# LMOP Webinar

## Leveraging Untapped Landfill Gas Potential

**March 10, 2022**

LANDFILL METHANE OUTREACH PROGRAM

# Welcome and Agenda

| Agenda |
| --- |
| ***Challenges and Solutions for Supplying Stable and Quality Landfill Gas to a Gas Processing Plant***<br>Charles Tremblay, President, Sysgaz Inc. |
| ***Leveraging the RNG Potential of Small to Medium Size Landfills***<br>Tanguy Largeau, Business Development and Commercial Vice President, Waga Energy, Inc.<br>and<br>Jason Pennypacker, Project Development Director, Waga Energy, Inc. |
| **Questions and Answers** |
| **Wrap Up** |

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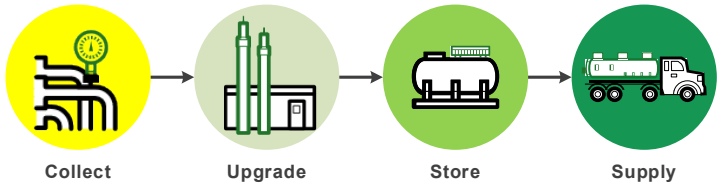
LANDFILL METHANE OUTREACH PROGRAM

# Challenges and Solutions for Supplying Stable and Quality Landfill Gas to a Gas Processing Plant

LMOP Webinar
Leveraging Untapped Landfill Gas Potential
March 10, 2022

Charles Tremblay, President, Sysgaz Inc.

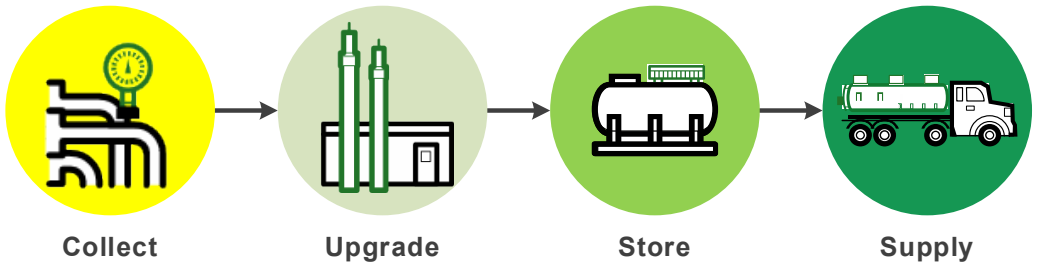



SYSGAZ

# Company Profile

Headquartered in Montréal, Sysgaz is an experienced Project Integrator and OEM Equipment Supplier specializing in RNG project development from landfills or anaerobic digesters.

As Project Integrator, Sysgaz provides integrated solutions throughout the whole RNG value chain to increase RNG project profitability (www.sysgaz.com).

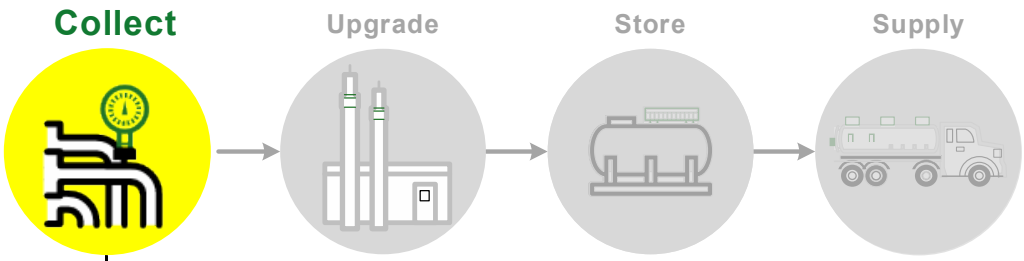


# Context & Contents

## Context:

- ✓ Gas processing plant requires stable landfill gas (LFG) for producing quality RNG
- ✓ Small landfills face more challenges collecting & supplying stable and quality LFG

## Contents:



# 1 Basics of LFG Generation

- ✓ LFG generation produces 60% $CH_4$ v./v. and 40% $CO_2$ v./v.
- ✓ In a perfect world, Gas Recovery Systems should collect the generated LFG plus a mixture of liquids and solids

**Typical Mixture in Landfills**

| Mixtures | Elements | Values (Typ.) |
|---|---|---|
| Gases (generation) | $CH_4$ | 60% v/v in LFG |
| | $CO_2$ | 40% v/v in LFG |
| | Others | Traces (ppm) |
| Liquids | Leachate | Variable |
| | Condensate | 1 USG / 4 400 CF @ 30°C |
| Solids | Particles | Variable |



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# 2 Parameters Impacting LFG Collection

**Landfill Cell Properties:**

- Waste type & Compaction
- Elevated or perched liquids within the waste mass
- Waste decomposition / Cell settling
- Daily cover and final cover permeability (Clay or Membrane)

**Gas Recovery System:**

- Piping failures & low points due to cell settling
- Wells, laterals, and headers blockage (Leachate, Particles, and Condensate)
- Air infiltration

**Environmental Parameters:**

- Atmospheric pressure variations
- Freezing temperature
- Leachate (biological activities and acidification)

# 3 Nitrogen and LFG Quality

Nitrogen is always related to air infiltration

**Air Infiltration Through Waste:**

- Air goes through landfilled wastes
- The $O_2$ is consumed by the bacteria
- The residual $N_2$ impacts the LFG quality by reducing its $CH_4$ content

**Air Infiltration Through External Piping:**

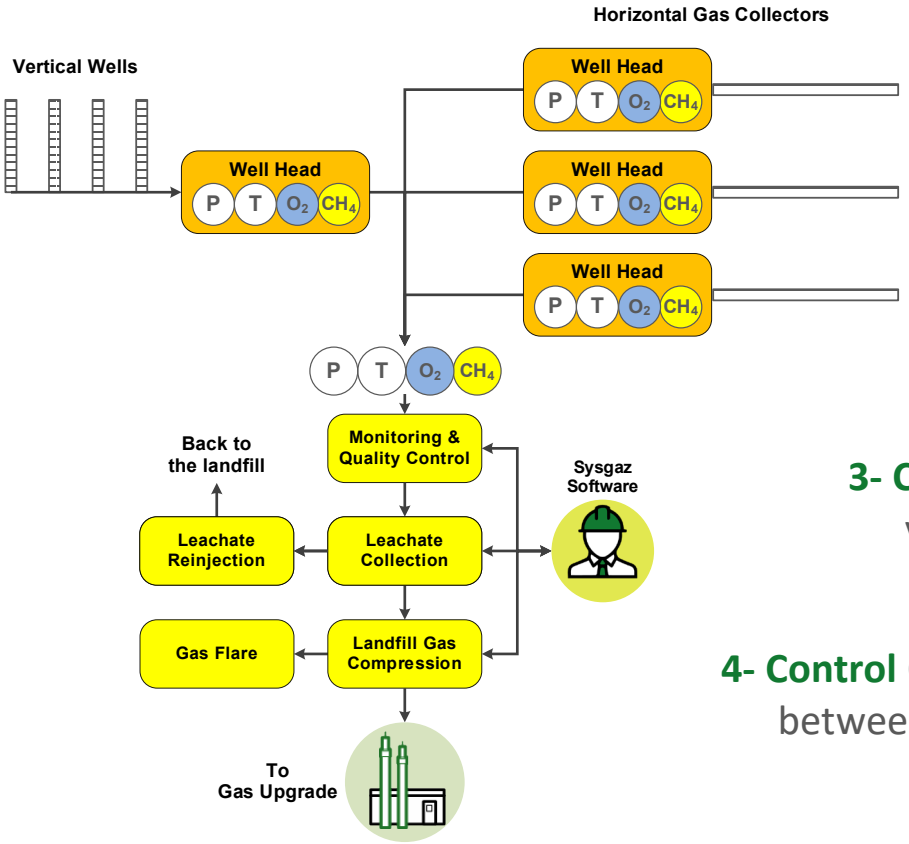
- Air infiltrates through Wells / Laterals / Headers / etc.
- $O_2$ ( 21% v./v.) and $N_2$ (79% v./v.) enter directly in the gas recovery system
- The infiltrated air impacts the LFG quality by reducing its $CH_4$ content

**Air Infiltration Combined Impacts (Waste + External Piping):**

- Air through waste: **$N_2$**
- Air in piping: **$O_2$** + **$N_2$**
- Impact in the gas recovery system: **$N_2$** + **$O_2$** + **$N_2$** (Infiltrations are additional)
- Impact on the LFG Quality: $CH_4$ content decreases as air infiltration increases

