



中国产业发展促进会生物质能产业分会
Biomass Energy Industry Promotion Association

Biomethane Industry Outlook under the Carbon Neutrality Goal

Analysis of Emissions Reduction Potential,
Cost-Effectiveness, and Market Demand
Executive Summary





About RMI

RMI is an independent nonprofit, founded in 1982 as Rocky Mountain Institute, that transforms global energy systems through market-driven solutions to align with a 1.5°C future and secure a clean, prosperous, zero-carbon future for all. We work in the world's most critical geographies and engage businesses, policymakers, communities, and nongovernmental organizations to identify and scale energy system interventions that will cut greenhouse gas emissions at least 50 percent by 2030. RMI has offices in Basalt and Boulder, Colorado; New York City; Oakland, California; Washington, D.C.; and in Beijing, People's Republic of China.



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About BEIPA

Biomass Energy Industry Promotion Association (BEIPA) was jointly established by China Association for the Promotion of Industrial Development (CAPID) and its standing executive members in June 2018. BEIPA is a national, non-profit, industrial social and non-corporate organization voluntarily formed by industrial institutions. The Association gives full play to its role as a bridge, provides industry consultation, industrial policy and other advisory services to the government, enterprises and society, and collaborates with international and domestic institutions to promote the high-quality development of the biomass energy industry.

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Executive Summary

Echoing global commitments to combat climate change, China has set forth its own carbon peaking and carbon neutrality commitments. A pivotal strategy in achieving these milestones is the transition to a green and low-carbon energy system, which necessitates the swift and extensive development of diverse renewable energy sources.

Biomethane, as one of the main methods for the utilization of biomass energy, will play a critical role in the decarbonization of energy consumption. Sourced from organic wastes like crop residues, livestock manure, food waste, and industrial wastewater, biomethane is a sustainable alternative to natural gas. Advancing the production and consumption of biomethane offers clear advantages to China — a country generating vast quantities of organic waste and importing 44% of its natural gas — across multiple domains, including energy, climate, rural development, and the environment.

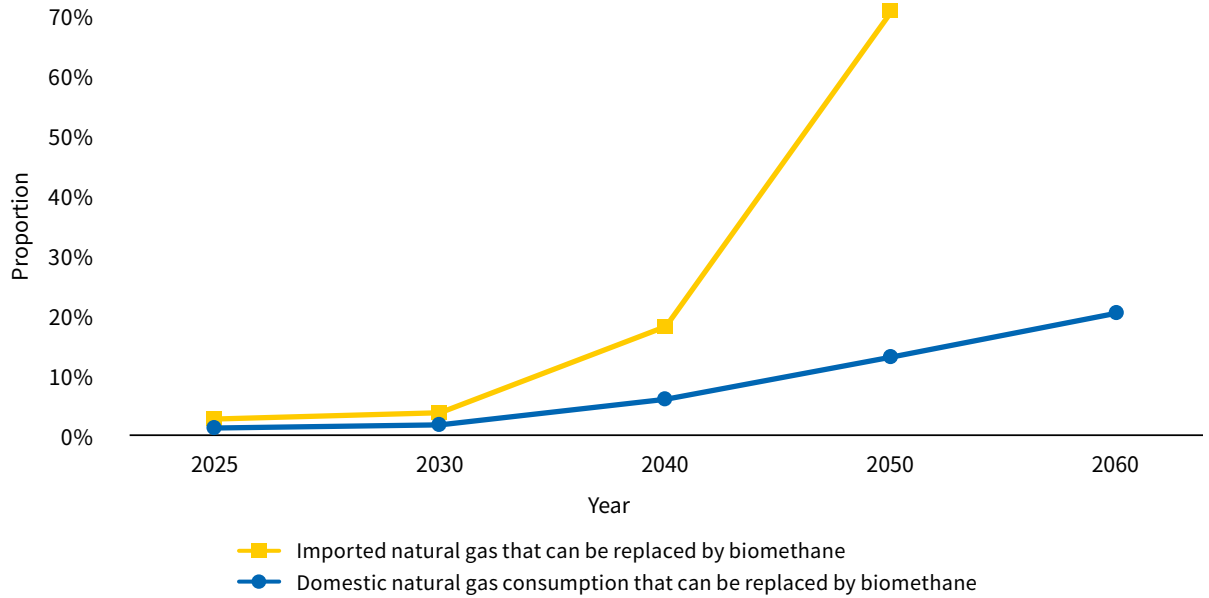
First, biomethane accelerates the energy transition. RMI forecasts that by 2060, China's biomethane consumption will be the equivalent of approximately 78 million tons of coal, which is equal to 8.1% of China's non-fossil fuel energy consumption in 2022. By this projection, biomethane is poised to satisfy close to 20% of the country's natural gas demand in 2060. Additionally, the surge in biomethane production will undoubtedly fortify China's energy security. By 2050, biomethane can supplant 68% of the nation's imported natural gas (see Exhibit 1), potentially saving China billions in energy import expenditures.

