Transforming Biosolids: Converting Biosolids into Energy Using Gasification

Wednesday, November 19, 2025

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Agenda

What you can expect in this presentation

1. Company Introduction
2. Challenges in Biosolids Disposal
3. Aries Gasification Technology for Biosolids Disposal
4. Fate of PFAS in Gasification
5. Q&A

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SECTION 1

COMPANY INTRODUCTION

Company Overview

Innovative technology providing a new option for biosolids disposal

Aries Clean Technologies, LLC owns and operates proprietary fluidized bed gasification technology that processes biosolids generated at municipal wastewater treatment plants. Aries builds, owns, and operates projects using its proven, patented gasification process to convert biosolids into renewable energy and beneficial use products.

- Commercial-scale facility located less than 15 miles from Manhattan with capacity to process the waste of ~1m people
- Owner of patented gasification technologies and related systems
- Biosolids disposal option that is renewable, removes PFAS, and reduces greenhouse gas emissions
- Expanding with 3 new facilities within 4 years

2010
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Company founded, originally known as PHG energy

2010
Thompson CAT
Receives initial investment from Thompson Machinery

2017
SPRING LANE CAPITAL
Spring Lane Capital invests in the company

2022
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First biosolids gasified at Linden, NJ facility

2024
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Location of second plant secured within 75 miles of Boston metro area

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SECTION 2

CHALLENGES IN BIOSOLIDS DISPOSAL

The Biosolids Problem

Why is additional capacity needed?

- Biosolids are the solid material recovered from the wastewater treatment process
- Over 1 million tons of biosolids are produced everyday worldwide regardless of economic, environmental, or societal conditions
- Biosolids must be disposed of in a timely manner, and current options are under increasing regulatory pressure
- As disposal options diminish cost of disposal is increasing

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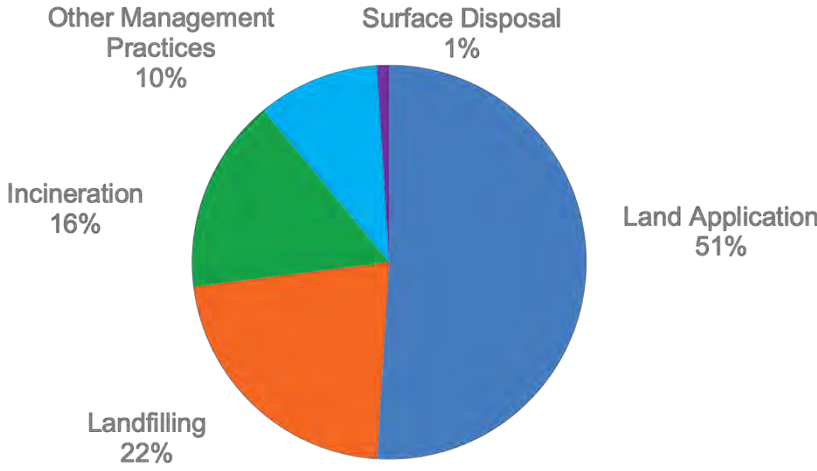
Current Biosolids Disposal Methods

Biosolids Disposal Landscape in the USA

- **Ocean dumping was banned** in 1988, leading to landfilling, incineration, and land application as disposal options
- **Landfills disposal of biosolids is decreasing** due to capacity restrictions, land availability, and public opposition
- **Incineration is becoming less prevalent** due to stricter environmental regulations
- **Land application is being restricted** and increasingly regulated as contamination from PFAS and other chemicals of concern escalates



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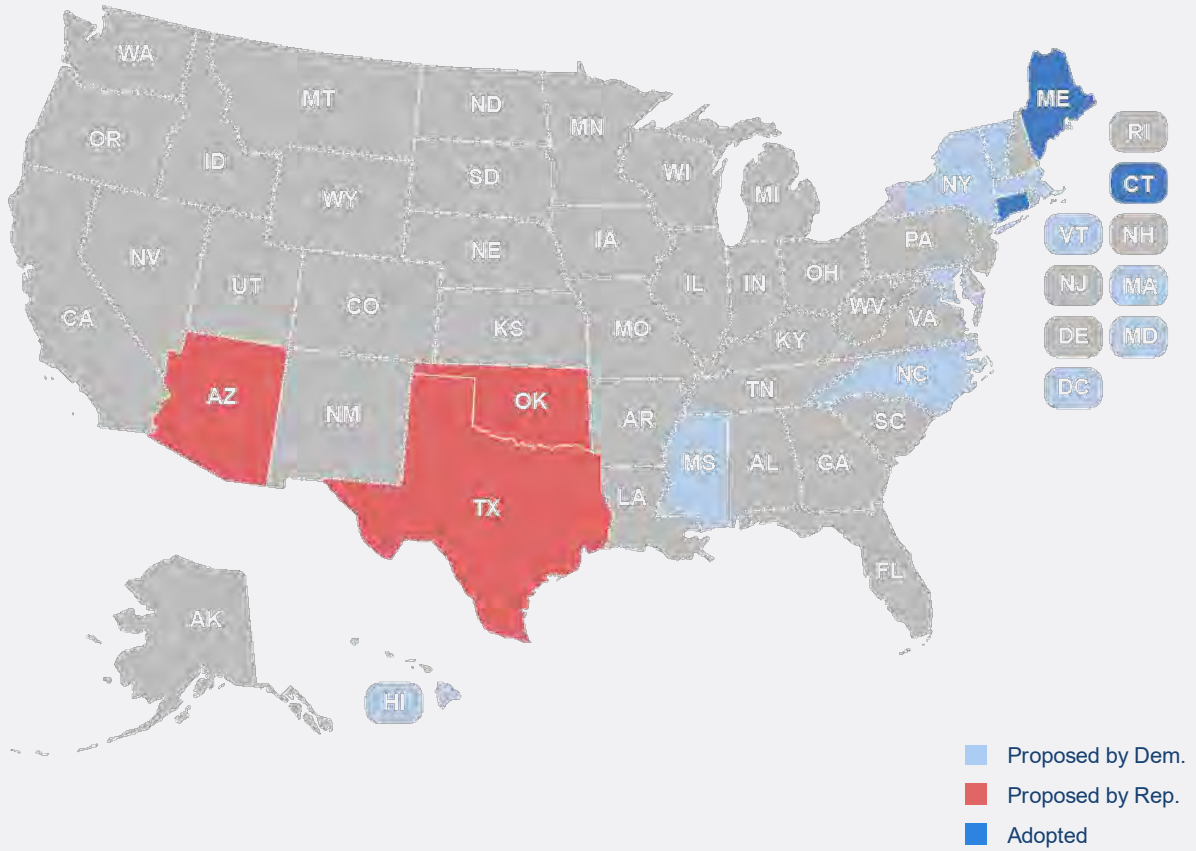
Biosolids Land Application Challenges

