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Pollutants Emissions
Global warming Potential Effect

First Comparison using External Costs on Urban Buses

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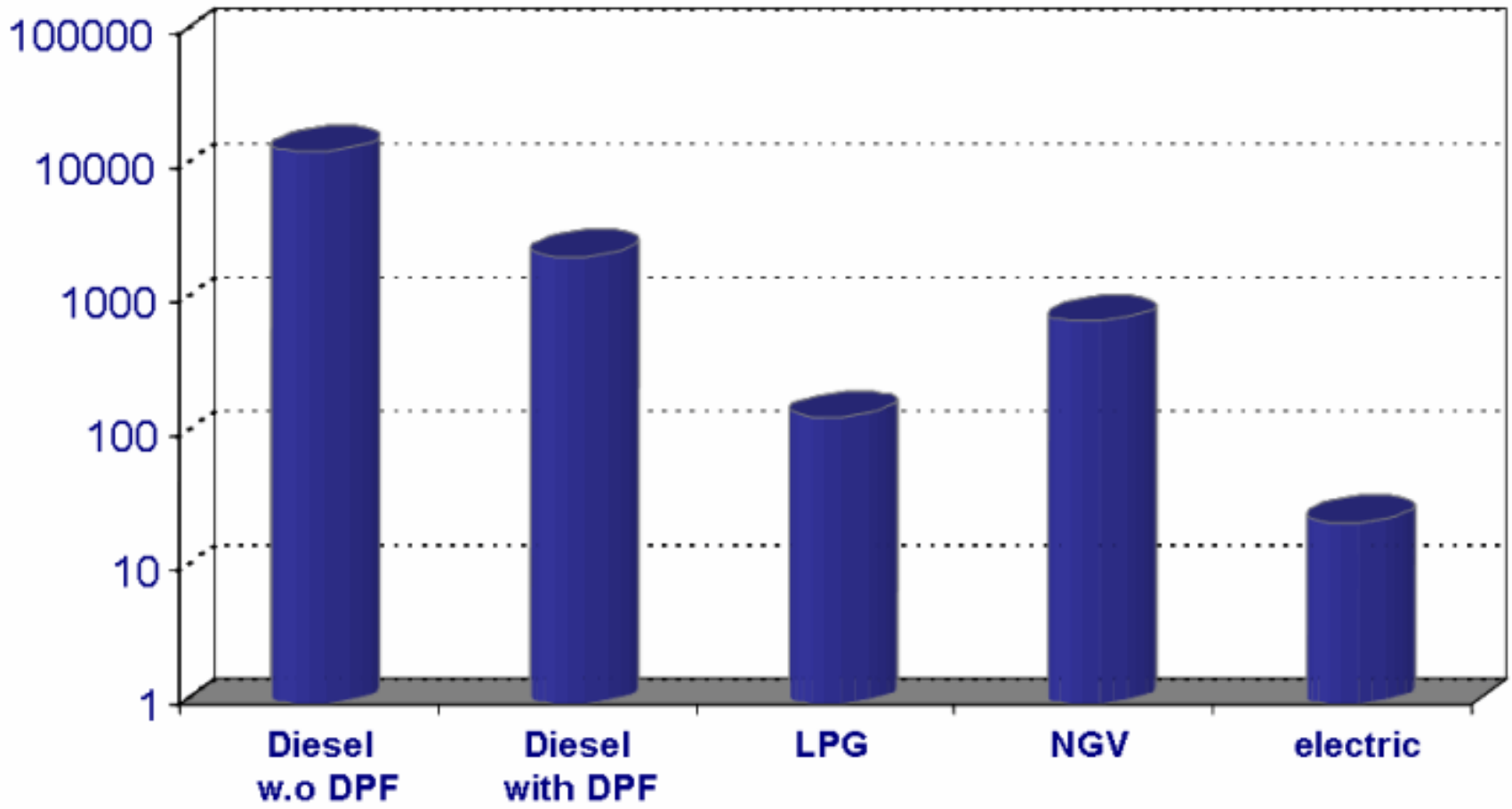
