EXECUTIVE SUMMARY

Global Dynamics, Drivers and Challenges

The biomethane industry —also known as renewable natural gas (RNG)— is entering a new phase of accelerated growth, broadening applications, and transformation. Surging production, an increasing number of producing countries, expanding applications (as a true complement to natural gas), growing industry participation, new market designs, and investment flowing into the sector are moving RNG from a niche to a cornerstone of the future renewable energy landscape. Biomethane, a **drop-in fuel** that can replace natural gas and make use of existing infrastructure and end-use equipment, offers a **high decarbonization potential** (it can even create negative emissions). In addition, its production uses **proven and established technologies available today**. At the intersection of the energy, agriculture, and waste management sectors, RNG provides **positive externalities** that go beyond the provision of renewable energy. Recognized for its multiple positive attributes, RNG benefits from **robust policy and market drivers**, and has now become an important solution to global climate and energy security issues, in addition to its key role as a catalyst for circular economies.

Accelerated growth: Global RNG production has nearly tripled in the last five years. Production reached **9.25 billion cubic meters (bcm) in 2023, a 22% increase from 2022**. The growth is driven by Europe and North America, which together accounted for 84% of the incremental supply in 2023. The emerging growth markets, mainly Brazil, China and India, also recorded significant growth, although from a small base. The number of producing countries has increased from 29 in 2018 to 39 in 2023, as more governments adopt RNG policies and financial support. More than **2,100 biogas upgrading plants were in operation at the end of 2023.** Production is estimated at **12 bcm in 2024 (up 30%)**, again illustrating the accelerated growth of the sector.

Expanded applications: The growing RNG supply supports its economic use as a sustainable alternative by a widening group of consumers across sectors. The transportation sector dominates with a market share of 44% of global demand in 2023 (4.1 bcm), primarily driven by renewable energy quotas in the sector and growing demand from large fleet owners. Moreover, **RNG applications are broadening**. An increasing number of **large corporations and energy-intensive industrial companies** are signing **biomethane purchase agreements (BPA)** with RNG producers and traders to achieve their environmental, social, and governance (ESG) commitments and meet their customers' needs for low-carbon products. These agreements initiate a merchant market and open a huge market opportunity for RNG going forward. **Energy and gas utilities are adopting RNG** as a key component of their decarbonization journey. A notable trend in 2023 and 2024 was the increasing adoption of RNG by US gas utilities and Brazilian distributors, while the trend is already well advanced in Europe and Canada. The use of **bio-LNG as bunker fuel** is opening a huge market for RNG as the LNG pathway has now emerged as the preferred option for alternative-fueled ships. Interest in and demand for bio-LNG as bunker fuel has increased over 2023/24 as the industry is looking to further decarbonize shipping. LNG exporters have also started to blend small batches of bio-LNG into their LNG supplies to reduce emissions, leveraging existing infrastructure, and offering a pathway to decarbonization. Moreover, the production of biohydrogen and derivatives is emerging as a new outlet for RNG.

Transformation: The market is evolving and becoming more sophisticated, with **new market designs** being developed in many countries. Since 2022, **biomethane blending mandates** for natural gas suppliers/distribution companies have been adopted by several European governments, some US states, India and Brazil, while such obligations have been in force in Canada (Quebec and British Columbia) for years. These obligations secure revenue streams for project developers and create new opportunities for market growth. As the market evolves from supply-side to demand-side incentives, **biomethane certificates** that value the environmental attributes of RNG are becoming a pivotal catalyst for the expansion of RNG markets. This is true not only in North America and Europe, but also in emerging growth markets such as Brazil, China and India. The market is also **evolving towards an integrated market** with more trading between regions, although some regulatory constraints still need to be resolved. There is also an emerging trend towards **better valorization of RNG co-products** (biogenic CO_2 and digestate).

