UNC INSTITUTE FOR THE ENVIRONMENT

ENST 698—Environmental Capstone
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Energy Management Plan for OWASA

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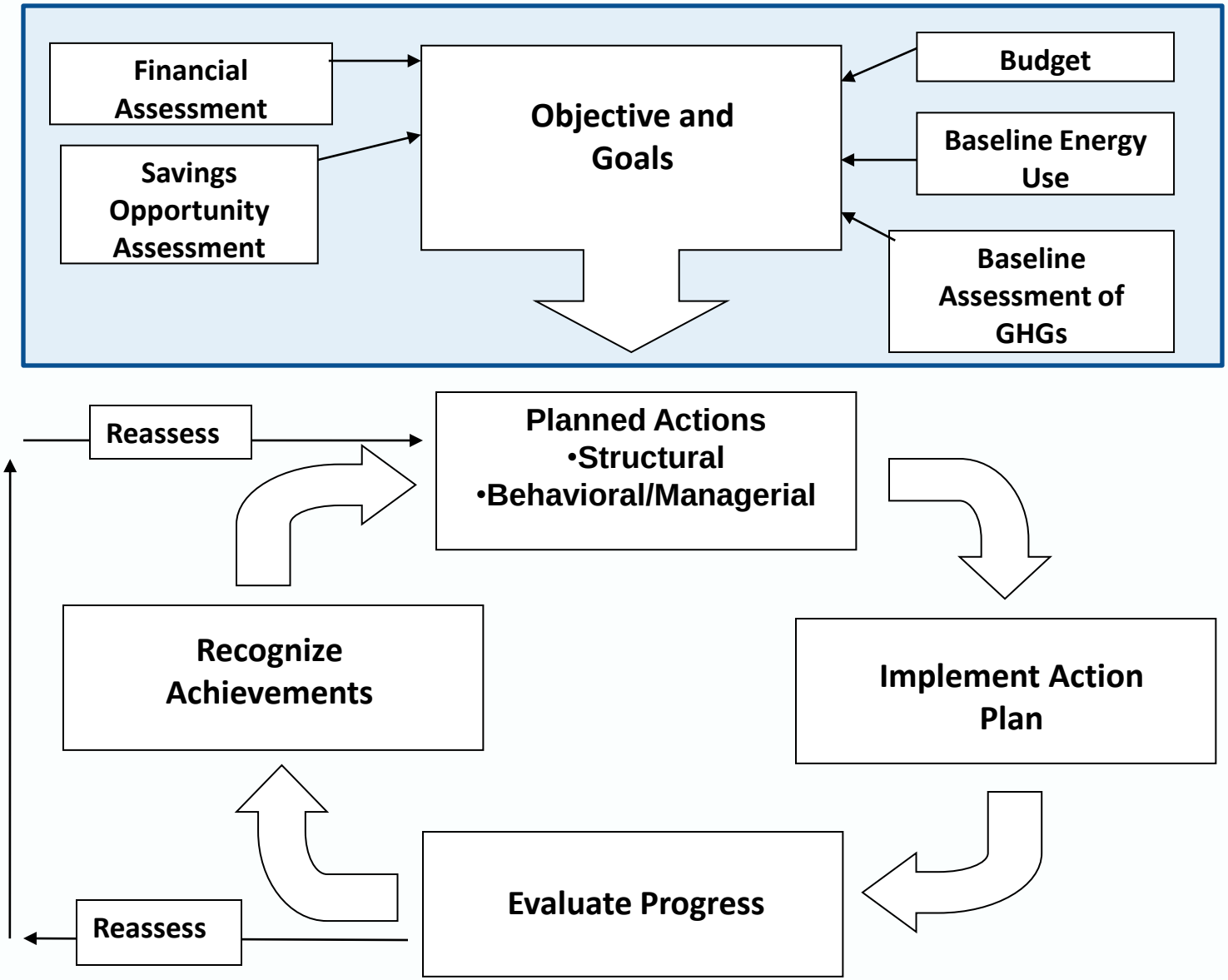
Framework for Development of OWASA Energy Management Plan

(based off the sample provided by Energy Star and Duke Study)



