Biogas Utilization for City of Raleigh's Bioenergy Recovery Project

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Acknowledgements

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Building a world of difference:

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Topics for Today's Presentation

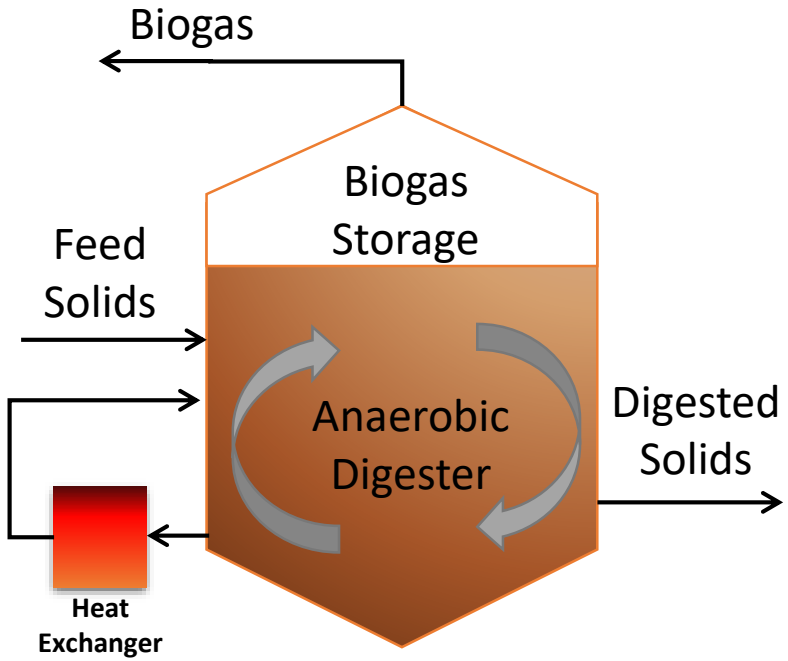
1. **Biogas Utilization Overview**
   - **What is biogas?**
   - **Considerations for biogas utilization**
2. **Biogas Utilization Planning for City's Bioenergy Recovery Project**
   - **Bioenergy Recovery Program overview**
   - **Biogas utilization alternatives considered**
   - **Gas cleaning system considerations and technologies considered**
   - **Proposed alternative for Bioenergy Recovery Project**
   - **Next Steps**

Biogas Utilization Overview

What is Biogas?

- **Biogas is an end product of the anaerobic digestion process**
- **Anaerobic digestion**
  - **Organic material biologically decomposed in absence of oxygen**

- **Organic material** → **Biosolids**
- **Decomposition** → **VS Reduction**
- **End products** → **Biogas**

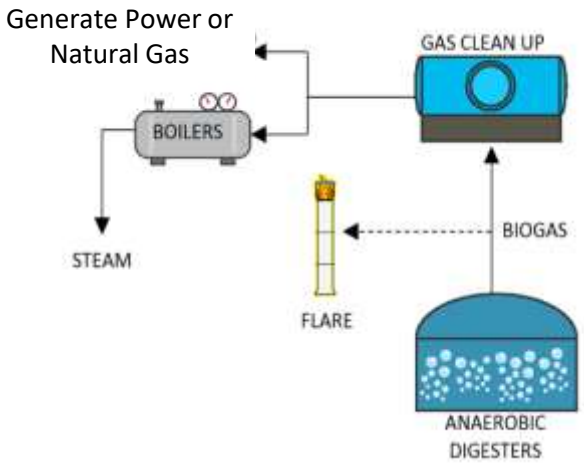


Biogas Components

- Methane (CH_4)
  - Typically 50 - 70% of biogas
- Carbon Dioxide (CO_2)
- Other constituents that also may need to be treated
  - Moisture
  - Hydrogen Sulfide (H_2S)
  - Siloxanes
  - VOCs
- Typically produce 15 scf of biogas /lb VSR

How is Biogas Utilized?

- **Provide heat to digesters**
  - **Hot water or steam for boilers**
- **Use for Combined Heat and Power**
  - **Heat for digesters +**
  - **Excess gas is used to generate electricity**
- **Renewable natural gas options**
  - **Biofuel for vehicles**
  - **Feed to natural gas pipeline**



Factors to Consider

Typical Biogas Handling Systems

Gas Storage

Gas Cleaning

Gas Cleaning

Flare

End Use - CHP Example

Biogas Utilization Planning for Bioenergy Recovery Project

Bioenergy Recovery Project Overview

Neuse River Resource Recovery Facility

- Currently expanding from 60 to 75 mgd
- Planning for expansion to 90 mgd (~ 2040)
- Centralized biosolids processing
  - Lime stabilization, composting, and some Class B liquid land application
- Converting to advanced digestion (Thermal Hydrolysis)
- Biogas energy recovery

Drivers for Change

Reliability and resiliency for future biosolids management

- Age of existing equipment
- Uncertainty of future Class B land application

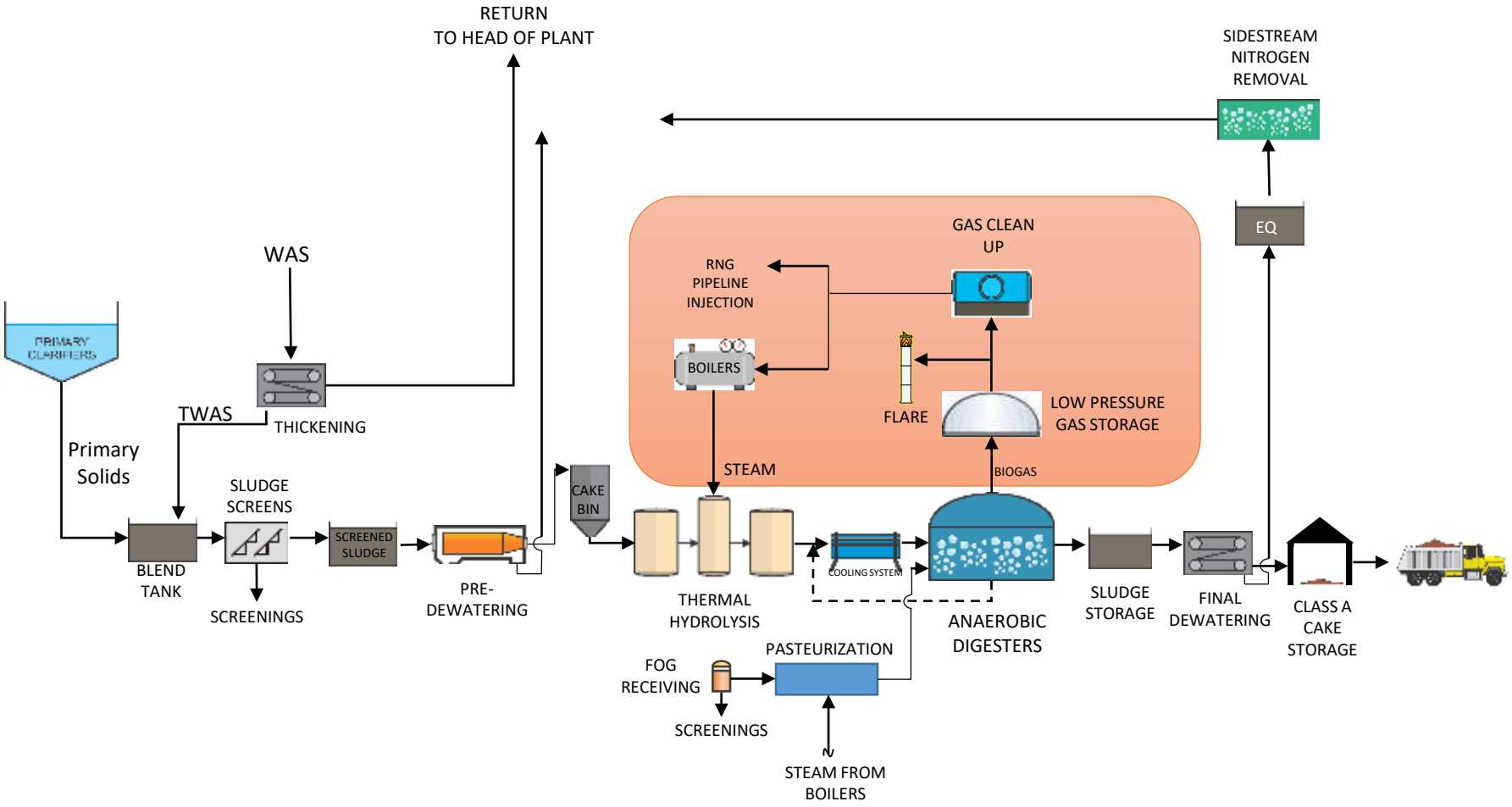
Sustainability and efficiency is a core focus of the City of Raleigh's strategic plan

