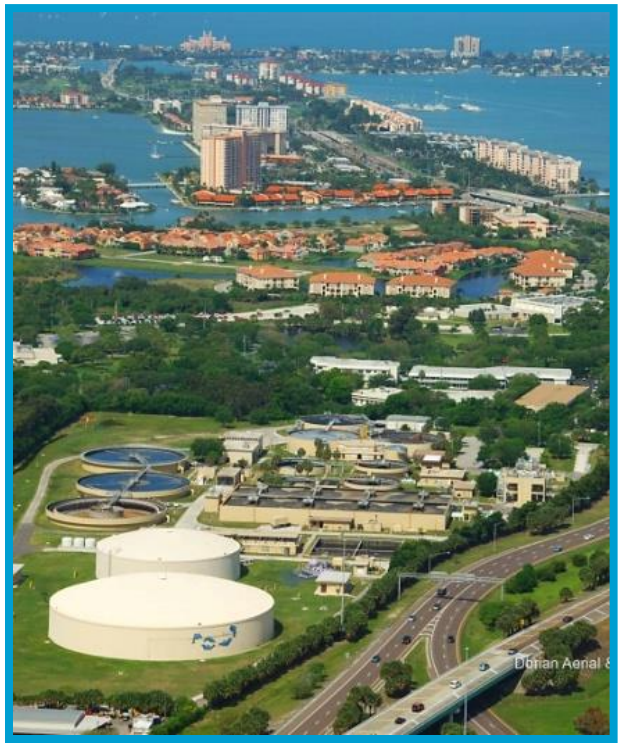
U.S Department of Energy - Biomass 2014

St. Petersburg, FL: Vehicle Use of Recycled Natural Gas Derived from Wastewater Biosolids



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City Project Manager

Eron Jacobson, PE
Brown and Caldwell
Gas Upgrade Systems Process Area Manager

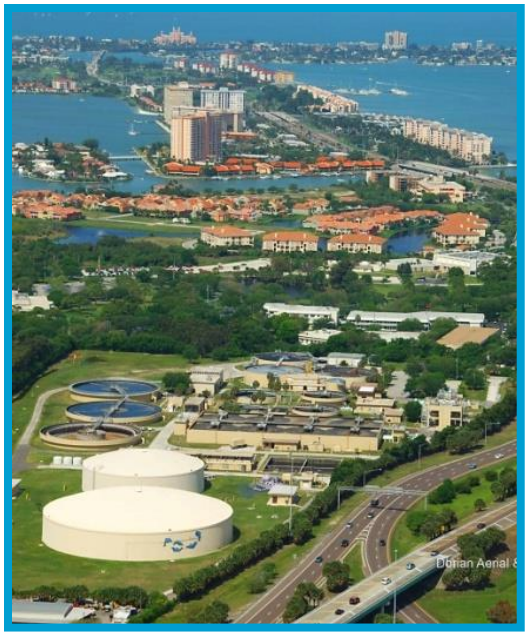
Presentation Outline

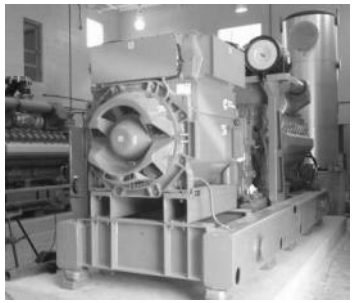
Project Summary

Biogas to Recycled Natural Gas Technology Evaluation and Design Phase

Future Considerations for Biogas to Recycled Natural Gas and Vehicle Fuel Use

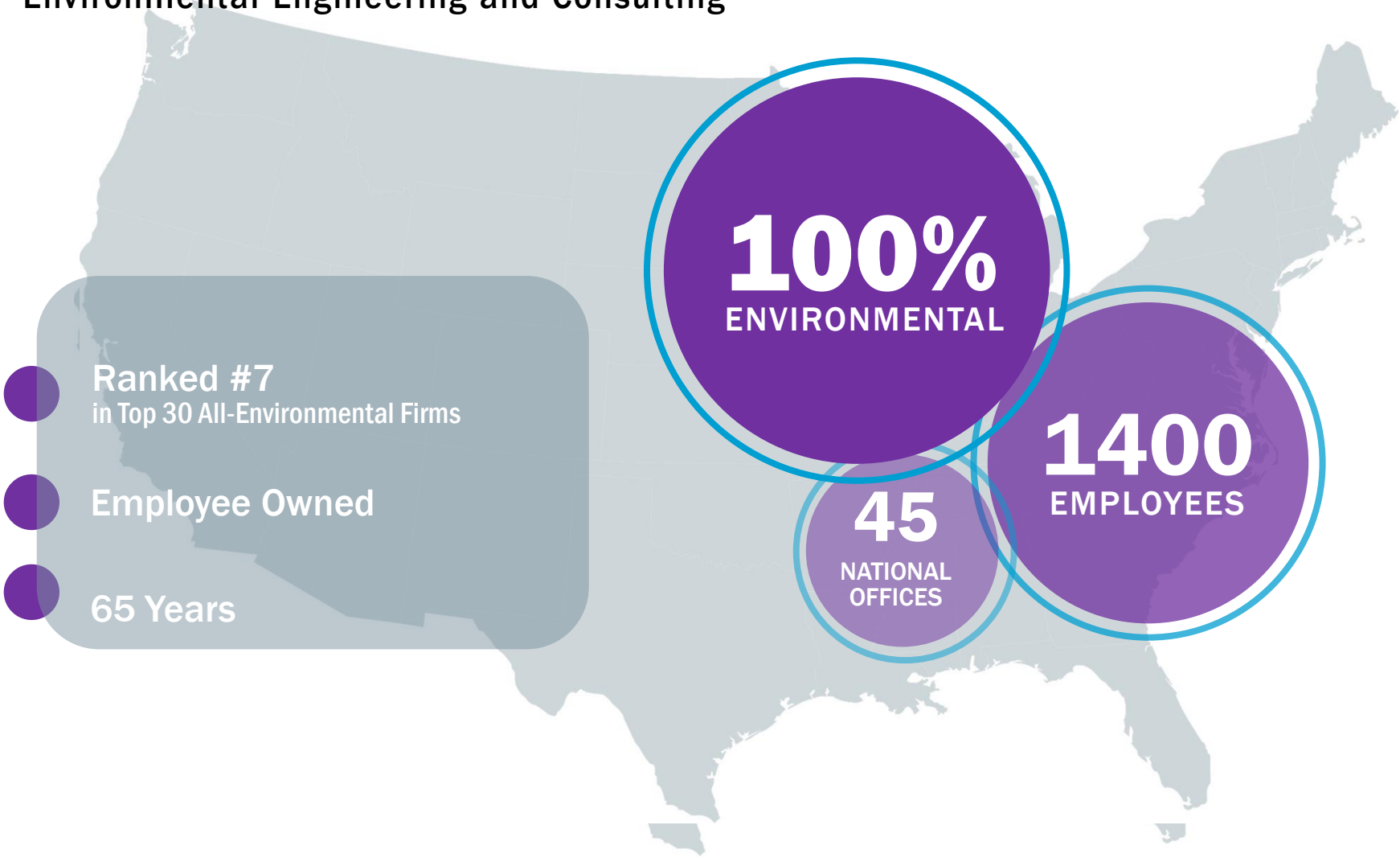
Project Summary





About Brown and Caldwell

Environmental Engineering and Consulting



- Ranked #7
  in Top 30 All-Environmental Firms
- Employee Owned
- 65 Years

Wastewater Biogas to Recycled Natural Gas Facilities in the US

- King County South Plant, Renton, Washington
  - Two 1,200,000 ft^3/day capacity systems
  - Operating since 1987

