Fostering energy efficiency investments in SMEs: the multiple benefits approach for energy audits and energy management systems

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Abstract

Investments in energy efficiency projects in SMEs face obstacles due to the perception of their limited relevance to business priorities and are often disregarded in favor of other investments with superior economic performance. Including the evaluation of Multiple Benefits (MBs) in the company's decision-making process has proven to enhance the uptake of energy efficiency measures. The DEESME project, co-funded under the Horizon 2020 Programme, has the primary objective of creating a connection between energy efficiency investments and the company's core business priorities.

This paper aims to present the methodology developed in the project and the results stemming from its application. The methodology consists of the incorporation of the MBs approach into both energy auditing and Energy Management Systems (EnMS). This paper aims to present the methodology developed in the project and the results stemming from its application. The methodology consists of the incorporation of the MBs approach into both energy auditing and Energy Management Systems (EnMS). The MBs approach for audits is structured in a four-stage methodology. This involves analysing the business model for value and efficiency, identifying opportunities for emission reduction through energy analysis, conducting a multiple benefits analysis to link energy decisions to business development, and advancing business model sustainability. Simultaneously, the EnMS methodology, fed by inputs derived from extended energy audits, seeks to underscore the correlation between the MBs approach and ISO 50001 certification. Emphasis is placed on integrating the MBs approach into every aspect of the standard. These methodologies have been successfully applied to SMEs in Italy, Bulgaria, Poland, and Germany. The presented paper is based on the insights gained from 42 audits and 22 EnMS implementations, all incorporating the MBs approach, contributed to gathering valuable lessons learnt and best practices.

Introduction

The role of Multiple Benefits (MBs)[1] of energy efficiency in industrial SMEs is a topic of growing importance. Energy efficiency measures in industry have been shown to yield quantifiable benefits in the areas of maintenance, production and environmental performance, besides substantial impacts on energy savings. However, the lack of awareness and knowledge on the achievable MBs tends to exclude energy efficiency from the decision-making process, in favour of investments with higher perceived profitability and payoff (Nehler and Rasmussen, 2016). This issue is even more severe in industrial SMEs, where, due to the smaller impact of energy costs on the total costs, energy issues tend to fall outside the core business of the company (Hermandi, Mast and Irrek, 2022).

Comprehensive categorizations of the possible benefits and losses deriving from the implementation of industrial energy efficiency measures have been conducted in literature. (Cagno

1. The term "Multiple Benefits" is here adopted, following IEA's terminology (IEA, 2015), to refer to both energy and non-energy benefits originated by energy efficiency measures. Different terminologies may be found in literature (e.g. Non-Energy Benefits, Co-benefits, Ancillary benefits, Multiple impacts).

et al., 2019) propose and validate a framework accounting for the benefits and losses stemming from both the implementation and service phase of energy efficiency measures. (Cagno *et al.*, 2022) introduce a new framework to characterize energy efficiency measures and the originated multiple impacts through a performance measurement system. (Nehler, 2018) conducts a systematic literature review on investigation methods for Non-Energy Benefits (NEBs) and proposes a guiding scheme for the utilisation of NEBs before and after the implementation of industrial energy efficiency measures.

MBs strategic value for companies has been investigated as well. (Killip *et al.*, 2019) conduct a literature review on MBs contribution in firm-level energy efficiency decisions, highlighting a gap in the research focusing on the incorporation of MBs in the company's decision-making process, denominated 'salience' approaches: the need of switching from a cost benefit approach to a strategic approach for energy efficiency measures, able to contribute to the firm's competitive advantage, is underlined. (Bailey *et al.*, 2009) present several suggestions for enhancing energy audit's implementation in companies, including the recommendation to incorporate in the audits all the benefits, the potential risk and the strategic values introduced by energy efficiency measures. (Cooremans, 2015) introduces a methodology designed to frame energy efficiency measures as strategic assets for businesses. This approach demonstrates how non-energy benefits (NEBs) enhance competitiveness by improving the value proposition and reducing risks and costs.