Second, biomethane curtails greenhouse gas (GHG) emissions. This includes not only the CO₂ emissions prevented by replacing natural gas, but also the methane and nitrous oxide emissions originating from the agricultural and waste sectors. Considering the variances in raw materials used in biomethane production, RMI projects that the annual GHG emissions savings range from 140 to 240 million tons (t) of CO₂ equivalent (CO₂e) by 2060, as depicted in Exhibit 2. Cumulatively, from now until 2040, the GHG emissions reduction can tally between 0.56 and 0.95 billion tCO₂e. Extending this projection to 2060, the aggregate savings could soar to a staggering 2.78–4.77 billion t CO₂e.

Third, biomethane plays a pivotal role in China's objectives for rural revitalization and ensures a just transition. Its development is aligned seamlessly with China's overarching strategies geared toward bolstering agricultural and rural development. By channeling investments into expansive projects and foundational infrastructure, biomethane has the potential to boost the income of rural households, supplement local government revenues, and generate significant employment opportunities.

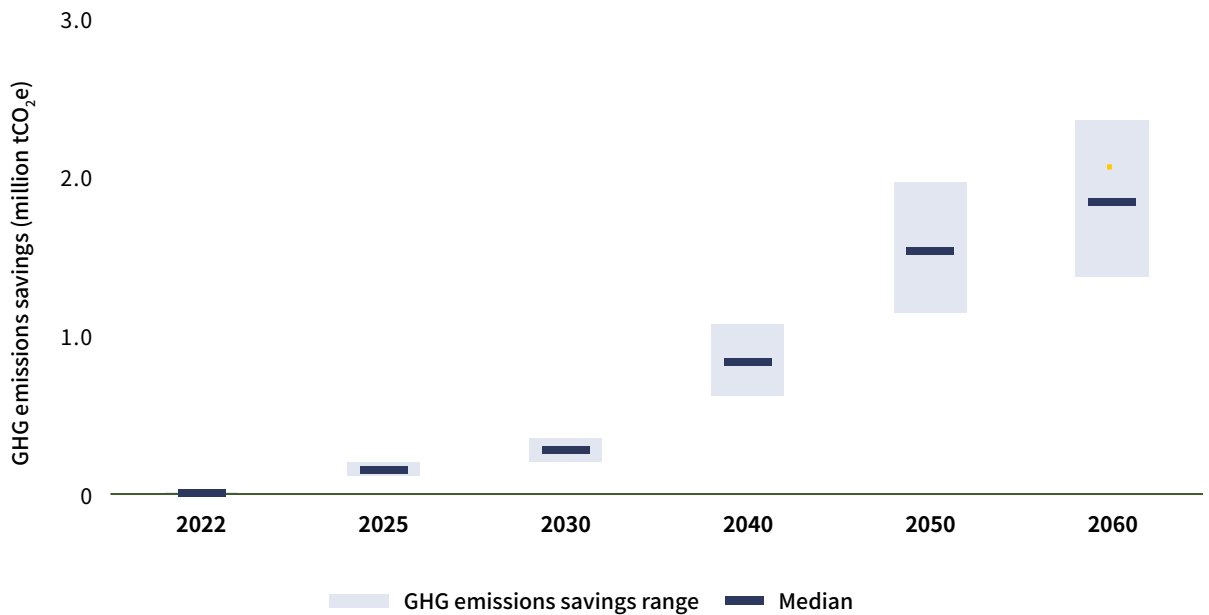
Furthermore, biomethane is an instrumental tool in environmental preservation and pollution mitigation. It offers a cleaner alternative to traditional energy sources in rural regions, such as coal, straw, and firewood, that are predominantly used for cooking and heating purposes, presenting a marked improvement in air quality and consequently public health. On another front, biomethane curtails soil and water contamination by transforming waste into organic fertilizers. It also curbs air pollution typically resulting from the unregulated incineration of straw.

