EnergyEfficiency4SMEs Follow-up Study

4 July 2025

Prepared for: Malta Business Bureau (MBB)

Co-funded by the European Union

Scope of Work

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- Carrying out a review of the data gathered to date by the project team.
- Conducting research to gather further insights and data pertinent to the study objectives.
- Formulating a complete state of play report addressing all the research objectives stipulated in the request for quotation.

More specifically, Deloitte Malta aims to fulfil the 4 research objectives mentioned in the Call for Quotation, namely:

- **Objective 1:** Examine Energy Efficiency Measures

  Evaluating energy efficiency measures collected through energy audits and performance surveys, assessing financing mechanisms used during implementation, and identifying barriers encountered.

- **Objective 2:** Conduct a Contextual Analysis

  Exploring the broader socio-economic benefits of energy savings, studying energy production trends in partner countries, estimating environmental externalities, and assessing current and future energy costs.

- **Objective 3:** Generate and Shortlist Recommendations

  Conducting short-listing exercises to refine the recommendations/measures.

- **Objective 4:** Evaluate and Prioritize Socio-Economic Impact

  Assessing the cost-benefit ratio and overall socio-economic impact of energy measures under various uptake and implementation scenarios, prioritizing actions with stakeholders.

Limitations of Study

The analysis and conclusions presented in Objective 1 (Examine Energy Efficiency Measures) are based solely on the data supplied by the client. As such, the accuracy, completeness, and reliability of the findings are contingent upon the integrity of the original data. The author assumes no liability for any errors, omissions, or misinterpretations resulting from inaccurate or incomplete data submissions. Readers are encouraged to interpret the results in Objective 1 with this context in mind and to consult the original data providers for clarification where needed.

Identifying and assessing the non-energy benefits (NEBs) and non-energy efforts (NEEs) of energy efficiency measures ówhether they are quantified or not óis highly context-dependent. Therefore, producing reliable, non ócompany-specific estimates of these impacts would require extensive primary data collection, such as large-scale surveys and structured stakeholder workshops across all nine countries. The scale and resource demands of such effort lie beyond the scope of this study.

Given this constrain, the study adopted a pragmatic approach to achieve Objective 4. First, it applied Tool 1 from the KNOWnNEBs project, which is developed from over 130,000 data points, to assign relevant NEBs to each targeted energy efficiency measure. Second, it compiled related NEEs through desktop research of peer-reviewed literature, policy documents, and expert sources. Finally, it outlined clear, replicable methodologies for quantifying these impacts and converting them into monetary terms, providing a foundation that future analysis can built upon as more data becomes available.

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EE4SMEs

Background

EE4SMEs

EE4SMEs (EnergyEfficiency4SMEs) is an EU-supported initiative designed to significantly enhance energy efficiency, reduce energy consumption, and promote sustainable energy practices among small and medium-sized enterprises (SMEs). The project focuses on specific NACE sectors, namely:

- Accommodation and food service activities (NACE Code: I55 to I56.3.0)
- Manufacturing óAgri-food (NACE Code: C10 to C11.0.7)
- Manufacturing óMetalwork (NACE Code: C24 to C25.9.9)

EE4SMEs is implemented by a consortium of 23 partners across 9 European countries. These include Austria, Bulgaria, Cyprus, Estonia, France, Germany, Italy, Malta, and Spain.

Over a 36-month period, the project aims to directly support 1,000 companies in conducting energy audits, with a specific target of completing 141 audits within this timeframe. In addition, EE4SMEs focuses on strengthening the skills and expertise of 1,000 company personnel and 200 energy auditors and stakeholders (1).

The key objectives of EE4SMEs include (2):

1. **Best Practices and Recommendations:** Identify best practices from larger companies and adapt these into cost-effective, tailored recommendations for SMEs in the targeted sectors.

2. **Tool Development**: Create practical tools and resources that facilitate the energy transition process for SMEs.

3. **Action and Analysis:** Identify concrete energy-saving measures and, when needed, carry out additional studies-such as energy diagnoses and feasibility assessments-to ensure the viability of the proposed actions.

4. **Awareness and Commitment:** Raise awareness and encourage SMEs to adopt sustainable energy management practices that can lead to the implementation of energy management systems.

5. **Capacity Building:** Strengthen the capacity of SMEs through targeted training and support for the implementation of energy efficiency measures.

6. **Financing Options:** Explore innovative financing options and funding mechanisms to help SMEs implement energy efficiency initiatives successfully.

a \Ù‡ :and Background for EE4SMEs Follow-Up Study

The Malta Business Bureau (MBB), in partnership with the Energy and Water Agency (EWA), serves as the local implementing partner for the EE4SMEs project in Malta. In this capacity, MBB operates an information contact point offering free advisory services to SMEs. These services include guidance on financial grants and financing opportunities to support the implementation of sustainable projects aimed at reducing emissions. Additionally, MBB assists businesses in applying for energy audits, with the EWA fully or partially covering the costs of selected audits.

An initial high-level economic study, titled " Z å X ß ((Y-Final High- [ô } ô + ß (è : 2 : 1 è ß was ô U : X e æ completed in October 2023. Its primary objective was to assess the current business needs for energy efficiency projects and the financing options available at both national and regional levels across participating countries. The study also includes sector-specific economic data and insights from self-assessment questionnaires, and it outlines key challenges, investment barriers, and high-level policy recommendations to support and advance energy efficiency initiatives among SMEs.

Building on this foundation, MBB is commissioning a follow-up study to revisit key areas covered in the initial report while expanding its scope to include: an analysis of the number and types of initiatives financed under the EE4SMEs project, a review of the financing mechanisms used for these initiatives, identification of barriers to financing, emerging trends and opportunities in the financing landscape, and recommendations for both the public and private sectors to develop or enhance financial mechanisms supporting energy efficiency initiatives.

Objective 1:

Examine Energy Efficiency Measures

Source: Templafy library, Deloitte Internal

Examine Energy Efficiency Measures

Evaluating energy efficiency measures collected through energy audits and performance surveys, assessing financing mechanisms used during implementation, and identifying barriers encountered.

Energy Audits

Directive (EU) 2023/1791 of 13 September 2023 on energy efficiency óread in tandem with the earlier Directive 2012/27/EU and Commission Recommendation (EU) 2024/2002, outlines the definition and objectives of energy audits.

Under these directives, an energy audit is defined as a systematic process that starts with a detailed analysis of the energy consumption profile of a building, group of buildings, industrial or commercial operation, or public service. Based on this analysis, energy conservation measures (ECMs) are proposed, accompanied by economic analysis to guide investment decisions (3).

