C40 Cities Climate Leadership Group

Mobilidade Sustentável

Programa de testes com ônibus limpos

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Cidades liderado a Agenda

HUFF POST GREEN

Cities and climate change

Greening the concrete jungle

America's cities are confronting climate change. They are also saving money

The Economist

The New York Times

theguardian

Bloomberg: Mayors hold key to climate change progress

World Bank to Help Cities Control Climate Change

By ALEXEI BARRIONUEVO
Published: June 1, 2011

Tackling Climate Change: New Reports Underscore Role Of Local Leaders

Megacity mayors leading the fight for sustainable survival at the C40 summit

grist
A BEACON IN THE SMOG

REUTERS

An Unlikely Power Duo Emerges in the Global Fight Against Climate Change

TIME

BBC WORLD NEWS

veja

CNN

Cities From London to Portland Slash Emissions as UN Climate Envoys Bicker

Q

Mayors reach climate deal with World Bank

(AFP) – Jun 1, 2011 0

CHINADAILY

TORONTO SUN
torontosun.com

indiatimes

The Jakarta Post

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PROGRAMA DE TESTES COM ONIBUS ELÉTRICOS E HIBRÍDOS NA AMÉRICA LATINA

Bogota, Rio de Janeiro, Santiago e Sao Paulo

In partnership with:

Agradecimentos:

- BID (Banco Interamericano)
- ISSRC e Qualipetro
- SPTRANS
- SMT e SVMA
- Operadores:
  Transpass e Ambiental
- Volvo
- Eletra
- Daimler
- BYD (Build Your Dream)
- Elektro (Iluminatti,
  Manvel e Sigma)

PROGRAMA DE TESTES:

- **Emissão de poluentes locais (HC, CO, NOx, PM);**
- **Teste piloto com diesel de cana.**
- **Eficiência Energética das diferentes tecnologias (motores combustão e elétricos – bateria e trólebus).**
- **Viabilidade econômica das tecnologias e ciclo de vida total em cada cidade.**

Tecnologias testadas? Total de 16 ônibus (diesel, híbridos, trólebus e elétrico a bateria).

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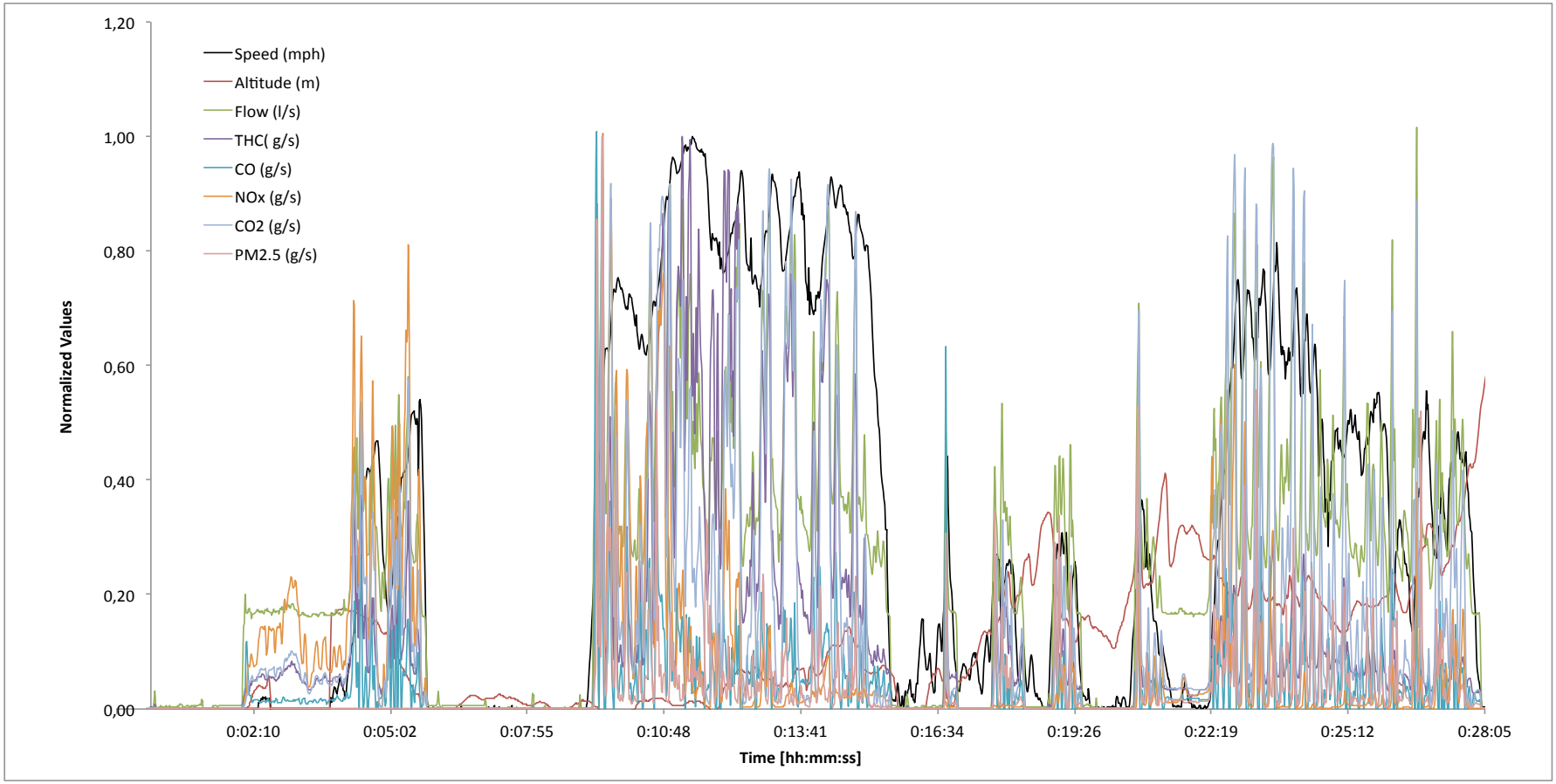
Como são feitos os testes?

Exemplo de medição das emissões segundo a segundo em ônibus rodando por linha comercial com carga máxima.



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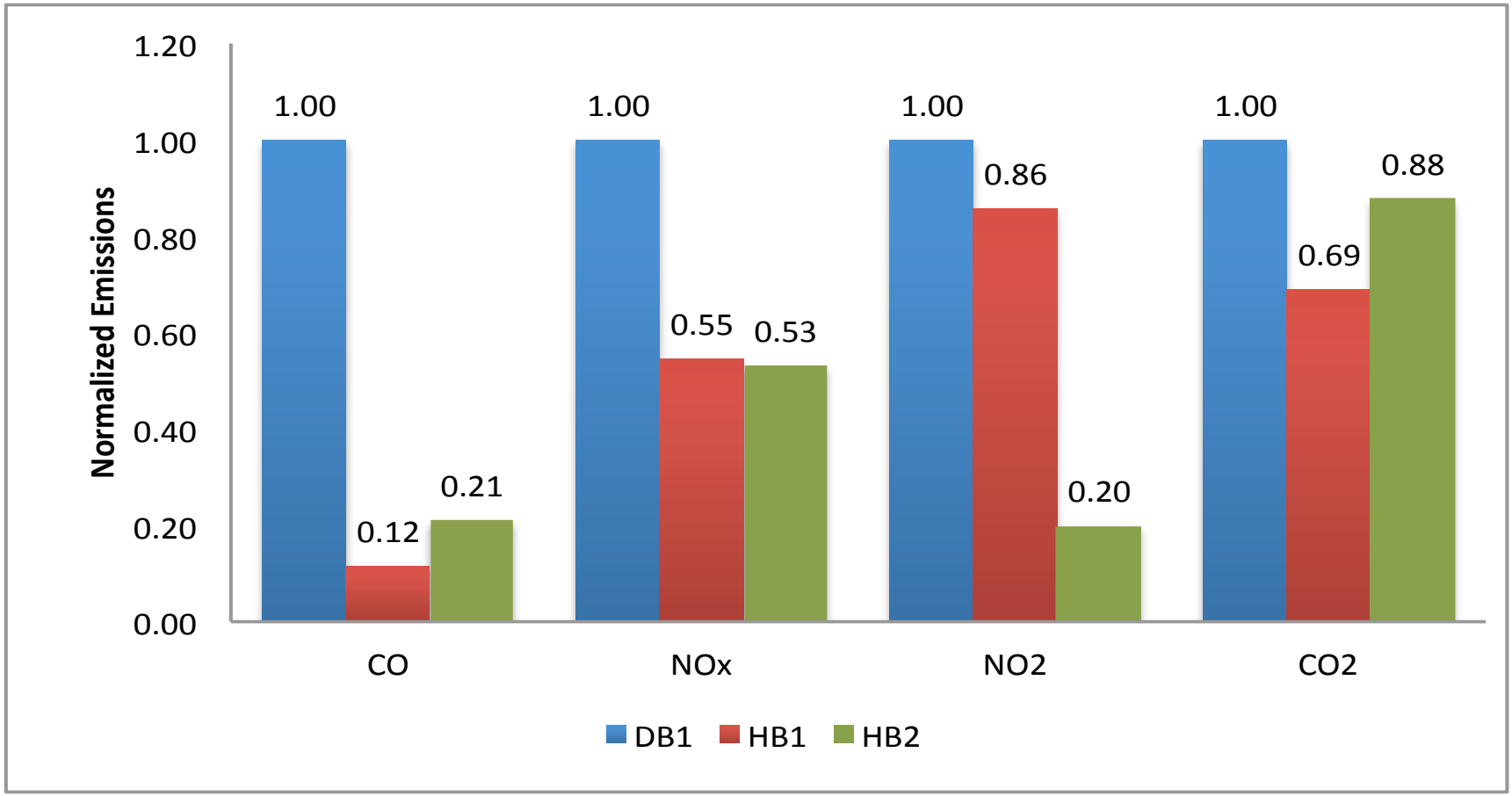
Sao Paulo com emissões padronizadas.

