Renewable and Sustainable Energy Reviews 78 (2017) 31–45

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Review of solid and liquid biofuel demand and supply in Northwest Europe towards 2030 – A comparison of national and regional projections

Ioannis Dafnomilis[a,*], Ric Hoefnagels[b], Yudistira W. Pratama[b], Dingena L. Schott[a], Gabriel Lodewijks[a], Martin Junginger[b]

[a] Maritime and Transport Technology, Delft University of Technology, Mekelweg 2, 2628CD Delft, The Netherlands
[b] Copernicus Institute of Sustainable Development, Utrecht University, Heidelberglaan 2, 3584CS Utrecht, The Netherlands

ARTICLE INFO

Keywords:
Biomass
Bioenergy
Biomass trade
Biomass imports
Northwest Europe

ABSTRACT

Biomass is the largest source of renewable energy carrier in the European Union (EU) contributing to over 60% of renewable energy, with the majority of supply coming from domestic sources. However, an increasing significant amount of feedstock is imported, either due to domestic undersupply or higher production costs within the country. This article provides an up-to-date view of bioenergy supply, demand and trade in Northwest Europe to 2030. Projections of the energy system model Green-X are compared to recent national studies concerning bioenergy imports. The results show that there is a sizeable gap of the projection bandwidths after the 2020 horizon. Projections might under- or overestimate biomass potential in certain cases, depending on whether they are derived from national reports or regional models, whether future policy developments were taken into account etc. The ranges of biomass consumption are multiple times apart by 2020 already, and the gap increases by 2030. Total biomass imports in the region can range between 14 and 44.3 Mt by 2020 and 18.5–60 Mt by 2030.

1. Introduction

1.1. Background

In a pathway towards sustainable energy supply with deep reductions in greenhouse gas (GHG) emissions and decreased dependency on fossil fuels, biomass used for energy purposes (bioenergy) is expected to play a substantial role by all Member States (MS). In 2013, bioenergy consumed in European Union (EU) amounted to 64% of the total renewable energy consumption; mainly in the heating sector, but with significant contributions to electricity production and transport fuels [1]. Although this share is expected to decrease by 2020, due to the development of other renewable sources such as wind and photovoltaics (PV), the actual amount of biomass for heating, electricity and transport is expected to rise by up to 1400 PJ [2].

Mandates and support policies to increase the share of renewable energy to 20% in 2020 as agreed on by EU MS in the Renewable Energy Directive (RED) 2009/28/EC have been the main driver of the increased supply of renewable energy including bioenergy in the EU. Between 2000 and 2013, bioenergy supply more than doubled. According to EU MS, renewable energy production from biomass should increase by 33% in 2020 compared to 2013 as reported in the National Renewable Action plans (NREAPs) [3].

Under the 2030 climate & energy framework, the EU has agreed to achieve 40% reduction in GHG emissions (compared to 1990), 27% energy consumption from renewable sources, and at least 27% increase in energy efficiency by 2030. A major challenge for the 2030 horizon is how this 27% share will be distributed through the EU, considering there are still no binding national targets. MS action plans will need to be drawn up, allowing for different national capacities for RE production, while expanding upon the already achieved targets of 2020 [4].

The publication of the ILUC directive (Directive EU 2015/1513), amends the Fuel Quality Directive (2009/30/EC) and RED by imposing a cap on food based biofuels. Similar to the RED, at least 10% of energy consumption in transport should come from renewable energy sources, with a maximum of 7% biofuels made from food crops. The imposed cap on food based transport biofuels might further shift biomass demand towards non-food lignocellulosic sources.

Abbreviations: GHG, Green House Gas; MS, Member State; EU, European Union; PV, Photovoltaics; RED, Renewable Energy Directive; FQD, Fuel Quality Directive; NREAP, National Renewable Action Plan; NW, Northwest; EC, European Commission; RES, Renewable Energy Source; DE, Deutschland (Germany); DK, Denmark; BE, Belgium; UK, United Kingdom; NL, Netherlands; BAU, Business As Usual; QUO, Quotas; UNFCCC, United Nations Framework Convention on Climate Change; DECC, Department of Energy and Climate Change; PJ, peta Joule; Mt, million tonnes

* Corresponding author.
E-mail address: I.Dafnomilis@tudelft.nl (I. Dafnomilis).

http://dx.doi.org/10.1016/j.rser.2017.04.108
Received 20 July 2016; Received in revised form 2 December 2016; Accepted 28 April 2017

With the growing demand for biomass in the last decade, international trade of liquid biofuels and solid biomass has grown substantially, particularly in the EU. Extra-EU imports of biodiesel were practically zero before 2005 but peaked in 2012 at 118 PJ (19% of transport biofuel consumption in the EU in 2012) and declined to 34 PJ in 2014.

The largest part of EU biomass supply is and will be based on domestic sources; currently, 4% of the total biomass used for energy purposes is imported. However by 2020, and especially by 2030, this amount could increase by a significant amount, taking into account potential supply gaps, especially in the industrial sector (electricity production, closing down of coal power plants) [5]. Inequalities in forested area, waste biomass streams, differences in the amounts of supply and demand for bioenergy from one MS to another, open up opportunities for bioenergy trade. In the case of surplus of supply, countries may export bioenergy products to other countries, where bioenergy demand cannot be fulfilled from local resources (the Netherlands, Belgium).

