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Energy Optimization

Energy & Resource – Sustainability

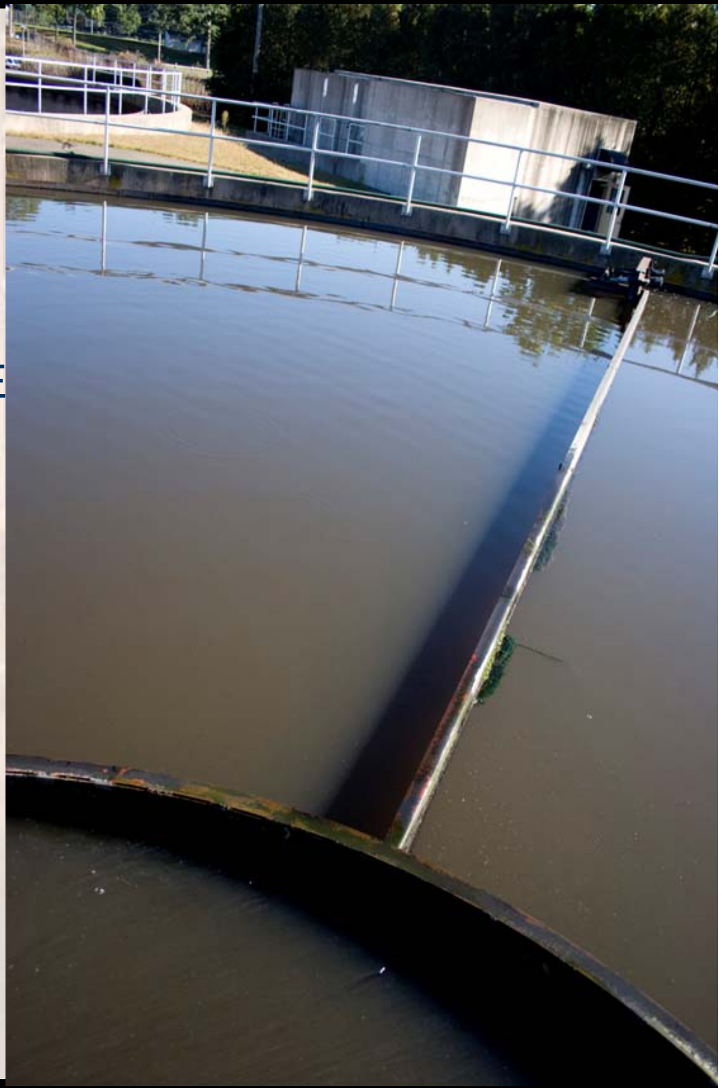
Greenhouse Gas Road Mapping & Current Green Initiatives in the Wastewater Industry

May 16, 2008

Speakers

- **Patrick Clifford, P.E. - CTE/AECOM**
  - Electrical/Instrumentation Engineer
  - 11 years of experience at CTE Engineers
  - Power Systems, SCADA, Energy Management
  - Business Unit Manager for CTE's Energy and AE Services Group

- **Joerg Blischke – M&E/AECOM**
  - Masters Degree in Chemical Process Engineering
  - 15 years of experience
  - M&E's waste-to-energy expert



Topic 1 – "Energy Optimization"

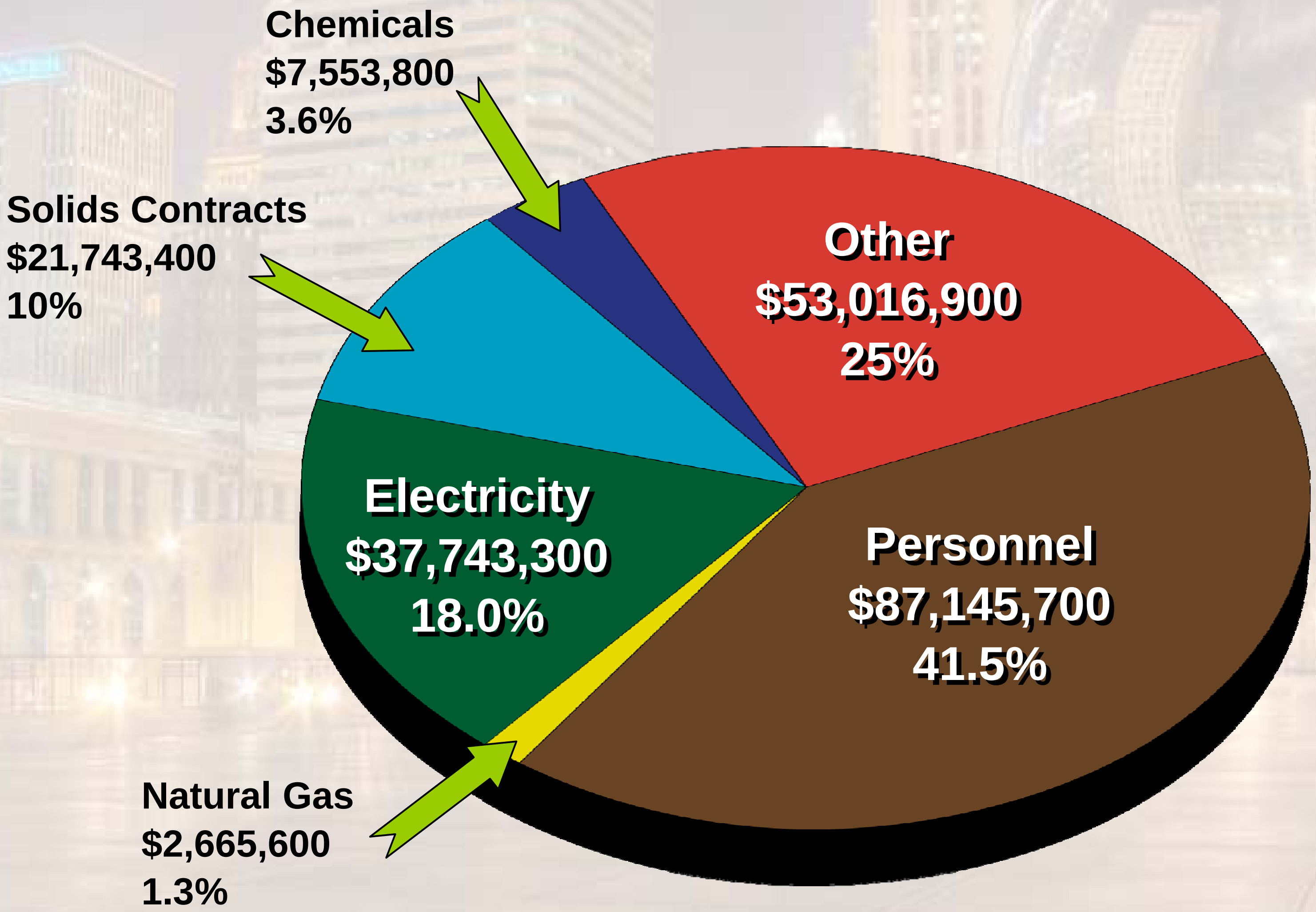
Speaker – Patrick Clifford CTE/AECOM

- **Energy Benchmarking**
  - Why Benchmarking?
  - Approach, Benefits
- **Typical Wastewater Treatment Energy Use Metrics**
  - Relevant Metrics
  - National Averages
- **Alternative Funding Mechanisms**
  - Local, Federal, Third Party
- **Areas of Energy Optimization**
  - Understanding Plant Processes
  - Equipment vs. Operational Modifications
- **Sustainable Design**

MWRDGC Energy Policy

The District's energy policy promotes sound energy practices at District facilities while continuing to comply with all operating permits. The objective of the energy policy is to establish energy management practices that promote fiscal responsibility while encouraging conservation of our natural resources and utilization of renewable energy sources. These practices promote the reduction of greenhouse gases by reducing District energy usage and/or by the substitution of conventional source with renewable resources.

MWRDGC Energy Policy



MWRDGC Energy Conservation

- **Executing a capacity based load reduction agreement (CLR7) with Commonwealth Edison**
- **Establishing an energy conservation committee**
- **Utilizing Computerized Dissolved Oxygen Control System for aeration tanks**
- **Utilizing 95% of digester gas produced**
- **Installing high efficiency motors and variable speed drives**
- **Establishing plant operations to match peak and off-peak power rates**

MWRDGC Green Initiatives

- **Installation of approximately 50 acres of natural prairie landscapes**
- **Implementation of a rain barrel distribution program**
- **Investigation of rain garden installations**
- **Installation of a prototype long-term Household Hazardous Waste collection facility**
- **Installation of replacement heavy equipment for new technologies that reduce drying time, and air emissions**

Energy Benchmarking

- **Business: Total Quality Management**

"Benchmarking – a continuous, systematic process for evaluating the products, services, and work processes of organizations that are recognized as representing best practices for the purpose of organizational improvement."

Michael J. Spendolini, The Benchmarking Book, 1992

- **Wastewater Treatment: Financial Tool**
  - Energy Management
  - Energy Optimization
  - Process Performance
  - Peer Comparison

- Energy Usage required to produce a specific per unit of

- Identify actions to improve performance
  - Process of Energy Benchmarking
    - Identify issues (metrics)
    - Collect Internal data (baseline)
    - Collect External data (comparison framework)
    - Analysis
    - Implement change
    - Monitor Impact
- You already have much of this information

Energy Benchmarking

- Greenhouse gas – CO_2 emission reduction
- Rising energy prices
- Total energy costs
- Performance compared to other sanitary districts
- Prioritize resources
- On-going tracking tool

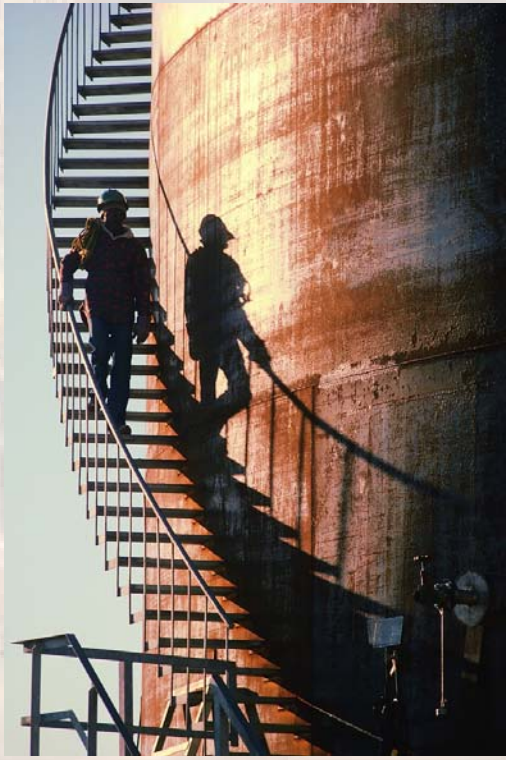
Energy Benchmarking Strategies

- **Energy Audits**
- **Energy benchmarking values**
- **Energy efficiency and emissions standards**
- **Energy efficient technologies**
- **Establish organizational and operational standards**

Energy Benchmarking: Strategies

Energy Audits

- In-depth study of all major energy consuming equipment in the plant
- Explores achievable energy saving measures through a systematic and scientific approach
- Evaluates existing energy usage as well as utility energy costs
- The analysis would include simple payback calculations
- Provides sizing and sourcing of retrofits and equipment
- Requires continuous interaction between audit team and plant personnel



Energy Benchmarking: Metrics

- **Normalized to Wastewater Treatment**
- **Energy Cost ($/MG)**
- **Energy Use (kWh/MG)**
- **BOD Removal – ($/# of BOD removed)**
- **Facility**
  - Geography
  - Flow
  - Loading
  - Process
- **Specific to process**
  - Pumping
  - Aeration
  - Filtration
  - Solids
  - Digestion
  - Chemical Treatment

Energy Benchmarking: Data Sources

1. Comparison to Past Performance

- **Diagnostic**
- **No comparison to others**
- **Only relative sense of performance over time**
- **“Look yourself in the mirror” approach**
- **Internal data source**
  - Monitor progress over a period of time
  - Operational benefits
  - Energy pricing impacts

Energy Benchmarking

2. Comparison to Large Scale Data: External

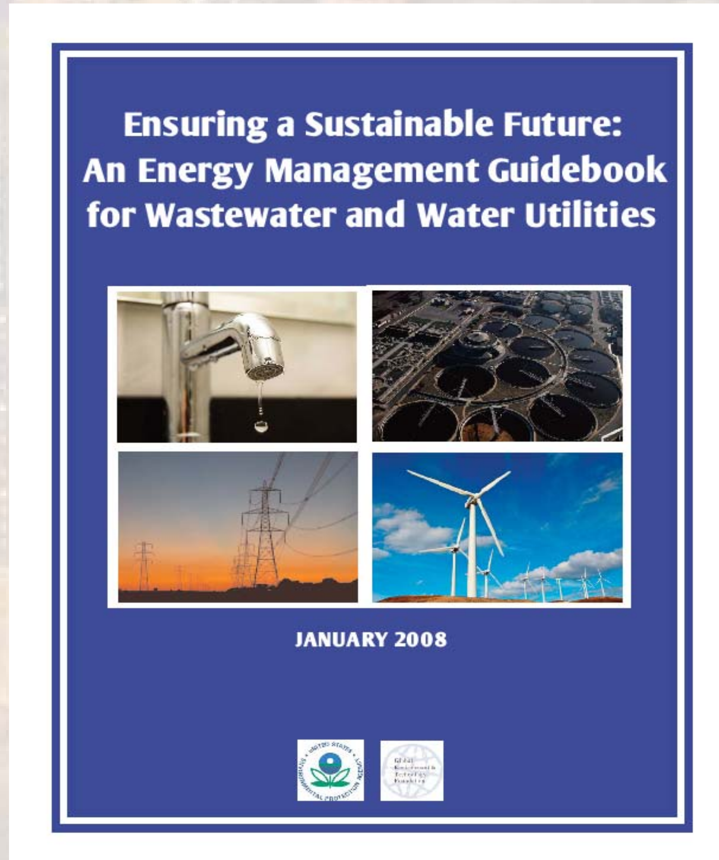
- **Industry Associations**
  - EPRI – www.epri.com
  - WERF - www.werf.org
  - AWWARF - www.awwarf.org
  - EPA/DOE - www.energystar.gov
  - NYSERDA – www.nyserda.org
  - CEC - www.energy.ca.gov
- **Limited by existing data sets**
- **Data by others**
- **Normalizing characteristics**
  - Weather, plant size, plant loading
- **Great way to determine where you stand in the pack**

Energy Benchmarking

ENERGY STAR

INPUTS

-Zip code
-Average influent flow
-Average influent biological oxygen demand (BOD5)
-Average effluent biological oxygen demand (BOD5)
-Plant design flow rate
-Presence of fixed film trickle filtration process
-Presence of nutrient removal process



