The Role of Anaerobic Technology in our Dream to be the Best Beer Company in a Better World

Thea Cummings
05/18/11

Agenda

- Introduction
- Reduction and Reuse
- Beneficial Reuse of By-Products
- Renewables
- Wastewater Treatment Overview
  - Bio-Energy Recovery System (BERS)

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Introduction – Energy and Fluids
Our Dream and Objectives

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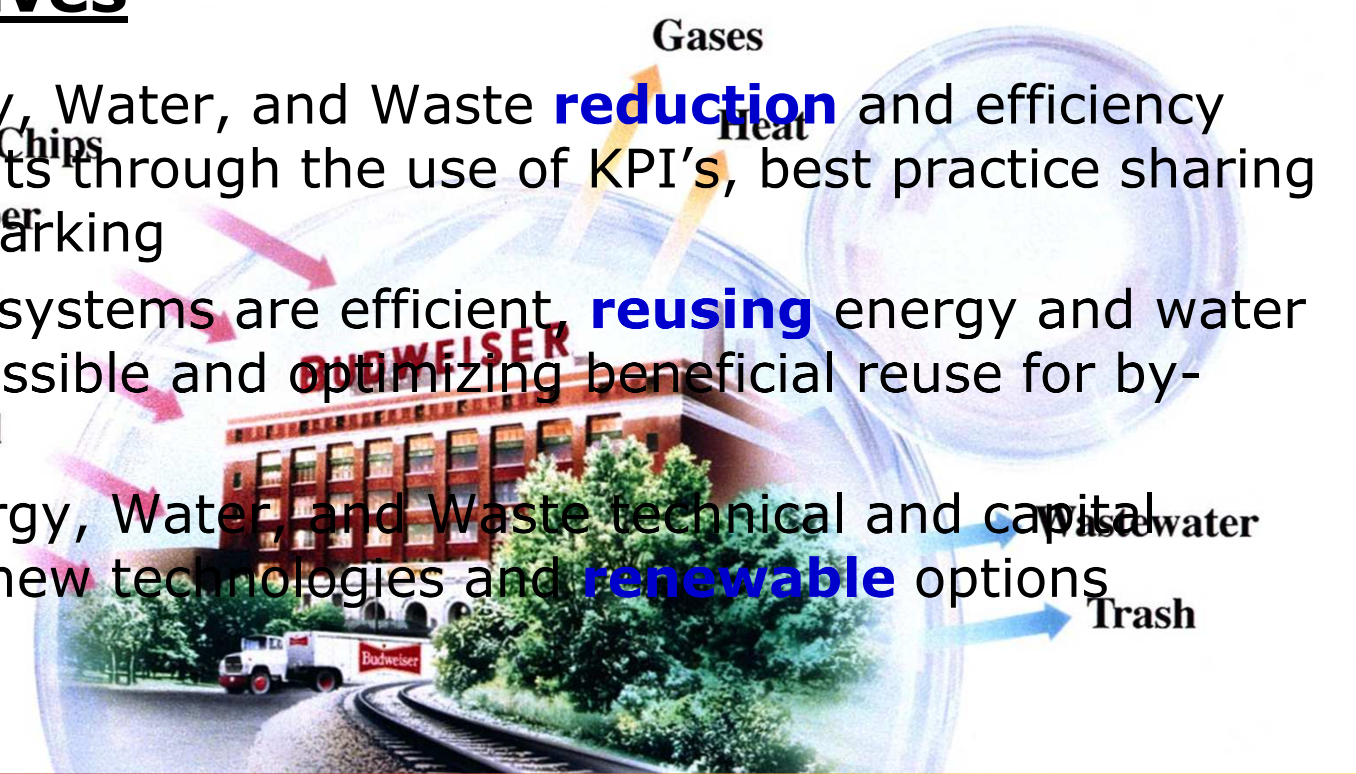
Our Dream

To be the Best Beer Company in a **Better** World

Our Objectives

- Drive Energy, Water, and Waste **reduction** and efficiency improvements through the use of KPI's, best practice sharing and benchmarking
- Ensure that systems are efficient, **reusing** energy and water wherever possible and optimizing beneficial reuse for by-products
- Provide Energy, Water, and Waste technical and capital support for new technologies and **renewable** options



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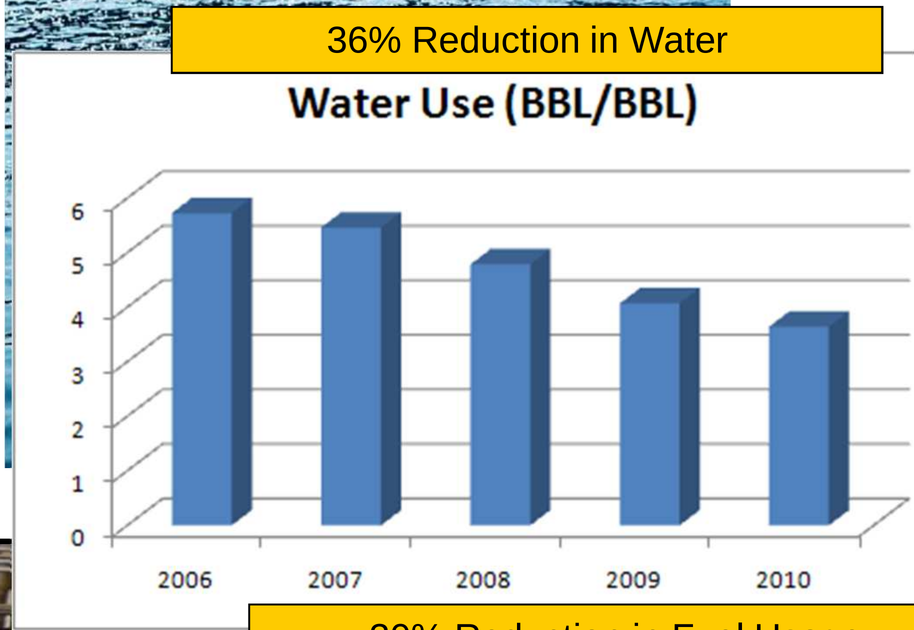
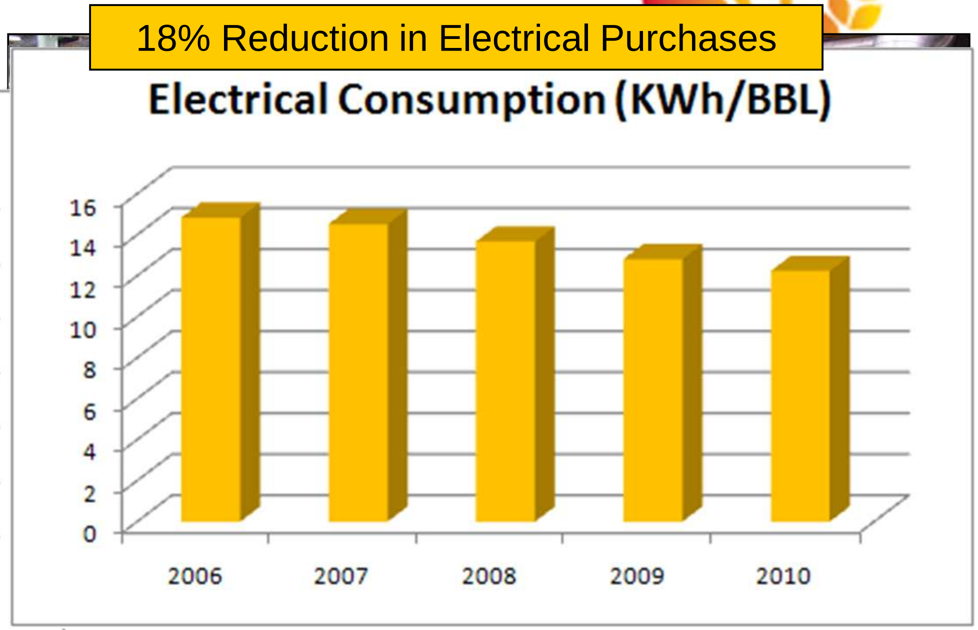
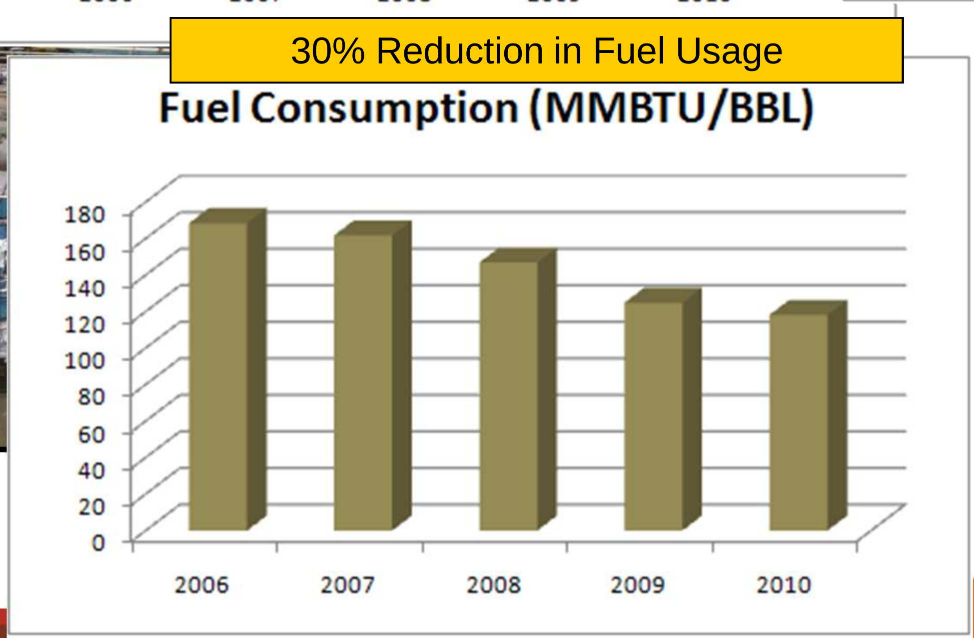
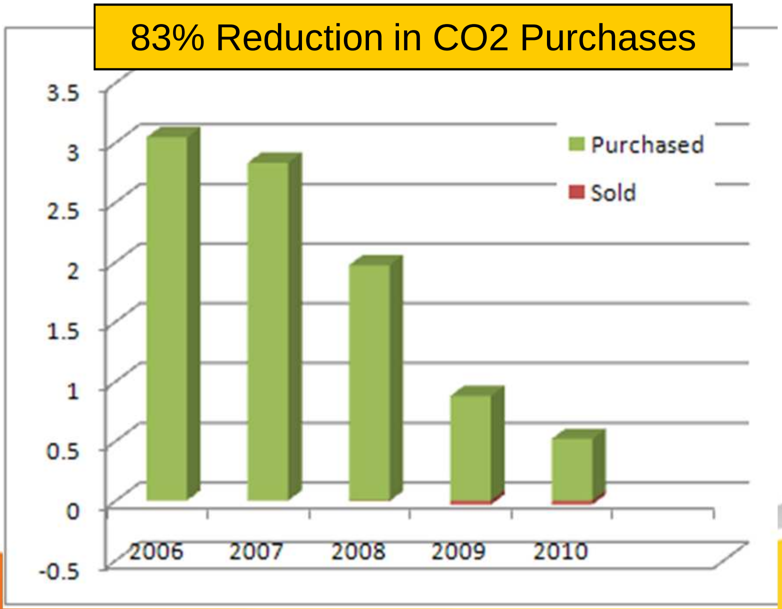
US Energy and Fluids Results









