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TRANSPORTS,
ENERGY AND ENVIRONMENT

Quantification of Energy Consumption and Emissions using Biodiesel in an Urban Bus Fleet

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Bioenergy: From Concept to Commercial Production
March, 8th, 2006

Our Mission

DTEA is a research team dedicated to innovation in the area of Transports, Energy and Environment through the development, transfer and dissemination of scientific and technological knowledge.

Our position within IST

INSTITUTO SUPERIOR TÉCNICO

IDMEC
Instituto de Engenharia Mecânica
Pólo IST

Research Group on Energy and Sustainable Development

DTEA
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Main Research Areas

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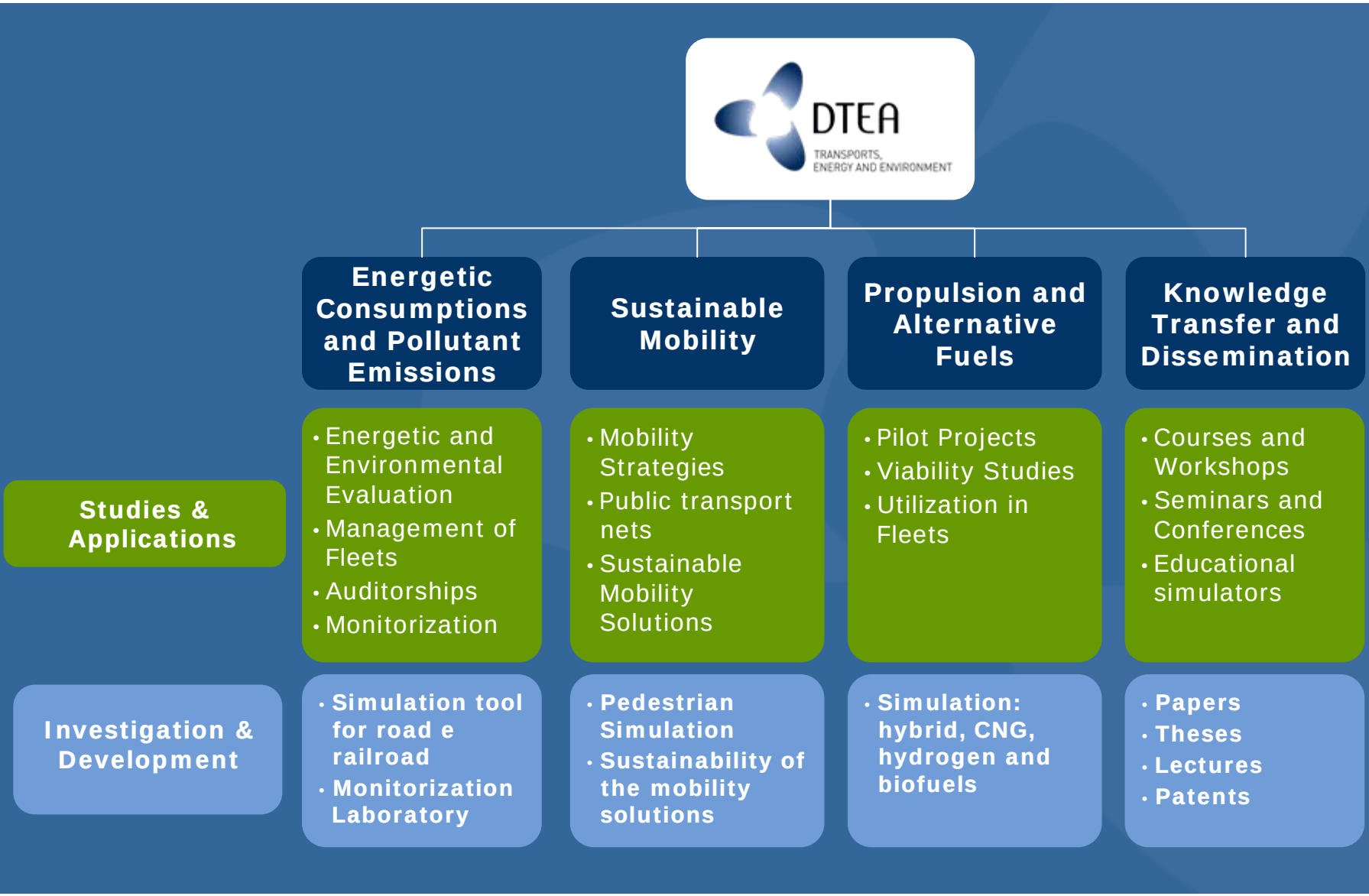

