TRANSPORTATION ENGINEERING PROGRAM (PET)

Global Forum on Electric Mobility

RIO+20
United Nations Conference on Sustainable Development

PLANNING THE USE OF ELECTRIC TRACTION FOR URBAN TRANSPORT. THE EXPERIENCE OF COPPE INSTITUTE

MÁRCIO D'AGOSTO
dagosto@pet.coppe.ufrj.br
BRUNO BORBA
bborba@ppe.ufrj.br

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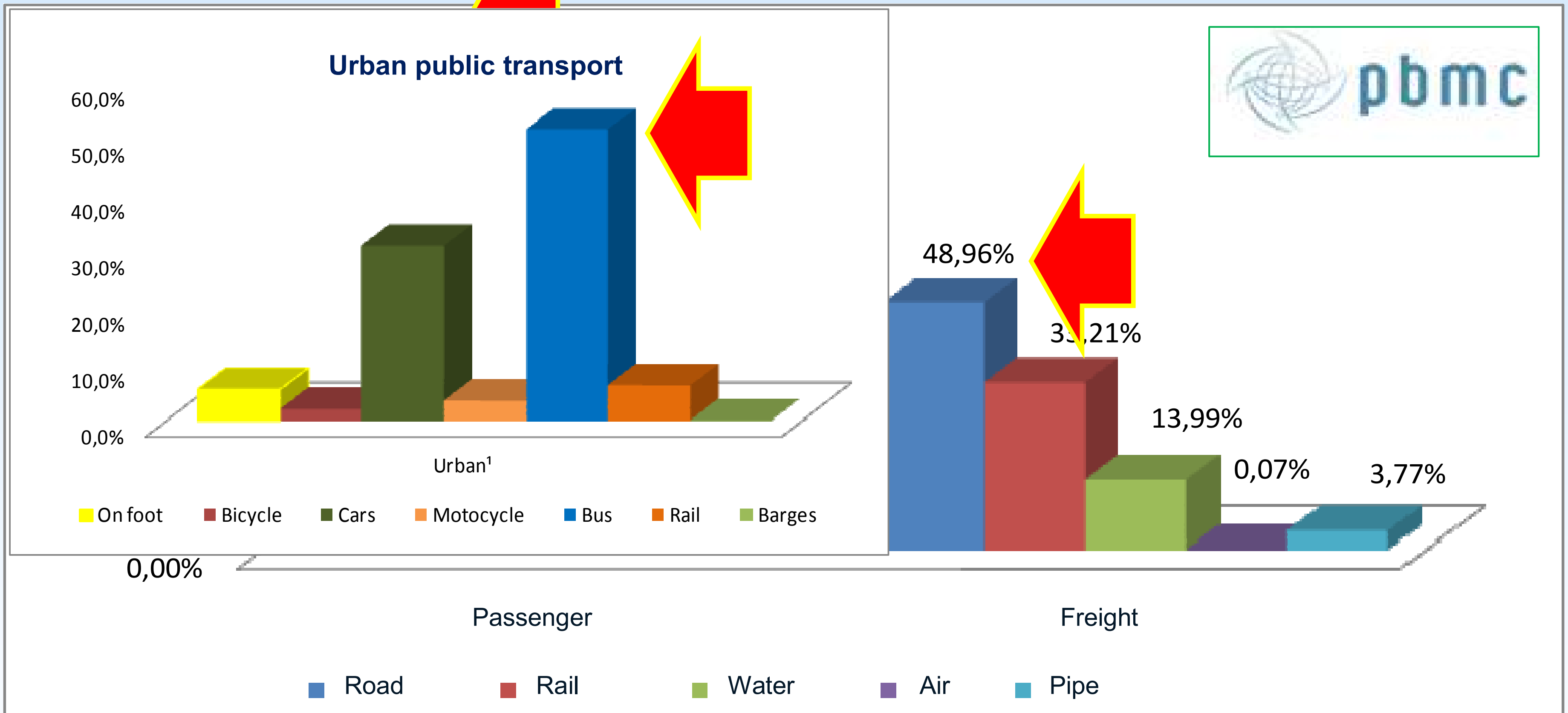
SUMARY

1. Brazilian transportation sector in figures
2. Opportunities – hybrid and electric buses;
3. Opportunities – electric cars;
4. Final considerations

BRAZILIAN TRANSPORTATION SECTOR - FIGURES

Brazilian Transportation Sector Modal Split



Passenger: ¹ Considering only ferry transport; ² Considering only national transport.
Feright: ³ Considering only freight transported by cabotage and inland waterways; ⁴ Considering only national freight.

Note: Percentages were calculated based on data provided in pass.km and t.km
Source: Own elaboration based on data from FIPE (2011), ANTT (2009), ANTAQ (2009), ANTP (2009) and ANAC (2009).

