working for clean rivers

Columbia Boulevard Wastewater Treatment Plant Biogas Utilization Technology Experiences

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ENVIRONMENTAL SERVICES
CITY OF PORTLAND

NICK FISH, COMMISSIONER
MICHAEL JORDAN, DIRECTOR

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Columbia Blvd WTP

Anaerobic Digestion

- Treatment process for solids removed from wastewater
- Heated and mixed process
- Generates biosolids and anaerobic digester gas

“Traditional” Biogas Usage At CBWTP

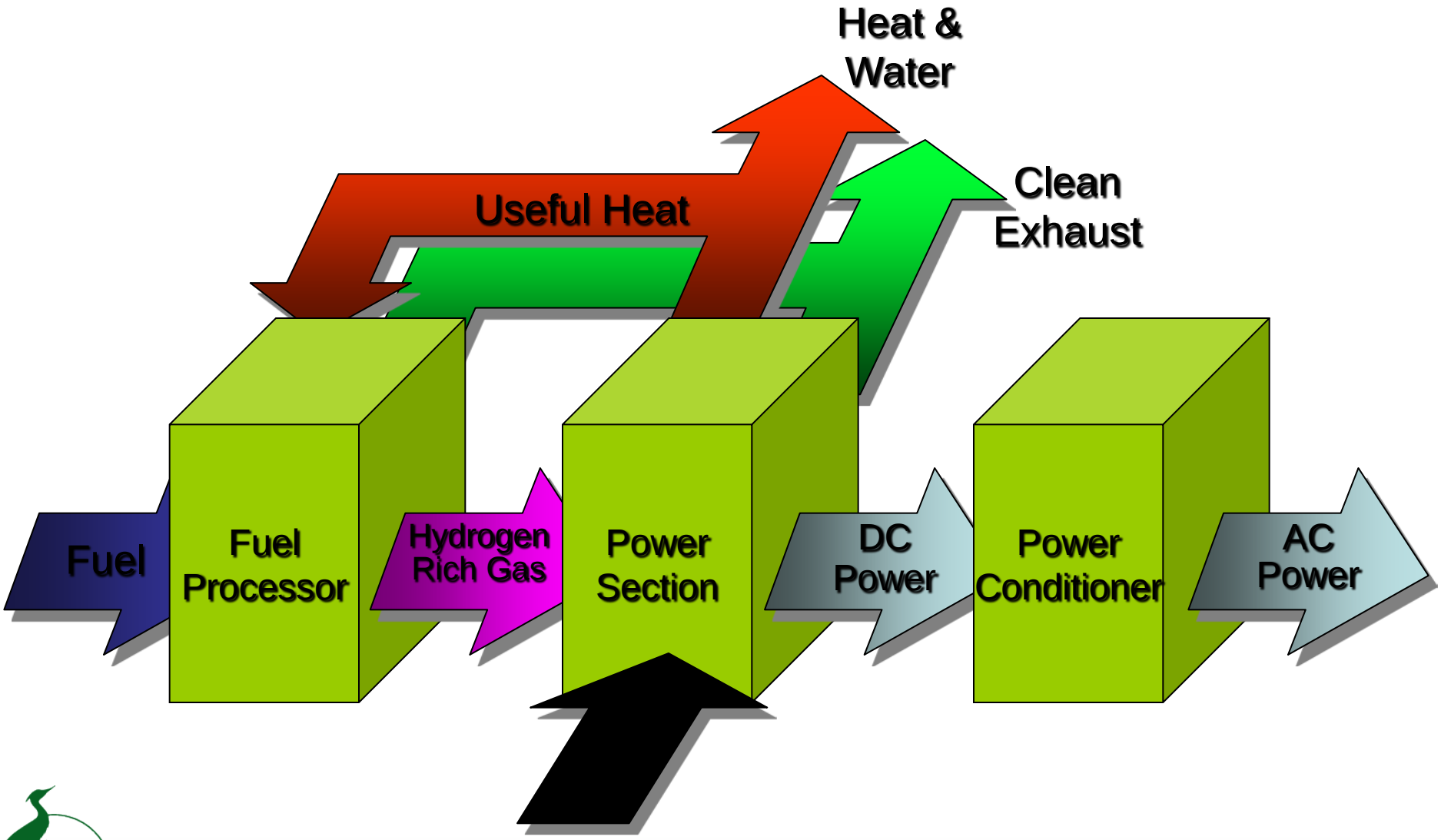
- Boilers
  - Digester heat
  - Facility heat
- Malarkey Roofing
  - $180K to >300K per year!
- Flares….