The DEESME project, co-funded under the Horizon 2020 Programme, seeks to fill in the gaps spotlighted by the literature integrating the MBs in the energy audit and energy management system (EnMS). The developed methodology results in compliance with the Article 11.6 and 11.7 of the new Energy Efficiency Directive (European Parliament, 2023), which prescribes that "Member States shall develop programmes with the aim of encouraging and providing technical support to SMEs […] to undergo energy audits and to subsequently implement the recommendations arising from those audits […]" and that "Member States shall ensure that the programmes […] include support to SMEs in quantifying the multiple benefits of energy efficiency measures within their operation […]".

The present paper aims to showcase the methodology developed within the project and the results obtained by its implementation.

Methodology

THE INTEGRATED MBS APPROACH FOR ENERGY AUDITS

The methodology developed in DEESME takes a novel and holistic approach. Traditionally, energy audits have focused primarily on identifying opportunities for energy savings and cost reductions. The methodology broadens the scope of energy audits to include the MBs and integrate them into the business's strategic and operational frameworks. The goal is to redefine energy audits as more than regulatory requirements and link energy efficiency to the core business model and business goals. The presented methodology for energy audits has been translated into the DEESME Integrated Multiple Benefits Support Tool (DEESME, 2023).

The Integrated MBs Approach is articulated into four main stages (Figure 1).

The process starts with an in-depth Business Analysis, aimed at understanding the overall business rationale, priorities, objectives and investment context and how these may be supported by investments in energy efficiency measures.

The Business Analysis foresees in first place an examination of the corporate business model, for which the Business Model Canvas is employed. The Canvas provides a representation of the company's business model along nine key areas: value propositions, customer segments, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure.

In second place, a cost structure analysis provides a detailed review of the business's cost centers and behavior, identifying and categorizing the types of cost necessary for the production processes. Each cost centre must be characterised according to its functionality, direct or indirect energy consumption, inputs and outputs, and computable energy indicators. The objective is to highlight areas where energy costs are significant and where efficiency improvements could lead to financial benefits.

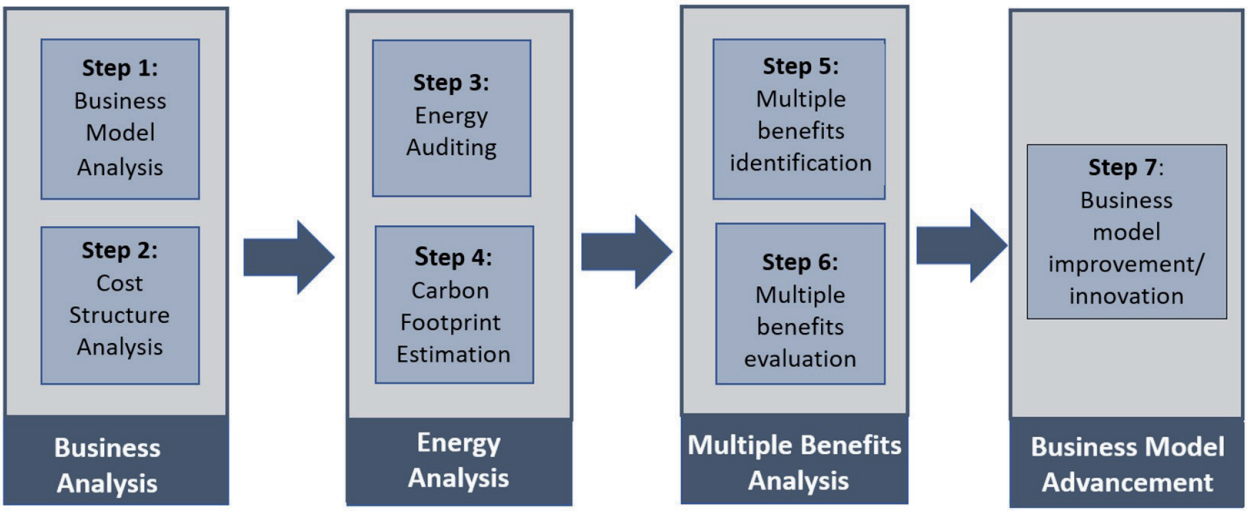

Figure 1. Structure of the Integrated MBs Approach for Energy Audits (DEESME, 2021).

