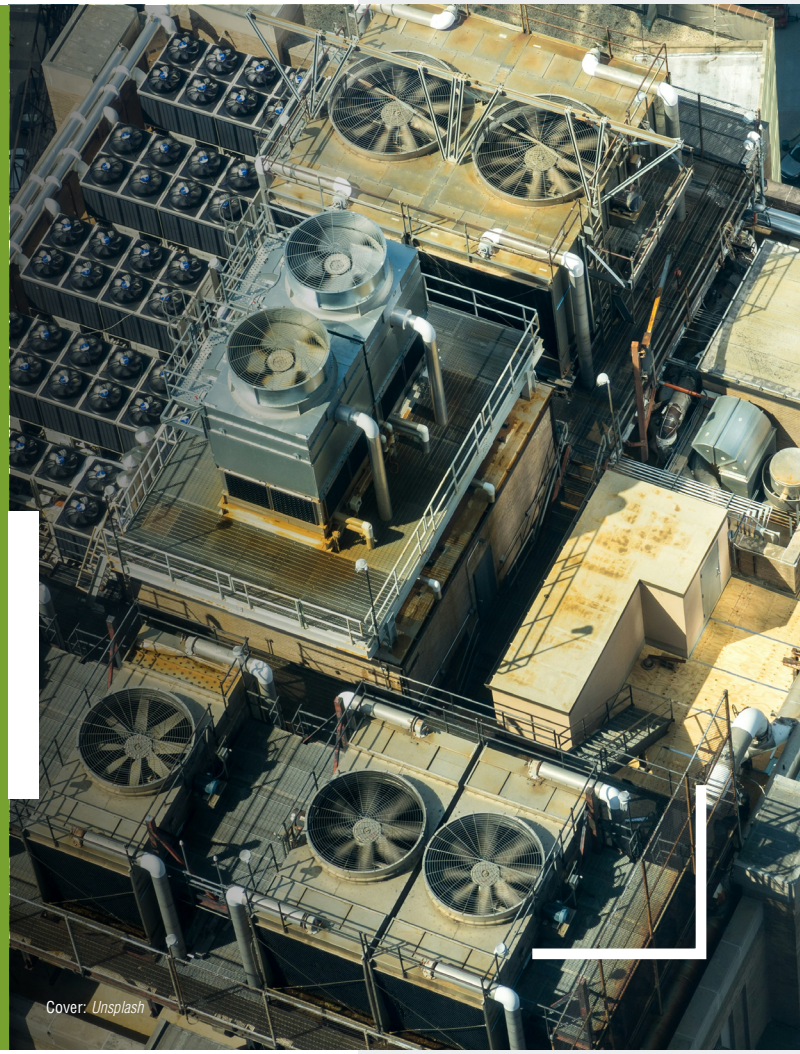
Urban Land Institute

Bending the Curve in Practice:

Unlocking Cost-Effective Cooling Retrofits in China

November 2026



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Acknowledgments

Urban Land Institute

Founded in 1936, the Urban Land Institute is an international, membership-based nonprofit research and education organisation. As the preeminent, multidisciplinary real estate forum, ULI facilitates the open exchange of ideas, information, and experience among local, national, and international industry leaders and policy makers dedicated to creating better places. The mission of the Urban Land Institute is to shape the future of the built environment for transformative impact in communities worldwide.

Carbon Containment Lab

The Carbon Containment Lab is a nonprofit organization based in New Haven, Connecticut. Its mission is to enable high-potential climate solutions through applying scientific, entrepreneurial, and investment expertise. Founded at the Yale School of the Environment, it became an independent organization in 2024. It has a vibrant program on measuring and reducing emissions associated with cooling, by advancing lifecycle refrigerant management and alternative cooling technologies.

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HANG LUNG PROPERTIES

Hang Lung Properties Limited creates compelling spaces that enrich lives. Headquartered in Hong Kong and Shanghai, the Company manages over 3.5 million square meters of retail, office, residential, and hotel properties across Hong Kong and Chinese Mainland. Its Hong Kong portfolio features prime office towers, shopping malls, and luxury residences. On the Mainland, its signature “66” mixed-use developments stand as premium landmarks across hearts of key cities including Shanghai, Shenyang, Jinan, Wuxi, Tianjin, Dalian, Kunming, Wuhan, and Hangzhou.