# 4 Supplying Quality LFG Monitoring & Control Strategy

Supplying stable and quality LFG require 24/7 gas wells Monitoring and Control




**1- Set** the LFG supply requirements
- % $CH_4$ / % $O_2$ / $CH_4$ Flow Rate

**2- Monitor** 24/7 LFG quality ($CH_4$, $O_2$, T.) from either vertical or horizontal wells

**3- Control** collected $CH_4$ content from gas wells by varying vacuum pressure at well heads

**4- Control** $CH_4$ flow rate by varying vacuum pressure between each gas well fields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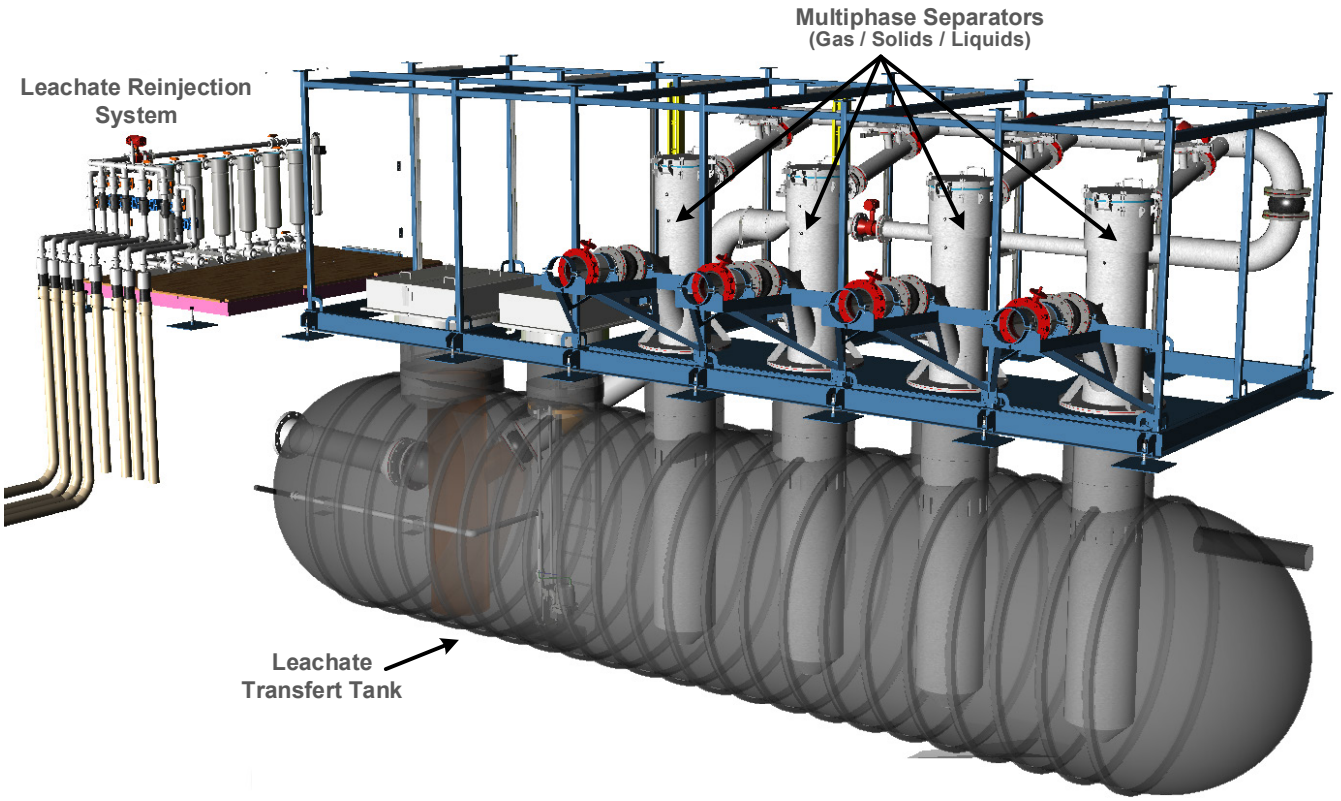
# 4 Supplying Quality LFG Gas Wellhead Station

Gas Monitoring & Control Systems must be designed for managing gases, leachate, particles, and condensate associated with LFG recovery



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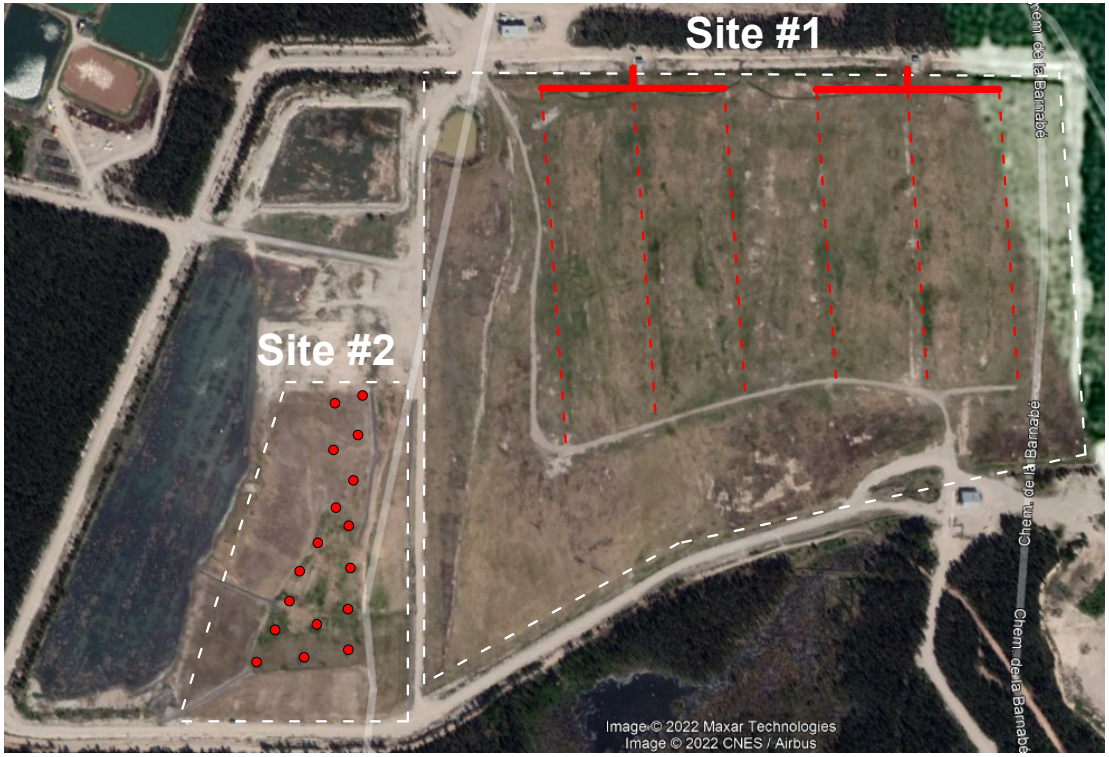
# 5 Case Study – Site Descriptions

| Sites | Status | Tons in Place | Area ( sq. ft ) | Height ( ft ) | Capping | Gas Well Types | Gas Well Quantity |
|---|---|---|---|---|---|---|---|
| # 1 | Closed (1982 - 2008) | 1,000,000 | 2,800,000 | 40 | Clay | Horizontal | 6 |
| # 2 | Closed (2009 - 2014) | 450,000 | 525,000 | 45 | Membrane | Vertical | 18 |



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# 5 Case Study – Project Challenges

1. **Site #1:** Collecting $CH_4$ using 6 horizontal wells from a small closed landfill (1982 – 2008 )
2. **Site #2:** Collecting $CH_4$ using 18 vertical wells from a small closed landfill ( 2009 – 2014 )
3. Supplying stable $CH_4$ flow rate to a boiler room through a 5-mile pipeline

| LFG Recovery Challenges | Site # 1 Horizontal Wells | Site # 2 Vertical Wells |
|---|---|---|
| Final Cover | Clay | Membrane |
| A. Pressure Variations | + + + | + |
| Air Infiltration - Waste ( $N_2$ ) | + + + | + |
| Air Infiltration - Piping ( $O_2$ + $N_2$ ) | — | + + + |
| Elevated / Perched Water | — | + + + |
| Condensate Blockage | — | + + |
| Well Head Freezing | — | + + |


