DEA & EESD, Energy Partnership Programme between Vietnam and Denmark, DE3 Output 2

Audit Guideline under the EE Incentive Scheme for energy intensive industries in Vietnam

Final Draft, 7 November 2023

NIRAS
RCEE-NIRAS

Viegand Maagøe

Report:	**Audit guideline under the EE Incentive Scheme for energy intensive industries in Vietnam**
Date:	**7'th of November 2023**
Project no:	**DE3 Output 4 (2023)**
Version:	**2**
Prepared by:	**PMP**
Prepared for:	**DEA & EESD**
QA by:	**CAG**
Approved by:	**CAG**

VIEGAND MAAGØE A/S

ZEALAND
Trụ sở
Nørre Søgade 35
DK 1370 Copenhagen K
Đan Mạch

T +45 33 34 90 00
info@viegandmaagoe.dk
www.viegandmaagoe.dk

CBR 29688834

JUTLAND
Samsøvej 31
DK 8382 Hinnerup

Content

Introduction

The following document serves as an extended guideline for energy audits and is based on the existing regulation in Circular 25 (2020) – see Annex 1.

The document defines additional requirements for energy audits to fulfil – next to Circular 25 – when carried out funded by the energy efficiency program under the Danish/Vietnamese cooperation.

As such, the guideline does not present issues described in Circular 25 but topics that the auditor shall include in the energy audit to benefit from Danish funding.

The aim of the guideline is by that to secure, that an energy audit will be comparable to international best practice.

Sections in annotated guideline

This guideline follows the main sections of an energy audit as defined in Circular 25, see table 1 below, that also includes a few requirements described later in the guideline.

Content of audit report	Requirements
Chapter 1: Summary	
Summary of results from audit	Overall annual energy consumption data and costs should be presented A table with identified energy efficiency projects, related savings and investments and payback period. The identified energy efficiency projects should be given priority and should be ranked in terms of importance Proposed further steps should be described
Chapter 2: Introduction	
Introduction to the energy audit	Overall company information (name, address etc.) Break down of company structure and production modes Definition of scope and success criteria for the energy audit
Chapter 3: Affairs of the company	
Overall history of the company, their products and operating data	Annual production outputs Overall annual energy consumption (3 years) Overall assessment of focus areas for energy audit and necessary competences and specialists to involve
Chapter 4: Description of procedures in technology processes	
Introduction to manufacturing process and production equipment	Principle diagrams for significant energy users Flow diagrams for production flow and energy usage
Chapter 5: Energy demands and supply capacity	
Mapping of energy consumption and breakdown of energy usage	Equipment lists, significant energy users Breakdown of energy usage by end-use

Chapter 6: Financial – technical obligations	
Economic framework for energy efficient solutions	Energy prices and relevant taxation Legal framework for energy efficiency Fuel and energy data
Chapter 7: Energy-saving solutions	
Assessment of energy efficiency potentials	Technical analysis of saving potentials via a variety of methodologies Technical and financial assessment of relevant investment projects Overview of non-energy benefits Proposal for energy management systems and KPI-structures

Table 1: Checklist of requirements for energy audits

The column “Requirements” in the table above is described in detail in relevant sections below.

1 Annotated Energy Audit Report

The following sections provide guidance for development of the Energy Audit Reports:

1. Summary
2. Introduction
3. Affairs of the company
4. Descriptions of procedures in technology processes
5. Energy demands and supply capacity
6. Financial – Technical Obligations
7. Energy saving solutions

In this guideline, mainly methodologies for identifying energy saving solutions (section 7) is expanded, but also in other sections, additional requirements are added.

1.1 Summary

Below, a few additional requirements to the summary of the energy audit report are described.

1.1.1 Annual energy consumption, costs and CO_2 emissions

A table with overall annual production outputs and overall energy usage should be present for the past 3 years so overall trends in energy consumption can be understood. The overall energy consumption should also include any use of biomass.

Also, overall annual costs for energy should be presented as well as annual CO_2 emissions.

1.1.2 Recommended energy efficiency projects

In addition to direct investments projects as stipulated in circular 25, recommendations from an energy audit can concern other aspects of energy efficiency, by example:

- Further analysis to investigate certain complicated areas in more detail.
- Improved maintenance procedures for significant energy users
- Better use of energy management procedures and energy-KPIs
- Etc.

Such recommendations should be considered in the overall assessment of energy efficiency potentials.

It should be stated which CO_2-emission reductions the individual energy efficiency projects can achieve.

It should be described which non-energy benefits that have been identified during the energy audit – if any (see Annex 2 for an overview of non-energy benefits).

1.1.3 Further steps

The report shall describe recommended further steps and conclude for which areas pre-feasibility and feasibility studies is to be elaborated in order to prepare the company management for Final Investment Decisions (FID) for significant energy efficiency projects.

Recommended suppliers to be involved in further work to assess precise investment levels should be identified.

1.2 Introduction

Next to immediate description of the company, the following sections should be added:

1.2.1 Scope of the energy audit

It shall be clearly described which motivation the management of the company has to participate in the energy audit, by example:

- Is CO_2-neutrality an important parameter for success of the energy audit? – does the company have a strategy to reduce CO_2-emissions – is phase out of fossil fuels a key question to look into?

- Are clients to the company requesting action to reduce energy consumptions and CO_2-emissions? – is supply chain question important in the management's priority of investments?

- Are non-energy benefits like increase of production capacity or improved product quality important parameters when assessing benefits from energy efficiency projects?

Such questions are important to clarify and describe in order to secure ownership to the energy audit at management level.

1.3 Affairs of the company

From the description of the company and the products it produces, overall focus areas to improve energy efficiency should be assessed and details of the energy audit planned.

1.3.1 Competences and organisation of the energy audit

For many companies, a majority of the energy saving potentials is to be found inside the production processes and not equally important in related utility systems. The energy audit team must include experts with knowledge and experience of the main energy consuming processes in the enterprise audited. In addition, the people responsible for the processes in the industrial enterprise should be involved in the energy audit.

