Gator Engineering

Energy Efficiency Assessments to Industrial Plants in Florida

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ENERGY SERVICES COALITION
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Mapping The Energy Landscape Of Water And Wastewater Treatment Plants In The State Of Florida

Florida Department of Agricultural and Consumer Services Office of Energy

Acknowledgements

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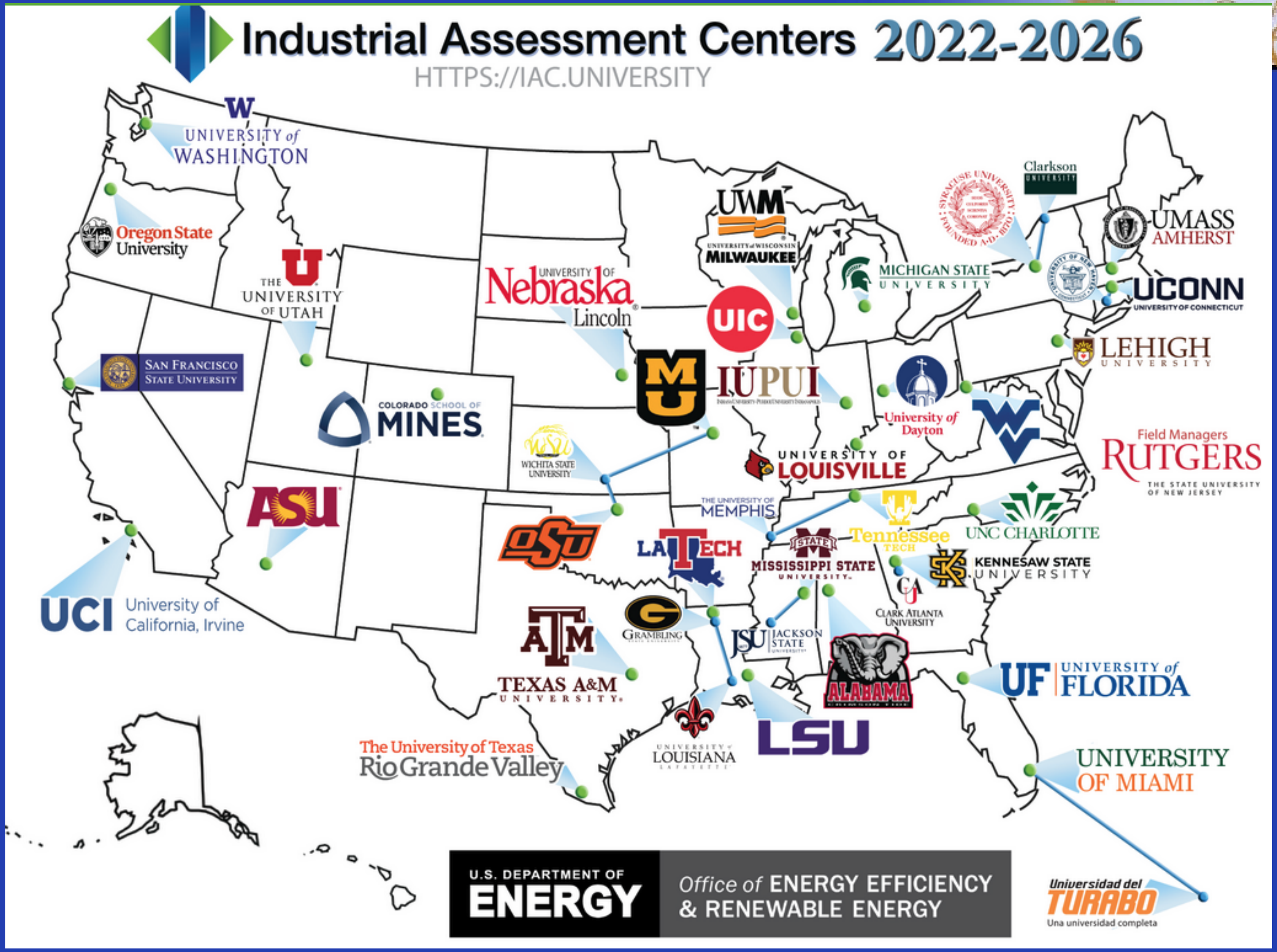
The UF-IAC Students

