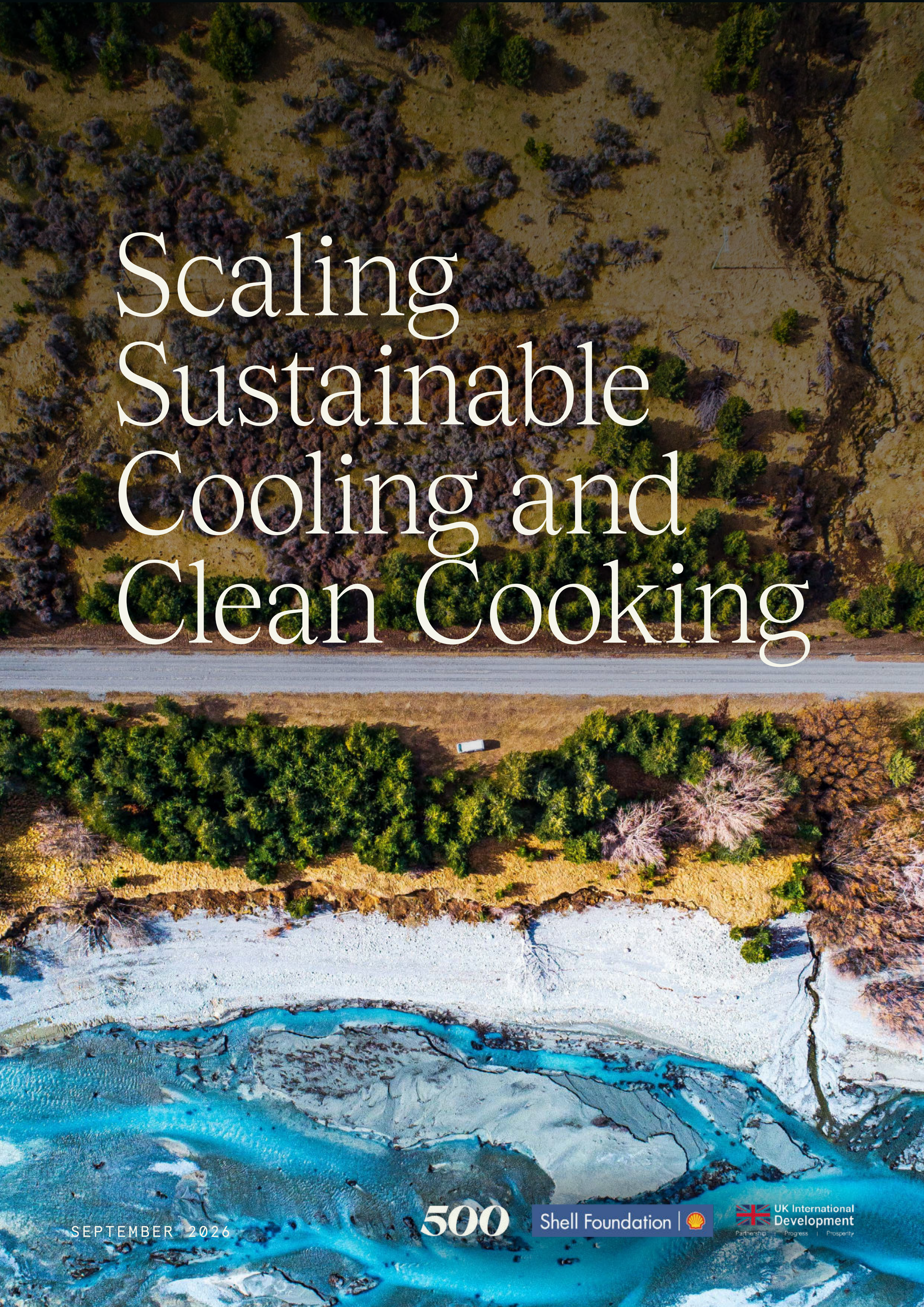


Scaling Sustainable Cooling and Clean Cooking

SEPTEMBER 2026

500
Shell Foundation
UK International Development
Partnership | Progress | Prosperity

Table of Content

About the Report

This report was developed by 500 Global and Shell Foundation, with research led by Steward Redqueen.

500 Global is a multi-stage, global venture capital firm investing in globally ambitious founders building fast-growing technology companies across more than 80 countries. **Shell Foundation** is an independent charity that empowers underserved customers to raise their incomes while lowering emissions. In 2025 they launched the **Sustainable Innovation Program**, supporting mission-driven founders as they scale ventures that deliver both market returns and measurable impact.

