Tanzania
Climate Friendly Cooling: Investment Brief

Climate Adaptation Market Opportunities
Infrastructure, Energy and Manufacturing

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GLOBAL CENTER ON ADAPTATION
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CGAP
PEGASYS CHANGING LIVES CHANGING WORLDS

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GLOBAL CENTER ON ADAPTATION

ABOUT THE GLOBAL CENTER ON ADAPTATION

The Global Center on Adaptation (GCA) is an international organisation, hosted by the Netherlands, which works as a solutions broker to accelerate action and support for adaptation solutions from the international to the local, in partnership with the public and private sector, to ensure we learn from each other and work together for a climate resilient future.

ABOUT AFRICA ADAPTATION ACCELERATION PROGRAM

GCA is providing technical assistance under the Africa Adaptation Acceleration Program (AAAP), a joint initiative launched by the GCA and the African Development Bank in 2021.

In close collaboration with:

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CONTEXT

This investment brief is part of a regional analysis undertaken by the Global Center on Adaptation, developed in close coordination with partners including CGAP and GCA's downstream financial institution partners under the Africa Adaptation Acceleration Program, in collaboration with the consulting firm Pegasys. The analysis identifies and operationalizes climate adaptation investment opportunities in infrastructure, energy, and manufacturing across Tanzania, Kenya, Zambia, and the Democratic Republic of Congo. Building on these results, the present brief aims to provide a decision-support resource for commercial banks, microfinance institutions, and other lenders seeking to assess and integrate climate-related risks and opportunities within their infrastructure, energy, and manufacturing portfolios.

Across energy, manufacturing and infrastructure, climate variability is increasingly translating into material credit risk. Erratic rainfall, rising temperatures, flooding, and more frequent extreme events disrupt energy generation and distribution, impair manufacturing operations, and reduce the reliability and service life of physical infrastructure. These impacts weaken borrower revenues and asset values, with direct implications for both clients and lenders, including deteriorating portfolio performance, elevated non-performing loan ratios, and increased volatility in infrastructure and corporate lending

The analytical framework underpinning this investment brief series reframes climate adaptation as a risk-adjusted investment opportunity. It identifies discrete, technology-driven interventions across value chains and assesses their bankability through market sizing, borrower segmentation, and business model analysis. Each brief is structured to align with financial sector requirements, including compatibility with existing lending instruments (e.g. asset finance, value chain finance) and applicability across borrower archetypes such as utilities, project developers, construction firms, and industrial SMEs.

The investment brief series, focused on Climate Adaptation Market Opportunities in Energy, Manufacturing and Infrastructure, aims to support financial institutions in systematically integrating adaptation into core lending operations, with a view to strengthening client and portfolio resilience while capturing emerging market opportunities.

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CLIMATE-EFFICIENT COOLING SYSTEMS FOR MANUFACTURERS IN TANZANIA

Executive Summary

Tanzania's manufacturing sector is confronting a heat crisis that is no longer a future risk — it is a present-day drag on productivity, quality, and profitability. Climate projections indicate average temperature increases of 2–3°C by mid-century, with a marked rise in extreme heat days above 35°C across Tanzania's main industrial hubs. For manufacturers, this is not an abstract environmental concern. Rising temperatures erode worker productivity for every degree above 27°C, accelerate spoilage and product losses in food and pharmaceutical processing, and increase dependence on expensive diesel back-up generation when grid power is most constrained. The financial costs are real, measurable, and growing — yet they are often invisible, buried in energy bills, output-per-head figures, and product shrinkage rather than attributed to heat as a cause.

For Tanzania's commercial banks, this matters. The manufacturing sector accounts for a substantial share of corporate and SME loan books, and rising temperatures are beginning to erode the financial fundamentals underpinning those lending relationships. Weaker operating margins reduce debt service capacity. Heat-related damage to inventory and fixed assets undermines the value of collateral. When climate stress affects an industrial zone, it tends to hit multiple borrowers simultaneously, creating concentration risk that a loan-by-loan view will miss. This is a portfolio-level exposure that banks cannot afford to ignore.

This brief makes the case that financing climate-efficient cooling in manufacturing is both a commercially rational risk management response and a significant new lending opportunity. Illustrative market sizing suggests a near-term Serviceable Available Market estimated under our core adoption scenario of US$14.5 million and a Total Addressable Market of up to US$21 million across Tanzania's manufacturing sector. This is a specific slice of a much larger African cooling market which could have a value in excess of $105 billion by 2050 (IFC & UNEP, 2024), up 600% on today's market size according to the International Finance Corporation.

The Adaptation Challenge: Cooling as a Commercial Necessity

The need for cooling in manufacturing is increasingly not discretionary. As ambient temperatures and humidity rise, manufacturers are already responding — installing air conditioning, expanding refrigeration, and running diesel generators for longer — simply to maintain the conditions needed for continued production. The question is not whether cooling demand will expand, but whether that expansion will be managed efficiently or will lock firms into higher costs, greater grid dependence, and growing emissions.

Efficient cooling systems break this cycle. Modern inverter-driven systems, high-efficiency chillers, packaged HVAC units, and complementary airflow management measures can reduce electricity consumption for cooling by 30–50% compared to older equipment common in Tanzanian factories today. In facilities relying significantly on diesel back-up generation — as roughly a third to half of firms across Sub-Saharan Africa do — the savings can be substantially larger. Critically, these benefits stack: energy cost reduction, labour productivity stabilisation, and reduced product and inventory losses accrue simultaneously, creating multiple reinforcing sources of cash flow improvement that could support loan repayments.

The technology required is neither experimental nor scarce. Efficient air conditioning systems, industrial chillers, packaged rooftop units, and ventilation and heat management solutions are already available in Tanzania, supplied by established equipment providers and imports that are increasingly aligned with international efficiency standards. Regulatory developments — including regionally harmonised Minimum Energy Performance Standards (MEPS) gazetted through the East African Community in 2025 — are progressively improving the performance baseline of newly imported equipment, reducing technology risk for lenders.

A Significant and Near-Term Market Opportunity

GCA and Pegasys analysis identifies a Total Addressable Market of up to **US$30 million** in climate-efficient cooling investment across Tanzania's formal manufacturing sector, spanning food and beverage processing, pharmaceuticals, textiles and apparel, plastics and chemicals, and selected heavy industries.

Under a moderate adoption scenario — reflecting current constraints on market awareness and credit access rather than any weakness in underlying demand — total project investment needs are estimated at approximately US$21 million, with a **Serviceable Available Market for bank lending of US$14.5 million**.

Food and beverage processing represents the single largest source of cooling-related credit demand, given the scale of operations and the direct financial consequence of heat stress on product quality and spoilage. Pharmaceuticals present the highest per-facility investment requirements. Six adjacent and rapidly growing sectors — including fish processing, horticulture, and cashew — extend the pipeline further for banks with existing lending relationships in agri-processing.

This market will not stay static. Tanzania's GDP exposure to heatwaves is projected to rise from approximately 2% today to 16% by 2080. **Globally, the IFC estimates the market for sustainable cooling in developing economies will double to over US$600 billion annually by 2050,** with Africa's active cooling market potentially growing more than six-fold. Near-term investments in origination capability and product design in the manufacturing sector represents an entry point into a larger, long-term opportunity across residential, commercial, and infrastructure segments.

The Commercial Logic for Banks: Risk and Opportunity

The case for lenders to engage rests on two complementary foundations. Defensively, efficient cooling investments stabilise manufacturer cash flows, protect inventory and fixed-asset collateral, and reduce the probability of heat-related default — turning adaptation lending into a core risk management tool for banks with significant manufacturing exposure.

Offensively, the opportunity represents a pipeline of near-term, bankable transactions in sectors that lenders already know well, using financial instruments they already have. The overall cooling market in Africa is expected to reach $105bn by 2050. With a US$14.5 million near-term serviceable market in Tanzanian manufacturing. Anchored in food processing, pharmaceuticals, and textiles, with extensions across six adjacent sub-sectors — this offers a commercially attractive, near-term lending pipeline that can be accessed using familiar instruments, with a long-run market trajectory that extends well beyond manufacturing.

In practice, cooling investments are well suited to existing banking products with limited adaptation. Medium-term equipment loans of 3–5 years align naturally with asset service lives. Leasing and asset finance structures can reduce upfront cost barriers for smaller manufacturers. Vendor- and supplier-linked finance — bundling equipment supply, installation, and maintenance in a single arrangement — reduces execution risk and provides deal flow at scale. Over the medium term, emerging Cooling as a Service models open a further route, allowing banks to finance specialist service providers rather than individual manufacturers.

Why Act Now

The foundations for cooling finance in Tanzania are in place. Regulatory tailwinds — including EAC energy performance standards and Tanzania's commitments under the Kigali Amendment — are raising the quality floor for cooling equipment entering the market. Concessional capital is available: the World Bank and GCF-funded Global Cooling Facility has over US$140 million in concessional loans and grants available for deployment via commercial financial intermediaries in qualifying markets, including East African nations. Banks that move early to develop cooling finance capability will be positioned to access this capital, reducing their cost of entry while building the credit assessment expertise that unlocks the broader opportunity.

The Bank of Tanzania's 2025 Guidelines on Climate-Related Financial Risk Management and Disclosures also heighten urgency: banks are now required to assess and disclose physical climate risk exposures. Efficient cooling loans offer a direct, verifiable instrument for demonstrating active portfolio de-risking — and for attracting the growing pool of ESG and adaptation-aligned capital from development finance institutions and institutional investors.

From Opportunity to Action: An Implementation and Scaling Pathway

Recognising that this is a nascent but commercially sound market segment, the brief recommends an implementation and scaling pathway for banks seeking to move from awareness to active lending over a three-to-five year horizon. Five action areas define that pathway.

Action Area 1 — Build internal bank capability. Equip credit officers covering manufacturing with a working understanding of cooling economics, reframe cooling investments as a risk management tool for the existing loan book rather than a new and untested category, and establish green finance reporting infrastructure from day one to support access to concessional capital.

Action Area 2 — Design products that fit the asset. No bank in Tanzania has yet designed a dedicated product for this market. The right product requires deliberate calibration on tenor (five to seven years for mid- and large-sized systems), collateral structure (treating cooling equipment as a standardised, productive asset), and bundled maintenance covenants to protect performance over the life of the loan.

Action Area 3 — Qualify the supply chain. Poor design and installation — not equipment failure — is the primary source of performance risk in this market. Banks can mitigate this by establishing approved supplier frameworks, extending working capital to qualified distributors to deepen supply chains, and actively supporting MEPS enforcement to sustain the efficiency premium.

Action Area 4 — Originate demand deliberately. Demand will not arrive unsolicited. Banks should target two or three anchor transactions in year one using existing manufacturing loan book relationships, deploying a simple heat-cost diagnostic to surface the financial problem before presenting a financing solution. Sector associations offer a secondary awareness channel that can generate a pipeline of informed prospects at low cost.

Action Area 5 — Access concessional capital in parallel to building bank capacity and lending products. Banks should pursue concessional finance partnerships concurrently with capability building, not after it. The World Bank and GCF-funded Global Cooling Facility holds over US$140 million in concessional loans and grants for deployment through local commercial financial intermediaries and is one example of a concessional capital pool that could be accessed as banks enter new markets and encounter higher transaction cost.

Full analysis of the adaptation challenge, technology landscape, market sizing, borrower business case, value chain risks, and implementation pathway is set out in the sections that follow.

1. The Adaptation Challenge

Rising temperatures are a material and under-addressed climate risk facing Tanzania's manufacturing sector. Climate projections indicate average temperature increases of approximately 2–3°C by mid-century, accompanied by a marked rise in the frequency of extreme heat days exceeding 35°C (GCA and Pegasys, 2026). These trends are particularly pronounced in Tanzania's main industrial hubs, including Dar es Salaam, Morogoro, Mwanza, Arusha, and Moshi, where manufacturing activity is concentrated and ambient heat is amplified by denser urban form and high humidity.

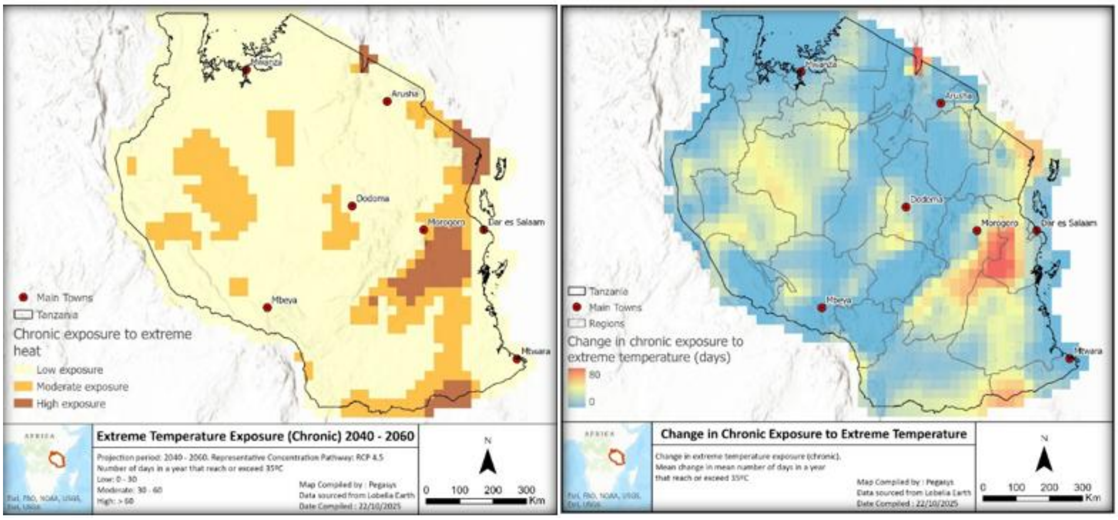

Figure 1: Projected distribution of chronic exposure to extreme temperatures and projected change in the distribution of chronic exposure to extreme temperatures (2040 – 2060)

Manufacturing facilities are inherently exposed to heat risk because production processes, labour, and equipment performance are all sensitive to thermal conditions. For example, climate risk analysis delivered by GCA and Pegasys shows that Tanzania's food processing industry, the largest manufacturing sub-sector in the country, is highly sensitive to extreme temperatures, impacting food safety and quality (GCA and Pegasys, 2026)[1]. The need for efficient cooling processes is acute in food and beverage manufacturing, where temperature control is integral to both productivity and compliance. Elevated ambient temperatures and humidity increase spoilage rates, compromise pathogen control, and undermine the stability of cold chains during processing, storage, and packaging. Similar vulnerabilities are observed in pharmaceuticals, cosmetics, and other quality-sensitive manufacturing subsectors.

