



Services of the San Francisco Public Utilities Commission

San Francisco Oceanside Plant Road to Energy Neutrality

2013 International Conference on Sustainability and Environmental Protection

CAEPA

San Francisco

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Presentation Outline

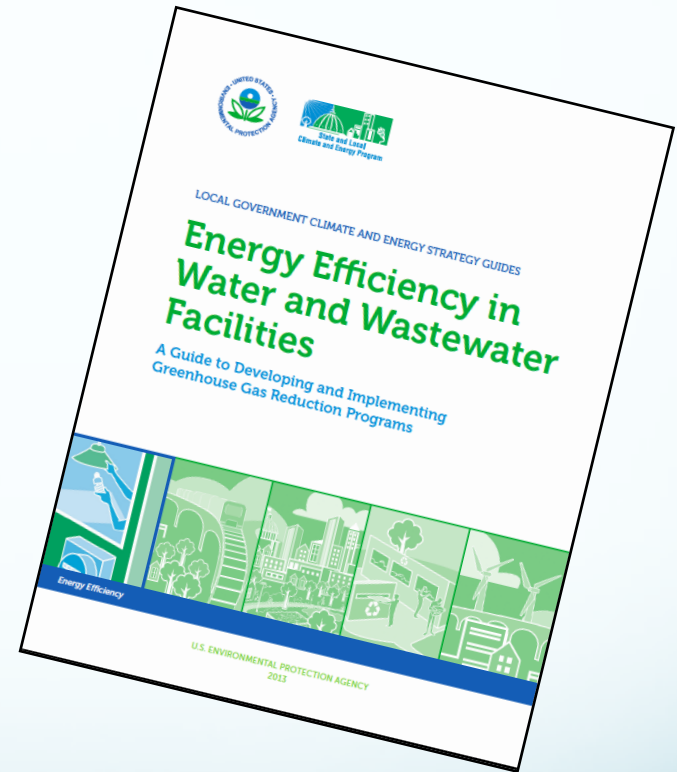
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- ❑ US Water & Wastewater Energy Footprint
- ❑ Energy Management: A 3-Way Approach
- ❑ Oceanside Plant Overview
- ❑ Oceanside Demand Side Management
- ❑ Oceanside Energy Efficiency
- ❑ Oceanside Energy Production
- ❑ Summary and Conclusions

US Water and Wastewater Energy Footprint

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- ☐ Potable water and wastewater systems account for approximately 3-4 % of energy use in the United State *(U.S. EPA, 2012)*
- ☐ Energy used by water and wastewater utilities accounts for 35% of typical U.S. municipality energy budget *(NYSERDA, 2008)*
- ☐ Electricity use accounts for 35% of the operating budgets from wastewater utilities *(NYSERDA, 2008)*

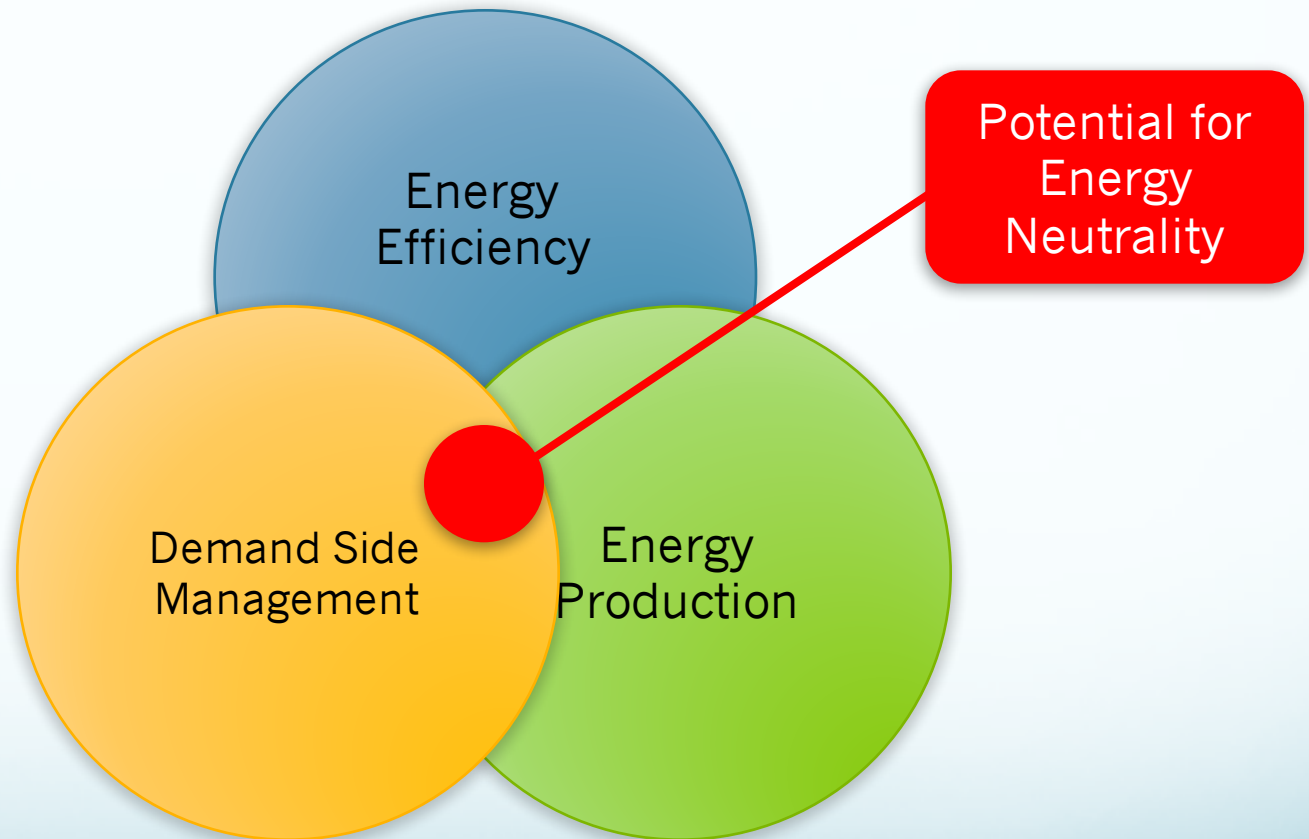


The Paradox:

On average, the energy content of wastewater is far greater than the energy required to treat it (Tchobanoglous et al., 2009)

Energy Management: A 3-Way Approach

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Energy Management: A 3-Way Approach

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Achieved by:

☐ **Equipment upgrade**

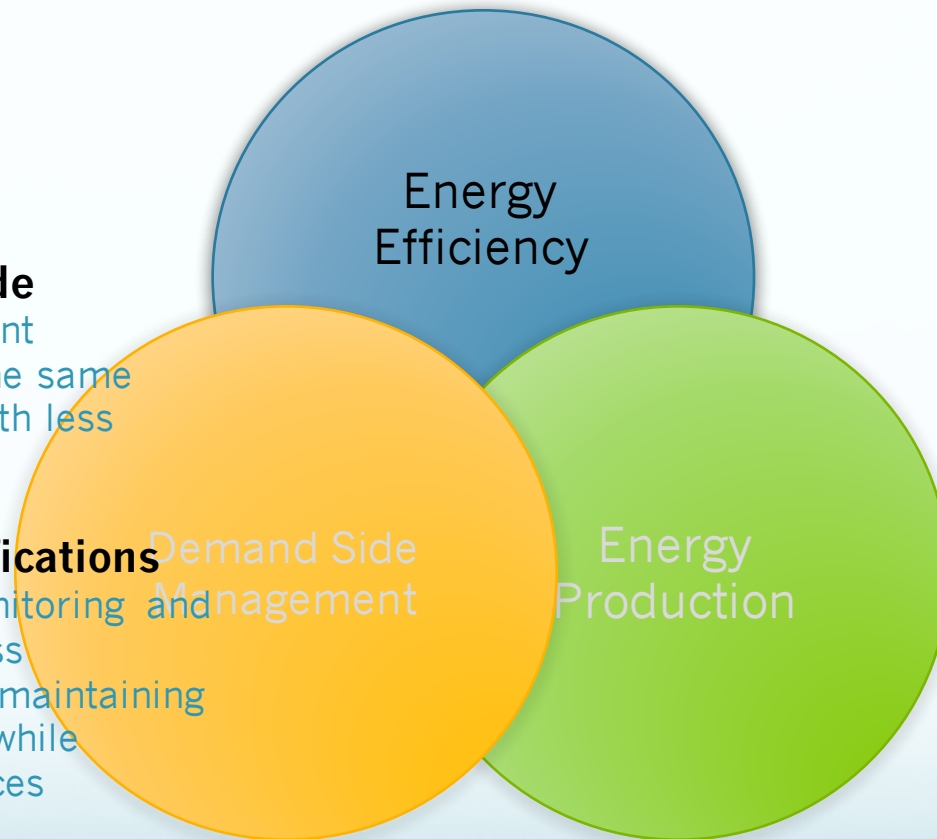
More energy efficient technology allow the same work to be done with less energy

☐ **Operational modifications**

Better process monitoring and control, and process optimization allow maintaining high performance while minimizing resources

