HERO("Advance Pinch") Project on collaboration between GC and TOYO

SIRINNA TANOSAWAN (GC)
KAKERU OUCHI (TOYO)

TNChE Asia 2024
3rd Thailand International Chemical Engineering & Chemical Technology
at Dusit Thani Pattaya, Thailand
on 19th – 21st June 2024

AGENDA

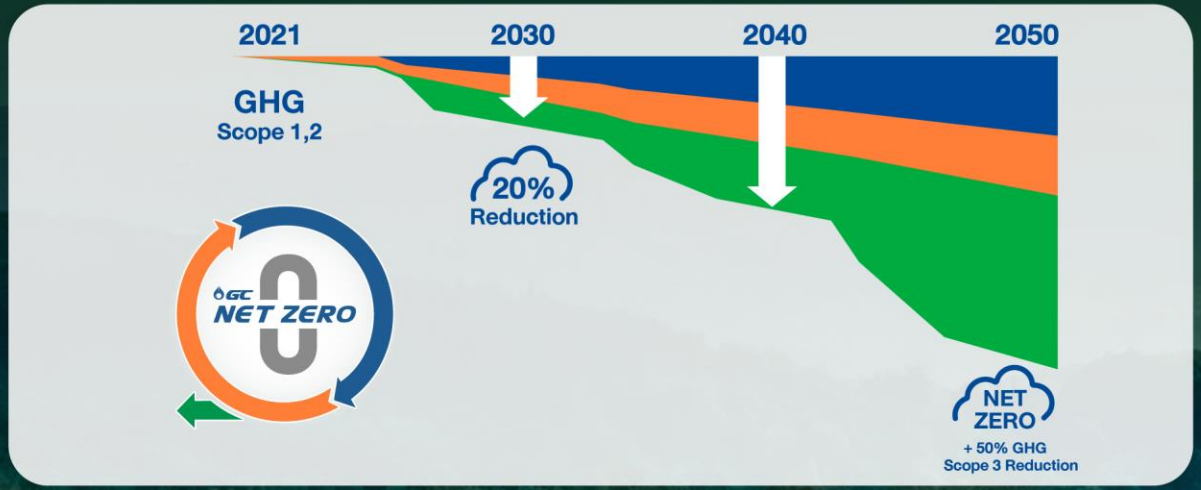
01 **Overview of HERO Project by GC and TOYO**

02 HERO (“Advance Pinch”)

- ☐ What is HERO?
- ☐ Energy efficiency study by HERO
- ☐ Result in the project by GC and TOYO

03 Impact of HERO Results

COMMITMENT TO NET ZERO BY 2050 WITH EXPLICIT PLANS AND ACTIONS



Portfolio-driven: 25%

3,300,000 tCO_2e

Portfolio transformation towards "High Value & Low Carbon"

- Specialty & Performance Chemicals
- Bio-based Products
- Circularity & Recycling

Bio & Circularity Solutions

InnoPlus · InnoEco · ingeo · + Others · YOU เกิร์น · UP TO YOU · UPCYCLING by GC · be ECOWISE™

Efficiency-driven: 20%

1,000,000⁺ tCO_2e

Energy & efficiency improvement (2050)

100%

Clean energy utilization (2050)

New Low Carbon Tech

To overcome today's limitation (Hydrogen, electrification, etc.)

Compensation-driven: 55%

6,300,000⁺ tCO_2e

CCS + collaboration with partners

- 1,200,000 tCO_2e (before 2030)

1,000,000⁺ tCO_2e

Carbon credit management

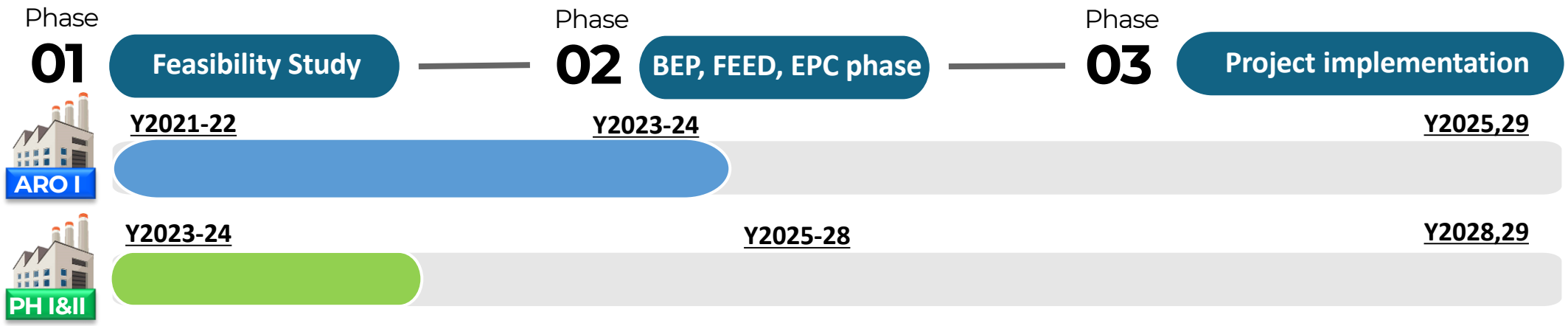
- Nature-based solutions
- Tech-based solutions
- Carbon credit purchase

OVERVIEW OF PROJECT

The pathway of GC to achieve net zero CO2 emissions, in particular by achieving the lowest utility consumption by improving energy efficiency, ARO I and Phenol plant 1&2 are looking for the best technology to reduce overall energy consumption. Since most of the conventional heat integration and heat recovery had been done already, a new method with more advanced technology is preferred.

