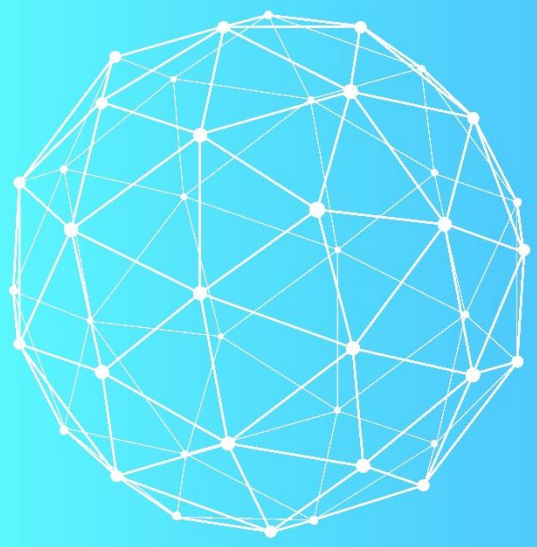

SPHERE

BIM DIGITAL TWIN PLATFORM

WP5 – ICT Operation Tools Implementation

D5.4 Workflows for the EnMS

Authors

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Website	http://sphere-project.eu/		
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Deliverable No.	D5.4		
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Description	Task 5.3: Energy Management The goal of this task will be to develop and implement the workflows for the EnMS. Scope of the work is to identify the energy sources, the energy use and related significant energy uses (i.e. heating, cooling, lighting, services, etc.) of each selected pilot, together with estimation of all possible improvement opportunities, including RES generation and CO2 emission reduction. This task will be performed based on outputs produced by all Tasks in WP2 and models developed in WP3 and WP4. Outputs produced by this Task will be the baseline for the impact energy saving assessment in WP7.		
WP No.	WP5		
Related task	T5.3		
Lead Beneficiary	R2M		
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1 Executive Summary

The ultimate goal of SPHERE's project is the improvement and optimization of buildings' energy design, construction, performance, and management, reducing construction costs and their environmental impact while increasing overall energy performance. The novelty of SPHERE project is the demonstration and validation the SPHERE platform working with real new and retrofitting construction cases.

SPHERE as a special Innovation Action assembles and integrates in a fully systematic, collaborative and integrated framework (IDDS) and corresponding Building Information Model (BIM) enabled set of tools with some diverse and complementary breakthrough Technology Readiness levels (TRL) 5-6 (Technology validated and demonstrated in relevant environment) technology assets. The demonstration activities in SPHERE will ensure that this platform, as well as the proposed tools, will finally reach TRL7 by the demonstration and validation on real residential construction and operational scenarios, both new and retrofitting.

D5.4 consists of three core sections. Firstly, the workflows for an Energy Management System (EnMS) have been developed in alignment with ISO 50001, the international reference standard for implementing an effective EnMS, achieving energy performance objectives and targets in a view of continual improvement. Then, the developed EnMS tasks are explained, representing sequential steps of the energy management process and the key concepts within ISO 50001. Tasks consist of brief explanations and include example templates and tables. Thirdly, the application of the EnMS at pilot sites is described in chapter 5: workflows and tasks have been reviewed in relation to the Finnish pilot site, identified as the most appropriate at this time.

Conclusions have been drawn, highlighting that an EnMS tool based on the developed workflows and tasks may provide a framework, within the SPHERE eco-system, in which other SPHERE activities and tools can interconnect. D5.4 could offer a starting point for organizations aiming to adopt an ISO 50001 EnMS, also presenting an opportunity to implement processes towards eventual ISO 50001 certification.

The main purpose of D5.4 is to pave the way for the implementation of an ISO 50001 EnMS tool within the SPHERE project. Target groups include structured organizations that intend to adopt an EnMS according to ISO 50001 principles, building stakeholders or organizations managing building stock who intend to address energy performance issues throughout the building life cycle, with a commitment towards continual improvement

2 Introduction

2.1 Purpose and target group

The scope of the deliverable is to implement workflows for the EnMS according to the main principles and core concepts of the ISO 50001:2018 Standard "Energy management systems – Requirements with guidance for use". Within the workflows, appropriate tasks were developed to describe actions to be taken in the process of implementing an ISO 50001 EnMS, in subsequent, sequential steps each related to a fundamental specific issue addressed in ISO 50001. Tasks focus on offering support throughout examples, templates, tables, additional workflows, worksheets to organize data etc. The main purpose of workflows and tasks is to provide a basis for the implementation of a tool that can facilitate the adoption of EnMS within the context of the SPHERE project. An EnMS can provide a framework in which other SPHERE activities and tools, such us energy simulation tools or operational control tools, may interconnect. From this perspective, workflows can also provide support to SPHERE partners to understand concepts, requirements, processes related to EnMS in SPHERE aiming the integration of tools, information, data within the SPHERE project.

Workflows and tasks, defined based on ISO 50001 main principles, could be also considered as a preliminary tool, that can offer a first stage of support to organizations aiming to adopt an EnMS according to ISO 50001, though full compliance with ISO 50001 requires deeper and more detailed analysis and an eventual certification is not offered by the SPHERE eco-system. Given this, the tool could help organizations to preliminary understand and address the main requirements of ISO 50001 and set the basis to develop and implement an EnMS (and related processes and documentation) according to ISO 50001 core principles.

Target groups for the tool related to EnMS that will be implemented could be:

- structured organization (typically medium to large, also in respect to energy use) managing a property portfolio or building stock, such as public entities, private companies, social housing bodies etc.
- ESCos and energy management professionals acting as external consultants for organizations in relation to ISO 50001.

The needs of this target groups relate to an implementation of an EnMS according to ISO 50001 and can be addressed by the adoption of tools to provide guidance, support and simple processes to address ISO 50001 principles and requirements with an organized and structured approach. They can also target achieving a better understand of the ISO 50001 concepts and requirements, approaching the EnMS with simple steps. Another need could be the integration of an EnMS in the company procedures and organizational structure. These needs have been considered in developing workflows and tasks, focusing on identification of the core concepts of ISO 50001, providing

examples, tables and guidance to support in collecting and manging information and in defining procedures and processes.

According to Amendment refence n. AMD-820805-3, VRM have undertaken to develop a platform, related to an ISO 50001 EnMS, during the implementation phase of the SPHERE project. The workflows and tasks produced by D5.4 will form the basis for the development of this platform.

2.2 Contributions of partners

R2M Energy, on the basis of a deep analysis of ISO 50001:2018 Standard and related standards, has defined, in collaboration with VRM, the workflows for an Energy Management System (EnMS) and has outlined related tasks. The workflows and tasks aim to summarize the main actions to undertake for implementing an EnMS according to ISO 50001 and provide support to breakdown the different steps of the EnMS processes. Given its background as an ESCos (Energy Service Company), R2M Energy focused on the more technical aspects relating to energy efficiency such us energy audit, Energy Performance Indicators and improvement opportunities. Under this perspective, R2M Energy facilitated the contribution of pilots, in particular working closely to Caverion on the Finnish Pilot. Caverion has implemented a selected stage of the workflow and the related tasks, with the purpose to obtain a valuable preliminary feedback. R2M Energy additionally cooperated with VRM to define the workflows and the tasks contents and format with the aim to be implemented in a software tool within the SPHERE environment and to identify of potential connection with other tools.

VRM carried out a detailed analysis of the revised 2018 version of ISO 50001 for Energy Management Systems in order to inform the workflows, tasks and outputs of an EnMS process, according to ISO 50001, which could in turn be applied to the four selected pilot project buildings. VRM have worked closely with R2M Energy on the workflow design and usability with a view to embedding the workflows within the core of the ISO 50001 application, due for delivery later in the project. VRM are WP5 leaders and have facilitated the Deliverable and Task reporting process, hosting regular work package and latterly Task-led calls.

Caverion's contribution focused on undertaking, from the point of view of Finnish pilot building, the tasks related to Planning stage of the workflows of the EnMS. These tasks concentrate on energy uses and energy performance of the pilot building. Caverion is implementing energy efficiency improvement measures in the pilot building, having availability of energy data related to the building. Caverion also provided valuable feedback on the preliminary implementation of workflows and tasks and outlined, from its point of view, potential benefits that can be obtained from the implementation of an EnMS according to ISO 50001.

De Cinque Services also provided interesting perspective of possible benefits of adopting an EnMS in the Italian pilot building (a new construction building currently in the design phase) and within its organization. Possible further application of the workflows and tool to the pilot site have been preliminary prospected and evaluated.

2.3 Baseline

Energy performance plays a fundamental role within organizations and the pursuit of energy performance improvement is an important objective in every sector, since it can bring economic, environmental and social benefits, therefore linking to sustainability. One of the ultimate goals of the SPHERE project is the improvement and optimization of buildings' energy design, construction, performance, and management, reducing construction costs and their environmental impact while increasing overall energy performance. An EnMS provides an opportunity to achieve energy related objectives and to structure an approach and a framework for dealing with energy aspects in a holistic, systematic, and continual way over the lifetime of a building. ISO 50001 standard describes in detail the requirements for an effective EnMS that can bring to a continual improvement in energy performance. ISO 50001 itself could be considered in fact as a tool. The applicability is wide as the standard defines general concepts, processes and requirements; major applications are related to the industrial and commercial sector and for organization with medium and large energy use [5] [7] [11] [12]. In the SPHERE project, an EnMS aims to address the different aspects of a building's lifetime from the concept design phase to the management phase, with the support of digital tools. In this perspective, an EnMS represents a systemic approach that addresses the issue of energy performance continuously and integrating different aspects and levels such as involvement of management, definition of policies, objectives and targets, definition of action plans, and control procedures. Unlike an energy audit activity (which takes place in a defined time phase and can provide a picture of the performance of a building or an organization at a given moment) the adoption of an EnMS involves the implementation of continual actions and activities aiming optimization of energy performance. Generally, energy audit (or energy review) is in fact one of the activities at the basis of an EnMS. In the same way, an EnMS-related tool can act as a general framework for various actions, activities and other tools related to energy performance.

2.4 Relations to other activities

Contents developed in WP2 were considered with particular regard to the D2.2 "SPHERE holistic sustainability assessment" in which KPIs relating to Energy Efficiency and Operational Performance were investigated, and D2.3 "SPHERE user scenarios and specific requirements for renovation" with regard to user stories and the relationships between the various SPHERE tools.

Regarding WP3, as Technical Core Group members VRM have ensured that D5.4 considerations and technical integration requirements have been included within the « toolkit ». VRM will provide the platform SSO (Single sign-on) and lead on the authentication protocols. The workflows developed as part of D5.4 will be integrated within VRM's ISO 50001 tool. This tool will be developed in line with the operational phase of WP3.

Working closely with WP4 leaders and members the consortium and D5.4 leaders have ensured that reporting, integration requirements, tool descriptions and collaboration between WP4 and WP5 has been upheld. The relationship between the Design stage and the Operational stage tools

was identified as critical to the success of the project at an early stage. Further work is required as the project continues to ensure that the two work packages continue to collaborate successfully as they have thus far.

As one of the WP5 « Operational » Tools D5.4 will be utilised together with the ISO 50001 tool to provide circular energy management solution within the SPHERE Eco-system. ISO 50001 principles will be implemented to establish energy management protocols and targets. The Clarity IoT Dashboard (D5.1) will enable live or near-live data visibility and export. EUT's Predictive Maintenance Tool (D5.2) and COMS's integration with CMMS (D5.3) will enable predictive maintenance solutions to be implemented. Together these four tools present a unique energy management suite to SPHERE stakeholders; the value of which will be developed further within the project timescale.

The activities of this deliverable are connected to the activities of WP6 regarding demonstration on pilot sites. A preliminary test of the workflow and tasks on the Finnish Pilot was carried out and an initial investigation was made into the possible benefits of implementation of EnMS workflows and tasks for other pilots. The demonstration activities related to the EnMS tool are ongoing. Outputs are limited to the fact that at this stage data for other pilots are not available due to current early stage of design and modelling.

Some of the concepts contained in the EnMS and in the tool such as objective targets, energy related KPI, improvement opportunities procedures, could provide also support in investigating SPHERE business models in WP7.

3 Workflows for the Energy Management Systems

3.1 Energy Management System and ISO 50001

The definition of a Management System according to ISO (International Organization of Standardization) is:

> *set of interrelated or interacting elements of an organization to establish policies and objectives and processes to achieve those objectives. [1]*

This general definition applies also in the scope related to energy, underlining that the core concepts at the base of an EnMS are represented by energy policies, objectives and processes related to the energy consumption, energy use and energy performance of an organization. An EnMS consists of different interconnected aspects or actions to be taken that aim to accomplish over time the intended objectives. Therefore, while timely activities such as energy audit, simulations, design of improvement interventions are carried out at a certain time or with a limited effort over time, the adoption of an EnMS system consists in a wider set of activities, (which also can include the mentioned actions) and requires sustained effort over time and continual and prolonged commitment.

From this perspective an EnMS is a concept that can fit well into the SPHERE project, in which all phases of a building's life cycle such as design, construction, performance and management are addressed. EnMS may therefore provide a framework for activities related to energy and to the different SPHERE tool that may occur at a certain phase of the building lifetime.

ISO 50001:2018 – "Energy management systems – Requirements with guidance for use" is a standard, developed by the International Organization for Standardization (ISO) that defines the requirements of EnMS. The scope of the ISO 50001 is the following [2]:

ISO 50001 Scope :

This document specifies requirements for establishing, implementing, maintaining and improving an energy management system (EnMS). The intended outcome is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance and the EnMS.

This document:

a) is applicable to any organization regardless of its type, size, complexity, geographical location, organizational culture or the products and services it provides;

b) is applicable to activities affecting energy performance that are managed and controlled by the organization;

c) is applicable irrespective of the quantity, use, or types of energy consumed;

d) requires demonstration of continual energy performance improvement, but does not define levels of energy performance improvement to be achieved;

e) can be used independently, or be aligned or integrated with other management systems .

The ISO 50001 standard is based on Plan-Do-Check-Act (PDCA) approach, a widely used iterative management process of control for continual improvement. The PDCA approach applies to EnMS elements and activities in the following way [2]:

— Plan: understand the context of the organization, establish an energy policy and an energy management team, consider actions to address risks and opportunities, conduct an energy review, identify significant energy uses (SEUs) and establish energy performance indicators (EnPIs), energy baseline(s) (EnBs), objectives and energy targets, and action plans necessary to deliver results that will improve energy performance in accordance with the organization's energy policy.

— Do: implement the action plans, operational and maintenance controls, and communication, ensure competence and consider energy performance in design and procurement.

— Check: monitor, measure, analyse, evaluate, audit and conduct management review(s) of energy performance and the EnMS.

— Act: take actions to address nonconformities and continually improve energy performance and the EnMS.

According to ISO, the ISO 50001:2018 standard contributes to the following United Nations Sustainable Development Goals: 7- Affordable and Clean Energy; 11 - Sustainable Cities and Communities; 12 – Responsible Consumption and Production; 13 – Climate Action.

The implementation of an EnMS according to ISO 50001, establishing a process for continual improvement, can provide organizations several benefit such as reduction of energy costs and subsequent increased competitiveness, achievement of environmental goals, introduction of a long-term factor of progress, innovation triggering [7], productivity and operational improvements [8].

Targeting wide applicability across different economic sectors (such as industrial plants, commercial, institutional and public facilities), it is estimated that the standard could influence up to 60% of the world's energy use. [5].

In its 2018 edition (compared to the previous one of 2011), ISO 50001 has introduced the adoption of the requirements of all ISO Management System standard, known as the "High Level Structure", that implies a common structure, terms and definitions and core text. This can offer organizations opportunities to address management of different aspects such as energy (ISO 50001), environment (ISO 14001), quality (9001) with a common and solid approach. Some additional key concepts were therefore included in the ISO 50001 2018 version of the standard, mainly relating to giving greater emphasis to the analysis and integration of the context of organization, to the strategic role of management and to the process of continual improvement.

One of the concepts at the base of the ISO 50001 standard is the development and management of documented information, also in relation to communication between different figures, roles and levels in an organization. This represents another important point of contact with SPHERE Project, where information in the digital environment relating to energy aspects involves different players, phases, tools and therefore effectiveness in managing information is fundamental.

Support provided by tools and digitalization can play an important role in the effectiveness of an EnMS. May et al. [4] identified four key elements for successfully integrating energy efficiency in manufacturing: strategic approach, manufacturing process paradigms, supporting tools/methodologies and ICT. Digitalization of an EnMS may provide benefit and support for different activities such as developing and managing documented information, tracking decisions, managing responsibilities, managing data, communicating EnMS core concepts, monitoring EnPIs, implementing reports, address nonconformities etc.

Offering an EnMS as one of the SPHERE platform's features has the potential to provide considerable added value in the eyes of core stakeholders responsible for changes to a building during its life cycle. One of the most reported challenges in implementing an ISO 50001 EnMS is related to that the lack of resources or limitations regarding human resources, technologies, infrastructure, financial, time [6], or lack of a culture of energy management [8]. Offering a workflow which follows the ISO 50001 rationale with no additional cost to the platform user provides a tangible added-value element. D5.4 participants also believe that the workflows could

help to encourage and aid an organisation's ISO 50001 implementation by offering a bedrock from which to begin the process that may lead to a third-party certification.

One of the main innovations with which SPHERE outcomes impact alignment with the call is related to bring ISO 50001 and Energy Action Plans to the building and residential sector and provide organizational level software for managing energy. A recent study (Dall'O' et al. [10]) related to first application of ISO 50001 for social housing building stock in Italy highlighted significative reduction of energy consumption and improvement in the comfort conditions of tenants.

> *Although the implementation of EnMS compliant with EN ISO 50001 is not widespread in the building sector, the application […] demonstrated its usefulness and effectiveness with reference to public bodies that manage large building stocks of social housing. [10]*

3.2 Workflows for the EnMS

3.2.1 Foreword

In defining the workflows and related tasks of an EnMS, the adopted approach aimed to develop the most relevant ISO 50001 concepts and requirements. The purpose is to set the basis of a tool within the SPHERE project that can facilitate implementation of an EnMS according to the ISO 50001 standard. At this stage, the workflows and tasks may be considered a preliminary tool in itself, presenting the core concepts of an ISO 50001 EnMS. R2M Energy utilised its experience as an ESCo to develop the aspects related to energy planning (stage 3) including tasks such as identification of risks and opportunities, objectives and targets, identification of Significant Energy Uses (SEUs), definition of EnPIs (Energy Performance Indicators) and EnB (Energy Baseline), improvement opportunities.

The ISO 50001 standard includes a wide series of requirements and concepts, it follows that each organization that intends to adopt an ISO 50001 EnMS should undertake specific evaluations based on the scope, context, type, and complexity of the organization. The tool provides general examples and approaches based on the ISO 50001 core concepts but does not offer certification to the standard itself. The type and extent of documented information may not be appropriate or applicable to all organizations. The level of detail of documented information and of the addressed issues is context-specific to the needs and type of organization in question, and full compliance with ISO 50001 should be assessed with deeper analysis and detail as required. Further development of workflows and related tasks, in an EnMS tool perspective, will be carried out and will utilise pilot partner feedback and inputs over the rest of the project duration.

The approach of the workflows and tasks is not designed to substitute the ISO 50001 standard. For a detailed explanation of terms, definitions and full descriptions of requirements, refer to ISO 50001.

Example tables, templates or guidelines provided in the tasks could support preparation of a preliminary draft on how data can be collected and managed. In this tool concepts and requirements of ISO 50001 have been summarized for clearer understating, additional indications or considerations have been added that could be considered useful in an EnMS implementation perspective. In some cases, the examples relate to buildings and residential sector only, as the context is related to SPHERE scope.

The workflows, tasks and related examples provided have been defined to aid development of an ISO 50001 EnMS tool in the SPHERE project. Tables and forms in the tasks, as well as documented information structure have been outlined considering the implementation in a software platform.

3.2.2 Structure of the workflows

Workflows in general represents an organized sequence of subsequent activities with the aim of outlining a working process and providing breakdown in different steps with a systematic approach.

The general workflow of the ISO 50001 is based on the Plan-Do-Check-Act-Process, for continual improvement approach. For this reason, the workflows are intended as consequent actions and tasks, that may be divided in different stages, to be undertaken in a cyclic way.

In general, the first cycle represents the moment in which the EnMS and the related plans, methods, processes, documented information may be defined for the first time. In carrying out the following cycles, greater attention is paid to review, refine, update and improve processes as well as to develop reports and documented information relating to actual periods.

Figure 1. provides a general overview of the workflows identified in the ISO 50001 standard context. The tasks and stages have been identified taking into consideration the main aspects outlined in the ISO 50001 standard according to the structure and concepts defined in the standard itself.

