Keys to an Effective Wastewater Treatment Plant Energy Audit

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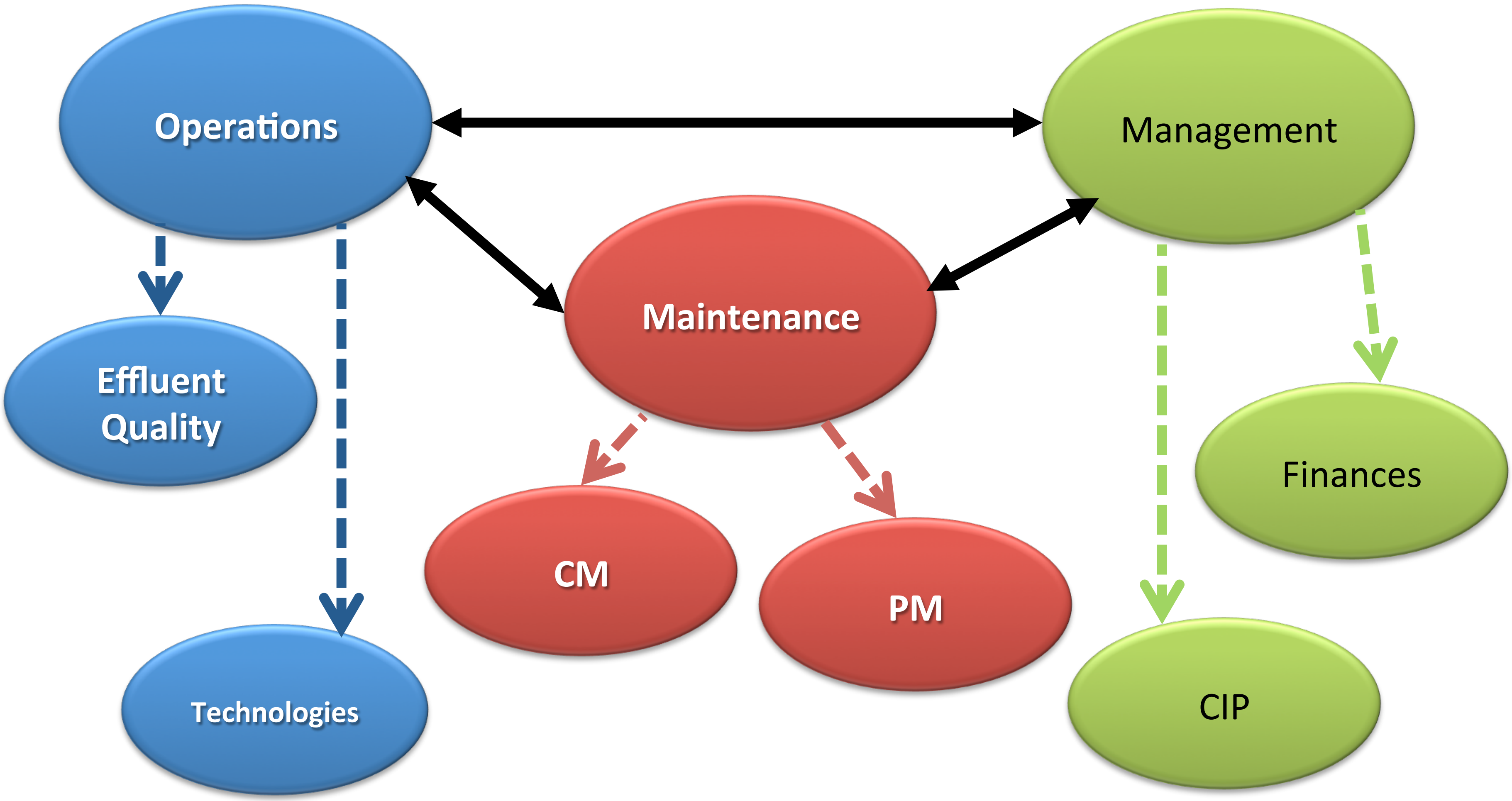
AECOM

