

Industrial Energy Audit – The Impact of Current Regulations on Increasing Energy Efficiency in Romania

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Abstract. *The European Union is implementing some of its most ambitious energy and environmental policies to become the first climate-neutral continent by 2050. Energy efficiency plays a key role in this initiative, being regulated by various legislative measures, including Directive 2012/27/EU. Gradually, Directive 2012/27 / EU has experienced several substantial changes, and for the sake of clarity, has been replaced by Directive 2023/1791/EU, which updates energy efficiency measures and sets the target of reducing energy consumption by 11.7% by 2030. The new directive also needs assistance for SMEs and sectors not subject to energy audit obligations. In the current state of the scientific literature, previous research looks at energy audits, management systems and the EE1 principle, but there is limited analysis on how recent legislative changes impact member states. The research methodology used in this paper examines the implementation of Directive 2012/27/EU in Romania, Germany and France, highlighting the difficulties encountered by Romania, which require a clearer transposition of Directive 2023/1791/EU and an advanced digitisation. The results suggest that around 20,000 new companies will have to apply energy efficiency measures, with a potential to reduce energy consumption of around 10%. These results underline the need for active involvement of authorities and effective support policies to enhance the implementation of energy efficiency measures at national level.*

Keywords. Energy Efficiency, Industrial Energy Audit, Energy Policy.

Introduction

Reducing greenhouse gas emissions (GHG) and transitioning to a climate-neutral future are major global challenges. In this context, the energy transition is described as “a pathway toward transforming the global energy sector from fossil-based to zero-carbon by the second half of this century” (IREA, 2018). Within the European Union, the energy transition is guided by several factors, including EU legislation, the intention to reduce the dependence on fossil fuels and increase energy efficiency (Rabbi, Popp, Máté & Kovács, 2022).

The European Green Deal, introduced in December 2019, aims to position Europe as the first continent to achieve climate neutrality by 2050. Key targets include cutting emissions by at

least 55% by 2030 (compared to 1990 levels) and ensuring a just transition. (European Commission, 2019).

A key area of interest in this transition is the industrial sector. Recent studies indicate that this sector was directly responsible for 9.0 GtCO₂ in 2022 (IEA, 2023). Therefore, decarbonizing the industrial sector is essential for addressing the climate crisis and reaching carbon neutrality. Industry uses energy not only as an end product, but also as an intermediate input. (Kim, Sovacool, Bazilian, Griffiths & Yang, 2024).

According to the IEA (2023), the actions needed to reduce emissions by 2030 are well understood and, in most cases, highly cost-effective. These include tripling renewable energy capacity, doubling energy efficiency improvements to 4% annually, accelerating electrification, and reducing methane emissions from fossil fuel operations. Together, these measures are expected to account for more than 80% of the emissions reductions required by 2030, putting the energy sector on track to limit global warming to 1.5 °C (Piterà & La Mura, 2024).

Given its significant impact on emissions, energy efficiency (EE) is a key strategy for reducing CO₂ emissions from industrial energy consumption. The main approaches to increasing energy efficiency in industry are the adoption of advanced energy saving technologies and the optimization of energy management practices (Farkas, Muresan, Stet, Czumbil, Ceclan & Micu, 2022) (Paramonova, Thollander & Ottosson, 2015).

Industrial Energy Audit is the most powerful tool to stimulate the growth of energy efficiency at the level of industrial companies. According to Kluczek & Olszewski (2017), industrial energy audits help identify energy savings, often through equipment upgrades or repurposing recovered energy, like heat. Advanced measures may involve converting energy forms to optimize savings and improve overall performance.

Policy measures play a vital role in addressing the barriers to energy efficiency and fostering an environment that promotes sustainable energy practices. A range of policy instruments, including informational, regulatory, and financial tools, can be employed by authorities and regulators to encourage investments in energy efficiency. (Rhouiria, Habiboullah Meyabeb, Benmoussac & Bensoudaa, 2024) (Cattaneo, 2019)

Since 2006, energy efficiency has played a central role in EU policy. Several directives have focused specifically on it as a primary objective. Notably, these include Directive 2006/32/EC on energy end-use efficiency and energy services and Directive 2012/27/EU (EED) on energy efficiency, along with its amendments (the 2018/2002 revision) (Dunlop, 2022).