Greetings

Outline

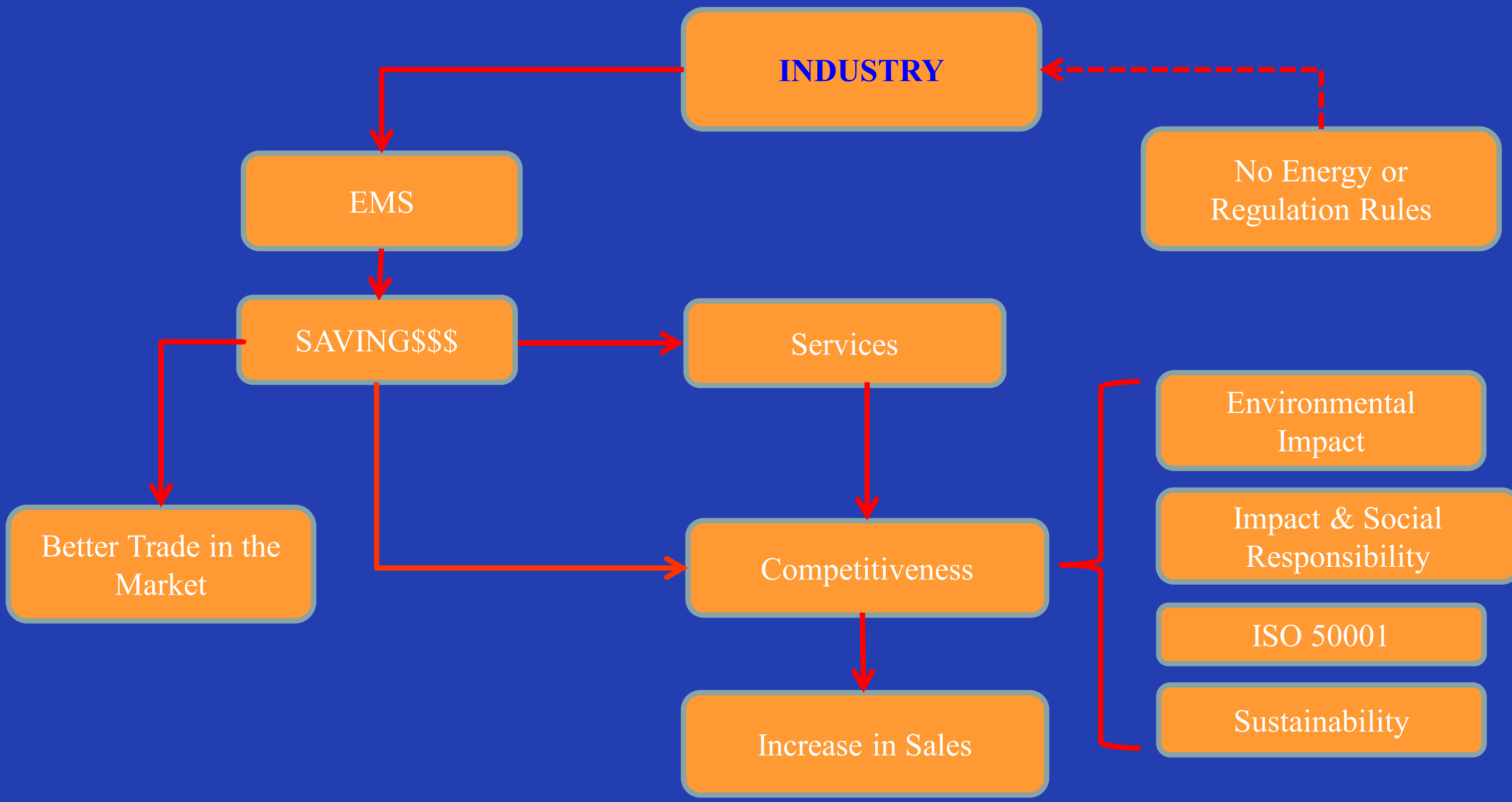
- Industrial Energy Audits
- Baseline and Metrics
- Energy Savings Opportunities
- The Implementation Rates and The Gaps
- The Wastewater Treatment Plants Case
- Emerging Energy Efficiency Technologies and ESCOs
- Conclusions



- IAC program was established in 1976 as the Energy Analysis and Diagnostic Center (EADC)
- In the 2021-2026 funding cycle, there are 31 Industrial Assessment Centers (IACs) in the US
- The UF-IAC was established in 1991 and has been in existence ever since
- The UF-IAC performs free energy assessments to midsize manufacturing facilities in Florida
- Scope of work involves energy efficiency, productivity enhancement, and waste management.

Industrial Energy Audit IDEAS

COMPETITIVENESS & INNOVATION



ENERGY AUDITS = EMS

E Policy = Objectives
- Incentives
- Training
- Energy Eff Team
- Energy Targets
- Social Commitmen

Energy Targets

Energy Policy

Energy Team

Training

M & V

Implementation

Energy Audit

Implementation:
- Conservation
- E. Eff. Oportunities
- SGE & ERNC
- Self-Generation

M & V:
- Metrics
- Energy Use
- GHG Emmisions
- Carbon Credits
- Economic Variables
- Regulations
- Effects in the Market

Energy Audit:
- Audit
- Benchmarking
- Energy Bills
- NCRE
- Sustainability
- Baseline & Metrics
- Energy Balance

Energy Efficiency Benefits

INCREASES COMPETITIVENESS

INCREASES PRODUCTIVITY

REDUCES WASTE

IMPROVES ENVIRONMENTAL PERFORMANCE

LOW PRODUCTION COSTS

ENERGY EFFICIENCY

Why Not Implementing EE in Industry

- Low ROI
- Initial Cost too High
- Flow of $ Doesn't Allow it
- High Operational Costs
- Impratical
- Processes/Equipment Changes
- Plant has Changed
- Personnel Changes
- Production Plan Changes
- Unknown
- Burocratic Restrictions
- Lack of Staff for Analysis and/or Implementation
- Not Worth it
- In disagreement
- Risk or Inconvenience for personnel
- Sospicious of Risk/Problem with Equipment or Producto
- Discarded, Imp. Failed
- Other …….

