AN ECOLOGICAL APPROACH TO BUILDING DESIGN

SOLARIS

Text by Ken Yeang and Mitch Gelber
Images courtesy of T.R. Hamzah & Yeang Sdn Bhd

"Saving our environment is the most vital issue that humankind must address today; thus designing ecologically is crucial. Within this context it is clear that the building of green and ecological buildings is just one part of the entire environmental equation that we must address. We must ultimately change our cities into green ecocities in entirety as well as change all of our industries and manufacturing, all of our forms of transportation and all of the myriad human activities. In making these green we must integrate them seamlessly with the natural environment.

Addressing the current state of environmental impairment has to be carried out at all levels of our human world—globally, regionally, locally and individually benign strategies. We need new social, economic and political models with non-polluting manufacturing and industrial production processes, using green systems and materials, that are carbon neutral and with zero-waste, as is the case with ecosystems in nature." (Yeang, 2007)[1]

[1] Ken Yeang, "Designing the Eco Skyscraper: Premises for Tall Building Design," Journal of the Structural Design of Tall and Special Buildings 16 no. 4 (2007): 411-427.

T. R. Hamzah & Yeang Sdn Bhd is an international architecture and planning firm with its headquarters in Kuala Lumpur, Malaysia. Under the leadership of its design principal, Dr. Ken Yeang, the office is best known for designing signature, deep green and innovative buildings and master plans. For the past 30 years, it has pioneered designs for passive low-energy tall buildings, known as "bioclimatic skyscrapers", and carried a comprehensive approach to green design that is characterised by the ultimate ecological objective of integrating designed systems seamlessly and benignly within the natural environment.

Projects such as Solaris, now under construction in Singapore, and the DiGi Technical Operations Centre, recently completed just outside of Kuala Lumpur, are typical of T. R. Hamzah & Yeang's innovative approach to skyrise greenery. Both projects feature extensive vertical eco-infrastructure in the forms of roof gardens, vegetated ramps and large-scale green walls.

In Solaris, a 1.5-kilometre long landscaped ramp runs continuously along the perimeter. This uninterrupted ecological armature connects the adjacent park at ground level with a cascading sequence of roof gardens at the building's highest levels. Similarly, continuous strips of vegetated green walls adorn the DiGi Technical Operation Centre's facades, covering a total area in excess of 1460 square-metres. This constitutes 32% of the total surface area of the building envelope. The continuity of these landscaped features represent a key component of these projects' ecological design concepts, allowing for fluid movement of organisms and plant species between all vegetated areas within the buildings, enhancing biodiversity and contributing to the overall health of these ecosystems. These building-integrated landscape systems provide ecological benefits to projects on multiple levels. They act as living filtration systems, improving the building's ambient air quality, reducing carbon dioxide levels, regulating local humidity, trapping dust and reducing noise. Extensive skyrise greenery also contributes directly to building performance by reducing solar gain (the transfer of heat by passive solar gain across the building envelope) and, by extension, building energy costs: it provides protection from the effects of UV radiation and acid rain, and helps lessen the building's contribution to the heat island effect, whereby forests replaced by concrete and asphalt cause urban centres to become warmer than natural areas. Finally, these systems promote biodiversity by fostering bird

and butterfly habitats along the building's perimeter, as well as enhancing ecological continuity between urban sites and adjacent natural areas.

Solaris is located in the one-north research and business park community in central Singapore. The building is a flagship project in the second phase of Fusionopolis, a research and development hub for Infocomm Technology, Media, Physical Sciences and Engineering industries, intended to facilitate innovation and entrepreneurship in these fields. The master plan for the visionary mixed-use development was prepared by Zaha Hadid Architects. Solaris stands as a dramatic demonstration of the possibilities inherent in an ecological approach to building design.

ECOLOGICAL DESIGN FEATURES

Solaris comprises two tower blocks separated by a grand naturally-ventilated central atrium. Office floors are linked by a series of sky bridges, which span the atrium at upper floors. A continuous spiral landscaped ramp, an extension of one-north Park across the street, forms an ecological nexus tying together an escalating sequence of roof gardens with sky terraces that interpenetrate the building's facade. With its extensive eco-infrastructure, sustainable design features and innovative vertical green concept, Solaris strives to enhance its site's existing ecosystems, rather than replace them.

The building's overall energy consumption represents a reduction of over 36% and its high performance façade has an External Thermal Transfer Value (ETTV) of less than 39 W/m^2. With over 8,000 square-metres of landscaping, Solaris also introduces vegetation which exceeds the area of the building's original site. With these design implementations, it was awarded BCA Green Mark Platinum rating in September 2009, the highest possible green certification granted by Singapore's sustainable building benchmark (its equivalents are LEED, GBI, GreenStar, BREEAM, etc.).

