GREATER LAWRENCE SANITARY DISTRICT

Discussion of Co-Digestion Start-up Experience
2nd North East Digestion Roundtable
April 9, 2021

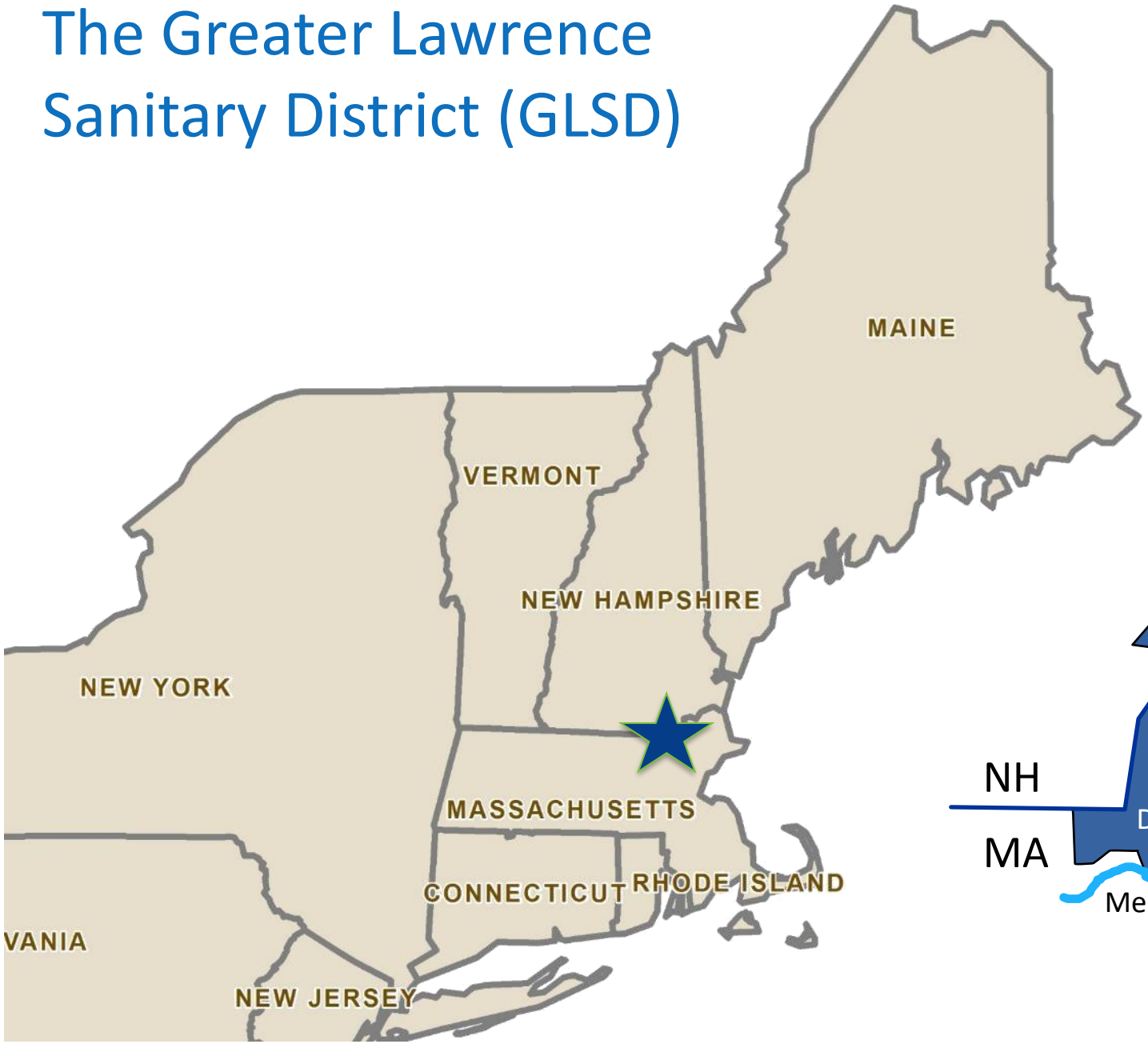
Discussion Topics

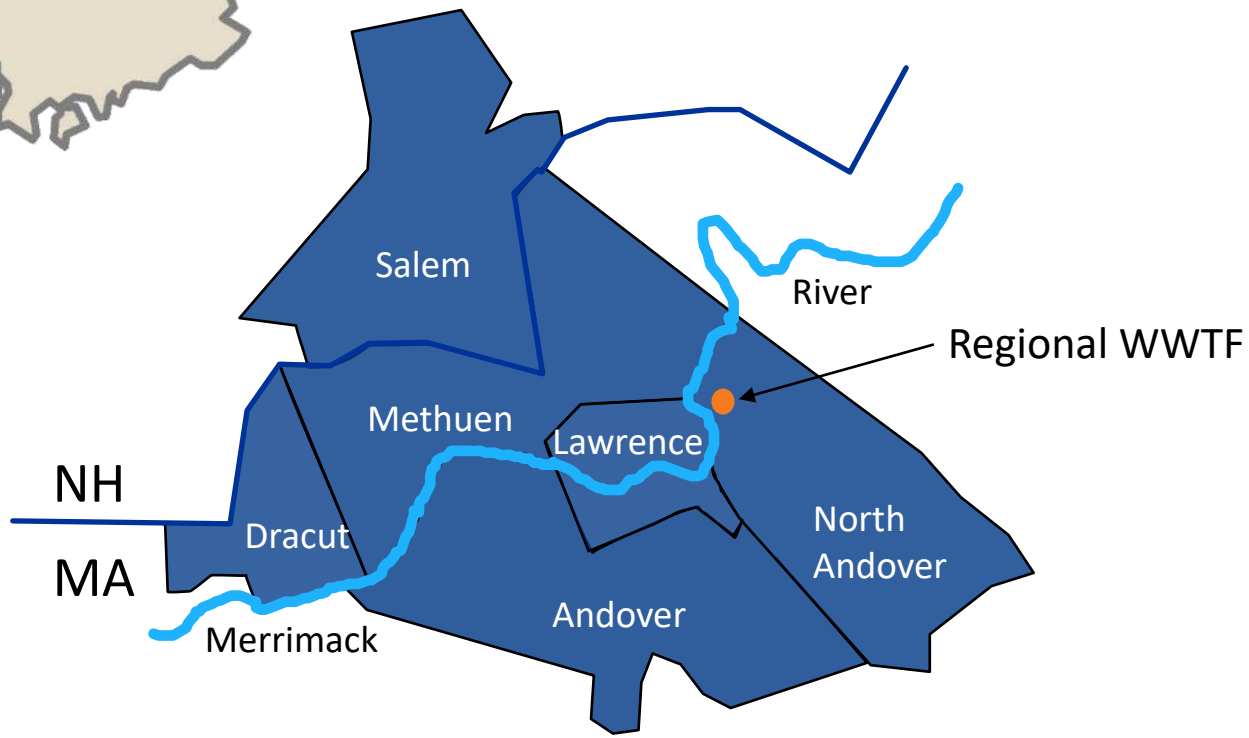
- GLSD Background & Sustainability Efforts
- Organics Ban & Co-Digestion Opportunity
- Project Components
- Start-up, Operation & Process Monitoring
- Costs & Funding
- Challenges & Highlights
- Questions

GLSD Background

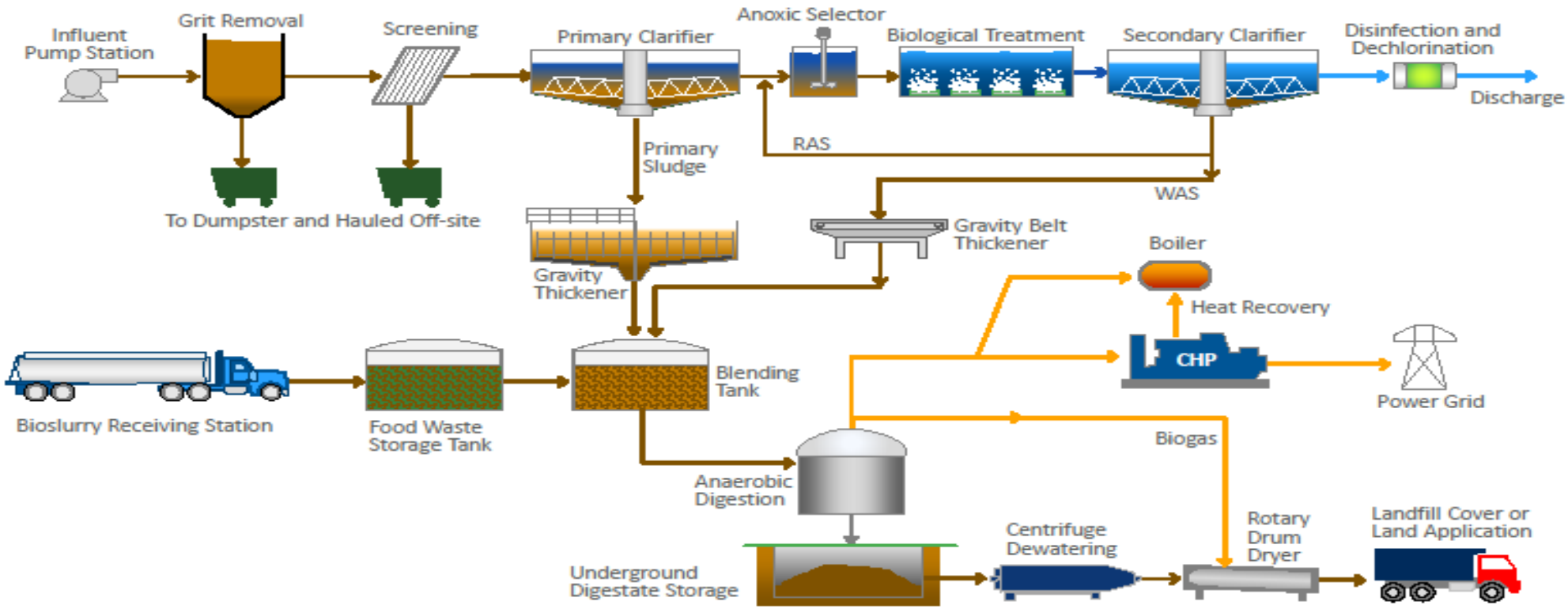
- Established by Legislation in 1968
- WWTP Operational Since April 1977
- Government Entity, Governed by a Board of Commissioners from Communities Serviced
- Regulated by US EPA & MADEP
- Design flow 52 mgd avg, 135 mgd peak
- Class A Biosolids Heat Drying Facility Built in 2002, ~ 5,000 Tons/Yr of Fertilizer Pellets
- 100% of Class A Fertilizer is sold to local farmers and landscapers every year

