

# RNG Tutorial

## (Renewable Natural Gas)



**Prepared By:**

**Lisa Barber**

Director, Business Development

**Email: [lisa@cemeng.ca](mailto:lisa@cemeng.ca)**

# Overview

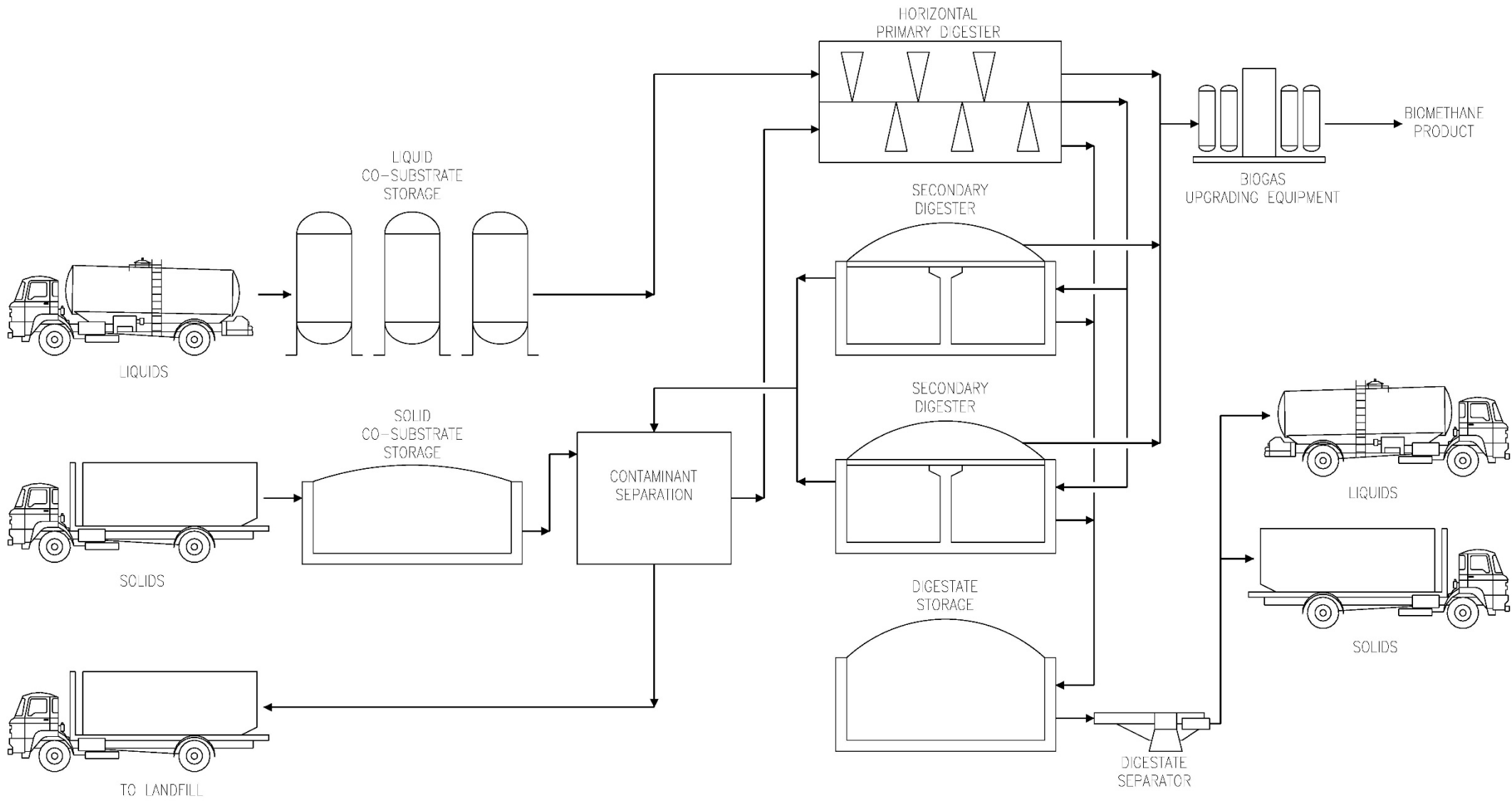


1. Tutorial
2. Conclusions/Critical Success Factors
3. Five (5) Examples
4. CEM's Biogas/AD Experience

# How is RNG Produced?



1. Organic Inputs
2. Inputs are converted to Carbon Neutral Gas:
  - Via Anaerobic Digestion (thus Biogas)
  - Via Landfill Site (thus Landfill Gas (LFG))
  - Via Wastewater Treatment Plant (thus, Digester Fuel Gas (DFG))
3. CO<sub>2</sub> (and other nasties) are stripped out, to meet LDC Fuel Spec, and then injected into LDC Service Lateral.



