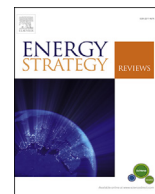




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Market and economic feasibility analysis for the implementation of 2nd generation biofuels in Greece

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ABSTRACT

Increasing demand for fossil fuels worldwide coupled with environmental concerns has intensified the focus on Renewable Energy Sources. So-called '2nd generation' biofuels, produced from residues, waste or cellulosic material, present distinct advantages over fossil fuels and can contribute to energy security and sustainable development of society.

This paper aims to demonstrate that Greece holds sufficient resources to support indigenous and possibly economic production of 2nd generation biofuels in order to meet the European Union 'Renewable Energy Directive' targets. These mandate 10% share of biofuels in the transport sector for member states by 2020 with continuous penetration of advanced biofuels towards the 2030 horizon (RED II). A market analysis has been performed to review the biofuels market in Greece and investigate the availability of 2nd generation resources, followed by economic feasibility assessment of their production routes.

Individual results identify substantial market gap, with potential to be filled through indigenous production of 2nd generation biofuels. This presents significant short to medium term growth opportunity as well as an attractive investment, provided appropriate technological pathways and feedstocks are selected that minimize overall supply-chain and productions costs, further supported by robust policies. In order to pursue this growth potential, careful central planning, de-risking and policy support from the government is required, followed by a radical reformation of the biofuels industry.

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1. Introduction

Increasing demand for fossil fuels worldwide coupled with environmental concerns has intensified the focus on Renewable Energy Sources (RES). Biofuels play an increasing role in meeting global energy demand and can contribute significantly to sustainable development of the society. So-called '2nd generation' biofuels, produced from residues, waste or cellulosic material, present a recent trend, as they are considerably advantaged in terms of GHG emissions, cost and social acceptability compared to 1st generation biofuels.

Implementation of biofuels in the global energy mix is

determined by national and international policies, key drivers for which include energy and environmental security, as well as economic development. At European Union (EU) level, targets for RES implementation are enforced through the 'Renewable Energy Directive' (RED), which mandates a minimum 10% share of biofuels in the transport sector for all member states by 2020, while the recently released RED-II addresses the sustainability issue of biofuels and mandates the reduction of their Greenhouse Gas (GHG) emissions by phasing out gradually food crop-based biofuels. The commitment of the Greek government to meet the RED targets by 2020 translates into measurable opportunities.

In principle, the market evolution towards 2nd generation biofuels is not only mandated by sustainability and quality issues of 1st generation biofuels that do not allow the extent of biofuels penetration according to the European regulatory framework, but also corresponds to a unique opportunity for Greece to fully exploit the indigenous RES potential and attract significant investments. The attractiveness of the investment environment is driven by the

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Table 1
EU RES scenarios by 2030 [7].

	30% RES	35% RES	40% RES	45% RES
Overall RES by 2030	30% RES	35% RES	40% RES	45% RES
Transport RES by 2030	9.9%	13.7%	17.4%	20.3%

competitive advantage of Greece in terms of raw materials availability, infrastructure and labour, which create the conditions for profitable investments, provided that some degree of support by the government will incentivize the investors. The benefits of such investments can be at multiple fronts, as the industry development will amplify RES penetration, enhance compliance with the EU directives, support the Greek economy and stimulate job creation.

The objectives of the current study are to demonstrate that Greece holds sufficient indigenous resources to support economic production of 2nd generation biofuels; show the growth potential of the sector in Greece; and articulate how this can be achieved.

Similar studies have been conducted by Boukis [1,2], describing the methodology to estimate biofuels demand in conjunction with demand for transportation fuels, and also outlining a detailed methodology for developing a national policy plan for biomass exploitation in Greece. The analysis describes the current situation with respect to the market of biomass and biofuels in Greece, the potential biomass availability, sourcing and production, the production cost, the supply chain and finally an economic evaluation. Tsita and Pilavachi [3], also using the Analytic Hierarchy Process, provide a rather complete set of evaluation criteria for all potential pathways of 2nd generation biofuels in terms of economic, technical, social and policy criteria.

A similar approach is followed in this study, the aim of which is to elaborate further on these ideas and show the potential for Greece to produce biofuels by focusing solely on abundant 2nd generation resources.

