

Mike Maringer
quasar energy group
September 25, 2013



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ABOUT quasar energy group

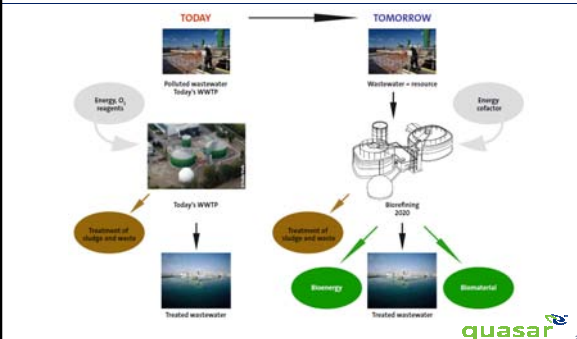
Quasar is a U.S. based renewable energy company.

- Aggregation of the best anaerobic digestion technology available
- Provide complete full service, turnkey anaerobic digestion solutions for our customers
- Produce energy for use as combined heat, power and fuel from organic sources
- Operate laboratory and engineering facilities on OSU-OARDC campus
- Dedicated to building systems based on U.S. components and U.S. suppliers
- Seven facilities operating in Ohio and one in Massachusetts
- One system under construction in Ohio and two in New York

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ANAEROBIC DIGESTION Wastewater Treatment

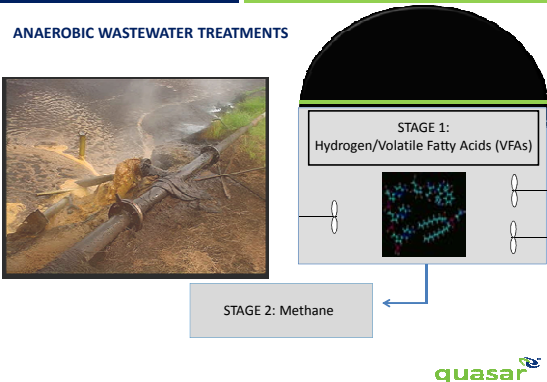
Over the next 10 years, wastewater treatment plants (WWTP) will undergo profound changes



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ANAEROBIC DIGESTION Wastewater Treatment

ANAEROBIC WASTEWATER TREATMENTS



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ANAEROBIC Digestion

Anaerobic digestion is a natural process where microorganisms break down organic biomass in the absence of oxygen.

INPUTS:

- Agricultural biomass (manure, crop residuals, energy crops)
- Food processing residuals and FOG (fats, oils and grease)
- Municipal wastewater (biosolids)
- Ethanol and Biodiesel processing residuals
- Expired, damaged or off-spec consumer goods

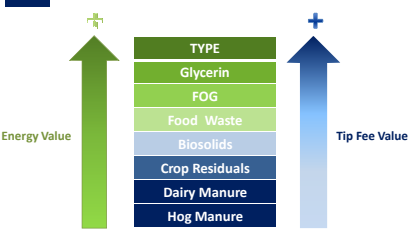
OUTPUTS:

- Renewable energy – natural gas, electricity, motor vehicle fuel (CNG/LNG)
- Animal bedding, peat alternative and compost
- Concentrated fertilizer with capacity for (P) separation
- Reduced greenhouse gas emissions, cleaner water, soil and cleaner air

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BIOMASS Value For Energy


Which types of biomass are best for a digester?



Biomass recipes will differ based on the type and quantity of feedstock available in the region. quasar's laboratory on the OSU/OARDC campus validates biomass recipes to guarantee a system's energy potential.

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POTENTIAL the German Industry



Germany's land mass as compared to that of the United States.

Germany, which has the largest installed base of solar and the third largest installed base of wind gets **1 more renewable energy from organic materials than wind and solar combined.**

In 2011, Germany had approximately 6,800 biogas facilities generating 2,300 MW of electricity. That's the equivalent of **207,300 gge per hour. 1.7 billion gallons of renewable fuel per year!**


Germany is approximately the size of Montana.

