Industry Guide for Building Operations

Strategies for Delivering Sustainable Cooling and Comfort

Preface

The Go 25 movement promotes a smarter approach to cooling buildings, balancing energy efficiency with occupant comfort. As the industry moves towards more sustainable practices, it is important to understand the challenges and opportunities involved in this shift.

This Industry Guide, developed by the Singapore Green Building Council (SGBC), provides practical strategies, tools, and insights to support building managers, engineers, and operators to Go 25. It draws on industry data and best practices to demonstrate that higher indoor temperatures does not mean compromising on thermal comfort.

Aligned with national sustainability goals and green building standards, the Guide aims to help optimise cooling systems and facility operations. Successful implementation requires strong collaboration between building property managers and occupiers.

To support this, SGBC has developed a structured framework that translates sustainability targets into clear, actionable steps. It highlights key success factors, common barriers, and how to navigate them effectively.

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What is Human Thermal Comfort?

Human thermal comfort refers to a state of mind that expresses satisfaction with the thermal environment. It is not merely about the air temperature, but a complex interplay of personal factors such as metabolism, activity levels and clothing, as well as environmental factors such as:

- Air temperature and humidity
- Radiant heat (from windows or equipment)
- Air velocity (from fans or draughts)

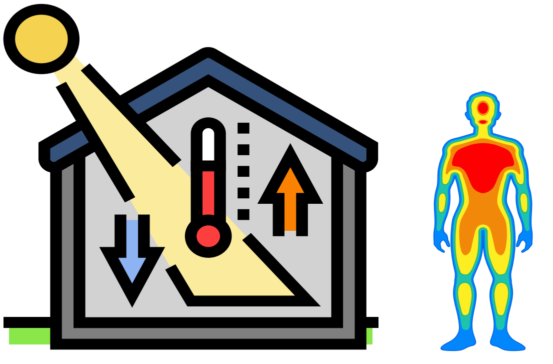
Traditionally, achieving comfort often meant relying heavily on energy-intensive air-conditioning to drastically lower temperatures.

In contrast, a holistic approach to thermal comfort aims to create an optimal indoor environment that enhances well-being and productivity, while simultaneously prioritising energy efficiency. This involves understanding how factors such as airflow, radiant heat, and controlled temperatures collectively influence how an individual perceives thermal comfort. The prospect of creating productive, sustainable, and truly comfortable workspaces that benefit both people and the planet is what makes optimising human thermal comfort so attractive.

Go 25 Industry Guide

When optimising thermal comfort in office or commercial spaces in Singapore, this Guide provides a comprehensive overview of actionable strategies. Insights are offered on approaches to setting an indoor dry bulb[1] temperature setpoint[2] as close as possible to 25°C, including leveraging hybrid cooling fans for improved airflow, implementing adaptable human resource (HR) policies such as flexible dress codes, and utilising technologies such as live monitoring through thermostat sensors and zonal temperature control. The Guide is designed to support the transition towards a more comfortable and energy efficient built environment.

If you have suggestions on how we can improve this Guide, or any questions about specific strategies and processes mentioned, please do get in touch with us at **outreach@sgbc.sg**.



[1] DRY BULB: THE TEMPERATURE OF AIR INDICATED BY AN ORDINARY THERMOMETER SHIELDED FROM SOLAR AND LONG WAVE RADIATION. DEFINITION ADAPTED FROM ASHRAE TERMINOLOGY.
[2] SETPOINT: THE POINT AT WHICH THE DESIRED TEMPERATURE OF THE COOLED SPACE IS SET. DEFINITION ADAPTED FROM ASHRAE TERMINOLOGY.

Introduction

Benefits of Raising Air-Conditioning Temperature

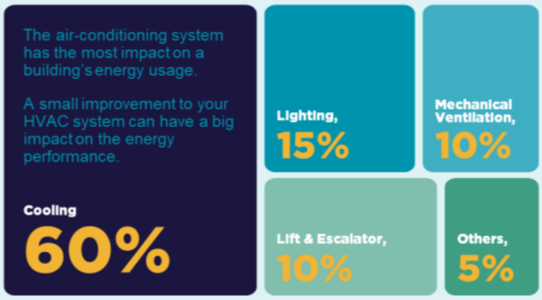
Buildings account for around one-third of Singapore's carbon emissions.[3] With air-conditioning systems being one of the largest energy consumers in a building, it is crucial to look at how we can optimise the use of such systems. Raising the setpoint to 25°C is a way to reduce emissions and energy use, reduce operating costs, while improving comfort and health of occupants.

Environmental Impact and Cost Savings

Air-conditioning significantly contributes to Singapore's carbon emissions through electricity use and refrigerant gas. Raising the setpoint by 3°C (from 22°C to 25°C) can reduce carbon emissions by around 30%, making it an effective measure to support Singapore's sustainability goals.[4]

Raising the setpoint reduces unnecessary cooling and system runtime, resulting in energy savings. It helps reduce energy consumption and supports more sustainable building operations without compromising occupant comfort. Lower energy consumption directly translates into reduced electricity bills. Even a small increase in temperature setpoint can lead to significant cost savings over time, benefiting building owners and operators financially while supporting sustainable practices.

TYPICAL LANDLORD ENERGY CONSUMPTION



Health and Comfort

Over-cooled indoor environments often cause discomfort, with occupants feeling "freezing", wearing extra layers, which are signs of both discomfort and energy waste. Research from SUSS found that people performed cognitive tasks 10% faster at 25°C compared to 21°C, likely because the body expends less energy staying warm. Most occupants prefer a moderate temperature without needing to bundle up.[4]

Another study found that occupants were comfortable at higher setpoints, with a mean comfort temperature of 24.6°C. While perceived comfort declined slightly at 26°C, most tolerated the increase.[5] Maintaining 25°C also helps to avoid the "thermal shock" when moving from Singapore's hot outdoors to an overly cold indoor environment, reducing issues such as dry skin and respiratory irritation.

BCA GREEN MARK

The BCA Green Mark 2021 scheme includes a Health and Wellbeing section that awards points for providing varied thermally comfortable spaces. This covers both air-conditioned and naturally ventilated areas, with emphasis on optimising thermal comfort through adjustable temperature controls and zone-specific solutions. Such strategies include the use of hybrid cooling systems with elevated aircon temperatures with provision of ceiling fans and/or individual desk fans where comfort can be controlled by the temperature of the conditioned air and windspeed variation.

