SUSTAINABLE REAL ESTATE: THE INFLUENCE OF SUSTAINABILITY METRICS ON OCCUPANCY RATE IN COMMERCIAL REAL ESTATE

Lappeenranta–Lahti University of Technology LUT

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Supervisor: Chief Digital Officer (D.Sc. Tech.) Lauri Pulkka

ABSTRACT

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Sustainable Real Estate: The Influence of Sustainability Metrics on Occupancy Rate in Commercial Real Estate

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Sustainability has become a critical challenge of our time, impacting industries worldwide. Although several sectors are pushing towards greener solutions, the world is navigating major sustainability challenges. The built environment is responsible for approximately 40 % of all greenhouse gas emissions globally, which pushes property owners and investors to move towards net zero and sustainable property investments. Business activities and decisions are driven by financial profitability, but sustainability has progressively been integrated into strategies, being recognized as long-term value creation.

This thesis focuses on identifying sustainability metrics and assessing their importance within commercial real estate. The main objective of this study is to determine whether sustainable assets achieve higher occupancy rates within commercial real estate.

The study is executed by conducting a regression analysis using Gretl and analysing the relationship between the chosen sustainability metrics and the occupancy rate of 229 assets.

The results suggest that there is not enough evidence to confirm that sustainable assets achieve higher occupancy rates. The dataset would require a higher variety in the sample to receive a deeper understanding on the relationship between the chosen variables.

TIIVISTELMÄ

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Kestävä kiinteistöliiketoiminta: Kestävyysmittareiden vaikutus vuokrattavuuteen liikekiinteistöissä

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Kestävä kehitys on aikamme kriittinen haaste, joka vaikuttaa maailmanlaajuisesti useisiin eri teollisuudenaloihin. Maapallomme kohtaa jatkuvasti haasteita kestävyyden saralla, ja useat sektorit pyrkivät yhä enemmän kestävimpiin ratkaisuihin. Rakennettu ympäristömme on vastuussa noin 40 % kaikista kasvihuonepäästöistä maailmanlaajuisesti, jonka seurauksena kiinteistön omistajat sekä sijoittavat joutuvat siirtymään kohti päästöttömiä ja kestäviä kiinteistösijoituksia. Liiketoimintaa ohjaa taloudellinen kannattavuus, mutta vastuullisuus on integroitu asteittain osaksi yritysten strategioita, ja se on tunnistettu pitkän arvonluonnin keinoksi.

Tämä diplomityö käsittelee kestävyysmittareiden tunnistamisten liikekiinteistöissä ja niiden merkityksen arviointiin suhteessa kiinteistön käyttöasteeseen. Diplomityön tarkoituksena on selvittää, saavuttavatko vastuulliset kiinteistöt korkeamman käyttöasteen liikekiinteistössä.

Tutkimus toteutettiin tekemällä regressioanalyysi Gretl-ohjelmiston avulla, analysoimalla valittujen kestävyysmittareiden suhdetta 229 kiinteistön käyttöasteeseen.

Tulosten perusteella ei ole riittävästi näyttöä vahvistamaan, että vastuulliseksi luokitellut kiinteistöt saavuttaisivat korkeampia käyttöasteita. Aineisto vaatisi suurempaa vaihtelua, jotta olisi mahdollista saavuttaa syvempi ymmärrys valittujen muuttujien välisestä suhteesta.

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May 2026 in Helsinki,

Sonja Arosuo

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ABBREVIATIONS

API	Application programming interfaces
BREEAM	Building Research Establishment Environmental Assessment Method
CSRD	Corporate Sustainability Reporting Directive
CSV	Comma-Separated Value
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
ESG	Environment, Social and Governance
GHG	Greenhouse gas
GOI	Gross Operating Income
gretl	Gnu Regression, Econometrics and Time-series Library
KPI	Key Performance Indicator
LSF	Leasable Square Footage
LEED	Leadership in Energy and Environmental Design
NOI	Net operating income
OER	Operating Expense Ratio
OLS	Ordinary Least Squares
PAI	Principal Adverse Impact
PV	Photovoltaic
ROA	Return on assets
ROE	Return on equity
RSF	Rentable Square Footage
SSR	Sum of Squared Residuals

TWh	Terawatt hours
TJ	terajoule

DECLARATIONS

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The originality of this thesis has been reviewed with the Turnitin similarity checking service.

AI usage

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1. ChatGPT
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2. Grammarly
    a. Purpose of use: To improve spelling and grammar.
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Responsibility

The author, Sonja Arosuo, takes full responsibility for the content of this thesis and has reviewed and edited the content generated by the possible use of AI tools.

1 Introduction

Sustainability has become a critical challenge of our time, impacting industries worldwide. According to the World Wildlife Fund (WWF), over a third of Earth's natural resources have been destroyed by humans in just thirty years – and we keep on consuming them at an increasing rate (Saeed, 2024). Although several sectors are pushing towards greener solutions, the world is navigating major sustainability challenges, such as shortages of energy and resources, climate change and biodiversity loss. Sustainable strategies and solutions are in high demand, especially within the commercial real estate industry. The sector is responsible for approximately 40 % of all greenhouse gas (GHG) emissions globally, directly and indirectly. As a result, the sector is aiming to achieve net zero, which demands major changes within the industry, meaning both new construction and existing buildings (Carlin, 2022).

We spend an average of 90 % of our time indoors, making the built environment a central part of our everyday life (World Economic Forum, 2024). Energy used for construction of new buildings as well as heating, cooling and lighting of existing buildings accounts for over one third of the total energy consumption and emissions globally. To be more specific, building operations account for 30 % of global final energy consumption, 8 % of global direct emissions in buildings and 18 % of indirect emissions from production of electricity and heat used in buildings (International Energy Agency, 2023). Extreme variations in temperature as well as changing weather patterns has an immediate effect on how much energy is being produced, delivered and consumed. In Finland, rising temperatures has led to an average temperature increase by 2.3 °C since the 19th century, breaking temperature records with increased heat waves in the Southern part of the country, but even in Lapland (Finnish Meteorological Institute). According to the preliminary data published by the Statistics Finland, the total energy consumption in Finland in 2024 was 1.29 million terajoules (TJ), which represents a 2 % decrease in comparison to the previous year. Households consumed approximately 21 % of final energy consumption and commercial and public services accounted for 12 % (Statistics Finland, 2025). Given the share of energy consumption and the emissions linked to the built environment, not to mention the signs of climate change have already been noticeable in Finland. As a response to the urgent measures required to correspond to these challenges, Finland has committed to the Climate

Change Act, which has set legally binding targets to achieve carbon neutrality by 2035. The Climate Change Act serves as the cornerstone of Finland's climate policy, focusing on emission reduction targets and carbon neutrality (Hiilamo et al. 2024).

Reducing the environmental impact of real estate is of highest priority. The opportunities are existing but are required to be utilized to their full potential. Investors and property owners are required to invest responsibly by maximizing the positive effects and minimizing the negative effects of properties on the environment, as well as society, while ensuring that the investors' goals are met. Environmentally sustainable investments, such as GHG emission reduction and renewable energy usage, is said to benefit property owners in ways such as increased property value and higher market prices. For a longer period, sustainability has been considered as an environmental movement, but due to the public awareness and increased consciousness, sustainability has become a commercial movement (Bocken et al. 2020).

The real estate market is shaped by various factors, from investment trends to cash flow and urbanization to infrastructure development. However, in recent years, sustainability and environmentally sustainable investments have been said to gain value, and responsible property investing has become one of the key focus areas for both developers and investors. The evolution of green real estate development is claimed to be driven by increasing regulatory pressure, but more importantly, the growing awareness of climate change and environmental degradation. As a result, sustainability is no longer viewed as optional but rather the core of decision making and a key strategic priority. However, recycling and fundamental energy-saving measures are no longer viewed as sufficient green investments and a more comprehensive approach towards sustainability measures are required to meet the growing expectations of policymakers, investors and consumers (Geipele et al, 2022).

Key Performance Indicators (KPIs) is a management tool which allows a specific activity or process to be followed closely, corrected and controlled, and this way ensured to achieve the desired outcome. In commercial real estate, KPIs serve as fundamental metrics to assess the success of investments, properties and portfolios. KPIs provide a better understanding of portfolio or property performance, enabling stakeholders to drive profitability, optimize operations and identify deficiency (Purba & Setiawan, 2020).

The KPIs used in commercial real estate capture both financial and operational dimensions of property performance. The most relevant KPIs include:

- Average Lease Term: Measures the average duration of a lease agreement made between the asset owner and the tenant.
- Gross Operating Income (GOI): Measures the total income of an asset after accounting for losses related to e.g. vacancies or credit issues. GOI provides an estimate of the annual income of an asset.
- Net Operating Income (NOI): Represents the income remaining after removing all necessary operating expenses, such as insurance. NOI measures the profitability of an asset and is widely used by e.g. banks to evaluate an investments capacity to meet e.g. debt obligations.
- Occupancy Rate: Measures the percentage of a leased space within an asset or a whole portfolio. A high occupancy rate signals both strong demand and income stability, whereas a low occupancy rate signals vacancies in the units and possible loss in revenue.
- Operating Expense Ratio (OER): Evaluates the efficiency of asset operations. In short, OER compares the cost to operate an asset with the income brought in by the asset. OER is calculated by dividing the total operating expenses with the GOI, which was further explained above.
- Rentable Square Footage (RSF) versus Leasable Square Footage (LSF): Metrics used to measure the total space available for lease. RSF represents the total floor area, which includes common areas and other shared facilities, whereas LSF represents the space that can be leased exclusively and only by the tenants.
- Tenant Retention Rate: Measures tenant stability by tracking lease renewals and terminations. A tenant retention rate is the percentage of tenants who renew or extend their leases over a specified period. (Alka et al., 2021; Alexandria Real Estate Equities Inc., 2023; Vesterinen, 2024; Lynch, 2025)

The KPIs above are presented and explained in square feet, however, this study uses square meters (m^2) as the unit of measurement.

At a time of raised awareness against environmental issues and sustainability, KPIs are playing a critical role in helping organizations and property owners becoming more environmentally sustainable. KPIs can be used to monitor the ESG performance on organizational level, including topics such as carbon emissions, energy efficiency and recycling rates. Sustainability and environmentally sustainable investments have been said to impact the ESG performance, which has led to organizations shifting towards integrating ESG into their strategies, and more precisely implications for risk management, investment decisions and sustainability policies (Naseer et al., 2025).

Sustainability within commercial real estate often requires a higher upfront investment, such as implementing energy-efficient building designs, renewable energy systems and obtaining green building certifications. Despite the upfront costs, the long-term benefits include a reduction in operating expenses, such as lower energy and water usage and decreased maintenance costs. These advantages have been linked to enhanced returns and value creation. Property owners and investors play a significant role in leveraging sustainability at a higher scale. Globally, investing in high-performing sustainable real estate has become a standard practice, where investors and property owners are slowly decarbonising the real estate market by prioritizing decarbonisation in their real estate portfolios as well as new investments. Furthermore, investors and property owners are becoming more cautious about climate risks, and monitoring their environmental impact has become a key priority. These measures have led to long-term ESG targets, where sustainable building practises are laying the foundation for the future of commercial real estate (Pai et al., 2022).

Figure 1 illustrates value creation in commercial real estate through two pathways. While energy-efficient measures reduce operating expenses and thereby increases NOI, sustainability has said to improve tenant demand and tenant satisfaction, often leading to higher occupancy rates. In conclusion, this supports revenue and the overall value creation of the property.

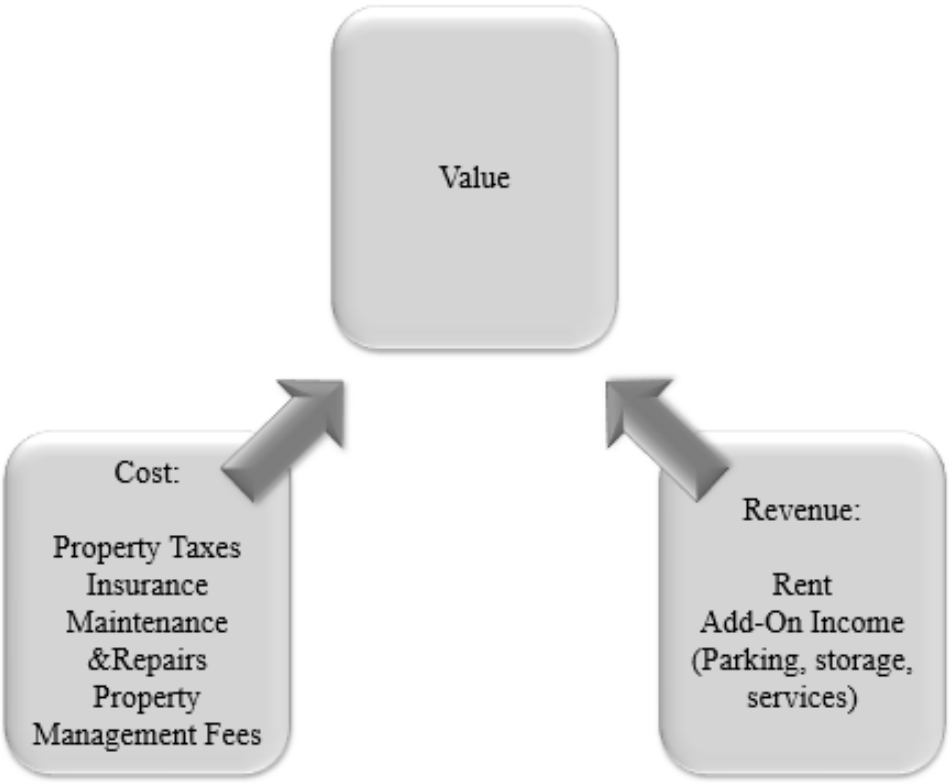

Figure 1. Value creation process in commercial real estate.

The evolution of green real estate development is claimed to be driven by increasing regulatory pressure, which has led to property owners and investors designing and maintaining their properties to comply with ESG standards. However, regulatory pressure applies simultaneously to tenants, especially for those with reporting obligations or net-zero goals. Tenants are becoming more cautious and ESG considerations have been said to become a key priority in lease negotiations. A strong market demand has often said to be driven by a strong tenant demand, and whereas tenant demand determines cash flow, market demand impacts pricing and liquidity. The commercial real estate industry is undergoing a significant change towards sustainable practices. The change is driven by a growing awareness of environmental responsibility, which benefits both property owners, investors and tenants (Vanags & Butanc, 2013).

