

An abstract background image featuring a large, flowing, wavy shape in shades of blue and orange, resembling a liquid or energy flow. The shape is set against a white background with a light blue gradient at the top and bottom.

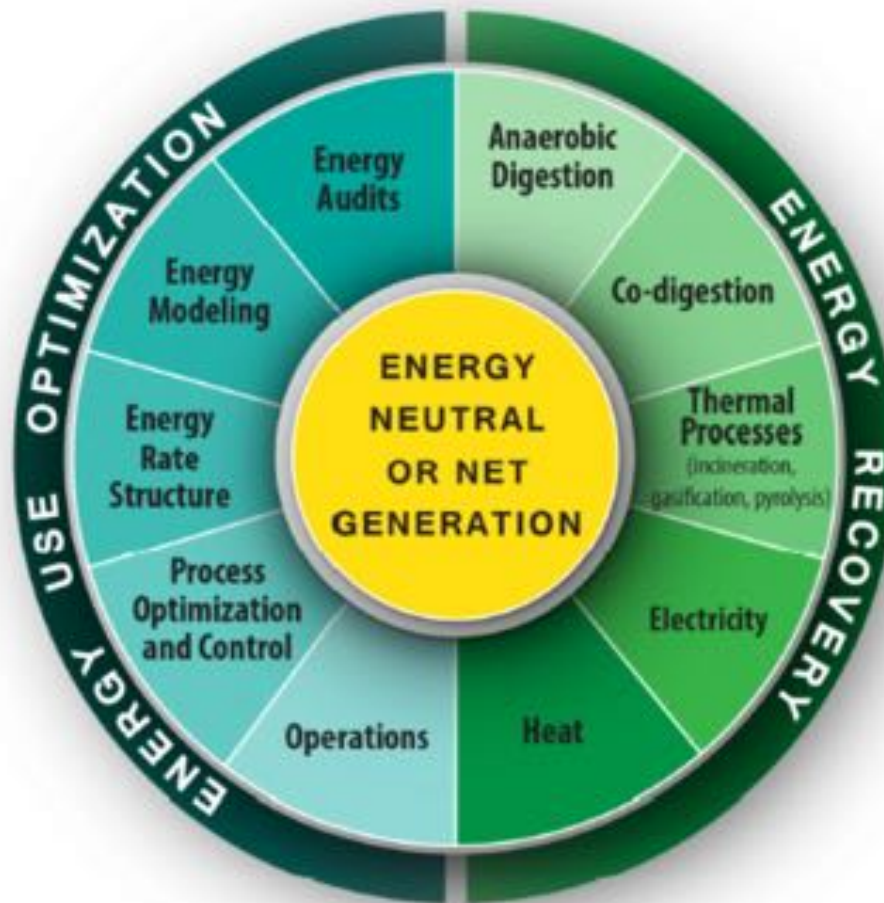
# Approaching Energy Neutrality With Carbon Diversion

