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BIOMASS ENERGY: A CRUCIAL FUTURE PRIORITY

The interest of the scientific community for the energy produced from biological systems is growing: in the future it will be a real economically advantageous alternative. Biomass can be converted to clean fuel and represent a replacement of petrochemical products. The possible strategies for biomass to be used in industrial processes are: the cultivation of energy crops, the collection of natural vegetation, the use of the organic wastes.

Ever since ancient times man has been dependent on energy, which represents an essential ingredient of his life. Science and technology have the merit of keeping the growth of per capita economic requirements within reasonable bounds: it has barely doubled over the past century. Already in ancient Roman times the energy obtained from domestic animals was much cheaper than that provided by slaves. Fossil fuels, combined with the use of increasingly efficient machines, pushed costs down even further. Oil is a good indicator of the value of energy as the cost of the other raw energy materials, sooner or later, depending on the specific case, have become aligned with that of crude oil. In the period 1975-1995 energy intensity dropped on average below 20%, thereby reducing the relative weight of energy materials as a cost component by a comparable amount. Also as far as crude oil is concerned, the requirements of the safeguarding of the environment have become more stringent. Some types of crude oil containing too much sulphur and previously allowed on the market are no longer accepted. Previously, transport by oil tanker was not considered a problem: the cisterns were rinsed with sea water which thus became polluted over huge areas. Many incidents at the time and the relative environmental consequences were never reported.

Moreover, costs, which are clearly visible in the case of the transport of oil and the like, and are even more significant in the

case of other energy materials, may be, albeit partly, offset by a lower level of atmospheric pollution, although this effect is difficult to assess in economic terms.

Also included among energy requirements are hydrocarbons that are not burned but used as raw materials in manufacturing: synthetic fibres, the plastics used in the electrical and mechanical industries, furniture. And this is not insignificant: for many countries it adds up to 10% of the oil and natural gas produced or imported by them. Farm waste and animal remains are a by-product of food production by the agricultural sector. On the other hand, it does not include the energy required to produce fabrics from animal or plant materials (wool, silk, cotton, linen, hemp) or items manufactured using wood (ligno-cellulosic crops). One important future aspect of the energy consumption of hydrocarbons also consists of the increased production of bioethanol, which also requires energy, and more precisely direct solar energy. The same is true of food production (cereals, maize, sugar beet and sweet sorghum) which has a solar energy requirement of not less than 600/700 Mtoe for year (determined only on the basis of its calorific power).

When the energy consumption of different countries are compared, the question asked is whether they all belong to the same “face”, for example, the industrialized one. If indeed the comparison is made among dishomogeneous groups, the forms of the socalled non tradable energy can lead to incorrect conclusions being drawn. It is to be hoped that as time goes by it will be possible to rationalize these statistics and thus be able to make important choices regarding the correct paths to follow in producing energy.

One of these choices is Biomass Energy. The term biomass refers to any material that is directly or indirectly linked to plant reproductive processes. The resource in question is based on thousands of aquatic and land plant species, on a number of agricultural and industrial residues, on processing waste, rubbish and animal residues: all these elements can one way or another be traced back to a vegetal source. In all this “mass” the true energy resource is the carbon fixed in it by means of photosynthesis. Every year throughout the world about 1.7×10^{14} tonnes of dry biomass are produced with a total consumption of 1.3×10^{12} tonnes. Energy derived from biomass (bioenergy) can play a fundamental role in satisfying world energy demand. The conversion of biomass into usable energy is the form of renewable energy with the highest degree of economic and social complexity.

The basic resource is highly diversified in terms of availability and physico-chemical composition. Its exploitation for energy purposes can follow different paths, also depending on its specific composition and structure. Direct thermo-chemical conversion is possible through oxidation of the carbon present (combustion) to produce thermal/or thermechanical energy.

Conversely, by means of various physico-chemical process a wide range of biofuels may be obtained, including methanol, ethanol and methane. The latter also afford the advantage of the possible use of alternative fuels to fossil fuels in unmodified conventional conversion systems, guaranteeing a good transportability from the point of view of security and the absence of solid waste in the combustion products. In any case whether direct conversion is used or biofuels are produced, the characteristic low energy intensity of biomass involves the transport of large volumes and consequent high transport costs. It follows that the collection and exploitation basin has a limited radius, which imposes severe limitations on the possible use of this resource. Also the power of the plants ensuring conversion into usable energy or biofuels is severely curtailed by the quantity of biomass available within a given economic collection radius.

