



ATMO sphere





NH₃ Heat Pumps

Is Australia ready for the large Heat Pumps?

Ricardo Claussen Hoffmann
Johnson Controls Australia

A HEAT PUMP is:

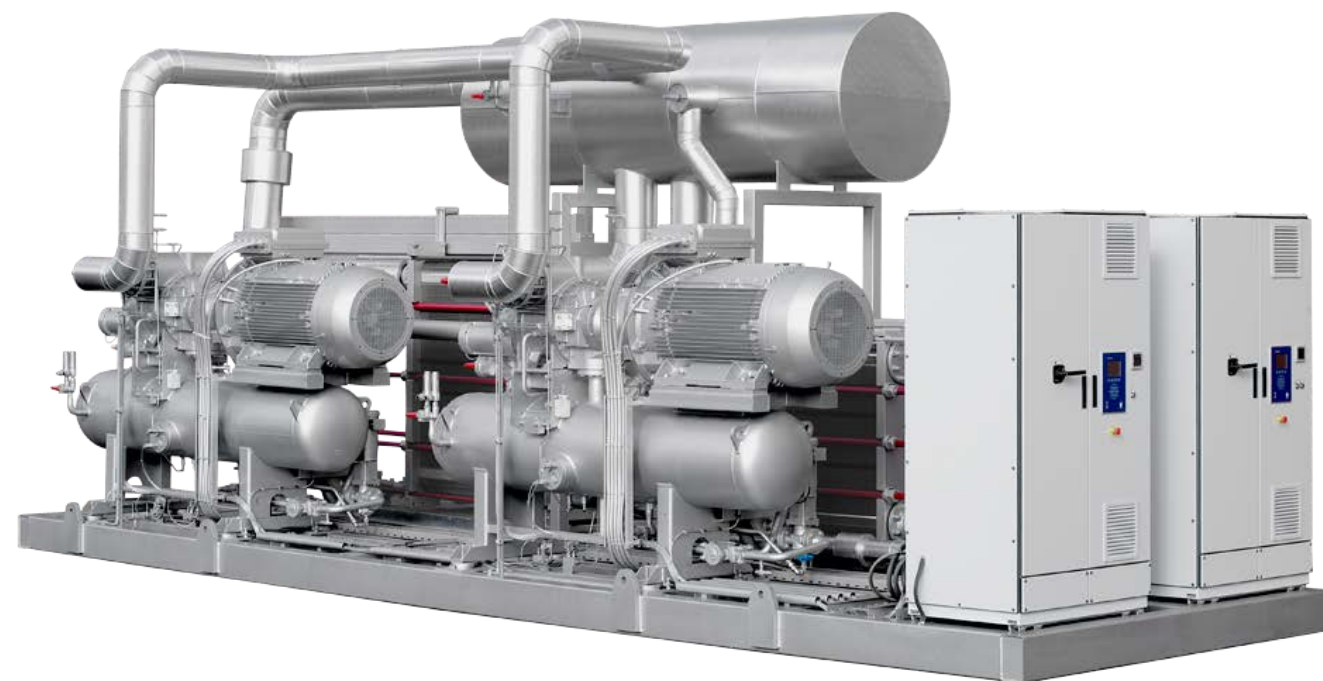
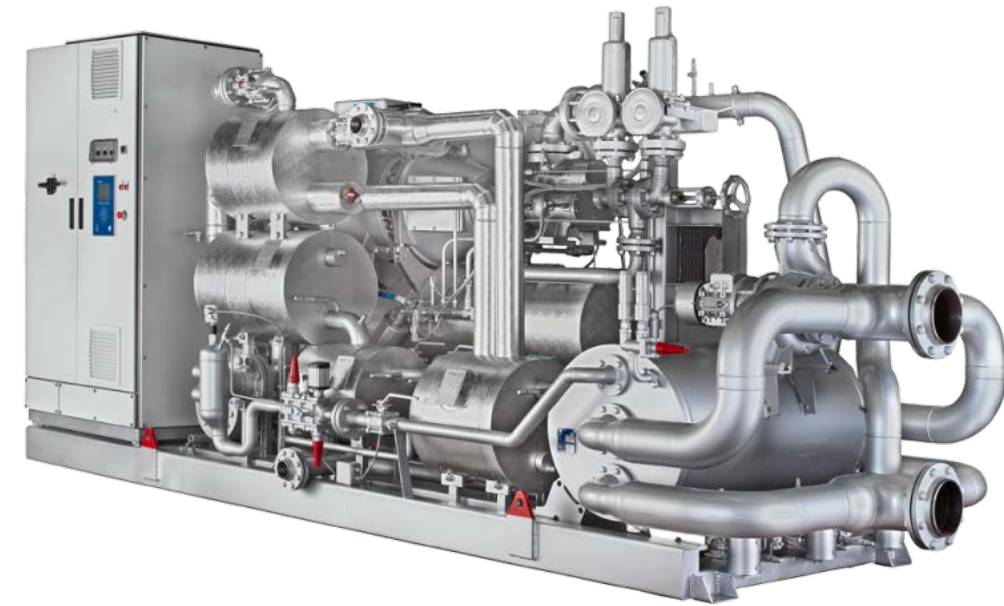
- accordingly to ASHRAE, a Heat Pump extracts heat from a source and transfers it to a sink at a higher temperature;
- in Engineering, ... the term Heat Pump is generally reserved for equipment that heats for beneficial purposes, rather than that which removes heat for cooling only

A LARGE HEAT PUMP is:


- equipment focused in industrial applications OR large commercial applications;
- offers large heating capacities;
- water cooled;

AMMONIA BASED SABROE HEAT PUMPS:

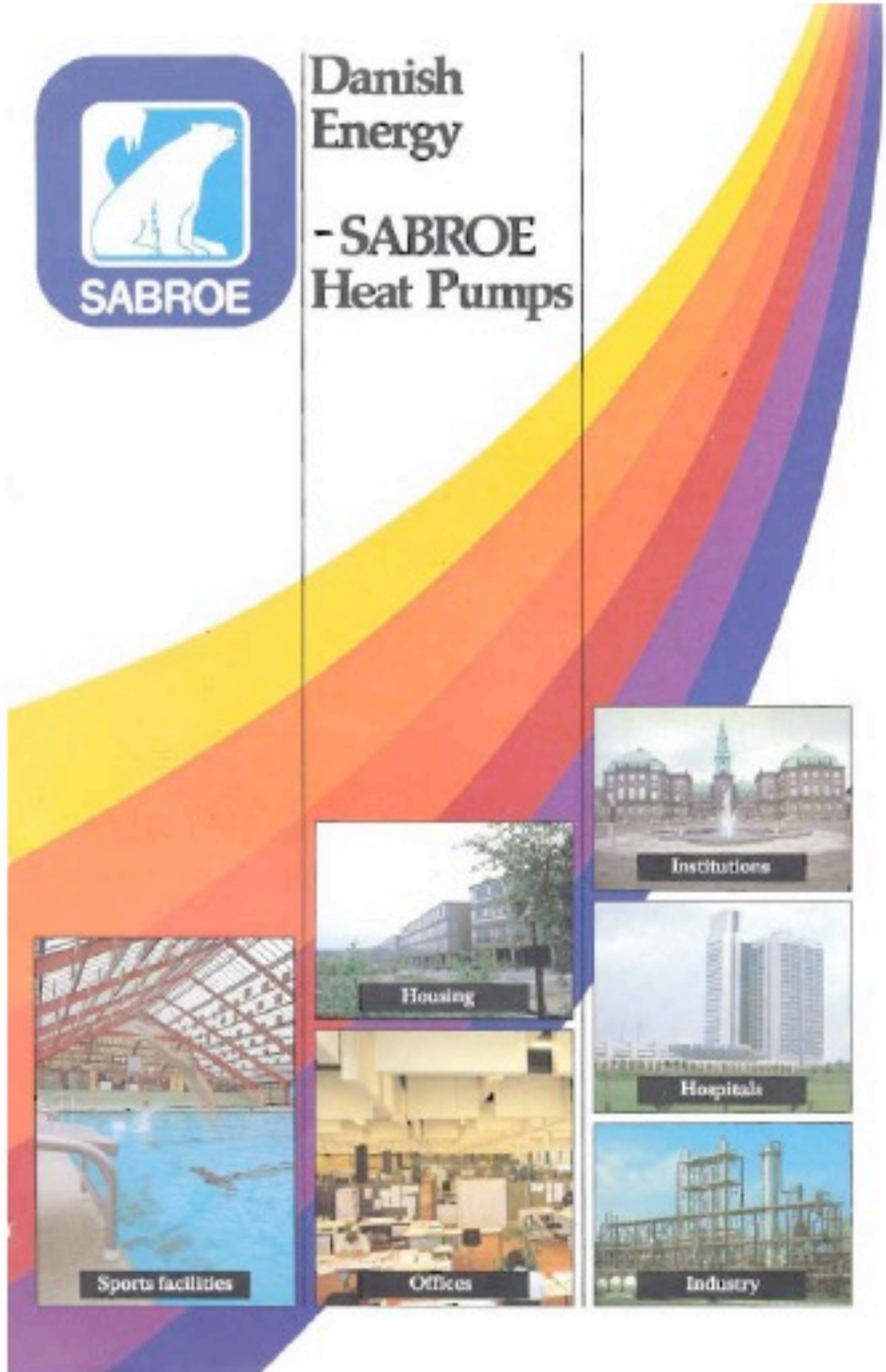
- Recip compressors;
- Screw compressors;
- Water cooled;
- Heating capacity from 150 KW to 13,000KW;
- Single Stages units;
- Two Stages units;
- Factory tested;
- Hot water up to 90°C;









HEAT PUMPS ARE NOT A NEW TECHNOLOGY:



Danish Energy
- SABROE Heat Pumps




Heat Sources - Available Everywhere

Cold does not exist in science. The absolute zero on the Centigrade temperature scale is -273°C. Any temperature above this limit is obtained by supply of heat. It is thus possible to recover heat from air below 0°C and from so-called "cold" water. The heat pump utilizes this physical fact. The pump extracts energy from the relevant source and enables the consumer to use it for heating purposes. The heat sources can be divided into four main groups: natural air, water, and soil, plus waste heat.

which is a result of human activities. The paying temperature range of the heat sources is illustrated in the diagram:







Access to one or more heat sources ought to motivate a thorough examination of both technical and financial aspects. The most important advantages/disadvantages of the four heat sources are mentioned below:

Advantages/disadvantages

Heat source	+	-
Air	Available everywhere	Considerable fluctuations of temperature
Water	Small fluctuations of temperature	Seldom available near the place of consumption
Soil	Minimal fluctuations of temperature	Open space is necessary
Waste heat	Available at high temperatures	Seldom available near the place of consumption

Effective utilization of the chosen heat source is guaranteed with a properly designed heat pump.