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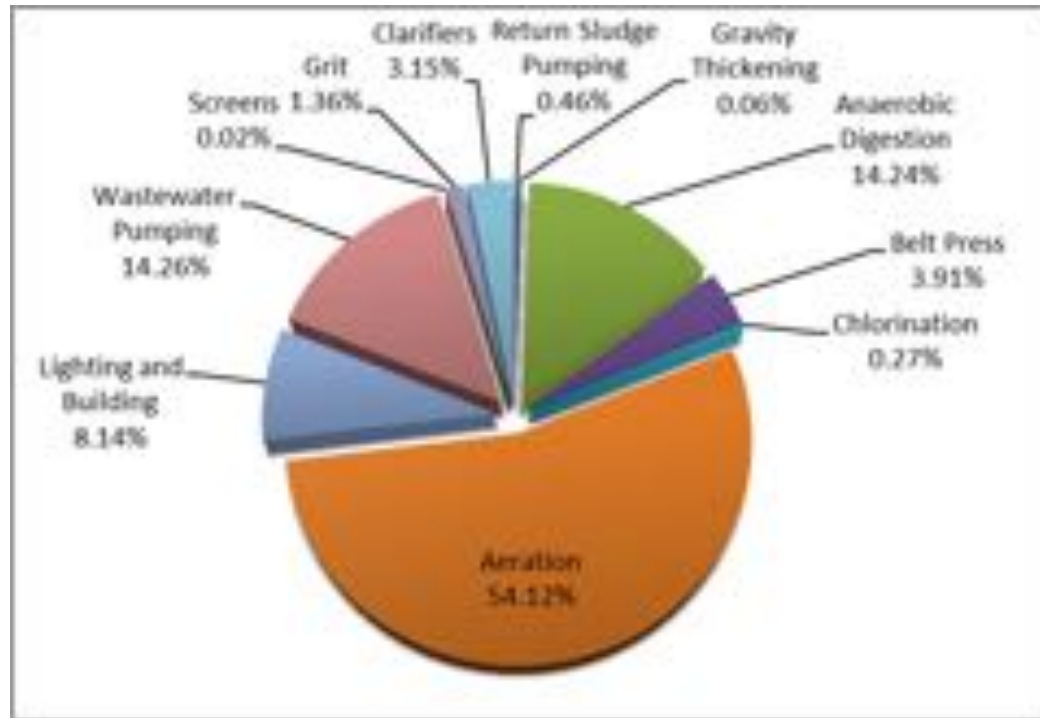
**WW contains nearly 5 times the energy needed to treat it.**  
**WW sector spends ~\$2.2B per year in electricity.**

*Source: American Biogas Council*



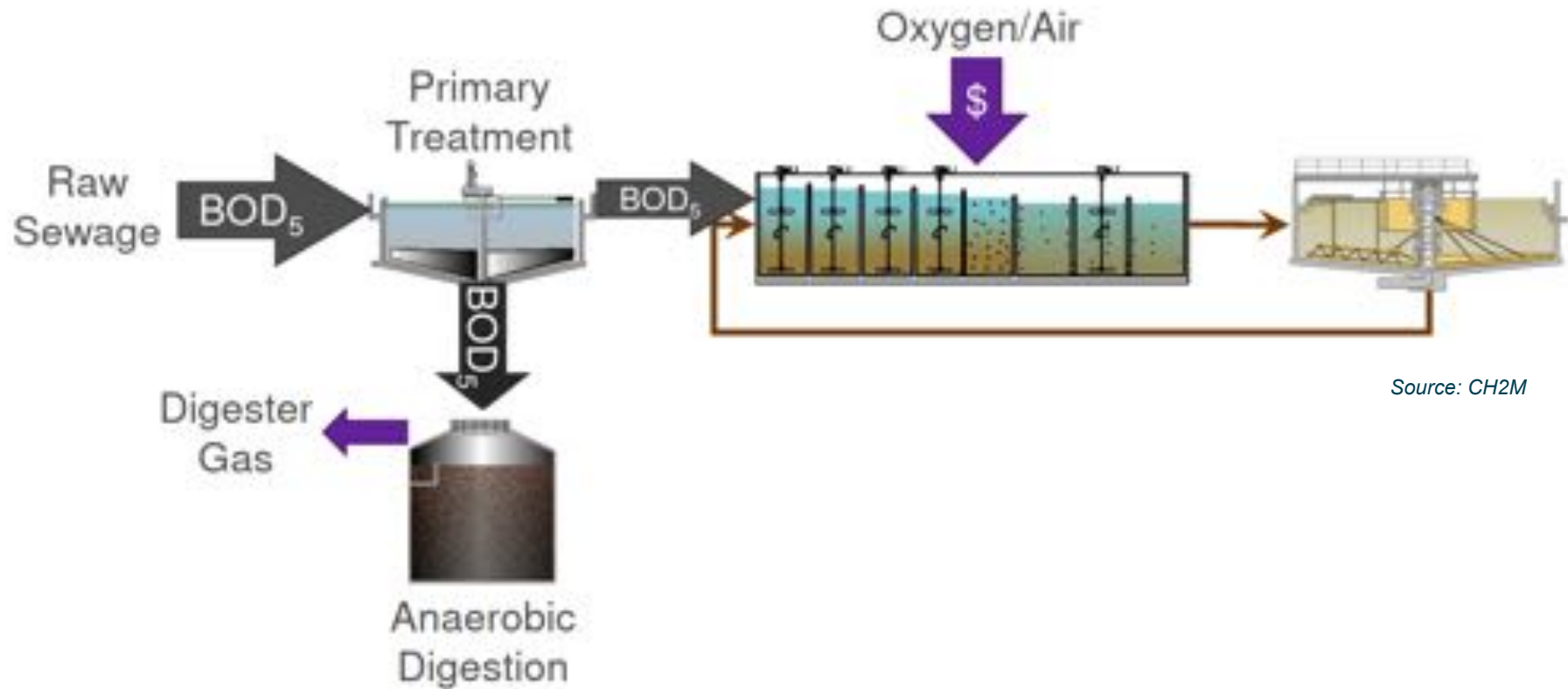
# Distribution of Energy Usage for Typical WWTP

