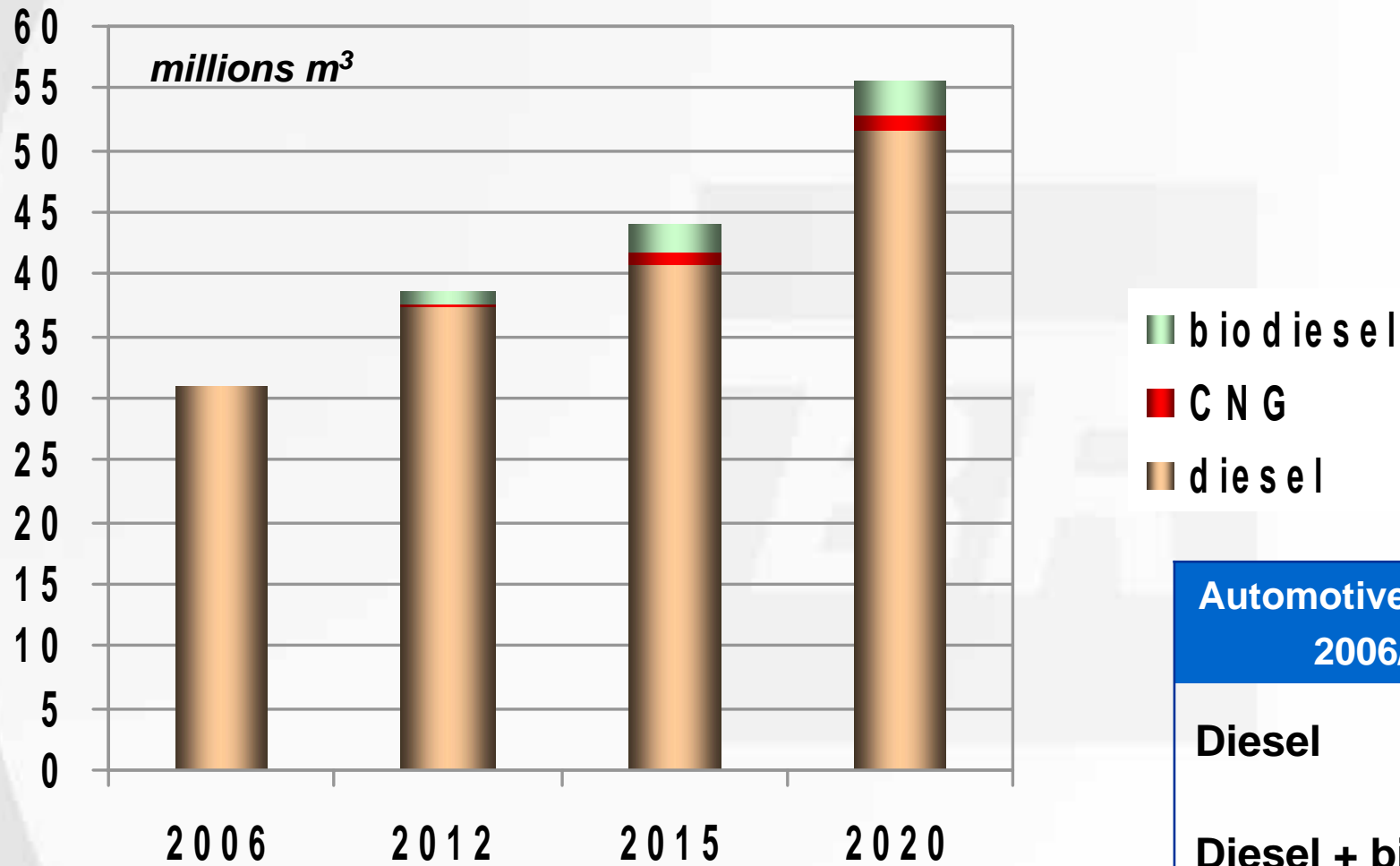
- Assuming 24% anhydrous content in gasoline in the long term
- Total pure gasoline and ethanol fuel (anhydrous + hydrous)