Biogas Technologies Evaluated

- Fuel Cell
- Micro-Turbines
- Internal Combustion Engine-Generators

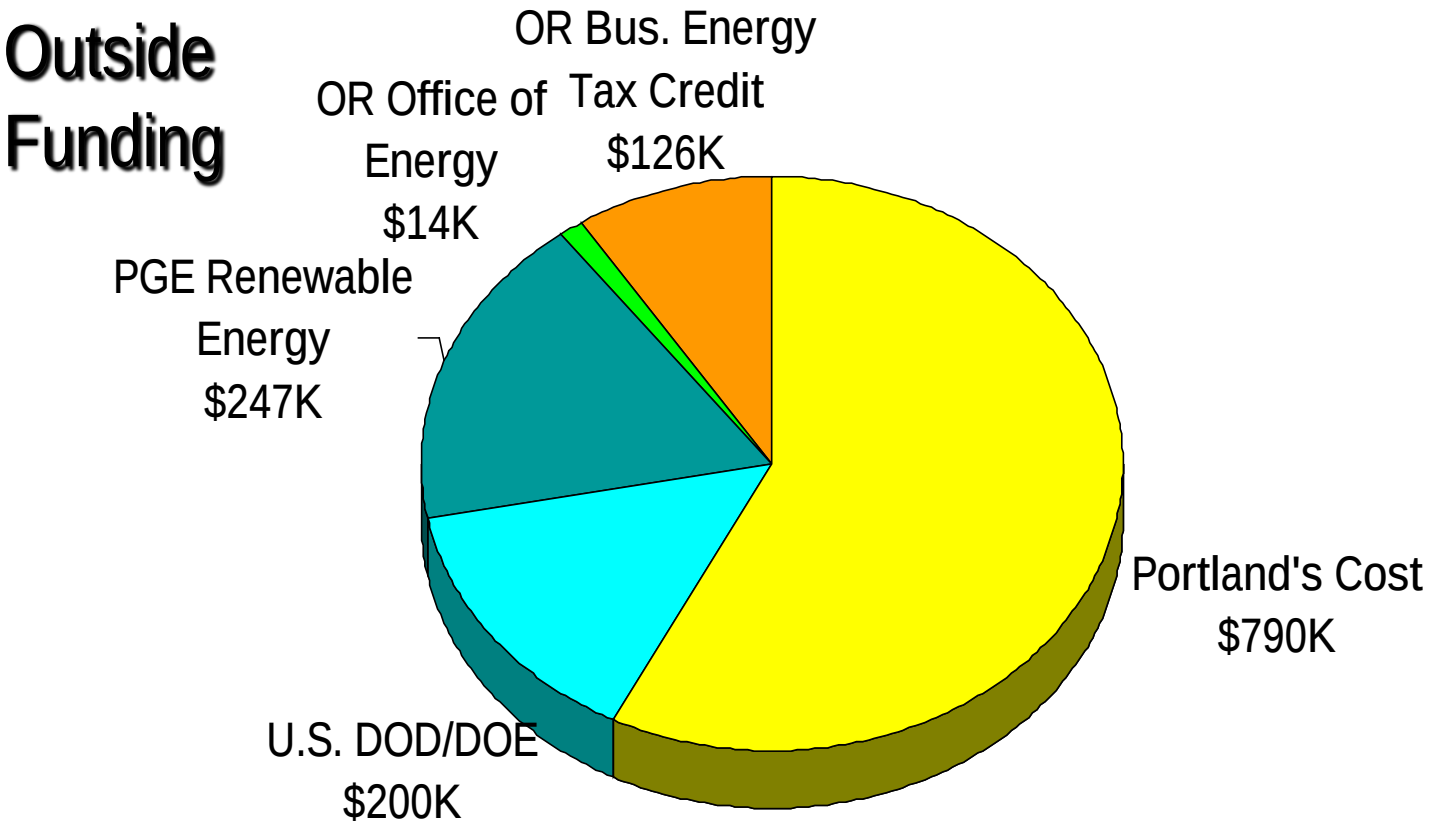
200 kW Phosphoric Acid Fuel Cell - 1999

Fuel Cell Power System



Fuel Cell Cost Funding Pie Chart:

Total Cost: $1.3 Million
$6,500 /kW



Design and Installation Issues

- Waste Heat (low temperature)
- Scrubber Carbon
  - Sulfur Content/Gas Contamination
- Moisture Trap
- Supply Pressure
- Water Treatment
- Fuel Piping Size

Estimated Annual Operation

- Produces 1.4 MWh/year
- Revenue $60,000/year
- Maintenance cost $10,000
- Annual Stack Replacement Cost
  - $22,000 x 6 years = $ 132,000

Operational History

Year	Operating Time (hrs)	Operational Uptime (%)	Grid MWh Delivered	Energy Savings ($)	Maintenance Cost ($)	Fuel Consumed (MSCF)
1999-2000	6,166	70	901	58,565	18,069	16.2
2000-2001	6,858	97	872	56,654	34,575	16.1
2001-2002	6,474	74	824	53,586	40,861	15.3
2002-2004 (Avg)	6,031	69	737	47,873	37,066	13.8

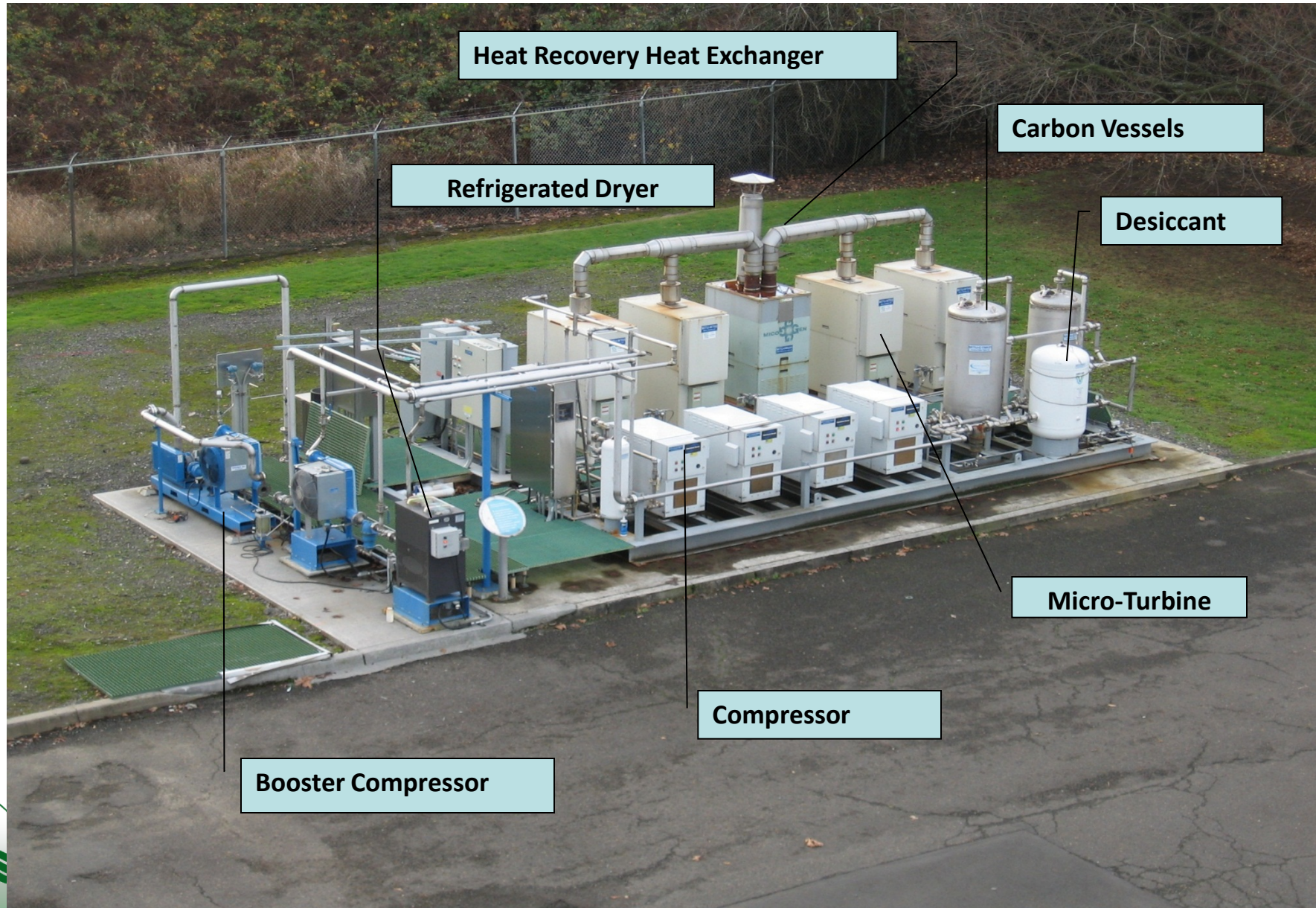
Fuel Stack Replacement after 5 years = $250K to $300K!

Decommissioned January 2005

Fuel Cell Project Benefits

- Better understanding of Cogen technology
- Learned how to benefit from Oregon Business Energy Tax Credit
- Ratepayers and general public feel good about the project
- Made way for Micro-Turbine technology

Micro-Turbines - 2003



Micro-Turbines Cost Data

- Purchased 4 units @ 30kW each = 120kW
- Purchase cost = $300,000
  - Turbines, compressors, heat recovery, gas processing, and electrical
- Estimated installation cost $46,000
- Total cost: $346,000 or $2,883 per kW
- Cost after BETC pass through = $309,000 or $2,575 per kW

Expected Performance

- Electric Output
  - 30 kW @ 480VAC, 60 Hz
- Efficiency
  - Electrical : 27%
  - Thermal: 53%
  - CHP: 80%
- Noise Levels
  - 65 dBA @ 33 feet
  - 83 dBA @ 2 feet

Operational History

- Installation and startup completed April 2003
- One month later, system shutdown due to excessive water, stayed down for 1-1/2 years
- Intermittent uptime – Dec 2004 to June 2007
- Decommissioned following startup of COGEN in 2009

Pencil It

	Proposal Basis (Annual)	Actual Dec. 2004 to June 2007
Run Time Hours	21,900 (30 months)	16,000 (not all running)
Production	890 MWh	480 MWh
Electric Bill Reduction	$40,000	$22,000
Maintenance Cost	$4,000	$17,000
5 yr rebuild costs	$10,000	???