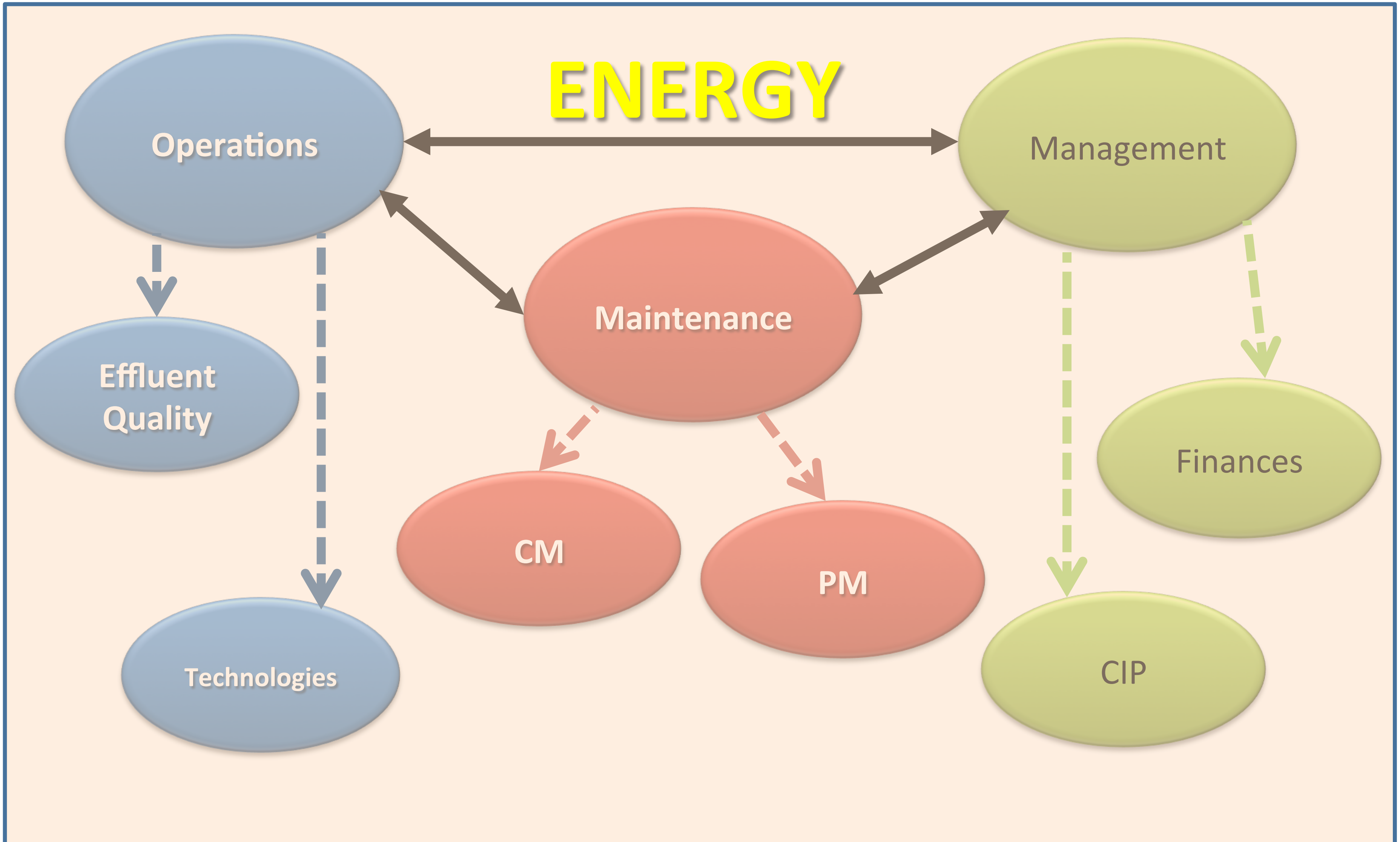
PRESENTATION GOALS

- Relationship between GHG and energy with plant O&M
- Benefits of a coupled energy & mass balance for future:
- Understand the dynamics of baselining a wastewater plant
- Beyond the ECM

Operations, Maintenance & Management



Operations, Maintenance & Management



Maintenance & Energy

Concept of Institutional Controls – Internal

Example 1: Preventative Maintenance

Building HVAC Filters and Motor Inlets

- Although typically small energy consumers, a clogged filter:
  - Results in lower air movement
  - Higher energy draw
  - Many filters add up!

- Dirty motor cooling fan inlets:
  - Allows dust to enter the motor can damage the motor
  - Can reduce motor efficiency

Maintenance & Energy

Concept of Institutional Controls – Internal

Example 2: Corrective Maintenance

Pump efficiencies change over time from curve data

- Pump efficiencies can decrease due to use
  - Worn impeller
  - Bearings

70% **85%** **83%**

ACTUAL AVERAGE EFFICIENCIES

OPERATING PUMP 1 REQUIRES 20% MORE KWH/D COMPARED TO PUMP 2

USE EFFICIENCIES TO DETERMINE MAINTENANCE AND GUIDE OPERATIONS

OPERATIONS & Energy

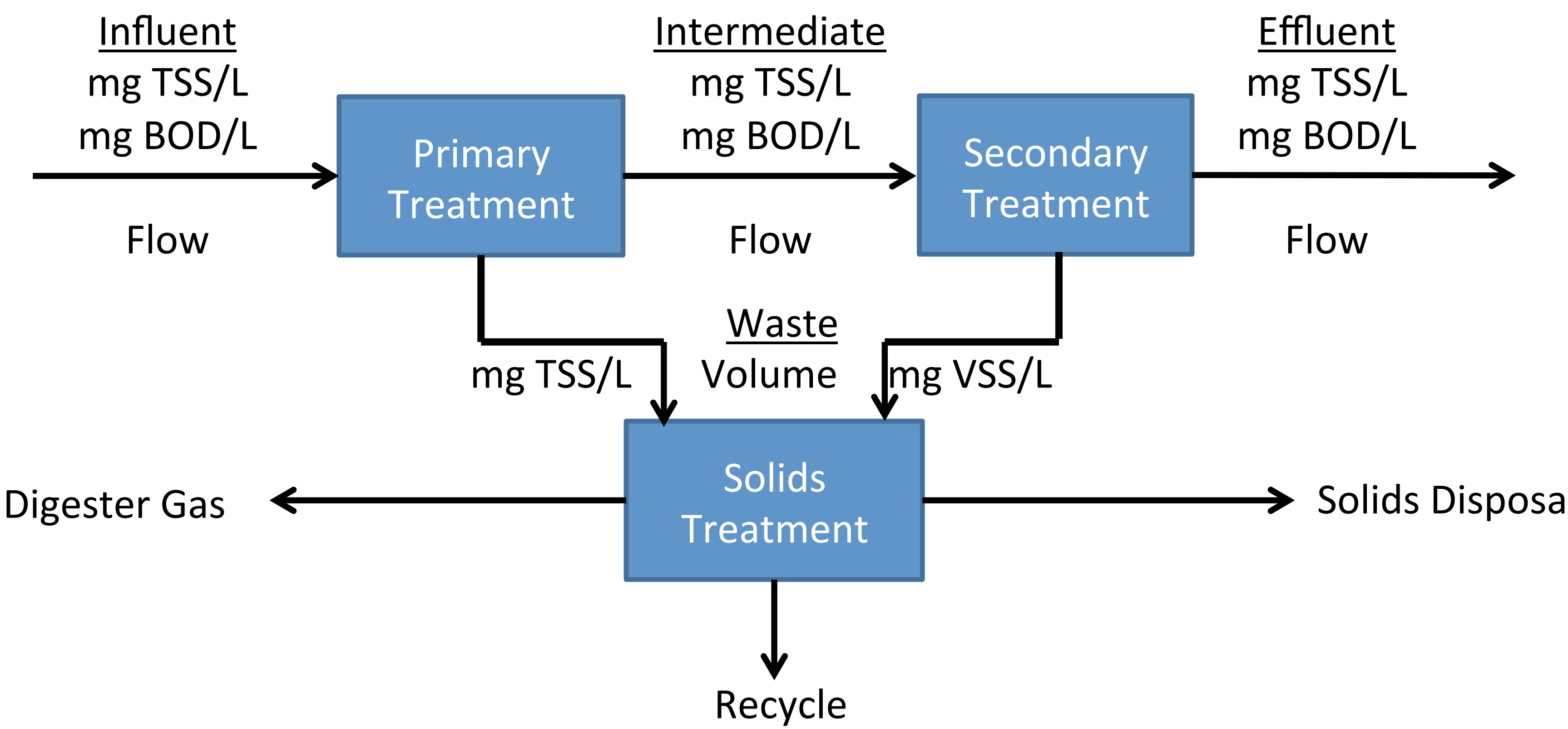
Concept of System Analysis

To clearly show the relationship between Operations and Energy several concepts need to be introduced:

- Coupling of energy and mass balances
- Baselining
- System Analysis

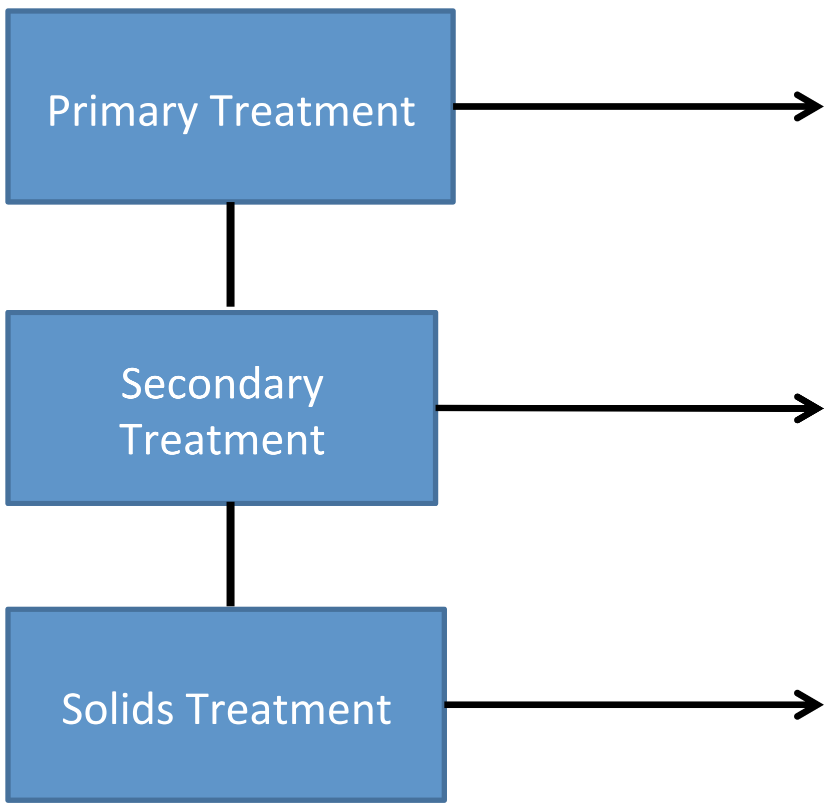
MASS BALANCE

Historically, wastewater treatment plants were analyzed using only a mass balance.



ENERGY BALANCE BALANCE

The comprehensive analysis incorporates an energy balance with a mass balance



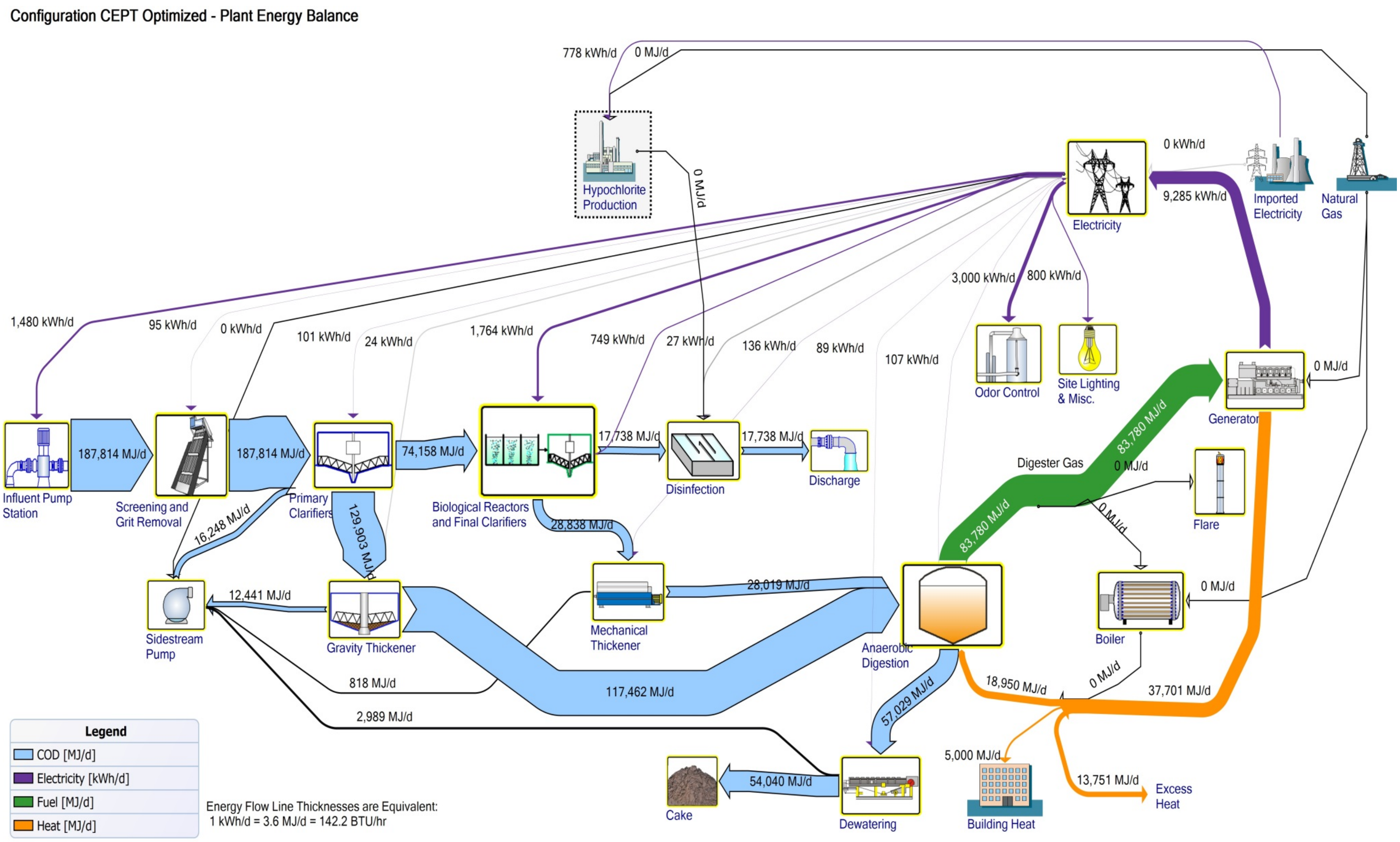
- Pumping Energy
- Solids Capture/Removal