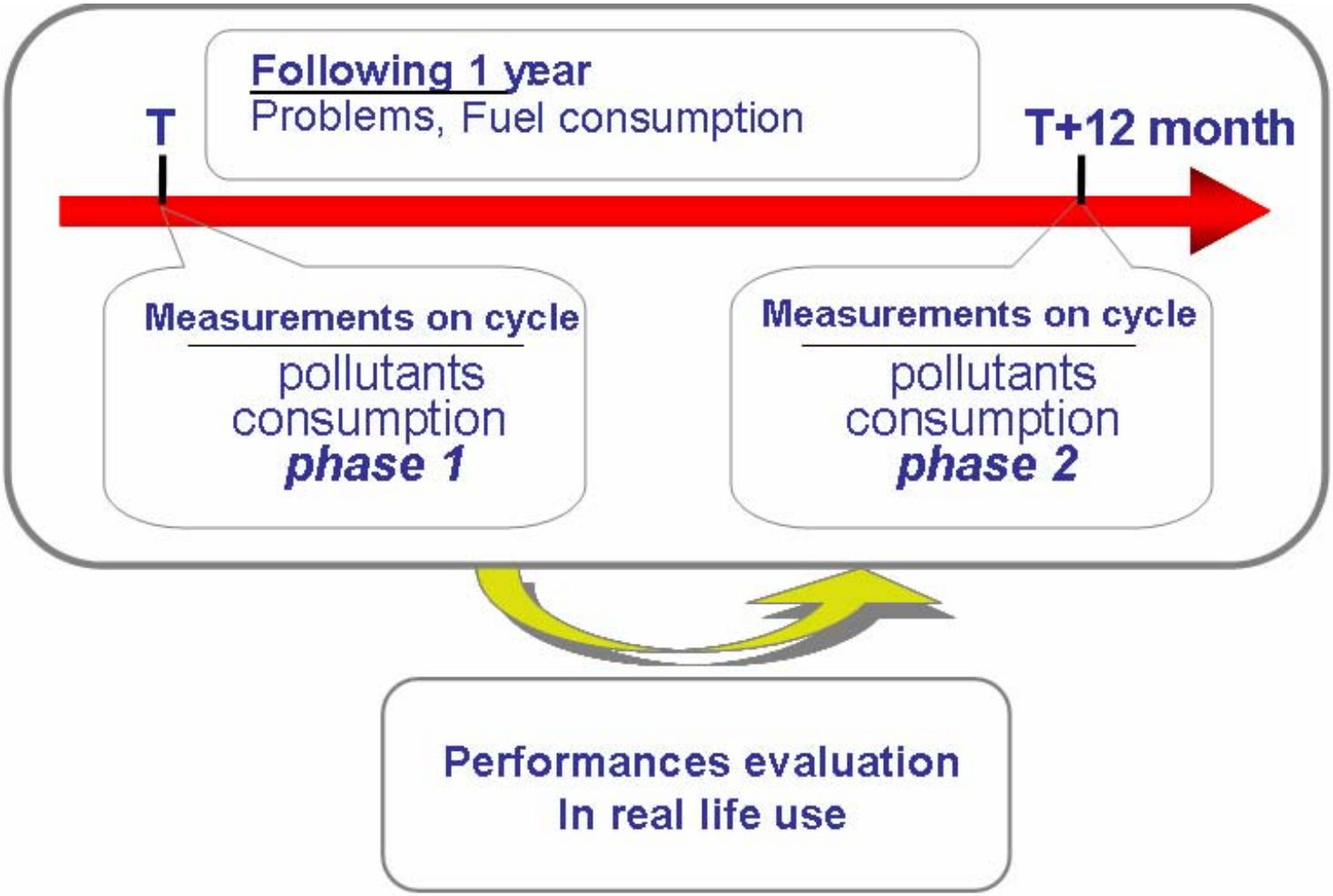
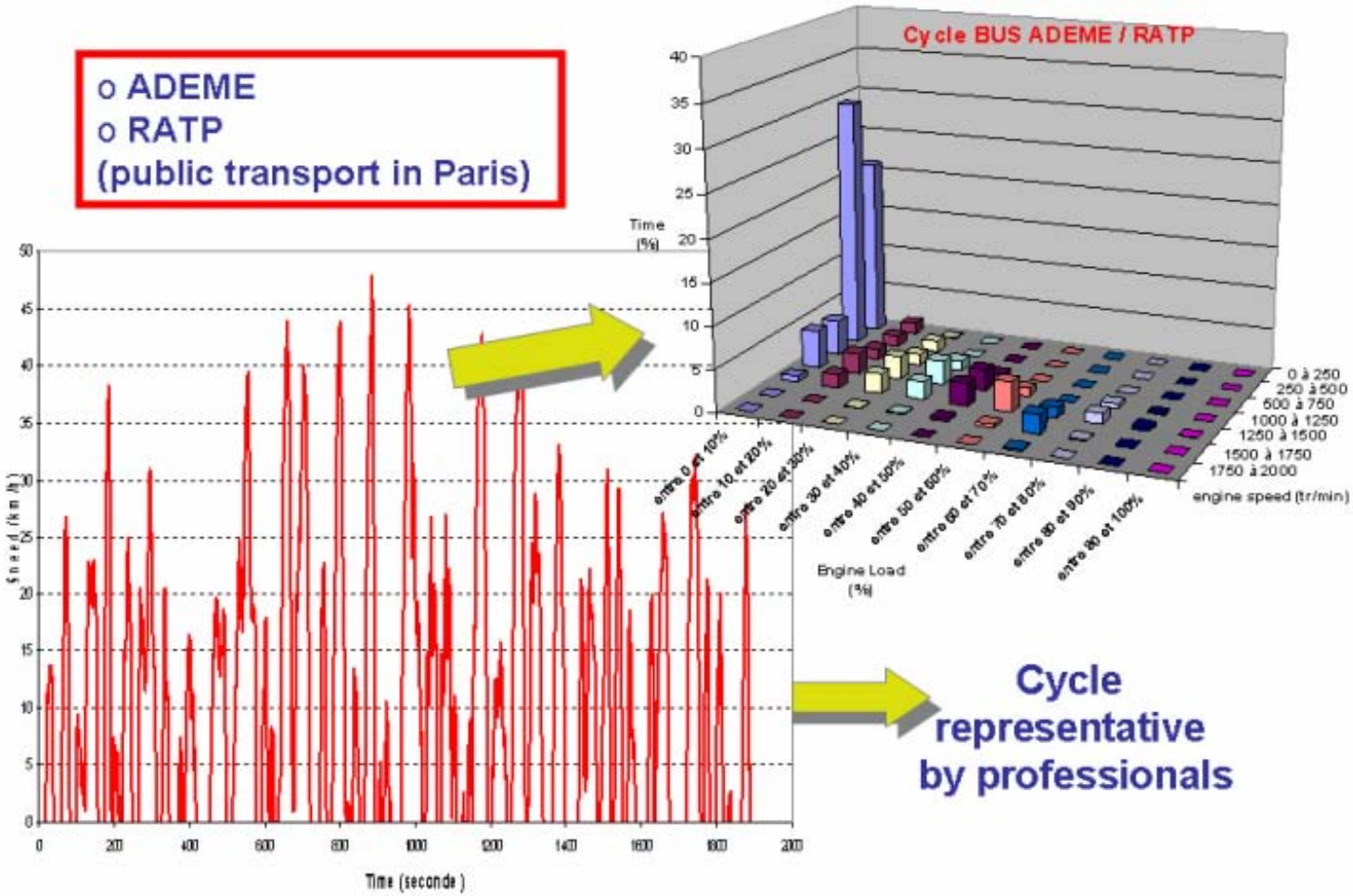
Buses in France



