Upgrading Landfill Gas into Biomethane

Using the WAGABOX® technology in France

Summary Series

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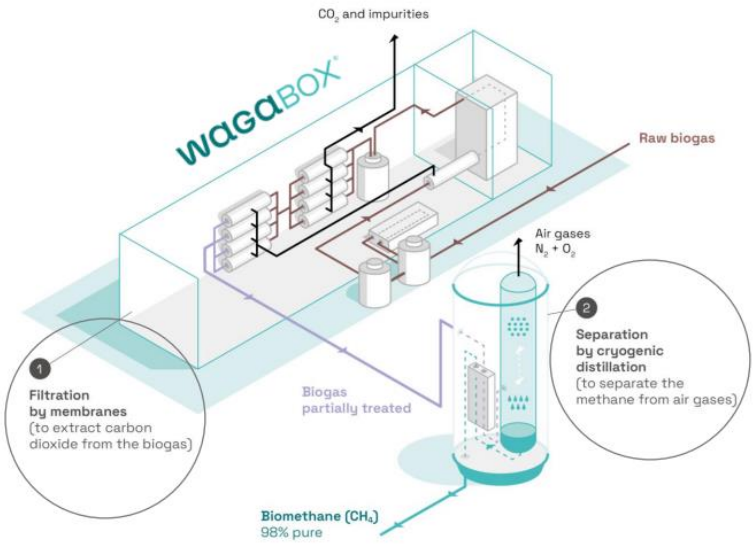
Mission and Vision

More than 2.1 billion tons of waste are produced annually[1], a figure expected to almost double by 2050 according to the UN Environment Program. Amid this global waste challenge, Waga Energy is addressing the problem of fugitive landfill gas emissions with its innovative WAGABOX® technology. Even in developed countries, a significant portion of waste ends up in landfills—40% in France, for example. Once landfilled, organic matter undergoes anaerobic digestion, producing a methane-rich gas. While some of this gas is flared to reduce emissions, a considerable portion escapes into the atmosphere, contributing to approximately 5% of global greenhouse gas emissions. Methane, with a global warming potential 28 times higher than CO_2 over a 100-year period, underscores the critical need to address emissions from landfill sites.



Despite its potential as a renewable energy source, only a few landfill sites upgrade landfill gas into biomethane, also known as renewable natural gas (RNG). Existing technologies for methane separation are often complex, costly, and inefficient, resulting in limited adoption. Waga Energy, leveraging over a decade of R&D and its innovative WAGABOX® technology, has addressed these challenges, transforming landfill gas into high-quality biomethane. This fact sheet highlights the WAGABOX® technology, its international deployment, and the lessons learned from key case studies.

[1] UN Environment Program, Global Waste Management Outlook 2024

The WAGABOX® process

Landfill gas contains up to 50% methane but also carbon dioxide plus 10%–25% air and impurities. The WAGABOX® system combines membrane filtration and cryogenic distillation (-160°C) to separate and extract, in a cost-effective way, 90% of the methane contained in this biogas. The remaining methane (<10%) is burned to avoid GHG and produce heat if necessary. The process consumes 8%–10% of the energy produced, depending on the landfill gas composition and injection pressure.

Pursuing higher efficiencies

Thanks to a subsidy granted by the French Agency for Ecological Transition (ADEME), the WHIPE project achieved significant improvements in the performance and efficiency of the WAGABOX® technology. With raw biogas containing 45% methane, it increased the methane recovery rate by more than 2%, reaching a final rate of 87%. It also improved production availability by 1%, bringing it to 96%. Furthermore, it maintained the recovery rate at the same level as before the WHIPE project while delivering biomethane with a higher oxygen quality of 2,000 ppm.

These advancements were accomplished while maintaining cost-effectiveness, reducing biomethane production costs by 3%. By ensuring compatibility with global gas grid standards (<0.2% oxygen content) and stabilizing operational performance, the WHIPE project positioned WAGABOX® as an effective solution for transforming landfill gas into renewable energy, enabling broader international deployment and contributing to the global energy transition.

Business model

To deploy WAGABOX® solution, Waga Energy has set up a scalable business model. The company purchases landfill gas from waste management companies, and builds, owns, operates, and maintains its units. In France, small-scale projects benefit from a Feed-in Tariff[2], while internationally, biomethane is sold to private off-takers via Biomethane Purchase Agreements (BPAs)[3]. Revenue sharing with landfill owners, based on the quantity of biogas delivered, incentivizes good operating practices[4] and helps reduce methane emissions from landfills.