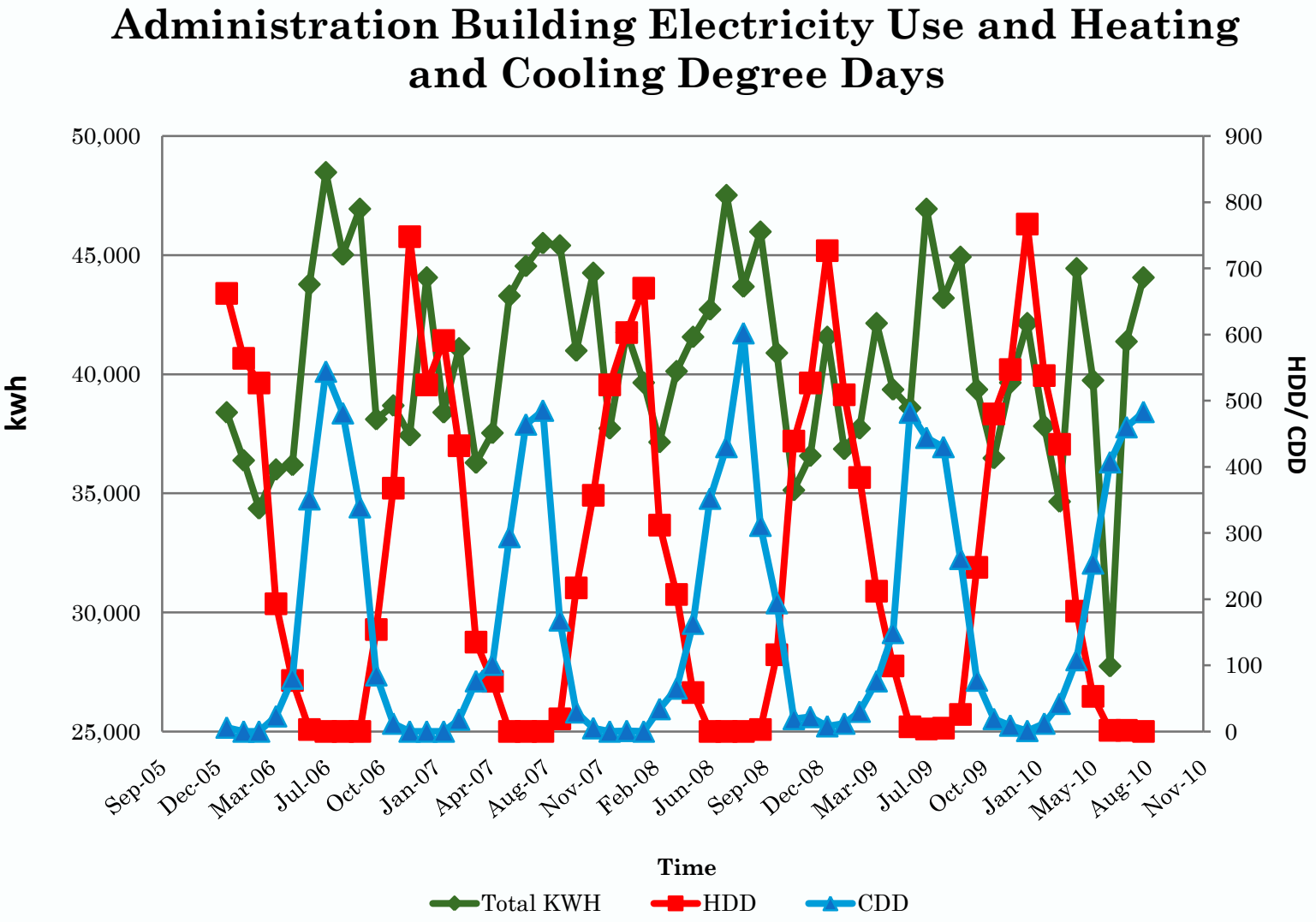
Team Methods

Methods

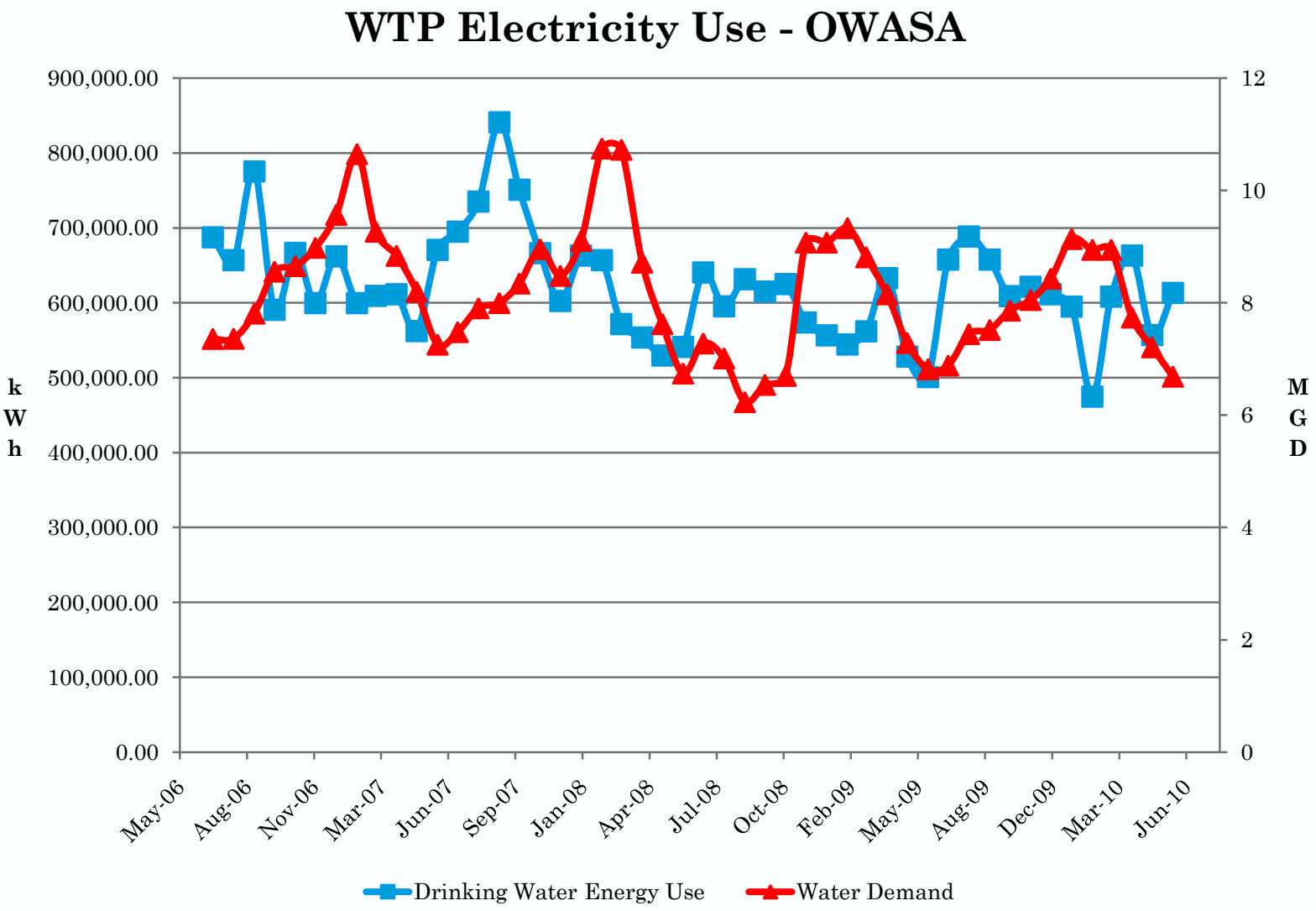
- Review energy use and GHG emissions data
- Identify opportunities to reduce use and impacts
- Establish a consumer outreach program
- Determine payback period

