DIY Passive Cooling Techniques for residents of Vancouver Downtown Eastside

Addressing heat-related vulnerabilities in marginalized populations living in social housing in the DTES region

Prepared by
Radhika Singh, MCRP
Sustainability Scholar
March 2024

Prepared for
Union Gospel Mission &
UBC Sustainability Hub

This report was produced as part of the UBC Sustainability Scholars Program, a partnership between the University of British Columbia and Union Gospel Mission in support of providing graduate students with opportunities to do applied research on projects that advance sustainability and climate action across the region.

This project was conducted under the mentorship of Union Gospel Mission Staff. The opinions and recommendations in this report and any errors are those of the author and do not necessarily reflect the views of Union Gospel Mission or the University of British Columbia.

Cover Image Credits: Wpcpey, Wikipedia

Acknowledgement

The author acknowledges that the work for this project took place on the unceded ancestral lands of the xwma@kwayam (Musqueam), Skwxwú7mesh (Squamish), Stó:lo and Salilwata?/Selilwitulh (Tsleil-Waututh) Nations.

Special thanks to Union Gospel Mission (UGM) for recognizing the significance of this work. Sincere gratitude is extended to R. Macdonald for being an invaluable contributor in shaping this project.

Additionally, the author acknowledges the pivotal role played by CLEAR (CLimate Equity, Activation, and Resilience), a collaborative sustainability initiative led by The UBC Learning Exchange and the UBC Sustainability Hub. This ground-breaking project endeavors to bridge climate research with the Downtown Eastside (DTES) community, fostering knowledge translation and mobilization.

Image Courtesy of Union Gospel Mission

Executive Summary

The summer of 2021 brought unprecedented challenges to Vancouver, as a severe heat dome engulfed the city, exposing vulnerabilities in marginalized communities, particularly the Downtown Eastside (DTES). The population residing in social housing faced significant risks due to the lack of access to cooling spaces, exacerbated by the absence of sufficient tree cover and older housing stock without adequate cooling infrastructure. This report delves into the urgent need for comprehensive measures to enhance the resilience of vulnerable communities in the face of extreme heat events.

The objective of this report is to explore immediate remedies, focusing on do-it-yourself (DIY) cooling options that are quick, affordable, and effective temporary solutions and to also support Vancouver's Climate Change Adaptation Plan Objective 4.2 (City of Vancouver, 2013) which aims to reduce morbidity and mortality during heatwaves. By conducting research, and recommending practical solutions, the report aims to strengthen the ability of vulnerable populations, especially in the DTES, to withstand extreme heat events.

Efforts by the City of Vancouver and the SRO Collaborative have provided some relief through initiatives like the distribution of cool kits and weekly water bottle distributions. However, challenges remain, including data collection issues and the effectiveness of resources, highlighting the need for more targeted and efficient cooling strategies.

Three DIY passive cooling techniques have been identified: insulation boards utilizing Tetra Paks, evaporative cooling with wet cloth, and cool roof coatings. These methods offer immediate relief and align with environmentally sustainable practices. This enhances their suitability for implementation, particularly in single room occupancy (SRO) units within the social housing in the DTES.

The action plan outlines four phases: Pre-Implementation Preparation, Action Plan Implementation, Documentation and Reporting, and Continuous Improvement. Each phase emphasizes engaging stakeholders, implementing DIY solutions, monitoring progress, and adapting strategies based on feedback.

While these DIY techniques provide immediate relief, their temporary nature and limitations necessitate more robust, long-term solutions. Building retrofits and community-led initiatives offer promising avenues for addressing heat stress sustainably. By investing in long-term sustainability and resilience, a healthier, more comfortable living environment for residents of DTES and similar underserved communities can be achieved.

Contents

01/ Background

In the summer of 2021, Vancouver faced a devastating heat dome, bringing extremely high temperatures that had wide-ranging effects on various communities. This weather event revealed vulnerabilities, especially in the Downtown Eastside (DTES), a community known for facing significant social and economic challenges, including poverty, housing insecurity, and health disparities. The impact on the unhoused and social housing-based population was particularly harsh, as they struggled with significant challenges due to the lack of access to cooling spaces, making them more vulnerable to the extreme heat. The 2021 heat dome highlighted troubling statistics, showing higher mortality rates among individuals with schizophrenia and substance use disorders during the extreme heat event (Wyton, 2023).

The absence of enough tree cover in the DTES made the "urban heat island" effect worse, increasing temperatures in the area during heatwaves (Nowlan & Linsell, 2023). While most fatalities happened indoors during the heat dome, the Downtown Eastside community played a crucial role in preventing deaths among the homeless population by offering support and resources. A significant factor contributing to the vulnerability of marginalized communities during extreme heat events is the presence of older housing stock without air conditioning and not designed to withstand today's weather conditions. Retrofitting such housing to include cooling systems is delayed due to high costs and the extended time needed for construction. This issue is especially acute in social housing and Single Room Occupancies (SROs) in the DTES, where many residents face additional economic and health challenges.

The consequences of the 2021 heat dome emphasize the need for comprehensive measures to enhance the resilience of vulnerable communities. Urgent attention is required to address the infrastructural deficiencies in housing, especially in economically disadvantaged areas, to lessen the impact of extreme weather events. Additionally, efforts to establish accessible cooling spaces and support systems for the unhoused population are crucial to ensure their well-being during such weather challenges. Policymakers and community leaders must work together to co-create and implement strategies that provide both short-term relief and long-term resilience in the face of increasingly frequent and intense heatwaves.

02/ Objective

This report aims to tackle this issue by looking into immediate remedies, such as DIY cooling options that can be put into practice quickly and affordably. This work aligns with Objective 4.2 of the Climate Change Adaptation Plan of Vancouver (City of Vancouver, 2013), which aims to minimize morbidity and mortality during heatwaves. By leveraging existing efforts and adding support to the city's work program, this project aligns with Vancouver's commitment to planning for heat and ensuring the well-being of its residents during extreme weather events.
This project seeks to build upon the existing foundation of community support, recognizing the critical role organizations like the Union Gospel Mission (UGM) play in supporting the well-being of marginalized populations through housing and essential services.

Through a combination of research, community involvement, and practical solutions, the report aims to strengthen the ability of vulnerable populations to withstand extreme heat events, particularly those in the DTES. By working together with community stakeholders and tapping into community-based knowledge and networks, this report pinpoints effective cooling strategies for individuals residing in older housing without sufficient access to cooling facilities. In doing so, the project strives to decrease heat-related illnesses and fatalities in marginalized communities, ultimately promoting a fairer and more resilient urban environment in the face of climate change.

The project's emphasis on swift and cost-effective DIY cooling solutions serves as a proactive approach to address the urgent needs of vulnerable populations during heatwaves. By collaborating with community stakeholders and drawing on the strengths of established organizations, the project aims to not only alleviate immediate challenges but also contribute to the resilience and well-being of marginalized populations in the face of ongoing climate-related threats.

03/ Literature Review of Policies and Programs

Policy tools to create and support cooler, safer indoor living spaces:

The report from Vancouver Coastal Health (VCH) emphasizes on the pressing need for proactive measures to address the health risks posed by extreme heat events, particularly considering the 2021 heat dome in British Columbia. The increasing frequency and severity of such events, worsened by climate change, highlight the importance for enhancing community resilience and adapting to extreme heat (Vancouver Coastal Health, 2023).

