MOIT

IGIP

EMBASSY OF DENMARK
Hanoi

Danish Energy Agency

DEMONSTRATION ENERGY AUDITS

from Ideas to Mature Project

Fertilizer Sector (Chemical)

Date 25 / 09 /2025

Overview

This Energy audit report is based on the "**Audit Guideline under the EE Incentive Scheme for energy intensive industries in Vietnam**" and the "**Energy Mapping User Guide**" from the "**Energy Partnership Program between Viet Nam and Denmark 2020 – 2025 (DEPP3).**"

Ministry of Industry and Trade is the governing body of the DEPP3. The Agency for Innovation, Green transition and Industry Promotion (IGIP) is the program owner.

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IGIP

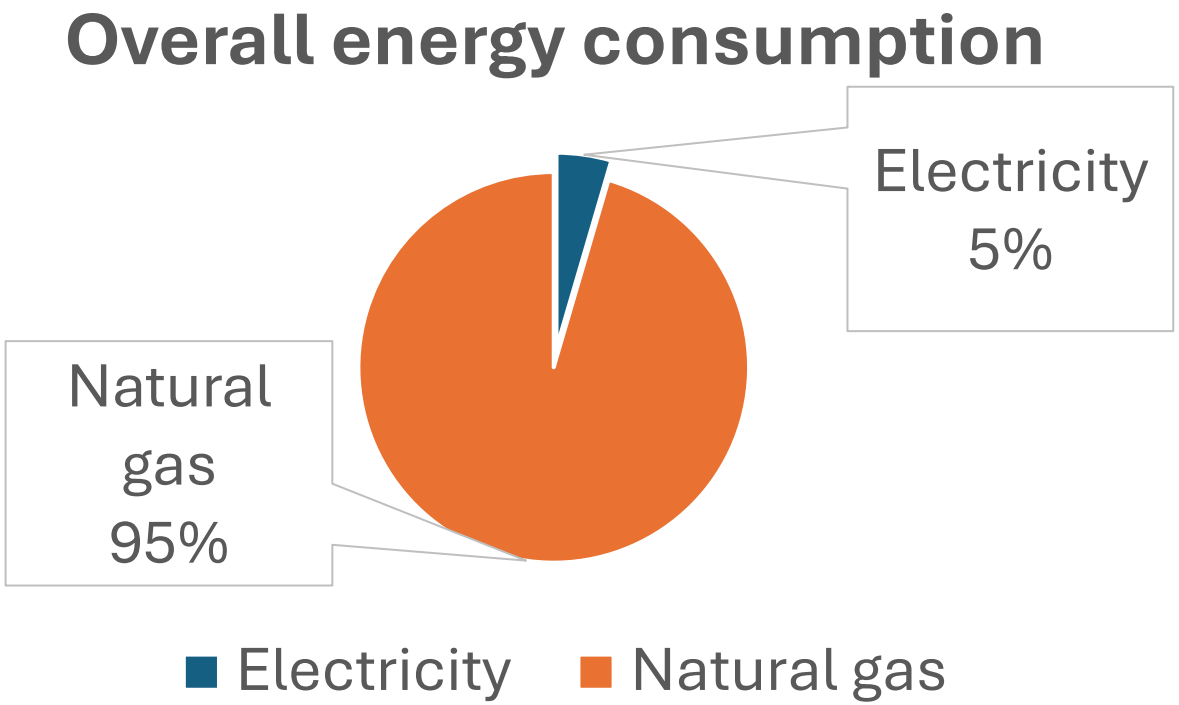
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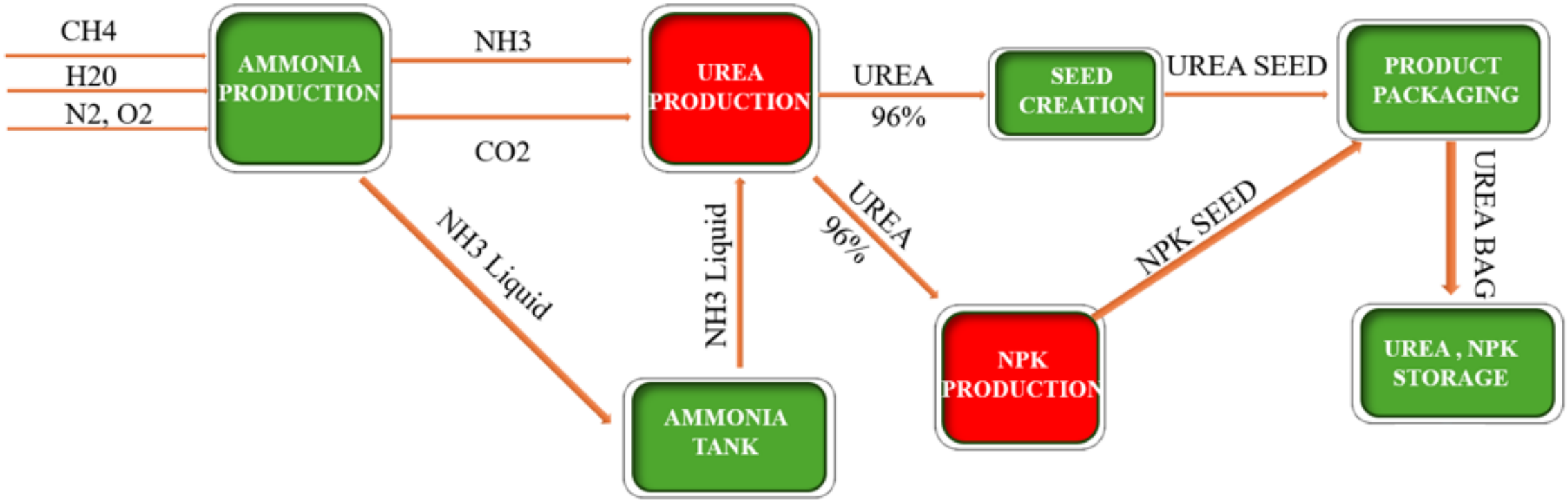
Case Overview

Baseline

- Sector: Fertilizer (Chemical)
- Main products:
  - Product 1: 949,130 (ton/year)
  - Product 2: 150,092 (ton/year)
  - Product 3: 541,517 (ton/year)
- Annual energy total consumption
  - Electricity:
    - Grid: 170,122,888 (kWh), equivalent to 26,249 (TOE),
  - NG: 20,750,348 (GJ), equivalent to 529,225 (TOE).