Workshop Participants

The workshop included the following experts and practitioners (listed alphabetically):

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Key takeaways

- **Racing against the heat.** Asia is warming faster than the global average, and fast-growing air-conditioning use is a major driver of global electricity demand growth. Without coordinated action, rising cooling demand will continue to outpace efficiency gains.
- **The economics already work.** Research found that a significant portion of cooling emissions from China's commercial real estate to 2060 could be abated through measures that make economic sense before any carbon price, led by smarter controls and maintenance.
- **The timing is right.** New office and retail construction starts in China in 2025 were more than 80% below 2015 levels, shifting the market's focus toward enhancing existing buildings, especially as a large cohort approaches its first major cooling replacement in the next decade.
- **The barriers are mostly not technical.** They come from who controls the equipment and data, how retrofit capital is budgeted and timed, and the resistance to changing default design and procurement practices.
- **Sort options by payback and by who must act.** Of the solutions available to building owners, implement operational quick wins now, plan equipment upgrades into the capex calendar before equipment fails, and coordinate across stakeholders on the rest.
- **A proposed next step:** a shared HVAC procurement guideline that makes asking the right questions routine across the equipment life cycle, from maintaining existing equipment to upgrading at retrofit and planning new builds.

1. Introduction: why we need to act this decade

COOLING DEMAND IS OUTPACING EFFICIENCY GAINS

Asia warmed nearly twice as fast over 1991–2025 as over 1961–1990, and China recorded its hottest summer on record in 2025.[1] Cooling demand is rising with the heat. In 2024, heatwaves in China and India drove up air-conditioning use, helping buildings account for nearly 60% of global electricity demand growth that year.[2]

Each generation of buildings and HVAC equipment is more efficient and better aligned with international policy to protect the ozone layer and the climate, but incremental gains are being outpaced by rising demand. Many remaining reductions also require coordination across the real estate value chain. Continued progress — and cities that stay livable in a warmer world — now depends on rethinking how we design, operate and manage the whole cooling system, from equipment selection to refrigerant end-of-life.

FROM RESEARCH TO PRACTICE

In early 2026, Carbon Containment Lab (CC Lab) published *Bending the Curve: Cost-effective Cooling Emission Reduction Pathways for Commercial Real Estate in China and the U.S.*,[3] which found that a significant share of cooling emissions in China's commercial buildings can be abated cost-effectively, much of it with net savings. In June 2026, ULI, CC Lab and Hang Lung Properties co-convened a practitioner workshop in Shanghai around one question: if these measures pay for themselves, what stops them from being implemented widely, and how can those barriers be removed?

The workshop brought together people with decision influence over HVAC equipment: over 30 owners, operators, designers, manufacturers, financiers and researchers. Follow-on interviews over the summer with owners of large China portfolios tested how the identified barriers show up in practice depending on the operating context.

This report is a milestone, not a conclusion, in this ongoing effort. It turns practitioner perspectives into a working guide, identifying where the barriers sit, how to sort the available solutions, and which levers each stakeholder group can pull. It closes by proposing a next step to coordinate the stakeholders toward common practices that can accelerate implementation.

WHY NOW: A RETROFIT WINDOW DURING A CONSTRUCTION DOWNTURN

Beyond more frequent heatwaves and grid-load records, the market cycle itself creates an opening. New construction of offices and retail space in China peaked in 2013–2014 and has fallen steeply since. In 2025, developers started 53 million square meters of office and retail floor space, less than a fifth of the 2015 level.[4] The market's focus has shifted from new builds to improving existing stock.

For cooling upgrades, that shift is an opportunity. The large cohort of commercial assets built in the 2010–2015 boom turns 15 over in this decade, roughly matching the first major replacement cycle of many cooling systems. With the 2030 national carbon-peaking target approaching, the rest of this decade is the window to move existing building stock to the next level of efficiency while cutting refrigerant emissions. Each end-of-life replacement locks performance in — or out — for the next 15 years or more.