1.1 Objectives and research questions

The main objective of this study is to determine whether sustainable assets within commercial real estate achieve higher occupancy rates, and secondly, which sustainability metrics particularly influence higher occupancy rates. The purpose is to find out whether there is a correlation between sustainable assets and higher occupancy rates. The research question can be formulated as follows:

1. *Are sustainable assets achieving higher occupancy rates within commercial real estate?*
2. *Which sustainability metrics influence the rentability of commercial real estate the most?*

2 Theoretical framework

The integration of sustainability practices in commercial real estate has become an important factor and key driver in improving both financial and operational performance. Investors and property owners following environmental guidelines and using various sustainability measures in their business strategies, such as energy efficiency and energy consumption, carbon emission and indoor air quality, can potentially lower their properties operating expenses, improve tenant satisfaction and increase property value. Following the correct sustainability measures depends on stakeholder demands, industry norms, regulatory frameworks and the relevance of the metrics to the performance of the property.

Following chapter presents the chosen sustainability metrics as well as the definition for a sustainable asset.

2.1 Green building certification

Green building certifications have been said to be the most common and well-known form to demonstrate sustainability in real estate and they are an effective way to demonstrate an organisation's commitment to sustainability. Green building certifications are built to evaluate the environmental performance of buildings through several detailed factors, including energy consumption and efficiency, waste management, water efficiency and indoor air quality. Green building certification systems, and companies behind them, serve as benchmarks for sustainable building practices. The most relevant framework for this study is BREEAM and LEED, both internationally recognized building certification standards and well-known within the Finnish real estate market. Even though BREEAM and LEED have their own focus and methodology, they both have a shared purpose of improving sustainability in the built environment, reducing environmental impact in terms of water, waste and energy and promoting well-being and health of building occupants (Feijao et al. 2024).

BREEAM (Building Research Establishment Environmental Assessment Method) is a building certification system developed in the UK by BRE. The first environmental

assessment method and its frameworks were first launched in 1990 and has since then become an internationally recognised measure for sustainable construction and operation. BREEAM's approach towards sustainable construction and operation is to measure environmental impacts through various categories and the assets performance in every category. BREEAM is divided into several schemes, whereas the main schemes include BREEAM New Construction for new buildings, BREEAM In-Use for existing buildings and BREEAM Refurbishment and Fit-Out for properties involving in modification and refurbishment of existing structures. This study focuses exclusively on BREEAM In-Use, since it measures sustainability on a longer life cycle with a goal-oriented mindset. Both BREEAM New Construction and BREEAM Refurbishment and Fit-out certifications presents the sustainability criteria at the time of assessment and assesses the building and its compliance with building standards at the time of the on-going certification project. The certifications do not have a formal expiration date or a requirement of renewal, however, building standards and regulations are in constant change and development, and therefore BREEAM New Construction and BREEAM Refurbishment and Fit-out certifications does not tell the most relevant status.

BREEAM In-Use provides rating benchmarks for existing buildings and assesses their performance throughout their operational cycle in various categories. The scheme for existing buildings is further divided into two main parts: Part 1, which assesses the physical and technical characteristics in a building; and Part 2, which assesses how the building is managed. These two parts go by the name Asset Performance and Building Management. Part 2, Building Management, is strongly linked to the company managing the property and therefore often follows policies and structures originating from the company, evaluation of Part 2 can be rather restricted, and therefore Part 2 is excluded from the research.

The certification scheme applies to both residential and commercial buildings with some variation due to the property type and weightings in each asset type. BREEAM In-Use provides technical standards in eight main categories, all divided into subheadings. BREEAM uses a rewarding system, where each category receives a credit for verification against the categories and their criteria. Each category, average weighting of the section and available credits are presented in Table 1.

Table 1. BREEAM In-Use categories and scoring.

Category	*Average weighting %*	*Available credits*
Health and Wellbeing	20	47
Energy	25	66
Transport	5	22
Water	11	38
Resources	13	23
Resilience	13	18
Land Use and Ecology	4	6
Pollution	9	18

Weightings for each achieved credit is based on a consensus-based stakeholder input. These weightings are applied to each achieved credit within each category, and this way creates an overall score. The final score determines the BREEAM rating and an overall score for the asset. The BREEAM rating benchmarks are outlined in Table 2.

Table 2. BREEAM In-Use International rating benchmarks for commercial properties.

BREEAM In-Use International Rating	*% score*
Outstanding	≥85
Excellent	≥70 to <85
Very Good	≥55 to <70
Good	≥40 to <55
Pass	≥25 to <40
Acceptable	≥10 to <25
Unclassified	<10

BREEAM In-Use certification is valid for three years from the date of certification, after which a reassessment is required to maintain the certification and its achieved score. This three-year validity period makes BREEAM In-Use a dynamic assessment style rather than static. Several aspects, such as energy consumption and efficiency, building management and tenant experience and behaviour can change over time, and therefore the three-year validity period ensures that the achieved certification remains credible and up to date (BRE Global, 2020).

Leadership in Energy and Environmental Design (LEED), is a U.S based green building rating system. LEED is developed by the U.S. Green Building Council, providing a point-based scoring system to evaluate asset's sustainability across different categories. LEED was first launched in 2000, focusing exclusively on new construction, but later extended its business into broader markets, including existing buildings. LEED, such as BREEAM, is designed to assess various building types. LEED rating system is structured into five schemes, which are Building Design and Construction (BD+C), Interior Design and Construction (ID+C), Building Operations and Maintenance (O+M), Neighborhood Development (ND) and Homes. LEED for Operations and Maintenance (O+M) is the scheme most equivalent to BREEAM In-Use, and therefore the other four certification schemes have been excluded from the study. LEED for Operations and Maintenance (O+M) is designed to assess the environmental performance of an existing and occupied commercial asset. The O+M scheme is divided into nine categories, all consisting of multiple sub-categories. The main categories and scoring are presented in Table 3 (USGBC, 2025).

Table 3. LEED O+M categories and scoring (USGBC, 2025).

Category	*Available credits*
Integrative Process, Planning and Assessments	4
Location and Transportation	15
Sustainable Sites	10
Water Efficiency	14
Energy and Atmosphere	38
Materials and Resources	11
Indoor Environmental Quality	16
Innovation	6
Regional Priority	4

The certification scheme uses a credit-based system, where points are awarded on a category-specific base. Like BREEAM In-Use, LEED for O+M awards credits for each

category that has been achieved. The earned credits create an overall score, which determines the final rating. The LEED O+M rating benchmarks are outlined in Table 4.

Table 4. LEED O+M rating benchmarks (USGBC, 2025).

LEED O+M Rating	*% score*
Platinum	≥80
Gold	≥60 to <79
Silver	≥50 to <59
Certified	≥40 to <49

LEED O+M, such as BREEAM In-Use, is valid for three years from the date of certification, after which a reassessment is required to maintain the certification and its achieved score. The fundamentals of BREAM In-Use and LEED O+M are similar and in close relation to each other. Like BREEAM In-Use, LEED O+M analyses several metrics, such as energy and water efficiency, transportation and accessibility, indoor air quality and tenant experience. Both certification rating systems are invested in long-term sustainability with a focus on maintaining ecological, social and economic systems in the built environment, without compromising and endangering future generations (USGBC, 2025).

2.2 Energy performance certificate

An Energy Performance Certificate (EPC) is a mandatory document assessing structural and technical efficiency, indicating the overall energy efficiency of a building. The EPC is building-specific and required when selling and renting an existing building or when constructing a new building as a part of the construction permit procedure. Buildings are classified into energy efficiency classes, where the scale varies from A (most efficient) to G (least efficient). The energy class is based on an energy efficiency benchmark, or E-figure for short, which is calculated for each building based on factors such as heating, ventilation and cooling systems, insulation, window, roof and door efficiency and energy consumption for lighting fixtures and other appliances. Buildings constructed and completed in the 2020s

typically have a higher E-figure, A or B, as the energy performance certificate is calculated in accordance with the latest regulations. The EPC serves as an indirect sustainability metric. The EPC calculates the estimated annual energy consumption and the CO^2 emissions based on the heating and cooling systems and the origin of the energy used, thereby assessing the building's environmental impact. In addition to this, EPCs considers the use of renewable energy sources, such as heat pumps and solar photovoltaic panels. Taken these metrics into consideration, it is stated that buildings with high E-figures are more indicative of energy efficiency, a reduced carbon footprint and an overall, improved and progressing sustainability (Motiva, 2026).

In Finland, the legislation concerning energy performance certificates aims to improve the overall energy efficiency in the Finnish building stock. The goal is to reduce energy consumption, enhance the use of renewable energy sources and reduce emissions (Kauppinen, 2024).

2.3 On-site renewable energy production

The Finnish government is committed to an ambitious target within green transition by reaching carbon neutrality in 2035, as stated in the Climate Change Act. This means that Finland is set on becoming carbon neutral 15 years before most of the other European countries and the EU as an entity. The Climate Change Act has set a goal of at least a 60 % reduction of greenhouse gas emissions by 2023 and 80 % by 2040. A long-term goal of a 90-95 % reduction in greenhouse gas emissions has set been set to be fulfilled by 2050. These goals are mandated to be met with renewable energy initiatives, the government laying its focus on strengthening electricity grids and developing technologies, but more importantly expanding the country's clean energy production (Ministry of the Environment, 2022; Birol, 2023).

According to preliminary data presented by Statistics Finland, an impressive 95 % of Finland's total electricity production in 2024 came from fossil-free sources. These include wind, hydro solar and nuclear power. The total electricity consumption rose by 3 %, amounting the total consumption to 82,7 Terawatt hours (TWh). 1,2 TWh of the total amount came from solar power, which grew by 61 % in 2024 (Statistics Finland, 2025).

The electricity supplies and total consumption is presented in Figure 2 below.

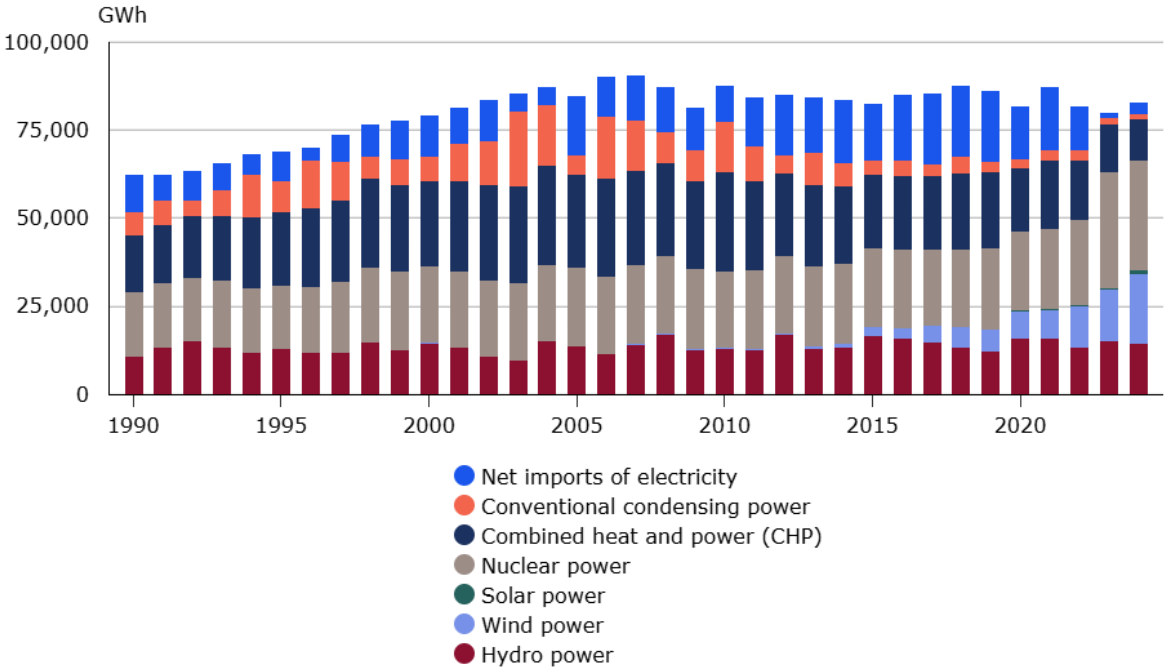

Figure 2. Supplies and total consumption of electricity 1990-2024 (Statistics Finland, 2025).

Due to legislative and regulatory changes, ambitious government targets but more so due to the global shift towards sustainability matters, the production of renewable energy in commercial real estate has increased significantly. A case study conducted in 2020 calculated the impact of renewable on-site energy production on property value, where on-site energy production concerned solar photovoltaic (PV) panels and ground source heat pumps. The calculations showed production and savings of an on-site energy investment for the first operating year, continuing with an estimation of a 30-year lifecycle of the system and its effect on property value. The net savings on operating costs for the first operating year was calculated as 101,000 €, with 70 % coming from the ground heat source heat pump and 30 % from the solar PV panels. Once factoring in the prime logistics yield in the area along side with the 30-year life span of the systems, the property value increases by 2,048,000 €. The on-site energy production system had a total cost of 1,560,00 €, which gained the property owner an immediate benefit of 490,000 €. The on-site energy production (MWh) and savings (€) is presented in Figure 3 (Leskinen et al., 2020).

