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Exploring The Potential of Biogas Technology in energy systems in India: Descriptive study

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Abstract

The burgeoning demand for energy and the necessity of sustainable development have rendered biogas technology an auspicious solution for the energy system of India. This treatise endeavors to investigate the potential of biogas technology in India's energy systems via scrutinizing the existing energy milieu, the benefits and obstacles of biogas technology, and the edicts and statutes regarding its assimilation. The energy domain of India is predominantly swayed by non-renewable fossil fuels, which are not only limited but also contribute considerably to the emission of greenhouse gases. Biogas technology, conversely, employs organic refuse as a feedstock to yield renewable power, thereby mitigating the carbon footprint. The potential of biogas technology to contend with the predicaments of energy security, agrarian expansion, and environmental sustainability in India is substantial. Nevertheless, the acceptance of biogas technology is confronted with several predicaments, such as inadequate infrastructure, meagre funding, inadequate awareness, and deficiencies in policy. In order to surmount these hindrances, the government has commenced diverse policies and programs, such as the National Biogas and Manure Management Program and the Swachh Bharat Abhiyan.

Keyword- Biogas Use, Obstacles of Biogas Usage, Biogas Technology, Manure Management Program. Swachh Bharat Abhiyan.

Introduction

India, a titan among energy consumers, is poised to maintain its rapid growth in energy demand in the imminent future. In response, the nation has explored numerous sources of energy. This notably including renewable options such as solar, wind, and hydropower. Alas, there remains a latent source of energy - biogas - that remains relatively untapped within the country's borders. Singh, Tyagi, Allen, Ibrahim, and Kothari (2011) biogas, a fascinating

alternative fuel sourced from the mysterious realms of organic waste materials, obtained through a mystical process known as anaerobic digestion. This enigmatic yet ubiquitous source of energy possesses immense potential for a variety of inventive and resourceful applications - such as but not confined to heating, cooking, power generation, and transportation. the coincidental generation of a fertilizer abundant in nutrients through the process of biogas production enables its implementation in agriculture, significantly contributing to the sustainability of ecological systems in a profound and mysterious manner.
The Indian subcontinent, a land of mystique and marvels, possesses a significant agricultural sector and bustling metropolises teeming with splendid organic waste, which presents a tantalizing opportunity to fully unleash the potential of biogas production, with all its complexity and mystique. India, true to its heritage of wisdom and power, has set a formidable and ambitious goal to produce a staggering 15 million metric tons of biogas, charged with enigmatic energy and fervent aspiration, by 2022. Dhar, Kumar & Kumar, (2017), the accomplishment of this objective would necessitate the establishment of 5 million biogas plants dispersed throughout the nation. An important feature of biogas technology is its capability to facilitate decentralized energy solutions, predominantly in rural regions where grid accessibility is inadequate.

Biogas building units can be installed on farms, and the remaining biogas may be employed for a multiplicity of uses: cooking, illumination, and even the propulsion of tractors and other agricultural machines. This technological advancement can considerably enhance the living conditions of farmers, as it abates their reliance on customary fuels, like kerosene and diesel. Not only that, biogas technology can also control the issue of waste management in India. The country bears a weighty responsibility concerning a significant amount of biodegradable detritus, a considerable segment of which typically decomposes in landfills or is jettisoned in unenclosed areas, thus engendering environmental and health hazards. Khoiyangbam, Gupta, & Kumar, (2011) states that By utilizing this refuse to manufacture biogas, India can produce power while simultaneously diminishing its carbon footprint and upgrading public well-being. Biogas innovation has an additional advantage in that it can create electricity. By igniting biogas in an engine, electricity can be produced and subsequently used to energize households and corporations.

This can alleviate India's dependency on fossil fuels and decrease the amount of greenhouse gas emissions. There are already some triumphing models of biogas technology at work in

India. One example is the Indian Oil Corporation's biogas facility situated at its Panipat refinery, which produces biogas from waste materials like spent wash from the distillery and sludge from the sewage treatment plant. The biogas is then used to produce electricity, which powers the refinery.

Rao, Baral, Dey, &Mutnuri, (2010) biogas plant set up by the The Punjab Energy Development Agency (PEDA) has accomplished the successful implementation of biogas technology. Waste material produced from the marketplace of vegetables is transformed into energy. The produced biogas is employed to run a generator that distributes energy back to the same market, making it a self-sustaining marketplace. This technology, which has proven to be both ecologically and financially feasible, guarantees a consistent and dependable source of energy for the marketplace.

biogas technology implementation presents certain difficulties, especially for small-scale farmers who rarely have access to funding due to the high expenditures of starting up. Furthermore, there is inadequate awareness among the masses about the advantages of biogas; thereby making it arduous to garner support for biogas projects.To surmount these obstacles, the Indian administration has initiated various policies to stimulate the implementation of biogas.

