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Review

Energy Performance of Buildings for Incentivisation in Energy-Efficient Structures: An Analysis of Secondary Data in Malta

Joseph Falzon [1], Rebecca Dalli Gonzi [1], Simon Grima [2,3,*] and Edward Vella [4]

[1] Department of Construction and Property Management, Faculty of Built Environment, University of Malta, MSD2080 Msida, Malta; joseph.falzon@melita.com (J.F.); rebecca.e.dalli-gonzi@um.edu.mt (R.D.G.)
[2] Department of Insurance and Risk Management, Faculty of Economics, Management and Accountancy, University of Malta, MSD2080 Msida, Malta
[3] Faculty of Business, Management and Economics, University of Latvia, LV-1586 Riga, Latvia
[4] Malta College of Arts Science and Technology Malta, University of Malta, PLA3032 Paola, Malta; edward.vella@mcast.edu.mt
* Correspondence: simon.grima@um.edu.mt or simon.grima@lu.lv; Tel.: +356-7965-1410

Abstract: High-performance green buildings mitigate the adverse environmental effects of energy consumption and carbon emissions while simultaneously demonstrating that sustainability does not mean compromising utility, productivity, or comfort. We need to address the identified gap in the evolution of energy-efficient structures facilitated in building applications to enhance energy usage without mitigating comfort. The aim of this study was to provide a review of the current methods used to assess energy efficiency in buildings in Malta through secondary data and to supplement this with qualitative data from interviews. The study investigated the importance of certification, compulsory legislation, and regulations implemented by local authorities and the European Union to incentivise energy performance measures. The findings, supplemented with qualitative data from representatives of public entities, show that most participants agreed that the current method of assessing needs requires a complete overhaul in order to promote a proactive approach to sustainable development. Recent public awareness has highlighted the limited understanding of sustainable practices implemented in buildings to capture and conserve energy. However, it is widely recognised that the building industry has significant potential for energy savings, which applies to both new constructions and existing structures, but the current level falls short of what is necessary in Malta. The study findings emphasise the primary energy users and pinpoint the obstacles in the implementation process. In conclusion, the use of software EPRDM, which may be applied to raise the importance of energy performance in building standards, lacks a value-driven focus, resulting in its full utilisation and potential being unexplored. Future applications of this study include the categorisation of old buildings for a possible bid in energy retrofit; campaigns to promote responsiveness; and the utilisation of advanced technological tools, such as DESIGNBUILDER and related software, to enable the simulation of an optimal building envelope. While increased energy efficiency may result in elevated rental and sale prices for buildings, this knowledge, when disseminated to prospective purchasers via the energy performance certificate (EPC) system, can catalyse investments in structures that are more energy efficient for the end user.

Keywords: energy-performance certification; high performance; green building; energy-efficient construction; Malta; energy strategy; government authority; building industry; energy investments

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1. Introduction

High-performance green buildings play a pivotal role in mitigating the adverse environmental impacts stemming from energy consumption and carbon emissions. These structures not only serve as beacons of sustainability but also challenge the misconception that environmental consciousness necessitates sacrificing utility, productivity, or comfort. Despite notable progress in sustainable building practices globally, certain regions, such as Malta, face unique challenges and opportunities in enhancing energy efficiency within their building infrastructure.

The aim of this study is rooted in addressing a critical gap in the evolution of energy-efficient structures, particularly within the context of Maltese building applications. While strides have been made to improve energy efficiency, there remains a notable disparity in ensuring that such enhancements do not compromise occupant comfort. The research questions are as follows:

1. What are the predominant methods and metrics utilised in assessing energy efficiency in buildings within the Maltese context, and how do these compare to international standards and best practices?
2. How do qualitative data from interviews with key stakeholders, such as building owners, architects, policymakers, and energy experts, complement existing secondary data sources in providing a comprehensive understanding of energy efficiency challenges and opportunities in Maltese buildings?

Thus, the primary objective of this research is to conduct a comprehensive review of the current methodologies utilised to assess energy efficiency in buildings within Malta. This review is augmented by qualitative data obtained through interviews, providing nuanced insights into the local landscape.

Central to this investigation is an exploration of the significance of certification, compulsory legislation, and regulations enacted by both local authorities and the European Union to incentivise measures aimed at improving energy performance. By scrutinising these mechanisms, this study seeks to elucidate the efficacy of existing policies and identify potential areas for refinement or enhancement. Moreover, it endeavours to discern the extent to which these regulatory frameworks align with the broader goal of fostering sustainable building practices while balancing economic considerations and societal needs.

Malta, characterised by its unique geographical and socio-economic attributes, presents a compelling case study for examining the interplay between regulatory frameworks, technological advancements, and socio-cultural factors in shaping energy efficiency initiatives within the built environment. As an island nation with limited land resources and a dense urban fabric, Malta grapples with the imperative to reconcile developmental aspirations with environmental stewardship.

In light of these considerations, this study endeavours to contribute to the discourse surrounding sustainable development in Malta by offering actionable insights gleaned from a rigorous examination of current practices and policies. By fostering a deeper understanding of the challenges and opportunities inherent in advancing energy efficiency within the built environment, this study aims to inform evidence-based decision-making and catalyse transformative change towards a more sustainable future for Malta's building infrastructure.

With this review, we emphasise the significance in addressing the pressing need to reconcile energy efficiency goals with considerations of comfort and functionality within the Maltese context. Through a multidimensional analysis encompassing regulatory, technological, and socio-cultural dimensions, this study aims to elucidate pathways for enhancing energy efficiency in Malta's building infrastructure while fostering a holistic approach to sustainability.

This study aims to establish the value of certification, laws, and regulations enforced by local governments and the European Union in evaluating energy efficiency in buildings in Malta. It also explores how incorporating cutting-edge technology into building designs can improve user comfort, community care, and occupier profitability. Considering that energy compliance has already been incorporated into the country's legislative framework and is recognised for enhancing building performance, the research question is to investigate the reasons behind the lack of using energy performance data to support energy compliance requirements by law in achieving new efficient building designs.

In this sense, the scale of the island, positioned in the centre of the Mediterranean, covering just over 316 km^2, and a full member of the European Union (EU) within the Eurozone, may act as a laboratory test for larger territories with similar challenges [1]. Although all states might be represented in decision-making processes, the larger states usually take over and sometimes dictate the final decision [2]. In the context of this study, scale is a key factor, and the support required at a national level for such a state, given that the circles governing the institutional state of affairs are different from those of larger states. Hence, this study and other similar studies hold significance as they articulate the concerns of less influential states and facilitate the comprehension of the consequences and ramifications of new legislation on smaller jurisdictions, namely within the European Union [2].