Directive 2012/27/EU of the European Parliament and of the Council has been substantially amended several times. As additional amendments have been made, this directive has been recast for reasons of clarity. Therefore, Directive 2012/27/EU is repealed with effect from 12 October 2025 and will be replaced by Directive 2023/1791/EU on energy efficiency and amending Regulation (EU) 2023/955 (recast).

Directive 2012/27/EU will be replaced by Directive 2023/1791/EU, which also amends Regulation (EU) 2023/955. Published on 20 September 2023, the new directive updates energy efficiency measures and establishes new provisions aimed at reducing final energy consumption across the EU by 11.7% by 2030, compared to 2020 forecasts. According to Article 39, the directive will enter into force 20 days after publication, with certain provisions taking effect from 30 June 2024 and others, including Articles 13-20 and specific annexes, applying from 12 October 2025 (Directive 2023/1791/EU, 2023).

Accordingly, the revision of the Energy Efficiency Directive (EED) is an integral component of the 'Fit for 55' package within the framework of the European Green Deal, which

aims to further reduce greenhouse gas (GHG) emissions by refining and strengthening key EU energy legislation (European Union, energy Profile, 2023).

This paper explores how current regulations, including the Energy Efficiency Directive, influence the adoption of energy-efficient technologies and practices within industrial sectors, with particular emphasis on their implications for energy consumers. This study primarily aims to assess how recent legislative updates can promote the adoption of energy-efficient practices in both large industries and SMEs. In doing so, it highlights the practical challenges and opportunities arising from the revised requirements and provides actionable recommendations to overcome barriers to effective implementation.

Literature review

Over time, the EU's legislative framework for energy efficiency has progressively adapted to the growing global climate goals and energy security needs. The European Union has long been at the forefront of energy efficiency policy, which was initially driven by the 1970's oil crisis and the need to secure energy supply (Malmberg, 2023). In more recent years, energy efficiency has become critical to meeting global climate goals, particularly the Paris Agreement's target of limiting global warming to 1.5°C. Subsequently, the EU introduced the "energy efficiency first" (EE1) principle in the 2016 "Clean Energy for All Europeans" package, later reinforcing it in the 2021 "Fit for 55" package (European Union, 2018).

In July 2021, the European Commission (EC) unveiled, a package of proposals designed to amend and update EU regulations on climate, energy, transport, land use, and taxation, collectively known as the 'Fit for 55' initiative. A key element of this package was the revision of the Energy Efficiency Directive (EED), which defines the EU's energy efficiency targets for 2030 and outlines specific requirements for national energy savings, as well as measures to enhance energy efficiency in the public and industrial sectors (European Commission, 2021).

The European Commission's proposal to recast the Energy Efficiency Directive (EED) aims for climate neutrality by 2050, positioning energy efficiency as a primary energy source. The "Energy Efficiency First" (EE1) principle seeks to maximize energy efficiency benefits for citizens and businesses, guiding EU policies across sectors, including finance. It mandates prioritizing energy efficiency in planning and investment decisions to ensure cost-effective energy use and avoid unnecessary energy production and stranded assets.

In the original version, the Energy Efficiency Directive 2012/27/EU (EED) focused on aligning energy efficiency policy with energy security and climate change mitigation. However, the 2018 amendment to the EED broadened this scope by incorporating the multiple benefits of energy efficiency, including its role in combating climate change. As Dunlop's notes (2022), the concept of energy efficiency has evolved over time, becoming more comprehensive and multifaceted (Malmberg, 2023).

Therefore, in accordance with Article 8 of the Energy Efficiency Directive 2012/27/EU (EED), large companies (i.e., non-SMEs) were required to conduct an energy audit at least once every four years. In addition, the directive also established compliance guidelines for energy audits and auditors, based on the EN 16247 standard. While EU member states incorporated this audit requirement into their national policies, many gradually introduced energy intensity thresholds to determine which companies were required to comply. As a result, the application of these criteria varied significantly across member states, with some even extending the audit obligation to high-energy-consuming SMEs.

