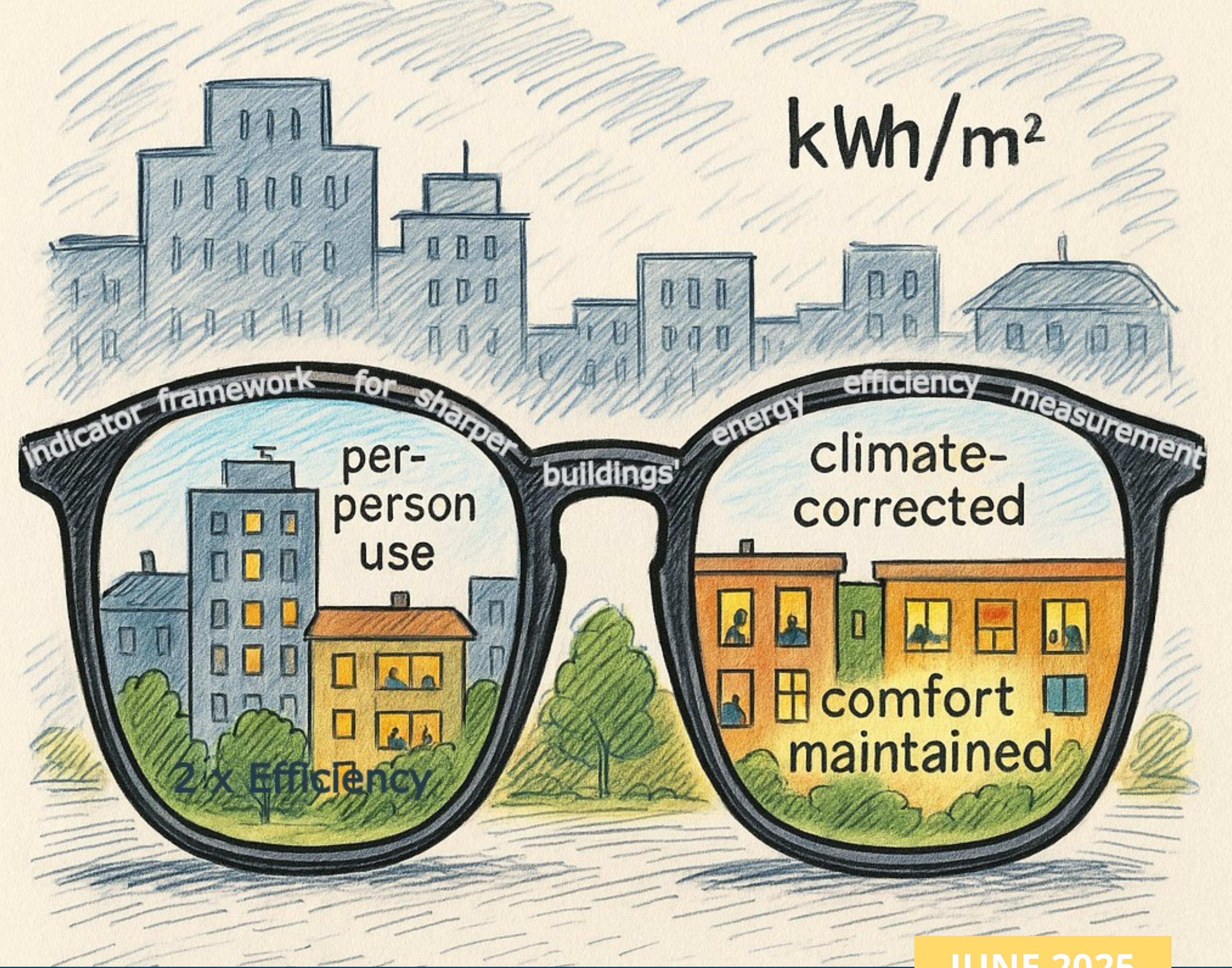

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MAKING THE GLOBAL PLEDGE TO DOUBLE ENERGY EFFICIENCY COUNT

FROM KWH TO ACCOUNTABILITY: IMPROVING HOW WE MEASURE BUILDINGS' EFFICIENCY

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EXECUTIVE SUMMARY

At COP28, nearly 200 countries signed the *Global Renewables and Energy Efficiency Pledge*[1], committing to double the global average annual rate of energy efficiency improvements — from approximately 2% to over 4% annually — by 2030. Yet, no shared methodology was established to measure progress toward this goal. This paper suggests how to measure energy efficiency progress in the buildings sector.

Currently used indicators, such as **final energy consumption per square metre (kWh/m²)**, i.e. energy intensity is a useful and intuitive metric. However, this indicator can be influenced by external factors, such as climate, economy and user behaviour, that obscure the picture on energy efficiency improvements achieved in buildings. Relying solely on energy intensity risks being misleading.

This paper explores how progress to improve the energy efficiency of buildings can be measured more meaningfully — in a way that is **transparent**, **sector-specific**, and **globally applicable**. We focus on three key complications that current indicators often overlook:

- **Climate variations and climate change**, which can distort perceived energy gains;
- **Economic and behavioural factors**, such as energy poverty or price-driven reductions in use;
- **Space-use intensity**, including how many people benefit from a given energy input.

To build on and refine the existing approach to measuring energy efficiency improvements, while **mitigating the limitations,** this paper **refines and complements the current indicator assessment,** tailors it to the building sector, and proposes three improvements to the energy intensity indicator:

1. **Climate correction** to isolate actual energy efficiency gains.
2. **Complementary comfort indicator** to distinguish between efficiency and energy poverty.
3. **Supplementary per-person indicator** to reflect space-use efficiency.

