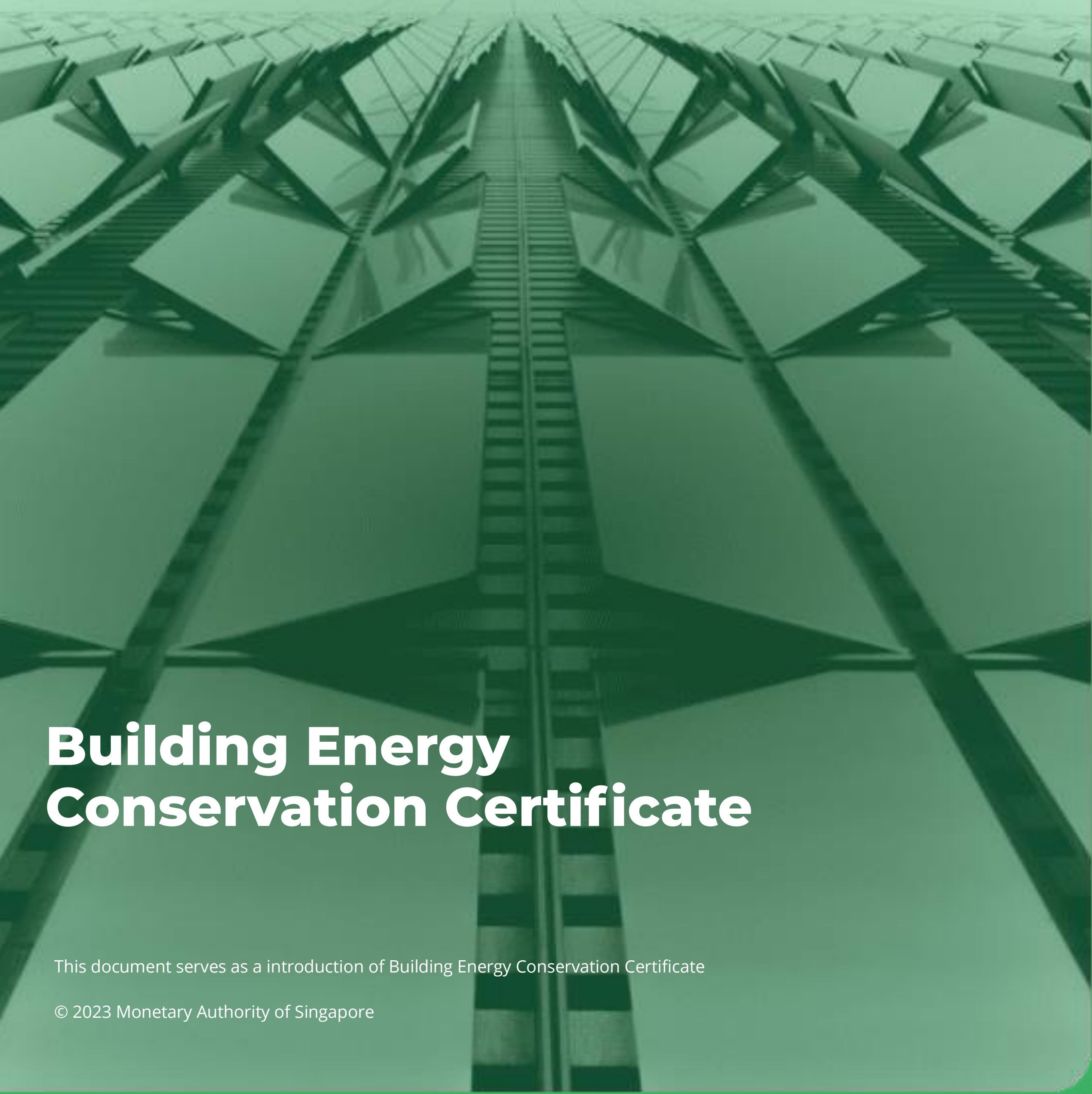

Building Energy Conservation Certificate

This document serves as a introduction of Building Energy Conservation Certificate

For any enquiry, please contact the point of contact at **sleb@bca.gov.sg**.

