

Understanding the Basics of Energy Costs and the Environmental Impact

Rafi Sohail
Manager, Technical Sales
CenterPoint Energy

- Energy Sources
- Conversion Factors
- Energy Costs Comparison
- Green Technology and Carbon Footprint
- Emissions Factors
- Environmental Impact Comparison
- Conclusion
- Questions and Answers

- **NATURAL GAS:** Measured in Therm or CCF - Priced at \$/Therm
- **PROPANE:** Measured in Gallons - Priced at \$/Gallon
- **ELECTRICITY:** Measured in kilowatt-hour (kWh) - Priced at \$/kWh
- **HEATING OR FUEL OIL:** Measured in Gallons - Priced at \$/Gallon

Energy Source - Prices

- **NATURAL GAS:** \$0.70/Therm
- **PROPANE:** \$1.45/Gallon
- **ELECTRICITY:** \$0.065/kWh
- **HEATING OR FUEL OIL:** \$2.65/Gallon

Which one is the cheapest Energy Source?

Conversion Factors

British Thermal Unit (Btu): Btu is the standard measurement used to state the amount of energy of the fuel.

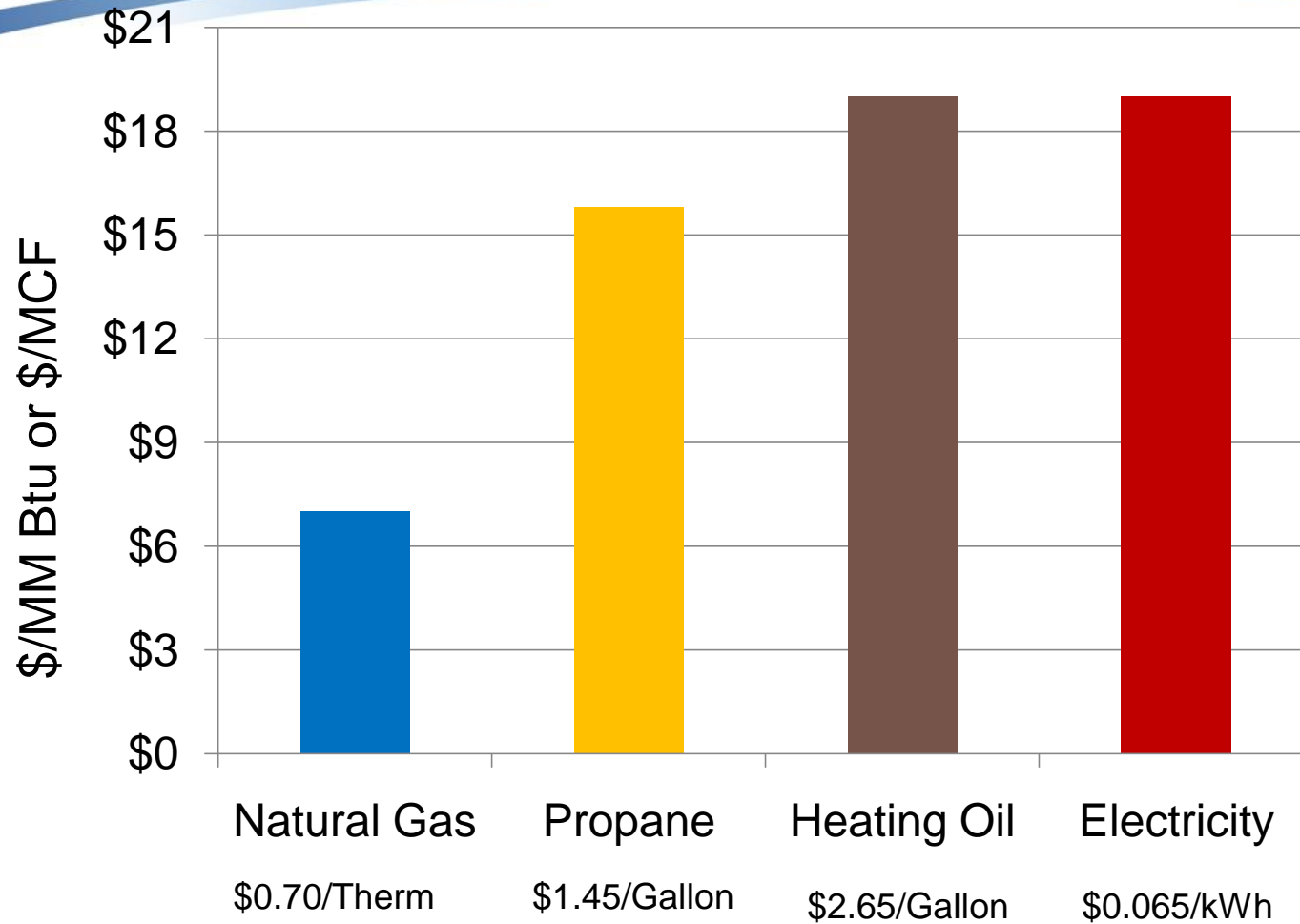
It is the amount of heat energy needed to raise the temperature of one pound of water by one degree F.

