Multiple benefits of energy efficiency: methodology and preliminary application to Italian plastics industry

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Abstract

The crucial importance of the "Energy Efficiency First Principle" has been recently underlined as a policy pillar at European level in the recast of the Energy Efficiency Directive (EED), with a specific article (Art.3). Energy efficiency is a key bridge among sustainability, climate neutrality and economic growth. The multiple benefits approach is focused on extending the direct benefits of energy efficiency (reduction of energy consumption and greenhouse gas emissions) to other dimensions, such as energy security, health and well-being, air quality, material resources efficiency, productivity, and other economic and social benefits, both at micro and macro level. This is a topic of recent and growing interest from academia, policymakers, and the private sector because of its impact on the profitability of energy efficiency investments. However, despite its importance, quantifying the multiple benefits is still demanding and particularly challenging for small and medium-sized enterprises (SMEs).

In this work an analysis of multiple benefits (MB, also known in literature as Non-Energy Benefits or Co-Benefits) in the Italian plastics industry is developed. The work is divided in two sections. Firstly, a general multi-sectoral characterization of MB has been carried out on the results of a wide scope survey targeted to both public and private stakeholders, where a gap was observed in the perception and role of MB by policymakers and enterprises. Secondly, a framework was developed to quantify the MB associated to different Energy Performance Improvement Actions (EPIAs), with a focus on the plastics manufacturing industry. Based on this framework, he potential quantification of the impact of MB is explored at sectoral level. The results obtained in this analysis can help companies in quantifying the MB associated with energy efficiency and to invest more consciously in EPIAs. The findings can also be helpful to National Authorities during the transposition of EED Articles 3, 11(7) and in support of Articles 9 and 10.

Introduction

The Recast EED (Directive (EU) 2023/1791, 2023) defines measures and plans to promote the containment of energy consumption in the European Union. Considering the current reference framework, it was deemed necessary to implement policies, investments and regulations aimed at containing energy consumption. Article 3 of the Directive introduces the "Energy Efficiency First Principle": energy efficiency becomes a key bridge among sustainability, climate neutrality and economic growth. In this way, energy efficiency and environmental sustainability are increasingly interconnected.

The multiple benefits approach is focused on extending the direct benefits of energy efficiency to other dimensions, such as energy security, health and well-being, air quality, material resources efficiency, productivity, and other economic and social benefits, both at micro and macro level. Therefore, the implementation of energy efficiency interventions, investments in renewable sources or projects aimed at reducing carbon emissions are increasingly interconnected aspects, with a view not only to energy efficiency but also to environmental sustainability in general.

Correctly identifying the MB of energy efficiency in the various productive sectors undoubtedly helps companies assessing the overall achievable benefits and directs them in the selection of cost-effective energy efficiency interventions.

In order to investigate such interesting and challenging topic, the authors intend to proceed with a thorough two-year investigation on different economic sectors in Italy, starting from the plastics manufacturing industry. The present paper describes the first part of the activities carried out by the authors on the Italian plastics industry.

The work presented in the paper has been carried out according to the following steps:

- A brief literature review on the topics of MB applicable to the industry and the plastics industry.
- The analysis of a wide scale survey (section "Survey") which describes the results from a mix of 281 expert and institutional opinions collected in the European geographical area on Energy audit policies and programmes in SMEs, which included specific questions on the topic of MB.
- The construction of a proposal for assessing the presence, relevance and measurability of MB associated to energy efficiency interventions' implementation in enterprises is presented and applied to the plastics sector.
- A first assessment of about 750 energy audits in the plastics industry, with the aim of identifying relevant interventions in terms of potential application of MB.
- The set-up and implementation of an assessment matrix based on the survey answers, according to literature references and the results of the internal assessment on the energy audits.

The data sources used in the current work are:

- The information included in the energy audits submitted to ENEA – Italian National Energy Agency – within the implementation of EED article 8 between 2019–2022.
- The results of the international survey on energy efficiency in SMEs, developed within the LEAP4SME project (LEAP4SME, 2021), which includes questions on the multiple benefits approach. The survey has been included in the Study according to the reason that the Italian plastics industry is made up of a considerable share of SMEs. For the case study of the present work, about the 75 % of the enterprises assessed through energy audits are energy-intensive SMEs.

The elaboration of the data is original and presented for the first time in this paper.

