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## Article

# Implementation of Energy Efficiency Improvement Measures in Romania and the Role of Professional Accountants

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## IMPLEMENTATION OF ENERGY EFFICIENCY IMPROVEMENT MEASURES IN ROMANIA AND THE ROLE OF PROFESSIONAL ACCOUNTANTS

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### Abstract

Energy efficiency is one of the main objectives of the European Union's policy. Organisations are trying to implement various measures to improve energy efficiency to optimise their business models. Professional accountants prepare the financial and nonfinancial information of the organisations. In this context, the objectives of the document are: (i) to assess progress in the implementation of energy efficiency improvement measures (EEIMs) within some Romanian organisations and (ii) to assess the usefulness of energy efficiency improvement measures and the perceived impact of these measures on the organisation. In this regard, exploratory research was carried out based on a questionnaire to which 445 professional accountants from Romania responded. The research results indicate that the most frequently implemented measure to increase energy efficiency for organisations in Romania is the purchase of equipment/computers with a lower energy consumption. Furthermore, there are differences in the implementation of each measure, depending on the size of the organisation and the activity sector. The implementation of all energy efficiency improvement measures, evaluated based on an original composite indicator, is achieved at an average level, and it is more frequent in the trade sector (except the construction products sector), services sector (except the architecture sector, consultancy in construction, engineering) and manufacturing sector, as well as in micro, medium, and large entities. Furthermore, professional accountants believe that the most useful measure of improving energy efficiency that an organisation could implement is the use of assets that belong to the highest class of energy efficiency. Our research helps identify the most practical measures that the state can adopt and that organisations can implement to improve energy efficiency.

**Keywords:** Energy efficiency, energy efficiency improvement measures (EEIMs), professional accountants, European Union, Romania.

**JEL Classification:** Q40, M40

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## Introduction

At the international level, there is a growing trend in concerns related to energy efficiency. This topic is the central point on the agenda of the International Energy Agency (IEA, 2018). At the European Union (EU) level, within the energy policy framework, one of the five established objectives aims to improve energy efficiency (Ciucci, 2021). European concerns about energy efficiency have materialised in the emergence of specific directives: the 2012/27/EU Directive and the 2018/2002/EU Directive. As a member of the EU, Romania transposed the European regulations on energy efficiency into national legislation, and its improvement is considered a strategic objective of the national energy policy.

Energy efficiency is a complex concept addressed in various research fields. The economic perspective is less represented in the total of research (8.1%), being included in other fields (Dunlop, 2019). In the current tense geopolitical context in Europe, where organisations are increasingly exposed to economic pressures generated by the accelerated increase in electricity prices, the economic approach to energy efficiency gains importance. Recently, at the EU level, the 2022/1854/EU Regulation was adopted, and it states that one of the options for non-household customers to benefit from support in the direction of mitigating the effects of high energy prices is to make investments in energy efficiency (EU, 2022, paragraph 47). In this context, accelerating the implementation of energy efficiency improvement measures should represent a goal for most organisations.

Those who collect and use data in every organisation are professional accountants. Instead of being in the background calculating the results of the business, professional accountants are drawn forward into a more strategic, forward-thinking game aimed at creating the score rather than setting the score (Roberts et al., 2022). Their role is constantly changing and increasingly considered business advisors or partners (CIMA, 2009). On the one hand, they have access to data specific to the organisation in which they operate, and on the other hand, they *produce* internal information intended for managers. Over time, in addition to classic attributions, they have adapted to some sustainability requirements, improving the accuracy of reports (Catusus and Johed, 2007) and the quality of sustainability reporting (Nechita et al., 2020), and are more often considered guardians of sustainability (Schaltegger and Zvezdov, 2015). More recently, the professional accountants' mission has been expanding toward preparing integrated reports in which energy efficiency information disclosure is required to ensure information connectivity (IFRS Foundation, 2021). Consequently, the results of the work of professional accountants are increasingly important, as the data they record have a potential surveillance role and can be used to change the behaviour of individuals in organisations (Walker, 2016). The continuous paradigm shift in the tasks of professional accountants makes these professionals reliable candidates to obtain relevant information related to implementing these measures by organisations.

The article has two objectives: (i) to evaluate progress in the implementation of energy efficiency improvement measures within some Romanian organisations and (ii) to assess the usefulness of energy efficiency improvement measures and the perceived impact of these measures on organisations. Research questions were formulated within each objective. To achieve these goals, we conducted exploratory research based on a questionnaire to which Romanian professional accountants responded. A total of 445 responses were received and processed.

Implementing energy efficiency measures in various organisations is an important phenomenon, and internal information on this subject is generally presented from the managers' perspective. However, it has been shown that the perspective of front-line workers on implementing EEIMs differs from that of managers (Smith, Wilson and Hassall, 2021). The perspective of professional accountants on implementing these measures is essential because they have a longitudinal view of the organisation's performance, both from a financial point of view and from the point of view of some non-financial aspects aimed at energy efficiency. The contribution of our study is that it helps to better understand the progress, usefulness, and impact of the implementation of these measures in organisations in Romania. The case of Romania is interesting, since it is the second EU member state with the lowest degree of dependence on energy imports: 28.2% compared to the European average of 57.5% (EC, 2022).

The other sections of this paper are structured as follows: in the first part, the EU normative framework regarding energy efficiency and its transposition into Romanian legislation is briefly presented to identify the specific measures organisations in Romania can implement. The second section presents the review of the academic literature, followed by the research data, methodology, results, and discussion. At the end of the paper, the authors' conclusions are presented.