Continuous Perimeter Landscaped Ramp

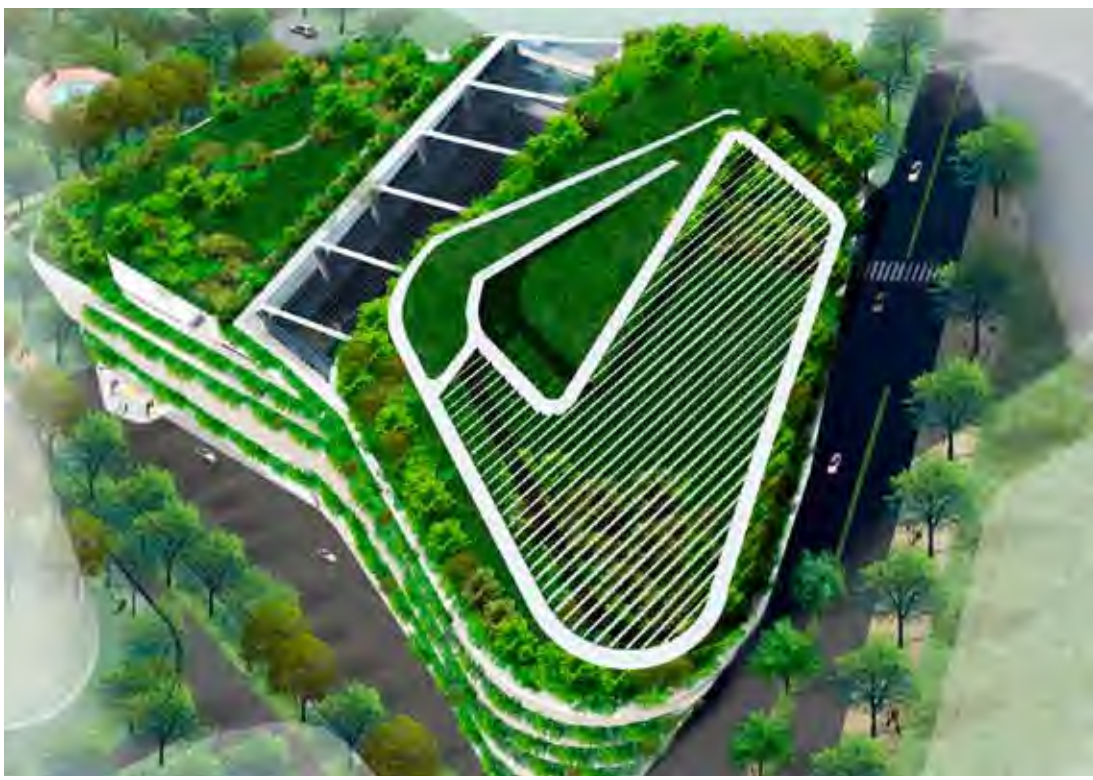
An uninterrupted 1.5-kilometre long ecological armature connects the adjacent one-north Park at ground level and the basement Eco-cell with the cascading sequence of roof gardens at the building's highest levels. The ramp has a minimum width of three metres. Maintenance of the spiral landscaped ramp is achieved via a parallel pathway, which allows for servicing of the continuous planters without requiring access from internal tenanted spaces. The pathway is also designed to serve as a linear park that stretches all the way from the ground plane to the uppermost roof areas. The continuity of the landscaping is a key component of the project's ecological design concept as it allows for fluid movement of organisms and plant species between all vegetated areas within the building, enhancing biodiversity and contributing to the overall health of these ecosystems. The ramp, with its deep overhangs and large concentrations of shade plants, represent a key element in the comprehensive strategy for the ambient cooling of the building facade. This eco-infrastructure provides social, interactive and creative environments for the occupants of the building's upper floors, while balancing the inherent static built-form with a more organic mass.

Solar Shaft

A diagonal shaft, that cuts through the upper floors of Tower A, allows daylight to penetrate deep into the building's interior. Internal lighting operates on a system of sensors, which reduces energy use by automatically turning lights off when adequate day-lighting is available. Landscaped terraces within the solar shaft bring added quality to adjacent spaces and enhance views up into the building from the street below.

Eco-cell

Located at the building's north-east corner where the spiral ramp meets the ground, the Eco-cell allows vegetation, daylight and natural ventilation to extend into the carpark levels below. The lowest level of the Eco-cell contains the storage tank and pump room of the rainwater harvesting system.



