



## Territorial level for biofuel production—Case study of an Italian region

A. Paiano, G. Camaggio, G. Lagioia\*

University of Bari Aldo Moro, Faculty of Economics, Department of Geographical and Commodity Science, Via Camillo Rosalba, 53-70124 Bari, Italy

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### ABSTRACT

An analysis of the biofuel production chain suggests that adapting and optimizing the whole system to an appropriate scale based on the availability of agricultural and/or agro-industrial biomass feedstock is needed. This study of the potential use of these biomass materials is carried out on a regional scale and, in particular, in Apulia, a region in south Italy with a high agricultural vocation. The aims of this paper are to identify the real availability of the residual biomass (particularly lignocellulosic), and form a hypothesis regarding launching new production chains (from biomass to diesel) on a regional scale with appropriate localization in the Apulia territory. According to the methodology (adapted from the European Directive 2009/28/EC on renewable energy sources), the greenhouse gas savings due to the replacement of a share of fossil diesel with BTL diesel produced from inland biomass are evaluated as well. A hypothesis regarding the appropriate scale and localization of BTL plant together with relative costs are presented in the results and discussion section. The conclusion section provides perspectives regarding the BTL diesel and bioenergy system, and the creation of an agro-energy district in the Apulia region.

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### 1. Introduction

The political strategy of the European institutions (Directive 2009/28/EC) [1] regarding the production and use of biofuels provides a boost toward the study of new and complementary energy options. The most relevant economic and environmental effects of the energy system can be analysed, allowing for different choices of raw materials.

Biofuels are a feasible tool for achieving the European Union (EU) environmental policy on the transport sector, and for securing and diversifying the energy supply. However, conventional biofuels [2] or the first-generation biofuels are based on agricultural feedstock, and are insufficient in meeting these policy goals. On the contrary, biofuels from lignocellulosic biomass (second-generation biofuels) could potentially overcome some limitations—for instance, the high costs of raw materials and land availability. Among the several sources for second-generation biofuel production, the residual biomass generated by the agricultural, forest, and agro-industrial sectors is a widespread and abundant material, not classified as waste, and is considered a potential feedstock for fuels.

We underline, however, that one of the main constraints concerning the chain of energy production from residual biomass is

\* Corresponding author. Tel.: +39 0805049086; fax: +39 0805049086.  
E-mail addresses: [a.paiano@dgm.uniba.it](mailto:a.paiano@dgm.uniba.it) (A. Paiano), [g.camaggio@dgm.uniba.it](mailto:g.camaggio@dgm.uniba.it) (G. Camaggio), [g.lagioia@dgm.uniba.it](mailto:g.lagioia@dgm.uniba.it) (G. Lagioia).

the feedstock supply: these biomass resources are not concentrated (they have a high territorial dispersion), with an inefficient mode of collection. Hence, additional transport and storage systems facilities may be required, consequently increasing costs and reducing the net energy production [3]. This is a critical item and it suggests the development of short or medium production chains, with a distance of 10 km (to a maximum of 60 km) from the collection/storage points to the energy conversion plant. The growth of short chains, however, could be negatively affected by the inability to compete with the longer bioenergy production chains with profitable economies of scale, supplied by cheap imported biomass. As a consequence, a local market of bioenergy (especially biofuels), has not emerged, and the potential economic and environmental advantages of the entire chain have failed to materialize.

In addition, the interaction between agriculture and industry is difficult because these two sectors usually have differing priorities and courses of action counter to each other. It is therefore important to establish an agreement between the sectors with the aim of achieving a common purpose—the creation of bioenergy production districts closely linked to the territory with its own potential for success.

A correct evaluation of potential biomass exploitation and the rationalization of the entire supply, storage, and energy production chain, requires detailed knowledge of the identified region. Thus, the specific area of study for this paper is Apulia, a region in the south of Italy.

The constraints concerning the bioenergy system mentioned earlier, together with the position taken up by the European institutions (see Section 1.1) place the focus on different criteria to determine the production and use of biofuels. Our analysis identifies the following two important criteria: (1) a biomass pathway at the local level for suitable development; and (2) the use of lignocellulosic biomass residues, particularly for diesel production [4]. These two criteria have been applied in the Apulia region to organize the production of biofuel from residual biomass through the creation of short or medium production chains.