The second stage consists in the Energy Analysis, articulated in the Energy Auditing, according to the EN 16247 standard, and the Carbon Footprint Estimation. Energy auditing is designed to evaluate the company's energy usage by analysing energy inputs, utilization, and flows. This process involves a detailed investigation of production processes and facilities and may extend to cover the company's transportation and the energy consumption patterns of its buildings. The carbon footprint analysis assesses the greenhouse gas (GHG) emissions resulting from the company's activities. It accounts for the mix of energy sources exploited in the production and delivery of products and services, along with non-energy related emissions. The protocol adopted by DEESME audits is the GHG Protocol (GHG Protocol, 2024) for carbon footprint estimation. Various emissions sources should be considered according to the protocol and depending on the selected carbon footprint scope (Scope 1, 2 or 3). These sources include fuel/energy purchases, fugitive emissions, raw materials, on-site combustions, process emissions, transportation (both inbound and outbound), business travels, employee commuting, waste/water usage, and biogenic emissions. Scope 1 considers direct GHG emissions, originating physically from sources operated by the project or process, such as emissions from fossil fuel combustion, industrial processes, and fugitive emissions like refrigerants or methane leaks. Scope 2 captures indirect GHG emissions associated with the consumption of electricity, heating, cooling, and steam. Scope 3 includes other indirect GHG emissions such as emissions from raw material production or extraction, vehicle emissions related to road infrastructure use and emissions from the electricity consumption of transportation modes like trains and electric vehicles. The phases to be followed for the application of the protocol are the selection of the carbon footprint scope, determination of the system boundaries (including organization and process boundaries), determination of the reference time period, collection and quality assessment of data, calculation of the GHG inventory, selection of impact categories and impact assessment, and verification of the consistency and completeness of the analysis.

The Multiple Benefits Analysis follows the Energy Analysis and has the purpose of highlighting the energy and non-energy benefits introduced by the proposed energy efficiency measures, linking the MBs to the company's energy management decisions and business priorities. The first step is the Multiple Benefits Identification, consisting in the selection, by the energy auditor and the company's managers, of a set of MBs and related indicators relevant for the company's needs and objectives. The MBs are linked to each domain of the Business Model Canvas as follows:

- Value Proposition: Benefits include enhanced efficiency of pro ducts/services, the introduction of new (especially "green") products, and innovation.
- Activities: Benefits linked to improvements in productivity, use, maintenance, emissions/carbon footprint, quality, and risk/accident reduction.
- Resources: Benefits linked to reduced energy and raw material consumption, waste reduction, recycling, and improvements in employee satisfaction, health, safety, skills, and training.
- Customers (including Channels and Relationships): Benefits involving an increased share of "green" customers/sales, acquiring new customers, and boosting customer satisfaction and loyalty.
- Partners: Benefits including better supply chain relationships, reduced litigation risks, regulatory compliance, and enhanced stakeholder relationships.

A synthetic and not exhaustive list of MBs and related indicators is reported in Table 1. Such a list is intended to serve as a basis for the auditor for selecting the MBs relevant for the company's priorities.

The identified MBs are then qualitatively evaluated by the energy auditor according to their significance ("Major", "Minor" or "None") and impact ("High" or "Low") on both the value creation and the business efficiency. An exploitation proposal is then outlined by the responsible energy auditor for those MBs with the greatest significance and impact, e.g. for the benefits showing "Major" significance and "High" impact on value creation and efficiency. An action plan must finally be prepared for the proposals deemed to have the highest priority according to the company's managers.

In the final stage, Business Model Sustainability Advancement, the energy auditor/consultant collaborates with the management team to reassess the business model initially outlined in the Business Analysis stage. This review is informed by the findings from the energy analysis and the identification and evaluation of MBs conducted in the earlier stages, along with the accumulated knowledge. The objective is to identify opportunities to enhance the business model's sustainability. Advancements can be achieved as a result of:

- Business Model Innovation: Innovating the business model involves rethinking its core components and their interrelations, especially considering the significant and positively impacting MBs identified in the previous stages. This innovation seeks to enhance value creation opportunities.
- Business Model Improvement: Improving the current business model's efficiency by leveraging MBs that significantly and positively impact operational efficiency.

THE EXTENDED ENERGY MANAGEMENT SYSTEM

The methodology developed within DEESME intends to provide consultants in the energy sector and business managers with a guideline incorporating the Multiple Benefits approach into the Energy Management System (EnMS). The guideline identifies relationships between the MBs approach and the ISO 50001 standard (ISO, 2018), providing specific recommendations to account for MBs in each relevant clause of the standard. The complete guideline is available on DEESME Knowledge Hub as Deliverable 3.2 (DEESME, 2022), while this article focusses on the most relevant aspects emerged from the application of the MBs approach. These aspects are listed in the following, reporting the specific chapter and paragraph of the ISO 50001 standard from which they were developed.

