



D3.2 Results from the pilot case studies



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List of Acronyms

EED	Energy Efficiency Directive
EnMs	Energy management systems
GHG	Greenhouse gas
GVA	Gross value added
IEA	International Energy Agency
KPIs	Key performance indicators
MS	Member States
OECD	Organisation for Economic Co-operation and Development
PU	Production units
SME	Small and Medium Enterprises
WP	Work Package

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Keywords list

- Resource efficiency
- Resource audits
- Key performance indicators
- Efficiency measures
- Behaviour factors

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Executive summary

Resource efficiency audits have the capacity to boost the implementation of energy, water and materials efficiency measures, increasing the companies' competitiveness. The quantification of the potential savings is fundamental, and its starting point should be the **definition of suitable KPIs**. Consequently, a resource audit methodology and framework were developed, to correctly assist with the **quantification** of the set KPIs.

Considering this, the **development of pilot case studies** was crucial for refining and validating the methodology, namely by identifying areas for improvement and confirming its feasibility in real-world settings. In total, **13 enterprises were audited** across Croatia, Greece, Malta, and Portugal, **covering sectors such as food, textiles, ceramics, glass, hospitality, and paper, ensuring broad representation and robust methodology testing**.

Looking into the primary findings of the resource audits, it was possible to observe that the results clearly demonstrate the **variability among the audited companies**. The data reveal broad KPI ranges, attributed to **differences in sector, process, and data maturity**. Particularly, energy metrics vary due to process and energy source diversity; water KPIs fluctuate depending on process requirements and metering; and material KPIs are influenced by product mix and waste management practices.

Regarding the **efficiency measures** identified during the pilot audits and the potential savings associated, **sectoral and data limitations greatly influence the estimated savings per country**. Overall, the analysis demonstrates that while energy-related actions drive the largest share of measurable savings, **there are substantial opportunities for resource efficiency improvements across all dimensions**. These findings show the importance of resource audits and the need for **improved data collection, especially for water and materials, to better quantify and realise potential savings in future assessments**.

Concerning the **decision-making factors influencing enterprises**, these were evaluated through an **initial short questionnaire** presented to the enterprises during the audit's initial meeting, as well as a **through a final survey**, shared after the resource audit report was completed. The quantitative responses to the final survey indicated that the pilot audits enhanced companies' commitment to sustainability, **increased their awareness of resource efficiency concepts**, and **strengthened their willingness to pursue further resource efficiency initiatives**.

Also, during the **implementation of the resource audits**, some **barriers and difficulties** were encountered. Overall, resource audits were seen as valuable but required considerable **skills and experience**. Additionally, some obstacles arose from the audited companies, such as **low engagement, fragmented responsibilities** across departments that hindered data collection, and audits coinciding with challenging periods such as summer.

Concluding, the **pilot audits confirmed the effectiveness of the resource audit methodology**, emphasizing the importance of thorough preparation. Obtaining reliable data - especially for water and materials dimensions - proved challenging, underlining the need for metering and monitoring systems as a foundation for efficiency improvements. **Several key improvement points and recommendations were identified**, including: (i) ensuring data confidentiality through agreements and anonymisation; (ii) developing sector-specific methodologies and auditor training; (iii) scheduling audits to maximise engagement; (iv) framing audit benefits strategically; (v) assigning clear responsibilities; (vi) promoting digital central data management; and (vii) expanding financial support mechanisms.

1. Introduction

1.1. LEAPto11 project goals

The LEAPto11 project aims to support Member States (MS) during the transposition and rollout phase of the new article 11 of the Energy Efficiency Directive (EED) recast through a joint action of cooperation of the consortium National Energy Agencies. The project **main goal** is to contribute to a comprehensive improvement of the quality framework for energy audits and energy management systems (EnMs) through the evaluation, update, upgrade and optimisation of current national programmes. The project will also investigate other parts of the EED recast dealing with energy savings in the business sector, to promote synergies among energy audits, EnMS, Energy Efficiency Obligation Schemes and alternative measures. Such goal will be reached through the following specific objectives:

- Improving the effectiveness of national programmes for a better data management and key performance indicators (KPIs) production, with benefits for the public and the private sector.
- Supporting Ministries, business actors (business associations, networks), auditors and National Agencies during the article 11 transposition, with data-driven and knowledge-based high-level policy advice, to get all stakeholders ready when National legislations are enforced.
- Spreading the culture, use and uptake of standards and protocols to increase the implementation of the energy efficiency measures recommended in audits and EnMS.

The LEAPto11 Work Package (WP) 3 – Resource Efficiency and Pilot Cases, intends to better investigate the benefits emerging from the joint use of energy, water, and material resources within an energy audit, as well as test the effectiveness of the use of KPIs not limited only to the energy dimension. Within this WP, four partners (ADENE, CRES, EIHP and EWA) will develop pilot case studies where an integrated methodology, acting over not only the energy dimension but also focusing on water efficiency and circular economy, will result in higher energy savings and benefits to the enterprises. This WP will also contribute to a better understanding of the use of the defined KPIs having in mind eventual development/improvements of programmes for non-obligated companies, as required by the recast EED article 11. The results of the activities carried out in this WP will be used as input for WP4 – Towards the policy implementation of the provisions on ‘energy management systems and energy audits’ in the recast EED. The WP3 has four main objectives:

O3.1) Definition of an integrated methodology (energy, water, and materials)

O3.2) Pilot audits development

O3.3) Assessment of the resource efficiency results and direct and indirect benefits to the enterprises

O3.4) Knowledge transfer through an international workshop on resource efficiency

Having this in mind, this second deliverable (D3.2) will summarize the outcomes of the pilot cases studies, held in four different countries (Croatia, Greece, Malta and Portugal), including the KPIs assessed and its values, barriers encountered and improvement suggestions. This report will also include the assessment of the direct and indirect benefits to the enterprises, resulting from the implementation of a resource efficiency audit.

1.2. Report content and structure

This report is structured as follows:

- Chapter 1. Introduction, provides a concise summary of the project and outlines the primary objectives of the report.
- Chapter 2. Resource efficiency audits, addresses the importance of promoting resource efficiency, provide an overview of key performance indicators, and outline the framework for conducting resource audit assessments.
- Chapter 3. Pilot audits preparation, outlines the process for pilot audits providing a comprehensive step-by-step guide to conducting a pilot resource audit, and details the methodology for selecting pilot audits.
- Chapter 4. Pilot audits results, presents the results of pilot audits, analyses key performance indicators, evaluates efficiency measures and potential savings, and examines decision-making behaviour within enterprises, based on responses from the audited companies.
- Chapter 5. Constraints and improvement points, outlines the primary constraints identified during the pilot audits, and provides targeted improvement points and recommendations to address these challenges.
- Chapter 6. Conclusions and next steps, provides a comprehensive summary of the principal findings presented in this report.
- Annex section, with supplementary details, examples and templates for conducting resource audits.

2. Resource efficiency audits

This chapter presents an overview of the significance of resource efficiency and the promotion of audits and summarises the previously established resource KPIs and the framework for resource audits assessment.

2.1. Resource efficiency and audits promotion

According to the United Nations Environment Programme [7], **resource efficiency** concerns the managing of raw materials, energy, and water along the value chain to minimize waste and detrimental impacts on the ecosystems throughout the entire lifecycle of production. Therefore, this will mean a careful selection of raw materials and energy resources; minimization of waste, emissions, hazards, and risks; responsible management of material and energy flows during the production process; accomplishment of a function, task, process or result with the minimal possible amount of water; and attention to the use, recycling, and disposal phases of the product life cycle [4]. This becomes even more significant given the consistent **global trend of increasing resource use** [8].

Moreover, as in the OECD (Organisation for Economic Co-operation and Development) report on *Resource-Efficient and Circular Economy* [5], resource monitoring is essential to design effective sustainability policies, as reliable information and consistent data are crucial. Considering this, **resource audits** may facilitate a smooth transition to a circular economy by providing information on progress in public policies and sustainability programmes, and by promoting more efficient production processes, higher quality products, and maximised gains at the enterprise level.

In practical terms, resource audits can **contribute** to cost reduction by identifying efficiency measures that lower operational expenses; enhance competitiveness through the optimisation of production processes; provide strategic support for defining new processes and fostering innovation; facilitate the transition to a circular economy by quantifying resource flows; and enable concrete actions to reduce resources surpluses, by implementing the efficiency measures highlighted during the audit.

Nonetheless, achieving this requires the establishment of **adequate resource KPIs** that provide a reliable foundation for informed decision-making and the implementation of efficiency measures, all supported by robust data. Therefore, this was the first step of the work developed.

2.2. Key performance indicators definition

During the Horizon 2020 [LEAP4SME](#) project a [set of resource efficiency KPIs](#) was proposed, using data collectable during an audit procedure, or that was already systematized within the companies' legal or voluntary requirements. **These KPIs were further elaborated upon in [LEAPto11](#) Deliverable 3.1 – Methodology Definition and are summarised in the following subchapters.**

2.2.1. Energy key performance indicators

The **energy KPIs** allow monitoring the evolution of their energy consumption, identify the suitable efficiency improvement measures to be implemented, as well as their impact, and be used for benchmarking purposes. There are **four main KPIs** that should be (at least) evaluated during an energy audit. These KPIs are the basis for an adequate energy efficiency evaluation, but there are others that may complement this evaluation.

The first one is the **energy intensity**, that represents the quotient between the total yearly energy consumption and the gross value added (GVA) of the activities directly connected with the industrial processes.

The second is the **carbon intensity**, that represents the quotient between the yearly greenhouse gas emissions resulting from the various forms of energy use during the production process (GHG emissions) and the total yearly energy consumption.

The third is the **energy specific consumption**, that represents the quotient between the total yearly energy consumption and the annual production. The production units (PU) depend on the analysed sector and can be defined as m², m³, kg etc., in manufacturing sectors, while in service sectors other units will be adopted (e.g., working hours, building area, etc.). This KPI refers to a particular product or process and can be applied to the complete facility or only to a certain product or process, evaluating the tendency that production and energy consumption are following.

The fourth is the **renewable energy production**, that represents the quotient between the total yearly production of renewable energy and the total yearly energy consumption. This KPI is an annual ratio and will assist the identification of potential for cost-effective use or production of renewable energy, as in the EED.

2.2.2. Water and water-energy nexus key performance indicators

Water and **water-energy nexus** audits are systematic assessment processes that evaluate the water efficiency of an organisation and identify improvement opportunities to minimise its consumption of water and associated energy, *i.e.*, the energy required to treat, transport and use water. This evaluation is based on the assessment of KPIs, such as water consumption and consumption of water from alternative water sources, and their evolution over time.

The **total water consumption** of an enterprise is considered as a 'base' indicator, as it will be used to calculate several others. For the pilot resource audit's purpose, water discharges and recirculated water within the production process were disregarded in the calculation of water consumption. Thus, this KPI is equivalent to a company's water intake, which may be from public water supply, self-water supply (e.g., water withdrawals and alternative water sources) or other supply sources.

Regarding the **water consumption per gross value added**, it represents the quotient between the total water consumption (as previously determined) and the GVA, which is an economic productivity metric that measures the contribution of a company to an economy, producer, sector, or region, obtained from the enterprise's economic reports.

The **water specific consumption** represents the quotient between the total yearly water consumption in the production process and the annual production. Therefore, it does not apply to commercial services such as

hospitality, tourism and retailers nor to industries that do not consume water in their manufacturing processes. In these cases, the water consumption per employee or guest should be used.

The **water consumption per employee** is a relevant KPI for service buildings, whose consumption is mainly associated with employee use, such as offices and commercial buildings. It represents the quotient between the total yearly water consumption within the company (which is the total water consumption, calculated as previously described) and its employees. Concerning hotels, it can be adapted by replacing the number of employees with the average number of guests per year (which can be found in the hotel's internal records).

The share of **alternative water sources used** is the ratio between the total yearly water consumption from alternative sources (the sum of the water consumed from all the alternative water sources used) and the total yearly water consumption within the company. The alternative water sources considered are rainwater, greywater and desalinated water and this KPI assess the savings in potable water achieved by implementing these solutions.

The share of **wastewater treated and reused** is the ratio between the total yearly treated and reused wastewater and the total yearly wastewater produced. This KPI applies to enterprises that treat and reuse its wastewater and allows to assess the savings in potable water that result from implementing this solution.

To determine the share of **water costs in the total costs incurred** by an enterprise, the total yearly water costs and the total yearly company costs need to be estimated. While the total yearly company costs can be obtained from the enterprise's economic reports, the total yearly water costs need to be determined by the auditor.

The **water specific cost** is the ratio between the total yearly costs concerning the water used within the production process and the annual production. This KPI is unsuitable for hotels and service buildings, but it can be adapted by replacing the production with the average number of guests per year or number of employees (using the total yearly costs of the water used within the building).

The **water productivity** measures the efficiency of water use and indicates how much economic output is produced per cubic meter of fresh water abstracted.

The **energy specific cost from water use** should be addressed by companies that (for example) consume energy for water heating purposes and/or treat and pump water, both of which need a significant amount of energy. Therefore, to estimate the total yearly cost of energy consumed, all energy sources should be considered, including billed energy, as well as the renewable and locally produced energy.

The **specific cost of water delivered** is the quotient between the total yearly cost of water delivered (the cost imputed to the water distribution entity, that can be found in the distribution or regulatory water entity in the area where the enterprise is located), and the total yearly water consumption.

The **energy specific consumption from water use** is the quotient between the total yearly energy consumption from water use and the total yearly water consumption.

2.2.3. Materials key performance indicators

The **materials' use KPIs** allow monitoring the use of raw materials and its productivity, as well as the waste valorisation¹ and byproducts² generated. There are four main KPIs that could be evaluated during the resource audit process.

The first one is the **materials specific consumption**, that represents the quotient between the total yearly materials consumption within the production process (raw materials consumed during the production process, when it exists a production line), and the annual production. The production units (P.U.) depend on the analysed sector and can be defined as m², m³, kg etc., in manufacturing sectors, while in service sectors other units will be adopted (e.g., working hours).

The **waste valorisation rate** is the quotient between the total yearly waste valorisation (waste valorisation activities performed annually) and the total yearly waste production (waste produced during a year). This KPI is an annual ratio and will assess the share of waste that is sent to valorisation and, consequently, decrease the amount of waste going to landfill (reducing associated costs) and at the same time maximizing the energy recovering associated.

The share of **byproducts in the production process** is the quotient between the quantity of yearly byproducts and the annual production.

The **material productivity** represents the quotient between the GVA of the activities directly connected with the industrial processes and the total yearly materials consumption within the production process. The material productivity indicator is the adaptation to the industrial environment of the resource productivity indicator, that quantifies the relation between economic activity and the consumption of material resources, which is an indicator derived from economy-wide material flow accounts.

2.3. Resource audits assessment framework

As the list of resource efficiency KPIs presented may not be equally applicable to all companies and activity sectors, different scenarios were set, where the KPIs were applied by levels, corresponding level D to the most elementary, and level A to the one where the higher number of the KPIs are suitable. With this configuration the enterprises may advance as the KPIs apply to their own specific case (in a general way) and/or as they have data available or interest. Therefore, the starting point is a set of **core KPIs** (level D), deemed as valid to most of the economic sectors.

