Absorption Heat Pump

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CampusEnergy2020
THE POWER TO CHANGE
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BROAD USA

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

• Agenda:

- Introducing LiBr cycle Absorption Heat Pump
- Types of Absorption Heat Pump
- Conditions & Applications of Heat Pump Applications
- Case Studies of Absorption Heat Pumps

What is an Absorption Heat Pump?

Water Pump

High Level Water

Low Level Water

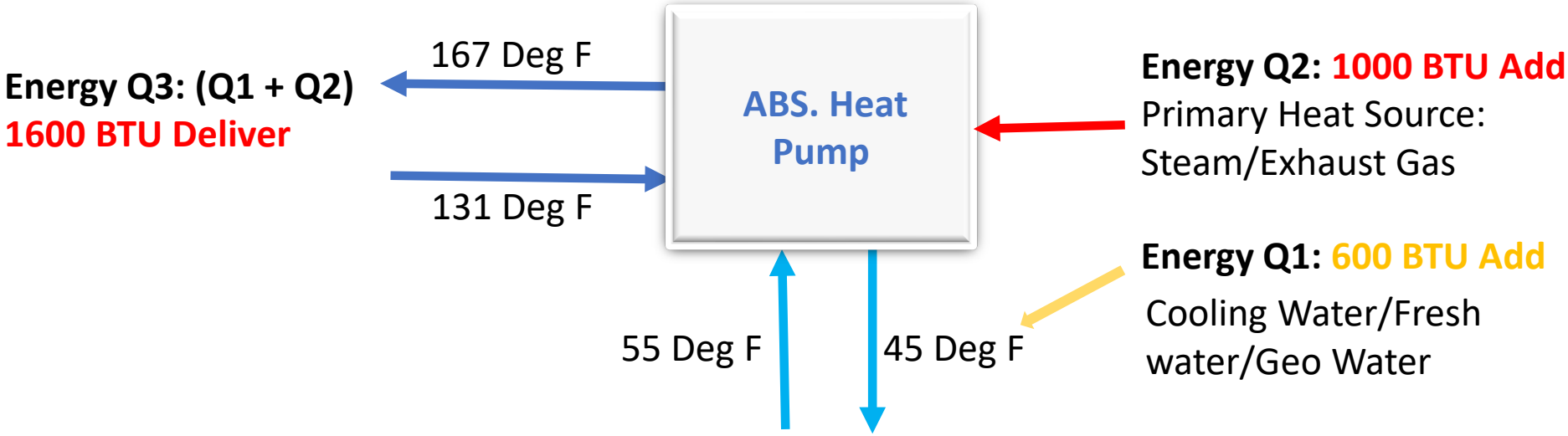
Abs. Heat Pump

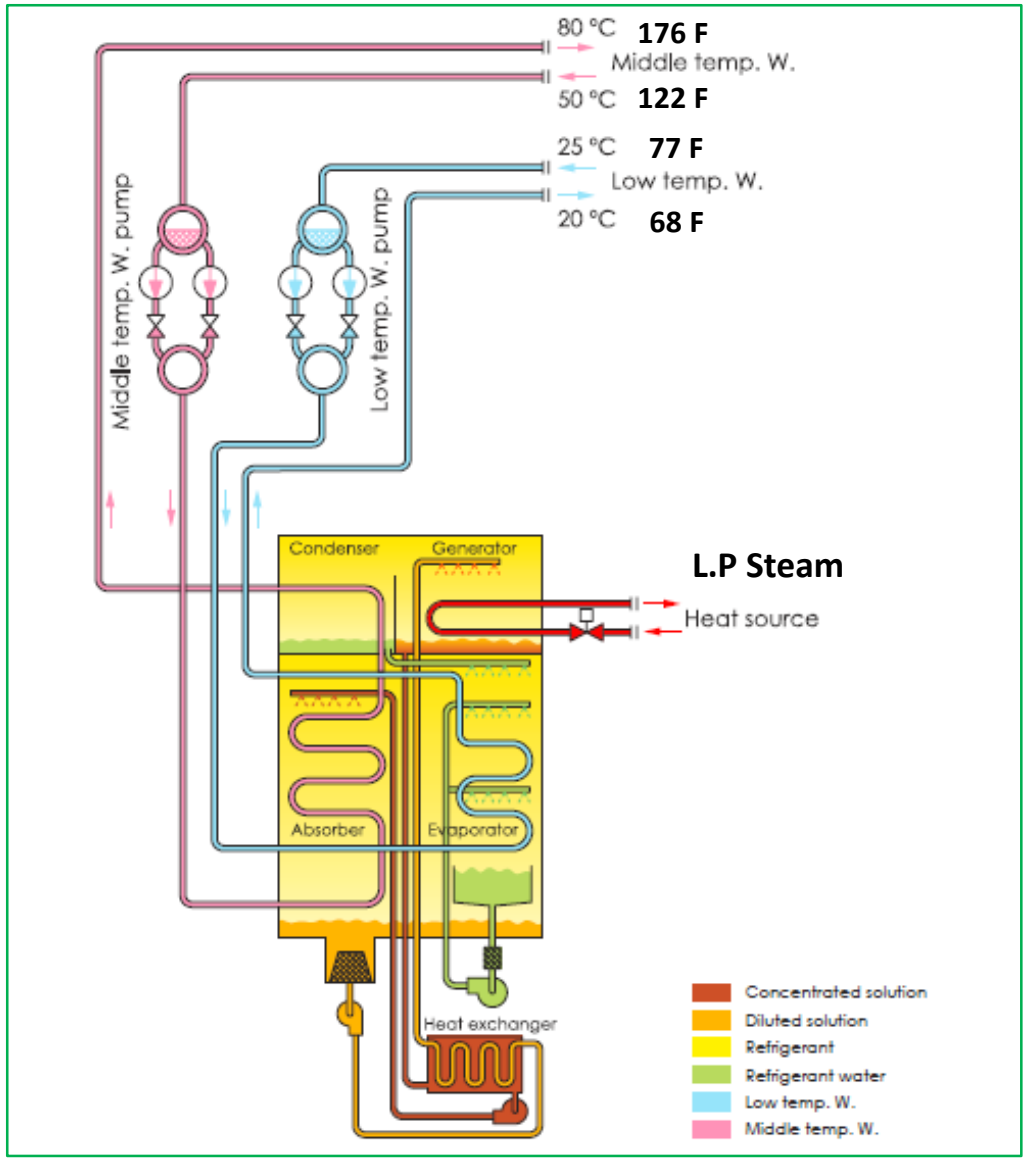
High Grade Heat

Low Grade Heat

ABS. Heat Pump transfers the heat, does not create it.

This machine pumps the heat from low temp. to high temp. by using a high grade energy as the driving source (Steam/ Exhaust Gas/Nat. Gas)





Heating principle of ABS. Heat Pump

Heat pump is driven by a heat source to recycle heat from low temperature water. Both heats get added to provide a middle-temperature water for heating usage. Refrigerant water from the Condenser enters Evaporator and vaporizes under vacuum and brings down the internal temperature. This helps convert low temp water of 77 F to 68 F. The vapor then gets absorbed in the Absorber by the concentrated solution provided by the Generator (heated by driving heat source).