Comparação Híbridos x Diesel



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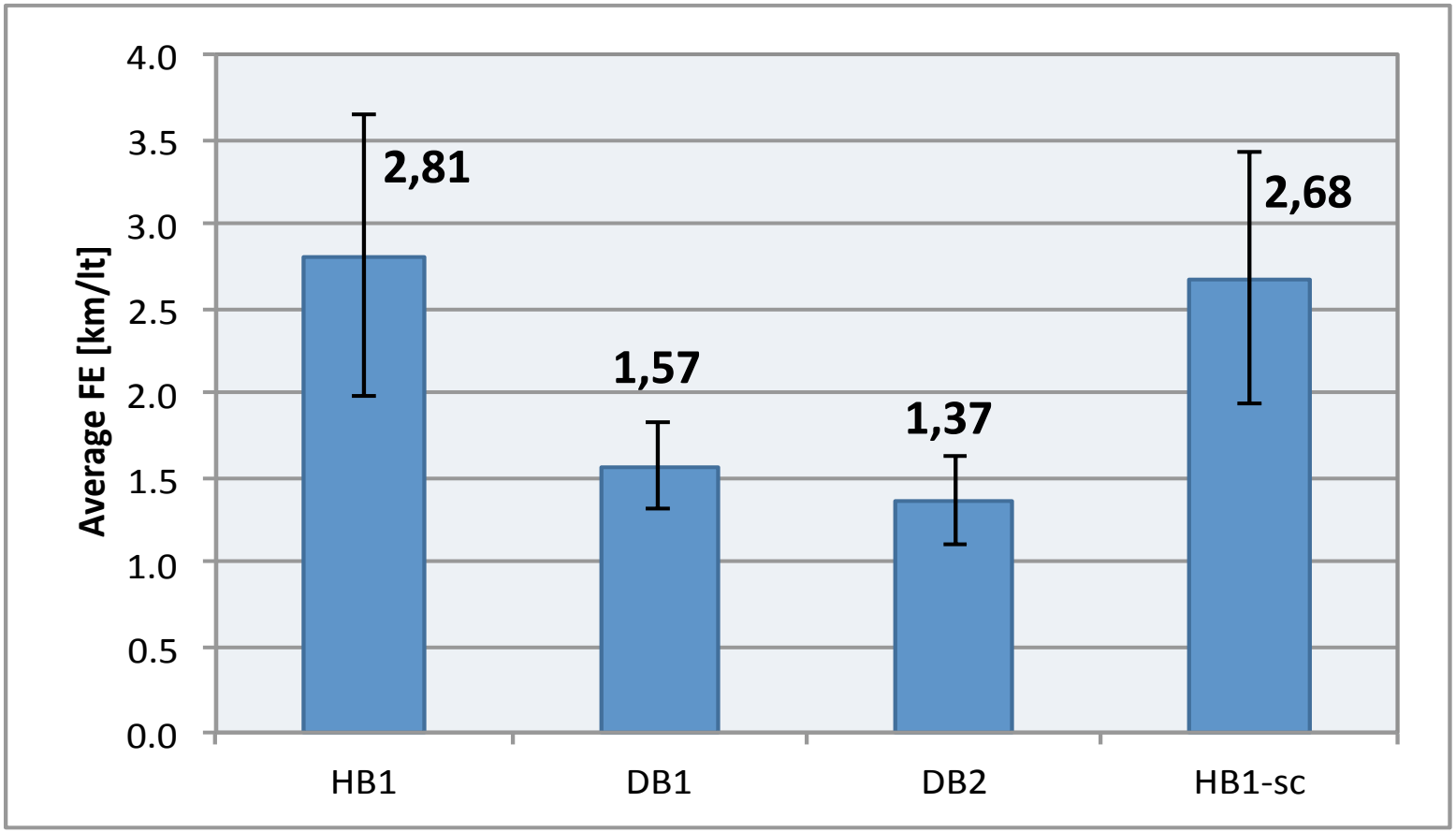
Eficiência energética em São Paulo

1° Campanha com híbrido paralelo (alguns testes com diesel cana).



HB1-sc : 100% DIESEL CANA

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Diesel 13,2m (DB1) Diesel 18m (DB2)
Hibrido Paralelo 12m (HB1)

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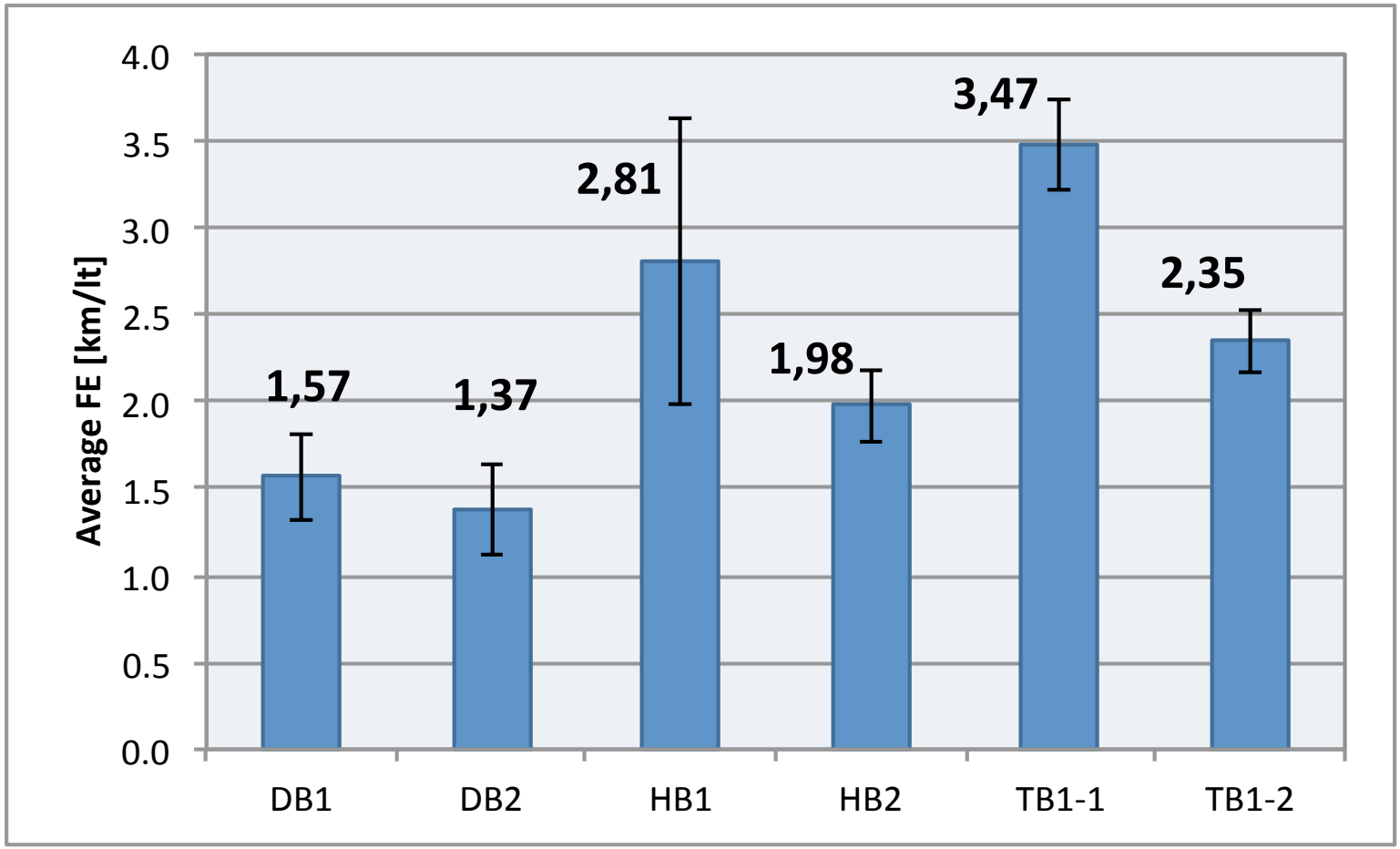
Eficiência energética em São Paulo

2° Campanha com híbrido serie e trólebus.