Data Analysis

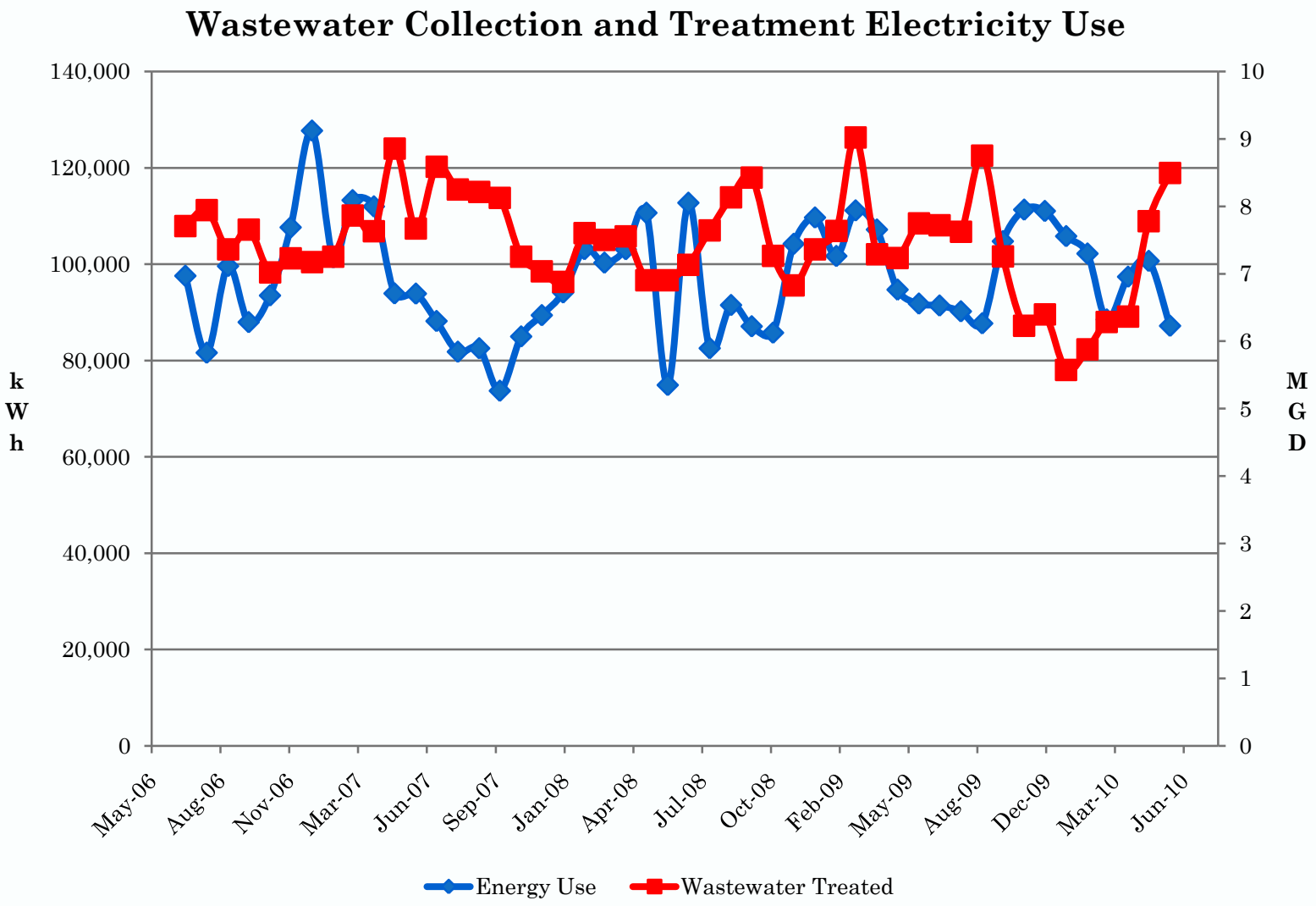
Support Facilities: Administration Building



