

Powering Progress: South Korea's Role in India's Waste-to-Energy Future

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Introduction:

India, the fifth largest economy, has emerged as a growth engine of the world economy and it's ambitiously aspire to emerge as the third largest by 2030 or even earlier. The rising per capita income of an ever-burgeoning customer base necessitate the ever-growing energy requirements across the different sectors of the economy. Moreover, India is actively pursuing an ambitious energy transition initiative, targeting a 50% cumulative electric power installed capacity from non-fossil fuel-based sources by 2030 and aspiring to achieve net-zero emissions by 2070¹. In alignment with these goals and in the pursuit of self-reliance in the energy sector, the optimal utilization of domestically available renewable energy alternatives becomes imperative. One such promising alternative is modern bioenergy, coming from biomass and waste to energy (WTE) sector.

In this framework, India targets a 10% reduction in import dependence by 2022, aiming to increase gas contribution to its energy mix from 6.5% to 15% (World Bank, 2022). Accordingly, with a projected natural gas demand of 100 million metric tonnes (MMT) by 2030, India seeks self-sufficiency, envisioning 45 MMT from domestic sources, notably through Compressed Biogas (CBG). The CBG potential of 62 MMT from diverse sources aligns with 'Sustainable Alternative towards Affordable Transportation' (SATAT) vision of establishing 5,000 plants by 2023-24, generating 15 MMT annually². As a result, India invites foreign collaboration to develop a robust CBG ecosystem, offering opportunities in the expanding renewable energy sector and proactively solicits global investments, technology, and expertise. According to the BlueWeave Consulting Report³ (2023), the market size of India's waste-to-energy (WTE) sector was approximated at USD 2.25 billion in 2022. The forecast for the period between 2023 and 2029 anticipates a steady growth, with the market projected to expand at a Compound Annual Growth Rate (CAGR) of 4.23%. This growth trajectory is expected to culminate in the market reaching a value of USD 3.01 billion by 2029 (Figure 1).

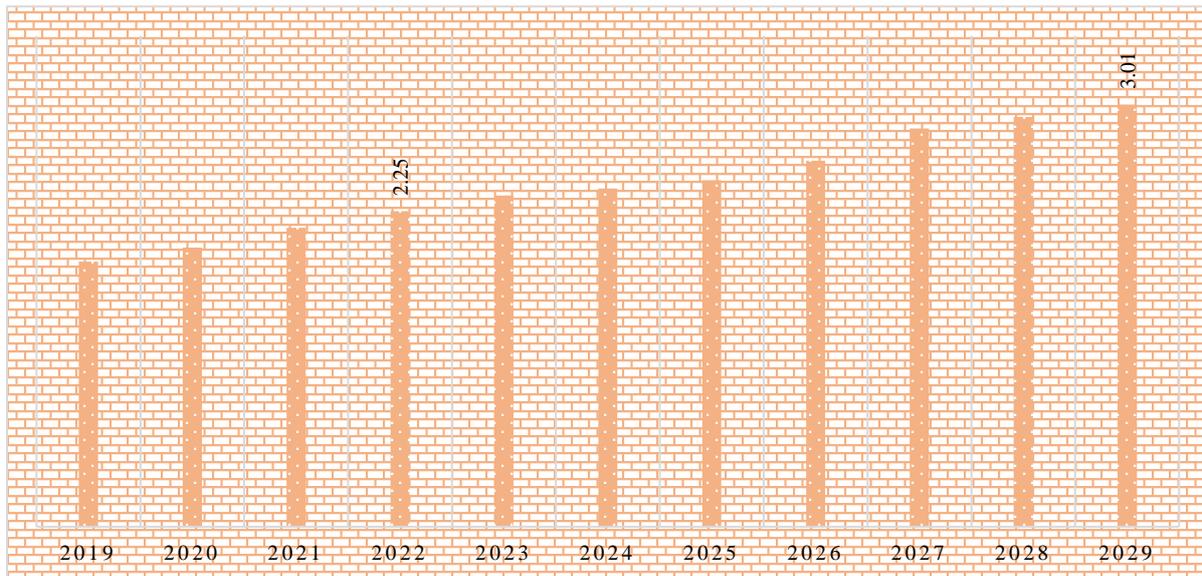
¹ The Energy and Resources Institute. (2023). Modern Biomass: India's Pathway to Net-Zero.