To demonstrate feasibility, this paper applies this modified indicator assessment framework to the European context, using data from Eurostat, the EU Building Stock Observatory, and EU-SILC. The results show:

1. **Europe's building sector is far behind the needed improvement rate**, with heating and cooling efficiency rising just ~0.4% annually since 2015 — compared to the 4% goal. Efficiency improvements in Europe need to change by a factor 10 to comply with the global goal.
2. **Improved data is urgently needed**, especially on disaggregated end-uses, space-use patterns, and comfort levels. Europe's system, despite gaps, offers a valuable model for global development.
3. **No single indicator can capture efficiency alone** — a robust approach must account for the relationship between energy input and useful, comfortable building space.

More broadly, a shared, credible way to measure real energy efficiency of buildings is missing. Without it, political pledges risk becoming empty promises.

This paper gives policymakers the tools to align on definitions, track genuine progress, and uphold the commitments made on the global stage at COP28 — with transparency, credibility, and urgency**.**

[1] https://energy.ec.europa.eu/system/files/2023-12/Global_Renewables_and_Energy_Efficiency_Pledge.pdf

INTRODUCTION

At COP28 in Dubai in 2023, nearly 200 countries signed the *Global Renewables and Energy Efficiency Pledge*, committing to **double the global average annual rate of energy efficiency improvement —** from around 2% to over 4% every year — until 2030. Improving the energy performance of buildings is therefore a cornerstone of delivering on the global pledge.

But how can we know if this goal is being met — especially in buildings? While the pledge has a clear numerical target, it lacks a common measurement framework. Unlike greenhouse gas emissions, which are tracked through well-established inventories, **energy efficiency improvements are not directly observable**. Their measurement depends on proxies and assumptions, particularly when applied to buildings, where local climate, occupancy patterns, and behavioural factors shape energy use. Without a shared understanding of how progress should be assessed, **it is difficult to monitor results or identify which countries or sectors are on track, and which are falling behind**.

Several indicators already exist. The **International Energy Agency (IEA)** reports energy intensity in buildings globally — typically measured as energy use per square metre (m^2) — as a high-level tracking indicator. The **Odyssee-Mure project** provides detailed, climate-corrected indicators (i.e. that account for annual changes in temperatures) for European countries, including climate-corrected energy use per dwelling, and per m^2. These are essential sources. Yet they come with limitations.

Energy efficiency is fundamentally a ratio: energy input (i.e. final energy consumption) must be compared to the useful output (i.e. comfortable space) it delivers. In buildings, this output is not just floor area, but **floor area that is adequately heated or cooled, occupied, and functionally used**. The energy input when measured as consumption is sensitive to **weather changes**, **economic cycles**, and **comfort sacrifices** and often include **energy uses unrelated to building efficiency**, such as by appliances. This means the indicator does not adjust for milder temperatures, nor does it account for changes in comfort, such as households reducing heating due to affordability pressures. Similarly, it ignores **how intensively a building is used**, missing improvements that come from better space-sharing or higher occupancy. That is how — if not corrected for these conditions — the indicator may **misrepresent true efficiency progress** — by showing improvements where none exist, or missing gains where conditions are challenging. This highlights the need for refined indicators that link energy consumption to relevant, context-aware outputs.

We propose a **refined and expanded indicator framework** that builds on existing data and metrics, adjusting them for climate, comfort, and occupancy. To demonstrate the approach, we apply it to the European context, where relatively complete datasets allow for testing and insight. This allows us to explore:

- What would a better indicator framework look like?
- What added accuracy or insight does it bring?
- And why does that matter for global progress tracking?

The aim is not to create a perfect system, but to **improve what exists** and identify **what kind of data and metrics are truly necessary** to measure whether the buildings sector is contributing its fair share toward the COP28 efficiency goal. The findings signal to policymakers what action is now needed to effectively meet the targets they pledged to achieve.

1. WHY TRACKING ENERGY EFFICIENCY IN BUILDINGS REQUIRES A SECTOR-SPECIFIC APPROACH

- COP28 pledged to **double global energy efficiency improvements** (2% → 4% annually), but **no method to measure progress towards this goal was defined**.
- The IEA provides valuable global tracking[2], but the **current indicators should be refined to obtain more robust** actionable insights about the energy performance of buildings.
- Energy intensity measured in kilowatt hour per square metre (kWh/m²) is intuitive but the factors of **climate variations, economic and behavioural choices for comfort indoors, and the space used in a building** must all be considered to correctly represent actual progress.

Improving building efficiency means delivering the same or better levels of comfort and adequate indoor environmental quality by heating, cooling, and ventilation using less energy. Improving building efficiency can be achieved with measures such as energy renovations which can significantly reduce energy demand, lower consumer bills, cut emissions, and strengthen energy security, while contributing directly to the COP28 goal of doubling global efficiency improvements. As no shared methodological framework was established to define the basic parameters for assessing and monitoring changes to energy efficiency, decision-makers in the building sector follow existing measures to assess progress and decide what effort or actions are needed, with the limitations and refinement options of these pre-existing measures discussed further below.