This report is funded by Shell Foundation and the UK government's Foreign, Commonwealth & Development Office (FCDO) through the Transforming Energy Access (TEA) platform and the Catalysing Agriculture by Scaling Energy Ecosystems (CASEE) programme via its Global Research and Technology Development (GRTD) portfolio and forms part of the UK's Ayrton Fund.

This report is coauthored by 500 Global and Steward Redqueen, who served as knowledge and learning partner to 500 Global on the Sustainable Innovation Program. Steward Redqueen is a boutique consulting firm with the mission to make business work for society, specialising in integrating sustainability, quantifying impact, and facilitating change — supporting commercial and impact-focused financial institutions, industry associations, multinationals, and government agencies in developed and emerging markets. The research team comprised Clive Tan, Gemma Pipo, Holly Smith, Pranav Kalra, Pauline Brunner, and René Kim.

This report investigates which business models can be successful in scaling sustainable cooling and clean cooking technologies in Kenya, Nigeria, and India. The research develops a theoretical understanding of the scalability and impact potential of a set of technologies and business models in the cooling and cooking verticals, supplemented by a contextual analysis of enablers and constraints across the three selected markets. The findings offer stakeholders recommendations to help build ventures that can scale sustainable cooling and clean cooking and create a more supportive ecosystem for sustainable startups.

500 Global, Shell Foundation, and Steward Redqueen would like to extend their gratitude to the founders, investors, and ecosystem partners who contributed their perspectives and insights, enriching this research into sustainable innovation across emerging markets.

Abbreviations

ABBREVIATION	DEFINITION
3PL	Third-Party Logistics
CaaS	Cooling-as-a-service
CSR	Corporate Social Responsibility
DFI	Development Finance Institution
FDI	Foreign Direct Investment
FFV	Fresh Fruits and Vegetables
FMCG	Fast-Moving Consumer Goods
FPO	Farmer Producer Organisation
LPG	Liquefied Petroleum Gas
MFI	Microfinance Institution
MSME	Micro, Small, and Medium Enterprises
NCAP	National Cooling Action Plan
PAYGO	Pay-As-You-Go
PM2.5	Particulate Matter 2.5, fine particles with a diameter of 2.5μm or less
PMUY	Pradhan Mantri Ujjwala Yojana
RBF	Results-Based Financing
SHG	Self-Help Group
TA	Technical Assistance

Executive Summary

Background and Objectives

Sustainable cooling and commercial clean cooking technologies have significant potential to increase incomes and improve resilience for low-income customers across Africa and Asia, while reducing emissions. For smallholder farmers, cooling can reduce post-harvest losses, preserve quality and improve market access. For food vendors, restaurants and food processors, modern cooking technologies can lower operating costs, improve productivity and increase sales. Despite these benefits, many solutions remain confined to pilots or donor-supported programmes and have not achieved sustainable commercial scale.

This report examines this scaling challenge across Kenya, Nigeria and India, focusing specifically on productive-use and commercial applications rather than household adoption. The analysis considers cooling solutions used by farmers, aggregators, cooperatives, retailers and food-service businesses, alongside modern cooking technologies used by microenterprises, restaurants, institutional kitchens and food processors.

The report is guided by the following research question:

Which business models have the greatest potential to scale sustainable cooling and commercial clean cooking technologies in Kenya, Nigeria and India while delivering both commercial viability and measurable development impact?

Rather than comparing technologies in isolation, the report assesses business model configurations comprising technology, customer segment, ownership structure, payment mechanism, service model and enabling environment. Each configuration is evaluated using a Supply-Side and Demand-Side (SS-DD) readiness framework that considers customer value, affordability, supplier economics, and whether the required infrastructure, financing and market conditions are in place.

Findings

The analysis suggests that scaling is driven less by the technology itself than by the degree to which technology, financing, customer economics and market structures are aligned. Models that solve a clear business problem for customers and fit existing value chains consistently outperform technology-led approaches.

Across both cooling and clean cooking, the most scalable business models are those in which:

- The customer or anchor captures enough of its value.
- Demand is sufficiently concentrated to support high asset utilisation and efficient service delivery.
- Suppliers can recover acquisition, financing, operating and servicing costs without permanent subsidy support.

> Scaling is driven less by the technology itself than by the degree to which technology, financing, customer economics and market structures are aligned.