Innovation: The sector is constantly innovating to adapt its technologies to new market needs, commercialize **innovative technologies** to treat a variety of feedstock (e.g., gasification), deploy modular designs for faster construction (e.g., Archaea Modular Design), **standardize and industrialize** the construction of RNG facilities to achieve cost reductions (e.g., Prodeval's factory in France), and scale up RNG production size to benefit from economies of scale. These innovations are critical to addressing current challenges, including reducing costs and accelerating capacity expansion to meet decarbonization targets by 2030 and beyond.

Investment: The sector is experiencing a surge in financing from major energy companies, gas and energy utilities, waste management and food processing companies, project developers, and the private capital market. M&A remains a key tool to enter the market, expand portfolio and acquire feedstock. Notable deals, strategic partnerships, and investments in 2024 include the announcement by **Reliance Industry Limited (RIL), India's largest private company, of a record investment of almost $8 billion to set up 500 RNG facilities in Andrah Pradesh**, by far the largest investment announced in the sector so far; the acquisition of a 40% stake in Genia Bioenergy by **Repsol** (Spain), positioning the company as an integrated player in the entire biomethane value chain; France's **ENGIE**'s acquisition of RNG facilities in three more countries; and the establishment of a strategic partnership between **TotalEnergies and US Vanguard Energy** to develop farm-based RNG projects in the US. European infrastructure funds continued to flow substantial capital into the sector, while there was no notable investment by US private funds in 2024, contrary to previous years.

Challenges: Despite its high potential, RNG faces several challenges, which differ according to region, but generally include the **high cost of RNG production**, the need for significant capital investment, infrastructure development, grid integration, and feedstock issues, including competition from alternative uses in the biofuel sector. Permitting processes, customer willingness to pay, and, in some regions, social acceptance, are other barriers that industry and policymakers must address. **Evolving and complex regulation** are additional challenges for RNG developers. RNG production costs remain relatively high compared to natural gas prices. This highlights the need to reduce production costs, while **better recognizing the positive externalities of RNG**, which largely outweigh RNG production costs.

Outlook: While many challenges remain to realize the full potential of biomethane, **the RNG market is poised for tremendous expansion over this decade and beyond, driven by strong policy and market drivers in both already well-developed and emerging growth markets.** Governments around the world have announced ambitious targets for the sector, which combined exceed **100 bcm/y by 2030**. Achieving this ambitious goal and effectively overcoming current barriers require an **effective framework of subsidy schemes and support mechanisms along the entire value chain**. Strategic public-private partnerships and collaboration among industry stakeholders will remain critical to scale up RNG production and realize its full potential.

Regional Insights

Europe leads the world's RNG production. **Production amounted to 5 bcm in 2023**, up 19% compared to 2022 (of which 4.2 bcm in the EU, up 21%). The growth was mainly driven by France, Denmark, and Italy. Production is preliminary estimated at 6 bcm in 2024 (up 21%), continuing its acceleration. An increasing number of European governments, such as Spain, Poland, Ireland and Ukraine, which previously had no public ambitions regarding RNG, have begun to develop RNG strategies, adopt policies and provide financial support. As a result, the number of producing countries in the region is growing. **There are now 25 European countries producing RNG.** In terms of both development and policy support, national RNG markets across Europe remain quite heterogeneous. RNG accounted for only 1.5% of EU gas demand in 2023, but in some countries, it has already reached 30% to 40%. The number of production facilities exceeded 1,500 at the end of 2023. France leads the way with 652 facilities. The rise in European RNG demand is driven by **strong growth in the transport sector**, including in shipping, rising decarbonization goals of energy-intensive industrial users and energy utilities. **Several large industrial users have signed BPA** to meet their 2030 decarbonization requirements and respond to customers' demand for cleaner products. **Energy utilities are investing heavily in RNG** as a key component of their decarbonization policies and clean energy supply. Trade of biomethane certificates increased significantly in 2023, although from a small base. Cross-border trade is not yet harmonized. Starting in 2025, the Union Database for Biofuels (UDB) will improve the traceability of mass-balanced biomethane certificates.