2. Literature Review

Sustainable energy-saving methods in buildings are currently under-addressed, necessitating public awareness campaigns to foster an energy-conscious ethos among building users and managers. Victoria et al. (2023) contribute to this discourse by examining energy efficiency in public buildings in Nigeria, aiming to establish a roadmap toward sustainability. They discuss various strategies and measures to enhance energy efficiency in public buildings, emphasising the importance of sustainable energy practices for environmental preservation and economic viability. The research highlights the awareness of the need for energy-saving measures in public infrastructure and explores potential pathways to achieve sustainability goals in Nigeria's context [3].

Concurrently, Juaidi et al. (2019) investigate urban design strategies to achieve sustainable energy in residential neighbourhoods within arid climates. They discuss various aspects of urban planning and design that can contribute to energy efficiency and sustainability, particularly in regions prone to arid conditions. The authors highlight the importance of raising awareness about sustainable energy-saving practices within residential areas, emphasising the role of urban design in mitigating energy consumption and promoting environmentally friendly lifestyles. They suggest specific design interventions and solutions tailored to the unique challenges posed by arid climates, aiming to enhance energy efficiency and reduce the environmental impact within residential communities [4].

Further enriching this discussion, Manzano-Agugliaro et al. (2023) focus on monitoring energy consumption in vending machines within university buildings, aiming to identify areas for improvement and implement targeted interventions to promote sustainable energy practices in academic environments. The research emphasises the importance of tracking energy consumption patterns to identify areas for improvement and implement targeted interventions. By monitoring vending machine energy usage, the study aimed to promote sustainable energy practices within university campuses, potentially contributing to broader sustainability initiatives in academic environments [5].

Similarly, Manzano-Agugliaro et al. (2015) present a review of bioclimatic architecture strategies for achieving thermal comfort, advocating for design principles prioritising natural elements and passive strategies to enhance energy efficiency and occupants' comfort. They discuss various architectural approaches and design principles that prioritise natural elements and passive strategies to regulate indoor temperatures effectively. The research emphasises the significance of bioclimatic designs in promoting energy efficiency and enhancing occupants' comfort while reducing reliance on mechanical heating or cooling systems. By synthesising existing knowledge on bioclimatic architecture, the study provides insights into sustainable building practices prioritising thermal comfort and environmental stewardship [6].

Expanding beyond building-level interventions, Perea-Moreno and Hernandez-Escobedo (2021) explore renewable energy and energy-saving systems within sustainable urban development contexts, emphasising the integration of renewable energy sources to enhance city resilience and mitigate climate change effects. The research emphasised the importance of integrating renewable energy sources and energy-efficient systems to enhance the resilience and efficiency of cities while mitigating the effects of climate change. By examining recent developments in this field, their study provided insights into the potential for sustainable urbanization and the role of renewable energy in shaping future cities [7].

Viciana et al. (2018) contribute by developing OpenZmeter, facilitating real-time energy consumption monitoring to empower users towards more sustainable practices indirectly. This device enables users to monitor and analyse energy consumption in real-time, promoting greater transparency and understanding of energy usage patterns. While the study may not directly address awareness, the availability and accessibility of such technologies can indirectly contribute to increasing awareness by empowering users to make informed decisions about their energy consumption and encouraging more sustainable practices [8].

Additionally, the editorial by Perea-Moreno et al. (2023) underscores the importance of awareness in achieving energy-saving goals for sustainable cities, emphasising informed decision-making and active engagement. They discuss the need to raise awareness among policymakers, stakeholders, and the general public about the significance of energy conservation measures and their role in creating more sustainable urban environments. The editorial highlights the potential impact of informed decision-making and active engagement in promoting energy-saving practices, ultimately contributing to developing more resilient and environmentally friendly cities [9].

Elaouzy and El Fadar (2023) delve into the sustainability of building-integrated bioclimatic design strategies, analysing their impact on energy consumption and affordability, thereby providing insights into the feasibility of sustainable practices in building construction. They examined how the implementation of such strategies impacts energy consumption and affordability within buildings. Their research emphasises the importance of raising awareness about energy-saving measures and their potential to enhance sustainability while considering economic factors such as energy affordability. By analysing the interplay between bioclimatic design strategies and energy affordability, the study provides insights into the feasibility and effectiveness of incorporating sustainable practices in building design and construction [10].

Examining policy landscapes, Skillington et al. (2022) offer a comprehensive review of existing policies aimed at reducing embodied energy and greenhouse gas emissions in buildings, highlighting the importance of policy interventions throughout the building lifecycle. They examine various regulations, incentives, and initiatives implemented at regional, national, and international levels to address the environmental impact of building construction and materials. The research emphasises the importance of policy interventions in promoting sustainable practices throughout the building lifecycle, from design and construction to demolition and disposal. By evaluating the effectiveness of existing policies, the study offers insights into potential strategies for enhancing policy frameworks to achieve more significant reductions in embodied energy and greenhouse gas emissions in the building sector [11].

The potential for energy saving in the building industry is recognised by all, both in new and existing buildings. However, similarly to other areas of energy efficiency, progress has been very difficult to achieve. The Energy Performance of Building Directive (EPBD) (Directive 2002/91/EC) is the main European Union (EU) policy instrument to improve energy performance in buildings (Energy Performance of Building Directive, 2021) [12]. All EU member states were given until 4 January 2006, to bring into force the necessary laws, regulations, and administrative provisions to introduce a framework for energy performance certification. Using an energy performance certificate (EPC) includes reference values, such as the current legal standards, so consumers can compare and assess their building's energy performance. The certificate should also include recommendations for cost-effective improvements to raise the rating and to better the performance of the building [13].

The recast of the EPBD in 2010 (Directive 2010/31/EU) gave a higher value to the role of EPCs by demanding the publication of energy performance indicators of the EPC during the advertising of a building for rental or sale rather than on the signing of the agreements. In November 2016, there was another attempt to further amend the directive (COM/2016/0765), and the European Commission published the "Clean Energy for All Europeans", a package of measures boosting the clean energy transition in line with its commitment to reduce CO_2 emissions by at least 40% by 2030. The building's performance can be modified by adopting measures to reduce consumption. Locally, the final EPC results determine the quality of the building with respect to energy efficiency and can be used as a driving force toward the building's improvement. Consumers are often more focused on the initial costs than the running ones, with little to no consideration attributed to "greener" buildings. Although several cost-effective energy-saving measures are available to property owners, their potential for energy conservation is not realised [14].