Bottom Line: Move Industry

FROM

"Motivated Confussion"

- Recognices the value of EE but …
- Confussion on HOW to Proceed, and ….
- The Problem is TOO big and therefore:
- Results: Little or NO Action

TO

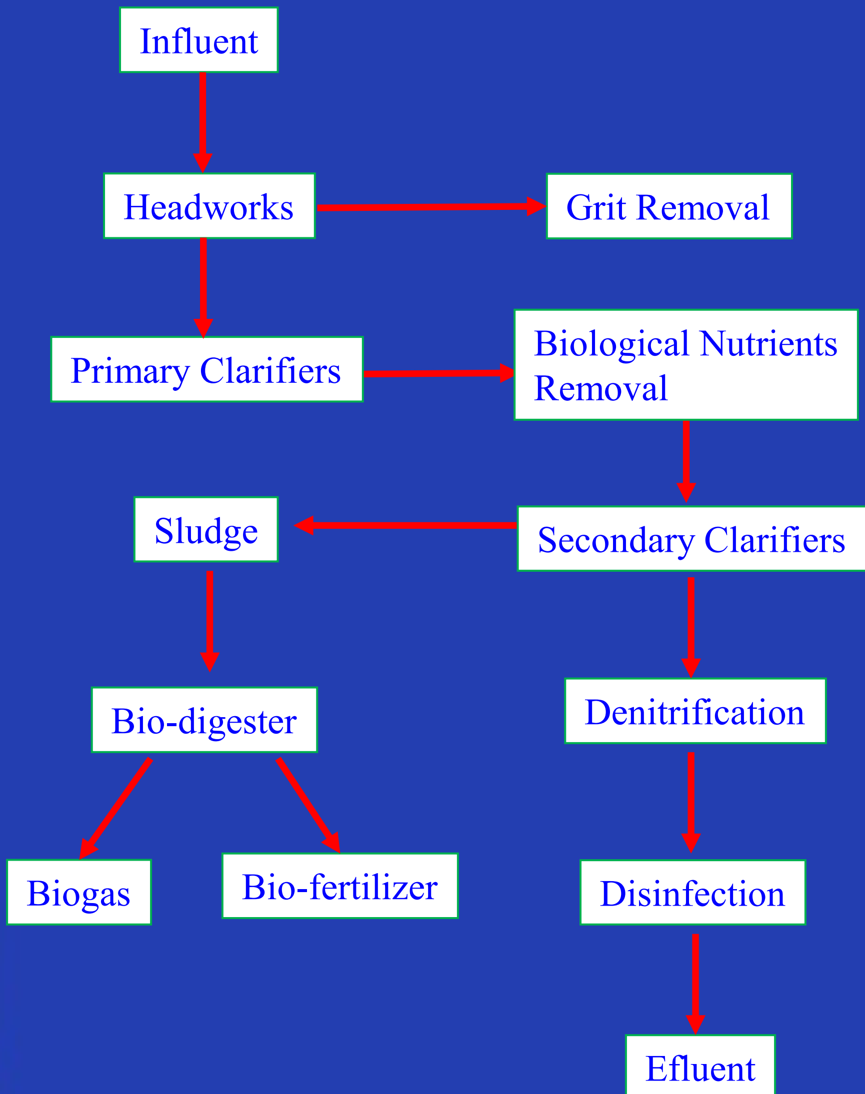
"Informed Actions"

- Apply Methods and Tools
- Identify subset of systems with Guaranteed Engineering
- Develop Management Policies (e.g., policies for everything: purchasing, replacements of equipment, supply chain, etc.) Policies For ALL