The European sector is experiencing multiple tailwinds, including regulatory support for clean energy sources, stricter and wider decarbonization targets under the renewable energy directive (RED III) and an increased focus on energy independence. Several countries are introducing RNG **blending obligations** (e.g., France, the Netherlands) to support further demand growth. Since the publication of the **REPowerEU plan**, which established an indicative target of **35 bcm by 2030**, the biomethane industry and policy makers have intensified their efforts and significant progress has been made towards achieving the target. The Biomethane Industrial Partnership was launched in September 2022 to support the achievement of the target and further growth beyond. EU governments have submitted their final National Energy and Climate Plans (NECPs), which include a chapter on RNG. **The NECP targets add up to around 20 bcm of production by 2030**, with several countries —including Germany, the largest producer— not having reported any targets. While this clearly indicates an acceleration in EU biomethane production, challenges remain for the sector. Unlocking the full potential of biomethane and

meeting the 2030 target requires a **holistic approach**, including policy support, regulatory facilitation, market stimulation and innovative financing. EU policy needs to be more consistent. By addressing these challenges, Europe can consolidate its position as the leader of the global biomethane market, reduce its GHG emissions efficiently and rapidly, and benefit from all the positive externalities that come with biomethane.

The US has strengthened its outstanding position, accounting for a third of global RNG production. Production from 305 RNG facilities increased to 3.1 bcm in 2023 and is estimated at 4 bcm in 2024 from 411 facilities. The Inflation Reduction Act (IRA) has been a catalyst in accelerating the build-out of RNG facilities, with tax credits available for projects that begun construction before the end of 2024. In addition, the US Environmental Protection Agency (EPA) significantly increased RNG production volumes for 2023-2025 under the federal **Renewable Fuel Standard (RFS)**, driving exponential growth in the transportation sector. **California's Low Carbon Fuel Standard (LCFS)** is undergoing significant regulatory changes with the phase-out of RNG for transportation by 2040, changes in feedstock and the book-and-claim approach. This is in line with California's policy to gradually shift RNG resources to other applications and end-use sectors. While most of the RNG developed to date has been in response to federal and state policies promoting the transportation fuel market, **additional demand from non-transportation sectors is poised to drive massive growth in RNG demand**. Voluntary customers have become an important growth market for RNG, driven by ESG-related targets and reporting requirements. In addition, a growing number of energy utilities are participating in the RNG market by adopting voluntary initiatives, setting RNG/green gases blending targets, and even producing RNG. Some states have adopted RNG standards and clean heat standards, further boosting RNG demand for thermal uses. **Regulatory policy alignment remains critical to the RNG industry and supply growth.** The recent shift away from supporting some clean energy sources under the new Trump administration brings **regulatory uncertainty**. Support for RNG is expected to continue as RNG enjoys bipartisan support. RFS rules for 2026 and beyond must be set in 2025 and will be critical to the continued acceleration of RNG demand in the transportation sector. **In Canada, production is surging**, albeit from a small base (0.29 bcm in 2023). RNG production is set to grow rapidly in the coming years, with around 90 projects under construction or development. Growth is driven primarily by provincial green mandates and voluntary programs, the spread of RNG production to more provinces, and the entry of new players into the sector. The federal Clean Fuel Regulation (CFR), launched in July 2023, is also expected to drive market growth. **If current trends of accelerated development and favorable policies continue, North American RNG production could reach 15-20 bcm by 2030.**

