Biomass Availability in Europe

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Biomass has been demonstrated as a capable source of energy to fulfill the increasing demand for clean energy sources which could last a long time. Replacing fossil fuels with biomass-based ones can potentially lead to a reduction of carbon emissions, which is the main target of the EU climate strategy. Based on RED II (revised Renewable Energy Directive 2018/2001/EU) and the European Green Deal, biomass is a promising energy source for achieving carbon neutrality in the future. However, the sustainable potential of biomass resources in the forthcoming decades is still a matter of question.

Keywords: biomass ; the European Green Deal ; GHG emissions ; RED II ; stranded assets ; coal phase-out ; biomass conversion technologies ; cost ; SWOT analysis

1. Introduction

1.1. Policy Issues of Climate Change

The EU has updated its energy policy framework, in order to achieve the transition away from fossil fuels towards cleaner energy, in line with the EU's Paris Agreement commitments about the reduction of greenhouse gas (GHG) emissions. The climate and energy framework for the EU sets targets for the 2021–2030 period, in which the GHG emissions reduction will be at least 40%, as well as the target that the shares of renewable energy and the improvement in energy efficiency will be at least 32% and 32.5%, respectively.

These changes will cause a significant impact from a consumer, environmental and economic perspective in the future. Consequently, they contribute to the long-term strategy of net-carbon emissions in the EU by 2050. This objective is a pillar of the new growth strategy, the European Green Deal, which corresponds to the Paris Agreement. It is a set of policy initiatives that reaffirm the Commission's intension to commit Europe to being the first continent to achieve climate-neutrality by 2050, increasing the EU 2030 climate target regarding GHG emissions reduction to at least 50%, and towards 55%, in a responsible way. All key economic sectors will be examined, including energy, transport, industry and agriculture. The action plan will be released in the summer of 2020.

Reducing Carbon Emissions: EU Targets

The RED II, included in the Clean Energy for all Europeans package, came into force intending to keep the EU as the global leader in renewables. Towards this direction, electricity produced from biomass fuels could be taken into account by all installations with a total rated thermal input lower than 50 MW, and in these with a total rated thermal input over 50 MW, which apply high-efficiency cogeneration technology or for only-electricity-producing, meeting specific technical demands. Installations with a capacity above 100 MW could be taken into account only if the net-electrical efficiency is at least 36%. About power-only-installations, the directive states that they will be considered on condition that they do not use mainly fossil fuels, and there is no cost-effective potential for the adjustment of high-efficiency cogeneration technology as stated in Article 14 of Directive 2012/27/EU. The GHG emission savings from the use of biomass fuels are expected to be at least 70% for installations starting within the period 2021–2025, and 80% for installations starting up in the beginning of 2026. The Annex V (part C) contains the methodology for the calculation of the total GHG emissions and emission saving of biomass fuels (RED II Methodology).

Whilst coal remains a main fuel in the European energy mix, coal power is on the decline as affected by several utility plans, which aim to be coal-free in 10 to 15 years. The transition to lower-carbon energy forms and innovative technologies, for instance, carbon capture and storage, is mandatory in order to meet the EU's binding target to reduce carbon emissions by 2030. In 2018, the total emissions of Europe's coal plants were 625 million tons of CO_2 [1], which accounts for almost 15% [2] of the EU's total GHG emissions. Although the shift to a low-carbon economy expounds opportunities, economic and social impacts in many coal regions should not be neglected, such as the utilization of capital assets (coal power plants), otherwise, they have to be abandoned. In this case, biomass could play a significant role, in order to be used as a non-conventional fuel for these plants, keeping the infrastructure in operation even while most of the countries have announced the coal phase-out.

1.2. The Transition to the Post-Lignite Era

The commitments to greatly limit carbon emissions by 2030 may demand a costly shift for the global economy. This entails the possibility of assets with high carbon-intensive operations becoming “stranded”. That means that these technologies would change into unprofitable assets, because of the regulation (e.g., taxes on carbon) and technological development. Carbon restrictions would possibly affect carbon-intensive industries in general, and especially industries depending on energy or other carbon-intensive inputs [3]. McGlade and Elkins’ (2015) [4] estimation in the context of accomplishing the Paris Agreement’s goal, of keeping the average global temperatures increasing below 2 °C, was that around 35%, 50% and 90% of current oil, gas and coal reserves, respectively, are useless. Following this, the Economist Intelligence Unit appraises that the expected financial loss of assets will be approximately USD 4.2 trillion [5].

The implementation of regulation to mitigate the emissions, so far, has shown significant variability and volatility in setting a cost for CO_2 emissions, and thus a depreciation of investment in green energy sources. This signifies that global investors are currently confronted with a stark choice. Either they will experience a failure unless their holdings in fossil fuel industries act on climate change, and be held, or they will face losses to their whole portfolio of manageable assets, if little lessening is forthcoming. Charting a path away from these two alternatives should be a strong incentive for long-term investors to engage with companies in their portfolios, and to alter investments in the direction of a lucrative, low-carbon future [5]. This strategy of diversifying away from vulnerable products, and diverting the marketplace and jobs toward income sources that are more environmentally friendly, is named “Economic diversification” [6].