Source: Energy Resources Center – University of Illinois at Chicago



- Aeration energy is more than 50% of WWTP energy
- Most organics/carbon aerobically oxidized
- Need aeration volume for BOD removal

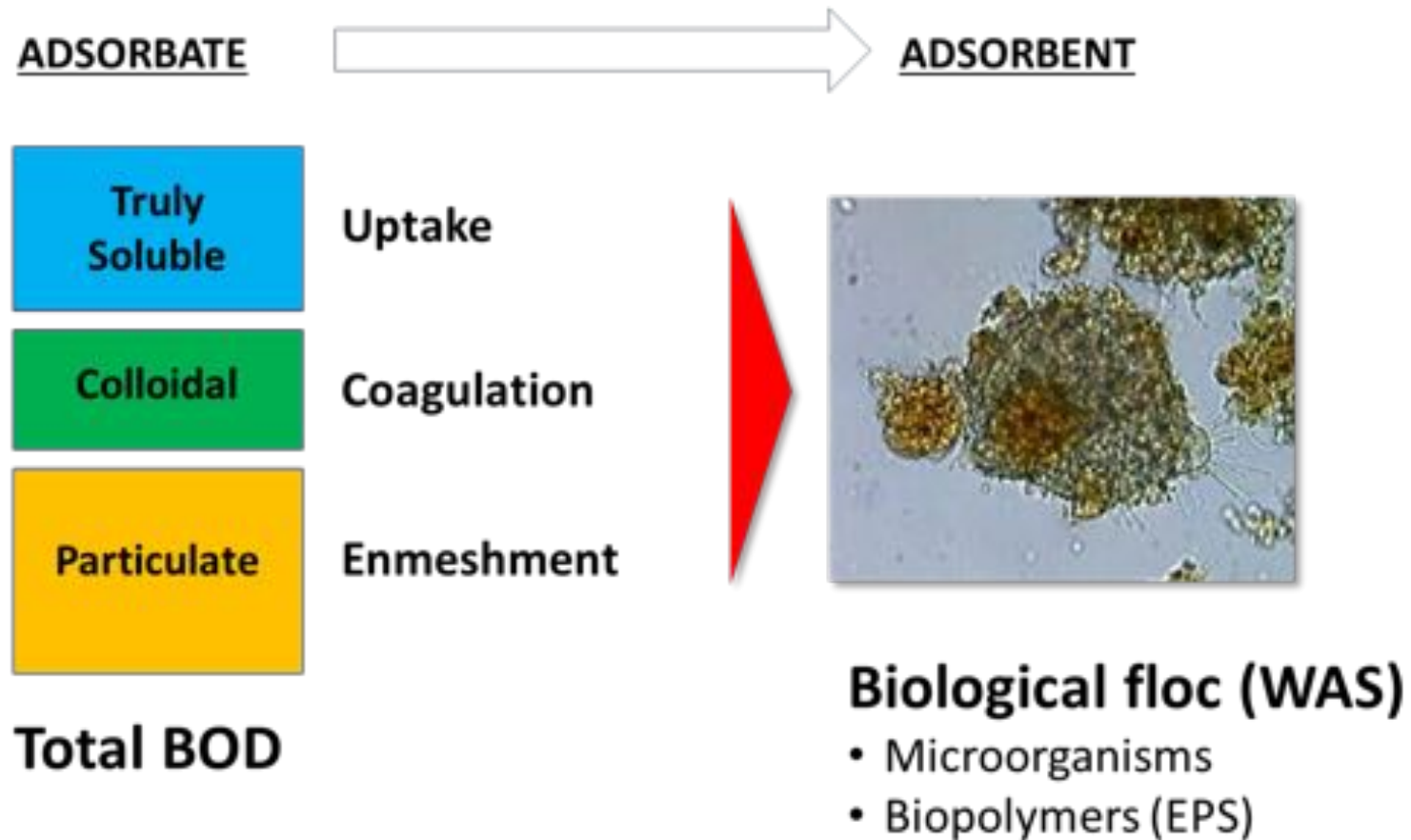
# Carbon Diversion



# Primary Treatment Technologies

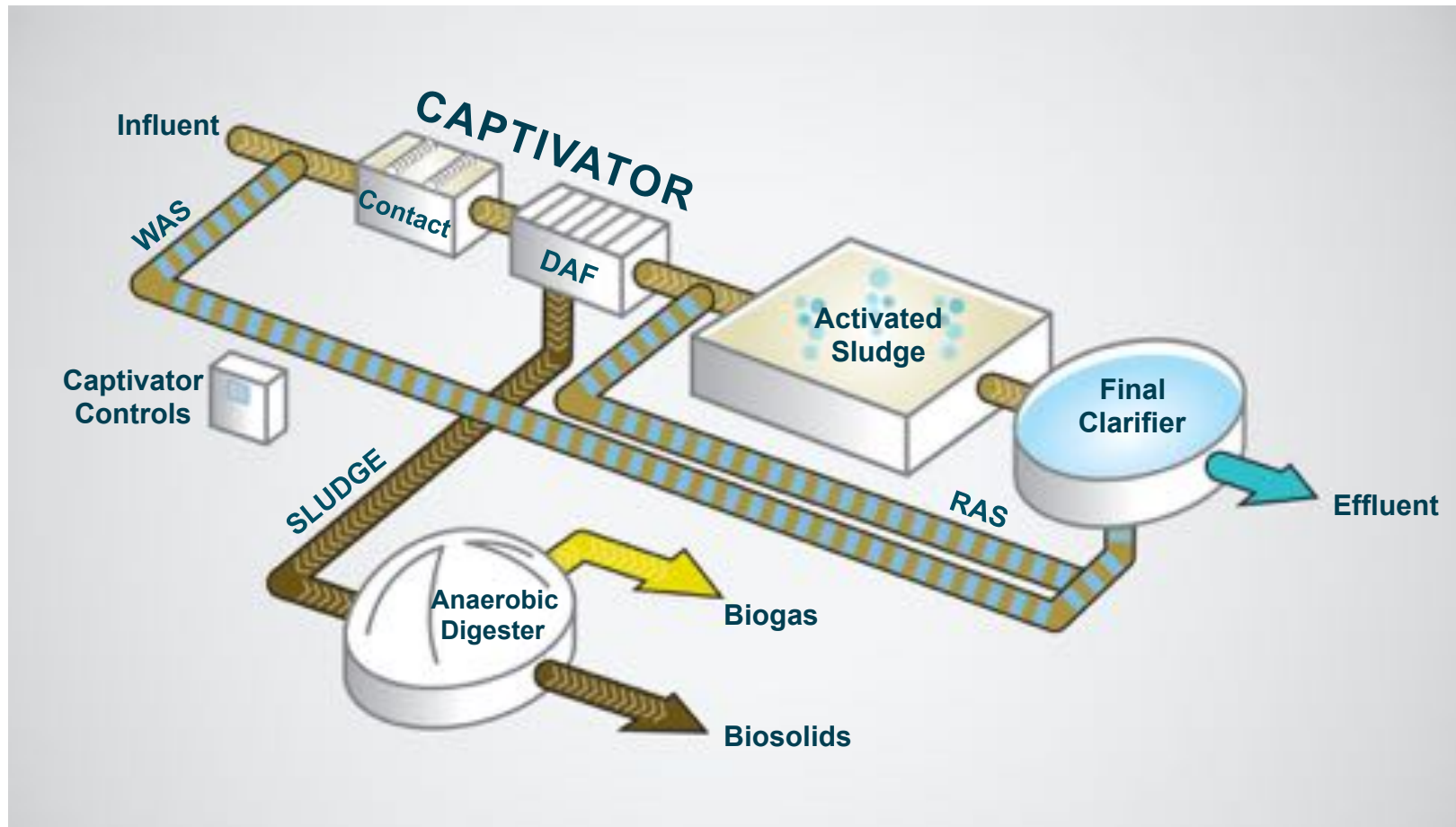
PRIMARY TREATMENT	BOD FRACTION REMOVED	REMOVAL MECHANISM
<b>Conventional</b> Primary Clarification	✓ Particulate/settleable	Sedimentation.
<b>Chemically Enhanced</b> Primary Clarification	✓ Particulate/settleable ✓ Colloidal	Sedimentation with chemical coagulation and flocculation.
<b>Mechanically Enhanced</b> Microscreens & Filters	✓ Particulate larger than filtering media	Physical barrier. Mechanical separation.
<b>Biologically Enhanced</b> “A” Stage of A/B Process	✓ Particulate ✓ Colloidal ✓ Soluble	Biosorption and sedimentation.
<b>Biologically Enhanced</b> Captivator®	✓ Particulate ✓ Colloidal ✓ Soluble	Biosorption and floatation.