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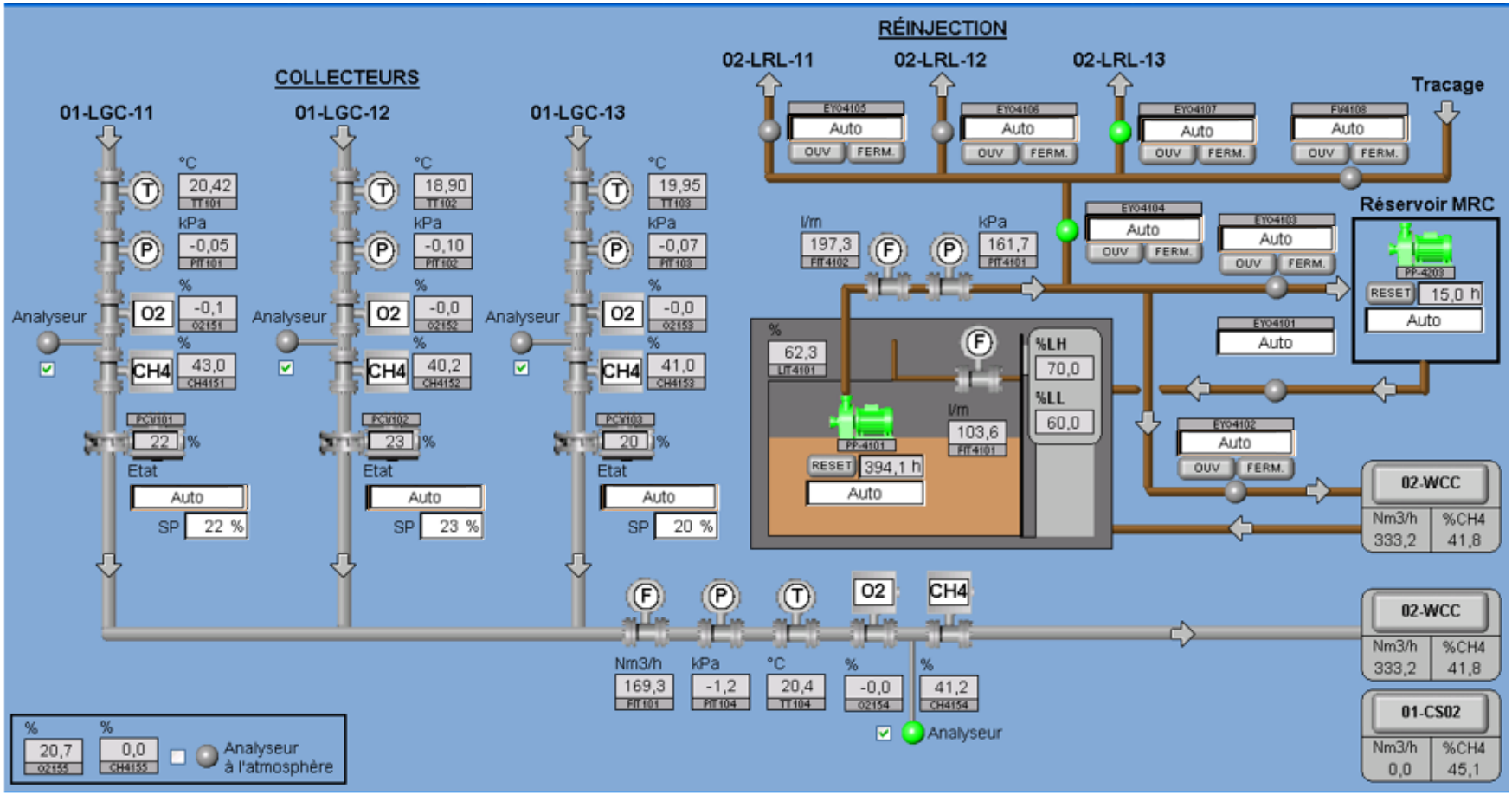
# 5 Case Study – Systems: Gas Wellhead Station

**Site #1 – Gas Wellhead Station Monitoring & Controlling Horizontal Wells**

Ascension Landfill Site, Québec

# 5 Case Study – Systems: Software

## Site #1 – HMI of the Gas Wellhead Station (Horizontal Wells + Leachate Reinjection)




Ascension Landfill Site, Québec



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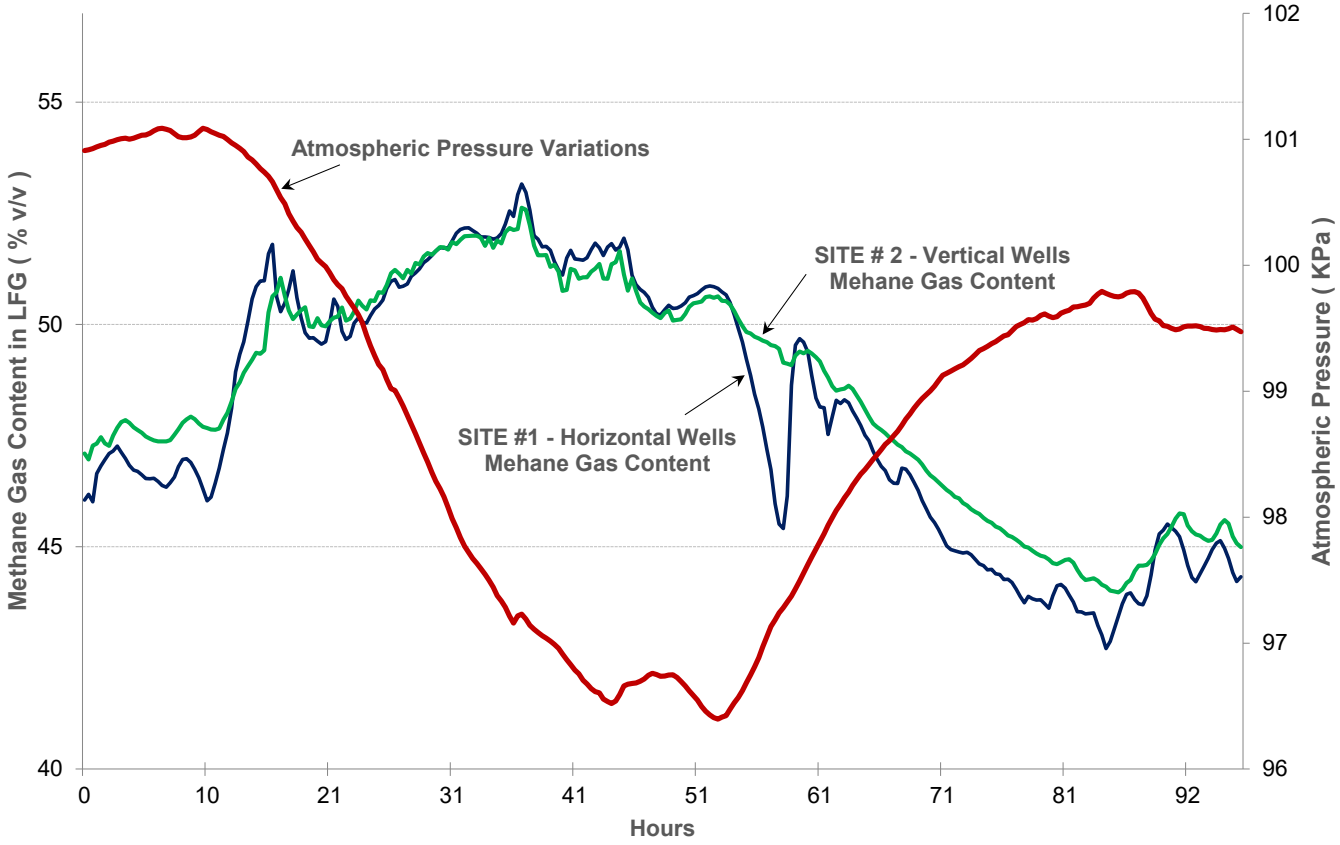
# 5 Case Study – Monitoring & Controlling LFG Quality

## Example #1:

- ✓ The LFG Quality is constantly impacted by atmospheric pressure variations
- ✓ **$CH_4$ Content** from gas wells was controlled by varying vacuum pressure at well heads