1,000,000 BTU = 1 million Btu = 1 MM Btu (Dth or MCF)

Energy Source	Unit of Measure	Btu	MM Btu
Natural Gas	1 Therm	100,000	0.1
Propane	1 Gallon	91,600	0.0916
Heating Oil (# 2 Oil)	1 Gallon	139,000	0.139
Electricity	1 kWh	3,413	0.003413

1 gallon of water weighs 8.34 lbs

Comparison of Prices



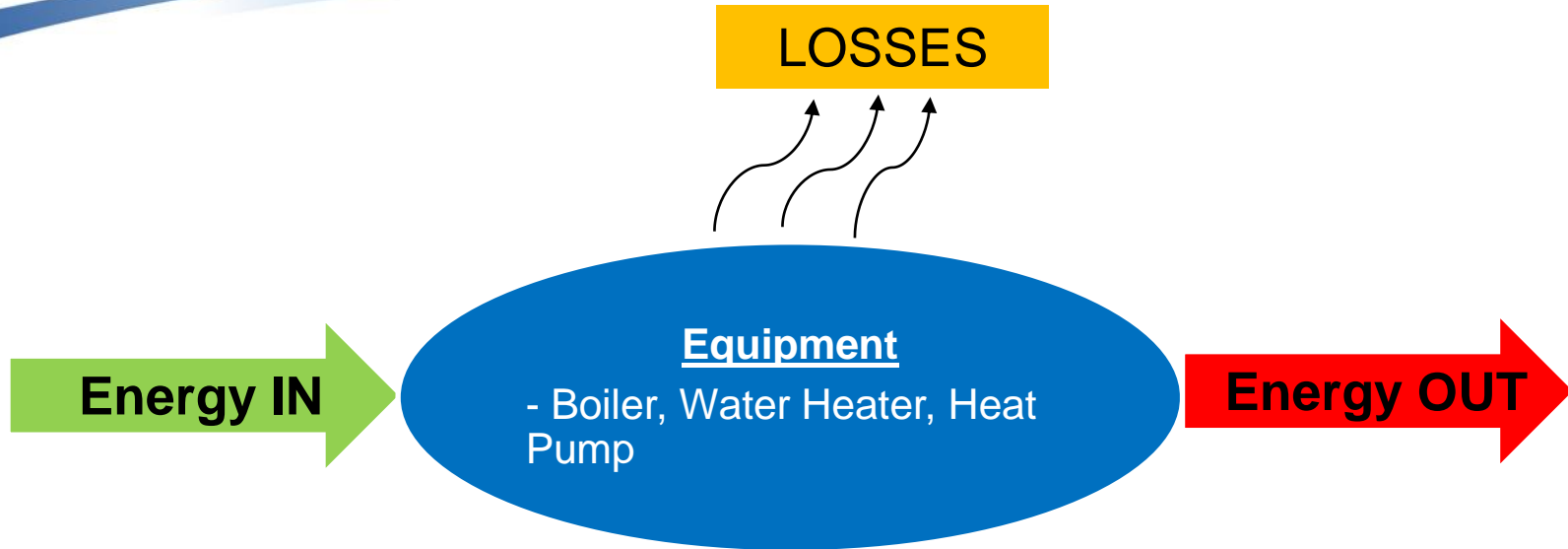
Conversion of Fuel Prices

\$/Unit Fuel	Conversion Formula	In \$/MM Btu Equivalent
\$0.70 / Therm (CCF) Natural Gas	$(0.70 / 100,000) \times 1,000,000$	\$7.00 / MM Btu
\$1.45 / Gallon Propane	$(1.45 / 91,600) \times 1,000,000$	\$15.80 / MM Btu
\$2.65 / Gallon #2 Fuel Oil	$(2.65 / 139,000) \times 1,000,000$	\$19.00 / MM Btu
\$0.065 / kWh Electricity	$(0.065 / 3,413) \times 1,000,000$	\$19.00 / MM Btu

Apply the **NET** \$/Unit price of the energy source:

- Including delivery or transportation, resource adjustment, special riders and tariffs, etc.

Efficiency comes into play



$$\text{Efficiency} = \frac{\text{Energy Output}}{\text{Energy Input}}$$

Four key variables to calculate the operating costs:

1. Btu (or MM Btu) output requirement for heating, water heating, or cooling
 2. Fuel source
 3. Efficiency of the equipment
 4. Price of fuel source
- Incremental Cost - Cost of selecting one option over other to determine the payback!

Energy Costs Comparison

Commercial Building Example

Assumptions:

- 2,200,000 Btu/h output requirement for heating
- 1000 hours of full load operating hours
- or 2,200 MM Btu annual output requirement

Competitive Technologies:

- 88% efficiency natural gas boiler
- 98% efficiency electric boiler
- 3.0 COP (or 300% efficiency) geothermal heat pump

Energy Costs Comparison

- Operating Costs Comparison

	Natural Gas Boiler	Electric Boiler	Geothermal Heat Pump
Annual Energy Requirement MM Btu output	2,200	2,200	2,200
Efficiency or COP	88%	98%	3.0
Annual Energy Consumption in MM Btu input	2,500	2,245	733
Consumption in Therms or kWh	25,000	657,779	214,767
Price: \$/Therm or \$/kWh	\$0.70	\$0.065	\$0.065
Total Annual Heating Cost	\$17,500	\$42,756	\$13,960
Savings with other options compared to Natural Gas Boiler		(\$25,256)	\$3,540