The IEA has published macro-level indicator to estimate global progress on energy efficiency. For the building sector, energy intensity (measured in kWh/m²) is used as the main indicator. While this analysis is valuable as it constructs a global picture, the indicator is limited in how it to supports robust, contextualised and short-term tracking, and in how it enables targeted action within the buildings sector, mainly due to the complexity of factors that influence energy use in buildings. These factors are context-specific and include changes in climate conditions, user-adjusted indoor comfort levels and the scope of measurement, especially when all energy uses are included, such as for appliances which are not linked to building efficiency. Also relevant for the discussion is the space-use intensity, where an efficient building could serve, for example, one family or two.

In section 3, we suggest how to account for these dimensions, as otherwise it becomes difficult to separate real energy efficiency gains from changes due to, for example, climate variations. Without due consideration for such context-specific factors, it is impossible to ensure that progress is not achieved at the expense of comfort. This makes it difficult to determine whether the buildings sector is delivering its share towards the global efficiency target, as well as to identify where and how progress has occurred — and where further efforts should be focused.

[2] https://www.iea.org/data-and-statistics/charts/global-floor-area-and-buildings-energy-intensity-in-the-net-zero-scenario-2010-2030

2. UNDERSTANDING LIMITATIONS OF USING ENERGY INTENSITY AS THE SOLE INDICATOR OF ENERGY EFFICIENCY IN BUILDINGS

- This indicator should not include **appliance and lighting energy** (both globally increasing), which obscures the efficiency improvement of building envelope and HVAC systems.
    - These uses are not linked to the efficiency of the building as such.
    - Further, Heating, Ventilation, and Air Conditioning (HVAC) electrification makes it harder to separate HVAC from plug loads.
- Its analysis should incorporate **climate** correction, i.e. reflect warmer winters or increased cooling needs during summer.
- The indicator does not account for **comfort** changes, i.e. comfort sacrificed during economic downturns — especially by vulnerable groups — and may falsely suggest efficiency gains.
- By design, the indicator focusses on the floor area in buildings instead of the function for the people who use them. Supplemental **per-person indicators** would address this gap on how many people benefit from the comfortable space.

One of the most commonly used indicators for energy efficiency in the buildings sector is energy intensity or energy consumption per square metre (kWh/m²). While this indicator is intuitive and easy to communicate, however, when it is derived from actual energy consumption as reported in national statistics, it is influenced by external factors, hence relying on it alone presents several problems.

First, climatic conditions need to be accounted for. Warmer winters or temporary shifts in cooling demand can reduce energy consumption even if no efficiency improvements have occurred.[3] Second, kWh/m² does not account for comfort. In times of energy price shocks or in contexts of energy poverty, reduced energy use may reflect under-heating rather than increased efficiency. Third, the indicator treats square metres of floor area as the functional unit but does not reflect how many people benefit from that space. Efficiency improvements that stem from more compact or shared housing cannot be captured.

A further limitation can arise if appliances and lighting are included in the energy use or building efficiency indicators, as for example in the IEA data and in the Eurostat data for non-residential buildings. These energy services are largely independent of the thermal quality of the building envelope or heating and cooling systems, and they are **not directly influenced by building design, structure, or thermal performance**. This inclusion can obscure trends in building-related efficiency, particularly because **appliances account for a large share of electricity use** and their **growing diffusion is linked to welfare-driven consumption patterns**. For **actionable insight and targeted policies**, it is therefore essential to focus on energy uses tied to the **building envelope and thermal systems,** i.e. **HVAC**. Even if, with increasing electrification of HVAC systems, especially smaller, decentralised ones, **the distinction between energy uses is becoming harder to measure,** because space heating will increasingly use electricity as an energy carrier, just as space cooling and appliances, reinforcing the need for clear methodological distinctions for accurate tracking of efficiency in space heating and cooling.

[3] As documented in ODYSSEE_MURE 2021. Rousselot, Pinto da Rocha. *Energy efficiency trends in buildings in the EU*. Page 4. https://www.odyssee-mure.eu/publications/policy-brief/buildings-energy-efficiency-trends.pdf

Taken together, these limitations show that using energy intensity as the exclusive indicator risks misrepresenting progress. It may show improvements where there are none — or miss real gains — and does not provide clear signals to policymakers and regulators on what is working and where intervention is needed.

Further, the measurement of final energy consumption per m^2 is connected to challenges that make it impossible to compare this indicator across Europe. Recording energy consumption and allocating portions to different sectors has a track record, with disaggregated data for types of energy use in the household sector being available since 2018 across Europe. However, when irregularities in the economy occur, such as the effects of the pandemic or the energy crisis, the allocation models need to be adjusted, with significant corrections to be expected both during such events and in the years that follow.

The assessment of floor area, including its definition, scope, frequency and method for recoding is very different across countries, for example in the EU. In the absence of direct annual measurement, the estimation of total floor area or number of dwellings typically relies on a combination of decennial or permanent census data and administrative records. Several EU Member States have transitioned to permanent census systems that draw from continuously updated administrative registers, such as population registries and building permit databases. While these systems enable more frequent updates, they generally capture only officially reported changes, such as new constructions, demolitions, or address modifications. As a result, they may miss informal housing adaptations, underreported vacancy, or changes in occupancy and use that do not trigger administrative updates. In some countries, dwelling numbers are interpolated between major census years using household survey data and statistical modelling, with assumed stability in average dwelling sizes. This introduces uncertainty, particularly in periods of rapid demographic or housing market change. Therefore, while administrative sources and permanent censuses improve timeliness, they require careful validation and are best complemented by periodic surveys or auxiliary data to ensure accuracy in estimating energy-related floor area indicators.