Water Treatment Plants



Wastewater Treatment Plants



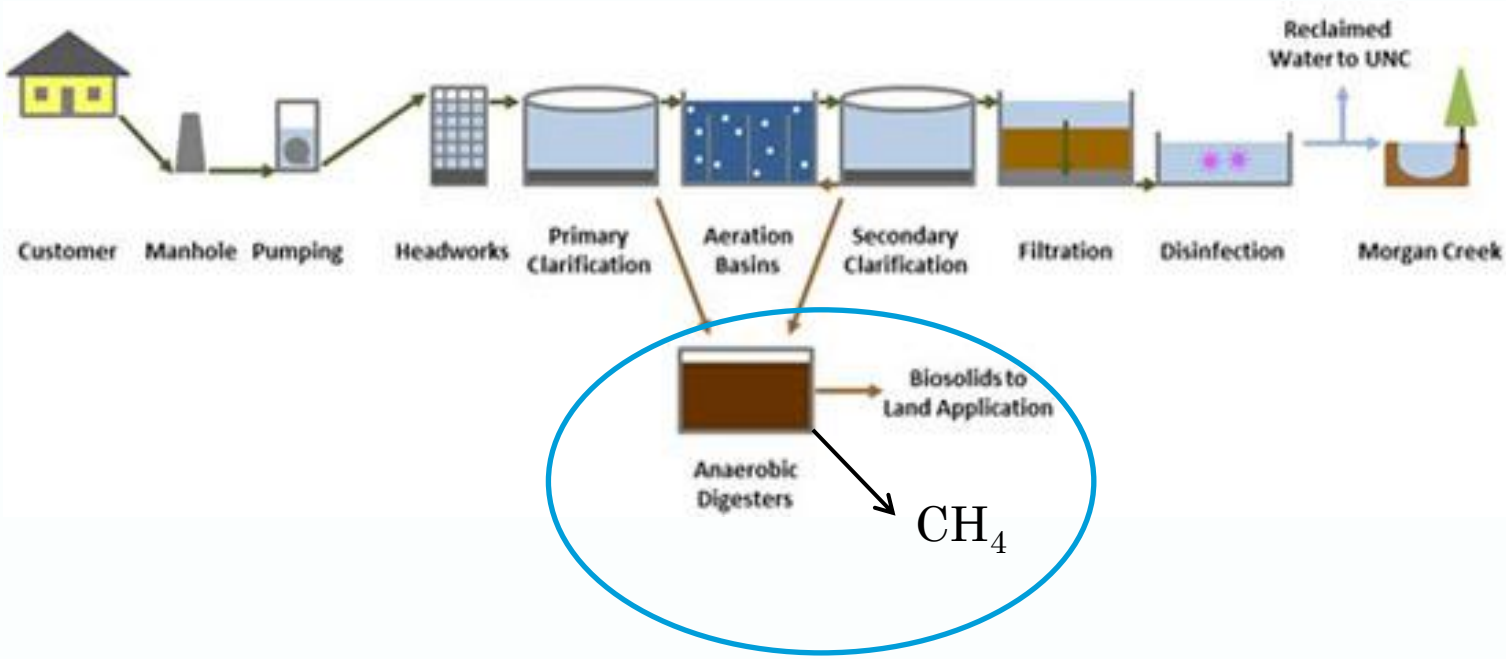
Energy Use Per 1000 Gallons Per Day

Electricity	kWh/1000 gallons/day
Raw Water	1.028032995
Finished Water	1.475140566
Wastewater	13.13444302

Areas of Analysis

- Anaerobic Digestion
- Vehicle Fleet
- Behavioral Analysis of OWASA Employees
- Customer Outreach

Anaerobic Digestion Process Energy



Overall Reaction:

$$C_6H_{12}O_6\,(\text{sludge}) \xrightarrow[\text{Anaerobic conditions}]{\text{heat}} CO_2 + CH_4$$

Image: OWASA

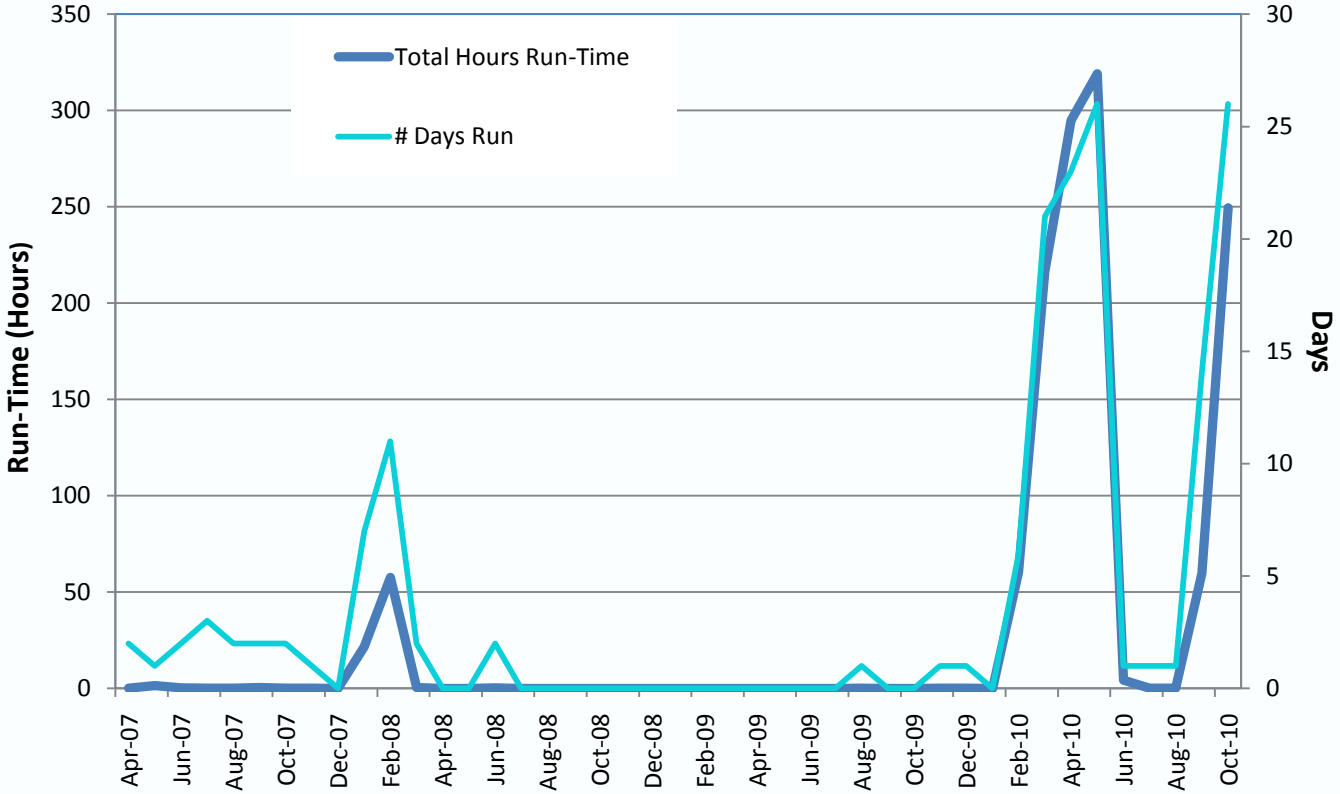
OWASA CH_4 UTILIZATION

- Digester gas captured
- Methane engine
- Boilers

Issues: Efficiency and reliability

Photos: OWASA

OWASA Methane Engine Run-Times, By Month



- Methane engine out of commission frequently
- Repair costs have been $80,000 or more since 2008
- Methane is flared off when the engine is down
- Efficiency is poor when the system does work

OWASA DIGESTER GAS UTILIZATION ALTERNATIVES

Molten carbonate fuel cell at King County South Treatment Plant, Seattle, WA. (Photo: King County)

