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Smart Readiness Indicator: Ready for Business? Evidence from a Northern EU Country

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Abstract: This paper aims to evaluate how well the increasingly popular, market-based real estate energy efficiency improvement projects support the EU's high-level smart energy transition targets. The implications of these EU-level targets for buildings are described in the smart readiness indicator (SRI) framework. As the SRI becomes mandatory, it is important for the industry to understand whether current market practices align with the SRI framework. This study is based on a qualitative analysis of 49 energy efficiency improvement project proposal reports for properties located in Finland. We use the SRI framework to evaluate the potential impact of the various energy efficiency improvements proposed in the reports on the smart energy transition targets. Three expert interviews were also conducted to gain the interviewees' interpretations of the industry. While energy efficiency improvement projects are obviously aimed at improving energy efficiency, the results indicate that they are beneficial for some parts of the SRI, mainly within the SRI's main categories of heating, controlled ventilation, and monitoring and control. Some proposed actions also contribute to increased smart readiness in the categories of cooling and lighting, but the remaining four main categories are generally not being taken into consideration.

Keywords: smart readiness indicator (SRI); energy efficiency improvement; smart buildings; smartness

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1. Introduction

The imperative to achieve carbon neutrality by 2050 is a paramount global objective in response to the escalating challenges of climate change [1]. Building stocks remain a substantial contributor, however, accounting for nearly 40% of total energy consumption in the European Union (EU) and more than one-third of carbon emissions generated in the EU [2]. Addressing this challenge necessitates a significant focus on the existing building stock to align with these objectives.

Several regulatory frameworks and incentive mechanisms have been devised to bolster efforts toward these goals. Within the EU, a marked emphasis is on advancing the smartness and energy efficiency of buildings. This emphasis to increase buildings' smartness has notably been manifested in various EU directives, such as the amended Energy Performance of Buildings Directive (EPBD) [3]. In this directive, a new instrument called the smart readiness indicator (SRI) was introduced as an energy efficiency assessment to promote smartness in the building sector [4]. The European Commission has recast the directive and prepared a delegated act mandating SRI application in large non-residential buildings by 2027 [2]. Smart readiness and energy efficiency are relatively straightforward goals to integrate into the legislative processes governing new construction projects. But if the goals of the SRI are integrated solely into the process of new construction projects, disregarding the existing real estate stock, then the benefits attained through regulation will remain significantly lower than their full potential. The EPDB emphasizes that by 2050, all buildings should be zero-emission structures. Currently, 75% of EU buildings have poor energy performance [2]. An important question revolves around the strategies and mechanisms for retrofitting and increasing the smart readiness and energy efficiency of this pre-existing infrastructure.

Energy efficiency improvement investments are well known to be a primary market-based vehicle to drive energy efficiency and to reduce the carbon footprint in existing building stock. In their strategic work, property investors often worry about raising operational costs as well as energy prices and frequently consider actions to cut energy consumption [5]. Investments in energy efficiency improvements typically align with long-term maintenance renovations of technical building systems, especially once their technical lifespans approach their conclusion. The impact of energy improvements can be easily measured and monitored and can translate into real economic savings, not only through decreased operating expenses but also in the increased value associated with higher property level revenues [6]. Hence, investments in improving energy-saving efficiency can be viewed as a business-driven practice aimed at reducing energy costs. Investments aimed at improving energy efficiency have been the subject of extensive research, with ample evidence demonstrating their value across numerous cases [7]. Previous studies indicate that energy efficiency investments provide tangible value to property owners, revealing true market demand and thereby promoting the achievement of climate goals. In the EU, energy efficiency has also been encouraged through energy certificates. But mere improvement in energy efficiency will not suffice in the future as society aims for carbon neutrality. Achieving carbon neutrality requires not only reducing energy consumption but also targeting overall energy consumption for those days and times of the day and year when renewable energy is readily available (in other words, "demand-side management practices"). The SRI measurement was developed to support this goal and is intended to be integrated into energy certificates [8]. While energy consumption decreases through the investments that are made, the extent to which these measures are congruent with the elements and smart readiness categories delineated by the SRI remains unclear, as is the question of whether they promote the goals of the EPBD and the desired flexibility in consumption mentioned above. If, in addition to reducing energy consumption, flexibility could be effectively increased, then it should be included in energy efficiency projects and in the abovementioned long-term repair planning.

The aim of this paper is to evaluate how various highly popular energy efficiency improvement practices support the EU's smart energy transition targets in real estate. To this end, we use the EU-based SRI framework to assess the smart readiness influence of proposed energy efficiency projects. In general, "smartness" refers to a building's capability to sense, interpret, communicate, and actively respond efficiently to changing conditions. This concept encompasses the operation of technical building systems, the external environment (including energy grids), and the demands from building occupants [9]. The SRI divides smartness into nine main categories: heating, domestic hot water, cooling, controlled ventilation, lighting, dynamic building envelope, on-site renewable energy generation, electric vehicle charging, and monitoring and control. This paper makes a valuable contribution to the existing body of research on smartness by offering an in-depth analysis of a recent dataset that illuminates the prevailing market dynamics and behaviors.

