INDIAN JOURNAL OF POWER & RIVER VALLEY DEVELOPMENT www.ijprvd.info

DISCUSSION-OPINION-EDITORIAL

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Co-firing of Biomass in coal power plants can be promoted just to reduce air pollution, inter alia other benefits

The status

Present bioenergy use consists mainly of burning lignocellulosic feedstocks (forest biomass, agricultural residues, and waste) for heat and electricity, but biomass is also used to produce biofuels for transportation, mainly biodiesel and ethanol. Many kinds of biomass can be co-fired: straws, husks, wood chips, pellets, and even some fractions of municipal solid waste. Regardless of energy sector (i.e., heat, electricity, or transportation fuel) lignocellulosic feedstocks are more cost-efficient than conventional European agricultural crops in the long term .

Co-firing is the simultaneous combustion of two or more fuels in the same plant in order to produce one or more energy carriers. Co-firing biomass with coal in existing boilers to generate electricity has been proposed as a near-term, low-cost way to use biomass (e.g., lignocellulosic feedstocks) for reducing carbon dioxide (CO_2) emissions. Globally, experience with biomass (or waste) co-firing with coal comes from about 300 power plants, either as pilot tests or in commercial use. A wide variety of biomass materials, including herbaceous and woody materials, wet and dry agricultural residues and energy crops are used.

Conversion efficiency

Currently, the typical conversion efficiency for a dedicated biomass-fired power plant is 25%. The average conversion efficiency for conventional coal-fired power plants (so-called subcritical pulverised plants) is around 36%, with new state-of-the-art plants reaching at least 45%. Since the impact on conversion efficiency from low levels of biomass co-firing is judged to be modest, biomass co-firing with coal represents a way to convert biomass with a high electric efficiency. Furthermore, experience shows that moderate biomass levels can be co-fired without any major problems of alkali-related high-temperature corrosion, slagging, and fouling.

The national targets that require an increased use of electricity produced from renewable energy sources imply that electricity utilities must increase investments in renewable

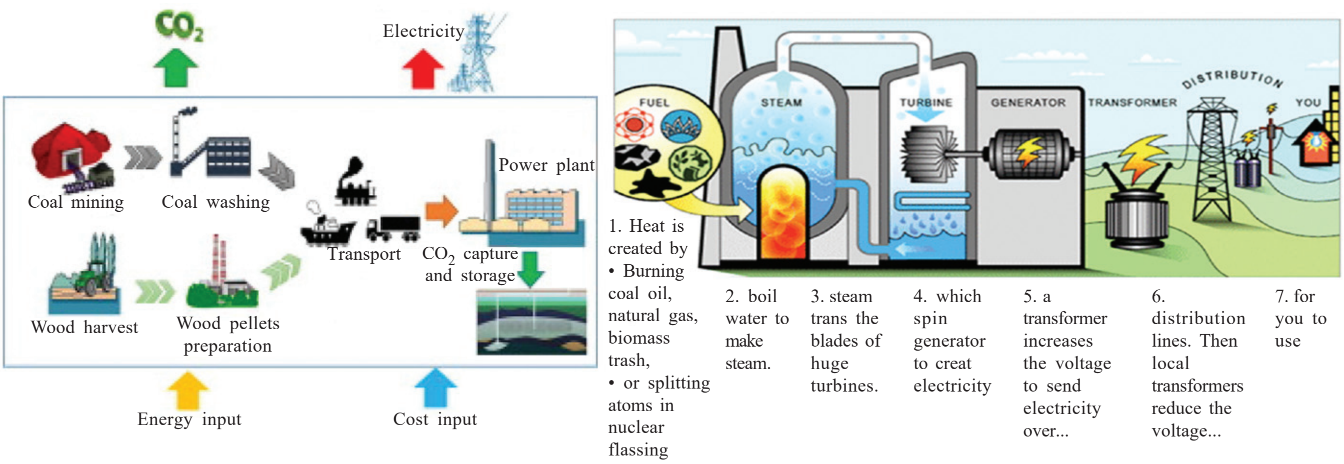

Fig.1: A scheme of co-firing

energy source – electrify (RES-E) generation. As mentioned above, biomass co-firing is commonly regarded as an attractive early measure. This since it, in addition to being efficient, requires relatively small changes at the power plants. As a consequence, biomass co-firing with coal costs less to implement than other biomass-based electricity generating options (about 1000 USD/kW compared to 2500–5000 USD/kW of biomass-based electricity capacity according to OECD/IEA, 2006). 2 It is also in the lower cost range compared to other RES-E options, e.g., hydropower, at roughly 2500 USD/kW and onshore wind power at roughly 1000 USD/kW (OECD/IEA, 2006). Biomass co-firing also holds the advantage of uncertain biomass supplies not jeopardizing the fuel supply for power plant owners, who can manage a temporary loss on the biomass supply side (or short-term biomass price volatility) by increasing the share of coal in the fuel mix. Globally, about 5000 PJ of biomass/waste could in theory be burned in coal power plants every year, assuming that biomass could be co-fired in all coal-fired power plants at a 10% fuel share (on energy basis). In countries like India there are a large number of coal-fired power plants which implies a substantial biomass co-firing potential.