The Team

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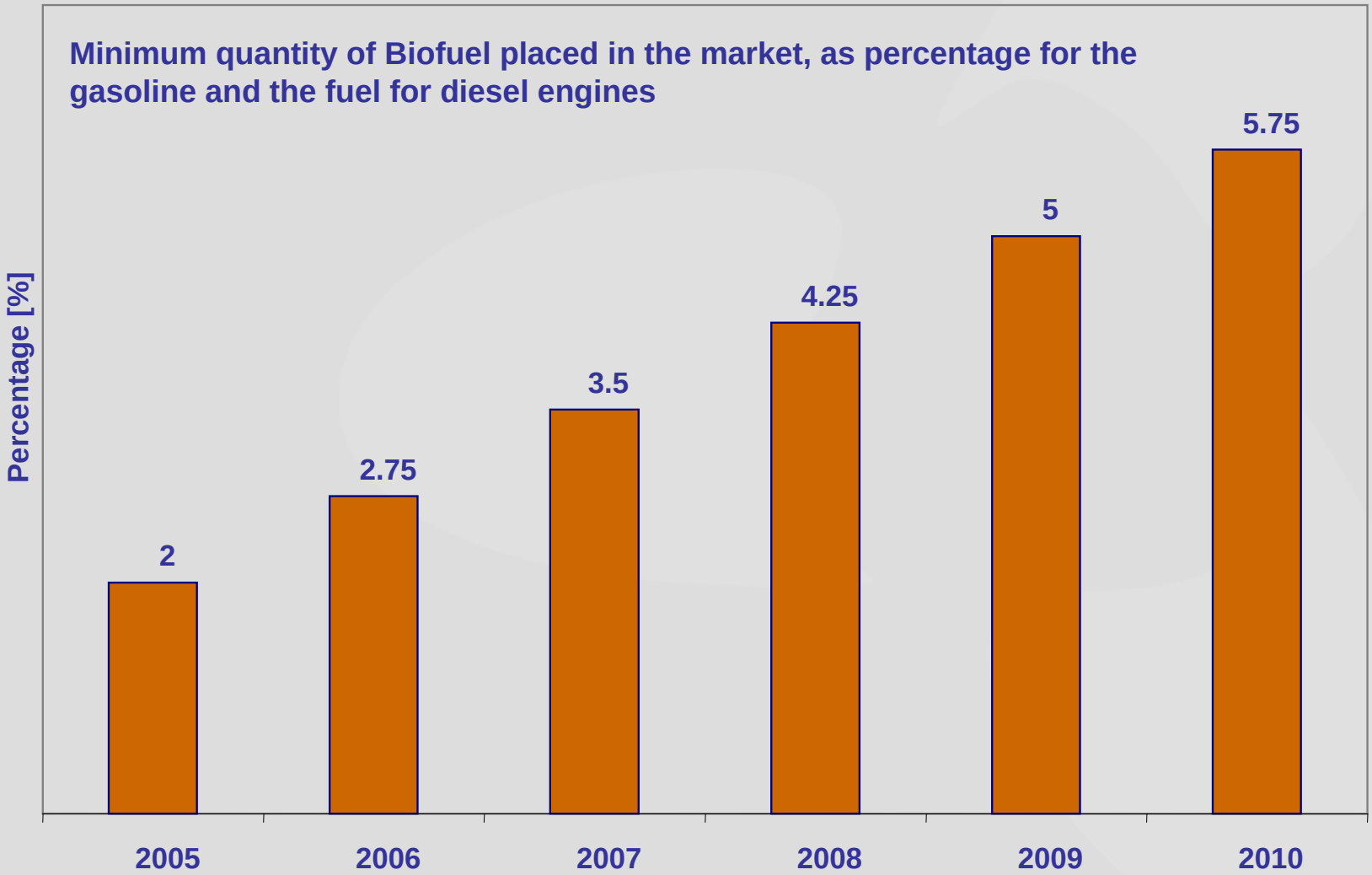
Biodiesel as an Alternative Fuel

