BIOGAS IN SOCIETY
A Case Story

UPGRADING LANDFILL GAS TO BIOMETHANE:

USING THE WAGABOX PROCESS

IEA Bioenergy Task 37

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MISSION AND VISION

More than 3 billion tons of waste is produced annually; this figure is due to continue increasing. Even in developed countries such as France, a significant percentage of this waste is not effectively re-use or recycled and ends up in landfill.

Once landfilled, organic matter naturally produces a methane-rich gas through an anaerobic digestion process. Landfill gas contains up to 50% methane (which is the source of energy) and (as for biogas) it also contains carbon dioxide. However, landfill gas differs from biogas in that it contains 10%–25% air; air is composed of 78% nitrogen and 21% oxygen. Landfill gas also contains numerous impurities. As such landfill gas is much more varied in composition than biogas. Safe and affordable methane/carbon dioxide/oxygen/nitrogen separation is very difficult. Very few landfill sites upgrade their gas to biomethane because existing technologies are complex and expensive and offer relatively low energy yields.

As a result, landfill gas is usually flared to avoid greenhouse gas emissions or sometimes burned to generate electricity (with about 30% energy yields). However, a considerable portion of landfill gas is still released to the atmosphere. Methane has a global warming potential (GWP) of 28 over a 100-year time frame (according to the fifth assessment report); these fugitive methane emissions from landfill sites are the reason that landfills are responsible for up to 5% of worldwide Greenhouse Gas (GHG) emissions.

THE WAGABOX SYSTEM

The decision to combine membrane filtration and cryogenic distillation.

After ten years of Research and Development, Waga Energy developed a breakthrough technology to upgrade landfill gas into high quality biomethane. This technology, called WAGABOX®, combines membrane filtration and cryogenic distillation to separate methane from carbon dioxide, nitrogen, oxygen and impurities. WAGABOX® delivers 98% pure biomethane from landfill gas compliant with grid injection requirements. More than 90% of the methane collected from the landfill is delivered to the grid. The remaining methane (less than 10%) is burned to reduce GHG emissions associated with the GWP of methane and is used to produce heat. The process delivers ten times more energy that it consumes. The final energy yield of a WAGABOX® can be three times that of electricity generation.

BUSINESS MODEL

To deploy this solution, Waga Energy set up a scalable business model. The company purchases landfill gas from waste management companies, and builds, owns, operates, and maintains the WAGABOX® units. Biomethane is sold to gas utilities and revenue is shared with landfill owners. A first contract was signed in December 2015 with Coved (subsidiary of Paprec) to install a WAGABOX® in Saint-Florentin (Burgundy, France; figures 1 & 2). The landfill receives 70,000 tons of waste a year; the