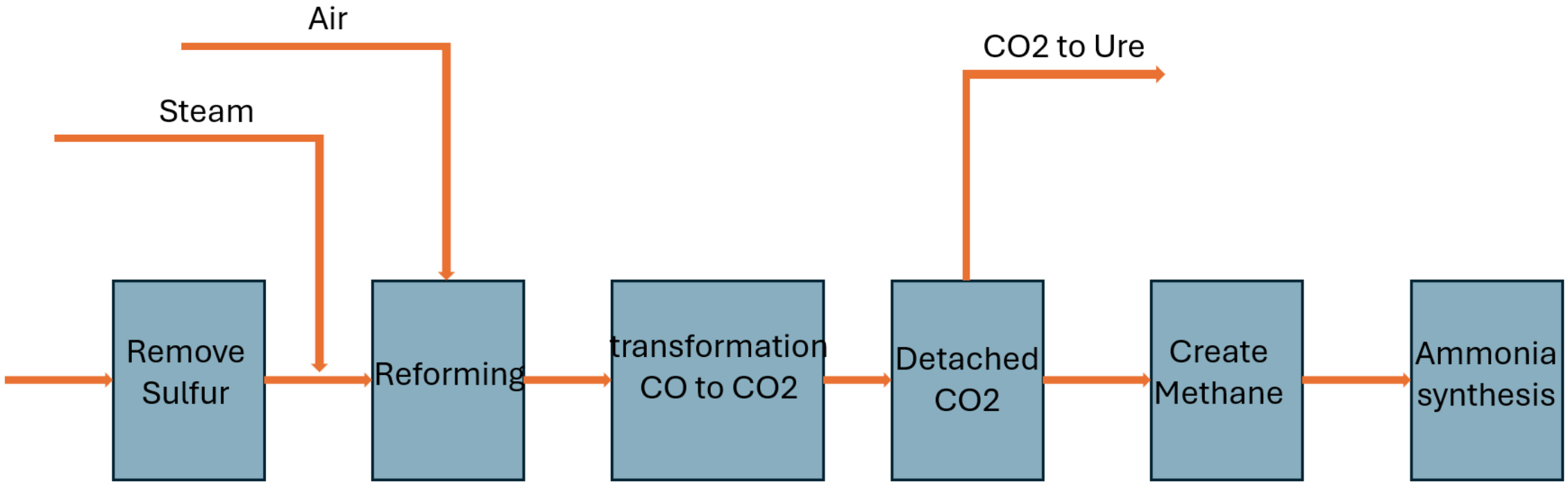


Case Overview



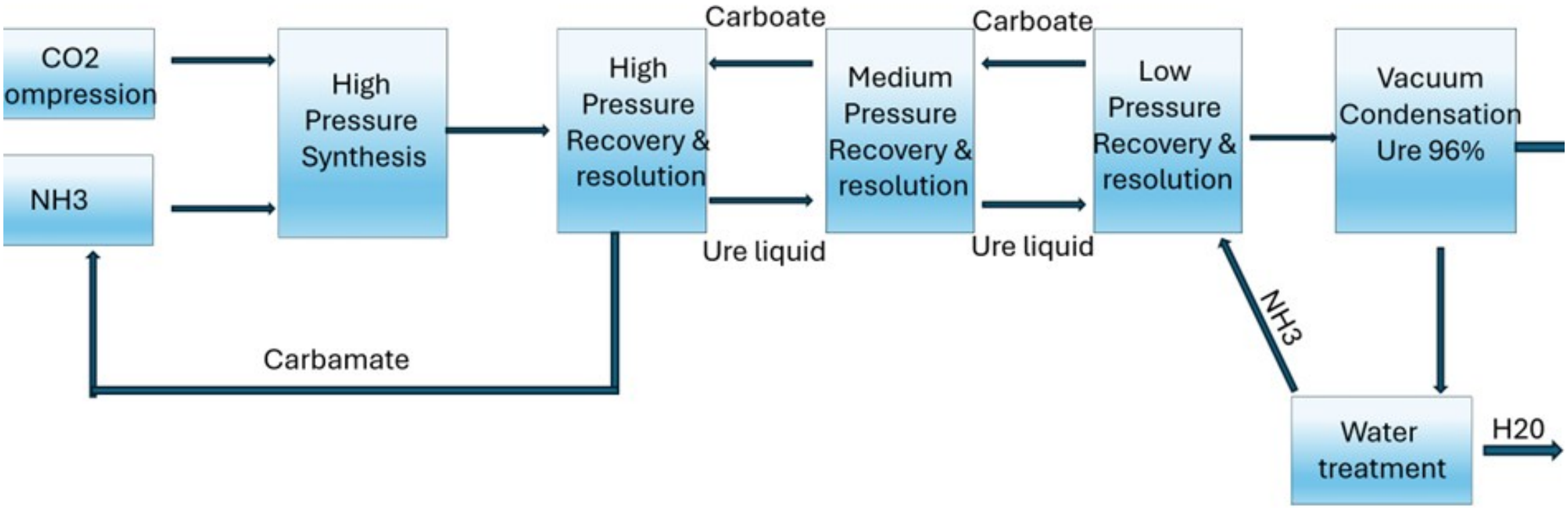
Process overview

Case Overview



AMMONIA production process

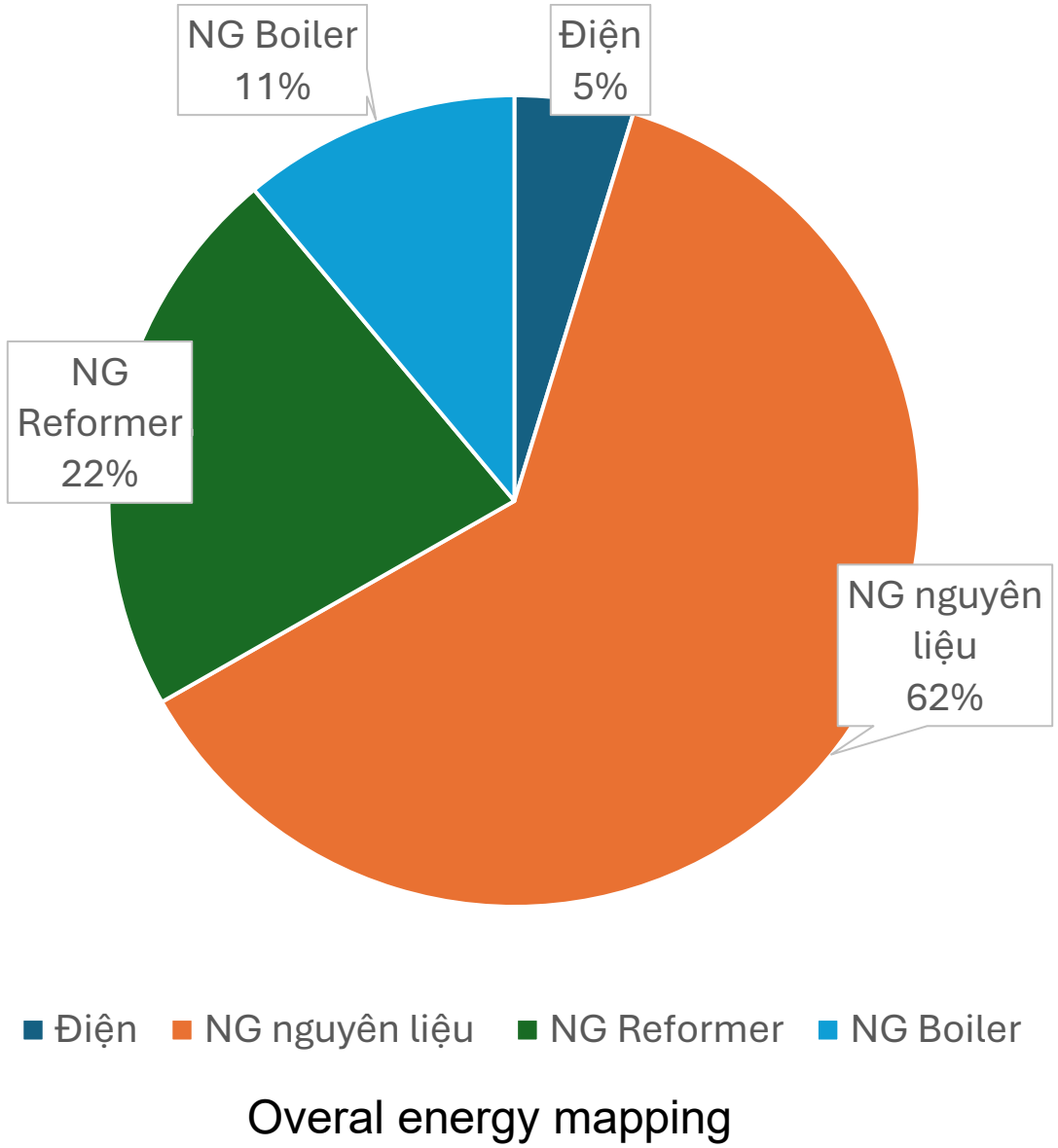
Case Overview



URE production process

Energy Audit procedures

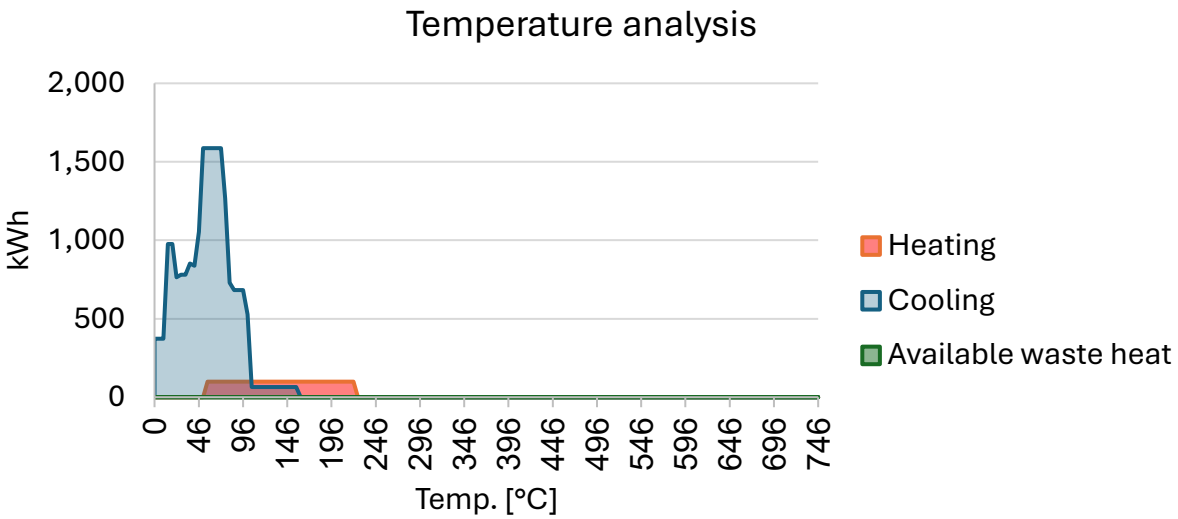
- Conduct energy audit and prepare an energy audit report with potential energy-saving solutions based on **circular 25/2020/TT**, **MOIT energy audit guideline** and **Energy Mapping User guide from DEPP3 project**.
- Based on energy mapping result, major energy consuming processes are identifed.



Overal energy mapping

Energy Audit procedures

- Intensive Temperature analysis is realized by level-2 mapping where any thermal energy demand (heating and cooling) is mapped by energy demand and temperatures.
- The purpose of this is to identify potential energy savings potentials through modification of processes or the energy supply systems.
- Based on the temperature analysis, energy saving opportunities are identified including potential for heat recovery.