A second well-documented commercial impact of rising heat is on worker productivity and safety. Empirical evidence shows that manufacturing sector productivity declines by approximately 3% for every 1°C increase above an indoor temperature threshold of around 27°C (OECD, 2024). Heat stress impairs physical endurance and cognitive performance, increasing fatigue, dehydration, and error rates. In labour-intensive manufacturing environments—such as food processing, textiles, packaging, and assembly—this translates into slower line speeds, higher defect rates, and greater rework and wastage. Studies in Vietnam show a direct impact on manufacturers Cost of Goods Sold (COGS) of +2.5% (Judd, Wakamo, Hertveldt, Rahman, & Better Work, 2025) attributable to higher chronic temperatures. Heat exposure also increases absenteeism, as workers are more likely to miss shifts due to heat-related illness or exhaustion, reducing effective labour hours and disrupting production schedules. International occupational health standards underscore the severity of this risk. Guidance from countries with mature industrial safety regimes identifies 26–27°C as the upper limit for comfortable indoor work, with urgent mitigation required above 30°C and sustained work increasingly considered unsafe beyond 35°C.

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[1] P.88 shows that high temperatures can cause incomplete inactivation of pathogens, leading to microbial contamination and foodborne illnesses such as listeria and salmonella. Over-processing or excessive heat can degrade nutrients and produce toxic compounds like acrylamide.

Climate projections indicate that these thresholds are being exceeded with growing frequency in Tanzanian factories, particularly during extended hot seasons.

Unlike climate shocks such as floods or storms, heat operates as a **chronic stressor** eroding productivity, quality, and asset performance incrementally, but persistently. As a result, its financial impacts often accumulate unnoticed until margins, competitiveness, and repayment capacity are materially affected[2].

These direct impacts are compounded by **energy system vulnerability**. Tanzania's electricity supply remains sensitive to climate variability, particularly through hydropower dependence that is exposed to drought and rising evaporation rates at major generation sites. As temperatures rise, demand for cooling increases precisely when electricity supply is most constrained. For manufacturers, this results in a double exposure: higher cooling loads and operating costs alongside more frequent outages and reliance on expensive diesel back-up generation. The interaction between heat stress and energy insecurity further undermines production continuity and cost predictability.

Cooling demand in manufacturing is therefore not discretionary; it is an unavoidable adaptation response. As ambient temperatures and humidity rise, manufacturers respond—formally or informally—by introducing cooling to protect workers, stabilise production processes, and maintain product quality. In practice, this may involve installing air conditioning in critical spaces, expanding refrigeration and cold storage, increasing ventilation, or relying more heavily on back-up generation to power cooling during outages. Across sectors such as food processing, textiles, pharmaceuticals, and chemicals, cooling increasingly becomes a prerequisite for continued operation rather than an optional upgrade.

However, the way cooling demand is met determines whether adaptation strengthens or undermines long-term resilience. Global evidence shows that unmanaged expansion of cooling—characterised by inefficient equipment, poor system design, high-Global Warming Potential (GWP) refrigerants, and diesel-based power supply—can significantly increase energy consumption and greenhouse gas emissions, placing additional stress on already constrained electricity systems and reinforcing the underlying drivers of climate change. This creates a **maladaptation risk**: a short-term response to heat that raises operating costs, worsens grid instability, and contributes to future warming. In manufacturing contexts, this risk is amplified because cooling loads often coincide with peak electricity demand periods, and because reliance on diesel back-up generation can multiply the effective cost and emissions intensity of each unit of cooling delivered.

Efficient, climate-friendly cooling resolves this adaptation paradox. As articulated by IFC's Sustainable Cooling Team, the UNEP Cool Coalition and others, sustainable cooling is not about suppressing demand for cooling where it is economically and socially necessary; it is about meeting that demand with the lowest possible energy use and emissions footprint. In manufacturing, this means prioritising:

- High-efficiency active cooling technologies
- System-level design that avoids oversizing and unnecessary run-hours,
- Complementary passive and airflow-based measures that reduce cooling loads before mechanical systems are engaged, and
- Alignment with Minimum Energy Performance Standards (MEPS) and refrigerant phase-down.

Critically, energy efficiency in cooling is not a marginal environmental benefit; it is a **core adaptation enabler**. By reducing electricity demand per unit of cooling delivered, efficient systems lower operating costs, reduce exposure to power outages, and limit dependence on expensive and emissions-intensive back-up generation.

From the perspective of commercial banks, an expansion in the market for efficient cooling processes and systems can help manage credit risk. By reducing the risks to productivity, higher energy costs,

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[2] This phenomenon is well documented in the dairy sector. Here, cows experience heat stress above 25°C, leading to reduced milk yield, lower butterfat and protein content, and higher somatic cell counts — all of which compress both volume and price realisation. Enterprises might see yields drop 10–15% over a hot summer and attribute it to seasonal variation, not recognising a multi-year trend. Over a decade, as average temperatures creep upward, the cumulative effect on margin can be severe. This is well documented by the USDA. The west African coca sector, and the experience of Barry Callebaut the world's largest producer also clearly documents the incremental and consistent impact of climatic changes on output and margins.

spoilage, and quality losses from heat stress that would otherwise weaken operating margins and destabilise cash flows. Inventory and fixed assets—often used as collateral—are more likely to deteriorate in value due to heat-related damage, accelerated equipment wear, or product loss. These effects are systemic, affecting clusters of borrowers within the same industrial zones and supply chains, and therefore posing concentration risk at the portfolio level.

Investments that stabilise thermal conditions within factories protect labour productivity, safeguard product quality, and reduce exposure to volatile energy costs. For lenders with significant exposure to manufacturing—a sector that represents a substantial share of commercial bank loan books in Tanzania—cooling solutions are both a borrower-level resilience measure and a commercially rational strategy to preserve asset quality and repayment capacity over time.

Banks can also see the efficient cooling market as a major growth opportunity. Demand for cooling is on the rise, it's a reality in Tanzania and globally. Research by the Rocky Mountain Institute (RMI) shows that global energy use for space cooling will grow 2.5-3x by 2050. Analysis by the International Finance Corporation (IFC) shows that the market for sustainable cooling in developing economies is set to double in size by 2050 from around $300 billion in annual demand currently.

By 2050 Africa's cooling market could have a value in excess of $105 billion (IFC & UNEP, 2024)**, up 600% on today's market size.** Most of this growth will come from active cooling solutions while passive measures are expected to account for about 10 percent of the market (IFC & UNEP, 2024).

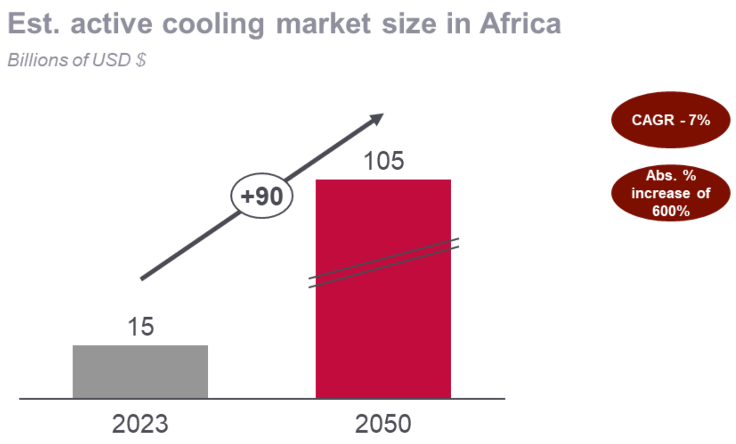


Figure 2: Estimated Size of the Active Cooling Market in Africa (Source: adapted based on data from IFC's 2024 Cooler Finance analysis)

Neutralizing emissions from increased active cooling is key. Globally, adoption of these solutions at scale could be one of the single biggest demand side actions we can take to mitigate climate change.

2. Market Context, Solution Readiness and Track Record

Defining options for climate efficient cooling in manufacturing | Passive vs. Active measures

Manufactures can deliver cooling through both passive and active cooling approaches[3] which are often deployed in tandem[4].

Passive cooling uses physical strategies, such as shading, insulation, and natural ventilation, to reduce indoor temperatures. This is a valuable measure and alongside workforce scheduling is an important part of the toolkit for reducing heat exposure. Passive measures can decrease temperatures by 2°C or more, although they are typically insufficient to protect against heat-related risks at higher temperatures (McKinsey Global Institute, 2025). And are expected to account for only ~10% of the global cooling market.

Active cooling technologies, use external energy (usually electricity) to remove heat from a space. These include air conditioners, chillers, and heat-pump–based systems that rely on refrigerants and powered equipment to maintain temperatures. Active cooling provides reliable and precise temperature control and is essential where strict thermal conditions are required, such as in industrial processes, laboratories, or controlled production environments. Given the high-heat intensity of manufacturing and the substantial market size, active technologies are the focus of this Investment Brief.

Sub-segments of the active cooling market for Tanzania's manufacturing sector

The active cooling market has three main segments, space cooling, refrigeration and mobile cooling. Demand for space cooling is the most substantial segment of the non-residential cooling market, as the chart below shows – based on market analysis delivered by the IFC across emerging markets. In Tanzanian manufacturing, particularly in the agri-processing sectors the refrigeration and mobile cooling of perishable food products are commercially important segments, but have been analysed through a parallel market brief focussed on cold chain storage in agri-food sectors and so are excluded here.

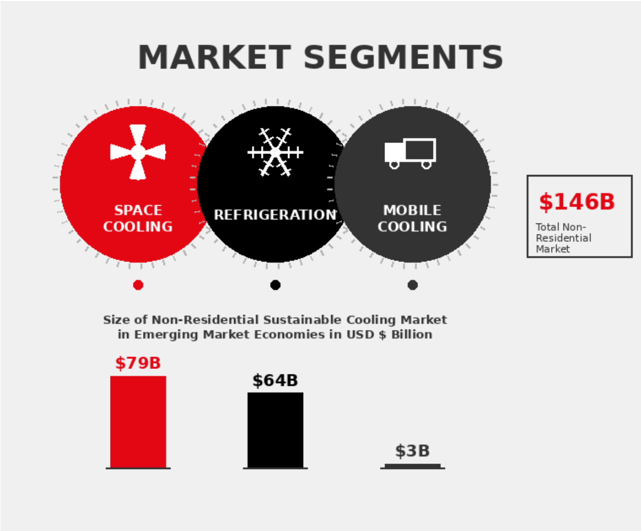


Figure 3: Estimated Size of Cooling Market Segments in Emerging Economies (source: Adapted from IFC 2004, using data from the Global Cooling Emissions Model).

[3] Companies should consider the "avoid–shift–improve" framework in considering cooling options, 1st by first designing buildings to minimize heat (avoid), using natural or efficient, sustainable, low-carbon, or renewable, energy sources for needed cooling (shift), and upgrading to highly efficient air conditioning systems (improve).

[4] The IEA emphasizes that the most effective cooling strategies combine both approaches: passive cooling to reduce overall cooling demand, and high-efficiency active systems to meet remaining comfort or process requirements. This integrated approach is central to meeting rising cooling needs while managing energy costs and system resilience.

The Active Cooling Technology Landscape

In Tanzania, climate-friendly active cooling in manufacturing is already defined by two well-understood equipment classes.

1) Energy and Coolant-Based Systems: These are the conventional cooling installations that use refrigerants and compressors to remove heat. They include solutions such as high-efficiency air conditioners and packaged HVAC units, industrial process chillers, cold storage refrigeration units, and heat-pump systems. These technologies provide reliable temperature control and can be retrofitted into existing factories (with appropriate design considerations). Improvements in this category – like inverter-driven compressors, better heat exchangers, or climate-friendly refrigerants – can dramatically reduce energy consumption (often 30–50% savings over older models; (Lwanga, 2026)). Because most existing Tanzanian factories were not built with cooling in mind, Category 1 solutions often represent the most practical way to add significant cooling capacity in *existing structures*.

Table 1: Energy & Coolant-Based Cooling Systems

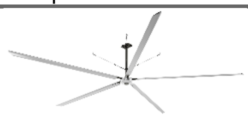
Technology	Description	Example	Key Characteristics
High-Efficiency Air Conditioning *Inverter / Variable-Speed Systems*	Split or multi-split air conditioners with inverter-driven compressors that continuously modulate speed to match the actual cooling demand of the space. Unlike fixed-speed units, inverter systems ramp up or down smoothly — avoiding high-energy start-up surges and maintaining a stable indoor temperature. An indoor wall-mounted evaporator extracts heat from the room and transfers it via refrigerant pipework to an outdoor condenser unit, where it is expelled outside. Multi-split configurations allow one outdoor unit to serve several indoor units across different zones. In a Tanzanian factory context, these systems are well-suited to office areas, quality-control rooms, and packing halls. Installation typically requires only a small wall penetration for refrigerant pipes, making retrofit into existing buildings straightforward.		▪ Inverter / variable-speed compressor ▪ Modulating capacity—no on/off cycling ▪ 30–50% energy saving vs fixed-speed[1] ▪ Stable, precise temperature control ▪ Minimal retrofit works required ▪ Compatible with low-GWP refrigerants
Packaged Rooftop Units *RTUs*	A packaged rooftop unit (RTU) houses all HVAC components — compressor, condenser coil, evaporator coil, supply and return fans, filters, and controls — within a single weatherproof enclosure mounted on the roof. Conditioned air is delivered through ductwork that passes through the roof structure and is distributed across the factory floor below. Because the entire mechanical system sits outside the conditioned space, RTUs free up valuable interior floor area and simplify the refrigerant circuit. They are particularly suited to Tanzanian industrial buildings with flat or low-pitch metal roofs that can support a rooftop installation. Modern RTUs are available with inverter-driven fans and compressors, economiser modes (using cooler outdoor air when available), and modular designs that allow capacity to be extended. For large single-floor factories, multiple RTUs can serve separate zones, providing redundancy and flexibility.		▪ All-in-one rooftop enclosure ▪ Ducted air distribution inside building ▪ Frees up interior floor space ▪ Requires flat / load-bearing roof ▪ Ductwork design needed ▪ Multi-zone via multiple RTUs
Chillers *Air-Cooled & Water-Cooled*	A chiller is a large-scale refrigeration machine that cools water (or a water-glycol solution). This water is pumped around the facility to air handling units (AHUs), fan coil units, or direct process cooling equipment, where it absorbs heat before returning to the chiller to be re-cooled. Air-cooled chillers reject heat via condenser fans mounted on the unit — suitable where water supply is limited. For large Tanzanian manufacturing sites, water-cooled chillers are often most energy-efficient once cooling loads exceed approximately 200–300 kW. Chillers can be the backbone of large-scale industrial cooling, simultaneously serving multiple production lines, cold rooms, and office areas.		▪ Centralised chilled water loop ▪ Air-cooled or water-cooled options ▪ High efficiency at large scale ▪ Simultaneous process & comfort cooling ▪ Precise temperature control ▪ Requires dedicated plant room ▪ Higher capital cost

2) Conductive and Airflow-Based Systems: This category comprises cooling and heat-management solutions that **move, dissipate, or reject heat** rather than actively refrigerating air or process streams. Technologies in this group include high-volume low-speed (HVLS) fans, industrial ventilation and exhaust

systems, evaporative cooling units, heat baffles and ducting, and cooling towers used for process heat rejection. Unlike energy and coolant-based systems, Category 2 solutions **do not aim to maintain tightly controlled indoor temperatures**. Instead, they reduce perceived heat stress, improve thermal comfort, and remove excess heat from production environments by enhancing air movement, promoting heat exchange, or extracting hot air from enclosed spaces. As a result, these systems are typically **less energy-intensive and cheaper to operate**, but they are also **limited in their ability to protect against extreme ambient heat or humidity**.