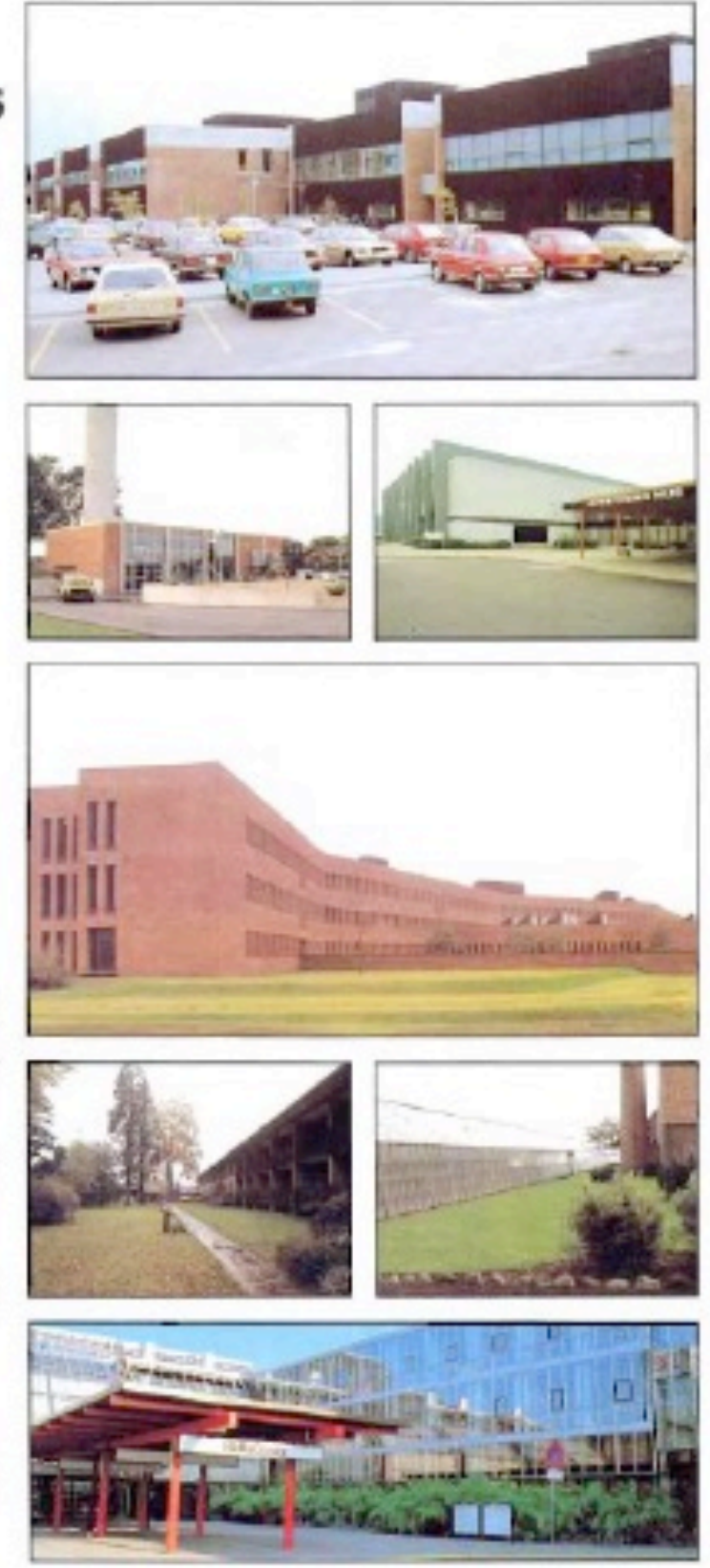
Possible Applications

The heat pump has a wide field of application. It can be used for any heating purpose - i.e. comfort heating or industrial processes where heat supply is required. The industrial heat pump is extensively used in the following fields:

- district heating
- the building sector
- swimming baths
- covered courts
- ice rinks
- offices
- schools
- public institutions
- hospitals
- exhibition rooms
- store rooms
- industrial firms
- horticulture, etc.

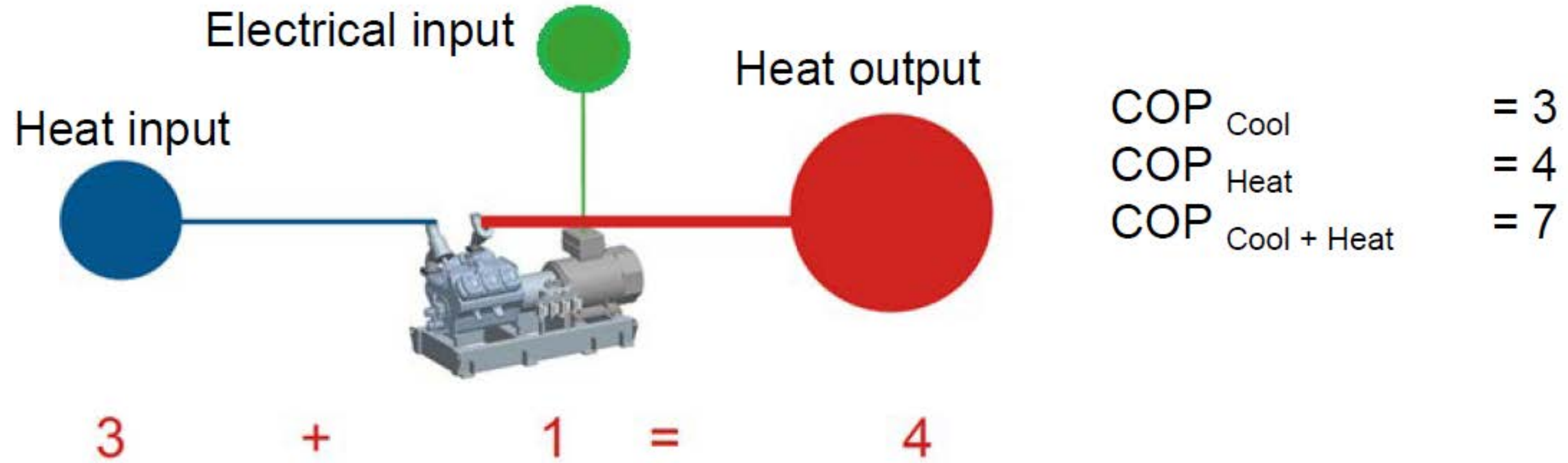
SABROE Know-How

An extensive experience within refrigeration has made SABROE one of the leading firms as regards heat pumps. The latest result of SABROE's ceaseless efforts to develop its products is a complete series of standardized industrial heat pumps with a capacity range from 50 kW to 5 MW or more. The standard series comprises 12 units and each unit is driven either by electricity, gas, or diesel. SABROE's own factory makes the heat pumps of well-known and thoroughly tested components. Moreover SABROE offers special solutions to individual demands.



