Hybrid-PDV: Bringing Passive Displacement Cooling to Buildings Without a Central Chilled-Water Plant

Yitac Pte Ltd

ARTICLE SUMMARY Hybrid-PDV retains the natural-convection cooling principle of conventional PDV but produces chilled water through dedicated modular chillers instead of a central plant.

Opening passive cooling to more buildings

Passive displacement ventilation (PDV), also known in cooling applications as passive displacement cooling (PDC), uses natural air movement instead of high-volume mechanical recirculation to cool an occupied space. This can reduce room-side fan demand while providing quiet operation and gentle air movement.

Conventional chilled-water PDV is most straightforward in buildings with a central chilled-water plant. Hybrid-PDV closes this infrastructure gap by combining passive cooling coils with dedicated modular chillers, variable-speed pumping and coordinated controls. It therefore allows selected smaller buildings and retrofits projects to use the same natural-convection principle without depending on a building-wide plant.

How the cooling cycle works

1. Heat enters the space. People, lighting, equipment and the building envelope warm the room air.

2. Warm air rises naturally. Buoyancy carries it towards the high-level inlet of the PDV coil enclosure.

3. Chilled-water coils remove heat. The air cools as it passes across the coil and becomes denser.

4. Cool air descends. It returns gently to the occupied zone, sustaining a continuous natural-convection loop.

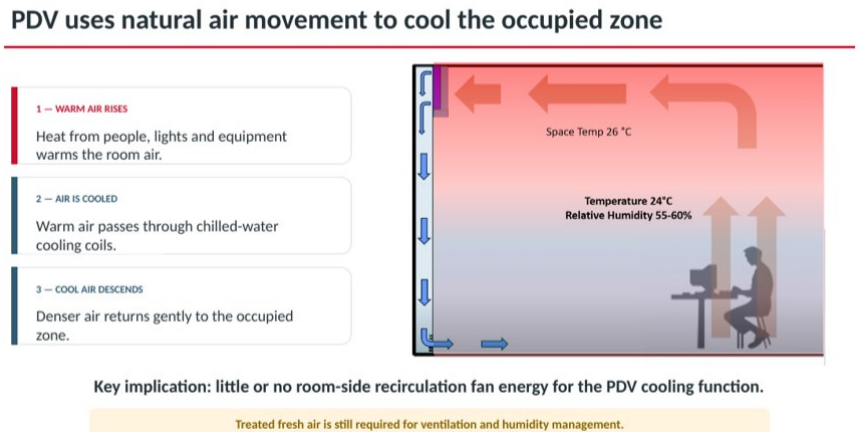

Figure 1. Warm air rises to the cooling coil; cooled, denser air descends gently into the occupied zone. Treated outdoor air is still required for ventilation and humidity control.

IMPORTANT DESIGN POINT PDV reduces or eliminates the room-side recirculation fan used for passive cooling but does not remove the need for treated outdoor air, humidity regulation or condensate management.

What makes the system 'hybrid'?

The room-side process is unchanged: warm air rises, passes through chilled-water coils, cools and descends gently into the occupied zone. The difference lies in how chilled water is produced and distributed.

Integrated system components

- Inverter-driven modular air-cooled chillers
- Passive displacement cooling coils
- Variable-speed pumps and hydronic controls
- Treated outdoor-air system, where required
- Temperature, humidity and condensation safeguards

Principal benefits

- Lower room-side fan demand
- Quiet, draught-minimised comfort
- Modular chilled-water infrastructure
- Architectural flexibility and simpler room-side maintenance

Application checklist

- Suitable sensible and latent load profile
- Stable natural-convection path
- Adequate treated outdoor air
- Humidity and condensation control
- Coordinated coil, pump, chiller and controls

Typical project attributes

- No central chilled-water plant
- Low-noise or gentle-air-movement requirement
- Local or extended-hours cooling
- Retrofit or phased implementation

Current markets

Singapore | Taiwan | Malaysia

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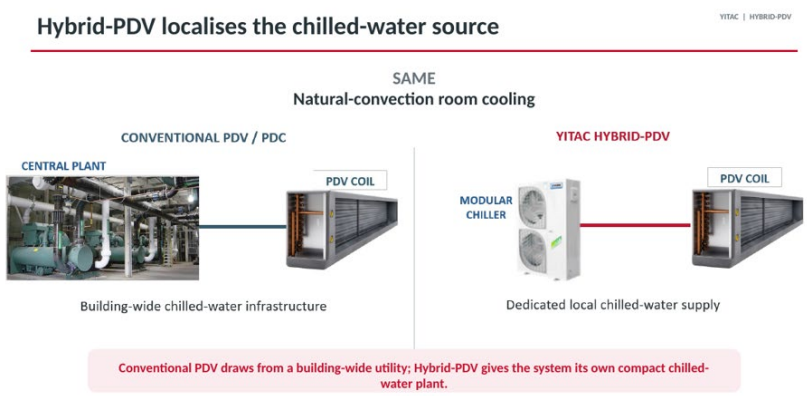

Figure 2. Hybrid-PDV localises the chilled-water source through dedicated modular chillers.

Conventional PDV: Uses an existing central chilled-water plant.

Hybrid-PDV: Uses dedicated modular chillers and local chilled-water distribution for the selected facility.

Where Hybrid-PDV fits best

Yitac's current applications span approximately 18-130 kW of cooling capacity. This is an existing project range, not an absolute technical limit. Suitable applications include smaller standalone facilities, community spaces, schools, offices, meeting rooms, tenant spaces operating beyond the main chiller schedule, and retrofit or phased projects without central chilled-water infrastructure.

Design discipline determines performance

Hybrid-PDV is not a universal drop-in replacement. A suitability study should assess the sensible and latent loads, ventilation rate, humidity target, room geometry, ceiling height, occupancy pattern, facade exposure and operating schedule. In Singapore's hot and humid climate, the fresh-air system must remove sufficient moisture, while chilled surfaces, valves and pipework require correct insulation, drainage and condensation protection. The coils, pumps, chillers and controls must be selected as one coordinated system.

From prototype to commercial applications

Since the completion of the concept prototyping, it has progressed into commercial applications in Singapore, Taiwan and Malaysia.

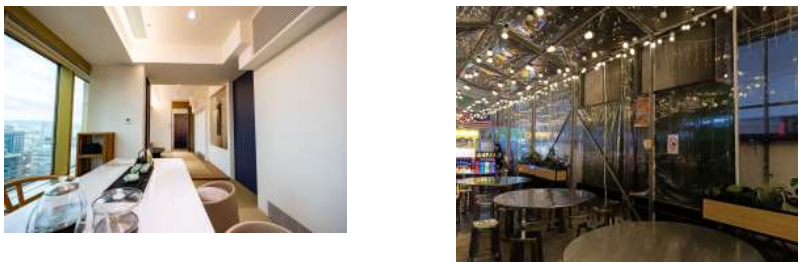

Figure 3. Commercial applications at Bao Yan Shi, Taiwan (left), and KL City Walk, Malaysia (right).

A practical extension of passive cooling. Hybrid-PDV does not change the physics of passive displacement cooling. It creates a compact, modular chilled-water pathway that allows the same principle to serve a wider range of projects when ventilation, humidity, condensation and controls are engineered as part of the complete system.