In fact, new advanced technology has been studied in Aromatic plant 1 in the same concept which showed a high benefit. This new technology for improving plant's energy consumption is Advance Pinch Analysis - Hybrid Energy system Re-Optimization (HERO) which is TOYO 's trademark. It is an optimization technology, by developing a mathematical optimization model of the entire plant, the resulting numerous possible configurations are examined.

Project status:



AGENDA

01 Overview of Project by GC and TOYO

02 HERO (“Advance Pinch”)

- ☐ **What is HERO?**
- ☐ **Energy efficiency study by HERO**
- ☐ **Result in the project by GC and TOYO**

03 Impact of HERO Results

WHAT IS HERO (“ADVANCE PINCH”) ?

HERO is an optimization technology,
which finds ***effective modifications for decarbonization***
(GHG-emission reduction via energy-efficiency improvement) through:

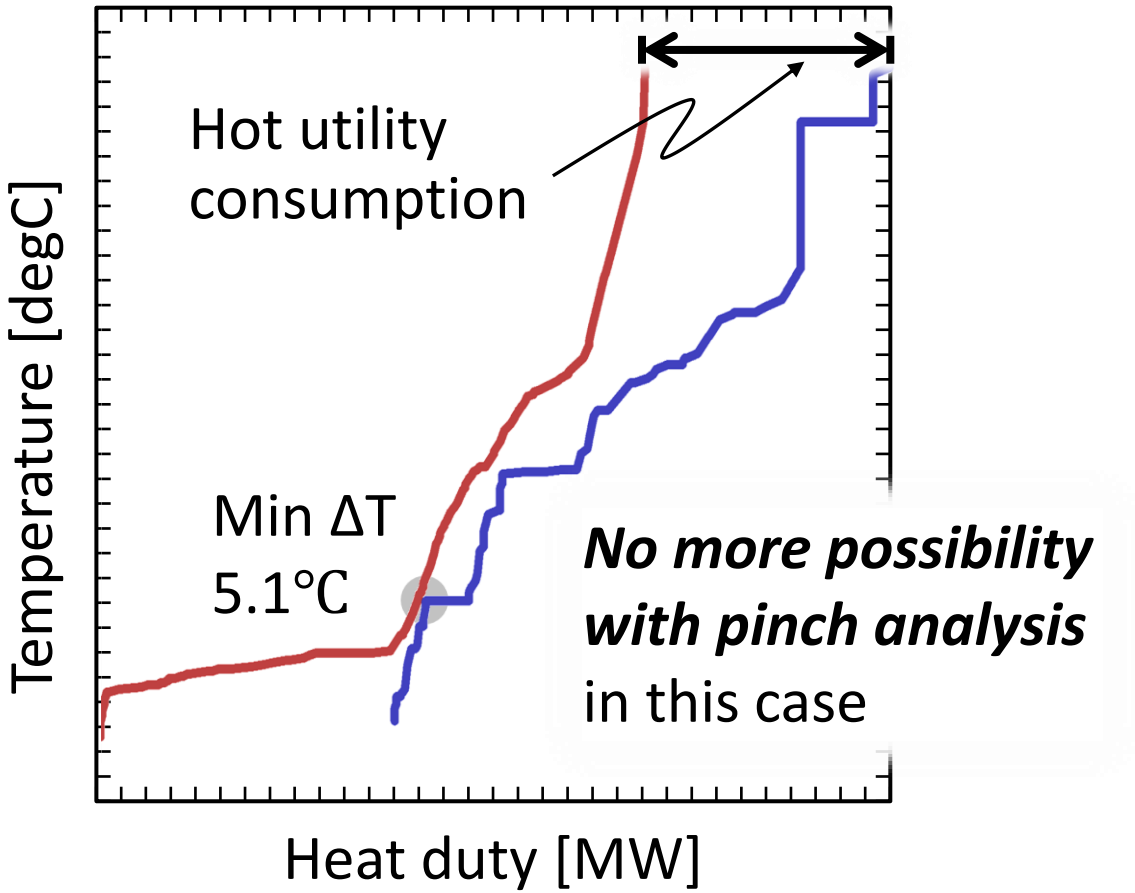
- ✓ Exploration of better heat recovery in process units
  beyond the limit of pinch analysis
- ✓ Comprehensive optimization including utility units
  for reducing net utility consumption

By developing a ***mathematical optimization model of the entire plant***,
the resulting ***numerous possible configurations are examined.***

