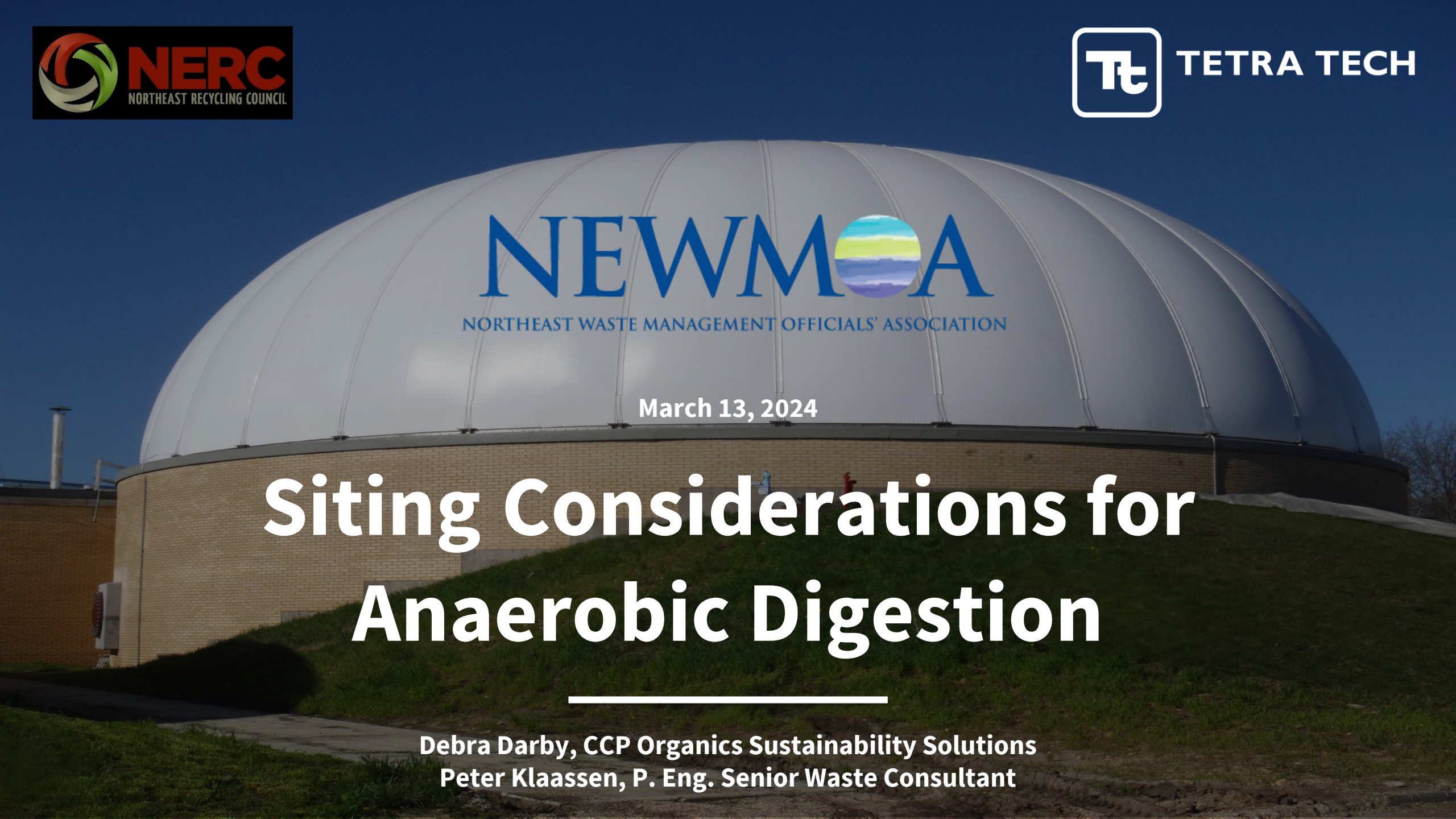

NERC
NORTHEAST RECYCLING COUNCIL

TETRA TECH

March 13, 2024

Siting Considerations for Anaerobic Digestion

Debra Darby, CCP Organics Sustainability Solutions
Peter Klaassen, P. Eng. Senior Waste Consultant

Today’s Presenters

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Organics Sustainability Solutions

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Senior Waste Consultant

Agenda

- Regulatory
- Anaerobic Digestion Technologies
- Siting Considerations
  - Logistics
  - Capital Costs
  - Operating Costs
  - End-markets / Revenue

***Source:** DRANCO*

Tetra Tech *ENR* Rankings

ENVIRONMENTAL RANKINGS

7 Top 200 Environmental Firms
2 Solid Waste
2 Environmental Science
2 Water Treatment/Supply
6 Engineering/Design
7 Environmental Firms in International Markets

DESIGN RANKINGS

4 Top 500 Design Firms
1 Hydro Plants
1 Treatment/Desalination
2 Dams & Reservoirs
8 General Building
12 Global Design Firms

Source: *Engineering News-Record* issues: 9/19/22, 5/1/23, 7/10/23, and 7/24/23

7/24/23

Tetra Tech Solid Waste Solutions

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Landfill Design and Engineering

