



PlanET BIOGAS

Anaerobic Digestion

Nutrient Recovery & Energy for a Greener Tomorrow



PlanET BIOGAS

Leading RNG & Biogas Plant Design and Manufacturing

 **870+**

Biogas plants in operation worldwide, including 150+ AD to RNG plants.

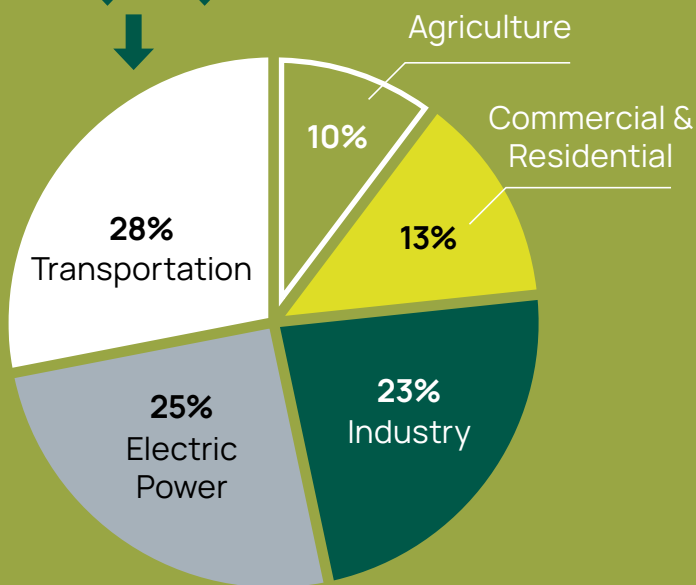
 **25+**

years of global experience. Established in 1998 and serving the North American market since 2006.

Digestors create biogas and digestate...



and reduce agricultural methane emissions.



Total U.S. Greenhouse Gas Emissions by Economic Sector (2022)

Source: www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

and PlanET's biogas plants historically have between

95%-99% Uptime



with **24/7** Energy Production

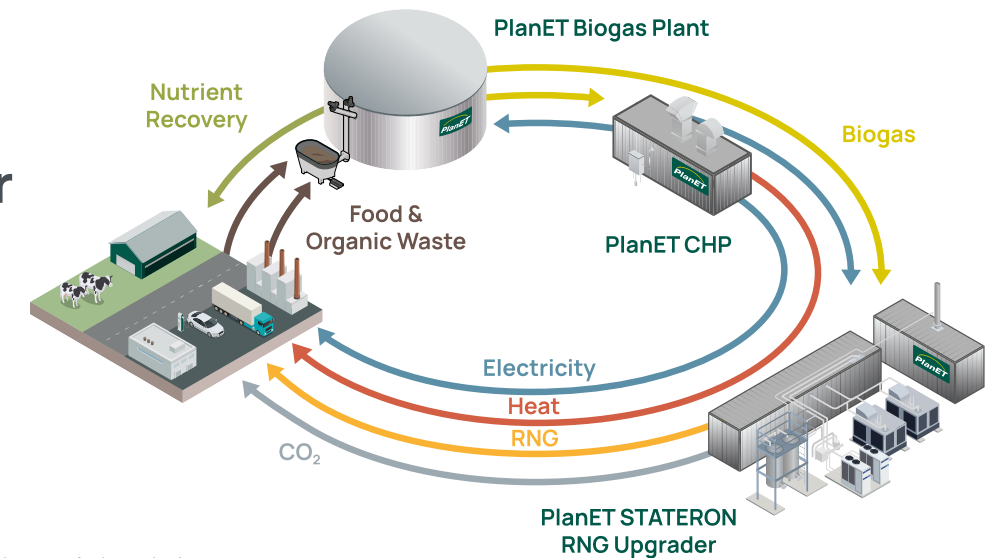


supports local jobs and investment. Every dollar of investment in renewables creates three times more jobs than in the fossil fuel industry, leading to an overall increase in energy sector jobs which supports local jobs.

Source: www.un.org/en/climatechange/science/key-findings

AD = Anaerobic Digestion, RNG = Renewable Natural Gas

The Potential for Biogas & RNG: Electricity, Heat & Fuel



What is Anaerobic Digestion?