Brochure from 1982 / first equipment commercialized in 1967

HEAT PUMPS USES THE ENERGY INPUT IN BOTH SIDES OF THE SYSTEM:



ADVANTAGES FOR THE HEAT RECOVERY USING HEAT PUMPS:



Reduced operating costs



CO₂ footprint reductions



Reduced water consumption
and chemical



LEED points

REDUCED OPERATING COSTS – AUSTRALIAN EXAMPLE:

Hot Water Requirement	Equipment	Average Efficiency	Energy Consumption	Cost of Source	Cost of Hot Water	HP Saving vs Gas Boiler
1 KWh	Gas Boiler	COP = 0.8	$1 \text{ KWh} / 0.8 = 1.25 \text{ KWh}$	$\$10/\text{GJ} = \$0.0360/\text{KWh}$	$1.25\text{KWh} \times \$0.0360/\text{KWh} = \0.0450	
1 KWh	Water Cooled Heat Pump (NH ³)	COP = 6.0	$1 \text{ KWh} / 6.0 = 0.167 \text{ KWh}$	$\$0.15/\text{KWh}$	$0.167\text{KW/h} \times \$0.15/\text{KWh} = \$0.02505$	-44%

Energy costs considered:

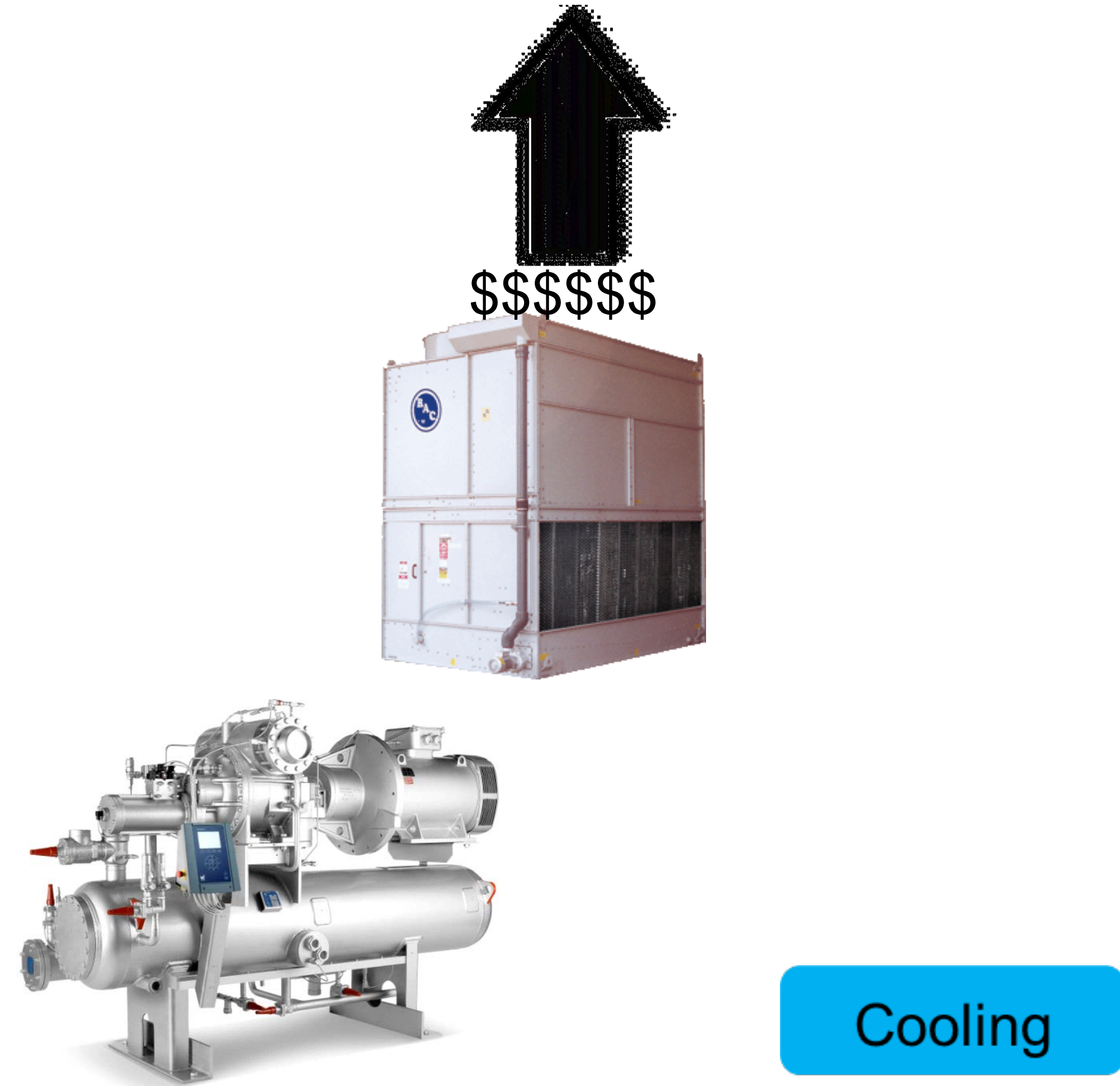
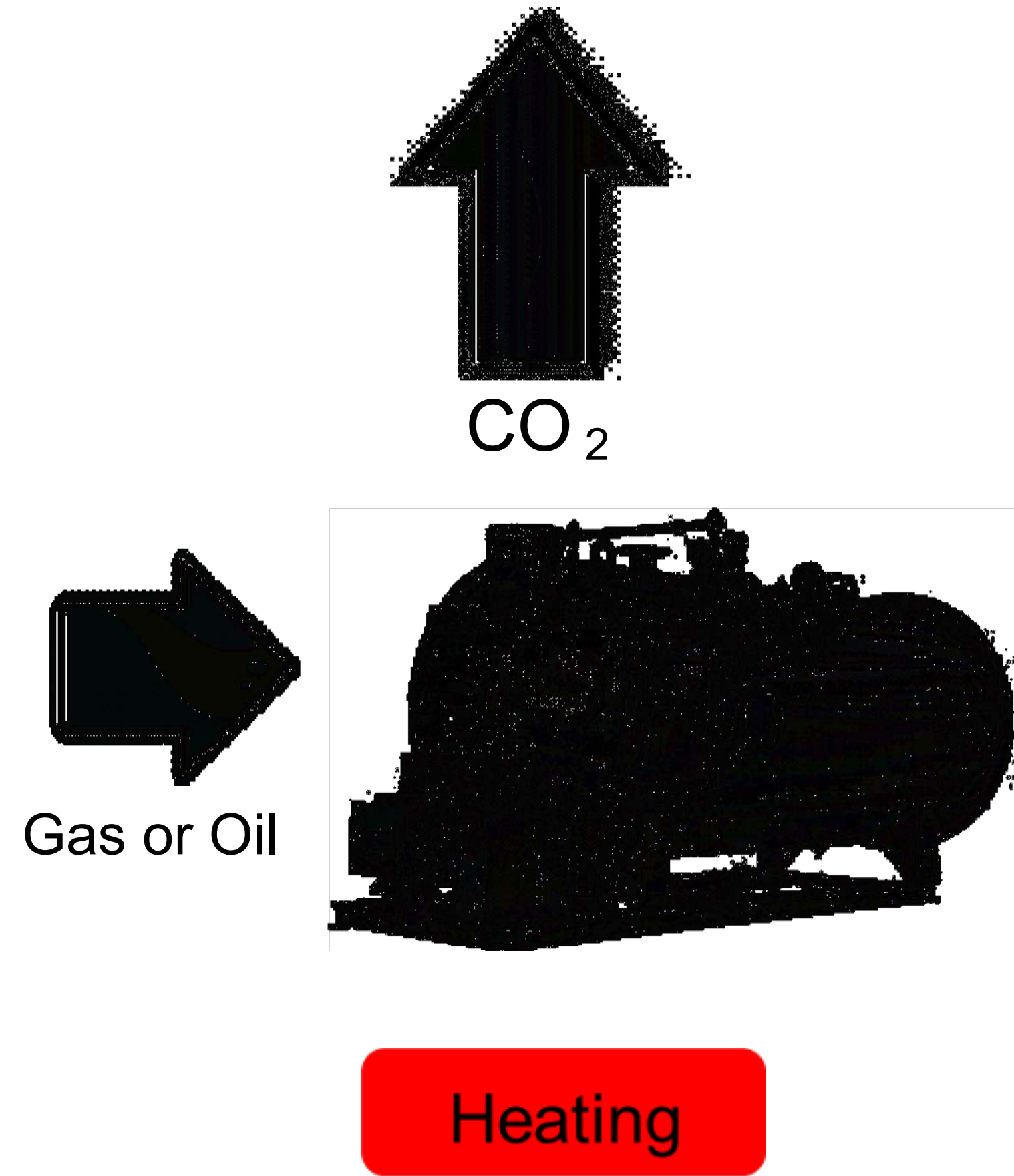
- cost of gas: \$10 per GJ
- cost of electricity: \$0.15 per KWh