In the Tanzanian manufacturing context, conductive and airflow-based systems are widely used as **first-line or complementary adaptation measures**—particularly in large, open production halls, warehouses, and process areas where full air-conditioning would be prohibitively expensive or technically impractical. They are most effective where buildings are designed (or retrofitted) to support airflow, heat exhaust, and shading. In existing factories, these solutions can deliver meaningful improvements in worker comfort and productivity, but **are rarely sufficient on their own** in high-heat, high-humidity conditions or in temperature-sensitive processes.

Figure 2 | Conductive and Airflow-Based Systems

Technology	Description	Example	Key Characteristics
High-Volume, Low-Speed (HVLS) Fans	Large-diameter ceiling-mounted fans that move high volumes of air at low speed, increasing convective and evaporative heat loss from workers rather than lowering air temperature. Widely used in large production halls and warehouses.		▪ High airflow, very low energy use Improves thermal comfort (≈2–4 °C perceived) Low operating & maintenance cost No humidity or temperature control
Industrial Ventilation & Exhaust Systems	Supply and exhaust fans with ducting and louvers that remove accumulated hot air, fumes, and process heat, replacing it with outside air where available. Performance depends on ambient conditions.		▪ Removes heat and contaminants Improves air quality & safety Fan-driven energy demand Limited effectiveness in hot/humid weather
Evaporative Cooling Systems	Systems that cool incoming air via water evaporation before it enters the workspace. Effective in hot, dry climates but performance drops sharply with high humidity.		▪ Low electrical energy demand Water-based cooling Effective in dry regions only Requires water supply & upkeep
Heat Baffles, Ducting & Airflow Management	Physical structures that shield workers or equipment from radiant and convective heat or redirect hot air away from occupied zones. Typically applied near ovens, kilns, or hot process lines.		▪ Low to medium CAPEX Highly targeted heat reduction Minimal energy use No ambient temperature control
Cooling Towers (Process Heat Rejection)	Towers that reject heat from industrial process cooling loops by transferring heat from water to ambient air, often via evaporation. Used in chemicals, plastics, beverages, and cement.		▪ High heat-rejection capacity Water-intensive Integral to process/chiller systems

Technology Readiness and Level of Adoption

Fortunately, the key cooling technologies needed for climate adaptation in manufacturing are **understood and already available in Tanzania**. The tables above summarize the major classes of cooling equipment that Tanzanian manufacturers can deploy, along with their key characteristics.

Notably, **many of these technologies have a proven track record internationally and some in Tanzania's market**. Stakeholder interviews confirmed that these systems are already being utilised in the Tanzanian manufacturing sectors. This existing experience **reduces adoption risk** – banks and firms are not being asked to back untested tech, but to upgrade or scale up known solutions with clear performance data.

Current Adoption and Gaps: Many of the above technologies are already used to some extent in East Africa – for instance, breweries and dairy processors often have industrial refrigeration, and larger textile mills may use evaporative cooling and ventilation. However, **adoption in Tanzania is far from saturation.**

Field research indicates that outside a handful of leading firms (often subsidiaries of multinationals or larger regional companies), most manufacturers have not yet invested in dedicated cooling upgrades.

Common practice is still reactive (e.g. using floor fans, or adding old air conditioners in only the office areas). This means the market is largely untapped – most factories potentially need some form of climate-smart cooling improvement, whether it's insulating a warehouse or financing a new chiller. The track record for successful projects in-country is limited but growing. One positive sign is that financing for such equipment isn't entirely novel: businesses already routinely finance machinery, and cooling systems can be treated similarly. Moreover, Tanzania's policymakers have recognized industrial modernization as a priority, which could support wider uptake of efficient technologies. In short, the technical solutions exist and have been proven effective; the next step is to deploy them at scale in Tanzania's manufacturing sector.

3. Market Opportunity

From Climate Risk to Financeable Demand

The need to adapt factories to higher temperatures creates a significant market opportunity for investment. In Tanzania, a broad range of manufacturing sites including agro-processing facilities – from large food-processing plants to midsized textile workshops – would benefit from climate-friendly cooling installations. Each installation (be it a set of roof insulation and fans for a small factory, or a modern chiller system for a large plant) represents a capital investment that could be financed. Collectively, these needs add up to a substantial pipeline of potential projects for lenders and solution providers. In other words, climate adaptation in manufacturing is not only an environmental or safety concern; it is also an emerging line of business.

Scope of the Market Sizing and Estimates

The market opportunity assessed in this Investment Brief focuses on **manufacturing sub-sectors where heat exposure has immediate financial consequences and where firms have a demonstrated ability to pay for cooling investments**. These include food and beverage processing, textiles and apparel, pharmaceuticals, plastics and chemicals, and selected heavy industries.

The analysis concentrates on **small, medium, and large formal manufacturing firms**[5], as these are most likely to: experience material productivity or quality losses from heat, require active cooling solutions, and access external financing for capital upgrades.

On the technology side, the scope includes active cooling and heat-management investments relevant to climate adaptation in factories, ranging from modular upgrades in small facilities to large-scale centralised systems in industrial plants.

Based on these factors we estimate the Total Addressable Market potential for climate-efficient cooling across Tanzania's formal manufacturing sector at up to US$30 million, representing a material and near-term bankable opportunity for commercial lenders. This Total Addressable Market spans heat-exposed sub-sectors — from food and beverage processors and pharmaceutical plants to horticulture exporters and cashew processors — and reflects the aggregate capital requirement of formally registered, bankable enterprises that face demonstrable heat stress and have both the economic incentive and the organisational capacity to act.

This estimate is derived using a structured bottom-up methodology: identifying heat-exposed sub-sectors, estimating the population of formal firms of meaningful scale within each, assigning investment package costs by facility size, applying an Efficiency Penetration Rate to isolate genuinely climate-efficient installations, and adjusting for the share of investment likely to be externally financed. Each step is conservative by design, and the underlying assumptions are set out in the Appendix.

The Serviceable Available Market — what the existing lending ecosystem could realistically reach in the near term — **is estimated at US$14.5 million** under the primary scenario, which assumes a 35% adoption

[5] Micro-enterprises, defined by IFC as those with <10 employees will also have cooling needs. However their ability to access formal bank financing is limited, and they are not included in the market sizing analysis. This is because structurally, micro-enterprises face greater barriers to formal finance than their small and medium counterparts for several reasons. First, they typically lack the financial track record, collateral, and credit history that commercial banks require to underwrite loans. Second, micro-enterprises are disproportionately informal: informality rates are highest among the smallest firms, and informal firms cannot produce the documentation — audited accounts, business plans, regulatory permits — that formal lenders demand. As a result, micro-enterprises tend to rely on retained earnings, rotating savings groups, and microfinance institutions (MFIs) rather than commercial banks. Consistent with this framing, other analyses of firm-level financing — including IFC-aligned work on agri-SMEs — explicitly exclude micro-enterprises on the same basis, noting that while they play a critical role in local economies, very few are able to access formal finance (ISF Advisors, 2022). For these reasons, the present analysis focuses on small, medium, and large formal manufacturing firms as the relevant universe of potential borrowers for cooling-related capital upgrades.

rate amongst firms and reflects the portion of lending likely to be sort from banks, with the total capital required estimated at $20.7 million. This reflects current constraints on climate awareness, product availability, and credit access, rather than any weakness in underlying demand.

Three adoption scenarios bracket the opportunity:

- Conservative (15% adoption): A Serviceable Available Market for bank lending of approximately US$6.2 million, from a total efficient cooling investment of around US$8.9 million.
- Moderate (35% adoption): Total project investment of around US$20.7 million, translating to a Serviceable Available Market of approximately US$14.5 million. This is the primary benchmark used in this analysis.
- High (50% adoption): Total project expenditure of approximately US$30 million and a Serviceable Available Market of approximately US$20.7 million.

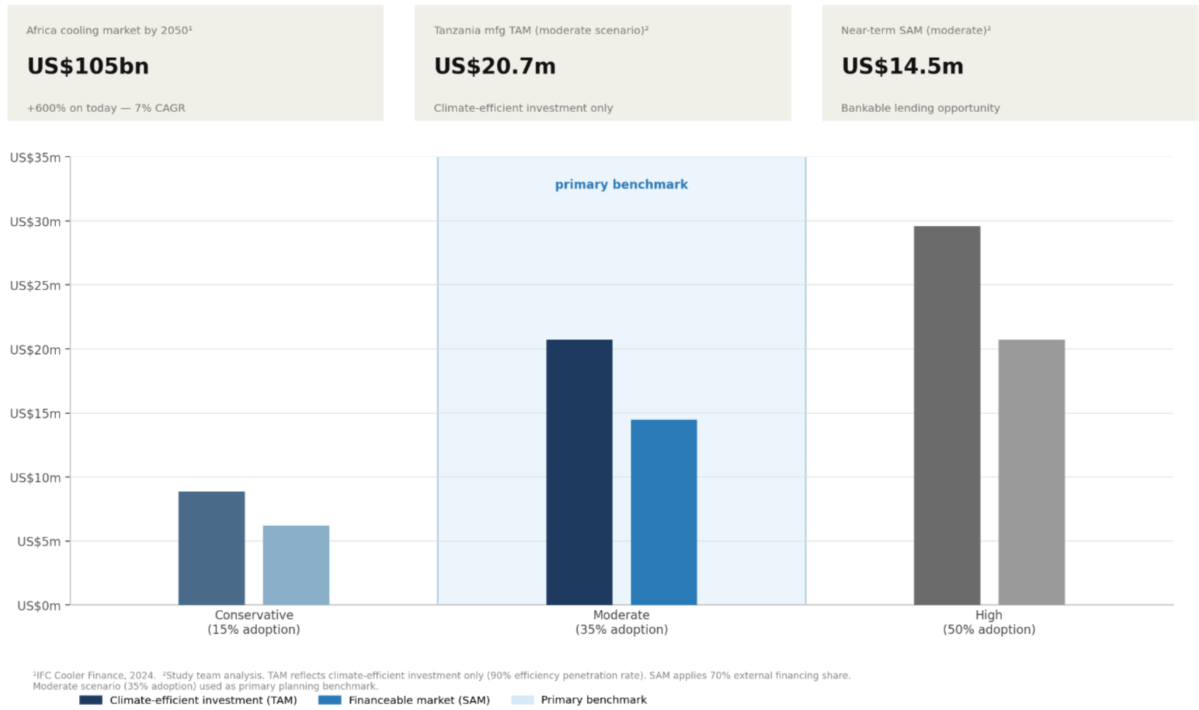


Figure 4: TAM and SAM Market Sizes

The roughly two-to-one gap between the high TAM and the moderate SAM reflects not a failure of underlying demand but the current immaturity of the cooling finance market — and the importance of complementary interventions in awareness, concessional capital, and product design in unlocking the full opportunity over time. As climate impacts intensify — Tanzania's GDP exposure to heatwaves is projected to rise from approximately 2 percent today to 16 percent by 2080 (GIZ, 2021) — and as technology costs continue to fall, adoption rates above 50 percent become increasingly plausible, expanding the addressable market well beyond the figures modelled here.

The Commercial Logic for Banks to Act

The sectoral concentration of this opportunity reinforces its commercial logic for lenders. Food and beverage processing represents the single largest source of cooling-related credit demand, given both the scale of operations and the direct financial consequence of heat stress on product quality and spoilage. Pharmaceuticals present some of the highest per-facility investment requirements given the precision climate control their processes demand. The six adjacent sectors — fish processing, horticulture, cashew, tobacco, meat and leather, and wood and packaging — are growing rapidly, driven by export market demand for temperature-managed supply chains. For banks with existing exposure to these sectors, efficient cooling finance is not a new market to enter cold: it is an extension of credit relationships they already hold, directed towards investments that protect the assets and cash flows that underpin those loans.

Manufacturing as a Beachhead, Not a Ceiling for Banks Lending

It is important to situate this analysis correctly. The US$14.5 million moderate SAM described above reflects only one slice of Tanzania's cooling finance opportunity — the manufacturing sector — and is intentionally bounded to what is conservatively and credibly evidenced.

It does not capture the residential cooling market, the commercial and retail sector, cold chain logistics and distribution, healthcare facilities, or the rapidly expanding hospitality and tourism sector. Each of these represents an independent and material source of future cooling-related lending demand, and each is subject to the same underlying climate driver: Tanzania is getting hotter, and the economic cost of doing nothing is rising across every sector of the economy.

The broader market context highlighted in the opening chapter also makes this point directly. Global energy demand for space cooling is projected to grow two-and-a-half to three times by 2050, driven almost entirely by emerging economies in tropical and sub-tropical regions (Rocky Mountain Institute). The IFC estimates that the market for sustainable cooling in developing economies currently stands at around US$300 billion in annual demand and is set to double in size by 2050. Africa's share of that growth is disproportionately large: the continent's active cooling market could reach in excess of US$105 billion by 2050 — an increase of more than 600 percent on today's market size — driven by a projected compound annual growth rate of 7 percent through to mid-century. Tanzania, as one of East Africa's largest and fastest-growing economies, sits squarely within that growth trajectory.

