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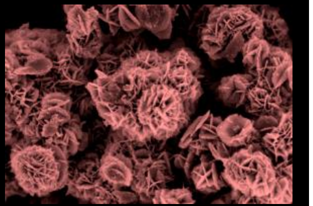

CDB 4313Z – HEAT INTEGRATION

HEAT EXCHANGER NETWORK (HEN) DESIGN
LOOP AND PATH

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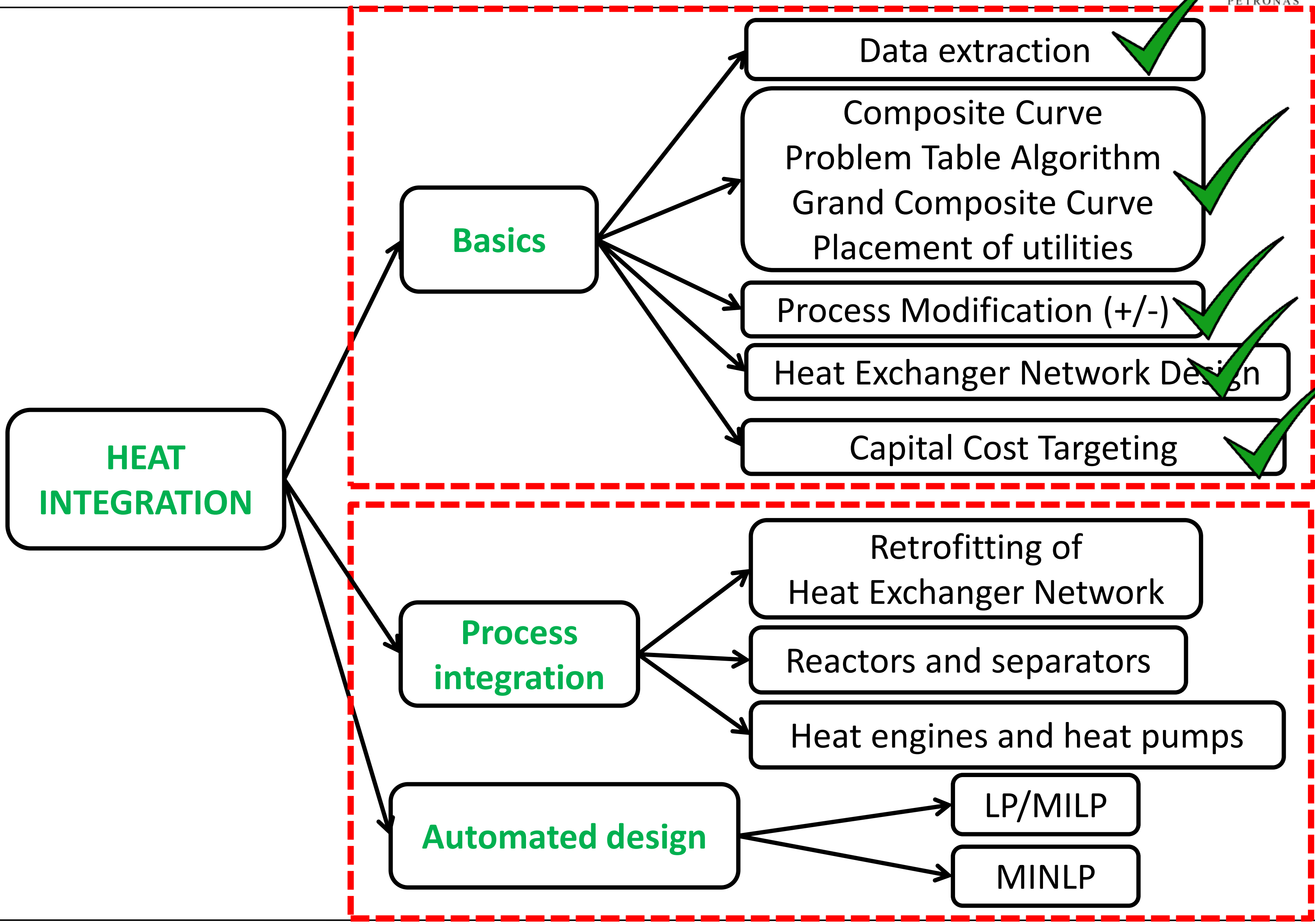
Discussion time: Friday 15.00 – 17.00

Chemical Engineering

COURSE OVERVIEW



COURSE LEARNING OUTCOMES

At the end of this course, students shall be able to:

1. Perform **targeting exercise** to determine the minimum utility requirements and maximum heat recovery possible for a process using composite curve or problem table algorithm

2. **Design heat exchanger network** for achieving maximum energy recovery or minimum total cost using pinch analysis technique

3. **Apply pinch analysis software** to perform heat integration and heat exchanger network design that is cost competitive and taking into account of sustainability factors

4. Analyze the **potential for heat and power integration** of a process and the possible implementation options, and to screen the options using cost effective strategy