# Biosorption Mechanism





# Captivator – Advanced Primary Treatment



**Conventional Technologies – Innovative Configuration**

## Performance Comparison



	Primary Clarification	Captivator
BOD removal	25-30%	45-60%
TSS removal	45-55%	65-80%



### ***Biologically Enhanced Primary Treatment***

- ✓ ***Biosorption***
- ✓ ***Bioflocculation***



# Contact Tank

- Short retention time. Small volume
- Mild and low intensity aeration
- Optimizes biosorption. Minimizes oxidation
- Preferable with Disc Aeration
- Options for other aeration/mixing equipment
- Can retrofit existing primary clarifiers (rectangular and circular)



# Why DAF for Solids-Liquid Separation?

## Hydraulically efficient

- **5X** smaller footprint than primary clarifiers
- Hydraulic loading: 5,000 gpd/ft<sup>2</sup> @ ADF
- Rapid transport of solids to digester

## Thickener (coflotation)

- **4-6%** solids without chemical
- **NO** need for additional thickeners

## Removes settleable solids

- Less grit to digesters



# ***Impacts on Downstream Processes***

# Impact on Aeration Basins

## Less BOD/TSS to Activated Sludge

- Less aeration energy
- Less MLSS = less solids load for clarifiers or membranes
- Smaller aeration basin
- Free up bioreactor volume
- Design considerations for denitrification and bio-P
- Less WAS generation



