BIOENERGY IN THE CONTEXT OF THE EU 2020- AND 2050-POLICY TARGETS: TECHNOLOGY PRIORITIES, OPPORTUNITIES AND BARRIERS

Gerald Kalt, Vienna University of Technology, Energy Economics Group, Tel.: +43 1 58801/370363, Fax: +43 1 58801/370397, kalt@eeg.tuwien.ac.at
Lukas Kranzl, Vienna University of Technology, Energy Economics Group, kranzl@eeg.tuwien.ac.at
Julian Matzenberger, Vienna University of Technology, Energy Economics Group, matzenberger@eeg.tuwien.ac.at

Overview

With the Renewable Energy Directive (European Commission, 2009), the Energy Roadmap 2050 (European Commission, 2011a) and the Roadmap for a Low-Carbon Economy in 2050 (European Commission, 2011b), the European Union has defined ambitious targets for the future deployment of renewable energy technologies and energy efficiency up to 2020 and beyond. Biomass will be of crucial importance for achieving both short- and long-term climate and energy policy targets, as the official renewable energy plans as well as scenarios up to 2050 indicate. Apart from its vast unused potentials in many EU countries, a main driver for bioenergy is that it can be used in all energy sectors: for sole heat and electricity generation, combined heat and power generation, in the transport sector (using existing infrastructures and conventional vehicles) as well as the integrated production of bioproducts and energy.

The purpose of this work is to assess the importance of bioenergy technologies for achieving the policy targets of the EU. Furthermore, an assessment of the bioenergy technologies which are considered crucial for facilitating the key role of biomass in a future sustainable energy system is carried out, and technology priorities are derived, using a multi-critera approach.

Methods

In a first step, a detailed investigation of the current state, recent developments and prospects for bioenergy use in the EU is carried out. Statistical data are primarily obtained from (Eurostat, 2011) as well as other sources, such as EurObserv'ER (2012) or EIA (2012). These data are also reviewed with regard to technologies and feedstocks used today as well as the sectoral structure of bioenergy consumption. Concerning projected/expected future developments, data on the member states' National Renewable Energy Action Plans (NREAP), following European Commission (2009), published in European Commission (2012) and summarized in Beurskens and Hekkenberg (2011) and Szabó et al. (2011) as well as long-term scenarios according to the Energy Roadmap 2050 (European Commission, 2011a) are used as the main sources. Next, technology roadmaps with a European and global scope (e.g. JRC, 2011; IEA, 2011 and BR&D, 2007) are reviewed with regard to technology priorities, expectations and recommendations as well as opportunities and barriers mentioned in connection with innovative bioenergy technologies. Finally, the data and information retrieved from these sources are used to carry out multi-criteria assessments for bioenergy technologies with a focus on advanced and innovative biomass utilization paths. These assessments are to provide a comprehensive insight into the expectations regarding certain technologies, their stages of development, anticipated potentials, economic performances as well as potential barriers and drawbacks. Economic aspects and the efficiency of different bioenergy technologies in greenhouse gas mitigation and fossil fuel replacement have already been investigated for the case of Austria in Kalt and Kranzl (2011). Building upon the findings of this work, this paper is to provide a more general view of this issue in the special context of the EU policy targets.

Results

Fig. 1a gives an overview of the historic development of biomass primary energy use in the EU-27, projections according to the NREAP forecast (Szabó et al., 2011) and according to the Energy Roadmap 2050, as well as data on technical biomass potentials in Europe. The figure illustrates that the current trend needs to be maintained until 2020, in order to achieve the overall NREAP target. In the ambitious scenarios according to the Energy Roadmap, biomass use increases to up to 13.4 EJ until 2050. Regarding the technical potentials available in Europe, most studies indicate that Europe is capable of supplying the required amounts of biomass. However, it is questionable whether these quantities can actually be mobilized, and increasing biomass imports from other world regions (primarily for biofuel production) are expected in most scenarios, especially if 2nd generation biofuel technologies will not be available until 2020.