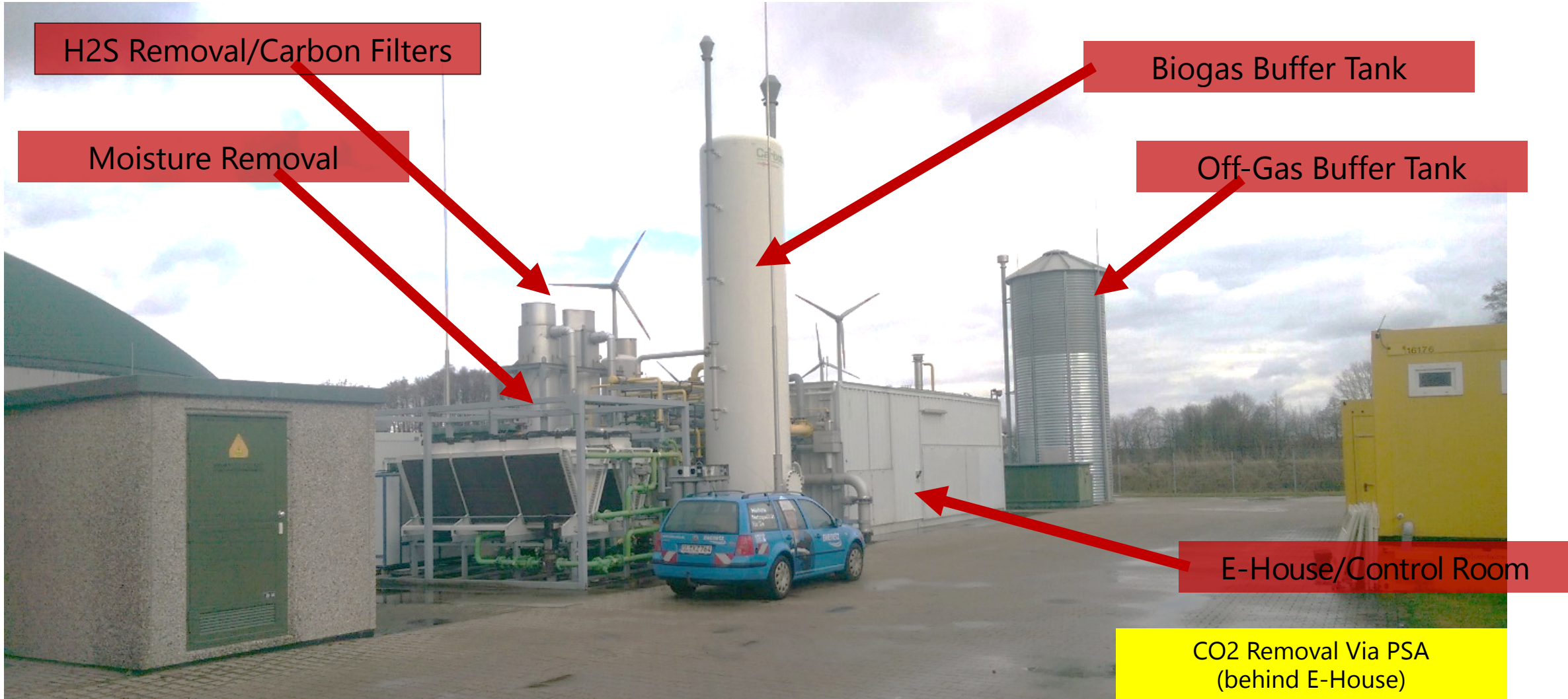
# Upgrading of Biogas to RNG



- Biogas is about 50% -70% methane, with the rest composed of:
  - CO<sub>2</sub> (carbon dioxide)
  - N<sub>2</sub> (nitrogen)
  - H<sub>2</sub>O (water)
  - H<sub>2</sub>S (hydrogen sulphide)
- Pipeline quality natural gas must be closer to 99% methane and be completely free of water and hydrogen sulphide

*CEM has the natural gas quality spec from both UGL and EGD*

# Upgrading of Biogas to RNG



PSA Upgrading Facility, Börger, Germany

# This Presentation Does NOT Cover

1. Production of H<sub>2</sub> (and Injection of H<sub>2</sub>) into LDC pipeline:
  - Via Electrolyzer
  - Power intensive process
  - HOWEVER, this **IS** the fuel of the future
  