Temperature analysis based on Level 2 mapping

Energy Audit procedures

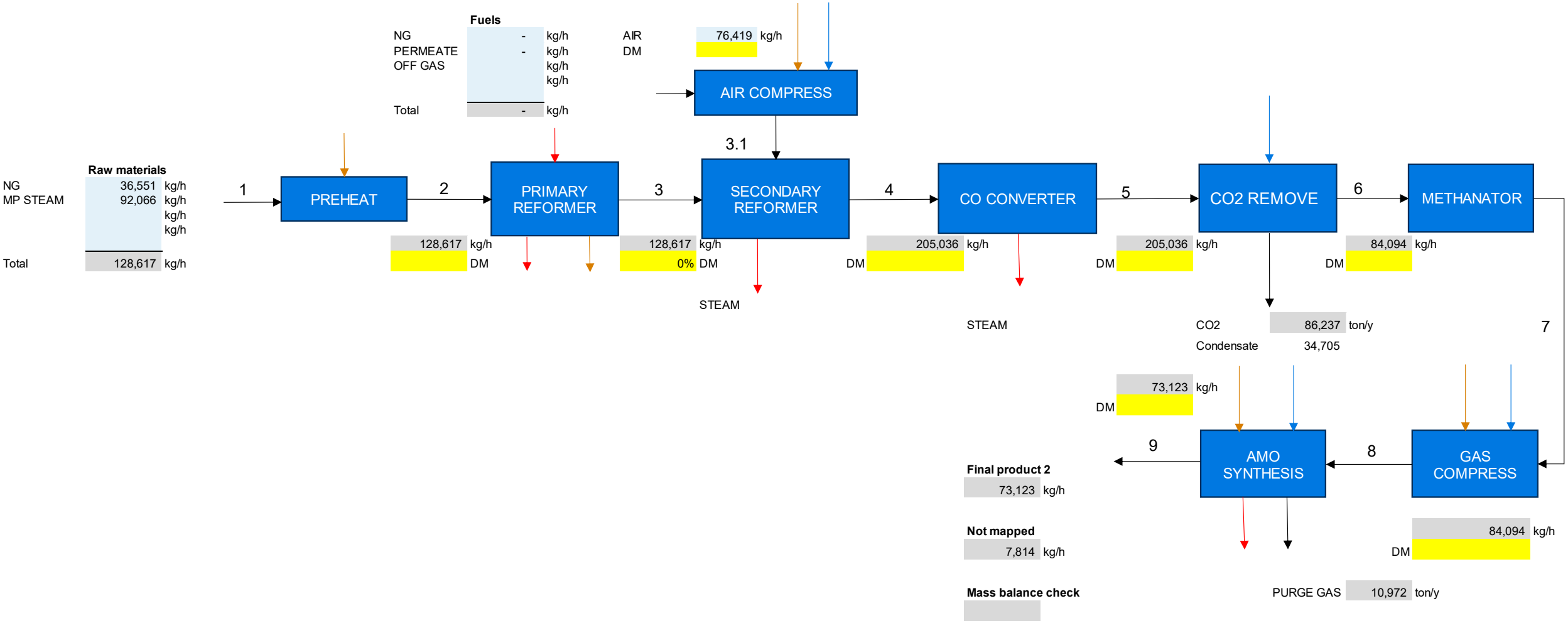
ACTIVITY	Responsible
Planning site visit	Project Coordinator (DEA)
Preparing agreement - LC/IC	International Consultant
Preparing agreement - VAS	Energy Efficiency and Sustainable Development Department - MOIT
Starting up the energy audit	Local Consultant
Outlining the audit report	Local Consultant
Introducing the company - Chapter 2	Local Consultant
Affairs of the company - Chapter 3	Local Consultant
Describing the process procedures - Chapter 4	Local Consultant
Energy demand and supply capacity - Chapter 5	Local Consultant
Thermal energy mapping	Local Consultant
Electrical energy mapping	Local Consultant
Utility mapping	Local Consultant

Energy Audit procedures

ACTIVITY	Responsible
Financial - technical obligation - Chapter 6	Local Consultant
Energy saving solution (project screening) - Chapter 7	Local Consultant
Developing project - Level A	Local Consultant
Developing project - Level B	Local Consultant
Reporting	Local Consultant
Review	International Consultant
Completion	Local Consultant
Internal project meeting - weekly	International Consultant
Work at the DEU conducted by EAC - 1st trip: Startup meeting; Collect data, measure, survey and evaluate	Local Consultant
Work at the DEU conducted by EAC - 2nd trip: Meeting for Mapping and screening; Collect more data, conduct more detailed measurements	Local Consultant
DEU project meeting - 3rd: Presentation of energy audit results; Get opinions from DEU to complete report	Local Consultant