Enterprises with an average annual final energy consumption exceeding 85 TJ over the previous three years are required to implement a certified energy management system, typically aligned with ISO 50001 standards. Those with consumption between 10 TJ and 85 TJ, and without a management system, must conduct an energy audit and repeat it every four years. Although SMEs generally do not exceed these thresholds, the directive encourages them to undertake audits voluntarily and implement recommended measures. EU-funded initiatives, such as the EE4SMEs project, provide technical assistance and financial incentives to make energy audits more accessible for smaller enterprises.

Audits Received

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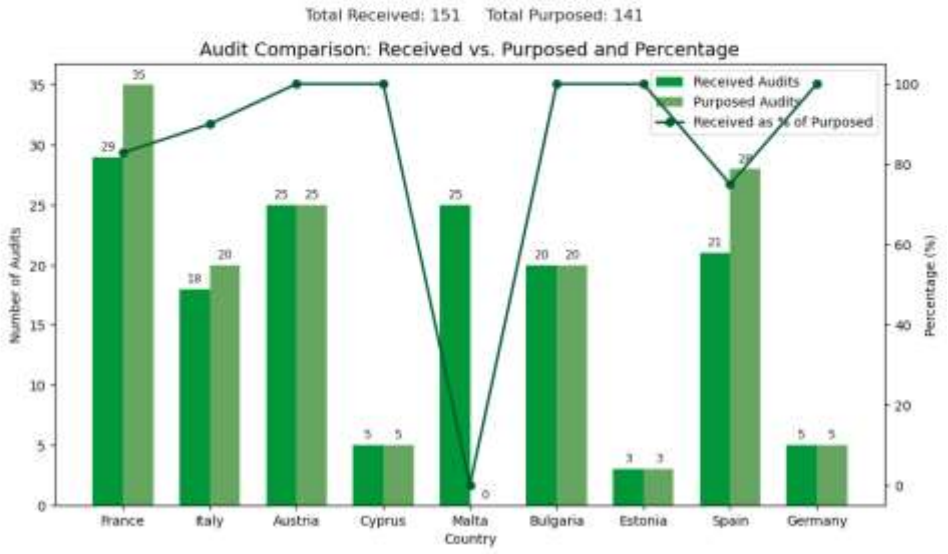
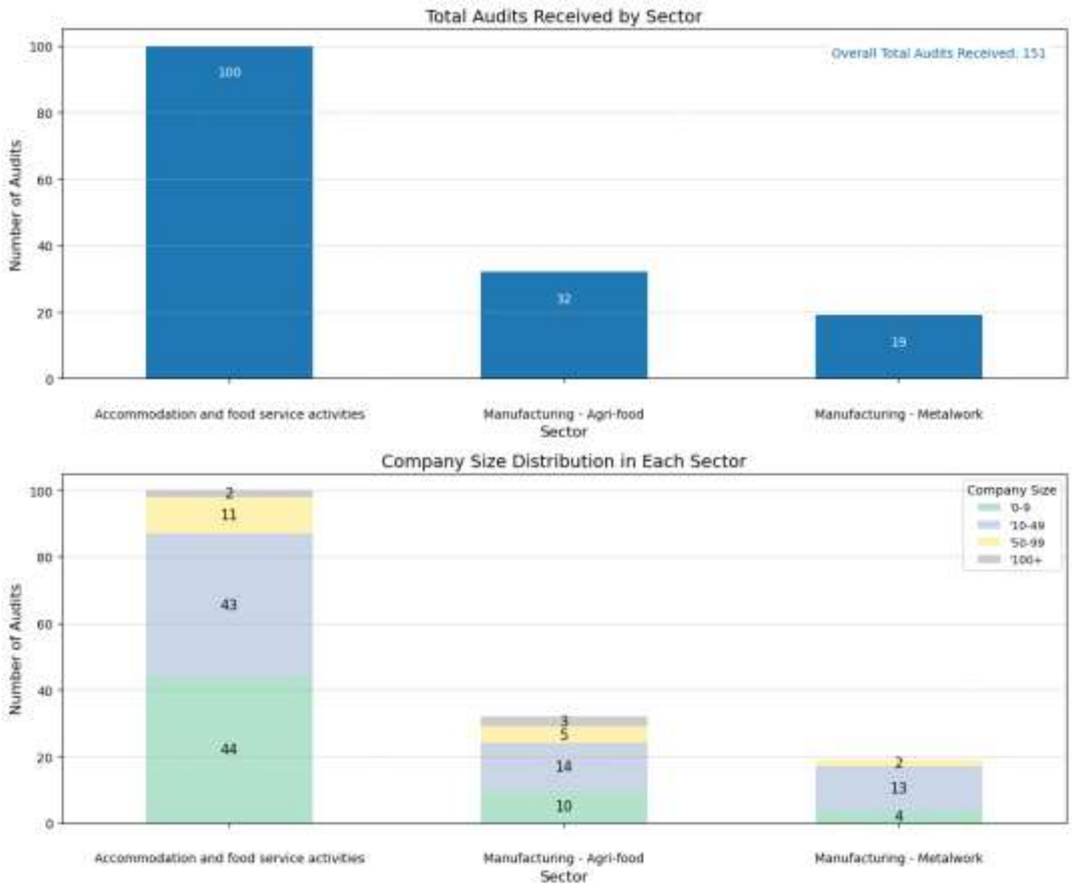
To date, 151 audits have been received, exceeding the original target by 7.1%. This overachievement is primarily due to several countries meeting or surpassing their assigned targets. Austria, Cyprus, Bulgaria, Estonia, and Germany each achieved 100% of their planned audits. **Malta, despite not having an assigned target, contributed an additional 25 audits.** In contrast, France, Italy, and Spain fell short of their targets, achieving approximately 83%, 90%, and 75% respectively.



Source: EE4SMEs WP3 Energy Audit Data

The methodology, progress, and results of these audits are documented under Work Package 3 (WP3), specifically in Deliverable 3.2, (2ôX …ß jî eß‡ôU:Xe\ßÍ2îß Í\ èß> 2î 2 \ßandXße ôß„ÍXe Deliverable 3.3, ‹j11ÍX…ß‡ôU:Xeß: ße ôß Í\ èß‡ôè:11ô2îÍe :2\ß :Xß(2ôX …ß˜U X j +î 2 \ßÍ2îß„X: Selected findings from these deliverables are discussed in the following sections of this report, alongside additional insights derived from the raw energy audit data provided by the WP3 lead.

