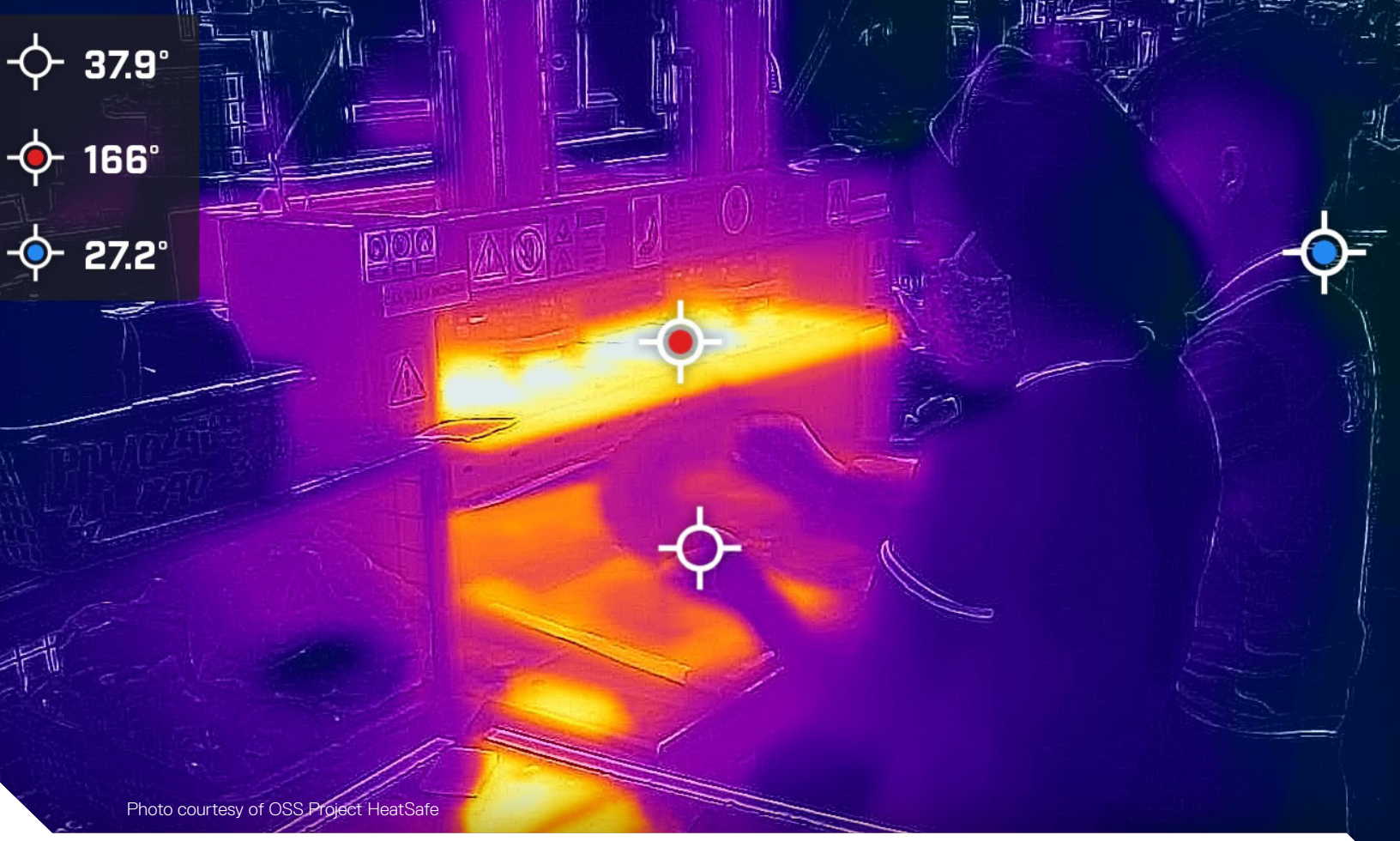

Photo courtesy of OSS Project HeatSafe

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Cooling Before It Got Cool:
Case Studies in Heat Adaptation in Southeast Asian Factories

By Sarah Krasley

ILR Global Labor Institute

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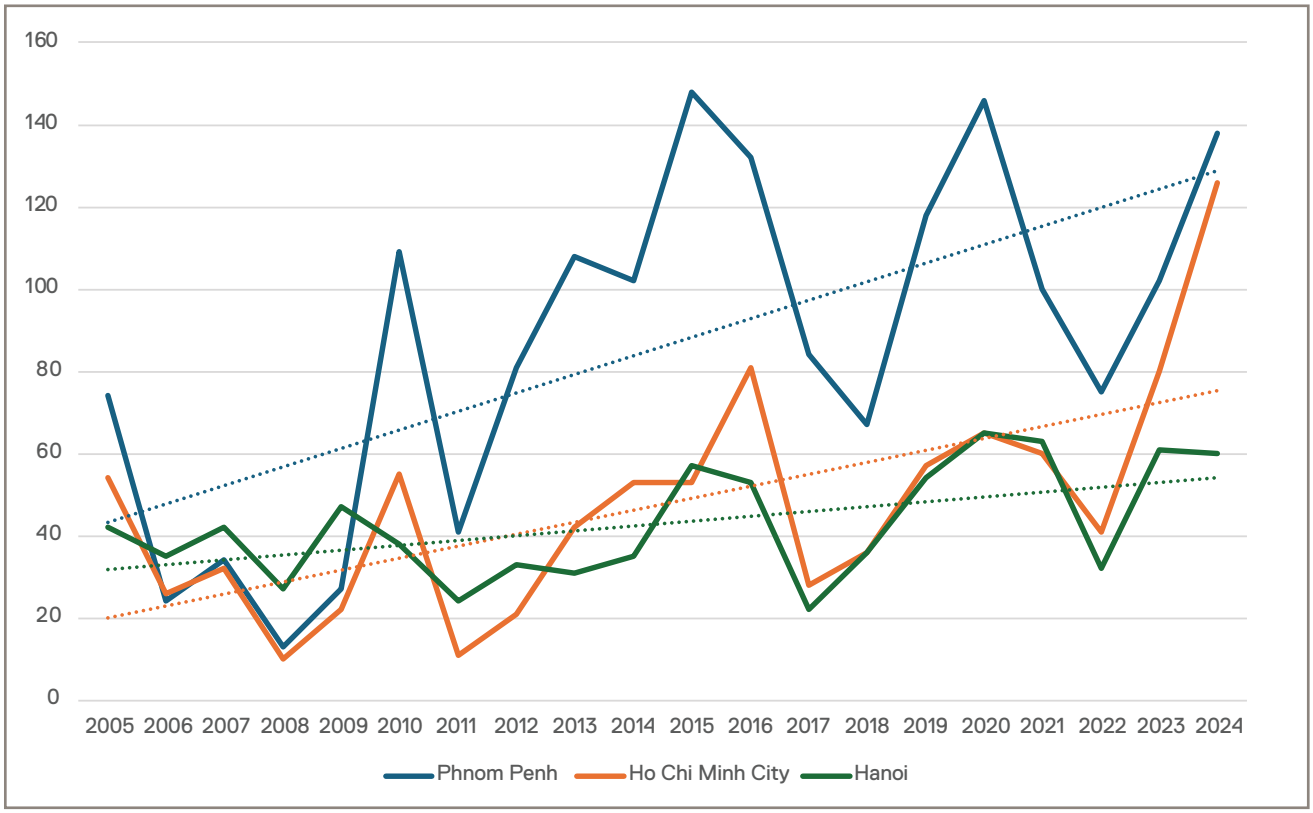
INTRODUCTION

Across Southeast Asia, extreme heat is no longer a passing disruption. It is a defining operating condition. In Vietnam and Cambodia, the number of days exceeding 35°C has climbed steadily over the past two decades, reshaping how factories function and how heat stress affects workers. As this graph shows, what once counted as extreme has become routine.[1]



Source: GLI analysis using direct observations/station data from Visual Crossing up to 30 September 2024

For manufacturing, this rise in heat collides with another structural shift: automation. As factories invest in more automated and semi-automated production, tolerance for thermal variability shrinks. Machines require stable temperatures and humidity to operate reliably. Materials behave differently under heat stress. Quality control becomes harder when environmental conditions fluctuate. In this sense, cooling is no longer only about worker comfort or compliance. It is increasingly an enabling condition for automation itself.