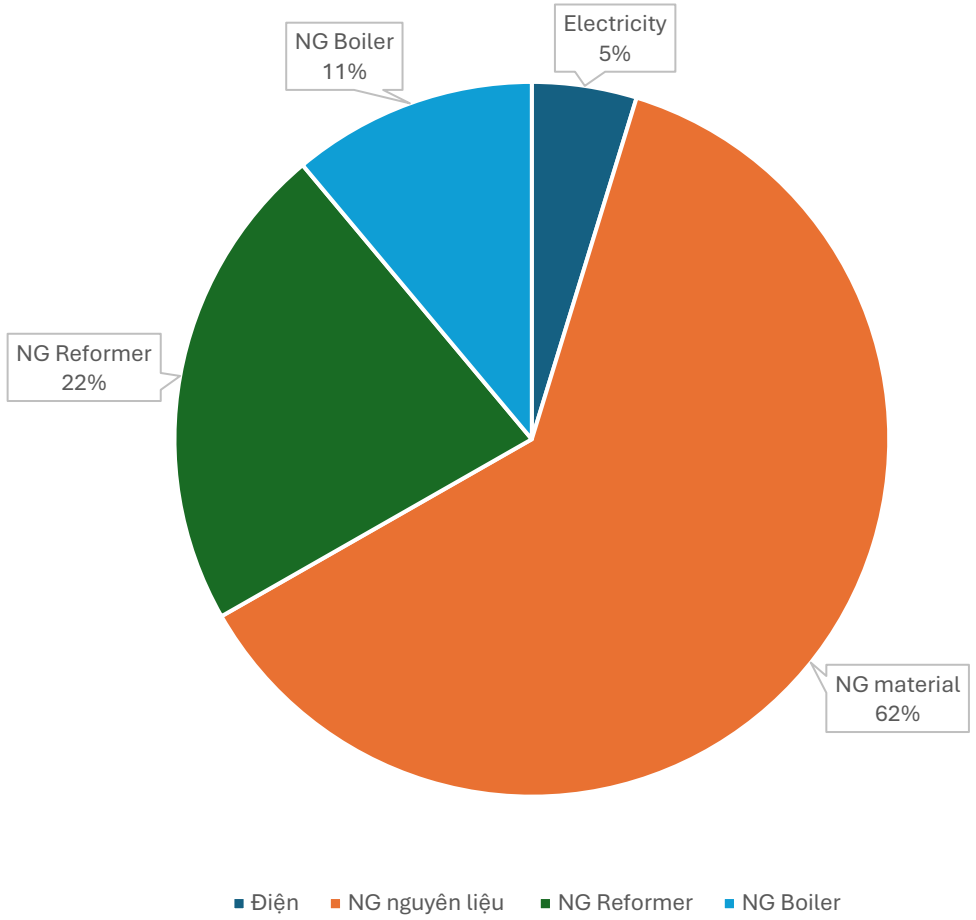
Energy mapping

Mass flow balance

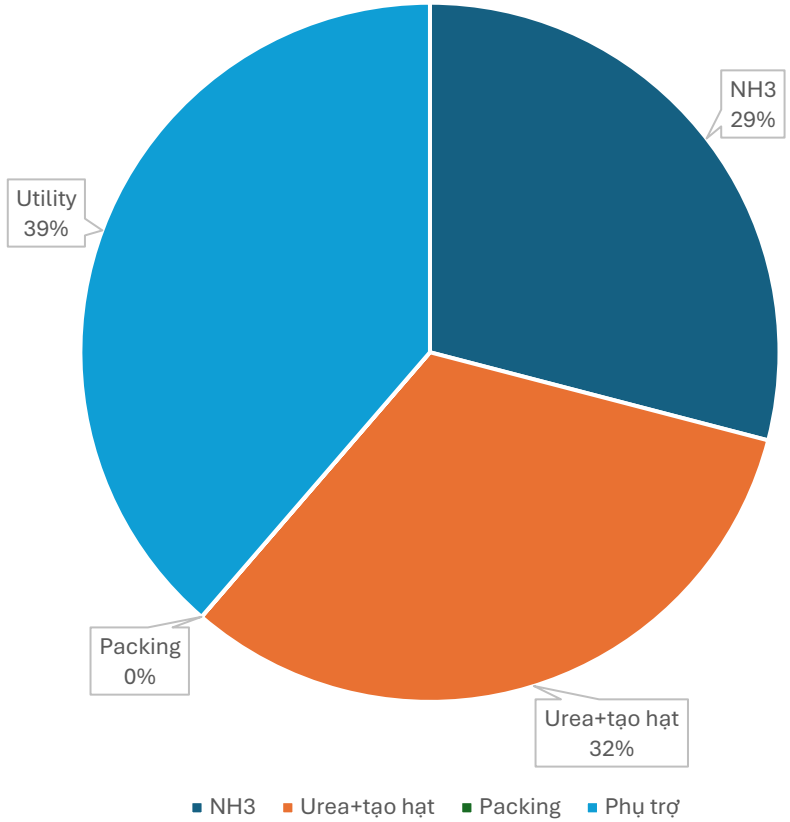


Energy mapping

Overall energy mapping



Energy usage rate in 2023



Electricity usage rate in 2023

Energy mapping

- The majority of the energy used in the plant is in the form of heat.
- During the discussions with ICs and the key-staff at the facility, the following assesments focus on rehabilitation of cooling water systems and utilization of waste heat and delta-T-hunting.
- All cooling consumers at the facility are identified with level-2 energy mapping, i.e. all heat exchangers where cooling water is used are identified and load and temperatures for each of these are mapped on the primary and secondary side.