- Pumping Energy
- Solids Production
- Aeration Energy
- Mixing Energy

- Pumping Energy
- Solids Thickening
- Heating
- Digester Gas Utilization

THE FULL BALANCE - BASELINE

Converting mass into energy (AND ITS NOT $E=mc^2$)



OPERATIONS & Energy

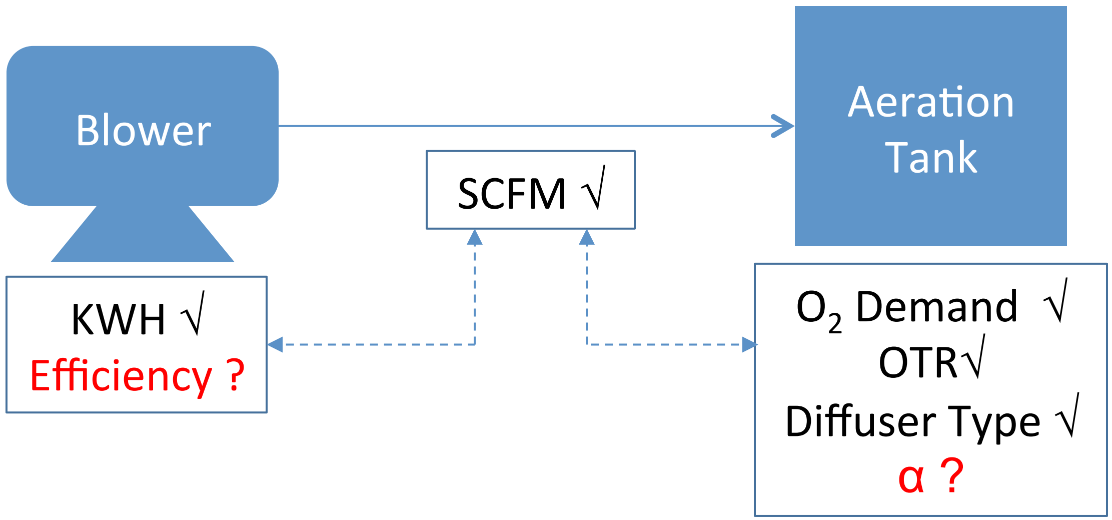
Baseline is the bottom line for analysis

Three examples follow on how energy, and the energy/mass balance coupling is connected to operations

- Squeeze play - α
- Digester
    - Prediction
    - Cleaning
- Pumping

OPERATIONS & Energy

Squeeze Play



With KWH, O_2 Demand, Diffuser Type, OTR – Match Airflow and Energy using Alpha and Blower Efficiency

Parameter	Actual	Calculated	% Difference
Airflow (scfm)	150,933	146,526	3%
Energy (Kwh/yr)	38,140,168	39,254,287	-3%

OPERATIONS & Energy

Digester Cleaning

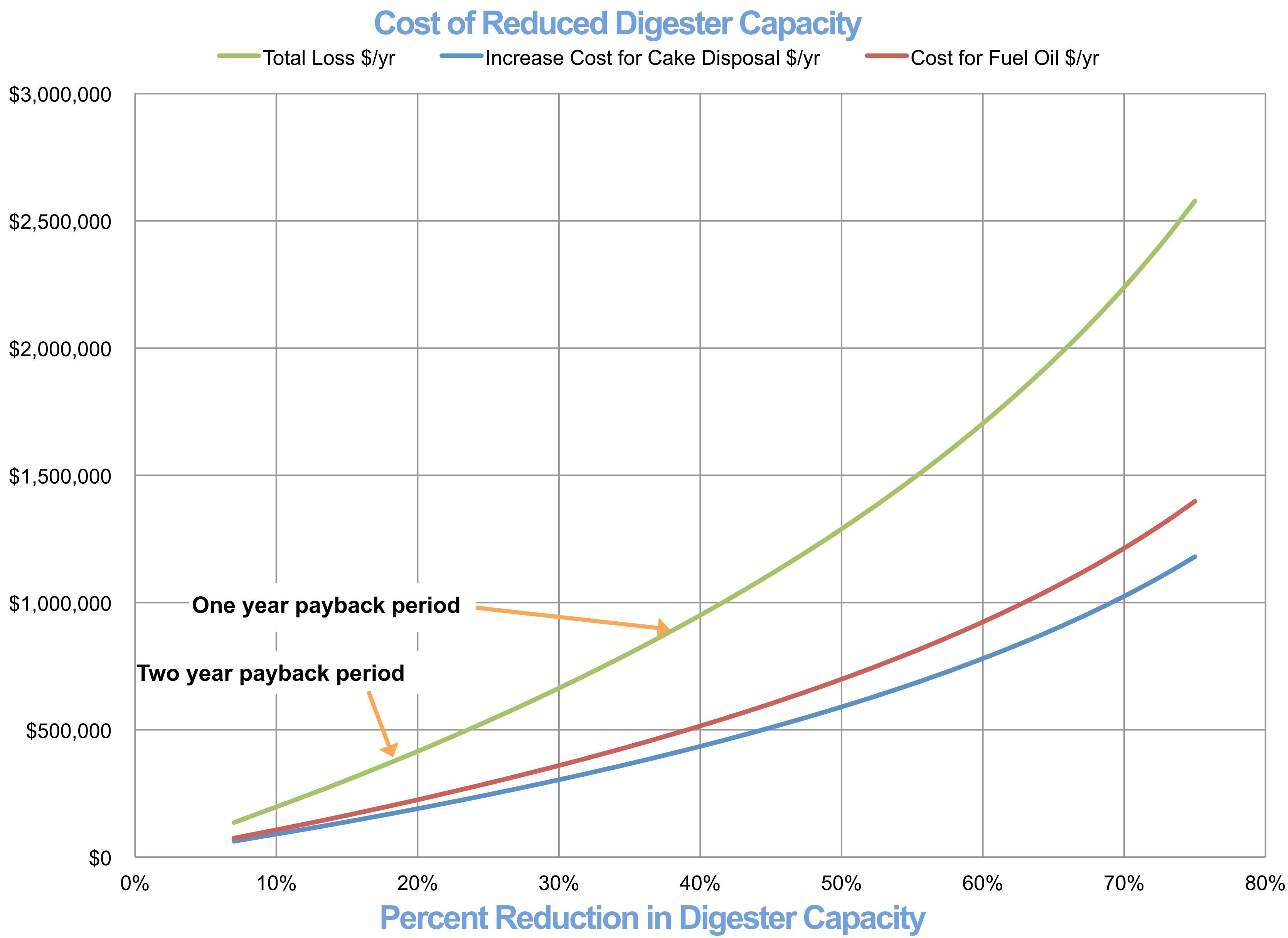
Grit, hairballs, and inerts accumulate in digesters – particularly for combined sewer systems thus requiring periodic digester cleaning.