2. Production of Syngas
  - Via gasification of biomass
  - Becoming VERY big in Western Europe

# New Pathways for Bulk Energy Storage and Conservation

## Power-to-Gas, Bulk Energy Storage

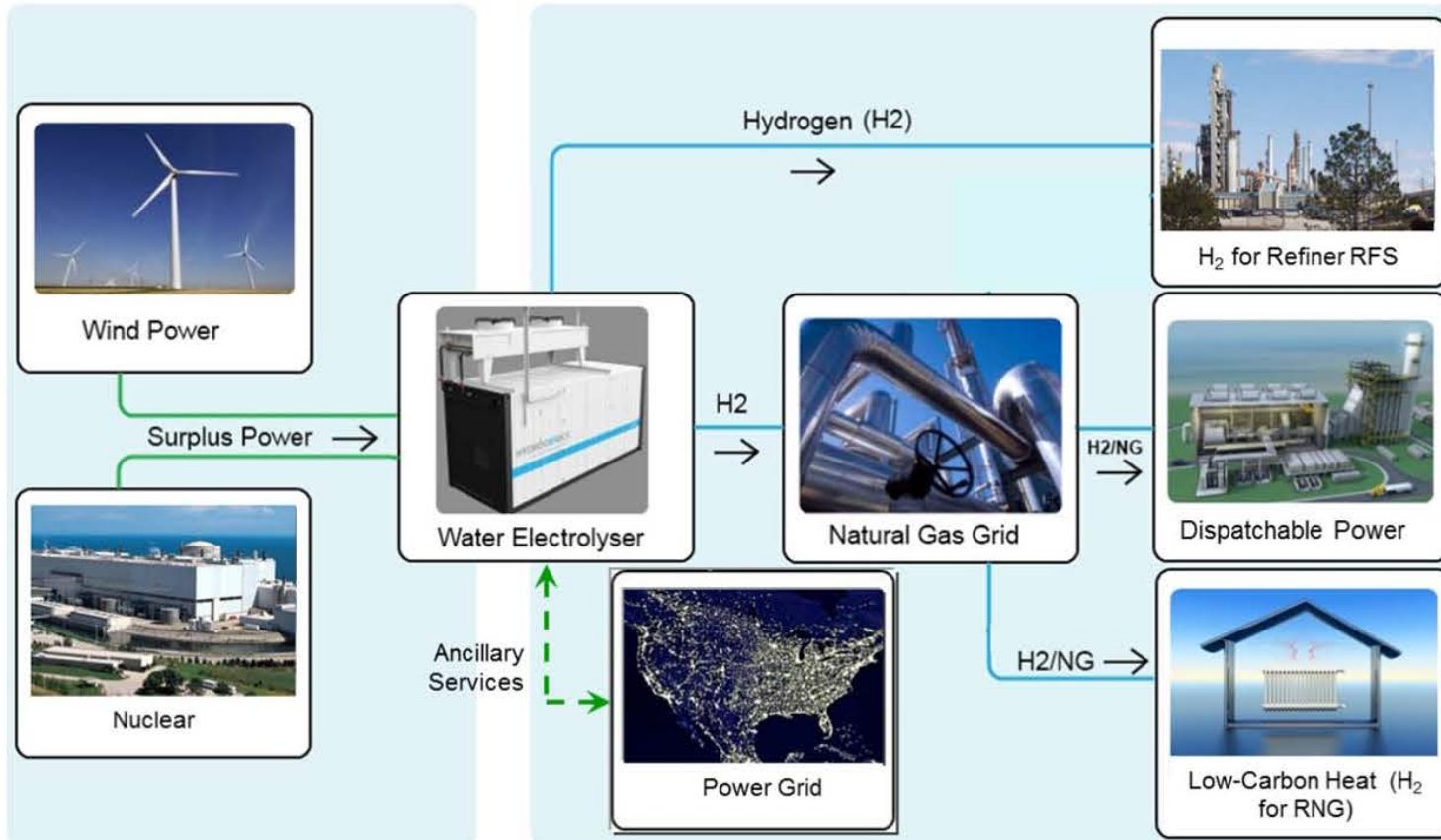


Image Source: Hydrogenics

1. Power-to-Gas links electricity & natural gas networks for bulk storage of low-C energy
2. Alternative inter-tie for the power grid; optimize surplus for Ont. competitive advantage
3. Green gas can be blended in gas distributor rates to further improve carbon reductions from CHP / other end-uses



# Critical Success Factors (a.k.a. CONCLUSIONS)



1. Predictable (High) Revenue Stream for RNG for 15 years
2. Getting ORGANIC INPUTS
  - At predictable quality and quantity
  - Securing inputs under Long-Term Contract (in case of AD)
  - “Decline Curve” (in case of LFG)
  - Control of DFG production (in case of DFG)
3. Stripping CO<sub>2</sub> Out (can be finicky)
4. Getting RNG INTO LDC pipeline
5. Working with LDC (meeting their RNG Quality Spec)

# Examples / RNG Case Studies



- |                                 |           |
|---------------------------------|-----------|
| 1. Fraser Valley Biogas         | AD/Biogas |
| 2. Woodward WWTP                | DFG       |
| 3. Lachenaie (Waste Connection) | LFG       |
| 4. Typical German RNG           | AD/Biogas |

# Fraser Valley RNG System



# Fraser Valley RNG System (AD)



- INPUTS:**
- organic by-products from potato chip plant
  - agricultural by-products (potatoes; vegetables)
  - manure from 1,000 cows and 1.5 million chickens
- OUTPUTS:**
- 240 – 800 m<sup>3</sup>/hr of biogas
  - 50,000 GJ/year of carbon neutral RNG
- SYSTEM:**
- Three (3) Anaerobic Digesters @ 2,700 m<sup>3</sup> each (2 primary + 1 secondary)
  - Pressure Swing Absorption (PSA) system to remove CO<sub>2</sub>/H<sub>2</sub>S
- CEM ROLE:**
- CEM responsible for electrical engineering
  - Martin & Matt (Lensink) heavily involved in development and implementation of biogas system (while with PlanET Biogas Solutions)

[CLICK HERE TO WATCH VIDEO](#)



# Woodward WWTP (DFG)



# Woodward Biogas Enhancement & Digester Upgrade



- Community
- People
- Processes
- Finance



Hamilton  
Public Works



# Hamilton Water Cogeneration Plant



- Community
- People
- Processes
- Finance



Hamilton  
Public Works



- 1.6 Megawatt cogeneration plant at the Woodward Waste Water Treatment Plant at a cost of \$4.4 million
- Renewable Energy Supply contract signed with the Ontario Electricity Financial Corp. Dec 2004 to supply Green Energy for a 20 year term
- Raw gas capacity of 15,300 m<sup>3</sup> per day
- Heat used to offset natural gas used in digesters
- Reduction of 6,500 tonnes of CO<sub>2</sub> emissions annually
- Annual Revenue



# Woodward Biogas Enhancement & Digester Upgrade

- Conventional activated sludge secondary treatment facility with seasonal disinfection.
- Capacity - 409 MLD average, 614 MLD peak
- Solids Train – anaerobic digestion, dewatering, land application

## Project Objectives:

- To enhance the ability to generate gas from the digesters
- To produce natural gas via gas purification

## Project objectives to be achieved through:

- Construction of a new quickened Sludge Building
- Upgrading the Digester Complex
- Installing a Gas Purification System