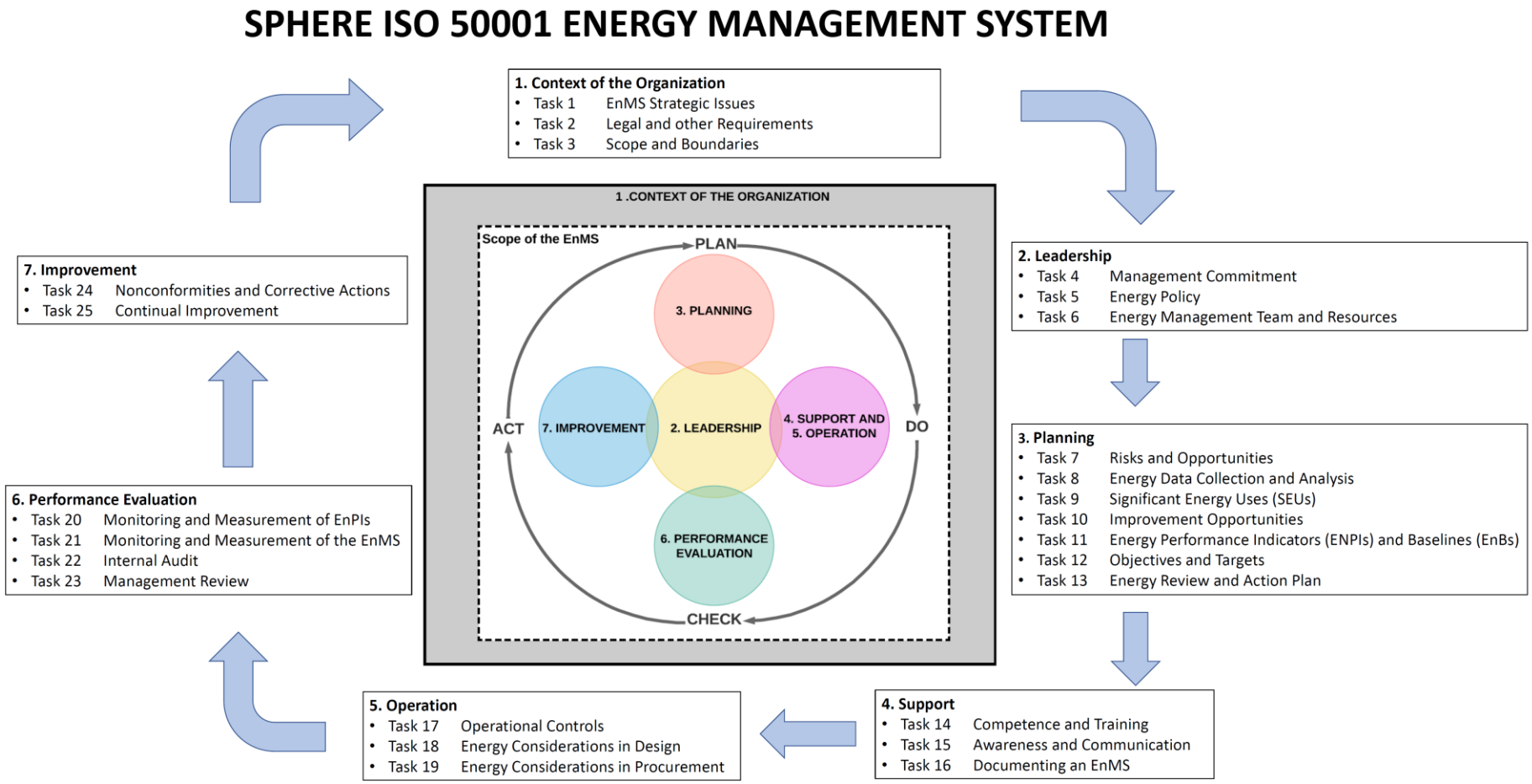


Figure 1.General overview of the workflows of EnMS according to ISO 50001 core concepts.

In particular, 25 tasks were identified divided into 7 different stages:

- the stages have been defined for a better detailing of the workflows and for defining a breakdown of actions into consecutive steps for clarity. The definition of different stages conceptually follows the approach and the clauses of ISO 50001 in its 2018 version in which the stages related to the context of the organization and leadership pave the way to Plan-Do-Check-Act phases and represent important aspects that apply transversally to the other stages. Examples are the definition of energy policy or the management commitment that are fundamental to ensure and support the effectiveness of the EnMS. The stages are described in chapter 4.
- tasks have been defined as actions to be taken for the implementation of an EnMS, relating to a specific section, concept or aspect defined by ISO 50001 and represent the different steps of the workflows and of the EnMS process. They are structured as a description of the activities to be undertaken within an EnMS and are enriched with examples, tables, additional workflows or guidance, to provide support for the implementation of an EnMS. The tasks are described in chapter 4 and reported in Appendix.

The Workflows have been summarized in 7 different graphs, one for each stage. The structure of each workflow is represented by a matrix in which operating flows, related actions, decisions to be taken, documentation and related information have been interconnected in a structured pattern.

The matrix has been divided into three rows:

- start: represents the beginning of the workflows of the stage and the connection with the workflows of the previous stage.
- development: includes flows, tasks, actions, decisions, documents and related information of the actual stage.
- end: represents the end of the stage's activities and the connection with the workflows of the following stage.

The matrix is also divided in columns: the first three columns from the left represent three different levels within the context of the organization in which the EnMS is implemented. Under this approach, the tasks and the related actions are represented within the column corresponding to the level in which they are carried out or in levels that are substantially involved in the tasks.

In particular, the three levels refer to:

- management: this level comprises tasks, actions and decisions related to management of the organization. It can refer to different levels of management involved according to the type and context of the organization, including top management. Management (especially top management) plays a fundamental role in the process of implementation of an EnMS according to ISO 50001 since it shall provide adequate support for activities and the continual

improvement of energy performance, ensuring the effectiveness of the EnMS. Management involvement in the EnMS deals also with review and approval of activities, documents and actions developed by the Energy Management Team. For this reason, review and approval activities by the management are planned along workflows at each stage. In general, management involvement could involve different levels of management depending on the context, characteristics and dimensions (e.g. top management, manager of different areas within the organization etc.). ISO 50001 pays great attention to involvement and commitment of top management.

- Energy Management Team: consists of a group, appointed by management, where different figures with different skills, roles and competence converge with the aim of implementing the EnMS within the context of the organization. The Energy Management Team have therefore the responsibility and authority (as assigned from management) for the effective implementation of the EnMS and for improvement of energy performance. Its main duty is to carry out activities envisaged by the EnMS, operating between the upper level of management (with whom it interacts for the approval of actions, policies, documents of different types) and with the lower level of personnel/users with whom it interacts to ensuring that the EnMS is applied, implemented and adopted. The Energy Management Team may include energy managers, technical figures, external consultants but could also involve figures with different competences in the organization.
- Personnel/users: represents the operational level of an organization, consisting of, for example, employees, workers (in a production context) or users (in a building context). These two terms generally summarize the level of the figures within the scope and boundaries of the EnMS who are not directly involved in the development and implementation of an EnMS but whose behaviours and activities may impact the EnMS in different ways.

The additional columns regard the documentation and related information such as the date on which the documentation is issued or the status, for example in relation to review, approvals, completion according to the procedures and methods defined by the organization for managing the documentation.

The graphic representation of the workflows has been defined to provide a clear flow path of the tasks and activities of the EnMS. In particular, the workflow is represented by a thicker line in which the activities follow each other, from the beginning to the end of each stage. Dotted lines represent activities linked in different levels or connections to information or related documentation. The graphics of the boxes in which tasks, documents and information have been described was also defined with the aim of making the workflows clearer and more understandable, as detailed in Table 1.

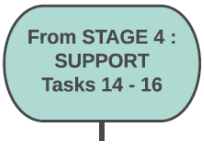
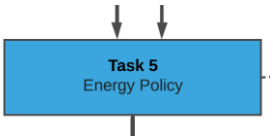
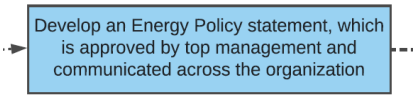
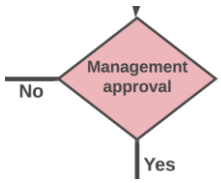
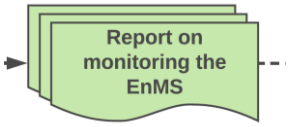
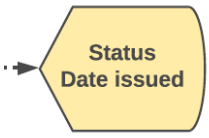
Symbol	Meaning
	**Start/End** The "terminator" symbol represents start and end points, connecting with previous and following stages.
	**Task** Main tasks title.
	**Tasks and actions description** Brief description of the tasks. It is represented in the column of the level in which the tasks are implemented (e.g. management, personnel/users, etc.)
	**Decision** Decision or approval that divides the workflow path in relation of the outcome of the decision or approval.
	**Documents/documented information** Implementation and development of documents or documented information related to tasks.
	**Status and date issued** Information related to date and status of documents/documented information that may be relevant in the EnMS implementation process: e.g. completed, pending, not completed, approved, reviewed etc.
	**Workflow connections** Main path of the workflows connecting subsequent tasks.
	**Other connections** It connects main tasks with tasks description, related documents and information.

Table 1. Key of symbols of the Workflows and related meaning.

The following figures represents the Workflows for the EnMS divided in stages, according to ISO 50001 core concepts.

