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OPERATING COST COMPARISON OF HEAT PUMPS VS. NATURAL GAS

HOW IT WORKS
MITSUBISHI ELECTRIC Heating and Cooling

This Article will set out a high-level way to compare a heat pump's operating costs to traditional fossil fuel prices to determine how effective a fuel-switching strategy may be. This method applies to any kind of heat pump (Air-to-Water, Water-to-Water, Air-to-Air) and Natural Gas Heating Appliances (Furnace, Boiler)

When comparing electricity and fossil fuel prices, the first step is to determine the total **DELIVERED** cost of the utilities. This can be done by dividing the pre-tax subtotal amount shown on the bill by the total usage (kWh for electricity or m^3 for Natural Gas). It is important to include the "Carbon Tax" or "Federal Carbon Charge" in the subtotal amount as this is a defined fixed cost per m^3 of Natural Gas. This article will use a total delivered rate of $0.50/$m^3$ of Natural Gas and $0.12/kWh of Electricity. Please note that this method does not account for Demand Charges

A **Heat Pump** has a **Coefficient of Performance (COP)**, which describes the efficiency, which is the heat output divided by the power input. A COP of 2 means it has an efficiency of 200%. Most modern Heat Pumps typically have a COP that is no lower than 2 and, depending on conditions, can be 4 or even higher when heat recovery is considered. A Natural Gas appliance's efficiency will always be below 100% due to the conversion efficiency. Modern Natural Gas Boilers can provide efficiencies as high as 95%, but this may not always be the actual operating efficiency as it depends on the return temperature from the hydronic system.

The equation below is used to determine the COP needed from a heat pump, based on delivered utility prices, to be cost-neutral to operate compared to a Natural Gas Appliance. When the equation is plotted for various Gas Conversion Efficiencies, we can determine the COP needed from a heat pump to be cost neutral. When the Actual COP is higher than the Breakeven COP, this represents cost savings. When the COP is lower, it may cost more to operate, but throughout the year it will average out considering that extreme ambient temperatures are not consistent during the winter and occur for an infrequent amount of time annually.

$$COP_{HEAT\ PUMP,\ Breakeven} = \frac{\$/kWh_{Electrical}}{\$/kWh_{Natural\ Gas}} \times \eta_{Boiler}$$

Conversion Factors:
$1\ m^3\ NG = 10.5\ kWh_{Natural\ Gas}$
$1\ GJ\ NG = 25.5\ m^3\ NG$

Average Natural Gas Price
= $0.50/m³ Approx. Total Effective Price from TOTAL of NG Bill (Based on 2022 Carbon Pricing @ $50/Ton CO_2e)

Avgerage Electricity Price
= $0.12/kWh

2023 Cost Ratio ≈ 2.52 E:NG
Breakeven $COP_{95\%}$ = 2.39
Breakeven $COP_{80\%}$ = 2.02