Anaerobic digestion is a process where bacteria break down organic matter in the absence of oxygen. Various feedstocks can be used including food waste, chicken litter, manure, ethanol stillage, sugar production by-products and slaughterhouse waste. An Anaerobic Digester is a system made up of airtight tanks that mix and heat organic material (the feedstock), resulting in two useful products – biogas and digestate. These products provide renewable sources of energy and nutrient recovery to the local community.

Mono-digestion involves the anaerobic digestion of a single type of feedstock, such as manure, agricultural residuals or organic waste, to produce biogas. Co-digestion, on the other hand, combines multiple feedstocks, often with diverse organic wastes like manure, food scraps, and industrial residues, to enhance biogas production. Co-digestion enhances digestibility, provides better process stability, increases biogas production and yields a higher nutrient value for the remaining digestate.

What is Biogas?

Biogas, one of the by-products generated from Anaerobic Digestion, contains a mixture of methane, carbon dioxide, and other impurities. Biogas can be used to produce renewable heat and electricity. By removing the carbon dioxide and other impurities, biogas can also be upgraded to Renewable Natural Gas (RNG), which has a lower carbon intensity compared to natural gas and can be injected into the natural gas grid.

What is Digestate?

Digestate, another by-product borne from Anaerobic Digestion, is a nutrient rich slurry. It is a wet mixture that is usually separated into a solid and/or liquid and it is used as a fertilizer for crops to recycle nutrients back to the soil. Proper handling and management of digestate are crucial to ensure both environmental sustainability and effective utilization of the resources it contains.

Feedstock

At PlanET, we have the capability to process a wide array of substrates, ensuring efficient and sustainable solutions for our clients. Our proven expertise spans North America and enables us to handle diverse organic materials and harvest clean energy effectively from the following substrates:

- Food Waste
- Chicken Litter
- Cow and Pig Manure
- Slaughterhouse Waste
- Agricultural Residuals
- Ethanol Stillage
- Sugar Production by-products
- Pulp and Paper Sludge



PlanET's Steel Anaerobic Digesters

At PlanET we make two types of digesters – steel and concrete. Our Anaerobic Digesters are reliable with a proven design based on 25+ years in the industry and hundreds of completed plants world-wide. Our innovative systems have made the widest array of feedstock delivery systems in the market work while providing best in class biogas quality combined with the lowest parasitic load, making us one of the most efficient and renowned technology providers in North America. It is our goal to ensure all designs are tailored to meet the needs of the operators while at the same time using standardized PlanET Digester configurations and designs to increase scalability, compress project timelines and reduce CAPEX.

Our steel CSTR (Continuous Stirred-Tank Reactor) digesters are constructed using high-quality stainless steel. They consist of a cylindrical tank with a dome-shaped roof. The tank is equipped with mixing and heating systems to maintain optimal conditions for the anaerobic digestion process. Steel CSTR digesters are suitable for both small-scale and large-scale operations and are known for their durability, corrosion resistance, and relatively faster construction. They are adaptable to various feedstocks and can handle both mono-digestion and co-digestion processes. Steel digesters ensure a long operational lifespan

of over 20 years. The availability of four modular stainless steel design options ensure our digester designs can be scaled to meet any project requirements. Our engineers will collaborate with your project team to identify the optimal combination of tanks and digester components and ancillaries.

Four Standard Stainless Steel Tank Sizes

- ✓ 111.5' (34m) ϕ x 29.5' (9m) H
Gross Volume: 2.2 M Gal (8300 m³)
- ✓ 111.5' (34m) ϕ x 24.5' (7.5m) H
Gross Volume: 1.8 M Gal (6920 m³)
- ✓ 98.5' (30m) ϕ x 29.5' (9m) H
Gross Volume: 1.7 M Gal (6360 m³)
- ✓ 98.5' (30m) ϕ x 24.5' (7.5m) H
Gross Volume: 1.4 M Gal (5300 m³)

Our standard stainless steel tanks measure 29.5' (9m) or 24.5' (7.5m) in height and the panels are delivered and erected onsite. As depicted on our engineering and assembly drawings, each tank panel is assigned a location so it can be easily positioned during construction. Panels can be assembled in as little as two weeks and unlike concrete tanks, there is no curing required during construction except for the foundations which can be planned to be poured during favorable site and weather conditions. In addition, the piping penetrations for substrates,

gas and heating fluids are fully designed and pre-fabricated prior to construction.