Policy tools identified in the report, including the National Building Code, BC Building Code, Residential Tenancy Act, and municipal bylaws, offer potential strategies for implementing cooling measures. However, challenges such as long update cycles and varying jurisdictional capacity complicate effective implementation. Similarly, while various cooling measures such as central air conditioning, heat pumps, and portable air conditioners were examined for feasibility, challenges related to cost, infrastructure limitations, and tenant affordability were identified (Vancouver Coastal Health, 2023).

Key messages from the report highlight the significance of enforceable policy interventions to prevent heat-related deaths and prioritize safety in indoor living spaces. It stresses the need for multiple policy interventions across different levels of government to address diverse building types and community needs. Additionally, it also addresses the necessity of considering feasibility constraints and equity impacts in adhering to cooling policies and the importance of policy and regulatory changes which needs to be realized across all homes in the region (Vancouver Coastal Health, 2023).

As we identify DIY passive cooling techniques, this report serves as a valuable resource, providing insights into the policy landscape and the challenges associated with implementing cooling measures. It strengthens our efforts to develop practical solutions that can complement existing policy interventions and contribute to enhancing community resilience to extreme heat events.

Passive Cooling Measures for Multi-Unit Residential Buildings:

The study conducted by Morrison Hershfield on passive cooling strategies for multi-unit residential buildings (MURBs) in Vancouver, presents critical findings relevant to ongoing identification of DIY passive cooling techniques. The study's focus on assessing the impact of passive cooling measures on reducing overheating in suites aligns closely with the objectives to create effective and affordable cooling solutions (Morrison Hershfield, 2017).

Key findings from the study highlight the effectiveness of various passive cooling measures, including shading, ventilation strategies, and reducing solar heat gain, in mitigating overheating (Morrison Hershfield, 2017). These findings significantly address the key components of the DIY passive cooling techniques identified in this report.

The study's cost analysis comparing passive cooling measures to mechanical cooling options is particularly relevant, suggesting that passive cooling strategies can offer cost savings compared to traditional cooling systems. This finding helps in understanding the potential affordability and accessibility of DIY passive cooling techniques, which can be implemented at lower costs while still providing effective relief from overheating (Morrison Hershfield, 2017).

This study provides valuable insights into the potential of passive cooling measures to enhance the sustainability and livability of multi-unit residential buildings which is applicable to SRO units within social housing in DTES. By aligning with the findings and recommendations of this study, the identification of DIY passive cooling techniques aims to contribute to the creation of more comfortable, affordable, and resilient living spaces in urban environments like DTES Vancouver.

Passive Design Toolkit for Vancouver:

The Passive Design Toolkit for Vancouver presents an invaluable resource for our efforts to identify DIY passive cooling techniques for social housing in the Downtown Eastside (DTES). This toolkit represents a significant stride towards Vancouver's ambitious goal of becoming the greenest city globally, aligning closely with our objectives to enhance the sustainability and livability of social housing in the DTES community.

Key aspects of the toolkit, such as its emphasis on occupant health, comfort, and energy efficiency, are relevant to the unique challenges faced by residents in social housing. By promoting passive design principles, the toolkit aims to reduce reliance on mechanical and electrical systems, aligning with our efforts to create affordable and sustainable cooling solutions for DTES social housing while minimizing carbon emissions (Mikler et al., 2009).

Furthermore, the toolkit's key recommendations, including designing facades specific to orientation, minimizing solar exposure, and optimizing window-to-wall ratios, offer actionable strategies for enhancing passive performance in building design (Mikler et al., 2009). These recommendations provide a blueprint for incorporating passive cooling techniques tailored to the unique needs and constraints of social housing in the DTES, thereby improving occupant comfort during extreme heat situations.

Vancouver Energy Modelling Guidelines:

The City of Vancouver's Energy Modelling Guidelines play a pivotal role in shaping sustainable urban development, particularly in addressing the challenges of overheating in passively cooled buildings. (Energy Modelling Guidelines, 2017). As we focus on identifying DIY passive cooling techniques for social housing in the Downtown Eastside (DTES), it is essential to examine how these guidelines can inform our efforts.

Of relevance to this report is the section on passively cooled buildings, which addresses the challenges associated with overheating in non-mechanically cooled structures. As we explore DIY passive cooling techniques for social housing in the DTES, understanding these challenges and the recommended mitigation strategies outlined in the guidelines is crucial. Strategies such as solar shading, minimizing internal gains, and effective natural ventilation methods can help mitigate overheating while promoting occupant comfort (Energy Modelling Guidelines, 2017).

By aligning our efforts with the insights and recommendations provided by the Energy Modelling Guidelines, we can advance Vancouver's aspiration to evolve into a more environmentally sustainable and robust city. Most essentially, this effort will enhance the quality of life for residents in social housing within the DTES.

Temperature-Controlled Rooms in B.C.'s Building Code:

The recent announcement of the British Columbia Building and Fire Codes (BC Codes 2024) by the province is a significant development that strongly supports and validates the goals of our project. These updated codes, set to take effect in March 2024, mandate all new buildings to integrate features that bolster safety, sustainability, accessibility, and climate resilience (BC Government News, 2023).

One of the key updates from these codes requires that all new residential buildings must provide at least one living space designed to maintain temperatures below 26°C (BC Government News, 2023), which directly relates to our project's focus on passive cooling techniques. This requirement is a commendable step towards mitigating the risks associated with extreme heat events, particularly for vulnerable populations in areas like the DTES. By advocating for built-in cooling measures in new constructions, the updated codes complement the exploration of DIY cooling options and stress the need for such measures in the fight against climate-induced heat stress.

04/ Current Cooling Resources and their Utilization

City of Vancouver

City of Vancouver has made diligent efforts to provide support to residents in staying cool at home through the distribution of over 1,500 cool kits via community partners. Additionally, the city has established Indoor Cooling Centers & Culturally Safe Cool Spaces throughout various locations, totaling 39 cooling centres including both civic and non-civic sites.

However, challenges arose in collecting data on Indoor Cooling Centre usage, particularly when Cooling Centers operated as entire facilities with ongoing programs. This made it difficult for staff to distinguish attendees specifically seeking cooling services, as asking or surveying attendees conflicted with the City's Access without Fear policy (Mochrie, 2022).

Figure 1. Map depicting cooling spaces in Downtown Eastside (City of Vancouver, 2023)

SRO - Collaborative

SRO Collaborative has also been active in distributing cooling resources. They have facilitated the distribution of cool kits provided by the City to Single Room Occupancy (SRO) buildings. Furthermore, weekly water bottle distributions have been organized in 30 SROs to ensure residents have access to hydration. Electrolyte powder, procured from Ballistic Labs through the Heart Tattoo Society, has been portioned and distributed along with the water bottles to enhance hydration efforts. Additionally, tenants have been supplied with tin foil to cover their windows, offering a simple yet effective method of reducing indoor temperatures (SRO Collaborative, 2022).

Figure 2. Extreme Heat Response in Action in DTES (Image Courtesy: UGM)

Gaps

Despite the proactive measures taken by the City of Vancouver and SRO Collaborative (SRO-C), some gaps have been identified in these cooling initiatives, as revealed by tenant surveys conducted by SRO-C (SRO Collaborative, 2022), memo presented by City of Vancouver (Mochrie, 2022) and analyzed in this report. The logistics of procurement and assembling Cool Kits presented challenges for the city, potentially affecting the timely distribution of resources (Mochrie, 2022). Additionally, while cooling centers serve as vital resources for heat relief, their usage may inadvertently create equity issues, especially when it's challenging to accurately track attendance without compromising individuals' privacy. Moreover, the effectiveness of tinfoil usage as a cooling method has been questioned by SRO-C staff, who found it to be an inefficient allocation of resources, suggesting a need for alternative strategies to address the cooling needs of tenants effectively (SRO Collaborative, 2022).