- Optimize public infrastructure projects to address community resiliency, sustainability and efficiency.

Decision to convert to anaerobic digestion

- Reduce energy demand - 2.6 million KWhr/yr

Proposed Biosolids Process



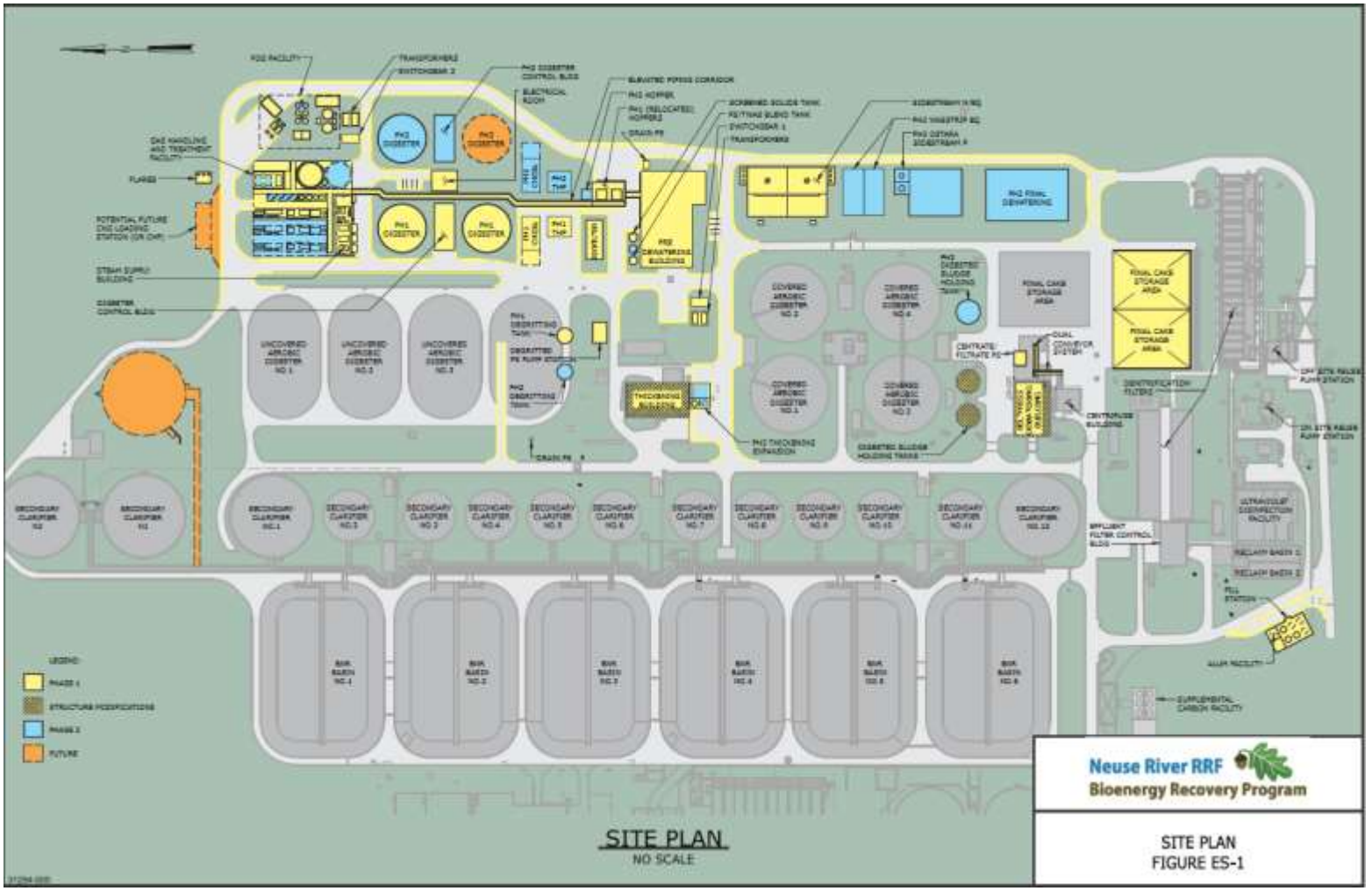
Thermal Hydrolysis Process (THP)

- **A sludge “pressure cooker” operating at about 330F/165C (90 psig)**

Some Key Components

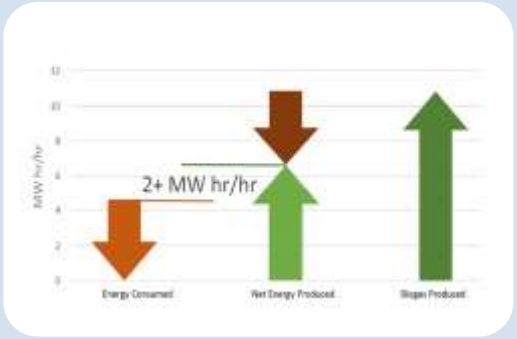
- FOG receiving and handling
- Reuse existing GBTs for WAS thickening
- Blended sludge screening
- Centrifuges for dewatering upstream of THP
- Single THP Train
- Closed loop sludge cooling
- Two 2.2 MG mesophilic anaerobic digesters
- Clean gas to meet pipeline injection standards
- New BFPs + existing centrifuge for post dewatering
- Sidestream nitrogen removal for Phase 1