Proceeding from this, the question 1) '**Does the company have a production process or is part of the construction sector?**' tries to establish whether the company is part of the production/construction sector or a service entity (with no physical production). If the entity does not have a production process associated, the water

¹ The **waste valorisation** activities can comprise three different activities: recycling, backfilling, and energy recovery. **Recycling** is defined as any recovery operation by which waste materials are reprocessed into substances, materials, or products. **Backfilling** is the recovery operation where suitable waste is used for engineering purposes in landscaping or for reclamation purposes in excavated areas where the waste is a substitute for non-waste materials. **Energy recovery** is the process which converts waste materials into electricity, fuel, or useable heat through a variety of methods which include combustion, gasification, and anaerobic digestion.

² **Byproducts** are secondary products derived from the production process produced unintentionally or incidentally, in addition to the main product. To be considered as a byproduct the product should fulfil all relevant product, environmental and health protection requirements for the specific use and not lead to overall adverse environmental or human health impacts.

consumption should be mainly associated with its use by employees, and the **water consumption per employee** is to be monitored. On the other hand, if the company has a production process associated, its **materials productivity** should be assessed. This KPI is particularly relevant for companies with significant raw materials consumption. With this the **level C** of KPIs monitoring is established. It is important to stress, that the evaluation is cumulative, so level C includes KPIs from level C and D.

Having established that the company has a production process associated or is part of the construction sector, the question **2) 'Does the company promote the use of byproducts within its main processes?'** should be posed. If so, the **share of byproducts in production process** is to be monitored. Another issue to evaluate at the same level is if the company has a production process that effectively consumes water, assessed by the question **3) 'Does the company consume water in its main processes?'** If not, the **materials specific consumption** should be evaluated, and the evaluation **ends** here. If the company has water consumption within its productive processes, there are a set of additional KPIs to be monitored, namely the **water specific consumption, water specific cost, energy specific cost resulting from the use of water, specific cost of water delivered** and **energy specific consumption from the water use**. These KPIs intend to weigh the associated energy consumption and costs of both water and energy. This sets **level B** of KPIs monitoring.

Finally, for companies that consume water from alternative water sources (e.g., rainwater, greywater and wastewater treated) it is important to assess the water consumption from these sources. In this sense, the question **4) 'Does the company consume water from alternative water sources?'** intends to check this. The KPIs to monitor are the following: **share of alternative water sources used** and **share of wastewater treated and reused** (only if the company consumes wastewater treated). This sets the **top-level A** of KPI monitoring.

These evaluation levels are designed to support the resource audit process and are not mandatory requirements. In certain situations, it may be impractical to assess the full range of KPIs specified for each level. Therefore, the auditor should conduct the assessment on a case-by-case basis.

In Table 1 the KPIs are presented **according to the evaluation level** where they are applied. Note that, as stated, the evaluation is cumulative so each level must include the KPIs from the levels before.

Evaluation level	Indicator
Level D	Energy intensity [kWh/€]
	Carbon intensity [t CO _{2e} /kWh]
	Energy specific consumption [kWh/P.U.]
	Renewable energy production [%]
	Total water consumption [m ³]
	Water consumption per GVA [m ³ /€]
	Water productivity [€/m ³]
	Water costs in the total costs incurred [%]
	Waste valorisation rate [%]
Level C	Water consumption/employee [m ³ /employee]
	Materials productivity [€/P.U.]
Level B	Byproducts in production process [%]
	Materials specific consumption [kg/P.U.]
	Water specific consumption [m ³ /P.U.]
	Water specific cost [€/P.U.]
	Energy specific cost resulting from the use of water [€/m ³]
	Specific cost of water delivered [€/m ³]
	Energy specific consumption from the water use [kWh/m ³]
Level A	Alternative water sources used [%]
	Wastewater treated and reused [%]

Table 1. Evaluation levels KPIs

3. Pilot audits preparation

This chapter presents an overview of the stages involved in conducting a resource audit, along with the methodology used for selecting pilot audits and its relevance.

3.1. Step by step pilot resource audit

The pilot resource audit is divided into four main stages, as following:

1. Start-up meeting/pre-audit questionnaire

The first step of a resource audit, after the preliminary contact is made, is to set an initial meeting to clearly define the audit's boundaries, confirming its scope, and engaging from the beginning all the relevant staff (this **includes the company's top-management**). The meeting's agenda should be shared beforehand, to allow the organization to be prepared to answer initial simple questions.

The auditing team should present the overall methodology of the resource efficiency audit and its process. During this meeting the auditor will inform that a **person responsible** for supporting the auditors should be nominated, and a **pre-audit questionnaire** (Annex I. Pre-audit technical questionnaire) requesting specific information from the organization will be shared (preferably right after the meeting). The purpose of the technical pre-audit questionnaire is to collect information regarding the company, namely highlighting its most energy and water intensive processes. This will allow the auditing team to perform a preliminary analysis of the relevant data and to carry out more effective on-site work.

Moreover, this initial meeting also provides a valuable opportunity to gather insights into the companies' **preliminary understanding of resource audits and their readiness to adopt efficiency measures**, particularly regarding the **barriers** and **drivers** to implementing resource audits and the **factors** that may enhance the companies' willingness to implement the efficiency measures identified during the audits.

The meeting should end with an agreement about the audit's plan for the subsequent days/weeks and ideally the first site visit scheduled.

2. Data collection, treatment and analysis

During the site visits, the auditing team will collect information that will allow them to effectively calculate the defined resource efficiency KPIs. This information may be comprised as, for example: electricity bills; other fuel bills; meter registration system operator data; gas point registration number data; access to online billing data; building layout drawings; asset/equipment lists; process diagrams; activity metrics (e.g., production output); historic energy performance information (previous audits); etc. Moreover, it could be necessary to perform field work, namely on-site measurements. To assist during this process, a **data collection template** was prepared to serve as guidance to the auditing team (Annex II. Data collection template).

Subsequently, the data analysis of the collected information will be conducted, with the objective of establishing the energy, water and materials performance of the organisation. The previously set **resource efficiency KPIs will be calculated**, as well as **identified and evaluated the performance improvement action opportunities** (divided into technically and financially feasible recommendations). Also, a simple financial analysis should be performed, calculating the necessary investment, simple payback period, and the expected impact and savings. Finally, the indirect benefits of the resource audit should also be considered, if feasible.

3. Reporting

Following the resource audit, a **report summarizing the collected data and treated information** will be elaborated. It should be preferably structured into seven main chapters (with an introductory executive summary): introduction, company characterization (including the production process), resource audit methodology, key performance indicators calculation, definition of improvement measures, triggers to behaviour change and conclusions and future work.

4. Closing meeting

After the resource audit report is completed, a **closing meeting with the technical staff involved**, as well as the top management, should be scheduled. The senior management often finds it difficult to allocate the time to this type of activities, so it is important that the auditing team prepares a short presentation for the closing meeting on the key observations recorded during the audit.

The items to be covered may include: energy and water consumptions and costs (identify all the energy and water sources); comparison of the calculated KPIs against known benchmarks; identification of the most relevant opportunities for improvement and their savings potential; recommended next steps. The lead auditor should be prepared to reply to any questions from the technical and/or management staff, with simple and clear answers.

3.2. Pilot audits relevance and selection

The **development of pilot cases** is fundamental to understand which are the points that need to be adjusted, refined, or adapted, as well as to verify the methodology viability. A pilot study validates the assumptions made, collecting feedback from a real context, and identifying technical or operational issues. It is an important step to perfect and improve the methodology proposed, demonstrating its values and benefits, and making it more robust to face future challenges.

The first step was the **selection of the pilot companies** to be studied within the framework of this project, that **comprised two main points**: (1) selection of the economic sectors of the companies and (2) identification of suitable companies within these sectors.

Concerning the **selection of the economic sectors**, this was undertaken by each pilot partner, considering: (1) the resource intensity of the sector; (2) its economic relevance; and (3) the possibility of collecting reliable data. Additionally, it was determined that **at least one activity sector would be common** across all countries (the food sector), and that **each country would cover a maximum of three economic sectors** and a **minimum of three pilot companies**.

After this, the pilot partners composed a short-list of suitable companies within each activity sector, having in mind that the companies selected should include SMEs and non-SMEs. Moreover, to determine whether the pre-selected **companies were suitable to be pilot cases** within the framework of this project, a **short survey** consisting of simple yes/no questions was set up to assess if the data available from each of the pre-selected companies was adequate to proceed with the application of the resource audit methodology (Annex III. Survey to pre-select pilot case studies). This **pre-screening activity** was intended to assist in selecting the most adequate case studies, while simultaneously engaging the companies from the outset of the process. Furthermore, the companies' readiness and commitment to provide the required data and collaborate fully with auditors throughout the entire audit were considered.

The selected case studies were divided into the following **economic sectors per country**, as presented in Table 2.

Country	Food sector	Textile	Ceramics & Glass	Hospitality	Paper
Croatia	x	x	x		
Greece	x				x
Malta	x			x	
Portugal	x	x	x		

Table 2. Economic sectors covered per country

Therefore, EIHP (Croatia) conducted three resource audits (one non-SME and two SMEs), focusing on the ceramics, textile, and food sectors; CRES (Greece) conducted three resource audits (all SMEs), focusing on the paper and food sectors; EWA (Malta) conducted three resource audits (all SMEs), focusing on the hospitality and food sectors; and ADENE (Portugal) conducted four resource audits (three non-SMEs and one SME), focusing on the ceramics, glass, textile, and food sectors. A total of **13 enterprises were audited, comprising 4 non-SMEs and 9 SMEs**, as in Figure 1 below.

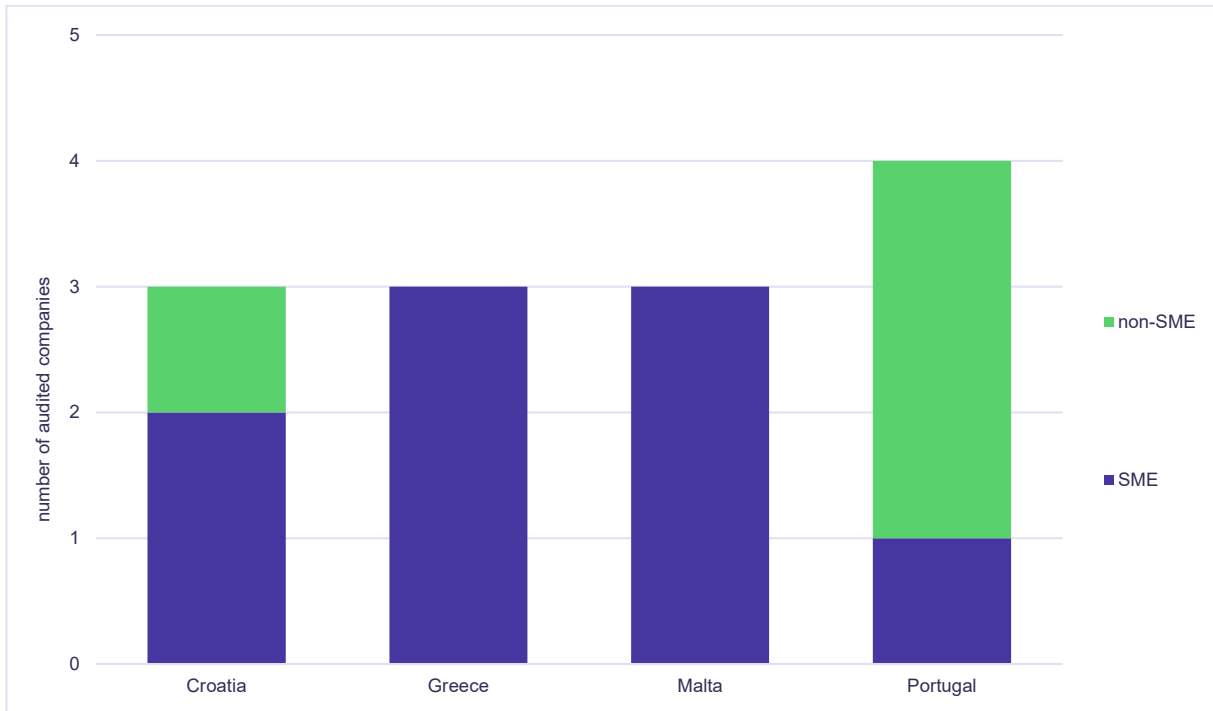


Figure 1. Distribution of the pilot audits

4. Pilot audits results

This chapter provides a comprehensive overview of the pilot resource audits main findings, with particular emphasis on key performance indicators, efficiency metrics, and analysis of potential savings. The finds are provided in aggregate; however, Annex IV. Summary of key pilot audits includes **examples from seven of the thirteen audits conducted**, offering a comprehensive view of their respective results. Additionally, chapter 4. examines the decision-making behaviours exhibited by enterprises, drawing on survey data collected from the audited organizations.

4.1. Key performance indicators analysis

The analysis of the defined KPIs will focus on the results of **three core KPIs for each dimension** – energy, water, and materials – selected based on their comparability and the availability of data across all pilot partners. These KPIs were chosen as they represent the **most consistent and relevant metrics for resource efficiency performance** within the scope of the pilot audits.

These results are presented as **ranges of values**, reflecting the variability observed among the audited companies. Furthermore, two complementary perspectives are provided:

- **Cross-country analysis for the food sector** (Table 3), which was selected as the **common sector** across all pilot countries to enable a comparative assessment.
- **Country-specific analysis** (Table 4), where the KPI ranges encompass the **different sectors** audited in each country.

As previously stated, a common sector of activity - the food sector - was defined for study. Although this sector is economically significant in all pilot countries, it presented **additional challenges** due to the varied nature of the pilot studies, which encompassed diverse processes (e.g. bakeries, restaurants, food processing plants). This disparity is reflected in the value ranges shown in Table 3 below.

KPI	Unit	Value range
Energy		
Energy intensity	[kWh/€]	0.20 – 6.90
Carbon intensity	[kg CO _{2eq} /kWh]	0.11 – 0.33
Energy specific consumption	[kWh/t]	135.00 – 1,900.00
Water		
Water productivity	[€/m ³]	1.50 – 109.90
Water specific consumption	[m ³ /t]	0.35 – 20.00
Energy specific cost resulting from the use of water	[€/m ³]	0.24 – 4.14
Materials		
Waste valorisation rate	[%]	92.50 – 99.10
Materials productivity	[€/kg]	2.87 – 4.97
Materials specific consumption	[kg/kg]	0.33 – 1.20

Table 3. Core KPIs range of values per dimension in the food sector

The **energy intensity** and **energy specific consumption** ranges show **large dispersion**, consistent with the heterogeneity of food sub-sectors. Such spread is expected in a multi-country, multi-process sample and reflects differences in **process design, operating regimes, maintenance practices, and metering resolution**. The **carbon intensity** range is comparatively **narrower** than energy-use metrics, which consists of variations in **energy mixes** (grid factors vs. on-site fuels) rather than extreme differences in total energy demand.

Water productivity and **water specific consumption** also span broad intervals, reflecting divergent **process water needs** and differences in **metering coverage** and **data granularity** across facilities. The **energy specific cost from water use** varies substantially, indicating different dependencies on **hot water, pumping, internal treatment, and recirculation**. Where hot-water processes are prominent, this KPI tends to rise, underscoring a **joint water-and-energy optimisation** imperative in food processing.