Across all participating countries, most audits (66%) were conducted within the Accommodation and Food Service Activities sector, followed by Manufacturing óAgri-food (21%) and Manufacturing ó Metalwork (13%). In terms of company size, the audits predominantly focused on smaller enterprises, particularly those with fewer than 50 employees. Micro enterprises (0–9 employees) and small enterprises (10–49 employees) accounted for the majority of audit activities, while lower-medium (50–99 employees) and upper-medium enterprises (100+ employees) represented a smaller proportion. This î \eX æje :2ÙXô +ôèe\Ùe ôÙUX:$ôèe \Ùô1U Í\ \Ù:2Ùô2 Í 2 Ùe ôÙ :j2îÍe :2 ecosystem when conducting energy audits.



Source: EE4SMEs WP3 Energy Audit Data

The contracted energy auditors were tasked with recommending energy efficiency measures based on their site inspections. For each recommended measure, they provided key economic indicators, including capital cost, net present value (NPV), internal rate of return (IRR), payback period, and break-even period. They also estimated both primary and final energy savings - broken down by electricity and fuel - as well as the projected reduction in greenhouse gas (GHG) emissions.

Energy Performance Survey

Following the launch of the EE4SMEs project, Work Package 8 (WP8) was established to monitor its effectiveness and impact. WP8 focuses on three key objectives:

- Measuring improvements in the energy performance of beneficiary SMEs.
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- Capitalising on results within the participating countries.

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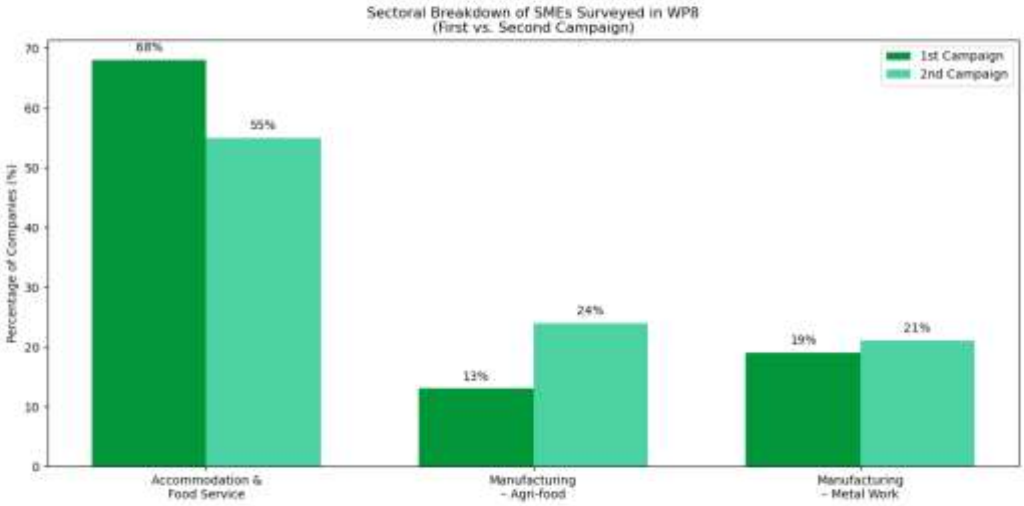
Surveys Received

Across both data collection campaigns, a total of 268 companies were surveyed. In the first WP8 survey, which included 123 firms, the majority of participating SMEs (68%) were from the accommodation and food services sector, with metalworking and agri-food manufacturing companies comprising 19% and 13% of the sample, respectively. In the second campaign, which surveyed 145 firms, participation expanded to include a wider range of manufacturing sub-sectors, particularly agri-food, while the share of companies from the hospitality sector decreased but remained represented.



Source: EE4SMEs WP8 Progress Reports

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Funding Mechanism ó EU or Public Funding Programs:

Among the companies that reported implementing energy efficiency measures, an average of 30% (across both surveys) received support from EU or public funding programs. The most frequently cited funding mechanisms are listed below:

Source: EE4SMEs WP8 Progress Reports

Förderung des Klima- und Energiefonds (Austria) - This + 1 Í e ô Ù Í 2 î Ù (2 ô X ... Ù > j 2 î Ù \ j U U : X e \ Ù U X : $ ô è e energy transition and climate protection goals, focusing on innovations in renewable energy, sustainable mobility, and energy efficiency for municipalities, businesses, and research institutions (14).

Operational Programme "Innovations and Competitiveness" (Bulgaria) - Co-funded by the EU, this programme aims to enhance innovation and energy efficiency among Bulgarian SMEs by offering grants for green investments such as energy audits, building upgrades, and renewable energy installations (15).

CEE ó ô X e è Í e Ù î) è : 2 : 1 ô \ Ù î) 2 ô X - The Energy Savings Certificate (CEE) scheme requires energy suppliers to finance energy efficiency projects in exchange for certificates representing the energy saved, making it a key funding mechanism for industrial and building improvements in France (16).

„ (‡ > ó Programme CCI BFC (France) - Led by the Chamber of Commerce and Industry of Bourgogne-Franche-Comté (CCI BFC), this regional initiative offers guidance and co-funding for SMEs to conduct energy audits and implement recommended measures, particularly within industrial operations (17).

Other Funding Sources:

- KfW Energieeffizienzprogramm (Germany)
- BAFA Energy Consulting (Germany)
- Conto Termico (Italy)
- KredEx Energy Efficiency Loans (Estonia)
- Energy Efficiency & Renewable Sources Fund (EERSF) (Bulgaria)
- National Energy Efficiency Fund (FNEE) (Spain)
- ADEME SME Financing (France)
- SME Guarantee Scheme (MDB)

GUEST Projects ÓEnergy Audit (Malta) - Led æ…Ùa ÉĦAÍ with MBB as a project partner, this initiative provides SMEs (boutique hotels and guesthouses) with free or subsidised energy audits to increase awareness of energy-saving opportunities and facilitate implementation by reducing upfront costs (18).

Energy Audits for SMEs (Malta) - Offered æ…Ùa ÉĦA, the Energy Audits for SMEs scheme provides certified energy audits to SMEs across all sectors. Depending on eligibility, it covers between LQàTOOÙÍ2î, reimbursing either the full or partial cost of the audit (96).