# Impact on Anaerobic Digesters

## More raw BOD to digestion

- Less WAS to digester
- More biogas
- More VS destruction

## Less grit

- More “useable” volume
- Fewer cleanings

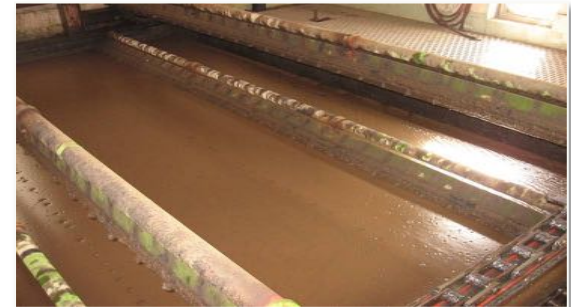


# Impact on Sludge Thickening

## Captivator delivers 4-6% thickened solids

- No sludge thickeners required

## No polymers needed





# Captivator

## *Development – Case study*

## Bethlehem, PA pilot

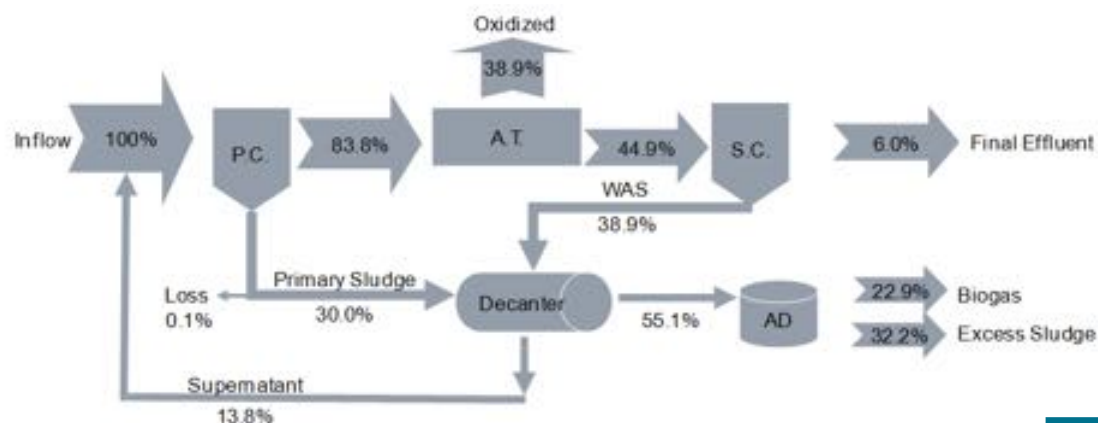
- Proved primary FF DAF
- WAS enhanced DAF performance
- Observed soluble BOD removal



## Singapore R&D study

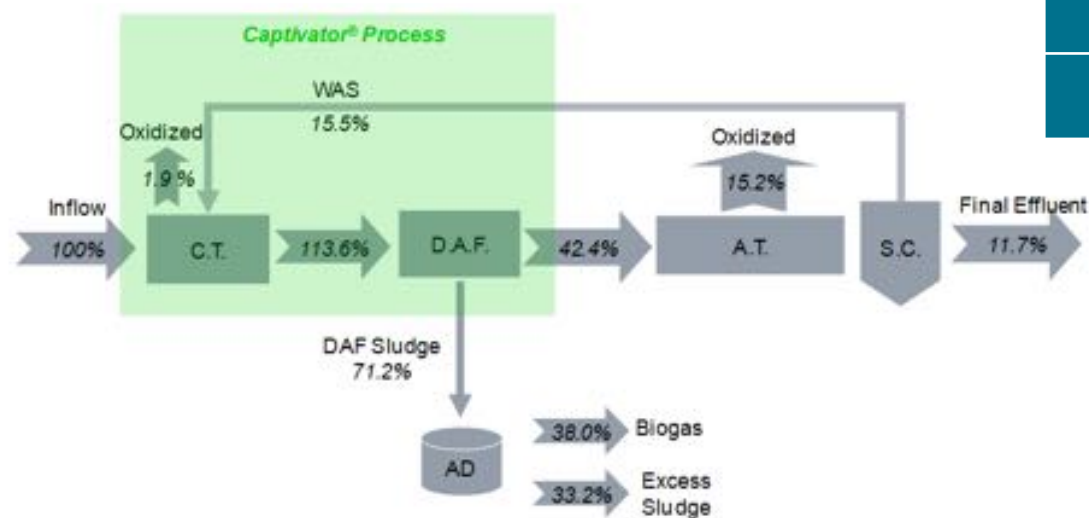
- Side-by-side program
- COD balance
- Proved enhanced BOD/TSS removal
- Proved biogas increase