The Ministry of New and Renewable Energy is overseeing the National Biogas and Manure Management Programme, which disburses financial assistance for the installation of biogas systems and also imparts capacity building and training to both entrepreneurs and farmers. Besides, the administration undertook CBG, compressing biogas as a substitute for fossil fuels in transportation. India necessitates additional funding and motivation to further enhance the implementation of biogas technology, despite the measures previously mentioned. Collaborative partnerships involving the government, private sector, and non-governmental organizations (NGOs) are critical for achieving success.

These alliances enable mutual cooperation and collaboration, essential for accomplishing shared objectives. Recognizing the worth of collaborative efforts and leveraging the strengths and resources of each sector is vital. By doing so, collective impact can be achieved, resulting in a positive impact on the world. Such partnerships aid in the mobilization of resources and expertise and in the dissemination of information and best practices. Progressing biogas

technology, minimizing costs, and discovering new applications requires further research and development. Success in this endeavor hinges on the cooperation between academic institutions, research teams, and pertinent industries.

Literature review

Chhabra, Manjunath, Panigrahy, & Parihar, (2013) The burning of fossil fuels coal and oil has contributed to the release of greenhouse gases. Carbon dioxide, carbon monoxide, methane, and chlorofluorocarbons hold accountable as the principal perpetrators that contribute significantly to the emergence of greenhouse gases. These GHGs block the release of radiation from the Earth's surface. This intensifies the issue of global warming. This has a detrimental effect on the environment and human wellbeing. Furthermore, India is the dwelling of the biggest livestock population in the world. This assortment of bovine creatures contains cattle, buffalo, sheep, goats, and poultry. Altogether, around 299.9 million of these animals are present, with 200.3 million of those being sheep and goats. Cattle occur in greater numbers than the remainder, making up more than two-thirds of all bovine animals, and buffalo account for no more than 28%.

An abundant number of organic fumes is emitted from these animals, which can be used as a suitable resource for the making of biogas. Somanathan &Bluffstone, (2015) Biogas is an environmentally friendly energy source that can be generated through the anaerobic fermentation of organic refuse. The detritus emanated from livestock can be introduced into a biogas installation, wherein microbial action breaks it down and begets biogas. Biogas can be harnessed to produce electricity, heat, and fuel.

This offers a myriad of advantages as a renewable energy source. It curtails the dependence on fossil fuels. This mitigates the detrimental effects of their emissions on the environment. By this attenuating the impact of climate change. With the use of localized production, this can provide a sustainable energy source that has the potential to uplift rural communities and narrow the chasm of energy poverty. Additionally, it can serve as an efficient method for managing the organic byproduct that stems from livestock animals, thus mitigating potential environmental hazards and health concerns.

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Vergara &Tchobanoglous, (2012) municipal solid waste (MSW) The escalating issue of waste production is a growing global concern, leading to adverse effects on both ecological circumstances and public welfare. The quandary at hand is particularly exacerbated in developing nations, where the swift upswing in urbanization and proliferation of inhabitants has significantly contributed to the gravity of the issue. India is facing a daunting task in the management of its Municipal Solid Waste (MSW). Urban and peri-urban areas generate an approximate 1,27,486 tons of waste daily due to varied household, industrial, and commercial activities.

The accumulation of this municipal solid waste (MSW) results in numerous negative consequences related to the environment and human health. Inappropriate disposal methods lead to the contamination of air and water, degradation of soil quality, and the dissemination of pathogenic microorganisms and poisonous substances. Kumar et al., (2017) the circumstance is worsened by the dearth of appropriate waste management systems in many parts of the world, as well as a limited public understanding and education about correct waste disposal methods. To tackle this problem, various initiatives have been set up by authorities, non-profit organizations, and other stakeholders to better MSW management and lessen its effect on the environment and health.

These initiatives involve the implementation of systems for sorting and recycling waste, setting up landfills and incineration sites. And, increase public knwoledge of reduce and proper disposal of waste are all important elements to consider. In India, the government has pushed for the Swachh Bharat Abhiyan (Clean India Mission). This primary program for improving cleanliness and managing debris in urban and rural areas. The program comprises of constructing toilets, placing waste bins, and furthering publicity campaigns on reducing waste and utilizing appropriate disposal techniques. Although some development has been accomplished in fortifying MSW management in India and other nations, a great deal more has to be completed to grapple with this worldwide issue. More efforts must be need to support eco-friendly disposal of waste. lessen the amount of waste produced. Limit the negative effects on health. the environment from the buildup of municipal solid waste.