2008 EPA Energy Guidebook
Wastewater Treatment Plants

Energy Benchmarking Summary

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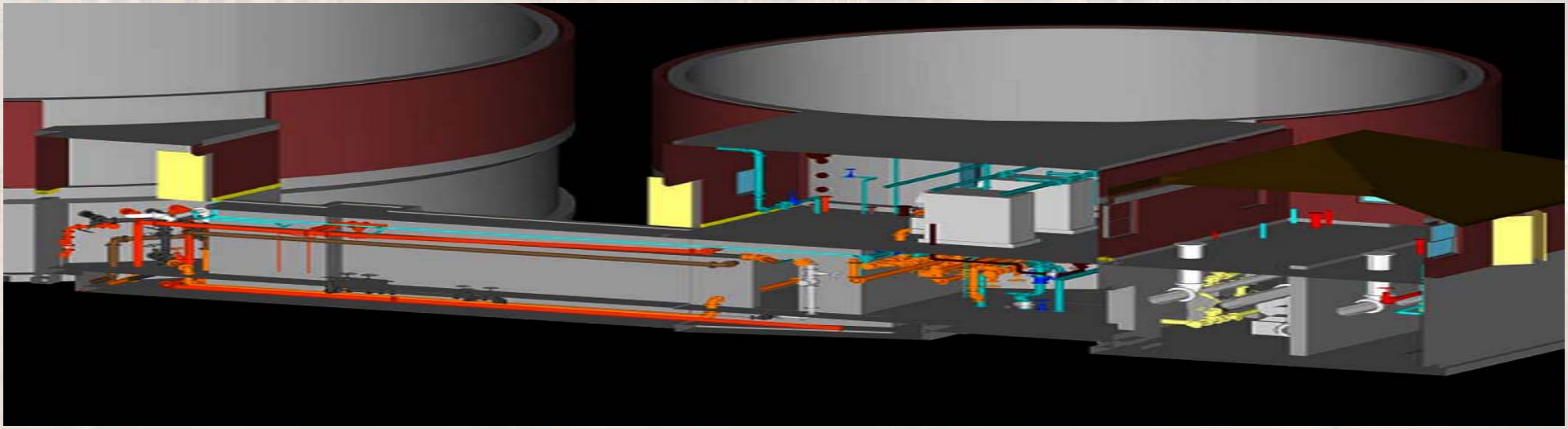
Wastewater Treatment Energy Use Metrics

- **Industry Facts**
- **Relevant Metrics**
- **National Averages**



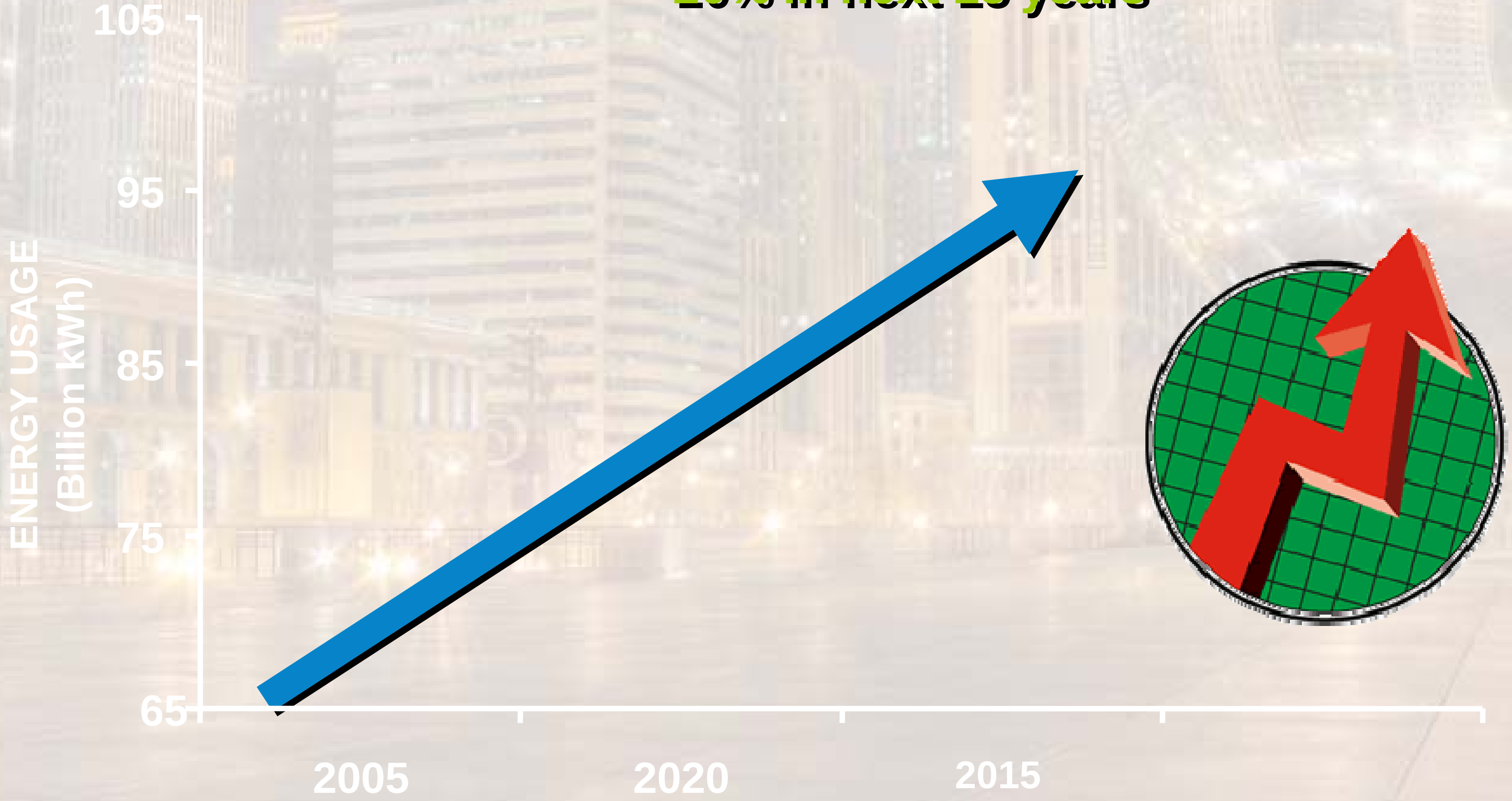
Large Energy Users

- National
  - More than 15,000 wastewater systems
    - *28,000 MGD treated*
  - Estimated 75 billion kWh
  - $6.5 billion/year on energy to pump, treat, deliver, collect, and clean water
  - Roughly 3% of annual US electricity use
  - Energy Costs = 30-50% of Total Operating Costs
  - Is the energy costs to run drinking water and wastewater systems 33% of a municipality’s energy bill
  - 10% energy reduction would save $650 million and 5 billion kWh annually

Typical Wastewater Treatment Energy Use Metrics

Water & Wastewater Treatment Industry Growing

Electricity requirements estimated to increase 20% in next 15 years



Typical Wastewater Treatment Energy Use Metrics

National Average Energy Use

Raw Water Pumping and Water → 350 kWh/MGG

Finished Water Dis → 1,150 kWh/MG

Wastewater Collection and Con → 150 kWh/MG

Wastewater Tre → 1,050 kWh/MG

Typical Wastewater Treatment Energy Use Metrics

Typical 330 MGD Plant

Large Energy Users	Typical Plant kWh/day	Typical Plant kWh/MG	North Side WWTP kWh/day	North Side WWTP kWh/MG
Wastewater Pumping	39,500	118	56,000	169
Aeration (Diffused Air)	175,500	532	143,000	433
Lighting and Building	10,000	30	27,000	110
Totals	392,000	1,188	226,000	684

Typical Wastewater Treatment Energy Use Metrics

Typical 30 MGD

Large Energy Users	kWh/day	kWh/MG
Wastewater Pumping	3,840	128
Aeration (Diffused Air)	15,960	532
Biological Nitrification	10,227	340
Filters	1,063	35
Digestion	4,800	160
Lighting and Building	10,000	60
Totals	50,300	1,558

Typical Wastewater Treatment Energy Use Metrics

Conclusion

- ***Must be developed over time***
- ***No one size solution fits all***
- ***Internal benchmarking is important***

Energy Optimization

Energy Optimization: conserving electrical energy usage by means of updating older inefficient equipment, optimizing process operations and system control, and improving maintenance procedures with the ultimate goal of enhancing system functionality while reducing costs.

Why is Energy Management Important

- Municipal Wastewater – Large Energy Users
- Wastewater Treatment is Growing
- Increasing Energy Costs
- Funding Concerns
- More Stringent Environmental Regulations

Environmental Regulations

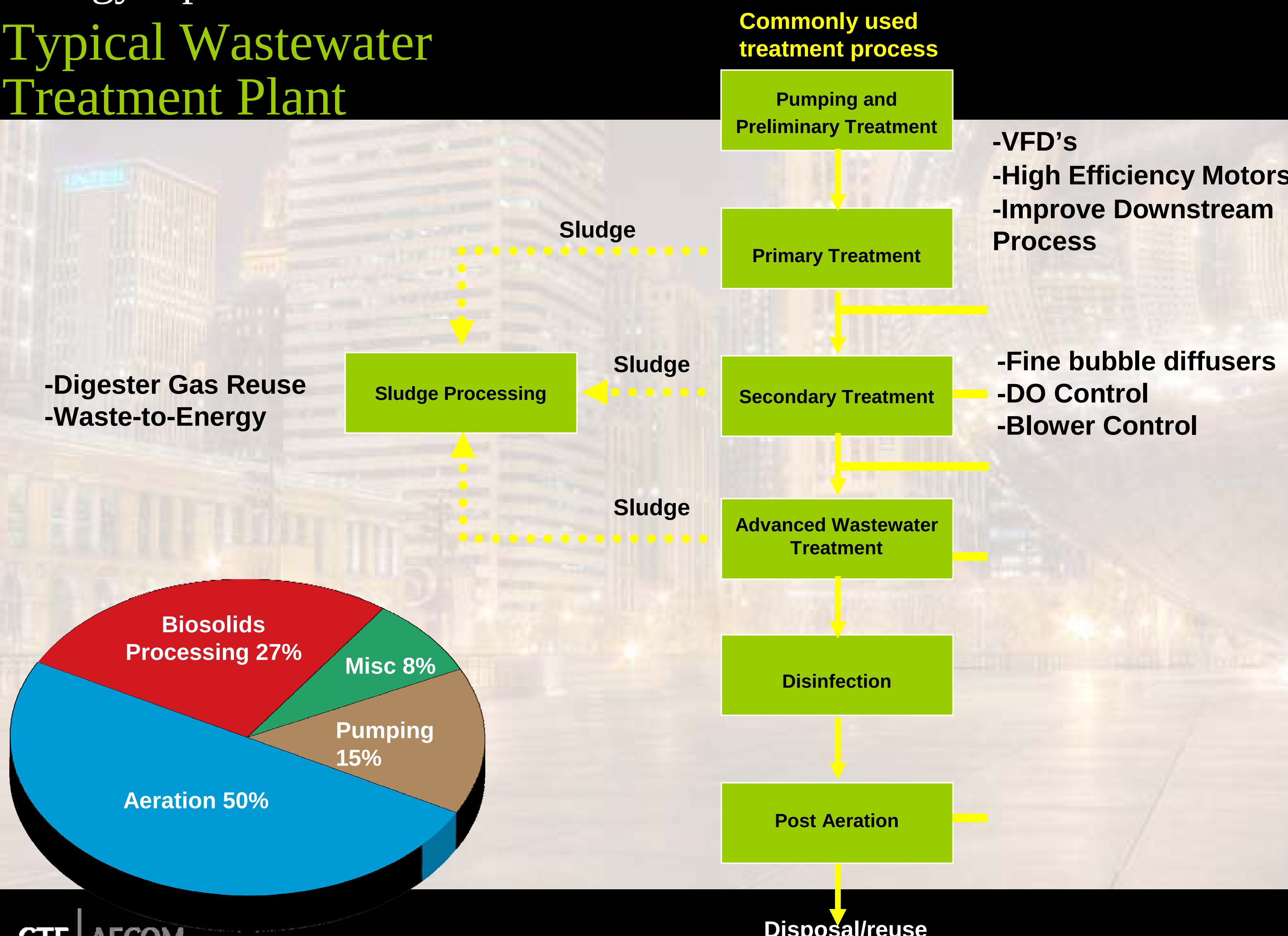
- **Wastewater**
  - **Odor Control**
  - **CSO's**
  - **Nutrient Removal**
  - **Disinfection (Ultraviolet Irradiation)**
  - **Biosolids Reduction**

How to Manage Energy

- **Must Understand Where it is Used**
- **Improve High Energy Use Equipment**
- **Control and Instrumentation**
- **Operational Considerations**
- **Load Shape Objectives**
- **Appoint an Energy Champion (#1)**

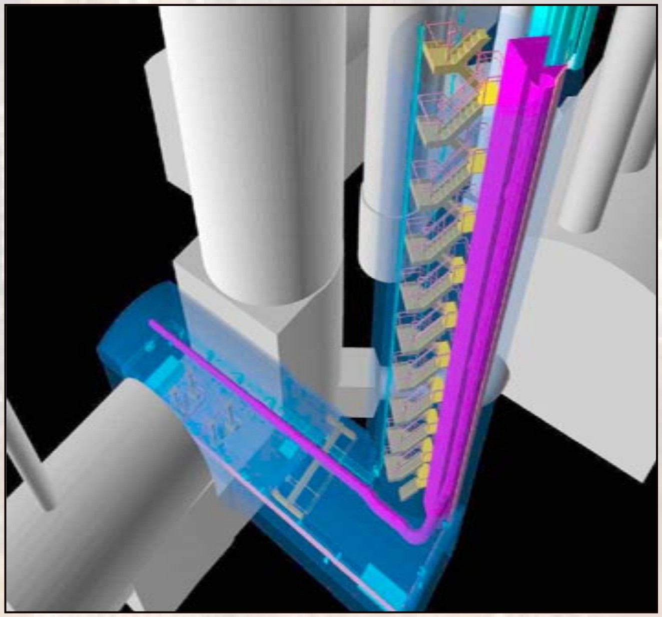
Energy Optimization

Typical Wastewater Treatment Plant



Energy Management Opportunities

- **Large Pumping Applications**
- **Wastewater Treatment Plant Aeration Process**
- **Energy Efficient Motors**
- **Centrifuge Energy Efficiency**
- **Bio-fuel Reuse**
- **Energy Management SCADA and Software**
- **Load Balancing/Load Shifting/Operational Considerations**
- **High Efficiency lighting/HVAC**
- **Include Energy Conservation Management (ECM) on all Projects**



Alternative Funding Mechanisms

How to Pay for these projects

•Illinois Clean Energy Community Foundation

www.illinoiscleanenergy.org

•Illinois Department of Commerce and Economic Opportunity (DCEO)

www.commerce.state.il.us

•Energy Efficiency and Renewable Energy (EERE) & U.S. Department of Energy (DOE)

www.eere.energy.gov

•Database of State Incentives for Renewable Energy (DSIRE)

www.dsireusa.org

•ComEd

www.exeloncorp.com/ComedCare_Main/ComedCare

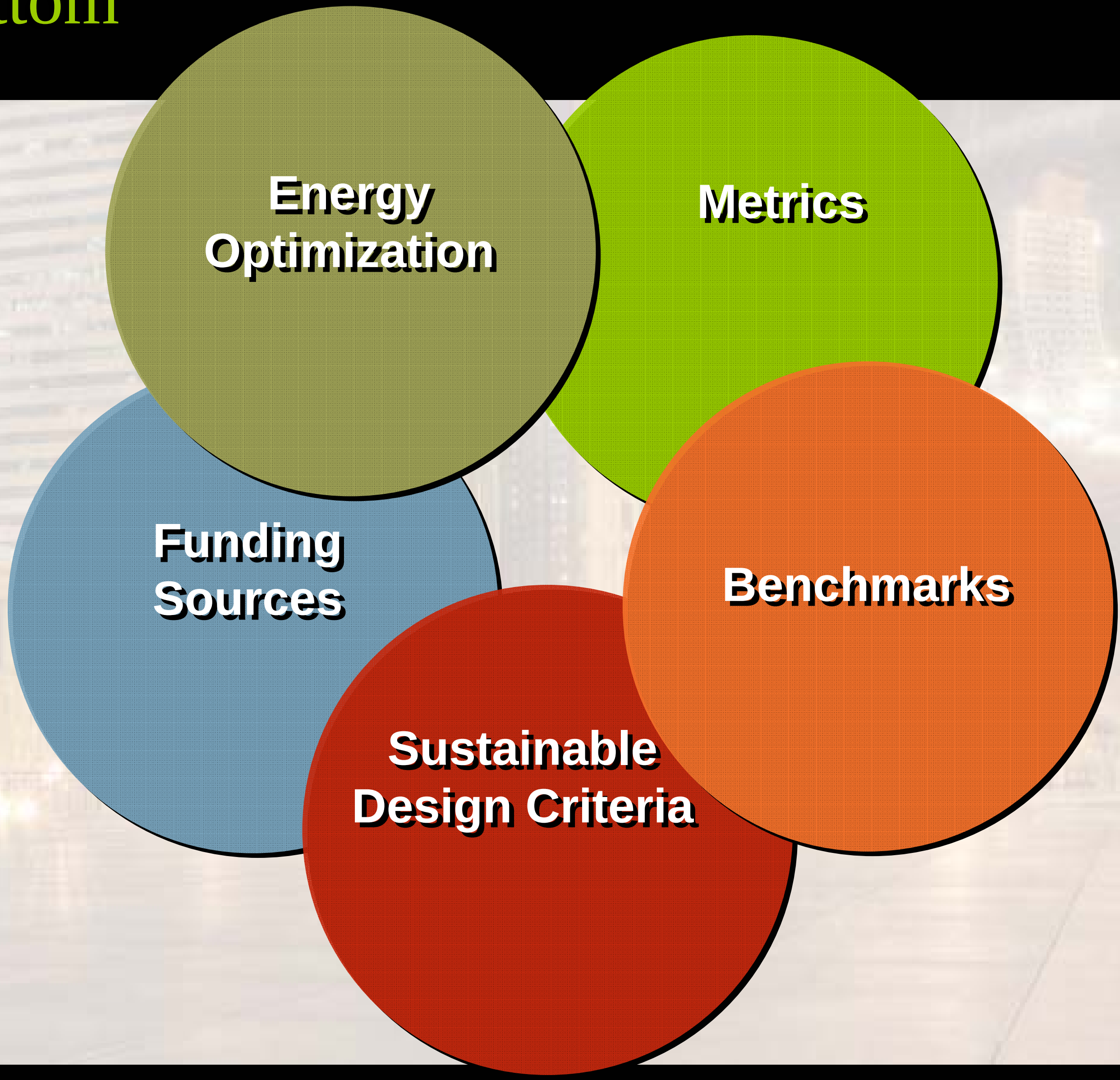
Alternative Funding Mechanisms

How to Pay for these projects

- Private Funding
  - -Energy Service Company (ESCO's)
  - -Public Private Partnerships (PPP's)
- Turnkey Solutions