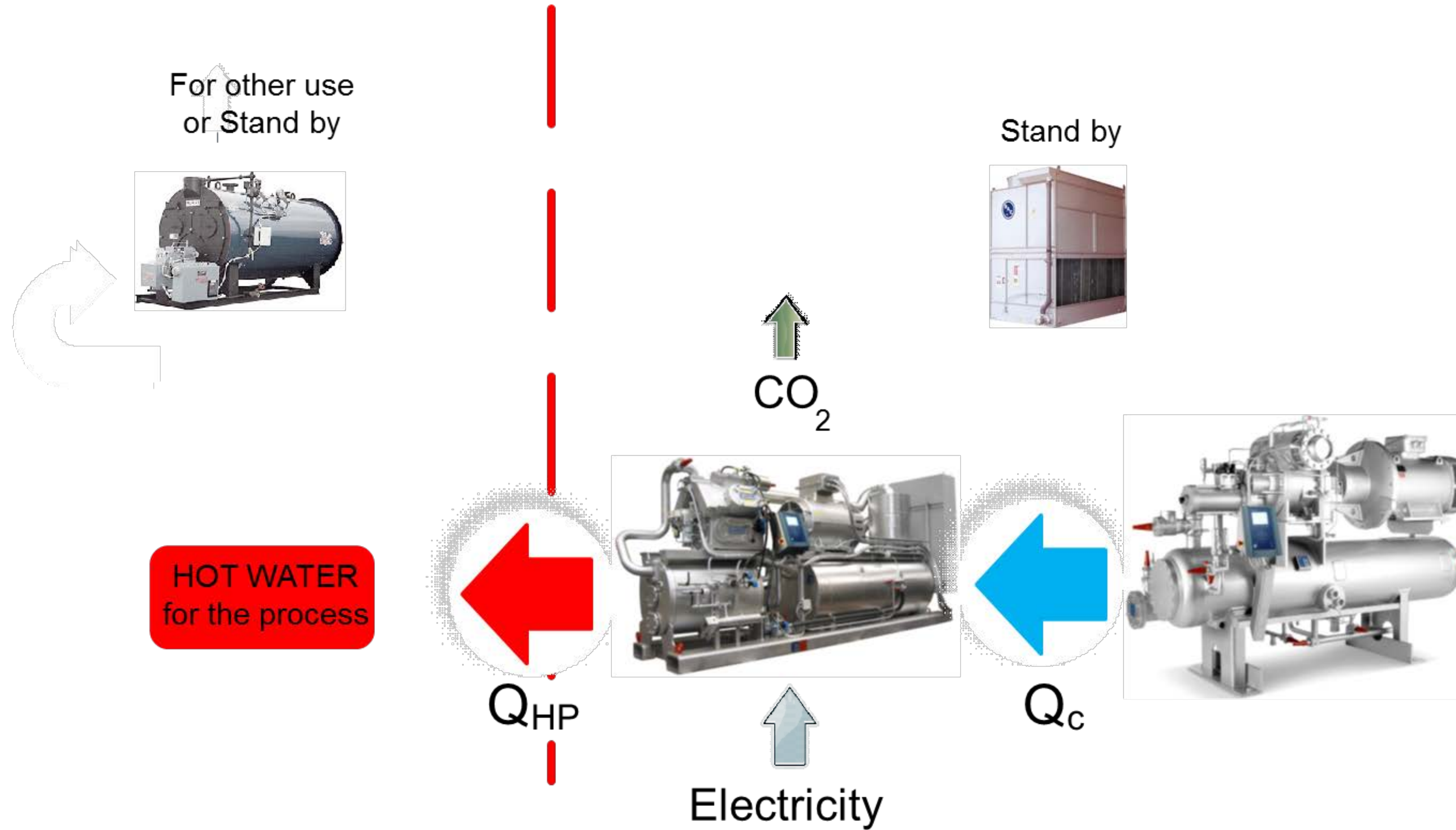
CO2 FOOTPRINT REDUCTIONS – AUSTRALIAN EXAMPLE:

Hot Water Requirement	Equipment	Average Efficiency	Energy Consumption	CO ₂ Source Emissions*	Carbon Footprint	HP CO ₂ Footprint reduction vs Gas Boiler
1 KWh	Gas Boiler	COP = 0.8	1 KWh / 0.8 = 1.25 KWh	185 g CO ₂ / KWh	1.25 KWh x 185g CO ₂ / KWh = 231 g CO ₂	
1 KWh	Water Cooled Heat Pump	COP = 6.0	1 KWh / 6 = 0.167 KWh	1080 g CO ₂ / KWh (VIC)	0.167 KWh x 1080g CO ₂ / KWh = 180 g CO ₂ (VIC)	-22% (VIC)
				830g CO ₂ / KWh (NSW & ACT)	0.167 KWh x 830g CO ₂ / KWh = 139 g CO ₂ (NSW & ACT)	-40% (NSW & ACT)
				790 g CO ₂ / KWh (QLD)	0.167 KWh x 790g CO ₂ / KWh = 132 g CO ₂ (QLD)	-43% (QLD)
				700 g CO ₂ / KWh (SWIS in WA)	0.167 KWh x 700g CO ₂ / KWh = 117 g CO ₂ (SWIS in WA)	-49% (SWIS WA)
				620 g CO ₂ / KWh (NWIS in WA)	0.167 KWh x 620g CO ₂ / KWh = 103 g CO ₂ (NWIS in WA)	-55% (NWIS WA)
				490 g CO ₂ / KWh (SA)	0.167 KWh x 490g CO ₂ / KWh = 82 g CO ₂ (SA)	-64% (SA)
140 g CO ₂ / KWh (TAS)	0.167 KWh x 140g CO ₂ / KWh = 23 g CO ₂ (TAS)	-90% (TAS)				

