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ESCUELA DE INGENIERÍAS INDUSTRIALES

UNIVERSIDAD DE VALLADOLID

ESCUELA DE INGENIERIAS INDUSTRIALES

Grado en Ingeniería en Tecnologías Industriales

PRIMEROS PASOS PARA IMPLEMENTAR UN SISTEMA DE GESTIÓN ENERGÉTICA

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TFG REALIZADO EN PROGRAMA DE INTERCAMBIO

TÍTULO: FIRST STEPS TO IMPLEMENT AN ENERGY MANAGEMENT SYSTEM

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RESUMEN Y PALABRAS CLAVE

El proyecto aquí descrito consiste en establecer los primeros pasos para implementar un Sistema de Gestión Energética (SGE) para la empresa Nedschroef Heldmond B.V, la cual es líder en Europa en el mecanizado de pernos y tornillos. El objetivo fundamental de que la mencionada implementación se lleve a cabo es que la empresa Nedschroef Heldmond B.V obtenga la certificación ISO 50001.

Una de las tareas realizadas en este proyecto fue crear un manual que ayude a la empresa a establecer el SGE. También se definieron una serie de prerrequisitos, cruciales para que la implantación del sistema sea exitoso, así como una serie de recomendaciones necesarias para mejorar el rendimiento energético de la empresa.

Otro reto importante en este proyecto fue implementar el SGE en los otros sistemas de gestión que tiene la empresa actualmente: calidad y medio ambiente.

Con el fin de combinar todas las tareas anteriormente descritas, se decidió realizar una aplicación interactiva que permitía ver la interconexión entre los sistemas de gestión (calidad, medio ambiente y energía). Esta aplicación también contenía el manual, los prerrequisitos y recomendaciones creados. El fin de esta de aplicación no es otro que ayudar a que la implementación del SGE se lleve a cabo

PALABRAS CLAVE:

- SGE: Sistema de Gestión Energética.
- IDEn: Indicadores de desempeño energético.
- Línea de base energética.
- Ciclo PDCA(Plan,Do,Check,Act).
- ISO :The International Organization for Standardization

Final Report

Helmond
January `18

Yeşim Aksu
Kal Verheijden
Daniel Nordman
Victor Barcena Gato
Alvaro Espeso Sanz

I Foreword

This is the final report of the Nedschroef project group. We participate in the EPS programme (European Project Semester), which is organized at Avans University of Applied Sciences in Den Bosch. Our Team consists of one Dutch student who is studying mechanical engineering in Breda. Two Spanish students, one of them is studying chemical engineering in Santander and the other member is studying industrial engineering in Valladolid. Another student is from Finland and is studying electrical engineering in Vaasa. The last student is from Germany and is studying international industrial engineering in Augsburg.

There are a lot of advantages of working in an international group. Different backgrounds and different cultures are leading in creating creative solutions.

The project group would like to thank the following individuals from Nedschroef Helmond for their assistance and support:

- René van Geffen – CIP
- Eric van Berlo – Quality manager
- Jack de Wit – Quality development engineer
- Rik Leenders - Maintenance

The project group would like to thank the following individuals from Avans University of Applied Sciences for finding a challenging and interesting project:

- Frans van Seggelen
- Adriana Quintero Ramirez
- Daphne van den Berg

Nedschroef project group. From left to right; Alvaro, Daniel, Kal, Yeşim, Victor

II Summary

Nedschroef project group of Avans University of Applied Sciences has created the following report in completion of the European Project Semester (EPS). Throughout the semester, the project team has been working with the Quality Department of Nedschroef Helmond B.V. to create an Energy Management System in order to receive the ISO 50001 certification.
The overall objective of this project was to establish the first steps in implementing the Energy Management System. The project group approached this goal by creating an application with power point. In the final application It is possible to navigate and find information about: different ISOs (9001,14001,50001, different manuals (environmental, energy), management system processes, prerequisites, recommendation, introduction for employees and description of the Energy Management System.

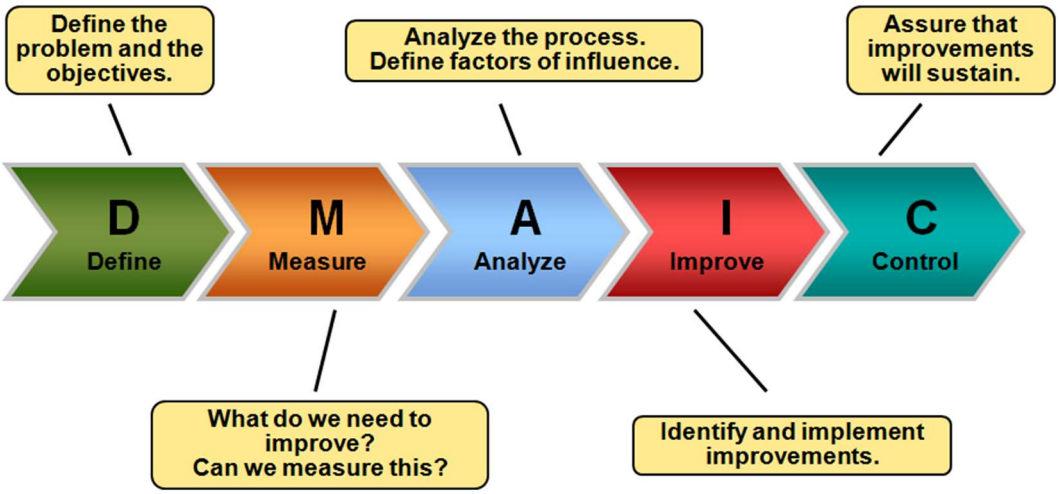
The energy management system consists of five main steps: Create an energy policy, make an energy planning, do an energy review, check the results and do a management review. These steps are core elements for a successful continuous improvement of energy performance. The former mentioned steps are comparable with the PDCA circle.

III Glossary

ISO: (International organization for standardization): ISO creates documents that provide requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose.

EnMS (Energy Management System): A system which purpose is to enable an organization to follow a systematic approach to achieve continual improvement of energy performance, including energy efficiency, energy use and consumption.

6-sigma: Six Sigma is an approach to data-driven management that seeks to improve quality by measuring how many defects there are in a process and systematically eliminating them until there are as close to zero defects as possible.



Stakeholders: A person, group or organisation that has interest or concern in a project. Stakeholders can affect or be affected by the organisation's actions, objectives and policies.

Kaizen: it is the Japanese word for "improvement". In business, kaizen refers to activities that continuously improve all functions and involve all employees from the chief executive office to the assembly line workers. It also applies to processes, such as purchasing and logistics, that cross organizational boundaries into the supply chain.

Pareto: The Pareto principle (also known as the 80/20 rule) states that, for many events, roughly 80% of the effects come from 20% of the causes.

LEAN: course that the company gives to the employees so that they understand the philosophy of the company, teaching to understand and to apply terms like Kaizen, 6-sigma, Pareto, etc.

IV List of abbreviations

Abbreviation	Meaning
EPS	European Project Semester
ISO	The International Organization for Standardization
PDCA	Plan, Do, Check, Act
EnMS	Energy Management System
EnPIs	Energy Performance Indicators
QM	Quality Manager
e-MJV	Electronical Environmental yearly report
EEP	Energy efficiency plan
OHSAS	Occupational Health and Safety Assessment Series
EnB	Energy Baseline
HRM	Human resources manager
GHG	Greenhouse Gases
OPS	Energy policy example
e.g.	Exampli gratia
S.E.U	Significant energy uses
N.M.D.S	Nedschroef Management Development System

V Mathematical symbol index

Math Symbol	Meaning
kWh	kilowatt per hour
m	Meter
kW	kilowatt
h	Hour
n^opc	Number of PCs
Kg	Kilograms
m^2	Square meter

Content

Chapter 1 Introduction

The task was to establish the first step to create an Energy Management System for receiving an ISO 50001 certification.

Nedschroef Helmond B.V. already has the ISO 9001 (quality) and ISO 14001 (environment) standards, which are a base for implementing the ISO 50001 standard. The structure of the Energy Management System is similar to the structure of the earlier management system for quality and environment because they are all based on the PDCA approach (Plan-Do-Check-Act)

The reason for implementing the ISO 50001 standard is mainly because of intrinsic motivation. This motivation comes from the facts that Nedschroef cares about the future and therefore wants to reduce their energy consumption. Reducing energy consumption also means less expenses. With the saved costs other more important things could be financed.

As global warming became more relevant and humanity started focusing more on the environment, ISO 50001 for energy management was introduced.

What makes the energy management system different from the others, is the energy planning stage which is one of the major parts of the systems. The energy planning consists of the following:

- General
- Legal requirements and other requirements
- Energy review
- Energy baseline
- Energy performance indicators
- Energy goals
- Energy objectives, targets and action plans

In order to find opportunities for energy performance improvements, the organisation must first know their energy consumption and energy usage.

Chapter 2 Nedschroef

2.0 Company overview

Nedschroef Holding B.V. with the headquarter in Helmond (Netherlands) is the leading automotive fasteners supplier in Europe. The enterprise was established in 1894 by Hendrik van Thiel. Nedschroef develops, manufactures and supplies fasteners and special parts for the automotive industry. Currently the group has 26 locations in 14 countries and employs about 2,000 people all over the world. Nedschroef has a global revenue of 629 million euro (2016). They produce 700 million pieces which means in total a weight of 32,000 tonnes. As a result, the headquarter in Helmond has a current product range of over 1,800 different types of nuts and bolts.

The figure below (figure 2.1) shows the different locations of Nedschroef. As mentioned the headquarter is in Helmond, the Netherlands. Furthermore, four sister production companies are in Germany, followed by Spain and China. There are a lot of sales offices spread mostly in eastern Europe. Nedschroef also has a special sector for plains – Nedschroef Aviation.