3. A REFINED AND EXPANDED FRAMEWORK: THREE IMPROVEMENTS TO ENABLE MEANINGFUL TRACKING

- **Climate-corrected kWh/m²** Normalize space heating and cooling using Heating and Cooling Degree Days (HDD and CDD).
- **Add a comfort indicator:** to ensure reduced energy consumption ≠ reduced well-being, use the indicator "inability to keep home adequately warm" or similar, for example in the EU from the survey on income and living conditions (SILC).
- **Add per-person energy consumption:** Track energy per capita or per household alongside per m² to reflect space-use efficiency and shared comfort.

To build on and refine the existing approach to measure changes to energy efficiency, while mitigating its limitations, this paper demonstrates three enhancements to the energy intensity kWh/m² indicator that make it more robust for assessing genuine progress.

First, we recommend applying a **climate correction** using Heating and Cooling Degree Days (HDD and CDD). This ensures that energy intensity trends reflect improvements in the building stock, rather than changes in weather. Without any climate correction, progress can be overestimated in mild years or underestimated in extremely hot or cold years. Such a correction is already partially available in the Odyssee key indicators specifically for space heating in households: Energy consumption per m² of households for space heating at normal climate.[4] Coverage of cooling in households has increasing importance and would also be possible whilst data by energy consumption in the service sector still make climate correction impossible.

Second, we propose **complementing[5] energy intensity indicators with a comfort indicator** that shows the potential influence of significant energy price fluctuations or energy delivery problems, or changes in comfort. Data on comfort can be collected through household surveys such as the EU Statistics on Income and Living Conditions (EU-SILC), which includes the share of the population unable to keep their home adequately warm.[6] Such indicators help distinguish between efficiency gains and comfort loss, which is critical for ensuring that reductions in energy consumption are not achieved at the expense of well-being.

Third, we suggest **adding a per-person or per-household variant** of the energy consumption indicator, in addition to the per-square-meter version. This captures improvements that stem from better use of space, for example, smaller or more efficiently shared dwellings, and helps policymakers understand whether efficiency is improving on a societal level, not just in terms of physical building stock.

Together, these three enhancements help create a more complete, interpretable picture of efficiency improvements in the buildings sector. They support decision-makers in understanding whether progress is real and whether efficiency progress in the building stock is aligned with the COP28 pledge and, if not, where efforts must be concentrated.

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[4] https://www.indicators.odyssee-mure.eu/key-indicators.html; Select: Households-Heating- Per m² (normal climate); Method described in ODYSSEE-MURE 2020. *Definition of data and energy efficiency indicators in ODYSSEE data base. https://www.odyssee-mure.eu/private/definition-indicators.pdf. P.34*

[5] The following paper on energy performance metrics discusses "…the fallacy of single indicators…" and "…suggests how multiple indicators may help resolve future problems." Bordass, B. (2020). Metrics for energy performance in operation: the fallacy of single indicators. Buildings and Cities, 1(1), pp. 260–276. DOI: https://doi.org/10.5334/bc.35; https://journal-buildingscities.org/articles/10.5334/bc.35

[6] https://ec.europa.eu/eurostat/databrowser/view/ILC_MDES01/default/table?lang=en

4. ANALYSING ENERGY EFFICIENCY MEASURES IN EUROPE

- **The refined indicator framework proposed in this paper was applied in a Europe-wide analysis**, using the floor area development derived from Odyssee-MURE alongside Eurostat energy data, population and climate data, as well as a comfort indicator from the EU survey on income and living conditions.
- While uncertainty persists, and improvements in data quality, collection, and harmonisation remain essential, the available energy intensity data suggest that **energy efficiency in buildings increased by at most 0.4% annually between 2015 and 2022**, falling far short of the 4% target implied by the COP28 pledge.
- The supplementary indicators on comfort and energy consumption per capita do not support this trend; instead, they suggest that **observed reductions in energy consumption may be partially or fully attributable to comfort sacrifices rather than genuine improvements in efficiency** and are cancelled out by increasing per-person floor area.

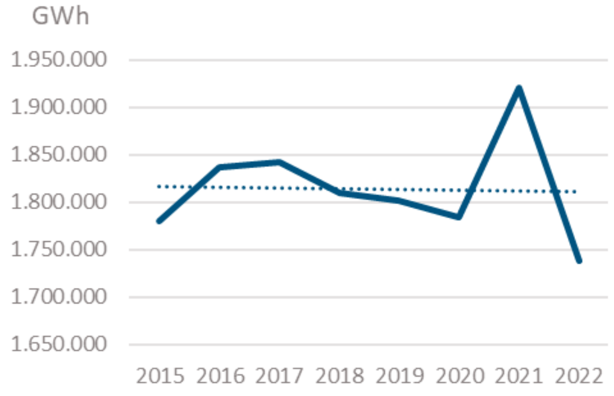
To illustrate the feasibility and added value of the refined indicator framework, this paper has applied it to the European context, where relatively robust and granular data on building energy consumption, climate, population, and comfort proxies are available by country. While the analysis focuses on methodological application rather than specific national results, it highlights how these indicators can be constructed using existing European data sources such as Eurostat, Odyssee Mure, the EU Building Stock Observatory, and EU-SILC. This example demonstrates not only the usefulness of more nuanced efficiency indicators but also the importance of grounding efficiency tracking in a clear conceptual relationship between energy input and functional output — such as occupied, conditioned space or the number of people using it. This framing enables more accurate and interpretable insights into where and how energy is used effectively in buildings.

