

Biomass for Heat and Power

HIGHLIGHTS

- PROCESS AND TECHNOLOGY STATUS** – On a global scale, biomass supplies more than 1% of the electricity demand, i.e. some 257 TWh per year (IEA, 2009a). Based on up-to-date combustion technologies, biomass and waste also supply approximately 4.5 EJ (105 Mtoe) of direct heat to the industrial and residential sectors, and 2 to 3 EJ (47 to 70 Mtoe) of heat from combined heat and power (CHP) plants (IEA, 2008). These estimates do not include traditional biomass combustion mostly used in developing countries. In the IEA countries, the use of combustible renewables (especially solid biomass) has a significant impact on the energy balance of countries and regions with abundant primary resources such as the European Nordic countries, Austria, and Switzerland while the use of biogas is increasing in Germany, the Netherlands, the United Kingdom, and Italy (IEA, 2009a). Power generation and CHP based on biomass and waste, as well as on biomass co-firing in coal-fired power plants, are also rapidly growing. In Germany, for instance, the growth of biomass-based CHP amounted to 23% per year in the period 2004-2008 (Fritsche et al, 2009) and state-of-the-art plants are characterised by high-performance steam parameters and efficiency. The capacity of biomass CHP plants varies considerably. Biogas anaerobic digestors are usually associated to gas-fired engines for heat and power generation with electrical capacity from tens of kW_e up to a few MW_e. Biomass-fired power plants and CHP plants have capacities ranging from a few MW_e up to 350 MW_e. Small and medium-size CHP plants are usually sourced with locally available biomass. Large CHP plants and coal/biomass co-firing power plants require biomass sourcing from a wide region and/or imported wood or forestry residues. Biomass CHP plants are mature technologies while biomass integrated gasification combined cycles (BIGCC), which offer high technical and economic performance, are currently in the process of entering the market, following the industrial demonstration phase.
- COSTS** – The investment costs of biomass CHP and power plants with capacities of up to 50 MW_e are between \$3,000 and \$6,000/kW_e (US\$2008). The annual operation and maintenance cost (O&M) of the CHP plants is approximately \$100/kW_e. The incremental investment cost and the annual O&M cost of biomass co-firing in coal-fired power plants are approximately \$335/kW_e and about \$12/kW_e, respectively. The investment costs of anaerobic digestors with gas-engines for CHP are in the range of \$3,000 to \$5,000/kW_e, with annual O&M cost of about \$ 300/kW_e.
- POTENTIAL & BARRIERS** – Biomass-based CHP or power generation is widely used in regions that have ample fuel wood resources, forestry or agricultural residues. A business plan including the cost of the biomass resource collection and logistics is needed to ensure that CHP or power generation from solid biomass is economically viable. For large-scale biomass co-firing in coal-fired power plants, the location close to a large harbour is economically important. Biomass use in CHP plants may compete with other, non-energy uses of agricultural residues such as straw, or with wood processing industry (i.e. pulp and paper) in the case of forestry residues. Increasing competition between different markets may increase the price of biomass. Large-scale use of biomass for power generation or co-firing may raise sustainability issues and limit the potential of biomass CHP and co-firing technologies.

PROCESS AND TECHNOLOGY STATUS – In the IEA countries, the use of solid biomass for heat and power generation, including combined generation, started during the 1970s, in the wake of the oil crises. Currently, on a global scale, biomass supplies more than 1% of the electricity demand, i.e. approximately 257 TWh per year (IEA, 2009a). Along with waste, biomass also supply approximately 4.5 EJ (105 Mtoe) of direct heat to the industrial and residential sectors, and between 2 and 3 EJ (47 to 70 Mtoe) of heat from combined heat and power plants (CHP). In Europe, the use of biomass is significant in regions with ample biomass resources, e.g. the Nordic countries, Austria, and Switzerland (IEA, 2009b). The status of major biomass technologies is highlighted in Figure 1.

Biomass-based power generation and CHP – Biomass-fired power and CHP plants can be characterised by the boiler technology. **Water-cooled vibrating grate (VG)** boilers (Figure 2) are an established technology for power generation from wood residues. Based on natural circulation, these boilers are designed to burn low-heating-value (LHV of about 13.8 MJ/kg) wood residues, with 30% humidity.

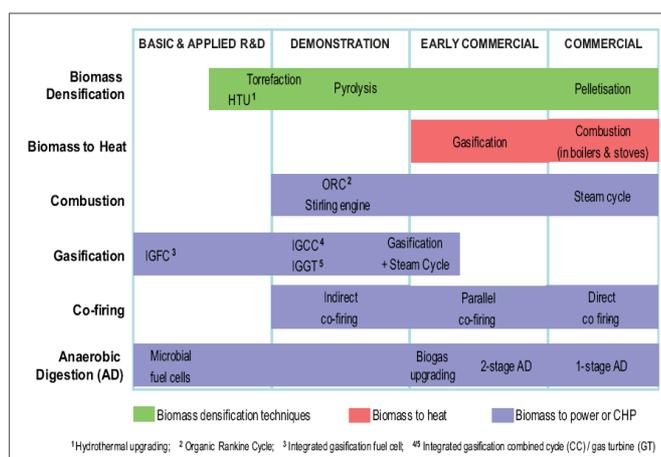


Fig. 1 - Status of major biomass technologies (IEA Bioenergy, 2009)

The typical power plant capacity is in the order of 10 MWe. **Bubbling fluidised bed combustion (BFBC)** boilers (Figure 3) for solid biomass and other feedstock are also a proven and commercial option, but continued improvements in CHP technology have made available