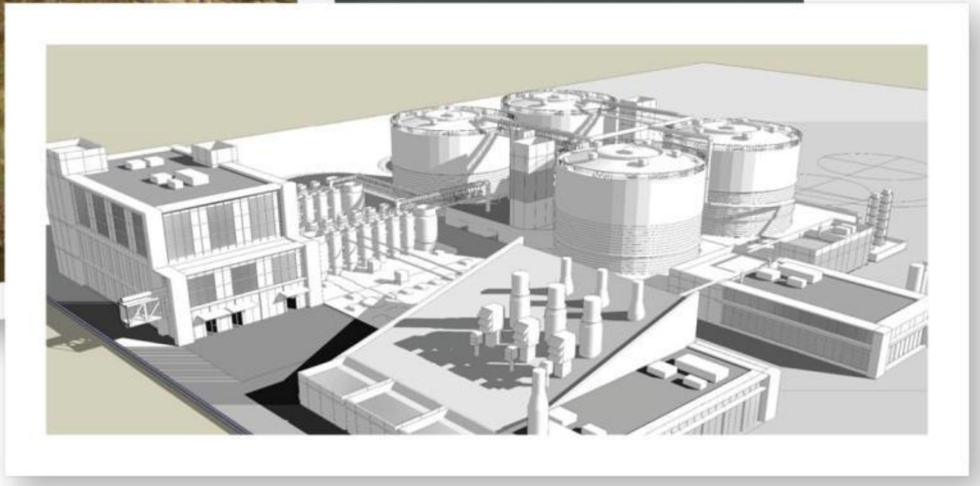
Resource Recovery

at DC Water



MWCOG Recycling Committee
October 1st, 2015

Chris Peot, P.E., BCEE
Director, Resource Recovery

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NUTRIENTS and CARBON RECYCLING

FARMING

Provides carbon and nutrients valued at $300.00 per acre.

SILVICULTURE

Increases yield and improves understory.

RECLAMATION

Restoring mines to their natural state and providing wildlife habitats.

URBAN RESTORATION

Grow trees and reduce runoff.

BLUE PLAINS ADVANCED WASTEWATER TREATMENT PLANT: A RESOURCE RECOVERY FACILITY

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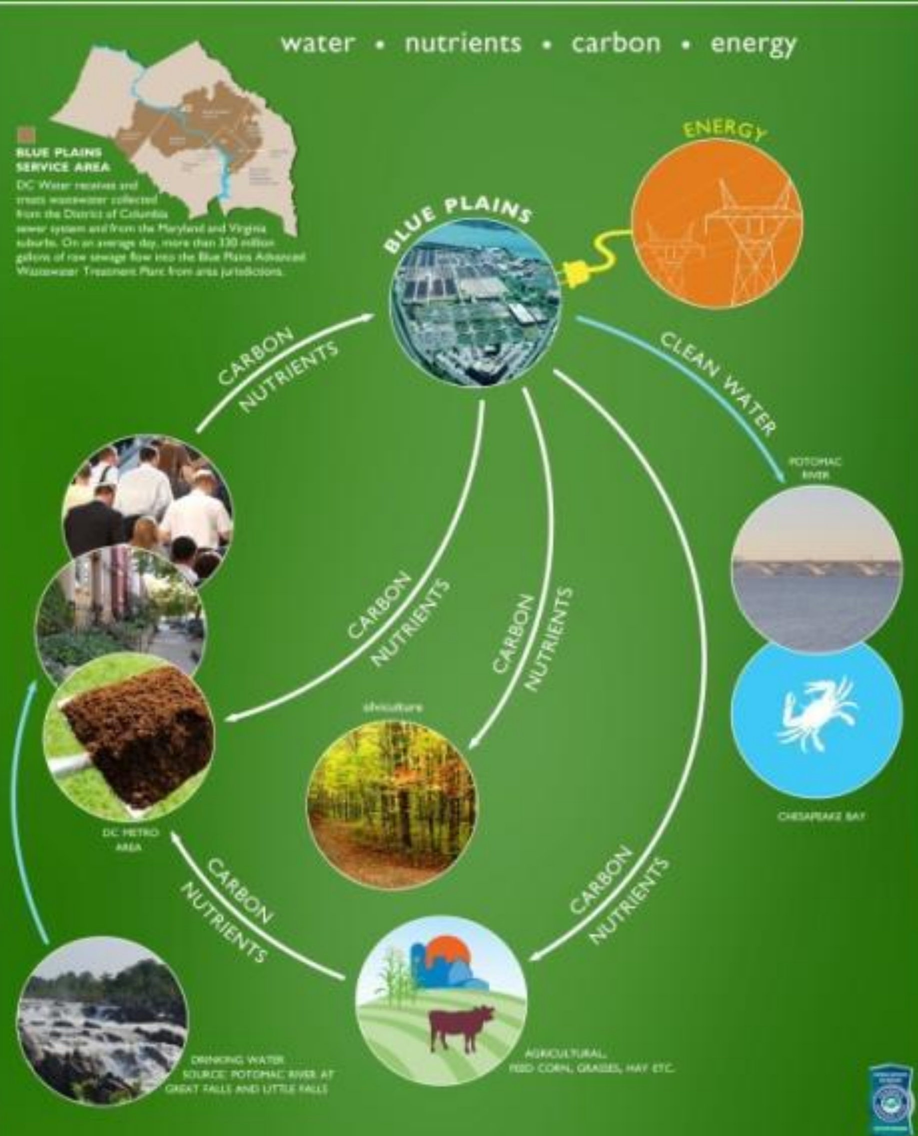
water • nutrients • carbon • energy



dcwater.com/biosolids

GREEN ENERGY BIORENEWABLES

THERMAL HYDROLYSIS PROCESS (THP) AND DIGESTION FACILITY

DC WATER THP AND DIGESTION FACILITY RENDERING

DC Water will be the first in North America to use thermal hydrolysis for wastewater treatment. When completed, this facility will be the largest plant of its kind in the world.

GREEN BENEFITS:

- Produce combined heat and power, generating 13 MW of electricity
- Save DC Water $10 million annually cutting grid demand by a third (DC Water is the largest consumer of electricity in the District)
- Reduce carbon emissions by approximately 50,000 metric tons of CO_2e per year.
- Reduce trucking by 1.7 million miles per year.
- Save $10 million in biosolids trucking costs
- Produce Class A biosolids to grow trees, sequester carbon and reduce runoff.