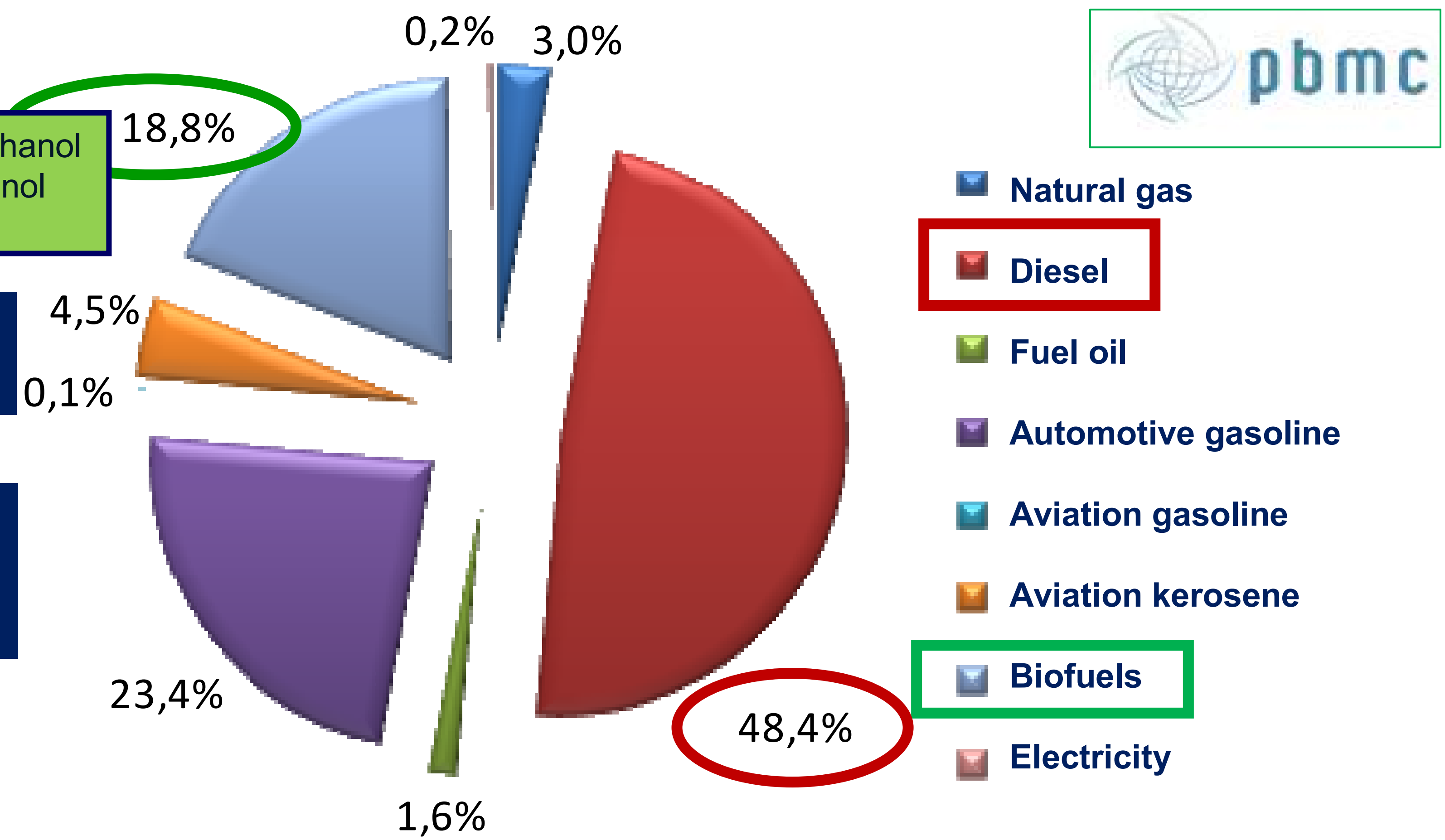
BRAZILIAN TRANSPORTATION SECTOR - FIGURES

Brazilian Transportation Sector Energy Consumption

28,76% Anhydrous ethanol
71,23% Hydrous ethanol
0,01% Biodiesel

28% - ENERGY FINAL USE

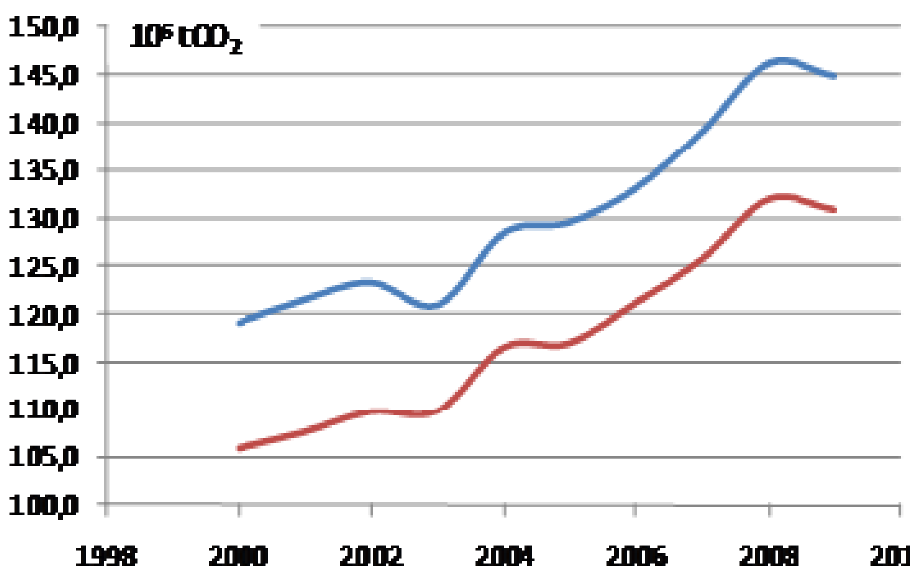
