NATIONAL ENERGY EFFICIENCY CONFERENCE 2023

An Initiative by: Energy Efficiency National Partnership

Best Practices from Energy Efficiency Opportunities Assessments

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National Environment Agency
Safeguard · Nurture · Cherish

Outline of Presentation

- Introduction of EEOA
- Benefits of EEOA
- Considerations for EEO implementation
- Energy efficiency best practices
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    2) Redesign chiller plant and make-up air units for better energy efficiency
    3) Adopt double-effect evaporation instead of conventional evaporation to improve specific energy consumption
- Conclusion

Introduction of EEOA

- Energy efficiency opportunities assessment (EEOA) is legislatively required under Energy Conservation Act (ECA) section 26A and section 27B for New Ventures (NV) and Registered Corporations (RC) respectively
- Relevant business activities from following industries with annual energy consumption (AEC) ≥ 54 TJ:

a) Manufacturing and manufacturing-related services

b) Supply of electricity, gas, steam, compressed air and chilled water for air-conditioning

c) Water supply, sewage and waste management

Introduction of EEOA

New Facilities & Major Expansions (New Ventures)

Review facility design to identify EE opportunities

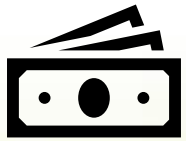
Registered Corporations

Conduct regular EE Opportunities Assessment (EEOA)

EEOA approach

- Form a multi-disciplinary team
- Compute annual energy consumption
- Cover at least 80% of AEC in EEOA scope
- Determine meaningful energy consumption systems (ECS) & specific energy consumptions (SEC)
- Identify energy efficiency opportunities (EEOs) as much as possible and prioritize for implementation
- Assess measured data & energy performance systematically

Benefits of EEOA



Lower capital cost of systems/equipment due to right sizing

Lower operating cost due to lower energy use

Lower Maintenance cost due to operating at optimal conditions

Carbon tax avoidance due to reduced energy consumption

Learn & share EE knowledge & experiences among EEOA team

Nurture EE culture in organisation

Considerations for EEO Implementation

Technical Feasibility

- Production and processes
- Project timeline/production schedule
- Space constraints
- Reliability and Operability
- Other factors, such as spare parts, maintenance services, technical support, training, etc.