1. Background

Singapore Sustainability Goals

Singapore has been committed to fulfilling its commitments under the Paris Agreement, even though Singapore contributes for only 0.1% of global emissions. The Singapore 2030 Green Plan sets out specific targets for Singapore over the next 10 years, reinforces Singapore's commitments under the United Nations 2030 Agenda for Sustainable Development and the Paris Agreement, and positions Singapore to achieve long-term net-zero emissions by 2050 wishes. Singapore has pledged to reduce its emissions intensity by 36% from 2005 levels by 2030 and stabilize greenhouse gas emissions, aiming to peak around 2030. Reduce the building's carbon emission is an important part of meeting the Singapore 2030 Green Plan.

Singapore's Buildings Sustainability Goals

Buildings in Singapore account for more than 20% of the country's total carbon emissions, and reducing carbon emissions from buildings is crucial for the country to meet its commitments. The Singapore Building and Construction Authority (BCA) and Singapore Green Building Council (SGBC) has set a Singapore Green Building Masterplan (SGBMP) edition 4 in March 2021. SGBMP set up three key targets of "80-80-80" in 2030, which include 80% of Singapore's buildings (by Gross Floor Area) to be green by 2030, 80% of new buildings (by Gross Floor Area) to be Super Low Energy buildings from 2030, and Best-in-class green buildings to see an 80% improvement in energy efficiency (over 2005 levels) by 2030. In this context, BCA has made the following efforts to help Singapore achieve its goals.

2. History

Green Mark Certification Scheme

The BCA has been leading the charge in promoting sustainable and energy-efficient building practices. A key component of this initiative is the BCA Green Mark Certification Scheme[1]. This is an internationally recognised green building certification program that evaluates a building's environmental impact and overall performance. According to Ministry of National Development (MND)[2], as of end-2020, more than 4,000 building projects in Singapore have met the BCA Green Mark standards. These cover about 123 million sqm, which is more than 43% of the total gross floor area of Singapore's building stock. It serves as a comprehensive framework to encourage sustainable design, as well as best practices in construction and operations of buildings. It is under this umbrella that the BCA has launched the Super Low Energy Building (SLEB) Programme.

SLEB Programme

The Super Low Energy Building (SLEB) Programme is a more ambitious initiative, aimed at promoting best-in-class energy efficiency in building design and operations. The programme not only emphasizes the importance of conserving energy but also the use of on-site and off-site renewable energy, combined with intelligent energy management strategies. This is a forward-looking move by BCA to set higher benchmarks for energy efficiency in buildings. The ultimate recognition under this initiative is the Green Mark SLE certification, awarded to super low energy buildings that achieve at least 60% energy savings compared to the 2005 building codes (see Fig.1), used as a benchmark.

[1] https://www1.bca.gov.sg/buildsg/sustainability/green-mark-certification-scheme/
[2] https://www.mnd.gov.sg/our-work/greening-our-home/bca-green-mark

