# Using Plant Effluent to Reduce Heating and Cooling Costs

Presented By:
Strand Associates, Inc.®

Hosted By:
Wisconsin Wastewater Operators' Association (WWOA)

# Introduction

- Greetings!
- Using Plant Effluent to Reduce Heating and Cooling Costs
  - Basics and Fundamentals
  - Equipment Utilized
    - Operation and Maintenance
    - Life Cycle Cost Analysis
  - Operating Costs
  - Impact on Potential Thermal Discharge Limits

- Questions and Answers

STRAND ASSOCIATES®

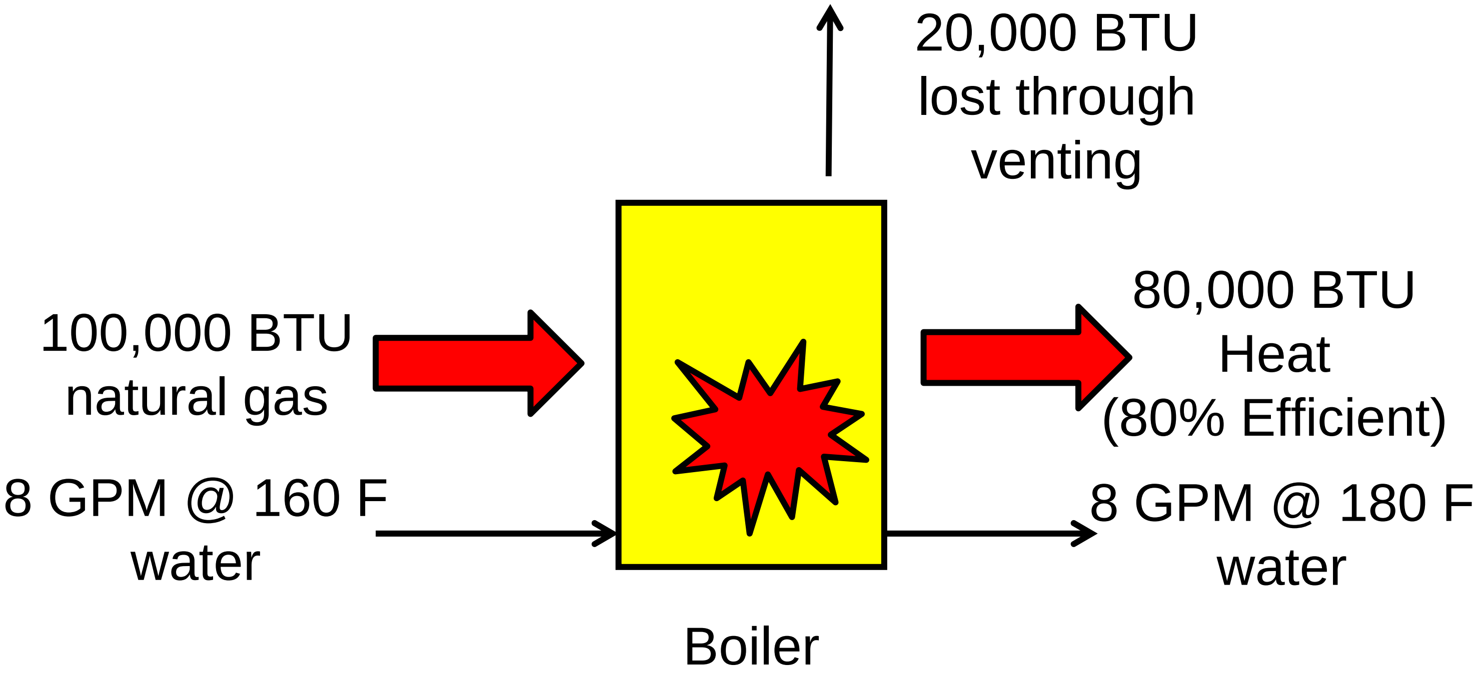
# Basics and Fundamentals

## Why Should I Save Energy?

- Reduce expenditures/taxpayer dollars spent
  - Utility bills
  - Labor costs
  - Indirect costs
- Reduce “Environmental Footprint”
  - Power plants
  - Distribution/transmission
  - Reduce fossil fuel consumption
    - Coal, natural gas, petroleum
  - Lower market energy prices

