DEA & EESD, Energy Partnership Programme between Vietnam and Denmark, DE3 Output 4

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

Draft, 25th of November 2024

NIRAS
RCEE-NIRAS

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Report:	**Project development guideline under the EE Incentive Scheme for energy intensive industries in Vietnam**
Date:	**25'th of November 2024**
Project no:	**DE3 Output 4 (2023)**
Version:	**1**
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Content

Introduction

The purpose of this guideline is to assist energy auditors in identifying, developing, and prioritizing energy efficiency projects based on the information gathered during the audit and the baseline energy mapping developed as part of the audit process. The guideline is prepared in the context of the Energy Partnership Programme between Vietnam and Denmark.

The guideline consists of separate sections going through the different steps of an energy audit process and gives ideas and general guides of the approach and what to take into consideration. It is not an audit guideline, but a guide to support the energy auditor in identifying project opportunities.

The guideline includes the following sections:

- **Project checklist**
    - This section consists of a checklist assisting the energy auditor to verify that the audit report considers and analyses all relevant aspects of the specific technologies as well as general operations of aspects of the industrial enterprise that effects the energy use.

- **General approach to identification of EE opportunities**
    - This section describes the general approach the auditor should use to address possible projects. The method ensures that the auditor looks at the need for the energy service and not only focus on the utility.

- **Before the audit**
    - This section outlines key considerations before conducting the physical walkthrough.

- **During the walkthrough**
    - This section highlights important observations to look for and note during the physical walkthrough of the enterprise.

- **Using Energy Mapping**
    - This section escribes how the energy mapping can and should be used as an important tool to develop projects effectively.

- **Other ways of identifying project**
    - This section explores other relevant methods to use when develop energy efficiency projects

- **Project development approach**
    - This section description an overall approach on how to prioritize the projects securing only to spend time on detailing selected projects.

These guidelines are focusing on the approach and overall guidelines and checklist for the auditor to consider throughout the energy audit process. They are to be used as an overall guide and thus additional details should be found in the audit guideline and the energy mapping guideline prepared as in the context of the Energy Partnership Programme between Vietnam and Denmark.

1 Project checklist.

The checklist should be used by the energy auditor as a quality check of all energy audits conducted. The checklist is a tool to ensure the energy auditor that he/she has carefully considered all major EE opportunities throughout the production processes, the utility systems, the maintenance practices, operator behaviour etc. as well as energy management organisation and practices.

The following chapters provide more details on each of the aspects in the checklist.

When relevant, the audit report should include the conclusions of these analysis steps in the energy audit report. In particular for significant energy consuming processes and utility systems, even if the conclusion of the audit would be that the specific significant energy user is very efficiency and no viable improvement opportunities are identified.

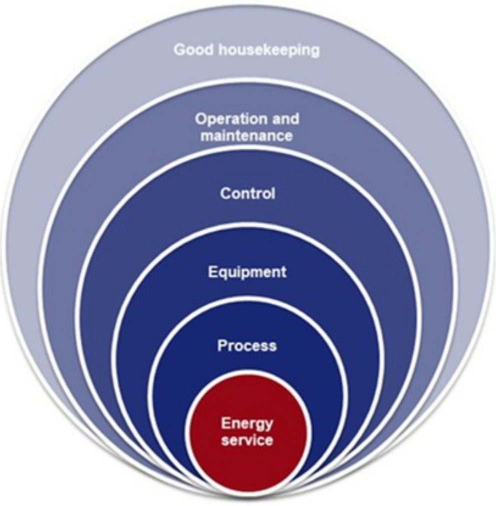
Sub-category	Actions	Included in the audit
General approach to identification of EE opportunities		
The Energy service	Is the energy service mapped? Are there options for reducing the energy service, temperatures, load duration etc.	
The Process	Are alternative processes considered?	
The Equipment	Is the equipment efficient?	
The Control	Is the equipment controlled efficiently?	
The operation and maintenance	Is the equipment operated and maintained as efficient as possible?	
The good Housekeeping	Does the company have a good strategy for continuously improve the energy performance?	
Before the audit, for each major production process		
Creating a overview of main energy users	Try to create a overview of the main energy users related to the production processes.	
Specifying/clarifying what is the actual energy service	See above	
Outline which unit operations that are involved.	Overview of unit operations and research of possible improvements	
Clarify who have an influence on the energy consumption	Identity who has an influence on the energy consumption	
Compare overall KPIs with KPIs from similar production facilities	Generate and compare KPIs of the entire production or on specific units and compare with similar production facilities	
Plans for future investments etc.	Create an overview of the companies plan for future changes that might influence the energy use.	
Energy management	Create an overview of the energy management system	
Start building up your screenings list	Create the screenings list template covering the different arears of the company and include the first find	
During the walkthrough – for each production process / major utility installation		
Look for inefficiencies	Identify the different inefficiencies related to the process and utility systems	
Maintenance status		