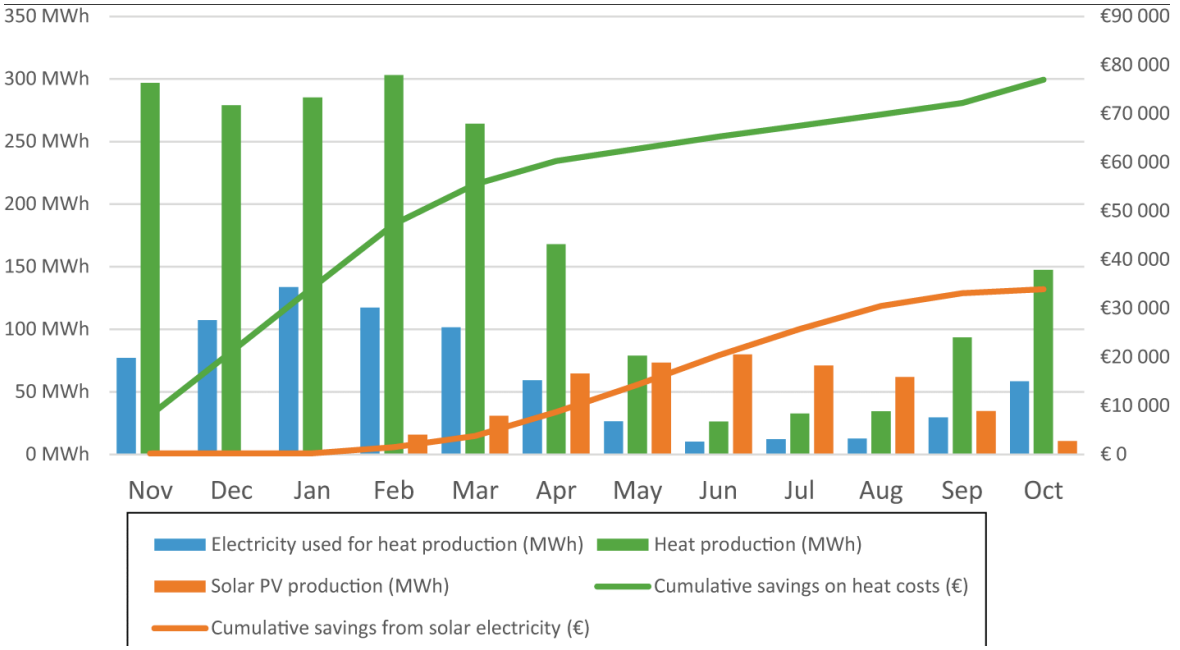

Figure 3. On-site energy investment for the first operating year (Leskinen et al., 2020).

Figure 3 suggests that renewable and energy efficient heating technologies can reduce operational costs and the cumulative savings may increase consistently over time.

2.4 Occupancy rate in commercial real estate

Occupancy rates in commercial real estate represents the ratio of occupied area compared to the total amount of rentable area. Occupancy rate is explained as:

$$Overall\ Rate = \frac{Occupied\ Area}{Total\ Rentable\ Area}\ x\ 100$$

Occupancy rates give valuable information on how well a property is performing. Maintaining a high occupancy rate is essential for property owners and investors for generating a consistent income, and a simple cost per square feet has served as the key metric to measure success. However, the metrics around commercial real estate is slowly shifting, and a high occupancy rate is more than just cost per square meter. The role of tenant satisfaction and tenant demand on the financial performance of commercial real estate has been studied to understand the link between these variables. Increasing tenant demand regarding sustainability metrics has been said to effect tenant leasing decisions, which has an immediate effect on occupancy rates (Hu et al., 2026).

Based on the presented theoretical framework, it is expected that the chosen sustainability metrics have an impact on occupancy rates in commercial real estate. Each sustainability metric has been presented individually, but their combined impact has been examined to better understand the relationship between the variables.

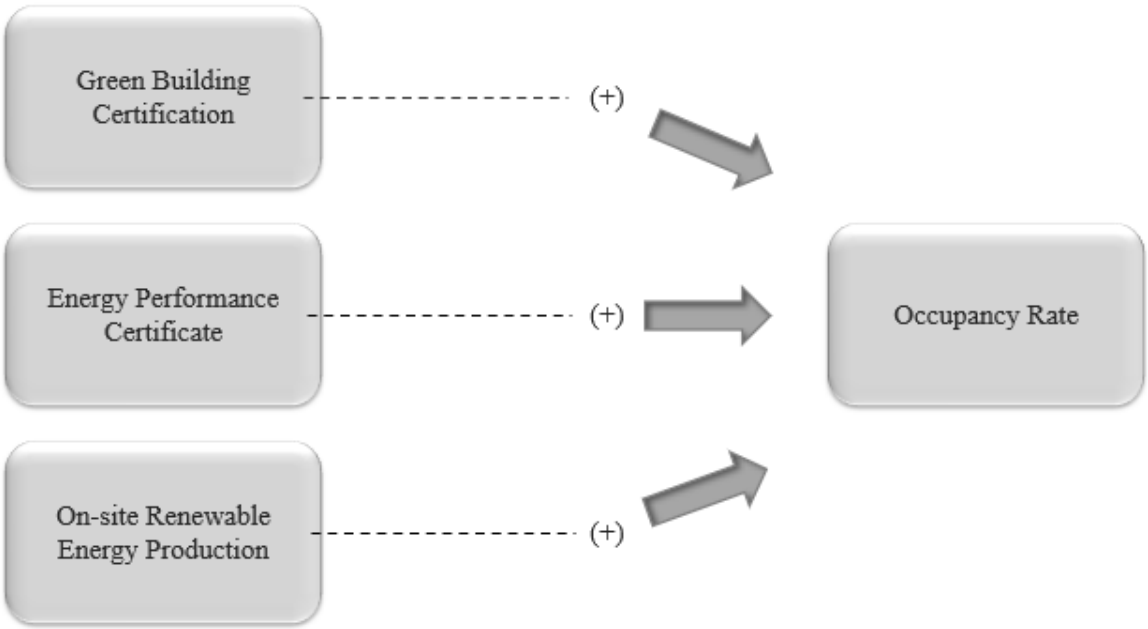

Figure 4. Conceptual research model of the study.

Figure 4 presents the conceptual research model of the study. Green building certification, energy performance certificate and on-site renewable energy production are hypothesized to have a positive relationship to occupancy rates of commercial real estate.

2.5 Sustainable asset

A sustainable asset is often said to implement ESG practises, focusing on a broader impact regarding not only financial returns but rather the society and the environment. There is no universal definition, but rather frameworks, that may agree on the same definition. This research is based on a subjective matter. Sustainable assets have been chosen based on what is considered as a sustainable asset purely from a subjective aspect and later narrowed down based on available data to the chosen metrics.

3 Methodology

This chapter describes the data, its origin and the chosen methods which have been used to gather and analyse the sustainability metrics and occupancy rates. Analysis is performed in an Excel spreadsheet and further analysed in a software, which supports econometric modelling.

3.1 Quantitative research method

This study adopts a quantitative approach. A quantitative research approach aims to develop an understanding of how carefully chosen variables are in relation to other chosen variables. To be more exact, a quantitative research approach asks questions such as “how many” and “the degree to which”, and this way aims to quantify the processed data and generalize findings. A quantitative research method relies on data collection and data analysis with a clear goal of testing a theory and generating a result and a conclusion. The key characteristic of quantitative research is to describe a problem which requires an explanation of a relationship or correlation between variables and collecting numerical data by using chosen instruments which support the research question (Temizhan et al. 2021; Ghanad, 2023).

To understand the effect of sustainability metrics on rental performance, a regression analysis is used to quantify and evaluate the outcome while having control over other variables, such as property size and construction year. The analysis is conducted using Gnu Regression, Econometrics and Time-series Library (Gretl), which is an open-source software used for regression and panel data analysis. Gretl was used due to its capabilities of handling quantitative datasets and implementing the chosen variables and metrics as regression models. In this study, Gretl was used to calculate the correlation between sustainability metrics and occupancy rate of commercial real estate assets. (Segall & Niu, 2020).

3.1.1 Regression analysis

Regression models are statistical methods used to examine a relationship between chosen variables. The variables are divided into two types, dependent variables and independent variables. A dependent variable, also known as the response or outcome variable, is the attribute which the model aims to predict. An independent variable, also known as the explanatory variable, is the attribute which is believed to have an influence on the dependent variable. The value of a dependent variable depends on the changes occurring in the independent variables (Olive, 2017).

To further identify the relationship between the dependent and independent variables, it is crucial to understand which type of model suits best for the purpose of the research. In general, a regression model can either take a linear or nonlinear shape, depending on how the dependent variable is assumed to respond to changes and variation in the independent variable (Hutcheson, 2011). This study follows an Ordinary Least Squares (OLS) method, which is a common method to present a simple linear regression model. OLS aims to find the best linear model through a series of data points by reducing the total of the squared differences between the actual values and the values that are predicted by the linear model. This can be presented as observations, where (Xi) represents the independent variable and (Yi) the dependent variable. The OSL coefficients are (β_0) and (β_1) and are presented as follows in the linear equation:

$$Y = \beta_0 + \beta_1 X + \varepsilon$$

In this OLS equation, (ε) represents the error term, which shows the difference between the actual observed values and the values predicted by the model. The OLS coefficients, (β_0) and (β_1), are the variables that make the predictions as close as possible to the actual values. OLS regression relies on assumptions, which are called the Gauss-Markov Theorem. Gauss-Markov assumptions ensure that its estimates are reliable and unbiased and are divided into assumptions. The first assumption assumes that the relationship between the dependent variable (Yi) and the independent variable (Xi) is linear, meaning that the (Yi) can be expressed as a linear function of (Xi), with an error term. The second assumption is that the error terms (ε) are independent of each other, implying that the value of one error does not provide information about another error term and its value. The third assumption is referred to as homoscedasticity, which means that the error terms are equally spread for all

independent variables (Xi). The fourth assumption refers to that there is no perfect multicollinearity, meaning that the independent variables should not be a perfectly linear combination, which would make it impossible to determine each variable's individual effect on the dependent variable (Majka, 2024).

In addition to the presented coefficients and standard errors, an OLS regression model in gretl describes the t-ratio and p-value, which gives valuable insight into the statistical significance of the estimated relationship between the indicators. The t-ratio tests and indicates whether the coefficient is significantly different from zero, as follows:

$$t = \frac{coefficient}{standard\ error}$$

The p-value tests the significance of the coefficient by observing whether an independent variable has any significance on the dependent variable. A p-value < 0.05 is typically seen as statistically significant. The significance is expressed as significance starts, where:

$p < 0.01$ = Highly significant ***

$p < 0.05$ = Significant **

$p < 0.10$ = Marginally significant *

The significance of the estimated relationship is assessed by comparing the t-ratio to the critical value, which can be derived from a two-tailed Z-test. 1.96 in statistics represents the critical value for a 95 % confidence interval in a standard, normal distribution. In practice, a classic curve ball captures exactly 95 % of the area below the curve, leaving a 2.5 % in each tail. This represents $\pm$ 1.96, which is widely used as a standard value in two-tailed hypothesis testing at the $p < 0.05$** significance level. $\pm$ 1.96 is an accepted benchmark for determining whether a coefficient is statistically significant. This study adapts a two-tailed Z-test, which is further presented in Figure 5 below to visualize the outcome (Forjan, 2019).

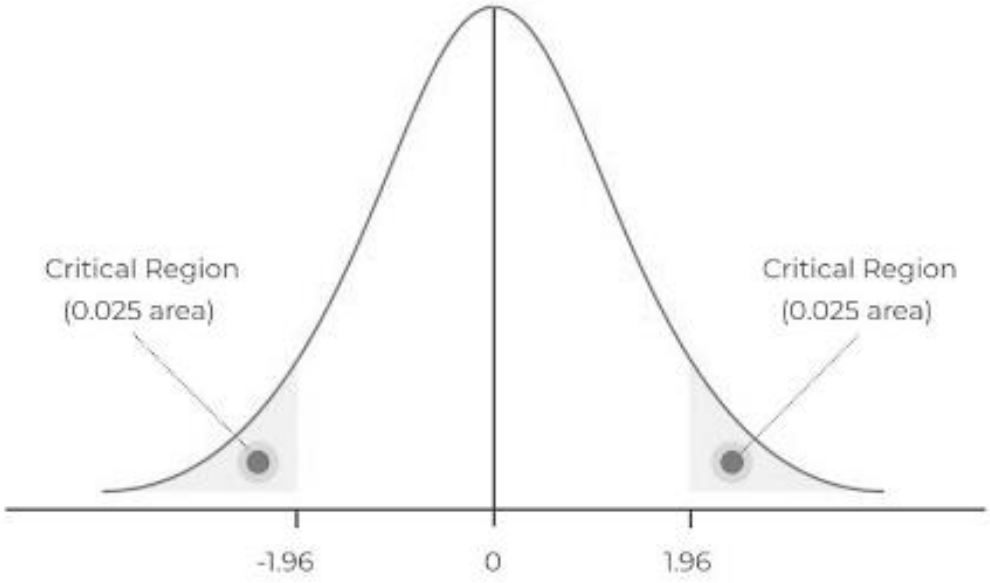

Figure 5. A two-tailed test (Forjan, 2019).

In addition to the estimated coefficients in the model, a typical OLS model reports several summary statistics, which helps to evaluate how well the model fits the data, how precise the coefficient estimates are and whether the model is statistically significant or meaningful (Taboga, 2021). To assess a typical OLS model in more detail, the main summary statistics are described below.

Every model has a constant (*const* in short), the baseline, which serves as the starting point for the analysis. The constant is the intercept of the model and represents the predicted value of the dependent variable, when all independent variables in the regression model are 0.

Standard error, or std. error, measures how precise the suggested coefficient is. A small standard error equals to a precise estimate, where a large standard error equals to a low precision. Standard error should be compared to the coefficient, meaning that when the standard error is larger than the coefficient, the estimated outcome is imprecise. In return, when the standard error is small relative to the coefficient, the estimate is more precise and more likely to be statistically significant.

The t-ratio measures how many standard errors the coefficient is away from zero. A higher absolute t-ratio suggests a greater estimate that the coefficient is not zero. The coefficient is often considered as statistically significant when its t-ratio is greater than +2 or less than -2.

The p-value plays a crucial role in the analysis, indicating whether the effect is statistically significant or no. A small p-value suggests a strong relationship between variables, typically a value below 0.05.

Mean dependent var, short for variable, represents the average value of the dependent variable. It provides information about the typical value in the dataset and gives insight into whether the coefficient is large or small compared to the average value.

S.D dependent var, short for standard deviation of dependant variable, explains the amount of variation that exists around the dependent variable.

Sum squared resid, translates as sum of squared residuals (SSR). SSR measures the total prediction error, where smaller values indicate a better fit of the model.