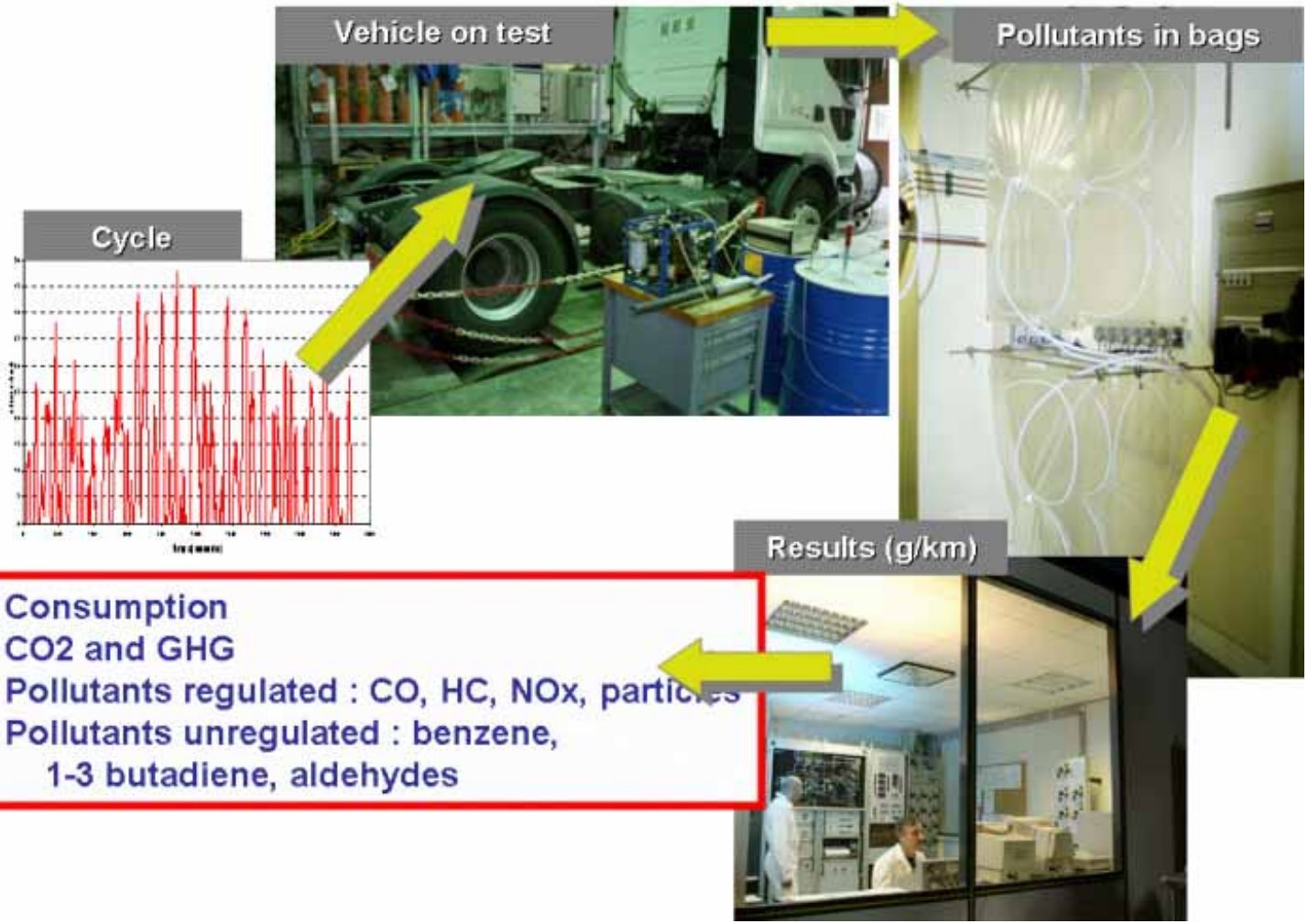
Methodology



Bus Cycle Vehicle and Engine



Measurements on Test Bench



- o Consumption
- o CO2 and GHG
- o Pollutants regulated : CO, HC, NOx, particles
- o Pollutants unregulated : benzene, 1-3 butadiene, aldehydes

Clean Buses Program

Pathways	Technology	Complete tests evaluation
LPG	Stochiometric	✓
NGV	Stochiometric	✓
	Lean Burn	✓
Diesel with DPF	Eminox (CRT)	✓
	Engelhard	✓
	Airmeex	✓
	Comela	✓
	Recycl'air	✓
Diesel with DPF / DeNOx	EGR, urea, …	06/2004
Diesel with Water	Aquazole (Total)	With / W.O DPF
	GECAM	
	Aspira (BP)	
Diesel with RME (30%)		With / W.O DPF
Hybrid	Hybrid	Pb, NiMH
Electric		✓

Comparaison Buses Multicriteria

	Health					GHG		Cost			Public perception	
	CO	*HC*	*NOx*	*Part*	*Non Regl*	*WtW*	*Energy*	*Invest.*	*Exploit*	*Fiability*	*Noise smoke smell*	*Image*
emulsion												
biocarb												
DPF												
NGV												
LPG												
Hybrid												
Electric												