Despite recognising the potential for energy savings in buildings, progress has been challenging. The Energy Performance of Building Directive (EPBD) serves as the primary EU policy instrument to improve building energy performance. However, obstacles such as consumers focusing on initial costs hinder the realisation of energy-saving measures. The study by Degiorgio and Barbara (2016) emphasises the broader efforts in Malta to enhance energy efficiency, highlighting challenges in quantifying the specific impact of EPBD [15]. However, the specific impact of the EPBD on energy efficiency in Malta has not been quantified yet. Determining this impact would be challenging, as it would require distinguishing between improvements resulting from the EPBD, other EU directives, and measures taken by private individuals or Maltese authorities.

Although housing units have been built over various periods, overall energy use in residential buildings remains low, resulting in a correspondingly low reduction in carbon dioxide emissions. Notably, cost-effective energy efficiency in this sector often involves integrating renewable energy sources (RES), particularly solar energy, into renovation or new construction projects [15]. The construction of offices and commercial buildings is rapidly increasing due to developments in the services industry. These buildings consume energy more intensively, and while EPBD requirements for this sector were implemented later, their effects have yet to be quantified. Nevertheless, this sector is expected to significantly contribute to improving energy efficiency.

Introducing new cost-optimal minimum requirements, including energy balance limits for buildings undergoing major renovations, is anticipated to enhance energy demand for building stock renovations already underway [15]. Buildings represent 40% of energy use and 33% of greenhouse gas emissions in Europe [16]. Nevertheless, a substantial capacity exists to greatly diminish this energy use by implementing more efficient building designs. Energy efficiency in buildings achieves two crucial objectives of sustainability. There are two ways to address this issue: first, by reducing energy use and optimising the use of primary resources, and second, by minimising the release of CO_2 into the environment.

Over the years, several technologies and tactics have been adopted to enhance the energy efficiency of buildings. Examining and utilising the research and discoveries of those who came before us is crucial for enhancing and refining present methodologies. Gaining insight into the development of energy-efficient buildings facilitates the implementation of strategies to enhance energy efficiency without compromising comfort. In general, occupants of buildings are conscious of the significance of implementing novel methods to conserve energy. However, it is well recognised that implementing directives and legislation is necessary to ensure greater compliance. The energy efficiency of a building can be divided into two components:

- Passive properties mostly arise from heat insulation, shading, natural lighting, ventilation, and solar radiation.
- Active properties refer to the utilisation of renewable energy obtained through wind, solar, and hydroelectric power.

Following the implementation of the initial Energy Performance Building Directive (2002/91/EC) by the European Union, the local authorities in Malta published a legal notice (LN238 of 2006) concerning the certification of buildings. Until this period, energy consumption in Malta had not been prioritised, resulting in a lack of understanding regarding energy efficiency in buildings. Following the legal notification, the authorities developed a software called EPRDM v1.0 [17] specifically designed for local residential buildings. This software evaluates the energy consumption of the buildings in terms of kilowatt-hours per square meter per year. The building's carbon dioxide emissions, measured in kg/m2/year, are also indicated. A similar software, known as iSBEM-mt v4.2.b (https://bca.org.mt/wp-content/uploads/EPB-Calculation-Methodology-for-Non-Residential-Buildings-User-Guide-SBEMmt.pdf, accessed on 25 April 2024), was built to certify commercial structures. According to the legal notice, this certificate is required as part of the documentation for the sale or rental of a property. The legal notice (LN 47 of 2018) has been modified to incorporate the minor revisions required by the European Union in 2010 (2010/30/EU). The primary purpose of these modifications was to eliminate any uncertainties, particularly in relation to contemporary technologies. Subsequent to that, no more revisions have been made regarding the building "boom" in Malta, and there is a pressing need for more environmentally friendly structures.

Furthermore, it is important to prioritise the retrofitting of existing structures, particularly those that have not yet obtained certification. The Ministry for the Environment (2017) identifies multiple obstacles in addressing energy efficiency. The primary hurdles encompass legal, technical, and financial dimensions. In 2017, the Energy and Water Agency initiated a public consultation to facilitate talks among engineers, regulators, companies, NGOs, and the Malta Business Bureau by introducing the EPC. The literature findings indicate that although the EPC model may be viable for Malta, its implementation is constrained by modest cost savings and excessively prolonged payback times. Contractors and developers are unable to provide cost savings unless the necessary maintenance is conducted [18]. With data from previous research marking the public's lack of awareness and lack of demand and the perception of high starting expenditures as barriers to high-performance building incentivisation impacting the developer's final profit [19], one must highlight whether the country is implementing several projects that are not sustainable or effective in the long term when it comes to energy measures.

3. Research Method

The collection and analysis of data for this study utilised both primary and secondary data. Our data search strategy included a scoping review of secondary data from various sources, including legal notices, books, journals, reports, articles, and websites. Electronic databases such as Google Scholar, EBSCO, PubMed, PubMed Central, Medline, Scopus, ProQuest, and Web of Science were searched. We searched for both academic and grey literature discussing energy performance and its awareness. The above-mentioned databases were chosen due to their strength and prominence in the research arena of energy performance and efficiency in public and private buildings. The keywords used were 'energy performance' OR 'energy-efficiency' OR 'incentivisation' AND 'Buildings' AND 'Structures'. Each keyword or combination of terms was used in the above-mentioned databases and sources. Lists were compared and contrasted using a manual search. This process was crucial for excluding papers that did not correspond with the goals of our evaluation by using the inclusion/exclusion criteria. We filtered our data to obtain the most recent data available.

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) flow diagram below (Figure 1) provides a clear representation of the search results obtained and how these findings were filtered to derive pertinent articles [20].

As of 15 December 2023, we retrieved a total of 425 papers that in the first instance, by looking at the titles of the article, seemed relevant from the above-mentioned publications. Only publications in English and those holding the keywords in the title were included, and there was no geographical limitation when considering studies. However, we then excluded the following types of documents: conference abstracts, editorial materials, correspondence, conference proceedings, and duplicates, ending with 159 seemingly relevant articles, for which the relevant information was exported to a folder on one of the authors' PCs. Following a read-through of the full articles, we ended up with 51 articles, which we exported to a Microsoft Word file v2021. One co-author initially extracted the results and then cross-checked with the other co-authors to ensure all data were filtered and reviewed. If co-authors had different opinions, the co-authors reviewed them together until a final agreement was reached (Figure 1 and Table 1).