R-squared explains the explanatory power of the model and how well the model fits the data. Higher values suggest a stronger explanatory power. Adjusted R-squared is a version of R-squared which is adjusted for the number of independent variables in the model. It prevents inflation of the R-squared when variables are added to the model which does not improve the model.

F-statistic and p-value (F) refers to the p-value explained earlier. They test the variables and the model as a whole and analyses whether it is statistically significant or no.

Log-likelihood is used as a goodness-of-fit measure, which analyses how well the model explains the observed data based on the likelihood function. Log-likelihood analyses the model's estimated coefficients and presents how likely the observed data are. Log-likelihood does not give much information about the dataset when standing alone, but it serves as the foundation for model comparison criteria, such as Akaike criterion, Schwarz criterion and Hannan-Quinn.

Akaike criterion, Schwarz criterion and Hannan-Quinn are statistical measures used in time series analysis. In a regression analysis, all three models serve as a model selection criterion that analyses the same dataset from three point of views (Chakrabarti & Ghosh, 2011; Rubinfeld & Card, 2025).

A typical visualised OLS regression model is presented in Figure 6. A scatter plot of data with a regression line presents the independent variable on x-axis and the dependent variable on y-axis. Each dot represents one individual observation in the dataset. The regression line in OLS represents the predicted values, which are calculated by using the estimated coefficients. The vertical distance between each individual observation and the regression line represents the error for that specific observation (Mohr, 2018; Gretl, 2023).

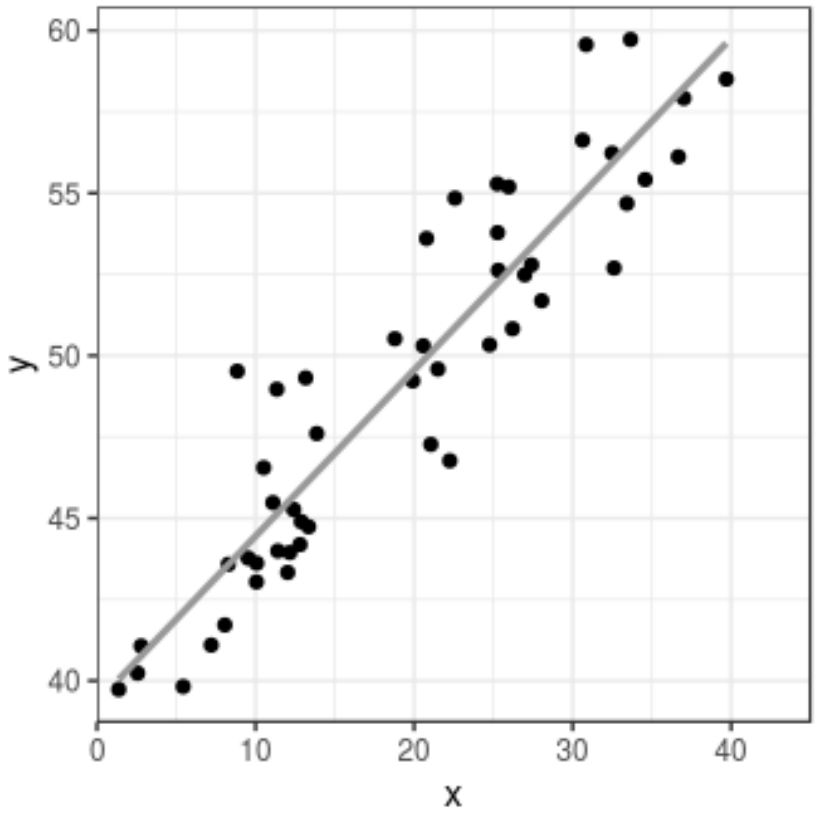

Figure 6. Typical Ordinary Least Squares (OLS) regression model (Mohr, 2018).

As mentioned, a regression analysis is often used in studies where a relationship between variables is required to be examined. In 2025, Senna and Moxotó conducted a regression analysis using Gretl, which purpose was to study the relationship between carbon emissions and the financial performance of Brazilian companies listed in the sustainability-focused Carbon Efficient Index. The study utilized the OLS method, where variables in the analysis included return on equity (ROE), return on assets (ROA) and revenue. The results suggested that the relationship between higher CO^2 emissions and better financial performance was positive, however, the OLS method should be further strengthened by conducting a sectoral

analysis, since the relationship between emissions and financial performance may differ from one sector to another, and therefore each industry should be analysed separately (Senna & Moxotó, 2025).

To provide another example, a regression analysis was used in a study to determine which factors influences housing prices in the National Capital Region in India. The study used the OLS method and quantile regression estimation approaches. The findings suggested that variables such as housing size, age and number of bathrooms had a positive impact on housing pricing, while the number of rooms and balconies as well as distances from school and metro station were found as negative factors (Kumar, 2026).

3.2 Description of the research data

The research relies on data received and collected from a real estate company providing asset management and real estate services for tenants, investors and property owners. The collected research data is stored in the company's own ESG-reporting platform and service developed for the real estate industry, such as investors, property owners and the building management. The platform is developed as an ESG-reporting software where important sustainability metrics are collected to give reliable and up to date information regarding assets' performance and sustainability requirements. The data stored in the ESG-reporting software is collected from several suppliers, which supports application programming interfaces (API) for data integration. These include various energy suppliers, such as Fortum and Helen, as well as national databases, such as Energiatodistusrekisteri (the Finnish Energy Certificate Register) and Kiinteistörekisteri (Building Information Register). The main goal of the platform is to give valuable insight on the ESG performance of properties, making it easier for property owners and investors to follow along how their properties are performing. The data presented in the ESG-platform helps in decision making and strategies, and it serves as a valuable tool in identifying development measures and targets. Furthermore, the platform follows up on regulatory demands within the real estate sector, such as Corporate Sustainability Reporting Directive (CSRD) and the EU Taxonomy.

The identified sustainability metrics were taken from the ESG-platform and transferred into an Excel spreadsheet. Each row in the spreadsheet presents an asset and their sustainability metric. The research data covers 229 office, retail and logistic buildings located in Uusimaa

region, Finland. Number of assets has been chosen in accordance with the sustainability metrics mentioned in chapter 2 and the research covers all assets found in the ESG-platform, which falls under the defined scope. This research does not give any indication on the used assets or portfolio owners, and it is not possible to identify which property or property owner is in question.

The chosen sustainability metrics collected from the ESG-platform were transferred to an Excel spreadsheet together with the occupancy rate and furthermore transformed into a suitable formatting, a Comma-Separated Values file (CSV), which Gretl supports. The assets were anonymized by numbering each property with an asset identification number from 1 to 229. Each independent variable represents a categorical value, which is converted into a dummy variable for the regression analysis. Table 5 presents the coded dummy variables for each categorical value.

Table 5. Dummy values for the regression analysis.

Variable	*Category*	*Dummy value*
Green Building Certification	Yes	1
	No	0
Energy Performance Certificate	Yes	1
	No	0
On-site Renewable Energy Production	Yes	1
	No	0

Each dummy variable takes the value one (1) if the chosen sustainability metric is present and zero (0) otherwise. Energy ratings better than B are considered as a sustainability metric being present and therefore translates as a yes in the Excel spreadsheet. A lower energy rating translates as the asset not being sustainable. On-site renewable energy production methods were identified as solar PV panels and/or heat pumps (both air and/or ground source). The same principle is adapted, meaning a yes (1) is when on-site renewable energy production is presented, and a no (0) when on-site renewable energy production is not present. The dummy values are further presented in Appendix 1.

The occupancy rate is taken from the ESG-platform and considers the occupancy rate of year 2025. Occupancy rate is measured from 0 to 1, where 1 equal to a 100 % occupancy rate and 0.1 to a 10 % occupancy rate.

The CSV file is downloaded into Gretl by using the open file selection. It is mandatory to define the structure of the dataset, and since the model does not follow a time series and the observations are measure at one time, the structure is defined as cross-sectional. The regression analysis is determined to follow an OLS model, and this can be found in the tool bar to the far left in Gretl. For the OLS model to be able to be conducted, the variables are required to be determined. The occupancy rate is specified as the dependent variable and assets including all the sustainable metrics are specified as the independent variable. Once the variables are specified, Gretl creates Model 1, which consist of all coefficients, standard errors, the t-ratio and the p-value.

The study analyses 229 office, retail and logistics building located in the Uusimaa region, Finland. For an asset to be considered as sustainable in this study, all sustainability metrics must be found in the asset. To conclude, an asset is required to have a green building certification, an E-figure higher than B and on-site renewable energy production, such as solar PV panels or heat pumps. The analysis is constructed as Model 1, which represents the composite variable and the dependent variable. The final model, Model 1, is specified as:

$$Occupancy\ Rate_1 = \beta_0 + \beta_1\ Sustainable_1 + \varepsilon_1$$

where:

β_0 = The baseline occupancy rate when the sustainability variable is equal to zero

β_1 = The effect of sustainability metrics on occupancy rate

$Sustainable_1$ = A composite variable capturing the identified sustainability metrics

ε = The error term, capturing unobserved factors affecting the dependent variable

4 Results

This chapter is divided into two parts, each part addressing one of the research questions. The first part presents results for research question 1, i.e. whether sustainable assets are achieving higher occupancy rates within commercial real estate, while the second part focuses on research question 2, i.e. which sustainability metrics influence the rentability of commercial real estate the most.

4.1 Occupancy rate of sustainable assets in commercial real estate

Model 1: OLS, using observations 1-229
Dependent variable: Occupancyrate

	coefficient	std. error	t-ratio	p-value	
const	0,922472	0,0126481	72,93	1,57e-159	***
Sustainable	-0,0887388	0,110505	-0,8030	0,4228	

Mean dependent var	0,921310	S.D. dependent var	0,189994
Sum squared resid	8,206969	S.E. of regression	0,190142
R-squared	0,002833	Adjusted R-squared	-0,001560
F(1, 227)	0,644858	P-value(F)	0,422797
Log-likelihood	56,20362	Akaike criterion	-108,4072
Schwarz criterion	-101,5398	Hannan-Quinn	-105,6367

Figure 7. OLS for Model 1.

Model 1, *Sustainable*, is specified in Figure 7, which presents the estimated outcome of the regression analysis for all sustainability metrics concluded into one variable. Coefficient on *Sustainable* (β = -0.0887388) measures the suggested effect of an independent variable on the dependent variable. The negative coefficient indicates that sustainable properties are associated with lower occupancy rates relative to assets with no sustainable features. The constant term (β = 0.92247) acts as the baseline occupancy rate when the independent variable *Sustainable* (β = -0.0887388) equals zero. The standard error in Model 1 should be compared to the coefficient, meaning that when the standard error (= 0.1105) in coefficient *Sustainable* (β = -0.0887388) is larger than the coefficient, the estimated outcome is

imprecise. The p-value plays a crucial role in the analysis, indicating whether the effect is statistically significant or no. The p-value ($p = 0.4228$) in Model 1 indicates that the variable is not statistically significant at the 5 % level, since $p < 0.05$.

The relationship between sustainability metrics and occupancy rate is suggested to be negative, meaning that sustainable assets tend to have a lower occupancy rate according to this model. The coefficient on *Sustainable* (β = -0.0887388) with a standard error of 0.11050 results in a *t-ratio* of approximately -0.803. Since the value of the *t-ratio* is greater than the critical value of 1.96 at the 5% significance level, the effect is not statistically significant. The observations in Model 1 indicate that the occupancy rates in sustainable assets are lower than in non-sustainable assets. The observed negative coefficient may be due to a random variation in the data and since the coefficient is insignificant, the suggested negative relationship should be considered.

Most of all observations are non-sustainable assets, and their occupancy rates range from low to full occupancy. In comparison, there are only a few sustainable assets found in the dataset. The regression coefficient for *Sustainable* (β = -0.0887388) indicates a negative relationship between the dependent and independent variable. Although the scatter plot demonstrates variation between both sustainable and non-sustainable assets, the limited number of sustainable observations may influence the estimated relationship strongly. Due to the small group of sustainable assets, each observation has a considerable impact on the overall pattern, and therefore the results should be interpreted with caution.

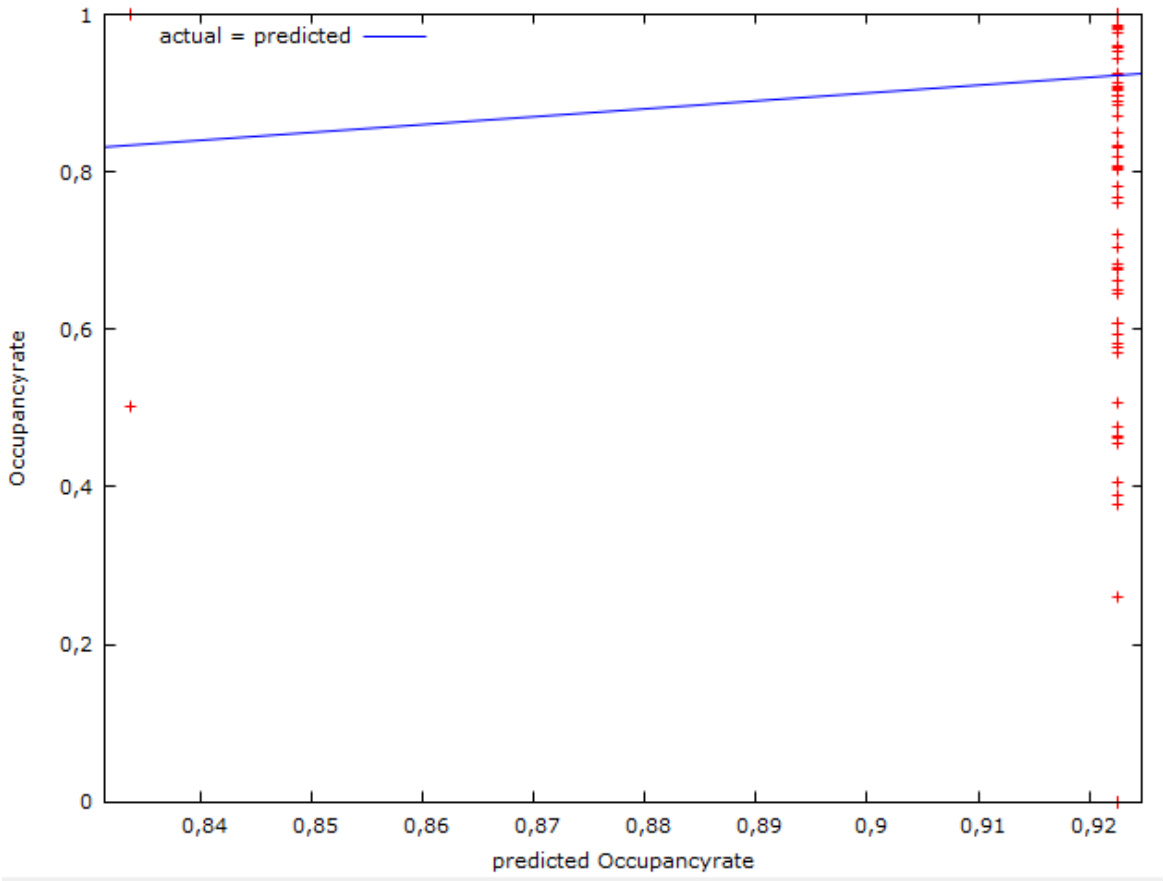

Figure 8. Scatter plot of the relationship between variables.