2. Data, Model, Applications and Influences

Biomass processing intends to endow biomass with characteristics that could ensure a simple and environmentally friendly technological conversion into useful energy. The conversion pathways are categorized by the type of biomass input, the technologies, and the end products. The harvested biomass can be used by either direct conversion to energy (primary biomass), or being treated before the energy conversion (secondary biomass). Primary biomass, such as woodchips and logwood, is burned usually to produce energy for electricity supply, cooking, steam, space heating and process heat. Secondary biomass is in different forms, such as solids (e.g., pellets, wood thermochemically treated fuel), liquids (e.g., vegetable oil, biodiesel, HVO/HEFA, bioethanol, Fischer-Tropsch fuels) or gases (e.g., syngas, biomethane, biogas, bio-H_2,), and can be used for a large number of applications, for instance, high-temperature industrial processes and transport [7]. These valuable energetic biomass forms could be interdependent in many cases. Specifically, syngas as a gas mixture of hydrogen, CO_2 and methane, could be upgraded to increase H_2 fraction in syngas [8]. Different parameters affecting the production of syngas from biomass, e.g. reactor model and conditions, and feedstock (carbon structure of biomass, the content of sulfur compound, etc.), have to be adjusted accordingly [9]. Moreover, the use of catalysts could be an effective method for increasing the H_2 yield from syngas [10].

The pathways of biomass-to-energy conversion can be defined by the processes: (i) The thermo-chemical processes, such as combustion, gasification, pyrolysis, torrefaction and carbonization, which are based on thermal energy of biomass. (ii) The physical-chemical conversion processes based on physical (e.g., milling, pressing, etc.) and chemical processes (e.g., hydrothermal treatment, esterification). (iii) The bio-chemical conversion, which is based on biological processes including the use of microorganisms, such as anaerobic digestion producing biogas, and fermentation producing ethanol [11]. The main distinction of a preferable technology is the moisture contented in biomass. In the case of "dry" biomass, thermochemical technologies are mainly preferred, and in the case of “wet” biomass, bio-chemical conversion technologies could be more suitable [12].

The total phase-out coal target, while maintaining the current assets in operation, can be a reason to use high shares of solid biomass in the fuel blend of biomass for powering technology, often up to 100%. This demands the change of fuel input, pre-treatment and burning system to something that could also use biomass properly. An example of a 100% retrofit to biomass is the power plant “Rodenhuize 4” (Table 1). The conversion began with the installation of infrastructures in transport and pre-treatment for the proper handling of wood pellets, and the conversion of a one-burner row in 2005. Firstly, the switch of burner rows to wood pellet firing was completed, and finally, the complete switching was succeeded by replacing the burner, and installing a Selective Catalytic Reduction (SCR) unit in order to monitor the NOx emissions [13].

Table 1. Retrofitting coal-to-biomass power plants [12].

Power Plant/Unit	Country	Finalization of Retrofits	Installed Capacity (MW Electrical)	Fuels Used	Combustion Technology
Les Awirs 4	Belgium	2005	80	Wood pellets	PF
Helsingborg	Sweden	2006	126	Wood pellets	PF
Västhamnsverket	Sweden	2006	69	Wood pellets	PF
Herning	Denmark	2009	75	44% wood chips, 44% wood pellets, 12% top-gas	GF (chips)/PF (pellets)
Rodenhuize 4	Belgium	2011	180	Wood pellets	PF
Tilbury *	United Kingdom	2011	750	Wood pellets	PF
Ironbridge *	United Kingdom	2012	740	Wood pellets	PF
Drax 1	United Kingdom	2013	660	Wood pellets	PF
Polaniec Green Unit	Poland	2013	195	80% wood chips, 20% agrobiomass	CFB
Drax 2	United Kingdom	2014	645	Wood pellets	PF
Atikokan	Canada	2014	205	Wood pellets	PF
Drax 3	United Kingdom	2015	645	Wood pellets	PF
Thunder Bay 3 *	Canada	2015	160	Arbacore wood pellets (steam explosion)	PF
Avedore 1	Denmark	2016	258	Wood pellets	PF
Studstrup 3	Denmark	2016	362	Wood pellets	PF
Yeongdong 1	South Korea	2017	125	Wood pellets	PF
Drax 4	United Kingdom	2018	645	Wood pellets	PF
Amer 9	Netherlands	2019	631	80% wood pellets, 20% coal	PF
Asnæs 6	Denmark	2019	25	Wood chips	BFB
Suzukawa	Japan	2020 (expected)	112	Wood pellets	PF
Uskmouth	United Kingdom	2021 (expected)	240	Subcoal® pellets (RDF pellets)	PF

A summary of plants that have been shifted from coal to biomass is provided in Table 1. Most retrofit conversions have been applied in pulverized fuel boilers. In these boilers, the retrofits were implemented to the pre-treatment and feeding system, along with the logistics infrastructure for biomass sourcing. An extensive retrofit example is the Polaniec Green Unit in Poland, in which the older boiler was replaced with an advanced circulating fluidized bed boiler, and the steam turbine was modified too.

Currently, the largest biomass consumer in the world, with four biomass-converted units, is the power plant company Drax. In 2018, more than 7 million tons of wood pellets were used as feedstock in this plant, originating mostly from the USA (62.2%) and Canada (17.3%), with the rest of the feedstock volumes originating from Brazil and other European countries [14].

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