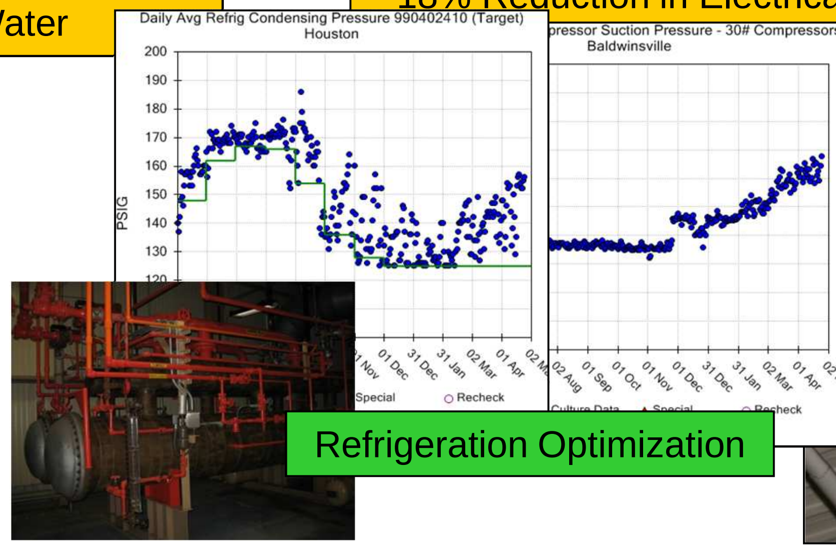
E&F Stragegy: Reduce First

36% Reduction in Water

Vessel	additional V	Pre rinse time (min)	pre rinse flowrate (hl/hr)	pre rinse volume (hl)	additional V	post rinse time (min)	post rinse flowrate (hl/hr)	post rinse volume (hl)	push volume (hl)	Total (hls)	Frequency
Fermenter 1-8		22	250	91.667		16.5	250	68.75		160.42	8 per week, one per fermenter
Fermenter 9-16		22	250	91.667		16.5	250	68.75		160.42	8 per week, one per fermenter
Fermenter 17-21		16.5	300	82.5		15	300	75		157.50	5 per week, one per fermenter
PYC tank		20	300	100		20	300	100		200.00	twice per month
Yeast collection line		5	300	25		5	300	25		50.00	as needed
CO2 collection line		2	300	10		5	300	25		35.00	one per quarter
PYC pump		5	300	25		15	300	75		100.00	twice per month
Ferm Lines		10	350	58.333		30	350	175	24	257.33	once per week
Long loop (aging to BBT)		10	350	58.333		50	350	291.67	71	421.00	once per week
Short loop(aging to BBT)		10	350	58.333		35	350	204.17	32	294.50	once per week
BBT co2 lines		5	350	29.167		30	350	175	14	218.17	once per year
BBT 101-103		10	200	33.333		25	200	83.333	48	164.67	3 times per week, once for each tank
BBT 104-106 (outside)		10	150	25		30	150	75	14	114.00	3 times per week, once for each tank
Tank 20 (BBT)		10	230	38.333		35	230	134.17	2	174.50	2-4 times per month
Keg tanks 17-19		10	150	25		40	150	100	16	141.00	twice per month
Rest tank		10	200	33.333		35	200	116.67	1.5	151.50	once per week
Surges		10	120	20		35	120	70	3	93.00	once per week
Tanks 21-24 (aging)		20	250	83.333		30	250	125	4	212.33	2-3 times per month
Tanks 25-30 (aging)		20	150	50		30	150	75	6	131.00	2-3 times per month
Tanks 31-38 (aging)		15	145	36.25		35	145	84.583	4	124.83	2-3 times per month
Tanks 51-54, 58 (aging)		20	350	116.67		30	350	175	16	307.67	2-3 times per month
Tanks 55-57 (aging)		20	230	76.667		36	230	138	4	218.67	2-3 times per month
Mash Mixer	30	0.5	450	33.75	4	6.5	450	52.75		86.50	once per week
Lauter Tun	50	0.5	450	53.75	4	10.5	450	82.75		136.50	once per week
Kettle + Thermostar	105	0.5	450	108.75	138	3.2	450	162		270.75	once per week
Thermostar	45		450	45	141		450	141		186.00	3 per week (16 brews)
Wort Cooler	30	0.17	300	30.833	28	2.5	300	40.5		71.33	daily
PRV	10	0.50	450	13.75	3	8.5	450	66.75		80.50	once per week
HWT	20	0.50	450	23.75	5	8.5	450	68.75		92.50	once per week
PRO/Trub	10	0.17	450	11.25	3	9.5	450	74.25		85.50	once per week
Caustic Brew (BH Lines)			450	0	71	21.5	450	232.25		232.25	once per week
Chilled Water Tank											year