# Fundamentals of Heat Transfer

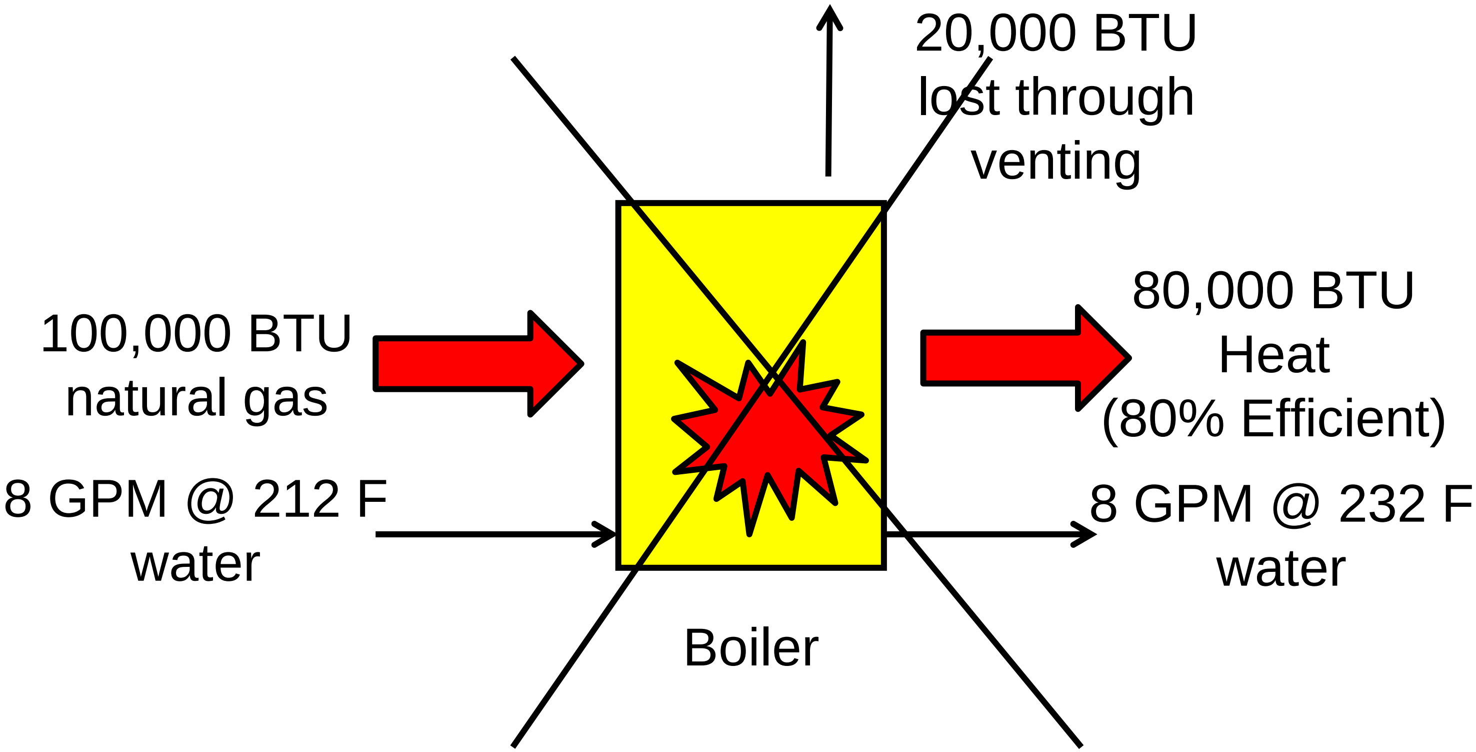
- The First Law of Thermodynamics:
  - "Energy is Neither Created Nor Destroyed."




STRAND ASSOCIATES®

# Fundamentals of Heat Transfer

- The First Law of Thermodynamics:
  - "Energy is Neither Created Nor Destroyed. It can only change forms."

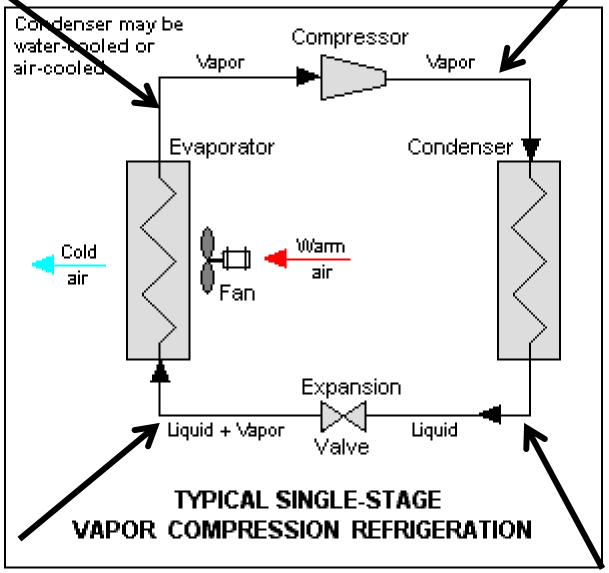


# Fundamentals of Heat Transfer

- The First Law of Thermodynamics:
  - “Energy is Neither Created Nor Destroyed. It can only change forms.”