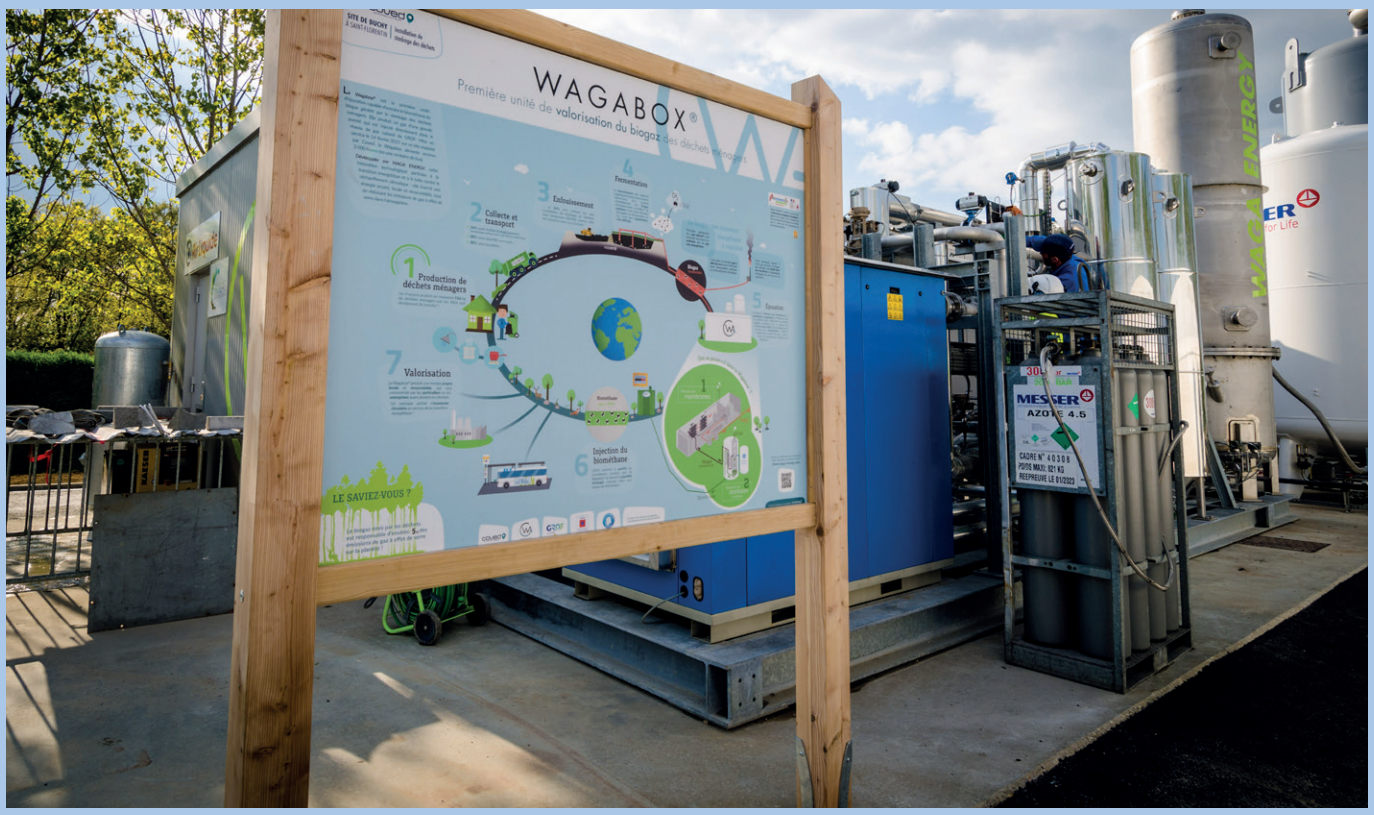

Figure 1: Entrance to Saint Florentin facility © Waga Energy

Figure 2: Aerial View of Saint Florentin facility © Waga Energy

Box 1: WAGABOX® 1 (Saint-Florentin, France)

- Technology: upgrading of biogas by membrane separation and cryogenic distillation
- Input (per year): 70,000 tons of domestic and industrial waste
- Capacity: 300-600 Nm^3/h
- Net output (per year): 25 GWh of biomethane

landfill gas contains 40 to 50% methane, and up to 3.5% oxygen. Waga Energy funded this very first WAGABOX® with a refundable advance of €2.3 million from the French Energy Agency (ADEME). The unit started operation on February 14, 2017. It injects biomethane directly to the natural gas grid, yielding 25GWh of gas per year, providing renewable gas to about 3,000 households, saving 4,000 of CO_2 emissions each year (Box 1).

A second WAGABOX® was commissioned in June 2017 in Saint-Maximin (North of Paris), on a landfill operated by Suez (figure 4). A third facility started in May 2018 in Pavie (South West of France) on a landfill site operated by local authorities (figure 3). Three new units will be commissioned by the end of 2018 for Suez and Veolia, and several more are already under construction to be set up in 2019.

Figure 3: View of the third Wagabox facility in Pavie © Waga Energy

LESSONS LEARNED

First lesson

Landfill gas composition is very difficult to predict and can change a lot in quantity and quality within a few hours; there are numerous variables that dictate the composition including for landfill material and weather (rainfall, temperature). A robust technology is essential to upgrade this landfill gas with an uptime of over 95%. The WAGABOX® process has proven to be effective in upgrading landfill gas using a combining membrane filtration and cryogenic distillation process.

Second lesson

The success of this facility was based upon a close collaboration between Waga Energy and the landfill owner. The design and development of the upgrading process with detailed analysis of the landfill gas characteristics over time is critical in meeting desirable outputs in terms of biomethane quality and consistency of operation. During operation of the facility, a close relation between the landfill gas operator and the upgrading facility manager is necessary to achieve optimum results.

THE FUTURE

Waga Energy is currently developing a new version of the WAGABOX®. Delivery time, ease of operation and performances will be improved to lower production cost, in order to deliver biomethane at a competitive price within the natural gas market.

Figure 4: View of the second Wagabox in Saint Maximin © Waga Energy

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IEA BIOENERGY

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