- Methane engine replacement
- Cogeneration systems
- Fuel cells
- Co-digestion of food waste

Methods

- Investigated amount of food waste in Orange County
- Used EPA's Co-Digestion Economic Analysis Tool to assess initial economic feasibility
  - Simulated three different scenarios given rates of participation

Scenario Simulations

- Scenario One: Best Case — Trash pick-up from all 130,000 people plus 499 establishments
- Scenario Two: 499 establishments, without households
- Scenario Three: Most Likely — No households, no establishments, some (200) restaurants

Sources of Food Waste, Orange County, North Carolina

Site Type	Number of Sites
Manufacturers/Processors	6
Wholesalers/Distributors	0
Hospitals	3
Nursing Homes	3
Colleges and Universities	1
Schools (K-12)	18
Correctional Institutions	1
Resorts/Conference Facilities	2
Supermarkets	15
Restaurants	450
Total	**499**

Source: Orange County Solid Waste Management

Co-digestion Food Waste Conclusions

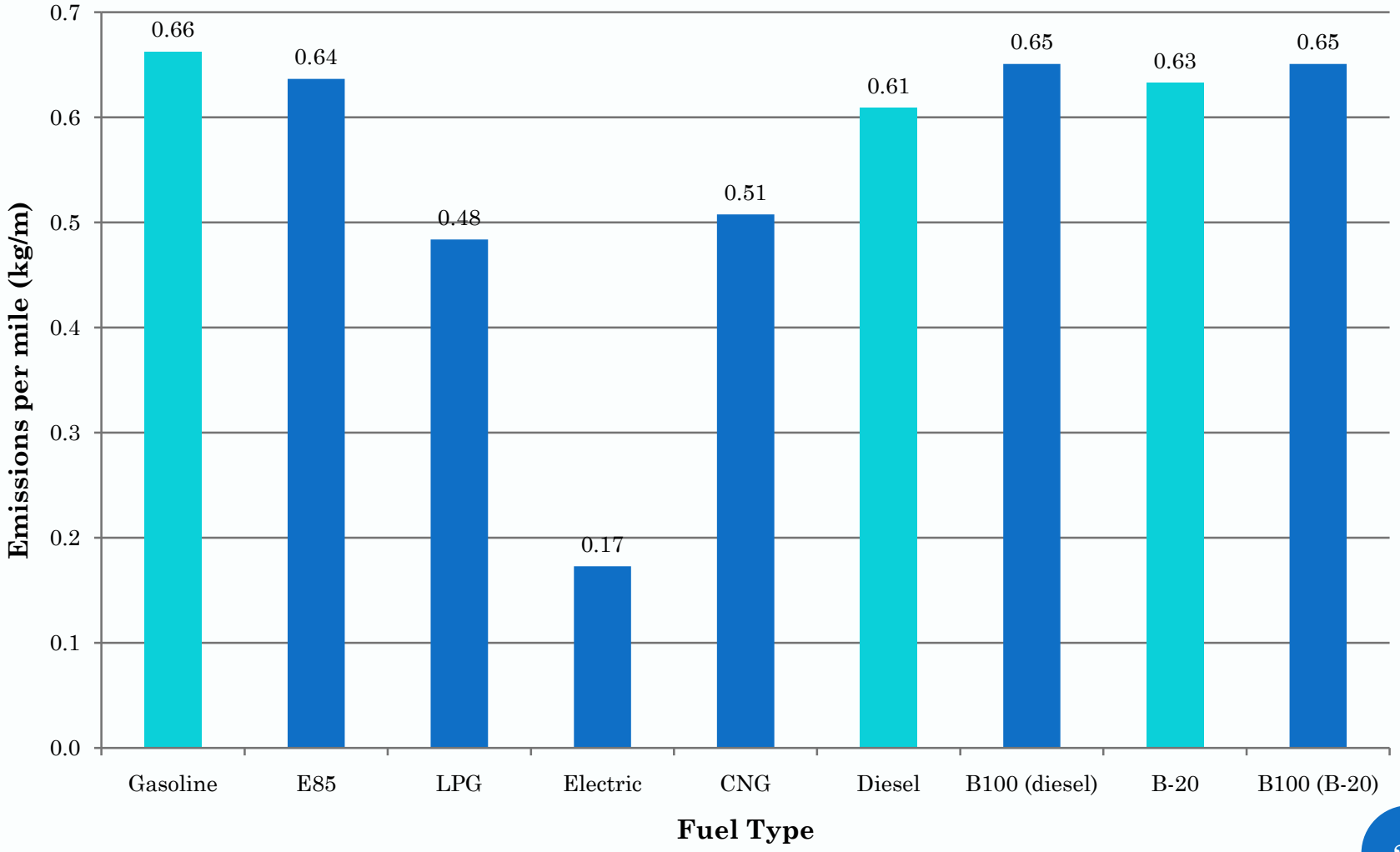
	Tons/day	Cubic feet of biogas/day	MMBtu/yr	Cost (millions)
Scenario One	146.30	944,161.95	209,045.95	$1.402
Scenario Two	78.65	506,831.12	112,216.97	$1.309
Scenario Three	27.76	178,878.17	39,605.24	$1.178

Fleet Analysis and GHG Methods

- Fleet breakdown, vehicle fuel type
- Fuel emissions calculation
- Case study suggestions
- Data analysis and application
- Recommendations