Directive 2003/30/CE



Objective of the work

- **Environmental and Energetic Analysis of the biodiesel life cycle:**
  - **Energy consumption**
  - **Pollutants emissions**

- **Application to a case study: the Évora Municipality Fleet, SITEE – EM;**

- **Comparison to the actual situation used in the fleet – diesel;**

- **Comparison results for different types of mixtures: B5, B20 and B100.**

Biodiesel

- Diesel displacement fuel made from plant oils, animal tallow or recycled cooking oils;
- Chemical process, that removes the glycerine and yield methyl or ethyl esters optimized for combustion;

- Purification Process in Europe obliges the regulation: EN 14214
- Renewable, non-toxic, usable in any percentage with a diesel mixture, allows a less energetic dependence.

The Case Study - Évora

- Application to the Évora Municipality Fleet:

Urban Fleet Transport

13 vehicles (Euro III)

Average Consumption - 41,4 l/100km

Annual Distance – 490 thousand km

Annual Average Consumption – 200 thousand litres

"Blue Line" Fleet

4 mini-buses (Euro II)

Average Consumption - 18 l 100km

Annual Distance – 288 thousand km

Annual Average Consumption – 52 thousand litres

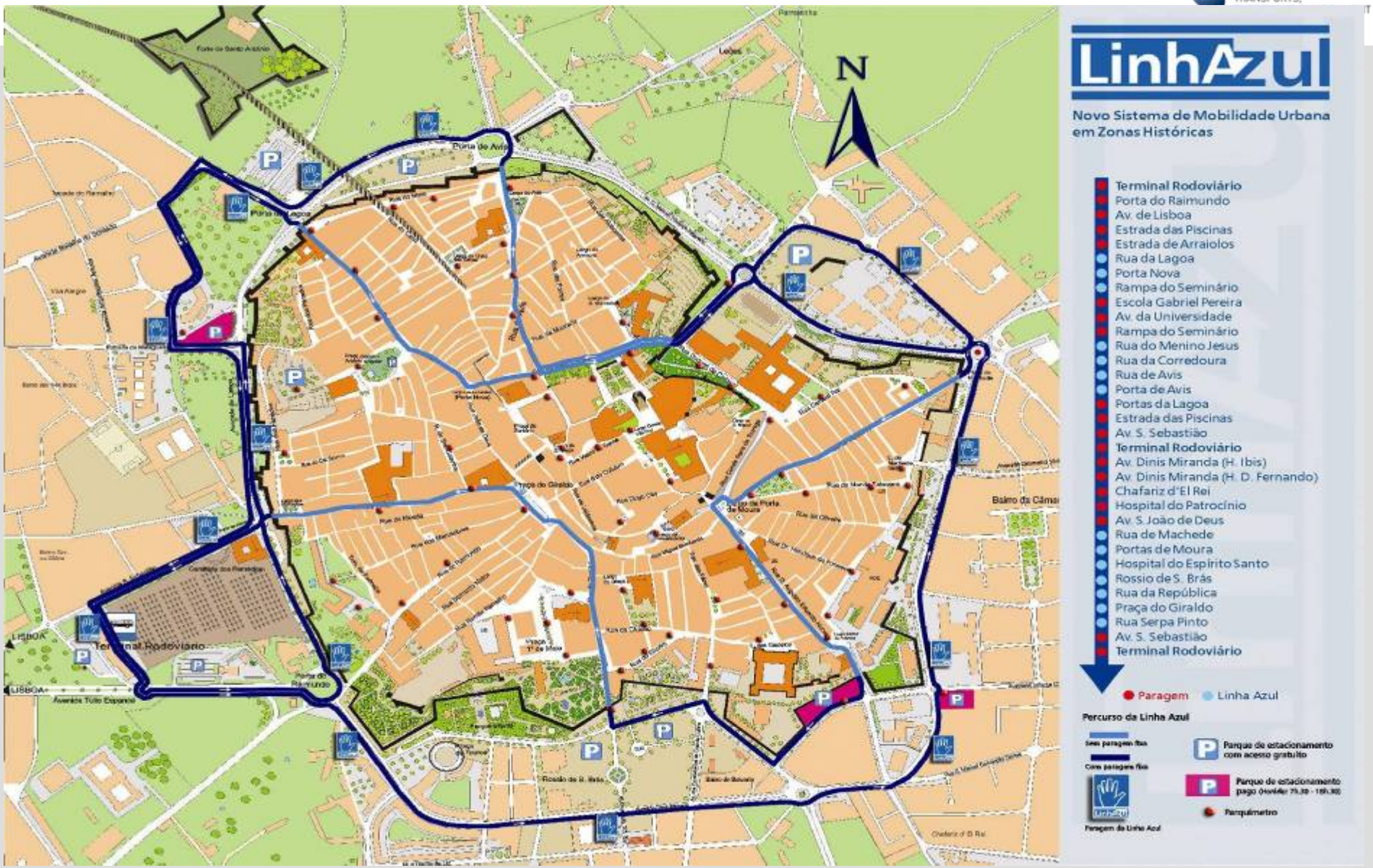
Together their consumption is 253 thousand l/year of diesel