The proposal to revise the Energy Efficiency Directive aimed to modify the criteria for mandatory energy audits, shifting the focus from company size to energy intensity. Moreover, it introduced a requirement for energy-intensive companies to implement an energy management system (Bourgault&Matušek, 2023)

Thus, starting in 2024, the target for annual energy savings in final energy consumption will gradually rise until 2030. By the end of this period, Member States will be required to achieve an average annual energy saving of 1.49%, with the target reaching 1.9% by 31 December 2030. To meet these goals, countries will be allowed to include in their calculations energy-saving measures already implemented, such as those under the Energy Performance of Buildings Directives, the EU Emissions Trading System (for installations, buildings, and transport), as well as emergency energy-saving actions.

The directive requires Member States to implement programs supporting SMEs and other sectors not typically subject to energy audit obligations, to encourage energy audits and the implementation of energy-saving measures. Companies with average annual energy consumption above: 85 TJ (approximately 2030 toe) are required to adopt an energy management system by October 11, 2027 and 10 TJ (approximately 239 toe) but not implementing an energy management system, must undergo an energy audit by October 11, 2026.

These audits should be carried out by qualified or accredited experts, or under the supervision of national authorities, and must comply with standards such as UNI CEI EN ISO 50001 or UNI CEI EN 16247. The audits will be required to be updated every four years.

The directive allows certain existing mechanisms, such as the EU Emissions Trading Scheme (EU ETS), to count as compatible with energy audits if they meet the directive's minimum requirements. For companies already meeting audit requirements, audits must continue every four years (Piterà & La Mura, 2024)

According to Piterà & La Mura (2024), energy audits are vital for planning energy efficiency and are central to EU regulations for reducing energy consumption and achieving decarbonization. As regulations tighten, Energy Management Experts will play a crucial role in implementing energy efficiency measures, ensuring compliance, and driving the transition to a sustainable energy model.

The revised Energy Efficiency Directive (EED) requires examining its provisions and practical implications for consumers. While previous research has explored energy audits, management systems, and the EE1 principle, there is limited analysis on how recent legislative changes, particularly the 2023/1791 Directive, can be implemented in industrial practices, especially with regard to SMEs.

Thus, this study will bridge this gap by critically analyzing the key articles of the EDF, focusing on their applicability to both large enterprises and SMEs under the new provisions. The necessary number of competent energy efficiency professionals will also be analysed in Romania.

By examining the feasibility of these provisions and identifying challenges to compliance, this research aims to contribute to the body of knowledge on the implementation of EU energy efficiency policies at the member state level. The methodology will therefore build on findings from the literature, while providing an understanding of the evolution of energy efficiency in practice through a detailed analysis of legislative requirements and their impact on the need for energy audits and energy management systems.

Methodology

This research analyzes the revised Energy Efficiency Directive 2023/1791/EU, focusing on its impact on industrial energy audits, energy management systems, and the "Energy Efficiency First" (EE1) principle in Romania and other EU member states.

This study evaluates the implementation of Directive 2012/27/EU, examining the effectiveness of energy efficiency measures, energy savings, and compliance with EU and national targets, along with progress in building renovations and heating system electrification.

Using official energy consumption data, national reports, and case studies, the research compares the approaches of France, Germany and Romania, highlighting differences in implementation strategies of the following indicators: industrial energy consumption, focusing on the consumption trend from 2000 to 2022, the dominant industry in increasing consumption and energy efficiency interventions applied by each country.

All these analyses demonstrate how challenges in implementing Directive 2012/27/EU influenced the adoption of Directive 2023/1791/EU, analyzing deficiencies, successes, and suggested revisions. Additionally, it considers the impact of the new regulations on the demand for energy auditors and managers, as well as the capacity required to support lowering carbon footprint in industry and progress toward EU decarbonization goals.

Results and proposal

This section presents the case study of Directive 2012/27/EU implementation in several EU member states, focusing on Romania. It highlights key differences in transposing energy efficiency measures and their impact on energy savings, industrial audits, and progress toward national and EU targets. The section also explores the challenges that led to the adoption of Directive 2023/1791/EU, offering proposals for enhancing energy efficiency measures to support industrial decarbonization and achieve EU 2030 goals.

By examining the implementation of Directive 2012/27/EU, the study will identify challenges that led to the adoption of Directive 2023/1791/EU.