The relevant experiences of the audit team as well as the inclusion of relevant operation and management staff in the industrial enterprise must be documented in the report.

1.4 Description of procedures in technology processes

The energy audit report must include details of how the production processes takes place in the company as well as the utility systems like steam boilers and compressed air systems. Depending on the context, the description must be supported by diagrams.

1.4.1 Simple process flow diagrams

Flow diagrams can be simple diagrams following the production flow including main components like furnaces, conveyors, silos etc. This will most often be enough for relatively simple production flows in by example cement industry, in brick production etc.

Simple production flow diagrams shall be supplied with illustrations for the main components in the plant, by example for furnaces and driers etc. like illustrated in figure 1 below.

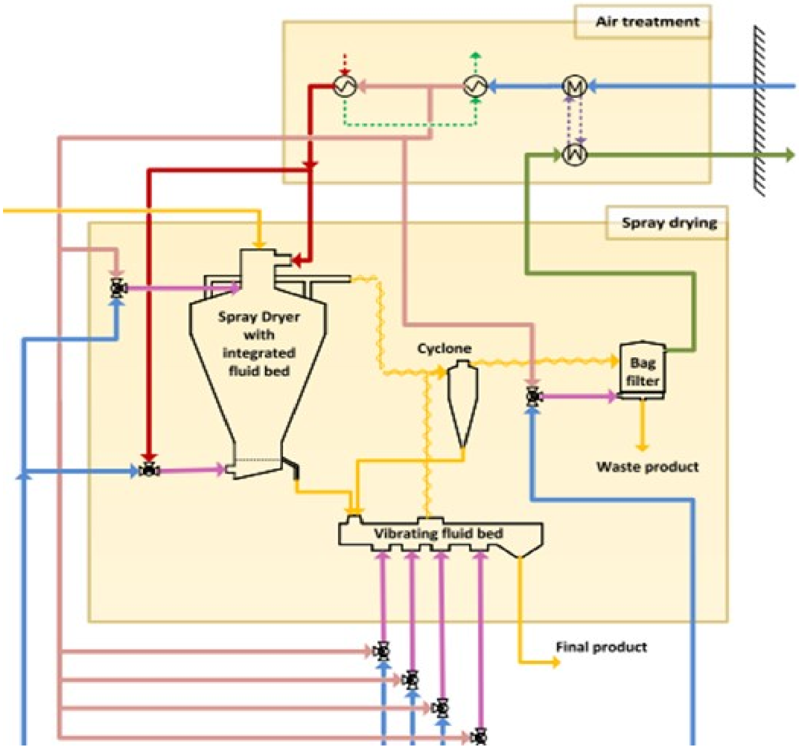


Figure 1. Example of a process flow diagram for an individual process (spray dryer)

Such diagrams provide a good understanding of the energy flows and often also of important process parameters like air flows, temperatures etc.

1.4.2 Advanced process flow diagrams

For sectors like food & beverage, chemical industry and pharmaceuticals etc., the production flow is much more complex, and the energy usage distributed across many different end -users. In such companies the production flow should be described in more detail to provide an understanding of how energy is used at the facility.

Figure 2 below shows a complete production flow diagram for a milk processing plant illustrating all product mass flows and supplied heating and cooling in the individual steps of the process.

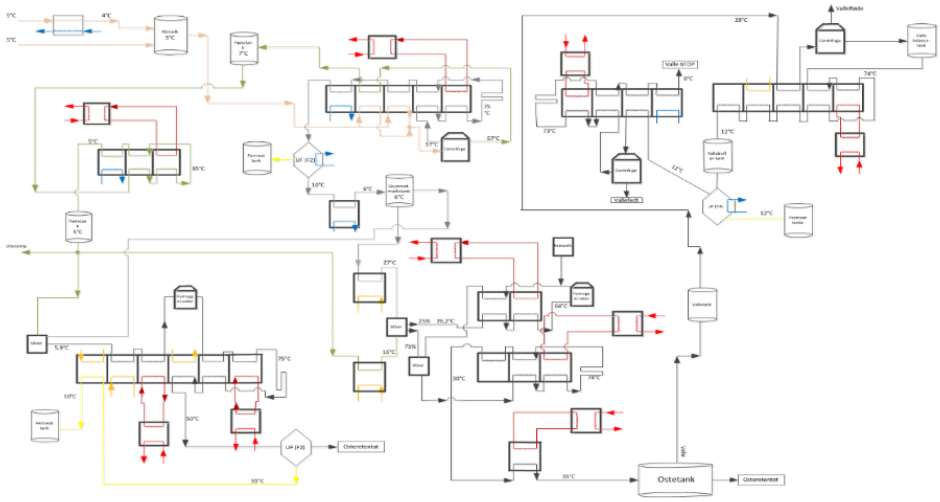


Figure 2. Example of an overall production flow sheet for a dairy plant including hot and cold utility

Such detail is important to understand the overall energy balance of the facility and assessing potentials for recovering heat between individual process steps.

1.4.3 Screen dumps from control rooms

Often screen dumps from control rooms (process supervision) provides valuable information on specific process parameters, see the example in figure 3 below.

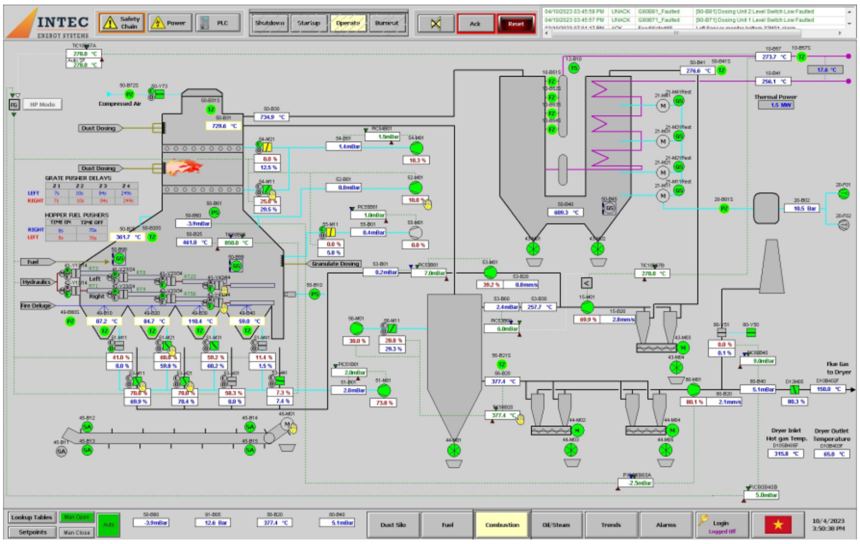


Figure 3. Example screen dump from control room

Such information shall be included in the energy audit report.