Image Courtesy of Union Gospel Mission

05/ DIY Passive Cooling Techniques

Understanding Housing Stock

Single Room Occupancy (SRO) units are typically a single room featuring a small kitchenette and sleeping area, often with a window for natural light. These rooms are part of a larger floor plan where multiple units share communal bathroom facilities. SROs are owned by a mix of government entities, non-profit organizations, or private owners. They serve as a crucial form of accommodation, especially for individuals with limited income. As demand for affordable housing has outstripped supply, SROs have become the last resort for many marginalized residents, highlighting the pressing need for stable housing solutions (City of Vancouver, 2017).

When it comes to managing heat in these structures, it's crucial to target the main contributors to heat gain – walls, windows, and roofs (especially for upper floors). To create a more comfortable living environment, solutions should prioritize addressing these areas effectively. Considering the nature of affordable housing, it's essential that these solutions are not only effective but also easy to implement and cost-effective.

Identifying passive cooling techniques

The identification process involved a comprehensive review of numerous passive cooling research papers, reports, and alternative solutions. Specifically, the selection criteria prioritized techniques that exhibited ease of implementation and were conducive to a do-it-yourself (DIY) approach. This screening process ensured that only the most practical and accessible strategies were considered for further evaluation and potential implementation.

Insulation Board with Tetra Paks

A notable method, initially conceived by researchers in Latin America for slum housing, revolves around insulation (Bonaccorso & da Graça, 2022). While primarily targeting slum roofs, this approach can be adapted for multi-unit buildings, extending its application to walls of the units and the roof of top-floor units.

The technique leverages recycled Tetra Pak packages to establish a thick, sealed air layer. By collecting and connecting Tetra Pak packages with adhesive tape, lightweight boards are formed, which are then affixed to walls using some more tape. This method not only enhances insulation but also introduces an additional air layer between the insulation surface and the existing wall, further bolstering its cooling efficacy. For a detailed step-by step installation guide, refer to Appendix B.

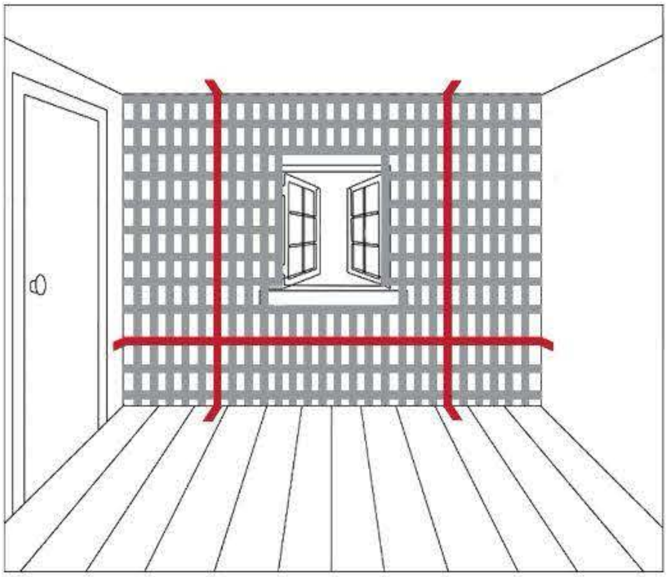


Figure 3. Diagram depicting the placement of insulation board on a wall

Nighttime ventilation is crucial when employing this strategy to prevent heat accumulation in the evening. Opening windows facilitates the release of stored heat, maintaining a comfortable indoor environment. Despite the potential for daytime heat retention, this issue is easily rectified through nighttime ventilation, emphasizing on the simplicity and effectiveness of this passive cooling approach.

In adapting this technique for multi-unit buildings, particular attention must be paid to optimizing its implementation across various structural elements. By incorporating insulation boards on walls and roofs, especially for top-floor units, the cooling benefits can be maximized throughout the entire building. This not only improves thermal comfort but also promotes energy efficiency, aligning with sustainable building practices.

The utilization of recycyled materials and straightforward installation procedures make this passive cooling method both environmentally friendly and cost-effective. Embracing such innovative strategies can enhance the livability of structures while reducing their environmental footprint, especially in emergency situations like extreme heat.

Evaporative Cooling with Wet Cloth

Utilizing evaporative cooling methods presents a simple yet effective approach to cooling indoor spaces without the need for air conditioning. One widely practiced method involves the strategic placement of wet towels or cotton bed sheets within the room. This low-barrier technique involves soaking a cloth in water, ensuring it is adequately damp but not dripping, and then positioning it either directly in front of an open window or on a drying rack within the room. Alternatively, a thin rope can be affixed to the sides of a window to suspend the cloth for optimal airflow. For a detailed step-by step installation guide, refer to Appendix B.

The principle behind this method lies in evaporative cooling, a process where water absorbs heat energy from the surrounding environment during evaporation, resulting in a cooling effect. As the moistened cloth evaporates, it cools the incoming air from the window, thereby reducing the room temperature naturally. For enhanced effectiveness, puncturing small holes in the cloth can facilitate improved airflow and cooling efficiency (Utopia, 2023). In the context of SROs, where natural ventilation through windows is often crucial, incorporating this combination of evaporative cooling and natural airflow can offer a cost-effective and environmentally friendly solution to mitigate heat buildup within these spaces.

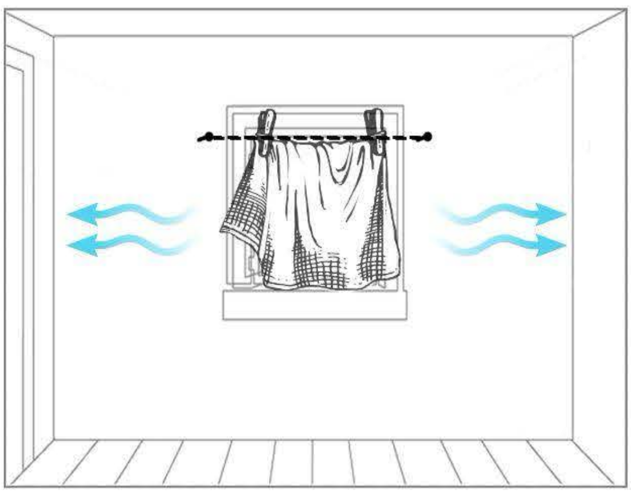


Figure 4. Diagram depicting wet cloth on the window

Cool Roofs

White coatings, characterized by their high solar reflectance and infrared emittance, serve as an effective passive cooling strategy for buildings. By reflecting a significant portion of incident light energy, typically through cool-colored or white coloured paints, these coatings contribute to reducing solar heat gain and mitigating the urban heat island effect (Kimemia et al., 2020).