The Industrial Energy Audit Results

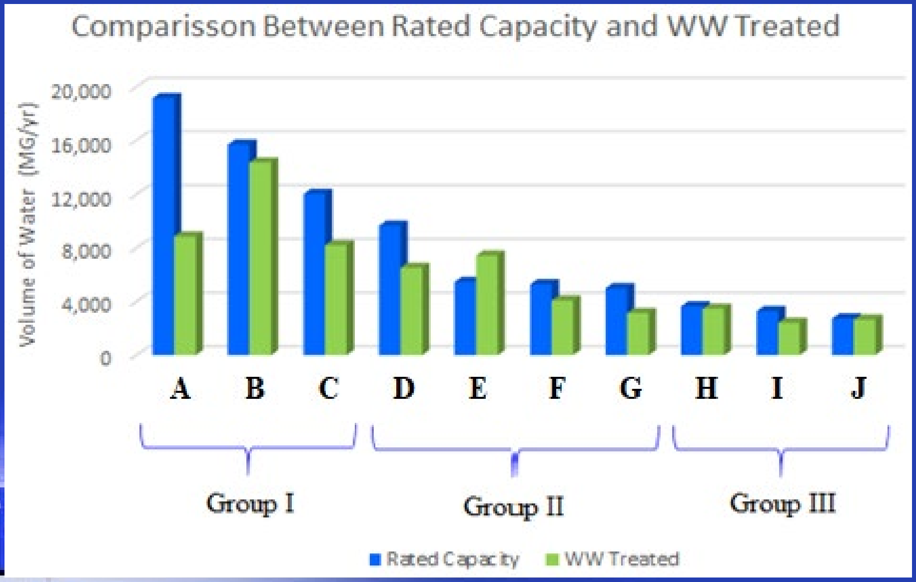
	Pesimist	Optimist	Cost	SPP	Type of Opportunities
I	0%	5%	Maint. Budget	0	Routine & Reactive Maintenance Operations
II	5%	15%	No Insvetment Cost	< 1 yr	Elimminate/reduce leaks: water, steam & air, change operations set-ups of equipment, high eff. motors, boilers condensate return, among others
III	15%	30%	Low Investment Cost	1 to 5 years	Insulation, Power Factor reduction, recover heat from steam bleading, economizers in boilers, efficiency increase, evaporators, etc.
IV	30%	50%	Major Investment Cost	> 5 yrs	Boilers insulation, evaporators, biogas generation from biomass, cogeneration systemsfrom biomass, or to satisfy termal loads for heating or cooling, etc.