Hot, low pressure gas

Hot, high pressure gas



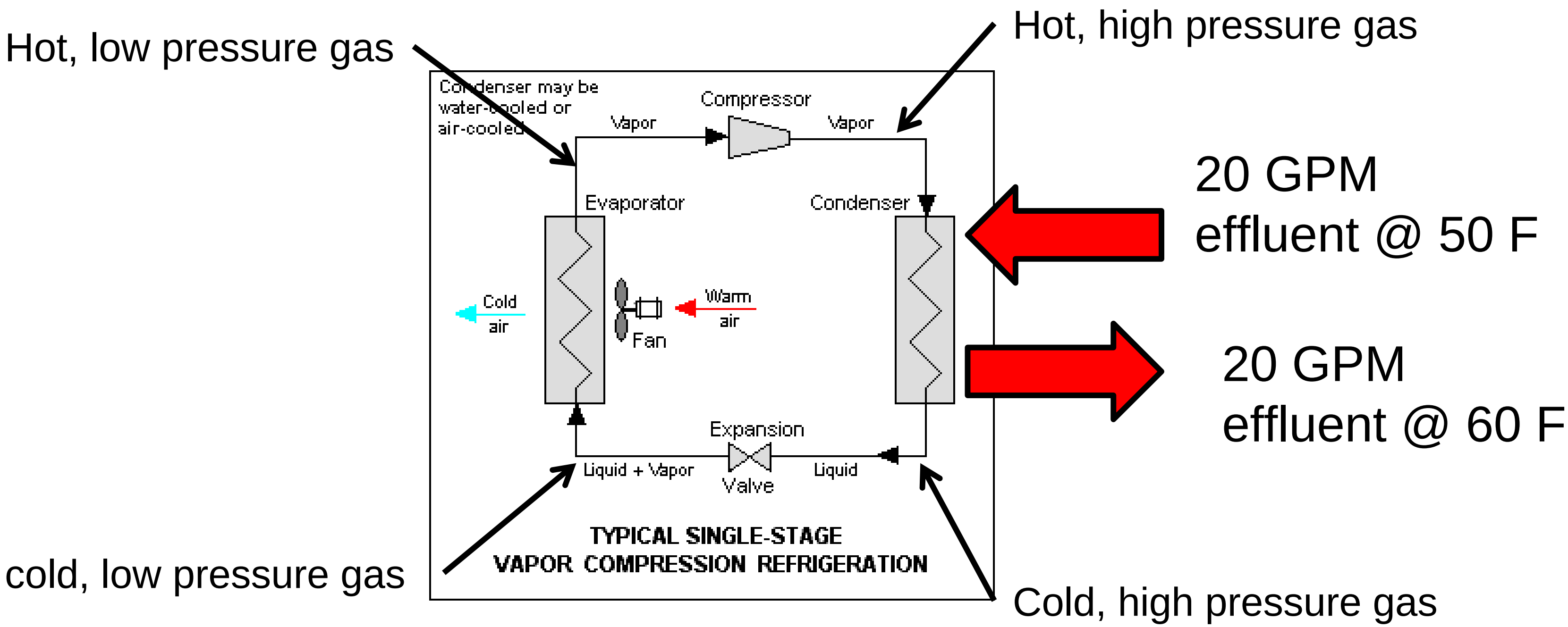

cold, low pressure gas

Cold, high pressure gas

Refrigerant can transfer significantly more heat than water because of it’s physical properties and ability to be compressed!

