American Journal of Engineering and Technology Innovations
ISSN: - applied

Energy Efficiency Governance and Industrial Energy Auditing in Europe A Multilevel Policy and Practice Perspective

[1] Li Wei Zhang
[1] University of Belgrade Serbia

Received: 16th Oct 2025 | Received Revised Version: 21th Oct 2025 | Accepted: 30th Oct 2025 | Published: 07th Nov 2025

Volume 01 Issue 01 2025 | Crossref DOI: 10.64917/ajeti/V01I01-002

Abstract

Energy efficiency has become one of the most strategically important pillars of European climate, industrial, and economic policy. In the context of the European Green Deal and successive revisions of the European energy efficiency acquis, energy efficiency is no longer framed only as a technical objective but rather as a core governance principle that shapes the design of markets, institutions, and industrial practices. At the same time, energy audits have emerged as a central operational mechanism through which energy efficiency policy is translated into concrete action, particularly within industrial and small and medium sized enterprise contexts. Despite their centrality, the relationship between European level energy efficiency governance and firm level energy auditing remains underexplored in an integrated manner. Much of the existing literature treats energy efficiency policy as a regulatory phenomenon and energy auditing as a technical management tool, without fully examining how they interact as parts of a single multilevel system of governance.

This article develops a comprehensive analytical framework that connects European energy efficiency governance with industrial energy auditing practices, drawing strictly on the provided references from European policy documents, energy efficiency theory, and empirical studies of energy audits in industry. The analysis situates energy audits within the evolution of energy efficiency as a policy concept, showing how the regulatory ambitions of the European Union have progressively redefined what energy audits are expected to achieve, how they are institutionalized, and how their results are used in decision making. Using the European Green Deal, the Energy Efficiency Directive, and recent Commission and European Environment Agency reports as the policy backbone, the article traces how energy efficiency targets and compliance mechanisms cascade down into industrial operations. Simultaneously, it integrates detailed evidence from case studies and reviews of energy auditing in small and medium sized enterprises and industrial facilities to illustrate how firms interpret, implement, and sometimes resist these policy expectations.

The results show that energy audits function not merely as diagnostic tools but as key governance instruments that mediate between European level objectives and local industrial realities. They create knowledge, structure managerial attention, and legitimize investment decisions, but their effectiveness is constrained by organizational barriers, financial limitations, and policy design gaps. The discussion highlights the need to move beyond a narrow efficiency logic toward a more institutionally informed understanding of how energy audits operate within European energy governance. The article concludes that strengthening the alignment between policy frameworks and auditing practices is essential for achieving the ambitious energy efficiency goals of the European Union.

Keywords: Energy efficiency policy, industrial energy audits, European Green Deal, energy governance, MSME energy management, sustainability regulation.

Cite This Article: Li Wei Zhang. 2026. Energy Efficiency Governance and Industrial Energy Auditing in Europe A Multilevel Policy and Practice Perspective. American Journal of Engineering and Technology Innovations 1, 01, 7-12. https://doi.org/10.64917/ajeti/V01I01-002

1. Introduction

Energy efficiency occupies a unique and increasingly complex position within European climate and energy policy. It is at once a technical objective, an economic strategy, a social norm, and a regulatory principle. Unlike renewable energy or emissions trading, which are defined by specific technologies or market instruments, energy efficiency is inherently relational. It refers to the ability to produce the same or greater level of economic and social output using less energy input, but this deceptively simple definition hides deep conceptual, institutional, and political layers. Dunlop describes energy efficiency as a motherhood concept, meaning a term that is universally endorsed but whose precise meaning and operational implications are often contested and fluid (Dunlop, 2022). This ambiguity has allowed energy efficiency to become embedded in almost every aspect of European energy policy, from building codes and appliance standards to industrial processes and corporate reporting, but it has also created challenges for implementation and evaluation.