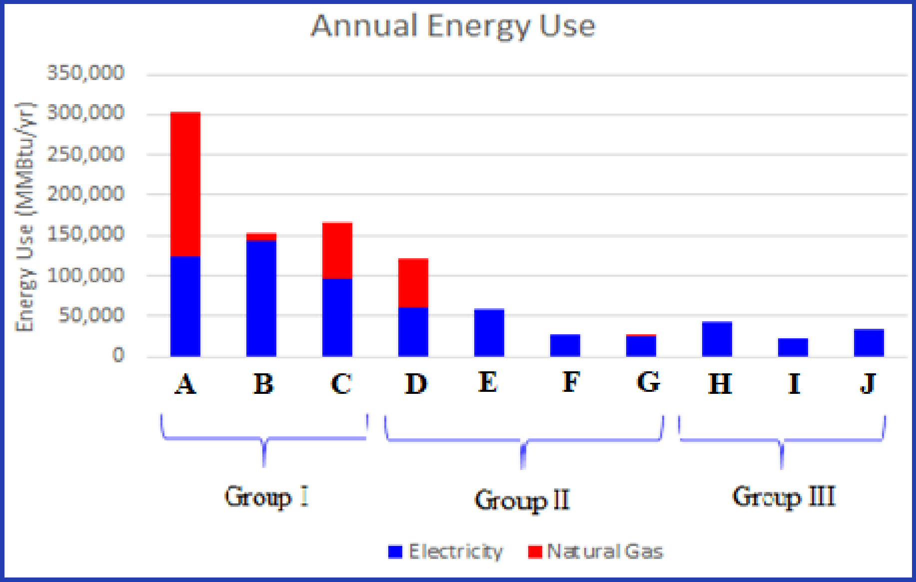
The WWTPs Case



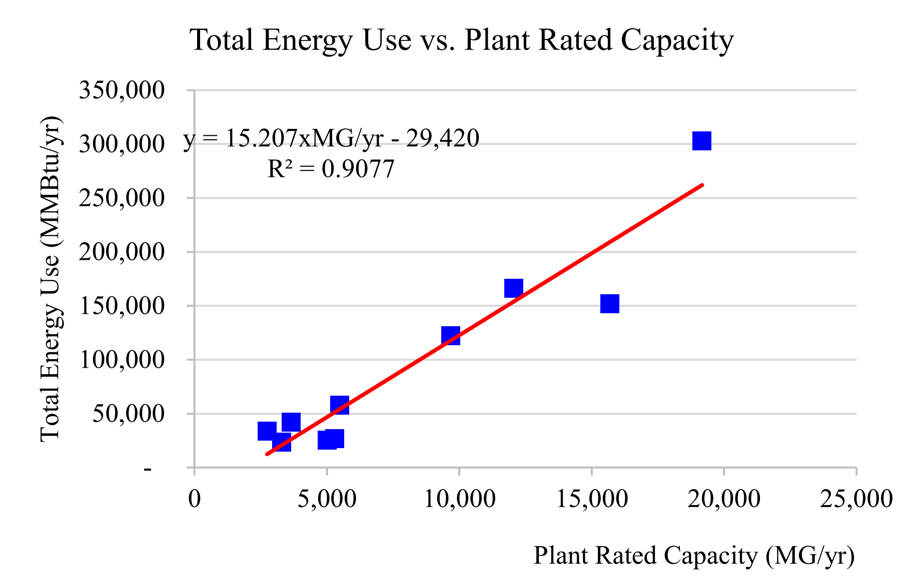
Energy Use in WWTPs

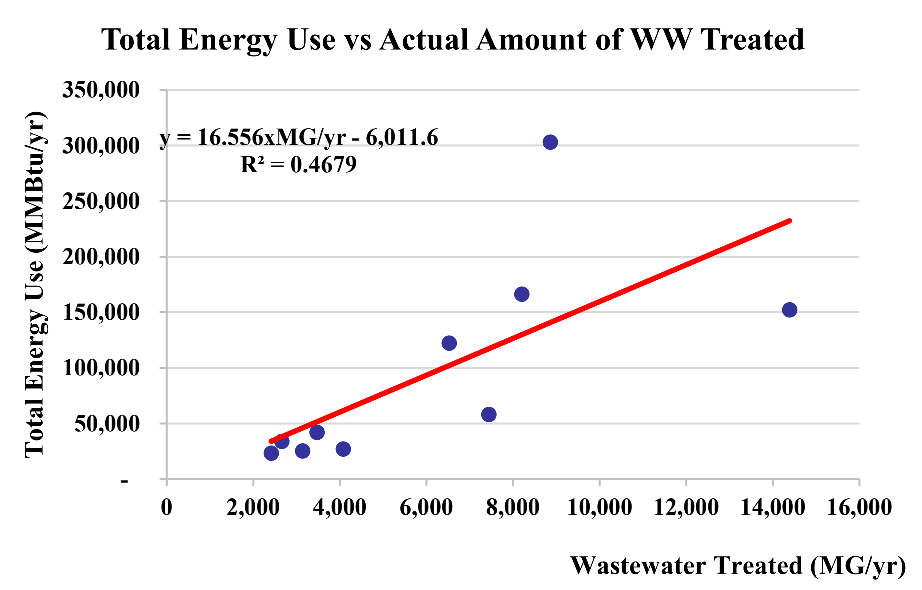
Group	Plant	Rated Capacity (MGD)	Rated Capacity (MG/yr)	Wastewater Treated (MG/yr)	Total Energy (MMBtu/yr)	Electricity (kWh/yr)	Natural Gas (MMBtu/yr)
I	A	52.5	19,162.5	8,860.8	302,986.9	35,968,031	180,264
	B	43	15,695.0	14,391.0	152,100.4	42,058,447	8,597
	C	33	12,045.0	8,206.3	166,378.1	28,473,059	69,228
II	D	26.5	9,672.5	6,524.7	122,336.9	18,074,400	60,667
	E	15	5,475.0	7,439.7	57,966.2	16,988,917	0
	F	14.5	5,292.5	4,080.8	26,896.3	7,882,844	0
	G	13.7	5,000.5	3,142.0	25,187.8	7,077,600	1,039
III	H	10	3,650.0	3,472.6	42,037.2	12,320,400	0
	I	9	3,285.0	2,415.6	23,367.7	6,848,676	0
	J	7.5	2,737.5	2,659.5	33,748.6	9,891,135	0