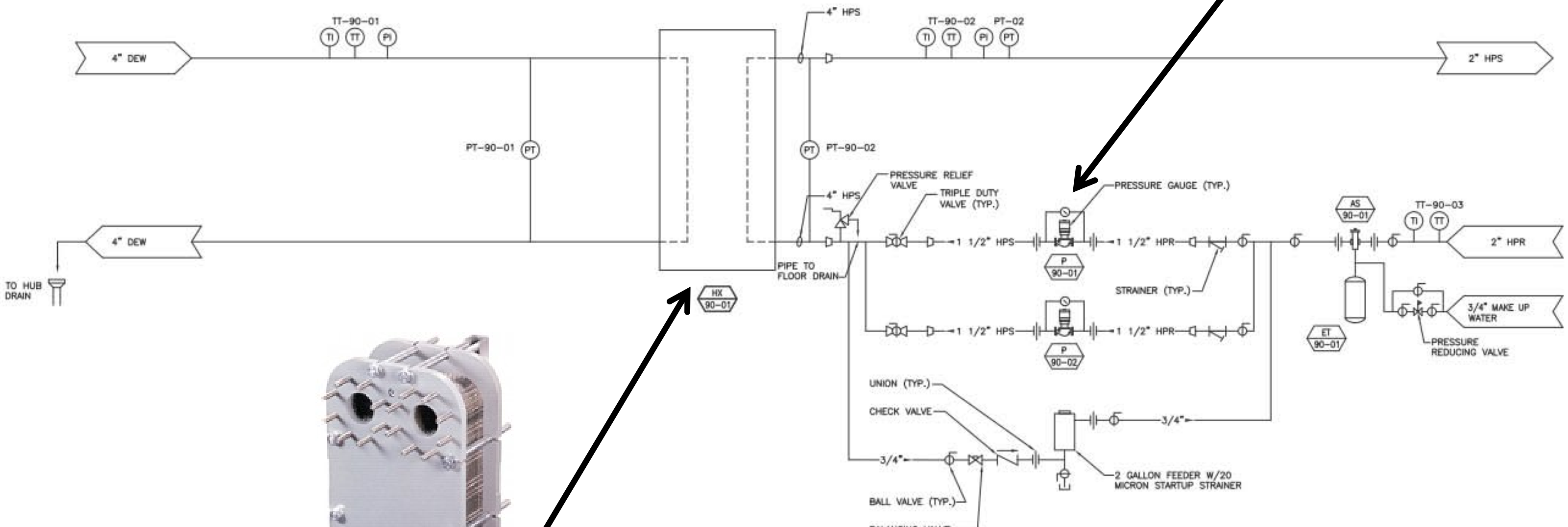
# Fundamentals of Heat Transfer

- How does this relate to plant effluent?
  - Use Effluent on the condenser section to make the refrigerant phase change!