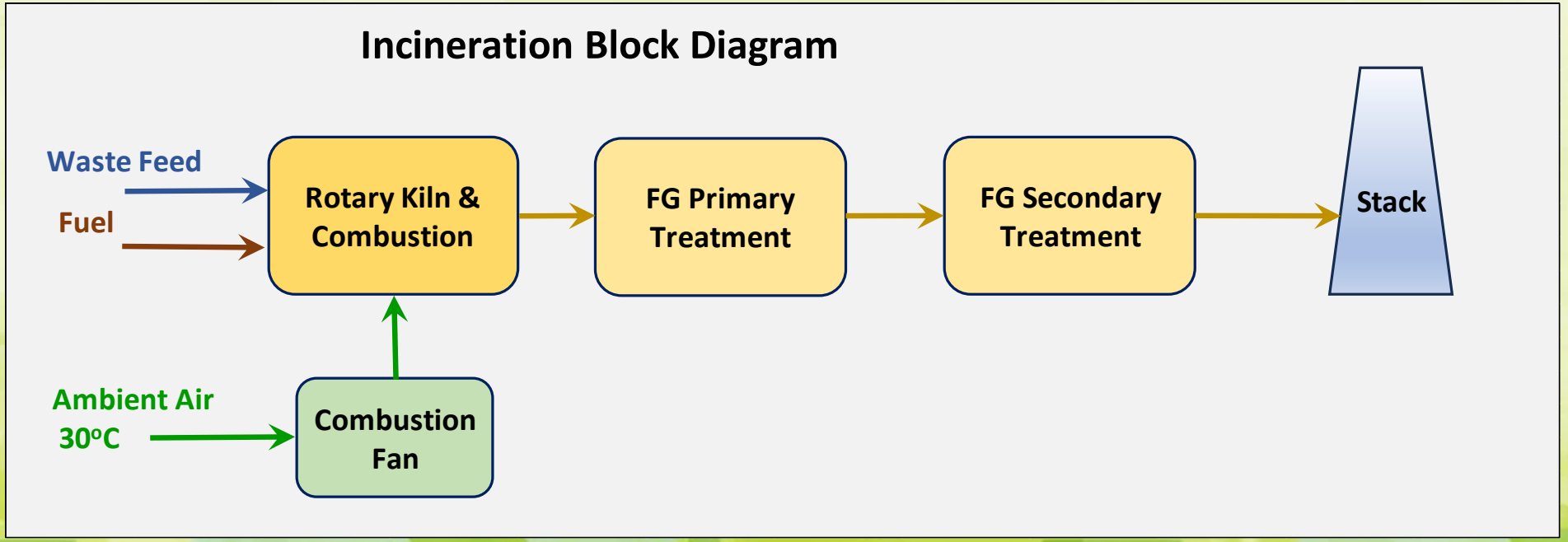
Financial Consideration

- Investment costs
- Payback
- Energy cost variation and carbon emission pricing
- Energy efficiency grant

Best Practice 1 – Install Air Preheater to Recover Heat from Fluegas

Background (Base Case)

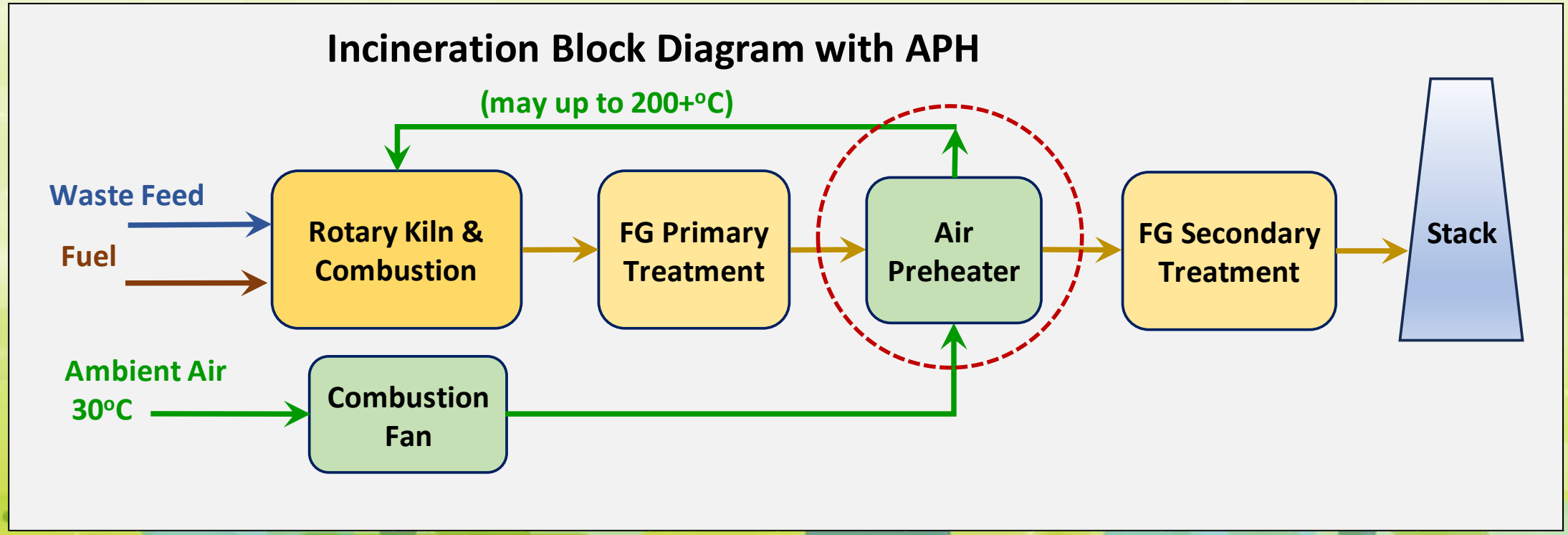
- Waste treatment incineration system that consists of combustion stages – rotary kiln / secondary combustion with fluegas treatment sections
- Air intake from environment for combustion without preheating and enters combustion section at ambient conditions (30°C)