China's RNG sector is experiencing robust growth, with production from large-scale facilities reaching 0.4 bcm in 2023, a 40% increase compared to 2022. This momentum is expected to persist, driven by several key developments. The role of RNG in China has been further reinforced since 2022, with the issuance of new policy directives aimed at accelerating RNG production and facilitating the industrialization of the sector. A strategic shift is underway to comprehensively promote rural revitalization, with the construction of large-scale biogas/RNG clusters at the county level. Since the global energy crisis, the development of RNG has also been identified as a crucial measure to ensure domestic energy supplies and enhance gas supply security. The reduction of methane emissions —an Action plan was adopted in November 2023— is also driving new growth in the biogas/RNG sector. **China is transitioning its RNG development model towards a model based on the sale of RNG combined with its environmental value.** This model will enable the sector to achieve rapid development, driven by high demand in the industrial and transportation sectors (including for bio-LNG and biohydrogen and its derivatives). RNG and certificates are in demand by large foreign companies operating in China. Additionally, the sector has witnessed the entry of national oil companies, major central state-owned enterprises, and key foreign companies, underscoring the sector's growing importance and potential for further development. The government's production target of **20 bcm/y by 2030**, established in 2019, remains unchanged in recent policy documents. According to international/Chinese forecasts, RNG production is expected to reach 12 bcm/y in 2030.

In India, the need to reduce emissions, improve air quality, and stimulate economic growth in rural areas, as well as the urgent need to reduce dependence on imported fossil fuels and synthetic fertilizers, is driving the growth in bio-CNG (compressed natural gas) production. In 2018, the government launched the **Sustainable Alternative towards Affordable Transportation (SATAT) scheme, with a goal of setting up 5,000 bio-CNG plants by 2023-24, producing 21 bcm/y**. However, development has been slow. **Production is estimated at 0.2 bcm in 2023 from 82 plants.** To address the challenges hindering the realization of the SATAT goal, the government has launched two new initiatives. In January 2023, a new support scheme, GOBARdhan, was initiated to promote biogas and bio-CNG. Combined with an investment of $1.2 billion, the scheme will enable the building of 200 bio-CNG plants. In addition, to further facilitate the growth of the sector, the government has introduced a **mandatory blending of bio-CNG in the city gas distribution sector**, starting at 1% in 2025-26, gradually raised to

5% from 2028-29 onwards. These policy initiatives have driven a new momentum for RNG in India. **As of the end of 2024, there were over 800 bio-CNG facilities in operation, under construction, and planned across the country, with a production capacity of 3.6 bcm/y.** The bio-CNG sector in India is poised for exponential growth, driven by increasing gas demand and a rapidly expanding natural gas vehicle (NGV) market, the entry of major domestic and foreign corporations into the sector, and the significant feedstock potential. The sector's growth is further supported by significant investments, with **RIL announcing a record investment of almost $8 billion in the sector.** Despite current challenges related to feedstock availability, technology, and infrastructure, the momentum is there for an exponential increase in bio-CNG production, which will contribute meaningfully to India's energy security and environmental objectives.

In Brazil, the commitment to reduce carbon and methane emissions, the energy crisis, the growing dependence on fuel imports and the shortage of fertilizers have increased the importance of RNG in the country. **RNG production is surging and is estimated at 0.2 bcm in 2023 from 29 operating plants.** It has grown by an average of 28% per year over the past five years. The acceleration of RNG production is driven by policy support (e.g., the Metano Zero and RenovaBio programs), certification of RNG, large investments by waste management, energy and biofuel companies, rising demand from large corporations and industrial customers, a potential massive growth in bio-CNG to displace diesel imports, and the huge feedstock potential, notably from the sugarcane industry. **State gas distributors are also becoming important anchors for new RNG facilities across Brazil**. In addition, **Brazil passed the Fuels for the Future Law in October 2024, which includes a mandate for biomethane.** Natural gas suppliers and importers will be required to purchase biomethane or guarantee of origin certificates, starting with 1% of all gas consumed in the country in 2026, and reaching 10% at a later date. **While Brazil has the potential to produce 12.7 bcm/y by 2030, a 10% target of gas consumption would translate into approximately 4 bcm of RNG production by 2030**. The Fuels of the Future Law provides a solid foundation for Brazil, already a world leader in the production of biofuels, to become a leader in the global biomethane market, helping Brazil meet its climate change goals while supporting rural development and energy security.