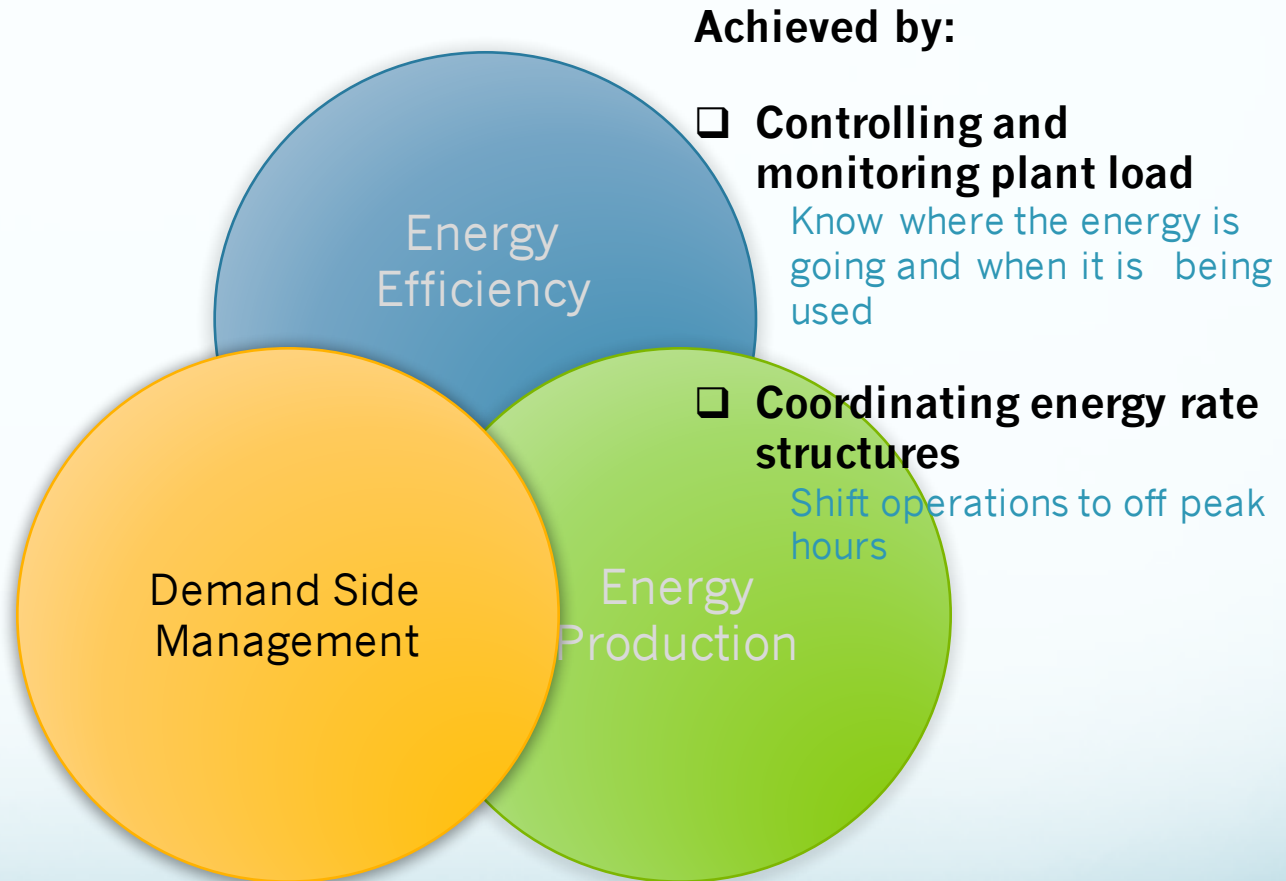
☐ **Facility modification**

Energy efficient lighting and HVAC system



Energy Management: A 3-Way Approach

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Energy Management: A 3-Way Approach

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Achieved by:

- ☐ **Co-digestion of high strength waste**

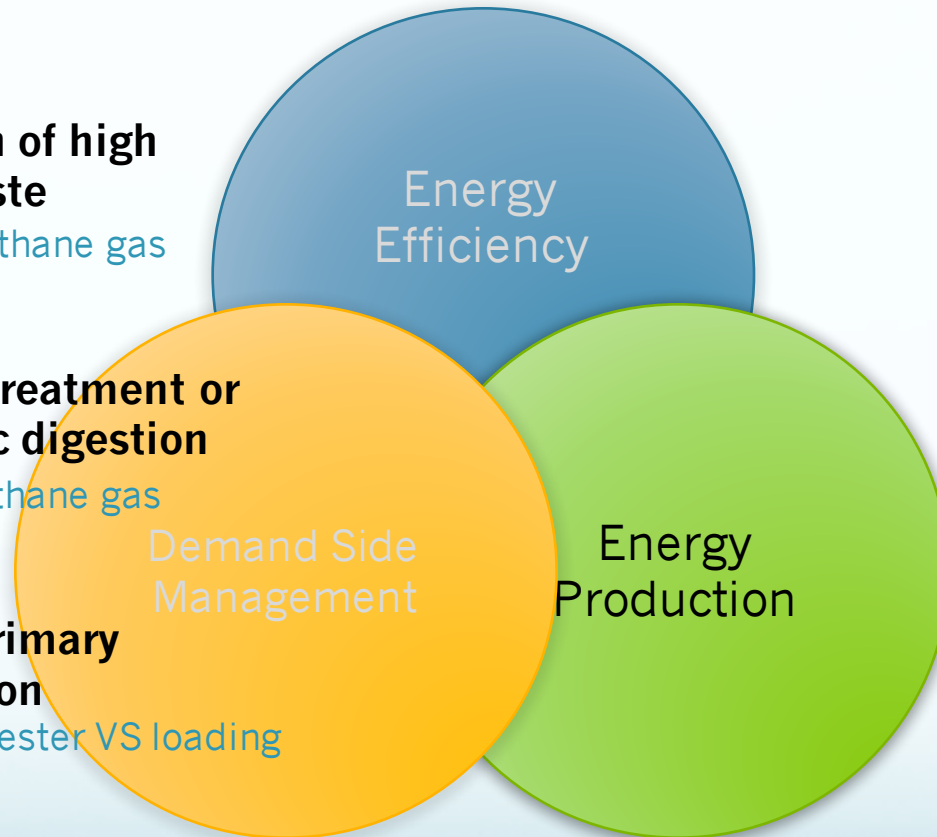
Increase methane gas production

- ☐ **Sludge pre-treatment or thermophilic digestion**

Increase methane gas production

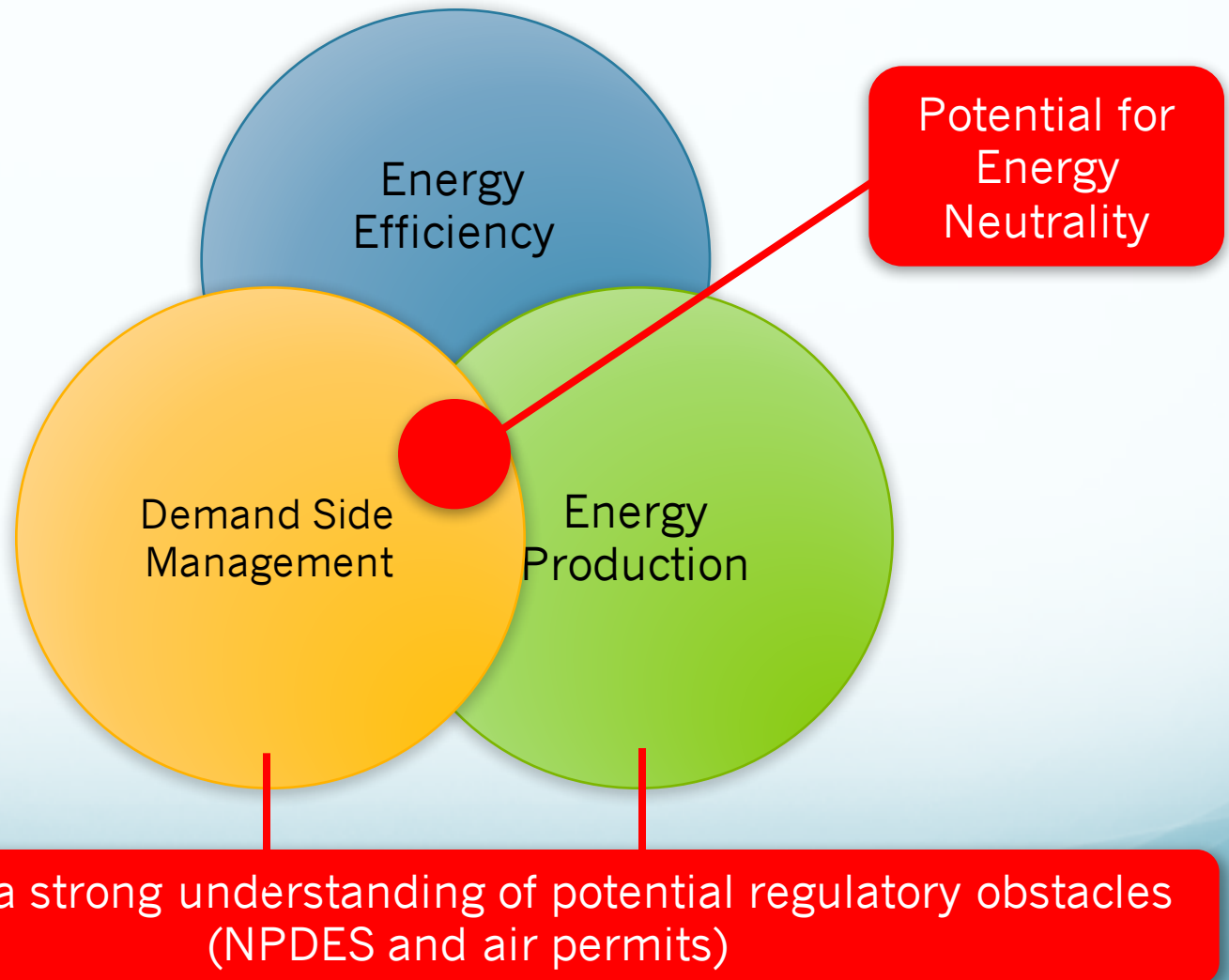
- ☐ **Enhanced primary sedimentation**

Increase digester VS loading



Energy Management: A 3-Way Approach

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Oceanside Plant Overview

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- ❑ Treats 20% of San Francisco's water

