NUS SDE4 seamlessly ensconces itself within its setting which comprises of mature trees and existing SDE blocks.

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NUS SDE4: PUSHING THE ENVELOPE

The National University of Singapore’s School of Design and Environment 4 (SDE4) is Singapore’s First New-Build Net-Zero Energy Building
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INTRODUCTION

NUS SDE4 started its journey in 2013, with a clear design brief that was more than a mere list of rooms and space allocations. It was an aspirational and strategic statement of how the School of Design and Environment wished to be perceived. Four key strategies were articulated in the brief: design, energy, process and well-being.

The performance target was perhaps the most demanding of all requirements. The building had to be a Net-Zero Energy Building (NZEB), meaning that the energy demand of the building would have to match its on-site energy production. In addition, SDE4 had to become a pedagogical instrument, facilitating the School’s teachings both inside and outside of the classroom. The design brief also looked at formulating strategies to foster embodied wellness with special attention to occupant well-being. Access to daylight, ventilation, views and fresh-air were pre-eminent requirements for the new building. And finally, SDE4 had to create an identity of itself whilst also being a complimentary part of the already established Design & Environment precinct.
CHALLENGES & OPPORTUNITIES

Like any project, SDE4 too had its share of challenges or rather site constraints which became an important driver in developing the design, as well as in managing the construction process.

The main constraint was the site’s topography. The site was an existing hillock adjacent to the existing SDE1 block. This presented a challenging terrain to set the building in and manage its proximity to the existing buildings. The other challenge associated with its site was the abundance of existing matured trees on site. The planning of the building’s footprint, driveway, and other site features had to negotiate with the requirements ascribed to mature such trees while assimilating the built spaces into this verdant landscape. The conscious effort to conserve these existing trees on site was paramount to both the design and the construction process.

In the former stage, the footprint of the building was mindfully located to avoid the trees. This also resulted in a limited building footprint which in-turn presented another challenge of creating ample roof area to support the necessary amount of photovoltaic (PV) panels to achieve the net-zero energy status. The team did explore the possibility of façade PVs (including BIPV), but these were limiting in their performance yield owing to the inherent sun-path of Singapore.
DESIGN IDEATION: ARCHITECTURE

The new SDE4 design is a model example of construction of a high-performance zero-energy building in a tropical climate. Rather than sealed air-conditioned interiors, the building embraces the potential of plants and landscape as part of the working environment. Solar shading is provided by an over-sailing roof on the south and perforated screens on the east and west facades. On the glazed facade there are large overhangs and high-level louvres. To encourage natural ventilation most glazing is openable. Interiors feature high ceilings with fans.

The building is envisioned as a porous architecture, structured in a juxtaposition of ‘platforms and boxes’ expressing its programmatic content. The design challenged the notion that an energy efficient building must be very opaque. The massing is broken down to give students and faculty better access to light and natural ventilation. The completed building is therefore seen as incredibly open where the boundary between the outside and the inside spaces is ambiguous. Most of the rooms are designed in a variety of sizes to allow a flexible rearrangement of layout for exhibitions, school-specific installations and future change of use. The design uses the potential of sectional connections across programmatic zones and a circulation strategy to set up unexpected meetings across the student body and faculty. A dramatic central staircase forms the social heart of the educational community: this is the place where students meet and share ideas. Level 3 features a plaza facing out over the landscaped hillside. These spaces are based on the idea that learning takes place both inside the studio but also in the informal social spaces of the building.
The design of the spaces and the facade act in concert with the innovative hybrid cooling system to create spaces that deliver comfort and wellness. © Transsolar Energietechnik GmbH

**DESIGN IDEATION: ENERGY, COMFORT AND WELLNESS**

The built environment affects occupants at physiological, psychological, and emotional levels. The design of SDE4 speaks to spatial quality and embodied wellness. But there is a general impression that better quality means using more energy. In the case of SDE4, the net-zero energy target necessitated hybridizing its systems and design to take advantage of the tropical climate. The architectural design of the building creates a porous form which is connected to the outdoors; whilst the innovative hybrid cooling system redefines thermal comfort in the tropic. This symbiosis between the design and the engineering systems creates a synergy wherein the architectural language complements the cooling requirement thus optimising the energy use.

The hybrid cooling system is a single pass system (100 percent fresh air with no return air) that supplies rooms with pre-cooled air, at higher temperature and humidity levels than in a conventional system, and augments this with an elevated air speed by using ceiling fans. This cool circulating air creates a thermal comfort condition that is significantly better than that of overcooled spaces. This idea of using fans was mooted at the very beginning of the design and was part of the winning bid. Fans also invoke a very tropical feel to the architecture.
DESIGN IDEATION: BIOPHILIA

SDE4 offers a deeply biophilic experience for its occupants, connecting them with the natural systems and processes; from uninterrupted views to greenery, to the visibility of energy and water systems, and access to daylight and air.
DESIGN IDEATION: WATER

The design of SDE4 has embraced water both as part of the building’s story as an educational resource. One third of the roof rainwater run-off is conveyed into a bioretention basin on level two which slows down the stormwater run-off, embellishes the landscape and filters the water through a dense vegetation layer. Water manifests itself mostly after rain, and this is made visible through two ponds located in the upstream and downstream ends of the landscape profile. Two thirds of the roof rainwater run-off are collected in a rainwater harvesting tank placed in the upper level of the building. The harvested water is then used for flushing and irrigation, catering for up to four days of the building’s non-potable water demand.
CONCLUSION

SDE4 succeeds in making the building systems and elements visible to the users. It enhances the users’ engagement and association with them by creating and utilising several living test beds. This is of particular interest as the building is designed to achieve a net-zero energy target and each of these architectural and engineering systems work in tandem to deliver the high-performance targets. The interstitial space between the inner and outer skins on the east and west facade is, for instance, designated for research. In these areas, elements of the façade can be dismantled and replaced with new systems depending on the School’s research needs. The building, thus, serves as a canvas for test-bedding and developing relevant green building technology, becoming, in effect, a living laboratory. In doing so, not only does the building envision how students are taught today but also paves the way they might be taught in the future.

“Projects like the NUS SDE4 have to be designed at the design brief stage with the goals and targets firmly held in mind and followed through even after the building’s completion and into the operational stage,” said Ar. Owen Wee, Lead Consultant for the project. The building has completed the first year of its operation. Subjective surveys completed by occupants show high levels of user acceptance of the environmental conditions offered by the building. In doing this, SDE4 speaks to multiple audiences: occupants and users, policy makers and developers. The building has also received the BCA Green Mark Platinum Certification, the Green Mark Super Low Energy (SLE) Award which was conferred to SDE4 as a Net-Zero Energy Institutional Building and the WELL Gold Certification awarded by the International Well Building Institute.

Project Details
Gross Floor Area: 8,588 sqm
Number of Storeys: Six
Lead Consultant: Surbana Jurong Consultants Pte. Ltd.
Design Architect: Serie + Multiply Architects Pte. Ltd.
QP Architect: Surbana Jurong Consultants Pte. Ltd.
M&E Engineer: Surbana Jurong Consultants Pte. Ltd.
C&S Engineer: Surbana Jurong Consultants Pte. Ltd.
Landscape Architect: Surbana Jurong Consultants Pte. Ltd.
Quantity Surveyor: Surbana Jurong Consultants Pte. Ltd.
Energy and Climate Consultant: Transsolar Energietechnik GmbH