Operation Equipment status	Create an overview of the how maintenance is being performed and what is the state of maintenance Create an overview of how operators are influencing the operation Create an overview of the status of equipment	
Using the energy mapping		
Electricity - Focus on significant users - Improve standard for efficiency - Cooling systems - Motor type - Types of motor drives - Light - Ventilation - Other electricity users Thermal - Focus on significant users - What is the demand - Delta T - Identification of losses and efficiencies - Heat recover potential - Potential for rearranging the utility system - System design Specific KPI's Difference between the difference mapping approaches: Mapping degree	Identification of significant electricity users Are there special areas where the efficiency standard should be improved (e.g. VLT on all motors)? Evaluate the performance of the cooling systems Evaluate the motors on site Evaluate the different types of motor drives on site Evaluate the light on site Evaluate the ventilation on site Consider if there are other electricity users that can be grouped and evaluated together Identification of significant electricity users Consider whether there are alternative ways of covering the thermal energy demand? Evaluate how the delta-T in the heat exchangers is optimal Evaluate losses and efficiencies (processes and utility systems) Analyze the heat recovery potential Evaluate whether there is a potential for alternative design of the utility systems Evaluate how the utility systems are matched to the process demand. Generate Specific KPI's and evaluate the performance of the system or sub-systems Use the different mapping approaches to identify discrepancies Use the mapping degree actively to evaluate the quality of the mapping or to identify underestimated consumptions or losses	
Other ways of identifying projects		
Energy management - Evaluating the base line - Future targets Experiences from other similar production sites Company strategy	Evaluate the base line Set targets for energy use, energy reduction etc. for short and long term. Compare with similar sites Make sure that the identified projects support the companies' strategies	
Project development approach		

Gross list Project level B Project level A	Develop the Gross list (screening list) and prioritize which projects to move on to the next project level B and A. It is important to involve the representatives from the company in the prioritization process.	

2 General approach to identification of EE opportunities

When identifying projects, it is very important to start with identifying the **energy service** — the basic purpose of the energy usage. Optimization of energy use should always begin with understanding the energy service itself. When the energy service is understood and determined the next steps in the identification of EE opportunities can progress through all the supporting functions and systems. This structured approach is known as the **Onion Diagram Approach**.



The layers in the onion diagram:

- **The Energy Service:**
  The "energy service" refers to the specific requirement that a process must fulfil. Example: In the production of a medical device, e.g. a needle, the energy service is to sterilize the product (the needle). However, in the specific example the needle is sterilized in bags filled with sterile water,. The energy service demand can be reduced if only the finished product (the needle) is sterilized and not also the sterilized water in the bags.

- **The Process:**
  The "process" refers to the type of method chosen to deliver the energy service. Alternative processes can often be considered to improve energy efficiency. Example: Currently, sterilization is performed via autoclaving, i.e. by heating the product (the needle) to more than 100°C. It should be considered and examined if the same energy service could be achieved using alternative methods such as other forms of thermal sterilization, chemical sterilization or radiation sterilization?

- **The Equipment:**
  The "equipment" relates to the energy efficiency of the tools and machinery used to execute the process. Some equipment may be inherently less efficient, while others are designed to optimize energy use. One way to evaluate equipment efficiency is by using the Total Cost of Ownership (TCO) approach,
  Example:
  Different autoclaving systems may have varying efficiencies depending on their design - both in terms of mechanical design and control system design.

- **The Control:**
  The control system used to manage the process plays a significant role in achieving energy efficient operations. Processes often operate under varying conditions with fluctuating outputs, so control systems must adapt to maintain efficiency.
  Example:

Proper planning during the design phase is crucial to ensure the installation of suitable transmitters for energy efficient operation. Additionally, using frequency control for motors, pumps, and similar equipment is often essential for optimizing energy efficiency during regulation.