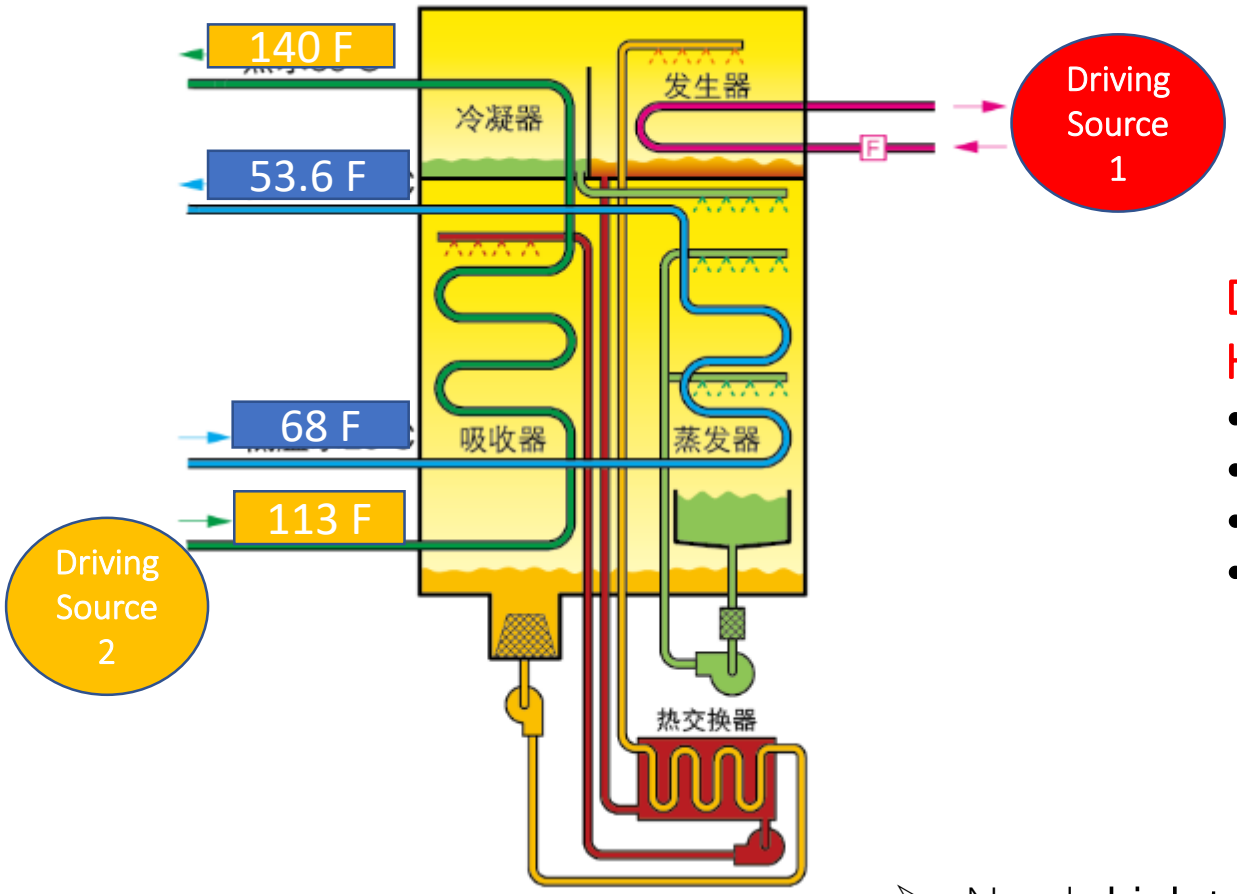
The absorption process being an exothermic reaction heats up the middle-temperature water of 122 F which further picks up the heat released by refrigerant's hot vapor in the Condenser while being delivered out at 176F serving the heating loop.

Absorption Heat Pump classification:

Type	Heating Capacity kW	2 Heat Sources	Input Conditions
Steam HP	282 to 56,489	low temp. water steam	low temp. water ≥41 °F steam pressure ≥14.5psi
Exhaust HP	282 to 56,489	low temp. water high temp exhaust	low temp. water ≥41 °F exhaust temperature ≥482 °F
Hot Water HP	282 to 56,489	low temp. water high-temp hot water	low temp. water ≥41 °F high-temp hot water ≥167 °F
Direct-Fried HP	282 to 56,489	low temp. water natural gas	low temp. water ≥41 °F

* HP: Heat Pump

R1 type Heat Pump



Driving Source 2 - Low Temp Heat input:

- Waste hot water from steam turbine condenser (~ 104 Deg F hot water)
- Hot water from engine low temp jacket water (~ 113 Deg F hot water)

Driving Source 1: High Temp Heat -

- Steam (44 ~ 103 psi)
- Exhaust (> 752 Deg F)
- Hot water (> 248 Deg F)
- NG / Diesel / LPG

