VIEGAND MAAGØE

Day 1: Introduction to energy mapping

Aim of Day 1

- Introduce the overall training program, structure, and learning objectives
- Create a comfortable and collaborative learning environment
- Provide a clear introduction to the concept of energy mapping
- Explore the Excel-based energy mapping tool through guided use of a simplified case

Day 1 Agenda

→ **Session 1:** Welcome and introduction to course and participants

→ **Session 2:** Introduction to onion-diagram and energy mapping

→ **Session 3:** Energy mapping based on case

→ **Session 4:** Reflections and discussion of case and first experience with energy mapping

→ **Wrap-up**

Session 1 – Introduction to the course

Welcome

Session 1 Objectives:

- Get to know each other and set expectations
- Introduce the course goals and structure
- Create a collaborative and open learning space

This training is…

- Interactive & hands-on
- Based on real-world cases
- Focused on group work and shared learning

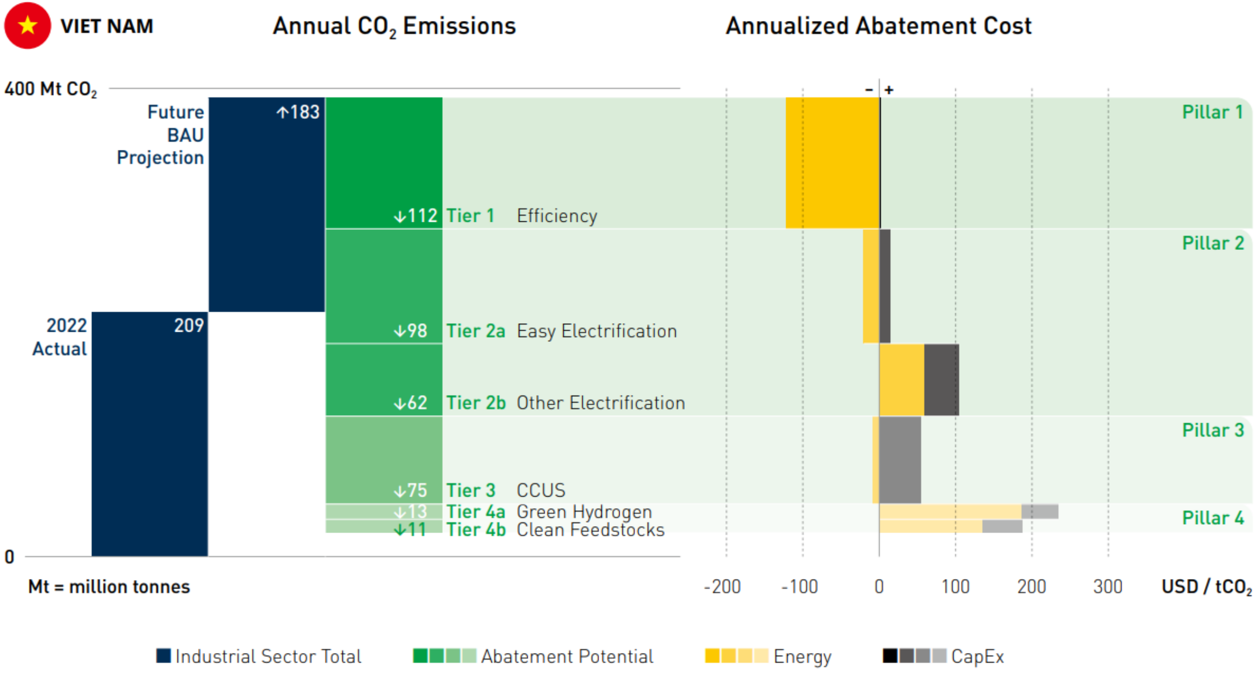
Participant introduction

Please share:

- Name, role, and organization
- Your experience with energy audits or projects
- A case or context you're bringing to the course
    - If you’re not currently working on a case, think of a facility or process you know where energy performance could be improved
- One expectation or question you have for this course

Introducing the ”new” energy auditor

Energy efficiency: the main no-regret option

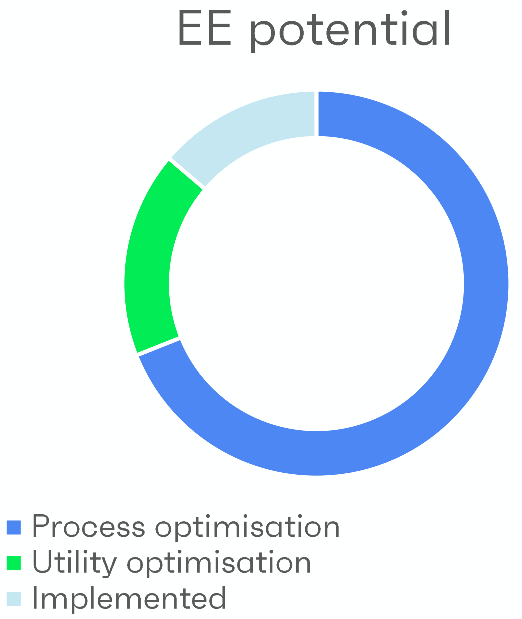


Source: Industrial Decarbonization in East Asia, World Bank, 2025.

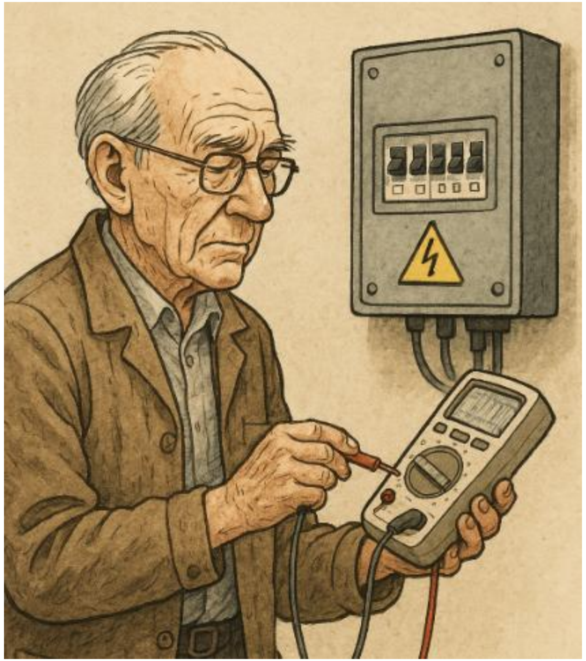
Shifting gear in the pursuit of energy efficiency

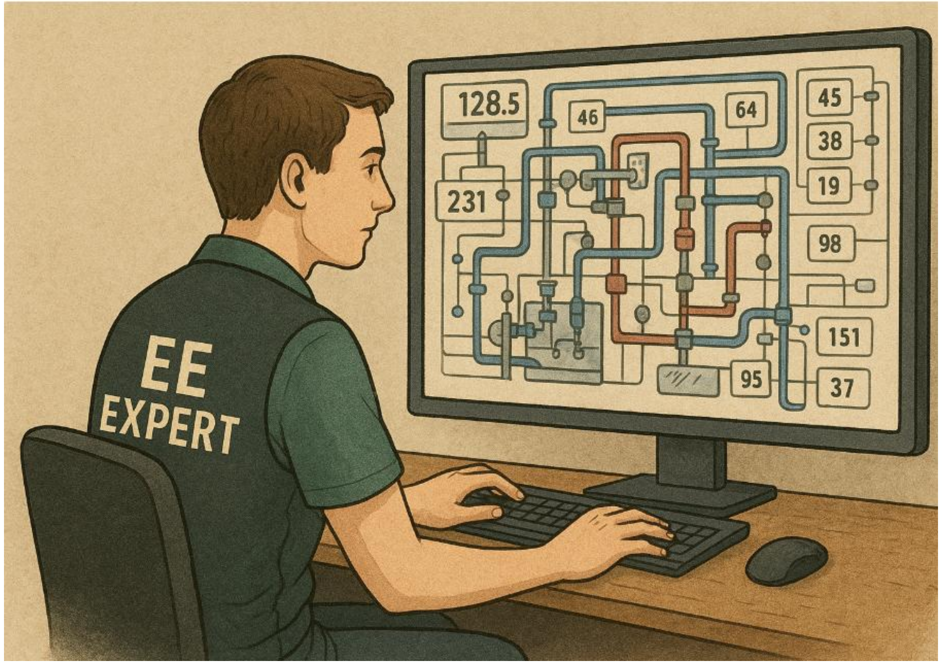
Implemented and remaining

- Industry consumes 50% of total energy in Vietnam
- 30% of energy can be saved through very cost-effective measures
- Currently about 5% of potential has been implemented.



The ”old” versus the ”new” energy auditor

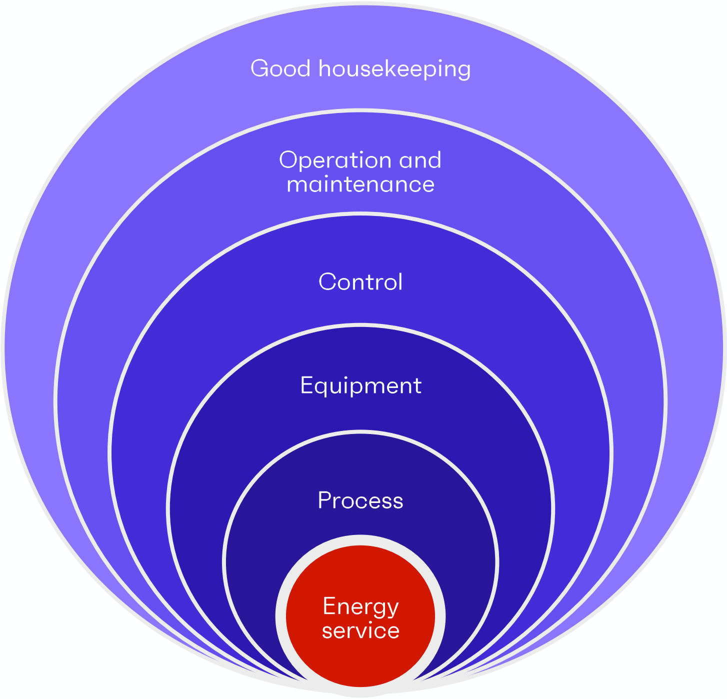




Comparing ”old” and ”new”

- ”Old” audit:
  - Focus on cross-cutting technologies only
  - Extensive measurement regime
  - Solutions based on auditors’ prior experience only

- ”New” audit:
  - Based on mapping of all process steps and utilities
  - Assessment of efficiency of each step
  - ”inside-out” analysis



ENERGY AUDIT CONSULTANT: KEY EXPERTISE

Energy manager: Key expertise:

- Deliver data for energy mapping
- apply energy audit results effectively
- continue updating energy mapping
- identify new energy efficiency opportunities

Session 2: Introduction to Energy Mapping

Session 2 - Program

This session introduces two tools that support a more strategic and structured approach to energy audits:

1. The Onion Diagram

- Helps break down processes into layers
- Emphasizes the importance of understanding the core process before proposing technical solutions
- Encourages thinking from the inside out when identifying energy saving opportunities

2. Energy Mapping

- Creates a clear overview of how energy is distributed and used in the system
- Links process conditions directly to energy demand, supporting a shared understanding across teams

These tools set the foundation for identifying targeted, impactful energy efficiency projects.

Introduction to the onion diagram

Approach for project development

Onion Diagram Approach for identifying projects

Understanding the energy service:

Before identifying projects, it is important to first identify the **energy service** — the basic purpose of the energy usage.

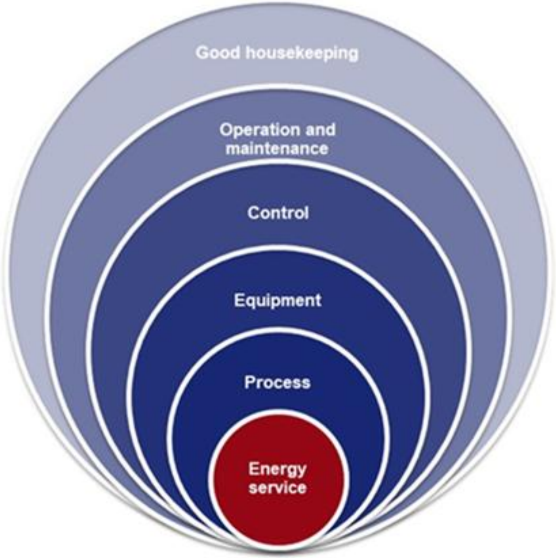
Optimization should begin with understanding the energy service itself and then progress through all the supporting functions and systems.

This structured approach is known as the **Onion Diagram Approach**.

Energy efficiency:

For each layer of the **Onion Diagram**, it is important to assess whether more energy-efficient solutions and practices can be adopted.

Reducing energy consumption at the core layer has a cascading effect on secondary energy consumption, maximizing overall efficiency.



Approach for project development

Layers of the Onion Diagram

- The Energy Service:

The specific requirement that a process must fulfil.

- The Process:

The type of method chosen to deliver the energy service.

- The Equipment:

The energy efficiency of the tools and machinery used to execute the process.

- **The Control:**

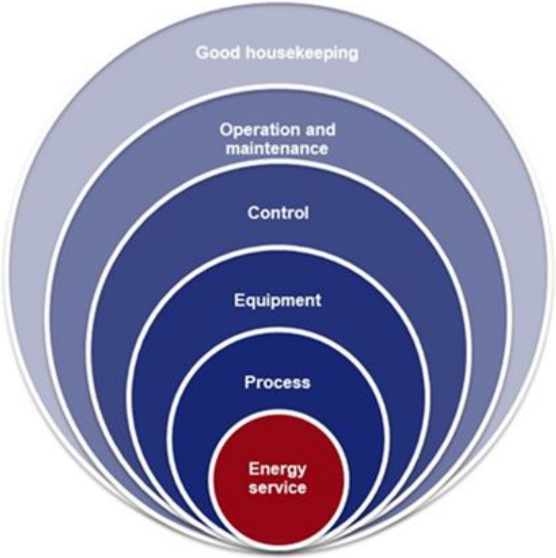
The control system used to manage the process plays a significant role in achieving energy-efficient operations.

- Operation and Maintenance:

Operation and maintenance procedures are critical for sustaining energy efficiency both in daily operations and over the long term.

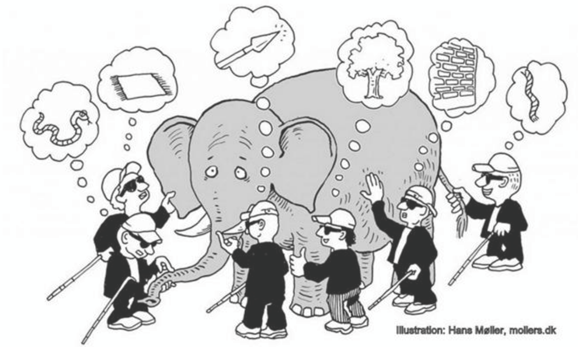
- Good Housekeeping

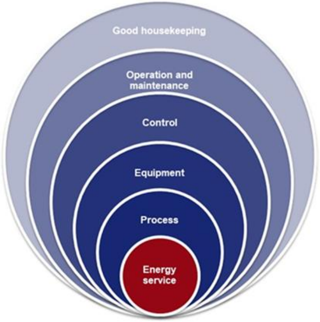
A company's culture and approach to energy management significantly influence overall energy consumption.



Introduction to the principals

- Creating an overview of how energy is used (energy distribution)
- Connecting process conditions to energy usages
- Creating a mutual understanding of the energy systems and its requirements
- Making the basis for making decisions on strategy, project development
- Minimizing the effort (costs) for creating the basis. Using the existing information and then deciding whether additional crats additional value (is it feasible?)
- Basis for using the onion diagram



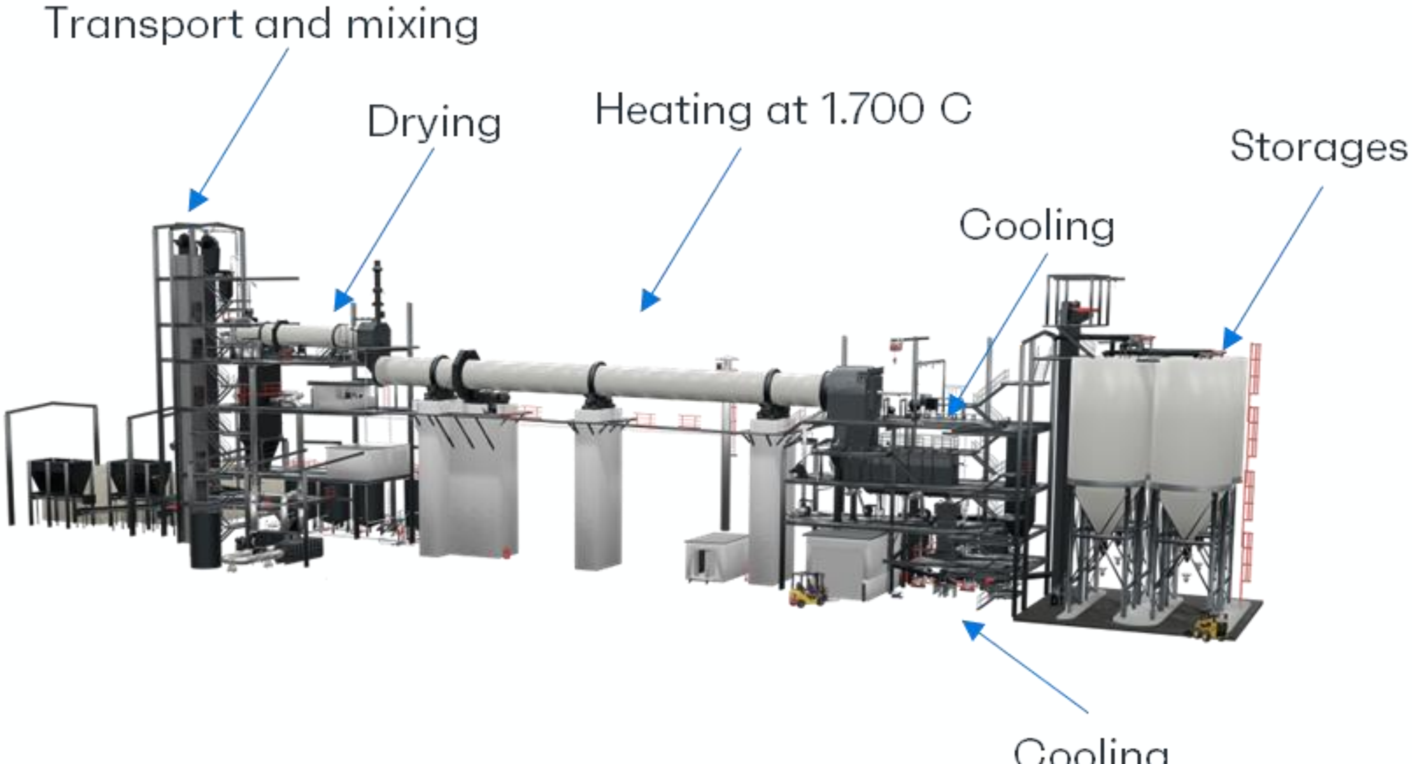


Understanding the Onion Diagram Approach

- Using a every-day-life-example
  - Lighting
  - Buying a new car for the family

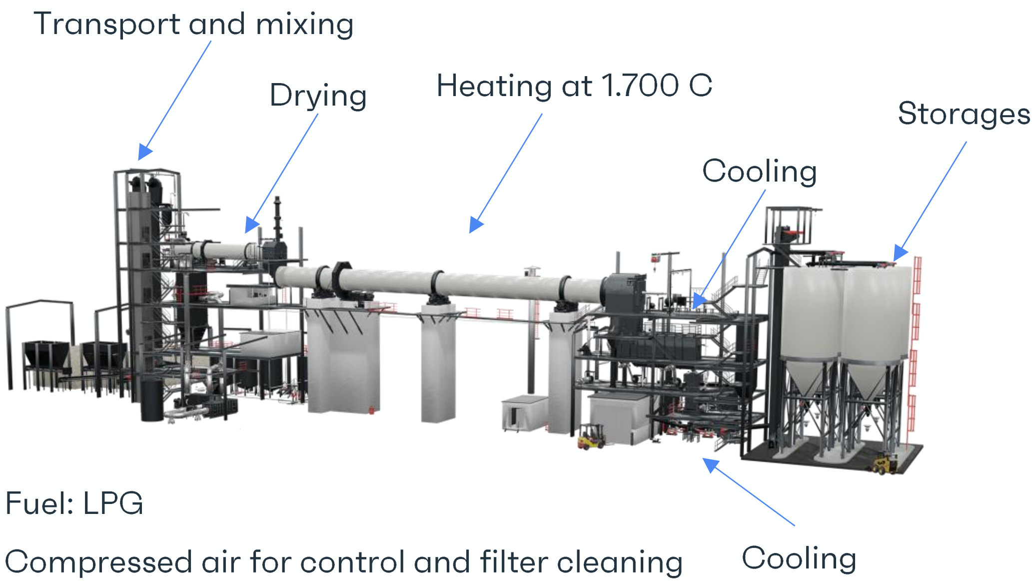
Approach for project development

Example of the onion diagram approch: Production of Cristobalite

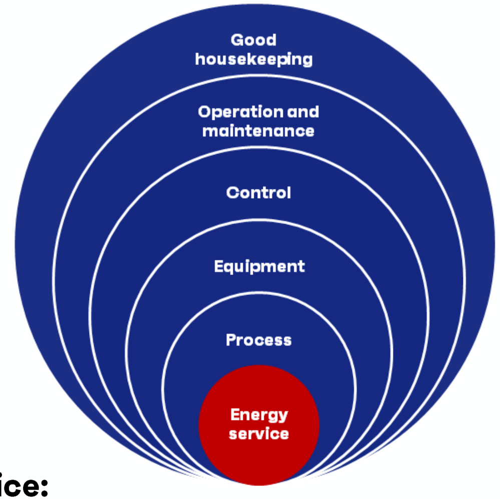


Approach for project development

Production of Cristobalite – The Energy Service



- Fuel: LPG
- Compressed air for control and filter cleaning
- Conveyer transport
- Cooling with wet cooling towers



The energy service:

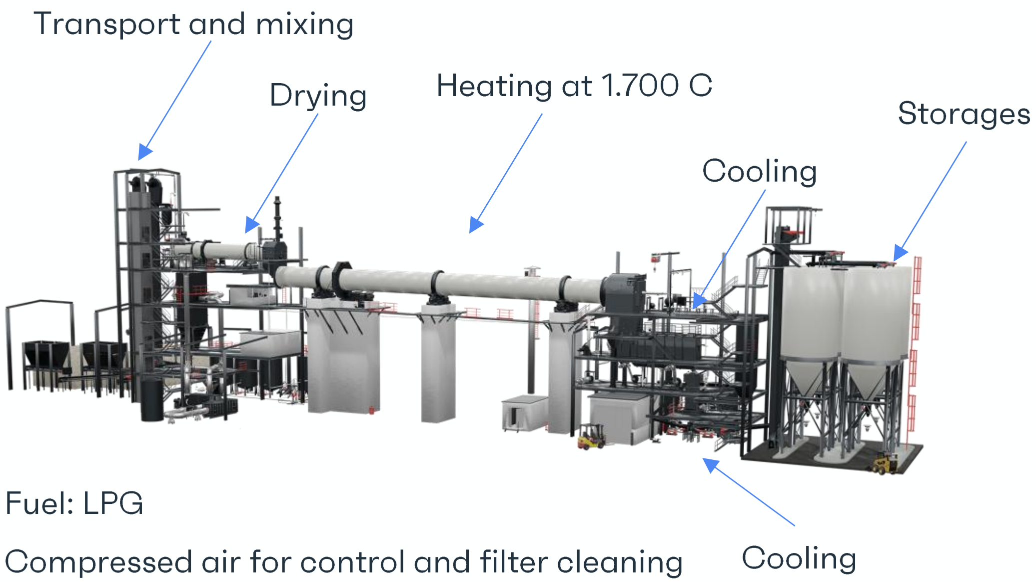
- **Producing cristobalite from quartz or silica**

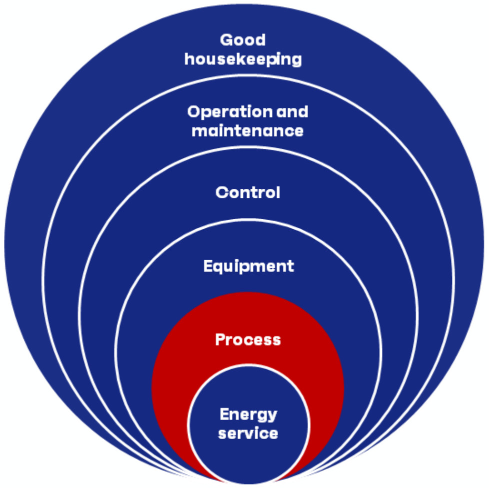
Good questions:

- **Is heat treatment necessary?**
- **Are there alternative raw material for producing cristobalite?**
- **How is the process performing compared to BAT**

Approach for project development

Production of Cristobalite – The process





- Fuel: LPG
- Compressed air for control and filter cleaning
- Conveyer transport
- Cooling with wet cooling towers

<u>The process:</u>

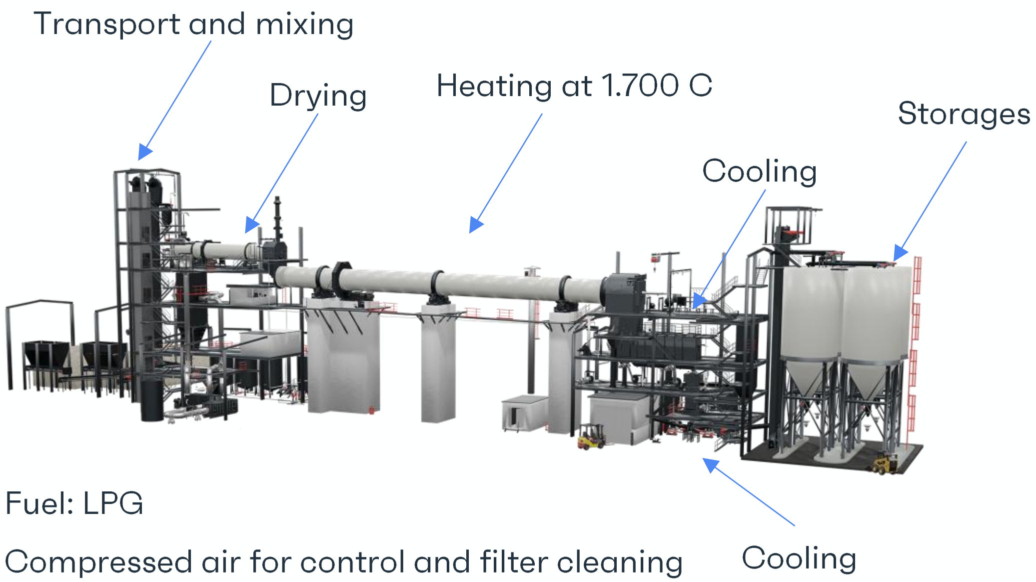
- **Thermal transformation**

<u>Good questions:</u>

- **Are there alternative methods to producing Cristobalite? Like:**
  - **High pressure**
  - **Using Catalysts or additives**

Approach for project development

Production of Cristobalite – The Equipment



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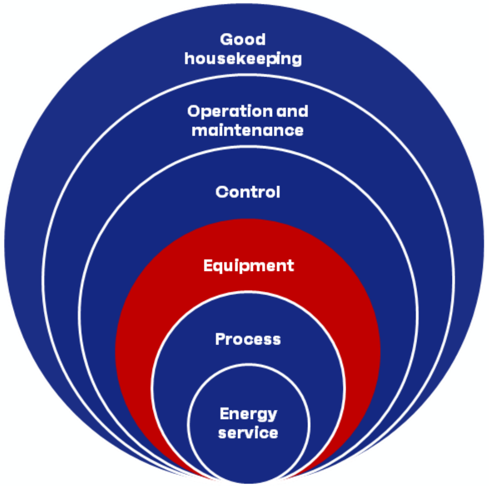


The equipment:

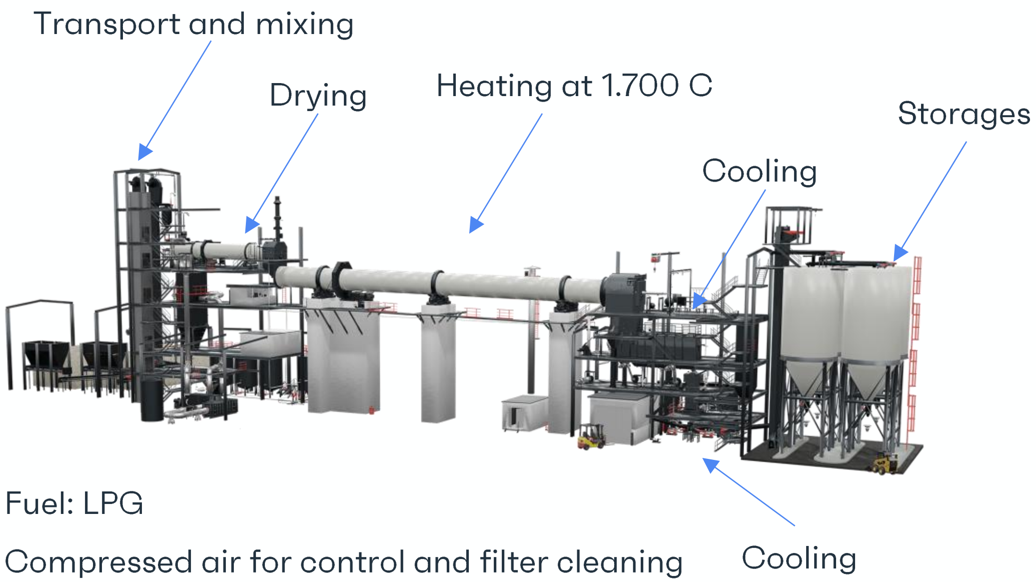
- **LPG for heating**

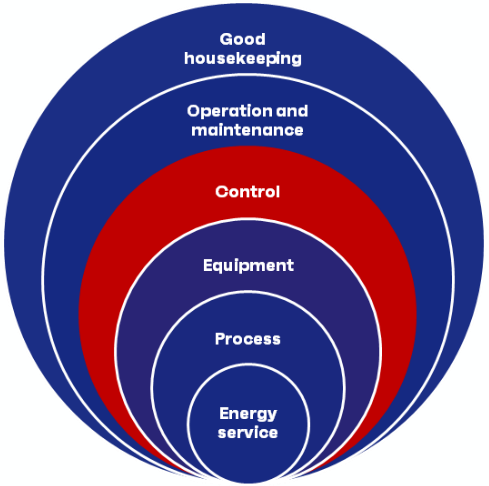
Good questions:

- **Is there alternative ways of generating heat?**
- **Can heat be recovered?**
- **Is then most efficient components used?**

Approach for project development

Production of Cristobalite– The control





- Fuel: LPG
- Compressed air for control and filter cleaning
- Conveyer transport
- Cooling with wet cooling towers

<u>The control:</u>

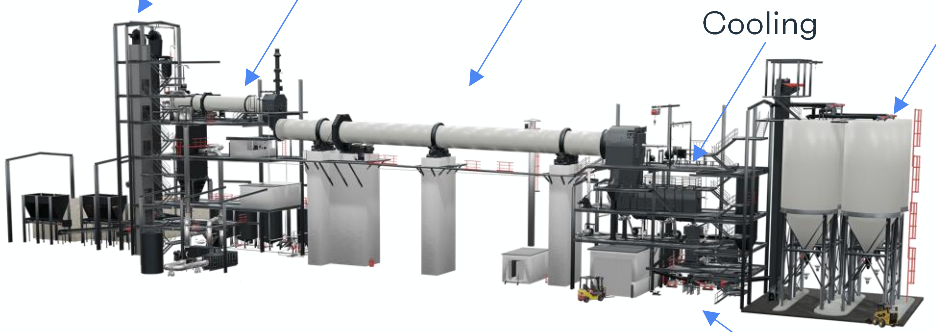
- **Control by speed and temperature**

<u>Good questions:</u>

- **How do we secure optimal drying?**
- **How is the temperature maintained in the kiln (formation from quarts to cristobalite)?**
- **How is control effected by warring inputs?**

Approach for project development

Production of Cristobalite – Operation and Maintenance



- Fuel: LPG
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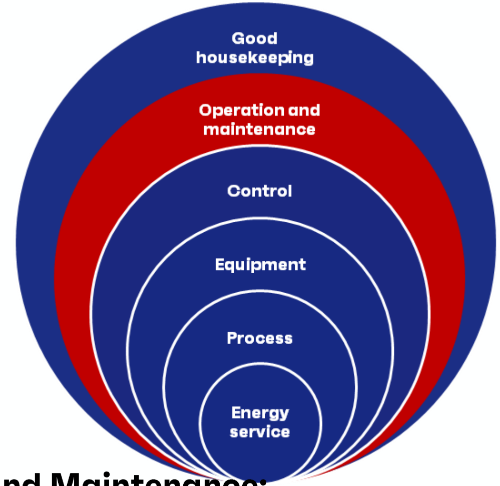
- Conveyer transport
- Cooling with wet cooling towers



<u>The Operation and Maintenance:</u>

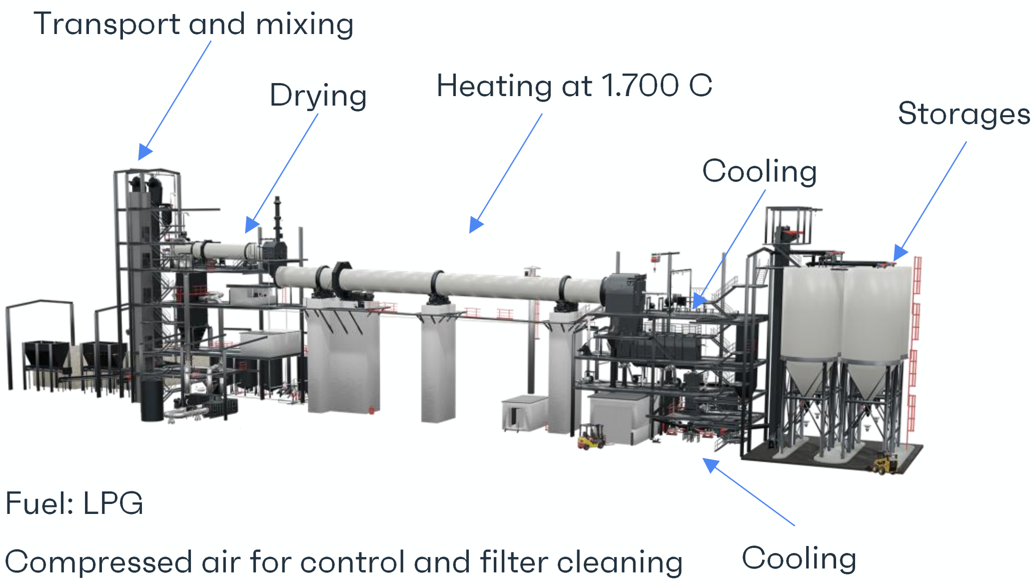
- **Keeping the production performing**

<u>Good questions:</u>

- **Are there routines for maintenance?**
- **Which KPI are used for operating the process?**
- **How is deviations evaluated and treated?**

Approach for project development

Production of Cristobalite – Good house keeping



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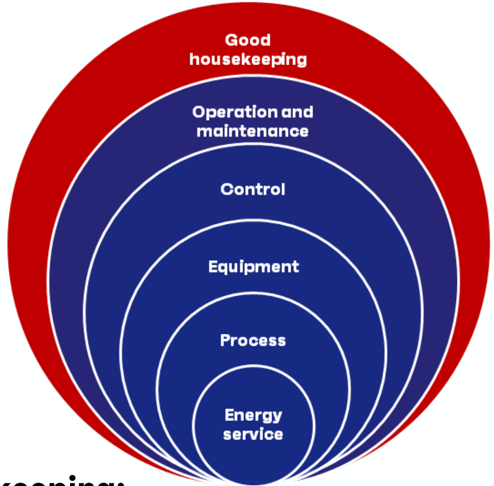

The Good housekeeping:

- **Company couture**

Good questions:

- **How is the performance secured in the long run – e.g. ISO 50001?**
- **How is knowledge gained, collected and used?**
- **Are there process for new initiatives?**

Introduction to the onion diagram (dairy examples)

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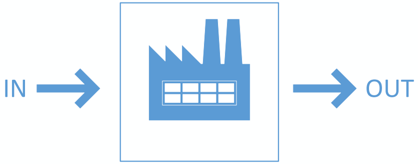
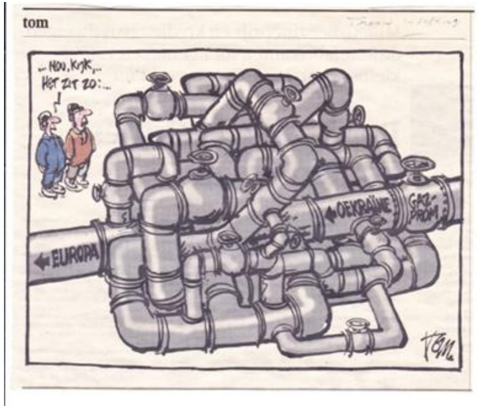
What is energy efficiency?

It can be many things…

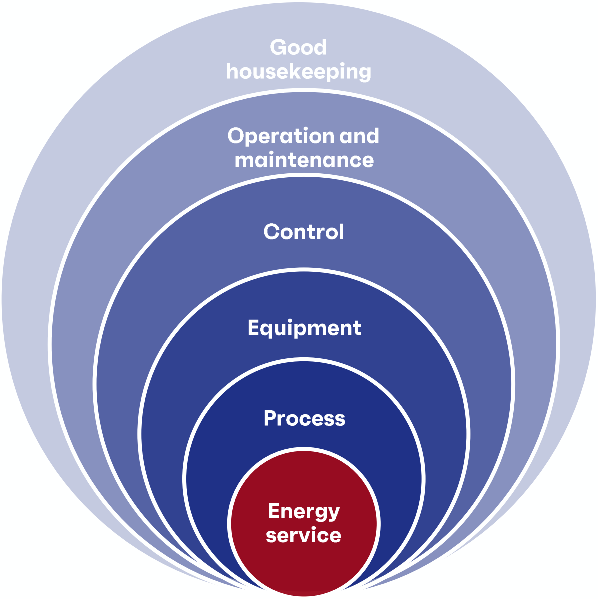
- Improvement of utility systems
- Improved maintenance
- Change of product recipes
- Small- and large-scale investment projects
- Training of operators
- Use of KPIs/EnPIs to monitor energy consumption
- Procedures for purchase and design of new installations
- Opportunities within buildings and transport
- Cleaning procedures (CIP/SIP)
- Etc.





Viegand Maagoe philosophy

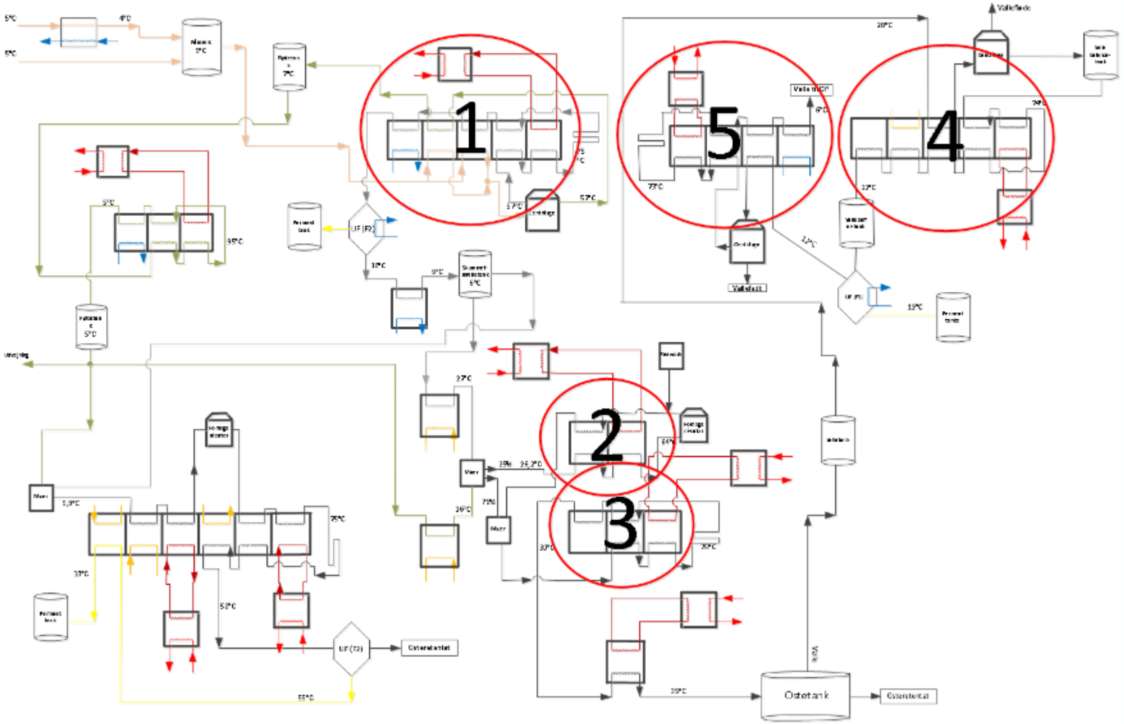
The onion diagram -> the ”inside-out” approach:



1. First get familliar with how and why energy is consumed…
2. … then establish an optimized baseline…
3. … finally utility systems and heat recovery systems are optimized!

