IEA Bioenergy

The future role of Thermal Biomass Power in renewable energy systems

- study of Germany

Summary Series

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Summary

The global energy supply system is in a transition from a centralized system dominated by dispatchable fossil-based sources to a system that is based on renewable energy sources. In countries where wind and solar are expected to play a dominant role in the energy transition, the integration of these energy sources in the power system places pressure on the grid operation as their supply is variable and non-dispatchable. This raises the challenge of balancing demand and supply in the power grid, especially in hours with low generation from wind and solar and given the fact that often these sources are generating when demand is low.

Bioenergy, being a dispatchable form of renewable generation, has the potential to play a key role as a stabilising element in a future green power system dominated by variable renewable energy. Following the interest expressed in the framework of the IEA Bioenergy, Task 32 has decided to further explore the role of thermal biomass power plants in the future, using a system approach.

In this analysis, development of the European power system is projected highlighting a thermal-dominated area, exemplified by Germany. The role of biomass technologies towards 2040 is analysed in two scenarios, *Reference* and *Biomass+,* utilizing the Balmorel model, a fundamental mathematical model of power and heat systems reproducing the day-ahead market dispatch and future development of the generation fleet.

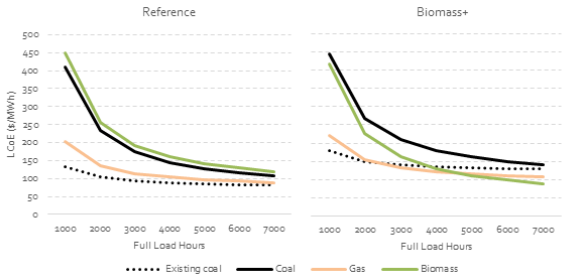
The *Reference scenario* is characterized by current preconditions and assumptions that represent a consolidated estimate of future demand, fuel prices, CO_2 costs, investment costs, etc. It reflects a situation where the recent suggestion to decommission all German coal power by 2038 is not implemented. The scenario shows very limited biomass-based electricity generation capacities and generation in 2040 in Germany and Europe more broadly while coal still plays a significant role. Not only biomass, but all conventional technologies in the power sector will be challenged by increasing competitiveness of wind and solar generation.

The model results underline the need for "firm and dispatchable" power in the electricity system. Gas, coal, biomass and to a certain extent nuclear technology fall in this category. However, due to increased utilisation of hydropower, increased flexibility in demand and increased cross-border, market and sector integration, the demand for firm and dispatchable power technologies will decrease substantially. The deployment of potential new storage technologies will contribute to challenging the business case of conventional power plants.

In the *Biomass+ scenario*, a more favourable framework for the deployment of biomass has been

simulated by assuming two main drivers compared to the reference: a doubled CO_2 price by 2040 and a biomass feedstock price halved from 2020 onward. The calculations for 2040 show that under these enabling conditions, substantial investments in biomass-based generation capacity take place and biomass power plants run for high numbers of annual operational hours, acting as baseload. Concurrently, biomass has also the potential to contribute with large share of district heating production, with heat revenues being an important driver for utilizing biomass CHP technologies. On the other hand, system flexibility services would be primarily delivered by more responsive hydropower, pumped and other electricity storages, and gas-fired power units.

Biomass is in direct competition with coal and natural gas, the main sources displaced in the Biomass+ scenario. CAPEX and OPEX ratios between these technologies are key in determining how they are dispatched, and consequently their overall economic competitiveness. Higher CO_2 price and lower biomass prices (or corresponding incentives) will decrease the levelized cost of electricity from biomass, especially at high utilization rates, making it able to compete even with existing coal power plants, which might be driven to decommissioning, co-firing or full conversion as is shown in the figure below. In this way, the scenario is an example how a decision following the recent suggestion to decommission all coal power plants by 2038 could be implemented.



It can be concluded that the existing and estimated future market conditions alone will not be able to drive substantial amounts of thermal biomass power into the German (and European at large) energy system up to 2040 due to competition with existing fossil fuel plants and cheap wind and solar investments. Special framework conditions and/or low feedstock prices are needed to see a large role for biomass in a future thermal-dominated power system like in Germany and more broadly in Europe.

The report can be found at the IEA Bioenergy Task 32 website: http://task32.ieabioenergy.com/

Main conclusions

IEA Bioenergy Task 32 Biomass Combustion and Co-firing has studied the role of biomass power in the future German energy system. Using the Balmorel model that enables analyses of the evolution of the combined heat and power sectors by calculating the least-cost solution for investments and dispatch, calculations of two scenarios have enabled the following conclusions:

- The existing and estimated future market conditions alone will not drive any substantial amount of thermal biomass power into the German energy system up to 2040,
- Given favourable framework conditions, thermal biomass power will supply base load electricity and heat for district heating,
- System flexibility services will mainly be provided by other sources such as hydropower, pumped and other electricity storages and gas-fired power units.