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Article

Admissibility Grid to Support the Decision for the Preferential Routing of Portuguese Endogenous Waste Biomass for the Production of Biogas, Advanced Biofuels, Electricity and Heat

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Abstract: A methodology was developed to assess the allocation of different types of endogenous waste biomass to eight technologies for producing electricity, heat, biogas and advanced biofuels. It was based on the identification of key physicochemical parameters for each conversion process and the definition of limit values for each parameter, applied to two different matrices of waste biomass. This enabled the creation of one Admissibility Grid with target values per type of waste biomass and conversion technology, applicable to a decision process in the routing to energy production. The construction of the grid was based on the evaluation of 24 types of waste biomass, corresponding to 48 sets of samples tested, for which a detailed physicochemical characterization and an admissibility assessment were made. The samples were collected from Municipal Solid Waste treatment facilities, sewage sludges, agro-industrial companies, poultry farms, and pulp and paper industries. The conversion technologies and energy products considered were (trans)esterification to fatty acid methyl esters, anaerobic digestion to methane, fermentation to bioethanol, dark fermentation to biohydrogen, combustion to electricity and heat, gasification to syngas, and pyrolysis and hydrothermal liquefaction to bio-oils. The validation of the Admissibility Grid was based on the determination of conversion rates and product yields over 23 case studies that were selected according to the best combinations of waste biomass type versus technological solution and energy product.

Keywords: waste-to-energy; (bio)chemical conversion; thermochemical conversion; biodiesel; biomethane; bioethanol; biohydrogen; electricity and heat; synthesis gas; bio-oils

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1. Introduction

Waste-to-energy is a broad wording that encompasses much more than waste incineration with energy recovery. It covers several waste treatment processes that generate energy directly in the form of electricity and/or heat or in the form of a fuel derived from waste, in each case with a particular environmental impact and a specific potential in a circular economy context [1]. Feedstocks such as residues and by-products from agriculture, food processing, industrial and municipal waste streams, and residues from forest harvesting and wood processing may account for up to 45 exajoules of the global bioenergy supply in the form of biogas, syngas, and advanced liquid biofuels in 2050 [2]. In fact, balanced combinations of materials and energy recovery in the waste hierarchy pyramid should not be disregarded in future solutions for unavoidable waste [3]. Waste biomass must be seen