Retrofitting Design Strategies

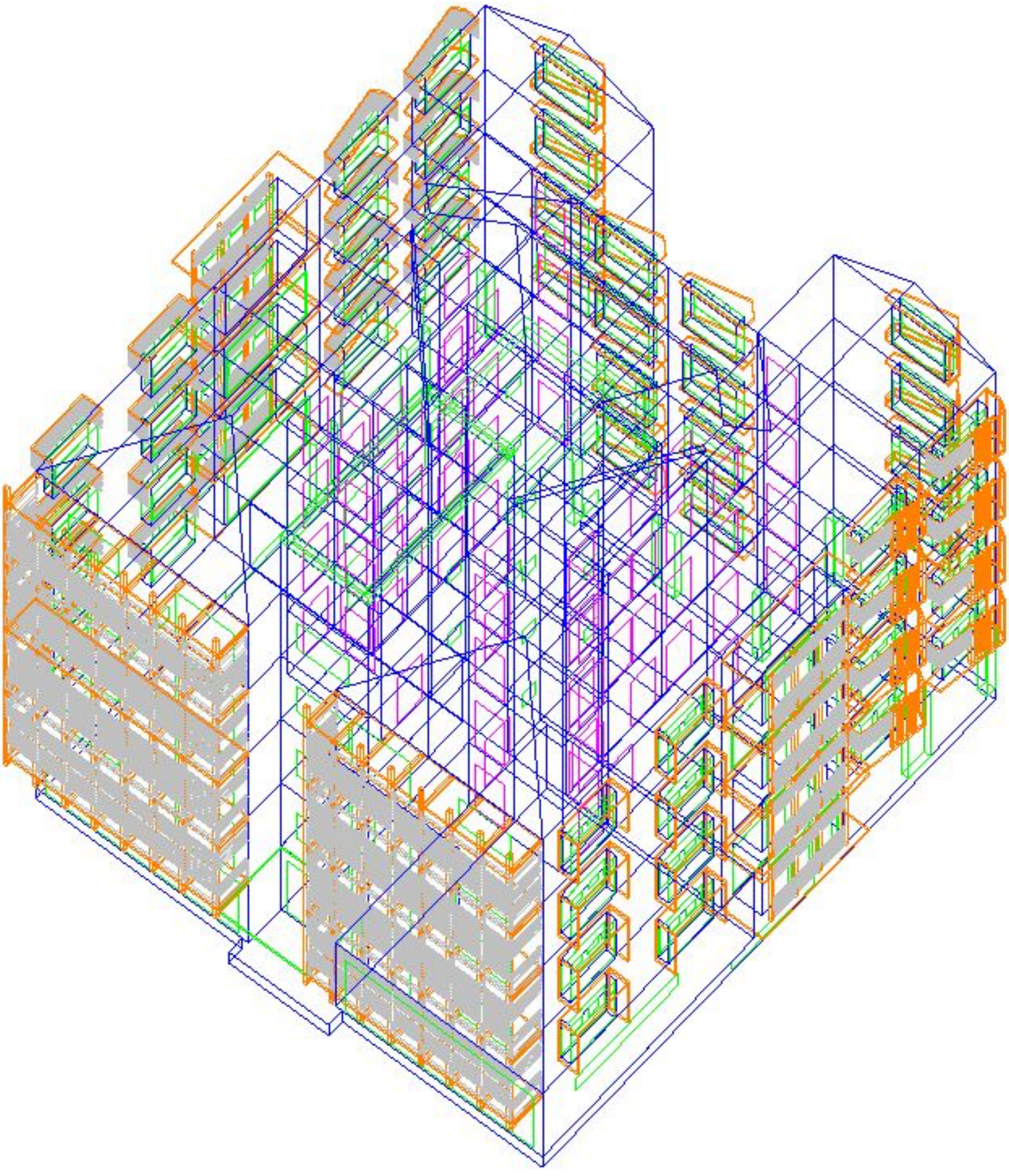

Figure 1: 3D rendering of analytical-energy model. Black-box energy model developed to test energy effectiveness of passive-cooling design strategies implemented onto building envelopes; each occupied space created in individual zones to undertake dynamic thermal simulations in IES-software. Off-site modular construction systems provided affordable refurbishment solutions to occupants and government initiatives to improve energy efficiency of dwellings.