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Diesel (DB1 e DB2) Hibrido Paralelo (HB1) e Hibrido serie (HB2) e Trólebus (TB1-1-Custos; TB2-Energia),

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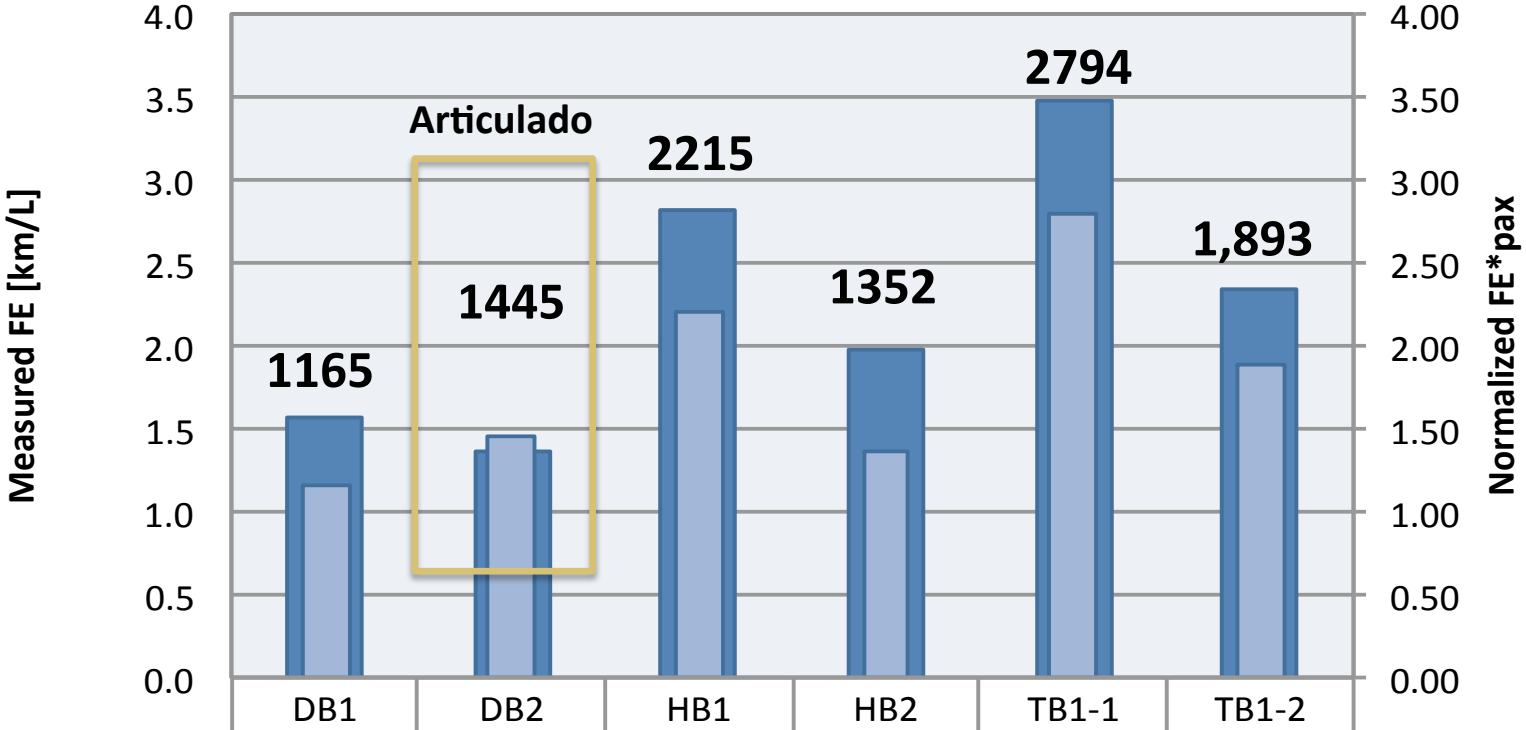
São Paulo: Eficiência energética padronizada pela capacidade de passageiros máxima.



	DB1	DB2	HB1	HB2	TB1-1	TB1-2
FE [km/L]	1.57	1.37	2.81	1.98	3.47	2.35
FE*pax	1.165	1.445	2.215	1.352	2.794	1.893

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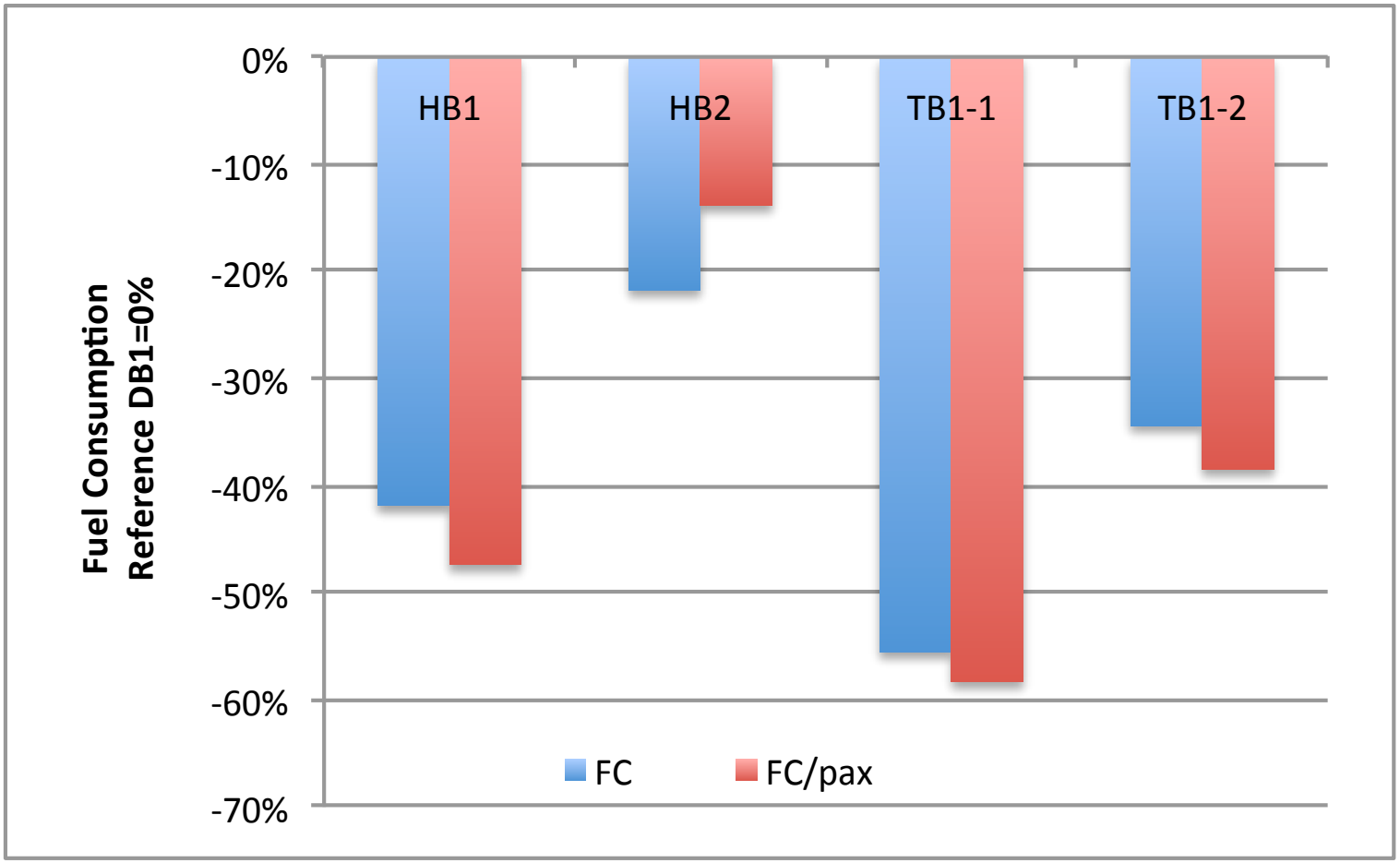
Diesel 13,2m: 76 passageiros - Diesel 18m: 109 passageiros
Hibrido1: 84 passageiros - Hibrido2:69 passageiros - Trolebus: 81 passageiros

Consumo de combustível padronizado dos Híbridos e Trólebus em relação ao ônibus diesel base