The findings indicate that the greatest increase in smartness has been observed in the proposed energy efficiency actions within the main SRI categories of heating, controlled ventilation, and monitoring and control. While cooling and lighting also encompass some proposed actions that contribute to increased smartness, the remaining main categories are generally not being taken into consideration. Energy efficiency improvements are mainly undertaken to renew building systems and to reduce overall energy consumption and operational costs. Other objectives of the SRI, such as the adaptability to the requirements of the energy grid and building occupants, are not currently emphasized, and progress through prevailing business-driven market practices at most when mutual benefit with energy efficiency is achievable. If this trend persists, there is a significant risk of missing out on substantial opportunities to integrate these smart features during routine renovation cycles in the existing building stock.

This research is based on an empirical investigation in which we utilized a dataset comprising 49 energy efficiency improvement inspections conducted within the Finnish real estate market. The data were subjected to rigorous analysis, then further bolstered by insights derived from interviews. These interviews were conducted with energy efficiency specialists with responsibility for conducting inspections.

2. Materials and Methods

The fundamental basis of this paper is a detailed evaluation of 49 reports on energy efficiency improvements. All the properties inspected in the reports are located in Finland. The primary objective of the analysis was to comprehend how existing project proposals for energy efficiency improvements incorporate the concept of "smartness", as delineated by the SRI. To achieve this objective, the actions outlined in the reports were categorized according to the main SRI categories, which sort smart readiness into heating, domestic hot water, cooling, controlled ventilation, lighting, dynamic building envelope, on-site renewable energy generation, electric vehicle charging, and monitoring and control [9]. The analysis was supported by expert interviews to enhance the overall understanding of the data and the topic under consideration and consequently to reinforce the conclusions drawn in the study.

2.1. Data Collection

The main dataset comprises energy efficiency improvement reports conducted by energy advisors on behalf of property owners. The aim of these reports is to identify opportunities for improving the overall energy performance of a given property through investments in replacing and improving existing building technology. Energy advisors visit properties to familiarize themselves with the current conditions of the property and its building technology. In the reports, they can provide proposals for renewing building technology systems, suggest smaller adjustments, and recommend the installation of additional sensors, to name a few examples. The advisors then make calculations to estimate energy savings, CO_2 reduction, and the financial implications of these proposed actions.

The original dataset contained 54 reports, although 5 reports were excluded because they focused on specific predefined technologies and aspects of energy efficiency rather than providing a broader, comprehensive examination. The data include reports from 7 different companies that provide energy advisory services, resulting in identifiable differences in their presentation styles. Some reports have a more engineering-oriented approach, while others were significantly more crafted for marketing purposes: the proposed measures were also packaged and presented more clearly. In terms of technical content, the reports were not very different—all addressed the content related to the research topic. The inspections were conducted between 2016 and 2023. The properties inspected represent various types and sectors, which are presented in Table 1.

The reports for this study are complemented by interviews with three energy advisors involved in some of these inspections and in report generation. These advisors actively engage in discussions with property owners and asset managers to define the objectives and scope of the inspections. The selection of advisors for interviews was based on their expertise and availability. The interviews were conducted using a qualitative interview method. The purpose of qualitative interviews is to gather data from the study subjects. During interviews, interviewees provide information, while the interviewer, as a representative of the study, directs the conversation toward topics relevant to the research [9].

Table 1. Distribution of properties inspected in the reports by property type.

Type	**N**	**%**
Offices	21	43
Residential	8	16
Logistics and warehouses	6	12
Shopping centers	6	12
Education	4	8
Hospitals	3	6
Hotels	1	2
Total	49	100

The interview questions were formulated based on insights from the report analysis and feedback received from the co-researchers. These questions were purposefully crafted to validate the analysis and facilitate a nuanced comprehension of the reports. They were designed to extract meaningful insights and perspectives on the overarching concept of smartness (Questionnaire S1 in Supplementary Materials). Quotations from the interviews are used to support the findings of the qualitative study of the project reports and are presented in the results alongside the findings for each relevant main category.

The interviewees were informed in advance that the background material for the interviews consisted of energy inspection reports, some of which they had been responsible for or were involved in drafting. Additionally, the interviewees were informed that the interview would also address the smartness of properties in general, but they did not have access to the actual interview questions prior to the interview. The interviews initially included questions about smartness and energy audit practices, after which the discussion progressed to cover the topic according to the main SRI categories. Additional questions related to each category were asked, as were clarifying questions about the interpretation of the data. The interviews were conducted in January 2024.

