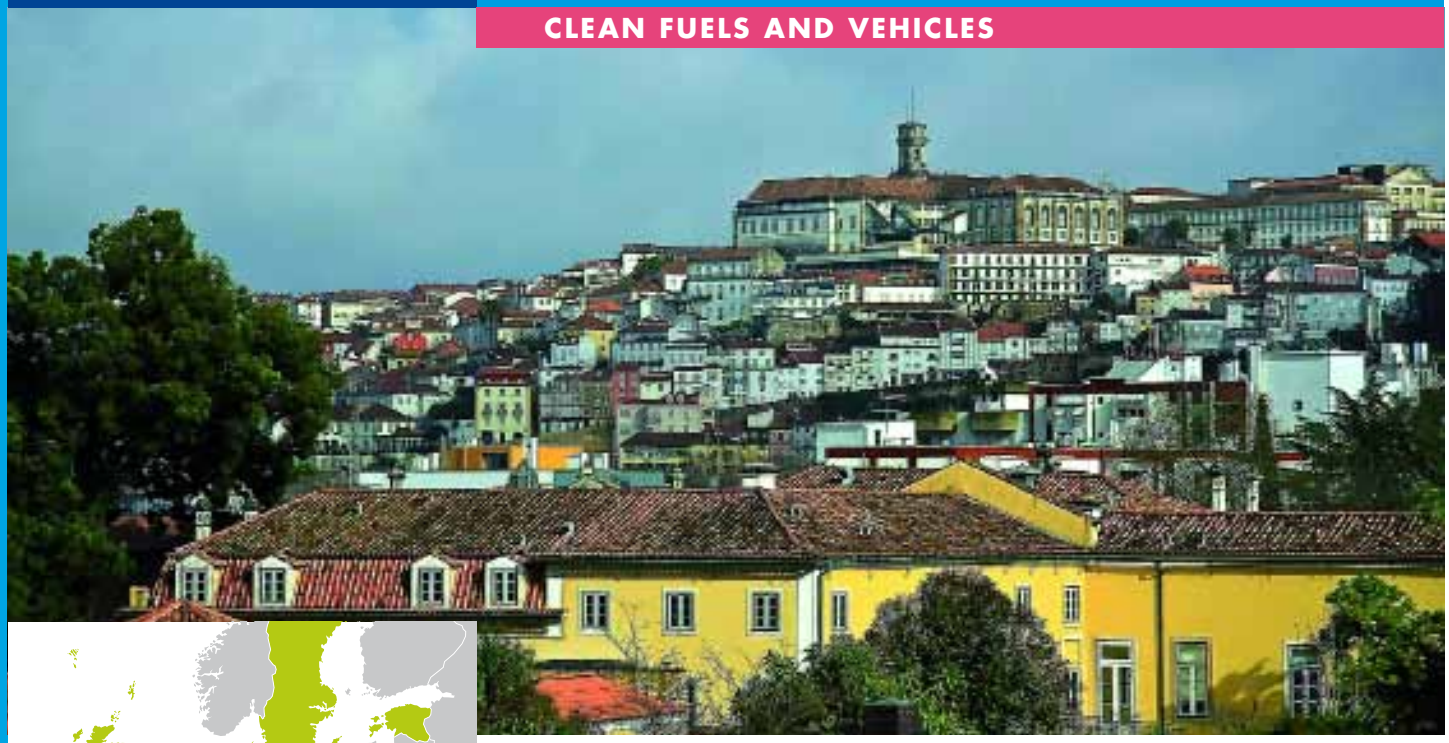
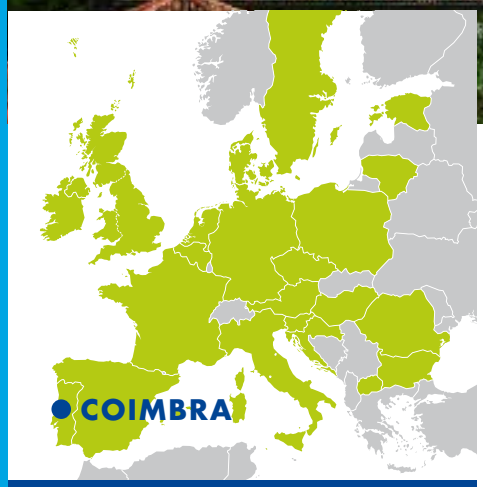
CiViTAS
Cleaner and better transport in cities
MODERN

CASE STUDY

TESTING BIOFUEL IN THE COIMBRA PUBLIC TRANSPORT FLEET

CLEAN FUELS AND VEHICLES





The rising price of oil coupled with the negative consequences of traffic pollution and energy inefficiency have made a transition to more sustainable energy policies inevitable. Coimbra tested the use of biofuel as an alternative for its public transport fleet. To date there has been little use of biofuel in the Portuguese public transportation sector. The Municipality of Coimbra tested a mix containing up to 50 percent biofuel in several trial buses.