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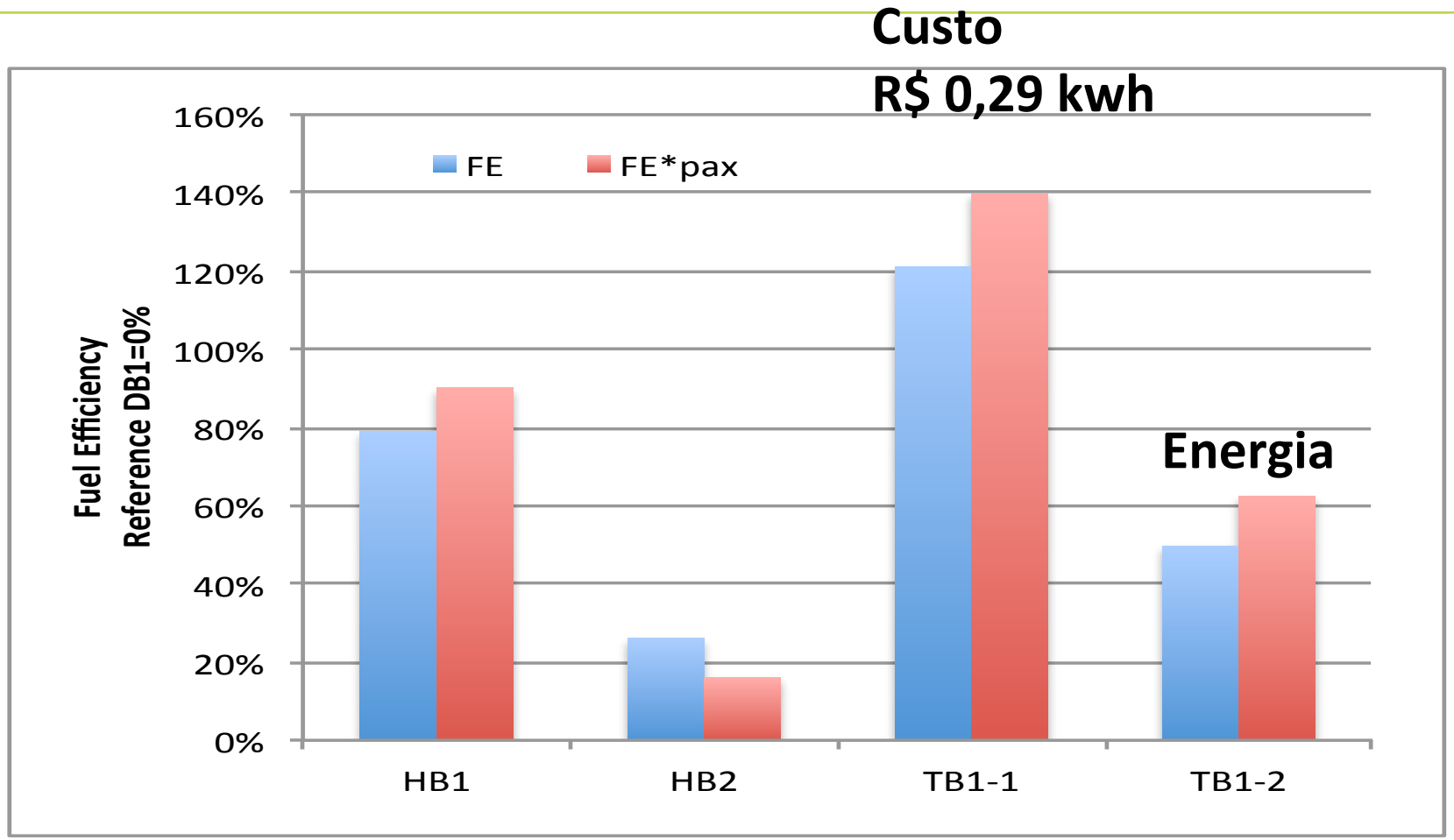
Eficiência do Ônibus Hibrido e Trólebus

Medida km/litro ou kwh



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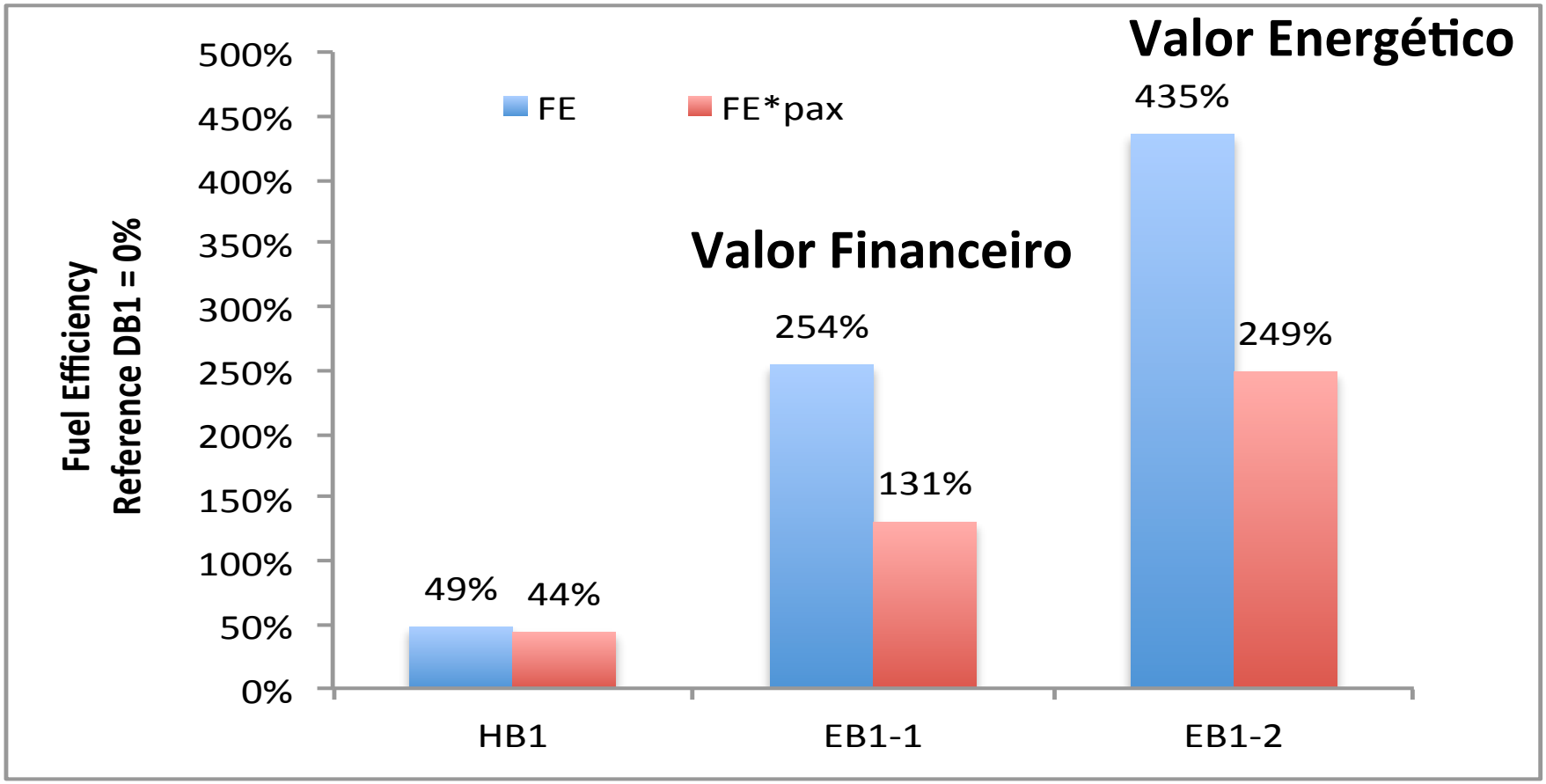
Eficiência do Ônibus Hibrido e Elétrico