REFERENCES:

- Renewable Energy World: [Integrating Anaerobic Digestion into our Culture Part 2](#)
- Assumptions: 3,412,142 BTU=1MW, Standard Electric Generator Efficiency – 33.2%, 114,000 BTU = 1gge

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U. S. INDUSTRY



1 AgSTAR Map of Operational Digester Systems


- 192 anaerobic digester systems are operating at commercial livestock farms in the United States.
- These systems have the ability to generate more than 66 MW of electricity each hour.
- The average U.S. system creates enough biogas to operate a 350 kW rated generator.
- The U.S. AD industry is about 3% the size of the German industry.

REFERENCES:

- AgSTAR Website: [Operating Anaerobic Digestion Projects](#)
Note: The AgSTAR database only tracks agricultural anaerobic digestion projects

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ANAEROBIC DIGESTERS in Ohio



Operational or Under Construction:

- Ashley (under construction)
- Cleveland
- Columbus
- Haviland
- North Ridgeville
- Wooster
- Zanesville
- Zanesville Expansion – IADs

Ohio Projects Scheduled in 2013:

- Celina
- Dayton
- Norton
- Toledo
- Uniontown
- Wooster II

Offices

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CLEVELAND, OH

Placed in Service: 2012
Annual Tons: 50,000 wet tons
Fuel per day: 1,800 GGE



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COLUMBUS, OH

Placed in Service: 2010
Annual Tons: 90,000 wet tons
Fuel per day: 3,600 GGE



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FRENCH CREEK, OH

Operational: April 2012
Annual Tons: 50,000 wet tons
Fuel per day: 1,800 GGE



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HAVILAND, OH

Placed in Service: 2012
 Annual Tons: 50,000 wet tons
 Fuel per day: 1,800 GGE

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RUTLAND, MA

Placed in Service: 2011
 Annual Tons: 15,000 wet tons
 Fuel per day: 450 GGE

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WOOSTER, OH

Placed in Service: 2010
 Annual Tons: 25,000 wet tons
 Fuel per day: 825 GGE

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ZANESVILLE, OH

Placed in Service: 2010
 Annual Tons: 50,000 wet tons
 Fuel per Day: 1,800 GGE

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ZANESVILLE, OH

iADs

Operational: Summer 2012
 Annual Tons: 8,000 iADs
 Plant Expansion Tons: 100,000
 Fuel Per Day: 7,550 GGE

The Integrated Anaerobic Digestion System (iADs) is patent pending technology developed at The Ohio State University. iADs integrates quasar's liquid anaerobic digestion with solid state anaerobic digestion, resulting in a technology that can treat and recover energy from feedstocks ranging from 0.5% to 85% total solids content.

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ASHLEY, OH

Under Construction: 2013
 Annual Tons: 50,000 wet tons
 Fuel per Day: 1,800 GGE

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BUFFALO, NY

Partner: Forest City Enterprises
 Under Construction: 2013
 Annual Tons: 50,000 wet tons
 Fuel per Day: 1,800 GGE

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WHEATFIELD, NY

Partner: Forest City Enterprises
 Under Construction: 2013
 Annual Tons: 50,000 wet tons
 Fuel per Day: 1,800 GGE

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COMPONENTS

Designed by quasar - Made in Ohio

Flare

Membrane

Mixers & Stands

Live Bottom Hopper

Heat Exchanger

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COLLABORATING

with The Ohio State University

Engineering Offices:

Laboratory:

OHIO STATE UNIVERSITY OARDC

BioBio Digester:

Laboratory:

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COLLABORATING

with The Ohio State University

- Laboratory Analysis and Testing:** quasar's OARDC lab benefits from the expertise of the University's renowned faculty and offers internships to ATI students.
- Developing Renewable Energy Curriculum:** preparing students for jobs in Ohio's growing anaerobic digestion renewable energy industry with classroom training and hands-on experience.
- By Training the Next Generation of Technicians:** we can be prepared to answer the growth of this industry with a ready and able workforce.

quasar's laboratory is the only anaerobic digestion laboratory of its kind in the United States.

OHIO STATE UNIVERSITY OARDC

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PROPRIETARY

Gas Cleaning Technology

quasar has collaborated with Air Products to develop proprietary gas cleaning technology.