**COD balance Singapore pilot  
Baseline system**

COD	Baseline System	Captivator System
Oxidized	39%	17%
Biogas	23%	38%



**COD balance Singapore pilot  
Captivator system**

# Agua Nueva WRF (Pima County, AZ) – 32 MGD

- Award winning DBO commissioned in December 2013.
- Evoqua integrated Captivator, clarifiers and disc filters.
- **Captivator** selected because of the benefits of reducing primary treatment footprint, aeration volume, aeration energy, and eliminating sludge thickeners.

*Captivator System*



Source: CH2M

## Agua Nueva WRF – Performance

	Captivator
<b>Soluble BOD removal</b>	29%
<b>Total BOD removal</b>	50%
<b>TSS removal</b>	66%



Source: CH2M

- Captivator system footprint = 126 ft x 190 ft.
- 65% footprint reduction compared to primary clarifier alternative.
- 35% reduction in aeration volume. 30% less diffusers. 30% smaller blowers.
- No separate sludge thickeners

# Agua Nueva WRF

Soluble BOD loads through CAPTIVATOR





# Application Criteria

## Must have

- Waste activated sludge (suspended growth) – existing or future.

## Nice to have

- Anaerobic digesters – existing or future
- Energy recovery (Cogen, sludge drying) – existing or future

## Good Candidates

- Plant expansions or upgrades (more flow, load, SRT in existing tanks)
- Conversion of fixed-film (RBC/TF) or HPO plants to activated sludge
- High BOD loading (industrial – F&B)
- Plants with primaries – existing or future
- Plants with beneficial use of biogas
- Footprint limited
- High energy costs