Energy Optimization

Improved Bottom Line

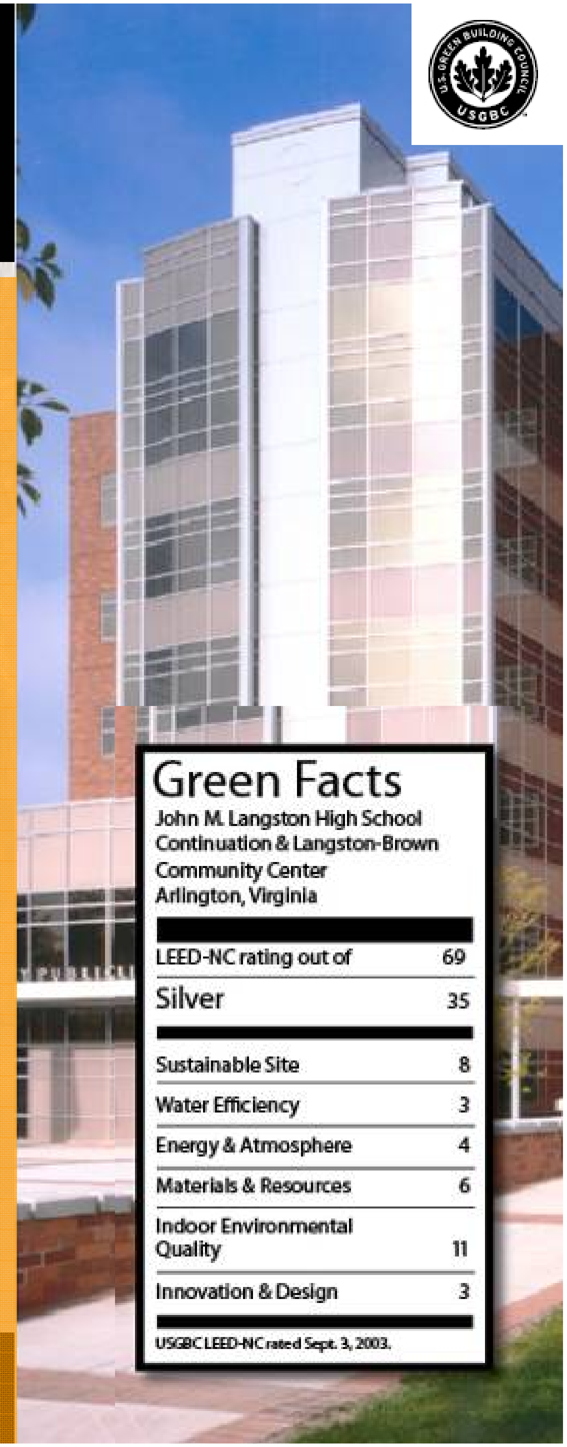


What is Sustainable Design?

-Reduces Non-renewable Resources
-Minimize Environmental Impact
-Identifies Renewable Resources
-Reduces Water Use
-Reduces Energy Use

SAVES LONG TERM OPERATIONAL COSTS

1. **Site Planning**
2. **Water Management**
3. **Energy Management**
4. **Material Use**
5. **Indoor Environmental Air Quality**
6. **Innovation & Design Process**



Sustainable Design

- **What are other similar organizations doing?**
  - ***What kind of programs have they established?***
  - ***How much money are they spending annually?***
    - **What kind of funding?**
    - **Where is it coming from?**
    - **How much?**
  - ***What are the financial, operational, and public relation benefits?***

Sustainable Design Opportunities

Construction Debris Reuse

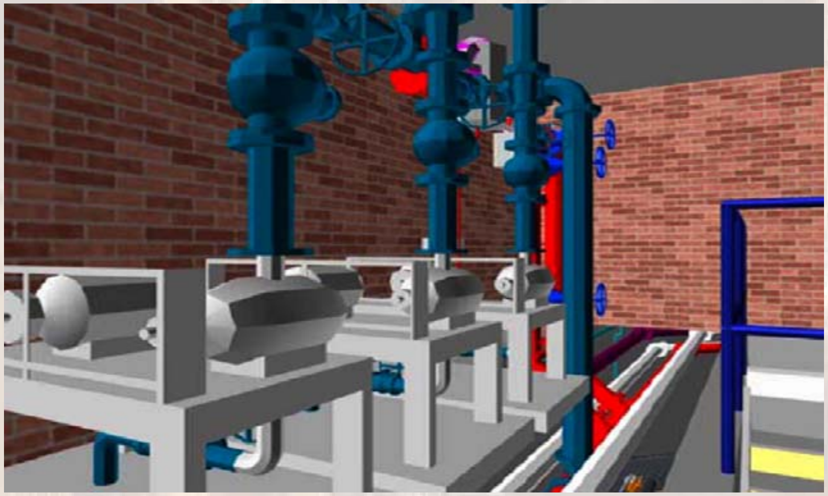
Transportation

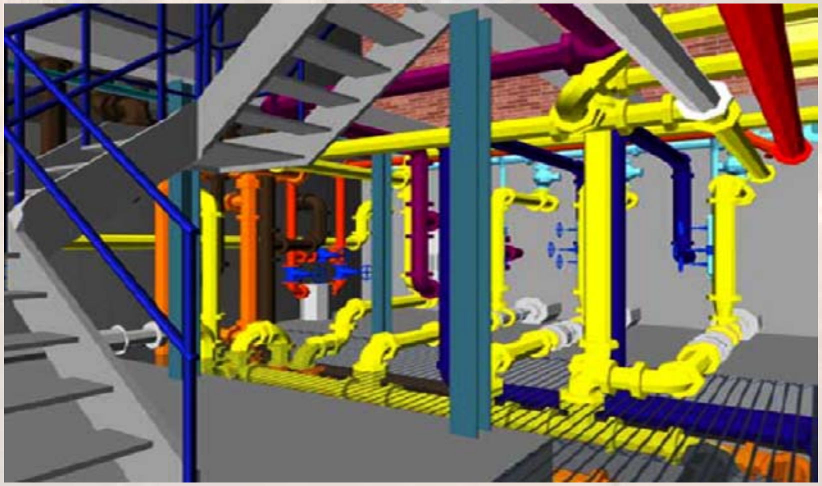
Water Efficiency

Energy Efficiency

HVAC and lighting controls

Renewable Energy





Break

End of Presentation

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Energy & Resource – Sustainability

Greenhouse Gas Road Mapping & Current Green Initiatives in the Wastewater Industry

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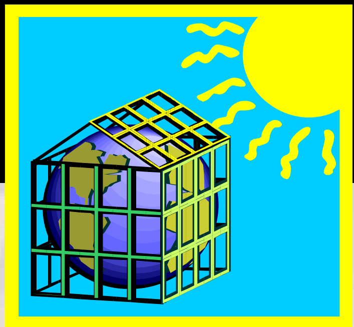
Topic 2 – "Energy & Resource; Sustainability

Speakers - Joerg Blischke – M&E/AECOM;
Patrick Clifford CTE/AECOM

- **Carbon Footprint and Greenhouse Gas Roadmapping for Wastewater Facilities**
  - *GHG 101*
  - *International – National – State: Legislation => Regulations*
  - Illinois: The Climate Action Registry => Gov. Blagojevich EO 11 (2006) "Executive Order on Climate Change and GHG Reduction"
  - Voluntary Carbon Trading: Chicago Climate Exchange
- **FOG and Food Waste to Energy**
  - FOG co-digestion and SSO digestion at WWTP's
  - Optimization of anaerobic digestion process – digester upgrades; gas yield increase
- **Cogeneration and Other Uses for Digester Gas**
- **Renewable Energy Opportunities and Evaluations at Wastewater Facilities**
  - Renewable Energy Opportunities at Wastewater Facilities
  - Legislation, Regulations

GHGs 101

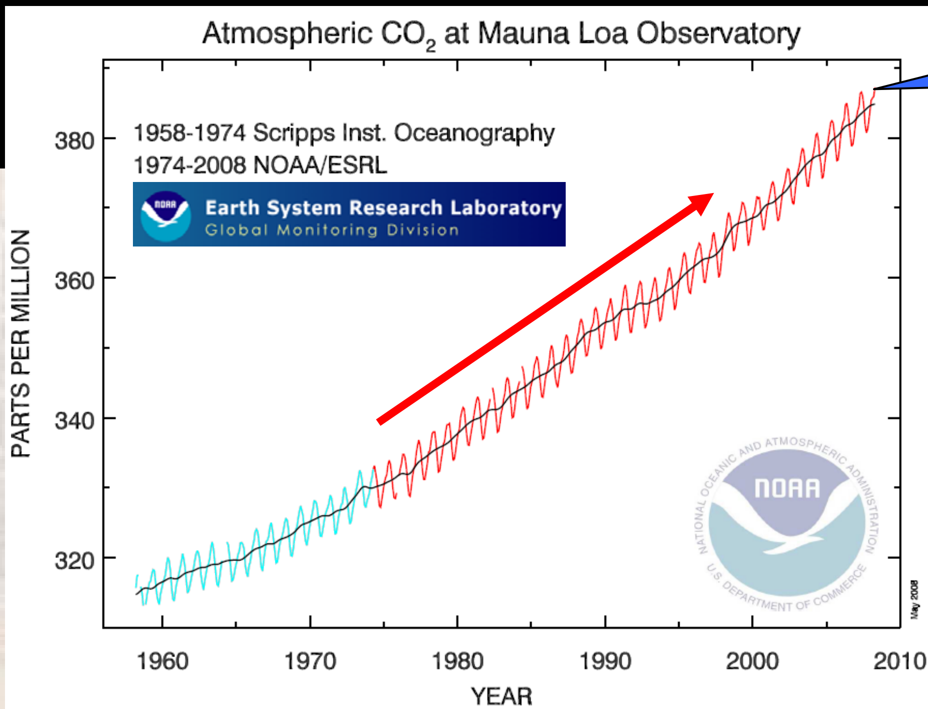


The Industrial Greenhouse Gases

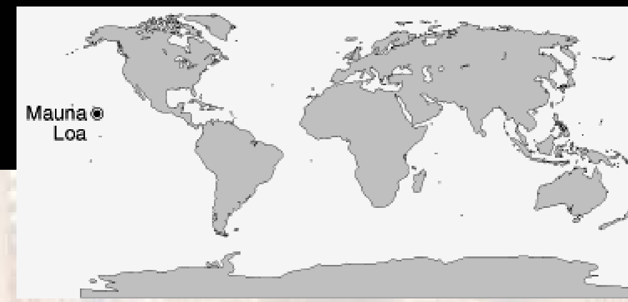
(the 6 “Kyoto Protocol” gases)

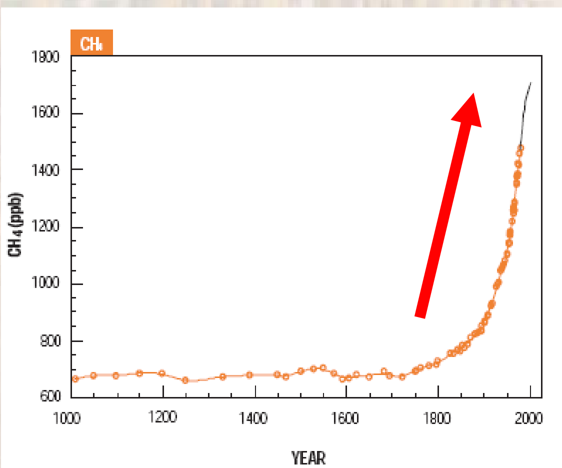
Comparison of 100-Year Global Warming Potential* (GWP) Estimates from the IPCC's Second Assessment Report (1996)	
Gas	**GWP in CO_2 equivalent (CO_2e)**
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
Fluorinated Gases (HFCs & PFCs)	140 – 11,700
Sulfur Hexafluoride (SF_6)	23,900

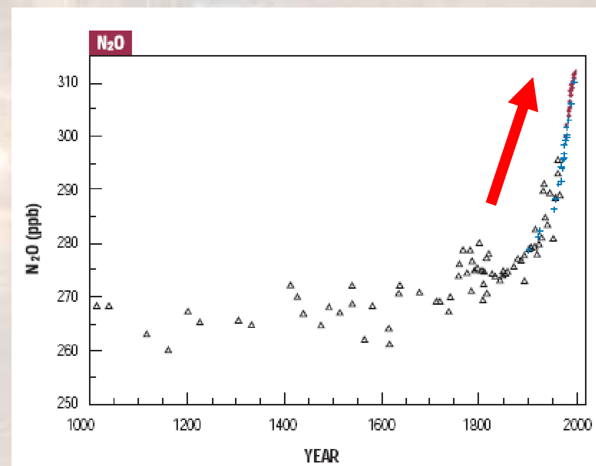
*** GWP = Measurement of the heat trapping potential of various GHGs relative to CO_2**