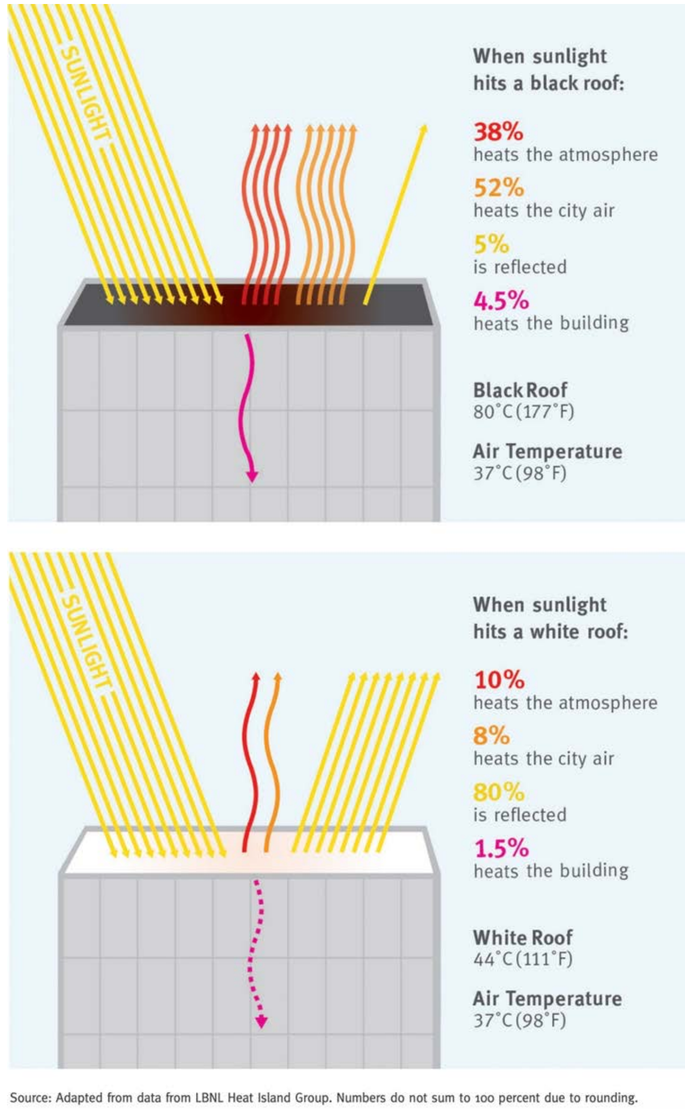


Figure 5. Comparison of Black and White flat roof during summer afternoon (Global Cool Cities Alliance, 2012)

Research indicates that applying cool coatings to building roofs can lead to substantial temperature reductions. A study implementing cool coatings on a test room's roof resulted in a notable decrease in ceiling temperature by 8-10°C and indoor temperature by 3-4°C (Pisello & Rosso, 2016).

Figure 6. Map image depicting roofs of social housing buildings: Unity Housing Society and Maurice Mcelrea Place (Source of Base Map: Google Earth)

Upon analyzing two social housing buildings within the DTES region, Unity Housing Society at 9 E Hastings St and Maurice Mcelrea Place at 361 Heatley Ave, using Google Earth imagery (see Fig 6), it is evident that their roofs are predominantly dark in color. By applying cool coatings to these roofs, the buildings can benefit from reduced solar heat absorption, leading to lower indoor temperatures, and enhanced thermal comfort for occupants. The adoption of white paint or cool roof paint aligns with sustainable building practices, contributing to energy efficiency and environmental sustainability within urban environments. The application of white coatings presents a promising strategy for improving the thermal performance and overall comfort of social housing buildings in DTES.

Summary and Cost Estimate for Passive Cooling Interventions in SROs

Table 1. Summary of Identified Passive Cooling Techniques

Passive Cooling Technique	Type	DIY Nature (L/M/H)*	Location of implementation
Insulation Board with Tetra Paks	Thermal Insulation, Heat Modulation by increasing thermal mass	M	Latin America and Caribbean
Evaporative Cooling with Wet Cloth	Evaporative Cooling + natural	H	-

	Ventilation + Shading		
Cool Roofs	Radiant Heat Reflection	M	Mexico
*L (Low), M (Medium), H (High)			

Table 2. Cost Estimate of identified Passive Cooling Techniques

Passive Cooling Technique	Cost
Insulation Board with Tetra Paks Materials Required: Empty Tetra Pak cartons, Duct Tape, Scissors, Ladder	$0.5/ sqft of wall + $0.04 /ft of tape
Evaporative Cooling with Wet Cloth Materials Required: A piece of cloth, Heavy Thread, Two Nails, Hammer	$2.4/sqft of window area+ $0.07/ft of window width + $0.42
Cool Roofs Materials Required: Cool Roof Reflective Paint or any white coloured paint for exterior surface	$0.57 - $1.8/sqft of roof

Suitability of identified techniques

While the proposed solutions did not originate in North America, they are relevant solutions for the Downtown Eastside (DTES). Insulation board with tetra paks, evaporative cooling with wet cloth and cool roofs falls under the categories of Natural Ventilation, Eco-evaporative Cooling, and Radiant Heat Barrier respectively. Despite Vancouver's temperate climate (Mikler et al., 2009), due to climate change, it also experiences days that are hot and dry during summers, with some days being humid (source: Weather Atlas). The suitability of these techniques for Vancouver's climate is supported by the data provided in Table 3, indicating that selected options would be effective for use in the DTES.

Table 3. Suitable climatic conditions for the application of the passive cooling methods (Oropeza-Perez & Østergaard, 2018)

Technique/Climate	HH	EHH	HD	EHD	HT	MT
Shading systems	•	•	•	•	•	•
PCM	•		•	•	•	•
Passive cooling shelter			•	•		
Heat sinks	•	•	•	•	•	•
Thermal capacity			•	•	•	•
Radiant heat barriers	•	•	•	•	•	
Eco-evaporation cooling			•	•	•	•
Natural ventilation	•		•		•	•
Solar-assisted AC	•	•	•	•	•	
Intelligent facades	•		•	•	•	•
Hot humid (HH), extreme hot humid (EHH), hot dry (HD), extreme hot dry (EHD), hot temperate (HT), mild temperate (MT).						

It is important to note that in extreme emergencies, it is better to apply all three passive cooling solutions together to maximize the benefits. During moderate temperatures, the wet cloth and cool roof techniques prove most effective. However, on hot and humid days, the insulation board technique also offers valuable protection from heat. By strategically integrating these methods, it becomes possible to achieve greater efficiency in heat reduction and temperature moderation, particularly during periods of intense heat. (Oropeza-Perez & Østergaard, 2018) (Ran & Tang, 2018)

06/ Action Plan

The action plan outlines a comprehensive approach to implementing DIY passive cooling techniques for social housing providers that includes additional stakeholders in the process. It is divided into four phases: Pre – Implementation Preparation, Action Plan Implementation, Documentation and Reporting and Continuous Improvement. A template is also provided in Appendix C. This serves as an example, readily adaptable to accommodate various constraints such as financial resources, human capital, and stakeholder expectations.

Phase 1: Pre-Implementation Preparation

A. Clarifying Objectives

- Clearly articulating the objectives of the project, focusing on the implementation of DIY passive cooling techniques.
- Goals include reducing indoor temperatures and enhancing comfort for the residents of Downtown Eastside.

B. Team-wide Education

- Conducting comprehensive education sessions for all team members, stakeholders, and individuals involved in the project.
- Ensuring a thorough understanding of the three identified DIY passive cooling techniques outlined in the research.

C. Assessing Community Needs

- Conducting a needs assessment to identify areas with the highest demand for DIY passive cooling solutions.
- Engaging with residents to understand their preferences, concerns, and potential barriers.