- Master Planning & Permitting
- Leachate & Environmental Control Systems
- Hydrogeologic Services
- Baseliner & Cover
- Infrastructure
- Construction-Related Services
- Operations Consulting

Site and Civil Design

- Site Engineering & Design
- Surface Water Management
- Environmental Engineering

Biogas

- Engineering, Design and Phasing
- Beneficial-Use Feasibility Studies
- Biogas-to-Energy Project
- Pipeline, Compressor Stations and Electrical Generation Station Design

Organics Infrastructure

- **Organics Management Planning & Feasibility Studies**
- **Composting Operations, Anaerobic Digestion Facility Design**
- **Construction Oversight**
- Solid Waste Management Planning
- Zero Waste / Waste Reduction
- Facility Planning, Permitting & Design
- Material Recycling Facilities
- Existing Facility Review

Operations and Maintenance

- Biogas Collection & Control Systems
- Leachate Management Systems
- Environmental Sampling
- Training of Site Personnel
- Construction Management
- Post-Closure Monitoring and Inspections

Air Quality

- Air Permitting
- Permit Compliance Support
- Federal, State & Location Reporting
- Greenhouse Gas Support & Reporting

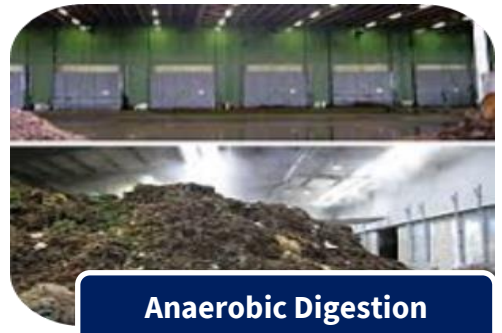
Organics Management and Waste Reduction

Solid Waste is a resource.

- Diversion to reduce disposal
- End-markets for renewables
  - High quality compost
  - Biofuels, energy
  - Green chemistry, bioplastics

Paradigm shift to a more circular infrastructure.

Organics is the next solid waste commodity.



Anaerobic Digestion

Commercial Composting

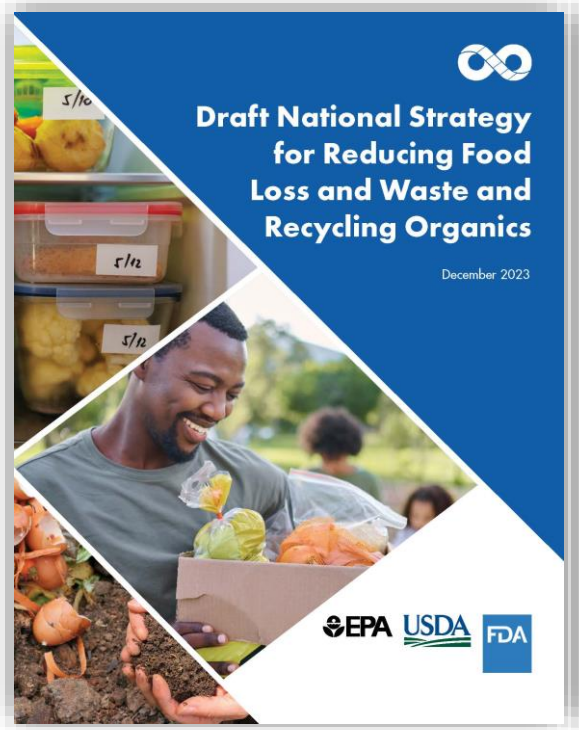
Community / Home Composting

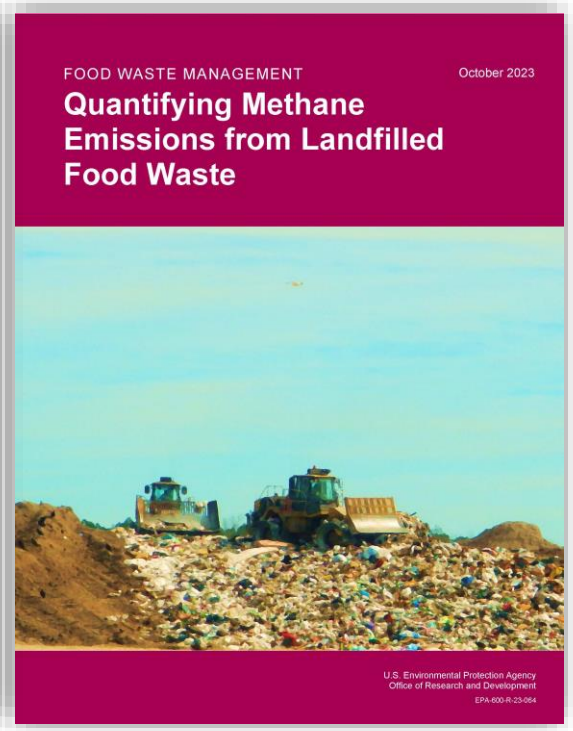
EPA: Reducing Environmental Impacts of Waste Food

Compost or Anaerobic Digestion with beneficial use of digestate/biosolids

EPA: Wasted Food and Climate Change

Date	Agency / Alignment	Action
2015	EPA / USDA	Reduce Food Loss & Waste 50% by 2030[a] (50 x 30)
2021	EPA / UNEP	Reduce Food Waste by 50% Across the Value Chain
2023	EPA	Quantify Methane Emissions from Landfilled Food Waste [b, c]
2023	EPA/USDA/FDA	Government Approach; Circularity For Organics to reach 50 x 30





[a] Recycling Food and other Organic Waste to drive National *Recycling Goal 50 x 30.*
[b] 58% of Landfill Methane emissions is from landfilled food waste.
[C] 61% of methane generated by landfilled food waste is captured by LFG collection systems.