### **1. The EU regulatory framework on energy efficiency and its transposition into Romanian legislation**

The 2012/27/EU Directive on energy efficiency was conceived in the context of multiple challenges faced by EU countries at the beginning of the last decade: increased dependence on energy imports, scarce energy resources, the need to limit climate change, and the need to overcome the economic crisis, respectively (EU, 2012, Article 1(1)). Energy efficiency is defined as the “ratio of the output of performance, service, goods or energy, to the input of energy”, and the concept of energy includes “all forms of energy products, combustible fuels, heat, renewable energy, electricity, or any other form of energy” (EU, 2012, Article 2(1,4)). However, although the concept of energy also involves the use of non-renewable resources, recent studies (Taptich, Horvath and Chester, 2016; Wehner et al., 2022) have demonstrated the critical role of the energy efficiency concept in achieving sustainability, one of the challenges that were likely to be mitigated by applying the provisions of this directive.

To achieve the energy efficiency objectives, “Member States should therefore put in place certification schemes for the providers of energy services, energy audits, and other energy efficiency improvement measures” (EU, 2012, Article 1(46)).

At the EU level, each Member State's approach to energy efficiency obligation schemes (EU, 2012, Article 7) is different: four Member States chose to use the energy efficiency obligation schemes only, twelve Member States chose to use a combination of energy efficiency obligation schemes and alternative measures, and the remaining twelve Member States (including Romania) chose to use alternative measures only (ESMOV, 2020).

The energy audit represents an energy efficiency improvement measure that any organisation can apply. It is defined as “a systematic procedure with the purpose of obtaining adequate knowledge of the existing energy consumption profile of a building or group of buildings, an industrial or commercial operation or installation, or a private or public service, identifying

and quantifying cost-effective energy savings opportunities, and reporting the findings” (EU, 2012, Article 2(25)). In this regard, there are different requirements regarding the performance of the energy audit, depending on the organisation's size. Therefore, entities that are not small and medium-sized enterprises (SMEs) must be subject to an energy audit carried out by qualified experts (EU, 2012, Article 9(4)). Member states must develop programmes for SMEs to encourage them to undergo energy audits (EU, 2012, Article 9(2)). In Romania, there needed to be more information on the application of these measures. In order to avoid a possible initiation of an infringement procedure by the European Commission, the state amended Law no. 121/2014 on energy efficiency in February 2019. In this sense, economic operators, except SMEs, must prepare an energy audit every four years (Romanian Parliament, 2014, Article 9).

As for other EEIMs, there is no obvious definition in the 2012/27/EU Directive or in Romanian legislation. The starting point for their identification is the definitions of the concepts of *policy measure* and *energy efficiency improvement*. A policy measure is “a regulatory, financial, fiscal, voluntary or information provision instrument formally established and implemented in a Member State to create a supportive framework, requirement, or incentive for market actors to provide and purchase energy services and to undertake other energy efficiency improvement measures” (EU, 2012, Article 2(18) and Romanian Parliament, 2014, Article 4 (26)). An energy efficiency improvement measure represents “an increase in energy efficiency as a result of technological, behavioural and/or economic changes” (EU, 2012, Article 2(6) and Romanian Parliament, 2014, Article 4 (20)).

We started from the definitions of two concepts and the existing novelties related to renewable energy sources that various organisations may apply to improve energy efficiency (for example, solar panel installation or passive house purchase). Then, we synthesised the ways of implementing policy measures and a series of energy efficiency improvement measures that can be applied at the member state and organisational levels, respectively (Table no. 1).

**Table no. 1. Energy efficiency improvement measures**

Terms	Ways of implementation	EEIMs	
		At the Member State level	At the organisational level
Policy measure	By regulations	2012/27/EU Directive	(1) Installation of smart electricity meters
		2012/27/EU Directive	(2) Installation of smart natural gas meters
		2018/2002 EU Directive	(3) Installation of remotely readable heat energy meters
		2012/27/EU Directive	(4) Energy audit of buildings, operations, and/or facilities (for entities that are not SMEs)
		2010/31/EU Directive	(5) Renovation of buildings to reduce energy consumption (for public institutions)

Terms	Ways of implementation	EEIMs		
		At the Member State level	At the organisational level	
Terms	Through financial measures	Non-refundable funding sources	-	
	Through fiscal measures	Fiscal framework to stimulate EEIMs	-	
	Voluntary		-	(5) Renovation of buildings to reduce energy consumption
				(6) Purchase/use of buildings with almost zero energy consumption (passive houses)
				(7) Purchase of new and more energy-efficient vehicles
				(8) Purchase of equipment/computers with lower energy consumption
	By informing consumers		-	(9) Installation of solar panels
(4) Energy audit of buildings, operations, and/or facilities (for SMEs)				
		-	(10) Receiving assistance for the EEIMs adoption	
Energy efficiency improvement	Through technological changes	-	(1), (2) and (3)	
	Through behavioural changes generated by: <ul style="list-style-type: none"> <li>• fiscal incentives;</li> <li>• access to finance, grants, or subsidies;</li> <li>• information provision;</li> <li>• exemplary projects;</li> <li>• workplace activities</li> </ul>	-	(10)	
	Through economic changes	-	(4), (5), (6), (7), (8) and (9)	

Source: Authors' compilation, 2022

The implementation of these measures is further analysed.

## 2. Literature review

An analysis of the academic literature, according to Dunlop (2019), highlighted that more than half of the research papers on energy efficiency are carried out in technical fields (engineering, computer science, and energy), with studies that address energy efficiency from an economic or sustainability perspective being less represented.