Best Practice 1 – Install Air Preheater to Recover Heat from Fluegas

EEO Case

- Installation of air preheater (APH) in-between/before fluegas treatments
- Energy efficiency of the system will be improved with higher combustion air temperature preheated by flue gas



Best Practice 1 – Install Air Preheater to Recover Heat from Fluegas

EEO Improvement Result

- SEC improved by around 50% (MJ_*heat*/kg_*feed*)
- Payback less than one year

Consideration for possible applications of this EEO

- This EEO is also applicable for new ventures and existing facilities with similar configurations to recover heat from stack flue gas such as incinerators, furnaces, boilers and oil heaters, etc.
- Indirect applications can be considered also such as generation of steam for steam turbine pumps instead of electric motors, absorption chillers, etc.

Best Practice 2 – Redesign Chiller Plant and MAU for Better Energy Efficiency

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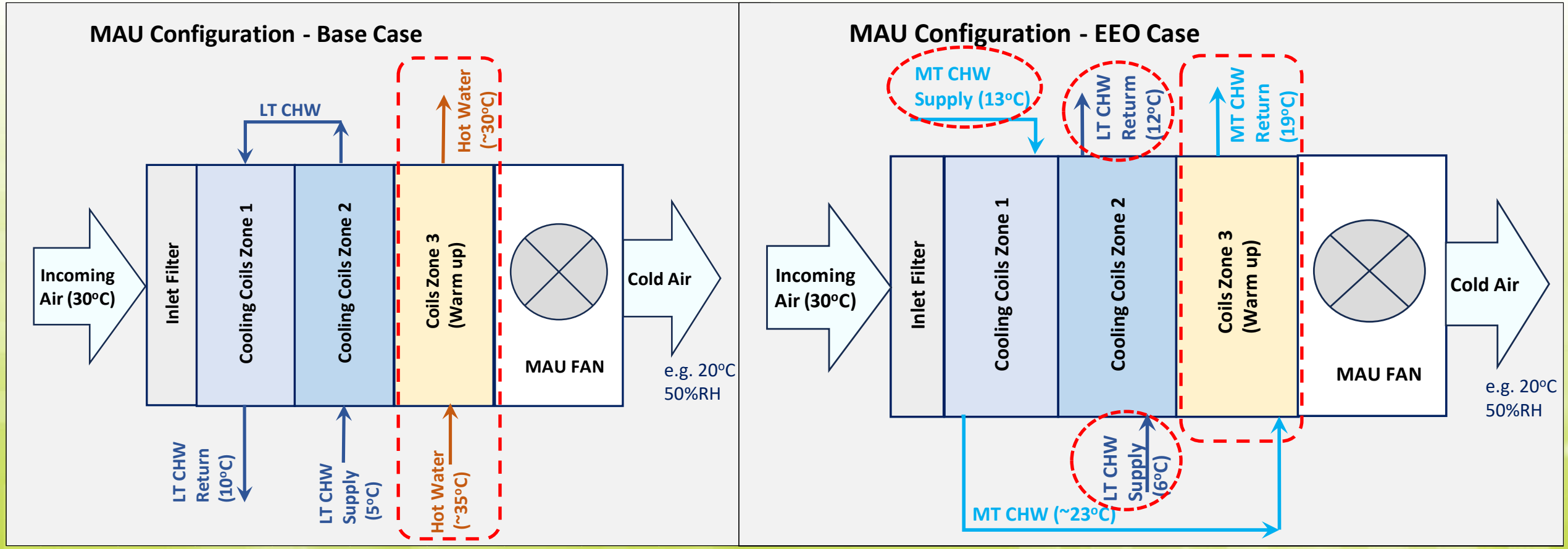
Background (Base Case)*