92% - ROADWAY TRANSPORT

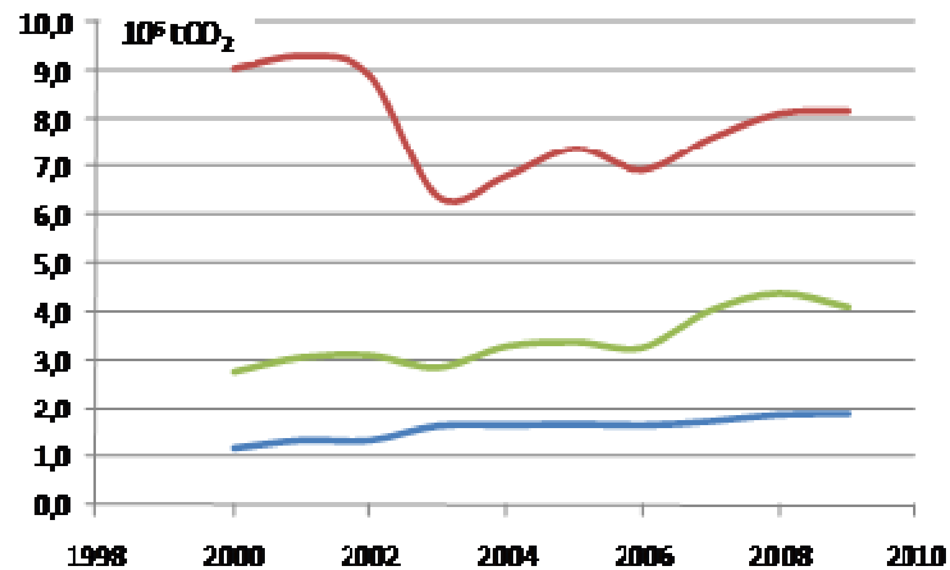


(2009)

BRAZILIAN TRANSPORTATION SECTOR - FIGURES

EMISSIONS OF CO2 AND LOCAL ATMOSPHERIC POLLUTANTS

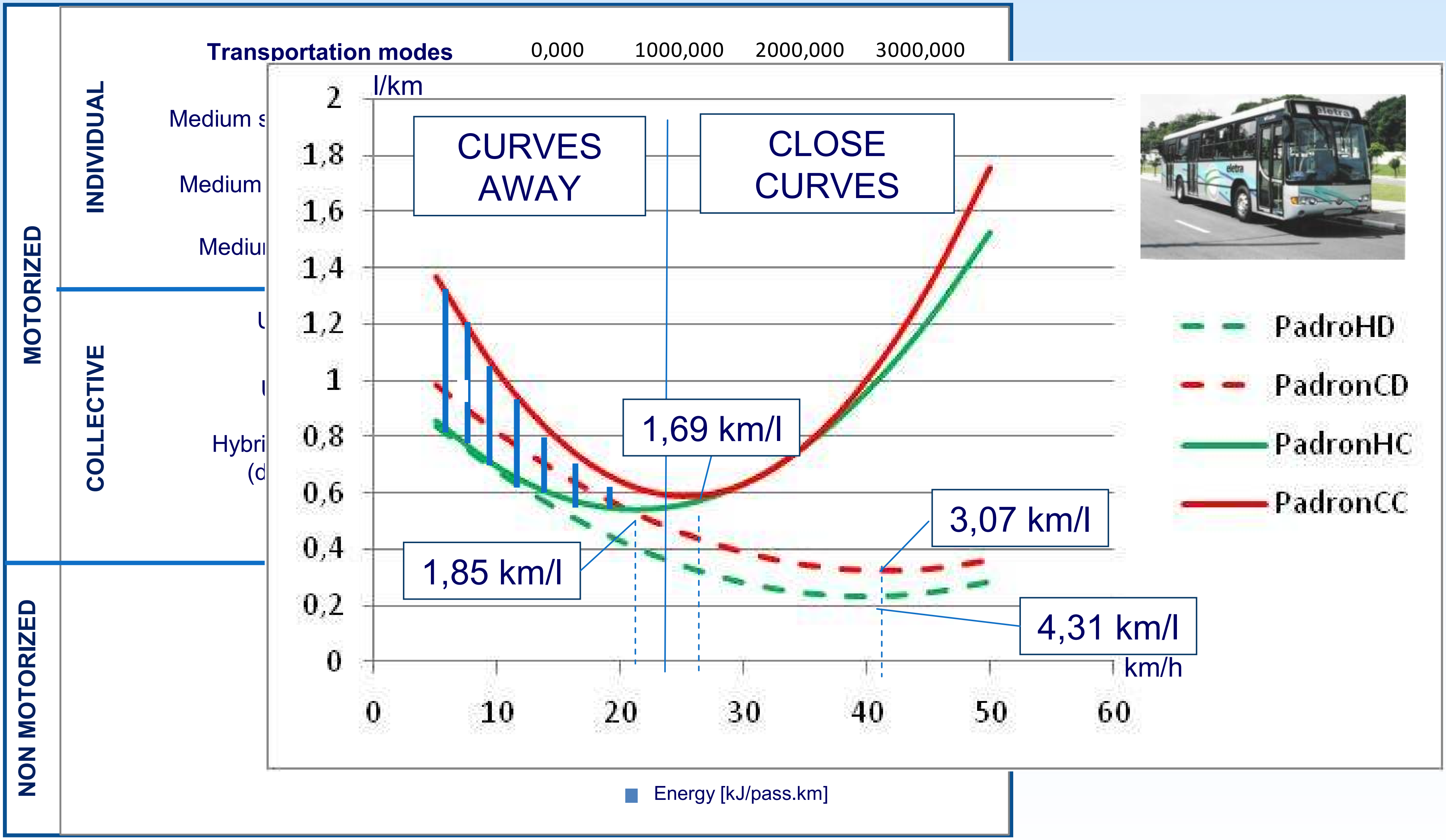




THE USE OF MORE EFFICIENT TECHNOLOGIES AND CLEANER FUELS.