Operational Lessons Learned

- Gas Treatment is Critically Important
  - Carbon Bed
  - Gas Drying
  - Siloxane Removal
- Equipment Requires Attention – not “Set and Forget”
  - Filter Cleaning
  - Carbon Media Replacement
- Design Issues
  - Hot Water Usage
  - Grid Independent Operation?
  - Integration into System; SCADA

Internal Combustion Engine-Generators

Engine Generators Cost Data

- Two Units @ 850kW Each = 1.7 MW
- Purchase Cost, Engines and Electrical: $1.4M
- 5 Yr Engine/Electrical Maintenance: $ 1.1M
- Total Cost: $ 7.9 Million or $ 4,650 per kW
- Cost After Oregon Energy Trust/BETC Pass-Through @ 25% (~$2.0 M):
  $ 6 Million or $ 3,500 per kW

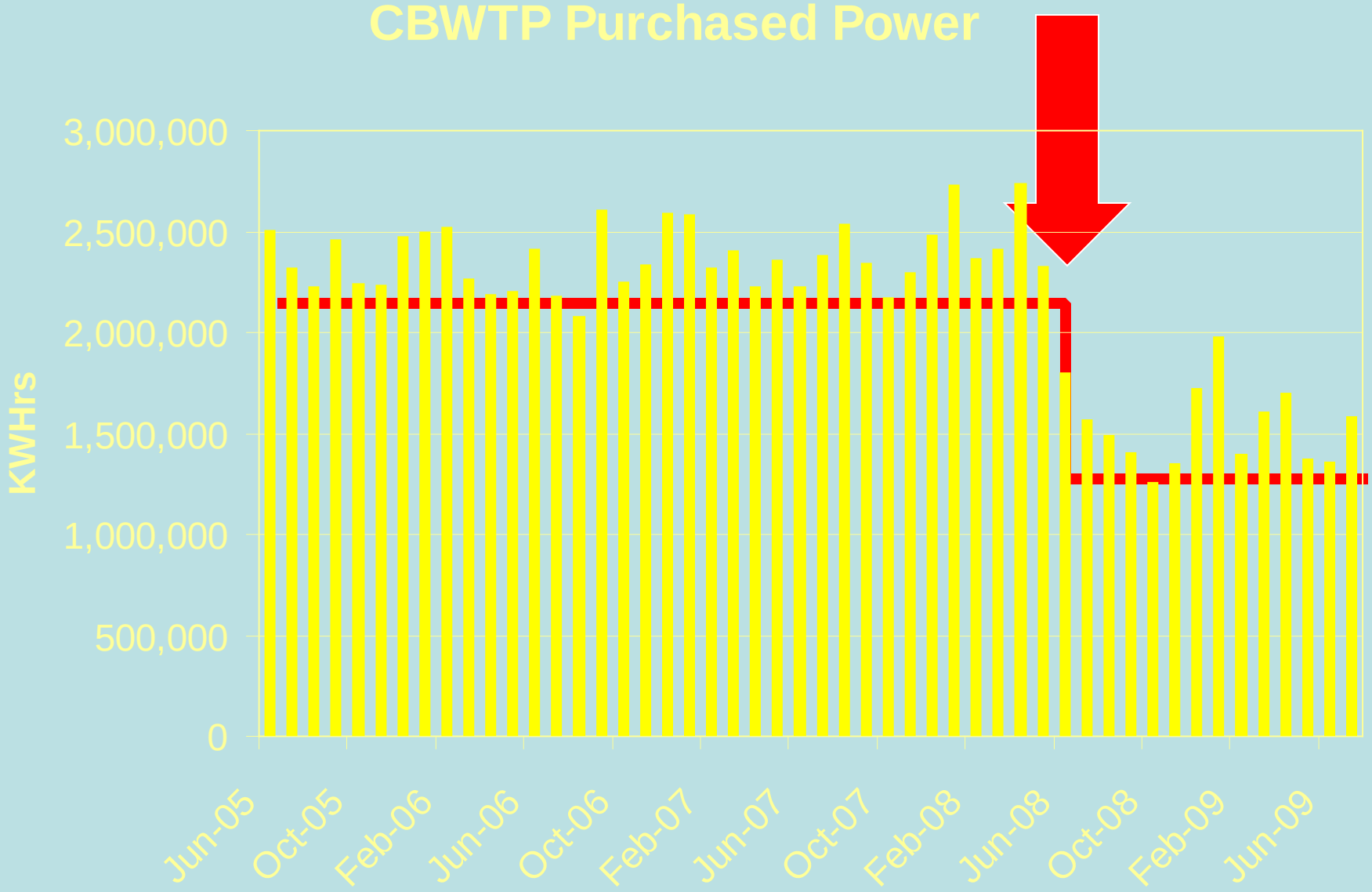
Expected Performance

- Electric: 850 kW Each @ 4160 VAC, 60 Hz
- Thermal: 3.6 MBTU /hr/ Unit
- Efficiency
  - Electrical: 37%
  - Thermal: 47%
  - CHP: 84%
- Noise Levels
  - 117 dBA @ 3 feet
- Emissions – Lean-Burn Combustion