Heat, of course, operates beyond the walls of a factory complex. Workers, often living in homes without sufficient cooling suffer prolonged exposure to high temperatures. This disrupts sleep, their ability to recover from a workday, as well as caregiving, and general household stability, shaping how workers arrive at work each day. Even in facilities with effective

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1 Sarah Krasley is the founder of Shimmy and a GLI Visiting Fellow in the Cornell University School of Labor and Industrial Relations. This research was supported by the Cornell University Southeast Asia Program. Sarah would like to thank the following people for their help in creating these case studies. First, Jason Judd, Joaquin Riveria, and Brian Wakamo at the Cornell University Global Labor Institute. This work would not have been possible without willing research participation and assistance from Nicole Chu, Lu Sujia, Davy Chen, Phang Hour, Mr. Zhou, Jack Ho, Jessie Vo, Hau Phung, Kang Kyoung Sob, Le Huong Phong Lan, Huynh Cong Hau, Chau Quan Tam, Doan Huynh Nhu, Nguyen Nhut Khanh, Nguyen Thi Kim Oanh, Vo Thanh Nha, and HuynhNhu-An. Special thanks to Rachel Philipson for her work designing this report.

indoor cooling, the physiological and cognitive effects of extreme heat outside working hours carry into the production environment. Heat is not just a workplace safety hazard; it is a systems-level pressure on labor.

Perspectives on how workers are coping with higher heat in Vietnam's apparel/footwear industry

Independent access for researchers to workers in Vietnam is limited. We rely here instead on general observations by long-time industry observers in Vietnam who report a mixed atmosphere when it comes to heat stress in the workplace. As one said, "The heat [has an] impact to the occupational health and safety of worker. [...] The first one is [a] complaint from workers saying, "OK, the workplace is hot, and we need some equipment to cool down the workplace." And: "For the workers, they generally say that it's hot and it's making their movements slow." They add it is especially dangerous for women workers: "The second concern is about female workers, especially pregnant workers. They feel discomfort when the temperature rises in the workplace. And a female worker is also concerned about their menstruation period."

Observers also report that some factories are taking steps to mitigate heat stress. In some factories, due to the temperature levels, "the factories have to arrange many heat breaks during the day, and they even have to set up something like an air conditioned room for [a] worker to go inside of that [so they can] rest and then come back to work."

Progress isn't always proactive or easy, despite reports that middle management believes heat impacts productivity. As one observer put it, "Management is inactively responding to the complaint[s] [from] worker[s] by setting up some fans or providing cool water or something like that."

This short series of case studies examines how three factories responded before heat regulation or climate breakdown, or both, forced their hands. Building on wide-lens analyses of heat impacts by the Global Labor Institute, the scope of these case studies is deliberately narrow: document real-world examples of heat abatement initiated by factory management, largely self-financed, and integrated into daily operations rather than treated as pilot projects or compliance exercises. These are not idealized facilities. They are functioning factories, navigating real constraints in an increasingly volatile operating environment.

Together, the cases trace three distinct adaptation pathways. One treats cooling as a foundational design assumption aligned with automation, safety and recruitment. A second case layers incremental interventions within an open-shed factory architecture. The third shows how workers and their organizations, data logging, and stepwise investment adapt to accelerating heat over time. What links them is timing. Each acted early enough that cooling became part of how the factory runs, not an emergency response as the climate warms.

Sabrina Garments: Proactive Cooling, Worker Voice, and Incremental Climate Adaptation as Temperatures Warm in Cambodia

Kampong Speu Province, Cambodia
6,200 Workers
Total Square Meters: 77,600
Established in 2014
Produces: Apparel
Semi-Automated
Concrete multi-story and shed-style, corrugated steel roof buildings
Cooled by: water curtains, exhaust and circulating fans, air conditioning

1. Facility Profile and Physical Environment

On the western edge of Phnom Penh in Kampong Speu Province, Sabrina Garments sits just off a busy highway. At ground level, the complex appears straightforward: multistory reinforced concrete production buildings, adjacent corrugated steel shed structures, and a noticeably tidy yard where workers move between buildings in small groups. In total there are 6,200 workers, 93 percent of them women.

Sabrina Garments specializes in cut and sew services for global sportswear brands. Eighty percent of the boxes on the loading docks are destined for United States consumers and the other 20 percent are headed off to the European market. This factory is part of a larger five-factory portfolio headquartered in Taiwan that has grown steadily over time. This

particular location was established in 2007 when Sabrina Garments purchased the complex's primary multistory buildings from another garment manufacturer and moved in, later expanding in 2016 to include additional warehouse and finishing spaces.

The core production buildings are multi-story reinforced concrete structures with concrete slab roofs that have no insulation or reflective coating. Solar was installed over some portions of the roof. The ceiling heights of the spaces vary. In Buildings A and D, ceilings rise to approximately 22 meters, creating large volumes of air above the production lines. In Buildings B and C, by contrast, ceilings are much lower, closer to eight and a half meters, a difference that matters when charting how heat accumulates and dissipates.

Clusters of mature shade trees line parts of the site's perimeter, and there are a handful of roof-shaded areas, but as is typical in much of Southeast Asia, the complex is exposed to direct sunlight for most of the day.

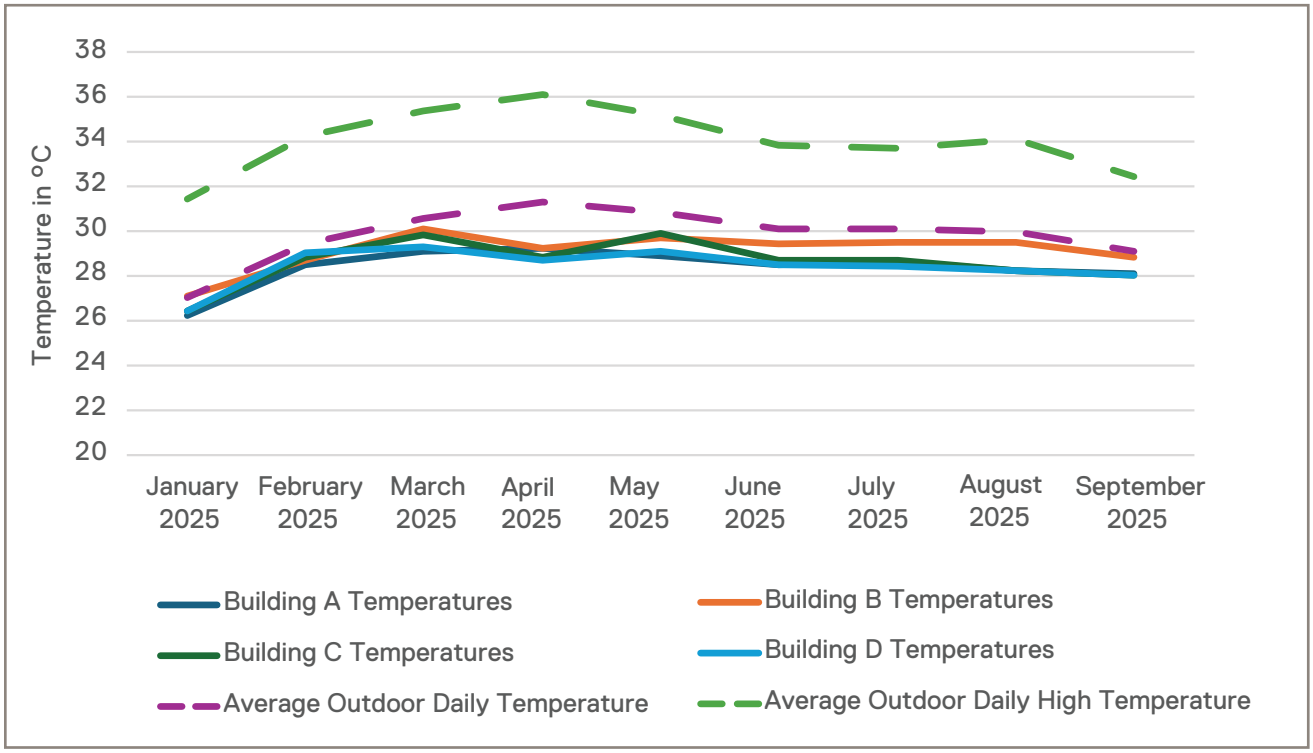
2. Climatic Conditions and Drivers of Cooling Investments