The Greater Lawrence Sanitary District (GLSD)



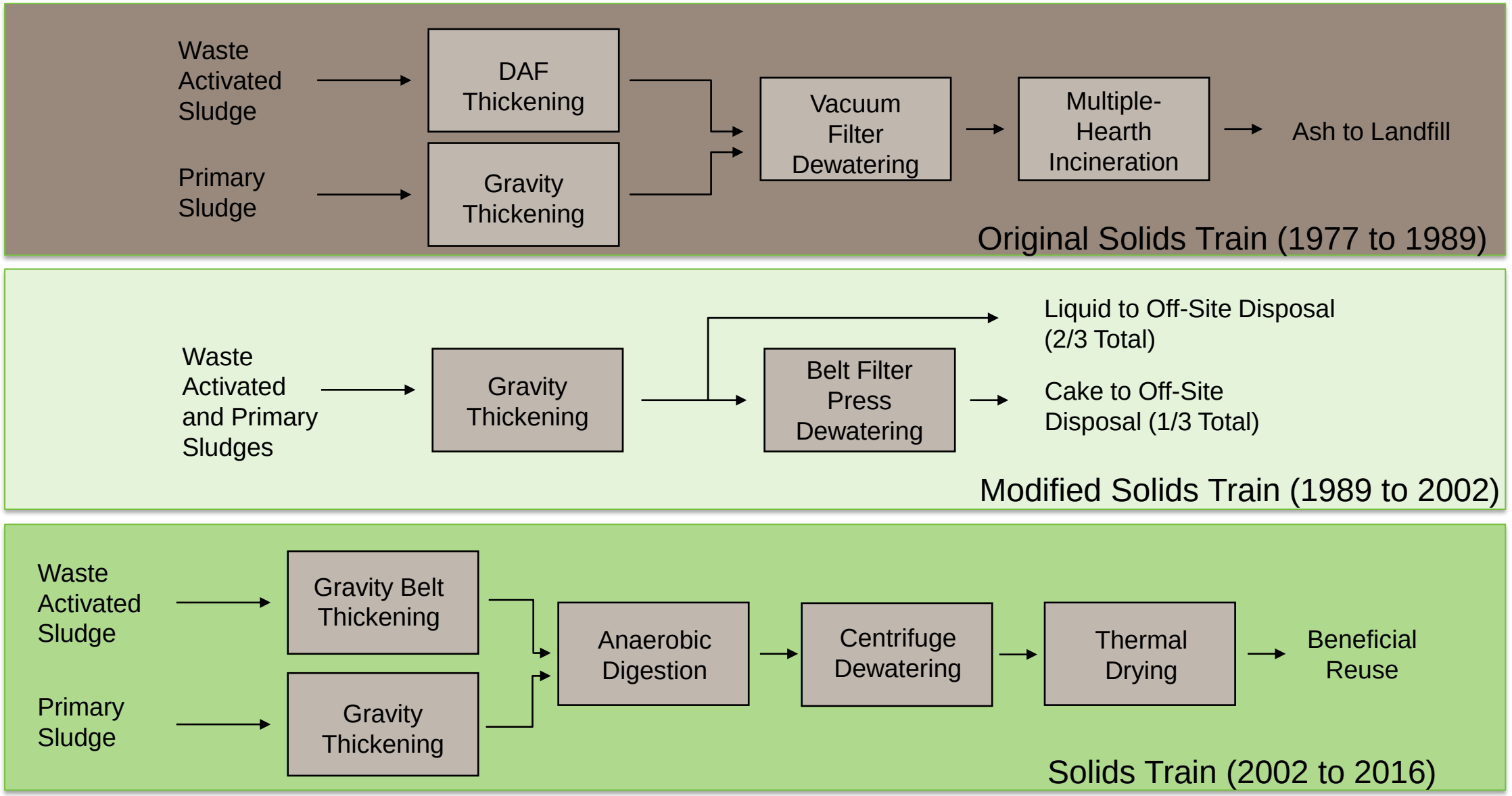


Greater Lawrence Sanitation District - Process Flow Diagram



Provided by Black and Veatch, April 2021

Evolution of Biosolids Management at GLSD



GLSD's Biosolids Recycling Program

Branded and distributed in bulk and bagged products under the **earthlife®** brand

earthlife®

Over **5,000 tons** sold annually to agriculture and landscape projects **since 2004**

A **Massachusetts** manufactured slow release product with **NPK** of **4-2-0 +Iron**

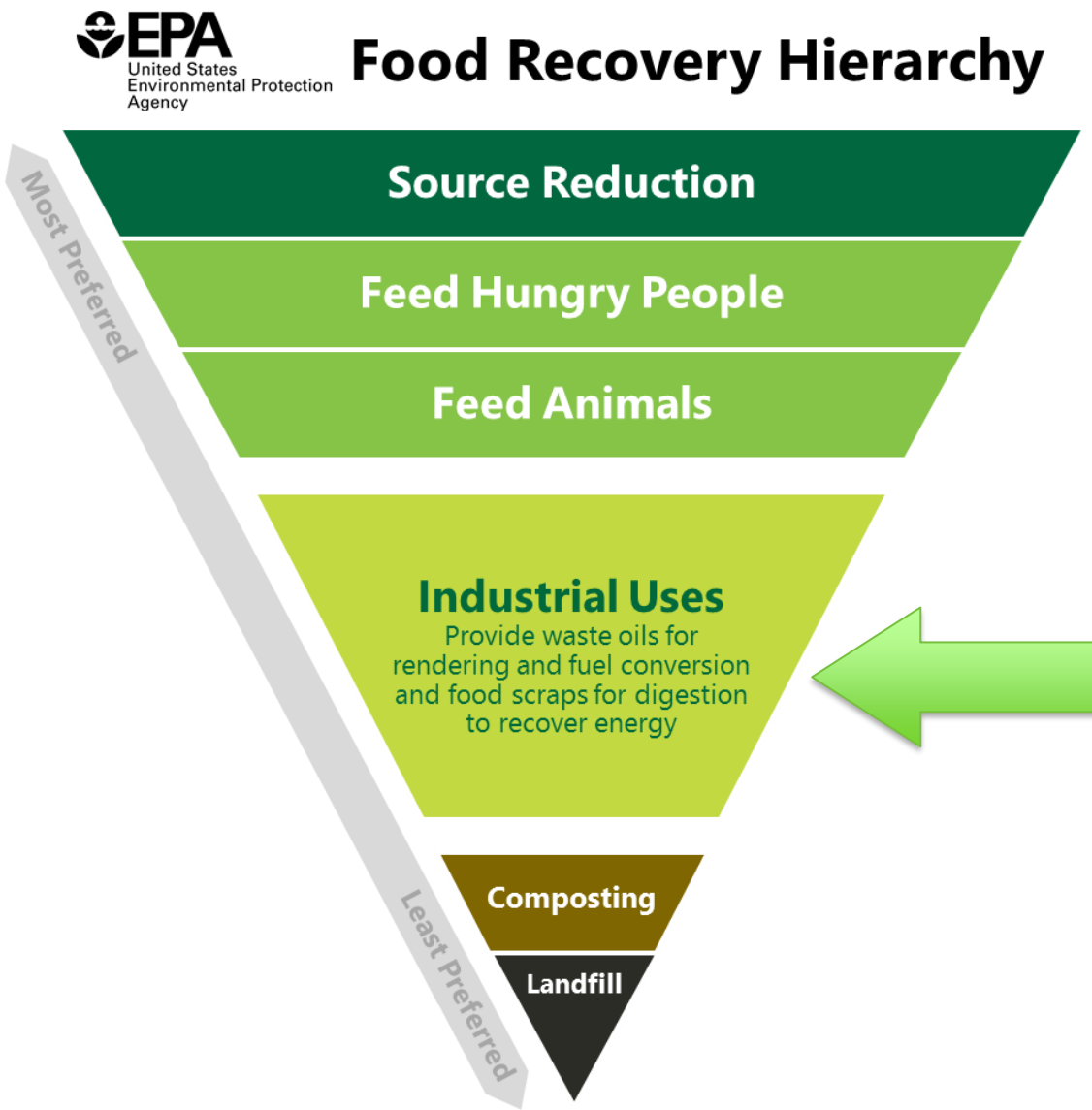
EPA Certified Class A EQ (Excellent Quality) product and is a **Registered Fertilizer** (#371) with the State of Massachusetts

