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Sustainability assessment of a laboratory building: case study of highest rated laboratory building in Singapore using Green Mark rating system

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Abstract

Laboratory intensive buildings pose a distinctive challenge in sustainable building design, since they represent energy guzzling spaces due to unique operation and energy demanding activities. Academic Block North (ABN), a laboratory intensive building in Singapore begs to differ from this norm by demonstrating 42% energy savings compared to a building constructed based on code standards. This paper highlights the process of sustainability assessment of ABN to achieve 126 points to go beyond Green Mark Platinum standards for a non-residential building. Such an approach and framework can be applied to other buildings to achieve higher energy efficiency and sustainability benchmarks.

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Keywords: Building performance evaluation, Laboratory Building, Energy Efficiency, Indoor Environment Quality, Sustainable building design, Green Mark, Green Infrastructure

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1. Introduction

In order to address climate change and reducing CO_2 emissions, Singapore has committed to reducing its emission index by 36% from 2005 levels by 2030 [1]. As non-residential commercial buildings consume about 37% of the total electricity [2], the building sector has a critical role in reducing the national energy consumption and carbon emissions. Moreover, laboratory buildings are highly energy intensive due to their unique operation and energy requirements and on an average end up using 5 to 10 times more energy per square foot than office buildings [3]. The main reason for the high-energy consumption in laboratory facilities, is the requirement to provide high ventilation rates and the associated air conditioning loads.

Being a leading advocate for green buildings, Singapore has set up an ambitious target of having 80% green buildings by 2030 [4]. Spearheading this movement is the Green Mark (GM) green building rating scheme, launched in 2005 to provide a platform to asses and improve the overall environmental credentials of buildings. Although the GM scheme was launched more than two decades ago, little has been publicized in literature, especially with regards to the building performance results while compared to more popular green building rating scheme like LEED which have been studied in detail [5] [6] [7] [8] [9]. There has been sporadic mention of GM in studies that compare the assessment criteria between different green building rating schemes [10] [11] and an assessment of the awareness of GM rating scheme by the occupants of the GM building as well as general public [12]. In this study, the results of using GM as a sustainability assessment criterion for a real building located in Singapore is highlighted.

2. Case Study

The case study building is located at the Nanyang Technological University (NTU) campus in Singapore, and is surrounded by four existing buildings as shown in Figure 1. The building is a seven-story academic building with a Gross Floor Area (GFA) of 29,578 m^2. More details of this building can be found in Table 1. This building is a multi-tenanted, laboratory intensive building. It is estimated to allocate 70% of the occupied space as laboratory spaces and the rest as office spaces.

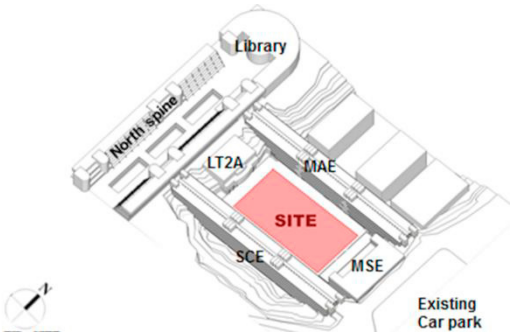

Figure 1: Building Site Plan

Table 1: Project brief

Site Area	5,742 m^2
Location	61 Nanyang Drive, Singapore 637335
GFA	29,578 m^2
Building Footprint	4,942 m^2
No. of Floors	7
Building Height	30.95 m
Building Orientation	North

The project team conducted design charrettes with the major stakeholders of the building to establish key project performance indicators based on the GM assessment criteria. Based on these performance indicators, technology recommendations were made to achieve these targets. For a more realistic understanding of the amalgamation of the technologies and performance, building modelling and energy simulations were performed. Finally, the design was developed via an iterative process to review the existing technology recommendations and results of the simulations. These changes led to achieving the requirements of the GM assessment criteria.

In the assessment of ABN, the BCA GM for New Non-Residential Buildings (Version NRB/4.1) is considered. To achieve a GM Award, the prerequisite requirements in different GM Rating sections must be fully obtained according to the new non-residential building criteria [13]. ABN in its aspiration to strive for higher energy savings qualified for the GM Incentive Scheme – Design prototype (GMIS-DP) for which the building targeted to achieve beyond GM Platinum; and demonstrate energy savings of at least 40% better than current base code or equivalent [14]. This scheme