CIP Benchmarking

18% Reduction in Electrical Purchases



Refrigeration Optimization

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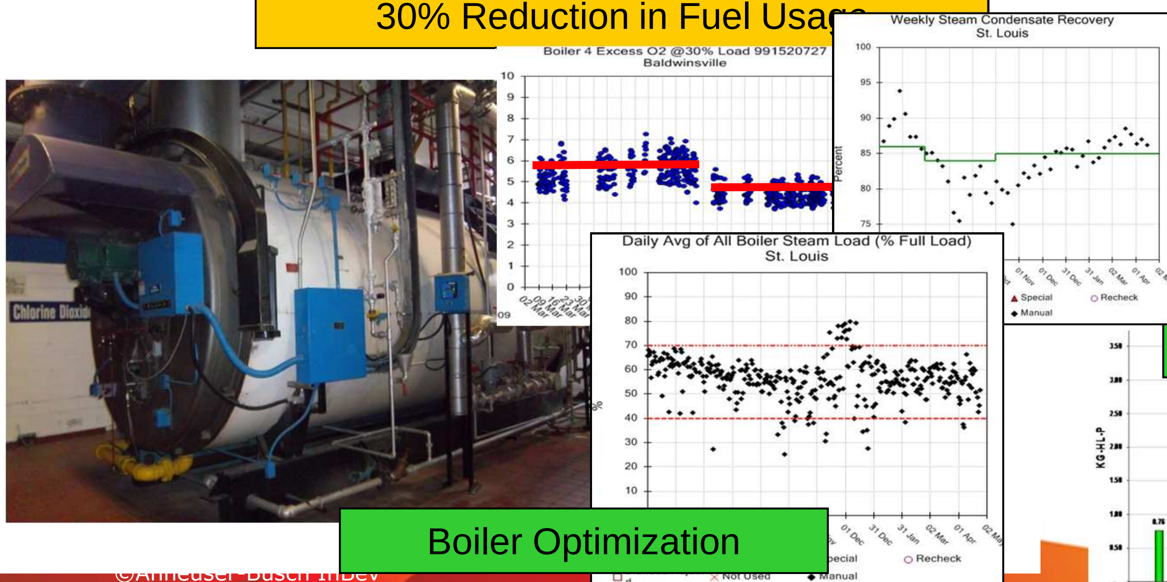
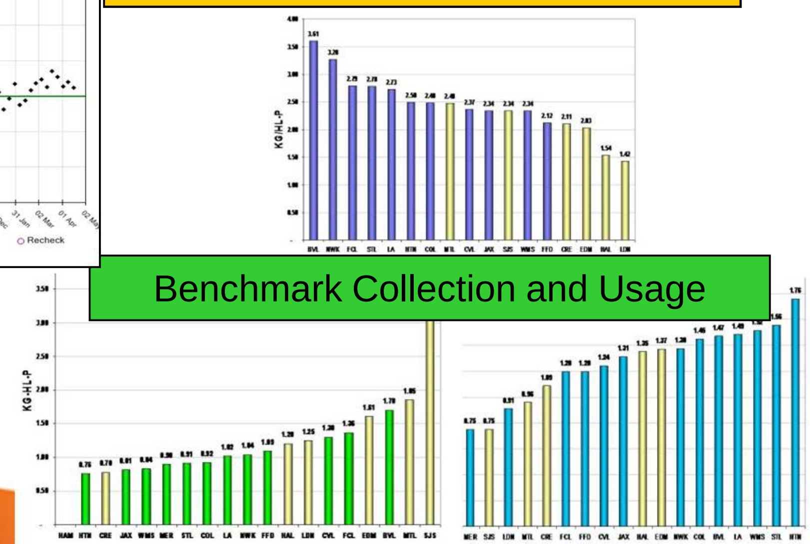
Efficient Lighting

30% Reduction in Fuel Usage



Boiler Optimization

83% Reduction in CO2 Purchases



Benchmark Collection and Usage

E&F Strategy: Reuse as Much As Possible

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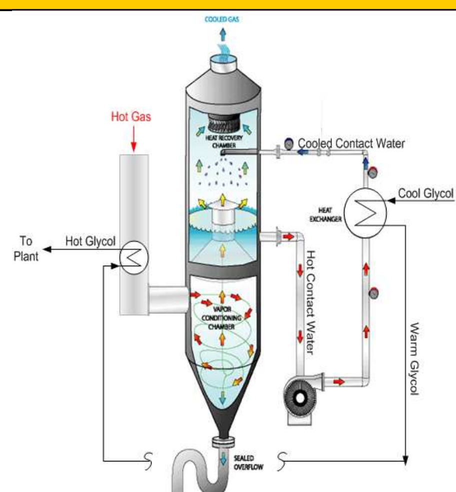
36% Reduction in Water

Extensive water reclaim systems to minimize first use water in Industrial applications

30% Reduction in Fuel Usage



Boiler Stack Heat Recovery

Brewkettle Heat Recovery

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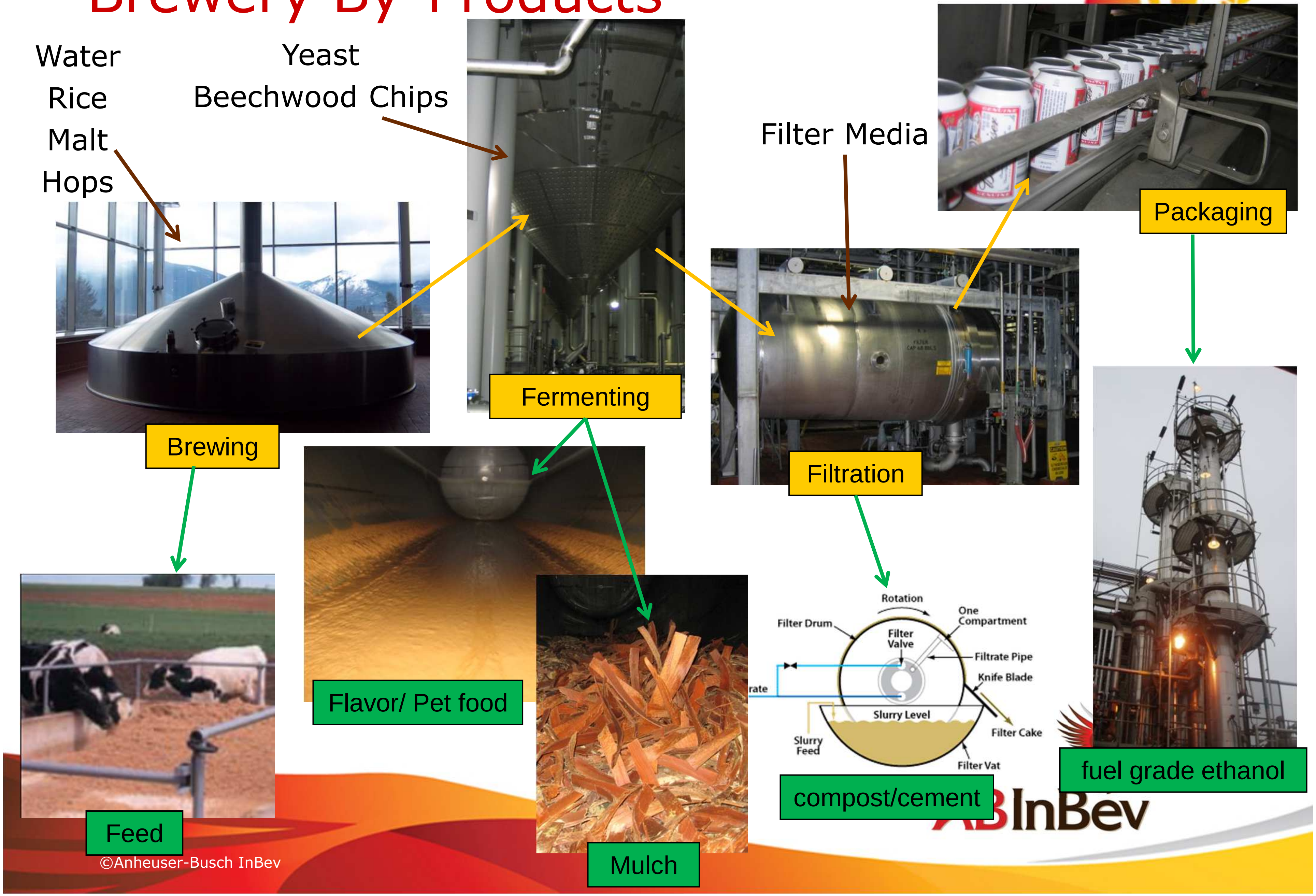
Brewery By-Products



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Renewable Energy: Electricity