By integrating supplementary indicators beyond energy intensity, such as climate correction, comfort levels, and space-use intensity, the European case showcases how sector-specific progress can be more meaningfully assessed. As such, this example provides a practical model for guiding similar efforts in other regions and informing the development of globally relevant monitoring approaches.

6 STEPS TO A QUANTITATIVE ANALYSIS OF ENERGY EFFICIENCY — THE EUROPEAN DEMONSTRATION CASE

Graph, Data and Method

Step 1: Energy consumption



Indicator Energy consumption for space heating and cooling (SHC)

Scope Residential buildings/ households, EU

Data Eurostat data: Space heating and space cooling in households

Quality Track record of consistent time series, since 2018 by energy use. Economic disruptions affect the allocation to energy uses, requiring corrections for example, after the pandemic or energy crisis

Analysis, Interpretation, Discussion

Presentation

This graph presents the annual final energy consumption for space heating and cooling in households in the EU.

Discussion

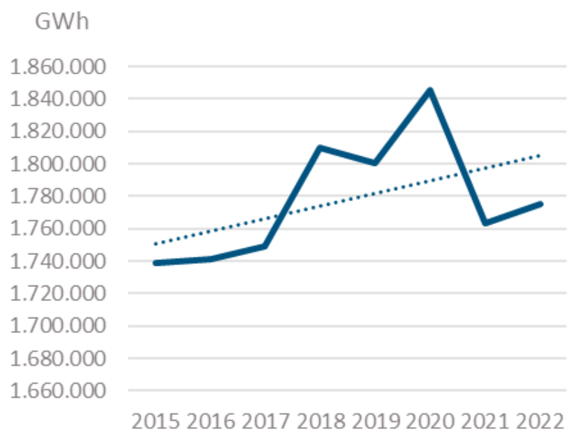
This well-recorded indicator serves as a starting point for deriving an indicator (system) for energy efficiency.

More robust indicators could be derived from calculated values such as Energy Performance Certificates (EPCs), which reflect asset-level efficiency rather than operational energy consumption influenced by user behaviour. However, EPC schemes are not yet comparable and do not cover the entire building stock.

Limitation

Due to missing annual data by energy consumption, the following countries were excluded: Belgium, Cyprus, Malta and Lithuania.

Step 2: Climate-corrected energy consumption



Indicator Climate-corrected energy consumption for space heating and cooling (SHC DD corr)

Data Eurostat: heating (cooling) degree days (HDD(CDD)) for space heating (cooling) correction

Method The reference year is 2018; Climate-corrected energy consumption is divided by specific year's degree-days (DD) and

Presentation

This graph shows the annual *climate-corrected* final energy consumption for space heating and cooling in households in the EU. It applies the climate correction to the energy consumption data shown above.

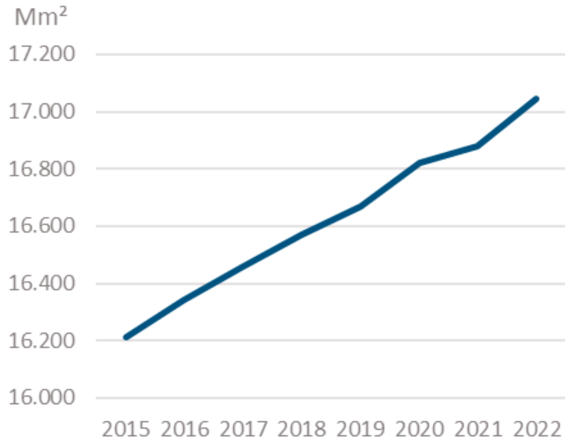
Comparison to the above and discussion

The graph reveals that the low energy consumption in 2020 was largely due to mild weather, not improved efficiency. Conversely, energy consumption in 2021 appears high, but after correction, it was relatively low, likely reflecting reduced demand due to rising energy prices.

Trend

Although the time series is relatively short (seven years) for a statistical conclusion, the climate-corrected data suggest a potential upward trend energy consumption.

Step 3: Floor area



Data

Floor area from Odyssee Mure: Floor area is derived from nationally-sourced dwelling numbers and typology of heated area per dwelling.

Presentation & Discussion

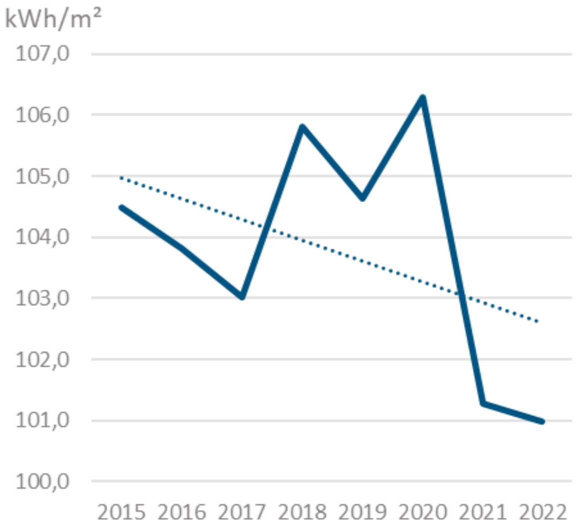
Floor area data introduces uncertainty due to differing definitions, scopes, methods and recording frequencies, even within countries. The floor area development shown here aggregates different national approaches. EU Member States (MS) rely on 10-year censuses or combine permanent censuses and updated registries to provide more frequent data. However, permanent registers typically capture only formal changes and miss informal developments or vacancies.

Despite its limitations, using EU-wide floor area data provides value and enables assessing energy efficiency of the buildings.