At PlanET, we also offer epoxy coated, U.S. domestic-supplied digesters to provide a robust and reliable option for biogas production while ensuring high-quality construction and durability.

Additionally, our high-top center agitated digesters (tall digester) feature a central top mixer and a fixed roof, allowing for a compact footprint, a reduced parasitic load, and lower operational costs (OPEX). The insulated roof design minimizes heat loss, improving overall thermal efficiency. These tall, center agitated digesters work well for higher total solids (TS%) substrates.

Advantages of PlanET Steel Digesters

- ✓ Robust and durable material to withstand harsh environmental conditions & corrosive substrates
- ✓ Long-lasting and reliable with high structural strength
- ✓ Modular design allowing for easy customization and expansion for a variety of applications
- ✓ Consistent and efficient biogas production and storage
- ✓ Cost effective and relatively easy to maintain

PlanET's Concrete Anaerobic Digesters

Our concrete CSTR digesters are built using reinforced concrete. Similar to steel CSTR digesters, they feature a cylindrical shape with a conical or dome-shaped roof. Concrete digesters offer excellent insulation and are well-suited for large-scale biogas projects. Concrete CSTR digesters are known for their longevity and robustness, making them a preferred choice for long-term biogas operations. The average concrete digester has an operational lifespan of 20+ years.

Concrete digesters offer several advantages due to their design features. One notable advantage is their flexibility in sizing, allowing for customization based on the amount of substrates available. These digesters can also be partially buried, effectively reducing their overall height and visual impact. Concrete digesters allow for the versatile placement of mixers, which can be mounted either internally or externally



based on preference and efficiency considerations. They are suitable for various feedstocks, from manure and agricultural residues to food waste and other organics and can handle both mono-digestion and co-digestion processes.

Both steel and concrete CSTR digesters play a crucial role in the anaerobic digestion process by providing an environment for microorganisms to break down organic materials and produce biogas. The choice between steel and concrete depends on factors such as project scale, budget, feedstock characteristics, and local construction pricing and practices.

Our team is dedicated to providing expert guidance and support to ensure your success. Whether you're seeking advice, information, or solutions, we're committed to working with you every step of the way.



Standard PlanET Heating and Mixer Options

Anaerobic digesters can be customized with various add-ons and components to enhance their efficiency, safety, and overall performance. Through efficient in-tank heating and continuous mixing, our heaters and mixers play an integral role in creating the stable conditions necessary for optimized anaerobic digestion. Efficient heating provides the stable heat transfer required for the breakdown of incoming feedstock, and effective mixing maintains uniformity of heat, food sources and chemical parameters necessary for optimal microorganism health and resulting biogas production. Additionally, our mixers reduce the accumulation of solids at the bottom of the digester, which optimizes waste-to-biogas conversion and reduces downtime.

Heating Options

PlanET offers in-tank stainless steel heating systems which can be used in both steel or concrete tanks. These heating loops or heating racks maintain and control the temperature within the digester, keeping energy efficiency top of mind. The microorganisms responsible for breaking down organic matter thrive within a specific temperature range, typically around 35-40°C (95-104°F) for mesophilic digestion.

Maintaining the appropriate temperature is essential for optimizing the activity of anaerobic microorganisms responsible for the breakdown of organic matter and the production of biogas promoting enhanced digestion and better quality of digestate even in colder climates or during seasonal temperature fluctuations.

PlanET Heating Loops

are circular heating pipes mounted either on a support or on the tank wall (if the tank is concrete). The heating loops maintain the digester's contents at the optimal temperature for these microorganisms to efficiently perform their digestion functions. They are a lower CAPEX option for digesters in warmer regions.