Agriculture


Bobcat

Blue Plains Garden & Compost Giveaway

Urban gardening community outreach

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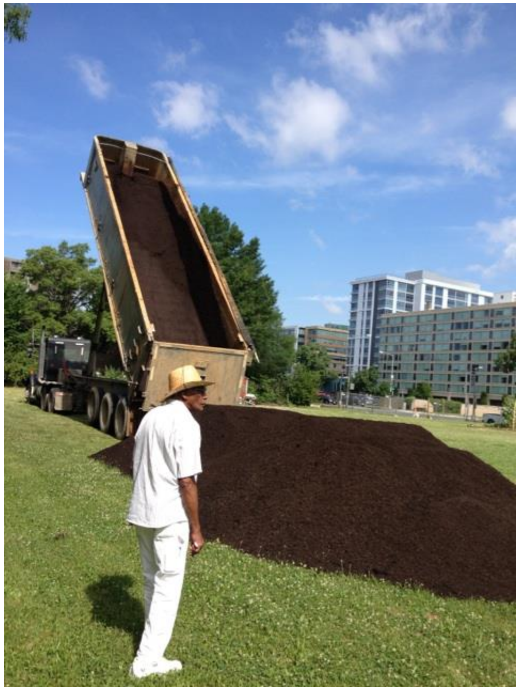
Community Gardens

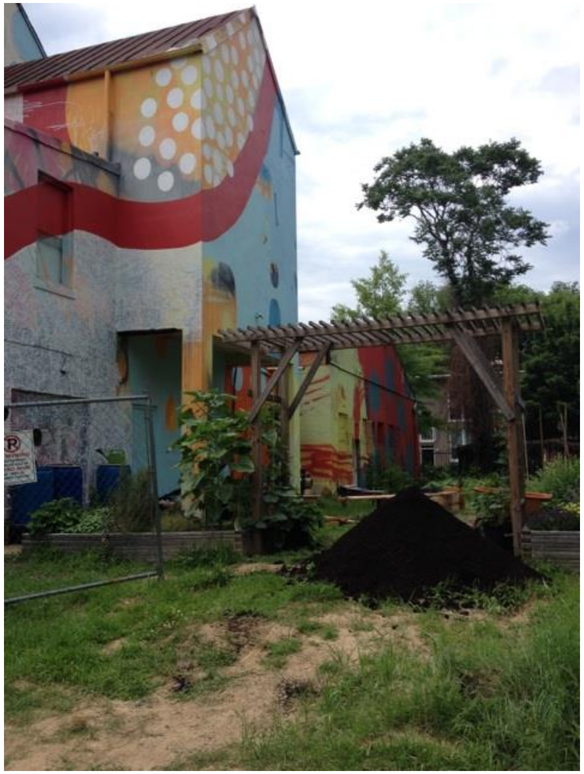



The Washington Youth Garden
Yesterday

That's right - we're trying out the highly regulated bio-solids compost from DC Water - and the raised bed we're using them in is amazingly healthy! — with Anna Benfield.

Like · Comment · Share 1

Kristin Brower, Emily Anne Roberts, Meghan Higginbotham and 23 others like this.



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Anaerobic Digestion

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Class B vs. Class A Product

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Future Plans for Class A Biosolids

- Continue land application of remaining Class A dewatered biosolids
- Produce a blended soil product (similar to compost)
- Use product in service area for tree planting, restoration, green infrastructure, etc.

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Program Benefits

Reduce biosolids quantities by more than 50%

Improve product quality (Class A and more)

Generate 10 MW of clean, renewable power

Cut GHG emissions dramatically

Save millions of dollars annually when the facility begins operating in 2014

Co-Digestion Concept Overview

- Digester capacity is an asset we can maximize
  - Most days we have considerable excess capacity
- Done at hundreds of plants worldwide (several in the US)
- Fits well in the GM's revenue generation goal
  - Potential revenue from gas production, tip fees, and REC sales
- Can help maximize the asset of digester capacity
- Start with low hanging fruit – likely processed foodwaste (high C:N ratio)
- Currently testing blends in pilot digesters – promising results
- Steps toward a 15 dtpd pilot project (5% of average flow)
  - Market survey (ongoing)
  - Research and development (ongoing)
  - Concept report
  - Design
  - Construction