Quality

It is the only source with an annual evolution. It follows a diligent approach with a consistent track record. It contains differences to floor area derived from other methods due to unrecorded changes such as vacancies, use intensity and use changes.

Step 4: Energy intensity



Indicator Energy intensity for space heating and cooling (SHC)

Method Climate-corrected final energy consumption for space heating and cooling in households is divided by the heated residential floor area based on evolution of number dwellings, as shown above.

Comparison to the above and discussion

Considering the floor area transforms the absolute final energy consumption evolution into the relative indicator: energy intensity expressing energy efficiency. This interpretation of energy intensity as a relationship between input (energy consumption) and output (comfortably usable space) shows that the more precisely this output is defined and measured, i.e. comfortable floor area, the more meaningful and reliable our efficiency indicator becomes.

Trend

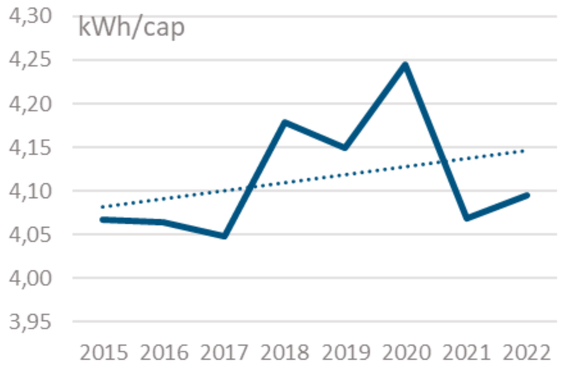
The floor area shown in the previous graph increases faster than the energy consumption shown before that due to increasing efficiency. Thus, introducing floor area transforms the upward trend — visible in energy consumption — into a slightly decreasing energy consumption per square meter (kWh/m²).

Impact

The graph shows a decreasing energy intensity. However, the decrease is not fast enough. In this observation period, the data show an annual decrease of 0.3% to 0.4%, so about one tenth of the efficiency gain that would be expected when doubling the efficiency effort to 4%.[7]

[7] This deviation is robust even considering that the impact of energy efficiency effort shown is not the effort itself, which would be investments or policies. Measuring the investment or policy effort would be difficult.

Step 5: Per capita energy consumption



Indicator Per capita climate-corrected final energy consumption for space heating and cooling (FEC SHC DDcorr/cap)

Data Population on 1 January, Eurostat (tps00001)

Method The climate-corrected energy consumption for space heating and cooling in households is divided by the population.

Comparison to the above and interpretation

When dividing the climate-corrected energy consumption by capita instead of by m2, the slight downward trend turns into a slight upward trend. This means that the gains in energy intensity that are visible in the per square meter indicator, are cancelled out by a higher square meter use per capita.

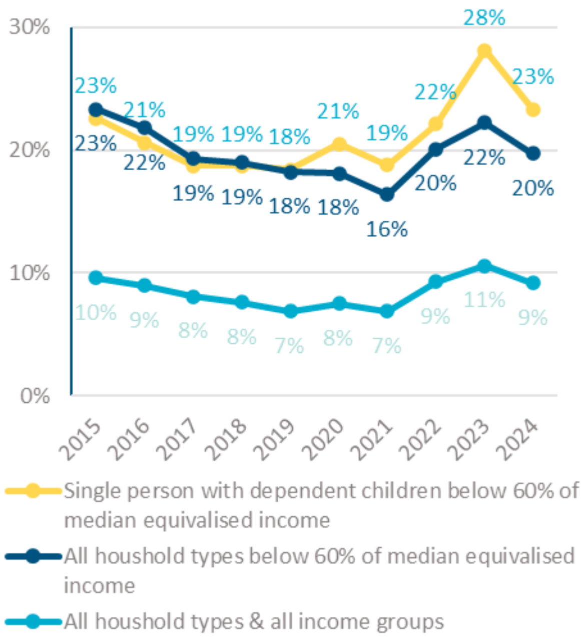
Discussion

When looking at energy efficiency in buildings, i.e. per m2, efficiency has increased; when looking at energy consumption for people's used space, it is still increasing. In other words, the energy savings per m^2 are not enough to compensate for people's increasing space use.

Interpretation

The energy efficiency for people's space used is still decreasing.

Step 6: Comfort



Indicator "The inability to keep home adequately warm refers to the percentage of persons in the total population who are in the state of enforced inability to keep home adequately warm."[8]

Data Eurostat (ilc_mdes01)

Method Selected the overall results: all households and income groups and two sub-indicators that stood out with specifically high values after 2021.

Presentation

This graph shows the economic strain of energy supply for selected combinations of households (HH) and incomes (INC). As this data was collected from household surveys, a one-year delay can be expected and responses are associated with the previous year's development. The graph shows that the share of the European population which cannot keep their homes adequately warm in winter decreased from 2015 and then sharply increased after the energy crisis began in 2021. While this trend affects all HH and INC, the largest impact can be observed in single person households with dependent children and an income below the 60% median income; these households were under particularly high economic strain in 2022-2024.

Discussion

During years of high economic strain, people and specifically vulnerable groups sacrifice comfort for economic savings, meaning they heat their homes less. The perceived energy saving coming alongside this user behaviour should not be interpreted as improved energy efficiency in buildings.