EPA

Reducing local agriculture's **dependence** on **inorganic fertilizers** made from **fossil fuels**

Massachusetts Organic Waste Disposal Ban

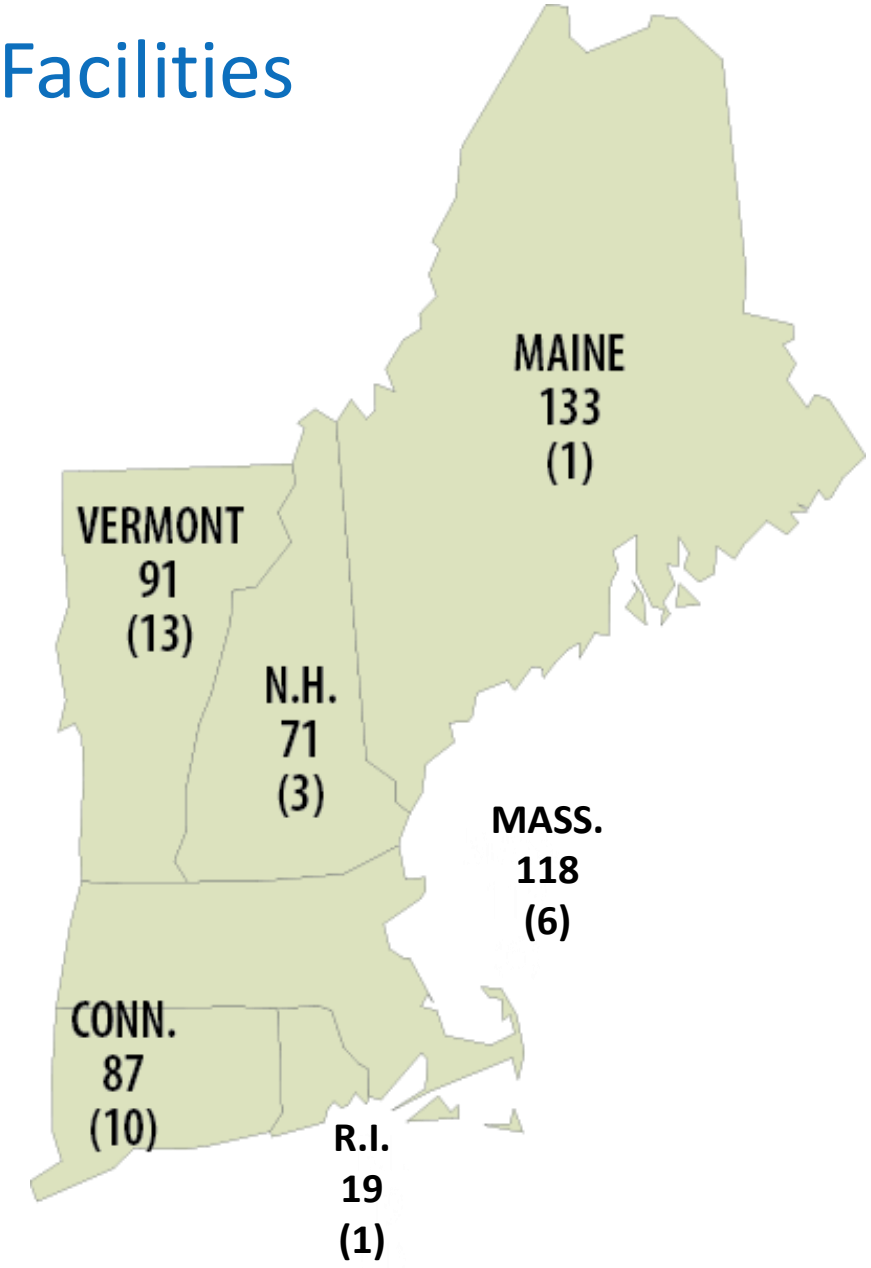
- Effective October 1, 2014 – Producers of >1 ton of food waste per week banned from landfills or incinerators
- Food waste must now be diverted to Food Kitchens, or recycled through composting or anaerobic digestion
- Impacts hotels, restaurants, universities, hospitals, supermarkets, food processors and wholesalers
- The Massachusetts State Master Plan targeted diversion of >35%, or over 350,000 tons per year of Source Separated Organics (SSO), by 2020.
- Long-term target is 80% diversion by 2050



- EPA and MA State Solid Waste Hierarchy encourages both composting and anaerobic digestion
- Anaerobic Digestion is favored due to opportunity for energy recovery + nutrient recovery. It's a "Two-Fer"
- Anaerobic Digestion results in lower GHG emissions and displaces fossil fuel usage with Renewable Natural Gas
- Co-Digestion at existing WWTPs is a uniquely urban solution for food waste, and uses existing infrastructure

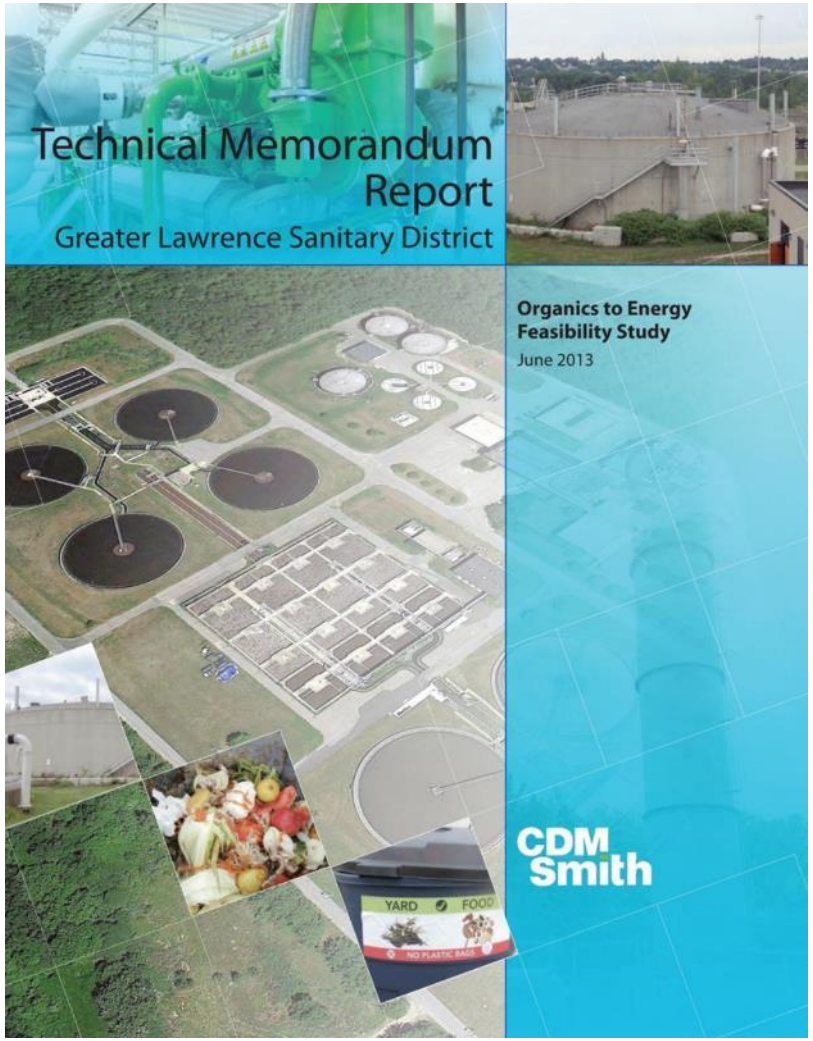
Limited New England Digestion Facilities

- Acceptable outlets include digestion facilities
- GLSD is one of only six in Massachusetts
- Second largest digestion facility in Massachusetts



GLSD Co-Digestion Feasibility Study (June 2013)

