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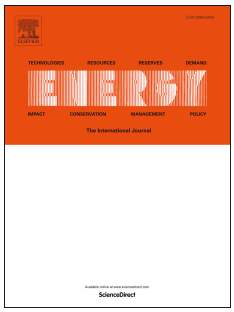

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Biomass-Gasification-Based Atmospheric Water Harvesting in India

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Abstract:

Biomass from crop residue remains an underutilized and inexpensive energy resource around the world. Inadequate supply chain management forces farmers to resort to field burning of crop residue, resulting in environmental, health, and economic issues. In this study, we conceptualize a novel approach for biomass utilization which jointly addresses the common and often concurrent issues of energy, environment, and water. We propose to use the thermal energy from the combustion of the producer gas obtained from biomass gasification to power an off-the-grid refrigeration system which can condense moisture from air. We conduct a detailed thermodynamic analysis of vapor-adsorption cycle-based atmospheric water harvesting (AWH) system to develop an integrated modeling framework. We use the ambient weather data to report that the biomass-powered AWH can condense 800-1200 liters of water per 1000 kg of biomass. Based on the local population and biomass availability, this can meet up to 10-12% of the potable water requirements in certain states of India. We also discuss the immediate challenges underlying this waste-to-value concept. Finally, we discuss that the proposition to jointly address energy, water, and the environment issues may motivate key paradigm shifts in policies required for practical implementation of this technology.

Keywords: Atmospheric Water Harvesting, Biomass, Gasification, Vapor Adsorption Refrigeration, Moisture Harvesting Index, Condensation

1. Introduction

Biomass is an inexpensive and abundant carbon-neutral source of energy, especially in developing countries [1] such as India. However, out of the ≈620 to 680 million tonnes (MT) of the biomass produced annually in India, only a small fraction is utilized as animal feed, cooking fuel, and for small-scale industrial usage. The majority of biomass remains unutilized and presents significant disposal-related challenges. A very common outcome is the large-scale burning of crop residue. Crop burning is prominent in agriculture dependent economies such as India where nearly ≈100 to 140 MT of biomass is subjected to field burning every year [2]. This amounts to nearly 2.5 exajoules (EJ) of annual energy