

CITY OF TOLEDO

BAY VIEW WASTEWATER TREATMENT PLANT  
ELECTRICAL POWER COGENERATION SYSTEM

presented to the

American Water Works Association,  
Illinois Chapter  
May 6, 2008

By

Dean E. Karafa, P.E.

***middough***

---

# Energy Requirements

Base Load                      4.5 MW

Peak Load                      9.5 MW

# Why Cogeneration?

- Reliability
- Energy Savings
- Green Power

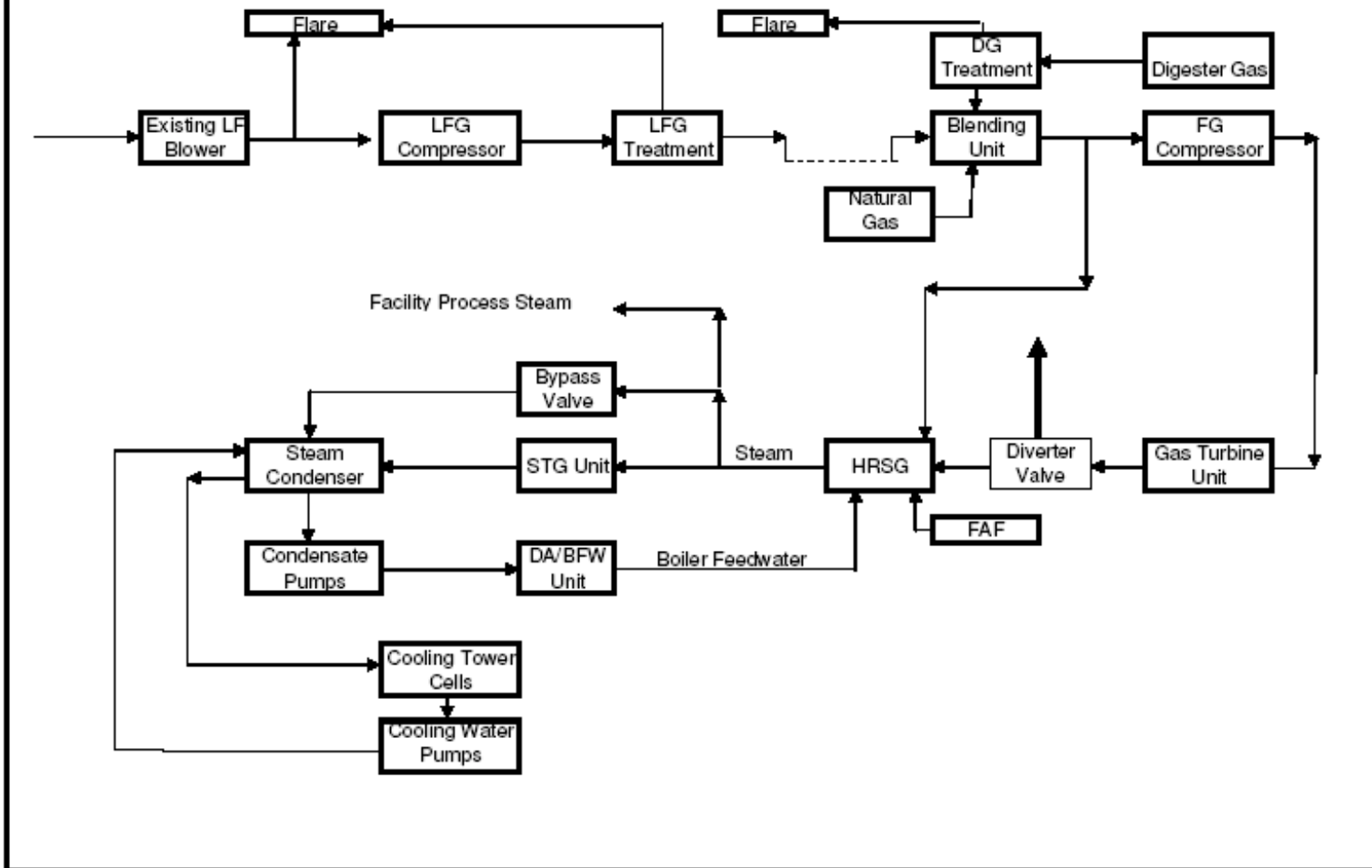
## Unique Fuel Mix

Digester Gas	13.7 MMBtu/hr 350 scfm @ 650 Btu/scfm
Landfill Gas	45.0 MMBtu/hr 1500 scfm @ 500 Btu/scfm
Natural Gas	As Needed @ 1000 Btu/hr