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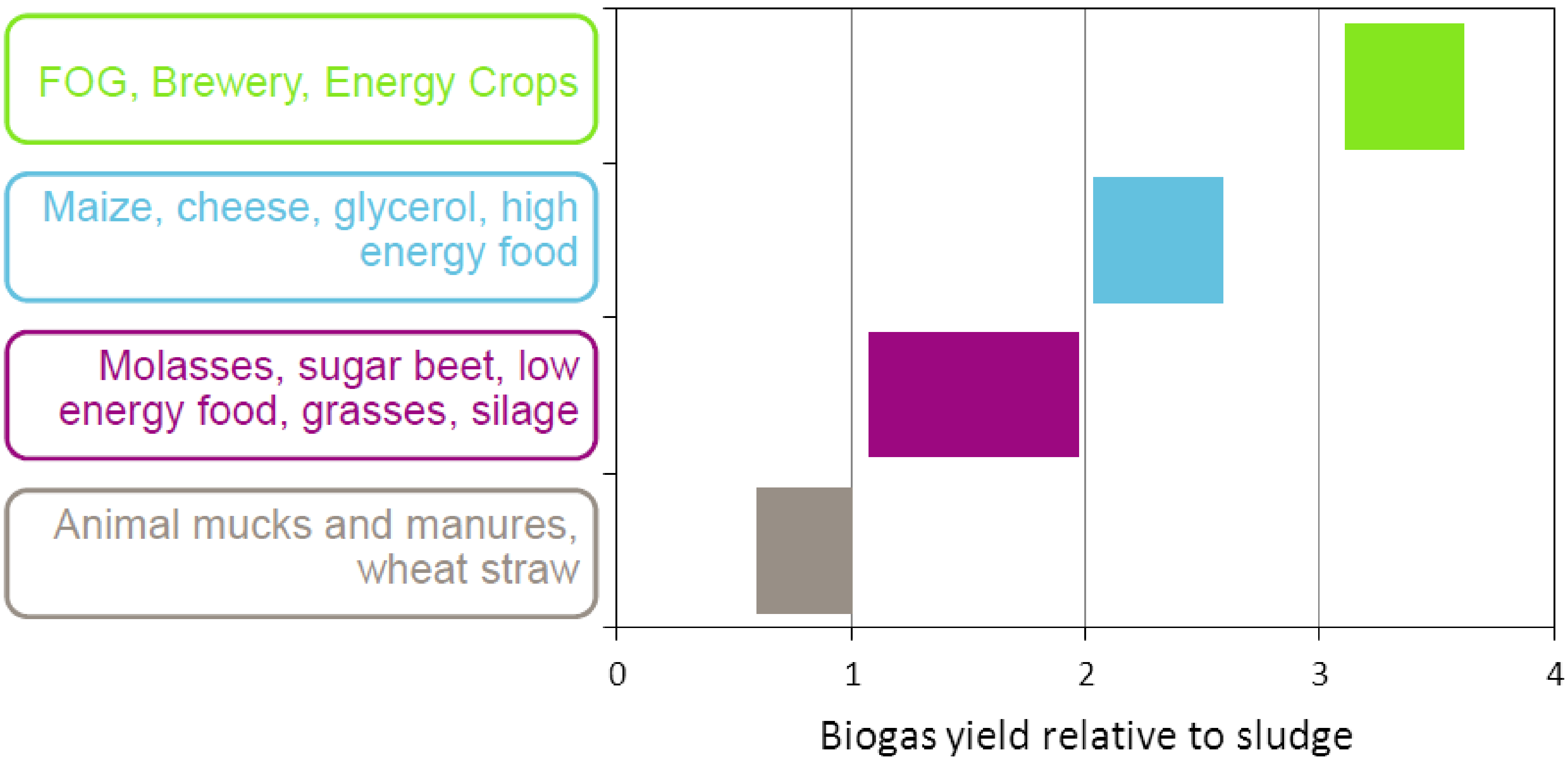
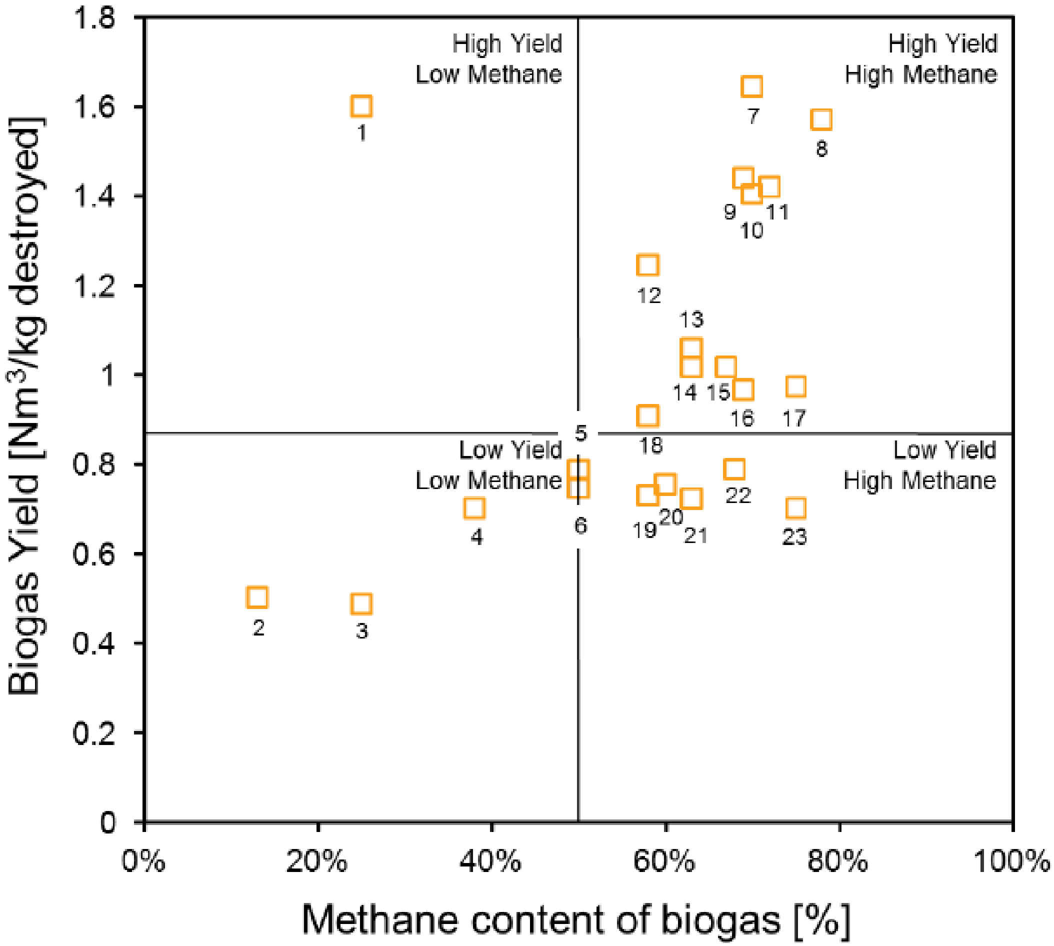
Biogas yield of wastes relative to sewage sludge