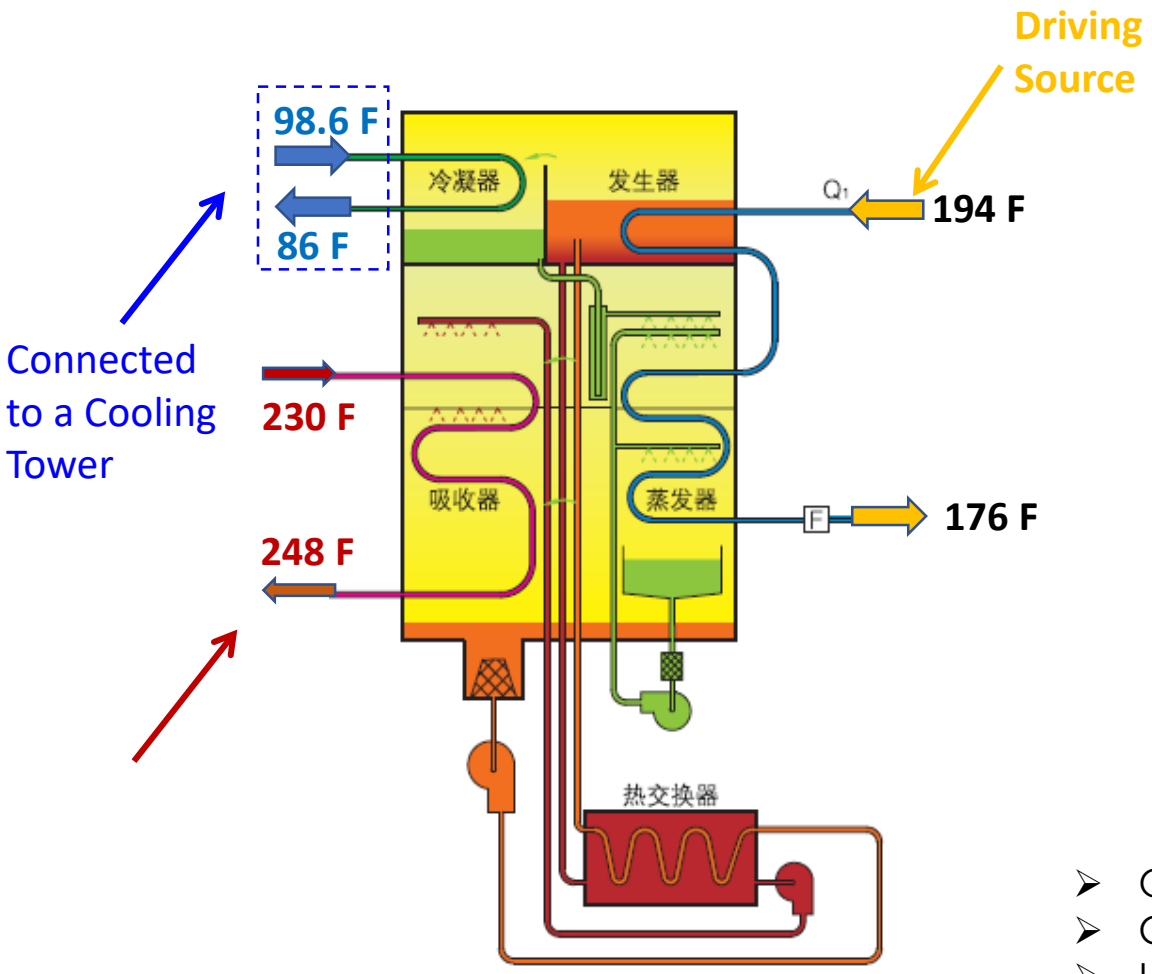
Heat Pump

Hot Water output:

- Heating water (< 185 Deg F)

- Needs **high temp** and **low temp** heat to drive.
- Hot water up to **203℉** possible
- COP may go up to **1.8**

R2 Type Heat Pump



. Low Temp Heat output:
- **May be Cooling tower (99 ~ 86 Deg F)**

Driving Source:
Medium Temp. Heat input:

- **Waste hot water (140 ~ 194 Deg F)**

Heat Pump

. High Temp Heat output:
- **Heating water (194 ~ 248 Deg F)**
- **For Heating Net**
- **For industry process heating**

- Only one driving source needed in this type
- Can provide hot water up to **248°F**
- Lower COP < 0.5

Applications of Abs. Heat Pump :

- Building Heating Load
- Domestic Hot Water Load
- Process Heating Water Load *[Engine LT circuit/Process HEXs]*
- Increased heating demand and insufficient heat supply in thermal power plants
- Centrifugal chiller can be clubbed with a heat pump to avoid a cooling tower and have simultaneously heating delivered.