2.2. Analysis

The analysis was conducted as desktop work without visiting the properties mentioned in the reports. The observations within each main category were divided into four classes (A–D) to clarify how and whether the proposed energy saving actions and measures contributed to the SRI rating and to discern which main categories would see an increase in smart readiness due to the proposals. Each main SRI category in every report was evaluated independently. The results were primarily analyzed qualitatively to identify any differences between the main categories rather than to detect exact differences in the number of observations. The classes are described in Table 2.

Table 2. Descriptions of classes A–D used for classifying observations.

	Description
Class A	Actions that increase smart readiness as defined by the SRI.
Class B	Actions that enhance energy efficiency, but do not contribute to increased smart readiness, for example, upgrading lighting to LED without incorporating presence sensors.
Class C	The main category is noted in the report, but no actions are presented. The measures are deemed unfeasible either due to economic or technical constraints, they are unnecessary as a result of recent repairs, or they are not proposed for other unknown reasons.
Class D	The main category was not acknowledged in the report.

The increase in smart readiness and the recording of observations into Class A were assessed for their effects on the subcategories of each main category. This logic is illustrated through examples in Table 3.

Table 3. Examples of criteria for classifying observations into Class A.

Main Category	Examples of Proposed Actions	Impact in Service Groups
Heating	Hybrid solutions and waste heat utilization	H-2, control heat production facilities
Heating	Adding sensors and integrating building automation	H-1, heat control—demand side
Heating	Participation in district heating demand response	H-4, flexibility and grid interactions
Controlled ventilation	Time, presence, and CO_2 concentration-based control for ventilation systems	V-1, airflow control
Controlled ventilation	Adding control units and sensors and investing in equipment that facilitates smarter control and adjustment	V-2, air temperature control
Lighting	The installation of light sensors and presence sensors alongside time schedules to support the control of lighting	L-1, artificial lighting control L-2, control artificial lighting power based on daylight levels

Although the study did not specifically focus on differences between property types—and the sample was not sufficiently large for accurately identifying these differences by property type—we conducted an analysis of how the findings were distributed across property types with respect to smart readiness-improving measures (Class A). The aim of this was to provide a preliminary indication that differences between property types can be observed in certain main categories.

To refine the analytic process, three reports were selected as the basis for a pilot study. A pilot study is important for improvement of the quality and efficiency of the main study [10]. For the pilot study, the dataset was initially reviewed with the aim of identifying somewhat varied reports containing a sufficient number of observations across different main categories. This approach was intended to allow for adequate testing of the chosen method's effectiveness based on the pilot results, ensuring that all classes created to categorize observations were also covered. The pilot study was audited collaboratively with a co-researcher to ensure investigator triangulation. This approach involved multiple researchers independently analyzing the same data to identify patterns, inconsistencies, and varying interpretations. The procedure was implemented to ascertain uniform comprehension of the results, thereby bolstering the validity and reliability of the analytical outcomes [11]. Considering the findings derived from the pilot study and the feedback received from the co-researcher, certain adjustments were implemented prior to delving into the remainder of the dataset. For example, concerning proposals related to controlled ventilation, in this context, we clarified that if some measures increased smart readiness while others did not, then the scoring for that particular report would be apportioned between the two classes approximately based on an investment-weighted criterion. The same logic was also applied (for example) in the main category "lighting" when the proposals in a report included upgrading the lighting to LEDs (Class B), but the addition of presence control (Class A) was proposed only for certain areas. Following the comprehensive analysis of the entire dataset, a subsequent iteration of investigator triangulation was undertaken. The results then underwent thorough examination, and essential interpretation guidelines were established.

The interviews were recorded and transcribed using summarization and selective transcription, omitting irrelevant details and repetition to focus on key points and themes. Responses were categorized according to the main SRI categories, distinguishing general comments related to property smartness to target the most useful content for report analysis. The interviews contributed to this analysis by providing a holistic understanding of the topic, but also served to enhance methodological triangulation by allowing for the cross-verification of information from diverse perspectives and sources [12].

3. Results

The findings of this study are presented in Figure 1, which delineates the distribution of proposed actions into main categories and classes of observations. In each report, all main categories were reviewed and one observation point was assigned to each main category, although this point could be divided among the classes within the main category, as described in the methodology. The total number of observation points for each main category was 49, corresponding to the number of reports we reviewed. The main categories in the figure are ordered by the number of proposals aimed at increasing smart readiness. The category with the most such proposals appears first. Each main category was subsequently examined independently in greater detail and elucidated with insightful quotes derived from the interviews.