Biomass share

The technical biomass co-firing potential depends on the capacity for burning biomass in available boilers, i.e., on the possible share of biomass in the fuel mix. There is likely to be difference in biomass fuel shares in co-firing share between fluidised bed (FB) boilers and pulverised coal-fired (PC) and grate-fired (GF) boilers, where the former generally allows a higher share of biomass than the latter .It is fair to assume that biomass can replace 15% of coal (in terms of energy) in FB boilers and 10% of coal in PC and GF boilers.

These assumed biomass fuel shares are based on the technical assessment of co-firing possibilities for different boiler types. Their assessment is based on co-firing in Europe and the US, with special attention to the Swedish experience (since co-firing has a relatively long history in Sweden and since this information was easily accessible). It should be noted that there are commercial co-firing applications with higher co-firing shares than those suggested e.g., a 20% biomass fuel share (energy terms) is applied in plants in Denmark (IEA). Thus, future co-firing levels might be higher, but the chosen values are judged as representative of the present levels and are considered low-risk, i.e., do not pose significant problems with corrosion, slagging and fouling, fuel handling, and fuel feeding.

New Knowledge of economics and externalities

The figure illustrates the system boundaries of co-firing that include the straw production, transport, and use. The results needing evaluation are the financial, employment, and environmental consequences. When judged on the externalities like attractiveness of the business proposition, air pollution reduction and job creation, the five key results of recent research are:

1. The business value is positive. It is possible to find the economic feasibility conditions for. However, the business value appears small from the stakeholders' business analysis point of view, especially in front of the supply stability risk. The business case is weak, in line with the international experience that co-firing rarely occurs without incentives.
2. Environmental externalities are several times larger than the business value. Moreover, the value of external benefits would be even more significant if the public benefits were assessed using a public discount rate lower than the private one, as they should.
3. The most crucial externality of co-firing straw is local air quality improvement. Co-firing straw at the power plant reduces the air pollution generated by burning straw in open fields. It also improves the combustion of coal, reducing pollution at the plant.
4. External benefits of carbon dioxide emission reduction appear small compared to air quality benefits when assessed with a social carbon value of 6 USD/tCO_2.
5. Regarding job creation, most of it is for straw collection. The capacity of straw winders used in Vietnam is small compared to the machines used in Europe or the US. Mechanization entails less work, more capital needs but requires large fields.

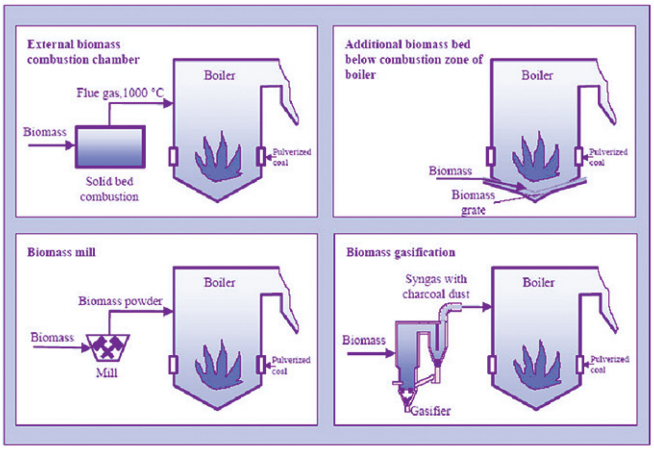

Fig.2 Co-firing

Pointers

These results suggest that mandating co-firing would be socially justified. The total social benefits exceed the cost. The positive business value implies that, even without subsidies, as long as the players share the business value fairly, no one would lose money. It is unnecessary to invoke high social values of carbon to justify co-firing; the local air quality improvements are sufficient reasons.

The upside of the weak business value is that the economic stakes are low. Whatever happens, co-firing will not impact much the production cost of electricity. This affordability contrasts with the wind and solar sectors, which receive feed-in tariffs well above the average production cost.

In some affluent countries, co-firing is justified as part of a national coal exit strategy, with a long-term view on biomass power generation with carbon capture and storage for negative emissions. In countries like India, as in many middle-income countries, such argument may be too early to be heard. However, local air pollution is a severe problem for many tropical middle-income countries today.

Acknowledgement

The materials for the write-up have been derived many public and private resources. The author gratefully acknowledges but fail to name to name all of them for the sake of brevity. One special mention is: “Economics of co-firing rice straw in coal power plants in Vietnam, Renewable and Sustainable Energy Reviews19 November 2021 by An Ha TruongMinh, Ha-DuongHoang and Anh Tran.