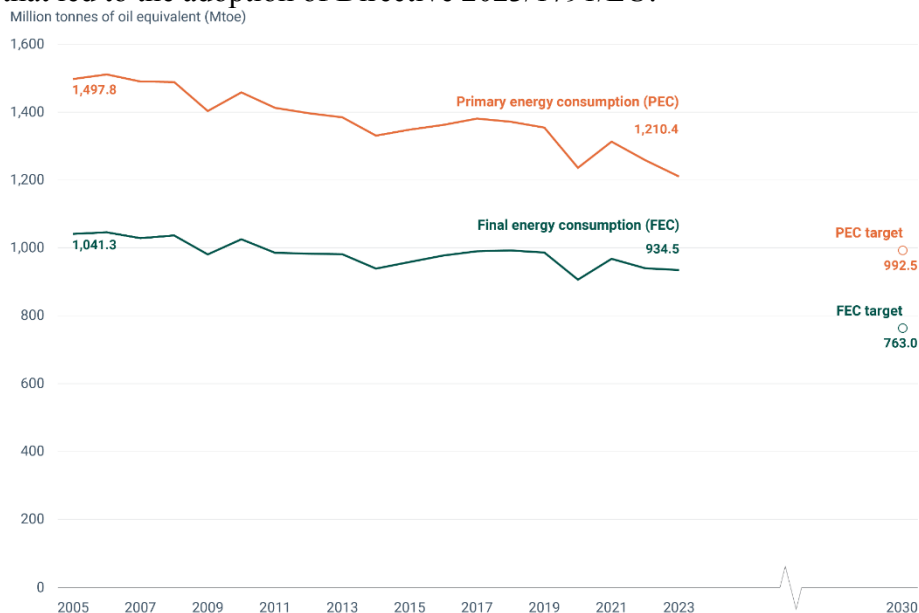


Figure 1. Primary and final energy consumption in the European Union

Source: <https://www.eea.europa.eu/en/analysis/indicators/primary-and-final-energy-consumption>.

According to European Environment Agency (EEA, 2024) estimates, the European Union's primary energy consumption (PEC) decreased by 3.8% in 2023 compared to 2022, and final energy consumption (FEC) decreased by 0.6%. Directive 1791/2023/EU sets a binding target of 992.5 Mtoe for primary energy consumption (PEC) and an indicative target of 763 Mtoe for final energy consumption (FEC) by 2030. The PEC includes all energy demand, including losses, and the FEC refers to energy used by consumers. (European Environment Agency (EEA), 2024).

To better understand the context and challenges that led to the adoption of Directive 2023/1791/EU, it is essential to first evaluate the outcomes of Directive 2012/27/EU. While the latter laid the groundwork for energy efficiency improvements, its effectiveness largely depended on how well it was transposed into national laws. This comparison will highlight the gaps and successes that informed the updates in the 2023 revision.

Examples of national transpositions include:

- Romania: Law 121/2014 on energy efficiency, published in the Official Monitor no. 128/2014;
- Germany: Energy Efficiency Act (Energieeffizienzgesetz), published in the Federal Law Gazette (Bundesgesetzblatt) 2015, Part I, No. 39, p. 1146, adopted on July 30, 2015;
- France: Decree No. 2016-1110 of August 19, 2016, on energy audits and efficiency measures, published in the Official Journal of the French Republic (Journal Officiel de la République Française), No. 0194, August 20, 2016;
- Italy: Legislative Decree No. 102/2014 of May 4, 2014, on industrial energy efficiency, published in the Official Gazette of the Italian Republic, No. 122, May 27, 2014;
- Poland: Energy Efficiency Act of May 20, 2016, published in the Dziennik Ustaw (Official Journal of Poland), 2016, item 831;
- Sweden: Energy Efficiency Act (2014:266), published in the Svensk Författningssamling (SFS), 2014:266.

As a result of transposing Directive 2012/27/EU in member states, the EU successfully met its energy efficiency targets for 2020 in both primary and final energy consumption.

In 2022, primary energy consumption decreased by 4.1% to 1,257 million tonnes of oil equivalent (Mtoe), and final energy consumption fell by 2.8% to 940 Mtoe, narrowing the gap to the 2030 targets.