- Organization and its Context (4.1): Recognizing external and internal factors relevant to the organization's purpose is crucial from a MBs perspective. The MBs approach encour-

Table 1. List of the Multiple Benefits and related indicators that could be identified in the MBs Analysis stage, for each BM Canvas domain.

DOMAIN	BENEFIT TYPE	INDICATOR
Value Proposition	1. Improved product/service efficiency	Energy cost per unit of product/service
	2. Introduction of new products/services	Nº of new 'green' products/services
	3. Development or innovations	Total R&D expenses for 'energy efficiency' initiatives
Activities	4. Increased productivity	Value of output items/Value of input items
	5. Increased utilization	Capacity utilization
	6. Improved maintenance	Maintenance Unit Cost
	7. Reduced carbon footprint	Total GHG emissions per year
	8. Improved quality	Right First Time
	9. Improved safety	Incidence Rate
Resources	10. reduced energy consumption	Total energy consumption per year
	11. Improved raw materials consumption	Quantity of raw materials purchased
	12. Increased recycling	Percentage of total waste that is recycled
	13. Reduced waste	Waste reduction rate
	14. Increased employee satisfaction	Employee Satisfaction Index
Customers	15. Acquisition of 'green' customers	'Green' customers share
	16. Acquisition of new customers	New customers share
	17. Increased customer satisfaction	Satisfied customers share
	18. Increased customer loyalty	Loyal customers rate
Partners	19. Improved supply chain relationships	Total nº of suppliers with ISO certification for energy or environmental management
	20. Improved stakeholder relationships	Total nº of stakeholders involved in decision making
	21. Reduced litigation risks	Total amount of expenses and fines related to environmental law violations
	22. Increased regulatory compliance	Nº of EU and national energy policies adopted

ages a broader investigation, including changes in environmental policies, health and safety laws, customer inquiries, and impacts on the working environment.

- Needs and Expectations of Interested Parties (4.2): The MBs approach might involve additional stakeholders not typically engaged in traditional EnMS. Interested parties could include local authorities, workers' unions, social associations, and research bodies. Engaging a wider range of stakeholders can help meet needs and expectations beyond energy savings.
- Leadership and Commitment (5.1), Energy Policy (5.2), Organization Roles and Authorities (5.3): Leadership plays a crucial role in integrating the management system into business processes. Improvements should be supported and communicated across all involved managers, emphasizing the importance of considering MBs in planning and execution. The energy management team's scope might be expanded to include members responsible for MBs aspects. The energy policy presents an opportunity to express commitment to the MBs approach. Top management should assign roles considering all the relevant aspects for any benefits within the extended EnMS, involving personnel across various domains. Particular focus should be given to business strategy, operations, finance, communication, and purchasing managers.
- Actions to Address Risks and Opportunities (6.1): The MBs approach requires considering a broader range of issues and stakeholder expectations beyond energy. Planning based on risk and opportunity analysis can lead to better results by including MBs aspects.
- Objectives, Energy Targets and Planning (6.2), Energy Review (6.3), Energy Performance Indicators (6.4) and Collection of Energy Data (6.6): The MBs approach allows setting objectives that span multiple business sectors with measurable criteria. Organizations should ensure that their objectives align with energy policies and legal requirements. They also need to be communicated effectively. It's important to integrate MBs into action plans for a cohesive improvement strategy.

  Energy analysis helps pinpoint major consumption areas, aiding in the accurate allocation of energy costs. MBs enables a holistic evaluation of improvement opportunities, incorporating various aspects beyond energy. An energy audit can extend to calculating the company's Carbon Footprint, highlighting cost savings and environmental impact reduction opportunities. Organizations must define energy performance indicators (EnPIs) suitable for monitoring and demonstrating energy performance improvements. Additional indicators related to MBs can be included to monitor their performance, such as water consumption and workplace environment improvements. Data collection plans should also cover parameters and variables relevant to MBs.
- Competence (7.2), Awareness (7.3) and Communication (7.4): Enhancing employee skills through training is vital, covering not only energy performance but also MBs related

actions, projects, and activities. Awareness among employees about the MBs approach is key for its success. Effective communication about the EnMS and MBs aspects with internal and external parties enhances transparency and values the projects' multiple benefits.