The aim of this paper is to analyse the potential of using residual biomass (particularly lignocellulosic) for biomass-to-liquid (BTL) diesel production. A suitable localization of a BTL plant in the Apulia region has been hypothesized, along with the relative environmental benefits on a regional scale from the prospective substitution of fossil diesel consumed in this area with an equal share of BTL diesel produced in loco.

In the following sub-section, the important policy developments at the European level concerning the role of biofuels are examined. In Section 2, the thermo-chemical process of BTL to produce second-generation biofuel from residual biomass is described, with a brief remark about the material and energy balance of the process. Sections 3 and 4 illustrate the methodology utilized and applied for mapping the biomass feedstock in this region. Sections 4.1–4.1.1 estimate the potential of this residual biomass to produce diesel, including identifying the region's greenhouse gas savings. Section 5 covers the results and discussion, and hypothesizes a suitable location for a BTL plant in Apulia on the basis of the data set out in Section 4, including brief remarks about the relative costs. Finally, the conclusion summarises the perspectives regarding the BTL diesel production chain and the creation of an agro-energy district in the Apulia region.

### 1.1. EU policy developments regarding biofuels

In March 2007, EU leaders committed to raising the share of biofuels in transport from the current level of approximately 2% (according to the EU's original 2003 Directive on the promotion of

biofuels) to 10% by 2020, in response to increasing oil prices, a need for an increased energy supply, and environmental concerns. This undertaking was translated into a legal proposal, presented on 23 January 2008 by the Commission, as part of a broader Directive on renewable energies [5].

This draft directive also replied to the many criticisms regarding biofuel production, including the use of food crops for biofuel production, a consequent danger of mass deforestation, a global increase in food prices, and water shortages. The Commission proposal did indeed ban “bad” biofuels, and introduced three sustainability criteria: (1) land with high carbon stocks should not be converted for biofuels production; (2) land with high biodiversity should not be converted for biofuels production; (3) biofuels should achieve a minimum level of greenhouse gas savings (carbon stock losses from land use change would not be included in this calculation).

These important concerns regarding biofuels production proved insufficient for both the European Parliament's Environment Committee and Parliament's Industry and Energy Committee. They confirmed the 10% Commission's target by 2020, and also decided to set an interim target of 5% by 2015. Moreover, they specified that at least 20% of the 2015 and 40% of the 2020 targets must be met by the use of electricity or hydrogen from renewable sources, biogas, or transport fuels of a “second generation,” made by lignocellulosic biomass, waste, or algae. This means that only 4% (by 2015) and 6% (by 2020) of the total road transport energy use could come from traditional “first generation” biofuels.

The Parliament's Industry and Energy Committee was also demanding that, before 2015, a full review of the whole EU biofuel promotion policy and its social and environmental impacts should be carried out to determine whether the targets need revising. Moreover, stricter sustainability criteria in terms of high greenhouse gas savings have been added: initially, the biofuels must save at least 45% of carbon emissions compared to fossil fuels (the Commission had proposed a saving of 35%) and, from 2015 onward, these savings must be at least 60% [6].

The European Economic and Social Committee has paid attention to the previous issues as well. The Committee considers that the current technologies for this sector demand a very high consumption of energy, water, and land, and that it is essential to secure biofuels using “zero-mile” domestic agricultural products for optimizing the fight against pollution [7]. The feedstock should not be transported from distant countries, consuming fossil fuels in the process. The difficulties in efficiently producing energy from agro-food residues arise from their widespread distribution, requiring costly transportation to processing centres, and from significant water content of the residues, requiring high volumes for processing. For these reasons, biomass of this kind should preferably be processed in situ. Therefore, it is important to point to the fact that the production of biofuels, even if it is a sector of national importance requiring reliable centralized planning, could only have real development possibilities if it is territorially closely linked.

Finally, on 17 December 2008 and 23 April 2009 [1], the European Parliament voted overwhelmingly in favour of the legislation package of energy and climate change, and translated the Commission proposal of January 2008 into law. An agreement was reached regarding three targets for the year 2020: a 20% reduction in greenhouse gas emissions, a 20% improvement in energy efficiency, and a 20% target for the overall share of energy from renewable sources. Mitigating many of the demands of the European Parliament's Industry and Energy Committee, the main changes introduced by the European Parliament are the following:

1. The share, at least 10% in 2020, of final consumption of energy in transport in each Member State shall be ensured to come from renewable sources, not only from biofuels (Article 3).

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