# System Components

Inline Pumps

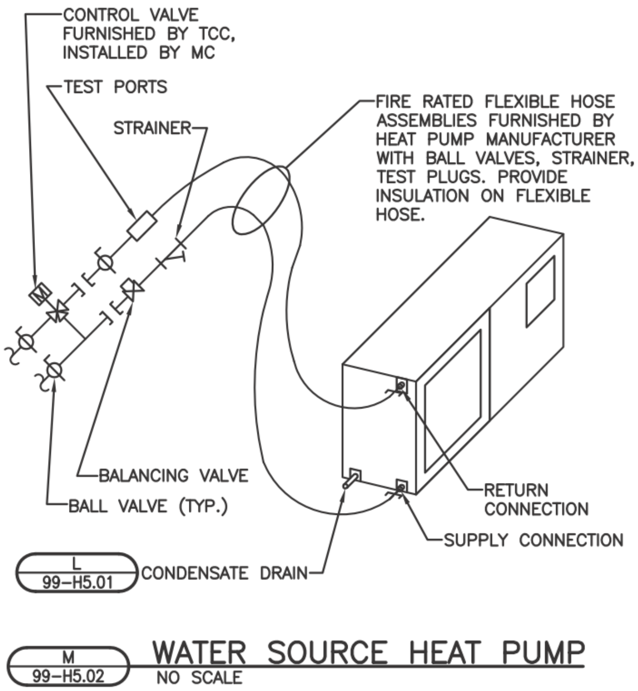


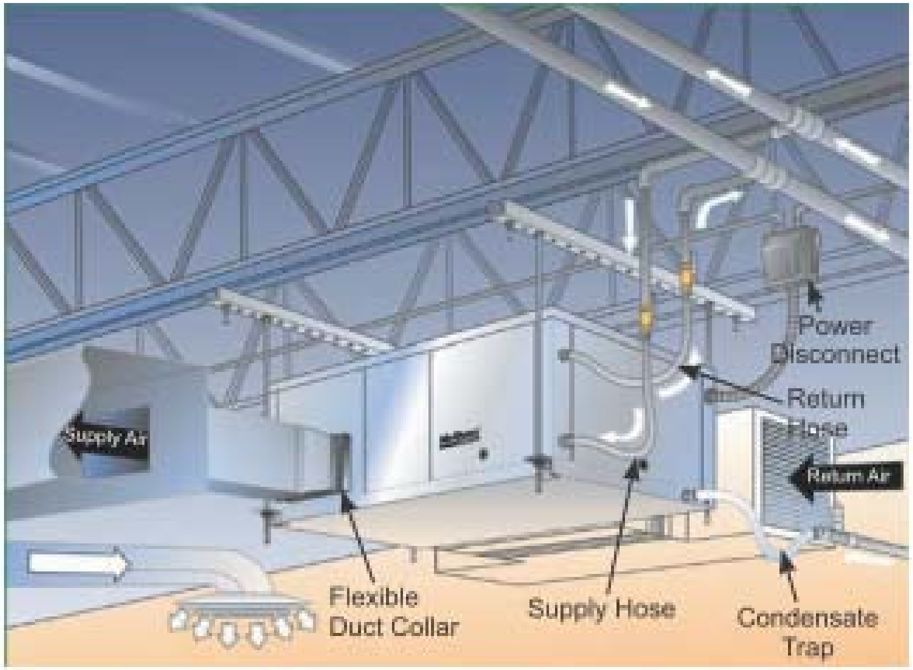

SYSTEM SCHEMATIC
NO SCALE

Plate & Frame Heat Exchanger

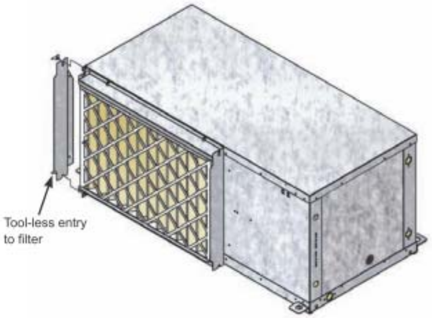
STRAND ASSOCIATES®

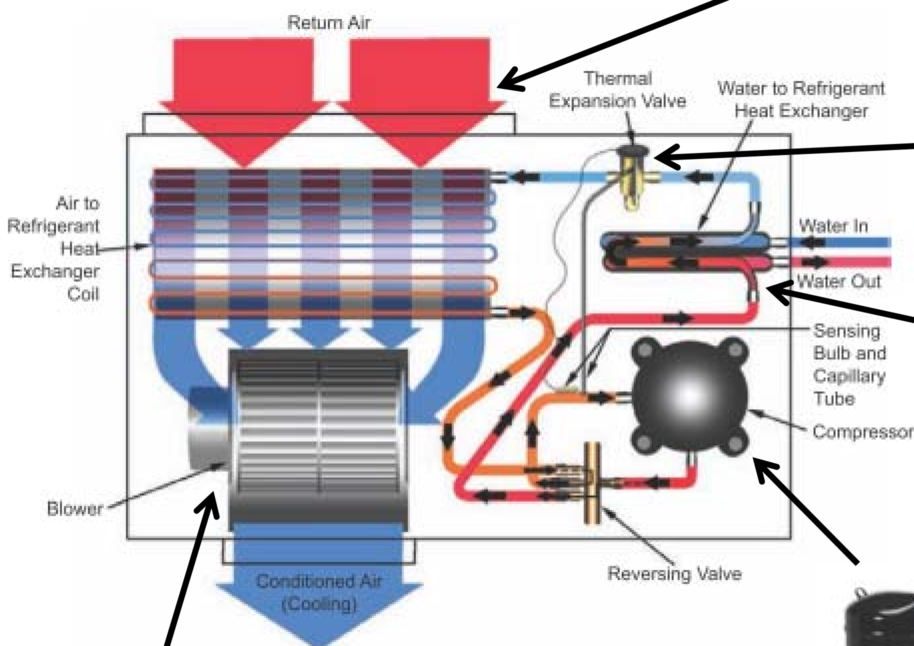
# System Components



# System Components



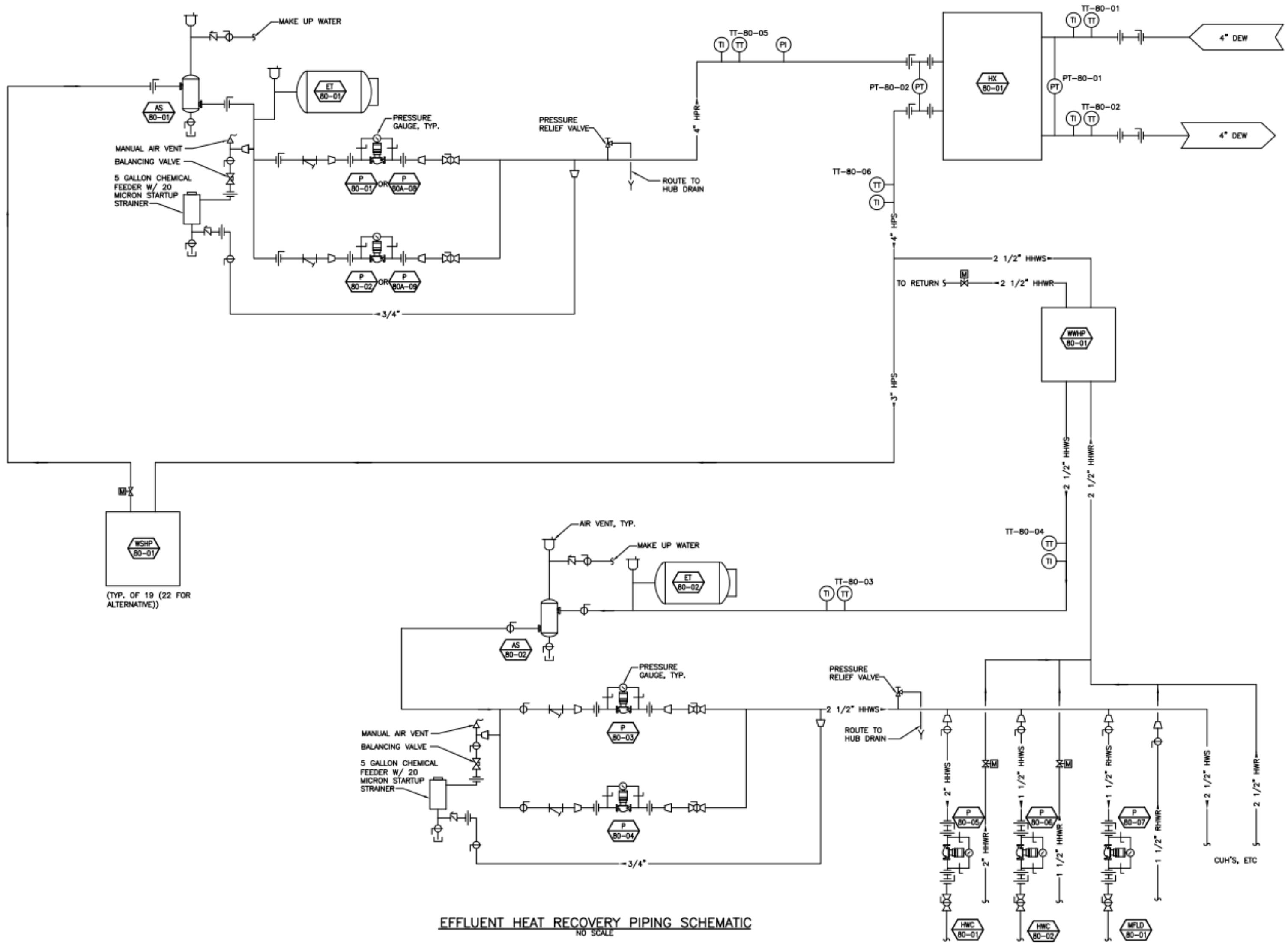

Scroll Compressor

Rotary Compressor

Reciprocating Compressor

STRAND ASSOCIATES®

# System Components




EFFLUENT HEAT RECOVERY PIPING SCHEMATIC
NO SCALE

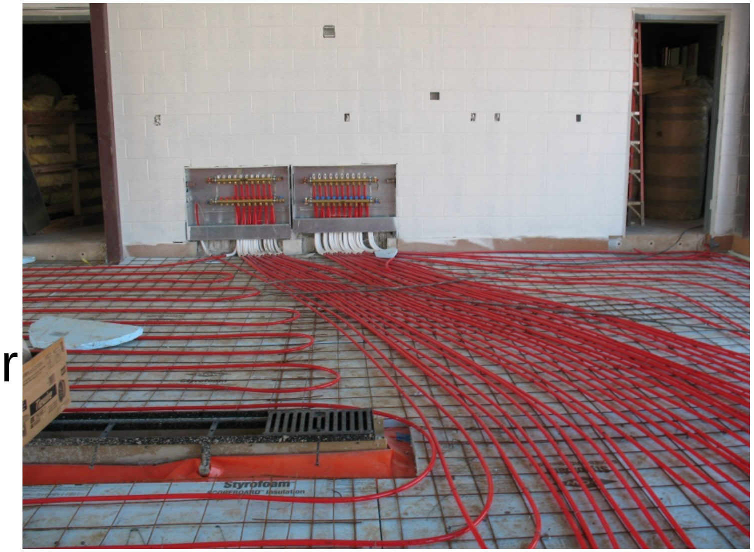
STRAND ASSOCIATES®

# System Components

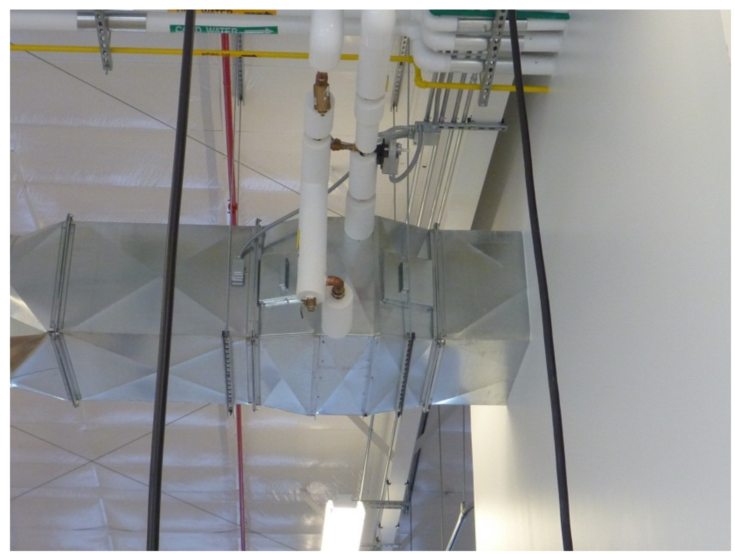
Effluent water

120 F water
To feed:

Water-to-water heat pump



Infloor radiant heat



Hot water duct coils

STRAND ASSOCIATES®

# Life Cycle Cost Analysis

| | Gas & Electric Heat | Effluent System |
|---|---|---|
| Boilers | 24 | N/A |
| Piping | >30 | >30 |
| Pumps | 10-20 | 10-20 |
| Unit Heaters | 13-20 | 13-20 |