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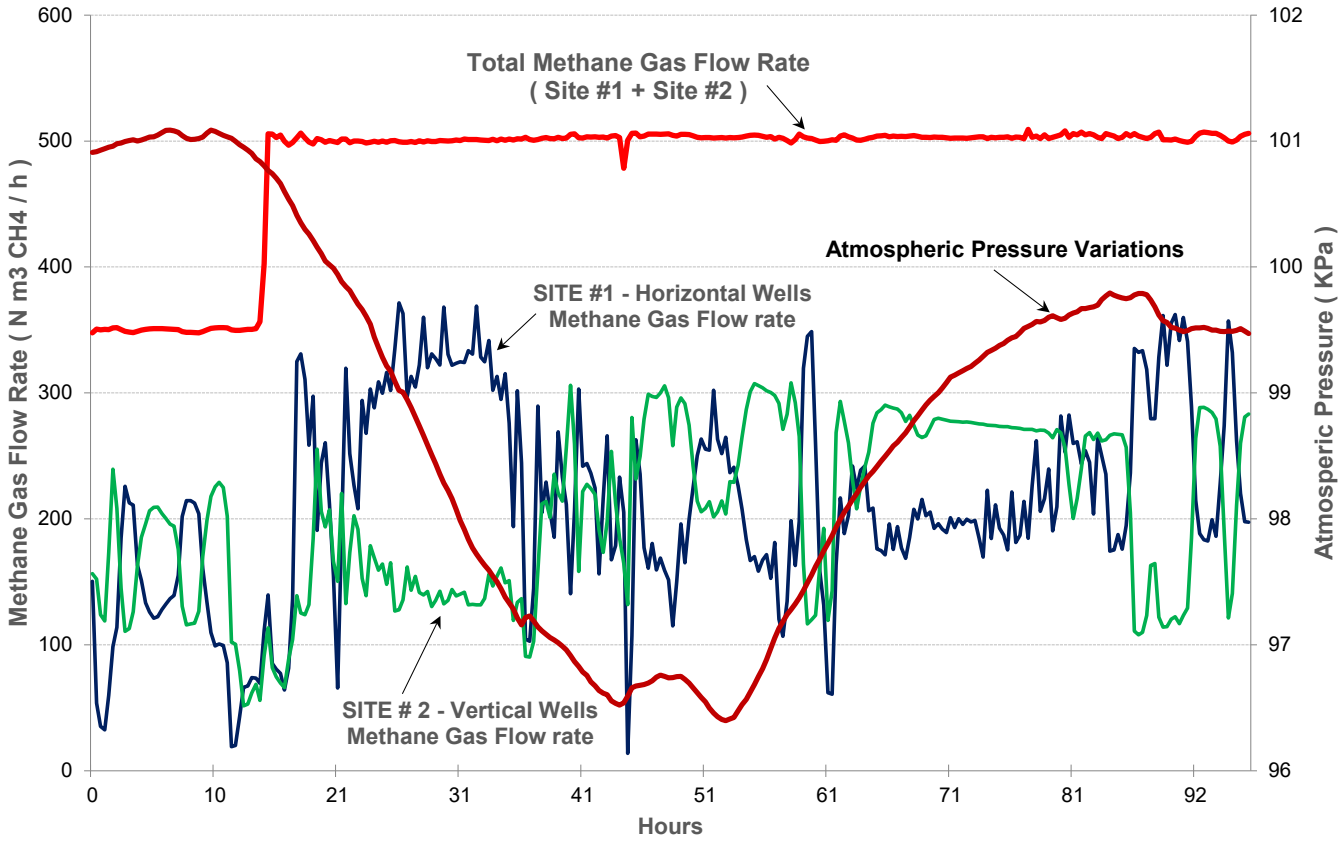
# 5 Case Study – Monitoring & Controlling LFG Quality

## Example #1:

- ✓ **$CH_4$ Flow Rate** was controlled by varying vacuum pressure between each gas well fields



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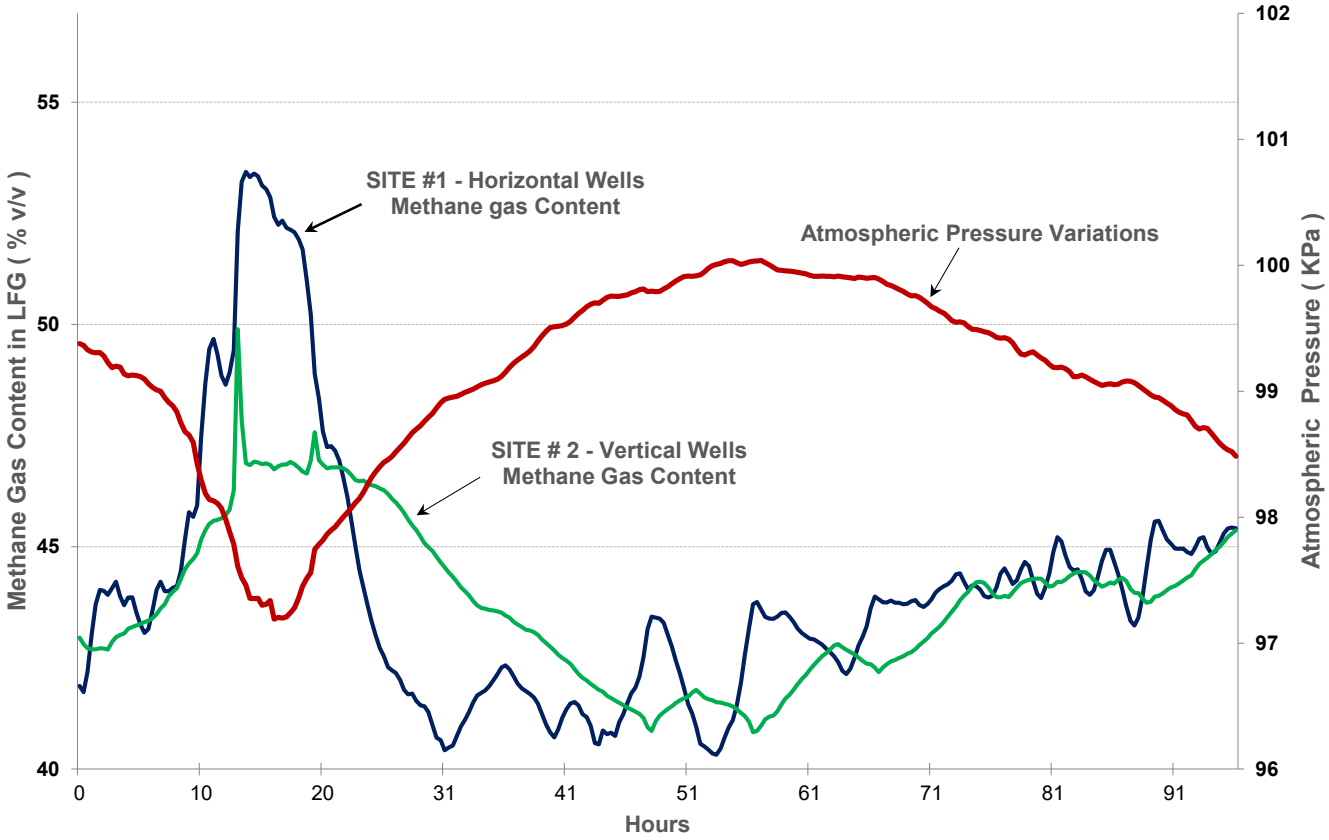
# 5 Case Study – Monitoring & Controlling LFG Quality

## Example #2:

- ✓ The LFG Quality is constantly impacted by atmospheric pressure variations
- ✓ **$CH_4$ Content** from gas wells was controlled by varying vacuum pressure at well heads



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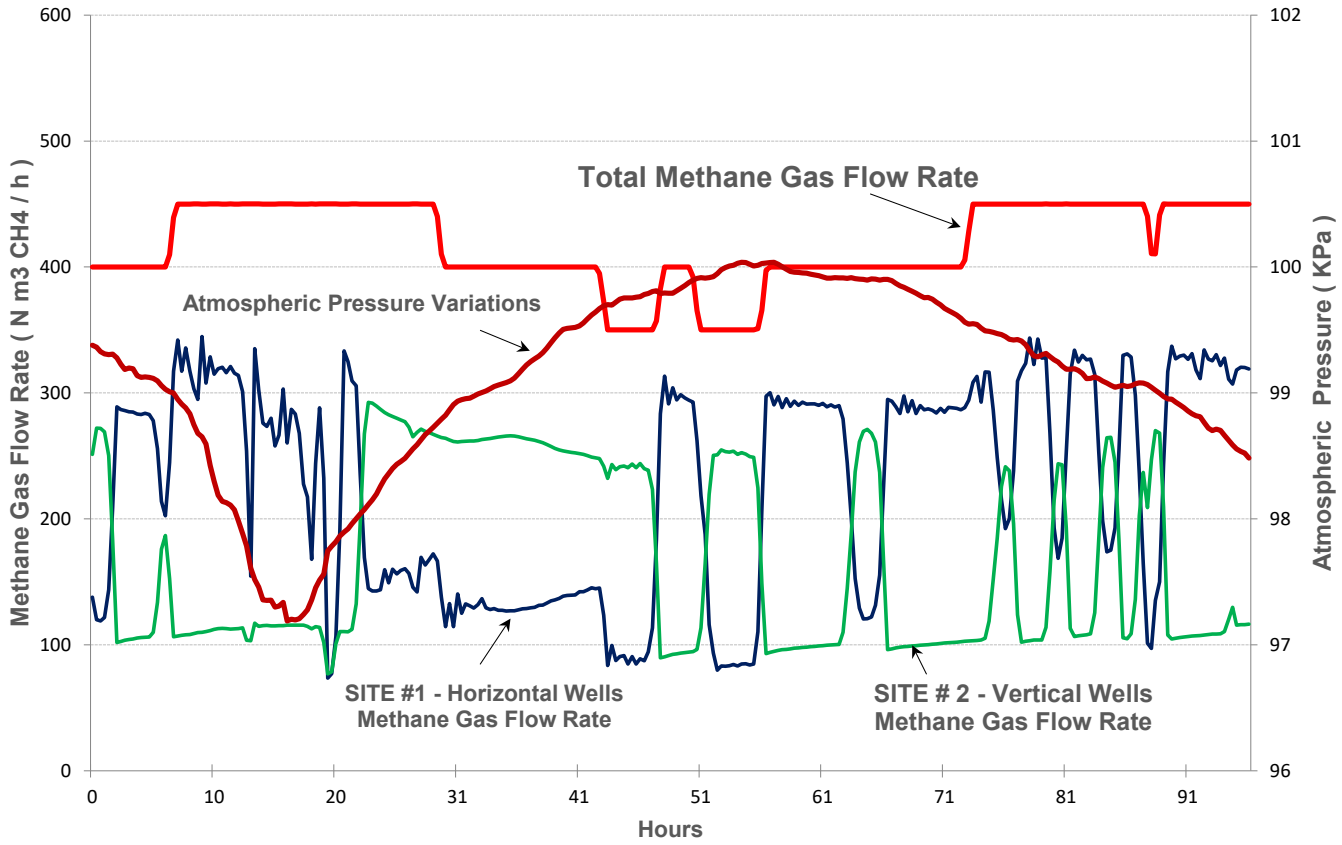
# 5 Case Study – Monitoring & Controlling LFG Quality