  Wheeled to natural gas provider
- San Antonio Water System, San Antonio Texas
  - 1,950,000 ft^3/day capacity system
  - Operating since 2010

  Wheeled to natural gas provider
- Newark WWTP, Newark, Ohio
  - 100,000 ft^3/day capacity system
  - Operating since 2011

  Vehicle fuel; however, currently Inactive due to other preferred use of biogas
- Hale Avenue WWTP, Escondido, California
  - 360,000 ft^3/day,
  - Operating since 2011

  Demonstration project
- ***St. Petersburg, FL***
  - ***~ 450,000 ft^3/day***
  - ***Target - 2017***

  Vehicle fuel and other in plant uses

Brown and Caldwell currently in preliminary stages of two additional projects in the US

Project Overview

City's Mission

- St. Petersburg is a "Green City"

Project Goals

- Utilize wastewater biosolids to produce energy

Primary Project Participants

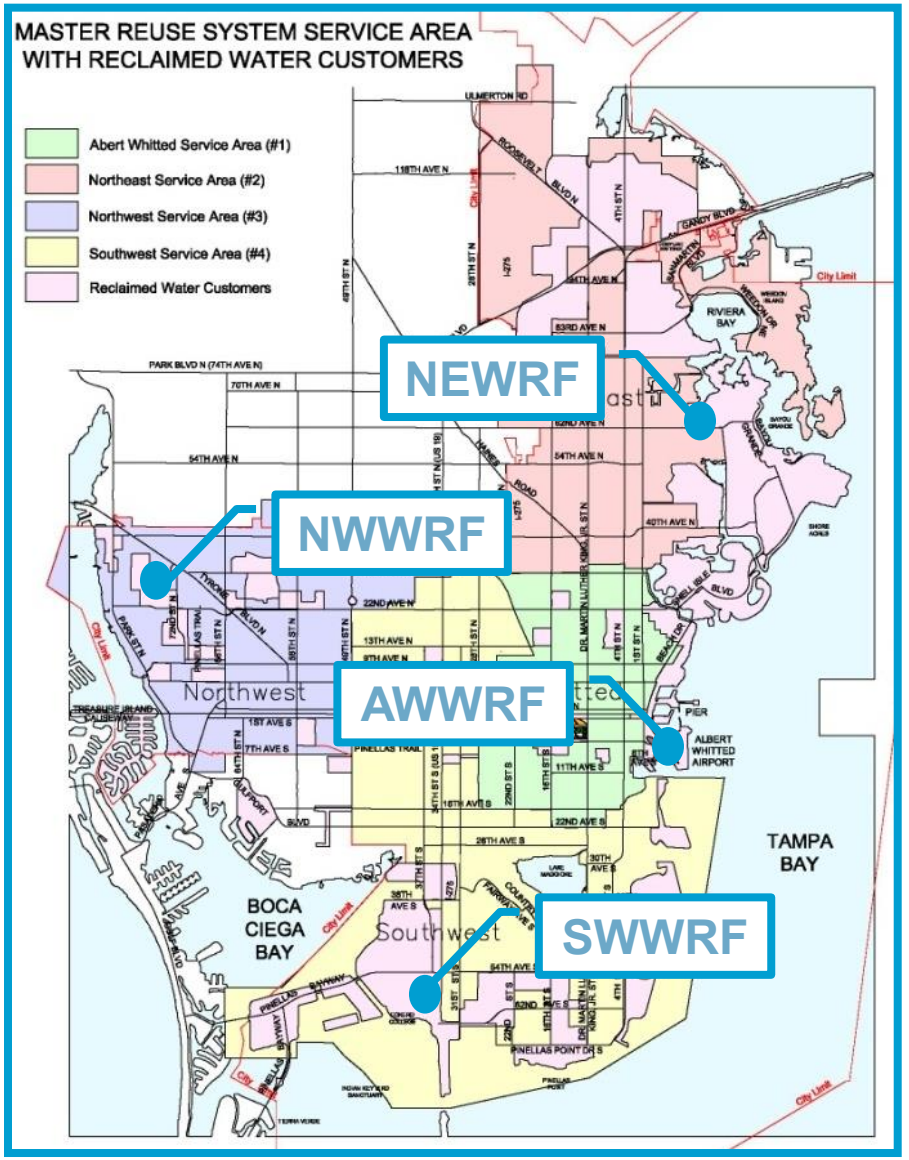
- City of St. Petersburg, U.S. Department of Energy (DOE)
  Brown and Caldwell, Black and Veatch

Project Phases

- Phase One – Project Wide Alternatives Analysis – (2011-2012)
- **Phase Two – Design (2013-2015**)
- Phase Three – Construction (2015-2017)