What makes Sabrina Garments worthy of our attention? It's not a story of a dramatic technological retrofit or a splashy ribbon-cutting ceremony for a fully-automated plant. It is the quieter, step-wise story of how a factory expanded and improved its cooling system over time in response to operational performance, rising temperatures and worker needs—as part of its bargaining relationship with a union. These improvements were not subsidized by buyers or development organizations. They reflect what management describes as an ethos rooted in stability, comfort and a commitment to addressing issues before they escalate.

On the day of my visit in mid-November, it's 26°C and humid outside. The air inside, however, is a surprise. It is cool, steady and almost gentle. Even at this point in the year, when humidity still lingers and the 'cool' season has not quite arrived, Sabrina Garments's sewing lines felt composed. Workers operate efficiently, and half of them, closest to the cooling vents, wore sweaters and light jackets to guard against the cooled air. I toured the entire factory on my visit and everywhere I went there was adequate ventilation.

Management's 2025 temperature and moisture record logs show that temperatures in the various sections remained below 32°C across the year, even as outdoor temperatures surpassed 40°C. Sabrina Garments's sustainability team also reports that absenteeism remained around one percent, even during the hottest weeks of the year.

Figure 1. Outdoor and indoor temperatures, Phnom Penh and Sabrina Garments, 2025



Sources: Sabrina Garments internal temperature readings and the Iowa Environmental Mesonet of Iowa State University

Cambodia's climate has grown hotter and more unpredictable in recent years**.** According to the Ministry of Water Resources and Meteorology in Cambodia, in 2024 the country faced the highest temperatures in 170 years, with prolonged temperatures above 35°C and peaks of 40–42°C in April. Workers report struggling to cool their homes during these periods of extreme heat, which impacts their ability to sleep and recover between shifts. Sabrina Garments's indoor cooling helps mitigate this during their working hours, but extreme outdoor heat still shapes how workers feel when they arrive at work.

Flooding also impacts operations. According to management, severe floods blocked the surrounding roads in 2021. The factory itself did not flood, but shipments were delayed. Workers could still walk or motorbike to the plant due to its proximity to the nearby residential areas where workers live, but absenteeism increased from one to around six percent during that peak flooding week.

Cambodia's 1997 labor law requires employers to keep workplaces below harmful thermal levels and mandates thermometers inside facilities, but does not set heat thresholds.[1] Sabrina Garments has 45 temperature and humidity sensors across the facility that are visible to workers, managers, and visitors alike. Management logs temperature and humidity readings multiple times per day, and has done so since the first day their doors were open. These sensors cost roughly USD 5 each.

Sabrina Garments also invested in solar energy early. In 2015, they installed an on-site solar array on the roof costing approximately USD 200,000, that supplied 18 percent of total electricity load. This happened before development partners and the ILO pushed a solar agenda with Cambodian suppliers in 2017 and before apparel brands began to ratchet up targets for reductions in greenhouse gas (GHG) emissions from their suppliers. Sabrina Garments's

1 Cambodia has a proposed new Occupational Safety and Health law in the works which discusses high temperatures and heat stress.

investment in solar was self-funded and has expanded to now total over USD 1.2 Million. The company has generated one third of the investment back so far in saved electricity costs.

Cooling investments at Sabrina Garments also predate external pressure. The factory's owner, a second-generation Cambodian, is known among her managers for an emphasis on stability and worker welfare in line with the legacy of her father who wanted to help Cambodian workers following the horrors of the Khmer Rouge regime. Each management interviewee for this case study—quite notably all senior female leaders in plant operations, HR, and CSR—indicated a strong culture of proactivity and continuous improvement.

For example, Sabrina Garments was among the first Cambodian factories to sign a collective bargaining agreement and in their most recent assessment, they comply with 20 of the 21 "Critical Issues" detailed by the ILO's Better Factories Cambodia program.

3. A Walk-Through of Sabrina Garments's Cooling

Inside the factory, the action begins on the first floor of Building A in a semi-automated area where fabrics and trims are unloaded from trucks, then collected and stored in protected, separated areas for different brands. As work on specific styles begins, fabric rolls are taken out of these temporary storage areas, inspected for defects, and stretched. This area runs warmer than the sewing floors because loading dock doors remain open throughout the day. Small fans were added above worker stations here to reduce heat exposure.

As workers move fabrics deeper into the production process, temperatures drop noticeably. As workers spread the fabric across automated cutting tables, I feel the first breeze from the line of water curtains along the wall of the space. Management reports that workers describe the interior as "comfortable" and "cool." Many wore light jackets, sweatshirts, or sweaters during the visit, particularly near water curtain walls where airflow is stronger.

When Sabrina Garments acquired the buildings, water curtains were already installed along parts of the factory walls. These systems provided some cooling but created uneven airflow.

Worker organizations and indoor heat levels

Union leadership from the Coalition of Cambodian Apparel Workers' Democratic Union (C.CAWDU) in Phnom Penh is the majority union at Sabrina Garments. It has a collective bargaining agreement with Sabrina Garments, as does its sister union at an older Phnom Penh facility in the Sabrina Garments group. Workers report outdoor temperatures have intensified in recent years from 35° or 36°C in March, April and May—Cambodia's hottest months—to 37° or 38°C and sometimes as high as 40°C in the last two years.

At Sabrina Garments, union leaders are familiar with the ILO Better Factories Cambodia's heat standard of 32°C and report engaging managers on heat levels inside the factory. Workers use channels like the Telegram app and the C.CAWDU union to report warm corners, stagnant air pockets and discomfort near machinery. Management reports that this feedback loop was a driver of cooling expansion and that cooling is "integral to workplace safety considerations in the CBA" and the employer's "responsibility for maintaining a safe workplace."

Union leaders at the older facility in Phnom Penh stated that factory engineers indicated that the building design prevented them from making structural cooling improvements and that the factory could not make what the union called "a systems improvement" and relied on short-term measures to reduce heat levels on the hottest days.

As we learned in Hot Air, there is little use in moving hot air around a manufacturing environment. The air must first be cooled and then moved in order for it to yield a benefit that's meaningful to a worker's health.

