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FAPESP BIOENERGY RESEARCH PROGRAM – BIOEN

International Workshop about the Ethanol Combustion Engines,

The Bioethanol for Sustainable Transportation Project - Results from Brazil

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FAPESP AUDITORIO
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FAPESP
FAPESP Workshop on Ethanol Based Engines for TransportationBiodiversidade & Química
Oct 4th - FAPESP - São Paulo

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CONTENT

1) Bioethanol for Sustainable Transportation – BEST project description
2) Technical and economic results from Brazilian experiment
3) Economic barrier for ethanol –How to remove
4) Conclusions

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BEST Project

- BEST Project aims to promote the ethanol usage, replacing diesel, in public urban transport in Brazil and worldwide;
- Beyond São Paulo, the pioneer city in America, eight cities in Europe and Asia take part in the project;
- The project is an European Union initiative, and it is coordinated by the Stockholm City Hall.

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Review

1985 – Tests started in Sweden.

1990 to 2007 - 600 operational buses

Programa ECOFROTA

PREFEITURA DE
SÃO PAULO
TRANSPORTES

Marcelo C. Branco

Changing the Energy Profile

✓ Diesel

ecofrota

✓ Biodiesel
✓ Ethanol
✓ Diesel from sugar cane

✓ Trolleybus
✓ Hybrid
✓ Electric
✓ Fuel cell bus

Biodiesel

- B20 – diesel S50 (50 ppm of S) + 20% biodiesel;
- 1200 busses – Operated by VIP + 800 up to end of 2012
- Distribution logistics - Very favourable;
- Product already available in the market and no vehicle retrofit required;
- 22% PM and 20% CO_2 reduction

Troleybus

- Present fleet - 190 busses;
- 64 new busses to be added soon;
- Replacement of the old 140 busses forecasted by end of 2012
- Tecnology well established and used in São Paulo;
- Zero CO_2 emission

Ethanol

- Tecnology from Scania;
- 60 Busses in operation (Metropolitana / TUPI);
- 90% PM and 64% NOx reduction;
- 95% CO2 emission reduction;
- Ethanol + 5% additive.

Diesel da Cana de Açúcar

- 160 busses – Operated by: Viação Sta. Brígida;
- Diesel S50 + 10% diesel from sugar cane;
- No engine retrofit required;
- Same consumption and performance as conventional diesel fuel;
- Less opacity and less PM

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The City of Sao Paulo Receives the First Bus Fleet of Diesel Engine Busses Running on Ethanol May 25th, 2011

26 de maio de 2011 • 21h53 • atualizado às 21h56

NOTÍCIA

60 busses already sold
10 busses in operation by May 27, 2011
50 busses in operation by June 30, 2011

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Charactheristics of Viação Metropolitana ethanol fed busses operating routes.

Line	6358-10	509M-10	577T-10
Itinerary	Jd Luso-T Bandeira	Jd Miriam-T Princ Isabel	Jd Miriam–V Gomes
Total fleet	13	15	40
Ethanol fleet	9	9	30
Main routes	Av. Cupecê	Av. Cupecê	Av. Cupecê
	Av. Ver José Diniz	Av. Ver José Diniz	Av. Jabaquara
	Av. Ibirapuera	Av. Ibirapuera	Av. Paulista
	Av. Nove de Julho	Av. Vinte e Três de Maio	Av. Rebouças
Km month (travelled by the fleet in the line)	80,402	98,707	202,998
IPK[1]	3.07	3.00	3.93
Diesel average efficiency	2.34	2.16	2.00
Ethanol average efficiency	(52%) 1.208	(56%) 1.200	(48%) 0.960

1 Number of Passenger/km travelled

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COSTS

COMBUSTÍVEL R$ / km						
DIESEL	B20	ETANOL	AMD10	TROLEIBUS	TROLEIBUS + INFRA	HIBRIDO
0,97	1,15	1,80	1,42	0,90	0,90	0,63

TECNOLOGIA R$ / km						
DIESEL	B20	ETANOL	AMD10	TROLEIBUS	TROLEIBUS + INFRA	HIBRIDO
5,40	5,60	6,50	5,80	6,20	7,40	6,90

EXPENSES

Combustível	2011			2012 até mar/12		
	Litros	Valor Compra R$	Reembolso SMT - R$	Litros	Valor R$	Reembolso SMT - R$
B20	43.720.002	87.419.679	14.880.328	13.205.000	27.643.849	5.462.305
Etanol	1.588.000	3.622.457	272.519	795.000	1.803.310	132.219
Amyris	205.000	527.138	162.483	955.000	2.459.662	764.729
Total	45.513.002	91.569.274	**15.315.330**	14.955.000	31.906.820	**6.359.253**