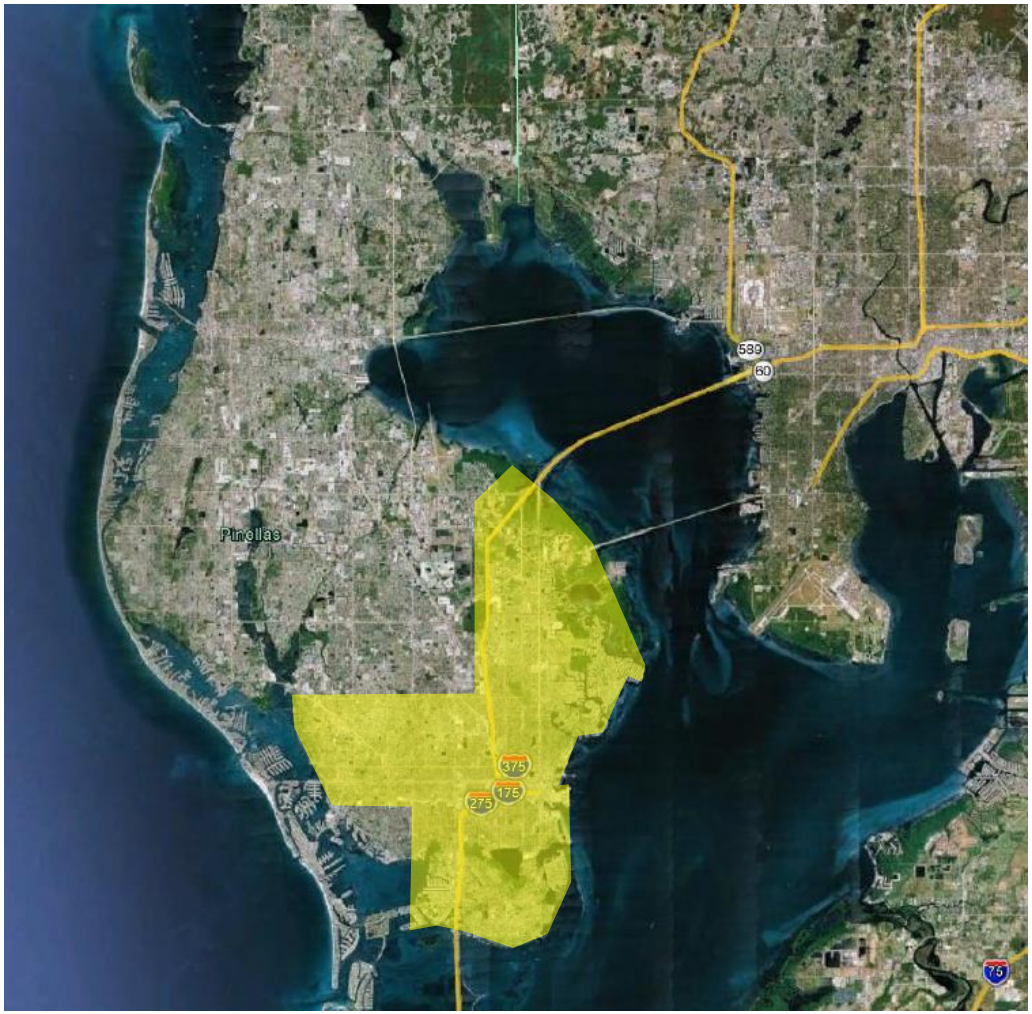
St. Petersburg Wastewater System

- 316,000 served
- 35 mgd wastewater flow, average
- 4 Water Reclamation Facilities (WRF's) (Wastewater)
- 6,200 dry tons of wastewater residuals produced per year



City of St. Petersburg

A Green City Surrounded by Water



st.petersburg

Phase 1 – Alternatives Analysis (2011-2012)

Utilizing Brown and Caldwell's Mass and Energy Model, Models were Developed for 35 Alternatives

Major Components of Modeling Included

- Sludge consolidation between WRF's
  - Sludge Forcemain
  - Gravity Sewer
  - Trucked Hauling
  - Import Fats, Oils and Greases (FOG)
  - Use of Food Wastes
- Thickening
  - Gravity Belts
- Anaerobic Digestion
  - Mesophilic
  - Thermophilic
  - Temperature Phased (TPAD)
  - Thermal Hydrolysis
- Thickening and Dewatering
  - Belt Filter Presses
  - Screw-Presses
  - Centrifuges
- Drying
  - Gas-fired
  - Solar
  - Concentrating Solar
- Gasification
- Incineration
- Gas Uses
  - Engine- Generators (CHP)
    - Use Electricity at Plant
    - Electricity Wheeling
    - Sale of Excess Heat
  - Recycled Natural Gas (rNG)
    - Vehicle Fuel
    - Natural Gas Wheeling

Phase 1 – Alternatives Analysis (2011-2012)