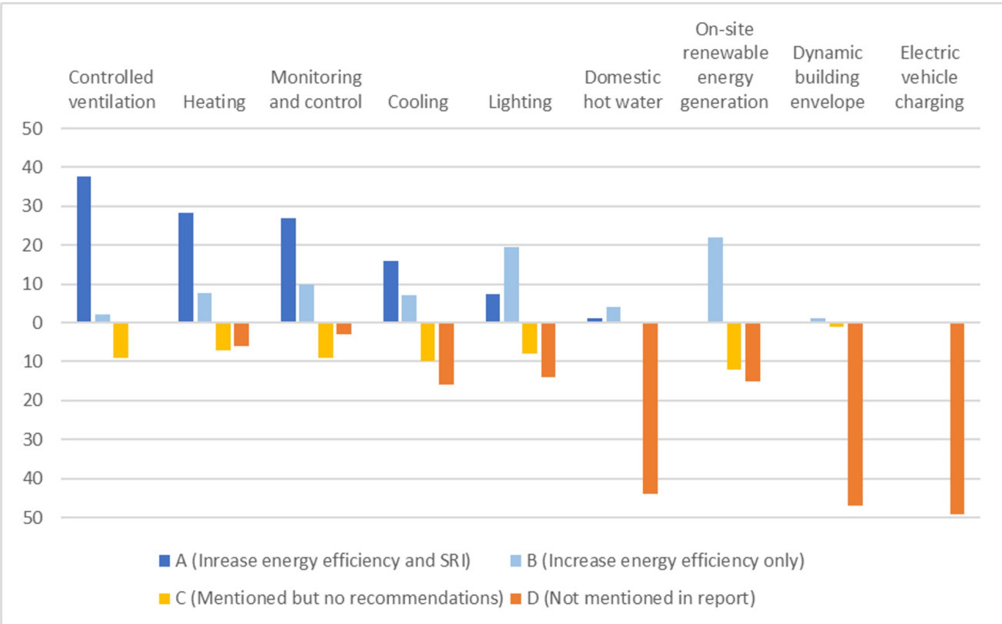

Figure 1. The distribution of proposed actions in the reports into classes A–D in each main SRI category.

The greatest increase in smart readiness was observed in proposed energy efficiency actions within the main categories of heating, monitoring and control, and controlled ventilation. While cooling and lighting also encompass some proposed actions that contribute to increased smart readiness, the remaining main categories are not typically being taken into consideration.

Some observations on the energy use of properties involved matters outside the main categories, such as the defrosting of walkways and ramps. Previous studies have pointed out that the SRI lacks certain cold-climate, country-specific technologies [4]. As expected, the reports focused on identifying improvements in energy efficiency and thereby finding cost savings, while the perspective of property occupants was sidelined. Some of the interviewees pointed out that if indoor air conditions were unsatisfactory or if certain devices were not functioning, they would propose necessary actions, although the main focus of the inspections would remain on energy efficiency and cost savings. Previous research has identified economic factors as the main drivers of decisions on energy efficiency investments [12].

Variations in the increase in smart readiness across the main categories were easily discernible, although variations in the distribution of observations within specific main categories may stem from different causes. For example, cooling is not common in all types of properties in the target country, and for this reason, fewer proposals are aimed at increasing smart readiness in this main category compared to heating or ventilation, for instance. Certain main categories, such as lighting and on-site renewable energy generation, may allow for energy-saving actions without increasing smart readiness, whereas others necessitate smartness to achieve energy savings.

Class D is somewhat different from the other classes, as such categorization means that the SRI category was not discussed in the report. It was not always clear whether the main category had not been considered at all or whether it had been considered, but no action proposals were found, and this situation was simply left undocumented. This ambiguity was addressed through interviews, and the related comments are presented in connection with the lighting results. Through the interviews, this ambiguity was partially resolved, although such resolution was not crucial to the results because the primary focus was on determining the main categories where smart readiness specifically increased.

Figure 2 shows the proportion of reports for each property type that included smart readiness–increasing measures within the main categories where such measures were presented.