D. Collaboration with Stakeholders

- Establishing partnerships with local community organizations, environmental groups, and government agencies.
- Seeking support from relevant authorities for funding, resources, and regulatory approvals.

Phase 2: Action Plan Implementation

A. Pilot Program

Selection of Pilot Location:

- Conducting an in-depth analysis of the neighborhood to identify a pilot location based on factors such as socio-economic conditions, housing structures, and current environmental challenges.
- Collaborating with local community leaders and residents to ensure the chosen pilot site reflects the diversity and needs of the community.

Implementation of DIY Passive Cooling Techniques:

- Developing a detailed timeline for implementing each chosen technique in the pilot location.
- Collaborating with local contractors, community volunteers, and residents to ensure proper installation of insulation boards, wet cloth or evaporative pads on windows, and cool roofs.
- Considering seasonal variations and weather conditions when planning the implementation schedule.

B. Monitoring and Evaluation

Assessment Metrics:

- Establishing clear metrics for evaluating the success of each cooling technique, including indoor temperature reduction, energy consumption, and resident satisfaction.
- Implementing data collection methods such as temperature sensors, energy meters, and resident surveys.

Adjustment Strategies:

- Designing a flexible monitoring plan that allows for real-time adjustments based on initial feedback and data analysis.
- Developing a protocol for addressing challenges or unforeseen issues during the pilot phase, ensuring timely adjustments to maximize effectiveness.

C. Community Education

Educational Materials:

- Creating user-friendly and culturally sensitive educational materials explaining the science behind DIY passive cooling techniques.
- Translating materials into multiple languages spoken within the community to ensure accessibility and inclusivity.

Workshops and Information Sessions:

- Organizing interactive workshops, virtual or in-person, led by experts in passive cooling techniques.
- Collaborating with local educational institutions, community centers, and NGOs to facilitate information sessions on DIY cooling strategies.

Phase 3: Documentation and Reporting

A. Recordkeeping

Comprehensive Records:

- Establishing a centralized database for recording all project-related activities, expenses, and implementation details.
- Documenting challenges faced, solutions implemented, and any unexpected outcomes.

Materials Inventory:

- Keeping an updated inventory of materials used in each cooling technique, including sources, costs, and environmental impact.

B. Reporting

Regular Progress Reports:

- Providing stakeholders with monthly progress reports highlighting key achievements, challenges, and any modifications made to the original plan.
- Sharing visual representations of data trends and success stories to engage stakeholders effectively.

Public Communication:

- Utilizing social media, local newspapers, and community newsletters to disseminate information about the project's progress.
- Organizing community events or webinars to showcase the positive impact of implemented cooling techniques.

Phase 4: Continuous Improvement

<u>A. Feedback Loop</u>

Resident Engagement:

- Establishing regular forums or focus groups for residents to share their experiences and provide feedback.
- Actively seeking suggestions for improvement and potential expansion of the program based on resident insights.

Stakeholder Collaboration:

- Scheduling periodic meetings with stakeholders to discuss the project's effectiveness and identify opportunities for collaboration and improvement.
- Encouraging open communication channels for stakeholders to express concerns and recommendations.

Adaptation Strategies:

- Developing a protocol for adapting the cooling strategies based on continuous feedback and evolving community needs.
- Considering scalability and potential replication of successful strategies in other social housing communities.

07/ Limitations of DIY Passive Cooling Approaches

While the identified passive cooling techniques present viable short-term solutions for mitigating heat stress in marginalized communities like the Downtown Eastside (DTES), it's essential to recognize their temporary nature and limitations. These solutions, while effective in emergency situations do not provide sustainable, long-term benefits for residents. Several factors contribute to the temporary nature of these solutions and highlight the need for more robust passive cooling techniques and building retrofits to address the ongoing impacts of climate change.

Limited Effectiveness in Extreme Conditions

The passive cooling techniques outlined in the report, (insulation boards with Tetra Paks, evaporative cooling with wet cloth, and cool roof coatings) are primarily designed to provide relief during short periods of extreme heat. However, in

prolonged heatwaves and longer duration of extreme heat, their effectiveness may diminish, necessitating additional measures to ensure indoor comfort and safety.

Dependency on External Factors

The efficacy of passive cooling techniques depends upon external factors such as ambient temperature, humidity levels, and airflow. While these techniques can help reduce indoor temperatures under favorable conditions, they may prove insufficient in poorly ventilated spaces where natural airflow is limited.

Limited Scope of Application

Passive cooling solutions like insulation boards and wet cloth evaporative cooling are suitable for individual rooms or small-scale applications within buildings. However, they may not be feasible or scalable for larger units, limiting their applicability in addressing the broader housing challenges faced by the DTES community.

Maintenance and Sustainability

The temporary nature of DIY passive cooling techniques also raises concerns regarding maintenance and sustainability. Materials used in these solutions, such as used Tetra Pak packages and wet cloth, may degrade over time, requiring frequent replacement or upkeep. Additionally, these solutions may not align with long-term sustainability goals or building retrofit initiatives aimed at improving energy efficiency and reducing environmental impact.

08/ Conclusion

There is a need for new buildings to be designed with climate resilience in mind, ensuring that cooling needs are met. This will not only reduce long-term costs and environmental impact but also ensures that buildings are inherently equipped to provide safe, comfortable living conditions in the face of increasing temperatures and extreme heat events. However, the DIY passive cooling techniques outlined in the report are anticipated to significantly alleviate the heat-related discomfort experienced by SRO residents in the DTES.

Given the temporary nature of DIY passive cooling techniques, there is a pressing need to explore more robust and sustainable solutions for addressing heat stress in marginalized communities like the DTES. Building retrofits are a promising response for enhancing the thermal performance of existing structures and improving indoor comfort levels for residents. Retrofit initiatives can include measures such as installing high-efficiency insulation and upgrading HVAC systems.

Investing in community-led initiatives and capacity-building programs can empower residents to actively participate in identifying and implementing sustainable cooling solutions tailored to specific living situations. By fostering collaboration between stakeholders, including local government agencies, community organizations, and academic institutions, it becomes possible to develop holistic approaches to passive cooling that prioritize equity, affordability, and long-term sustainability. By investing in long-term sustainability and resilience, we can create healthier, more comfortable living environments for residents of the DTES and similar underserved communities.

Works Cited

BC Government News. (2023, December 5). New code will make buildings safer, more accessible and resilient to climate change. *BC Government News*. https://news.gov.bc.ca/releases/2023HOUS0167-001923#:~:text=Most%20code%20changes%20will%20come,building%20entrances%20and%20universal%20washrooms.

Bonaccorso, N., & da Graça, G. C. (2022). Low-cost DIY thermal upgrades for overheating mitigation in slum houses in Latin America & Caribbean. *Energy and Buildings*, *271*. https://doi.org/10.1016/j.enbuild.2022.112319

City of Vancouver. (2013). *Climate Change Adaptation Strategy*. https://vancouver.ca/files/cov/Vancouver-Climate-Change-Adaptation-Strategy-2012-11-07.pdf

City of Vancouver. (2015). *Replacement, Renewal & Change: 2015 Survey of Single Room Accommodation & Non-Market Housing in the Downtown Core*. https://vancouver.ca/files/cov/2015-survey-single-room-accommodation-non-market-housing-downtown-core.pdf

City of Vancouver. (2017). *Single Room occupancy (SRO) Revitalization Action Plan*. https://vancouver.ca/files/cov/sro-revitalization-action-plan.pdf

City of Vancouver. (2023). *Keeping Cool in Vancouver Map*. City of Vancouver. https://vancouver.ca/files/cov/keeping-cool-map-downtown-eastside.pdf

Energy Modelling Guidelines. (2017).