Alternative Selected

Major Components of Modeling Included

- Sludge consolidation between WRF's
  - Sludge Forcemain
  - Gravity Sewer
  - Trucked Hauling
  - Import Fats, Oils and Greases (FOG)
  - Use of Food Wastes
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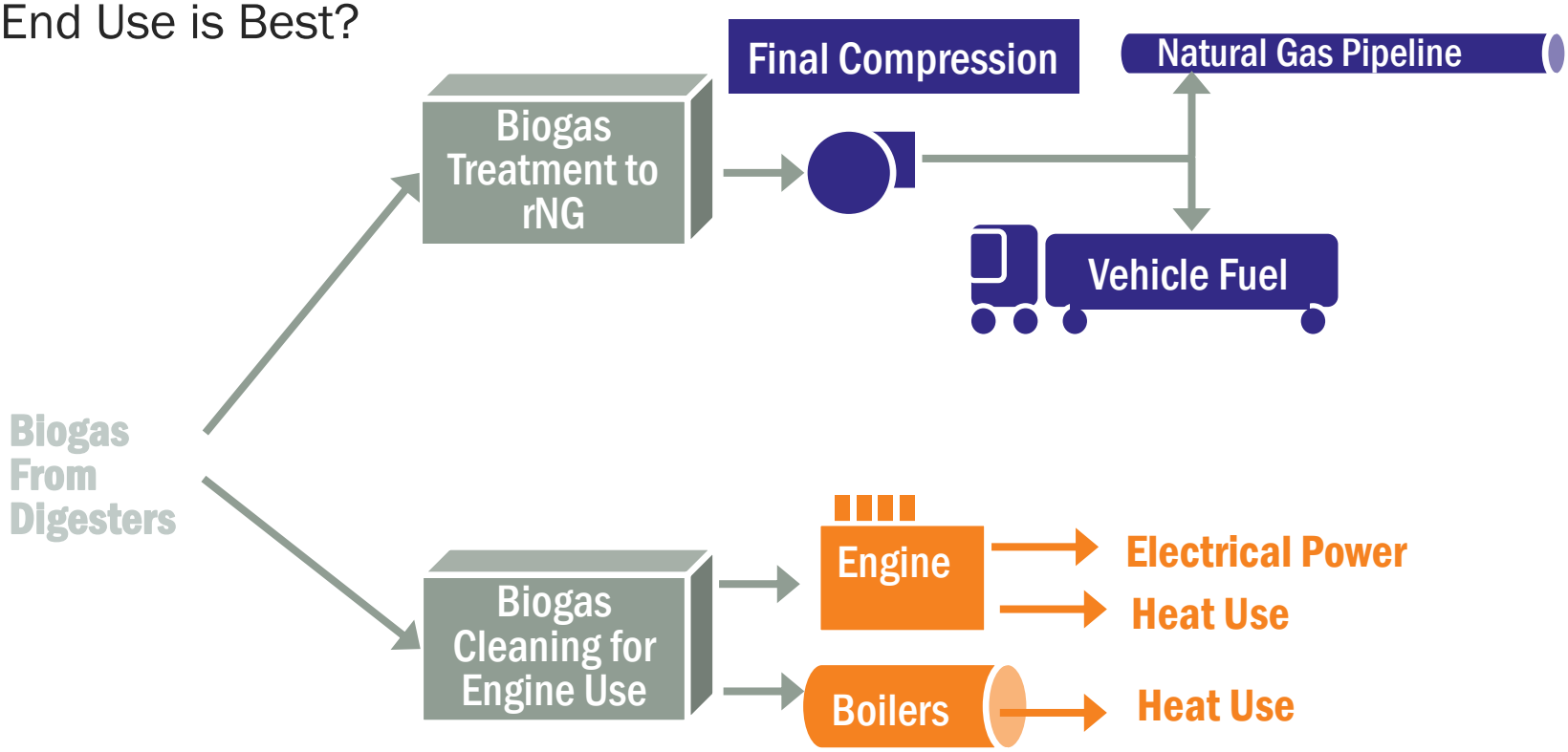
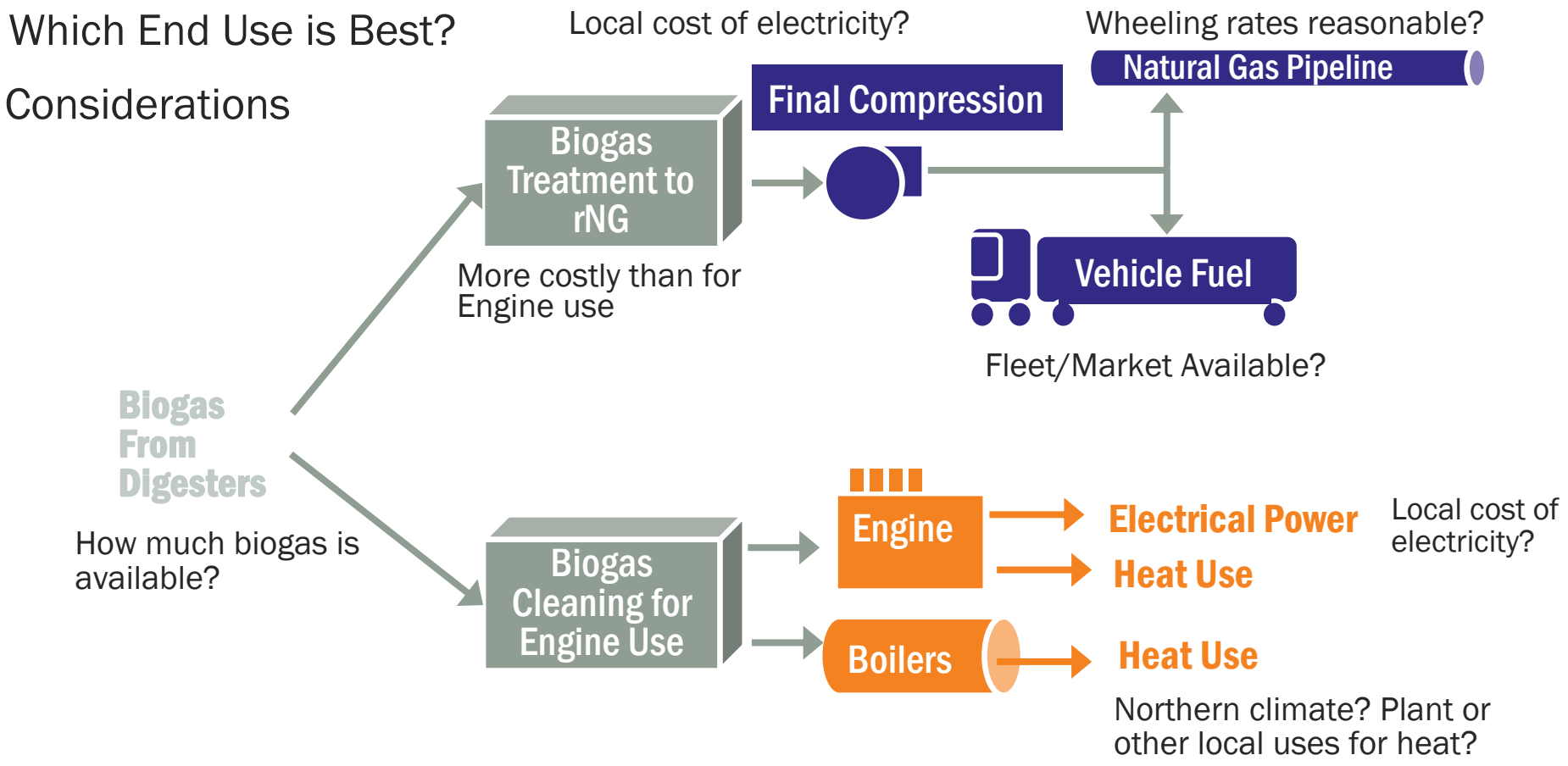
- Incineration
- Gas Uses
  - Engines- Generators (CHP)
    - Use Electricity at Plant
    - Electricity Wheeling
    - Sale of Excess Heat
  - **Recycled Natural Gas (rNG)**
    - **Vehicle Fuel**
    - Natural Gas Wheeling

The Key Design Issue Related to Biogas Use

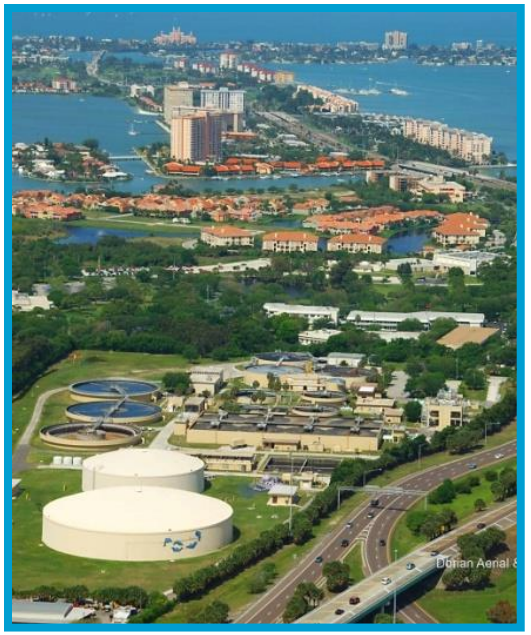
Which End Use is Best?

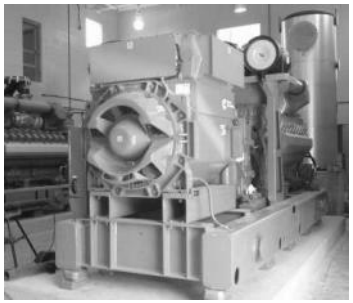


The Key Design Issue Related to Biogas Use



Biogas to Recycled Natural Gas Technology Evaluation and Design Phase





Design –Conversion of Biogas to Recycled Natural Gas

- Biogas to Recycled Natural Gas Technologies
  - Physical Absorption with Water or Solvents
  - Pressure Swing Adsorption
  - Membranes

Design –Conversion of Biogas to Recycled Natural Gas

Technology Evaluation

After review of potential options, two selected for final evaluation

1) Physical Absorption – Water
2) Pressure Swing Adsorption

Though limited sites are available, site visits of an existing facility of each technology were performed

Physical Absorption Technology,
Fair Oaks Farms, Fair Oaks, IN

- Installed at 30,000 cow dairy farm
- Designed for 1,500 scfm
  - ~3x flow as SWWRF
- Operating since 2011
- Biomethane end uses:
  - Pipeline natural gas
  - CNG for vehicles
  - Onsite engine-generator
- Owned by *third party*, Anaergia

Fair Oaks Dairy, IN Fueling Facility

- Quiet installation
  - Acoustical enclosure for compressor
- Quick fill times
  - 18 minutes for 135 DGE tank if storage vessels full
- Easy filling