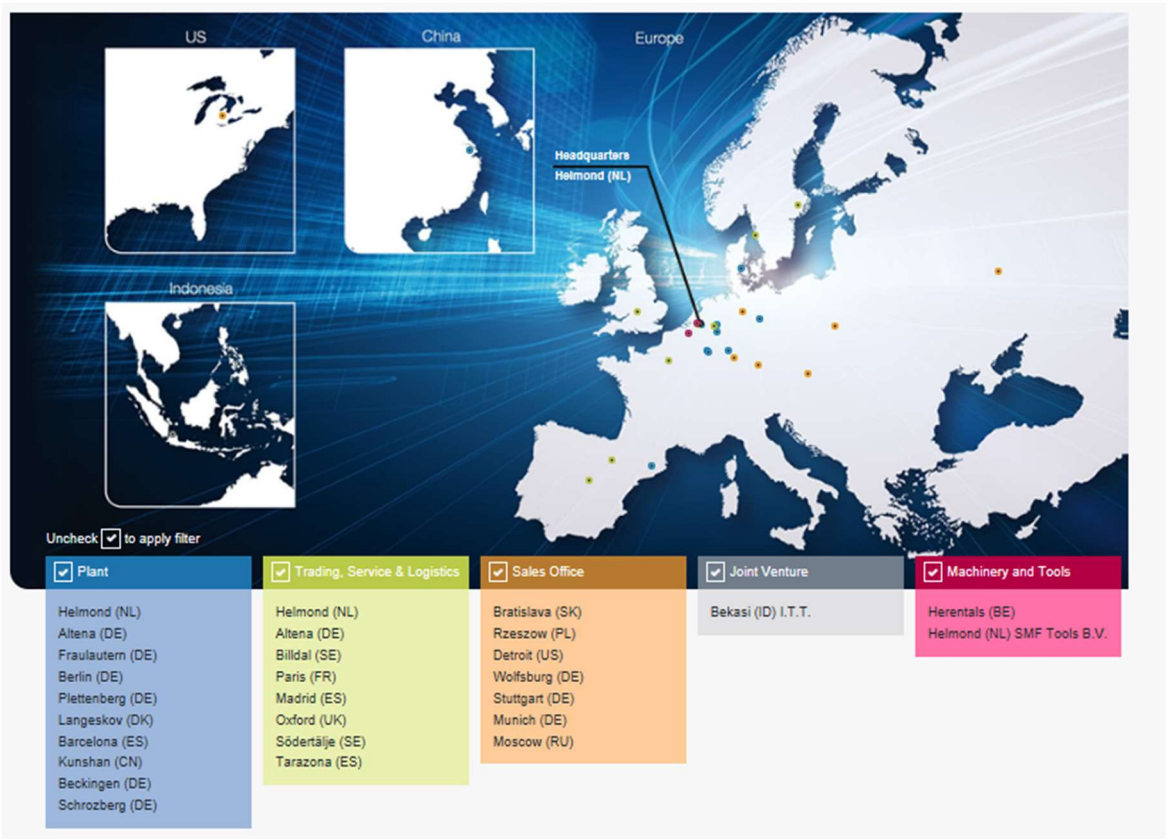


Figure 2.1 Nedschroef plants

The headquarter is producing bolts and fasteners. The department called Nedshape, is well known for its customized products. Automotive customers such as BMW, Audi, DAF and Scania are Nedschroef's most important customers. As shown in figure 2.2, there are a huge range of customized bolts. Mostly, these bolts are getting attached to the engine and transmission of the car.

Figure 2.2. - BOLTS

2.1 Quality department

Nedschroef Helmond B.V. is divided into several departments, the quality department is one of these departments. The quality department consists of four key components: quality planning, quality assurance, quality control and quality improvement. The quality department oversees quality of all the different products, but also processes and procedures, and lastly, how to achieve a consistent quality. An example of what the quality department does is: decides whether to rework defects or put them in the trash.

Eric van Berlo who is the company tutor of the project group, is the quality manager of Nedschroef Helmond B.V.

Quality and Nedschroef B.V. goes hand in hand, and quality has the one of the highest priorities. In addition, Nedschroef Helmond B.V. created their own philosophy of continuous improvement, which is called LEAN NMDS.

2.2. Nedschroef Management Development System

The NMDS allows Nedschroef Helmond to achieve continuous improvements using tools as 6-sigma, lean management and the Pareto (80/20). LEAN NMDS is designed to evaluate all internal processes, detect possible waste and with a team improve their processes in small but significant steps. As a result, all employees continue to work to achieve an outstanding performance aligned with customer expectations, as Nedschroef has done for many years.

The project group participated in an NMDS-quick training course which helped them understand the philosophy of the company. The information the project group received was useful for the project.

As it can be seen in figure 2.3 the LEAN NED's priority point is the continuous improvement of their employees. It is a steady moving 'nut' to the top of the bolt.

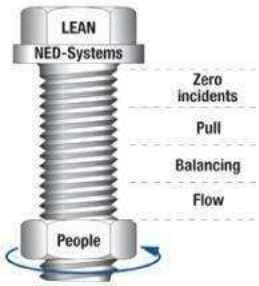


Figure 2.3. LEAN NMDS

Chapter 3 Project description

The task of the project group is to establish the first step to create an EnMS for the ISO 50001 standard.

This ISO 50001 standard is a next step after ISO 14001 (environment) and ISO 9001 (Quality). The two ISO standards (14001 and 9001) are the basement for ISO 50001.

The Energy Management System aims to continuously improve energy performance.

The project plan which includes project stakeholders, goals, program of requirements, plan of approach, schedule, time management and risk assessment can be found in appendix 22.

3.0 Project boundaries and scope

The boundaries of the project group are Nedschroef Helmond B.V. The reason is Nedschroef Helmond B.V. is the project owner.

During the process of the project the scope changed. The first three weeks, the project team focused analyzing diverse documents which had to do with consumption and usage of energy. The aim was to do an energy review of the last 3-4 years of Nedschroef Helmond B.V. Consequently, the documents were incomplete, and it was not possible to create a summary of the energy consumption. After different meetings with the university and the company tutor, the team decided to develop the first steps for the Energy Management System. The focus of the project group shifted from the energy review process to the system itself.

3.1 Project stakeholders

Project internal stakeholders include the project team, Avans University of the International Programs and internal customers of Nedschroef.

Furthermore, the external stakeholders are energy suppliers, the Dutch government and automotive customers such as Scania, BMW and DAF. These are the most powerful and most influential stakeholders. See (appendix 22) for more information.

3.2 Project goals

The project team together with the project supervisors defined the following objectives:

- To implement an Energy Management System in the already existing management systems (quality, environmental management).
- To design a requirements framework ("manual") that helps Nedschroef Helmond to establish an EnMS in Nedschroef Helmond B.V.
- To define the necessary prerequisites to establish the EnMS in Nedschroef Helmond B.V.
- To create a process that allows to develop the EnMS in Nedschroef Helmond B.V.
- To create a recommendation that allows to develop the EnMS in Nedschroef Helmond B.V.

3.3 Energy Management System

The project group created the basement for a system to improve energy performance. The following steps are used, but also a requirement of ISO 50001. The different steps will be explained below. The EnMS is divided into four different steps, which are also known as Plan-Do-Check-Act (PDCA).

- **Energy policy**
  This is the start of an EnMS and should be accepted by the entire company. This document aims for continuously improvement.

  "The energy policy is the driver for implementing and improving an organisation's energy management system and energy performance within its scope and boundaries" [1]

- **Energy planning**
  In this stage the energy consumption of the company should be measured. With the gathered data a baseline and EnPIs could be created. With these tools it will be easy to compare the usage of each machine and see if the energy consumption is reducing.

- **Implementation and operation**
  This stage is about training employees and making everybody in the company aware of the ISO 50001 standard.

- **Checking**
  The name of this phase explains itself. In this stage all the action taken will be checked on efficiency.

- **Management review**
  In this final stage all the checked information will be reviewed. After the review new actions will be made to reduce more energy.

A more detailed guide of the different stages of the EnMS can be found in the appendix (16 step PDCA).

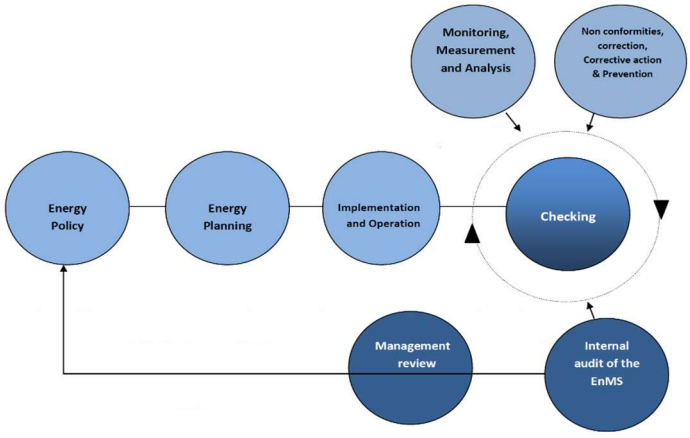


Figure 3.1 – The different steps of the Energy Management System

The project group decided to integrate their energy management system into the already existing environmental and quality management system. All the management systems are based on the same plan-do-check-act approach. Due to the similarities between management systems, the integration of management systems is possible. (sister companies) The management system lay-out divides the system into five different parts: the manual, processes, procedures, work instructions, and forms & records. One of tasks of the project group was to: write an 'energy manual', which was combined with already existing manual, and create processes for above mentioned manual. Some of the similar processes are: communication, documentation, audits, management review.

3.4. The relation between earlier management systems

All the management systems are based on the plan-do-check-act approach. The management system lay-out is divided into five different levels. Top to bottom those levels are: manual, processes, procedures, work instructions, forms & records. The quality manager is responsible for the two top layers, and the department manager is responsible for the rest of the layers. The existing manual for the management systems is written in the following way: manual, requirements, policy, implementation and operation, control and corrective measures and review by the management.

Management system lay-out

The integrated Quality- and Environmental management is divided a manual, process descriptions, procedures, working instructions and forms / records and makes use of Document Control Centers for the preparation, publishing and managing of the different document levels. 1st and 2nd level documents are the responsibility of the Manager Quality 3rd, 4th and 5th level (Procedures, working instructions, forms and records) of each department manager.

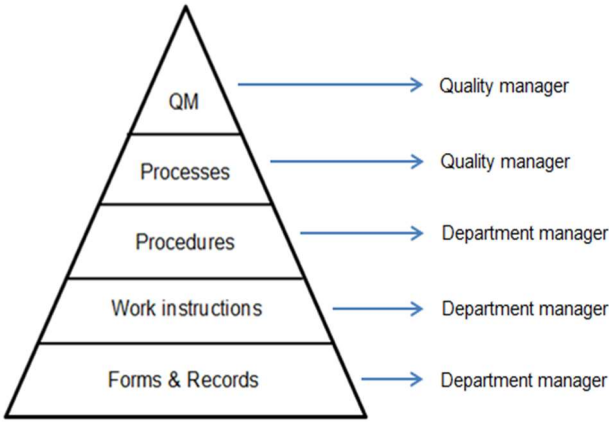


Figure 3.2. – Quality Management System Layout

Chapter 4 Process of work

The project group initially divided the project into five different phases;

- the research phases
- solution finding/creation phase
- energy management system creation phase
- manual writing phase and
- lastly the implementation phase.