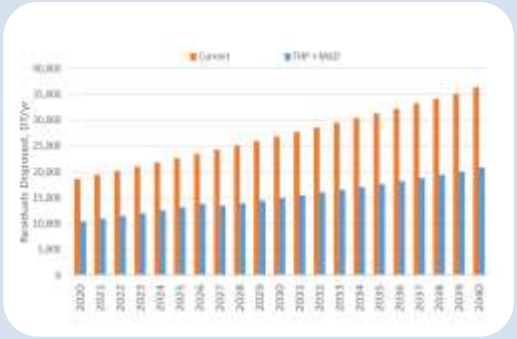
Overall Facility Site Plan and Layout for New Residuals Processing Complex

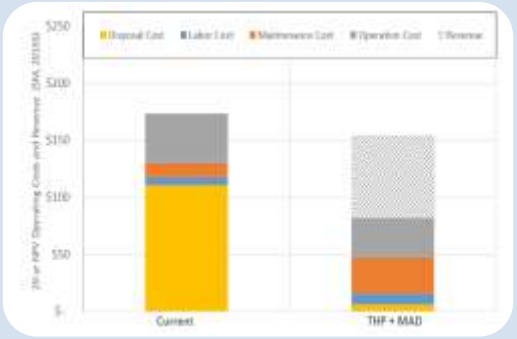


Visualization of the New Residuals Handling Complex (30-Percent Design Concept)

Project Benefits







Net Energy Production with Renewable Natural Gas

Significant reduction in residuals mass for final disposal

Reduced operating costs

Biogas Utilization Evaluation of Options

Goals of Gas Utilization at NRRRF

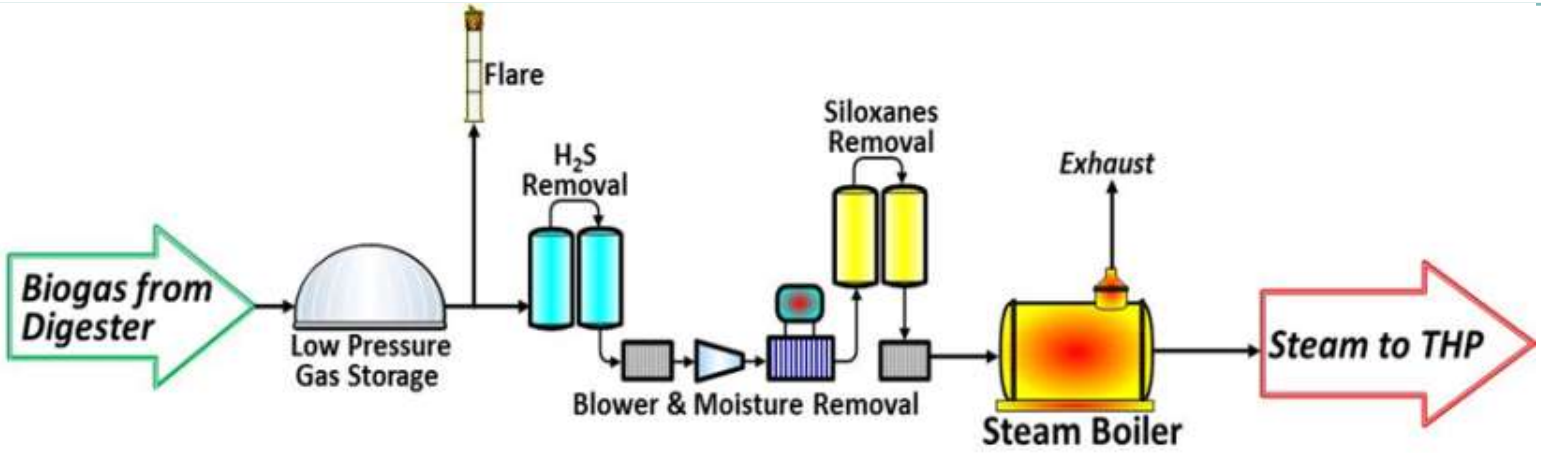
- Produce steam for THP and FOG pasteurization
- Convert biogas to an energy ‘commodity’ with value to the City
- Best life cycle cost solution
- Minimize risk / maximize flexibility

Options Evaluated

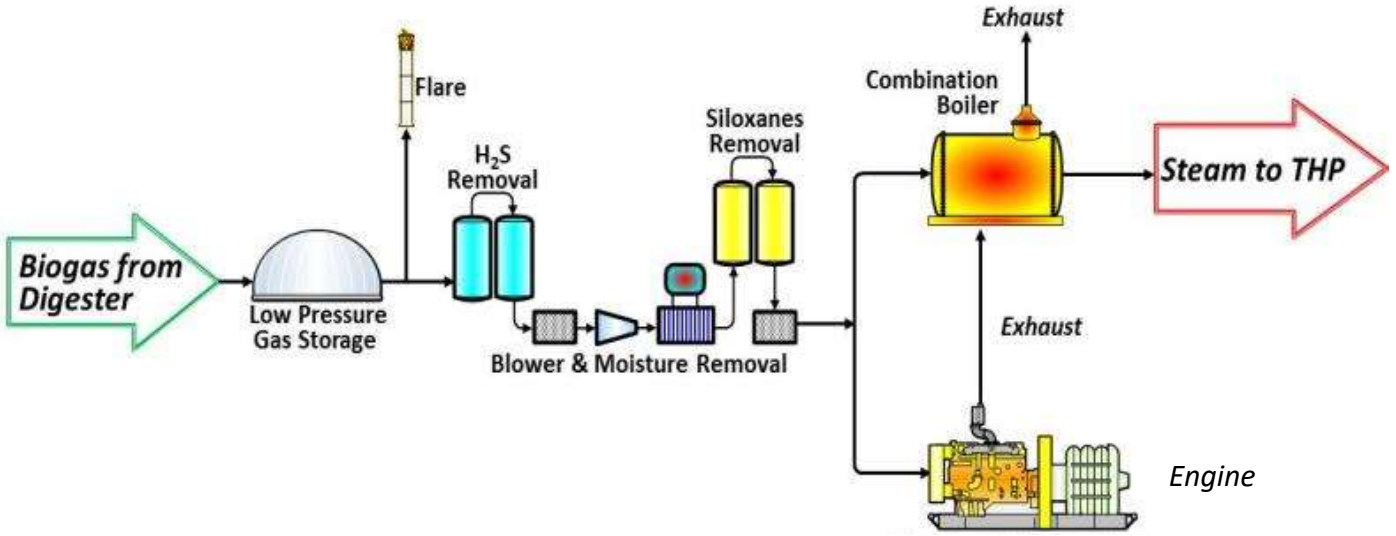
- **Base Option: Steam boiler only**
- **Engine driven blower**
- **CHP with engine generators**
- **Vehicle Fuel (buses)**
- **Vehicle Fuel (garbage trucks)**
- **Vehicle Fuel (both)**
- **1 MW CHP and RNG to buses**
- **2 MW CHP and RNG to buses**