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TOTAL FLEET PROFILE

ECOFROTA

	B20	ETHANOL	AMD10	DUALFUEL	HIBRIDO	B20+AMD10	TROLEBUS	% ECOFROTA	% ECOFROTA + B5
2011	1200	60	160				190 (20)	9,5	100
2012	1415	105	469	293	100	104	190 (140)	16,7	100

EMISSIONS

	2011	2012
Emission reduction (%)	6.3	9.5
CO2 reduction (%)	6.7	9.2
CO2 reduction (t/month)	7,835	10,735

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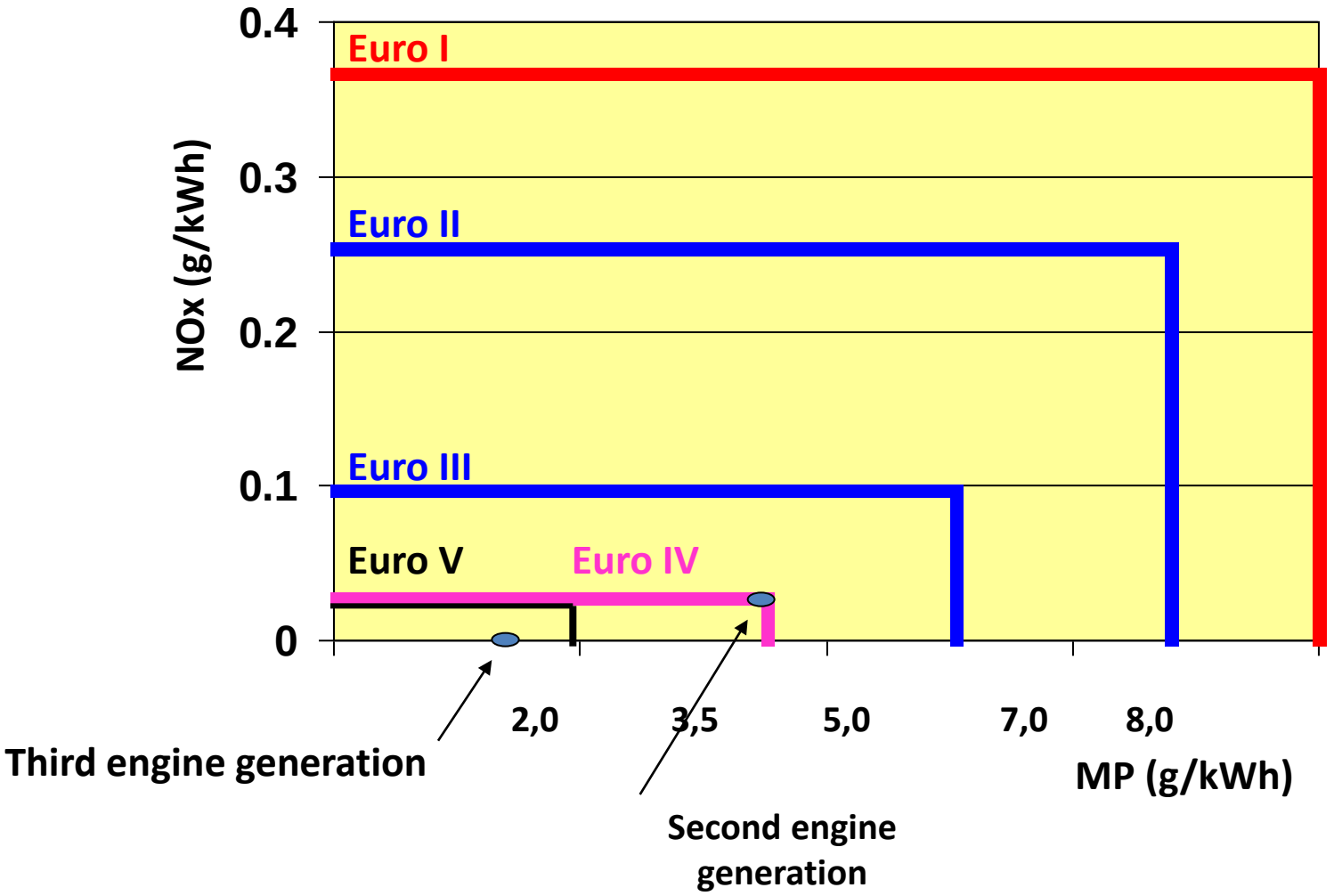
Emission Limits for diesel engines