1.5 Energy demands and supply capacity

A good understanding of the present energy usage is crucial for identifying any relevant energy efficiency project.

1.5.1 Equipment lists

As a part of the energy audit, tables with design and capacity data for the most important installations must be prepared, first of all for:

- Boilers
- Refrigeration systems
- Large exhaust fan systems (>25 kW)
- Large air conditioning systems (>25 kW)
- Compressed air systems
- Process equipment and other equipment with installed capacity > 25 kW

For each of such systems, the following data should be provided:

- Installation ID
- Name of manufacturer
- Year of installation
- Design capacity
- Rated efficiency (where relevant)
- Operating parameters (flows, temperatures, pressures etc.)

It is important that this mapping not only targets energy supply systems but also collects data for major processes.

1.5.2 Significant energy users

In addition to requirements set out in Step 4 of Annex III of Circular 25, energy and water consumption must be broken down into categories of significant energy users. A significant user may be one particular installation, a set of installations forming a specific manufacturing process (such as paper machine) or a number of installations of similar category (such as lighting; ventilation etc.)

From the initial mapping of equipment, it should be determined which energy users in the facility that should be considered as "significant". Any installation or category of installations consuming more than 5% of the total energy consumption must be mapped.

Examples of such significant end-users is listed in table 2 below.

Thermal end-users (steam, hot water etc.)	**Electrical end-users**	**Water end-users**
– drying – process heating – evaporator lines – boiling – distilling – kilns & furnaces – building heating/HVAC – CIP/SIP – water heating – conversion losses – distribution losses	– refrigeration – natural cooling – compressed air – process air – fans/HVAC – air-conditioning – production machinery – pumps – hydraulics – small motors – lighting	- process (additives) - steam injection (heating) - water for injection (WFI) - RO-plants - humidification of air - cleaning of premises - CIP/SIP - condensate losses - cooling towers - showers - accommodation

Table 2: Examples of significant energy and water users in the industrial sector

For companies with high water usage, also significant water end-users should be identified as much energy usually is bound into heating, cooling and evaporation of water.

1.5.3 Overview of energy consumption by end use

Companies always lack energy meters to monitor a precise distribution of energy usage, both in terms of thermal energy usage, electricity usage and other resources like for example water. Mapping of energy consumption should to the extent possible be based on existing meters. In the absence of meters, a significant element of energy audit work shall therefore be to calculate an estimated distribution of energy end-users.

Assessment of end-users not covered by the strategic spots of measurements in Step 5.1. of the circular, energy consumption should be assessed from the following parameters:

- Installed capacity (kW)
- Estimated load factor (%)
- Annual run-hours (hours)

From such calculations, the importance of significant end-users of energy (table 2 above) can be assessed and tables or pie-charts for usage of thermal energy, electricity and water can be estimated.

1.6 Financial - technical obligations

For each technical solution proposed, in addition to technological and environmental issues, also other significant non-energy benefits, such as implications on production output capacity, product quality, operational costs etc. must be described. If feasible, the financial implications of these benefits must be quantified, and the value must be included in the financial assessment. A list of frequently observed non-energy benefits is shown in Annex 2.

1.7 Energy saving solutions

The analysis of energy consuming processes should follow the approach illustrated in the below onion diagram. Each step must be considered, and a conclusion of the findings must be reported.

1.7.1 Challenging the energy service

An advanced understanding of the energy consumption in a company can often be described via the “onion diagram” illustrated below.

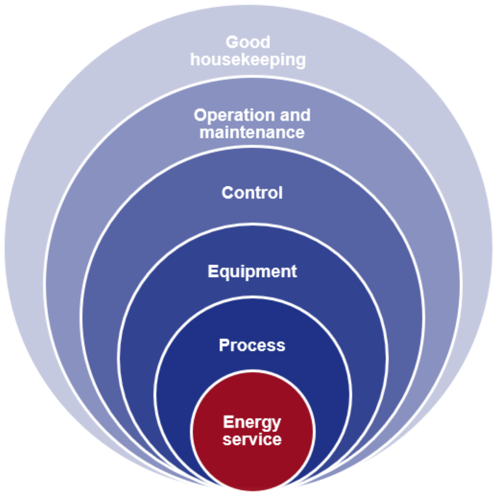


Figure 4. The "Onion diagram" for advanced understanding of energy consumption.

This diagram illustrates, that for any significant energy user there is a reason for why significant amounts of energy is needed, by example:

- For large fan- and ventilations systems, the energy service by example can be:
  - A need for cleaning air in combustion areas via air change and filtration of air
  - A need for maintaining a fair working environment in terms of temperature and humidity

- For autoclaves, the energy service by example can be:
  - Sterilization of product
  - Heat treatment of product

- For large furnaces, the energy service by example can be:
  - Drying of a product
  - Chemical processing of a product (by example sintering or calcination)

The basic idea of understanding the energy service is that the need for this sometimes can be challenged – if by example an air change rate is reduced, then the demand for energy is reduced similarly.
An example of such a discussion is illustrated in figure 5 below for the milk reception in a dairy.