Previous studies address the implementation of EEIMs within organisations from various fields of activity (Accordini, Cagno and Trianni, 2021; Cagno et al., 2022; Hafez et al., 2023). Implementing these measures is a way organisations can optimise their energy consumption (Smith, Wilson and Hassall, 2021) and reduce their carbon dioxide emissions (Lovins, 2018). However, no sustainability measure will be implemented by an organisation if it is not economically advantageous.

Reviewing the literature, Cagno (2022) highlighted the lack of an integrated holistic approach capable of describing the impact of these measures on operations and the absence of a performance measurement system. However, these measures have been shown to be easily implemented and high investment returns are expected (IEA, 2018). Their adoption could influence the organisation's performance (Cagno et al., 2022) through non-energy benefits (Trianni et al., 2014) but also non-energy losses (Cagno, Moschetta and Trianni, 2019). The benefits consist of: reducing maintenance costs (Rasmussen, 2017), reducing raw materials consumption (Lung et al., 2019), reducing waste from the production process (Nehler, 2018), increasing productivity (Worrell et al., 2003), the reduction of operating expenses and the postponement of capital investments (Smith, Wilson and Hassall, 2021). Losses are generated by the interruption of the production process. Another economic factor that influences the adoption of EEIMs is the possibility of their financing. In this sense, innovative financing tools (Bergman and Foxon, 2020) and risks and uncertainties (Koutsandreas et al., 2022) have been identified.

A research direction found in the academic literature investigating the European Union area is related to the way the member states have chosen to implement the energy efficiency obligation schemes (Bertoldi et al., 2015; Argun et al., 2021; Cin et al., 2021) and the changes that have taken place in this direction (Fawcett et al., 2019). Romania chose to adopt only alternative measures, not obligation schemes, regarding energy efficiency (ESMOV, 2020). As an alternative to establishing an energy efficiency obligation scheme, Member States may adopt other policy measures to achieve energy savings (EU, 2012, Article 7(9)). These measures focus primarily on reducing energy consumption, which must be considered by all member states, regardless of the levels of economic growth (EU, 2018). Existing research has highlighted significant energy efficiency gains recorded during expansion and economic recession (Collado and Economidou, 2021) and reduction in energy consumption, both in countries affected by the financial crisis and with the highest GDP growth (Andreoni, 2020). Among the policy measures listed in Directive 2012/27/EU Article 7(9), the "application of energy-efficient technology or techniques that have the effect of reducing end-use energy consumption" can be applied on a large scale, voluntarily, by most organisations in various fields of activity (EU, 2012). Regarding the reduction of the impact of equipment use on energy consumption, an increasing number of research articles related to equipment energy efficiency are available in the academic literature (Denkena et al., 2020). Furthermore, investments in energy efficiency (Rasmussen, 2017) or the use of electronic tools (Cuc et al., 2022) represent means of reducing energy consumption. Reducing this consumption is the first impact that can be perceived as a result of adopting energy efficiency improvement measures (Pye and McKane, 2000; Anderson and Newell, 2004).

Energy efficiency policies and programmes focus on energy auditing (Drum et al., 2013). This is considered one of the most cost-effective measures to improve energy efficiency (Trianni et al., 2014), a first step in optimising energy consumption (Backlund and Thollander, 2015), as well as a significant energy efficiency initiative (Kluczek and Olszewski, 2017). The following characteristics influence organisations' decision to conduct an energy audit: size and productivity (Worrell et al., 2000; Kalantzis and Revoltella, 2019), capital intensity, sector affiliation, and national policies regarding the transposition of relevant EU legislation (Kalantzis and Revoltella, 2019). Regulations regarding the obligation to carry out the energy audit have different provisions depending on the organisation's size (whether or not it falls under the SME category) (EU, 2012; Romanian Parliament, 2014). Moreover, specific sectors, especially energy-intensive ones such as the manufacturing sector, are more motivated to perform an energy audit (Arvanitis et al., 2002; Almus and Czarnitzki, 2003; Czarnitzki et al., 2007).

In reviewing the literature, it is noteworthy that the analysis of how to implement various energy efficiency improvement measures based on a composite indicator is scarcely addressed. Some studies aimed to design and analyse specific indicators to evaluate the impact of a single measure: technical indicators to measure the energy performance of buildings (González et al., 2011; Abu-Bakar et al., 2015) or industry-specific indicators that can be used as management tools (Virtanen et al., 2012). Other studies have aimed to design an energy efficiency composite index based on a bottom-up approach throughout the economy (Ang, 2006), evaluate the progress of implementation of EEIMs (Economidou et al., 2020), or design a composite index to quantify the degree of improvement in energy efficiency over time (Su et al., 2022).

The application of energy efficiency improvement measures implies the existence of constraints and critical factors that ensure the successful implementation of these measures. The main barriers mentioned in the academic literature are lack of financial resources, lack of assistance regarding the implementation of these measures (Fresner, 2017; Hrovatin et al., 2021), risk and hidden costs of implementation (Hrovatin et al., 2021), lack of time, lack of internal skills, lack of personnel awareness, lack of necessary technologies (Hafez, et al., 2023) and difficulty in their implementation (Trianni and Cagno, 2012). These are balanced by many drivers that contribute to the successful implementation of these measures: economic incentives (Hrovatin et al., 2021) and financial incentives granted by the state in the form of subsidies to finance energy efficiency investments (Özbuğday et al., 2020), and government policies to promote the implementation of new technologies (Paramonova et al., 2015). Considering the barriers and drivers regarding the EEIMs implementation, mainly of a financial nature, the perception of professional accountants who currently process this information becomes an essential enabler in assessing these measures' usefulness and impact on the organisations.