Largest US biosolids disposal option facing headwinds

- An increasing number of states are restricting land application due to PFAS in biosolids
- Land application currently accounts for >50% of biosolids use and disposal in the US
- Two states have imposed bans on land application of biosolids; Maine and Connecticut
- Multiple other states have proposed legislation either banning or limiting land application
- EPA recently issued draft Risk Assessment about PFAS in biosolids indicating a potential for risk from contamination of PFOS and PFOA

Land application bans proposed / adopted



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PFAS 101

Per- or Poly - Fluorinated Alkyl Substance

Group of synthetic chemicals

Example: P - F - O – (A or S)

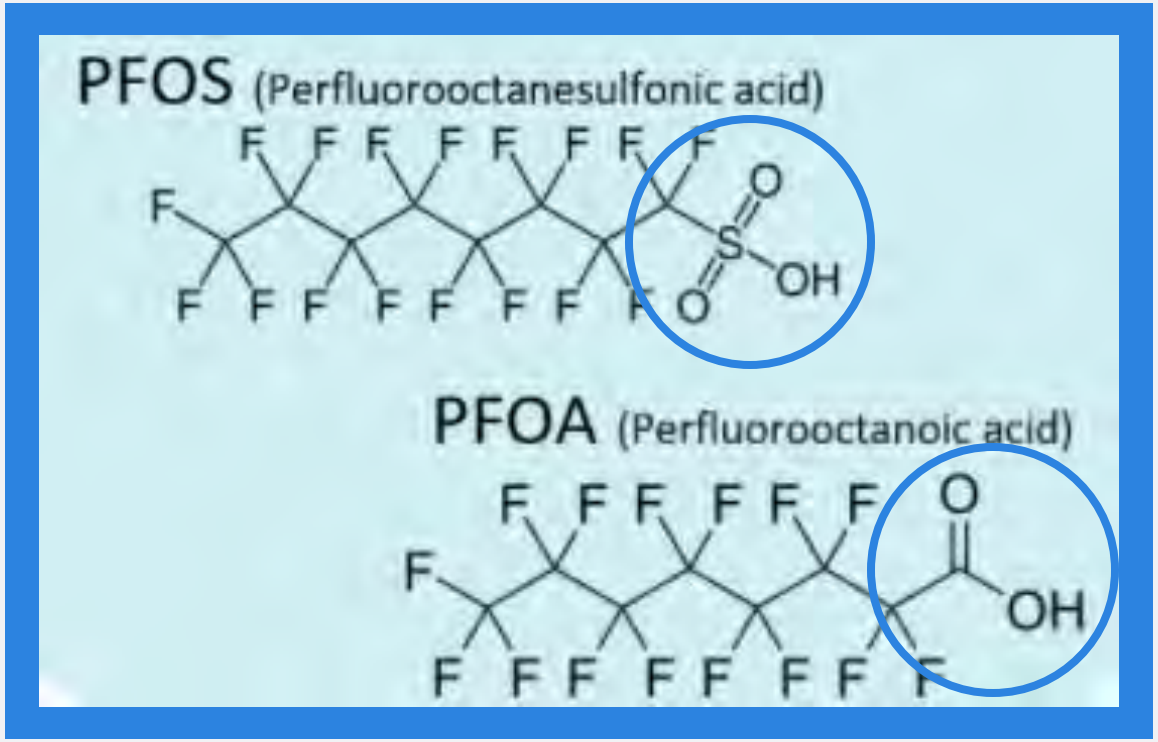
P- per- (fully) or poly- (partially)

F – fluorinated

O – octa; refers to length of carbon chain;
A or S – functional group

Result:

- Persistent in the Environment
- Linked to negative human health impacts
- Accumulate in “passive receivers” such as landfills and WWTPs (including biosolids)