As the project started to take pace, the project group emanated the Energy Management System from the structure of ISO 50001. The different tasks of the team members were selected from said structure, which would also function as a basis for their work, upon which they built their Energy Management System. The project group saw the connection between the PDCA and the corresponding chapters of the ISO and made the following conclusion:

- Plan = Energy planning
- Do = Implementation and operation
- Check = Check
- Act = Management Review

The EnMS was split into the abovementioned parts. The project group members researched each section and worked according to said sections. The complexity of each part advanced as time flew by. From being merely information documents, it transformed to documents containing detailed information which translated through the different layers of the management system pyramid. In addition, requirements and process descriptions for every section of the EnMS were created.

The mentioned phases are extracted from the Project Plan which can be found in the appendix below. (appendix 22)

The actual phases of the project were the following, which will be explained in more detail below:

- Research
- Manual writing
- Completion of manual
- Realization of the Energy Management System
- Finalization

4.0 First phase – Research

Research [week 0-6]:

During the research phase, the project group analysed a lot of different documents and interviewed a lot of office workers. They also had an introduction course to the philosophy of the company called NMDS quick training.

Almost all documents related to energy usage and consumption were analysed. All the gathered information would eventually be used in the 'energy review' of the energy management system. The energy review was done because ISO 50001 requires complete understanding off all relevant data concerning energy.

The project group spent a lot of time trying to analyse, partly because everything was written in Dutch and because the data was incomplete but also lacking units.

During the research phase, the project group also tried to identify inefficient processes and/or use of energy. This way was not the right way to go for the EnMS.

The management system partly consists of processes, but not the processes the project group thought of.

There was no real manual yet in phase 1.

Phase 1 ended after the project group had a meeting with their university coach.

4.1 Second phase – Manual writing

Manual writing [week 6-9]

After the meeting with the university coach, the project group decided to take a more general approach to the project.

They started to analyse what ISO 50001 was really about and from it a basic structure for the 'energy manual' and the required appendixes were created.

The project group used the auditor checklist as a useful document in the process of creating the energy management system. During this phase the project group focused a lot of time on writing the 'energy manual' and not so much time on the 'energy management system'.

After yet another meeting with the company coach, the project group decided to make a combined 'energy+environmental' manual instead of the previous 'energy manual'. The company coach also explained how the company's earlier management system was created and the manual it the top layer of the pyramid. In addition, the project group had to create 'processes' for the EnMS.

The project group made efforts in contacting sister companies of Nedschroef. The project group saw it necessary to communicate with external companies because the sister companies had already received the certification for ISO 50001.

As a result, the project group succeeded in making an appointment with Nedschroef Plettenberg. However, the meeting was scheduled as late as at the end of November. The project group also received feedback from another company, located in Altena, Germany.

4.2 Third phase – Completion of manual

Completion of manual [week 9-13]

It was concluded that there were many similarities between the earlier 'environmental manual' and both ISO 14001 and ISO 50001. This led to yet another structure change in the manual.

The structure of ISO 50001 would later work as the structure of their energy management system. During these weeks, the progress of the new combined 'energy+environment' manual really took up pace.

At this point, the manual had a lot of pages, and the project group released this was not the most efficient way. So, they decided that the manual would only consist of general information, and all specific information would be moved to appendixes. This led to the creation of a lot of appendixes and a well- written manual. The manual had been completed.

After the completion of the manual it was necessary to make preparations for the meeting with Nedschroef Plettenberg, Germany.

4.3 Forth phase – Realisation of the EnMS

Realisation of the EnMS [week 13-17]

After the meeting with Nedschroef Plettenberg, the project group concluded that Plettenberg and the other Germany sister-companies had help by an external company to implement their Energy Management System. They also concluded that the manual is merely the top of the pyramid (see chapter 3.2).

Nedschroef Plettenberg had certainly no lack of organisation. The meeting with Nedschroef Plettenberg allowed for the project group to realise how all the pieces fit together (see chapter 5).

The project group now knew how they would present their Energy Management System, from a structure not so different from that of ISO 50001. The project group could know visualize all aspects of their project in an application made in Power Point (see chapter 5 for more information).

The project group analysed the existing processes of the company, updated a few of them and created ten completely new processes for the energy management system.

The project group made additions with requirement and process descriptions for each topic of the Energy Management System.

4.4 Fifth phase – Finalization

Finalization [week 17-20]

The final phase of the project started after the Christmas holidays. At this point everything was mostly finished, and only some minor editing was required. The project group spent the last couple of weeks of the project writing their final report and creating the final presentation, both for Avans and the company.

The final product consists of an application made in Power Point which includes the necessary appendixes. In addition, a folder with subfolders with a lot of documents.

4.5 Summary of the phases

Although the plan of approach changed a couple of times, the number of phases remained the same.

The idea was at first to create a manual, but the scope of the project changed and so did the objectives.

The Energy Management System was not completed in phase 3, but in the 4th phase. At the end of the project semester, the project group agreed that they had spent too much time focusing on writing the manual, which is just one part of the Energy Management System.

This became clear to the project group as they advanced throughout their project. Although, the project group had created a lot useful information, they did not know how to put all the pieces together until after the meeting with Nedschroef Plettenberg.

In phase 1, the project group looked for inefficient processes and inefficient use of energy. This step was unnecessary for the project, although appreciated by the company.

Brainstorming played a big part in the project. On average, the project group brainstormed at least once a week, which resulted in a lot of good ideas and new ways of thinking. *The actual Plan of Approach and the previous plan of approach can be found in appendix 22 (project plan)*

Chapter 5 Description of the final product

The project group created an application in Power Point with the main objective to stablish the first steps in order to develop an Energy Management System for Nedschroef Helmond B.V. This chapter explains the objectives, functions and content of the application.

5.0 Requirements

Before starting the creation of the application, a series of requirements were set. The requirements are coherent with the objectives defined at the start of the project.

- The application must follow a structure similar to ISO 50001.
- The application will contain examples, diagrams, schemes and tables that will make the EnMS easier to understand, and these documents will be useful in the future.
- The application should be visual, and all the information should be easy to find.
- The application will be based on the philosophy of Nedschroef.

5.1 The results

- **Brief description**

The created application shows the interconnection between the different management systems (Quality, Energy, Environmental)

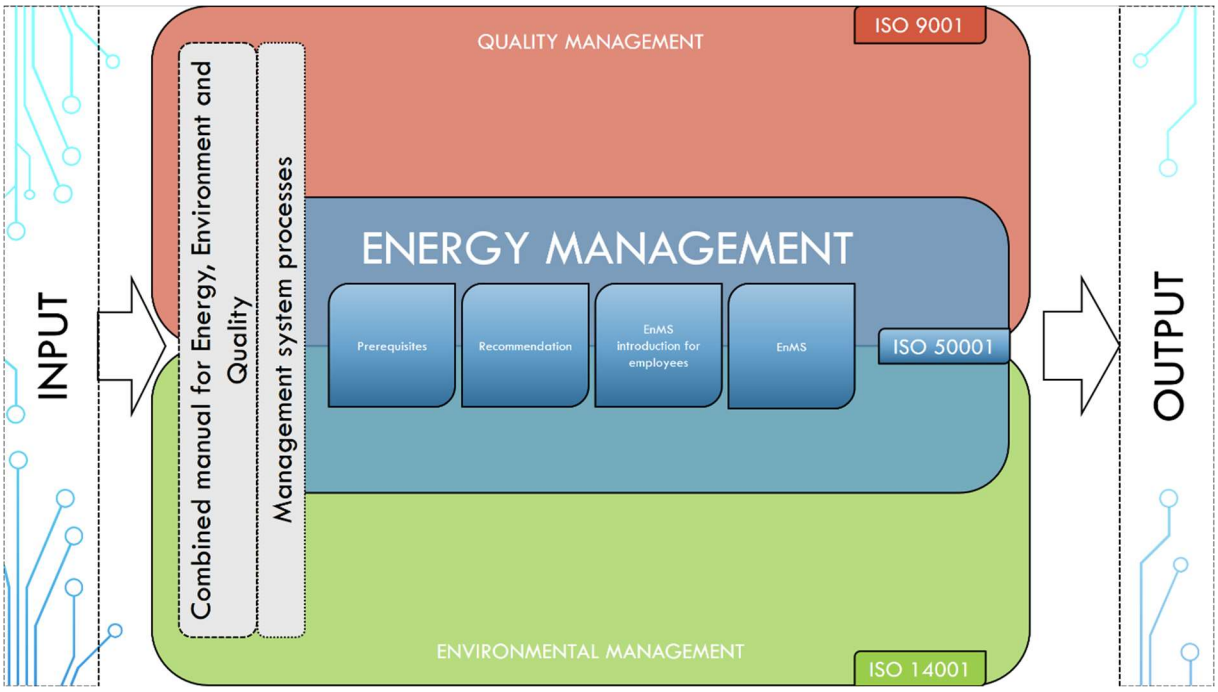


Figure 5.1 – First page of application

It is possible to click on every topic and navigate to and from desired information. From the first slide it is possible to navigate to the pillars of the management systems. Figure 5.1 displays the inter dependencies between the ISOs. The pillars are as follows:

- Combined manual for energy, environment and quality
- Management system processes
- Quality Management
- Energy Management
    - Prerequisites
    - Recommendation
    - Introduction to ISO 50001
    - EnMS
- The different ISOs (9001, 14001, 50001)

- **Functions**

In order to meet the defined requirements, the following functions in the application were created:

- The application has an index where information can be easily found. Each of the sections of this index can be displayed in other subsections:

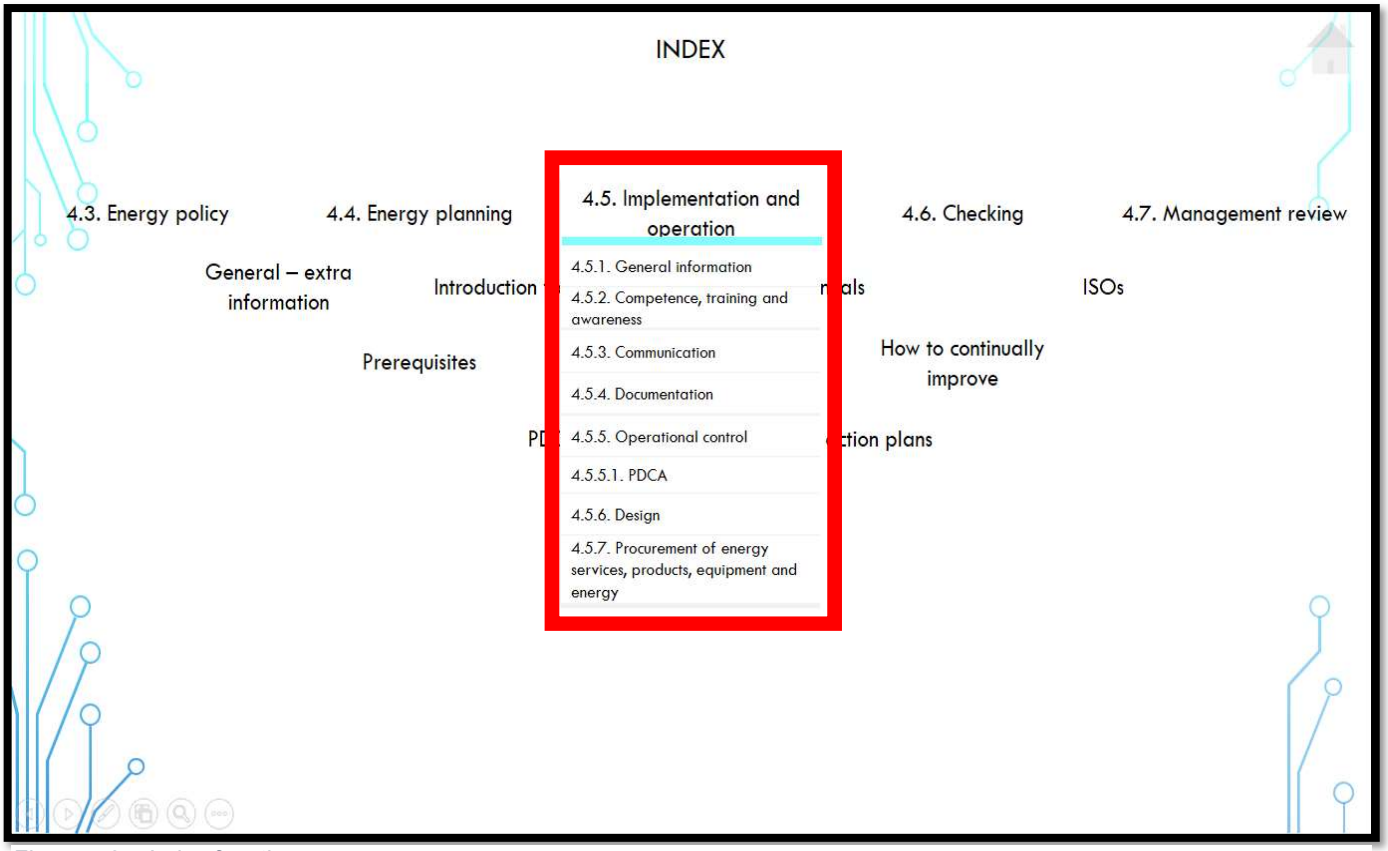


Figure 5.2 – Index functions

- Most of the pages of the application has two a home (house) icons. The icon with the normal house allows one to return to the previous page and the icon with the index house allows one return to the beginning which is described in figure 5.2. With this function the Project team wants to achieve a simple and comfortable navigation within the application.

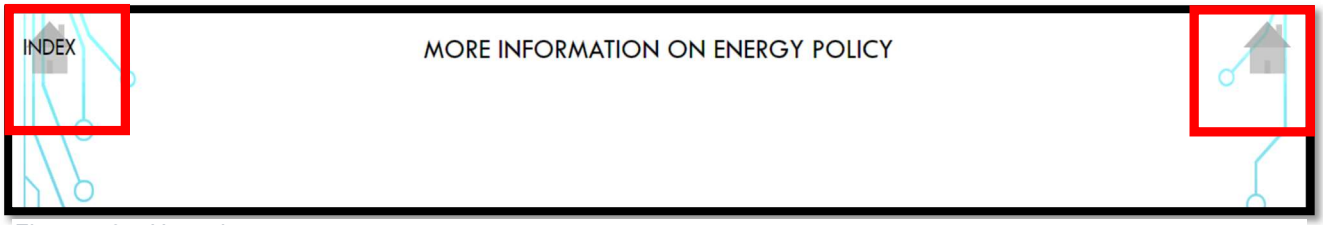


Figure 5.3 – Home icons

- Most of the slides have a brief description of the topic in its main page as well as a box with the following information at the bottom of the page:
  - Requirements
  - Information about the topic
  - Process description
  - More Information where you it can be find examples, schemes, documents with information on the topic ... etc

- As an addition to the manual the project group created processes, process descriptions and requirements for their Energy Management System. Process description for many of the topics, which describes action items the processes need to cover and if there is a relation between the Energy Management System and earlier management systems.

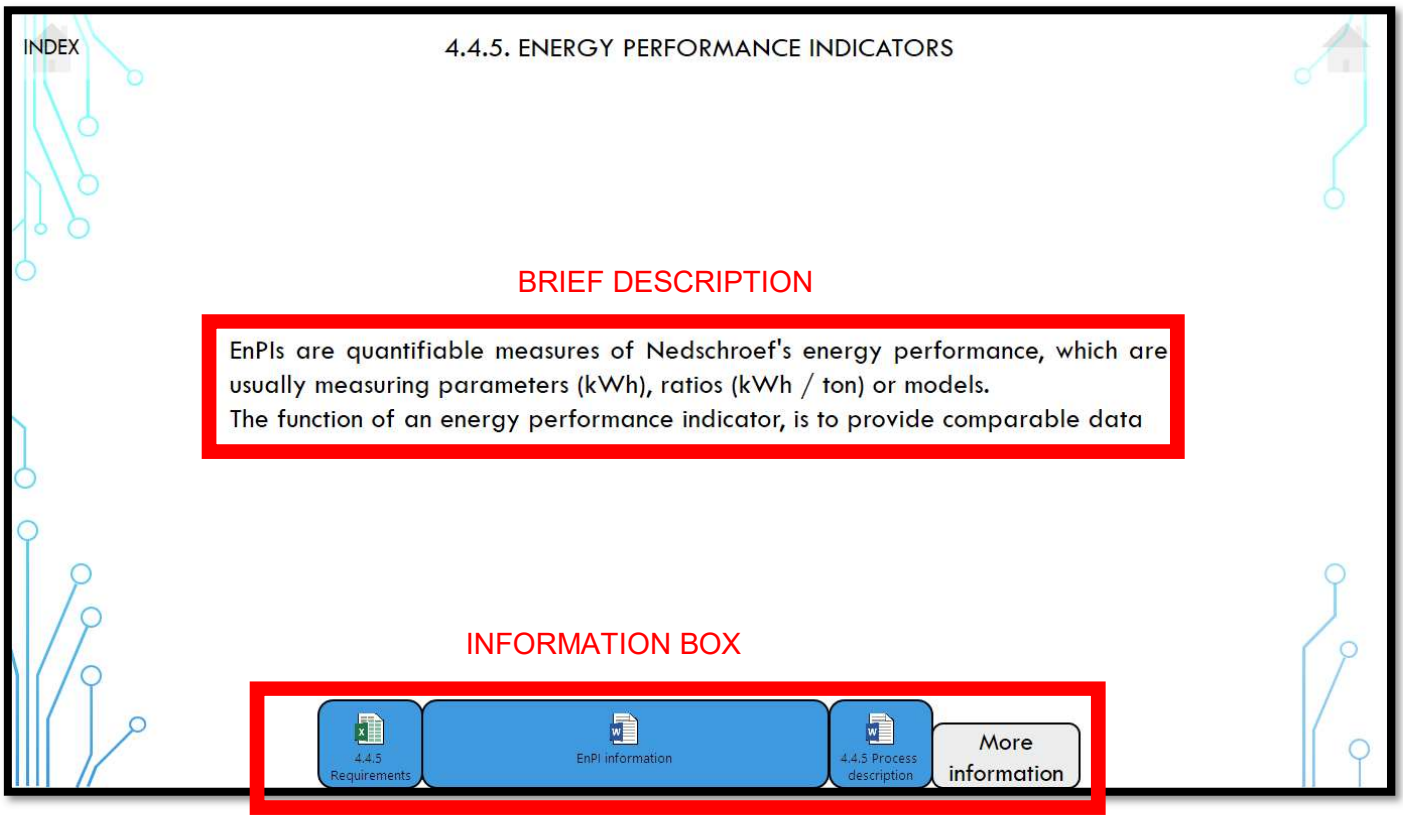


Figure 5.4. – Brief description and information box

- Most of the pages contain interactive schemes that allows access to other pages with more information.

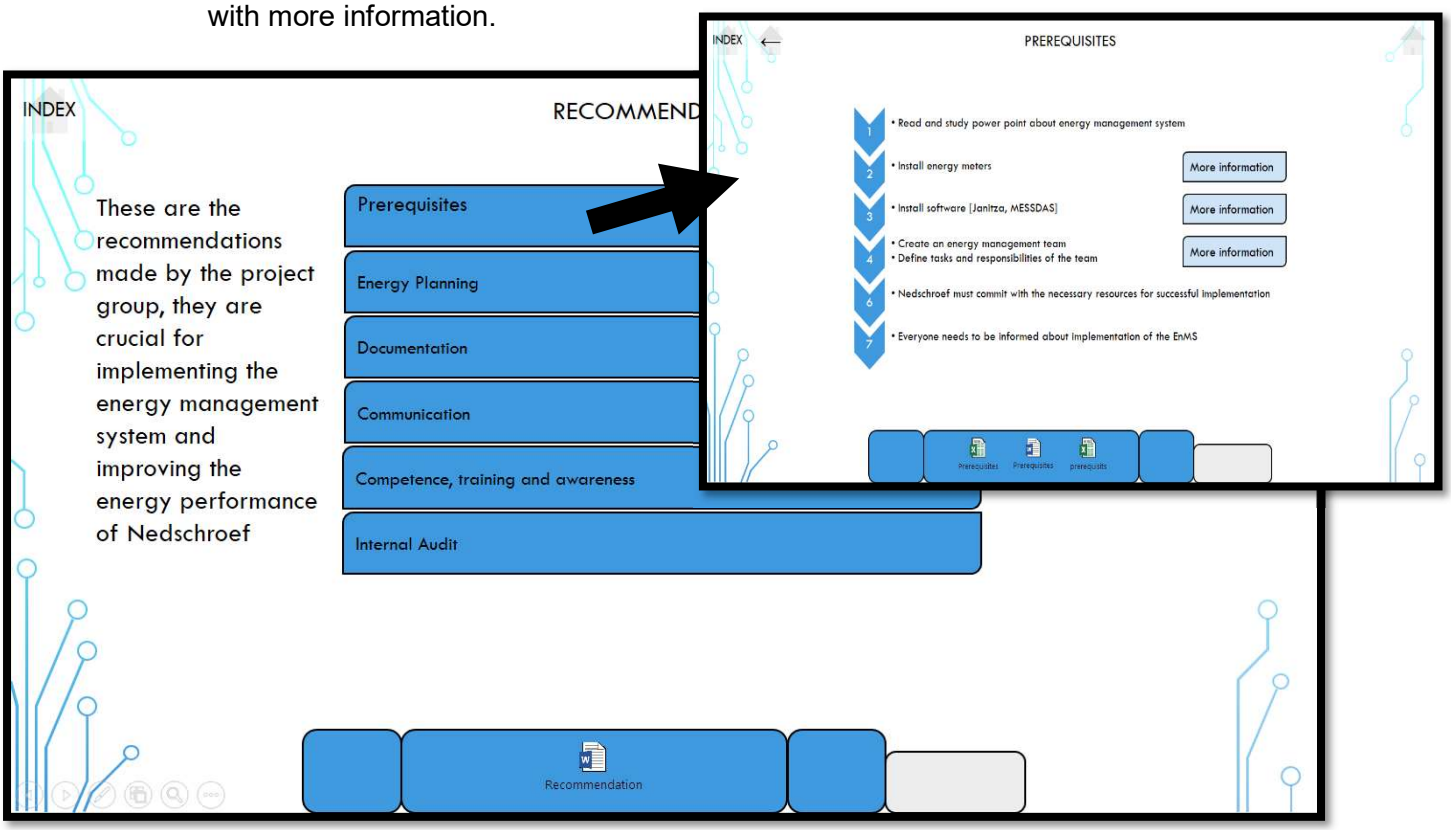


Figure 5.5 – Interactive scheme

5.1.1 The manual

The manual was created as a 'shell' for the Energy Management System, it contains elements from three different management systems; energy, environmental and quality management. *The manual can be found in the appendix below:*