Challenge the Process

How energy is used



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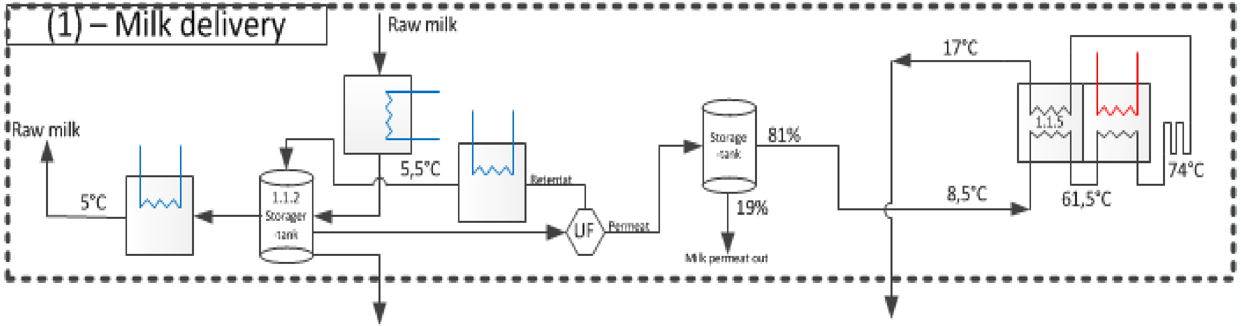
Challenge the Process



- What is target temperature for cooling received milk/whey/raw material? - 40 F? - 45 F? - 50 F?
- Is the target temperature the same for all products and raw materials?
- When is deviation-reports prepared - at 45 F? - 50 F? - 55 F?
- 5 F has a significant impact on cooling demand

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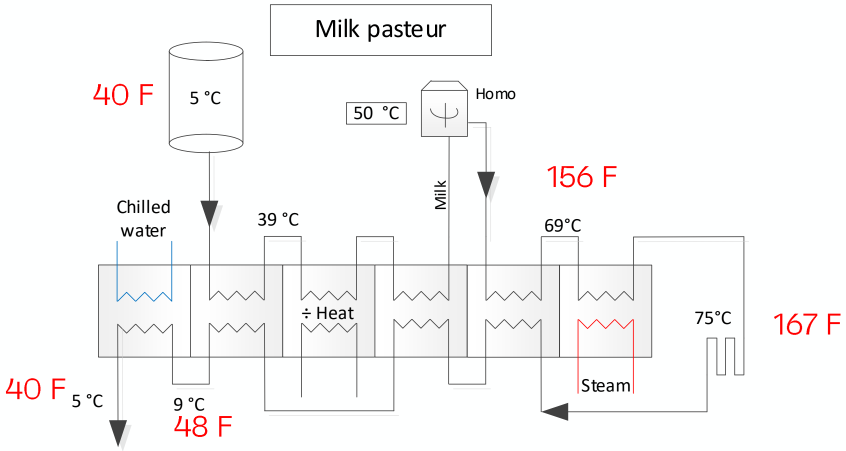
Optimize the process

Example: Dairy pasteurization process



Ratio between steam heating vs. internal heat recovery:

- Best practice 10% steam – 90% heat recovery
- Internationally 70% steam – 30% heat recovery

Significant scope for saving heating and cooling (electricity)

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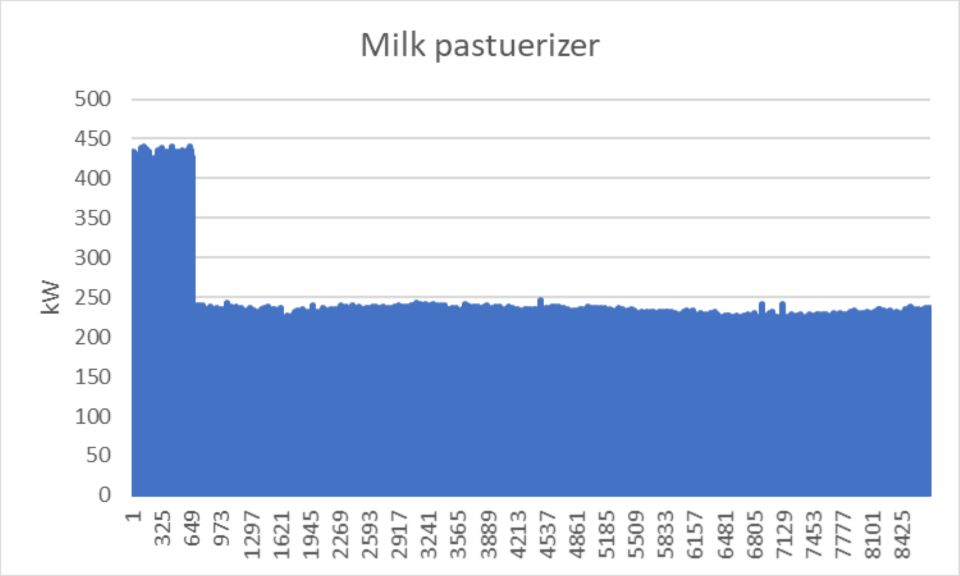
Optimize the process

Internal heat recovery of milk pasteurization (2020)



- The old milk pasteurizer from 2013 was replaced with a new pasteurizer with improved heat recovery!
- Steam savings of 600 MWh/year (40%)
  - 5% of total dairy consumption
- Ice water consumption eliminated
- PBP < 2 years

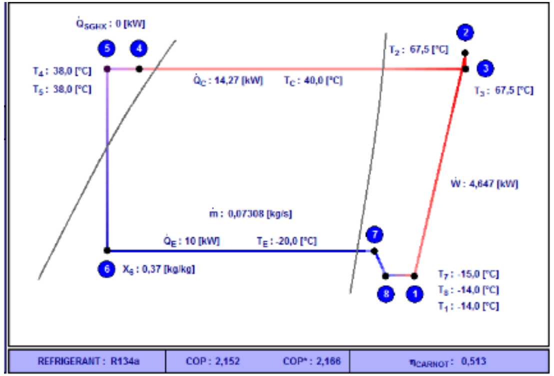
Utility Tune-Up

Refrigeration

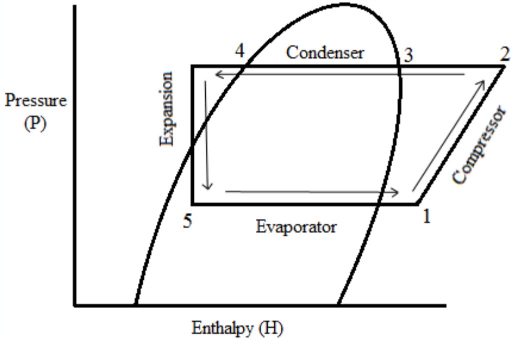
- Refrigeration plant R 134a
  - Con 988 kPa => 38 °C
  - Evp 133 kPa => -20 °C

100 F

- 4 F



- COP optimisation:
  - Controlling the pressure levels according to the surrounding
  - Condenser fan control
  - Pump control
  - $COP \frac{\sum Cooling\ output}{\sum electricial\ input}$



- Saving potential 30%

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Utility Tune-Up

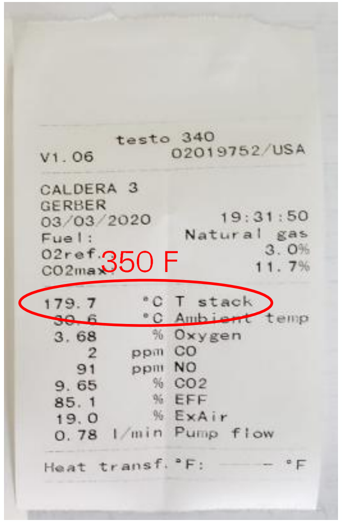
Boilers

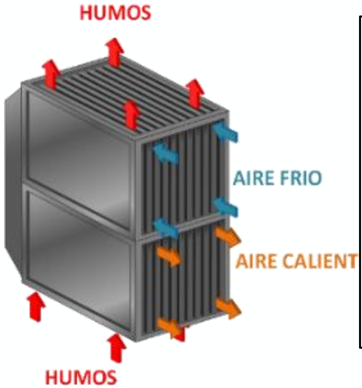
If flue gas temperature above 250 F (natural gas), economizers should be installed for i.e.:

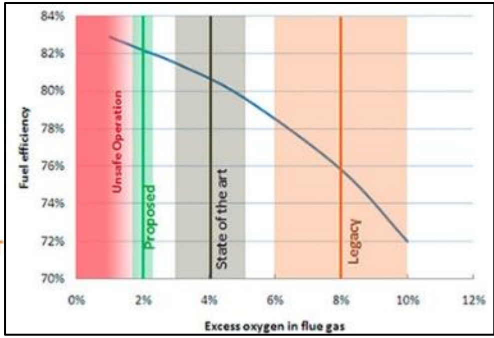
- feedwater preheating
- combustion air preheating
- Process heat

If O_2 in flue gas is above 6%, burner should be adjusted and automatic O_2-control installed

- PBP < 2 years





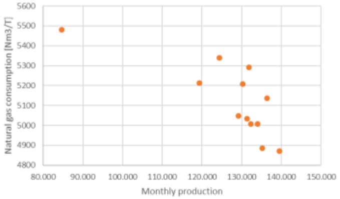


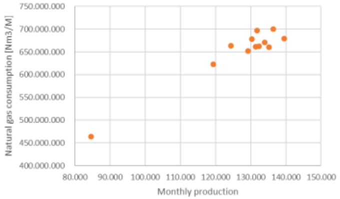
Controlling and monitoring

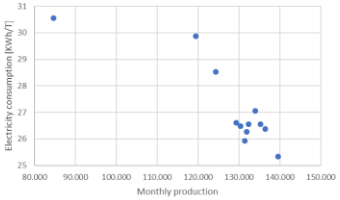
Operational KPIs

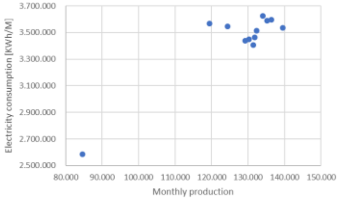
Establish a range of useful KPIs for main energy intensive processes

- Operators seem to have personal preferences on how the production is run
- Many processes can therefore often be operated more precisely
  - Training of operators
  - Better data and control systems
  - Benchmarking
  - Production planning
- Often 2-5% saving with little or no investments
- Will be necessary if future EMS is considered



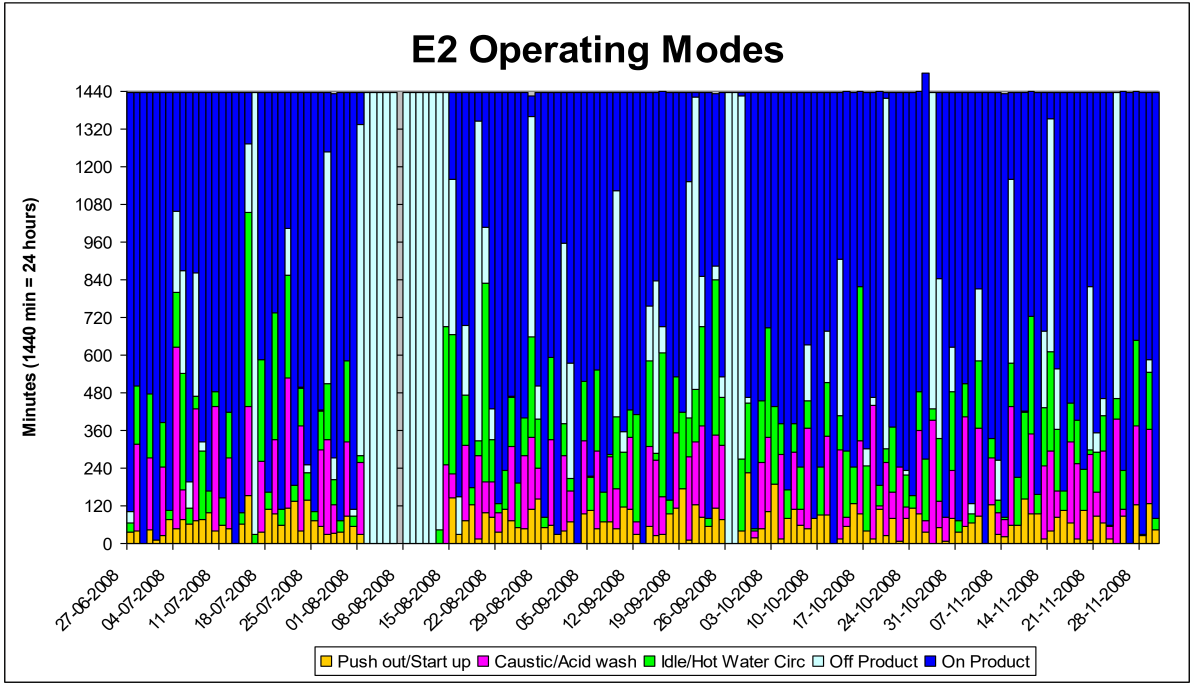






Controlling and monitoring

Operator influence



Maintenance and "good housekeeping"

Steam Traps, leakages & Insulation

Poorly maintained steam distribution systems may loose 20-30% of generated steam energy to the surroundings

- Repair steam traps and leakages
- Mount missing insulation on all valves and pipe – also in processing areas

Same thing for compressed air!

- Leakage detection and repairs
- Systematically and repeatedly

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Heat recovery potentials

Recovery and reuse of waste heat - external

When all processes are optimized from the inside-out, recover and reuse remaining waste heat

Common examples of heat sources:

- Driers and evaporators
- Refrigeration plants (from condensers, oil cooling etc.)
- Compressed air plants
- Boilers (exhaust gas from combustion)
- Process cooling

And heat sinks:

- Heating of water for cleaning purposes (manual and CIP)
- Heating of water for process or heating of product directly
- Pre-heating of combustion air for boilers
- Pre-heating of air for dryers and ovens
- Building heating during the cold season

In cases where waste heat is cold low for direct utilization, heat pumps or existing heat sources may be applied for boosting temperatures

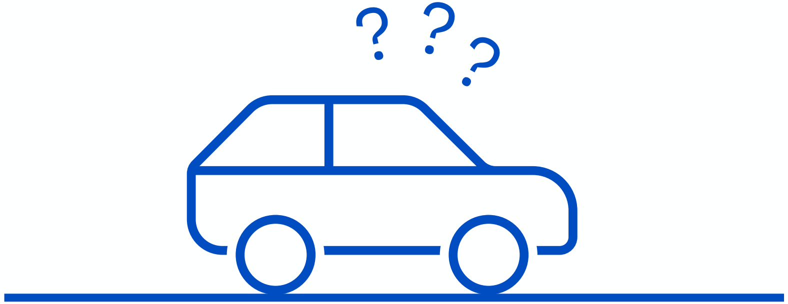
Introducing the Onion Diagram
Everyday life example

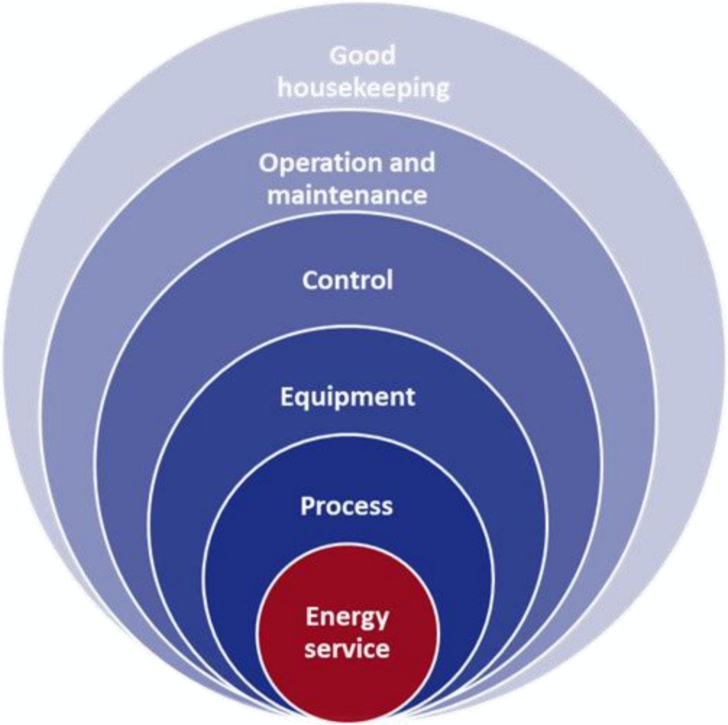
Layers in energy consumption

The onion diagram approach

The following slides illustrate the onion diagram through an everyday example:

Considerations involved in buying a new car.





Energy service

Theoretical need for transportation

Minimization of energy demand

The "energy service" is the theoretical energy consumption to give the service - transport.

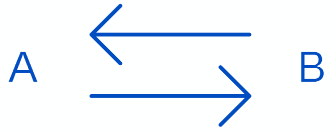
Example

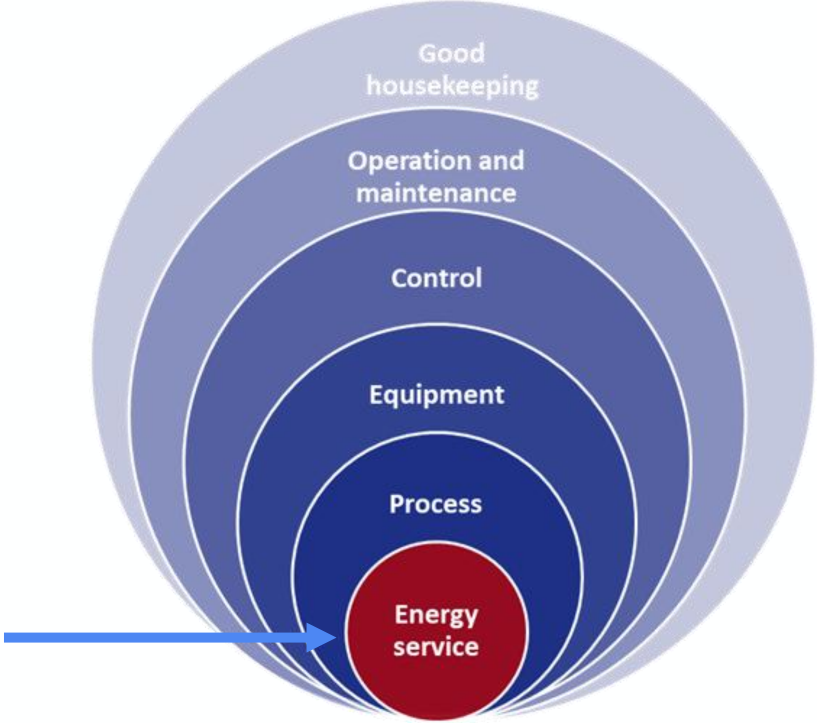
Step 1 (the core of the onion) is to investigate/analyze the need.

What is the transportation need?

You need to be able to get from one place to another. That is the actual need.

The need is not a new car – the need is to be transported.





Process

Selection of process

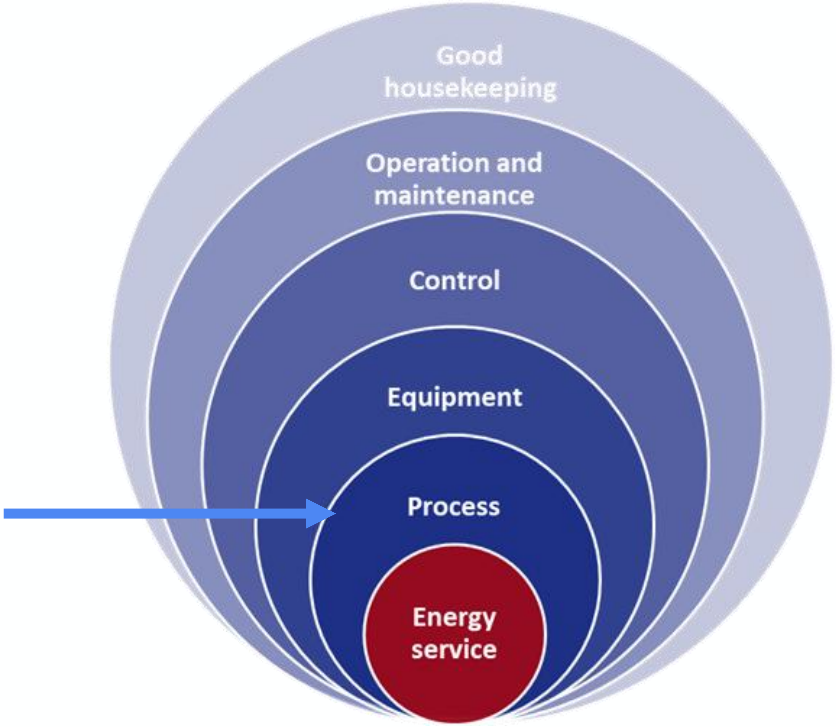
The process with least energy consumption

The process involves an analysis and decision about how the transportation should take place.

There are many alternatives:

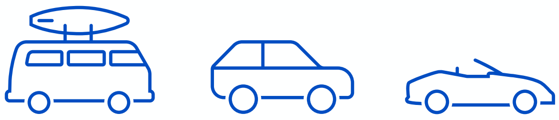
- You can walk (but maybe the distance is too far)
- You can bike (but perhaps there are no changing facilities at work, or it’s not practical for the whole family)
- You can use public transport (but it might be too expensive, there may be no bus nearby, or it takes too long on weekdays — e.g. with many transfers, etc. — or it’s just a bit too inconvenient)

All the possible alternatives are analyzed, and in the end, you conclude that it needs to be a car…



Equipment

Selection of equipment



Energy efficient equipment

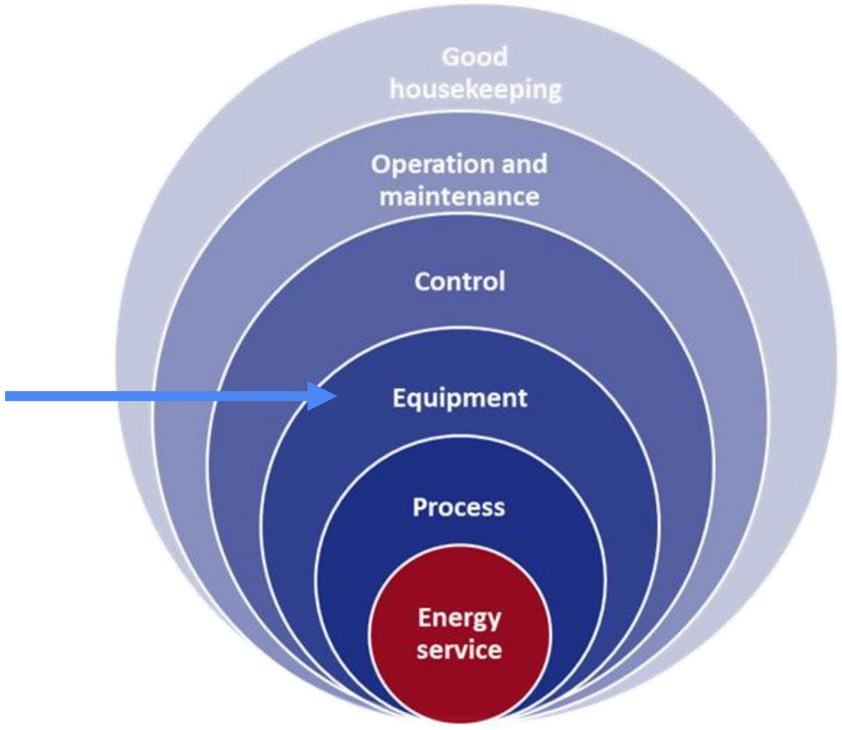
It has now been decided that a car is necessary (the process) to meet the transportation need (the energy service).

The equipment step is about deciding which car it should be.

Again, the decision should aim to fulfill the need as energy-efficiently as possible.

Some of the considerations could be:

- Should it be a small, energy-efficient model (or would that mean the family needs more than one car)?
- Should it be an electric vehicle or a fossil-fueled car?



Control

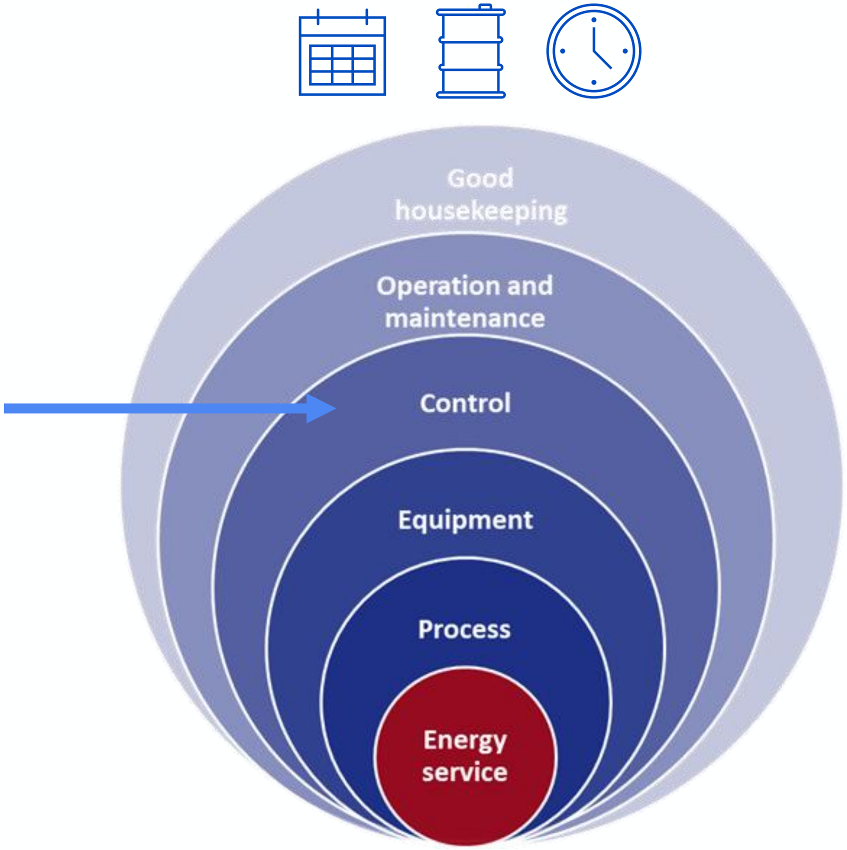
Energy efficient process control

Control system

Before making the final decision on which car to choose, you also need to consider how to ensure the most energy-efficient operation.