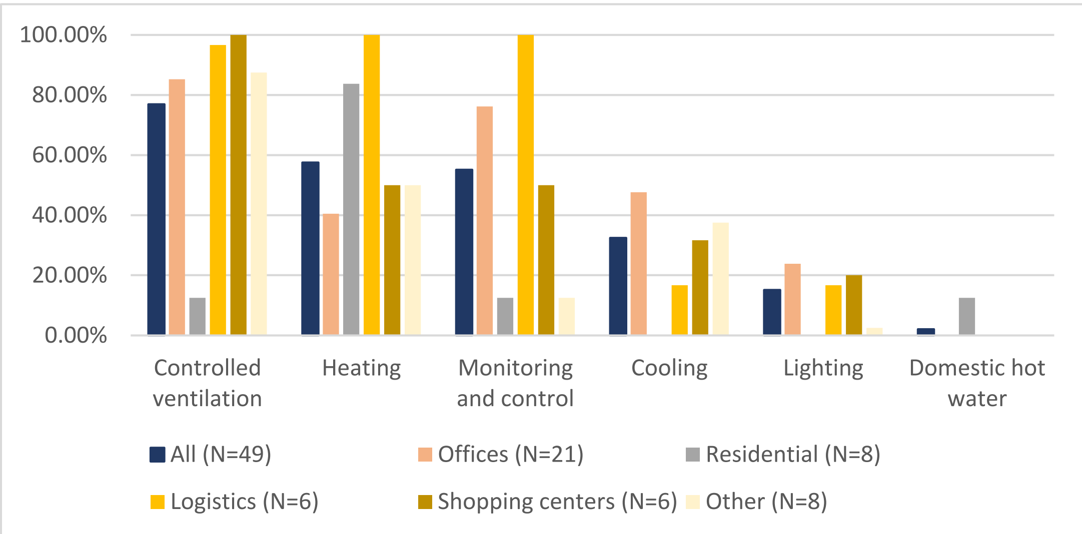

Figure 2. The proportion of reports for each property type that included measures to increase smart readiness.

Far-reaching conclusions about the differences should be avoided, given that the samples for different building types are small. However, differences can be observed, and particularly the difference between residential properties, where smart readiness–increasing measures were primarily suggested for heating, and other types, where the proposals are more evenly distributed, merits further investigation in the future. Moreover, in logistics properties, energy efficiency measures related to heating and monitoring and control, which improve smart readiness, appear to be more prominent.

Below, we present our key findings for the main SRI categories. At the end of our analysis in each category, we also provide the observations collected from our expert interviews and how they enhanced the overall understanding of the data and topic under consideration.

3.1. Controlled Ventilation

The main category "controlled ventilation" emerged as the most focused area from an energy efficiency perspective and was noticeable in all reports. This category also received the highest level of actions that supported the addition of smart readiness. Similarly to heating, market-driven energy efficiency and smart readiness appear to converge in this main category based on the results. Class A proposals included adding control units and sensors, and they involved incorporating time and presence control, as well as the CO_2 concentration–based control of ventilation machines.

> "Measures to enable demand-based ventilation are the most profitable and effective energy efficiency actions, alongside investments in heating". (Interviewee 2)

Based on the interviews, at a certain point, increasing the smart readiness of controlled ventilation encounters a conflict between the owner's interest and the tenant's needs. Some of the interviewees pointed out that, for example, cost-effective solutions involved floor-level adjustments, but from the tenant's perspective, having adjustments on a smaller scale might be preferable. Interviewees also noted that more precise control required additional sensors, which in turn necessitated additional investments and might require maintenance. In addition to these long-established techniques, various machine learning algorithms can already be used to enhance occupant-centric control by accurately predicting occupants' presence and behavior, thereby optimizing energy efficiency without compromising comfort [13].

Total system renewal for ventilation, encompassing the aforementioned actions, was also considered in the reports. The action of solely renewing the air blowers of ventilation machines initially lacked clarity regarding the approach's contribution to increased smart readiness. The interviewees did emphasize, however, that such renewal generally enables easy fan speed control, a crucial element for smart readiness. The interviewees noted enhancing the sealing of blowing chambers and making smaller adjustments as actions that would not contribute to an increase in smart features (Class B). Findings in Class C indicated that ventilation renovations had already been completed. In certain residential properties where the main category was considered, no propositions were identified to enhance either energy efficiency or smart features.

3.2. Heating

Within the main category of "heating," we identified proposals that contributed to increased smart readiness (Class A) in slightly more than half the reports. The interviewees also highlighted this category.

> "The smartness of the property is crucial in heating, as a significant amount of energy is consumed in cold-climate countries". (Interviewee 1)

Actions deemed to increase smart readiness included the replacement of oil heating with an air-source heat pump and a bio-oil heater hybrid solution, participating in district heating demand response, the use of residual heat from cooling equipment, the addition of sensors, and the integration of these sensors into a building's automation system. Previous studies have pointed out that heat pumps can be highly profitable and that district heating companies should revise their pricing models to compete and to enable hybrid solutions [14]. The interviewees supported this conclusion, also revealing that negotiations on these matters were already underway. They highlighted the smartness required for hybrid solutions.

> "The utilization of multiple heating methods requires an increase in smartness, as the devices need to be coordinated". (Interviewee 3)

The actions proposed in Class B encompassed activities such as balancing hydronic radiators, making basic adjustments to heating systems, and adding radiators to spaces that had recently experienced cold conditions, according to tenant feedback. While observations in Class C centered on the consideration of using geothermal heating, these proposals were not set forth due to the location of the properties: the sites were situated on plots that did not permit the drilling of an adequate number of energy wells required for the implementation of a geothermal system.

3.3. Monitoring and Control

In the main category of "monitoring and control", slightly over half the reports we analyzed incorporated measures to increase smart readiness (Class A) in the property, and the interviewees highlighted the role of building automation.