After reviewing the academic literature, the research aims to answer the following specific questions related to the two intended objectives:

- (i) progress evaluation with respect to implementation of EEIMs at the level of some organisations in Romania
  - Which energy efficiency improvement measures are the most frequently implemented in Romania?
  - What is the implementation degree of energy efficiency improvement measures, analysed as a whole, within organisations in Romania?



(ii) Evaluate the usefulness of energy efficiency improvement measures and the impact of these measures on organisations.

- What are the most useful energy efficiency improvement measures that organisations can apply?
- What are the most useful measures to improve energy efficiency that the state and its institutions can take?
- What is the impact of these measures on organisations?

### **3. Data and methodology**

The survey or interview effectively collects information on implementing energy efficiency improvement measures (Smith, Wilson and Hassall, 2021). To evaluate the implementation of these measures at the level of some organisations in Romania, we conducted exploratory research based on a questionnaire. After developing the first version of the questionnaire, a qualitative pre-test was carried out in which graduates of some faculties with a financial-accounting profile participated (Smith, 2011). Based on feedback, some questions have been reformulated to increase intelligibility. The final questionnaire was later distributed to the Body of Expert and Licensed Accountants of Romania members who participated in professional development activities during November 1<sup>st</sup> and November 18<sup>th</sup>, 2022; 445 responses were collected, all valid, which made up the final representative sample size. The test was carried out between the first answers from the pilot survey and the answers from the actual investigation, with the results showing no significant differences. When accessing the questionnaire link, potential respondents were informed about the purpose of completing the questionnaire (testing the perception of professional accountants in Romania on energy efficiency improvement measures) and the use of the collected information (research activity). They were assured of the confidentiality of their answers (respondents' names or email addresses were not collected). The targeted sampling strata were activity sector, organisation size, and urban/rural typology, and the type of activity the respondents perform within the organisation.

The questionnaire contains information on the effective implementation of energy efficiency improvement measures applied by organisations and the perception of professional accountants about the impact of the implementation of these measures. The questions target the perception of the respondents to capture the usefulness of energy efficiency improvement measures that organisations could implement and the state could adopt, and the implementation impact of these measures on the organisations. The tested measures were based on the classification illustrated in Table no. 1.

Energy efficiency improvement measures have been captured using binary variables, coded with 1 if the measures have been applied and with 0 – otherwise. The perception of professional accountants about the usefulness of these measures that the state and organisations can apply, together with their perception about the impact of these measures, have been captured using ordinal variables, measured on a 5-point Likert scale, from one the least important to five the most important.

The research methodology combines classical statistical techniques with more sophisticated methods and is built on two main stages. In the first stage, descriptive statistics highlight the collected responses, while non-parametric Mann-Whitney (Krasodomska et al., 2020;

Smalheiser, 2017) and Kruskal-Wallis tests demonstrate how various sociodemographic factors may lead to statistically significant differences. In the second stage, progress in the implementation of EEIMs has been assessed by building an original composite index regarding the implementation of these measures, depending on the weights provided by the multiple correspondence analysis and taking into account the standardised scores of the first component based on all ten measures. In order to investigate the internal consistency of all measures and to build a unidimensional index, the Cronbach alpha coefficient (c-alpha) was used, a value greater than the cut-off of 0.7, highlighting an acceptable reliability threshold. The index, as such, is further scaled to take values from 0 to 100. The multiple correspondence analysis considers the effective implementation of the measures as a multidimensional latent variable (unobserved). It uses binary variables in its construction process and is based on the axiom of monotonicity and the consistency of order of the first axis. Valuable information for the application of this type of method was provided, among others, by Asselin (2002), Asselin and Anh (2008), and Davidescu et al. (2020). To apply the whole methodology, the STATA 15 version has been used.

#### 4. Empirical results and discussions

##### 4.1. Profile of organisations and descriptive statistics

The structure of the respondents who provide accounting services to various organisations is the following: 78.2% are women, almost 70% are over 45 years old, and 55% have more than 20 years of experience in the accounting field. Regarding the main tasks provided by professional accountants, it can be highlighted that the most important activities they are involved in are the following: accounting records (80.22%), financial reporting (69.21%), and completion of fiscal works (tax computation, fees, preparation, and submission of tax declarations) (63.59%). Concerning the characteristics of the organisations where professional accountants worked, the distribution is as follows: 40% micro-entities, 26% medium and large entities, 21% small entities, and 13% entities with another organisation form. Regarding the main activity sector, most of the organisations are active in the manufacturing sector (33%), followed by the service sector (specialised in architecture, construction and engineering consultancy) (18%). More than 87% of the organisations in the sample are from an urban area and the Muntenia region has a significant proportion.

Table no. 2 presents the most important descriptive statistics, highlighting the mean, median value, and standard deviation. The EEIMs composite index has a median value of 49.88, indicating that half of the investigated organisations are below the 50% threshold, while the other half is above. The standard deviation that measures the degree of dispersion is 28.8. Based on statistical indicators, the most useful measures to improve energy efficiency are *the use of assets that belong to the highest energy efficiency class*, with an average value of 4.02 (representing the maximum utility), and *the installation of smart metres*, with an average value of 3.46. The median value also supports this result, recording high values. For all measures, the standard deviation is around the same value, which supports the stability of the results.