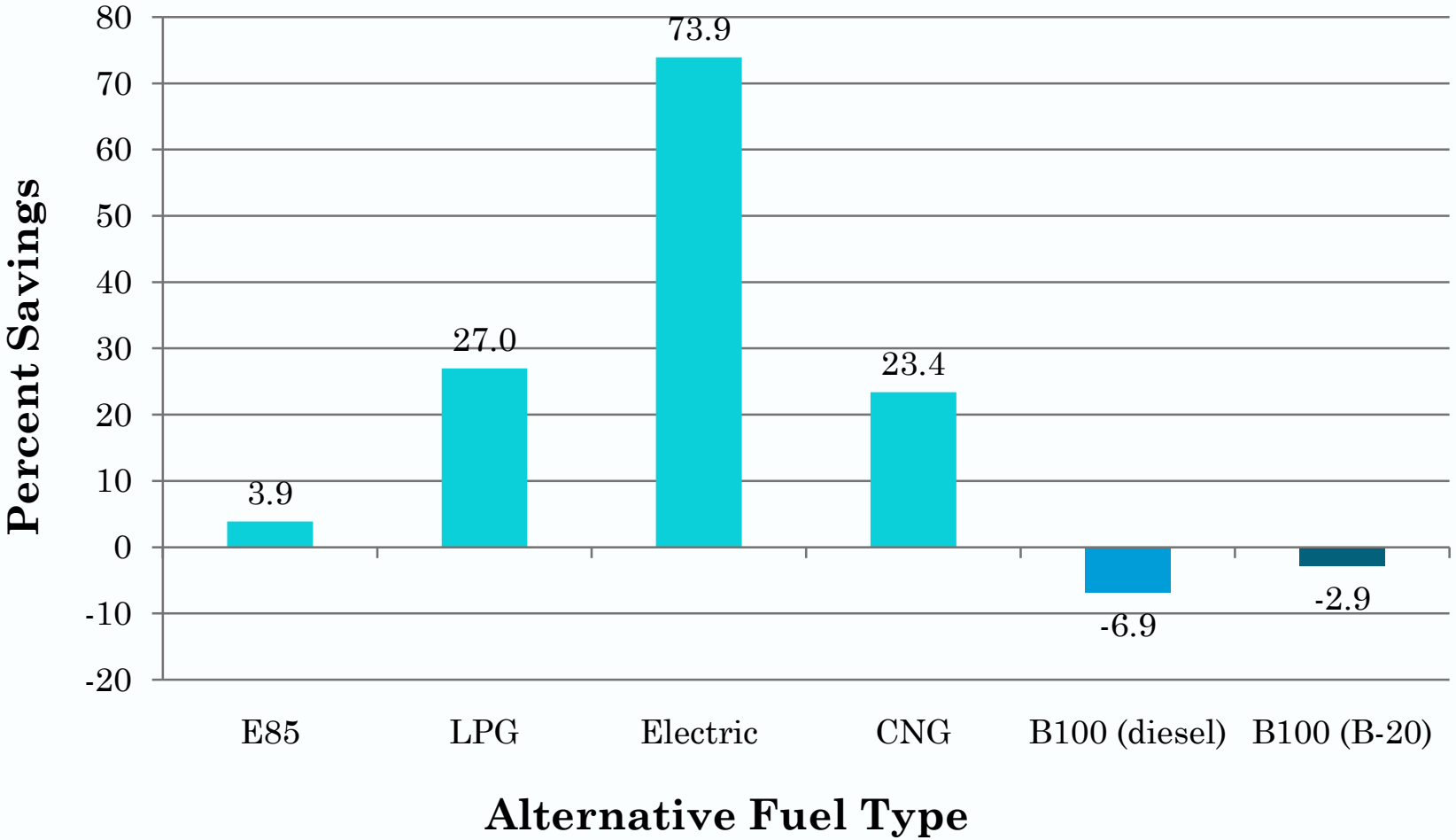
Photo: OWASA

Average Emissions (kg) Per Mile (in kg CO2) Including Tailpipe and Production Emissions



Source: Environmental Defense Fund

Percent Emissions Savings



Source: Environmental Defense Fund

Recommendations for Reduced Emissions

OWASA Fleet Recommendations

- Electric power provides greatest potential for emissions reduction
- LPG and CNG are possible options for new fleet vehicles

Driver Recommendations

- Drive slow and steady
- Minimize idling
- Lighten payload
- Regular service and maintenance

Behavioral Observations of Employees

- Methods
  - Observational tours
  - Equipment inventory
  - Employee interviews

Photos: OWASA

Findings

- Implemented changes
- Areas for improvement
- OWASA needs to better inform its employees about their energy use

http://newlighted.com/wordpress/?page_id=913

Davis 2010

Recommendations

Behavioral

- Turn off lights as you leave a room
- Turn off computers and equipment
- Unplug appliances when not in use
- Remove mini-fridges and personal space-heaters

Structural

- Continue current projects
- Reconfigure security lighting
- Check and reconfigure thermostat settings
- Install a network computer shut-down system

Customer Outreach

Did you know…

- The average dishwasher uses 12 gallons/load.
- The average washing machine uses 43 gallons/load.
- The average lawn care water use is 90 gallons/10 minutes.
- The average shower uses 4 gallons per minute. (about 28 gallons/day
- The average hand wash of dishes uses 4 gallons per minute. (about 20 gallons/day.
- The average toilet uses 4 gallons per flush. (about 20 gallons/day)
- This totals to an average of 258 gallons/person/day. It takes OWASA 4.83 kwH of energy to provide this amount of water/day.

With 4.83 kwH you could…

- Make 14.5 brews of coffee
- Microwave 63 meals
- Listen to 10,351 songs
- Watch 63 sitcoms
- Use a laptop for 97 hours
- Make 174 pieces of toast
- Iron 24 shirts

Ways to reduce use:

- Take shorter showers
- Run only full loads of laundry
- Run only full loads of dishes
- Turn off the water when brushing your teeth