EXPLORATION OF HEAT RECOVERY IN PRS

Pinch analysis

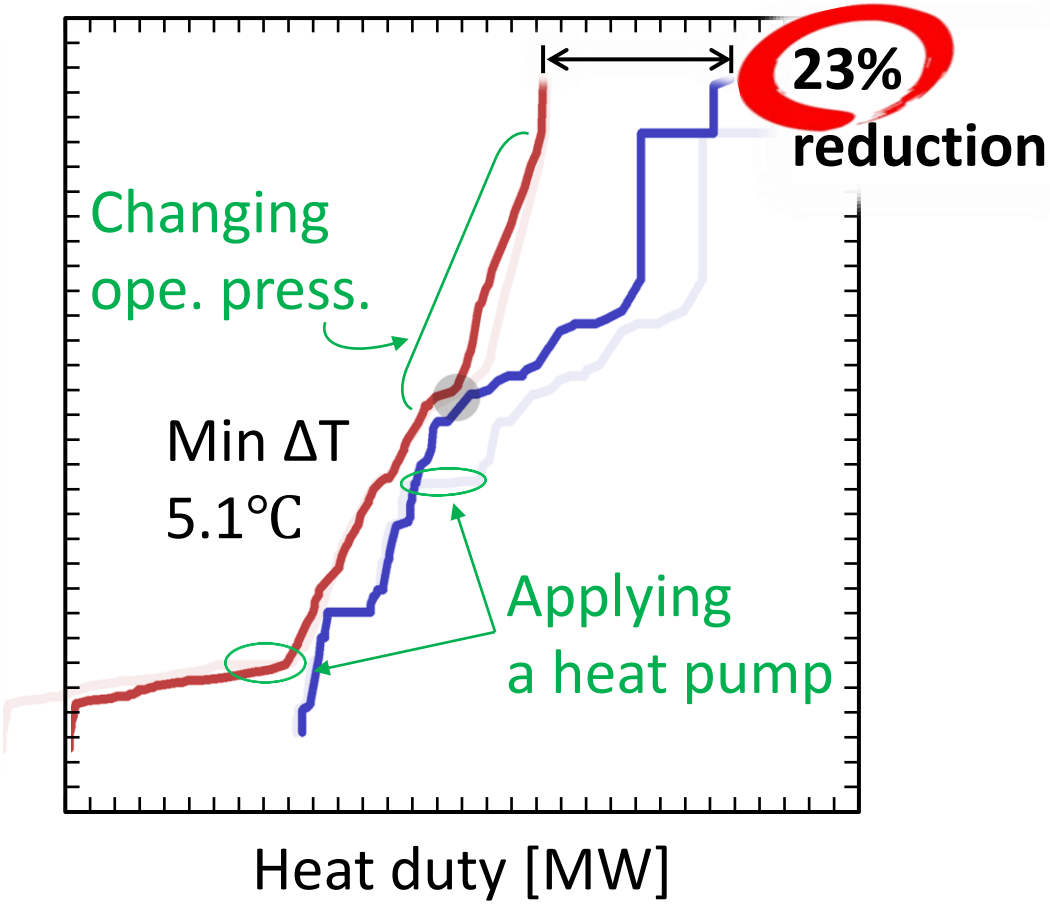
Study **withOUT changing composite curve**
i.e. P, T, Q are not changed.



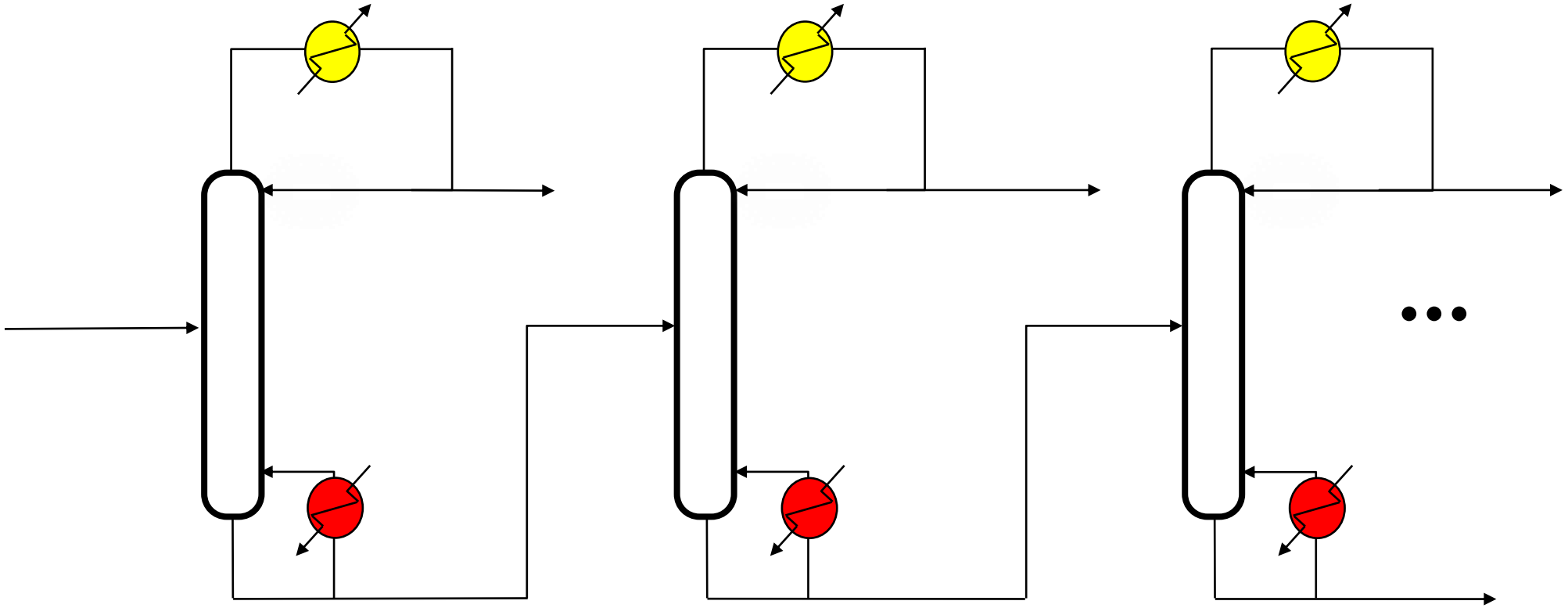
No more possibility with pinch analysis in this case

HERO

Study **with changing composite curve**
i.e. P, T, Q are also optimized.