- The chiller plant consists of
  1) Low temperature (LT) chilled water (CHW, 5°C/10°C) system
  2) Medium temperature (MT) chilled water (CHW, 13°C/18°C) system
  3) Cooling towers (CT) supply condensate water (CW) for both LT and MT CHW systems
  4) Each chiller has dedicated VSD primary/secondary CHW pumps, VSD CW pump
- LT CHW supply to make-up air units (MAU) cooling coils for fresh air dehumidification and the hot water (HW, 35°C/30°C) supplies for reheat of the air after dehumidification
- MT CHW supply to dry cooling coils (DCCs) and heat exchangers for process cooling water (PCW)

*Note: *Figures are assumed from typical industrial applications*

Best Practice 2 – Redesign Chiller Plant and MAU for Better Energy Efficiency

MAU Design Improvement (Base Case vs EEO Case)



Best Practice 2 – Redesign Chiller Plant and MAU for Better Energy Efficiency

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EEO Improvement

- Re-designed LT and MT chilled water systems from optimising LT & MT chiller numbers and capacities
- Increased LT CHW supply temperature from 5°C to 6°C and CHW DT from 5°C to 6°C (5°C/10°C to 6°C/12°C)
- Increased MT CHW DT from 5°C to 6°C (13°C/18°C to 13°C/19°C)
- MAUs re-designed bigger size with MT 13°C/19°C run-around cooling coils and LT CHW 6°C/12°C dehumidification cooling coils
- Transferred MAU system partial cooling demand from LT CHW system to MT CHW system
- Removed hot water section which includes hot water pumps
- Optimised chilled water & CW pipelines sizes & loops to minimize pressure losses

Best Practice 2 – Redesign Chiller Plant and MAU for Better Energy Efficiency

EEO Results

- Combined CHW system SEC improves more than 20%
- Annual energy savings: *CHW system has positive energy saving and MAU section has negative energy saving*
- Payback: less than 3 years*

Consideration for other possible applications of this EEO

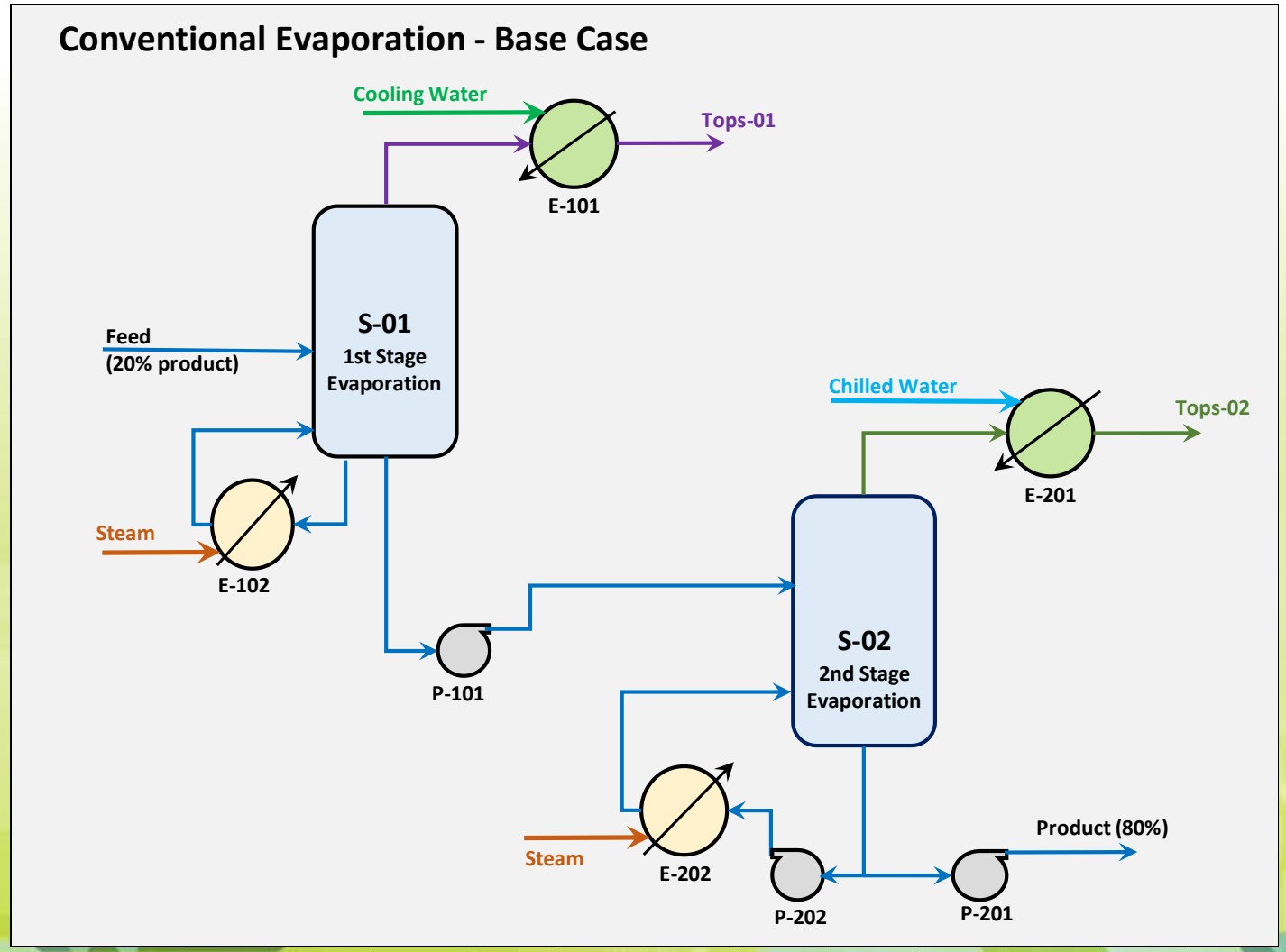
- This EEO is applicable for new ventures (from design stage) and applicable existing facilities retrofits with relevant grant application for overall chilled water system & MAU energy efficiency improvement