In Kumar et al., (2017). size, classification of the person utilizing it, and locale are all used to decide the amount of allowance available. India is categorized into three areas depending on the average altitude in order to ascertain the amount. The highest availability of allowance is in the northeastern mountainous region while the states with hilly or high-altitude areas comprise the second tier. The last group of states employs an allowance system based on the social standing of the recipient. Non-caste Hindus, scheduled castes, scheduled tribes, and smallholders are all eligible and the entitlement is decided based on everyone's social group. The grant amount varies between social categories. For those without property and marginal farmers, higher subsidies are provided than to those in the regular group. The regular group contains all farmers who do not fit the social criteria outlined above, yet possess more than five hectares of land. The allowance scheme in India of biogas plants is designed to support the use of green energy and bestow financial help to the economically disadvantaged. India's biogas plant allowance is a demonstration of the government's dedication to sustaining energy resources and decreasing destitution.

This allowance system is an essential move towards meeting these objectives by encouraging people to take up renewable energy sources, and offering economic assistance to those in the most need of it. The police force is the agency that serves the public by protecting them and maintaining order. Law enforcement is responsible for safeguarding the community by keeping people safe and instituting legal rules.Raha, Mahanta, & Clarke, (2014) india has the intensity to become a top producer of biogas. India has essential role of agriculture in its economy. Despite some hindrances experienced by the biogas trade, signs of rehabilitation are advocating optimistic prospects. Moreover, there is increased investments from large companies, both domestic and foreign, and from the public sector and private entities, which suggest that the biogas sector has a bright future.

Biogas has the possibility to tackle India's refuse management challenge in multiple ways and fuel economic development in a variety of realms. When purified from hydrogen sulfide (H2S), carbon dioxide (CO2), and steam, and then crammed as compressed biogas (CBG/biomethane) with more than 90% methane (CH4) composition, it can serve as an adequate replacement for CNG, offering more energy security. Biogas production has the ability to offer a durable answer to waste management in the nation. It can transform agricultural and organic waste into objectives of substantial value and at the same time lower contamination.

According to Minde, Magdum, and Kalyanraman (2013) the expansion of biogas industries can open the door to a variety of new industries such as organic agriculture, decomposition, and energy-from-waste systems, resulting in a wider economic boom. the biogas sector has the capacity to manage the problem of rural power supply. This still affects numerous areas in India. It is essential to commit to research and development of fresh and enhanced bioenergy technologies. To boost the sector's effectiveness, affordability, and capacity to extend to more areas. This can result in the creation of energy from biogas production. Which would be supplied to communities across. This will facilitate sustained growth and reducing reliance on fossil fuels. Gupta, Tuohy, Kubicek, Saddler, & Xu, (2013) bioenergy technologies Investments in research and development (R&D) for bioenergy technologies are playing an indispensable role in fulfilling the surging global demand for sustainable energy while mitigating the hazardous carbon emissions. Nonetheless, there are still challenges that require attention to render these technologies more feasible.

The chief advantage of investing in bioenergy R&D lies in the possibility of enhanced efficiency. Novel technologies can be devised to augment the conversion of biomass into energy, thereby boosting energy production while minimizing waste.Investing in research and growth (R&D) could have a considerable influence on the cost-efficiency of producing bioenergy due to advancements made through technology. The capability to increase the size of these technologies could be critical in satisfying higher creation outputs to meet the energy needs of larger populations and expanding economies.

bioenergy, being an infinite and renewable energy source, has a competitive edge over conventional fossil fuels that are finite in supply. Therefore, investing in bioenergy R&D can offer a compelling source of electricity. The environmental benefits of bioenergy R&D are noteworthy as well, as more efficient technologies and cost reductions lead to fewer emissions of greenhouse gases. Gupta, Tuohy, Kubicek, Saddler, & Xu, (2013) International cooperation can greatly enhance the expansion of the bioenergy industry by fostering the exchange of valuable knowledge, technological innovations, and efficient procedures. The relationship between nations plays a vital role in accessing emerging markets. This would have a significant impact on the global bioenergy industry. As a sustainable alternative to non-renewable fossil fuels, bioenergy presents a powerful tool for mitigating the effects of climate change.

The realization of this potential demands a concerted and collaborative global effort aimed at accelerating the development and adoption of environmentally friendly energy sources like bioenergy, with significant benefits for both the environment and the economy. Achieving this objective requires an abundance of resources, including extensive scientific research, technical prowess in engineering, and a substantial infusion of capital.