- Operational Planning and Control (8.1), Design (8.2) and Procurement (8.3): The company must plan, implement, and control significant energy use processes to meet ISO 50001 requirements. Operational control should extend to MBs aspects, addressing impacts on product quality, air emissions, and indoor environment. Design of new or renovated facilities should consider improvement opportunities beyond direct energy performance, such as water consumption and noise level reductions. An integrated design approach should involve all concerned management areas to maximize benefits. Procurement criteria should include considerations beyond direct energy performance, accounting for indirect effects on energy consumption. Organizations should involve suppliers in the MBs approach, emphasizing improvements in areas like water consumption and noise reduction.
- Monitoring, Measurement, Analysis, and Evaluation (9.1): Monitoring is central to EnMS, focusing on energy use and consumption through Energy Performance Indicators to identify and evaluate improvement actions. The MBs approach extends monitoring to other benefits, despite challenges in choosing parameters for non-technical aspects like corporate climate and involvement. Organizations should also assess compliance with legal and other requirements related to energy management and MBs aspects.

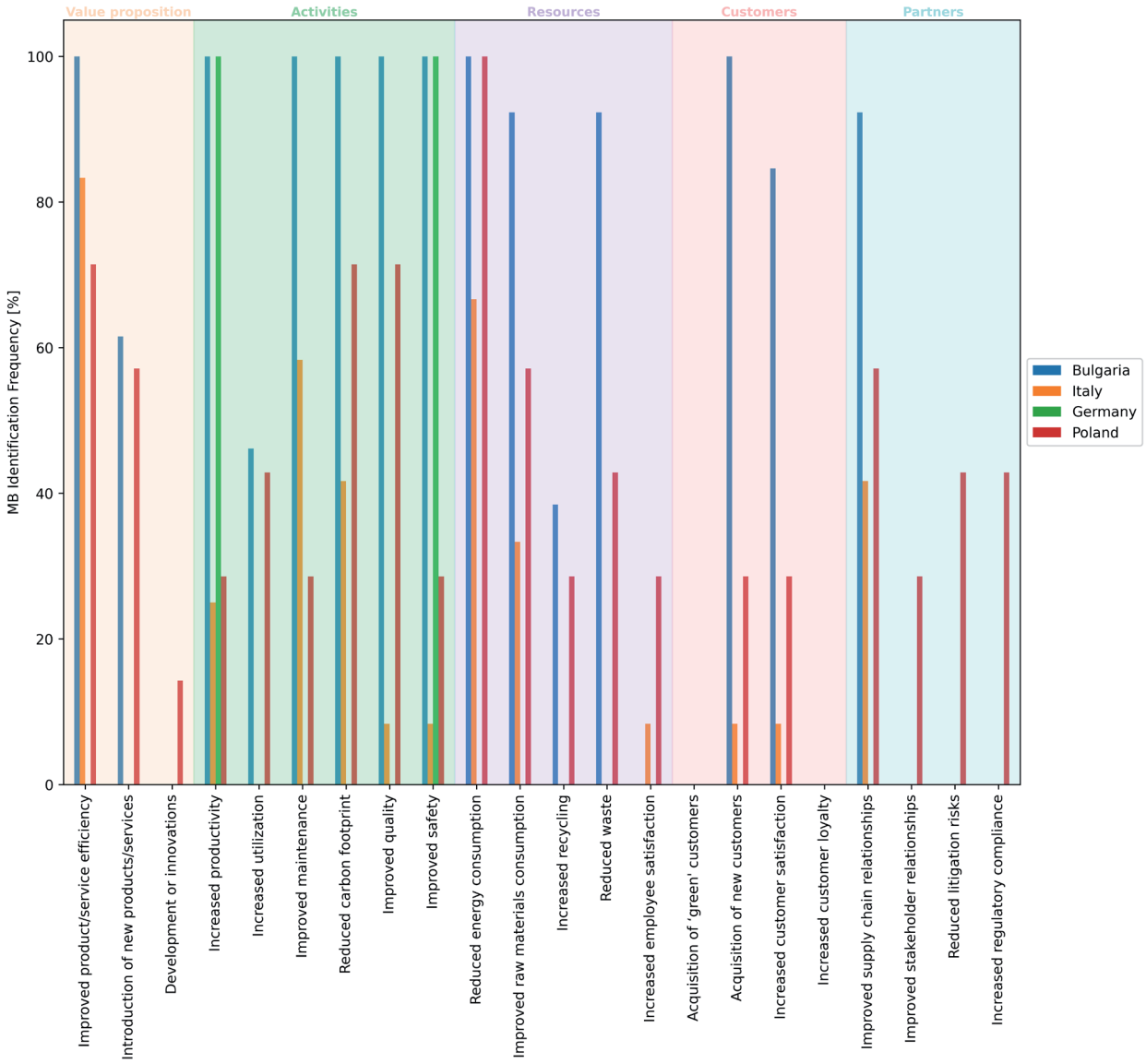

Figure 2. Identified MBs in DEESME implementation countries. The vertical axis represents the frequency with which each MB was identified in the companies (for each country) and evaluated with high significance and impact by the auditor. The MBs have been classified according to the BM Canvas domains, represented by different background colours.

The MBs Approach for EnMS is suitable and may be advantageous for companies already implementing alternative standards such as ISO 14001 (Environmental Management), ISO 45001 (Health and Safety Management Systems), ISO 9001 (Quality Management) and ISO 46001 (Water Efficiency Management Systems).

Results from the Implementation

The Multiple Benefits Approach applied to the energy audits and the EnMS have been implemented in 4 European Member States (Bulgaria, Germany, Italy and Poland) within the activities of the DEESME project. In total, 42 companies have conducted an energy audit and 22 have additionally implemented an EnMS according to the MBs approach. The target companies were mainly composed of small and medium-sized enterprises, with a distribution of 5 micro, 22 small, 14 medium, and 1 large company. The companies' number of employees strongly varied, from the smallest enterprise with merely 2 employees to the largest with 492 employees. Key sectors targeted across the 4 countries include food production (specifically, meat products manufacturing and soft drinks/mineral water production), textile and garment industry, paper and cardboard stationery production, printing and binding, plastic packaging and leather preparation and tanning, and services.