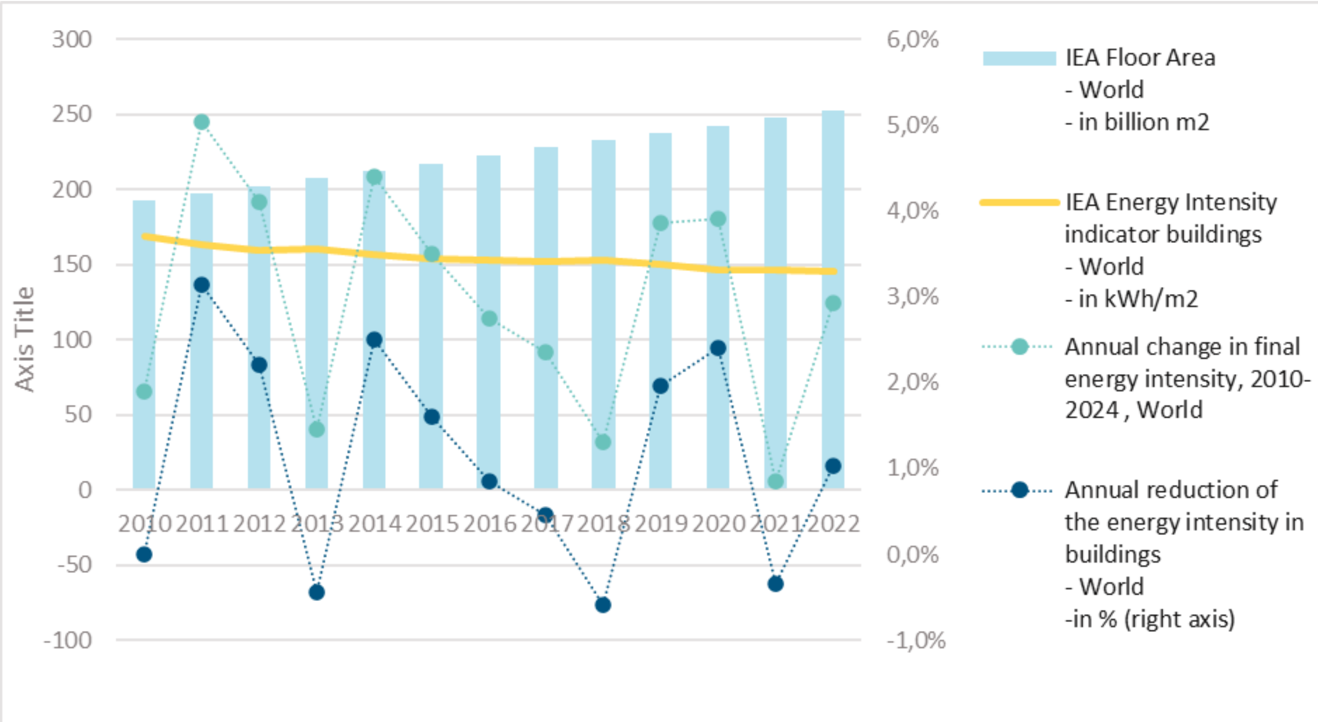
Interpretation

When interpreting the energy intensity in Graph 3, comfort sacrifices made in 2015 and 2021-2022 must be accounted for. The low energy intensity values in these years are likely caused by economic strain and linked to comfort sacrifices. Thus, the evidence for better energy efficiency is fading. This analysis of comfort puts into question the already-weak trend in energy efficiency gain observed in the energy intensity indicator.

[8] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=EU_statistics_on_income_and_living_conditions_(EU-SILC)_methodology_-_economic_strain

5. WORLDWIDE, EFFICIENCY OF ALL ENERGY USES IN BUILDINGS INCREASES BY 1.2% ANNUALLY 2010-2022

The only data available for a worldwide analysis of energy efficiency in buildings come from the IEA. While this data includes floor area and global energy intensity in buildings, it covers "all energy-using activities"[9] such as household appliances, which make up a large and growing portion of the electricity consumption while not reflecting a building's energy efficiency performance. The energy efficiency gain can thus not entirely be associated with buildings alone and distinguishing buildings' efficiency requires more detailed data.



The IEA data for worldwide energy intensity in buildings show a clear decline (yellow line), while the floor area is increasing (light blue bars). The annual reduction in energy intensity in buildings (dark blue dots) corresponds to the impact of energy efficiency efforts. While there are wide fluctuations, the data shows mostly positive values reducing energy intensity over time, with an average annual reduction of 1.2% between 2010 and 2022 and remained well under 3% after 2015, showing the world is behind the pledged goal of 4% energy efficiency. Comparing this development to the annual change in cross-sectoral final energy intensity (green dots) shows that building efficiency improvement globally was below the global average improvement across sectors.

These indicators provide a good high-level perspective, but lack insight on climate correction, comfort and use intensity which would enable the development of more robust guidance **for sector-specific actions**, particularly in the building sector, where energy consumption is highly context-dependent and driven by climate, comfort, and space utilisation patterns.

[9] IEA (2014), *Energy Efficiency Indicators: Fundamentals on Statistics*, IEA, Paris https://www.iea.org/reports/energy-efficiency-indicators-fundamentals-on-statistics , Licence: CC BY 4.0; p. 35

6. RECOMMENDATIONS FOR POLICY MAKING AND DATA RECORDING, AND METHODS FOR GLOBAL TRACKING

1. Europe and the world are far behind doubling energy efficiency in buildings

Despite the COP28 pledge[10], current energy efficiency progress in buildings is falling far short. Globally, efficiency for all energy uses in buildings improved by 1.2% annually between 2010 and 2022, and Europe's space heating and cooling efficiency improved by only 0.4% between 2015 and 2022 — both well below the 4% annual improvement target. These trends reveal a substantial implementation gap — both in ambition and in tangible outcomes.