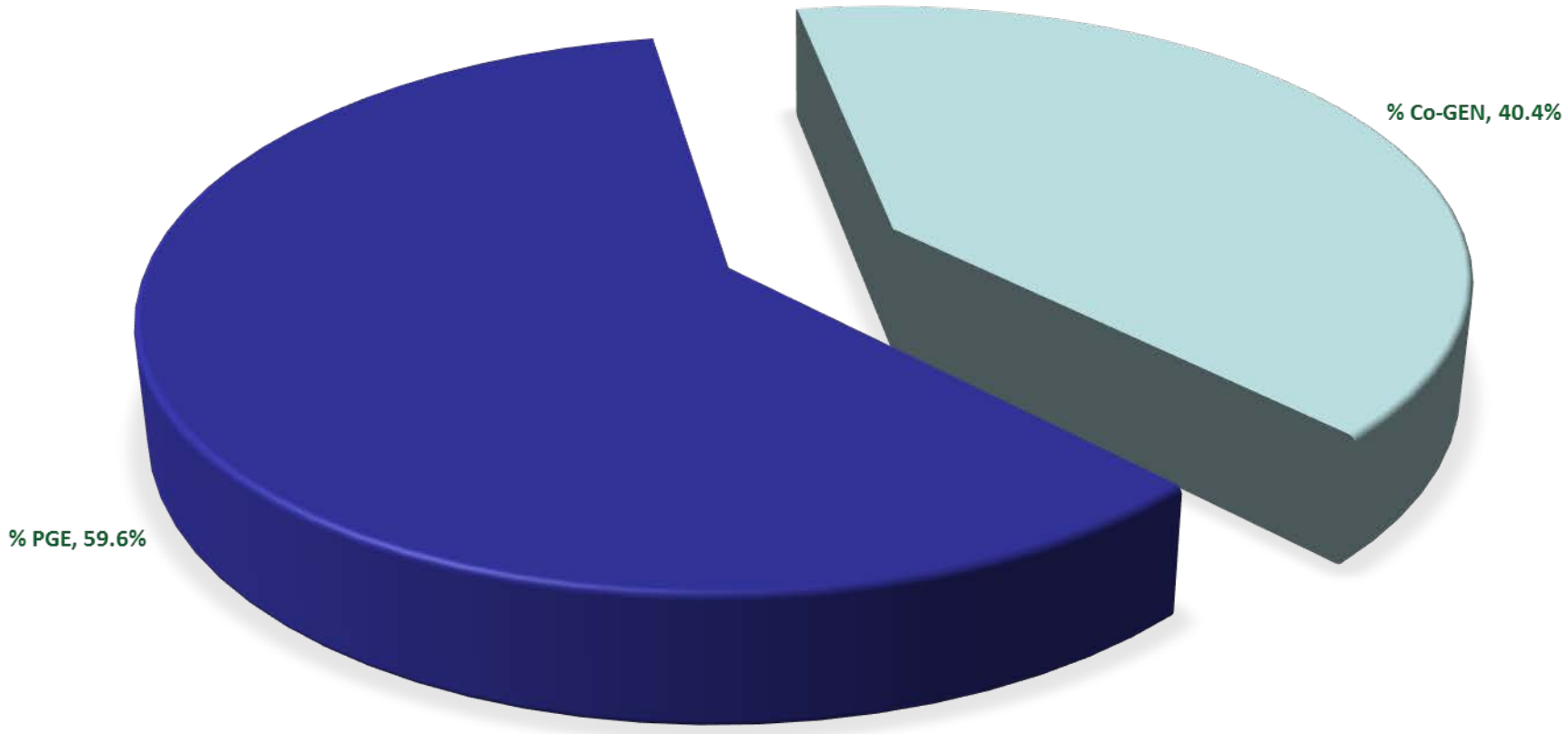
Digester Gas Treatment

- Skid Mounted, Vendor Design and Fabricate
- H_2S Scrubber
  - Iron Sponge
- Pressure Boost
  - 2.5 PSIG
- Moisture Removal
  - 40 degree F Dew Point
- Siloxane Scrubber
  - Activated Carbon

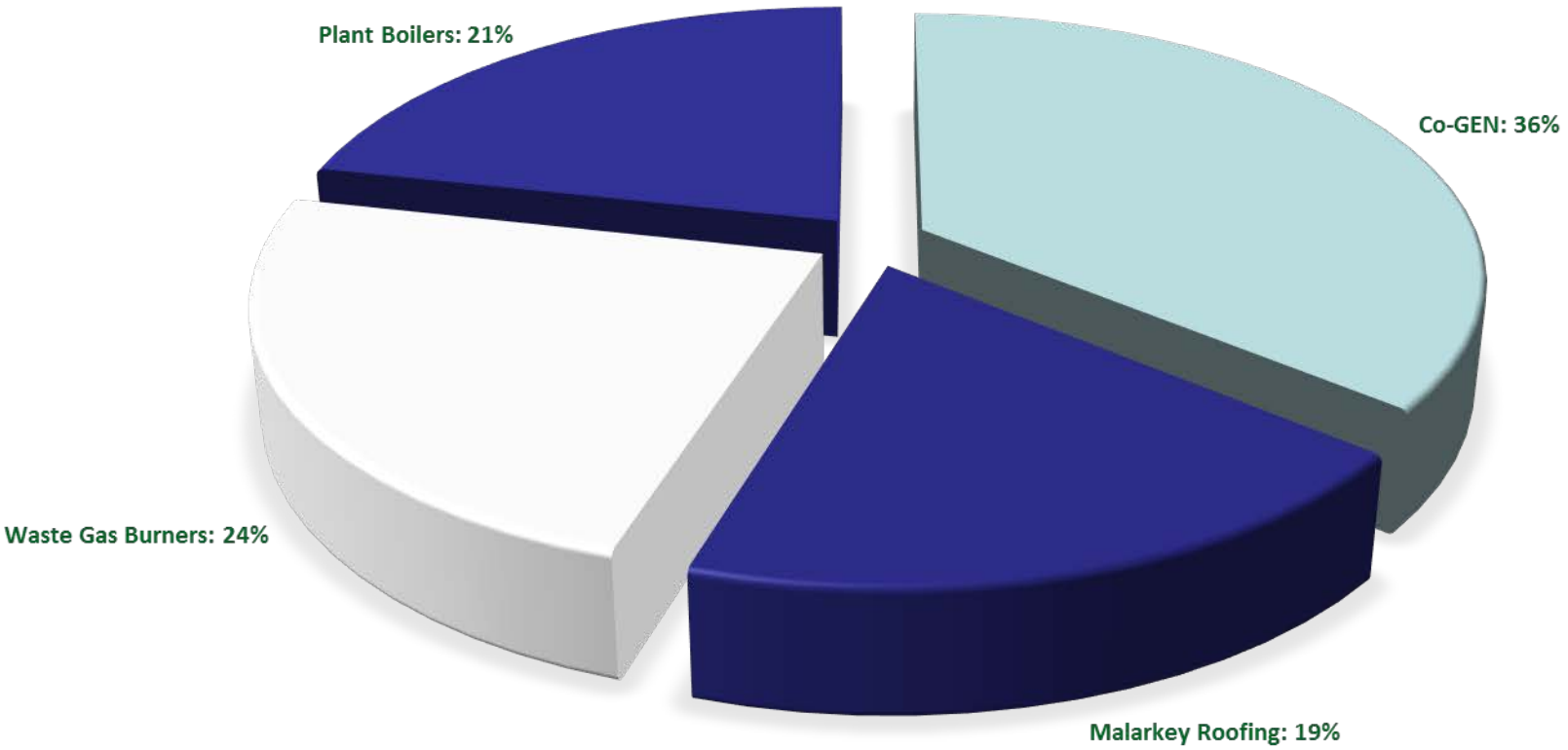
CBWTP Purchased Power



CBWTP Electrical Power FY13-17 Average



CBWTP Gas Utilization FY15-17 Average



COGEN Performance History FY15-17

- Uptime: 90%
- Power Generation: 15,300,000 kWh/yr
- Approximately $1M/year utility bill reduction
- $211K/year O&M Costs