However, achieving the 11.7% reduction target for final energy consumption by 2030 will require additional efforts, as current progress shows only a 5.8% reduction compared to projections. While these targets were met, the current progress in energy efficiency shows that further measures are needed to close the gap and ensure compliance with the 2030 objectives.

In the industrial sector, mandatory energy audits have been essential for identifying energy-saving opportunities, but energy savings from obligation schemes remain below 60% of required levels, requiring more intensive action in the coming years. This highlights the need for stronger implementation of energy efficiency measures, including energy audits and the electrification of industrial heating systems, to meet 2030 targets and drive decarbonization (European Commission, 2024).

Germany and France have been successful in implementing energy efficiency measures, playing a key role in achieving EU objectives.

Although each member state transposed the Directive in a manner suited to their local context, the overall impact of these measures was significant, contributing to the achievement of the EU's 2020 objectives. However, significant challenges remain in order to meet the 2030 targets.

In Germany: The 2015 Energy Efficiency Act (Energieeffizienzgesetz) drove significant reductions in industrial energy consumption through mandatory audits and strong monitoring. However, progress in small and medium-sized enterprises (SMEs) was slower, hindered by unclear regulations and limited enforcement. In Germany, energy audits and management systems have led to savings of approximately 3.4% of total energy consumption, with potential savings varying by sector. Following the 2015 audit obligation, challenges with audit quality and auditor capacity arose. In 2019, Germany introduced measures requiring companies to submit detailed online audit statements, enabling automatic checks by government entities and random audits by BAFA (Bundesamt für Wirtschaft und Ausfuhrkontrolle). To ensure high-quality reports, auditors must register with BAFA, prove qualifications, and undergo regular training. A mechanism to remove low-quality auditors may be introduced in the future (Eichhammer, ISI, Berger, ISI, Steinbach, Friedrichsen & Choi, 2022).

In France: Decree No. 2016-1110 promoted energy audits in large industries, boosting energy efficiency. However, regional disparities and inconsistent enforcement impeded full alignment with EU targets, particularly for SMEs.

Between 2000 and 2021, industrial energy consumption decreased by 0.8% per year, reaching 27.2 Mtoe. France's energy efficiency policies for industry rely on market-based instruments like the EU-ETS and Energy Savings Certificates. Regulatory measures include mandatory energy audits every four years under the Energy Efficiency Directive (2012/27/EU). The France 2030 plan, allocating €5.6 billion for industrial decarbonisation, complements other financial incentives, including subsidies for energy efficiency and low-carbon industrial heat, with additional support from Agence de la transition écologique's Heat Fund and targeted loans for SMEs (France, Energy Profile, 2024).

Romania transposed Directive 2012/27/EU through Law 121/2014 on energy efficiency, published in the Official Monitor no. 128/2014, a key regulation for energy efficiency. The law clarified energy audit procedures, the role of auditors and energy managers, and set obligations for consumers. However, despite the implementation of Law 121/2014 in Romania, the lack of enforcement and clarity regarding the energy audit obligations for small consumers has resulted in limited progress in achieving the intended energy savings in the industrial and services sectors.

Regarding Romania, Law 121/2014 was one of the most important documents in the field of energy efficiency issued in Romania to date. The mandatory energy audit threshold of 1,000 toe/year and the use of authorized energy managers remain in place. However, a vague requirement for small consumers, excluding SMEs, to conduct energy audits has resulted in low compliance, leaving significant energy consumption unmonitored in both the industrial and service sectors.

According to Law 121/2014, companies consuming less than 1,000 toe/year must submit the total energy consumption declaration by June 30th of each year and conduct an energy audit every 4 years for the entire energy consumption perimeter.

On the other hand, companies consuming more than 1,000 toe/year have the following obligations: They hire a certified Energy Manager or sign a contract with an Energy Service Company, submit the total energy consumption declaration by June 30th of each year, submit the energy analysis questionnaire by June 30th of each year, develop an Energy Efficiency Improvement Program by September 30th of each year; conduct an energy audit every four years for the entire energy consumption scope.

Based on the information available at the level of 2019, the last reporting year of ANRE in the field of energy efficiency, Romania has about 35 very large consumers (>50,000 toe/year), 1920 large consumers, thus: 220 (5,000-50,000 toe/year) and 1,700 (1,000-5,000 toe/year), and

20,000 small and medium consumers (230-1,000 toe/year). The small consumer segments are largely unmonitored by energy audits.

