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The Living Wall System, external interstitial wall passive HVAC systems creating true Zero Net Energy Buildings ZNEB

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System-scale: Overview, ZNEB Zero Net Energy Buildings

The Living Wall System is developed as an integral part of an interstitial wall or double exterior wall system for multi-story commercial and residential building solutions. The Living Wall reacts to the building's external environment and climate, driven by solar exposure, air temperature and wind. This multiple wall system of between 1 ½ feet up to a half a dozen feet thick, consists of an exterior layer of high tech smart glazing with multiple high tech coatings. This outer curtain wall acts like a greenhouse trapping solar energy inside a thermal chimney. The inner wall of the double walled system consists of a high tech Living Wall system reacting to the intense heat generated within the thermal chimney of the wall. The rising heat developed within the interstitial wall creates tremendous heat, that fuel rapid movement of heat into the Living Wall as well as a thermal uplift of predictable speed and volume. The thermal uplift and exhausting of the interstitial wall air creates negative pressure within the building's volume ventilating the interior at rates exceeding 20 ACH. The generated heat collected within the Living Wall, allows for the collection, focusing, transport and storage of that heat through the building's skin for redistribution within the building's cold elevations, seeding an instilled thermal uplift and chimney. The entire system is balanced with the heat generated by the solar walls "seeding" the upper half of non-solar cool walls with excess heat, facilitating the thermal uplift of the interstitial air column via an expanded temperature gradient, providing ventilating air movement to all exterior elevations of the building. No matter the solar exposure, this air movement and heat generating system on the exterior skin, creates universal non-mechanical ventilation of the building's interior, regulated, distributed and controlled by a BAS Building Automated Systems.

System-scale: Living Wall Mechanics

The Living Skin, the inner layer of the interstitial wall is a multi layered heat and light exchanging wall panel that rapidly collects and transports the excess heat via a thermal hydrogel rapidly moving the generated heat into a PCM layer within the Living Wall system. That heat, once concentrated through the phase change of the PCM is then collected within the wall via a capillary matrix layer. The heat is drawn off to the BAS controlled central system for use and collection elsewhere in the building. The inner

layer of the Living Wall creates an insulation layer to prevent excess heat from overheating perimeter spaces. The entire Living Wall System remains semi-translucent with a Tvis of above .20 while producing ultra efficient and rapid heat exchange. Our architectural research focuses on developing and testing this entire system, providing enough heating, cooling, ventilation and light for a completely passive ZNEB, Zero Net Energy Building.

The biomimic Living Wall interstitial building system mimics an organism's skin, acting as a thermal and moisture regulating exterior building skin, transmitting heat both into and out from a building's skin. The thermally reactive hydrogel within the Living Wall rapidly transmits heat horizontally into inner Living Wall of a double walled curtain wall system. That heat transfer is tuned and regulated via the Building Automated System to maximize the concentration of heat at the top of all perimeter interstitial walls on the sunny and shaded sides of the building's exterior. The thermal chimney walls surrounding all sides of a commercial building create full building ventilation by producing a quantifiable and predictable heat source and thermal uplift within the double walls. The extreme generated heat from the solar walls then provides a super heat source for the hydrogel based Living Wall, rapidly transferring, concentrating and transporting that heat to the shaded walls, initiating a full building perimeter chimney effect. This solar chimney wall exhaust creates sufficient negative pressure to draw air through the building's volume as well as intake air through ground or thermal sink heat exchangers. That air is then distributed throughout the building's floors delivered by under floor distribution systems and drawn into the interstitial wall evacuation system. All concepts are modeled and tested with a variety of energy and air movement analysis programs. The final computer modeling will be written into an Energy Plus module for interstitial wall performance analysis for architects and engineers.

In residential buildings requiring heating in the winter and cooling in the summer, heat is rapidly transported into the Living Wall as part of an envelope trombe wall system. In a similar fashion the heat is rapidly transported directly into the adjacent interior space in the winter by via direct gain conduction and convection. In the summer daytime, heat is used as a thermal chimney exhaust system, drawing cool ground coupled air from beneath the house through the interior and exhausting that air into the Living Wall system. Summer nighttime cooling is accomplished by simple night flush, powered by the stored heat of the Living Wall's thermal chimney with interior heat exhausted from the ceilings into the exterior double wall system.

In both commercial and residential cases, the thermal uplift speed and volume produced by a large temperature gradient created by ground coupling at the bottom and solar heat through the height of the wall, creates a quantifiable air movement that evacuates air at a rate exceeding 15 ACH with 60 degree air. Heat exhausted from interstitial wall systems will include heat recovery strategies augmenting the collected heat stored within the building's central system. The end result produces enough solar heat, moves enough air, draws in sufficient cool air, exhausts enough heat in both commercial and residential strategies to create true Zero Net Energy Buildings (ZNEB) by eliminating mechanical heating, cooling and ventilation systems.