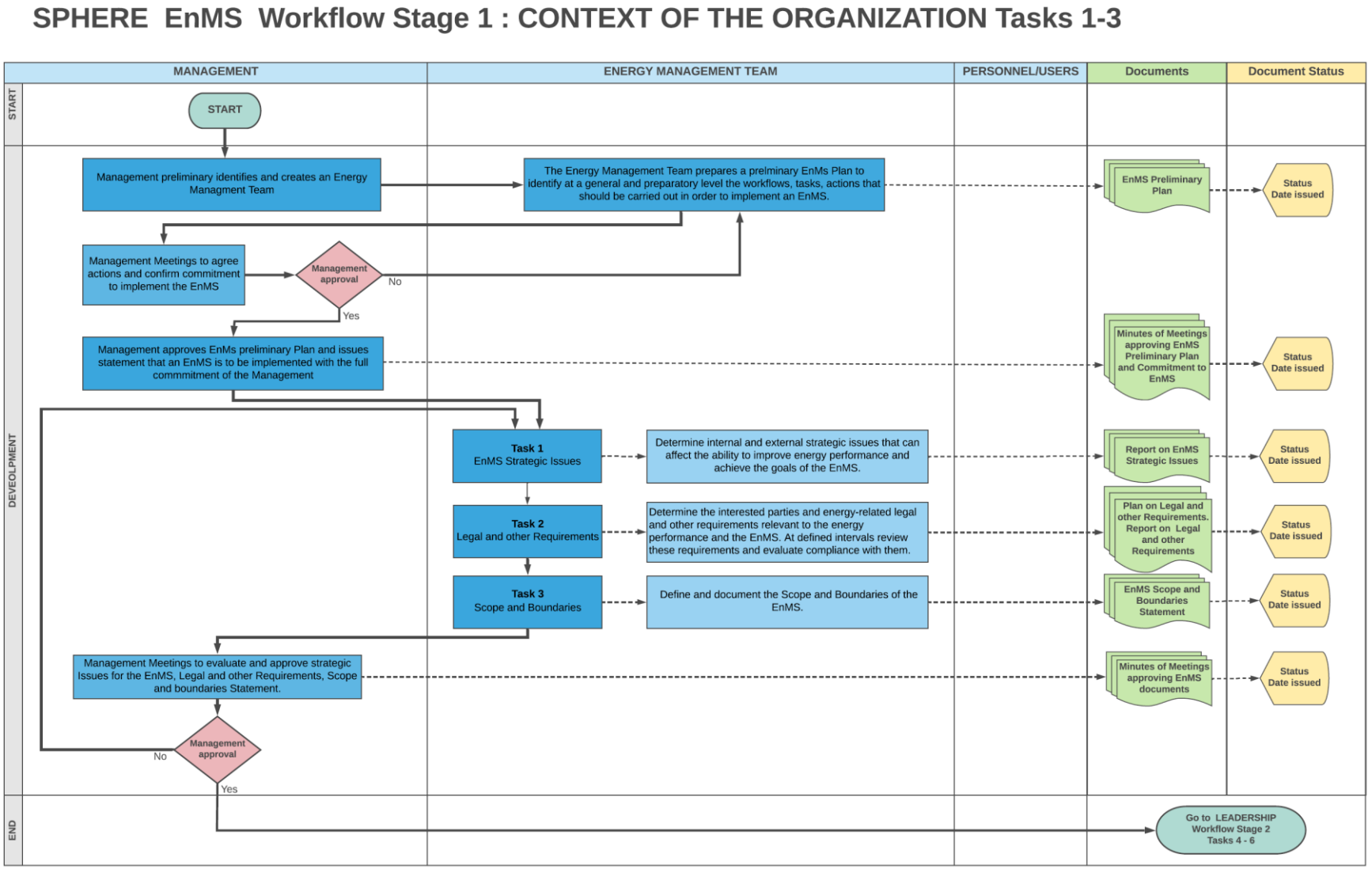


Figure 2. Workflow Stage 1: Context of the organization

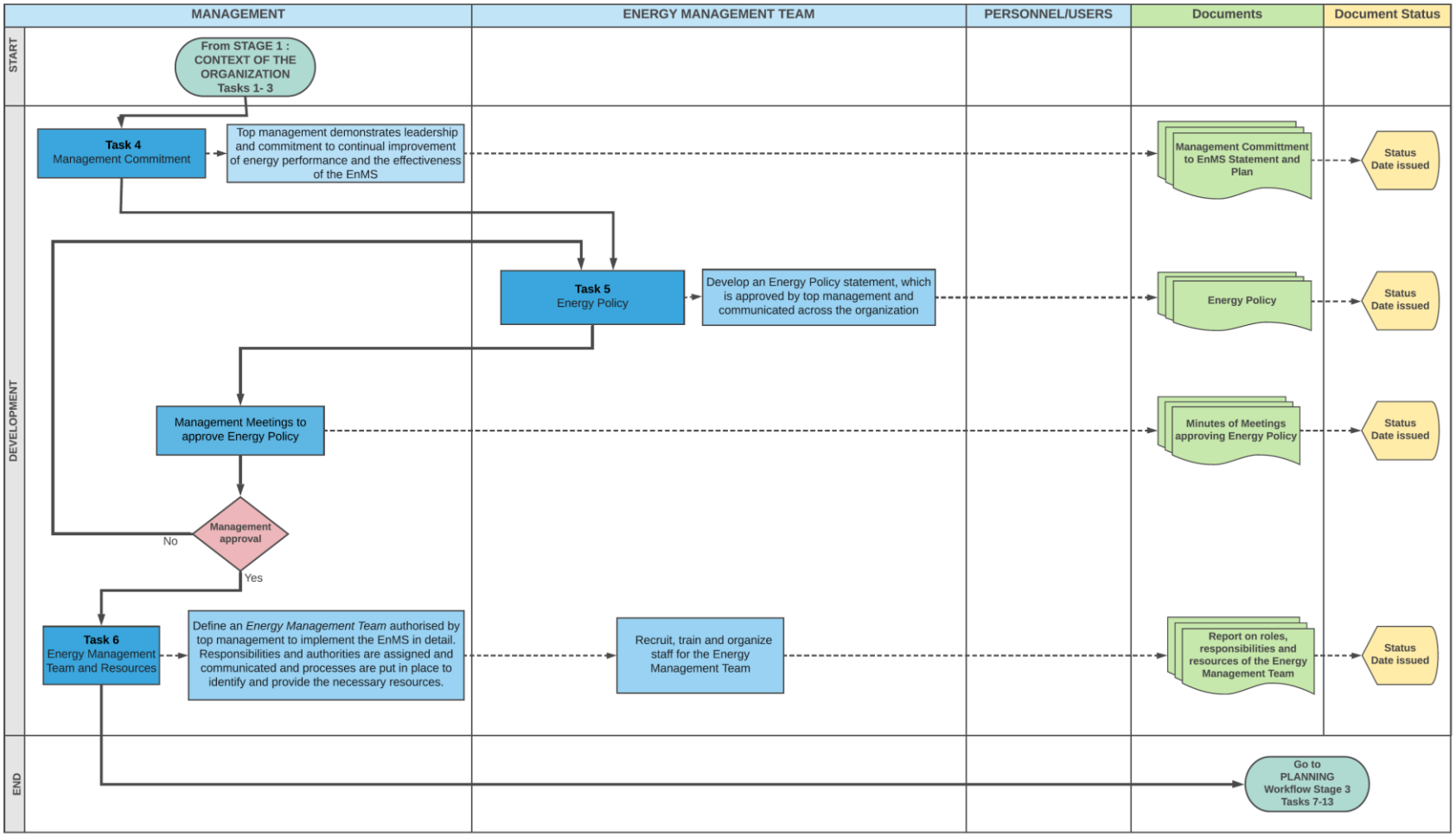


Figure 3. Workflow Stage 2: Leadership

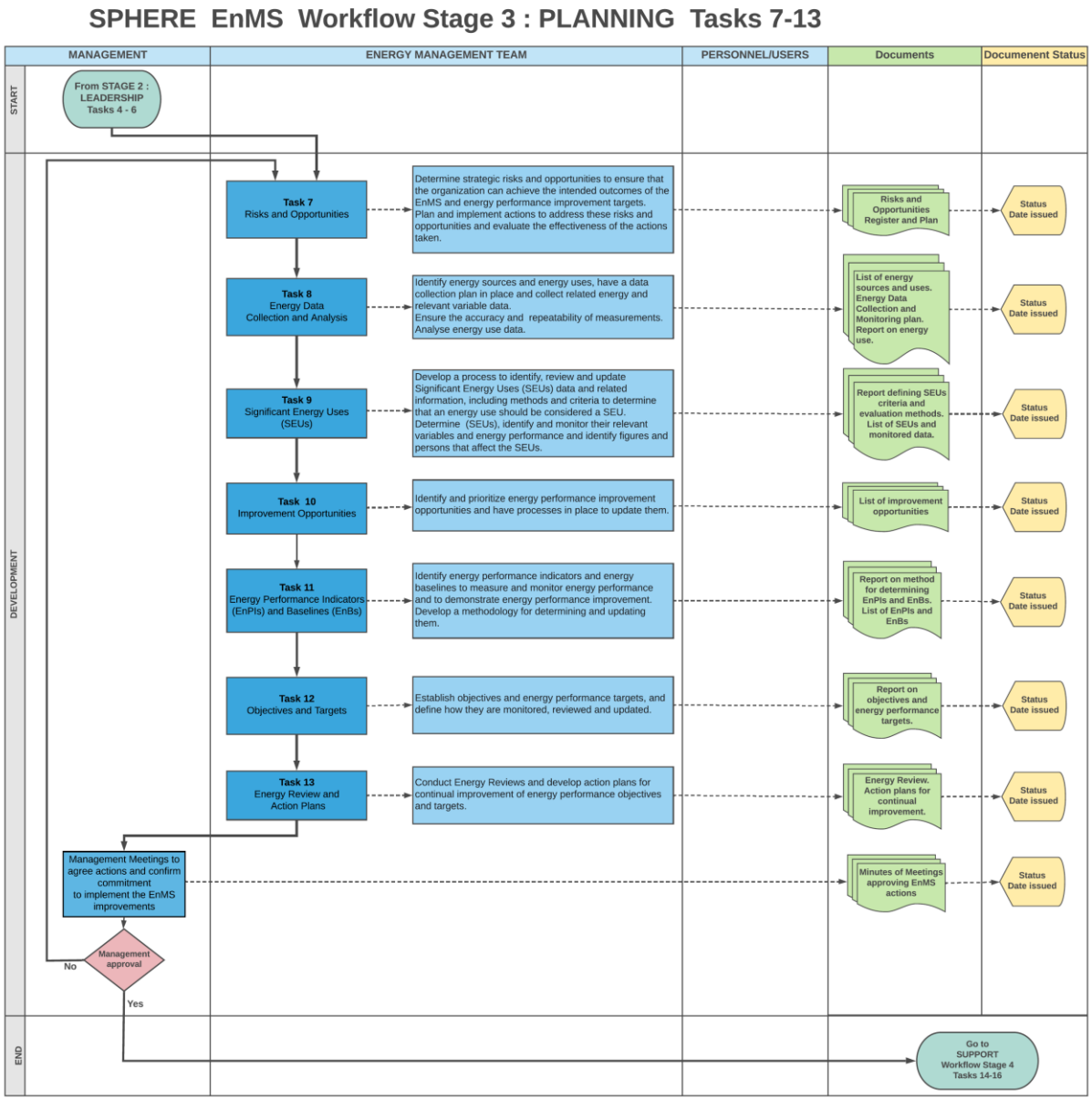


Figure 4. Workflow Stage 3:Planning

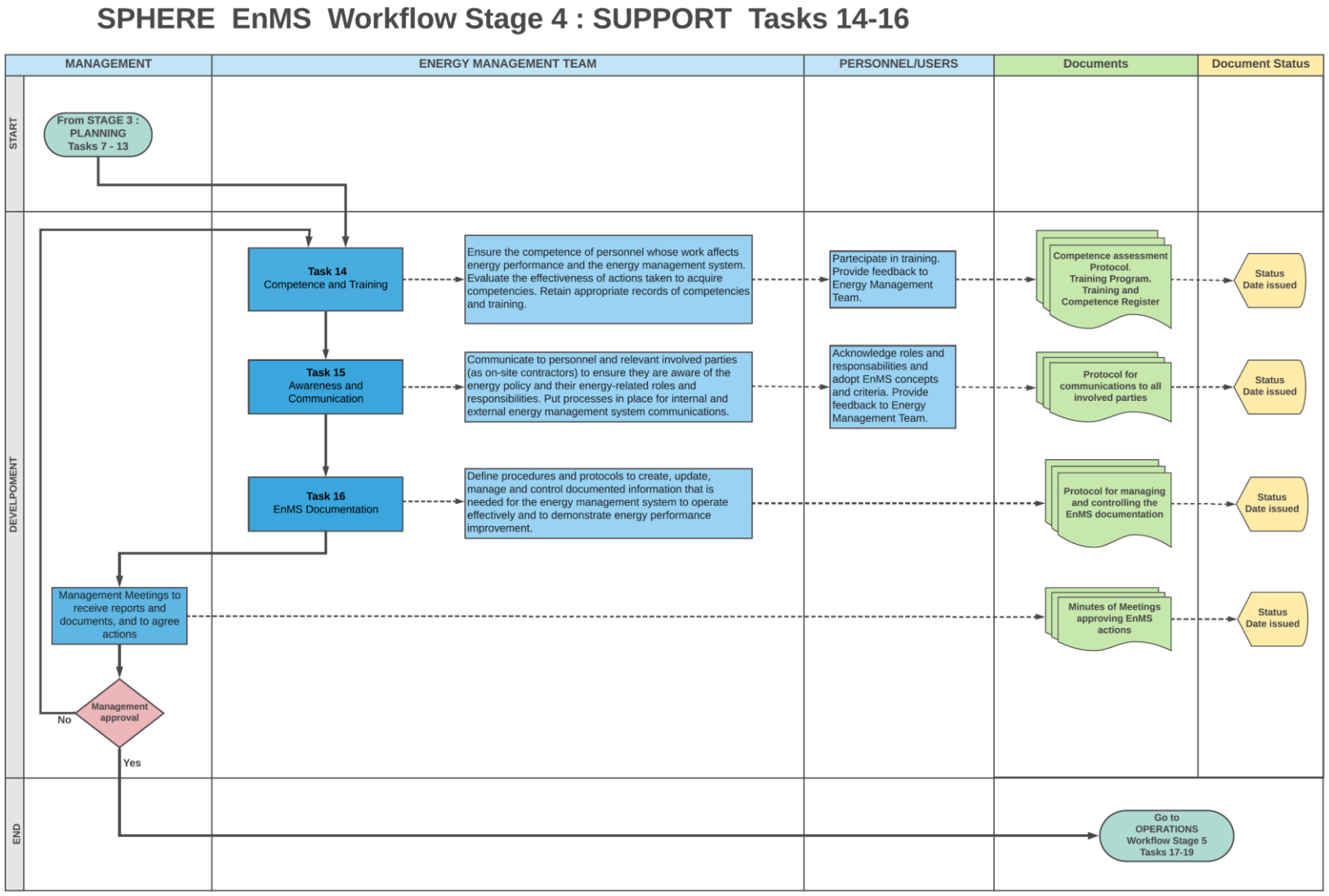


Figure 5. Workflow Stage 4:Support

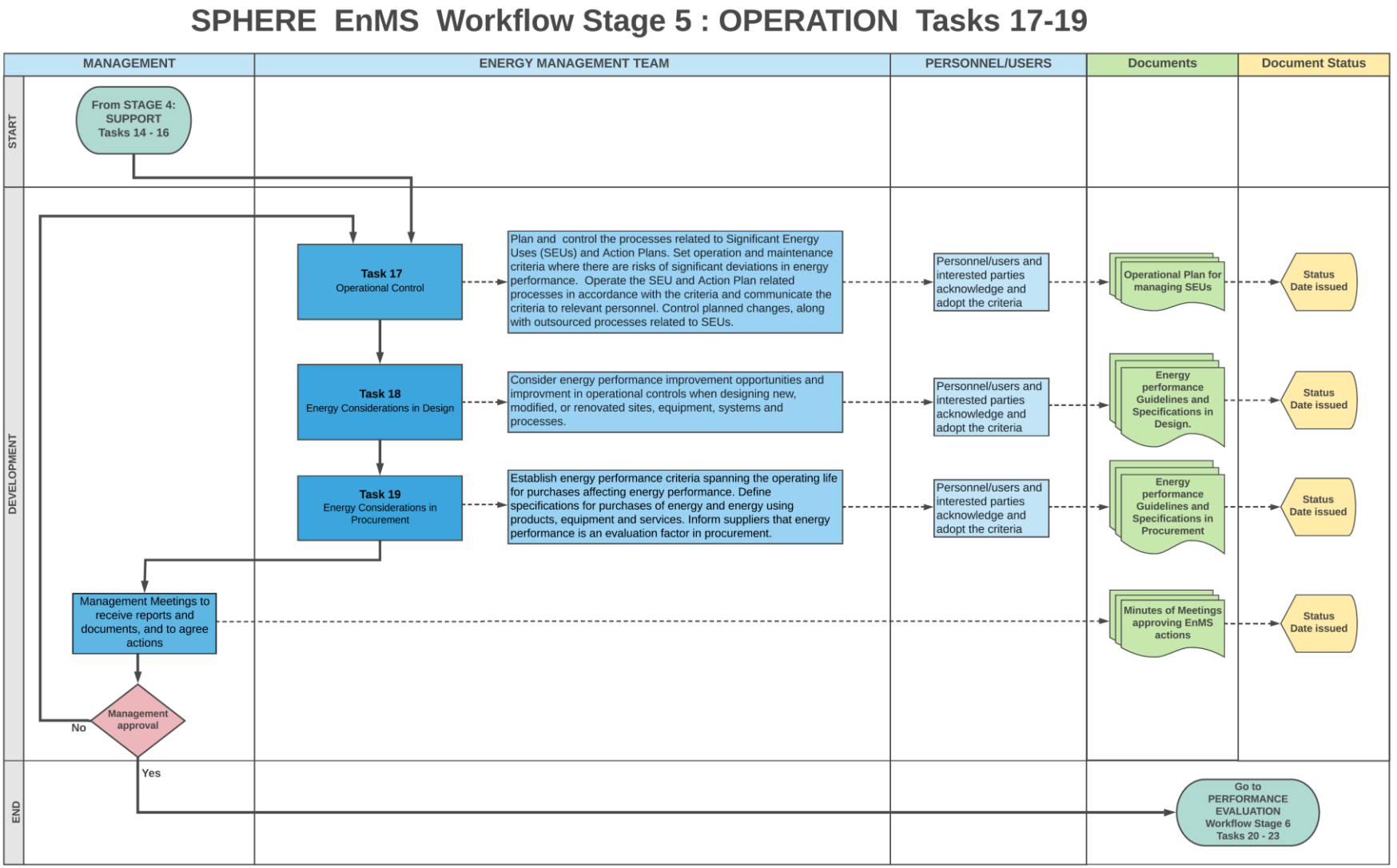


Figure 6. Workflow Stage 5: Operation

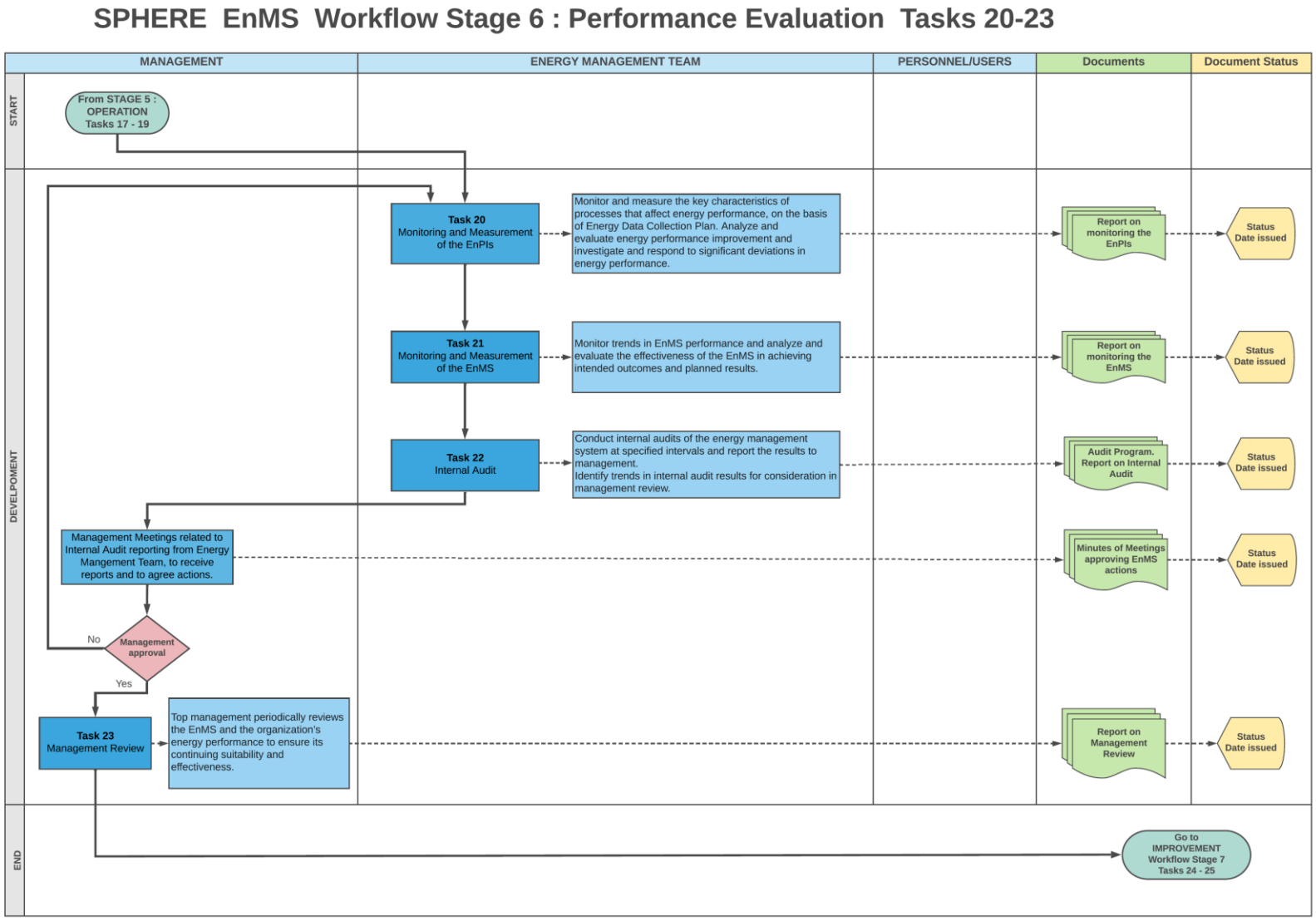


Figure 7. Workflow Stage 6: Performance Evaluation

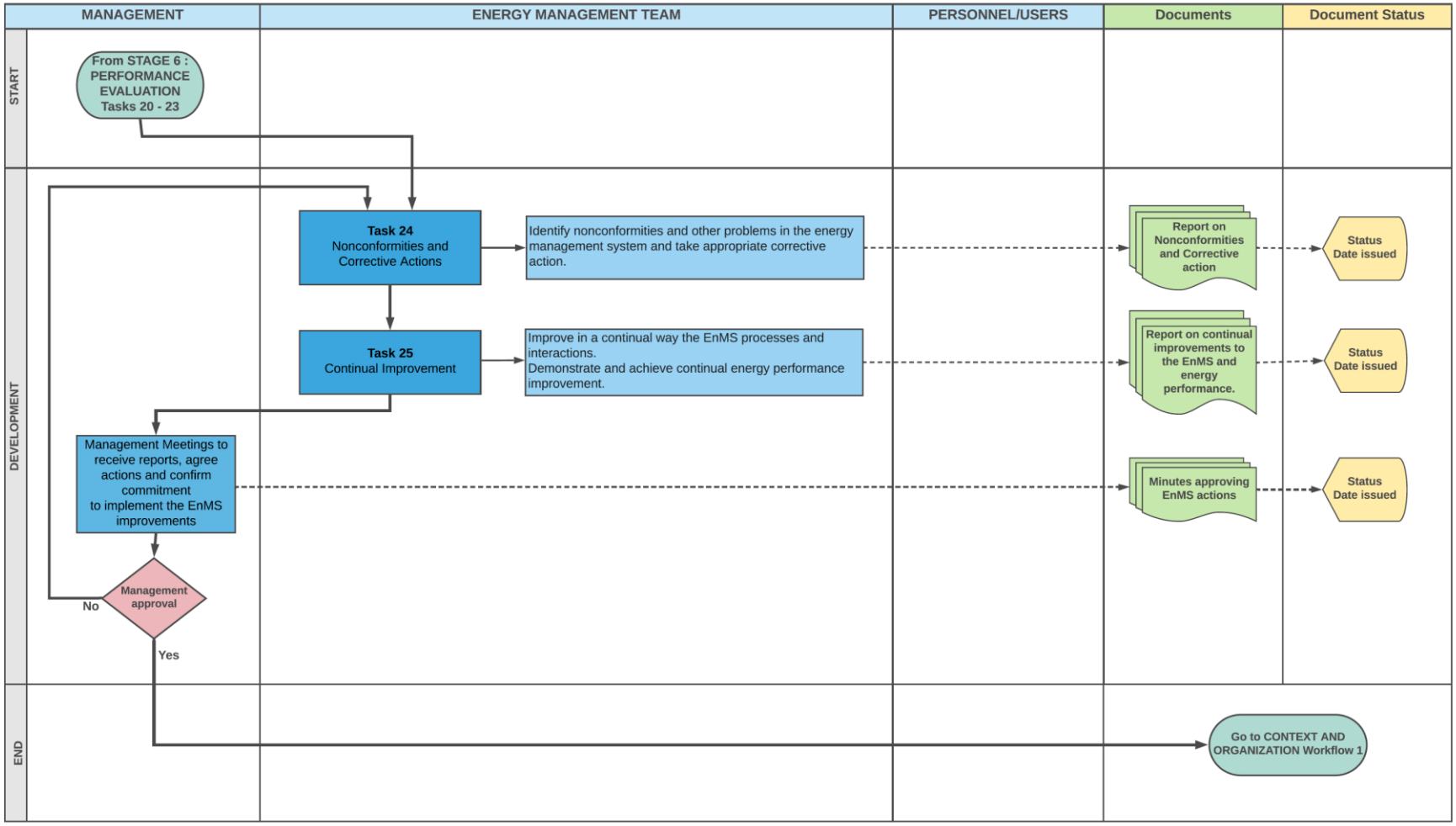


Figure 8 Workflow Stage 7: Improvement

4 Tasks of the EnMS

Workflows are divided into stages, that reflect some of the main sections and clauses of ISO 50001 standard related to PDCA approach and include, as initial stages, aspects related to understanding the context of organization as well as leadership involvement and commitment.

Each stage represents therefore a workflow of tasks, and each task consists in a short section containing:

- general description of the scope of the task;
- actions to be taken to implement an EnMS according the core concepts of the ISO 50001;
- additional considerations related to the activities of the tasks;
- example tables, templates, checklists, forms, provided to support the collection, organization and documentation of data;
- documented information to develop.

As addressed in the Foreword chapter, the tasks are intended to give support to implement an EnMS according to ISO 50001 principles, with regards to the SPHERE project framework. ISO 50001 standard is the reference document to consider assessing in detail the minimum requirements to comply to ISO 50001 standard itself. Type, level of detail and structure of documented information could vary significatively from organization to another in relation to its characteristic, extent, scope etc.

Briefly, the scope of the tasks in general is to provide a breakdown of activities in smaller steps related to ISO 50001 approach and requirements, aiding in defining actions, documents, approach, procedures, also recalling correlated other tasks.

Example tables, matrices and templates have been developed with the purpose of being implemented into a software within the SPHERE Project. Some forms in the task may be filled with sentences, considerations, bullet points list for implementing the first draft and basis of documented information related to an ISO 50001 EnMS.

Figure 9 and Table 2 show an example of a workflow of actions and of an example table provided in the tasks.

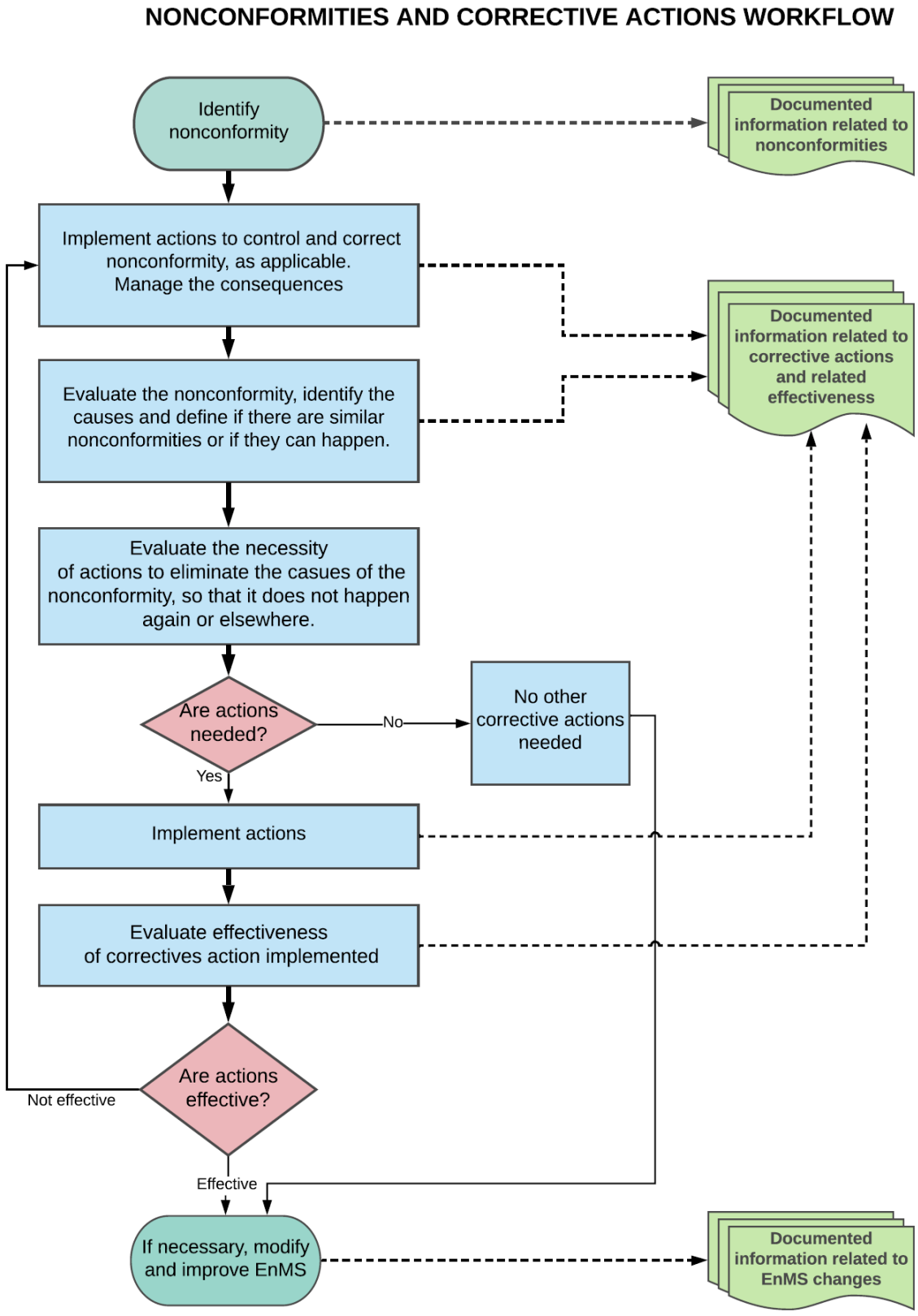


Figure 9. Example of a workflow related to activities in a task based on ISO 50001 principles.

Data collection - energy meters and variables								
N.	**Type**	**Energy type or vector**	**Measured Energy variables**	**Unit**	**Frequency of measure**	**Data collection method**	**Responsible**	**Required for management review**
1								
2								
3								
4								
…								

Table 2. Example of table related to documented information of a tasks

The 7 stages follow the processes outlined within ISO 50001 and reflect the structure of the clauses in which the standard is divided, in the following way:

Stage 1 – Context of the organization

The first stage includes preliminary tasks regarding management commitment and creation of an initial energy management team with the purpose to outline a preliminary plan for implementing an EnMS according to ISO 50001. Other tasks of the stage cope with the necessity of the organization to understand its context and strategic issues, in relation to its energy use and energy performance, establishing scope and boundaries of the EnMS.

Stage 2 – Leadership

This stage underlines the crucial role of top management commitment to the energy management system and regards the definition of an energy policy approved from management, established in the organization and properly communicated. It also tackles the implementation of an Energy Management Team, defining roles and responsibilities in relation to the EnMS.

Stage 3 – Planning

The tasks in this stage outline requirements of the organization related to planning actions for different aspects such as addressing risks and opportunities, defining objectives and targets to achieve, identifying energy performance indicators, energy baseline, establishing a plan for energy data collection. In this stage the activities of carrying out Energy Reviews and Action plans for continual improvement are also addressed.

Stage 4 – Support

This stage refers to support activities that are relevant for the effectiveness of the EnMS as: communication, training and competences, management and control of documented information.

Stage 5 - Operation

Operation stage relates mainly to Operational Control and integration of energy consideration and specification in design and procurement within the organization.

Stage 6 - Performance evaluation

The tasks in stage 6 regard performance evaluation throughout monitoring and measurement of energy performance and EnMS effectiveness. Internal Audits and Management Review are fundamental steps to assess the EnMS effectiveness and energy performance, also identifying nonconformities.

Stage 7 – Improvement

The activities of this stage relate to addressing nonconformities and taking appropriate corrective actions for continual improvement.

The tasks are reported in Appendix.

5 Application on Pilot sites

5.1 Pilot involvement

SPHERE Task 5.3 includes the development and the implementation of the EnMS workflows, and in relation to selected pilots, the identification of energy sources, energy use and related significant energy uses and an estimate of all possible improvement opportunities, including RES generation and CO_2 emission reduction.

The involvement of the Pilots is therefore fundamental to have a first feedback on the application of the workflows. It also has allowed to identify sets of data relating to energy aspects and energy efficiency of the demonstrative building, outlining needs, expectations, approach of a stakeholders in relation to the EnMS.

The pilot that has been considered as most appropriate is the Finnish one, since it is an existing building, while the other pilots are new buildings currently still to be built or completed. The Finnish pilot therefore has availability of data relating to energy consumption and has already identified possible interventions to improve energy performance.

About the Italian pilot, DE5 Services has expressed its point of view in relation to the possible application of an energy management system to its building and more generally to his reality. In particular the outlook of the Italian pilot is valuable as they are owner, constructors and manager of the Italian pilot and their approach in relation to an ISO 50001 EnMS may include aspects like energy policy, objective and targets, management involvement, nonconformities and improvement etc. Further involvement of the Italian pilot will be assessed and evaluated in relation to EnMS as the design and construction phases of the building will progress.

The following chapters report genuine contributions of involved partners: Chapter 5.2 explains Finland pilot, Chapter 5.3 Italy pilot, and Chapter 5.4 reports considerations on other pilots.