EENergy (EU-wide) Ó Funded through the Enterprise Europe Network, the EENergy initiative provides SMEs with direct, non-repayable grants of up to LPOàOOOÙe:Ù\jUU:XeÙô2ôX …Ùô è ô2è…Ù covering advisory services, investments, or training designed to achieve at least a 5% reduction in energy consumption and GHG emissions (97).

Andalusian Regional Energy Agency (Spain) - The Agencia Andaluza de la Energía offers grants to SMEs for energy audits, equipment upgrades, and renewable energy installations (19).

NextGenerationEU (EU-wide, Spanish Allocation) -As part of the broader NextGenerationEU recovery programme, funding in Spain is directed towards green and digital transitions, with significant allocations for energy-efficient building renovations, SME support, and clean energy projects (20).

Funding Mechanisms ÓOther Sources:

For companies that implemented energy efficiency measures without public or EU funding, the WP8 reports and survey data do not specify the alternative financing mechanisms used. Therefore, desktop research and insights from high-level economic studies (D5.3) were used and revisited to identify the following options:

Bank Loans and Green Loans:

Traditional bank loans remain a widely used financing option for SMEs undertaking clean energy projects. I2èXôÍ\ 2 +…àÙè:11ôXè Í+ÙæÍ2'\Ù: ôXÙ -linked loans specifically tailored to 2Íæ + e… support energy efficiency improvements and renewable energy installations. These loans provide upfront capital that SMEs repay over time with interest, typically secured against project assets or company revenues.

Banks often offer preferential terms for projects with clear environmental benefits, such as reduced interest rates or extended repayment periods. In Spain, for example, BBVA and other banks are expanding green loan portfolios to support such initiatives (21). These loans are frequently combined with risk-sharing instruments from institutions like the European Investment Bank, which help reduce financial risk and encourage greater private sector investment in clean energy.

Equipment Leasing and Green Leasing:

Instead of purchasing equipment outright, SMEs can lease energy-efficient technologies or renewable ô2ôX …Ù\…\eô1\àÙ\jè ÙÍ\Ù\:+ÍXÙUÍ2ô+\Ù:XÙô+ôèeX èÙ}ô è+ô\ßÙ˜2îôXÙÍ company or bank buys the equipment and the SME makes periodic payments for its use. This model is particularly beneficial for high-cost clean technologies, as it eliminates the need for significant upfront investment.

In Austria, for example, the Klima- und Energiefonds has partnered with banks to promote clean technology leasing by combining public incentives with private financing (14). Similarly, solar leasing models in Malta and Cyprus enable companies to install solar panels on SME premises at little to no upfront cost, with the SME paying a fixed monthly fee rather than owning the system outright, thereby reducing barriers to renewable energy adoption (22).

Green Bonds and Sustainable Bonds:

Green bonds are fixed-income debt instruments whose proceeds are dedicated exclusively to environmentally beneficial projects. While SMEs typically do not issue their own green bonds due to their smaller scale, they can benefit indirectly. Large corporations or banks issue green bonds to raise capital, which is then used to finance numerous smaller projects, including energy upgrades for SMEs.
For example, in France, corporate green bonds have funded solar farm developments and building retrofits, with SMEs often involved as contractors or beneficiaries of financing down the supply chain (23). In Italy, banks such as Intesa Sanpaolo have issued green bonds and used the proceeds to provide discounted loans to businesses for renewable energy installations (24).

Energy Performance Contracts (EPCs) with ESCOs:

An Energy Performance Contract (EPC) is an agreement in which an Energy Service Company (ESCO) implements energy efficiency or renewable energy measures for a client, such as an SME, while guaranteeing a specified level of energy savings. This market-based mechanism typically requires no upfront payment from the SME; instead, the project costs are repaid over time using the savings
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or from a bank or investor that provides capital based on the guaranteed future savings.
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bundle multiple projects to generate white certificates (tradable energy efficiency certificates), creating an additional revenue stream through the sale of these certificates (25).

Energy Service Agreements & Power Purchase Agreements (PPAs):

A Power Purchase Agreement (PPA) is a contract commonly used in renewable energy projects, where a developer or investor builds and operates a renewable energy installation - such as a solar array or wind turbine - and the customer (off-taker) agrees to purchase the generated electricity at a fixed rate over a long-term period, typically 10 ́20 years. For SMEs, this often involves hosting a solar PV system on their rooftop, funded by a third party, allowing them to buy clean electricity at an agreed price without making any capital investment in the system (26).
Similarly, some ESCOs offer Energy Service Agreements, installing equipment such as high-efficiency
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this arrangement, the SME avoids the upfront cost of purchasing equipment and instead pays for the delivered service-whether heat, cooling, or electricity-at a rate that is typically lower and more efficient than their previous supply (27).

Carbon Credit Trading:

SMEs undertaking decarbonisation projects can generate carbon credits, typically equivalent to one ton
: Ù i ¼ Ù ë : X Ù e \ Ù equivalent) emissions reduced per credit. For example, installing energy-efficient machinery or biogas units that verifiably cut emissions beyond a set baseline can result in certified credits, which can then be sold to other companies-often larger emitters-seeking to offset their emissions to meet compliance requirements or voluntary climate goals.
Within the EU, large emitters such as power plants, heavy industry, and aviation operators participate in the EU Emissions Trading System (EU ETS), a mandatory cap-and-trade scheme covering around 40% of
e ô Ù (˜ \ Ù X ô ô 2 : j \ ô Ù Í \ Ù ô 1 \ \ : 2 \ ß Ù ‹ a (\ à Ù ô \ U ô è Í + + … Ù those outside the sectors regulated under the EU ETS, typically engage in voluntary carbon markets to offset their emissions or support external climate

projects. These voluntary markets enable SMEs to buy or sell carbon credits generated from projects that reduce or remove greenhouse gases, including initiatives outside the EU or in unregulated sectors (28).

Energy Efficiency Certificates (White certificates):

Some countries, notably Italy and France, operate Energy Efficiency Certificate schemes, commonly '2:•2ÙÍ\Ù • eôÙèôXe èÍeô\ß Ù“ ô\ôÙeXÍîÍæ+ôÙèôXe èÍeô\ÙÍXôÙÍ•ÍXîôî
Utilities and large energy distributors, which have mandated energy-saving targets, can purchase these certificates from organisations that exceed their savings, such as ESCOs or companies implementing efficiency projects.