[3] NATIONAL CLIMATE CHANGE SECRETARIAT. (2025, JULY 2). SINGAPORE'S EMISSIONS PROFILE. HTTPS://WWW.NCCS.GOV.SG/SINGAPORES-CLIMATE-ACTION/SINGAPORES-CLIMATE-TARGETS/SINGAPORE-EMISSIONS-PROFILE/

[4] KUEK, R., & HO, N. (2023, JULY 8). WHAT IMPACT CAN 3 °C HAVE? THE RIGHT AIR-CON SETTING MAY BOOST PRODUCTIVITY, AND MORE. CNA INSIDER. (UPDATED AUGUST 7, 2023). HTTPS://WWW.CHANNELNEWSASIA.COM/CNA-INSIDER/AIR-CONDITIONING-IMPACT-25-DEGREES-CELSIUS-TEMPERATURE-SETTING-PRODUCTIVITY-3613256

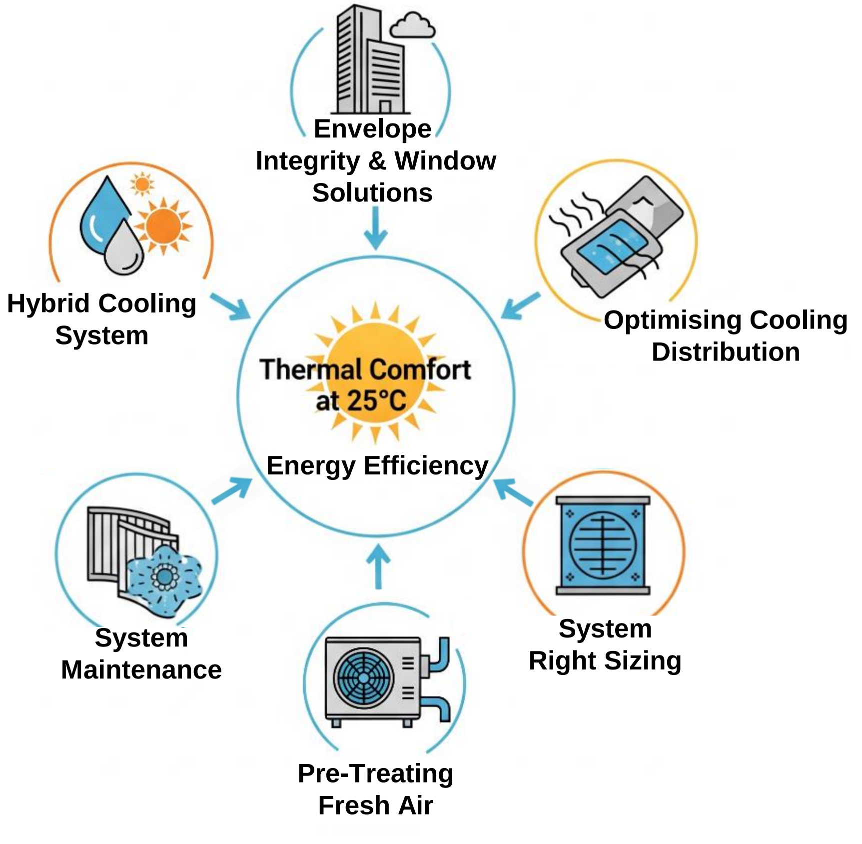
[5] ABDUL RAHMAN, N. H., MOHD NOR, M. F. I., MOHD ARIFFIN, M. A., MOHD YUNOS, M. Y., & ZAINAL, A. (2022). THERMAL COMFORT AND OCCUPANTS' PREFERENCES IN AI4R-CONDITIONED OFFICES OF MALAYSIAN UNIVERSITIES. ENERGY AND BUILT ENVIRONMENT, 4(3), 409–418. HTTPS://DOI.ORG/10.1016/J.ENBENV.2022.12.001

For Existing and Older Buildings

Existing and older buildings often face technical and infrastructure limitations that make it more challenging to adopt energy-efficient cooling strategies. These may include aging Air-Conditioning and Mechanical Ventilation (ACMV) systems, limited automation, inadequate zoning, or poor insulation. However, these constraints do not mean that improvements are out of reach.

Achieving optimal thermal comfort and significant energy savings in buildings, particularly in existing structures, requires a holistic approach that goes beyond conventional air-conditioning. By integrating several key strategies, facilities can drastically reduce cooling loads, improve indoor air quality, and ensure occupant satisfaction while minimising operational costs and environmental impact.

To optimise building cooling, enhance energy efficiency, and ensure occupant comfort, several key strategies are crucial. These include improving the building envelope and upgrading window systems to minimise heat gain, optimising cooling distribution for uniform thermal comfort, and committing to regular system maintenance. Further improvements can be expected from adopting hybrid cooling systems that combine air-conditioning with enhanced air movement, pre-treating fresh air to reduce load and manage humidity, and ensuring system right sizing for optimal performance. While these are pivotal measures, it is important to note that the focus is on key areas rather than an exhaustive list of all possible interventions.



Go 25 Strategies

Addressing Heat Gain: Envelope Integrity and Window Solutions

For many existing and older buildings, their original design and construction often predate modern energy efficiency standards. This means their envelopes, such as the roofs, walls and windows, are typically less insulated and more prone to heat transfer and air leakage. Addressing these fundamental aspects of envelope integrity and window performance is crucial, as they are primary determinants of indoor thermal comfort, energy consumption, and ultimately, a building's environmental footprint, especially Singapore’s warm climate.

Sealing and Insulating the Building Envelope

Older buildings often present significant challenges due to their original design and construction, which frequently lack adequate insulation. This deficiency directly leads to noticeable temperature fluctuations, higher energy consumption during warmer periods, and reduced occupant comfort. Common issues stem from uncontrolled heat gain, primarily through uninsulated roofs and external walls, as well as pervasive air leakage resulting from unsealed joints, cracks, and gaps throughout the building envelope. These weaknesses allow unwanted heat to infiltrate during hot weather, putting a constant strain on ACMV systems.

Addressing these fundamental issues through practical enhancements can dramatically improve a building's thermal performance. Effective strategies include applying insulated or highly reflective coatings to roofs to deflect solar radiation and systematically sealing all identified gaps and cracks with weather stripping, caulking, or appropriate sealants. Such measures are generally low-cost to implement, cause minimal disruption to daily operations, and can be phased in over time, making them ideal for occupied commercial buildings aiming for better thermal stability and energy efficiency without extensive renovations.

Window Solutions for Solar Control

Windows, while providing natural light and views, are often major culprits for unwanted heat gain and glare, particularly in older buildings. Significant solar heat gain through windows, especially on east and west facing facades, directly contributes to increased indoor temperatures and places a heavy load on air-conditioning systems. Uncontrolled glare can also lead to occupant discomfort and reduced productivity. Several effective window specific retrofits can mitigate these issues:

- **Solar Control Film**: A cost effective and low disruption option which can be applied on existing windows to reduce heat gain and glare while preserving natural light.
- **Double Glazing Retrofit**: For greater thermal insulation, consider replacing single panes with double-glazed units: two glass panes separated by an air or gas-filled space to significantly reduce heat transfer.
- **Low-Emissivity Coatings**: Whether applied to new double-glazed units or as a film to existing windows, Low-E coatings selectively reflect heat while allowing visible light to pass through, further enhancing thermal performance.
- **External Shading Devices**: Awnings, louvers, or external blinds can block direct sunlight before it hits the window, offering effective control of heat and glare.

Go 25 Strategies

Optimising Cooling Distribution

Proper air distribution is essential for achieving uniform cooling, avoiding hot or cold spots, and maintaining comfort at the 25°C setpoint. In many existing buildings, especially those with varied layouts or outdated systems, thermal inconsistencies can undermine occupant comfort and system performance.

Zone for Control

- Divide spaces into thermal zones (e.g., east/west perimeter, interior spaces, high occupancy areas, meeting rooms) to reflect differing heat loads and usage patterns.
- Install individual thermostatic controls for each zone to enable tailored temperature management.
- Prioritise zoning in retrofits to maximise comfort without full system overhauls.