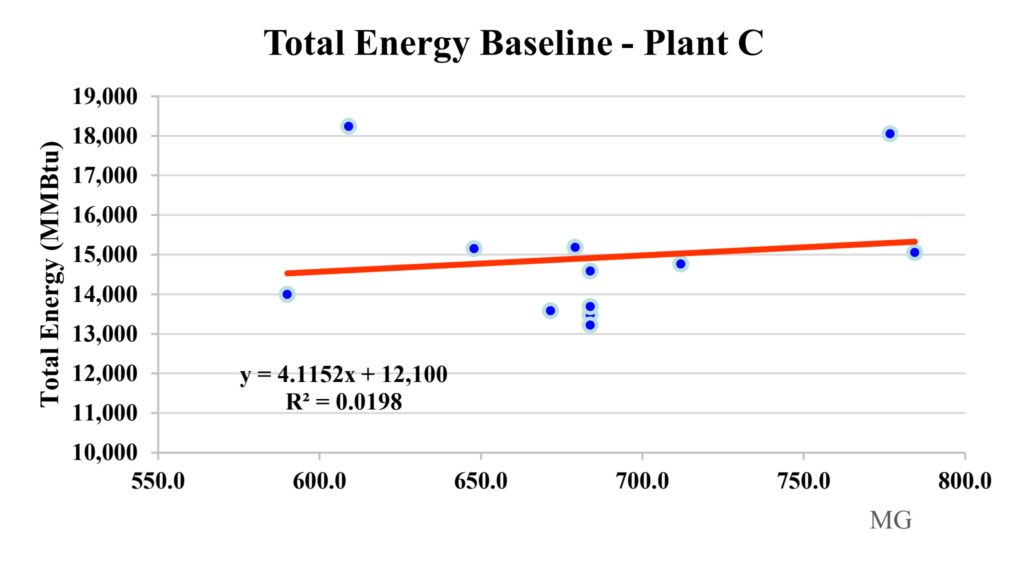




Energy Baseline





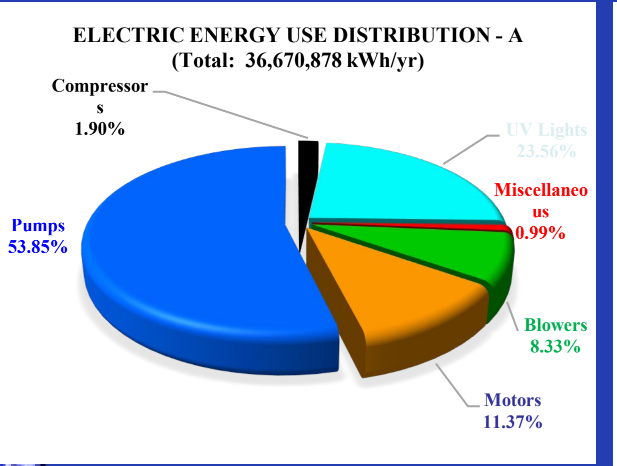


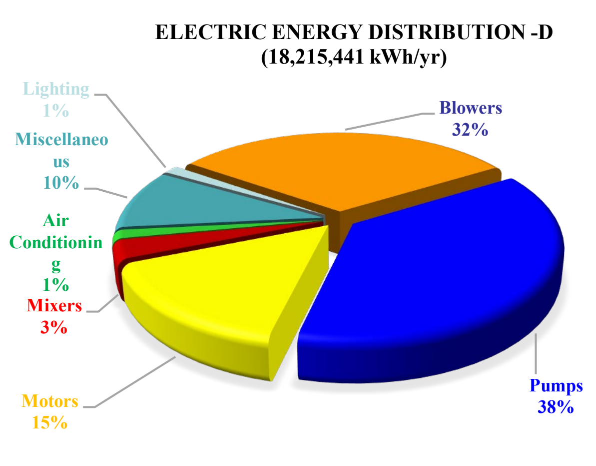
Electric Energy Use Distribution

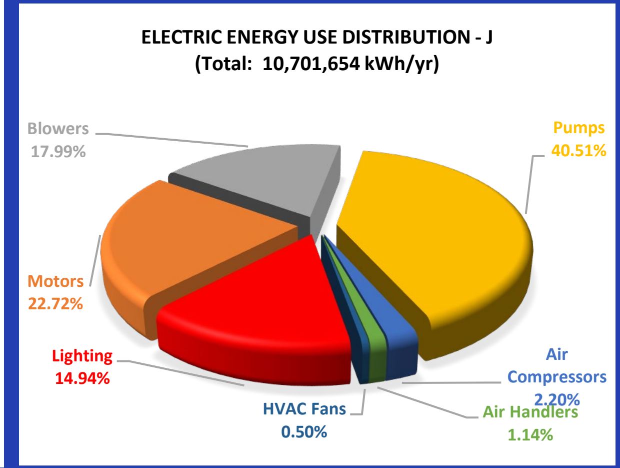
Energy Baselines for All Ten Plants

Group		m (MMBtu/MG)	b (MMBtu)	R^2 (%)
I	A	-1.4834	26,344	2.05
	B	0.4032	12,283	0.51
	C	4.1152	12,100	1.98
II	D	5.8238	7,028.20	6.77
	E	-0.2552	4,988.90	0.06
	F	2.5126	1,386.90	13.98
	G	1.2981	1,780.30	6.77
III	H	-582.54	1.00E+06	5.47
	I	0.6619	1,814.10	0.62
	J	2,759.70	212,644	49.89

Group		Energy Cost (from slope m) ($/MG)	Non-Treatment Cost (from intercept b) ($)
I	A	13.71	243,566
	B	6.65	202,394
	C	42.3	124,370
II	D	102.98	124,294
	E	4.67	91,390
	F	46.55	25,679
	G	22.25	38,517
III	H	54.8	94,000
	I	15.52	42,453
	J	173.9	13,397