*Note: *New facility basis with additional 1 set chiller along with the associated pumps / cooling towers and additional costs for pipework / electrical, etc.*

Best Practice 3 – Double-effect Evaporator instead of Conventional Evaporator

Background (Base Case)

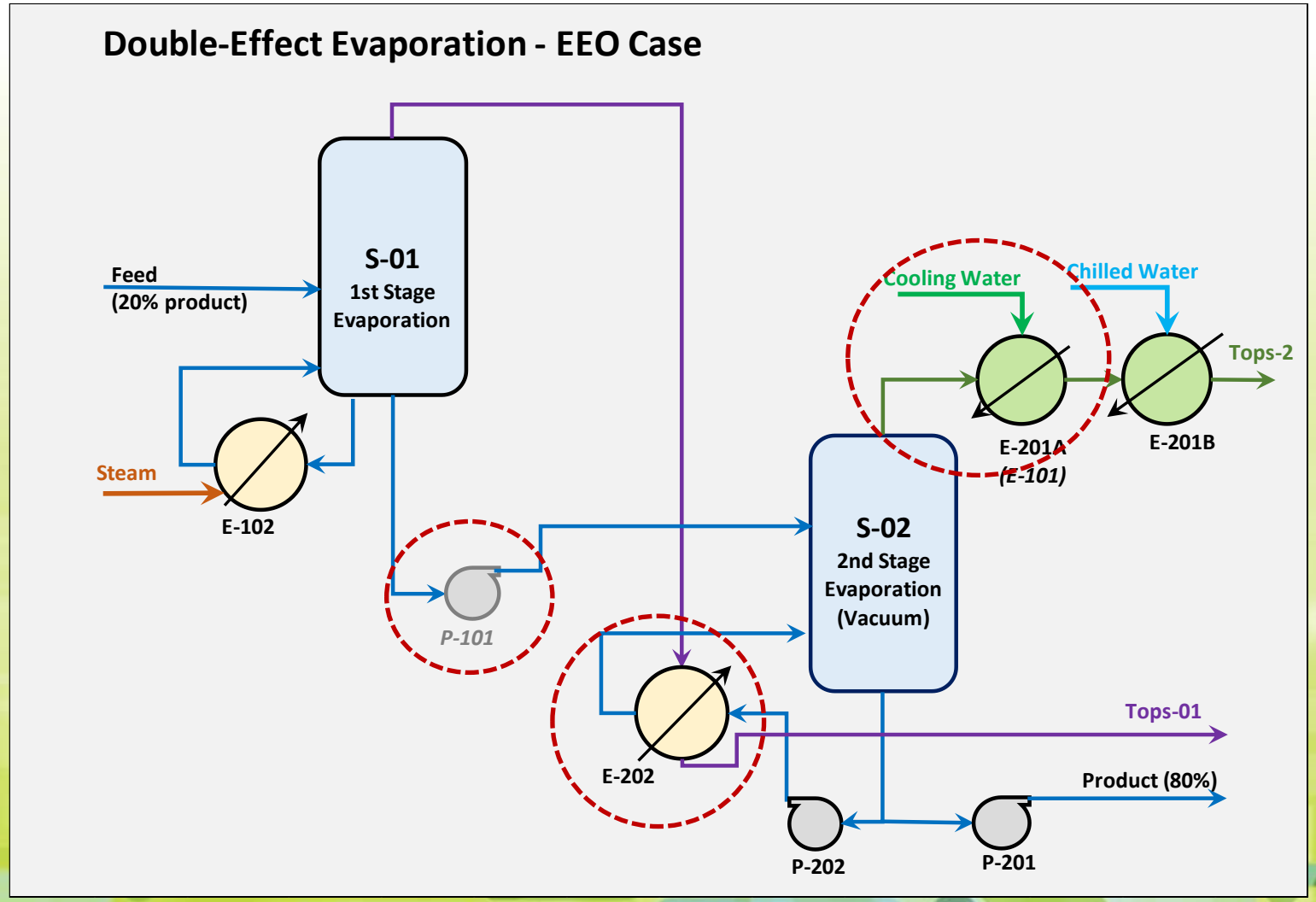
- Product in aqueous solution (20%) feeds to the system and will be concentrated to 80%.
- Product concentration is achieved by evaporating water in 2 stages
- Two flash drums S-01/S-02 in series with dedicated reboilers and condensers supplied with steam and CHW/cooling water respectively



Best Practice 3 – Double-effect Evaporator instead of Conventional Evaporator

Improvement (EEO Case)

- Product in aqueous solution (20%) feeds to the system and will be concentrated to 80%.
- Product concentration is achieved by evaporating water in 2 stages
- the first stage (S-01) is at atmospheric pressure while the second stage (S-02) is under vacuum
- E202 acts as condenser for the first stage and as reboiler for the second stage – double-effect
- Two stage condensation cooling at S-02 overhead and elimination of P-101 can be verified



Best Practice 3 – Double-effect Evaporator instead of Conventional Evaporator

EEO Improvement

- SEC reduced by more than 50% (MJ/kg, kg: product)
- Payback: less than 0.5 year (for NV case)
- Payback less than 1.5 years (to reuse some existing equipment for retrofit case)

Consideration for possible applications of this EEO

- EEO may be applicable for new ventures and existing facilities where there are similar configurations such as multiple-effect evaporation / distillation
- Mechanical vapour recompression (MVR) technology can be considered if approach temperature/heat supply is not sufficient.
- EE incentive grants such as REG(E) grant (carbon abatement >0.5 ktpa) may be applicable.

Conclusion

- Conduct EEOA systematically and periodically with measured data and proper documentation to achieve continual EE improvement and cost savings
- Focus on energy performance of entire site as well as individual system/equipment
- Determine meaningful ECSs and SECs and identify EEOs with a competent multi-disciplinary team including senior management
- Implement continuous monitoring capabilities such as EMIS to facilitate identification of improvement opportunities
- Have a positive mindset towards EEOA, nurture a learning & sharing EE culture by involving more people and communicating EE knowledge & experience throughout the entire organization

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THANK YOU

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