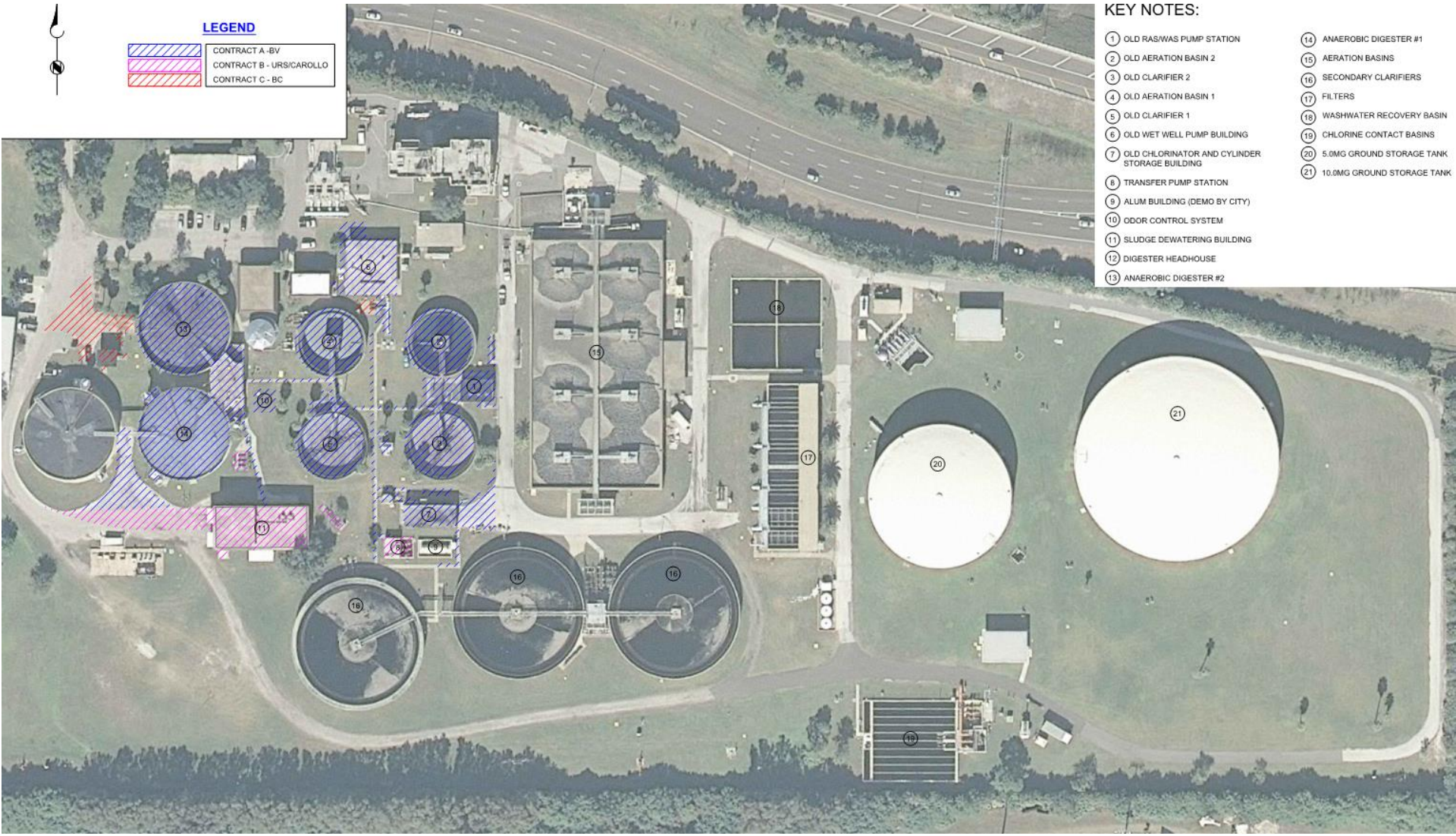
Pressure Swing Adsorption Technology,
San Antonio Water System, San Antonio, TX

- Installed at 125 mgd Dos Rios WRF
- Designed for 1,200 scfm
  - ~3x flow at SWWRF
- Operating since 2010
- rNG wheeled to natural gas pipeline
- Owned by *third party*, Ameresco

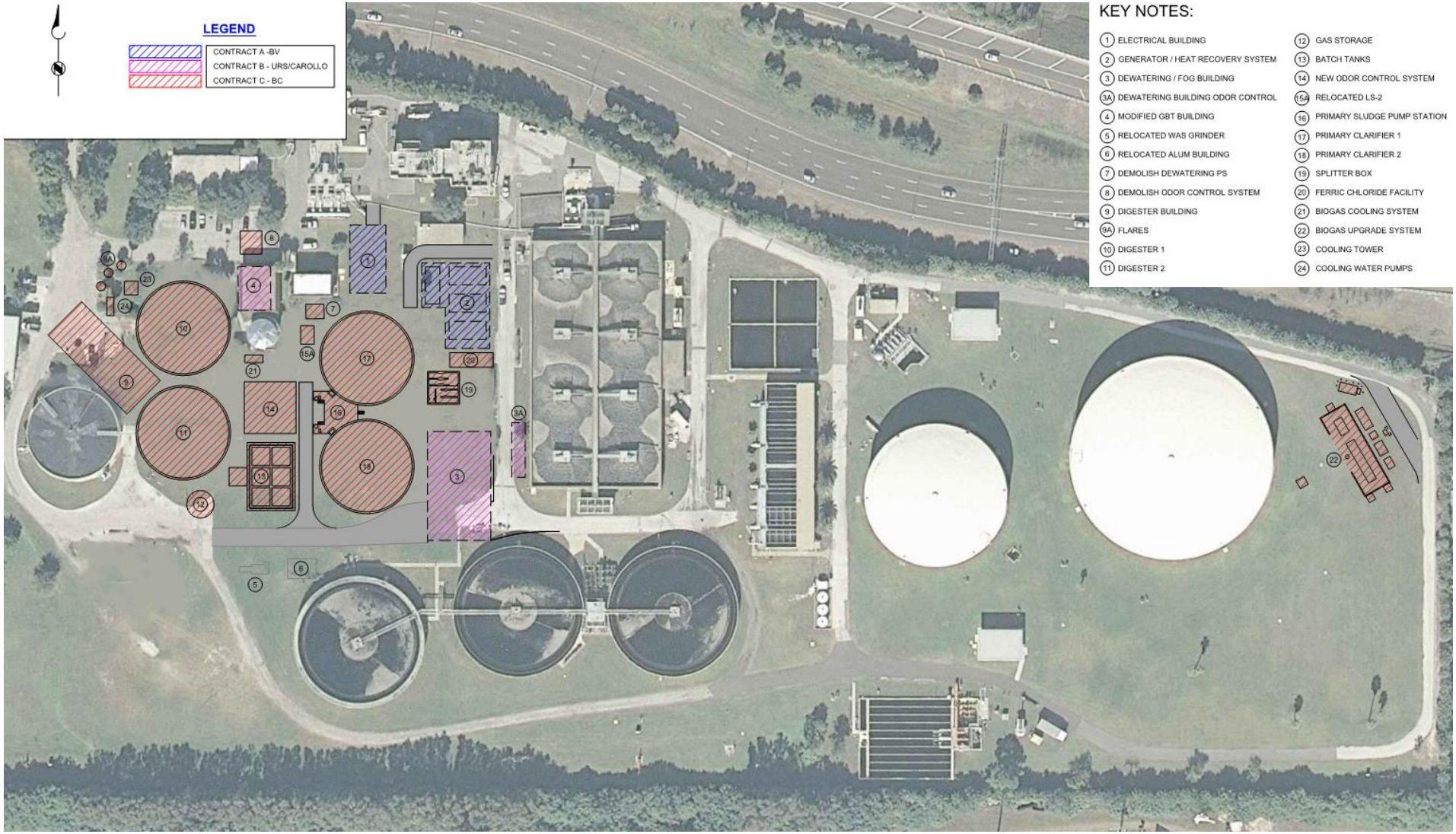
St. Petersburg Conversion of Biogas to Recycled Natural Gas