Exhibit 1 Biomethane's role in enhancing energy security in China



RMI Graphic. Source: RMI analysis

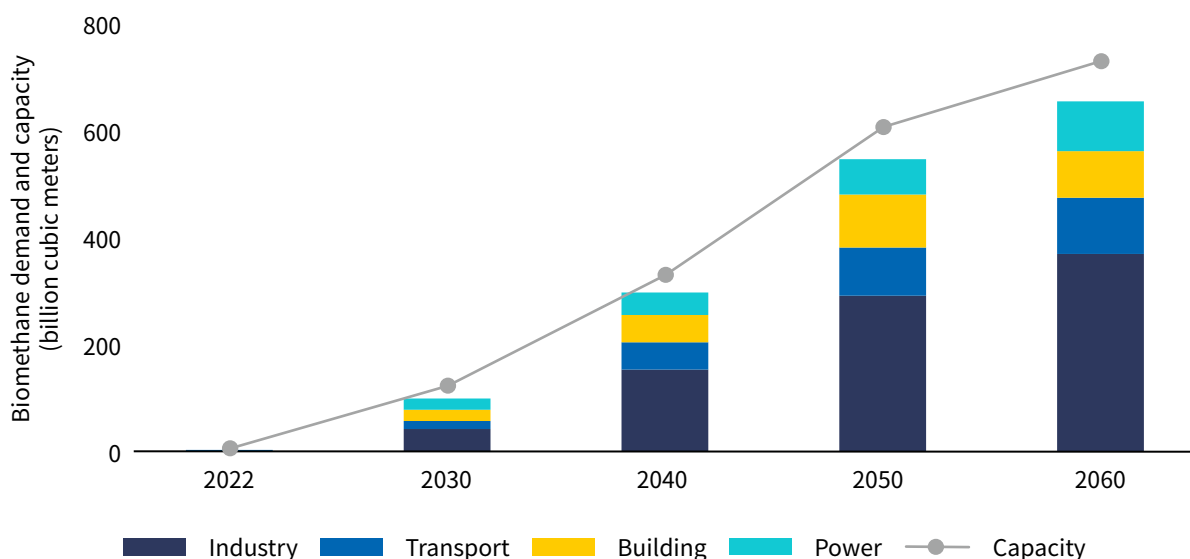
Exhibit 2 Annual GHG emissions savings of China's biomethane development



RMI Graphic. Source: RMI analysis

As China steers toward carbon neutrality, the trajectory for biomethane supply and demand is unmistakably upward, mirroring the escalating pace of energy system decarbonization. RMI's forecasts suggest that by 2030, China's yearly demand for biomethane will scale up to a substantial 10 billion m³, with projections indicating a leap to 63 billion m³ by 2060, as visualized in Exhibit 3. Predominantly, this surge in demand can be attributed to the industry sector's ambition to decarbonize fuels and raw materials. However, a diverse array of other sectors also sees potential applications for biomethane, amplifying its multifaceted utility.