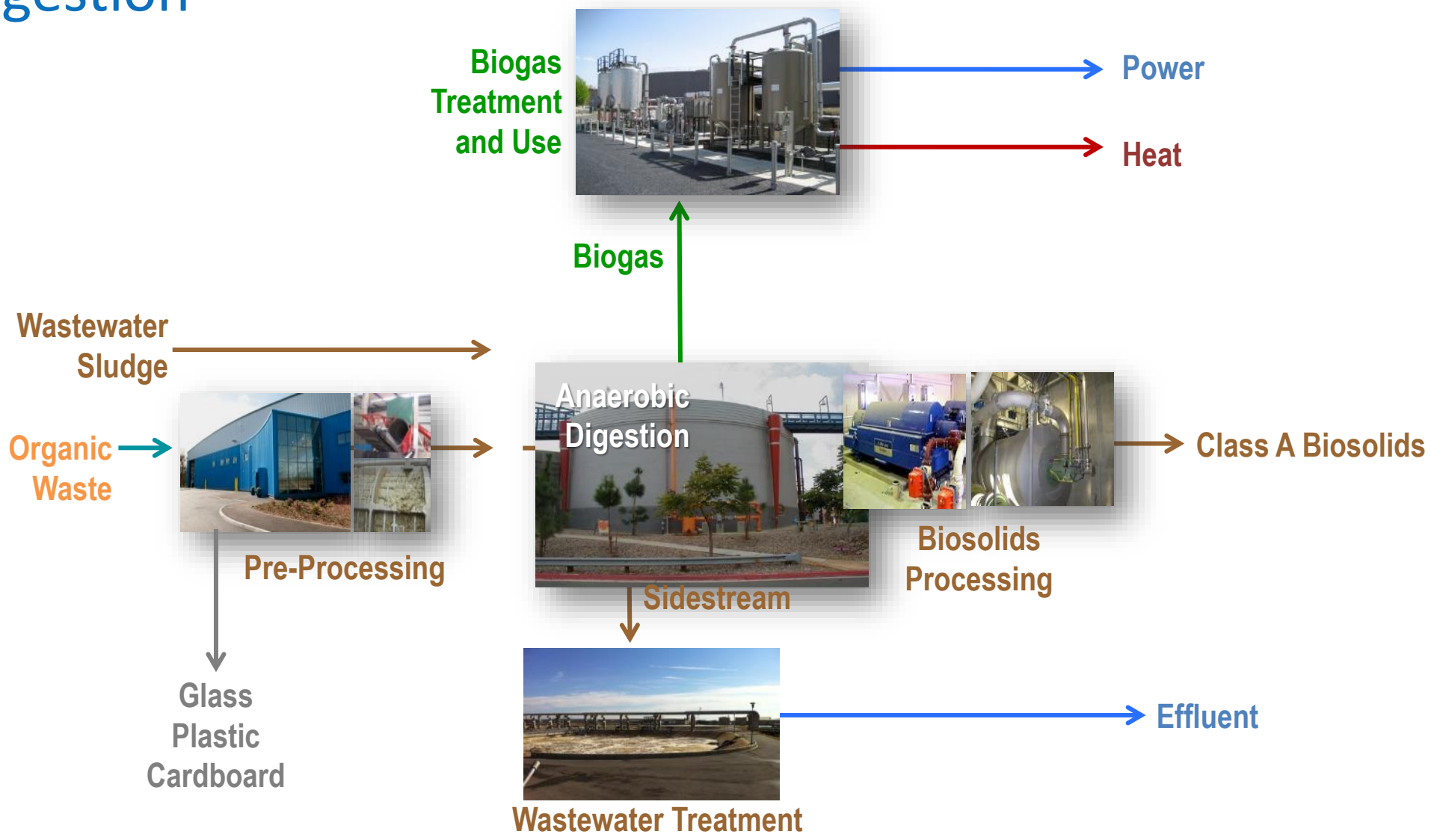
- GLSD could handle ~28,000 gpd of SSO material in existing digestion system
- Could accept up to 92,000 gpd of SSO material with addition of 4th digester
- GLSD has the potential to generate >100% of its WWTP energy needs using 100% renewable energy
- Project could eliminate $2.8 M annual electrical costs & provide stable back up power to facility
- At full capacity, GLSD will meet a sizable fraction of the State's goal for SSO diversion based on DEP projections

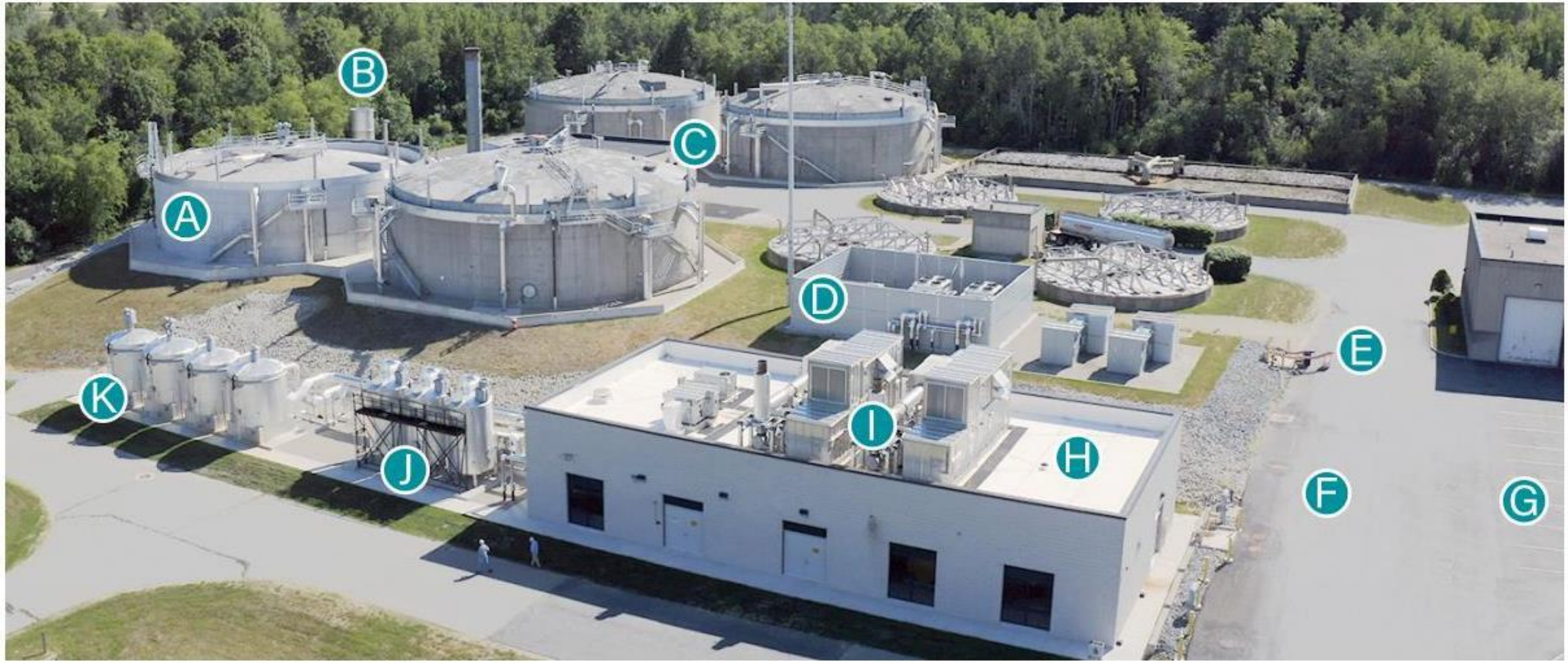


Impact of Co-Digestion on Biogas Production

	Biosolids	Source Separated Organic (SSO) Food Waste
Feed Stock (Gal/Day)	10,000	10,000
Solids (%)	5	13
Volatile Solids (%)	75	85
Volatile Solids Converted (%)	55	82
Biogas Yield (Cubic Feet/lb)	15	13.5
Biogas Volume (Cubic Feet/day)	**26,000**	**102,000**
Energy Produced (MMBTU/day)	**14**	**56**
Potential Electrical Production (kWH/yr)	**600,000**	**2,300,000**

Co-Digestion





GLSD Organics to Energy Project Components

- A Digester #4
- B Waste Gas Burner
- C Digester Equipment Upgrades
- D Radiators and Chillers
- E Organic Waste Receiving Station
- F Organic Waste Receiving Tanks *(below grade)*
- G Organic Waste Pump Station *(below grade)*
- H Cogeneration Building
- I CHP Exhaust Treatment (Oxidation Catalysts & Selective Catalytic Reduction)
- J Siloxane Removal
- K H_2S Removal

Organic Waste Receiving and Conveyance

Truck Offload Stations

Receiving Tanks

Transfer & Mix Pumping Station

Anaerobic Digester No. 4

- 1.4-MG volume
- Draft tube mixers & Steel gas-holding cover
- Space available within existing building for new equipment

Biogas Conveyance and Treatment

Fixed media H2S & siloxane treatment

Expanded gas conveyance capacity

New flare for increased capacity

Combined Heat & Power (CHP) Production

- Two reciprocating CHP generators
- Total capacity of 3.2 MW
- Space for future third engine
- Power fed to site electrical system and net metered to the utility grid
- Projected avg power demands:
  - Plant: 1,700 kW (onsite)
  - RSPS: 700 kW (via net metering)
- Heat captured to supply digesters and other on-site heating demands

CHP Engine Emissions Control

- Oxidation catalyst technology to remove VOC and CO
- Selective Catalytic Reduction (SCR) technology to remove NOX
- Best available control technology as determined by MassDEP

Co-Digestion Pilot Program

- Assess the logistical issues associated with receiving and processing the material.
- Determine impacts on:
  - Digestion operating parameters
    (pH, VFA/Alk, etc, etc)
  - Solids production
  - Gas production
  - Dewatering and thermal drying

Food Waste Conversion to EBS® (Engineered Bioslurry)

