Annex 2 YGEN report

Example report for a factory

Year of Construction	Factory Age (years)	Last Renovation Year
2000-2005	20-25	Not available
Roof Material	**Wall Material**	**Insulation Present**
Concrete	Brick	No
Number of Shifts	**Worker Density**	**Workers per Shift**
1	4.79 sqm per worker	1,550

Factory profile and floor-wise observations

Building / Floor	Production Line / Function	Area (sqm)	Temperature (°C)	Relative Humidity (%)
Ground Floor	Cutting, fabric inspection, fabric relaxation, warehouse, spreader and automatic cutter	1,486.45	29.2	49.8
1st Floor	Finishing, packing, store, checking, loop cutting, inside check, sewing-related activities	1,486.45	31.5	49.8
2nd Floor	Finishing, ironing, snap button, spot removing, sewing, steam iron	1,486.45	30.1	54.0
3rd Floor	Sewing, pocket ironing, steam iron	1,486.45	31.9	50.5
4th Floor	Canteen	Not counted	—	—
5th Floor	Sewing, jeans and gabardine production	1,486.45	29.4	47.0

Note:

1. *The temperature and relative humidity readings shown above are from the YGEN visiting team's measurement device. These are not Cornell sensor readings.*
2. *The 4th floor is used as a canteen and is therefore excluded from the production-area cooling calculation.*
3. *The total production/intervention area considered for this report is 7,432.25 sqm, covering five production floors.*
4. *The factory visit took place on 13.11.2025, during a relatively mild weather period. Ambient temperature in the area was around 28°C on the day of visit. As a result, the observed production-floor temperature was generally within a comfortable range.*
5. *Several exhaust fans and ceiling fans were switched off during the visit because workers reportedly felt the floors became too cool when all fans were operating. However, during peak summer, when ambient temperature exceeds 35°C, the indoor temperature and WBGT are expected to increase significantly.*
6. *The 1st and 2nd floors are not treated as fully finishing/ironing floors. These floors include sewing-related activities as well. Since exact area data is not available, 30% of each of these two floors is estimated as the special ironing/finishing zone requiring separation and targeted closed-loop cooling.*

High heat threshold: 32–34°C

According to factory management, the factory generally aims to keep production-floor temperature within the range of 32–34°C. During the visit, the observed temperature was below this threshold because it took place in November under mild ambient conditions.

However, the factory's cooling arrangement is heavily dependent on ambient conditions and fan-based air movement. Therefore, temperature and WBGT may rise during peak summer periods, especially in zones with poor airflow distribution, cutting areas with sustained heat exposure, and ironing/finishing sections with steam and localized heat sources.

Environmental conditions and operations

Item	**Observation**
Production units	Five production floors considered: cutting, finishing/ironing, sewing, packing, and quality-related operations
Sewing lines	18 sewing lines across the production floors
Shift	8:00 AM to 5:00 PM; 9-hour production shift
Total production/intervention area	5,000-10,000 sqm
Visit date	13.11.2025

Item	Observation
Temperature readings	Taken by YGEN visiting team's device
General visit condition	Mild outdoor weather; several fans were not operating at full capacity during the visit
Key observation	Lack of air movement was noticeable in the middle floor areas; air felt heavy in some zones

The field visit did not encounter extreme heat conditions because it was conducted during a cooler month. However, the observed airflow pattern indicates that the factory may experience higher heat stress during peak summer. The main issue is not simply the absence of fans, but the uneven distribution and effectiveness of airflow.

Power and energy

Item	Value
Grid supply	0.57 MW
Gas generator	0.82 MW
Solar photovoltaic system	0.12 MW
Total plant capacity	1.51 MW
Electricity cost used for calculation	Tk 12/kWh
Factory efficiency status	Semi-automated

This factory uses a combination of grid electricity and solar photovoltaic power, and gas generation for load-shedding. For the cooling-intervention cost calculation, Tk 12/kWh is used as the electricity cost.