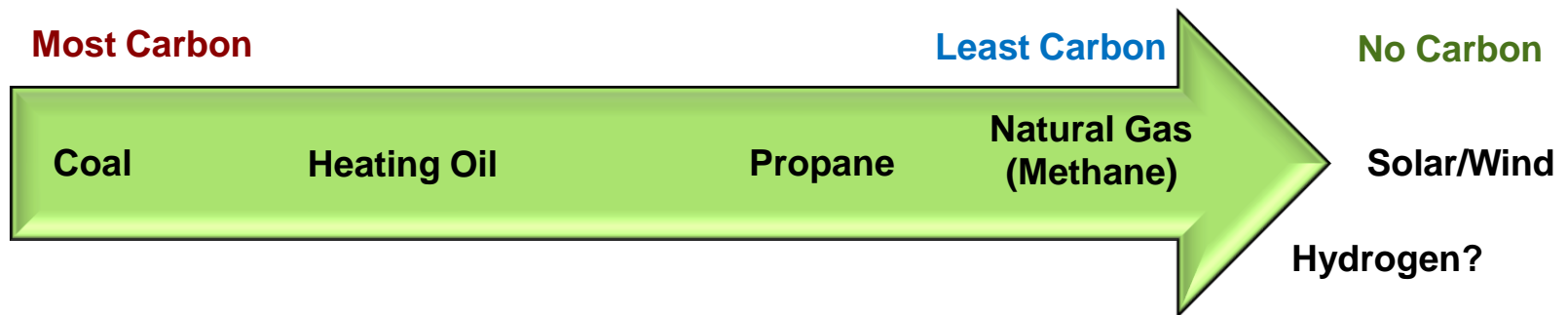
Investment Cost Comparison

- Calculate the Return on Investment

	Natural Gas Boiler	Geothermal Heat Pump
Total Annual Heating Cost	\$16,250	\$13,960
Savings with other options compared to Natural Gas Boiler		\$3,540
Capital Cost:	\$65,000	\$165,000
Incremental Cost of heat pump	\$100,000	
Simple Payback with heat pump	28 years	

Green Technology: A technology that consumes fuel to operate and gives out the least amount of emissions to the environment.

Carbon Footprint: A measurement of greenhouse gases (GHG) produced through the direct or indirect consumption of fossil fuels including domestic energy consumption, transportation, and manufacturing. Measured in metric tons (or lbs) of CO₂ equivalent.



Emissions Factors

Exhaust gas or flue gas is emitted as a result of the combustion of fuels (on-site or at power plant) to heat or cool a facility. Discharge to atmosphere as particles or Emissions Factors.