CORe® SSO Receipt Hopper & Bioseparator

EBS® Mixing & Storage Tank

EBS® Product

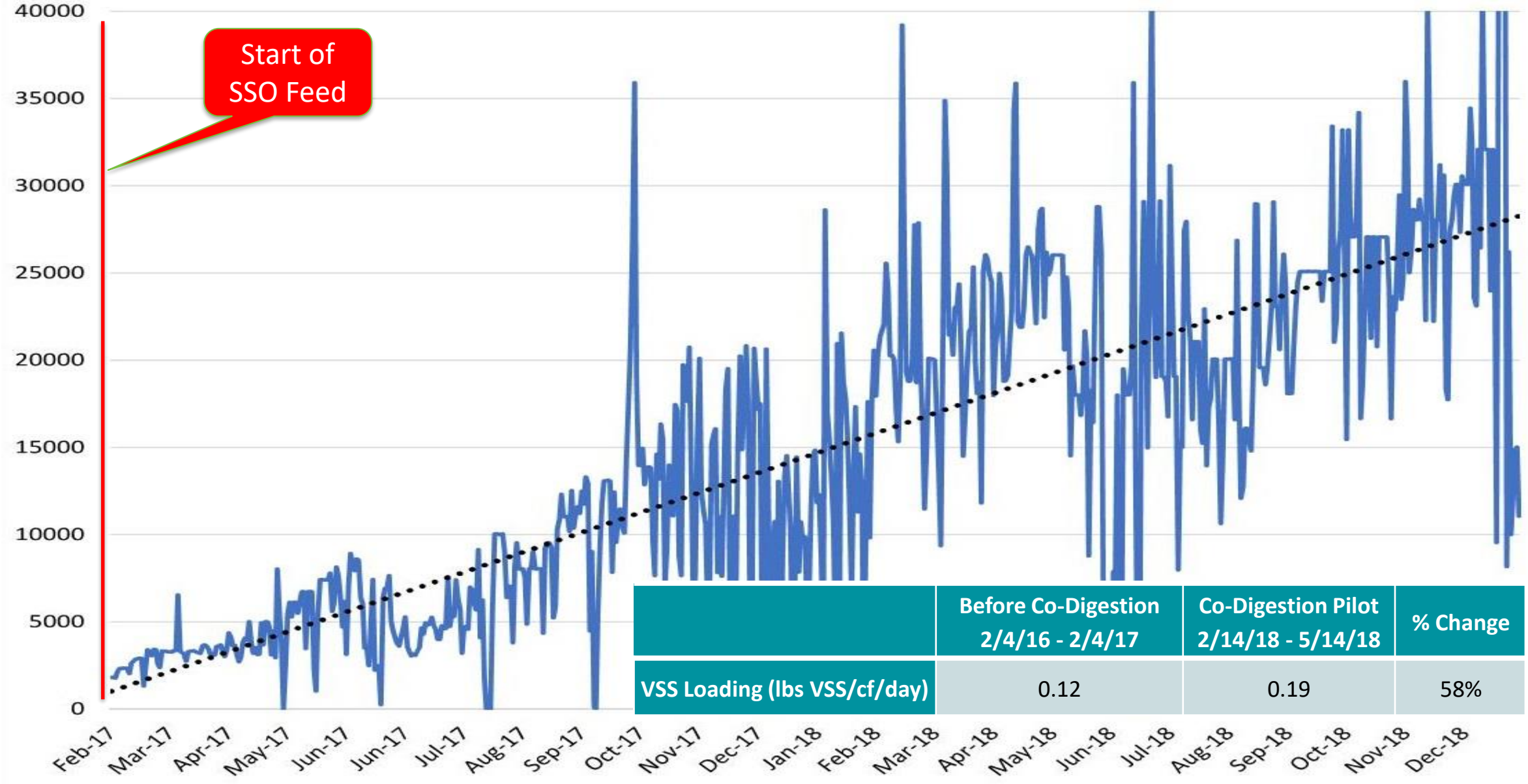
TYPICAL SSO (WM EBS) CHARACTERISTICS

- pH: 3.75
- TSS: 9.15 %
- % TS: 14
- % VS: 93
- %VS/TS 85%
- Total COD: 269,000

Typical Process Performance Before Co-Digestion

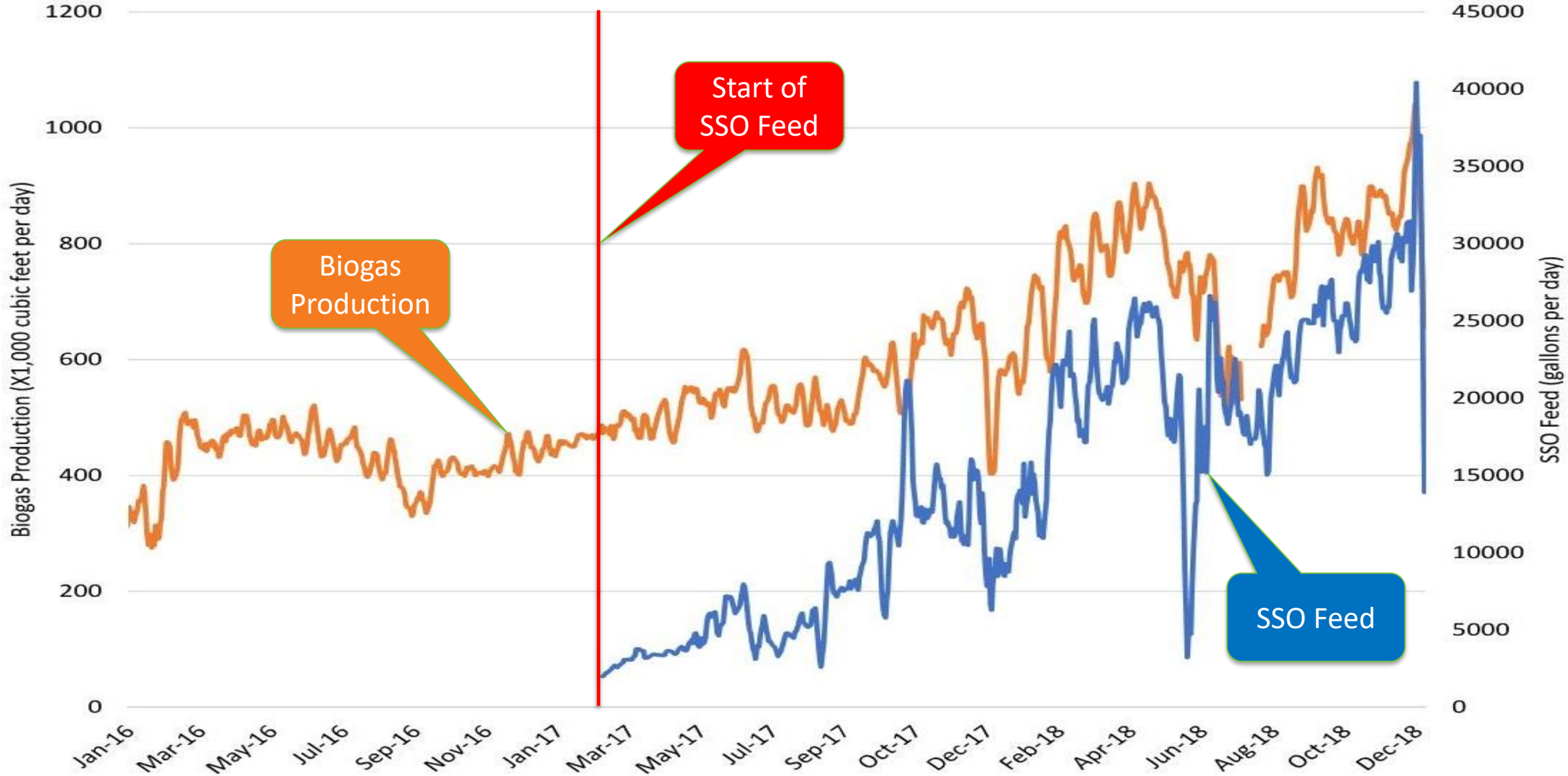
Feed	165,000 gpd
Feed Solids	4.3%
Digestate Solids	2.1%
VSS Reduction	64.3%
Overall Solids Reduction	48.3%
Detention Time	18.4 days
Total Biogas Production	441,000 cf/d

Start-up of SSO Feed (gpd)