For commercial banks, the implication is strategic as well as transactional. A bank that develops the origination capability, product design, and borrower relationships to serve the manufacturing cooling market today is positioning itself to capture a far larger opportunity as demand scales across residential, commercial, and infrastructure segments.

The manufacturing sector offers a natural entry point precisely because the borrowers are already known, the investment rationale is straightforward to appraise, and the ticket sizes sit comfortably within existing commercial lending parameters.

Early movers in cooling finance in comparable markets have consistently found that the discipline of underwriting efficiency investments in manufacturing creates transferable credit assessment capabilities that accelerate entry into adjacent segments. The question for Tanzanian banks is not whether the cooling market will grow — the trajectory is unambiguous — but whether they will be positioned to lead it when it does.

4. Value Chain, Borrower Business Case and the Route to Market for Financial Institutions

The Value Chain for Delivering Cooling in Tanzania

Delivering cooling in manufacturing depends on a value chain of actors, in which performance and risk are distributed across several stages. Weakness at any point — poor design, low-quality equipment, inadequate installation, or neglected maintenance — can undermine the economic case for the end-user/borrower and, by extension, the lender. At its simplest the cooling value chain in Tanzania has four components: Technology Supply, System Design & Installation, Financing and Operation & Maintenance. Understanding how these elements interact is essential for financial institutions seeking to understand risk, opportunity and scale lending in this market.

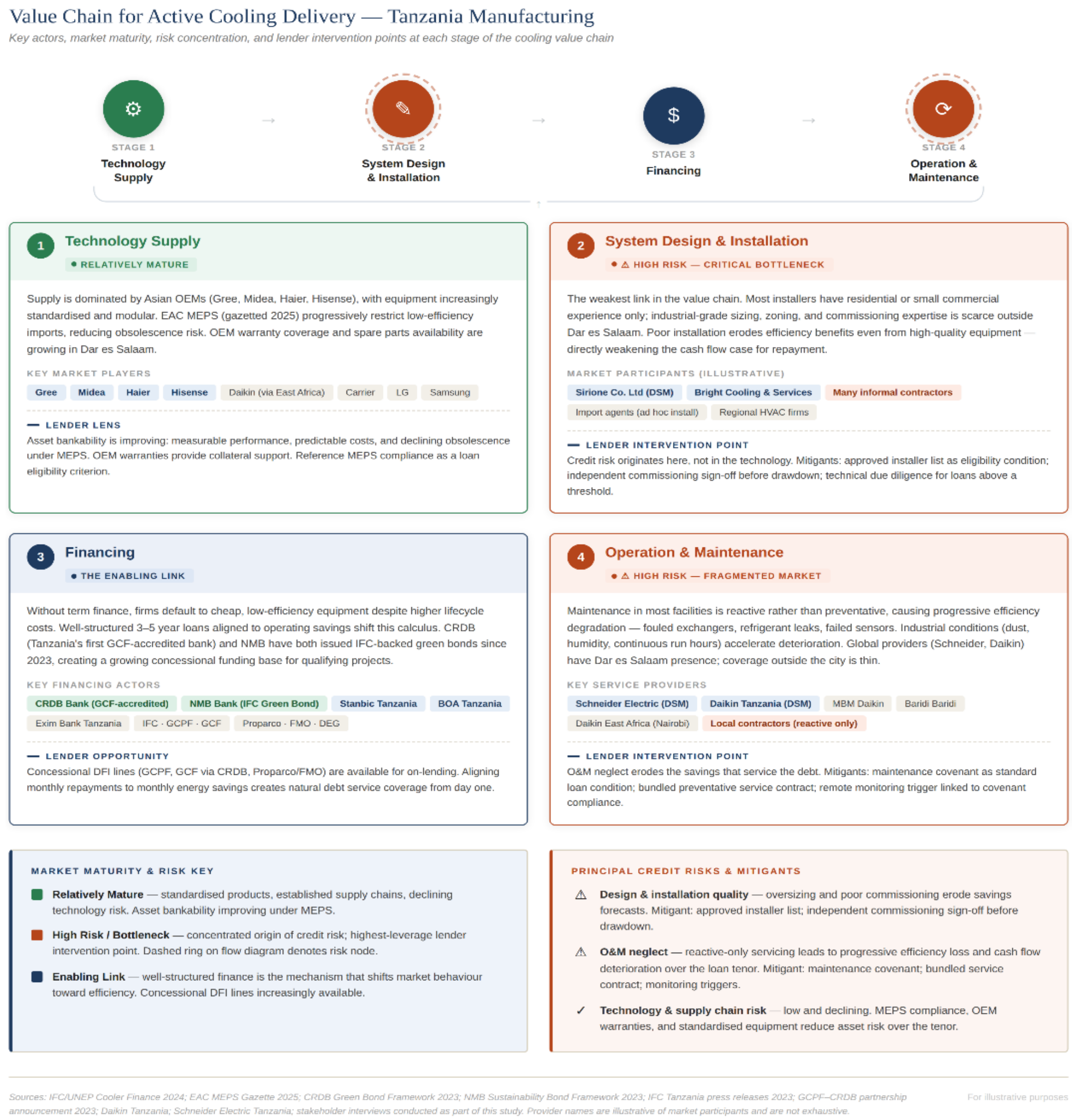


Figure 5: Value Chain for Active Cooling Delivery

Technology Supply: Imported, but Increasingly Standardised

Most active cooling equipment used in Tanzanian manufacturing — including air conditioners, packaged HVAC units, chillers, refrigeration systems, fans, and control systems — is imported, with supply dominated by large Asian manufacturers and OEMs such as Gree, Midea, Haier, and Hisense (IFC & UNEP, 2024), (Xinhuanet, 2025)[6]. These suppliers dominate East Africa's cooling imports due to their scale, cost competitiveness, and growing alignment with international efficiency and refrigerant standards. For lenders, this implies that cooling assets are increasingly standardised, replaceable, and supported by mature global supply chains rather than bespoke or experimental technologies.

While imports are sometimes assumed to imply lower quality or obsolescence risk, recent regulatory developments significantly alter this risk profile. Through the East African Community, regionally harmonised Minimum Energy Performance Standards (MEPS) for air conditioners and refrigeration appliances were gazetted in 2025, with national implementation now underway in Tanzania. These standards define minimum efficiency thresholds and refrigerant requirements, progressively restricting the import of low-efficiency, high-GWP equipment into the market. In parallel, the Kigali Amendment has driven global manufacturers to redesign product lines around climate-friendly refrigerants[7], meaning that equipment supplied to Tanzania increasingly conforms to known international efficiency and environmental performance baselines. As a result, newly financed cooling equipment increasingly conforms to a known and improving performance baseline, reducing technology risk over the life of a typical loan. For lenders, this means cooling increasingly resembles other financeable productive assets with:

- Performance characteristics standardised and measurable
- Unit costs falling within predictable ranges
- Equipment is increasingly mass-produced, modular, and replaceable
- Global OEM presence (while limited) is growing and expansion of the local market increasingly ensures spare parts availability, particularly in Dar es Salaam and other cities.
- Regulatory risk of near-term obsolescence is declining.

This shift materially improves the bankability of cooling assets relative to earlier market conditions.

System Design and Installation: A Critical Bottleneck

While equipment supply is relatively mature, system design and installation remain a weak link in the cooling value chain. Evidence from IFC and UNEP's work on sustainable cooling in developing economies shows that realised energy savings depend as much on system sizing, controls, zoning, and commissioning as on headline equipment efficiency. This was corroborated by Tanzania specific stakeholder engagements conducted as part of this study.

In manufacturing environments — where heat loads vary by process, space, and time — poor design can erode a substantial share of expected benefits even when high-efficiency equipment is installed. In Tanzania, many manufacturers rely on installers whose experience is concentrated in residential or small commercial systems. Industrial facilities may therefore frequently be cooled using oversized, poorly zoned, or poorly controlled systems, leading to higher electricity consumption and weaker realised savings than design assumptions would suggest. From a financial perspective this creates a risk.

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[6] Independent reporting documents the growing presence of major Chinese appliance and HVAC manufacturers — including Midea, Haier, and Hisense — across African markets, with Africa identified as a strategic growth region for cooling equipment exports. In addition UNEP United for Efficiency (U4E) & East African Centre of Excellence for Renewable Energy and Energy Efficiency (EACREEE) (2022–2025). *Tanzania Country Savings Assessment* and *East African Community harmonised MEPS for air conditioners and refrigeration appliances*. Regional market assessments and regulatory documentation confirm that cooling equipment markets in East Africa, including Tanzania, are predominantly supplied by imported equipment, with Chinese manufacturers prominent among suppliers meeting regional efficiency standards. Supporting evidence of Gree's presence is reflected in East African HVAC distributor catalogues listing Gree systems as standard offerings.

[7] The Kigali Amendment is a legally binding global agreement adopted in 2016 as an amendment to the Montreal Protocol. It requires manufacturers to move away from high-GWP HFC refrigerants. Because cooling equipment is traded globally, manufacturers have redesigned entire product lines to comply with Kigali requirements across all export markets—not just in Europe or North America

Financing: The Enabling Link in the Value Chain

Financing plays a determinative role in shaping both the quality and performance of cooling investments. Across developing economies work by the likes of Rocky Mountain Institute, IFC and UNEP's Cool Coalition find that firms systematically under-invest in energy efficiency when relying on internal cash or short-term credit, selecting lower-cost equipment despite higher lifecycle costs. This dynamic is particularly pronounced for cooling, where upfront price differences obscure large differences in operating expenditure over the asset life. In Tanzania, this tendency is reinforced by high upfront capital costs relative to firm cash flows and limited awareness of lifecycle cost trade-offs.

The result is widespread adoption of cooling solutions that minimise upfront expenditure but lock firms into higher energy costs, greater exposure to grid unreliability, and increased vulnerability to heat stress.

Well-structured finance could help change this dynamic. By spreading capital costs over time and aligning repayment schedules with operating savings, financing enables firms to:

- Select higher-efficiency equipment, now increasingly standardised through MEPS,
- Invest in proper system design and controls, and
- capture multiple benefit streams — energy savings, productivity gains, and reduced spoilage — simultaneously.

Operations and Maintenance: an important determinant of stronger realised performance

While the increasing standardisation of imported cooling equipment reduces technology risk, realised performance over the life of loans depends critically on operations and maintenance (O&M). Global evidence shows that a substantial share of the efficiency gap in cooling systems arises not from equipment choice, but from poor maintenance practices, including inadequate refrigerant management, fouled heat exchangers, failed sensors, and lack of periodic system re-commissioning[8]. In industrial and manufacturing environments, these issues are exacerbated by high dust loads, humidity, and continuous operating hours, leading to progressive efficiency degradation if O&M is weak.

In East African markets, including Tanzania, cooling systems in manufacturing facilities are frequently maintained on a reactive rather than preventative basis, with servicing triggered by system failure rather than performance decline.[2] This results in higher electricity consumption, reduced cooling capacity during peak heat periods, and increased equipment failure risk — all of which directly affect operating costs and cash-flow stability.

The Tanzanian cooling O&M market appears to be fragmented. While data is not strong there is evidence that some of the larger global O&M providers such as Schneider Electric and Daikin have operations in country. However services may frequently be delivered via local and regional affiliates and partners, some of whom offer preventative maintenance as well as on-demand repair services[9].

From a lender's perspective, O&M therefore represents a material risk. Where maintenance is neglected, projected energy savings and productivity benefits may not fully materialise, weakening debt-service capacity over time even when the initial system design and equipment selection are sound. Conversely, simple interventions — such as maintenance covenants, bundled service contracts, or alignment with installer-led O&M services — can materially improve performance persistence over the loan tenor.

Borrower Business Case and Unit Economics

Inefficient cooling operates as an invisible tax on Tanzanian manufacturing businesses. Firms pay for it every day through three channels: electricity bills that are higher than they need to be, workers who produce less than they could because of high temperatures, and products that spoil before they reach a

[8] Engineering literature and industrial case evidence show that fouling of heat-exchange surfaces alone can reduce thermal efficiency by 10–30%, forcing longer run-hours and higher electricity consumption to deliver the same cooling output.

[9] Companies offering this may include Superheat Solutions and Frostline.

customer. The costs might be hidden in the energy line, output per head, and product shrinkage. But they are real, they are measurable, and they are growing as temperatures rise.

Efficient cooling eliminates or reduces that tax. A firm that upgrades to efficient cooling equipment captures benefits across all three channels simultaneously. That stacking is what makes the economics attractive: the payback does not depend on any single benefit alone. For a financial institution, this means the borrower has multiple sources of cash flow improvement to service the loan.

Three tiers of benefit. Not all benefits are equal from a lending perspective. The tiers of benefits for borrowers can be defined based on how directly they convert to the cash flows that a firm controls.

Table 2: The 3 tiers of benefits for borrowers

TIER 1 — CORE	TIER 2 — SECOND ORDER	TIER 3 — SOCIETAL
Hits companies P&L directly. Repays a loan.	Reduces risk and improves credit quality.	Delivers real social benefits but not ones directly reflect on the firm's balance sheet.
1. Energy cost reduction Lower electricity bill. Measurable from month one. **2. Labour productivity gains** More output per worker per hour. Fewer errors, less fatigue, lower absenteeism. **3. Reduced product & inventory loss** Less spoilage, lower shrinkage, fewer write-offs. Directly visible in margin.	• Lower maintenance costs from inverter-driven compressors, with fewer off-on cycles[10]. • Regulatory compliance (Kigali Amendment, Tanzanian MEPS) • Access to green / concessional finance through demonstrable adaptation and mitigation cases • Able to demonstrate ESG progress and respond to buyer supply chain requirements • Staff retention advantage, through enhanced working conditions	• GHG emission reductions via reduced energy consumption • Grid stability- contribution by reduced energy demand • Improved public health outcomes • Benefits for gender equity & access to employment • Food security & nutrition – via reduced food spoilage

How Efficient Cooling Converts Losses into Cash-Flow Gains

Efficient cooling delivers 'Core - Tier 1' borrower-level financial benefits that impact the Profit and Loss Statement through three primary channels:

1. Energy cost reduction | Modern inverter-driven cooling systems, improved controls, and better system design reduce electricity consumption per unit of cooling delivered. For firms operating on grid power, this translates directly into lower monthly energy bills. For firms reliant on diesel back-up generation during outages, the savings are often substantially larger, as avoided self-generation displaces electricity that is several times more expensive than grid supply.