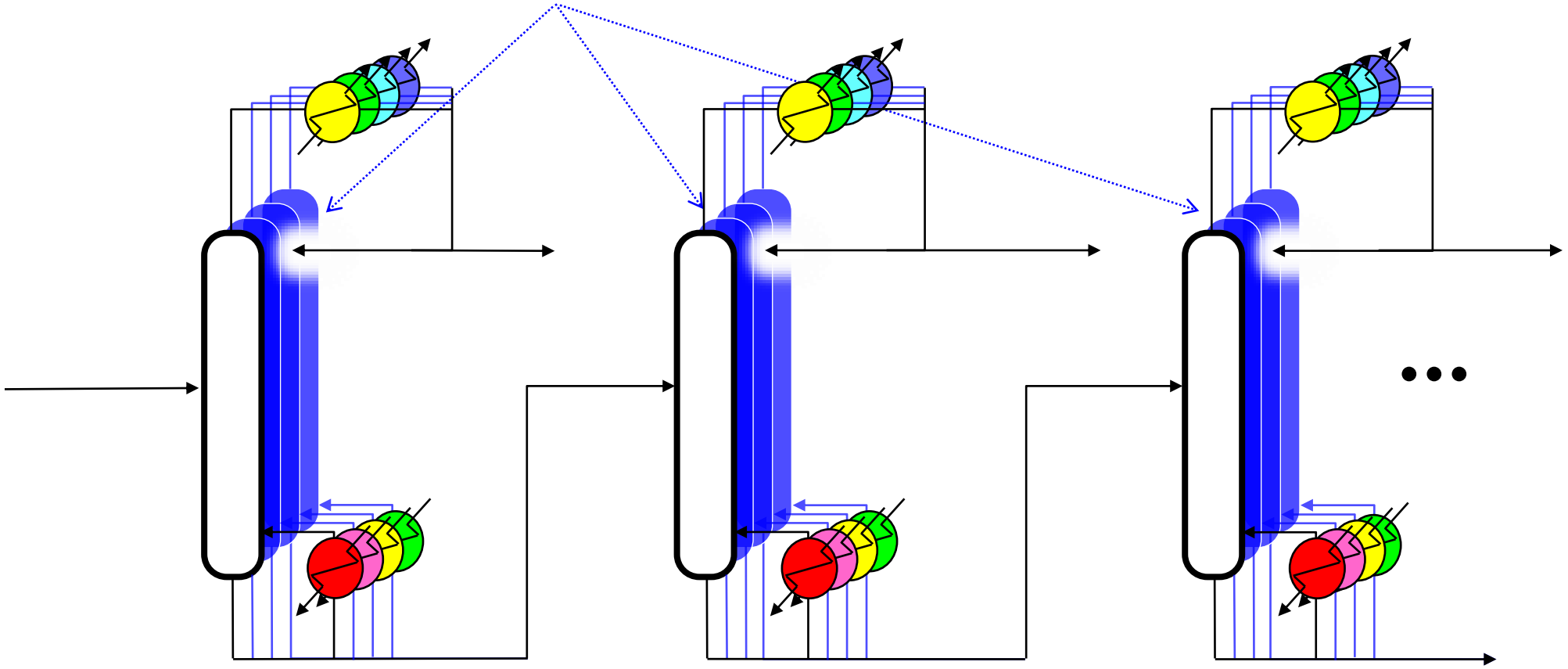
EXAMPLE OF PROCESS MODEL



EXAMPLE OF PROCESS MODEL

Optimize operating pressures for better multi-effect distillation

Behavior with different operating pressures
are embedded into the optimization model.