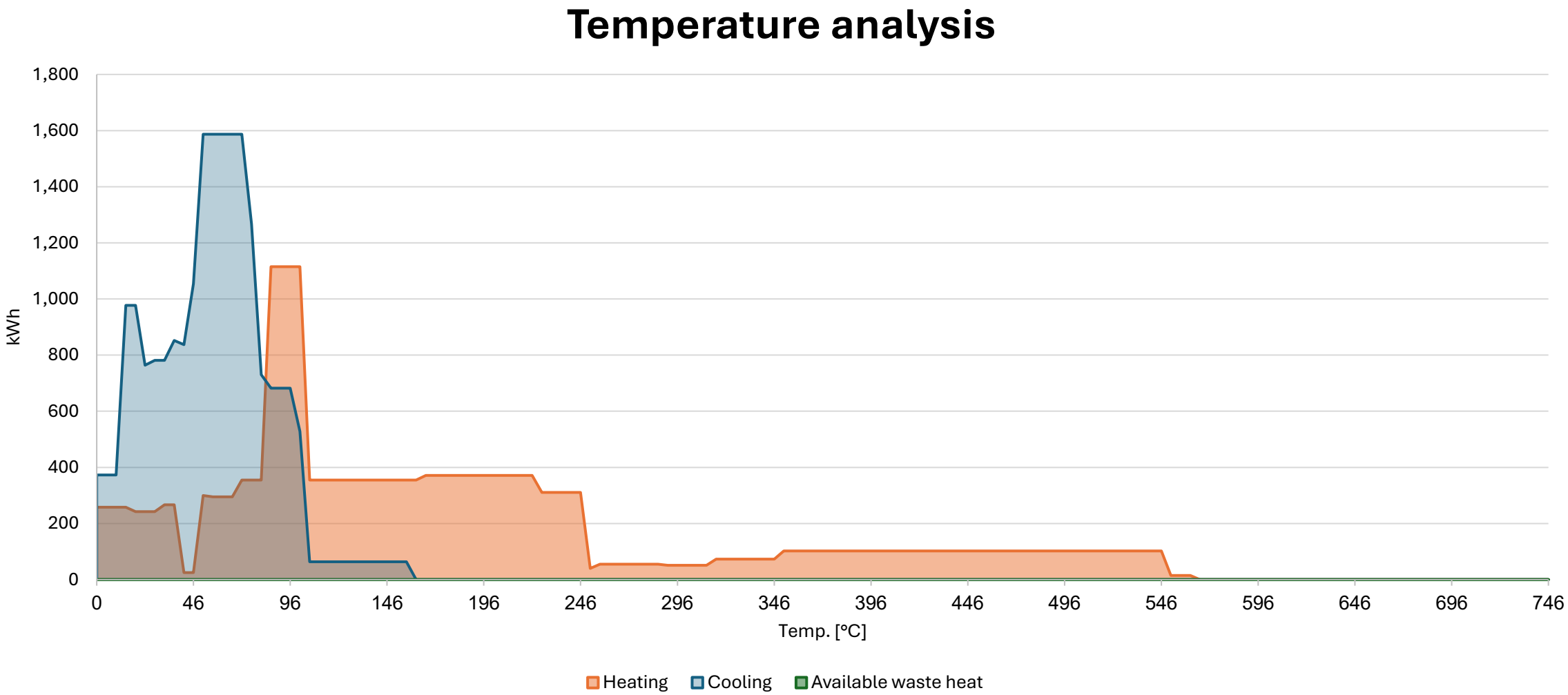
Level-2 energy mapping

No.	Name	Func.	Capacity (KW)	1 Tin	1 Tout	2 Tin	2 Tout
1	E04217	FEED & FUEL PREHEATER	520	30	51.1	91.8	81.2
2	E04204-3	FEED GAS PREHEATER	1,670	51.1	135.8	173.5	158.5
…							
5	E04201	FEED GAS & STEAM PREHEATER	17,480	346	546.2	1023.8	869.9
…							
9	E04209	STEAM SUPER HEATER	7,570	387.5	346.3	322	329.1
…							
49	E04503	HOT HEAT EXCHANGER	54,220	280.8	73.7		
50	E04504	WATER COOLER	6,000	73.7	40	34.5	43.3

A number of heat exchangers have significant delta-Ts (exergy loss), especially no.5 E04201 (FEED GAS&STEAM PREHEATER), and no.9 E04209 (STEAM SUPER HEATER).

E04503 (~195 GJ/h) has high delta-T that can be improved to recover heat and reduce cooling load at E04504.

Temperature analysis



Temperature analysis

Based on the temperature analysis, it can be seen that a significant amount of waste heat—ranging from 50°C to 150°C—is being discharged into the cooling system, indicating strong potential for heat recovery.

- E04510 AMO Chiller Condenser: Capacity: 28,650 kW; Operating Temperature: 102.4°C
- E04433 Compressed S. Gas Cooler 3: Capacity: 7,719 kW; Operating Temperature: 157.6°C
- E04221-E04224 C. Air Cooler: Operating Temperature: 124.8°C

These waste heat sources could be harnessed either to generate electricity using an Organic Rankine Cycle (ORC) or to produce chilled water via an absorption chiller.

Energy saving solutions - Level B projects

NO.	SOLUTIONS	DETAIL
1	Rehabilitation of cooling systems	- There are opportunities to apply cooling tower water directly for process cooling in some areas in stead of using fresh water cooling (5oC higher temperature) This will make cooling more efficient due to lower feed temperature of cooling tower water ➢ This will also increase the capacity on E21201H-T (eventually reducing delta-T) - Promissing locations are: ➢ Syn Gas compressor intercooler E04431, E04432, E04433 (16,629 kW). ➢ Air compressor intercooler E04221, E04222, E04223, E04224 (9,738 kW) ➢ CO2 compressor intercooler E06119, E06120, E06121 (11,040 kW)
2	Optimization of Plate Heat exchangers E21201H-T	A delta-T of 5 degrees for E21201H-T is relatively high compared to other water-to-water plate heat ex-changers of similar size. The current construction of the heat exchanger E21201H-T leaves a place for extra plates to increase size minimizing delta-T. Fresh cooling water temperature can ben reduced by about 1.1 oC after increasing E21201H-T size by 50%.

Energy saving solutions - Level B projects

NO.	SOLUTIONS	DETAIL
3	Use of VSDs to control the capacity of large fans and pumps	It has been observed that large manual valves are installed in multiple locations within the utility systems to regulate flow capacity. Specifically, the following dampers are partially closed: B07602 and B07603 (70%), B07605 (60%), and B07601 (50%). The plant has already planned to install a Variable Speed Drive (VSD) for B07602 to reduce energy consumption. It is recommended that VSDs also be considered for B07602, B07603 and B07605 to enhance energy efficiency.
4	Delta-T-hunting and improved heat recovery	E04503 (~195 GJ/h) has high delta-T that can be improved to recover heat and reduce cooling load at E04504.

Energy saving solutions - Level B projects

NO.	SOLUTIONS	DETAIL
5	Increased power production with ORC	After a comprehensive mapping of the heat exchangers and cooling system, the following waste heat sources have been identified as candidates for power production using an Organic Rankine Cycle (ORC) or for chilled water production using an absorption chiller: ➢ E04510 AMO Chiller Condenser: Capacity: 28,650 kW; Operating Temperature: 102.4°C ➢ E04433 Compressed S. Gas Cooler 3: Capacity: 7,719 kW; Operating Temperature: 157.6°C ➢ E04221-E04224 C. Air Cooler: Operating Temperature: 124.8°C ➢ E06119 CO2 compressor first intercooler: Capacity 3,217 kW, temperature in 170.2 °C ➢ E06120 CO2 compressor second intercooler: Capacity 3,669 kW, temperature in 220.8 °C ➢ E06121 CO2 compressor third intercooler: Capacity 2,722 kW, temperature in 177 °C.