For SMEs, this means that by undertaking qualifying energy efficiency projects, they-or an ESCO acting on their behalf-can earn certificates that can be sold for cash, creating an additional revenue stream. Under IeÍ+… \Ù“ e:+ Ùî Ù(è ô2•ÍÙ(2ôX ôe èÍÙü“((ýÙ\…\eô1àÙ :XÙô„Í1U+ôàÙÍ2
LED would generate certificates based on the kWh saved (29). These certificates can then be sold to obligated parties, such as electricity distributors, either directly if the SME is accredited or via an ESCO that manages the certification and sale process.

Crowdfunding and Peer-to-Peer Financing:

With growing sustainability awareness, crowdfunding platforms now enable private citizens to invest directly in renewable energy and energy efficiency projects, including those led by SMEs. Through dedicated platforms such as Lendosphere in France (30), SMEs can raise funds for initiatives like solar farms or building retrofits from public or private investors, often offering a small equity stake, interest payments, or a share of future revenues in return.

Hybrid Models (Blended Finance & Insurance):

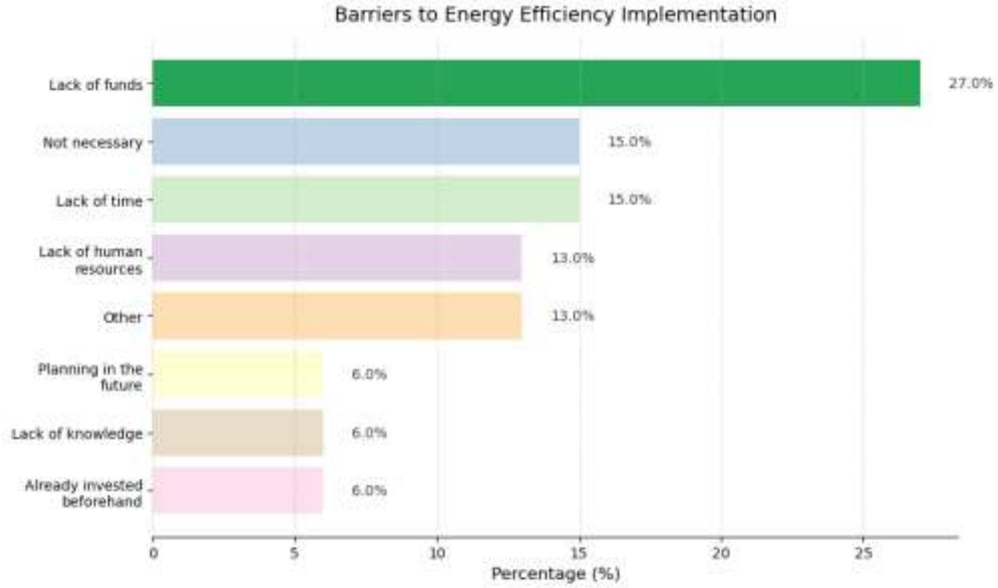
In addition to purely private financing mechanisms, hybrid models combine private capital with guarantees or insurance products to reduce risks.

- **Energy Savings Insurance (ESI):** Developed by the Basel Agency for Sustainable Energy (BASE) and piloted in several EU countries, ESI involves an insurance company guaranteeing the expected energy savings from a project (31). For example, if an SME installs an energy-efficient compressor and the projected savings are not achieved, the insurance policy compensates the SME for the shortfall. This assurance increases bank confidence in lending and encourages SMEs to invest by reducing performance risk.

Overall, these mechanisms mobilise private capital and market incentives to support SME decarbonisation. In practice, SMEs often combine multiple tools-such as using a bank loan alongside an EPC with an ESCO, while also benefiting from white certificates and potentially selling carbon credits. Layering these financing sources makes projects more bankable and affordable.

Barriers to Financing:

Despite the availability of various public and private funding sources, SMEs often remain hesitant to invest in energy efficiency measures due to a combination of financial, organisational, and informational barriers. These challenges are documented in the WP8 D8.2 report and summarised below:



Source: EE4SMEs WP8 Progress Reports

Survey results identified lack of funds as the most common barrier, reported by 27% of respondents. Lack of time and the perception that energy efficiency measures are unnecessary were each cited by 15% of participants. Additionally, lack of human resources and other reasons were each mentioned by 13% of companies.

Beyond these primary categories, SMEs highlighted several qualitative barriers, including:

- **Concerns about profitability and return on investment (ROI)** - particularly when the ROI is perceived as too long-term or uncertain.
- **Administrative burdens and complexity** in accessing available support mechanisms.
- **Context-specific restrictions**, such as heritage protection rules, space constraints, the presence of asbestos, or building ownership issues.
- **Operational concerns**, including extended downtime during implementation, increased maintenance requirements, and compatibility challenges with existing systems.
- **Strategic or perceptual barriers,** such as other competing business priorities, pressure to increase turnover, or a general lack of interest or awareness regarding energy efficiency opportunities.

These findings underscore the importance of comprehensive support strategies that address not only financial limitations but also the operational, regulatory, and perceptual challenges SMEs face in pursuing energy efficiency.

Energy Efficiency Measures Analysis

The following sections compare energy efficiency measures identified through energy audits (WP3) and energy performance surveys (WP8) to provide insights into SME adoption patterns and underlying drivers. This analysis draws on selected findings from project deliverables, supplemented by raw datasets provided by project stakeholders.

However, these results should be interpreted with caution due to data limitations, including the small sample size and potential biases caused by the over-representation of certain countries, sectors, or company sizes.

Standardisation of Measures

Energy efficiency measures reported in both the energy audits (WP3) and energy performance surveys (WP8) were captured using broad, predefined categories. Rather than providing detailed descriptions, respondents typically selected ô 2 ô X Í + Ù : U e : 2 \ Ù \ j è Ù Í \ Ù æ j + î 2 è : 1 U X ô \ \ ô î Ù Í X à Ù : X Ù } ô 2 e + Í e type of intervention implemented or recommended. : e Ù \ : j X è ô \ Ù Í + \ : Ù 2 è + j î ô î Ù Í 2 Ù i e capture measures not covered by existing options.

WP8 uses a categorisation system outlined in Deliverables 8.1 (D8.1 Intermediate Report 1 ù Life-CET-Business ù EE4SMEs) and 8.2 (D8.2 Intermediate Report 2 ù Life-CET-Business ù EE4SMEs).

WP3 uses a classification system detailed in Appendix A of Deliverable 3.3 (Aggregated Upgrade Measures Recommendations of the Energy Audit).