Global Cool Cities Alliance. (2012). *A Practical Guide to Cool Roofs and Cool Pavements*. https://www.coolrooftoolkit.org/wp-content/pdfs/CoolRoofToolkit_Full.pdf

Kimemia, D., Van Niekerk, A., Annegarn, H., & Seedat, M. (2020). Passive cooling for thermal comfort in informal housing. *Journal of Energy in Southern Africa*, *31*(1), 28–39. https://doi.org/10.17159/2413-3051/2020/v31i1a7689

Mikler, V., Bicol, A., & Breisnes, B. (2009). *Passive Design Toolkit*. https://vancouver.ca/files/cov/passive-design-large-buildings.pdf

Mochrie, P. (2022). *Updates to Extreme Heat Response Plans for 2022*. City of Vancouver.

Morrison Hershfield. (2017). *Passive Cooling Measures for Multi-Unit Residential Buildings*. https://vancouver.ca/files/cov/passive-cooling-measures-for-murbs.pdf

Nowlan, L., & Linsell, T. (2023, September 27). Extreme heat, extreme inequality: Addressing climate justice in Vancouver's Downtown Eastside. *The Conversation*. https://theconversation.com/extreme-heat-extreme-inequality-addressing-climate-justice-in-vancouvers-downtown-eastside-211724#:~:text=We%20believe%20in%20the%20free%20flow%20of%20information&text=And%20the%20hardest%20hit%20by,and%20shoddy%20and%20aging%20housing.

Oropeza-Perez, I., & Østergaard, P. A. (2018). Active and passive cooling methods for dwellings: A review. In *Renewable and Sustainable Energy Reviews* (Vol. 82, pp. 531–544). Elsevier Ltd. https://doi.org/10.1016/j.rser.2017.09.059

Pisello, A. L., & Rosso, F. (2016). Natural materials for thermal insulation and passive cooling application. *Key Engineering Materials*, *666*, 1–16. https://doi.org/10.4028/www.scientific.net/KEM.666.1

Ran, J., & Tang, M. (2018). Passive cooling of the green roofs combined with night-time ventilation and walls insulation in hot and humid regions. *Sustainable Cities and Society*, *38*, 466–475. https://doi.org/10.1016/j.scs.2018.01.027

SRO Collaborative. (2022). *SRO Extreme Heat Preparedness and Response Initiative*. https://srocollaborative.org/wp-content/uploads/2023/05/HeatEvaluationReport.pdf

Utopia. (2023, June 20). 7 Proven Ways to Cool a Room Without AC: Escape the Heat! *Utopia*. https://utopia.org/guide/how-to-cool-a-room-without-ac-7-ways/

Vancouver Coastal Health. (2023). *Policy tools to create and support cooler, safer indoor living spaces*. https://www.vch.ca/en/media/19796

Wyton, M. (2023, June 23). More supports needed to protect people with schizophrenia from extreme heat, experts say. *CBC News*. https://www.cbc.ca/news/canada/british-columbia/schizophrenia-extreme-heat-risk-1.6887581

Image Courtesy of Union Gospel Mission

Appendix A: Glossary of Terminologies

DIY (Do-It-Yourself)
DIY refers to the practice of creating, modifying, or repairing things independently by individuals without professional assistance or specialized training.

Evaporative Cooling
Evaporative cooling is a natural process where water absorbs heat from its surroundings as it evaporates, resulting in a cooling effect. This principle is often utilized in systems that use water evaporation to lower indoor temperatures.

Extreme Heat
Extreme heat denotes temperatures significantly above average for a particular location, posing potential health risks and often requiring special precautions.

Infrared Emittance
Infrared emittance refers to the ability of a material to emit infrared radiation, which affects its ability to dissipate heat. Materials with high infrared emittance release heat more efficiently, contributing to passive cooling strategies.

Nighttime or Natural Ventilation
Nighttime or natural ventilation involves the use of openings, such as windows or vents, to allow fresh air to circulate through a building without the need for mechanical systems, typically taking advantage of cooler outdoor temperatures during the night.

Occupant Comfort
Occupant comfort refers to the overall satisfaction and well-being of people in a particular space, like a building or vehicle. It involves factors such as temperature, air quality, lighting, noise levels, and overall environmental conditions.

Passive Cooling
Passive cooling involves designing buildings or systems to naturally maintain comfortable indoor temperatures without the use of mechanical devices, typically through strategies such as shading, ventilation, and thermal mass.

Single Room Occupancy
Single room occupancy (SRO) typically refers to housing units consisting of one room used as both living and sleeping space, often found in urban areas, and catering to individuals with limited housing options.

Solar Heat Gain
Solar heat gain refers to the increase in temperature within a building caused by solar radiation entering through windows, walls, or roofs, which can lead to higher cooling loads and discomfort if not managed effectively.

Solar Reflectance
Solar reflectance measures the ability of a surface to reflect sunlight, reducing the amount of heat absorbed by buildings or

outdoor spaces, thus helping to mitigate the urban heat island effect and lower cooling energy demands.

Sustainable Architecture

Sustainable architecture refers to buildings and spaces that minimize negative impacts on the environment and promote efficient use of resources. It involves designing structures that reduce energy consumption, use eco-friendly materials, optimize water usage, maximize natural light and ventilation, and incorporate renewable energy sources like solar power.

Thermal Insulation

Thermal insulation refers to materials or techniques used to reduce the transfer of heat between spaces, helping to maintain consistent indoor temperatures and improve energy efficiency.

Urban Heat Island Effect

The urban heat island effect describes the phenomenon where urban areas experience higher temperatures compared to their rural surroundings due to human activities, such as buildings, roads, and transportation, which absorb and retain heat.

Appendix B: Step-By-Step Ways to implement the DIY passive cooling techniques

(This page has been intentionally left blank)

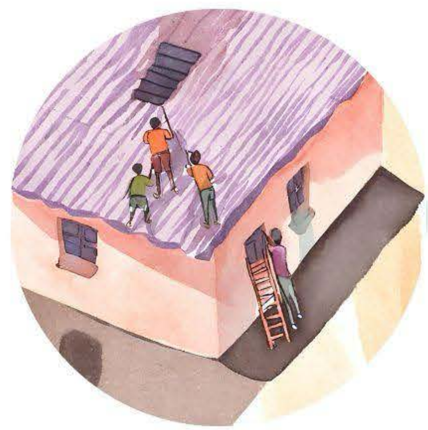
(This page has been intentionally left blank)

(This page has been intentionally left blank)

1 2 3 to Beat the Heat with PASSIVE COOLING

Passive cooling means cooling your space without any electricity or mechanical systems!

Sounds Cool? Let's D-I-Y this!!



1

INSULATE

Creating an insulation board for walls using tetra paks.

2

INDUCE

Inducing or drawing in cooler air indoors by hanging a wet cloth on the window.

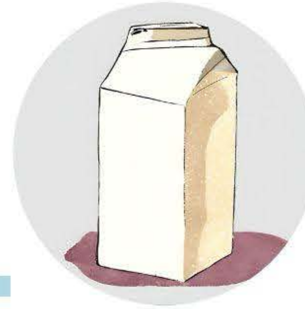
3

PROTECT

Protecting the roofs from extreme heat by painting it with cool roof paint.