The energy consumption of large consumers is estimated at 5,000-6,000 toe/year, totaling about 11 million toe/year, considering that about 2,000 consumers are active on the Romanian market. Assuming a 3% reduction in energy use through efficiency measures, the potential market for energy efficiency projects is estimated at 330,000 toe/year, valued at 330 million EUR annually. With a payback period of 4 years, the total market value could reach 1.3 billion EUR.

In addition to the 47 authorized companies for energy audits, there are a total of 645 entities that must be authorized every 3 years. It results in an authorization requirement of approximately 220 entities annually, with an average number of 18 authorizations per meeting, the average number of meetings required is 12 annually, which fully corresponds to reality (Ministry of Energy, 2024).

The transposition of the revised Directive 2023/1791/EU in Romania will have a number of main effects.

To fulfill the legislative obligations, a number of about 20,000 companies will receive taxation in terms of conducting energy audits, declaring energy consumption, reducing energy losses. The auditing market will grow by a potential 6,300 audits per year.

Assuming 30% compliance in the first period, the industrial audit market will grow by approximately 2,000 audits annually. If there are 40 active firms, each will conduct an average of 50 additional audits annually. Given that the current average is 15 audits per firm, it is expected that the work of auditors will double or triple, and the number of companies and auditors will increase proportionally over the next 5 years to meet market requirements.

Considering a weighted mean of annual energy use for small and medium consumers of 350 toe/year, by multiplying by the number of consumers, results in their annual energy consumption of about 7 million toe/ year. Clearly, the level of energy efficiency of these companies is lower than for those that have been audited in the last 20 years. As a result, we can consider that there is a potential to reduce consumption by about 10%. The potential level of energy savings is therefore double what can be reached annually from auditing large companies if compliance is sufficiently high. Repeating the previous calculations, it results in an annual potential of energy efficiency projects of at least EUR 2.6 billion/year.

Germany and France have overcome challenges in implementing energy efficiency measures through clear regulations, subsidies, and an effective oversight and control system. In contrast, Romania faces difficulties due to weak enforcement of regulations, limited capacity for training energy auditors and managers, and a absence of financial resources for SMEs, which limits progress.

Conclusion

The case study showed that, unlike Germany and France, Romania encounters major challenges in implementing energy efficiency regulations. Although all the member states analysed face difficulties in achieving full compliance with the EU's SME objectives, Romania requires a clear transposition of Directive 2023/1791/EU to improve compliance. The authorities will play a crucial role in assisting the private sector in implementing energy audits and implementing the necessary measures.

Recent history has shown that associating the achievement of certain benefits or compliance with certain obligations to the presentation of a document certifying the fulfilment of energy efficiency obligations is the best approach. Making the receipt of any state support in the energy

field conditional on the fulfilment of obligations can be done, for example, when submitting any applications for funding or, at the limit, when signing an energy supply contract. A mass of 20,000 new companies to report energy efficiency actions, however, must be thoroughly managed to avoid obstacles.

For Romania, increasing the number of auditors and rapidly adapting the market to the obligations of the directive will be essential to achieve the objectives of decarbonisation and energy efficiency. It calls for doubling or even tripling the number of audit firms and authorised auditors over the next 5 years to meet the requirements and support SMEs in the green transition process. According to the new regulations and estimates, about 100 new Audit companies and 300 new auditors will go to the Commission to obtain the licenses. The annual effort could increase to double the frequency of authorization meetings. This will clearly be possible through advanced digitization that will be able to support the entire process without obstacle.

Currently, not many studies have been carried out to assess the impact of the new provisions imposed by Directive 2023/1791/EU on energy efficiency in Romania.

There are studies at European Union level on the role of energy audit and measures to increase energy efficiency particularly for large energy consumers. Small and medium-sized consumers have so far not been an overriding subject in regulations. The current study could be the start of a series of studies on the importance of energy tracking for all categories of energy consumers, including SMEs. Also, in the future, the discussion is open to evaluating the results of reducing energy consumption in this sector and the benefits that will contribute to Romania's transition to a decarbonized economy.

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