IMPLEMENTATION OF THE INTEGRATED MBS APPROACH FOR ENERGY AUDITS

The most frequent energy efficiency measures identified by the Energy Analysis stage in DEESME audits are the installation of PV systems, revamping of existing PV systems, installation of IE4 electric motors, LED lighting, steam generator replacement, consumption monitoring systems, E-Power system installation, fixing compressed air leaks, burner replacement, heat pump installation, and cogeneration.

Figure 2 summarizes the Multiple Benefits identified by the audits in the MBs Identification phase and evaluated with high significance and impact by the auditors and the companies. The high variability in the identified benefits highlights how the identification procedure strongly depends on a series of factors such as the company's sector, size and country, as well as the implementing auditor and company's management characteristics. In particular, the results from Germany are peculiar if compared to the other MS, since companies' sectors encompass financial service and insurance, business consultancy and the operation of sports facilities. In such companies, the replacement of old luminescent lamps with new LED and monitoring systems for heating have been the most common measures recommended by audits, thus leading to benefits in improved safety and increased productivity ("Activities" domain).

In all the implementation countries, excluding Germany, improved product/service efficiency and reduced energy consumption ("Resources" domain) were reported as positive benefits across all the companies. In Italy and Bulgaria, most of the audits highlighted a positive impact on maintenance and minorly on raw materials consumption. Audits from Bulgaria and Poland reported improvements in supply chain relationships ("Partners" domain), while in Italy improved stakeholder relationships, increased regulatory compliance and reduced litigation risks were identified.

Concerning the Business Model Sustainability Advancement, the following outcomes were achieved in the four Member States.

In Italy, the analysis of 12 companies revealed that the most impacted areas were Key Resources, Key Activities, and Cost Structure. Companies recognized the importance of reducing energy consumption to lower operating costs and stay competitive. Utilizing renewable energy in production was reported to attract customers interested in eco-friendly products, opening new market opportunities, while implementing monitoring systems could offer real-time data on energy use, helping to pinpoint and rectify inefficiencies.