- Pipeline injection ruled out during screening – no suitable sized main available locally

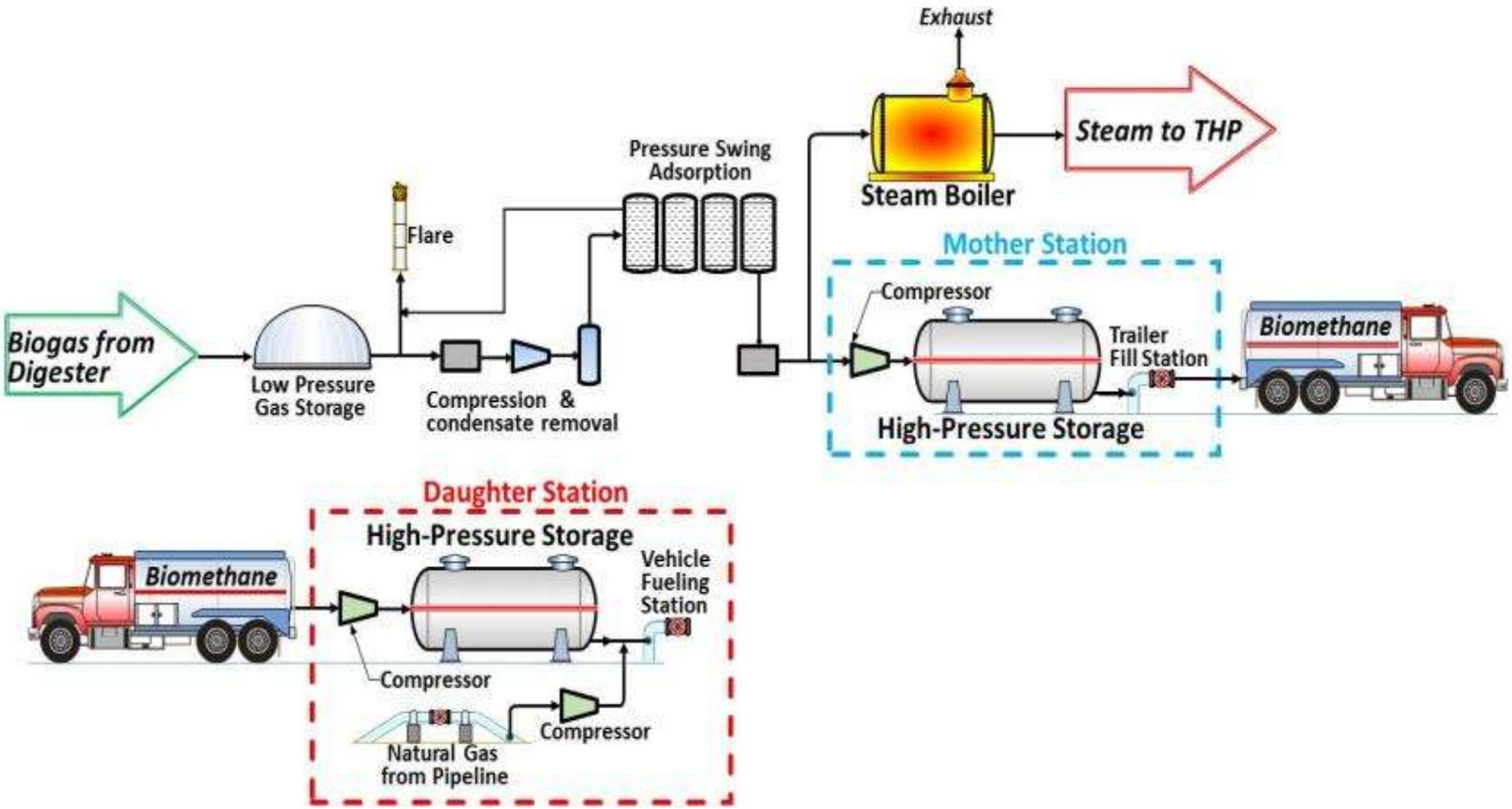
Base Option: Steam Generation Only



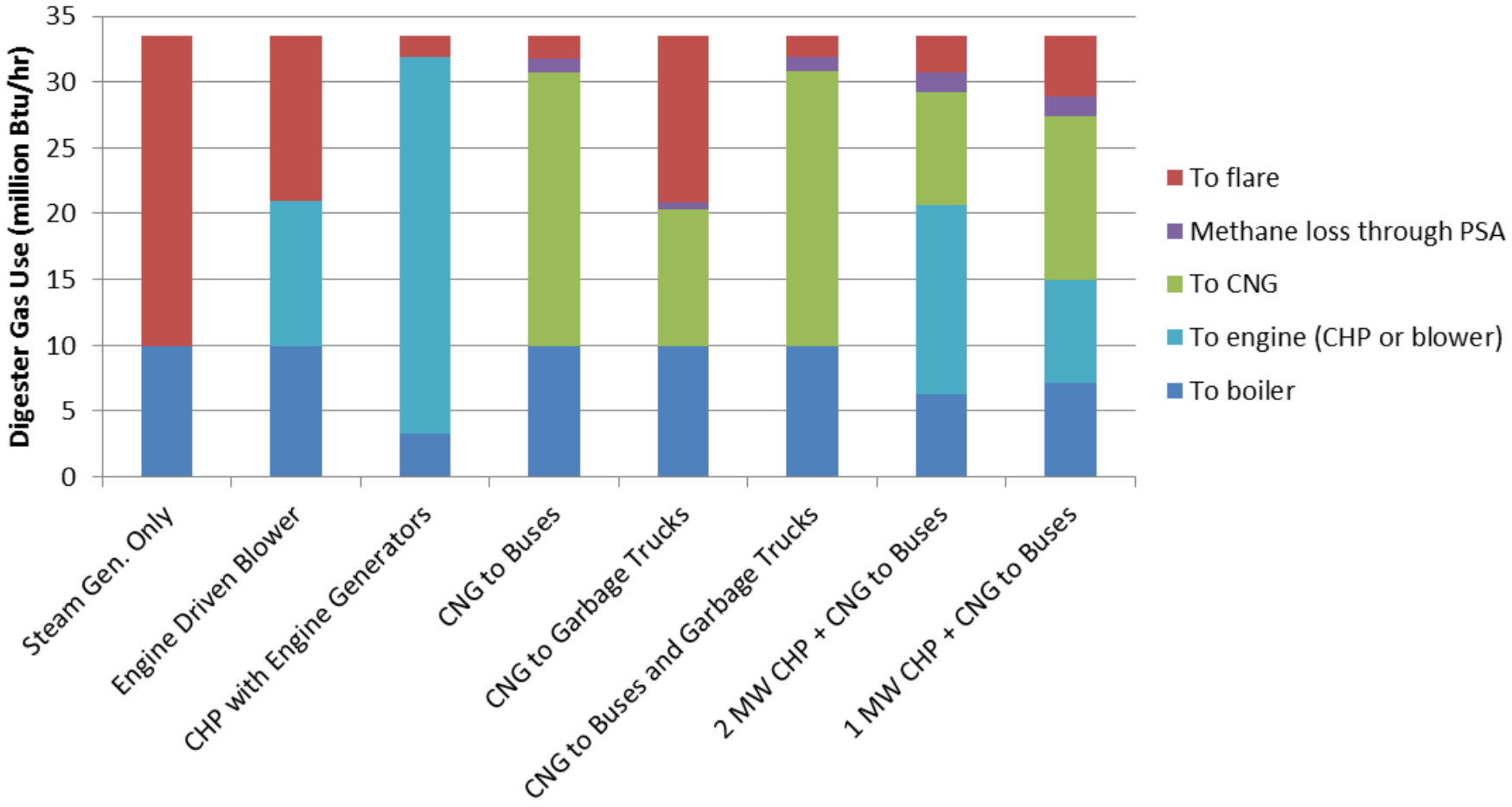
Engine Driven Blower / Engine Generator



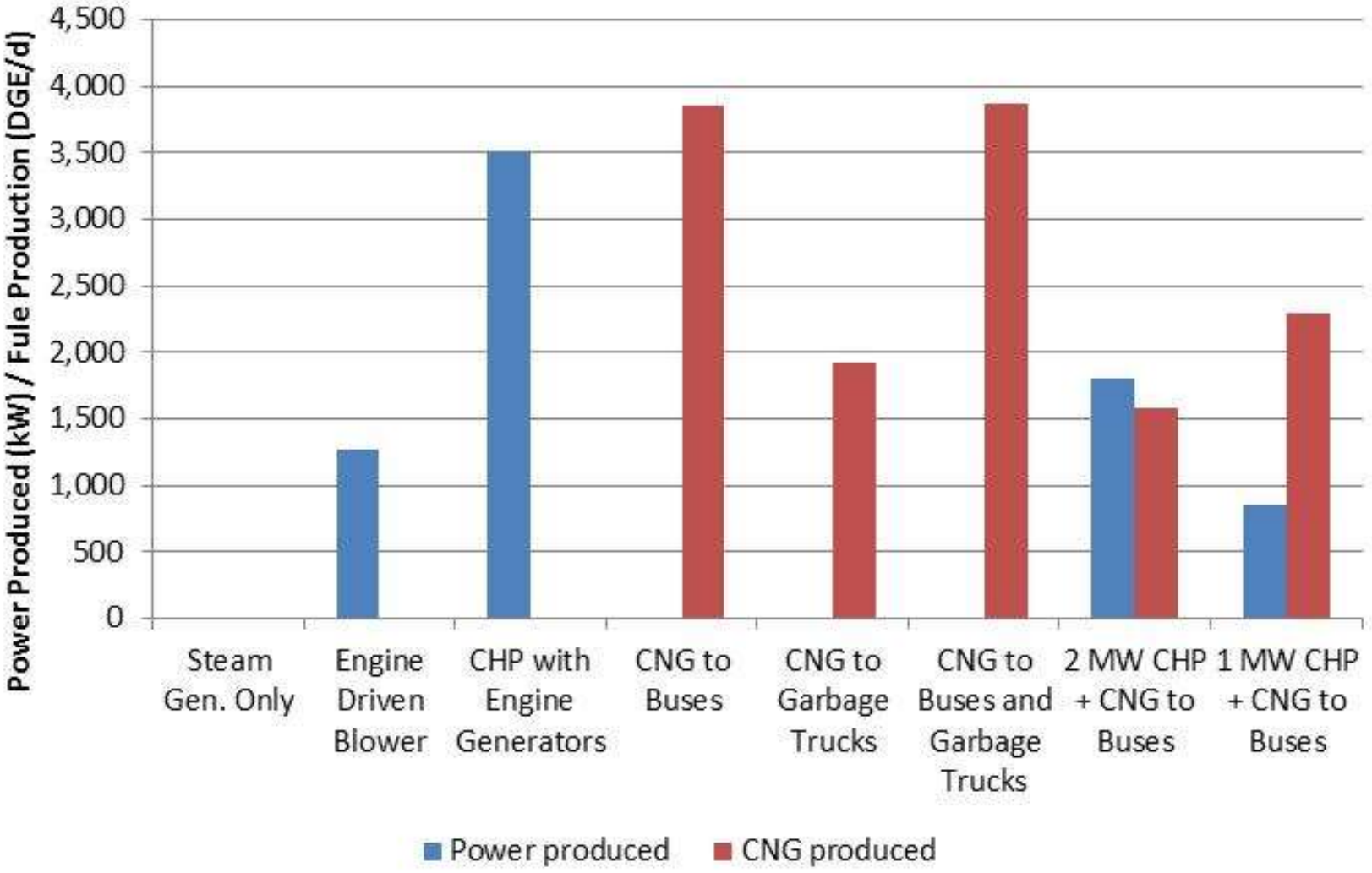
CNG to Buses, Garbage Trucks, or Both