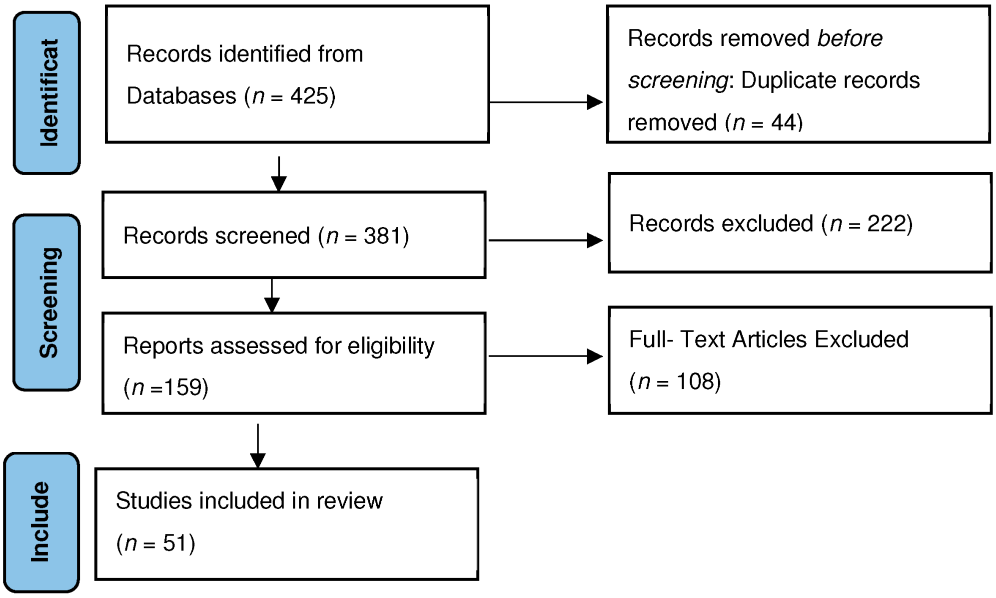

Figure 1. Data Extraction Process (PRISMA).

The use of secondary research was to analyse data obtained from previous studies in areas related to software data collecting for energy inquiry and mainly concerning Malta's building stock and first-time property buyers to gather U-value standards as data used to support the incentivisation of energy-efficient building investment. Researchers frequently utilise secondary data to corroborate results obtained from other primary data-gathering methods, such as interviews, case studies, surveys, and experiments [21].

Supplementing this first phase review was a series of structured open-ended interviews as a second phase conducted with public sector entities in Malta's energy and sustainability sector to affirm the objectives identified from the secondary data, which included the following: (1) the significant entities and bodies influencing Malta's energy policies and regulations; (2) the purpose of the EPC and its relevance to the building energy sector; (3) the tools that are being used to conduct testing for the purpose of certificate issuance; (4) the stakeholders with a purpose of input towards energy efficiency; and (5) the identification of participants to empower policies and regulations [22].

Structured interviews introduced objectivity to the findings, allowing for equitable comparisons and reducing bias among interviewers. Structured interviews employ standardised, situationally or behaviourally grounded inquiries. This necessitates meticulous development of a scoring rubric and training of interviewers, which ultimately results in enhanced agreements and reduced biases compared to conventional interview methods [23]. Since we served as the principal instruments of data collection, we aimed to avoid any insufficient consideration of potential biases or errors in judgment as much as possible since this may harm the integrity of the data and the ultimate result of the research [24]. Rigorousness was attained in this context using deliberate and strategic preparation, ongoing utilisation of our reflexivity, and effective communication between us as researchers and the relevant parties concerning the study's outcomes.

Table 1. Inclusion/Exclusion Criteria.

Item	Inclusion Criteria	Exclusion Criteria	Justification
Language	Articles written in the English language	Articles written in other languages	Scoping review authors/reviewers use English as their working language
Dating	Research articles published from 2020–2024	Articles published pre-2020	Looked for relevant documents mainly from the last decade to ensure they are the most recent articles possible.
Research Setting	Articles holding the keywords: 'energy performance' OR 'energy-efficiency' OR 'incentivisation' AND 'Buildings' AND 'Structures', in their title.	Articles on other areas were excluded	The aim of this study was to provide a review of the current methods used to assess energy efficiency in buildings in Malta.
Target population	Articles from Electronic databases such as Google Scholar, EBSCO, PubMed, PubMed Central, Medline, Scopus, ProQuest and Web of Science were searched. Both academic and grey literature discussing energy performance and its awareness. Articles, books, reports, websites and legal notices chosen due to their strength and prominence in the re-search arena of energy performance and efficiency in public and private buildings.	Conference abstracts, editorial materials, correspondence and conference proceedings.	This was deemed to add rigor, strength, and value to the scoping review.
Evidence-based Research	Only primary evidence-based research articles were included	Opinion articles and other speculative write-ups.	This was deemed to avoid bias as much as possible.
Perspective	Articles taken from an organisational perspective or case study	Articles deemed by authors as being biased	Deemed to differ according to specific perspective or case.

Source: Authors' Compilation.