- Community
- People
- Processes
- Finance



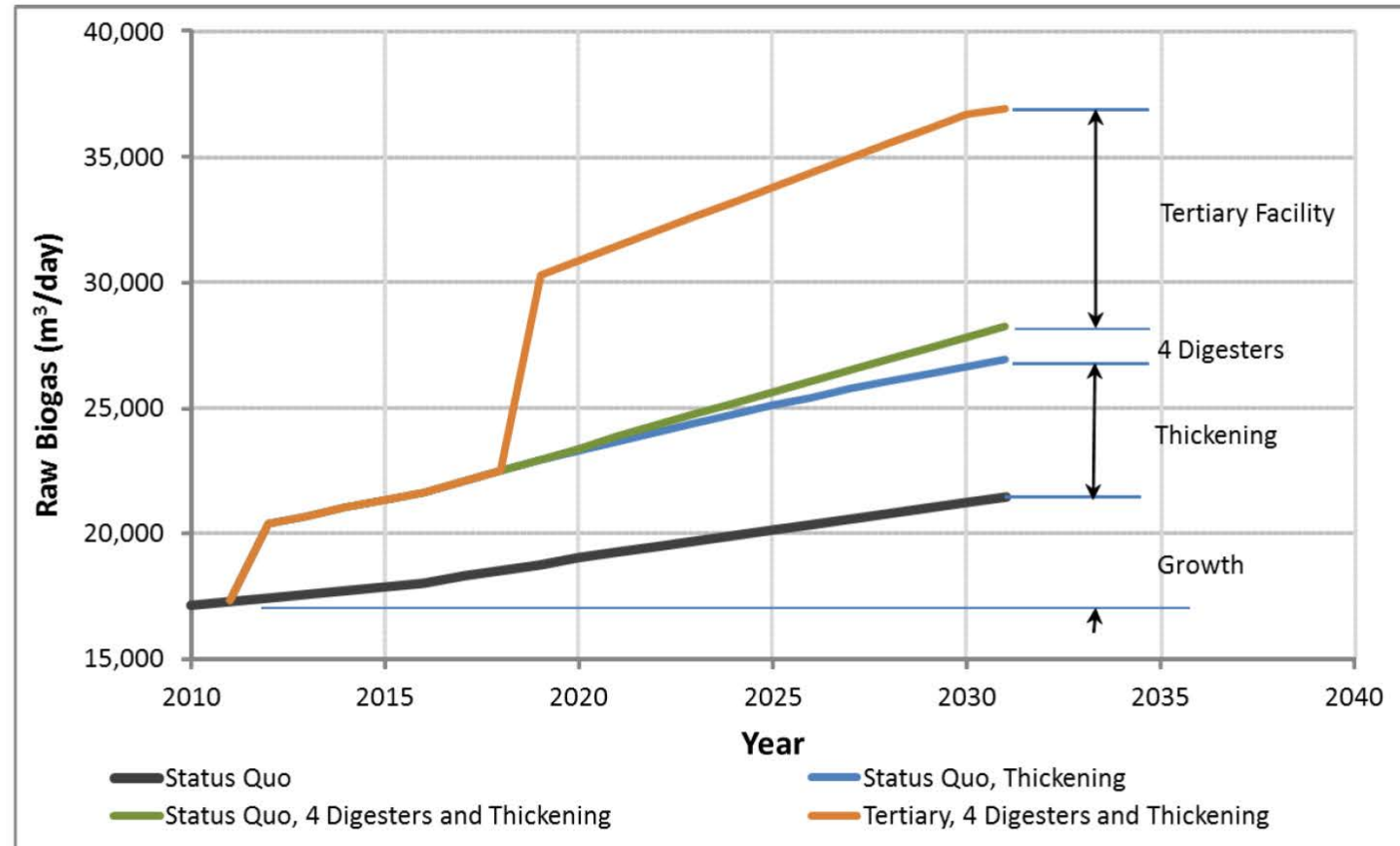
Hamilton  
Public Works

# Anticipated Biogas Production

- Community
- People
- Processes
- Finance



Hamilton  
Public Works



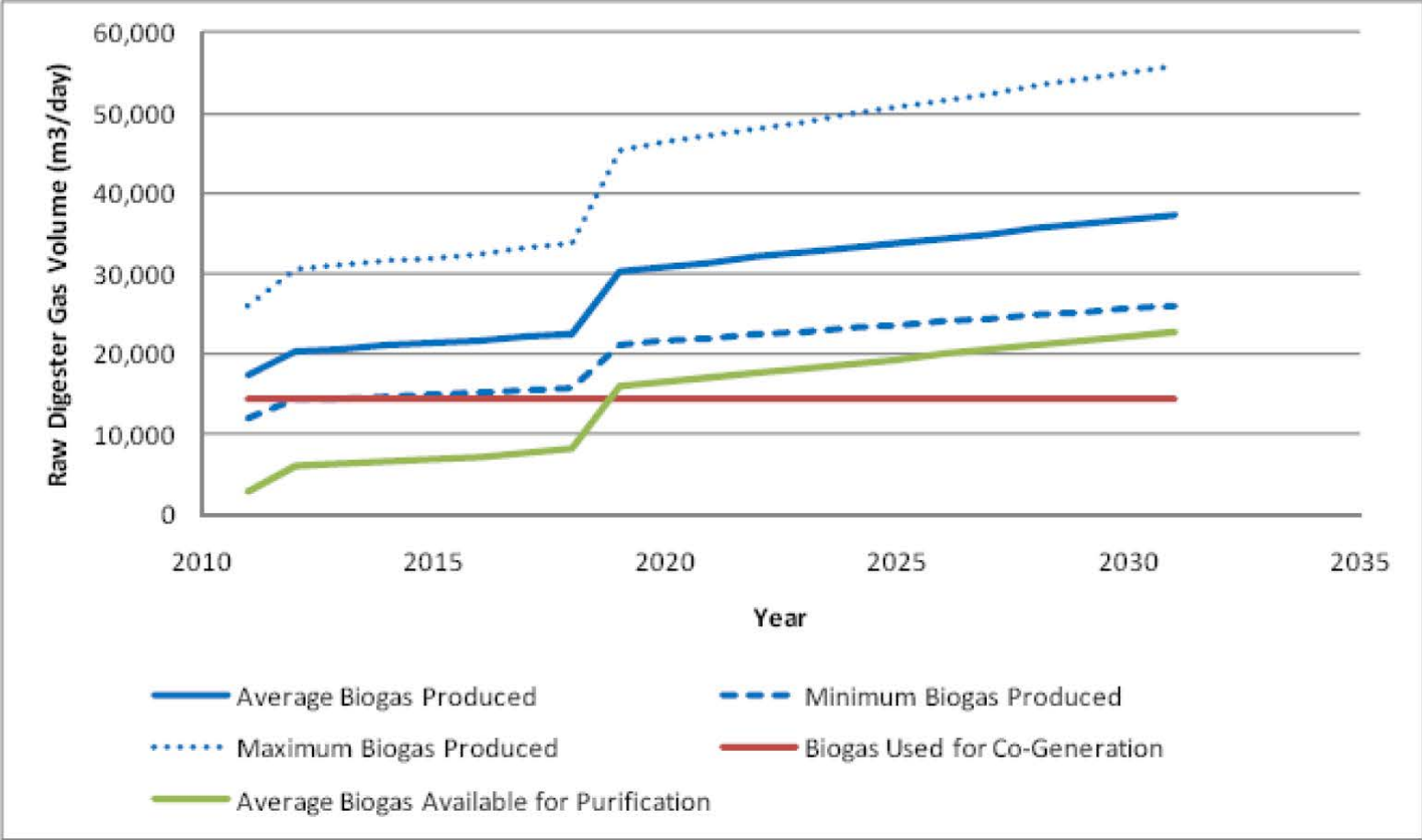
# Biogas Production Forecast Model



- Community
- People
- Processes
- Finance



Hamilton  
Public Works



# The Biogas Purification Unit

- Five purification processes evaluated
- Water Scrubbing Technology selected – Greenlane RIMU
- Ability to process up to 10,000 cubic meters RNG/day (equivalent of heating 1200 homes)
- Inject to Union Gas distribution grid
- Gas quality monitored at the Biogas Purification Unit (BPU) and Union Gas meter station
- Biogas generation rates were based on 0.9 m<sup>3</sup> of biogas generated for each 1.0 kg of volatile solids (VS) destroyed in digestion

- Community
- People
- Processes
- Finance

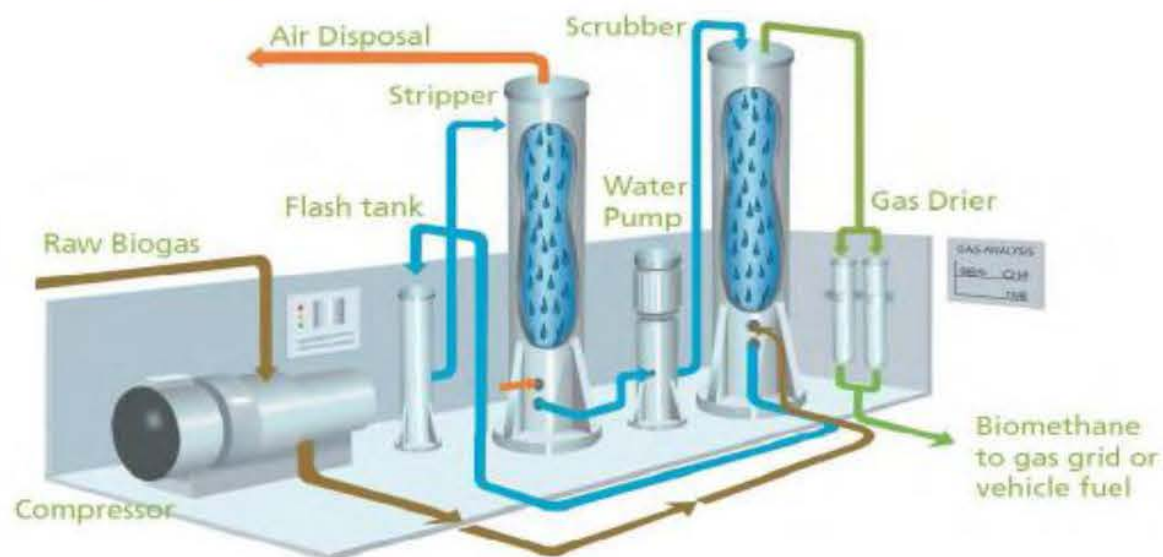


Hamilton

# Water Scrubbing

## How Water Scrubbing Works

- The raw biogas is compressed, then fed to a 'scrubbing' vessel where it is contacted with water. CO<sub>2</sub>, H<sub>2</sub>S, siloxanes and other trace contaminants are preferentially absorbed by the water.
- Absorbed methane is 'flashed' off, in a vessel at a lower pressure and recovered by returning it to the start of the process.