Airflow Management

- Adjust layout or furniture positioning in overheated zones to improve air circulation.
- Balance supply air distribution to avoid draughts and uneven temperatures.
- Conduct airflow tuning by adjusting diffuser positions and air volumes.
- Consider fabric air diffusers in large areas to ensure even airflow without major ductwork changes.
- Schedule periodic airflow checks to maintain consistent performance.

Localised Cooling

- Deploy portable fans or spot-cooling units in zones with persistent thermal discomfort to supplement general air distribution.
- Install directional diffusers or adjustable grilles to better target airflow in problematic areas without major system changes.

What to Do When Challenges Arise

Despite best efforts, some office spaces may still experience inconsistent temperatures, draughts, or persistent hot/cold zones. When that happens, it is important to take a data-driven approach and seek expert support when needed.

- Install IoT temperature sensors to identify areas of concern.
- Engage a qualified specialist: Detailed measurements of airflow and temperature distribution will be carried out, and potential causes of discomfort can be identified through expertise in ACMV system diagnostics, air balancing, and building performance.
- Request Air Balancing Services: Air balancing ensures the correct volume of air is delivered to each zone, reducing uneven cooling and energy waste. It is especially important after layout changes or system retrofits.
- Document and Benchmark Issues: Keep a record of comfort complaints, problem zones, and past adjustments. This helps service providers diagnose root causes more effectively.

Go 25 Strategies

System Right Sizing

Air-conditioning systems that are oversized for their actual cooling load often result in short-cycling, such as cooling spaces too quickly, then shutting off. This cycling pattern leads to temperature instability, poor humidity control, and overall reduced system efficiency. Spaces may feel alternately too cold or too warm, undermining the goal of maintaining a steady 25°C.

To avoid these issues, designers should move beyond rule-of-thumb sizing and instead adopt a holistic load assessment, as guided by SS 553:2016. This includes:

- Accounting for realistic occupancy levels, equipment heat gains, internal zoning, and usage schedules
- Considering diversity factors across multiple spaces rather than assuming full load conditions everywhere
- Avoid unnecessary overprovisioning of capacity especially in spaces with intermittent and variable loads.

It is necessary to consider system flexibility, encouraging designs that can operate efficiently at partial load conditions, which most buildings operate for most of the day. Instead of overcooling in bursts, a right-sized system can run steadily at lower output, achieving better temperature stability and greater energy efficiency.

Pre-Treating Fresh Air

Maintaining comfort at 25°C must align to meet fresh air and indoor air quality (IAQ) requirements. As per SS 553:2016, minimum outdoor air intake rates must be provided based on occupancy type, while SS 554:2016 ensures that indoor pollutant and CO_2 levels are kept within acceptable limits.

However, outdoor air introduces additional heat and moisture, which can burden the ACMV system. To maintain temperature and humidity efficiently, consider below measures:

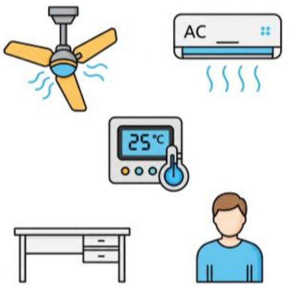
- Avoid overloading the primary cooling system by decoupling fresh air treatment. Use Dedicated Outdoor Air Systems (DOAS) or heat recovery systems to pre-cool and dehumidify outdoor air before it enters the main system.
- Keep airflow and sensors calibrated to deliver required ventilation without energy waste.
- Smart integration of fresh air strategies enables compliance with IAQ standards while maintaining energy-efficient thermal comfort.

System Maintenance

Sustaining performance at 25°C requires regular inspection and maintenance of ACMV systems. Check for issues such as uncalibrated thermostats, blocked air vents, airflow imbalances, and poor filter conditions, all of which can undermine comfort and efficiency.

Refer to the ACMV and IAQ inspection checklists provided in the last section to guide routine assessments and ensure the system continues to operate reliably and aligns with Go 25 movement.

Go 25 Strategies



Hybrid Cooling System for Air-Conditioning

TR 141:2025 – Hybrid Cooling System for Air-Conditioning provides practical guidance for achieving acceptable thermal comfort at higher temperature setpoints, such as 25°C, through a hybrid approach that combines air-conditioning with enhanced air movement.

Maximise Energy Savings: Achieve up to 30% energy reduction by increasing AC temperature (2-3°C) with fan integration. This maintains comfort while significantly cutting cooling load.

Lower Capital Costs & Streamline: Reduced cooling loads mean smaller ducts and downsized ACMV components (chillers, air handling units (AHUs)). Ceiling fans aid air distribution, potentially cutting duct/diffuser needs.

Personalise Comfort: Adjustable ceiling fans allow occupants to fine-tune their environment, enhancing individual thermal comfort, satisfaction, and productivity.

To support Go 25 movement, the following best practices drawn from TR 141 can be adopted

Design for Thermal Comfort → **Effective Fan Selection & Placement** → **Integration of Control Strategies** → **Commission & Maintenance for Long-Term Performance**

Design with Thermal Comfort in Mind, referencing international standards such as ASHRAE 55 to define acceptable comfort zones. It highlights how air movement can compensate for higher temperature. Example a ceiling fan can make 26°C feel like 24°C, thus maintaining comfort while conserving energy.

Select / Position Ceiling Fans Effectively: TR 141 provides detailed recommendations on ceiling fan types, sizes, and layout to ensure optimal airflow. Proper placement and mounting of ceiling fans avoids still-air zones and improves air circulation across occupied areas.

Integrate Controls for Better Efficiency, through standalone controls (manual fan control) or integration with BMS to automate temperature and fan speed. TR 141 outlines control strategies suited for different system configurations (e.g., VAV, DOAS with FCUs).

Effective commissioning and regular maintenance are essential for performance. The guide includes checklists and survey tools to help assess comfort and verify system effectiveness post-installation.

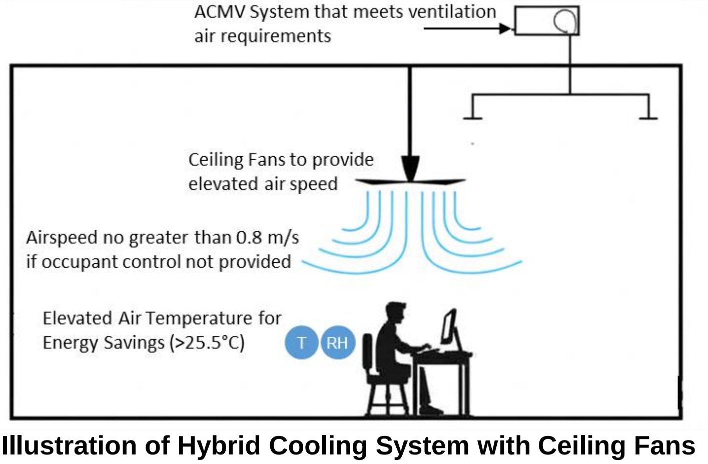


Illustration of Hybrid Cooling System with Ceiling Fans

Key Considerations

- Use brushless direct current motors for ceiling fans, which are quieter and more energy efficient.
- Avoid placing lightings directly above ceiling fans to reduce flicker and strobing; position lights below or away from fan blades where possible.
- For safety, ceiling fans under 2.1m diameter require 2.4m floor to blade clearance, while those over 2.1m need 3m minimum clearance.
- For multi-fan spaces (i.e. open plan offices) and optimisation of ceiling fan layout, to consult with manufacturers or CFD simulation to ensure the design meets all thermal comfort requirements efficiently.