5. Perform **correct data extraction** from process flowsheet for the purpose of performing pinch analysis

Chemical Engineering
Inspiring Potential · Generating Futures

ENERGY RELAXATION

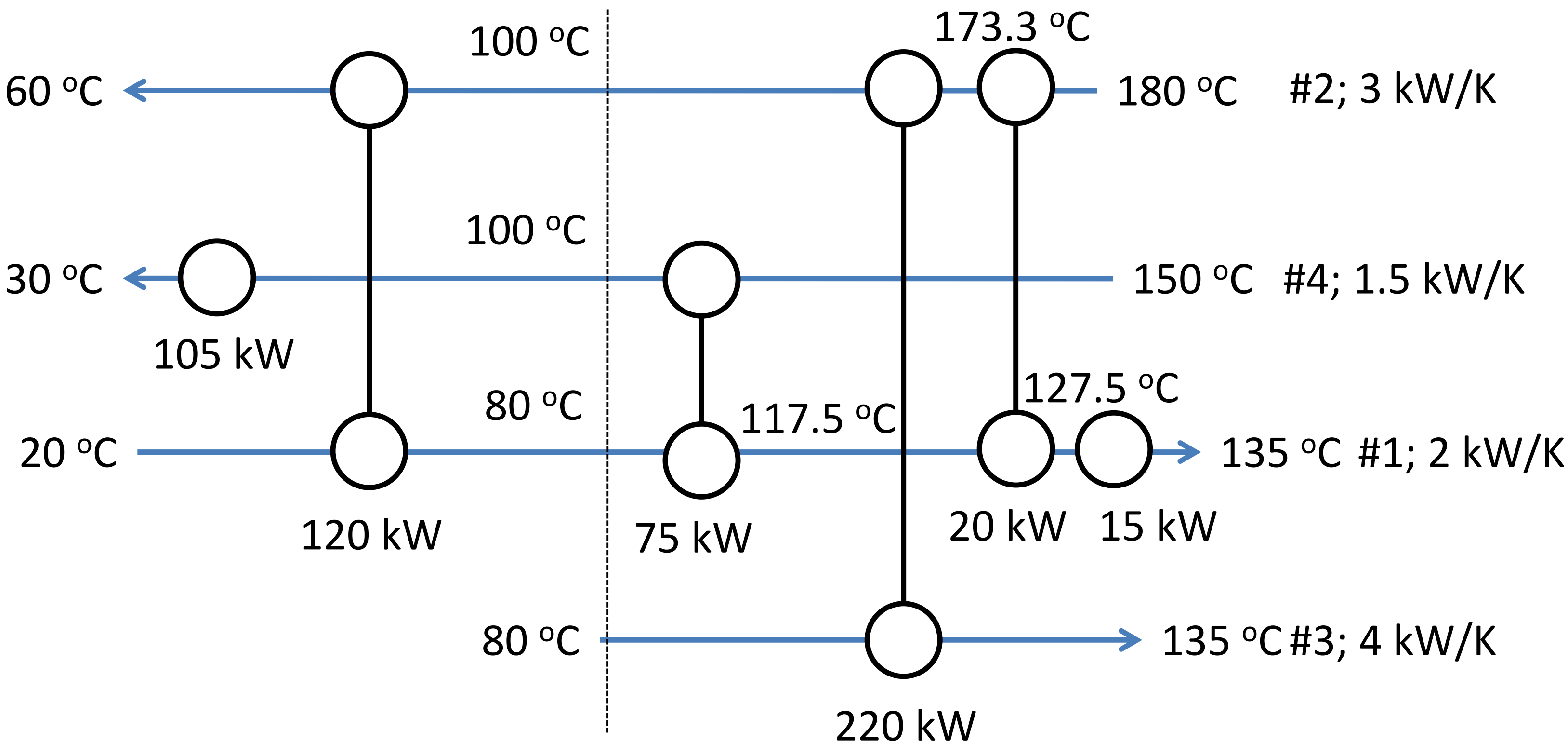
- Energy relaxation → procedure to allow increase in utilities for the following advantages:
  - Reduction in area
  - Reduction in number of heat exchangers
  - Reduction in complexity

- Two methods:
  - Loop → a circuit through the network that starts at one exchanger and ends in the same exchanger
  - Path → a circuit through the network that starts at a heater and ends at a cooler

BRAINSTORM

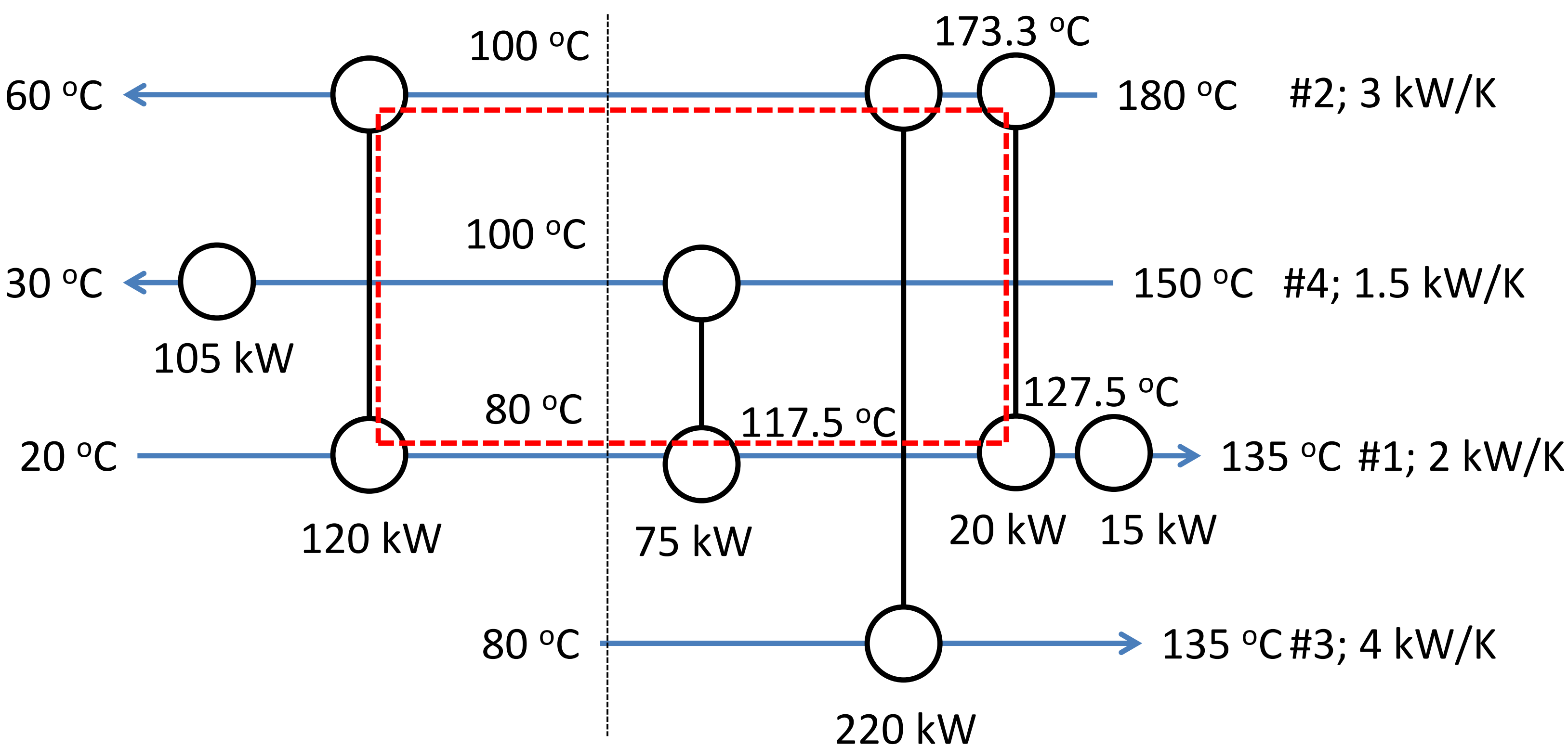
Why do we do energy relaxation?