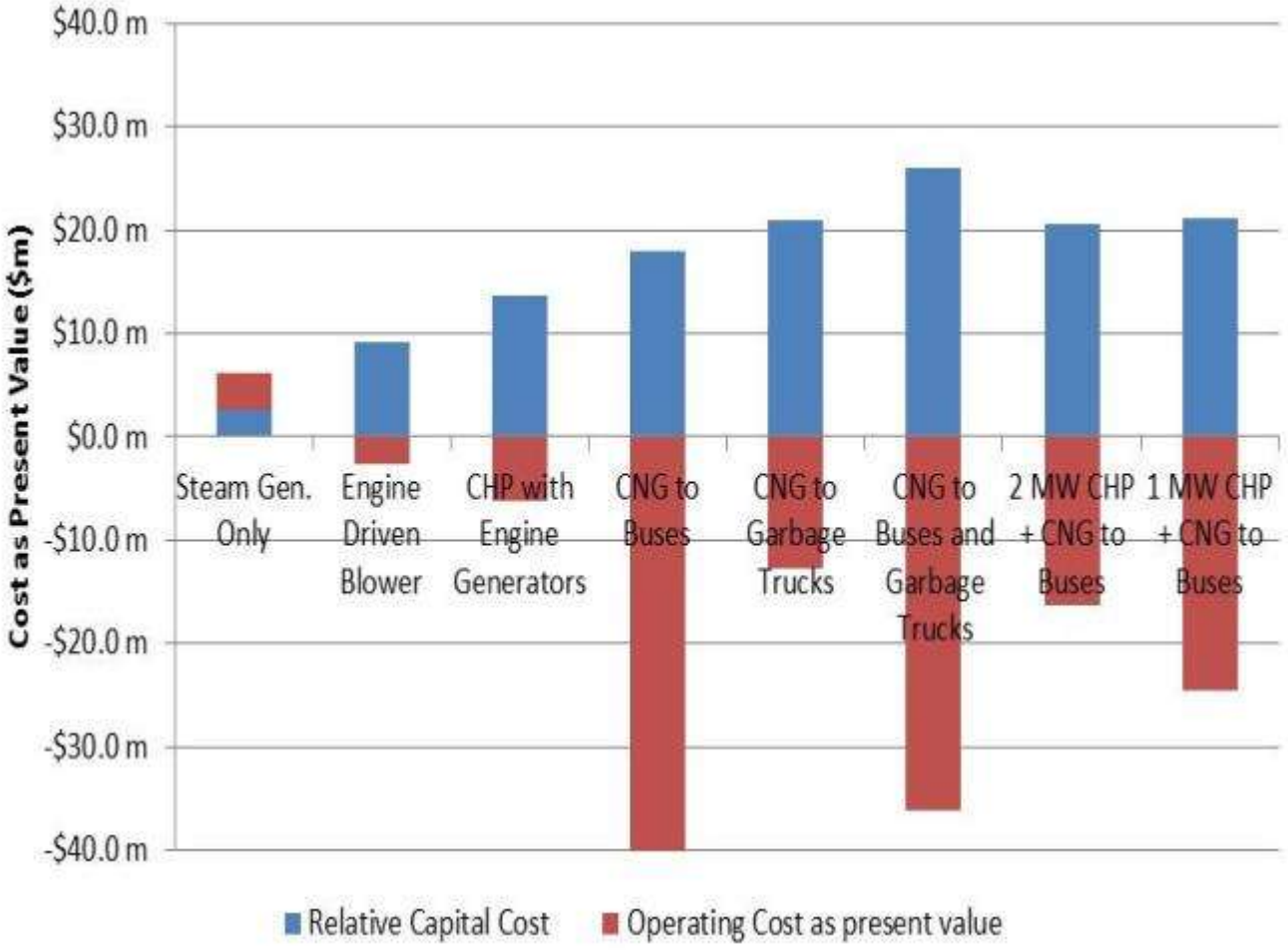
Results – Biogas Usage



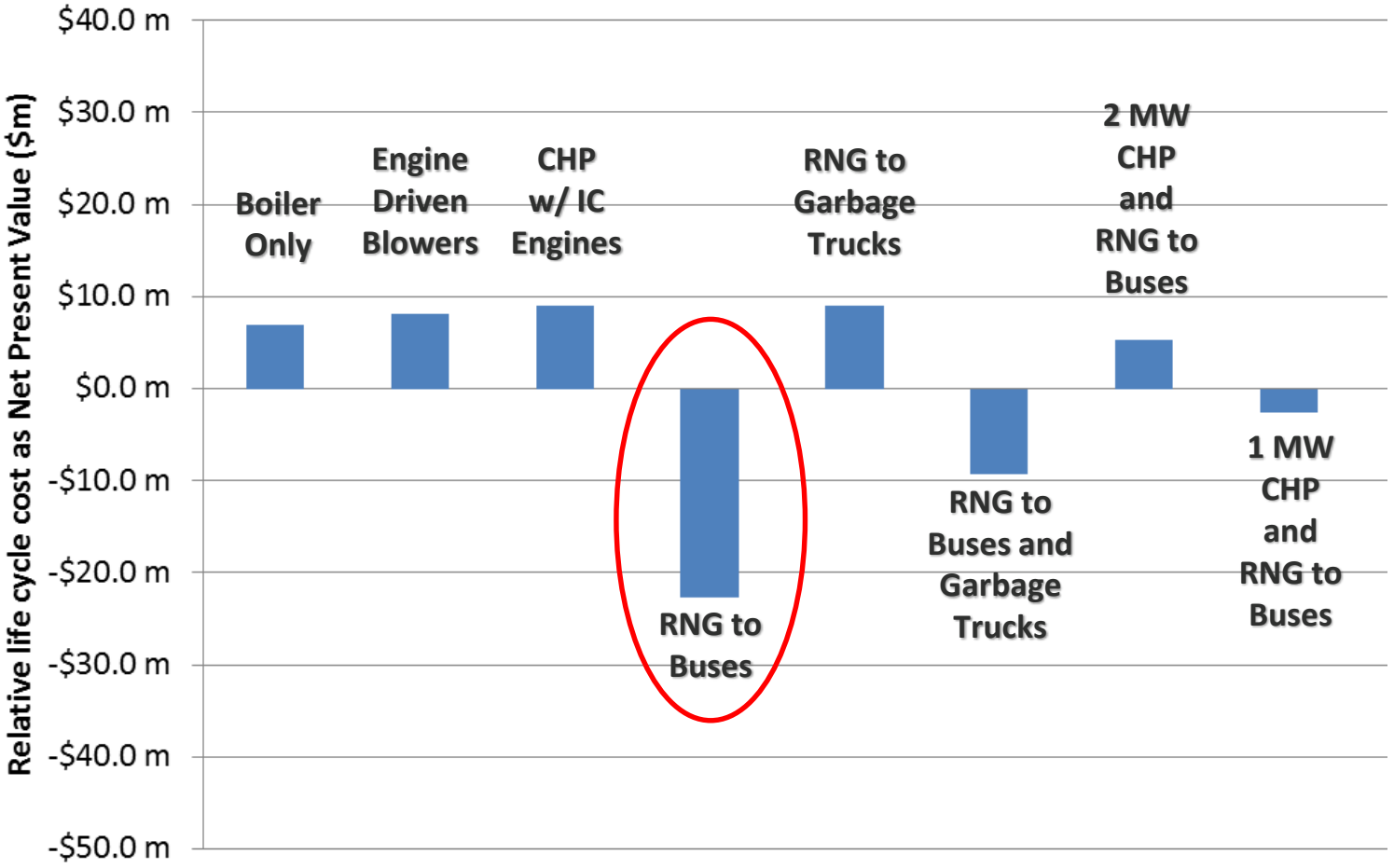
Energy Balance Results- Power Production



Life Cycle Evaluation: Capital and Operating Costs



Results – Net Present Value Comparison



(Negative is favorable)

Incentives & Funding

RINS

- Identification numbers used by the EPA to track renewable transport fuels in terms of compliance with the Renewable Fuel Standard (RFS)
- RFS is a federal program which requires vehicle fuel to be blended to contain a prescribed quantity of renewable fuel
- Program assigns renewable volume obligations to fuel suppliers
- CNG from digester gas will qualify for D3 Cellulosic RINS (category expanded in 2014)