- The conversion process will be a pressure swing adsorption (PSA) type.
- Product gas quality:
  - Meet recommendations of the Society of Automotive Engineers standard for compressed natural gas vehicle fuel, SAE J1616
  - Local natural gas company quality requirements for a HHV of 985 Btu/scf
- Product gas sent to the CNG fueling system or sent to the onsite engine-generators
  - Demand for City Sanitation Fleet will be met first with remaining being used for engine-generators and on-site boilers

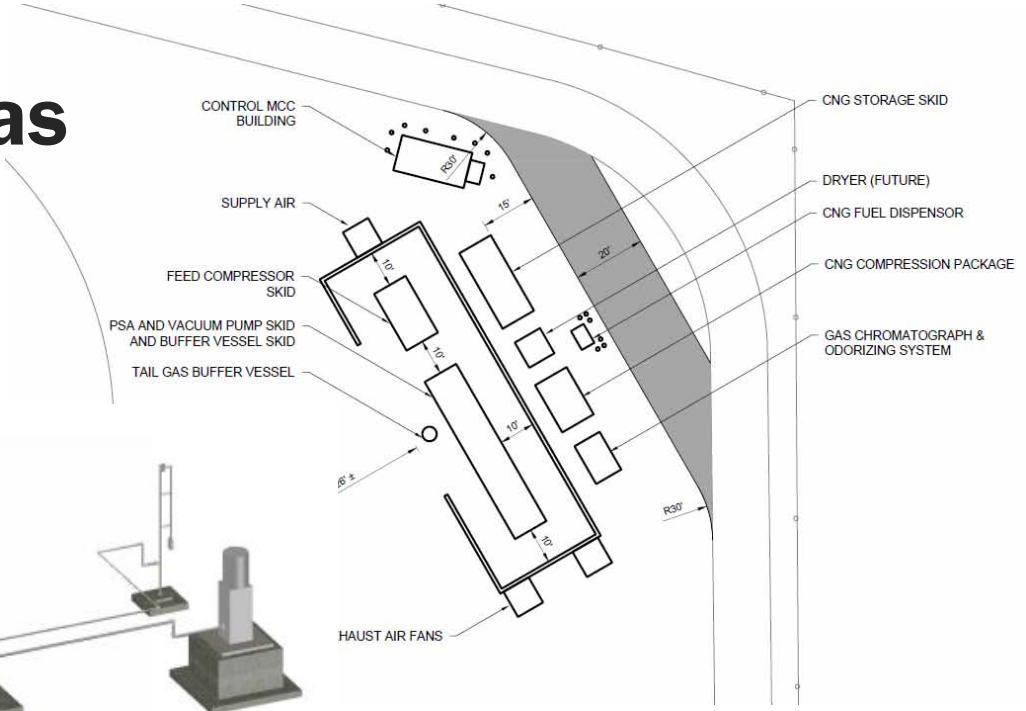
Existing and Demolition of Plant

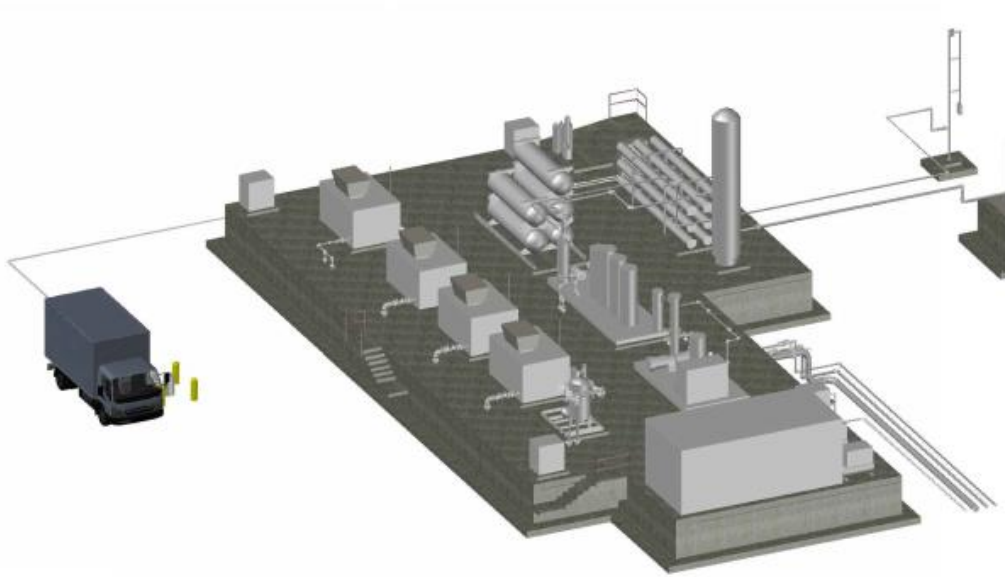


New Construction



Biogas to Recycled Natural Gas Facility and Compressed Natural Gas Fueling Facility





Pressure Swing Adsorption Technology Chosen for Final Design

Summary of Benefits

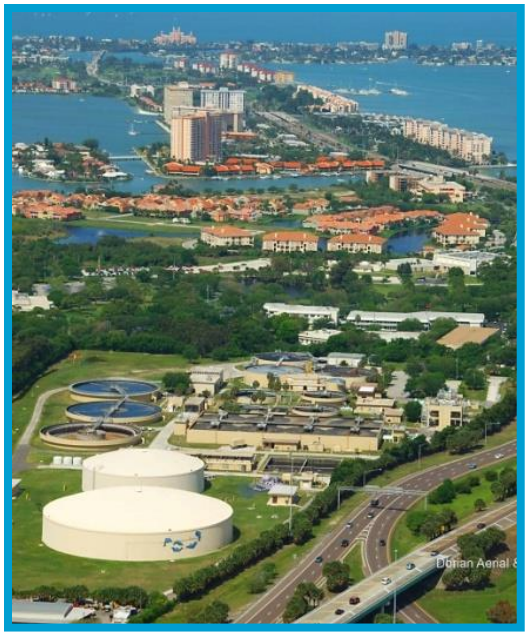
Economics

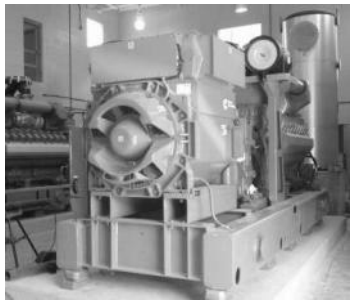
- **Save the City $66 Million Based on a 20 Year Present Worth Analysis**

