Evapotranspiration: The Cooling Engine Nobody Plugged In

Plants pull heat from air through water. Measurably. Silently. [1]

At a Glance

Water travels from roots through stems to leaf stomata, where it evaporates. This phase change absorbs 2,260 kJ per kilogram, pulling heat from surrounding air. Green facade research measured temperature reductions of 2 to 5 degrees Celsius from vegetation evapotranspiration. [1] The mechanism contributes 25 to 35 percent of total cooling from vegetated surfaces. [1]

Deep Dive

Every cooling system operates on one principle: move heat from where it bothers people to where it does not matter. Mechanical air conditioning uses refrigerant compression, consuming electricity at every step. Plants use water and sunlight, consuming nothing from the grid.

The mechanism is evapotranspiration. Water enters through roots, travels up the xylem, and exits through stomatal pores on leaf undersides. As liquid water becomes vapour, it absorbs latent heat: 2,260 kilojoules per kilogram. This energy is drawn from air immediately surrounding the leaf, producing a localised temperature drop that is measurable with standard instruments at close range. [1]

Bakhshoodeh, Ocampo, and Oldham (2022) studied evapotranspirative cooling of a green facade in controlled conditions. Their findings, published in Sustainable Cities and Society, showed wall temperatures behind the green facade were up to 7 degrees Celsius cooler than those behind shade sails. Evapotranspiration contributed 25 to 35 percent of the total cooling gap induced by the green facades. The remaining cooling came from shading, with the combination producing temperature reductions up to 11 degrees below ambient. [1]

Convertino, Vox, and Schettini (2022) published parallel findings in MDPI Sustainability. 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. Leaf area index and plant coverage positively correlate with cooling magnitude. A soil substrate without plants could not produce the same temperature reduction: canopy transpiration and shading, not soil moisture alone, drove the cooling effect. The living canopy was the active agent. [3]

Bucher et al. (2025) examined vertical indoor greening with tropical ornamental plants in Indoor Air. They characterised transpiration rates and stomatal conductance under different indoor climate parameters. Light intensity (photosynthetically active radiation) showed a positive correlation with transpiration rate and stomatal conductance, while ambient air temperature showed a negative correlation. Indoor greening contributed to keeping both relative humidity and temperature at levels suitable for building occupancy. [6]

A 2024 study in MDPI Buildings found that integrating potted plants in tropical urban buildings significantly enhanced thermal comfort and reduced cooling energy consumption. The evapotranspiration mechanism, followed by shading throughout the day, played the major role in the measured temperature drop at the occupied zone where people sit and work. [17]

The latent heat equation has been understood since the 18th century. Transpiration measurement dates to the 1890s. What no building system had done, until Biothermal Microconditioning, was engineer managed indoor plant clusters that harness evapotranspiration as a primary occupant cooling mechanism at the breathing zone. Easy Retrofit. 1 day to deploy.

Summary

Evapotranspiration combines soil evaporation and leaf transpiration into a single cooling process. The phase change from liquid water to vapour absorbs 2,260 kilojoules per kilogram, drawn from the immediate environment. [1]

Green facade research in Sustainable Cities and Society measured wall temperatures behind vegetated surfaces up to 7 degrees Celsius cooler than shade sails. Evapotranspiration accounted for 25 to 35 percent of the total cooling gap. [1] MDPI Sustainability research confirmed that plant coverage and leaf area index positively correlate with passive cooling. A soil substrate without plants could not replicate the effect: canopy transpiration drives cooling, not moisture alone. [3]

A 2025 Indoor Air study characterised tropical ornamental plants under varying indoor conditions. Light intensity correlated positively with transpiration rate. Indoor greening contributed to maintaining both humidity and temperature at appropriate levels. [6]

For tropical buildings, potted plants enhanced thermal comfort and reduced cooling energy. Evapotranspiration and shading from the canopy produced measurable temperature drops at the occupied zone. [17] No compressor. No duct. Physics that plants have run for 450 million years, finally applied indoors.