For example, you might need to decide:

- Will the car be used every day?
- If fossil-fueled — what type of fuel should it use?
- Electricity or fuel should be filled up when it is cheap.

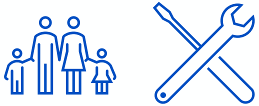


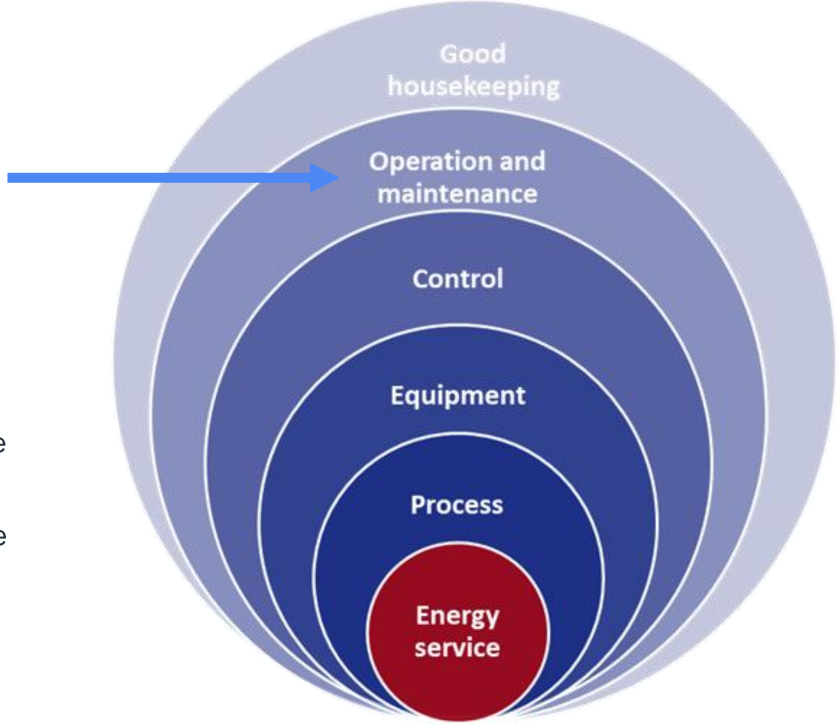
Operation and maintenance

Energy efficient O&M

Operation and maintenance

Once the car has been chosen, you must ensure that it continues to run well and energy efficiently.

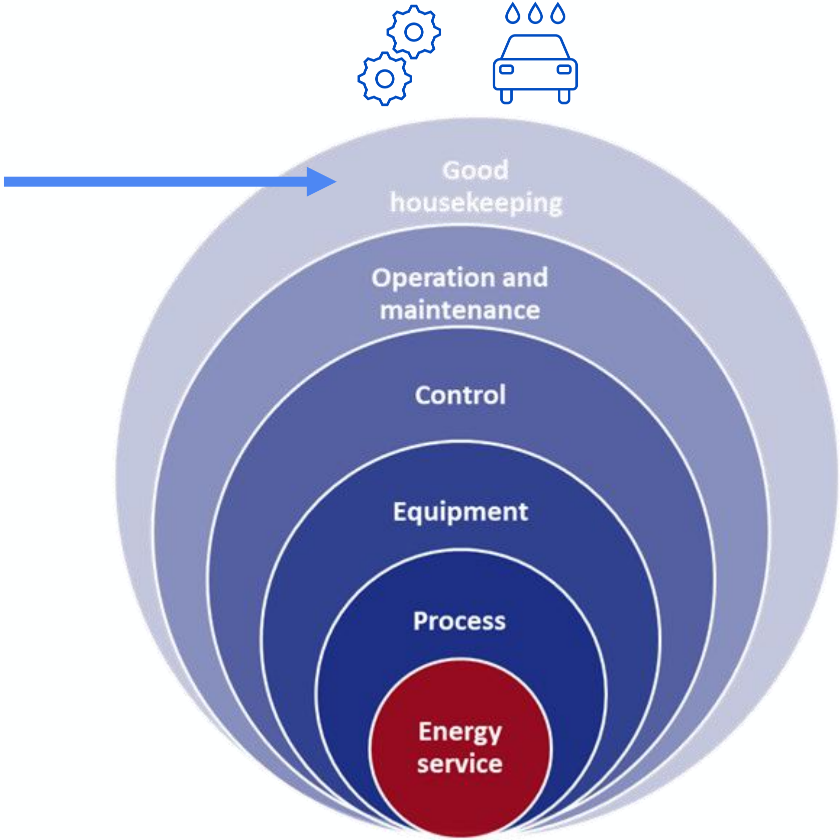




Some considerations:

- May all family members drive the car?
- Should the young ones, for example, take a driving technique course to ensure they drive as energy efficiently as possible?
- How do you ensure continuous or regular maintenance of the engine – should you sign up for a service plan?
- You must ensure that tire condition and pressure are as they should be and maintain them regularly.

Good housekeeping



Good housekeeping

It is also important to maintain the car to ensure good energy efficiency and, overall, to secure the car's long lifespan.

Things to consider:

- How often does it need oil, or should filters and other parts be replaced?
- The car's paint should be maintained through regular washing.
- Tires and tire pressure should be maintained (to ensure energy-efficient operation and long lifespan).

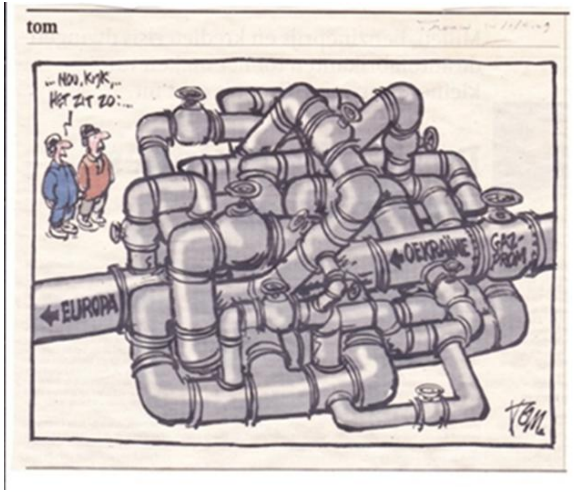
Energy Mapping

Prior to the energy mapping

Before starting

1. Define a clear purpose
    - How will the energy mapping be used, for what and by who?
    - Will it form the basis for a strategy
    - Screening and project development

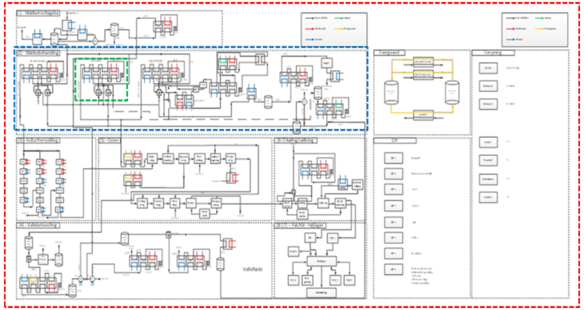
2. Decision on level of detail and on available information
    - Should both electrical and thermal energy be included?
    - How component specific should the analysis be?
    - Which kind of information is available

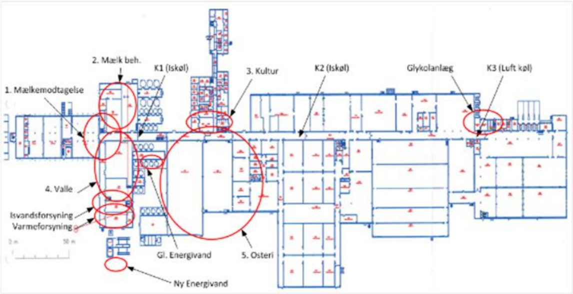


Energy Mapping

1. Create an overview and a mutual understanding of the site and operating conditions.
2. Make an EPFD (Energy Process Flow Diagram)
3. The EPFD will be the basis for the entire mapping.
4. The EPFD must be seen in context with the site plan
5. Collecting data
6. Setting up the energy and mass balances

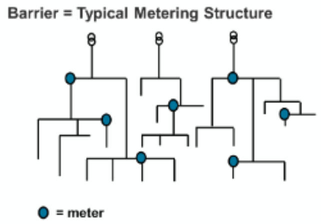
There are many ways to get there

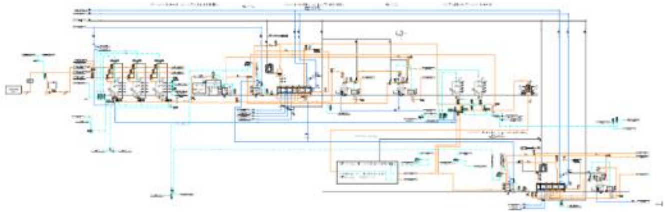


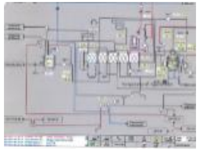


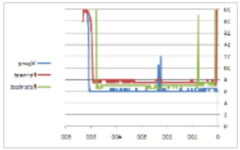
Collection of data for energy mapping

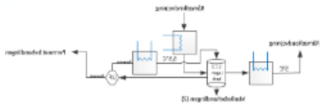
1. Operators
2. Trends
3. Manual readings
4. Digital readings/metering
5. Experience
6. Comparison from similar equipment
7. Theoretical calculations
8. Information's from suppliers
9. Performing tests
10. Process diagrams
11. Site plans
12. Metering plans
13. Etc











Session 3: Simple Energy Mapping and introduction to excel-tool

1. Complete the individual exercise - Energy Mapping of a Brewery

Introduction to the case

This exercise will introduce the process of conducting an energy mapping. I will do so by considering a small part of a production line at a brewery – a can filling line. A Process Flow Diagram (PFD) is given for the production line. This could for example have been drawn during a site visit to the brewery to understand the process.

The production line consists of several process steps. Final products are canned beer and canned soda.

Introduction to the case

Beer production goes through the following steps:

→ Beer is cooled to 7°C before entering the can filler.

→ Beer is filled into cans and sent to the Tunnel-Pasteur

→ In the tunnel pasteur the filled cans are first heated to 65°C and then cooled to 20°C

→ The pasteurized beer is sent to storage

Soda production goes through the following steps:

→ Syrup and water is mixed and pumped to a pasteurizer

→ The pasteurizer consists of several sections of plate heat exchangers.

→ The exit temperature from the pasteurizer is 7°C

→ After pasteurization the soda is sent to the same can filling machine as the beer. The only difference being that for soda production CO2 is added to the syrup mix.

→ From the can filling machine, the filled soda cans enter the Tunnel Pasteur and go through an identical process as the beer.

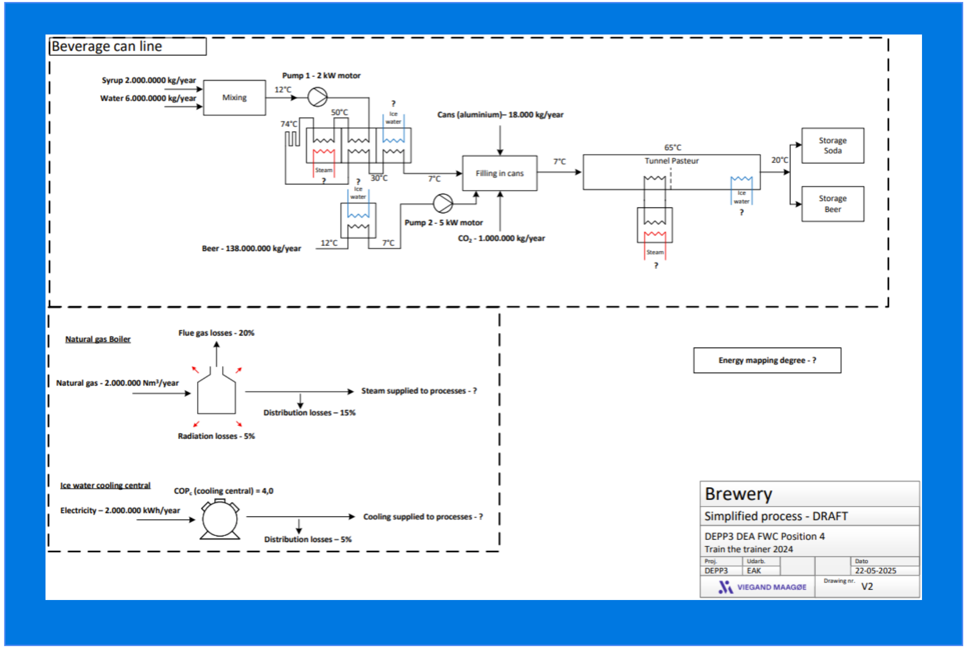
→ After the tunnel pasteurizer the soda cans are sent to storage.

Introduction to the case

The beverage can line is supplied by two types of utilities: Steam for heating and ice water for cooling. A simple diagram of utility systems is also given.

The exercise has **two parts:**

1. first the energy consumption in the production line is mapped.
2. Next, the actual utility supplied from the utility equipment is analyzed.



Individual Exercises

Exercise 1: Process mapping

Process mapping

1. The Process Flow Diagram shows the mass in ton/year of all inputs to the process. Using this information finalize the mass balance by calculating the mass flows to each process. (NB. remember the production line produces two products)
2. Using the mass balance and the given temperatures, calculate the steam consumption in each process.
3. Using the mass balance and the given temperatures, calculate the ice water consumption in each process.
4. The Process Flow Diagram has indicated two pumps. The rated capacity was noted during the site visit. One of the operators of the can filling line estimates that the line runs 70% of the time during a whole year. Try to estimate the electricity consumption of each pump.

Individual Exercises

Exercise 2: Utility mapping

Utility mapping:

The brewery has informed you how much natural gas they use in their steam boiler and how much electricity they use in their cooling central. Based on the site visit you have estimated the efficiencies of the utility equipment and distribution losses.

1. Calculate the steam and ice water supplied to the factory.
2. Using the results from the process mapping, calculate the energy mapping degree.
3. Do you see any potentials for saving energy in this beverage production line?

2. Introduction to the tool

Typical energy mapping approach

Every factory is different, but these steps usually works!

1. Sitewalk
at the factory and energy supply

2. Understanding
the production flow (dialogue with operators)

3. Drawing
of process diagram based on dialogue with operators

4. Mapping
of the energy supply (boilers, refrigeration systems, heat pumps, etc.) and distribution systems (steam, hot water, ice water, cooling water) (dialogue with maintenance)

5. Mass balance
from raw materials, split through the process, to finished goods/by-products/residues (dialogue with operators)

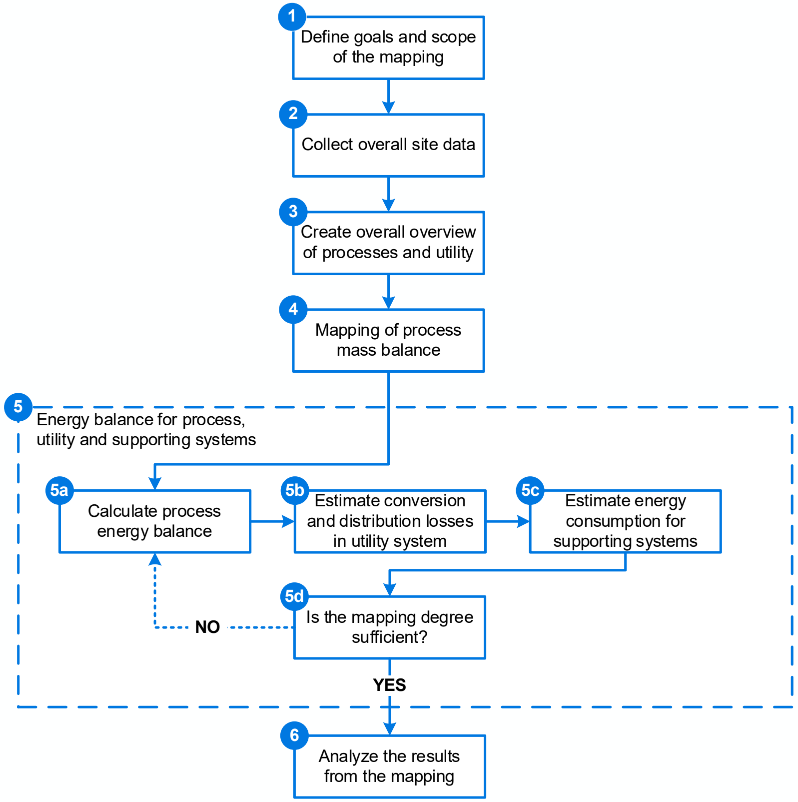
6. Energy balance
of heating and cooling needs are mapped (temperatures are looked up/measured/determined in cooperation with operators)

7. Analysis
Is there a match between energy supplied from the energy supply and the energy demand in production?

8. Energy consumption
divided between departments/consumers presented per energy type (steam, hot water, ice water, cooling water, electricity)

Overall energy mapping process

- Overview of processes and utilities
- Mass and energy balances
- Show potential for heat integration and energy saving projects



1. Define goals and scope of the mapping

- The following questions should be considered before starting the energy mapping:

    1. Should the mapping include the entire facility or focus on certain areas?

    2. Which level of detail can be achieved within the given timeline

    3. What is the main driver for conducting the energy mapping?
        - Detailed overview of energy consumption
        - Economic evaluations
        - Emission and environmental impacts

2. Collect overall site data

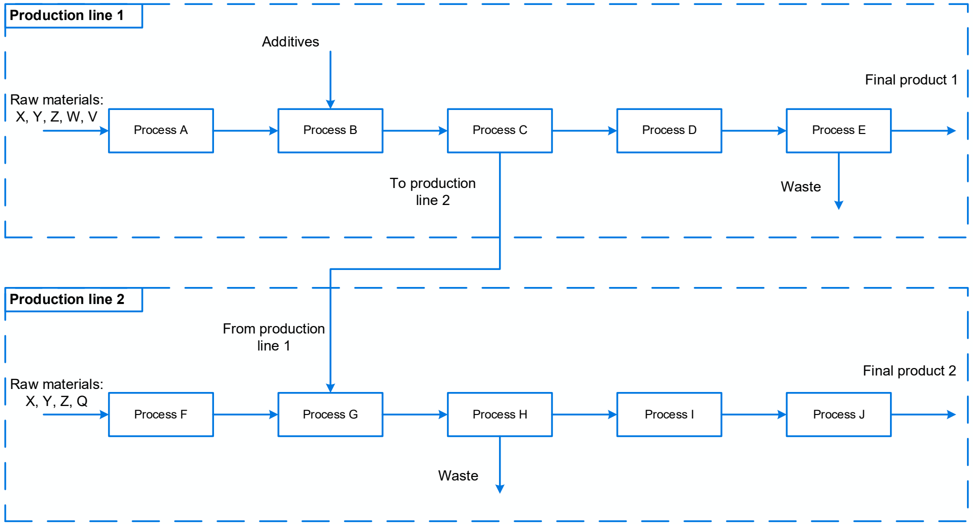
- When the scope is defined, an overview of the overall site data should be made.
- Site data covers
  - Purchased primary energy (electricity, natural gas, coal, biomass etc.)
  - Raw materials
  - Production quantities
- Overall data collection is shown in the sheet “Yearly data”
  - Input sheet for the mass balance and utility mapping

Yearly data

Energy Data	**Year**	
Purchased Electricity	20.000.000	kWh/y
Purchased Natural Gas Steam boiler	20.000.000	kWh/y
Purchased Coal	18.000.000	kWh/y
Total Purchased Energy	**58.000.000**	**kWh/y**
Production data		
Material X	160.000	Ton/y
Material Y	20.000	Ton/y
Material Z	40.000	Ton/y
Material W	5.000	Ton/y
Material V	10.000	Ton/y
Material Q	15.000	Ton/y
Total Raw materials	**250.000**	**Ton/y**
Additives production line 1	10.000	Ton/y
Additives production line 2	-	Ton/y
Total Additives	**10.000**	Ton/y
Final product data		
Final product 1	100.000	Ton/y
Final product 2	80.000	Ton/y
Total final product	**180.000**	**Ton/y**

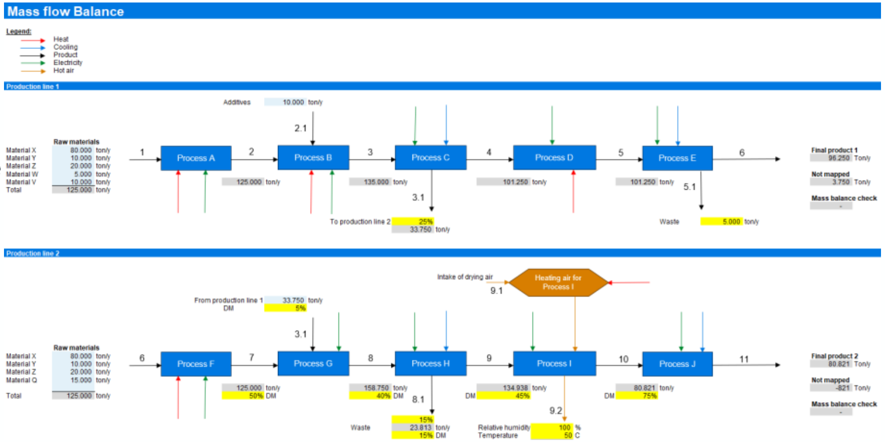
3. Create overall overview of processes and utility

- Construct a simple process diagram of all production lines
- Create a basic overview of the entire production flow at the site
  - Include all processes in the right order
  - Mass flow quantities and energy inputs is not necessarily required
- Create an overview of utility structures
  - Required for the sheet "Utility mapping"



