Bioelectricity generation technologies: actual vs. perceived impacts

A recent study reviewed the lifetime environmental, social and economic impacts of 25 bioelectricity technologies. The technologies included gasification, combustion, pyrolysis and co-combustion technologies. Stakeholders were also questioned about their preferences.

On 17th December 2008, the EU agreed that 20 per cent of its final energy consumption should be derived from renewable sources by 2020. Greenhouse gas (GHG) emissions should be reduced by 20 percent by this date. Biomass power generation (burning plant material, such as wood or straw, for example) is expected to rapidly increase during this period. When assessing bioenergy systems, it is important to take account of not only technical, but also environmental, economic and social factors. This study addresses the challenge of analysing, quantifying and comparing these factors for bioenergy power generation systems.

The study used wide-ranging assessment tools designed to be accessible to non-specialist audiences. The technologies assessed were both power only (PO) or combined heat and power (CHP) plants. Every stage of the bioenergy chain was considered using a life cycle analysis approach. For example, ground preparation, fertilisation, harvesting and transportation. Area of land use, job creation and noise levels at the plant were also considered, among many other factors, to provide a complete picture of the impact of each technology.

Different indigenous fuel crops were considered: short rotation coppice wood (e.g. poplar and willow), straw and miscanthus, as were different sized power plants, from 250 KWe to 25 MWe outputs. With this integrated approach, all the bioelectricity technologies achieved approximately a 90 per cent reduction in GHG emissions compared with conventional fossil fuel generation. Variation between the technologies was small, despite wide variations in the scale and efficiency of the power plants studied.

The study was designed to help understand selection criteria and not define an 'optimal' system. The appropriate bioenergy systems will differ for different applications. For example, CHP plants (selling heat as well as electricity) extract the most useful energy per unit of biomass of the different methods. The heat generated also makes important carbon savings. However, the electricity is relatively expensive because initial costs are higher. Across all systems, smaller power plants generally produced more emissions per unit of electricity. GHG savings per hectare of land used for growing biofuel crops were also considered. Miscanthus was the best performing crop in this category. Land use change can negate GHG benefits of biofuels, so it is important to additionally consider GHG balances on a local level.

In addition to this technical assessment, stakeholders were questioned about their priorities. They tend to prefer small and medium scale CHP plants because they used local wood resources and were perceived to perform better both environmentally and socially. The researchers argue that this positive opinion could be built upon by providing subsidies in the supply chain. This would help rural communities move away from their reliance on fossil fuels.

Carbon saving was the most important consideration for UK stakeholders, followed by transport impacts, rural jobs and emissions. However, soil carbon budgets were not considered. The EU has recognised the importance of the soil carbon reservoir and land use / management conflicts, particularly with respect to biofuels. Replacing conventional arable crops with biofuels would represent a carbon saving but reduce food production. Additionally, replacing grassland would release a large amount of carbon. This study finds that straw is less efficient than wood and miscanthus as a fuel in terms of land use intensity, but notes that it is a by-product of cereal, another productive use of the same land which is not recognised in such calculations.

1 http://ec.europa.eu/energy/strategies/2008/2008_01_climate_change_en.htm
2 http://ec.europa.eu/environment/soil/index_en.htm

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