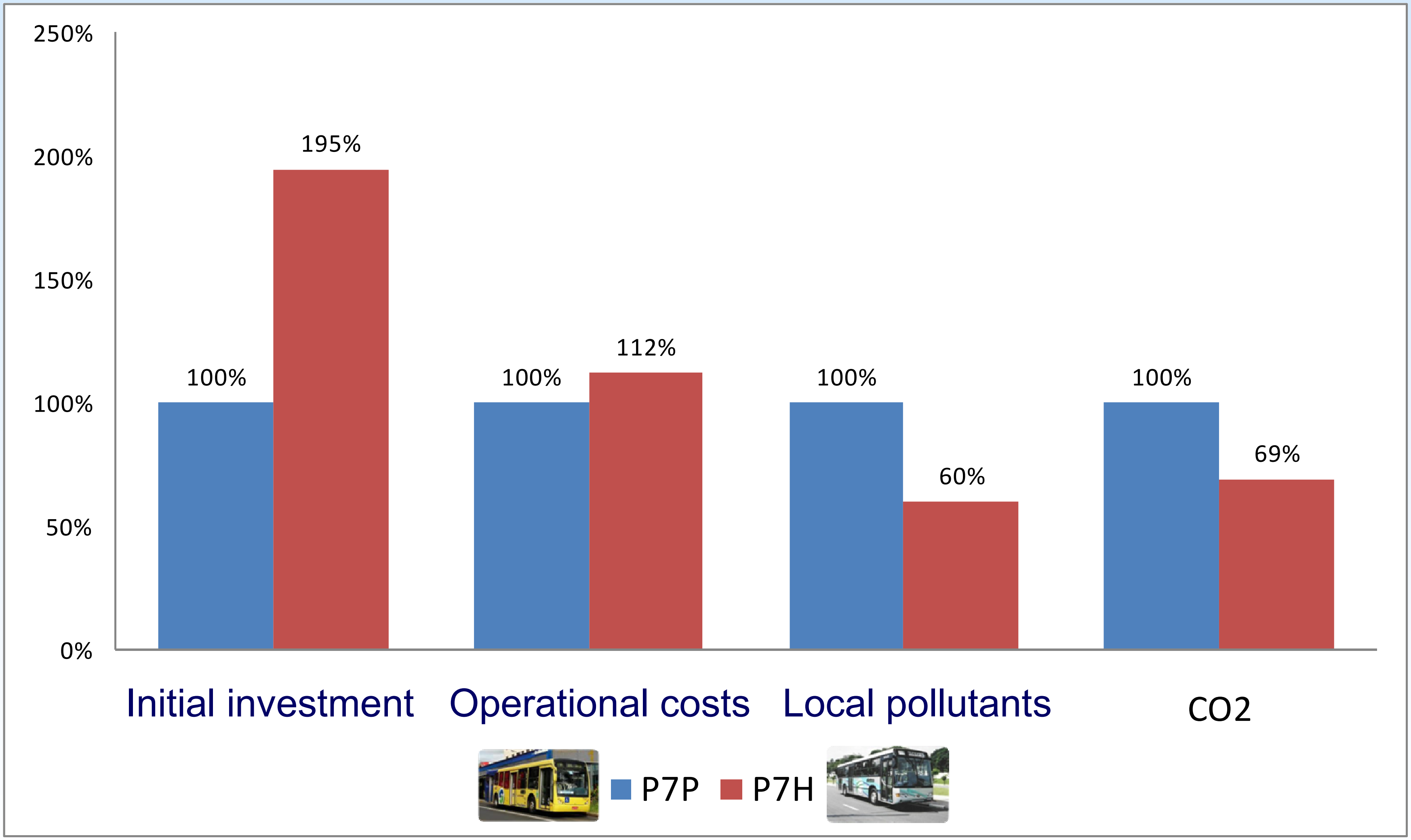
Year	Fleet	Emissions [t]				
		CO	THC	NOx	MP	RCHO
1980	9.307.366	4.702.658	848.022	716.330	42.675	7.330
2010	41.055.938	1.372.103	257.709	966.578	28.807	7.103
	341%	-71%	-70%	35%	-32%	-3%