Litro ou kwh/ km



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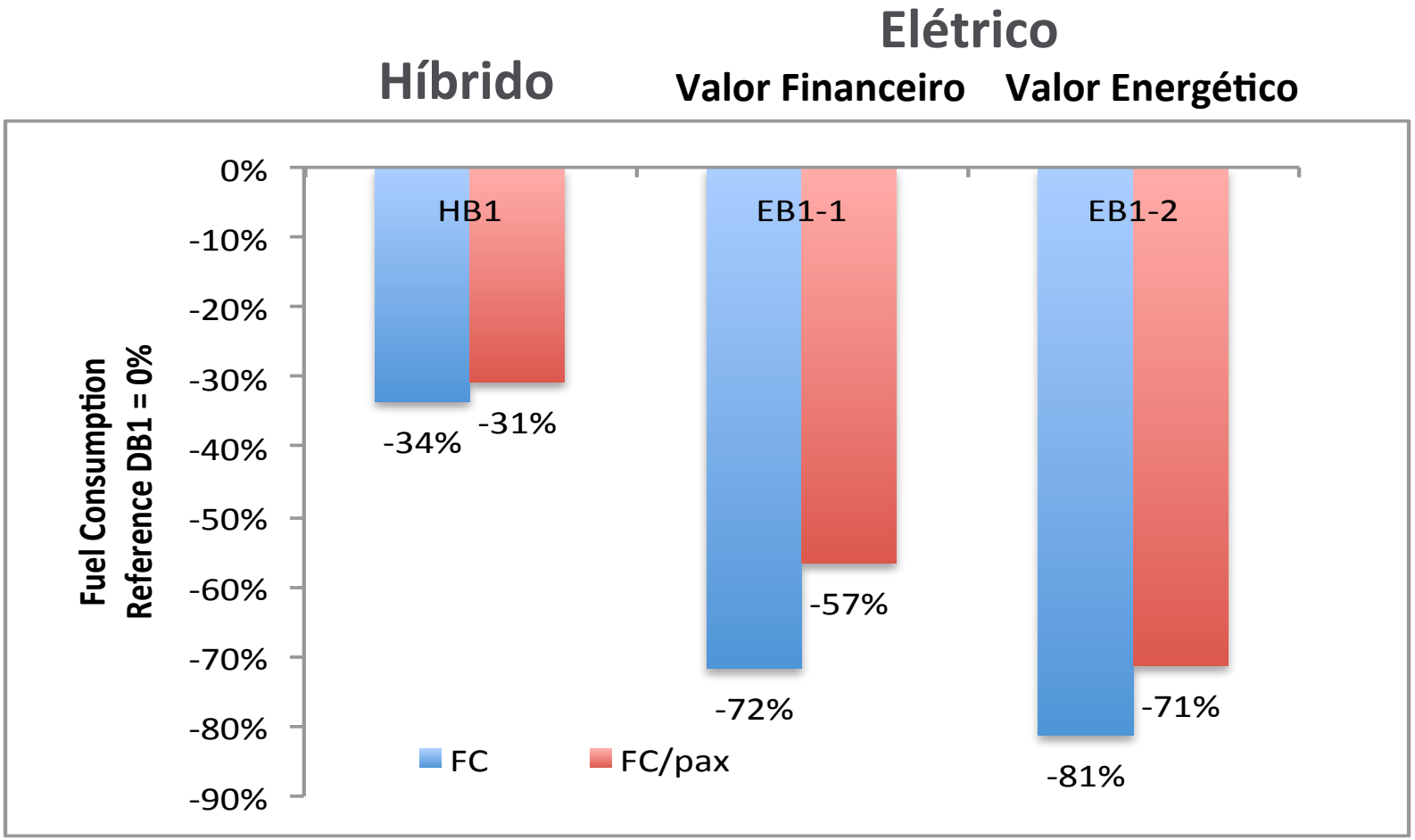
Maior eficiência nos Ônibus Hibridos e Elétricos

Litro ou kilowatts/ kilometro



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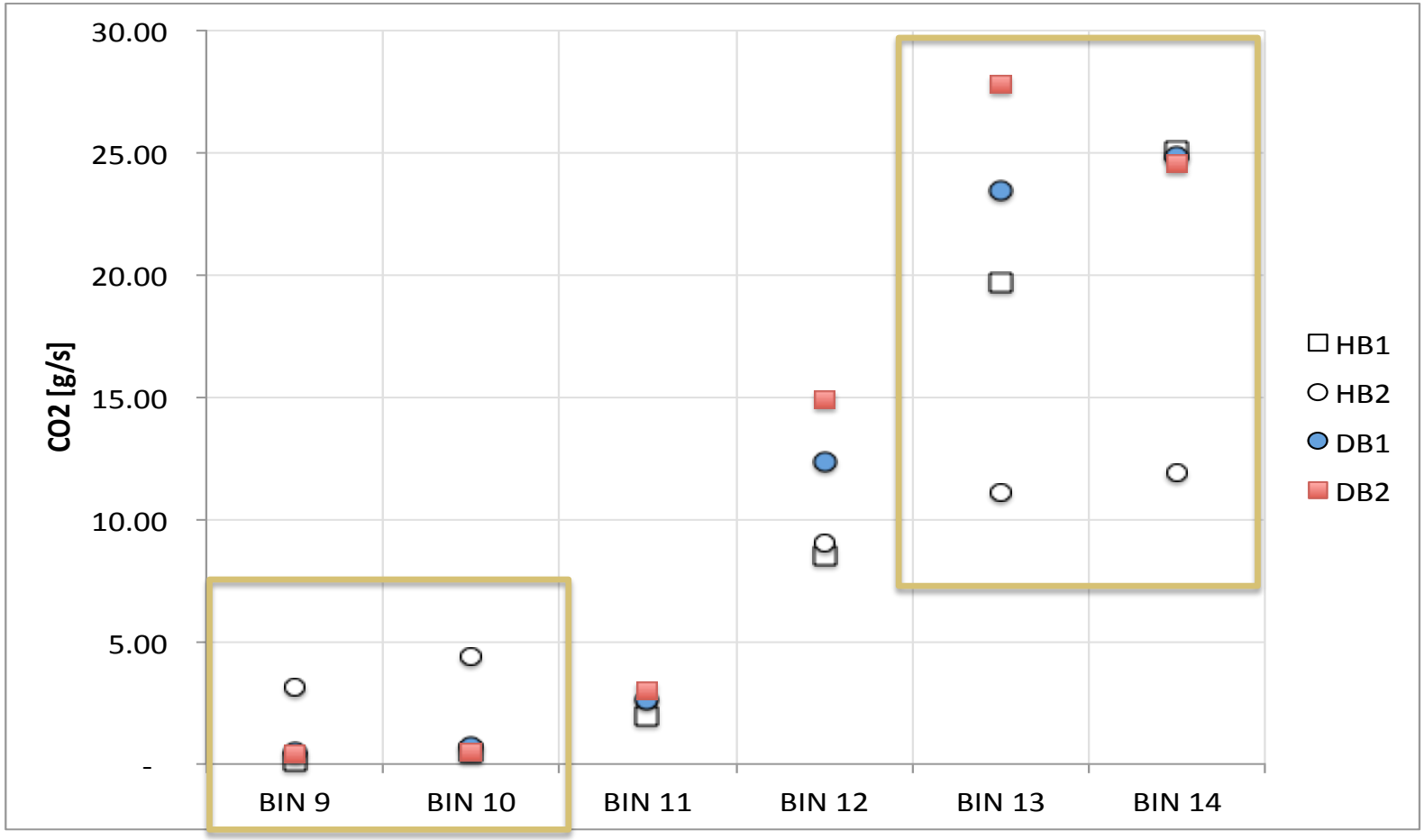
Comparação das emissões em relação ao VSP (Vehycle Specific Power)

- Com ciclos de operação repetitivos, sendo que 96% da operação em São Paulo ocorre entre Bins 10 to 14. Representando um VSP de -7 to 13.6 kw/ton (massa veiculo).
- Para as emissões de poluentes, distribuição dos resultados também são bastante parecida (98% dos resultados de emissões estão entre os Bin 10 e Bin 14).

- **Diesel e Híbridos seguem mesma relação** – Baixa emissão nos bins que demandam pouca energia (9, 10 and 11) e alta emissão nos bins mais altos.
- Híbridos em serie emitem mais em baixos usos energéticos, mas tem melhor desempenho quando o consumo energético do motor e' grande.

- Como a operação em **São Paulo apresenta velocidades mais baixas** em função do transito intenso (baixos VSP) híbridos tem desempenho muito bom em **função dos freios regenerativos e previsibilidade dos trajetos**
  (Obs.: desempenho ainda melhor nos elétricos, em especial movidos `a baterias).

Comparação do consumo em relação ao VSP (*Vehycle Specific Power*)