PlanET Heating Racks

are made of stainless steel, and are installed inside the digester to hold and support heating pipes. These racks help position the heating elements optimally for efficient heat distribution within the digester contents and are pre-fabricated as "plug and play" to improve construction timelines and overall costs. Our patented design provides optimal heat transfer while minimizing flow resistance making them ideal for larger digesters.

Mixer Options

Mixers are crucial components in anaerobic digesters that play a vital role in maintaining optimal conditions for the anaerobic digestion process. Proper mixing helps distribute nutrients, maintain temperature uniformity, prevents stratification, and enhances the overall efficiency of the digestion process.

PlanET's diverse range of mixing solutions helps create tailor-made solutions that are efficient and purpose driven for a variety of substrates with varying total solids percentages. We offer both internal and external mixer options and PlanET's team of experts will work with you to find the best solution for your project.

PlanET offers two kinds of Internal Submersible Mixers. These mixers are installed directly inside the digester and can be mounted on the digester floor.

Our PlanET eco® prop,

(aka Banana Mixer) is a low speed, high torque mixer positioned within the tank that is excellent at generating mixing currents for increased mixer performance and assists in the reduction of settling.

Our PlanET eco® mix

is a column mixer that can be adjusted to mix at different heights while in operation and is located near the internal tank wall. It effectively eliminates floating layers in the digester while ensuring proper mixing.

We also offer two types of external mixing options.

The PlanET eco® powermix

is our external mounted shaft mixer option. These mixers are positioned outside the digester to agitate the contents through the walls of the digester. The external placement further facilitates effective maintenance procedures, reducing digester downtime.

Another option is the top-mounted Central Agitator, consisting of a rotating shaft with blades or paddles that agitate the substrate inside the digester. The agitation helps with uniform mixing, preventing solids build-up and handling higher total solids (TS) while optimizing both capital (CAPEX) and operational (OPEX) costs.

PlanET HEATING RACKS



PlanET MIXERS



Solutions to Align with your Project's Requirements

In addition to heaters and mixers, there are numerous other components that improve the effectiveness and functionality of anaerobic digesters and are integral to our design.

Double Membrane Roof

One of the central technical components of demand-oriented electricity production is gas storage. In particular, flexible operations with one or more CHP reciprocating engines requires variable volume flow rates despite constant gas production.

The PlanET Flexstore XL is a double-walled, air-supported roof which provides gas-tight cover, to the highest safety standards for PlanET digesters and digestate storage tanks.

The PlanET eco® gas storage dome provides extra storage volume. The weather-protection membrane comes in dust-grey, as standard, to blend in well with the environment. Other colors are available on request.

Flexstore Roofs Advantages at a Glance

- Up to 35% more storage volume than conventional cone-roof storage tanks
- Roof blower redundancy
- Blower Fan unit is completely enclosed in Polyethylene (PE), protecting against corrosion and external influences, pressure is regulated via a throttle valve
- Storm-resistant to hurricane force winds (12 on the Beaufort scale)
- Highly durable weather protection membrane
- 5 years warranty on weather protection membrane

PlanET eco® cover

The thick synthetic mesh PlanET eco® cover desulfurizes biogas reliably inside the digester improving gas quality. This polyethylene (PE) fabric offers sufficient area to act as a surface for hydrogen sulfide (H₂S) removal and is more stable and maintenance friendly than comparable structures. PlanET eco® cover provides greater H₂S removal efficiency, targeted cost reduction and improved corrosion resistance.



PlanET's Vario Dry Feeder

PlanET's Vario Dry Feeder introduces solid substrates into the digester. Dry feeders play a crucial role in supplying the digester with a consistent and controlled feedstock to optimize the biogas production process while requiring minimal energy. They convey a wide range of feedstock, including challenging, long-fibre substrates. The feeder is distinguished by its modularity and patented conveyor rails that ensure even discharge of the material so it can be sized to suit the application.