Commercial Cooking Currently Presents the Clearest Near-Term Scaling Opportunity

Among all configurations assessed, **financed commercial cooking solutions for fixed food businesses** demonstrate the strongest combination of customer value, supplier viability and scalability. The evidence from Kenya and India suggests that fixed food vendors, kiosks, cafés and micro-restaurants can translate modern cooking technologies with adequate electricity or fuel infrastructure into measurable productivity gains through: Faster cooking; greater throughput during peak periods; lower energy costs; Improved consistency and product quality.

The strongest opportunities include:

🇰🇪 Kenya: PAYGO-Financed Electric Cooking

Urban and peri-urban food businesses represent the most commercially attractive customer segment. Businesses with predictable daily c ash flows can repay appliances through Pay-As-You-Go (PAYGO) mechanisms, while Kenya's mobile-money infrastructure lowers transaction costs and improves repayment collection. Productive-use research shows that appliance packages combining finance, suitable cookware, training and after-sales support can generate sustained adoption and measurable business benefits.

🇮🇳 India: Task-Specific Commercial eCooking

India provides the strongest overall foundation for commercial electric cooking scale. Fixed food businesses are increasingly adopting induction cookers, infrared cookers and electric pressure cookers for specific tasks while retaining Liquefied Petroleum Gas (LPG) for others. This task-by-task approach allows businesses to capture productivity gains without requiring complete fuel switching. Strong electricity access, established retail channels and widespread familiarity with modern cooking fuels support scalability.

🇳🇬 Nigeria: Selective Commercial eCooking and LPG Models

Nigeria offers a large market opportunity but remains constrained by unreliable electricity and macroeconomic instability. In the near term, recurring LPG supply models represent the most commercially viable pathway, while electric cooking remains viable only for defined customer segments such as modern restaurants, caterers and food processors in locations with dependable power.

The Highest-Impact Cooling Opportunity Lies at the Agricultural First Mile

First-mile agricultural applications realise the greatest livelihood, resilience and emissions benefit. This includes pre-cooling, milk chilling, packhouses and shared cold storage. These interventions occur closest to the point where food losses occur and therefore offer the strongest potential to: reduce spoilage; preserve quality;Increase farmer incomes; and improve market access.

However, these models are also among the most commercially challenging because they operate in fragmented, seasonal and dispersed production systems. The report therefore finds that individual farmer ownership is rarely the optimal scaling pathway. Instead, the strongest cooling opportunities emerge when assets are owned or managed by institutions capable of aggregating demand. The analysis finds that the strongest combination of technology, customer and business model is **commodity-specific first-mile cooling anchored by an aggregator** rather than an individual farmer.

Aggregator, Cooperative and Off-Taker-Led Cooling Models Offer the Strongest Route to Scale

Across all three countries, high-impact first-mile cooling depends on an accountable commercial anchor. This includes cooperatives, farmer producer organisations, aggregators, daily processors. These actors can aggregate supply, improve asset use, reduce customer-acquisition costs, recover payments through existing value-chain relationships and link cooling services directly to markets. The anchor is rarely created by the cooling business. It usually exists already, which is why organised dairy collection is the most reliable entry point in most markets and why horticulture depends on whether a cluster, cooperative or export chain is already in place.

The analysis highlights three particularly promising opportunities:

🇮🇳 India: Anchor-Led First-Mile Cooling

India presents the most mature opportunity for commercially viable first-mile cooling. Strong agricultural aggregation structures, existing cold-chain infrastructure and sizeable commodity clusters create favourable conditions for pre-cooling and chilling systems owned by Farmer Producer Organisation (FPOs), cooperatives and processors.

🇰🇪 Kenya: Cooperative-Led Horticulture and Dairy Cooling

Kenya’s strongest opportunity lies in domestic horticulture and dairy value chains. Although further market building is required, cooperative- and aggregator-led models can address both utilisation and payment risks while delivering material farmer-income benefits.

🇳🇬 Nigeria: Integrated Cold-Chain Corridors

Nigeria’s greatest cooling opportunity lies not in isolated cold rooms but in integrated cold-chain services combining aggregation, storage, refrigerated transport and market linkage. Because losses occur across multiple stages of the value chain, corridor-based service models offer substantially greater impact than standalone cooling assets.

Downstream Refrigeration Is Commercially Easier but Has Lower System-Wide Impact

Commercial refrigeration for retailers, food-service businesses and microenterprises is among the most commercially mature cooling opportunities. Users typically observe immediate benefits through reduced spoilage, improved inventory management and higher sales, while daily cash flows support repayment.