Environmental

- Produce a Class “A” Sludge (Fertilizer Grade)
- **Reduce Diesel Fuel Consumption by up to 1,250 gal/day**
- Reduce City’s Carbon Footprint by 12,000 MT CO2e/year

Future Considerations for Biogas to Recycled Natural Gas and Vehicle Fuel Use





Brown and Caldwell's Goals Over the Next 10 Years with this Technology

- Expand recognition of this technology as an optional end-use of biogas
- Increase awareness of the benefits of maximizing biogas production from wastewater treatment plants
- Expand utilization of materials beyond biosolids at the wastewater treatment solids facilities
  - Food wastes
  - Fats, Oils and Greases from Restaurants
- Streamline evaluation, selection and design efforts for this technology

What is Needed to Expand Technology Implementation

- Education of Municipal Wastewater Authorities
  - Benefits of this Technology
  - Benefits to Maximizing Biogas Production
- Encouragement of Public-Private Partnerships
- Capital Funding Support for Projects
  - With tight budgets and aging infrastructure, capital availability for wastewater authorities is limited.
  - Long term benefits, good return on investment; however, with a high initial investment. St. Petersburg project will cost $50 million (+/-) for the entire program and $6 million (+/-) for the biogas to rNG portion.

What is Needed to Expand Technology Implementation

- Analysis and Design Streamlining
  - More Quickly Evaluate the Best Use of the Biogas
    - Conversion to Recycled Natural Gas (Wheeling or Direct Vehicle Use)
    - Use in Engine-Generators to Produce Electricity and Heat
  - Streamline Design Over Time (Layouts, Engineering Knowledge)
- Technology and End Uses
  - Off the shelf packages at fixed sizes
  - Sound attenuation/mitigation for existing technologies
  - Broader range of technology options
  - Encourage acceptance of wheeling by natural gas companies
  - Encourage conversion to natural gas fleets

Questions?

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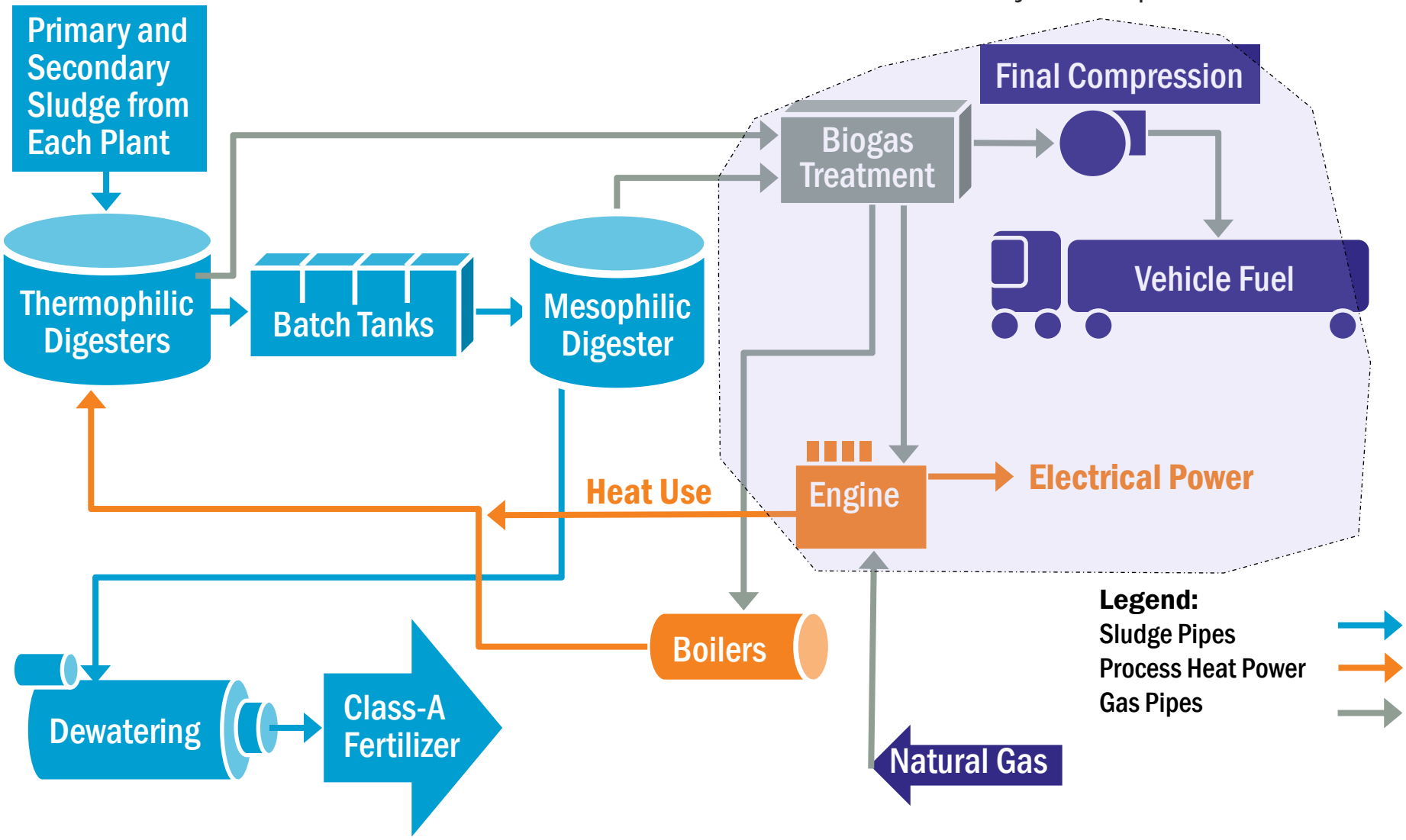
Appendix Slides