Waste valorisation rates are **very high** (approaching full valorisation in some cases), suggesting mature waste segregation and recovery practices in the audited sample. Incremental gains are still possible (quality of segregation, byproduct valorisation pathways), but absolute headroom appears limited relative to energy/water. **Materials productivity** and **materials specific consumption** ranges are consistent with **differing product mixes**, yields, and byproduct generation across sub-sectors. Facilities producing higher-value outputs per unit of raw material naturally plot higher in materials productivity, while processes with greater transformation losses or auxiliary inputs exhibit higher specific consumption.

The wide ranges observed are a **feature, not a flaw**, of a cross-country food-sector aggregation; they reflect structural differences across sub-sectors and companies' data maturity levels. Consequently, Table 3 should be used **for contextualisation rather than ranking**.

Differences in **metering/ monitoring** can widen ranges and should be considered when interpreting extremes. The methodology explicitly relies on **on-site data collection and KPI computation**, which strengthens comparability over time within each facility.

Given the multi-sub-sector composition and absence of harmonised benchmarks, **no deterministic sector-wide conclusions** can be drawn from the ranges alone; instead, they **set baselines** for each audited facility and inform **prioritisation** of subsequent measures.

Furthermore, a **country-specific analysis** encompassing the **different sectors** audited was performed. In Table 4 below it is possible to see the indicative KPI ranges for each country, reflecting the diversity of sectors audited - food, textile, ceramics, glass, hospitality and paper – across the four countries.

KPI	Unit	Croatia	Greece	Malta	Portugal
Energy					
Energy intensity	[kWh/€]	6.90 – 10.34	-	0.20 – 0.87	0.80 – 8.03
Carbon intensity	[kg CO _{2eq} /kWh]	0.14 – 0.20	0.11 – 0.26	0.27 – 0.36	0.12 – 0.27
Energy specific consumption	[kWh/t]	839.00 – 3676.00	1280.00 - 2450.00	-	4310.00 – 8252.00
Water					
Water productivity	[€/m ³]	0.10 – 1.63	-	-	5.93 – 1509.00
Water specific consumption	[m ³ /t]	5.32 – 7.95	0.35 – 20.00	-	5.57 – 86.70
Energy specific cost resulting from the use of water	[€/m ³]	-	0.24 – 4.14	-	0.94 – 3.76
Materials					
Waste valorisation rate	[%]	70.00 – 98.30	63.60 – 92.50	-	59.30 – 100.00
Materials productivity	[€/kg]	1.55 – 4.97	-	-	0.10 – 2.87
Materials specific consumption	[kg/kg]	1.03 – 1.20	0.33 – 1.16	-	1.26 – 1.27

Table 4. Core KPIs values in each country, considering a range of values across sectors

The wide dispersion observed is expected and primarily driven by **sectoral composition** (e.g., ceramics and glass vs. hospitality), **process complexity**, and **data maturity**. **Energy-related** KPIs show higher values in countries with energy-intensive industries, while **water** and **materials** indicators vary according to process water dependency and waste valorisation practices. Fields marked with ‘-’ denote KPIs that could not be calculated due to insufficient data availability.

Examining the **carbon intensity** indicator - which is crucial for evaluating the environmental impact across economic sectors and informing effective decarbonization strategies - it is important to recognize that a lower carbon intensity signifies that an activity produces fewer emissions relative to its production or economic output, thereby reflecting higher environmental efficiency. Therefore, despite the presented value ranges are limited, they may allow for comparisons of environmental performance between different sectors and countries. Also, they can be used to design policies and strategies for emission reduction - a company may prioritize investment in low-carbon technologies if it identifies that its carbon intensity is high compared to the industry average.

On the other hand, **water productivity** clearly reflects process efficiency and water usage - higher values correspond to greater efficiency and reduced water consumption during the production process. Specifically, the higher value observed for the Portuguese pilot reflects a production process that demonstrates considerable water efficiency by utilising a reduced quantity of water – a ceramic sector enterprise.

Regarding the **waste valorisation rate**, it evaluates the proportion of waste that is diverted to valorisation, thereby reducing the amount sent to landfill (and the associated costs), while also maximising energy recovery. These rates

are generally high across the audited companies – with the lowest calculated rates being around 60% and referring to textile and paper companies; however, there remains room for improvement.

It is important to note that the value ranges presented are provided solely for **contextual reference** and should not be used for benchmarking or ranking purposes, as meaningful conclusions would require a detailed, sector-specific analysis across multiple companies.

4.2. Efficiency measures and potential savings

This section presents the analysis of the **efficiency measures identified during the pilot audits** and their associated **potential savings**. The results are illustrated through a set of charts that provide complementary perspectives:

- **Total potential savings per country** (in monetary terms), enabling a comparison of the overall impact of recommended measures across the four pilot countries.
- **Potential savings by resource dimension** (energy, water, materials) expressed as percentages, allowing the identification of the dimension with the greatest impact.
- **Distribution of savings by measure category**, highlighting which types of actions (e.g., heating systems, monitoring and control, process optimisation) contribute most to the savings potential.
- **Number of measures per category and per dimension**, presented both in absolute values and percentage shares, to indicate which measures are most frequently recommended and their relative importance across dimensions.

Together, these graphs allow for a comprehensive interpretation of the results, supporting the identification of:

- The **measures with the highest savings potential**.
- The **categories most frequently recommended** during audits.
- The **resource dimension** (energy, water, or materials) that achieved the largest share of potential savings.

This analysis provides valuable insights for **prioritising actions** and **designing strategies** to maximise resource efficiency improvements.

It is important to note that the '**renewable energy**' category has been excluded from all graphs analysing monetary savings, as its values would distort the comparison. Moreover, given that this category is predominantly associated with **decarbonisation strategies** as opposed to **energy efficiency measures**, it has been also excluded to maintain consistency and comparability between the results presented.

Below, Figure 2 illustrates the estimated **total potential savings for each country**, expressed in monetary terms. This graph provides a comparative overview of the aggregated savings resulting from the efficiency measures

identified during the audits, enabling the overall scale of the potential economic impact at a country level to be understood.

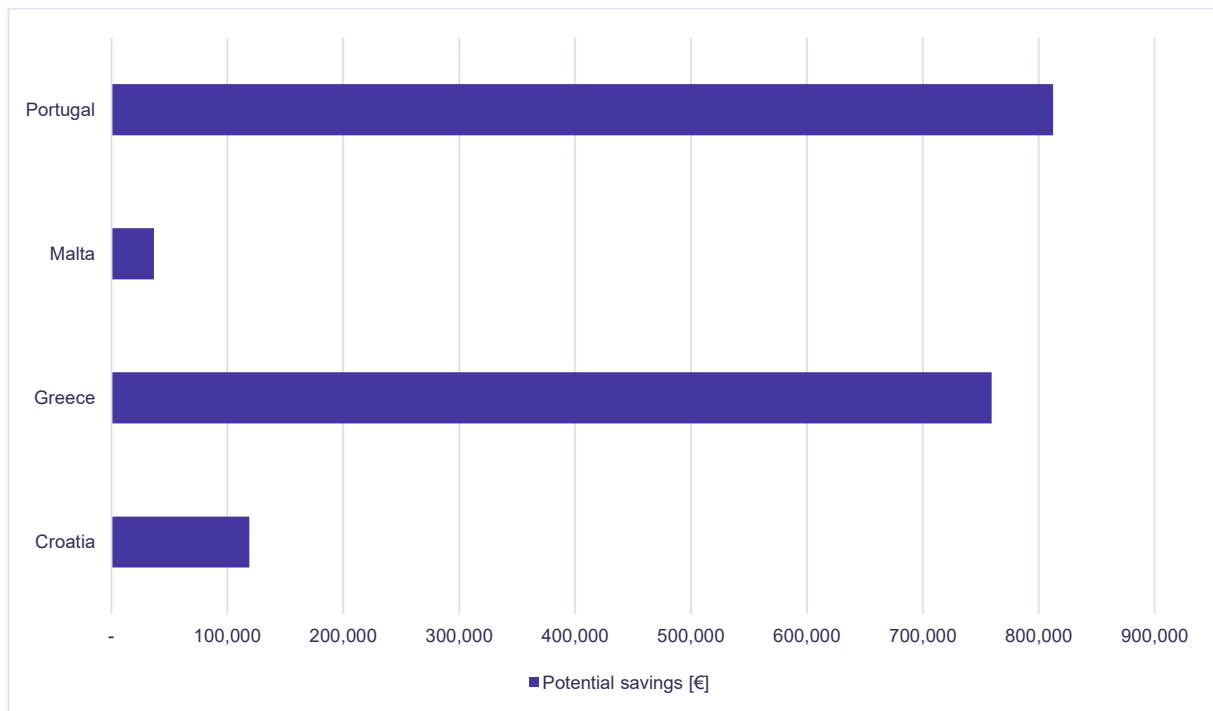


Figure 2. Potential financial savings per country

The **total potential financial savings estimated** for the **four countries** amount to **1 727 383 €**. These savings vary significantly across countries: Portugal and Greece present the highest aggregated savings, followed by Croatia, while Malta remains with a significantly lower value. These differences reflect the **sectoral composition** and **scale of audited facilities**. Moreover, the **low savings value observed for Malta** is justified by the fact that, due to the **type of sectors audited** and the **limited availability of data**, it was not possible to quantify savings for measures in the **water and materials dimensions**. This limitation significantly reduces the overall savings potential reported for Malta compared to other countries, where multiple resource dimensions were assessed and quantified.

Figure 3 illustrates the **distribution of potential financial savings by dimension** - energy, water, and materials - expressed as percentages of total estimated financial savings. This graph enables a cross-dimensional comparison, showing which resource areas contribute most significantly to the overall savings potential. It also supports the identification of priority dimensions for action and investment across the pilot audits.

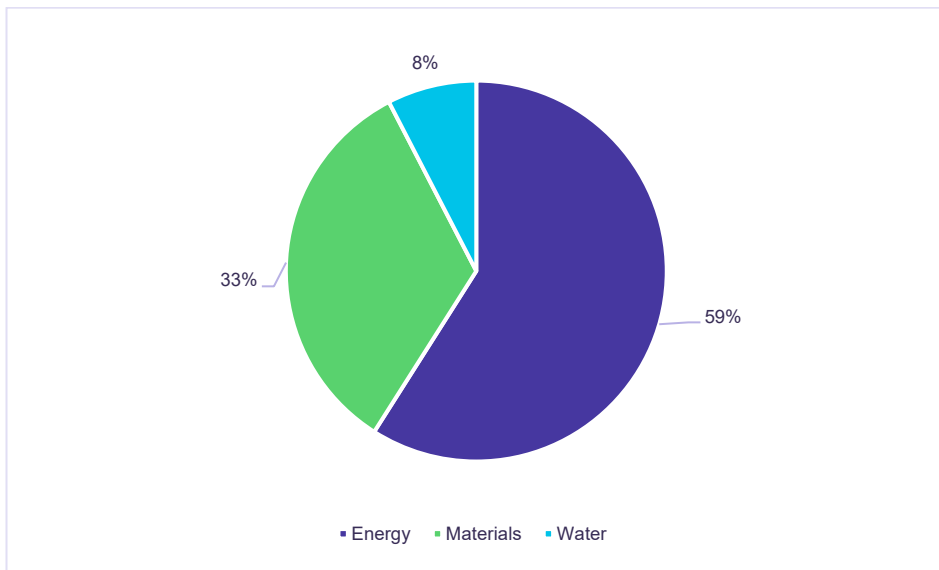


Figure 3. Potential financial savings per dimension

The results indicate that **energy measures dominate the savings potential**, accounting for **59%** of all quantified savings. **Materials measures represent 33%**, showing that actions such as raw material optimisation and waste valorisation offer meaningful economic benefits. **Water measures amount to 8%**, reflecting both the lower contribution of water-related actions and the challenge of quantifying savings in this dimension.

It is important to note that **energy was also the dimension with the highest number of measures quantified**, while measures relating to materials and water **could not always be quantified**, particularly for water due to metering and data limitations, which affected the proportional results. Additionally, for Malta, **no quantification** of measures in the water and materials dimensions was possible due to sector and data constraints, contributing to the lower share of savings reported.

Figure 4 displays the **potential savings per measure category**, highlighting the contribution of different types of efficiency actions to the overall economic impact. This graph is instrumental in identifying the categories that offer the greatest potential for savings, thereby providing a valuable insight into where interventions may be most effective from a cost-benefit perspective.

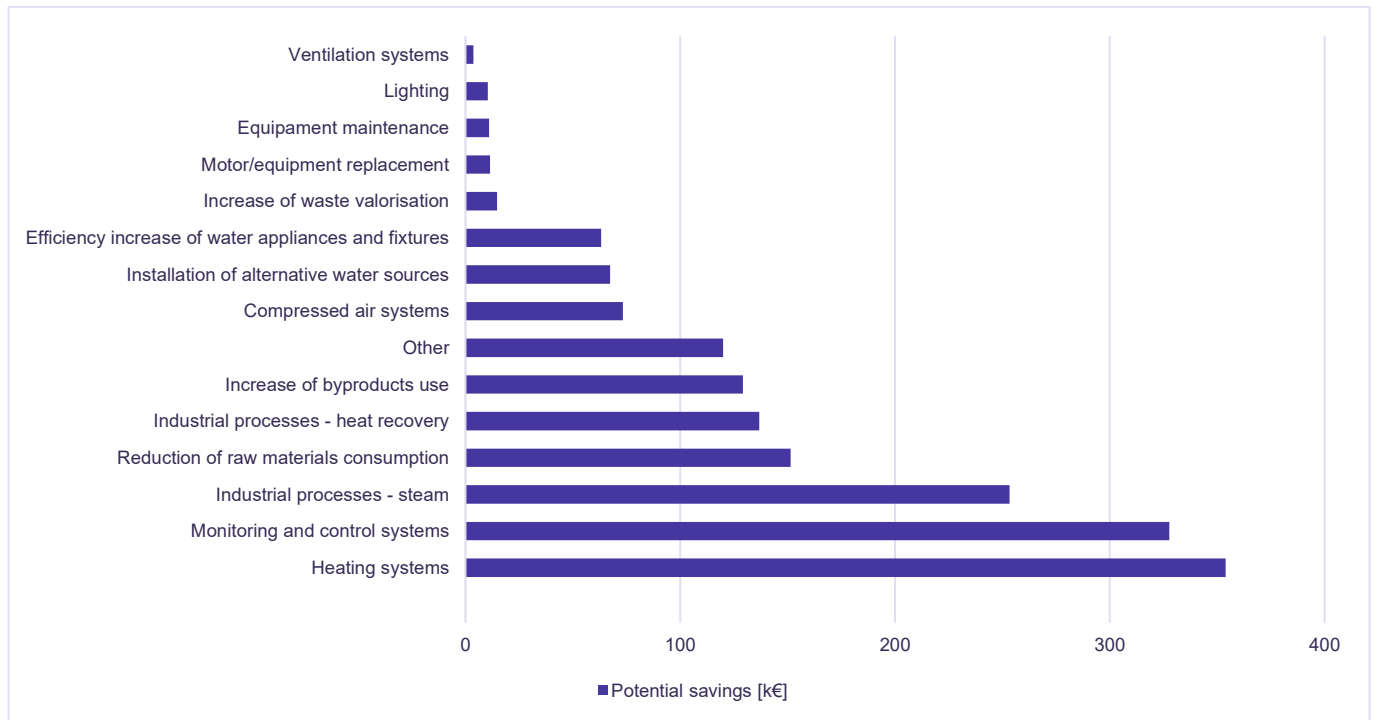


Figure 4. Potential savings per measure category

Further looking into Figure 4, it is possible to conclude that measures related to **heating systems**, **monitoring and control systems**, and **steam process optimisation** emerge as the most impactful, together representing the categories with the highest potential savings. These results confirm the importance of interventions targeting **thermal systems**, **process control**, and **process heat optimisation**, which are typically linked to higher energy consumption and therefore offer substantial opportunities for improvement.