Heat Exchanger Design – Final Design



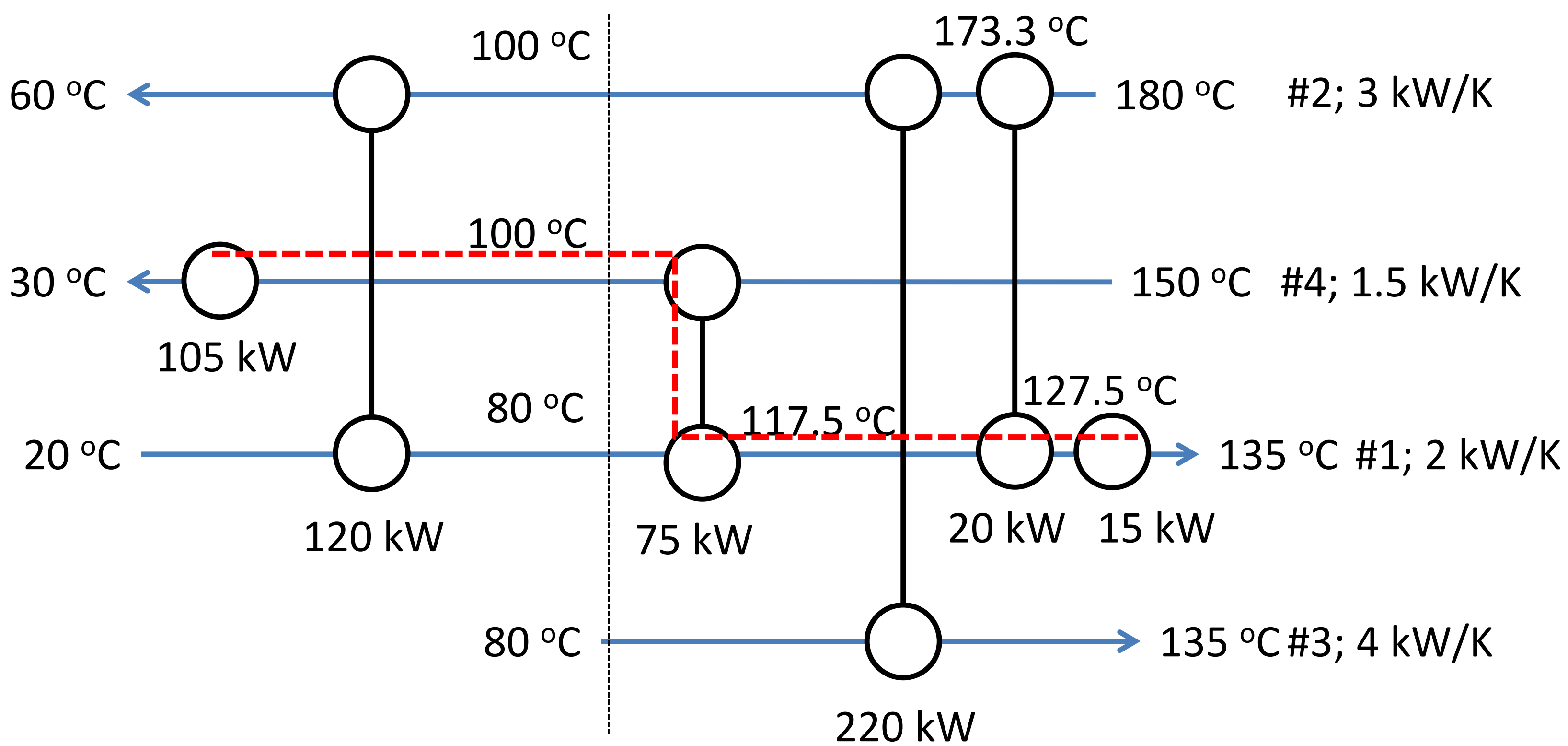
Loop

Loop → starts and ends in the same exchanger



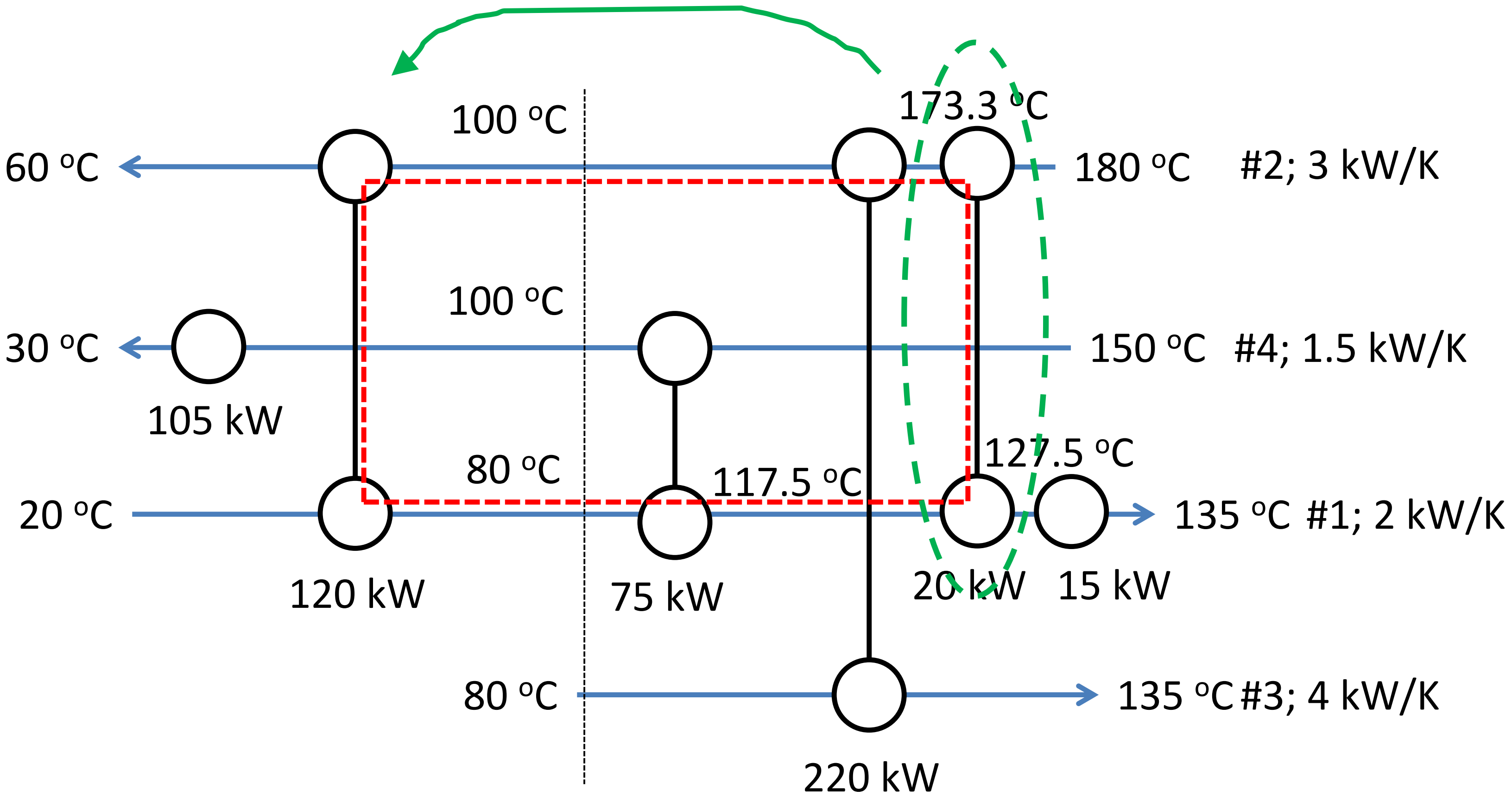