April'08
387ppm

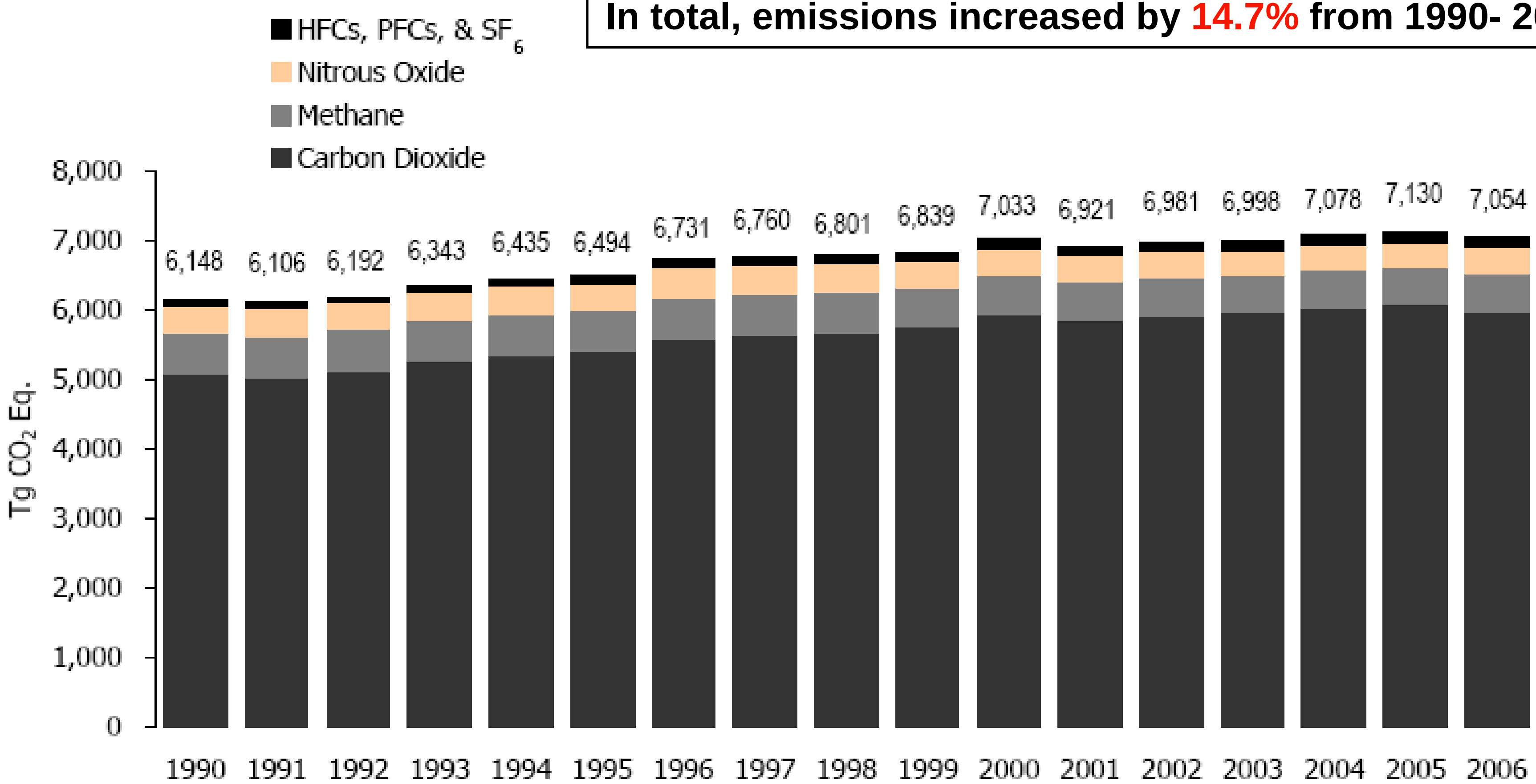






U.S. GHG Emissions by Gas

In total, emissions increased by 14.7% from 1990- 2006



Source: EPA Inventory of GHG Emissions and Sinks: 1990-2006

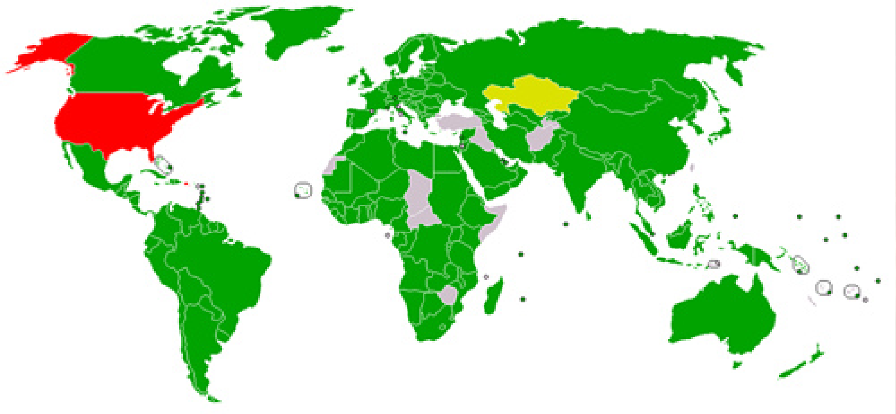
The Benefits of Greenhouse Gas Reduction

Design & Engineering Policies and Practices that reduce GHGs produce many benefits:

- Reduces wastefulness; improves process efficiency
- Increases system sustainability
- Fulfills emerging global compliance
- Multi-billion dollar investment, re-industrialization and job growth
- Provides own hedge fund against rising energy costs
- Reduces our national & financial security risks
- GHG credits that can be sold
- Climate stabilization
- Reduces costs / saves money
- Technology improvements

The Kyoto Protocol

- **1997 - Negotiated in Kyoto, Japan**
- **Kyoto is a '*cap and trade*' system (allows emission trading)**
  - ❖ Imposes national caps on GHG emissions of more than 33 industrialized countries.
  - ❖ On average, this cap requires countries to reduce their emissions 5.2% below their 1990 baseline over the 2008 to 2012 period.



World map: Kyoto Protocol, participation (December 2007)

green - signed and ratified
yellow - signed, ratification pending
red - signed, ratification declined
gray - no position

Legislative Actions

- **Federal** (No cohesive federal climate change protection strategy yet)
  - **April 2, 2007 - *Supreme Court Decision on Massachusetts Vs. EPA:***
  - **EPA authorized to regulate CO_2 as a pollutant under the Clean Air Act**
  - **CO_2 may be regulated similarly to the six criteria pollutants identified in the Federal Clean Air Act**

- **State**

California – AB 32: GW Solution Act of '06

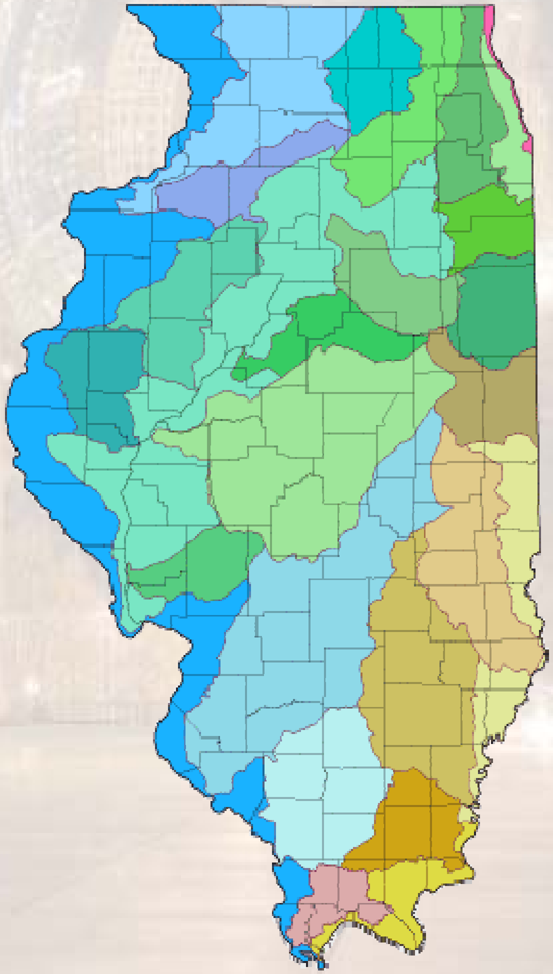
  - **Reduce GHG emissions back to 1990 level by 2020**
  - **The strongest and only standard in the nation**
  - **CA Air Resources Board to develop regulations to achieve pollution reduction goals**
  - **Mandatory reporting of GHG emissions by 2008; begin making reductions by 2012**
  - **Emission trade component starting in 2012**

Legislative Actions

- **State**

  Illinois

  2006 - Governor Blagojevich announcing a new global warming initiative building on Illinois' role as a national leader in protecting the environment, signs Executive Order 2006-11, creating the Illinois Climate Change Advisory Group, which will consider policies and strategies to reduce GHG emissions in Illinois and make recommendations to the Governor.



Regional Voluntary Actions

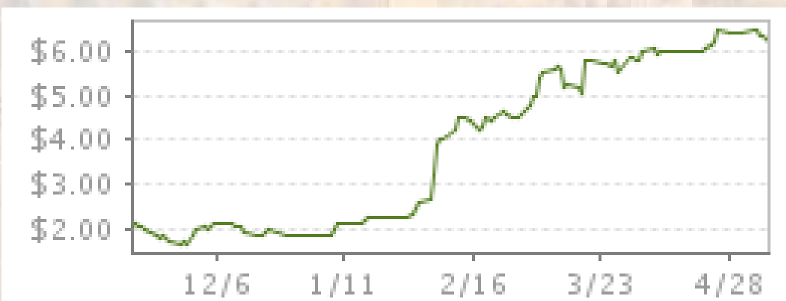
The Climate Registry

- 39 U.S. States
- 7 Canadian Provinces
- 6 Mexican States
- 3 Native American Tribes

Source: www.theclimateregistry.org

Local Opportunities

CCX Chicago Climate Exchange



Source: www.chicagoclimatex.com

- Launched in 2003, is the world's first active voluntary, legally binding integrated trading system to reduce emissions of all six GHGs, with offset projects worldwide.
- Trading price of $6.35/Carbon Financial Instrument (CFI) = 1metric ton CO_2e as of May 2008

Focused Wastewater Process GHG Emissions

- **CO_2 –** Biogenic = net zero impacts
- **CH_4 + N_2O** = **Focus Area**

U.S. Wastewater GHG Emissions (2006)

- **WWTP <1% of total U.S. GHG emissions**
- **External GHG emissions not considered**
- **4% of CH_4 emissions and 2% of N_2O emissions**
- **CH_4 emissions up by 4% and N_2O emissions up by 29%**
- **32 $TgCO_2e$ total**
  - o **75% CH_4 (8th largest source of CH_4)**
  - o **25% N_2O (6th largest source of N_2O)**

Source: EPA Inventory of GHG Emissions and Sinks: 1990-2006

GHG Emission Sources for WWTP Processes

Process Step Expected GHG Emissions

- ✓ Primary Treatment - None expected
- ✓ Secondary Treatment
  - **None** expected from aerobic processes
  - **CH_4** from anaerobic treatment processes (i.e., lagoons)
  - Advanced Treatment **N_2O** emissions from nitrification/denitrification process
- ✓ Solids Handling
  - **CH_4** emissions from sludge handling (digestion, incineration, fugitive emissions)
- ✓ Effluent Discharge
  - **N_2O** emissions from denitrification of nitrogen species originating from wastewater effluent in receiving water

CA AB 32 Impacts on WWTPs

- Emissions Reporting
- GHG Emissions Reductions
- Cap-and-Trade Program

Comprehensive GHG Mitigation Approach

Monitoring, inventory, and base-line assessment (Phase I)

Assessment & planning of feasible alternatives & mitigating options (Phase II)

Design/build implementation of selected options (Phase III)

Monitoring of results (Phase IV)

Renewable Resources-to-Energy
Green Vision for San Jose WWTP, CA - Example

1 - Reduce per Capita Energy Use by 50%

2 - 100% of Electric Power from Clean Renewable Sources

3 - 100% Waste Diversion from Landfill => Convert Waste to Energy

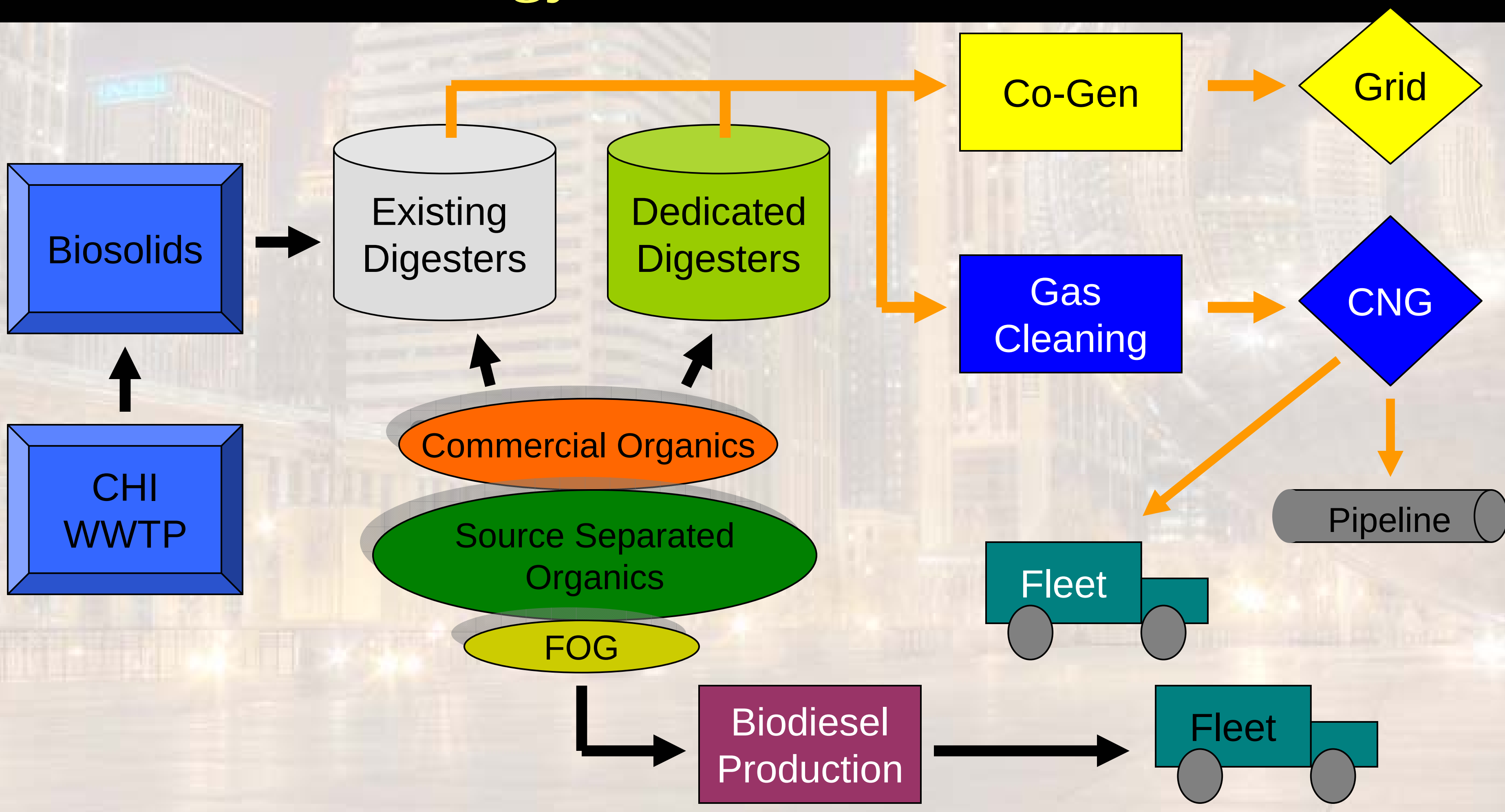
4 - 100% of Public Fleet Vehicles Run on Alternative Fuels

Conservation / Efficiency

Renewable Resources	Expertise / Experience - Examples
Biomass	CHP; CNG
Wind	Wind Turbine Parks
Sun	Solar PV