## Example #2:

- ✓ **$CH_4$ Flow Rate** was controlled by varying vacuum pressure between each gas well fields



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# 5 Case Study – Conclusion

- ✓ **Without 24/7 Gas Wells Monitoring and Control over $CH_4$ Content and $CH_4$ Flow Rate, this project wouldn't be possible at these small landfills**
- ✓ **Monitoring and Controlling LFG also enabled reducing $N_2$ and $O_2$ impacts over LFG quality**

Ascension, Canada



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# Thank You

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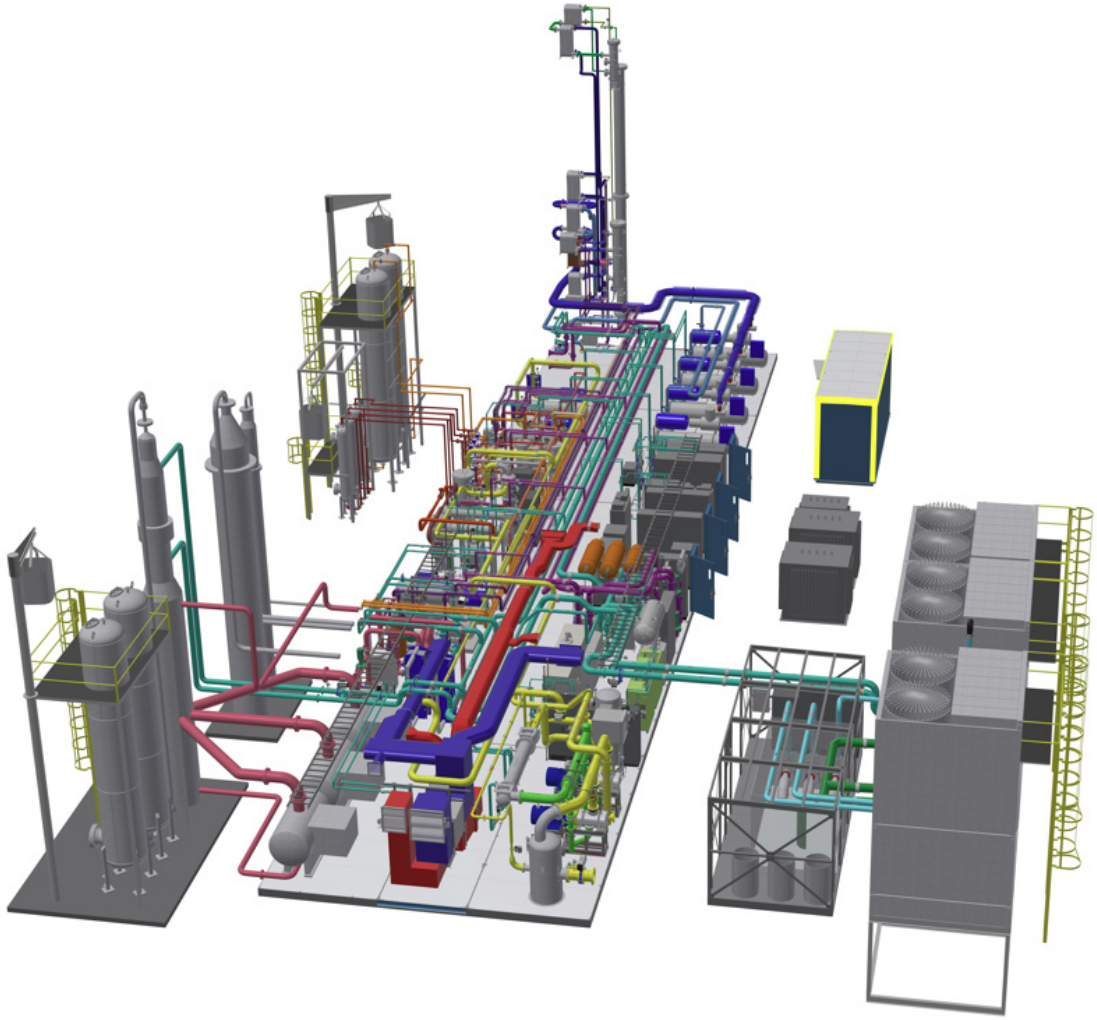



WAGA
ENERGY

# LEVERAGING THE RNG POTENTIAL OF SMALL TO MEDIUM SIZE LANDFILLS

## U.S. EPA Landfill Methane Outreach Program (LMOP) Webinar

March 10, 2022

# WHO IS WAGA ENERGY?

Founded in 2015 by former Engineers from Air Liquide

Headquartered in France with subsidiaries in the USA, Canada and Spain

100+ landfill gas to energy experts worldwide

Driven by an absolute dedication to the safety of our employees and partners

Inventors of the WAGABOX®, a breakthrough technology dedicated to landfill gas upgrading

11 WAGABOX® facilities in operation, 14 projects in execution

**We are Engineers, Entrepreneurs, and Environmentalists committed to mitigating climate change for Future Generations**

01

# Introduction to RNG from landfill gas

WAGABOX®, An innovative solution to upgrade landfill gas

Integrated business-model

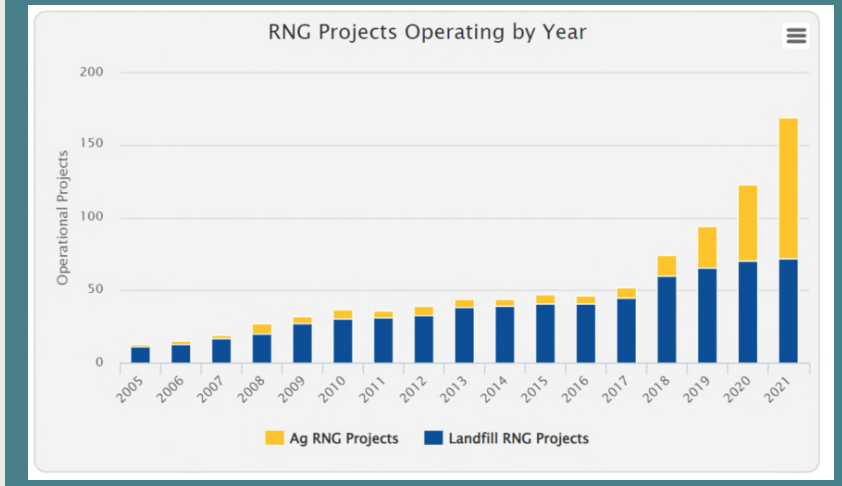
# US LANDFILL GAS POTENTIAL

2,500+ landfills in the USA

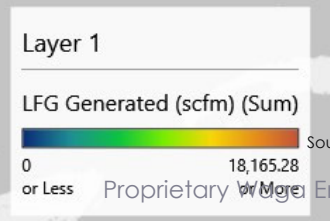
2MM+ scfm of landfill gas available

497 landfills converting landfill gas to energy (68 RNG)

67 projects under construction (55 RNG)