Mass/Energy Balance can help determine when!

- **%VS Destroyed=(18.9+LN(HRT)*13.7)/100** (From M&E 4th Edition)

[Equation is general and due to different sludge types (primary, secondary, BNR, etc.) a plant specific correlation should be developed first]

- **Reduced %VS destruction**
  - Reduces digester gas production
  - Increases sludge for disposal


Cost of Reduced Digester Capacity
Total Loss $/yr
Increase Cost for Cake Disposal $/yr
Cost for Fuel Oil $/yr
$3,000,000
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$0
0%
10%
20%
30%
40%
50%
60%
70%
80%
One year payback period
Two year payback period
Percent Reduction in Digester Capacity

OPERATIONS & Energy

Pumping

The power of energy monitoring and potential of real-time control

Pumping systems using VFDs takes advantage of the Affinity Laws

$$P1/P2 = (Q13/Q23\ )$$

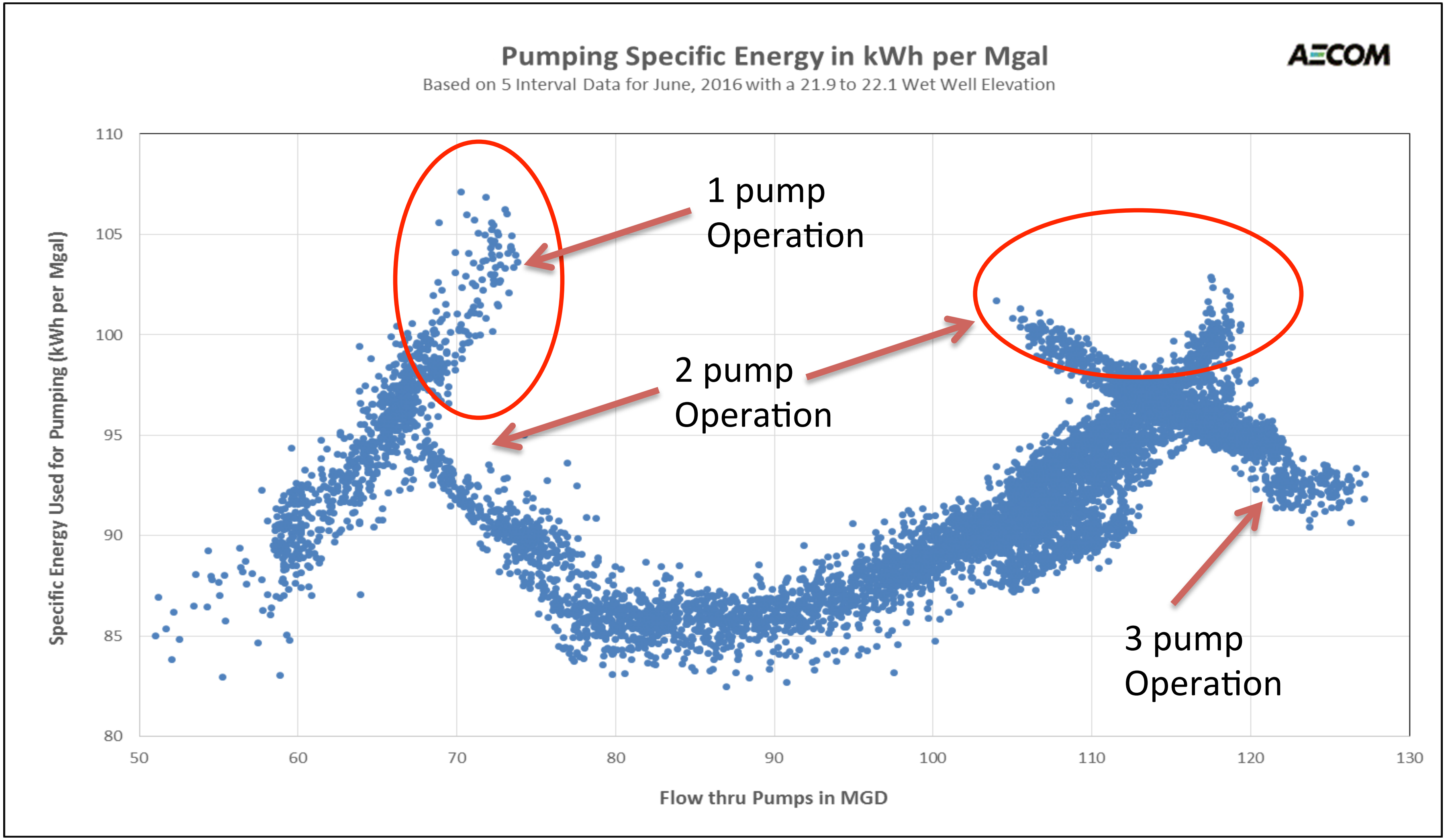
(for friction and flow only)

- Power can be reduced significantly and operating an additional pump can reduce power.

- Real-time power monitoring can help operational energy control.