EPA: Quantifying Methane Emissions from Landfilled Food Waste

- Organics stream is up to 50% of the MSW stream
- EPA reports that Food Waste alone is 24% of MSW disposed in landfills.
- 58% of fugitive methane emissions are from landfilled food waste.
- Environmental impacts of methane is 25X greater than C02 release into the atmosphere
  - Some studies report up to 80X times greater

EPA: Definition of Environmental Justice

Federal Justice40 Initiative

State EJ Policies and Regulations

Massachusetts	Pennsylvania
New Jersey	North Carolina
Connecticut	New York

"Fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."

State Organics Bans and Diversion Mandates
(as of January 2024)

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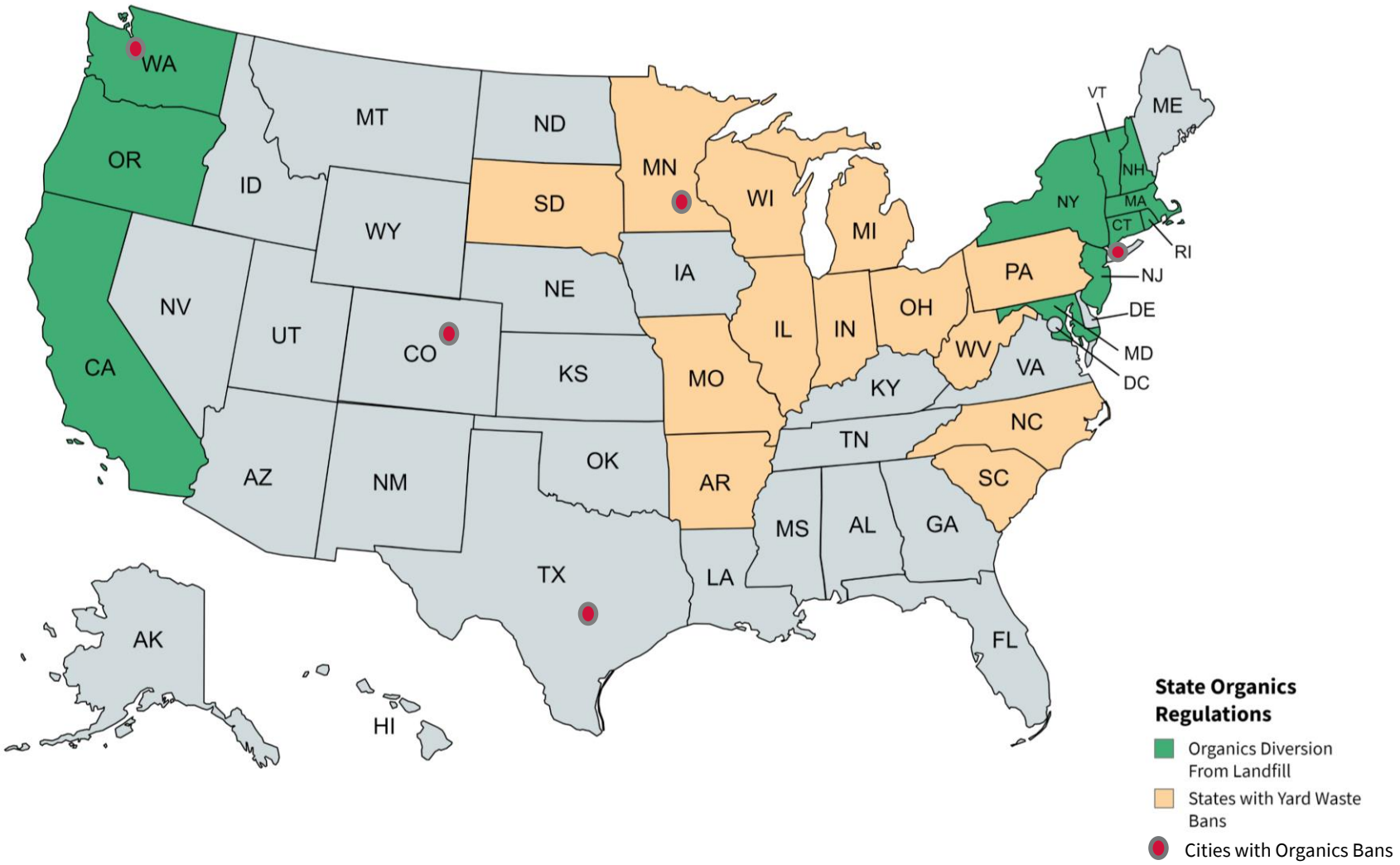

Why AD For Organics Management

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Regulatory and Policy Drivers

- **Organics diversion from landfill**
- **Climate Mitigation**
- **Soil Health – land application of digestate for carbon sequestration**

Financial

- Disposal cost, transportation/distance, labor

Solid Waste Disposal Capacity

- MSW landfill closures
- WTE closures

Feedstock and End-Markets – Renewable Energy Generation (RNG)

- Fuel for engines & generators
- Combined heat & power electricity
- Compressed for vehicle fuel (CNG)

Anaerobic digestion is the natural process in which microorganisms break down organic materials, such as food scraps, grease, and biosolids. This process produces biogas, a renewable energy source.