Figure 8 visualizes the actual versus predicted occupancy rates and gives information regarding model performance. The x-axis represents the predicted occupancy rate presented in Model 1, while the y-axis represents the actual observed occupancy rate, which is based on real data found in the data set. Each red dot represents one asset. Since Model 1 only includes one independent variable, *Sustainable*, and can only produce two predicted values, non-sustainable and sustainable assets, most observations are far away from the blue line and stacked vertically around 0.92 on the x-axis. Model 1 predicts almost the same value for most observations (0.92), but the actual occupancy rates in the data set varies tremendously, from everything between 0.25 to 1.0.

The *Sustainable* variable suggested a negative relationship with occupancy rates, as suggested by the estimated coefficient on *Sustainable* (β = -0.0887388). The variable suggests that assets with a green building certification, high E-figure and on-site renewable energy production are associated with occupancy rates approximately 8.9 % points lower than non-sustainable assets. However, the model is not statistically significant (t-ratio =

-0.8030, p-value = 0.4228), meaning that there is not enough evidence to conclude that sustainability metrics has a systematic impact on occupancy rates. Furthermore, the scatter plot indicates a strong imbalance between sustainable and non-sustainable assets, since the dataset contains only a few sustainable observations compared to a considerable amount of non-sustainable observations. This imbalance limits heavily the reliability of the estimated effect and makes the results highly sensitive to individual observations in the regression.

Model 1 cannot be considered statistically significant at conventional levels *(p = 0.4228),* since the model does not provide a strong and reliable explanatory power. The large standard error in the model compared to the coefficient indicates several uncertainties and limitations around the estimate. For the analysis to reach the 10 % threshold and to be considered statistically significant, the model would require a smaller standard error or a wider range of sustainable assets.

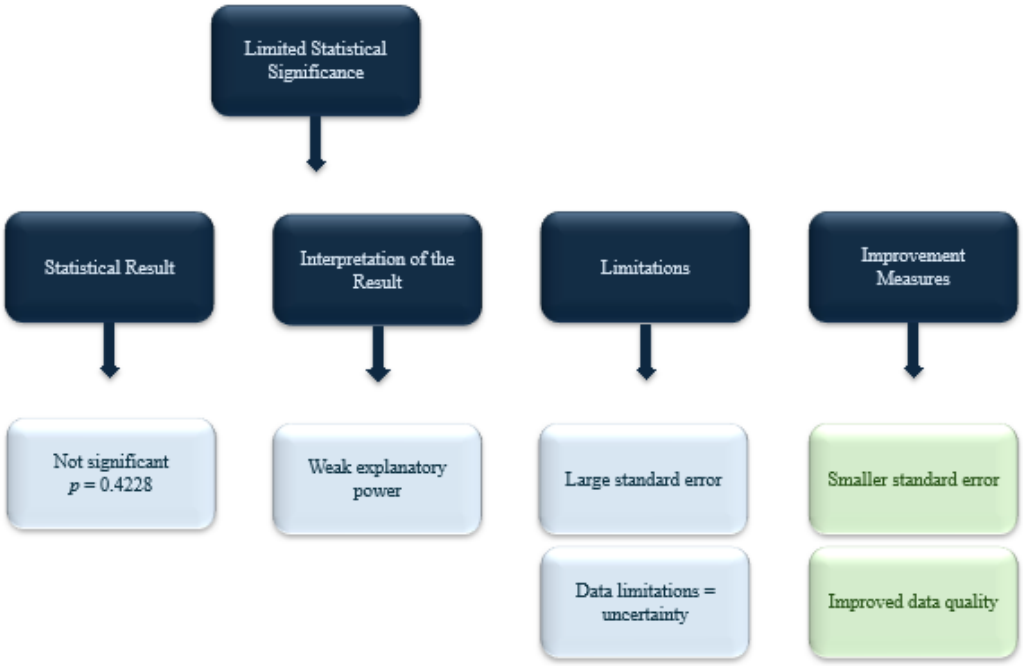

Figure 9. Model 1 simplified.

Model 1 is further simplified in Figure 9 to illustrate the outcomes of the OLS regression. The results are highlighted in light blue, whereas light green presents the possibilities and the potential improvement measures for achieving a more detailed regression model.

4.1 Sustainability metrics and rentability of commercial real estate

This chapter describes the chosen sustainability metrics individually and examines the relationship between each metric with occupancy rates. This approach enables the research to examine whether a broader sustainability performance is associated with higher occupancy rates rather than focusing on entirely individual metrics.

When analysing the relationship between occupancy rates and each variable separately, green building certifications are found to have the most potential to affect occupancy rates. The coefficient for *BREEAM* (β = 0.0850195) in Model 2 suggests that when green building certifications increase with one-unit, the occupancy rate increases with approximately 0.09 units. To confirm this, the variable shows strong evidence against the null hypothesis of no effect, since *t-ratio* = 3.396 and *p-value* = 0.0008***. The positive coefficient indicates that assets with a green building certification are associated with higher occupancy rates, making the overall findings of the research statistically significant with extremely strong evidence of green building certifications having a positive effect on occupancy rates. Model 2 is further presented in Figure 10.

```
Model 2: OLS, using observations 1-229
Dependent variable: Occupancyrate

             coefficient   std. error   t-ratio    p-value
  ---------------------------------------------------------
  const       0,887153     0,0158699    55,90     1,06e-134 ***
  BREEAM      0,0850195    0,0250380     3,396    0,0008    ***

Mean dependent var   0,921310   S.D. dependent var   0,189994
Sum squared resid    7,832441   S.E. of regression   0,185753
R-squared            0,048339   Adjusted R-squared   0,044146
F(1, 227)            11,53026   P-value(F)           0,000808
Log-likelihood       61,55185   Akaike criterion    -119,1037
Schwarz criterion   -112,2362   Hannan-Quinn        -116,3332
```

Figure 10. OLS for Model 2.

Model 2 is further simplified in Figure 11 to illustrate the outcomes of the OLS regression for coefficient *BREEAM* (β = 0.0850195). The results are highlighted in light green,

indicating that the whole coefficient for *BREEAM* demonstrates a positive and strong statistical result. Even though the results are suggested to be positive, an improved data quality would further strengthen the regression.

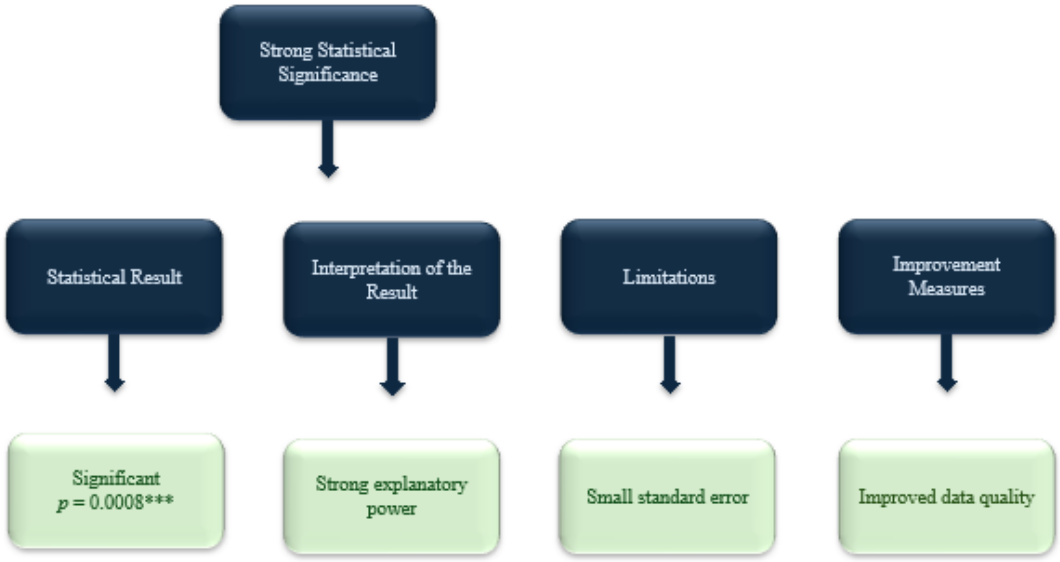

Figure 11. Model 2 simplified.

Model 3 is presented in Figure 12 with the coefficient for *Energyclass* (β = 0.0512021), including assets with an E-figure A or higher. When energy performance certificates increase with one unit, the occupancy rate increases with approximately 0.05 units. The regression shows a potentially positive relationship between a high E-figure and occupancy rates. However, the regression is not statistically significant (*p-value* = 0.1756 and *t-ratio* = 1.359), and the regression fails to reject the null hypothesis of no effect. This is due to the *p-value* = 0.1756, which exceeds conventional significance levels.

```
Model 3: OLS, using observations 1-229
Dependent variable: Occupancyrate

              coefficient   std. error   t-ratio    p-value
  ------------------------------------------------------------
  const          0,914826    0,0134097    68,22     3,13e-153 ***
  Energyclass    0,0512021   0,0376825     1,359    0,1756

Mean dependent var    0,921310   S.D. dependent var    0,189994
Sum squared resid     8,163883   S.E. of regression    0,189642
R-squared             0,008068   Adjusted R-squared    0,003698
F(1, 227)             1,846277   P-value(F)            0,175566
Log-likelihood        56,80631   Akaike criterion     -109,6126
Schwarz criterion    -102,7452   Hannan-Quinn         -106,8421
```

Figure 12. OLS for Model 3.

Model 3 is further simplified in Figure 13 to illustrate the outcomes of the OLS regression for coefficient *Energyclass* (β = 0.0512021). The results are highlighted in light blue, whereas light green presents the potential improvement measures for achieving a more detailed model.

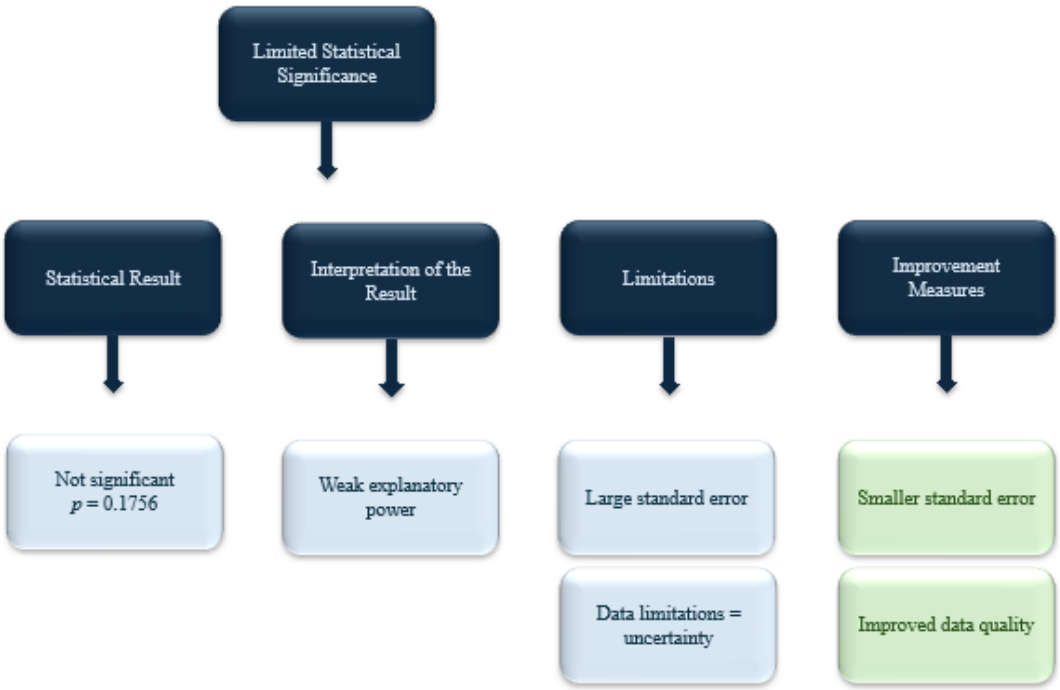

Figure 13. Model 3 simplified.

```
Model 4: OLS, using observations 1-229
Dependent variable: Occupancyrate

                   coefficient   std. error   t-ratio    p-value
  ------------------------------------------------------------------
  const              0,916961     0,0130680    70,17     7,02e-156 ***
  Renewableenergy    0,0553282    0,0466113     1,187    0,2365

Mean dependent var   0,921310   S.D. dependent var   0,189994
Sum squared resid    8,179512   S.E. of regression   0,189824
R-squared            0,006169   Adjusted R-squared   0,001791
F(1, 227)            1,409001   P-value(F)           0,236463
Log-likelihood       56,58732   Akaike criterion    -109,1746
Schwarz criterion   -102,3072   Hannan-Quinn        -106,4041
```

Figure 14. OLS for Model 4.

The coefficient for *Renewableenergy* (β = 0.972289) is presented above in Figure 14 as Model 4. The model and the coefficient *Renewableenergy* include assets with on-site renewable energy sources, including solar PV panels and/or heat pumps (both air and/or ground source). When on-site renewable energy increase with one-unit, the occupancy rate increases with approximately 0.055 units, which makes the relationship between occupancy rate and on-site renewable energy strong with a positive effect. However, the coefficient for *Renewableenergy* follows a similar pattern as the coefficient for *Energyclass,* where the *p-value* = 0.2365 and the *t-ratio* = 1.187. Since the p-value is above conventional significance levels, the study fails to reject the null hypothesis of no effect. This indicates that there is not enough evidence to confirm that on-site renewable energy production has a significant impact on occupancy rates.