The Case Study - Évora

LinhAzul

- 4 mini-buses connecting the peripheral parks of the city to the historical centre
- Circuit crossed
- Outside the
- Inside the W
- Without a pr

The “Blue Line”

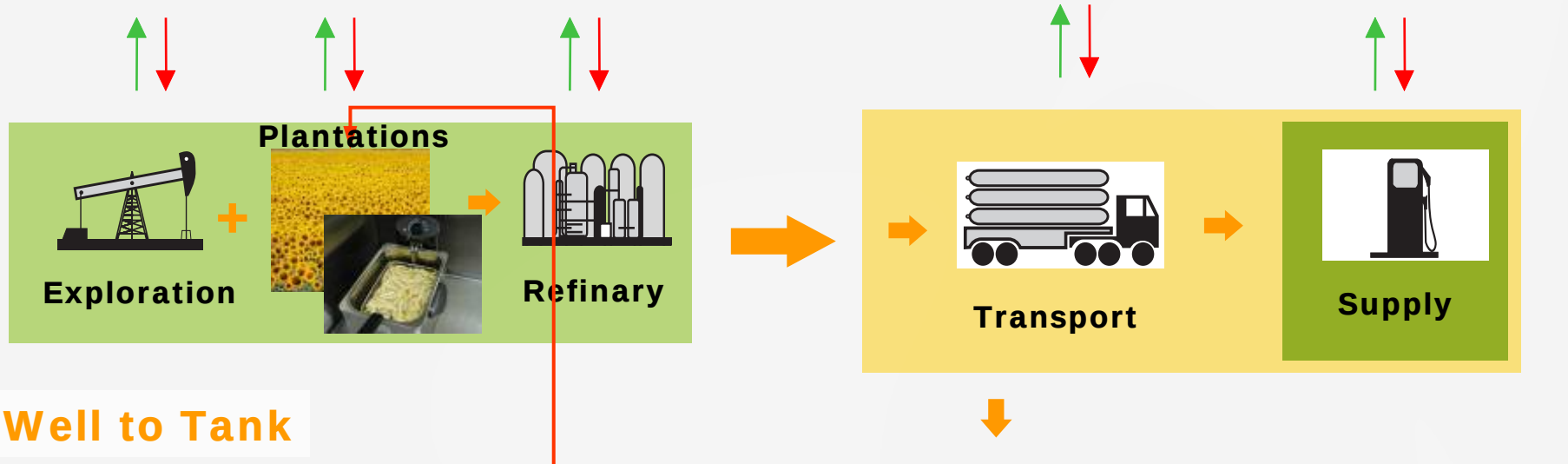


The Case Study - Évora

- Biodiesel production from recycled cooking oils;
- Reutilization of a residue produced in large quantities and that in Portugal doesn't has an appropriate final use;
- HORECA (Hotel, Restaurants and Coffees) Group considered for the Historical Centre of Évora

- Collect System adopted:
  - HORECA Group: 191 establishments;
  - Daily Production of 2 L: every 15 days, collected in a door to door system;
  - Vehicle: Mercedes Sprinter 308 CDI (consumption 15 l/100km);