Literature review

The MB of energy efficiency have been analysed in literature from two different perspectives. On the one hand, the "Energy Efficiency First Principle" derives in multiple benefits with an important impact in macroeconomic development; public budgets; health and wellbeing; industrial productivity and energy delivery (IEA, 2015). On the other hand, at firm level, the analysis, quantification and monetization of MB is still scarce and to be effective it must be based on and linked to direct energy benefits (Killip et al., 2019). In any case it is important to note that both dimensions are interconnected and some MB at company level imply positive impacts at society level, such as improvement in energy security, public health and macroeconomic indicators.

In order to rationalize the analysis of MB some classifications have been proposed in literature. Generally there are three categories at macro level: environmental, social and economic (Reuter et al., 2020). At firm level the categories vary from six to four. The most accepted classification considers six categories: Production, Operation and maintenance, Waste, Emissions, Working environment and Other (Nehler et al., 2014; Trianni et al., 2014; Worrell et al., 2003). Other alternative classifications reduced the categories to increase the engagement of the enterprises (A2M Project, 2024) or adapted them to faster monetization of the multiple benefits (Wagner et al., 2020). The MB are subsequently classified inside the categories (i.e. increased product output/yields in "Production", reduced waste in "Waste", reduced noise levels in "Working environment", or Improved public/corporate image in "Others"). If necessary, these indicators can be further refined to adapt the multiple benefit to a specific sector, or a specific EPIA. The summary of categories is presented in Table 1.

The quantification and monetization of the MB is a topic which has been addressed from different points of view, generally based on extensive literature reviews. In Nehler & Rasmussen (2016) a scheme to classify investments based on MB was proposed as function of time and impact, with 18 specific indicators to measure and monetize the MB impact. This analysis was subsequently deepened by proposing a guideline for the best use of industrial multiple benefits with Ex-ante and Ex-post quantification of the impact of the implementation of EPIAs (Nehler, 2018). Wagner et al. (2020) defined 71 indicators to quantify the potential of different multiple benefits and assess their implementation potential. Cagno et al. (2019) defined a complete framework to support decision-maker in the evaluation of adopting an EPIA, including additional attributes to quantify the impacts of the MB. This framework defines both the positive MB due to the implementation of EPIAs and the reduction of negative impacts ("Non-Energy Losses") linked to the EPIAs, in addition to the energy benefits. Other authors consider that the monetization of MB is not particularly important in the prioritisation of investments by the decision-makers and propose that other strategic aspects should be underlined, such as the value proposition, and the reduction of risks and costs (Cooremans, 2012).

Survey

In late 2021 the LEAP4SME project consortium prepared and launched a survey in two sections on the topic of energy efficiency in SMEs. The first section was aimed to Organisations, such as national agencies, business associations, ministries, NGOs and industrial associations, with the main goal of collecting and assessing the perception of SME-related stakeholders. The second section reached out to SMEs to learn more about the individual barriers facing European businesses to get access to energy audits and support.

From the Organisations survey, 177 answers have been received – with a good balance between public and private answers. For the purposes of this work, the answers from National Energy Agencies have been extracted and considered. From the

Table 1. Main categories of MB and the number of specific MB proposed in literature at firms and macro-economic levels.

	Firms			Macro
References	(Nehler et al., 2014; Trianni et al., 2014; Worrell et al., 2003)	(Wagner et al., 2020)	(A2M Project, 2024)	(Reuter et al., 2020)
Categories	Production Operation and maintenance Waste Emissions Working environment Other	Operations Assets Resources–waste–emissions Human resources Water Public image Regulatory	Productivity Operation &Maintenance Work environment Other	Environmental Social Economic
Indicators	28	27	16	20

Table 2. Relevance of MB for SMEs (all, industry and services) and Energy Agencies respondent to LEAP4SME survey.

	All SMEs (104)		Industry (41)		Services (61)		Energy Agencies (23)	
	Relevance	Rank	Relevance	Rank	Relevance	Rank	Relevance	Rank
Reducing energy costs	87 %	#1	88 %	#2	87 %	#1	96 %	#1
Reducing GHG emissions	82 %	#2	90 %	#1	77 %	#2	74 %	#4
Green Marketing	75 %	#3	78 %	#3	74 %	#3	52 %	#8
Including renewable energy	71 %	#4	73 %	#4	70 %	#5	78 %	#3
Improving air quality	67 %	#5	68 %	#5	67 %	#6	48 %	#9
Reducing O&M costs	66 %	#6	56 %	#8	74 %	#4	57 %	#5
Increasing the process efficiency	58 %	#7	51 %	#10	62 %	#7	83 %	#2
Innovative solutions	56 %	#8	56 %	#9	56 %	#8	43 %	#10
Reducing raw materials	55 %	#9	61 %	#6	51 %	#9	57 %	#6
Increasing competitiveness	54 %	#10	59 %	#7	51 %	#10	57 %	#7
Optimizing water use	49 %	#11	49 %	#11	49 %	#11	22 %	#12
Increasing product quality	28 %	#12	29 %	#12	28 %	#12	30 %	#11