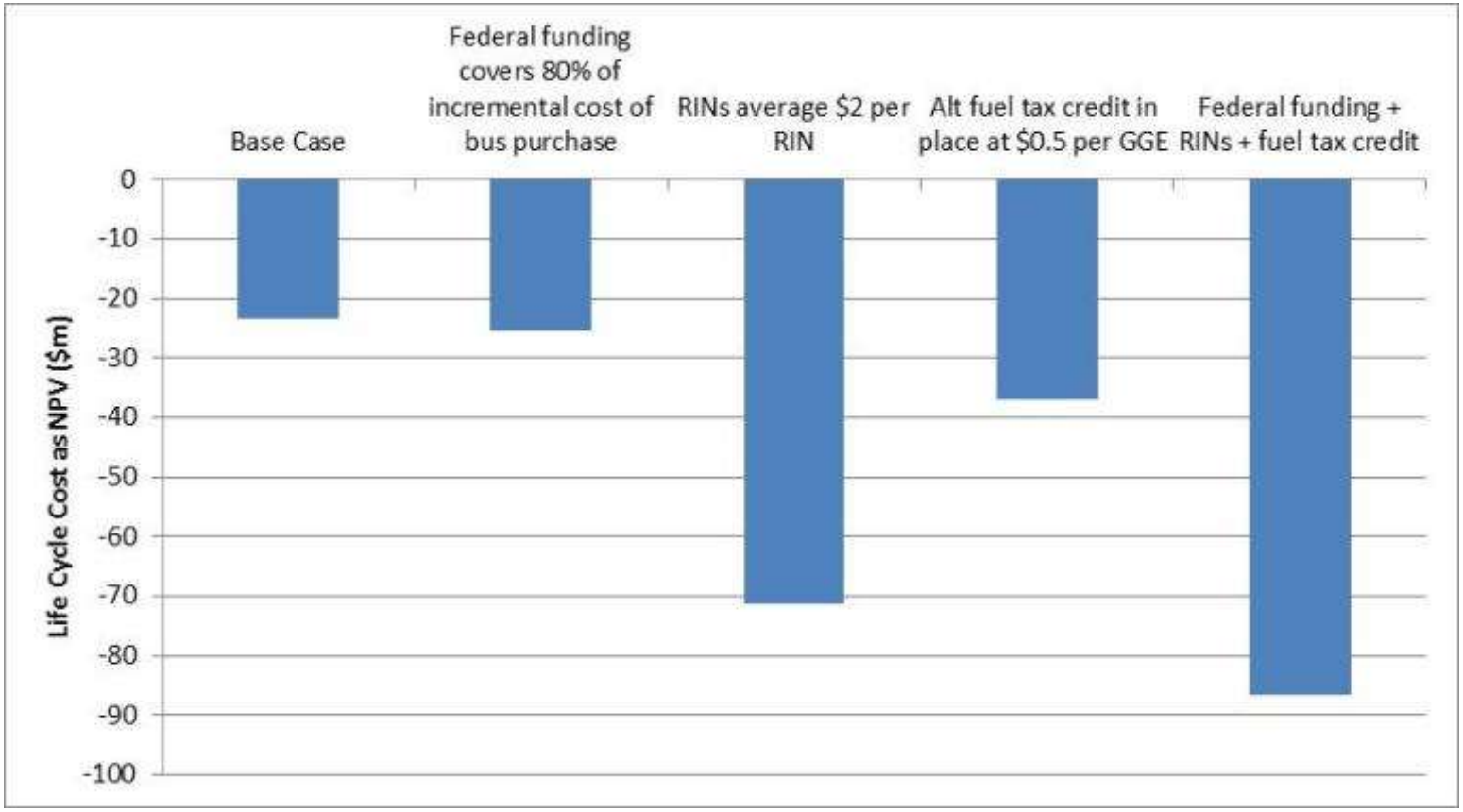
Bus Purchase

- 80 % funded by federal government (12 year minimum service life)

Alternative Fuel Excise Tax Credit

- Tax incentive for compressed natural gas (CNG) and liquefied natural gas (LNG) when used as a motor vehicle fuel
- $0.50 per GGE

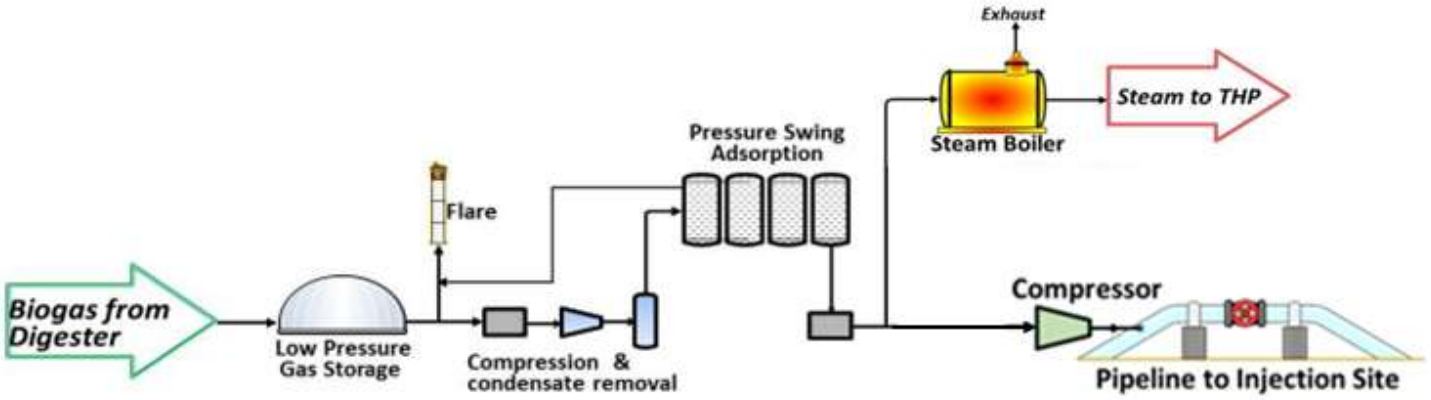
City buses - Cost Sensitivity to Incentives