Energy Savings Opportunities

ARs	GROUP I			GROUP II				GROUP III		
	A	B	C	D	E	F	G	H	I	J
Replace blowers with air compressors	√	√				√				
Turn on the UV controller	√									
Install high-efficiency motors	√	√			√	√	√	√	√	√
Put oxygen sensor in boiler's exhaust	√									
Install a CHP system		√								
Install CHP or CNG syst. using biogas				√						
Install high-efficiency lighting		√	√	√			√			
Insulate tanks			√							
Enhance biogas generation			√							
Install occupancy sensors			√				√			
Replace V-belts with cogged V-belts			√		√	√	√			
Install an energy management System			√	√						√
Preheat the air to the dryer				√						
Install O_2 sensor in boiler exhaust				√			√			
Install variable frequency drives					√				√	√
Install heat recovery for the boiler							√			
Install a photovoltaic system								√		
Install higher eff. blades in aerators								√		
Turn off the digester's pumps								√		
Install pipes for biomass transport								√		
Install timers for outside lights								√		
Treat rejected water with ozone									√	
Optimize comp. air vol. generation										√
Install a back-up generator switch										√
Energy Cost Savings ($/yr)	**480,698**	**274,070**	**331,342**	**222,530**	**128,672**	**256,917**	**50,986**	**146,122**	**95,000**	**120,627**
% of Energy Costs Saved	**17.16**	**8.16**	**16.22**	**11.82**	**12.10**	**51.73**	**10.00**	**10.75**	**17.34**	**19.43**

Productivity Increase Opportunities

ARs	GROUP I			GROUP II				GROUP III		
	A	B	C	D	E	F	G	H	I	J
Install a reactor for nutrient recovery	√	√		√						
Automate the aeration process								√		
Productivity Cost Savings ($/yr)	**493,101**	**492,292**		**495,807**				**70,421**		

Waste Management Opportunities

ARs	GROUP I			GROUP II				GROUP III		
	A	B	C	D	E	F	G	H	I	J
Install a Biodigester										√
Cost Savings ($/yr)										**396,790**

Total Cost Savings Opportunities

ARs	GROUP I			GROUP II				GROUP III		
	A	B	C	D	E	F	G	H	I	J
TOTAL COST SAVINGS	973,799	766,362	331,342	718,337	128,672	256,917	50,986	216,543	95,000	517,417

Cost and Energy Savings for the Three Groups of WWTPs

	Cost Savings	Implementation Cost	Simple Payback Period	Return on Investment	Electric Energy Savings	Thermal Energy Savings	CO_2 Reduction
GROUP	($/yr)	($)	(yrs)	(%/yr)	(kWh/yr)	(MMBtu/yr)	(tons CO_2/yr)
I	2,199,991	6,973,813	3.17	31.55	20,454,658	146,290.0	1838.6
II	6,938,084	639,958	0.09	1,084.15	2,574,181	82,593.5	1369.9
III	829,404	1,953,407	2.36	42.46	3,734,988	145,611.0	3146.0
Total	**9,967,479**	**9,567,178**			**26,763,827**	**374,494.5**	**6,354.5**

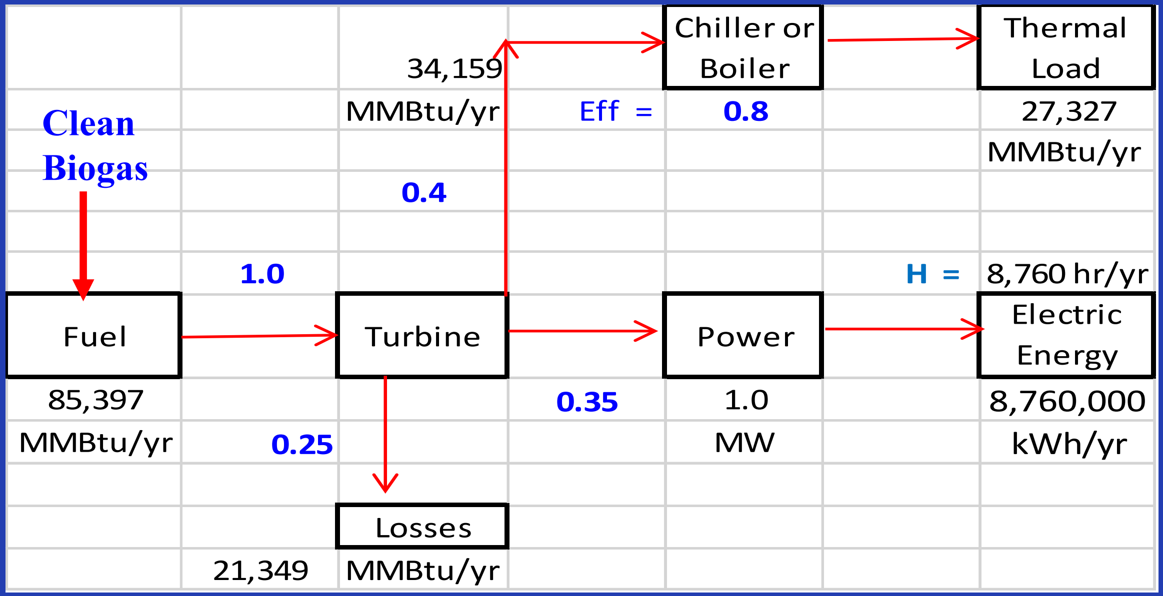
Total annual cost savings of all plants is about $9,967,479

This represents a plant average of $996,748/yr in savings

Total reduction in energy consumption per plant is about 17.5%

A Combined Heat and Power System or CNG

Consider the following diagram and run some energy calculations.