The interview schedule was divided into five sections, as outlined above. In this study, we involved the participation of various public sector entities, including academic institutions, government advisory bodies, developers' associations, qualified personnel, and their respective chambers. A formal invitation was extended to each entity/individual for the purpose of selecting a representative. For the purpose of data collection, all interviews were conducted online and documented. Moreover, the duration of the interview was reportedly around one hour. The entities that accepted the invitation to participate are listed below: The Malta Developers Association; The Building Construction Authority; The University of Malta; The Institute of Sustainable Energy in Buildings; Institute of Engineering and Transport—Building and Construction at the Malta College of Arts, Science and Technology (MCAST)—The Institute of Engineering and Transport; Building & Construction; The Malta Chamber of Construction Management; The Chamber of Engineers; and Architects by profession (to replace the Chamber of Architects). Through the implementation of standardised questions related to key areas, (i) roles and responsibilities, (ii) the entity under investigation and energy performance, (iii) method for assessing energy performance in the building, (iv) the value and worth of an EP certificate, and (v) future legislative requirements, all participants were asked the same set of questions. However, they were granted the opportunity to elaborate on the topics covered in the interviews, with an open-ended option to conclude each particular session. A total of 18 questions were asked to a portion of 7 public-sector participants. The sample adequacy was determined based on saturation parameters. Saturation has emerged as the 'gold standard' in qualitative inquiry, with a number of studies also suggesting that data saturation is to be applied with caution because 'saturation' is the least known [25], suggesting that it is not always applicable to all types of qualitative research studies. In qualitative inquiry, sample adequacy refers to the suitability of the sample size and composition. In this case, purposive sampling selected 'information-rich' cases, as recent research demonstrates the greater efficiency of purposive sampling compared to random sampling in qualitative studies [26]. Results were analysed using manual thematic analysis, which was considered to have been superseded by much more current software methodologies. The manual thematic analysis method was founded on a six-step "Reflexive TA" procedure. The reflective TA approach, created by Braun and Clarke (2006) [27], is a six-part process and was applied herewith. The first phase included the following: (i) becoming familiar with the topic and note-taking; (ii) assigning codes and labels to data to identify significant and pertinent characteristics; (iii) generating themes and organising them into overarching patterns; (iv) evaluating and enhancing themes; (v) refining and specifying themes; and (vi) assembling the analytical narrative.

4. Data Analysis and Results

4.1. Secondary Data Results

4.1.1. Enterprise Resource Planning Data Management Metrics (ERPDM) Calculation Tool (2013, 2021)

Using pre-existing data that have been developed to substantiate this inquiry in Malta, the study considered the impact collated over the years through the adopted use of the ERPDM version 1.0 calculation tool, developed in 2009 by CASA inginiera. This was used to calculate energy consumption and CO_2 emissions in self-contained dwellings. It considers climate and net energy required for heating, cooling, water heating, ventilation, and lighting and excludes renewable energy sources. The tool currently in use calculates the thermal performance of walls and floors using an Excel sheet found on the National Building & Construction Agency website. Assessors input heat gains into ERPDM software, which is uploaded to the authority's platform. Data collated by Yousif (2013) [28] found that the tool compares favourably with Design Builder—EnergyPlus. Data from Yousif's 2013 study reveal that current asset ratings for residential buildings in Malta are underestimating their actual energy consumption. This means that evidence for improving the sector's resilience to meet sustainable targets is incomplete. EPRDM, the only recognised software for energy certification, can be considered a crucial national tool for providing a realistic assessment and issuing EPC data for trends and analysis. Gatt, D. et al. (2021) [29] simulated three buildings using WUFI 5.1 pro and EPRDM, finding that both subjects are well engineered. In 2015, the Institute for Sustainable Energy at the University of Malta exploited research by evaluating the strengths and weaknesses of the EPRDM tool by evaluating the experience of EPB assessors. Data were collected via a survey that was sent out to 114 registered EPB assessors, with feedback from fifty respondents. Fifteen out of fifty stated they never conducted an audit with the scope of issuing EPC data.

4.1.2. Energy Performance Certificate (EPC) Analysis (Local Drivers)

One of the main drivers and opportunities for energy incentivisation is the energy performance certificate (EPC), which can be issued at various stages of a property's development, including design, shell form, and finished stages. However, the current EPRDM system in use does not differentiate data between these forms, making it difficult to issue a meaningful EPC for buildings still in design or shell form. This is due to assumptions about finishes and systems. Additionally, first-time buyers may not be able to include renewable resources from the start, making it difficult to apply the assumed assumptions for the same property in a finished state. Other difficulties include specifications of opaque and glazed inputs, U-values, absorptivity, and emissivity. An EPC should provide an indication of energy consumption, and another should be conducted when the building is ready to be occupied to ensure there are no drastic changes from the original plans. The primary catalyst for issuing certificates is property transfers and long-term rentals. However, the substantial benefit of issuing an EPC certificate, which would determine whether the implementation of energy measures has enhanced the overall building performance to comply with new regulatory standards, is a potential undertaking for future projects. In a study carried out in 2022, a gap has been identified in the local Maltese construction industry in certifying and analysing buildings and proving their performance [30] when compared to internationally approved practices of building assessment. The results showed that the consequences of unregulated building approval may subject inhabitants to conditions that can lead to buildings underperforming in a number of aspects and being unsafe for both occupants and third-party property owners. Using a testbed of Phases 1 and 2, the study highlighted the use of building certification issuance in conjunction with adopting the concept of an EPC standard to potentially detect disparities in construction techniques, identify regulatory inconsistencies, and identify building neglect. The study analysed habitable spaces as new assessment indicators, using building assessments to determine accuracy and building simulation to analyse thermal comfort in a Mediterranean climate. The outcomes showed that well-designed buildings could achieve high levels of thermal comfort, offering large-scale potential opportunities for the market. However, energy ratings are only bound by compliance with LN 47/2018 [31], a rating that evaluates or benchmarks the building's energy performance and by which purchasers or sellers are not obliged to act on the recommendations.

4.1.3. U-Value Calculation

In 2015, a study was carried out in relation to U-values for building elements. Assessors argued that calculating U-values for opaque and glazed elements and unconditioned spaces is complicated and time-consuming due to the need for excessive basic Excel sheet computations. The survey carried out by Camilleri [32] found that 91.4% of respondents agreed that an in-built library of building elements with pre-set U-values should be integrated into software. However, other assessors argued that finding a standard U-value for various building elements is difficult and that specific U-values would be more precise. Thus, suggestions were made to allow users to incorporate a function of adjusted U-values to determine heat gain or loss for specific elements. U-value data are critical to indicate thermal efficiency in construction. Lower U-values translate to more economical heating costs for residential properties. Precise calculations are important if a selection of materials is to be made in the overall energy efficiency strategy for building incentivisation [32].

4.2. Primary Data Results

4.2.1. The Domestic Scenario

The entities interviewed in this study noted the current system's shortcomings and suggested approaches for its improvement. In general, all parties had a common goal: to define the standards for reducing emissions into the environment without sacrificing comfort. According to the literature and supported by secondary data, the most commonly used method for assessing energy consumption in residential buildings is the Energy Performance Rating and Diagnostic Method (EPRDM). Therefore, the participants were first asked about their familiarity with this software. All interviewees except for the Malta Developers Association (MDA) were assessors. Consequently, they had a considerable level of expertise in using the software. All participants unanimously recognised that introducing the EPRDM software was a genuine effort to construct a system that allows assessors to evaluate the effectiveness of a building precisely. However, they agreed that modifying this software to meet further domestic needs is currently necessary. Before commencing the development of a revised or new software, it is imperative to determine the precise objectives that must be accomplished, as indicated by the University of Malta—Institute of Sustainable Energy in Buildings (UOM). Unfortunately, the responses indicated that the authorities implemented the certification solely to comply with the EU's regulations. In this early undertaking, there was a scarcity of authentic commitment towards any momentum to build more ecologically sustainable structures [32,33].