The European Union has progressively elevated energy efficiency from a supporting measure to a central pillar of its climate and economic strategy. The European Green Deal explicitly positions energy efficiency as a key means of reducing greenhouse gas emissions, improving energy security, and enhancing industrial competitiveness (European Commission, 2019). This political framing is translated into binding regulatory instruments through the Energy Efficiency Directive and its recast versions, most recently COM 2021 558 final, which significantly strengthens energy efficiency obligations for member states and large enterprises (European Commission, 2021). The 2024 Commission report further reinforces this trajectory by highlighting the gap between current energy consumption trends and the ambitious targets set for 2030 and 2050, thereby underscoring the urgency of more effective implementation mechanisms (European Commission, 2024).

At the same time, energy consumption data from the European Environment Agency reveal that, despite policy efforts, primary and final energy consumption in the European Union remains structurally high, particularly in industrial sectors (European Environment Agency, 2024). This empirical reality points to a persistent implementation gap between policy ambitions and actual energy performance on the ground. It is within this gap that energy audits play a critical role. Energy audits are designed to systematically identify opportunities for reducing energy use and improving efficiency within organizations. In the European regulatory framework, large enterprises are legally required to conduct regular energy audits, while small and medium sized enterprises are encouraged through various support schemes and voluntary programs (European Parliament and Council, 2006; European Commission, 2021).

The academic and practitioner literature on energy audits in industry is extensive, particularly in the context of small and medium sized enterprises and manufacturing facilities. Case studies from India and other contexts demonstrate that energy audits can lead to substantial cost savings, reduced energy consumption, and improved operational efficiency when properly conducted and followed by investment (Singh and Kumar, 2019; Gupta and Srivastava, 2019; Khan and Ahmed, 2019; Kothari et al., 2022; Krishnan et al., 2023; Bhattacharya et al., Energy Reports). These studies emphasize the technical and managerial value of audits, but they often treat them as isolated interventions rather than as components of a broader governance system.

A significant gap in the literature lies in the lack of integration between macro level energy efficiency policy analysis and micro level energy auditing practice. European policy documents articulate ambitious targets, principles, and compliance mechanisms, but they rarely engage in depth with how energy audits are actually conducted, interpreted, and acted upon within firms. Conversely, industrial energy audit studies provide detailed insights into technical savings and management practices but rarely situate these findings within the evolving European regulatory context. Cattaneo identifies internal and external barriers to energy efficiency that limit the uptake of efficiency measures even when they are economically rational, including information deficits, organizational inertia, and policy design flaws (Cattaneo, 2019). These barriers are highly relevant to understanding why energy audits do not always lead to the expected improvements, yet they are seldom analyzed in relation to European level governance.

This article seeks to bridge this divide by developing an integrated analysis of European energy efficiency governance and industrial energy auditing. It asks how European policies shape the purpose, scope, and institutionalization of energy audits, and how, in turn, the realities of auditing practice influence the effectiveness of energy efficiency policy. By drawing strictly on the provided references, the article constructs a multilevel perspective that links the European Green Deal, the Energy Efficiency Directive, and Commission and EEA reports with detailed studies of energy audits in industrial and small

and medium sized enterprise contexts. In doing so, it aims to contribute to a more theoretically and empirically grounded understanding of how energy efficiency is governed in Europe and how this governance is enacted through energy audits.

The central argument developed here is that energy audits should be understood not merely as technical tools but as governance instruments that mediate between policy and practice. They translate abstract efficiency targets into concrete organizational decisions, create knowledge that shapes managerial priorities, and provide the evidentiary basis for regulatory compliance and financial support. However, their effectiveness depends on how they are embedded within institutional frameworks, organizational cultures, and policy incentives. Without addressing the barriers identified in the literature and aligning auditing practices more closely with European policy objectives, the transformative potential of energy efficiency will remain only partially realized.

2. Methodology

The methodological approach adopted in this article is qualitative, integrative, and interpretive, grounded in a systematic analysis of the provided references. Rather than employing primary data collection or statistical modeling, the study relies on a structured synthesis of policy documents, theoretical contributions, and empirical case studies to develop a coherent analytical framework. This approach is particularly appropriate given the complex and multilevel nature of energy efficiency governance, which cannot be fully captured through quantitative indicators alone but requires careful interpretation of institutional arrangements, policy discourses, and organizational practices.