Heat management: Field observations

Cooling / Heat-management observation	Interpretation
56-inch industrial exhaust fans are mounted on walls on multiple sides.	The existing exhaust system is useful, but the placement reduces effectiveness. Some fans are clustered in the same wall section, while other wall sections have no exhaust coverage. This leaves some production areas under-exhausted.
Some exhaust fans have obstacles in front of them, including machines and piles of fabric.	Obstructions reduce exhaust performance and prevent proper removal of hot air from the floor.
The factory has many ceiling fans.	Ceiling fans improve perceived comfort, but the airflow does not evenly cover all workers. Gaps between fans are larger because many fans are 48-inch units.
Table fans are used in some areas.	Table fans are mainly used in packaging, folding, cutting and other areas where ceiling-fan airflow can disturb fabric or packaging materials.
Middle-floor areas felt heavy during the visit.	This indicates stagnant air pockets and insufficient directed airflow, even though the factory already has many fans.
Steam iron and heat-generating activities are present in finishing/ ironing areas.	These areas create localized heat and humidity, requiring separation, local exhaust and targeted cooling.

Cooling and ventilation

Item	Description
Roof	Concrete
Walls	Brick wall
Typical roof height	3.65 m
Ground-floor roof height	4.26 m
Existing exhaust fans	39 units
Existing ceiling fans	627 units
Existing table fans	79 units

Existing cooling systems in place

Cooling mechanism	Number	Description
Industrial exhaust fan	39	Exhaust fans are installed, but not uniformly distributed across the production floor. Some exhaust points are obstructed or poorly positioned.
Ceiling fan	627	Large number of ceiling fans, but airflow gaps remain. Some workers are positioned under low-airflow zones.
Table fan	79	Mainly used in packaging, folding and cutting areas where strong ceiling airflow may disturb fabric, packets or materials.

Effectiveness

The average observed temperature was around 30.5°C, which is comfortable under the mild weather conditions during the visit. However, the factory's existing cooling system is highly dependent on ambient temperature and air movement. Since the outside temperature was only around 28°C during the visit, the observed indoor condition should not be treated as representative of peak summer.

During hotter months, the indoor temperature and WBGT can rise significantly, especially in:

- stagnant middle-floor zones;
- cutting areas with sustained WBGT exposure;
- ironing/finishing areas with steam and localized heat sources;
- locations where exhaust fans are obstructed by machines or fabric piles.

Machinery

This factory is a semi-automated factory. The observed production machinery includes sewing machines, pocket-ironing equipment, steam irons, snap-button equipment, spot-removing equipment, spreaders, automatic cutters, fabric inspection machines and related finishing and cutting machinery.

The factory accounts for around 5% annual degradation in machine efficiency for maintenance planning. This is treated as a general maintenance assumption and is not directly attributed to the impact of heat or humidity.

Recommended next steps

The recommended cooling package for this factory is a zonal intervention package, not a full-factory mechanical cooling system. The factory already has a large number of ceiling, table, and exhaust fans. The main issue is uneven airflow distribution, insufficient directed airflow in some middle-floor areas, and localized heat/humidity in the ironing/finishing sections.

The recommended approach is therefore to improve the existing ventilation system first and apply targeted stronger cooling only where the WBGT risk is higher.

The recommended package includes:

1. Reflective roof coating for the roof-exposed area.
2. Ventilation and airflow correction across all production areas.
3. Transparent non-combustible partitioning for the estimated ironing/finishing zone.
4. Local steam and heat extraction for the estimated ironing/finishing zone.
5. Targeted closed-loop cooling for the estimated ironing/finishing zone only.
6. Solution 2, evaporative cooling, only as a conditional future pilot option.

For this factory, 30% of the 1st- and 2nd-floor areas are estimated as an ironing/finishing zone because exact area data is unavailable. This estimated special zone is separated from the normal production area for costing and intervention design. The remaining 70% of those floors are treated as normal production/sewing-type areas and do not receive special closed-loop cooling.