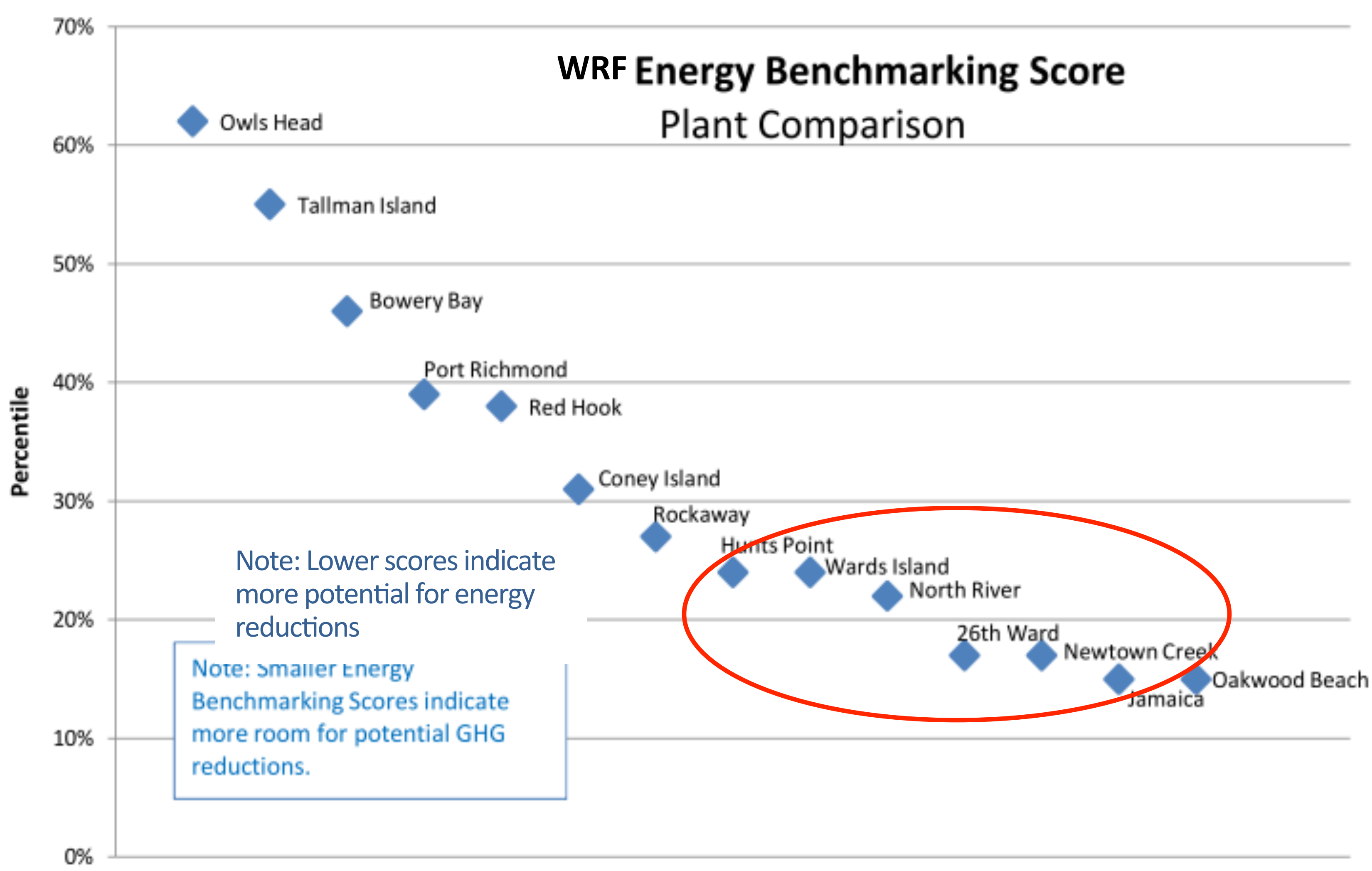
OPERATIONS & Energy

Pumping



OPERATIONS & Energy

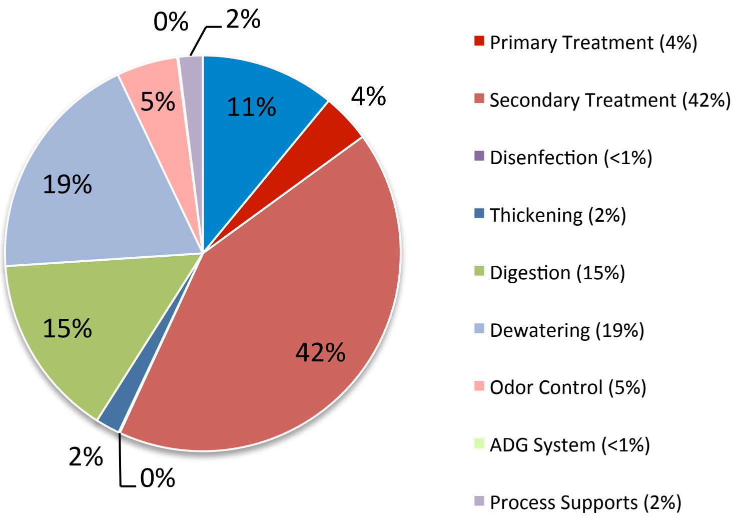
NYC Audit Example: Benchmarking Operations