Energy saving solutions - Level B projects

NO.	SOLUTIONS	DETAIL
6	Rehabilitation of boiler feedwater preheating system	Increase E04205 feedwater preheater size to recover more heat from pre-reformer furnace exhaust gas (160°C).
7	Rehabilitation of condensers in ammonia chiller system to improve COP	Replacing the water-cooled condenser E04510 with an Evaporative Condenser. The condensing temperature can be reduced from 40.6oC to 33oC (temperature difference of 6.4oC), which can potentially increase the cooling capacity by 6.4%.
8	Optimization of compressed air systems operation	Including 1 or 2 compressors with VSD-drive to avoid frequent in-efficient load/un-load-operations
9	Assessment of potentials for use of biomass, CO2-capture and green hydrogen	There is potential to use biomass for the auxiliary boiler as a replacement for natural gas (NG). However, this option could impact plant operations and require further research. Therefore, it is not a priority at this time.

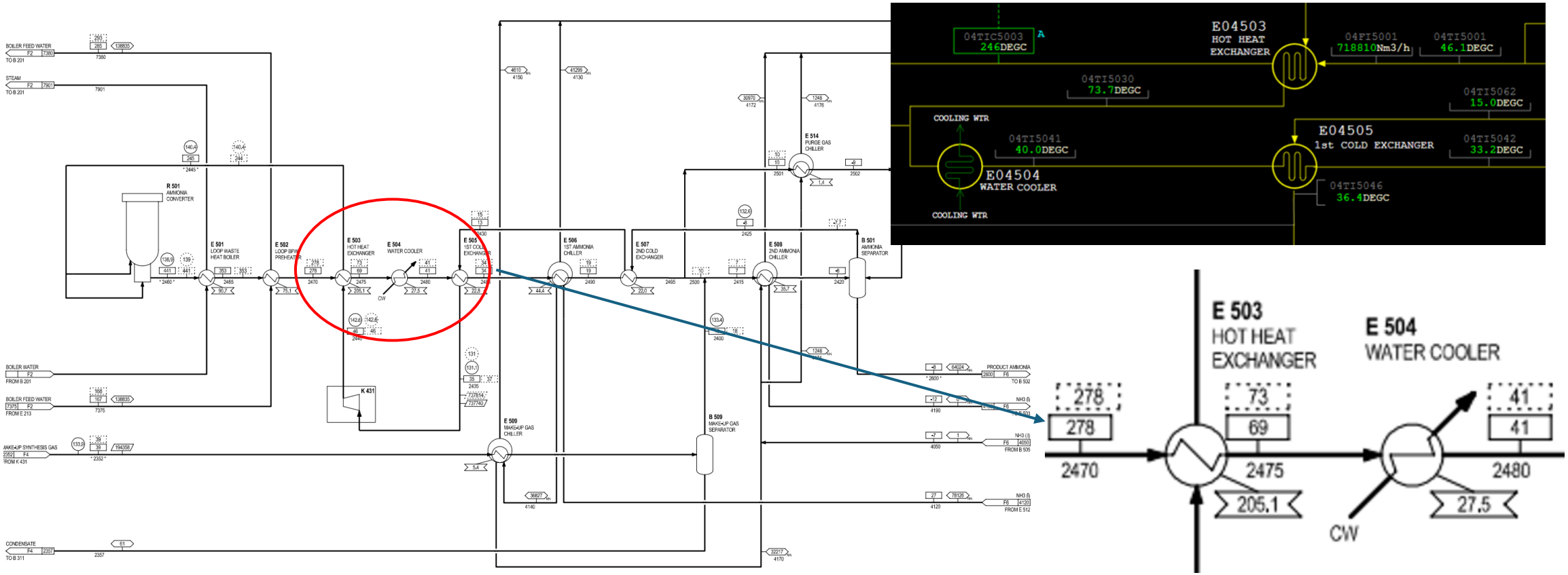
Energy saving solutions - Level B projects

Table 1.1. Energy saving potential and investment cost estimates

No.	Project	Saving (Energy GJ/year)	Saving (CO2 ton/year)	Saving (Financial USD/year)	Budget (USD)	Simple payback (year)
1	Optimization of Plate Heat exchangers E21201H-T	9,811	550	98,112	150,000	1.5
2	Replacement of Ammonia Refrigeration Condenser by Evaporative Condenser	38,806	2,134	388,000	300,000	0.77
3	Increase E04503 capacity to reduce energy loss at E04504	131,400	7,227	1,314,000	2,000,000	1.52
4	Direct use of cooling tower water for intercooler of compressors	49,055	2,750	490,560	500,000	1.02

