



# White Earth Nation Biomass Feasibility Study

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White Earth Nation



# Presentation Overview

- Study Objectives
- Accomplishments to Date
- Initial Findings
- Observations
- Plans Forward



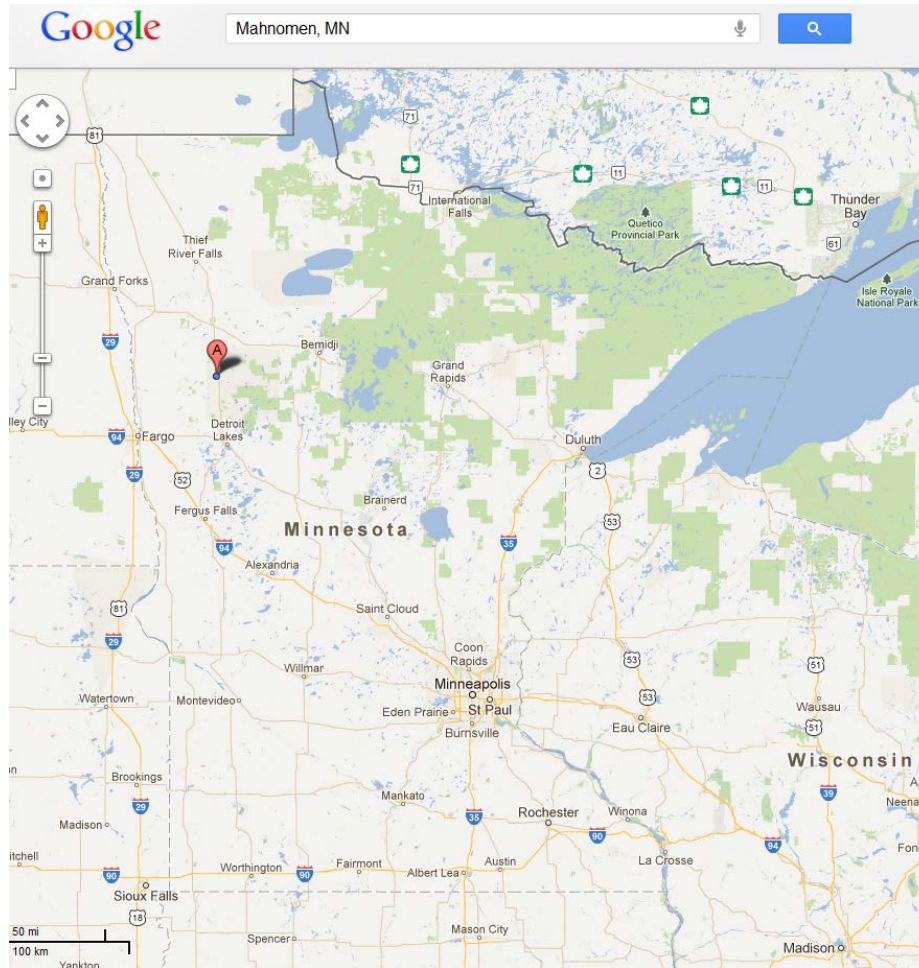


# Study Objectives

- Primary Objectives:
  - Conduct a due diligence grade feasibility study to assess the opportunity to convert existing thermal and power systems at the Shooting Star Casino to a sustainable bioenergy system.
- Background
  - The Casino is utilizing fuel oil and propane fired boilers as primary source of thermal energy. Electricity is provided by the local public utility district (Otter Tail Power).
- Implementation Schedule:
  - Start – May 2012
  - Issue Final Report – 2014



# Shooting Star Casino Mahnomen, Minnesota





# Shooting Star Casino Aerial View





# Study Overview

## Key Tasks:

- Energy Load Assessment
- Feedstock Availability and Cost Assessment
- Conversion Technology Review and Selection
- Preliminary System Design
- Capital, Installation and O&M Costs
- Environmental Permit Review
- Energy Sales and Marketing
- Economic Feasibility Analysis
- Environmental Benefit Analysis
- Tribal Benefit Analysis
- Training and Professional Development
- Final Report