| Heat Exchangers | N/A | ~24 |
| Heat Pumps | N/A | >24 |
| Compressors | N/A | 20 |

Expected Useful Life of Equipment

STRAND ASSOCIATES®

# Life Cycle Cost Analysis

| | Gas & Electric Heat | Effluent System |
|---|---|---|
| Boilers | $$$ | N/A |
| Piping | $ | $ |
| Pumps | $$ | $$ |
| Unit Heaters | $ | $ |
| Heat Exchangers | N/A | $ |
| Heat Pumps | N/A | $$ |
| Compressors | N/A | $$ |

Expected Maintenance Costs

STRAND ASSOCIATES®

# Annual Operating Cost Analysis

| | Gas & Electric Heat | Effluent System |
|---|---|---|
| Heat-Electric | 2,930 kWh | 5,567 kWh |
| Heat-Gas | 804 therms | 0 |
| Cooling-Electric | 7,852 kWh | 3,574 kWh |
| Pumps, Fans-Electric | 3,838 kWh | 9,024 kWh |
| Total Usage | 14,620 kWh + 804 therms | 18,165 kWh only |
| Power Cost | $1,023 | $1,272 |
| Gas Cost | $854 | $0 |
| Total Utility Cost | $1,877 | $1,272 |
| Savings | $605 (32%) | |

Example 1 – 3,000 square foot Pumping Station