> "The role of building automation is significant". (Interviewee 1)

> "[Building automation] parallels the smartness of the property". (Interviewee 2)

The proposed actions encompassed activities such as the replacement of outdated building automation systems or individual automation substations, the integration of multiple building technology systems into building automation that had not been previously connected, and the addition of sensors to facilitate smarter control of the building automation system. Installing new technologies in existing properties and the need to optimize the existing systems to interact with such new technologies can lead to technical challenges, however [15]. The interviewees also referred to this topic in the justification for the proposed building automation replacements.

> "The implementation of smart control methods often requires the renovation of building automation, as it may not be possible to implement [such automation] in old devices, even if they still have some technical lifespan left". (Interviewee 1)

Some of the interviewees, however, did mention that even with smaller changes, significant energy savings could be achieved. Optimizing the investment in building automation is crucial, and, for example, coordinating cooling and heating is essential for achieving the most significant cuts in energy costs. On the other hand, the interviewees deemed that increasing smart readiness to achieve every possible minor savings was not economically justified. They also noted that proposals could even lead to conflicting solutions. In some situations, advisors may propose having room-specific cooling controls implemented in building automation, but they may not suggest heating to be controlled accordingly. The reason they cited was once again the costs involved, since the smarter solutions can be expensive to implement. They emphasized that the data collected through building automation can control almost everything related to a property's use. In energy efficiency projects, most building technical systems are meant to be connected to building automation, provided they are not already connected, although the interviewees did note that exceptions can occur.

Proposals in Class B encompassed the addition of sensors dedicated to a specific building technology system, such as ventilation. Other suggestions involved rectifying erroneous information and set values in the building automation system, along with making small-scale adjustments. Several reports conducted for residential buildings took building automation into consideration (Class C), but they put forward no specific proposals. The rationale behind this absence remains unclear, especially in cases where some properties lacked a building automation system altogether.

3.4. Cooling

Approximately one-third of the reports featured proposals for adding smart readiness (Class A) to the main category "cooling". The increase in smart readiness was not explicitly outlined in all reports, but the consensus was that the new technology inherently possessed greater smart capabilities than the older counterparts. This conclusion was validated in the interviews.

The majority of these propositions explored the upgrading of cooling systems, including the renewal or substitution with air-source heat pumps or air–water heat pumps. In interviews discussing the smart readiness of cooling, the interviewees usually brought up heat pump solutions. These solutions not only provide cooling but also enable heating during the winter season, which they saw as cost-effective solutions in cold-climate countries. They also mentioned control methods such as temperature limits. They considered adjusting the inlet water temperature of the cooling network based on outdoor air to be uncommon due to the relatively small savings potential, even though it could be a sensible approach. They also highlighted the role of building automation as a coordinator and in the smart control of cooling.

> "Smartness of cooling, in the form of building automation, is needed to control both cooling and heating, to avoid overlapping". (Interviewee 3)

Proposals under the class of not increasing smart readiness (Class B) encompassed actions such as the replacement of valves, the introduction of independent air-source heat pumps to enhance indoor conditions in specific smaller areas, and the cleaning of condensers.

3.5. Lighting

In the main category of "lighting", we identified several propositions for adding smart features (Class A). These proposals all involved the addition of presence sensors to control lighting by either switching it off or dimming it, aligning with the occupants' needs. All interviewees identified the potential of these smart readiness–increasing actions in lighting investments, but the proposals in the reports mostly included measures that lacked a smart readiness–increasing impact. Propositions in Class B involved considering the replacement of old lights with LED lighting. The interviewees assessed reasons for non-smart investments.

> "The greatest savings were expected to come from these simple renewals". (Interviewee 2)

Interviewees mentioned conflicts between the payer of the investment and the recipient of the benefit in situations where the tenant pays for the electricity. They revealed that in office buildings, the tenants' spaces might not even be examined for this reason.

In Class C, the entries in the reports indicated that LED replacement had already been implemented in these properties, but considering the observations in reports in Classes C and D, the interviewees may have handled situations differently in cases where the property already had modern lighting. One interviewee noted the importance of recording these data in the report (Class C), while another stated that such information might go unmentioned in the absence of improvement suggestions, which could partly explain the significant number of observations related to Class D.

3.6. Domestic Hot Water

The main category "domestic hot water" received minimal consideration in the reports. The interviewees assessed that the prevalent district heating network (which provides an efficient way to heat domestic water) and local regulations requiring high temperatures for domestic water to prevent the spread of *Legionella* bacteria were the main reasons. Due to the broad district heating system in the target country of this study, researchers have questioned the relevance of this main category in cold-climate countries such as Finland [4]. One report suggested introducing smart readiness (Class A) by utilizing waste heat from other systems to heat water. Reports suggested a few Class B proposals, such as adding decompression valves to reduce water usage and incorporating a domestic hot-water circulation pipe to minimize heat wastage. The majority of the reports did not address domestic hot-water considerations, and neither of the two interviewees estimated significant potential.