Other categories, such as raw material consumption reduction and heat recovery, also contribute significantly, showing that **material efficiency** can be an important economic lever when sector and process characteristics permit quantification.

Figure 5 illustrates the **quantity of efficiency measures identified within each category**, providing insight into the prevalence of different types of recommendations made during the audits. By demonstrating the distribution of measures across categories, the graph facilitates the identification of prevalent operational issues, recurrent opportunities for enhancement, and the emphasis placed on certain types of interventions.

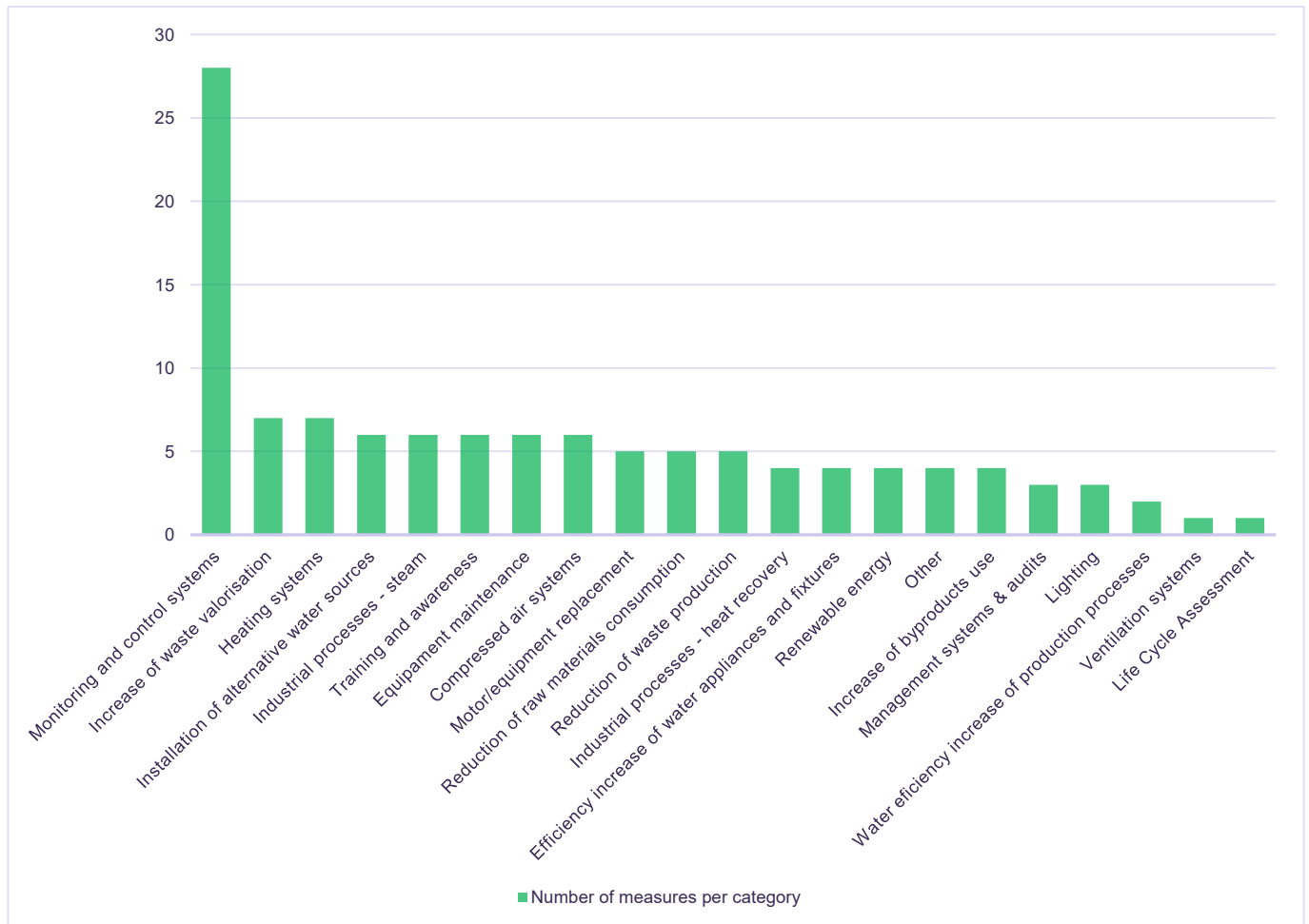


Figure 5. Number of identified efficiency measures per category

An analysis of Figure 5 reveals which categories of measures were most frequently identified during the audits. **Monitoring and control systems** appear as the most common improvement area, followed by **waste valorisation**, **heating systems**, and several water-efficiency related categories. This demonstrates that operational and low-cost optimisation measures are widely applicable across different sectors and often represent **immediate opportunities** for performance improvement.

Figure 6 provides a summary of the **distribution of the identified measures by dimension** – energy, water and materials - expressed as a percentage. It complements the analysis already performed by demonstrating the distribution of recommended actions across various dimensions. Consequently, facilitates a more comprehensive understanding of the alignment between the potential for savings and the frequency of measures identified in each area. Furthermore, it provides insight into the integrated nature of the resource audits.

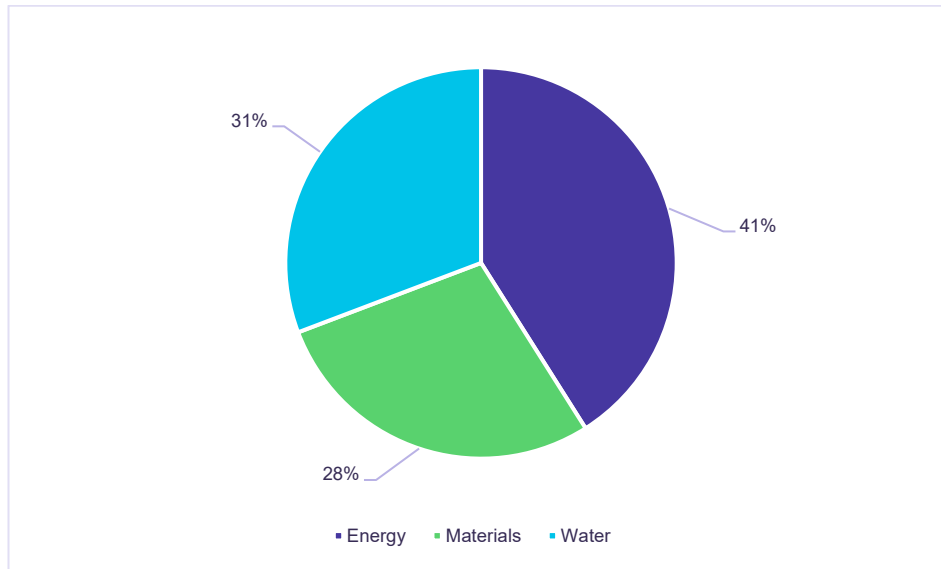


Figure 6. Distribution of measures per dimension

Further looking into Figure 6, it is possible to see the proportion of measures identified across the three dimensions: **energy (41%)**, **water (31%)**, and **materials (28%)**. This distribution is relatively balanced and demonstrates that the audits effectively considered all resource dimensions, rather than focusing solely on energy.

It is worth noting that the energy dimension was also the one with the highest number of measures quantified, while **water and materials measures were not always quantifiable**, particularly due to data and metering limitations in the water dimension. This explains why Figure 3 shows savings dominated by energy, despite the more balanced distribution of measures in Figure 6.

Overall, the analysis of the efficiency measures identified across the pilot audits highlights clear patterns in both the distribution and the impact of the proposed actions. The **total estimated savings** demonstrate substantial variation between countries, largely influenced by sectoral composition, data availability, and the predominance of energy-intensive industries in certain national contexts. At the dimensional level, **energy measures represent the largest share of quantifiable savings**, a result that is reinforced by the fact that the energy dimension was also the one with the highest number of measures that could be fully quantified.

Although **materials and water measures** were identified in comparable proportions to energy measures, their savings could not always be calculated, particularly in the case of water, where data and metering limitations frequently prevented quantification. This disparity is also reflected geographically, as seen in Malta, where the type of audited sector and limited data availability did not allow savings to be calculated for water and materials measures.

Furthermore, actions targeting **heating systems, monitoring and control, and process-related thermal optimisation** stand out as the most impactful in terms of economic savings. Also, the **most frequently recommended measures** relate to **operational optimisation** - particularly monitoring and control systems - which indicates a strong potential for low-cost, high-applicability improvements across sectors.

Finally, the **combined results** demonstrate the **value of an integrated resource audit approach**: while energy savings dominate the quantifiable potential, the balanced distribution of measures across energy, water and materials shows that **opportunities for improvement exist across all resource dimensions**. **Strengthening metering, monitoring and data quality - especially for water and materials - will be essential to unlocking a fuller understanding of their savings potential in future audits.**

4.3. Decision-making behaviour factors in enterprises

The International Energy Agency (IEA) [1] estimated that at least 25% of energy efficiency potential could be accessed by changing behaviour, including enabling and motivating people to implement energy efficiency projects and to invest in energy efficiency. Moreover, a **better understanding of behaviour and decision making** in organisations could contribute to the development of more effective policies and programmes and help accelerate the implementation of energy efficiency improvements. **A concise overview of the key decision-making factors within enterprises was presented in LEAPto11 Deliverable 3.1 – Methodology Definition.**

Considering this, a significant portion of the pilot audits was dedicated to gaining a better understanding of the types of factors, that could directly or indirectly influence companies in implementing resource efficiency audits. Therefore, during the pilot audit initial meeting a **set of three brief questions was posed**:

1. Which **barriers** do you consider most relevant to **resource audits** implementation?
2. Which **drivers** do you consider most relevant to **resource audits** implementation?
3. Which are the **factors** that may boost the companies' willingness to implement **efficiency measures**?

Regarding the first two questions, Table 5 shows that the **drivers and barriers identified by the audited companies** can be categorised as either economic or organisational. This is consistent with the factors influencing companies' behaviour and decision-making identified in the IEA report [9], namely: (i) financial imperatives; (ii) policy obligations; (iii) recognition of savings opportunities within the company; and (iv) commitment to environmental protection and energy efficiency, as well as the strategic need for top management support.

Barriers		Drivers
Economical	High investment Efficiency measures cost Payback time Uncertainty of savings Lack of financial support and incentives	Financing programmes Fiscal incentives Audit added value Cost savings Client request
Organizational	Lack of human resources Integration with other obligations (namely, legal)	Strategic investment Alignment with sustainability goals Top management support

Table 5. Barriers and drivers to resource audits implementation

Additionally, the analysis of the responses regarding the **implementation of efficiency measures**, as presented in Table 6 below, indicates alignment with the previously identified drivers.

Factors	Description
Process optimisation / operation time reduction	Streamlining processes and reducing the time required for operations, leading to increased productivity and efficiency.
Resource savings	Minimising the use of energy, water, and raw materials, which can result in cost savings and support sustainability objectives.
Environmental awareness / green image benefits	Enhancing the organisation's reputation by demonstrating commitment to environmental responsibility and sustainable practices.
Improved competitiveness	Gaining a competitive edge by adopting efficient practices, which can lead to reduced costs and a stronger market position.
Legal requirements	Ensuring compliance with relevant regulations and standards related to resource efficiency and environmental protection.
Cost reduction	Lowering operational expenses through efficiency measures and optimised resource use.

Table 6. Factors to boost efficiency measures implementation

After the resource audit report was completed, a final survey was shared with the audited companies. This survey was divided into three main sections (Annex V. Final survey presented to pilot case studies): (1) sustainability and efficiency goals; (2) LEAPto11 project; and (3) LEAPto11 pilot audits. The main objectives of this final survey were to **understand the companies' sustainability policies and targets**, as well as the **actual impact of the LEAPto11 project and pilot resource audits** carried out.

Regarding the responses related to the companies' **sustainability policy**, nine of the audited companies reported having an established policy, while one indicated a policy was in development. All respondents had defined targets for energy, water, and environmental dimensions, with half also outlining objectives for materials use or waste reduction. Additionally, all but two companies intended to increase their sustainability goals; one company did not anticipate any changes, and another remained undecided.

Concerning the **support required** to optimise the achievement of established goals, the primary areas of focus and their descriptions are outlined in Table 7, and essentially comprise a set of **advisory, capacity building and financial measures**.

Type of support	Description
Subsidies/Grants	Financial support to help cover the costs of implementing sustainability measures and resource efficiency improvements.
Collaborative projects	Participation in joint initiatives with other companies, research institutions, or public bodies. This collaboration can facilitate knowledge sharing, access to best practices, and collective problem-solving.
Tax reduction	Fiscal incentives such as reduced taxes or tax credits for companies that invest in sustainability and efficiency. These incentives can improve the financial viability of resource efficiency projects.
Training	Capacity building for staff and management on sustainability practices, resource efficiency methodologies, and behavioural change. Training can include workshops, seminars, or tailored courses to address specific needs.
Tailored advisory services	Personalised consultancy to help companies identify opportunities, design strategies, and implement efficiency measures. Advisory services may include audits, technical support, and guidance on regulatory compliance.

Table 7. Types of necessary support identified by the companies

On the other hand, addressing the answers regarding the **LEAPto11 project and pilot audits**, among the audited pilot companies, **five have previously considered conducting an integrated resource audit**, which indicates a growing **interest in comprehensive approaches** to resource efficiency. These companies identified **several factors that discouraged** them from undertaking these audits, namely: the resistance to change within the organization; lack of support or regulatory requirements; financial constraints limiting investment capacity; lack of awareness about the benefits and processes; limited technological options available; and perceived complexity of the audit process.

However, after the pilot audit was conducted, the companies did not perceive the audit process as time-consuming, as only one found the data requirements extensive. The **audits generally met expectations**, although two companies considered them too complex. Regarding the implementation of the identified efficiency measures, the audited companies expressed their **willingness to implement at least one of the efficiency measures identified** during the audit. However, one company indicated it was too early to decide on implementation.

In conclusion, while there is a positive attitude towards efficiency improvements, **overcoming barriers such as resistance to change, financial limitations, and perceived complexity** remains **essential** for broader **adoption of resource efficiency practices**.

In addition, the survey incorporated a series of **quantitative questions** that required companies to assess the **impact of the LEAPto11 pilot audits** using a scale from 1 to 5, where 1 corresponds to 'not increase at all' and 5 corresponds to 'highly increased'. It should be emphasised that, of the 13 audited companies, not all provided a quantitative response to the questions posed, stating that it was 'too early' to assess the true impact of the pilot audits in these areas.

A summary of the responses is presented in Figure 7 below.

