UNIVERSITAS
GADJAH MADA
**Evaluasi Kinerja Keberlanjutan Operasional Gedung Smart and Green Learning Center FT UGM Berdasarkan
Emisi Karbon Operasional dan Konservasi Air Menggunakan Pendekatan Baseline Building**
Lulu Finka Hariyono, Ir. Nurul Alvia Istiqomah, S.T., M.Sc., Ph.D. IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

INTISARI

Sektor bangunan merupakan salah satu penyumbang emisi karbon terbesar akibat tingginya aktivitas selama masa operasional bangunan. Penerapan konsep *green building* diharapkan mampu menekan dampak lingkungan tersebut melalui strategi efisiensi energi, konservasi air, dan pengelolaan sampah yang berkelanjutan. Gedung Smart and Green Learning Center (SGLC) Fakultas Teknik Universitas Gadjah Mada merupakan bangunan pendidikan yang telah menerapkan berbagai fitur *green building* sehingga perlu dievaluasi kontribusinya terhadap pengurangan emisi karbon operasional.

Penelitian ini bertujuan untuk menguantifikasi konsumsi energi dan emisi karbon operasional bangunan, menganalisis pengelolaan sampah dan konservasi air, mengevaluasi manfaat penerapan *green building* Gedung SGLC melalui perbandingan kondisi *designed building* dan *baseline building*, serta menyusun rekomendasi penurunan emisi karbon operasional. Metode penelitian menggunakan pendekatan *process-based operational carbon assessment* dan *comparative scenario analysis*. Analisis dilakukan pada kategori *Energy Efficiency and Conservation* (EEC), *Building Environmental Management* (BEM), dan *Water Conservation* (WAC) berdasarkan parameter GREENSHIP *New Building* v1.2. Emisi karbon dihitung menggunakan faktor emisi listrik nasional dan faktor emisi pengelolaan sampah.

Hasil penelitian menunjukkan bahwa konsumsi energi *designed building* sebesar 421.044,16 kWh/tahun, lebih rendah dibandingkan *baseline building* sebesar 526.892,71 kWh/tahun sehingga terjadi penghematan energi sebesar 20,09%. Total emisi karbon operasional bangunan menurun dari 473.562,14 $kgCO_2$-eq/tahun pada *baseline building* menjadi 373.700,47 $kgCO_2$-eq/tahun pada *designed building* atau berkurang sebesar 21,09%. Pada aspek pengelolaan sampah, penerapan pemilahan dan pengolahan sampah mampu menurunkan emisi sebesar 38,48%. Pada aspek konservasi air, penerapan *water efficient fixture, rainwater harvesting*, dan *recycle water* mampu mengurangi kebutuhan air primer sebesar 48,42%. Rekomendasi yang diusulkan berupa optimalisasi sistem HVAC dan peningkatan efisiensi pencahayaan yang berpotensi menurunkan emisi karbon energi sebesar 20,29% dibandingkan *designed building*, sedangkan terhadap kondisi *baseline*, strategi rekomendasi dapat menurunkan emisi karbon energi hingga 36,30%, serta pengembangan sistem monitoring konservasi air untuk mendukung peningkatan kinerja bangunan hijau.

Kata kunci: *green building*, emisi karbon operasional, efisiensi energi, konservasi air, GREENSHIP.

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ABSTRACT

The building sector is one of the largest contributors to carbon emissions due to the high level of activities occurring during the operational phase of buildings. The implementation of the green building concept is expected to mitigate these environmental impacts through energy efficiency, water conservation, and sustainable waste management strategies. The Smart and Green Learning Center (SGLC) Building of the Faculty of Engineering, Universitas Gadjah Mada, is an educational building that has implemented various green building features; therefore, its contribution to reducing operational carbon emissions needs to be evaluated.

This study aims to quantify the building's energy consumption and operational carbon emissions, analyze waste management and water conservation practices, evaluate the benefits of green building of SGLC implementation through a comparison between the designed building and the baseline building, and develop recommendations for reducing operational carbon emissions. The study employed a process-based operational carbon assessment and comparative scenario analysis approach. The analysis focused on the Energy Efficiency and Conservation (EEC), Building Environmental Management (BEM), and Water Conservation (WAC) categories based on the GREENSHIP New Building v1.2 rating system. Carbon emissions were calculated using the national electricity emission factor and waste management emission factors.

The results indicate that the designed building consumed 421,044.16 kWh/year, which was lower than the baseline building's consumption of 526,892.71 kWh/year, resulting in energy savings of 20.09%. Total operational carbon emissions decreased from 473,562.14 $kgCO_2$-eq/year in the baseline building to 373,700.47 $kgCO_2$-eq/year in the designed building, representing a reduction of 21.09%. In terms of waste management, waste segregation and treatment practices reduced emissions by 38.48%. Regarding water conservation, the implementation of water-efficient fixtures, rainwater harvesting, and recycled water systems reduced primary water demand by 48,42%. The proposed recommendations include HVAC system optimization and lighting efficiency improvements, which have the potential to reduce carbon emissions of energy by 20.29% compared to the designed building. Relative to the baseline condition, the proposed strategies could achieve a carbon emission of energy reduction up to 36.30%. In addition, the development of a water conservation monitoring system is recommended to further improve green building performance.

Keywords: green building, operational carbon emissions, energy efficiency, water conservation, GREENSHIP.