# Shooting Star Casino Fuel Oil Boiler System





# Shooting Star Casino Event Center Propane Boiler System



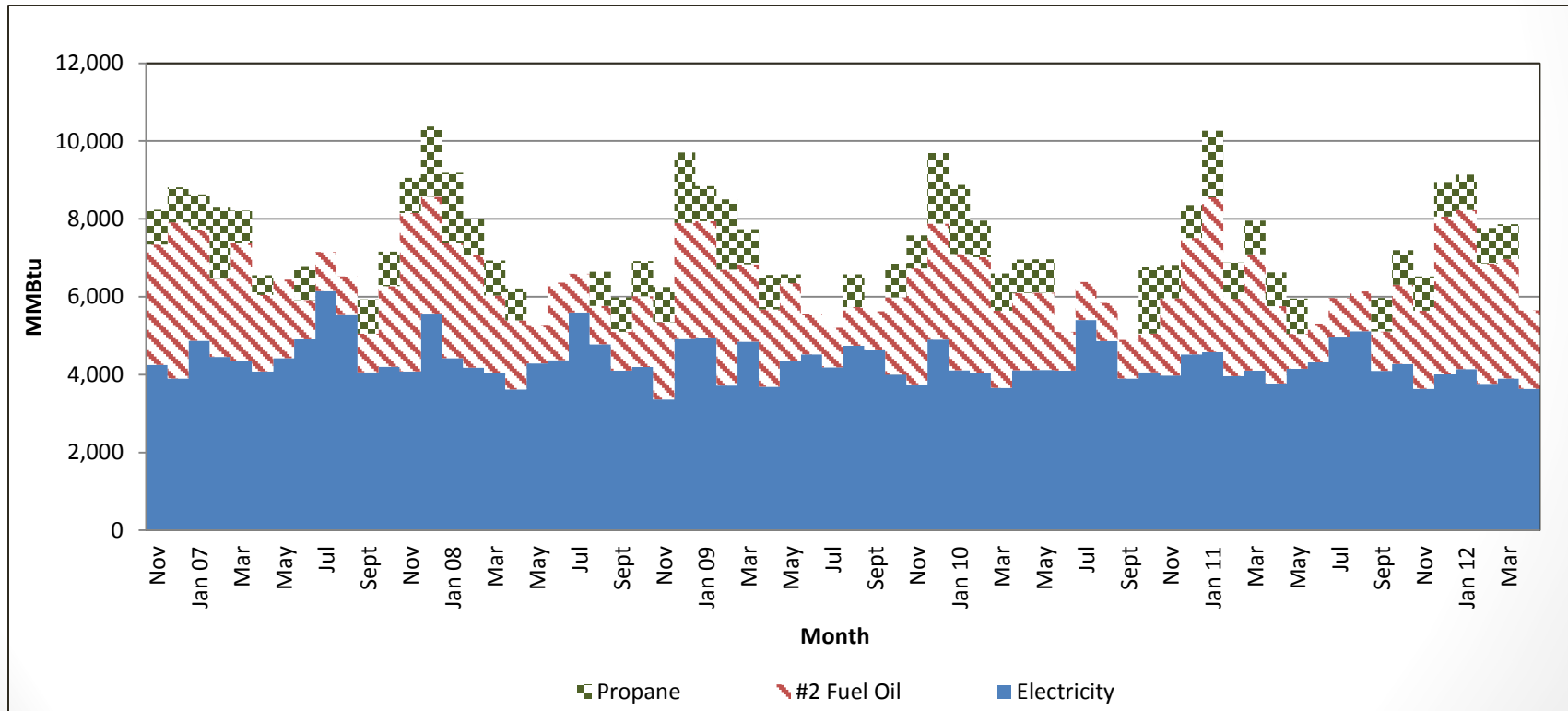


# Energy Load Assessment

## Key Findings – Part I



### Historic Energy Consumption

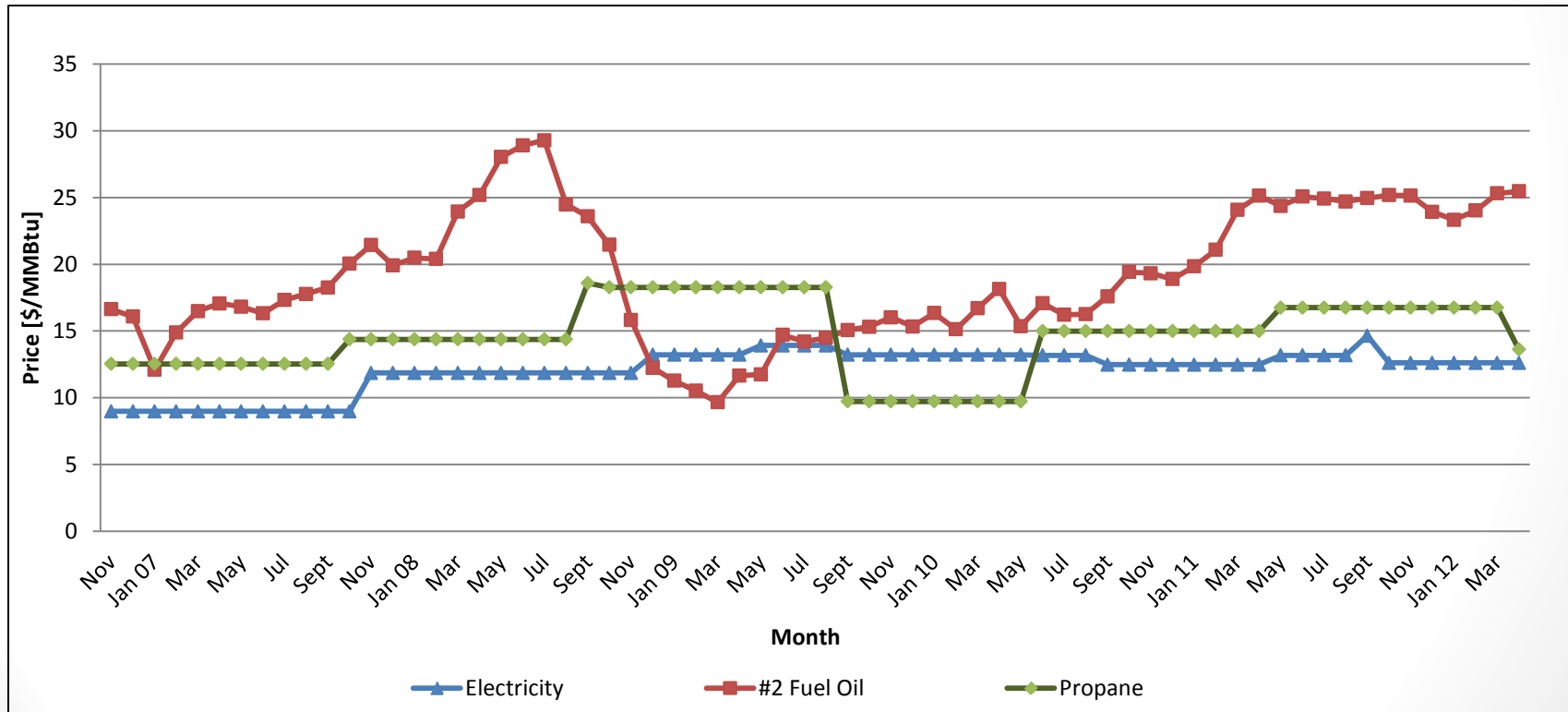


# Energy Load Assessment

## Key Findings – Part II



### Historic Energy Prices



# Energy Load Assessment

## Key Findings – Part III



### Cost of Energy

<b>ENERGY SOURCE</b>	<b>CURRENT PRICE</b>	<b>CURRENT PRICE (\$/MMBtu)</b>	<b>5-YEAR AVERAGE (\$/MMBtu)</b>
Fuel Oil	\$3.510/gal	\$25.34	\$19.21
Electricity	\$0.04304/kWh	\$12.61	\$12.09
Propane	\$1.260/gal	\$13.62	\$14.64



# Energy Sales and Marketing

## Key Findings:

- Minnesota has a Renewable Energy Standard:
  - Enacted February 2007
  - Electric utilities serving customers in Minnesota are held to the RES:
    - Electric Utilities without nuclear power generation – 25% renewable generation by 2025
    - Electric Utilities with nuclear power generation – 30% renewable generation by 2025
- Due to significant market response from wind power generation systems located in North Dakota, renewable power is currently priced very low:

DESCRIPTION	CAPACITY PAYMENT (ON-PEAK ONLY)	ENERGY CREDIT ON-PEAK	ENERGY CREDIT OFF-PEAK
Summer (Firm Power and Non-Firm Power)	0.275¢ per kWh	3.699¢ per kWh	2.536¢ per kWh
Winter (Firm Power and Non-Firm Power)	0.275¢ per kWh	4.311¢ per kWh	2.433¢ per kWh