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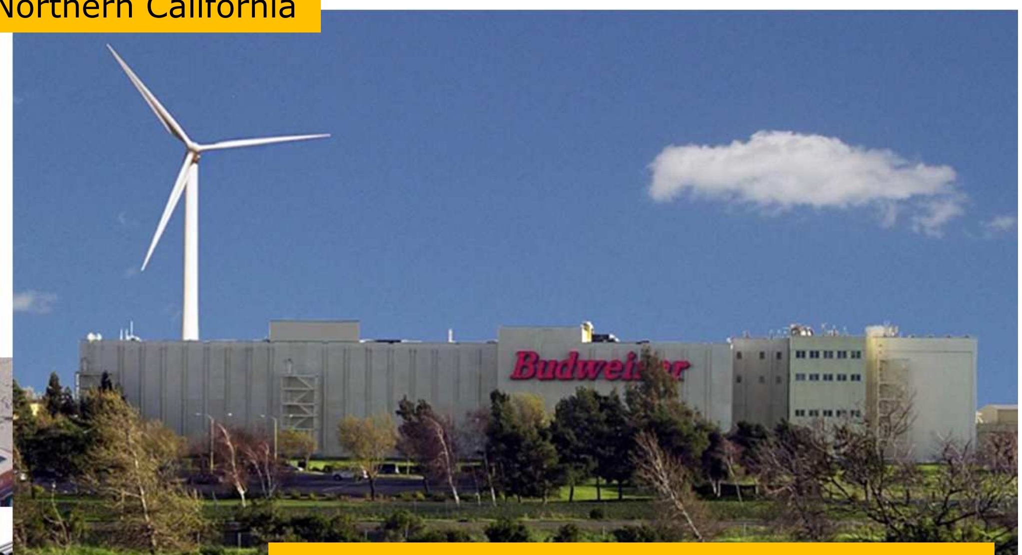
6 acre Solar Field in Northern California



Wind Turbine in Northern California should be complete by the end of the year

7,000 PV units on Newark roof covering 130,000 sf

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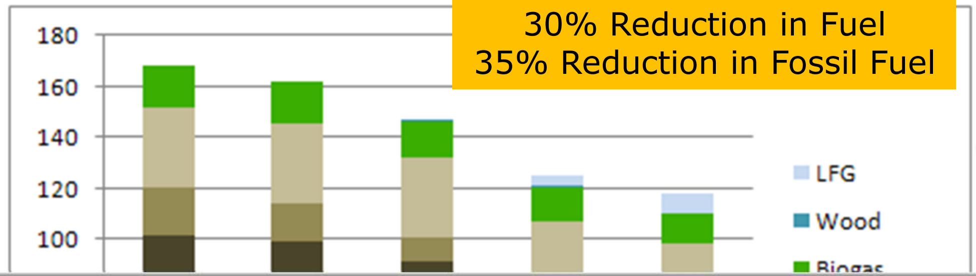
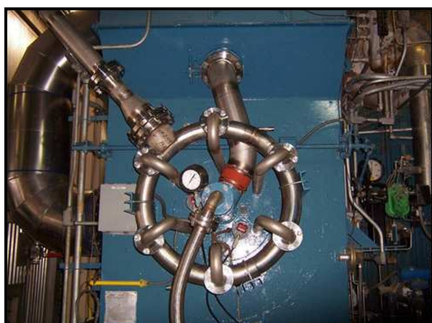
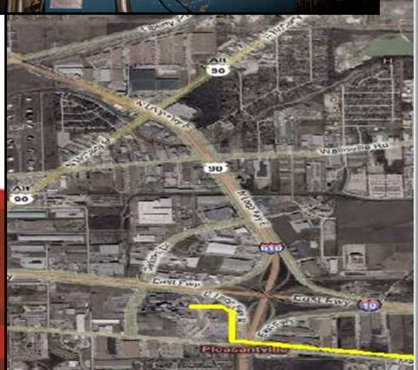
Renewable Energy: Fuel