4. Mapping of process mass balance

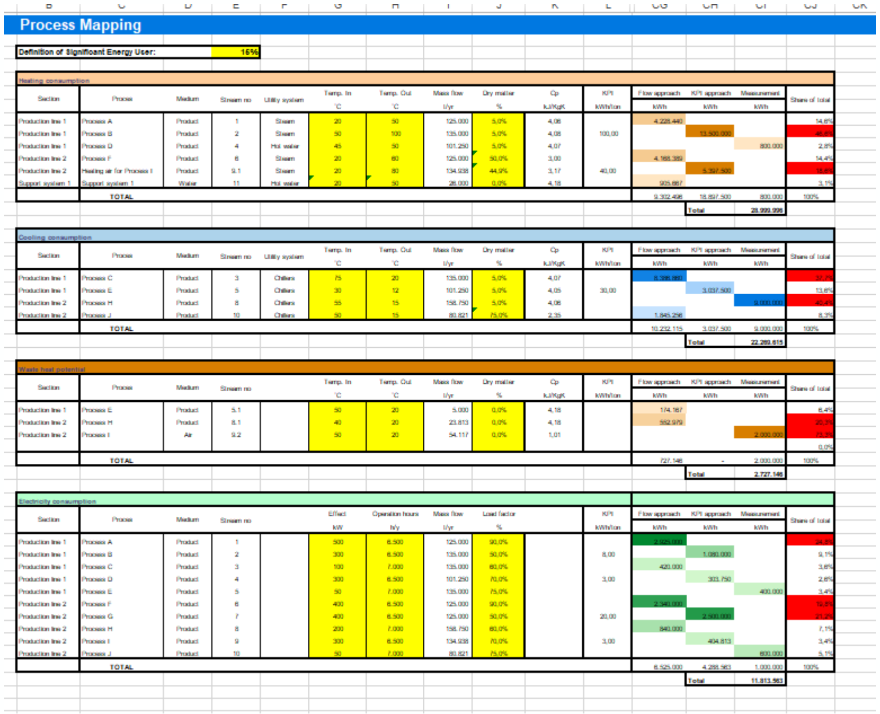
- Combine data from “Yearly data” with the process flow diagram, to create a mass flow balance of each production line in the sheet “Mass flow balance”.
    - Avoid direct inputs, create references to the sheet “yearly data” and then adjust the mass flow by the yellow cells
- The following steps should be followed for each process
    - Quantify any addition or extraction of material
        - Data collection
        - Estimate
        - Calculation
    - All streams must be numbered
    - Mass balance data should be compared to actual



5a. Calculate process energy balance

Heating and cooling

- Evaluate energy inputs for each process in the mass balance
    - Consider heating, cooling, electricity, and waste heat
- Specific energy consumption of each process where heating or cooling is applied.
    - Energy amount of each stream is mapped in the sheet “Process mapping”
- Different approaches can be used to quantify the energy consumption



5a. Calculate process energy balance

Approaches to quantify energy demand

- Energy demand is calculated from the mass flow.

$$Q = m \times c_p \times \Delta T$$

- KPI of a specific process equipment or unit.

$$Q = m \times KPI$$

- Measurements of energy consumption
  - Continuous data logging
  - Representative period which is extrapolated to a yearly consumption

5a. Calculate process energy balance

Significant energy user

- In the sheet “Process mapping” it is possible to define a threshold for a significant energy user (SEU)
  - A SEU is a process or equipment that uses a vast amount of energy, and therefore should be monitored regularly
    - Create KPIs for the SEU and consider targets for the KPI for next years mapping

5b. Estimate conversion and distribution losses

- Following the process energy balances, the utility energy balances can be made.
- The utility mapping is divided into 4 columns
  - Purchased
  - Conversion
  - Distribution
  - Consumption

5b. Estimate conversion and distribution losses

Purchase

- Energy input cells should refer to the initial data from the sheet “Yearly data”
- All fuel types should be included e.g.
    - Natural gas
    - Coal
    - Oil
    - Biomass
    - Electricity

5b. Estimate conversion and distribution losses

Conversion

- Add all major utility equipment (e.g. steam boilers, chillers or compressed air systems)
- Estimate efficiency and general losses such as
  - COP
  - Boiler efficiency
  - Energy losses to blowdown, deaerator, flue gas, and radiation
- Energy waste streams may be an optimal source for heat recovery

5b. Estimate conversion and distribution losses

Distribution

- Add all energy distribution systems such as
  - Steam distribution
  - Hot water distribution
  - Cooling water
  - Glycol
  - Compressed air
- Estimate distribution losses for each distribution system

5b. Estimate conversion and distribution losses

Consumption

- The consumption refers to sheet “Process mapping” for heating, cooling and electricity.
- The mapping degree can be calculated
  - Important parameter as this shows if the energy balances and assumptions throughout the mapping has been valid
    - If mapping degree is deemed too low the energy balances should be reevaluated
- The energy consumption is carried over to the sheet “Result Overview”

5c. Estimate energy consumption for supporting systems

- Many production sites have supporting systems that is not part of the production facilities such as
  - CIP
  - Washers
  - Packaging
- Important to map the supporting systems as these can use large amount of energy (often electricity or steam/hot water)

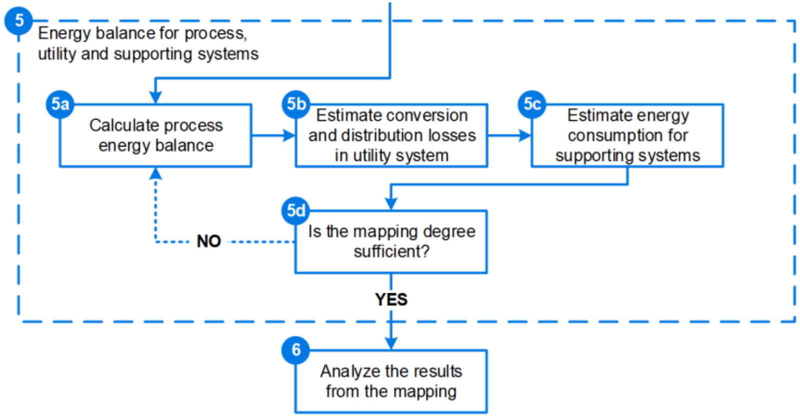
IMPORTANT note

The energy balance is not accounting for the supporting systems as they may differ significantly to the type of production site.

Therefore, remember to include the supporting systems into the energy balance in the “Process mapping” sheet.

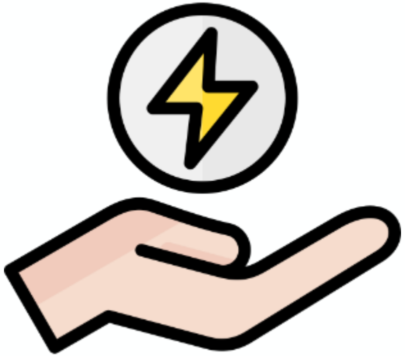
5d. Is the mapping degree sufficient?

- If the mapping degree is too low the mass and energy balances should be reevaluated for errors or undisclosed losses.
- The sufficient mapping degree may vary according to the size of production facilities and detail of mapping.
- Important to reflect upon the reasons why an exact match is not reached.



Conclusions

- Energy mapping should be made every year or every other year
  - Develop further on the previous energy mapping to gain higher degree of detail
- Gain more knowledge on process and energy consumption
  - Energy saving projects
  - Emissions and environmental impact
  - Process overview and energy consumption
  - Individual fuel type consumption
  - Energy losses
  - Heating and cooling requirements



3. Examples of energy mapping

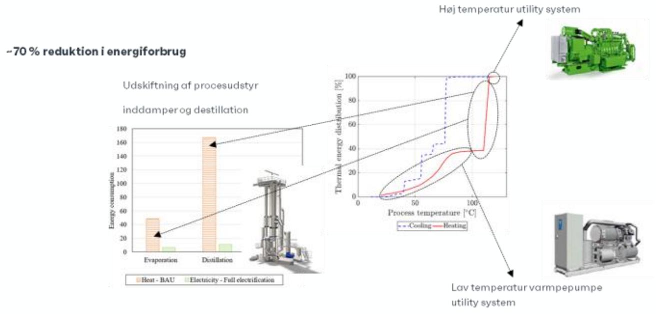
Conclusions

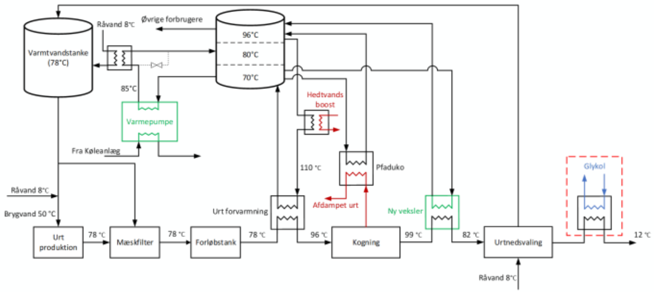
1. Full electrification in food ingrediency

- Significant cost savings
- 70 % energy saving
- 100 % carbon reduction

2. Waste heat recovery by heat pump in brewery

- Significant cost savings
- 30 % energy saving
- 40 % carbon reduction





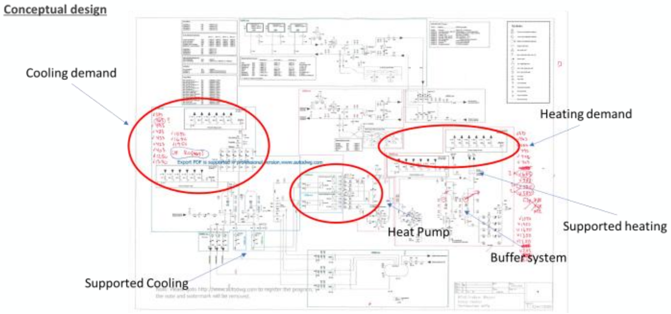
Conclusions

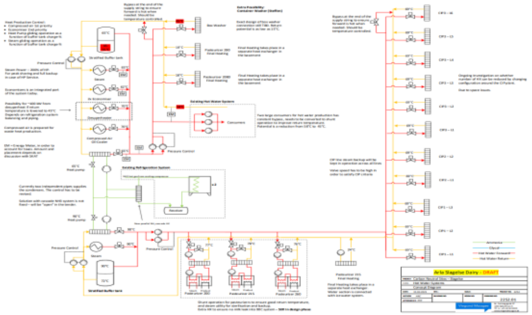
3. Central heat pump system in a dairy

- Significant cost savings
- 33 % energy saving
- 50 % carbon reduction

4. Waste heat collection in a dairy

- Significant cost savings
- 15 % energy saving
- 20 % carbon reduction





4. Use the tool on the brewery case

Individual Exercises

Exercise 3: Populating the energy mapping tool

Use the energy mapping tool:

Using the process and utility mapping from the previous exercises, try and populate the Excel tool. Try and follow the following steps:

1. Draw the PFD into the “Mass flow balance” sheet
2. Put the mass flow and calculated energy consumptions for the simplified process from the 1st step into the energy mapping tool.
3. Put the calculated energy consumed, produced and lost from each utility made in the 2nd step into the energy mapping tool.
4. Use the tool to assess the energy consumption mapped for the process compared to the effective output of the utilities and calculate the part of unmapped energy.
    - NB: the case will not lead to a full mapping of the energy consumption.

Session 4: Group reflections

Reflections on using the energy mapping tool

Discussing your first experiences working with the tool.

Key questions to reflect on:

- What worked well in your mapping process?
- Where did you encounter challenges or uncertainties?
- What did you learn about the link between process energy use and utility supply?

Think about:

- How assumptions and data choices affected your results
- The role of system thinking in structuring your mapping

Reflections on using the energy mapping tool

Discussing your first experiences working with the tool.

Using the Tool:

- How intuitive was the Excel tool’s structure?
- Were the sheet connections and data flows clear?
- Did the overview help you identify gaps?

Working with Data:

- What assumptions did you make, and why?
- How did you estimate or fill in missing data?
- How did you handle non-process energy demands?

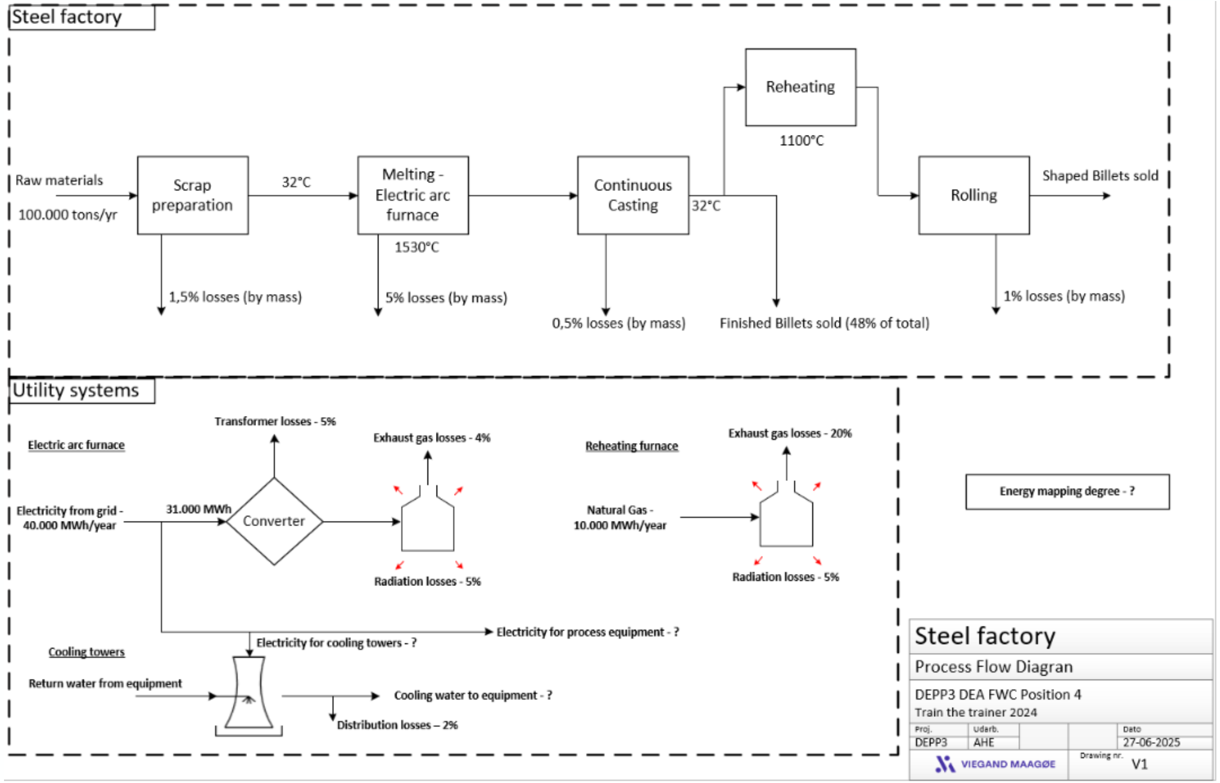
Real Case Potential:

- Can you imagine applying this tool in your work?
- What data might be difficult to get in real settings?
- Could this tool help communicate energy insights to clients?

1. Use the tool to map a steel factory

Individual exercise: Energy mapping of a steel plant

Carry out an energy mapping of a full steel factory



2. Summing up the day

Wrap-Up – Key Learnings from Day 1

What we covered today:

- Practiced energy mapping on a simplified common case
- Explored how utilities and processes interact
- Applied the method to a case
- Reflected on challenges, insights, and assumptions through group discussion

Why it matters:

Today you worked step-by-step through a structured energy mapping method.

This gives you a foundation to analyze real industrial systems and communicate them clearly and visually.

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Day 2: How to utilize the energy mapping

Session 1: Advanced energy mapping

First reflection from using the energy mapping tool

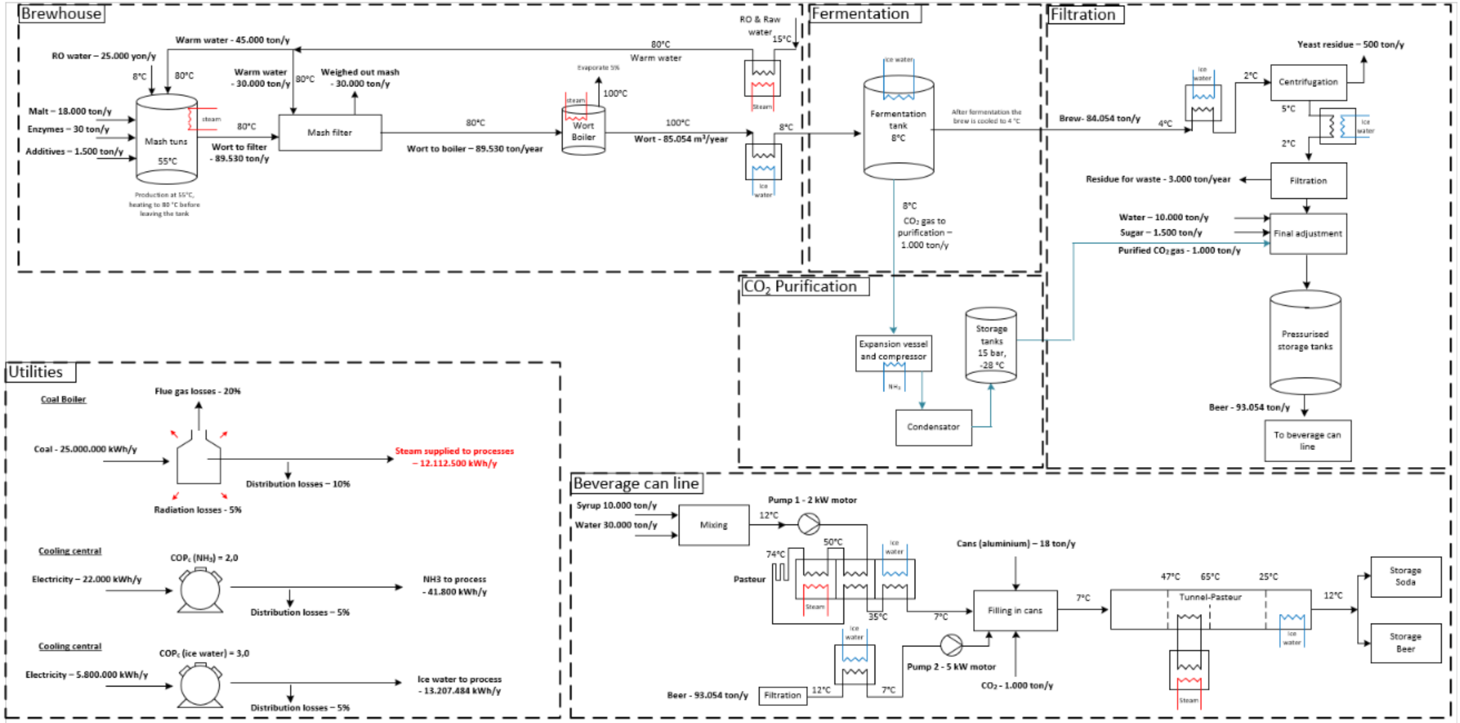
Discussing your first experiences working with the tool.

Key questions to reflect on:

- Is it helpful to use energy mapping?
- What limitations do you see in using it?

Individual Exercise: Advanced energy mapping

Conduct an energy mapping of a more advanced process diagram



Session 2: Advanced energy mapping - results

Session 3: Project identification and development

1. Revisiting the onion diagram

Approach for project development

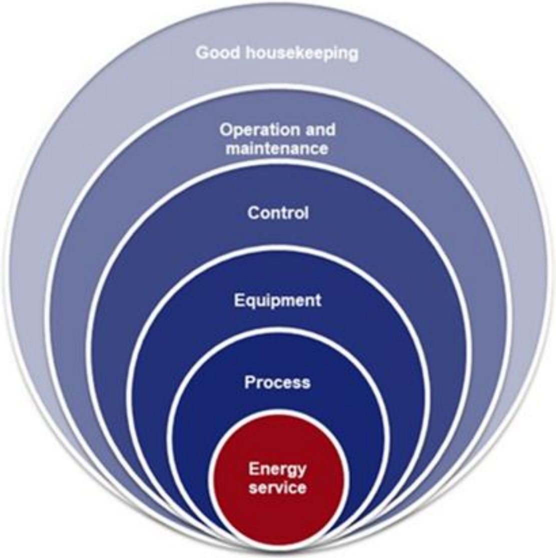
Onion Diagram Approach for identifying projects

Understanding the energy service:

Before identifying projects, it is important to first identify the **energy service** — the basic purpose of the energy usage.
Optimization should begin with understanding the energy service itself and then progress through all the supporting functions and systems.
This structured approach is known as the **Onion Diagram Approach**.

Energy efficiency:

For each layer of the **Onion Diagram**, it is important to assess whether more energy-efficient solutions and practices can be adopted.
Reducing energy consumption at the core layer has a cascading effect on secondary energy consumption, maximizing overall efficiency.



Approach for project development

Layers of the Onion Diagram

- The Energy Service:

The specific requirement that a process must fulfil.

- The Process:

The type of method chosen to deliver the energy service.

- The Equipment:

The energy efficiency of the tools and machinery used to execute the process.

- **The Control:**

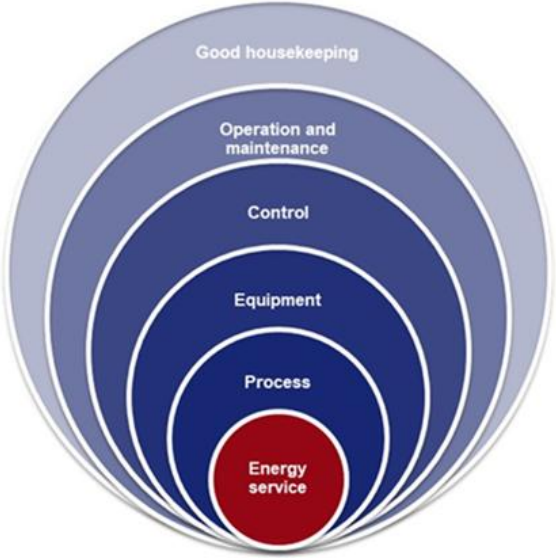
The control system used to manage the process plays a significant role in achieving energy-efficient operations.

- Operation and Maintenance:

Operation and maintenance procedures are critical for sustaining energy efficiency both in daily operations and over the long term.

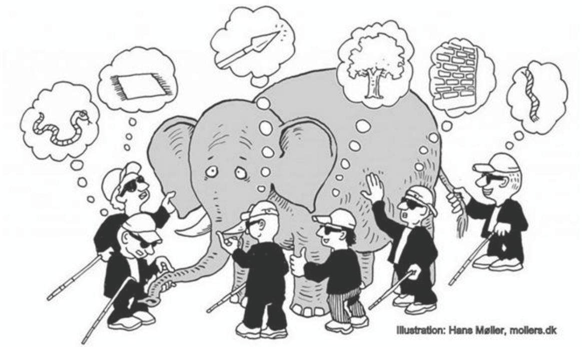
- Good Housekeeping

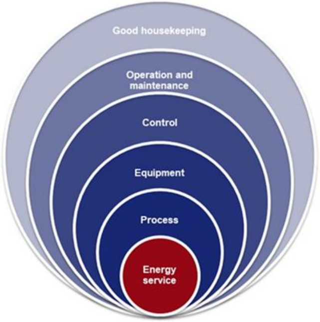
A company's culture and approach to energy management significantly influence overall energy consumption.