Exploitation of bioenergy

Biomass is the clean energy source with the greatest scope for development, at least in Europe. The raw material is readily available and has an extremely favourable energy conversion, as well as offering all the advantages of renewable energy sources in general. It is therefore in the forefront as regards the attainment of the objective of reducing the amount of greenhouse gases released into the atmosphere and to increase the proportion of energy produced in a sustainable and renewable way that the larger industrialized countries have set themselves starting from the 1997 Kyoto protocol. Nor should it be overlooked that the exploitation of biomasss for energy purposes brings with it the non negligible advantage of being able to exploit many of the by-products of farming, forestry and grazing activities, as well as the organic component of solid urban waste. It therefore represents a concrete opportunity to finally solve such thorny problems as the impoverishment and depopulation of the marginal inland areas and the pollution caused by conventional systems of waste storage and disposal. However, as will be clearly demonstrated in the following, the use of biomass as an energy source is also accompanied by a series of problems that currently represent a strong hindrance to the implementation of systems capable of economically ensuring the energy conversion of biomass.

Of this type of energy source and the various ways the energy locked up inside it can be converted and then exploited, the present note aims to strike a balance between the strong and weak points of biomass in order to shed light on all the aspects of its current level of exploitation, to trace out possible guidelines leading to a definitive and significant penetration of the market by biomass.

The exploitation of biomass for energy purposes can be divided into two categories:

- the conversion of waste products, an operation that enhances

the energy balance and the efficiency of economic activities carried on in the biomass field;
- its cultivation by activating ad hoc agricultural activities involving a number of investments defined in terms of territorial resources.

In the latter case, unless the necessary precautions are taken, biomass exploitation could lead to an impoverishment of the land's capacity to provide food and also affect its long-term quality. In the industrialized countries, it often happens that, for market reasons, large quantities of agricultural products remain unsold and have to be disposed of, thus discouraging land cultivation for food purposes. In a situation of this kind it would be possible to convert the agricultural activities into the production of "energy" biomass production without altering the existing equilibrium. On the other hand, it might come about that conversion for energy purposes of areas originally set aside for food production could degenerate into food shortages and increase the cost of foodstuffs.

The most significant energy applications of biomass involve its direct conversion (combustion), methane produced by means of anaerobic digesters, thermochemical gasification, and methanol and ethanol production. Except for the historically well-documented and consolidated practice of the direct combustion of wood, they are all still at the research and experimental stage. The anaerobic digestion of biomass is based on the action of anaerobic microorganisms that use their enzymes at catalysts to convert organic matter into methane and carbon dioxide. In thermochemical gasification, biomass is converted into a mixture of hydrogen, carbon monoxide, methane, carbon dioxide, water and simple olefins; the characteristics of this mixture and its energy capacity depend on the chemical and physical properties of the original biomass and its moisture content. Gasification may be performed in different ways: pyrolysis, hydrogenation, oxygenation or injection of steam.

Methods

Biomass resources for energy production may be divided into three categories: forests and timber working waste (wood chips); farm waste and animal remains; "energy" crops. Wood is a resource offering immediate exploitation and in OECD countries has an annual potential of slightly less than 2000GWH. In these countries the timber industry covers 25% of energy requirements precisely through the direct combustion of waste and residues. Farm waste and animal remains are a by-product of food production by the agricultural sector. It is possible to compute an estimate of the recoverable energy, by which is meant precisely the biomass energy that can effectively be obtained from the conversion of these residues and remains into energy. The extensive cultivation of biomass that is particularly suitable for conversion into energy and other useful forms is potentially the most reliable and interesting technology. In quantitative terms, its significance is dependent on the economic, agricultural and social policies of the individual countries.

Lastly, biomass cultivation as a renewable resource has a much lower greenhouse gas emission rate than fossil fuels. For instance, 1GJ (10^9 joule) produced by ad hoc crops has a carbon release of 2kg compared with 24 for coal, 22 for oil and 14 for natural gas. Agriculture can have the dual role of an activity to produce energy and to help monitor the quality of the environment.

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ABSTRACT

Energia dalle biomasse: una priorità cruciale per il futuro

L'interesse della comunità scientifica per l'energia prodotta da sistemi biologici è continuamente crescente. Sarà questa in futuro un'alternativa reale economicamente vantaggiosa. La biomassa può essere convertita in combustibili puliti ed in validi sostituti dei prodotti petrolchimici. Le possibili strategie per ottenere biomassa da impiegare nei processi industriali sono: la coltivazione di colture energetiche, la raccolta di vegetazione spontanea e l'utilizzo dei rifiuti organici.