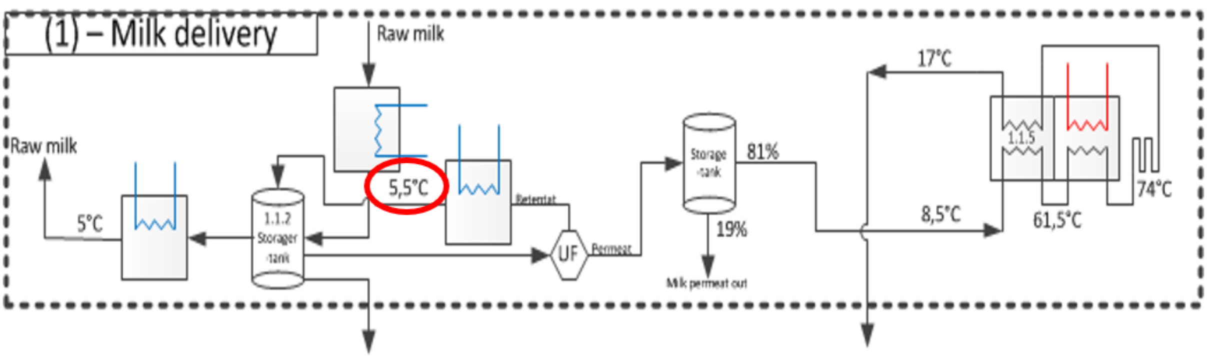


Figure 5. Target temperatures in the milk reception-section of a dairy.

The example shows that all milk received in the dairy by tradition is cooled down to a target temperature of 5.5°C (or even lower), which can lead to the following questions:

- Is the target temperature the same for all products received?

- Is the target temperature the same for all products to deliver?

Such questions might be difficult to answer and bounded in SOPs (Standard Operational Procedures) and any further dialogue should be taken with key-staff in the company able to make decisions on any change of SOPs. The benefit can best-case be that SOPs can be changed and energy savings achieved without any investment.

The energy auditor shall in the energy audit report present an understanding of these questions, i.e. for the most significant energy users it shall be described which overall process parameters that defines the energy consumption. It should further be assessed if these parameters can be challenged and with which benefit.

1.7.2 Energy balances – Sankey diagrams

For the most significant energy users, an energy balance should be established to illustrate the total energy balance and which losses that occur in the operation. The energy balance must quantify all energy and mass flows to and from a certain process. The energy balance should be represented in a diagram such as a Sankey diagram like illustrated below for a drying process in a paper mill.

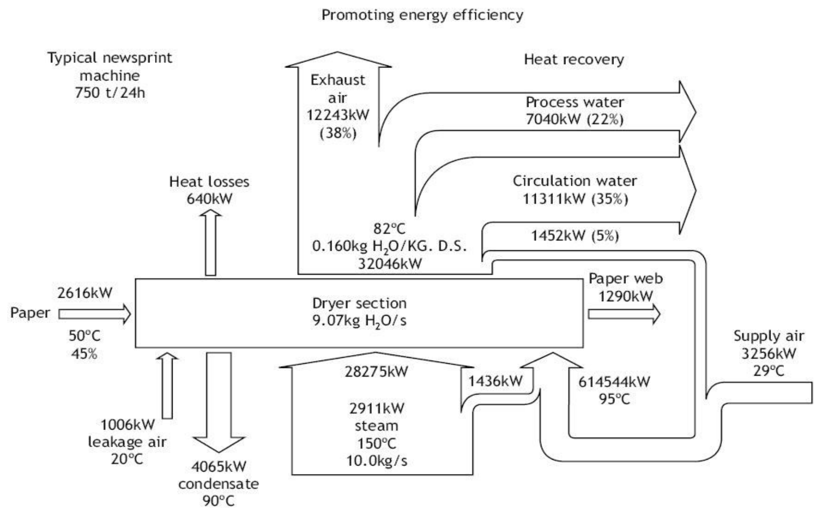


Figure 6. Example of Sankey diagram of the energy balance of a drying process

The benefit from such an analysis is a throughout understanding of the losses in operation and by that an assessment of the efficiency of the process. The analysis can further identify possible opportunities to recover waste heat into the process in order to reduce energy consumption.

Reduction of losses or opportunities for waste heat recovery should be assessed in the energy audit report.

1.7.3 "Level-2"-mapping

In case of processes, where there can be observed large temperature differences between the source and the sink of heating or cooling (for example the temperature difference between the steam supply and the air heated by the steam), the energy audit must perform a level-2 mapping. The purpose of this is to identify potential energy savings potentials through modification of processes or the energy supply systems.

Especially in sectors like food & beverage, chemical industry and pharmaceuticals, it is often seen widespread heat and cooling distributions systems supply heating and cooling to many areas of the facility, with widely different requirement for temperatures – by example steam at 8 bars and 160°C can be used for heating of low temperature heat demands – by example heating of cleaning water or process water to 60°C.

Similarly, it is seen that high quality cooling – by example glycol at minus 6°C – is used for cooling of high temperature cooling demands – by example cooling hydraulic oil at 60°C.

It is important to understand that such large differences in delta-T, i.e. differences in process demand-temperature and delivered utility-temperature, can represent significant energy saving potentials.

To enable such an understanding, companies with such energy supply patterns should carry out a "level-2"-mapping, where any thermal energy demand (heating and cooling) should be mapped by energy demand and temperatures like illustrated in table 3 below.

Process	Temperature Start (°C)	Temperature Target (°C)	Amount (kg/year)	Heat capacity (KJ/kg/°C)	Heat demand (KJ/year)
1					
2					
3					
4					
5					
Etc.					
Total					

Table 3. Data to collect in a level-2-mapping.

The data collection should further collect data for waste heat ventilated to the surroundings, by example hot exhaust from a furnace or a dryer and categorize these as a cooling demand in table 3 above.

The idea of such a data collection is two-fold:

- To assess whether the current energy supply structures is energy efficient (section 1.7.4 below)
- To assess whether heat recovery relevant option for the company (section 1.7.5 below)

To illustrate such potentials, a temperature vs. load-curve as illustrated in figure 7 below should be established.