- Combined manual for energy, environment and quality (appendix 21)

5.1.2 Management System Processes

Ten new processes were created, and two existing processes were updated.

5.1.3 Energy Management

5.1.3.0 Prerequisites

The project group needed to create prerequisites before the EnMS can be implemented. The prerequisites are simple, yet crucial for the successful implementation of the system. Some of the requirements created by the project group are:

- Top management commitment
- Commitment of necessary resources such as software and energy meters
- Knowledge about the energy management system (Power Point)

The perquisites of the project group are the following:

1. Read and study the power point about Energy Management System.
2. Install energy meters.
3. An energy measuring software (Janitza, MESSDAS) must be installed for effective monitoring of all machines. Every major power consumer must be connected to this software.
4. Nedschroef Helmond B.V. needs to create an energy management team, the tasks and responsibilities of team must be clear.
5. Nedschroef Helmond B.V. needs to invest enough resources for the successful implementation of the EnMS.
6. Everyone needs to be aware about the implementation of the EnMS.

The project group also created recommendations for the prerequisites. *The recommendations can be found in appendix 26.*

5.1.3.1 Recommendations

Recommendation are crucial for implementing the energy management system and improving the energy performance of Nedschroef Helmond B.V.

After studying the real situation of the company, and ISO 50001, it was considered to make recommendations in order to facilitate and optimize the future implementation of the EnMS and obtain ISO 50001 certification. Consequently, recommendations for each part of the EnMS were created:

- Energy planning
  - Energy review
  - Energy baseline
  - Energy performance indicators
  - Energy objectives, energy targets and energy management action plans
- Documentation
- Competence, training and awareness
- Internal audit

The structure of these recommendations is divided into 3 parts:

- What: situation or issue that is going to be analyse
- How: a possible way to take on the issue or situation
- Why: The reason why this problem or situation should be considered

A communication recommendation can be seen below in table 1. *To see more recommendations, check the appendix 27.*

Table 1 - recommendations

What?	How?	Why?
Publications and communication		
Future Projects in the company (e.g. change of the compressor)	It is recommended to publish future projects by several means: 1. Via mail 2.Create poster or brochure 3.Video or audio-visual media The frequency of publications will depend on future projects, but it is advisable to publish monthly	Everybody should participate in future projects for Nedschroef
Saved energy consumption		Give all the members in the company a feedback to show what they achieved
Ideas		
Collecting suggestions from workers	Put an info box at accessible places like: canteen, entrance…	Each responsible area knows its machines on the best way. Consequently, they can give the best improvement ideas

5.1.3.2 EnMS Introduction for employees

The employees should be informed about the situation of the company even if they will not participate directly in the implementation of the EnMS.

The EnMS is an opportunity to improve the energy performance of Nedschroef Helmond B.V. Consequently, everybody should be involved in one way or another. To do this, an introduction presentation has been created. It includes an introduction video to inform and motivate the employees in a positive way. *The EnMS introduction presentation can be found in appendix 28.*

5.1.3.3 Energy Management System

The structure of the EnMS has been created to be similar to the structure of ISO 50001. The structure can be seen in the figure below.

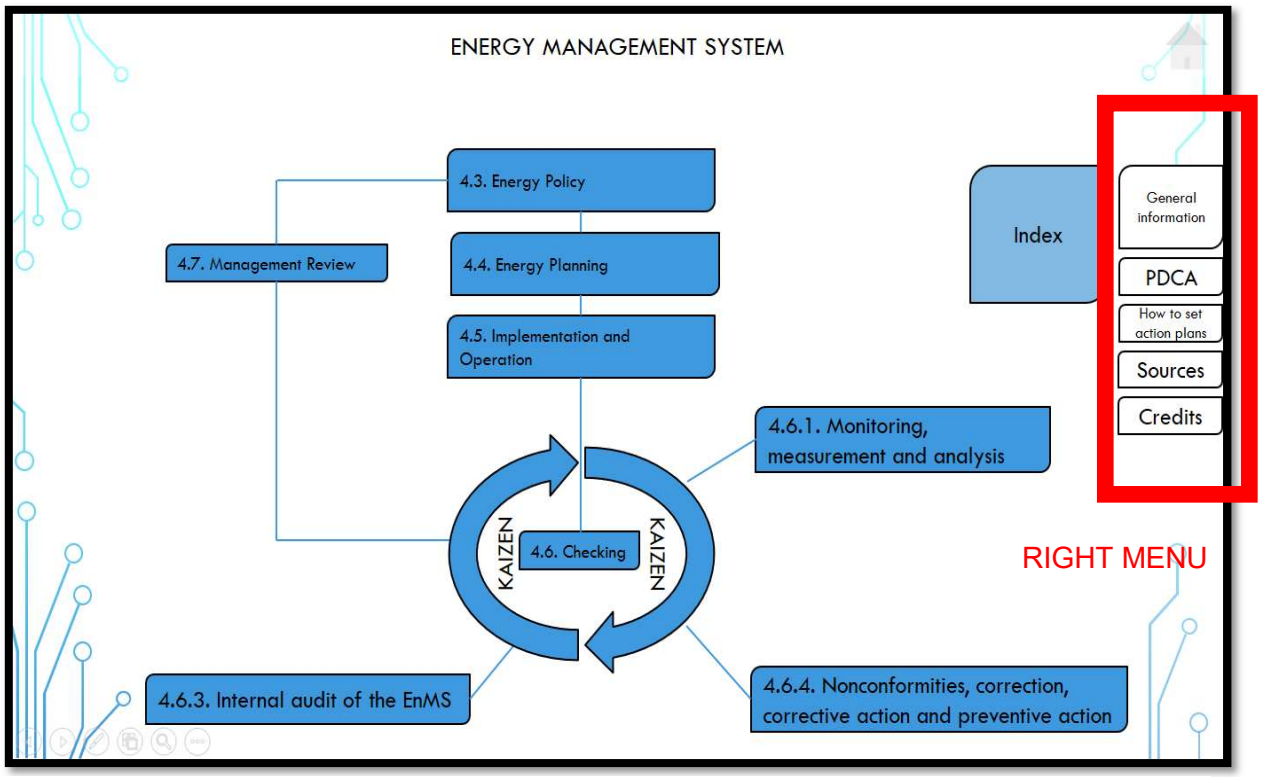


Figure 5.6 – Structure of the Energy Management System

On the right side a menu containing the following information can be found:

- General Information
    - Scope
    - List of abbreviation
    - General requirements
    - Management responsibility
- PDCA
- How to set action plans
- Sources
- Credits

In the central part of this page an interactive scheme of the EnMS can be found. This scheme allows for navigation to different topics, where information about said topics can be found.

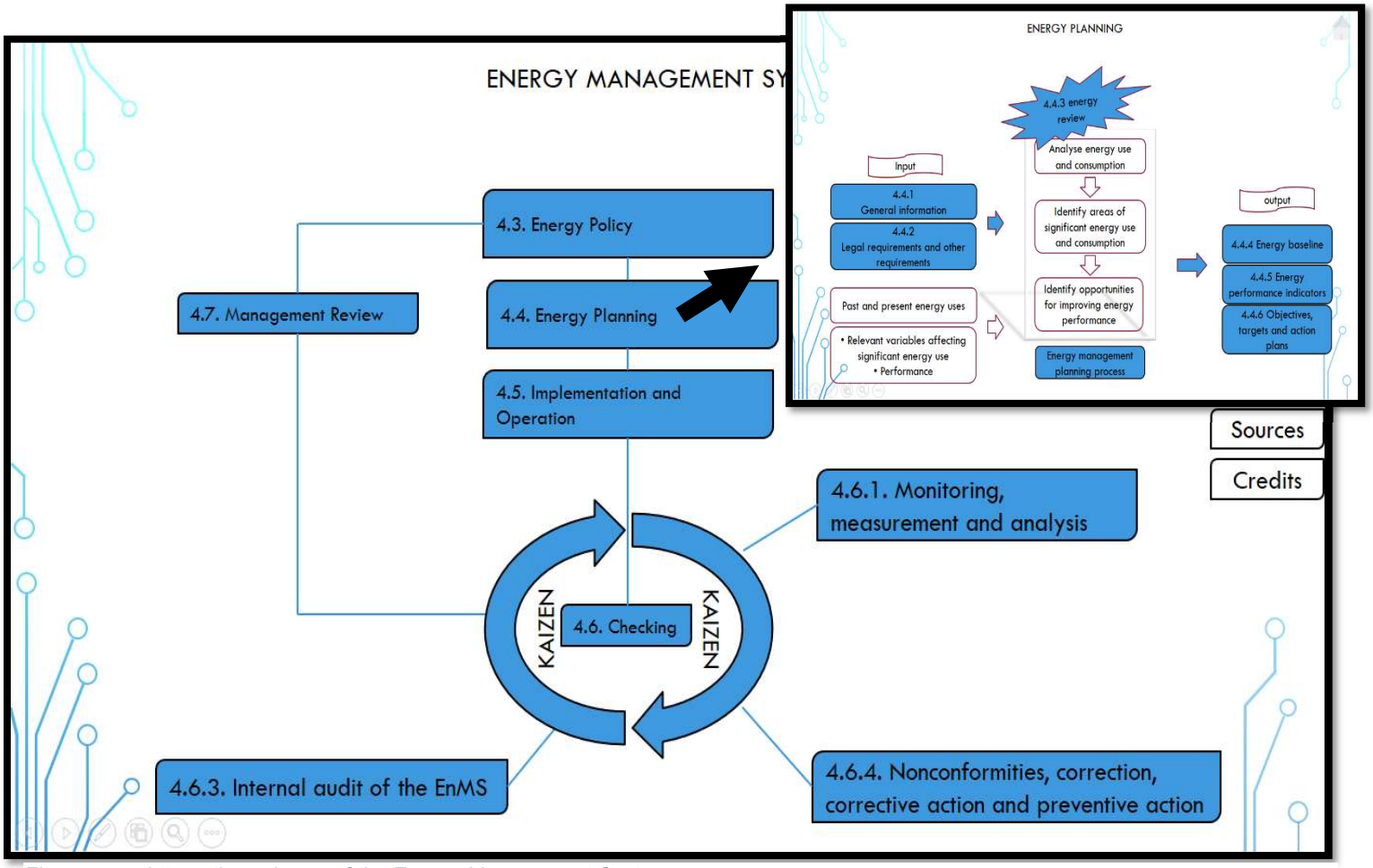


Figure 5.7 – Interactive scheme of the Energy Management System

Chapter 6 Energy Management System

As the Energy Management System continues to perform, the energy planning stage becomes more important. Detailed measurement will be required as the EnMS continues to perform.