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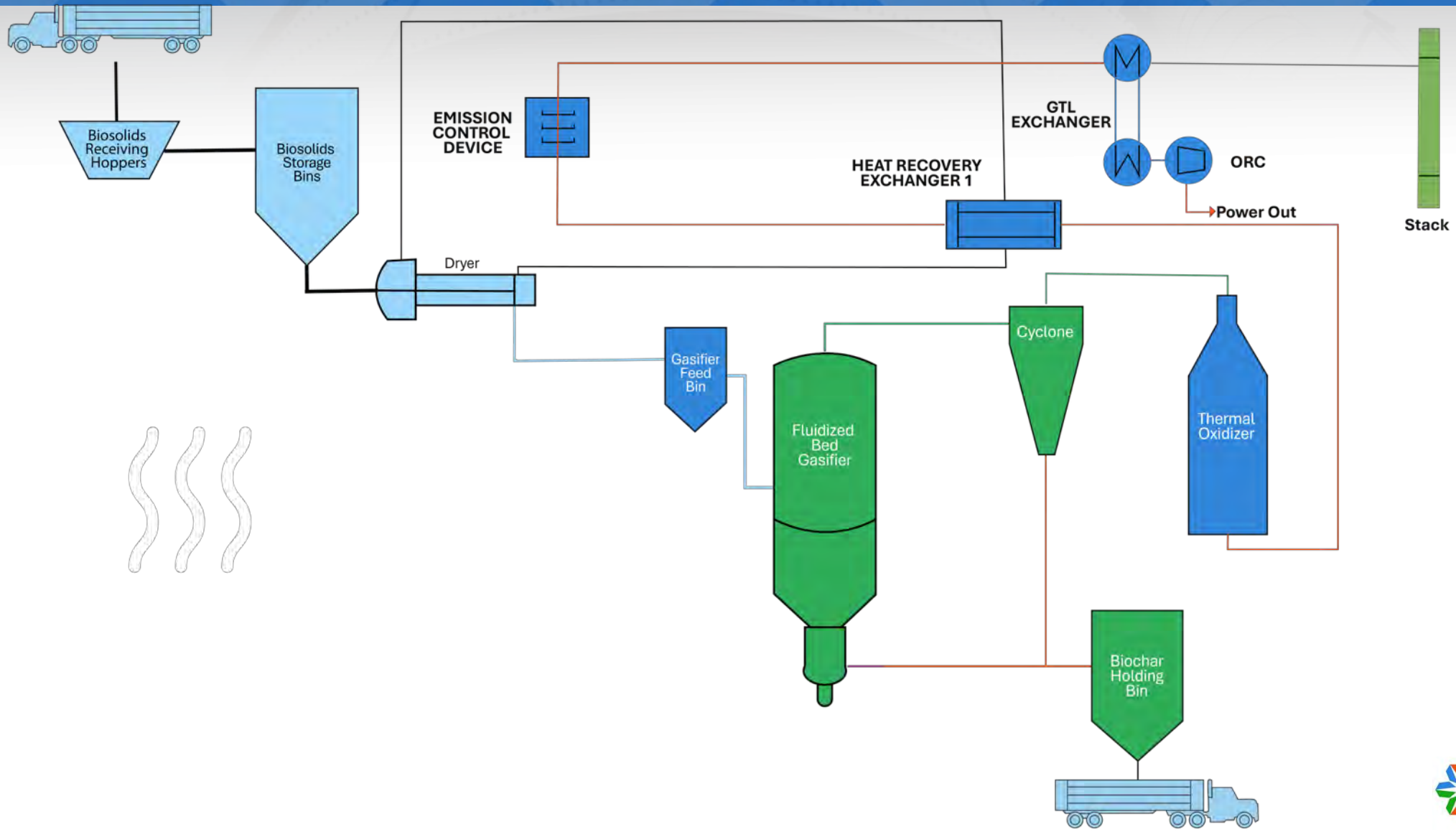
SECTION 3

ARIES GASIFICATION TECHNOLOGY FOR BIOSOLIDS DISPOSAL

ARIES PROCESS FLOW DIAGRAM



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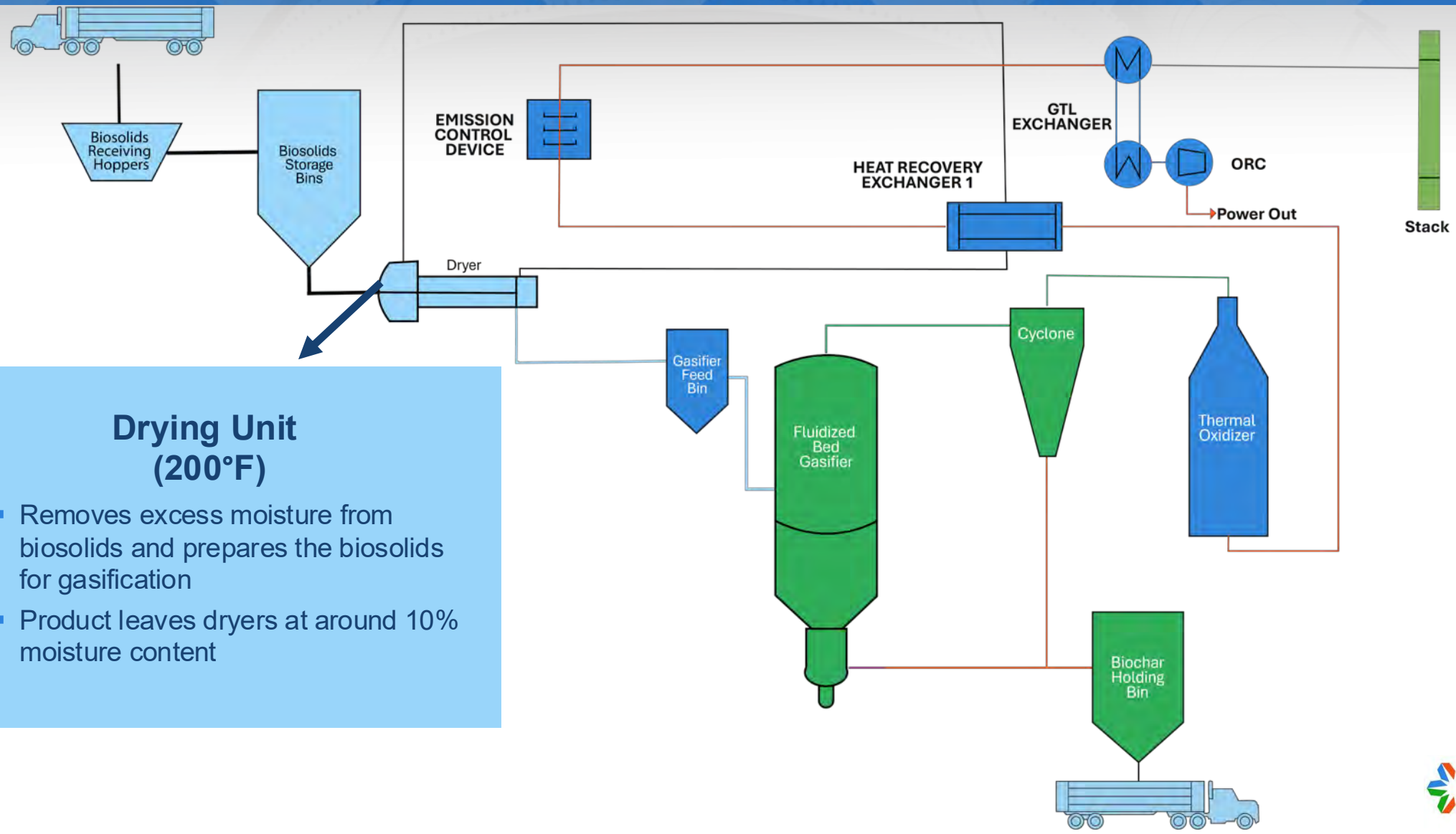
ARIES PROCESS FLOW DIAGRAM