So what exactly is a water curtain? A water curtain, cooling pad, or evaporative cooling panel are used interchangeably and are examples of active, evaporative cooling systems. This kind of cooling works by creating negative pressure that pulls fresh air from outside through water-saturated cellulose or metal pads known as water curtains or cooling pads. The pads, arranged in a honeycomb structure at Sabrina Garments, provide a large surface for evaporation. As warm air passes through, water, stored in nearby tanks, evaporates and cools the air by five to twelve degrees, depending on humidity. The cooled air is then pulled across the floor by large exhaust fans on the opposite sides of the room.

Inside views of the water curtains.

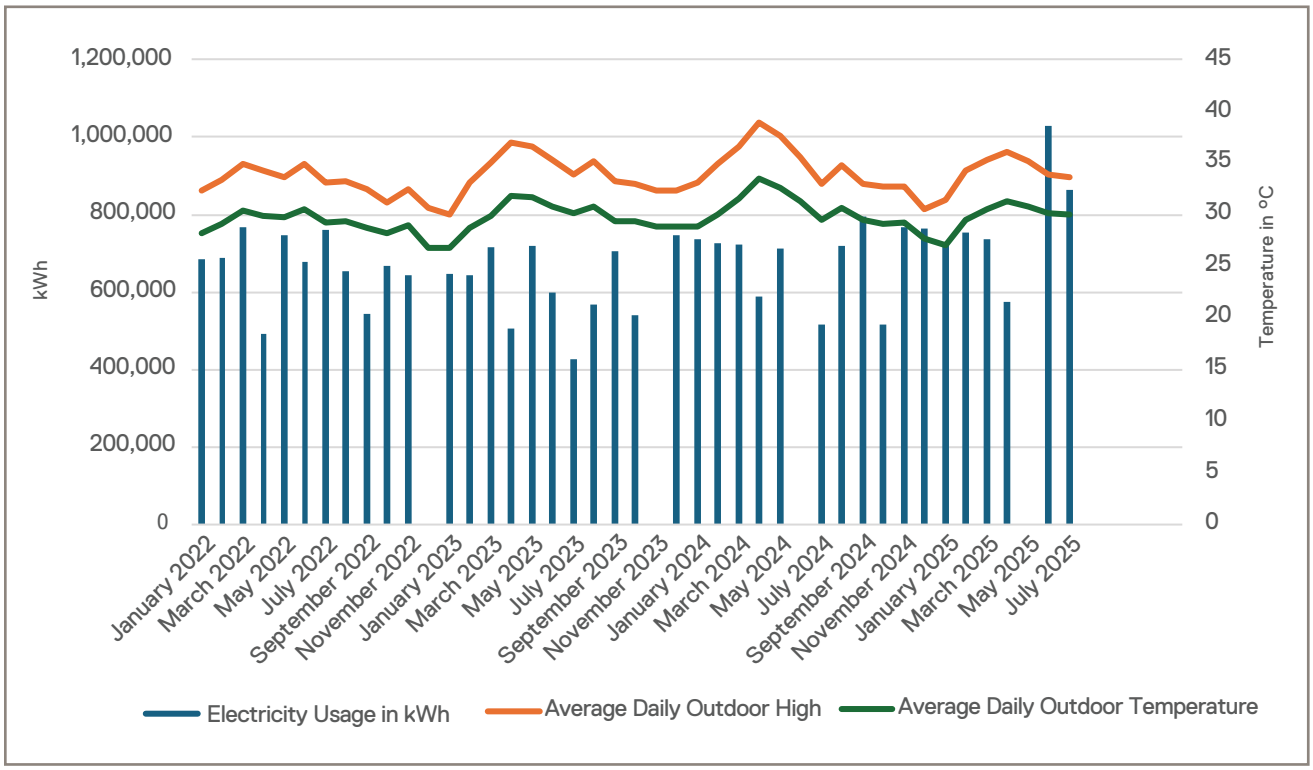
Sabrina Garments currently has 46 water curtains covering 97,600 square meters of production space. These water curtains are in the warehouse, cutting area, and sewing areas of the factory.

As sewing operations expanded to additional floors, Sabrina Garments extended the evaporative cooling system. New water curtain walls, pumps, piping and drainage sections were added at an investment of USD 250,000. In this way, the factory did not implement this expansion all at once. It progressed floor by floor based on experience and worker feedback.

This setup – water curtains on one side of the room and exhaust fans on the other—distributes cooled air across the sewing floors. Workers stationed near curtain walls often wear sweaters, while those in central aisles experience milder airflow. When workers raise concerns about cold drafts, the factory temporarily adjusts fans accordingly.

Management reports that water curtains and exhaust fans are a cost-effective means to abate heat. Pads are cleaned or replaced every 8 - 10 months at a cost of roughly USD 110 per square meter, or USD 10,000 per year, and maintenance of them costs about USD 12,000 per year.

Figure 2. Outdoor temperature and electricity use at Sabrina Garments



Sources: Sabrina Garments internal documents and the Iowa Environmental Mesonet of Iowa State University

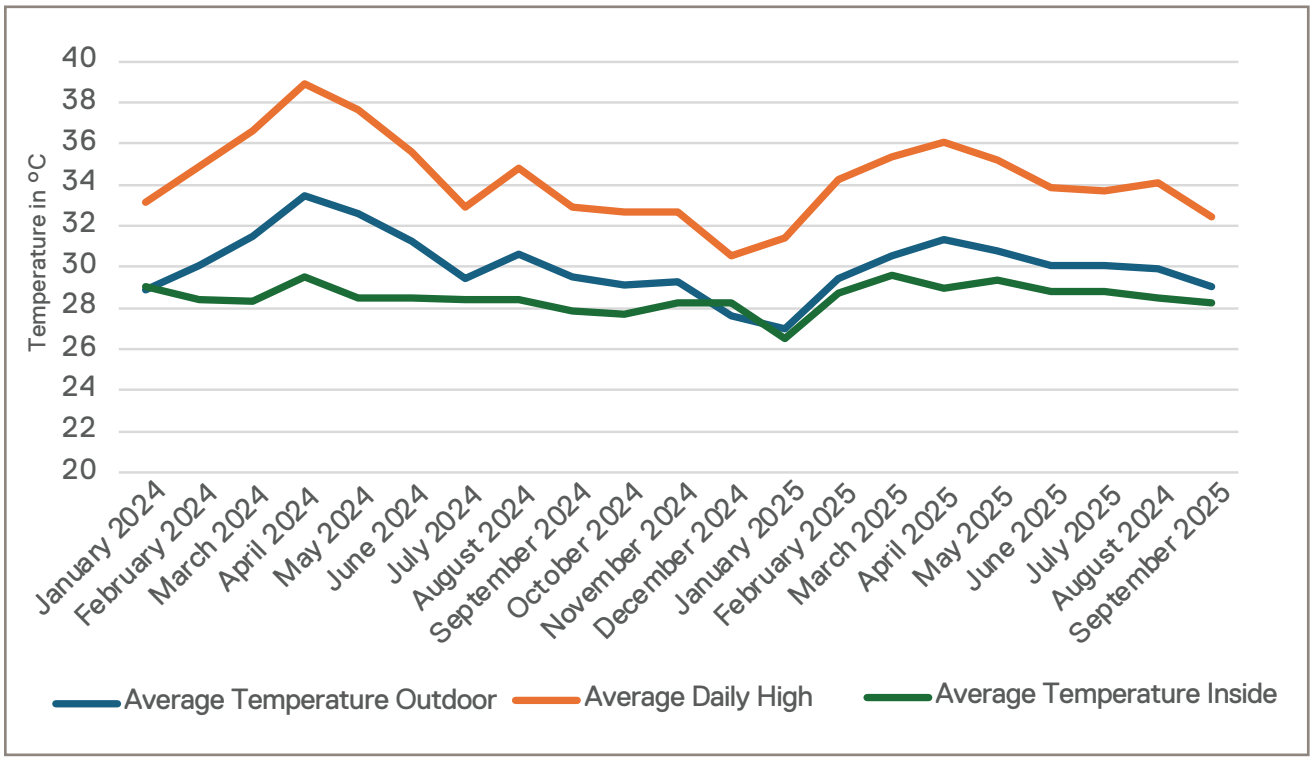
There are also sections of the factory that house production with highly automated equipment, laser cutting, and other heat-sensitive operations. These sections are walled off and cooled with refrigerant air-conditioning. This is required by the machine manufacturers in order to maintain the precise temperatures and humidity control needed by the machines. The air conditioning is typically installed with the machinery and the costs are bundled in with the investment in automation.

