

# LATEST BIOFUEL TECHNOLOGIES FOR SUSTAINABLE TOURISM

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## ABSTRACT

This paper addresses the challenge of transforming European Hotels into sustainable tourism areas, through the direct (or indirect) use of renewable energy projects and technologies. Developing an appreciation of the factors that can lead to sustainable tourism in especially Europe using renewable energy is a priority issue for two main reasons. Firstly, because until now scientific literature has only discussed the question of photovoltaics' integration into tourism buildings, and secondly, because of the relatively high vulnerability to climate change impacts of crowded touristic cities. Nowadays, reduction of gaseous emissions into the atmosphere, reducing the adverse effects of climate change in Europe has become a significant component of national priorities. This work demonstrates recent biofuel technologies that can be implemented today and in future in full compliance with the obligations at a national level and from European Guidelines and Directives.

## INTRODUCTION

Nowadays, one of the main focus in World Tourism is "Tourism and Sustainable Energy". The international tourism community offers a unique opportunity to emphasize the steps it has taken so far to strengthen sustainable development. Tourism authorities are highlighting some of the world's most ambitious and innovative clean energy solutions: the aviation industry uses the latest technologies to make aircraft lighter than ever before; commercial flights are beginning to use biofuels in fuel mixtures; key card systems and energy-saving bulbs are increasingly used in hotel rooms worldwide; and tour operators demand energy efficiency across their supply chains.

Within the scope of sustainable tourism, the use of renewable energy sources by tourism enterprises reduces their environmental losses and reduces their costs. This situation provides a significant competitive advantage to tourism enterprises [1]. Considering the growing and rapidly developing structure of the tourism sector, this is expected to contribute greatly to the development of national economies. On the other hand, while economies are growing, it is observed that tourists have a growing tendency to become aware of the damage they cause to the environment. This situation, which is an important factor affecting tourism demand, is an important attitude in the sustainable growth of tourism sector in the future. Moving from all these explanations, the investments made by the tourism sector in renewable energy sources and their studies on this subject show that they have an important place in the development and development of the sector. Thus, clean energy solutions in tourism is not only reducing the carbon emissions of the sector, but also letting local communities use modern energy services and create job opportunities and economic development.

## DEVELOPED AND EMERGING TECHNOLOGIES IN BIOFUEL PRODUCTION

Figure 1 shows that USA and Brazil are leading countries based on biofuel production in 2017 followed by Germany and Argentina [3]. Except Germany, in Europe we still not reached to the level of these countries. Therefore, we aim in this study to introduce the established and developing technologies (seen in Table 1) in biofuel production and usage in the scope of sustainable tourism is investigated in detail.

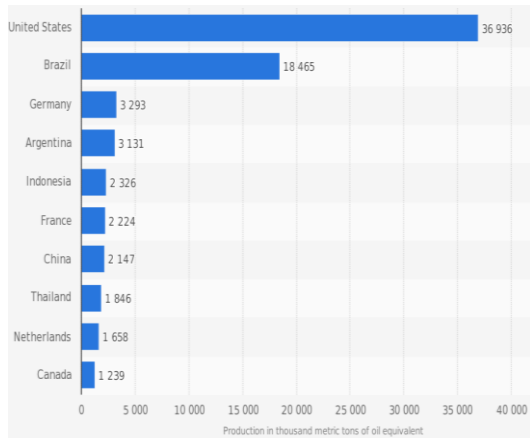


Table 1: Biofuel Technologies [2]

<i>Established</i>	<i>Developing</i>	<i>Demonstration</i>
Wood pellets	Biogas/AD	Slow Pyrolysis (biochar)
Fermentation Ethanol	Cellulosic Ethanol	Fast Pyrolysis (pyrolysis oil)
Biodiesel	Renewable Diesel/HEFA	Torrefaction (biocoal)
Biomass Gasification		Butanol
		Steam Explosion (black pellets)

Figure 1: Leading Countries based on biofuel production in 2017 [3]

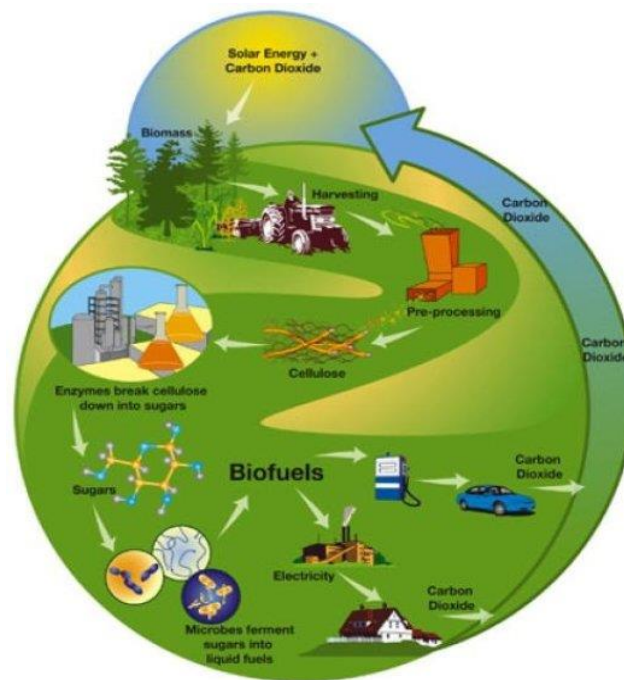
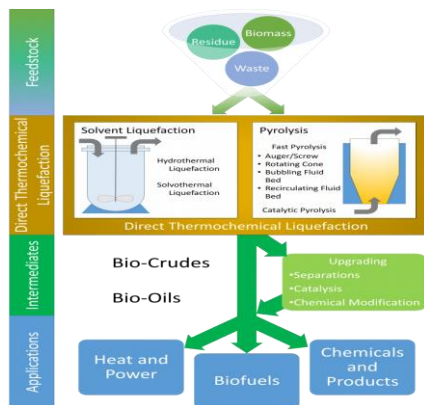