- **Emissions generated onsite**
- **Emissions generated at power plant**

The top four Emissions Factors that impact the environment:

- Carbon Dioxide CO₂ - a major greenhouse gas
- Sulfur Dioxide SO₂ - a key cause of acid rain and haze
- Nitrogen Oxides NO_x - the primary cause of smog
- Mercury (Hg) - a common cause of contamination in fish

Emissions Factors

- EPA – AP 42 Emission Factors report provides the pollutants release in air data of a fuel source’s combustion.
- EPA – eGRID data tracks emissions factors of all U.S. electricity generating plants that provide power to the electric grid and report data to the U.S. government (eGRID2007).

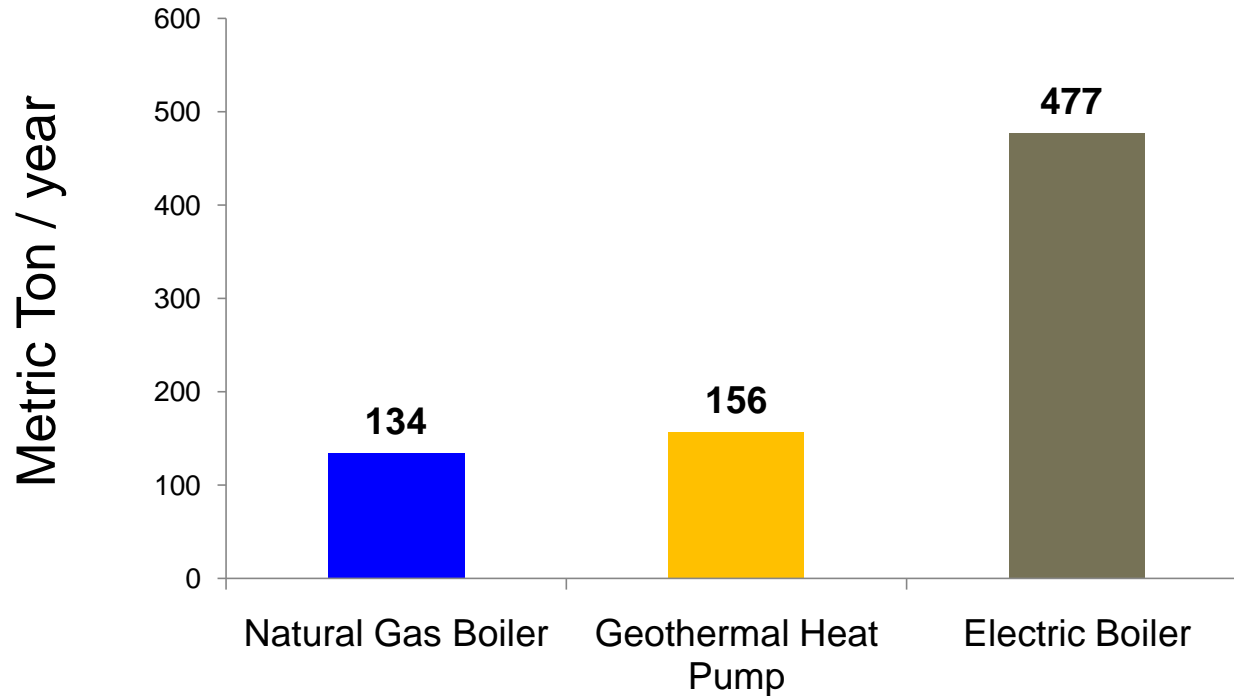
Emission Factors	Natural Gas (lbs/MM Btu)	Electricity MN Avg. (lbs/MM Btu)	% Natural Gas versus Electric
CO ₂	117.6	467.2	25.1%
SO ₂	0.0006	1.169	0.05%
NO _x	0.19	0.9815	19.3%
Mercury (Hg)	-	0.0000083	0%