Municipal context

Former capital of Portugal, Coimbra has always been associated with tradition. Founded over two thousand years ago by the Romans, the city is home to Portugal's oldest university. Established in 1290, it shaped the city's development for centuries, influencing the local culture and lifestyle. The activities associated with the university, such as education and health services, consolidated the image of Coimbra as the preeminent university city of Portugal.

In recent decades, Coimbra has seen its population grow, registering over 140,000 residents in the latest census. Besides a relatively large population, Coimbra accommodates several important regional services which give it a metropolitan quality. Accordingly, the city generates a high influx of commuters daily, which affects its citizen's mobility.

Introduction

The rising price of oil and the detrimental consequences of traffic pollution and energy inefficiencies have motivated authorities to implement more sustainable energy policies in its public transportation systems. The use of biofuel has been gaining considerable significance in the public transportation sector. In Portugal, some public transportation operators already use biofuel in their bus fleets. However, the amount and rate of implementation is low.

MUNICIPAL PROFILE

LOCATION
Coimbra, Portugal

POPULATION
140,000

LAND AREA
319 km^2

CIVITAS BUDGET
EUR 2 million

COIMBRA IN CIVITAS

Coimbra (Portugal) participated in CIVITAS MODERN. Under the motto "MObility, Development and Energy use ReductioN", CIVITAS MODERN connects the cities of Craiova (Romania), Brescia (Italy), Coimbra (Portugal), and Vitoria-Gasteiz (Spain).

PROJECT INFORMATION

Representing cities across Europe, each with a desire to preserve their historic and cultural centres from damage caused by private vehicles, the CIVITAS MODERN project enacted 42 measures that led to cleaner and better urban transport. Besides promoting sustainable mobility measures and interaction among the participating cities, CIVITAS MODERN specifically focused on encouraging strong cooperation among scientists and technicians to learn from experience and best practice throughout Europe.

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Bus drivers assess the bus performance

Accordingly, the municipal public transportation operator in Coimbra, SMTUC, wanted to assess the feasibility of using biofuel in its bus fleet in a manner that could contribute to effective savings in fuel costs and decrease pollution in the city. Coimbra has a long tradition of using alternative energy sources in its public transport (PT) services. The possibility of participating in a European project that could assist SMTUC technically through the experience acquired in other cities seemed a perfect opportunity to proceed with the experiment.

Taking a closer look

SMTUC has tested different mixes of biofuel in four buses under real operating conditions. By doing so, information on energy consumption and atmospheric pollution caused by emissions, as well as percentages of biofuel tolerated by the conventional engines, was collected. Furthermore, a cost-benefit analysis was carried out on the use of biofuel versus conventional diesel. Due to the fact that CIVITAS is a demonstration project, this measure was not limited to a "laboratory analysis," rather a full-scale experimentation on regular public service lines was carried out. The tests were the first systematic study on the use of biofuel in PT carried out in real operational conditions in Portugal.

During the first phase of the measure, the test parameters were established and a supplier of biofuels was located. The second phase focused on the training of the personnel that coordinated and carried-out the trials, the preparation of the space and the installation of the equipment needed for the tests.

The trial phase itself was divided into three stages, in which the different fuel mixtures were tested. The first test used a mix of 30 percent. The level was increased by 10 percent in each stage until reaching a maximum of 50 percent - i.e., 30 percent (B30), 40 percent (B40), and 50 percent (B50). Fuel mix tests were conducted every 25,000 kilometres (roughly five months), which coincided with the scheduled maintenances of the fleet.

In early 2011, the installation of the necessary equipment was completed and the trials were initiated with a 30 percent mix used on four buses. However, in early May, the two buses equipped with common-rail technology for the diesel injection revealed problems in the feed system, which forced the suspension of the trial on these two units. More precisely, an examination of the filters and injectors revealed a concentration of a gel-like substance.

The other two buses continued the trial without any problems and the mixtures were upgraded until they reached 50 percent.

At every mixture upgrade, tests were conducted on the trial vehicles. The yield tests focused on the quality of lubricant oils (carried out by the lubricant oil supplier), fuel consumption evaluation, the number of repairs and maintenance required, performance evaluation (through a driver survey on bus performance), and analysis of emissions.

After the trials were completed, the data was analysed.

Results

The average operating costs of the four buses tested with B30 and B50 biofuel blends turned out to be lower than the average operating costs of similar vehicles running on diesel for the same period. The difference is more evident for B30, were the average operating costs in the ex-post have been 10 percent lower.

Concerning the hypothesis of introducing the use of B30 fuel to the entire PT fleet, it has been estimated a potential saving in operating costs equal to roughly EUR 420,000 /year.