Federal Regulatory Environment - Overview

National Ambient Air Quality Standards (NAAQS)	Resource Conservation & Recovery Act (RCRA)	National Pollutant Discharge Elimination System (NPDES)	Land Application of Digestate	Environmental Justice (EJ)
Clean Air Act requires EPA to set NAAQS for 6 criteria pollutants: CO, PM, No2, Pb, O_3, SO2 Title V, 40 CFR Part 70 **Complexity of the air permitting regulations, consult with an expert on Title V permitting process.**	Subtitle D requirements for landfilling of non-hazardous solid wastes. • Depends on state, AD facility to be located – may be exempt from solid waste permitting requirements. • Depends on type and volume of feedstock. **Conduct due diligence report or organics feedstock evaluation.**	Discharge from an AD system to waters of the U.S. or to a municipal (publicly owned) Wastewater Treatment Plant (POTW) requires an NPDES or pretreatment program discharge permit. Stormwater discharge during construction and from AD facilities.	Sewage Sludge Regulations promulgated under the Clean Water. RCRA Subtitle D requirements state environmental agencies will manage the beneficial use of industrial non-hazardous secondary materials.	Executive Order 12898 Practices & NEPA: Federal Action to Address Environmental Justice in Minority & Low-Income Populations. Public health & industry data to minimize nuisance impact to neighbors. **Develop public participation strategies, job creation potential, facility location.** **- Build Trust**

Environmental Justice Mapping Tools by State

	EJ Mapping Tool
U.S.EPA	EPA EJScreen: EJ Screening and Mapping Tool
Council on Environmental Quality	Climate and Economic Justice Screening Tool
California	CalEnviroScreen 4.0
Colorado	Colorado Enviroscreen
Connecticut	CTDEEP Environmental Justice
Illinois	Illinois Environmental Justice
Maryland	MDE Environmental Justice Screening Tool
Massachusetts	MA Environmental Justice Populations 2020

	EJ Mapping Tool
Michigan	MiEJScreen: Environmental Justice Screening Tool
Minnesota	MPCA Environmental Justice
New Jersey	NJDEP Environmental Justice
New York State	NYS GIS Tools for Environmental Justice
North Carolina	DEQ NC Community Mapping System
Pennsylvania	PA Environmental Justice Areas
Virginia	VA DEQ Environmental Data Hub
Washington State	Washington Environmental Health Disparities Map

NEWMOA/NERC Regulatory Guide *New!*

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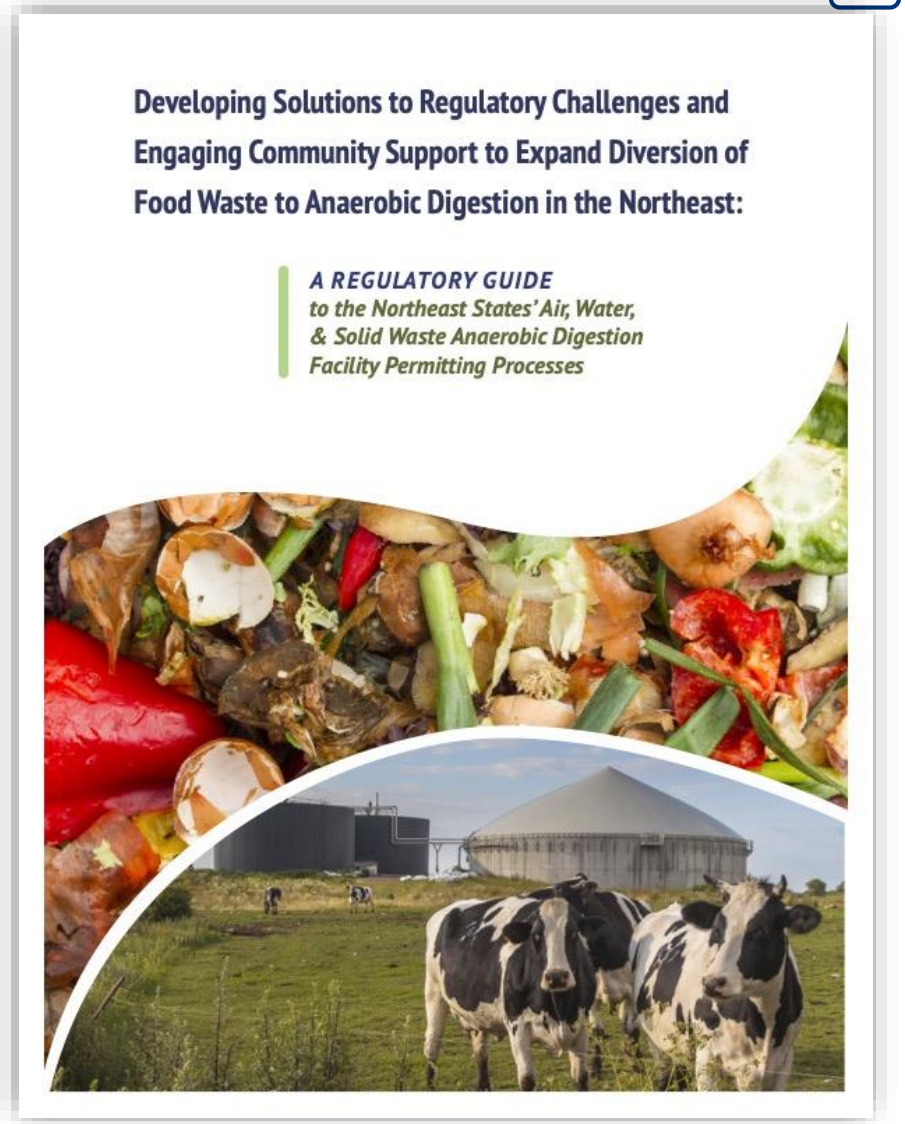
For AD Developers:

- Provide a baseline understanding of regulations.
- Overview requirements for new development opportunities in the 11 Northeast states.



Example: Wet AD System Co-Located at Landfill Facility

100 TPD of Food Waste

$30 - $40M in CAPEX

$1.3 - $1.8M per year in OPEX

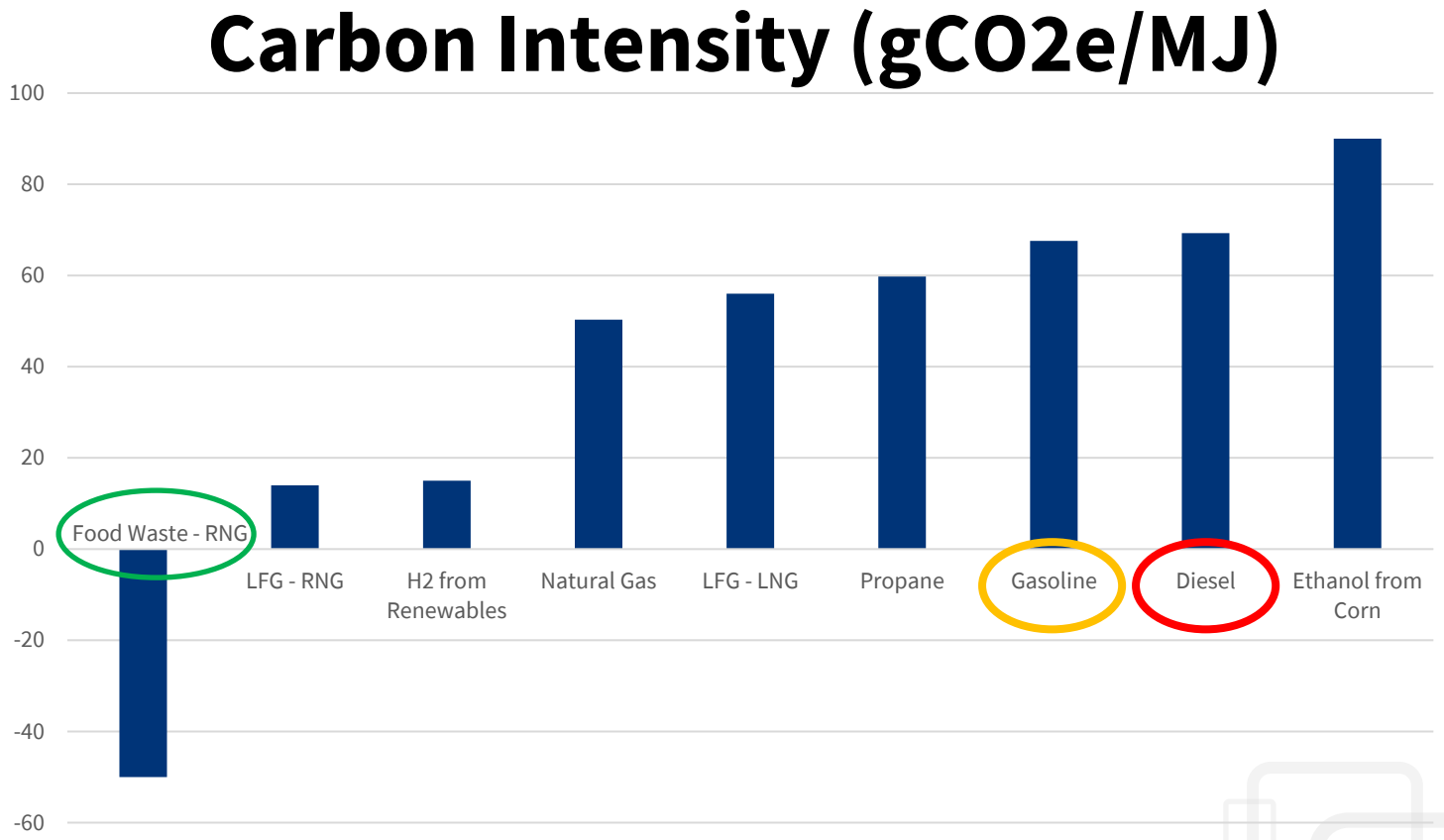
_____

Over 20 years of operation ~ **$81M Cost**
At $50 per ton Tipping Fee ~ **$88M Revenue**
- (not including biogas revenue)

350-400 scfm of biogas @ 60-65% CH4

Added Benefit
Utilize the generated biogas in an existing gas utilization project or create a new stand-alone AD project.