5.2 Finnish Pilot

Caverion and VTT, as partners related to the Finnish Pilot, have been involved in activities that included preliminary meetings to present the structure of the workflows and related tasks for the EnMS by R2M Energy and VRM. It was agreed that the approach would be focused to the Planning Stage (n.3) of the workflows and of the ISO 50001, that comprise, among others, the tasks related to energy data and definition of energy uses, EnPI and improvement opportunities.

The methods of development of the tasks and the production of related documents envisaged by the tasks were also arranged. Caverion does not have availability of energy data of the single apartments in the pilot building, so it was also agreed how to address this issue through calculations and evaluations based on literature values, aiming to have a most complete picture as possible of all energy-related aspects related to the pilot building.

The purpose of the activity has not been to assess Caverion's data or approach to EnMS and workflows, while it is considered more valuable to obtain a first feedback and test in term of effectiveness, usefulness and clarity of the workflows for the EnMS and related tasks. Another helpful contribution has been provided from Caverion's input related to potential benefit that the workflows and tasks may offer. Caverion focused on addressing tasks from 7 to 13, related to the Workflow of Planning Stage and regarding energy related data, objectives and targets, EnPIs and improvement opportunities. This in order to develop the objectives of the SPHERE Task 5.3 and also to take in account the role of Caverion within the pilot site: not being the owners of the building, some of the concepts related to definition of energy objectives, targets or energy policies are not easy to address. In particular the tasks that have been carried out from Caverion are the following:

- Task 7: Risks and Opportunities
- Task 8: Energy Data Collection and Analysis
- Task 9: Significant Energy Uses (SEUs)
- Task 10: Improvement Opportunities
- Task 11: Energy Performance Indicators (EnPIs) and Baselines (EnBs)
- Task 12: Objectives and Targets
- Task 13: Energy Review and Action Plans

The following documented information was developed from Caverion in relation to the Finnish Pilot:

- Risk and Opportunities register and plan (task 7)
- List of energy sources and uses (task 8)
- Energy data collection and monitoring plan (task 8)
- Report on energy use (task 8)
- Report defining SEUs (Significative Energy Uses) criteria and evaluation methods (task 9)
- List of SEUs and monitored data (task 9)
- List of improvement opportunities (task 10)
- Report on method for determining EnPIs and EnBs (task 11)
- List of EnPIs and EnBs (task 11)
- Report on objectives and energy performance targets (Task 12)
- Report on Energy Review (Task 13)
- Action plan for continual improvement (Task 13)

In the following sections is reported the documented information as developed by Caverion for each task as genuine contribution.

5.2.1 Task 7 - Risks and Opportunities

This section is used to identify risks that affect the energy management system and implementing it. As there is not yet any EnMS set for this building, the risks are mostly related to the upcoming renovation, which also includes targets and is an energy performance improvement. If the building

owner decides to create an official EnMS or set continuous energy performance objectives, the risks and opportunities should be assessed for them as well.

5.2.1.1 Risk and Opportunities Register and Plan

Some risks related to the objectives are also addressed in Task 10, but are also discussed here. Some mentionable risks related to the planned renovation are at least the high costs of the measures and the possibility of not receiving a building permit for some measure options. The lack of suitable incentives would increase the costs of the measures significantly. Furthermore, achieving the targets is not completely certain because the target energy reductions are estimates and there are variables that impact the outcomes of the renovation measures. It is also possible that there are not enough financial resources to be able to execute the planned measures. Most of these risks can be mitigated by thorough planning and/or discussions with the building owner. However, there are also risks related to the availability of the needed materials and workforce, which could be caused by something similar to COVID-19. This type of risk is improbable and unexpected, but possible. Thorough planning should include mitigation of some more unexpected and unlikely risks as well.

There are several opportunities related to the targets and an EnMS in general. Having an EnMS for this building, or a group of buildings including this one as well, would decrease the operation costs which would give the opportunity to lower the rent prices. Achieving the targets would also decrease the dependency on district heat, which will probably become more expensive in the future. The indoor air healthiness and comfortability could be increased by certain measures related to energy performance. An EnMS would also most probably lower the environmental impacts of the building and make the building more attractive in the eyes of potential tenants. Especially younger generations could be estimated to appreciate energy performance objectives. It would be important to emphasize the EnMS and energy performance improvements and targets in marketing.

With a more detailed analysis, even more risks and opportunities can most probably be defined. However, the key examples were able to be defined here.

5.2.2 Task 8 - Energy Data Collection and Analysis

This section shows the available energy consumption data in the pilot building at the time of writing (2020). The energy sources are listed and a report of the overall energy use in the pilot building is compiled and shown below. The measurement and monitoring methods are presented as well.

5.2.2.1 List of energy sources and uses

The tables below provide information on both the conventional energy sources and renewable energy sources present in the building before any planned improvements.

Energy type or vector	Yes	No	Uses
Electric Energy	X		all building systems
Natural gas		X	
Heating Oil		X	
LPG		X	
District Heating	X		space heating and DHW heating
District Cooling		X	
Other (specify)		X	

Table 3. Energy types and vectors representing conventional energy sources in the building.

RES (Renewable Energy Sources) and other sources	Yes	No
Photovoltaic		X
Solar thermal		X
CHP		X
Biomass		X
Other (specify)		X

Table 4. Energy types and vectors representing renewable energy production in the building.

Energy uses	Yes	No	Energy type or vector
Heating	X		District Heating
Cooling		X	
DHW (Domestic Hot Water)	X		District Heating
Air handling units/ventilation	X		Electric Energy
Lighting	X		Electric Energy
Lifts and elevators	X		Electric Energy
Water pumps	X		Electric Energy
Electrical appliance	X		Electric Energy
Kitchen equipment	X		Electric Energy
Other equipment	X		Electric Energy

Table 5. Energy types and vectors used for each energy use in the building.

As can be seen in Table 3Table 5, the pilot building is currently using only district heat and electric energy.

5.2.2.2 Energy data collection and monitoring plan

There is no specific plan for energy monitoring in the building because no energy management system is not yet created for the building. However, there are several regular measurements which will be further improved during 2021. Currently, all the existing energy meters in the building are owned by the local energy providers and they have quite basic qualities. The table below presents all the energy meters in the pilot building.

Energy meters and variables							
N.	**Type**	**Energy type or vector**	**Measured Energy variables**	**Unit of measure**	**Frequency of measure**	**Data collection**	**Responsible**
1	District heat energy meter	District heating	Space heating, DHW	Wh	15-60 min	automatic	district heating provider
2	Electricity meter	Electric energy	Electricity for building systems in common spaces	Wh	15-60 min	automatic	electricity network owner
3	Electricity meter for each household	Electric energy	Household electricity	Wh	data not available, minimum 60 min	automatic	electricity network owner

Table 6. Energy meters and their measured variables in the pilot building.

Very specific information on the meters is unfortunately not available, and some inputs in Table 6 are vaguely estimated for this reason. In addition to the meters in Table 6, the systems might include some meters that measure the energy consumption of some specific appliances.

Despite some uncertainties, it is certain that building-specific data is currently collected only by the meters shown in Table 6 and by some water consumption meters. The measurements presented in Table 6 are repeatable and comparable, and the accuracy is also adequate for collecting data for creating an energy management system for a building of this kind, even though more specific measurements would be ideal. The data from the meters is displayed in a system available for the building owner and building managers. It is likely that some existing energy meters show information in real time as well, but most likely no real-time values are sent to any system. The values collected by these meters are regularly monitored by the building managers and at times by the building owner. Deviations in data found out by building managers are reported and the issue is

investigated. Sometimes the deviations in values could be caused by faulty meters, but this issue is usually noticed when first testing the meter or shortly after installing it. The current meters are working as supposed. Most likely, monthly reports on the energy consumption in the building are created by building managers or monitoring service.

Furthermore, several more advanced meters will be added to the building during the planned renovation in 2021 and it will be possible to make more detailed metering. With these meters, real-time monitoring of the values in the monitor room, in a system and at place is possible and the data is saved every 15-60 minutes. This will make it easier to create and keep up with an energy management system, and a more specific energy monitoring plan can be created.

In addition to metering the total energy consumption, It would be good to be able to collect data on household electricity consumption in order to ensure the energy-efficiency of kitchen appliances etc., but the data would be greatly affected by tenants' behaviour, making this difficult.

5.2.2.3 Report on energy use

The energy use data from the year 2019 shows both the district heat and electricity consumption. As in a typical Finnish apartment building, the heat use is much higher during the winter months and during spring, summer and the beginning of autumn, heat is only used for DHW (domestic hot water). The use of electricity in common spaces is quite stable around the year.

The energy use trends during previous years can also be included in this report for comparison purposes. When looking at the trend 2009-2016, there has not been too many notable changes in either district heat consumption or electricity consumption. This is probably because the apartments are usually not empty for a long time because of the high demand of housing in the Helsinki metropolitan area. The outside temperature in winter has probably the largest impact on the total energy use, and that creates some deviation in annual values as some winters are colder than others. Normalized heat consumption values are available and deviation is seen in them as well, indicating that not all changes are due to the weather. The reasons behind the deviations could possibly be known by the building owner, but this is not certain. The data from 2019 is comparable to 2009-2016, because no substantial changes are made in the building during 2009-2019.

After the energy renovation planned for 2021, the electricity use of heat pump should be monitored at least. The heat production of the heat pump and other related data could also be monitored if needed in order to track the efficiency of the heat pump, for example. If any other energy use changes occur because of the renovation, monitoring those should be considered. Further analysis might be needed to allocate the electricity consumption of the building systems to different end uses (such as lighting, water pumps etc.).

5.2.3 Task 9 - Significant Energy Uses (SEUs)

This task analyses the energy use of the building and how it is allocated between the SEUs.

5.2.3.1 Report on defining SEU criteria and evaluation method

Finding several SEUs in a single apartment building based on the available data is often difficult. Different energy uses are often not separated, and the only available data is on heat consumption and electricity consumption in the common spaces (staircase, yard, elevator etc.), which is the case for almost all apartment buildings. There is no question about these being SEUs in the building. Defining SEUs beyond these two SEUs requires usually mostly estimates, making the data uncertain.

However, by using good estimates more SEUs can be defined if wanted. If some changes that majorly affect the energy use in the building are made, SEUs are evaluated again. Additionally, SEUs should be monitored at least annually to notice any major changes in the consumption of the existing SEUs or if SEUs have to be defined again.

5.2.3.2 List of SEUs and monitored data

The table below shows all the identified SEUs in the building. Unfortunately, there is not much available data on the electricity consumption. The only dataset includes the total electricity consumption of the building systems, because of which the energy consumption has to be allocated with the help of estimates. Furthermore, the tenants are billed for their own electricity consumption separately, and no data on household electricity can, therefore, be obtained. Hence, household electricity consumption is estimated as well.

SEU - Significant Energy Use						
N.	**Description**	**Energy type or vector**	**Relevant variables**	**Operational criteria**	**Process or person that affects consumptions**	**Energy Performance**
1	Space heating	District heating	Outdoor temperature, number and behaviour of tenants	the system is shut off for spring and summer when outside temperature has been over 15 degrees for several hours	weather, tenants, condition of the systems	adequate
2	DHW	District heating	number and behaviour of tenants	always running to some extent in order to heat towel heater, else when requested	tenants, condition of the systems	adequate
3	Pumps and ventilation (common spaces)	Electric energy	outdoor temperature, number and behaviour of tenants, time of day	ventilation at full speed some hours of the day, else at half speed	weather, tenants, condition of the systems	no specific data, probably good
4	Lighting (common spaces)	Electric energy	number and behaviour of tenants, time of year	most are shut off after certain time	tenants, condition of the systems	no specific data, probably good
5	Elevators (common spaces)	Electric energy	number and behaviour of tenants	running when requested	tenants, condition of the systems	no specific data, probably good
6	Kitchen appliances (households)	Electric energy	number and behaviour of tenants, number of appliances	running when requested	tenants, condition of the systems	no specific data
7	Electronics (households)	Electric energy	number and behaviour of tenants, number of appliances	running when requested	tenants, condition of the systems	no specific data
8	Sauna (households)	Electric energy	number and behaviour of tenants	running when requested	tenants, condition of the systems	no specific data
9	Lighting (households)	Electric energy	number and behaviour of tenants, time of year	running when requested	tenants, condition of the systems	no specific data
10	Others (households)	Electric energy	number and behaviour of tenants	no data	tenants, condition of the systems	no specific data

Table 7. List of all SEUs in the pilot building.

The energy performance assessments in Table 7 were made quickly and more thorough estimations would require more analysis on the performance of these systems.

The following two tables present quantitative data on the SEUs.

SEU - Significant Energy Use				
Energy type or vector 1 – district heating				
Yearly consumption from bills or measured data			553 MWh (2019)	
N.	**Description**	**M = Measured C = Calculated**	**Yearly consumption measured or calculated**	**% of yearly total energy consumption from bills or measure data**
1	Space heating	C	467 MWh	84,3 %
2	DHW	C	87 MWh	15,7 %
TOTAL			553 MWh	100 %

Table 8. SEUs included in district heating.

SEU - Significant Energy Use				
Energy type or vector 2 – electric energy				
Yearly consumption from bills or measured data			51 MWh (2019) (only common spaces) estimated consumption in households 130 MWh	
N.	**Description**	**M = Measured C = Calculated**	**Yearly consumption measured or calculated**	**% of yearly total energy consumption from bills or measure data**
	Building systems in common spaces	*M*	*(51 MWh)*	*(28,2 %)*
1	Pumps and ventilation	C	28,05 MWh	15,5 %
2	Lighting	C	15,3 MWh	8,5 %
3	Elevators	C	7,65 MWh	4,2 %
	Household electricity	*C*	*(130 MWh)*	*(71,8 %)*
4	Kitchen appliances	C	45,5 MWh	25,1 %
5	Electronics	C	32,5 MWh	18,0 %
6	Sauna	C	26 MWh	14,4 %
7	Lighting	C	13 MWh	7,2 %
8	Others	C	13 MWh	7,2 %
TOTAL			181 MWh	100 %

Table 9. SEUs included in electric energy.

The energy consumption for SEUs was partly estimated in Table 8 and Table 9, and the estimations were made with the help of common national averages.

The workflow for estimating district heating energy allocation went as follows:

- water usage in building was known and total district heating consumption was known
- 40 % of water usage was estimated to be heated for DHW and heated 55 degrees from its original temperature
- Energy needed for DHW heating was calculated when density and heat capacity were assumed constant
- The remaining energy was allocated for space heating
- The share of DHW heat consumption from total heating is 16 %, while the common average is 15-20 %, which shows the calculation probably gives a good estimate

The workflow for estimating electric energy allocation went as follows:

- Energy for building systems in common spaces
    - total electricity consumption for building systems was known
    - Based on data on a similarly equipped building and applying the information on this building, the shares of different energy uses are estimated approximately as follows: pumps and ventilation 55 %, lighting 30 %, elevators 15 %
- Household electricity
    - Average consumption per household (2-3 people) 2550 kWh (literature from 2011)
    - 51 apartments in the building (however only about 1,55 people/apartment but this is ignored in this case)
    - Total consumption is about 130 MWh
    - Based on data on a similarly equipped building and applying the information on this building, the shares of different energy uses are estimated approximately as follows: kitchen appliances 35 %, electronics 25 %, sauna 20 %, lighting 10 %, others 10 %

5.2.4 Task 10 - Improvement Opportunities

This section presents the possible opportunities for improving the energy performance of the building.

5.2.4.1 List of improvement opportunities

The table below shows the improvements that are planned to be executed in the building in the near future. Additionally, there are some suggestions for measures that could be suitable to further improve the situation.

n.	Improvement opportunities	Available incentives	Risks	Impact on achieving EnMS target	Estimated costs	Energy savings (household electricity not included)	Economic savings (annual)	Other potential advantages
1	**Installing an EAHP (exhaust air heat pump)**	none	shortage of available space	high impact	200 000 eur	reduction of total purchased energy 52 %	19 000 eur	Annual CO_2 savings 26 tons
2	**Installing an EAHP with geothermal wells**	none	shortage of available space; possibility that construction is not allowed	very high impact	300 000 eur	reduction of total purchased energy 66 %	25 000 eur	Annual CO_2 savings 34 tons
3	**Installing apartment-specific air quality meters**	none	none	low impact	financed by innovation funding	non-existent	not estimated – probably low	Improved air quality for tenants
4	**Installing better BAS (building automation system)**	none	none	moderate impact	financed by innovation funding	not estimated, probably moderate	not estimated, probably moderate	Improved monitoring and avoidance of problem situations
5	**Roof-mounted PV panels**	none	can not be used for household electricity at the moment, therefore maybe not cost-effective	moderate impact	about 30 000 - 40 000 eur	estimated reduction 10-25 % of electricity	about 2000-3000 eur	Relatively easy installation because of the gable roof with quite optimal 22° angle

Table 10. Energy efficiency improvement opportunities recognized in the Finnish pilot building.

As Table 10 shows, installing a heat pump is the most feasible energy efficiency measure because of the high consumption of district heat. Especially recovering energy from exhaust air would provide a smart and efficient way to decrease the energy consumption because over a third of the building's heat losses are caused by releasing warm exhaust air. At the moment, the feasibility of PV panels in an apartment building in Finland is questionable. This is not only because of the rather low production when electricity is needed the most (winter), but also because the produced electricity can not be feasibly used for household electricity. Furthermore, selling the produced electricity back to the grid is not so feasible. However, the PV panels would provide renewable electricity for the heat pump and if cooling would later be added to the building, the feasibility of installing PV panels would significantly increase. Also, legislation changes allowing the allocation of PV production between households are planned in Finland.

The shown CO_2 reductions can vary depending on the electricity and district heat production methods. In this case, district heat in the area is produced mostly by biomass, reducing the CO_2 savings created by decreasing the use of biomass. In most Finnish locations, district heat is slightly more polluting, increasing the shown CO_2 savings. The building owner has also the possibility to choose a more environmentally-friendly electricity contract, which would greatly increase the estimated CO_2 savings of the improvement opportunities shown in Table 10.

Additional improvement opportunities should be added to the list if the building owner decides so. Building managers or consultants can help with finding possible measures. New improvement opportunities should be explored regularly.

5.2.5 Task 11 - Energy Performance Indicators (EnPIs) and Baselines (EnBs)

In this task the Energy Performance Indicators (EnPIs) and Energy Baselines (EnBs) for the building are identified. EnPIs are used to measure energy performance and can be a metric or a ratio, for example. EnBs present EnPI values in the baseline period and they can be used for comparing energy performance changes between this baseline period and reporting period.

5.2.5.1 Report on method for determining EnPIs and EnBs

Determining the EnPIs in a single apartment building is rather straightforward because of the low number of measured energy uses. The chosen EnPIs should be able to be measured repeatedly, and in this case, only district heat consumption and electricity consumption of the building systems are measured. After the planned renovation measures, some values related to the heat pump should be measured. Additionally, some other values might have to be added after any other major energy use changes.

When it comes to defining EnBs, the most accessible data is from the year 2019 and years 2009-2016. Using the values from a single year does maybe not make a good baseline due to the many variables, because of which even normalized annual values can be different from each other. Therefore, even though the values from 2019 are the most recent values, average and normalized values from the most recent and available 5 years (in this case the years 2012-2016) are probably

the most suitable for EnBs. The normalized values from the most recent years, 2015-2019, are probably available in some system, and when found, they should be used as EnBs instead of the values from 2012-2016 that are now chosen.

5.2.5.2 List of EnPIs and EnBs

The table below presents the identified EnPIs.

EnPI - Energy Performance Indicators				
N.	**EnPI**	**Level**	**Users**	**Purpose**
1	Primary energy consumption (purchased energy)	building level, electricity in households excluded	building owner, tenants, building energy manager	to track system performance, to track and decrease the energy consumption
2	District heat consumption	building level		to track system performance, to track and decrease the energy consumption
3	Electricity consumption of the building systems	building level, electricity in households excluded		to track system performance, to track and decrease the energy consumption
4	Heat pump COP (after planned renovation)	appliance level	building owner, building energy manager	to track the electricity consumption and efficiency of heat pump

Table 11. Short description of EnPIs in the Finnish pilot building.

The two tables below present more detailed information about chosen EnPIs and EnBs.

N.	EnPI	Description and measurement/calculation method	EnPI Boundary	Relevant variables	Static factors	Normalization
1	Primary energy consumption (purchased energy), kWh/m^2	Sum of the two below	individual	number and behaviour of tenants, weather, system condition	area, number of apartments	heat consumption normalized (by degree days by report compiler)
2	District heat consumption, kWh/m^2	Automatic measurements, divided by total area	individual	number and behaviour of tenants, weather, system condition	area, number of apartments	
3	Electricity consumption, kWh/m^2	Automatic measurements, divided by total area	individual	number and behaviour of tenants, after renovation also weather (heat pump uses electricity), system condition	area, number of apartments	none
4	Heat pump COP (after renovation)	Automatic measurements	individual	number and behaviour of tenants, weather, system condition	none to be mentioned	none

Table 12. Description of EnPIs.

N.	EnB	EnB value	Related EnPI	Description and measurement - calculation method	Period	Updating process
1	Primary energy consumption average 2012-2016	125 kWh/m^2	Primary energy consumption (purchased energy), kWh/m^2	Average of normalized values from the most recent and available 5 years	year	The EnB value should be updated each year to correspond the next available period of 5 years
2	District heat consumption average 2012-2016	113 kWh/m^2	District heat consumption, kWh/m^2		year	
3	Building systems electricity consumption average 2012-2016	12 kWh/m^2	Electricity consumption, kWh/m^2	Average of values from the most recent and available 5 years	year	
4	Initial measured COP value after installation	estimated to be 4	Heat pump COP (after renovation)	not defined yet, but values can be read from system	year	not defined yet

Table 13. Description of EnBs.

The three first EnPIs in Table 12 would be ideally divided by net heated area instead of total area. However, the heated net area is not known and it has to be calculated, if needed. Updating this when possible would be the best.

The normalization processes and relevant variables of the EnBs in Table 13 are the same as the ones of the corresponding EnPIs in Table 12. The EnBs can also be chosen differently if wanted, the suitability of the chosen EnBs in table 3 should be evaluated by a professional energy specialist.