Based on policy and technology roadmaps, priorities according to the SET-Plan (Strategic Energy Technologies Plan) and other publications (focusing on the EU and other contries/world regions), it was found the following advanced bioenergy technologies are generally considered to hold a great potential (technologies are roughly listed in the order of their technical maturity, starting with the most mature): (1) Biomethane injected into the gas grid and used for heat, electricity generation and/or as transport fuel, (2) Biomass gasification (Integrated gasification combined heat and power generation, and production of synthetic natural gas), (3) Advanced biofuels for transport and aviation (BtL, cellulosic ethanol etc.), (4) Advanced biorefineries and polygeneration plants, (5) Cultivation of algae and production of transport fuels, chemicals etc.

With regard to the continuing shift of biomass use towards electricity generation and the transport sector shown in Fig. 1b, it is obvious that technologies for advanced biofuel production (primarily such produced from cellulosic biomass and wastes) and highly efficient biomass CHP can be considered as R&D priorities for the coming years and decades. The flexibility and variety of utilization paths facilitated by gaseous fuels (biomethane and SNG) injected into the gas grid are considered as the main driver for these conversion technologies. On the longer term, the integrated production of bioenergy, chemicals, bioproducts etc. will be a crucial step towards a low-carbon economy. Therefore, biorefinery concepts, based on different feedstocks (including aquatic biomass) and conversion paths, and producing a wide variety of products, will most likely be a long-term research priority in the EU.

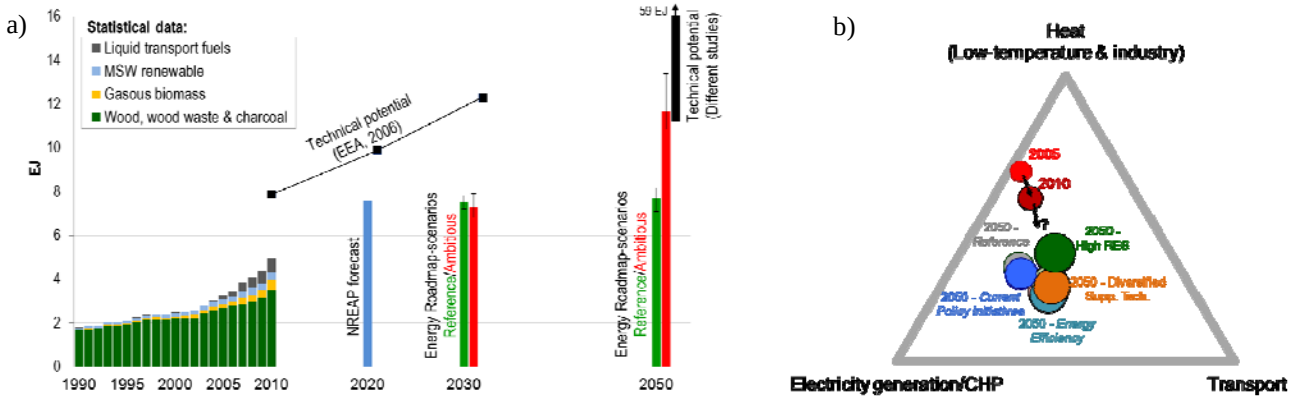

Figure 1a) Statistical data, scenarios and potentials for biomass use in the EU up to 2050; b) Illustration of the historic and expected structural changes of bioenergy use in the EU, according to Energy Roadmap-scenarios (The location of the bubbles indicate the shares of primary energy used for heat generation, electricity/CHP and transport, and their size the total amount of biomass used.); Main sources: Eurostat (2011), Szabó et al. (2011), EEA (2006), European Commission (2011a), Haberl et al. (2010), Smeets et al. (2007), own calculations and illustrations