Environmental Attributes

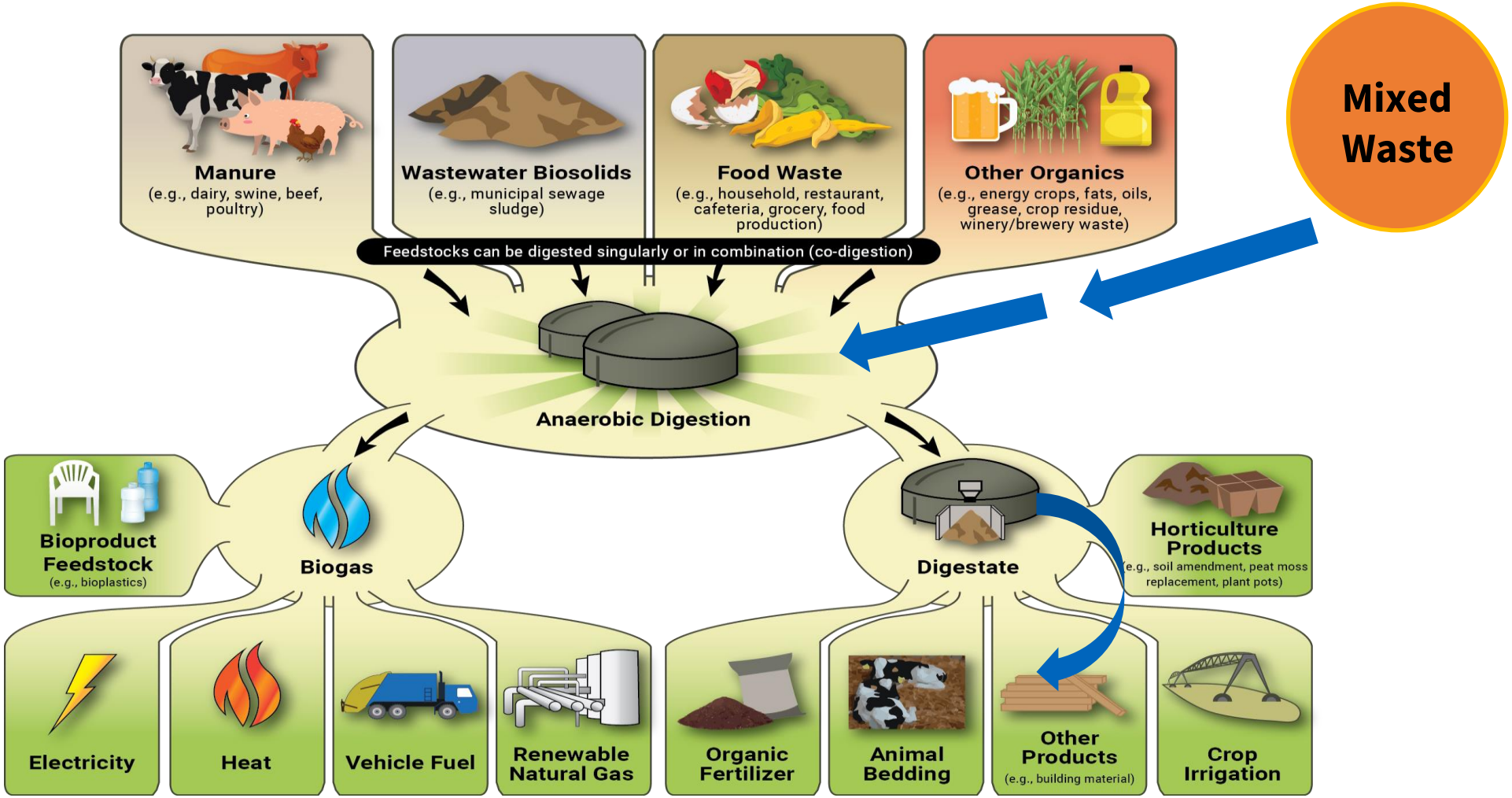


Sources: US Energy Information Administration FAQS https://www.eia.gov/tools/faqs/faq.php?id=73&t=11, and
California Air Resources Board, Carbon Intensity Values of Certified Pathways https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities.