Exhibit 3 Forecasts of biomethane demand and capacity in China

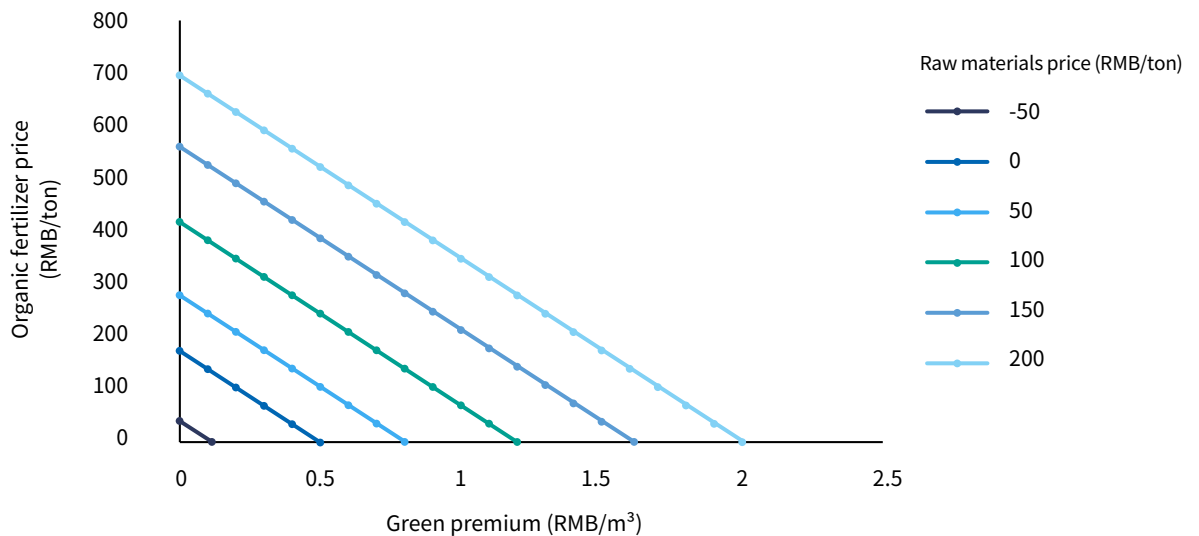


RMI Graphic. Source: RMI analysis

To scale up biomethane production, commercially viable solutions must be established. This fundamentally hinges on enhancing the cost-effectiveness of biomethane projects by curtailing costs while bolstering revenues, as depicted in Exhibit 4. RMI's detailed techno-economic examination of biomethane production pinpoints two pivotal determinants impacting cost competitiveness: raw materials costs and by-product revenues. To make the levelized cost of energy (LCOE) for biomethane competitive with natural gas market prices, producers must minimize raw materials costs or even earn from waste treatment fees. Concurrently, by-products, notably organic fertilizers, must be marketable at reasonable prices.

Several other variables contribute to determining the cost competitiveness of biomethane projects, including investment costs and potential revenues derived from the green premium. In the realm of investment costs, technological advancements and the benefits of economies of scale are anticipated to usher in cost reductions. These can lead to a projected 21%–30% decrease in the LCOE across various technology pathways by 2060. However, these reductions might still fall short of giving biomethane a competitive edge over natural gas. As for the green premium that differentiates biomethane from natural gas, there is an opportunity to translate the positive climate impact of biomethane into tangible financial returns through China's Certified Emission Reduction mechanism or renewable energy certificates. Enhancements to the carbon pricing mechanism and renewable energy certification system could further amplify the financial viability and cost competitiveness of biomethane.