Figure 2: Biofuels chain [4]

In literature, there are three classifications of industrial status. The first one is the established technologies consisting of modern facilities which are geographically wide-spread, and operational for a decade or more. Most of them use incineration, but several of them use biomass gasification. Larger scale biomass gasification projects have limited success compared to incineration, but smaller-scale biomass gasification units have some success and technology has been established for a long time. Emerging technologies have several modern industrial scale

plants with a proven track record for several years, but their geographical coverage is limited. Over the last decade, biogas / anaerobic digester technologies have evolved into the developing category beyond the development stage. Demonstration technologies are the first modern full-scale facilities which were built and operated continuously (as capacity) for a long time to show their reliability, operating costs and profitability. There are several biofuel technologies that are being developed for many years but cannot fall into the developing category on an industrial scale. One of them is slow pyrolysis which has a long history and is most known for its traditional technology for the production of charcoal, but new industrial-scale plants have not been built [4]. Fast pyrolysis, which can also produce biochar, has new demonstration facilities recently come on stream Fast pyrolysis, which can also produce biochar, has new demonstration facilities recently come on stream [5] followed by the other demonstration technologies include torrefaction [6], biobutanol [7] and steam explosion [4].



Date	Durability	Pine	Date	Durability	Straw
October 2012	88.8		February 2013	84.2	
January 2013	92.3		September 2013	94.3	
June 2013	94.7		October 2013	96.6	
November 2013	95.7		November 2013	97.6	

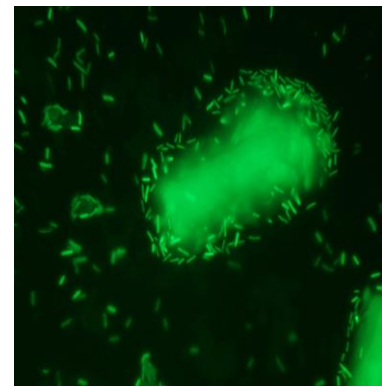


Figure 3: Direct Thermochemical Liquefaction (DTL) [8]

Figure 4: Torrefied pine and straw pellets at CENER [6]

Figure 5: Biobutanol developed at National University of Singapore (NUS) [9]

## APPLICATIONS

Figure 6 shows wood pellet consumption in the industry and household consumption in Europe. The land areas were colored to show the proportion of pellets in the total primary energy consumption. As seen here Sweden, England, Austria and Belgium account for over 0.1% of energy consumption on pellets, while Italy, Estonia and Latvia also have higher proportions compared to the rest of the countries. In Europe, the industrial sector leads in England and Denmark as consumers. Biomethane map for Europe is given in Figure 7.

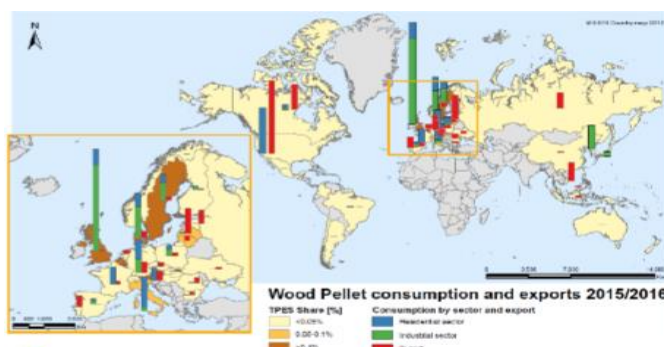


Figure 6: Wood pellet consumption in Europe [10]

Figure 7: Interactive Biomethane Map [11]

The use of biogas as fuel is considered to be one of the most effective means of reducing greenhouse gas emissions in the transport sector, thereby reducing its climate impact. In order

to use the biogas it is necessary to upgrade it, i.e. purified mainly from CO<sub>2</sub>. Figure 8 shows promising technologies economically viable for biomethane production.



Figure 8: Promising technologies economically viable biomethane production [12]

## RESULTS AND DISCUSSION

Biofuels have grown rapidly in production and consumption worldwide. The most important point in terms of biofuels production policies, instead of importing the raw materials they use in the production process, they try to obtain agricultural products grown in the country. This policy must be adopted to tourism industry, giving the opportunity to focus on local production and create new employment and income opportunities within the sector. New technologies should be encouraged by the European tourism authorities since it is easier to apply them in small scale which fits more for hotels. Thus, they can be reached to the developed technologies level.

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