The first methodological step involved a close reading and thematic coding of the European policy documents included in the reference list. These documents, including the European Green Deal, the Energy Efficiency Directive, and the Commission reports from 2021 and 2024, were analyzed to identify their core objectives, regulatory mechanisms, and underlying assumptions about how energy efficiency should be achieved (European Commission, 2019; European Commission, 2021; European Commission, 2024; European Parliament and Council, 2006). Particular attention was paid to how these texts conceptualize energy efficiency, how they assign responsibilities to different actors, and how they operationalize compliance through instruments such as energy audits.

The second step consisted of integrating theoretical insights from the academic literature on energy efficiency. Dunlop's conceptualization of energy efficiency as a motherhood concept provided a critical lens for understanding the flexibility and ambiguity inherent in policy discourse (Dunlop, 2022). Cattaneo's analysis of internal and external barriers offered a framework for interpreting why policy instruments do not always lead to expected outcomes (Cattaneo, 2019). The German case study by Eichhammer and colleagues was used to illustrate how national level policy implementation interacts with European directives and industrial structures (Eichhammer et al., 2022). Bourgault and Matus ek's discussion of the European auditing system contributed insights into the institutional mechanisms through which compliance and oversight are exercised (Bourgault and Matus ek, 2023).

The third step focused on the empirical literature on energy audits in industry and small and medium sized enterprises. Although many of these studies are based in non European contexts, their detailed examination of auditing methodologies, organizational responses, and realized energy savings provides valuable insights into how energy audits function in practice (Singh and Kumar, 2019; Gupta and Srivastava, 2019; Khan and Ahmed, 2019; Kothari et al., 2022; Krishnan et al., 2023; Bhattacharya et al.). These sources were analyzed to extract recurring themes such as the types of measures identified, the barriers to implementation, and the role of management commitment and financial constraints.

The final methodological step involved synthesizing these different strands into an integrated narrative. Rather than treating policy and practice as separate domains, the analysis was structured to show how European level governance frameworks shape and are shaped by the micro level realities of energy auditing. This interpretive synthesis allows for the identification of causal mechanisms, institutional dynamics, and points of tension that would not be visible in a more fragmented analysis. All claims and interpretations presented in the article are grounded in the cited references, ensuring that the analysis remains faithful to the provided sources while offering original theoretical integration.

3. Results

The integrated analysis of European energy efficiency governance and industrial energy auditing reveals several interrelated patterns that are crucial for understanding how energy efficiency is pursued and why its outcomes often fall short of policy ambitions.

One of the most significant findings is that European energy efficiency policy has become increasingly ambitious and comprehensive over time, but its implementation relies heavily on instruments that operate at the organizational level, particularly energy audits. The European Green Deal establishes energy efficiency as a cornerstone of the transition to a climate neutral economy, framing it as both an environmental necessity and an economic opportunity (European Commission, 2019). This framing is operationalized through the Energy Efficiency Directive, which imposes binding obligations on member states to achieve specific savings and requires large enterprises to conduct regular energy audits (European Commission, 2021). The 2024 Commission report underscores that these measures are not merely symbolic but are intended to drive real reductions in energy consumption, as the gap between current trends and targets remains substantial (European Commission, 2024).

At the same time, data from the European Environment Agency indicate that primary and final energy consumption in the European Union has not declined at the pace required to meet these targets, particularly in industrial sectors that account for a large share of energy use (European Environment Agency, 2024). This suggests that the policy instruments currently in place, including energy audits, are not yet delivering their full potential. The results of the empirical energy audit studies help to explain why.

Across a wide range of industrial contexts, energy audits consistently identify significant opportunities for energy savings, often through relatively straightforward measures such as equipment upgrades, process optimization, and improved maintenance (Singh and Kumar, 2019; Gupta and Srivastava, 2019; Khan and Ahmed, 2019; Kothari et al., 2022; Krishnan et al., 2023; Bhattacharya et al.). These findings confirm the fundamental economic logic of energy efficiency, which holds that many profitable efficiency investments remain unrealized due to information and organizational barriers rather than technological limitations.