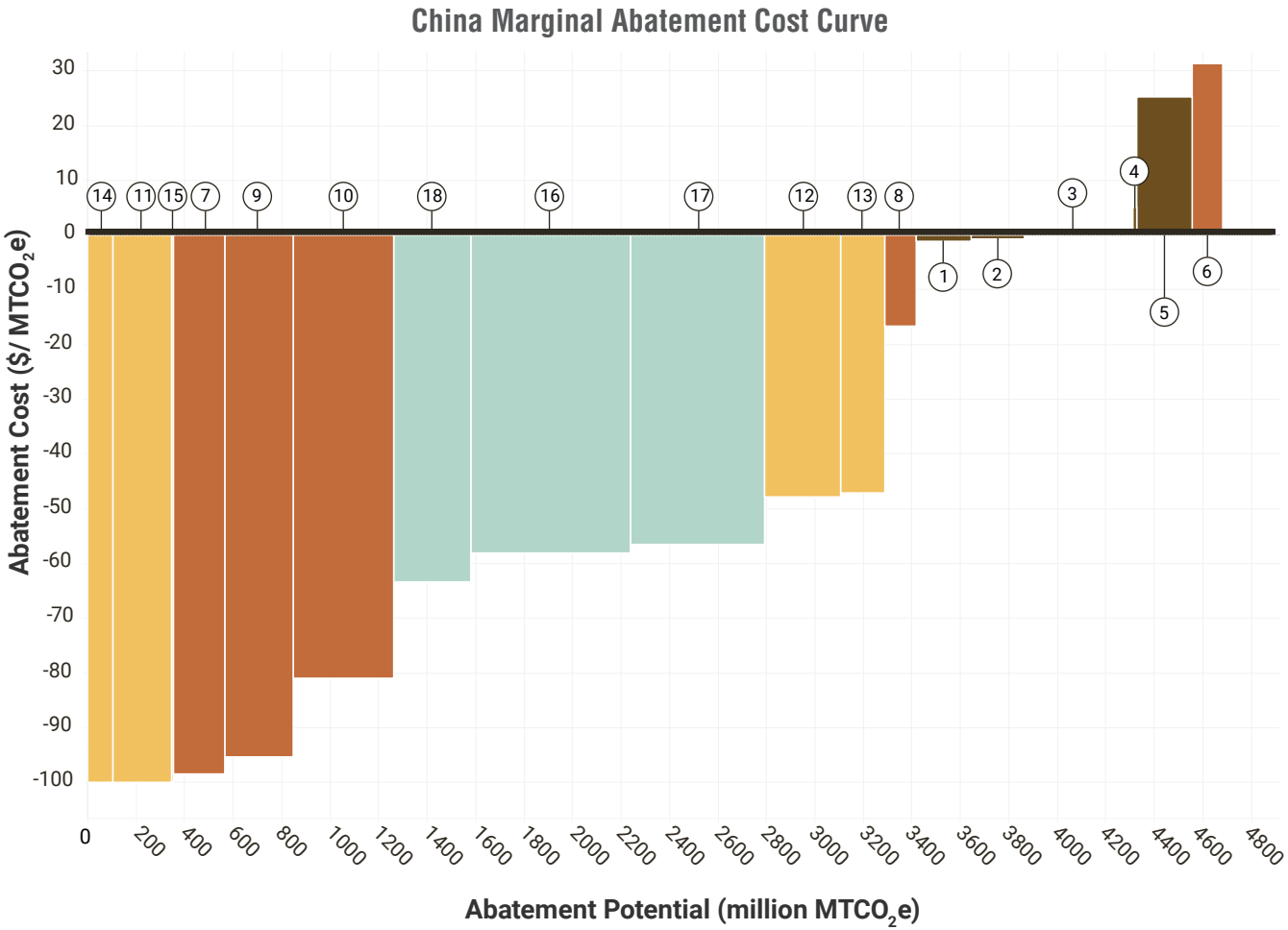
Yet in practice these decisions are often deferred. The rest of this report sets out why, and what could be done to change it.

2. The solution landscape: what pays back, and how to choose

WHAT THE RESEARCH SHOWS

Bending the Curve puts cumulative cooling emissions from China's commercial real estate at about 10 billion metric tons of CO_2e between 2026 and 2060. Roughly a third of this could be abated through economically viable measures before any carbon price.

Figure 1: China marginal abatement cost curve from Bending the Curve (CC Lab, 2026).