Naturally Ventilated and Daylit Grand Atrium

A public plaza between the two tower blocks provides space for communal activities and creative performances. This naturally-ventilated ground floor operates as a mixed-mode (non-air conditioned) zone with an operable glass-louvered roof over the atrium, enhancing ventilation while providing protection from the elements when needed. Computational Fluid Dynamics (CFD) simulations were used to analyse thermal conditions and wind-speeds within the atrium. The results of these studies were used to optimise the atrium facade design to improve air flow and enhance comfort levels.

Pocket Park/ Plaza

Ground level landscaping, linking to one-north Park across the street, allows for cross ventilation of the ground floor plaza and provides a venue for social or interactive events.

Extensive Sun-Shading Louvers

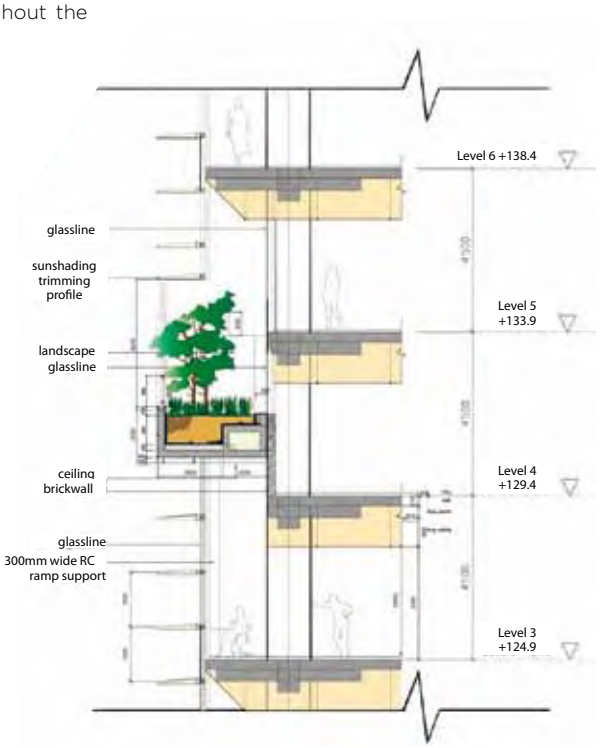
The project's climate-responsive façade design originated from an analysis of the local sun-path. Singapore is at the equator and the sun-path is almost exactly East-West. Facade studies analysing the solar-path determined the shape and depth of the sunshade louvers, which also double as light-shelves. This solar shading strategy further reduces heat transfer across the building's low-e double-glazed perimeter facade, contributing to a low External Thermal Transfer Value (ETTV) of 39 W/m^2. In conjunction with the spiral landscaped ramp, sky gardens, and deep overhangs, the sunshade louvers also assist in establishing comfortable microclimates in habitable spaces along the building's exterior. The combined linear length of the building's sunshade louvers exceeds 10km.