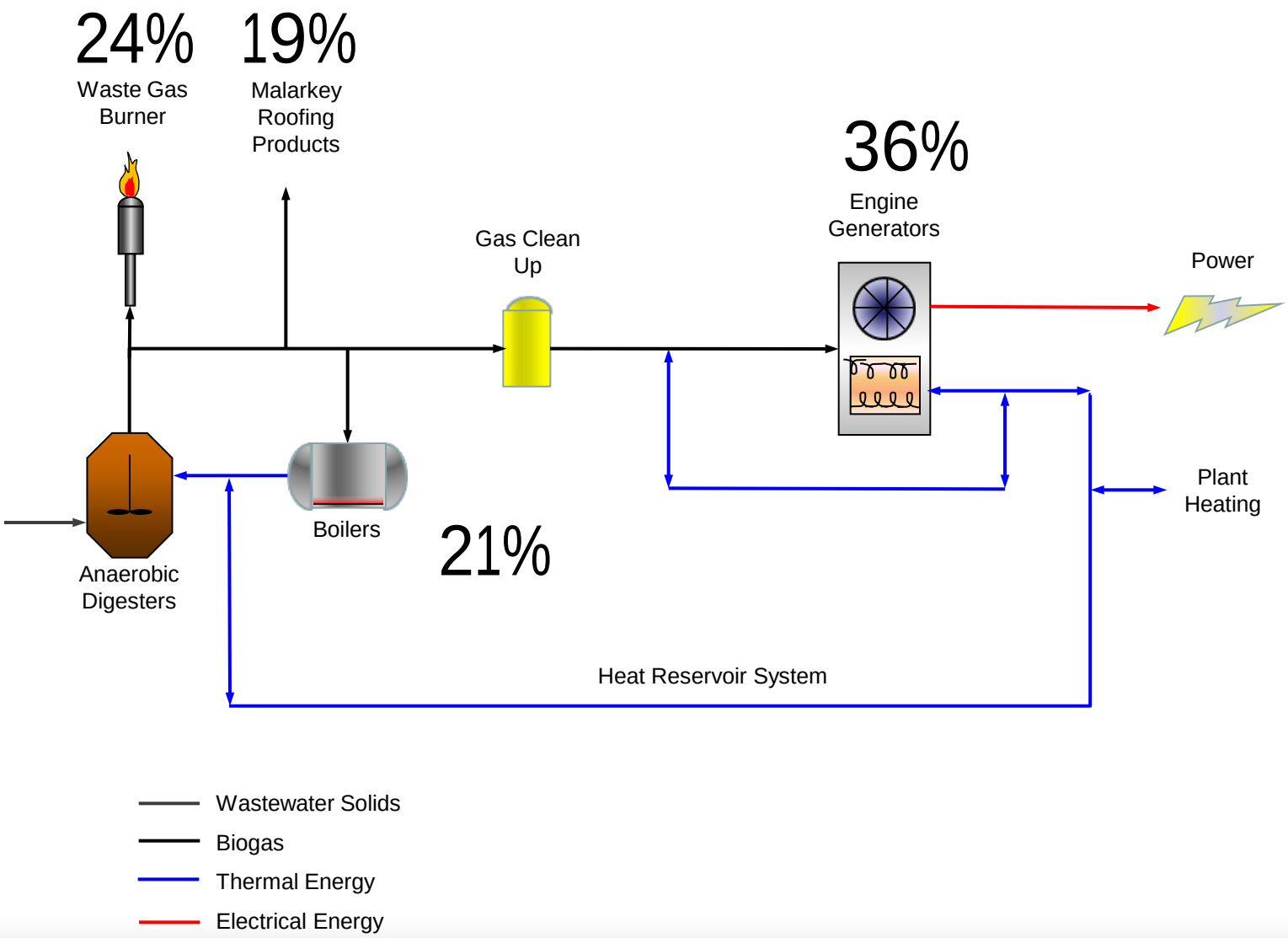
Lessons Learned

- Biogas Treatment
- Heat Balance – Use and Waste
- Power Company Coordination (PGE)
  - Grid Synchronization
  - Grid Independent Operation (no, in our case)
  - Buy Back Power or Trip?
- Engine
  - Housing
  - Load Follow, Fuel Follow?
  - Auxiliary Motor Control and Interlocks
- Communications and Monitoring

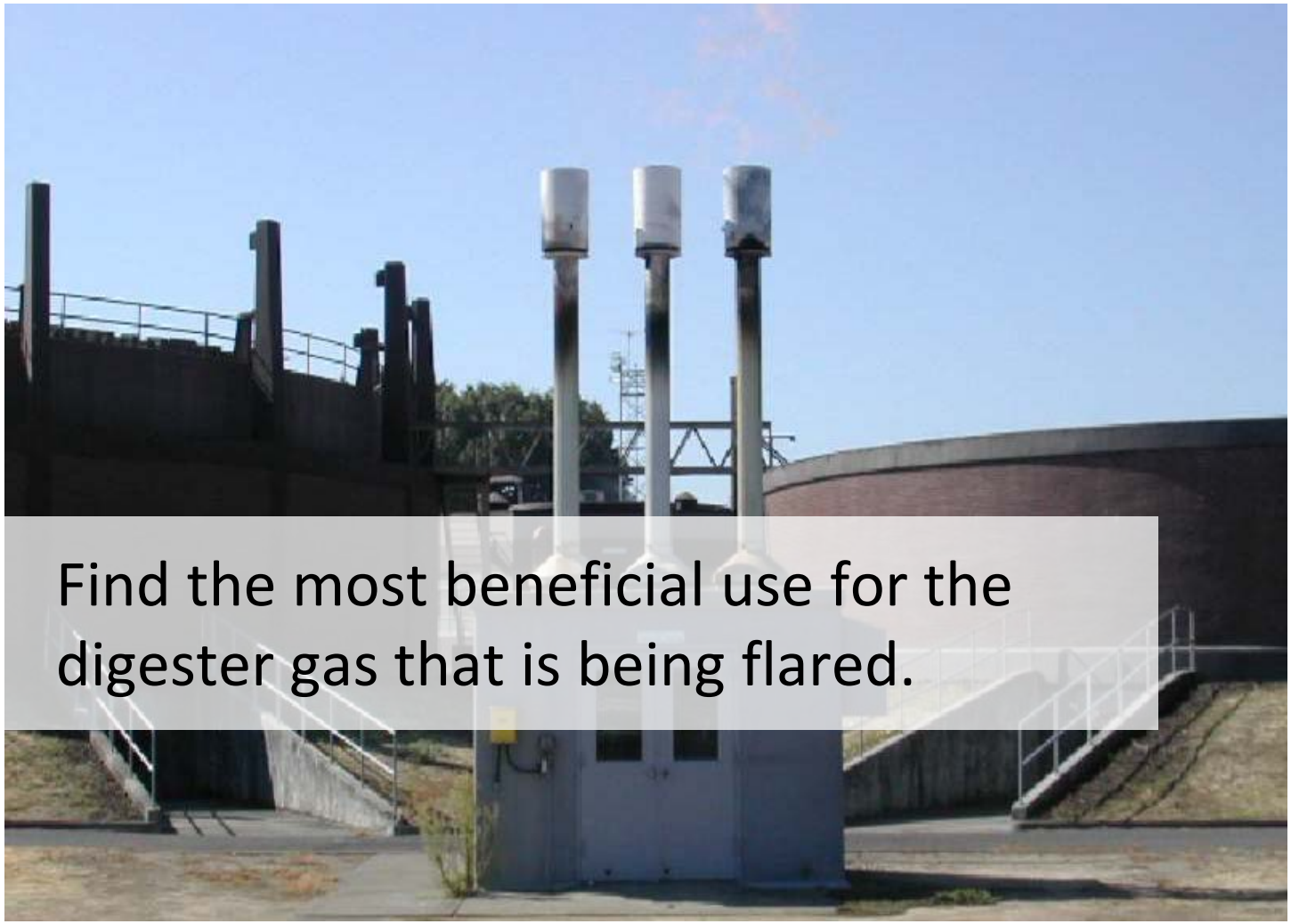
Operational Lessons Learned

- Performance is not NPDES permit related
- Waste heat system inadequate
- Iron Sponge Media life shorter than expected