Cooling intervention cost summary

Solution / Intervention	**Application Area**	**Annual Energy Consumption**	**Annual O&M Cost incl. Energy**	**Installation Cost**
Reflective roof coating	Roof-exposed area	0 kWh	Minimal	USD 3,046.00
Ventilation + airflow correction	General production areas	23,045.64 kWh	USD 2,380.12	USD 34,750.00
Targeted closed-loop cooling	Estimated ironing/ finishing zone	22,254.01 kWh	USD 2,407.81	USD 18,087.12
Fire-safe partitioning + local steam extraction	Estimated ironing/ finishing zone	6,030.77 kWh	USD 622.85	USD 22,852.46
Total recommended package	**Total production/ intervention area: 5,000-10,000 sqm**	**51,330.42 kWh**	**USD 5,410.78/year**	**USD 78,735.59**

Summary table for GLI costing

For the GLI summary table, the solution terms can be shortened as follows:

Recommended Solution Mix	**CAPEX per 100 sqm**	**O&M per 100 sqm/ year**
Reflective roof coating; ventilation + airflow correction; targeted closed-loop cooling for finishing/ironing	USD 1,059.38	USD 72.80

Reflective roof coating

Reflective roof coating is recommended as a passive heat-reduction measure for the roof-exposed area. Roof surfaces absorb solar radiation during the day and transfer part of that heat into the occupied floors below. Reflective coating reduces solar heat gain and can reduce indoor heat buildup before active ventilation or cooling is required.

For this factory, the roof-treatment area is estimated at 1,486.45 sqm.

Item	Value
Roof treatment area	1,486.45 sqm
Unit cost	Tk 250/sqm
Total cost	Tk 371,612.50 or USD 3,046

Ventilation and airflow correction

Ventilation and airflow correction are the primary interventions for this factory. The factory already has many exhaust fans, ceiling fans and table fans, but the airflow is uneven. Exhaust fans are clustered in certain wall sections rather than evenly distributed; some exhaust points are blocked by machines or fabric piles, and gaps in ceiling fans create stagnant middle-floor zones.

The proposed ventilation and airflow-correction package includes:

- high-flow Z-fans or directional wall fans;
- fresh-air fans with ductwork;
- additional industrial exhaust fans in persistent hot spots.

Proposed equipment

Component	Unit Cost	Quantity	Installation Cost
High-flow Z-fans / directional wall fans	USD 1,000	15 units	USD 15,000
Fresh-air fans, 24 inch	USD 350	25 units	USD 8,750
Fresh-air ductwork and installation	USD 1,000/floor	5 floors	USD 5,000

Component	Unit Cost	Quantity	Installation Cost
Additional industrial exhaust fans, 56-inch	USD 600	10 units	USD 6,000
Total installation cost	—	—	**USD 34,750**

The Z-fans are calculated at 3 units per production floor across 5 production floors. Fresh-air fans are calculated at 5 units per floor. Additional exhaust fans are calculated at 2 units per floor.

Energy and O&M

Item	Value
Connected load	27.25 kW
Annual energy consumption	23,045.64 kWh/year
Annual electricity cost	USD 2,266.78/year
Maintenance at 5%	USD 113.34/year
Annual O&M cost	USD 2,380.12/year

Note: *This intervention is suitable as the base cooling layer for sewing, cutting and normal production areas. It also supports the estimated ironing/finishing zone, but it is not sufficient on its own for that special zone because of sustained high-zone WBGT exposure.*

Targeted finishing/ironing-zone intervention

The 1st and 2nd floors are mixed-use production floors. They include sewing lines as well as finishing and ironing activities. Since accurate area data is unavailable, 30% of each of these two floors is designated as the special ironing/finishing zone.

Estimated special ironing/finishing area = 1,486.45 sqm × 2 floors × 30% = 891.87 sqm

This special zone should receive:

- transparent non-combustible partitioning;
- local steam and heat extraction;
- controlled make-up air;
- targeted closed-loop cooling.

The remaining 70% of the 1st and 2nd floors is treated as normal production/sewing-type area and should receive general ventilation and airflow correction only.