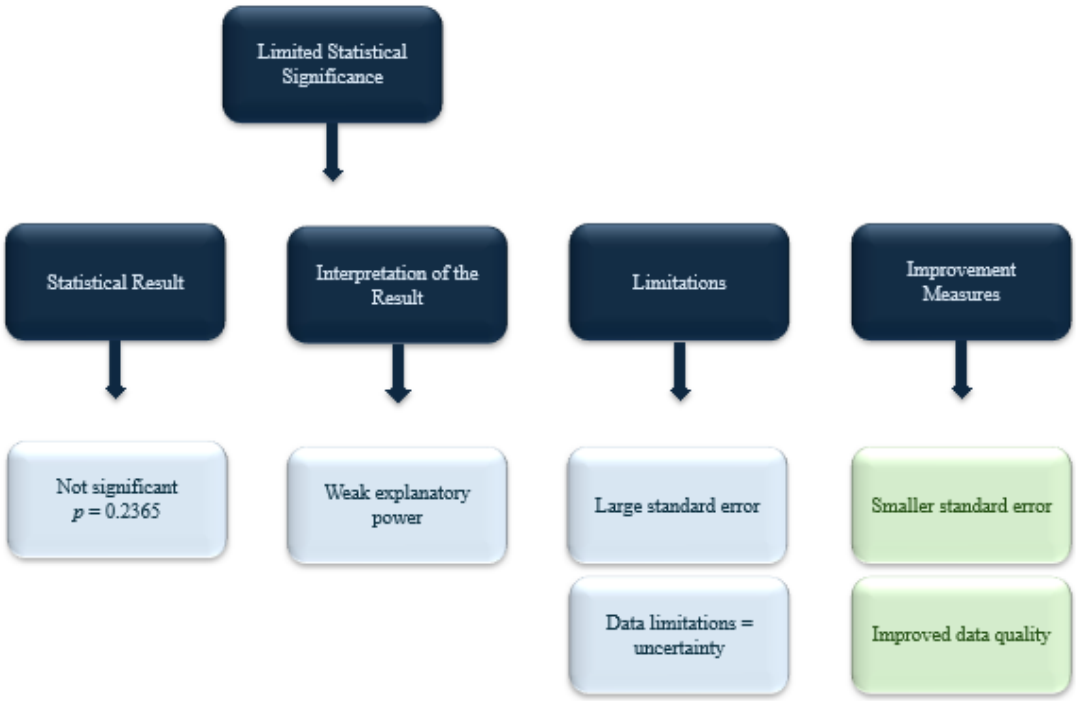

Figure 15. Model 4 simplified.

Model 4 is further simplified in Figure 15 to illustrate the outcomes of the OLS regression for coefficient *Renewableenergy* (β = 0.972289). The results are highlighted in light blue, whereas light green presents the potential improvement measures for achieving a more detailed model.

5 Discussion

The main objective of this study was to determine whether sustainable assets within commercial real estate achieve higher occupancy rates, and secondly, which sustainability metrics particularly influence higher occupancy rates. The purpose is to find out whether there is a correlation between sustainable assets and higher occupancy rates. The research questions were formulated as follows:

1. *Are sustainable assets achieving higher occupancy rates within commercial real estate?*
2. *Which sustainability metrics influence the rentability of commercial real estate the most?*

5.1 Occupancy rate of sustainable assets in commercial real estate

The OLS regression for Model 1 suggested that sustainable assets were found to have slightly lower occupancy rates than assets classified as non-sustainable. However, the model was not found to be statistically significant, and the model showcased little to no variance in occupancy rates, meaning that sustainability alone does not serve as a sufficient indicator. Model 1 suggests that properties classified as sustainable are estimated to have occupancy rates that are 0.0887388 lower (approximately 8,9 %) than non-sustainable assets. Model 1 analysed several sustainability metrics as one variable. Research as such has not been conducted previously; studies analysing the relationship between one specific metric and occupancy rates have been conducted far more, and the results have been positive.

According to a study conducted in 2020, the relationship between occupancy rates and sustainability certifications was found to be positive. The study analysed commercial real estate in the U.S., and how LEED-certified offices showed occupancy rates approximately 8 % higher compared to non-certified assets. The findings suggested that tenants value sustainable assets due to benefits, such as lower operating costs and corporate image. LEED-certified assets demonstrated a stronger occupancy performance across several market

segments, suggesting that sustainability features in an asset may contribute to long-term resilience within commercial real estate (Fuerst & McAllister, 2020).

A similar study was conducted on commercial real estate in London. The study examined the influence of green building certifications on economic performance, and whether assets holding a certification achieved higher rents and property value in comparison to assets in the same market, without a green building certification. The study connected sustainability with long-term investment resilience, where assets in hold of a green building certification were expected to have a lower risk of vacancy, making the asset more attractive to future tenants (Chegut et al., 2013).

Furthermore, studies have shown that energy efficient assets with a high E-figures generate stronger financial performance in comparison to assets with lower E-figures or poor energy efficiency. The study conducted on energy performance and real estate revenues suggested that assets with better energy performance tend to achieve higher revenues through e.g. improved and stronger tenant demand. These assets were found to be more attractive to tenants, since they reduced operating costs and improved stronger long-term investment performance. The study found a clear connection between sustainability and financial value within commercial real estate (Bonde & Song, 2013).

5.2 Sustainability metrics and rentability of commercial real estate

In the first part of the analysis, the sustainability metrics are examined as the dependent variable, as sustainability metrics combined as one. This approach enables the research to examine whether a broader sustainability performance is associated with higher occupancy rates rather than focusing on entirely individual metrics. While the chosen sustainability metrics collectively examines sustainability performance within commercial real estate, each metric may influence occupancy rates in various, different ways. Therefore, this study concludes the research by identifying the individual relationship of each metric with occupancy rates and this way examine whether a specific sustainability metric has a more significant relationship with occupancy rates than other metrics.

The coefficient for *BREEAM* (β = 0.0850195) in Model 2 is found to be positive, indicating that assets with a green building certification are associated with higher occupancy rates,

making the overall findings of the research statistically significant with extremely strong evidence of green building certifications having a positive effect on occupancy rates. According to statistics concerning green building certifications in Finland, over 870 commercial properties are in hold of a BREEAM green building certification, and to be more precise, four out of five properties hold a BREEAM In-Use certification (FIGBC, 2023). Green building certifications have gained value since the 2010s when first studies concerning green certificates and their effect on property cash flows were studied with positive outcomes. These studies were mainly focusing on individual property analysis, but a recent shift has led to broader portfolio-level assessments. In general, several studies have shown that sustainability is a significant factor in the success of real estate investments, where most studies have found positive impacts of a green certificate on both cash flows and property values. However, several challenges do exist and have been identified. The relevance of green building certifications can vary, since they may provide less useful information in geographical areas where construction and building standards are already high. Studies assessing the impact of green building certifications on commercial real estate is more attached to the location of the property as one would realise (Leskinen et al., 2020).

Furthermore, green finance is quickly becoming a key factor helping companies and municipalities to invest in projects aimed at reducing their environmental impact and carbon footprint. With the goal of achieving carbon neutrality by 2035, banks are offering special loans and bonds for sustainability initiatives and environmentally friendly investments made by companies, investors and property owners. Green building certifications plays a significant role in green finance, and several banks in Finland determines the eligibility of green financing by the level of certification a property has achieved. The criteria for BREEAM are Very Good and LEED is Gold (Kuntarahoitus, 2025).

The coefficient for *Energyclass* (β = 0.0512021) in Model 3 presented in Figure 11 shows a potentially positive relationship between a high E-figure and occupancy rates. However, the regression is not statistically significant (*p-value* = 0.1756 and *t-ratio* = 1.359), and the regression fails to reject the null hypothesis of no effect. In 2011, a study based on a cross-section of 708 commercial property assets located in the UK was conducted to determine whether energy performance ratings influenced appraised capital values and rental values. A hedonic regression procedure was used at the time to estimate the influence of EPCs and energy performance ratings on capital value and rental value. The initial findings of the study

suggests that energy performance ratings are not significantly influencing market values and rental prices, however, the influence would be expected to be much higher if EPC ratings were associated with substantial cost savings that are fully reflected in capital value (Fuerst & McAllister, 2011). A more recent study conducted in 2024 reflected on the energy performance ratings and their effect on rents within the commercial real estate market in the UK. The study shows that there is consistent evidence of rental premiums for more energy efficient buildings, meaning that a property with E-figures A or B command statistically significant rental premiums varying between 10 % and 15 %. Even in regional centres, tenants of properties with an E-figure B are willing to pay 12 % more to rent the property. In addition to this, properties with an E-figure E and F do not command any additional rent in comparison to those with the lowest E-figure G (Ke & White, 2024). Previous studies support the results in Model 3, suggesting that the coefficient is statistically significant with extremely strong evidence of assets with a high E-figure having a positive effect on occupancy rates.

The coefficient for *Renewableenergy* (β = 0.972289) is presented in Figure 12 as Model 4 follows a similar pattern as the coefficient for *Energyclass,* where the t-ratio = 1.187 and p-value = 0.2365. Since the p-value is above conventional significance levels, the study fails to reject the null hypothesis of no effect. This indicates that there is not enough evidence to confirm that on-site renewable energy production has a significant impact on occupancy rates. Renewable energy is seen as a strategic investment, attracting environmentally conscious tenants and providing energy independence for property owners as well as asset users. Properties with renewable energy systems are often found to be more attractive to environmentally conscious tenants. On-site renewable energy production, such as solar panels and heat pumps, have been said to increase the value and attractiveness of commercial properties by reducing operating costs while enhancing sustainability. Several case studies have shown that when a properties or portfolios energy savings are capitalized into a property's cash flow, the value gains have a possibility to exceed the investment costs, especially in urban areas with active where property markets are active and yields are low. Real estate experts have been able to recognise the value of it, but more traditional value practices often fail to capture the full benefits, especially more intangible practises such as improved marketability or tenant satisfaction (Leskinen et al., 2020).

A study conducted in 2024 on ESG ratings and real estate key metrics analysed how ESG performance is related to property-level, financial, outcomes. The research included rent levels, vacancy rates and investment risks. The study found that a higher ESG performance in an asset is generally associated with higher, more stable rental income as well as lower vacancy risks. The study suggests that a higher ESG performance on property level improves tenant demand and retention. In addition to this, the study concludes that ESG is becoming a relevant factor in real estate valuation and overall decision-making, but the impact is required to be studied further to fully standardize this across markets (Vonlanthen, 2024).

5.3 Limitations and uncertainties

The data used in the research was taken from the ESG platform in March 2025 and is analysed in its current state during that period. Since the data is relatively new and transported into the ESG-platform early March 2025, the analysis is based on a short period of time, which only captures a short-term relationship between the sustainability metrics and occupancy rates. A longer observation period would recognize patterns in vacancies and occupancy rates in the asset, and it would make the analysis more content. In addition to this, an extended period would most likely improve the reliability of the findings, and this way lease agreements could be analysed deeper.

The data was found to have come coverage limitations, and some data concerning present sustainability metrics were found to be missing. Relevant property-level data was missing to some extent, which affected the overall data coverage. In short, the data concerning a specific sustainability metric was found to be missing for some assets, which affected the reliability of the data used in the analysis. When a metric was found to be missing, there was an uncertainty whether the sustainability was indeed not found in the asset, or whether the data was incomplete in the platform.

Furthermore, the data was required to be handled manually, which can often increase the likelihood for human error during data preparations and processing. The data collecting was consistent, since the data was collected from one platform, one source. However, the data required to be handled manually due to formatting inconsistencies between the platform and Gretl, and therefore the risk for human error increased, and the possibility for a data coverage limitation due to this matter should not be ignored.

Due to limitations in the received data, the power of the regression model declined and changed the possible outcome. The data should provide a 100 % coverage for each metric and asset, to present the best possible outcome for the analysis.

6 Conclusions

This thesis examines the correlation between sustainability metrics and the occupancy rate of commercial real estate. The purpose was to determine whether commercial assets with higher sustainability standards achieve better occupancy rates. The data used in the analysis is based on data received and collected from a real estate company providing asset management and real estate services for tenants, investors and property owners. The correlation between chosen variables were examined by conducting a regression analysis where sustainability metrics serve as the dependent variable and occupancy rate as the independent variable. The sustainability metrics were chosen based on data accessibility, meaning that the independent variables were selected solely on their wide data coverage per asset in comparison to other sustainability metrics.

The correlation between sustainability metrics and property value of commercial real estate has been studied, but a direct association between sustainability metrics and occupancy rate has been researched far less. This is highly due to privacy matters concerning tenants and property owners, and therefore this type of information is not publicly available and has not been able to be studied closely. To understand the importance of sustainability within commercial real estate, this study relies on previous research presented in chapter 3. When analysing the coefficient *Sustainable,* including all sustainability metrics, Model 1 cannot be considered statistically significant at conventional levels *($p = 0.4228$),* since the model does not provide a strong and reliable explanatory power. The large standard error presented in the model compared to the coefficient indicates several uncertainties and limitations around the estimate. The results are most likely negative due to limitations and gaps in data coverage, where the number of sustainable assets remains rather low and property level data is missing to some extent. However, when analysing the sustainability metrics separately, especially green building certifications, were found to have a positive effect on occupancy rate. Green building certifications were suggested to be statistically significant with a strong positive relationship to occupancy rates. Several studies support this, and green building certifications have been found to be most appealing to property owners, investors and tenants.

In conclusion, a commercial real estate with all sustainability metrics being present is required to be studied further to receive a more accurate result. Due to the secrecy of the company as well as limitations in the received data, the research covered only a limited number of assets with certain sustainability metrics. For future research, the occupancy rate could be controlled better by various important determinants. E.g., analysing the occupancy rate for a longer period and including the possible shifting in the rates could potentially give an insight into rentability patterns and how occupancy rates change over the course of time. Furthermore, a wider data coverage, including e.g. construction year and length of lease could provide the needed accuracy to the study to determine whether the model is statistically significant.