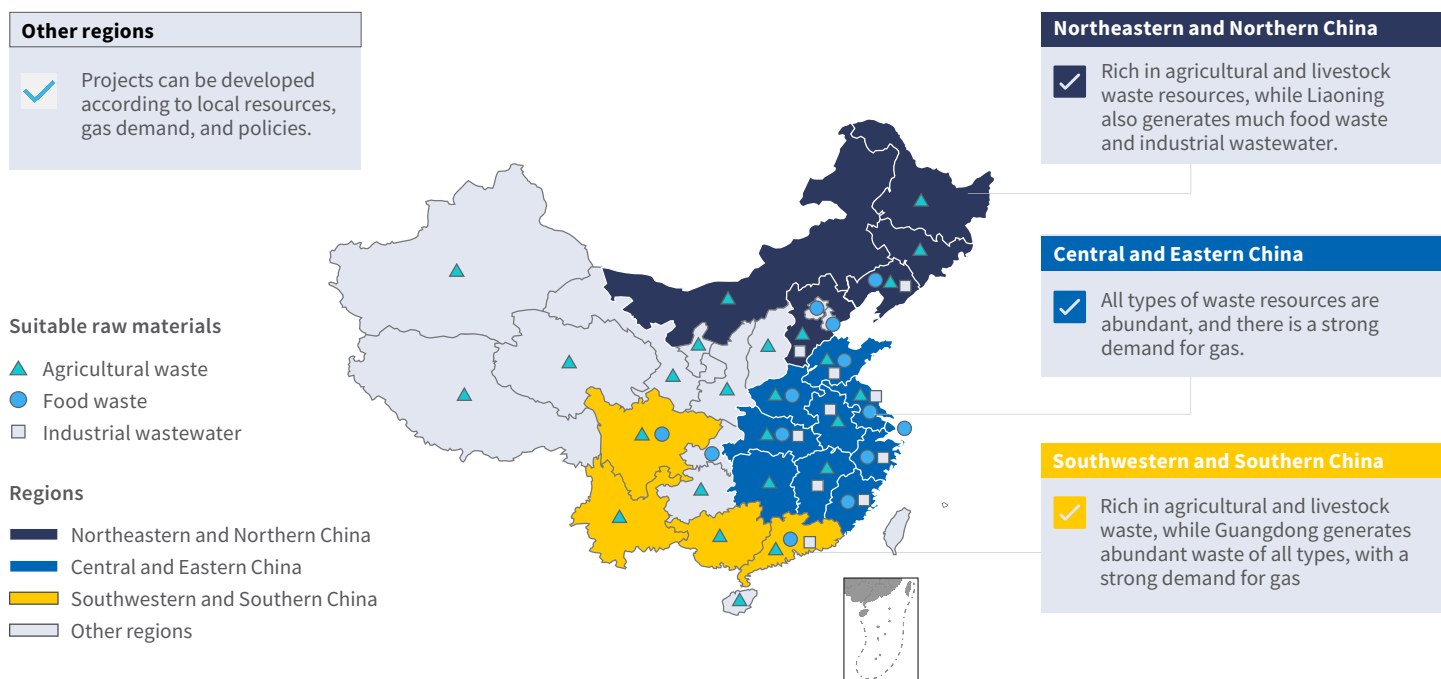
Exhibit 4 Price parity curve for new projects in 2030 utilizing manure and straw as raw materials



Note: The combination of raw materials costs, by-product prices, and the green premium on the price parity curve positions the LCOE of biomethane projects on par with conventional natural gas market prices.
 RMI Graphic. Source: BEIPA, RMI Analysis

How is the future of China’s biomethane industry envisioned? RMI posits that the roadmap can be discerned through two distinct lenses: regional development and the progression of the industrial chain. From a regional development standpoint, the biomethane industry in China is poised to form distinct clusters across various regions, as depicted in Exhibit 5. These regions are equipped to scale up biomethane capacities that align with their inherent characteristics, be it resource availability, the dynamics of natural gas supply and demand, or prevailing agricultural and waste management policies. A holistic approach to the industrial chain is paramount. In the upstream, there should be a robust supply framework that encompasses a spectrum of organic waste from both urban and rural areas. The midstream necessitates the integration of contemporary technological solutions complemented by state-of-the-art engineering infrastructures. Simultaneously, the downstream should be identified by a thriving marketplace that accepts not only biomethane but also its by-products.

Exhibit 5 Prospects for the regional development cluster of China's biomethane industry



RMI Graphic. Source: RMI analysis

To unlock biomethane's potential and hasten China's march toward carbon neutrality, concerted efforts across policy, technology, infrastructure, and finance are paramount. RMI proposes seven recommendations to spur the high-quality evolution of China's biomethane industry:

- **Technological advancement:** Propel innovation of biomethane production technologies that resonate with China's national circumstances.
- **Business model exploration:** Pave the way for novel business paradigms through pilot demonstrations and enhance policies that bolster every tier of the industrial chain, from upstream to downstream.
- **Strategic policy planning:** Enhance macro-level schematics and amplify policy coordination to ensure a streamlined trajectory for the industry.
- **Consumption-oriented instruments:** Revamp regulatory frameworks and devise incentives to stimulate the consumption of biomethane and its by-products.
- **Climate finance:** Enhance policies, standards, and mechanisms related to climate finance. Engage both public and private stakeholders to channel financial resources toward biomethane projects.
- **Holistic industry development:** Craft a market-driven industry ecosystem. Encourage a collaborative approach in which governments, research hubs, corporations, financial entities, and media outlets each play to their strengths.
- **International cooperation:** Bolster international alliances and dismantle impediments for a swifter global energy transition and collective climate action.

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