Partitioning and local extraction

Intervention	Installation Cost	Annual Energy Use	Annual O&M Cost	Comment
Transparent partitioning with fire-safety allowance	USD 18,852.46	0 kWh	Minimal	Required to isolate the special ironing/ finishing area
Local steam and heat extraction	USD 4,000.00	6,030.77 kWh	USD 622.85	Captures heat and moisture at source

The partitioning should not create an airtight or unsafe enclosure. It must allow worker movement, emergency access, sprinkler coverage, fire detection coverage and make-up air. The partitioned area should be kept under slight negative pressure so that steam and hot, humid air do not spread into adjacent production areas.

Targeted closed-loop cooling

Targeted closed-loop cooling is recommended only for the estimated ironing/finishing zone. It is not recommended for the full factory.

This system is more reliable than evaporative cooling in high-humidity zones because it does not add moisture to the production area. It should operate primarily during high- and severe-WBGT periods.

Item	Value
Target area	891.87 sqm
Installation cost rate	USD 20.28/sqm
Installation cost	USD 18,087.12
Connected load	21.40 kW
Equivalent operating hours	1,039.67 hours/year
Annual energy consumption	22,254.01 kWh/year
Annual electricity cost	USD 2,188.92/year

Item	Value
Maintenance at 10%	USD 218.89/year
Annual O&M cost	USD 2,407.81/year

The target condition is to bring WBGT below 28°C. For finishing/ironing zones, a preferred practical target of 26–27°C WBGT may be considered where feasible, but this would increase operating hours and energy cost.

Solution 2: Conditional pilot only

Modular evaporative cooling is not included in the base recommended package for this factory. Although evaporative cooling can reduce dry-bulb air temperature, its performance depends heavily on relative humidity. If it increases indoor humidity, the final WBGT reduction may be limited.

This is especially important in finishing/ironing zones, where steam and localized moisture already contribute to heat stress.

Solution 2 may be considered only as a future pilot option in selected sewing or cutting areas if:

- the area has high dry-bulb temperature but manageable RH;
- strong exhaust and fresh-air pathways are available;
- the area is not dominated by steam or wet processes;
- temperature and RH sensors can control operation;
- final WBGT reduction can be verified after operation.

Feasibility

The recommended intervention is highly feasible because this factory already has a strong base of ventilation equipment and available wall-mounted fan infrastructure. The proposed works mainly improve distribution, direction and targeted treatment rather than introducing a full-factory mechanical cooling system.

The main implementation requirement will be careful floor-by-floor coordination, especially in the 1st and 2nd floor ironing/finishing zones where partitioning, local extraction and targeted closed-loop cooling will be installed.

Confidence level

Confidence level is high for the general intervention direction because field observations, equipment counts and WBGT exposure all point to the same issue: uneven airflow and localized high-risk heat zones.

The exact cost may vary depending on supplier quotations, final fan placement, duct routing, partition length, installation complexity and fire-safety requirements. For reporting purposes, this should be treated as a planning-level engineering estimate with approximately 5–10% variability.

Time estimation for implementation

Cooling system installation in operating RMG factories should be carried out in phases. Full production stoppage across all floors is generally not required if installation is planned floor-by-floor or zone-by-zone.

Intervention / Activity	Estimated duration	Production impact
Reflective roof coating and roof-surface preparation	1–2 weeks	Minimal, as work is outside the production floor
Ventilation and airflow correction, including Z-fans, fresh-air fans, ducting and additional exhaust fans	1–2 months	Low and localized; temporary relocation may be needed near wall openings or duct routes
Partitioning of the estimated ironing/finishing zone and local steam/heat extraction	1–2 months	Moderate but controllable; applies only to the estimated ironing/finishing zone on the 1st and 2nd floors
Targeted closed-loop cooling for the estimated ironing/finishing zone	1–2 months	Localized and manageable; installation should follow partitioning and local extraction works
Overall implementation timeline	Approximately 3–5 months if done sequentially; shorter if procurement and installation activities overlap	Full factory shutdown is not required

If implemented sequentially, the total timeline may be approximately **3–5 months**. If procurement and some installation activities overlap, the timeline can be shortened.

A full factory shutdown is not required. The work can be completed through floor- and zone-wise implementation, with off-hours coordination.