SME survey, aimed to get insights from the companies, 104 answers have been collected. The surveys were not targeted to specific industry sectors, rather to SMEs and Industrial SMEs more in general. One of the questions concerned the respondents' perception of the MB associated with EPIAs and the results are shown in the table below. A list of possible MB was proposed to them to gather their opinion on the importance of the different categories. In Table 1, the column "Relevance" shows the share of answers that assigned an extremely high or high relevance to the specific benefits. The column rank orders the benefits according to the value of this share. Analysing the answers, we can easily observe the following trends:

- Out of 12 answers, only one ranks in the same position ("Reducing energy costs") between respondents from enterprises and respondents from Energy Agencies, meaning that also at a first glance the perceived relevance appears to be quite different.
- There are relevant MB such as "Optimizing water use" and "Increasing product quality" which are seldom considered from both categories of respondents.

More in detail, the driver "Reducing energy costs" is confirmed to be the highly important for both SMEs and National Energy Agencies. The level of relevance is high for SMEs (87 %) and extremely high for Energy Agencies (96 %). The option "Reducing greenhouse gas emissions" is also important for SMEs, while for Energy Agencies the second by relevance is for "Increasing the process overall efficiency". The process overall efficiency is a key factor which is not properly considered in the assessment of the effects of EPIAs, mostly because of a lack of awareness from companies. In fact, it ranks 7th in the SMEs relevance perception and even 10th for SMEs in the industrial sector (NACE codes C, D, F). On the other side, from the Energy Agencies perspective it ranks second in terms of importance, even before reducing the GHG emissions.

It is interesting to notice that "Green marketing" is perceived quite differently from SMEs and Energy Agencies. Enterprises, with basically no differences between the Industry and Services sectors. Optimizing water use is not considered immediately emerging as MB from the implementation of in SMEs. Surprisingly, "Increasing product quality" is considered to be not a particularly relevant – on the average of the answers from both categories – and this response will be deepening in future interactions with plastics manufacturers.

Five of the MB presented in the survey, have been explicitly considered to build the matrix for the plastics sector (see below): "Reducing greenhouse gas emissions", "Improving the company's image", "Improving the process efficiency", "Optimising water use", "Increasing Product quality".

The case study of Italian plastics manufacturing industry

ENEA collects mandatory energy audits for large and energy intensive enterprises, according to Italy's Legislative Decree 102/2014. This institutional role is associated to the management of a database which includes a relevant number of EPIAs associated to energy audits. Such EPIAs are both relative to implemented and proposed actions. This information basis allowed to build up a proposal for assessing the presence, relevance and measurability of multiple benefits associated to EPIAs implementation in enterprises. The impact of MB may differ from sector to sector and strongly depends on the EPIAs.

MB for EPIAs have been analysed in a matrix where the benefits are grouped in columns a by macro-categories. The identification of such a matrix is the first step of an assessment methodology which – during the second part of the activity to be carried out in 2024 – will involve the enterprises at sectoral level through a survey, asking to fill the matrix according to their own experience.

MB macro-categories and categories have been identified as follows:

1. **Product and process related benefits**
    a. **Maintenance:** EPIAs could reduce maintenance frequency both relative to plant down time and self-maintenance, increase production reliability and lifetime of equipment.
    b. **Process productivity:** EPIAs could lead to increased production rate and shorter cycle time of process. These improvements can be due to both technical and management interventions.
    c. **Product quality:** EPIAs would improve productivity but also the flexibility of production process and the quality of product, implying advances in its technical and aesthetic features.
    d. **By-products:** EPIAs would not only improve the production yields per unit of input but also reduce by-products.
2. **Environmental benefits**
    a. **Decarbonization:** EPIAs reduce energy use and the associated GHG emissions, both direct emissions (in plastics manufacturing mainly associated to fossil fuel combustion) or indirect (associated to electricity use). These emissions correspond to Scope 1 and 2 respectively according to GHG Protocol
    b. **Water:** When EPIAs concern production phases implying water use, their introduction would affect the level of company water consumption.
    c. **Waste:** When EPIAs involve technologies producing wastes to be treated or disposed (waste fuel, heat, gas, hazardous wastes), their introduction would reduce or eliminate such wastes.
3. **Impact on staff and working environment**
    a. **Safety:** EPIAs are associated to new technologies and procedures, aligned with updated safety rules and legislation, and then improve workers' safety and enhance operations, reducing the risk of workplace accidents and hazards and human errors.
    b. **Health and wellbeing:** EPIAs could be associated to improvement of air quality, control of temperature, lighting and ergonomics, and reduction of noise, directly related to workers morale and health.
    c. **Awareness:** EPIAs associated both to new equipment and organizational procedures, could imply an increase in employers' awareness of their active role in monitoring production process, scheduling operations and saving energy. Employees are made aware on firm commitment in energy efficiency and environmental sustainability. The higher empowerment of employees and managers could be also associated to lower barriers in the decision-making processes.
4. **Other benefits**
    a. **Green Marketing:** The benefits associated to EPIAs implementation could be valued by the company to show its commitment to decarbonization and sustainability and improve its image. This could have positive impacts on the relationships with shareholders and value chain partners, also paving the way to adopt environmental certifications and comply with ESG standards.
    b. **Regulation compliance:** EPIAs are associated to new technologies and procedures, aligned with most recent legislation (and preparatory to future standards) and their introduction could also help to apply for energy, environmental and quality certification as well as comply with ESG standards.
    c. **Resilience:** EPIAs could make the company more competitive and independent from market fluctuations (energy prices, raw materials' prices and availability) and in this way improve its resilience, both towards economic conjuncture and climate change.

Basing on a first assessment of 750 energy audits in the plastics manufacturing sector, six interventions have been chosen as particularly representative of the EPIAs in the NACE codes C22.2.1, C22.2.2 and C22.2.9. For the plastics manufacturing

Table 3. Description of possible MB associated to typical EPIAs in the plastics manufacturing industry.

EPIA	MB macro-categories	Description of possible multiple benefits
Production Lines: Replacement of hydraulic presses with electric or hybrid presses or replacement of extruders	Maintenance	Reduction of maintenance frequency both relative to plant down time and self-maintenance
	Process productivity	Improvement of process productivity in terms of operational time and costs
	Product quality	Improvement of the technical and aesthetic features of the final product
	By-products	The better performances of new press or extruder allows to reduce by-products
	Decarbonization	Reduction of CO_2 emissions intensity of the production
	Water	Saving of water for oil cooling (in case of hydraulic press replacement)
	Waste	Waste reduction due to the avoided production of motor oil for disposal (only in case of hydraulic press)
	Safety	Improved operator safety
	Health and wellbeing	New press ergonomics, improved quality of work due to reduced maintenance and plant downtime, noise reduction
	Awareness	Improved staff awareness for self-maintenance possibilities
	Green marketing	Improved company image due to commitment to waste reduction and process sustainability
	Regulation compliance	Possible application for energy, environmental and quality certification as well as comply with ESG standards
	Resilience	Reduction of dependence on electricity market prices due to the high energy savings
Production Lines: Installation of inverters on motors (for hydraulic presses and extruders)	Maintenance	Reduction of maintenance frequency both relative to plant down time and self-maintenance. Extension of motor life
	Process productivity	Reduction of operational time and costs, due to higher flexibility of presses an extruders functioning
	Product quality	Improvement of the technical and aesthetic features of the final product, due to process higher flexibility
	By-products	The more flexible functioning of press or extruder allows to reduce the process by-products
	Decarbonization	Reduction of CO_2 emissions intensity of the production
	Health and wellbeing	Reduction of noise
	Awareness	Improved staff awareness due to self-maintenance possibilities
	Green marketing	Improved company image through commitment to waste reduction and process sustainability
	Regulation compliance	Process update allows to align with most recent legislation and potential future standards
	Resilience	Reduction of dependence on electricity market prices due to production flexibility and electricity savings
General/Managerial: Monitoring system	Maintenance	Reduced cost due to the possibility of condition-based rather than time-based maintenance and predictive maintenance
	Process productivity	Improved productivity through better maintenance and consumption awareness
	Product quality	Timely detection of malfunctioning affecting product quality
	By-products	Monitoring the process allows to identify potential malfunctioning generating higher level of by-products
	Decarbonization	Monitoring enables to identify process wastes and reduce of CO_2 emissions intensity
	Water	Monitoring increase knowledge of water consumption and allows its optimisation
	Waste	Monitoring the process allows to reduce wastes
	Health and wellbeing	Improved staff well-being through improved quality of work due to reduced maintenance and downtime
	Awareness	Improved staff awareness and empowerment related to energy consumption and savings
	Green marketing	Monitoring indicators could be valued to improve company image
	Regulation compliance	Alignment with recent legislation and preparation to future standards, and potential certification and ESG standards
	Resilience	Reduction of dependence on energy market prices due to availability of monitoring data