Monitoring and Control

Achieving a comfortable and energy efficient indoor environment depends on precise monitoring and intelligent controls. By leveraging smart technologies and IoT-enabled sensors, buildings can maintain stable temperatures, track performance in real time, and respond to changes.

Thermostat Placement and Calibration

Accurate temperature sensing is necessary to maintain the comfort and energy efficiency. To ensure consistent room temperature readings, thermostats and sensors should be installed at representative indoor locations, away from direct sunlight, supply air vents, or heat-emitting equipment. For more accurate readings, sensors should be installed at the height where occupants are typically situated, rather than mounting them at ceiling level or within return air ducts.

Sensors should be calibrated against a reference thermometer at least once a year. Modern Building Management System (BMS) sensors and digital thermostats often include calibration or offset adjustment functions, allowing alignment with actual ambient temperatures. This ensures that a setpoint of 25°C accurately reflects conditions in the occupied zone within a small margin of error.

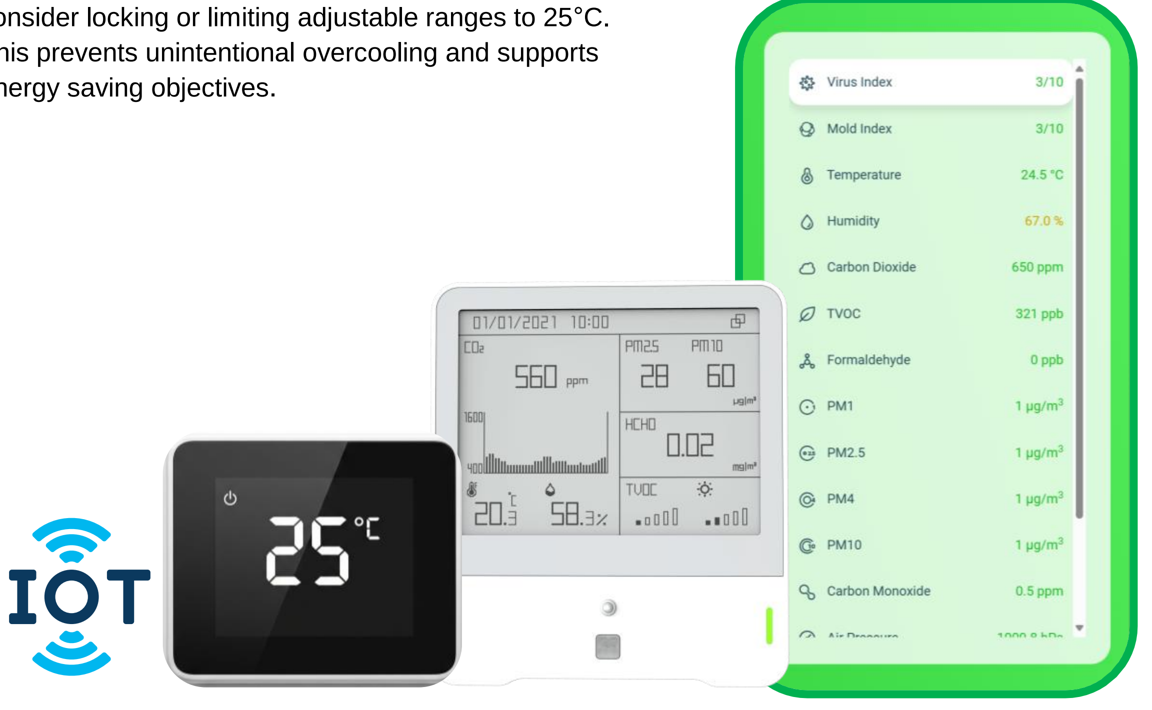
For spaces with occupant-controlled thermostats, consider locking or limiting adjustable ranges to 25°C. This prevents unintentional overcooling and supports energy saving objectives.

Real-time Insights

Smart technologies and IoT enabled controls can provide real-time monitoring and feedback, enabling building managers to quickly identify and correct deviations from target conditions.

However, the effectiveness of these systems rely heavily on the accuracy and reliability of the sensor data. Continuous data quality monitoring is therefore essential to ensure that sensor readings remain trustworthy over time, allowing for informed decision-making and timely interventions.

By maintaining high-quality data inputs, continuous data tracking not only enhances system optimisation efforts but also supports long term performance benchmarking. It enables early detection of faulty or drifting sensors, prevents misdiagnosis of system issues, and ensures that energy saving, and performance strategies are based on credible insights.

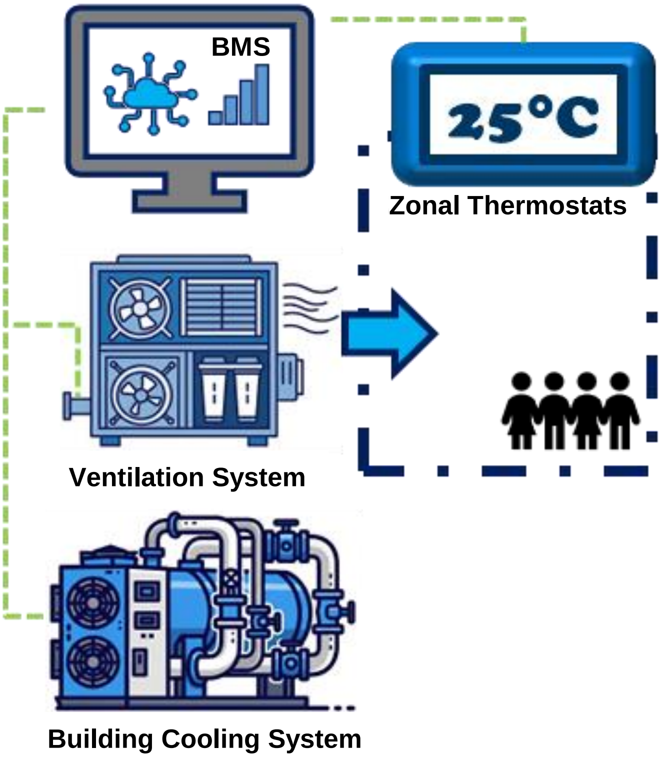


Monitoring and Control

Data-driven Performance Monitoring

In larger buildings, effective implementation of Go 25 relies heavily on data-driven control through a BMS system or other centralised control platforms. A well configured BMS enables precise coordination of ACMV components to maintain the indoor temperature at 25°C with minimal energy waste.

The BMS can dynamically adjust supply air temperatures, adjust fan speeds, and sequence chillers to match cooling loads. Once the target temperature is achieved, the system can automatically reduce fan speeds or cycle compressors to maintain conditions without unnecessary overcooling.



Adaptive Controls & Variable Speeds

To enhance responsiveness and efficiency, key ACMV components such as AHU fans, chilled water pumps, and cooling tower fans should be equipped with variable speed drives (VSDs) or modulating controls. These allow systems to respond precisely to part-load conditions, optimising energy use while avoiding temperature swings.

