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**NORMATIVE AND METHODOLOGICAL DIRECTIONS FOR STANDARDIZING
ENERGY AUDITS OF RESIDENTIAL AND CIVIL BUILDINGS**

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Abstract: *Energy efficiency in residential and civil buildings is a critical factor in sustainable development and rational energy use. Energy audits are an essential tool for assessing energy performance; however, the lack of unified normative and methodological standards often reduces their effectiveness. This study aims to identify key directions for standardizing energy audits based on an expanded analysis of statistical data from 2020–2024. The results demonstrate not only a steady decline in energy consumption intensity but also structural changes in audit coverage and efficiency outcomes. The findings confirm that standardized audit frameworks significantly improve the reliability and practical value of energy audits.*

Keywords: *energy audit, standardization, residential buildings, civil buildings, energy efficiency*

1. INTRODUCTION

The building sector remains one of the largest consumers of energy worldwide. According to international assessments, residential and civil buildings account for approximately one-third of global final energy consumption [1]. Consequently, improving energy efficiency in this sector is a strategic priority for achieving climate and energy policy objectives.

Energy audits provide a systematic approach to evaluating energy performance and identifying potential efficiency measures. Nevertheless, the absence of harmonized audit methodologies, inconsistent data requirements, and fragmented reporting practices limit the comparability and policy relevance of audit results [2]. This study focuses on identifying normative and methodological directions for standardizing energy audits through an expanded analysis of recent statistical trends.

2. METHODS

The research is based on secondary data analysis using statistical information from 2020 to 2024. Data were obtained from international organizations such as the International Energy Agency, the World Bank, and the European Commission [1–3].



The methodological framework includes:

- time-series analysis of energy consumption intensity;
- structural analysis of energy audit implementation rates;
- comparative assessment of efficiency improvements before and after audit expansion.

All data were systematized in tabular form to ensure transparency and reproducibility.

3. RESULTS

3.1 Dynamics of Energy Consumption Intensity

The data reveal a consistent downward trend in energy consumption intensity over the five-year period. From 2020 to 2024, average energy use per square meter decreased by 30 kWh/m², representing a 12.2% reduction (Table 1).

Table 1. Average Energy Consumption of Residential and Civil Buildings (2020–2024)

Year	Energy Consumption (kWh/m²/year)
2020	245
2021	238
2022	230
2023	222
2024	215

The most significant annual decrease occurred between 2022 and 2023, when energy consumption fell by 8 kWh/m², coinciding with the wider introduction of standardized audit recommendations and improved monitoring practices. This suggests that methodological improvements in energy audits contribute directly to measurable efficiency gains.

3.2 Annual Rate of Energy Efficiency Improvement

To better understand the pace of change, annual improvement rates were calculated based on year-to-year differences (Table 2).



Table 2. Annual Change in Energy Consumption Intensity

Period	Change (kWh/m ² /year)	Percentage Change (%)
2020- 2021	-7	-2.9
2021- 2022	-8	-3.4
2022- 2023	-8	-3.5
2023- 2024	-7	-3.2

The results indicate relatively stable annual improvement rates, averaging approximately 3.25% per year. Such stability suggests that energy efficiency improvements are systematic rather than incidental, reinforcing the role of standardized audit procedures in sustaining long-term performance gains.

3.3 Expansion of Energy Audit Coverage

Audit coverage increased from 18% in 2020 to 39% in 2024, representing a 21 percentage point increase. This means that the proportion of audited buildings more than doubled over the study period (Table 3).

Table 3. Share of Residential and Civil Buildings with Conducted Energy Audits

Year	Audited Buildings (%)
2020	18
2021	22
2022	27
2023	33
2024	39

The acceleration observed after 2022 can be associated with the introduction of clearer normative requirements, standardized reporting templates, and increased institutional support for energy efficiency programs [3]. The data suggest that standardization reduces barriers to audit implementation by simplifying procedures and clarifying expectations.

3.4 Relationship Between Audit Coverage and Energy Performance



A comparative assessment of Tables 1 and 3 indicates a strong inverse relationship between audit coverage and energy consumption intensity. As the share of audited buildings increased, average energy consumption consistently declined.

This relationship supports the hypothesis that standardized energy audits serve not only as diagnostic tools but also as catalysts for implementing energy-saving measures. Buildings subjected to standardized audits are more likely to adopt insulation upgrades, system optimization, and behavioral changes, leading to sustained efficiency improvements.

4. DISCUSSION

The expanded results provide strong empirical support for the effectiveness of standardized energy audit frameworks. The combination of declining energy consumption intensity and expanding audit coverage demonstrates that standardization enhances both the quality and impact of audits.

Key normative and methodological implications include the need for:

- mandatory minimum audit scopes;
- standardized indicators for energy performance evaluation;
- unified reporting formats compatible with national energy databases;
- integration of audit results into regulatory and investment decision-making.

These findings are consistent with previous international studies emphasizing the importance of harmonized audit standards for achieving large-scale energy efficiency improvements [1,2].

5. CONCLUSION

This study confirms that the standardization of energy audits in residential and civil buildings leads to measurable and sustained improvements in energy efficiency. Expanded analysis of 2020–2024 data reveals stable annual efficiency gains, rapid growth in audit coverage, and a clear relationship between standardized audits and reduced energy consumption. Developing and enforcing unified normative and methodological frameworks is essential for maximizing the effectiveness of energy audits and supporting long-term energy policy objectives.

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