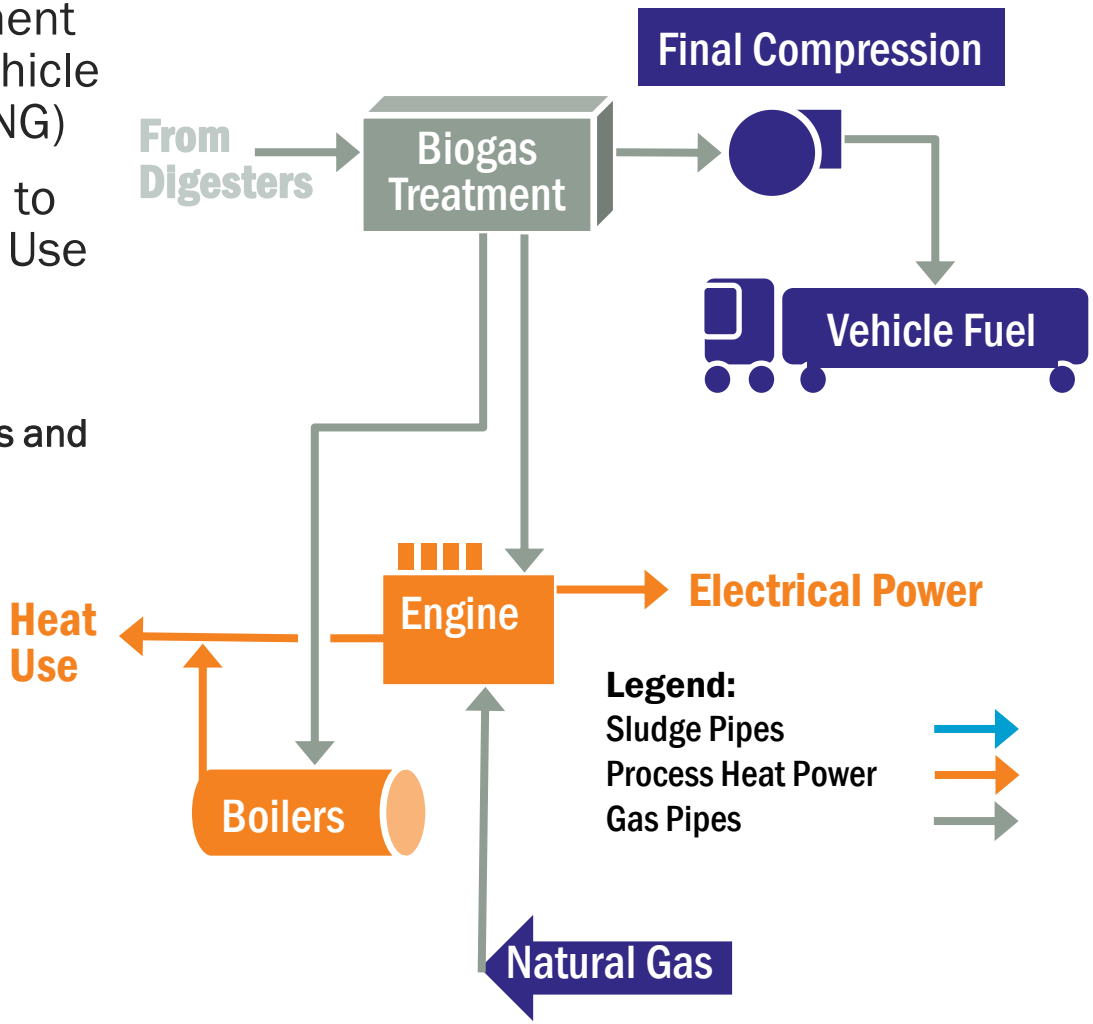
Alternative Selected

Recycled Natural Gas (rNG)
Vehicle Use
Project Component

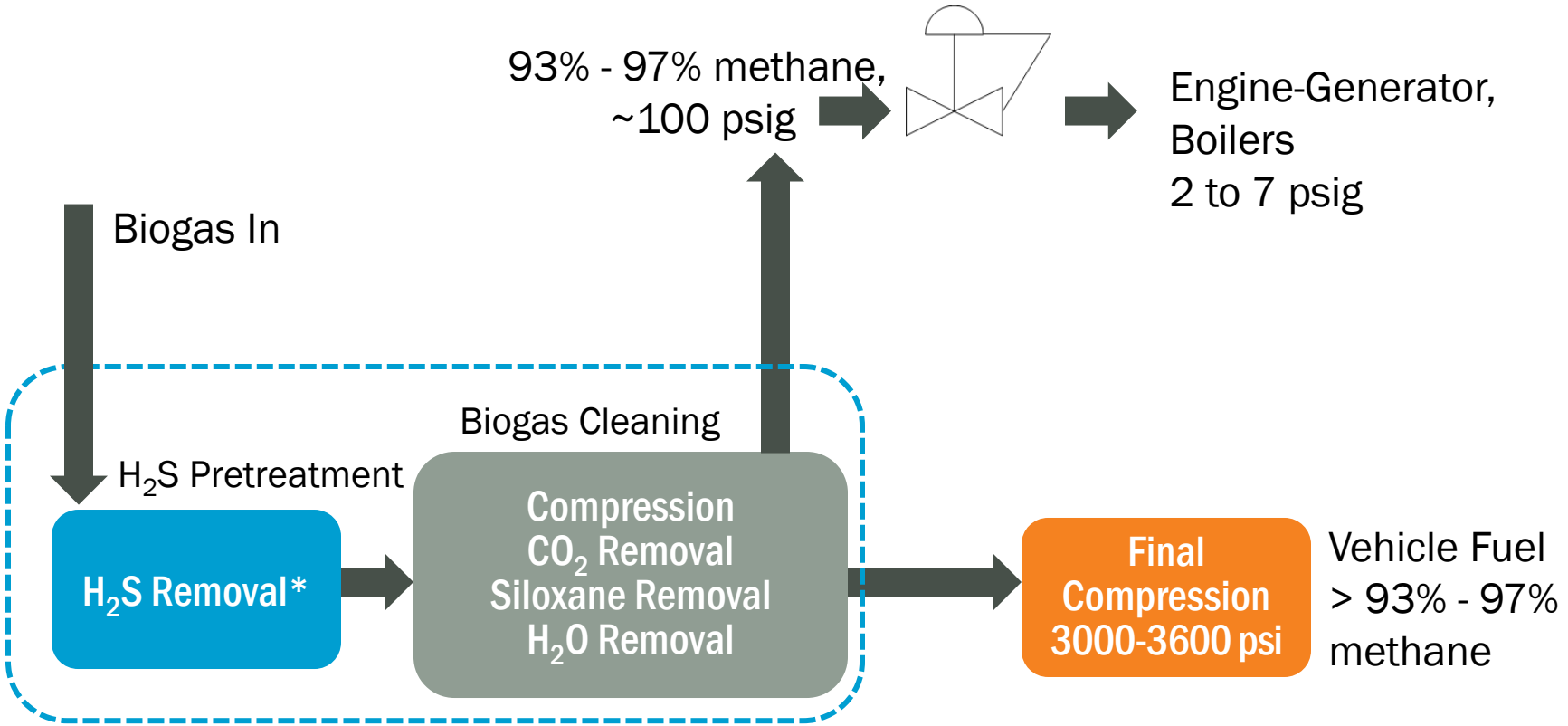


Design - Biogas to Recycled Natural Gas

- Determine which Biogas Treatment Process to Utilize to Produce Vehicle Quality Recycled Natural Gas (rNG)
- Determine Breakpoint for When to Use Gas in Engine and When to Use Gas for Vehicle Fuel
- Other Design Issues
  - **Level of Biogas Treatment for Engines and Boilers**
  - Type and Amount of Gas Storage
  - Noise Associated with Biogas Treatment System and Engines
  - Need for Pretreatment of Biogas to Remove H_2S



Biogas Treatment: One System



* Need and type depends on characteristics of waste gas, biogas end-use, and local air quality requirements. Process not in St. Petersburg project.

** Depending on engine combustion flexibility and local natural gas Wobbe Index