- Product gas is further purified by a proprietary TSA, before being analyzed and delivered to the customer.



- Community
- People
- Processes
- Finance



# Raw Biogas Quality

- Community
- People
- Processes
- Finance



Hamilton  
Public Works

Parameter	Typical	Range	Units
Raw Biogas Pressure	103.8	99.0 - 105.0	kPa
Raw Biogas Temperature	37	20 - 60	Deg C
Methane	63	55 – 70	%
Carbon Dioxide	37	30 – 45	%
Water	Saturated	-	-
Oxygen	0.0	0 – 0.5	%
Nitrogen	0	0 – 2	%
Hydrogen Sulphide	13	0 – 300	ppm
Total Sulphur as H <sub>2</sub> S	25	0 – 300	ppm
Carbon Monoxide	3	0 – 15	ppm
Silicon	16	0 – 100	mgSi/m <sup>3</sup>
Non-Methane Hydrocarbons	250	0 – 800	ppm

# Quality Criteria of Product Gas



- Community
- People
- Processes
- Finance



Hamilton  
Public Works

Parameter	Criteria
CO <sub>2</sub>	2%
CO	<=0.5%
Heating Value	36.0 to 40.2 MJ/Nm <sup>3</sup>
Hydrogen	<=trace
H <sub>2</sub> S	7 mg/Nm <sup>3</sup>
Mercaptans	5 mg/Nm <sup>3</sup>

Parameter	Criteria
Oxygen	<=0.4 %
Pressure	550 to 1035 kPa
Temperature	<=43 Deg C
Total Sulphur	100 mg/Nm <sup>3</sup>
Water Vapour	<80 mg/Nm <sup>3</sup>

Hydrocarbons	No liquefiable hydrocarbons (> -10°C and < 5,500 kPa)
Overall Quality	Merchantable and commercially free from objectionable substance (sand, dust, gums, crude oils, lubricating oils, liquids, chemicals, etc.)

