

Chapter 10


Automated Electric Power Generation From Agricultural Resources

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ABSTRACT

From agricultural resources, automatic generation of electric power represents the revolutionary approach towards energy production. In this chapter, the incorporation of automation technology in agricultural practices aimed at optimizing the conversion of organic waste, crop residues, and other biomass into electricity has been referred to. It places emphasis on such modern techniques as anaerobic digestion, gasification, and biomass combustion and hints at the innovations brought about by automation, which significantly enhance efficiency, reduce the costs of operations, and minimize adverse impact on the environment. Scale, system integration, and economic feasibility are considered issues as well. Monitoring

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and controlling of power generation systems and processes through the implementation of key technologies like sensors, control systems, and data analytics are considered.

INTRODUCTION

This is one of the greatest global challenges: to seek sources of sustainable and renewable energy. Its main drivers include mitigating climate change, reducing dependence on fossil fuels, and ensuring long-term energy security. Agricultural resources are largely ignored in the discourse surrounding energy supply. Rather than being left sitting unbuilt for the generation of renewable electricity, they have much to promise. This chapter explores new opportunities to combine automation technologies with agricultural resource management for the efficient and sustainable generation of electric power (Tian et al., 2020).

Agriculture forms the backbone of human civilization, by providing food, fiber, and fuel. Also, large quantities of organic wastes are produced in these units-including crop residues, animal manure, and other biomass products. Normally, these materials are regarded as waste, useful only for either as soil-enrichment amendments or animal feed. However, due to technological advancement and the newfound emphasis on sustainability, these byproducts are now seen as a valuable resource for energy production. Automated electric power generation from agricultural resources harnesses organic materials through such methods as anaerobic digestion, gasification, and biomass combustion. Each of these processes converts biomass to usable forms of energy that also promote waste management and environmental sustainability. Through automation, reliability and efficiency in the processes are introduced while they become more economically viable (Navulur et al., 2017).

This is a biological process of anaerobic digestion whereby organic matter decomposes in the absence of oxygen, leading ultimately to biogas production-mainly methane and carbon dioxide. This biogas can then be used further as fuel for electricity generation hence means of renewable source of energy besides reducing further the greenhouse gas emissions brought about by reduced waste disposal. Automation has also been fundamentally important in optimizing anaerobic digestion by continually monitoring and controlling critical parameters such as temperature, pH, and substrate composition; the process of digestion remains stable and efficient, achieving higher biogas production and, consequently, electricity generation. Gasification converts biomass into syngas, which is synthetic gas produced by partial oxidation at high temperatures (Jagannathan et al., 2015). Syngas can be used to generate electricity or otherwise upgraded to other fuels, which are made up of hydrogen, carbon monoxide, and carbon dioxide. Automation in gasification systems also increases the control over the environment of gasification, which consists of temperature and oxygen levels, thereby enhancing the efficiency and safety of the process. Adaptation of control strategies based on variations in feedstock quality as well as operation, as real-time monitoring and data analytics optimize system performance (Nikolidakis et al., 2015).

Biomass combustion is another direct method of electricity production where organic material is combusted to produce steam, which powers turbines coupled to generators. Again, it is simpler compared to anaerobic digestion and gasification, but biomass combustion, like the two previous methods, also benefits from automation practices. Consistent, efficient, and safe operations are ensured by automated fuel handling, combustion control, and emission monitoring systems. Emission control capabilities-further enhanced by breakthroughs in automation technologies - have also contributed to the reduction of the environmental impact generated through biomass combustion to within acceptable levels as regulated(Mohanraj et al., 2016).

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