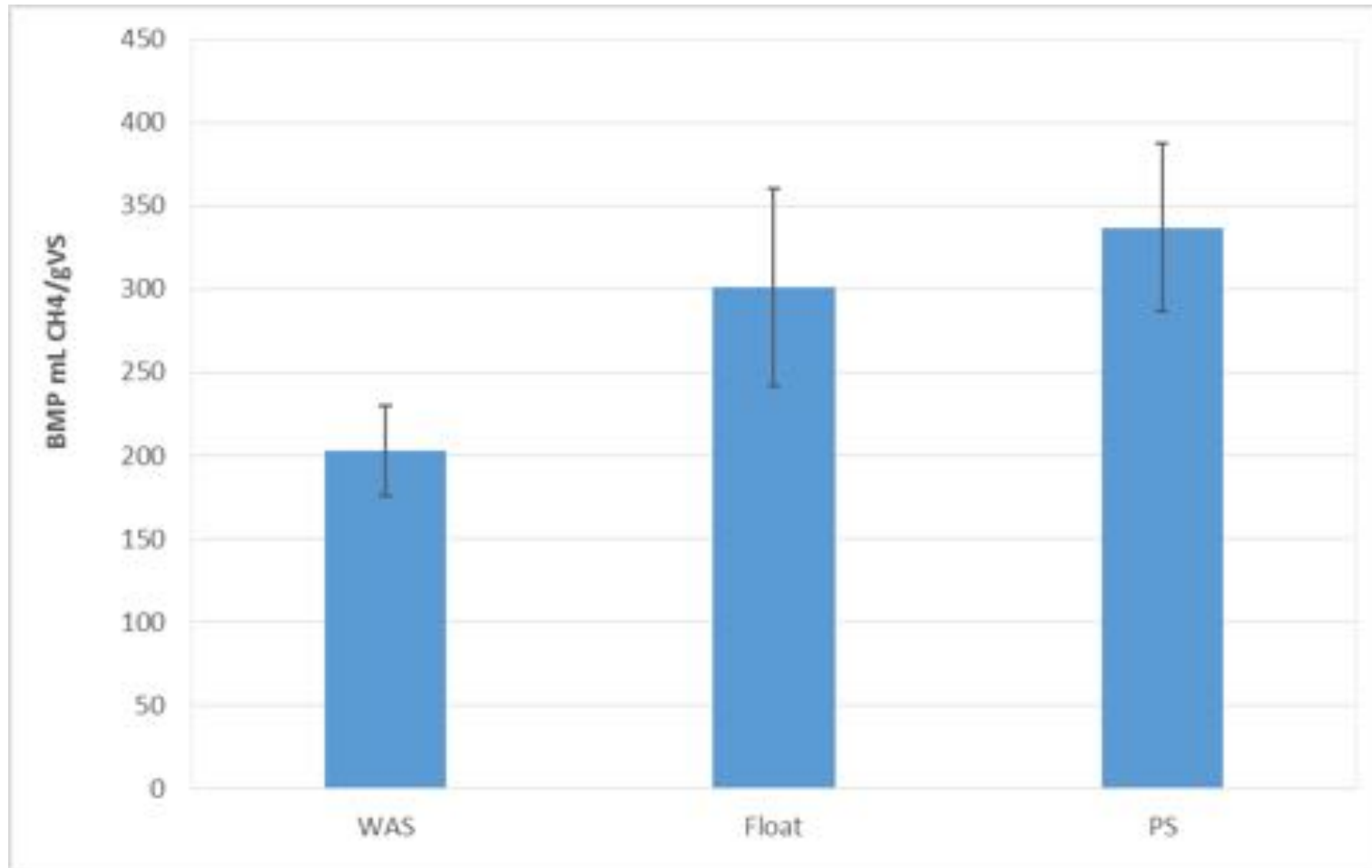
# **Captivator**

## ***Demonstration & Pilot Program***

## 0.3-MGD Captivator Pilot Unit



## Captivator Pilot – BMP test



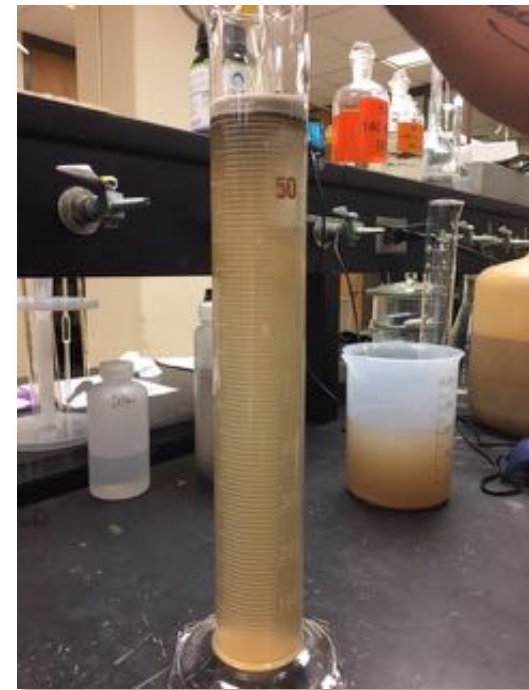
## Bench Tests



Contact  
Tank  
Simulation



Pressurized  
System



DAF  
Simulation

# TAKEAWAYS



- ❖ Biologically Enhanced Primary Treatment – *carbon diversion*.
- ❖ Enhanced BOD/TSS removal combined with sludge thickening.
- ❖ Shift carbon balance from “*consuming*” to “*producing*”.  
**Less** aeration and **More** biogas.
- ❖ Expansions in existing tanks. Free-up bioreactor volume.
- ❖ Small footprint. Can use existing tanks.
- ❖ Conventional technologies with innovative configuration.



**THANKS FOR YOUR ATTENTION**

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