SJ WWTP

Renewable Resources-to-Energy
Biomass-to-Energy



Waste Recycling

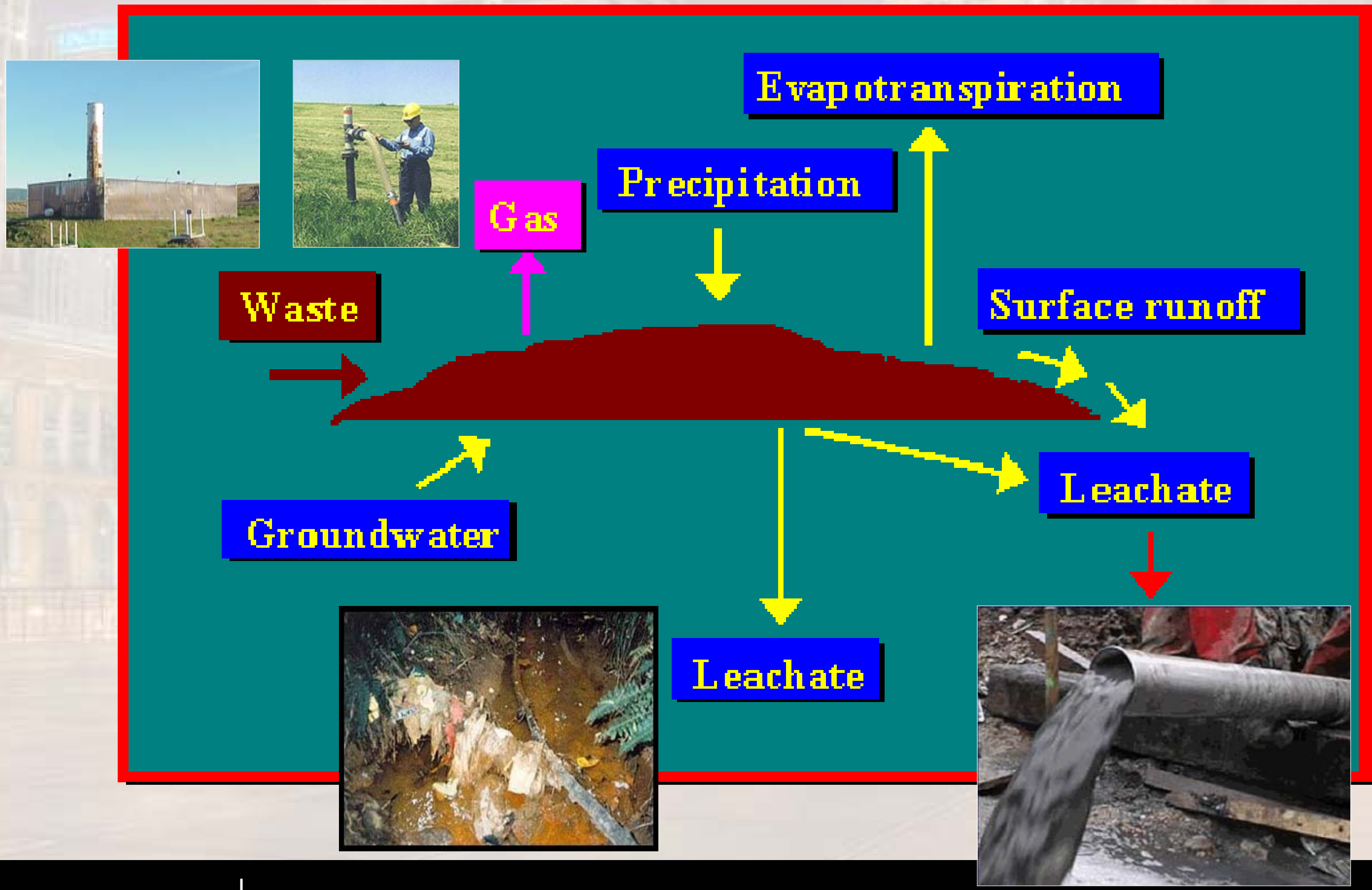
Renewable Energy + Carbon Credits

Reduced Fossil Fuel Use

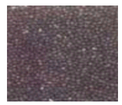
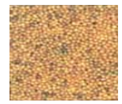
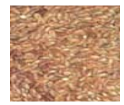
Eco-Friendly

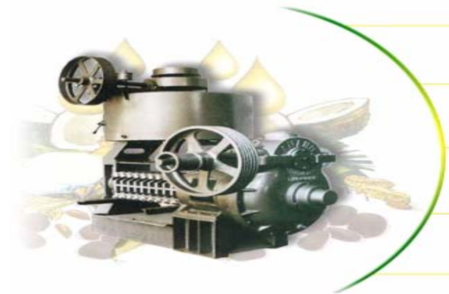
Renewable Resources-to-Energy

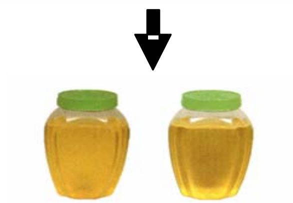
Landfill Gas (LFG) and Leachate Mitigation Through Organics Recovery and Diversion



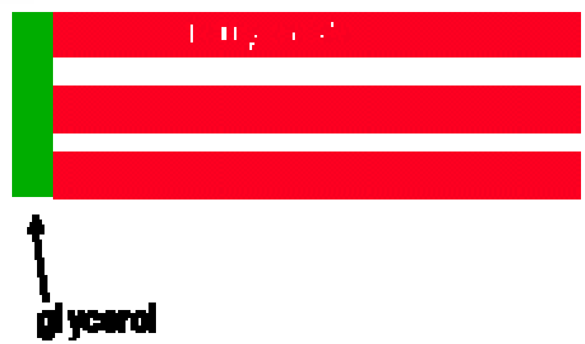
Renewable Resources-to-Energy
Fats, Oil, Grease 101 - Oil Crops & Content

PALM KERNEL	SESAME	RAPESEED	MUSTARD	LINSEED	COTTON SEED	SOYBEAN	PALM FRUIT
							
38 to 45%	50 to 56%	38 to 45%	38 to 45%	40 to 50%	18 to 22%	18 to 22%	20 to 22%

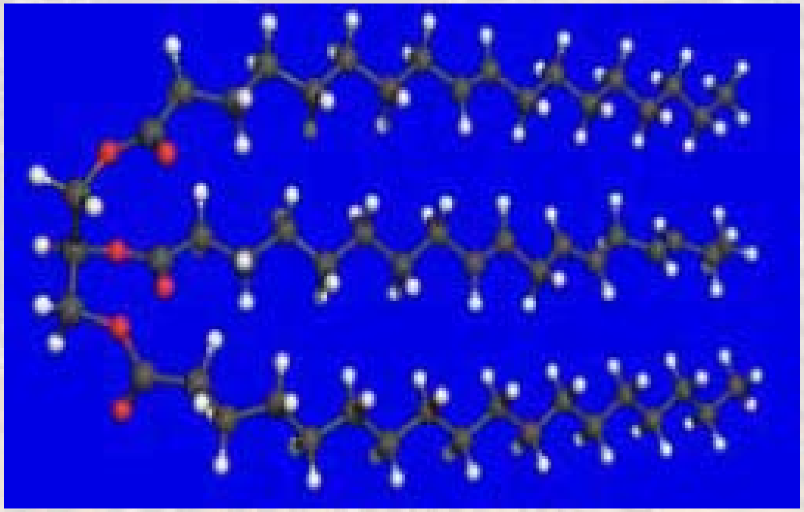




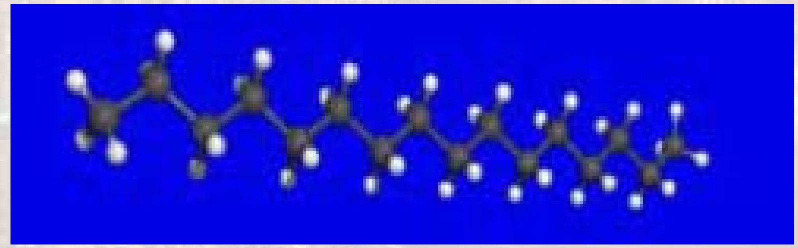
Vegetable Oil = Triglyceride



Renewable Resources-to-Energy
Fats, Oil, Grease 101 - What is Free Fatty Acid?



Fat Molecule (Triglyceride)



A free fatty acid chain that has broken off the "fat molecule"

Free Fatty Acid (FFA) break off through hydrolysis
=> Steam from cooking foods, salts, chemicals, heat, etc.

Renewable Resources-to-Energy
Fats, Oil, Grease 101 - Usage

Feedstock	Free Fatty Acid	Usage
Virgin Oils (Soy, Canola, Palm)	**Negligible**	**Food; Cosmetics; Soap; Biodiesel**
Yellow Grease	**< 15%**	**Cattle Feed; Soap; Biodiesel**
Brown Grease	**> 15 %**	**Cattle feed; Co-Digestion; Biodiesel**

Renewable Resources-to-Energy
Fats, Oil and Grease (FOG) – Yellow and Brown Grease

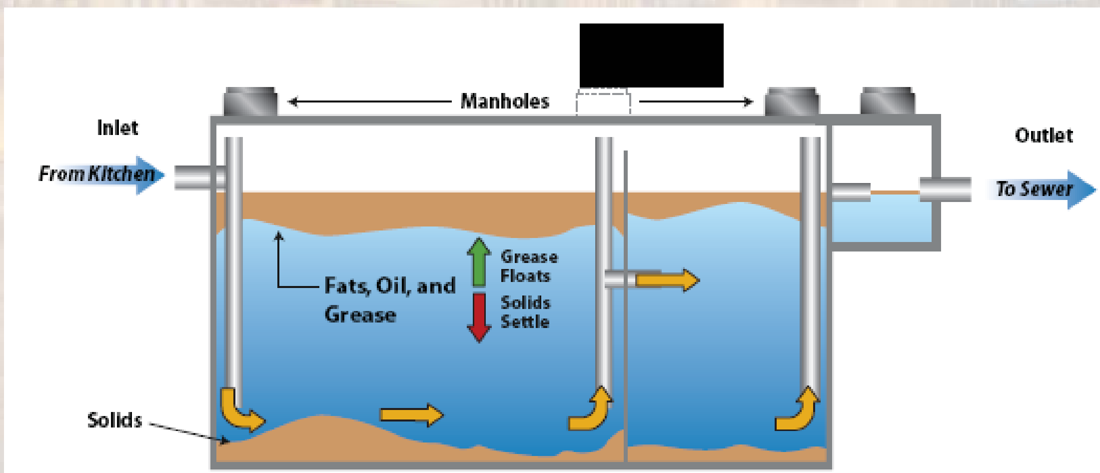
Objectives and Measures:

- **Reduce the amount of FOG released to the sewer system to extend its useful life**
- **recover the energy value of FOG to reduce the City's dependence on fossil fuel sources**
- **Develop & enhance the City's FOG control ordinance including FOG Discharge Limits and Enforcement**
- **Educate all licensed food establishments of the importance of installing and maintaining grease traps**

Renewable Resources-to-Energy
FOG Collection

Grease Interceptor (Outdoor, In-ground)

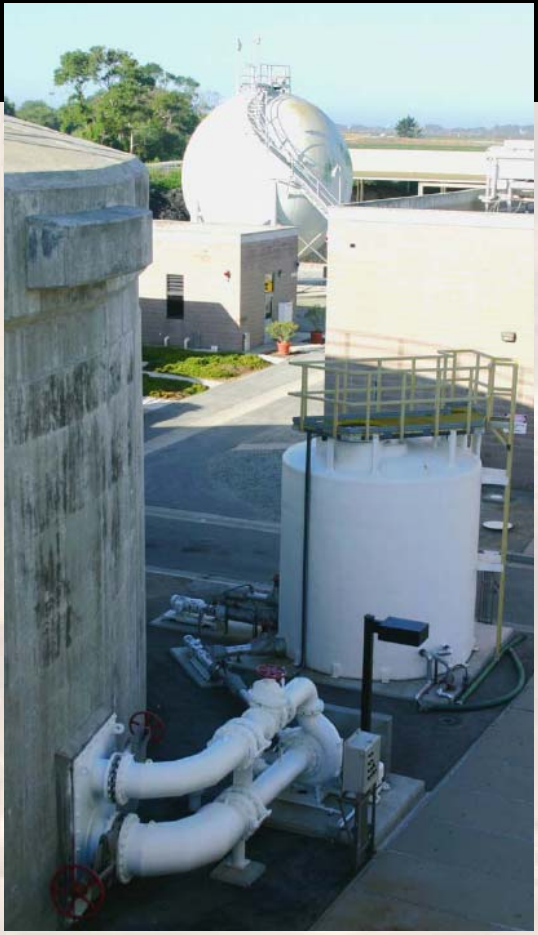
Restaurant Sink



Collection

Renewable Resources-to-Energy
FOG Co-Digestion

- **East Bay Municipal Utility District (EBMUD), CA**
- **Watsonville WWTP, CA**
- **Oxnard WWTP, CA**
- **Millbrae WPCP, CA**
- **South Bay System Authority, Redwood City, CA**
- **Riverside WWTP, CA**
- **Duisburg-Kasslerfeld WWTP, Germany**



Source: HDR

Watsonville WWTP, FOG Storage & Digester Mixing

Renewable Resources-to-Energy
FOG Co-Digestion - Example

Renewable Resources-to-Energy
FOG Co-Digestion - Example

DU-Kasslerfeld WWTP,
FOG Receiving
& Storage

Renewable Resources-to-Energy
FOG Co-Digestion - Example

Oxnard WWTP,
FOG Collection &
Direct Injection

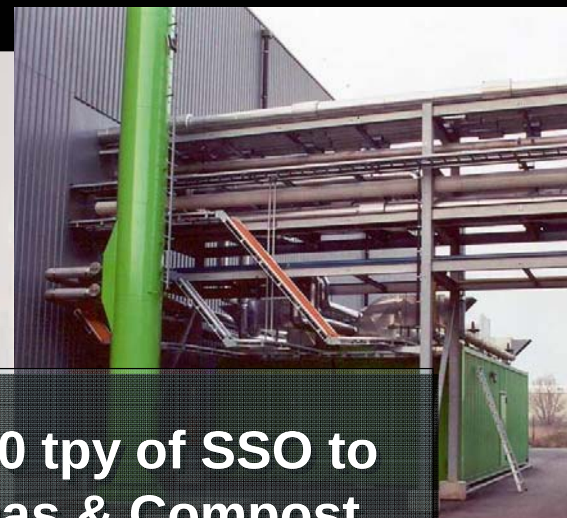
Renewable Resources-to-Energy
Organic Feedstock Recovery