Table no. 2. Descriptive statistics

Variable	Mean	Median	Standard deviation
EEIMs Index (%)	50	49.88	28.79171
<b>The usefulness of EEIMs that organisations can apply</b>			
Use of products/equipment/assets that belong to the highest energy efficiency class	4.020225	5	1.190066
Installation of smart metres	3.462921	4	1.349540
Changing the energy supplier according to the applied tariffs	3.267416	3	1.459033
Requesting technical assistance for the implementation of EEIMs	3.130337	3	1.390476
Requesting energy audit missions	2.613483	3	1.386485
<b>The usefulness of EEIMs that the state and its institutions can take</b>			
The existence of non-reimbursable funding sources for the EEIMs implementation	4.301124	5	1.085998
The existence of a fiscal framework to encourage the EEIMs implementation	4.186517	5	1.118557
<b>The EEIMs' potential impact on the organisation</b>			
The organisation would deal better with uncertainties in the external environment	3.658427	4	1.259273
The organisation would improve its performance	3.624719	4	1.257704
It would increase the value of the organisation	3.602247	4	1.312276
The organisation would be more competitive with competitors	3.393258	3	1.330667

Source: Authors' compilation, 2022

Regarding the energy efficiency improvement measures that the state could take, the most useful is *the existence of non-reimbursable funding sources for the EEIMs' implementation*, with an average value of 4.30 and a median value of 5, characterised by a smaller standard deviation. From the perspective of the EEIMs' potential impact on the organisation, the following preferences stand out, in descending order of the mean and median value: *better management of uncertainties in the external environment, improvement of the organisation's performance and increasing the organisation's value*.

#### 4.2. Shedding light on the dashboard of the implementation of energy efficiency improvement measures in some organisations in Romania

The first research question is related to the implementation frequency of energy efficiency improvement measures by organisations in Romania. In this regard, the research results showed that the most frequently implemented measure is *the purchase of equipment/computers with lower energy consumption* (63.15%). It is followed by the *renovation of buildings to reduce energy consumption* (59.55%), *the purchase of new and more energy-efficient vehicles* (51.91%) and the *installation of smart electricity metres* (46.74%). On the other hand, we can find the *purchase/use of buildings with almost zero energy consumption (passive houses)* (24.72%) and the *energy audit of buildings, operations, and/or facilities* (31.91%) (Table no. 3).

Table no. 3. The most frequently implemented EEIMs

EEIMs	Weight	Activity sector (Kruskal Wallis Test)		Organisation size (Kruskal Wallis Test)		Region (Kruskal Wallis Test)		Urban/rural typology (Mann-Whitney Test)	
		chi2	prob	chi2	prob	chi2	prob	z	prob
Purchase of equipment/computers with lower energy consumption	63.15%	8.115	0.422	8.316	0.040**	7.404	0.192	-0.002	0.998
Renovation of buildings to reduce energy consumption	59.55%	10.212	0.250	13.836	0.003***	6.657	0.247	-0.305	0.760
Purchase of new and more energy-efficient vehicles	51.91%	17.712	0.023**	9,719	0.021**	1.142	0.950	-0.117	0.907
Installation of smart electricity meters	46.74%	9.456	0.305	4.965	0.174	1.590	0.902	-1.805	0.071*
Installation of solar panels	40.67%	23.955	0.002***	10.685	0.014***	2.336	0.801	-1.966	0.049**
Installation of smart natural gas meters	39.10%	3.788	0.876	4.302	0.231	0.822	0.976	-0.374	0.708
Receiving assistance for the EEIMs adoption	36.18%	5.358	0.719	10.337	0.016***	1.617	0.899	-0.184	0.854
Installation of remotely readable heat energy meters	34.16%	5.698	0.681	1.499	0.683	4.814	0.439	-0.140	0.888
Energy audit of buildings, operations, and/or facilities	31.91%	25.604	0.001***	21.141	0.00***	5,616	0,345	-0.551	0.582
Purchase/use of buildings with almost zero energy consumption (passive houses)	24.72%	12.490	0.131	7.991	0.046**	3,096	0,685	-0.358	0.720

Note: \*\*\*, \*\*, \* mean statistically significant at the significance level of 1%, 5%, and 10%, respectively.

Source: Authors' compilation, 2022

The result of our research regarding the fact that the most frequently implemented measure is *the purchase of equipment/computers with reduced energy consumption* converges with the academic literature related to equipment energy efficiency (Denkena et al., 2020). In addition, the lowest degree of implementation of *the purchase/use of buildings with almost zero energy consumption (passive houses)* is justified by the existence of an imbalance between the heating and cooling estimation regarding the passive house requirements and the impact on the comfort as a result of the climate in Romania (Mureşan and Attia, 2017). This type of measure also requires considerable financial effort.

To capture the statistical differences among EEIMs depending on the organisation's size, the main activity sector, urban/rural typology, or region, Kruskal-Wallis and Mann-Whitney tests

(Table no. 3) were used. The empirical results revealed the existence of statistical differences regarding the implementation of these measures at a maximum significance level of 10%, as follows:

- *The installation of solar panels and the energy audit of buildings, operations, and/or facilities* are more widespread energy efficiency improvement measures among organisations active in the production sector and the service sector (specialised in architecture, construction, and engineering consultancy).

- *Renovation of buildings to reduce energy consumption, purchase of new and more energy-efficient vehicles, an energy audit of buildings, operations, and/or facilities, receiving assistance for the EEIMs adoption, and installation of solar panels* are measures adopted mostly by micro-entities.