- **Operation and Maintenance:**
  Operation and maintenance procedures are critical for sustaining energy efficiency both in daily operations and over the long term. Focus on regular maintenance and proper operation will often lead to non- or low investment EE projects.
  Example:
  Operators make decisions that significantly impact energy efficiency. Equipment efficiency can degrade over time due to lack of maintenance, fouling, leaks, or other issues. Regular maintenance and proper operational practices are essential to prevent these losses.

- **Good Housekeeping:**
  A company's culture and approach to energy management significantly influence overall energy consumption.
  Example:
  Implementing an energy management system aligned with **ISO 50001** ensures systematic energy efficiency practices. Energy awareness among all personnel involved in energy use is crucial.

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.

3 Before the audit

Before starting an industrial energy audit, it's essential to gather key information to ensure the audit is as efficient and effective as possible. This preparation helps the audit team understand the facility's energy needs, operational requirements, and potential areas for improvement.

Having this information in advance streamlines the audit process, allowing the team to focus on key areas, tailor recommendations to the facility's needs, and deliver actionable, cost-effective results aligned with organizational goals.

- **Main consumption:**
  Create an overview of the main consumption. E.g. which of the production process are using a large share of the energy consumption.

- **Specifying/Clarifying the Actual Energy Service:**
  A clear understanding of the specific energy service related to the process enables the auditor to begin considering the elements in the onion diagram.

- **Outlining Unit Operations Involved:**
  Identify the unit operations involved in the facility's processes. This provides an overview of the types of equipment the auditor can expect to encounter. With this information, the auditor can make initial research on energy efficient improvements that already have been implemented at the facility or by others in similar facilities.

- **Identifying Who Influences Energy Consumption:**
  Understanding who influence the energy consumption the most helps the auditor to identify the key personnel to engage during the walkthrough. The auditor should also consider the most common operational practices to be able to analysis both negative and positive impacts on the energy performance.

- **Comparing KPIs with Similar Facilities:**
  By comparing the facility's key performance indicators (KPIs) with similar production facilities (both globally and regionally) the auditor can identify areas of focus for developing energy efficiency projects.

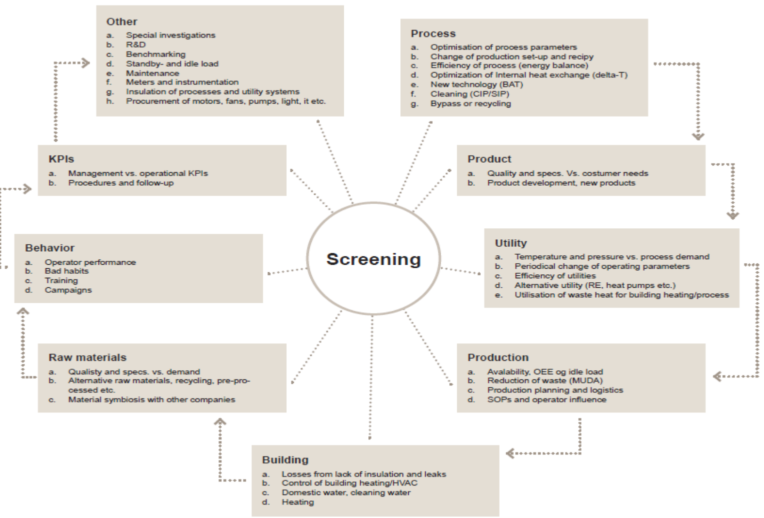
- **Assessing Future Needs:**
  It is important for the auditor to understand the facility's future requirements. Energy efficiency activities should ideally be integrated with planned changes, such as new equipment installations, capacity expansions, or the introduction of new production lines. Implementing energy improvements during these changes is often more feasible and cost-effective than retrofitting afterward. This approach can also facilitate the adoption of new technologies or new production processes.

- **Reviewing Energy Management Status:**
  The current status of the facility's energy management efforts provides valuable insights into how the company has been addressing energy performance.

- **Building a Screening List:**
  Developing a comprehensive screening list ensures the auditor examines all relevant elements and avoids focusing exclusively on areas of personal interest. The list should be prepared before the audit and developed further as part of the audit making sure that all areas of interest, and not only e.g. the utility, are covered during the audit.

Elements than might be considered in the screenings list:

- Process
- Product
- Utility
- Production
- Building
- Raw material
- Behaviour
- KPI's
- ….