Environmental Impact

- **Next Step:** Multiply the natural gas and electricity emissions factors to the annual energy consumption for each application to calculate the emissions generated.
- Comparing the earlier example of 2,200 MM Btu output requirement:
 - 88% efficiency natural gas boiler
 - 98% efficiency electric boiler
 - 3.0 COP (or 300% efficiency) geothermal heat pump

	Natural Gas Boiler	Electric Boiler	Geothermal Heat Pump
Annual Energy Consumption	25,000 Therms	657,779 kWh	214,767 kWh

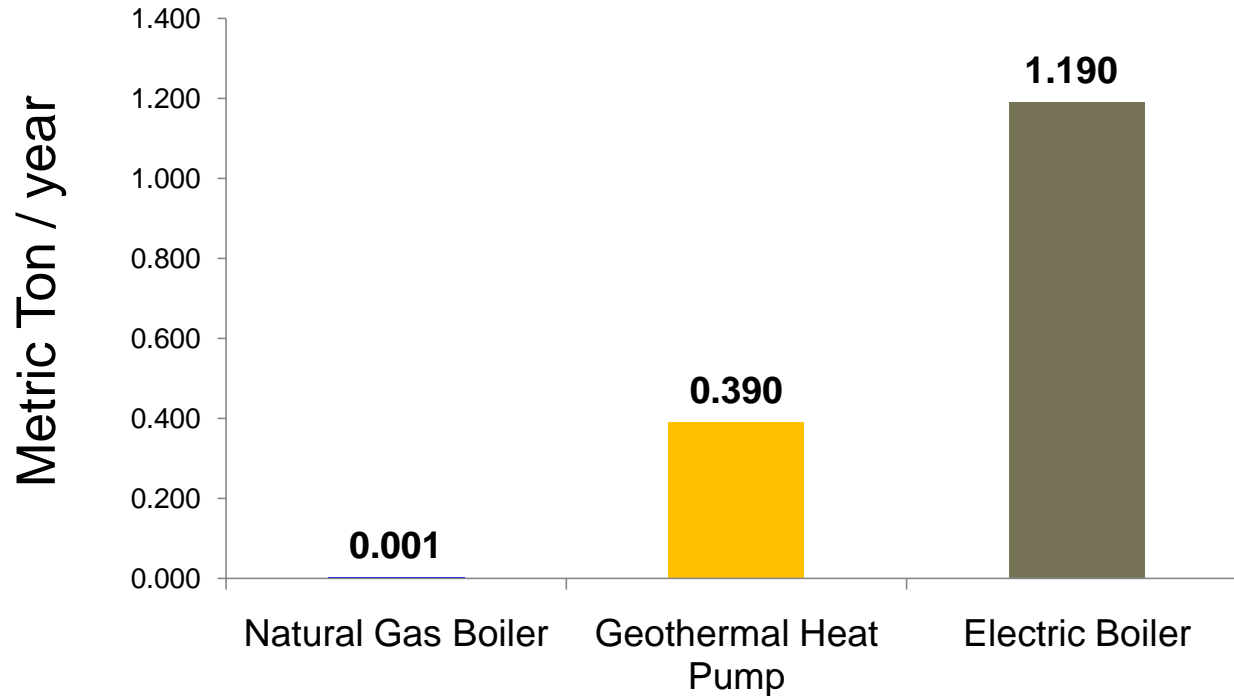
Environmental Impact - CO₂ Emissions Comparison