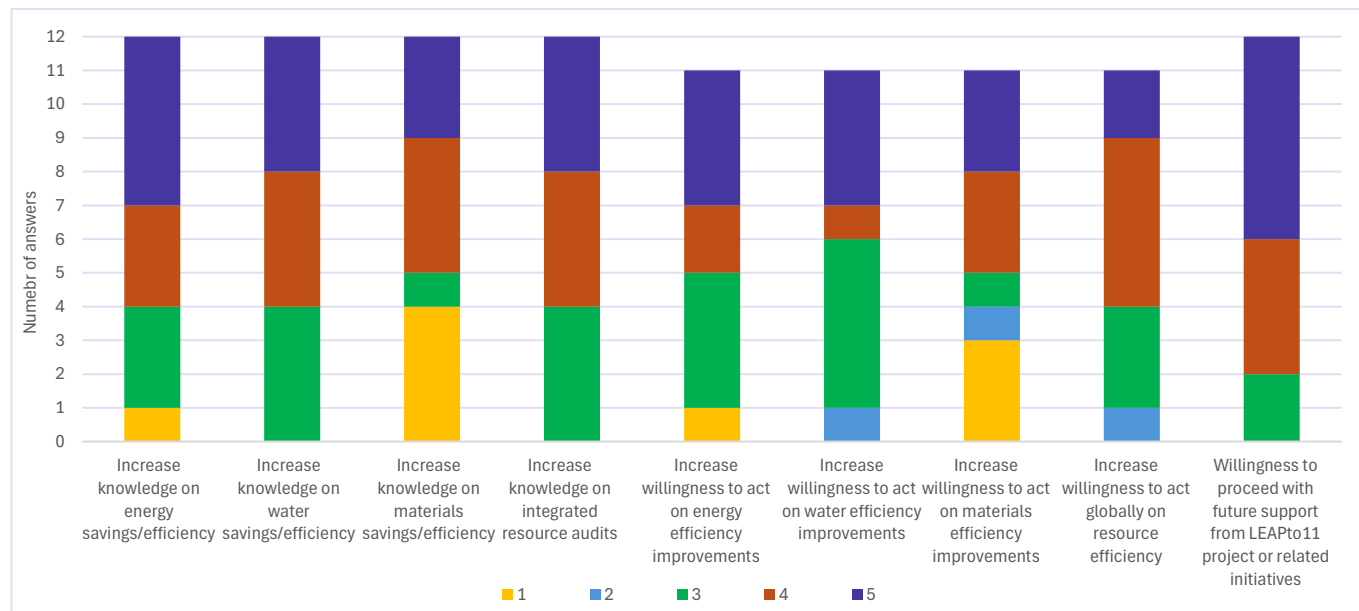


Figure 7. Perceived impact of pilot audits

Overall, the companies considered that LEAPto11 pilot audits **increased** their:

- **Efforts towards sustainability** goals and/or net zero emissions.
- Willingness to **act** globally on **resource efficiency**.
- **Knowledge** and **awareness** of **energy and water efficiency**; and in less extent of **materials efficiency**.
- Willingness **to act on energy efficiency improvements**; and in less extent on **materials** and **water efficiency improvements**.
- **Knowledge** regarding the concept of **integrated resource audit**.
- Willingness to proceed with **future support** from the LEAPto11 project or related initiatives.

5. Constraints and improvement points

This chapter presents an overview of the primary challenges and obstacles experienced by partner auditors throughout the pilot resource audit process, along with key areas for enhancement and recommendations for future audit activities.

5.1. Main constraints encountered during the pilot audits

During the application of the methodology, several barriers and difficulties were encountered. However, these were not perceived in the same way by all partners. Overall, issues relating to **data confidentiality and availability** were consistently reported. Additionally, constraints in **quantifying savings** due to **process complexity** and limited **sector-specific expertise** - particularly regarding the water and materials components - within the audit team were also noted. Resource audits were perceived as valuable, but **resource** (skills and experience) **intensive**.

A significant hurdle identified by the pilot partners was the **low level of engagement** from some of the selected companies (despite efforts to adequately identify pilot companies, as outlined in section 3.2. Pilot audits selection). This was exacerbated by the **fragmented responsibilities** observed in certain organisations, where energy, water, maintenance, and finance were managed by separate departments, without a centralized system for data collection and storage. Additionally, some audits were conducted during the summer period, which further contributed to the challenge. These primary **constraints and challenges** are outlined in Table 8 below.

Constraint/Challenge	Description
Data confidentiality	Restrictions on sharing certain type of information, as detailed cost data or the company's gross value added.
Process complexity	Processes demand deep sector-specific knowledge to interpret and assess system interactions. Lack of harmonised cross-sector referential to facilitate benchmarking activities.
Limited sector specific expertise	
Low engagement level	Available human resources directed toward core business operations (particularly in small companies).
Strategic prioritization	
Fragmented responsibilities	Data dispersed across departments. Lack of a centralised system for data collection and storage.
Data availability	

Table 8. Main constraints identified during the pilot audits

5.2. Improvement points and recommendations

In general, the pilot audits carried out **validated the resource audit methodology** developed. It was confirmed that pre-audit questionnaires and **early audit preparation** – namely, regarding data requests – as well as **structured planning and preparation**, are fundamental to a successful audit. This should be complemented by an adequate **definition of the audit scope** during the initial meeting with the audited company.

Regarding the audited dimensions, as previously expected, it was more **challenging to obtain valid information on water and materials flows**, as in some cases, no data was available. Consequently, without information on consumption, efficiency measures and savings are general estimates. Therefore, the implementation of a metering and monitoring system should be considered the first step to promote efficiency in these areas.

Thus, considering the constraints encountered during the implementation of the pilot audits, as well as the factors previously identified in section 4.3, some **improvement points and recommendations** have been identified and summarized in Table 9.

Improvement point	Recommendations
Data confidentiality	<p>Sign non-disclosure and/or confidentiality agreements early in the process to reassure companies and formalise data protection.</p> <p>Implement anonymisation or aggregation techniques so companies can provide data without disclosing sensitive details.</p> <p>Communicate clearly how data will be used, emphasising compliance with GDPR and project guidelines.</p>
Process complexity	<p>Create sector specific resource audit methodologies, including a summary of the processes, typical consumption patterns, and benchmark KPIs.</p>
Limited sector specific expertise	<p>Strengthen sector specific auditor training, particularly for water and materials flows, where knowledge is more limited.</p> <p>Consider implementing a centralised repository of audit examples, typical measures, and KPI references by sector.</p>
Low engagement level	<p>Plan audit steps around production schedules to avoid high-activity periods (e.g., summer for certain sectors).</p> <p>Highlight quick wins early on to build motivation and demonstrate immediate value.</p> <p>Ensure top-management involvement from the start.</p>

Improvement point	Recommendations
Strategic prioritization	<p>Frame audit benefits in strategic terms, emphasising cost reduction, compliance, competitiveness, and risk mitigation.</p> <p>Identify (if available) supporting mechanisms (technical or financial) to implement the identified efficiency measures.</p> <p>Connect efficiency measures to corporate sustainability goals.</p> <p>Use payback-based prioritisation, presenting both low-cost and strategic long-term actions.</p> <p>Organize awareness campaigns, workshops, and training sessions to increase understanding of the benefits and processes of integrated resource audits.</p>
Fragmented responsibilities	<p>Identify a single focal point at the initial meeting to coordinate internally, clearly assign responsibilities and encourage cross-department meetings</p> <p>Recommend companies to develop a centralised digital data repository.</p>
Data availability	<p>Promote the installation of basic metering as a first step.</p> <p>Train companies on maintaining better records and recommend digitalisation of monitoring data.</p> <p>Establish mechanisms for monitoring the implementation of efficiency measures.</p>
Financial supporting mechanisms	<p>Develop and promote targeted financial instruments such as grants, subsidies, or low-interest loans specifically for resource efficiency projects.</p>

Table 9. Improvement points and recommendations

6. Conclusions and next steps

Resource efficiency audits have the capacity to boost the implementation of energy, water and materials efficiency measures, reducing the use of energy, water, and raw materials, and therefore increasing the companies' competitiveness and diminishing the uncertainties of externalities. The quantification of these audits' potential savings is fundamental, and its starting point should be the **definition of suitable KPIs**, capable of creating a basis for decision making and efficiency measures implementation, supported by solid data. Consequently, a resource audit methodology and framework were developed, to correctly assist with the **quantification** of the set KPIs.

In this context, the **development of pilot case studies** was crucial for refining and validating this methodology, namely by identifying areas for improvement and confirming its feasibility in real-world settings. The first step involved selecting both the economic sectors and companies for study, with each country choosing sectors based on resource intensity, economic importance, and data reliability. Each country audited at least three companies across up to three sectors, ensuring that the food sector was included in all countries for comparability. Also, companies were shortlisted to ensure a mix of SMEs and non-SMEs, as well as assessed their ability and willingness to provide necessary data. In total, **13 enterprises were audited** across Croatia, Greece, Malta, and Portugal, **covering sectors such as food, textiles, ceramics, glass, hospitality, and paper, ensuring broad representation and robust methodology testing.**

Looking into the primary findings of the resource audits conducted, it is possible to observe that the results of the main **KPIs calculated** (presented as value ranges) clearly demonstrate the **variability among the audited companies**. Also, two perspectives were highlighted: a cross-country comparison for the food sector and country-specific ranges for the other sectors. The analysed data reveal broad KPI ranges, attributed to **differences in sector, process, and data maturity**. Particularly, energy metrics vary due to process and energy source diversity; water KPIs fluctuate depending on process requirements and metering; and material KPIs are influenced by product mix and waste management practices. However, it should be noted that these KPI values, presented as ranges, are intended to **serve as contextual baselines** rather than benchmarks, underlining the importance of sector-specific analysis.

Regarding the **efficiency measures** identified during the pilot audits and the potential savings associated, it should be highlighted that **sectoral and data limitations greatly influence the estimated savings per country**. Additionally, **energy efficiency measures accounted for most of the quantifiable savings** (around 60%), reflecting the prevalence of energy measures and the greater difficulty in quantifying water and materials savings. It was also identified that the most impactful measures in terms of economic savings are related to heating systems, monitoring and control systems, and steam process optimisation - these areas typically offer significant opportunities for improvement due to their high energy consumption. Moreover, monitoring and control systems are the most frequently recommended measures, followed by waste valorisation and heating systems, indicating that operational and low-cost improvements are widely applicable and often prioritised. Furthermore, the distribution of identified measures is balanced across energy (41%), water (31%), and materials (28%), showing that audits addressed all resource types, even if quantifiable savings were dominated by energy. Overall, the analysis demonstrates that while energy-related actions drive the largest share of measurable savings, **there are substantial opportunities for resource efficiency improvements across all dimensions**. These findings highlight the importance of resource audits and the need for **improved data collection, especially for water and materials, to better quantify and**

realise potential savings in future assessments. Despite the quantification limitations, the resource audits conducted indicated a potential savings impact ranging from approximately 2% to 23%, depending on the pilot country. On average, these **audits identified potential savings of about 10%.**

Concerning the **decision-making factors influencing enterprises** in implementing resource efficiency audits and the identified efficiency measures, these were evaluated through an **initial short questionnaire** presented to the enterprises during the audit's initial meeting, as well as a **through a final survey**, shared with the enterprise's personnel involved, after the resource audit report was completed. Initially, enterprises identified two sets of **main barriers** to the implementation of resource audits: (i) economic (e.g., investment cost, payback time, financial support) and (ii) organisational (e.g., human resources, legal obligations). Furthermore, **key factors for companies to implement efficiency measures** included process optimisation, resource savings, environmental reputation, competitiveness, legal compliance, and cost reduction. On the other hand, the final survey results showed that most enterprises had already established sustainability policies and targets, particularly for energy, water, and environmental dimensions. Also, companies expressed a **need for support** in the form of subsidies, collaborative projects, tax incentives, training, and tailored advisory services to help achieve their sustainability goals and implement the identified efficiency measures. Prior to the pilot audits, some companies hesitated to conduct resource audits due to resistance to change, financial and regulatory limitations, lack of awareness, and perceived process complexity. Post-audit feedback was more positive, with most companies expressing **willingness to implement at least one recommended efficiency measure**, though some still cited early stage of decision-making. Quantitative survey responses suggested that the **pilot audits increased companies' efforts toward sustainability, awareness of resource efficiency concepts, and willingness to pursue further resource efficiency actions.**

It should be noted that, during the **implementation of resource audits**, some **barriers and difficulties** were encountered, although not all partners perceived these in the same manner. Common challenges included concerns regarding data confidentiality and availability, difficulties in quantifying potential savings due to complex processes, and a lack of sector-specific expertise - especially for water and materials. Overall, resource audits were seen as valuable but required considerable **skills and experience**. Additionally, some obstacles arose from the audited companies themselves, such as **low engagement, fragmented responsibilities** across departments that hindered data collection, and audits coinciding with challenging periods such as summer.

In conclusion, the **pilot audits conducted confirmed the effectiveness of the developed resource audit methodology**, highlighting the importance of thorough preparation. Obtaining reliable data - especially for water and materials dimensions - proved challenging, underlining the need for metering and monitoring systems as a foundation for efficiency improvements. **Several key improvement points and recommendations were identified**, including: (i) ensuring data confidentiality through agreements and anonymisation; (ii) developing sector-specific methodologies and auditor training; (iii) scheduling audits to maximise engagement; (iv) framing audit benefits strategically, highlighting non-energy benefits to raise the perceived value of efficiency measures; (v) assigning clear responsibilities; (vi) promoting digital central data management; and (vii) expanding financial support mechanisms (such as grants and low-interest loans).