OPPORTUNITIES – HYBRID BUSES

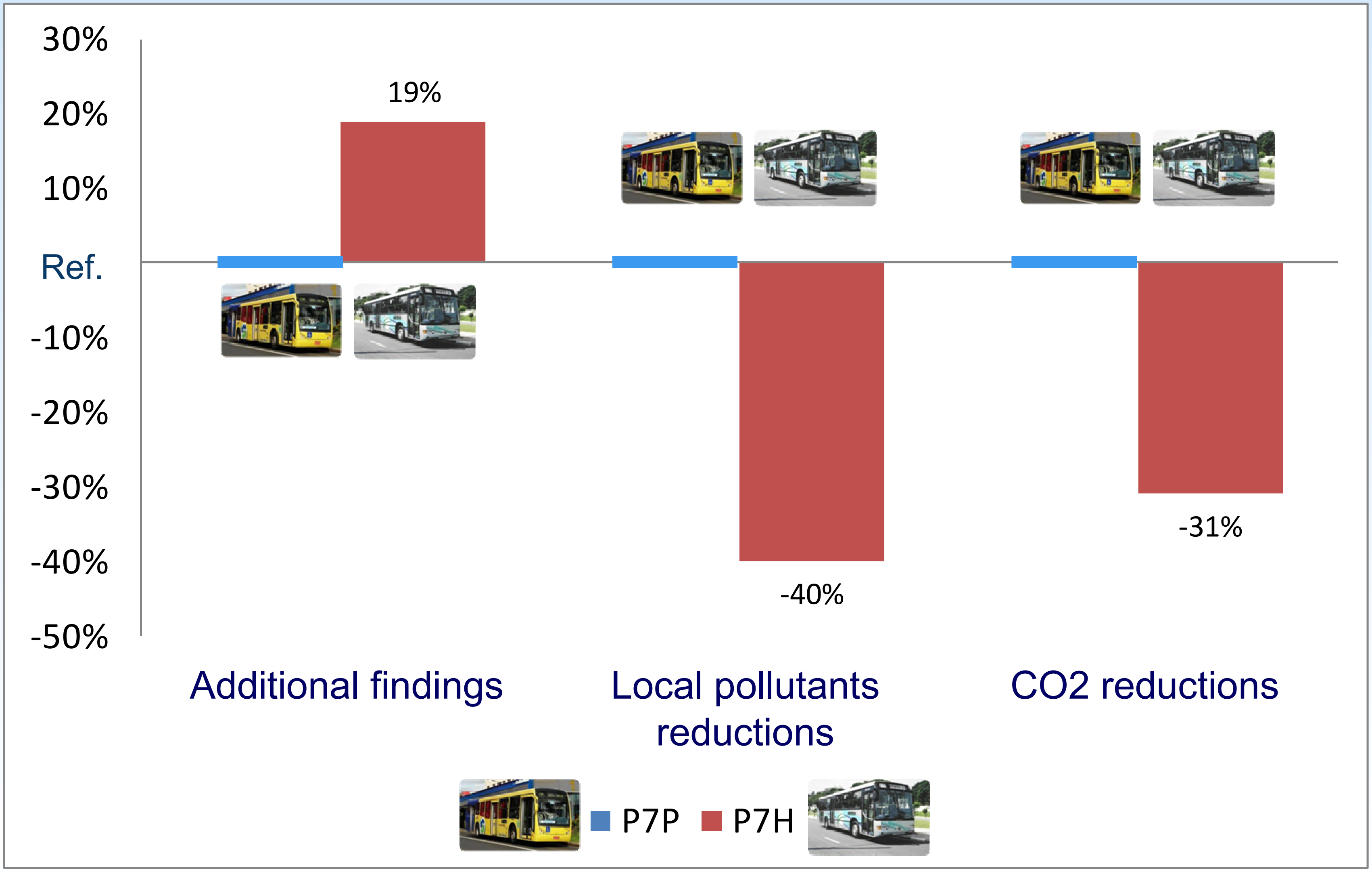


OPPORTUNITIES – HYBRID BUSES

Rio de Janeiro local transit system – between neighborhoods.



OPPORTUNITIES – HYBRID BUSES



OPPORTUNITIES – ELECTRIC BUSES

COPPE/UFRJ FUEL CELL BUS

Hybrid Bus: Electricity and Hydrogen

Fuel Cell + Battery or
Ethanol Engine + Battery or
Battery Only

Experimental vehicle is operating in Rio+20 and on display at COPPE's pavilion at Parque dos Atletas.

ALL ARE INVITED!

Hydrogen Laboratory - COPPE/UFRJ - **Prof. Paulo Emílio**
Phone: +55 21 2562-8791

Why Electric Vehicles?

- **Way to both reduce atmospheric emissions (primarily CO_2) and increase supply security of the transportation sector**

- **Smart charging:**
  - ✓ Decrease the cycling of the power plants (or avoid additional generator start-ups, which would otherwise decrease the overall efficiency)
  - ✓ Way to maximize the integration of variable renewable energy in power systems

- **Other benefits:**
  - ✓ Quiet operation
  - ✓ Absence or low tailpipe emissions
  - ✓ Higher tank to wheel efficiency

- **Impacts on the power system and/or the distribution system:**
  - ✓ Increased the evening peak load
  - ✓ Increased transformer loads
  - ✓ Losses in the distribution system
  - ✓ Voltage fluctuations
  - ✓ Increased fault current
  - ✓ Power quality (reactive power and current harmonics)

OPPORTUNITIES – ELECTRIC CARS

In terms of Energy

% BEV of the actual fleet *	BEV Fleet (10^3 vehicles)	Distance per year (km)	Performance (km/kWh)	Energy (TWh)	% Consumption Brasil 2011 **
10%	2,980	8,000	6.0	4.0	**0.9%**
20%	5,960	8,000	6.0	7.9	**1.7%**
50%	14,899	8,000	6.0	19.9	**4.4%**
70%	20,859	8,000	6.0	27.8	**6.1%**
100%	29,798	8,000	6.0	39.7	**8.7%**

* Considering a fleet of 29.8 million LDVs (ANFAVEA, 2011)
** Assuming a annual electricity consumption of 450 TWh (EPE, 2011)