- ❑ Flows:

 - 21 MGD (design)

 - 14 MGD (current)

 - 65 MGD (wet weather peak)

- ❑ High rate pure oxygen plant

- ❑ cBOD removal only

- ❑ Egg-shaped digester:

 - 4 x 750,000 gal (mesophilic)

- ❑ Co-generation:

 - 2 x 550 kW



Challenges:

- ❑ Located in the middle of a recreational area

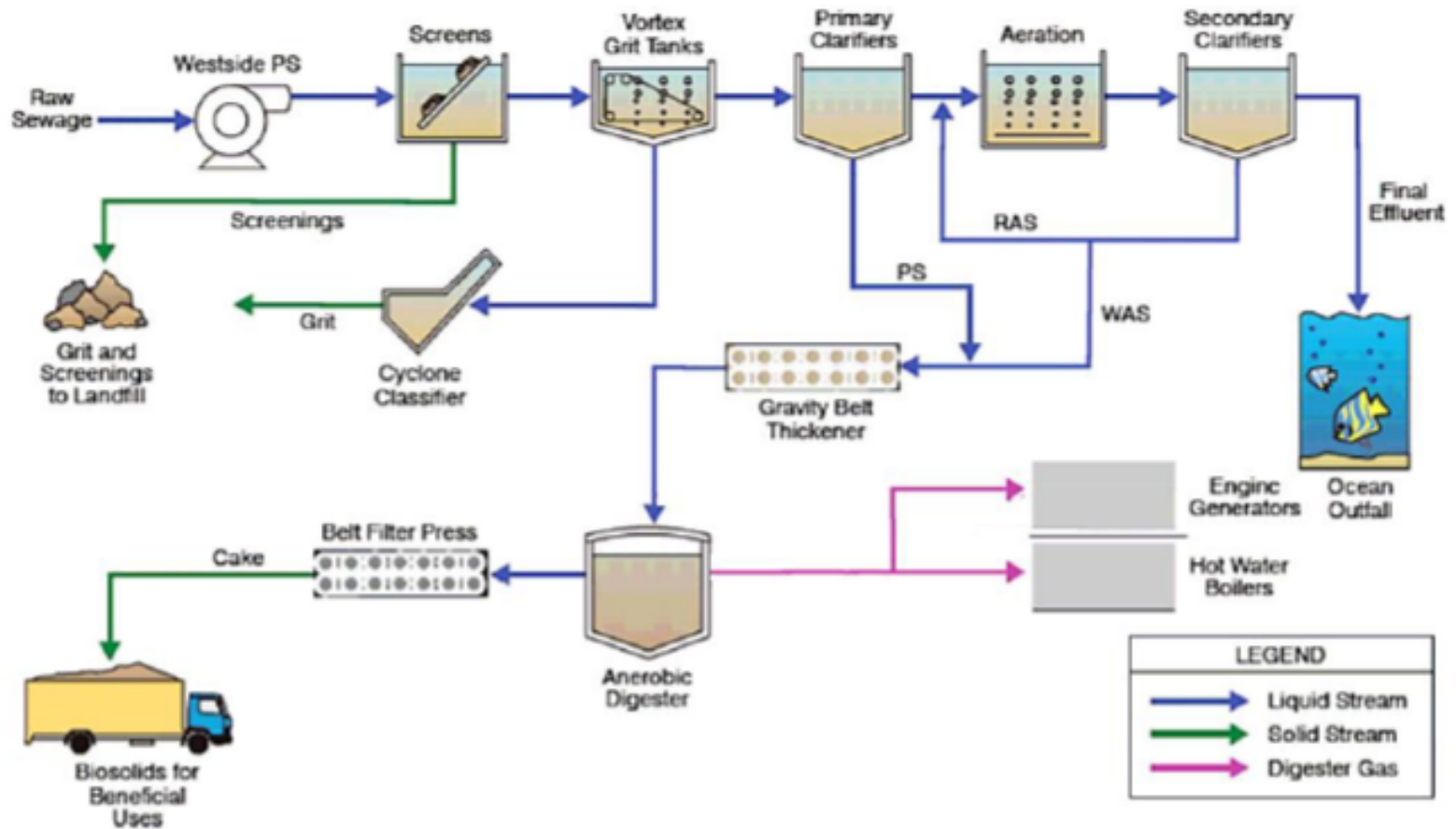
- ❑ Compact plant

- ❑ $\frac{3}{4}$ of the facility is underground

- ❑ No odors allowed outside the perimeter of the plant

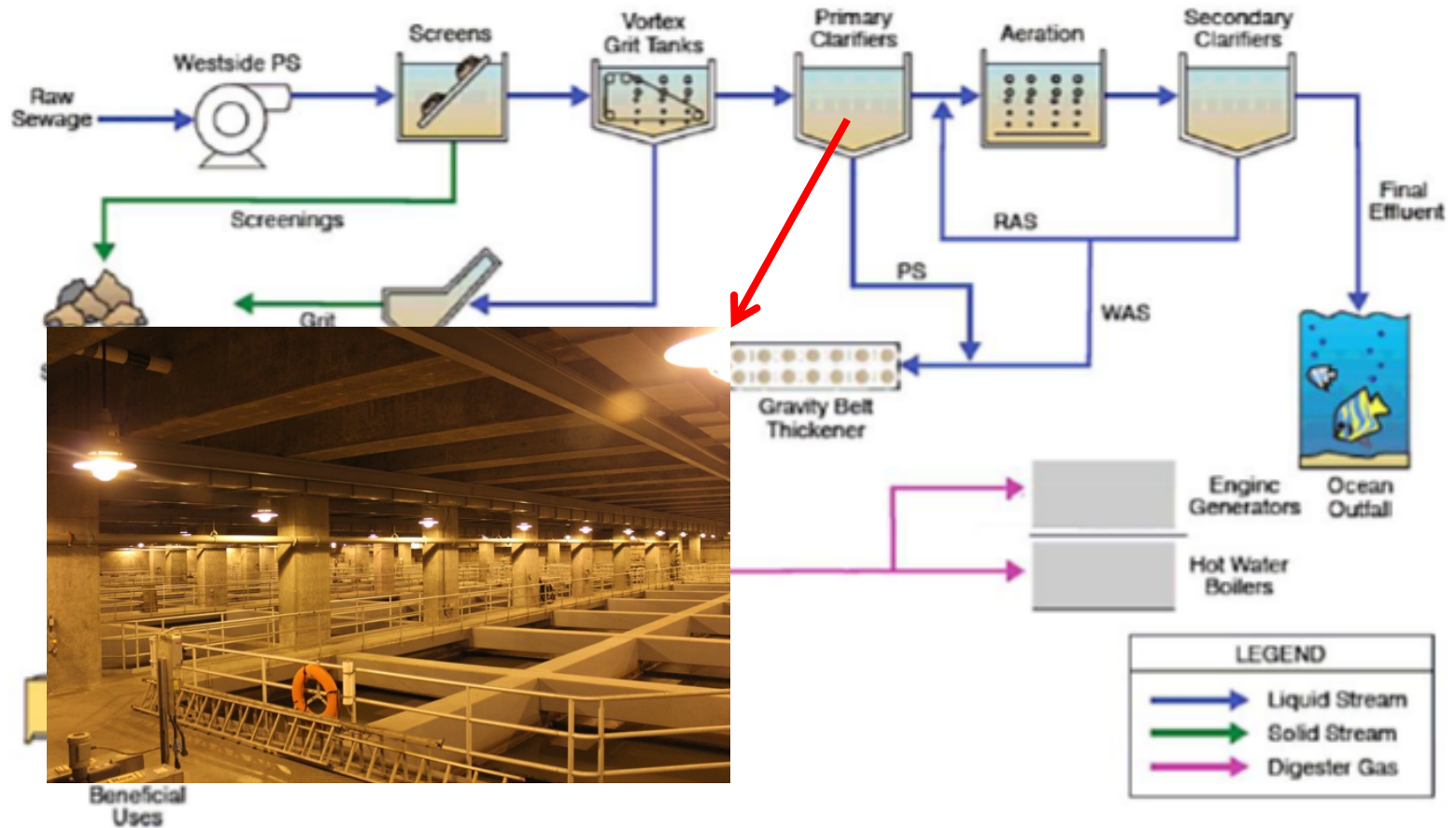
Oceanside Plant Process Flow Chart

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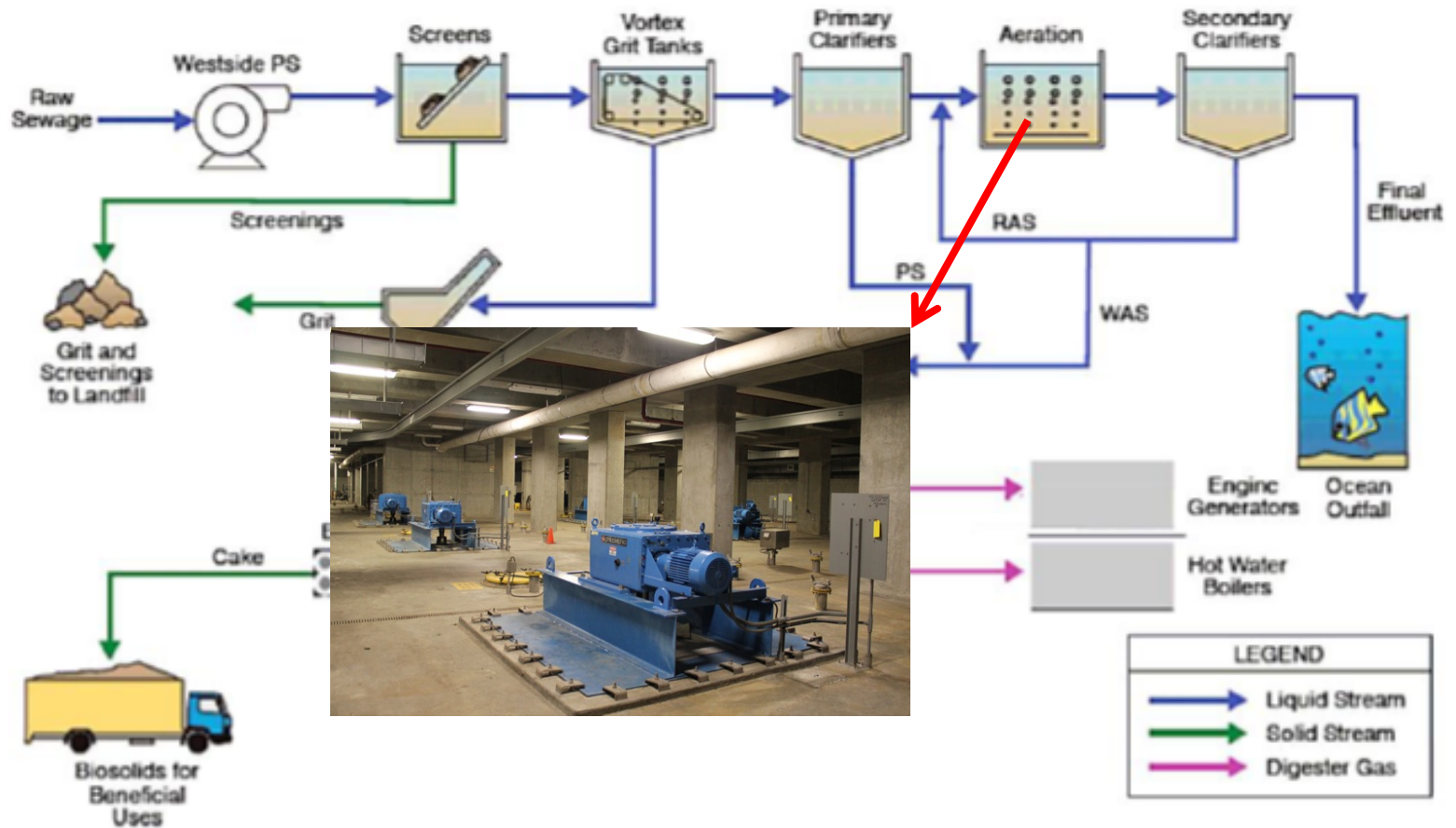
Oceanside Plant Process Flow Chart

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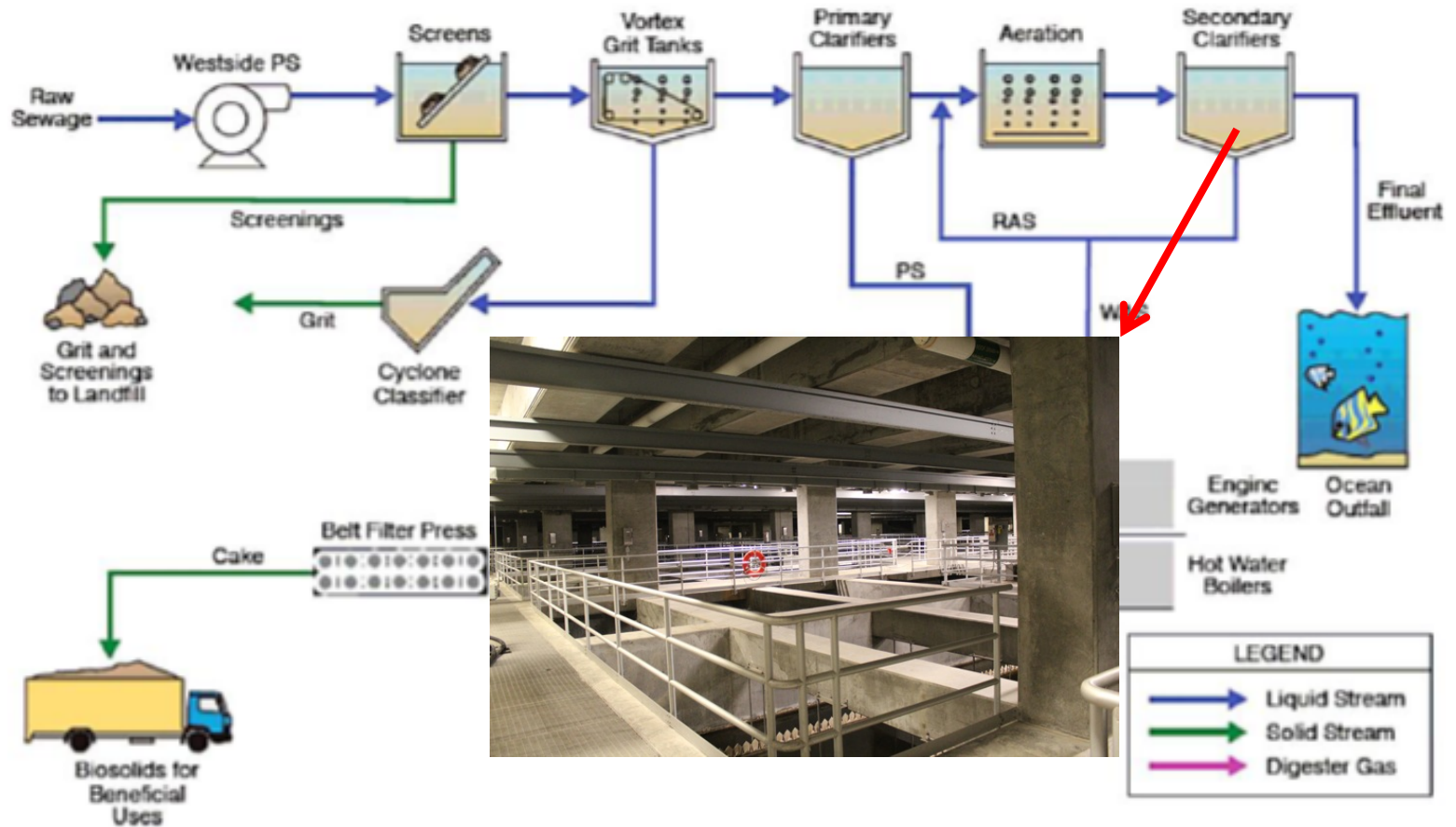
Oceanside Plant Process Flow Chart

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Oceanside Plant Process Flow Chart

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The image displays a schematic diagram of a wastewater treatment plant (WWT) and a photograph of an anaerobic digester.

Schematic Diagram:

- Raw Sewage** enters the **Westside PS** (Pump Station).
- The flow continues to **Screens**, which produce **Screenings** (sent to **Grit and Screenings to Landfill**) and **Grit** (sent to a **Cyclone Classifier**).
- The flow proceeds to **Vortex Grit Tanks**, which also send **Grit** to the **Cyclone Classifier**.
- The flow then goes to **Primary Clarifiers**, which return **RAS** (Return Activated Sludge) to the **Aeration** stage and send **WAS** (Waste Activated Sludge) to the **Gravity Belt Thickener**.
- The **Gravity Belt Thickener** sends thickened sludge to the **Anerobic Digester**.
- The **Anerobic Digester** produces **Digester Gas**, which is used for **Engine Generators** and **Hot Water Boilers**.
- The flow from the **Anerobic Digester** goes to the **Final Effluent**, which is discharged into the **Ocean Outfall**.