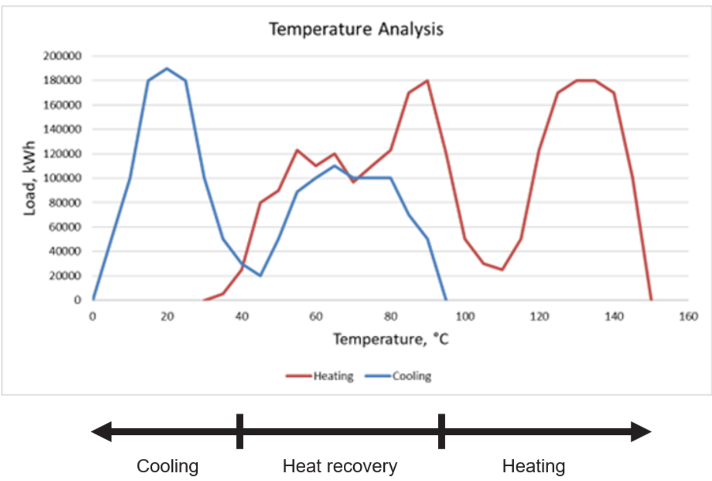


Figure 7. Example temperature/load-curves for cooling demand (blue) and heating demand (red)

This figure shows all heating demands (red) and cooling demands (blue) in a facility integrated into 2 curves by temperature and load. Overlaps in temperatures can be illustrated in such a figure – in this case indicating a significant potential to recovery heat and thus save hot and cold utility.

1.7.4 Utility structures

The understanding of hot utility requirements with the Level-2-mapping can also be illustrated in a diagram like below.

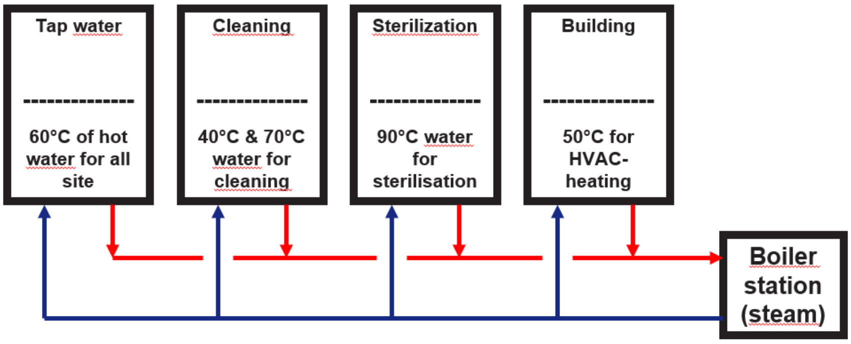


Figure 8. Example how hot utility is supplied across a facility.

In cases where steam is used for many heating demands at low temperatures (< 100°C), the following options to save energy shall be considered:

- Will a hot water system be much more efficient to operate?
- Can heat pumps – eventually driven with solar PV – supply hot water to significant energy users?
- Can waste heat be used to cover certain energy demands?

For cooling demand, similar analysis should be performed like illustrated in figure 9 below.

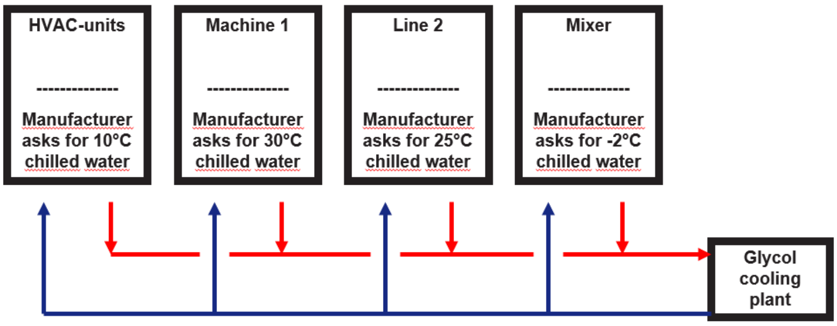


Figure 9. Example how cold utility is supplied across a facility.

In cases, where cooling like brine or glycol at temperatures < 0°C is used for many cooling demands across the facility, the following options to save energy shall be considered:

- Can separate cooling systems at higher temperature – by example +6°C - be applied?
- Can natural cooling (cooling towers) be applied to cover certain cooling demands at high temperature?
- Can internal heat recovery reduce the demand for utility cooling?

Such opportunities are described further below.

1.7.5 Heat recovery schemes

In most facilities heat recovery schemes represent significant energy saving potentials and overall, the following options are to be considered:

- Improved efficiency of already existing heat recovery systems
- Installation of new heat recovery systems internal at significant energy users
- Heat recovery systems across multiple energy consumers

The first of these options address the fact that many existing heat recovery systems have bad performance – either because of fouled heat exchangers with poor heat transfer or because of significant change in operating parameters – by example flows – since the original installation.

The second of these options address the fact that many unit operations/processes have been designed without heat recovery thus impairing the efficiency of the process significantly.

The third option addresses the fact that many industries have waste heat available at many sources across the site and that a collection of these waste heat streams can cover a significant part of the heat demand (heat demands below by example 60°C).

In Annex 3, some examples of such solutions are presented.

1.7.6 Large fan and pumping systems

In certain sectors like cement, iron & steel, paper & pulp and chemical industry (fertilizers) comprehensive fan- and cooling water systems are operated. Such systems are often complex and with low efficiency, which shall be assessed carefully.

For large fans like the one shown in figure 10 below, the control strategy as well as the total fan efficiency must be assessed – often such fans are old with low design efficiency and often the capacity is controlled with dampers and not efficiently with VSDs.

Figure 10. Large exhaust fan in an iron & steel industry

Figure 11 below shows the benefit from controlling capacity of fans and pumps with VSD vs. damper-control.