The ISO 50001 specifies the EnMS requirements upon which an organization can develop and implement an energy policy, establish objectives, targets and action plans which take into account legal requirements and information related to significant energy use. An EnMS enables an organization to achieve its policy commitments. The EnMS takes action as needed to improve its energy performance and demonstrate the conformity of the energy system to the requirements of the organization, including the complexity of the system, degree of documentation and resources.

The first step to develop the Energy Management System should be defined into the following sections:

- Scope and boundaries:
  - Scope is the creation of processes and an organization which allows the company to:
    - manage the energy in an efficient way
    - aim a continuous improvement of the energy consumption
  - Boundaries: Nedschroef Helmond B.V.

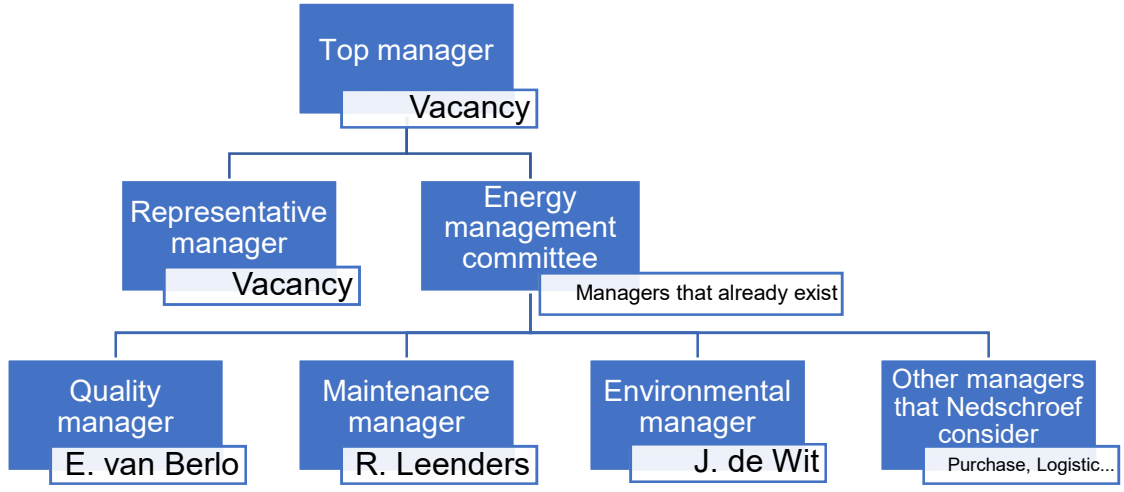


Figure 6.1 - Hierarchy

- Energy management team
  - Figure 6.1 describes the hierarchy of the energy management team of the energy management system. The most important thing is to create members of the energy management team: top manager and manager representative who are performing the main tasks of the EnMS.

  - The energy management must appear at every part of the company as that is the reason for the existence of the energy management committee. The committee contains a quality, maintenance, environmental and other managers who are carrying out the implementation of all the measures decided from the top manager.

- Management responsibility
  In addition to the current responsibilities of the managers, the energy management must also be taken into account.

  Top management

  Top management will show its commitment to support the EnMS and to continually improve its effectiveness by:

  a) Defining, establishing, implementing and maintaining an energy policy;

  b) Appointing a management representative and approving the formation of an energy management team;

  c) Providing the resources needed to establish, implement, maintain and improve the EnMS and the resulting energy performance;

  NOTE Resources include human resources, specialized skills, technology and financial resources.

  d) Identifying the scope and boundaries to be addressed by the EnMS;

  e) Communicating the importance of energy management to those in the Nedschroef Helmond;

  f) Ensuring that energy objectives and targets are established;

  g) Ensuring that EnPIs are appropriate to the organization;

  h) Considering energy performance in long-term planning;

  i) Ensuring that results are measured and reported at determined intervals;

  j) conducting management reviews.

  Management representative

  Top management will appoint a management representative(s) with appropriate skills and competence, who respective of other responsibilities. The management representative is responsibility and authority to:

  a) Ensure the EnMS is established, implemented, maintained, and continually improved in accordance with this International Standard;

  b) Identify person(s), authorized by an appropriate level of management, to work with the management representative in support of energy management activities;

  c) Report to top management on energy performance;

  d) Report to top management on the performance of the EnMS;

  e) Ensure that the planning of energy management activities is designed to support the organization's energy policy;

f) Define and communicate responsibilities and authorities to facilitate effective energy management;

g) Determine criteria and methods needed to ensure that both the operation and control of the EnMS are effective;

h) Promote awareness of the energy policy and objectives at all levels of the organization.

The system is based on the PDCA (Plan, Do, Check, Act) cycle which can be defined as follows:

- Plan
  - Legal requirements
  - Establish an energy policy
  - Establish an energy baseline
  - Procurements of energy services
  - Design
- Do
  - Energy Review
  - Establish Energy Performance Indicators
  - Energy Management Action Plans
  - Implementation
  - Competence, Training and Awareness
- Check
  - Control of documents
  - Operations Control
  - Evaluation of Compliance
  - Internal Audits
  - Monitoring, Measurement, Analysis
- Act
  - Nonconformities, correction
  - Management review
  - Control of records
  - Documentation
  - Communication

In the Figure 6.2 the different steps of the EnMS can be seen.

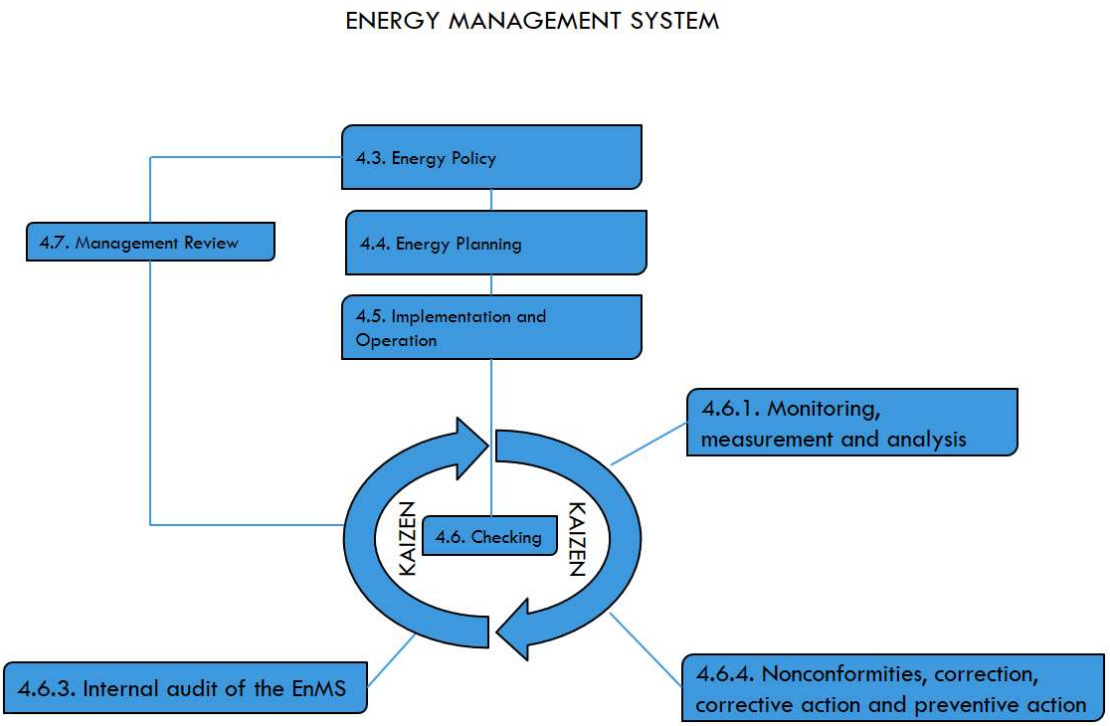


Figure 6.2 – Energy Management System

Note: After every paragraph title there is a number. This number refers to the paragraph number in the ISO 50001 standard.

6.0 Energy policy (4.3)

This chapter contains information about the energy policy. Research showed that there is no need for a separate 'energy policy'. The policy could be integrated in the total company policy. The reason for this is the similarities between the management system structure of ISO 9001,14001 and ISO 50001. In addition, the *total company manual* which the project group had written, contains elements from all three management systems.

The policy will contain information about energy management. It is the initial step for the energy management system and the way to receiving the ISO certification. The policy will support the commitment of the company, and eventually be considered and signed by the top manager.

The project group created the following documents which can be found in the appendix:

- *Energy policy information (appendix 1.0)*
- *Energy policy example (appendix 1.1)*
- *Policy process description (appendix 1.2)*
- *Policy requirements (appendix 1.3)*

6.1 Energy planning (4.4)

Energy Planning is one of the key stages for the Energy Management System. It is the first step towards continuous energy performance improvements for Nedschroef. The Figure 6.3 shows the different elements of the energy planning stage.