LEGEND:

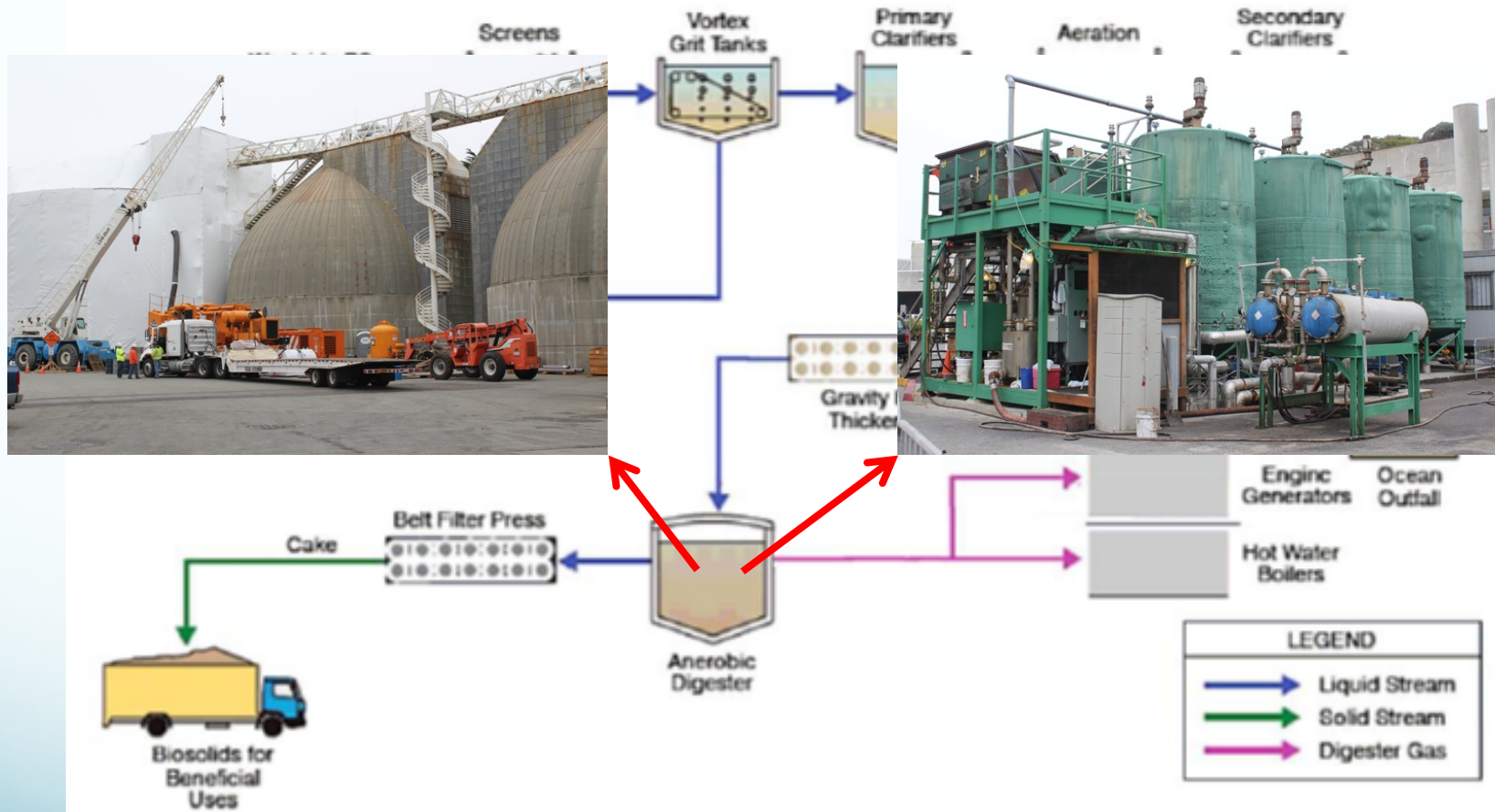
- Blue arrow: Liquid Stream
- Green arrow: Solid Stream
- Pink arrow: Digester Gas

Photograph: The photograph shows the interior of an anaerobic digester, featuring large metal tanks filled with dark, sludgy material, likely the thickened sludge being digested.