<https://www.building.co.uk/data/sustainability-biomass-energy/3109725.article>

² Ministry of New and Renewable Energy, Government of India. (2023). National Biogas Mission. <https://biogas.mnre.gov.in/>

³ <https://www.blueweaveconsulting.com/report/india-waste-to-energy-market>

Figure 1:
India's Biomass and Waste to Energy Market Size by Value (US\$ Billion)



Source: BlueWeave Consulting, accessed at <https://www.blueweaveconsulting.com/report/india-waste-to-energy-market>

India boasts a significant surplus of biomass and various waste resources, presenting a prospective opportunity for energy recovery from these sources. Modern bioenergy stands out due to its multifaceted benefits, encompassing social and environmental advantages alongside the provision of clean fuels. For instance, bioenergy applications can play a key role in mitigating air, water, and land pollution, contributing to overall environmental sustainability. Beyond environmental gains, the deployment of modern bioenergy has far-reaching social and economic implications. It has the potential to generate local employment, foster business opportunities, and nurture the ecosystem for development of decentralized and independent communities. Furthermore, the private sector stands to gain by leveraging bioenergy for the decarbonisation of industries, aligning with global sustainability trends. Recognizing the immense potential of modern bioenergy, the Ministry of New and Renewable Energy (MNRE) has taken a proactive stance which is evident in the National Bioenergy Programme for the period from April 1, 2021, to March 31, 2026 as envisaged by Government of India. The comprehensive National Bioenergy Programme encompasses various sub-schemes, each tailored to address specific aspects of bioenergy utilization:

- a. **Waste to Energy Programme (Programme on Energy from Urban, Industrial, and Agricultural Wastes/Residues):** This sub-scheme focuses on harnessing energy from diverse waste streams, including urban, industrial, and agricultural residues. By converting these wastes into energy, the program aims to contribute to both sustainable waste management and energy generation.
- b. **Biomass Programme (Scheme to Support Manufacturing of Briquettes & Pellets and Promotion of Biomass (non-bagasse) based cogeneration in Industries):** This scheme is designed to support the manufacturing of briquettes and pellets, facilitating the efficient utilization of biomass resources. Additionally, it promotes biomass-based cogeneration in industries, enhancing energy efficiency and reducing dependence on conventional energy sources.
- c. **Biogas Programme:** Focused on the production and utilization of biogas, this sub-scheme aims to tap into the potential of anaerobic digestion of organic waste. By

promoting biogas as a clean energy source, the program contributes to both waste management and the generation of renewable energy.

In the above realm, India's National Bioenergy Program represents a strategic and concerted effort to leverage the abundant biomass and waste resources within the country. By embracing modern bioenergy solutions, India not only aims to meet its renewable energy targets but also anticipates a range of socio-economic and environmental benefits, positioning itself as a leader in sustainable energy practices.

2. Leveraging South Korean Expertise in India:

From the South Korea's experience, India can draw valuable insights for its waste-to-energy and biomass energy programs, benefiting from their advanced technologies, efficient waste management practices, and successful project execution. South Korea's experience in integrating cutting-edge technologies for waste conversion, coupled with their comprehensive biomass energy strategies, provides a blueprint for India to enhance its own initiatives (Figure 2). To foster cooperation, collaboration, and co-creation, India and the Republic of Korea can engage in knowledge exchange, joint research & development ventures, and technology transfer. Establishing partnerships between Indian and Korean companies can lead to the creation of innovative solutions, optimizing waste-to-energy processes and biomass utilization. By leveraging each other's strengths, the two nations can collaboratively address India's vast energy needs, contributing to sustainable development while fostering a robust bilateral relationship in the renewable energy sector.

Figure 2:

Key Strengths of South Korea's Biomass and Waste-to-Energy Sector:

Technological Innovation:	Operational Efficiency and Optimization:	Strong Policy and Market Support:	Additional Advantages:
<ul style="list-style-type: none"> • Advanced Gasification and Pyrolysis. • Smart Waste Management Systems. • Integration with Existing Infrastructure. 	<ul style="list-style-type: none"> • High Plant Efficiency. • Strict Emission Control. • Focus on Safety and Reliability. 	<ul style="list-style-type: none"> • Government Incentives. • Established Demand for Clean Energy. • Private Sector Expertise. 	<ul style="list-style-type: none"> • Skilled Workforce. • Experience in International Projects. • Continuous Research and Development.

Source: Author's compilations

South Korean companies such as POSCO Energy, KEPCO (Korea Electric Power Corporation), and Kepeco Engineering & Construction have demonstrated significant success and impact in the waste-to-energy and biomass energy sectors. POSCO Energy, with its expertise in gasification technologies, has played a major role in efficient waste conversion. KEPCO, a leading energy utility, has successfully implemented biomass power projects, contributing to sustainable energy solutions. Kepeco Engineering & Construction's track record in executing waste-to-energy initiatives showcases their technical prowess. These companies, with their proven capabilities, technological innovation, and global recognition, stand as prominent examples of South Korea's leadership in advancing renewable energy solutions. Figure 3 illustratively lists the area of expertise of South Korean companies.