4 During the walkthrough

During the walkthrough audit, there are several elements for the energy auditor to investigate:

- **Look for inefficiencies:** There are many signs of inefficiencies that the auditor should be aware of:
    - **Thermal losses:** These include combustion losses, radiation and convection losses from operating units and pipes, high delta-T on heat exchangers, etc.
    - **Idle load:** Equipment running without production, such as conveyors operating without products or evaporators evaporating water while on "hot standby."
    - **Regulating losses:** Are motors, pumps, fans, etc., controlled by belts, gears, valves instead of a variable speed drive?
    - **Loss of condensate:** Is condensate not being returned to the boiler? This could indicate malfunctioning steam traps or poor system design. Makeup water will need to compensate for the condensate losses, which reduces energy performance and increases water consumption.
    - **Design:** Equipment that are poorly designed, e.g.

- **Maintenance status:** What is the current status of maintenance? For example: Are filters blocked?
    - Is transport equipment dirty, increasing friction?
    - Are there insulation damages?
    - Are electrical terminals not tightened?
    - What is the extent of leakages (air, steam, water, etc.)? These issues often result in temperature increases, which can be identified with a thermal camera.

- **Operation:**
  To what extent do the operators influence energy performance on site?
    - Is the operator responsible for and aware of determining the extent of idle load?
    - Is the operator responsible for and aware of setting the Cleaning-In-Place (CIP) time?
    - How are temperatures, pressures and flows managed?
    - How is performance monitored?

- **Equipment status:**
    - What is the overall impression of the equipment? Is it worn down or in near-new condition?
    - What is the overall impression of operations? Do the operators prioritize energy performance?
    -

All the questions above can help identify potential project opportunities.

5 Using the energy mapping

Based on the initial data collection, it is recommended to conduct an energy mapping, as described in the Energy Mapping Guideline.

There are various ways to use the information within the energy mapping, with a primary focus on identifying project opportunities.

It is essential to always keep in mind the purpose of the project when identifying opportunities. When considering potential projects, it is important to categorize the approach into Electricity and Thermal, as each will require different strategies.

Electricity:

Electricity consumption is mapped based on parameters such as power, operating hours, load, mass flow, and key performance indicators (KPIs) or measurements. With this information, a wide range of questions can be raised, forming the basis for further investigation aimed at project development. Some ways to identify projects include:

- **Focus on significant users:**
  Energy mapping helps identify the most significant energy consumers. These major users give the auditor a clear focus area. For example, if 70% of energy consumption is related to motors, it is recommended to focus on motor standards, drives, controls, etc.

- **Where to set new standards**:
  Are there specific areas that require particular attention? For instance, should the company establish motor purchasing guidelines or a maintenance strategy?

- **Motor type:**
  What is the status of the motor installations? Should specific motors or groups of motors be replaced or upgraded?

- **Drive type:**
  What is the standard of motor drives? Should attention be focused on specific drives, or is a more general approach needed?

- **Electrical unit operation:**
  The energy consumption for different unit operation like transport systems, cooling and chillers (see the thermal section below), ventilation, agitation, etc. should be determined. If the specific unit operation is associated with a large share of the energy demand special attention should be given to that specific unit operation. E.g. is the agitation controlled according to the demand and are the agitators designed for the specific product?

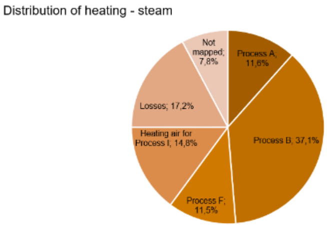
- **Lighting:**
  What is the current status of the lighting at the site? Should specific areas of lighting be upgraded, or should a company-wide lighting strategy be implemented?

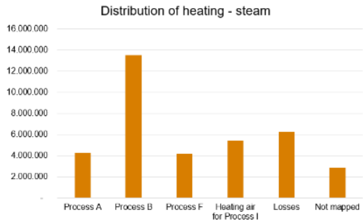
Other electricity users should be analysed using the same approach as outlined above.

Thermal:

- **Focus on significant users:**

Energy mapping also identifies significant thermal energy users, helping the auditor to determine where to focus the effort to develop EE projects. For example, if 50% of energy consumption is related to a particular unit operation, the auditor should focus on improving the energy performance of that operation.