Conditions for Abs. Heat Pump:

Application conditions:

1. **Find the Low temperature Heat Sources** e.g.

- Natural heat source: seawater, river water, hot spring water, groundwater
- Process heat: Waste heat from industrial production, Cooling water from Power plant auxiliary , Engine LT jacket water , Chemical process plant, Petroleum smelting etc.

2. **Find the Drive Heat Sources** e.g.

- Steam pressure with wide range for single effect heat pumps **14.5 ~ 116psig**
- Cogeneration LP Steam, Gas Turbine/Engine Exhaust Gas, High/Low Temp Hot Water, Natural Gas/Propane/Bio Gas can be used

...continued

3. Find the Heating Demands e.g.

- Long heating time with steady demand is good for shorter payback period
- Heating temperature required should not be too high
- The total heating demand BTUs should balance out with the rejected BTUs of the driving heat sources
- Heat demand side should not be far from the driving heat sources. It will save the heating loop's transmission cost.

I. Case Study of Denmark Medical University

The Problem:

The Campus wanted to save electrical energy consumed by their round the year cooling and heating demand. They also wanted to cut emissions by stopping the fossil fuel boiler otherwise required for heating.

Identifying the application for ABS. Heat Pump:

Their medical surgery and clean room application wings had a low but continuous cooling load which was identified as Low Temp Heat Input for the ABS. Heat Pump.

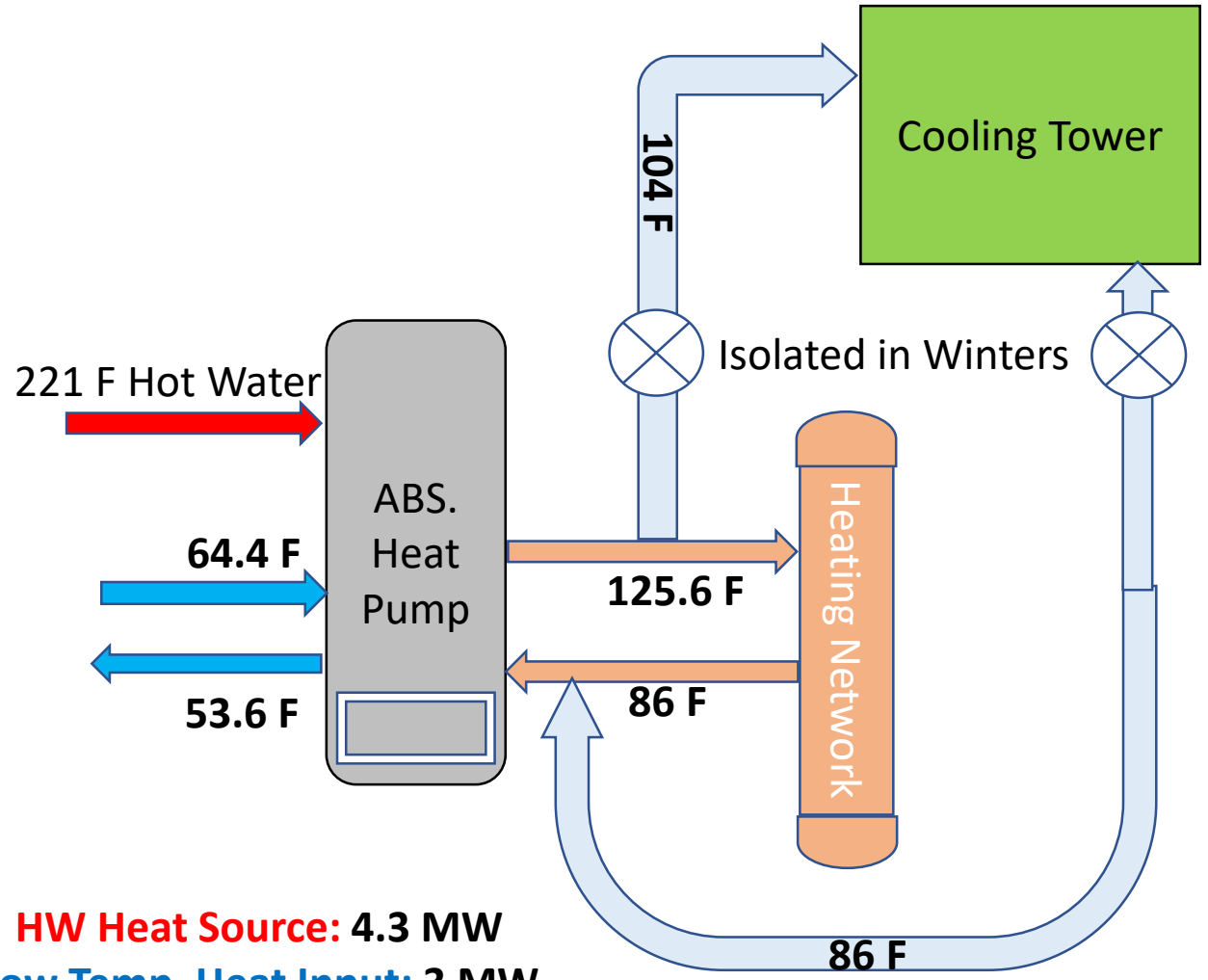
Their Heating network on the campus needed hot water round the year either for space heating or domestic water usage and it was identified as Medium Temperature Outlet from the Heat Pump.