The EnPIs and EnBs shown in Table 12 and Table 13 are always relevant, but some new ones have to be added if new systems are added (e.g. solar PV) and also, if new energy meters are added to provide information on more SEUs. Any EnPIs and EnBs should be updated as soon as possible if static factors or major building changes occur.

5.2.6 Task 12 - Objectives and Targets

In this section, some objectives and targets for the energy performance of the building are set. Only the objectives planned to be achieved by the upcoming renovation measures can be addressed here.

5.2.6.1 Report on objectives and energy performance targets

All the current objectives and targets can be classified as operational. In the case of other facilities or especially organizations, there are probably some objectives and targets that can be categorized as strategic or tactical.

The table below shows the objectives that can currently be defined. They are mostly the targets of the planned energy renovation and they should ideally be updated after the renovation, because the energy performance levels reached after the renovation should be aimed to be further lowered during normal operation.

Objectives & Targets	Qualitative	Quantitative
Operational	Reduce primary energy supply	reduction of 50-85 %
Operational	Reduce district heat consumption	-
Operational	Increase utilization of heat recovery	-
Operational	Increase the use of efficient building automation	-
Operational	(suggested, not currently planned to be done) Increase renewable energy production/use by solar PV	-

Table 14. Established objectives expressed both qualitatively and quantitatively.

n.	Objective/Target	Can it be measured? (if applies)	Can it be monitored?	Is it consistent with Energy Policy?	Is it feasible? Can it be reached?
1	Reduce primary energy use by 50-85 %	□ **YES** □ NO	□ **YES** □ NO	□ YES □ NO	□ **YES** □ NO
2	Reduce district heating use	□ **YES** □ NO	□ **YES** □ NO	□ YES □ NO	□ **YES** □ NO
3	Increase utilization of heat recovery	□ **YES** □ NO	□ **YES** □ NO	□ YES □ NO	□ **YES** □ NO
4	Increase the use of efficient building automation	□ YES □ **NO**	□ YES □ **NO**	□ YES □ NO	□ **YES** □ NO

Table 15. More information on the objectives planned to be met.

In Table 15, one of the columns is left unanswered because there is currently no energy policy for the building. More detailed information on the objectives can be found in the following table.

n.	Objective/Target	EnPi(s)	Actions	Resources	Responsible	Date to complete
1	Reduce primary energy use	Primary energy consumption (purchased energy)	Installing heat pump and smart metering system	decided by building owner	contractor	not set, estimated 31.7.2021
2	Reduce district heating use	District heat consumption	Installing heat pump and smart metering system	decided by building owner	contractor	
3	Increase utilization of heat recovery	Share of recovered energy of total used energy	Installing heat pump and smart metering system	decided by building owner	contractor	
4	Increase the use of efficient building automation	-	Installing a new BAS	decided by building owner	contractor	

Table 16. Details on the established objectives.

Even though in Table 16 the completion date is set to the completion date of the renovation, more time is needed to have a proper analysis on whether the targets are met. In this case, the needed time period would be a year.

The objectives are not planned to be communicated outside maintenance staff and building owner, but they could be communicated to tenants in a newsletter or on a website.

The targets in Table 16 are mostly related to the result of the renovation and are not continuous. It would be ideal if the building owner would establish new objectives to further increase the energy performance during the normal operation, that is, after the planned renovation measures.

5.2.7 Task 13 – Energy Reviews and Action Plans for Continual Improvement

In this section, plans for ensuring continuous improvement of energy performance in the building are made. These types of plans are typically made for a group of buildings or an organization, but in this case, some plans are made for this single pilot building. Furthermore, non-conformities occurred and energy reviews made for the building are shortly analysed.

5.2.7.1 Report on energy Review

The records include only one energy review made in the building. The 2012 energy review of the building concluded the energy consumption of the building as moderate, class C of classes A-G with a consumption of 136 kWh/m^2/year. This was calculated by using consumption values from 2011. The only energy-saving measure included in the energy review was changing the light bulbs in the yard and the estimated savings would decrease the energy consumption by 1 kWh/m^2/year.

The energy review format has been updated after 2012, and the energy classes have also been modified. For example, the requirements are now stricter and also household electricity is included. In the older energy review format, the E-value was calculated by dividing the consumption by total area instead of net heated area. In the current format the E-value is a computational energy efficiency value, where each used energy source is weighted with a different coefficient. The result is then divided by net heated area to receive the comparison value, based on which the building is put to an energy class. It can be estimated that the current energy consumption of the building would probably put the building to class D in the current scale. When conducting a new energy review for the building, the result depends of course on whether any of the planned improvements presented in task 10 have been done.

5.2.7.2 Action plan for continual improvement

There are currently few records of non-conformities related to energy consumption in the building, also because of the low number of existing meters. However, both the existing meters and some new meters are planned to be linked to a system which will monitor and display the values in a more detailed manner. This system will also analyse these values and make it easier to not only monitor the meters and energy consumption, but also to decrease the energy consumption.

On one day during January in 2019, no heat consumption was recorded by the meters. This was clearly caused by some temporary fault or it was immediately fixed, and because it happened only on a single day during the year, it does not affect the accuracy of the annual values. This kind of situations are usually avoided by always testing and checking the meters immediately after installation. By monitoring, the faulty meters are identified and fixed or replaced as soon as possible.

Creation of an action plan for improving the energy consumption has to be led by the building owner. The building owner has to make the decisions on how and how often energy consumption is monitored and which improvements will be made. Building managers and consultants can help the building owner with this. This kind of an action plan is rather made for a group of buildings first, but some targets and plans can be set for this individual building. In addition to the new monitoring system mentioned above, the building managers or monitorers can assess the energy consumption of the building as often as the building manager wants. Usually, this is done at least monthly.

5.2.8 General considerations and feedback from the Finnish Pilot

Caverion is currently working as a contractor for energy performance improvement measures in the building in question. It is likely that Caverion will be monitoring the energy performance of the building and possibly maintaining the building in the future.

The most difficulties encountered when developing the tasks were unrelated to the tool. It is not common to create an EnMS for a single apartment building and there is not any existing EnMS for this building. Furthermore, Caverion is neither the owner nor the manager of the building. This results to not being able to set goals for the EnMS, make any other permanent decisions, and also, not all needed information was available and some of the inputs were more or less hypothetical. When it comes to the provided paper-based tool, it is easy to use and contains clear definitions and instructions in contrast to the ISO 50001 standard. A similar tool is essential when creating an EnMS and especially, when helping a client to create an EnMS. Some parts of the tasks were not applicable for a residential building, which is understandable, because energy management systems are usually created for organizations and not residential buildings. The documents produced with the help of the provided EnMS tool can be used as a basis for creating an actual EnMS for a group of buildings including this one. However, these documents lack some information that was requested in the paper-based tool and the answers should have ideally been more extensive, but this was not possible because of the limitations mentioned above.

This kind of a tool allows almost anyone to gather information needed for an EnMS, because of its clarity compared to the ISO 50001 standard. However, Caverion already uses an external software for EnMS where some, mostly quantitative, data can be directly put into the software and some data is sent in the form of a document. This software includes most of the functionalities required. A common limitation of a software for energy audit or EnMS is that it cannot be well used at place, e.g. on a tablet or mobile phone, and the values have to be written down and put to the system when being back at the office. One important goal is to also be able to integrate the EnMS tool into

existing building automation or other monitoring systems, so that the existing energy meters are connected as well. This would reduce the number of times that same information has to be put into the system and makes it easier to find information when only one system is in use. A tool including all the wanted functionalities is not available in Finland and in some countries there might be no tool for creating and implementing an EnMS. Therefore, a software created according to the provided paper-based tool would be very useful.

5.3 Italian Pilot

The Italian pilot is an existing building consisting of three floors: in which two levels, intended for retail sales, are completed and fully functional while the third level, currently in the redesign phase, will be used for residential purposes. DE5 Services, as General Contractor of the entire building, will use this level as a demonstration site for the SPHERE project.

Considering this, the business model of this building intervention will not be the sale, but the rental of the dwellings as is already the case for the two underlying commercial levels. Therefore the use and adoption of procedures and tools relating to the rational management of energy (ISO 50001) would lead to management advantages that would not only concern the opportunity that the client could offer to the users/tenants of these mini-homes a rent with an all-inclusive formula (which includes rent + consumption) but precisely because being owner as well as manager it can respect the entire **Deming Cycle** at the basis of a management practice of continual improvement. Therefore, achieve and complete the 4 parts of which the cycle is composed:

- PLAN: planning (identify objectives and propose strategies);
- DO: implementation (implementation of planned actions);
- CHECK: verification (by measuring and monitoring the actions taken to evaluate any differences with respect to the set objectives) and this would also be done through the SPHERE platform.
- ACT: adoption of corrective actions to further improve the results achieved

DE5 thanks to these activities and tools (included in the ecosystem of the SPHERE platform) could ultimately undertake improvement actions also at different levels (cyclical or structural) such as retrofitting, restructuring and corrective actions in management; precisely because it's the owner, builder and manager of the property. Furthermore, it is possible to note that the management of an entire building at a centralized level (where the application of SPHERE tools may also provide support) leads to a rationalization of the use of energy and implementation of energy saving practices with respect to a management logic for single unit implemented by the single user/tenant who could only pursue personal wellness/thermal comfort with the possibility of consuming and using energy in a way that is unsustainable but above all not convenient. Finally, then the DE5 Network group could extend this type of approach, defined by these procedures and tools, to future achievements and also to commercial activities carried out at lower levels where their adoption would potentially be more necessary and desirable.

5.4 Other Pilots

D5.4 describes a preliminary demonstration of an EnMS implementation in relation to the current situation of pilots. Future involvement of other pilot sites for the implementation of an EnMS will be addressed as part of WP6, based on to the implementation of the construction process of the pilot buildings.

6 Conclusions

6.1 Summary of achievements

The workflows for an EnMS according to ISO 50001:2018 core principles and requirements have been defined and presented. Tasks constituting the pattern of the workflows have been developed to provide the basis on which an EnMS software tool will be developed and implemented. Workflows and tasks may be considered independently as a preliminary tool, offering support to users and organizations within the SPHERE project or not, that pursue the implementation of an ISO 50001 EnMS in a continual improvement perspective.

Examples tables, templates, checklist, matrices, additional workflows and guidance have been developed within the tasks, in order to set up a tool related to ISO 50001 EnMS. The structure and format of workflows, tasks and templates have been outlined based on ISO 50001 core principles and requirements in anticipation of future application within a software tool, to be developed in the SPHERE ecosystem.

Since energy performance is a fundamental aspect in building sector, this tool aims to provide a valuable resource in the context of the SPHERE Project, considering energy related issues and opportunities in a systematic, organized way on the basis of the ISO 50001 concepts. ISO 50001, an international standard widely applied and recognized, leads to continual improvement in a PDCA perspective. Indeed ISO 50001 addresses all fundamental aspect to take in account for an effective EnMS and for energy performance improvement, bringing an energy management culture within the organization. Implementation of an EnMS according to ISO 50001 may also pave the way to targeting an ISO 50001 third-party certification in order to document and demonstrate to internal and external involved parties the commitment from organization to continual energy performance improvement.

6.2 Relation to continual development

The workflows and tasks have been defined as a tool in the SPHERE project and the process of implementation in a software tool is an ongoing development at VRM. Evaluation of potential application in demonstrations sites is on ongoing activity, as well as the process of identifying possible connection with other tools in the SPHERE eco-system.

VRM have undertaken to produce a Beta-version of an ISO 50001 platform during the implementation phase of WP3. Testing and production of the proof of concept tool has begun and the first iteration should be available in Q4 2020. The workflows produced within D5.4 will form the basis of this tool.

During the process of implementation of a software tool based on workflows and tasks, additional detailed evaluation related to compliance to ISO 50001 requirements will be necessary. Future improvements will also be pursed based on pilot's feedback and inputs.

6.3 Other conclusions and lessons learned

During the activities, several valuable lessons were learned.

Lesson 1: Organisational complexity

Whilst defining the workflows and tasks, it became apparent that a given organization may require different levels of detail and support to engage effectively. Their ability and willingness to carry out in-depth analysis using ISO 50001 concepts and processes requires successful integration within the organizational structure. The workflows were developed according to ISO 50001 core concepts for implementation by organisations of varying complexity.

Lesson 2: Future-proofing

The development of example tables, sheets and checklists was carried out in anticipation of their implementation within the project by a software tool. The support material related to tasks of the EnMS have been developed to combine complementary needs such as user-friendliness for supporting users, clearness in summarizing data for review and usability of different users.

Lesson 3: User-driven adaptability

Involvement from SPHERE pilot partners provided valuable feedback on workflows and tasks' positive and implementable aspects. It also highlighted in a tangible way the varying needs and expectations of stakeholders. Users may be constrained as to their levels of EnMS implementation, subject to the actual responsibility they have over the building in question. E.g. in a building application, users different from the owner may not be in the position to set policies and targets related to EnMS (as emerged from Finnish Pilot site). During the implementation phase of T5.3 a focus will be given to assessing and assisting users to maximise their individual situation. E.g. users related to operation and maintenance of buildings could operate in Operational Control workflows and tasks and Measurement and Monitoring EnPIs.

Lesson 4: Ecosystem relationships

Developing the processes, core concepts and workflows without consideration of the sister applications and consortium knowledge-base risked the production of a standalone paper-based tool which SPHERE eco-system users may have been unwilling to adopt. By exploring potential connection between the EnMS workflows and other SPHERE applications (e.g. IoT platform <> Predictive Maintenance Tool) and committing to a strong implementation phase in 2020 we hope to ensure that the workflows and the corresponding ISO 50001 software application are developed in sympathy with the rest of the ecosystem's "toolkit".

7 Acronyms and glossary

7.1 Acronyms

DHW: Domestic Hot Water

EnB: Energy Baseline

EnMS: Energy Management System.

EnPI: Energy Performance Indicator.

ESCo: Energy Service Company

IoT: Internet of things

ISO: International Organization for Standardization

O&M: Operation and maintenance

PDCA: Plan-Do-Check-Act

SEU: Significant Energy Use

7.2 Glossary

The terms of this glossary refer to ISO 50001:2018 definitions.

Energy: electricity, fuels, steam, heat, compressed air and other similar media. [2]

Energy management system: management system to establish an energy policy, objectives, energy targets, action plans and process(es) to achieve the objectives and energy targets.[2]

Documented information: information required to be controlled and maintained by an organization and the medium on which it is contained. [2]

Organization: person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its objectives. .[2]

Energy performance: measurable result(s) related to energy efficiency, energy use and energy consumption. [2]

Energy use: application of energy. [2]

Continual: occurring over a period of time, including eventual intervals of interruption (unlike "continuous" which indicates occurrence without interruption).[2]

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9 Appendix – Tasks for the EnMS

9.1 Foreword

The workflows and tasks of an EnMS have been developed according to ISO 50001 core principles, for implementing an EnMS tool in the SPHERE project. Workflows and tasks could provide a support helping to understand the structure and core concepts of an EnMS in relation to ISO 50001 main requirements.

Further development of workflow for EnMS and related tasks, in an EnMS tool perspective, will be related to assess in detail compliance with ISO 50001 requirements.

Full compliance to ISO 50001 requirements should be analysed in depth from organizations that intend adopt an ISO 50001 EnMS, in relation to their characteristics, size, type of activities, processes, complexity, competence of personnel etc.

9.2 Preliminary tasks

ISO 50001:2018 states that:

> *The organization shall establish, implement, maintain and continually improve an EnMS, including the processes needed and their interactions, and continually improve energy performance, in accordance with the requirements of [ISO 50001]. [2]*

If an organization decides and commit to adopt and Energy Management System (EnMS) according to ISO 50001 standard, preliminary tasks may be undertaken to create a first team, with energy management competences, which can develop a preliminary action plan, collaborate with the management and provide an overview of the actions that must be taken to implement an EnMS.

The preliminary tasks could be the following:

- Management identifies and creates at preliminary level an Energy Management Team, with the purpose of:
    - Support management with an initial definition of the steps needed to implement an EnMS in the organization. This requires a first outlook and analysis of the organization and its context, resources, constrains and opportunities.
    - Ensure (with the support of the management) the implementation, maintenance, and continual improvement of EnMS in accordance with ISO 50001 requirements. The role of the Energy Management Team stands between management and personnel/staff/users of the organization, connecting different levels within the

organization for implementing an EnMS. In this way, the Energy Management Team can be aware of both the requirements, issues and operational aspects related to personnel and the more strategic and general aspects defined by the management. Competences, skills, responsibilities, and roles of the Energy Management Team are defined by the company in relation to its characteristics and needs and are reviewed and refined in subsequent tasks of implementation of EnMS (see task 6 – Energy Management Team and Resources).

- Energy Management Team implements a preliminary EnMS Plan. The Plan identifies at a general and preparatory level the workflows, tasks, actions that should be carried out to implement an EnMS. This can also provide an overview of the EnMS pattern and of the effort required for implementing an ISO 50001 EnMS.

- Management reviews and agrees actions and tasks defined in the plan and confirm commitment to implement the EnMS.

- Management approves EnMS preliminary Plan and issues statements to staff that the EnMS is to be implemented with the full commitment of the Management

Documented information:
Based on the tasks, define an **EnMS Preliminary Plan**, a **Management Commitment to EnMS** (and other eventual appropriate documented information).

9.3 Task 1: EnMS Strategic Issues

Scope of this tasks is to understand the organization and its context and determine strategic internal and external issues that affect the ability to improve energy performance and achieve the goals of the EnMS.

With the intent of understanding of the organization and its context, determine external and internal issues that are relevant to the organization purpose and may influence the ability to improve energy performance and achieve EnMS goals.

External Issues		
N.	**Issue**	**Influence on EnMS and energy performance improvement**
1		
2		
3		
4		
…		

Examples of external issues are: energy costs; restrictions or limitation on energy supply, security, and reliability; availability of types of energy; effects of weather or climate change; existing national or sector objectives, requirements or standard etc. [2]

Internal Issues		
N.	**Issue**	**Influence on EnMS and energy performance improvement**
1		
2		
3		
4		
…		

Example of internal issues are: core business objectives and strategies; sustainability considerations; operational risks and liability considerations; financial resources, energy management maturity and culture etc**.** [2]

Include eventual additional inputs from management related to strategic direction of the organization that may have an impact on continual improvement**:**

Documented information:
Based on the activities of the task, define a **Report on EnMS Strategic Issues**

9.4 Task 2: Legal and Other requirements

Scope of this task is to identify and determine needs and expectations of interested parties and energy-related legal and other requirements relevant to the energy performance and the EnMS. The tasks regard also the activities related to plan at defined intervals to review requirements and evaluate compliance with them**.**

According to ISO 50001:2018, an interested party (or stakeholder) is defined as person or organization that can affect, be affected by, or perceive itself to be affected by a decision or activity [2].

Identify and understand requirements and expectations of interested parties considering the following questions.

- Which are the interested parties that could be considered relevant to energy performance and the EnMS?

- What are their relevant requirements?

- Are the identified needs and expectations the organization addresses through its EnMS? How?

The following table is an example to summarize requirements, needs and expectation of interested parties.

Needs and expectations of interested parties				
N.	**Interested parties**	**Requirements, needs or expectations**	**Are requirements, needs, expectations addressed through EnMS?**	**How are they addressed?**
1			□ YES □ NO	
2			□ YES □ NO	
3			□ YES □ NO	
4			□ YES □ NO	
…			□ YES □ NO	

Identify and understand legal and other requirements related to energy efficiency, energy use and energy consumption in organization and define a strategy, processes and develop a Plan to:

- ensure that the organization has access to the applicable legal requirements and other requirements and define how these requirements relate to energy related aspects
- guarantee that these requirements are considered
- review and update at defined intervals legal requirements and other requirements
- conduct at planned intervals compliance evaluations with legal and other requirements related to energy efficiency, energy use, energy consumption and the EnMS. Establish a schedule and assign responsibilities.

Ensure that records of results are maintained, developing appropriate documented information as periodic Reports of evaluation of compliance to legal and other requirements related to energy efficiency, energy use, energy consumption and the EnMS and evaluation of other relevant related aspects.

Documented Information:
Based on the tasks, define a **Plan on Legal and other requirements** and a **Report on Legal and other requirements compliance.**

Additional templates:

The following table is an example of a Compliance Evaluation Checklist.

Compliance Evaluation Checklist				
Requirement	**In Compliance?**			**Notes**
	Yes	**No**	**N/A**	
E.g. Building Regulations				
Health and Safety Regulations				
…				

The following table is an example of a Legal and other requirements tracking matrix:

Location/Facility:	**Prepared by:**
Original Issue Date:	**Review/Revision Dates:**

LEGAL AND OTHER REQUIREMENTS TRACKING MATRIX						
Title of Legal or Other Requirement	**Issue Date** (approval reference number, if applicable)	**Type of Requirement Legal = L Other = O**	**Applies To:** (List Affected Operations)	**Required Reports/ Report Due Dates**	**Responsible Position**	**Next Review Date**

The following Guidance could provide additional information regarding Requirements affecting the EnMS.

Guidance on People & Legal Requirements Affecting the EnMS

Social pressures can be as important as financial and legal issues for an organization. An EnMS can help address social issues as well as provide evidence of an organization's efforts to do so. Many public concerns are related to environmental issues, but there are other issues that are equally important. Some of these may include:

- Ethics, values, principles
- Climate change (carbon emissions/carbon footprint/greenhouse gases)
- Sustainability
- Renewable energies (solar, wind, thermal, hydro, biomass)
- Natural resource depletion
- Environmental stewardship
- Energy conservation
- Energy waste
- Triple Bottom Line

Pressures can be exerted by local communities, trade associations, environmental groups, government entities and employees. An organization should identify the relevant issues and use their management system processes to minimize negative impacts and communicate the positive efforts being made to address them.