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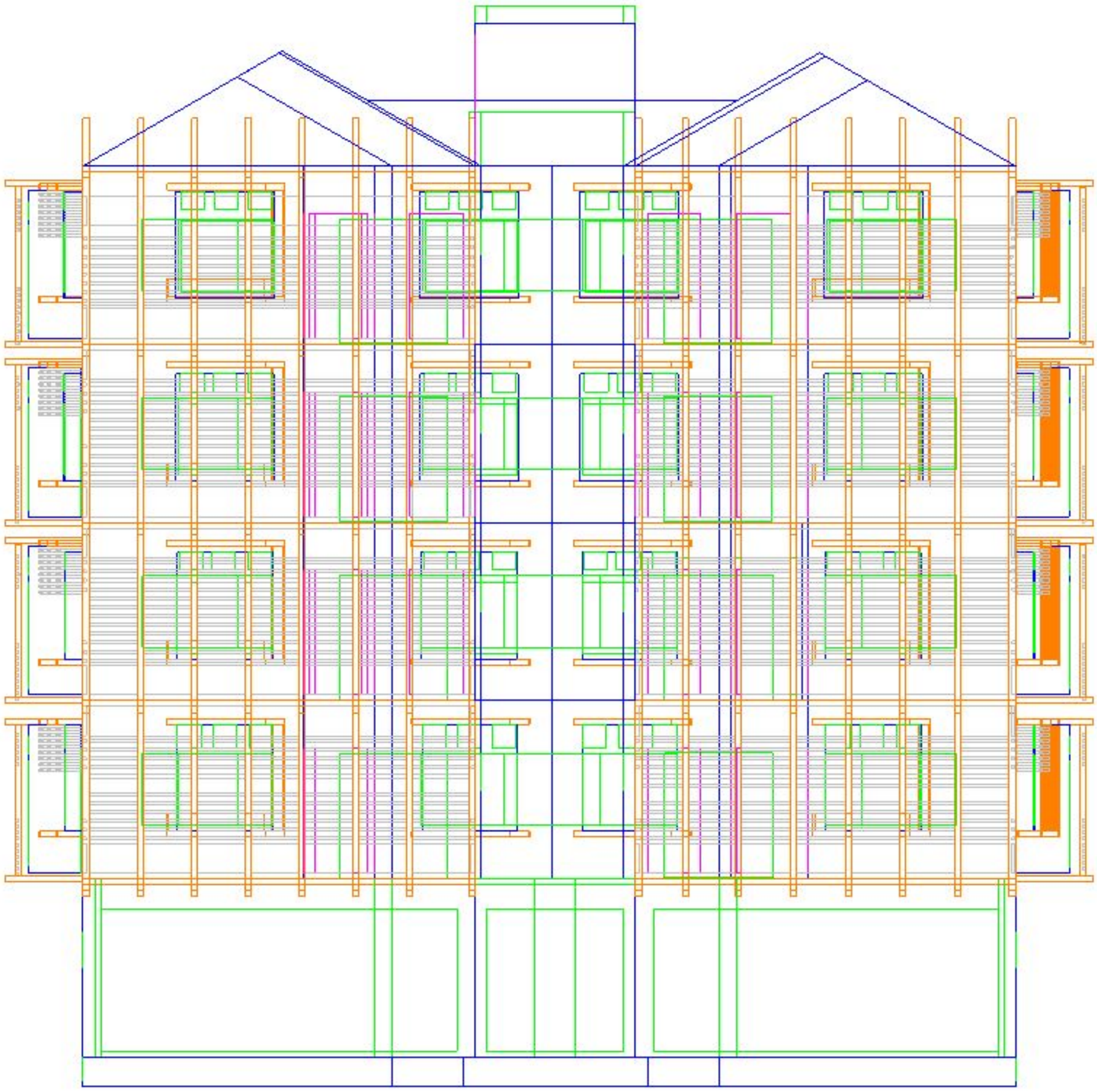

Figure 2: Front elevation of RTB prototype after all six passive-cooling design strategies implemented. Volumetric balcony space addition with adjustable horizontal passive shading elements (i.e., brise soleil) improved architectural quality of building and brought RTBs up to European housing-standard criterion; varied according to building envelope orientation. Monitored environmental parameters and household feed-forward interviews demonstrated roadmap to develop evidence-based retrofitting strategy.

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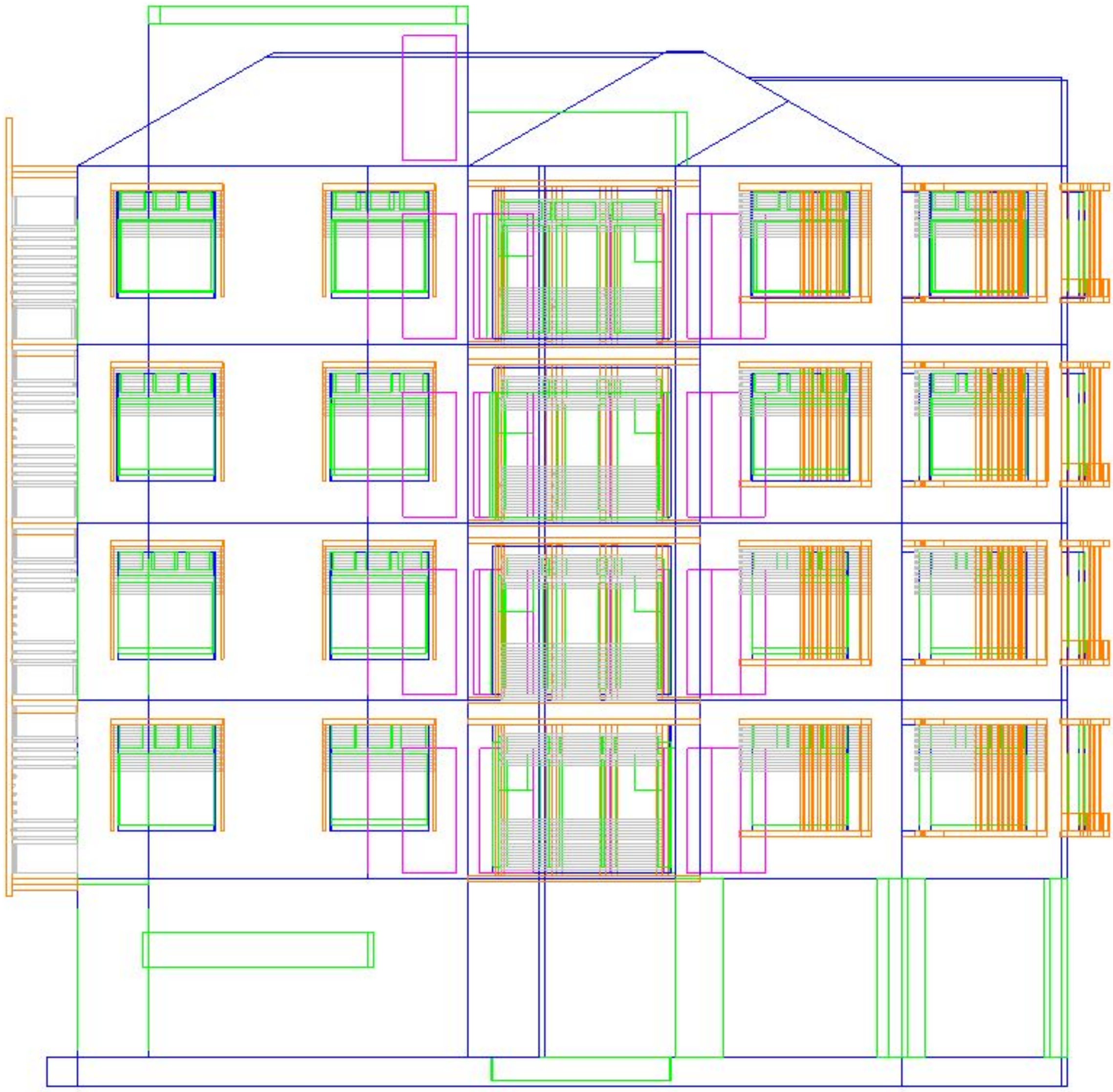