Instead of shutting off entirely, a variable capacity or inverter driven cooling system can modulate its output to maintain 25°C steadily. Likewise, VAV systems fine-tune airflow by adjusting fan speeds and damper positions, preventing temperature overshoot and improving efficiency.

Monitoring and Control

Operational Strategies and Practical Safeguards

Beyond measurement and controls, effective cooling at 25 °C depends on how systems are scheduled, managed, and safeguarded throughout daily operations. This includes aligning cooling delivery with actual occupancy, maintaining comfort without overcooling, and tuning systems for balanced humidity control.

The following strategies help optimise system runtime, reduce unnecessary energy use, and ensure temperature setpoints are respected especially during after-hours or low-occupancy periods. When thoughtfully implemented, these practices reinforce the stability, comfort, and efficiency goals of Go 25.

Occupancy-Based & Scheduled Controls

- Align Schedules with Occupancy: Avoid unnecessary operation by linking cooling to actual building usage.
- Pre-Cool for Comfort: Initiate cooling 30 to 60 minutes before staff arrival, targeting 25°C by start of day.
- After-Hours Strategy: Switch to higher setpoint or stand-by mode to conserve energy.
- Automate: Utilise occupancy sensors or timers to streamline scheduling.

Maintaining Optimal Humidity

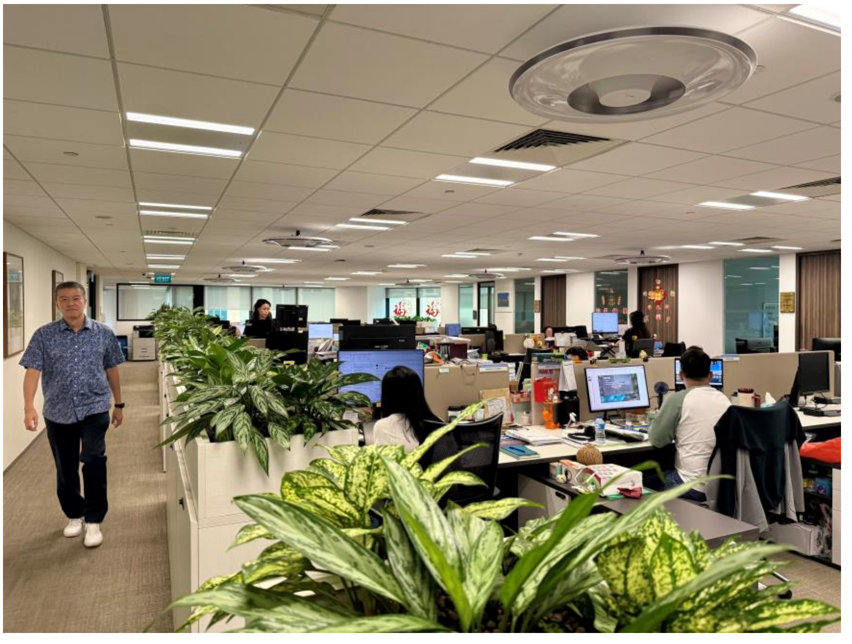
- Humidity Target: Maintain relative humidity not exceeding 70% at 25°C to support occupant comfort, equipment reliability, and overall indoor air quality.
- System Tuning: Proper dehumidification relies on balanced system runtime and coil temperature.
- In systems without fresh air pre-treatment or active dehumidification, temporary overcooling may occur to manage humidity. To minimise this, tune settings to restore humidity control efficiently and revert to the 25°C setpoint once stable. Continuous monitoring helps balance comfort without excessive cooling.

Safeguards Against Overcooling

- BMS Setpoint Locks: Implement fail-safes, such as locking thermostat settings at a minimum of 24 - 25°C within BMS system.
- Staff Education: Educate cleaning crews and security personnel to prevent manual overrides or setting units to extreme cooling modes outside of regular hours.

Go 25 Case Study

City Developments Limited Corporate Office (Republic Plaza)



Outcome: Going 25 in the office is projected to reduce cooling load by around 20%, translating to an estimated annual carbon reduction of over 14,000 kgCO_2e.

Setting a New Comfort Standard at 25°C: CDL has adopted 25°C as its indoor temperature standard across our corporate offices, balancing energy efficiency with occupant comfort.

Hybrid Cooling Fan Implementation: CDL has introduced over 100 bladeless Hybrid Cooling Fans equipped with vortex technology to enhance airflow and ensure thermal comfort, while reducing reliance on energy-intensive air-conditioning.

Business Casual Dress Code: To further ensure the thermal comfort of staffs, CDL has also implemented a business casual dress code policy to promote comfort in a higher temperature setting since October 2024. This move was well-received among staff, as reflected in the survey results with 85% of respondents indicated that thermal comfort at 25°C was maintained with the introduction of new fans and revised dress code.

Live Monitoring via Thermostat Sensors: To provide instant real-time access to temperature and humidity readings across strategically located visible areas to ensure a comfortable and consistent indoor environmental condition throughout the office and encourage occupant awareness.

Zonal Temperature Control: Enables adjustment of Variable Air Volume (VAV) boxes to maintain optimal thermal comfort for occupants

C&W Services Office

Real-time Monitoring and Display provides immediate access to temperature, ensuring stable and comfortable environmental conditions. Temperature are publicly displayed fostering occupant awareness and active engagement.

Zonal Temperature Controls, supported by strategically placed thermostats and VAV boxes, ensure precise adjustments across office areas for consistent comfort and energy efficiency without hotspots.

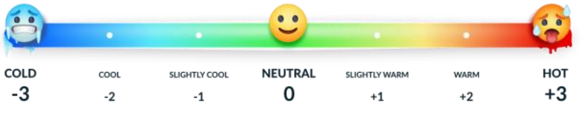
Window Solar Films for Heat Mitigation helps reduce heat gain and glare from office window areas, and also reduces exposure of interiors to strong morning and afternoon sunlight.

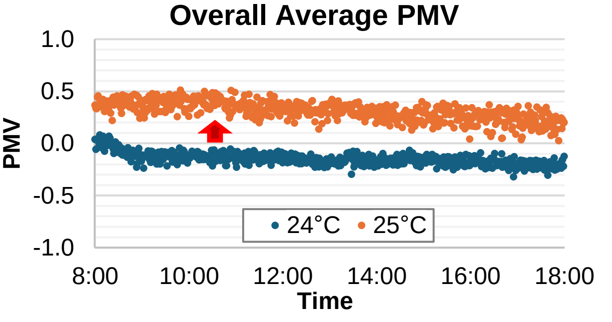
Flexible Seating Arrangement empowers occupants to select workspaces that best align with their individual thermal comfort preferences, supporting personalised comfort.

Findings: Increasing the average room temperature by 1.5°C can reduce cooling energy use by about 18%, while a 1.0°C rise can save roughly 12%. These adjustments remain within thermal comfort thresholds but still require careful tuning of airflow, humidity, and user comfort adaptation.