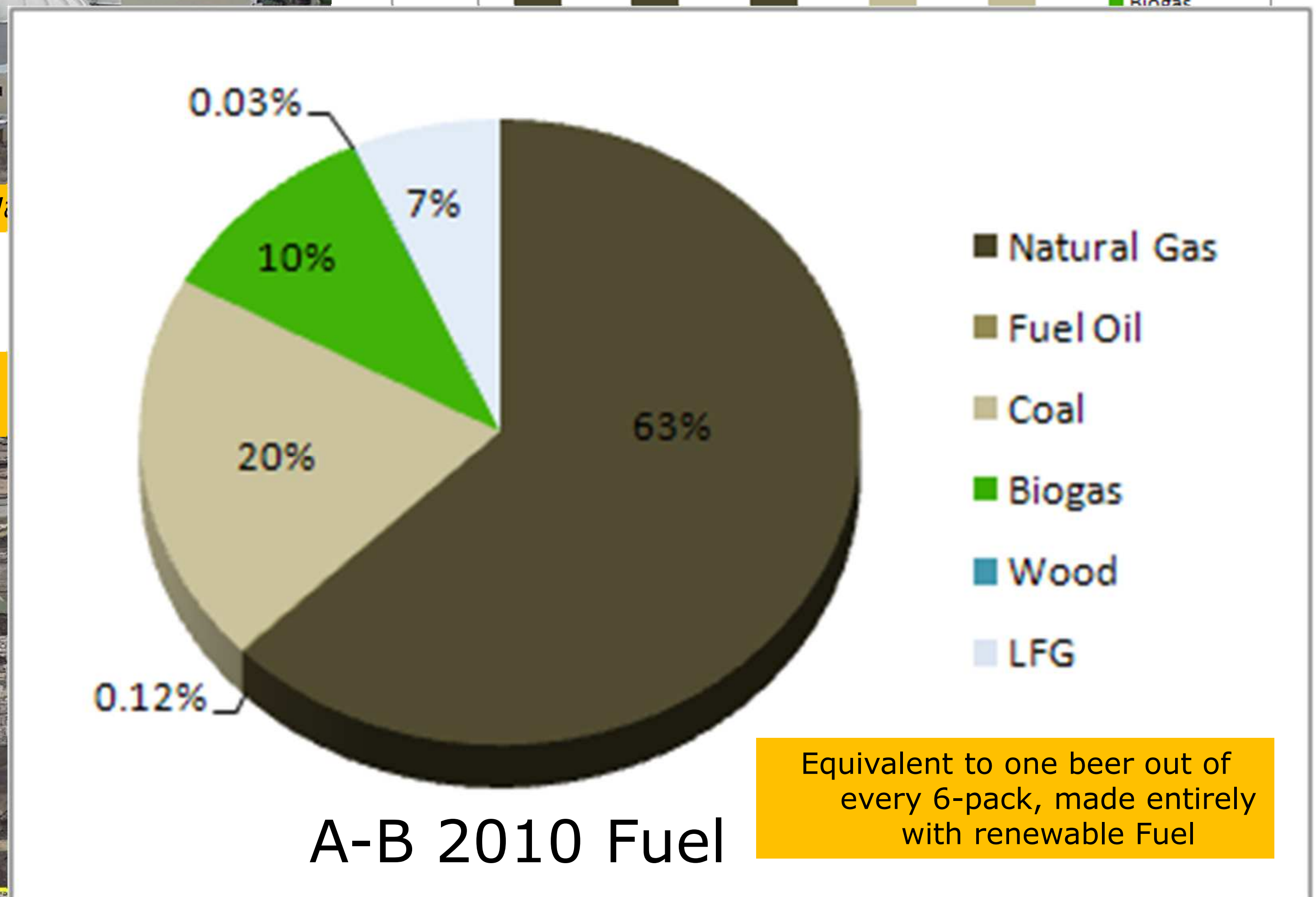
Biogas from Anaerobic Wa



30% Reduction in Fuel
35% Reduction in Fossil Fuel







Equivalent to one beer out of every 6-pack, made entirely with renewable Fuel

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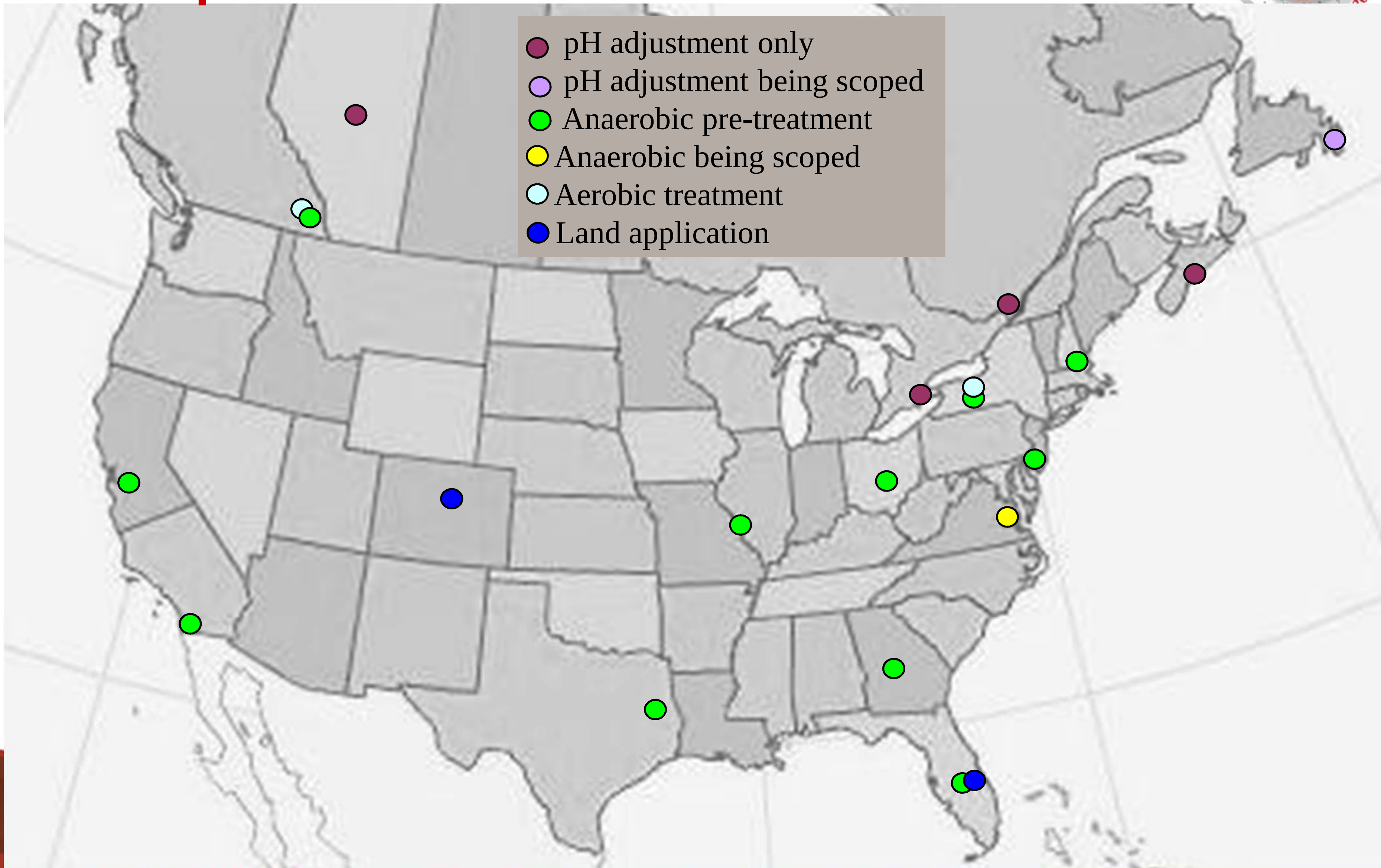
Wastewater Overview
Multiple Locations

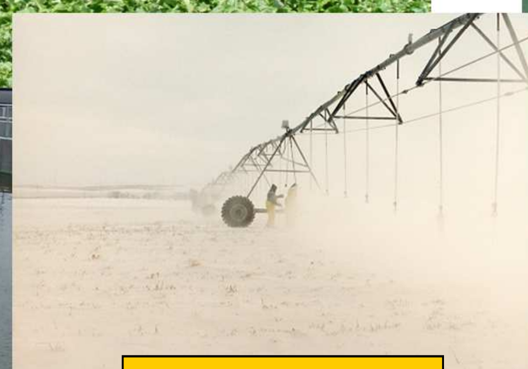


Wastewater Overview

Multiple Processes

Solids Handling

Anaerobic Systems (BERS)



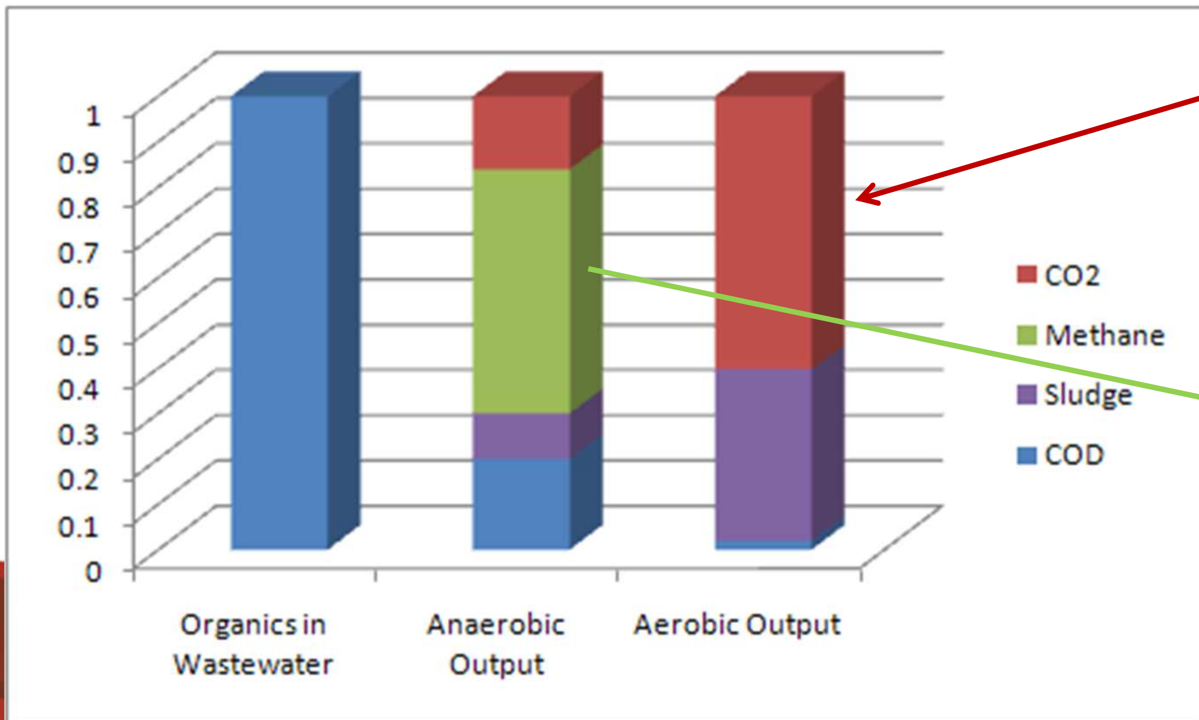
Full Treatment (direct discharge)

Land Application

Wastewater Overview

Aerobic v. Anaerobic

- Aerobic (Respiration)
  - Air added to oxidize organic carbon to CO_2
- Anaerobic (Fermentation)
  - Organic carbon reduced to methane

