APPLYING A SYSTEMS THINKING APPROACH TO OVERHEATING

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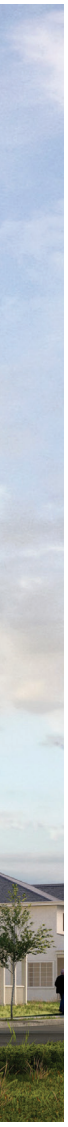
"Hot! Be careful!" "Caution: Contents very hot." We are used to these warnings on our coffee cups, but should buildings / apartments that overheat have them? Some provinces require disclosure of flooding[1] when buying / selling. In the U.S., insurance companies are leaving states where assets are too expensive to insure due to floods and wildfires.[2] Will buildings that are too expensive (or impossible!) to cool be next? Will informed consumers / investors pass opportunities in hot buildings in favor of cooler places? Let's explore what stakeholders can do to reduce the likelihood of having a pool of stranded assets in their portfolio.

Overheating is the "cumulative effect on the thermal comfort (or heat stress) and health of building occupants directly exposed to continuous daily indoor heat events (Laouadi et al. 2021 in EGBC, 2022)." Overheating impacts occupants' health and wellbeing, from productivity loss to heat-derived deaths. From a portfolio / investment point of view, it may increase the buildings' likelihood of becoming a stranded asset due to hazardous conditions arising during extreme heating events resulting in a need for cooling. Online property search engines readily filter for properties with air conditioning, highlighting this advantage.

To mitigate overheating impacts, the British Columbia Building Code (BCBC) Energy Step Code (ESC) requires compliance with the City of Vancouver (CoV) Energy Modelling Guidelines (EMG) for buildings with passively cooled occupied spaces. This follows ASHRAE 55's Adaptive Model of Thermal



High-albedo, lightly-coloured external finishes, combined with external shading and optimized window-to-wall ratio, contribute to reducing unwanted heat gains from indoors. Photo courtesy of Romses Architects Inc.

Comfort, whereby interior dry bulb temperatures of occupied spaces must not exceed the 80 per cent acceptability limits for naturally conditioned spaces for more than 200 hours per year for any occupied zone. For vulnerable occupants (ie, senior or supportive housing, etc.), this limit is 20 hours. The thermal comfort study considers solar heat gains after accounting for the solar control strategies present, like overhangs, blinds, and the glazing's properties.[3] Compliance with this criteria does not guarantee thermal comfort nor safety.

Stakeholders are in a good place to protect the value of their assets (including natural and public assets) against regulatory obsolescence, consumer preferences for wellbeing, or prioritizing public health by designing thermally safe spaces. They must seize opportunities to build products that contribute to their environmental, social, and governance (ESG) targets.[4] Stakeholders range from occupants to authorities having jurisdiction (AHJs). With an assortment of inputs (and impacts!), a systems thinking approach is needed. If the attempt to resolve this is at the building level, then there are a few missed opportunities, with the building being the "last line of defense."

When applying a systems thinking approach to overheating, it is evident that it is best addressed by shaping the broader environment in tandem with the buildings. The urban heat island (UHI) effect is a phenomenon where temperatures in cities are elevated compared to surrounding rural areas due to having more heat-absorbing surfaces.[5] This has such an impact that London (UK) has weather files for urban, semi-urban, and rural areas to account for this difference in temperatures.[6] Having entered the "global boiling era",[7] it is imperative to capture these nuances.

Actions by AHJs include shaping the "green infrastructure" to reduce the UHI.[8] At building scale (MURBs or a detached home), they can establish a cooling hierarchy to demonstrate how buildings passively reduce heat, leaving active cooling as the last step.[9] The AHJs can also require cooling energy demand intensity (CEDI) disclosure, similar to thermal energy demand intensity (TEDI) targets for Vancouver Building Bylaw or BC ESC. These strategies may be better overseen by Chief Heat Officers responsible for reducing the impacts of extreme heat in their cities.[10]

Developers / owners can exceed compliance and incorporate adaptability and resilience. Design briefs can specify an envelope where heat reduction measures can be retrofitted. Internal and external shading improves thermal comfort, with the exterior performing better.[11] Owners can request space and load allowances that would allow to retrofit cooling. The brief can specify a floor-to-ceiling height enabling ceiling fan installation. As retrofitting cooling for all units in one building may be prohibitively expensive, developers could consider cooling one common area only, providing backup power so it becomes a common refuge area during power outages.[12]

Architects impact the project by designing the building geometry. They are also in a prime position to select a team experienced at reducing the likelihood of overheating. This includes acknowledging the value that iterative improvements undertaken by the building modellers bring to the project, such as studies assessing external shading, using future weather files, etc. and communicating this to the client.[13] Making evidence-based design decisions will help create an adaptable and resilient project.

Building enclosure engineers need to consider thermal bridges from external shading projections in addition to those of balconies. Energy efficient standards, such as Passive House, rely on bridge-free constructions to meet energy demand requirements. This results in flush façades oftentimes with no balconies, but also, no external shading. Engineers would seek to balance bridge-free envelopes, external shading, and daylight.

Building modellers typically undertake analysis to assess overheating, including thermal comfort, external shading, and window-to-wall ratio design iterations. With their simulation tools, they are well-placed to assess the balance between daylight, overheating, energy and greenhouse gases, and CEDI. They can also assess mixed-mode ventilation options to reduce the cooling load and the number of hours active cooling may be needed. Appropriate information from these workflows needs to be communicated to the mechanical engineers to implement a solution.

These could be considered no-regrets solutions, as in naturally ventilated buildings where overheating conditions could be mitigated. In the case of mechanically cooled buildings, the cooling load will be reduced resulting in smaller equipment being more affordable to run. Thermal comfort conditions may be maintained for longer in case of power outage in buildings that prioritize unwanted heat gain reductions. As with any warnings or disclosures, increasing transparency, and therefore trust in consumers or investors, overheating may become a category that has to be acknowledged during transactions. This may affect properties' desirability and subsequent demand.

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