Figure 3:

Leveraging South Korean Expertise in India's Biomass and Waste to Energy Sector

Technology and Expertise	<ul style="list-style-type: none"> • Advanced WTE Solutions: South Korea boasts highly efficient and eco-friendly WTE technologies. Korean firms can partner with Indian companies or set up independent projects to bring advanced gasification, pyrolysis, and plasma gasification technologies to India. • Biomass Processing and Utilization: Korean expertise in biomass pre-processing, briquetting, and pelletization can help convert India's abundant agricultural waste into usable fuel for power generation.
Project Development and Investment	<ul style="list-style-type: none"> • Public-Private Partnerships (PPPs): India actively encourages PPPs in the WTE sector. Korean firms can collaborate with Indian government agencies and private players to develop, finance, and operate waste-to-energy plants across the country. • Investment Opportunities: Korean firms can invest in existing Indian WTE projects or set up their own greenfield ventures. India offers attractive incentives like land allocation, tax breaks, and guaranteed power purchase agreements.
Knowledge Sharing and Capacity Building	<ul style="list-style-type: none"> • Technology Transfer and Training: Korean firms can partner with Indian institutions and universities to share knowledge and expertise in WTE technologies. Training programs can help build a skilled workforce in India, fostering long-term collaboration. • Joint Research and Development: Research partnerships between Korean and Indian institutions can focus on developing innovative, locally-relevant solutions for waste management and energy generation from biomass.
Additional Considerations	<ul style="list-style-type: none"> • Sustainability and Environmental Impact: Korean firms should prioritize environmentally friendly technologies and best practices to ensure projects meet India's strict emissions standards. • Social Responsibility and Community Engagement: Addressing local concerns and actively engaging with communities near project sites can build trust and ensure project success.

Source: Author's compilation

South Korea's waste management success story offers crucial lessons for India as it grapples with the deteriorating quality of life in its towns and cities due to poor waste disposal and management practices. India faces a significant waste challenge, generating over 250,000 tonnes of Municipal Solid Waste (MSW) daily in 2023, with projections indicating a rise to 377,000 tonnes by 2025. South Korea, despite its rapid industrialization, achieved a 40% reduction in MSW generation since the 1980s through innovative strategies. The country shifted its focus from traditional incineration and landfills to a volume-based waste fee system, emphasizing waste reduction and maximum recycling.

South Korea's waste-to-energy initiatives also provide a noteworthy model for India. Complementary to waste management, South Korea invested in Waste-to-Energy (WTE) projects, supporting local governments in expanding WTE facilities since 2008. The country even pioneered the world's first landfill-powered hydrogen plant in 2011. As India faces an impending waste crisis, adopting South Korea's integrated approach, combining waste reduction, recycling, and WTE, is imperative. The Nanjido landfill recovery project exemplifies how waste sites can be transformed into sustainable attractions, emphasizing the need for accessory initiatives. The success of South Korea's waste management is a testament to the potential positive impact of strong political will, public participation, and comprehensive waste management strategies, offering invaluable lessons for India to ensure a cleaner and healthier environment for current and future generations.

Attractiveness of Indian Market:

The allure of India's biomass and waste-to-energy (WTE) market is particularly enticing for South Korean firms, driven by several key factors. Firstly, India's capacity to generate substantial amounts of biomass and waste stands as an untapped resource with immense potential for generating clean energy through advanced WTE technologies. The active backing of the Indian government further enhances the attractiveness of the sector for South Korean investors, as the government provides incentives such as subsidies, tax breaks, and favourable policies (Figure 4), fostering an environment conducive to investment.

Figure 4:
Indian Government Support for Biomass and Waste-to-Energy Sector:

Financial Incentives:	Policy Support:	Additional Support:
<ul style="list-style-type: none"> • Central Financial Assistance (CFA): Up to 30% of project cost for setting up WTE plants in economically weaker states. • Capital Grant: 20% of project cost for small-scale (up to 20 MW) WTE plants under the National Policy on Biofuels 2018. • Generation-Based Incentives: Additional tariff payable by DISCOMs for WTE-generated electricity under 'State Specific Tariff Policy and Regulations. • Soft Loans: Loans at concessional interest rates through specialized institutions like Indian Renewable Energy Development Agency (IREDA) and Small Industries Development Bank of India (SIDBI). • Accelerated Depreciation: Allowing faster deduction of plant cost from taxable income, reducing tax burden. • Exemption from Customs Duty and Goods and Services Tax (GST): On import of certain WTE equipment and components. 	<ul style="list-style-type: none"> • Land Allocation: Assistance in land acquisition for setting up WTE projects. • Feed-in Tariffs: Guaranteed minimum price for electricity generated from WTE, providing revenue predictability. • Single Window Clearance: Streamlined process for obtaining approvals and permits, reducing bureaucratic hurdles. • Demonstration Projects: Government funding for demonstration projects to showcase advanced WTE technologies and encourage private investment. • Skill Development Programs: Initiatives to train and upskill workforce for operation and maintenance of WTE plants. 	<ul style="list-style-type: none"> • Carbon Credits: Issuance of carbon credits for WTE projects under national and international carbon trading schemes. • Research and Development Funding: Grants and support for research in advanced WTE technologies and biomass utilization. • Public Awareness Campaigns: Promoting public understanding of WTE benefits and encouraging waste segregation.

Source: Adapted from Ministry of New and Renewable Energy, <https://mnre.gov.in/policies-and-regulations/schemes-and-guidelines/schemes/>

Conclusion: Collaborating for Shared Future

South Korean companies bring to the table their extensive experience in advanced WTE technologies and successful project executions. This experience, when leveraged effectively, allows these firms to adapt readily to the Indian context and make meaningful contributions to the country's sustainable energy goals. Entering the Indian market not only offers immediate opportunities but also serves as a strategic foothold for South Korean firms looking to expand their presence in the broader Asian market, in fact, India is most promising among them all. Beyond the economic advantages, the development of WTE infrastructure in India supports the concept of a circular economy. By promoting resource recovery from waste and minimizing the environmental impact of waste generation, South Korean firms participating in this sector contribute to both environmental sustainability and economic efficiency, aligning with the overarching goals of a circular economy.

In the face of an impending climate-change crisis, the imperative for humanity is to forge alliances for sustainable development, transforming shared responsibility into collaborative action. At this critical juncture, India and South Korea, two nations with distinct yet interconnected challenges, find themselves uniquely positioned to collaborate for a brighter and sustainable future. Their opportunity lies in harnessing the vast potential of the biomass and waste-to-energy sector, not merely for their respective nations but for the global well-being. India, with its burgeoning population and economic growth, contends with waste management and air pollution issues. South Korea, as a technological powerhouse, seeks cleaner energy sources to balance industrial might. The convergence of these challenges becomes an avenue for joint efforts.

India's abundant agricultural resources, in the form of biomass like crop residues and organic waste, complement South Korea's cutting-edge waste-to-energy technologies, including efficient gasification and pyrolysis methods. The envisioned synergy between South Korea's technological prowess and India's resource base could result in collaborative ventures. Generous Korean government support could catalyse the establishment of efficient waste-to-energy plants across India, converting waste into clean energy. Beyond mitigating environmental damage, such partnerships promise economic growth, job creation, and enhanced cultural ties between these middle-income economies. The benefits extend beyond the immediate sectors, creating a ripple effect across industries. As South Korean companies establish themselves as clean energy partners in India, their reputation and goodwill can soar, paving the way for expanded cooperation in diverse sectors such as electronics, automobiles, electricals, and white goods. This collaborative approach exemplifies mutual prosperity, setting a precedent for global sustainable development partnerships for the entire world.

While venturing into India's biogas and waste-to-energy sector, South Korean companies must remain vigilant of nuanced operational challenges as India's business environment remained challenging even amid the series of economic reforms. They should meticulously work on navigating India's complex regulatory landscape, adapting to distinct cultural and business environments, and overcoming bureaucratic processes for project approvals which at times may be time consuming due to layered approval mechanism. Further, they may encounter infrastructure constraints, legal intricacies, and competition with local players thus resulting in complexity in business operations. Additionally, managing currency fluctuations, addressing political and economic uncertainties, and tackling infrastructure gaps pose hurdles in establishing a foothold. Hence, they must exercise due diligence, careful planning, transparent communication, and a commitment to compliance to surmount these challenges.

In conclusion, the promise of a bio-alliance between India and South Korea beckons for a shared future. By leveraging their mutual strengths, South Korea and India have the potential to redefine the narrative of environmental challenges and climate change issues and can effectively transform threats into opportunities for collective progress. Fuelled by technology, goodwill, and a vision for a cleaner planet, South Korea-India partnership in this crucial sector can serve as a beacon of hope for humanity and mankind as a whole. By choosing commitment, cooperation and collaboration over competition, South Korea and India can pave the way for a future where clean energy flows not only from biomass but from the shared commitment of two great cultures united in their dedication to saving the planet.