Figure 3: Typical side elevation of RTB prototype after all six passive-cooling design strategies implemented. Overhanging kitchen addition designed to improve space quality in kitchen areas. Operable shading elements implemented to avoid direct solar radiation due to different RTB orientations; top-window openings positioned in each occupied space (i.e., living room, Bedroom 1, Bedroom 2 and Bedroom 3) to increase frequency of natural ventilation; appropriate shading systems proposed that took RTB orientations into consideration.

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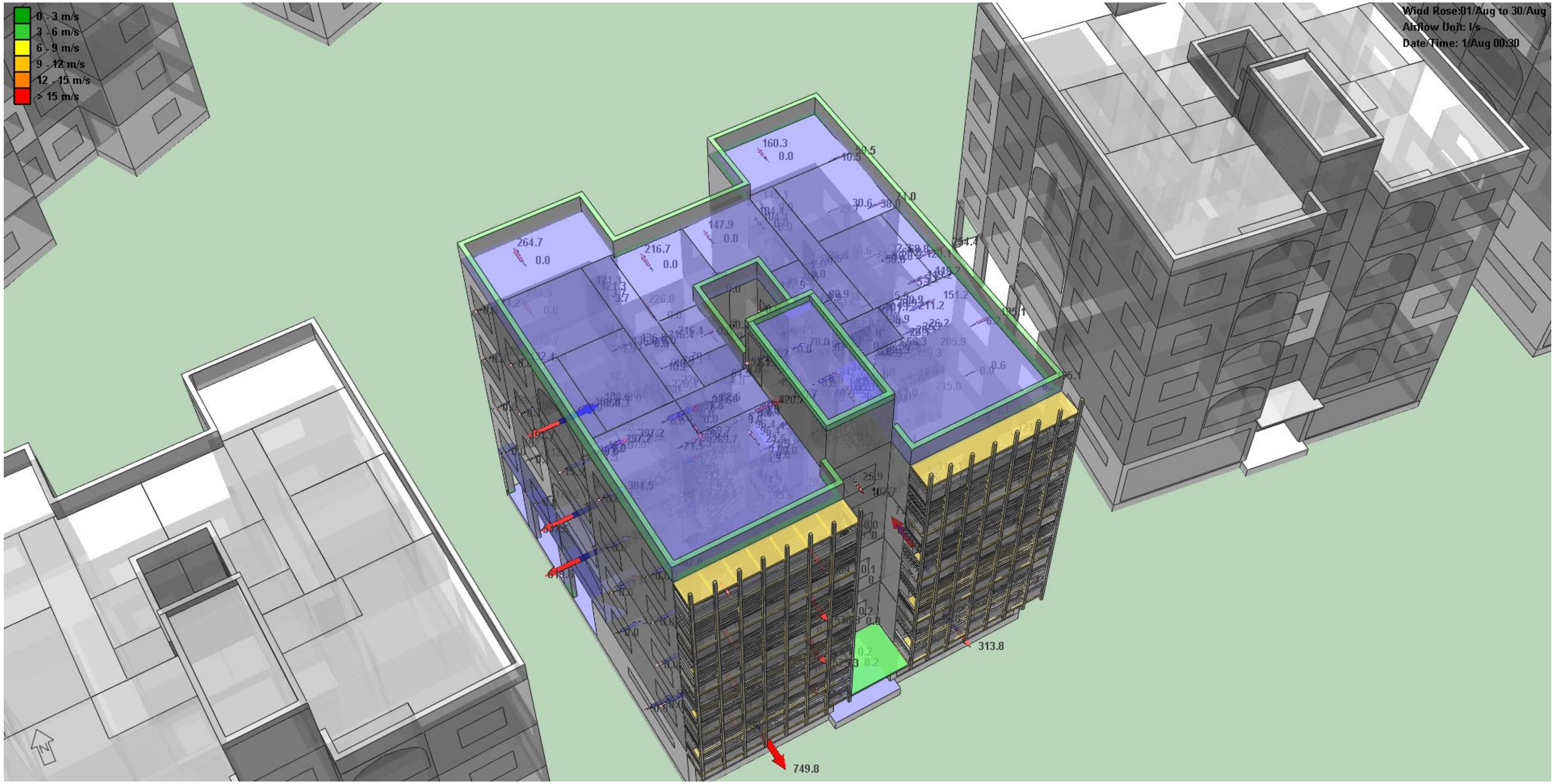

