

New biofuel production technology to recover used frying oils and power the Seville's urban bus fleet.

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Used cooking oils are an abundant food residue in southern European countries such as Spain and specially in regions such as Andalusia, where large amounts of this waste are generated both in the industrial sector (hospitality sector mainly) and in homes.

In Spain, the HORECA sector (Hotels, Restaurants and Catering) generates approximately 400,000 t/year of used cooking oils (Project PSE PROBIOGAS 2010). Andalusia generates some 58,000 t/year, according to Andalusian Energy Agency data (Biofuels in Andalucía, 2014), and the province of Sevilla generates some 13,000 t/year. Most of these oils are poured down sinks, toilets, and disposed of through household waste, causing serious public health and environmental impact. These huge figures give us an idea of the potential of used cooking oils for future developments, as well as the environmental problem if they are considered as a waste.

Oil is the main food for cockroaches and rats, which can be found in large numbers in those buildings where oils are poured down the drain. Dumping oils into the sewage system rises the cost of urban wastewater treatment. When oils are dumped in the environment they destroy the ecosystems. Also, fossil fuel-powered vehicles are the main cause for the high levels of pollution in cities.

Just like any other vegetable oil, used cooking oils can be used as raw material for the production of biofuel, which is similar to diesel fuel of fossil origin (petroleum). Replacing fossil fuels with biofuels will help reduce pollutant emissions by about 90%. According to the study carried out by the Andalusian Energy Agency, "compared to EN-590 diesel, the biodiesel produced from used vegetable oils reduces the emission of 144 g of equivalent CO₂ (88%) per km".

Production of biodiesel on an industrial scale began in 1992 in some European countries (Austria, Belgium, France, Germany, Italy and Sweden), reaching more than 11.5 million tons consumed per year in 2012 (...). We should not forget that the first cars designed with diesel cycle were vegetable oil-powered. Current diesel engines do not require any modification and can operate normally using biodiesel, thus reducing pollutant emissions. Since biodiesel can also be obtained through the transformation of used cooking oil, the need to recycle used cooking oils has become ever popular, especially those from the hospitality industry. Furthermore, the use of used cooking oils will see a reduction in the cost of raw material as biodiesel will become more competitive with respect to the existing fuels.

The LIFE BIOSEVILLE project aims to develop an integrated and sustainable system for the recovery and processing of used cooking oils generated in the city of Seville to produce a new, more competitive and efficient biofuel made with methyl esters and glycerine esters.

Objectives:

- Development of an evaluation system and feasibility analysis of used cooking oils to produce a new fuel, which can be implemented in other areas of Spain and other countries.
- Demonstration of the feasibility of the new fuel through the development of a pilot processing plant to produce methyl esters and a module to produce glycerine esters.
- Evaluation of used cooking oils as a fuel.
- Production of methyl esters through an innovative transesterification technology.
- Production of technical grade glycerine of at least 95% purity using membrane technology.
- Production of glycerine esters from technical grade glycerine and acetic acid through acid catalysis.
- Production of a new biofuel based on mixtures of glycerine esters and methyl esters.
- Demonstration of the improvements in the combustion process of the new biofuel through a test in an engine bench and under real operating conditions using a bus from Seville's city bus fleet (TUSSAM).
- Establishing a programme aimed to encourage the collection of used cooking oils by local citizens and to compensate their efforts. It is also aimed to disseminate the project's results.

Success in achieving these objectives will demonstrate the environmental, economic and energy sustainability of used frying oils management and recovery in the city of Seville, and the decrease of pollutant emissions and greenhouse gases through the use of the new biofuel produced in the fleet buses of the city of Seville.

With the completion of the project it is expected to achieve the following results:

- Demonstration of the technical and economic viability of the new production technology by testing on a bus at least 40 m³ of 4 different types of the new biofuel with different proportions of conventional diesel. The bus will circulate along three different routes.
- Development of a prototype module for the production of methyl esters (99.5% purity) and glycerine (80% purity) from 55 m³ of used frying oils.
- Production of at least 40 m³ of high quality new biofuel according to the European standard EN 14214.
- Development of a production process, from glycerine, of at least 4.000 liters of additives (glycerine esters) for its use together with biofuels.
- Reduction of pollutant emissions in the urban buses fleet of the city of Seville for each 4 tested biofuels.
- Quantitative evaluation of the reduction of the impact on the global CO₂ emissions, which is achieved through the demonstration process, integrating the collection of frying oils, the production of methyl esters and glycerin esters and the use of this new biodiesel to fuel Seville's urban bus fleet.
- Analysis of the social effects of implementing this project.

LIFE BIOSEVILLE is a reference project to demonstrate the integral treatment of used cooking oils. The results of the project will be representative for its technical and economic viability, its replicability on different sites.

Fig 1. Process Diagram of LIFE BIOSEVILLE project.

