

# One Unit, Five Functions: Shade, Cooling, Humidity, Air Quality, Comfort

*One plant cluster delivers shade, cooling, humidity, air quality, and comfort. [1]*

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## At a Glance

A managed areca palm cluster performs five functions. The canopy shades the occupied zone. Transpiration cools surrounding air through latent heat absorption. [1] Moisture release corrects dry indoor air. Leaf surfaces and soil microorganisms filter airborne compounds. [4] The combined effect improves cognitive performance and reduces occupant stress.

## Deep Dive

Mechanical systems are single-function. A chiller cools. A humidifier humidifies. A HEPA filter filters. A desk lamp lights. Each requires electricity, maintenance, and replacement cycles. A managed areca palm cluster runs all five functions from one living system, powered by ambient light and soil moisture.

Function 1: Shade. The canopy intercepts direct and diffuse solar radiation, reducing the radiant heat load at the occupied zone. Bakhshoodeh, Ocampo, and Oldham (2022) measured wall temperatures behind green facades up to 7 degrees Celsius cooler than shade sails. Shading accounted for the majority of the total cooling, with evapotranspiration adding 25 to 35 percent on top. [1]

Function 2: Cooling. Evapotranspiration absorbs latent heat at 2,260 kilojoules per kilogram of water transpired. Convertino, Vox, and Schettini (2022) found green facades reduced indoor air temperature by 4.57 to 5.64 degrees Celsius and decreased heat flux by 7.84 to 16.79 watts per square metre. The cooling effect correlates directly with leaf area index: more leaf surface means more transpiration per hour and more heat extracted from surrounding air. [3]

Function 3: Humidity correction. Transpiration releases moisture through stomata into indoor air. Berger, Essah, and Blanusa (2024) studied the impact of plants on humidity in naturally ventilated office environments, published in the Journal of Building Engineering. Indoor plants acted as humidity sources, with the effect varying by species (Epipremnum and Ficus tested) and by season. In dry indoor conditions, this moisture release helps correct the low relative humidity that mechanical cooling creates. [10]

Function 4: Air quality. Wolverton, Johnson, and Bounds (1989) demonstrated that interior landscape plants removed benzene, formaldehyde, and trichloroethylene from sealed chambers, with soil microorganisms contributing to the purification alongside leaf surfaces. [4] The NASA study was designed for sealed space station environments. In ventilated buildings, plant-based VOC removal supplements rather than replaces mechanical ventilation. The contribution at the breathing zone around a cluster is localised and measurable, though not sufficient to replace dedicated air handling.

Function 5: Cognitive comfort. A 2023 systematic review published in PMC examined restorative effects of biophilic workplace design and nature exposure during working time. The review found that cognitive performance improved in all biophilic conditions compared to baseline. Small indoor plants on desks reduced office workers' stress. Immersive biophilic environments improved occupants' satisfaction and

cognitive performance while reducing stress. [23]

No other single deployable unit delivers all five functions. A chiller cannot shade, humidify, filter VOCs, or improve cognition. Biothermal Microconditioning does. Easy Retrofit. 1 day.

## Summary

A single Biothermal Microconditioning unit delivers five measurable functions from one living system.

Shade: the canopy intercepts direct and diffuse radiation, reducing radiant heat at the occupied zone. Green facade research showed vegetated surfaces were up to 7 degrees Celsius cooler than shade sails. [1]

Cooling: evapotranspiration absorbs 2,260 kJ per kilogram of water transpired. Green facades reduced indoor air temperature by 4.57 to 5.64 degrees Celsius in measured studies. [3]

Humidity: transpiration releases moisture into indoor air. Research in the Journal of Building Engineering confirmed plants act as humidity sources, with effects varying by species and season. [10]

Air quality: NASA's 1989 study demonstrated VOC removal by interior plants in sealed environments. [4] In ventilated buildings, plant filtration at the breathing zone supplements mechanical ventilation.

Comfort: a 2023 PMC systematic review found biophilic environments improved cognitive performance in all conditions, and desk plants reduced workers' stress. [23]

No other single deployable unit delivers all five. Biothermal Microconditioning is five functions from one living system.