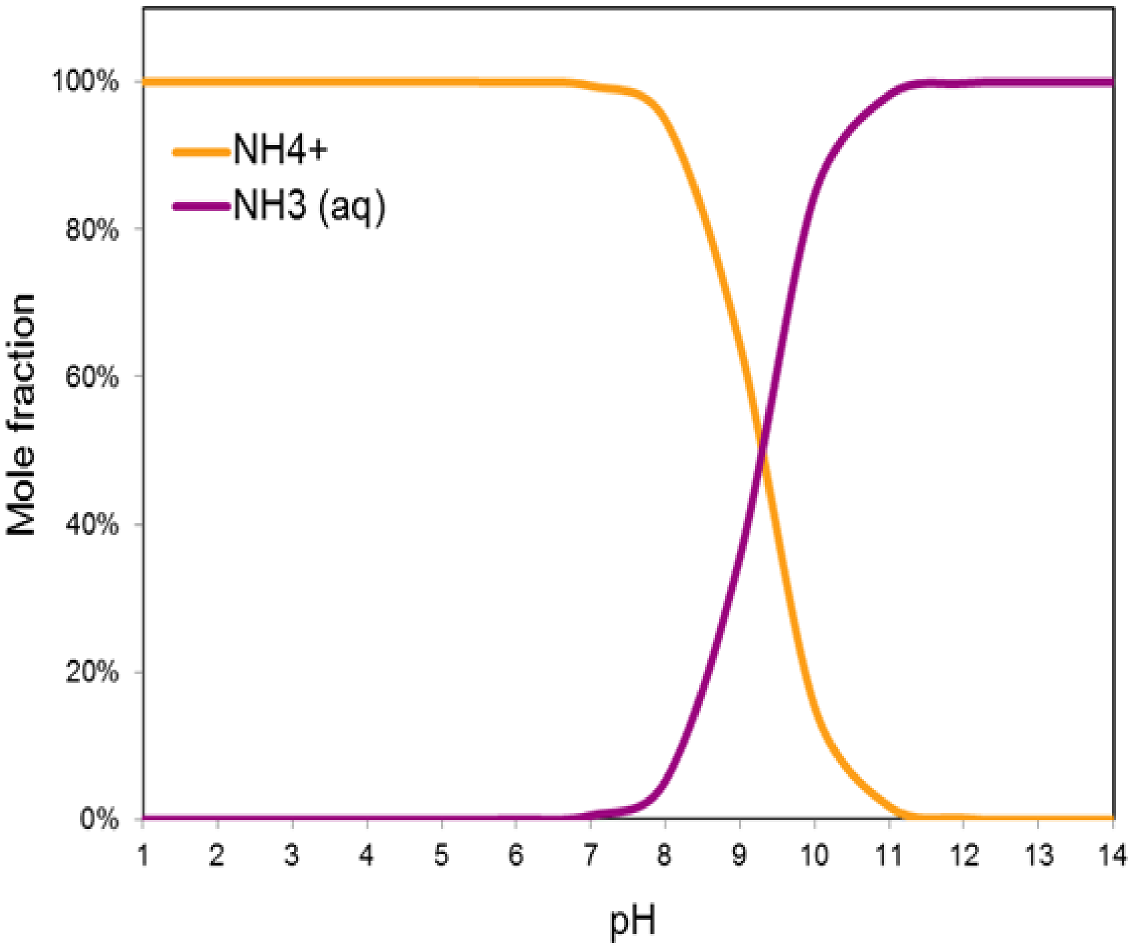
Theoretical Biogas Yield



Key

1 Carbon Monoxide
2 Oxalic acid
3 Formic acid
4 Citric acid
5 Maize
6 Sugar (glucose)
7 Algae (Botryococcus braunii)
8 Gasoline
9 Polyunsaturated fat (linoleic acid)
10 Vegetable oil
11 Saturated fat (stearic acid)
12 Grass (lignin)
13 Primary sludge
14 Butyric acid
15 Protein (Phenylaniline)
16 Wastewater
17 Ethanol
18 Propionic acid
19 Glycerol
20 Manure
21 Ethylene glycol (natural polymer)
22 Secondary sludge
23 Methanol

Food effect on pH

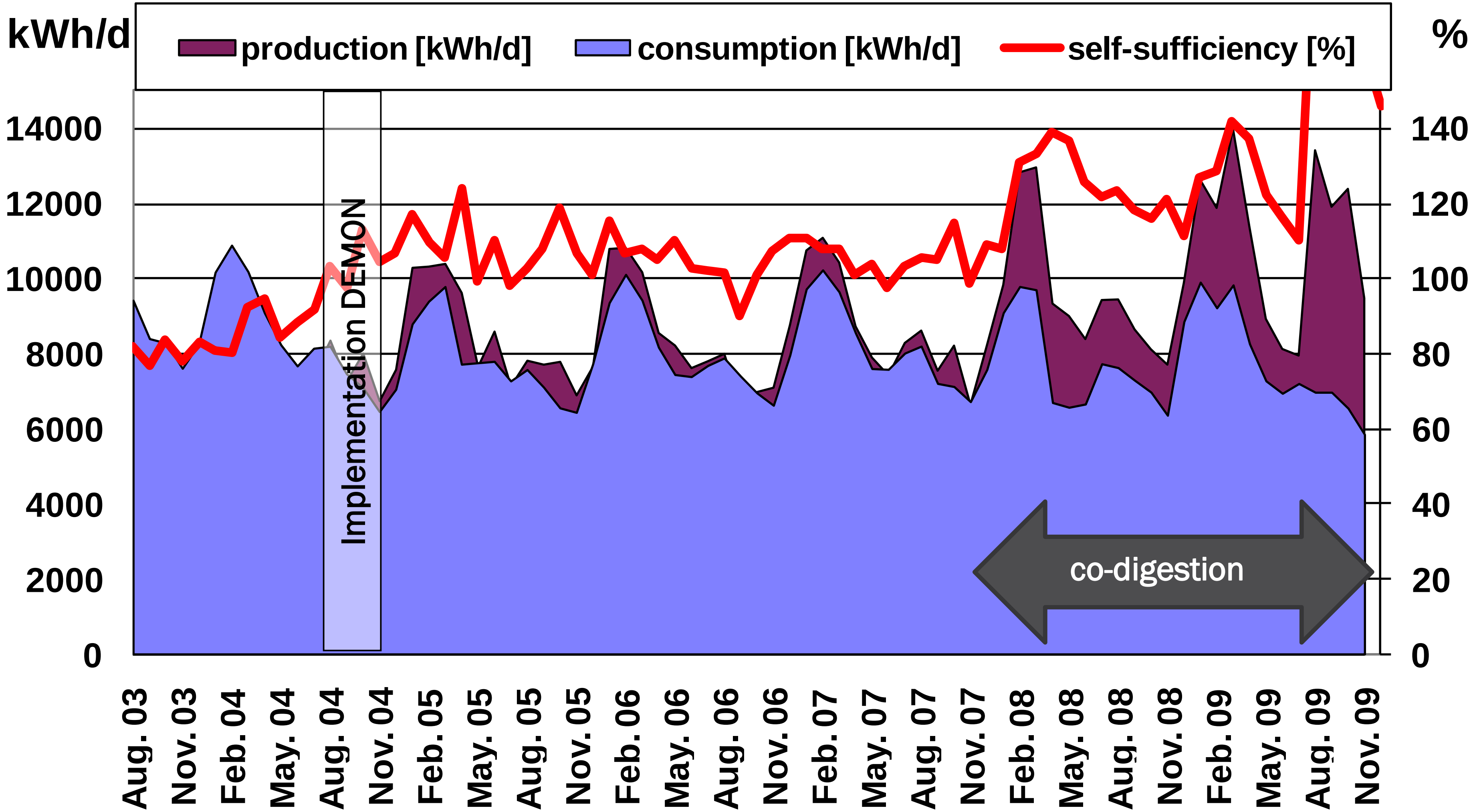


- At pH 8, ~10% ammonia, enough to put us on the edge of TH digestion performance
- Add a waste with high C:N ratio (like foodwaste) pH will drop.
- At 7.5 pH the ammonia drops to about 3% and the toxicity of ammonia has dropped by a factor of 3.
- The digester is no longer performing on the edge, so in principle we can add more material.