➢ **From an energy point of view, the impact would be acceptable**

OPPORTUNITIES – ELECTRIC CARS

In terms of Power

% BEV *	BEV Fleet (10^3 vehicles)	Power Recharge (kW)	Superposition Rate	Power (GW)	% Peak Power **	% Installed Capacity ***
10	2,980	1.9	60%	3.4	**4.9%**	**2.8%**
20	5,960	1.9	60%	6.8	**9.7%**	**5.7%**
50	14,899	1.9	60%	17.0	**24.3%**	**14.2%**
70	20,859	1.9	60%	23.8	**34.1%**	**19.9%**
100	29,798	1.9	60%	34.0	**48.7%**	**28.5%**
		7.7	30%	6.9	**9.9%**	**5.8%**
		7.7	30%	13.8	**19.7%**	**11.5%**
		7.7	30%	34.4	**49.3%**	**28.9%**
		7.7	30%	48.2	**69.1%**	**40.4%**
		7.7	30%	68.8	**98.7%**	**57.7%**
		150	1%	4.5	**6.4%**	**3.7%**
		150	1%	8.9	**12.8%**	**7.5%**
		150	1%	22.3	**32.0%**	**18.7%**
		150	1%	31.3	**44.9%**	**26.2%**
		150	1%	44.7	**64.1%**	**37.5%**

*** Considering a fleet of 29.8 million LDVs (ANFAVEA, 2011)**
**** Assuming the peak power of 65 GW (ONS, 2011)**
***** Considering the installed capacity of 110 GW (ANEEL, 2011)**

➢ **From a power point of view, the impact can be significant, mainly influenced by the type of recharge**

The Case of Wind Generation

- **The variability of wind power → electricity surpluses (especially for wind power plants inserted in inflexible systems)**
  - ✓ **The total installed wind power capacity is increasing, mainly in the Northeast**
  - ✓ **Electric power system of Brazil's Northeast region is expected to increasingly rely on inflexible power plants**
- **This situation requires the appropriate modeling of the power system**
  - ✓ **In this case, electricity storage technologies can be considered, including the promotion of EV and PHEVs**
- **We tested the use of a PHEV fleet of PHEVs in northeastern Brazil as a way to stimulate the electrification of vehicles and postpone the costs of smart grids**
  - ✓ **The wind annual generation surplus, with proper coordination, can be used to supply a PHEVs fleet**
  - ✓ **The battery charging time of these vehicles could be achieved through timers and could be easily controlled using, for instance, a fleet management**