Figure 4: 3D rendering of RTB prototype after Strategy 1 (i.e., volumetric balcony space addition with adjustable shading elements) implemented; image shows infiltration rates of each occupied space on different floor levels; results generated from MacroFlow application of IES software.

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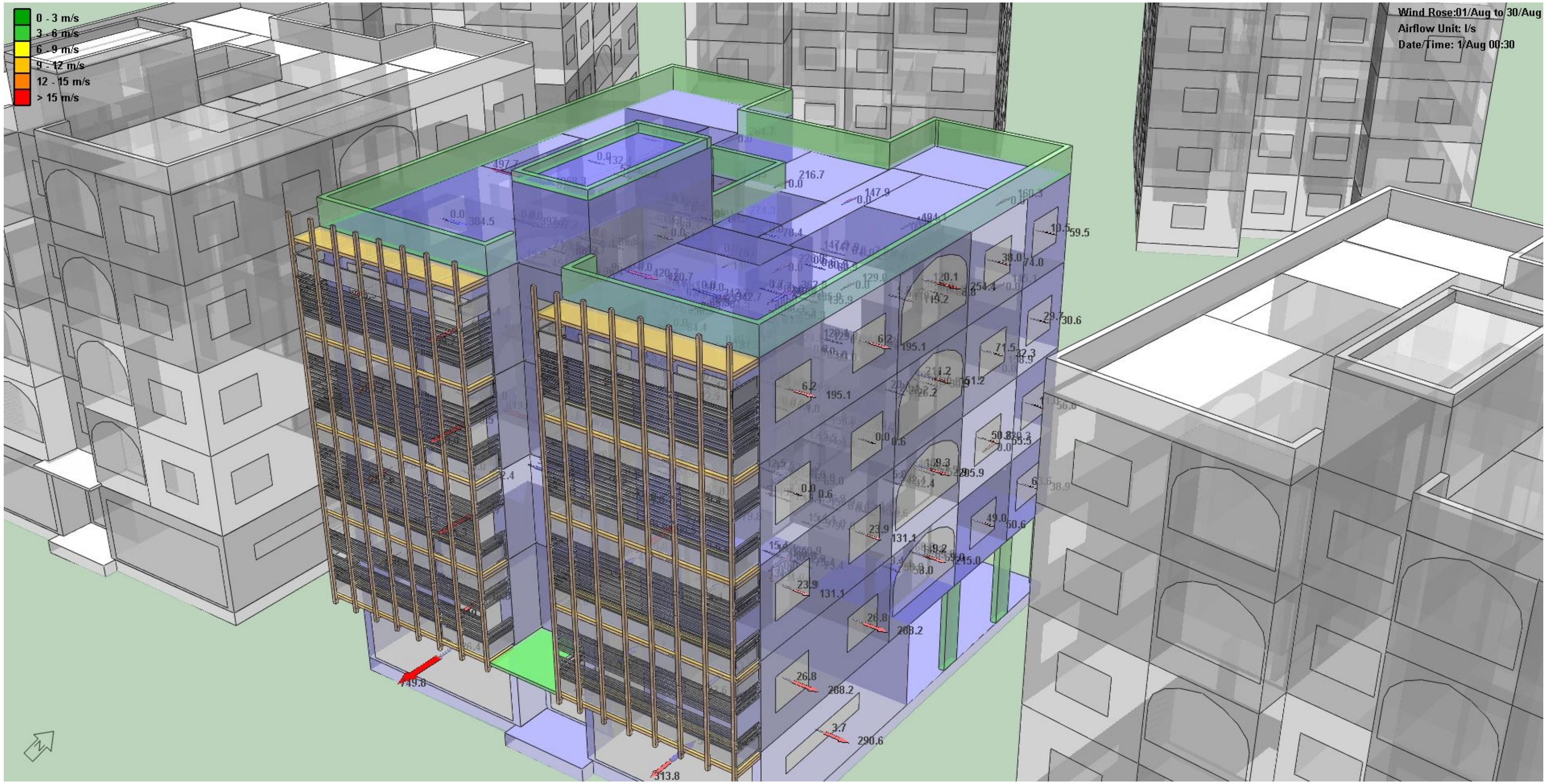

Figure 5: 3D rendering of RTB prototype after Strategy 1 implemented; image shows infiltration rates of occupied spaces on side elevation. RTBs built in close proximity to one another, which caused poor natural ventilation; S1 was not intended to reduce overheating risk of each occupied space, but to provide optimised indoor-air quality for occupant thermal comfort.