Thermal Comfort Analysis

A Go 25 structured study was conducted by SGBC in an office space in Singapore to understand the impact of higher indoor temperature settings on comfort and energy performance, between February to May 2025. After the adjustment, the actual average indoor temperature increased from 24.4°C to 25.9°C. Thermal comfort assessment was conducted based on ISO 7730: Ergonomics of the thermal environment, which specifies that acceptable indoor conditions for office spaces fall within a Predicted Mean Vote (PMV)[6] range of –0.5 to +0.5 and a Predicted Percentage of Dissatisfied (PPD)[7] below 10%.





Post implementation shows that PMV remained below +0.5 and PPD stayed under 10%, indicating that the indoor environment continued to meet internationally recognised thermal comfort standards. The results were used to reassure employees that comfort was maintained within thermal comfort standards, and to build understanding and acceptance of the change.

Operationally, some feedback was received regarding warmer zones or hotspots. Investigation revealed that several VAV units were not functioning, which were subsequently rectified.

To support employee comfort and facilitate the transition, several measures were introduced:

- Free seating arrangements were encouraged to allow individuals to choose workspaces that suited their thermal preferences.
- Employee engagement and communication were key, explaining the initiative's purpose, expected outcomes, and reassurance using PMV data.
- Localised cooling solutions, such as personal fans, were used by some employees who preferred additional cooling, providing individual flexibility.
- Real-time monitoring using temperature sensors and zonal controls enabled identification and resolution of comfort issues.

Outcome: An increase in average room temperature by 1.5°C resulted in an estimated 18% reduction in cooling load. This corresponds to an approximate reduction of 12% in cooling load per 1°C increase in temperature.

Comparison of Cooling Performance at Setpoints of 24°C and 25°C

	Setpoint (24°C)	Higher Setpoint (25°C)		
		Value	*Diff.*	
AVG. Cooling Load, *kW*	**171.86**	**140.32**	***-31.54***	***-18.4%***
AVG. Ambient Temperature, *°C*	29.40	30.05	*0.65*	*2.2%*
AVG. Room Temperature, *°C*	24.40	25.90	***1.50***	*6.1%*
AVG. Daily Cooling Energy, *kWh*	**1,904.30**	**1,563.64**	***-340.66***	***-17.9%***

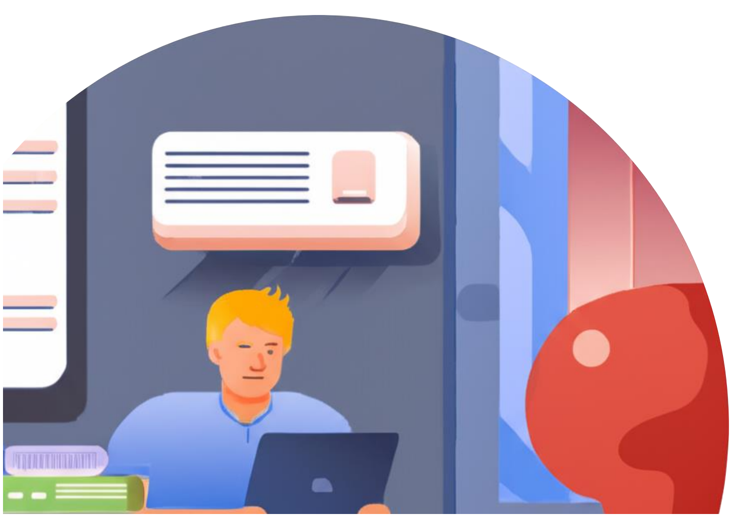
[6] *PREDICTED MEAN VOTE (PMV): AN INDEX PREDICTS THE MEAN VALUE OF THERMAL SENSATION VOTES OF A LARGE GROUP OF PERSONS, EXPRESSED ON A SEVEN-POINT SCALE. DEFINITION ADAPTED FROM ASHRAE TERMINOLOGY.*

[7] *PREDICTED PERCENTAGE DISSATISFIED (PPD): AN INDEX THAT PREDICTS THE PERCENTAGE OF A LARGE GROUP OF PEOPLE WHO ARE LIKELY TO FEEL THERMALLY DISSATISFIED FOR THE BODY AS A WHOLE (I.E., FEEL EITHER TOO WARM OR TOO COLD). DEFINITION ADAPTED FROM ASHRAE TERMINOLOGY.*

Best Practices

Maintaining an efficient and comfortable indoor environment relies not only on building systems but also on everyday operational habits and occupant behaviours.

These guidelines promote energy saving actions, effective temperature management, and occupant awareness to support both comfort and sustainability goals.



Set Room Setpoint towards 25°C

Temperatures should be monitored using data loggers or the BMS to ensure levels remain close to 25°C. In areas consistently registering much lower temperatures, settings should be adjusted or investigated for potential issues such as oversized equipment or incorrect thermostat placement. Occupants should be informed of the importance of maintaining 25°C for comfort and sustainability.

Gradual Adjustment and Adaptation

Increase the temperature by 0.5°C each week to help occupants adjust gradually. During this time, simple surveys or forms should be distributed to collect feedback and identify any discomfort or hotspots. Most people will adapt within a few weeks and may find 25°C comfortable when the change is done gradually. It is advisable to not to lower the temperature at the first complaint, instead, clearly communicate the purpose of the change and allow a few months for everyone to gradually adjust.

Dress Code and Occupant Awareness

Encourage a culture of comfortable dressing in the workplace. At 25°C, employees in typical business attire (lightweight shirts, etc.) should feel comfortable. Reinforce that jackets or cardigans are often not necessary at this temperature. For events or special occasions, inform guests or participants in advance about the space temperature to help them prepare appropriately.

Internal Heat Management

Encourage practices that reduce internal heat load. Switch off or set computers to sleep when not in use, as many devices left on can noticeably increase indoor temperatures. Placing heat-generating equipment such as printers away from workstations may prevent added discomfort.

Getting Started

Improving comfort and energy efficiency begins with understanding current operations. The Go 25 movement is not a one-time effort. It is a progressive shift towards smarter, more sustainable cooling practices. Start with simple, low- or no-cost actions: review air-conditioning settings, observe space usage, and track indoor temperatures over a typical week using the BMS, data loggers, or manual checks. Small insights can lead to impactful change.

1 Assess Current Conditions

Begin by understanding current site operations. Review air-conditioning settings, equipment usage, and occupancy patterns. Utilise the BMS, data loggers, or manual spot checks to record indoor temperatures and energy consumption over a typical week.

2 Prioritise Efforts Strategically

Not everything can be changed at once. Prioritise measures that are easiest to implement and offer noticeable impact. Consider piloting changes such as temperature setpoint adjustments or airflow improvements on one or two floors first to assess results and build buy-in. Align improvements with operational needs and set realistic timeframes and responsibilities to maintain momentum and accountability.

3 Engage the Right People

Getting buy-in is critical. Involve technical personnels, tenants, users, and decision makers early to ensure alignment and cooperation. Engage them not just on technical changes, but also on behavioural aspects, such as promoting a comfortable dress code. Where technical issues arise, tap on internal expertise or consult qualified professionals to fine-tune the setup. A combined approach of awareness, collaboration, and technical adjustment sets the foundation for success.