Category A:
Lifecycle Refrigerant Management ("fuel")

1. Recover & recycle refrigerants on-site
2. Recover & reclaim pure refrigerants
3. Recover & reclaim mixed refrigerants
4. Recover & destroy refrigerants
5. Use 'drop-in' lower GWP refrigerants

Category B:
Cooling Equipment Upgrades ("engine")

6. Upgrade to lower GWP refrigerant equipment
7. Conduct smart equipment maintenance and calibration
8. Install sensors to detect leaks in compressors
9. Use best practice equipment installation and calibration
10. Upgrade to higher COP cooling equipment

Category C:
Reduced Primary Cooling Load ("demand")

11. Establish higher cooling set-points
12. Increase insulation, shading, reflection
13. Install heat exchanger between incoming and outgoing air
14. Install occupancy sensors for lighting systems
15. Transition from open to closed refrigerated displays

Category D:
Cooling System Management ("system-wide")

16. Implement intelligent, data-driven control
17. Enhance management & operator skills
18. Upgrade system hardware

Cumulative (2026 to 2060) emissions reduction potential from economically feasible abatement opportunities, by category, for cooling in the Chinese commercial real estate sector.

Source: Carbon Containment Lab, 2026

The measures fall into four categories:

- **Reduced primary cooling load ("demand"):** set-points, shading and insulation, heat recovery, occupancy sensors.
- **Cooling system management ("system-wide"):** data-driven controls, operator skills, system hardware.
- **Cooling equipment upgrades ("engine"):** higher-efficiency equipment (higher coefficient of performance, COP), lower global-warming-potential (GWP) refrigerant equipment, maintenance and leak detection.
- **Lifecycle refrigerant management ("fuel"):** recovery, reclaim, destruction and lower-GWP drop-ins.

The first three categories dominate the negative-cost side of the curve. Refrigerant lifecycle management is a meaningful parallel category that typically needs only a small implied carbon price, but depends on data and incentive infrastructure that does not yet exist at scale in China. The workshop thus focused on the left side of the curve, where the near-term business case is strongest.

WHAT PRACTITIONERS SEE ON THE GROUND

Most near-term cost-effective levers sit in operations and system software. Many buildings already have variable-speed drives and a building management system (BMS) but run them at a fraction of their potential. The causes are data gaps and silos, and misaligned incentives between those who maintain the systems and those who pay the utility bills.

The business case for HVAC equipment upgrades is stronger when planned into a broader asset enhancement strategy rather than as standalone projects. Higher-COP equipment with lower-GWP refrigerant is available for many applications, but upgrading usually makes sense at end of life, not when the existing chiller is only five years old. Participants shared indicative paybacks as illustrative examples:

- **Control-system upgrade:** ~3–4 years.
- **Full high-efficiency plant-room replacement:** ~10+ years.
- **Energy management contract (EMC), where an energy service provider funds the upgrade and is repaid from utility savings:** little or no upfront capex for the building owner, spread over a ~20-year service life. However, this type of contract can complicate a sale of the building to the next owner.