Commercial Organics & Source Separated Organics

<u>Objectives & Measures:</u>

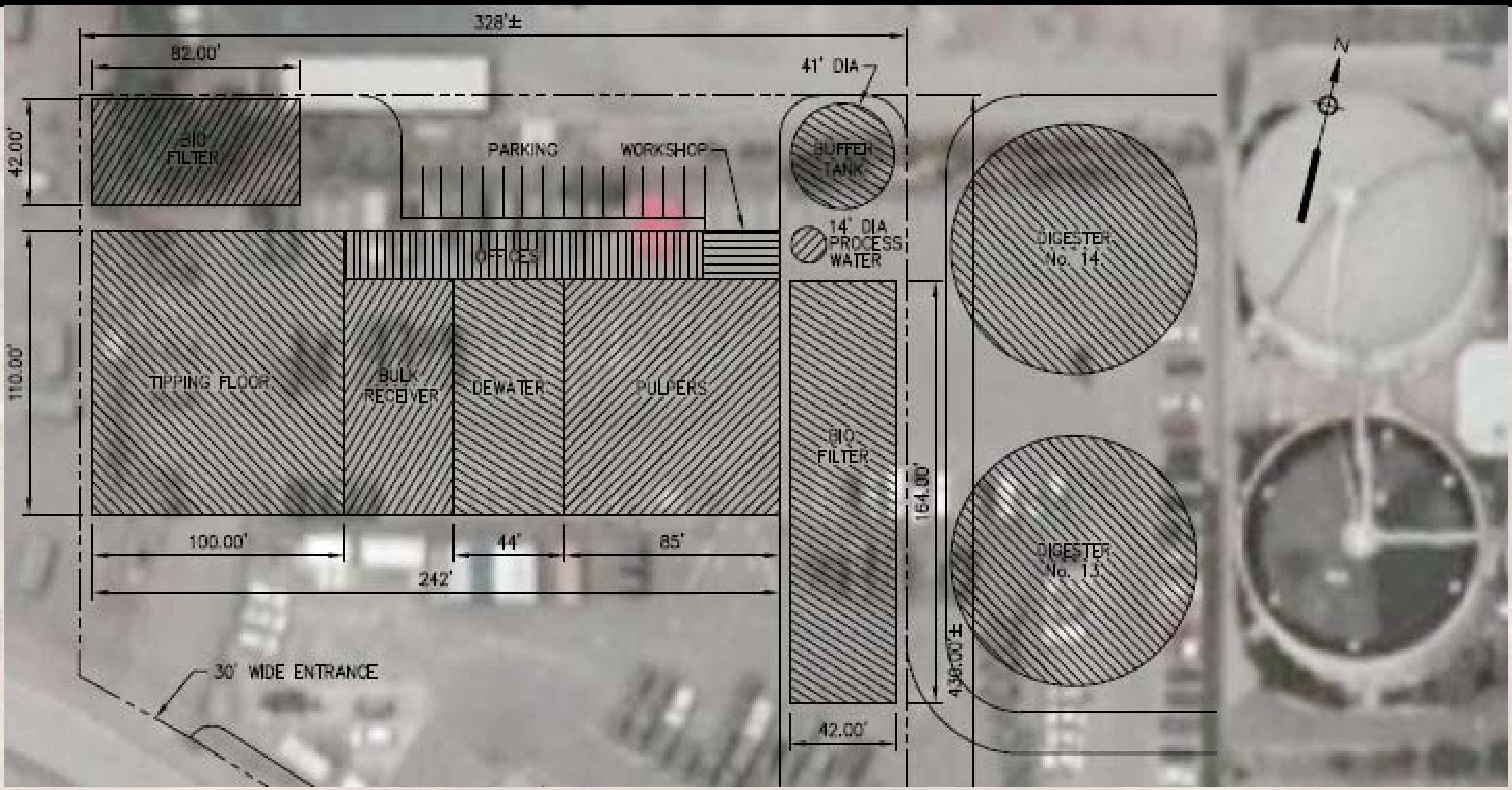
- **Increase of Waste Diversion towards Zero Waste Goal**
- **Closing Carbon and Nutrient Loop**
- **Cheap feedstock for energy production**
- **Develop and implement ordinance & organics collection program**
- **Educate food establishments, food processors, retailers, and residents of organics collection**

Renewable Resources-to-Energy
AD of Source Separated Organics (SSO) - Example



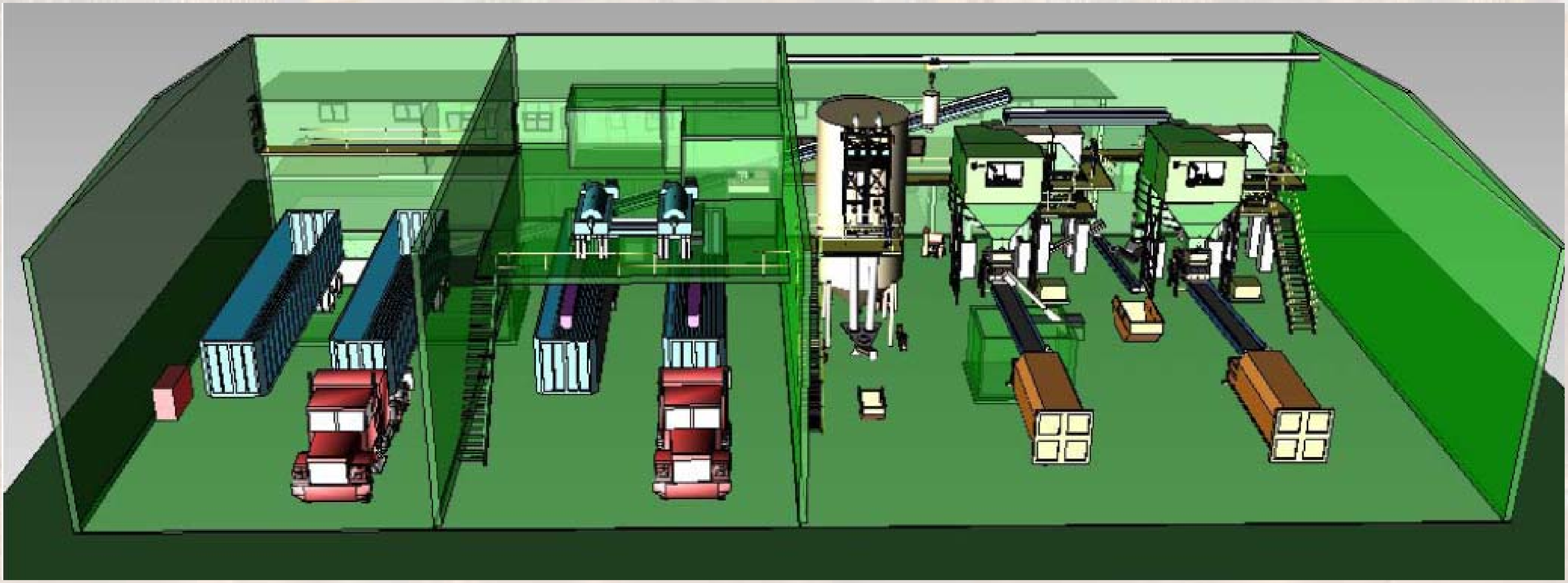
55,000 tpy of SSO to Biogas & Compost Ypres, Belgium

Renewable Resources-to-Energy
AD of Source Separated Organics - Example



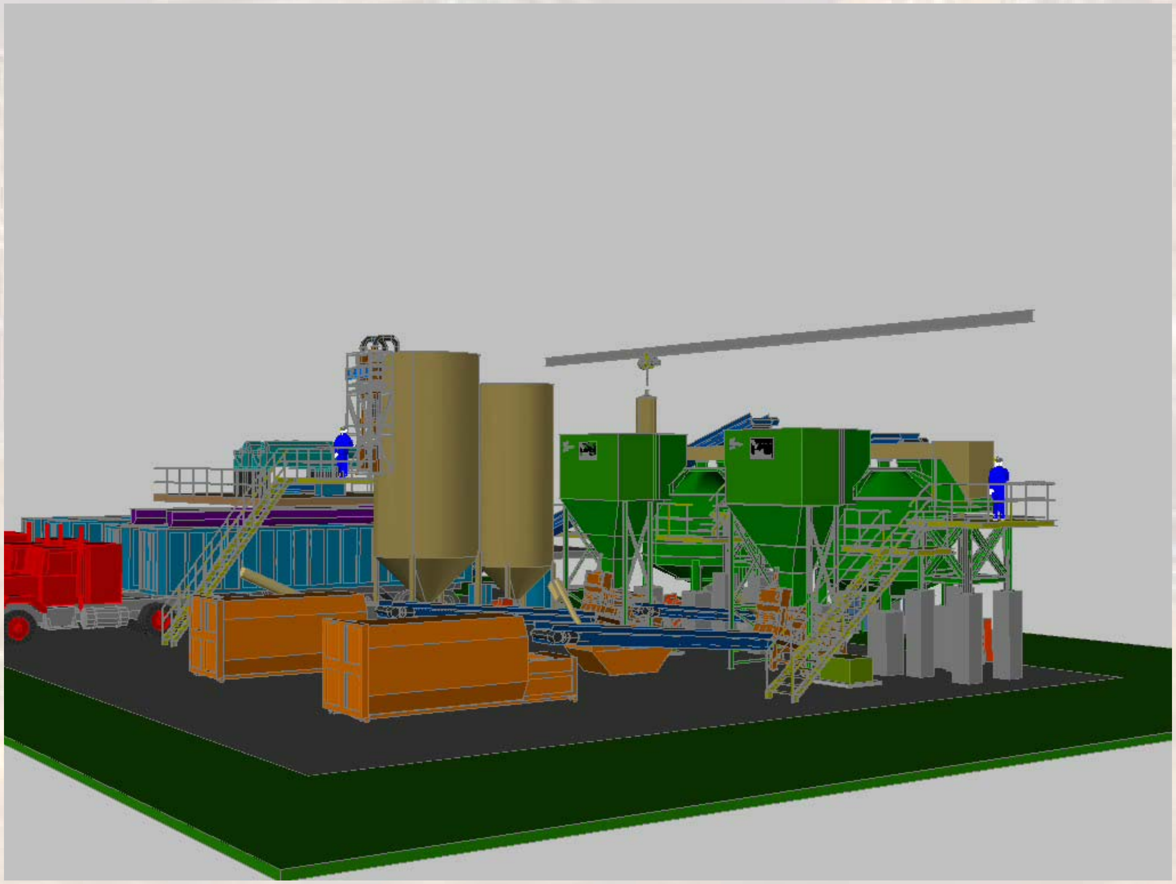
SSO Receiving and Pre-Treatment Facility at a WWTP in California, Conceptual Design

Renewable Resources-to-Energy
AD of Source Separated Organics - Example



SSO Receiving and Pre-Treatment Facility at a WWTP in California, Conceptual 3D Model

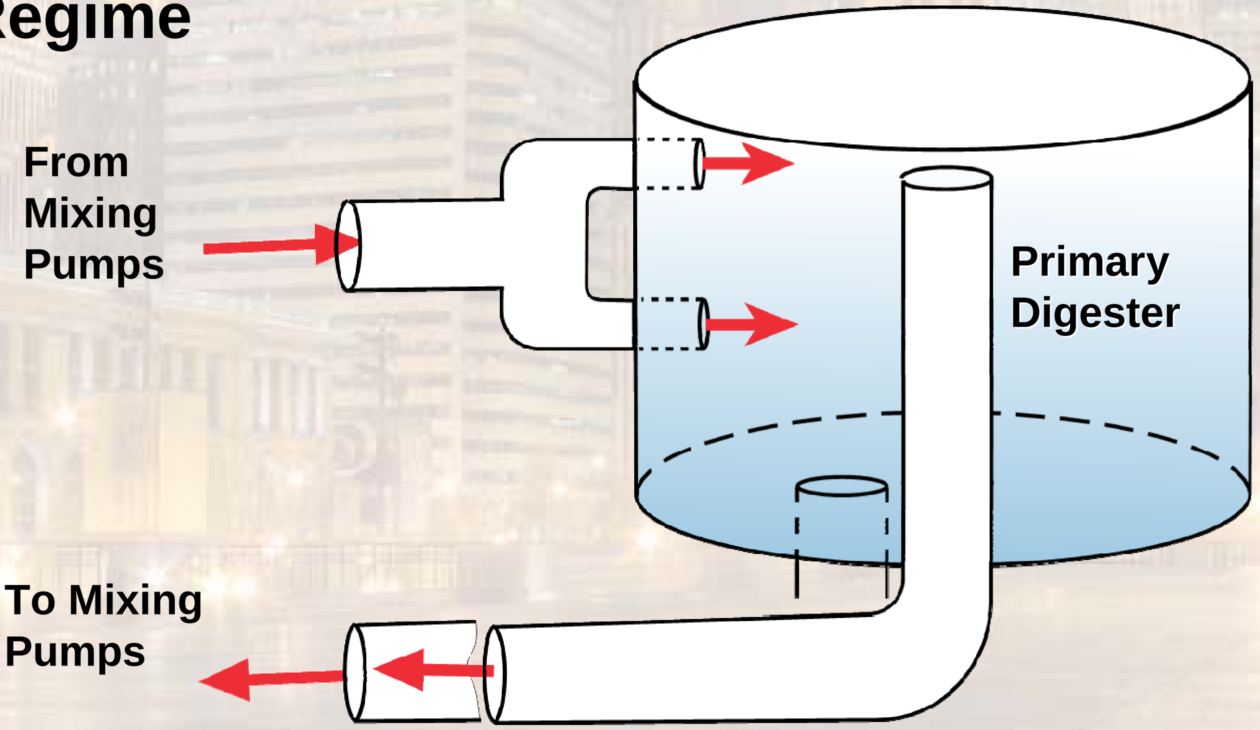
Renewable Resources-to-Energy
AD of Source Separated Organics - Example



SSO Receiving and Pre-Treatment Facility at a WWTP in California, Conceptual 3D Animation

Renewable Resources-to-Energy
Optimizations of AD Performance – Digester Upgrades

Enhancement of Digester Mixing Regime



South Bay System Authority WWTP

Source: SBSA

Renewable Resources-to-Energy
Combined Heat and Power Generation

Source: Stirling Biopower (former STM Power)

Cogeneration with Digester Gas

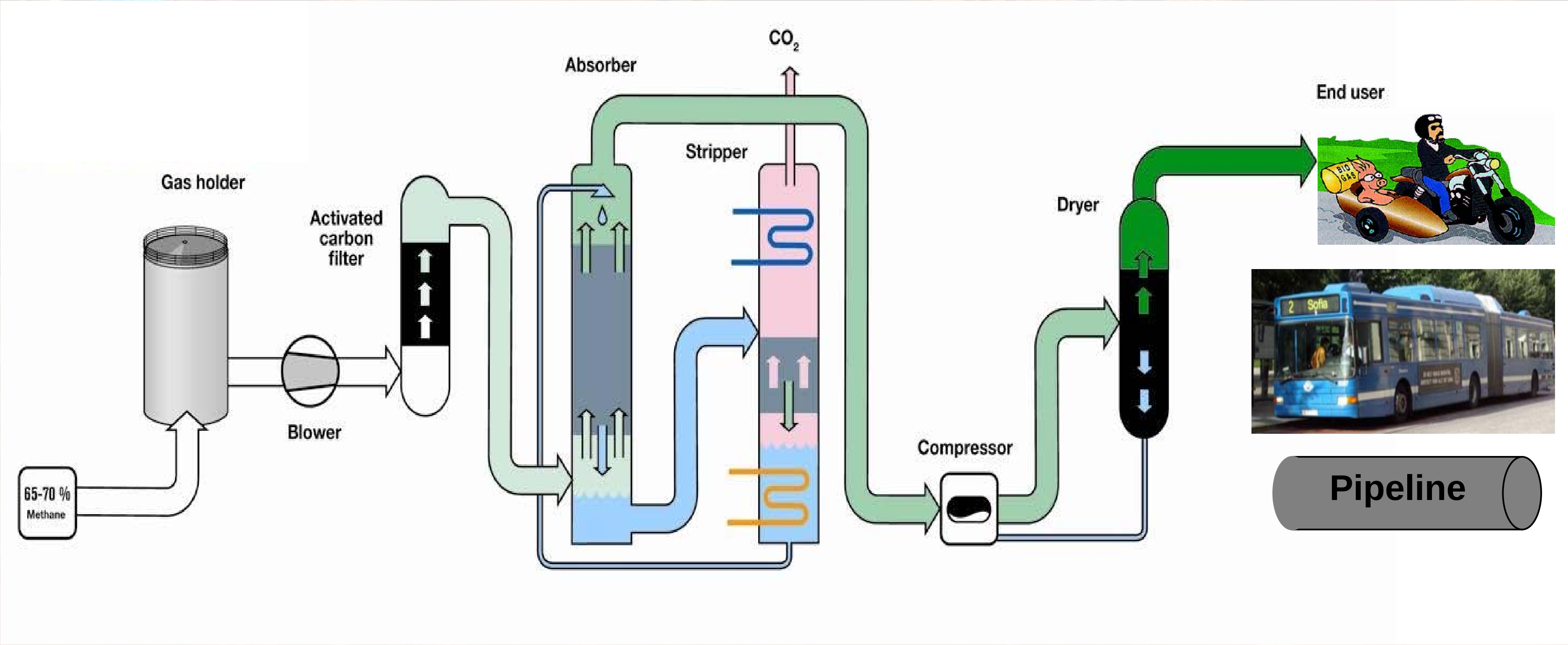
- Reciprocating ICEs
- Dual-Fueled (Gas with Diesel Pilot) ICEs
- Micro Turbines (30-250kW)
- Gas Turbines >1,000kW)
- Fuel Cells (200 – 1,000 kW)
- Stirling Engines (25kW+)

Source: Capstone

Source: CTE/AECOM

Source: King County WWTP, WA

Renewable Resources-to-Energy
Digester Gas Upgrade to Biomethane (Biomethanation) - Example



Amine Carbon Dioxide Absorption Process (LP Cooab™); Courtesy PURAC, adapted

Renewable Resources-to-Energy
Digester Gas Upgrade to Biomethane - Example

Gothenburg (Sweden), LP- Cooab™ biogas upgrading plant; Coutesy Purac

Renewable Resources-to-Energy
Digester Gas Upgrade to Biomethane - Example

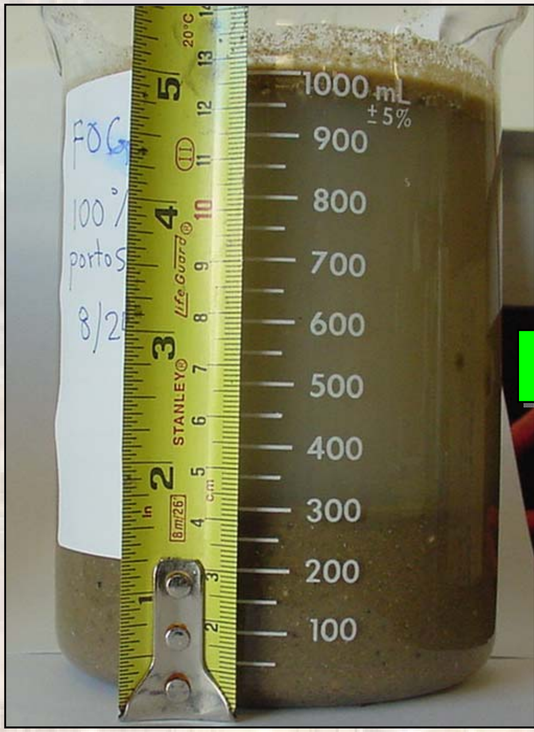
Trollhättan (Sweden), 50,000 inhabitants, north of Gothenburg,
12 buses and personal vehicles run on a biomethane;
AD Feedstock: Biosolids and organic commercial waste from a fish processing factory.