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Table 3. Description of possible MB associated to typical EPIAs in the plastics manufacturing industry (continued).

Production from renewable sources: PV installation	Decarbonization	Substitution of fossil fuels with renewables
	Health and wellbeing	Lower dependence on fluctuations in electricity prices and better possibilities to adapt air conditioning to actual needs
	Awareness	Employees are made aware on firm commitment in environmental sustainability and enjoy the associated benefits
	Green marketing	Image improvement due to commitment to decarbonization and sustainability
	Regulation compliance	Better possibilities to apply for energy and environmental certification as well as to comply with ESG standards
	Resilience	Reduction of dependence on electricity market prices
Thermal power plant/Heat recovery: Heat recovery from hydraulic press cooling	Process productivity	Improved process productivity through reduced waste heat
	Decarbonization	CO_2 emissions savings
	Waste	Improvement of wasted heat
	Health and wellbeing	Lower dependence on fluctuations in gas prices and better possibilities to adapt heating to actual needs
	Awareness	Employees are made aware on firm commitment in waste reduction and enjoy the associated benefits
	Green marketing	Image improvement through waste reduction efforts and process sustainability
	Regulation compliance	Possible application for energy and environmental certification as well as to comply with ESG standards
	Resilience	Reduced dependence on gas market prices
Compressed Air: Compressor replacement	Maintenance	Reduction of maintenance frequency both relative to plant down time and self-maintenance
	Process productivity	Process optimization due to better use of compressed air
	Product quality	Improvement of the technical and aesthetic features of the final product, due to process higher flexibility
	Decarbonization	Reduction of CO_2 emissions intensity of the production
	Safety	Improved operator safety
	Health and wellbeing	Improved quality of work due to reduced maintenance and plant downtime, reduced noise, improved air quality
	Awareness	Improved staff awareness for self-maintenance possibilities
	Green marketing	Image improvement through process sustainability
	Regulation compliance	Possible application for energy and environmental certification
	Resilience	Reduction of dependence on electricity market prices

sector, the mentioned 750 energy audits have been submitted by 650 enterprises (75 % SMEs) referred to year 2019. This EPIAs proposed in the audits are 2,500, the implemented ones are 700. The business association and the enterprises have been involved in analysing the data in order to validate the choice of representative actions.

The following interventions have been considered for the analysis:

1. **Replacement of hydraulic** presses with electric or hybrid presses or replacement of extruders. In plastics manufacturing industries, the replacement of hydraulic presses with electric ones allows significant energy savings. Indeed, with hydraulic presses the power should be fixed at the maximum level in every phase of the process, even in the cooling phase when the mechanisms are stopped. By contrast with an electric press the power could be regulated, and it should be set at the maximum level only during the opening and closing of the moulds. Furthermore, significant electrical savings are also connected with the avoided necessity to cool motor oil, which, in hydraulic presses, must be kept below certain temperatures to not lose its viscosity. The replacement of extruders leads to a significant increase in efficiency in relation to a more efficient transmission systems and engines, latest generation screw geometry, etc. Both the replacement of presses and extruders are associated to a relatively high investment.
2. **Installation of inverters on motors (for hydraulic presses and extruders):** this type of intervention, allowing the regulation of electric motors, has short payback times and allows significant energy savings to be achieved.
3. **Monitoring system:** this intervention, even if it does not generate immediately quantifiable savings, allows to identify the most energy-intensive areas of the process, elaborate energy performance indicators and compare them with similar plants, immediately detect anomalous consumptions and restore correct operation.
4. **Photovoltaic (PV) installation:** this intervention is particularly recommended in plastics industry where almost all energy consumption is electrical.