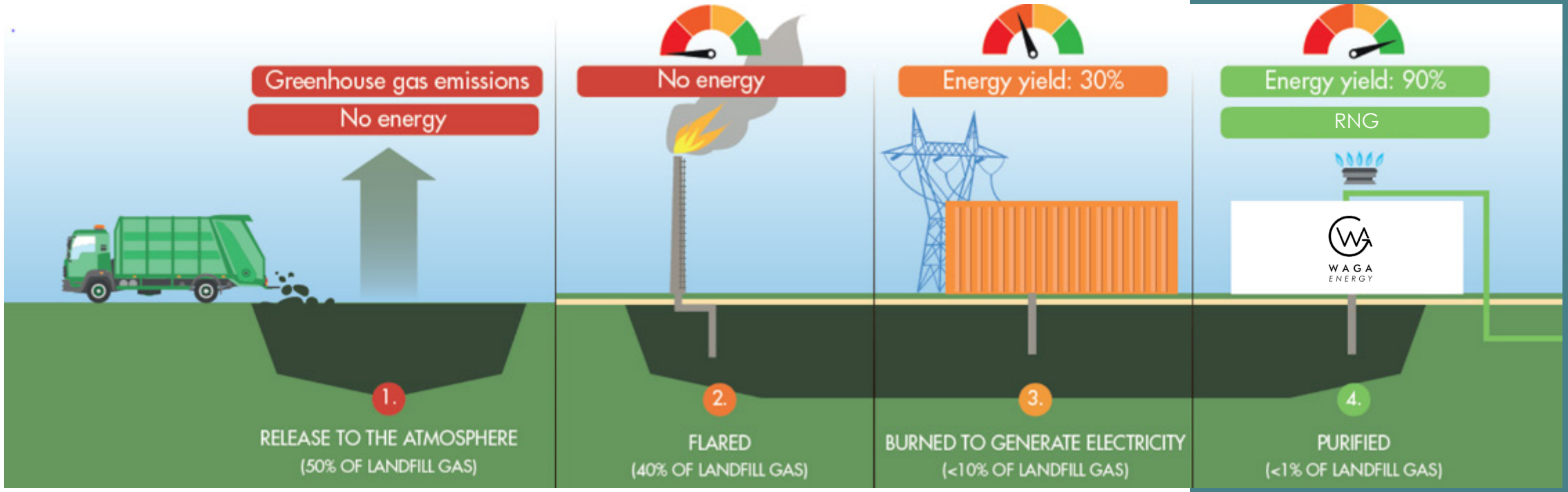



Source: EPA LMOP




Source: EPA LMOP

# LANDFILLS WHERE RNG POTENTIAL IS STILL LARGELY UNEXPLOITED




**+90%** *More than 90% of landfill gas is unused*

**<10%** *Less than 10% is burned with low energy yield*

**<1%** *Less than 1% is recovered and purified for grid injection*

Source: Waga Energy

# WAGABOX®, A DISRUPTIVE TECHNOLOGY TO TRANSFORM LANDFILL GAS INTO GRID-QUALITY RENEWABLE NATURAL GAS

**YESTERDAY**

*No available technology to efficiently upgrade landfill gas into RNG*

**TODAY**

## *WAGABOX®*

*Is the* ***only standardized solution*** *based on proprietary technology to* ***recover landfill gas*** *and* ***purify it into RNG***


## *UNLOCKING THE POTENTIAL OF LANDFILL GAS:*

- √ **Separate the oxygen and the nitrogen included in landfill gas (main biogas upgrading challenge)**
- √ **Manage high volatility over time and high composition**

## *PATENTED TECHNOLOGY*

***15+ years of R&D***
*started at Air Liquide and continued at Waga Energy*

Air Liquide

WAGA ENERGY


02

Introduction to RNG from landfill gas

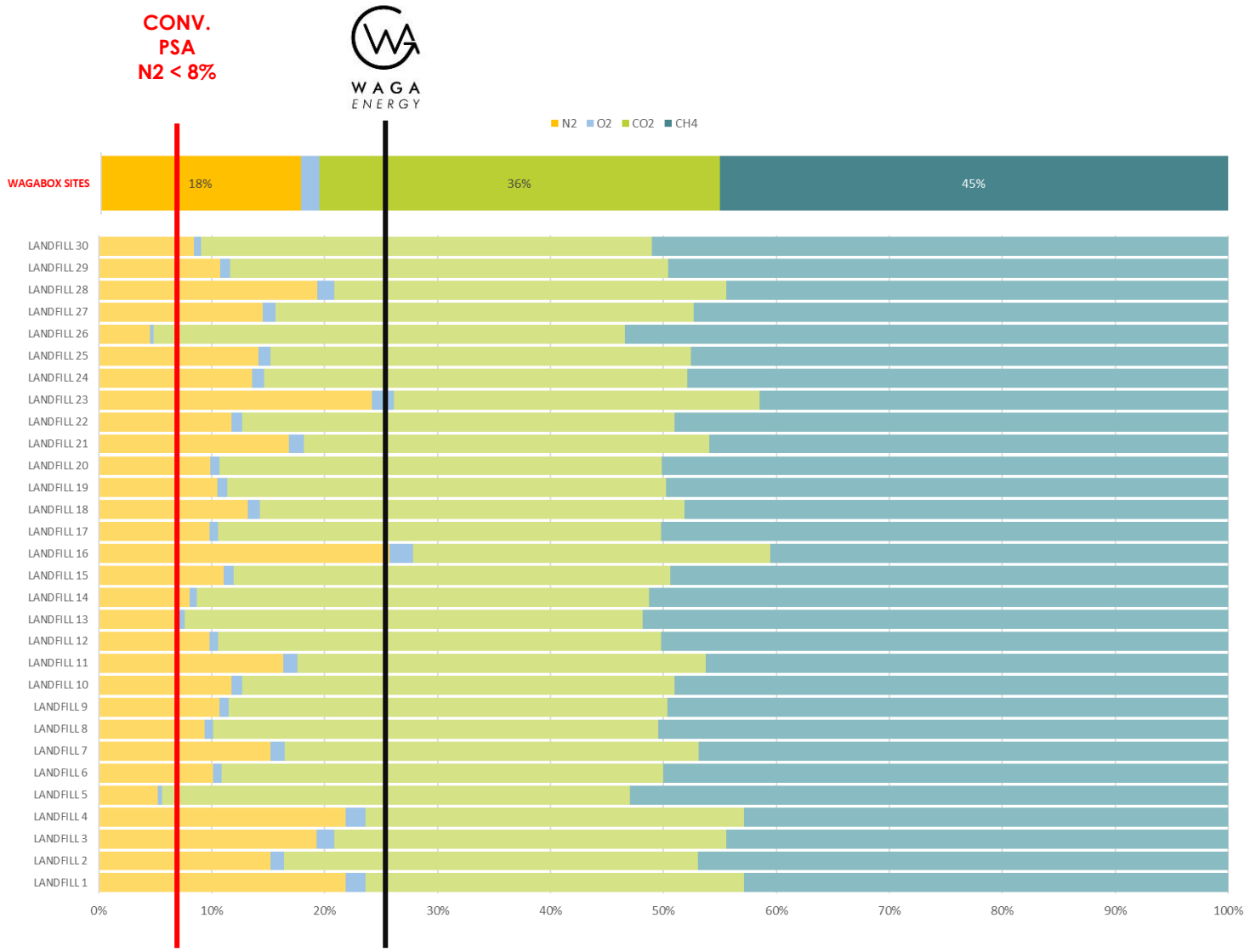
# WAGABOX®, An innovative solution to upgrade landfill gas