# Annual Operating Cost Analysis

| | Gas & Electric Heat | Effluent System |
|---|---|---|
| Heat-Electric | 17,902 kWh | 1,817 kWh |
| Heat-Gas | 99 therms | 99 therms |
| Cooling-Electric | 9,259 kWh | 6,419 kWh |
| Pumps, Fans-Electric | 16,031 kWh | 8,500 kWh |
| Total Usage | 43,192 kWh + 99 therms | 16,736 kWh + 99 therms |
| Power Cost | $5,615 | $2,176 |
| Gas Cost | $126 | $126 |
| Total Utility Cost | $5,741 | $2,302 |
| Savings | $3,439 (60%) | |

Example 2 – 4,500 square foot Administration Building with Lab

STRAND ASSOCIATES®

# Annual Operating Cost Analysis

| | Gas Heat | Effluent System |
|---|---|---|
| Heat-Electric | 0 kWh | 33,562 kWh |
| Heat-Gas | 24,750 therms | 5,475 therms |
| Fan-Electric | 65,350 kWh | 65,350 kWh |
| Pump-Electric | 0 kWh | 1,334 kWh |
| Total Usage | 65,350 kWh + 24,750 therms | 100,246 kWh + 5,475 therms |
| Power Cost | $6,535 | $10,025 |
| Gas Cost | $24,750 | $5,475 |
| Total Utility Cost | $31,285 | $15,500 |
| Savings | $15,750 (50%) | |