Source:SEKAB

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Ethanol engine contribution to reduce pollutants

Emissions reductions in comparison to diesel

(CONAMA 5)

CO: - 92%	**MP: - 93%**
HC: - 87%	**NOx: - 52%**
SOx: ~ 100%	**CO_2: ~ 100%**

Regulated emissions limit for heavy diesel vehicles according with the several historical PROCONVE phase (g/kWh)

PROCONVE	EURO	CO	HC	NOx	PM	Period	(CONAMA) Legislagion	Sulfur Content
Phase I (P1)	NA	14.00*	3.50*	18.00*	-	1989 a 1993	Res. 18/86	-
Phase II (P2)	Euro 0	11.20	2.45	14.40	0.60	1994 a 1995	Res. 83/93	3.000 a 10.000 ppm
Phase III (P3)	Euro 1	4.90	1.23	9.00	0.40 ou 0.70[1]	1996 a 1999	Res. 08/93	3.000 a 10.000 ppm
Phase IV (P4)	Euro 2	4.00	1,.0	7.00	0.15	2000 a 2005	Res. 08/93	3.000 a 10.000 ppm
Phase V (P5)	Euro 3	2.10	0.66	5.00	0.10 ou 0.13[2]	2006 a 2008	Res. 315/02	500 a 2.000 ppm
Phase VI (P6)	Euro 4	1.50	0.46	3.50	0.02	2009 a 2012[3]	Res. 315/02	50 ppm
Phase VI I (P7)	Euro 5	1.50	0.46	2.00	0.02	2012	Res. 403/08	10 ppm

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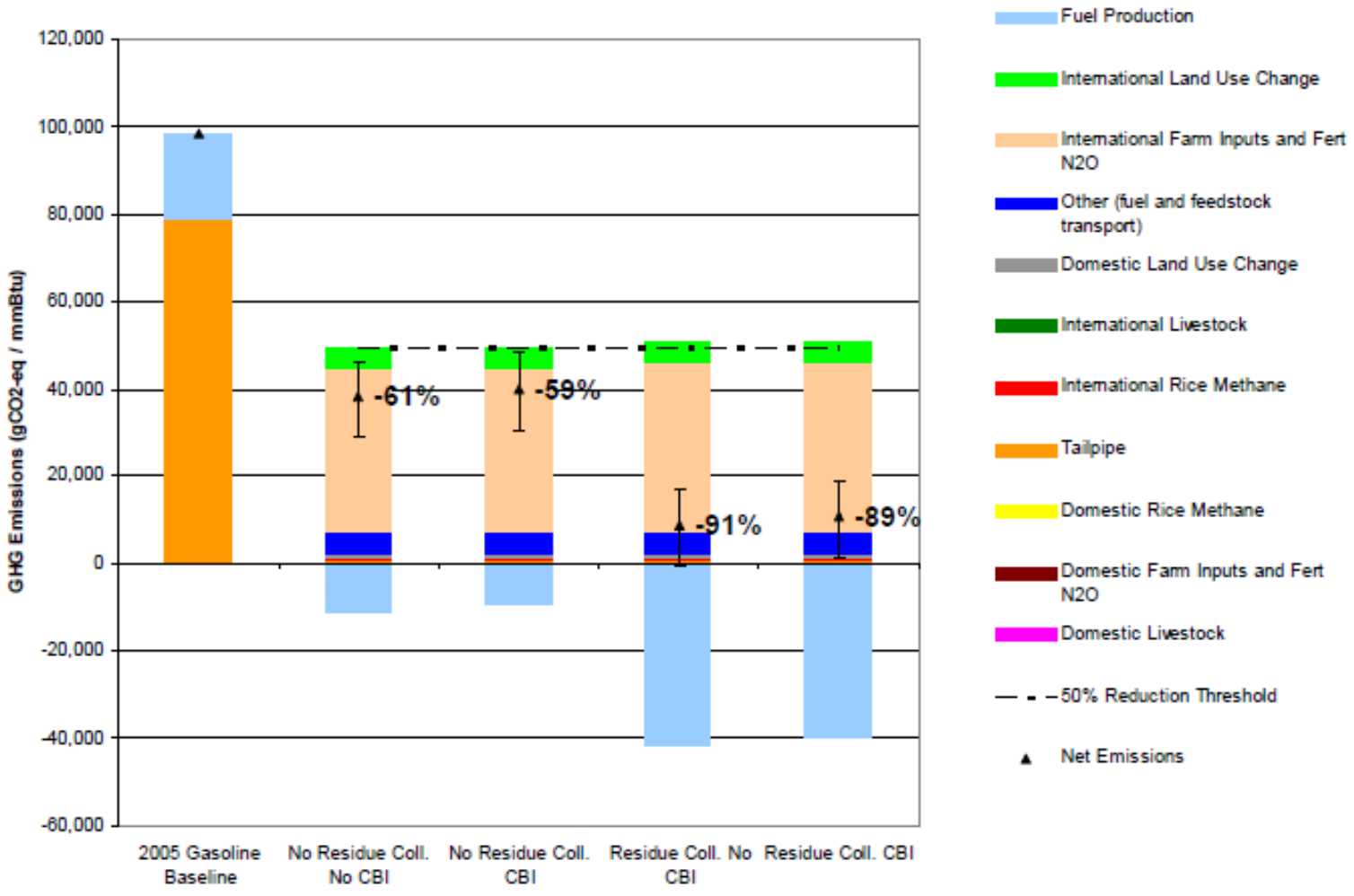
Figure 2.6-10. Results for Sugarcane Ethanol by Lifecycle Stage With and without residue collection and CBI