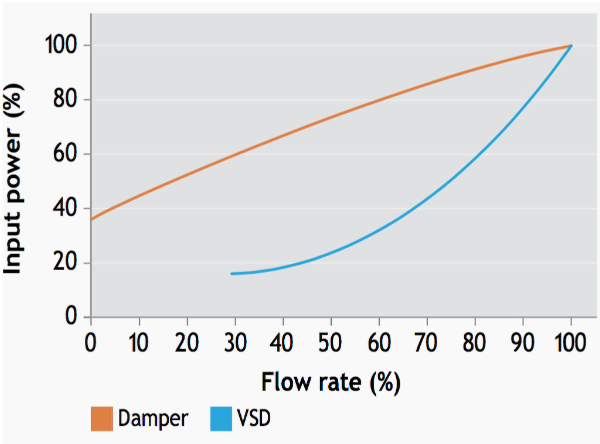


Figure 11. Efficiency of damper- vs. VSD-control for large fans and pumps.

For large cooling water systems like the one shown in figure 12 below, the situation is the same.

Figure 12. Cooling water system in an iron & steel industry

For such large cooling water systems, a careful comparison of delivered cooling and consumed electricity for fans and pumps should be monitored continuously and the COP-system shall be calculated and mapped over longer time-spans as illustrated in Figure 13 below.

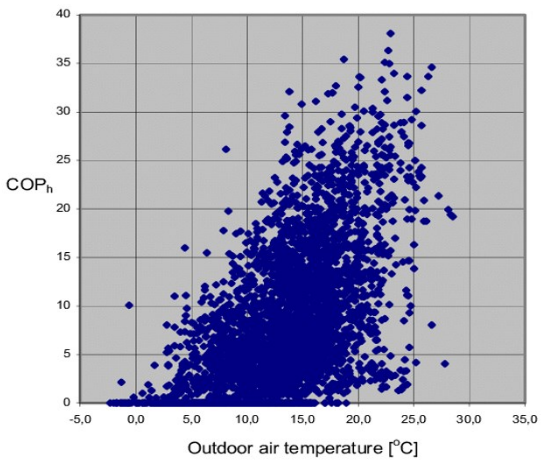


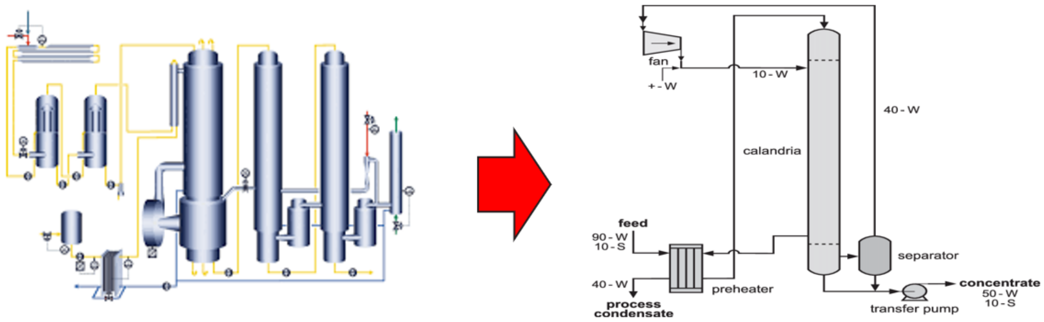
Figure 13. COP monitored for large cooling tower system.

The benefit from such COP-surveillance is that large variations in system efficiency can be discovered thus identifying large potential energy savings via better control of fans and pumps.

1.7.7 BAT-assessments

A throughout understanding of Best Available Technology (BAT) can provide important information on potential energy savings in existing plants.

Detailed information on BAT-solutions can be found in the link to the European Union's BAT-library provided below[1] and illustrated with an example below.



Thermal vapour recompression (TVR) Mechanical vapour recompression (MVR)

Figure 14. Traditional and BAT-solutions for evaporator systems.

In Figure 14, a traditional evaporator system (TVR) is illustrated on the left side and a best-practice MVR-plant is illustrated on the right side – a solution that via electrification might save up to 80% of the supplied energy.

It is important to stress that BAT-solution often will address the core unit operations in a facility and therefore is to be considered as a major and very expensive rehabilitation of these. Such changes are most often only possible if other benefits than energy savings can be achieved, by example increase production capacity, improved product quality, better flexibility of operation etc (see Annex 2 for an overview of "non-energy"-benefits.

It is requested that the energy auditor during the initial phases of the energy audit identifies any need to address non-energy benefits of the facility and then address opportunities for BAT-solution from conclusions in this area.

1.7.8 Maintenance procedures

The sections above have mainly addressed more complex assessments of process energy usage, and it should be emphasized that most industries have significant energy saving potentials simply via improving maintenance procedures for the most important energy users, by example:

- Regular control of boiler efficiency (oxygen-percentage and temperature of exhaust gas)
- Repair or installation of missing insulation at all hot surfaces (piping, valves etc.)
- Repair of leaks in compressed air piping systems
- Cleaning of fouled heat exchangers
- Monitoring of water content in ammonia in refrigeration systems
- Removal/purging of air in condensers in freezing plants
- Repair of steam traps in steam distribution systems
- Etc.

The energy audit must assess if such simple improvements will provide significant energy savings in a company.

[1] *https://eippcb.jrc.ec.europa.eu/reference*

1.7.9 Operational control and KPIs

During the course of an energy audit, is shall therefore be identified if losses from inefficient operation of processes and utility systems occur and how such losses can be prevented.

It shall further be assessed if technical instrumentation and automation systems can prevent these losses or whether specific groups of personal employed in the facility should be trained, by example:

- Operators in control rooms responsible for daily operation of the processes
- Personal responsible for cleaning of equipment and process installations
- Process people responsible for adjusting process parameters
- Etc.

Figure 15 below show an example of the operating pattern for a large evaporator system with indication of how many hours each day the evaporator is processing product (blue), is under clearing (pink), is operated "water-mode" without product but with full energy consumption (green) etc.