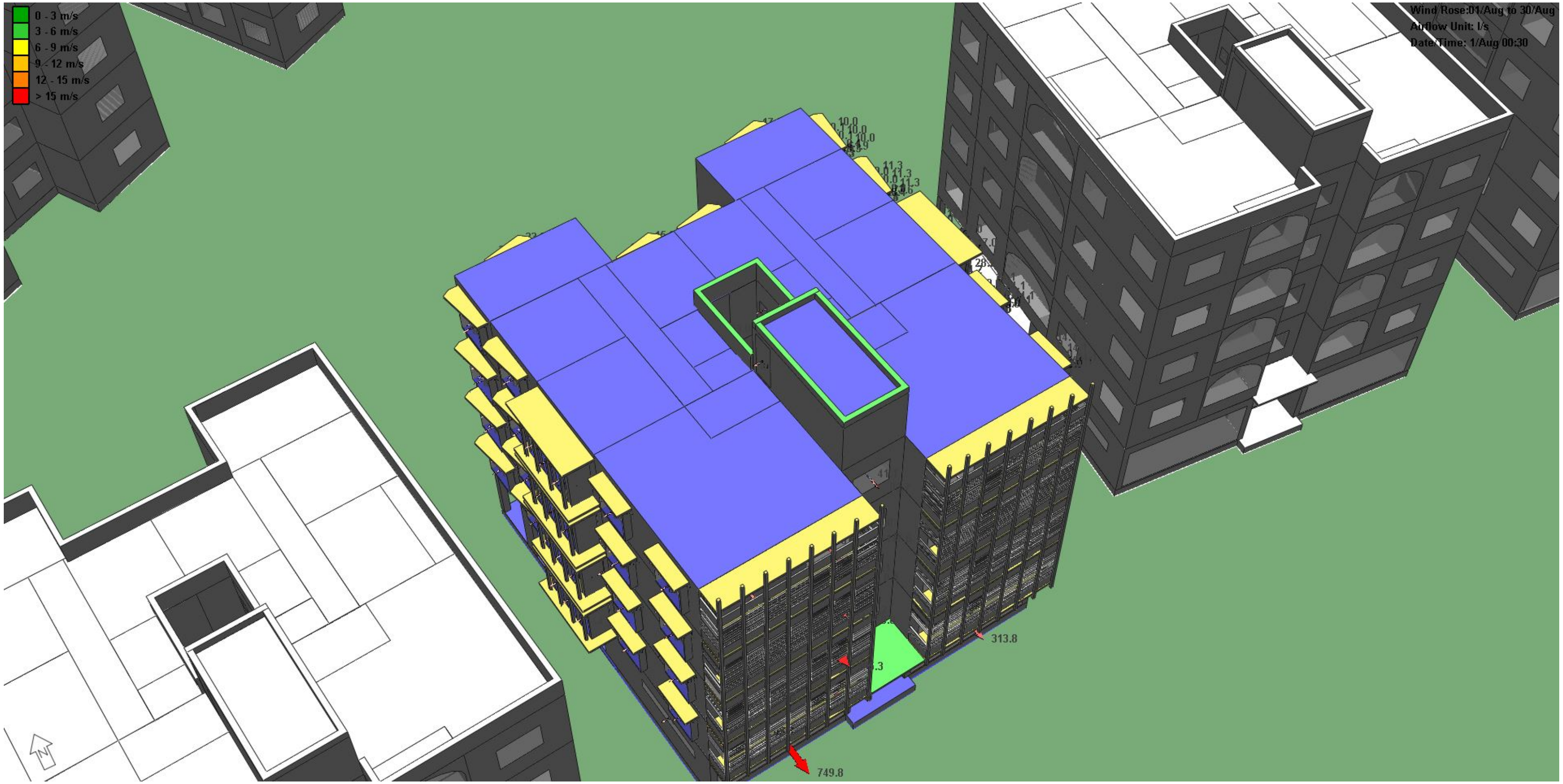

Figure 6: 3D rendering of RTB prototype after all six passive-design strategies implemented; overhanging living room balcony with adjustable shading elements and kitchen balcony projection added significant value. Initial strategies intended to reduce effect of high solar radiation in summer so retrofitting efforts could achieve EU housing standards while considering real-life experiences related to home-energy performance.