Production costs of bioenergy feedstock (e.g. wood pellets) are also an important factor driving bioenergy trade. These costs can be lower if raw materials are pre-treated, in the form of wood pellets, torrefied wood pellets, intermediate or final form of biofuels in the case of liquid biomass. The higher costs for producing bioenergy feedstock within the EU (labor cost, supply of raw materials), make the option of importing bioenergy feedstock from countries where raw materials are abundant and production costs are cheaper, a more reasonable option [6]. This situation supports the growth of global bioenergy trade since availability of raw materials and cheap production cost are usually found in countries outside EU (United States, Canada, Brazil, and Indonesia) that can cater to several diverse end markets of biomass.

Especially in the US, which is by far the biggest exporter of wood pellets to the EU, independence of mills from the sawmill industry has allowed a focus on the export of pellets. Raw material is more readily available as a result of the lower demand from a declining paper and pulp industry and increasing forest productivity. A combination of factors such as a large availability of feedstock at competitive prices, as well as a sound and sustainable forest management system, relatively easy logistics, and cheap transport has rapidly attracted investment in the southeast USA from American as well as European companies. Much of the additional US capacity installed since 2010 is aimed at producing industrial pellets for export to the EU [7–10].

Biomass use is expected to grow in specific sectors, such as co-firing in coal power plants in the short-term future, possible high quality industrial heat in the long-term future and residential heating. The resource for the two first aforementioned sectors is wood pellets, while residential is traditionally achieved through the use of wood logs. However, use of higher quality wood pellets for heating has been getting traction the last several years. Moreover, in light of the conservation or unavailability of domestic resources, imports of solid biomass may increase across the EU region [11–13].

1.2. Problem definition and objectives

Despite the importance of biomass in the renewable energy landscape in the medium to long term future 2020–2030), there is a great deal of uncertainty on how the development of bioenergy will be like. While scenarios show a growth in bioenergy if renewable energy and climate policy targets are pursued [2,12], subsequent policy progress and political conviction seem to be lacking in respect to bioenergy support.

Bioenergy development projections, while attempting to take policy progress into account, do not always directly reflect the effects of policy measures, as it can usually be difficult to predict behavior (including the behavior of markets). As an example, the latest National Energy Outlook of the Netherlands under the ‘existing policy’ variant refers to specific, officially published measures and measures that are as binding as possible, such as the European Emissions Trading System (ETS) and subsidies for renewable energy. The ‘intended policy’ variant is based on existing policy plus published intended measures that, as of May 1st, 2015, were not yet officially implemented but were specific enough to incorporate in the calculations [14]. Latest developments show that the utility companies in the country have submitted four applications for co-firing under the spring SDE+ auction [15].

The bioenergy situation in Northwest Europe is generally characterized by highly erratic short term developments, diverse sustainability criteria between MS, complex logistics and hesitation for long term investment in dedicated infrastructure. Actual economic growth, demographic development, technology costs and other developments in and outside the MS are not always in line with these projections [14]. There is a knowledge gap concerning biomass's future presence in the sectors of electricity, heating and transport, as well as the supply potentials of EU – which region will need to import biomass, to what amounts and what will be the source region.

This work's objective is to quantify the uncertainties of the future status of bioenergy supply in NW Europe. An effort is made to provide, in as much detail as possible, developments in the bioenergy field on a regional level initially and on a MS level additionally. The main path to achieve that is to accurately supplement previous regional (EU level) model projections related to the bioenergy future with up-to-date national (MS level) plans for the short to long term energy sector evolution.

All of the above mentioned uncertainties are translated into ‘bandwidths’ (ranges) for the projections, relating to indicators such as final and primary energy demand and, more importantly, future supply, as imports of feedstock will heavily influence sector growth and international trade of biofuels, especially in the MS that have small potential of domestic supply. The results of this work can be used to visualize the needs for future infrastructure development, as well as logistics and policy support in the bioenergy sector.

In order to achieve this objective the following steps need to be undertaken:

1) Review of current status of bioenergy by end use sector
2) Review of national and regional projections of renewable energy deployment
3) Industry, market announcements, expert interviews, existing and future policies and sustainability criteria relevant to bioenergy in NW Europe, stakeholder participation in workshops
4) Comparison of projections of solid and liquid biomass demand and supply in Northwest Europe
5) Quantification of future bandwidths of biomass imports

1.3. Scope of work

The focus is largely set on lignocellulosic biomass, as heat and electricity needs consist by far the biggest percentage of biomass use. According to Sikkema and Fiorese [16], EU has become the largest importer of woody biomass for energy purposes in the form of wood pellets. Import of woody biomass, especially for electricity generation, will likely continue beyond 2020. In 2035, the authors remark that the import of biomass may reach up to 16 Mt of wood pellets, in order to fulfill the demand in the electricity sector alone.

Liquid biofuel prospects are also explored, as the use of second generation (advanced) biofuels is expected to grow beyond 2020 in order to prevent conflict between energy supply and food security issues [17].

Production of biochemicals, plastics and novel biomaterials through biomass were excluded from this research. According to expert opinions and industry representatives as well as macro-economic outlooks of sustainable energy and biorenewable innovations the use of biomass for energy purposes (heat, electricity and transport fuels) is still expected to be dominant over biobased materials up to 2030.