Drying Unit (200°F)

- Removes excess moisture from biosolids and prepares the biosolids for gasification
- Product leaves dryers at around 10% moisture content

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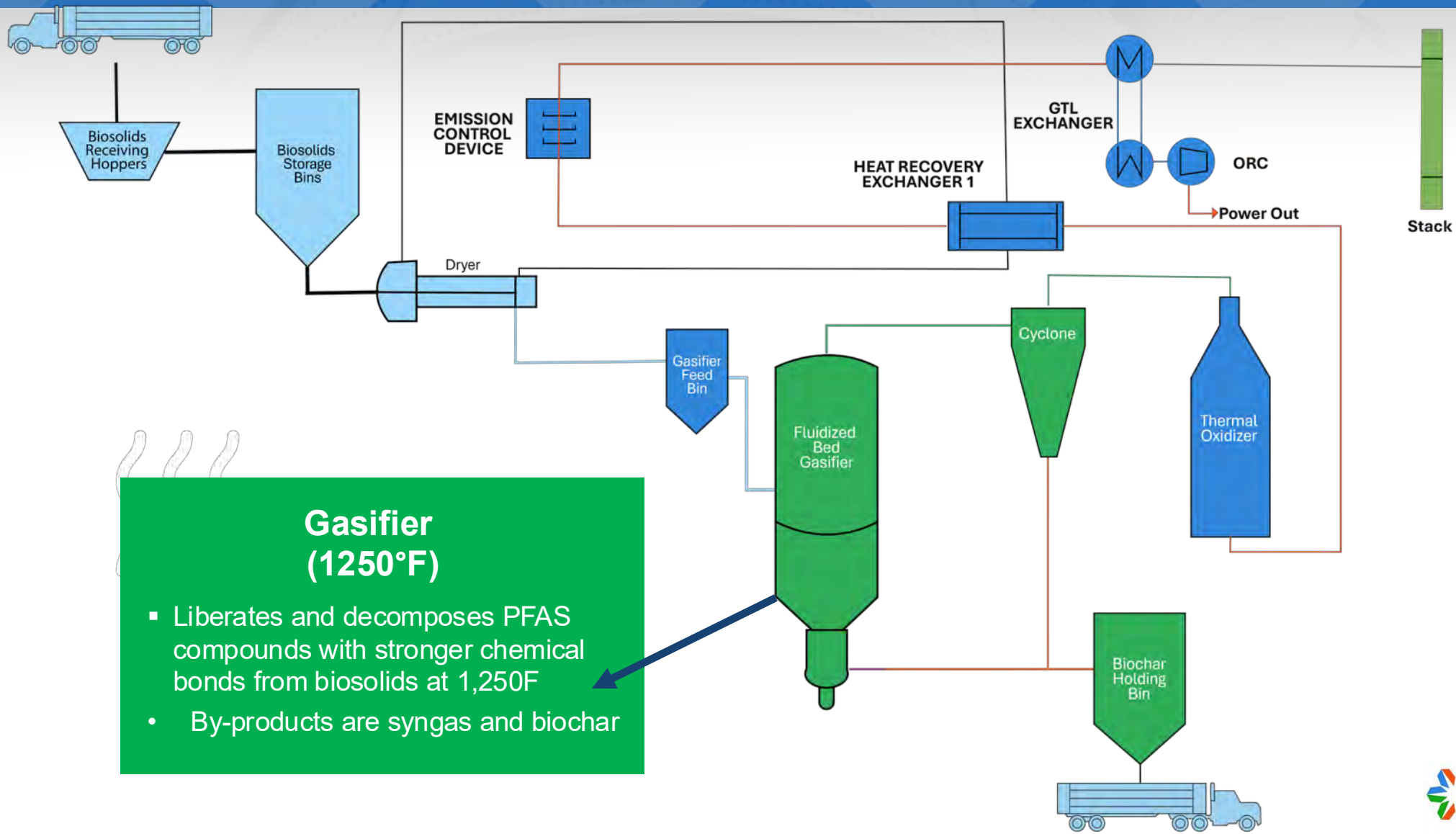
ARIES PROCESS FLOW DIAGRAM



Gasifier (1250°F)

- Liberates and decomposes PFAS compounds with stronger chemical bonds from biosolids at 1,250F
- By-products are syngas and biochar