Evaporative cooling requires less energy than mechanical air conditioning, but actual consumption depends on pump capacities, fan hours and building load.

4. Workforce and Productivity Benefits

HR and management estimated that before cooling improvements, seasonal efficiency dips of around five percent were common during the hottest months. These dips have narrowed significantly as Sabrina Garments has increased their commitment to heat abatement.

Figure 3. Comparison of indoor and outdoor temperatures in 2025



Sources: Sabrina Garments internal temperature readings and the Iowa Environmental Mesonet of Iowa State University

As we see in Figure 3, despite rising outdoor temperatures, indoor temperatures remained largely consistent. Sabrina Garments management reports that this is reflected in their output and productivity data. Monthly production output does not show a consistent decline during hotter periods. Output remains high in several of the warmest months, including March 2025, suggesting that any production output variability is not attributable to high heat, or to heat alone. Overall, for the sampling of months we reviewed, the weak correlation between outdoor heat and output points to the possibility that cooling systems are effectively helping buffer workers' productivity from climatic stress, though further analysis to isolate variables such as style complexity, production pressure, absenteeism, etc. would be needed to confirm this relationship.

There have been periods of extreme heat that tested the existing cooling infrastructure, however. In those instances, Sabrina Garments added ice directly to the water reservoirs at a cost of approximately USD 4,125. The ice water fed the cooling pads in order to deal with the hotter air outside. This particularly impacted spaces on the third and fourth floors of the multistory building since they run warmer than the ground floors. Managers report that workers felt the difference; temperatures dropped and the airflow felt fresher even during those hottest days.

HR reported few heat-related clinic visits by workers and said that visits increase more so during the rainy season due to fevers, not heat stress. Absenteeism remains around one percent, which managers report is rare in the Cambodian garment sector. Workers reportedly stay with Sabrina Garments for ten to fifteen years and many return after family leave.

Cool indoor temperatures are not the primary attractor for jobseekers. Workers are more influenced by the stories they hear from existing employees around competitive salaries, subsidized lunches and a calm, respectful environment. Nevertheless, Sabrina Garments managers argue that thermal comfort is an important stabilizing factor.

Conclusion

Sabrina Garments is an example of climate adaptation built in small steps over time. Indoor temperatures remain stable because the factory pays attention to airflow and comfort, listens to workers and maintains systems consistently.

Lessons Learned from Sabrina Garments

- Adaptation does not always require a major retrofit. In purpose-built facilities, incremental improvements can accumulate into a robust system
- Worker feedback and union bargaining provide precise guidance on where cooling is needed most
- Evaporative cooling performs well in Cambodia's climate when maintained consistently
- Extreme heat events require flexible reinforcement measures such as ice supplementation
- Cultural elements matter. A respectful, responsive management culture and a bargaining relationship with the worker organization amplifies the effectiveness of technical solutions

An Giang Samho: Cooling with GHG Reduction Pressures, the Realities of Heat in a Complex Semi-Automated Footwear Plant

An Giang Province, Vietnam
10,599 Workers
Total Square Meters: 280,000
Established in 2014
Produces: Footwear
Semi-Automated
Shed-style, corrugated steel roof buildings
Cooled by: exhaust fans, fans at worker stations, ice machines, solar absorption

1. Factory Overview

An Giang Samho is a large semi-automated footwear complex, a sprawl of blue-and-white buildings where more than 10,500 workers mold, stitch, glue, print, and assemble shoes in a region that is getting hotter by the year.

The plant was initially constructed in 2014. It follows the standard regional footwear layout: long, shed-style buildings with corrugated steel roofs and open sides. Interior airflow depends on natural cross-ventilation, reinforced by large exhaust fans at the ends of the production lines and on the exterior walls. Closer to the action, rows of workstation-level fans are aimed at workers and adjusted throughout the day, a constant response to subtle changes in air movement.

During my November site visit, indoor readings averaged 31.4°C with 68.8 percent humidity, compared to 27°C and 75 percent humidity outdoors. In a plant built on open-shed architecture and dependent on fans for cooling, those numbers point to two pervasive tensions. One, fans can move air across a work area but they do not significantly cool it. And two, in a production environment with adhesives and printing solvents, cooling solutions are limited because moving air risks moving fumes too.

2. Climate Context

Samho's complex sits in Southern Vietnam alongside the Hau River near the border with Cambodia. Bucolic farmlands and quaint towns surround the industrial zone underneath a wide sky where approaching weather is visible hours before it arrives.

Managers at the plant described winters that no longer feel like winters and summers that stretch longer, with hotter nights and storms that creep farther inland than they used to. The industrial park surrounding Samho experienced at least one major flood event when drainage systems failed and water lingered in nearby roads for several days, pushing the company into broader conversations with local authorities and neighboring factories about climate-risk infrastructure.

Samho managers reported that in 2022 they recognized the need to focus on cooling and, like Sabrina Garments Cambodia, started on a plan to cool the building and the workers inside it.

3. Solar is the Anchor

Samho's most consequential climate adaptation came through a vendor-financed solar installation with SkyX Solar in 2022. This financing structure allowed them to adopt renewable energy without upfront capital or downtime. It works like this: the panels act as a thermal shield, catching the heat from the sun before it warms the roof and in turn, the interior. Combined with new insulation, this lowered indoor temperatures by around 3°C, according to management and technical staff interviewed during the visit.

The array generates renewable energy and replaces some of the grid-connected power that has a much higher greenhouse gas footprint. Management estimates energy cost savings of roughly USD 3,000 per month from arrays on one of their buildings. The installation also delivers more predictable electricity pricing. Multiple supervisors described the building as cooler during the midday hours since the installation.

Inside view of roof insulation. Courtesy of An Giang Samho

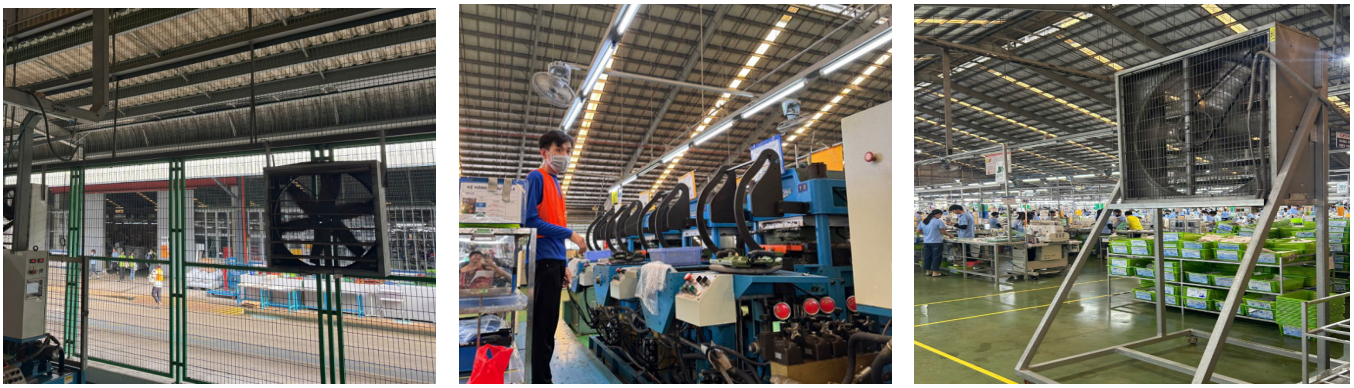
Solar array on the roof. Courtesy of An Giang Samho

4. Exhaust-Fan Upgrades

In 2024, Samho implemented major exhaust-fan improvements because rising heat made the prior system insufficient. Managers described these upgrades as necessary to keep airflow moving across the production lines and to prevent hot air from stagnating in the lamination and gluing areas, which consistently run hotter because of the chemical processes and machine configurations needed to cure components as they are glued together. Technical staff noted that fan placement and airflow patterns are changed when hotspots emerge.