AD Options Tailored to your Project's Needs

Technical Container – PlanET's proprietary Technical Container is a pre-fabricated 40' container that contains the critical ancillary components of the anaerobic digester system. It helps provide a compact footprint and facilitates easy and cost-effective onsite installation. Some of the components included in the container are:

Rotary Lobe Pump & Substrate Manifold - responsible for distributing digestate from reception pit to digester, digester to digester, digester to separator. The PlanET Rotary Lobe Pump situated in the PlanET Technical container is easy to maintain with access through the double container doors. Rotary lobes are widely used, and the preferred choice for manure & other applications. The main advantages are maintenance-friendly access to the rotary piston via the mounting cover without disassembling the substrate manifold. And it's ideal for inspection or repair. The ability to change direction of flow in the manifold provides additional operational flexibility.

Heating Manifold – controls the distribution of heating fluid. Based on

temperature readings, it only supplies heat, when necessary, through flow monitoring and in-line pumps that provide precise flow to the digester in-tank heating rack or heating loops.

Water Manifold - supplies water for utility and cleaning purposes.

Oxygen Generator - Direct O₂ injection allows for desulfurization of the biogas while it is still inside the digester. Using only oxygen means that other impurities are not introduced into the gas stream while strict oxygen injection control ensures the biogas upgrading plant is meeting stringent RNG pipeline specifications.

Electrical Cabinets - provides power to the digester system and auxiliaries and houses the PlanET HMI.

Human Machine Interface (HMI) - enables interaction with the system. This HMI panel houses the safety and sensor equipment which are critical components in anaerobic digester plants to ensure the well-being of personnel, prevent accidents, and monitor the digester's performance. These systems help operators maintain optimal digester conditions, respond to anom-

alies, and protect the environment. Key safety equipment components include Gas Detectors, Emergency Shutdown Systems, Pressure Relief Valves, Flame Arrestors, PPE, appropriate Signage and Ventilation Systems are all vital components to a safe site and work in synergy to create a comprehensive safety framework for anaerobic digestion facilities. PlanET encourages clients to adhere to safety regulations and best practices through training and ongoing maintenance.

In addition to safety equipment, there are several types of sensors that monitor the digesters to keep them working optimally. Temperature Sensors, Gas Sensors, Pressure Sensors, Level Sensors, Flow Sensors and Liquid Level and Gas Pressure Transmitters all aid in operational monitoring and control.

These safety and sensor systems work together to create a comprehensive monitoring and control network for anaerobic digesters. Regular maintenance and calibration of these systems which PlanET can offer for our digester systems are essential to ensure their accuracy and reliability.

Preparing Food Waste for Digestion

A depacker, used in pre-treatment for food waste plants, is a specialized piece of equipment designed to separate organic material from its packaging to ensure a clean and consistent feedstock. This is necessary when processing packaged or bagged food waste as it ensures that only biodegradable material enters the digester.

Depackers tear apart the packaging to liberate the organic material. Once extracted, the material is screened to further remove the contaminants like plastic, metal and other non-digestible materials prior to digestion.

PlanET works with a number of suppliers for substrate depackaging, and based on the specific engineering requirements of each project, we carefully evaluate and recommend the most suitable option to ensure optimal performance and efficiency.

STATERON M-Series

3-STAGE MEMBRANE



STATERON P-Series

PRESSURE SWING ADSORPTION (PSA)



HMI & CONTROL CENTRE



PlanET TECHNICAL CONTAINER



PlanET STATERON

PlanET STATERON is our RNG Upgrader technology that boasts a modular, pre-fabricated turnkey solution for our customers unique RNG project requirements, ensuring optimal efficiency and operational uptime. We use one of two carefully selected types of RNG upgrader technology.

PlanET STATERON M-Series

Our STATERON M-Series is a packaged 3-Stage Membrane system that uses the principle of selective permeability through the membrane surface. The STATERON M-Series has a best in class methane recovery (up to 99.6%) simple process control & high RNG plant availability.

PlanET STATERON P-Series

Our STATERON P-Series uses Pressure Swing Adsorption (PSA) technology, a widely used process in the gas industry. Our containerized systems are designed for ease of onsite installation and operation for large (>1000 scfm / >1600 Nm³/hr biogas inlet) RNG plants.