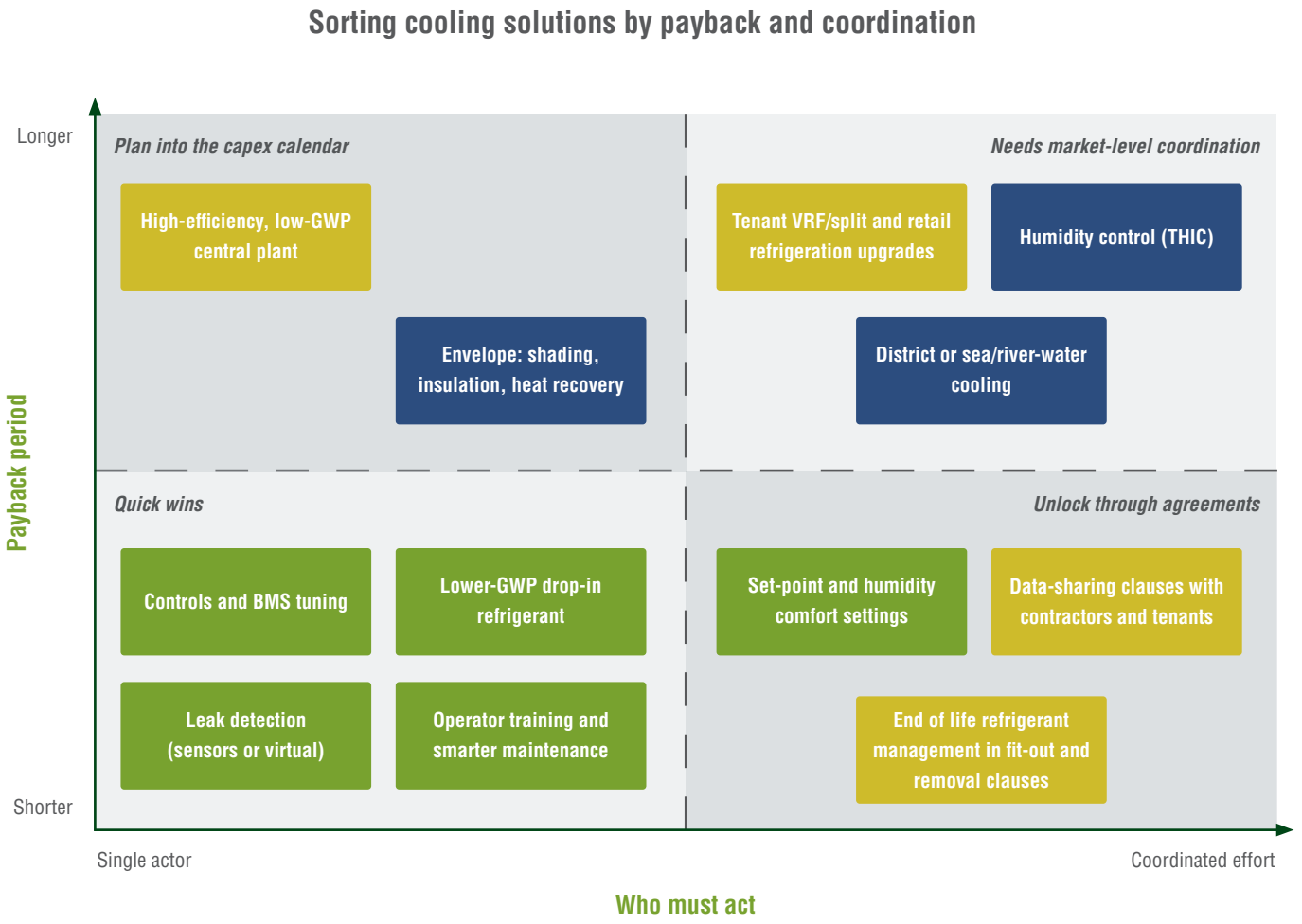
Two solution areas are less market-ready today, but behaviour change should be put on the agenda now to build market acceptance:

- **Temperature and humidity independent control (THIC):** In humid southern and eastern China, much cooling energy goes to overcooling air to remove moisture, then reheating it to the desired temperature. Managing humidity and temperature separately could save up to 50% of that energy according to a workshop participant. THIC is emerging in China but faces high capex and retrofit constraints such as extra ductwork or heavy liquid desiccant tanks. The near-term step is education during the design phase, so tenants and procurement teams can build THIC into their planning.
- **Refrigerant lifecycle management:** Refrigerant recovery happens largely outside owners' control, and recovery data is seldom shared back. One viable strategy today is a lower-GWP drop-in refrigerant in existing equipment. Manufacturers confirmed such options exist, some with competitive COP performance and cost, yet buyers rarely ask for the comparison.

SORTING THE OPTIONS BY PAYBACK HORIZON AND WHO NEEDS TO ACT

Figure 2 sorts each option by how long it takes to pay back and how many parties need to act, with colour showing when in the asset cycle it can be implemented. The placements are indicative, as many factors (such as financing tools) could influence the payback and the coordination needed. This framework is meant to guide decisions through complex constraints, showing which levers are best pulled when, and with whom.

Figure 2: Cooling solutions by payback horizon and who needs to act



When to act

- Anytime, with existing equipment
- At equipment upgrade or lease renewal
- At design stage or major retrofit

The solutions in the lower left are relatively quick wins and often need little or no capex or external permission. The options in the upper left need to be planned into the replacement or retrofit calendar, so decisions are not made under time pressure or deferred indefinitely. Options on the right are hard to scale without cross-sector coordination, which is where an industry convening effort could help unlock inertia.

3. Why implementation stalls and what unlocks it

THE BARRIERS

Each barrier represents a misalignment between the actor who pays, the actor who benefits and the actor who decides. The misalignments fall into three groups.