4.2.2. Energy Calculation

The results showed that the current energy consumption assessment software in Malta is rated 4 out of 10 by the Chamber of Engineers (COE) and MCAST engineers, as it is primarily based on heating, which is unsuitable for local climate conditions. The software also assumes that heating is obtained through electricity, unlike in other systems such as gas or heat pumps. The MC disagreed with the results issued, arguing that it is useless to rate buildings in $kW/m^2/yr$ if the client cannot relate this to efficiency classifications. The architect's responses described the current method as cumbersome, with multiple calculations needed before setting data. The software is mostly numerically based and does not provide dynamic results, which could lead to incorrect calculations and negatively affect the rating. The EPRDM overestimates actual energy consumption, which could lead to incorrect calculations and negatively affect the rating. The Malta Chamber of Construction Management (MC) also noted that different assessors interpret the same U-values differently due to a lack of selections made available in document F and local suppliers not providing U-values for building elements, particularly those of fenestration and glazing. The MDA advocates for more importance given to international certifications, such as LEED and BREEAM, as they provide better building value and quality. The findings showed that authorities should lead by example and assist private developers in achieving sufficient energy consumption in commercial buildings. International certifications can be useful when designing green buildings, but respondents argued that authorities should support developers financially while implementing the finalised building [32,33].

4.2.3. Current Position

In aggregate, Malta experienced a notable uptick of 13.3% in newly established photovoltaic (PV) systems, with the Southern Harbour district marking the most substantial surge. Predominantly, the surge in new PV installations occurred within the domestic sphere. Moreover, the domestic sector emerged as the primary proprietor of such systems, commanding an overwhelming 94% share of the total PV installations. In contrast, the commercial and public sectors held 4.9% and 1.1% shares, respectively.

During the calendar year 2017, energy generation from PV sources witnessed a 20% escalation compared to the preceding year, culminating in a total kilowatt-peak (kWp) production of 112,341.4 kWp. Once again, the domestic sector spearheaded this advancement, contributing 54% of the total output. Subsequently, the commercial and public sectors accounted for 41.2% and 4.8% of the aggregate production, respectively [34].

In comparison, the majority of energy certification methodologies put forward and enacted in other central and Northern European countries are primarily tailored to the winter climate conditions. Studies indicate that even the streamlined approaches delineated within the EN ISO 13790 (2008) Standard demonstrate greater consistency when employed for estimating heating energy consumption as opposed to cooling energy utilisation [35]. Conversely, Southern European nations have conveyed a lack of established labelling systems or market frameworks for low-energy constructions or passive dwellings [36].

The study conducted by BIPE (2010) elucidates that numerous EU Member States confront challenges in integrating energy performance certificates (EPCs) within their respective national legislative frameworks. These challenges frequently culminate in delays and suboptimal implementation strategies. The intricacies inherent in the adoption of EPCs contribute substantially to the encountered implementation hurdles. Diverse national contexts and circumstances among member states engender a spectrum of implementation approaches, particularly concerning calculation methodologies, registration protocols, promotional endeavours, quality assurance mechanisms, and enforcement strategies. Consequently, substantial disparities emerge among countries regarding the efficacy of EPCs in fostering tangible enhancements in energy efficiency within the building sector [37].

Fonseca et al. (2011) emphasised the necessity for enhancing the quality control mechanisms pertaining to energy performance certificates (EPCs) [38]. Their findings indicate that Portugal has implemented a quality control system aimed at fostering confidence and reliability in the certification scheme. ADENE (Portuguese Agency for Energy) routinely oversees the quality of EPCs through two distinct dimensions:

- Approximately 1% of EPCs undergo meticulous scrutiny, involving a comprehensive review of the work conducted by the qualified expert, including on-site inspections.
- Around 6% of EPCs uploaded onto the national platform are subjected to a more cursory examination to detect any anomalies. Suspicious cases prompt further investigation, leading to a detailed assessment.

In instances where discrepancies are identified, a detailed report is forwarded to the respective qualified expert, mandating corrective measures or, if necessary, a complete re-evaluation of the EPC [38,39].

The updated Energy Performance of Buildings directive is poised to accelerate the pace of renovation activities, especially targeting the most poorly performing buildings within each member state. Additionally, it will facilitate advancements in air quality and the integration of digital technologies into building energy systems, while also promoting the establishment of sustainable mobility infrastructure. Acknowledging the divergent circumstances prevailing across EU nations, such as variations in existing building stock, geographical considerations, and climate dynamics, the directive affords governments the flexibility to determine the most appropriate renovation measures tailored to their specific national contexts. Moreover, countries retain the prerogative to exempt certain categories of buildings from the regulatory framework, encompassing historical structures and vacation residences [40].

The benchmarks for residential buildings in Malta aimed at achieving nearly zero energy standards have been established utilising recognised EPBD cost-optimal methodologies. However, the existing guidelines, which adopt a simplified one-step and one-benchmark framework, overlook crucial factors, such as peak loads, interactions with the grid, and energy storage considerations. To address these shortcomings, an innovative multi-criteria approach, inspired by the ISO 52000-1:2017 standard, has been implemented. This approach aligns with the new EPBD requirements, focusing on optimising comfort levels and addressing energy poverty concerns [41].

According to official data, as of 2016, only 12% of buildings mandated by EU regulations to possess an energy performance certificate (EPC) had obtained certification. A spokesperson from the infrastructure ministry disclosed to the Times of Malta that a mere

10,586 properties had been certified by that time, out of an estimated 85,000 structures requiring certification for the period spanning 2009 to 2015, as stipulated by an EU directive initially issued in 2010. Nonetheless, this figure denotes a notable improvement compared to previous years, with only 139 certificates issued in 2013, escalating to 1420 in 2014 [29].

The EPC serves as a means to gauge the energy efficiency of a building, utilising a color-coded ranking system akin to the energy labels found on household appliances, such as refrigerators. As per legal requirements, individuals involved in the sale, construction, or rental of a building are mandated to furnish an EPC, which remains valid for a duration of 10 years, during the negotiation phase of a sale or rental agreement or upon contract execution [41].