Introduction to the principals

- Creating an overview of how energy is used (energy distribution)
- Connecting process conditions to energy usages
- Creating a mutual understanding of the energy systems and its requirements
- Making the basis for making decisions on strategy, project development
- Minimizing the effort (costs) for creating the basis. Using the existing information and then deciding whether additional crats additional value (is it feasible?)
- Basis for using the onion diagram





2. How to assess energy mapping results

Using the energy mapping

Typical energy mapping approach

1. Defining goals and scope
for developing the energy mapping

2. Collecting data
Priori to site walk. during site walk and after site walk

3. Creat a overviw
of process and utility

Understanding

4. Mass balance
from raw materials, split through the process, to finished goods/by-products/residues (dialogue with operators)

5. Process energy balance
of heating, cooling and electricity needs are mapped (temperatures are looked up/measured/determined in cooperation with operators)

5. Utility energy balance
of the energy supply (boilers, refrigeration systems, heat pumps, etc.) and distribution systems (steam, hot water, ice water, cooling water) (dialogue with maintenance)

Mapping

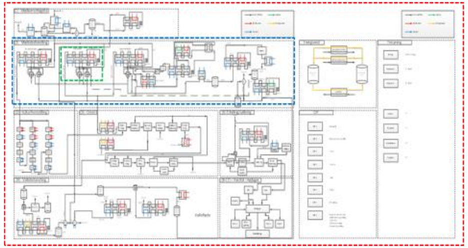
6. Analysis
Is there a match between energy supplied from the energy supply and the energy demand in production?

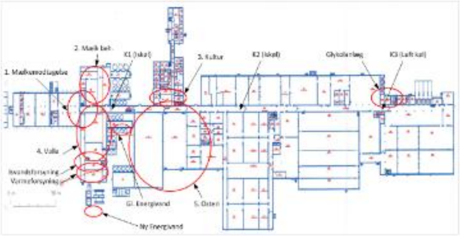
Evaluating

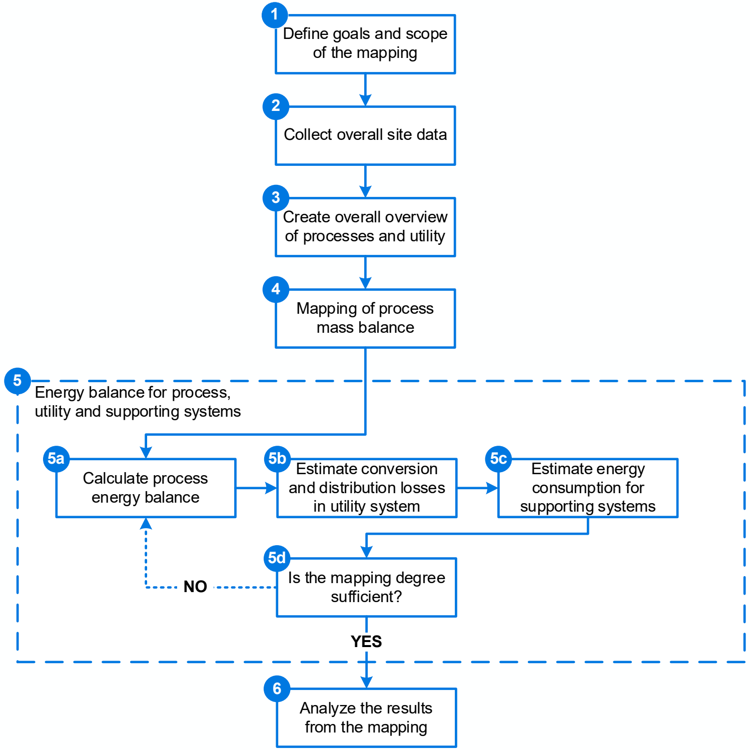
Using the energy mapping

Overall energy mapping process

- Overview of processes and utilities
- Mass and energy balances
- Continue process until sufficient mapping degree has been reached





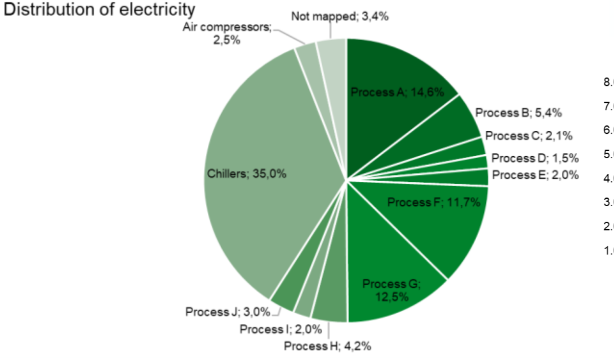


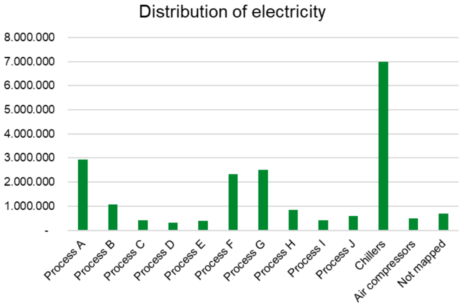
Using the energy mapping

Identifying projects using energy mapping

Electrical savings projects:

- **Focus on significant users**
  - Biggest users identified from mapping
- **Motor type**
  - Should specific motors be replaced/upgraded?
- **Drive type**
  - What is the standard of motor drives?
- **Electrical unit operation**
  - Transport systems, cooling, chillers, ventilation, etc.
- **Lighting**
  - What is current status?
  - should specific areas be upgraded?





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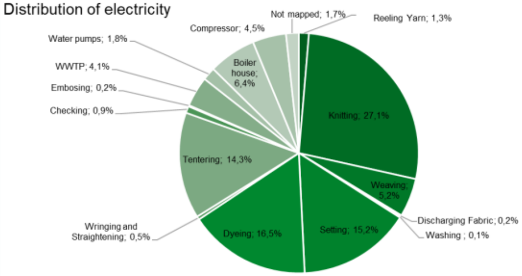
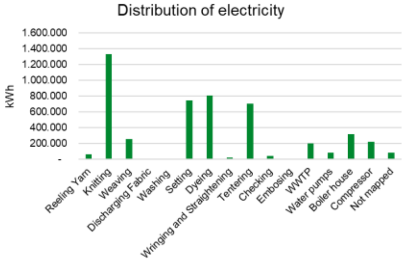


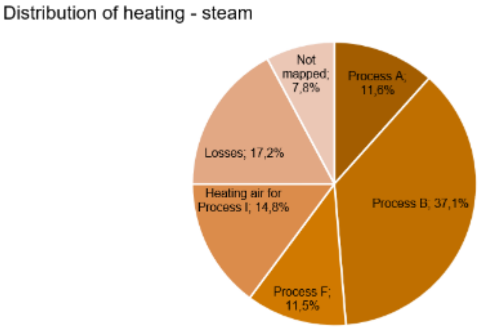


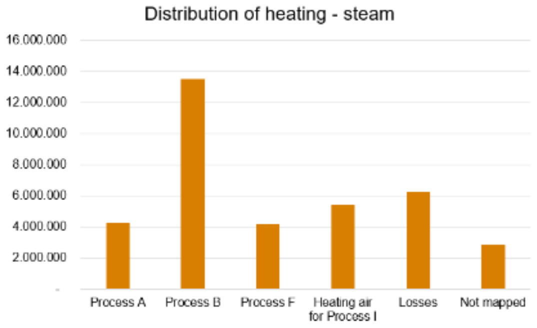
Using the energy mapping

Identifying projects using energy mapping

Thermal savings projects:

- **Focus on significant users**
    - Biggest users identified from mapping
- **Demand analysis**
    - Can energy system be tailored to meet demands more efficiently?
- **Delta T (Temperature Difference)**
    - Can temperature differences be improved across site?
- **Identification of losses and efficiencies**
    - Can efficiency be improved on utility systems. Insulation, preheat air etc.





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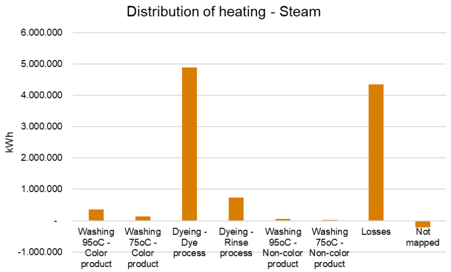
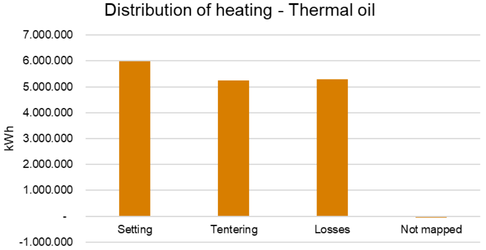




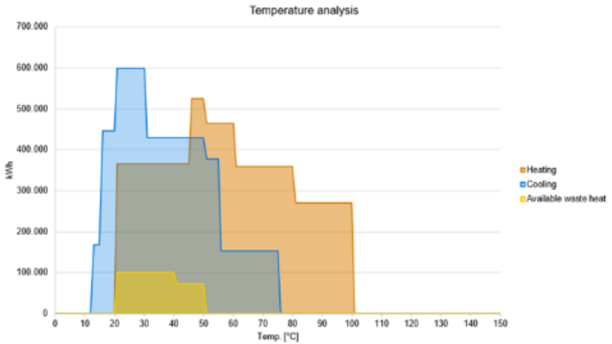
Using the energy mapping

Identifying projects using energy mapping

Heat recovery projects:

Heat recovery projects are often cost-effective. For example, the energy mapping output might display energy consumption by degree for cold, hot, and waste heat recovery of thermal systems.

The overlap between cooling (blue) and heating (orange) demand indicates potential for **direct heat recovery** between the two systems. However, this is a theoretical approach—real potential will be influenced by factors such as temperature differences, timing, sizing, and distance.



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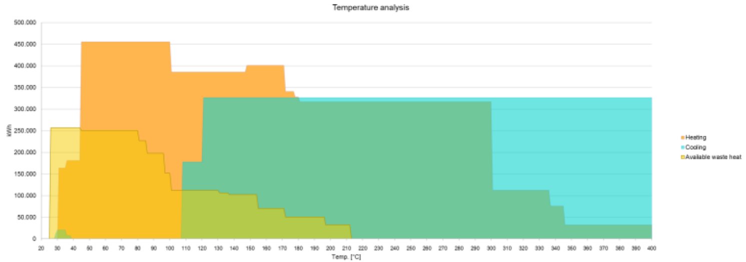


Using the energy mapping

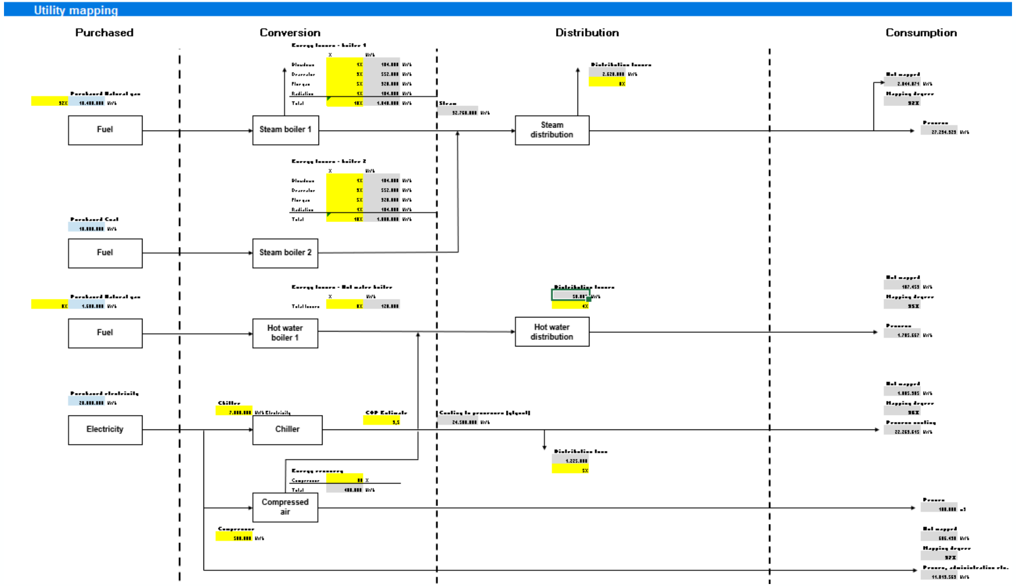
Identifying projects using energy mapping

Potential for rearranging the utility system:

Several questions can be raised when analysing the setup of utility systems based on the energy mapping.

Examples:

- Differentiated steam system instead of single steam system?
- Implement hot water system to replace steam
- Could more heat be recovered from chillers or air compressors compared to best practices?
- Are there significant distribution losses?
- Are conversion losses, such as boiler losses, higher than expected?
- Is the COP of the chillers within the range of best practice?



Using the energy mapping

Identifying projects using energy mapping

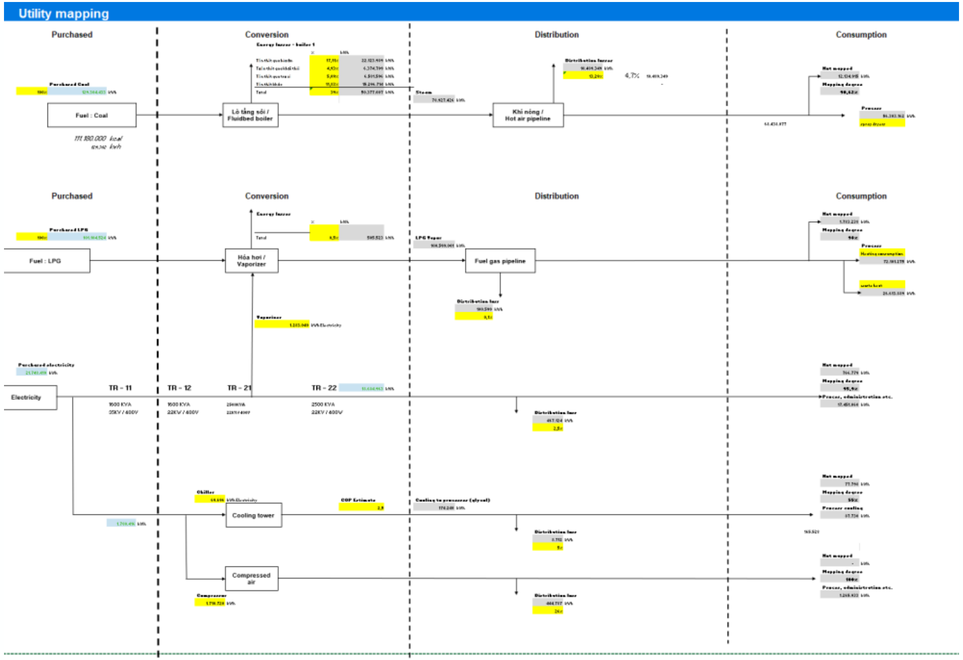
What can we read from the utility mapping?

Examples:

- **Solutions used**
- **Specific consumptions on utility systems**
- **Use of conversion methods**
- **Use of distribution solutions**
- **Losses**
- **Basis for KPI**
- **Mapping degree**

The onion diagram approach can be applied on the different elements, to develop projects

Example:



Using the energy mapping

Identifying projects using energy mapping

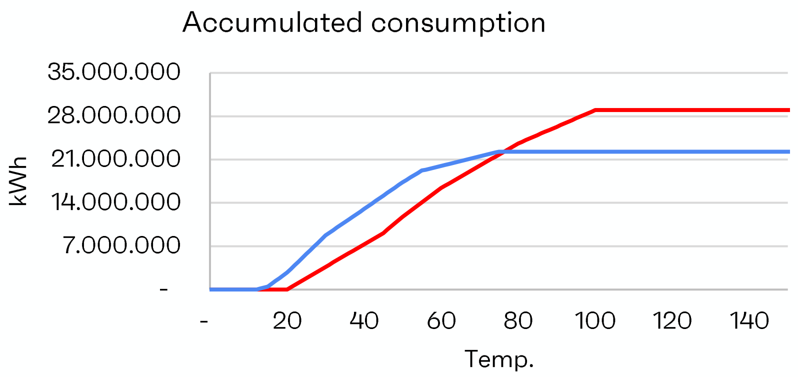
System design considerations:

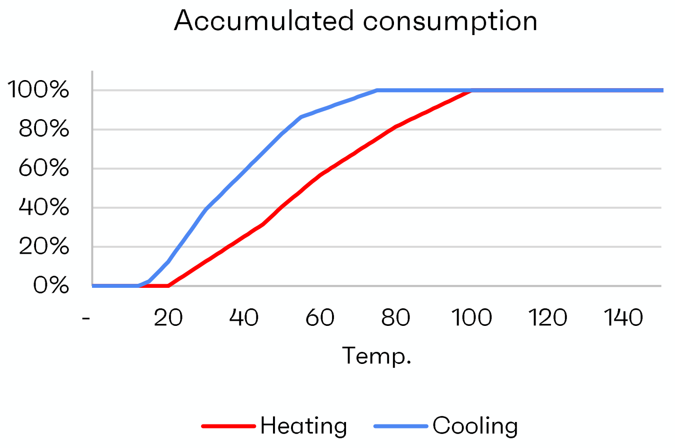
From the energy mapping create accumulated consumption per temperature graph.

Raise questions:

- If 55% of the heating demand is used below 60°C
  - Why is steam used to cover this?
  - Can a hot water system be considered?

- If 50% of cooling demand is above 30°C
  - Are chillers needed for this?
  - Can another technology be used?





Using the energy mapping

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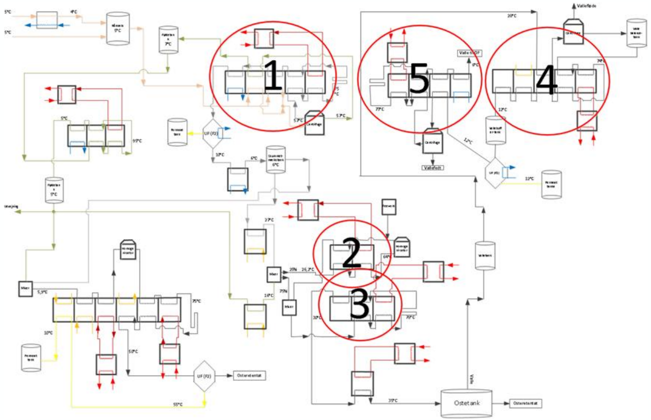
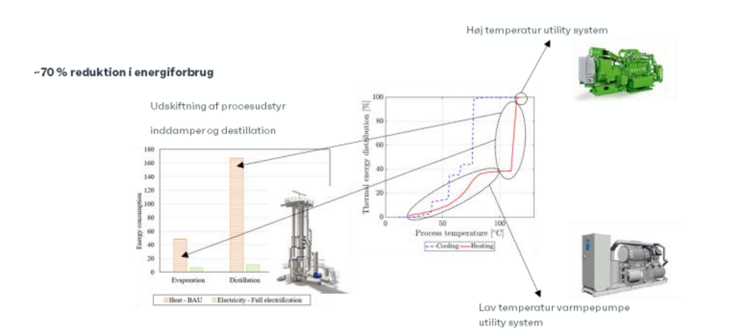


Viegand Maagøe

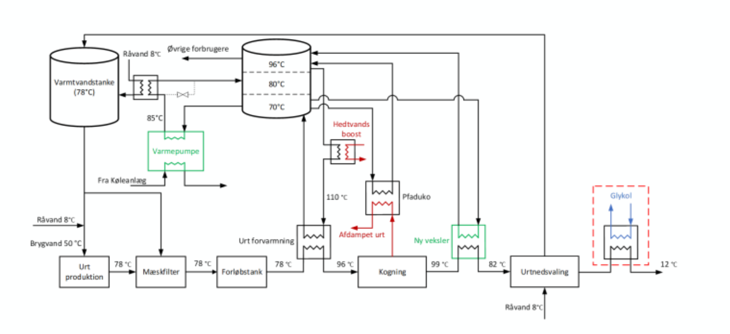
Using the energy mapping

Results – examples of working with the energy mapping

- Full electrification in food ingrediency
    - Significant cost savings
    - 70 % energy saving
    - 100 % carbon reduction



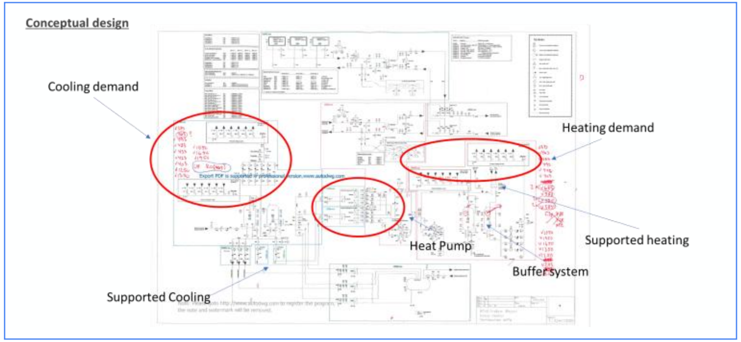
- Waste heat recovery by heat pump in brewery
    - Significant cost savings
    - 30 % energy saving
    - 40 % carbon reduction



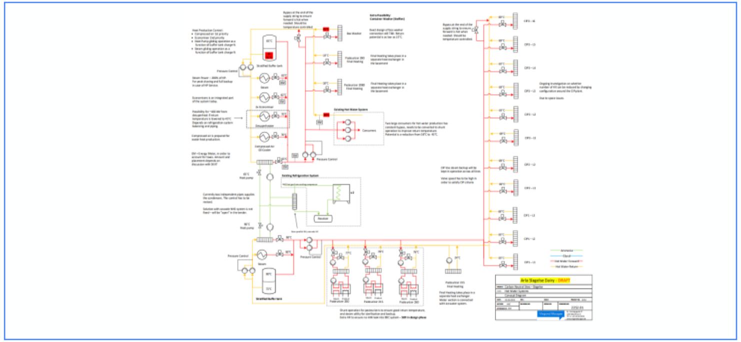
Using the energy mapping

Results – examples of working with the energy mapping

3. Central heat pump system in a dairy
   - Significant cost savings
   - 33 % energy saving
   - 50 % carbon reduction



4. Waste heat collection in a dairy
   - Significant cost savings
   - 15 % energy saving
   - 20 % carbon reduction



VIEGAND MAAGØE

Day 3:
Energy mapping and Pre-feasibility study

From Energy Mapping to Pre-feasibility study

Content:

- Transition from mapping → decision-making.
- Finalize and present energy mapping
- Learn and apply pre-feasibility study
- Group exercise: Brewery case

Day 3 Agenda

→ **Session 1:** Finalize & prepare mapping presentation

→ **Session 2:** Presentations & Reflection on Case Work

→ **Session 3:** Introduction to Pre-Feasibility study

→ **Session 4:** Group exercise: Pre-FS on Brewery Case

→ **Wrap-up**

Session 1:
Develop Case Presentation

Session 1 – Prepare Your Case Presentation

Develop & Prepare Your Case Presentation

Objective: Communicate your mapping results clearly and persuasively.