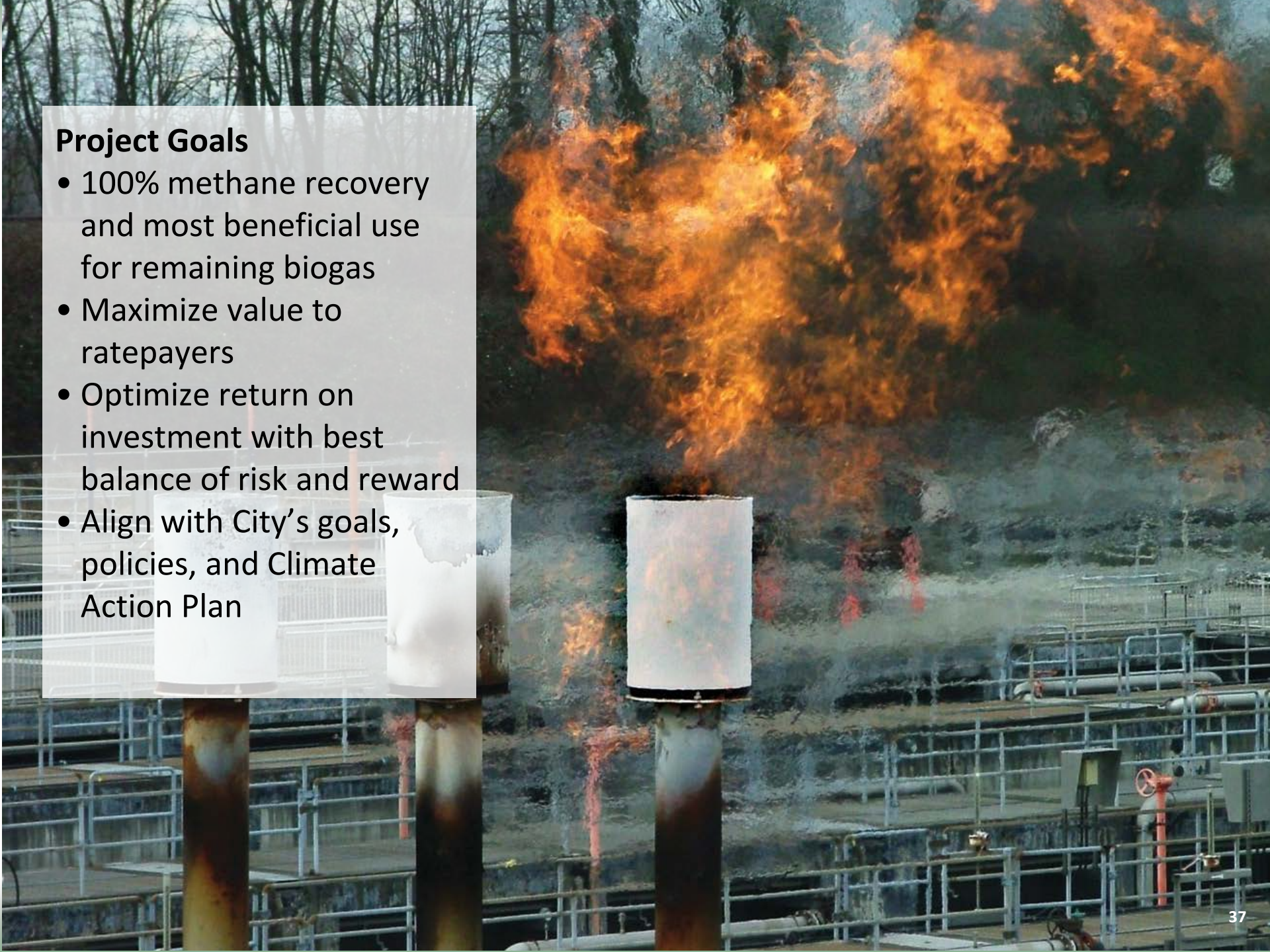
Current Biogas Utilization



Biogas Utilization (Encore)



Find the most beneficial use for the digester gas that is being flared.



Project Goals

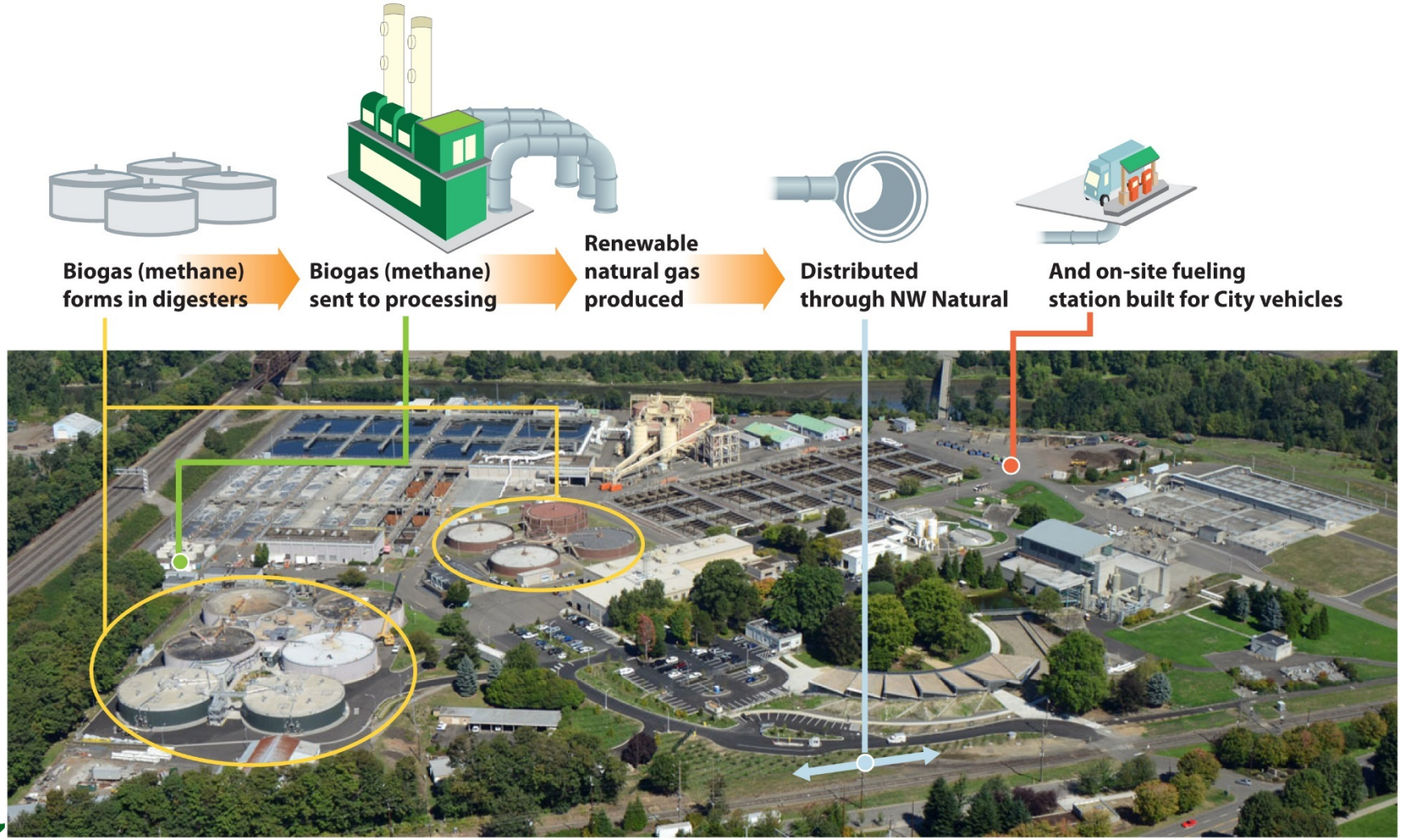
- 100% methane recovery and most beneficial use for remaining biogas
- Maximize value to ratepayers
- Optimize return on investment with best balance of risk and reward
- Align with City's goals, policies, and Climate Action Plan