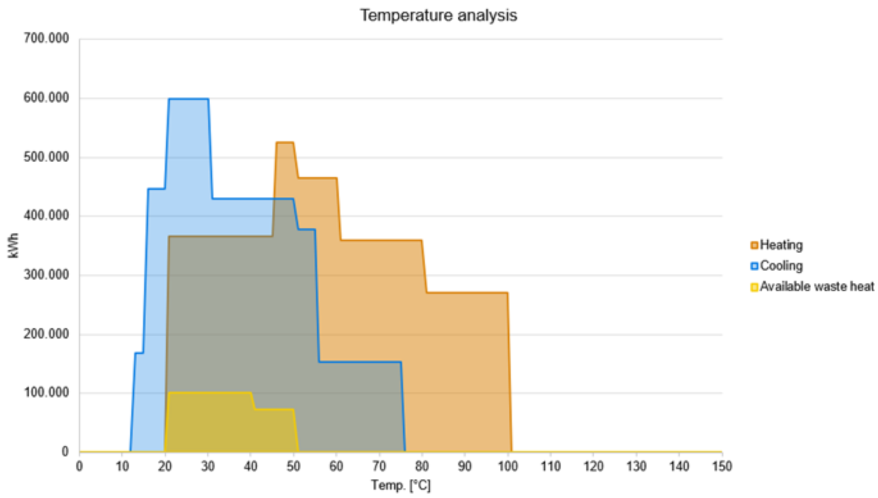
There are different ways to present energy usage. Two common methods include showing energy distribution in relative terms (percentages) or in absolute terms (kWh/year). By examining these figures, the auditor can pinpoint areas to target. For instance, if the process area consumes 37% of energy, accounting for 14 GWh/year, even a small improvement could significantly impact total energy consumption. The mapping also highlights losses (e.g., 17.2%), which often represent relatively easy areas to improve.

- **Demand analysis:** Energy mapping clarifies the specific energy demand from a process perspective. This data can be used to tailor energy systems to meet demand more efficiently. For example, it should be investigated if a large could be met by a low-temperature system powered partly or entirely by waste heat?

- **Delta T (Temperature Difference):** The energy mapping can reveal thermal efficiencies by showing temperature differences across heat exchangers. This information can be used to optimize existing thermal systems. For example, improving return temperature in the heating system could reduce thermal losses and thus improve boiler efficiency.

- **Identification of losses and efficiencies:** Energy mapping identifies losses in utility systems, providing opportunities for improvement. For example, if boiler losses are higher than those of similar installations, the auditor can explore ways to improve the boiler's energy performance. The same applies to distribution systems - if losses are higher than expected, improving thermal insulation should be considered. Additionally, the mapping may include the **Coefficient of Performance (COP)** for chillers, refrigeration, and heat pumps. Comparing this data with best practices can provide insight into areas for improvement. The mapping will also show how much heat is recovered from boilers, chillers, air compressors, etc., helping the auditor to determine whether further improvements can be made.

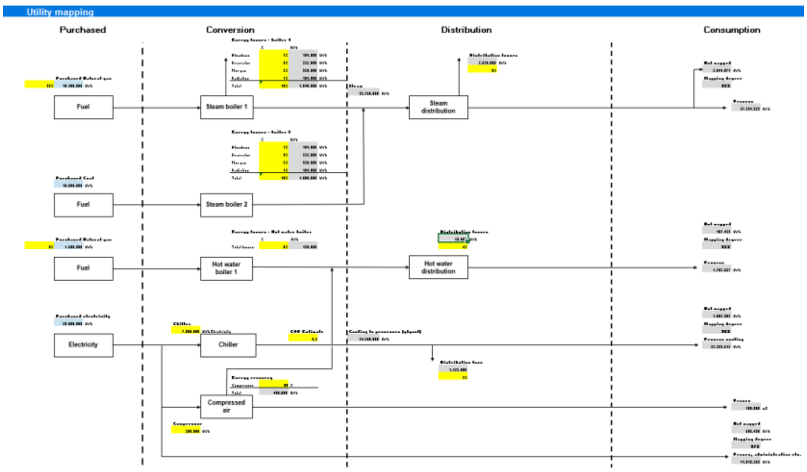
- **Heat recovery potential:** Heat recovery projects are often cost-effective. For example, the energy mapping output might display energy consumption by degree for cold, hot, and waste heat recovery thermal systems.



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

The yellow area shows the available waste heat, which could potentially meet some heating demand but has no impact on cooling demand. If the heating and cooling areas don't overlap, it may be worthwhile to consider using a heat pump to transfer heat from the cooling system to the heating system using electricity.