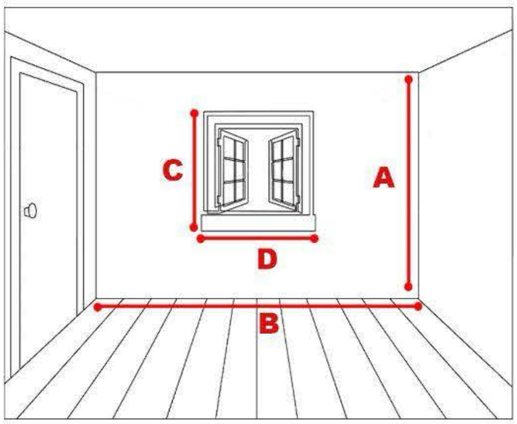
INSULATE

Making the walls thicker by adding layer made of milk cartons can delay outside heat from getting into the room. This helps to keep the room cooler.

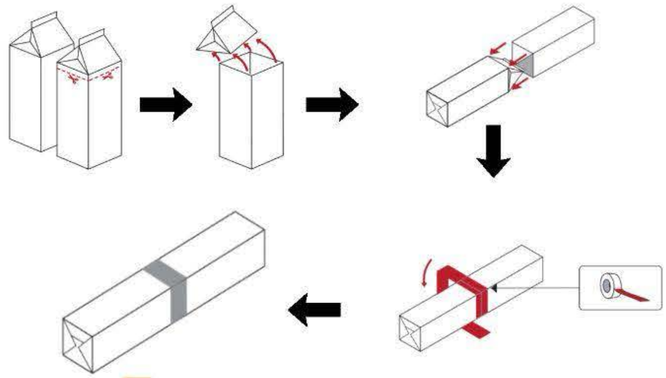


Step 1: Identify the main wall. The main wall is the one which is directly facing outside or where the sun's heat comes inside the room. Usually it is the one which has a window. There might be two main walls in your room, one with a window, and the other without.

Step 2: Measure the wall and note down the measurements A, B, C & D, in case of walls without windows, only note A & B.

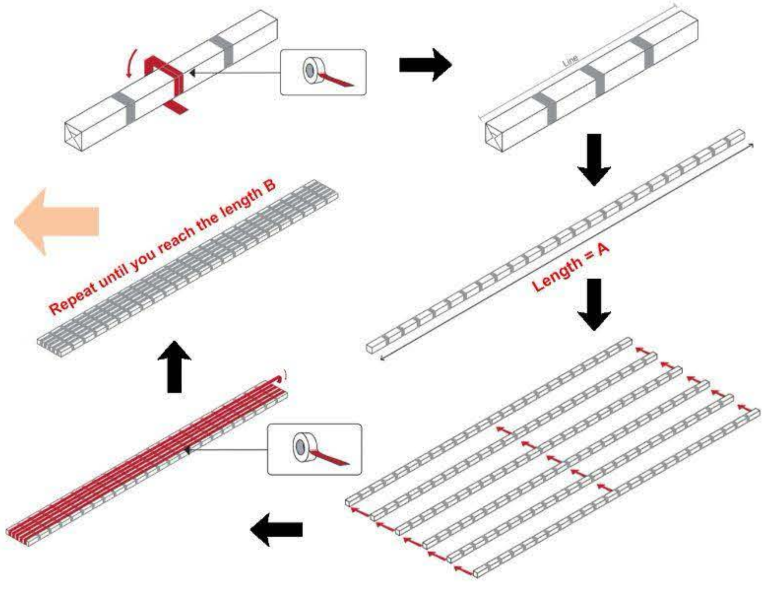


Step 3: Prepare the cartons for making a board by first cleaning it thoroughly and then cutting it in the way shown in the diagram below. Then start taping the cartons in pairs.

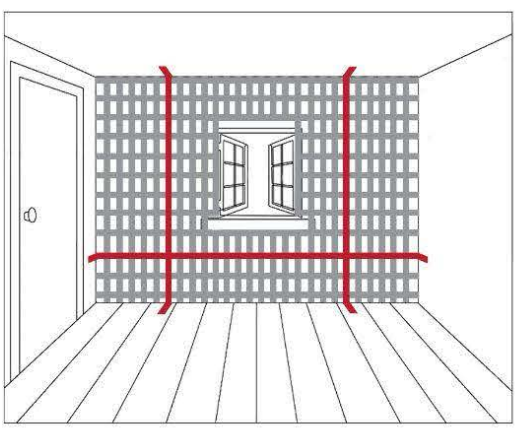


Images for step 3 & 4 adopted from (Bonaccorso, 2022)

Step 4: Start taping the cartons together and continue till the length of them together becomes equal to A. Then make multiple lines of cartons and put them together until you reach the width of B. Be sure to skip places where there is window by subtracting the lengths C & D.



Step 5: Place the board on the wall and secure the board through long tapes running parallel to lengths A and B.

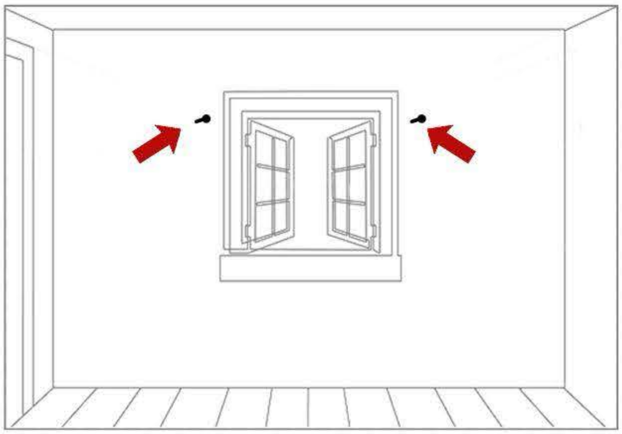


NOTE: This technique works best when you use night ventilation. It's important to let fresh air in by opening windows and doors during the late evening and early morning. Make sure air can move around by having openings on opposite sides. This helps cool things down even more.

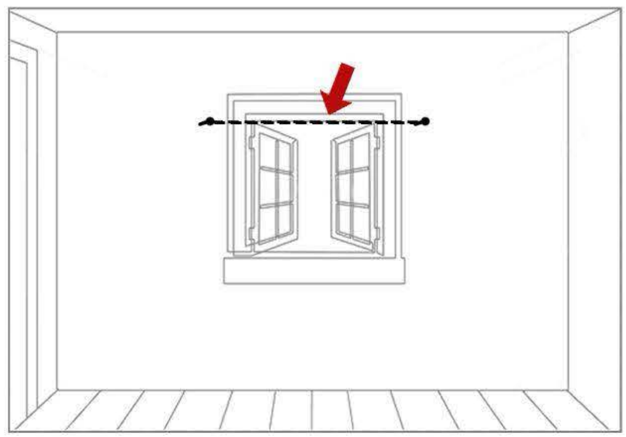
2 INDUCE

Hanging a wet cloth on the window will induce or draw in cooler air indoors and provide an immediate relief from extreme heat.