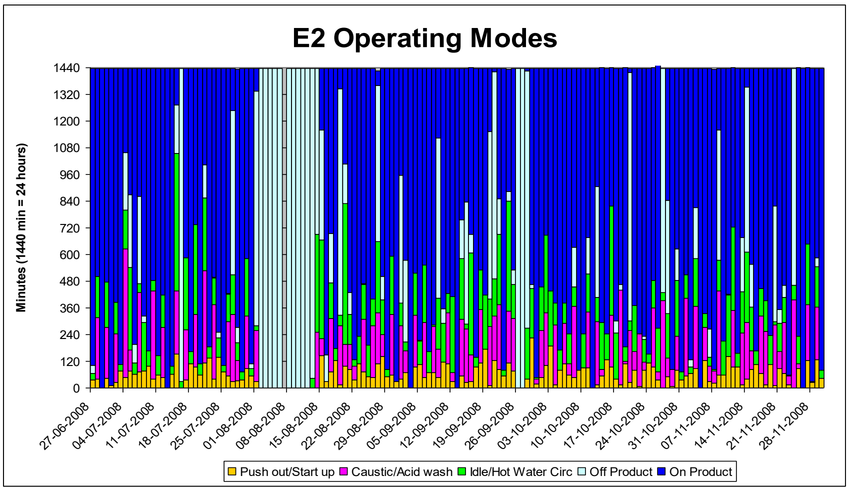


Figure 15. Example of operating modes in large evaporator systems.

A detailed analysis of this diagram shows that operators often clean the evaporator system much to many hours per days and that the evaporator often are operated long hours in "water-mode" – in both cases with significant losses of used energy.

1.7.10 Energy Management Systems

Organization of energy management shall be proposed including identification of relevant staff requirements to cover the necessary positions (e.g. energy managers, boards for energy management).

A proper organisation of an energy management system should further most likely involve different staff at the facility, i.e. technical department, process responsibles, QA-department etc. As an integrated part of these assessments, overlaps with other management systems should be identified, first of all:

- ISO50001: Energy Management
- ISO14001: Environmental Management
- ISO9001: Quality Management

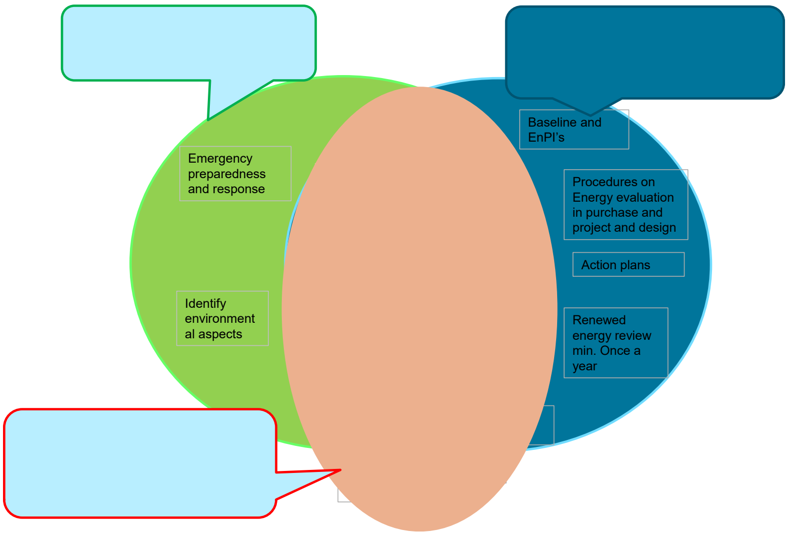


Figure 16. Elements of commonly used management standards

The energy audit shall describe the expected outcomes of such EMS-systems and define which observations and cornerstones the system should be build on.

Appendix 1. Circular 25

Circular 25 (2020) - Planning and Reporting the Implementation Plans for Energy Efficiency; Implementation of Energy Audit

Link to UK version (60 pages): vepg.vn/wp-content/uploads/2020/12/Circular-25-2020_EN.pdf

Appendix 2. Non-energy benefits

M-Benefits: D2.2 Guidelines for Protocols, Interventions and Evaluations

BENEFITS OF ENERGY-EFFICIENCY PROJECTS (This list is based on proven benefits of past projects in Europe and the US)	**IMPACT ON RISKS**	**IMPACT ON COSTS**	**IMPACT ON VALUE PROPOSITION**
Waste			
Reduced waste heat		X	
Reduction hazardous waste	X	X	
Reduced sewage volume	X	X	
Reduced sewage pollution level	X	X	
Reduced product waste	X	X	
Emissions			
Reduced dust emissions	X	X	X
Reduced CO, CO2, NOx, SOx emissions	X	X	X
Reduction of refrigerant gases emissions	X	X	X
Production			
Reduced malfunction or breakdown of machinery and equipment	X	X	X
Improved equipment performance	X	X	X
Longer equipment life (due to reduced wear and tear)		X	
Improved product quality	X	X	X

BENEFITS OF ENERGY-EFFICIENCY PROJECTS (This list is based on proven benefits of past projects in Europe and the US)	IMPACT ON RISKS	IMPACT ON COSTS	IMPACT ON VALUE PROPOSITION
Increased production reliability (due to better control)	X	X	X
Larger product range			X
Reduced customer service costs (due to better quality)		X	X

Improved flexibility of production	X	X	X
Improved temperature control	X	X	X
Improved air filtration system	X	X	X
Reduced raw material need	(X)	X	
Reduced water consumption	(X)	X	
Reduced consumables	(X)	X	
Shorter production cycle (shorter process cycle time)		X	X
Increased production yields		X	X
Operations and maintenance			
Reduced maintenance cost		X	
Reduced machinery and equipment wear and tear	X	X	
Reduced engineering control cost		X	
Working Environment			
Reduced noise	X	X	X
Air quality improvement	X	X	X
Improved temperature control (thermal comfort)	X	X	X
Improved lighting (visual comfort)	X	X	X
Improved workforce comfort	X		X
BENEFITS OF ENERGY-EFFICIENCY PROJECTS (This list is based on proven benefits of past projects in Europe and the US)	IMPACT ON RISKS	IMPACT ON COSTS	IMPACT ON VALUE PROPOSITION
Improved workforce productivity	X	X	X
Reduced absenteeism	X	X	X
Reduction of health costs		X	
Reduced need for protective equipment		X	