Key Siting Considerations

- Policy and Regulatory Aspects (Federal/State/Municipal)
- Waste Characteristics/Sources
- Technologies
- Location
  - Source of Organics
  - Proximity to NG Pipeline or Electric Grid
  - Proximity to end use of Digestate
  - Proximity to Sensitive Receptors
- Financial Outcome
  - CAPEX, OPEX, Revenues

EPA AgSTAR: Anaerobic System Design and Technology



Source: [EPA AgSTAR AD System Design and Technology]

Technologies

- Dry AD
  - Garage style
  - Plug flow digesters
- Wet AD
- Depackaging
  - Preprocessing and Postprocessing requirements

Anaerobic Digestion – Dry Technologies

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Dry (High Solids)

1. **Garage style**
2. **Plug flow digesters**

- Commonly used for source separated organics (SSO) including food waste and woody materials such as yard waste.
- Substrate is 20% to 50% total solids
- Higher solids content equates to higher transport efficiencies in comparison to wet systems where 90% or more of the feedstock transported is simply water.
- Typically higher CAPEX

Anaerobic Digestion – Wet Technology

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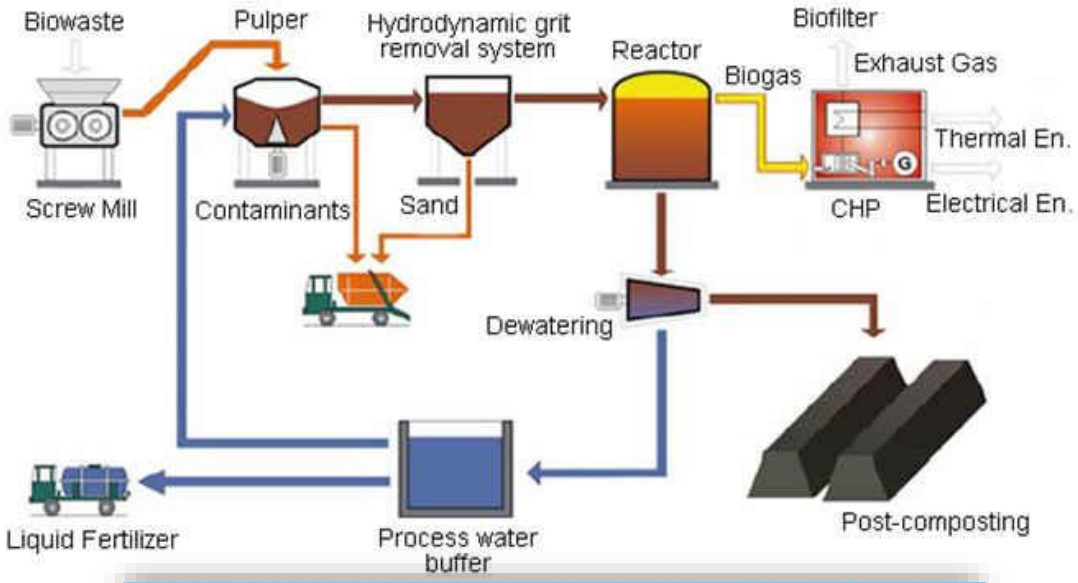
Wet AD (Low Solids)

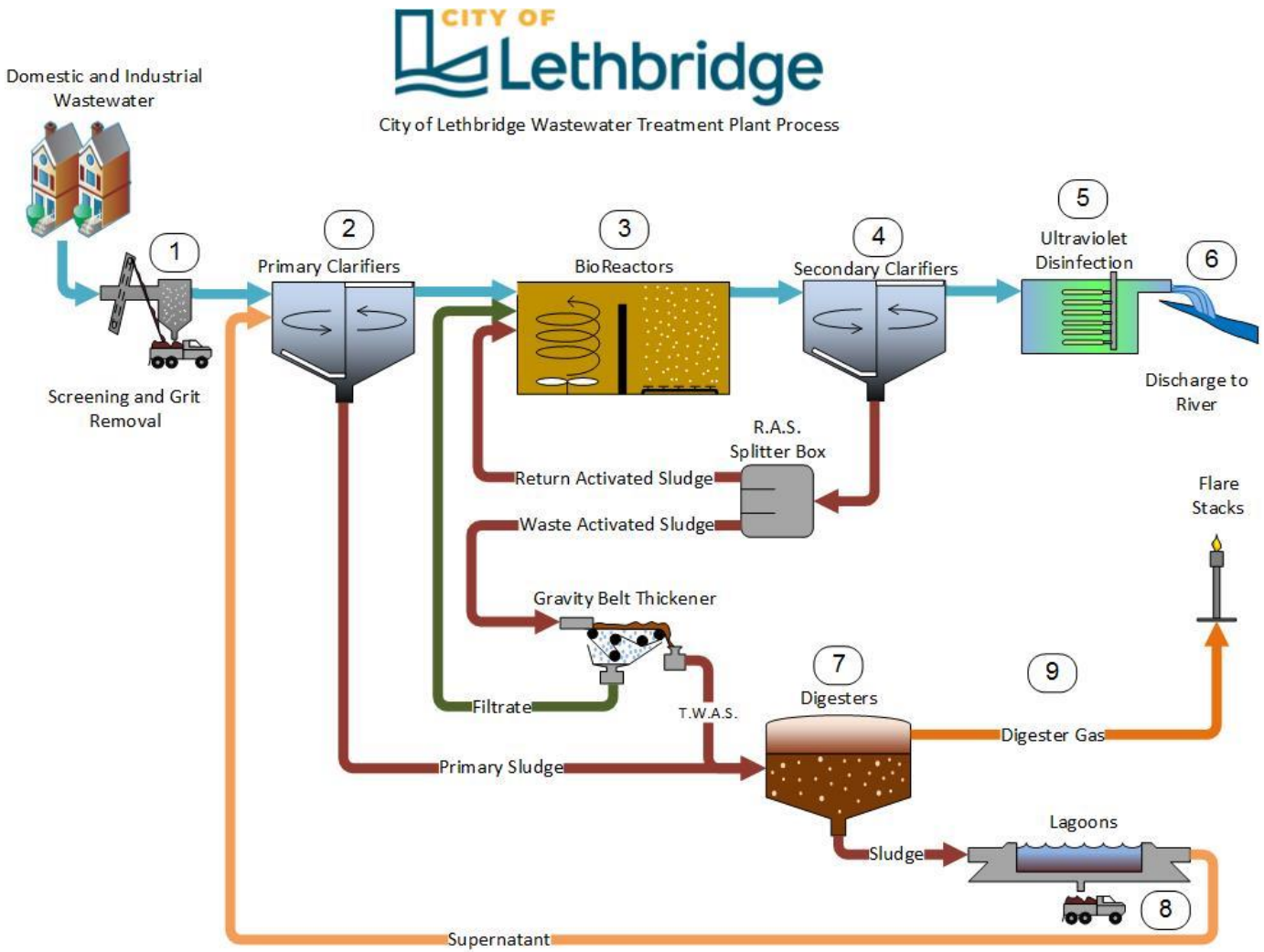
- Similar biological process as Dry
- Substrate is a slurry (<15% total solids by mass)
- Co-digestion of wastewater treatment residuals (biosolids) with source separated organics (SSO) from MSW is underway at WWTF.
  - No yard waste
  - Food waste and biosolids as feedstocks
  - Person hygiene products (i.e., diapers) can be included in some processes