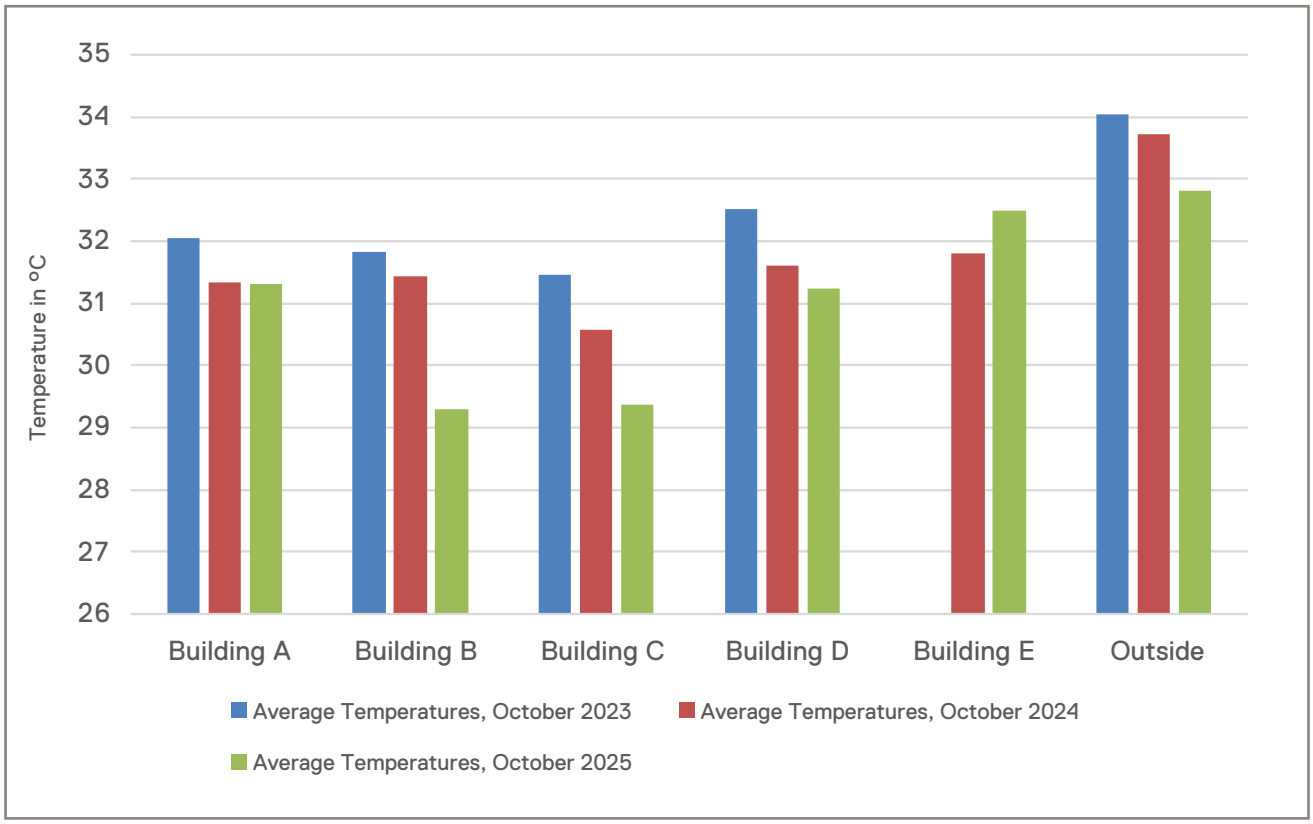
Each fan is roughly a 1.1 kW capacity and costs about USD 190. Samho installed 156 of these fans, which as a group require approximately 428 MWh of electricity per year and generate roughly 1 to 6 tons of CO_2 per factory per year. The energy costs for running these fans are USD 34,700 per year.

These figures show a factory making serious, sustained investments to keep conditions tolerable, while signaling the limits of fan-based cooling as heat intensifies.



Interior images of exhaust and worker station fans. Courtesy of An Giang Samho

Figure 1. Temperatures at Samho as these interventions rolled out



Source: Samho internal documents

5. Ice Machines: A Worker-centered Intervention

Kang Kyounsob, General Manager, begins most days walking the floor of the factory and watching workers closely. In 2024, he noticed workers bending over makeshift ice buckets they brought from home with ice that came from their neighborhoods. That ice sometimes came from unsanitary molds and water sources that caused workers to get ill. Mr. Kang saw a solution to two problems: provide free ice from sanitary sources to workers which would help them stay cool and help them have safer drinking water.

Ice machines were installed as a simple wellbeing improvement. The machines make and store clean ice, anytime, for anyone. The response was immediate. Workers began using them often, supervisors reported fewer mid-day heat complaints, and the VGCL union representative I spoke with described the decision as meaningful because it signaled management attention to an everyday discomfort—a gesture of care beyond mitigating a compliance risk.

The effect was visible during my visit in November. At lunchtime, workers gathered in small groups, chatting and taking brief naps in the shade before a cheerful melody over the factory loudspeaker called them back to their workstations. Nearly every worker I saw carried a chunky, insulated, gallon-sized water jug with a white handle as they headed back to the line, a small but telling artifact of how the factory's response to heat had become part of a normal workday.

6. Operational and Worker Impacts

Indoor temperatures taken during the November visit averaged 31.4°C, with 68.8% humidity. Some areas—especially lamination and gluing—felt hotter due to the processes and heat coming from the exhaust fans of the machinery. Without the solar shielding and insulation, conditions would likely have exceeded permissible temperatures.

Vietnamese law states that indoor workplace temperatures should not exceed 34°C, 32°C and 30°C for light, medium and heavy work, respectively. Relative humidity should not exceed 80%. Samho tracks their temperature limit to 32°C.

7. Productivity and Efficiency

Management believes the solar-insulation system improves consistency of production by reducing fatigue. However, because the factory does not track defects or productivity alongside temperature and humidity, this effect is observational rather than quantified.

Samho also does not log real-time humidity or temperature data across zones, making precise before-and-after comparisons difficult.

The workforce is drawn from surrounding agricultural communities. As HR explained, turnover hovers around 5 percent and absenteeism is roughly 5.7 percent. Workers often leave temporarily to help their families for peak farming seasons and then return. The nurse on duty at the clinic during my site visit noted a small uptick in clinic visits on hot days, mostly related to insomnia from hot nights rather than acute heat illness.

Workers come to An Giang Samho because of the salary – competitive for the region. This is the primary draw.

There is also greater automation on the way, as the General Manager noted, cooling is not only about workers; it is about the machines. Future machinery will need more stable temperatures and humidity to function reliably.