However, the same studies also show that the translation of audit recommendations into actual investments is far from automatic. Firms frequently face financial constraints, competing investment priorities, and limited managerial attention, which prevent them from acting on audit findings even when the projected payback periods are attractive (Cattaneo, 2019; Singh and Kumar, 2019; Kothari et al., 2022). In small and medium sized enterprises in particular, energy costs may represent only a small fraction of total expenditures, reducing the perceived urgency of efficiency improvements despite their long term benefits (Gupta and Srivastava, 2019; Khan and Ahmed, 2019).

From a governance perspective, this gap between identified potential and realized savings is critical. European policy assumes that by mandating or encouraging energy audits, firms will be provided with the information necessary to make rational investment decisions that align with broader societal goals (European Parliament and Council, 2006; European Commission, 2021). Yet the evidence suggests that information alone is insufficient to overcome the structural and organizational barriers identified by Cattaneo (2019). This means that energy audits, while necessary, are not sufficient instruments for achieving the deep energy efficiency gains envisioned by European policy.

Another important result concerns the role of institutional frameworks in shaping the effectiveness of energy audits. Bourgault and Matus ek emphasize that the European auditing system is not merely a technical apparatus but a set of institutionalized procedures for ensuring compliance, accountability, and credibility (Bourgault and Matus ek, 2023). Within the context of energy efficiency, this means that energy audits serve multiple functions simultaneously. They provide technical diagnoses, generate data for policy monitoring, and create a formal record of organizational performance. However, when these functions are not well aligned, audits can become ritualistic rather than transformative.

The German case provides a concrete illustration of this dynamic. Eichhammer and colleagues describe how Germany has developed an extensive set of energy efficiency policies and support mechanisms, including subsidies, standards, and information programs, to encourage firms to implement audit recommendations (Eichhammer et al., 2022). This integrated policy environment increases the likelihood that audits will lead to real investments, as firms are not left to bear the full financial and organizational burden alone. In contrast, where such supportive frameworks are weaker, audits may identify opportunities without providing the means or incentives to act on them.

Taken together, these results indicate that energy audits function as a crucial interface between European level energy efficiency governance and firm level decision making. They make abstract targets concrete, but their impact depends on how they are embedded within broader institutional and policy contexts.

4. Discussion

The findings of this study have important theoretical and

practical implications for understanding energy efficiency governance in Europe. At a theoretical level, they support Dunlop's characterization of energy efficiency as a motherhood concept whose meaning and effectiveness depend on how it is operationalized through specific instruments and institutions (Dunlop, 2022). Energy audits exemplify this dynamic. They are widely endorsed as a rational and necessary step toward greater efficiency, yet their actual impact varies widely depending on organizational, financial, and regulatory conditions.

From the perspective of policy design, the analysis highlights a fundamental tension between the European Union's reliance on informational and procedural instruments and the structural barriers that limit their effectiveness. The Energy Efficiency Directive and related policies assume that providing firms with detailed information about their energy use will lead to economically rational decisions that align with societal goals (European Commission, 2021). However, as Cattaneo demonstrates, internal and external barriers such as split incentives, capital constraints, and organizational inertia often prevent such rationality from being realized in practice (Cattaneo, 2019). This suggests that energy efficiency governance must go beyond audits and reporting requirements to include stronger financial, regulatory, and organizational support mechanisms.

The German case illustrates the potential of such an integrated approach. By combining mandatory audits with subsidies, technical assistance, and long term policy stability, Germany has created an environment in which firms are more likely to act on audit recommendations (Eichhammer et al., 2022). This contrasts with contexts in which audits are conducted primarily to satisfy regulatory requirements, leading to a compliance oriented rather than improvement oriented culture.

At the same time, the industrial energy audit literature provides a cautionary note. Even in supportive policy environments, the success of energy audits depends on managerial commitment and organizational learning. Studies consistently show that when top management is engaged and energy efficiency is integrated into broader business strategies, audits are more likely to lead to sustained improvements (Singh and Kumar, 2019; Kothari et al., 2022; Krishnan et al., 2023). This highlights the importance of viewing energy audits not merely as technical exercises but as processes of organizational change.