*Energy auditing of buildings, operations, and/or facilities* is a particular case. Although it is among the least EEIMs implemented by organisations (31.91%), this measure is adopted differently depending on the organisation's size and the activity sector. The low degree of energy audit implementation in organisations in Romania can be justified by the fact that the transposition of this measure into the national legislation was done late (in 2019) (Romanian Parliament, 2014, Article 9). The predominant implementation of the energy audit in the manufacturing sector confirms the results of previous studies, according to which organisations in this sector are more motivated to carry out an energy audit (Arvanitis et al., 2002; Almus and Czarnitzki, 2003; Czarnitzki et al., 2007; Kalantzis and Revoltella, 2019). In addition, the energy audit implementation, especially in organisations in the service sector (specialised in architecture consulting) and micro-entities, is consistent with the results of Kalantzis and Revoltella (2019). According to them, the energy audit implementation's impact seems to be higher for micro-entities, medium-sized enterprises, and organisations in the service and infrastructure sector.

Regarding *renovating buildings to reduce energy consumption*, statistics confirm that, at the EU level, buildings consume 40% of the final energy, requiring urgent energy efficiency measures (Cziszter et al., 2022). According to the European Commission (2020), the wave of building renovations in the EU will require regulation, financing, and *technical assistance* (EC, 2020). Furthermore, *the installation of solar panels* has expanded rapidly in Romania. Last year, the energy production generated by photovoltaic panels measured 1.1% of the total energy produced (Năstase et al., 2018). Our research results indicate that *building renovation to reduce energy consumption* and *the installation of solar panels* are energy efficiency improvement measures adopted mainly by micro-entities. A possible explanation for this trend is that these measures are among the most popularised in the Romanian press and are often associated with reducing energy expenses, which represents a significant concern, especially for micro-entities.

#### **4.3. Evaluating the effective implementation degree of energy efficiency improvement measures through a composite index based on the multiple correspondence analysis**

To answer the second research question aimed at analysing the degree of implementation of energy efficiency improvement measures, as a whole, an original composite index was built that captured the implementation degree of these measures at the level of some organisations in Romania. Accordingly, we have applied the multiple correspondence analysis. Empirical

results proved the relevance of a unique component, which explained 97.46% of total variability, while the value of the Cronbach's alpha statistic test (0.88) fully supported this type of composite index. Based on the weights of the first factorial axis for both categories, the EEIMs composite index determines the significance of each kind of measure based on the sign and value of the weights, indicating a balanced distribution across all ten measures (Table no.4).

**Table no. 4. The relative contribution of energy efficiency improvement measures**

EEIMs	Relative contribution (%)
Installation of smart natural gas meters	9.58
Installation of smart electricity meters	9.71
Installation of remotely readable heat energy meters	9.73
Purchase/use of buildings with almost zero energy consumption (passive houses)	9.84
Receiving assistance for the EEIMs adoption	9.85
Energy audit of buildings, operations, and/or facilities	9,87
Purchase of new and more energy-efficient vehicles	10.28
Installation of solar panels	10.31
Purchase of equipment/computers with lower energy consumption	10.39
Renovation of buildings to reduce energy consumption	10.41

*Source: Authors' compilation, 2022*

The EEIMs index has also been rescaled to take values between 0 and 100, where 0 represents the lowest implementation level and 100 represents the highest implementation level. This index has been computed as the average of its weight categories corresponding to the average of standardised scores on the first factorial axis. The index spans from 7.19 to 91.91, with an average level of 49.88, meaning that half of the investigated organisations have the EEIMs index below the 50% threshold, while the other half are above this threshold (Table no. 2). The analysis highlighted that 75% of the organisations in the survey have an EEIM index value less than 74.72%, and only 25% are above this value. By converting the index from a continuous score ranging from 0 to 100 into three groups (low, medium, and high level of implementation), it can be highlighted that almost 41% of the organisations reported a medium implementation level, and 30% have a high level of implementation of these measures (Table no. 5).

**Table no. 5. EEIMs index**

EEIMs index	Frequency	Percentage
Low implementation level (EEIMs index $\leq$ 30)	129	28.99
Medium implementation level (30 < EEIMs index $\leq$ 70)	183	41.12
High implementation level (EEIMs index > 70)	133	29.89
<b>Total</b>	445	100

*Source: Authors' compilation, 2022*

The medium level of EEIMs effective implementation degree in Romania could be explained by the fact that Romania is one of the European states with the lowest degree of dependence in terms of energy import: 28.2% compared to the EU average of 57.5% (EC, 2022).

Some statistical differences have been highlighted on the basis of the results of the Kruskal-Wallis and Mann-Whitney tests (Table no. 6) after exploring the structure of the EEIMs index concerning regional distribution, organisation size, urban/rural typology, and activity sector. Therefore, significant differences in energy efficiency improvement measures were shown according to the activity sector and the size of the organisation.

Table no. 6. Cross-sectional analysis

Cross-sectional analysis	Activity sector (Kruskal Wallis Test)		Organisation size (Kruskal Wallis Test)		Region (Kruskal Wallis Test)		Urban/rural typology (Mann-Whitney Test)	
	chi2	prob	chi2	prob	chi2	prob	z	prob
EEIMs Index	16.774	0.0524**	14.93	0.0019**	0.936	0.9676	-0.923	0.3558

Note: \*\*\*, \*\*, \* mean statistically significant at the significance level of 1%, 5%, and 10%, respectively.

Source: Authors' compilation, 2022

Energy efficiency improvement measures are more common in certain sectors, such as the trade sector (except for organisations that sell construction products) or services sector (except for organisations that provide services in architecture, construction consulting, and engineering) and the manufacturing sector. The increased implementation of EEIMs in the manufacturing sector is consistent with the results of Macharia et al. (2022). Also, according to the results of the Kruskal Wallis test, these measures are more common in the case of micro-entities and medium and large entities compared to small entities and other types of organisations.