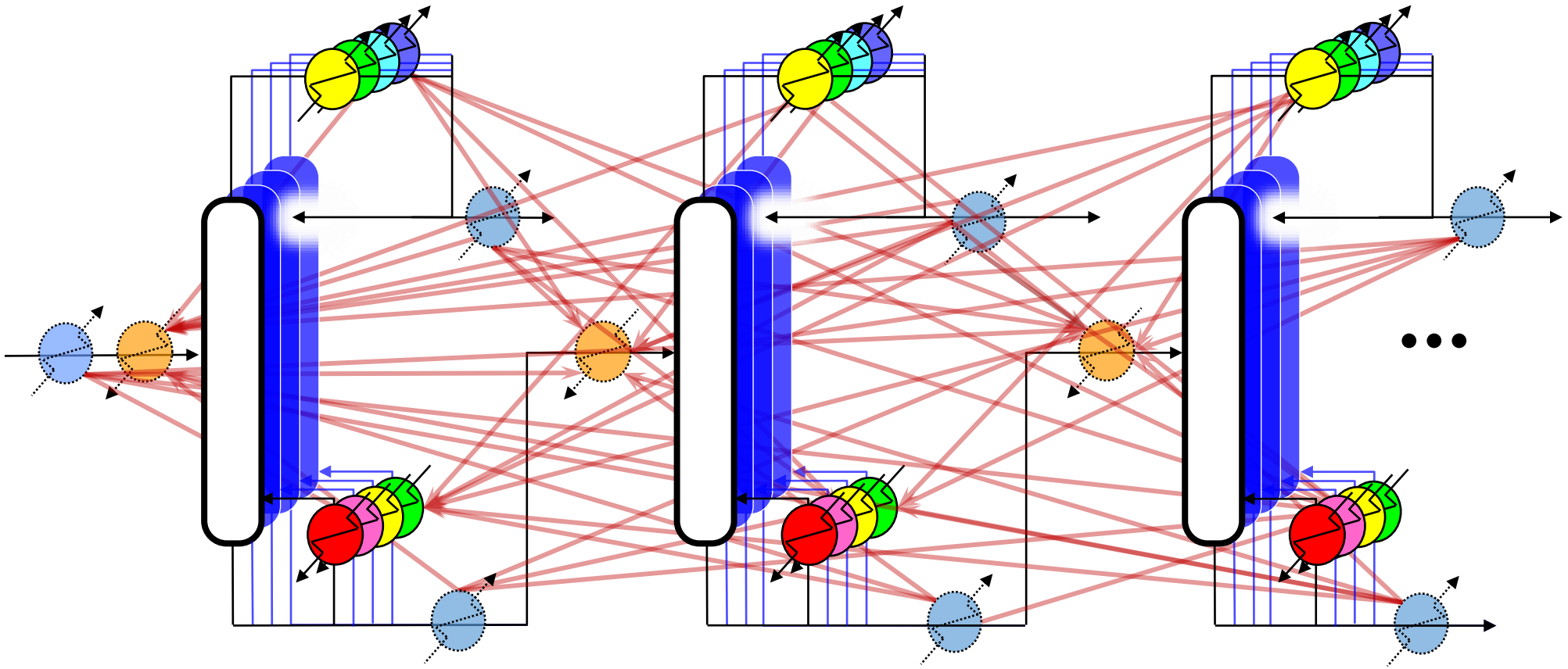


EXAMPLE OF PROCESS MODEL

All options which might be effective are covered.

- ✓ Cooling: Condenser, heat recoveries at outlets
- ✓ Heating: Reboiler, feed preheaters

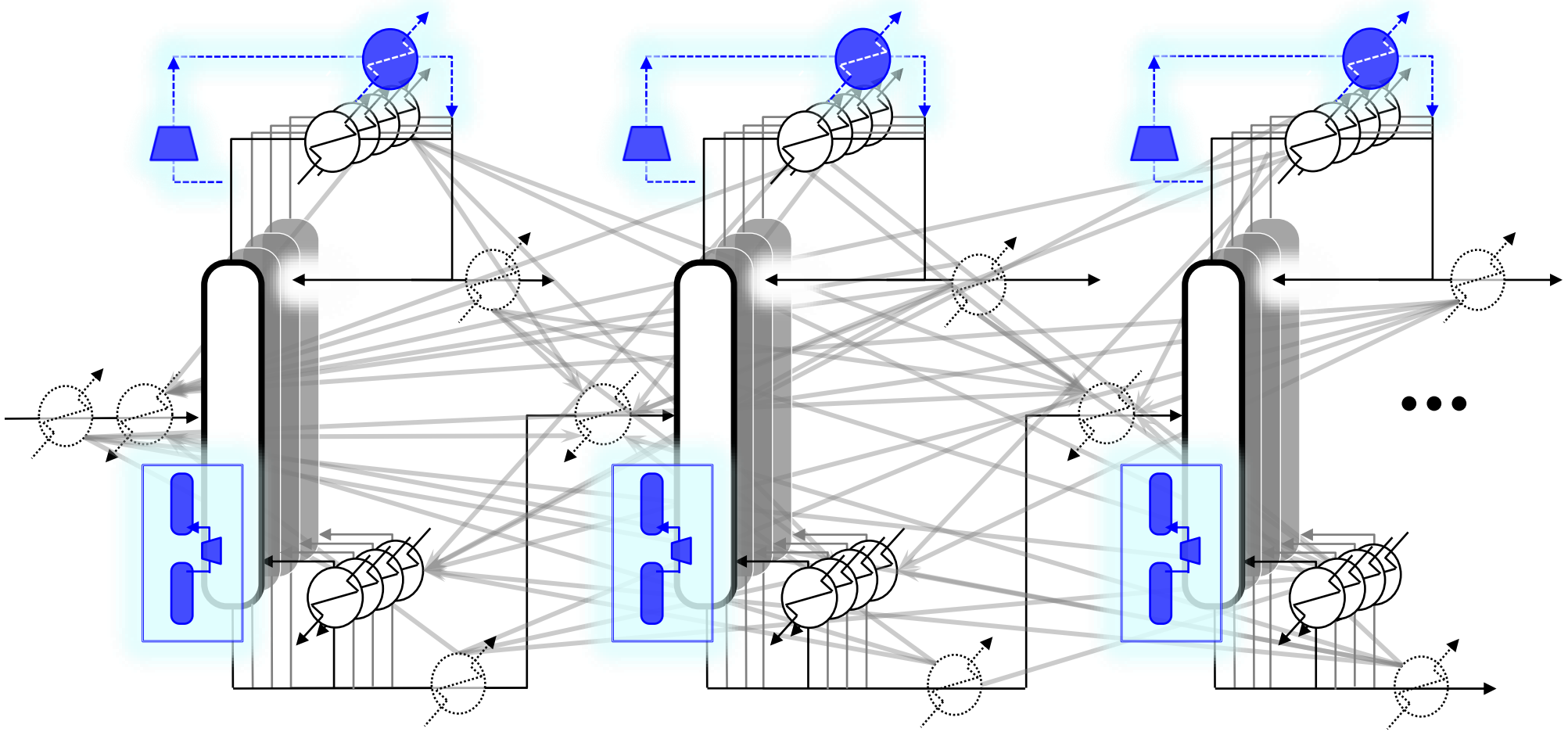
Furthermore,
constraints for feasibility can be imposed.
Ex. Limit of No. of new heat exchangers
Exclusion of unrealistic combination



*Although this figure is simplified, all heat-exchange combinations with all possible operating pressures are fully considered.

EXAMPLE OF PROCESS MODEL

- ✓ Heat-pump via OVHD re-compression is examined.
- ✓ Implementation of *SUPERHIDIC*® is also examined.