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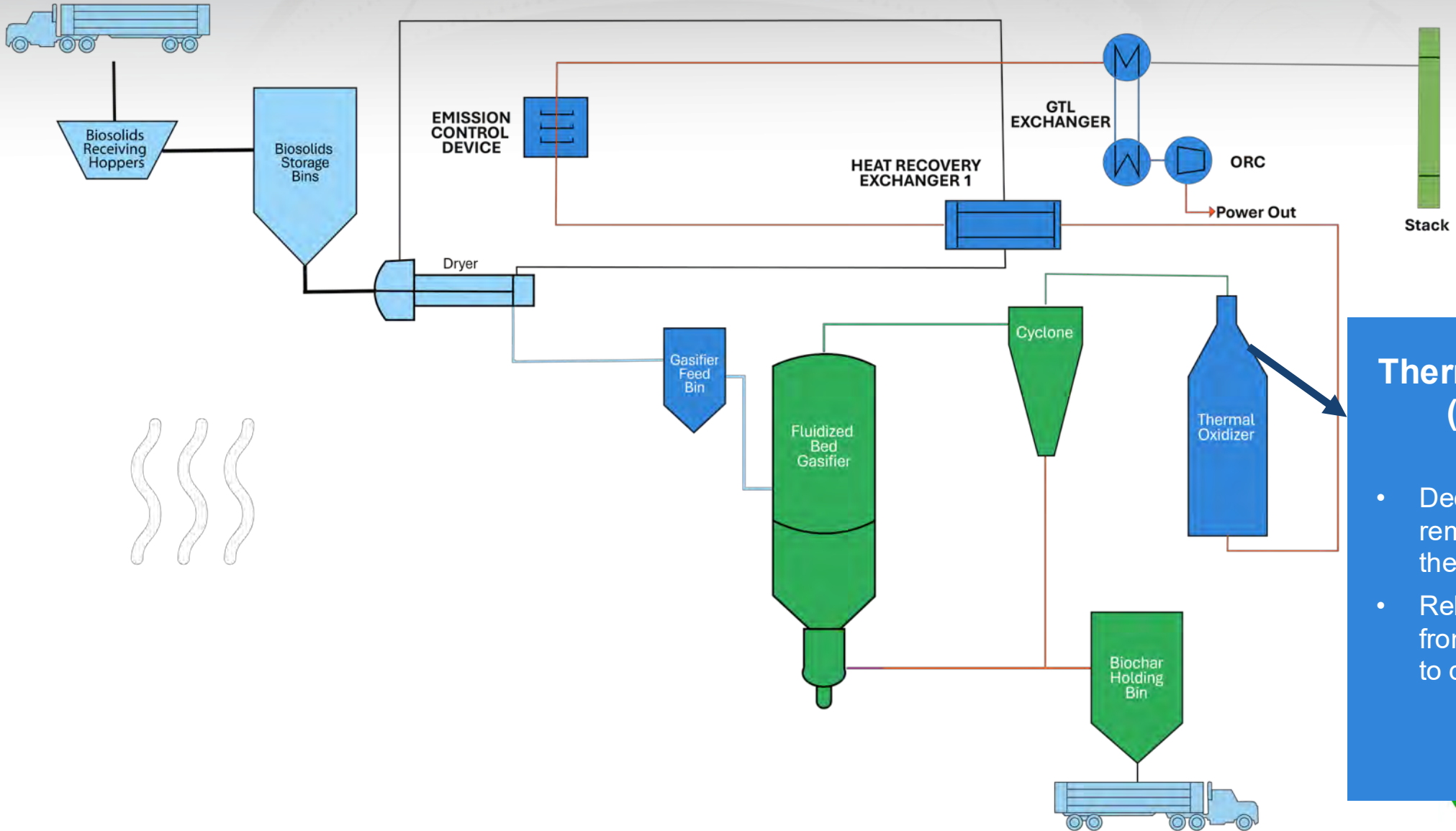
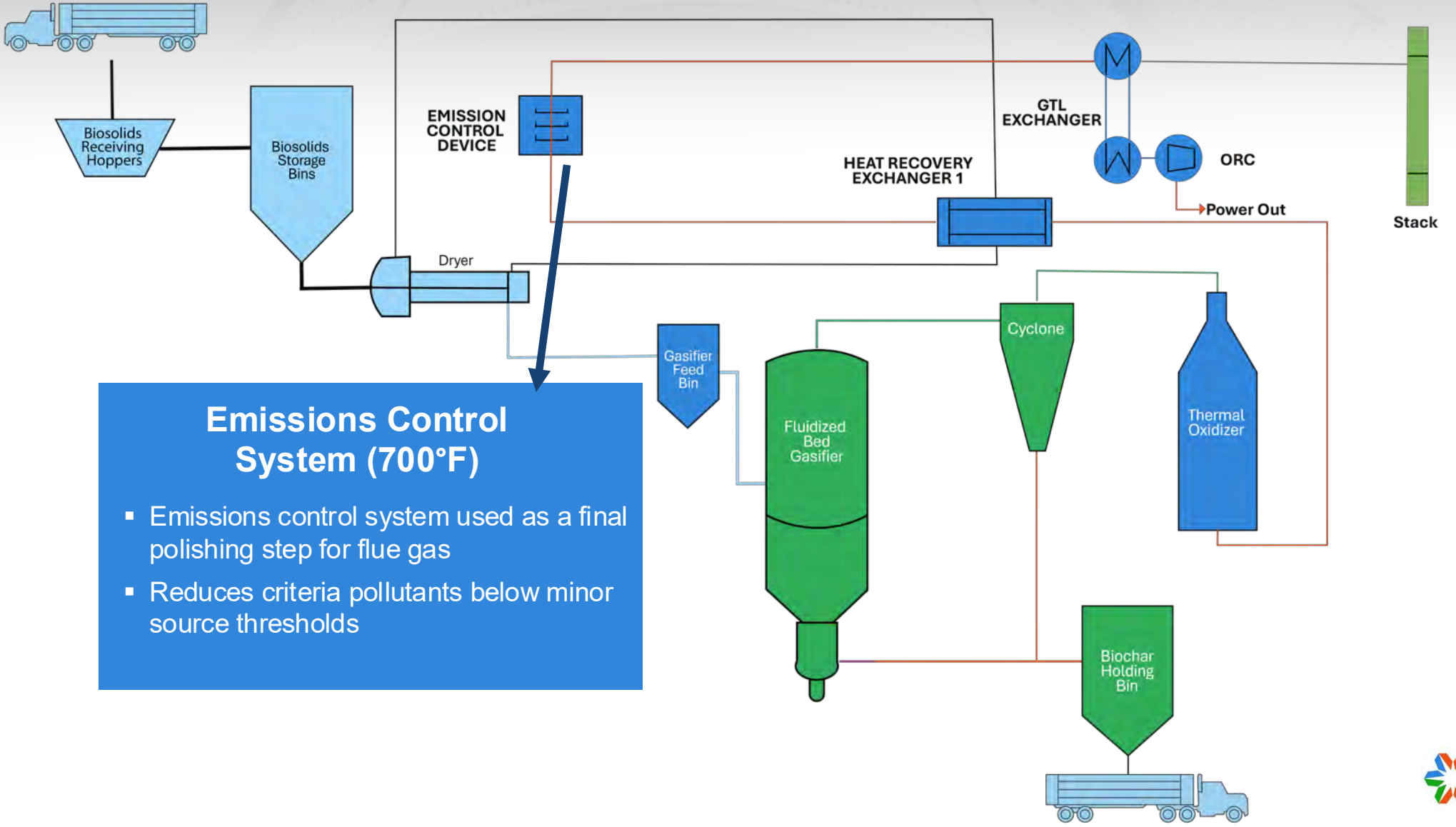
ARIES PROCESS FLOW DIAGRAM