Who controls the equipment and the data

- **Equipment outside landlord control**. For some owners, most cooling units are tenant-owned (VRF/split systems, retail refrigeration). Multi-site tenants deal with many landlords, which makes it more difficult for a single party on either side to standardise practice.
- **Split behaviour drivers.** The person who controls the temperature might not be the one paying the bill. Especially in a soft leasing market, building managers could raise the cooling set-point by a degree, but a tenant could raise a complaint and bring it back down. In warm climate markets, a cooler retail interior could also signal luxury, and cooling costs might be just a small part of a store's overall experience budget.
- **Data and visibility gaps.** China's VRF-heavy stock often lacks integration across vendors, interfaces, controls and data systems. Outsourced maintenance contractors may not share performance data, and in markets such as Hong Kong, owners cannot see tenant submeter data for privacy reasons. Where data is collected, it often serves reporting only, with no feedback loop to optimise operations.

Capital and timing

- **Payback-horizon mismatch.** Operators rarely accept paybacks beyond 3 years; some want 1–2. Asset managers who hold the asset for a few years might discount longer-term measures.
- **Locked capital plans.** HVAC upgrade is usually one line inside an overall asset enhancement plan that is budgeted years ahead, which limits the owner's ability to explore solutions that emerge in the time between budgeting and implementation.
- **No deadline.** Unlike a new build, an efficiency retrofit can always slide to next year's budget. A 20-year-old system is like an old car that still runs: "use it until it breaks" feels reasonable.
- **Finance friction.** Green finance needs to meet return thresholds and funding often comes with substantial administrative burdens, which price out smaller projects. GWP metrics are beginning to be adopted into financial taxonomies, but bank products still prioritise more traditional energy-efficiency measures over cooling retrofits, which are perceived to be riskier.

Design and procurement defaults

- **Late design input.** MEP engineers are engaged too late to change layouts, and clients and designers default to the standard designs they know. Changing plant space becomes too costly by the equipment procurement phase.
- **Default specifications.** Most owners don't proactively ask about alternative refrigerants, and manufacturers market their standard high-GWP range by default. One owner participant shared that they were readily offered competitive lower-GWP equipment options upon request.

WHO CAN UNLOCK WHAT

No single stakeholder or individual action can clear these barriers, and strategies must treat landlord- and tenant-controlled equipment separately. Many of the actions listed below might be primarily driven or initiated by one role, but they often require partnership from other roles to work in practice.

Landlords (central plant)

- Adopt an "efficiency at end of life" protocol, so any plant due for replacement at the next retrofit defaults to the high-efficiency, lower-GWP option, pre-planned into the capex calendar.

- Ask for GWP alongside COP and cost in every specification and consultant brief; the signal is stronger when owners ask together.
- Use tightening regulation as the urgency case to push internally: energy-use standards with penalties already exist, and participants expect enforcement to tighten toward 2030. From 2029, new small air-conditioning units (≤12 kW) cannot use refrigerants above GWP 750, and most other new equipment is capped at GWP 2,500 (note 5); these caps could further tighten .
- Ease reinstatement obligations (a tenant's duty to restore premises to their original state at lease end) for tenant-installed efficiency upgrades that benefit future tenants, and write refrigerant capture into fit-out and removal clauses.

Tenants (VRF/split, retail and cold chain)

- Specify efficient, lower-GWP equipment in fit-outs, and start treating humidity as part of comfort ahead of THIC maturing.
- Multi-site tenants: standardise equipment procurement practice across landlords.

Operators and maintenance contractors

- Make sharing performance and refrigerant-use data with owners a contract term.
- Overlay IoT sensors on VRF systems and use virtual (algorithmic) leak detection for fleet-level monitoring.

Designers and MEP engineers

- Engage early in the concept phase, and build flexibility into façades and heat-rejection placement to accommodate future uses and technology changes.
- Present a lower-GWP, higher-COP alternative beside the standard design; at district scale, consider district cooling, sea- or river-water cooling and local renewables.

Suppliers and manufacturers

- Put comparisons of COP, GWP and lifecycle cost in front of buyers as default practice, not only on request.