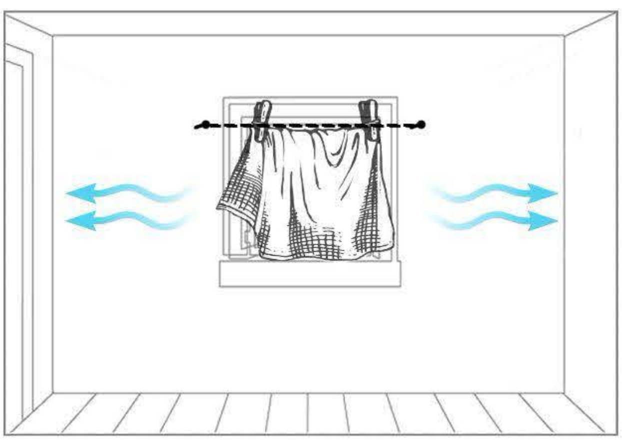
Step 1: Open the window and place two nails (one on each side) of the window.



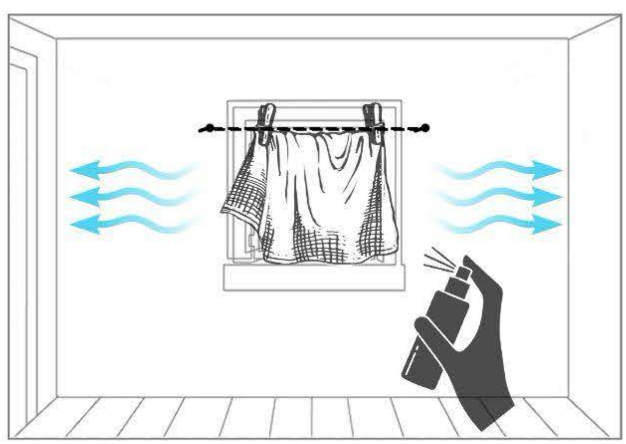
Step 2: Tie the thread tightly on both the nails.



Step 3: Slightly wet the cloth with water and hang on the thread. Use cloth clips if needed for a better hold.



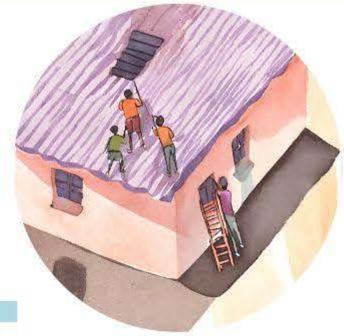
Step 4: Keep wetting the cloth with a spray bottle or by directly placing the cloth under running water on regular intervals to keep the cooling effect consistent.



NOTE: In the event that it feels like cool air isn't coming through due to low air flow or wind speed, small holes can also be created on the cloth, which will facilitate better air circulation and enhance the cooling effect.

3 PROTECT

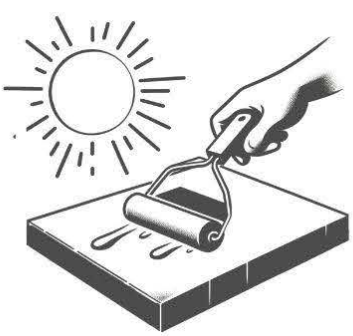
Coating your flat concrete roof with white paint can reflect the sun's heat, preventing it from getting too hot inside.



Step 1: As a safety measure, wear gloves before starting to paint.

Step 2: Clean the roof thoroughly to avoid any inconsistencies during painting.

Step 3: Stir the white paint thoroughly before use and follow the manufacturer's instructions for proper mixing.



Step 4: Begin painting in the morning or late afternoon to avoid extreme temperatures. Work from one side of the roof to the other,

Step 5: Allow drying by following the manufacturer's instructions for drying time between coats. Ensure the paint is fully dry before applying additional coats.

Appendix C: Cost Calculations for Passive Cooling Interventions in SROs

Wall Insulation Using Tetra Paks

- Average size of SRO wall (City of Vancouver, 2015): 10ft by 8ft = 80 sqft
- Area to be insulated with Tetra Paks: 74 sqft (assuming window and door spaces)
- Number of Tetra Packs required: 370
- Cost of Tetra Paks (recycled): $37
- Length of tape required: (370 X 0.64) + 24ft + 28ft = 288.8 ~ 300ft
- Total Cost of tape: $12
- **Total cost for wall insulation: $49**

Window Cooling Using Evaporative Techniques

- Average Size of window: 2ft by 3ft = 6 sqft
- Cost of cloth (6 sqft): $15.6
- Length of thread required: 3ft
- Cost of thread: $0.21
- Cost of nails: $0.42
- **Total cost for window cooling: $16.23**

Roof Coating for Heat Reflectivity

- Area of the roof for Unity Housing Society: 480 sqm approximately 5166.68 sqft

Using Silicone White Roof Coating:

- Cost for 5 gallons: $585 (covers 320 sqft)
- Cost per sqft: $1.8
- **Total cost for cool roof coating with silicone: $9,300**

Using Epoxy White Floor Paint:

- Cost for 5 gallons: $288 (covers 500 sqft)
- Cost per sqft: $0.57
- **Total cost for cool roof coating with epoxy: $2,945**

Table 4. Detailed Cost Estimate of DIY passive cooling techniques

Passive Cooling Technique	Per sqft Cost	Cost of implementation in SRO
Insulation Board with Tetra Paks Materials Required: Empty Tetra Pak cartons, Duct Tape, Scissors, Ladder	$0.5/ sqft of wall + $0.04 /ft of tape	$49

Evaporative Cooling with Wet Cloth Materials Required: A piece of cloth, Heavy Thread, Two Nails, Hammer	$2.4/sqft of window area+ $0.07/ft of window width + $0.42	$16.23
Cool Roofs Materials Required: Cool Roof Reflective Paint or any white coloured paint for exterior surface	$0.57 - $1.8/sqft of roof	$2,945 - $9,300

Methodology: The costs were estimated based on the prices of basic materials sourced from local stores and Amazon.ca. These materials include duct tape, used Tetra Paks, cloth, thread, nails etc. The calculations for painting the roof were done by considering two types of paints: Silicone White Roof Coating and Epoxy White Floor Paint. The price range for roof painting varies from $2,945 to $9,300, depending on the paint quality selected. Both paints will effectively reduce heat absorption, with the primary difference being durability. Silicone White Roof Coating is specifically designed for roofs and may offer greater resistance to wear and tear. Given Vancouver's wet climate, it's notable that both paint types are waterproof, making them suitable options.

Appendix D: Action Plan Template

Phase	Action Steps	Responsible Party	Timeline	Budget Allocation	Progress Tracking
1. Pre-Implementation Preparation	Clarifying Objectives & a thorough review of identified DIY techniques.	[Specify] UGM, City of Vancouver, SRO Collaborative etc.	[Specify Dates] April 1, 2024- April 20, 2024	[Specify Budget] $$	[Specify Tracking Method] Weekly Meetings/Monthly Reviews/ Progress Reports etc.
	Conduct community meetings to introduce techniques.				
	Gather feedback and preferences from community members.				
2. Action Plan Implementation	**Pilot Program**				
	Identify a suitable pilot location for each technique.				

	Collaborate with local contractors for installation.				
	Monitoring and Evaluation				
	Establish metrics for evaluating success.				
	Implement data collection methods (sensors, surveys).				
	Community Education				
	Develop user-friendly educational materials.				
	Conduct workshops and information sessions.				
3. Documentation and Reporting	Establish a centralized database for recording activities.				

	Provide regular progress reports to stakeholders.				
4. Continuous Improvement	Collect feedback from residents and stakeholders.				
	Schedule periodic meetings for project evaluation.				

Image Courtesy of Union Gospel Mission