In Bulgaria, key potential improvements in textile companies include benefits in upcycling fabric leftovers, producing complex designs more efficiently and at lower costs, and improving product and service quality while optimizing resource usage. These benefits extend to companies in other sectors, emphasizing precision, faster production, and reduced energy and material costs. Increased automation is expected to enhance product and service quality, helping companies retain and attract customers, potentially expanding their market share. Improved product quality can boost client satisfaction and relationships, while reduced material waste and increased productivity can lead to better supplier relationships due to more precise planning and optimized expenses. Energy efficiency measures, including equipment upgrades, are expected to enhance production precision, speed, and execution, thereby reducing errors and waste. Regarding the Cost Structure, a decrease in energy, maintenance, and raw material costs is expected, alongside reduced waste from scrapped products, lowering overall production costs.

In Germany, the proposed energy efficiency measures were expected to have positive impact in the Key activities area: the implementation of the monitoring and control system could facilitate proactive heating management, enabling the companies to anticipate and regulate heating processes.

Lastly, in Polish companies it has been highlighted a shift towards consumers preferring sustainable development, anticipating a positive reception to increased energy efficiency. Companies plan to communicate the enhanced sustainability of their production processes to partners and strengthen customer relationships by offering products with lower energy consumption and production costs, thus attracting and retaining customers through competitive pricing.

IMPLEMENTATION OF THE EXTENDED ENMS

Among the companies where DEESME audits had been conducted, 22 companies (5 in Bulgaria, 5 in Italy, 5 in Germany, 7 in Poland) were involved in the preliminary investigation of DEESME EnMS implementation, without certification requirements. None of the companies had already implemented an EnMS before.

The analysis was conducted relying on the Plan-Do-Check-Act model, which constitutes the ISO 50001 implementation cycle. In the "Plan" phase, an assessment of the attention to the MBs stemming from the interventions highlighted in the company's energy policy was carried out. The implementation ("Do") phase involved the analysis and resolution of potential critical issues emerging from the application of the EnMS when considering MBs. The main identified criticalities in this phase

concerned the measurement of the indicators associated to the MBs. In the "Check" phase, the companies planned to implement periodic monitoring of the results concerning MBs. Lastly, in the "Act" phase the outcomes of the previous phases were reviewed and exploited to implement concrete actions.

The activity permitted to gain takeaways fundamental for future actions and implementations.

- Italy: The expansion of the DEESME approach in the companies highlighted the need for more comprehensive data collection, increased personnel training and greater commitment from top management. The role of qualified energy auditors is highlighted as fundamental in assisting SMEs. The reliability of MBs indicators is currently a challenge, with top management often skeptical due to their perceived lack of solidity. The implementation of the EnMS is beneficial for gathering MBs-related data.
- Bulgaria: Companies implementing Management Systems compliant with ISO standards (14001, 9001, and 50001) must focus on continuous improvement in the environmental, quality, and energy areas. This challenge is more intense for small companies due to resource constraints. Commitment to this task requires dedicating human resources to maintain the documentation processes and the overall EnMS. The benefits of energy efficiency measures often materialize over the long term, posing challenges for SMEs with immediate priorities and limited financial resources.
- Germany and Poland: The adoption of the MBs approach necessitates support from qualified experts to navigate initial technical and managerial challenges. SMEs also faced difficulties in integrating the MBs approach into their daily operations. SMEs continue to require expert assistance to fully implement the system, but the MBs approach is expected to yield substantial benefits once the EnMS is fully operational.

Conclusions

The methodology presented is expected to introduce a useful and effective support tool for industrial SMEs to successfully implement energy efficiency measures and exploit the strategic value of Multiple Benefits. The results obtained by applying the methodology demonstrate its effectiveness in linking energy efficiency to core business objectives, highlighted as a critical issue by the literature.

The lessons learnt will be exploited for further implementation in the framework of DEESME 2050 project (DEESME 2050, 2024), targeting the furniture sector and its supply chain in Bulgaria, France, Italy and Poland. Future activities will indeed focus on refining the MBs approach and the Integrated Multiple Benefits Tool, exploring its applicability for a wider sample of companies and diverse industrial sectors. The lack of technical knowledge in SMEs will be tackled through dedicated trainings in the companies tailored on the developed methodologies. Lastly, linkages to the financing opportunities available for supporting energy efficiency measures implementation in SMEs will be explored.

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