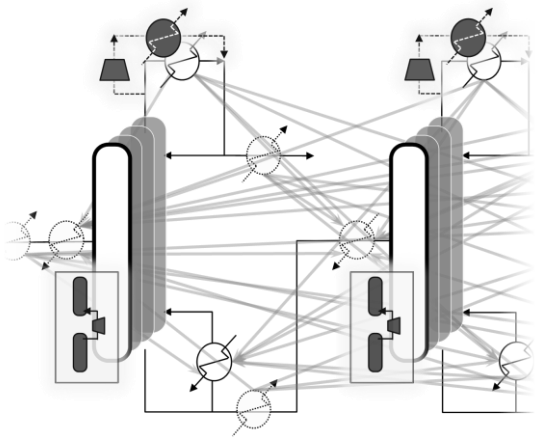
**SUPERHIDIC*® is an advanced energy-saving distillation technology utilizing heat-pump.

OPTIMIZATION INCLUDING UTILITY UNITS

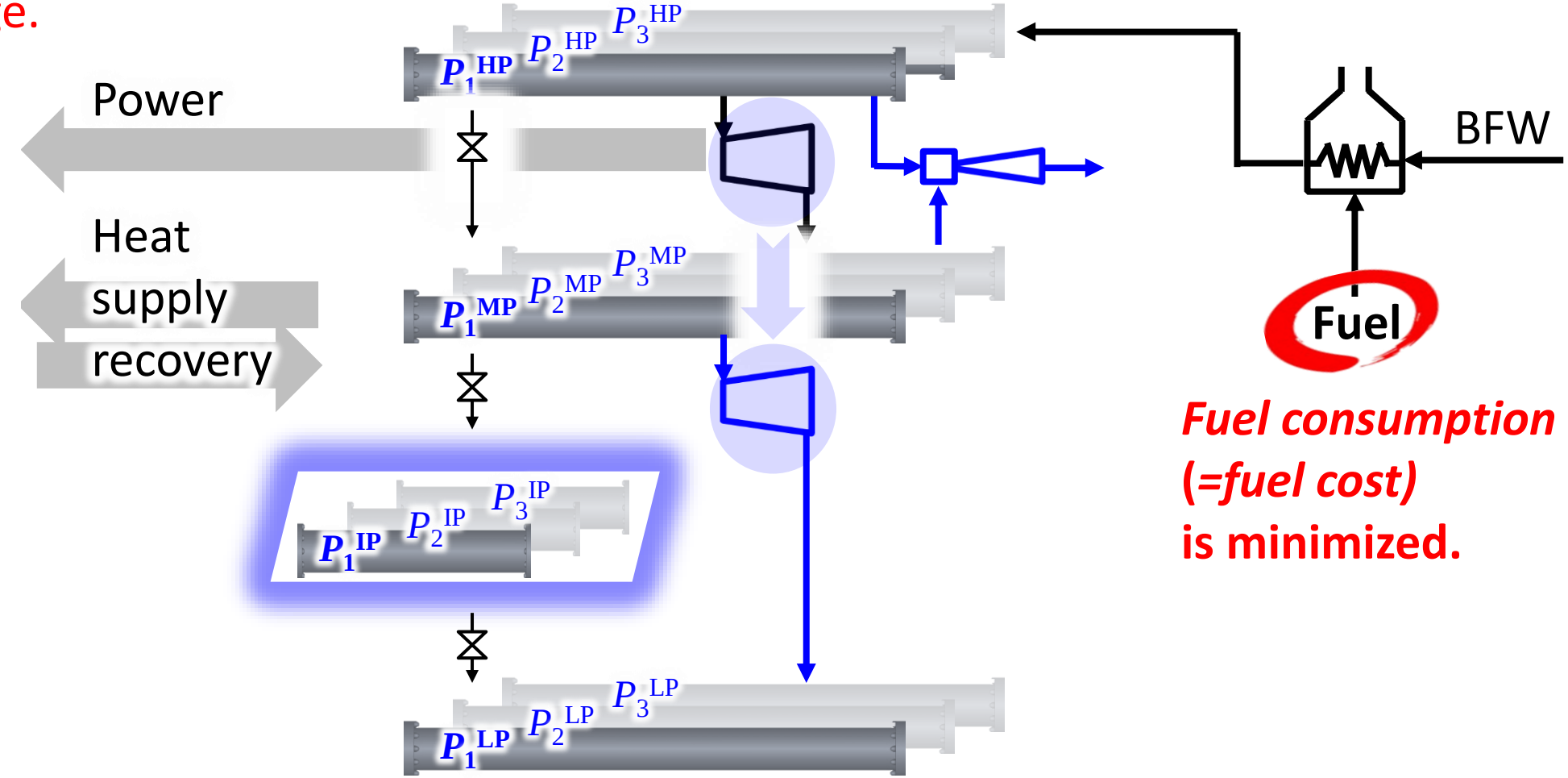
Energy-saving effect shall be evaluated with a net reduction of external utility usage.

Optimization with considering:

- ✓ Alternation of STM press./turbine-inlet STM
- ✓ Implementation of thermo-compressor/new header level(s)