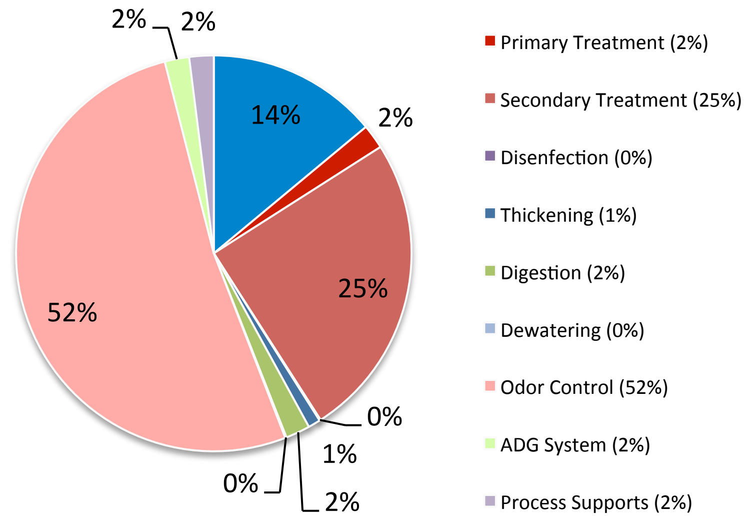
Energy End Use Analysis

CIP

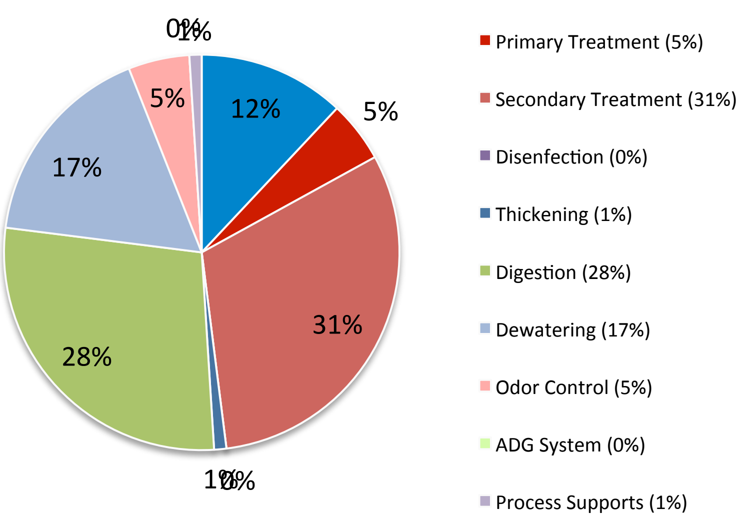
Hunts Point



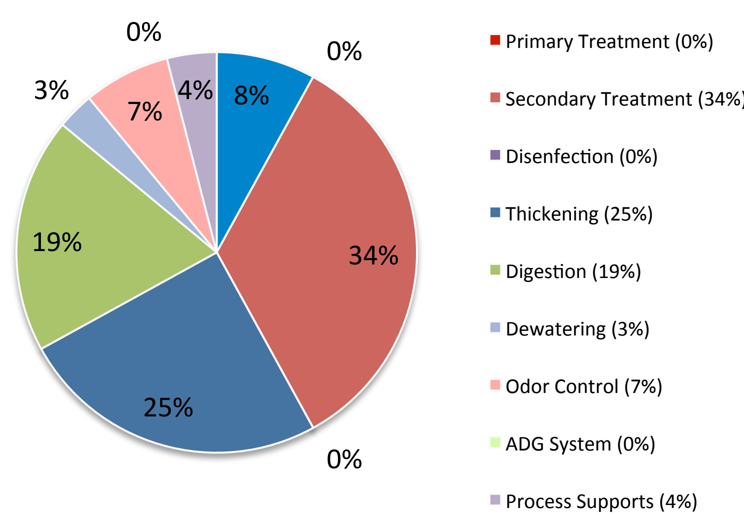
North River



26th Ward



Newtown Creek



CIP and Energy

Where does Energy Fit Into CIP

- Revamp existing projects
  - Centrifuge with Rotary Drum Thickeners
- Re-evaluate timeline due to energy savings
- Group smaller energy project work with larger projects with in the same process area
- Investigate advanced or emerging technologies

Programmatic and Institutional Controls

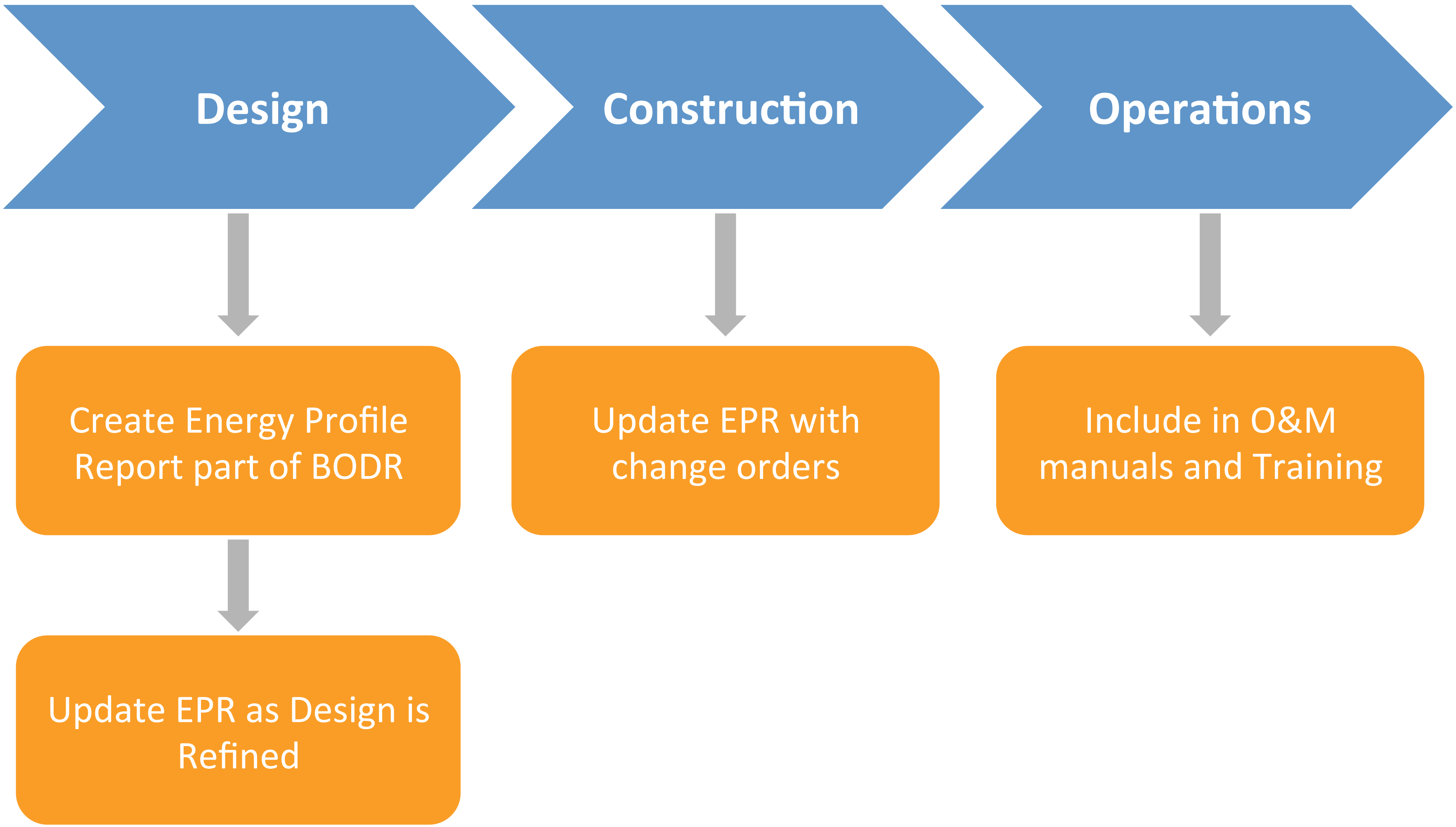
In-Plant Programmatic Controls

- Reduce recycle flows (washwater, draining tanks, ducking weirs, etc.)
- Automatic lighting controls
- Automatic heating/cooling levels
- Diffuser cleaning schedule
- Fan filter replacement schedule