Thermal Oxidizer (1800°F+)

- Decomposes PFAS remaining in syngas thermally at 1800°F
- Releases energy from Producer Gas to dry biosolids.

ARIES PROCESS FLOW DIAGRAM



Emissions Control System (700°F)

- Emissions control system used as a final polishing step for flue gas
- Reduces criteria pollutants below minor source thresholds

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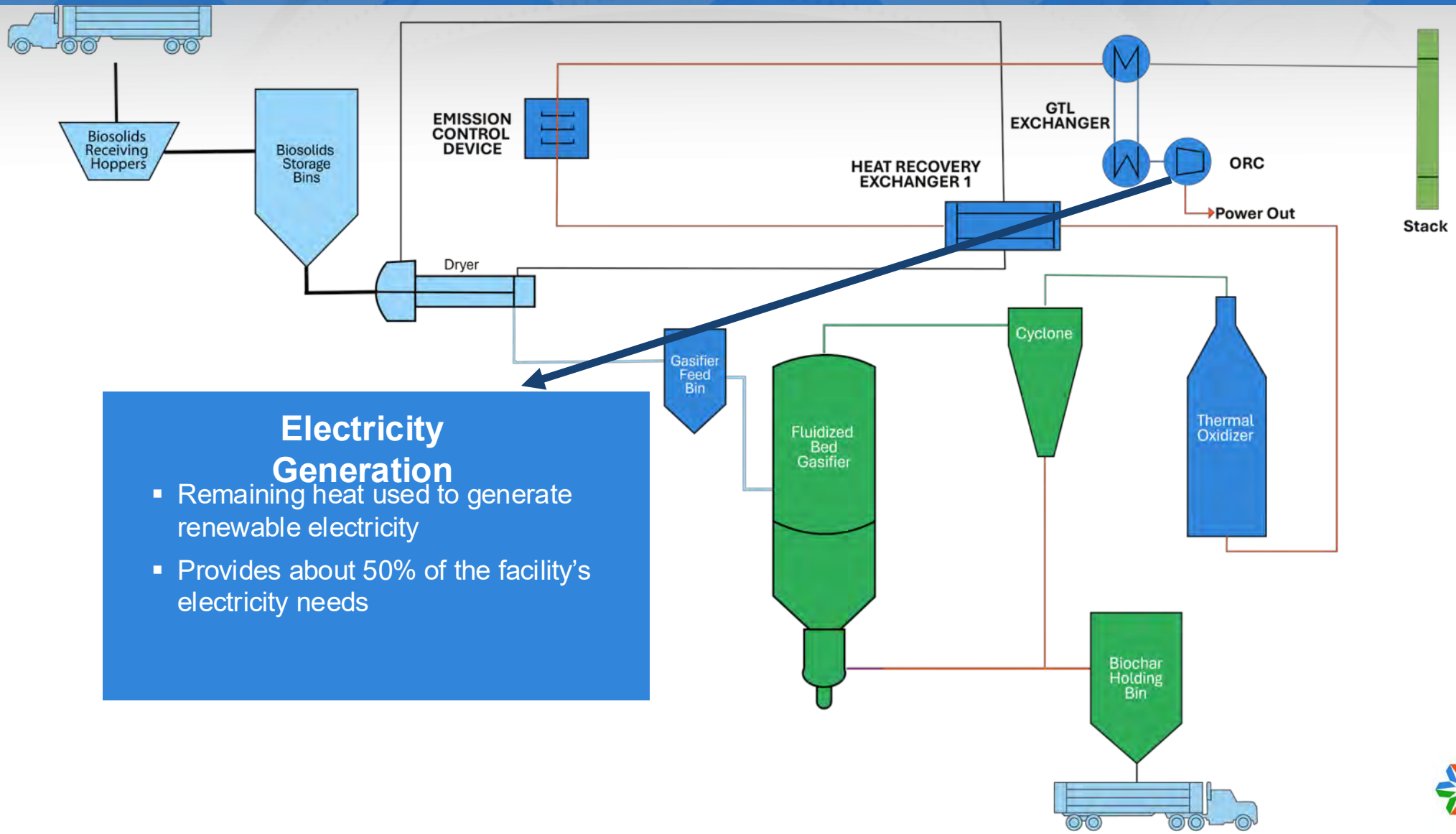