There are also important limitations to consider. The empirical studies cited are often based on specific industries or regions, and their findings may not be directly generalizable to all European contexts. Moreover, the policy documents analyzed represent official perspectives that may not fully capture the diversity of implementation practices across member states. Nevertheless, the convergence of evidence from policy analysis and industrial case studies provides a robust basis for the conclusions drawn here.

Future research could build on this analysis by examining how different member states have integrated energy audits into their national energy efficiency strategies and how these approaches affect outcomes. Greater attention should also be paid to the role of auditors themselves as intermediaries who translate policy requirements into organizational action, a dimension that remains underexplored in both policy and academic literature.

5. Conclusion

This article has demonstrated that energy audits occupy a central but complex position within European energy efficiency governance. They are not simply technical tools for identifying energy savings but key instruments through which European policy ambitions are translated into organizational practices. By integrating insights from European policy documents, theoretical analyses of energy efficiency, and empirical studies of industrial energy audits, the study has shown that the effectiveness of audits depends on their institutional embedding, organizational reception, and policy support.

The European Union's commitment to energy efficiency, as articulated in the European Green Deal and the Energy Efficiency Directive, is both ambitious and necessary in light of persistent high energy consumption levels (European Commission, 2019; European Commission, 2021; European Environment Agency, 2024). However, achieving these goals requires more than mandates and information. It requires a governance system that aligns audits with financial incentives, organizational capabilities, and long term policy stability.

Ultimately, the success of European energy efficiency policy will depend on whether energy audits can fulfill their potential as catalysts for real change rather than merely as compliance instruments. Strengthening this link between governance and practice is one of the most important challenges facing Europe's transition to a sustainable energy future.

References

1. Bourgault, J., and Matus ek, M. (2023). European

auditing system.

2. Cattaneo, C. (2019). Internal and external barriers to energy efficiency Which role for policy interventions. Energy Efficiency, 12, 1293 to 1311. DOI 10.1007 s12053 019 09775 1.
3. Dunlop, T. (2022). Energy efficiency The evolution of a motherhood concept. Social Studies of Science, 1 to 23. https doi org 10.1177 03063127221096171.
4. Eichhammer, W., Berger, F., Steinbach, J., Friedrichsen, N., Choi, S., and ISI, F. (2022). Energy efficiency policy in Germany. ISI Fraunhofer.
5. European Commission. (2019). The European Green Deal. https ec europa eu info strategy priorities 2019 2024 european green deal en.
6. European Commission. (2021). Proposal for a directive of the European Parliament and the Council on energy efficiency recast COM 2021 558 final. Brussels.
7. European Commission. (2024). Report from the Commission to the European Parliament the Council the European Economic and Social Committee and the Committee of the Regions COM 2024 404 final. Brussels.
8. European Environment Agency. (2024). Primary and final energy consumption in the European Union. https www eea europa eu en analysis indicators primary and final energy consumption.
9. European Parliament and Council. (2006). Directive 2006 32 EC on energy end use efficiency and energy services. Official Journal of the European Union.
10. Singh, R., and Kumar, A. (2019). Energy audit and management in small scale industries A case study. International Journal of Engineering Trends and Technology, 66, 234 to 238.
11. Gupta, A., and Srivastava, S. (2019). Energy audit and management in small scale industries A review. International Journal of Scientific Research and Engineering Development, 2, 67 to 72.
12. Khan, A., and Ahmed, S. (2019). Energy audit and conservation in small scale industries A case study of a food processing unit. International Journal of Advanced Engineering Research and Science, 6, 120 to 124.
13. Kothari, A. K., et al. (2022). Energy audit and its impact on MSME sector.
14. Krishnan, V. U., Prasad, S., Azeez, A., and Kinatingal, V. A. A. (2023). Energy audit of an industry for energy conservation and economical operations.
15. Bhattacharya, A., Kumar, P., and Gupta, R. Energy Audit A Case Study of an Industrial Facility. Energy Reports.