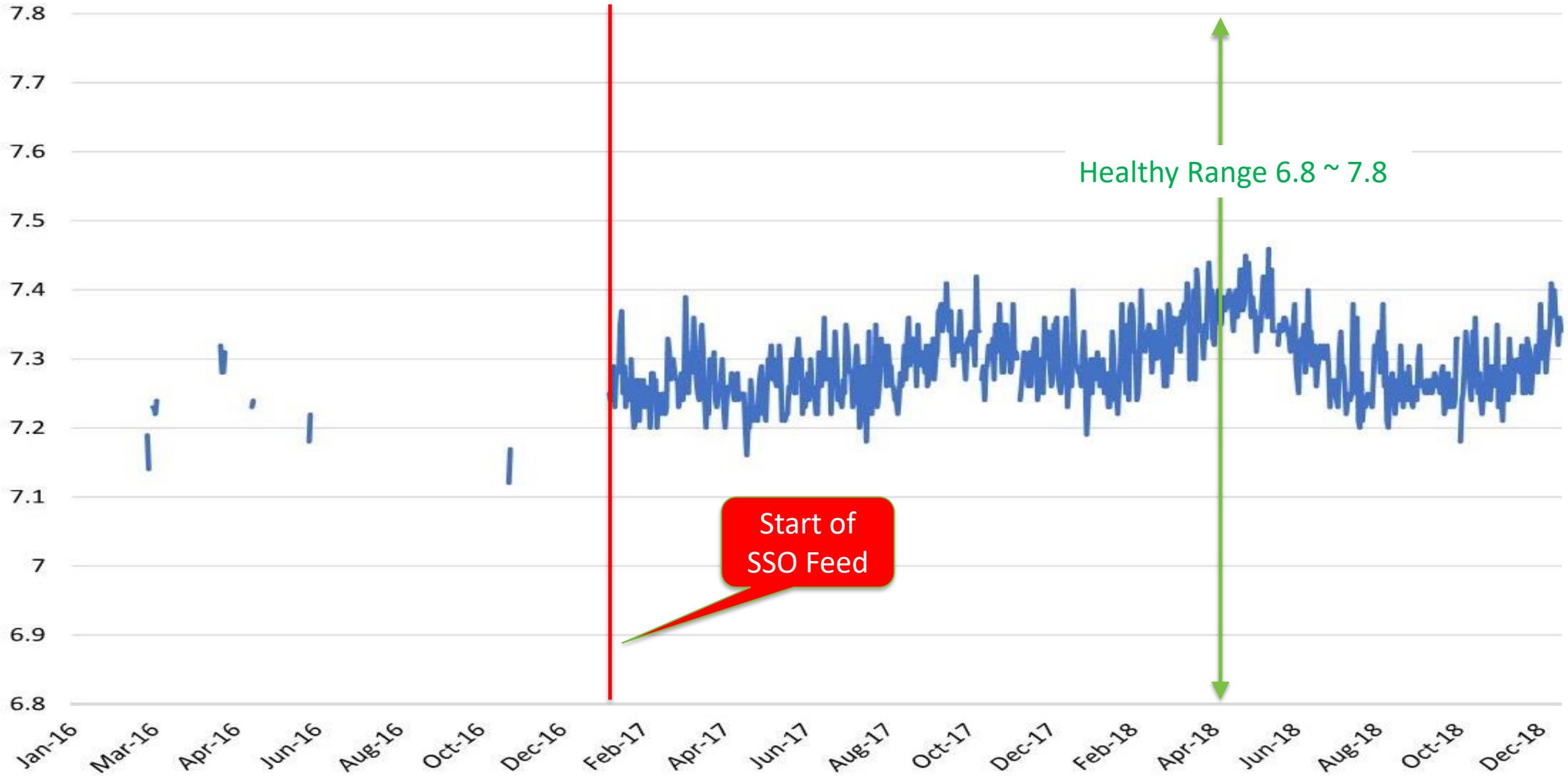


	Before Co-Digestion 2/4/16 - 2/4/17	Co-Digestion Pilot 2/14/18 - 5/14/18	% Change
VSS Loading (lbs VSS/cf/day)	0.12	0.19	58%

Biogas Production (7-day moving average)



Digester pH


7.8
7.7
7.6
7.5
7.4
7.3
7.2
7.1
7
6.9
6.8
Jan-16
Mar-16
Apr-16
Jun-16
Aug-16
Oct-16
Dec-16
Feb-17
Apr-17
Jun-17
Aug-17
Oct-17
Dec-17
Feb-18
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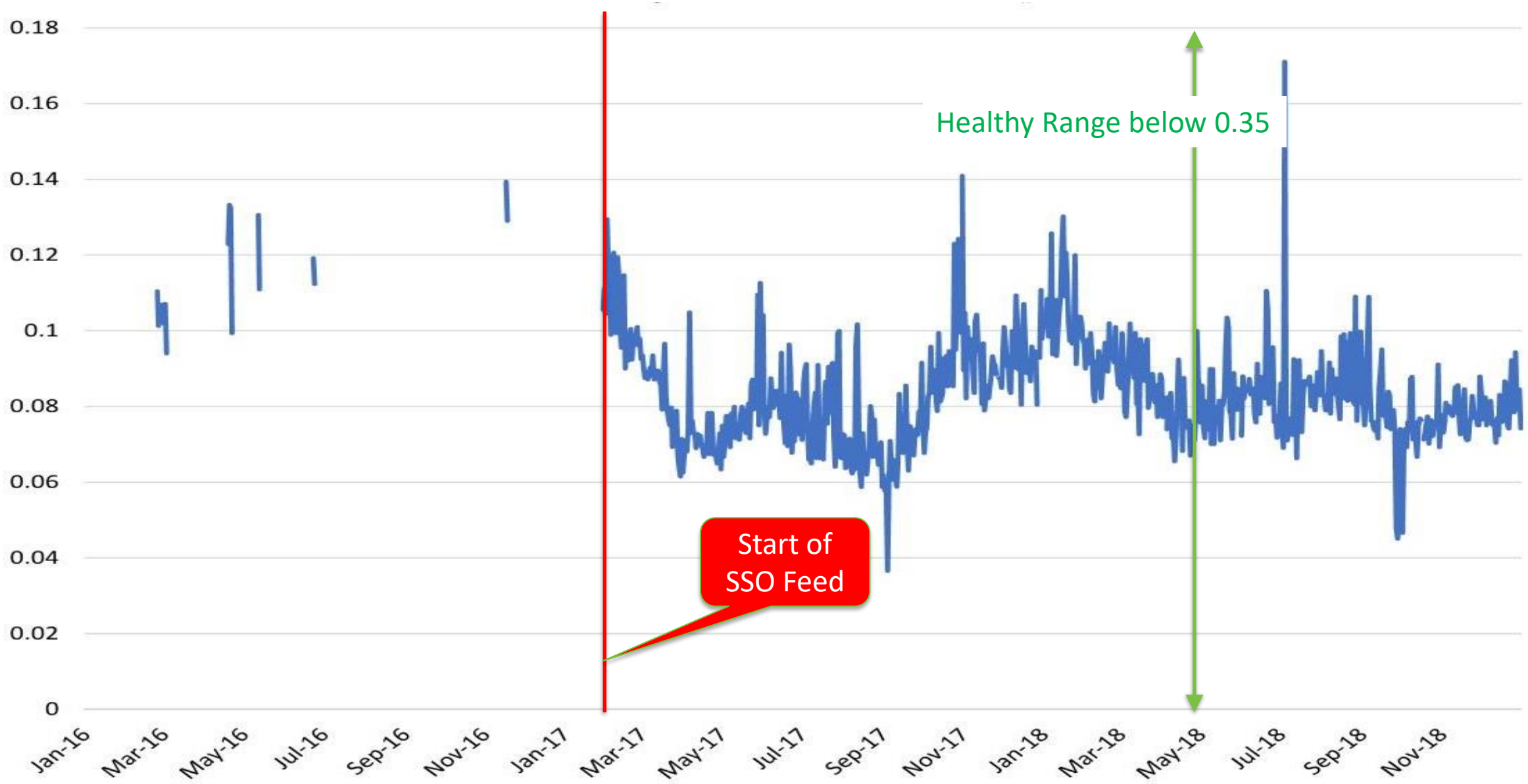
Healthy Range 6.8 ~ 7.8
Start of SSO Feed

Digester Volatile Acid to Alkalinity Ratio



Food Waste Addition and Biogas Production (2020)

Electrical Power Production and Export (2020)