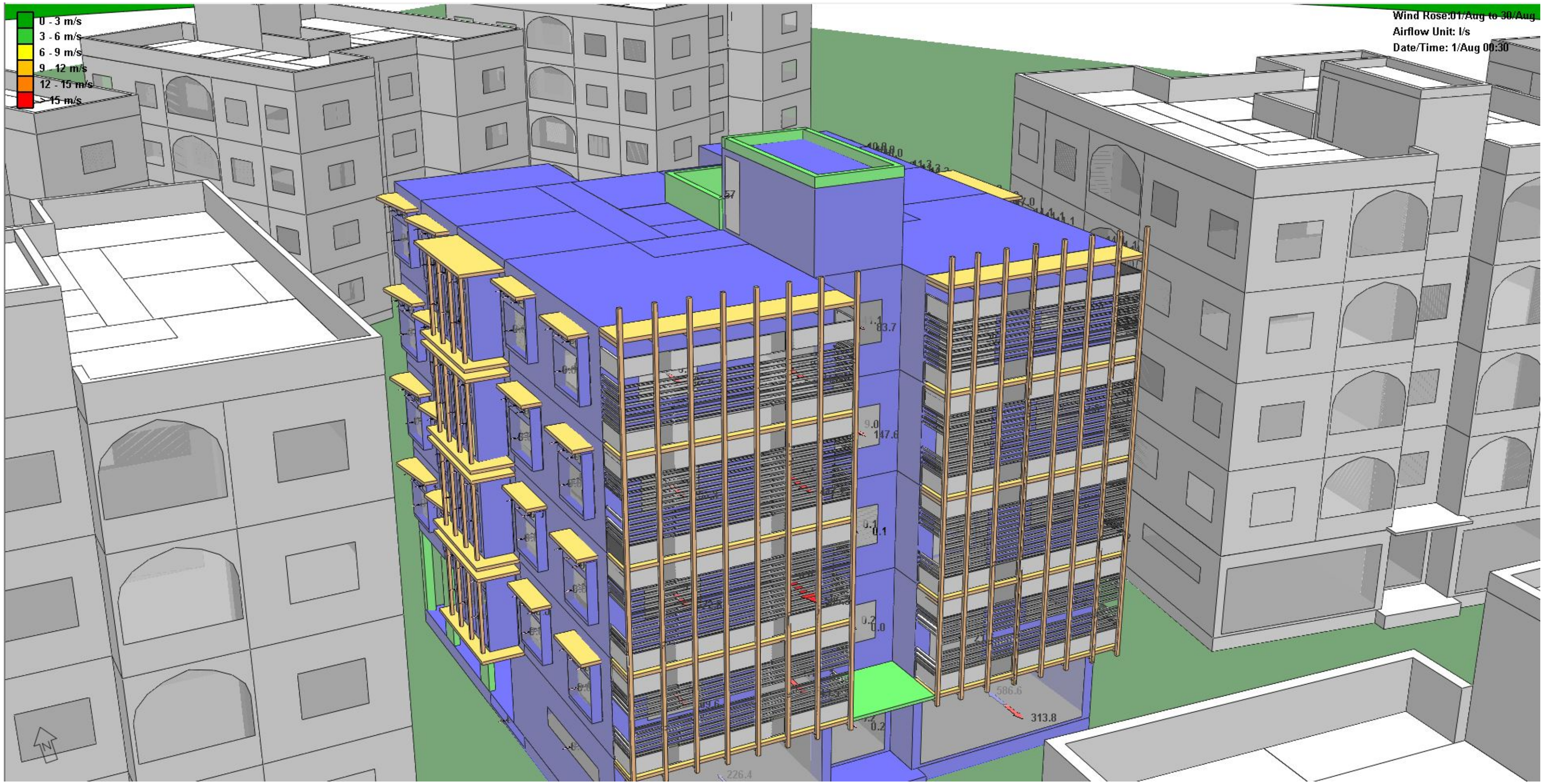

Figure 7: 3D rendering of RTB prototype after all six passive-cooling design strategies implemented. Image shows volumetric balcony space addition with adjustable shading elements on front elevation; side elevation shows fenestration design of window openings designed taking RTB orientation into consideration.