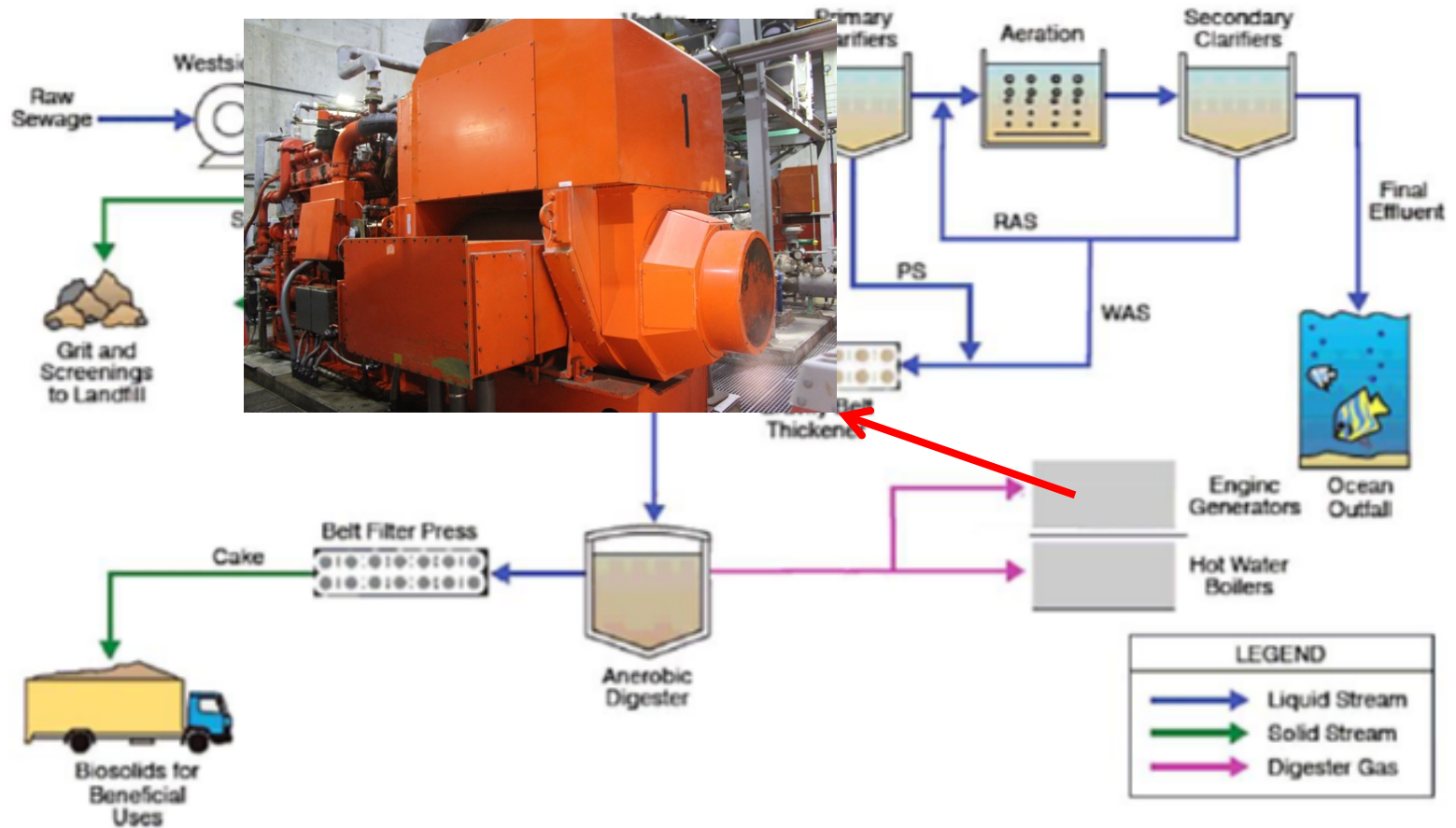
Oceanside Plant Process Flow Chart

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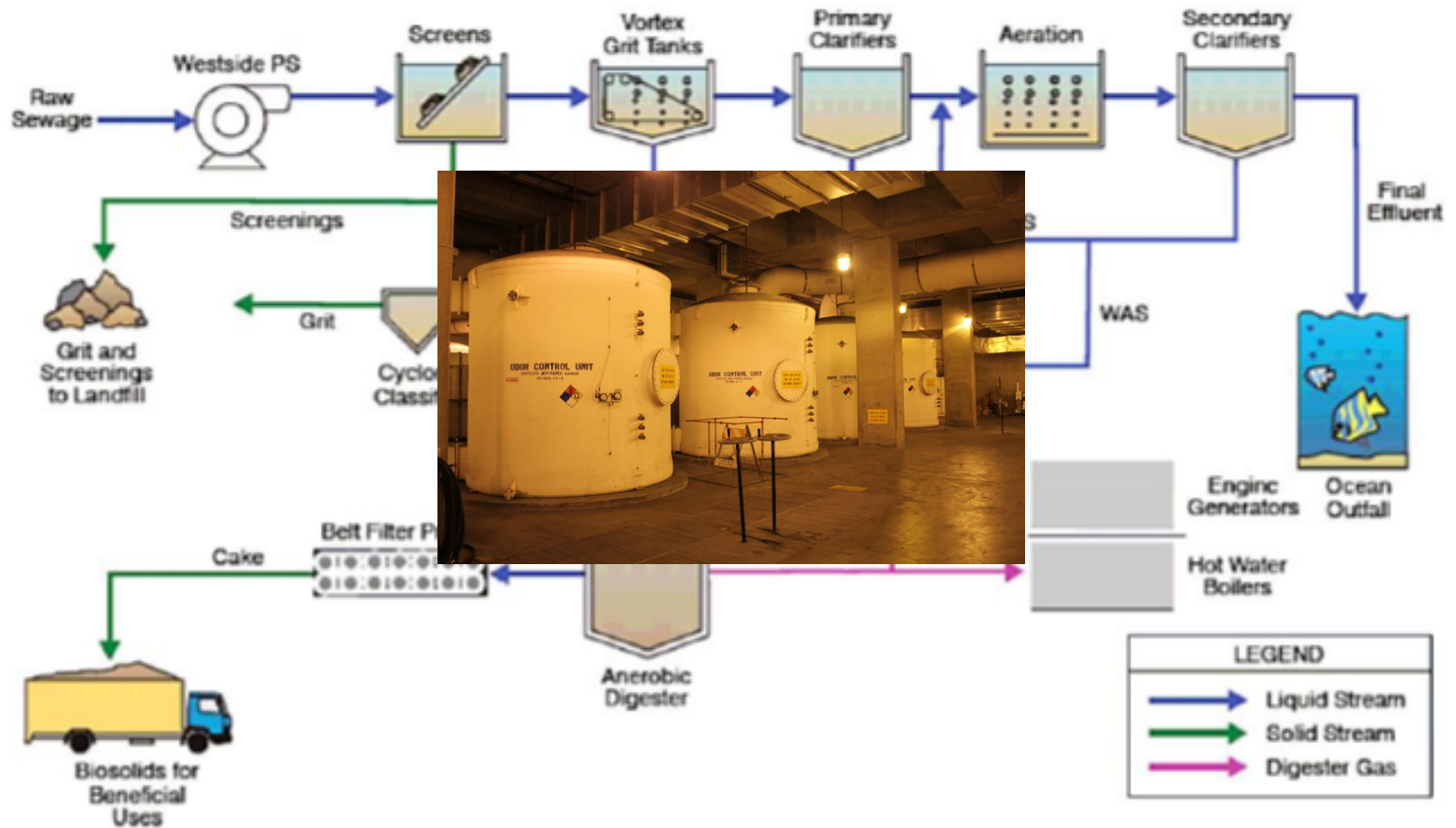
Oceanside Plant Process Flow Chart

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Oceanside Plant Process Flow Chart

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Demand Side Management Oceanside Energy Audit

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Mar. 2011 to Feb. 2012	Usage*	Maximum Demand	Energy Cost	Demand Cost	Other Cost	Total Cost
Rate Schedule E20S (Westside Pump Station)						
Power Purchased from PG&E	2,363,660 kWh	1,696kW	\$208,568	\$205,582	\$12,025	\$426,175
Average Values	193,458 kWh/month	1,184 kW	0.0882/kWh	\$14.68/k W		\$0.1803/kWh
Rate Schedule E20P (Main Plant)						
Power Purchased from PG&E	13,272,630 kWh	2,073 kW	\$1,168,113	\$333,605	\$18,037	\$1,519,756
Average Values	1,106,052 kWh/month	1,871 kW	0.0088/kWh	\$14.85/k W		\$0.1145/kWh

**Does not include the onsite production of electricity from August to February only (1,699,222 kWh)*

- ☐ Data gathered during an energy audit sponsored by the US Department of Energy and conducted by the San Francisco State University Industrial Assessment Center



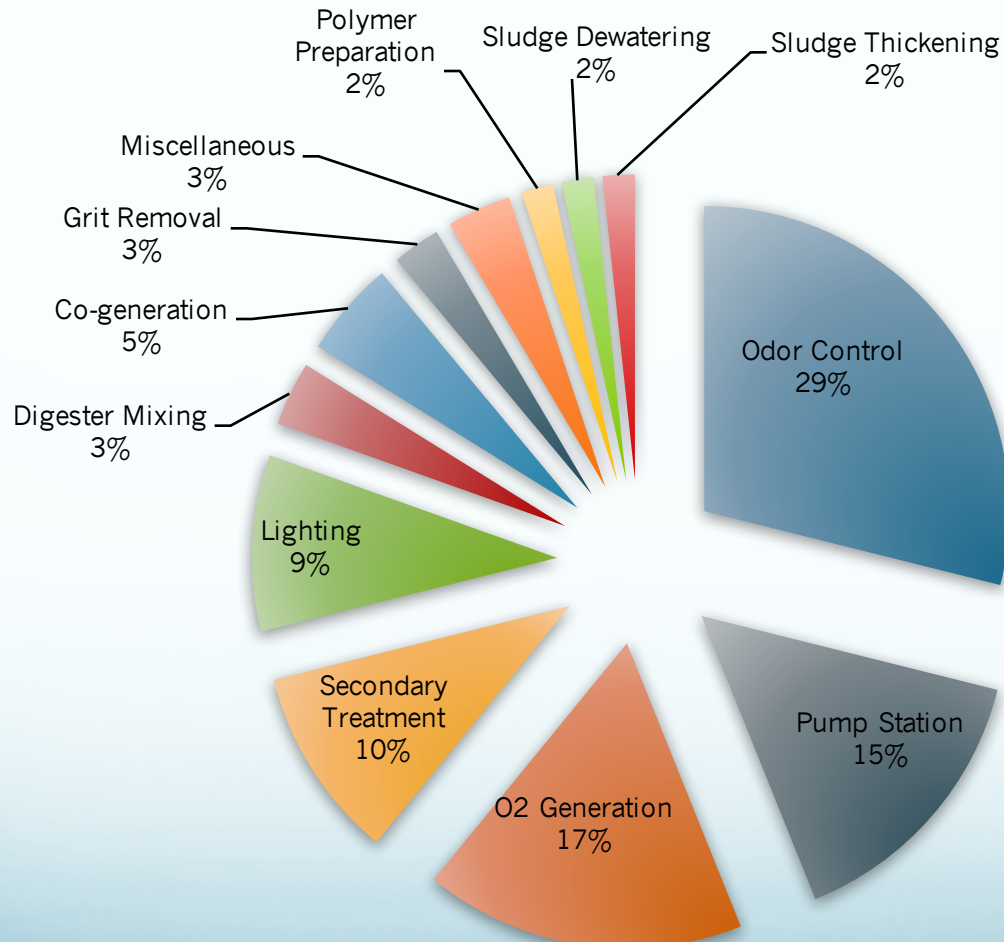
Demand Side Management Oceanside Energy Audit

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- ❑ Total yearly usage including onsite production: 17,335,500 kWh
- ❑ Average plant demand: 1,978 kW
- ❑ Average rate (demand included): \$0.1244/ kWh
- ❑ Estimated electrical energy cost without onsite production: \$2,156,540/year

Demand Side Management Oceanside Energy Distribution

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Demand Side Management To Do

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- ☐ Evaluate the possibilities and the benefits of shifting part of the operation to off-peak periods.

➡ The Westside collection system can store up to about 50 million gallons.



Energy Efficiency

What is being done at Oceanside

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- ❑ Implemented aeration system DO control and optimized anaerobic selector in 2010 (**improved plant performance and reduced O&M**).

➡ More consistent operation, no polymer needed to improve settleability, better SVI values, significant reduction in supplemental liquid oxygen

- ❑ Will install online %TS meter, automated SRT controller, more efficient WAS pumps in 2014 (**expected improved plant performance and reduced O&M**).

➡ Better control of the secondary treatment operation will allow pushing the limits of the system, maintaining same or better performance while saving resources.

- ❑ Reduced digester mixing by 80% in 2013 (**3% reduction in plant electrical demand at no capital cost**).

➡ A one-year full scale experiment conducted in 2012 where we progressively decreased digester mixing showed that digester performance were not affected after permanently stopping the 50HP mix pumps.



Energy Efficiency

What is being done at Oceanside

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- ❑ Will convert the pure oxygen aeration system into a air based system by 2015 (**expected 4% reduction in plant electrical demand** and significant reduction in O&M and system footprint).
- ➡ Preliminary work shows that same oxygen transfer can be achieved with air, rather than with pure oxygen by using high efficiency turbo blower and high efficiency parabolic mixers due to plant excess capacity.
- ❑ Will implement the miscellaneous energy conservation opportunities identified during the energy audit by 2015 (**expected 4% reduction in plant electrical demand**).
- ➡
 - Replace standard efficiency lighting with high efficiency lighting (savings: \$89,707/year)
 - Install lighting controls (savings: \$39,048)
 - Set back temperature in the offices during non-office hours (savings: \$6,448/year)
 - Install a VFD air compressor (savings: \$5,082/year)
 - Repair air system leaks (savings: \$923/year)
 - Reduce air compressor discharge pressure (savings: \$805/year)



Energy Efficiency

What is being done at Oceanside

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- ❑ Will turn down the odor control air flow in the primary sedimentation and secondary clarification buildings while the room is not occupied by 2014 (**expected 4% reduction in plant electrical demand and reduced O&M cost**).