**Conclusion – Opportunities to sell renewable power from a biomass combined heat and power system are very limited. Best to focus on thermal only system.**

# Feedstock Availability and Cost Assessment Key Findings – Part I



## Feedstock Availability

<b>FEEDSTOCK TYPE</b>	<b>POTENTIALLY AVAILABLE FEEDSTOCK (GT)</b>	<b>PRACTICALLY AVAILABLE FEEDSTOCK (GT)</b>
Corn Stover	229,792	63,193
Wheat Straw	264,900	72,848
Sugar Beet Tailings	23,000	46,000
Animal Waste	186,674	18,667
Food Waste	590	1,600
Forest Operations	66,625	34,640
Forest Product Manufacturing	14,000	14,000
Urban Wood Waste	21,329	2,000
<b>TOTALS</b>	<b>806,910</b>	<b>252,948</b>

# Feedstock Availability and Cost Assessment Key Findings – Part II



## Feedstock Pricing

FEEDSTOCK TYPE	ESTIMATED PRICE RANGE (\$/GT)	
	LOW RANGE	HIGH RANGE
Corn Stover	\$55.00	\$75.00
Wheat Straw	\$50.00	\$70.00
Sugar Beet Tailings	\$15.00	\$22.00
Animal Waste	\$14.00	\$24.00
Food Waste	\$14.00	\$85.00
Forest Operations	\$23.00	\$55.00
Forest Product Manufacturing	\$20.00	\$28.00
Urban Wood Waste	\$20.00	\$28.00

# Feedstock Availability and Cost Assessment Key Findings – Part III



Woody Biomass Feedstock Pricing Forecast  
(Assumes primary Feedstock is a blend of forest operations and sawmill byproducts)

<b>FEEDSTOCK PRICE SCENARIO</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>
Best Case \$/GT	\$33.90	\$33.90	\$33.90	\$34.58	\$35.27
Worst Case \$/GT	\$37.90	\$39.23	\$40.60	\$42.02	\$40.06



# Conversion Technology Review and Selection

## Key Findings:

- Optimized technology is conventional biomass combustion system
  - Considered:
    - Anaerobic digestion
    - Gasification
- Primary feedstock is a blend of sawmill residuals and forest operations generated woody biomass
  - Compelling feedstock attributes considered:
    - Feedstock quality – Btu/pound, ash content
    - Pricing - \$/GT delivered to Mahnomen
    - Availability year round



# Conversion Technology Review and Selection



Several vendors are currently being considered for the request for proposal process, including although not limited to:



**Solagen**



**Hurst**



# Economic Feasibility Analysis

## Initial Findings:

- Attractive Payback compared with alternative fuel sources

Simple Payback (years)						
	Costs	Existing Boiler (Assumes these Boilers are already installed and operating)				
	Annual Fuel Expense	All #2 Fuel Oil	All Propane	Fuel Oil & Propane	All Natural Gas	Electricity
Annual Fuel Expense	-	\$960,335.50	\$522,126.62	\$785,051.95	\$351,616.55	\$394,647.46
High Range Wood Feedstock	\$264,812.58	1.44	3.89	1.92	11.52	7.70
Low Range Wood Feedstock	\$85,081.59	1.14	2.29	1.43	3.75	3.23

- Note: While the Shooting Star Casino does not have a Natural Gas or Electric Boiler, the Simple Payback Chart reviews the hypothetical situation that these boiler options are already installed and operating at the Casino.
- Note: The Fuel Oil & Propane column represents the Casino's current state of operations.



# Economic Feasibility Analysis

## Initial Findings:

- Simplified

Simple Payback (years)		
	Annual Fuel Expense	Fuel Oil & Propane
Annual Fuel Expense	-	\$785,051.95
High Range Wood Feedstock	\$264,812.58	1.92
Low Range Wood Feedstock	\$85,081.59	1.43

- **Current analysis is showing that a wood fired biomass boiler will pay for itself in about a year and a half with ongoing savings of..... (drum roll) over \$500,000 annually!**

# Energy Assessment Findings



- Electricity
  - The Casino pays less than \$.05/kWh for electricity.
  - The avoided cost potential is too low to justify the investment in biomass renewable electricity production.
- Heat/Thermal
  - The high cost of propane and fuel oil relative to biomass offer significant potential for cost savings.
  - The Casino's thermal demand supports the development of a biomass boiler sized between 3.0 and 5.0 MMBtu/hour.
    - The fuel oil and propane boilers would remain in place for redundancy and peak demand.