Paying extra attention to energy efficiency is based on the decision-making process within an organisation (Fawcett and Hampton, 2020). Such differentiated implementation of these measures, depending on the organisation size and the activity sector, is justified by the existence of barriers associated with such characteristics (Trianni and Cagno, 2012; Smith, Wilson and Hassall, 2021). The empirical results did not confirm the statistical differences according to the region and the urban / rural typology.

**4.4. Exploring the perception of professional accountants about the usefulness of the energy efficiency improvement measures and the potential impact of these measures on organisations**

Regarding how professional accountants perceive the usefulness and the impact of energy efficiency improvement measures, it is interesting to know the answer to the following questions: What are the most useful energy efficiency improvement measures that organisations can apply? What are the most useful energy efficiency improvement measures the state and its institutions can take? What is the impact of these measures on organisations?

The analysis of the perception of the professional accountants regarding the usefulness of the EEIMs that the organisations should apply (Table no.7) emphasised the *use of products, equipment, or assets that belong to the highest energy efficiency class* (4.02 out of the

maximum possible score of 5) as the most useful measure. This is followed by *the installation of smart meters* (3.46).

**Table no. 7. The perceived usefulness of EEIMs that the organisation could apply**

EEIMs that the organisation could apply	Average score (from 5)	Activity sector (Kruskal Wallis Test)		Organisation size (Kruskal Wallis Test)		Region (Kruskal Wallis Test)		Urban/rural typology (Mann-Whitney Test)	
		chi2	prob	chi2	prob	chi2	prob	z	prob
Use of products/equipment/assets that belong to the highest energy efficiency class	4.02	12.853	0.1694	1.687	0.6399	8.41	0.135	-1.316	0.1882
Installation of smart metres	3.46	5.041	0.8307	0.052	0.9969	7.956	0.1587	-1.309	0.1906
Changing the energy supplier according to the applied tariffs	3.27	7.962	0.538	2.554	0.4657	7.046	0.2172	-2.159	0.0309**
Requesting technical assistance for the implementation of EEIMs	3.13	12.921	0.1662	4.253	0.2354	4.555	0.4725	-2.793	0.052**
Requesting energy audit missions	2.61	12.252	0.1995	3.99	0.2625	1.802	0.8758	-2.094	0.0363**

Note: \*\*\*, \*\*, \* mean statistically significant at the significance level of 1%, 5%, and 10%, respectively.

Source: Authors' compilation, 2022

Professional accountants consider that the most useful EEIM an organisation can apply relates to electricity consumption reduction (*use of products/equipment/assets that belong to the highest energy efficiency class*). This result is consistent with the opinion of Hrovatin et al. (2021). The economic context of the study (the threat of an economic recession in the coming months) justifies such an approach. Our findings indicate a perception of professional accountants regarding the EEIMs' usefulness implementation that contributes to the reduction of electricity consumption, similar to the results of research on the effective reduction of energy consumption under recession conditions (Collado and Economidou, 2021) or under crisis conditions (Andreoni, 2020).

Exploring the existence of statistical differences in the usefulness of these measures concerning regional distribution, organisation size, urban/rural typology, and activity sector, the results of the Kruskal Wallis and Mann-Whitney tests (table no. 8) highlighted statistical differences regarding the usefulness of EEIMs according to the urban/rural typology only. In this context, some measures (*changing the energy supplier depending on the applied tariffs, requesting energy audit missions, and requesting technical assistance for the EEIMs' implementation*) are perceived as important and valuable, especially by the respondents who operate in the urban area.

Regarding the measures that the state and its institutions should adopt, there is a balance between both measures, which relate to *non-reimbursable funding sources*, and *the existence of an adequate fiscal framework*. The average score is slightly higher for *non-reimbursable funding sources* (Table no. 8).



Table no. 8. The perceived usefulness of the EEIMs that the state could adopt

EEIMs that could be adopted by the state and its institutions	Average score	Activity sector (Kruskal Wallis Test)		Organisation size (Kruskal Wallis Test)		Region (Kruskal Wallis Test)		Urban/rural typology (Mann-Whitney Test)	
		chi2	prob	chi2	prob	chi2	prob	z	prob
The existence of non-reimbursable funding sources for the EEIMs implementation	4.30	12.617	0.1807	4.43	0.2186	10.281	0.0676*	-1.412	0.158
The existence of a fiscal framework to encourage the EEIMs implementation	4.18	7.296	0.6064	4.021	0.2592	6.847	0.2322	-1.021	0.3074

Note: \*\*\*, \*\*, \* mean statistically significant at the significance level of 1%, 5%, and 10%, respectively.

Source: Authors' compilation, 2022

The Kruskal-Wallis and Mann-Whitney tests highlighted significant differences in the region for the measure aimed at *the existence of non-reimbursable funding sources for the EEIMs implementation*. The preference for the use of non-reimbursable funding sources could be justified by the fact that Romania adopted the Government's Emergency Ordinance no. 112/2022, in the geopolitical context of the war in Ukraine, to establish a financial support scheme for SMEs and to stimulate investments in energy efficiency in Romania (Romanian Government, 2022). Such investments can be directed toward renewable energy, ensuring economic growth, national security (Panait et al., 2022), and green growth (Özbuğday et al., 2020).

Regarding how the potential impact of the EEIMs' implementation on the organisations is perceived, the common perception is that these measures would help the organisation better deal with *external environment uncertainties* and increase the *organisation's performance* (Table no. 9).