Energy Production

What is being done at Oceanside

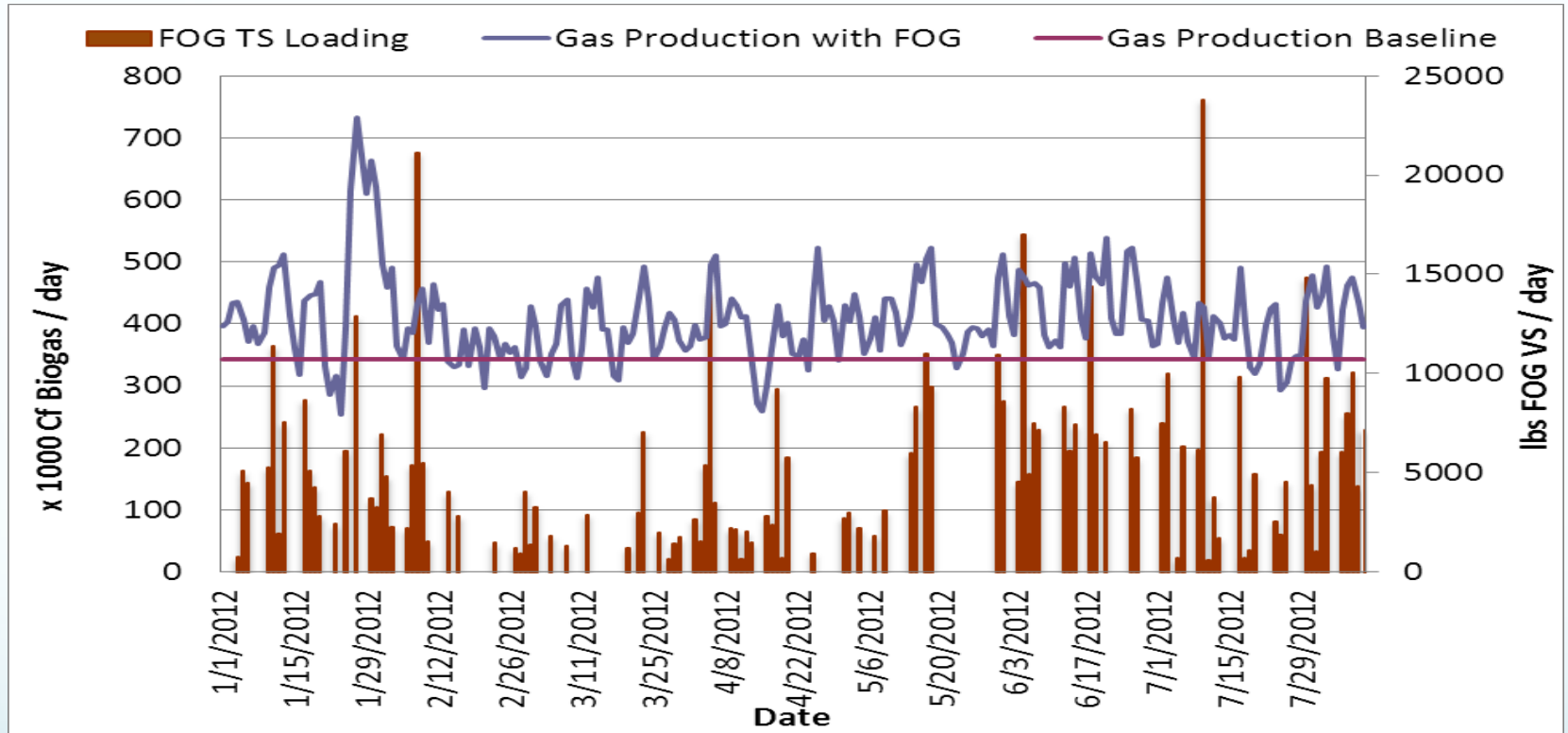
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- ❑ Implemented a FOG co-digestion program (**27% increase in methane gas production since 2012 and potential for a >50% increase**).
- ➡ The plant have received an average 10,000 gallons of restaurant trap waste per weekday since January 2012. But, the digesters could handle up to 30,000 gallons per day.

Energy Production

What is being done at Oceanside

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- ☐ ~ 9,500 gal./weekday from Jan 2012 to August 2012
- ☐ ~ 6% increase in digester TVS loading due to GTW
- ☐ ~ 19% increase in biogas production
- ☐ ~ 27% increase in CH₄ gas production because of higher gas CH₄ content



Energy Production

What is being done at Oceanside

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Process Condition	Gas Production
Historical gas production with plant sludge only	340,000 scf/day
Observed gas production with co-digestion of 10,000 gal. of grease trap waste per weekday (more than 2 years of full scale data)	410,000 scf/day
Estimated gas production with co-digestion of 10,000 gal. of grease trap waste per weekday in the new thermophilic process (under construction)	446,000 scf/day
Estimated gas production with co-digestion of 30,000 gal. of grease trap waste per weekday in the new thermophilic process (under construction)	500,000 scf/day



Energy Production

What is being done at Oceanside

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- ❑ Implemented a FOG co-digestion program (**27% increase in methane gas production since 2012 and potential for a >50% increase**).
- ➡ The plant have received an average 10,000 gallons of restaurant trap waste per weekday since January 2012. But, the digesters could handle up to 30,000 gallons per day.
- ❑ Currently implementing a thermophilic digestion process (**expected 10% increase in methane gas production by 2015 and Class A biosolids production**).
- ➡ The mesophilic digester are being converted to a Temperature Phased Anaerobic Digestion process.



Energy Production

What is being done at Oceanside

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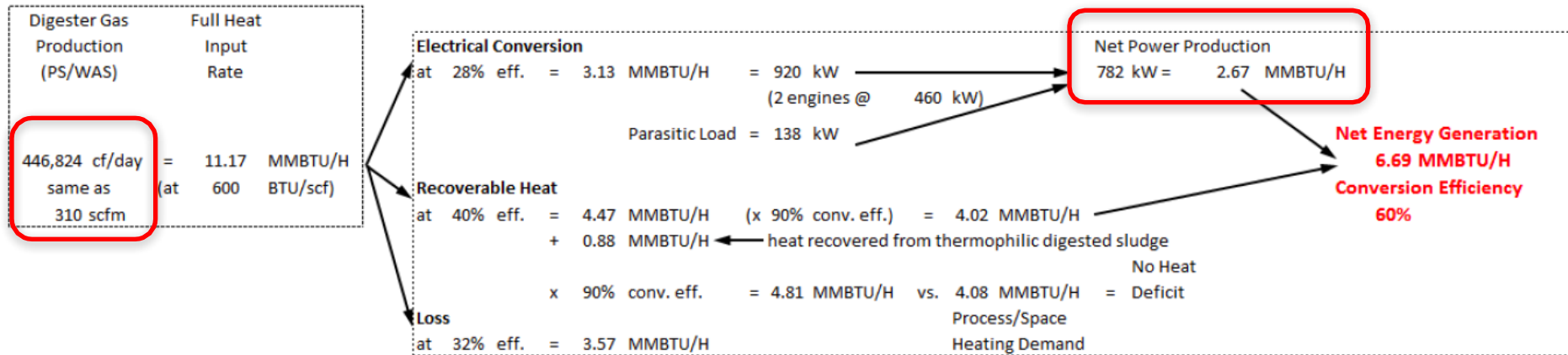
- ❑ Currently working on a conceptual design report to install a new co-generation system having a capacity that could meet the Oceanside electrical demand.
- ➡ Preliminary study shows that IC engines are the best option for Oceanside but other options are still being considered.

Energy Production

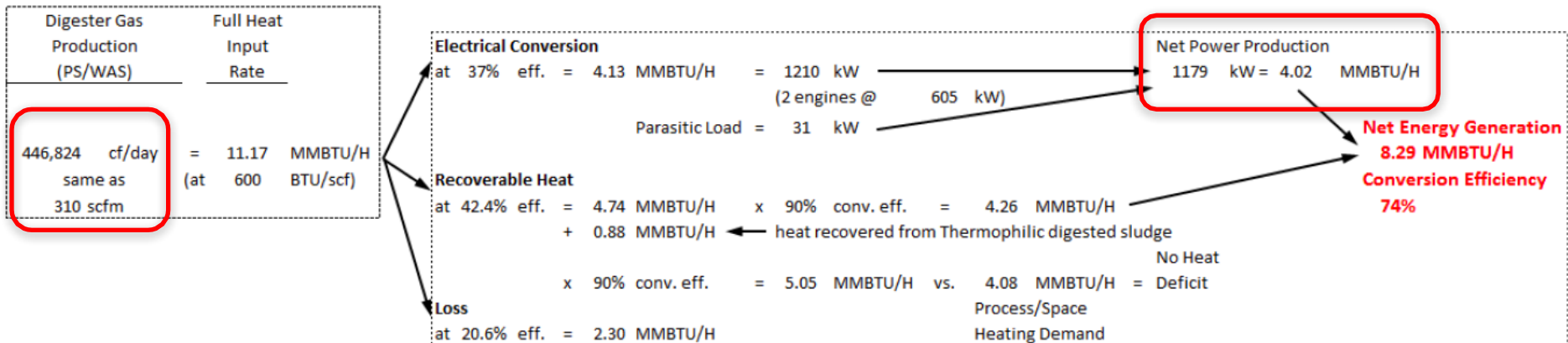
What is being done at Oceanside

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Existing internal combustion engine expected performance after rebuilt