PROJECT SPOTLIGHT

Dairy manure to transportation fuel in South Dakota

PlanET's client with a facility in Beresford, South Dakota has been providing energy-related solutions for its customers since the mid-1990s. Together with PlanET Biogas as the technology partner, our client built on its existing three projects in Wisconsin, when a new opportunity presented itself with two large dairies in South Dakota. These two farms, have a combined total of 15,000 dairy cows and after a comprehensive evaluation, the project was underway.

Commissioned in 2022, the plant boasts four PlanET anaerobic digester tanks, each with a gross capacity of 2.2 million gallons. These tanks represent the largest of four PlanET modular design options, allowing complete customization for any size North American project. The Plant stands out as an impressive 1.2 MMCFD dairy farm biogas to Renewable Natural Gas (RNG) processing plant.

Through the anaerobic digestion (AD) process, the manure from 15,000 dairy cows undergoes decomposition, generating biogas using advanced PlanET AD technology. This technology ensures efficient anaerobic digestion and in-tank desulfurization. The produced biogas is then transformed into RNG.

The RNG produced at this facility travels 8 miles through a buried pipeline before connecting with a larger transmission line. From there, a Renewable Energy Fuel Company distributes it as transportation fuel to California. This plant not only generates RNG but also produces digestate, a valuable fertilizer. All digestate is either returned to the fields or used as bedding for the cows, exemplifying a closed-loop system that maximizes resource utilization and embodying the circular economy.

The facility stands out for several reasons:

- Large Digester Tanks: The facility features the largest PlanET modular digester tanks available, each holding 2.2 million gallons.
- High RNG Production: The site produces enough RNG to service the energy needs of the equivalent to 4,325 homes.
- Environmental Impact: By converting fugitive methane, a potent greenhouse gas, into RNG and producing a high-value fertilizer, the site significantly reduces its environmental footprint.
- Strategic Location: Being the first of its kind in the area, the plant sets a benchmark for future biogas projects in the region.

By converting methane into renewable products that replace fossil fuels and synthetic fertilizers, the client, PlanET, and the local dairy farmers collaboratively contribute to sustainable energy production at the Beresford, South Dakota facility.

| | |
|------------------------|---|
| Commissioned | 2022 |
| Digester(s) | 4 stainless steel digesters (2.2 Mgal / 8300 m ³ each) |
| Technical Container(s) | Two 40' technical containers |
| Mixers | 24 submersed mixers |
| Heating System | 24 heating racks |

AD Feedstock
Dairy manure from 15,000 cows





AD Feedstock
Dairy & chicken manure
along with packaged
food waste

PROJECT SPOTLIGHT

Sustainability in action at the Dicklands farms AD to RNG facility

Dicklands Farms, a family-run dairy operation in Chilliwack, British Columbia, has been a leader in sustainable farming since its establishment in 1946. Originally spanning 75 acres with 50 dairy cows, the farm has expanded to 400 acres and now houses over 400 Holstein cows, including young stock and replacement cattle. To enhance sustainability and diversify revenue streams, Dicklands Farms partnered with PlanET Biogas to construct an advanced biogas plant on-site in 2023.

The biogas facility integrates anaerobic digestion (AD) technology to process dairy manure, chicken manure, and food waste. This process generates renewable natural gas (RNG), organic fertilizer pellets, and clean water, promoting a circular economy and maximizing resource utilization.

The plant features two 30m x 8m concrete digesters, which receive dairy manure from both Dicklands and neighboring farms. Packaged food waste is also delivered to site and undergoes advanced de-packaging to separate organic material from non-organic contaminants. The resulting biogas

is upgraded into RNG using PlanET's STATERON M-Series membrane system, achieving a >99% methane recovery yield. The RNG is then injected into the FortisBC natural gas grid as a sustainable alternative to fossil fuels.

The biogas plant is notable in a couple of ways:

- Sustainable Byproducts: The facility produces Renewable Natural Gas (RNG), nutrient-rich organic fertilizer pellets and clean water that together reduce GHG emissions by >9,000 tCO2e annually, decreases reliance on synthetic fertilizers and improves water quality.
- Odour and Emissions Control: The plant operates under negative pressure, with an advanced chemical scrubber and biofilter system to minimize odours and ammonia emissions.