By pooling resources and sharing ideas, rapid advancements in the field can be made, leading to continued sustainable energy practices among nations. The advantages of international cooperation in the domain of bioenergy are multifaceted, extending far beyond technological and economic benefits. It also engenders opportunities for intercultural communication and encourages greater understanding among nations.

Long, Li, Wang, and Jia (2013) the implementing biogas as a form of renewable energy comes with many roadblocks that must be tackled. Major issues that need to be taken care of to effectively switch to the use of biogas include the absence of decent supply networks for harvesting farming waste. A lot of agriculturists are still unaware of the advantages of biogas and its capability to upsurge the sustainability of the farming sector.

There is a need to spread knowledge and understanding about the value of agricultural residue and its role in generating biogas in order to provide farmers with enough aggregation yards. Awareness programmes ought to be rolled out to inform farmers about the economic benefits of biogas. Additionally, there is a need to develop formal aggregation models in use for livestock waste. The original text cannot be paraphrased as it is incomplete.

It is very beneficial to utilize livestock waste for biogas production, yet there is a notable absence of aggregation models making collection and transfer to biogas plants a difficult task. To handle this obstacle, collaborations between both biogas plant operators and livestock farmers are essential. Through these links, the farmers are provided with the ability to transfer their livestock waste to the biogas plants, benefiting the farmers monetarily and diminishing the ecological impact of livestock waste all in one. The scarcity of organic fertilizer taken away is another major issue that merits consideration. Afazeli, Jafari, Rafiee, & Nosrati, (2014) biogas production plant operators can create high-quality organic fertilizer that can enrich soil and increase crop yields, but since there is no established market for it, their

marketing efforts need to be taken into consideration in order to make farmers aware of the product. Furthermore, ambitious entrepreneurs may find it hard to secure bank loans due to expensive interest rates and insufficient expertise about biogas technology. Biogas still isn't fully appreciated in many regions, making it hard for those wishing to establish projects to find affordable financing. Banks don't yet understand the potential of biogas technologies and so interest rates can be high. Consequently, it is important to create models that will make it easier for entrepreneurs to find reasonable funding for biogas ventures.

Methodology

This study is descriptive in nature in which data is obtained from 210 respondents who have used Biogas for various purposes. A checklist question was used to analyze and interpret the data. In a checklist question respondents choose “Yes” or “No” for all the questions.

Table1. Exploring The Potential of sBiogas Technology In energy systems in India

	Exploring The Potential Of Biogas Technology In energy systems in India	Yes	%Yes	No	%No	Total
1	Use of biogas reduces burden on fossil fuel	175	83.33	35	16.67	210
2	Use of biogas helps in achieving sustainable development goal	179	85.24	31	14.76	210
3	Use of biogas helps in handling organic waste effectively	188	89.52	22	10.48	210
4	Use of biogas reduces emission of Methane Gas	182	86.67	28	13.33	210
5	Use of biogas reduces emission of carbon dioxide	176	83.81	34	16.19	210
6	Use of biogas helps in handling organic waste effectively	190	90.48	20	9.52	210
7	Use of biogas contributes in reducing pollution	172	81.90	38	18.10	210
8	Use of biogas provides energy security	165	78.57	45	21.43	210

Table1. shows that 90.48% respondents agree that use of biogas helps in handling organic waste effectively, while 89.52% respondents agree that use of biogas helps in handling organic waste effectively. 86.67% respondents agree that use of biogas reduces emission of Methane Gas while 85.24% respondents agree that use of biogas helps in achieving

sustainable development goal. 83.81% respondents agree that use of biogas reduces emission of carbon dioxide, while 83.33% respondents agree that use of biogas reduces burden on fossil fuel. 81.90% respondents agree that use of biogas contributes in reducing pollution while 78.57% respondents agree that use of biogas provides energy security.

Conclusion

The immense opportunity to use biogas technology in India's energy systems is untapped. A thorough examination underscores the benefits of this technology, such as being renewable and earth-friendly, being able to provide energy locally, and having the capacity to reduce emissions of greenhouse gasses. The inquiry also highlights the difficulties that impede the adoption of biogas technology, such as deficient infrastructure, lack of awareness, and financial constraints. In general, the study emphasizes the exigency for a comprehensive policy framework and institutional support to facilitate the advancement and implementation of biogas technology in India. If executed effectively, biogas technology can play a decisive role in ensuring energy security, curbing environmental degradation, and propelling sustainable development in the country.

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