# Energy Assessment Findings



FOSSIL FUEL SOURCE	CURRENT PRICE [\$/UNIT]		CURRENT PRICE [\$/MMBTU]	
Fuel Oil	3.510/gal		25.34	
Electricity	0.04283/kWh		12.55	
Propane	1.260/gal		13.62	
Natural Gas	0.775361/therm		7.75	
BIOMASS FEEDSTOCK SOURCE	LOW RANGE [\$/GT]	HIGH RANGE [\$/GT]	LOW RANGE [\$/MMBTU]	HIGH RANGE [\$/MMBTU]
Corn Stover	55.00	75.00	4.87	6.64
Wheat Straw	50.00	70.00	4.06	5.69
Sugar Beet Tailings	15.00	22.00	5.90	8.65
Animal Waste	14.00	24.00	1.99	3.41
Food Waste	14.00	85.00	2.33	14.17
Forest Operations	23.00	55.00	2.44	5.83
Forest Product Manufacturing	20.00	28.00	2.02	2.82
Urban Wood Waste	20.00	28.00	1.58	2.21



# Feedstock Availability Findings

- **Anaerobic Digestion**

- There are insufficient quantities of locally available sugar beet tailings, animal waste, and food waste at appropriate prices to support an anaerobic digester.
- Collection and transportation costs of high moisture content feedstock are the primary cost considerations.

- **Biomass Thermal**

- Woody biomass is the low-cost leader compared to agricultural biomass

BIOMASS FEEDSTOCK SOURCE	LOW RANGE [\$/GT]	HIGH RANGE [\$/GT]
Corn Stover	55.00	75.00
Wheat Straw	50.00	70.00
Forest Operations	23.00	55.00
Forest Product Manufacturing	20.00	28.00
Urban Wood Waste	20.00	28.00

- There is sufficient woody biomass was with a coverage ratio of 15.4:1.

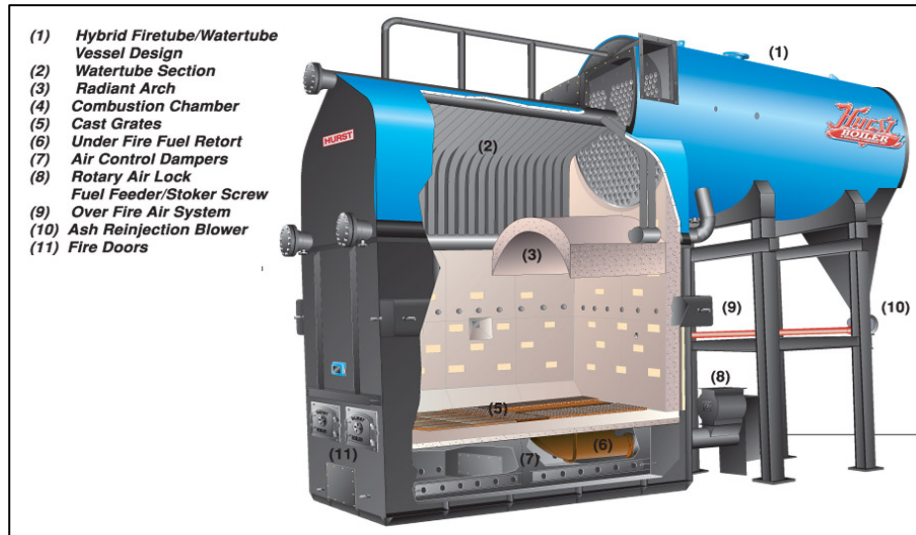
# Conversion Technology Findings



- Biomass thermal using direct combustion is the most appropriate for the feedstock and the available space.
- Eight direct-combustion manufacturers were vetted.
- One manufacturer was selected as the preferred vendor.