Electricity Generation

- Remaining heat used to generate renewable electricity
- Provides about 50% of the facility's electricity needs

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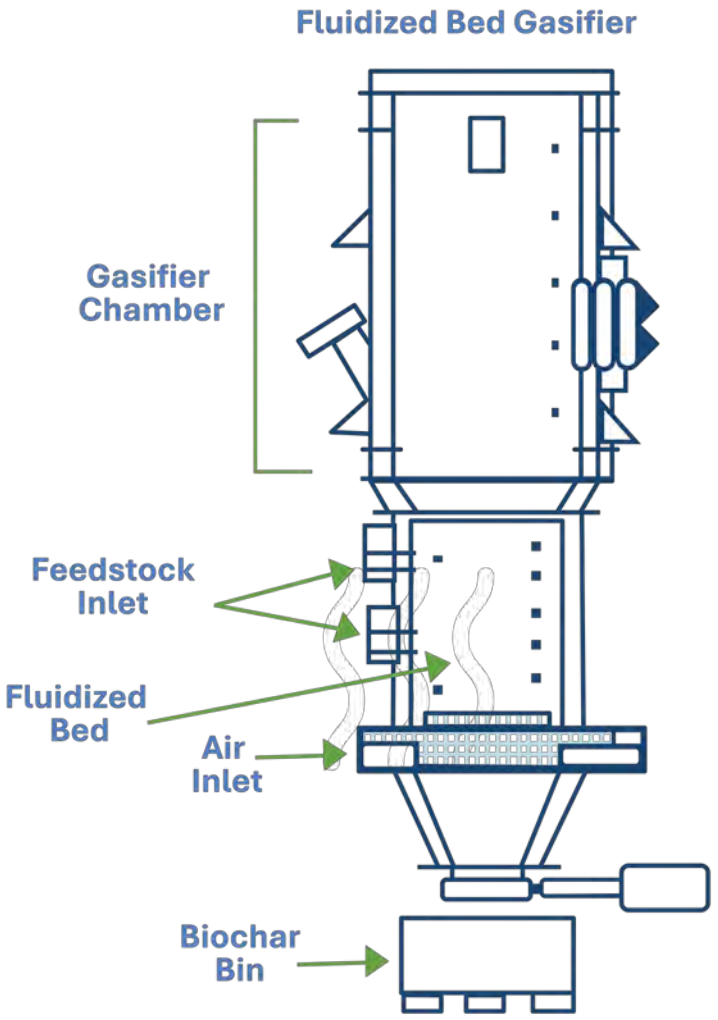
Patented Fluidized Bed Gasifier Technology

How it works



Patented Technology

System cleanly reduces biosolids by as much as 95% through a proprietary patented thermo-chemical process.

Beneficial Byproducts

Renewable Syngas is generated for heat and electric power generation while biochar is generated for land application, industrial, and manufactured product applications.

Financial Benefits

Renewable heat from gasification displaces all thermal energy required for drying. Renewable electricity offsets operating costs.

Sustainability Benefits

Reduced carbon footprint and elimination of land application of PFAS-containing waste achieve industry and municipal goals.

Feedstock Options

System handles a wide range of biosolid feedstocks from multiple sources.

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SECTION 4

FATE OF PFAS IN GASIFICATION

Linden Biosolids Processing Facility

Location for the PFAS testing

Overview

- Located < 20 miles from New York City
- ~30 full-time employees
- Thermal energy produced accounts for 100% of thermal needs offsetting natural gas use
- Gasification in a reducing environment (oxygen free)
- Generates renewable electricity with waste heat
- Minor source air permit

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Commercial Scale PFAS Testing

Aries Linden Gasification Facility

- Testing was completed in November 2024
- Worked with Barr Engineering's PFAS testing group who independently performed the sampling
- Testing was performed on entire integrated dryer and gasifier system
- Laboratory used for testing was Eurofins
- Solids and liquids samples were tested using EPA Method 1633 for 40 PFAS compounds
- Stack testing followed EPA Other Test Method (OTM) 45 Rev. 1