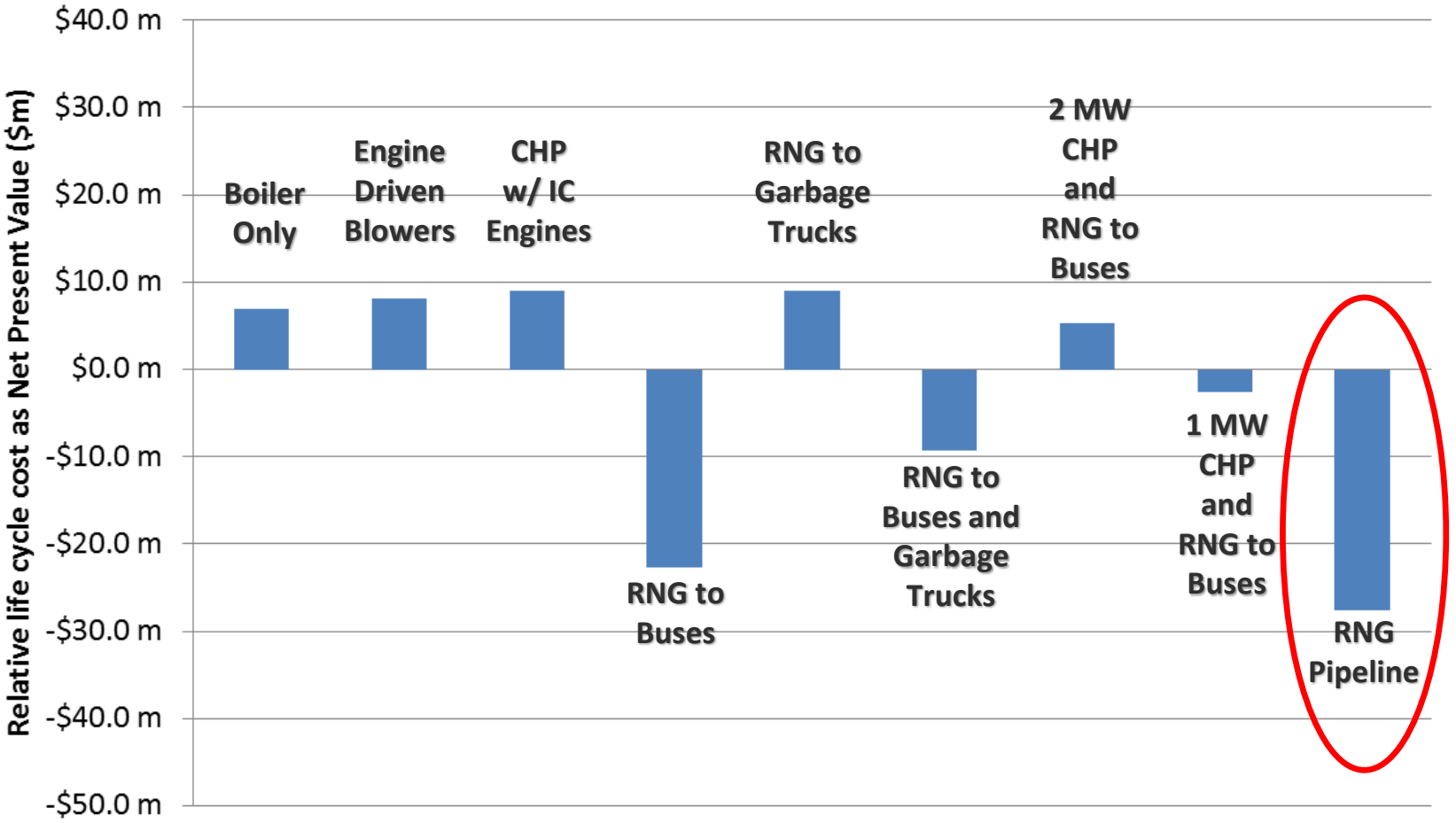
Conclusion: biogas clean up for use in City buses = most attractive option

A Pipeline Injection Alternative

- Considerations
  - City bus fleet conversion likely > 5 yrs away
  - New PSNC regional gas pipeline on NRRRF Site
- City approached by PSNC regarding new gas transfer main through Neuse River Facility
- Phased RNG Alternative
  - 1: RNG to pipeline (direct sale or third party offtake)
  - 2: RNG to City transport via third party offtake



Updated Net Present Value Results



Technology Evaluation

Biogas Upgrading Technologies

Pressure Swing Adsorption
(Source: Guild Molecular Gate**)**

Selective Membranes
(Source: BioCNG)

Water Scrubbing
(Source: Green Lane)

Amine Scrubbing
(Source: Purac)

Vendor proposals

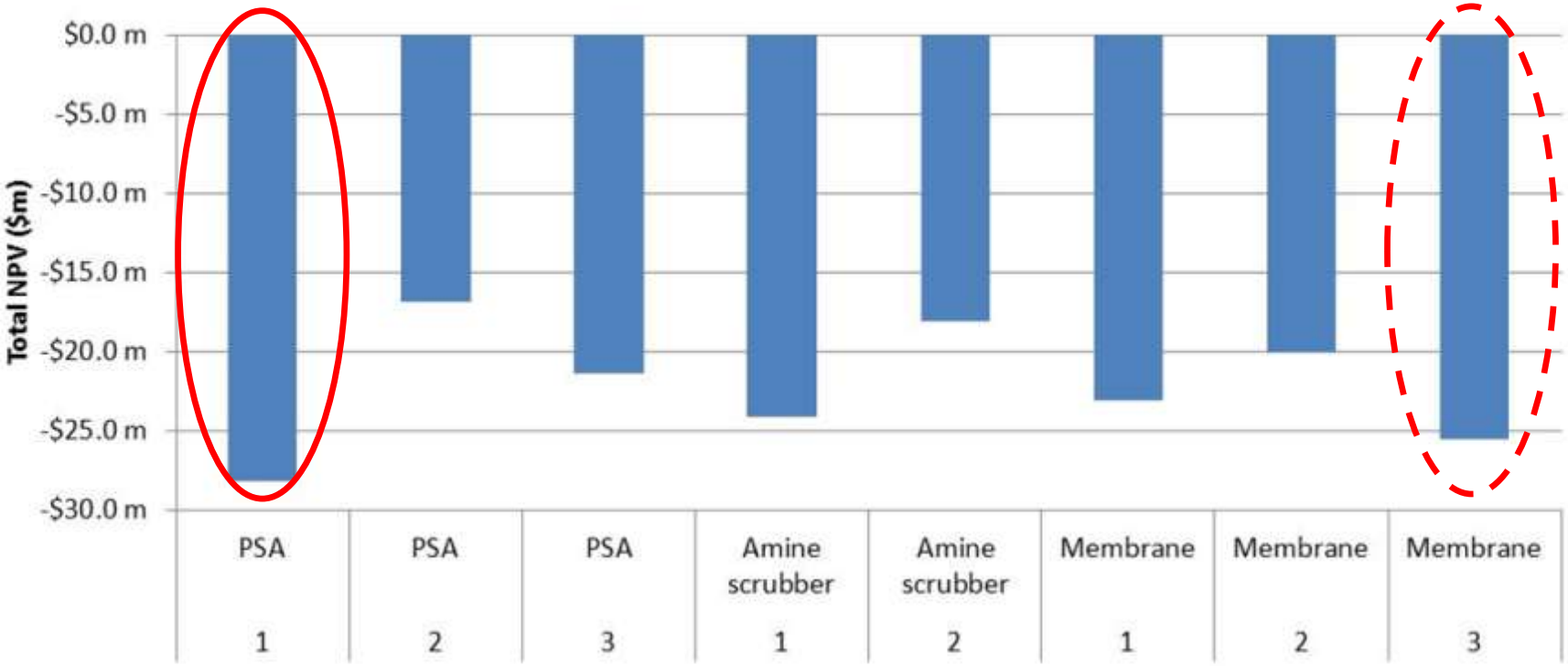
Options Evaluated:

- **4 pressure swing adsorption technologies**
- **2 amine scrubbing technologies**
- **3 selective membrane technologies**

Options Not Evaluated:

- **Water scrubbing: Leading vendors of water scrubbing technology in the USA proposed a PSA system instead**

NET PRESENT COST OUTCOME



(Negative is favorable)

Next Steps

- **City transport department has confirmed feasibility of CNG vehicle fuel program**
- **PSNC have confirmed pipe routing will be local to NRRRF**
  - **Discussion ongoing regarding injection of gas from NRRRF**
- **Bioenergy Project is in detailed design**

Thank You!

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