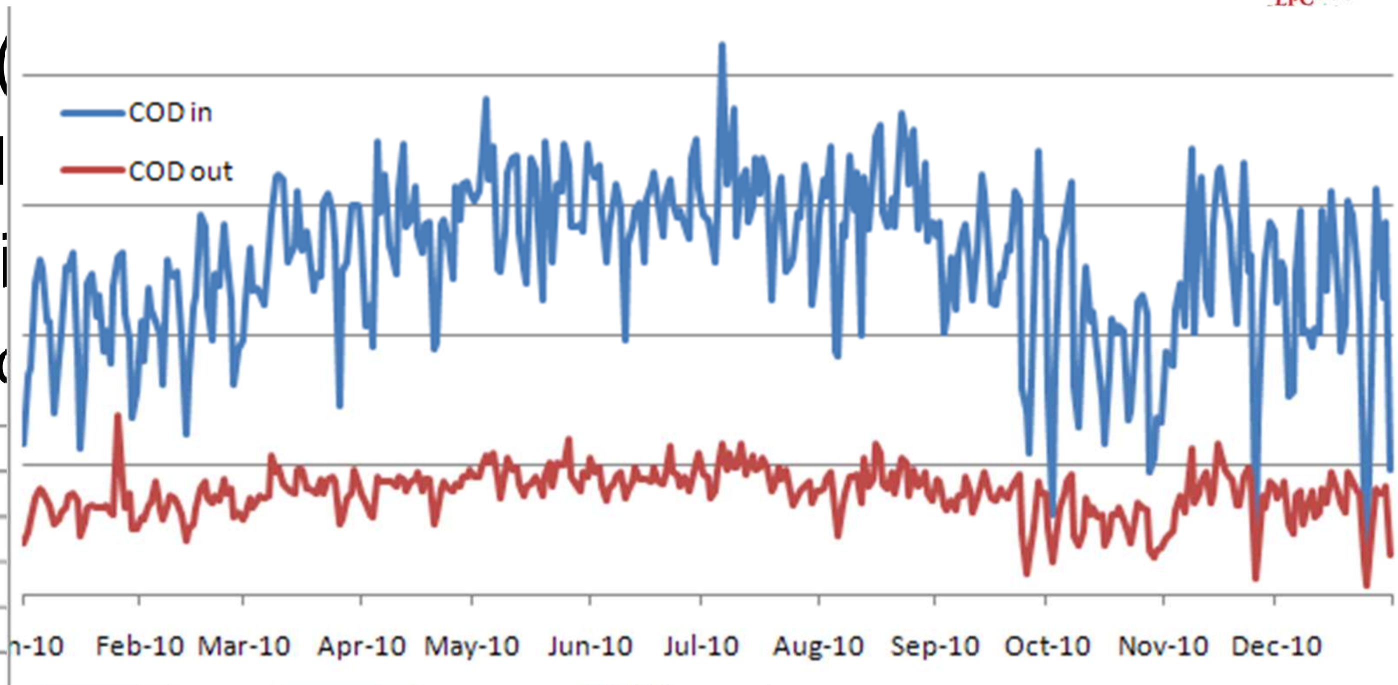


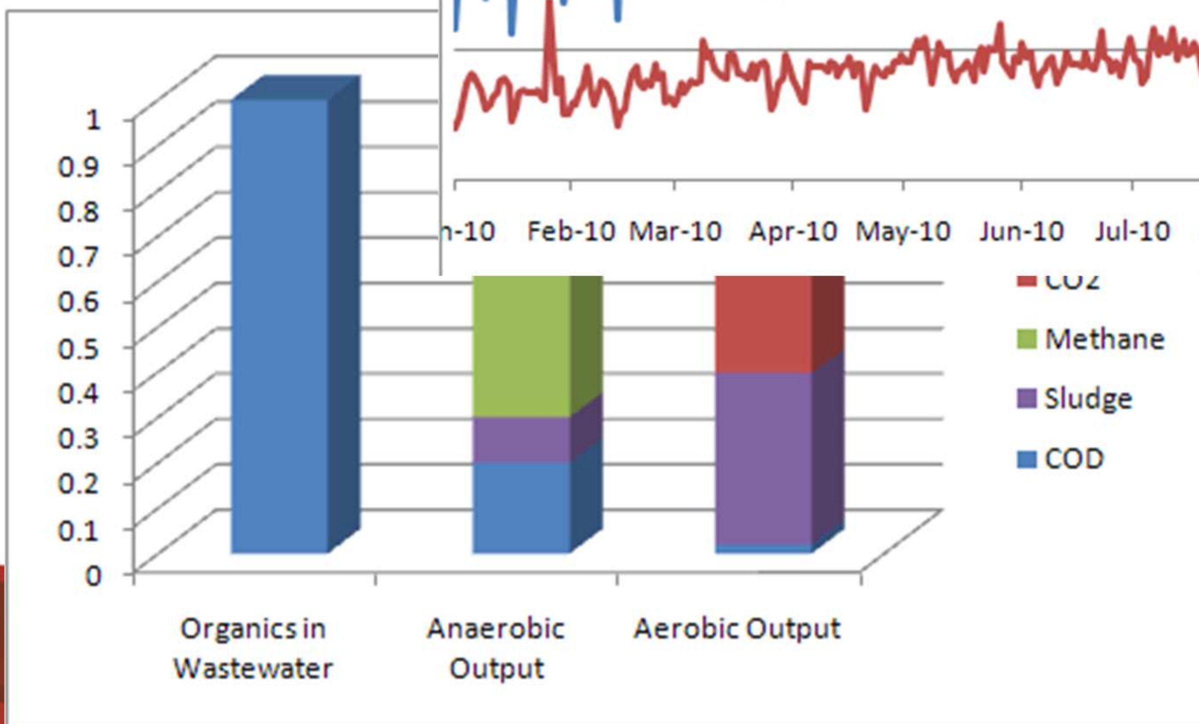
Energy Used (Electricity)

Energy Produced (Methane)

Wastewater Overview
Aerobic v. Anaerobic

- Aerobic (
  - Air add
- Anaerobi
  - Organi





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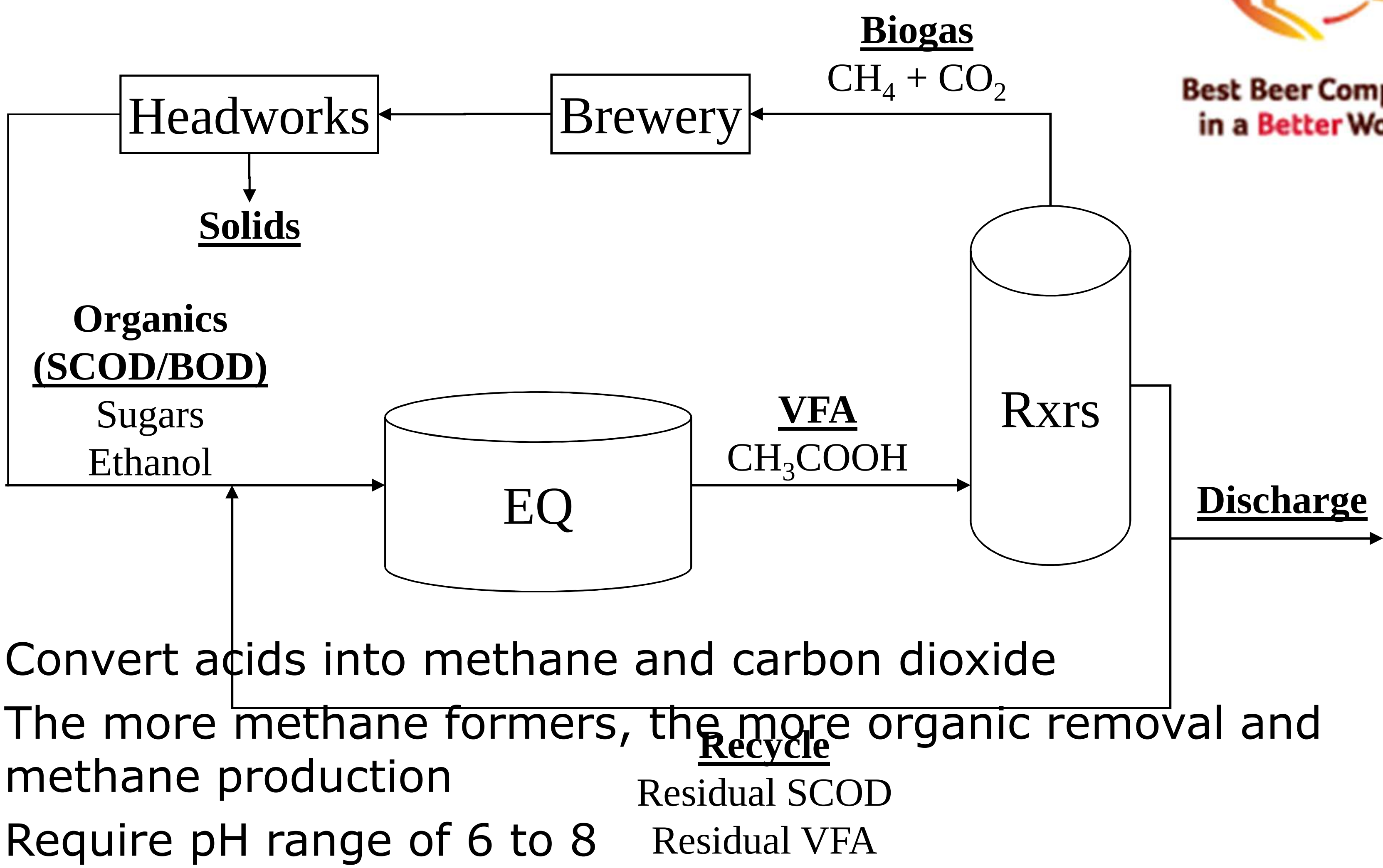
BERS Process Overview



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- Convert acids into methane and carbon dioxide
- The more methane formers, the more organic removal and methane production
- Require pH range of 6 to 8
- Reproduce every 3-5 days