Renewable Resources-to-Energy
Biodiesel - Feedstock & Production

Feedstock	Free Fatty Acid	Production Complexity	Cost of Feedstock	Cost for Production
Virgin Oils (Soy, Canola, Palm)	**Negligible**	**Low**	**$$$**	**$**
Yellow Grease	**< 15%**	**Medium**	**$$**	**$$**
Brown Grease	**50-100%**	**High**	**$**	**$$$**

Source: EBMUD

Renewable Resources-to-Energy
Biodiesel from FOG



<u>Raw FOG</u>

from restaurant interceptor pump-outs

<u>Brown Grease</u>

2-5% of delivered FOG

<u>Biodiesel</u>

25-60% conversion yield

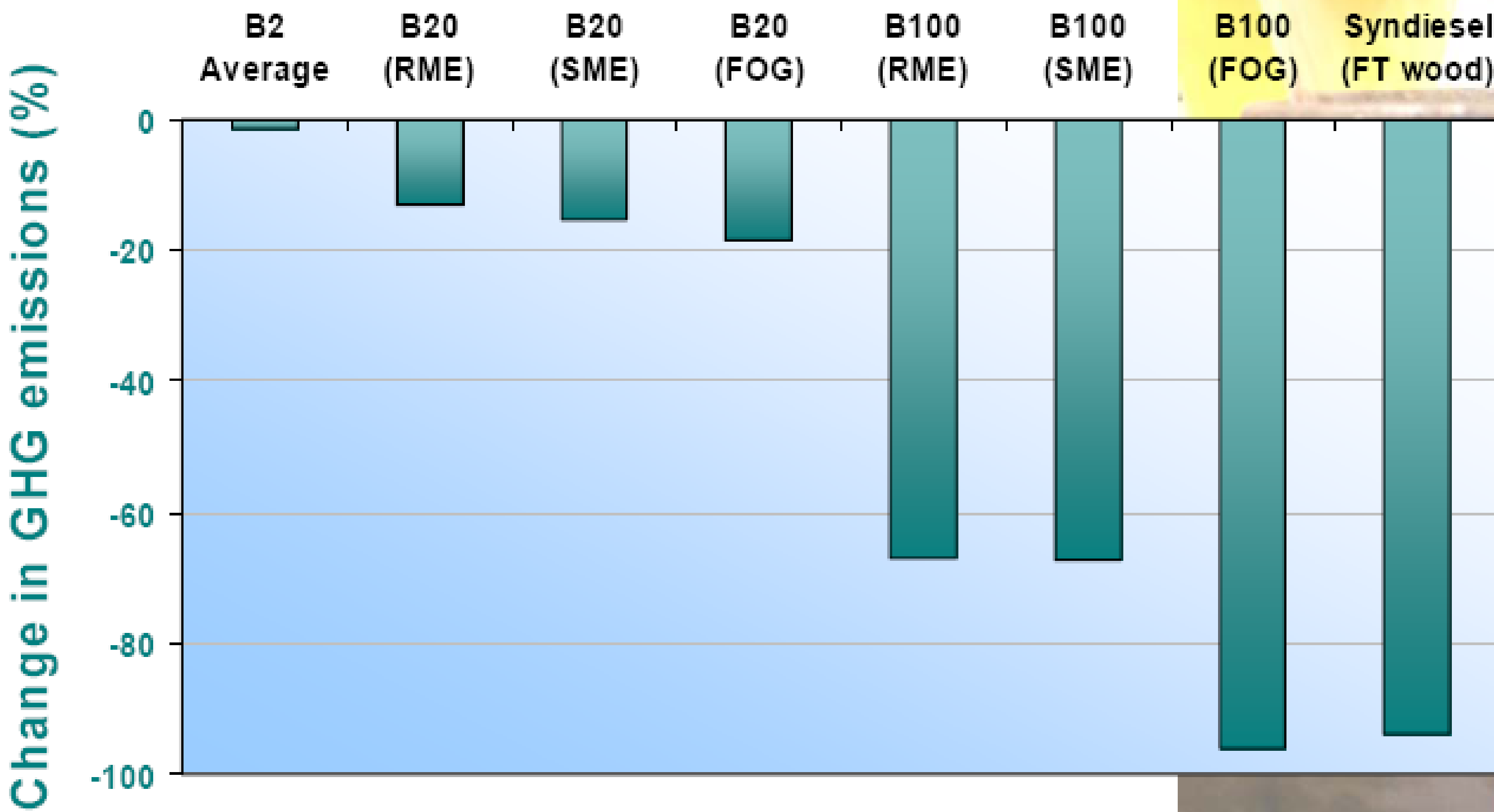
Renewable Resources-to-Energy
Biodiesel from FOG - Example

- **Brown grease to biodiesel: Acid pre-esterification & base transesterification with methanol + wash**
- **Glycerin, water, and waste methanol are byproducts**
- **Production challenges include:**
  - ❖ Variable quality feedstock
  - ❖ Contaminant level (water and solids)
  - ❖ High free fatty acid content
  - ❖ High sulfur content of feedstock
  - ❖ Cloud point
  - ❖ ASTM Standards

Source: EBMUD

Biodiesel Pilot Facility; EBMUD

Lifecycle renewable-diesel GHG emissions relative to diesel

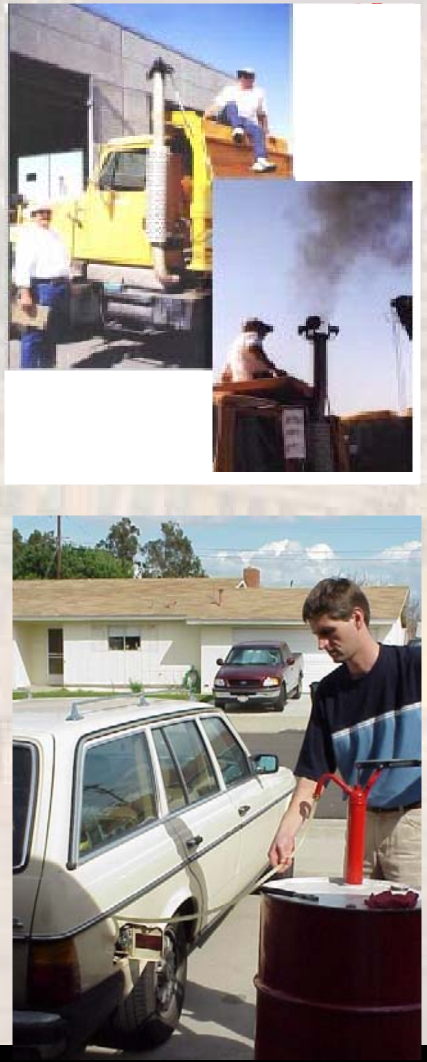


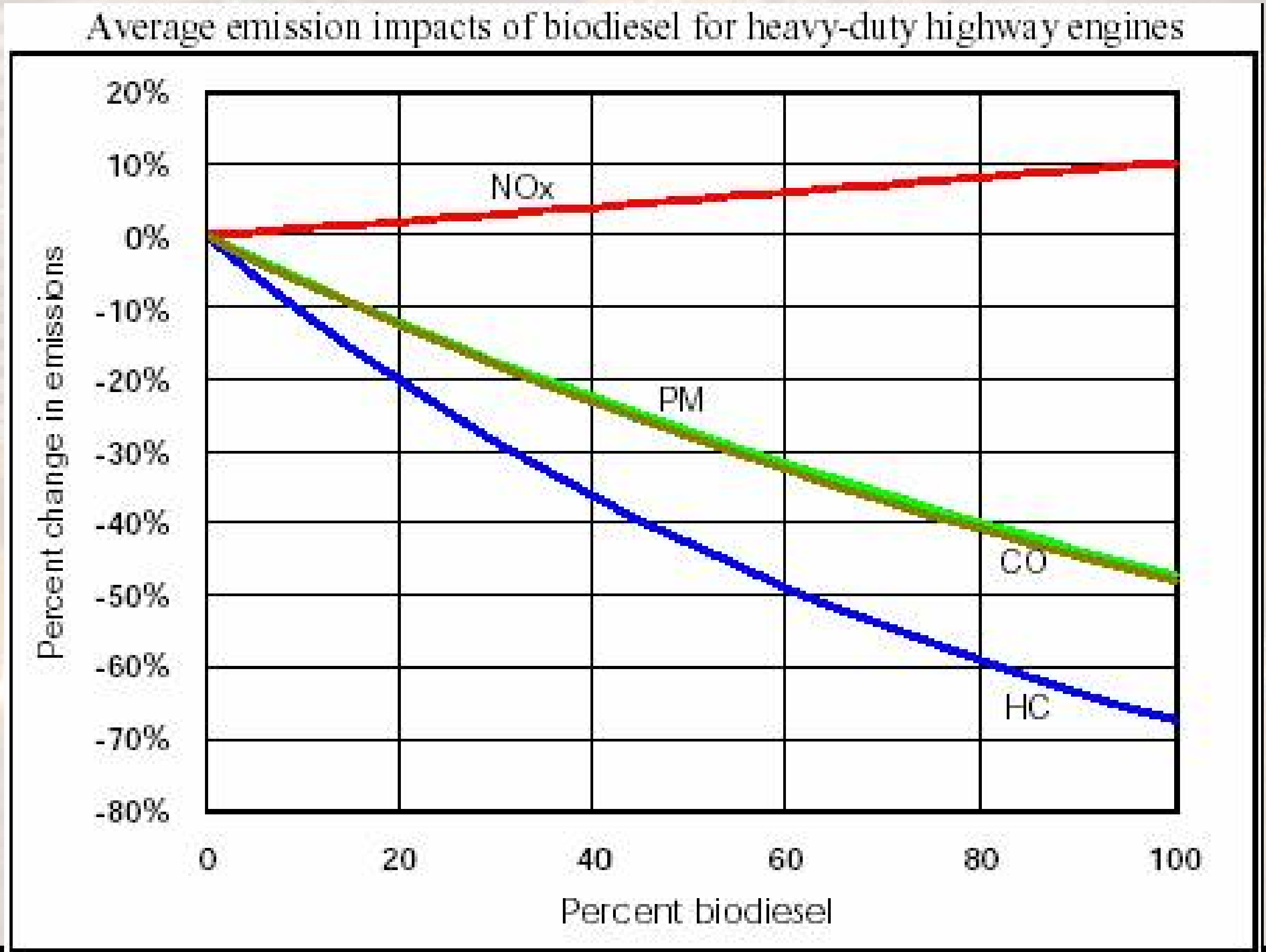
Natural Resources Canada, 2005; Williams, 2006

UCDAVIS

CALIFORNIA biomass

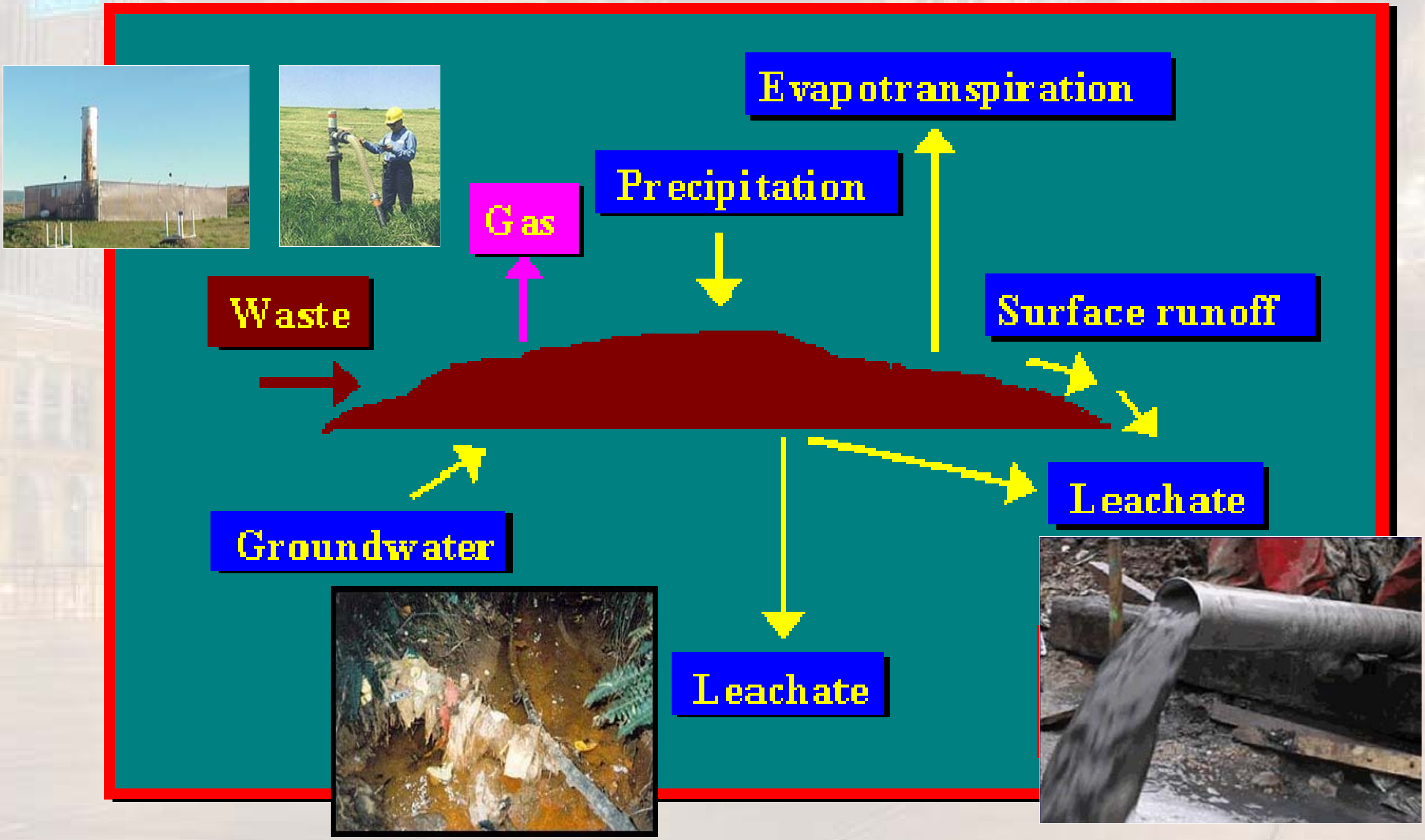
Renewable Resources-to-Energy
Biodiesel – Emission Profile