Methodology Adopted – WTW Analysis



Operation

Tank to Wheel

Emissions

Fuel Consumption

Methodology Adopted – WTW Analysis

- **Production Phase: Software Gabi 4**

- Necessity to create different plans:
  - Electricity
  - Biodiesel
  - Diesel

- **Utilization Phase:**

- Diesel: COPERT III
- Biodiesel

Fuel Consumption →

Using distances covered, consumptions of the vehicle and the Heating Value

Fuel Consumption →

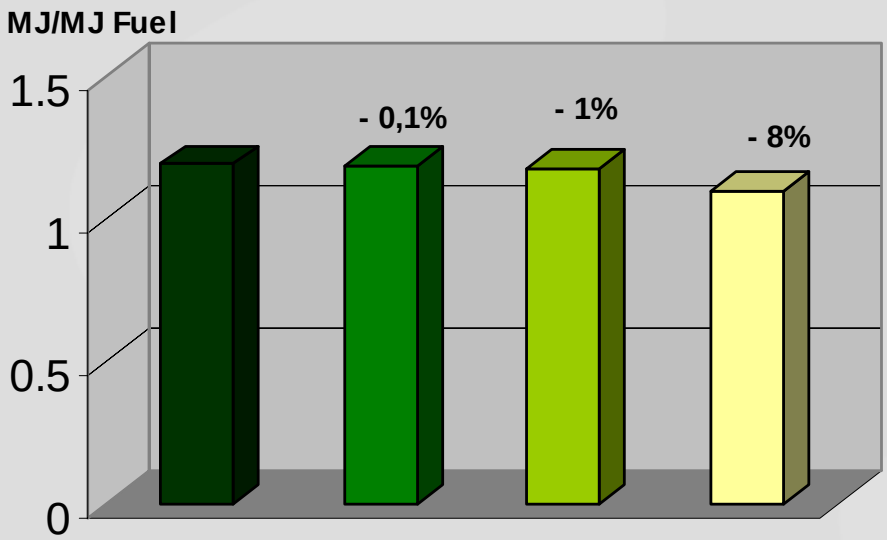
CO_2: EF X Fuel Consumption

CO, NO_x, COV, PM: COPERT and EPA Study

Main Results

Energetic Characterization – Production Phase

Used Cooking Oils vs Diesel

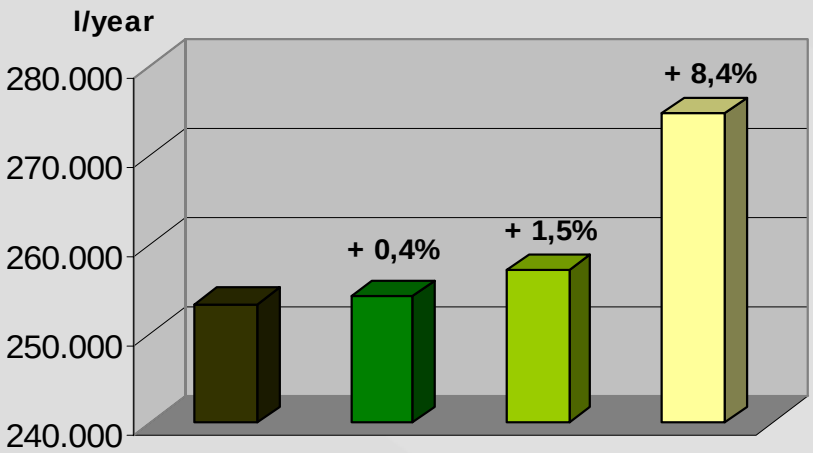


Diesel	B5	B20	B100
1,19	1,19	1,18	1,10

Energy ↓

Main Results

Fuel Consumption (l/year) – Utilization Phase



Gasóleo	B5	B20	B100
253.000	254.000	257.000	275.000

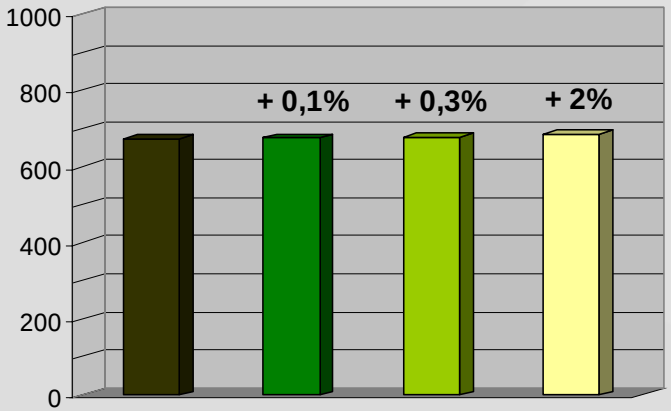