> "Advancements in technology, such as new air-source heat pumps, may enable alternative solutions, but significant changes are not currently foreseeable". (Interviewee 3)

3.7. On-Site Renewable Energy Generation

The main category "on-site renewable energy generation" was addressed in two-thirds of the reports, and propositions to add photovoltaic solar panels were present in almost half of them. No smart solutions were suggested, however, since increasing smart readiness in the main category would require installing energy storage systems. While the omission of adding energy storage systems was not explicitly stated in the reports, the inference was that these actions typically do not involve the addition of energy storage systems. We drew this conclusion based on market-practice awareness from this study and validated it through comments gathered from the interviews.

> "It is generally more cost-effective and economically secure to design a system to be sized so that all the electricity is used on-site rather than participating in the reserve market". (Interviewee 1)

The matter was not clearly presented in the reports, but through the interviews, we found that solar panel systems are rarely connected to building automation. The interviewees considered these systems to operate independently, and as mentioned earlier, although there is a general desire to invest in solar power plants, smart solutions to doing so have received little attention. The findings in Class C included observations indicating that solar panels were deemed financially or technically unfeasible in the given property, or they have already been installed or are already planned to be installed. This information is not always documented, which may lead to inaccuracies in observations between Classes C and D.

3.8. Dynamic Building Envelope

In the main category of "dynamic building envelope", only two considerations involved protecting against solar overheating. These considerations were not categorized as smart solutions: one report suggested the addition of solar-protecting films to windows, while the other did not recommend such measures. The reason that one interviewee provided was the geographical location.

> "The perceived benefit of protection against solar heat is small and financially unprofitable". (Interviewee 2)

3.9. Electric Vehicle Charging

The main category "electric vehicle charging" did not feature any proposals in any of the reports we analyzed. Interviewees mentioned that this was because the assessments are generally conducted to reduce energy consumption, which is not promoted by this measure, although one interviewee did state the following:

> "[Electric vehicle charging proposals] were occasionally considered in the reports at the request of the property owner when I worked for my previous employer". (Interviewee 2)

4. Discussion and Conclusions

In this paper, we have aimed to evaluate how various highly popular energy efficiency improvement practices support the EU's smart energy transition targets in real estate. To achieve this goal, we used the EU-based SRI framework to assess the smartness level of several proposed energy efficiency improvements. Through our examination of a comprehensive dataset collected from real business environments, the study's results provide an interesting opportunity to identify potential conflicts between market-driven energy efficiency improvement practices and the smart building stock objectives promoted in the EU. Considering the extent of the data in our research, the results of this study are generalizable, at least to countries with similar climate conditions to Finland's. The results will contribute to smart readiness research and will provide an understanding of which aspects of smart readiness, as measured through the SRI, seem to be progressing through various proposed energy efficiency improvement projects and which are not. Because the reports are only project proposals, however, we cannot definitively state how many of these proposals will actually materialize into projects and to what extent the embedded smart readiness will be realized in practice.

The greatest increase in smart readiness was observed in the proposed energy efficiency actions within the main categories of heating, controlled ventilation, and monitoring and control. While cooling and lighting also encompass some proposed actions that contribute to increased smart readiness, the remaining main categories are generally not being taken into consideration. Energy efficiency improvement project proposals, in line with the goals of the SRI, promote energy efficiency, as their name suggests. Other SRI objectives, such as to adapt to property occupants and electricity grid flexibility, are typically overlooked in most proposals, and progress mostly only if mutual benefit with energy efficiency is achievable.

Smart readiness from the occupants' perspective could plausibly increase as a result of these proposals, especially when they align with improvements in energy efficiency, but improving occupants' conditions is not an objective and has received little attention. Based on this study, we cannot conclude that no investment in smart readiness from the perspective of occupants' needs will occur due to the research design and the data we used. The energy efficiency projects, and the long-term maintenance repairs may not even be the path through which the smart readiness of properties progresses from the occupants' perspective. Other possible routes include tenant improvement projects and extensive renovations, but related data were not examined in this study. Examining investments in smart readiness from the occupants' perspective would require a different research design and could be an intriguing topic for further research. But property owners, service providers, and other stakeholders can still benefit from the results of this study by gaining a better understanding of the areas of smart readiness that are not progressing through energy efficiency improvement projects and thus require separate measures.