4 Build it into Daily Operations

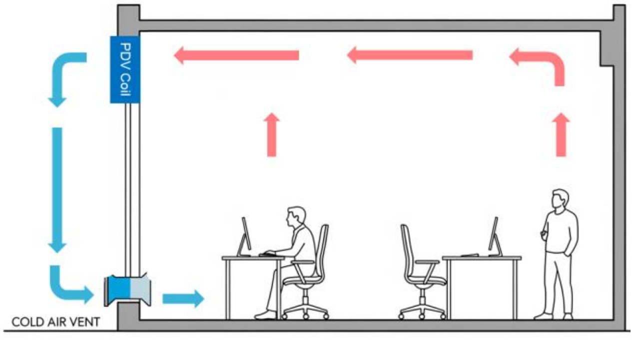
After setting the temperature to 25°C, ensure that it stays consistent by regularly checking thermostats and performing routine maintenance. Simple upkeep helps maintain comfort and energy efficiency. Encourage facilities management (FM) teams and occupants to stay engaged through maintenance and awareness efforts.

Additional Resources

As the need for diverse and optimised building solutions grows, it is beneficial to explore cooling approaches beyond traditional air-conditioning. This section introduces alternative cooling technologies such as Passive Displacement and Radiant Cooling. These systems represent different ways to achieve comfortable indoor environments, offering unique operational characteristics and potential benefits for specific applications.

Passive Displacement Cooling (PDC)

Passive Displacement Cooling is an energy efficient air-conditioning strategy that leverages natural convection and thermal stratification to cool indoor spaces with minimal mechanical energy input. By employing displacement ventilation principles, PDC introduces cool air at low velocity near the floor level, allowing it to gently spread across the occupied zone without the need for fans. The system relies on buoyancy driven airflow, where the natural difference in density between warm and cool air drives air movement.

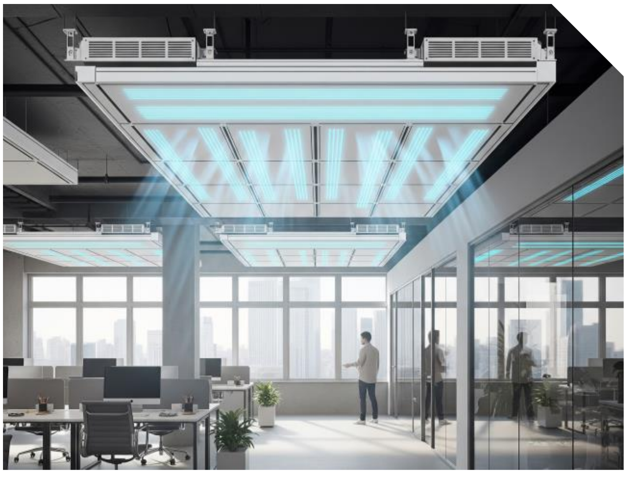


As warm air rises towards the ceiling and denser, cooled air settles in the occupied zone, a self-sustaining cycle of air circulation is established. This method enables uniform temperature distribution, enhances thermal comfort, and minimises temperature gradients across the space. Because air is delivered through natural convection rather than forced air movement, PDC eliminates the need for mechanical fan energy. This low energy approach also supports the use of higher chilled water temperature setpoints, improving chiller plant efficiency and contributing to overall energy savings.

Radiant Cooling

Radiant cooling is an energy-efficient approach that provides thermal comfort by cooling surfaces rather than air, allowing heat to be absorbed directly from occupants and their surroundings. This enables comfortable indoor conditions at higher air temperatures while reducing overall energy consumption.

However, in tropical climates, traditional radiant systems face limitations due to surface condensation risks. Recent innovations, such as vacuum-assisted radiant panels, address this by maintaining low pressure within the panel cavity to prevent condensation. This advancement makes radiant cooling viable in naturally ventilated environment in humid regions. Suitable for hybrid cooling applications in outdoor and semi-open spaces, radiant cooling can reduce building energy use, improve indoor air quality, and enhance occupant comfort. Field tests and thermal surveys have shown that such systems can achieve up to 50% energy savings over conventional air-conditioning, with over 80% of occupants reporting neutral or cool thermal sensation.[8]



[8] SLEB.SG, "DEVELOPMENT OF A HYBRID COOLING SYSTEM WITH HIGHER INDOOR TEMPERATURE BY VACUUM ASSISTANT RADIANT COOLING (VARC)," SLEB.SG PROJECT MAPS, ACCESSED JULY 7, 2025, HTTPS://SLEB.SG/PROJECTMAPS/PROJECTDETAILS/132

Additional Resources

Useful Links & Guidance

Go 25 National Movement	• A national movement to encourages everyone in Singapore to adopt optimal cooling by setting indoor temperatures towards 25°C, a simple step towards greater comfort, energy savings, and a more sustainable future. ► https://greenbuildings.sg/go25
Go Green SG 25	• A whole-of-nation movement to rally citizens, organisations & the community to take collective action towards a more environmentally sustainable and climate resilient Singapore. ► https://www.gogreen.gov.sg/
Singapore Standards (SS)	• **SS 553:2016** outlines the code of practice for air-conditioning and mechanical ventilation (ACMV) system design in buildings. It provides key requirements for system sizing, ventilation rates, fresh air intake, and operational efficiency • **SS 554 : 2016** provides guidance on the design, installation, and operation of air-conditioning and mechanical ventilation systems to maintain thermal comfort, energy efficiency, and indoor air quality. • **TR 102 : 2022** encourages best practices on the use on PDC systems in our tropical climate to maximise their cost and sustainability potential while addressing challenges in designing, operating and maintaining the systems. • **TR 141 : 2025** promotes hybrid cooling systems that combine higher temperature setpoints with increased air movement to enhance comfort and energy efficiency, supporting sustainable cooling and occupant wellbeing. ► https://www.singaporestandardseshop.sg/
Singapore Green Building Council (SGBC)	• A non-profit, member driven organisation uniting stakeholders across the built environment to drive sustainable transformation. ► https://www.sgbc.sg/
SGBC Directories	• Directories containing information on certified green building products as well as certified service providers with expertise in areas such as air balancing, cooling, and energy audits; to support thermal comfort at 25°C and enable greener cooling. ► https://web.sgbc.online/public/product ► https://web.sgbc.online/public/service
Super Low Energy Building (SLEB) Smart Hub	• The SLEB Smart Hub offers smart services and resources to help transform your buildings, sharing practical information from BCA Green Mark projects to support better building operations in line with Go 25. ► https://www.sleb.sg/Home/Index