Preliminary template for customer mailer

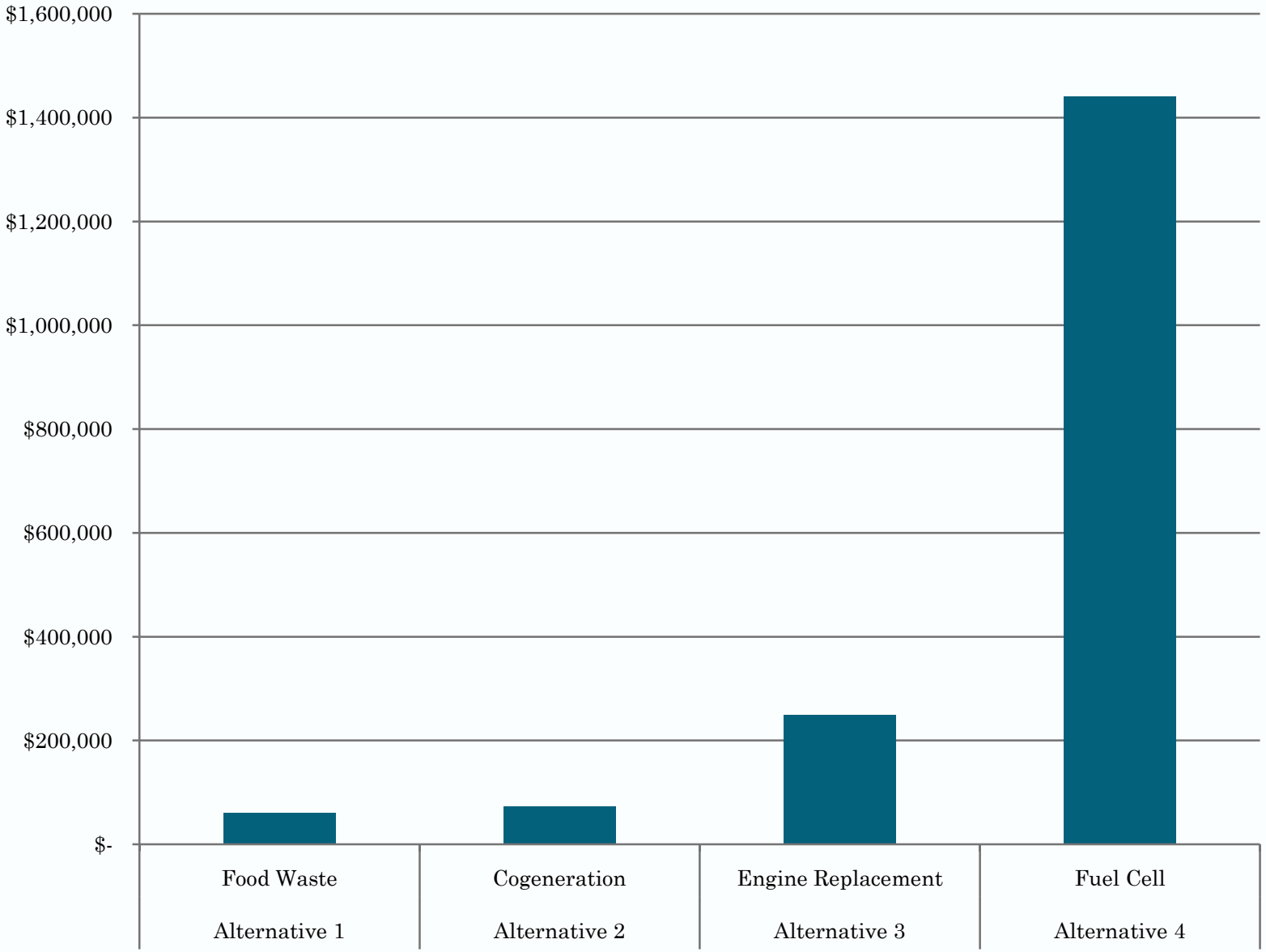
Source: The State of NC and GE Appliance Energy Use