2. Second, labour productivity stabilisation | By maintaining indoor temperatures within safe and comfortable thresholds, cooling protects effective working hours, reduces fatigue-related errors, and lowers heat-related absenteeism. In labour-intensive manufacturing subsectors, even small percentage improvements in output per worker can materially affect unit costs and margins.

3. Reduction in product and inventory losses | In heat- and humidity-sensitive processes — particularly food processing, pharmaceuticals, and packaging — effective cooling reduces spoilage, reject rates, and quality failures. These losses are often hidden within cost-of-goods-sold figures but have a direct impact on gross margins.

Crucially, these benefit streams accrue **simultaneously**. A cooling investment does not need to "work" on all channels to be viable; the combined effect creates multiple, reinforcing sources of cash-flow improvement. **The benefits of this efficient cooling 'stack' is illustrated below.** The stacking creates a

[10] Efficient cooling equipment — specifically inverter-driven compressors — runs at variable speed rather than cycling on and off repeatedly. An inverter unit ramps up and down smoothly, which means less mechanical stress, fewer breakdowns, and longer component life. For a commercial building running 10–20 split units, that translates to meaningful savings on technician call-outs and replacement parts, plus less disruption to operations. The evidence base for this translating to savings originates in manufacturer data and building management studies in other markets.

margin of safety for lenders. Even if energy savings alone don't fully cover loan repayment, the productivity and loss-reduction benefits provide additional cash flow. Tier 2 effects — lower maintenance, regulatory compliance, access to green finance — further reduce credit risk.

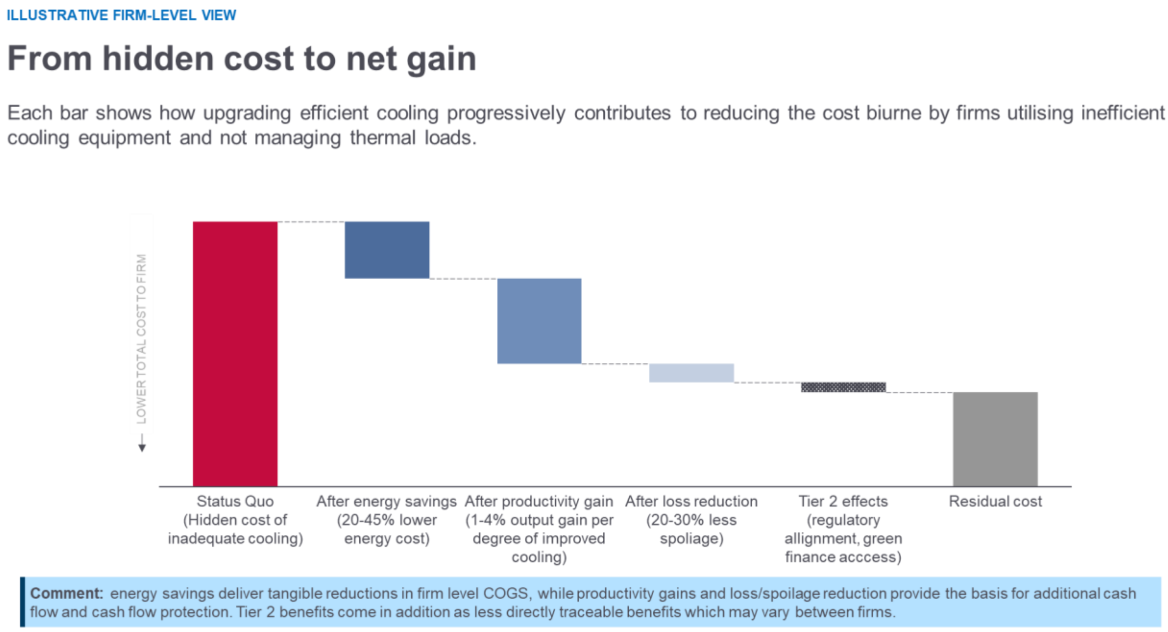

Figure 6: Illustrative Firm Level Cost Reduction Benefits from Efficient Cooling

What the evidence says about the magnitude of benefits

The table below summarises the global, regional and Tanzania specific evidence on Tier 1 benefits, in percentage terms. These are the headline parameters — drawn from peer-reviewed and institutional sources.

Benefit	Indicative range	What this means and where it comes from
Energy cost reduction	*30–50% of cooling energy costs*	Best-available AC units (EER 5.0–6.0) vs. baseline units common in Tanzania (EER 2.5–3.0). Inverter technology alone delivers 25–35% savings over fixed-speed units. Expert interviews from the assignment suggest 35-50% energy savings are typical. *Sources | IFC/UNEP Cooler Finance 2024; UNEP Global Cooling Watch 2023; CLASP* Energy use may account for 5-10% of COGS for a Tanzanian manufacturing firm on reliable grid power, comparable to other lower-income countries. For firms relying on diesel backup (Enterprise Survey data shows roughly 35–46% of SSA firms own generators), that figure could be 15–25% or higher, because the self-generation cost is 3–10x grid price. *Sources | Pegasys analysis*
Labour productivity	*1–4% output gain per °C of cooling improvement*	Cognitive performance declines ~2% per °C above 25°C for office work. Physical labour productivity drops 3–5% at wet-bulb globe temperatures above 28°C. ILO estimates 3–5% of working hours are lost to heat stress in West Africa — a reasonable proxy for coastal Tanzania. Absenteeism and error rates both increase in uncooled workplaces — the effects compound. *Sources | ILO Working on a Warmer Planet 2019; Lancet Countdown; Seppänen et al. meta-analysis*
Product & inventory loss	*20–40% reduction in spoilage with cold chain*	Tanzania loses 30–40% of horticultural and dairy output post-harvest, largely due to temperature. Cold chain access can reduce losses to under 10% for perishable commodities. Pharmaceutical spoilage: 25–50% of vaccines and heat-sensitive medicines degrade in transit across sub-Saharan Africa. Cold storage also unlocks price premiums — stored produce sells at 20–60% above distress-sale prices. *Sources | FAO; Tanzania NRDS-II; SEforALL Chilling Prospects; WHO cold chain data*

These ranges represent what the evidence supports at a sector level, while specific firm level impacts and the resulting payback periods will vary with key sensitivities including the degree to which firms depend on back-up generators for a substantial portion of their power and the efficiency of existing cooling systems.

Product fit and go-to-market routes for commercial banks to consider

The suitability of cooling investments for bank finance depends both on the performance and novelty of the technology, but also on how well financial products align with the risk profile, cash-flow dynamics, and asset characteristics described in the preceding sections. For most commercial banks, the opportunity lies not in developing new instruments, but in adapting existing products to a class of investments that is already familiar in many respects. This section outlines the types of financial products and market entry routes that maybe most consistent with cooling investments in manufacturing, focusing on approaches that are practical, scalable, and aligned with existing banking capabilities in East Africa and Tanzania specifically.

In practice, several existing banking products are already well suited to financing cooling investments in manufacturing, with only limited adaptation required.

Investment and equipment loans represent the most straightforward entry point. Cooling systems — including HVAC units, chillers, refrigeration equipment, and control systems — are tangible, productive assets with with service lives that substantially exceed medium-term loan tenors of 3–5 years, providing lenders with durable collateral security[11]. Where manufacturers already finance machinery or process equipment through term loans, cooling investments can be treated similarly, provided appropriate attention is paid to system design and installation quality.

For smaller manufacturers or modular upgrades, **leasing and asset-finance structures** may be particularly attractive. Leasing can reduce upfront cost barriers, align payments with realised savings, and simplify collateral arrangements, especially where equipment is standardised and replaceable. From a credit perspective, leasing also allows banks to retain greater control over the asset in the event of underperformance or default.

Vendor-linked or supplier-supported finance can further improve product fit. In this model, banks partner with equipment suppliers or installers to originate transactions, standardise technical specifications, and reduce due-diligence costs. For cooling investments, where performance is highly sensitive to design and installation, such partnerships can materially reduce execution risk while supporting deal flow. Given the constraints and lack of reliable standardises O&M in Tanzania, vendor finance that can bundle preventative maintenance and service contracts will likely be highly attractive to borrowers and lenders.

In most cases, cooling finance will sit within balance-sheet-based lending frameworks, rather than pure cash-flow lending. While operating savings support repayment, banks typically remain more comfortable anchoring credit decisions in the borrower's overall financial position, particularly in early stages of market development. Over time, as performance data accumulates, greater reliance on cash-flow-based underwriting may become feasible.

Taken together, these product types allow banks to enter the cooling market using familiar instruments, minimising the need for new credit policies or systems while still capturing the benefits of a growing adaptation investment segment.

A further financing model — currently nascent in Tanzania but relevant for its potential — is **Cooling as a Service (CaaS)**. Under this model, a technology provider finances, installs, owns, and operates cooling equipment, recovering its costs through a periodic fee charged to the end-user per unit of cooling delivered, rather than through the upfront sale of equipment.

[11] Commercial banks in emerging markets typically finance movable productive assets over medium-term tenors of approximately 3–5 years, with longer tenors generally requiring concessional funding, guarantees, or development finance participation. This is supported by Central Bank of Kenya (2025). *Survey Report on MSME Access to Bank Credit*. Equipment lifespans are typically significantly longer than this, in excess of 15 years. See ASHREE Equipment Life Expectancy Charts.

The model eliminates the capital barrier entirely for the borrower and, because the provider retains ownership and bears operating costs including electricity, creates a strong commercial incentive to install and maintain the most efficient equipment available. CaaS has been piloted with measurable success across several emerging market contexts — particularly in food processing, cold chain logistics, and commercial real estate — and has been advanced as a globally scalable instrument by the Basel Agency for Sustainable Energy (BASE) through its CaaS Initiative, which the Global Innovation Lab for Climate Finance recognised in 2019 as one of the most actionable financial instruments for climate-compatible cooling.

However, for most commercial banks in markets such as Tanzania, CaaS models should be viewed as a medium-term opportunity rather than an immediate go-to-market route.

At present, the CaaS ecosystem remains relatively immature. It requires:

- specialised service providers with sufficient balance-sheet strength,
- the ability to aggregate multiple sites to achieve scale,
- strong contractual enforcement of service payments, and
- access to patient capital to fund upfront equipment costs.

Where these conditions are not yet in place, CaaS models can introduce additional counterparty and execution risk, rather than reducing it. That said, CaaS models do create distinct opportunities for banks over time. Rather than lending to many individual manufacturers, banks can finance a smaller number of specialised cooling service providers, effectively intermediating technical and performance risk. In this role, banks finance the asset base of the service provider, while the provider manages installation, operation, and maintenance across multiple client sites.

In the near term, a pragmatic approach is to view CaaS as an evolutionary pathway. Banks can begin by supporting "Energy Service Contract (ESCO)-lite" arrangements — such as bundled equipment finance with mandatory maintenance contracts — which capture some benefits of CaaS without requiring full service-based business models. As market experience and performance data grow, more sophisticated service-based financing structures may become viable.

Cooling as a Service in Practice: Evidence from South African Industry

Afrupro is a South African fruit packing company operating in Limpopo Province, cooling avocados and litchis for export markets where temperature control is critical to product quality and marketability. Its existing industrial ammonia refrigeration plant had become unreliable — cold rooms were exceeding target temperatures, glycol tanks were leaking, and mounting energy and maintenance costs were being compounded by product losses.

Facing the need for urgent capital investment, Afrupro had initially sought to replace the plant with a conventional high-GWP synthetic refrigerant system. Instead, Energy Partners Refrigeration — a South African ESCO operating a CaaS model since 2016 — proposed a fully outsourced solution: Energy Partners would finance the upgrade (approximately USD 200,000), take ownership of the plant under a 10-year CaaS contract, and bear full operational responsibility including remote 24-hour monitoring.

Afrupro payed the monthly fixed and variable service fees, with no capital outlay. The upgraded ammonia system delivered a 20% reduction in energy consumption, avoided over 4,200 tonnes of CO_2e over the contract period, and eliminated product losses that had stemmed from temperature instability.

Relevance for Tanzania. The Afrupro case shows how a CaaS model can unlock investment in higher-efficiency systems in situations where upfront capital is a binding constraint — the same dynamic that drives Tanzanian manufacturers toward lower-cost, lower-efficiency equipment. Second, the provider's retention of asset ownership and operating risk creates a durable incentive for quality maintenance, directly addressing the O&M gap identified elsewhere in this analysis. Third, the model generates predictable, contracted cash flows that are financeable — Energy Partners structures its projects using 70% bank debt and 30% equity, demonstrating that where a credible service provider exists, conventional lenders can participate. The primary constraint for Tanzania appears to be the current absence of local or regional service providers with the capital base and technical capacity to operate at scale under this model. This is a gap that targeted development finance support and guarantee instruments could help to close if appropriate service providers can emerge or enter the market.

5. Alignment with ESG Finance Mandates and Development and Climate Co-Benefits

Investments in manufacturing cooling aligns strongly with prevailing **green finance and ESG criteria**, reinforcing the attractiveness of these investments to both financiers and regulators. Climate efficient cooling can typically align in the following ways.

- **Climate Adaptation & Resilience:** By definition, cooling projects build resilience to heat stress – a clear climate adaptation outcome. International climate finance taxonomies (like the EU Taxonomy or Climate Bonds Initiative criteria) explicitly recognize cooling and heat resilience measures as adaptation activities, since they reduce vulnerability of economic assets (factories, workers) to climate change. Banks can confidently categorize loans for cooling upgrades as **Adaptation Finance** as long as evidence of greater efficiency or reduced Global Warming Potential of refrigerants is provided. The adoption of Minimum Energy Performance Standards in Tanzania can provide confidence around enhanced efficiency and deployment of lower impact refrigerants.
- **Energy Efficiency & Mitigation Co-Benefits:** The focus on *efficient* cooling means many of these investments yield energy savings and emissions reductions (relative to either the absence of cooling, which leads to inefficient coping like diesel generators, or relative to older cooling tech). For instance, financing a variable-speed chiller that uses 30% less electricity than an outdated model contributes to mitigation by cutting power consumption (and hence fossil fuel use on the grid). If some cooling systems are coupled with solar power (e.g. solar-powered cold rooms or integration of PV to offset AC load), the mitigation angle is even stronger. Therefore, these projects can often be reported under climate mitigation or energy efficiency portfolios as well. In green bond frameworks, for example, energy efficiency in industrial processes is a common eligible category – high-efficiency cooling would fall under that. This dual adaptation-mitigation benefit is attractive in ESG terms.
- **Environmental Safeguards:** Efficient cooling solutions frequently involve modern refrigerants and technologies that are better for the environment. For example, older cooling units might use refrigerants with high global warming potential (GWP) or be prone to leaks. Upgrading to new systems can facilitate a switch to low-GWP refrigerants (in line with Kigali Amendment goals) – further aligning with environmental sustainability. Banks can include these considerations in loan covenants or selection criteria (e.g. only financing equipment that uses approved refrigerants and has high efficiency ratings). This ensures the financed adaptation is also ecologically responsible.
- **Social and Governance Aspects:** Improved cooling has direct benefits for worker health and safety. Supporting loans that lead to safer working conditions aligns with the "S" in ESG. It shows that the bank is facilitating investments that improve labor standards and community well-being (since factories with better conditions can sustain employment and economic activity).