Risk Reduction			
Reduced risk of accident and occupational disease	X	X	
Reduced CO_2 and energy price risks	X	X	
Reduced water price risk	X	X	
Reduced commercial risk	X	X	
Reduced legal risk	X	X	
Reduced disruption of energy supply risk	X	X	
Others			
Increased installation safety	X	X	X
Improved staff satisfaction and loyalty	X	X	X
Reduced staff turnover	X	X	X
Delayed or reduced capital expenditure		X	
Reduced insurance cost		X	
Additional space		X	X
Simplification and automation of customs procedures		X	X
Contribution to company's vision or strategy			X
Improved image or reputation	X		X

Source: Killip, G., Cooremans, C. & Fawcett, T. (2018). ***M-Benefits: D2.2 Guidelines for Protocols, Interventions and Evaluations.***
Report link:
https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5bd4f4af7&appId=PPGMS

Appendix 3. Examples of heat recovery systems

Figure 17 below shows an example of a pasteurizer in a whey processing plant, where efficiency can be improved significantly be re-designing heat transfer area in the individual sections thus saving both hot- and cold utility.

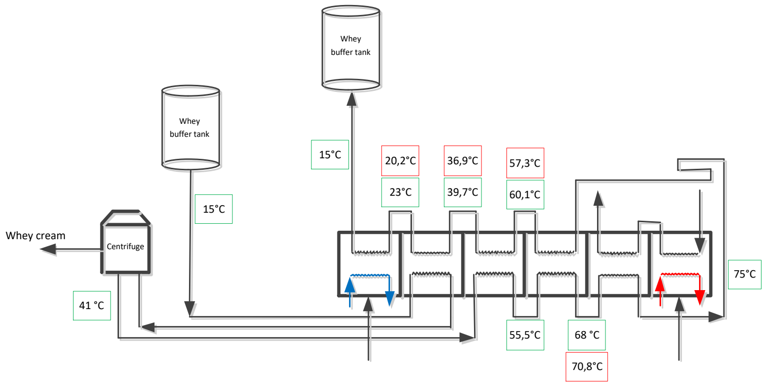


Figure 17. Re-design of pasteurizer in whey-processing plant

The second of these options address the fact that many process installations like furnaces, kilns and dryers ventilates significant amount of waste heat into the surroundings instead of using the heat to pre-heat inlet to the process like illustrated below for a spray dryer system.

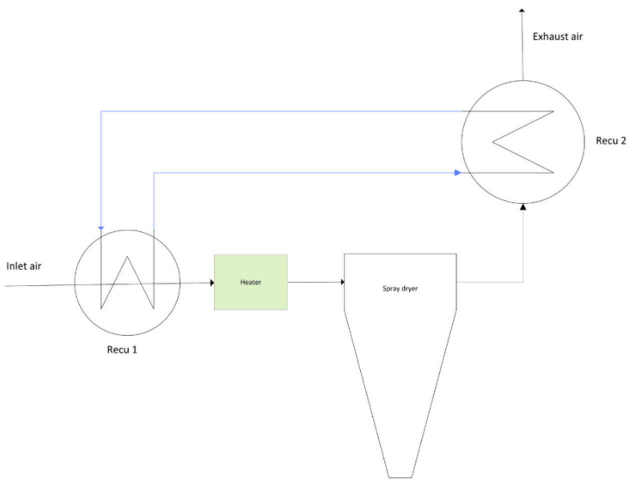


Figure 18. Internal heat recovery outlet-to-inlet in a spray dryer system.

The third of the options listed above address the opportunity to collect waste heat across many sources in a facility, by example from compressed air plants, oil cooling, hot outlets to the surroundings and use this waste heat – eventually boosted with heat pumps – to supply heat to hot water circuits covering certain heating demands in a facility.

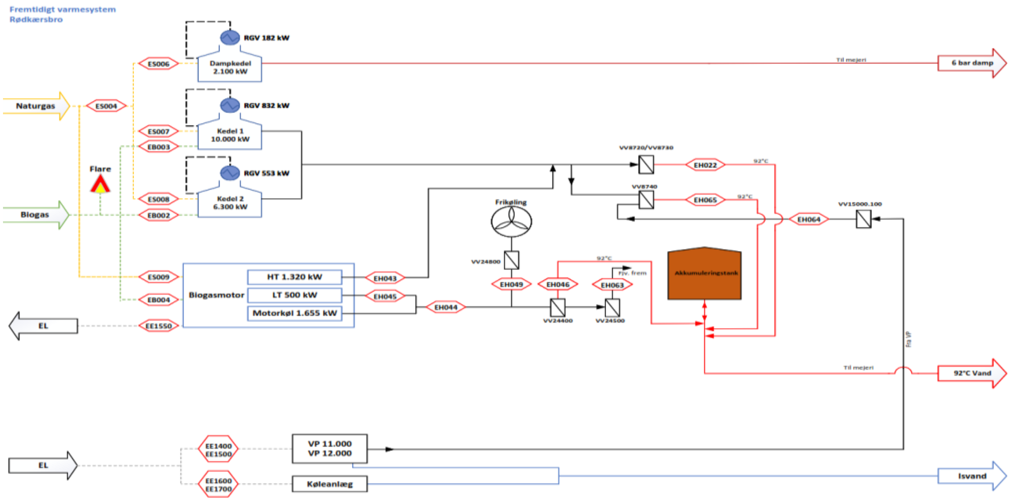


Figure 19. Heat recovery loop with heat pump supplying hot water for certain heating demands.

Such solutions are relevant in food & beverage, in chemical industry and pharmaceuticals and will often cover up to 50% of the total heating demand.

For these sectors such a solution must be considered, while sectors such as cement, paper & pulp and bricks & ceramics only should assess heat recovery options at individual process installations.

In sectors like textile and garments, also heat recovery across energy users should be considered, while mechanics, plastics and electronics most often only can apply waste heat for building heating (seldomly relevant in Vietnam).