EXTERNAL DRIVERS and the EnMS

External drivers are typically outside the organization's control. There are many external groups and stakeholders that could have an interest in the organization's energy activities and help drive the organization's direction. Their interest could be reflected through financial, legal or social drivers. The external groups that have or can have an impact on the organization can be identified, and appropriate procedures and communication channels installed to address the needs and interests of these groups relative to energy use and efficiency. An EnMS can help with addressing these needs and interests.

Some of the influencing groups could be:

Customers – Customers want the best return for their money. Reducing costs and improving efficiencies allow products and services to be offered at the lowest price with less waste, thus providing the best value to the customer and improving the organization's competitiveness. The continuous improvements of an EnMS can help an organization be more efficient and reduce costs.

Shareholders – Shareholders are interested in the profitability of the organization and in measures that reduce costs. They are also interested in addressing relevant social issues, and

they expect to be provided with a measure of assurance of the business's sustainability.

Suppliers – An efficient supply chain is important to competitiveness. An important component of supplier selection and maintenance is a commitment to continual improvement including energy efficiency. An EnMS can help with supplier selection. The presence of an EnMS would be one indication of a supplier's commitment to energy efficiency improvement.

Investors, Lenders –An EnMS is a tool for the organization to address continual improvement thereby improving efficiencies and profits which can support the economic resilience of the organization. The ESG (Environmental Social and Governance) policies of a company can be supported by a successful EnMS.

Public –The public in general as well as many public groups can be drivers for an organization's operation. Both can provide pressure relative to emissions reduction, resource conservation, alternative fuels, and the like. Public utilities can impose requirements that must be addressed. An EnMS can help an organization address these issues and provide evidence of its efforts. Examples of public interested parties are:

- Neighbors
- Community
- Utilities
- Schools
- Environmental groups
- Trade associations
- Development organizations

Government – An EnMS can help an organization address existing regulations and plan for future government regulations. It provides the system to help the organization identify and address relevant government codes and laws. Examples of government agencies with an interest in energy use would be:

- Department of energy
- Building Regulation enforcement
- Environmental protection agency
- Department of natural resources
- International regulatory agencies

INTERNAL DRIVERS and the EnMS

There are internal drivers that impact an organization's strategy and drive its needs. Internal drivers are generally controlled by the organization and reflect the need of an internal stakeholder but can be a response to an external driver. These drivers are identified to address internal needs and interests relative to energy use and efficiency.

Relevant internal drivers can include:

Staff satisfaction – Employees want to operate in a good working environment. Improving energy efficiency usually makes any process more efficient and can result in an improved working environment and improving the indoor environmental quality.

Productivity – As operations are improved and less energy is required, they can become more productive. An improved working environment promotes higher employee morale, increased output relative to input and improved operational control. Examples of energy efficiency changes that can result in improved productivity include:

1. Efficient energy procurement practices
2. Improved working environment
3. Improved capacity utilization
4. Process and equipment efficiency improvement
5. Fuel and equipment efficiency improvement
6. Waste heat recovery
7. Automated control systems
8. Improvements from monitoring information
9. Reduced breakdowns and better reliability with monitored equipment

Technology – Advanced technologies are typically more energy efficient and may improve a process or operation. In addition to improving efficiency, advanced technologies can also result in improved operational flexibility and better control.

Maintenance – Regular maintenance is critical to maintaining equipment operating efficiency, which results in peak energy efficiency. It also promotes improved reliability, better schedule adherence, better utilization, and extended equipment life. Predictive maintenance with monitored data can reduce downtime and maintenance costs.

Organization development goals – Strategic goals by the organization to increase competitiveness can drive the organization to include energy efficiency as a component of their management system. Financial, legal and social drivers all play into the organizational goals and the role energy efficiency plays in addressing those drivers should be addressed.

9.5 Task 3: Scope and Boundaries

ISO 50001 requirements relates to the activities under the control of the organization. In defining and determining scope and boundaries of the EnMS it is important to establish to what EnMS applies and what may not be included and to ensure that an organization can have the authority to control its energy efficiency, energy use and energy consumption within the scope and boundaries, also in relation to activities, responsibilities and roles of management, Energy Management Team and personnel/users.

According to ISO 50001 a boundary is defined as physical or organizational limit, while the EnMS scope represents a set of activities, that can include several boundaries [2].
Determine boundaries and applicability of the EnMS to establish its scope, taking in account:

- internal and external issues identified in task 1 – EnMS Strategic Issues
- requirements identified in task 2 – Legal and Other requirements

In determining Scope and Boundaries, identify what is included or excluded, considering what is under the control of the organization. E.g. of boundaries can be related to sites, facilities, buildings, processes, equipment, energy systems, people etc.
Maintain documented information of the EnMS scope and boundaries in a Scope and Boundaries Statement. Review Scope and Boundaries of EnMS at planned intervals or when significant changes occur in organization activities, processes, sites, facilities energy uses or other relevant aspects that may affect the applicability of the EnMS.

The following questions may be considered, as applicable:

1. Do you have a building or location that you are not including?
2. Can you isolate the energy use of those locations?
3. Do you have a process or product line you are not including?
4. Can you isolate or subtract out the energy use of the process or product line?
5. Is there an area on which you do not have energy information?
6. Is there an area where you cannot gain employee involvement or participation?
7. Are there areas that have a different management team or decision structure?
8. What are the physical limitations of the areas that are included?
9. What are the physical limitations of the areas that are not included?
10. How do the areas that are included and are not included compare to the site map or plan?

The following tables represents an example of how information related to scope and boundaries may be summarized.

Boundaries		
Topic	**What is Included?**	**What is Excluded?**
Sites		
Processes		
Facilities		
Equipment		
People		
…		

Scope		
Topic	**What is Included?**	**What is Excluded?**
Activities		
…		

Resources within your organization that can be useful in identifying the Scope and Boundaries of the EnMS can include the following:

1. Organization chart
2. Site map or site plan
3. Site photographs
4. List of on-site contractors and related operations
5. Facility/building layout
6. Process layouts/maps
7. Process flow diagrams
8. Utilities drawings
9. Facility/building energy consumption data
10. Equipment energy consumption data

Documented information:

Based on the tasks, develop a **Scope and Boundaries Statement.**

9.6 Task 4: Management Commitment

This task focus on demonstrating top management leadership and commitment to continual improvement of energy performance and the effectiveness of the EnMS.
Management involvement, commitment, support and leadership is addressed in ISO 50001 as an essential issue for the effectiveness and positive outcome of the EnMS and for the improvement of energy performance within the organization, in a perspective of continual improvement.

ISO 50001 underlines the importance that top Management shall demonstrates leadership and commitment to continual improvement of energy performance and EnMS throughout supporting, promoting and ensuring that the aspects of the EnMS are appropriately established and addressed within the organization, with particular regard to the following main aspects (presented as a preliminary checklist):

Management Commitment		
Issue	**Related Task**	**Included**
Legal & other requirements	Task 2	□ YES □ NO
Scope and Boundaries	Task 3	□ YES □ NO
Energy Policy	Task 5	□ YES □ NO
Resources needed for the EnMS	Task 6	□ YES □ NO
Formation and training of an Energy Management Team	Task 6	□ YES □ NO
Risks and opportunities	Task 7	□ YES □ NO
Improvement opportunities	Task 10	□ YES □ NO
Suitability and appropriateness of EnPIs and EnBs	Task 11	□ YES □ NO
Objective and targets and intended outcomes	Task 12	□ YES □ NO
Action plans for continual improvement implementation	Task 13	□ YES □ NO
Competences and training	Task 14	□ YES □ NO
Communication of the importance of conform to EnMS requirements	Task 15	□ YES □ NO
Communication of the value of an effective energy management	Task 15	□ YES □ NO
Internal audit	Task 22	□ YES □ NO
Continual improvement of EnMS and energy performance	Task 25	□ YES □ NO
EnMS requirements integrations in the organization's activities and processes		□ YES □ NO
Process to identify and address changes affecting the EnMS and energy performance		□ YES □ NO
Leadership and support of other management roles and personnel		□ YES □ NO

The checklist represents an example to preliminary assess the Management Commitment in respect to core concepts of an ISO 50001 EnMS.

Documented information:
Based on the tasks define a **Management Commitment to EnMS Statement and Plan.**

9.7 Task 5: Energy Policy

The definition and communication of an Energy Policy within an organization is one of the fundamental pillars of an EnMS in ISO 50001. It represents one of the first step that involve management commitment to achieving energy performance improvement, also providing a guideline related to EnMS implementation in terms of objectives and expected outcomes to involved parties within the organizations (but eventually also externally, if appropriate).

The following table provides a guideline to set a preliminary draft on Energy Policy:

1. Write a sentence or phrase that describes the activities of your organization.
2. How does your organization use energy? Consider: - How much energy does the organization use? - What type(s) of energy does the organization use? Do you use renewable energy? - What are the effects of the organization's energy use: on the environment; on the community; on the organization?
3. Write a sentence committing your organization to achieving continual improvement in energy efficient performance.
4. Write a sentence that commits your organization to providing the resources and information needed to achieve your energy improvement objectives and targets.
5. Write a sentence committing your organization to comply with all legal requirements and other requirements which relate to your organization's use of energy.
6. Write a sentence committing your organization to the use of energy objectives and targets.
7. Write a sentence committing your organization to the purchase of energy efficient products and services.
8. Considering your response to item #2, combine your statements from items 1, 3-7 into a short paragraph to form a draft Energy Policy Statement. Consider the use of bullets points for clarity.

In defining and Energy Policy or if the organization already has a draft or approved energy policy or other management system policy, this checklist can provide support to preliminary evaluate whether the policy meets the main requirements for an ISO 50001 Energy Policy. (All the following criteria should be met).

Yes	Requirements
☐	1. Did top management establish the policy?
☐	2. Does the policy reflect the nature and extent of the organization's energy use and is it appropriate to the purpose of the organization?
☐	3. Does the policy contain a commitment to achieving continual improvement in energy performance and EnMS?
☐	4. Does the policy commit to providing the resources and availability of information needed to achieve objectives and targets?
☐	5. With respect to the organization's energy use, energy efficiency and consumptions, does the policy commit to complying with applicable legal and other requirements?
☐	6. Is the context for setting and achieving objectives and targets related to EnMS outlined by the policy, in particular in terms of commitment to guarantee resources and availability of information?
☐	7. Is the procurement and purchase of energy efficient products and services supported by the policy?
☐	8. Are design activities that consider energy performance improvement supported by the policy?
☐	9. Is the energy policy available as documented information?
☐	10. Is the energy policy available to interested parties, as appropriate?
☐	11. Is the policy communicated within the organization to personnel/users or others working on behalf of the organization (e.g. on-site contractors and suppliers)?
☐	12. Is the policy regularly reviewed and updated as needed?

Documented information:
Based on this task, develop an **Energy Policy**

9.8 Task 6: Energy Management Team and Resources

Scope of this task is to develop an Energy Management Team authorized by management to oversee the EnMS. Responsibilities and authorities are assigned, communicated and processes are put in place to identify and provide the necessary resources.

Top management plays and important role in leading and supporting Energy Management Team and ensuring that the EnMS is properly implemented and continually improved within the organization conforming the requirements of ISO 50001.

Top management:

- identify and create an Energy Management Team, defining roles, responsibilities and authorities.
- identify and provide the adequate resources necessary for the creation, implementation and continual improvement of the EnMS.
- ensure communication within the organization of roles, responsibilities, authorities, procedures of the EnMS Implementation team.

In assigning roles, responsibilities and authorities to the Energy management team describe how the following issues will be addressed and ensured:

EnMS conformity to ISO 50001 requirements and concepts

EnMS effective implementation, update and continual improvement within the organization

Development and execution of action plans to continually improve energy performance (see task 14)

Periodically reporting the effectiveness of the EnMS and energy performance improvement to top management

Definition and implementation of criteria and procedures required to guarantee the effectiveness of operational and control (see task 17)

Documentation of actions and tasks related to EnMS implementation, including managing authorization related to viewing or changing documented information related (see tasks 16)

Management of nonconformities and corrective actions (see task 24)

Communication of EnMS in the organization at different levels (see task 14)

Document information related to energy management team members and their responsibilities, to provide a reference for determining whether the functions and individuals, who can provide a relevant perspective and impact on energy performance and EnMS improvement, have been included.

The following table is an example of how roles and responsibilities may be listed and documented.

n.	Name	Role	Authorities	Responsibilities	Contact details
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
…					

Describe which resources should be provided to implement EnMS.
Resources may include:

- economic resources.
- human resources (including experts or personnel with specific skills)
- technologies
- meters, monitoring systems, data collection systems
- data and documentation management systems

The table below represents an example of how Resources may be listed and documented.

n.	Resource	type (economic, HR, systems etc.)	Purpose	Responsible	Impact on EnMS implementation
1					
2					
3					
4					
5					
…					

Define procedures to review periodically the EnMS Implementation, team roles, authorities and resources in relation to eventual changes and modification within the organization.

Documented information

Based on the tasks, define a **Report on roles, responsibilities and resources of the Energy Management Team**

9.9 Task 7: Risks and Opportunities

Scope of this task is to identify risks and opportunities that need to be addressed to achieve the intended outcome of EnMS and energy performance targets.

Consider all aspects that can provide undesired effect and all aspect that can influence the achievement of the goals and targets. Consider strategic internal and External Issues identified in task 1 and needs and expectations of interested parties addressed in task 2.

Foresee potential situations and related impacts as well as consequences that can be addressed in advance. Define opportunities that may be related to the achievement of the outcome of EnMS and that could provide potential advantageous effects.

In assessing risks, a Risk Matrix may be implemented as for the example below.

Risk Matrix		Impact			
		Acceptable	Tolerable	Unacceptable	Critical
Likelihood	Improbable				
	Possible				
	Probable				

In order to define Opportunities and Risks a SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) may be implemented as for the example below:

SWOT Analysis	**Helpful to achieving the objective**	**Harmful to achieving the objective**
Internal (attributes of the organization)	Strengths:	Weaknesses:
External (attributes of the environment)	Opportunities:	Threats:

Define mitigation actions for the identified risks and actions to take advantage of opportunities to ensure that the organization may achieve the intended outcomes of the EnMS and energy performance improvement targets. Determine how actions could be integrated in the EnMS and organization

processes. Identify responsibilities, resources and procedures to evaluate the effectiveness of the action.

The following table is an example to summarize data related to risk and opportunities and related actions:

Risks/ Opportunities	Mitigation/ Improvement Actions	Responsible	Resources	Evaluation of effectiveness

Documented information:
Based on the task, define a **Risk and Opportunities Register and Plan**

9.10 Task 8: Energy Data Collection and Analysis

Scope of the task is to identify energy sources and energy uses, to implement and establish an Energy Data Collection Plan and collect related energy and relevant variable data, ensuring accuracy and repeatability of measurements. This tasks also involves the analysis of energy use data to understand where opportunities for improve energy performance exist.

The first step is to identify energy sources and energy uses within scope and boundaries of the organization.
The following tables represents examples of how data can be gathered or summarized. The examples below are mainly referred to buildings:

Energy type or vector	Yes	No	Uses
Electric Energy			
Natural gas			
Heating Oil			
LPG			
District Heating			
District Cooling			
Other (specify)			

RES (Renewable Energy Sources) and other sources	Yes	No	Uses
Photovoltaic			
Solar thermal			
Biomass			
CHP			
Other (specify)			

Identify energy uses (building related list):

Energy uses	Yes	No	Energy
Heating			
Cooling			
DHW (Domestic Hot Water)			
Air handling units/ventilation			Electric Energy
Lighting			Electric Energy
Lifts and elevators			Electric Energy
Water pumps			Electric Energy
Electrical appliance			Electric Energy
Kitchen equipment			
Other equipment			Electric Energy
Other (specify)			

The second step is to identify energy data sources, measured variables and responsibilities.

The following table represents example of how data con be summarized.

Data collection - energy meters and variables								
N.	**Type**	**Energy type or vector**	**Measured Energy variables**	**Unit**	**Frequency of measure**	**Data collection method**	**Responsible**	**Required for management review**
1								
2								
3								
4								
…								

In relation to energy data to be collected, the main aspects addressed in ISO 50001 include:

- SEUs relevant variables, energy consumption, operational criteria (task 9)
- Static factors (task 10)
- Energy consumption
- Data detailed in action plans (task 13)

Data could be not only related energy consumption but to other aspects impacting energy performance or energy consumption. E.g. data related to normalization or definition of static factors for EnPIs and EnBs (task 10).

In relation to **Measuring and monitoring**:
Determine for energy performance and the EnMS what is necessary to measure and monitor. The following aspects are minimum key requirements addressed by ISO 50001:

- the effectiveness of the action plans in accomplishing objectives and targets;
- EnPI(s);
- operation of SEUs;
- comparison between actual versus expected energy consumption.

Establish and implement methods for monitoring, measurement, analysis and evaluation to guarantee valid results.

Determine when the monitoring and measurement shall be performed.

Define when the results from monitoring and measurement shall be analysed and evaluated

Different levels of monitoring, analysis and evaluation may be defined with different frequency, depending on the case. E.g. Periodic detailed analysis and evaluation and more frequent less detailed periodic monitoring and assessments of energy performance to identify promptly eventual deviations, issues or problems and implement related corrective actions.

Some other question to consider in defining the **Energy Data Collection and Monitoring Plan**:

1. What data are important to collect?
2. How data are collected?
3. How often data are collected?
4. Have the key aspects of operations impacting on energy performance identified, measured and monitored?
5. Is the plan appropriate to size, complexity, measurement equipment?
6. The accuracy of measurements is adequate to the level of analysis and detail required in the EnMS?
7. What are the factors that may influence or negatively affect the accuracy of the measurements?
8. What are the procedures to ensure that measurements are accurate, repeatable and comparable? How documented information will be developed and maintained related to accuracy and repeatability?
9. What are the procedures to evaluate the effectiveness and accuracy of measurements?
10. Are data validated? In case what is the validation procedure?
11. What are the procedures of data monitoring (frequency, responsibility, outputs etc.)?
12. What are the procedures to store and organize data?
13. Are responsibilities regarding data collection and analysis defined?
14. What are the procedures in case of data loss, errors or malfunctioning of energy meters?
15. How are addressed relevant changes in energy usage or in systems and equipment?
16. What are the procedures to periodically review and update the energy data collection plan?
17. What are the procedures to ensure that energy data are evaluated and analysed at planned intervals?

Analyse energy use data and consider the following aspects to define a **Report on energy use**:

1. How can you describe the energy use of your organization?

2. What have been the energy trends in the current period of reporting?

3. Is there any relevant change in energy use (sources, uses, variables, vectors)?

4. Are data comparable with historical data?

5. Are there any relevant changes in energy profiles?

6. What are the expected future energy use and consumption?

7. Which other energy use may need to be monitored?

8. Which energy uses may need further or deeper analysis?

Documented information:
Based on the tasks, develop the following documents:

- **List of energy sources and uses.**
- **Energy Data collection and Monitoring Plan.**
- **Report on energy use.**

Additional templates:
The following template provides an example for estimating future energy use when the effect of factors that can influence future consumption are known or can be approximated. The approach could be to start with the current energy use and energy consumption and modify it based on changes that are projected to occur.

This sheet may also be applied for estimating energy use and consumption at SEU-level (see task 9).

Future Energy Use(s) and Consumption Estimate
Energy Use: _____ Location: _____ The energy consumption for this use in the last: week, month, year, or other period _____ Units: □ kWh; □m^3; □ litre; □ other_____
During the period from _____to_____, the factors expected to influence energy consumption are:_____ The anticipated changes are :_____ Production levels (or other relevant variables) will increase/decrease by % changing energy consumption by +/-_____% Capital investments (or other relevant actions) will be completed and will change energy consumption by +/-_____% Energy source will change from _____ to _____changing energy consumption by +/-_____% Energy saving procedures will reduce energy consumption by +/-_____% Other factors to consider: new technologies, process changes, supplier changes, materials changes, product changes, weather changes, changes in operational criteria, economic forecasts, industry development, etc. _____ changing energy consumption by +/-_____% _____ _changing energy consumption by +/-_____% Sum of energy consumption changes expected: _____% Expected consumption for next period is expected to be = last period consumption x (1 + % change): _____ = _____ Units: : : □ kWh; □m^3; □ litre; □ other _____ Attach lists of planned investments and energy saving measures that will affect future energy use.

9.11 Task 9: Significant Energy Uses (SEUs)

Scope of this tasks is to determine Significant Energy Uses (SEUs), identify and monitor their relevant variables and energy performance and identify the persons that affect the SEUs.

According to ISO 50001 the definition for Significant Energy Use (SEU) is: energy use accounting for substantial energy consumption and/or offering considerable potential for energy performance improvement [2]. SEUs can be related to facilities, systems, processes, or equipment.
Within the organization boundaries:

- analyse energy flows for every energy type or vector.
- identify current types of energy (see task 7 – Energy data collection): Electric Energy, Natural gas, Heating Oil, LPG, District Heating, District Cooling etc. ; other media such us steam, compressed air can be considered as energy or secondary energy types or vectors, on the basis of the organization approach.
- evaluate energy use and consumption based on bills, measurement data etc.
- assess past and current energy consumption

Some questions to consider in defining List of SEUs and monitored data:

- Which are the areas (facilities, processes, systems, equipment) where there is a substantial consumption of energy?
- Are there already any the specific criteria for identifying SEU in your organization?
- What is the percentage of energy consumption, for every energy type or vector, covered by the sum of identified SEUs?
- What are the relevant variables that impact significatively on energy consumption and energy performance?

Develop a process to review and update SEU data and related information, including methods and criteria to determine that an energy use should be an SEU.

SEUs could eventually be divided in different categories as for the example below, based on the classification for Italian Energy Audit scheme according to Directive 2012/12/EU proposed by ENEA (Italian National Agency for Energy and Environment).
- principal processes
- auxiliary services
- general services

Typical significant energy use for residential buildings can be:

- Heating
- Cooling
- DHW (Domestic Hot Water)

- Air handling units/ventilation
- Lighting
- Lifts and elevators
- Water pumps
- Kitchen equipment
- Other electrical appliance.