Go 25 Checklists

ACMV & Building Envelope Performance Review Checklist

S/N	Action and Checkpoints	Yes	No	Remarks
1	**Thermostat & Control**			
1.1	Gradually adjust thermostat settings in 0.5°C increments, towards achieving a room temperature of 25°C. Before the adjustment, review all the checkpoints in this checklist to ensure conditions are suitable for effective progress.			
1.2	Have thermostat readings been verified against a reliable reference thermometer to ensure accuracy?			
1.3	Are thermostats actively controlling the indoor temperature as intended?			
1.4	Have thermostats been relocated following any layout or space usage changes?			
1.5	Are thermostats installed in suitable, representative locations—not near heat sources, windows, or air vents?			
1.6	Are setpoints consistent across different zones, and are overrides or manual adjustments managed appropriately?			
1.7	Is the air-conditioning system scheduled appropriately throughout the day, including automatic shut-off during low-use periods and after office hours?			
2	**Airflow & Distribution**			
2.1	Are flexible ducts twisted, kinked, or poorly routed, restricting airflow?			
2.2	How many supply air and extract air vents are there in each room or area? (Is there at least one in each area?)			
2.3	Are vents located in positions that will permit the best air circulation?			
2.4	Are occupants seated directly under diffusers, potentially experiencing discomfort from direct airflow?			
2.5	Does air circulate effectively to all parts of the space, or are there zones or diffusers, with little or no airflow (e.g., dead spots)?			
2.6	Has airflow balancing or diffuser adjustment been carried out recently to reflect changes in recent change of space usage?			
3	**Building Envelope**			
3.1	Are there noticeable temperature fluctuations or hot zones in perimeter areas, especially during mid-day or afternoon sun?			
3.2	Are there signs of heat gain through windows, walls, or the roof—such as warm interior surfaces or frequent complaints of stuffiness?			
3.3	Are windows single-glazed or uncoated, particularly on east- and west-facing façades that receive direct sun?			
3.4	Are existing shading devices (e.g. awnings, blinds) missing, damaged, or ineffective at blocking direct sunlight?			
3.5	Are there visible gaps, cracks, or poorly sealed joints around doors, windows, or service penetrations that may be causing air leakage?			

Go 25 Checklists

Daily Operation & User Behaviour Checklist

S/N	Action and Checkpoints	Yes	No	Remarks
1	**Engaging Occupants for Success**			
1.1	Have occupants been educated on the energy-saving benefits of maintaining 25 °C, helping them understand the broader purpose of the initiative?			
1.2	Are there visible prompts (e.g., posters, digital screens, wall decals) reinforcing the 25 °C message and encouraging supportive behaviour?			
1.3	Has a gradual roll-out or "thermal adaptation period" been communicated to allow occupants to adjust over time rather than experiencing a sudden shift?			
1.4	Has a comfortable dress code been encouraged to align with the indoor temperature (e.g., lightweight business attire instead of jackets)?			
1.5	Is the workplace culture supportive of dressing appropriately for a warmer but still comfortable office environment?			
1.6	Are guests, meeting participants, or event attendees informed in advance about typical room temperatures to help them dress accordingly?			
1.7	Are there feedback channels (e.g., surveys, helpdesk, suggestion boxes) for occupants to report discomfort or thermal issues?			
2	**Monitoring and Control**			
2.1	Are smart sensors or IoT-enabled devices in place to continuously monitor temperature and humidity across different zones?			
2.2	Is real-time data accessible to facility teams or building managers to allow quick detection and correction of deviations from setpoints (e.g., exceeding 25 °C or high humidity)?			
2.3	Are insights from your Building Management System (BMS) or other platforms being used to support day-to-day decisions and operational fine-tuning?			
2.4	Is the collected data used to identify recurring comfort or performance issues over time, rather than relying only on occupant complaints?			
2.5	Has benchmarking of temperature trends and energy usage begun to evaluate long-term system performance and impact of changes?			
2.6	Is a Building Management System (BMS) or centralised platform in place to monitor and coordinate HVAC zone-level operations?			
2.7	Can the system dynamically adjust supply air temperatures, fan speeds, or VAV damper positions based on real-time zone conditions and occupancy?			
2.8	Are AHU fans and other major air-side components equipped with variable speed drives (VSDs) or modulating controls for efficient part-load operation?			
2.9	Does the system reduce fan speeds or ramp down cooling output when thermal conditions are met, helping conserve energy without compromising comfort?			
2.10	Are control strategies (e.g., morning pre-cool, setback modes after hours) periodically reviewed and fine-tuned based on performance data?			

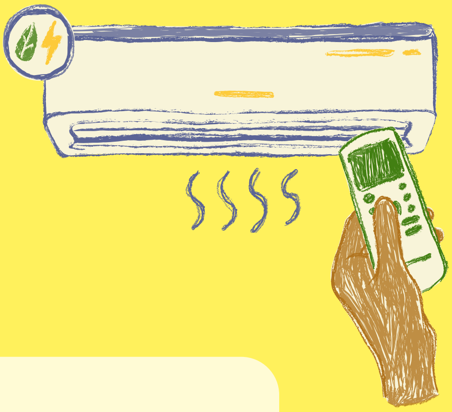
Air-Conditioning System Maintenance Checklist

S/N	Action and Checkpoints	Yes	No	Remarks
1	**General System Maintenance**			
1.1	Regular cleaning and/or replacement of air filters			
1.2	Routine cleaning of cooling coil			
1.3	Routine refrigerant charge and leak checks			
1.4	Fan and motor maintenance (symptoms: unusual noises, vibrations, overheating)			
1.5	Cleaning and inspection of condensate drain pans for standing water, mould or algae			
1.6	Clearing of drain lines and ensuring proper flow			
1.7	Calibration of all control systems, thermostats, and sensors for accuracy			
1.8	Perform verification of proper operation and check response to setpoints			
2	**VRV/VRF Systems Maintenance**			
2.1	Indoor Units (Fan Coil Units/Cassettes/Ducted)			
2.1.1	*Clean/replace filters for each individual indoor unit*			
2.1.2	*Clean indoor unit coils and drain pans*			
2.1.3	*Check condensate pumps (if present) for debris and proper operation*			
2.1.4	*Inspect fan blades and motors for noise/vibration*			
2.1.5	*Verify control panel and remote functionality*			
2.1.6	*Check for error codes or warnings on controllers*			
2.2	Outdoor Units (Condensing Units)			
2.2.1	*Inspect and clean outdoor unit condenser coils (remove debris, leaves, etc.)*			
2.2.2	*Check for fan blades and motor*			
2.2.3	*Check for refrigerant levels and inspect for leaks*			
2.2.4	*Inspect piping connections and insulation*			

Go 25 Checklists

S/N	Action and Checkpoints	Yes	No	Remarks
3	**Air Handling Units Maintenance**			
3.1	Inspect and replace filters, per determined schedule and pressure drop			
3.2	Ensure filter gaskets are sealed properly to prevent bypass			
3.3	Inspect cooling coil condition and perform cleaning if required			
3.4	Inspect the air dampers for smooth operation and response			
3.5	Verify temperature, humidity sensors and pressure field devices			
3.6	Inspect AHU casing for leaks, corrosion, or damaged insulation			
3.7	Verify chilled water valves respond and operate through full range of motion			
3.8	Check chilled water strainer condition and ensure regular cleaning regime			
4	**Ducted Systems Maintenance**			
4.1	Verify dampers respond and operate through full range of motion			
4.2	Test minimum and maximum airflow settings			
4.3	Inspect all ductwork for leaks, dislodged insulation or poor connection/sealings			

Go 25
Industry Guide for Building Operations



The Go 25 National Movement, co-organised by the Singapore Green Building Council (SGBC) with the Ministry of Sustainability and the Environment (MSE) and supported by the National Environment Agency (NEA) as well as Building and Construction Authority (BCA), encourages all Singapore residents to adopt optimal cooling practices, starting with setting indoor temperatures to at least 25°C in their homes, offices, and buildings.

For more information, visit **https://go.gov.sg/go25**.

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Ministry of Sustainability and the Environment SINGAPORE

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