Biodiesel as a % of Total Diesel



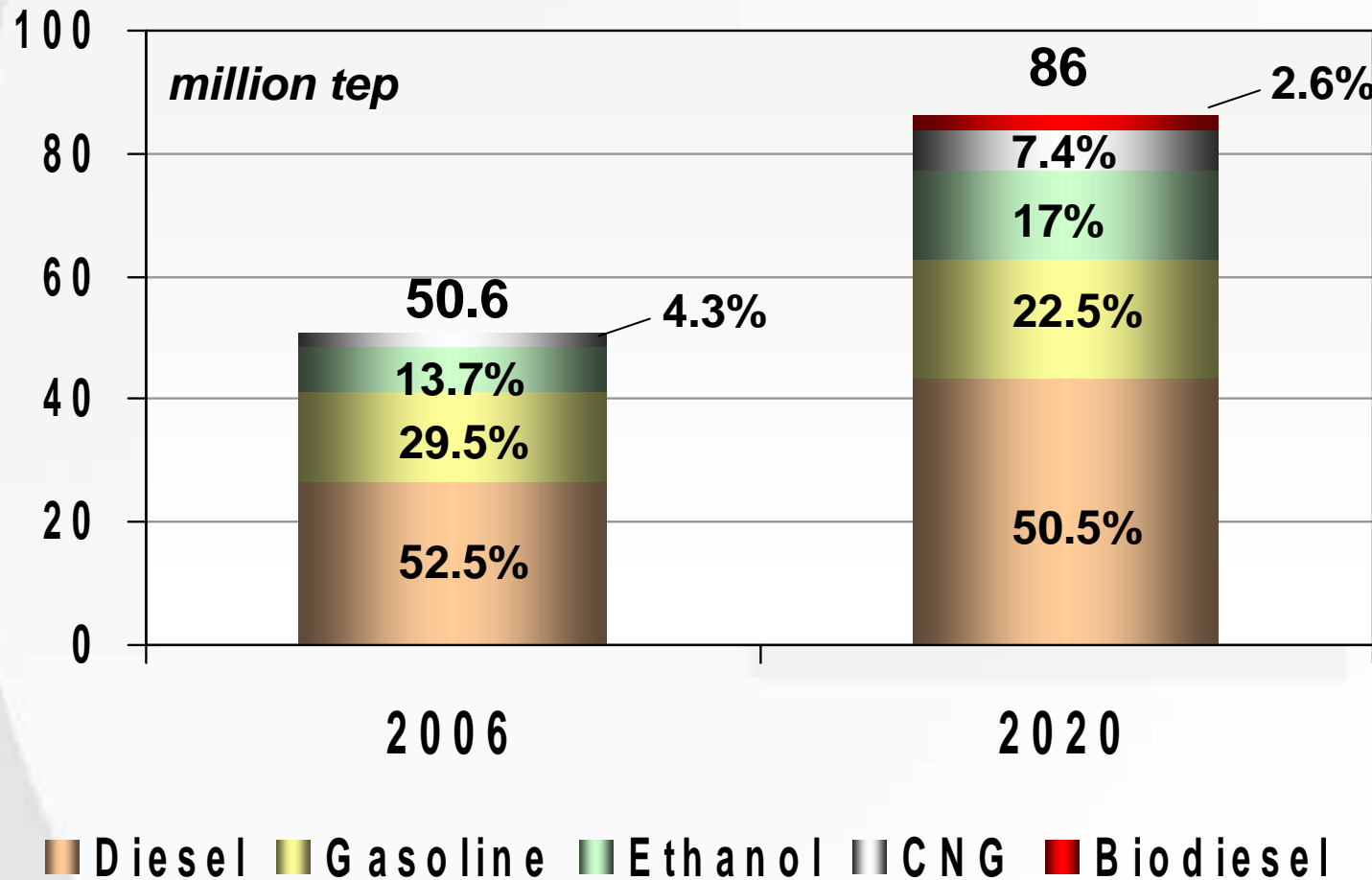
- According to Bill # 11.097, the mandatory percentage of biodiesel addition in the diesel would be 2% minimum in 2008 and 5% in 2013.

Brazilian Automotive Diesel Market



Automotive Diesel Market Growth	
2006/2020	(% p.y.)
Diesel	3.6
Diesel + biodiesel	3.9
Diesel + CNG + biodiesel	4.1