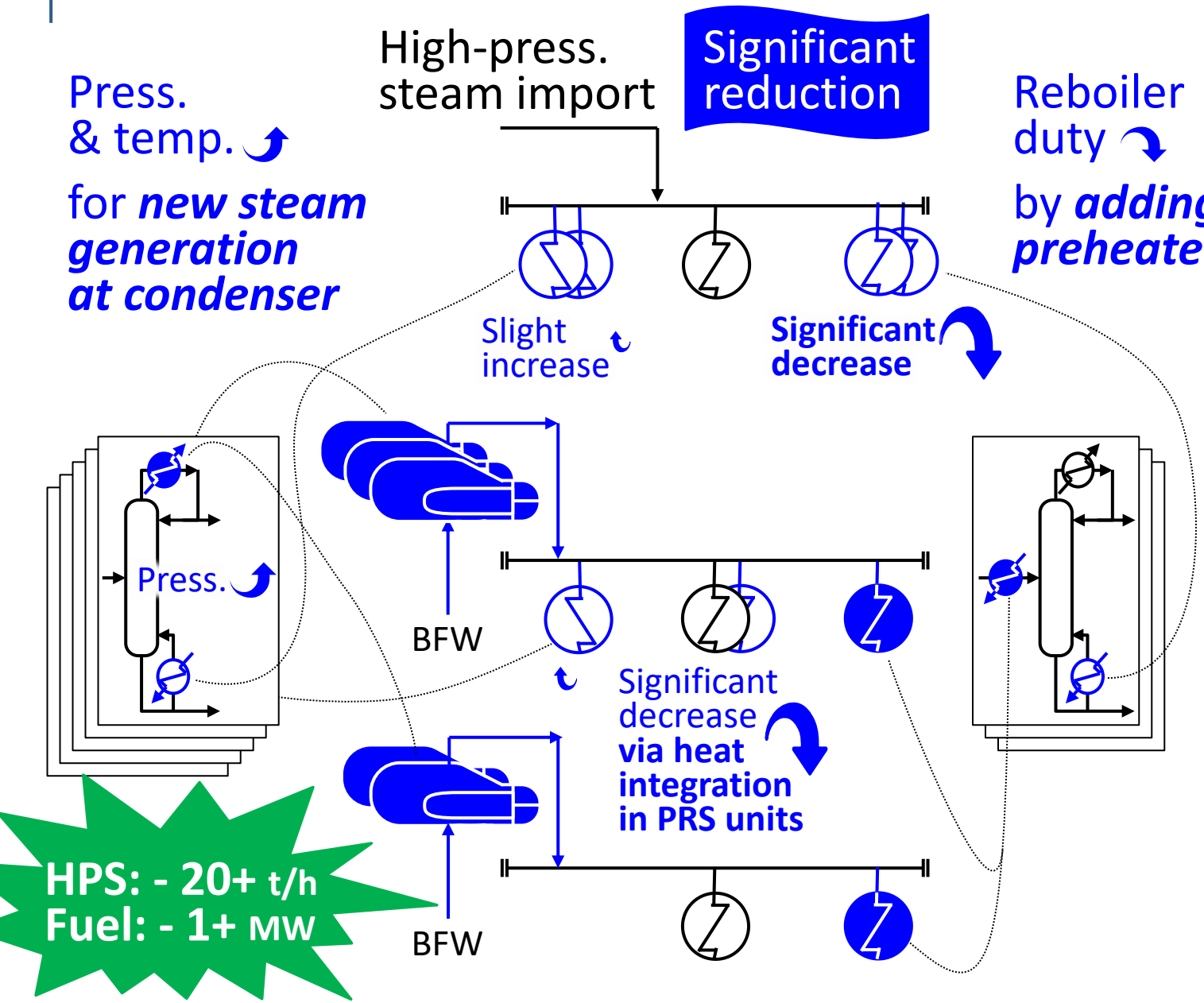


Process units



***Fuel consumption (=fuel cost)* is minimized.**

OVERVIEW OF RESULT IN GC'S AROMATICS 1 PJ



For obtaining good energy saving,
NUMEROUS candidates
must be examined.

- ☐ **What units** shall be modified?
- ☐ **What type** of mod. is suitable?
- ☐ **How much P, T, Q** are changed?

Due to too numerous candidates,
It is

✕ ***impossible by trial and error***

but

○ ***possible by HERO***

thanks to the
quite efficient search
using mathematical theory.

OVERVIEW OF RESULT IN GC'S PHENOL PJ

Challenge on Phenol Plant;

- **Ope. Press. can't be changed** easily due to process constraints.
- Latent heat at tower OVHD is **already recovered** at existing plant.