BARR®

eurofins

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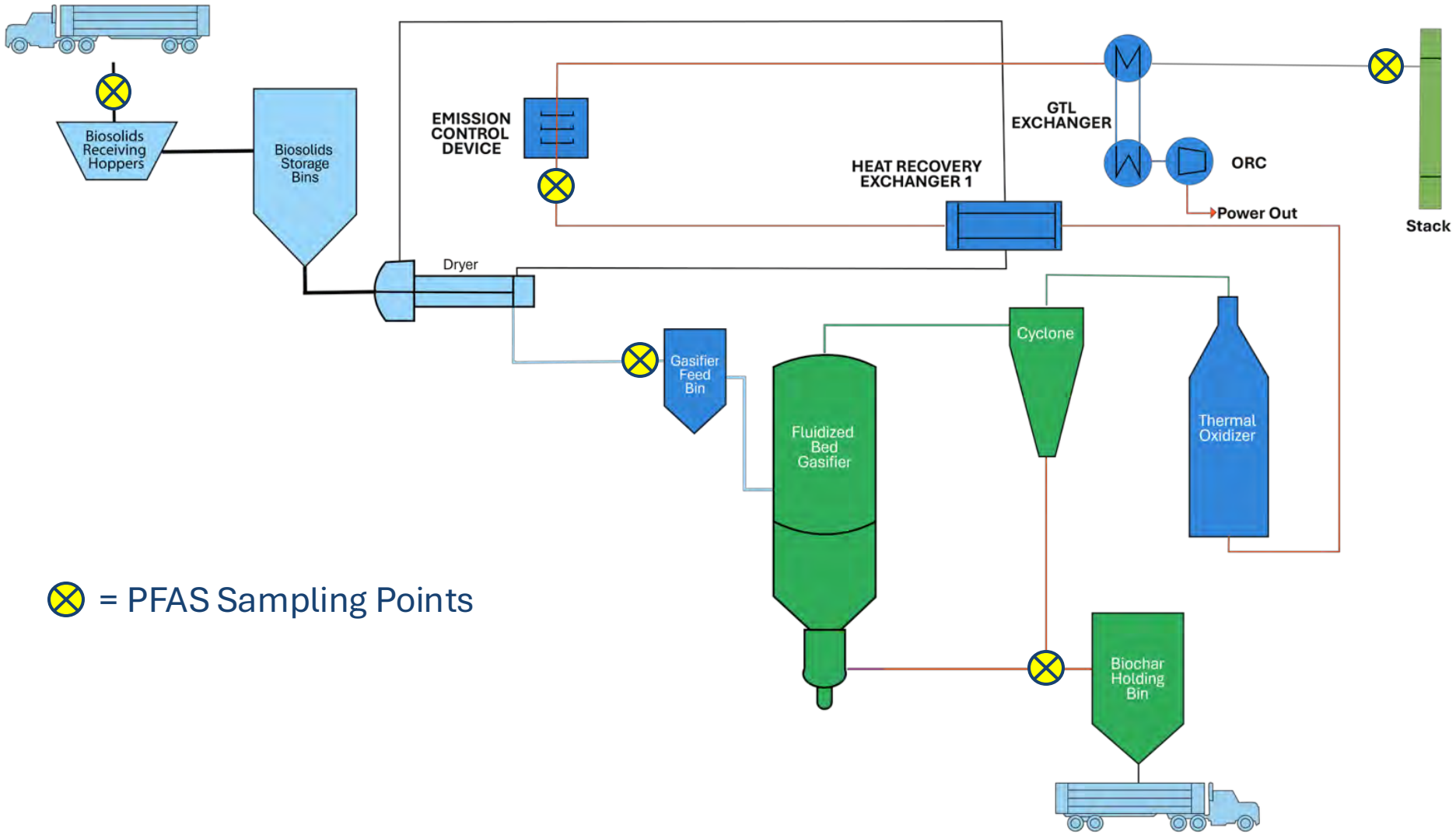
Sampling Points for PFAS Test



⊗ = PFAS Sampling Points

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Aries Clean Technologies' Biosolids Gasification Process and Output Results

760 mg/hr of PFAS
in wet biosolids (67 ppb)

25,000 lbs/hr

Thermal Energy

Recovered heat provides heat for the drying of incoming sludge

6 HEAT RECOVERY

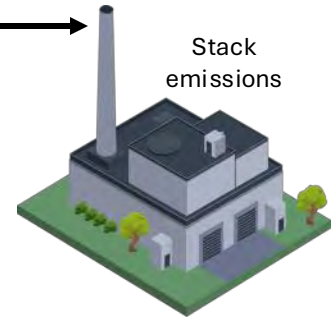
Emission control device

Exchanger 2

Exchanger 1

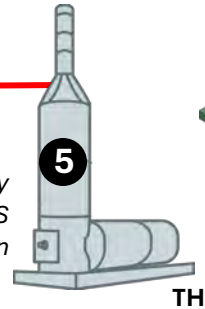
17 mg/hr of PFAS

1/30th the level of Michigan limits



Stack emissions

Flue Gas



Secondary step in PFAS destruction

5

THERMAL OXIDATION

1 DRYING

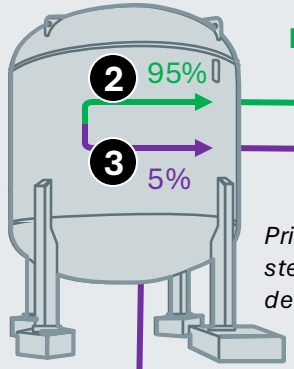
Sludge Storage bins

Dryer 1

Dryer 2

Dried **biosolids**

GASIFICATION



2 95%

3 5%

Producer Gas

Biochar

Primary step in PFAS destruction

Cyclone

Producer Gas

4

Condensate

12 mg/hr (~1 ppb)

(Next Gen will comply with EPA drinking water limits via commercial treatment technologies)

Non-detect PFAS

4 PFAS destruction and removal efficiency (DRE) increases when condensate is treated or disposed of

Not treated	97.3%
Treated	98.9%

Calculations based on Run 3, which contained design efficiencies

- PFOA = 81.8% reduction
- PFOS = 99.4% Reduction

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1 Wet biosolids are dried from ~18-22% solids to 90% solids in a 2-train drying system.

2 Biosolids are converted to molecules of methane, carbon monoxide, hydrogen, and other minor species to form a low energy producer gas.

3 Approximately 5% of the total volume after gasification remains as biochar, which consists of elemental carbon and ash and are separated through the top of the gasifier and captured in a cyclone.

5 Producer gas is combusted to create heating for the system.

6 Heat exchangers recover thermal energy from gasification process.

Summary

- Gasification reduces wet cake volume by 90-95%
- Eliminates natural gas use of traditional thermal drying plants
- PFAS reduced by 97%
- No PFAS detected in biochar produced by the gasifier
- Stack emissions levels were 30 times lower than the most strict US standards (Michigan)

Thank you!

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Questions?