SolaGen Unit



- (1) Hybrid Firetube/Watertube Vessel Design
- (2) Watertube Section
- (3) Radiant Arch
- (4) Combustion Chamber
- (5) Cast Grates
- (6) Under Fire Fuel Retort
- (7) Air Control Dampers
- (8) Rotary Air Lock Fuel Feeder/Stoker Screw
- (9) Over Fire Air System
- (10) Ash Reinjection Blower
- (11) Fire Doors

Hurst Unit



# Siting Findings

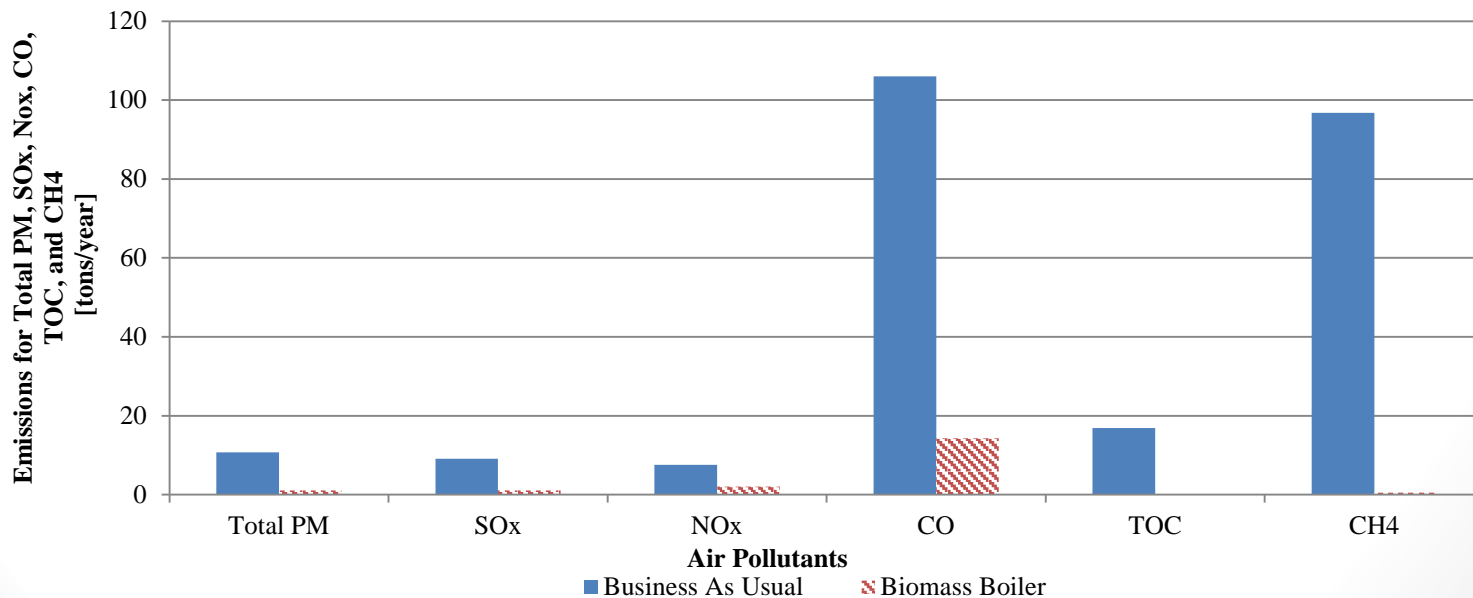
- The preferred site is the room adjacent to the Casino Boiler Room for the following reasons:
  - Access to the interconnection infrastructure used for the fuel oil boilers.
  - Access for truck traffic for wood chip delivery.
  - Existing building minimizes upfront expense.
- Other locations reviewed:
  - Across Jefferson Avenue from the overflow lot.
  - South of the City of Mahanomen water pumping station.
  - South of the cement batch plant.
  - North of the existing onsite maintenance shop.