PATH

Path → starts at a heater and ends at a cooler



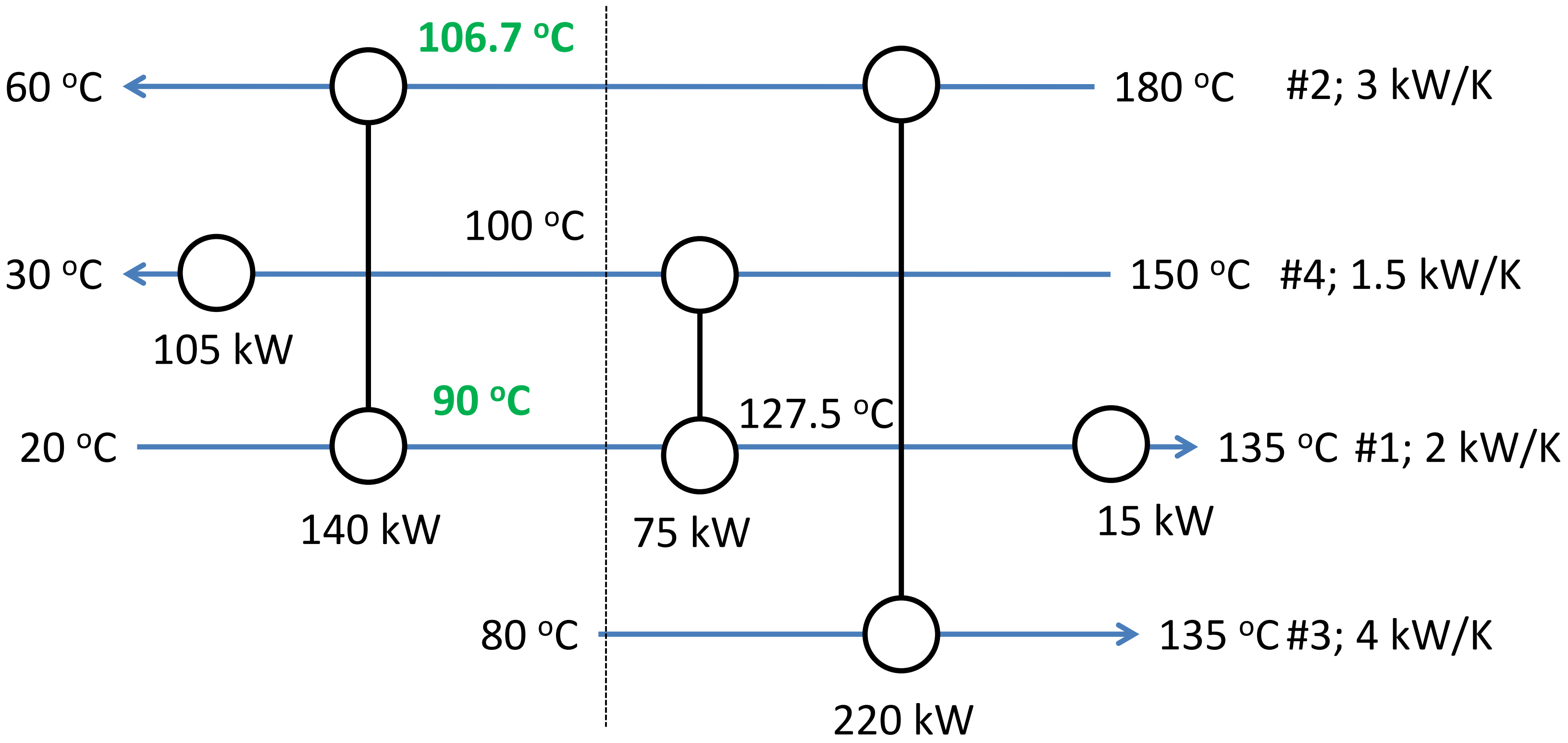
REMOVING LOOP

Rule of thumb → remove a loop by moving the smallest load