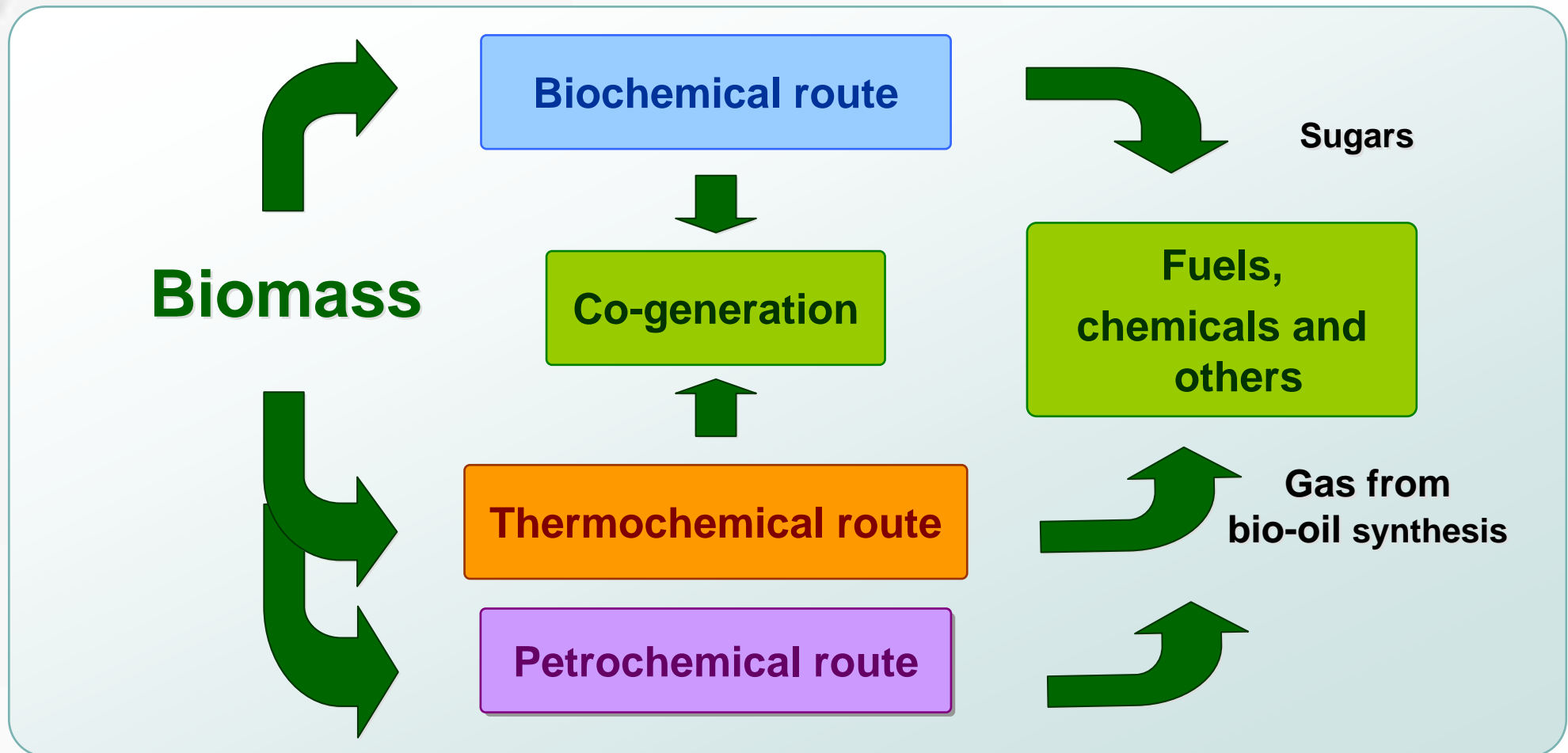
Brazilian Automotive Segment Energy Matrix



- Oil products are losing space in the automotive segment's matrix, but still dominate, accounting, in 2020, for 73% of the final energy consumption.

- Biofuels would account for 19.6% in 2020, compared to 13.7 in 2006.

Technological strategies for the use of biomass



A bio-refinery is an industrial complex that integrates the processes of converting biomass to produce fuels, energy and high added-value chemical products.

H-BIO (joint processing of vegetable and mineral oils)

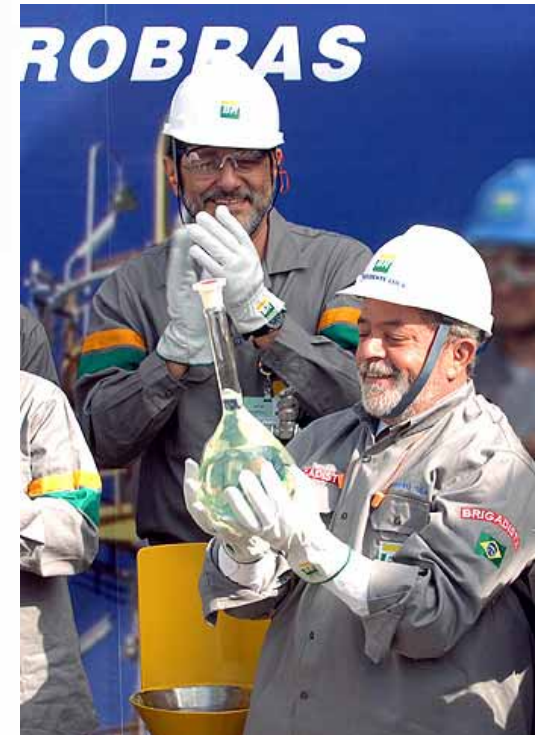
- ✓ Implemented in 5 refineries by 2008

H100 (processing of crude vegetable oils)

- ✓ Pilot tests (2007)
- ✓ Available at the Premium Refinery (2011)

Biodiesel

- ✓ Two demonstration units
- ✓ Preparation for industrial projects :
 - Using varied raw materials (2007)
 - Using 100% castor oil (2008)



Thermochemical route - BTL

- ✓ Partnerships for developing an optimized catalyst
- ✓ Working with partners to design and construct a gasification plant
- ✓ Pilot plant (2009)
- ✓ Demonstration plant (2012)
- ✓ Seeking partnerships to speed up the development of the industrial process



Biochemical route - Ethanol from bagasse

- ✓ Development in partnership with Brazilian institutions
- ✓ Highly promising results (220 l/ton of bagasse)
- ✓ Pilot plant at Cenpes for the production of ethanol from sugar cane bagasse (Sep/2007)
- ✓ Demonstration plant for sugar cane bagasse (2010)
- ✓ Seeking partnerships to speed up the development of the industrial process



Thermochemical route

Co-processing of biomass at FCC

- ✓ Bench and pilot tests
- ✓ Development of catalytic systems

Bio-oil

- ✓ Sample production - rapid pyrolysis
- ✓ Partnerships - catalytic pyrolysis
- ✓ Development alongside Brazilian universities