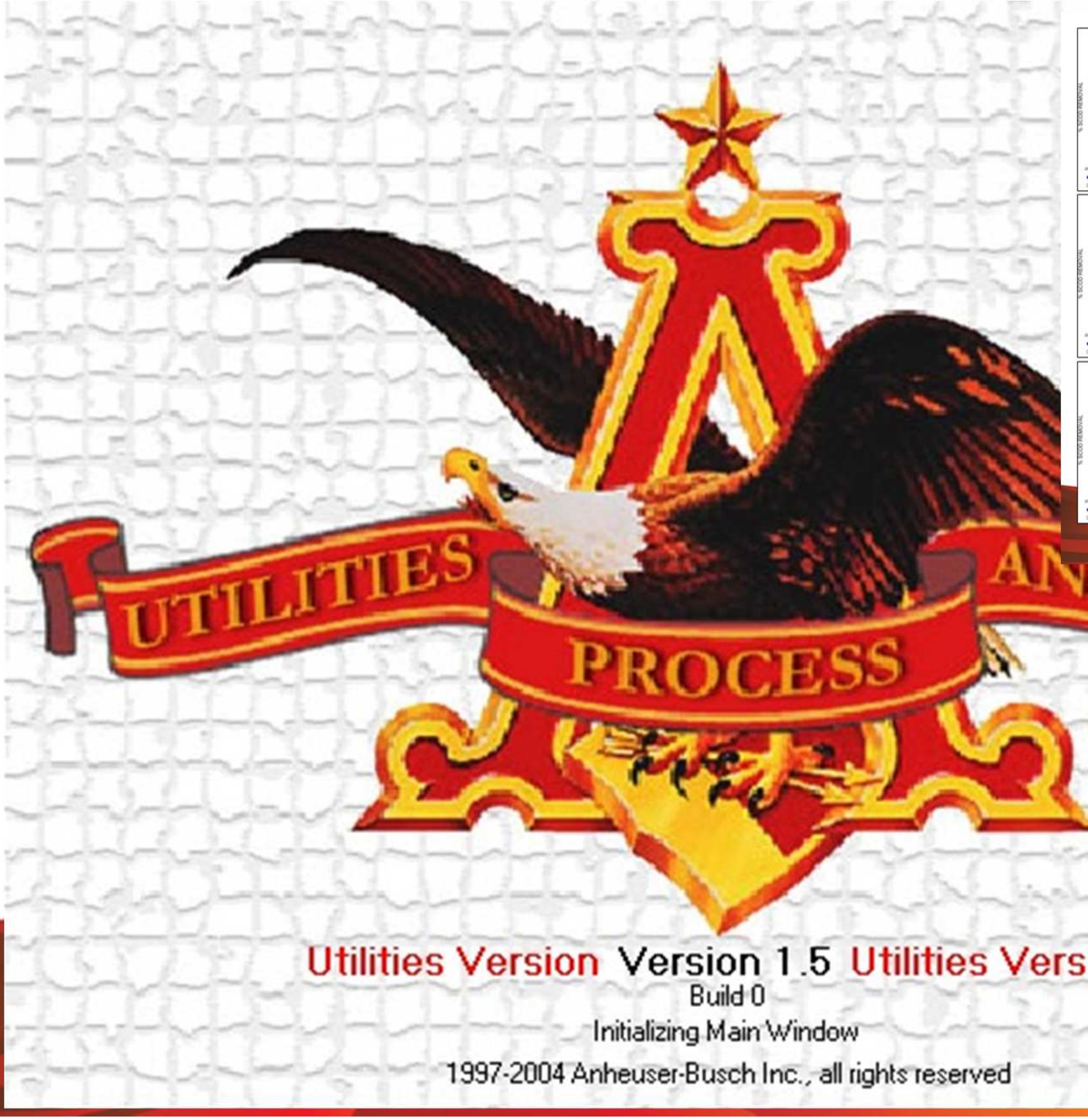
Granulation Theory

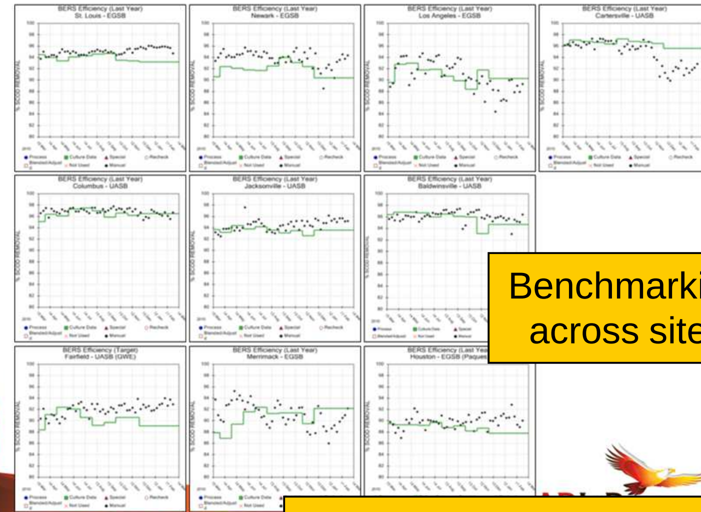
- Filamentous acid-formers provide "skeletal structure"
- Calcium carbonate and extracellular polysaccharides provide the aggregate
- Turbulence within the reactor promotes granulation (to a point – too much will shear granules)
- Upflow reactor velocity will select for retention of granule size based upon Stoke's Law:

$$v = \frac{2\,\mathrm{r}^2\, g\Delta\rho}{9\mu}$$

System Operation

- Data drives response to process changes





Benchmarking across sites

Daily Communication

STL BERS Daily Report for 1

Key Indicators			Target
SCOD Removal	94.6	%	> 90
Biogas Flared	0.0	%	< 0

Brewery Wastewater			
BERS Bypass	0.00	%	0.00
Influent Temp	97.6	°F	-
Influent pH	8.24	s.u.	< 10.00
Influent Flow	3.01	MGD	-
Influent BODest	96,511	lb/d	< 150,000
Influent TSS	1442	mg/l	< 1200

Performance			
Effluent TSS	1550	mg/l	< 1500
Effluent SCOD	230	mg/l	-
Effluent pH Avg	6.54	s.u.	> 6.50
Effluent Temp	81.6	°F	< 106

Plant Specific Criteria			Target
Mag Oxide	1312	lb/d	-
Effluent LEL Avg	0.3	%	-
EQ Tank Temp Max	97.7	°F	-
EQ Tank Temp Avg	96.6	°F	-
Infl BOD/BBL Brwd	5.440	Lbs/Bbl	-
Infl TSS/BBL Brwd	2.040	Lbs/Bbl	-

Biogas/Offgas			
Biogas Flow	887,905	CFD	-
Biogas H_2S	3500	ppm	< 10,000
Raw Offgas H_2S	370	ppm	< 1000
Final Offgas H_2S	0.00	ppm	< 1.00

Chemical Feed			
Mag Hydroxide	0	GPD	-
Iron Chloride	1634	GPD	-
Caustic	492	GPD	-
Bleach	35	GPD	-

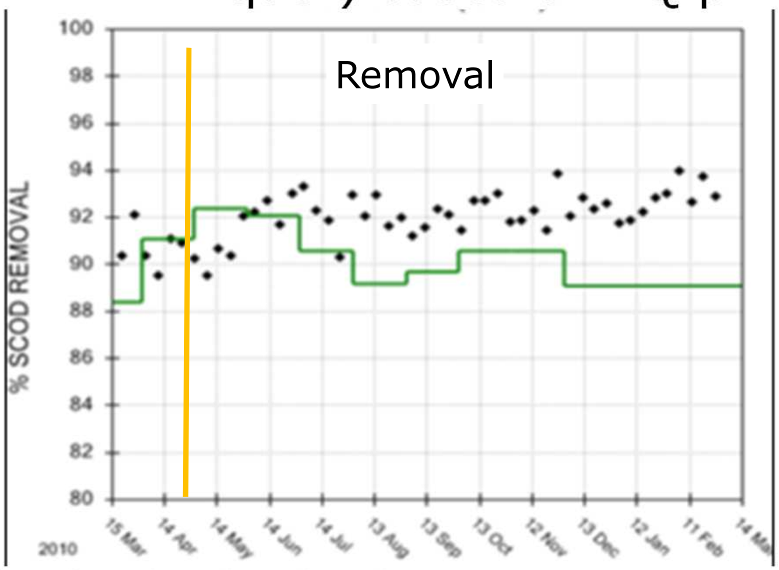
Reactors	Avg/Sum	R1	R2	R3	R4	R5	R6	Target
VFA (meq/l)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	< 3
Alkalinity (meq/l)	16.7	16.8	16.6	16.6	16.8	16.8	16.6	> 16
Feed Rate (gpm)	1549	1550	1550	1544	1550	1550	1550	> 1000
Biomass (kgVSS)	250,000	41,000	51,000	37,000	36,000	38,000	47,000	> 35,000

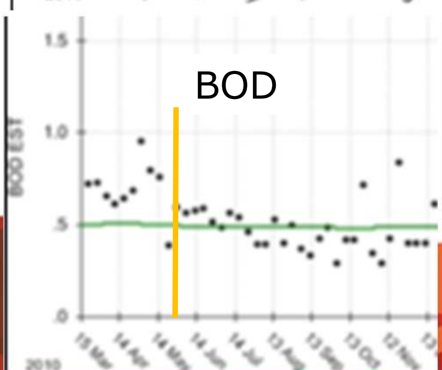
Comments: High TSS's from spent grains centrifuges being down for pipe modifications and the loss of #5 press on 1st shift and cleanup afterwards.