Source: EPA

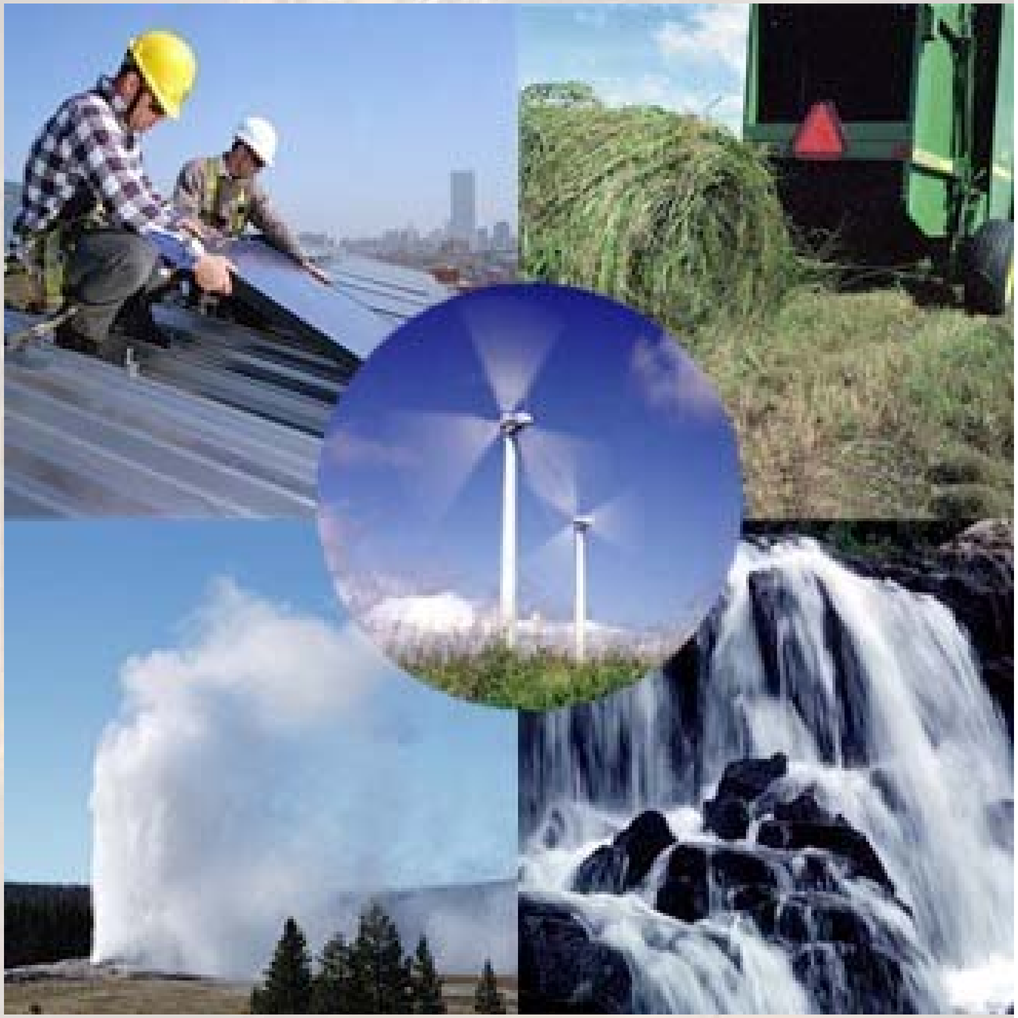
Renewable Resources-to-Energy
LFG and Leachate Mitigation Through Organics Diversion –> WIN – WIN – WIN



Renewable Energy

Definition of Renewable Energy

Renewable Energy is energy produced from the utilization of <u>natural resources</u> such as sunlight, wind, rain, tides, and geothermal heat which are naturally replenished.



Laws and Regulations

- **Federal Energy Policy Act of 2005 & Executive Order 13423**
  - 3% of total electricity used at federal facilities must be from a renewable energy source in fiscal years 2007 to 2009
  - Increases gradually to 7.5% by fiscal year 2013
  - 50% of total renewable energy must be from new sources (post 1999)
- **Renewable Energy Portfolio Standards**
  - Two types - Mandatory and Voluntary
  - Sets % of electric generation which must be from renewable sources
  - Currently 29 states with RPS
    - ***25 Mandatory and 4 voluntary***
  - State of Illinois
    - ***Mandatory as of 2008***
    - ***2% by 2008 with incremental increases to 25% by 2025***
    - ***75% of renewable energy must come from wind power***

Why Should You Go GREEN?

- **WWTP's are perfect candidates for renewable energy projects**
  - Large energy users
    - ***Water treatment and pumping account for approximately 3-5% of total US electricity use***
    - ***Energy costs account for 30-50% of plant operating budgets***
  - Favorable site conditions
    - ***Large amounts of land***
    - ***Ample rooftops for mounting of solar panels***
- **The Three Benefits of Going *GREEN***
  - Reduction in Plant Operating Costs
  - Improved Public Relations
  - Preparedness For The Future

Financial Incentives

- **Open Market**
  - **1. Selling of Renewable Energy Credits**
    - ***We Energies Utility Company***
      - **Purchases electricity generated by the customer from on-site solar panels at $0.225 per kW-h**
    - ***Illinois utilities do not currently offer these programs***
- **Private**
  - **2. Equipment installed and owned by third party**
    - ***Third party can utilize 30% Federal Income Tax Credit to offset project costs***
    - ***No initial capital expenditures, and no price volatility on purchased power***
    - ***Project paid for by municipality buying electricity from the installer***
    - ***Equipment turned over to municipality after set period***

Financial Incentives

3. State

- ***Illinois Department of Commerce and Economic Opportunity***
  - **Solar Energy Rebate Program**
  - **Rebate of 30% of project costs, up to a maximum of $10,000**
  - **Total project cost must be <$50,000**
  - **Capacity of system must be > 800 watts**
- ***IDCEO***
  - **Wind Energy Production Development Program**
  - **Grant of $25,000 to offset project costs**
  - **Maximum project capacity of 500 kW**
- ***www.dsireusa.org***

Renewable Energy Audits

- **Uses existing software package to provide low cost pre-feasibility analysis**
- **Allows 'apples-to-apples' comparison of different renewable energy technologies**
- **Resources can be focused on the most promising solutions**
- **Easily updated if major inputs change (utility prices, consumption, equipment costs, etc.)**

Types of Renewable Energy Evaluated

- Photovoltaic
- Wind
- Ground Source Heat Pump
- Solar Water Heating
- Cogeneration
- Solar Air Heating
- Passive Solar Heating
- Biomass Heating

Wind

- Illinois is ranked 8th for existing capacity, at almost 700MW, and 16th for wind potential
- Over 9,000MW of capacity can be installed in prime areas, just 1.2% of the state's land
- Small capacity turbines are becoming more cost-effective

Wind Case Study Example

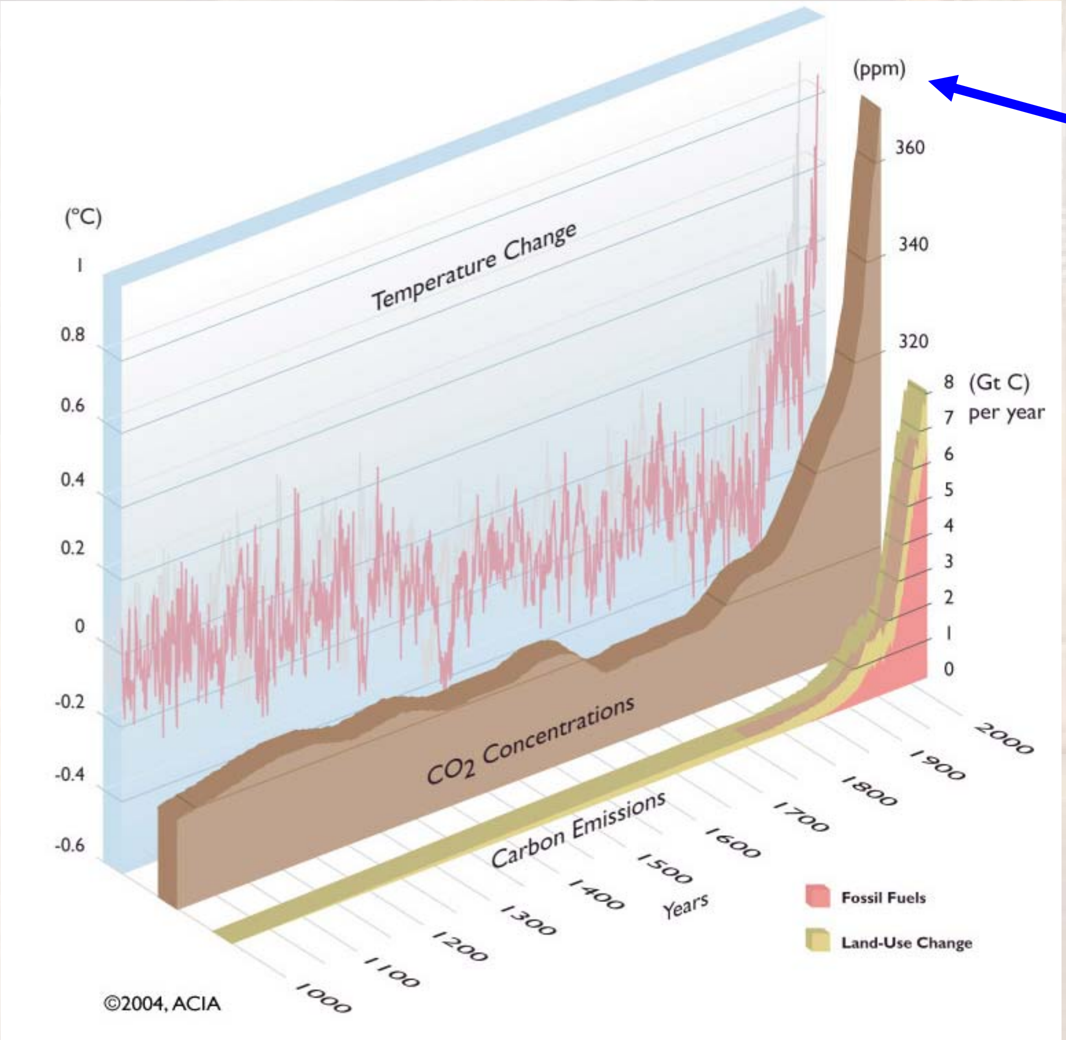
- **Wastewater treatment plant in Ohio**
- **50kW turbine**
- **$145,000 installed cost**
- **Simple Payback under 10 years without incentives**
- **Over 140MWh expected annual output**

Backup

GHGs - The Realities of Our Problem

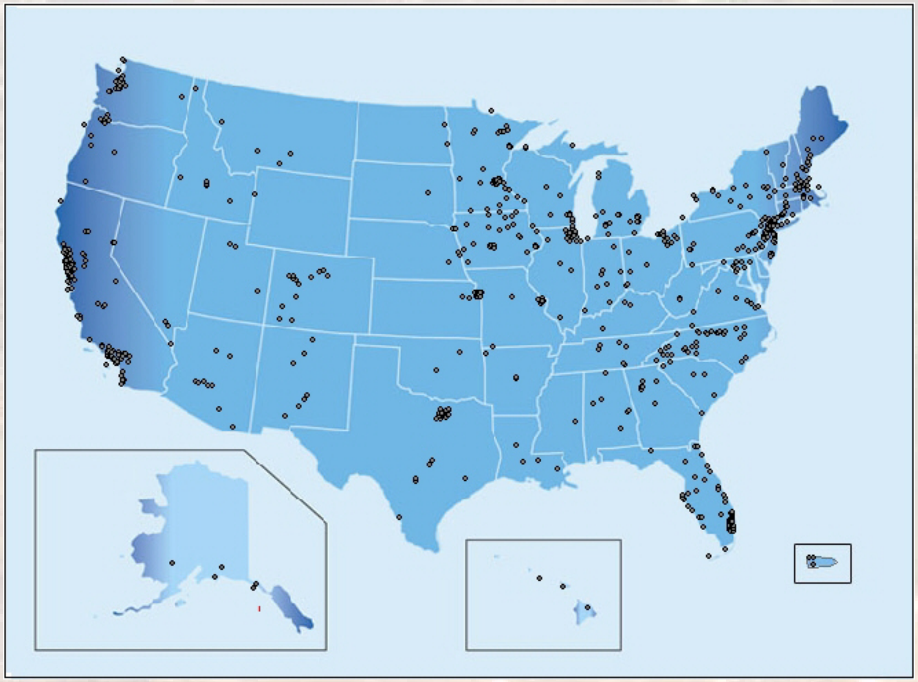
- **Now seeing effects of GHG levels from 30 yrs ago**
  - There is a 30 yr lag between GHG levels and their climate impacts.
- **Our children will be the 1st generation of humans to see the North Pole free of ice in the summer**
  - And our grandchildren will likely see a different geographic outline of the world
- **Current industrial systems are the source of the problem – we are not a sustainable economy**
  - Ex: over-dependence on fossil-based energy
- **Water certainty will be the greatest casualty of climate change**
  - More extremes of both draught and flood
- **State-level Greenhouse Gas Emission Factors for Electricity Generation (Source: www.eia.doe.gov)**
  - East-North Central States (ave.) 0.740 metric tons CO_2/MWh
  - Illinois 0.528
  - California 0.275

1000 Years –
Carbon Emissions, CO_2 & Temperature



One ppm is the same as 1 minute in 2 years or 1 cent in $10,000.

U.S. Mayors Climate Protection Agreement



Source: www.usmayors.org

- **2005 - U.S. Conference of Mayors Climate Protection Agreement, in which mayors commit to reduce emissions in their cities to 7% below 1990 levels by 2012**
- **852 Cities have signed on as of 5/6/2008 representing a total population of over 80 million citizens**

Renewable Resources-to-Energy
SUMMARY EXAMPLE PROJECTS

Renewable Resources	Application / Utilization	Expertise / Experience - Projects
Biomass – Source Separated Organics to Biogas	Heat / Power (ICE CHP)	- Cogeneration 4 x 300kW ; Ieper, Belgium Design/Build; Status: Completed 2003 - Receiving & Pre-Treatment Facility at WWTP in CA; Engineering Services; Status: Ongoing
Biomass – Biosoilds to Digester Gas	Heat / Power (ICE CHP)	- Cogeneration 3 x 250kW; Northeast Treatment Plant, Urbana/Champaign, IL - IEUA Regional Plant-1,, 8x30kW Microturbines; Chino, CA; Engineering Design Services; Status: Completed 2002
Biomass - FOG to Digester Gas and Biodiesel	Heat / Power / Fuel (ICE; Fuel)	SFPUC: - FOG Program - CEC PIER Grant Fog-to-Biofuels Engineering Services; Status: Ongoing
Biomass – Biosoilds to Digester Gas	Heat / Power / Fuel (CNG)	Digester Gas-to-Pipeline Quality; Philadelphia, PA Engineering Services; Status: Ongoing
Wind	Wind Power Turbines	Several 100MW each Nobel Wind Parks, NY; Engineering Design, Status: Complete in 2009
Sun	Solar Power (PV)	350kW of solar PV energy, Rooftop mounted system & parking lot canopy structure CSU, San Bernardino, CA Engineering Services; Status: Ongoing

Title

METCALF & EDDY | AECOM

Break


Positive proof of global warming.
18th Century
1900
1950
1970
1980
1990
2006