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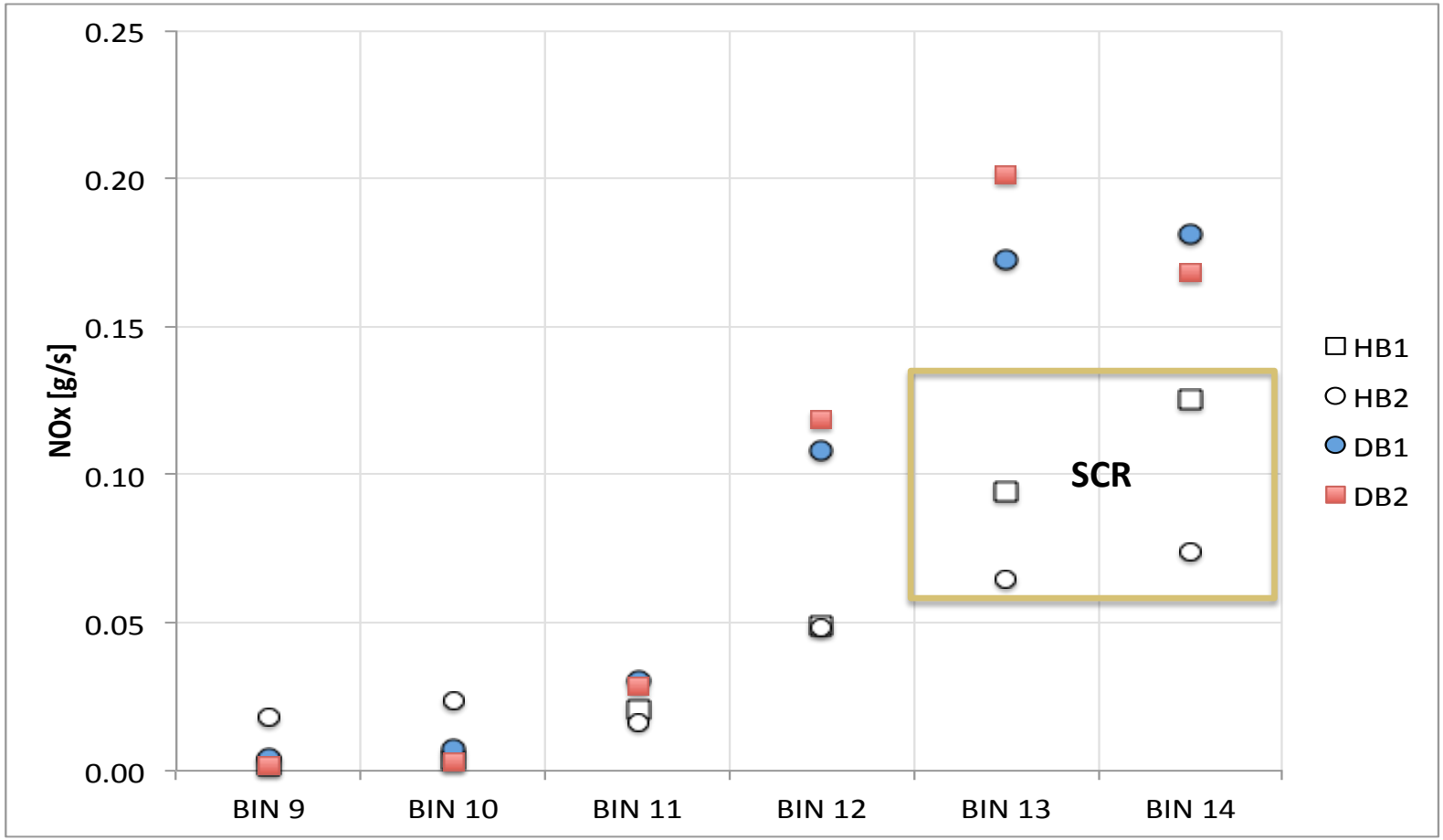
Comparação das emissões em relação ao VSP (*Vehycle Specific Power*)



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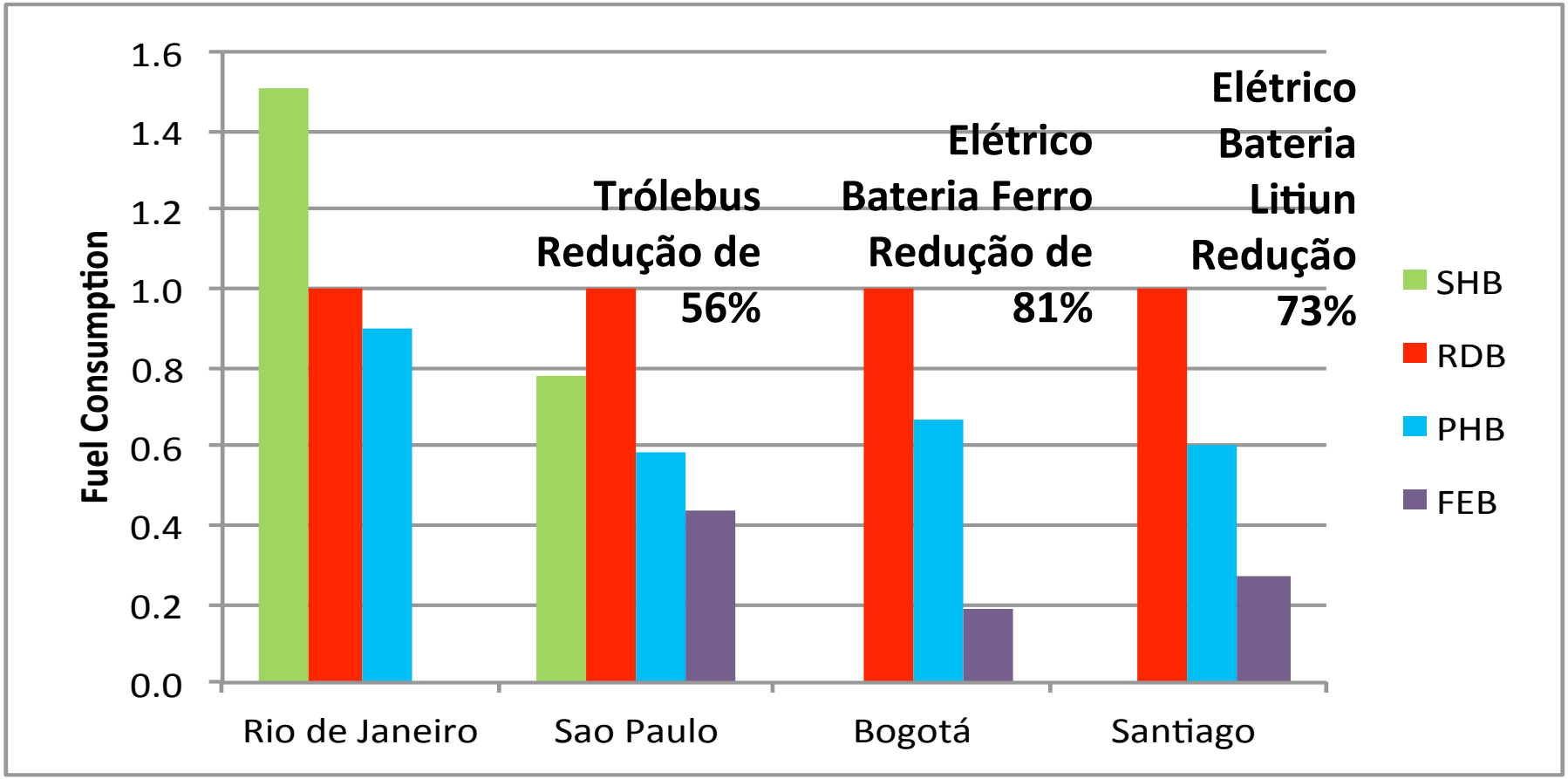
Conclusão geral sobre consumo energético



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Híbridos: Redução media de 31%

Conclusões iniciais

- Significativa redução na emissões de poluentes dos híbridos.
- Zero emissões de poluentes locais nos ônibus elétricos.
- **Aumento de velocidade** gera redução no consumo e nas emissões.
- **Variação de consumo** em função de motoristas (20%).
- Grande economia de combustível/energia com eletricidade.
  - Híbridos entre 31% a 39% em planície.
  - Trólebus geram redução de 56% no consumo energético.
  - Ônibus elétricos teve redução média de 77% no consumo. Ônibus elétricos com baterias de fosfato de ferro são tecnologia com melhor desempenho de todas (81% redução consumo).

Nov/Dez 2012: Visita tecnica

- Cidade do México;
- Gotemburgo;
- Estocolmo;
- Londres
- Xangai;
- Shenzhen,
- Changsa;
- Hong Kong

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IDB
Inter-American Development Bank

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HYBRID ELECTRIC BUS TEST PROGRAM IN LATIN AMERICA: Economic Analysis of the Program

Prepared by: Dalberg
Global Development Advisors

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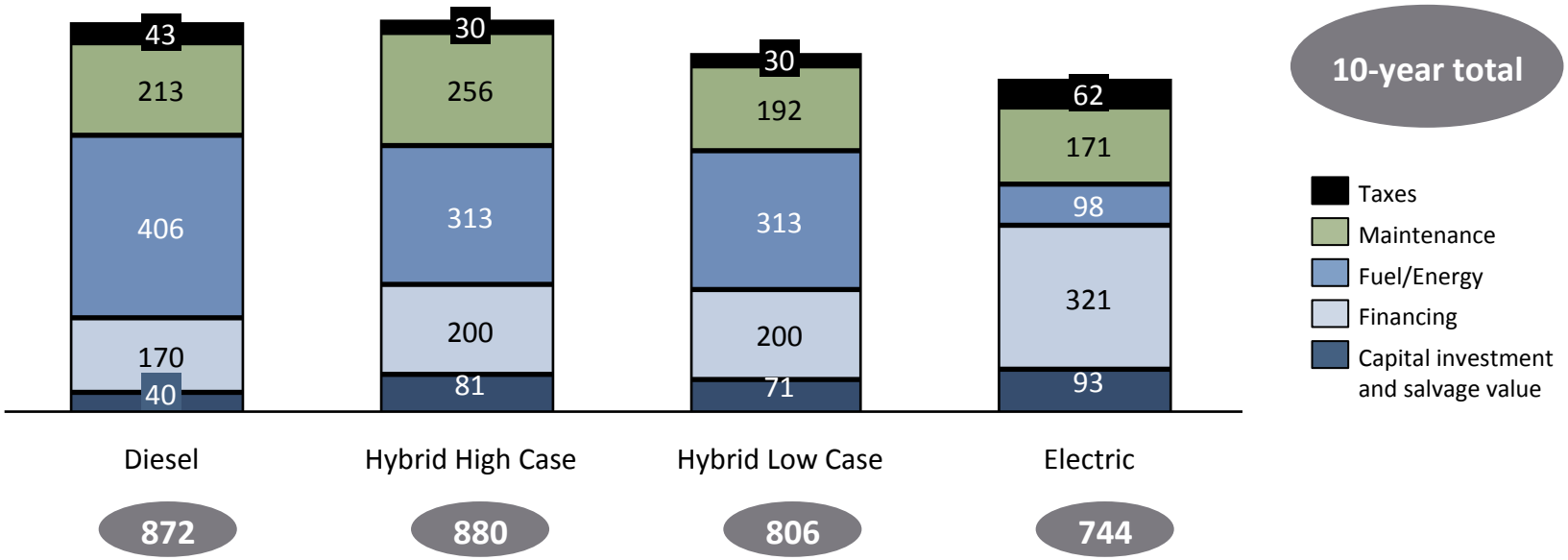
Lower energy and maintenance costs reduce lifecycle costs for hybrid and electric buses compared to diesel buses