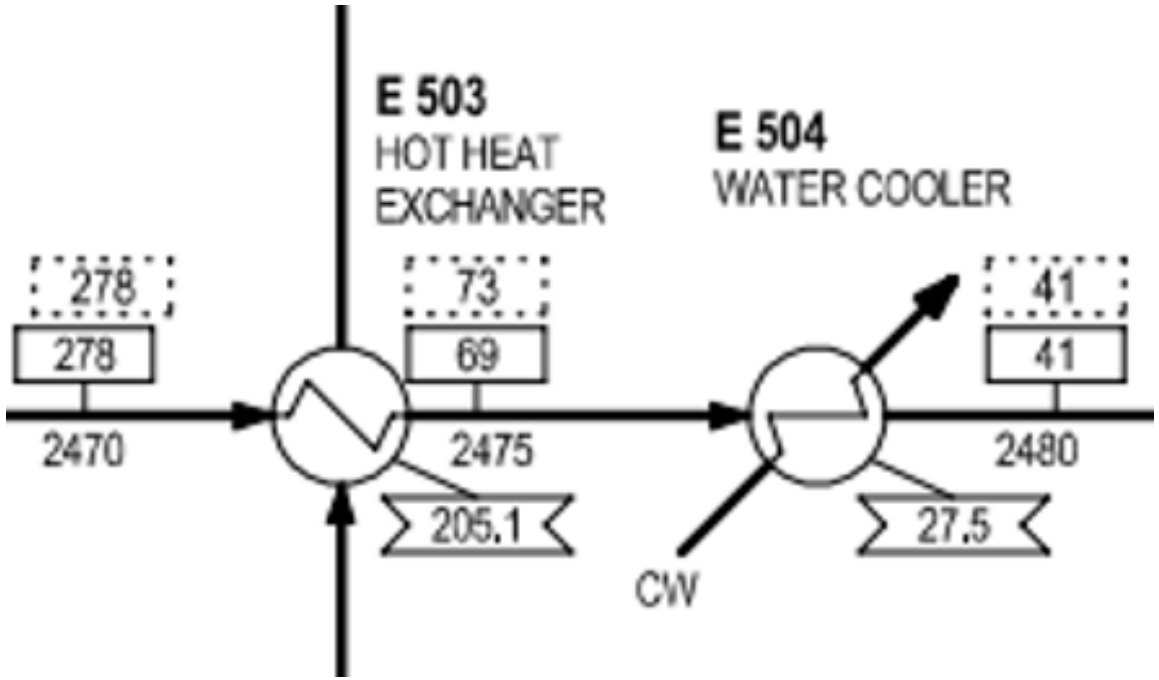
Example solutions

Increase E04503 capacity to reduce energy loss at E04504



Example solutions

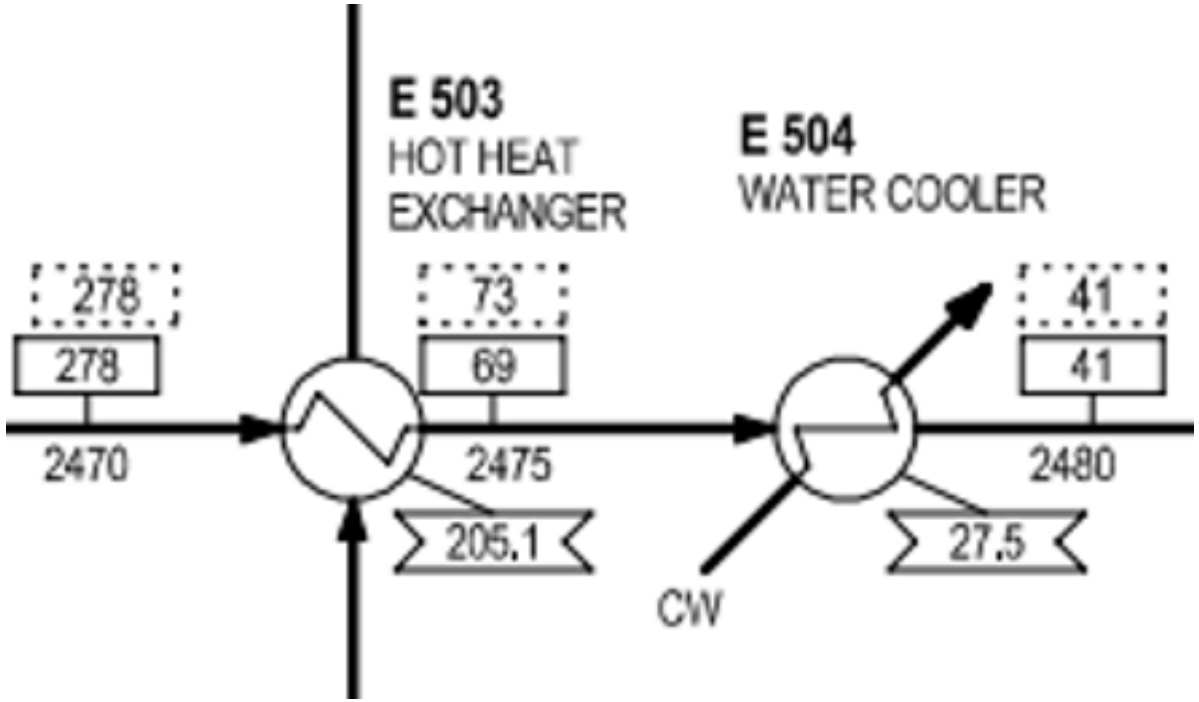
- The synthesis gas is cooled to 65°C in the hot heat exchanger E04503 by heating the synthesis tower inlet gas to recovery heat
- The synthesis gas is then cooled to 41°C in the water chiller E04504.
- E04503 (~195 GJ/h) has high delta-T that can be improved to recover heat and reduce cooling load at E04504.



Example solutions

Proposed project

- Increase E04503 capacity by 12% to 234 GJ/h to recover heat and reduce cooling load at E04504. Heat recovery by heating inlet gas from 46.1°C to ~ 270 °C.



Example solutions

Project Budget

Element	Units	Unit costs	Costs
Total	2,000,000 USD		

TIME SCHEDULE

Activity	1	2	3	4	5	6	7	8	9	10	11	12
Pre-feasibility												
Feasibility studies												
Final Investment Decisions					X							

Saving

Energy(annual): 131,400 GJ	Financial (annual): 1,314,000 USD/year
Co2 (annual): 7,227 tons	Simple Payback (years): 1.52 years

Lesson learnt and reflections

Energy Audit Procedures/Approach

- ✓Energy mapping is a good approach for identify energy saving and heat recovery potentials.

Challenges/Gaps:

- ✓Lack of standardized auditing procedures across industries.

Solutions:

- ✓Develop a national standard protocol for energy audits.
- ✓Conduct training workshops on best practices.

Lesson learnt and reflections

Energy Mapping Practices

Challenges/Gaps:

- There are many heat exchangers in the factory.
- Incomplete or inconsistent data availability.
- Absence of real-time monitoring.

Solutions:

✓Select representative heat exchangers based on manufacturing process

✓Implement energy information systems to automate data collection

✓Using of design parameters and theoretical correction factors for missing data

✓Develop standardized energy flow diagrams for key sectors (textile, food, cement, etc.)