Institutional Controls

- Energy usage/purchase reduction goals
- Identifying and Screening Protocols (FOG/food waste program, etc.)
- Energy policies (e.g. LEED)
- SOPs for design specification
- Energy analysis/consideration during design

SOP and Policy Development



Design Consideration: Example

- Design: 200 ft pipe run with 15 ft lift at 400 gpm
- Consideration: 3" vs. 4" pipe – same pump

	3"	4"
Pipe Cost	$16,890	$18,540
Energy Cost ($0.11/ kwh)	$2,813/year	$2,200/year

Savings: Over $600/year

Simple Pay Back: Under 4 years

Case Study

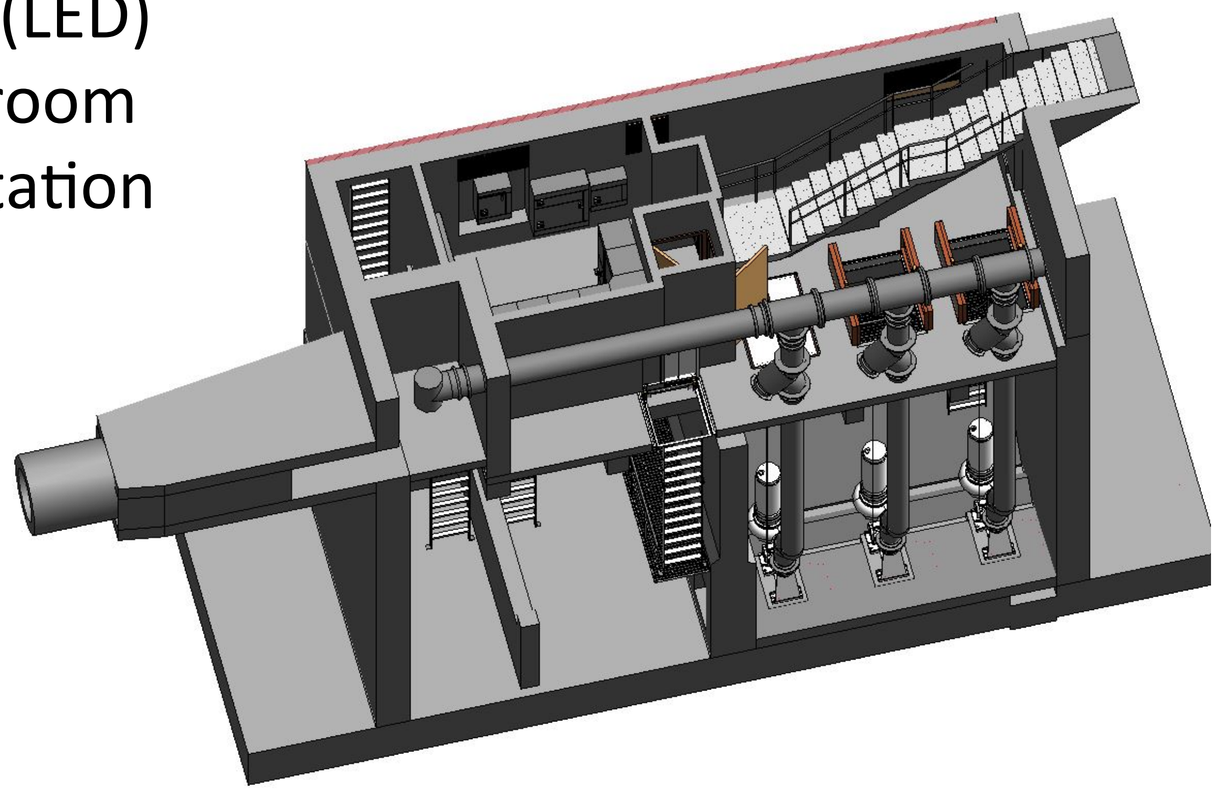
- Rehabilitate an old Stormwater Pump Station
- Initial construction in 1950's – 9.8 MGD



Case Study

Work:

- Replace three axial flow pumps with submersible pumps
- Improve lighting (LED)
- Install electrical room
- Improve pump station access



Case Study

Storm Return Period	Future			Current			Change		
	Electric Consumed	GHG Emissions	Cost	Electric Consumed	GHG Emissions	Cost	Electric Consumed	GHG Emissions	Cost
Year	kwh/event	lb CO2e	$/event	kwh/event	lb CO2e	$/event	kwh/event	lb CO2e	$/event
1	43	28	$ 7.78	29	19	$ 5.31	14	9	$ 2.48
2	52	34	$ 9.34	35	23	$ 6.37	17	11	$ 2.97
10	69	46	$ 12.45	47	31	$ 8.49	22	14	$ 3.96
25	86	57	$ 15.57	59	39	$ 10.61	28	18	$ 4.95
50	104	68	$ 18.68	71	47	$ 12.74	33	22	$ 5.95
100	121	80	$ 21.80	83	54	$ 14.86	39	25	$ 6.94

Future - Current (+ is increase/- is decrease)

Asset	Future			Current			Change		
	Power	GHG Emmission	Cost	Power	GHG Emmission	Cost	Power	GHG Emmission	Cost
	kwh/yr	tons CO2e/year	$/yr	kwh/yr	tons CO2e/year	$/yr	kwh/yr	tons CO2e/year	$/yr
Fan	13,065	4	$2,352	8,165	3	$1,470	4,899	1.6	$882
Unit Heaters	86,880	29	$15,638	76,020	25	$13,684	10,860	3.6	$1,955
Total HVAC System	99,945	33	$17,990	84,185	28	$15,153	15,759	5.2	$2,837

Future - Current (+ is increase/- is decrease)

Case Study

The design needs in this case justified an increase in energy costs. Due to the need to improve climate conditions particularly for the electrical components: A less efficient submersible pump as opposed to a centrifugal pump was needed to facilitate footprint.

Change from Current Operations to FSD	
Estimated Annual Electrical Consumption	16,035 KWH/year
Estimated Annual GHG Emissions	5 tons CO2e/year
Estimated Annual Operating Costs	$2,886/year
Future – Current (+ is increase / - is decrease)	

QUESTIONS?

THANK YOU

May 11, 2017

CIP and Energy Program Timeline