Bogotá

Lifecycle Costs *('000 USD, 10-Year Net Present Value)*



	Diesel	Hybrid High Case	Hybrid Low Case	Electric
Financing	10% interest 10 year term	6% interest 10 year term	6% interest 10 year term	6% interest 10 year term
Maintenance costs	(baseline)	+20% higher than diesel	-10% lower than diesel	-20% lower than diesel
Salvage Value	Zero	10% of battery value	30% of battery value	30% of battery value

- **Hybrid and electric buses have lower lifecycle costs as scale and learning effects drive down maintenance costs**
- **Preferential financing can speed adoption, scale, and learning**

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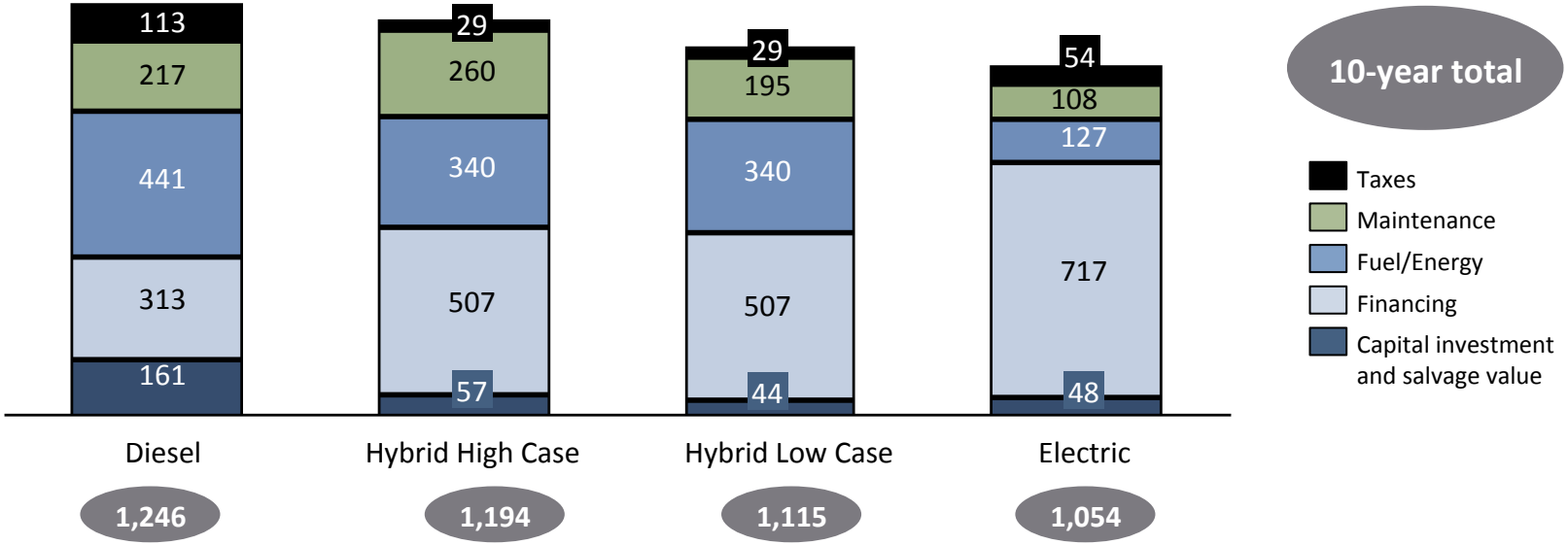
Notes: Bus costs/initial taxes are as follows: Diesel ($180K/$29K), Hybrid ($290K/$5K), Electric ($450K/$23K). Battery total value for hybrids are $100K. Battery total value for electrics is $203K. Salvage value represents % of total value discounted to year zero. Capital investment includes deduction for salvage value; Taxes include initial taxes and annual taxes related to bus ownership

Electrics achieve savings of ~20% compared to diesel assuming partially local production and

Rio de Janeiro

Lifecycle Costs ***('000 BRL, 10-Year Net Present Value)***



Financing	10% interest 5 year term	5% interest 10 year term	5% interest 10 year term	5% interest 10 year term
Maintenance costs	(baseline)	+20% higher than diesel	-10% lower than diesel	-50% lower than diesel
Salvage Value	30% of bus value (BRL 123,280)	10% of battery value	30% of battery value	30% of battery value

- **Electric buses achieve significant savings in lifecycle costs compared to diesel**
- **Hybrids are less costly than diesel even accounting for higher maintenance costs**

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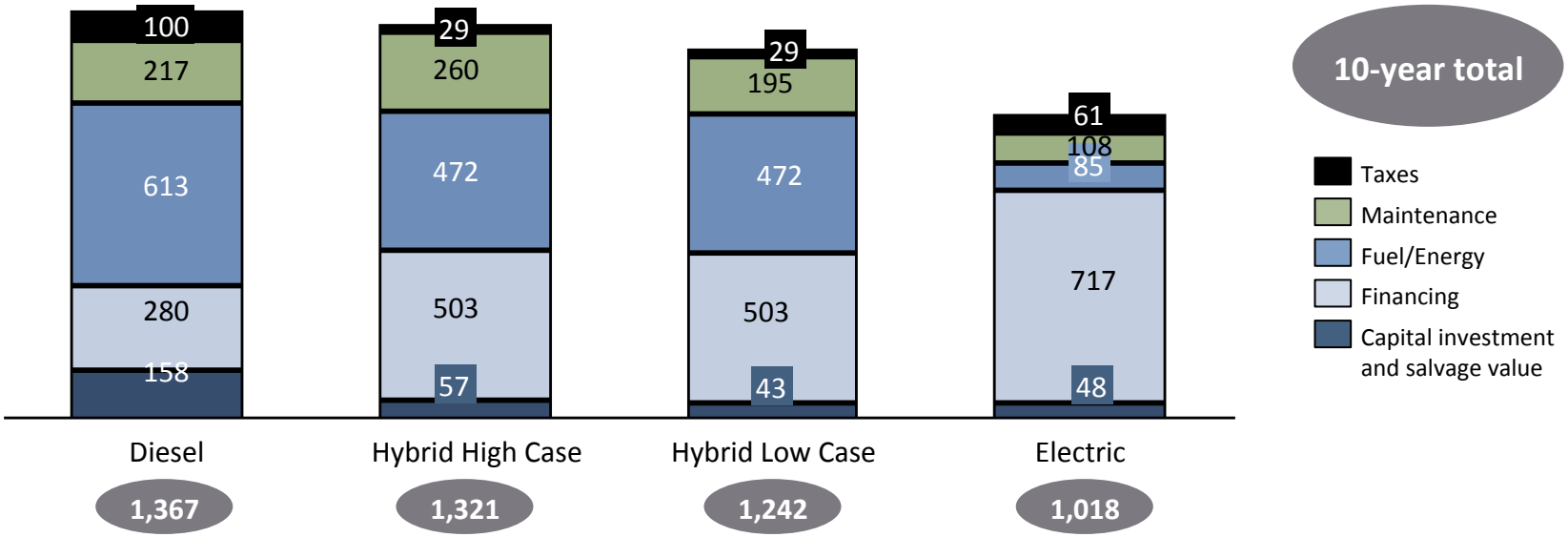
Assumes electric buses are partially produced/assembled locally, bypassing most import taxes. 10-year diesel costs includes purchase/resale of new bus after 5 years of operation. Capital investment includes deduction for salvage value; Taxes include annual taxes related to bus ownership. Bus costs/initial taxes are as follows: Diesel (BRL 329K/ BRL 140K), Hybrid (BRL 493K/BRL 151K), Electric (BRL 735K/BRL 175K). Battery total value for hybrids are BRL 163K; For electrics value is BRL 340K. Salvage value represents % of total value discounted to year zero.