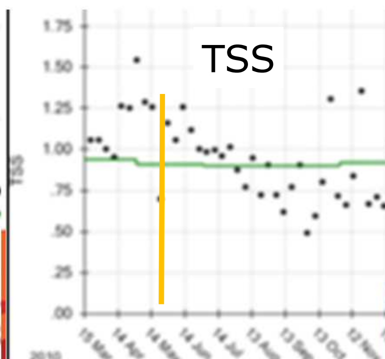
Incremental Improvements

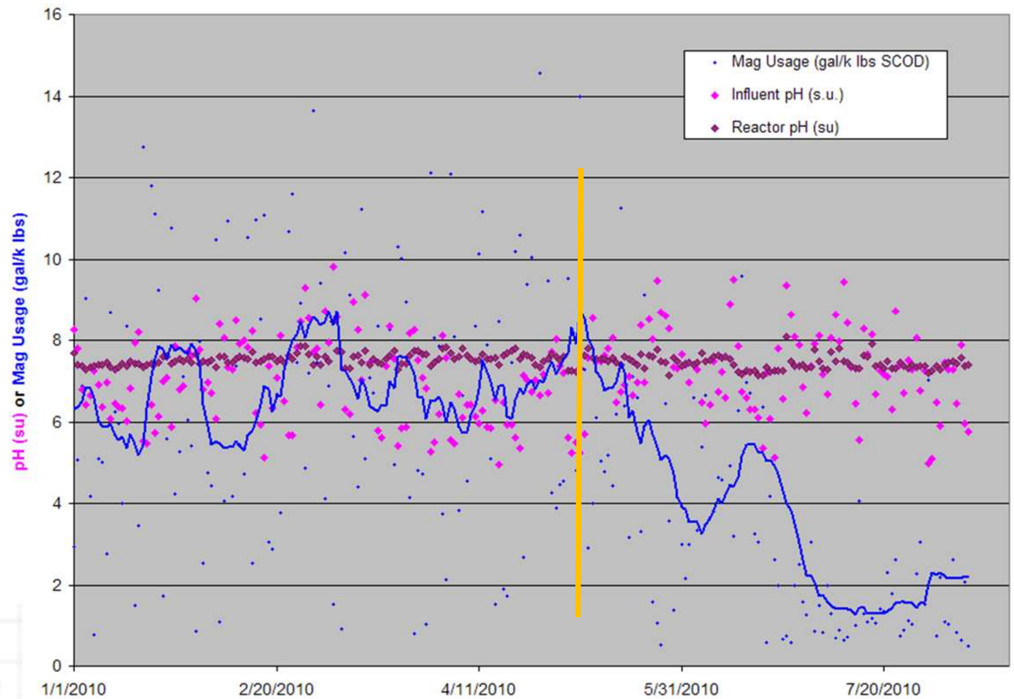
Load Management

- Operator identified opportunity to modulate discharge of high strength stream (spent grain liquor) based on EQ pH









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Incremental Improvements

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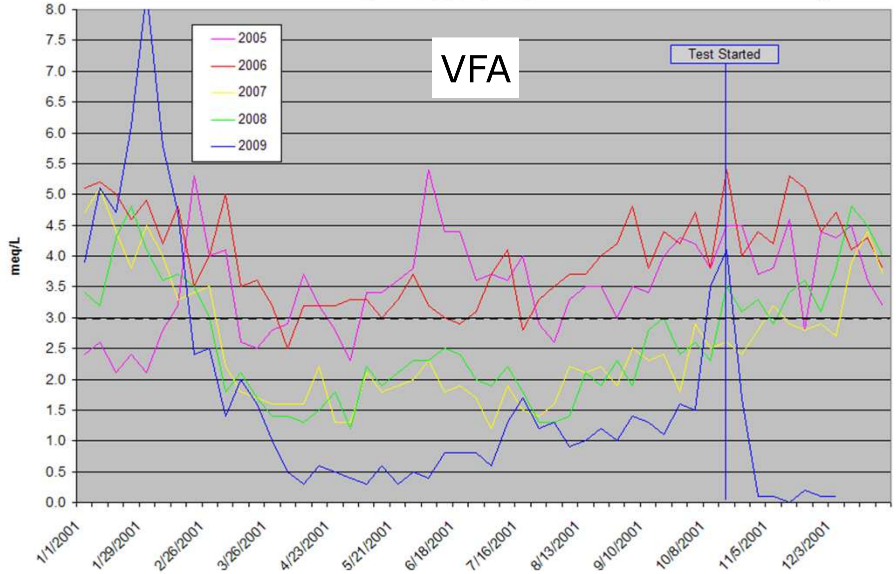
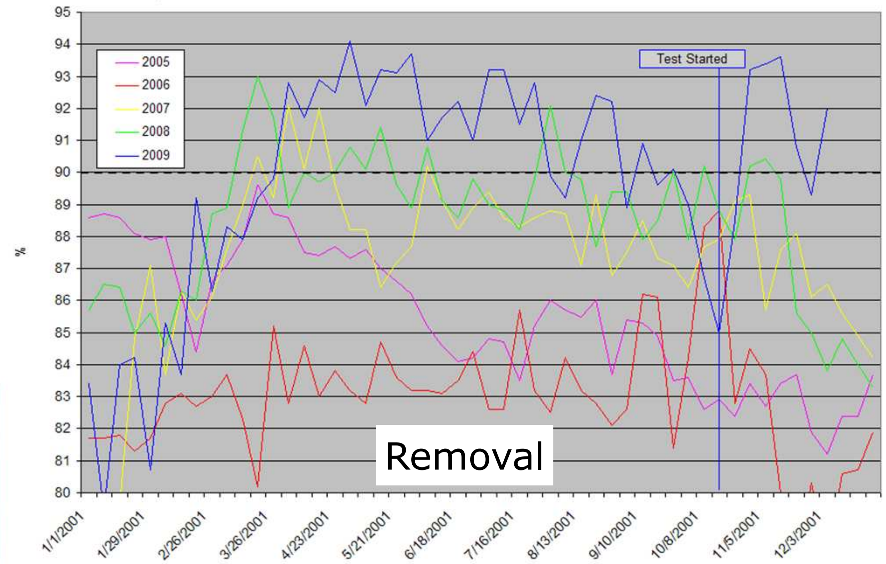
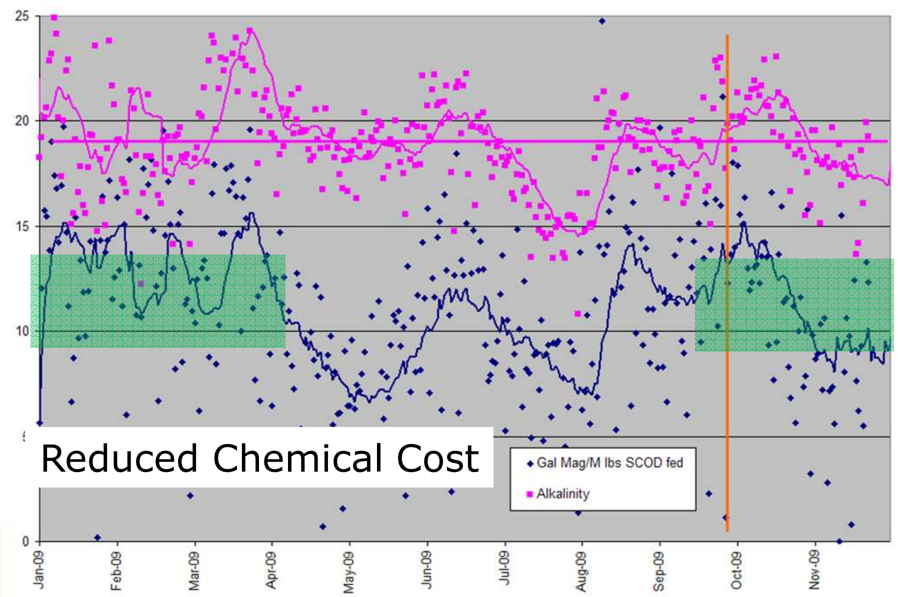
▸ Micronutrients: Improved stability



- Every year, we get better, but lose ground when temperature drops
- Micronutrients allow biomass to be more resilient to changing conditions





Take Aways

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- **Anaerobic technology** plays a key role in our dream of being the Best Beer Company in a better World by **removing organics** from our wastewater and **producing renewable fuel**.
- Benchmarking between similar systems is key to **continuously challenge** self to do better.
- Key to maintaining system performance is **watching data** to catch system changes early and determine how to counteract them.
- Incremental system improvements are possible by continuously looking for ways to create **stability** for the biomass.

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Questions???

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