Carbon Dioxide CO₂ - a major greenhouse gas

* 2,200 lbs = 1 Metric Ton

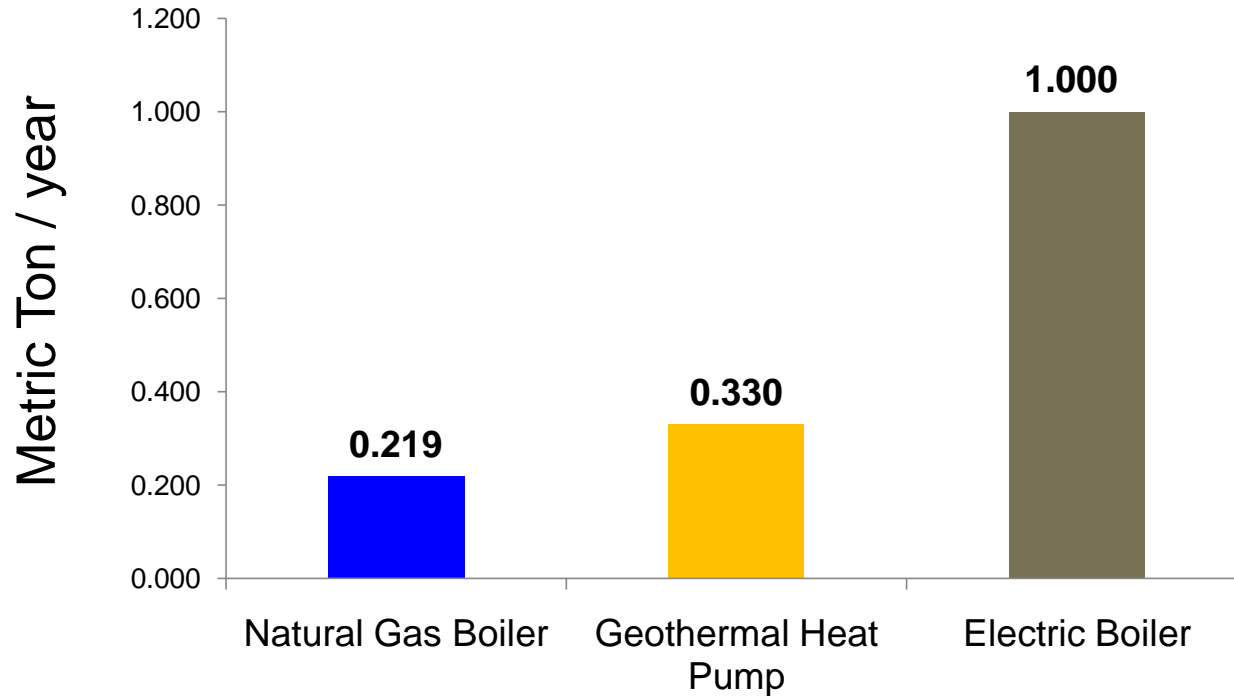
Environmental Impact - SO₂ Emissions Comparison