The first WAGABOX® was commissioned in partnership with Coved/Paprec in Saint-Florentin, in February 2017, supported by a refundable advance of €2.3 million from the ADEME. Since then, 21 additional units have been commissioned in France, with 4 more under construction. The largest European unit, located in Claye-Souilly, produces 120 GWh (409,000 mmBtu) of RNG per year. Globally, there is 1 unit operating Spain near Barcelona, 1 under construction in Italy near Florence, 3 in operation in Canada (with 3 more under construction), and 3 in operation in the United States (with 11 under construction).

Cases' retrospective

The Madaillan WAGABOX® unit, commissioned in June 2023, was built at a Suez landfill. It injects 20 GWh (68,240 mmBtu) per year of biomethane into the GRDF gas grid, France's distribution system operator, meeting the annual energy needs of approximately 3,000 households. By producing RNG as a substitute for fossil-based natural gas, the unit avoids 3,300 tons of CO_2 equivalent emissions annually. The biomethane is sold under the Feed-in Tariff scheme to the French energy supplier Ekwateur.

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[2] A government policy that guarantees a fixed price per unit of biomethane injected into the natural gas grid, often over a set period. This mechanism incentivizes renewable energy production by providing stable, above-market rates to producers.

[3] A long-term contract between a biomethane producer and a buyer (such as a private company or utility) for the purchase of RNG at a negotiated price. BPAs enable projects to operate without subsidies by securing predictable revenue streams.

[4] These practices have been studied along with Suez and Veolia in the E-CUBE Strategy Consultants report: "Contribution of non-hazardous waste landfills to the achievement of the GHG emission reduction targets in the EU".

The WAGABOX® unit processes biogas from the Madaillan landfill, which receives approximately 105,000 tonnes of waste per year.

The Claye-Souilly WAGABOX® unit was commissioned in 2022. Located in one of Veolia's largest landfills in France, it consumes circa 12 GWh of electricity to produce 120 GWh (409,000 mmBtu) of biomethane per year. The biomethane, injected into the GRDF gas grid, is sold through a Biomethane Purchase Agreement (BPA) to Engie and Veolia, supplying renewable energy to 20,000 households and avoiding 25,000 tons of CO_2 equivalent emissions per year.

WAGABOX® unit processes biogas from the Claye-Souilly landfill, which handles approximately 1.1 million tonnes of waste per year.

Lessons Learned

First lesson

The WAGABOX® technology has proven to be a reliable and efficient solution for converting landfill gas into clean, renewable energy. It operates effectively with varying gas quality and flow rates, consistently producing biomethane that meets grid injection standards in both Europe and North America. To support global industrial deployment, Waga Energy has developed a plug-and-play approach, offering modular units with capacities ranging from 600 Nm^3/h to 4,800 Nm^3/h of landfill gas intake, ensuring seamless scalability. With over 95% uptime and exceptional energy efficiency, WAGABOX® delivers stable performance while significantly reducing greenhouse gas emissions.

Second lesson

The WHIPE project enabled the scaling up of larger units, exemplified by the WAGABOX® at Can Mata in Spain. In its first year of operations, this unit injected 57 GWh (194,492 mmBtu) of renewable natural gas, avoiding 14,925 tons of CO_2 equivalent emissions—comparable to removing 66,852 gasoline cars from the road. Operating without Feed-in Tariffs, the project was financed directly on the market thanks to a competitive BPA. Recognized by the EU Innovation Fund for its scale, emissions reductions, and innovative market approach, the Can Mata WAGABOX® highlights the scalability of this technology, paving the way to address larger and more challenging landfill markets in the Americas and emerging economies, even in the absence of subsidies.

Conclusion: The future

Since its inception, the WAGABOX® has proven to be an efficient and reliable technology for reducing greenhouse gas emissions from landfill gas while producing renewable energy to replace fossil natural gas.

Landfills have a finite capacity before closure, but the WAGABOX® effectively valorises biogas during operation and continues to do so long after closure. While Waga Energy strongly supports efforts to reduce waste volumes and aligns with initiatives such as the European Landfill Directive (2018/850), existing landfills present a significant opportunity to capture and valorise residual landfill gas, even years after closure. For instance, the WAGABOX® unit in Chicoutimi, Canada, produces 16 GWh (54,595 mmBtu) of biomethane annually from a closed landfill—avoiding 2,500 tonnes of equivalent CO_2 emissions each year—while the unit under construction in Italy will inject 29 GWh (98,950 mmBtu) of RNG annually from a similar site.

Regarding the future, the company aims to further upgrade the remaining ~13% of raw landfill gas currently flared in the thermal oxidizer. Waga Energy is also conducting R&D to develop their own deoxidizer to comply with the very demanding oxygen levels required for gas grids, such as those in North America.

Besides these improvements, new applications for biomethane are being explored, such as compression or liquefaction for remote and insular landfills and the utilization of CO_2 from biogas for industrial purposes. These innovations highlight the ongoing potential for landfill gas to support the renewable energy transition while reducing GHG emissions.

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