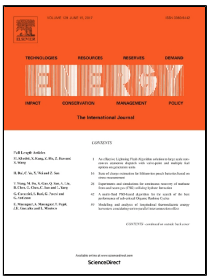
Accepted Manuscript



Optimal use of biomass in large-scale energy systems: insights for energy policy

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PII:	S0360-5442(17)30783-1
DOI:	10.1016/j.energy.2017.05.027
Reference:	EGY 10834
To appear in:	*Energy*
Received Date:	15 October 2016
Revised Date:	10 April 2017
Accepted Date:	02 May 2017

Please cite this article as: Víctor Codina Gironès, Stefano Moret, Emanuela Peduzzi, Marco Nasato, François Maréchal, Optimal use of biomass in large-scale energy systems: insights for energy policy, *Energy* (2017), doi: 10.1016/j.energy.2017.05.027

Optimal use of biomass in large-scale energy systems: insights for energy policy

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Abstract:

Biomass chemical conversion processes allow the production of solid, liquid and gaseous biofuels, which can substitute almost any kind of fossil fuel and the associated greenhouse gas emissions. Despite this potential, high investment costs and conversion losses reaching up to 30-40 % of the input biomass energy content are major barriers to a higher penetration of the chemical conversion processes. Thus, biomass is nowadays predominantly used for direct combustion. However, conversion losses of chemical processes may be compensated by the fact that biofuels can be used in more efficient technologies compared to standard raw biomass fuelled technologies. As an example, Synthetic Natural Gas (SNG) can be used in a cogeneration-heat pump system to produce heat, reaching an overall efficiency much higher compared to a wood boiler.

In this work biomass conversion options are compared taking into account the complete energy conversion pathway, from the resource to the supply of energy services. The comparison is performed by evaluating the CO_2 abatement potential of integrating these different pathways into a national energy system with a Mixed-Integer Linear Programming (MILP) modeling approach. The comparison is done with 56 scenarios, which are classified in two different groups. In the first group the choice of the biomass chemical conversion process is the only possible change in the system. In the second group, other changes are allowed in the energy system, such as an important deployment of efficient technologies. Results show that biofuels can allow for an overall better performance in terms of avoided CO_2 emissions compared to direct combustion of biomass. To exploit this potential, however, it is necessary to link the production of biofuels to a wider deployment of the corresponding efficient end-use technologies.

Keywords:

Biomass Use, Strategic Energy Planning, Energy Policy, Biofuels, Biomass Conversion Pathways.

1. Introduction

The IEA (International Energy Agency) forecasts a 70% increase in global energy demand and a 60% increase in greenhouse gas emissions in 2050 compared with 2011. Constraining the increase in average global temperatures to 2°C would require a 50% greenhouse gas (GHG) emissions reduction compared to 2009 levels, and limiting the increase in energy demand to 25% from today to 2050 [1]. Thus, the substitution of fossil fuels with renewable energy sources, such as biomass, is one of the key measures to limit energy related GHG emissions.

Biomass represents the building material of plants and the way they store energy. It is one of the oldest energy resources used by humankind. In 2014, biomass represented 10.3% of the global primary energy supply [2]. However, if the solar radiation is considered as input, the efficiency of the photosynthesis is considerably low, less than 1% [3]. Biomass is a scarce, diffused, low density resource and its use for energy can enter in competition with land use for food and fodder. Therefore it is necessary to make the best use of available biomass in order to maximize its CO_2 emissions abatement potential.