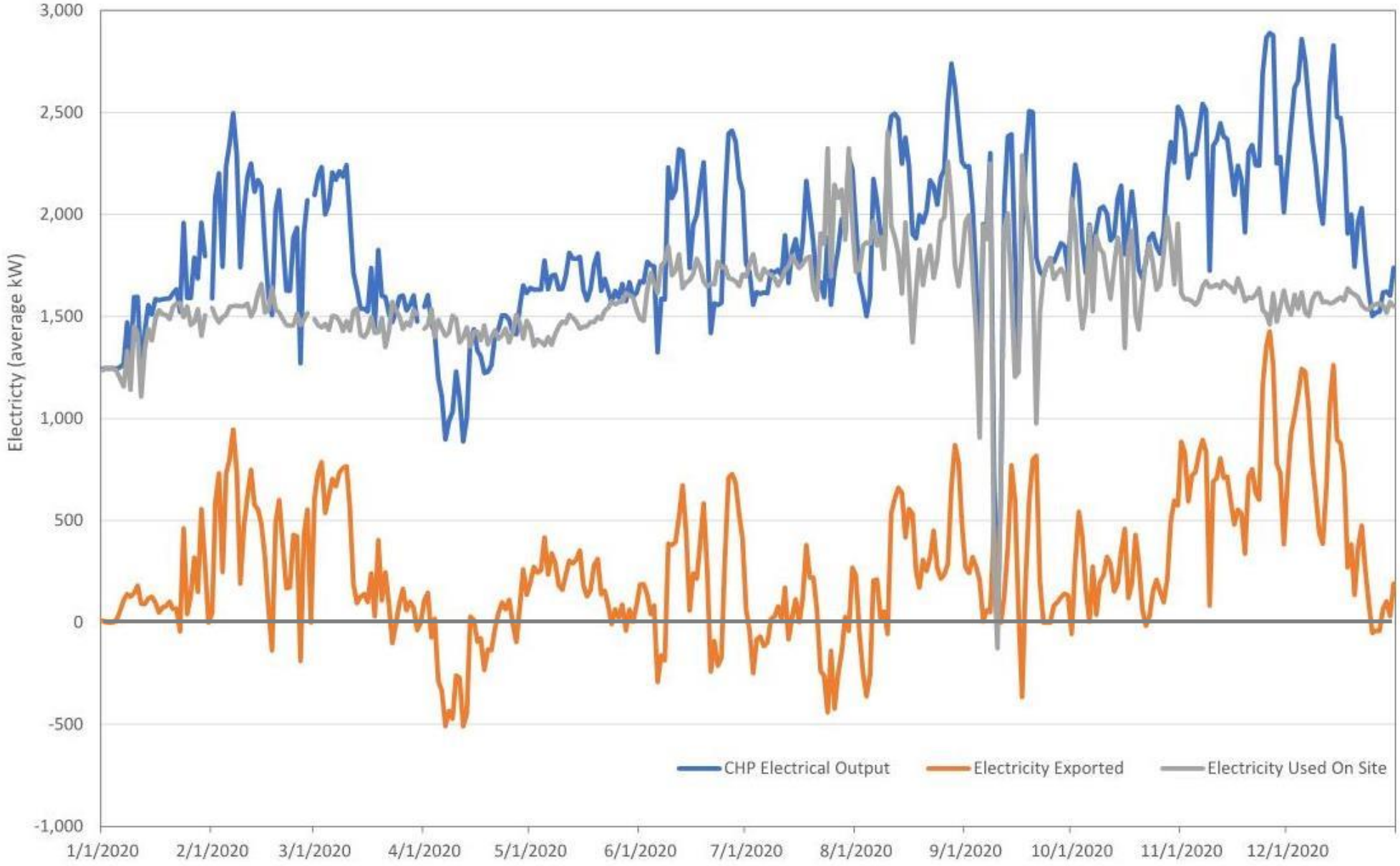


Figure 4
Summary of Clean Energy Production
(Mid-January to Mid-March 2020)

Project Implementation Costs

Construction Cost:	$27,800,000
Grants and Incentives	
Massachusetts Clean Energy Center	$ 400,000
Massachusetts Department of Environmental Protection	$ 500,000
Massachusetts Department of Energy Resources	$5,000,000
National Grid	$2,340,000
MassDEP Principal Forgiveness	$1,597,994
Total Grants and Incentives	$9,837,994

The Economics of Co-Digestion

Credits

Revenue
- Tipping Fees
- Alternative Energy Credits
- Renewable Energy Credits
- Clean Peak Credits

Avoided Cost
- Purchase of Utility Electricity
- Future Increases in Energy Costs

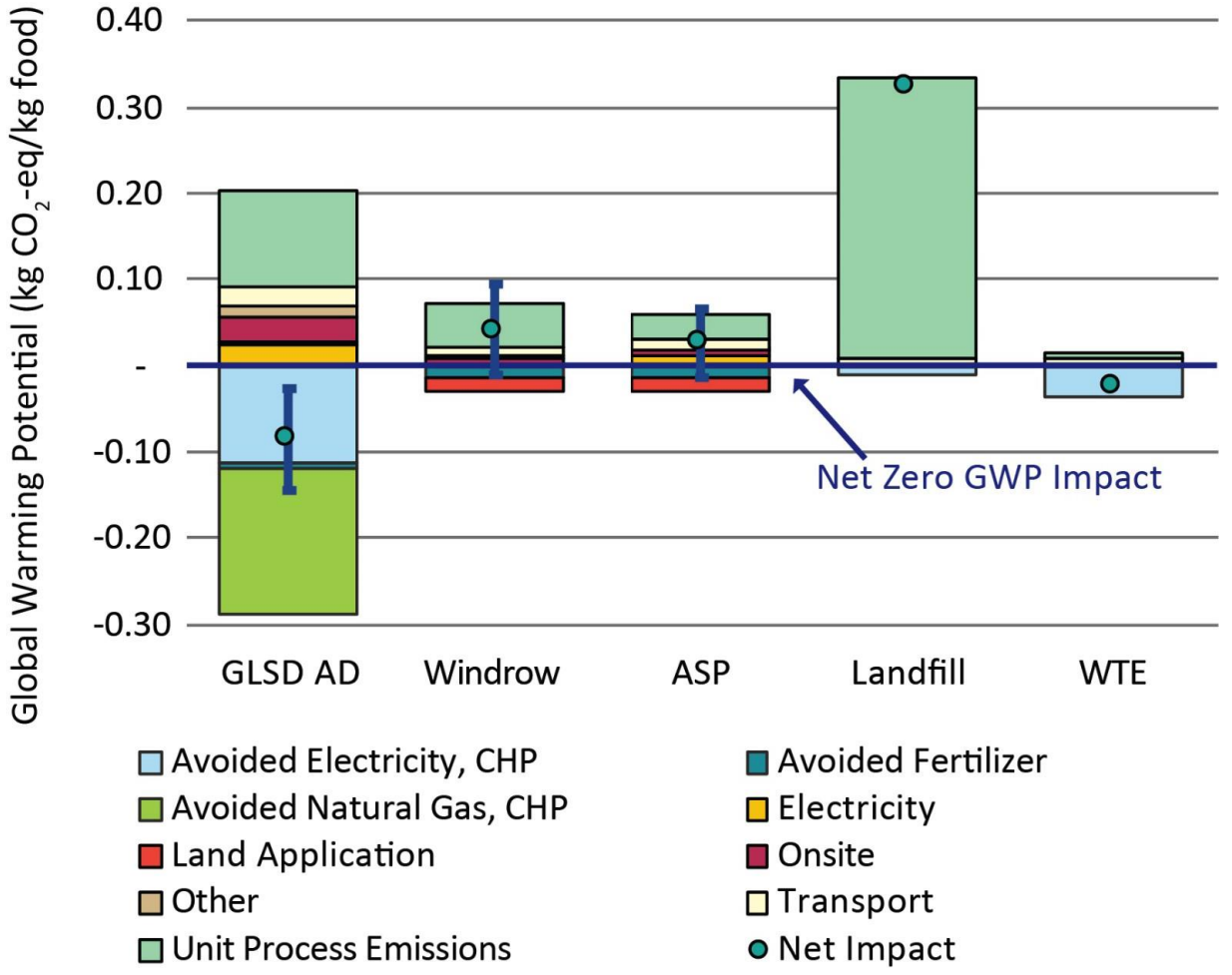
Grants and Incentives
- Mass DEP
- Mass Clean Energy Center
- Mass Department of Energy Resources
- National Grid (Electric Supplier)

Costs

Capital
- SSO Receiving Facilities
- Expansion of Existing Digestion System
- Biogas Treatment
- Combined Heat & Power (CHP) Facilities
- CHP Emissions Control

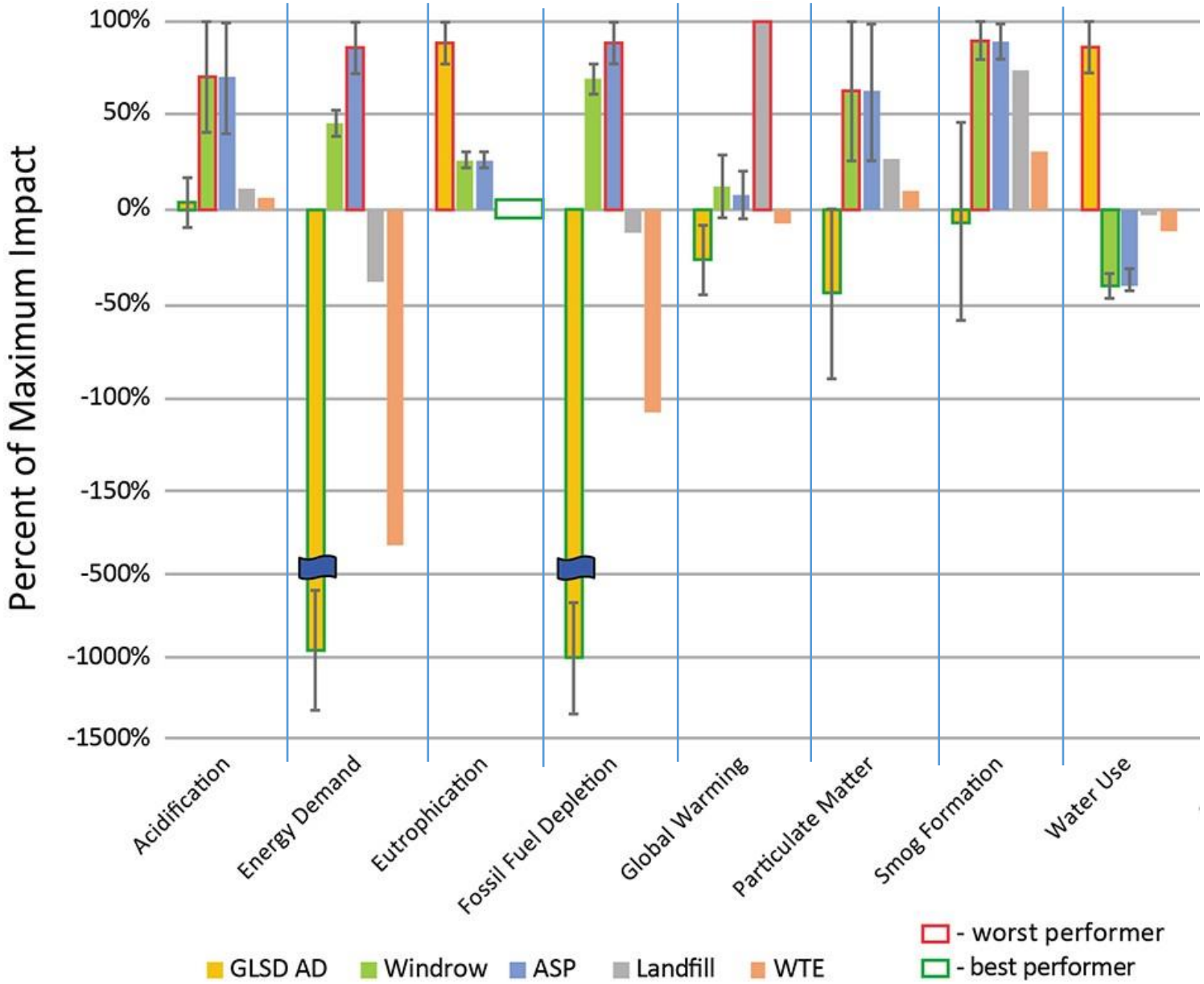
Operations and Maintenance
- Increased Dewatering / Drying Costs
- CHP Maintenance
- Biogas Media Replacement