8. Conclusion and Future Plans

None of these interventions resolves the structural problem at the heart of the factory. Cooling an open-air, shed-style building that handles chemical processes remains an engineering challenge, and the measures in place do not fully offset the climate risks that are likely to intensify in the years ahead. But taken together, they tell a different kind of story. They show what early, incremental adaptation looks like inside a complex manufacturing environment built at a time when extreme heat was not yet a central concern, and when the expectation was that fans and open walls would be enough.

Samho's management started with what was feasible, tested what worked, and expanded from there. Ice machines addressed heat stress while also solving a separate problem of access to safe drinking water. Solar panels and roof insulation reduced indoor temperatures and steadied energy costs. Exhaust-fan upgrades reshaped airflow across the production floor, even as they made clear the limits of fan-based cooling in chemical-intensive spaces. None of these steps solves the whole problem, but together they make the workday more tolerable for the people on the line.

Looking ahead, Samho is considering whether solar installations could be extended to parking structures, made more plausible by newer, lighter panels that do not require reinforced roofing. Management is also exploring more targeted cooling in chemical-intensive zones, an approach that would need to be carefully designed to avoid redistributing fumes. The path forward is constrained, but it is not static. Samho's experience suggests that in manufacturing, adaptation is rarely a single decisive leap. More often, it is a series of small, deliberate moves, taken early enough to buy time in a warming climate.

WorldOn: Cooling as a Foundational Operating Principle and Strategic Imperative

Ho Chi Minh City, Vietnam
Workforce: 17,500 workers
Established in 2015
Produces: Cut & Sew, Printing, Embroidery, Warehousing, Packaging
Highly Automated
Mix of multi-story insulated concrete buildings and steel-roof shed-style buildings
Cooled by: central air conditioning, fans, water curtain systems

1. Factory Overview

WorldOn is a large cut-and-sew facility located approximately 90 minutes outside Ho Chi Minh City, Vietnam. The factory employs approximately 17,500 workers and operates across an expansive campus comprised of multi-story production buildings and single-story shed-style structures used for cut and sew, printing, embroidery, and warehousing.

Cooling systems across the factory include central air conditioning, fans, and water curtain evaporative systems. During the November 2025 visit, indoor temperatures averaged approximately 26.8°C with 56.6 percent relative humidity, while outdoor conditions were approximately 29°C with 70 percent relative humidity, based on readings observed on site.

2. Physical Layout and Building Types

WorldOn's complex stretches across two large plots in an industrial park, up from one plot when the factory expanded in 2020. While brands were reeling from COVID-related inventory bloat and uncertainty about the future, WorldOn made the strategic decision to use the time to build and be ready for post-pandemic demand. It was certainly a risk, but one that put the business in a strong position as the world reopened.

The newer plot houses a mix of multistory buildings all cooled by air conditioning. The WorldOn team has invested heavily in automation for these factory buildings – for cutting, sewing, and even packing.

The older plot also houses automated and semi-automated printing, embroidery, and warehouse functions cooled by a mixture of water curtains, air conditioning, and fans.

3. Cooling as a Design Assumption

Cooling at WorldOn was not introduced as a retrofit or in response to regulatory pressure or heat-related incidents. Management stated that air conditioning has been in place since the factory opened in 2015 and that production has never operated without it.

Management reported that this approach was driven by a combination of brand requirements, quality standards, and a belief that stable environmental conditions are necessary to support productivity, safety, and automation. At the time of construction, management noted that fully air-conditioned production environments were still uncommon in Vietnam.

Today, cooling accounts for 23.37 percent of WorldOn's total electricity consumption, up from 21.90 percent in 2023. Energy costs rose sharply over the same period, increasing by approximately 31 percent between 2023 and 2024 and by a further 19 percent between 2024 and 2025. Management estimated the annual cost to be over USD 300,000. Despite this, the WorldOn team stated unequivocally that the investment in cooling is justified and even if there were cost-cutting initiatives within WorldOn at some point, cooling levels would not be compromised.

4. Sewing Operations and Material Handling Automation

Sewing operations at WorldOn are highly automated relative to regional norms in apparel production. According to the International Labour Organization, automation technologies such as robotic sewing and advanced line automation remain limited in core garment processes, particularly sewing, even as adoption grows in other sectors of manufacturing.

At WorldOn, sewing lines are supported by conveyor-style material handling systems that deliver bundles directly to operators. According to operations leadership, these systems track time between stations, operator cycle times, and workflow progression.

Operations stated that stable temperature and humidity are critical to the performance of these systems, noting that fluctuations can affect fabric behavior, machine calibration, and operator endurance throughout their shifts. Cooling was consistently described as an enabling condition for automation rather than a parallel investment.

During the walkthrough, we moved from a highly automated sewing floor to a second floor housing an earlier-generation sewing line with substantially less automation. Despite the difference in technology, temperature readings on both floors were observed to be nearly identical.

As we neared the end of the sewing floor, we encountered a tidy row of fences, behind which was a fully autonomous line of industrial robots assembling cardboard boxes, packing finished goods, taping them shut, and moving them along conveyor systems to be stacked and shipped to brands and retailers in the EU and US.

According to management, automating packing procedures reduces the risk associated with physical strain on workers and improves consistency and throughput. These were among the drivers for expanding automation to these processes.

5. Reducing Heat at the Equipment Level

In addition to broad environmental cooling, WorldOn has taken steps to reduce heat generation at the equipment level. Management stated that several machines traditionally associated with high heat output including fabric relaxing machines and ironing stations have been replaced with electric alternatives.

Electric ironing station. Image courtesy of WorldOn.

As noted in a recent report by Climate Rights International, ironing stations are typically some of the hottest areas inside a factory. At the ironing stations at WorldOn, electric systems have replaced steam-based heating. During the site visit, the ironing area was observed to be warm but did not exhibit the intense ambient heat typically associated with steam pipes running through floors and workstations.

According to WorldOn managers, electric systems provide a safer, more cost-effective, and low-emission alternative to central steam boilers, with the added benefit of simplified operations. Human Resources staff reported that workers were trained directly at the machines and adapted quickly to the new equipment.

6. Cooling Infrastructure and Air Distribution

WorldOn uses fabric-based air dispersion ducts to distribute air conditioned air throughout production areas. Management stated that the system does not require balancing through dampers or diffusers, distributes air evenly without drafts, operates quietly, and reduces condensation risk due to the permeable fabric material. Management also explained that they are much easier to clean than conventional ductwork as they can be deflated by periodically stopping airflow and cleaning the exterior surface to remove dust and maintain air quality.

During the visit, the ducts appeared clean and unobtrusive, and airflow distribution was observed to be quiet and uniform across work areas.

View of fabric air dispersion ducts. Image courtesy of WorldOn.

Throughout the sampling of readings across multiple buildings of the factory during April, August, and December of 2025, our team noted that temperature and humidity data from the factory's environmental monitoring system seemed very stable across seasons (See Figure 1) and throughout the day.