According to the EMEP/EEA emission inventory guidebook [1], the effect of biofuel on other technologies may vary, but the extent of the variation is difficult to estimate in the absence of detailed data. With regard to nitric oxide, nitrogen dioxide, carbon monoxide and carbon dioxide, any effect of technology should be negligible, given the marginal effect of biofuel on these pollutants in general. That's why the use of biofuel as a blend with diesel may lead to some changes in emissions, but for these specific gases, the effect was marginal.

By comparing the results of the ex-post period with baseline and business-as-usual (BAU) scenario – all obtained by applying the EMEP/EEA parameters – the average carbon monoxide emissions decreased for all biofuel blends tested. Considering only B30, the average emissions decreased from 2,670 gCO/vkm in the baseline period to 2,422 gCO/vkm, representing an overall reduction of about 9 percent.

Additionally, the average particulate matter emissions decreases for all biofuel blends that were tested. Considering only B30, the average emissions decreased from 0,207 gCO/vkm in the baseline period to 0,168 gCO/vkm in the ex-post, representing an overall reduction of about 18 percent. In this regard, in the future, if B30 will be used in all vehicles of the SMTUC bus fleet (100 vehicles), the total PM emissions of the fleet in a given year (6,000,000 vkm), would theoretically decrease from about 1,2 tPM/year to 1,0 tPM/year, representing an overall reduction of around 19 percent.

Economy:

Indicator	Ex-Ante Baseline	BAU			Ex-Post			Difference Ex Post- Ex Ante			Difference Ex Post - BAU		
	Jan 2010-Jan 2011	Feb-Jun 11	Jul-Dec 11	Jan-Jul 12	B30 Feb-Jun 11	B40 Jul-Dec 11	B50 Jan-Jul 12	B30	B40	B50	B30	B40	B50
1. Average Operating Costs (€/vkm)	0,538	0,686	0,707	0,735	0,616	0,723	0,720	0,078	0,185	0,182	-0,070	0,016	-0,015

Energy:

Indicator	Ex-Ante Baseline	BAU			Ex-Post			Difference Ex Post- Ex Ante			Difference Ex Post - BAU		
	Jan 2010-Jan 2011	Feb-Jun 11	Jul-Dec 11	Jan-Jul 12	B30 Feb-Jun 11	B40 Jul-Dec 11	B50 Jan-Jul 12	B30	B40	B50	B30	B40	B50
2. Average Fuel Efficiency (MJ/vkm)	16,763	19,644	19,442	19,671	18,051	19,803	20,589	1,288	3,040	3,826	-1,593	0,361	0,918

Environment:

Indicator	Ex-Ante Baseline	BAU	Ex-Post			Difference Ex Post- Ex Ante			Difference Ex Post - BAU		
	Jan 2010-Jan 2011	Feb-Jul 12	B30	B40	B50	B30	B40	B50	B30	B40	B50
			Feb-Jul 12								
3. Average CO emissions per vehicle-km (g CO/vkm)	2,670	2,670	2,422	2,382	2,339	-0,228	-0,288	-0,331	-0,228	-0,288	-0,331

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Lessons learned

During the trials, it was established that buses using common rail technology in their injection system showed problems. More precisely, a gel-like substance was identified and testing on buses with common rail was halted in May, while still using a 30 percent mix. Accordingly, after inspection, SMTUC concluded that the use of biofuel in buses with common rail technology is not advisable due to the inherent mechanical problems.

The national economic situation hindered more rigorous tests on the wear that biofuel had on the mechanical components. Due to the high costs involved, the contracting of specialists for more detailed analysis was not carried out. Accordingly, these analyses were carried out with the available company resources which lacked some of the technical experience necessary to complete more comprehensive testing.

Regarding consumption levels, the initial data indicates an augmentation of consumption using biofuel. Considering the difference in unitary fuel prices it is calculated that the higher consumption levels using biofuel will not offset the cost savings. On the other hand, the higher level of consumption may imply an increase in emissions.

Lastly, difficulties were encountered in the acquisition of large volumes of biofuel. This situation may hinder the future acquisition of this fuel and its application to the entire bus fleet.

Upscaling and transferability

The use of biofuel may be up-scaled to other vehicles in the SMTUC fleet that do not possess common rail technology. Also, the results may open up the way for further implementation of biofuel in other municipal vehicles, such as garbage trucks and other delivery vehicles. While some of these vehicles already use biofuel, the percentage is low to the point of being insignificant. This can eventually be increased. The results of the tests may help encourage the use of biofuel amongst other local PT operators throughout the country.

Budget and finances

Due to the diminutive number of vehicles used in the tests, the price of the biofuel purchased was considerably higher. It is expected that the purchase of biofuel in greater quantity will reduce its overall cost.

[1] http://eea.europa.eu/emep-eea guidebook

Bus ready to receive Biofuel mix

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References or sources

www.civitas.eu > Cities > Coimbra

TRANSPORTES URBANOS DE COIMBRA

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