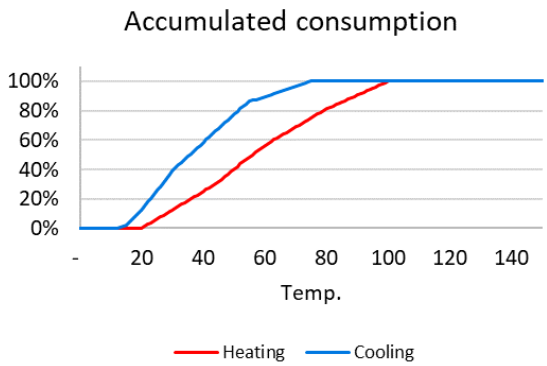
- **Potential for rearranging the utility system:** Several questions can be raised when analysing the setup of utility systems.



Some examples are:

- Instead of having one single steam system, could a differentiated system with different steam pressures be implemented. Lower steam pressure uses less energy and thus different steam pressures could improve energy performance by reducing losses and increasing unit efficiency?
- Could a hot water system be introduced to meet part of the current steam demand? This would open opportunities to integrate different heat recovery systems.
- 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?

- **System design considerations:**
  Looking at the energy distribution data, it may be apparent that e.g. some of the heating demand can be delivered at a lower temperature that the existing system is set for. In the illustrated example below, it is evident that 55% of heating demand is below 60°C. This raises the question: why use steam to cover such a low-temperature demand? Similarly, in the example 50% of cooling demand is above 30°C, could this demand be met with other technologies, rather than chillers? Why not tailor the energy system to match the actual demands of the users?



- **Specific KPIs:**
  Energy mapping allows for the generation of mass-based KPIs for all energy uses, which can be used to compare different units against best practices. This comparison is a powerful tool for identifying opportunities for improvements.

- **Differences in Mapping Approaches:**
  Multiple mapping approaches can be used in energy mapping (flow, KPI, and measurements). Using more than one approach can help validate the accuracy of the data and identify discrepancies.

- **Mapping Degree:**
  The mapping degree or detailing of the energy mapping indicates how accurately energy consumption is accounted for. A low mapping degree may suggest: Some energy users have unconsciously been overlooked.
  Losses may be higher than initially estimated.
  Idle or standby loads are not included.
  There may be inefficient control systems, either automated or manual.

  These issues could indicate opportunities for improvement.

  On the other hand, a high mapping degree (>100%) suggests that some estimates may be too high, potentially leading to overestimated project opportunities.

6 Other ways of identifying projects.

Besides the method to identify EE projects described in the previous sections of this guideline, a few other ways of identifying projects can be mentioned.

- Energy management: Energy management is the company's tool to ensure that all relevant activities and decisions related to the efficiency of energy consumption is considered. Energy management is the proactive and systematic monitoring, control, and optimization of an organization's energy consumption to conserve use and decrease energy costs. And Energy Management is thus more a good way of securing the continues work with energy efficiency. The method described in the sections above can be part a natural part of the energy management system securing that all EE projects are considered.

  Experience shows that energy management can provide significant energy savings in the first year. The vast majority of companies can make their energy consumption more efficient, even if they didn't think it was possible.

  Energy consumption also means climate impact. With energy management, the company ensures that it does not affect the climate more than necessary and signals a "green" profile in relation to customers and business relationships.

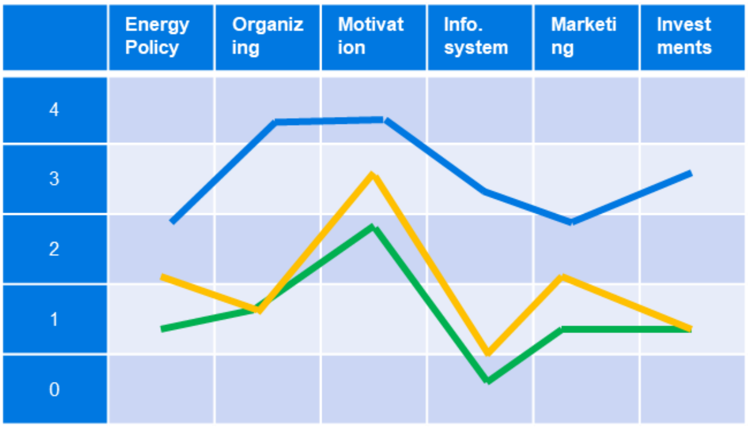
  Energy management is much more than technology. It is a management tool on same level as environmental management and quality management. The systematic work with energy savings provides experience and skills for a possible later certification in energy management.