REMOVING LOOP

Rule of thumb → remove a loop by moving the smallest load

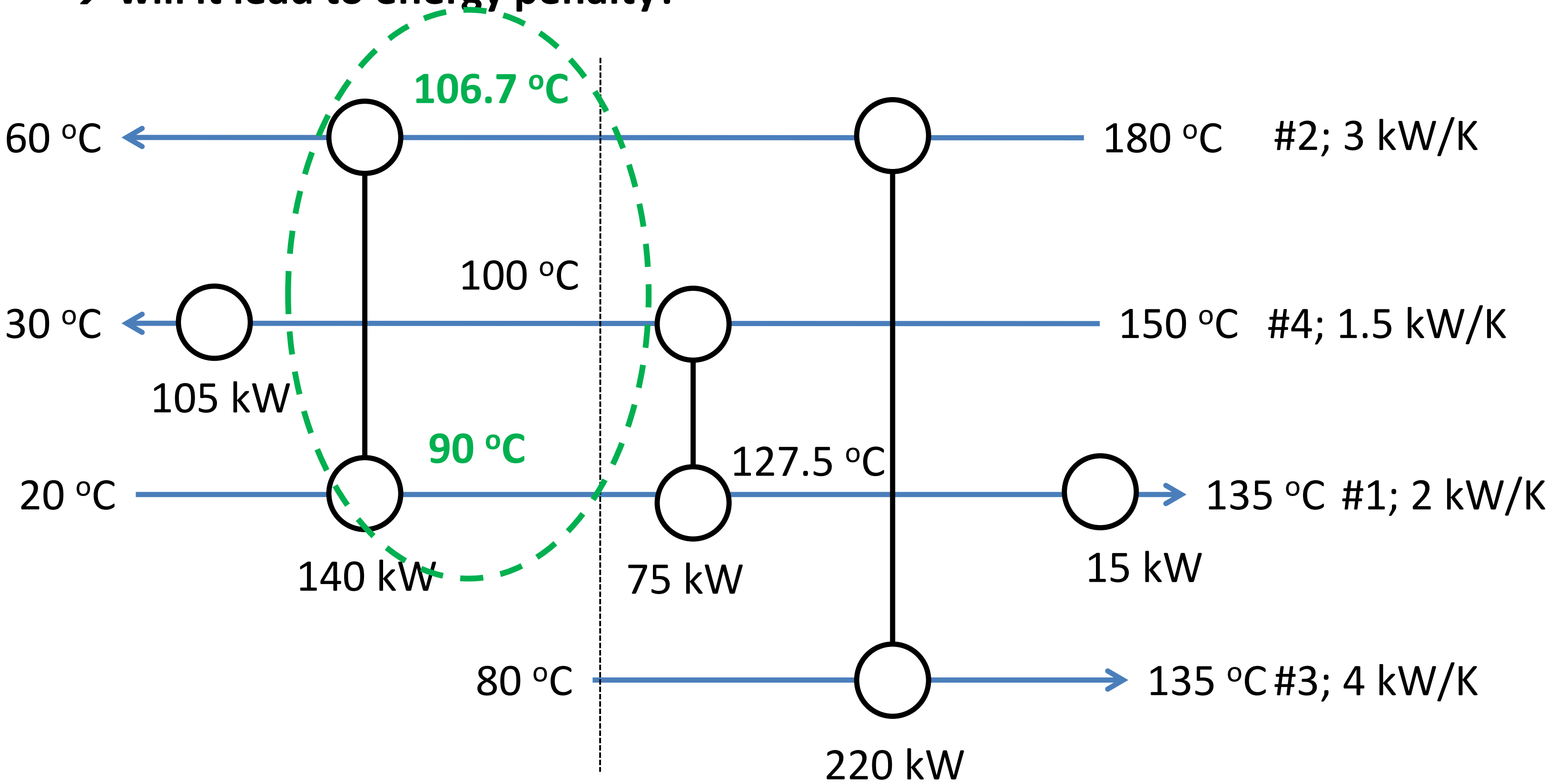


Removing loop

ΔTmin violation!!!