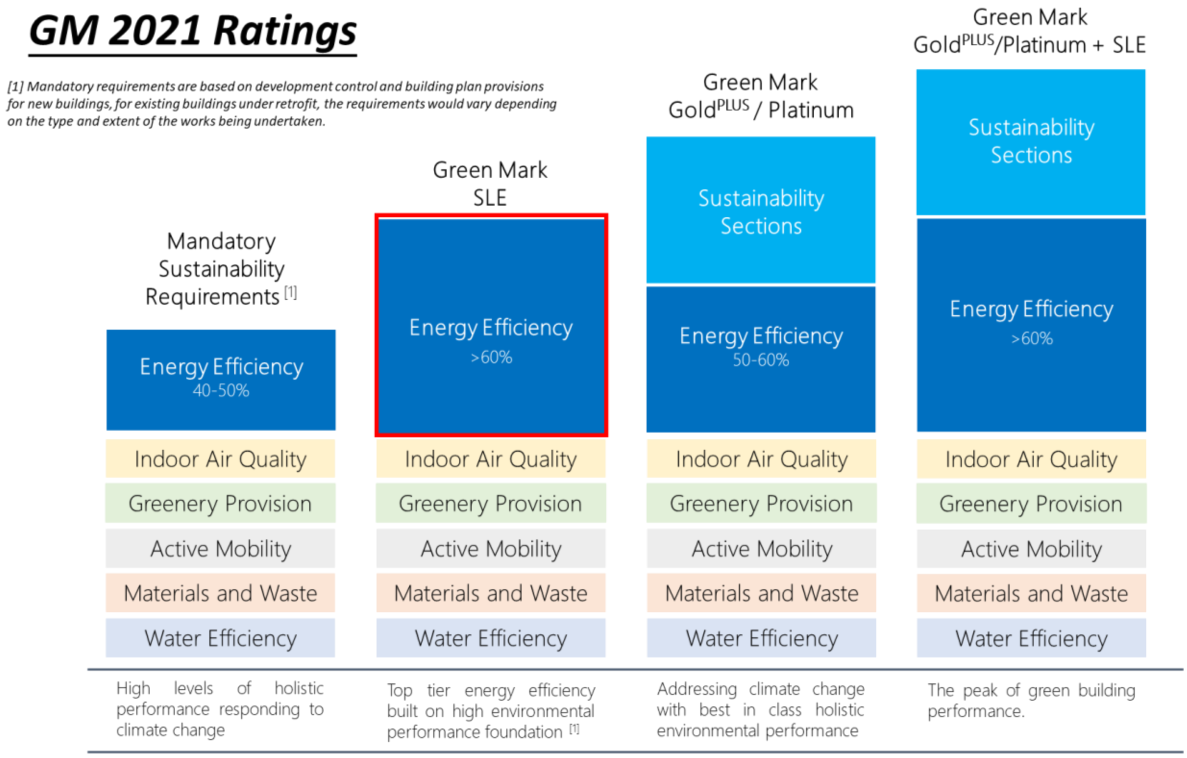

Figure 1 Green Mark Super Low Energy Building requirement

<u>SLEB Smart Hub</u>

To further support and facilitate the industry's move towards super low energy buildings, BCA has also launched the Super Low Energy Building Smart Hub in September 2019. This digital platform serves as a one-stop digital platform that enables super low energy buildings through its wealth of data, actionable insights, and advanced analytical tools. It aids in the sharing of best practices and successful case studies, encouraging the industry to continually innovate and raise the bar for energy efficiency in building design and management.

<u>Project NovA!</u>

Project NovA! is a standardised green financial instrument for Financial Institutions (FIs) launched by MAS in June 2022 and is part of the National Artificial Intelligence (AI) Programme in Finance, The aim is to help FIs use AI to spot financial risks and provide lender risk assessments to FIs at all stages of the sustainability linked loan. Project NovA!'s functions include helping FIs to assess corporate sustainability linked loan risks, comparing the historical performance of real estate enterprise borrowers to ensure that borrowers' sustainability indicators can be improved, and assisting FIs to set reasonable sustainability performance targets (SPTs) for lenders. And through the application of AI, relevant information is automatically extracted from documents. This will FIs better hedge against possible sustainability linked loan risk, screen suitable borrowers, and reduce FIs' overall operation costs

<u>AI-powered Building Energy Model</u>

Leveraging historical big data from past Green Mark projects, the Building and Construction Authority (BCA) and Monetary Authority of Singapore (MAS) jointly developed an advanced, AI-powered building energy model. This will henceforth be referred to as the "AI model". This innovative model offers a compelling alternative to traditional physical model-based energy modelling. Even with significantly fewer inputs and reduced computation time, this data-driven AI model delivers accuracy that aligns with industry benchmarks. It can estimate the key energy performance metrics, such as building's Energy Use Intensity (EUI) and the percentage of energy savings relative to the Green Mark baseline and the 2005 code compliance level. This model essentially creates a digital twin of a building's energy system, offering a powerful tool for estimating and improving energy efficiency.