Wet Co-Digestion At Existing WWTF

- Utilize available digester capacity at wastewater treatment facility
- Increase biogas quality and quantity that could be sold and/or used to supplement energy use at the plant
- Increase reaction time in the reactor

Wastewater Treatment Facility



- Low Solids (5%) Biogas Generation
- Lower due to Low Solids
- Typically flared

Residential Curbside Organics

Wet AD versus Dry AD

- Wet creates more Biogas
- Dry more adaptable to Leaf and Yard Waste
- Plug flow fits between Wet and Dry AD

Location

- Proximity to Feedstocks
  - Transportation
  - Timing
- Proximity to End-Markets
  - Digestate
  - NG pipeline
- Proximity to Sensitive Receptors
  - Odor
  - Traffic
  - Community Engagement (EJ)

Economics

- Capital costs (CAPEX)
  - Technologies (wet to dry)
- Operating costs (OPEX)
- Revenues
  - Tipping Fees
    - MSW, ICI Organics, Other materials
  - RNG revenues
  - Electrical Revenues
  - Others

RNG Market US

- Three Potential Markets
  - Transport Fuel Market
  - Voluntary Market
  - Emerging Market
- RIN/LCFS (Renewable Identification Number/Low Carbon Fuel Standard)
  - D3 and D5
  - Daily Rates
- CI (Carbon Intensity) - LCA
- Approximate value – 6-10 X NG value ($32/MMBtu)

RNG Market Canada

Federal and Provincial Organics Policies

- Organics bans – purchase credits from Canada for the US
- Key drivers: BC and Quebec (future Ontario)
  - Gas providers have mandates (5% by 2026 / 20% by 2030) – forcing gas companies to buy credits from outside these provinces.
- CI measured
- Longer term contract (10 to 15 year)
- Approximately $24/MMBtu

Organics Diversion and Infrastructure for a Circular Economy

Anaerobic Digestion Technology

Due Diligence

Planning

Feedstock Market Analysis

Equipment Evaluations and Recommendations

Civil & Facility Design / Permitting

Sustainability

Zero Waste and Waste Reduction

Solid Waste Planning / Materials Management

Stakeholder Engagement

Wrap Up

- Existing Facilities should consider the changes coming to the industry. (It's here!)
- Organics Infrastructure needed for service area.
- Leverage opportunities
- Create end-markets and new revenue streams.
- Circular Economy

Thank You! Questions?

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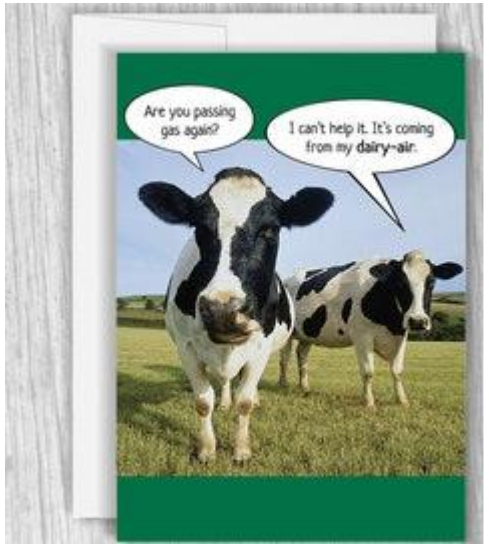
AAHHHHH!


Are you passing gas again?
I can't help it. It's coming from my dairy-air.