Worst than Diesel			**Euro 3**			**Better than Diesel**

Buses Comparison
by external costs

European Project : Cleaner Drive
www.cleaner-drive.com

GT & Buses Comparison by external costs

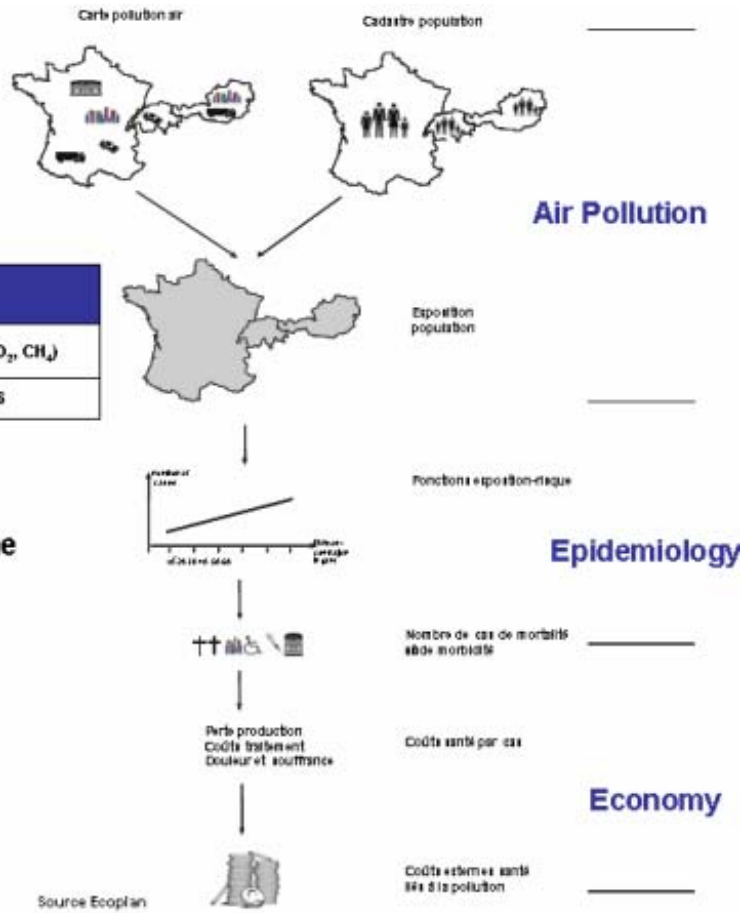
A « well to wheel » calculation

Cost for pollutants € / ton				
CO	HC (HC no CH4)	NOx	Particles	GHG (CO_2, CH_4)
3,5	2000	8200	126 900	46

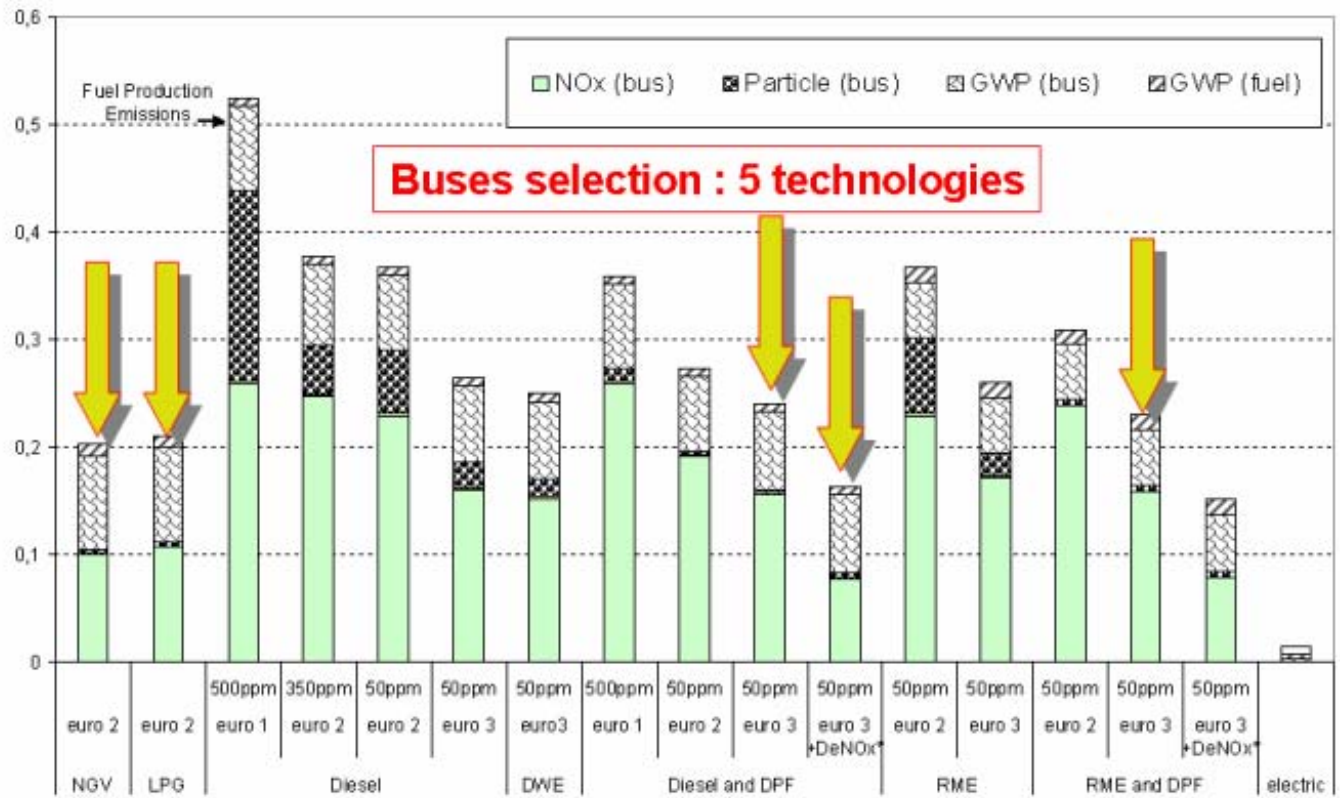
External cost reflects the overall damage to the environment and to human health caused by emissions