Co-digestion Experience

- Summary of Representative Programs
  - North America
    - EBMUD (Oakland, CA)
    - Central Marin County (Northern SF Bay Area, CA)
    - Tacoma, WA
    - Sheboygan, WI
    - MWRA (Boston, MA)
    - NYC DEP
  - Europe
    - All over
    - 20+ yrs experience

Strass, Austria – Co-Digestion and DEMON
Degree of self-sufficiency ~ 150%



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DC WATER PILOT DIGESTER FINDINGS (TO DATE)

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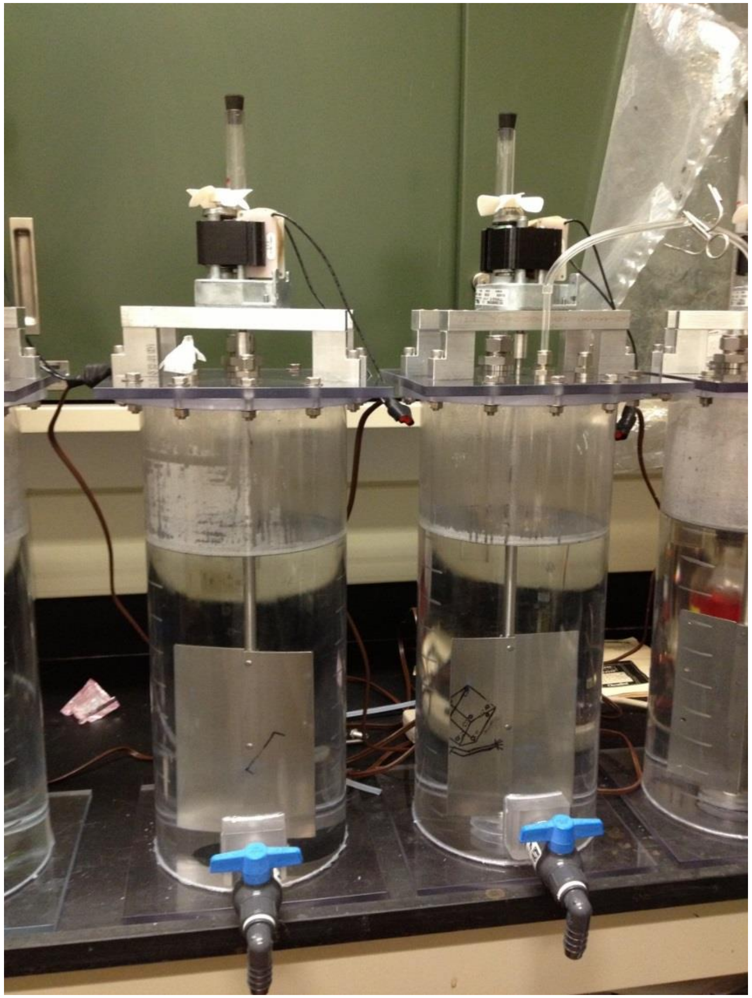
LAB DIGESTERS



- 10 L active volume
- Large Paddle Mixer
- High Torque, 100 rpm Motor
- Continuous Mixing
- Gas Volume and Rate by Respirometer

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OPERATION AND TESTING

- Fed once per day, same time every day
- Measurements so far include:
  1. TS/VS (Influent and Effluent)
  2. TCOD, sCOD (Influent and Effluent)
  3. Headspace Gas (CH_4, CO_2, H_2, MT, DMS)
  4. Total gas volume and gas production rates
  5. pH and alkalinity
  6. Viscosity
  7. NH_4^+, and other cations
  8. VFA concentration and speciation

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POTENTIAL FEEDSTOCKS IN THE DC REGION

DC feedstocks

- Food
- FOG
- Bottling waste
- Industrial wastes
- Others??
- Have launched a comprehensive market survey

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WM PROPOSAL FOR FOOD SLURRY (15 DTPD)