The progress of energy efficiency goals depends partly on the recipient of the benefits. Energy efficiency inspections may not necessarily cover the entire property, and some investments may not be included in the proposals and could remain undone if the benefits primarily accrue to the tenant. In terms of carbon neutrality goals, the situation becomes problematic when energy efficiency inspections do not focus on improving the overall energy efficiency of the entire property, since conflicting interests may lead to the partially unrealized potential of energy savings. Investments that would contribute to the SRI's goal of property participation in electricity grid flexibility did not emerge in the data we examined. The reasons assessed in the interviews were that energy storage systems have been too expensive until recently, and participation in reserve market activities was generally not considered to be commercially viable. In addition, the interviewees pointed out the existence of regulatory requirements and restrictions on placing energy storage systems in a property, which can make such systems difficult to implement in some cases. The interviewees noted that widespread adoption of energy storage systems would require further price reductions and better predictability in electricity pricing. Previous studies, however, have pointed out that investments in energy storage systems can be profitable [16].

Integrating smart readiness sufficiently into long-term property maintenance repairs would be beneficial, since such repairs can provide a natural investment pathway in systems that increase smart readiness. A different energy efficiency inspection concept, or rather a smart readiness inspection concept, could also advance the more comprehensive achievement of smart readiness and could incorporate grid flexibility and occupants' needs into the investment cycle. Doing so would require the abovementioned predictability in electricity prices, however, and the tenants of properties (and consequently their owners) being willing to pay for smarter spaces. For the conclusions of the research, it is important to recognize that the increase in the smart readiness of existing real estate stock may also progress through market mechanisms other than energy efficiency investments. Various environmental certifications (e.g., BREEAM, LEED, WELL) are sought for properties, and improvements are made to raise the level of these certifications, which can also contribute to enhancing the smart readiness.

The research design demonstrated effectiveness, particularly in the identification of action propositions within the main categories of the SRI, and the allocation to classes A through D appeared to be appropriate. While some propositions were challenging to classify, the use of investigator triangulation and interviews proved beneficial in resolving such cases. The interviews helped to reinforce interpretations about whether a proposed action would increase smart readiness, but also to understand the inspection process and its impact on the proposed solutions, the rationale behind the proposed solutions, and the reasons for differences between the main categories. Through this approach, the interviews reinforced various assumptions and conclusions about why certain energy efficiency or smart readiness solutions, such as presence-controlled lighting, are not always proposed for implementation.

Although the study provides a comprehensive overview at a general level of the main categories in which smart readiness increases as a result of energy efficiency projects, it does not quantify the precise impact of these projects on SRI scoring. A more detailed evaluation of this effect would require measuring the SRI scores of the case properties and comparing the impact of the measures on the scoring. A quantitative assessment of this impact, for instance, through a multiple-case study, would represent a logical and scientifically grounded direction for future research.

The sample size of the study was comprehensive and included proposals across various property types, although this variation poses a challenge for making precise conclusions, since certain differences between the main categories may stem from property type–specific variations, as described and presented in the results section. For example, the role of building automation is minor and cooling systems are not commonly used in residential properties within the target country. This scenario partly influences the outcomes compared to one where only office buildings are examined. In this light, it is important to note that in the SRI assessment itself, the main categories that are not represented in an evaluated property are disregarded in the assessment. Although the property type–specific results were presented in an indicative manner, the sample was not large enough to reliably identify and compare property type–specific trends within the dataset either. For future research, it would be interesting to conduct a similar comparison focused on a specific property type, such as office buildings, since property types differ in terms of installed technology and the needs of the occupants using the properties. Research along these lines has already been conducted, and a potential need for adapting the SRI methodology to different property types has also been highlighted [17].

All study subjects were located in Finland in a cold-climate zone, which partially influences the generalizability of the results, as different climatic conditions prioritize different aspects of property energy efficiency and smart readiness. Simultaneously, this influence underscores the challenges of implementing the SRI in the study's geographical area and prompts consideration of whether all the main categories of the SRI, such as the dynamic building envelope, merit investment in Finland, potentially diverting resources from other more energy-efficient investment options. Previous researchers have questioned the feasibility of the SRI in cold-climate countries [4]. On the other hand, similar challenges related to the SRI have also been observed elsewhere [18].

The results of this study bring up further considerations about the measurement methods of the SRI and the guidance provided by its results. Most of the reports we examined either proposed or at least evaluated the use of solar energy, which can be seen as desirable from the perspective of climate goals, even if the solar energy system is not smart. But the SRI measurement is unforgiving for these non-smart investments into renewable energy, since they lead to low scores, whereas the absence of this technology results in the main category not being considered in the measurement and therefore leads to higher total scores. In previous research, it has also been emphasized that the SRI framework itself would benefit from quantitative elements to enhance its objectivity [19].

The EU aims to provide guidance toward a comprehensive smart approach, but based on these energy efficiency improvement proposals, the market-driven direction for smart readiness appears to be primarily geared toward those main categories and actions that can directly achieve energy and cost savings. If progress in smart readiness in other categories and objectives is desired, modes of encouraging adoption must be considered.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/buildings14113638/s1, Questionnaire S1: Interview Questions.

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