The structure of the current paper is as follows: The biofuels market penetration required to meet RED targets is estimated in section 2 based on the forecasted demand. Subsequently in section 3, the current market environment in Greece with respect to biofuels supply is investigated, followed in section 4 by the availability of 2nd generation resources to meet RED targets and close the market gap. In section 5, the production economics of 2nd generation biofuels are investigated and an economic evaluation of the

most promising route is provided. The constraints of the current business environment (policy, supply-chain, market, technology) are analysed in section 6 and a suitable strategy mix defined in section 7, based on which a conceptual industry model for Greece is proposed. Finally, section 8 presents the conclusions of the study.

2. Analysis of demand in Greece

Market trends with respect to biofuels demand towards the 2030 horizon are investigated on the basis of demand for transportation fuels, into which they are blended. The projected demand for transportation gasoline and diesel is estimated based on linear regression of historic data from 1990 to 2015 as provided by the Ministry of Environment Energy & Climate Change in Greece [4,5].

After estimating the transport fuels demand, the amount of biofuels blended into the existing transport fuels pool is determined through a national policy plan implemented by MEECC and which is derived from the EU directive that mandates a RES percentage of 10% in the transport sector by 2020.

The 2030 RES scenarios are determined according to the EU commission [6], energy and climate goals for 2030. These have converged towards a binding EU target of at least 40% reduction of Green House Gas (GHG), corresponding to a 40% RES penetration to the energy mix with the share of biofuels reaching 17.4% in the transport sector (Table 1) according to a scenario by Resch et al. [7].

The forecasted biofuels demand is estimated based on a linear regression model as presented in Fig. 1. Since biofuels demand is based on transport fuels demand, naturally a dispersion of the estimates is observed based on the various sources depicted in Fig. 1. 2020 predictions are provided in all cases by the given source while 2030 predictions are forecasted via each individual demand model slope. The changing slope of the model estimate is due to the rapid increase of RES share in the transport sector after 2010 based on the national plan [7]. Nevertheless, the forecast model is found to be in very good agreement with the average biofuels demand data from various sources and reported in Table 2 (model deviation from estimated average equals 2% for 2020 and 0% for 2030 forecasts). The model demand forecast predicts an estimate of 655 ktOE RES consumption in 2020 (literature range 606–766 ktOE) and 1234 ktOE RES consumption in 2030 (literature range 907–1462 ktOE) to comply with the EU RED. Based on these values the model

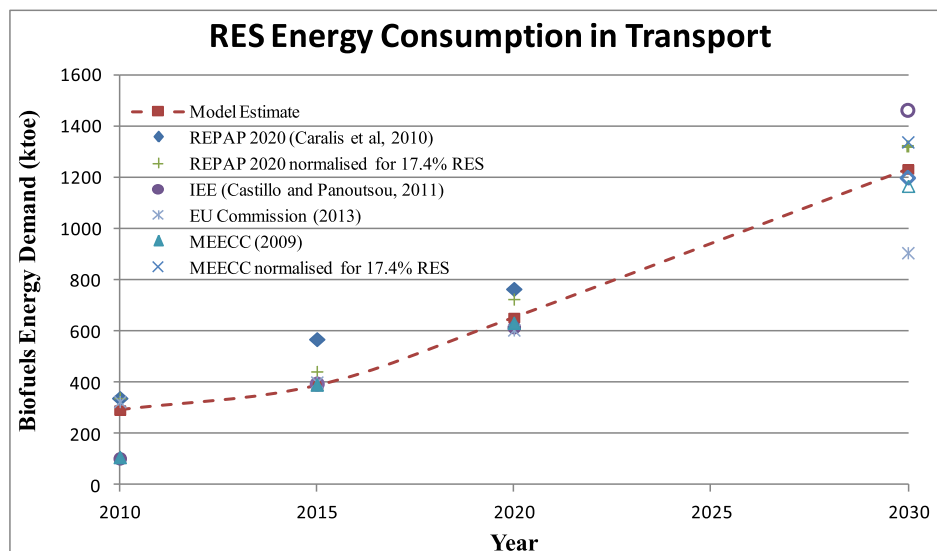


Fig. 1. Biofuels demand estimation for transport in Greece.

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