- Now biogas can be affordably upgraded to biomethane exceeding pipeline quality.
- Ohio organic residuals represent the equivalent of 1,000,000,000 gallons of renewable fuel annually.

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AIR PRODUCTS

Gas Cleaning


Gas Drying & Compression

Gas Separation Air Products Prism® Membranes

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EMISSIONS Natural Gas Vehicles



Transit buses equipped with model year 2004 CNG engines compared to model year 2004 diesel engines:

- CNG buses produced 49% lower nitrogen oxides emissions
- CNG buses produced 84% lower particulate matter emissions

In a study of UPS delivery trucks running on CNG compared to diesel trucks of a similar age:

- CNG trucks produced 75% lower carbon monoxide emissions
- CNG Trucks produced 49% lower nitrogen oxides emissions
- CNG trucks produced 95% lower particulate matter emissions

REFERENCES:
1. U.S Department of Energy: [UPS CNG Truck Fleet: Final Results](#)

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quasar natural gas the future of energy is renewable fuel




quasar has introduced our new brand of alternative motor vehicle fuel – qng (or quasar natural gas). Fueling stations are already operational at our Corporate Headquarters and at our Columbus, Zanesville and Wooster plants and will be coming soon to Cleveland, North Ridgeville and Haviland.

quasar will continue installing fueling stations at our anaerobic digester systems, helping to build the infrastructure necessary to reduce transportation costs of goods and services to Americans.

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equate Sustainable Nutrients

Quasar's process generates two products: renewable energy and nutrient rich fertilizer alternative. *equate* can be applied to farm fields for agronomic benefit.



- **high organic matter:** Adding organic matter to fields increases their ability to hold water in drought years and helps clay soils drain more effectively.
- **ecofriendly alternative:** *equate* is an ecofriendly alternative to traditional fertilizer options such as land application of manure or chemical fertilizers.
- **odor management:** odor causing solids are naturally reduced during anaerobic digestion by converting volatile solids into biogas – resulting in a less odorous product.

Typical Fertilizer Value
5-4-1

Annual Cost Savings
\$150 per acre

*average concentrations and values listed above are based on laboratory tests of representative samples. Nutrient values may vary slightly.

equate 27

q-bio Where Composting Meets Energy

Composting is an excellent way to manage organic waste while generating a valuable byproduct.

quasar's **q-bio** is where composting meets energy – organic residuals are diverted from landfills and processed in an anaerobic digester that produces renewable energy. The nutrient rich liquid byproduct is mixed with **q-bio** adsorption powder and used to inoculate woody biomass (yard waste and crop waste).


The result is a nutrient rich compost product which can be sold to regional landscape supply companies.



q-bio 28

ANAEROBIC DIGESTION The Big Picture Impact

Anaerobic digestion impacts America's food processing companies, waste water treatment plants, farmers, manufacturing plants, public and private vehicle fleets, electric and natural gas utilities, and consumers who benefit from all of these activities. Anaerobic digestion is the starting point for sustainable solutions with economic benefits that will affect every American.



quasar energy group qng equate q-bio iADs

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ANAEROBIC DIGESTION Wastewater Treatment

40 CFR 403.2

Objectives of general pretreatment regulations:

- To prevent the introduction of pollutants into POTWs, which will pass through the treatment works
- To improve opportunities to recycle and reclaim municipal and industrial wastewaters and sludges

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ANAEROBIC DIGESTION Wastewater Treatment

Characteristics of Some Wastewaters from the Food Processing Industry

Industry	BOD (mg/L)	TSS (mg/L)	pH
Brewery	850	90	4 – 6
Cannery	2,000	7,000	ACID
Diary	600 – 1,000	200 – 400	ACID
Potato Processing	2,000	2,500	11 – 13
Sugar Beet	450 – 2,000	800 – 1,000	7 - 8
Slaughter House	1,500	800	7
Silage	2,500 – 50,000	Low	ACID

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ANAEROBIC DIGESTION Wastewater Treatment

Why Wastewater Treatment Plants?