Integrated business-model

# WHY IS UPGRADING LANDFILL GAS INTO RNG A CHALLENGE?

## Key Notes

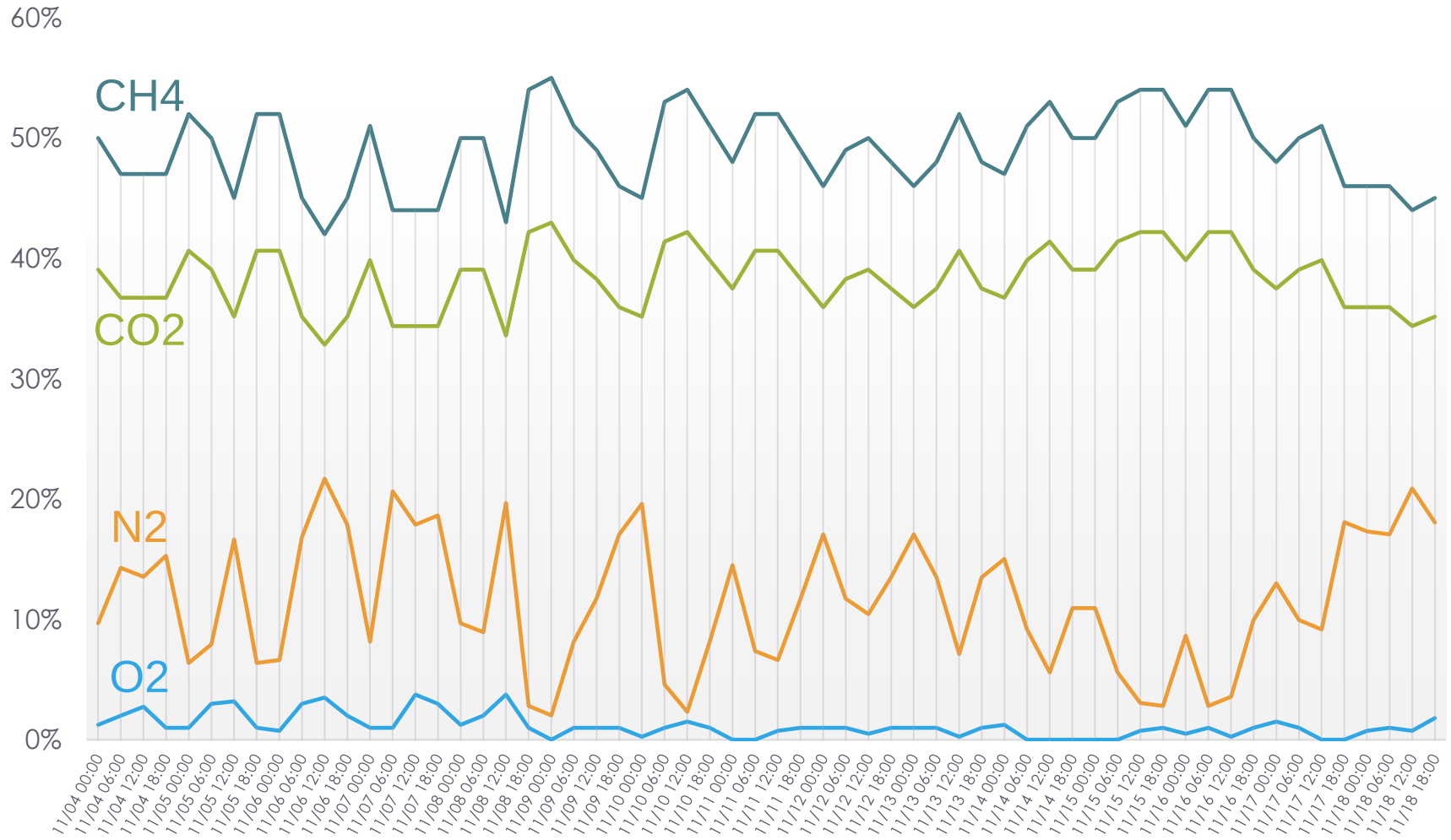
- Landfill gas is mainly composed of $CH_4$, $CO_2$, $N_2$ and $O_2$.
- Landfill gas composition varies and is unique to every site.
- Existing technologies are highly sensitive to air gases ($N_2$+$O_2$).
- Low pressure cryogenic distillation technology revolutionize how nitrogen and oxygen are removed from landfill gases.



# WHY IS UPGRADING LANDFILL GAS INTO RNG A CHALLENGE?

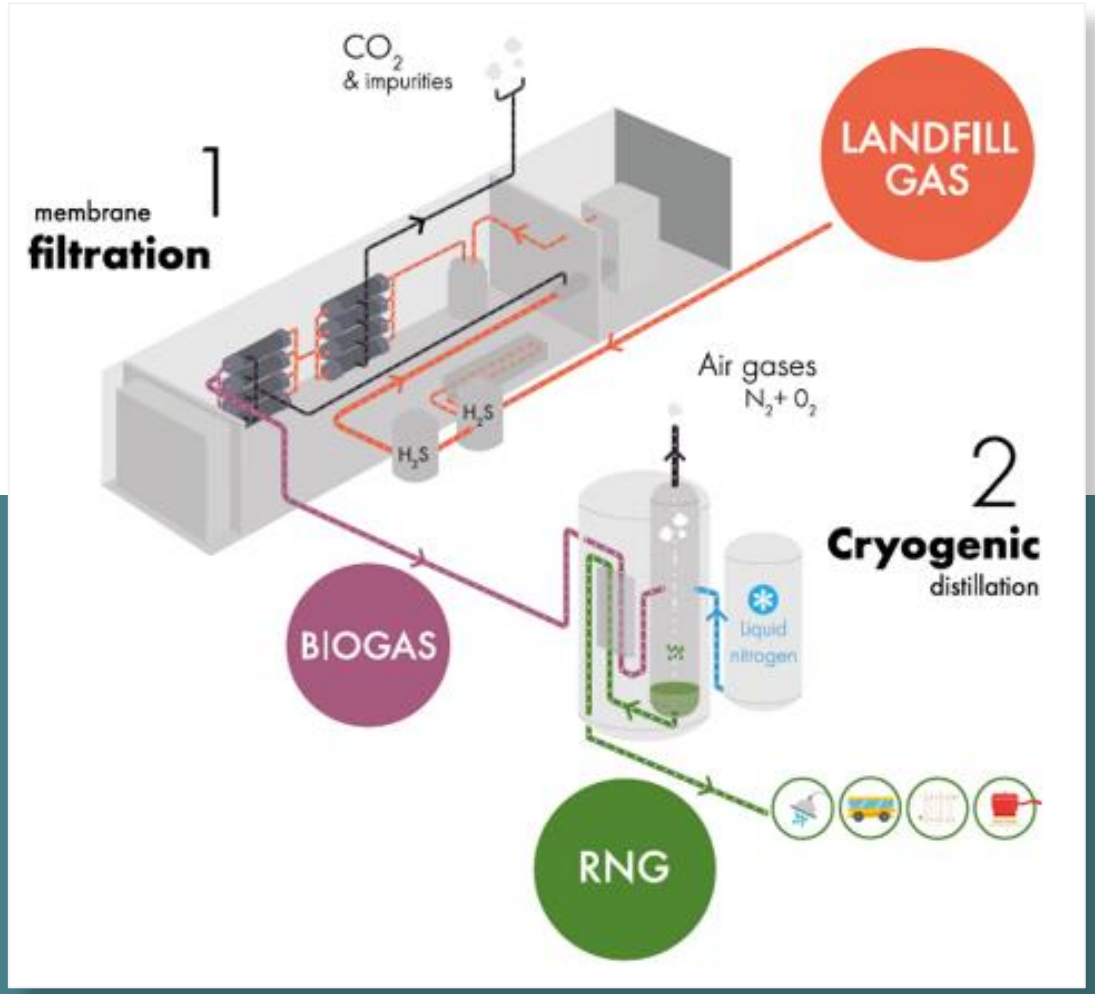
## Key Notes

- Unpredictable variations in gas flow and composition.
- Reducing air intake in the wellfield is costly.
- Limiting wellfield vacuum exposes the landfill operator to compliance and odor issues.
- Accepting air gases in landfill gas increases the total amount of energy recovered.




**Low pressure cryogenic distillation can accept a wide range of landfill gas quality and still achieve pipeline quality requirements.**

# UNIQUE PATENTED TECHNOLOGY COMBINING MEMBRANE FILTRATION AND LOW-PRESSURE CRYOGENIC DISTILLATION




## A 2-step process

**1**

**Membrane unit**
for $CO_2$ & VOC removal

**2**

**Cryogenic distillation**
for $N_2$ & $O_2$ removal

## 6 patents worldwide including 2 main patents

Process for the production of RNG from the purification of landfill biogas

Cryogenic process for the separation of a feed gas containing methane and air gases

# A closer look at the WAGABOX®

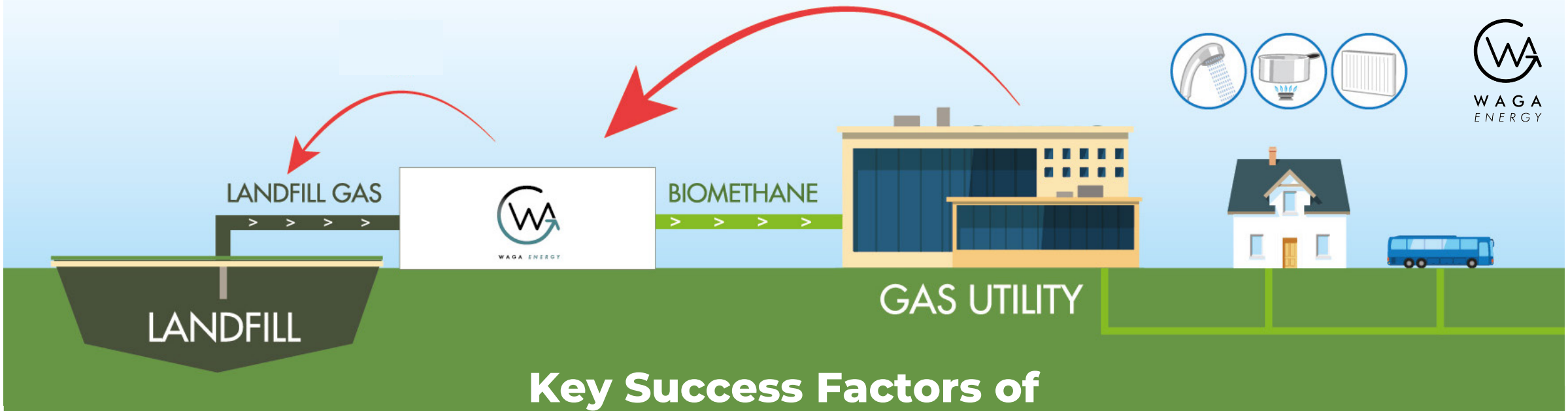
*WAGABOX #8, SUEZ Landfill, France (2020)*


03

# Integrated business-model

Introduction to RNG from landfill gas

WAGABOX®, An innovative solution to upgrade landfill gas




# Key Success Factors of a Landfill Gas to RNG project

## Landfill

Predictability of the landfill resources is key to the long-term success of the project.