3. What are Building Energy Conservation Certificate?

The Energy Conservation Certificate (ECC) serves as a prestigious recognition awarded to building owners who have successfully implemented measures to secure energy savings exceeding the Energy Efficiency (EE) benchmark. This benchmark signifies a monumental percentage of energy savings compared to the 2005 Green Mark benchmark. Please refer to Table 1 for the specific percentage targets by year for buildings constructed before and after the year 2022. In essence, the ECC quantifies the annual energy conservation efforts of a building. Each certificate represents one megawatt-hours (MWh) of energy that has been avoided yearly in an existing building, owing to the adoption of energy-efficient measures. This transformative initiative not only acknowledges but also quantifies the substantial efforts made to enhance building energy efficiency.

4. Why Need a Building Energy Conservation Certificate?

While the BCA Green Mark certification scheme acknowledges buildings that attain Super Low Energy, Zero Energy, and Positive Energy standards, there is a 40% energy savings gap between Super Low Energy (i.e., 60% energy savings over the 2005 Green Mark benchmark) and Zero Energy (i.e., 100% energy savings over the 2005 Green Mark benchmark). The ECC fills this void, recognizing and quantifying energy conservation efforts that exceed the Energy Efficiency (EE) threshold. Furthermore, the ECC could potentially be converted into a tradable commodity, providing an additional revenue stream for building owners who invest further in reducing building energy consumption.

In addition, there is a lack of trusted mechanisms for financial institutions to offer sustainability-linked loans to building owners or corporations. With ECC, financial institutions have a reliable reference to evaluate the sustainability efforts of building owners or corporations, enabling them to adjust interest rates based on these efforts.

5. The Benefits

Securing an ECC makes buildings or corporations eligible for green and sustainability-linked loans, allowing them to enjoy preferential interest rates by achieving superior energy savings. Additionally, ECC holders can potentially convert their certificates into tradable carbon credits. These credits can then be sold as commodities to entities requiring them to offset their carbon tax. Given that the Singapore carbon tax is set to increase to S$25/t$CO_2$e in 2024 and 2025, and S$45/t$CO_2$e in 2026 and 2027, aiming to reach S$50-80/t$CO_2$e by 2030, the potential revenue from selling carbon offsets could be substantial.

For instance, consider a 20,000 sqm building that saves 20 kWh/m^2 annually, resulting in an energy savings of 400 MWh/year. The equivalent CO_2 emissions reduction, based on Singapore's grid emission factor of 0.4057 kgCO_2/kWh in 2021, would be 162.28 tonnes of CO_2 (tCO_2e). With the projected carbon tax of S$50-80/t$CO_2$e, the estimated annual revenue from selling carbon offsets could range between S$ 8,000 and S$ 13,000 by 2030.

The Energy Conservation Certificate (ECC) plays a pivotal role in realising Singapore's Green Plan 2030. It does so by supplying reliable energy saving data and implementing strategic mechanisms that guide the decarbonization process within the built environment. This pivotal initiative underscores the commitment towards achieving a sustainable future in line with the city-state's broader environmental goals.

6. Who are eligible to get Energy Conservation Certificate?

Buildings that are capable of reducing their energy consumption beyond the benchmark set by the Super Low Energy level qualify to receive the Energy Conservation Certificate (ECC). This certificate serves as recognition for those properties that significantly contribute to environmental sustainability through advanced energy-saving measures.

7. How to Compute the Building Energy Conservation?

Consistent with BCA Green Mark 2021, ECC could be applied to building projects for:

- Retrofitting
- In Operation

7.1 Overall process

The determination of energy conservation outcomes is conducted via a meticulous and robust process, depicted in Figure 1. The process encompasses the collection of factual data, including variables such as the actual energy consumption of the building, intrinsic characteristics of the building, key performance indicators of the building's energy usage, and corresponding weather data.

This collected raw data is subsequently analysed and utilized in a calibration process, leveraging advanced AI-powered building energy models to deduce attributes specific to the building in question.