A bank that finances, say, 20 factories to install efficient cooling could aggregate the outcome: X megawatts of efficient cooling capacity added, Y MWh/year of energy saved, Z tons of CO_2 emissions avoided, and improved resilience for N hundreds of workers. These metrics can feed into sustainability reports and satisfy stakeholders looking for quantifiable impact.

Finally, alignment with green finance mandates means the potential to access support and lower cost capital. Projects that meet adaptation and mitigation criteria can qualify for lower-cost funding from green financing facilities such as the World Bank and GCF Funded Global Cooling Facility, which has +$140m of concessional loans and grants available, some of which will be deployed via local commercial financial intermediaries. Ensuring that cooling finance fits these templates could allow Tanzanian banks to tap such facilities, reducing their cost of capital and risk in this segment.

Development and Climate Impact Benefits

The figure below summarizes how efficient cooling technology contributes to key Sustainable Development Goals and further discussion of those benefits is provided below.

Figure 7: The contribution of cooling technology to Sustainable Development Goals

Protecting Jobs and Economic Productivity: Manufacturing is a key contributor to Tanzania's GDP and employment. Heat stress threatens to chip away at industrial growth by undermining productivity and increasing costs. By adopting efficient cooling, factories can maintain or even increase their output in the face of rising temperatures, thereby *safeguarding jobs*. A stable manufacturing sector supports livelihoods for thousands of workers and their families. Especially in sectors like food processing and textiles that employ a significant number of women and youth, improved working conditions (cooler, safer factories) contribute to better labour outcomes and gender inclusion. Workers are less likely to suffer heat-related illnesses, improving overall health and attendance. This not only benefits individuals but also preserves the skills and human capital that industries rely on. In the long run, protecting manufacturing from climate shocks helps ensure the sector can continue to diversify the economy and provide the foundation for Tanzania's aim of semi-industrialized status.

Food Security and Quality Management: A considerable portion of Tanzania's manufacturing is agro-processing – turning agricultural products into food/beverage items. Effective cooling directly reduces post-harvest losses and spoilage in these value chains. For example, cold rooms and chillers in dairy, meat, or produce processing keep products from perishing in heat, which means more of the food produced actually reaches markets and consumers in good quality. This has a food security benefit, as less output is wasted. It also improves public health by ensuring food safety standards are met (consistent refrigeration helps prevent bacterial growth and contamination).

Climate Change Mitigation (avoiding maladaptation): A major concern globally is that as temperatures rise, societies will turn to more air conditioning and cooling which, if done with inefficient technology and polluting energy, could dramatically increase greenhouse gas emissions – a potential *maladaptation*. By focusing on climate-friendly cooling, these investments ensure that adaptation does not come at the cost of exacerbating climate change. Efficient systems use far less electricity for the same cooling output, and when paired with renewable energy or modern refrigerants, the carbon footprint is minimized. While the primary goal here is adaptation, the cumulative effect of dozens of factories cutting their power use and generator hours is a meaningful emissions reduction relative to a baseline scenario. One analysis cited in an IFC report suggests that adopting best-available cooling technologies at scale could be one of the largest demand-side mitigation measures globally. In Tanzania, every kilowatt-hour saved through an efficient motor or every liter of diesel avoided by better thermal design contributes to the country's mitigation efforts and reduces local air pollution. Thus, these projects support Tanzania's climate commitments (NDCs) on the mitigation side as well.

Health and Safety Improvements: Cooler workplaces are healthier workplaces. Extreme heat in factories can lead to heat stroke, accidents (due to loss of concentration), and long-term health issues for workers. By maintaining safe temperatures, companies reduce these health risks, aligning with international occupational health standards that call for urgent mitigation above 30°C. This also lessens the strain on public health systems; workers who are not falling ill from heat or respiratory issues (exacerbated by hot, poorly ventilated air) won't need as much medical care.

Gender and Social Inclusion (GESI): Although not immediately obvious, there can be gender-differentiated impacts of heat and cooling. For instance, in some manufacturing subsectors (like textiles or certain agribusinesses), a large portion of the workforce may be women. Heat stress on women – especially expectant mothers – can have disproportionate effects. Improving factory climate control contributes to a more inclusive workplace where vulnerable groups are better protected. Additionally, if adaptation financing is made accessible to smaller enterprises (including those owned by women or local entrepreneurs), it ensures that the benefits of resilience are widely distributed, not just concentrated in large corporations.

International bodies have taken note of these kinds of benefits. The IPCC's Sixth Assessment Report highlights indoor industrial workplaces in Africa as high-risk environments for heat-related productivity loss, and emphasizes heat management as a priority adaptation measure to protect economic performance and worker health. The ILO has warned of the economic and social costs of heat stress on labor productivity (projecting significant output losses in developing countries by 2030 if no action is taken). By implementing the cooling solutions discussed, Tanzania is effectively answering these calls to action, turning research recommendations into on-the-ground improvements.

In sum, the developmental and climate impacts of investing in efficient cooling are overwhelmingly positive. They contribute to at least five Sustainable Development Goals (SDGs): SDG8 (Decent Work and Economic Growth), SDG9 (Industry, Innovation, and Infrastructure), SDG3 (Good Health and Well-being), SDG13 (Climate Action), and SDG7 (Affordable and Clean Energy, via efficiency gains). This alignment with global goals means efforts in this domain could attract support from government and international donors as part of climate-resilient development initiatives.

6. Implementation and Scaling Pathway

A nascent market, but one with sound fundamentals

Tanzania's leading banks — notably CRDB, which launched the country's first green bond in 2023 with IFC backing — have created broad green lending products under which cooling investments are in principle eligible. However, few if any banks have designed a product specifically calibrated for efficient industrial cooling in manufacturing: with dedicated technology criteria, approved installer frameworks, maintenance covenants, or cooling-specific credit underwriting. **This is a first-mover opportunity for commercial banks not a mature market segment.**

What is not nascent is the underlying demand. Climate projections show average temperatures in Tanzania rising 2–3°C by mid-century, with days exceeding 35°C increasing sharply in the country's main industrial corridors. Manufacturing productivity declines approximately 3% for every degree above 27°C indoors. These are physical trends already underway, not projections contingent on policy change. The investment opportunity is increasingly recognised. Recent McKinsey analysis of global adaptation costs found that active cooling accounts for 38% of the total annual adaptation spending needed to bring the world to developed-economy standards of climate protection — the single largest category, ahead of coastal defences, irrigation, and all other measures combined (McKinsey Global Institute, 2025). The IFC and UNEP's 2024 Cooler Finance analysis projects Africa's cooling market to grow sevenfold by 2050 (IFC & UNEP, 2024).

The risk argument for existing bank clients is equally sound. A commercial bank with significant manufacturing sector exposure already carries credit risk to heat-related productivity loss, inventory deterioration, and energy cost volatility — whether or not it has labelled that risk as climate-related. A food processor with inefficient cold rooms, a textile mill with workers above safe temperature thresholds, a pharma manufacturer whose product quality is humidity-sensitive: these are existing borrowers whose cash flows and collateral values are already affected by heat. Financing heat management solutions for them is risk mitigation on existing exposures, not the creation of new ones.

In this context an implementation pathway for climate efficient cooling in Tanzania needs to be propositional and to be tested with commercial bank partners in order to move from a nascent market today to one that becomes a commercially viable lending segment over three to five years. We identify five areas of action as being needed.

Action Area 1: build internal Bank capability before launching dedicated products

A common failure in climate finance product launches in emerging markets is deploying a credit line before the institution has the capability to use it. In GCA's experience three dimensions matter here:

Sector knowledge. Credit officers covering manufacturing need a working understanding of the economics of cooling: what it costs, what it saves, and how those savings interact with the borrower's existing financial profile. This is lifecycle cost analysis applied to a new asset class — not a specialist skill, but one that needs calibrating to Tanzanian conditions. A bank entering this market should identify two or three credit officers with existing manufacturing coverage, equip them with a simple analytical toolkit, and treat early transactions as live learning exercises.

Portfolio risk reframing. Risk teams need to understand that cooling investments improve the credit quality of existing borrowers rather than introducing new risks. A borrower who installs efficient cooling has lower energy costs, more stable cash flows, and better-protected inventory than before. Framing this as a risk management tool for the existing manufacturing book — rather than as a new and untested product category — can help secure credit committee support, particularly in the early stages when local performance data is absent.

Green finance reporting infrastructure. Banks seeking to access climate finance need to track and report climate outcomes at the loan level — energy savings, emissions reductions, adaptation benefits — from day one. The IFC Sustainable Banking and Finance Network has published practical frameworks for this. Establishing simple reporting infrastructure before the first disbursement ensures the bank can credibly access concessional capital and, critically, begins building the local evidence base the market currently lacks.

Action Area 2: design products that fit the asset and test

It does not appear that bank's in Tanzania have yet designed dedicated product for this market. The right product will likely require deliberate calibration on at least three parameters.

Tenor | Cooling equipment has a service life of fifteen years or more. The financial benefits comfortably exceed repayment obligations — but only if loan tenors are long enough to let savings service the debt comfortably. Three years is the minimum for small modular upgrades; five to seven years suits mid-sized and large industrial systems. Commercial banks in East Africa typically cap equipment finance at three to five years on commercial funding, which means accessing concessional capital with longer tenors — a specific deliverable of Workstream 5 — is needed to unlock the full market.

Collateral structure | Cooling equipment is a tangible productive asset with the potential to operate with defined unit costs and standardised performance characteristics — secured equipment lending. The increasing standardisation of equipment, driven by MEPS compliance and the dominance of major Asian Original Equipment Manufacturers (OEMS), further supports collateral valuation. Where collateral coverage is thin for smaller borrowers, partial guarantee facilities available through the likes of IFC's MSME Finance Platform or bilateral programmes may be able to bridge the gap as the sector matures.

Bundled maintenance covenants | It's clear from global studies and experience in other markets that performance over a loan's life depends critically on equipment maintenance. Fouling of heat exchangers alone can reduce thermal efficiency by 10-30% within two to three years. In Tanzania, where reactive rather than preventative maintenance is the norm, making a qualified service contract a condition of drawdown is a effective risk mitigation measure available to lenders — and creates a commercial incentive for O&M providers to formalise their offerings. **This is a potentially significant market gap and one where partnerships with equipment providers and maintenance contractors may need to be created.**

Action Area 3: qualify the supply chain

Poor design and installation — not equipment failure — is a key source of performance risk in this market. A bank cannot control what its borrowers buy or who installs it, but it can structure its product to incentivise quality and build the market relationships that make quality accessible.

An approved supplier framework should be explored. In this scenario a bank would identify a shortlist of equipment suppliers and installation firms meeting defined minimum criteria — MEPS adherence, demonstrated industrial project experience, commissioning report capability, and preventative maintenance availability — and makes lending to borrowers who use approved suppliers faster to process and potentially better priced. IFC, as an example, has used this approach successfully in energy efficiency lending across South and Southeast Asia. It reduces due diligence cost, raises installation quality, and creates a commercial incentive for suppliers to invest in capability.

Supplier finance is a complementary entry point. Capital-constrained distributors and installers who cannot offer flexible payment terms limit the conversion of customer interest into purchases. Extending working capital or supply chain finance to qualified cooling suppliers simultaneously deepens the supply chain and generates deal flow — a dual-sided approach to market entry that WRI and IFC have recommended for productive use of renewable energy lending in East Africa.

Banks should also actively support MEPS enforcement. The EAC Minimum Energy Performance Standards for air conditioners and refrigeration appliances, gazetted in 2025, create the regulatory foundation for a quality floor in the market. Making MEPS compliance a minimum condition for financed equipment, and engaging with TBS and EWURA on enforcement, reinforces that floor. Without it, efficiency incentives collapse: buyers cannot distinguish compliant from non-compliant products, and the price premium for efficient equipment becomes unsustainable.

Action Area 4: originate demand deliberately and build a pipeline of demand

Because the market is nascent, demand will not arrive unsolicited. Most Tanzanian manufacturers have not yet identified heat exposure as a quantifiable financial problem. To stimulate demand and build market understanding banks could target their ambition towards closing two to three anchor transactions in year one — to learn and establish confidence in the markets potential. Demonstration transactions are a powerful tool. Rocky Mountain Institutes (RMI's) Deal Lab shows how in nascent markets, the first deals that succeed visibly accelerate adoption. A single well-executed cooling loan — with documented energy savings, productivity gains, and strong repayment — creates the evidence base that converts sceptical credit committees and borrowers.

A efficient starting point is the existing corporate loan book. A portfolio screen identifying manufacturing borrowers in heat-exposed sub-sectors — food processing, pharmaceuticals, textiles, chemicals — in high-heat industrial zones generates a qualified prospect list at minimal cost. Relationship managers can initiate structured conversations using a simple diagnostic: How much do you spend on cooling energy? What share of working hours are your people above 30°C? What proportion of product losses are temperature-related? This surfaces the financial problem before presenting a financing solution, and converts existing client trust into a new product conversation.

Sector associations offer a secondary channel. Tanzania's CTI and sector-specific industry bodies are well-positioned to build awareness amongst manufacturing members. A simple heat-cost diagnostic tool, distributed through these networks, could create a pipeline of informed prospects. IFC's TechEmerge programme demonstrated that structured awareness campaigns within industry networks generate material deal flow in markets where demand is not yet articulated.

Action Area 5: access concessional capital in parallel

Banks entering nascent climate markets should look to collaborate with existing development finance providers. Here they may be able to access concessional capital and risk-sharing instruments to reduce the cost and credit risk of first-mover lending, with the expectation that banks take over on purely commercial terms as markets mature. Several relevant facilities are accessible to Tanzanian commercial banks. For example the World Bank Group's Global Cooling Facility holds over $140 million in concessional loans and grants designed to be deployed through local commercial financial intermediaries. Tanzania's designation in October 2024 as the second country under the IMF–World Bank Enhanced Cooperation Framework for Climate Action creates a direct entry point for engaging the World Bank Group on cooling finance partnerships.