7. References

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8. Annex

I. Pre-audit technical questionnaire

General information

Data	Value
Country	
Location	
Sector of activity	
Main activities developed	
Production process(es) (include process diagrams)	
Annual production [P.U./year]	
Labour schedule	
NACE Code	
SME	<input type="checkbox"/> Yes <input type="checkbox"/> No
Number of employees / annual guests [nr]	
Company's Gross Value Added [€]	
Year(s) of the data collected	

Energy

Data	Value
Which of the following systems does the enterprise have for energy consumption monitoring?	<input type="checkbox"/> Dedicated energy monitoring system <input type="checkbox"/> Dedicated energy meter <input type="checkbox"/> Energy meter shared with other enterprises <input type="checkbox"/> Dedicated energy billing system <input type="checkbox"/> Energy billing system shared with other enterprises
Monthly bills of the energy consumption (electric, fuel, natural gas, other)	
Technical features of the main equipment (e.g. steam production and distribution and condensate return; hot water boilers, thermal oil boilers and hot air generators; domestic hot water production; compressed air production and distribution; cold production and distribution; HVAC systems; lighting; etc.)	
Technical schemes of the thermal and electric energy distribution	
Disaggregated consumption of the main energy users	

Water

Data	Value
The company consumes water during its main activities?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Which of the following systems does the enterprise have for water consumption monitoring?	<input type="checkbox"/> Dedicated water monitoring system <input type="checkbox"/> Dedicated water meter <input type="checkbox"/> Water meter shared with other enterprises <input type="checkbox"/> Dedicated water billing system <input type="checkbox"/> Water billing system shared with other enterprises
Monthly bills of water energy consumption	
Sources of water used by the enterprise	<input type="checkbox"/> Public supply <input type="checkbox"/> Self-supply: Water withdrawals <input type="checkbox"/> Self-supply: Rainwater <input type="checkbox"/> Self-supply: Greywater <input type="checkbox"/> Self-supply: Desalted water <input type="checkbox"/> Self-supply: Treated wastewater

Materials

Data	Value
The company uses byproducts within its main production processes?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Integrated Waste Registration Map	
Raw Materials procurement and purchase registers (associated with the production processes)	

II. Data collection template

General data

Information	Unit	Value
Usable area	[m ²]	
Gross value added (GVA)	[€]	
Annual production	[P.U/year]	
Number of employees	[nr]	
Number of annual guests*	[guests/year]	
Main production processes	Short description	
Total yearly costs of the company	[€]	

Energy

Evaluation level	Data	Value	Unit
D	Total yearly energy consumption		-
	<i>Globally</i>		[kWh]
	<i>Per fuel type (electricity, natural, gas, ...)</i>		[kWh]
D	Total yearly production of renewable energy		[kWh]
D	GHG emissions		[t CO ₂ e]
D	Total yearly energy costs		[€]

Water

Evaluation level	Data	Value	Unit
D	Total yearly water consumption		[m3]
D	Total yearly water costs		[€]
B	Total yearly water consumption within the production process		[m3]
B	Total yearly costs concerning water used within the production process		[€]
B	Total yearly cost of water delivered		[€]
A	Total yearly water consumption from alternative sources		-
	<i>Volume of the rainwater cistern</i>		[m3]
	<i>Volume of the greywater cistern</i>		[m3]
	<i>Production capacity of the desalter</i>		[m3]
A	Total yearly treated and reused wastewater		[m3]
A	Total yearly wastewater produced		[m3]

Material

Evaluation level	Data	Value	Unit
D	Total yearly waste valorization		[kg]
D	Total yearly waste production		[kg]
D	Total yearly raw materials costs		[€]
C	Total yearly materials consumption within the production process		[kg]
B	Total yearly byproducts		[kg]

III. Survey to pre-select pilot case studies

Minimum criteria for company selection

Water	Energy	Material
Data regarding total water consumption [m ³]	Data regarding total energy consumption per type of fuel [TJ]	Data regarding total material consumption within the production process [kg]
Data regarding total water costs [€]	Data regarding total energy costs per type of fuel [€]	Data regarding total waste produced [kg]
Data regarding total water consumption within the production process [m ³]	Data regarding energy consumption per process or equipment per type of fuel [TJ]	Data regarding total waste valorisation [kg]
Data regarding total water consumption from alternative sources [m ³]	-	-

Company ID

Question	Answer
Country	
Sector of activity	
NACE Code	
SME	<input type="checkbox"/> Yes <input type="checkbox"/> No
Main activities developed	

Energy

Question	Answer
Data regarding total energy consumption per type of fuel (electricity, natural gas, other) [TJ]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding total energy consumption per type of fuel (electricity, natural gas, other) [toe]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding renewable energy consumption [TJ]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding energy consumption per process or equipment per type of fuel (electricity, natural gas, other) [TJ]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding total energy costs per type of fuel (electricity, natural gas, other) [€]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Mandatory energy audit	<input type="checkbox"/> Yes <input type="checkbox"/> No
Energy Management System (ISO 50001 or other)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Energy Management System (equipment/hardware)	<input type="checkbox"/> Yes <input type="checkbox"/> No

Water

Question	Answer
Data regarding total water consumption [m ³]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding total water consumption within the production process [m ³]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding total water consumption from alternative sources (rainwater, greywater, groundwater or stormwater) [m ³]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding total wastewater produced [m ³]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding total wastewater treated [m ³]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding total wastewater reused [m ³]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding total water costs [€]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding total costs concerning water used within the production process [€]	<input type="checkbox"/> Yes <input type="checkbox"/> No

Material

Question	Answer
Data regarding total material consumption within the production process [kg]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding total waste produced [kg]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding total waste valorisation [kg]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Data regarding total byproducts used within the production process [kg]	<input type="checkbox"/> Yes <input type="checkbox"/> No
Life cycle analysis of the material used	<input type="checkbox"/> Yes <input type="checkbox"/> No

Other sustainability factors

Question	Answer
Other standards and/or norms (e.g. ISO 14001 or other)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Differentiating sustainability measures in place	<input type="checkbox"/> Yes <input type="checkbox"/> No

IV. Summary of key pilot audits

Company ID

Country	Croatia
Sector of activity	Food
SME	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Main activities developed	Meat processing

Consumption and costs summary

Dimension	Consumption/year	Unit	Costs/year [€]
Energy	101,532,300	[kWh]	14,708,466.06
Water	531,871	[m ³]	864,322.93
Raw materials	80,513	[t]	332,753,599.38

KPIs values per dimension

KPI	Unit	Value
Energy		
Energy intensity	[kWh/€]	6.90
Carbon intensity	[kg CO ₂ eq./kWh]	0.20
Energy specific consumption	[kWh/t]	1,517.60
Water		
Total water consumption	[m ³]	531,871.00
Water consumption per GVA	[m ³ /€]	0.04
Water productivity	[€/m ³]	1.63
Water costs in the total costs incurred	[%]	5.55
Water consumption/employee	[m ³ /employee]	323.72
Water specific consumption	[m ³ /t]	7.95
Water specific cost	[€/t]	12.92
Specific cost of water delivered	[€/m ³]	1.63
Energy specific consumption from the water use	[kWh/m ³]	190.9
Alternative water sources used	[%]	43.6
Materials		
Waste valorisation rate	[%]	98.30
Materials productivity	[€/kg]	4.97
Materials specific consumption	[kg/kg]	1.20

Energy efficiency measures

Description of measure	Investment [€]	Payback period [years]	Savings potential/year					
			Electricity [kWh]	Electricity [€]	GHG emissions [tCO _{2eq.}]	Natural Gas [kWh]	Natural Gas [€]	GHG emissions [tCO _{2eq.}]
Reducing compressed air pressure	4,000.00	0.33	63,000.00	12,001.50	10.02	-	-	-
Leak detection and repair program	12,000.00	1.25	50,400.00	9,601.20	8.01	-	-	-
On-site solar PV (3.8 MWp)	4,584,000.00	5.73	4,202,000.00	800,481.00	668.12	-	-	-
Combustion optimization on steam boilers	23,000.00	0.46	-	-	-	481,371.80	50,475.27	103.01
Blowdown heat recovery (continuous blowdown and heat exchanger)	40,000.00	1.58	-	-	-	240,685.90	25,237.64	51.51
Knife sterilizers insulation, cover & migrate to low-pressure steam*	-	-	-	-	-	-	-	-
Steam distribution optimization — traps, leaks, insulation, unused lines*	-	-	-	-	-	-	-	-
Total	4,663,000.00	-	4,315,400.00	822,083.70	686.15	722,057.70	75,712.91	154.52

* Quantification of these measures was not performed because the necessary data for reliable assessment was unavailable or these measures represent future options that require further study.

Water and materials efficiency measures

Description of measure	Qualitative impact
Water	
Water management plan and audits	Typically reduces total intake and WWTP load by revealing hidden losses and prioritizing high-ROI fixes; enables later quantification per end-use.
Optimization of water flow (presence sensors, timers, automatic shut-off)	Consistently reduces run-hours and flow at stations with intermittent demand; savings verified with simple hour-counters or pulse meters.
Efficient nozzles and showers with presence control	SA-BREF reports flow cuts from ~3,000–4,000 L/h to ~400 L/h with presence-controlled flat-jet nozzles; payback around 6 months (case-specific).
Optimized CIP (clean-in-place): dosing and rinse-recovery	Reduces hot-water volumes and detergent use; site trials typically show notable water and chemical savings when rinse-recovery is enabled.
Reuse of treated water for non-potable purposes (where hygiene allows)	Can displace a meaningful share of freshwater intake in auxiliary uses; requires QA validation and, where needed, polishing treatment.
Materials	
Segregate residues at source and maximize by-product recovery	Increases mass sent to valorisation (revenue) and reduces suspended solids, fats and COD to WWTP; enables higher recovery quality (less contamination).
Minimize biological degradation of by-products (quick collection and chilled storage)	Preserves material quality (higher-value outlets), reduces odour and WWTP load; SA-BREF documents the need for refrigerated blood storage and frequent removal/cleaning as key elements of this technique.
Proper selection of cleaning chemicals and disinfectants (avoid harmful substances)	Reduces hazardous load to effluent and residuals, improves occupational safety, and can lower downstream treatment chemical usage.
Reuse of cleaning chemicals in CIP (closed circuits)	Reduces purchase of detergents/disinfectants and hot water demand; cuts material losses to drain. (SA-BREF details reuse logic, control instrumentation and typical benefits).
Dry cleaning and low-loss cleaning practice (before wet washdown)	Reduces material waste into drains and cuts chemical usage in subsequent wet cleaning; supports higher recovery of solids as by-products.

Description of measure	Qualitative impact
Resource-efficiency management	Systematic reduction of materials and chemicals per ton of product; creates the governance backbone for the specific measures above.

The assessment of potential water and material savings was qualitative and grounded in the Best Available Techniques (BAT) commonly applied to slaughterhouses and animal by-products facilities. The SA-BREF (Best Available Techniques Reference Document for Slaughterhouses, Animal By-products and/or Edible Co-products Industries) served as the primary source for indicative evidence and examples; however, precise quantification would necessitate a site-specific analysis.

Key messages

The audited company exhibited a high level of resource intensity characteristic of the meat industry, primarily due to refrigeration, steam generation, and hygiene requirements. The energy intensity measured 6.90 kWh/€ and specific consumption reached 1,518 kWh per tonne of meat product, indicative of the intricate nature of slaughtering and processing activities. The water-energy nexus was notable, driven by heating and pumping needs, which suggests significant potential for optimization through reuse strategies and enhanced process control. Material consumption was largely comprised of raw meat inputs, including live pigs, cattle, and fresh or frozen meat. Additionally, the company achieved a substantial waste valorisation rate (98.3%), with by-products allocated to rendering and energy recovery, in alignment with circular economy principles.

The strategic next steps identified involve the implementation of ISO 50001 for comprehensive energy management, the expansion of monitoring and control systems, and the utilisation of available financial incentives for renewable energy and efficiency projects. These initiatives will enhance the company's competitiveness, minimise its environmental footprint, and ensure alignment with EU sustainability objectives. In addition, to foster continuous improvement and accurately assess the outcomes of the identified efficiency measures, it is recommended that the following KPIs be consistently monitored and incorporated into the company's ISO 50001 framework:

- Energy intensity [kWh/€]
- Specific energy consumption [kWh/t of meat product]
- Carbon intensity [t CO_{2eq}/kWh]
- Renewable energy share [%]
- Water specific consumption [m³/t of product]
- Water reuse rate [%]
- Material yield [%] and waste valorisation rate [%]

Finally, some challenges and barriers were identified during the audit process:

- **Financial constraints**, high upfront investment requirements and uncertainty regarding payback periods for advanced efficiency measures.
- **Operational priorities**, continuous production and strict food safety standards limit flexibility for implementing certain measures.
- **Data confidentiality**, restrictions on sharing detailed cost data for raw materials and internal processes reduced the granularity of the financial analysis. The company had an internal policy that restricted sharing financial with external stakeholders, such as detailed cost figures. Therefore, for the cost analysis, average unit prices available at the time of report preparation were used.
- **Complexity of technical systems**, interdependencies between refrigeration, steam generation, compressed air, and hygiene processes require multidisciplinary expertise for optimization.
- **High technical complexity of the facility**, which demands deep sector-specific knowledge to fully interpret and assess system interactions.
- **Limited availability of specialized competencies of LEAPto11 auditors** in certain areas, which may have constrained the depth of analysis in highly integrated systems.

Company ID

Country	Croatia
Sector of activity	Textile
SME	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Main activities developed	Preparation and spinning of textile fibres

Consumption and costs summary

Dimension	Consumption/year	Unit	Costs/year [€]
Energy	20,593,088	[kWh]	1,991,439.09
Water	30,577	[m ³]	3,173.88
Raw materials	5,786.10	[t]	8,679,150.00

KPIs values per dimension

KPI	Unit	Value
Energy		
Energy intensity	[kWh/€]	10.34
Carbon intensity	[kg CO _{2eq} /kWh]	0.14
Energy specific consumption	[kWh/t]	3,675.70
Renewable energy production	[%]	14.90
Water		
Total water consumption	[m ³]	30,577
Water consumption per GVA	[m ³ /€]	0.14
Water productivity	[€/m ³]	0.10
Water costs in the total costs incurred	[%]	0.16
Water consumption/employee	[m ³ /employee]	7.03
Water specific consumption	[m ³ /t]	5.32
Water specific cost	[€/t]	0.40
Specific cost of water delivered	[€/m ³]	0.10
Materials		
Waste valorisation rate	[%]	70.00
Materials productivity	[€/kg]	1.55
Materials specific consumption	[kg/kg]	1.03

Energy efficiency measures

Description	Investment [€]	Payback period [years]	Savings potential/year		
			Electricity [kWh]	Electricity [€]	GHG emissions [t CO _{2eq}]
Reducing compressed air pressure	4,000.00	0.41	86,561.95	9,870.05	13.76
Leak detection and repair program	12,000.00	1.52	69,249.56	7,896.04	11.01
Demand-Controlled Ventilation (DCV) for dust extraction in spinning	40,000.00	10.99	31,920.00	3,639.61	5.08
Expansion of sub-metering and energy monitoring system *	-	-	-	-	-
Expansion of the photovoltaic (PV) system – ground-mounted installation	3,600,000.00	8.8	3,588,000.00	409,114.52	570.49
Battery Energy Storage System (BESS) – future option for dynamic energy management *	-	-	-	-	-
Total	3,656,000.00	-	3,775,731.51	430,520.22	600.34

* Quantification of these measures was not performed because the necessary data for reliable assessment was unavailable or these measures represent future options that require further study.

Water efficiency measures

Description	Investment [€]	Payback period [years]	Savings potential/year		
			Water [m ³]	Water [€]	GHG emissions [t CO _{2eq.}]
Water management plan, sub-metering and annual audit	3,900.00	35.19	1,490.55	110.82	-
Sanitary and service water efficiency	1,800.00	18.80	76.60	95.75	-
Total	5,700.00	-	1,567.15	206.57	-

Materials efficiency measures

Description	Qualitative impact
Systematic Monitoring of Material Yield	Maintain the current high material yield (96.76%). Enables early detection of deviations, supports process optimization, and ensures consistent product quality.
Valorisations of Production Residues	Currently, 70% of process losses are valorised; this can be increased. Reduces waste disposal needs, supports circular economy principles, and may generate additional revenue.
Segregated Waste Collection and Registry	Improves compliance with environmental regulations and facilitates recycling. Potential reduction in mixed waste disposal costs.
Supplier Engagement for Raw Material Quality	Reduces variability in production and improves process stability. Potential reduction in material waste by 0.5–1%.
Staff Training on Material Handling and Loss Prevention	Increases awareness and accountability among staff. Potential reduction in material losses by 0.2–0.5%.
Optimization of Packaging Materials	Reduces environmental footprint and improves sustainability image. Potential 10–20% reduction in packaging waste.

Description	Qualitative impact
Benchmarking Against Sectoral Waste Rates	Confirms strong performance and highlights areas for further improvement. Validates that the company performs better than average (3.24% total losses).

The material efficiency measures outlined are intended for reference only, as the quantification of impacts was not feasible due to limited data availability and a lack of specialised expertise in material management within the yarn production sector.