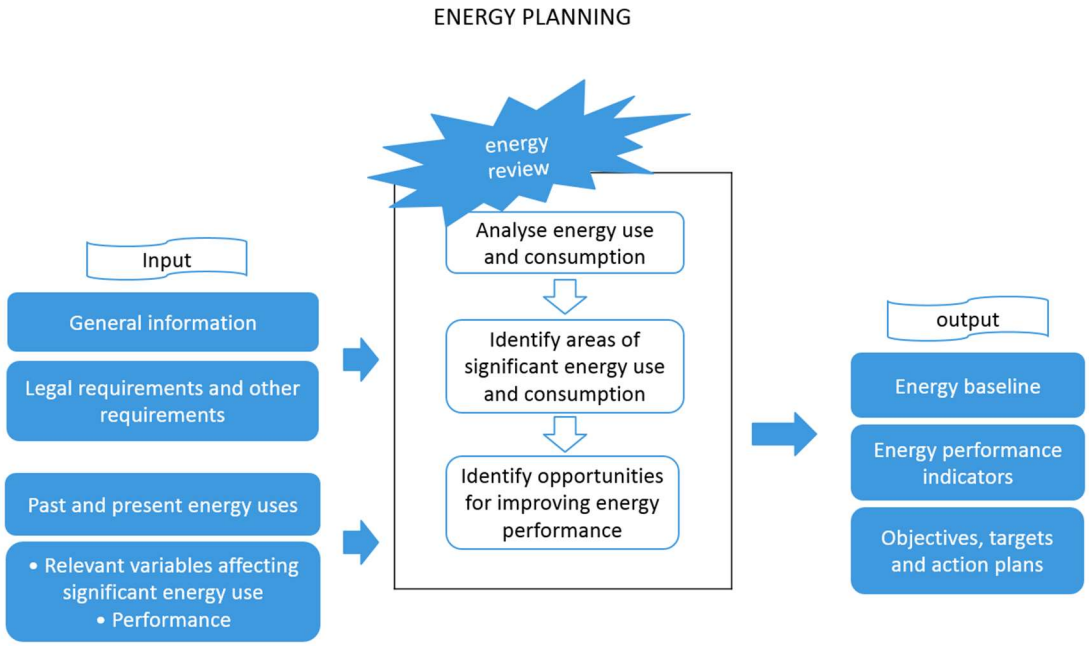


Figure 6.3 – Energy planning

The energy planning contains three main points:

- Input: General information, legal requirements and other requirements, past and present energy uses, relevant variable affecting significant energy use, performance
- Energy review: Analyse, identify, prioritize
- Output: Energy Baseline, energy performance indicators, objectives, targets and action plans

6.1.0 Inputs

6.1.0.1 Legal requirements and other requirements (4.4.2)

The legal requirements must be met to ensure compliance with the law. Research showed that there are no legal requirements for energy in the Netherlands. The requirement which the project group discovered was the e-MJV [2] which was mostly about environmental issues and the co-operation pool between like-minded companies. The project group discovered three requirements. The e-MJV which was mostly about environmental issues, the cooperation pool between like-minded companies, and the need of detailed and comprehensive documentation of all the energy management system and its different parts.

The requirement of the cooperation pool is an energy performance improvement of 6% in the upcoming 3 years, or 2% each year. As long as Nedschroef Helmond B.V stays in the cooperation pool, the requirement should be met.

6.1.1 Energy Review

The objective of this stage is to understand and analyse the different uses of energy and energy consumption, as well as the energy performance and the variables that affect it. The main reason to do an energy review is to find ways to improve the energy performance.

The energy review is split into the following steps:

- Analyse: Nedschroef Helmond should analyse all consumption of energy and all the different uses of energy (as data obtained by software, data obtained from the machines…)
- Identify: The most significant usages and consumption of energy must be identified, and it will in turn lead to opportunities for improving energy performance.
- Prioritize: Changes which does not need any investment as procedures or maintenance, and changes with a high rentability and a fast return of the investment.

To obtain further information about the energy review, check the *appendix 2:*

- *Energy review information (appendix 2.0)*
- *Energy review identification stage (appendix 2.1)*
- *Energy review analysis (appendix 2.2)*
- *Energy review process description (appendix 2.3)*
- *Energy review list of machines (appendix 2.4)*
- *Energy review prioritization stage (appendix 2.5)*

6.1.2 Outputs

6.1.2.1 Energy baseline (4.4.4)

The energy baseline is a result of the energy review, and it is a way to compare the energy uses and consumptions before and after energy performance improvements. The energy baseline could measure energy uses, energy consumption or energy performance over a suitable time-period. The energy baseline must change if variables which significantly affect energy consumption change. Variables such as; new machinery, new equipment, weather conditions or change in business activities. The energy baseline will be maintained and recorded. *The project group created the following documents which can be found in the appendix:*

- *Energy baseline (appendix 3.0)*
- *Energy baseline process description (appendix 3.1)*
- *Energy baseline requirements (appendix 3.2)*

6.1.2.2 Energy performance indicators (4.4.5)

Energy performance indicators (EnPI) are used to compare energy performance. EnPIs could be a simple parameter, a simple ratio or a complex model. An EnPI could be energy consumption over time, energy consumption per unit of production or energy usage per m^2. Use of EnPIs allows for an easy comparison of energy performance, for instance between departments, units and companies. EnPIs must be maintained, updated and documented when necessary. *The project group created the following documents which can be found in the appendix:*

- *EnPI (appendix 4.0)*
- *EnPI process description (appendix 4.1)*
- *EnPI requirements (appendix 4.2)*
- *EnPI example (appendix 4.3)*

6.1.2.3 Energy objectives, targets and action plans (4.4.6)

The energy objectives, targets and management action plans are the last and most important output from the energy review process. Energy performance opportunities made from analyses in the energy which can be found. Numbers of improvement opportunities depends on the level of analyses in the energy review. Deeper analyses will naturally yield a larger number of improvement opportunities.

Said improvements can be divided into three different categories; targets (goals), objectives and action plans. A target (goal) is a topic-specific statement describing what the organization wants to achieve. An objective is an effort intended to help reach a goal. An action plan is a specific implementation of plans of how to achieve goals and objectives. *The project group created the following documents which can be found in the annex:*

Figure 6.4 – Objectives, targets and action plans

- *Objectives, targets, and action plans (appendix 5.0)*
- *Objectives, targets process description (appendix 5.1)*
- *Example of objectives (appendix 5.2)*
- *Objectives requirements (appendix 5.3)*

6.2 Implementation and operation (4.5)

Objectives, goals and action plans created in the stage of energy planning will be implemented. It can only be done after the policy has been created and an energy review has been done. The plan of activities must be coherent with the energy policy, targets, goals and action plans created. *The project group created the following document which can be found in appendix:*

- *Implementation and operation (appendix 6.0 -Steps, tools)*
- *Implementation process description (appendix 6.1)*

6.2.0 Competence, training and awareness (4.5.2)

In order to operate the Energy Management System, training of employees will be required. Training is essential for achieving the goals and objectives and includes both general and specific training and skills.

Staff training follows the already existing process. The staff training requirements are periodically determined by knowledge and skills matrices, after this the program course/after-school is planned and executed. It ensures that employees of all levels and from all disciplines can participate in training.

Employees who carry out specific tasks that significantly affect the environmental/energy performance of Nedschroef are trained or supplemented by additional education so that their knowledge and skills comply with the state of the art.

New employees or external parties are prepared and incorporated through internal instructions and training.

The project group created the following documents which can be found in the appendix:

- *Competence, training and awareness (appendix 7.0)*
- *Competence process description (appendix 7.1)*
- *Competence requirements (appendix 7.2)*

6.2.1 Communication (4.5.3)

To motivate and involve all employees into the policy of Nedschroef, it is necessary to provide regularly adequate information on activities that have a direct or indirect impact on energy, environmental and employment issues.

The project group created the following documents which can be found in the appendix:

- *Communication information (appendix 8.0)*
- *Communication process description (appendix 8.1)*
- *Communication requirements (appendix 8.2)*
- *Communication example (appendix 8.39*

6.2.2 Documentation (4.5.4)

The documentation is divided into the already existing management system layout and is split into the following:

- Manual
- Processes
- Procedures
- Work instructions and forms

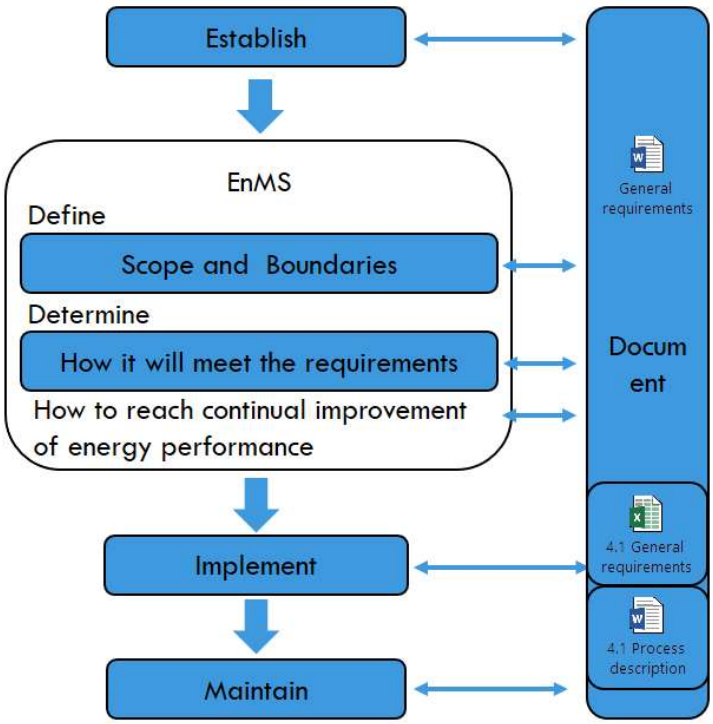


Figure 6.5 – Documentation requirements

The documentation of the Energy Management System is illustrated in the figure (6.4). The documentation of the EnMS can be found in the Final Product (Chapter 5) that the Project group did it.

The documentation is also a requirement of ISO 50001

The documentation is updated and maintained whenever changes are made.

The project group created the following documents which can be found in the appendix:

- *Documentation information (appendix 9.0)*
- *Documentation process description (appendix 9.1)*
- *Documentation requirements process description (appendix 9.2)*
- *Documentation control process description (appendix 9.3)*
- *Documentation requirements (appendix 9.4)*

6.2.3 Operational control (4.5.5)

The improvement plans derived from energy planning stage will be implemented and carried out. The plan of the activities must be coherent with the energy policy, targets, goals and action plans. To implement the operational control, Nedschroef should do the following:

1. Develop work instructions
    a. Operation criteria: describes the way and in which time the principal energy equipment is working.
    b. Maintenance criteria: establishes the frequency of the maintenance tasks of energy equipment.
2. Communicate the work instructions to the employees, or give some additional training.
3. Nedschroef should design registers and work materials to support the activities of operational control, if necessary.