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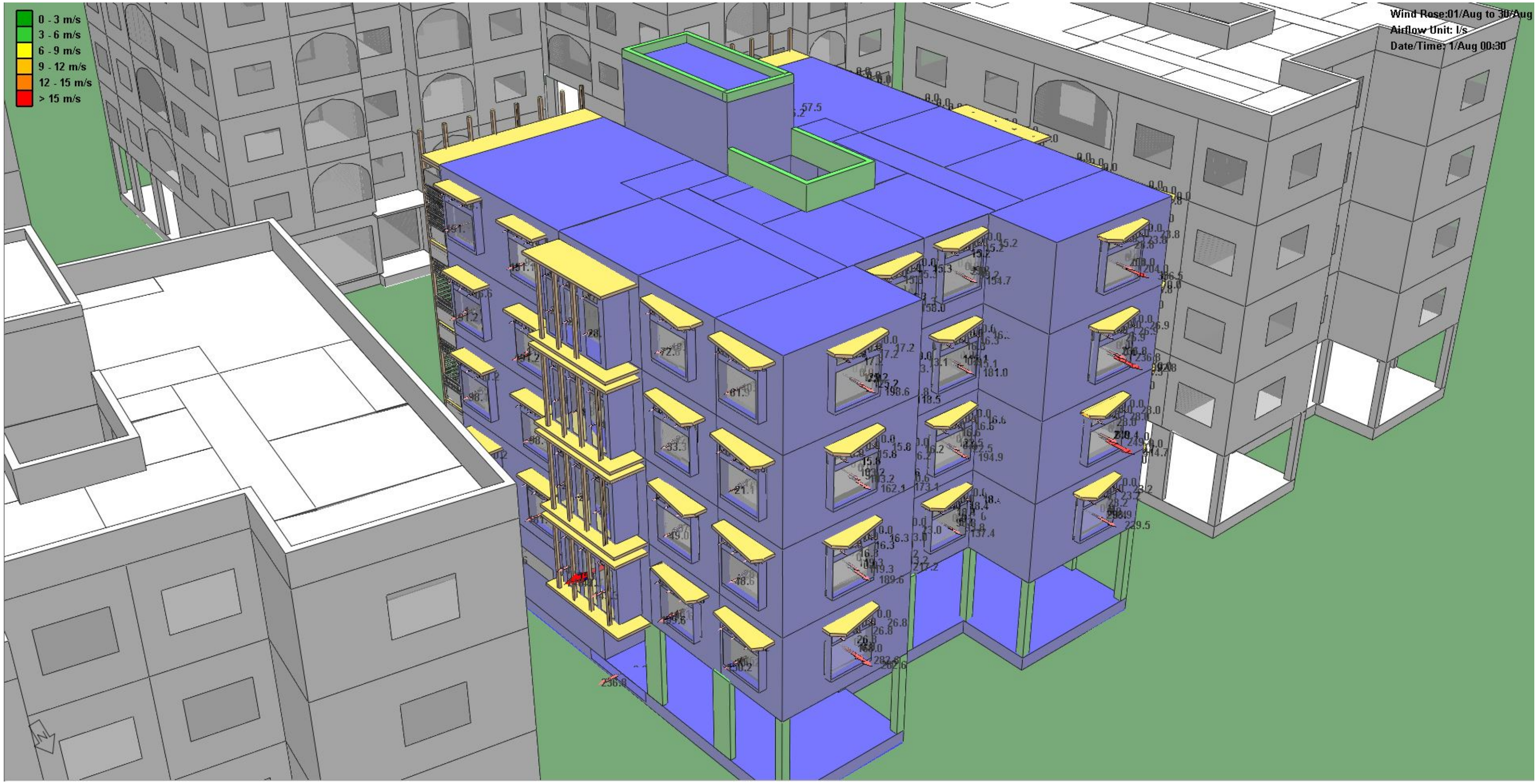

Figure 8: 3D rendering of RTB prototype after all six passive-cooling design strategies implemented. Image shows back elevation, where Bedroom 1 and Bedroom 2 are located; fenestration design was intended to accommodate three top window openings to increase air infiltration rate at night.

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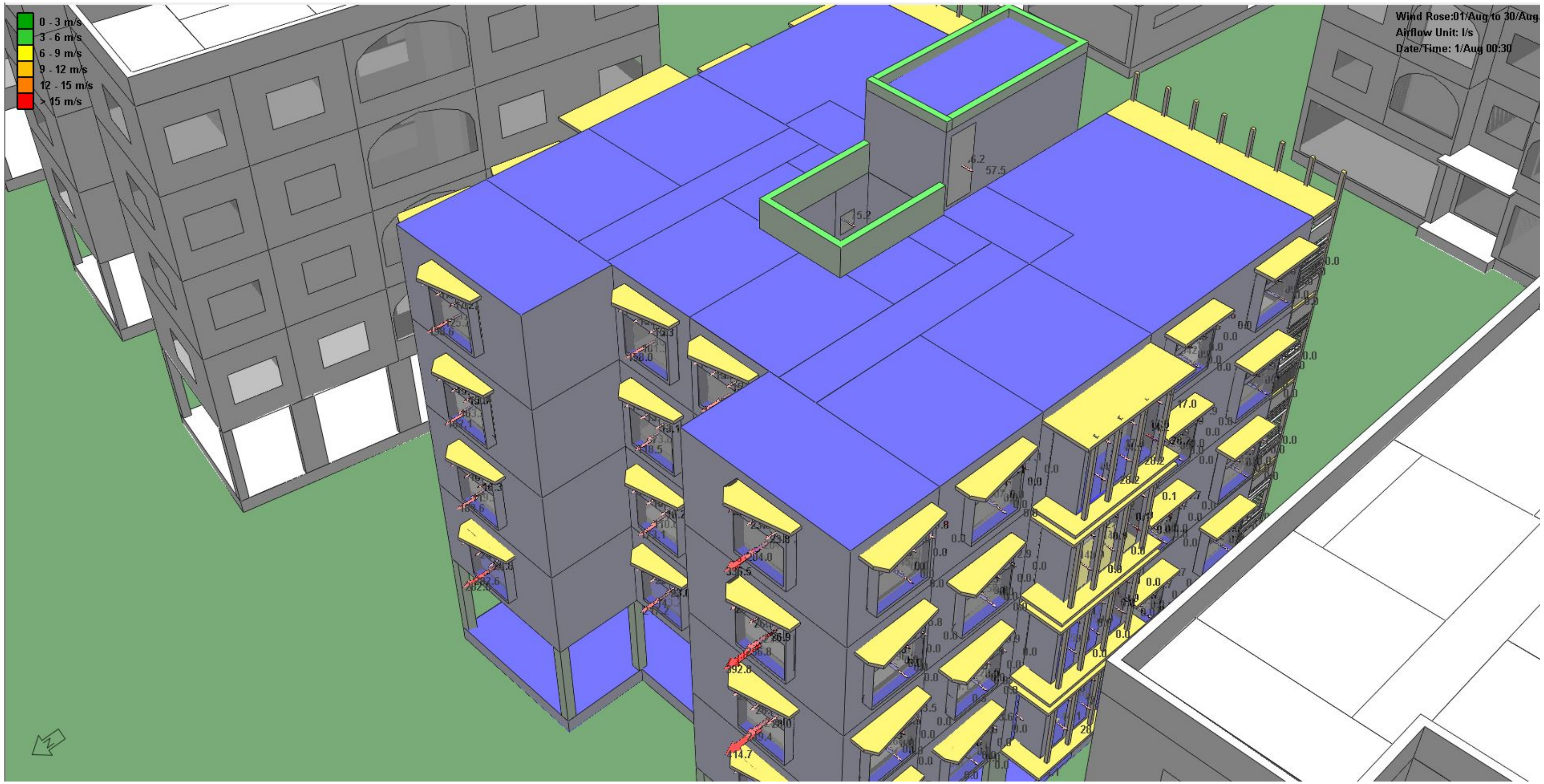