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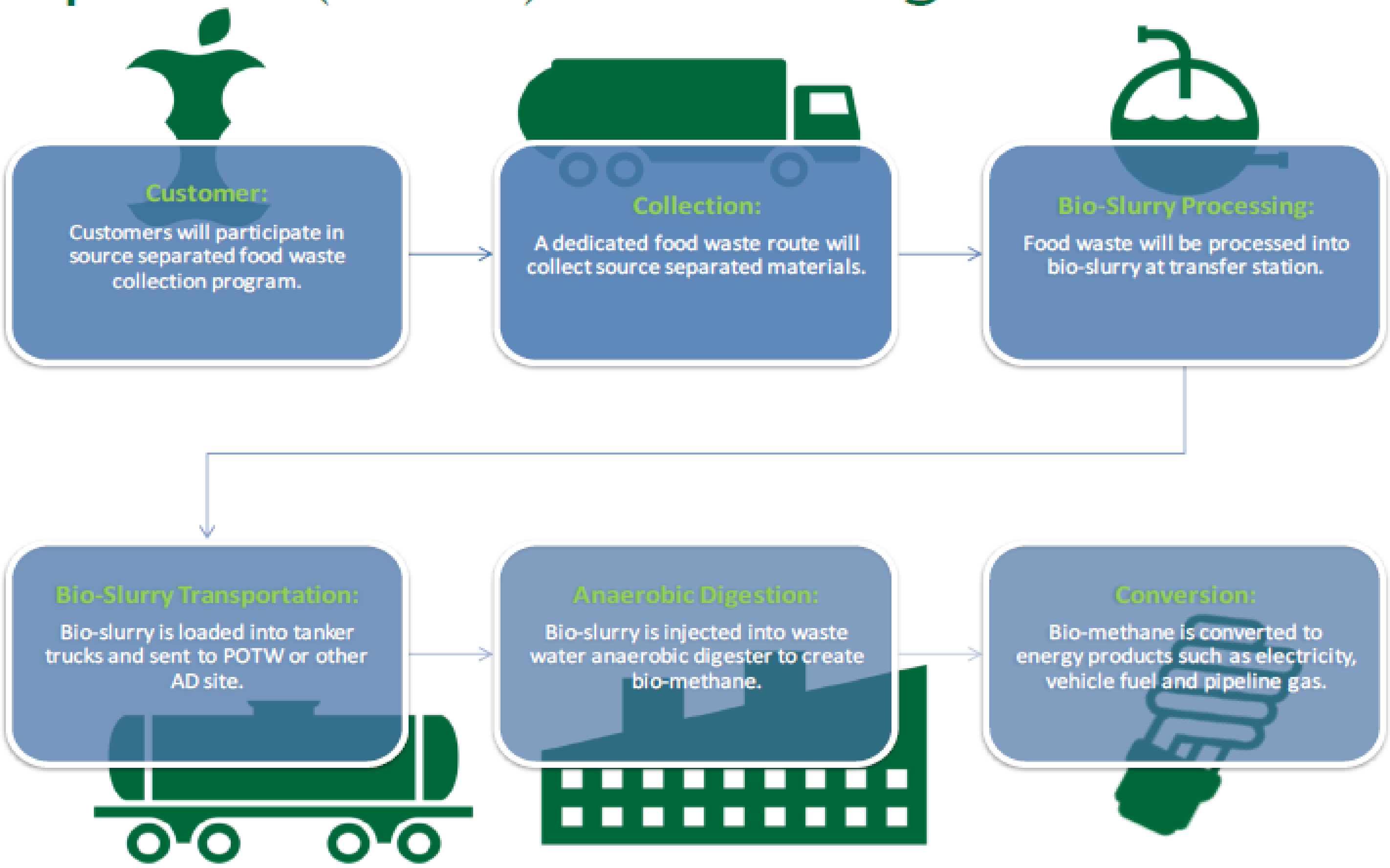
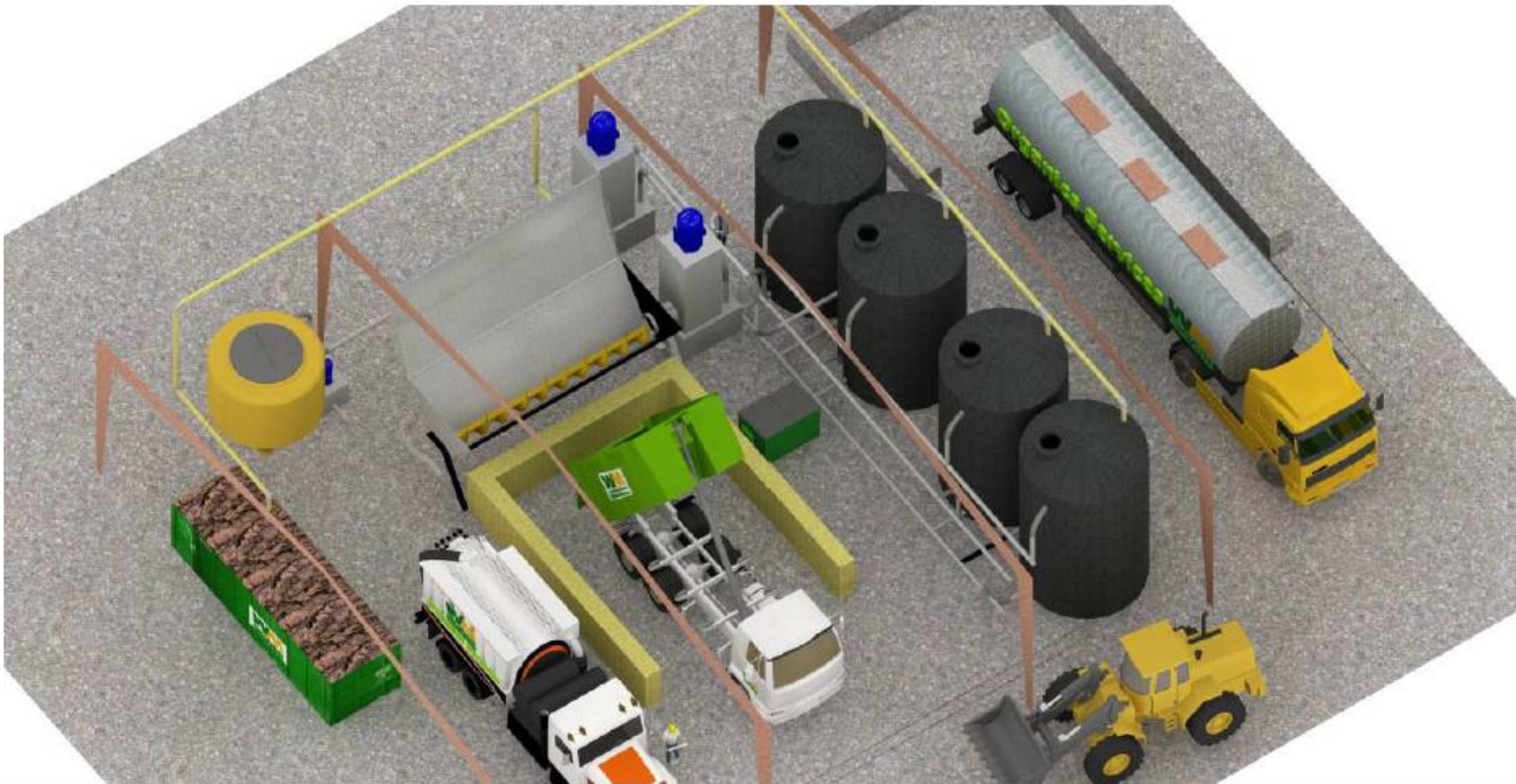
WMOR Centralized Organics Recycling Equipment (CORe) and Co-Digestion



WMOR CORE system overview



WM food slurry – 10% TS

Addition of 150 wet tons/d (15 dt/day) organic waste

= 5% addition by flow
= 11% addition by load

Parameter	Baseline*	With Organic Waste	Units
Digester HRT	21.5	20.4	[d]
Organic Loading	5.59	6.31	[kg VS/m^3.d]
Power Generation	8.13	9.61 (= +1.47)	[MW]
Turbine capacity used (at 85% uptime)	69%	82%	[%]
Dewatering capacity used	58%	59%	[%]
Additional (20m^3)** trucks		11	[trucks/d]
Additional Ammonia***-N		0.76 (+12%)	[t/d]
Additional COD		13.5 (+8%)	[t/d]

* Baseline of 290 tones/d dry solids feed to digesters
** Based on deliveries 5 days per week for 52 weeks
*** Based on waste containing 3% N