For the correct successful implementation, the following tools would be useful:

- Systems of control and automation of the facilities (software)
- Maintenance plans for equipment which are consuming energy
- Technical introductions of operational control for equipment which are consuming energy
- Guidelines to check the energy performance

The project group created the following documents which can be found in the appendix:

- *Operational control information (appendix 10.0)*
- *Operational control process description (appendix 10.1)*
- *Operational control requirements (appendix 10.2)*

6.2.4. Design and Procurement of energy services, products, equipment and energy (4.5.6) (4.5.7)

Nedschroef should consider energy performance improvement opportunities and operational control in the design of new, modified and renovated facilities, equipment, systems and processes that can have a significant impact on its energy performance. The reason why the company should care about the design is to have an efficient energy consumption as much as possible and to take care about its environment in the best way. *The project group create the following documents which can be found in the appendix:*

- *Design and procurement information (appendix 11.0)*
- *Design process description (appendix 11.1)*
- *Procurement process description (appendix 11.2)*
- *Example of design (appendix 11.3)*
- *Design requirements (appendix 11.4)*
- *Procurement requirements (appendix 11.5)*

6.3 Checking (4.6)

After the changes have been implemented, checking will be required to confirm their success.

The project group created the following documents which can be found in the appendix:

-Checking process description (appendix 12.0)

The following topic must be considered and follow during the checking stage:

6.3.1 Monitoring, measurement and analysis (4.6.1)

The implemented measures from 'implementation & operation' stage is monitored. Data collected from monitoring and measurement will be analysed to identify patterns and obtain information. Furthermore, corrective and preventive action will be implemented if deemed necessary. The project group created the following documents which can be found in the appendix:

- Checking process description (appendix 13.0)
- Monitoring, measurement and analysis information (appendix 13.1)
- Monitoring, measurement and analysis process description (appendix 13.2)
- Monitoring, measurement and analysis requirements (appendix 13.3)
- Monitoring, measurement and analysis example (appendix 13.4)

6.3.2 Evaluation of compliance with legal requirements and other requirements (4.6.2)

The only known legal requirements are made and adjusted by the cooperation pool. As long as those requirements are followed, the legal requirements are met.

The project group created the following documents which can be found in the appendix:

- *Evaluation of compliance requirements (appendix 14.0)*
- *Evaluation of compliance process description (appendix 14.1)*

6.3.3 Internal audit of the EnMS (4.6.3)

An internal audit is an independent, objective assurance and consulting activity designed to add value and improve an organization's operations. It helps Nedschroef to accomplish its objectives by bringing a systematic, disciplined approach to evaluate and improve the effectiveness of management systems.

Nedschroef's internal audit should have the following objectives:

- Verify that the Energy management system has been implemented and maintained correctly
- Define and identify the areas and processes where there are opportunities for improvements

In addition, there are some main tasks of the internal audit. The frequency of the audit should be higher at the beginning of the implementation of the EnMS. Furthermore, important or high-risk processes should be audited on a more frequent basis. The importance of risky processes will be prioritized by Nedschroef themselves. In this process a checklist will help to go through it.

The reason for having an internal audit is to ensure the continuous success of the Energy Management System.

The project group created the following documents which can be found in the appendix:

- *Internal audit information (appendix 15.0)*
- *Internal audit process description (appendix 15.1)*
- *Internal audit requirements (appendix 15.2)*

6.3.4 Nonconformities, correction, corrective action and preventive action (4.6.4)

There are diverse ways to identify the deviations:

- Evidence related to the monitoring and measurement of energy performance.
- In the audit processes (both internal and external)
- In routine processes of evaluation of the EnMS.
- Detection of real or potential problems by workers.

The types of findings can be classified at non-conformance, deviation and observation. After that the top manager should deal with the deviations and establish different solutions depending on the nature of the finding

The project group created the following documents which can be found in the appendix:

- *Nonconformities information (appendix 16.0)*
- *Nonconformities process description (appendix 16.1)*
- *Nonconformities requirements (appendix 16.2)*

6.3.5 Control of records (4.6.5)

There are four steps which are existing for controlling the records.

1) Identification: the records must be properly identifiable. In addition, the identification code should include additional information such as the date of completion of the same, the name of the person who filled it out or who was responsible for its approval.
2) Storage: In order to find the records easily when it is necessary, it must be indicated where the records will be archived.
3) Retention: must determine the conservation time of each record. In case, it is decided to eliminate or discard a record once the established retention time has elapsed; it must be defined how it will be done.
4) Disposition of records: if Nedschroef decides to store indefinitely, they should indicate the place where it will be archived.

The project created the following documents which can be found in the appendix:

- Control of records information (appendix 17.0)

- Control of records process description (appendix 17.1)

- Control of records requirements (appendix 17.2)

6.4 Management review (4.7)

At planned intervals, top management shall review the organisation's EnMS to ensure its continuing suitability, adequacy and effectiveness. Records of management review shall be maintained.

To do the management review it is necessary receive some inputs about the whole EnMS (energy policy review, audit result, etc) and with that the management will produce outputs (changes to the energy policy, the EnPIs, etc).

The project group created the following documents which can be found in the appendix below:

- Management review information (appendix 18.0)

- Management review process description (appendix 18.1)

- Management review requirements (appendix 18.2)

Chapter 7 Conclusion and recommendation

Not only did the project group succeed in the given task, they were also able to establish the first step in creating an Energy Management System. This was done in an application created in Power Point, which contains all necessary information about the EnMS.

Due to the similarities between the structure of the earlier management systems, an EnMS could easily be integrated. This includes an integrated manual, processes, etc. The new management system contains elements from energy, environmental and quality management.

The prerequisites and recommendations done by the project group are necessary for the successful implementation of the new system.

The Energy Management System of Nedschroef is a system that provides the company to continuously improve in their energy performance. Intrinsic motivation and energy savings are the driving force for the implementation of the energy system. Not only the system helps for improve the environment it also helps to get new business requests worldwide.

The Energy Management System consists of five main steps:

- Create an energy policy
- Do an energy planning
- Implement action plans
- Check the results
- Do a management review

These steps are core elements for a successful continuous improvement of energy performance. The former mentioned steps are comparable with the PDCA circle.

Nedschroef Helmond B.V. should use energy meters in combination with suitable software to monitor their energy consumption. With the gathered data the company can compare the actual and the calculated energy usage. Compared data will be used by the company to set action plans, objectives and goals for the future.

With the created application and documents Nedschroef Helmond B.V. has a good base for the successful implementation of the Energy Management System.

Communication

To establish an Energy Management System, it is essential to have a good level of communication between departments and employees.

Commitment

Top management should show commitment to motivate employees and maintain the Energy Management System. Commitment is one of the key components for the success of the success of the project.

Control of records

The standard for record keeping must be the same for all documents, which should be complete and include units. This is important because it makes reading and understanding documents and information easier.

Energy planning

The energy planning stage of the Energy Management System needs to be carefully considered and carried out. A well-done energy planning will result in better and more opportunities for energy performance improvements.

Training for employees

Training is essential for carrying out tasks correctly. The training should not only be limited to the energy management team, but employees will also need training for implementing changes when they become necessary.

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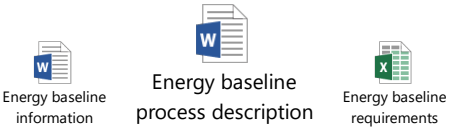
Chapter 9 Appendixes

Appendix 1.0-1.2 Energy policy

Appendix 2.0-2.6 Energy review

Appendix 3.0-3.2 Energy baseline appendix



Appendix 4.0-4.3 Energy performance indicators

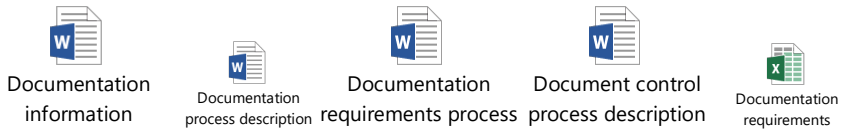
Appendix 5.0-5.3 Energy objectives, targets and action plans

Appendix 6.0-6.1. Implementation and operation

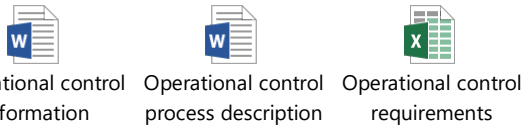
Appendix 7.0-7.2. Competence, training and awareness

Appendix 8.0-8.3. Communication

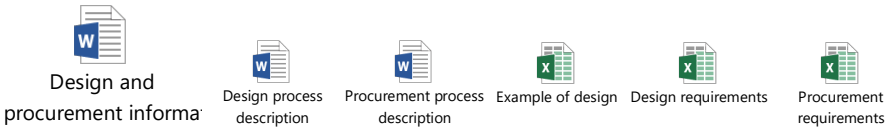
Appendix 9.0-9.4. Documentation



Appendix 10.0-10.3 Operational control



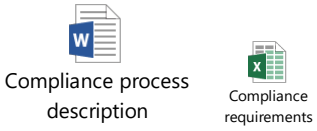
Appendix 11.0-11.5 Design + procurement of energy services, products, equipment and energy



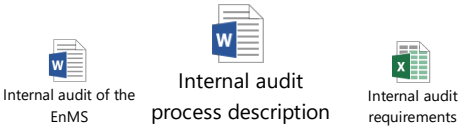
Appendix 12.0 Checking

Appendix 13.0-13.3 Monitoring, measurement and analysis

Appendix 14.0-14.1 Evaluation of compliance with legal requirements and other requirements



Appendix 15.0-15.2 Internal audit of the Energy Management System



Appendix 16.0-16.2 Nonconformities, correction, corrective action and preventive action

Appendix 17.0-17.2 Control of records

Appendix 18.0-18.2 Management review (input to and from management review)

Appendix 19 Risk assessment

Detailed risk assessment

Appendix 20 List of abbreviations

List of abbreviations

Appendix 21 Combined manual for energy, environment and quality

Combined manual 24-11-2017

Appendix 22 Project plan

Project Plan

Appendix 23 Processes created for the Energy Management System

4.3.process

4.4.2.process

4.4.3.process

4.4.4.process

4.4.5.process

4.6.1.process

4.4.6.1.process

4.4.6.2.process

4.5.process

4.7.process

Appendix 24 Updated existing processes for the Energy Management System

PB-1 Management rev07

PB-2 Improvement

Appendix 25 Sixteen step PDCA

EnMS in 16 steps

Appendix 26 Prerequisites

prerequisites recommendation

Appendix 27 Recommendation

recommendations

Appendix 28 Introduction presentation

introduction presentation for empl