Future CBWTP Gas Utilization Technology

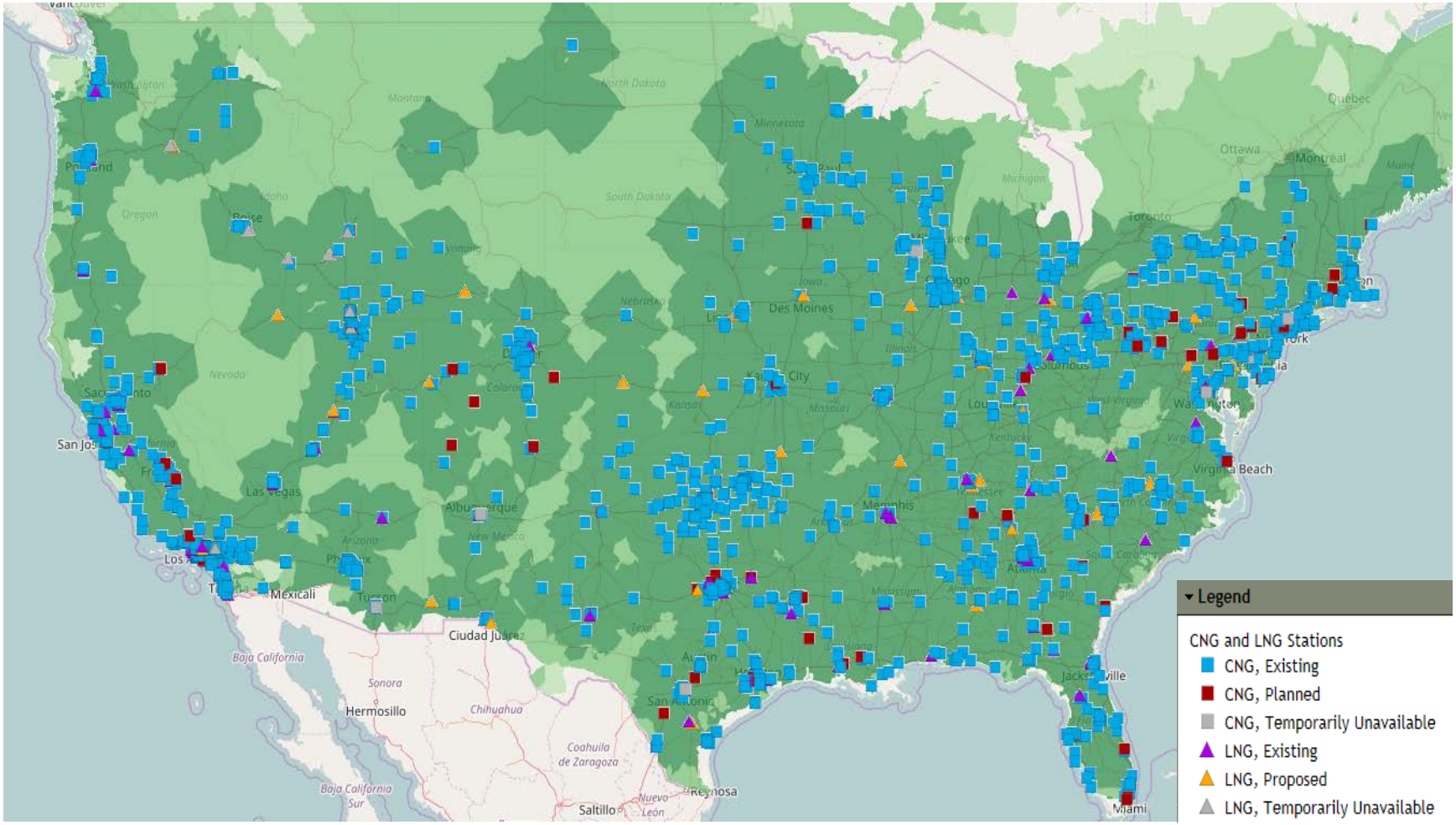
Alternatives Analyzed

ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Cogeneration Expansion without Biogas Storage	**Cogeneration Expansion with Biogas Storage**	**Biogas Treatment for Vehicle Use**	**Biogas Treatment for Sale to Industry/ Pipeline Injection**	**Biogas Used in Biosolids Drying**