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System limitations

Quantity of waste required to:	wtpd	Trucks/d**
Require a 4th turbine*	366	26
Decrease digestion retention time by 25%	1251	88
Increase digester loading to 8 kg VS/m^3.d	501	36
Quantity proposed	150	11

* Based on 85% availability
** Based on deliveries 5 days per week for 52 weeks

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IMPACTS – TIP FEES, GAS & POWER PRODUCTION, CARBON VALUE, OPERATIONS AND SIDESTREAM TREATMENT COSTS

Value and Cost

- Values
  - Power: currently saves DC Water $0.02/kwhr
  - REC’s: current value ~$12/MWhr (in MD)
  - Tip fee: need to negotiate

Costs

  - Sidestream treatment – based on existing process
    - $9/wt
  - Additional steam
    - $1.50/wt
  - Additional dewatering and hauling
    - May be a wash – need to investigate further
  - Total cost estimate - $575,000 / yr
  - DC Water wants to break even or show positive cash flow in order to undertake this project

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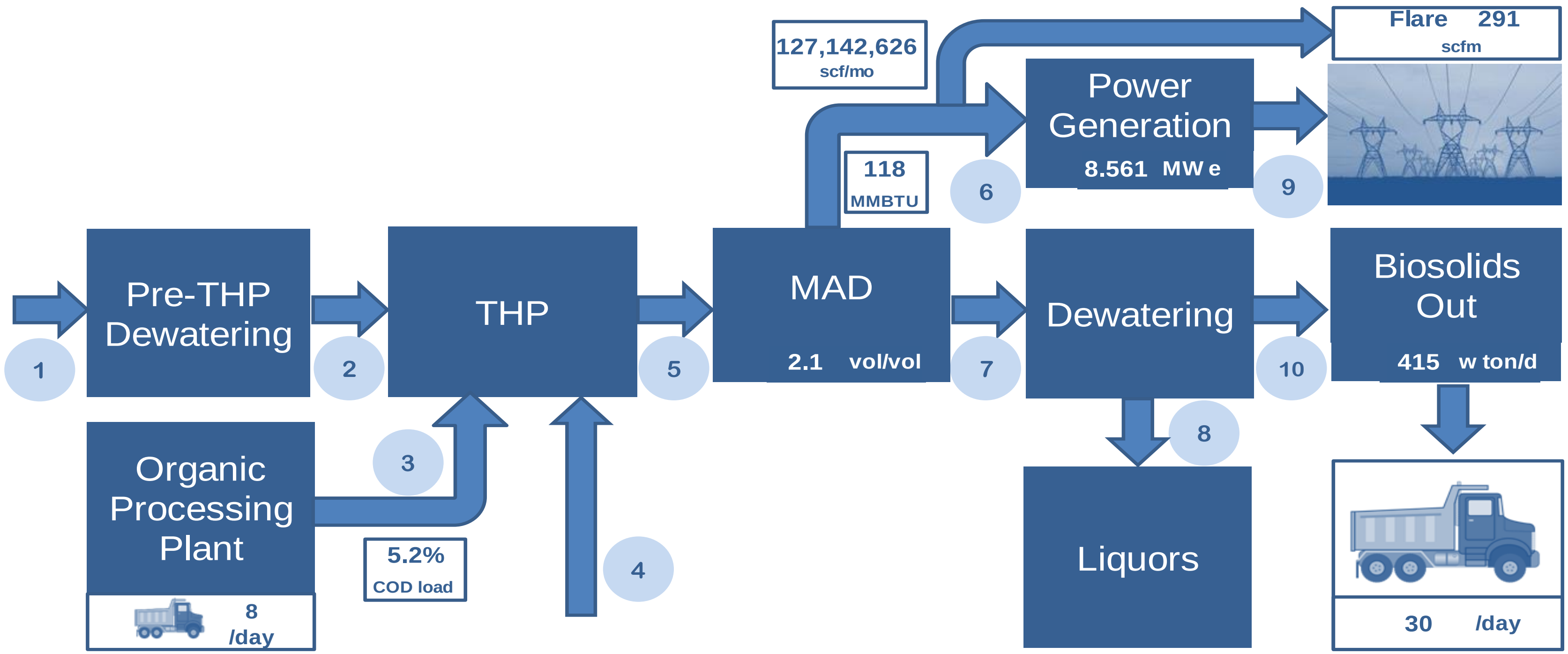
Technical Summary for Co – Digestion Model (DRAFT)



Stream		1	2	3	4	5	6	7	8	9	10
	Name	Raw sludge	THP sludge feed	Organic Waste	Trim Water	MAD feed	Biogas	DW feed	Liquors	Power output	Biosolids output
TDSd	tDS.d [US]	290	284	14		298		135			133
%DS	%	5%	16%	14%		10%		4.5%			32%
%VS	%	75%	75%	80%		75%		51%			51%
Wet	gpm	1063	326	18		547		547	471		76
DS	lbs/hr	24167	23683	1167		24850		11290	226		11064
VS	lbs/hr	18125	17763	933		18696		5756	115		5641
COD	lbs/hr	28420		1658		30078			10707		
Trim Water	gpm				88						
Ammonia	lbs/hr	142.7	142.7	4.3		146.9		705.6	705.6		
Ammonia	mg/l	267	872	462		535		2618	2618		
Biogas	scfm						2903				
Biogas	MMBTU						118				
Power output	MW e									8.56	

Technical Inputs for Co – Digestion Model (DRAFT)

Minimum processing Fee

Tipping Fee Required	$ 0.06	$/gallon

		Capacity		
Turbines	67%		Medium	Critical
MAD	66%		60%	85%
THP	61%			
DW	44%			

Sludge		
TDS.d	290	tDS.d [US]
Capture	98%	% capture
%DS	5%	%
%VS	75%	%
N% of VS	6.67%	%
Ammonia of N	0.118	dimensionless
COD/VS ratio	1.6	dimensionless
%VSR	65%	%

Pre-THP Dewatering

Dry Solids output	16%

THP

Steam dilution	4%
DS feed to MAD	10%
Trains in operation	4
Vessels per train	6

MAD

Design OLR	lbs VS/ft3.d	0.344
Biogas CH4 sludge		62%
Biogas CH4 organics		62%

Power Generation

Electrical efficiency	29.3%	%
Turbine inlet air temperature	74	F
Availability	90%	%
Number of turbines	3	
Number of turbines used	3	
Output each	4.60	MW e