Key messages

The audited company demonstrated a high level of resource efficiency throughout its energy, water, and material operations, even within a complex industrial framework marked by continuous production, advanced automation, and numerous interconnected technical subsystems. The facility incorporates various spinning technologies, compressed air systems, HVAC systems, and renewable energy generation, collectively contributing to a dynamic and energy-intensive environment. During the audit performed, an important strategic opportunity identified was the expansion of the current photovoltaic system, which has the potential to substantially enhance the proportion of electricity generated in-house.

The company is currently in the process of adopting the ISO 50001 Energy Management System, demonstrating a clear dedication to sustainability and ongoing enhancement. In addition, to foster continuous improvement and accurately assess the outcomes of the identified efficiency measures, it is recommended that the following KPIs be consistently monitored and incorporated into the company's ISO 50001 framework:

- Energy intensity [kWh/€]
- Specific energy consumption [kWh/t of yarn]
- Carbon intensity [t CO_{2eq}/kWh]
- Renewable energy share [%]
- Material yield [%]
- Waste valorisation rate [%]

Finally, some challenges and barriers were identified during the audit process:

- **Financial constraints**, high upfront investment requirements and uncertainty regarding payback periods for advanced efficiency measures.
- **Strategic prioritization**, where available resources are often directed toward core business operations.

- **Organizational complexity**, particularly in areas such as material and water efficiency and waste valorization, which require a multidisciplinary approach and sector-specific expertise.
- **Limited availability of certain data**, which was often dispersed across departments and not readily accessible within the required timeframe.
- **Internal data protection policies**, especially regarding cost-related information, which understandably limit the scope of data sharing.
- **High technical complexity of the facility**, which demands deep sector-specific knowledge to fully interpret and assess system interactions.
- **Limited availability of specialized competencies of LEAPto11 auditors** in certain areas, which may have constrained the depth of analysis in highly integrated systems.

Company ID

Country	Greece
Sector of activity	Food
SME	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Main activities developed	Food processing

Consumption and costs summary

Dimension	Consumption/year	Unit	Costs/year [€]
Energy	19,134,814	[kWh]	595,066
Water	4,342	[m ³]	6,501
Raw materials	12,504,704	[kg]	not available

KPIs values per dimension

KPI	Unit	Value
Energy		
Carbon intensity	[kg CO ₂ eq./kWh]	0.11
Energy specific consumption	[kWh/t]	1,900.00
Renewable energy production	[%]	70.21
Water		
Total water consumption	[m ³]	4,342
Water productivity	[€/m ³]	1.50
Water costs in the total costs incurred	[%]	1.09
Water specific consumption	[m ³ /t]	0.35
Water specific cost	[€/t]	0.53
Energy specific cost resulting from the use of water	[€/m ³]	4.14
Energy specific consumption from the water use	[kWh/m ³]	79.12
Materials		
Waste valorisation rate	[%]	92.50
Materials productivity	[€/kg]	80.90
Materials specific consumption	[kg/kg]	0.33

Energy efficiency measures

Description	Investment [€]	Payback period [years]	Energy savings/year [kWh _e]	Cost savings/year [€]	GHG emissions reduction/year [t CO ₂ eq.]
Installation of an Energy Management Software	150,000	5.37	154,302.00	27,913.00	92.58
Total	150,000	-	154,302.00	27,913.00	92.58

Water efficiency measures

Description	Investment [€]	Payback period [years]	Water savings/year [m ³]	Cost savings/year [€]	% savings
Automatic Boiler Blowdown Control	10,000	> 15 years	961.32	1,439.00	50% of make-up water
Repairing steam and condensate leaks	< 1,000				
Replacement of mechanical traps	1,500 per steam trap				
Total	-	-	961.32	1,439.00	-

Materials efficiency measures

Description	Investment [€]	Payback period [years]	Materials savings/year [kg]	Cost savings/year [€]	% savings
Optimize milling settings	-	-	616,182	120,000 – 320,000	3.5%
Regular equipment maintenance	-	-			2.5%
Employee training	-	-			2%
Packaging optimization	-	-			1%
Total	-	-	616,182	-	-

Key messages

The resource audit performed identified opportunities to optimize energy, water, and material consumption while reducing operational costs and environmental impact. Regarding the energy dimension, potential savings have been identified through the implementation of an EnMS, which could reduce electrical consumption by 5%. In relation to water efficiency, three key improvement measures have been proposed; although precise savings cannot be quantified due to data limitations, these measures are expected to significantly reduce both water consumption and the associated energy use for water heating. Finally, in terms of materials efficiency, the facility processes 12,500 tonnes of raw materials annually, generating 3.3 million kg of by-products, of which 92.5% is currently valorised. Opportunities exist to further optimise material usage through milling process adjustments (potential 3.5% savings), enhanced equipment maintenance (2.5% savings), and employee training programmes (2% savings). Packaging optimisation could yield an additional 1% reduction in material waste.

Moreover, to capitalize the identified opportunities, the company's management was advised to prioritize three key actions:

- Investment in the EnMS to establish baseline monitoring capabilities.
- Development of a comprehensive water management plan to quantify and address inefficiencies.
- Initiation of employee engagement programs to foster a culture of resource efficiency.

These steps will position the company to achieve both short-term cost reductions and long-term sustainability goals while enhancing operational resilience. In addition, it was recommended that the following KPIs be consistently monitored and incorporated into the company's EnMS framework:

- Specific energy consumption [kWh/t]
- Renewable energy share [%]
- Water specific consumption [m³/t]
- Wastewater treated and reused [%]
- Byproducts in production process [%]
- Material yield [%]
- Waste valorisation rate [%]

Finally, some challenges and barriers were identified during the audit process:

- **Limited management engagement**, which has resulted in restricted access to key personnel and operational data.
- **Data availability and quality**, namely persistent issues with water consumption metrics forcing auditors to rely on incomplete invoice records from 2023 as proxies for current consumption patterns.

- **Unavailable financial data**, related to material waste disposal costs and by-product revenues, creating gaps in the cost-benefit analysis of proposed improvements.
- **Operational constraints**, such as delegation of audit responsibilities to junior technicians rather than dedicated process engineers, have resulted in delayed responses to technical queries and occasional provision of inaccurate operational data.
- **Technical barriers**, including the absence of submetering for major energy-consuming equipment, making it difficult to pinpoint specific inefficiencies.

Company ID

Country	Greece
Sector of activity	Paper
SME	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Main activities developed	Paper and paperboard manufacturing industry

Consumption and costs summary

Dimension	Consumption/year	Unit	Costs/year [€]
Energy	56.34	[kWh]	not available
Water	1,382,601	[m ³]	not available
Raw materials	120,119.06	[kg]	not available

KPIs values per dimension

KPI	Unit	Value
Energy		
Carbon intensity	[kg CO _{2eq} /kWh]	0.18
Energy specific consumption	[kWh/t]	2,450.00
Renewable energy production	[%]	70.34
Water		
Total water consumption	[m ³]	1,382,601.00
Water specific consumption	[m ³ /t]	13.00
Water specific cost	[€/t]	0.003
Energy specific cost resulting from the use of water	[€/m ³]	0.24
Energy specific consumption from the water use	[kWh/m ³]	1.25
Materials		
Waste valorisation rate	[%]	63.60
Materials specific consumption	[kg/kg]	1.16

Energy efficiency measures

Description	Investment [€]	Payback period [years]	Energy savings/year [kWh _e]	Cost savings/year [€]	GHG emissions reduction/year [t CO _{2eq.}]
Installation of an Energy Management Software	500,000	1.8	2,817,134	281,713	1,690.28
Total	-	-	2,817,134	281,713	1,690.28

Water efficiency measures

Description	Investment [€]	Payback period [years]	Water savings/year [m ³]	Cost savings/year [€]	% savings
Automatic Boiler Blowdown Control	30,000	-	-	-	50% of make-up water
Repairing steam and condensate leaks	< 1,000	-			
Replacement of mechanical traps	1,500 per steam trap	-			
Optimization of Process-Water Recycling in the Pulping Stage	2,000,000	-	200,000	-	-
Installation of Water-Consumption Meters Across Key Process Stages	200,000	5,8	70,000	-	-
Total	-	-	270,000	-	-

Materials efficiency measures

Description	Investment [€]	Energy savings/year [kWh]	Materials savings/year [kg]	Cost savings/year [€]	GHG emissions reduction/year [t CO _{2eq.}]	% thermal savings
Replacement of Boiler Biomass Fuel from Sunflower Pellet to Wood from Crushed Pallets	0	4,046,330	943,411	161,723.60	715.20	2.33%
Total	0	4,046,330	943,411	161,723.60	715.20	2.33%

Key messages

The resource audit revealed opportunities for optimizing energy, water, and material usage, thereby lowering operational costs and minimizing environmental impact. The main efficiency measures identified were the implementation of an EnMS; enhancements to the plant's water management infrastructure; and optimization of material use. Additionally, in relation to thermal energy supply, an opportunity for fuel substitution in the biomass boiler has been identified. This change will be executed without altering the boiler's mechanical configuration or control systems, thereby ensuring that combustion performance, steam generation capacity, and operational stability continue to meet established technical standards.

Moreover, to capitalize the identified opportunities, the company's management was advised to prioritize two key actions:

- Investment in the EnMS to establish baseline monitoring capabilities.
- Development of a comprehensive water management plan to quantify and address inefficiencies.

These steps will position the company to achieve both short-term cost reductions and long-term sustainability goals while enhancing operational resilience. In addition, it was recommended that (at least) the following KPIs be consistently monitored:

- Specific energy consumption [kWh/kg]
- Carbon intensity [kg CO_{2,eq}/kWh]
- Renewable energy share [%]
- Water specific consumption [m³/t]
- Wastewater treated and reused [%]

Finally, some challenges and barriers were identified during the audit process:

- **Audit timing**, which has resulted in limited availability of key personnel, difficult access to information, and hard coordination of site visits/interviews.
- **Lack of centralized data management**, resulted in being data fragmented across several departments and individuals, which slowed the audit process and made it challenging to verify the accuracy of the information provided, as well as cross-reference data from different sources.
- **Data availability**, monthly breakdowns of production, energy, and water, as well as detailed cost information were lacking, preventing granular analysis, limiting benchmarking and restricting KPI calculation.
- **Unavailable financial data**, such as GVA or specific cost figures, restricted the ability to calculate some of the KPIs and to provide a fully comprehensive assessment.
- **Communication barriers**, such as the delegation of audit responsibilities to technical staff under pre-season workload pressures, resulted in delayed or incomplete responses to technical queries.
- **Pre-questionnaire not completed**, forcing the audit team to rely on direct interviews and on-site inspections to gather the necessary data, resulting in less efficient and more time-consuming data collection.

Company ID

Country	Portugal
Sector of activity	Textile
SME	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Main activities developed	Textile dyeing and finishing

Consumption and costs summary

Dimension	Consumption/year	Unit	Costs/year [€]
Energy	37,725,000	[kWh]	1,641,000
Water	473,827	[m ³]	37,967
Raw materials	not available	[kg]	not available

During this production process, the main raw material (fabric) is only processed and not accounted for as consumed raw material. However, during this production process, auxiliary dyeing products, natural dyes, and other softening and finishing products are consumed, but these have not been quantified.

KPIs values per dimension

KPI	Unit	Value
Energy		
Energy intensity	[kWh/€]	2.50
Carbon intensity	[kg CO ₂ eq./kWh]	0.12
Energy specific consumption	[kWh/t]	8,252.00
Renewable energy production	[%]	1.00
Water		
Total water consumption	[m ³]	473,827.00
Water consumption per GVA	[m ³ /€]	0.17
Water productivity	[€/m ³]	5.93
Water costs in the total costs incurred	[%]	1.00
Water specific consumption	[m ³ /t]	86.7
Water specific cost	[€/t]	6.95
Energy specific cost resulting from the use of water	[€/m ³]	0.94
Energy specific consumption from the water use	[kWh/m ³]	44,6
Alternative water sources used	[%]	23.00
Wastewater treated and reused	[%]	19.00
Materials		
Waste valorisation rate	[%]	59.30
Materials productivity	[€/kg]	0.61
Byproducts in production process	[%]	2.76

Energy efficiency measures

Description	Investment [€]	Paypack [years]	Savings potential/year								
			Electricity [kWh]	Electricity [€]	GHG emission [t CO _{2eq}]	Natural Gas [kWh]	Natural Gas [€]	GHG emissions [t CO _{2eq}]	Biomass [kWh]	Biomass [€]	GHG emissions [t CO _{2eq}]
Repair and replacement of steam traps	10,350.00	0.3	-	-	-	-	-	-	1,811,813.00	37,971.00	0.00
Installation of thermal insulation (steam network)	4,700.00	1.5	-	-	-	-	-	-	152,215.00	3,190.00	0.00
Heat recovery from liquid effluents (dyeing)	130,000.00	2.5	-	-	-	-	-	-	2,500,437.00	52,402.00	0.00
Heat recovery from gaseous effluent	350,000.00	5.9	-	-	-	514,497.00	32,867.00	119.00	1,255,800.00	26,318.00	0.00
Replacement of fluorescent lamps with LEDs	17,780.00	1.8	92,780.00	9,835.00	44.00	-	-	-	-	-	-
Total	512,830.00	-	92,780.00	9,835.00	44.00	514,497.00	32,867.00	119.00	5,720,265.00	119,881.00	0.00

Water efficiency measures

Description	Investment [€]	Payback [years]	Savings potential/year	
			Water [m ³]	Water [€]
Reuse of wastewater	- ³	-	-	67,364.00 ⁴
Monitoring of water consumption indicators	< 1,000	-	-	-
Total	-	-	-	67,364.00

Materials efficiency measures

Description	Investment [€]	Payback [years]	Savings potential/year	
			Materials [kg]	Materials [€]
Classification of byproducts from knitted and woven fabric waste	1,500.00 ⁵	1	125,981.00 ⁶	24,167.00 ⁷
Recovery of ash from the biomass boiler	-	-	-	7,340.00 ⁸
Total	1,500.00	-	125,981.00	31,507.00

³ Calculated on a case-by-case basis, depending on the dimensions.

⁴ These savings relate to operating costs.

⁵ Approximate investment value with the byproduct classification process.

⁶ Potential material savings are considered from an external perspective, i.e., materials with potential for use by other companies in the textile sector.

⁷ Estimated savings of €162/t considering the elimination of waste treatment costs, currently borne by the company, and the sale of the byproduct at zero cost. Depending on the quality of the byproduct, a financial return may be obtained, with informal research showing an average market value of around €50/t. There is also greater potential for the recovery of 100% cotton scraps that are clean, dry and properly separated. The savings from waste treatment can be added to the sale value, resulting in a much higher gain than indicated.

⁸ Savings of €67/t obtained from the difference between disposal costs of €132/t, currently borne by the company, and the cost of recovery, assuming an average treatment cost per recovery operation of €65/t.

Key messages

The audit performed enabled a detailed characterisation of the facility's energy consumption profile, as well as the identification of the main points of inefficiency and potential improvement opportunities. Energy consumption was mainly related to steam production and, consequently, to hot water generation, accounting for around 56% of total consumption. Thus, during the assessment, several improvement opportunities were identified, including:

- Repair and replacement of steam traps that are leaking steam.
- Installation of thermal insulation on piping and accessories in the steam distribution and condensate return networks.
- Heat recovery from liquid effluents from the dyeing section for pre-heating process water.
- Heat recovery from gaseous effluents from a stenter for pre-heating air and process water; and
- Replacement of fluorescent lighting with LED technology in production areas.