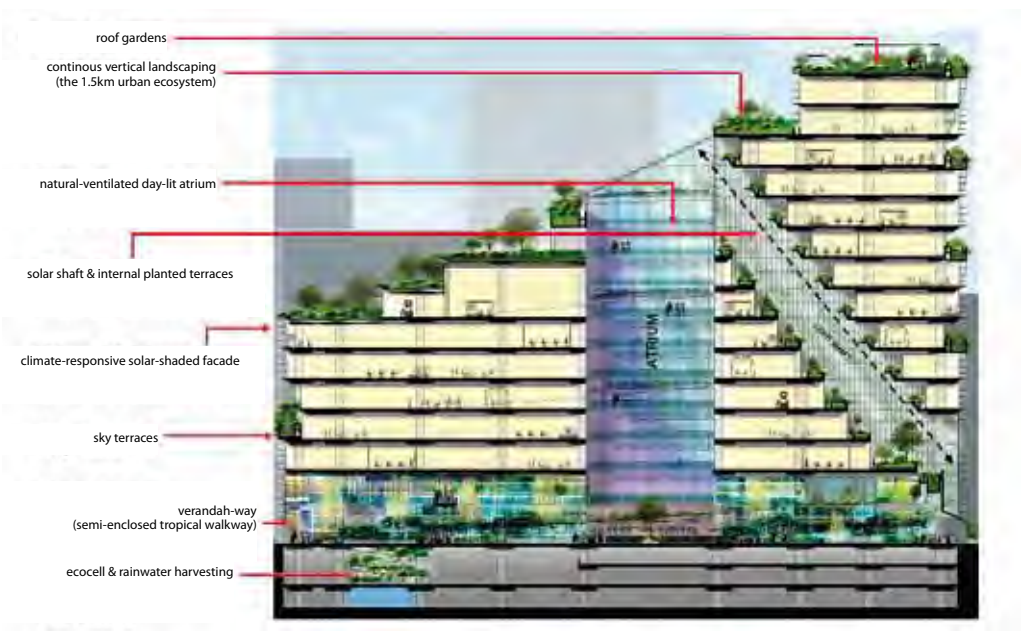
Roof Gardens and Corner Sky Terraces

Vertical landscaping acts as a thermal buffer and creates areas for relaxation and event spaces. These extensive gardens allow building occupants to interact with nature and offer opportunities to experience the external environment and enjoy views of the treetops of the adjacent one-north Park. As it reaches each corner of the building, the spiral ramp expands into generous double-volume sky terraces. Upon completion, the sum of its vegetated areas will exceed the footprint of the site on which the building sits. A dramatic vision of the possibilities inherent in skyrise greenery design, 95% of the project's total landscaped area is above ground level.

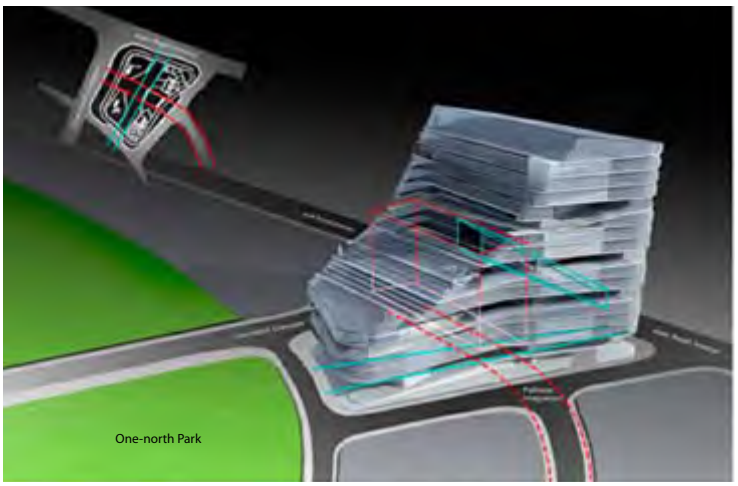
Rainwater Harvesting/Recycling

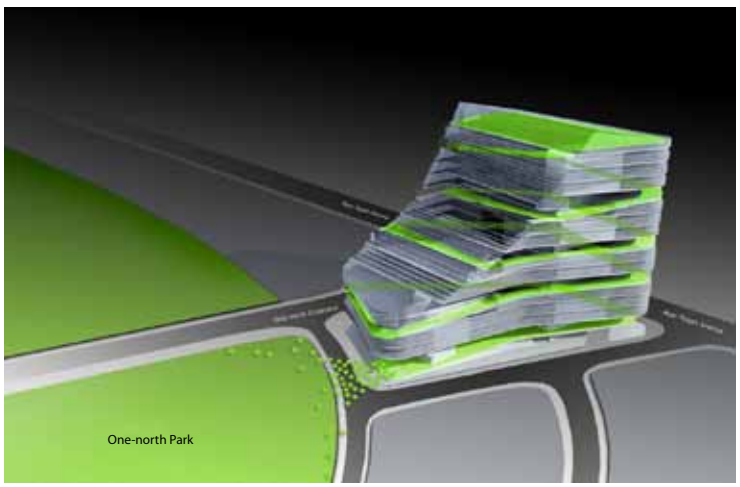
The building's extensive landscaped areas are irrigated via a large-scale rainwater recycling system. Rainwater is collected from the drainage downpipes of the perimeter landscaped ramp and from the roof of Tower B via Siphonic drainage. It is stored in rooftop tanks and at the lowest basement level, beneath the Eco-cell. A combined storage capacity of over 700 cubic-metres allows the building's vegetated areas to be irrigated almost exclusively via harvested rainwater. An integrated fertigation system helps maintain organic nutrient levels throughout the irrigation cycle.