However, solar photovoltaics (PV) have gained global traction, especially in utility-scale projects situated in regions with high solar irradiance [41]. Substantial insights have been garnered from these deployments, presenting invaluable knowledge for developers embarking on new projects. Various operational metrics, including the degradation rate, maintenance expenses, and PV efficiency, have been meticulously documented.

Suitability analyses employing a multi-criteria approach have been conducted to identify optimal PV sites, considering these aforementioned factors. Developers may also consider additional parameters, such as the choice between utilising tracking devices or fixed mounting for solar modules, along with other performance indicators, to tailor the project to their specific needs and objectives [42].

Also, the report authored by Olaussen (2017) provides a comprehensive literature review encompassing 22 studies utilising hedonic regression models to scrutinise the influence of energy performance certificates (EPCs) on property values [43]. Furthermore, the report conducts its own analysis utilising the hedonic regression model and utilising datasets sourced from Austria, Belgium, France, Ireland, and the U.K. The findings of the analysis overwhelmingly indicate that energy efficiency is positively correlated with market value [29,39] (European Commission, 2013, p. 12). In light of this conclusion, the report advocates for the reinforcement of the EPCs' role. Specifically, it recommends expediting the implementation process, disclosing EPCs earlier in the transactional continuum (e.g., at the advertising stage), enhancing their visibility (e.g., through more conspicuous front-page presentation), and facilitating comprehension (e.g., by employing plain language and optimising the layout design) [42].

Moreover, with the non-energy advantages of building renovations still underappreciated and inadequately measured, member states are overlooking a significant opportunity to leverage long-term renovation strategies as a pivotal instrument to address a multitude of policy goals. These include objectives pertaining to health, environmental sustainability, economic prosperity, and social welfare. Moreover, a more comprehensive quantification and elucidation of broader benefits, such as the favourable effects on air quality or the mitigation of energy poverty, can bolster public support for renovation policies and enhance societal cost-effectiveness [44].

5. Discussion

We find that the focus is mainly on the importance of the assessor's role in advising and recommending strategies for improving building performance at the end of each certificate. The participants agreed that the advisory part of the report is important, as clients should be informed on how to reduce consumption and make the building more efficient. Some interviewees recommended a set of default selections to assist the assessor in identifying possible measures, but the flexibility of allowing the assessor to include further recommendations should still be available. The assessor should be responsible enough to suggest and recommend measures that actually could be implemented. The study also discusses the tangible value of the current EPC, which is limited to issuing a building permit for construction works and its submission while renting or transferring property. All participants expressed concerns about the tangible value of the EPC and the lack of follow-ups to ensure the certificate reaches the minimum standards. The UOM representative argued that there is no real pass-or-fail result and that something needs to be done to ensure that certifications reach the minimum standards.

The EU continuously issues target dates to member states to improve energy performance, with the last target being to have all buildings rated as nearly zero by the end of 2030. Malta is lacking in reaching the desired targets compared to most European countries, with only Sweden, Finland, and Latvia increasing renewables by 50%. The MC argued that the Building & Construction Authority (BRO/BCA) should collate data from the 60,000 EPCs currently in their possession to understand Malta's position better. The study also highlights the need for governments to lead by example, as the MC expects authorities to be the prime advocates of sustainable buildings. However, 98% of government buildings do not even satisfy the minimum standards of document F. Furthermore, participant data suggest that a greater emphasis should be placed on the sustainability of public buildings, particularly during retrofitting processes. An innovative approach for the government to set a positive example is prioritising sustainability in constructing new social housing. This involves implementing various measures to achieve optimal performance and ultimately serving as a valuable case study for developers to learn and apply these strategies. While modern technology has made it possible for machines to provide comfort in buildings through features such as air-conditioning and air-handling units, old buildings can still be improved by incorporating passive measures, such as proper ventilation, shading devices, and double-glazed windows. However, participatory data note that the government's current emphasis is on comfort rather than prioritising energy efficiency. Furthermore, data indicate that establishing national building codes to assist renovators in retrofitting would address the issue of engineers' recommendations being disregarded due to budget constraints.

Public buildings, while sharing similarities with private ones in terms of requiring regular maintenance for optimal functioning, present unique opportunities for advancing energy efficiency due to their distinct purposes and funding mechanisms. Unlike private buildings, public sector structures are owned by the electorate, bringing about challenges such as a mix of old and new systems, limited cloud connectivity due to cybersecurity concerns, extensive documentation needs, stringent procurement processes, and stricter building regulations. Additionally, public buildings must prioritise public safety and comfort, serving diverse functions and accommodating individuals with varying needs, notably government employees who utilise these spaces regularly.

Implementing programs aimed at improving energy efficiency in public sector buildings faces a significant barrier: unlike private building occupants who directly benefit from cost savings, individuals in public buildings often do not reap the rewards of reduced energy consumption. While private sector workers understand the link between profitability and job security, government employees may lack this incentive. Thus, addressing the behaviour of those working in public buildings becomes crucial for enhancing their energy efficiency.

Key strategies for achieving energy efficiency in public sector buildings include empowering workers to control energy usage, educating them about their impact on consumption, fostering positive attitudes toward energy conservation, enhancing their knowledge of energy-saving actions, and promoting personal norms prioritising energy reduction. Recognising and addressing the motivational disparities between public and private sector employees is vital for encouraging energy-saving behaviours.

Research supports the effectiveness of such approaches. For instance, a 2020 study conducted in Greece demonstrated that educating public building employees about energy consumption and providing guidance on adopting energy-efficient habits led to significant behavioural changes and improved attitudes toward energy conservation. By understanding and addressing these motivational differences, meaningful progress can be made toward achieving energy efficiency in public sector buildings [43].

The study conducted by Papadakis and Katsaprakakis (2023) emphasises the significance of awareness in energy efficiency interventions for public buildings. Their review highlights the importance of raising awareness among stakeholders, including building managers, employees, and the general public, about the benefits and necessity of energy efficiency measures. Increased awareness can lead to greater engagement and participation in energy-saving initiatives, ultimately facilitating the successful implementation of interventions to improve energy efficiency in public buildings [39,45,46].