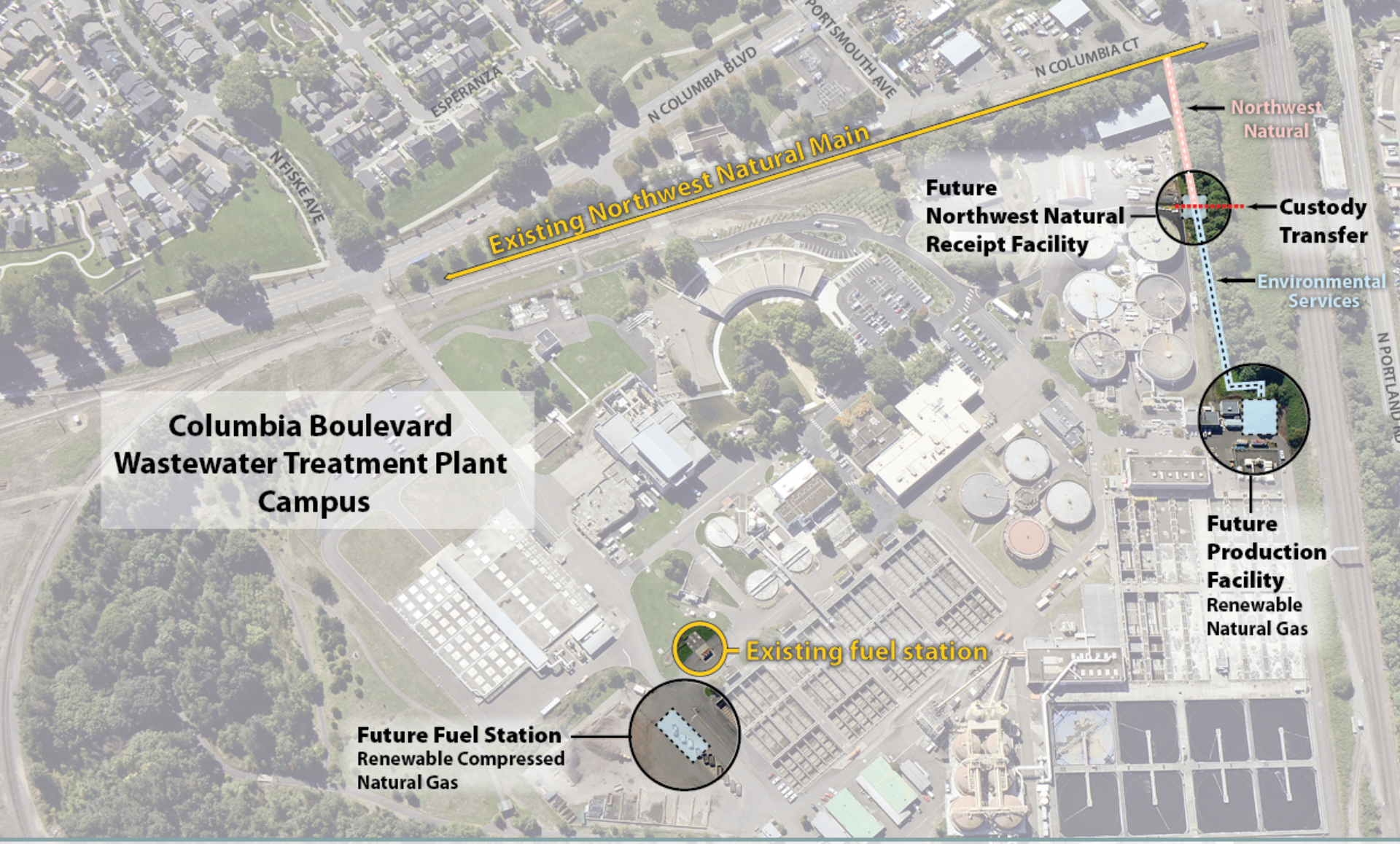
Pipeline Injection for Transporting RNG



Map of CNG Fueling Stations in the U.S.



Source: NGVAmerica



Biogas (Methane) to Renewable Natural Gas Facilities

RNG Production Technology (Water Wash)

Source: Greenlane Biogas

On-Site RCNG Fueling Station

- Consists of compressor, storage tanks and fuel dispensers
- Use for City Fleet or contractor vehicles with operation on site
- Enter Schedule H agreement with NWN to design, build and maintain
- ODOE AVFI Tax credit available

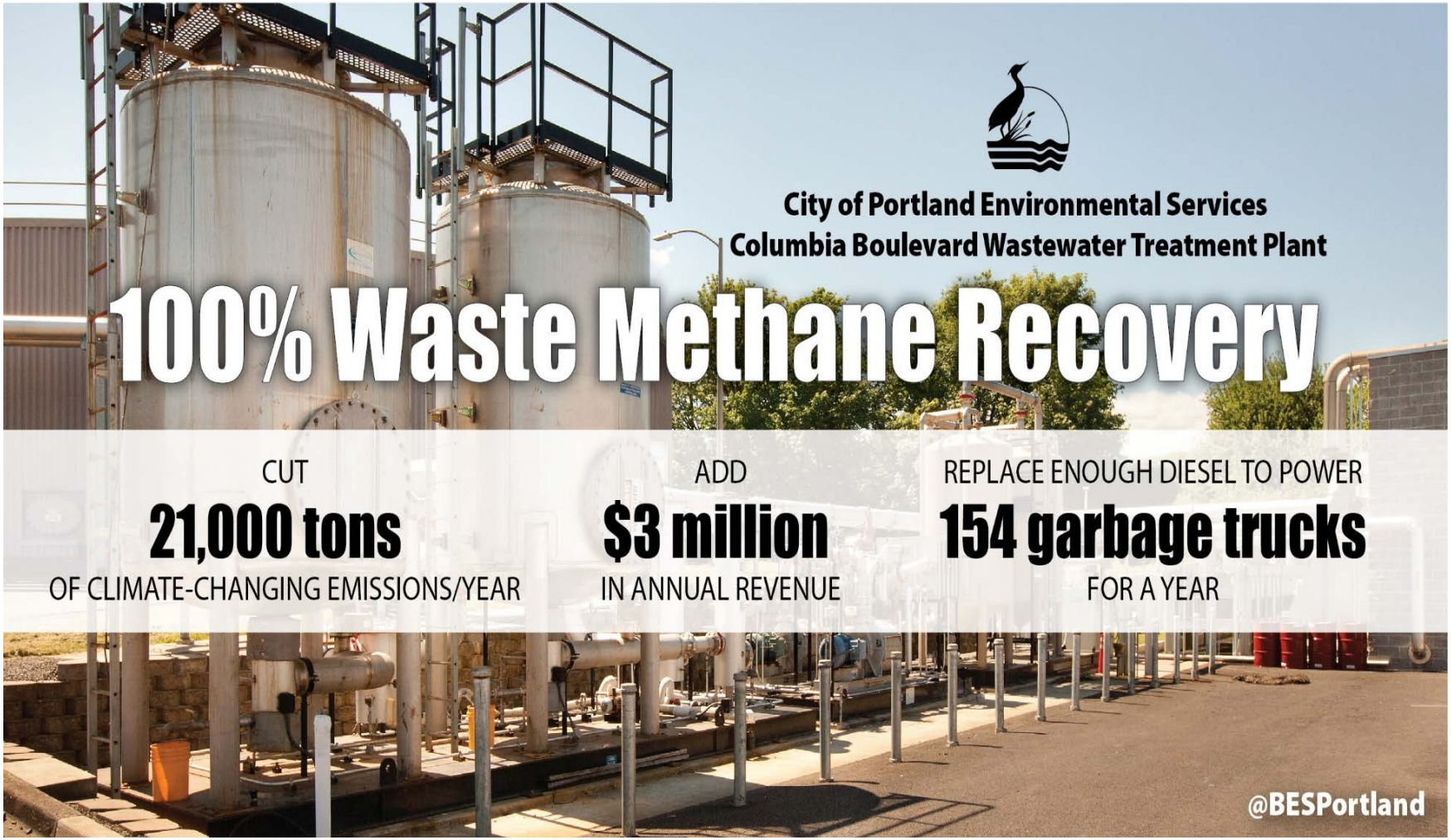
Source: GE CNG-IN-A-BOX

NWN Monitoring Facility

- Located on CBWTP site for monitoring RNG quality before the pipeline injection
- NW Natural to design, build, operate and maintain during the term of the agreement, with BES to pay the costs over time

Source: Fortis BC

Triple Win Solution



Questions?

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End of Presentation