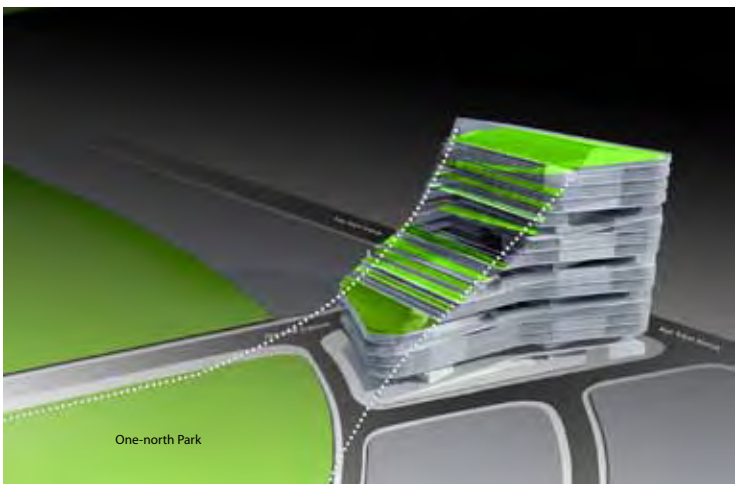




> “THE CONTINUITY OF THE LANDSCAPING IS A KEY COMPONENT OF THE PROJECT’S ECOLOGICAL DESIGN CONCEPT AS IT ALLOWS FOR FLUID MOVEMENT OF ORGANISMS AND PLANT SPECIES BETWEEN ALL VEGETATED AREAS WITHIN THE BUILDING, ENHANCING BIODIVERSITY AND CONTRIBUTING TO THE OVERALL HEALTH OF THESE ECOSYSTEMS.”


One-north Park


One-north Park


One-north Park


basement 2


basement 1


basement 1 mezzanine


level 1


level 2


level 3


level 4


level 5


level 6


level 7


level 8


level 9


level 10


level 11


level 12


level 13

Project Credits

building name Solaris
site Fusionopolis [Phase 2B]
location One-North, Singapore
start of construction September 2008
scheduled completion September 2010
building height 80 m
tower A 15 Storeys + roof garden
tower B: 9 Storeys + roof gardens
total GFA: 51,282 m^2
site area: 7,734 m^2
total landscaped area 8,363 m^2
BCA GreenMark Platinum Rating

Consultant Team

land owner JTC Corporation
developer SB (Solaris) Investment P/L, a subsidiary of SoilBuild Group Holdings Ltd
lead designer T. R. Hamzah & Yeang Sdn Bhd
architect CPG Consultants Pte Ltd
civil and structural engineer Arup Singapore Pte Ltd
mechanical and electrical engineer CPG Consultants Pte Ltd
facade consultant Aurecon Singapore (Pte) Ltd
sustainability consultant Aurecon Singapore (Pte) Ltd
landscaping consultant Tropical Environment Pte Ltd
landscape concept consultant T. R. Hamzah & Yeang Sdn Bhd
contractor Soil-Build (Pte) Ltd
quantity surveyor PEB Consultants

T. R. Hamzah & Yeang Design Team

principal Dr. Ken Yeang
project leader Mitchell Gelber
senior designer Esther Klausen
designer Jan Rehders
assistant designer Faizah Rahmat
3D visualization Vijai Kumar

CPG Consultants Pte Ltd Architectural Team

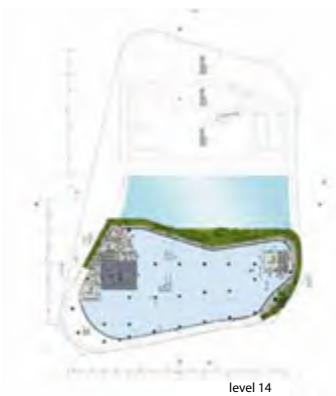
project director Lim Choon Keang
qualified person Kuan Chee Yung
senior arch. associate Foo E-Jin
arch. associate Terence Tan Chin Chieh

Table of Landscaped Areas

roof gardens 2,987 m^2
atrium planter boxes 304 m^2
eco-cell 83 m^2
green ramp 4,115 m^2
solar shaft: 223 m^2
ground level landscaping: 487 m^2
green walls: 164 m^2
total landscaped area: 8,363 m^2
ratio of landscaping to GFA: 17% Green
ratio of landscaping to site area: 108% Green
percentage of total landscape area above ground level: 95%

Awards and Publications

First Prize – Skyrise Greenery Awards 2009, Singapore Institute of Architects and National Parks Board Singapore
Platinum Rating – BCA Green Mark 2009, Building and Construction Authority Singapore
GreenSource Magazine – May 2009, "Ramping Up Green"
Vertical Eco-Infrastructure – by Leon van Schaik [Images Publishing], "Solaris, Singapore"
Time Based Architecture International – June 2009, "Continuous Green"
Channel NewsAsia International – August 2009, "The Green List"
Roof & Façade Asia – November 2009, "Solaris Multiplexes"
FutureArc – 1st Quarter 2010, Vol 16, "Solaris"
The Wall Street Journal Asia – March 2010, "Architecture: What's Next"
Eco Build Magazine – May-June 2010, "The Living Office"
Ecological Architecture - by Chris van Uffelen [Braun], "Solaris, Singapore"


level 14


level 15


roof garden


roof canopy