Source : european study ExternE

European Project : Cleaner Drive
www.cleaner-drive.com

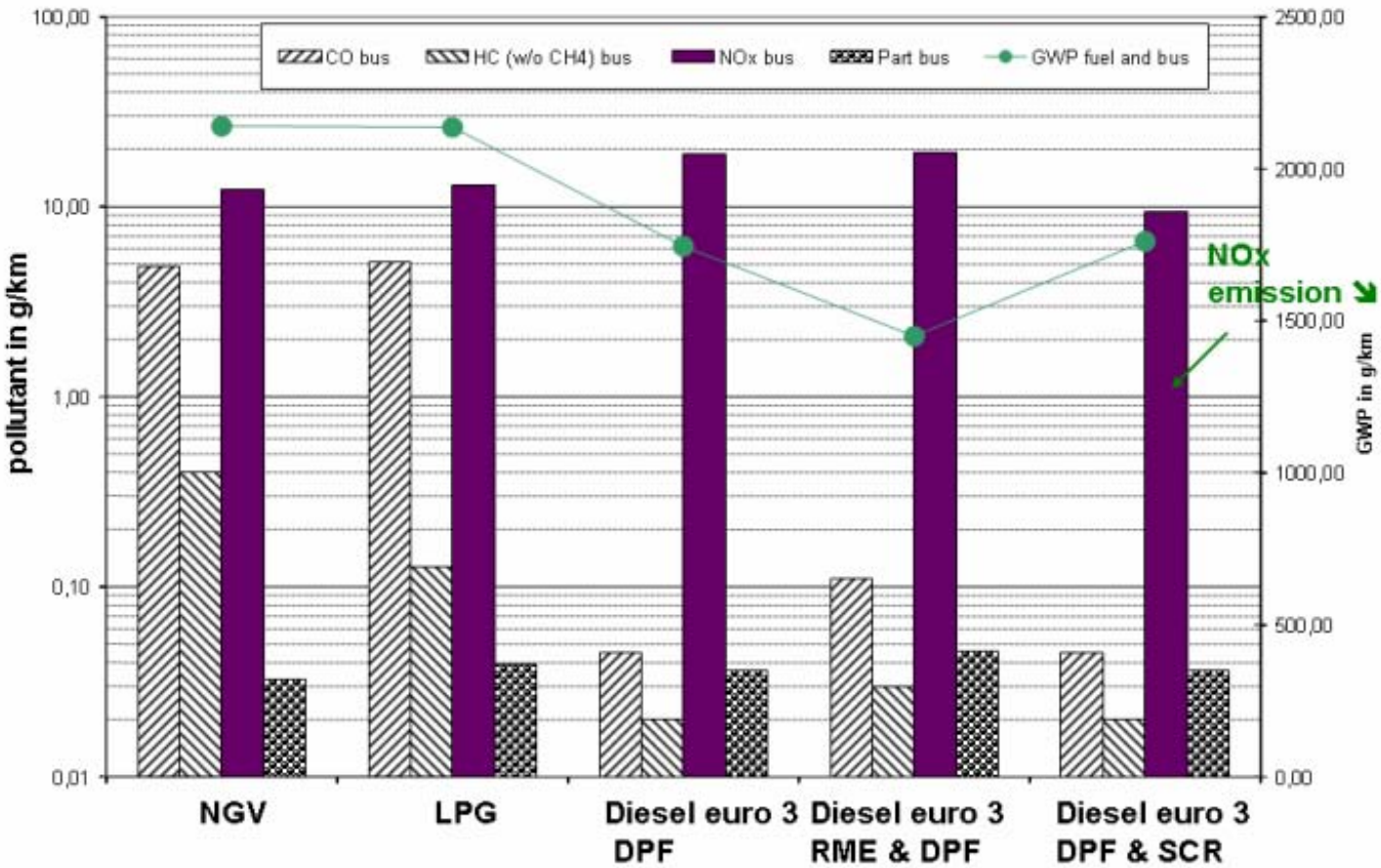


Buses Comparison by External Costs

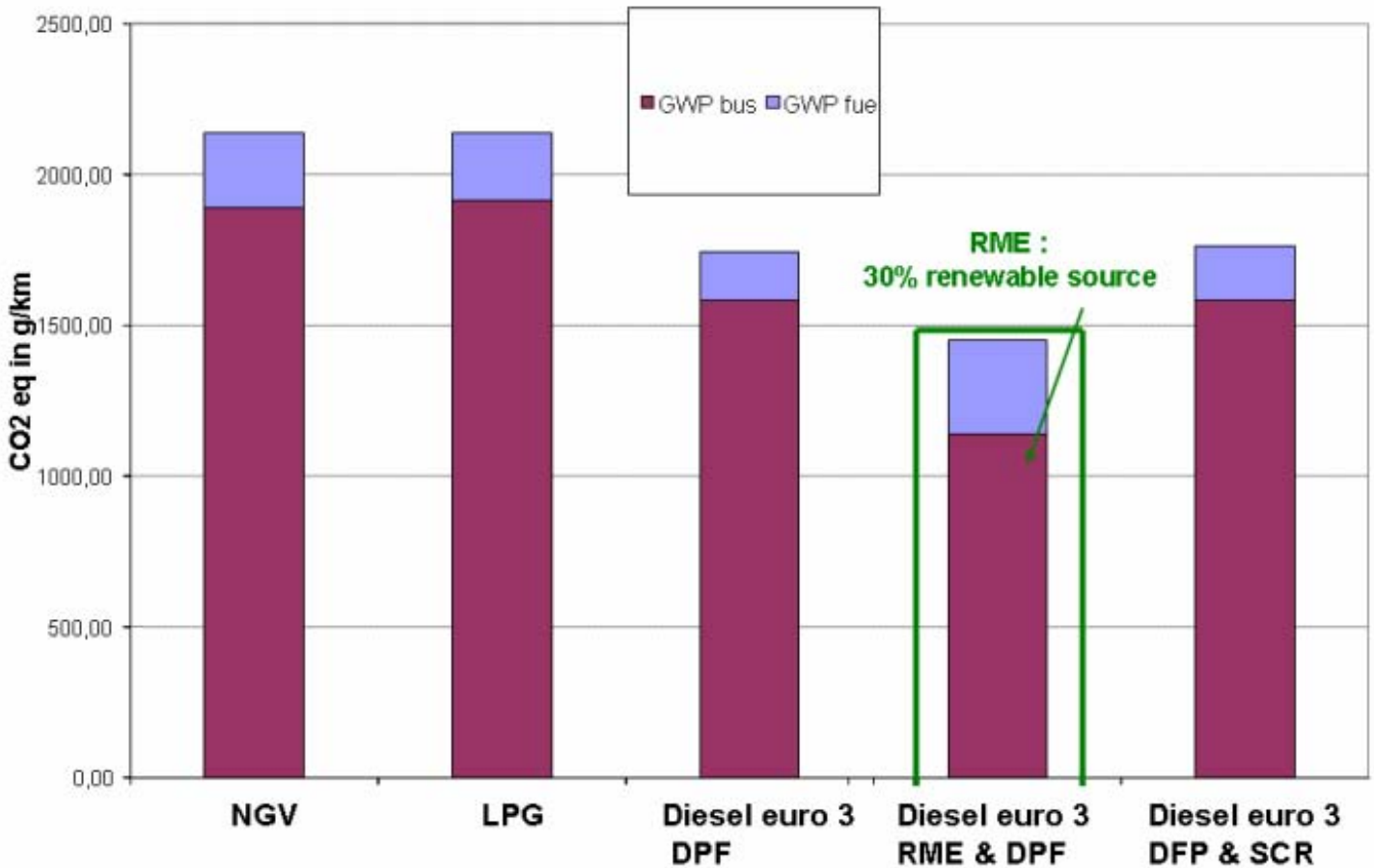


Fuel & Bus emissions cost comparison in €/km

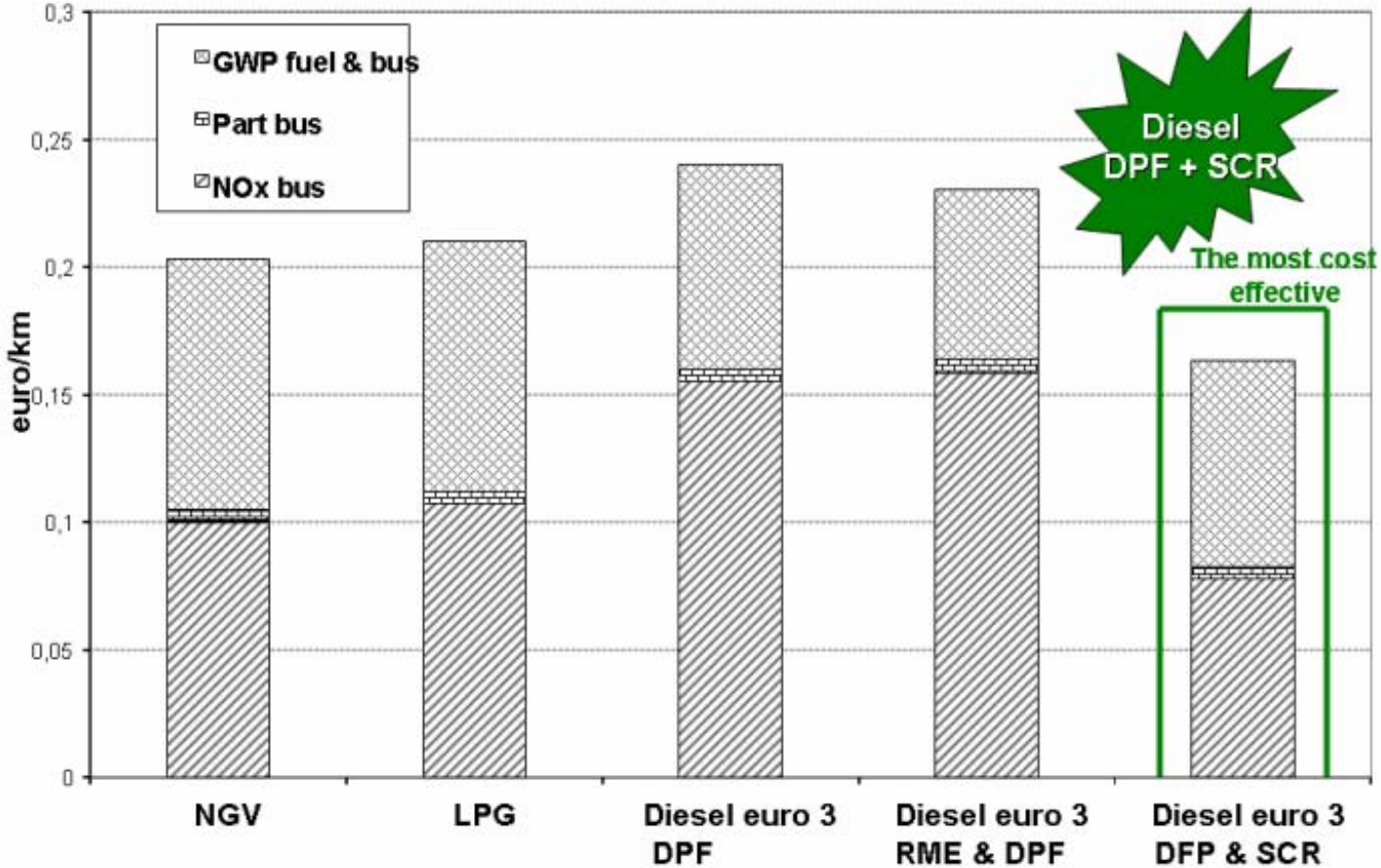
Buses Comparison : pollutants emissions source



Buses Comparison: GHG



Buses Comparison: Cost



Conclusions (1)

- External cost methodology is useful to compare different technologies with different pollutants and GHG emissions.
- Strength and weakness of each technology can be identified.
- Other parameters should be included : Noise, Unregulated pollutants and economic parameters (investments, …)

Conclusions (2)

- Best technologies are :
  - NGV, LPG
  - Diesel with DPF + SCR
  - Diesel with DPF and RME

- NOx : Diesel > NGV, LPG > Diesel + SCR
- GHG : NGV, LPG > Diesel

- Association DPF + SCR technology allows Diesel engine to be the most cost effective

- NGV, LPG must progress on GHG (fuel and bus)

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Thank you
for
your attention

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Appendix

Emission Data Fuel Cycle

Fuel Cycle emission *include those produced during :*

- Fuel extraction
- Refining
- Transport and distribution

GWP (g eq CO_2 / MJ)				
Diesel	**Bio Diesel 30% RME**	**Diesel with 10% water**	**NGV**	**LPG**
7,5	**12,3**	**6,5**	**9,2**	**7,5**