# Biogas Unit



- Community
- People
- Processes
- Finance



Hamilton  
Public Works





# Biogas Unit



- Community
- People
- Processes
- Finance



Hamilton  
Public Works



# Renewable Natural Gas



- Community
- People
- Processes
- Finance



Hamilton  
Public Works

- In partnership with Union Gas, the City completed a new (CNG) station at the Mountain Transit Centre
- In September 2015, 18 new CNG - buses were added, bringing the fleet of CNG buses to 48.
- An additional 80-100 CNG buses are expected to be added over the next 3 years.
- Current contribution of RNG to the transit fleet is approximately 15%



# Lachenaie Landfill (PQ) (LFG)

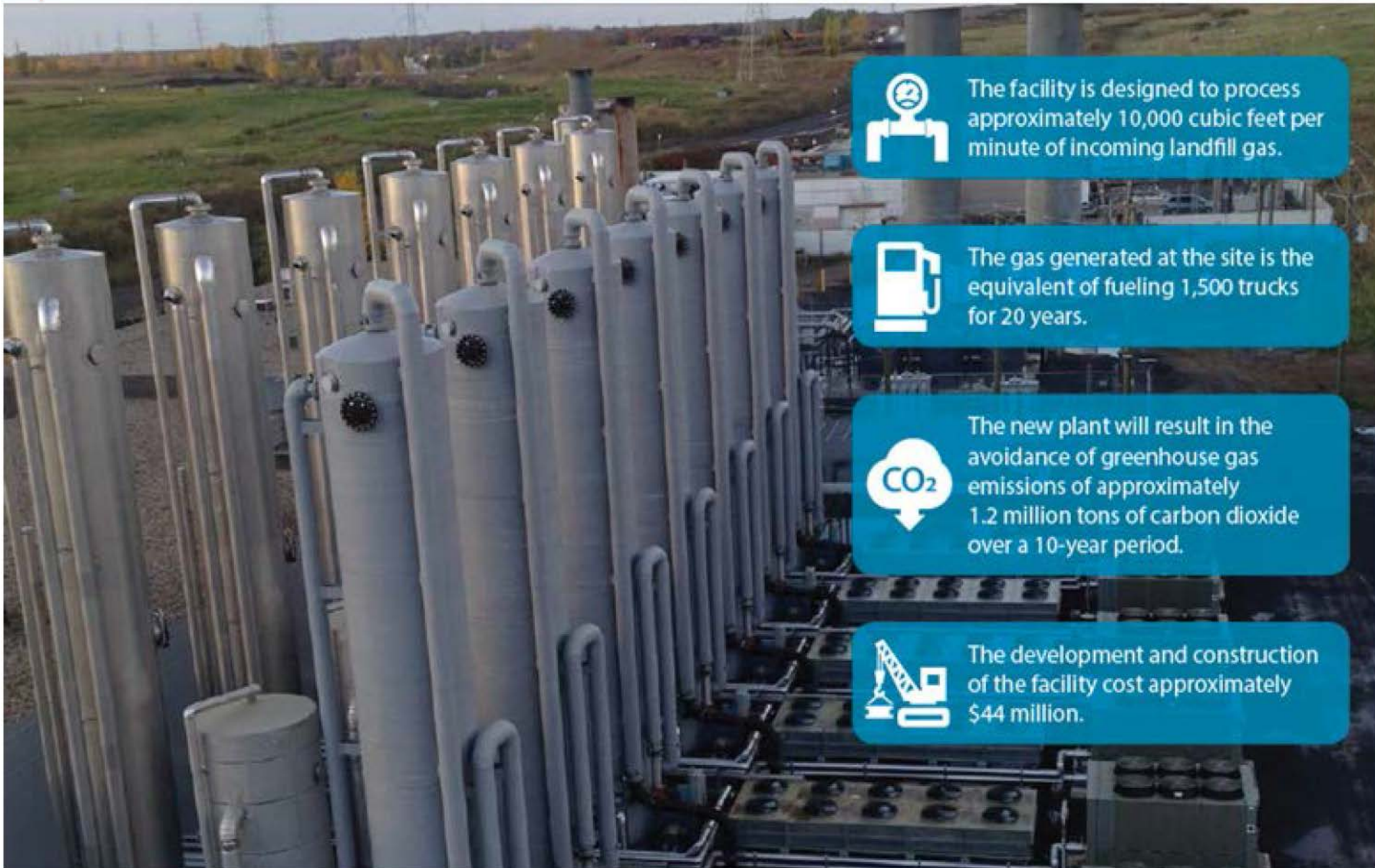


# LET de Lachenaie réseau d'extraction de biogaz, traitement du lixiviat et de l'azote ammoniacal



In 2015, we opened a renewable natural gas facility, the largest of its kind in Canada and one of the largest in North America. The facility, located in Terrebonne, Quebec, near Montreal, is converting landfill gas to natural gas which is then delivered to the TransCanada pipeline network, via an injection point adjacent to the landfill site.

# QUÉBEC LACHENAIE LANDFILL Biomethane Plant



The facility is designed to process approximately 10,000 cubic feet per minute of incoming landfill gas.