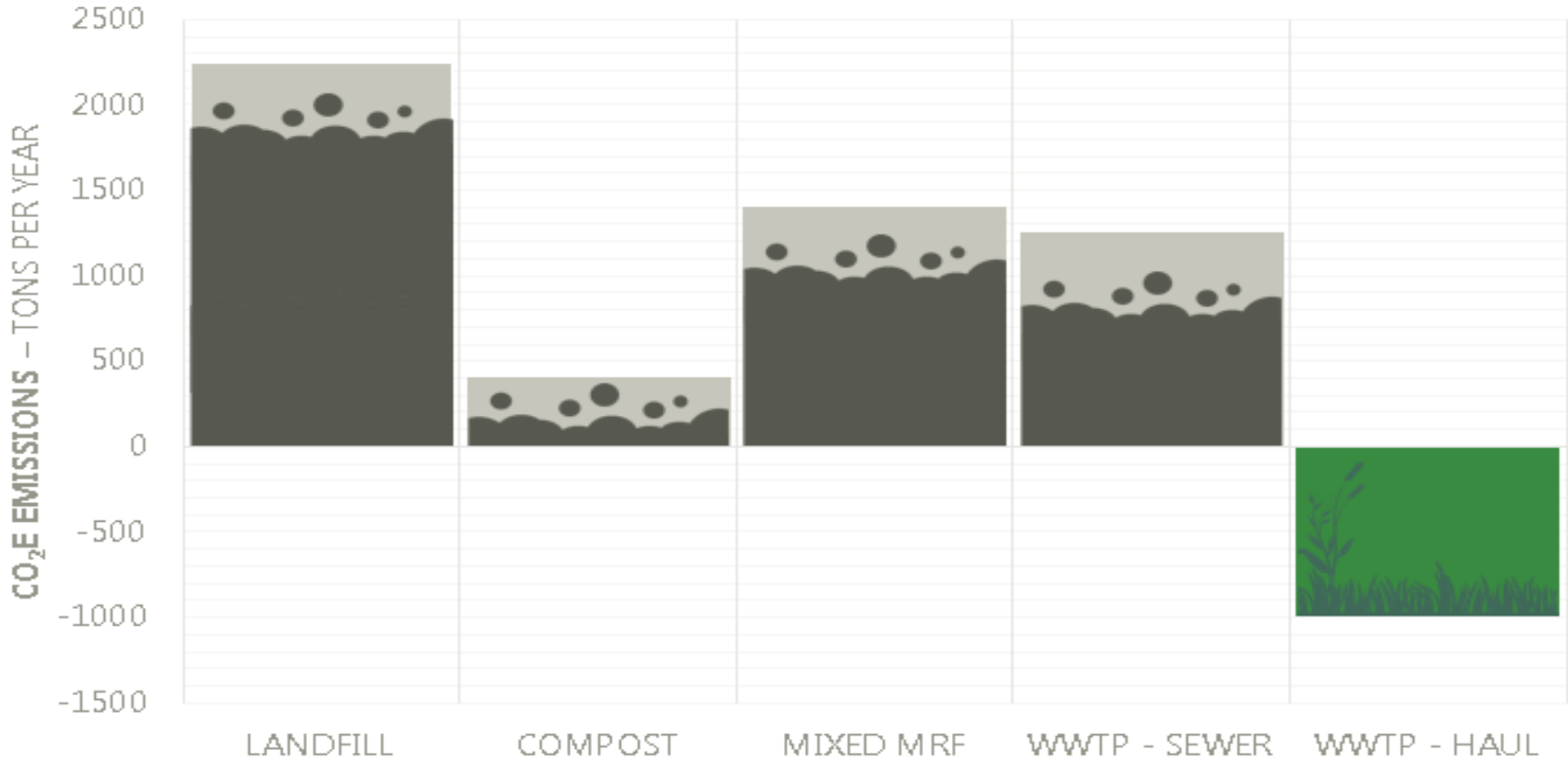
Results of EPA's Lifecycle Analysis



Global warming potential results for five food waste recycling and disposal systems. Error bars represent a low and high range of estimated impact potential.
AD: anaerobic digestion, ASP: aerated static pile; CHP: combined heat and power; GWP: global warming potential; WTE: waste-to-energy

Summary LCA results. Bar height represents average net impact potential for each treatment option as a percentage of maximum impact. Error bars mark high and low estimates of relative impact based on AD performance scenarios and compost process emission scenarios.
AD: anaerobic digestion, ASP: aerated static pile; WTE: waste-to-energy





"From a carbon footprint comparison, the **WWTP/Hauler** alternative had the **lowest carbon dioxide** equivalent (CO_2E) **emissions** compared to the other alternatives"

THE Water Research FOUNDATION

Challenges

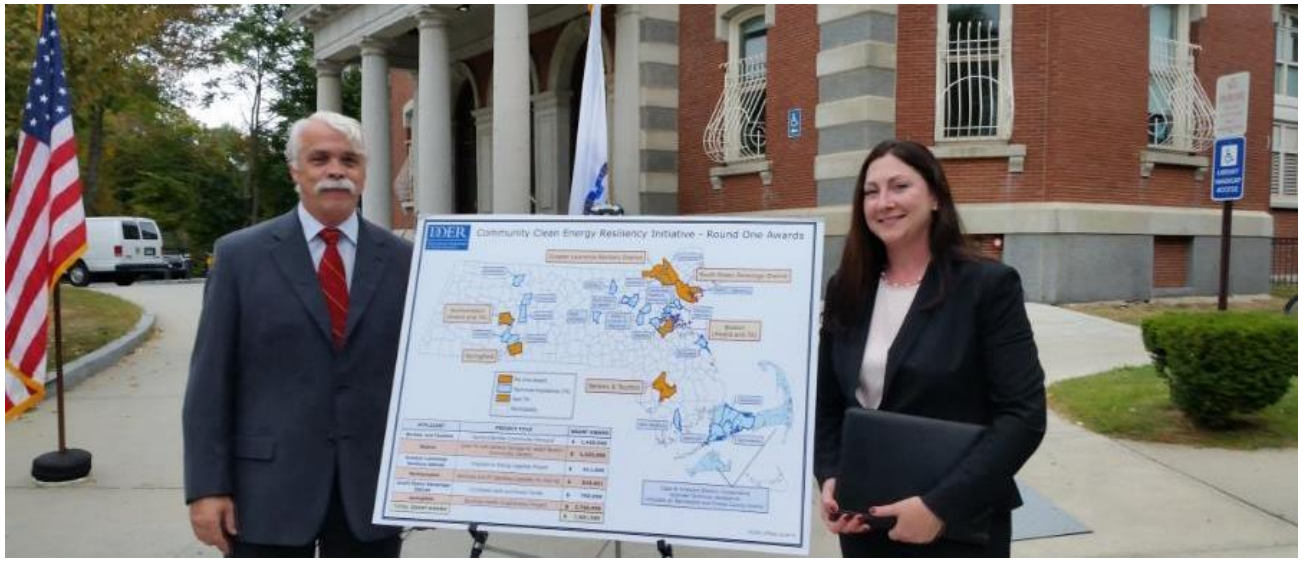
- Financing an Atypical Wastewater Project (costs vs. revenues)
- Net Metering Cap
- Community Acceptance
- Securing Feedstock
- Permitting (Air and Noise Pollution Control)
- Engine Operations and Maintenance
- Market Analysis

Environmental Benefits

- Biogas is a 100% Renewable Energy
- 20% reduction in annual net GHG Emissions
- Energy benefits alone equivalent to removing 1,035+ cars from the road (MA DOER)
- If utility power fails, can:
  - Sustain full plant operations during an extended power outage using natural gas
  - Provides operational reliability and flexibility

Project Highlights

- $27 M total investment in new facilities
- $9.8 M in financial assistance (MA DOER, MassDEP, CEC, CWT, National Grid)
- Provides a net economic benefit to the District (Environmental Justice)
- Advances the Recycling of Organics for Massachusetts to meet state goals
- GLSD working to become a Net Zero or Net Positive Electric Energy User
- Furthers GLSD's Tradition of Innovation and Goal of Net Zero Operation



Project Partners

CDM Smith®

Methuen CONSTRUCTION

WM
WASTE MANAGEMENT®

DOER
Massachusetts Department of Energy Resources

MassDEP

MASSACHUSETTS CLEAN ENERGY CENTER

nationalgrid

QUESTIONS?

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