

## Biogas as a Renewable Energy Fuel: A Review of Biogas Upgrading, Utilization and Storage

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**Abstract :** Biogas upgrading is a widely studied and discussed topic, and its utilization as a natural gas substitute has gained significant attention in recent years. The production of biomethane provides a versatile application in both heat and power generation and as a vehicular fuel. This paper systematically reviews the state of the art of biogas upgrading technologies with upgrading efficiency, methane (CH<sub>4</sub>) loss, environmental effect, development and commercialization, and challenges in terms of energy consumption and economic assessment. The market situation for biogas upgrading has changed rapidly in recent years, giving membrane separation a significant market share with traditional biogas upgrading technologies. In addition, the potential utilization of biogas, efficient conversion into bio-compressed natural gas (bio-CNG), and storage systems are investigated in depth. Two storing systems for bio-CNG at filling stations, namely buffer and cascade storage systems are used. The best storage system should be selected on the basis of the advantages of both systems. Also, the fuel economy and mass emissions for bio-CNG and CNG-filled vehicles are studied. There is the same fuel economy and less carbon dioxide (CO<sub>2</sub>) emission for bio-CNG. Based on the results of comparisons between the technical features of upgrading technologies, various specific requirements for biogas utilization and the relevant investment, and operating and maintenance costs, future recommendations are made for biogas upgrading.

**Keywords :** biogas upgrading, cost, utilization, bio-CNG, storage, energy

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