# Environmental Benefits



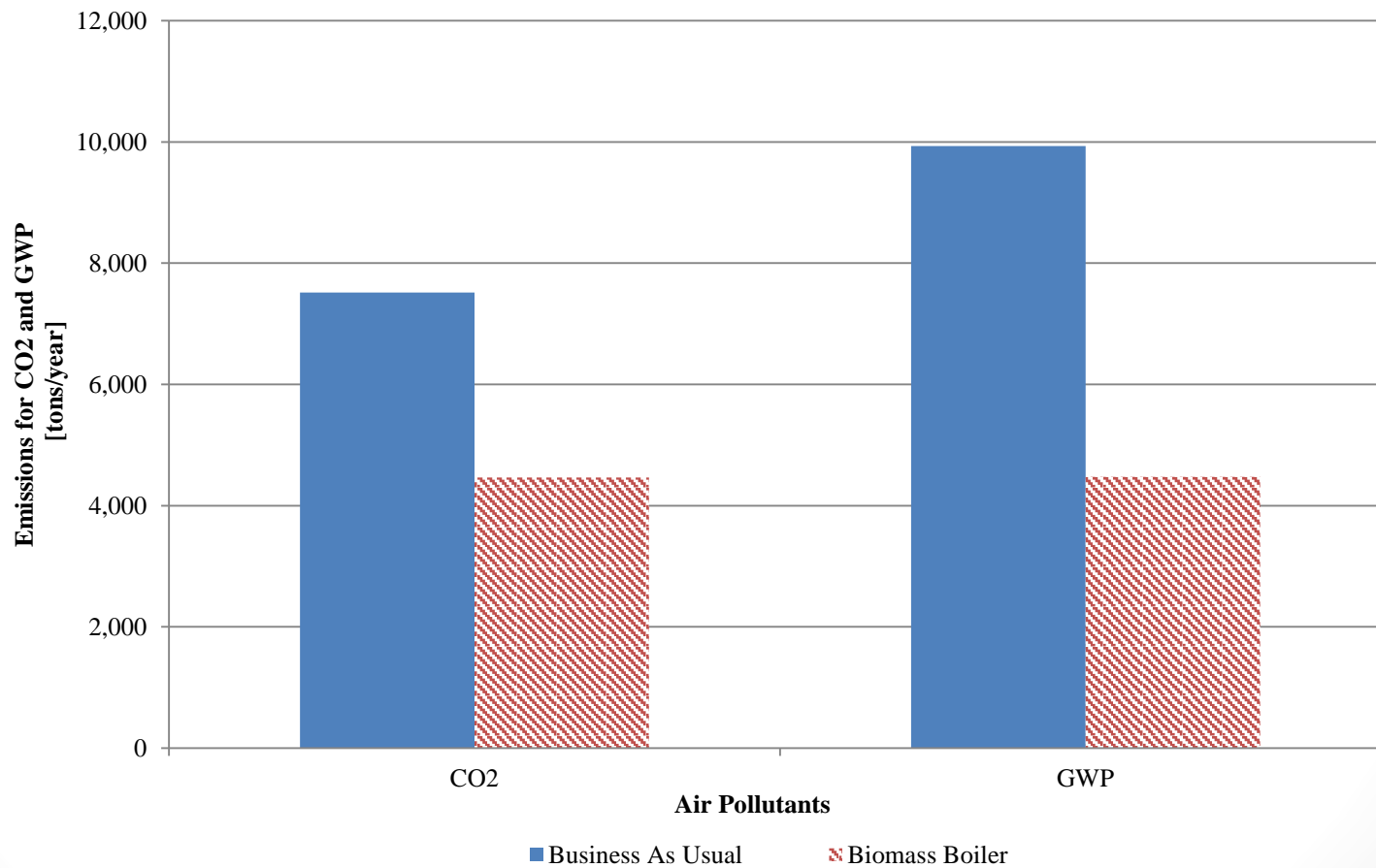
- Using a life cycle assessment that includes emissions from processing and transporting biomass feedstock, an optimized feedstock blend using forest-sourced material and sawmill byproduct yields significant air emissions reductions.



# Environmental Benefits



- Decreased total greenhouse gas emissions as well.



# Economic Feasibility Analysis



- Major Economic Factors
  - Total Project Upfront Cost: \$1,174,003
  - Feedstock Costs: \$142,304/year
  - Operations & Maintenance: \$13,990/year
- Avoided Costs
  - Has the potential to displace \$750,000/year of fossil fuel consumption
- Financial Proforma Results:
  - Simple Payback Period: 1.72 years\*
  - Internal Rate of Return: 164.5%\*\*

\* 1.72 year SPP when compared to the Casino's Fuel Oil and Propane blended use. 3.75 year payback when compared to a hypothetical natural gas boiler, and 3.24 year payback when compared to a hypothetical electric boiler.

\*\*Assumes a 75% debt and a 5 year repayment of the loan at 5% interest.

# Economic Feasibility Analysis



- Sensitivity Analysis found four key parameters
  - Upfront Cost
  - Feedstock Price
  - Fossil Fuel Price
  - Capacity Factor (Total Up-Time)
- Findings
  - Project viability is dependent on the disparity between fossil fuel prices and feedstock prices which drive annual savings.
    - 10-year feedstock forecast shows stable biomass pricing.
  - All other key parameters yield Simple Payback Periods of less than 3 years at the worst case scenario.



# Questions?

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