However, these models primarily benefit individual enterprises and contribute less to solving the larger first-mile food-loss challenge. As a result, they offer stronger commercial scalability but lower aggregate development impact than first-mile cooling systems.

The analysis also finds that cooling assets have high upfront costs, long payback periods and slow cash cycles, while available finance is often designed for faster-moving businesses. Smaller productive-use suppliers also face collateral requirements, high interest rates and funding ticket sizes that are often above their needs.

Implications for Investors, Donors and Ecosystem Builders

1. Scale requires business-model innovation, not only technology innovation

Across both sectors, the central challenge is no longer technology development. Effective cooling and cooking technologies already exist. The primary challenge is designing business models that align customer incentives, financing structures, utilisation patterns and service delivery.

2. Identify the anchor and the task before funding equipment

For first-mile cooling, aggregation is part of the business model. The asset should be anchored by an existing cooperative, aggregator, processor or off-taker that can concentrate volumes and connect producers to buyers.

For cooking, the task comes first. An appliance creates value where it matches the customer's menu, cooking volume and power supply. Finance, appliance selection, training and after-sales support are therefore critical components of the value proposition.


PHOTO: FARMERS TREND, FARMERSTREND.CO.KE

3. Use commercial capital for proven models and concessional capital to address early gaps

The models easiest to scale in the near term do not always have the greatest potential to increase incomes. Commercial capital should support configurations where customer value, asset use and repayment are already visible. DFIs, foundations and other funders should use time-bound grants and concessional finance to remove the specific barriers limiting higher-impact models and create a path to commercial finance.

4. Measure sustained use not just access

Equipment sales do not show whether customers use the solution regularly or receive lasting value from it. Investors should assess evidence of sustained use and repayment to judge whether the business can generate reliable revenue. Likewise, donors should assess whether their support produces real income, productivity and climate benefits.

Conclusion: Which Business Models Show the Greatest Potential to Scale?

The analysis suggests that the highest-potential configurations differ between cooling and commercial cooking.

For **commercial cooking**, the strongest near-term opportunities are:

PAYGO-financed electric cooking for fixed food businesses in Kenya.	Task-specific financed eCooking for fixed food businesses in India.	Recurring LPG and selective eCooking models for defined commercial segments in Nigeria.

For **sustainable cooling**, two distinct opportunities emerge:

Anchor-led pre-cooling packhouses, milk chilling and cold storage in organised agriculture clusters.	Financed commercial refrigeration for retailers and food businesses where value is directly captured by the user.

The analysis shows that the cooling configuration with the greatest development impact is not the one with the clearest commercial route. Both are demonstrated in practice. What separates them is access to finance that reaches the buyer, not the strength of the underlying model.

> What separates them is access to finance that reaches the buyer, not the strength of the underlying model.

Overall, the report concludes that the greatest potential for both commercial scale and development impact lies not in standalone technologies but in business model configurations that combine productive-use assets with aggregation, finance, service delivery and market linkage. Ventures that can align these elements are most likely to achieve sustainable commercial growth while meaningfully increasing incomes, strengthening livelihoods and reducing emissions across Kenya, Nigeria and India.

01

CHAPTER

Introduction

1.1

Introduction

The Development and Commercial Opportunity

Sustainable cooling and commercial clean cooking technologies have the potential to improve incomes, strengthen livelihoods, and enhance resilience for low income customers across Africa and Asia while reducing greenhouse gas emissions. Their value is particularly important for smallholder farmers, food vendors and other microentrepreneurs whose incomes depend on perishable products, energy-intensive activities or the ability to serve customers efficiently.

For smallholder farmers and agricultural value-chain actors, access to cooling can reduce post-harvest losses, maintain food quality and safety, and provide greater flexibility over when and where produce is sold. Globally, an estimated 14% of food produced for human consumption is lost before reaching consumers. The absence of effective refrigeration contributed to the loss of approximately 526 million tonnes of food, equivalent to about 12% of global food production in 2017. Post-harvest losses are also estimated to reduce the incomes of around 470 million small-scale farmers by as much as 15%.[1, 2, 3]

Cooling therefore represents more than a food-preservation technology. When incorporated into a functioning agricultural value chain, it can help farmers reduce distress sales, access higher-value markets, improve food security and adapt to rising temperatures and increasingly unpredictable production conditions. However, the environmental benefits depend on the technologies used. Conventional cold chains can be energy-intensive and may rely on high-global-warming-potential refrigerants. Sustainable cooling must therefore combine expanded access with energy-efficient equipment, clean energy sources, appropriate refrigerants and effective end-of-life management.[2, 4]