The following table is an example of how information could be summarized:

SEU - Significant Energy Use						
N.	**Description**	**Energy type**	**Relevant variables**	**Operational criteria**	**Process or person (role in the organization) that affects consumptions**	**Energy Performance** (e.g. poor, adequate, good, excellent)
1						
2						
3						
4						
…						

SEU - Significant Energy Use				
Energy type or vector 1				
Yearly consumption from bills or measured data				
N.	**Description**	**M = Measured C = Calcualted**	**Yearly consumption measured or calculated**	**% of yearly total energy consumption from bills or measure data**
1				
2				
3				
4				
5				
…				
TOTAL				

Documented information:

Based on the task develop:

- **Report defining SEU criteria and evaluation methods.**
- **List of SEUs and monitored data.**

9.12 Task 10: Improvement Opportunities

Scope of this task is to identify and prioritize energy performance improvement opportunities.

Take in account that Energy Audits could contain or provide energy improvement recommendations ranked on the basis of criteria such as energy performance improvement entity or financial return on investment.
Evaluate the scope to which energy is required for a process and assess if it is possible to recover energy for the same or other processes.
One of the possible approaches could be start focusing on Significant Energy Uses that effect most on energy consumption and evaluate the impact in terms of energy savings of improvement opportunities in these uses. Energy efficiency optimization in energy-using processes could have a significant impact on achieving energy performance targets over the operating lifetime.
Energy performance improvement opportunities could be implemented in the design or renovation of new facilities, equipment, or systems (see task 18 e 19).

The following list provide examples of some of the most common energy efficiency improvement opportunities related to buildings.
Envelope:

- Thermal insulation of external walls or walls facing non heated space.
- Thermal insulation of roofs
- Thermal insulation of floors facing the external environment or non heated space.
- Installation of high energy performance windows
- Installation of solar shading on the windows

Systems

- High efficiency boilers (e.g. condensing boilers)
- High efficiency heat pumps for heating, DHW production or cooling
- Hybrid systems (Heat pumps and gas boilers)
- Implementation of a BMS
- Installation of efficient lighting systems (e.g. LED)
- Energy recovery in controlled mechanical ventilation systems
- Energy efficient auxiliary: fans, motors, pumps etc.
- Installation of inverters
- Thermal energy recovery (e.g. drain water heat recovery system)
- Thermal storage
- Smart grids
- Improvement of equipment efficiency (e.g. refrigerators, white goods)
- Data centres energy efficiency measures
- CHP (Combined Heat and Power)
- Electric Energy storage systems

Management and costs optimization

- Improvement and optimization of management of systems (regulations, setpoints etc.)
- Optimization of energy costs

RES (Renewable Energy Sources):

- PV systems
- Solar thermal panels for DHW or heating
- Biomass

According to ISO 50001 the installation of a renewable energy type does not represent an energy performance improvement. In general, the use renewable energy can have a positive environmental effect or be profitable and organization could aim to install renewable energy systems. In such cases, an organization needs to assess the renewable energy production separately. [2]

Improving opportunities could be related to:

- Facilities, equipment, systems (e.g.. renovate, update, improve energy efficiency)
- Operational (e.g. optimization of how systems and equipment can be operated and maintained to improve energy efficiency).

Improvement opportunities could also relate to energy costs (e.g. optimization of energy contracts conditions and energy consumption profile in relation to costs) also if this doesn't represent an improvement in energy performance, but it relates in a broader way to energy management.

Improving opportunities could be:

- Low cost or no cost (e.g. regulation, O&M optimization, improvement of systems controls and settings etc.)
- Medium cost (opportunities that have a cost that can be considered between low and high)
- Capital intensive intervention (opportunities that require a significative capital investment and generally need to be evaluated in detail)

The following table represents an example of how information related to improvement opportunities could be summarized:

Improvement opportunities	Low cost or no cost	Medium cost	Capital intensive intervention
Facilities, systems, equipment			
Operation and management			
Energy costs			

For each improvement opportunity consider the following aspects:

Which are the current available incentives and subsides (local, national, international), if applicable? What is the entity of the incentives? Is it feasible to obtain them (e.g. in relation to technical requirements)? What source of funds may be used to finance this improvement opportunities?

(E.g: capital budget, maintenance budget, EPC and ESCO investment, loan etc.)

What are the risks connected to the implementation of the improvement opportunities (e.g. interference with other processes, increased complexity of O&M, etc.)? Consider Task 7- Risks and Opportunities.

What are other potential advantages and beneficial outcomes related to the implementation of the improvement opportunity (e.g. increased reliability of system, better comfort for users, increased value of the asset etc.) - Consider Task 7- Risks and Opportunities.

How does this improvement opportunity contribute and impact on achieving EnMS target? Consider Task 11 - Objectives and Targets.

The following table provides an example of how data can be summarized:

n.	Improvement opportunities	Available incentives	Risks	Other advantages or opportunities	Impact on achieving EnMS targets	Estimated costs	Energy savings	Economic savings	CO2 reduction
1									
2									
3									
4									
….									

Describe the processes in place to periodically update the list of improvement opportunities and to identify new possible improvement of energy performance.

Documented information:

Based on the consideration above, create a **List of improvement opportunities**

9.13 Task 11: Energy Performance Indicators (EnPIs) and Energy Baselines (EnBs)

Scope of this task is to identify Energy Performance Indicators and Energy Baselines to measure and monitor energy performance and to demonstrate energy performance improvement. The task also concerns the development of a methodology for determining and updating EnPIs and EnBs.

EnPIs – Energy Performance Indicators

Energy Performance can be measured through Energy Performance Indicators, defined from ISO 50006 as a quantitative value or measure of energy performance [3].

EnPIs allows an organization to assess how energy is used, how much is consumed in a period, what are the levels of efficiency of processes, equipment, services etc.

EnPIs could be expressed as a simple metric, ratio or throughout a more complex model.

EnPIs should, when compared over time or with benchmarks or baselines, allow an organization to understand and prove if the energy performance has improved or decreased.

In defining EnPIs, energy consumption profiles features of the organization needs be understood: e.g. variable loads, fixed loads, main variables and parameters that affect energy consumption (e.g. production, weather, occupancy, setpoint, equipment efficiency etc.).

In measuring and monitoring EnPI and other energy related variables, a valuable resource is provided from IPMVP Protocol (International Performance Measurement and Verification Protocol), describing concepts and best practise for determining results of energy efficiency improvements with the purpose to increase reliability and certainly.
In defining EnPIs consider:

- Levels: EnPIs can be general or specifically related to whole organization, single energy use, service or equipment, users.
- Users: EnPIs may be useful for stakeholders at different levels in an organization (e.g. top management, facility manager, plant manager, O&M personnel, external users etc.)
- Purpose: to define a relevant and useful EnPI the purpose of the EnPIs has to be clear. Define what effective and useful information related to energy consumption and performance can be provided from the EnPI.

The following table represents an example for summarizing information related to EnPIs.

EnPI - Energy Performance Indicators				
N.	**EnPI**	**Level**	**Users**	**Purpose**
1				
2				
3				
4				
…				

In defining EnPIs consider:

- Measurement and calculation: consider available energy data and meters; the necessity to implement monitoring system may be evaluated. Data and measurement at the basis of EnPIs shall be reliable and repeatable
- EnPI Boundaries: a measure boundary has to be defined to measure energy performance. The three primary EnPI boundary levels according ISO 50006 are: individual (related to individual facility, equipment or process), system (related to a group of facilities, equipment or processes) and organizational.[3]-
- Energy relevant variables: identity and quantify relevant variables that impact on energy performance and are subjected to change.
- Static factors: identify static factors, that are defined by ISO 50006 as factors that impacts on energy performance and does not change routinely.[3]
- Normalization: energy performance shall be compared under equivalent condition. Normalization is a process of modelling energy data in relation to appropriate variables that may be change, to allow effective and reliable comparisons.
- Updating process: define a process to review and update EnPIs periodically and in particular when activities and energy uses change in a relevant way and/or static factors are subject to changes.

Relevant energy related information to define EnPIs can be obtained from Energy Reviews or Energy Audits.

The following table represents an example for summarizing information related to EnPIs.

EnPIs - Energy Performance Indicators							
N.	**EnPI**	**Description and measurement/calculation method**	**EnPI Boundary**	**Relevant variables**	**Static factors**	**Normalization**	**Updating process**
1							
2							
3							
4							
…							

The following table (elaborated on the basis of the template for Italian Energy Audit scheme according to Directive 2012/12/EU proposed by ENEA Italian National Agency for Energy and Environment) provides an example regarding how EnPIs may be related to Significant energy Uses, defining variables for normalizations at general and specific levels.

Energy type or vector	Consumption		General variable		General Index	
	kWh	primary energy (e.g. toe - tonne of oil equivalent)	value	unit of measure	Type of measure (measured, calculate)	kWh/ unit of measure

		Consumption		General Index		Specific variable		Specific Index
	Energy use	kWh	primary energy (e.g. toe - tonne of oil equivalent)	Type of measure (measured, calculated)	kWh/ unit of measure	Unit of measure	Type of measure (measured, calculated)	kWh/ unit of measure
1								
2								
3								
4								
…								

The following list provides some examples of common energy efficiency and operational performance metrics found in existing projects and literature, as identified in Deliverable D2.2 SPHERE HOLISTIC SUSTAINABILITY ASSESSMENT - KPI's Definitions and Assessment Methodology for the SPHERE Digital Twin Platform. D2.2 include the complete list of KPIs.

Energy Use, Energy Efficiency and Energy Supply KPIs

- Total energy consumption [kWh/m^2]
- Energy demand for heating/cooling/ventilation/DHW production [kWh/m^2]
- Overall electricity consumption of the building per m^2
- Overall electricity consumption for lighting per m^2
- Electricity consumption of indoor lighting per m^2
- Overall electricity consumption on appliances per m^2
- Electricity consumption of mechanical ventilation systems normalized by m^2
- Energy consumption per person
- Heat pump seasonal efficiency
- Equipment energy efficiency
- Operating Energy Costs
- Occupancy Energy Costs
- Energy performance classes (e.g. kWh/m^2/year or kWh/m^3/year]
- Heating consumption per square meter and heating degree days
- Building energy demand met in % from renewable energy systems

Other KPIs (Environmental and Operational efficiency metrics):

- CO_2eq Emissions: kg CO_2 / year
- IEQ: Thermal Comfort
- Energy Costs (Before/After Renovation) [€/m^2]

Energy Baselines – EnB

According to ISO 50001 definition, Energy Baseline consists of quantitative reference(s) providing a basis for comparison of energy performance. [2]

EnBs represent EnPI values in the baseline period and allow an organization to compare energy performance changes between the reporting period and the baseline period.

In defining EnPIs consider:

- Purpose: the purpose of EnPI related to Energy Baseline should be taken in account.
- Period: outline a suitable period on the basis of how energy is used within the organization. The typical baseline period is 1 year to take in consideration seasonality in energy consumption (due to weather, operation patterns etc.) and related relevant variables. EnB periods of less than 1 year may be considered if there is no seasonality in energy consumption or when the period could be considered representative of a reasonable variety of energy consumption and operating trends.
- Measurement and data: consider availability of historical energy data. Data and measurement at the basis of EnPIs and EnBs shall be reliable and repeatable.
- Energy relevant variables: identity and quantify relevant variables that impact on energy performance and are subjected to change over time.
- Normalization: energy performance shall be compared under equivalent condition. Normalization is a process of modelling energy data in relation to appropriate variables that may be change, to allow effective and reliable comparisons.
- Update and revision: define processes to update and revise EnB(s) if relevant modification in static factors occurs and to periodically test EnBs to ensure effectiveness.

The following table represents an example for summarizing information related to EnBs.

EnBs - Energy Baselines							
N.	**EnB**	**Related EnPI**	**Description and measurement - calculation method**	**Period**	**Relevant variables**	**Normalization**	**Updating process**
1							
2							
3							
4							
…							

Documented information:

Based on the task, define a**:**

- **Report on method for determining EnPIs and EnBs.**
- **List of EnPIs and EnBs.**

9.14 Task 12: Objectives and Targets

Scope of the task is to identify and establish objectives and energy performance targets.

With the purpose, in defining Objectives and energy target take in account:

- Consistency with Energy Policy (task 1)
- Legal and other requirements (task 2)
- Risks and Opportunities (task 7)
- SEUs (task 9)
- Improvement Opportunities (task 10).
- EnPIs and EnBs (task 11): energy performance targets should be characterized by EnPI values.

Consider that objectives and targets may:

- refer to different disciplines (financial, health and safety, environmental, energy, technical…)
- apply at different levels (organization, project, process…)
- consist in an intended outcome, a purpose, an operational criterion, energy objective.

In ISO 50001:2018 an Objective is defined as a result to be achieved, that can be related to different disciplines; Energy Target is a quantifiable objective of energy performance improvement and it can be included within an objective [2]. In this perspective objective can also be qualitative.

The following table provide an example matrix to outline a first draft list of objectives and targets.

Objectives & Targets	Qualitative	Quantitative
Strategic		
Tactical		
Operational		

The following table provide an example to evaluate the preliminary Objectives and targets identified:

n.	Objective/Target	Can it be measured? (if applies)	Can it be monitored?	Is it consistent with Energy Policy?	Is it feasible? Can it be reached?
1		□ YES □ NO	□ YES □ NO	□ YES □ NO	□ YES □ NO
2		□ YES □ NO	□ YES □ NO	□ YES □ NO	□ YES □ NO
3		□ YES □ NO	□ YES □ NO	□ YES □ NO	□ YES □ NO
4		□ YES □ NO	□ YES □ NO	□ YES □ NO	□ YES □ NO
….		□ YES □ NO	□ YES □ NO	□ YES □ NO	□ YES □ NO

For the established identified Objectives and Target define required actions, committed resources, responsible staff, completion date.

The following table is an example of how information could be summarized.

n.	Objective/Target	EnPi(s)	Actions	Resources	Responsible	Date to complete
1						
2						
3						
4						
….						

Develop a Report on Objective and Targets, defining:

1. How identified Objectives and Targets identified will be communicated.

2. How Objectives and Targets will be integrated in the organization processes.

3. How Objectives and Targets will take in account of risks, opportunities, legal and other requirements

4. Howe Objectives and Targets will be monitored, verified, updated

The following example template refers to the main aspects to consider for each identified Objective and target and provides an example of how information can be summarized.

Objectives and Targets
Objective: Target:
List the Energy Policy commitments relevant and consistent to this objective or target:
Considerations
How were applicable legal and other energy requirements taken into account in the development of this objective and related targets?
Is this objective related to one or more legal, regulatory or other energy requirement(s)?
If yes, list the relevant legal or other requirements:
How has the prioritized list of opportunities from the energy review been considered in the development of this objective?
What technology options are feasible to achieve this objective?
What financial requirements or conditions are relevant to this objective?
What source of funds will be used to finance this objective/target? (Eg: Capital budget, Maintenance budget, EPC, ESCO investment, loan, grant aided)
What business and operational conditions or constraints are relevant to this objective?
Who are the interested parties who have or may have views relevant to this objective and target(s)?
How have the views of interested parties been considered?

Monitoring and Measurement	
How will the objective be monitored and measured?	
How will the target be monitored and measured?	
How often will monitoring and measuring be done?	
What data will be collected or analysed?	
Who will collect and analyse the data?	
List any plant or equipment control systems that are already in place:	
What operational controls are needed?	
Can existing or proposed controls export data about the system/equipment it is controlling?	
What monitoring and measurement equipment will be used?	
What metrics will be recorded by monitoring and measurement?	
What will be the EnPI that will be used to report this target?	
Which equipment will require calibration?	
Is this equipment already in the calibration system?	
How will be the calibration of equipment be recorded?	
Related EnMS Action Plans (List the Action Plans associated with achieving this objective and related targets)	

Documented information:

Based on the task, develop a **Report on objectives and energy performance targets**.

9.15 Task 13: Energy Review and Action Plans

Scope of this task is to conduct an Energy Review and develop and establish Action Plans that define the procedures for Continual Improvement of the organization.

In conducting an **Energy Review**:

- Analyse energy data related to energy consumption and energy uses as defined in task 8 (Energy Data Collection and Analysis). Include assessment and evaluation of past and actual energy uses and consumption and estimate future energy uses and consumptions.

- Include identification and assessment of SEUs (task 9).

- Include evaluation on improvement opportunities (task 10) related to energy performance and a definition of a scale of priorities. The priorities may be outlined considering different aspect (e.g. cost-benefit approach, impact on energy performance or EnMS improvement, impact in achievement of objective and targets, expected positive outcomes etc.).

- Define procedures to update the Energy Review at planned interval or when significant changes in the organization that impacts energy consumption, use and performance may occur.

In defining **Action Plans** for continual improvement consider and include:

1. What is the general timescale of action for assess, achieve, verify the energy performance improvement in your organization.

2. Which improvements are priorities for your organization.

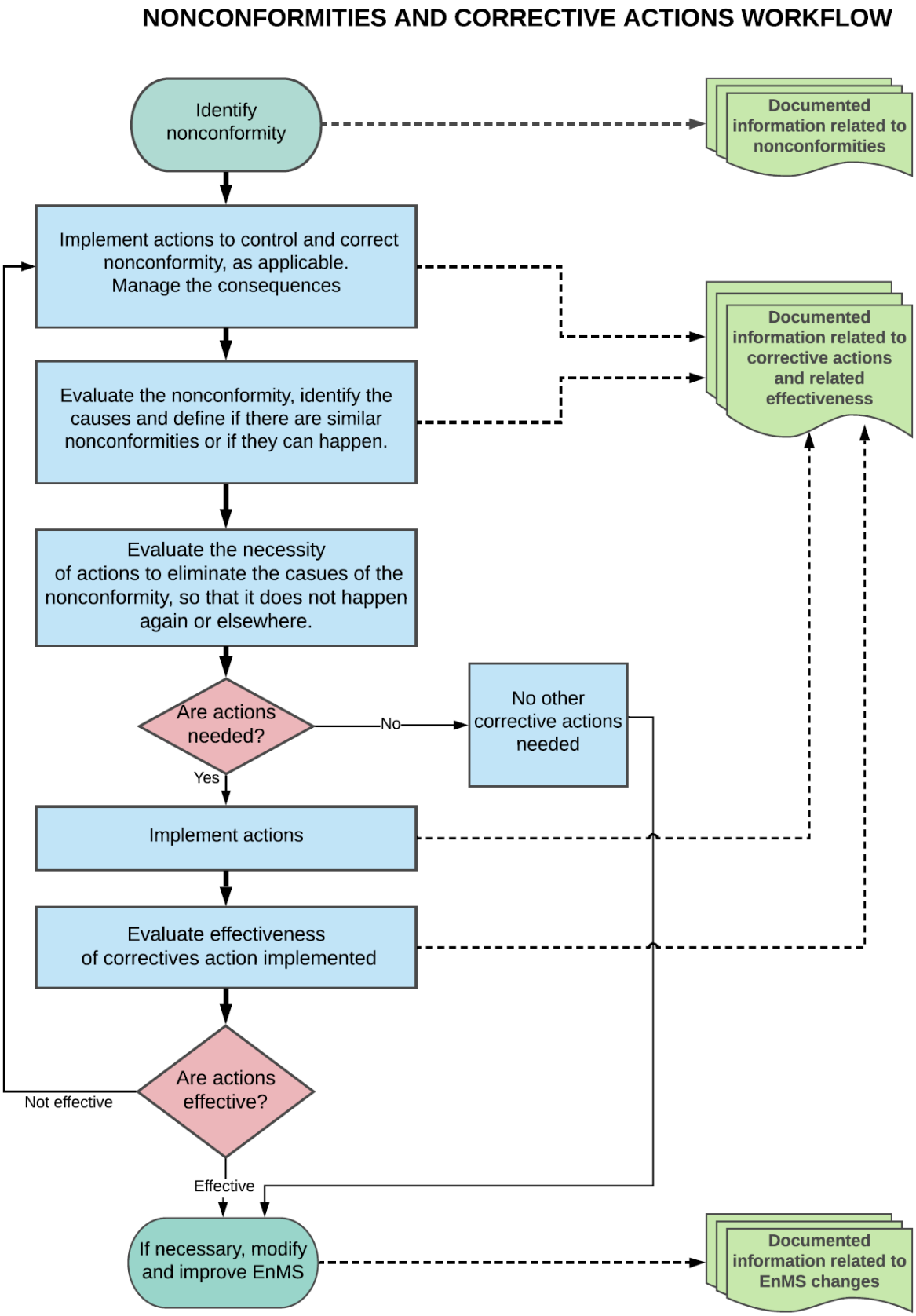
3. Actions defined to address risk and opportunities and to evaluate effective of the actions, as defined in task 7 – Risk and Opportunities.

4. In relation to achievement of Objective and the following aspects, as defined in task 12-Objective and Targets: actions to be taken, Resources, Responsibilities, planning of activities, procedures to evaluate outcomes end energy improvements.

5. how can energy performance improvement be demonstrated? E.g. reduction of normalized energy consumption, progress towards the achievement of targets, improvement of EnPIs, management of SEUs etc..

In Action Plans for continual improvement identify procedures related to identification and management of nonconformities with the aim of achieving continual improvement of energy performance and of the EnMS. In the procedures explain how to address the implementation of appropriate corrective actions to eliminate nonconformities and related causes.

The following workflow summarizes the ISO 50001 approach to manage nonconformities and related corrective actions.



To define a procedure to address nonconformities and corrective actions consider the following steps, in relation to the context and characteristic of the organization:

1. Describe the procedure to identify nonconformities and to evaluate impact and consequences of nonconformities (consider responsible figures, timing, documentation, communication).

2. Describe the procedure to correct the nonconformities and to implement corrective action, also including evaluation about the need for action to eliminate the causes.