Enhancing energy efficiency in public sector buildings involves a systematic approach, encompassing various stages such as building surveys, energy audits, and financial analyses to gauge the viability of proposed strategies. Decision-making regarding efficiency measures is influenced by factors such as health and safety considerations, occupant well-being, job creation prospects, and the potential impact on economic development. Challenges arise particularly in older public buildings, characterised by unfavourable positioning and outdated HVAC systems and insulation, posing obstacles to retrofitting for efficiency. However, these very characteristics present opportunities for significant impact through efficiency measures. Consequently, retrofitting initiatives often present more economic advantages than challenges.

Successful retrofitting examples from around the world illustrate the efficacy of tailored strategies:

Australia's SAVEnergy program saw a notable increase in retrofitting projects in federal buildings following adjustments to energy efficiency auditing procedures [47].

In Canada, retrofitting endeavours executed by energy service companies yielded substantial savings of approximately 15–20% per building, amounting to millions of dollars annually [48].

Mexico's focus on energy-saving lighting retrofits in government facilities significantly reduced electricity consumption [49–54].

Moreover, the presence of project champions is pivotal in advancing retrofitting initiatives, with energy audits playing a crucial role in driving planning processes for building retrofits, whether managed internally or externally.

6. Conclusions

This study aimed to review the existing approaches for evaluating energy efficiency in buildings in Malta and to supplement this with qualitative data. The research examined the significance of certification, mandatory legislation, and regulations enforced by local authorities and the European Union. The findings indicated that most interviewees concurred that the existing approach to evaluating needs necessitates a comprehensive restructuring to foster a collective and proactive approach towards sustainable development management. It is necessary for all parties involved to work together in order to raise knowledge about building performance in Malta and promote more efficient energy usage. The study's second purpose was to comprehend assessors' challenges when utilising the EPRDM for certification and explore potential enhancements.

Secondary data indicate that the current asset ratings for residential buildings in Malta are underestimating their real energy consumption, notwithstanding the tools provided on the National Building & Construction Agency website. In addition, EPC data for audit purposes are not currently being utilised, even though EPCs can be issued at various stages of a property's construction. Buyers are not fully aided from the start because the EPC data are supplied after completion, which is too late to help purchase renewable resources. Thus, issuing certificates is primarily done for property transfers and long-term rentals, whilst obtaining an EPC accreditation can allow for an evaluation of whether energy improvements have enhanced the building's performance to comply with current regulations. Buyers or sellers are not obligated to adhere to EPC outcome guidelines due to the absence of a binding law.

Furthermore, assessors argued that calculating U-values for solid and glazed components and unconditioned areas is intricate and time-consuming due to the need for many basic Excel calculations and the absence of exact estimations. Qualitative data identified multiple deficiencies that must be rectified in order to prevent any possibility of ambiguity.

The current findings fail to represent the building's performance accurately. Moreover, the intended recipients of incentivisation disregarded the majority of the suggestions on account of their excessive expenses and limited availability of roof areas for implementation methods. The interpretation of the results pertaining to floor space should be revised, as there is evidence of low energy consumption in structures that were expected to have high energy usage. In addition, the energy performance certificate (EPC) could be enhanced to increase its value, incentivising developers and homeowners to invest in energy-efficient buildings. Expanding the certificate (EPC) principle to older buildings is imperative, as many of these properties lack methods to decrease energy use.

Regulatory bodies should guarantee that all newly constructed structures meet the fundamental criteria. The results suggest a lack of enforcement of regulations pertaining to individuals who do not meet the minimum requirements, which causes a disparity in property values when efficiency is considered as the common metric. Greater compensation should be allocated to developers and households whose investments yield high scores, corresponding with the value of their investments. The classification of buildings was another topic of discussion. The BCA aimed to standardise the process and employ a dual-penalty and incentive strategy, whereby proactive measures were rewarded, and those failing to satisfy the minimum requirements were penalised. It is critical that the new set of national building codes be issued immediately, accompanied by extensive training for contractors and assessors.

Implementing education initiatives for workers and upgrading buildings with high-efficiency equipment can result in significant cost savings. However, integrating smart systems and cutting-edge controls can revolutionise energy usage in private and public sector buildings. Advanced building management systems, supported by secure Internet of Things (IoT) devices and predictive analytics, have the potential to transform even older buildings into truly energy-efficient structures.

Smart systems driven by analytics can reduce energy consumption in several ways:

They can automatically adjust lighting and HVAC functions based on occupancy, season, operating hours, and indoor air quality.

They can analyse historical energy usage to identify trends and areas for improvement, utilise advanced fault detection and diagnostics to identify equipment performance issues, and objectively track progress toward energy efficiency goals.

They can impact smart technologies on energy efficiency. By partnering with energy service companies, it achieved significant energy consumption reductions in its buildings. Integrating building controls with occupancy patterns exceeds the energy reduction target. The success of projects lies in the holistic approach to system integration, which allows for the coordinated control of lighting. These systems conserve energy and provide valuable insights into energy usage for proactive maintenance.

Referred to as "deep retrofits", these projects showcase the potential of leveraging technology to enhance energy efficiency in both private and public sector buildings. In addition to immediate benefits, investing in smart building management systems promises long-term advantages, including economic growth, environmental protection, and the advancement of smart city initiatives.

7. Recommendations

The research emphasised the need for a comprehensive restructuring of existing evaluation methods, enhanced regulations, and the integration of smart technologies to foster sustainable development and energy-efficient building practices in Malta.

- Need for Enhanced Energy Performance Certificates (EPCs): The study highlighted the potential for enhancing EPCs to increase their value and incentivise investments in energy-efficient buildings. Suggestions included expanding the scope of EPC principles to older buildings and revising interpretations of the results to accurately reflect building performance.

- Enforcement of Regulations: There was evidence of a lack of enforcement of regulations, leading to disparities in property values based on energy efficiency metrics. Regulatory bodies were urged to ensure that newly constructed structures meet the fundamental criteria, and greater compensation was suggested for developers and households investing in high-scoring energy-efficient buildings.
- Integration of Smart Building Technologies: The study underscored the importance of integrating smart systems and cutting-edge controls to revolutionise energy usage in both private and public sector buildings. Advanced building management systems, supported by secure Internet of Things (IoT) devices and predictive analytics, were identified as promising avenues for achieving significant energy consumption reductions.
- Potential of Deep Retrofits: Projects referred to as "deep retrofits" were highlighted as showcasing the potential of leveraging technology to enhance energy efficiency in buildings. These projects not only offer immediate benefits but also promise long-term advantages, such as economic growth, environmental protection, and the advancement of smart city initiatives.

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