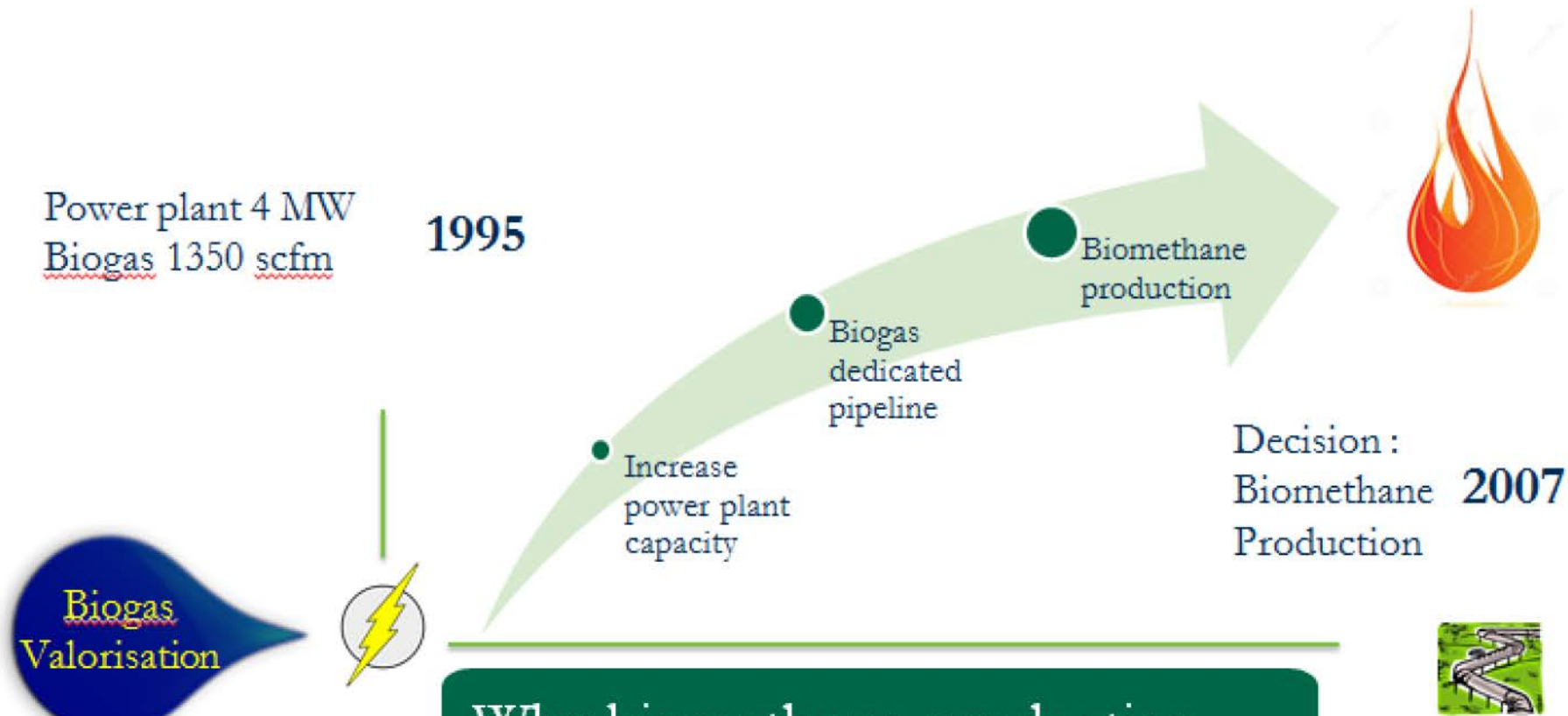
The gas generated at the site is the equivalent of fueling 1,500 trucks for 20 years.



The new plant will result in the avoidance of greenhouse gas emissions of approximately 1.2 million tons of carbon dioxide over a 10-year period.



The development and construction of the facility cost approximately \$44 million.