3. Define procedures to review the effectiveness of corrective actions (consider responsible figures, timing, documentation, communication etc.), including procedures for changing and improving the EnMS, when necessary.

Documented information:

Based on the task, develop an **Energy Review** and **Action plans for continual improvement.**

9.16 Task 14: Competence and Training

Scope of this tasks is to assess, program, evaluate and keep track of the competences and training of relevant personnel, users or persons at different levels, impacting energy performance and EnMS to ensure that they have the appropriate competences.

To define a Competence assessment Protocol:

- Identify the persons whose work impacts on energy performance and EnMS and define the minimum necessary competences. Define competence requirements in relation to function, role and level of persons in the organization.
- Evaluate if these persons have the adequate competences based on education, training, experience or skills and implement eventual corrective action to ensure that they acquire the necessary competence, considering certification where qualification scheme are available. In a perspective of continual improvement evaluate the effectiveness of actions taken.

The following tables provide example of how evaluation of competences can be documented and summarized. In particular the first table represents an example to assess and record competences with more detail for each person, while the second table provides an example of a more general way to summarize competences for obtaining a general overview of the relevant personnel.

Person:				
Role:				
Affected EnPIs or SEUs:				
Type	**Minimum requirements**	**Competences of the person**	**Are competences adequate?**	**Corrective actions**
Education			□ YES □ NO	
Skills			□ YES □ NO	
Training			□ YES □ NO	
Experience			□ YES □ NO	
Certification			□ YES □ NO	
….				

n.	Person affecting EnMS or energy performance	Role in the organization	EnPIs or SEUs affected	Minimum Competence Required	Competences of the person	Are competences adequate?	Corrective actions needed
1						□ YES □ NO	
2						□ YES □ NO	
3						□ YES □ NO	
4						□ YES □ NO	
…						□ YES □ NO	

With the aim of developing **a Training Program** and **Training and competences Register**, define a procedure to program and record training activities and evaluate the effectiveness of actions taken to acquire competencies.

The table below represents an example of a template for recording training and competences.

			Person:				
			Role:				
			Affected EnPI or SEU:				
n.	**Date**	**Training Description**	**Training provider**	**Objective**	**Certification**	**Training Evaluation**	**Expiration date (if applicable)**
1							
2							
3							
4							
…							

Documented information:

Based on task, develop a **Competence Assessment Protocol**, a **Training Program** and a **Training and Competence Register.**

9.17 Task 15: Awareness and Communication

Scope of this task is to communicate to personnel and on-site contractors to ensure they are aware of the energy policy and their energy-related roles and responsibilities.

One of the main aspects related to this task regard the identification of the involved parties to which it is important to communicate relevant aspects of EnMS and its core concepts. In particular, personnel, users and persons doing work under the organization's control (e.g. including on site-contractors) shall be aware on:

- Energy Policy (tasks 5)
- procedure related to EnMS
- impact of the involved personnel/users on the effectiveness of the EnMS
- influence of the behaviour and activities of the personnel/users on the achievement of targets and on energy performance improvement (task 12)
- consequences of non-compliance with EnMS requirements.

To put processes in place for internal and external energy management system communications and to define a communication protocol, consider these questions related to EnMS:

1. What are the key concepts, information, data, procedures, achievements to communicate?

2. When and with what timing, intervals, frequency is the communication made?

3. Who are the main recipients? How can communication be made effective so as to be differentiated and appropriate to the type of recipients?

4. What is the best way to communicate?

5. Who are the figures, persons, roles and resources involved in the communication?

6. What is the process to obtain feedbacks, comments, suggestion improvements related to EnMS and energy performance and how it will be documented?

7. What are the methods and procedure to ensure that the interested parties have acknowledged and are aware of the communicated information related to EnMS?

8. What are the methods and procedure to ensure information communicated is reliable and coherent with information in the EnMS?

Documented information:

Based on previous answers and considerations define a **Protocol for communications to all involved parties**

9.18 Task 16: EnMS Documentation

Documentation is a crucial aspect in implementing an ISO 50001 compliant EnMS. A detailed and adequate process and protocol for creating, updating, controlling and managing documented information and data related to EnMS is essential for the effectiveness of the EnMS and also for an ISO 50001 Certification process.

In the EnMS, define documented information necessary to demonstrate compliance with ISO 50001 standard.

Define documented information that the organization may need to ensure effectiveness of the EnMS, support and maintain the EnMS and to prove continual improvement of energy performance.

The extent of documented information can differ from one organization to another, related to its context, type of activities, size, complexity and competences. Documents may be internal or external (e.g. laws, regulations, standards, equipment datasheets and manuals, data related to normalization, static factors or other relevant data). External data relevant and necessary for the EnMS shall be identified and, as appropriate controlled.

Implement a procedure according to ISO 50001 requirements related to **creating and updating** documented information to guarantee appropriate: identification and description, format, media, review and approval procedures.

Define procedures to ensure that documented information required by the EnMS and ISO 50001 requirements is **controlled**, ensuring availability and suitability for use and adequate protection (e.g. from loss of confidentiality, improper use, loss of integrity).

ISO 50001 requires to address the following activities, as applicable, for the **control** of documentation:

- distribution, access (e.g. permission to view or view and change), retrieval and use

- storage and preservation, including preservation of legibility;
- control of changes (e.g. version control);
- retention and disposition.[2]

On the basis of the ISO 50001 requirements, define a procedure to ensure appropriate control of documented information.

Documented information:
Based on the tasks, define a **Protocol for managing and controlling the EnMS documentation.**

9.19 Task 17: Operational control

The scope of this task is to plan and control the processes related to Significant Energy Uses (SEUs) and define Operational Plans form managing SEUs. The aim is to implement actions outlined in Action Plans (task 13) to achieve defined objective and targets (task 12).

Define operation and maintenance criteria for the processes where there are risks of significant deviations in expected energy performance (see task 9 – Significant Energy Uses). Processes include effective operation and maintenance of facilities, equipment, systems and energy using processes.

Carry out control of the processes related to SEUs in accordance with established criteria and communicate the criteria to relevant personnel/user and ensure that acknowledge and adopt the criteria.

Describe how criteria are controlled:

Describe how criteria are communicated:

Describe how acknowledgment and adoption of criteria from relevant personnel/user will be ensured:

Define how evidence will be maintained with documented information (see task 16) to demonstrate and ensure that the processes have been implemented as planned according to established criteria.

The table below provides an example of how operational control criteria may be summarized:

SEU - Significant Energy Use - Operational Control								
N.	**SEU**	**Relevant equipment, system, facilities**	**Operational criteria**	**Control Criteria**	**Responsible personnel**	**Personnel/users involved**	**Communication criteria**	**Documented information**
1								
2								
3								
4								
…								

Describe how planned or unintended changes and are controlled and managed:

Describe how outsourced processes related to SEUs, including outsourced SEUs, are controlled:

Describe actions taken to mitigate unplanned effects:

Documented information:
Based on the tasks define an **Operational Plan for managing SEUs.**

9.20 Task 18: Energy Considerations in Design

The purpose of this task is to consider energy performance improvement opportunities and operational controls when designing new, modified, or renovated sites, equipment, systems and processes.

Particular attention needs to be paid to the most energy consuming systems and processes and on those that have the greatest impact on energy performance. Consider the operating lifetime of systems, equipment, components and also improved technologies and techniques for new facilities under an energy performance improvement perspective.

As Energy Efficiency standards on the markets and at regulatory requirements level are continuously improving, consider a periodic update of energy performance consideration in Design.

Based on the organization needs and where applicable, include energy performance consideration in design activities.

Describe the procedure defining roles, responsibilities, target, guidelines, scope, communication methods, periodic updates and other relevant information:

On a building perspective, energy efficiency specifications more performing that regulatory requirements could be set as a requirement in designing new, modified, or renovated sites, equipment, systems and processes.

For example, they can be related to:

- general energy performance on building or energy rating
- energy performance of envelope
- efficiency of boilers, heat pumps
- efficiency of auxiliary equipment
- optimization of energy management and energy performance monitoring

In Design of facilities, equipment, systems etc., consider the possibility to access incentives (e.g. national, regional, local etc.) where available, that often reward the achievement of energy performance higher than the minimum legal requirements.

The following tables represents an example of summarizing energy consideration in Design and related relevant information.

Energy consideration in Design						
n.	**Facilities, equipment, systems, processes etc.**	**Impact on energy performance**	**Energy performance specification regulatory requirements**	**Additional/ superiors energy performance specification**	**Additional opportunities, benefit, intended outcomes that could be achieved**	**Available incentives**
1						
2						
3						
4						
…						

Documented information:
Based on the tasks, define an **Energy performance Guidelines and Specifications in Design.**

9.21 Task 19: Energy Considerations in Procurement

Scope of this task is to establish energy performance criteria spanning the operating life for purchases affecting energy performance and define specifications for purchases of energy and energy using products, equipment and services. The task also involves informing suppliers that energy performance is an evaluation factor in procurement.

Identify the products, equipment and services that have a substantial impact of energy performance in the organization.

Define specifications, certifications, energy performance features related to products, equipment and services. The purchase of energy should be included, while according to ISO 50001 purchasing renewable energy from outside the scope of EnMS does not improve energy performance (but can have positive environmental impacts).

In procuring energy using products, equipment or services consider the possibility to access incentives (e.g. national, regional, local etc.) where available, that generally could reward the achievement of energy performance higher than the minimum legal requirements.

The following tables represents an example of summarizing energy consideration in Procurement and related relevant information.

Energy consideration in Procurement							
n.	**Product, equipment or service**	**Impact on energy performance**	**Average frequency of purchases**	**Energy performance specification regulatory requirements**	**Additional energy performance specifications, certifications or considerations**	**Additional opportunities, benefit, intended outcomes that could be achieved**	**Available incentives**
1							
2							
3							
4							
…							

As Energy Efficiency standards on the markets and at regulatory requirements level are continuously improving, consider a periodic update of energy performance consideration in Procurement.

Based on the organization needs and where applicable, include energy performance consideration in procurement activities.

Describe the procedure defining roles, responsibilities, target, guidelines, scope, communication methods, periodic updates and other relevant information:

Documented information:

Based on previous answers and considerations define **Energy Performance Guidelines and specification in Procurement.**

9.22 Task 20: Measurement and Monitoring of Energy Performance

Scope of this tasks is to measure and monitor the key characteristics of processes that affect energy performance, on the basis of Energy Data Collection Plan, and to analyse and evaluate energy performance improvement or significant deviations in energy performance.

On the basis of the Energy Data collection plan, and of EnPIs, EnBs defined in tasks 11, analyse and evaluate energy performance comparing EnPI values over time with corresponding EnBs. Improvement can be demonstrated by improvements in EnPIs in relation to corresponding EnBs.

In measuring and monitoring EnPI and other energy related variables, a valuable resource is provided from IPMVP Protocol (International Performance Measurement and Verification Protocol), describing concepts and best practise for determining results of energy efficiency improvements with the purpose to increase reliability and certainly

In the analysis and related evaluation consider the following aspects:

1. Monitoring and measurement period

2. Normalization and static factors associated to the period

3. Eventual issues or limitations related to data (consistency, accuracy, measurement uncertainty)

4. Significant deviations in energy performance.

For continual improvement, in analysing and evaluating energy performance, highlight issues and identify potential improvement opportunities related to monitoring, measurement, data collection, EnPIs and EnBs (e.g. new EnPIs and EnBs definition) and other relevant related aspects.

The following table represents an example of how a comparison between EnPIs and EnBs could be summarized (note: the extent, level of details and analysis can very significatively from organization to another in relations to its needs, size, characteristics etc.).

Energy Performance analysis and evaluation							
N.	**EnPI name/ description**	**EnPI value**	**EnB value**	**Reference Period**	**Variation [unit of measure]**	**Variation [%]**	**Evaluation on improvement, deviation, causes, consequences, issues**
1							
2							
3							
4							
…							

Documented information:
Based of the tasks define a **Report on monitoring the EnPIs.**

9.23 Task 20: Monitoring, Measurement of the EnMS

Scope of this tasks is to monitor trends in energy management system (EnMS) performance and analyse and evaluate the effectiveness of the EnMS in achieving intended outcomes and planned results.

Effectiveness of the EnMS can be demonstrated by improvement in energy performance and other intended outcomes.

Analyse and evaluate effectiveness of the EnMS considering the following aspects, if applicable:

1. What are the achieved improvements in energy performance?

2. How has the EnMS met the intended outcomes?

3. What are the weaknesses and the strengths of the EnMS within the context of the organization?

4. What are the internal and external factors that impact most on the EnMS effectiveness?

5. How was the EnMS acknowledged and adopted within the organization?

6. What are the eventual causes of EnMS ineffectiveness?

7. What potential improvement opportunities related to EnMS effectiveness have been highlighted and identified for continual improvement?

Evaluation of EnMS quantitative evaluation could be related not only to energy performance improvement: methods and criteria of analysis may be developed in define quantitative performance evaluation also to other relevant aspects and outcomes.

Documented information:
Based on the tasks define a **Report on monitoring the EnMS**

9.24 Task 22: Internal Audit

Scope of this tasks is to define an Audit Program, conduct internal audits of the EnMS at specified intervals and report the results to management and identify trends in internal audit results for consideration in management review.

Internal Audit is a different concept than energy Audit or energy assessment.

The objectives of Internal audits are to assess if EnMS:

- is effectively implemented, maintained and improves energy performance in the organization
- complies to the organization requirements for its EnMS, Energy Policy (task 5), Objective and targets of the organization (task 12), ISO 50001 requirements.

Define, plan, adopt and maintain an Audit Program that includes the definition of:

1. Frequency of the audits, conducted at planned intervals

2. Responsibilities

3. Reporting methods

4. General criteria and scope of the audit

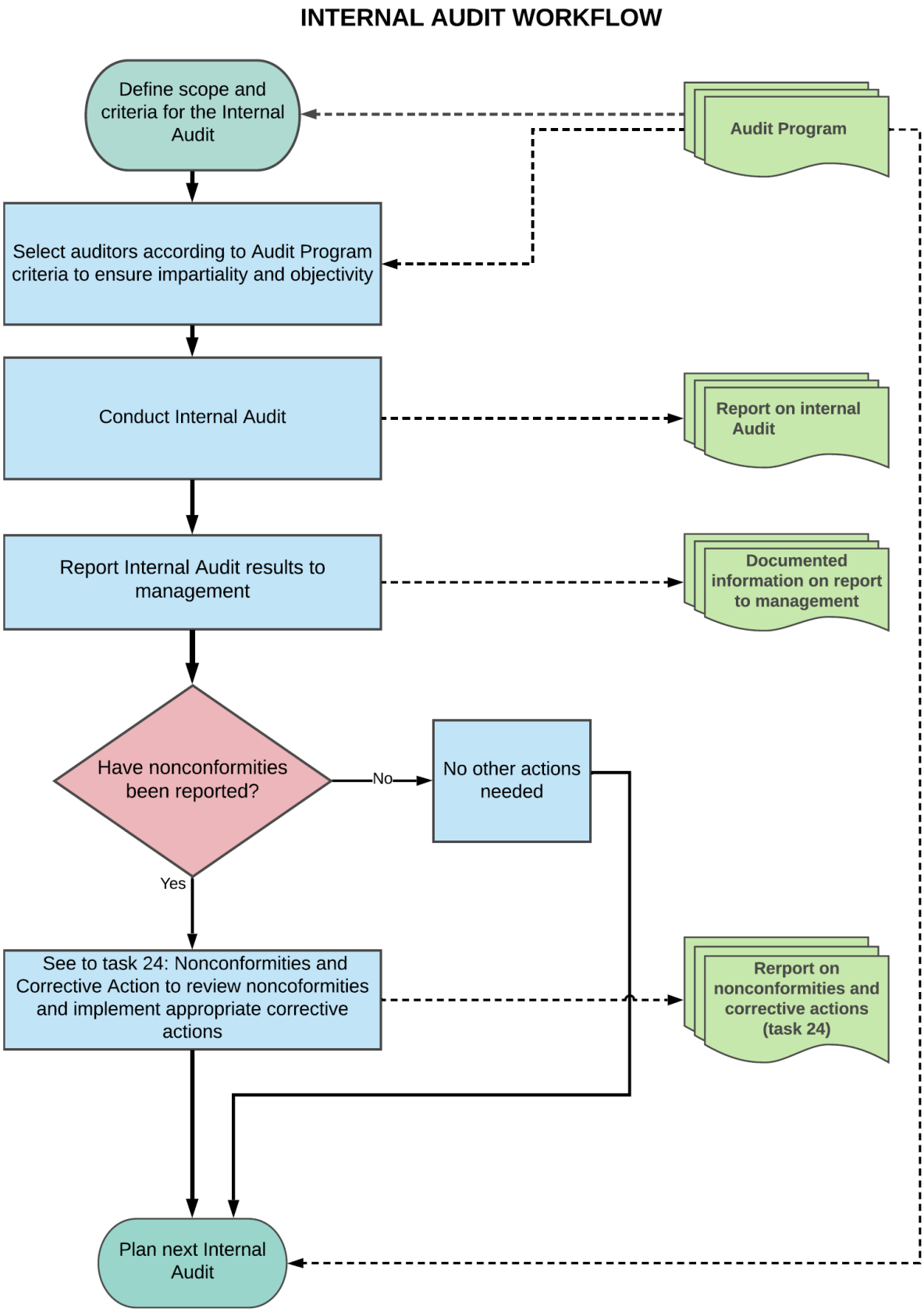
5. Procedures to selects auditors to guarantee impartiality, objectivity and independence of auditors (internal or external)

6. Methods of reporting internal audit to management

7. Address nonconformities and corrective actions (task 24)

On the basis of the Audit Program, conduct Internal Audit and maintain documented information of the audit results in Reports on Internal Audit.

The following graph summarize the workflow of an Internal Audit process according to ISO 50001.



Documented information:

Based on tasks, define an **Audit Program** and **Report on Internal Audit.**

9.25 Task 23: Management Review

This task concerns Top management periodical review of the EnMS and the organization's energy performance to ensure its continuing suitability and effectiveness.

In order to include these aspects in the Review, consider, evaluate and analyse the following main aspects, as indicated in the ISO 50001 requirements:

Management Review		
Issue	**Related Task**	**Included**
Previous management reviews and the status of related actions	Task 23	☐
Modification in external and internal issues and related risks and opportunities that are relevant to the EnMS	Task 1 e 7	☐
Results of the evaluation of compliance with legal requirements and other requirements	Task 2	☐
Energy policy	Task 5	☐
Opportunities for continual improvement	Task 10	☐
Opportunities for continual development of competence	Task 14	☐
Information and data related to the achievement of objectives and target	Task 10	☐
Measuring and monitoring results and analysis related to EnPIs and energy performance improvement	Task 11, 20, 21	☐
Status of Action Plans	Task 13	☐
Monitoring and measurement results	Task 20 and 21	☐
Audit Results	Task 22	☐
Nonconformities and corrective actions	Task 24	☐

The checklist represents an example to assess and take in account the ISO 50001 core concepts in Management Review.

Determine any need to change and any opportunity to improve (in a continual improvement perspective) related to the following main aspects addressed by ISO 50001:

1. Decision related to opportunities to improve energy performance:

2. Energy policies updates:

3. EnPIs or EnBs:

4. Objectives and energy targets:

5. Action plans:

6. Integration of EnMS with business processes:

7. Resources:

8. Competence, awareness and communication:

9. Action to be taken if requirements or objectives of the EnMS have not been met:

10. Other relevant aspects of EnMS:

Documented information:

To keep record and evidence of Management reviews develop a **Report on Management Review**

9.26 Task 24: Nonconformities and Corrective actions

Scope of this task is to identify nonconformities and other problems in the EnMS and take appropriate corrective action.

Nonconformities and implementation of corrective actions represents an essential tool of the Plan-Do-Check-Act continual improvement approach. The procedure of identification and management of these aspects, as addressed in task 13, is fundamental to the effectiveness of EnMS and improvement of energy performance over time.

The efficient communication and administration of documented information related to nonconformities and related corrective action is another important aspect to address.

Consider the procedures defined in Action Plan for Continuous Improvement implemented in task 13.

Consider the results of Internal Audit (task 22).

Maintain documented information related to nonconformities and corrective actions taken and related to outcomes of corrective actions by developing at planned intervals **Report on nonconformities and corrective actions**.

The tables below represent examples to summarize non-conformities and the related information.

n.	Non-conformity description	Causes and Consequences	Responsible figures and resources	Date occurred	Corrective actions	Documentation
1						
2						
3						
4						
…						

n.	Non-conformity description	Effectiveness of corrective action	Responsible figures and resources	Date of completion	Non-conformity corrected?	Documentation
1					□ YES □ NO	
2					□ YES □ NO	
3					□ YES □ NO	
4					□ YES □ NO	
…					□ YES □ NO	

Documented information:

Based on the tasks, define a **Report on Nonconformities and Corrective actions**

9.27 Task 25: Continual improvement

Scope of this tasks is to continually improve the effectiveness of the EnMS and demonstrate continual improvement of energy performance of the organization.

Consider:

- procedures defined in Action Plan for Continual Improvement defined in task 13.
- results of Internal Audit (task 22).

Consider the following questions, as applicable:

What are the improvements achieved related to energy performance?

How can energy performance improvement be demonstrated?
E.g. reduction of normalized energy consumption, progress towards the achievement of targets, improvement of EnPIs, management of SEUs etc.

How improvement occurs over time?

How can the achieved improvement be considered in relation to historical trends of energy performance improvement within the organization?

What are the improvements achieved related to EnMS effectiveness?

What are the actions, internal and external factors that affects most the continual improvement?

What are the eventual positive effects or negative impacts generated from energy performance improvement?

What are the improvements related to energy performance that could be evaluated or achieved in the future?

What are the improvements related to effectiveness of the EnMS that could be achieved in the future?

Documented information:

Based on the tasks define a **Report on continual improvement to the EnMS and energy performance.**