Table 4. Matrix for assessing MB of typical EPIAs in plastics manufacturing industry (the level of difficulty in MB measurability is show in green – easily measurable, yellow – challenging).

MB categories			EPIA	Replacement of hydraulic presses with electric or hybrid presses or replacement of extruders	Installation of inverters on motors (for hydraulic presses and extruders)	Monitoring system	PV installation	Heat recovery from press cooling	Compressor replacement
			Area of intervention	Production Lines		General/ Managerial	Renewable energy production	Thermal power plant/Heat recovery	Compressed Air
Product and process benefits		Maintenance		5	3	3	–	–	3
		Process productivity		5	3	3	–	1	3
		Product quality		4	1	1	–	–	1
		Reduction of by-products		4	2	1	–	-	–
Environmental savings		Decarbonization		4	3	2	5	2	3
		Water		2	–	4	–	–	–
		Waste		3	–	1	–	2	–
Staff and working environment		Safety		4	–	–	–	–	1
		Health and well-being		4	2	2	3	4	4
		Awareness		2	1	4	3	2	1
Other		Green marketing		4	2	4	5	2	2
		Regulation compliance		2	2	5	4	1	2
		Resilience		3	2	1	5	2	2

5. **Heat recovery from hydraulic press cooling:** this intervention allows heat recovery from oil cooling used to heat work environments. In this case payback time is very short.

6. **Compressor replacement:** consumption for compressed air production represents around 9 % of plastics industry electric consumption and 7 % of the total plastics industry consumption, then carrying out this intervention can lead to significant savings.

A first attempt to compile the proposed matrix is provided in the following paragraph. The matrix is compiled with information elaborated by the authors basing on energy audit database, authors' (policy implementers, policy officers and researchers) assessment and existing literature on the EPIAs multiple benefits. This compilation is aimed to elaborate a first assessment framework, which will then be validated and integrated through a structured interaction with enterprises. This will allow to compare the general and partly theoretical overview with the real experience and findings at enterprise level, helping in identifying the barriers to EPIAs and the associated MB. Moreover, this methodology will provide a better understanding of the relation between intervention impacts and MB. Table 3 provides the description of the possible multiple benefits

for each EPIA, classified in different areas. Table 4 shows the matrix compiled with information elaborated by the authors (the scale spreads from 1 if the impact of the analysed EPIA on the MB present a very low relevance, up to 5 if the relevance is extremely high, 3 is an average value and "–" is applied if the MB is no applicable to the EPIA considered).

Discussion and conclusions

This paper proposes a methodology for analysing and quantifying the multiple benefits (MB) associated with energy efficiency interventions with a focus on the Italian plastics industry. The analysis presented was based on surveys, data from energy audits and on the interaction with stakeholders.

The approach proposed in this work, addressed to the plastics manufacturing sector but potentially applicable to other sectors, goes in the direction of bridging those gaps. The developed matrix and its overall scores include the results from the abovementioned survey built, grouped, extended and customised for the application on the plastics industry. On this basis, a preliminary analysis of the potential MB of six types of interventions relating to the plastics manufacturing industry has been carried out. The analysis of these types of energy efficiency interventions, based on 750 energy audits, led to the definition of a series of multiple benefits linked to the various EPIAs, divided into four main macro-categories (Product and process benefits, Environmental savings, Impact on staff and work environment, Other).

These categories of MB were placed in a matrix characterising the relevance and the possibility of quantifying the specific MB for each EPIA. A preliminary compilation of the matrix is proposed, mainly linked to the data contained in the analysed energy audits, but it will be finalised by means of a survey that will be submitted to the companies also in cooperation with the Italian trade association Federazione Gomma Plastica.

The collected results from surveys show the presence of two gaps: the lack of awareness on the potential of some MB, which can be addressed through tailored training and extended onsite assessments, and the gap in the perception of such benefits among different stakeholders, which can be reduced through an improved institutional-private sector dialogue based on scientific evidence.

Once the matrix will be finalised, the next steps – outside the scope of this paper – will be: the testing of the matrix on a sample of case studies on Italian SMEs; a more in-depth survey of EPIAs included in energy audits, in order to continuously refine the methodology and cover additional SME-tailored MB; and complement this analysis with an investigation on how different barriers (such as administrative burden) are correlated to the implementation of EPIAs and then indirectly with MB.

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