

# Biofuels

Our society, in the course of its development, is facing many problems related to the energy sector.

The fundamental questions concern the quantity of energetic resources, which are largely not renewable and therefore destined to be depleted. In addition there are the poor distribution of resources, which are concentrated in the hands of a few nations, the continuous increase in global demand for energy, due to the rapid growth in developing countries, and all the geopolitical problems arising therefrom. Then we must consider the great problem of the environmental impact from all the different energy sources.

An alternative energy source, still unknown to most people but with a great potential, could be the answer to many of these problems: biofuels.

A biofuel is a fuel obtained indirectly from biomass, i.e. from the biodegradable parts of agricultural residues, forestry, or from industrial and municipal waste.

Biofuels, however, don't have a strict definition, because their evolution over the years has led to many transformations: today we distinguish between four different generations of biofuels.

The first generation is composed of fuels derived from developed crops used for food purposes. They are obtained from glucose present in these biomasses. The most typical first generation biofuels are those ones derived from soya and maize, in USA, or from sugar cane in Brazil. Since their origin, however, the fuels of first generation have presented a disadvantage: the competitiveness with the food industry. The fact that the first generation enter into competition with the right to food of people has soon led to the birth of second generation biofuels.

The second generation uses the cellulosic wooden waste from agricultural productions and from the food industry and the organic part of municipal waste. The main advantage is the lack of competitiveness with the food sector.

The second generation fuel that more has assumed importance is bioethanol, an alcohol obtained by the fermentation of vegetable raw materials rich in simple sugars and complex sugars (starch and cellulose). The manufacturing process of bioethanol is exemplary to understand how the production of biofuels works. The phases are:

- Pretreatments: cellulose starting material is crushed and ground
- Hydrolysis: it can be chemical or enzymatic, it serves to obtain a mixture of sugars
- saccharification: the separation between glucose and fructose takes place through dilutions and pH changes
- Fermentation: you get the alcohol, i.e. the bioethanol

The greatest drawback encountered in the production of second generation biofuels is the cost of the hydrolysis of cellulose, although in recent years the development of the enzymatic hydrolysis seems to have improved the processing costs.

In order to solve the problems linked to the treatment cost of cellulose we have moved to the third generation biofuels, which envisages the use of bacterial or algal cultures to produce biomass starting directly from solar energy and CO<sub>2</sub>.

A practical example is biodiesel, obtained from oil (*algae llo*) extracted from *spirulina platensis*, an alga. It is a transparent liquid, which has similar characteristics to the diesel fuel obtained from petroleum. The lipids used to produce it, after the extraction, are subjected to a transesterification in a basic environment, with methyl alcohol, to obtain methyl or ethyl esters. This process is similar to fractional distillation and its conversion yield is 98%, therefore it's very advantageous.

There is eventually a last step in the evolution of biofuels: the fourth generation, which exploits genetically engineered microorganisms capable of capturing large amounts of CO<sub>2</sub>. These organisms, whose mechanism of fermentation is similar to those of the third generation biofuels, using their capacity to consume large quantities of carbon dioxide would also be able to have a positive environmental impact by reducing greenhouse gases present in the atmosphere.

### Effects

The effects of the diffusion of biofuels would be many. Firstly there would be a decisive change in the energy economy of our society, with a profound economic impact. Secondly there would be a revaluation of the waste, in particular of biological ones, whose value would increase.

Eventually there would be the diffusion of *green culture*, a way of not only respect the nature, but also see it as a possible source of energy, and so respect