Financiers

- Use EMC and shared-savings models to move upfront cost off owners' balance sheets, and design products that transfer long-payback risk for owners with uncertain hold periods.
- Build lower-GWP thresholds into green retrofit loan and green bond criteria rather than standalone refrigerant products, since retrofit capital is bundled years ahead.

Regulators and utilities

- Continue to enforce energy-use standards and tighten GWP caps to drive the whole market to transition.
- Enable submeter data sharing so landlords have timely and granular data to optimise across the whole building.

Industry associations and conveners

- Convene owners to send a common demand signal to consultants and suppliers.
- Run a tenant-landlord track aligning large multi-site tenants, such as regional retail and F&B chains, with their many landlords. Outputs could include shared best practices for fit-outs, end-of-life equipment upgrades, refrigerant recovery, and cooling demand reduction.

4. Where we go from here

Many of the solutions and barriers discussed in the workshop and interviews point to a common theme: accelerating change beyond single-asset and equipment decisions requires multi-stakeholder coordination at the market level. Owners need tenants to cooperate, tenants need owners to lead and standardise practice, operators need data they don't currently control, financiers need projects with viable paybacks and manageable risks; everyone needs someone else to move first to build the business case. The inertia is not permanent; it breaks when a few conditions shift at once. The replacement wave during the downturn years is not a crisis to manage but a coordination opportunity.

With technical solutions increasingly available at reasonable cost, the most useful next step for sustainability and building-operations teams is identifying and pulling two or three alignment levers — a lease clause, a capex planning protocol, a pilot EMC — before the window closes and the next inefficient equipment cycle begins.

A PROPOSED NEXT STEP: A SHARED HVAC PROCUREMENT GUIDELINE

Building on what we heard in the workshop, we propose one practical next step. Several barriers come down to defaults: buyers don't ask, so suppliers and designers don't offer. A shared procurement guideline would make the right questions routine at each decision moment:

- **Existing equipment not yet due for replacement:** at the next servicing, ask whether a lower-GWP drop-in refrigerant is compatible, what it means for efficiency, safety and warranty, and if reclaimed gas is available.
- **Equipment due for replacement:** request GWP alongside COP and lifecycle cost in every quote, and plan the choice into the capex calendar before the equipment fails.
- **New builds and major retrofits:** engage MEP engineers at concept stage, specify lower-GWP options, and design flexibility into plant and duct space.

Shifting market behaviour requires cross-sector coordination, so this type of resource is best developed with owners, suppliers, designers and industry bodies together. We welcome organisations interested in shaping it to reach out to us at asiapacific@uli.org.

We are grateful to our co-conveners and to all participants who contributed their experience to inform our collective action.

NOTES:

1. World Meteorological Organization, *State of the Climate in Asia 2025* (June 2026).
2. International Energy Agency, *Global Energy Review 2025* (March 2025).
3. Carbon Containment Lab, *Bending the Curve: Cost-effective Cooling Emission Reduction Pathways for Commercial Real Estate in China and the U.S.* (January 2026).
4. National Bureau of Statistics of China, annual national real estate releases, *2011–2025*: new starts of office and retail floor space by real estate development enterprises.
5. Ministry of Ecology and Environment and four other ministries, National Plan for China's Implementation of the Montreal Protocol (2025–2030) (《中国履行〈关于消耗臭氧层物质的蒙特利尔议定书〉国家方案（2025—2030年）》), April 2025. See an expert *interpretation* published by the Ministry.

Appendix: Glossary

TERM	MEANING
BMS	Building management system: the software and controls that monitor and run a building's HVAC and other systems
CC Lab	Carbon Containment Lab
COP	Coefficient of performance: cooling delivered per unit of electricity used; higher is more efficient
CO_2e	Carbon dioxide equivalent
EMC	Energy management contract: an energy service provider funds an upgrade and is repaid from the energy savings
F&B	Food and beverage (as a tenant segment)
GWP	Global warming potential: a refrigerant's warming effect relative to the same mass of CO_2 over 100 years
HVAC	Heating, ventilation and air conditioning
IoT	Internet of things: networked sensors and devices that report data
MEP	Mechanical, electrical and plumbing (engineering)
THIC	Temperature and humidity independent control: handling humidity and temperature separately rather than overcooling air to dry it
ULI	Urban Land Institute
VRF	Variable refrigerant flow: systems in which one outdoor unit serves several indoor units, common in China's commercial stock

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