Conclusions

There is a wide range of bioenergy technologies which could – from today's point of view – contribute significantly to an increasing efficiency and importance of bioenergy use in the EU. Considering this technological diversity and the central role of biomass for achieving the 2020- and 2050-energy and climate policy targets, strategic planning of bioenergy R&D priorities is of crucial importance. As these priorities are strongly interlinked with the strategic energy goals of the EU, continuous monitoring of the technological progress, upcoming barriers and potential showstoppers is required. Due to the numerous criteria which need to be taken into account in a holistic assessment of bioenergy technologies, multi-criteria assessments (taking into account economic and non-economic aspects, barriers, demand-side potentials etc.) are considered a suitable approach for evaluating the potentials of different bioenergy technologies. Previous work has shown that at least on the short- to medium term, biomass use for heat generation is often the most efficient option with regard to costs, GHG mitigation and fossil fuel replacement. Large-scale CHP generation based on biomass gasification could become a highly economic and efficient utilization path in the near future, whereas advanced biofuels are found to be less efficient due to relatively low conversion efficiencies (Kalt and Kranzl, 2011). However, considering the EU policy targets and official long-term scenarios, as well as the numerous alternatives for renewable energy in the heat and power sector, advanced biofuels will most likely remain one of the top priorities in bioenergy R&D. Up to 2050, biorefineries and biofuels based on aquatic biomass are often expected to result in revolutionary advances in biomass use and pave the way towards a low-carbon economy. More detailed results and conclusions will be available in the full version of this paper.

References

Beurskens, L.W.M., Hekkenberg, M., 2011. Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States. European Environment Agency: Copenhagen, Denmark.

BR&D, 2007. Roadmap for bioenergy and biobased products in the United States. Biomass Research and Development Technical Advisory Committee, Biomass Research and Development Initiative.

EEA, 2006. How much bioenergy can Europe produce without harming the environment? (No. 7/2006). European Environment Agency, Copenhagen.

EIA, 2012. EIA - International Energy Statistics [WWW Document]. URL http://www.eia.gov/countries/data.cfm

EurObserv'ER, 2012. EurObserv'ER Barometer [WWW Document]. URL http://www.eurobserv-er.org/

European Commission, 2009. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

European Commission, 2011a. Communication from the commission to the European Parliament, the Council, the European economic and social Committee and the Committee of the regions. Energy Roadmap 2050. COM(2011) 885/2 [WWW Document]. URL http://ec.europa.eu/energy/energy2020/roadmap/index_en.htm

European Commission, 2011b. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions; A Roadmap for moving to a competitive low carbon economy in 2050.

European Commission, 2012. Energy: National Renewable Energy Action Plans - European commission [WWW Document]. URL http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm

Eurostat, 2011. Website of Eurostat - Energy database [WWW Document]. URL http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/database

Haberl, H., Beringer, T., Bhattacharya, S.C., Erb, K.-H., Hoogwijk, M., 2010. The global technical potential of bio-energy in 2050 considering sustainability constraints. Current Opinion in Environmental Sustainability 2, 394–403.

IEA, 2011. Technology Roadmap. Biofuels for Transport. OECD/IEA, Paris.

JRC, 2011. 2011 Technology Map of the European Strategic Energy Technology Plan (SET-Plan). Technology Descriptions, JRC Scientifi c and Technical Reports. European Commission, Joint Research Centre, Petten.

Kalt, G., Kranzl, L., 2011. Assessing the economic efficiency of bioenergy technologies in climate mitigation and fossil fuel replacement in Austria using a techno-economic approach. Applied Energy 88, 3665–3684.

Smeets, E.M.., Faaij, A.P.., Lewandowski, I.., Turkenburg, W.., 2007. A bottom-up assessment and review of global bio-energy potentials to 2050. Progress in Energy and Combustion Science 33, 56–106.

Szabó, M., Jäger-Waldau, A., Monforti-Ferrario, F., Scarlat, N., et al, 2011. Technical Assessment of the Renewable Energy Action Plans, JRC Reference Reports. Joint Research Centre of the EC, Institute for Energy and Transport.