# Renewable Energy DG System Considerations

- Renewable “Fuel” Source – Quantity & Availability Profile
- Renewable “Fuel” Source – Equiv BTU Content and HHV/LHV Values
- Renewable “Fuel” Source – Treatment Requirements
- Renewable “Fuel” Source – Storage Requirements
- DG Equipment Options – Best Fit Evaluation including System % Efficiency
- DG Equipment Options – Electric, Steam, Hot Water, Chilled Water Facility Needs/Use
- Facility Load Profile – Best Use Integration: Load Share vs Base Loading
- Utility Interconnection Requirements / Use of Power: Prime vs Standby
- Utility Interconnection Requirements: Standby Charges, Interruptible Rate, Net Metering
- System Reliability Requirements
- Environmental and Emissions Permitting Requirements
- Green Energy Credits: REC’s, Green Tags, Carbon Offset Credits, etc.
- Rate of Return, Payback, and Life Cycle Analysis
- Community Involvement
- Project Champion(s)

City of Toledo Improvement 53  
Cogeneration Block Diagram



# Fuel Gas System

- Landfill Gas Delivery
  - Landfill provides gas at low pressure
  - Gas compressor increases pressure to 40 psi
  - 3 Stage Gas Cleanup
  - 2 Mile Pipeline to Bay View WWTP
- Digester Gas Delivery
  - Spherical storage provides gas at low pressure
  - 3 Stage Gas Cleanup

# Fuel Cleanup System

## Stage 1

Pleated nanofiber filter element for removal of solids, liquids, and aerosols

## Stage 2

Media packed adsorption tower for removal of siloxane

## Stage 3

Pleated nanofiber filter element

# Fuel Gas System

- Fuel Gas Blending Unit
- Side Stream to HRSG
- High Pressure Fuel Gas Compression

# Energy Cycle

## Unfired HRSG

### Combustion Turbine

Fuel Input	56.1 MMBtu/hr
Electrical Output	5,107 kW
Exhaust Conditions	172,200 lb/hr 888°F

# Energy Cycle

## Unfired HRSG

### HRSG

Steam Production

19,831 lb/hr

700°F

650 psig

### Steam Turbine

Electrical Output      1,566 kW

# Energy Cycle

## Unfired HRSG

### Total Output

Combustion Turbine	5,107 kW
Steam Turbine	<u>1,566 kW</u>
Gross Total Output	6,673 kW
Less Auxiliary Load	<u>845 kW</u>
Net Total Output	5,828 kW

Net Heat Rate 9,626 Btu/kWh

# Energy Cycle Fired HRSG

## Combustion Turbine

Fuel Input	56.1 MMBtu/hr
Electrical Output	5,107 kW
Exhaust Conditions	172,200 lb/hr 888°F

# Energy Cycle Fired HRSG

## HRSG

Fuel to HRSG 61.7 MMBtu/hr

Steam Production

77,000 lb/hr

700°F

650 psig

## Steam Turbine

Electrical Output 6,163 kW

# Energy Cycle Fired HRSG

## Total Output

Combustion Turbine	5,107 kW
Steam Turbine	<u>6,163 kW</u>
Gross Total Output	11,270 kW
Less Auxiliary Load	<u>972 kW</u>
Net Total Output	10,298 kW

Net Heat Rate 11,439 Btu/kWh

# Cogeneration Facility

## Facility Location





# Cogeneration Facility

## New Building Site View



**middough**

SOUTHEAST VIEW



CITY OF TOLEDO  
DEPARTMENT OF PUBLIC UTILITIES  
DIVISION OF WATER RECLAMATION  
COGENERATION FACILITY  
MARCH 16, 2017



**middough**

# Solar Turbines Combustion Turbine

A Caterpillar Company



**middough**

# Cogeneration Facility

HRSR (Heat Recovery Steam Generator)



# Cogeneration Facility

Gas Compressor Skid