Instructions:

- Finalize Excel tool inputs
- Prepare key results for presentation of 5-10 minutes.
- Each team should acts as if presenting to the company's Energy Manager and CEO. The audience and trainer acts as Energy Manager and CEO.

Audience Reminder

CEO/Plant Director's Perspective
Big-picture impact and "why it matters". Focus on cost savings and strategic benefits.

Energy Manager's Perspective
Technical details and accurate numbers. Quantify energy savings, efficiency gains, etc

Session 2:
Presentation and reflection

Reflection Round – Group Exchange

- What worked?
- Where did you struggle?
- What assumptions did you make?
- Could you use this in your real job?

Key Takeaways from Mapping

- **Value of Structured Tools:** A systematic approach (like energy mapping) yields clarity and credibility in analysis
- **Cross-Disciplinary Communication:** Combining technical and business perspectives is vital – practice translating data into executive insights
- **Next Up – Pre-Feasibility:** We move from identifying opportunities to **evaluating** which opportunities to pursue using pre-FS.

Sesion 3: Introducion to pre-feasibility study

Pre-Feasibility in Our Own Work

Discussion – Have You Done a Pre-FS?

Discussion question 1

Who has ever worked on something like a pre-feasibility study in your job or personal projects?

Discussion question 2

If yes, briefly describe:

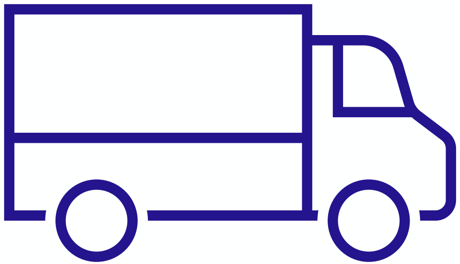
- What was the project or investment? (e.g. new equipment, process change, major purchase)
- What alternatives did you consider or compare?
- Did you consider non-financial factors (emissions, safety, convenience, etc.)?

Discussion question 3

If no, think of any time you compared options before deciding.

Everyday Example – Buying a New Car

- Imagine you need a new car. You don’t buy the first one you see; you explore options: a used petrol car vs. a hybrid vs. an EV.
- You estimate costs: purchase price, fuel or charging cost, maintenance.
- You consider performance: driving range, reliability.
- You also factor in personal needs or preferences: enough space for family? Safety ratings? Fun to drive?
- This is a pre-feasibility assessment in daily life – comparing alternatives, weighing financial and non-financial pros/cons



From Energy Audit to Pre-Feasibility

- **Energy Audit/Mapping (Day 2):** Identified potential energy-saving opportunities and where energy is used or wasted. Essentially, it showed what's possible.
- **Pre-Feasibility Study (Day 3):** Takes selected opportunities and analyzes if they are worth pursuing as projects. Uses actual data (utility consumption, costs) to evaluate viability.
- **Workflow:** Audit findings → Pre-FS analysis → (if promising) Full Feasibility Study → Implementation.
- Pre-FS is the critical "checkpoint" before in-depth engineering.

From Energy Audit to Pre-Feasibility

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Workflow: Audit findings → **Pre-FS analysis** → (if promising) Full Feasibility Study → Implementation.

Pre-FS: the critical "checkpoint" before in-depth engineering.

Pre-Feasibility Study – What, when and why

What is a Pre-FS

An early-stage decision support analysis for a project

Evaluates whether an idea is worth investing more time/money into detailed study. It's a go/no-go filtering step.

Relies on high-level estimates, not final designs.

Usually performed after an audit and before committing resources to a full feasibility or procurement

When do we use a Pre-FS

Before committing significant resources to a full feasibility study or project implementation.

Typically right after identifying project ideas (audit stage). If the pre-FS is positive, you proceed; if not, you save time and money by stopping early.

Why we use a Pre-FS

Screening Projects: Avoid investing in weak or high-risk projects by filtering them out early

Comparing Options: Provide a transparent, side-by-side analysis of multiple solutions to find the best one

Building Stakeholder Buy-in: Give decision-makers a clear, business-focused case for why a project is or isn't worth further development.

Typical Pre-FS Structure

A pre-feasibility study report usually includes:

- Baseline Scenario: Business-as-usual case (no change) to compare against
- Alternative Solutions: 2–3 different technical solutions or project options to consider
- Cost Estimates: Capital Expenditure (CAPEX) and Operating Expenditure (OPEX) for each option
- Energy & Emissions: Projected energy savings and CO_2 reduction for each option vs. baseline
- Financial Metrics: Simple indicators like payback period, Net Present Value (NPV), Internal Rate of Return (IRR) for each option
- Qualitative Assessment: Non-financial factors – implementation risks, ease of operation, maintenance needs, etc.
- Preliminary Recommendation: Which option appears best and why, based on the above factors

Decision Criteria for Project Viability

In a pre-FS, these factors guide the decision on the preferred solution:

- CAPEX & OPEX: Is the upfront cost affordable and are ongoing costs reasonable?
- Payback Period: How quickly will energy cost savings pay back the investment?
- NPV: The project's value in today's money – a positive NPV means it earns more than it costs
- IRR: The effective annual return of the project
- Energy & CO2 Savings: Does it significantly cut energy use or emissions? Align with sustainability goals?
- Risks & Practicality: Any implementation risks? Is it easy to operate and maintain? Any impacts on safety or production?
- Other non-energy benefits

Summarizing discussion questions

- **Discussion question 1:** Which parts of the pre-FS process feel familiar to you from your work? (E.g., estimating costs, comparing options, assessing risks)
- **Discussion question 2:** Have you seen a good technical solution fail because no one did a solid pre-FS? What happened?

Remember: *"An audit tells you what's possible. A pre-FS tells you what's worth doing – from both a technical and business perspective."*

Session 4: Pre-FS Group Exercise (Brewery Case)

Introduction to Exercise

- **Exercise:** Apply the pre-FS method to a case. Work in teams to perform a pre-feasibility analysis for a medium-sized brewery.
- **Deliverable:** Complete the pre-FS Excel tool input and prepare a brief analysis of results for three project options versus the baseline. Formulate a recommendation.
- **Your Role:** You are advisors helping the brewery decide which energy efficiency project to pursue.

Case Background

This exercise builds on your previous energy mapping work. You are now tasked with conducting a pre-feasibility study to help brewery management evaluate and select a preferred energy efficiency solution. This selected solution will then be developed further in a detailed feasibility study.

Using data from the previous exercise and additional provided inputs, evaluate the following four scenarios:

- Baseline (Business as Usual) – Continued operation of the current inefficient boiler.
- Base Case Solution – Replacement of the old boiler with a new high-efficiency boiler.
- Alternative Solution 1 – Implementation of heat recovery between processes.
- Alternative solution 2 - Install a new wort boiler which will allow the brewhouse to only evaporate 2% of the wort and give the same quality.
- Alternative solution 3 - Install a new wort boiler and condenser so you can evaporate less and recover heat from the evaporated amount. It is therefore a combination of solutions 1 and 2.

Group Task – Conduct the Pre-Feasibility Analysis

In your teams, complete the following:

1. Justify the Pre-Feasibility Study. Briefly summarize the motivation and background for undertaking this study (e.g., high energy costs, aging equipment, environmental compliance pressures).
2. Outline all the above-described solutions. Provide a clear description of the three proposed solutions in comparison to BAU.
3. Non-Energy Benefits Analysis. Identify and describe any non-energy benefits to each solution (e.g., emission reduction of SO_x/NO_x, improved working environment, higher product quality, etc.).
4. Define the scope of the base case solution. What systems, utilities, and processes will be impacted? What improvements are expected?
5. Define the scope of the alternative solution(s).
6. Use the above data to fill out the input sheet of the pre-fs excel tool to conduct your economic and energy analysis of the pre-fs.
7. Summarize key economic findings in a table so that the reader can evaluate the three solutions against the business as usual case. The table should include investment cost, operational costs, payback time, CO_2, NPV and IRR for each solution vs. BAU.
8. Conduct the sensitivity analysis by adjusting at least two variables (e.g., discount rate, energy prices, production levels) and justify your choices. Comment on how sensitive each solution is to these assumptions.
9. Conclude on a preferred project scope and the most attractive alternative solutions.

Presenting Pre-FS Results

Each group will have 5–7 minutes to present their pre-feasibility findings and recommendation:

- The preferred solution and why you chose it.
- Key figures: investment, savings, payback, NPV, IRR, CO_2 reduction for each option (especially the winner vs. others).
- Any noteworthy assumptions or sensitivities (e.g., “if gas price doubles, option B becomes less attractive”).

Summary of Day 3

Wrap-Up – Key Learnings from Day 3

- **Compare Alternatives:** Always evaluate multiple options (including doing nothing) before deciding on a project. A project that looks good alone might not be the best when others are considered side-by-side.
- **Use Structured Analysis:** Tools like energy mapping and pre-FS templates help quantify trade-offs and avoid guesswork. They bring data and consistency into decision-making.
- **Context Matters:** The "best" solution depends on context – organizational goals, available budget, risk appetite, and policy environment. What is optimal for one company might differ for another.
- **Collaboration:** Combining technical, financial, and managerial perspectives leads to more robust outcomes (as we saw in group work and discussions).

Reflection & Next Steps

- **Apply in Your Work:** Think about an upcoming project or idea in your own organization – how could you use a pre-feasibility approach to evaluate it? Start with a baseline and a couple of alternatives, and do a quick comparison of costs and benefits.
- **Identify Support Needs:** What would you need to conduct a solid pre-feasibility study on your own? (data, management buy-in, software tools, team members, etc.). Consider seeking that support so you can implement these methods confidently.
- **Continuous Learning:** Pre-feasibility is an iterative skill – the more you practice on different projects, the better you get at pinpointing the best solutions quickly.

Day 4: Pre-FS

Refining assumptions, interpreting results, and communicating recommendations.

Day 4 Agenda

→ **Session 1:** Recap and how to communicate Pre-FS results to different stakeholders

→ **Session 2:** Finalize brewery case and prepare presentations

→ **Session 3:** Presentation of case results with simulated management setting

→ **Session 4:** Strategies for handling data gaps in Pre-FS

→ **Wrap-up**

Session 1: Recap and how to communicate Pre-FS results to different stakeholders

Recap of day 3

Key takeaways

Yesterday we covered the two first steps of the typical project journey: Energy mapping and pre-fs.

You covered:

- Energy mapping: tool application & case results
- Communicating findings to experts and management
- Introduction to pre-feasibility studies
- Using the pre-feasibility study Excel tool

Summarizing discussion questions

Complete the following sentences with the person sitting next to you

- **Discussion question 1:** “What I found most useful about the structured approach of the pre-feasibility study was…”
- **Discussion question 2:** “When working with the pre-feasibility study yesterday, one new aspect compared to how I have done such studies before was…”
- **Discussion question 3:** “One way the pre-feasibility study can support decision-making in real projects is…”
- **Discussion question 4:** “One insight I gained about comparing different project options was…”
- **Discussion question 5:** “One assumption I imagine I would have to make in real life when using the pre-FS tool is…”

Plan for Day 4

- Today, you will continue working on the brewery case and deepen your pre-FS analysis
- You’ll also practice how to communicate pre-FS results to different stakeholders, simulating a real-world management setting.
- We’ll end by examining how to deal with missing or uncertain data — a reality in all early-stage project assessments — and explore how structured tools help turn uncertainty into transparency.

Communicating Pre-FS results

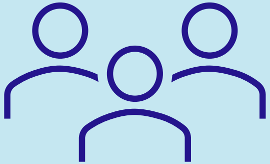
Today's Lecture Structure

We will cover:

1. Why communication matters
2. Understanding your stakeholders
3. Common pitfalls
4. Practical tips and examples for clarity and impact
5. Reflection & discussion prompts

Why communications matters

Strong analysis ≠ impact if not understood & trusted



Different stakeholders = different lenses (risk, cost, compliance, strategy)

Good communication = translating results into their language

Understanding your stakeholders

Technical staff

Presenting a pre-FS or FS to **technical staff** requires demonstrating:

- **That your assumptions are technically sound and traceable**
  (e.g., efficiency rates, operating hours, equipment specs)
- **That the methodology is clear and replicable**
  (e.g., how calculations were done, what standards or benchmarks were used)
- **That the solution integrates well with existing systems**
  (e.g., no production disruption, technical compatibility)

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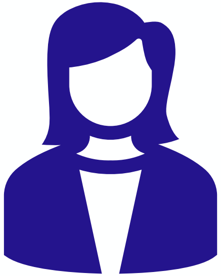
Understanding your stakeholders

Managers & Executives



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Understanding your stakeholders

Summarizing the three key audiences

Audience	What They Care About	How to Reach Them
Technical staff	Inputs, assumptions, methodology, technical feasibility	Detailed data, calculations, reliability
Managers/Executives	ROI, payback, risk, strategic alignment, clarity	Visuals, brief summaries, decision framing

Common Pitfalls in Communication

Pitfalls to avoid

Data overload

Too many numbers, no story.

Unclear assumptions

Hidden or vague variables.

Lack of visuals

Complex tables without interpretation

Generic messaging

One-size-fits-all delivery

Recommended tables to include in the pre-fs report of the baseline project

Assumptions/data on energy consumption (Table 1 from guideline)

	Unit	2025	2028	2032
Annual product output	Tons			
Annual operation hours	Hours/year			
Fuel consumption	MWh/year			
Electricity consumption	kWh/year			
Water consumption	M3			
Cooling consumption	MWh/year			
Compressed air consumption	Nm3/year			

Recommended tables to include in the pre-fs report of the baseline project

Assumptions/data on costs (Table 1 from guideline)

	Unit	2025	2028	2032
Fuel price	VND/MWh			
Electricity price	VND/MWh			
Water price	VND/m3			
Annual fuel costs	million VND			
Annual water costs	million VND			
Annual utility costs	million VND			
Annual labor costs	million VND			
Annual maintenance costs	million VND			

Figures to include in the pre-fs report of the solution and alternative project

Illustrating the Solution Principle (Figure 1 from guideline)

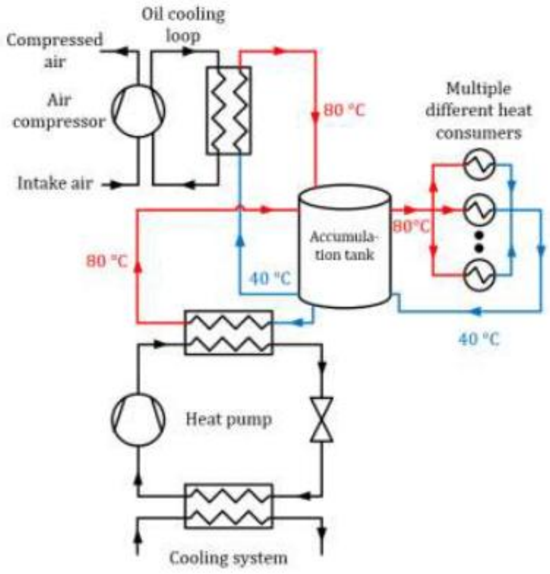


Figure 1. Example of principle diagram for heat recovery project

Recommended tables to include in the pre-fs report of the solution and alternative project

Assumptions/data on key elements for project (Table 2 from guideline)

Equipment	Technology	Capacity	Operating data	Comments
New Boiler	Steam boiler	8 ton/hour	6 bars	...
New steam distribution	...	...	...	Supply to new workshop
Water treatment	...	...	...	...
...	...	...	...	...

Assessment of necessary investments (CAPEX) of the solution and alternative project

Assumptions/data on CAPEX (Table 3 from guideline)

Equipment	CAPEX (mill. VND)	Source of information	Source of information	Level of certainty of assessment	Comments
New Boiler	VND/MWh				
New steam distribution	VND/MWh				
Water treatment	VND/m3				
…	million VND				
Contingency	million VND				
Total	million VND				

Assessment of necessary investments (CAPEX) of the solution and the alternative project

Results of the pre-fs (Table 4 from guideline)

Scenario	CAPEX (mill. VND)	OPEX (mill. VND/year)	IRR (%)	NPV (VND)	CO2 emission reductions compared to baseline	Other impacts compared to baseline
Main solution						
Alternative A						
Alternative B						
...						

Tips for Effective Communication

Tips for Clarity and Impact

A. Structure your story

Introduce a simple 4-part structure for communicating pre-FS findings:

1. **Context** – What is the problem or opportunity?
2. **Options** – What solutions were considered?
3. **Assumptions/data** – What are the key assumptions/underlying data behind the analysis?
4. **Findings** – What are the results (technical + financial)?
5. **Recommendation** – What should we do and why?

B. Visual Aids

- Use **figures**, **comparison tables and traffic light indicators**
- Replace dense Excel screenshots with simplified graphics

C. Clarity in language

- Use plain language wherever possible.

Summary

Three takeaway messages:

1. **Know your audience—speak their language, not yours.**
2. **Don’t just show the data—tell the story.**
3. **Structure, visuals, and clarity turn a good analysis into a decision-making tool.**

Session 2: Finalize brewery case and prepare presentations

Finalize brewery case

- You now break into your groups and finalize the brewery case from yesterday.
- Afterwards, you should prepare a 5–7 min presentation to an audience consisting of a CEO, and a technical evaluator.
- Your presentation should include:
  - Case summary & alternatives
  - Assumptions (highlight uncertainties)
  - Results (financial + environmental)
  - Final recommendation

Session 3: Presentation time

Session 4: Handling missing data

Uncertainty in Pre fs

How to address uncertainty in a pre-fs

- No pre-FS has perfect data – that's the nature of the stage.
- The goal is decision support, not detailed design.
- You should always demonstrate that you address missing data, uncertainty and risk in your pre-fs.
- This should be done by clearly stating the assumptions and indicating the level of uncertainty.

Assumptions

Using assumptions in pre-fs

If real cases aren't available, assumptions can be used.

Good assumptions are those that are:

- Obtained from reference cases
- Clearly documented
- Labeled with certainty level (High / Medium / Low)
- Tested in sensitivity analysis

For example, information about energy consumption after implementation of the base case project may again be obtained from reference cases.

Strategies for Common Data Gaps

Challenge	Strategy	Example
Missing consumption data	Use benchmarks, BAT data or internal ratios from similar facitlities	Energy consumption per produced unit, compare to BAT or literature
Missing CAPEX cost for new equipment	Use proxy pricing from supplier brochures or similar projects	Vendor catalogues or web tools
Uncertain production volumes or growth	Use scenario modelling with low-mid-high scenarios	Include production ramp-up option
Fuel prices unstable	Use average or conservative prices, test sensitivity	Include recent 3-year average and “+15%” scenario
O&M cost uknown	Use percent-of-investment rule-of-thumb	e.g., 1–3% of CAPEX per year

Good Practices for Handling Uncertainty

- Document assumptions in a structured table
- Label certainty levels: High / Medium / Low
- Perform sensitivity analyses
- Explain logic and references clearly

Plenum exercise 1: ”Make your feet talk”

Plenum exercise 2: ”Circle discussions”

Discussion questions

Key take-aways to reflect on

- What do you do if data is insufficient?
- Who can help validate or improve assumptions?
- When is an assumption “good enough”?
- Which is worse: a wrong assumption, or one not documented?
- How to handle pushback against ranges/scenarios?
- Have you seen projects fail due to hidden assumptions?
- How can pre-FS tools make uncertainty more acceptable?

VIEGAND MAAGØE

Day 5: Pre-FS & Loan Application

Day 5 Agenda

- → **Session 1:** Introduction to feasibility studies (FS)
- → **Session 2:** Introduction to risk assessment
- → **Session 3:** Introduction loan application
- → **Session 4:** Examination
- → **Wrap-up**

Session 1: Introduction to FS

Why a Full Feasibility Study? How does it differ from the Pre-FS study?

- A pre-FS rules out unattractive options; a full FS develops the preferred one.
- FS aims to provide a basis for a Final Investment Decision (FID).
- Often required when the technical design, supplier selection, or financial viability are not obvious.
- Often required for loan applications or tender processes.

Target Audience

Internal:
- Management
- Financial decision-makers
- Technical department

External:
- Investors & commercial banks
- Public authorities (permits, incentives)

What should the FS deliver?

- Technical maturity (scope, solution design, supplier dialogue)
- Financial clarity (CAPEX/OPEX, sensitivity analysis)
- Non-energy benefits & risks (externalities, co-benefits)
- Decision support (business case, sustainability case, risk mitigation)

Structure of a Full FS

- Project scope and objectives
- Technical specifications
- Financial analysis
- Non-energy benefits and greenhouse gas savings
- Sensitivity analysis
- Social/environmental assessment
- Risk log and mitigation strategies
- Implementation plan
- Conclusions and recommendations

Project objectives

The project objective should as a minimum address the following:

- How does the project align/contribute with overall company strategy
- Is it solely an energy efficiency project?
- Is it a replacement of worn-out equipment?
- Is it a capacity expansion project?
- It is a simple 1:1 replacement of already existing equipment? Or is the project an add on to already existing equipment?
- Will the project comprise other installations, buildings work etc.?

Examples of strategic goals

(Table is from the FS guideline)

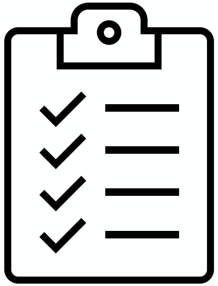
	Examples of strategic goals	Examples of project objectives
#1	Reduce unit cost [$/ton of product output] by year 20xx	The project is expected to increase automation and reduce manual labor, decreasing the company's operating expenditures.
#2	Reduce energy consumption by x% by year 20xx	The project replaces gas boilers with electric heat pumps with higher COP (coefficient of performance).
#3	Eliminate energy related carbon emissions at for all production sites by year 20xx	The project is expected to reduce carbon emissions from electricity and gas by 50% in 5 years and 100% in 10 years.
#4	Increasing the capacity of the energy system by xx % by year 20xx	Securing capacity expansion of the energy system, that supports the planned production expansion towards 2030.
#5	[…]	[…]

Project scope

The project scope should include a reference to the pre-feasibility study and any technical studies completed after the pre-feasibility study.