526 million tonnes

Of food lost annually due to inadequate refrigeration

14%

Of all food produced for human consumption is lost before it reaches consumers

470 million

Small-scale farmers see incomes cut by up to 15% from post-harvest losses

Commercial clean cooking technologies offer a parallel opportunity for food-related businesses. Electric pressure cookers, induction cookers, efficient Liquefied Petroleum Gas (LPG) appliances and other modern cooking solutions can reduce cooking time, lower or stabilise fuel expenditure, improve working conditions and enable businesses to serve more customers. Recent research supported by Shell Foundation and the Modern Energy Cooking Services programme found that more than 80% of surveyed women-led food businesses in Kenya and Tanzania identified time savings as the main reason for purchasing induction cookstoves. In Kenya, more than 73% of participating businesses reported increased sales after adoption, with most attributing the increase to faster cooking and improved ability to serve customers during peak periods.[5]

These productive-use applications create a direct connection between clean energy access and income generation. Unlike household appliances that are purchased primarily for consumption or convenience, cooling and cooking technologies used by enterprises can generate financial returns through higher sales, lower losses, reduced costs or increased productivity. This creates the possibility that customers can repay the cost of an appliance or service from the additional income it helps generate. Despite this potential, many sustainable cooling and commercial clean cooking solutions have struggled to move beyond donor-supported pilots or reach commercially sustainable scale.

PHOTO: SHELL FOUNDATION, SHELLFOUNDATION.ORG

1.2

Existing Technologies Already Demonstrate Value

The scaling challenge is not primarily the absence of effective technologies. A range of cooling solutions are already being used by farmers, cooperatives, aggregators and microenterprises. These include energy-efficient and solar-powered refrigerators, milk chillers, modular cold rooms, packhouses, refrigerated vehicles, insulated containers and commercial display refrigerators.

Shell Foundation's research on *Productive Use of Energy Solutions for Microentrepreneurs* identified 49 cooling suppliers serving microenterprises across Kenya, Nigeria and India. These businesses target fish, meat, dairy, horticulture and beverage value chains through a combination of standalone refrigeration, walk-in cold rooms and cold-chain logistics services. The wider study found that market fragmentation, high upfront prices, low customer awareness, limited last-mile distribution and mismatches between enterprise financing needs and available capital continue to constrain adoption.[6]

WHAT DO WE MEAN BY "PRODUCTIVE USE"?

This report focuses specifically on cooling and cooking technologies used commercially — to earn income, reduce waste, or improve livelihoods — not for domestic household use. A solar refrigerator at a dairy collection point, a cold room at a smallholder cooperative, or an induction stove at a market vendor's stall all qualify. This distinction matters because productive-use contexts create clearer revenue streams, stronger repayment motivation, and more scalable business models than household use alone.

The evidence suggests that well-matched cooling solutions can improve enterprise performance:

- In India, 70% of microenterprises in one sample that acquired a refrigerator reported an average monthly profit increase of US$57.[6]

- In Kenya, a pilot involving 20 dairy farmers found that access to solar-powered refrigeration reduced spoilage, increased sales and raised daily operating profit by 123%.[7]

+123%

Daily operating profit increase for smallholder dairy farmers following introduction of solar-powered refrigeration

- Across Kenya, Nigeria and India, cold-chain market assessments identify substantial unmet demand in the fruit and vegetable, dairy, fish and meat value chains, although the nature of this demand and the maturity of existing infrastructure vary considerably by country. [8, 9]and solar-powered refrigerators, milk chillers, modular cold rooms, packhouses, refrigerated vehicles, insulated containers and commercial display refrigerators.

The evidence base for commercial clean cooking is also developing. Modern cooking appliances can reduce the time required to prepare food, improve consistency, reduce exposure to smoke and heat, and allow vendors to complete more cooking cycles during busy periods. However, the commercial returns vary according to appliance efficiency, energy tariffs, fuel prices, menu composition, cooking volumes and the reliability of the energy supply.

Recent evidence shows that electric cooking can generate measurable commercial value for food businesses:

- In a three-month study involving 760 vendors in Delhi and Bihar, 75% reported an increase in income, while 71% reported net monthly savings.

