greenscreen®

EDUCATION SERIES
RESEARCH REVIEWS

The **green**screen® *Education Series - Research Reviews* is a series of briefs composed as summaries to help educate our design partners about important issues supported by international research efforts. Document titles and authors are listed, and we encourage you to read original transcripts for a complete understanding of methodologies, intent, and the original research summaries.

Also available: The **green**screen® *Education Series - Case Studies* is a series reviewing specific **green**screen® installations for a variety of climate zones, building types, site and landscape conditions.

Vegetated Facades and Thermal Performance: *Impact of various green facade and living wall systems on performance of buildings and their immediate environment based on surface and ambient temperatures.*

Original Study Title: "Thermal evaluation of vertical greenery systems for building walls"

Authors: Nyuk Hien Wong a, Alex Yong Kwang Tan a,*, Yu Chen a, Kannagi Sekar a,b, Puay Yok Tan b, Derek Chan b, Kelly Chiang b, Ngian Chung Wong c

a Department of Building, School of Design and Environment, National University of Singapore, 4 Architecture Drive, Singapore 117566, Singapore

b National Parks Board, Singapore Botanic Garden, 1 Cluny Road, Singapore 259569, Singapore

c Building and Construction Authority, 5 Maxwell Road, Singapore 069110, Singapore

Hypothesis: There is potential to mitigate the UHI effect through the use of various facade greening systems to shade walls and cool structures through evapotranspiration thus lowering surface and ambient temperatures. Vertical greenery systems can both reduce solar energy entering the building through shading and reduce heat flow through evaporative cooling, both translating into energy savings and reducing radiant output of heat over night.

Method: 8 different vertical greenery systems (one rigid trellis system and seven living wall systems) were installed in HortPark, Singapore on concrete walls, to evaluate the thermal impacts on the performance of buildings and their immediate environment based on the measurement of surface and ambient temperatures. The subject green wall types were sourced from different parts of the world to cover the spectrum of commercially available systems. Included were a three-dimensional welded wire trellis panel (greenscreen®), supporting climbing plants from planters at the base of the wall and seven complex Living Wall systems, one of which was a flexible mat composite with soil substrate and one a moss tile with an inorganic substrate.

Evaluation: Surface Temperature: The presence of climbing plants reduces the overall wall surface average temperature. Cooling is directly due to the shading effect and evapotranspiration from the leaves. Complex Living Wall systems show the best thermal performance in maximum reduction of average wall surface temperature compared to the control wall. Maximum reductions of 11.58 _C in the wall surface temperatures on clear days were observed. This result is due in large part to the presence in complex Living Wall systems of a dense soil substrate with moisture content in structural containers of relatively high mass between the plants and the wall surface. The welded wire trellis panel alone has little effect on temperature reduction on the surface wall especially at night. However, with the foliage of the climbing plants rooted in a soil container at the base of the wall and supported by the trellis, there is a 4.36 _C reduction in the average temperature of the wall surface on 21 June 2008. Even without a soil substrate or heavy structure, the vegetation supported by the trellis has an overall cooling effect especially in the heat of the afternoon.

Evaluation: Ambient Temperature: Foliage density and air circulation affect ambient temperature. The effect of complex Living Wall systems on ambient temperature is more significant than that of a trellis system without a vertical soil substrate. Ambient temperature is most affected by the presence of vertical greening systems within a distance of .15 m (6”) away, with a reduction of 3.33_C observed from Living Wall systems.

Conclusion: Effective reduction in wall temperatures will lead to a corresponding reduction in the energy cooling load and consequent saving in energy cost. Furthermore, intake air at cooler ambient temperatures translates into reduced cooling load and energy saving. In terms of the lowest diurnal range of average wall surface temperature fluctuation, Living Wall systems show the highest capacities. No system performs relatively well in terms of the least fluctuation in the diurnal range of average substrate temperature because of a mixed range of values. By limiting the diurnal fluctuation of wall surface temperatures, the lifespan of building façade materials is prolonged, slowing down wear and tear as well as savings in maintenance cost and the replacement of façade parts. The effects of vertical greenery systems on ambient temperature are found to depend on specific systems. The welded wire trellis has hardly any effect on ambient temperature while the effects of a complex living wall system are felt up to 0.60 m (24”) away.

Recommended Design Strategies: Green Facade system

- Locate the green facade on the elevations exposed to the highest daily temperatures.
- Design for maximum leaf area and shade to the building wall.
- Select the optimal plant palette for maximum coverage and density in your microclimate.
- Provide for the maximum depth of soil beds or containers to ensure good coverage.
- Structure the facade system around air intake grilles.
- Consider using free-standing screens with deciduous vines to shade glazed areas in the summer and allow solar warming in the cooler months.

Recommended Design Strategies: Living Wall system

- Locate the living wall on the elevations exposed to the highest daily temperatures.
- Provide waterproof membrane to protect the building skin if not built into LW system.
- Provide adequate load-bearing structure to support mass of soil, system, plants and moisture.
- Select plant species for maximum coverage and density with maintenance costs in mind.
- Design adequate irrigation supply and drainage according to species and orientation.