Upon obtaining these building-specific attributes, they act as a foundation to create a baseline model. This baseline model is instrumental in the calculation of the baseline energy consumption. The latter serves as a benchmark, setting the stage for the calculation of energy savings.

The measurement of energy savings is performed by comparing the actual energy consumption with the predetermined threshold derived from the baseline model. The energy savings are then quantified as the difference between the actual and threshold energy consumption. This highlights the quantity of energy consumption that has been successfully avoided, reflecting the effectiveness of energy conservation efforts.

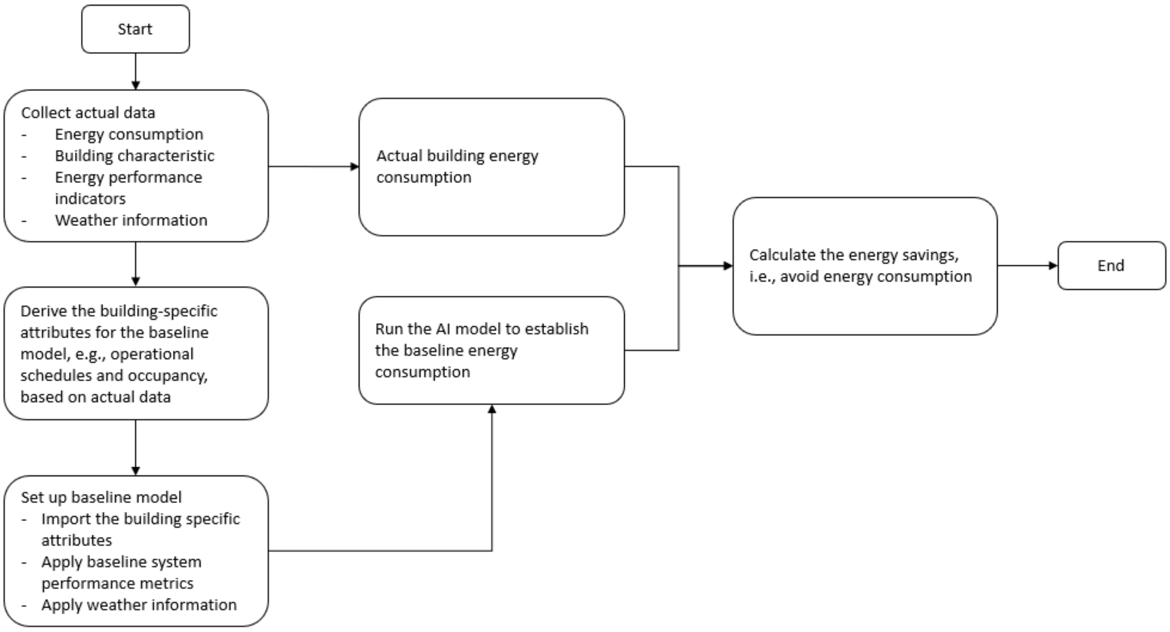

Figure 2 Process of Energy Conservation Generation

The following sections explain the calculation methodology in detail.

7.2 Derivation of building-specific attributes

Building-specific attributes (e.g., gross floor area, operation schedule, and occupancy density) are needed to generate the baseline energy consumption. It encompasses various data that can be obtained or derived from the collected data. Some attributes, such as the gross floor area, can be directly obtained through user input. However, acquiring accurate values for other attributes, like occupancy density, can be more challenging. In such cases, a calibration process can be employed to determine these values.

Figure 2 illustrates the process of deriving building-specific attributes. Available data, including obtained building-specific attributes, system performance metrics, and weather data, are input into an AI model. Simultaneously, different values of the building-specific attributes to be derived are also input into the AI model in an iterative process. The building-specific attributes which allows the AI model to generate an output energy consumption that closely matches the actual energy consumption data will be selected as the output and utilized in the baseline model.