- 85% recovery vs 36% electricity
- Natural gas pipeline near site

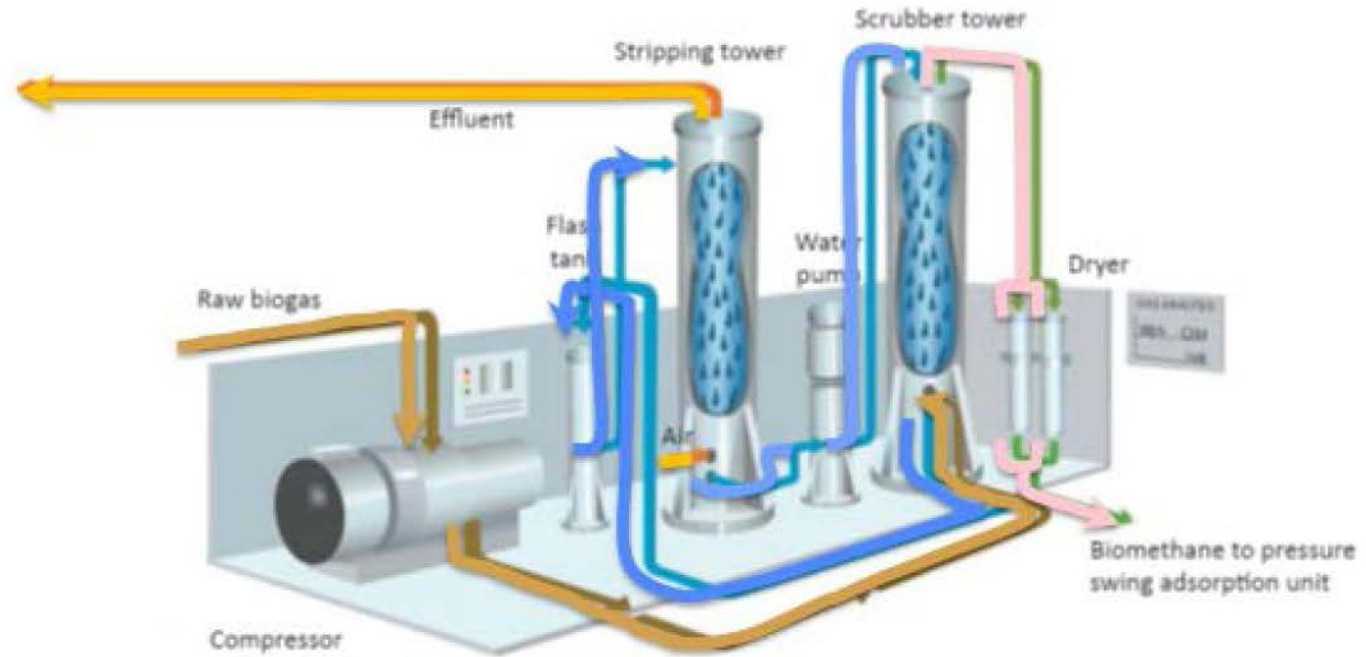


# Simplified Biomethane Production Process





# Simplified Diagram Biogas Water Wash Process





# Our growing CNG fleet



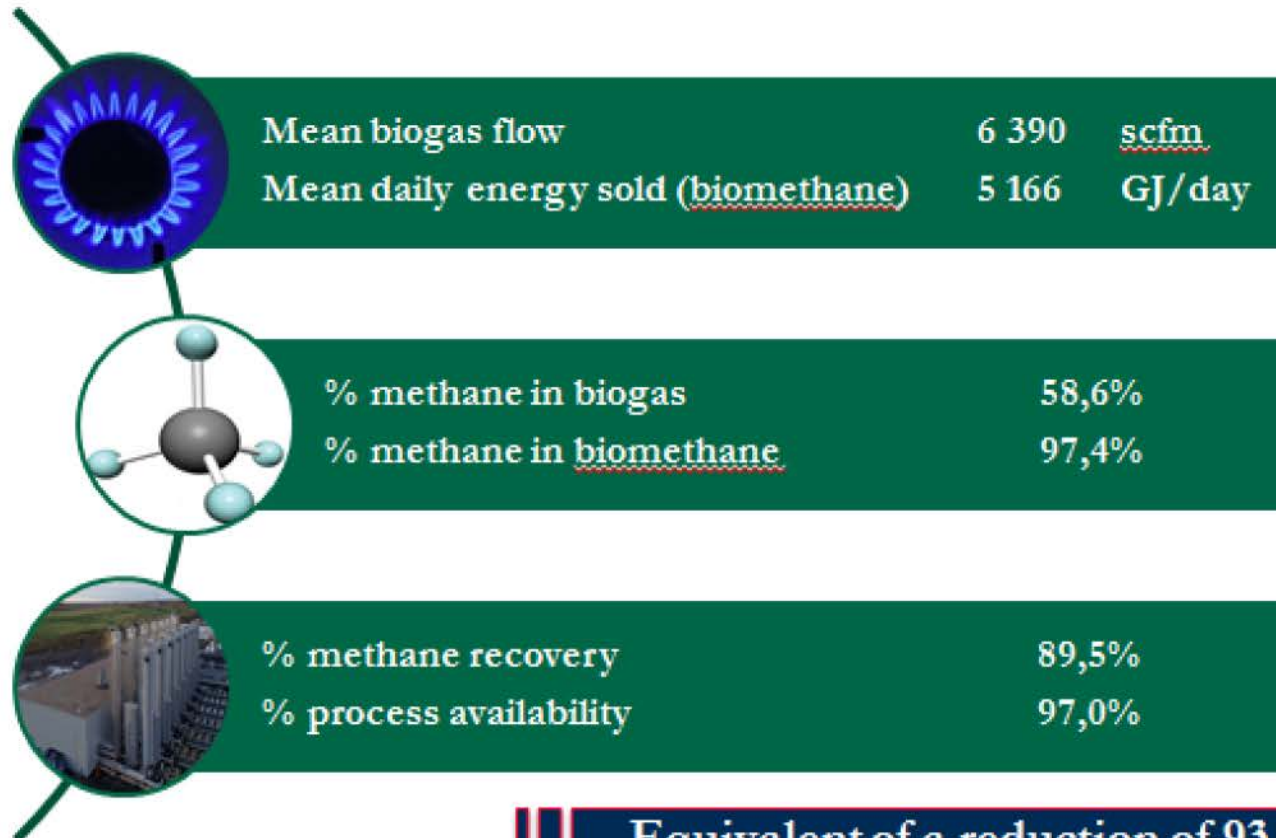
We are committed to growing our fleet of compressed natural gas (CNG) powered vehicles in many of our markets.



About 30% of the fleet is powered by CNG in Canada.



# Lachenaie Landfill Last 365 Days Gas Production



Equivalent of a reduction of 93 000 mt  
 $\text{CO}_2$   
(1 275 heavy diesel truck)



# Typical German AD/RNG System



1. 260,000 tonnes/year organic inputs
2. >90% of raw biogas from Brewery Spent Grains
3. 15 million m<sup>3</sup>/year raw biogas
4. 1 MW<sub>e</sub> CHP for parasitic power and heat
5. 800 m<sup>3</sup>/hour of Pipeline Quality RNG
6. CAPEX ~ 17 million €



# EXAMPLE OF BIOGAS SYSTEM



## LETHBRIDGE BIOGAS LTD (4 ACRES)

### INPUTS:

- Industrial and agricultural by-products
- Specified Risk Materials (SRM)
- 100,000 tonnes/year of raw material

### OUTPUTS:

- 10.5 10<sup>6</sup>m<sup>3</sup>/year of biogas

### SYSTEM:

- Two (2) 1.4 MW<sub>e</sub> biogas-fueled cogeneration units generating electricity and power

### CEM ROLE:

- CEM designed the electrical interconnection and provided complete project management services.



# Contact Info



## CEM Engineering

Lisa Barber- Director, Business Development

289-241-2534

[lisa@cemeng.ca](mailto:lisa@cemeng.ca)

227 Bunting Road, St. Catharines, Ontario, L2M 3Y2

905-935-5815

[www.cemeng.ca](http://www.cemeng.ca)

[info@cemeng.ca](mailto:info@cemeng.ca)