Nat Gas Savings = Fuel Energy - Heat For Boiler

= 85,397 MMBtu/yr – 34,159 MMBtu/yr = 51,238 MMBtu/yr

Cost Savings = Demand + Energy – Fuel – Maintenance

Payback = Imp. Cost/Cost Savings = $1,4000,000 / $302,404/yr = 4.63 yrs (3.45 yr)

Return on Investment = ($302,404/yr / $1,4000,000) x 100 = 21.60%/yr (28.92%/yr

DOE CHP Technical Assistance Partnerships (CHP TAPs)

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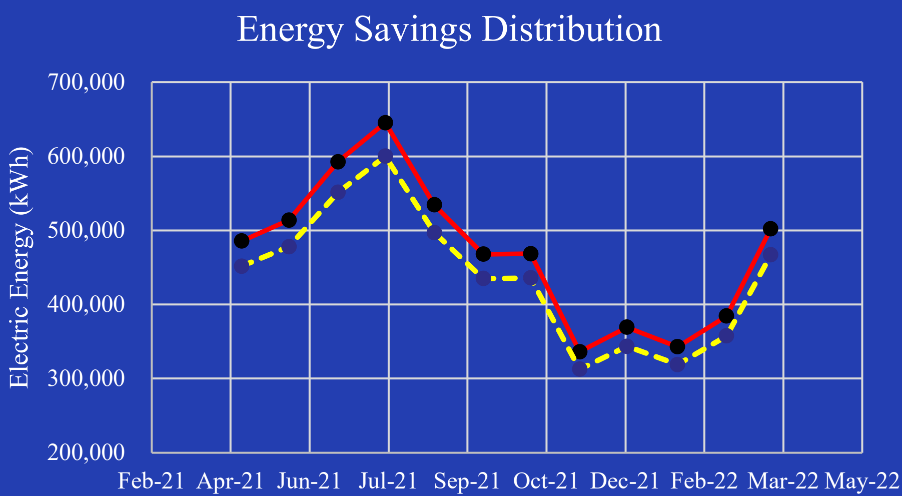
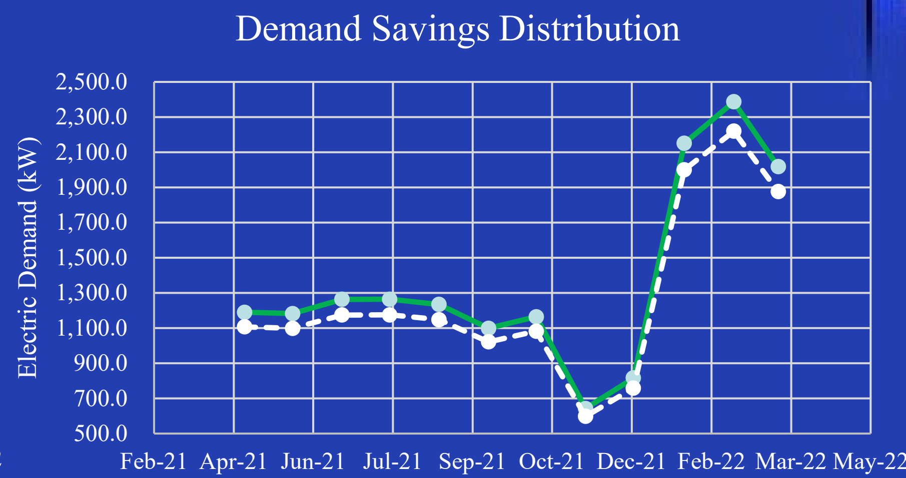
Electric Energy Stabilizer





IC = $30,000 CS = $37,000/yr SPP = 0.81 yrs

Integrate IoT Into SCADA System

IC = $10,000 CS = $47,000/yr SPP = 0.21 yrs

Implement a Remote Access to SCADA-HMI

IC = $0 CS = $5,000/yr SPP = Immediate

Sell Sludge as Fertilizer

IC = $53,000 CS = $560,000/yr SPP = 0.10 yrs

In Summary

- Free Energy Audits
- Free CHP – TAP Evaluation
- MACR$
- New Implementation Funding Resources

CONCLUSIONS

- There are opportunities for on-site power generation using CHP.
- NCRE such as photovoltaics (PV) can be made part of the plants' energy use portfolio.
- The correlation of electric energy usage with the amount of wastewater treated for plants with only electric energy capability is poor. The same is true for the linear correlation of natural gas energy usage with the amount of wastewater treated. Poor linear correlation is also observed between the electric energy usage and the amount of wastewater treated for those plants that use both modes of energy.
- Energy used per MG of WW treated is below recommended values by the US - DOE.
- Equipment runs a fraction of the annual hours of operation, but not necessarily at the same time.
- Electric equipment has different operating parameters, efficiencies and capacities.
- Plants that do not further treat their sludge, have great opportunities to generate biogas and biofertilizers, and self-generate power through CHP. All with very appealing savings.

What is not a best practice becomes a recommendation

Questions ?