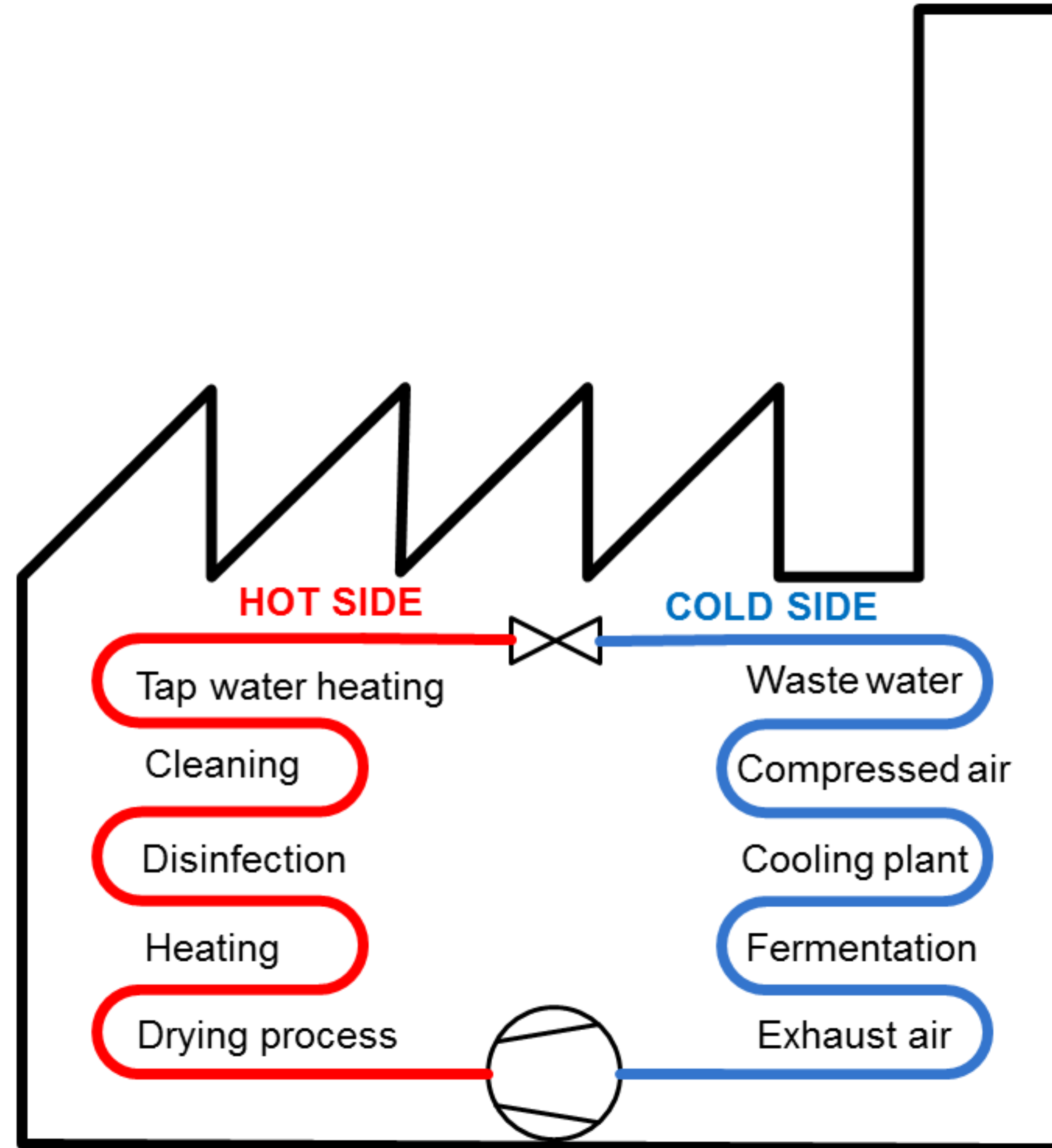
* <http://www.environment.gov.au/climate-change/climate-science-data/greenhouse-gas-measurement/publications/national-greenhouse-accounts-factors-july-2017>

NORMAL SCENARIO – SYSTEMS TOTALLY SEPARATED:





**FOOD & BEVERAGE
INDUSTRY**



MAPPING A BREWERY FACTORY

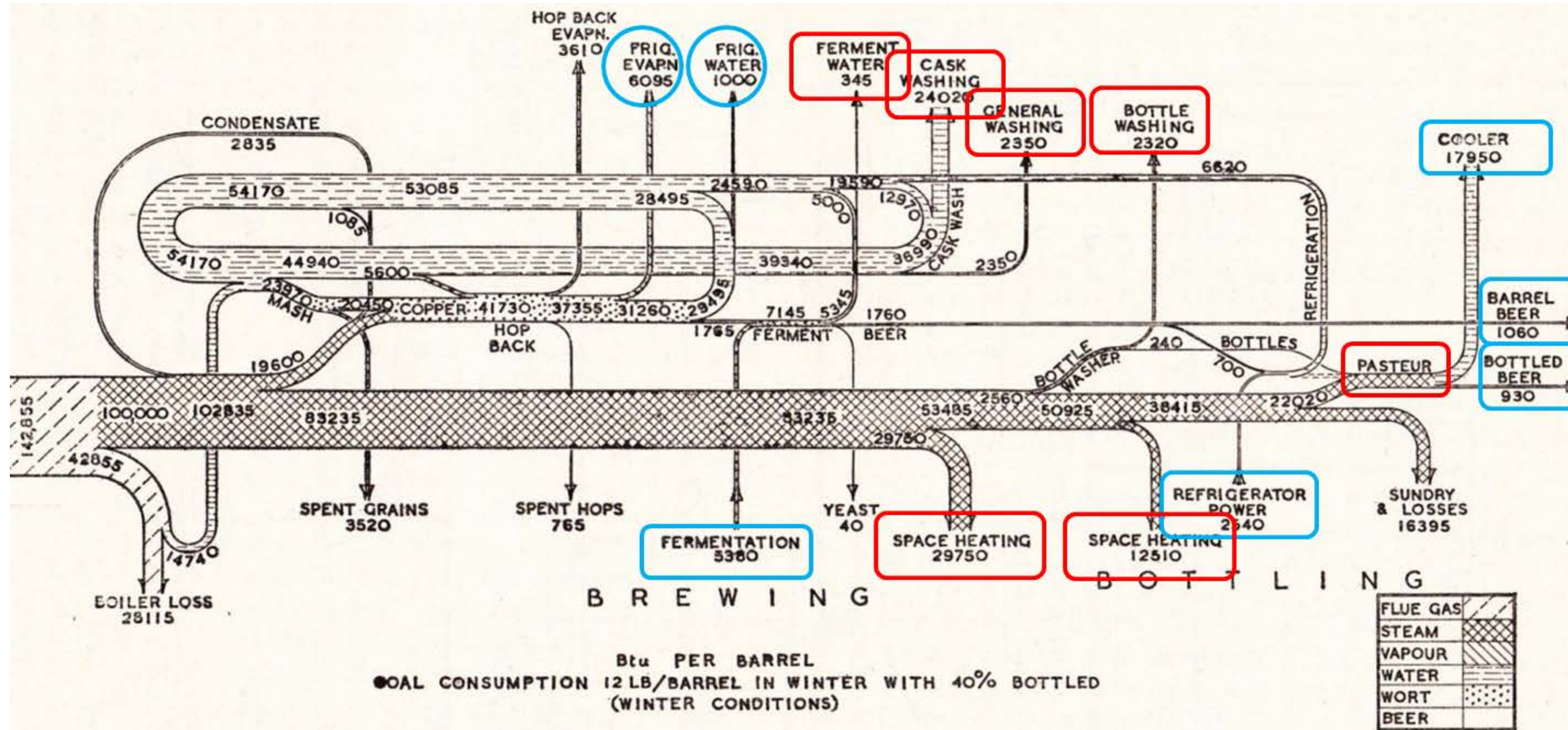
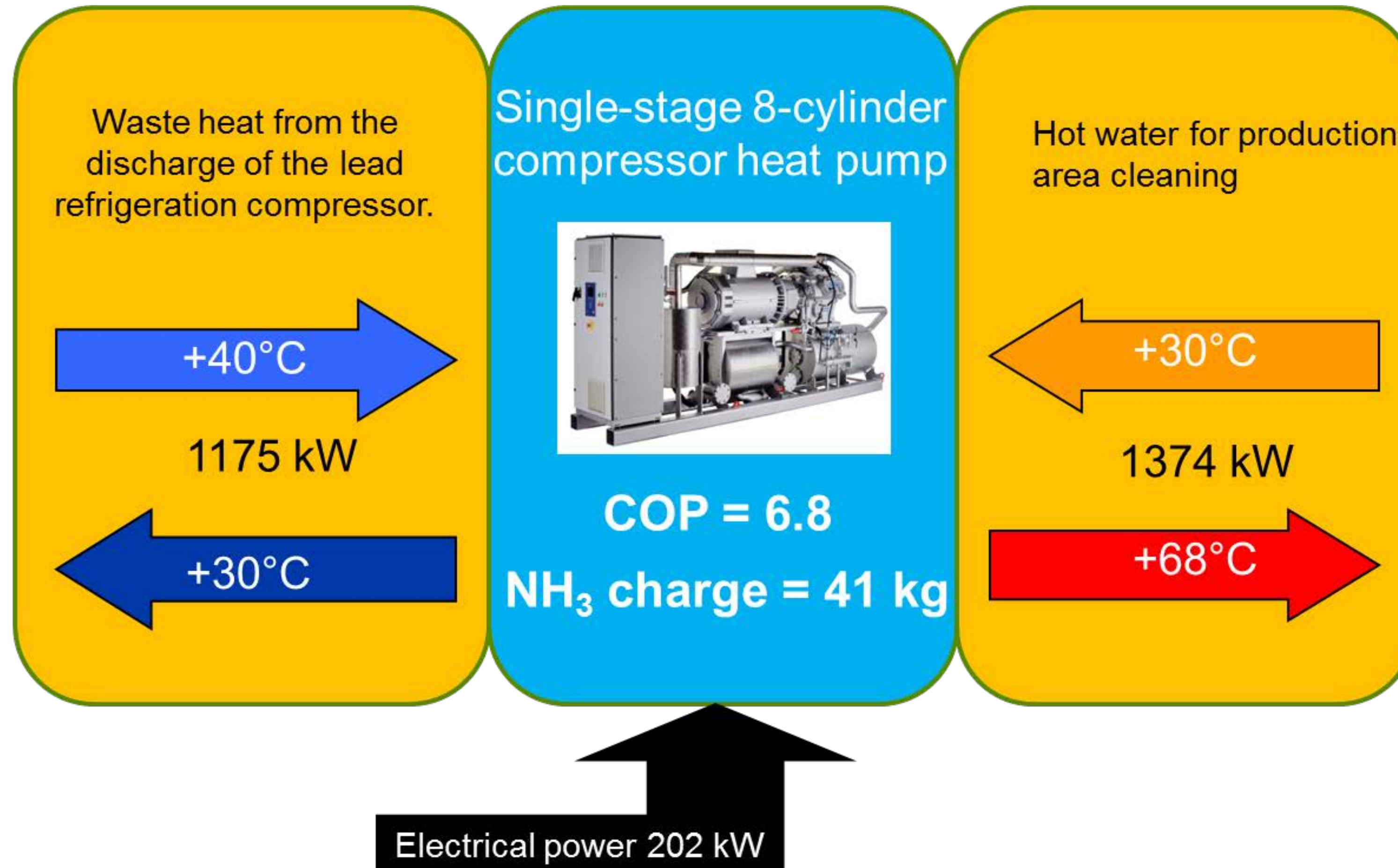


FIG. 366. BREWERY HEAT DISTRIBUTION WITH BOGEY HEAT REQUIREMENTS. TECHNIQUE ALTERED

Source	Temperature level	Capacity	Current way out
Refrigeration	30	3000	Cooling tower
AC chiller	30	1000	Cooling tower
Compressed air	50	1000	Cooling tower
Waste water	25	1000	Sewer
Exhaust air	30	2000	Out in the blue
Total heat source capacity		8000	

In the same site we have 4 boilers with a capacity of 1600 KW each (6400 KW in total)

- **Rapid escalation in gas prices and potential gas supply constraints;**
- **Need to move to low carbon energy solutions;**
- **Despite of small number of local HP examples, there are many business case under analysis;**
- **A2EP (Australian Alliance for Energy Productivity) released recently a study about “High Temperature Heat Pumps for the Australian food industry”;**
- **ARENA (Australian Renewable Energy Agency) considers HP applications as an example of Renewable energy and grants can be offered for approved projects. The key funding decision questions are:**
 - ❖ **is the project innovative or novel?**
 - ❖ **is there a pathway to commercialization?**
 - ❖ **will the project help unlock future investment?**



- **There are many possibilities for recovering heat in industrial process in AUSTRALIA;**
- **The creation of a good business case, mapping all the heat sources in the system, is crucial for the project success;**
- **Applications where you can use heating and cooling will show higher COP's;**
- **Heat Pump technology is considered as a renewable source of energy and also can reduce the CO² footprint of the facility that is using it;**
- **ARENA can help some approved projects with partial funding;**



ATMO
sphere

Thank you very much!