Figure 9: 3D rendering of RTB prototype after all six passive-cooling design strategies implemented. Bird's-eye view shows that shading systems designed with fenestration strategies to acclimatise indoor-air environment; balcony projections show that spatial layout of each flat was re-configured to increase liveability in condominiums.

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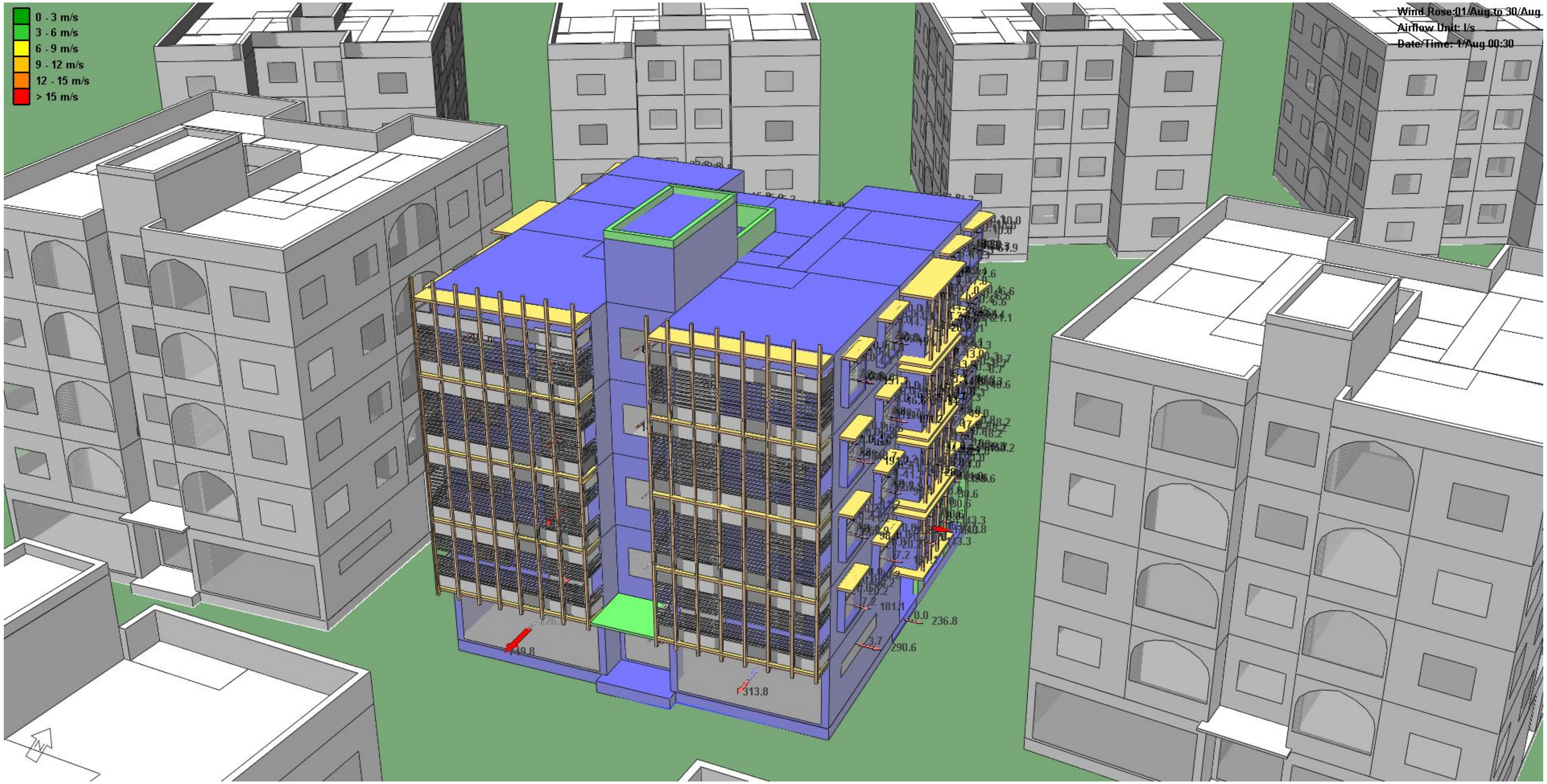

Figure 10: 3D rendering of street view of RTB prototype and psychological cognition of all six passive design strategies. These strategies not limited to reducing overheating risks and optimising occupant thermal comfort; existing housing could also be treated to achieve EU housing quality standards.