Lifecycle costs of hybrid and electric buses are lower than costs for diesel buses due to preferential financing options

Sao Paulo

Lifecycle Costs *('000 BRL, 10-Year Net Present Value)*



Financing	10% interest 5 year term	5% interest 10 year term	5% interest 10 year term	5% interest 10 year term
Maintenance costs	(baseline)	+20% higher than diesel	-10% lower than diesel	-50% lower than diesel
Salvage Value	20% of bus value (BRL 98,600)	10% of battery value	30% of battery value	30% of battery value

- **Electric buses achieve ~30% lower lifecycle costs than diesel**
- **Even with 20% higher maintenance costs, hybrids are more attractive than diesel**

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Assumes electric buses are partially produced/assembled locally, bypassing most import taxes. 10-year diesel costs includes purchase/resale of new bus after 5 years of operation. Capital investment includes deduction for salvage value; Taxes include annual taxes related to bus ownership. Bus costs/initial taxes are as follows: Diesel (BRL 296K/ BRL 123K), Hybrid (BRL 493K/BRL 146K), Electric (BRL 735K/BRL 175K). Battery total value f or hybrids are BRL 163K; For electrics value is BRL 340K. Salvage value represents % of total value discounted to year zero.

São Paulo uptake: Policy and favorable financing can drive uptake and conversion to hybrid and electric buses

São Paulo

Primary Drivers of Uptake in São Paulo

Policy

- **Enforcement of existing Climate Change Law**
  - Law requires bus operators to switch away from fossil-based fuels entirely by 2018; Legislation favors electric, biodiesel, ethanol, and sugarcane diesel technologies
- Adding **technology or fuel performance standards** in new BRT concession awards and existing concession renewals
  - Standards can be included in 4 new BRT routes and in the renewal of other existing contracts to require transition to hybrid or electric technologies

Economic/Market

- **Low-interest financing** for hybrid & electric technologies
  - BNDES may reverse financing incentives that currently favor diesel buses over hybrid and electric buses
- **Reduce/eliminate unfavorable taxes and subsidies**
  - Current high tax rates (import and other taxes) add ~35% to the cost of new electric buses imported
  - Petrobras subsidizes the cost of diesel fuel for operators, while electricity is taxed heavily

Other

- **Demonstrated evidence** of the advantages and operational east of hybrids in other Brazilian cities
  - Small hybrid fleet has begun service in Curitiba, and has the potential to provide tangible favorable evidence to reduce transition risk for other operators in Brazil

High Uptake Scenario

Assumptions:

- Climate Law introduces exemption for diesel hybrids
- Large operators become comfortable with operation and maintenance of hybrid technologies in Curitiba
- New/renewed contracts include strict requirements to transition to cleaner fuels more quickly
- BNDES establishes concessional finance lines for hybrid and electric buses significantly below rates for diesel

Potential uptake:

- ~2% of fleet transitions to hybrid or electric each year 2013-2015, rising to 5% in 2016 and 10% in 2019
- 12% of fleet (~1,200 buses) is H/E by 2016; ~70% by 2023 (~7,400 buses)

Low Uptake Scenario

Assumptions:

- Ethanol and/or sugarcane diesel prices decline steadily
- BNDES unable to provide additional financing incentives for hybrid or electric buses
- No tax relief provided for imported electric buses

Potential uptake:

- Minimal uptake by 2016 (approximately 300 buses)
- Gradual increase in uptake as cost and performance improve; ~13% of fleet transitions by 2020 (~1,330 buses); ~30 of fleet transitions by 2023 (~3,200)

Source: Drivers based on discussions with officials and operators in São Paulo. Uptake scenarios based on Dalberg analysis and assumptions regarding potential conversion rates

São Paulo Roadmap

São Paulo

	Potential solutions	Estimated impact	Likely feasibility	Timeframe needed for implementation (years)	Stakeholder to influence
Economic	A. BNDES preferential loans for H/E buses at lower interest than diesel				BNDES/Buyers
	B. Leasing electric battery system				Manufacturers
	C. Fixed maintenance/fuel/ energy fee to reduce costs and technological uncertainty				Manufacturers
	D. Extend life contracts and eliminate 5 year average maximum on contracts				City officials
Policy	E. Fuel efficiency standards for new concessions				State/City officials
	1.Inter-municipal 4 new BRTs				State officials
	2.City new BRT (150kms)				City officials
	F. Preferential import tax rates for H/E				Min.Com./Fin./Ind
	G. Incentives locally produce H/E				Min.Com./Fin./Ind
	H. Reduce subsidies to diesel				Ministry of Ind.
	I. Reduce taxes to electricity				Ministry of Ener.
Misc	J. Leasing bus entity to eliminate technological risk/ reselling			***High Potential***	BNDES/BID/ Manufacturers

Timeframe needed for implementation (years): 1 | 2 | 3 | 4 | 5

Source: Interviews with stakeholders; CCI/C40; Dalberg analysis

São Paulo uptake: Fleet conversion will be required to meet mandates of Climate Change Law by 2018

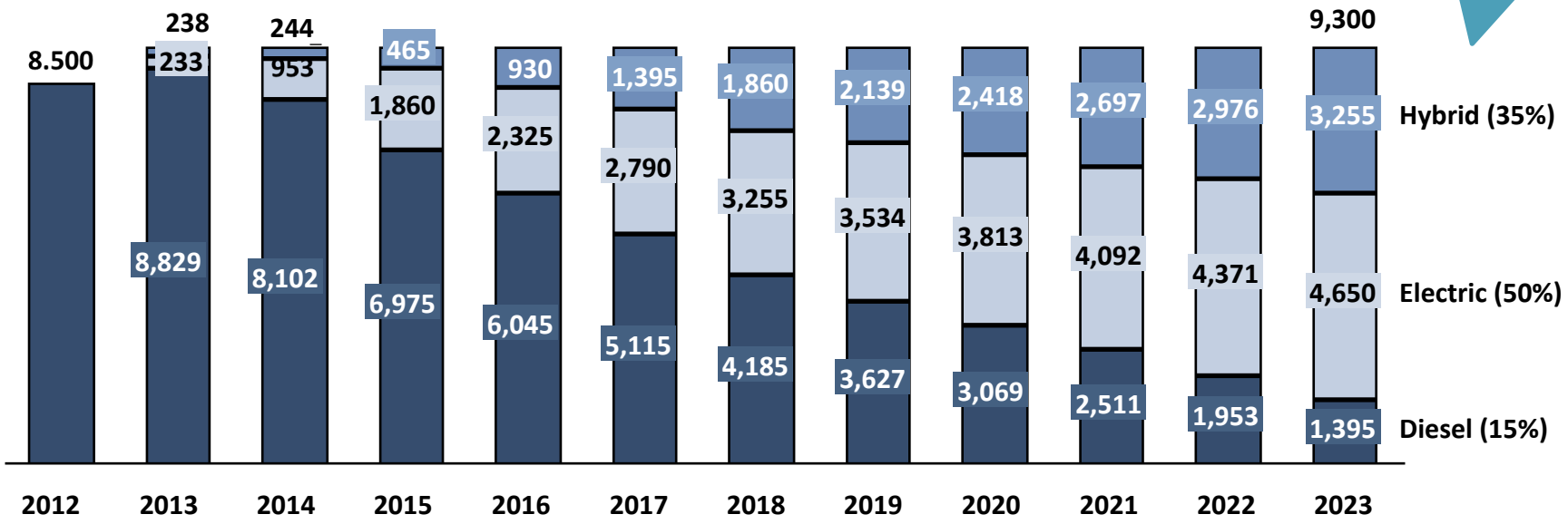
São Paulo

Potential Fleet Transition in São Paulo, 2013-2023 *(Illustrative High Uptake Scenario)*

- Additional ~800 buses enter service for BRTs; 1/3 of new BRT buses are hybrid
- Another ~250 electric buses enter service

Incremental conversion of ~2% of fleet to hybrid and electric buses annually, rising to 5% in 2016 and 10% in 2019

By 2023 over 3/4 of fleet is composed of hybrid or electric buses



Assumptions and Drivers of Change:

- Local production to avoid Import tax and/or reduction of taxes
- Climate Change Law provides exemption for hybrid (diesel) buses, catalyzing their growth
- Share of hybrid and electric buses in fleet reaches 55% by 2018; Remaining diesel buses shift to biodiesel blend & sugarcane to comply with Climate Law
- Share of hybrid and electric buses increases by 5% points in each year from 2014 to 2018, growth slowing starting in 2019

Source: Dalberg estimates based on projections and assumed annual conversion rates

Muito obrigado.

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Maiores informações

Adalberto Maluf

amaluf@c40.org

Website: www.c40.org

Twitter: @C40cities

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