OPPORTUNITIES – ELECTRIC CARS

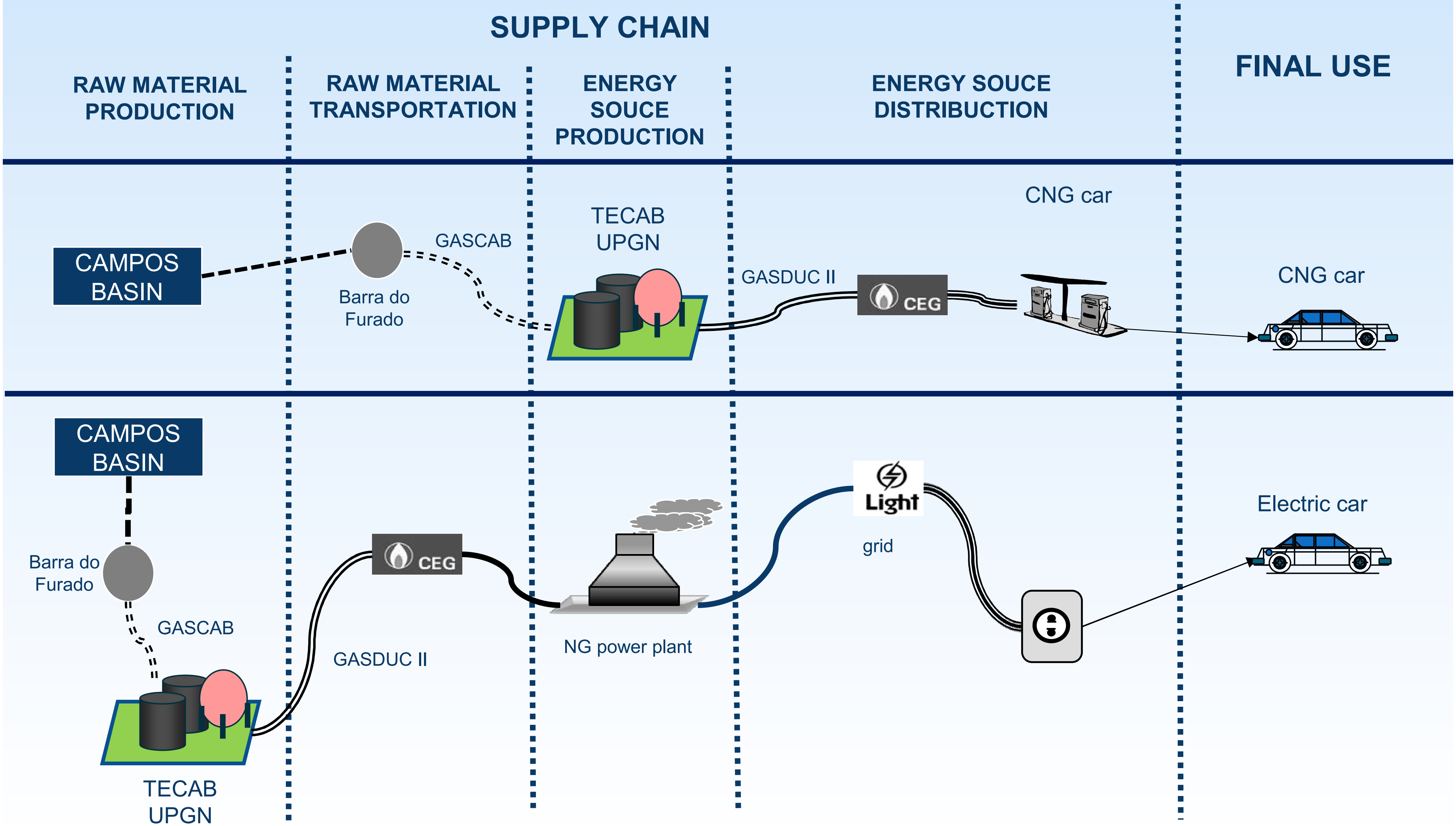
The Case of Wind Generation

➢ **Results: Wind energy surplus in Northeast (GWh)**

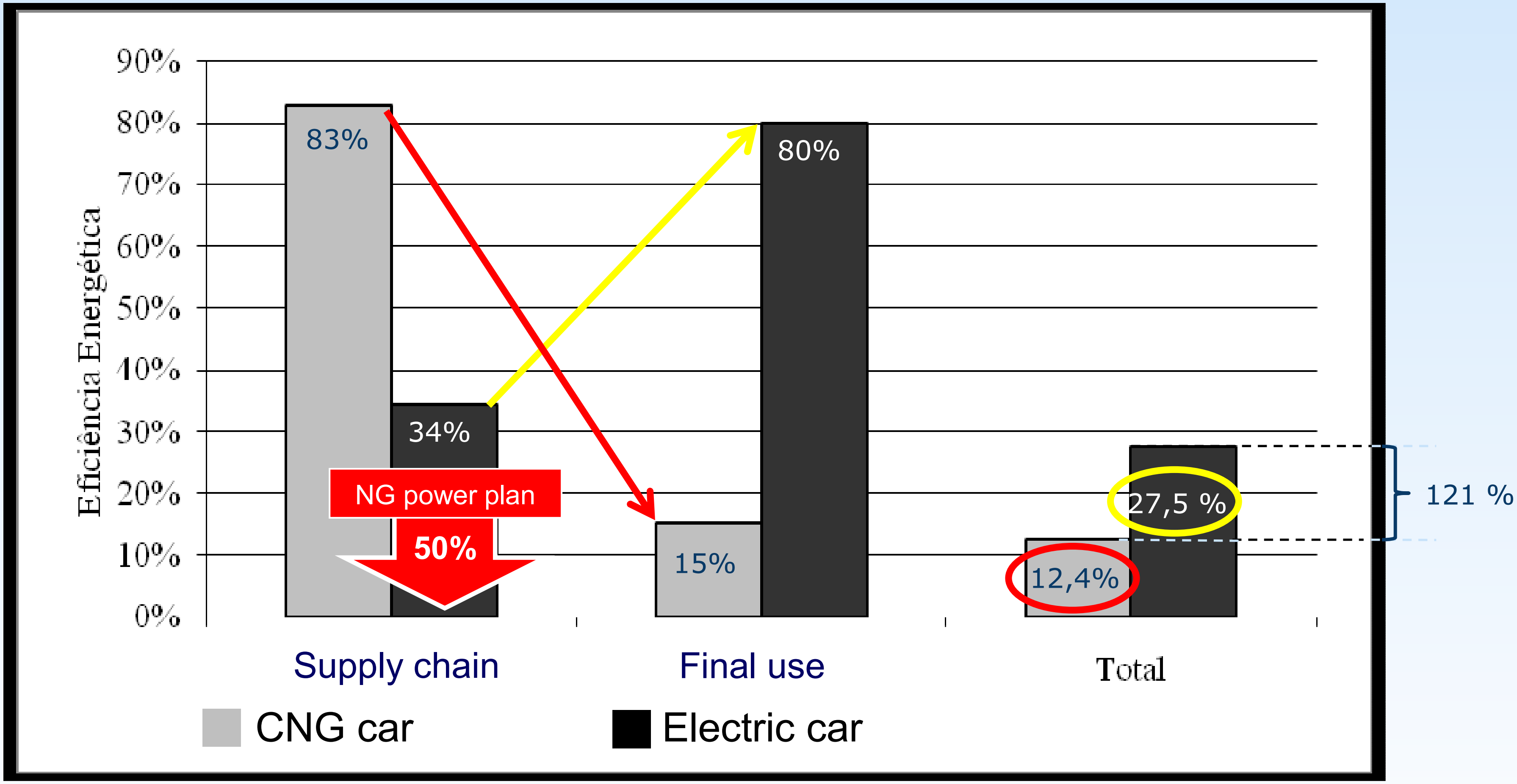
	GWh	2015	2020	2025	2030	2035	2040
Jan/Feb/Mar	1 - 6h	185	317	448	580	712	837
	6 - 10h	92	158	224	290	356	419
	10 - 18h	0	0	0	0	0	0
	18 - 21h	0	0	0	0	0	0
	21 - 24h	0	0	0	0	0	0
Apr/May/Jun	1 - 6h	295	506	716	927	1,137	1,337
	6 - 10h	0	253	358	463	569	668
	10 - 18h	0	0	0	0	0	0
	18 - 21h	0	0	0	0	0	0
	21 - 24h	0	0	0	0	0	0
Jul/Aug/Sep	1 - 6h	51	0	0	0	0	0
	6 - 10h	0	0	0	0	0	0
	10 - 18h	0	0	0	0	0	0
	18 - 21h	0	0	0	0	0	0
	21 - 24h	0	0	0	0	0	0
Oct/Nov/Dec	1 - 6h	67	0	0	0	0	0
	6 - 10h	0	0	0	0	0	0
	10 - 18h	0	0	0	0	0	0
	18 - 21h	0	0	0	0	0	0
	21 - 24h	0	0	0	0	0	0