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Impacts on health due PM and CO in the city of São Paulo

Reduction in hospitalization	4.588 person/yr
Redução in young population mortality	745 person/yr
Reduction in expenses associated with dieseases and mortality	US$ 146.5 million/yr

SOURCE; Study from Medical University of USP

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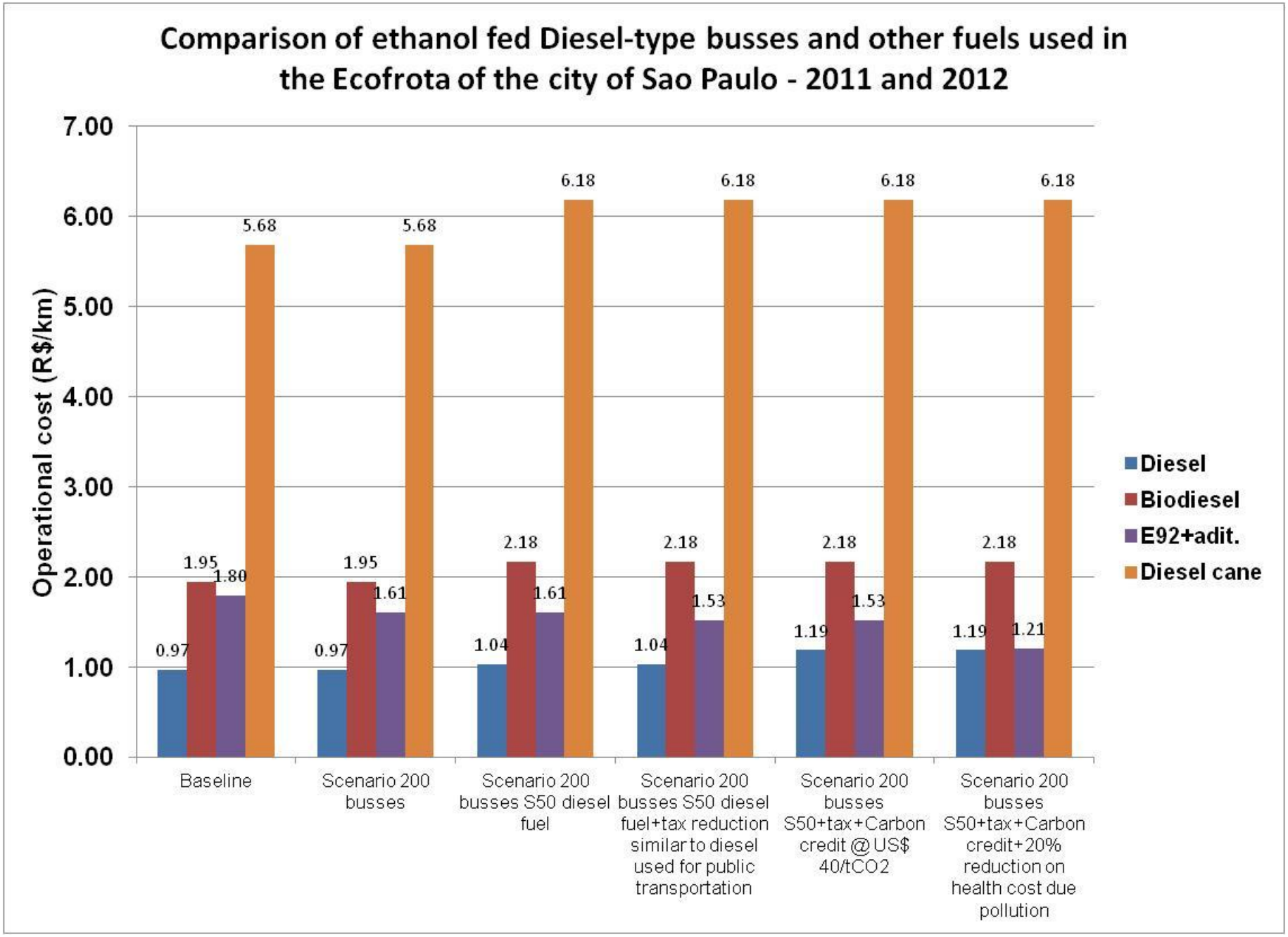
Fuel Costs for Ecofleet

	Diesel	Biodiesel	E92+adit.	Diesel cane
Scenario	**Operational cost (R$/km)**			
Baseline	**0.97**	**1.95**	**1.80**	**5.68**
200 busses	**0.97**	**1.95**	**1.61**	**5.68**
200 busses S50 diesel fuel	**1.04**	**2.18**	**1.61**	**6.18**
200 busses S50 diesel fuel+tax reduction similar to diesel used for public transportation	**1.04**	**2.18**	**1.53**	**6.18**
Scenario 200 busses S50+tax+Carbon credit @ US$ 40/tCO2	**1.19**	**2.18**	**1.53**	**6.18**
200 busses S50+tax+Carbon credit+20% reduction on health cost due pollution	**1.19**	**2.18**	**1.21**	**6.18**


Comparison of ethanol fed Diesel-type busses and other fuels used in the Ecofrota of the city of Sao Paulo - 2011 and 2012
Operational cost (R$/km)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.97
1.95
1.80
5.68
0.97
1.95
1.61
5.68
1.04
2.18
1.61
6.18
1.04
2.18
1.53
6.18
1.19
2.18
1.53
6.18
1.19
2.18
1.21
6.18
Baseline
Scenario 200 busses
Scenario 200 busses S50 diesel fuel
Scenario 200 busses S50 diesel fuel+tax reduction similar to diesel used for public transportation
Scenario 200 busses S50+tax+Carbon credit @ US$ 40/tCO2
Scenario 200 busses S50+tax+Carbon credit+20% reduction on health cost due pollution
Diesel
Biodiesel
E92+adit.
Diesel cane

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Advantages with the use of Ethanol in diesel type engines

- Ethanol is renewable, clean and biodegradable;
- Reduction on local air pollution: 90% for particulate matter and 62% for NOx;
- Fulfills EURO 5 and EEV – *Enhanced Environmental Vehicle*;
- Zero sulfur content, thus no impact on acid rain;
- 80% or more reduction on GHG emissions;
- Creates employments on rural areas;
- Is almost commercially feasible;
- Is immediately available in large amounts;
- Is fully compatible with existent liquid fuel distribution system;
- Is a national product.

Today it is already less costly than biodiesel

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THANK YOU VERY MUCH

QUESTIONS?

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