Dewatering

Sludge polymer	16	lbs/TDS
Sludge capture rate	98%	%
Sludge dry solids	30%	%
Co-digestion polymer	16	lbs/TDS
Co-digestion waste capture rate	98%	%
Co-digstion waste dry solids	32%	%

Biosolids Out

Truck capacity	20	wet tonnes
Days operation/wk	5	

Co-digestate		
Volume/day	100	wet tonnes
%DS	14%	%
%VS	80%	%
COD	180000	mg/l
N% of VS	3.86%	%
Ammonia of N	0.118	dimensionless
Density	1.2	lbs/ft3
%CODR	78%	% removed
Sludge yield	45%	dimensionless
Truck capacity	20	wet tonnes
Days operation/wk	5	days
Power demand	0	kWhr/wet ton

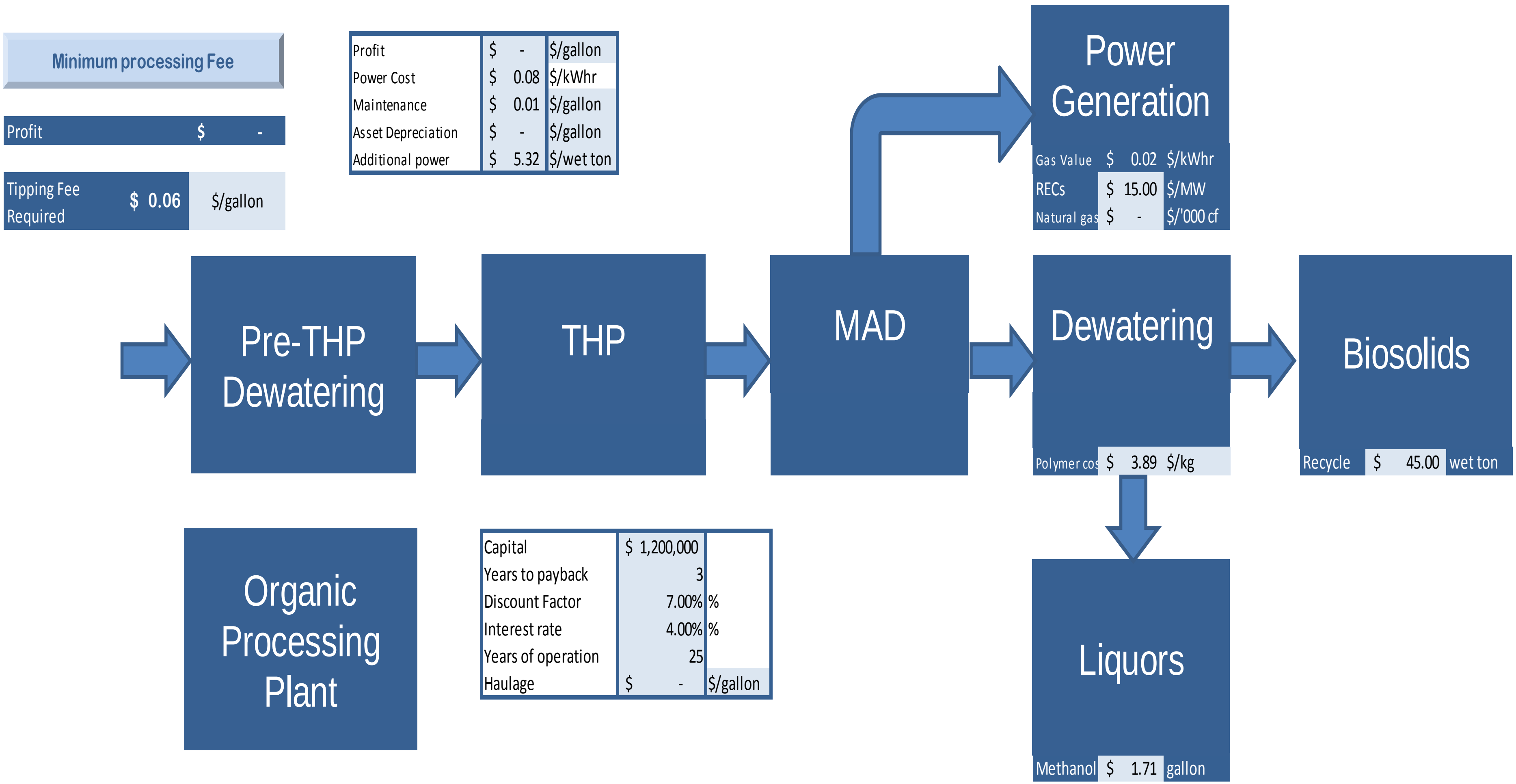
Organic Processing Plant

Sludge Production calculation
Yield

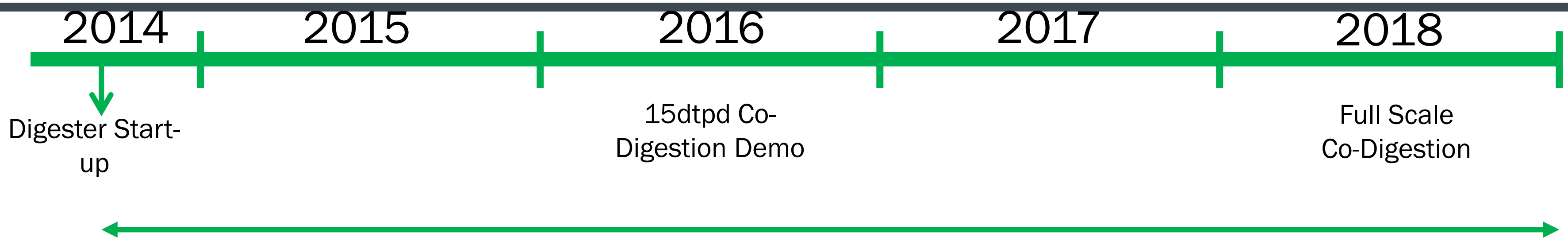
Liquors

Nitrogen release	80%	
Liquors treated in sidestream	85%	
Sidestream Power	1.06	kWhr/kg N
Mainstream Power	1.91	kWhr/kg N
Mainstream methanol	0.88	gal/kg N

Financial Inputs for Co – Digestion Model (DRAFT)



Conceptual Schedule



Task Force Activities to be undertaken between now and 2018

1. Market Assessment
2. Continue R&D to define successful concept
3. 15dtpd Co-Digestion Demo
4. Full Scale Design
5. Construction
6. Start-up & operations

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There is no such thing as waste, only wasted resources.

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