A Biomass boiler was able to provide adequate BTUs in form of 221F Hot water and chosen for Heat Pump's driving heat source.

Case Study of Denmark Medical University

Solution:

- In the winter, the heat pump recycles the air conditioning waste heat from the hospital (64.4 F / 53.6 F) as the lower temperature heat input and is provided drive heat source of 221 F Hot water from a biomass boiler. In return, the Heat Pump delivers 125.6 F Medium Temperature Hot Water for the campus heating network. (Simultaneous Cooling & Heating)
- In the summer, the same heat pump works like a chiller providing chilled water for their new Particle Therapy center. During this time, it gets connected to a cooling tower for dissipating the absorption heat and chilled water temperature is made more lower.
- It saves tangible energy otherwise be consumed by conventional methods of cooling and heating water generation.



HW Heat Source: 4.3 MW
Low Temp. Heat Input: 3 MW
Medium Temp. Heat Output: 7.3 MW

II. Case Study of Latvia District Heating

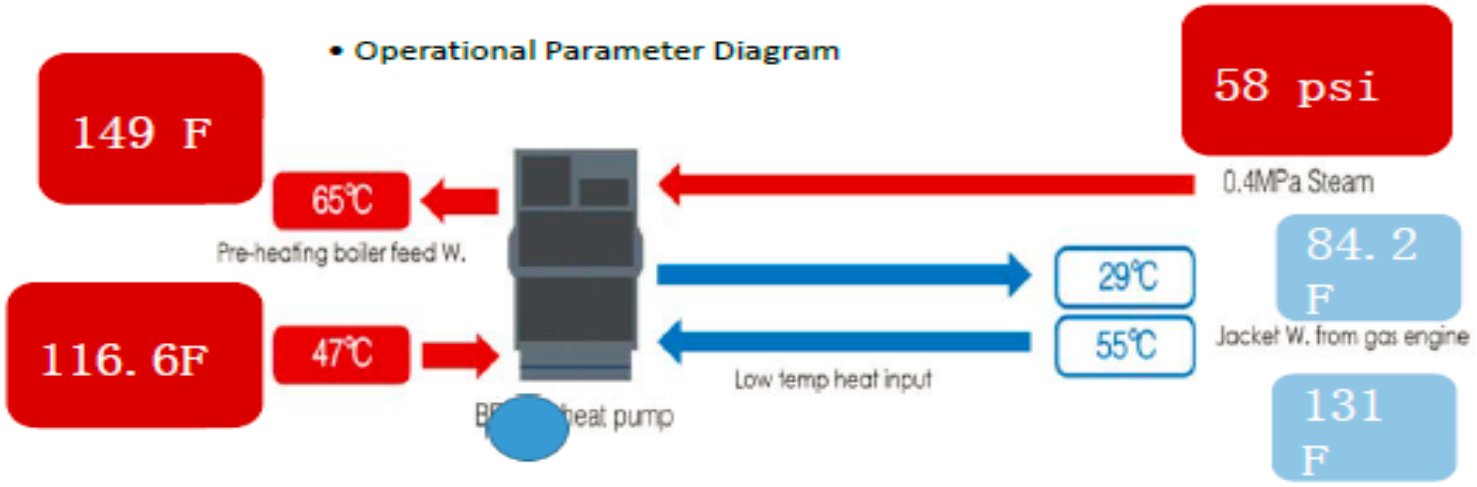
Rigas Power Plant

- District heating supplier in Baltic sea area . Applied heat pump to recycle the heat from gas engine for central heating.
- Heating capacity: 5,000kW
  Heating COP: 1.74
  Yearly energy saving equivalent: 425 ton oil
  Yearly CO_2 cutting: 1,275 ton