New recommended internal combustion engine expected performance





Energy Production

What is being done at Oceanside

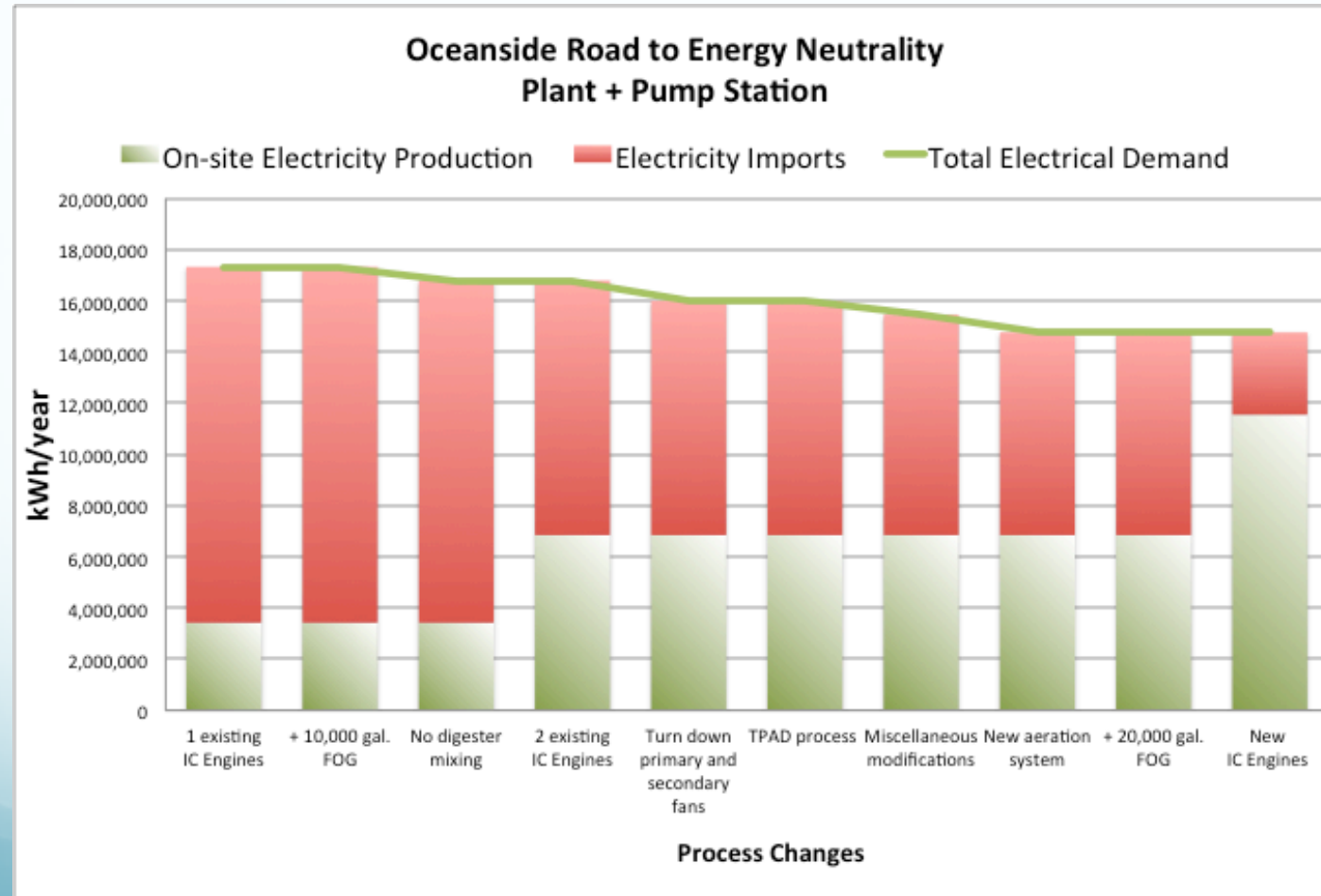
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- ☐ Will pilot the potential benefits of enhanced primary sedimentation to increase digester loading while decreasing aeration system loading.



Oceanside Road To Energy Neutrality Summary (Plant + Pump Station)

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Potential:

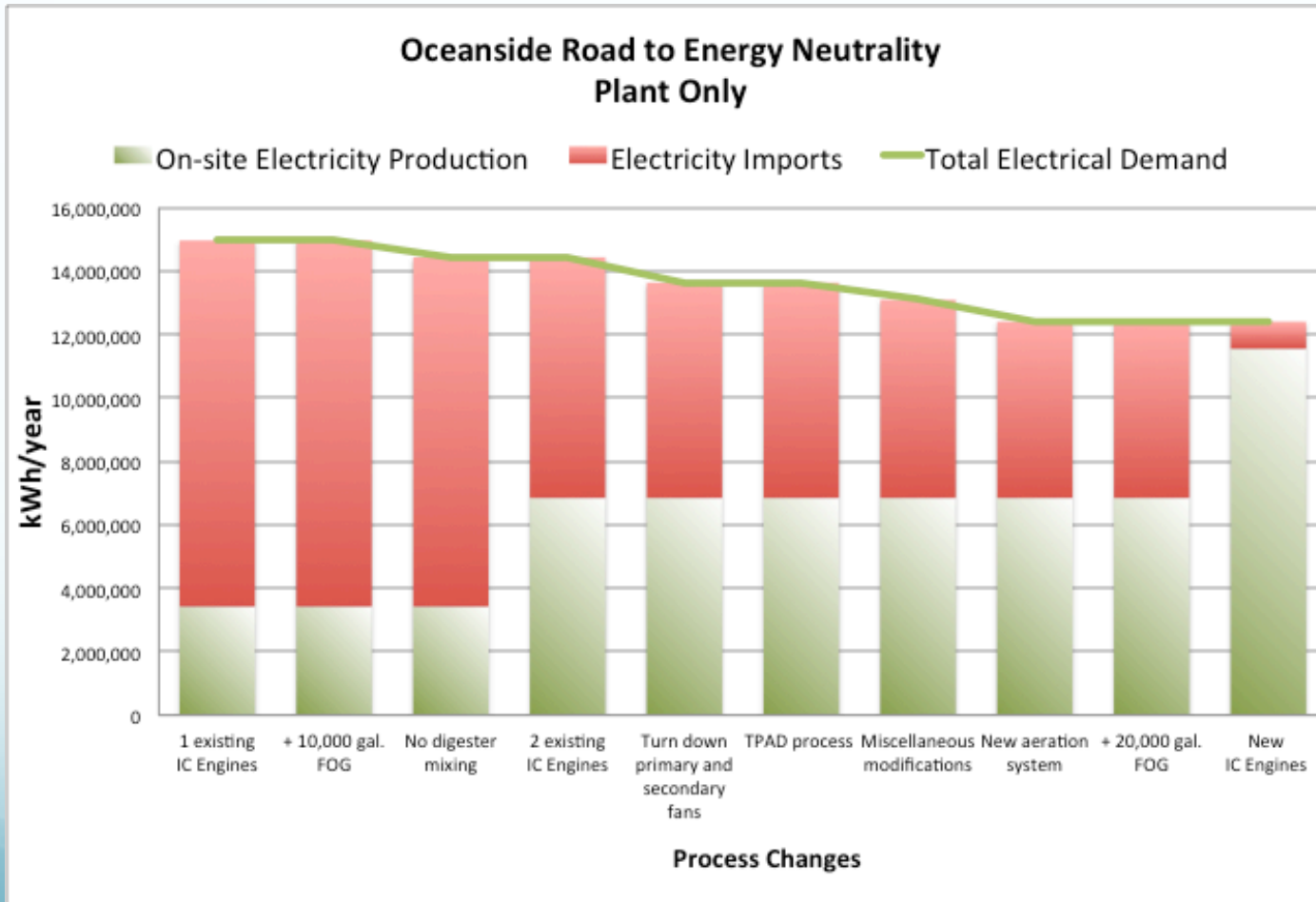
15% decrease
in electrical
demand

230% increase
in electricity
production

78% energy
neutral

Oceanside Road To Energy Neutrality Summary (Plant Only)

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Potential:

17% decrease
in electrical
demand

237% increase
in electricity
production

93% energy
neutral



Oceanside Road To Energy Neutrality Conclusions

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- ❑ With the ongoing process improvements and despite the challenging environment, the Oceanside plant could be energy neutral at 78% (pump station included).
- ❑ More opportunities might be available (enhanced primary sedimentation, biofilters for odor control, new pump station...)
- ❑ More robust monitoring and control is necessary as we are pushing the performance of our systems (less oxygen to our aeration system and increase organic loadings to our digestion process).
- ❑ Efficient operators training and operators buy-in will be key to the success of the new operating strategies and process systems.
- ❑ A good understanding of the local regulatory context is necessary.



Q&A

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