While the global data are not disaggregated by energy use and thus may reflect efficiency gains in appliances rather than in the building envelope or systems, the European data offer more granularity. However, they remain limited by gaps in country coverage and time series length. Importantly, supplementary indicators on comfort levels and per capita energy consumption further weaken the evidence for genuine efficiency improvements, suggesting that observed reductions in energy consumption may reflect behavioural responses, such as reduced heating during economic strain rather than structural energy performance gains undermined by increased floor area per person.

However, even remediating the limitations in the data recording or interpretation would not improve the results enough to get close to the COP28 pledge for increasing the energy efficiency effort by 4% and, furthermore, efficiency improvement would remain below 2%. Building efficiency development in Europe and the world is far behind the goal of 4% improvement per year.

2. One indicator is not enough

Energy efficiency progress cannot be meaningfully assessed with a single indicator. Final energy consumption per square meter is a useful and intuitive indicator, however, when it is derived from national statistics based on actual energy consumption, it is influenced by external factors such as weather conditions, user comfort choices, or occupancy patterns. Without correcting for these factors, the indicator may wrongly suggest efficiency gains — for example, when a mild winter or economic hardship leads to lower energy consumption.

The analysis of the European context demonstrated the influence of external factors by assessing complementary indicators and revealed that improvements in energy efficiency per square meter were largely offset by increasing floor area per person and periods of reduced comfort. This underscores the urgency for a more holistic approach that delivers accurate and actionable efficiency tracking when using statistical data. The issue lies not with the indicator itself, but with the underlying data and how it is interpreted.

More robust indicator data could be derived from calculated, standardised efficiency indicators, such as EPCs, if they were available. With the national implementation of the 2024 recast of the EU Energy Performance of Buildings Directive (EPBD), EPCs shall provide a standardised assessment of building efficiency, independent of user behaviour or short-term climate variation, in the future. While now EPC schemes still vary across the EU and partially within Member States, are not yet comparable, and do not comprehensively cover the entire European building stock, they likely play an important role in the future to better inform stakeholders' decision-making once comparability within and across countries is improved.

[10] https://www.cop28.com/en/global-renewables-and-energy-efficiency-pledge

In the meantime, energy efficiency indicators rely on statistics of national energy consumption and the building stock development, meaning data analysts and policymakers must be proactively aware of and understand the implications of limited methodological choices.

To consistently assess energy efficiency data, analysts should consider that:

Meaningful indicators for energy efficiency must reflect both the energy input and its fluctuations and the functional output, such as the amount of comfortable space in use or the number of people benefiting from comfortable, functional buildings. Awareness of this input–output framing when interpreting results provides a more robust discussion on trends and guiding action.

For understanding the method discussion, policymakers should be aware that:

To track real progress, energy efficiency indicators must go beyond simply measuring how much energy is used to reflect how well that energy delivers useful outcomes — such as warm homes and comfortable workplaces. This connection between energy consumption and the quality of indoor environments helps identify where efficiency is truly improving, and where lower energy consumption might instead reflect hardship or underuse.

This paper calls for a clear and consistent measurement approach that broadens the indicator set to enable more robust interpretation of progress toward the COP28 energy efficiency goal in buildings. The proposed indicator framework adds dimensions such as climate correction, comfort proxies, and per-person indicators to supplement energy intensity.

3. Better data is the foundation for better action

More granular and comparable data is urgently needed. Countries must distinguish building-related energy use from appliances, improve building stock and renovation tracking, and monitor comfort and occupancy levels. Europe's framework, despite coverage gaps, offers a useful starting point and reference model for improving global data collection and comparability.

Data quality needs to improve for a better decision-making basis

A robust way to measure energy efficiency in buildings that avoids fluctuations from user behaviour and economic cycles is to keep track of the individual building's energy performance and calculate the energy efficiency based on the building components, equipment and quality. The European EPC framework, refined with the recast EPBD in 2024, aims to fulfil this role but still needs time to cover substantial parts of the building stock and deliver ratings that are comparable within and across countries.

The foundation of a reliable tracking framework is better data. In addition to improving EPC coverage and comparability, complementary efforts are needed to improve the availability and quality of operational data.

Targeted improvements in data collection can help bridge the gap and enhance current monitoring:

- **Track energy improvements**, particularly the rate and depth of renovations.
- **Monitor new construction and efficiency levels**, ensuring data reflect what is actually built and renovated and what energy efficiency is achieved.
- **Record energy consumption by end-use**, with special attention to separating heating, cooling, and ventilation from appliance use, which is unrelated to building quality.
- **Clarify floor area definitions**, distinguishing between gross, net, usable, and conditioned space.
- **Capture occupancy patterns and vacancy rates**, which influence per capita and per m^2 indicators.
- **Monitor comfort levels and behavioural responses to economic stress**, to avoid misinterpreting reduced energy use as efficiency gains.
- **Disaggregate data by settlement type**, distinguishing urban, rural, and informal areas.

While Europe still faces challenges in ensuring comparable and sufficiently disaggregated data, especially in the service sector, its existing frameworks, such as Eurostat and the EU Building Stock Observatory, provide a solid foundation. These could serve as a guidance for other countries' efforts to build consistent and transparent data systems for energy efficiency tracking under the COP28 pledge. Together, the findings highlighted in this paper stress the urgency of strengthening efforts in the buildings sector — not only in terms of policies and investments, but also for aligning how efficiency is defined, measured, and interpreted.