Steam Type Heat Pump

Steam Type Heat Pump

- Operational Parameter Diagram



Case Study of Rigas Siltums, Latvia

The Problem:

The treated make up water used in the Cooling Tower to cool the LT circuit of a continuous running Gas Engine was a burning issue. They also wanted to save water in maintaining the deaerator feed water temperature.

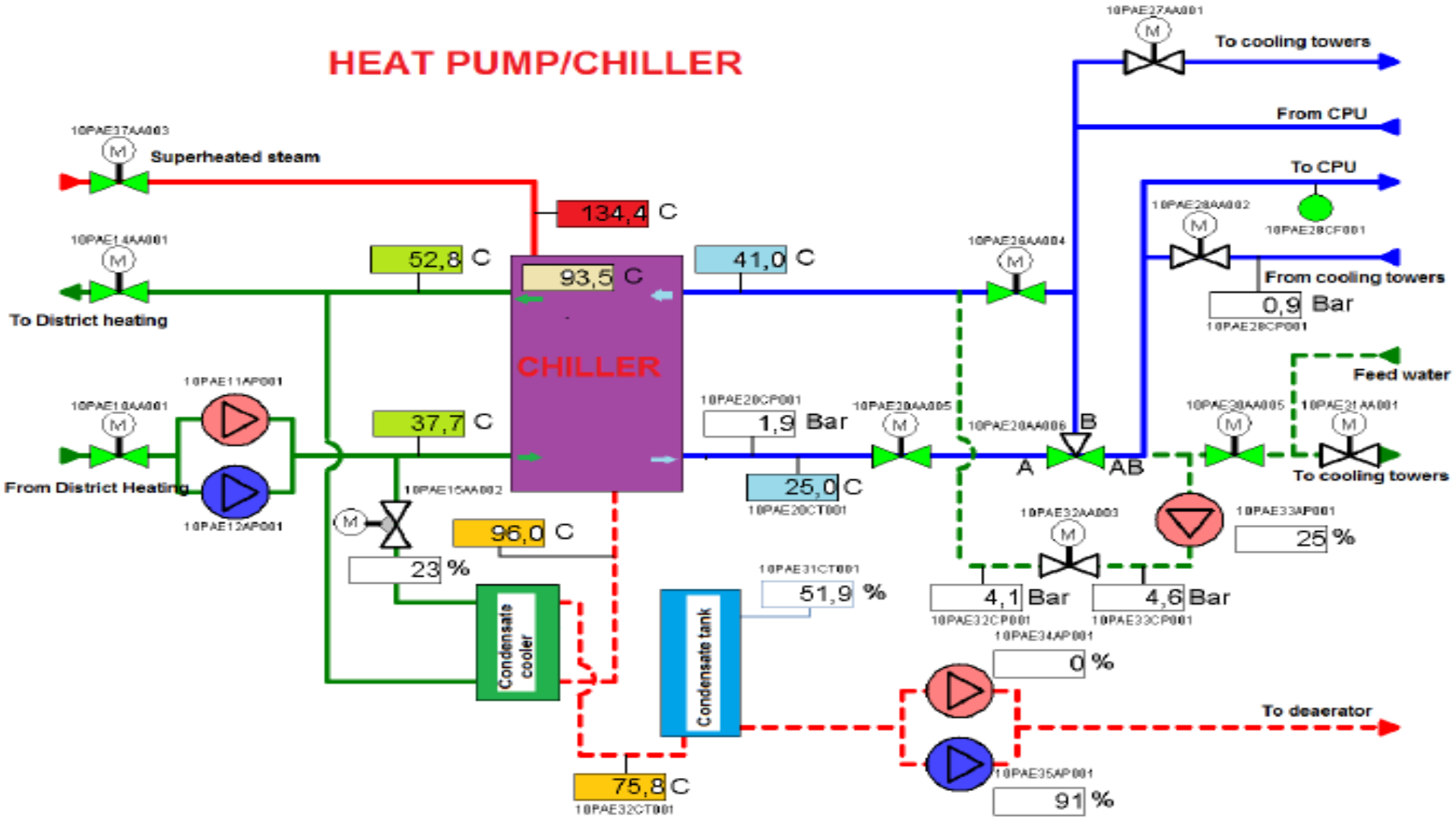
Identifying the application for ABS. Heat Pump:

The Energy company recognized the Engine's LT circuit water as the Low Temp Heat Input for the Heat Pump.

Their district heating network needed hot water on continuous basis and was identified as Medium Temperature Outlet from the Heat Pump.

The on-site cogeneration had spare low pressure steam @ 58 psi to be made as the Heat Pump's driving heat source.

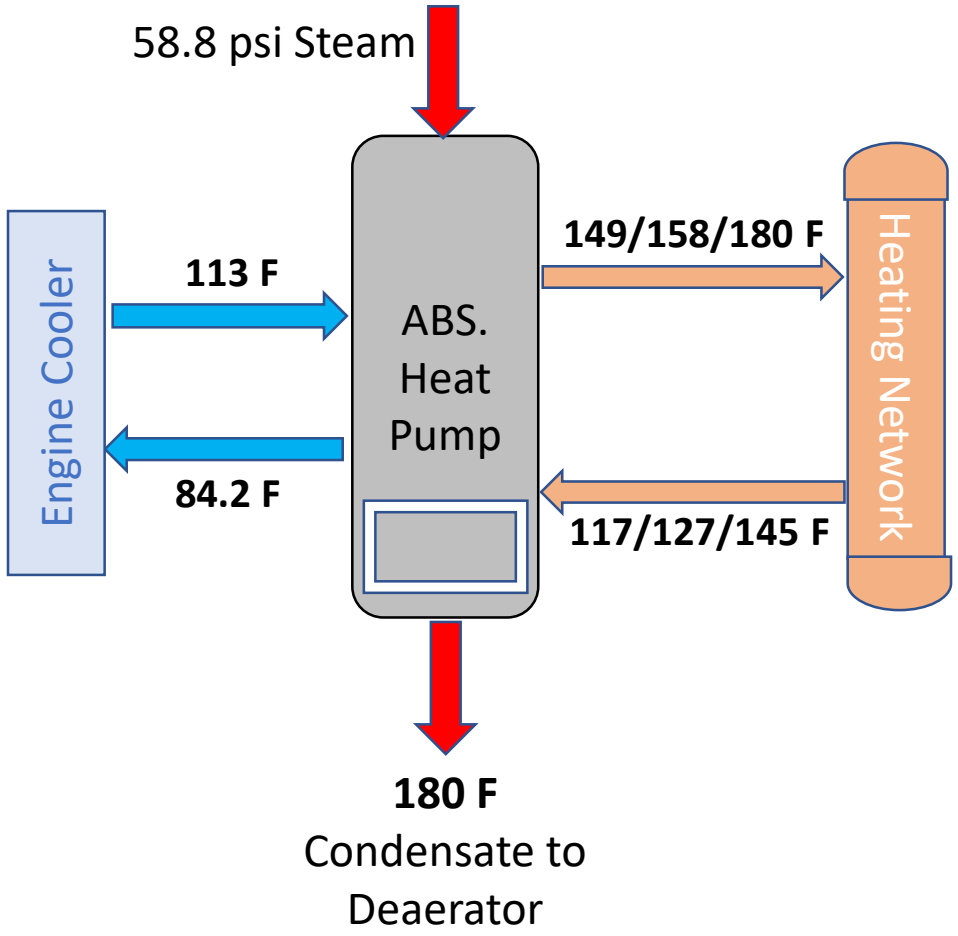
P&ID of Heat Pump Heating Circuit



Case Study of Latvia District Heating

Solution:

- 16 t/year Make -up water saved
- 1.16 MM m3/year Nat. Gas saved in heating
- 5 MW Heating contributed by Heat Pump
- 2 MW Engine Aux. Cooling contributed too



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