The recommended sequencing is to pursue concessional finance partnerships in parallel with capability building, not after it. Preparing for a DFI partnership — building reporting infrastructure, defining a product concept, securing senior management commitment — itself accelerates internal capability. Blended finance structures, including first-loss guarantees, concessional interest rate subsidies, and technical assistance grants, can make the product commercially viable at the transaction volumes realistic in year one. IFC's MSME Finance Platform, which launched a $4 billion facility with a catalytic first-loss guarantee in May 2024, is one applicable instrument.

RESOURCES

This brief directly builds on the following technical report:

- GCA (2026), Rapid Climate Risk Assessment and Adaptation Investment Opportunities Mapping in Infrastructure, Energy and Manufacturing, Tanzania Country Report. Developed in cooperation with partners including CGAP, and consulting firm: Pegasys.

Relevant bibliography and selected resources used for these technical reports include:

- AUHF. (2019). *Tanzania's Housing Construction and Related Activities.*
- Centre for Affordable Housing Finance in Africa (CAHF). (2024). *Tanzania Country Profile.*
- CGAP. (2024). *Climate Adaptation, Resilience, and Financial Inclusion: A New Agenda.*
- Correia, M. (2025). *Indoor thermal comfort in informal settlements.*
- GCA and Pegasys. (2026). *Tanzania Country Report: Phase 1 Analysis.*
- GIZ. (2021). *Climate Risk Profile for Tanzania.*
- Ibrahim Nor, M., Audu, B., & Mohamed, A. (2025). *Investigating the impact of property characteristics, cost of living, and environmental factors on rental prices in Baidoa's climate-affected real estate market: a hybrid approach using hedonic regression and neural networks.* Frontiers.
- IFC & UNEP. (2024). *Cooler Finance: Mobilizing Investment for the Developing World's Sustainable Cooling Needs.*
- IIED. (2024). *Community-led Climate Adaptation in Informal Settlements: Dar es Salaam, Tanzania.*
- IIED. (2025). *Hybrid Infrastructure for Urban Flood Risk and Climate-Related Hazard Management in Sekondi-Takoradi, Ghana. Winnipeg: International Institute for Sustainable Development.*
- IMF. (2025). *Laying the Ground for Scaling up Climate Finance in Sub-Saharan Africa.*
- International Journal of Economics, Commerce & Management . (2019). *SUCCESS OF SAVINGS AND CREDIT CO-OPERATIVE SOCIETIES IN TANZANIA: THE CASE OF DODOMA CITY.*
- Judd, J., Wakamo, B., Hertveldt, S., Rahman, N., & Better Work. (2025). *The Heat Is On: How heat stress impacts the apparel industry, jobs, and worker health.*
- Lwanga, C. (2026). Tanzanian Stakeholder Interview. (D. Seddon-Daines, Interviewer)
- McKinsey Global Institute. (2025). *Advancing adaptation: Mapping costs from cooling to coastal defenses.*
- OECD. (2024). *The Heat Is On: Heat Stress, Productivity and Adaptation among Firms.*
- SDG Investment Opportunities. (2023). *Affordable Housing Finance - Tanzania Investment Centre.*
- SDG Opportunities Portal, Tanzania Investment Centre. (2022). *Affordable Housing Finance.* Retrieved from Tanzania Investment Centre: sdg.tic.go.tz
- Shinan-Altman, S., & Hamama-Raz, Y. (2025). *Climate change worry, awareness, risk appraisal, and pro-environmental behaviors: Are these factors different for individuals with and without chronic diseases?*
- UN-Habitat. (2025). *Proposed Recommendations on Housing Finance.* . Nairobi: United Nations Human Settlements Programme.
- UN-Habitat, Statement by the Republic of Tanzania. (2025). *United Republic of Tanzania: Key Talking Notes at the High Level Dialogue on Adequate Housing.*
- World Bank. (2025). *Building Resilience to Climate Change: Cash Transfers and Accompanying Measures.*
- Xinhuanet. (2025). *Chinese home appliance giant expands investment in Africa*. Retrieved from Xinhuaet .

APPENDIX

ANNEX 1. ILLUSTRATIVE MARKET SIZING APPROACH

While there is a strong emerging body of analysis on cooling demand in emerging economies, the study team could not identify a single published figure for the size of the climate efficient cooling market in Tanzania. Specific manufacturing sector estimates are non-existent.

So, to establish a plausible estimate of the size of this market the team used a structured, bottom-up estimation methodology. It is based on the following logic:

a) Identifying which manufacturing sub-sectors are most exposed to heat stress, and therefore most likely to benefit from cooling investments in Tanzania – thereby ensuring that the market we size is geared towards climate adaptation investments.
b) Uses available macro data on the number of manufacturing firms in Tanzania to make informed estimates about the number of heat-exposed firms with a realistic ability to act, based on firm size
c) Defines a set of "efficient active cooling investment packages" based on the typical technologies deployed and responding to the evidence that firms frequently adopt several approaches simultaneously to manage heat exposure economically
d) Assumes that not all firms will select technologies which are significantly more energy efficient than their prior systems, and therefore meet the criteria for climate efficient cooling, so it's necessary to apply a further uptake % rate assumption. We call this Efficiency Penetration Rate as a shorthand.
e) Assumes that not all firms will invest even if there is a demonstrable climate rationale to do so, so it's necessary to apply adoption rates to reflect realistic uptake
f) Assumes not all firm level investments will be financed externally. Some firms may self-finance. So the share of investments likely to be financed via bank loans are required to get to a realistic market for Bank lending.

It should be noted that this approach is illustrative. Due to underlying data weaknesses, including on the number of sites likely to deploy cooling technology it should be treated as illustrative and could be enhanced should newer and more accurate underlying data be provided.

More detail on each step is provided below.

a) We identify 5 core manufacturing sub-sectors as priority candidates for active cooling solutions in Tanzania. These represent industries that are material in size and where heat stress has immediate financial impacts – e.g. on worker productivity, equipment performance, product spoilage – and where companies can reasonably be assumed to have economic incentives (and ability to pay) to invest in cooling measures. By focusing on such heat-vulnerable manufacturing sub-sectors, we ensure the market sizing targets relevant areas for climate adaptation investment. These are:

Food & Beverage processing: The largest manufacturing sub-sector in Tanzania by output and employment. It encompasses agro-processing industries like grain milling, dairy and meat processing, breweries, edible oils, and beverages. These operations are highly sensitive to heat: elevated temperatures lead to faster spoilage and contamination, interrupt cold-chain requirements, and can cause product losses or safety issues. Ensuring reliable cooling is critical for maintaining food safety standards and reducing waste in this sector.

Non-metallic minerals & basic metals: Cement factories, glass makers, steel mills and similar heavy industries generate intense process heat. While they may not cool the entire plant, they often invest in targeted cooling systems – such as cooling towers, heat exchangers, or ventilation – to protect critical equipment and manage working conditions.

Plastics & Chemicals: Includes plastic product manufacturers, paints, chemicals, etc., many of which use heat-intensive processes. Cooling is needed for equipment (e.g. cooling water loops for plastic moulding and chemical reactors) and to ensure safe working conditions when ambient heat combines with process heat.

Pharmaceuticals: This sub-sector requires controlled environments for production and storage. As identified in the earlier phase of this project Tanzania's pharma sector is comparably modest and relies primarily on imports. However the ~18 existing operations are likely to depend on reliable HVAC systems, dehumidifiers, and refrigeration to maintain strict temperature/humidity levels for product quality and prevent the spoiling of medicines or vaccines.

Textiles & Apparel: A significant employer of labour, particularly women, with a small number of large firms (fewer than a dozen major textile mills or garment factories in Tanzania). These facilities often face extremely hot indoor conditions that reduce worker productivity and increase error rates. Active cooling (e.g. factory floor ventilation, localized air-conditioning) helps protect worker health and output during hot seasons.

b) Estimated Number of Small/Medium/Large Firms in Target Sub-Sectors: The formal manufacturing base in Tanzania comprises thousands of firms, but the majority are micro enterprises. We focus on small, medium and large firms (small being defined as those >10 employees, conforming to standard definitions used by IFC) since they are likelier to be able to undertake capital investments in cooling and to be eligible for Bank loans[12]. Based on available data and industry reports:

- Food & Beverage Processing: This is the largest segment by count with roughly 25% of all registered manufacturing enterprises in Tanzania indicated by published data to be in the food processing sector. While recent data is weak we can base estimates on Tanzanian CTI data from the mid-2000s, which indicated roughly 1,000 formal manufacturing firms in Tanzania, we can escalate this in line with manufacturing sector growth over that period to indicate ~438 formal firms in this sub-sector are of meaningful scale (including large agribusiness processors, beverage bottlers, dairy and grain mills, etc.) that might need substantial cooling upgrades.
- Textiles & Apparel: The number of sizable textile and garment factories is relatively small. There are only *around 9–12 major textile/apparel firms in recent years*, plus a larger number of small garment workshops. While the count of big players is limited, these few factories (e.g. integrated textile mills or export garment factories) employ many workers and would each require significant cooling/ventilation investments. We have not been able to find reliable information on the number of workshops in this second category and so have limited the number of sites to 9.
- Pharmaceutical Manufacturing: Tanzania's pharma manufacturing is limited in scale. We found evidence of 42 total medical-product manufacturing sites, including medical device companies in the early 2000's. We account for a modest 20% growth in the number of those enterprises since then and assume 50 pharmaceutical plants that would be candidates for advanced HVAC, clean-room cooling, and dehumidification systems.
- Plastics & Chemicals: The chemicals and plastics sector in Tanzania includes a mix of medium enterprises (like plastics factories, fertilizer or paint manufacturers) and a handful of larger industrial chemical plants. We don't have a precise count, but it likely comprises a few dozen mid-sized companies, and a more substantial number (~200) mostly smaller firms. Many of these will need process cooling (chillers, cooling towers) and improved ventilation to cope with heat. We assume 100 sites to be conservative.
- Cement, Steel & Other heavy industries: Tanzania has several large cement plants (e.g. Twiga, Dangote, etc.), a few steel/metal factories, and other construction material makers. These may number perhaps 5–10 large plants in total (each often part of bigger corporations). Cooling needs here are specialized (cooling machinery, managing waste heat), but they still represent substantial potential investments per site.

This gives us a initial foundation of ~606 sites in scope in core sectors. We add 300 sites to account for non-core but still impacted sectors, such as horticulture[13]. This gives us 906 sites as the basis for our

[12] A potential methodological concern is that focusing on formally registered manufacturing enterprises understates the true population of heat-exposed firms. We consider this a feature rather than a limitation. The relevant market for this analysis is firms that are eligible for and likely to seek commercial bank lending to finance cooling capital investments. Informal enterprises face major exclusion from Tanzania's formal credit system — an estimated 81% of Tanzania's 3.2 million MSMEs lack access to finance (IFC/CRDB, 2022), with informal operators disproportionately excluded. Given investment ticket sizes of $12,500–$350,000 identified for this sizing exercise the practical universe of borrowers is constrained to formally registered firms with auditable financials, recognised collateral, and established banking relationships. We consider formal enterprise data as therefore being a logical starting point for a bank-lending market sizing."

[13] More details of the panel of sub-sectors included in this directional estimate can be found in the market sizing model.

market size calculation. This is a reasoned approximation noting very weak recent data. This is an area where further study and future analysis is required.

c) Active Cooling Investment Packages (Archetypes & Costs): In practice, Tanzanian manufacturers have a set of proven active cooling technologies to choose from. Below are three typical investment packages for active cooling in factories, along with their likely components and cost ranges. More details on how these costs where estimated, using industry databases and sales prices can be found in the market sizing model. The specific technical specifications of equipment needed for any given site will be variable with a significant error bar, for instance industrial chillers can have significantly higher $ costs that product cool rooms, dragging up mean average costs, so some adjustments have been made in the market sizing model to account for these distortions. Given the nature of this study this must be acknowledged as an inherent limitation and an area where further technical and in-country analysis is required.

Facility Type & Scale	Example Active Cooling Upgrades	Indicative Investment Range (USD), in all cases we take the mid-point for the purposes of estimates
Small Factory / Workshop *e.g. small food processor or garment workshop*	▪ Several industrial fans or spot coolers for worker areas ▪ Small AC units for critical rooms or offices (e.g. a server room or quality control lab) ▪ Mini cold storage cabinet or chest freezer for perishable raw materials or finished products	▪ $5,000 – $20,000 (low-cost upgrades, often modular)
Mid-Sized Factory *e.g. medium dairy, brewery, grain mill, plastics or pharma plant*	▪ Network of high-capacity ceiling fans or evaporative coolers on shop floors for general ventilation (I,e using a hybrid approach of using fans an HVAC) ▪ Packaged HVAC systems (rooftop or split-unit air conditioners) serving production areas or warehouses ▪ A moderate-size cold room for ingredient or product storage (e.g. 50–200 m³) ▪ Industrial chiller or large AC for process cooling (if needed for machinery or temp-sensitive processes)	▪ $50,000 – $150,000 (medium capital project; often requires external financing)
Large Industrial Plant *e.g. big food/beverage plant, cement or chemical factory, textile mill*	▪ High-capacity industrial chillers (for process cooling or central air-conditioning) ▪ Multiple cold storage units (raw materials or finished goods) ▪ Centralized HVAC system or custom-built air handling units for whole-facility cooling ▪ Extensive mechanical ventilation and heat-extraction systems (e.g. cooling towers, large exhaust fans) for hot process areas ▪ Industrial dehumidification systems if humidity control is required (e.g. in pharmaceuticals) ▪ Sensors & automated controls for climate monitoring and energy optimization	▪ $200,000 – $500,000+ (major retrofit or installation)

These technology archetypes cover the core of "active" cooling solutions relevant to climate adaptation in factories. Some key points: industrial refrigeration and cold storage (for food, beverage, and pharmaceutical firms) typically costs on the order of tens of thousands of dollars per unit (e.g. a small cold room installation can cost around $10k–$25k). Standard air conditioning/HVAC systems for industrial spaces can range from a few thousand dollars for a single zone up to $100k+ for larger centralized units. Process chillers (for cooling manufacturing equipment or processes) are costlier – large industrial chillers can be $100k–$200k each. Meanwhile, simpler ventilation and cooling fans are relatively cheap (often <$5k for a set of industrial-grade fans), and dehumidifiers or control systems fall in the midrange (several thousand dollars). These figures provide a sense of the capital needed per facility. In practice, each firm will adopt a tailored mix of technologies. For instance, a dairy processor might spend ~$50,000 to install a new high-efficiency cold room and some HVAC upgrades, whereas a large brewery could invest a few hundred thousand dollars on chillers, cooling towers, and a plant-wide automation system.

d) Efficiency Penetration Rate

The climate-efficient cooling market should only count investments that result in genuinely more efficient equipment. Without this, we potentially overstate the market. i.e by including firms that simply replace a broken chiller with another standard-efficiency chiller or a lower-efficiency device. To manage this we introduce another filter, which we call this Efficiency Penetration Rate as a shorthand. This will be expressed in the model as a % of all cooling equipment purchases or the selected sectors that are more efficient than their replacements.