- Wastewater contains 10 times more energy than is needed to treat it¹
- 30% - 60% of a city's energy bill is from water and wastewater treatment
- Food waste produces three times more methane than wastewater solids

REFERENCES:
1. Water Environment Research Foundation

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ANAEROBIC DIGESTION Streams

Input

- Organic Carbon (OC)
- Organic Nitrogen (ON)
- Organic Phosphorous (OP)
- Organic Sulfur (OS)
- Ammonia nitrogen (NH₄⁺)
- Sulfate (SO₄²⁻)
- Phosphate (PO₄³⁻)

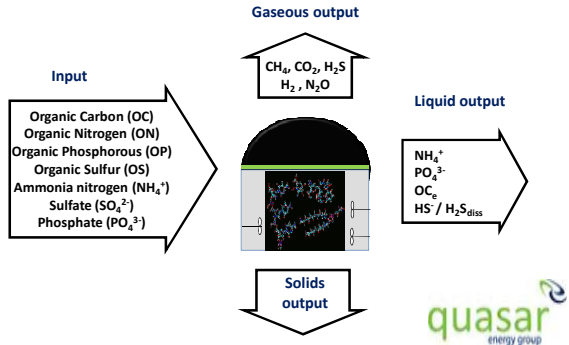
Gaseous output

CH₄, CO₂, H₂S
H₂, N₂O

Liquid output

NH₄⁺
PO₄³⁻
OC_e
HS / H₂S_{diss}

Solids output

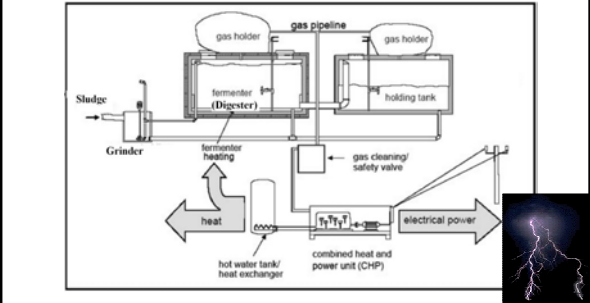


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ANAEROBIC DIGESTION ENERGY

CHP Process (Combined Heat and Power)



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ANAEROBIC DIGESTION ENERGY

Gasoline Gallon Equivalents (gge)


Fuel Type	Unit of Measure	BTUs/Unit	gge
Gasoline (regular)	Gallon	114,100	1.00 gallon
Diesel #2	Gallon	129,500	0.88 gallons
Ethanol (E85)	Gallon	81,800	1.39 gallons
Compressed Natural Gas	Cubic foot	900	126.67 cu. ft.
Liquid Natural Gas	Gallon	75,000	1.52 gallons

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OSU & quasar energy group

Working on sustainable, renewable transportation solutions:

- Recycling automotive oils
- Alternative fuel vehicles (CNG)
- Supporting local auto industry and infrastructure



College of Engineering

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ANAEROBIC DIGESTION SOLUTIONS




- Most organic waste is =90% water
- Water weighs about 8.3 lbs. per gallon and is typically twice as heavy as regular waste
- By removing organic waste, you are removing up to 90% of the total weight of trash
- The highest % of companies' trash bill is based on weight

Reduced waste volume and weight = reduced costs


*Water analysis based on averages of typical food-oriented businesses. Remaining waste is presumed to be packaging, paper, plastic and miscellaneous waste with densities lower than water

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BIOMASS Depackaging



Depackaging at Campbell's Soup Company in Napoleon, Ohio

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ANAEROBIC DIGESTION ENERGY

One load can produce:

19,404 kWh


or

2,547 gge



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BIOMASS	Depackaging
<p>Depackaging equipment presents a new opportunity to capture organic materials from products with recyclable packaging such as:</p> <ul style="list-style-type: none"> • wax-coated cardboard • glass bottles • aluminum cans • plastic bottles, wrappers & containers <p>quasar has been actively conducting depackaging trials at our Wooster and Zanesville anaerobic digestion facilities since 2010.</p>	 <p>Dupps depackaging equipment in Zanesville, Ohio</p>
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