Financial Analysis

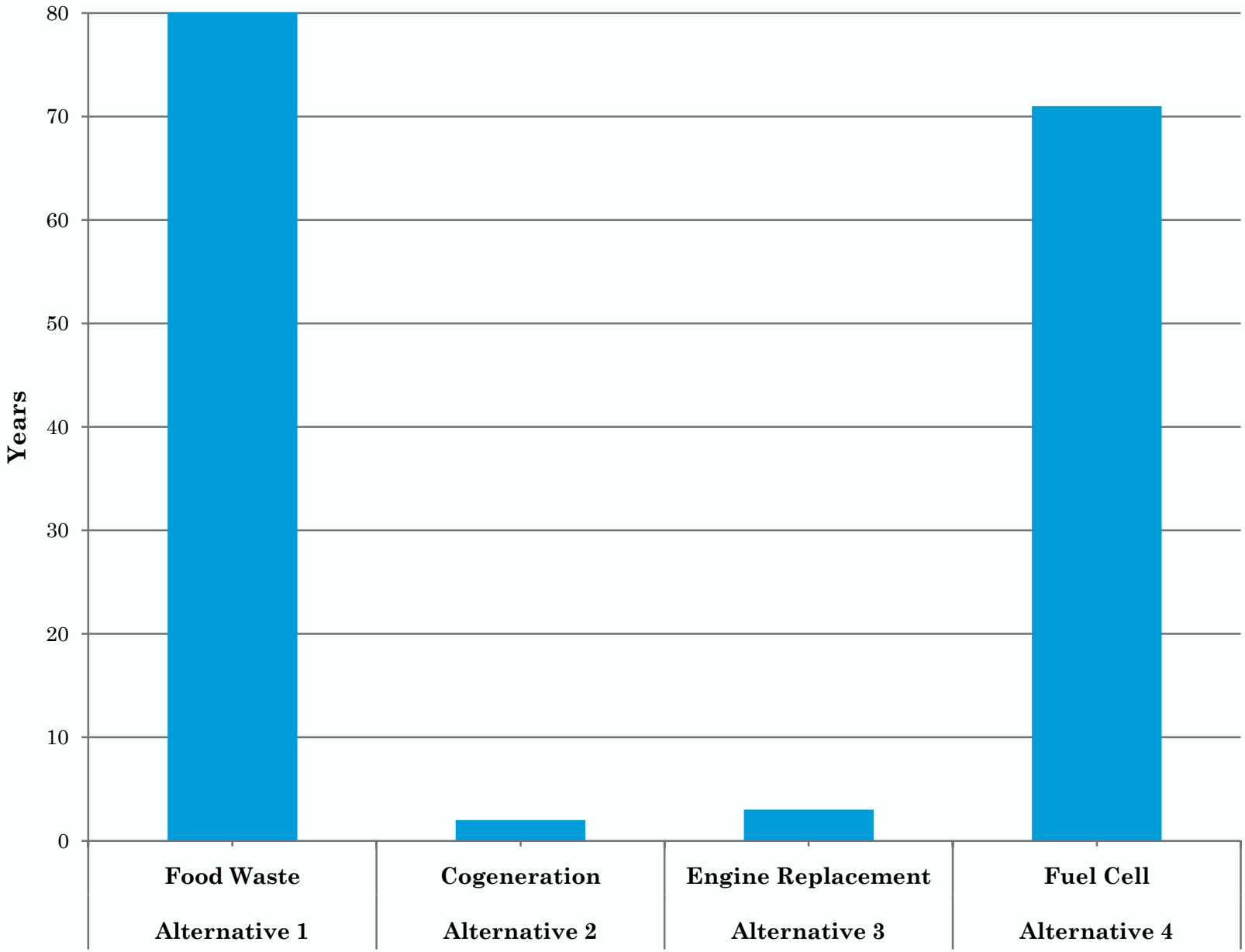
Financial Analysis

- Alternative 0: No Change
- Alternative 1: Addition of food waste to digesters
- Alternative 2: Cogeneration system
- Alternative 3: Replacing methane engine
- Alternative 4: Molten Carbonate Fuel Cell

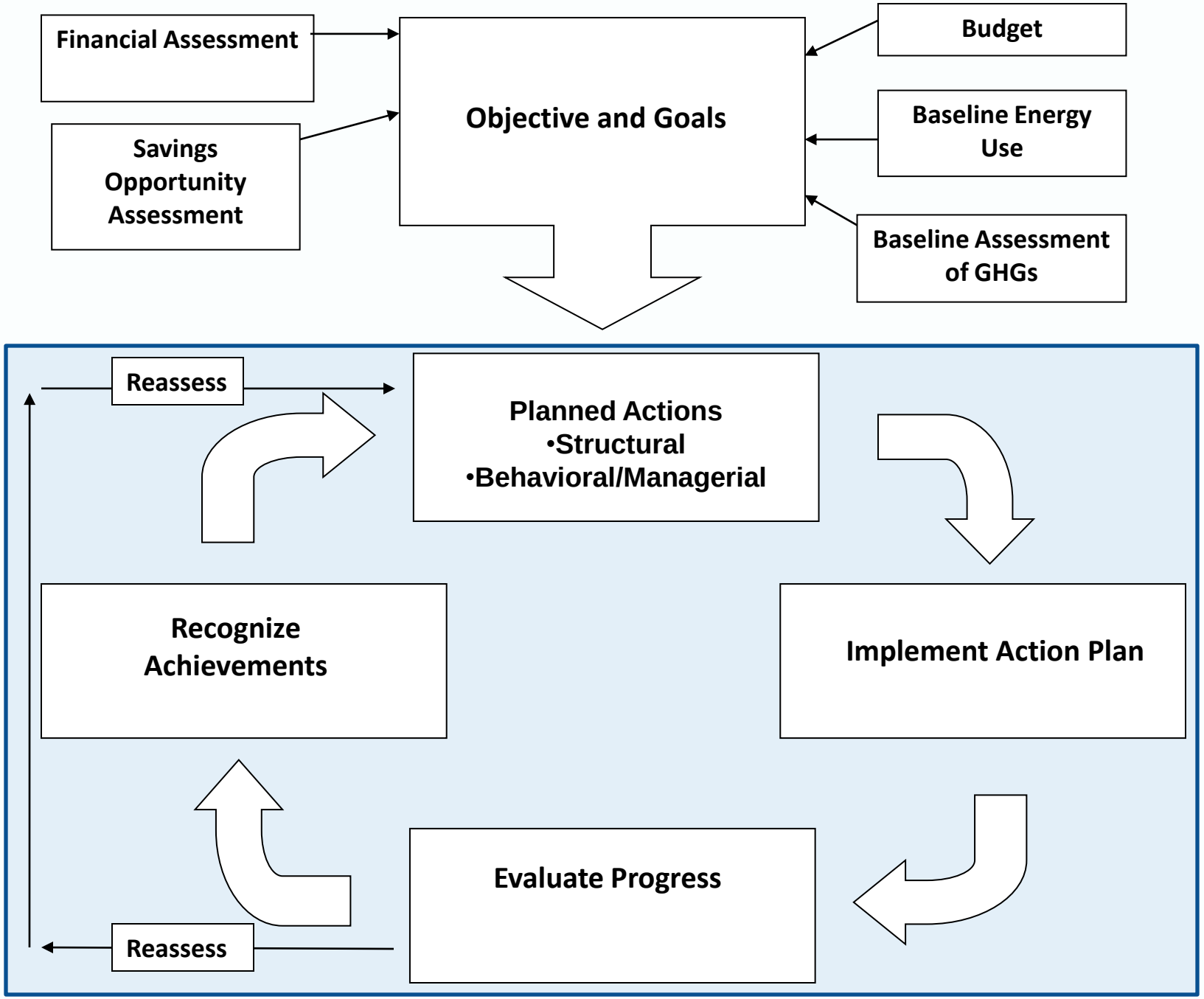
Comparison of Alternatives: Capital Cost



Comparison of Alternatives: Payback Period



Conclusions and What's Next?


Financial Assessment
Savings Opportunity Assessment
Objective and Goals
Budget
Baseline Energy Use
Baseline Assessment of GHGs
Reassess
Planned Actions
•Structural
•Behavioral/Managerial
Implement Action Plan
Evaluate Progress
Recognize Achievements
Reassess

Energy Management Plan for OWASA

Thank you for your time and attention.

Are there any questions at this time?

A special thanks to Pat Davis, Dr. Elizabeth Shay, and Anne Eshleman for their dedication and patience this semester