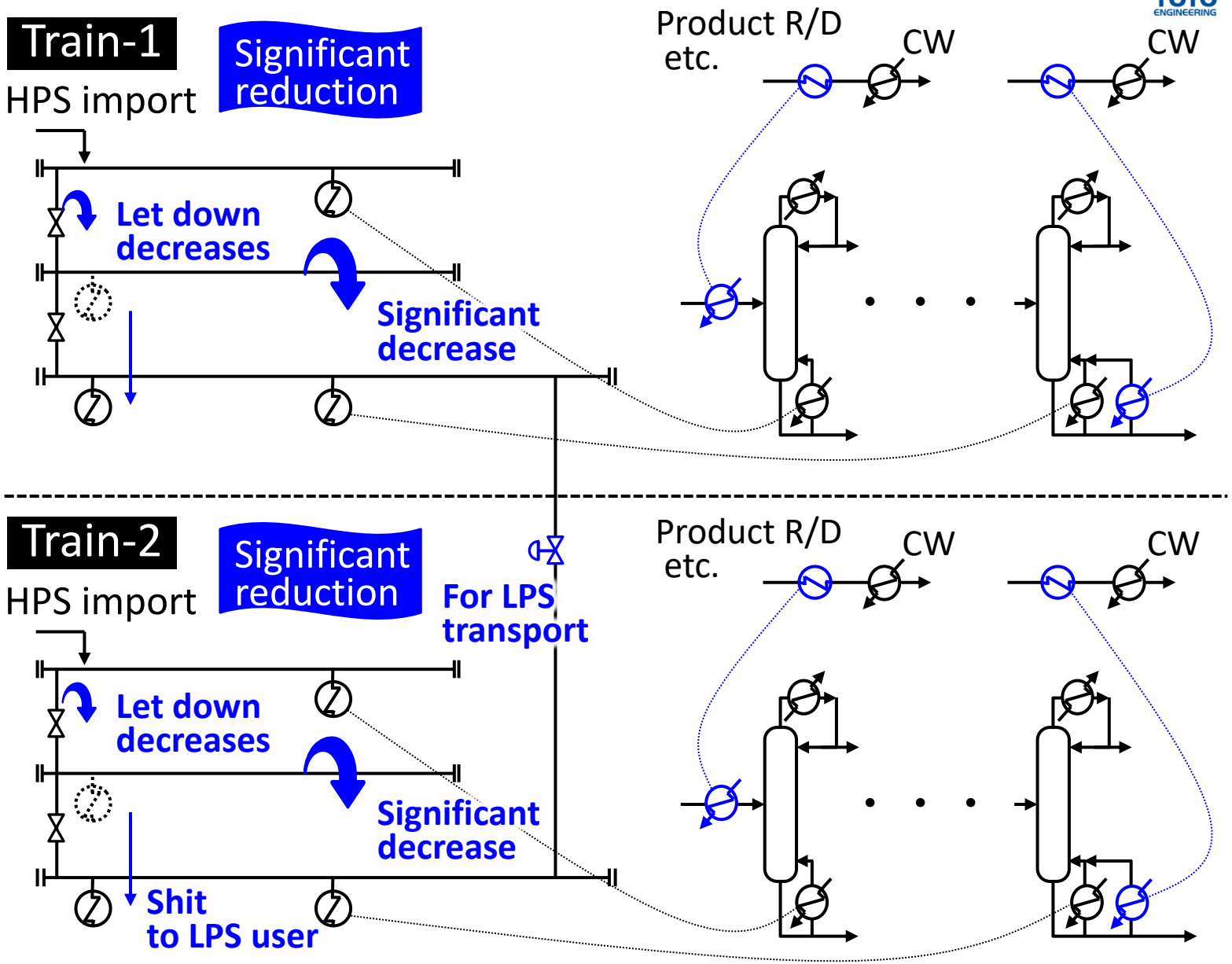
However,…we found some points to be optimized;

① Heat wasted via CW HEX

② Optimization of STM balance

Optimization considering above is ***possible by HERO***

thanks to the comprehensive model incl. process unit and utility unit.



AGENDA

01 Overview of Project by GC and TOYO

02 HERO (“Advance Pinch”)

- ☐ What is HERO?
- ☐ Energy efficiency study by HERO
- ☐ Result in the project by GC and TOYO

03 Impact of HERO Results

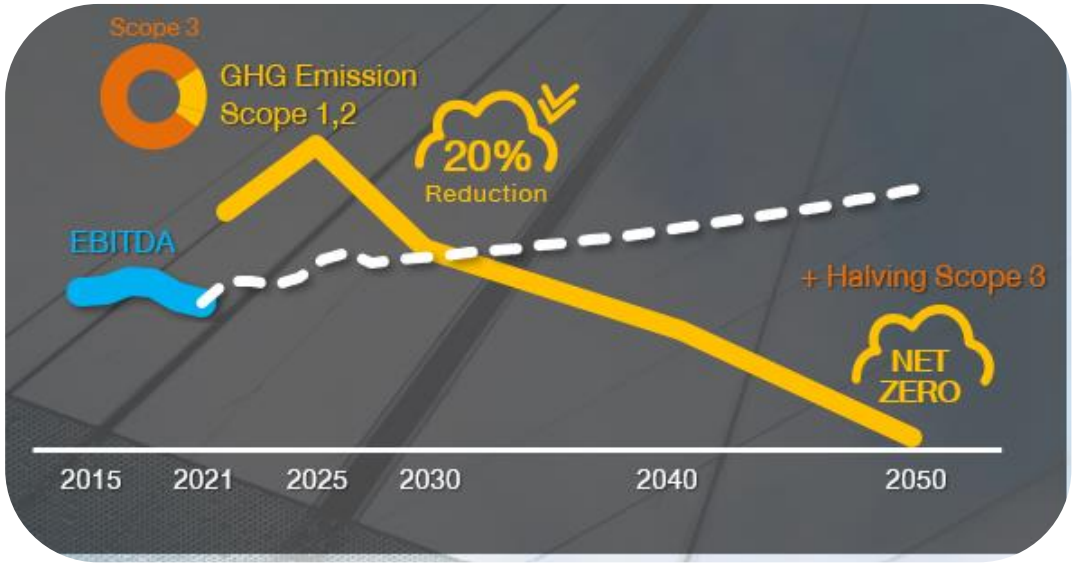
GHG EMISSIONS REDUCTION BY HERO

GC and TOYO collaborating on GC's Aromatic I Plant and Phenol Plant.
Estimated GHG emissions reduction are;

- ✓ Aromatic I: Approx. 55 kton-CO_2 / year
- ✓ Phenol Plant*: Approx. 13 kton-CO_2 / year

68 ktons CO_2 is equal to GC's**

- ✓ **0.8%** of **emissions in 2021** (Scope 1 & 2)



*One of the plans in FS, GC is in the configuration selection.
** Amount only two plant of more than 20 plant of GC group.

SUMMARY

- ✓ HERO can offer ***effective modification solutions for energy efficiency*** even in case well-experienced process engineers cannot obtain solutions through pinch analysis

- ✓ GC confirmed the effectiveness of HERO through the ongoing PJ
  - ➢ Aromatic I: ***20 t/h+ STM and 1 MW fuel reduction***
  - ➢ Phenol: ***14 t/h+ STM reduction***

- ✓ GC and TOYO expand collaboration aiming for GHG emissions reduction by HERO.