However, the categorisation systems differed between WP3 and WP8 ó each using different naming conventions and including measure types not present in the other. To enable comparison of measures across WP3 and WP8, standardisation was required. This process was challenged by the absence of clear definitions for many categories, necessitating the use of informed judgment to interpret each è Í e ô : X … \ Ù 2 e ô 2 î ô î Ù 1 ô Í 2 2 and ensure consistent harmonisation.

The alignment of energy efficiency measures followed these steps:

- **Selection of Reference Framework**:
  The WP8 categorisation system was chosen as the primary reference due to its greater detail and broader coverage of measure types.
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  - j + î 2 Ù X ô 2 : } Í e : 2 Ù 1 ô Í \ j X ô \ Ù 2 e Í + + … Ù è + Í \ \ ô î Ù j 2 î ô X Ù i e ô X existing WP8 categories. Where no suitable category existed, new categories were created to match WP3 classifications.
  - Industrial furnaces à Ù U X ô } j 2 è \ Í + e . ô Ù X \ ô î Ù j 2 î ô X Ù i e ô X à Ù • Í \ Ù Í \ \ 2 ô î Ù e distinct category.
  - The category ‡ Í \ 2 Ù \ e Í Ù Í • Í X ô 2 ô \ \ Ù was created to specifically capture behavioural changes, distinguishing them from operational improvements, which are captured j 2 î ô X Ù e ô Ù i U e 1 \ Í e : 2 Ù è Í e ô : X … ß Ù
- **Mapping WP3 Measures to WP8 Categories:**
  Once the updated WP8 categorisation was finalised, all measures reported through WP3 were mapped to these standardised categories to ensure consistency.

Details of the alignment procedure and the full mapping of energy efficiency measures are provided in Appendix A.

Standardised Measure Categories

The following standardised categories were used in this analysis:

1. **Lighting**:
   Upgrading to energy-efficient lighting technologies (e.g. LEDs) to reduce electricity use and improve illumination quality.
2. **Building Heating**:
   Improving heating systems through high-efficiency equipment and better insulation to reduce energy consumption while maintaining comfort.
3. **Renewable Energies**:
   Integrating renewable sources such as solar panels or wind turbines to generate sustainable energy and reduce fossil fuel dependency.
4. **Heat Pumps and Heat Recovery**:
   Using heat pumps for efficient heating/cooling and implementing heat recovery systems to reuse waste heat from processes or ventilation.
5. **Compressed Air**:
   Optimising compressed air systems by fixing leaks, adjusting pressure settings, and upgrading equipment to increase efficiency in industrial operations.
6. **Ventilation**:
   Enhancing ventilation systems with energy recovery ventilators or demand-controlled ventilation to maintain air quality while reducing energy loss.
7. **Cooling**:
   Upgrading cooling systems to high-efficiency models and applying passive cooling strategies to lower energy consumption and improve indoor comfort.
8. **Energy Management**:
   Implementing automated systems and data analysis tools to monitor, control, and optimise energy use within facilities.
9. **Office Space (e.g., Equipment):**
   Using energy-efficient office equipment and power management practices to reduce electricity use in office environments.
10. **Facade Thermal Insulation, Roof Thermal Insulation, Openings Replacement, and Shading**:
    Enhancing facades, roofs, windows, and shading to reduce heat loss/gain through insulation, efficient openings, and shading devices.
11. **Industrial Furnaces**:
    Upgrading furnaces with advanced controls, efficient burners, and improved insulation to reduce energy use and enhance process efficiency.
12. **Distribution Networks and Insulation**:
    Improving efficiency in facility distribution systems by insulating pipes/ducts and optimising layouts to minimise energy losses.
13. **Pumps**:
    Installing energy-efficient pumps and controls, such as variable frequency drives, to align pump operation with system demand and reduce energy use.
14. **Optimisation**:
    Technical or procedural changes to existing systems or infrastructure that improve energy efficiency or reduce emissions without requiring significant behavioural change from users.
15. **Raising Staff Awareness**:
    Action focused on changing human behaviour to encourage more energy-conscious habits, without making major technical changes.
16. **Transportation**:

Actions that reduce the energy consumption or emissions of business-related transport activities ǵincluding fleets, logistics, commuting, and distribution.

Energy Efficiency Measures Attributes

Following the standardisation of energy efficiency measures from the energy audits and the energy performance survey, their key attributes were analysed to enable meaningful comparisons and insights. Three primary attributes were defined:

1. **technical feasibility,**
2. **economic viability, and**
3. **environmental impact.**

These attributes align with those reported in the WP3 and WP8 datasets and reflect the most commonly cited barriers to implementing or investing in energy efficiency measures, as identified in the WP8 survey and discussed earlier in this report.

The rationale for basing these attributes on reported barriers is intentional. When firms cite barriers such as high costs, technical challenges, or limited environmental benefits, they reveal the underlying criteria used to evaluate energy efficiency investments. For example, if a measure is rejected due to cost concerns, it indicates that economic viability is a critical consideration in decision-making. The same logic applies to technical feasibility and environmental impact.

Barriers related to strategic priorities, organisational perceptions, or context-specific factors were excluded from the attribute definitions, as these are often subjective and inconsistent across organisations.

The attributes are defined as follows:

- **Technical feasibility** assesses the level of difficulty involved in implementing a measure within the existing infrastructure.
- **Economic viability** considers the cost-effectiveness of a measure, including capital costs, operational savings, and payback periods.
- **Environmental impact** relates to the potential reduction in greenhouse gas (GHG) emissions and other associated environmental benefits.

Technical Feasibility

Due to insufficient data in the provided datasets to directly assess the technical feasibility of energy efficiency measures, a new evaluation methodology was developed. Informed by academic literature and technical guidelines, this approach assessed feasibility based on three key factors:

1. **installation complexity,**
2. **compatibility with existing infrastructure, and**
3. **maintenance requirements.**

Installation complexity refers to the scope and difficulty of implementing a measure. This includes the need for specialised engineering modifications, the extent of construction or retrofitting, potential downtime or operational disruptions, and whether installation can be phased or requires a single major intervention (7). Measures that can be installed quickly with minimal operational impact are considered more feasible than those requiring extensive construction or major system overhauls.

Compatibility with existing infrastructure assesses how well a measure integrates with current building systems, equipment, and structural constraints. This factor examines whether the new technology can be adopted without significant modifications to existing infrastructure (8). Measures offering straightforward integration (e.g. plug-and-play components) are rated as more feasible compared to those demanding extensive alterations.