Outlet temperature of #1 is higher than the cold pinch temperature

→ **will it lead to energy penalty?**

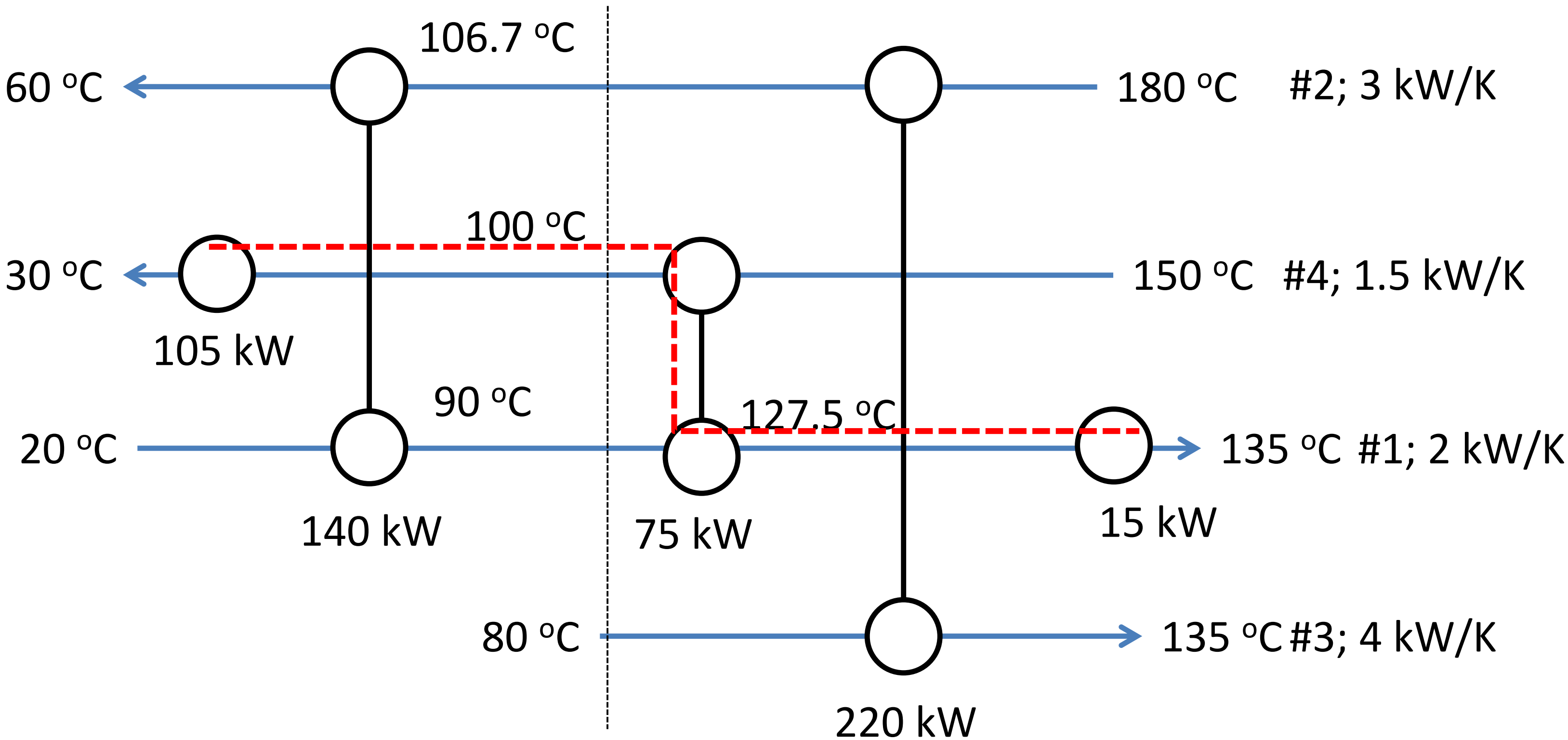


Hot and cold utilities are still the same

In this case, there is **NO NET** heat across the pinch

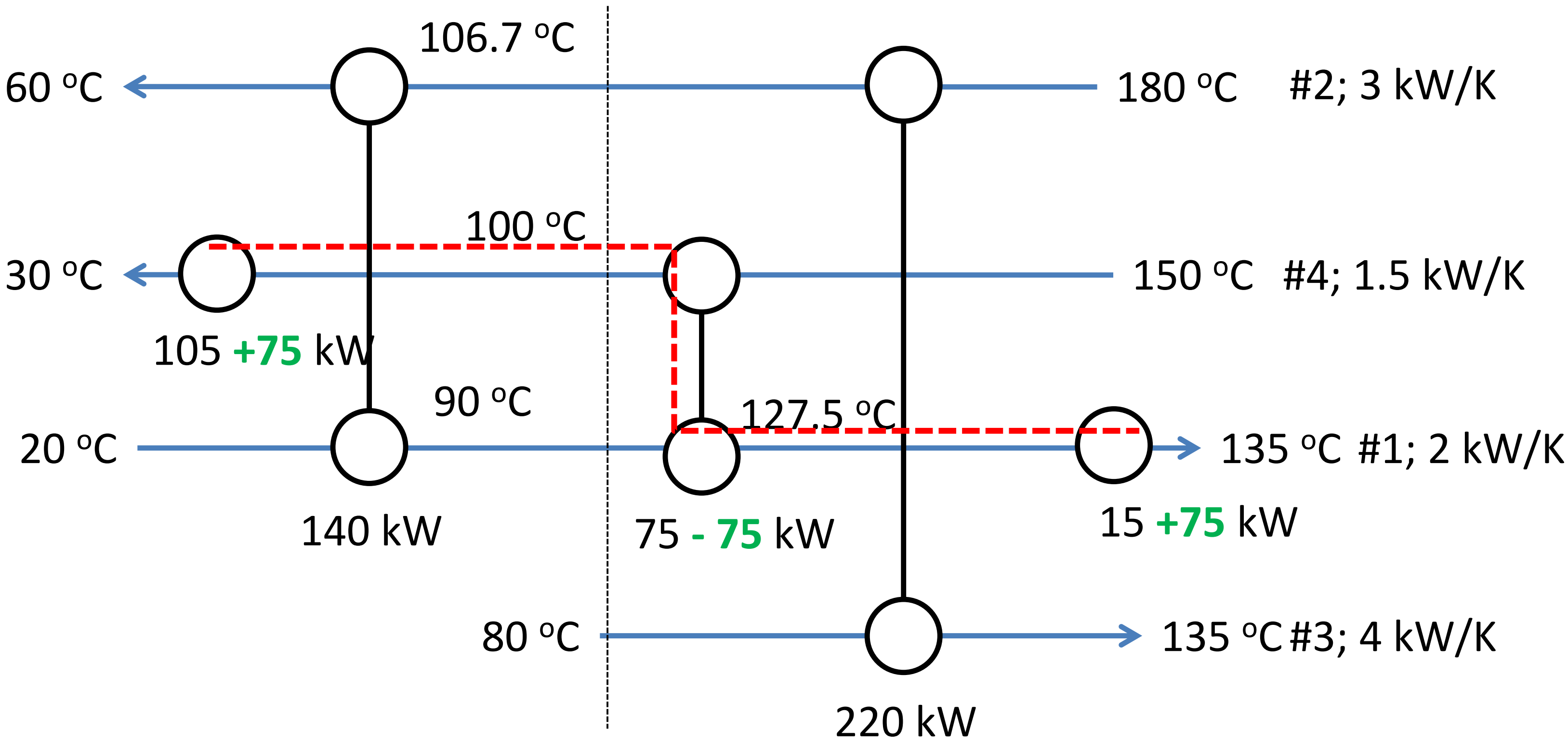
REMOVING PATH

Remove a path by shifting its load to the utilities



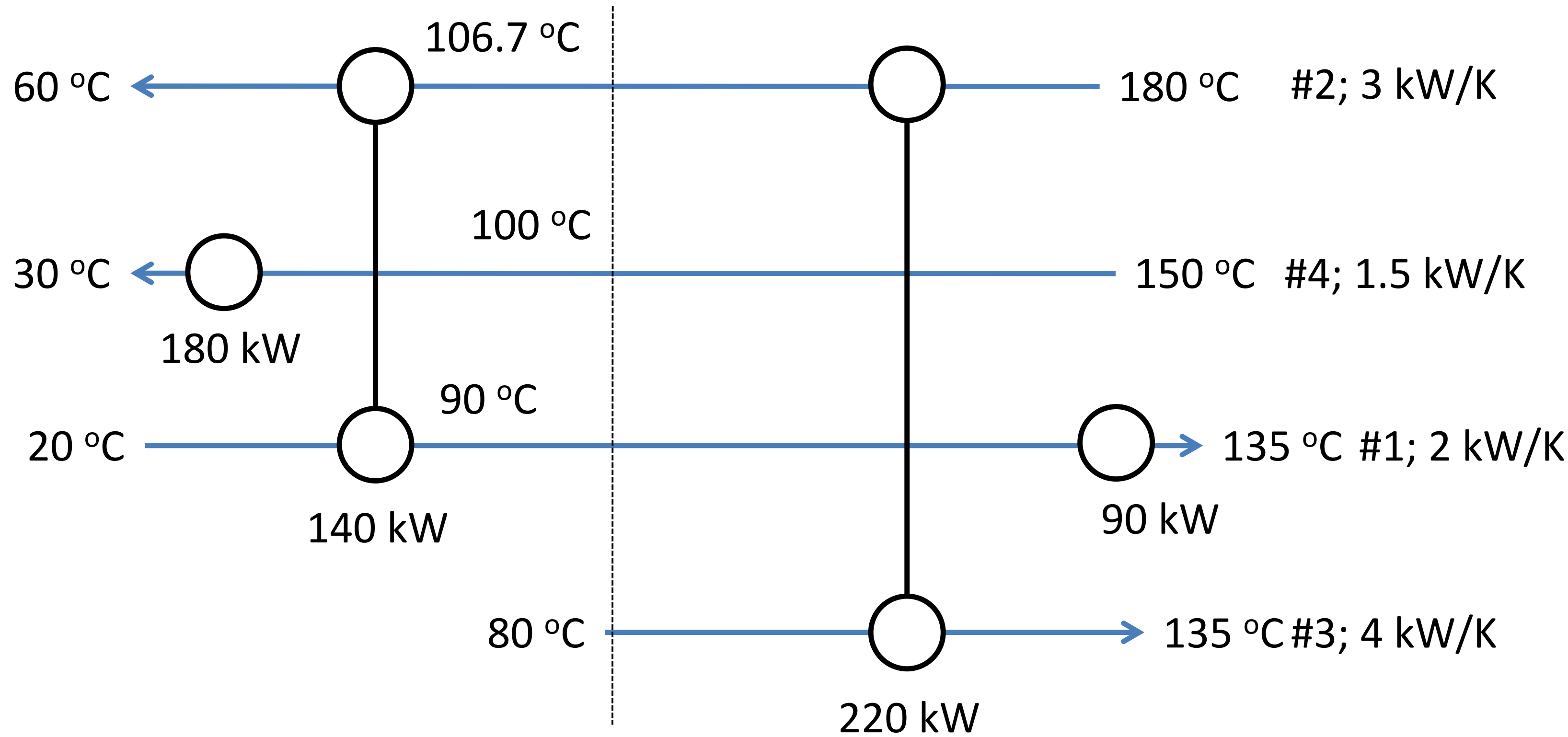
REMOVING PATH

Remove a path by shifting its load to the utilities



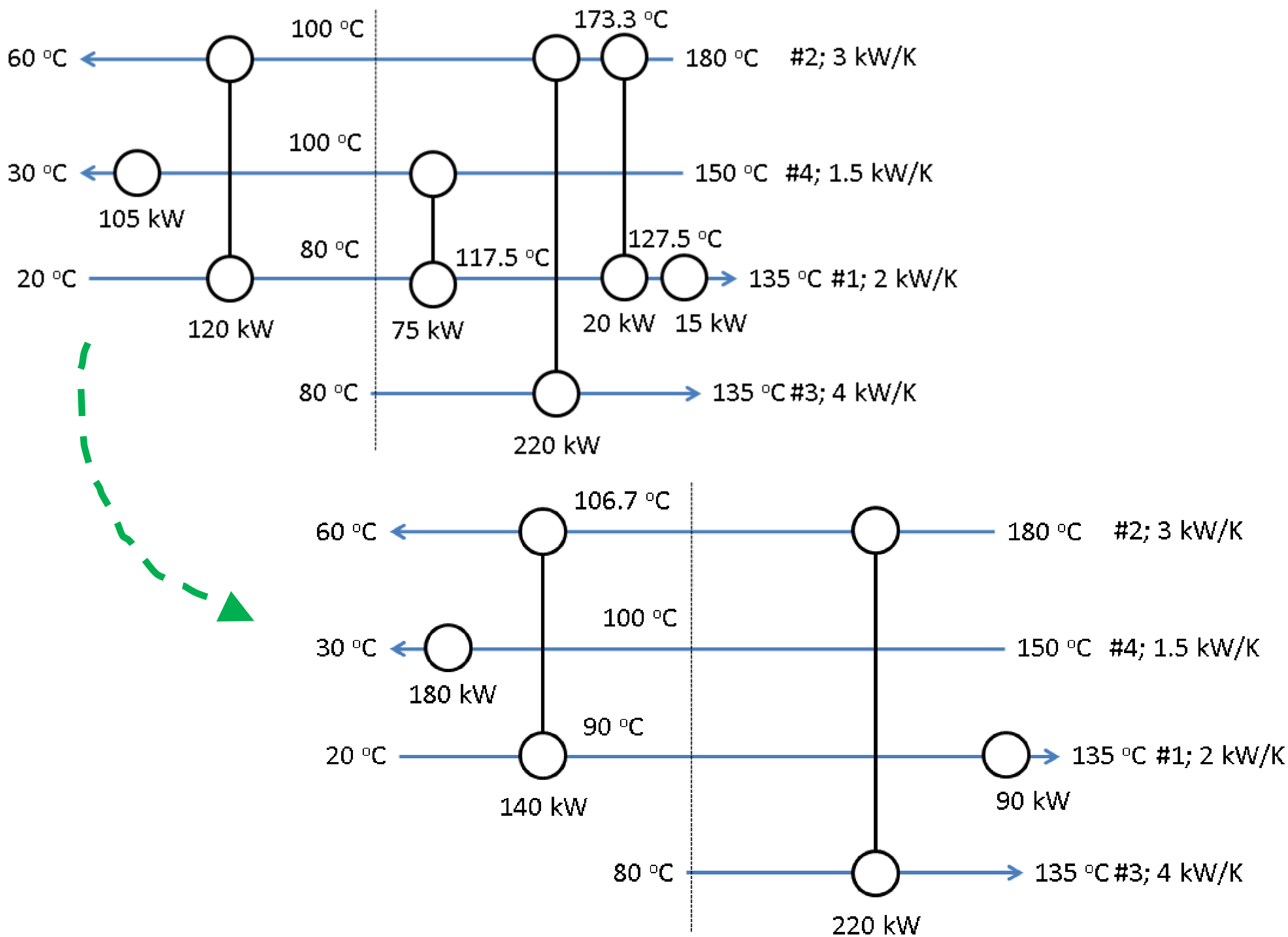