- Sufficient flow for economic equilibrium
- Landfill gas accurate qualification and quantification

## Technology

The technology choice will impact the success of the project.

- Flexibility in the quality of gas accepted
- Proven uptime and recovery performance
- Capital Investment adapted to the project size

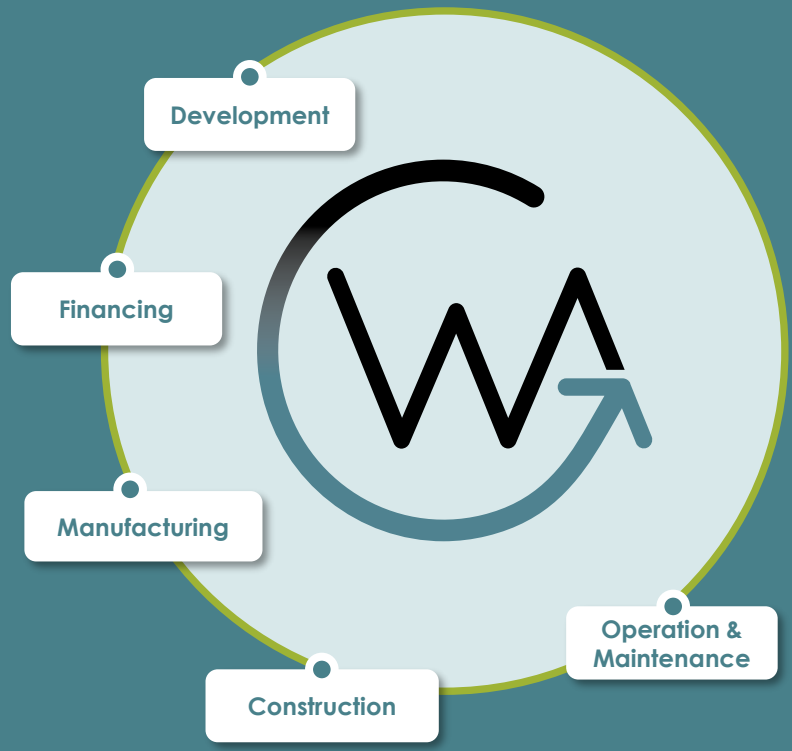
## Gas Utility and Offtake

Gas Grid Operators are key partners to succeed in developing RNG project.

- Gas interconnect cost of capital
- Gas quality specifications
- Long-term offtake

# UNIQUE POSITIONING AS A RNG PRODUCER WITH A PROPRIETARY TECHNOLOGY

*Integrated business model*




**Benefit for the landfill:**

**Revenue sharing of the RNG sale backed by 10- to 20-year gas offtake agreements**

# 11 WAGABOX® PLANTS IN OPERATIONS

WB#1

February 2017

WB#4


November 2018

WB#7


November 2019

WB#10


September 2020

WB#2

June 2017

WB#5


November 2018

WB#8


January 2020

WB#11

January 2022

WB#3

May 2018

WB#6


December 2018

WB#9

January 2019

**Your WAGABOX® here!**

# NORTH AMERICAN PROJECT REFERENCES

## ST ETIENNE DES GRES

- St-Étienne-des-Grès, QC
- 2000 scfm
- N2: 17-25%
- 33,000t of eqCO2 avoided per year
- COD July 2022

## BROME

- Cowansville, QC
- 600 scfm
- N2: 17-25%
- 6,000t of eqCO2 avoided per year
- COD Nov 2022

## MALLARD RIDGE

- Delavan, WI
- 2000 scfm
- N2: 9%
- COD March 2022

## WINNEBAGO

- Rockford, IL
- 6000 scfm
- N2: 24%
- COD December 2023

## STEUBEN

- Bath, NY
- 1000 scfm
- N2: 19%
- 13,500t of eqCO2 avoided per year
- COD March 2023

**More WAGABOX® under construction in Europe and North America**

# KEY TAKEAWAYS

- There is significant untapped potential to develop energy projects on small and medium size landfills.
- Smaller-scale sites are now candidates for RNG projects.
- Technology exists that is adapted to smaller sites.
- High levels of nitrogen in LFG is no longer a limiting factor in operating an RNG plant.

# Thank You!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# Questions

Q&A

Wrap Up

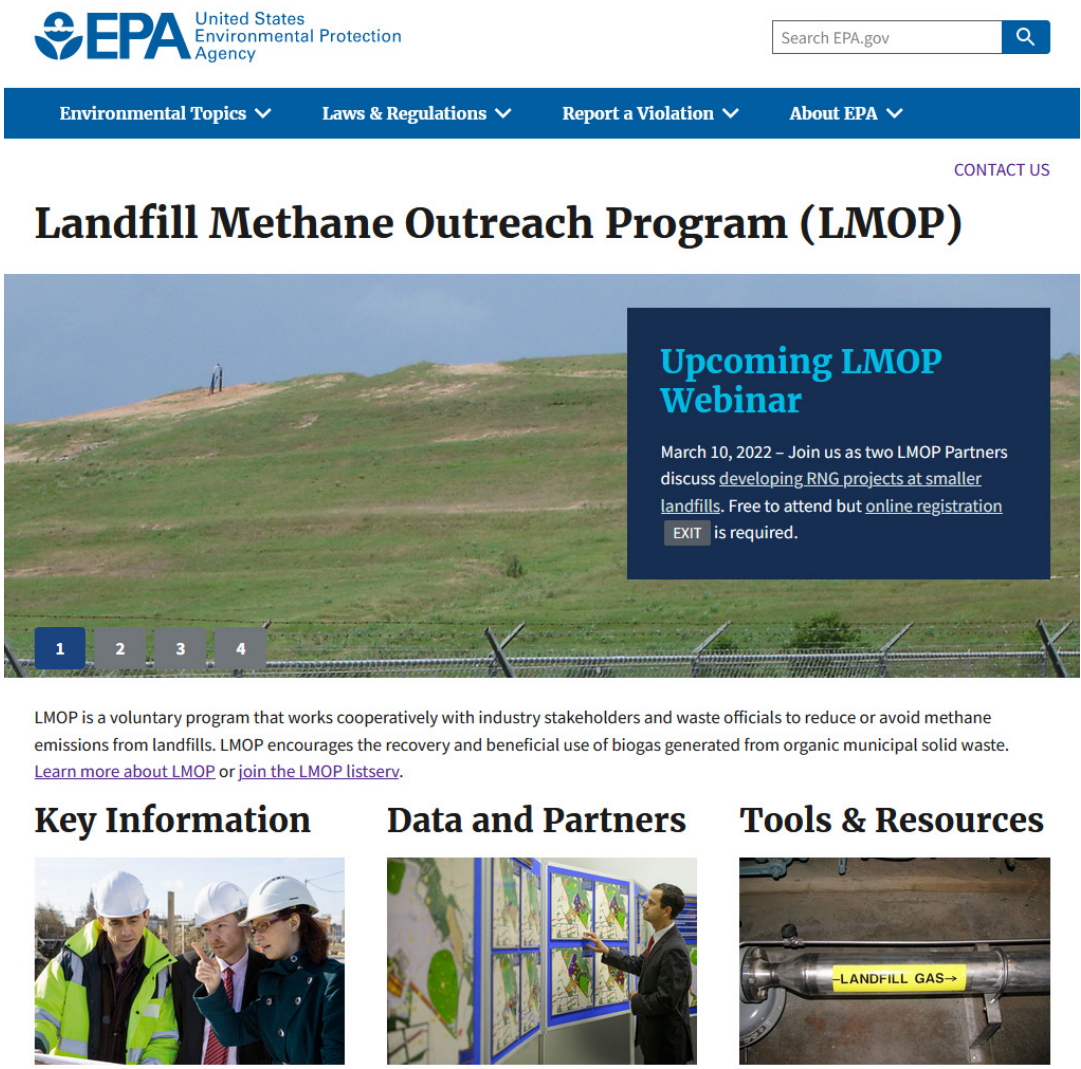
Contact Information



LANDFILL METHANE OUTREACH PROGRAM

# Wrap Up

- The slides and recording from today's webinar will be posted on the LMOP website
- To learn more about LMOP or LFG energy, visit our website at epa.gov/lmop
- Have a webinar idea? Drop us a note with your email in the Q&A box or email lmop@epa.gov



# Thank You

Please reach out with any questions or comments

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