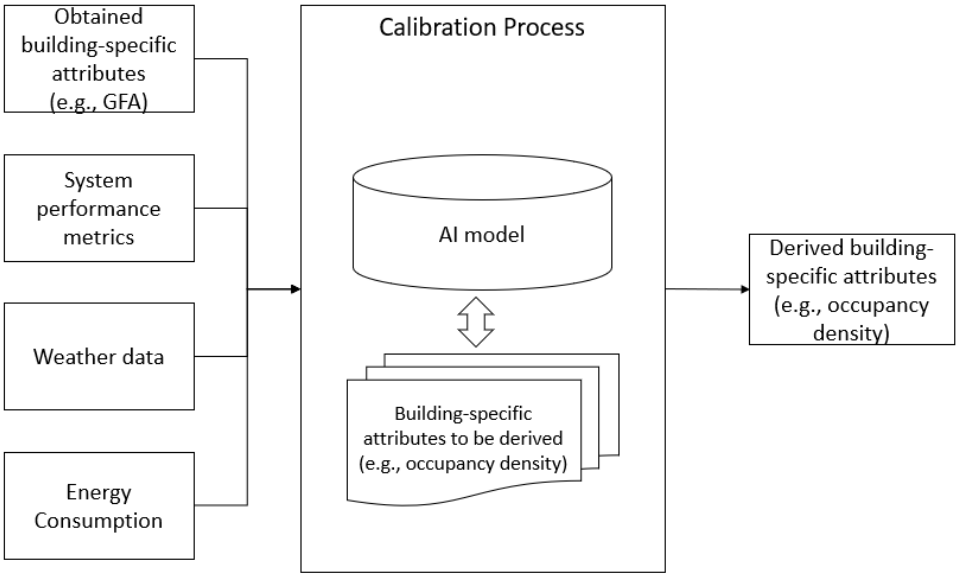

Figure 3 Building-specific attributes derivation process

7.3 Baseline model set-up

The baseline model is constructed using various input data, encompassing building characteristics (e.g., gross floor area, air-conditioning area), operation schedules, occupancy density, weather data and system efficiencies (e.g., air-conditioning system efficiency). These data can be classified into three categories: baseline system performance metrics, building-specific attributes and weather data, as shown in Figure 3.

Baseline system performance metrics pertains to the system's baseline performance, including metrics such as baseline ETTV (Envelope Thermal Transfer Value), air-conditioning system efficiency, and other relevant factors that influence the building's energy performance.

Building-specific attributes, on the other hand, comprises information that should accurately reflect the actual building's attributes. This includes details like gross floor area, operation schedule, and occupancy density, ensuring that the baseline model is representative of the specific building being analyzed. The building-specific attributes can be obtained or derived from the collected information, as explained above.

Weather data involves data that captures the prevailing weather patterns and conditions surrounding the building. This data accounts for the influence of external factors, such as temperature, humidity, and solar radiation, on the building's energy performance.

The AI model receives input data consisting of the three types and utilizes its algorithms to generate the baseline energy consumption. The AI model is a powerful tool that leverages comprehensive datasets and advanced algorithms to generate the baseline energy consumption. It incorporates building system modelling algorithms and machine learning algorithms to ensure accuracy and reliability.