REMOVING PATH

Remove a path by shifting its load to the utilities



Removing path increases utilities!

FINAL DESIGN - COMPARED



PAIR TEST: WHICH DESIGN IS BETTER?

Use U = 1000 W/($m^2.^oC$)

Annual heat exchanger cost (RM/yr) = $8000 + 500 \cdot A^{0.75}$

Hot utility cost = 200 RM/kWyr

Cold utility cost = 20 RM/kWyr

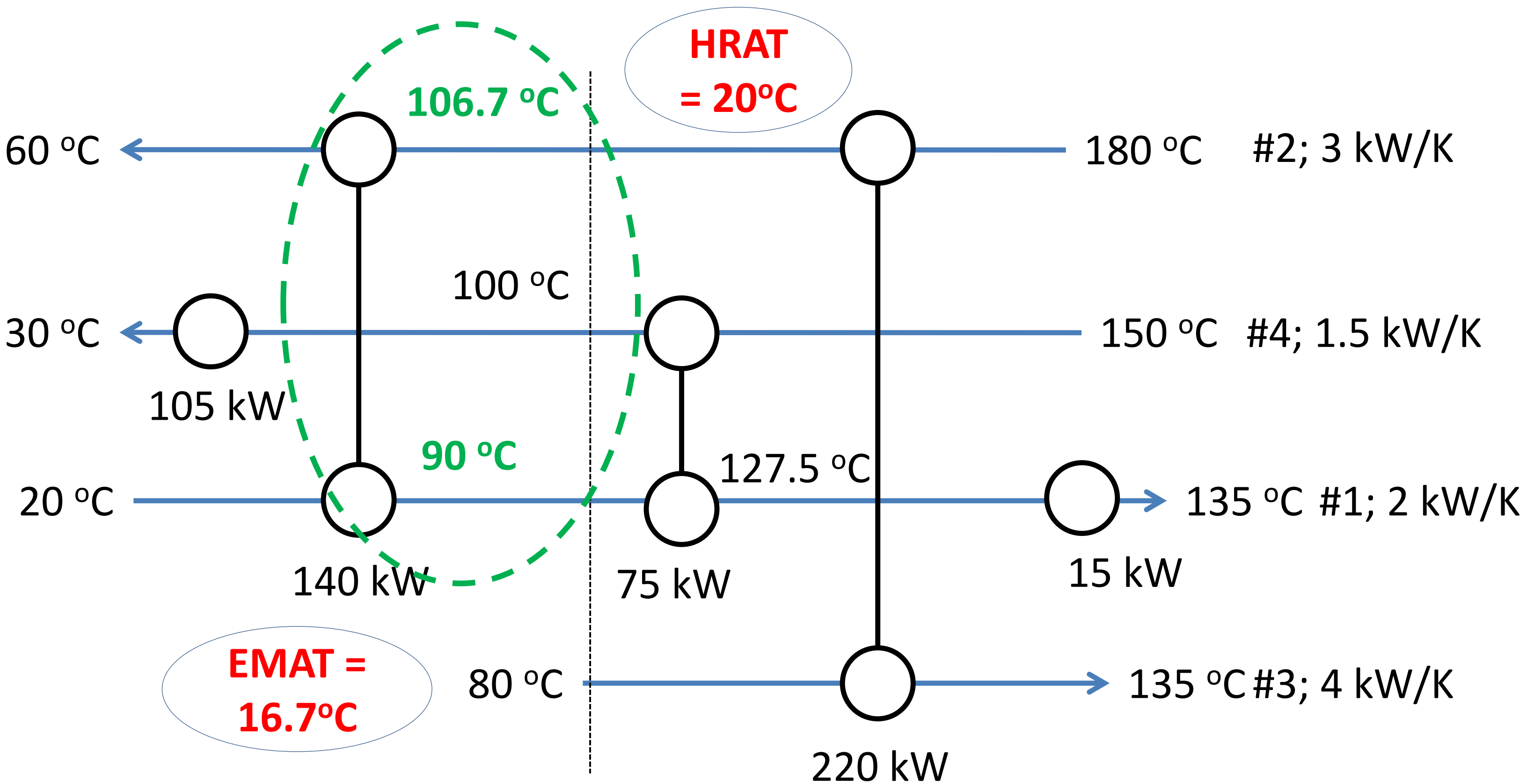
Calculate total annual cost!

ΔT RELAXATION

There are now two types of ΔT_{min}:

- ΔT_{min} to calculate minimum utility → Heat Recovery Approach Temp. (HRAT)

- ΔT_{min} allowed in heat exchangers → Exchanger Min. Approach Temp. (EMAT)



Closure Review

- Why do we do energy relaxation?
- What are the methods to relax HEN?
- What are some of the advantages of the energy relaxation methods?

GROUP WORK

From your designed HEN,
Simplify and optimize the HEN by using Loop and/or Path

Use $U = 1000\ W/(m^2.^{o}C)$
Annual heat exchanger cost (RM/yr) = $8000 + 500 \cdot A^{0.75}$
Hot utility cost = 200 RM/kWyr
Cold utility cost = 20 RM/kWyr

COURSE OVERVIEW