Additionally, it was recommended to continuously monitor energy performance through energy efficiency indicators, as well as to implement an EnMS to ensure ongoing tracking of results and improved practices.

Concerning water and the water-energy nexus, it was observed that the water consumed at the facility is drawn from the river, and the installation is equipped with several sub-meters, allowing for the identification of water consumption at each stage of the production process, as well as the detection of water leaks. Additionally, it was possible to determine that 42% of the water consumed at the unit is already recovered in the dyeing process, through the recovery of cooling and dyeing water. Consequently, improvement measures proposed include the installation of a WWTP (Industrial Wastewater Treatment Plant) for the treatment and reuse of the facility's wastewater. Beyond ongoing monitoring of the proposed indicators, it is recommended that their results be compared with the indicative environmental performance values for specific water consumption established in Commission Implementing Decision (EU) 2022/2508 of 9 December 2022. Additionally, the energy-related measure concerning the repair or replacement of steam traps in the steam distribution network also contributes to reducing water waste by preventing steam losses.

In the materials dimension, regarding waste management, it is noted that the recovery rate of around 60% demonstrates a partial application of the principles of the waste management hierarchy, giving priority to recovery. However, there is significant potential for improvement, particularly in relation to the ashes produced by the biomass boiler (LER 100101), which are currently sent to landfill. Furthermore, the absence of a formal classification of by-products represents a relevant opportunity for material recovery and for strengthening the circularity of the production process. The fabric trimmings, currently classified as processed textile fibre waste (LER 04 02 22), represent a stream with high recovery potential, estimated at around 3% of total production. Obtaining a by-product declaration for this material would allow its integration as a secondary raw material in the production processes of other companies in the textile sector, simultaneously contributing to waste reduction, decreased consumption of virgin raw materials, and the creation of economic value associated with its commercialisation.

Overall, the continuous monitoring of the main indicators analysed was considered essential for tracking performance progress, verifying the effectiveness of improvement actions implemented, and ensuring ongoing alignment with best practices in the sector.

Company ID

Country	Portugal
Sector of activity	Ceramics
SME	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Main activities developed	Production of ceramic tiles

Consumption and costs summary

Dimension	Consumption/year	Unit	Costs/year [€]
Energy	21,130,860	[kWh]	1,386,221
Water	1,744	[m ³]	4,710
Raw materials	25,119,672	[kg]	6,676,416

KPIs values per dimension

KPI	Unit	Value
Energy		
Energy intensity	[kWh/€]	8.03
Carbon intensity	[kg CO _{2e} /kWh]	0.19
Energy specific consumption	[kWh/m ²]	11.00
Renewable energy production	[%]	37.00
Water		
Total water consumption	[m ³]	1,744
Water consumption per GVA	[m ³ /€]	0.66
Water productivity	[€/m ³]	1,509
Water costs in the total costs incurred	[%]	
Water specific consumption	[m ³ /m ²]	0.0008
Water specific cost	[€/m ²]	0.0021
Materials		
Waste valorisation rate	[%]	100.00
Materials productivity	[€/kg]	0.10
Byproducts in production process	[%]	7.20
Materials specific consumption	[kg/kg]	1.27

Energy efficiency measures

Description	Invest. [€]	Payback [years]	Savings potential/year		
			Electricity [kWh]	Electricity [€]	GHG emissions [t CO _{2eq}]
Emissions-free dryer	-	-	2,000,000.00	132,000.00	-
IE2 to IE4 Motor	14,900.00	19	12,227.00	802.13	5.75
Total	14,900.00	-	2,012,227.00	132,802.13	5.75

Water efficiency measures

Description	Invest. [€]	Payback [years]	Savings potential/year	
			Water [%]	Water [€]
Ultrasonic Partial water meters for domestic and production uses (separate metering)	3,000.00	-	-	-
Ultrasonic Meter on the treated water line from the WWTP	1,000.00	3	-	-
Telemetry system for real time water monitoring	6,000.00	11	10 to 20%	540.00
Wastewater output ultrasonic meter	1,000.00	-	-	-
Total	11,000.00	-	-	540.00

Materials efficiency measures

Description	Invest. [€]	Payback [years]	Savings potential/year	
			Raw materials [kg]	Raw materials [€]
Reintegration or external incorporation of ceramic waste as a secondary material	n.a	n.a.	761,420.00	151,366.00 ⁹
Total	-	-	761,420.00	151,366.00

Key messages

The audited company demonstrated a moderately high energy intensity of 8.03 kWh/€, indicating that a significant amount of energy is required to generate economic output. With an energy specific consumption of 11.00 kWh per production unit, the site has room to optimize processes and reduce consumption per unit output. The carbon intensity, currently at 0.194 kg CO_{2eq}/kWh, suggests a considerable reliance on fossil fuels — particularly natural gas — and highlights the need for further decarbonization efforts. Notably, 37% of electricity consumption is covered by renewable sources, showing a solid level of clean energy integration.

It was possible to identify and evaluate high-impact energy efficiency measures, namely the installation of an emission-free dryer and the replacement of IE1/IE2 electric motors with IE4 models. These measures do not present significant technical or operational barriers. The dryer intervention was designed to avoid altering the production layout, and replacing the motors is a direct, low-tech, low-risk replacement. The only potential barriers are related to investment costs and the relatively long payback period for some measures, requiring appropriate financial planning. Moreover, continuous monitoring of the following KPIs was recommended:

- Energy specific consumption [kWh/P.U.] to assess the actual effectiveness of the measures implemented.
- Renewable energy production [%] to optimize the use of renewable energy in dryer operation.
- Carbon Intensity [t CO_{2eq}/KWh] to directly monitor environmental gains.

The analysis of the water related KPIs revealed a relatively low overall level of water consumption and apparently high efficiency in economic and production terms. Indicators such as water consumption per GVA (<1litre/€), specific water consumption (0.82 litre/m²) and water productivity (1,509 €/m³) suggest that the company uses low amounts of water to generate economic value and product production. Furthermore, the specific cost of water (0.0021 €/m²) confirms that water expenses represent an insignificant part of total production costs. However, these favourable figures should be interpreted with caution. The low water consumption and related efficiency indicators are mainly

⁹ Estimation based on 2024 consumption of 22 934 tonnes of atomised powder, a 3% reintegration would correspond to the avoidance of ~ 688 tonnes of virgin material per year. This would yield potential cost savings of over 151,000 €/year, assuming a conservative average powder cost of 220 €/t, obtained with an informal survey.

the result of the company's production setup and material supply chain, where raw materials are delivered ready to use, thus reducing the need for water intensive processing steps. Consequently, the KPIs reflect an overall low demand for water rather than deliberate water saving technologies or process optimisations. In summary, although KPIs indicate excellent water efficiency, the results mainly reflect the structural and operational characteristics of the production process than water management strategies. Further improvements should focus on maintaining low consumption levels by exploiting opportunities for active water efficiency measures and sustainable water management practises. Promoting water consumption monitoring will generate data records that support an understanding of the measures needed to increase the efficiency of processes and operations associated with the production line.

The company demonstrated a strong level of material efficiency, with materials specific consumption of 1.27 kg/kg and materials productivity of 0.10 €/kg, indicating effective use of raw materials relative to production output. While the current performance is good, there is potential to further optimise the incorporation of byproducts into ceramic production processes, thus reducing virgin material consumption. From a waste generation perspective, 100% of the solid waste is valorised, which aligns with the best available techniques for the sector. Measures such as powder recovery from pressing are already reducing waste. Furthermore, implementing a life cycle analysis enabled the identification of additional optimisation opportunities in line with the recommendations of the circular economy and best available techniques. This approach offers a low-risk, cost-effective way to gradually increase material recovery while maintaining product quality and process stability.

Company ID

Country	Malta
Sector of activity	Tourism/Hospitality
SME	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Main activities developed	Hotel

Consumption and costs summary

Dimension	Consumption/year	Unit	Costs/year [€]
Energy	430,339	[kWh]	61,092.93
Water	3,298	[m ³]	8,033.65
Raw materials	not available	[kg]	not available

Companies involved in the tourism sector are obliged by law to have in place and carry out waste separation practices at source for both organic and recyclable materials. This company already had in place practices enabling onsite waste separation and recycling. However, data on waste generated was not collected and therefore, no data/information was available for the materials dimension.

KPIs values per dimension

KPI	Unit	Value
Energy		
Energy intensity	[kWh/€]	0.77
Carbon intensity	[kg CO _{2eq} /kWh]	0.36
Water		
Total water consumption	[m ³]	3,298.00
Water consumption per GVA	[m ³ /€]	0.006
Water costs in the total costs incurred	[%]	0.80
Water consumption/employee	[m ³ /employee]	109.93

Energy efficiency measures

Description	Invest. [€]	Payback [years]	Savings potential/year		
			Electricity [kWh]	Electricity [€]	GHG emissions [t CO _{2eq}]
Installation of a BMS	38,400.00	2.7	99,592.75	14,938.91	38,741.60
Installation of permanent energy monitoring equipment	920.00	0.4	15,934.84	2,390.23	6,198.60
Installation of air-to water heat pumps	26,800.00	8.5	21,056	3,158.40	8,190.78
Total	66,120.00	-	136,583.59	20,487.54	53,130.98

Key messages

The results of the resource audit indicate that the company's energy and water usage align with industry standards for tourism organizations of comparable size and type. Regarding data availability, only limited information and data were available on the energy-water nexus dimension; moreover, there was no data available on the materials dimension, as this was not collected by the company.

During the audit, it was recommended to facilitate the metering, monitoring, and optimum operation of various systems - including HVAC and lighting - through the installation of a Building Management System (BMS), possibly integrated with a Room Management System (REMS). A similar, albeit less complex, improvement would be to install permanent energy monitoring equipment. The audited company noted that it generally adopts measures that have a low return on investment; therefore, the proposed measure to install heat pump water heaters was considered unfeasible.

Regarding the efficiency measures related to the energy-water nexus, the company considered opting for push-button water faucets when the current low-flow water faucets require replacement. It also noted that most of the recommended practices identified during the audit were already in place and emphasised the importance of training and raising awareness.

Furthermore, some barriers were identified during the audit process:

- **Company's initial involvement**, as it was difficult to get in touch with the company to provide data and schedule the resource audit at the beginning; although, the process of conducting the resource audit was smoother.
- **Data availability and quality**, namely GVA, materials, as well as granular data energy and water consumption. This limited the ability to accurately assess the company's resource consumption performance compared to similar organizations.
- **Top management mindset**, as the top management perceived the resource audit as too complex and felt that it did not fully meet their expectations, even though technical personnel informally expressed positive views about the resource audit.

V. Final survey presented to pilot case studies

General information

Question	Answer
Country	
Location	
Sector of activity	
Main activities developed	
NACE Code	
SME	<input type="checkbox"/> Yes <input type="checkbox"/> No

Sustainability and efficiency goals

Question	Answer
1. Do you have in place a clear sustainability policy ?	<input type="checkbox"/> Yes <input type="checkbox"/> No
2. Do you have specific sustainability/efficiency targets ?	<input type="checkbox"/> Energy <input type="checkbox"/> Water <input type="checkbox"/> Use of materials <input type="checkbox"/> Waste reduction <input type="checkbox"/> Environmental <input type="checkbox"/> Other

Question	Answer
3. Do you plan to increase your efforts towards sustainability goals and/or net zero emissions in the next 1-3 years?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Undecided
4. What kind of support would you need to maximise your goals?	<input type="checkbox"/> Training <input type="checkbox"/> Subsidies/grants <input type="checkbox"/> Tax reduction <input type="checkbox"/> Tailored advice services <input type="checkbox"/> Collaborative projects <input type="checkbox"/> Other

LEAPto11 project

Question	Answer
1. Have you ever considered to perform an integrated resource audit (energy, water and materials) before the LEAPto11 pilot audits?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Only water <input type="checkbox"/> Only materials
2. If your answer was yes, and the audit was not done, what prevented you from proceeding?	<input type="checkbox"/> Financial constraints <input type="checkbox"/> Lack of awareness <input type="checkbox"/> Limited technological options <input type="checkbox"/> Resistance to change <input type="checkbox"/> Lack of support or regulation <input type="checkbox"/> Perceived complexity
3. The LEAPto11 project influenced you to increase your efforts towards sustainability goals and/or net zero emissions?	<input type="checkbox"/> Yes <input type="checkbox"/> No

Question	Answer
<p>4. If your answer was yes, in which degree (from 1 to 5, 1 not influence at all and 5 totally influenced it)?</p>	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5
<p>5. In which degree the LEAPto11 project increased your knowledge/awareness on energy savings and/or energy efficiency (from 1 to 5, 1 not increased at all and 5 highly increased)?</p>	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5
<p>6. In which degree the LEAPto11 project increased your knowledge/awareness on water savings and/or water efficiency (from 1 to 5, 1 not increased at all and 5 highly increased)?</p>	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5
<p>7. In which degree the LEAPto11 project increased your knowledge/awareness on materials savings and/or materials efficiency (from 1 to 5, 1 not increased at all and 5 highly increased)?</p>	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5
<p>8. In which degree the LEAPto11 project increased your knowledge/awareness on the concept of integrated resource audit (from 1 to 5, 1 not increased at all and 5 highly increased)?</p>	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5

Question	Answer
<p>9. In which degree the LEAPto11 project increased your willingness to act on energy efficiency improvements (from 1 to 5, 1 not increased at all and 5 highly increased)?</p>	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5
<p>10. In which degree the LEAPto11 project increased your willingness to act on water efficiency improvements (from 1 to 5, 1 not increased at all and 5 highly increased)?</p>	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5
<p>11. In which degree the LEAPto11 project increased your willingness to act on materials efficiency improvements (from 1 to 5, 1 not increased at all and 5 highly increased)?</p>	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5
<p>12. In which degree the LEAPto11 project increased your willingness to act globally on resource efficiency features (from 1 to 5, 1 not increased at all and 5 highly increased)?</p>	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5
<p>13. What is your willingness to proceed with potential future support from LEAPto11 project or related initiatives (from 1 to 5, 1 not interested at all and 5 highly interested)?</p>	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5

LEAPto11 pilot audits

Question	Answer
1. Do you consider that the pilot audit performed was excessively time-consuming ?	<input type="checkbox"/> Yes <input type="checkbox"/> No
2. If your answer was yes, why?	<input type="checkbox"/> Field audit took too long <input type="checkbox"/> Pre-audit data too complex to collect <input type="checkbox"/> Too many interactions with the audit team (post-audit data requirements) <input type="checkbox"/> Other
3. Do you consider that the audit report fulfilled the top management expectations?	<input type="checkbox"/> Yes <input type="checkbox"/> No
4. If your answer was no, why?	<input type="checkbox"/> Too long <input type="checkbox"/> Too complex <input type="checkbox"/> Not adapted to the company needs <input type="checkbox"/> Other
5. Do you consider implementing any of the efficiency/improvement measures suggested?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Only water <input type="checkbox"/> Only materials <input type="checkbox"/> Only energy
6. Do you have any comment and/or advice to improve the pilot audit overall approach?	