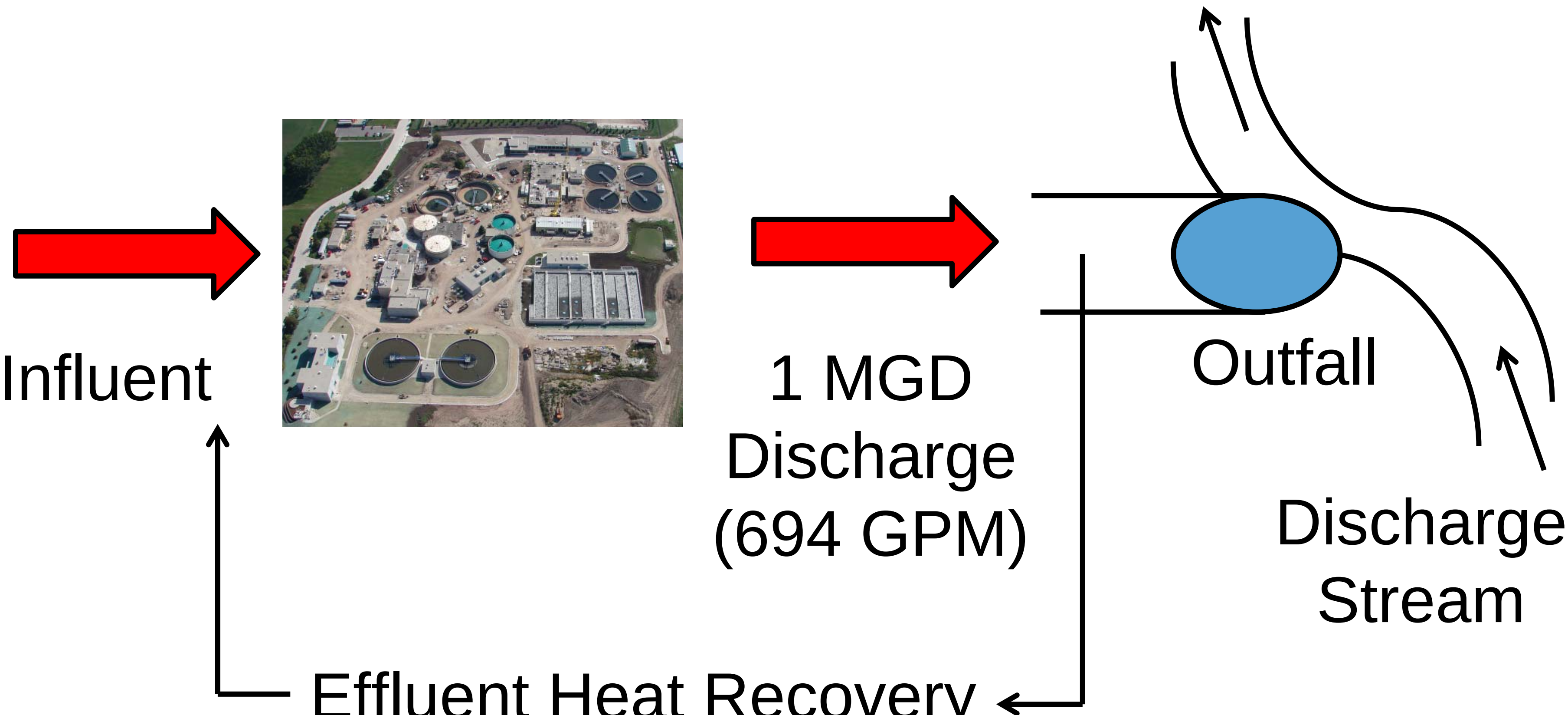
Example 3 – 10,000 CFM Make-up Air Unit Running Continuously

# Which Applications Are Suited For Effluent Heat Recovery?

| Likely Use | Unlikely Use |
|---|---|
| Medium-Large Scale Use | Small Applications |
| Administration Buildings | Small Labs |
| MCC Rooms | Remote Buildings |
| Makeup Air Units | |
| Energy Recovery Equipment | |
| Infloor Heating | |
| DEW Water Facilities | |
| Campus-type Generation | |

STRAND ASSOCIATES®

# Impact on Potential Thermal Discharge Limits




It Takes 150 Tons of Cooling to Drop 1 MGD 5 F

# Summary

- Using Plant Effluent Water For Heating and Cooling Results in 30-60% Annual Energy Savings.
- Energy Savings Is The Result Of The Effluent Water Causing A Refrigerant Phase Change.
- Components Of An Effluent Heat Recovery System Are Similar to Other Equipment In A Wastewater Treatment Plant.
- Effluent Heat Recovery System Creates Little Impact On Thermal Discharge Limits

STRAND ASSOCIATES®

# Questions

Any Questions?

STRAND ASSOCIATES®