Energy Surplus (GWh)	597	822	1.165	1,507	1,850	2,174
% Northeast Demand	0.6	0.7	0.8	0.9	1.00	1.10
Feet (PHEV 50)	**447,907**	**616,604**	**873,522**	**1,130,440**	**1,387,360**	**1,630,324**

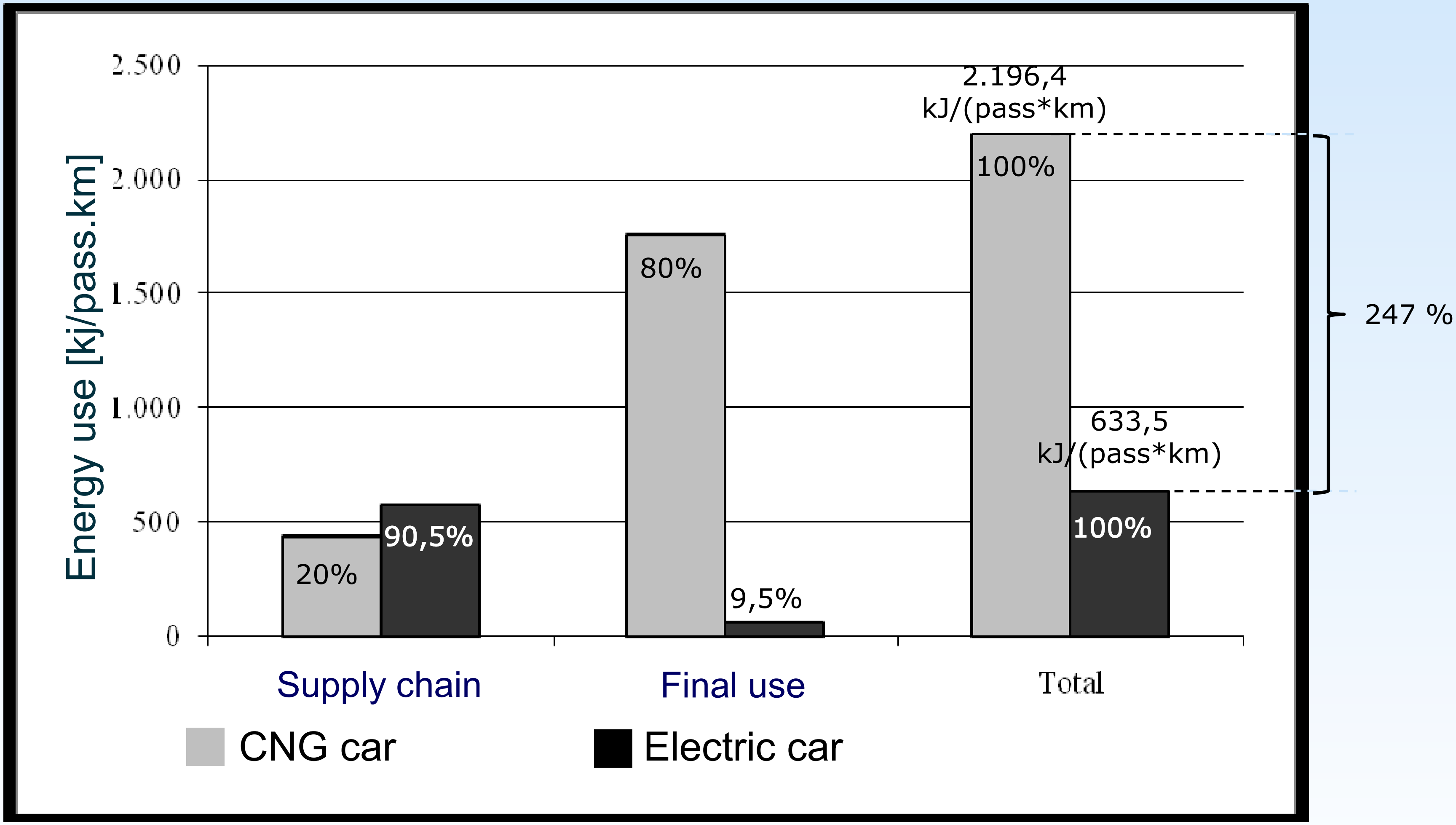
OPPORTUNITIES – ELECTRIC CARS



OPPORTUNITIES – ELECTRIC CARS



OPPORTUNITIES – ELECTRIC CARS



Investment, autonomy, operational costs?

FINAL CONSIDERATIONS

1. Brazil has many options for roadway urban transport energy sources and is planning the introduction of electric vehicles;
2. Comparative studies are being conducted considering financial and environmental aspects - end-use;
3. Additional studies are being conducted involving the supply of infrastructure and life cycle;
4. The use of electric traction in road vehicles appears to be inevitable step to take.

E1

FREIGHT TRANSPORT LABORATORY (LTC)

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www.ltc.coppe.ufrj.br
Coordinator: Márcio de Almeida D'Agosto
dagosto@pet.coppe.ufrj.br

Centro de Tecnologia, Bloco H, Sala 119
Cidade Universitária, Ilha do Fundão,
CEP: 21.949-900 – Rio de Janeiro – RJ
Phone: + 55 21 2562-8139 / 2562-8129

Slide 19

E1 Numero da fonte 28
Emmanuela, 01/08/2010