Table no. 9. Accountants' perception of the EEIMs' potential impact on the organisation

The EEIMs' potential impact on the organisation	Average score (max. 5)	Activity sector (Kruskal Wallis Test)		Organisation size (Kruskal Wallis Test)		Region (Kruskal Wallis Test)		Urban/rural typology (Mann-Whitney Test)	
		chi2	prob	chi2	prob	chi2	prob	z	prob
The organisation would deal better with uncertainties in the external environment	3.66	18.84	0.0266**	8.087	0.0442**	9.191	0.1017	-2.127	0.0335**

The EEIMs' potential impact on the organisation	Average score (max. 5)	Activity sector (Kruskal Wallis Test)		Organisation size (Kruskal Wallis Test)		Region (Kruskal Wallis Test)		Urban/rural typology (Mann-Whitney Test)	
		chi2	prob	chi2	prob	chi2	prob	z	prob
The organisation would improve its performance.	3.62	17.067	0.0477**	11.277	0.0103***	6.295	0.2786	-1.966	0.0492**
It would increase the value of the organisation.	3.60	15.837	0.0704*	15.888	0.0012***	5.988	0.3074	-1.493	0.1355
The organisation would be more competitive with competitors	3.39	33.604	0.0001***	19.336	0.0002***	6.353	0.2734	-2.095	0.0362**

Note: \*\*\*, \*\*, \* mean statistically significant at the significance level of 1%, 5%, and 10%, respectively.

Source: Authors' compilation, 2022

Energy efficiency investments can significantly increase productivity within the industry (Worrell, et al., 2003), leading to increased performance (Özbuğday et al., 2020). Traditionally, professional accountants are associated with the *organisation's performance* through the lens of their profession. However, they showed a slightly higher preference for avoiding *uncertainties from the external environment*. This issue could be caused by the uncertain geopolitical context or the strong tendency of Romanians to avoid uncertainty (Hofstede et al., 2010) and risks (Hrovatin et al., 2021).

The results of the Mann-Whitney and Kruskal-Wallis tests revealed significant differences in the potential impact of these measures on the organisation concerning the activity sector, the organisation size, and the urban/rural typology. Therefore, the respondents involved in the service sector (except for architecture), those from micro, medium, or large organisations, and those who work more in the urban area consider that all measures will significantly impact the organisation.

## Conclusions

According to the professional accountants who answered the questionnaire, the measure most often implemented by organisations in Romania is *the purchase of equipment/computers with lower energy consumption* (63.15%). This result converges with the academic literature research related to equipment energy efficiency (Denkena et al., 2020). A detailed analysis revealed differences regarding the implementation of each measure according to several important characteristics, such as the organisation's size and the activity sector. Such a difference was highlighted in the *energy audit* case, mainly implemented in micro-entities and the manufacturing and services sectors. Our research findings on the energy audit

implementation, especially in the manufacturing sector, confirm the results of other research (Arvanitis et al., 2002; Almus and Czarnitzki, 2003; Czarnitzki et al. al., 2007, Kalantzis and Revoltella, 2019). In addition, the energy audit implementation, especially in organisations in the service sector (specialised in architecture consulting) and micro-entities, confirms the results of Kalantzis and Revoltella (2019). According to them, the energy audit implementation's impact seems more significant for micro-entities and medium-sized enterprises and organisations belonging mainly to the services and infrastructure sector (Kalantzis and Revoltella, 2019).

The evaluation of progress in the effective implementation of the EEIMs was carried out by designing an original composite index based on the responses of professional accountants working in organisations in various regions of Romania. The research results revealed that the overall effective implementation of EEIMs is at the medium level. Our research showed that the effective implementation of these measures is more often carried out in sectors such as trade (except for the construction products sector), services (except for the architecture, construction consultancy, and engineering sector), and manufacturing sector, but also in micro-entities and medium and large entities. Such differentiation related to implementing these measures, depending on the organisation's size and the activity sector, can be explained by the existence of barriers that depend on the organisation's characteristics (Trianni and Cagno, 2012). The empirical results did not confirm the statistical differences according to the region and the urban / rural typology.

Some directions were outlined concerning professional accountants' perception of EEIMs' usefulness and the impact of these measures on the organisation. Professional accountants state that the most useful measure that the organisation could implement is the *use of products/equipment/assets that belong to the highest energy efficiency class*, which results in the reduction of electricity consumption, similar to the opinion of Hrovatin et al. (2021). Significant differences were observed in the EEIMs' potential impact on the organisation involving the activity sector, the organisation size, and the urban/rural typology. Concerning the investigation of the professional accountants' perception regarding the usefulness of the measures that the state and its institutions could adopt, the research results indicate a slight preference for *the existence of non-reimbursable funding sources for the EEIMs implementation*, an aspect also reported by (Özbuğday et al., 2020). Furthermore, the perception of professional accountants regarding the implementation of these measures is that it would help the organisation better manage *uncertainties in the external environment* (Hofstede, et al., 2010), *improve its performance*, and *increase its value* (Özbuğday et al., 2020).

Our research contributes to the progress assessment of EEIM implementation and to the identification of the most useful measures that organisations and the state can implement from the perspective of professional accountants. Detailed knowledge of information related to EEIM helps decision makers develop the most effective energy efficiency policies (Trianni et al., 2014) and could be used to change the behaviour of individuals in organisations with respect to their implementation (Walker, 2016).

One of the limits of our research is that the answers received may have a certain amount of subjectivity, which is common in research carried out on questionnaires. Future research on energy efficiency improvement measures could be the scaling of the intensity of implementation of the measures under implementation according to European and national

regulations. Thus, researchers obtain additional information on the impact of these measures within various organisations, both at the actual and desired levels.

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