  Energy management leads to operational optimization. Focusing on energy consumption will often lead to better utilization of machinery and raw materials, as idle losses and waste are minimized. At the same time, the company gets better key figures on operating costs.

  To improve the energy management system a matrix evaluation like the one shown below can be used. The matrix can both be used to evaluate the present status of the energy management system, and it can be used to recommend and decide how the company should develop the energy management system in a short term and in a long term.

Level	Energy policy	Organize structure	Training & awareness	Measure, monitor	Communication	Investment
4	There is an energy policy, an action plan, and a commitment from the CEO.	Energy management is one of the contents of the plant management	There are regular channels of information on energy management at the plant.	There is a system to set energy consumption, complete monitoring for factories, workshops and large energy users.	There is always information, advertising about the plant and energy efficiency activities both inside and outside the plant.	There are specific and detailed plans for new investments and improvements to existing equipment.
3	There is an energy policy, but without CEO commitment	There is an energy management committee/group at the plant.	The Energy Department has always had direct contact with the key energy users.	There are measurement and monitoring systems for factories and workshops.	Regular campaigns to raise awareness about energy management throughout the plant.	Use the return on investment criteria to grade investment activities
2	No clear energy policy	Energy management responsibilities are not clearly defined.	Contact the main consumers through a temporary management board	There is only measurement and monitoring system for the plant level.	There is regular communication but only in a few parts of the plant.	Considering investment only in terms of quick payback.
1	There are no written energy efficiency guidelines.	The energy manager has a limited role in the plant.	Informal contact between engineers and users	Data analysis based on energy bills	There are not often communication activities	Only implemented low-cost measures.
0	There are no energy policy	There is no organization/individual responsible for energy consumption at the plant.	No contact with users	There is no information and measurement system.	No communication about energy efficiency	No investment plan to improve energy efficiency

The evaluation and the development can graphically be illustrated as in the figure below (green= present status, yellow= short term development and blue=long term development).



When suggesting for improvements it is important to consider the following questions:

- What is the value of the new target?
- What is the investment in the new target?
- What resources are needed to obtain the new target?
- How will the target be maintained?
- How will the target be monitored?

- **Experiences from other similar production sites:**
  It is important that the auditor also include experiences from other sites that have similar production or are using some of the same unit operation.

- **Company strategy:**
  The company's strategy can also be very determined on how to develop projects. Should the projects be developed based on targets for energy savings, carbon savings, financial savings, potential for increasing the production capacity or a mix of these aspects. E.g. if an oil boiler is replaced with an electrical boiler the energy savings in terms of kWh are minimal, but the carbon savings are large if the electricity is produced by solar PV.

- **BAT notes**:
  In the BAT (Best Available Technology) notes a lot of inspiration can be found related to standard systems, KPI's, energy improvement projects, and emergent technologies:
  https://eippcb.jrc.ec.europa.eu/reference

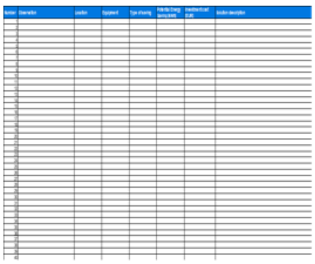
7 Project development approach

In order not to spend too much time on developing details of projects that turns out not to be feasible it is recommended to narrow down the number of projects before increasing the level of details.

The starting point will be the **Gross list**, containing all projects, both good and poor ones. It is important to keep all the projects on the list, because a project that might be relatively poor today micht turn out to be good in a few years e.g. if the boundary conditions changes. The **project level B** (Basis) develops the project to a certain extent and then finally the project is developed to a **project level A** (advanced) where more details are added to the project evaluation.

Gross list

- All project ideas



Project B (Basic)

- Project description (one or two lines)
- Energy savings
- Financial savings
- Investment (based on experience)

Level A (Advanced)

- Project description
- Energy savings
- Financial savings
- Investment
- Payback time
- Simple system process flow diagram (PFD)
- Simple Risk analysis
- Non energy benefits

Between each project development level, the projects are prioritized based on the company’s strategy, ensuring the most attractive project for the company will be prioritized and further developed, and thus supporting the company’s strategy. Finally, the list of proposed projects will be narrowed down to a limited number of projects that can be examined through feasibility studies leading to final investment decisions.