The project scope should as a minimum address the following

- What are the goals of the project?
- What are the deliverables?
- What tasks needs to be performed?
- What is the basis for the investment?
- What are the deadlines?
- Who should be involved?



Technical specifications

Results of the pre-FS: Description of the work done and conclusions developed.

Analysis and studies during the FS: description of any further analysis and studies done under the FS leading to the proposed project.

The proposed project: detailed information about the technologies, systems, and processes involved in the project. The technical specifications should be based on best available technologies (BAT) available on the market.

Solution design: The content of the FS must comply with Article 54 of the Construction Law. It follows that the basic design must include explanations and drawings expressing the contents described in further detail in the table on the next slide.

Technical specifications

	Details in a basic design description in FS according to Article 54 in the Construction Law
a)	The construction location, direction of the line of works, list, sizes, types, and grades of works on the whole construction ground.
b)	Selected technological, technical and equipment plans (if any).
c)	Architectural solutions, ground plan, cross-sections and vertical sections of construction works and their sizes and main structures.
d)	Construction solutions, major materials to be used, estimated construction cost of every work.
dd)	Plan on connection of technical infrastructures inside and outside the works, fire and explosion prevention and fighting solutions.
e)	Applied standards and technical regulations and construction survey results for making the basic design.

Financial analysis

Key elements of the financial analysis:

1. CAPEX: pre-construction costs/Development costs, construction costs, Soft expenditures and contingency for unexpected costs
2. OPEX: labor costs, energy costs, maintenance costs, taxes, deferred reinvestment in existing technology, annual service agreements, etc.
3. Energy savings: based on forecasts of production volumes and the costs of energy
4. GHG savings: Apply the annual emission coefficient of the national power grid for projects using electricity, and the non-electricity emissions factors published through MONRE for projects using other forms of energy.
5. Corporate taxes, import duties and inflation rate
6. Financing plan and cost of capital
7. Incentive schemes
8. Assessment of financial viability of the project
9. (Economic analysis)

Non-energy benefits and costs

Why non-energy benefits matter

- NEBs can be as important as energy savings: They may improve competitiveness & project attractiveness and can help secure financing external financing (banks, EIB, WB)
- NB: There may also be non-energy costs (e.g. space needs)
- **Can you think of some non-energy benefits or costs?**

Sensitivity analysis

FS requires sensitivity analysis

Uncertainties to test

- CAPEX
- Energy price
- Production volumes & mix
- Financing cost
- Incentive

Output table should include:

Scenario	A	B	C
Investment			
Lifetime			
NPV			
IRR			
Payback time			

Social/environmental assessment

Examples of social and environmental implications

- Job creation: Does the project create or preserve jobs in the local area?
- Public health and labour safety: Reducing emissions or improving workplace safety can have direct and measurable benefits.
- Emissions of pollutants: Many projects reduce not just CO_2 but also other harmful pollutants, which improves environmental compliance and community relations.
- Local industry interests: Sometimes a project helps strengthen the competitiveness of an entire sector, not just one company.
- Waste reduction: Lower energy use often correlates with less waste and fewer resources consumed.

Implementation plan

Why it matters

- Shows project is realistic & manageable
- Builds investor & management confidence

What to include

- Key phases of the project
- Major milestones (e.g., budget approval, financing secured)
- Required permits for implementation
- Description of potential risks
- A list of critical stakeholders and their roles across phases

Group reflections

How do you work with FS in your organisations?

1. Does your organisation assess environmental impacts? When is this required?
2. In your organisation, which types of projects typically require a full FS? Why?
   a) Consider: Stakeholder expectations, investment size, complexity.
3. What are the key risks of skipping a feasibility study before final investment?
4. What needs to be in place for investors or management to commit?
5. What level of detail is typically expected by the CEO vs. a bank vs. the technical team?”

Group reflections

Split into small groups (3–4 people)

- Each group discusses and notes down:
- Under what conditions is a full FS necessary?
- What specific decision or audience does it support?
- What is one example from your own work where a full FS could have (or did) change the outcome?
- What should a good FS include to be convincing?

Group reflections

Work in pairs or small groups (same group as in Part 2) to complete the comparison table below

Aspect	Pre-Feasibility Study	Full Feasibility Study
Goal		
Scope of study		
Level of detail		
CAPEX & OPEX data		
Risk analysis		
Use of suppliers		
Target audience		
Primary output		

Session 2: Risk assessment and exercises

Risk and mitigation strategies

Risk log

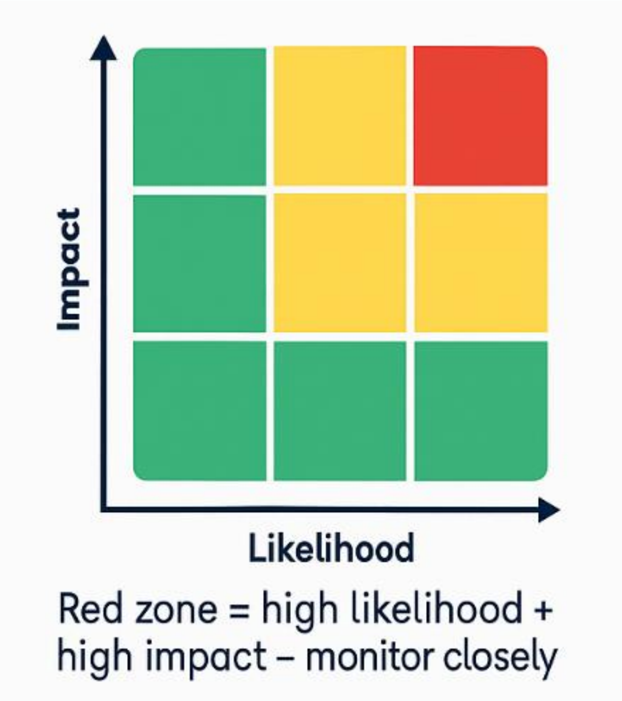
- Identifies risks
- Highlights actions/solutions to the risk

Risk Matrix

- Plots risks by **Impact** vs. **Likelihood**
- Red zone = high likelihood + high impact → monitor closely

Why it matters

- Risks must be identified and documented in the FS
- Strong mitigation strategy → boosts investor confidence



Risk log

Example of risk log and mitigation strategy (Table 8 in FS guideline)

ID	Category	Specific risk description	Impact	Likelihood	Action(s)
1	Political risks	1.1 Existing scheme for financial support for EE investments is discontinued	[...]	[...]	[...]
2	Regulatory risk	2.1 Delays in obtaining necessary permits and regulatory approval.	[...]	[...]	[...]
3	Technical risk	3.1. The technology does not deliver the expected product quality or production capacity.	[...]	[...]	[...]
4	Risks of budget increase	4.1 The tender outcome is higher than budget estimates.	[...]	[...]	[...]
5	Risks of schedule delays	5.1 The project implementation is delayed due to e.g. delayed subcontractors...	[...]	[...]	[...]
6	Risks of reduced results	6.1 The technology does not deliver the expected energy savings.	[...]	[...]	[...]

Conclusions and recommendations

Project soundness

Covers technical, financial and practical rationale

Benefits

Energy savings & GHG emissions

Cost savings

Other non-energy benefits

Recommendation

Outline next actions and steps for implementation

Ensure alignment with investor & management needs

Group reflections

Split into small groups (3–4 people)

1. What is a risk assessment?
2. Why do we need to assess risks?
3. What types of risks are we assessing?
4. Who should be involved in the assessment?
5. How is it carried out? And how do we prioritize risks?
6. What happens after the risk assessment is made? How is it used?

Group exercise

Split into small groups (3–4 people)

- Evaluate potential risks related to one of the heat recovery projects from the brewery case.
- Be creative and cover all types of risks.
- For each risk fill out a mitigation strategy.

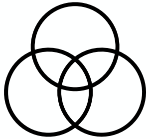
Session 3: Introduction to loan application

When should a loan application be made?

Typical steps in developing an EE project follows these steps:

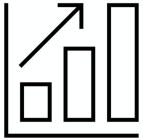
Energy audit /Screening

Identify savings and options



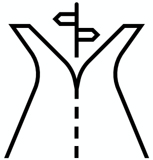
Pre FS

Compare options and select best solution



FS

Detail design, risk, costs, savings, documentation for financing



FID

Management approval and funding decision: equity and/or **loan**

Why a Loan Application?

- EE projects often require significant upfront capital.
- Loan financing enables implementation without depleting internal funds.
- Required for many industrial EE projects, especially when supported by:
    - Dedicated EE financing (e.g., VSUEE)
    - Public or concessional loan programs
    - Helps unlock additional incentives, grants, or blended finance packages.

Who is the Target Audience?

Internal

- Company management
- Finance officers
- Project managers

External

- Commercial banks
- EE financing institutions
- Government authorities
- Development banks

Loan Application Process

A loan application process is a series of steps that a borrower must follow to request a loan from a financial institution.

1. Preparation of loan documents
- Legal documents
- Financial documents
- Project-related documents

2. Submission
- Submit loan documents to the financial institution

3. Review
- Legal readiness
- Financial credibility
- Project feasibility
- Credit risk

4. Approval
- Lender decides to approve or reject the loan.
- Conditional approval

5. Loan disbursement
- Disbursement can be phased or made in full

6. Monitoring & Reporting
- Lender monitors fund utilization, energy savings, & compliance with the loan agreement

Typical requirements

Typical requirements from general financing institutions and EE financing facilities

Requirements from general financing institutions

- Legal documents
- Financial documents
- Investment documents

Additional requirements from EE Financing Facility

- Project description and objectives
- Technical assessment and baseline
- Baseline energy consumption and projected project energy savings
- Environmental and social impact assessment
- Investment cost and financing plan
- Financial and economic analysis

What Makes a Good Loan Application?

- Legal completeness
  - Includes all valid documents proving legal status, authorization, and internal approvals.
- Financial credibility
  - Provides transparent and reliable financial statements (preferably audited).
  - Demonstrates stable cash flow, debt-servicing capacity, and a sound credit history.
- Project feasibility
  - Clearly defines the scope, timeline, investment cost, funding sources, and procurement plan.
  - Supported by a feasibility study (FS) report proving technical and financial viability.
- Risk and mitigation measures
  - Includes risk assessment, collateral details, and cash flow projections.
- Funding alignment
  - Meets the objectives and eligibility requirements of the financing program (e.g., EE savings, GHG reduction, environmental and social compliance).

What Should a Loan Application Deliver?

- Legal and institutional readiness: Company registration, board approvals, signatures
- Financial credibility: Audited financials, debt servicing capacity, business plans
- Project clarity: Scope, timeline, investment cost, procurement plan
- Documentation to justify credit risk: Cash flow projection, risk analysis, collateral
- Alignment with funding criteria: Eligibility for EE program, GHG savings, compliance with safeguards

Contents of a Loan Application

- Legal Documents
  - Business registration certificate, company charter, and other documents verifying the enterprise's legal status and the authorized signatory.
- Financial Documents
  - Audited or unaudited financial statements for the past three years (or for available years).
  - Debt servicing capacity.
- Project Documents
  - Complete and clear information about the project.
  - Feasibility study report (demonstrating both technical and financial feasibility).
  - Project's debt repayment capacity.
  - Contracts related to procurement or project implementation.
  - Other Information
  - Demonstrated energy savings, emission reduction, and environmental and social feasibility.

Key Considerations for Financial Documents

- Provide complete financial statements for the past three years (audited versions are preferred).
- Data must be consistent across the balance sheet, income statement, and cash flow statement.
- Separate the project cash flow from the company's overall cash flow.
- Demonstrate that the cash flow is strong and stable enough to service debt (both principal and interest).

Income statement

- A report showing the profit or income of the enterprise. It records the revenue, expenses, and profit/loss of the enterprise or project over a specific period.
- Purpose:
  - Shows how much revenue the enterprise has earned
  - Indicates what expenses have been incurred
- Ultimately shows the profit or loss.
- Helps evaluate business performance.
- Serves as an important basis for financial and managerial decision-making.

Income statement – Example

Items	2023	2024
1. Net Revenue	10,000	12,000
2. Cost of Goods Sold	7,000	8,400
3. Gross Profit	3,000	3,600
4. Selling Expenses	800	950
5. General & Administrative Expenses	600	700
6. Operating Profit	1,600	1,950
7. Financial Income	200	250
8. Financial Expenses (Interest)	300	350
9. Profit Before Tax	1,500	1,850
10. Corporate Income Tax (20%)	300	370
11. Net Profit After Tax	1,200	1,480

Cash flow statement

- A report reflecting the cash inflows and outflows of the enterprise over a specific period.
- Main structure:
  - Operating activities – cash flow from sales and operating expenses
  - Investing activities – asset purchases, asset disposal, capital contributions, etc.
  - Financing activities – borrowing, debt repayment, share issuance, dividend payments
- Helps assess the enterprise’s ability to generate cash.
- Determines financial safety and payment capacity.

Cash flow statement - Example

Items	2023	2024
CASH INFLOW		
Revenue (Cash Sales)	900,000	900,000
Other income (in cash)	50,000	50,000
Total Inflow	950,000	950,000
CASH OUTFLOW		
Cost of Goods Sold	262,500	245,000
Operating Expenses	120,000	115,000
Interest Expense	30,000	35,000
Tax Payment	142,100	145,040
Total Outflow	554,600	540,040
NET CASH FLOW	**395,400**	**409,960**

Balance sheet

- Shows the status of assets, liabilities, and equity of an enterprise at a specific point in time.
- Reflects the "financial health" of the enterprise.
- Main structure:
  - Assets: What the enterprise owns (cash, inventory, buildings, machinery, etc.).
  - Liabilities: What the enterprise owes (bank loans, payables to suppliers, etc.).
  - Equity
- **Total assets = Total liabilities + Shareholder's equity**
- Helps assess the enterprise's payment ability and financial structure.
- Provides managers, investors, and creditors with a clear understanding of the enterprise's resources and obligations.

Balance sheet - Example

Items	2023	2024
ASSETS		
Current Assets		
• Cash & Cash Equivalents	500	600
• Accounts Receivable	300	320
• Inventory	400	380
Total Current Assets	1.200	1.300
Fixed Assets (Net)	1.800	1.900
TOTAL ASSETS	3.000	3.200
LIABILITIES & EQUITY		
Current Liabilities		
• Accounts Payable	250	260
• Short-term Loans	300	320
Total Current Liabilities	550	580
Long-term Liabilities	900	870
TOTAL LIABILITIES	1.450	1.450
Owner's Equity		
• Share Capital	1.000	1.000
• Retained Earnings	550	750
TOTAL EQUITY	1.550	1.750
TOTAL LIABILITIES & EQUITY	3.000	3.200

Total Asets = Total Liabilities + Equity

Key financial indicators

Profitability ratio

$$\text{Net Profit Margin} = \frac{\text{Net Profit after Tax}}{\text{Net Sales}}$$

Liquidity ratio

$$\text{Current Ratio} = \frac{\text{Current Assets}}{\text{Current Liabilities}}$$

Solvency ratio

$$\text{DSCR} = \frac{\text{EBIDTA}}{\text{Loan Repayment+Interest}}$$

DSCR: Debt service cover ratio
EBITDA: Earning before interest, depreciation and amortization

Case study: Example of financial documents

Case study: EE project of company Z

- Company Z is an industrial manufacturing company in food industry. Due to outdated and energy-inefficient equipment, production costs, especially energy costs, have been increasing, reducing the company's profitability.
- The management plans to invest in an Energy Efficiency (EE) project to reduce operating costs and improve competitiveness. The proposed measures include:

Measure	Description
Replacing old motors & pumps	Replace 20 IE1 motors with high-efficiency IE3/IE4 motors
Installing Variable Speed Drives (VSD)	Install VSDs for 15 large pumps/fans to control speed based on load
Upgrading to LED lighting	Replace all fluorescent lamps with high-efficiency LED lights with motion sensors
Installing Energy Management System (EMS)	EMS software to monitor energy use and control loads during peak hours
Insulating steam pipes & boilers	Insulate all steam pipes and hot water tanks to reduce heat loss

Exercise: EE project of company Z (2)

Item	Value
Total investment cost	4 billion VND
Project lifetime (operation)	7 years
Depreciation period	5 years (800 million/year)
Annual energy cost savings	2.7 billion VND/year
Additional annual O&M costs	40 million VND/year
Equity contribution	1 billion VND
Bank loan	3 billion VND
Interest rate	10%/year
Loan term	4 years (1-year grace, repayment in year 2–4)
Corporate income tax rate	20%

With the given information, we now prepare:

- The 7-year Profit & Loss statement, Cash Flow statement, and Balance Sheet
- Calculate and analyze: Profitability, Debt service coverage ratio (DSCR)

Loan repayment

Unit: 1000 VND

Unit: 1000 VND

Year	0	1	2	3	4	5	6	7
Loan Principal	3,000,000	3,000,000	3,000,000	2,000,000	1,000,000	0	0	0
Principal Repayment	0	0	1,000,000	1,000,000	1,000,000	0	0	0
Interest 10%	0	300,000	300,000	200,000	100,000	0	0	0
Total Payment	0	300,000	1,300,000	1,200,000	1,100,000	0	0	0

Profit and loss statement

Unit: 1000 VND

Year	0	1	2	3	4	5	6	7
From operation		0	0	0	0	0	0	0
Energy saving		2,700,000	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000
Additional operating cost		40,000	40,000	40,000	40,000	40,000	40,000	40,000
Interest		300,000	300,000	200,000	100,000			
Depreciation		800,000	800,000	800,000	800,000	800,000		
Taxable income		1,560,000	1,560,000	1,660,000	1,760,000	1,860,000	2,660,000	2,660,000
Coporate tax rate (20%)		312,000	312,000	332,000	352,000	372,000	532,000	532,000
Additional profit after tax (1000 VND)		**1,248,000**	**1,248,000**	**1,328,000**	**1,408,000**	**1,488,000**	**2,128,000**	**2,128,000**

Cash flow statement

Unit: 1000 VND

Year	0	1	2	3	4	5	6	7
Investment CF	4,000,000							
Operating CF								
Energy saving		2,700,000	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000
Additional operating cost		40,000	40,000	40,000	40,000	40,000	40,000	40,000
Financial CF								
Borrow	3,000,000							
Principle		-	1,000,000	1,000,000	1,000,000			
Interest		300,000	300,000	200,000	100,000			
Equity	1,000,000							
Corporate tax	-	312,000	312,000	332,000	352,000	372,000	532,000	532,000
NET CF	-	2,048,000	1,048,000	1,128,000	1,208,000	2,288,000	2,128,000	2,128,000
Accrual cash flow		**2,048,000**	**3,096,000**	**4,224,000**	**5,432,000**	**7,720,000**	**9,848,000**	**11,976,000**

Balance sheet

Đơn vị: 1000 VND

Year	0	1	2	3	4	5	6	7
ASSET								
Additional fixed asset	4,000,000							
Depreciation		800,000	800,000	800,000	800,000	800,000		
Salvage values		3,200,000	2,400,000	1,600,000	800,000	-	-	-
Cash	-	2,048,000	3,096,000	4,224,000	5,432,000	7,720,000	9,848,000	11,976,000
TOTAL ASSET	**4,000,000**	**5,248,000**	**5,496,000**	**5,824,000**	**6,232,000**	**7,720,000**	**9,848,000**	**11,976,000**
CAPITAL								
Equity	1,000,000	2,048,000	3,096,000	4,224,000	5,432,000	7,720,000	9,848,000	11,976,000
Loan	3,000,000							
Interest		300,000	300,000	200,000	100,000	-		
TOTAL CAPITAL	**4,000,000**	**2,348,000**	**3,396,000**	**4,424,000**	**5,532,000**	**7,720,000**	**9,848,000**	**11,976,000**

Financial ratios

Year	0	1	2	3	4	5	6	7
Energy saving	-	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000
Additional operating cost	-	40,000	40,000	40,000	40,000	40,000	40,000	40,000
Depreciation	-	800,000	800,000	800,000	800,000	800,000	-	-
Interest	-	300,000	300,000	200,000	100,000	-	-	-
Additional profit before tax	**-**	**1,560,000**	**1,560,000**	**1,660,000**	**1,760,000**	**1,860,000**	**2,660,000**	**2,660,000**
Corporate tax	-	312,000	312,000	332,000	352,000	372,000	532,000	532,000
Additional profit after tax	**-**	**1,248,000**	**1,248,000**	**1,328,000**	**1,408,000**	**1,488,000**	**2,128,000**	2,128,000
Cash	-	2,048,000	3,096,000	4,224,000	5,432,000	7,720,000	9,848,000	11,976,000
Total repayment	-	300,000	1,300,000	1,200,000	1,100,000	-	-	-
EBITDA		**2,360,000**	**2,360,000**	**2,460,000**	**2,560,000**	**2,660,000**	**2,660,000**	**2,660,000**
Net Profit Margin	-	46.22%	46.22%	49.19%	52.15%	55.11%	78.81%	78.81%
Current Ratio	-	6.83	2.38	3.52	4.94			
DSCR	-	7.87	1.82	2.05	2.33	-	-	-

Exercise: Financial statements

Exercise

1. Prepare the following financial statements for the brewery case based on the provided data:
   - Income Statement
   - Cash Flow Statement
   - Balance Sheet
2. Calculate key financial indicators to demonstrate the project's debt repayment capacity, such as:
   - Debt Service Coverage Ratio (DSCR)
   - Quick ratio or current ratio
   - Any other relevant cash flow metrics
3. Discuss in the group what the financials reveal about the project's ability to service debt.

Enhancing credit access for EE projects (1)

- Strong banking relationships:
  - Established or maintaining stable relationships with banks (accounts, deposits, commercial credit, etc.).
- Transparent financial reporting:
  - Complete and clear financial statements, audited or prepared according to accounting standards.
- Business performance:
  - The enterprise has stable profits and operates efficiently.
- Market reputation of products/services:
  - Products or services are reputable and well-regarded by customers.

Enhancing credit access for EE projects (2)

- Operating in a stable and promising industry:
    - Enterprise is in an industry with stable operations and growth potential.
- Qualified management and staff:
    - Employees and management are well-trained and experienced in managing and implementing projects.
- Good credit history:
    - No bad debts and no violations of prior credit agreements.
- Ability to generate cash flow:
    - The project and the enterprise can generate sufficient cash flow to cover debt and operational costs.

Session 4: Examination