Sulfur Dioxide SO₂ - a key cause of acid rain and haze

* 2,200 lbs = 1 Metric Ton

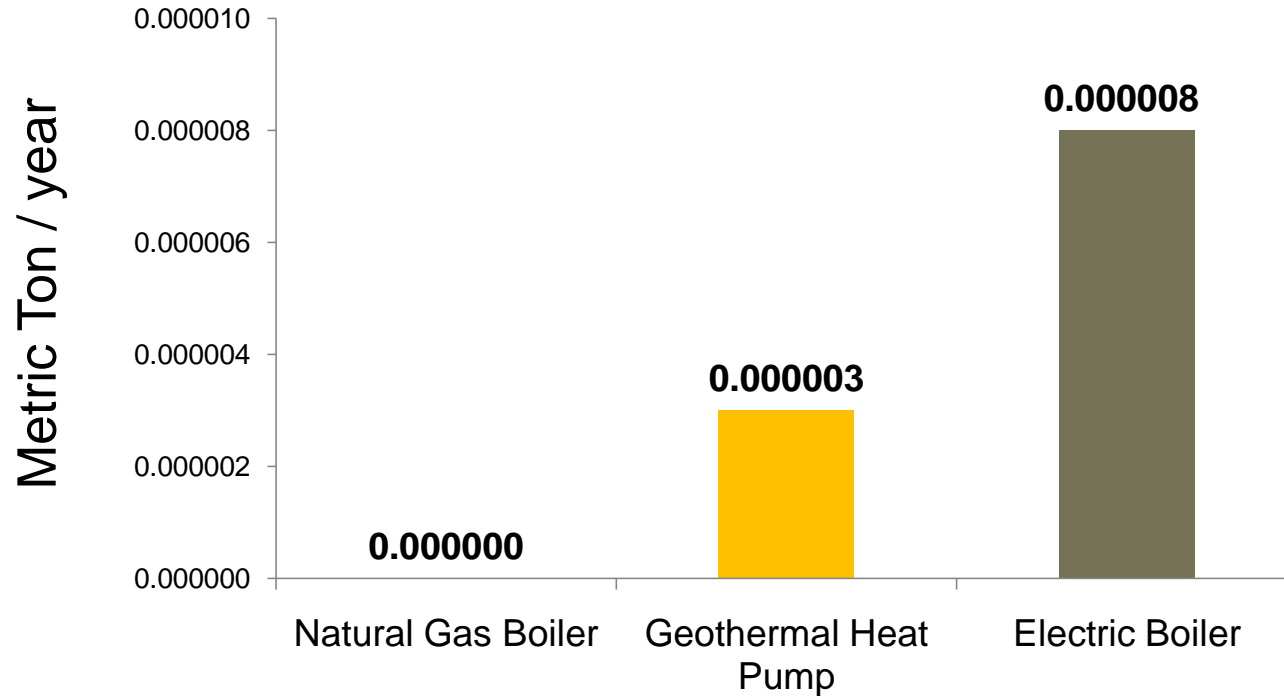
Environmental Impact - NOx Emissions Comparison



Nitrogen Oxides NOx - the primary cause of smog

* 2,200 lbs = 1 Metric Ton

Environmental Impact - Mercury Emissions Comparison



Mercury (Hg) - a common cause of contamination in fish

* 2,200 lbs = 1 Metric Ton

Key Points

- Apply the common unit (Btu) to compare energy sources
- Include the net \$/unit cost in your calculation
- Start with the energy output (Btu) requirement to conduct apples to apples comparison
- Understand your payback threshold and return on investment
- How green is your technology and carbon footprint!

Conclusion

Natural Gas versus Other Fuels

Capital cost has a direct impact on payback and return on investment:

- *Very long payback with the geothermal heat pump option!*

Green technology is defined as technology with the lowest emissions:

- *Natural gas is the preferred green technology option with the least amount of emissions even compared to geothermal heat pump!*

THANK YOU!

Questions & Answers

Contact Information:

Rafi Sohail

Phone: 612-321-4779

Email: Rafi.Sohail@CenterPointEnergy.com