PlanET was responsible for overall engineering of the project, including process design, site layout, office and process buildings, integration of 3rd party process equipment, and permitting support. Today, PlanET provides ongoing operational support in addition to preventative and scheduled maintenance.

Dicklands Farms is at the forefront of sustainable agriculture, demonstrating how biogas technology can transform farm operations by recycling food waste and agricultural by-products into renewable energy, contributing to a cleaner, more resilient energy future.

| | |
|---------------------------|--|
| Commissioned | 2023 |
| Depackaging | 1 Hammermill depacker |
| Pre-tanks | 2 organics pre-storage tanks (60 kgal / 228m ³ each) and 1 food waste pre-storage tank (149 kgal / 565 m ³) |
| Digester(s) | 2 concrete anaerobic digesters (1.49 MGal / 5654 m ³ each) |
| Technical Container(s) | One 40' technical container |
| Mixers | 8 shaft mixers and 4 banana mixers |
| Heating System | 24 heating racks |
| RNG Upgrader Technology | STATERON M-Series 3 stage membrane |
| Biogas Upgrading Capacity | 780 scfm / 1260 Nm ³ /h |



About PlanET

Founded in 1998, PlanET Biogas is an innovative international company with offices in Germany, France, United States, Canada, Italy, and Brazil. We have extensive experience and knowledge of the global market for biogas technologies and specialize in the design, construction, and servicing of anaerobic digestion and biogas utilization systems including RNG plants.

PlanET Biogas in North America

PlanET's North American companies are subsidiaries of PlanET Biogas Group, headquartered in Germany. With offices in Colorado, New York and Ontario, PlanET's localized presence is well positioned to support your project anywhere in North America.

With emphasis on the food, chicken litter, cow & pig manure, slaughterhouse, ethanol, sugar production by-products, agricultural residuals and pulp & paper waste sectors, PlanET has solidified our position as key providers of AD & RNG technology solutions. Our expertise and experience enable us to address the unique challenges and requirements of these sectors, providing tailored solutions to meet the needs of our clients.

PlanET Biogas Group New Headquarters

2022 marked the opening of PlanET Biogas Group's headquarters in Gescher, Germany. This state-of-the-art facility showcases our commitment to sustainability by integrating a renewable energy concept that combines RNG-fueled CHP, geothermal technology, and solar power. With a focus on meeting our energy needs and reducing peak loads, we efficiently generate electricity and heat while minimizing our carbon footprint. Our geothermal system provides heating and cooling, and solar panels contribute clean energy. Additionally, we have installed 18 charging stations to support electric vehicles.



Research & Development

We actively engage in research and development, collaborating on scientific projects dedicated to organics resource recycling, upcycling, and diversion, as well as the beneficial use of biogas. This commitment directly benefits our customers by ensuring that our products and technology incorporate the latest scientific findings. We gain valuable insights into emerging technologies and best practices, enabling us to continually enhance the performance of our biogas plants. By staying at the forefront of research and innovation, PlanET provides our customers with state-of-the-art engineering design and technology solutions that improve energy production, organic waste management, and environmental sustainability.

Our Clients

We serve a diverse customer base, including gas & electric utilities, fuel suppliers & distributors, agricultural businesses (including farms & slaughterhouses), the food & beverage industry, organic waste diversion companies (involved in processing pre- & post-consumer food waste & source-separated organics), municipalities, and other industries seeking sustainable energy solutions.



25+

YEARS OF EXPERIENCE IN THE BIOGAS INDUSTRY

19+

YEARS IN NORTH AMERICA

100%

DEDICATED TO ANAEROBIC DIGESTION, BIOGAS UTILIZATION & RNG TECHNOLOGY SOLUTIONS

870+

BIOGAS PLANTS OPERATIONAL WORLDWIDE

150+

AD TO RNG PLANTS IN OPERATION WORLDWIDE

400+

EMPLOYEES WORLDWIDE