References

Alexandria Real Estate Equities, Inc. 2023. Earnings Press Release & Supplemental Information. 2023. Available at: https://www.sec.gov/Archives/edgar/data/1035443/000103544323000304/a3q23ex991supp.htm?utm_source=chatgpt.com [Accessed: 21.3.2026]

Alka, Rani, Singh, Rajwinder, Taneja, Shilpa, Prasad, B. Arun. 2021. A Review on Key Performance Indicators for Measuring Real Estate Project Success. Available at: https://www.researchgate.net/publication/355758192_A_review_on_key_performance_indicators_for_measuring_real_estate_project_success [Accessed: 24.5.2025]

Birol, Fatih. 2023. Finland 2023: Energy Policy Review. Available at: https://iea.blob.core.windows.net/assets/07c88e41-c17b-4ea1-b35d-85dffd665de4/Finland2023-EnergyPolicyReview.pdf [Accessed: 15.5.2026]

Bocken, Nancy, M.P. and Geradts, Thijs H.J. 2020. Barriers and drivers to sustainable business model innovation: Organization design and dynamic capabilities. Available at: https://www.sciencedirect.com/science/article/pii/S0024630119301062 [Accessed: 24.5.2025]

Bonde, Magnus and Song, Han-Suck. 2013. Does Greater Energy Performance have Impact on Real Estate Revenues? Available at: https://www.researchgate.net/publication/262181615_Does_Greater_Energy_Performance_have_an_Impact_on_Real_Estate_Revenues [Accessed: 3.5.2026]

BRE Global. 2020. BREEAM In-Use International Technical Manual. Available at: https://breeam.com/standards/technical-manuals-form [Accessed: 10.12.2025]

Carlin, David. 2022. United Nations Environment Programme Finance Initiative: 40 % of emissions come from real estate; here's how the sector can decarbonize. Available at: https://www.unepfi.org/themes/climate-change/40-of-emissions-come-from-real-estate-heres-how-the-sector-can-decarbonize/ [Accessed: 15.5.2026]

Chakrabarti, Arijit and Ghosh, Jayanta K. 2011. AIC, BIC and Recent Advances in Model Selection. Available at: https://www.sciencedirect.com/topics/mathematics/akaike-information-criterion?utm_source=chatgpt.com [Accessed: 10.5.2026]

Chegut, Andrea, Eichholz, Piet and Kok, Nils. 2013. Supply, Demand and the Value of Green Buildings. Available at: https://journals.sagepub.com/doi/10.1177/0042098013484526?utm_source=chatgpt.com [Accessed: 3.5.2026]

Fuerst, Franz and McAllister, Patrick. 2020. An Investigation of the Effect of Eco-Labeling on Office Occupancy Rates. Available at: https://www.tandfonline.com/doi/abs/10.1080/10835547.2009.12091793 [Accessed: 3.5.2026]

Geipele, Ineta, Kauskale, Linda, Zvirgzdins, Janis. 2022. The Real Estate Market and its Influencing Factors for Sustainable Real Estate Development: A Case of Latvia. Available at: https://www.researchgate.net/publication/365806850_The_Real_Estate_Market_and_its_Influencing_Factors_for_Sustainable_Real_Estate_Development_A_Case_of_Latvia [Accessed: 25.5.2025]

Ghanad, Anahita. 2023. An overview of quantitative research methods. Available at: https://www.researchgate.net/profile/AnahitaGhanad/publication/373370007_An_Overview_of_Quantitative_Research_Methods/links/67b28ffc645ef274a48341a1/An-Overview-of-Quantitative-Research-Methods.pdf [Accessed: 14.7.2025]

Green Building Council Finland. 2023. Ympäristösertifikaattien määrä jatkaa tasaista kasvua. Available at: https://figbc.fi/ymparistosertifointien-maara-jatkaa-tasaista-kasvua#kaytonaikaiset-breeam-luokitukset-yleistyvat-kovaa-vauhtia-suomessanbsp [Accessed: 22.1.2026]

Gretl. 2023. API reference for libgretl-1.0 version 44.0.0. Available at: https://gretl.sourceforge.net/API/new/gretl/index.html [Accessed: 11.2.2026]

Haakana, Maarit, Laitila, Päivi and Forssell, Kirsi-Maaria. 2020. Implementation of the EPBD Finland, Status in 2020. Available at: https://cdn.ca-

epbd.eu/epbd/Media/638373600619852427/Implementation-of-the-EPBD-in-Finland--2020.pdf [Accessed: 14.10.2025]

Hiilamo, Heikki, Kuitto, Kati, Schoyen Mi Ah. 2024. Finland Report: Sustainable Governance Indicators 2024. Available at: https://www.sgi-network.org/docs/2024/country/SGI2024_Finland.pdf [Accessed: 28.5.2025]

Hu, Minyi, Kok, Nils and Palacios, Juan. 2026. Tenant Satisfaction and Commercial Building Performance. Available at: https://eres.architexturez.net/system/files/P_20230221195520_2606.pdf [Accessed: 28.1.2026]

Hutcheson, G.D. 2011. Ordinary least-squares regression. The SAGE dictionary of quantitative management research, pp. 224-228.

International Energy Agency. 2023. World Energy Outlook 2023. Available at: https://iea.blob.core.windows.net/assets/86ede39e-4436-42d7-ba2a-edf61467e070/WorldEnergyOutlook2023.pdf [Accessed: 22.5.2025]

Ke, Qiulin and White, Michael. 2024. Does Energy Performance Rating Affect Office Rents? A Study of the UK Office Market. Available at: https://discovery.ucl.ac.uk/id/eprint/10193353/1/Does%20Energy%20Performance%20Rating%20Affect%20Office%20Rents%20%20A%20Study%20of%20the%20UK%20Office%20Market.pdf?utm_source=chatgpt.com [Accessed: 22.1.2026]

Kumar, Ashish. 2025. Factors impacting housing prices in National Capital Region (NCR), India: A quantile regression approach. Available at: https://www-emerald-com.ezproxy.cc.lut.fi/pm/article/44/1/68/1278786/Factors-impacting-housing-prices-in-National [Accessed: 25.2.2026]

Kuntarahoitus. 2025. Vihreä rahoitus: Edellytykset ja hakeminen. Available at: https://www.kuntarahoitus.fi/wp-content/uploads/2025/11/Vihrean-rahoituksen-edellytykset-ja-hakeminen-2025.pdf [Accessed: 22.1.2026]

Leskinen, Niina, Vimpari, Jussi and Junnila, Seppo. 2020. A review of the impact of green building certification on the cash flows and values of commercial properties. Available at: https://www.mdpi.com/2071-1050/12/7/2729#B2-sustainability-12-02729 [Accessed: 24.5.2025]

Leskinen, Niina, Vimpari, Jussi and Junnila, Seppo. 2020. The impact of renewable on-site energy production on property values. Available at: https://www.emerald.com/insight/content/doi/10.1108/jerer-11-2019-0041/full/html#ref047 [Accessed: 21.1.2025]

Ou, Yunbei, Bailey, Nick, McArthur, David Philip and Zhao, Qunshan. 2025. The Price Premium of Residential Energy Performance Certificates: A Scoping Review of the European Literature. Available at: https://www.sciencedirect.com/science/article/pii/S0378778825001070?utm_source=chatgpt.com [Accessed: 22.1.2026]

Pai, Reshma, Behl, Aanchal, Joshi, Jyotsna, Jain, Rohit, Sah, Anukriti, Barua, Rohan, Sharda, Damini, Patil, Shubham, Nadar, Vimal, Goel, Shreeda, Kukdolkar, Pallavi and Bhusnur, Shreya. 2022. KPMG & Colliers: Sustainable Real Estate: An Opportunity to Leverage. Available at: https://assets.kpmg.com/content/dam/kpmg/in/pdf/2023/11/sustainable-real-estate-an-opportunity-to-leverage.pdf [Accessed: 22.1.2026]

Ministry of the Environment. 2022. Medium-term Climate Change Policy Plan: Towards a carbon-neutral society in 2035. Available at: https://julkaisut.valtioneuvosto.fi/server/api/core/bitstreams/02e3d635-d4da-4e53-a7b9-3e942d3cf1b0/content [Accessed: 15.5.2026]

Mohr, M. Franz. 2018. An Introduction to Ordinary Least Squares (OLS) in R. Available at: https://www.r-econometrics.com/methods/ols/ [Accessed: 21.1.2026]

Motiva. 2026. Mikä on energiatodistus? Available at: https://www.motiva.fi/tietopankki/energiatodistusneuvonta/mika-on-energiatodistus/#milloin-energiatodistus-tarvitaan-ja-milloin-ei [Accessed: 21.1.2026]

Naseer, Mirza Muhammad, Guo, Yongsheng and Zhu, Xiaoxian. 2025. Short-term costs and long-term gains of ESG initiatives in high-risk environments: Evidence from UK firms. Available at: https://www.sciencedirect.com/science/article/pii/S2950524025000356 [Accessed: 21.1.2026]

Purba, Humiras Hardi, Setiawan Indra. 2020. A Systematic Literature Review of Key Performance Indicators (KPIs) Implementation. Available at:

https://www.researchgate.net/profile/Humiras-Purba/publication/345941517_A_Systematic_Literature_Review_of_Key_Performance_Indicators_KPIs_Implementation/links/5fb3620a45851518fdacb9e0/A-Systematic-Literature-Review-of-Key-Performance-Indicators-KPIs-Implementation.pdf [Accessed: 21.1.2026]

Rubinfeld, Daniel L. and Card, David. 2025. Reference Guide on Multiple Regression and Advanced Statistical Models. Available at: https://www.ncbi.nlm.nih.gov/books/NBK621591/?utm_source=chatgpt.com [Accessed: 21.4.2026]

Saeed, Rana. 2024. Role of Education for Green Technology and Sustainability. Available at: https://bpasjournals.com/library-science/index.php/journal/article/view/957/2284 [Accessed: 21.1.2026]

Segal, Richard S., Niu, Gao. 2020. Open Source Software for Statistical Analysis of Big Data: Emerging Research and Opportunities. Available at: https://www.igi-global.com/book/open-source-software-statistical-analysis/237841 [Accessed: 21.1.2026]

Senna, Asafe Lopesde, Moxotó, Ana Claudia de Araujo. 2025. Carbon emissions and financial performance in the Brazilian stock market. Available at: https://www-sciencedirect-com.ezproxy.cc.lut.fi/science/article/pii/S0301479725006747?via%3Dihub [Accessed: 25.2.2026]

Taboga, Marco. 2021. Linear regression model: Lectures on probability theory and mathematical statistics. Available at: https://www.statlect.com/fundamentals-of-statistics/linear-regression?utm_source=chatgpt.com [Accessed: 25.3.2026]

Temizhan, Ebru, Hamit, Mirtagioglu and Mendes, Mehmet. 2021. Which correlation coefficient should be used for investigating relations between quantitative variables? Available at: https://www.researchgate.net/profile/Ebru-Temizhan/publication/359579944_Which_Correlation_Coefficient_Should_Be_Used_for_Investigating_Relations_between_Quantitative_Variables/links/624445ae21077329f2e26065/Which-Correlation-Coefficient-Should-Be-Used-for-Investigating-Relations-between-Quantitative-Variables.pdf [Accessed: 14.7.2025]

USGBC. 2025. LEED v5 Rating System: Operations and Maintenance. Available at: https://www.usgbc.org/sites/default/files/2025-10/LEED%20v5%20O%2BM%20Rating%20System_November%202025_tracked.pdf [Accessed: 12.12.2025]

Vanags, Janis and Butane, Ilona. 2013. Major Aspects of Development of Sustainable Investment Environment in Real Estate Industry. Available at: https://www.researchgate.net/publication/271891220_Major_Aspects_of_Development_of_Sustainable_Investment_Environment_in_Real_Estate_Industry [Accessed: 11.12.2025]

Vesterinen, Arttu. 2024. 10 Most common KPIs in Commercial Real Estate. Available at: https://blog.falcony.io/en/10-most-common-kpis-in-commercial-real-estate?utm_source=chatgpt.com [Accessed: 12.3.2026]

Vonlanthen, Joël. 2024. ESG Ratings and Real Estate Key Metrics: A Case Study. Available at: https://www.mdpi.com/2813-8090/1/3/14 [Accessed: 2.5.2026]

World Economic Forum. 2025. Why indoor air quality must be a global health priority. Available at: https://www.weforum.org/stories/2025/06/why-indoor-air-quality-must-be-a-global-health-priority/ [Accessed: 12.12.2025]

Kauppinen, Jyrki. 2024. Rakennusten energiatehokkuus. Available at: https://ym.fi/rakennusten-energiatehokkuus [Accessed: 10.12.2025]

Appendices

Appendix 2. Dummy values used in the regression model.