Fire safety and humidity impact assessment

The recommended cooling package includes:

- reflective roof coating;
- ventilation and airflow correction;
- transparent non-combustible partitioning;
- local steam and heat extraction;
- targeted closed-loop cooling for the estimated ironing/finishing zone.

The proposed interventions do not inherently increase fire risk if they are connected to the factory's emergency shutdown procedure and installed in compliance with fire-safety requirements.

During a fire incident, standard factory protocol requires the main electrical power supply to be switched off. Once power is isolated:

- exhaust fans stop;
- fresh-air fans stop;
- Z-fans stop;
- local extraction fans stop;
- pumps, blowers and closed-loop cooling equipment stop.

As a result, forced airflow no longer supplies oxygen to the fire.

The partitioned ironing/finishing zone should not be designed as an airtight enclosure. It must allow safe worker movement, emergency access, sprinkler coverage, fire detection coverage and controlled make-up air.

Fire-safety interpretation

Intervention	Fire-safety interpretation	Risk level
Reflective roof coating	Passive roof treatment with no electrical load	Low
Ventilation + airflow correction	Fan-based system; should be connected to emergency power cut-off	Low
Transparent partitioning	Must use non-combustible material and maintain emergency access	Low, subject to compliant design
Local steam and heat extraction	Should be electrically interlocked with emergency shutdown	Low
Targeted closed-loop cooling	Should be interlocked with emergency shutdown and fire-safety system where feasible	Low, subject to compliant design

Humidity control is important because the project target is WBGT reduction, not only dry-bulb temperature reduction. Increasing humidity can reduce the effectiveness of cooling from a heat-stress perspective.

The recommended package avoids full-factory evaporative cooling as the base solution. Instead, it uses ventilation correction, local steam extraction and targeted closed-loop cooling.

Humidity interpretation

Intervention	Humidity impact
Reflective roof coating	No humidity impact
Ventilation + airflow correction	Does not add moisture; improves air turnover and reduces stagnant humid air
Local steam and heat extraction	Removes steam and moisture at source before it spreads
Transparent partitioning	Limits migration of steam and hot humid air into surrounding production areas
Targeted closed-loop cooling	Does not add moisture to the production area
Solution 2: evaporative cooling	Not included in the base package because it may increase RH and may not sufficiently reduce WBGT

Overall humidity impact of the recommended package: **neutral to positive**.

Incremental energy consumption and cost specification

The existing cooling system at the factory already includes 39 exhaust fans, 627 ceiling fans and 79 table fans. The recommended intervention package is an additional system layered on top of the existing cooling arrangement, although the actual net increase may be lower if some existing fans are later relocated, replaced, controlled or operated differently.

Existing baseline

Item	Value
Existing cooling-system annual energy use	249,238.13 kWh/year
Existing cooling-system annual O&M cost	USD 26,515.23/year

Additional recommended intervention

Intervention	Annual energy use	Annual O&M cost
Ventilation + airflow correction	23,045.64 kWh/year	USD 2,380.12/year
Local steam and heat extraction	6,030.77 kWh/year	USD 622.85/year
Targeted closed-loop cooling	22,254.01 kWh/year	USD 2,407.81/year
Reflective roof coating and partitioning	0 kWh/year	Minimal
Total additional intervention	51,330.42 kWh/year	USD 5,410.78/year

Estimated total cooling-system energy and O&M after intervention

Item	Value
Existing cooling-system annual energy use	249,238.13 kWh/year
Additional intervention energy use	51,330.42 kWh/year
Estimated total cooling-system energy use after intervention	300,568.55 kWh/year
Existing cooling-system annual O&M cost	USD 26,515.23/year
Additional intervention O&M cost	USD 5,410.78/year
Estimated total cooling-system O&M after intervention	USD 31,926.01/year

Percentage increase

Item	Increase
Energy consumption increases	20.60%
O&M cost increase	20.41%

This factory does not require full-factory mechanical cooling. The recommended approach is reflective roof coating, ventilation and airflow correction across production areas, and targeted closed-loop cooling for the estimated ironing/ finishing zones after partitioning and local steam extraction. This approach is expected to provide the required WBGT reduction with substantially lower capital and operating cost than factory-wide mechanical cooling.