Maintenance requirements and operability consider the ongoing operational implications of a measure. Ideally, feasible solutions should be reliable and not impose excessive maintenance demands beyond the capacity of facility staff or service providers (9). This includes the availability of spare parts and expertise, the frequency and complexity of maintenance tasks, and potential impacts on existing equipment lifespan. Measures requiring highly specialised maintenance or substantial changes to operational routines are deemed less practical, while those that reduce maintenance needs or can be managed using existing skills are favoured.

Each energy efficiency measure was assessed against the three feasibility factors using a simple scoring scale:

- 1 = **Low adherence** (high complexity, poor compatibility, heavy maintenance)
- 2 = **Moderate adherence** (some disruption, partial compatibility, moderate upkeep)
- 3 = **High adherence** (easy installation, seamless integration, low maintenance)

The individual factor scores were then summed to generate an overall feasibility score ranging from 3 (least feasible) to 9 (most feasible). This scoring system offers a consistent basis for comparing the technical practicality of different measures, as shown in the table below.

However, this approach has limitations. It does not account for site-specific conditions, operational constraints, or industry-specific factors that could influence the actual feasibility of implementation. Additionally, applying equal weighting across all criteria and using a simplified scoring method may overlook important technical nuances.

Therefore, **this methodology is intended solely for high-level comparative analysis within the scope of this study, particularly where pre-existing feasibility data is unavailable. It is not designed for detailed, site-specific decision-making. Enhancing the robustness of this assessment would require stakeholder input and the use of more advanced multi-criteria decision-making frameworks, which are beyond the current scope of this study**.

Measures	Installation Complexity	Compatibility	Maintenance Requirements	Technical Feasibility (Score)	Technical Feasibility
Optimisation	3	3	3	9	High
Office Equipment Efficiency	2	3	3	8	High
Raising Staff Awareness	3	3	3	9	High
Transportation	2	3	2	7	High
Heat Pumps and Heat Recovery	2	3	2	7	High
Lighting	3	3	3	9	High
Compressed Air	2	3	2	7	High
Pumps	2	3	2	7	High
Energy Management	2	2	2	6	Medium
Distribution Networks and Insulation	2	2	2	6	Medium
Building Heating	2	2	2	6	Medium
Industrial Furnace	2	2	2	6	Medium
Cooling	2	2	2	6	Medium
Ventilation	2	2	2	6	Medium
Renewable Energies	2	2	2	6	Medium
Roof Thermal Insulation	1	2	2	5	Low
Openings Replacement and Shading	1	2	2	5	Low
Façade Thermal Insulation	1	2	2	5	Low

Source: (10) ó(13)

Economic Viability

To assess the economic viability of energy efficiency measures, this analysis evaluates both upfront investment requirements and long-term cost-effectiveness based on four key indicators:

1. **Capital Cost,**
2. **Net Present Value (NPV),**
3. **Energy Savings, and**
4. **Payback Period.**

Capital cost represents the initial expenditure required to implement an energy efficiency measure. Although it does not capture future savings or financial returns, it remains a critical consideration in investment decisions. In this analysis, most capital cost data was drawn from the WP8 energy performance survey rather than from energy audit estimates, as WP8 reflects actual implementation costs and therefore provides a more reliable basis for analysis. The only exception is e ôÙ ‡Í \ 2 Ù\eÍ Ù Í•ÍXô2ô\ measure, whose capital cost was taken from WP3 estimates, since it was not included in the WP8 dataset.

Energy savings are key to understanding the long-term value of a measure and are incorporated within the **Net Present Value** (NPV), which accounts for the time value of money to capture lifecycle costs and benefits. Energy Savings data was primarily sourced from WP3, which provides estimates for most measures. WP8 includes savings data only for renewable energy measures, so those values were taken from WP8 to better reflect actual performance rather than projections. Since neither WP3 nor WP8 provide energy savings data for 2îj\eX Í+Ù jX2Íèô ÙÍ2îÙ eXÍ2\U:XeÍe :2 Ù these measures were assigned a value of zero to reflect the absence of data. Similarly, NPV data was mainly drawn from WP3, except for e ôÙ 2îj\eX Í+Ù jX2Íèô ÙÍ2îÙ eXÍ2\U:XeÍe :2 Ù1ôÍ\jXô\àÙ• è Ù•ôXôÙô„è+ limitations.

Although less comprehensive than NPV, **payback period** remains widely used due to its simplicity, providing a quick indication of how soon the initial investment will be recovered through energy savings. Since only WP3 provides payback period data, this dataset was used for the analysis.

To derive representative values for capital cost, NPV, energy savings, and payback period, the skewness of each distribution was first evaluated to inform appropriate summary statistics. Table1 in Appendix A report skewness values by measure type. The analysis showed consistent positive skewness, often exceeding 1, indicating that a few very high values were inflating the arithmetic mean. As such, the median was adopted as a more robust measure of central tendency, providing more reliable estimates less affected by extreme outliers.

Median Values

After removing non-numeric and zero entries, the graphs below present the median values for key metrics - including capital cost, NPV, payback period, and energy savings (disaggregated into primary and final energy savings) - across the analysed energy efficiency measures.

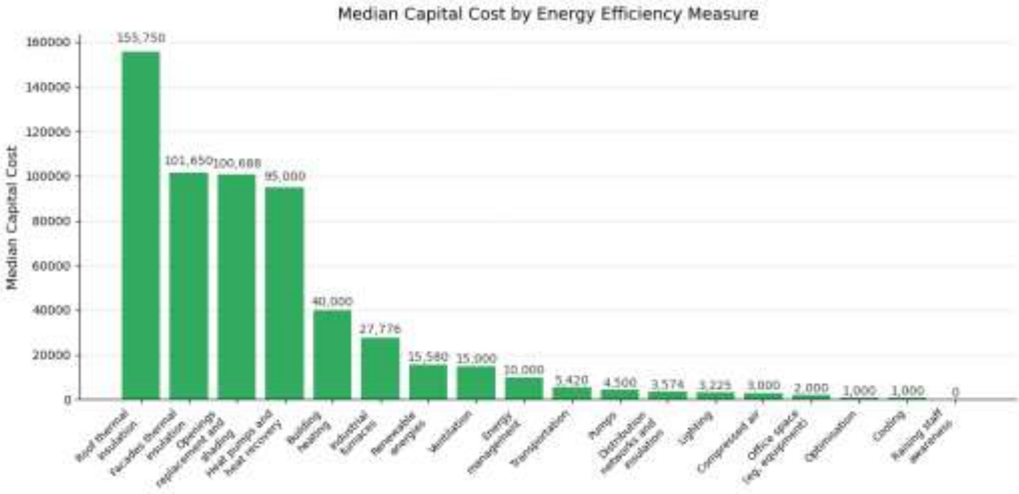
While this analysis focuses on medians as robust measures of central tendency, it is worth noting that variance metrics, such as Relative Mean Absolute Deviation (r-MAD)-calculated by dividing the MAD by the median and expressing it as a percentage-could provide further insights into data dispersion and the reliability of reported values.