Asset name	Property type	Energy class	BREEAM	Renewable energy	Sustainable	Occupancy rate	Year
1	4. Liikerakennukset	0	1	0	0	1	2025
2	3. Toimistorakennukset	0	1	0	0	1	2025
3	3. Toimistorakennukset	0	0	0	0	1	2025
4	3. Toimistorakennukset	0	1	0	0	1	2025
5	3. Toimistorakennukset	0	1	0	0	1	2025
6	3. Toimistorakennukset	0	1	0	0	1	2025
7	3. Toimistorakennukset	0	1	0	0	1	2025
8	3. Toimistorakennukset	0	0	0	0	0,8075	2025
9	3. Toimistorakennukset	1	1	0	0	1	2025
10	3. Toimistorakennukset	0	0	0	0	1	2025
11	3. Toimistorakennukset	0	0	0	0	1	2025
12	4. Liikerakennukset	0	0	0	0	0,8028	2025
13	3. Toimistorakennukset	0	0	0	0	1	2025
14	3. Toimistorakennukset	0	0	0	0	1	2025
15	3. Toimistorakennukset	0	0	0	0	1	2025
16	3. Toimistorakennukset	0	0	0	0	1	2025
17	3. Toimistorakennukset	0	1	0	0	0,7048	2025
18	3. Toimistorakennukset	0	0	0	0	1	2025
19	3. Toimistorakennukset	0	0	0	0	1	2025
20	3. Toimistorakennukset	0	0	0	0	1	2025
21	3. Toimistorakennukset	0	0	0	0	1	2025
22	3. Toimistorakennukset	1	0	0	0	1	2025
23	4. Toimistorakennukset	0	0	0	0	1	2025
24	3. Toimistorakennukset	1	1	1	1	1	2025
25	4. Liikerakennukset	0	1	0	0	1	2025
26	3. Toimistorakennukset	0	0	0	0	1	2025
27	3. Toimistorakennukset	0	0	0	0	1	2025
28	3. Toimistorakennukset	0	0	0	0	1	2025
29	3. Toimistorakennukset	0	0	0	0	0,8505	2025
30	4. Liikerakennukset	0	0	0	0	1	2025
31	3. Toimistorakennukset	0	1	0	0	1	2025
32	3. Toimistorakennukset	0	1	0	0	1	2025
33	4. Liikerakennukset	1	0	0	0	1	2025
34	4. Liikerakennukset	0	0	0	0	1	2025
35	3. Toimistorakennukset	0	0	1	0	1	2025
36	4. Toimistorakennukset	0	0	0	0	1	2025
37	3. Toimistorakennukset	0	0	0	0	1	2025
38	3. Toimistorakennukset	0	1	1	0	1	2025
39	3. Toimistorakennukset	0	1	0	0	1	2025
40	3. Toimistorakennukset	0	1	0	0	1	2025
41	3. Toimistorakennukset	0	1	0	0	1	2025
42	3. Toimistorakennukset	0	0	0	0	1	2025
43	3. Toimistorakennukset	0	0	0	0	1	2025
44	3. Toimistorakennukset	0	0	0	0	0,3771	2025
45	3. Toimistorakennukset	0	0	0	0	1	2025
46	3. Toimistorakennukset	0	0	0	0	1	2025
47	3. Toimistorakennukset	0	1	0	0	1	2025
48	3. Toimistorakennukset	0	1	0	0	1	2025
49	3. Toimistorakennukset	0	1	1	0	1	2025
50	4. Liikerakennukset	0	0	0	0	1	2025
51	3. Toimistorakennukset	0	0	0	0	0,9427	2025
52	3. Toimistorakennukset	0	0	0	0	1	2025
53	3. Toimistorakennukset	0	0	0	0	1	2025
54	3. Toimistorakennukset	0	0	0	0	1	2025
55	3. Toimistorakennukset	0	0	0	0	1	2025
56	3. Toimistorakennukset	0	1	0	0	1	2025
57	3. Toimistorakennukset	0	1	0	0	1	2025
58	3. Toimistorakennukset	0	0	0	0	0,8041	2025
59	3. Toimistorakennukset	0	0	0	0	1	2025
60	3. Toimistorakennukset	0	1	0	0	0,9578	2025
61	3. Toimistorakennukset	1	1	0	0	0,9768	2025
62	9. Muut rakennukset	0	0	0	0	1	2025
63	3. Toimistorakennukset	1	0	1	0	1	2025
64	3. Toimistorakennukset	0	0	0	0	1	2025
65	9. Muut rakennukset	0	0	0	0	1	2025

66	3. Toimistorakennukset	0	1	0	0	1	2025
67	3. Toimistorakennukset	0	1	0	0	1	2025
68	3. Toimistorakennukset	0	0	0	0	1	2025
69	3. Toimistorakennukset	0	1	0	0	1	2025
70	3. Toimistorakennukset	0	1	0	0	1	2025
71	3. Toimistorakennukset	0	0	0	0	1	2025
72	3. Toimistorakennukset	0	1	0	0	1	2025
73	3. Toimistorakennukset	0	1	0	0	1	2025
74	3. Toimistorakennukset	0	0	0	0	1	2025
75	3. Toimistorakennukset	0	0	0	0	1	2025
76	3. Toimistorakennukset	0	0	0	0	1	2025
77	3. Toimistorakennukset	0	0	0	0	1	2025
78	3. Toimistorakennukset	0	0	0	0	1	2025
79	3. Toimistorakennukset	1	0	0	0	1	2025
80	3. Toimistorakennukset	0	0	0	0	1	2025
81	3. Toimistorakennukset	0	0	0	0	1	2025
82	9. Muut rakennukset	1	1	1	1	1	2025
83	3. Toimistorakennukset	0	1	0	0	1	2025
84	3. Toimistorakennukset	0	0	0	0	0,6511	2025
85	5. Liikerakennukset	0	0	0	0	0,5947	2025
86	3. Toimistorakennukset	0	0	0	0	1	2025
87	3. Toimistorakennukset	1	0	1	0	1	2025
88	3. Toimistorakennukset	1	0	0	0	0,8895	2025
89	4. Liikerakennukset	0	0	0	0	0,6087	2025
90	4. Liikerakennukset	0	0	0	0	0,8332	2025
91	3. Toimistorakennukset	0	0	0	0	1	2025
92	3. Toimistorakennukset	0	0	0	0	0,904	2025
93	3. Toimistorakennukset	0	0	0	0	1	2025
94	3. Toimistorakennukset	1	0	0	0	0,9851	2025
95	3. Toimistorakennukset	0	0	0	0	1	2025
96	3. Toimistorakennukset	0	0	0	0	1	2025
97	3. Toimistorakennukset	1	1	0	0	1	2025
98	9. Muut rakennukset	0	0	1	0	1	2025

99	3. Toimistorakennukset	0	0	1	0	1	2025
100	4. Liikerakennukset	1	0	0	0	1	2025
101	3. Toimistorakennukset	0	1	0	0	1	2025
102	5. Liikerakennukset	0	0	0	0	1	2025
103	3. Toimistorakennukset	1	1	0	0	0,6622	2025
104	3. Toimistorakennukset	0	0	0	0	1	2025
105	3. Toimistorakennukset	1	1	1	1	0,5012	2025
106	3. Toimistorakennukset	0	0	0	0	0,456	2025
107	3. Toimistorakennukset	0	1	0	0	1	2025
108	3. Toimistorakennukset	1	0	1	0	1	2025
109	4. Toimistorakennukset	1	0	0	0	1	2025
110	3. Toimistorakennukset	0	0	0	0	1	2025
111	4. Liikerakennukset	0	0	0	0	1	2025
112	4. Liikerakennukset	1	0	0	0	1	2025
113	3. Toimistorakennukset	0	0	0	0	1	2025
114	4. Liikerakennukset	1	0	0	0	1	2025
115	3. Toimistorakennukset	0	0	0	0	1	2025
116	3. Toimistorakennukset	1	0	0	0	1	2025
117	4. Liikerakennukset	0	0	0	0	1	2025
118	4. Liikerakennukset	0	0	0	0	1	2025
119	3. Toimistorakennukset	1	0	1	0	1	2025
120	9. Muut rakennukset	1	0	0	0	1	2025
121	3. Toimistorakennukset	0	1	1	0	1	2025
122	3. Toimistorakennukset	1	0	0	0	1	2025
123	3. Toimistorakennukset	1	1	0	0	1	2025
124	3. Toimistorakennukset	0	0	0	0	1	2025
125	3. Toimistorakennukset	0	0	0	0	1	2025
126	3. Toimistorakennukset	0	0	0	0	0,5066	2025
127	3. Toimistorakennukset	1	0	0	0	1	2025
128	3. Toimistorakennukset	0	0	0	0	1	2025
129	4. Toimistorakennukset	0	0	0	0	1	2025
130	3. Toimistorakennukset	0	1	0	0	0,7593	2025
131	3. Toimistorakennukset	0	1	0	0	1	2025

132	3. Toimistorakennukset	0	0	0	0	0,9053	2025
133	3. Toimistorakennukset	1	0	0	0	1	2025
134	3. Toimistorakennukset	1	0	0	0	1	2025
135	5. Liikerakennukset	0	0	0	0	1	2025
136	ıkennukset ja erilliset moottoriajı	0	1	0	0	1	2025
137	3. Toimistorakennukset	0	0	1	0	1	2025
138	3. Toimistorakennukset	0	0	1	0	1	2025
139	3. Toimistorakennukset	0	0	0	0	1	2025
140	3. Toimistorakennukset	0	0	0	0	1	2025
141	3. Toimistorakennukset	0	0	0	0	1	2025
142	3. Toimistorakennukset	0	1	0	0	1	2025
143	3. Toimistorakennukset	1	1	0	0	1	2025
144	3. Toimistorakennukset	1	1	0	0	1	2025
145	3. Toimistorakennukset	0	1	0	0	1	2025
146	3. Toimistorakennukset	0	0	0	0	1	2025
147	3. Toimistorakennukset	0	1	0	0	1	2025
148	3. Toimistorakennukset	0	1	0	0	1	2025
149	3. Toimistorakennukset	0	1	0	0	1	2025
150	3. Toimistorakennukset	0	0	1	0	1	2025
151	3. Toimistorakennukset	0	1	0	0	1	2025
152	3. Toimistorakennukset	0	1	0	0	1	2025
153	3. Toimistorakennukset	0	1	0	0	1	2025
154	3. Toimistorakennukset	0	0	0	0	1	2025
155	3. Toimistorakennukset	0	1	0	0	1	2025
156	3. Toimistorakennukset	0	1	0	0	1	2025
157	3. Toimistorakennukset	0	1	0	0	1	2025
158	3. Toimistorakennukset	0	1	0	0	1	2025
159	3. Toimistorakennukset	0	1	0	0	1	2025
160	3. Toimistorakennukset	0	1	0	0	1	2025
161	3. Toimistorakennukset	0	1	0	0	1	2025
162	3. Toimistorakennukset	0	1	0	0	1	2025
163	3. Toimistorakennukset	0	0	0	0	1	2025
164	3. Toimistorakennukset	0	1	0	0	1	2025

165	3. Toimistorakennukset	0	1	0	0	1	2025
166	3. Toimistorakennukset	0	1	0	0	1	2025
167	3. Toimistorakennukset	0	1	0	0	1	2025
168	3. Toimistorakennukset	0	1	0	0	1	2025
169	3. Toimistorakennukset	0	1	0	0	1	2025
170	3. Toimistorakennukset	0	1	0	0	1	2025
171	3. Toimistorakennukset	0	1	0	0	1	2025
172	3. Toimistorakennukset	0	1	0	0	1	2025
173	3. Toimistorakennukset	0	1	0	0	1	2025
174	3. Toimistorakennukset	0	1	0	0	1	2025
175	3. Toimistorakennukset	0	1	0	0	1	2025
176	3. Toimistorakennukset	0	1	0	0	1	2025
177	3. Toimistorakennukset	0	1	0	0	1	2025
178	3. Toimistorakennukset	0	1	0	0	1	2025
179	3. Toimistorakennukset	0	1	0	0	1	2025
180	3. Toimistorakennukset	0	1	0	0	1	2025
181	3. Toimistorakennukset	0	1	0	0	1	2025
182	3. Toimistorakennukset	0	1	0	0	1	2025
183	3. Toimistorakennukset	0	1	0	0	1	2025
184	3. Toimistorakennukset	0	1	0	0	1	2025
185	3. Toimistorakennukset	0	1	0	0	1	2025
186	3. Toimistorakennukset	0	1	0	0	1	2025
187	3. Toimistorakennukset	0	1	0	0	0,5809	2025
188	3. Toimistorakennukset	0	1	0	0	1	2025
189	3. Toimistorakennukset	0	1	0	0	1	2025
190	3. Toimistorakennukset	0	1	0	0	0,8317	2025
191	3. Toimistorakennukset	0	1	0	0	1	2025
192	3. Toimistorakennukset	0	0	1	0	1	2025
193	3. Toimistorakennukset	0	1	0	0	1	2025
194	3. Toimistorakennukset	0	1	0	0	1	2025
195	3. Toimistorakennukset	0	1	0	0	1	2025
196	3. Toimistorakennukset	0	0	1	0	1	2025
197	3. Toimistorakennukset	0	0	0	0	0	2025

198	3. Toimistorakennukset	0	0	0	0	0,7663	2025
199	3. Toimistorakennukset	0	0	0	0	0,4625	2025
200	3. Toimistorakennukset	0	0	0	0	0,477	2025
201	3. Toimistorakennukset	0	0	0	0	0,7216	2025
202	3. Toimistorakennukset	0	0	0	0	0,2592	2025
203	3. Toimistorakennukset	0	0	0	0	0,6835	2025
204	3. Toimistorakennukset	0	0	0	0	0,7823	2025
205	3. Toimistorakennukset	0	1	0	0	0,8195	2025
206	3. Toimistorakennukset	0	0	0	0	0	2025
207	3. Toimistorakennukset	0	0	0	0	0,8968	2025
208	3. Toimistorakennukset	0	0	0	0	0,3893	2025
209	3. Toimistorakennukset	0	1	0	0	0,6457	2025
210	3. Toimistorakennukset	0	0	0	0	0	2025
211	3. Toimistorakennukset	0	0	0	0	0,8854	2025
212	3. Toimistorakennukset	0	0	0	0	0,9591	2025
213	3. Toimistorakennukset	0	0	0	0	0,6086	2025
214	3. Toimistorakennukset	0	0	0	0	0,6769	2025
215	3. Toimistorakennukset	0	0	0	0	0,5708	2025
216	3. Toimistorakennukset	0	0	0	0	0,983	2025
217	3. Toimistorakennukset	0	0	0	0	0	2025
218	3. Toimistorakennukset	0	0	0	0	0,9231	2025
219	3. Toimistorakennukset	0	0	0	0	0,465	2025
220	3. Toimistorakennukset	0	0	0	0	0,9078	2025
221	3. Toimistorakennukset	0	0	0	0	0,8971	2025
222	3. Toimistorakennukset	0	0	0	0	0,9249	2025
223	3. Toimistorakennukset	0	0	0	0	0,6763	2025
224	3. Toimistorakennukset	0	0	0	0	0,5765	2025
225	3. Toimistorakennukset	0	0	0	0	0,9819	2025
226	3. Toimistorakennukset	0	0	0	0	0,4064	2025
227	3. Toimistorakennukset	0	0	0	0	0,9538	2025
228	3. Toimistorakennukset	0	0	0	0	0,872	2025
229	3. Toimistorakennukset	0	0	0	0	0,914	2025