Fuel	Consumption (l/100km)	
	Blue Line	Urban Fleet
Diesel	18	41,4
B5	18,1	41,6
B20	18,3	42,0
B100	19,5	44,9

Fuel ↑

Main Results

Environmental Performance – Life Cycle Analysis

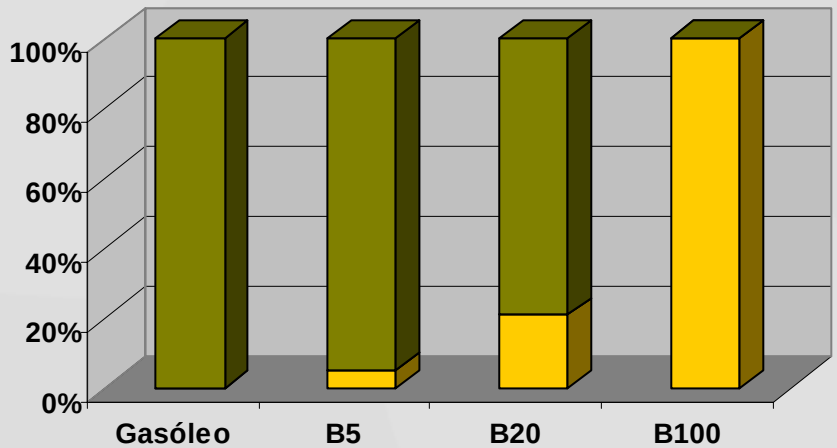
CO_2 Emissions (ton/year)



Diesel	B5	B20	B100
674	675	676	686

Emissions CO_2 ↑

CO_2 Emissions



Emissions from fossil fuel sources

Emissions from renewable sources

Main Conclusions of the Work

- The Energy Consumption is Lower when using biodiesel:

Fuel	Saving in diesel (l/year)	Number of barrils
B5	13.000	90
B20	54.000	380
B100	253.000	1760

- An increase of fuel consumption was verified in the fleet when using biodiesel (lower heating value);
- Environmental performance: an increase in the emissions of CO_2 and NO_X was noticed, compared to a decrease in other pollutants like CO, PM and COV;

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