Introducing this requires us to have a view on the comparative ***Coefficient of Performance (COP)*** of cooling systems in Zambia and the % improvements. The COP calculates how many units of cooling are produced for every one unit of electricity consumed. Perhaps counterintuitively the overwhelming majority of equipment available, even from low cost importers in Tanzanian appears likely to have a significantly higher COP that the equipment it replaces. This is a function of increasing adoption of efficiency standards by producers and adoption of standard efficiency performance for all imports in Tanzania.

We can consider for example that:

- The likely COP of 10 year old Tanzanian cooling equipment = 2.0-2.5
- Most modern air conditioners have a COP of 3.5 to 5 and Chinese manufacturers like Gree, Midea, and Haier are producing units at this level. These are the dominant imports in Tanzania. We can assume 3.5-4.5 for a modern Chinese inverter unit
- This means we are looking at roughly a 75-100% efficiency improvement - meaning the new unit would use nearly half the electricity to provide the same cooling. If the old unit had a COP of 2.2, and the new one has a COP of 4.0, you'd cut your electricity consumption for cooling by ~45%.

3) Adoption Scenarios: Using the sub-sector focus and estimates of company sites in #a and #b we then estimate how many of those firms might realistically implement efficient cooling projects. Given that active cooling for climate adaptation is an emerging concept, initial adoption rates are likely to be modest, even if evidence suggests the cost savings make the business case appealing. This reality was verified by stakeholder consultations conducted with representatives from the Ministry of Energy and external cooling finance specialists as part of this assignment. However due to the lack of explicit reputable studies on the level of uptake we model three scenarios:

- Conservative (15% adoption): This implies ~ 136 factories in total (across all sub-sectors) implementing projects such as those described above. Using average project costs and a 15% adoption scenario total project investment of the order of $8.9m in active cooling
- Moderate (35% adoption): This could be on the order of 320 factories equipping themselves with better cooling. At average costs this implies roughly $20.7 million in cumulative investment.
- High (50% adoption): In an accelerated scenario, perhaps fuelled by strong awareness and favourable financing, as many as half of the major manufacturing firms implement cooling solutions. This equates to around 220 factories upgrading their cooling systems. Even at a somewhat higher average project cost (since later adopters may include bigger facilities), this level of adoption could generate on the order of $30 million in total project expenditure.

In the long run, as climate impacts intensify and technology costs potentially decrease, adoption could go beyond 50% of firms – expanding the *Total Addressable Market* further. But even the moderate scenario indicates a significant new investment opportunity in the near term.

e) Financeable Market Opportunity (External Financing Share): Finally, we determine how much of the above investment is likely to be financed through external sources (e.g. bank loans, leasing, or other financing) as opposed to being paid in cash by the companies. Tanzanian manufacturers – especially small and mid-sized ones – face constraints in accessing affordable credit. For estimation, we assume roughly 70% of the total investment would be financed by banks or leasing companies (with firms covering the remainder via upfront equity or cash).

Applying this to our scenarios:

- Under the 15% adoption case (SAM), perhaps $6.2 million would be debt-financed (the rest paid by companies).
- In the 35% adoption case (SAM), perhaps $14.5 million would be debt-financed (the rest paid by companies).
- In the 50% adoption case (SAM), perhaps $20.7 million would be debt-financed (the rest paid by companies).

In summary, even *conservative uptake of active cooling by Tanzanian manufacturers yields a multi-million dollar lending opportunity*, and with broader adoption this opportunity could scale to +$20m USD in the coming years. This growth aligns with global trends in cooling demand and is especially concentrated in sectors like food processing, textiles, and pharma where heat resilience is both a necessity and a sound business investment.

ANNEX 2. BUSINESS BENEFITS MATRIX

The table below presents the full inventory of identified business benefits, their quantification (where available), a brief description and the source organisations that identify them.

Business Benefit	Quantification	Description	Source(s)
Energy Cost Savings	US$17 trillion cumulative savings by 2050 (global); US$5.6 trillion in developing economy electricity bills	Efficient cooling equipment and passive strategies reduce electricity consumption for end users, lowering operating costs for businesses and households	UNEP Cool Coalition (GCW 2023 & 2025); IFC/UNEP (Cooler Finance 2024)
Labour Productivity Gains	US$2.4 trillion/year in avoided losses globally by 2030; 80 million full-time job equivalents; West Africa ~5% of working hours lost	Heat stress reduces cognitive and physical performance. Cooling workplaces, warehouses and factories restores productive working hours, especially in agriculture and construction	ILO; UNEP Cool Coalition; SEforALL (Chilling Prospects); IFC
Reduced Post-Harvest Food Loss	526 million tonnes of food lost annually due to lack of cold chain; 30–40% of harvested crops lost in Tanzania; cold chains can avoid 55% of current food losses	Cold storage and refrigerated transport preserve perishable produce, extending shelf life, reducing spoilage and increasing farmer incomes by up to 15%	UNEP Cool Coalition; SEforALL (Chilling Prospects); FAO; IFC
Health Outcomes (Reduced Mortality & Morbidity)	~546,000 heat-related deaths/year globally; 1.2 billion people at high risk from lack of cooling access; 117 million children at risk of missing vaccines due to cold chain gaps	Cooling reduces heat-related illness and death, preserves vaccine potency, and protects medicines (50% are heat-sensitive). Critical for health system resilience	UNEP Cool Coalition; SEforALL (Chilling Prospects); WHO; IFC
GHG Emission Reductions	64–96% reduction in cooling emissions below BAU by 2050 (3.8 bn tonnes CO_2e avoided); up to 210–460 $GtCO_2e$ avoided over 40 years	Efficient equipment, low-GWP refrigerants and passive strategies dramatically cut direct and indirect emissions from the cooling sector	UNEP Cool Coalition (GCW 2023 & 2025); Global Cooling Pledge; IEA
Avoided Grid / Power Infrastructure Investment	US$4–5 trillion in avoided power generation investment (GCW 2023); up to US$26 trillion (GCW 2025); peak demand reduced by 1.5–2 TW	Efficient cooling lowers peak electricity demand, reducing the need for costly new power plants and grid reinforcement – critical for Tanzania's constrained grid	UNEP Cool Coalition (GCW 2023 & 2025)
Market Growth & Private Sector Opportunity	US$600 billion/year market by 2050; Africa's cooling market to grow 7x; >US$8 trillion in cumulative benefits for developing countries	The transition to sustainable cooling creates large investment and business opportunities across manufacturing, distribution, installation and servicing	IFC/UNEP (Cooler Finance 2024); Cool Coalition

Expanded Cooling Access & Equity	3.5 billion additional people benefiting from cooling by 2050; 1.02 billion currently at high risk; passive cooling reduces indoor temps by 0.5–8°C	Efficient and passive cooling solutions are more affordable, extending access to low-income communities, women, smallholder farmers and the elderly	UNEP Cool Coalition (GCW 2025); SEforALL (Chilling Prospects); Global Cooling Pledge
Food Security & Nutrition	1.6 billion people could be fed with food currently lost; 14% of food lost between harvest and retail; cold chain improvements support SDG2	Improved cold chains preserve nutritional quality, enable trade in perishable high-value crops, and strengthen food system resilience under climate change	FAO; UNEP Cool Coalition; SEforALL (Chilling Prospects); IFC
Job Creation & Green Economy	Qualitative – significant employment potential across cooling value chain, including technicians, installers, and maintenance roles	Scaling sustainable cooling creates skilled jobs in manufacturing, installation, maintenance, and cold-chain logistics – especially for youth and women	IFC (TechEmerge); UNEP Cool Coalition; ILO
Climate Resilience & Adaptation	Climate change could cost Tanzania ~2% of GDP/year by 2030; WBGT >30 in Tanzania by mid-century challenges outdoor workers	Cooling is a critical adaptation measure – protecting communities, infrastructure and economic activity from rising temperatures and extreme heat events	UNEP Cool Coalition; IFC; Nature (2024)
Passive Cooling Cost Savings	Up to 24% reduction in cooling demand by 2050; US$3 trillion in avoided equipment costs; 1.3 bn tonnes CO2 avoided; payback in 2–8 years	Passive strategies (insulation, reflective roofs, shading, ventilation) are low-cost, low-tech, and reduce or eliminate need for mechanical cooling	UNEP Cool Coalition (GCW 2025); IFC/UNEP (Cooler Finance 2024)

ANNEX 3. BENEFITS GROUPED BY CATEGORY

4.1 Economic & Financial Benefits

- Energy cost savings: Efficient cooling can save US$17 trillion cumulatively by 2050 globally, with US$5.6 trillion in developing economy electricity bills alone (IFC/UNEP Cooler Finance). For Tanzanian businesses, this translates directly to lower operating costs.
- Market opportunity: The cooling market in developing economies will grow from US$300 billion to at least US$600 billion/year by 2050. Africa's market is expected to grow sevenfold, making Tanzania a high-growth opportunity for cooling technology providers and investors (IFC/UNEP).
- Avoided grid infrastructure: Sustainable cooling pathways could avoid US$4–5 trillion (GCW 2023) to US$26 trillion (GCW 2025) in power generation investments globally, reducing strain on Tanzania's electricity grid and deferring costly capacity additions.
- Private sector returns: The sustainable cooling market could generate over US$8 trillion in cumulative benefits for developing countries, encompassing manufacturing, services, installation, maintenance and cold-chain logistics.

4.2 Labour Productivity Benefits

- Global losses: The ILO estimates that by 2030, heat stress will cause the loss of 2.2% of total working hours worldwide (80 million full-time jobs), at a cost of US$2.4 trillion per year. West Africa alone is projected to lose ~5% of working hours, with similar impacts across East Africa.
- Tanzania-specific risk: Research published in Nature (2024) highlights that by mid-century, Tanzania's average summer wet bulb globe temperature (WBGT) will exceed 30, challenging the ability of most outdoor workers to function. Agriculture (60% of projected lost hours) and construction (19%) are the most affected sectors.
- Indoor productivity: Cooling offices, factories and warehouses directly improves cognitive function, reduces error rates, and enables longer effective working hours – a direct productivity gain for businesses.
- Gender dimension: Women in subsistence agriculture and men in construction face the greatest exposure. Cooling interventions can disproportionately benefit these vulnerable groups (ILO, SEforALL).

4.3 Food Security & Agricultural Benefits

- Post-harvest loss reduction: In Tanzania, 30–40% of harvested crops are lost annually (USDA, FAO). Globally, 526 million tonnes of food are lost due to lack of cold chain (SEforALL). Sustainable cold chain expansion could avoid 55% of current food losses.
- Farmer income: A 15% improvement in smallholder farmer income is associated with cold chain access (SEforALL). Cold storage enables farmers to sell at optimal market prices rather than at distressed harvest-time prices.
- Nutritional value: Refrigeration preserves the nutritional quality of perishable foods – fruits, vegetables, dairy, meat – which is critical for addressing malnutrition in Tanzania.
- Trade enablement: Cold chains enable Tanzania to participate in regional and international trade of high-value perishable products, supporting the objectives of the African Continental Free Trade Area (AfCFTA).

4.4 Health & Human Safety Benefits

- Heat-related mortality: Approximately 546,000 heat-related deaths occur globally each year (WHO/WMO). In Tanzania, rising temperatures pose growing risks to vulnerable populations, including the elderly and outdoor workers.
- Vaccine cold chain: Cold chain breakdowns risk vaccine spoilage. Over 117 million children are at risk of missing temperature-sensitive vaccines (SEforALL). Tanzania has been partnering with organisations like Nexleaf to deploy remote temperature monitoring to protect its vaccine supply.

- Medicine preservation: Approximately 50% of medicines are heat-sensitive (IIR). In Tanzania, where rural health facilities often lack reliable electricity, efficient solar-powered cooling can protect pharmaceutical stocks.
- Reduced disease burden: Cooling lowers the incidence of food-borne illness from spoiled food and supports safer storage of blood products and diagnostic reagents.

4.5 Environmental & Climate Benefits

- Emission reductions: The Sustainable Cooling Pathway can reduce cooling-related emissions by 64% below business-as-usual by 2050 (2.6 billion tonnes CO_2e). Combined with grid decarbonisation, this rises to 97% (UNEP Cool Coalition GCW 2025).
- Kigali Amendment compliance: Phasing down HFC refrigerants under the Kigali Amendment could avoid up to 0.4°C of global warming by 2100. Efficient cooling supports Tanzania's compliance obligations.
- Passive cooling potential: Passive strategies (insulation, cool roofs, shading, ventilation) can reduce cooling demand by 24% by 2050, saving US$3 trillion in equipment costs and avoiding 1.3 billion tonnes of CO_2 (UNEP Cool Coalition GCW 2025).
- Reduced food system emissions: Cutting food loss through better cold chains also reduces the GHG emissions embedded in wasted food production.

4.6 Social & Equity Benefits

- Expanded access: 1.2 billion people globally are at high risk from lack of cooling access (SEforALL). The Sustainable Cooling Pathway could extend cooling to an additional 3.5 billion people by 2050, including vulnerable communities in Tanzania.
- Gender equity: Women comprise over 50% of the agricultural labour force in Sub-Saharan Africa but face a 15–60% wage gap. Access to cooling and cold chain infrastructure can improve women's economic empowerment and reduce their disproportionate exposure to heat risk.
- Job creation: Scaling sustainable cooling creates skilled employment in manufacturing, installation, maintenance, and cold chain logistics, with particular opportunities for youth and women (IFC TechEmerge).
- Reduced climate-driven migration: By protecting livelihoods from heat stress and food loss, cooling technologies can reduce pressure for climate-driven rural-to-urban migration.

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