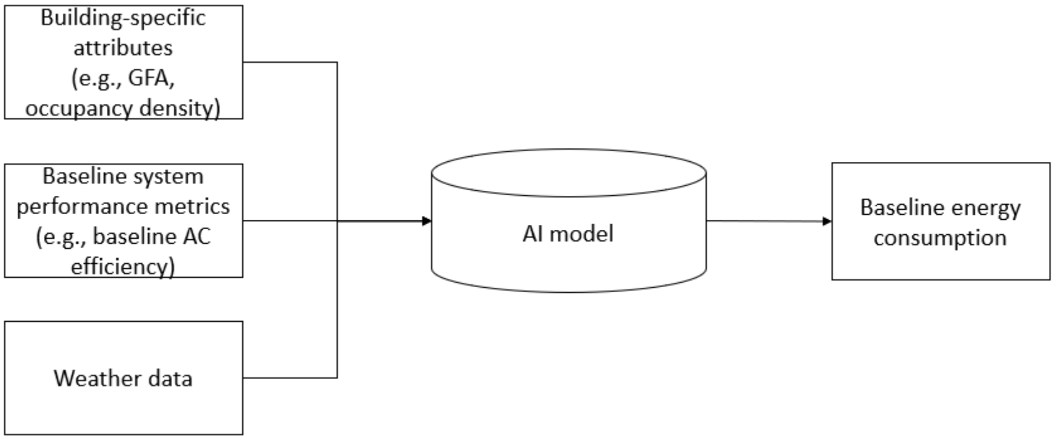

Figure 4 Baseline energy consumption generation process

7.4 Energy conservation calculation method

In Figure 4, the computation of energy conservation for retrofitting and in-operation projects is illustrated. The process involves measuring the building's energy consumption on an annual basis and comparing it against a predefined threshold.

The threshold is derived from the baseline energy consumption generated by the baseline model, specifically the 2005 virtual energy model. To establish the threshold, a 60% savings target is applied to the baseline energy consumption. This means that the threshold represents a consumption level that is 60% lower than what would be expected based on the baseline model.

To calculate the energy conservation, the actual energy consumption of the building is subtracted from the threshold consumption. This difference reflects the amount of energy ~~saved or~~ conserved compared to the threshold. A positive value indicates energy conservation, indicating that the building's energy consumption is below the threshold. Conversely, a negative value implies that the building's energy consumption exceeds the threshold.

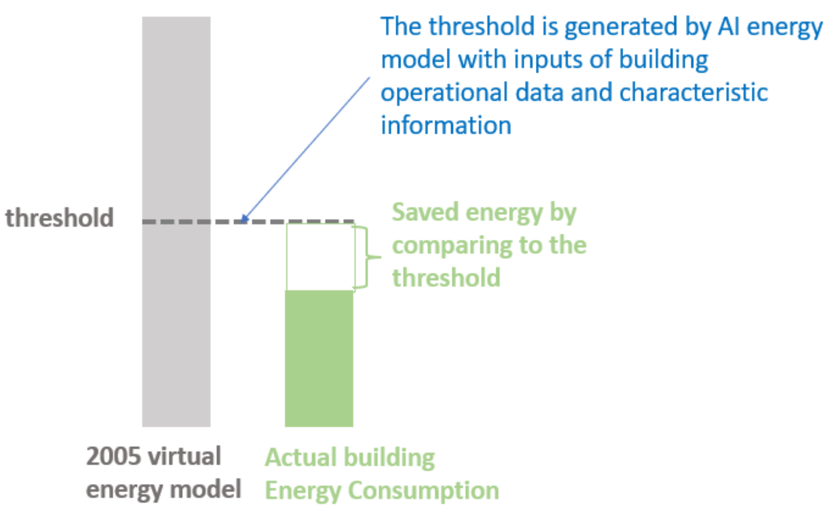

Figure 5 Building Energy Consumption vs Baseline Consumption

8. Process for Issuing the Energy Conservation Certificate

Utilizing a centralized monitoring, reporting, and verification portal, the process of issuing the Energy Conservation Certificate (ECC) has been fully digitized and automated, thereby ensuring accuracy and efficiency. Here's how it works:

Step 1: The applicant registers as a member on SLEB.sg, designating themselves as the building owner, and grants permission for data-sharing.

Step 2: The applicant then utilizes the 'My Building' feature of the SLEB platform to submit their building data. This data can be automatically populated if it's already available on the SLEB platform. Alternatively, the building’s energy management system can be connected to SLEB via APIs to feed in the relevant information.

Step 3: The SLEB-NovA! AI model then computes the energy savings above the established threshold, subsequently determining the number of MWhs of consumption that have been avoided.

Step 4: Once processed, the applicant can download the e-certificate directly from the SLEB platform. After the e-certificate is issued, the energy conservation balance is reset to zero to prevent any potential double-counting of energy savings.