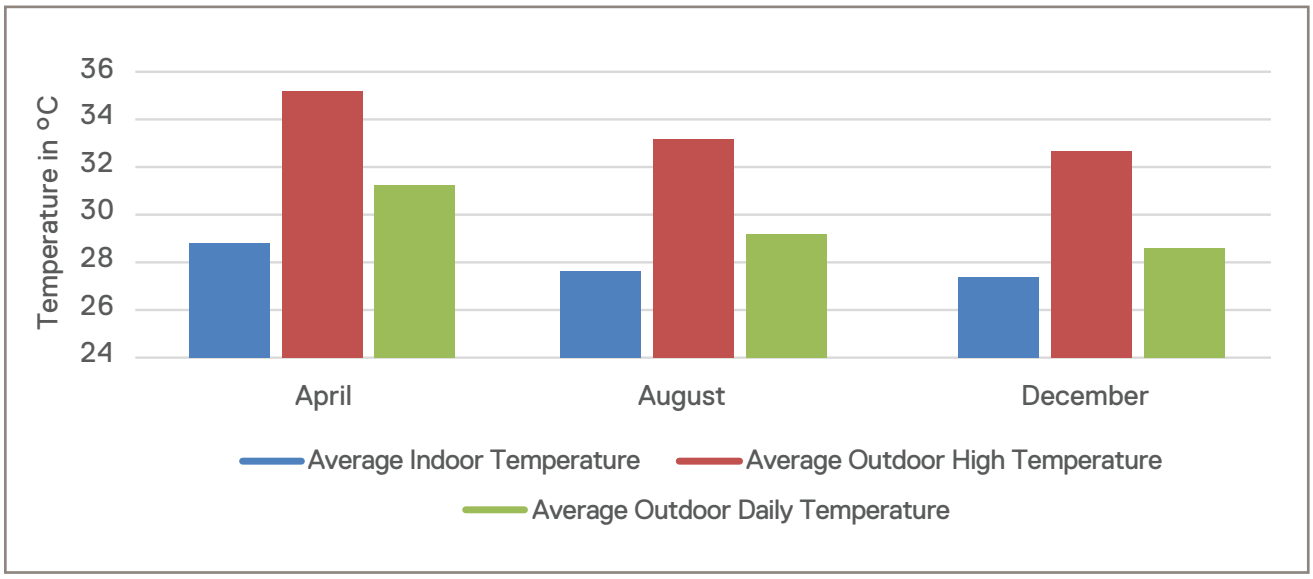
Indoor temperatures remain tightly clustered within a narrow range, with gradual and soft variation rather than sharp spikes. While relative humidity fluctuates more than temperature, it remains within controlled bounds and does not exhibit runaway increases during peak production hours, indicating active environmental management rather than passive ventilation.

Temperature and humidity are continuously monitored throughout the factory using a digital environmental monitoring system, according to management. Sensors are installed across production areas and operations staff repeatedly reviews data.

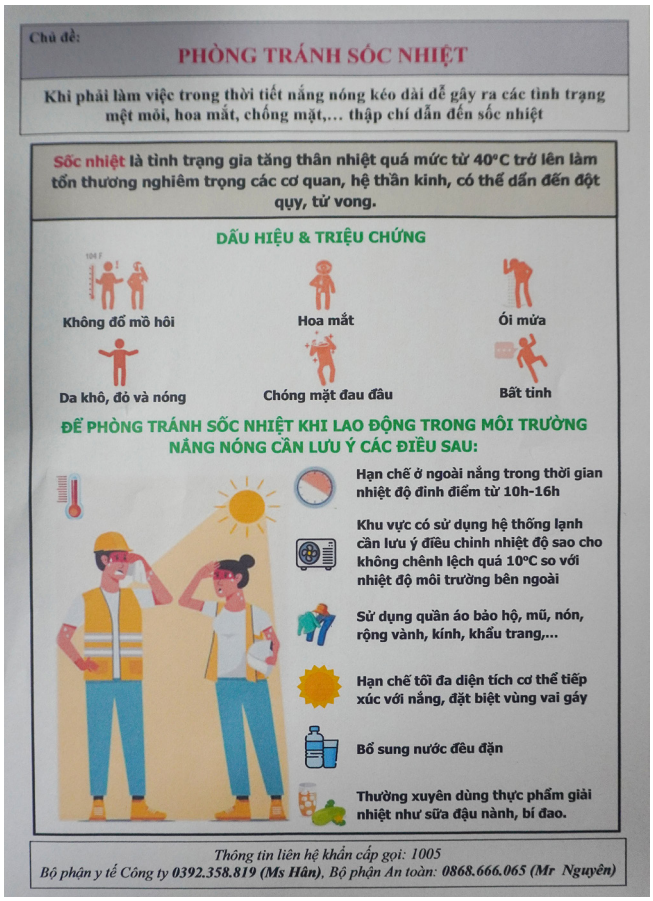
Monitoring is particularly important in printing areas, where volatile organic compounds complicate airflow decisions. In these zones, cooling must be balanced with ventilation requirements to avoid dispersing chemical fumes. Management reported that the printing department remains the warmest area of the factory, a condition also observed during the site visit. This part of the factory is cooled by water curtains, evaporative cooling walls.

External view of a water curtain at the factory. Image courtesy of WorldOn.

Figure 1. WorldOn indoor average temperatures vs. outdoor temperatures across three months in 2025



Sources: WorldOn internal temperature readings and the Iowa Environmental Mesonet of Iowa State University



Picture of Heat Stress Training Materials for Workers

7. Worker Safety, Recruitment and Retention

Cooling is a keystone in WorldOn's broader safety framework. HR reported that the factory conducts regular safety training, annual safety knowledge competitions, and provides channels for workers to submit safety improvement suggestions.

WorldOn shared pictures and curriculum examples showing how heat stress education is incorporated into the broader safety curriculum. Even though heat stress is not an issue inside the climate-controlled factory, workers receive guidance on hydration and heat exposure during hot periods to help them stay safe when they are not at work.

HR reported that the factory recorded zero safety incidents during hot periods in the current year.

Cooling is also critical to WorldOn's hiring strategy. HR reported that air conditioning makes hiring easier and is the primary reason workers seek employment at WorldOn.

Worker dormitories provided by the company are also air conditioned. HR stated that dormitory cooling contributes significantly to worker morale, rest quality, and retention. Workers reportedly stay at WorldOn for about five years on average.

8. Cooling, Quality, and Product Complexity

Beyond its effects on worker comfort and safety, cooling also shapes product innovation. Performance garments, particularly those made from synthetic yarns, are sensitive to prolonged exposure to high heat and humidity, which can affect material stability, consistency, and quality during production. In fact, some brands insist finished goods be placed in walk in refrigerators to guard against degradation before the goods are shipped.

Management at WorldOn noted that, like many major manufacturers, the factory works with brands to develop new products in laboratory settings before they move into mass production. These development labs are typically climate controlled. When production scales, however, those same materials must perform in manufacturing environments that are often significantly hotter and more humid than the lab. Management stated that maintaining consistent cooling beyond laboratory spaces allows WorldOn to translate new designs into full-scale production more quickly and with greater reliability, reducing the risk that environmental conditions undermine product performance during early production runs.

Conclusions

WorldOn's leadership framed cooling as part of a long-term resilience strategy. Management stated that during the COVID-19 period, the factory expanded rather than contracted, viewing cooling, automation, and capacity expansion as interconnected investments rather than discrete upgrades. The team further stated that cooling would be among the last areas considered for reduction under future cost pressures and expressed confidence that existing systems could accommodate significant increases in external temperatures, including scenarios of up to 10°C.

When asked what advice he would offer to other factories considering investments in cooling, Mr. Zhou, the General Manager, stated, "Just try. Don't calculate it," explaining that the benefits of cooling emerge over time across safety, quality, workforce stability, and buyer trust, making strict return-on-investment calculations difficult when impacts are distributed across multiple operational goals.

Management emphasized that achieving stable and effective cooling requires a holistic approach that integrates architectural design, automation choices, and management systems, rather than relying solely on standalone cooling equipment. In this view, cooling performance is shaped as much by building design, process layout, and equipment selection as by the cooling system itself.

Management linked WorldOn's operating model to a broader philosophy articulated by Mr. Ma, Chairman of Shenzhou International Group, the multinational parent company with manufacturing operations across China, Cambodia, and Vietnam. According to management, the principle of "No skill – Comfortable – Efficiency" reflects the Group's view that worker comfort is foundational to skill development and efficiency on the factory floor.

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