The accompanying table shows r-MAD values for each measure across all key metrics. The results indicate that most measures have r-MAD values exceeding 60%, reflecting significant dispersion and variability in estimates. This high variability persists even when data is segmented by company size and recalculated, suggesting it is inherent to the dataset rather than influenced by company size differences.

Measures	Capital Cost	NPV	Payback	Primary Energy Savings	Final Energy Savings
Optimisation	120.8	794.9	13223230000	681.1	597.6
Heat pumps and heat recovery	220.6	645.6	1330.1	7078641.9	11643460.5
Distribution networks and Insulation	161.9	73.3	62.7	263.3	321.3
Energy Management	90.8	566.4	237590.6	144.1	428.1
Lighting	6995.5	216.9	35351.6	358	516.9
Ventilation	55.1	552.9	703353	266	244.3
Openings replacement and shading	221.6	-416.7	100404	35272.1	294.1
Pumps	88.9	191.8	42319.9	734.9	327.8
Renewable Energies	1617.5	180.7	405978	713.3	1435.9
Façade thermal insulation	146.6	291.2	119666.9	182.6	123.4
Building heating	211.4	5875.4	510	416.2	16793880.8
Roof thermal insulation	191.0	1621.5	159759.4	2089.3	2493.2
Cooling	346848.2	307.7	142.8	242239.3	1368898.8
Compressed air	150.0	229.9	28.1	28.7	25.7
Office space (e.g., equipment)	435.0	79.7	150.4	16717.5	6211785.2
Industrial Furnace	71.5	0	0	0	0
Transportation	53.9	0	0	0	0
Raising staff awareness	0	0	0	0	

Source: EE4SMEs WP3 and WP8

A detailed investigation into the causes of this variability is beyond the scope of this study but may include data quality limitations, small or uneven sample sizes, and variations in cost estimation methodologies. Therefore, to maintain a focus on robust and interpretable findings, variance metrics have been excluded from the main analysis.



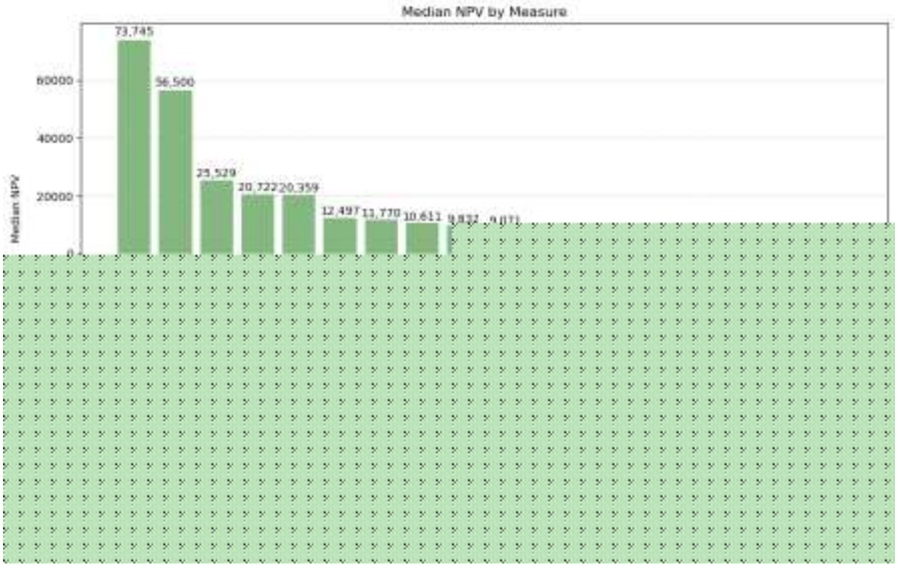
Measure	Median Capital Cost (EUR)
Roof thermal insulation	155,750
Facades thermal insulation	101,650
Openings replacement and shading	100,688
Heat pumps and heat recovery	95,000
Building heating	40,000
Industrial furnaces	27,776
Renewables energies	15,580
Ventilation	15,000
Energy management	10,000
Transportation	5,420
Pumps	4,500
Distribution networks and insulation	3,574
Lighting	3,225
Compressed air	3,000
Office space (e.g., equipment)	2,000
Optimisation	1,000
Cooling	1,000
Raising staff awareness	0

Source: EE4SMEs WP3 and WP8

The capital cost graph and table show significant variability across different energy efficiency measures. Envelope-related upgrades, such as roof insulation, façade insulation, and openings replacement ǵhave the highest median capital costs due to the extensive structural work they require. Interestingly, heat pumps and heat recovery systems also show high capital costs, raising questions about why they are more expensive than other mechanical systems.

Mechanical system upgrades and renewable energy installations ǵlike building heating, industrial furnaces, ventilation, and energy management ǵfall into a mid-range capital cost category. These still require notable investment but are generally less costly than major structural upgrades.

At the lower end of the spectrum are measures like compressed air improvements, operational optimisation, and raising staff awareness. These typically involve minimal upfront investment, making them more accessible for organisations with limited capital for energy efficiency measures.



Source: EE4SMEs WP3 and WP8

The NPV graph illustrates the long-term economic value of different energy efficiency measures. Measures such as façade thermal insulation and renewable energy installations show high positive median NPVs, indicating strong potential for long-term financial returns. Distribution networks and insulation, as well as pumps and ventilation, also yield solid positive NPVs, though slightly lower than the top-performing categories. In contrast, measures like cooling, lighting, raising staff awareness, and è:1UXô\\ôîÙÍ XÙ 1UX:}ô1ô2e\Ù\ :•Ù1:îô\eÙe:Ù+:•Ù1ôî Í2Ùb„«\àÙ ô2ôXÍ++ LWàOOOß

A notable exception is the replacement of openings and shading, which has a negative median NPV of - LSQàRSSßÙ“ \Ù\j ô\e\Ùe ÍeàÙ:2ÙÍ}ôXÍ ôàÙe ôÙ 2Í2è Í+Ùæô2ô e\Ù: Ùe costs over the expected lifetime, raising concerns about its overall cost-effectiveness.