- A separate study involving nearly 400 women-led food businesses in Kenya and Tanzania, supported by usage data from 2,457 connected induction stoves, found that more than 80% of businesses identified time savings as the main reason for adoption. In Kenya, 73% reported increased sales, while average monthly fuel savings were approximately US$20 per business in Kenya and US$29 in Tanzania. [10, 11]

The ROI Case for Productive-Use Technology

REFRIGERATION (INDIA) VS. ELECTRIC COOKING (DELHI/BIHAR)

INDIA	DELHI / BIHAR
70% → US$57	75% vs 71%
Share of microenterprises that acquired a refrigerator vs. their average monthly profit increase	Vendors reporting increased income vs. vendors reporting net monthly savings after adopting electric cooking

Importantly, adoption does not generally involve an immediate or complete transition from one fuel to another. Many businesses continue to combine modern appliances with charcoal, firewood, kerosene or LPG. This practice, commonly known as fuel stacking, allows businesses to manage electricity interruptions, prepare dishes that require different heat profiles and respond to fluctuations in fuel prices. It also means that the benefits of adopting a clean cooking appliance should not automatically be treated as equivalent to the complete displacement of traditional fuels.

These patterns show why product-market fit matters. Commercial cooking appliances do not always suit local cuisines, cooking methods, pot sizes or the demands of peak periods. Electric appliances may also be limited by poor power quality or insufficient connection capacity. Experience in Kenya illustrates how the viability of electric cooking depends not only on appliance availability but also on electricity reliability, clean cooking policy, mobile-money infrastructure and the wider ecosystem of energy and finance providers.[12]

The central challenge is therefore not whether these technologies can create value. It is whether the right combination of technology, customer segment, delivery model, enabling infrastructure and finance can produce sufficient value for customers while also supporting a viable and scalable enterprise.

> “The central challenge is not whether these technologies can create value. It is whether the right combination of technology, customer segment, delivery model, enabling infrastructure and finance can produce sufficient value for customers while also supporting a viable and scalable enterprise.

1.3

Business Models Currently Being Tested

Several approaches have emerged to make cooling and commercial cooking technologies more accessible. These can be grouped into three broad business-model categories.

Individual Asset Ownership

Under this model, an individual farmer, food vendor or microenterprise acquires an appliance through an outright purchase, credit arrangement, pay-as-you-go financing or lease-to-own agreement. The model is most applicable to smaller, standardised assets such as refrigerators, freezers, induction cookers and efficient LPG stoves.

Asset ownership gives customers control over how and when the equipment is used and allows them to retain the full value generated by the appliance. However, adoption depends on the customer's ability to finance the initial cost or make regular repayments from often low and variable business income.

BURN, for example, has supplied pay-as-you-go induction cookstoves to women-led food businesses in Kenya and Tanzania. These arrangements lower the initial payment required from the customer and can align repayments more closely with business cash flows. Nevertheless, they transfer working-capital requirements and credit risk to the supplier or financing partner.

Shared Infrastructure and Pay-Per-Use Services

Shared or cooling-as-a-service models are more common for expensive assets that individual customers cannot fully utilise or afford. The supplier, cooperative or specialised operator retains ownership of the infrastructure, while users pay according to the quantity stored, the number of crates or pallets, the duration of storage, or the distance over which products are transported.

The approach can spread asset costs across multiple users, reduce the customer's upfront expenditure and place responsibility for maintenance with a specialised operator. However, commercial viability depends on achieving high and consistent asset utilisation. Seasonal production, dispersed customers and irregular volumes can leave facilities underused for significant periods. The operator must also manage customer aggregation, payment collection, energy supply, maintenance and, in some cases, links to transport and markets.

Enterprise Sales, Leasing and Service Contracts

A third category involves larger systems supplied to cooperatives, aggregators, agribusinesses, logistics companies or institutional kitchens. Revenues may come from equipment sales, leasing, maintenance contracts or longer-term service agreements.

For example, InspiraFarms supplies cooling systems and packhouses to agricultural enterprises in Kenya, including through lease-to-own arrangements. These business-to-business models can reduce customer-acquisition and servicing costs because a single transaction may reach a larger group of end users. They can also benefit from the stronger balance sheets, established supply relationships and more predictable throughput of cooperatives and aggregators.

However, they require suppliers to develop longer sales pipelines and meet the procurement, performance and reporting requirements of larger organisations. They may also create concentration risk if the supplier becomes dependent on a small number of institutional customers.

These three categories are not mutually exclusive. A venture may combine equipment sales with maintenance contracts, operate some assets directly while leasing others, or use an aggregator as both a customer and a distribution partner. The key question is not which model is theoretically preferable, but which model best aligns asset cost, utilisation, customer cash flow, value-chain structure and the supplier's financing capacity.

PHOTO: INSPIRAFARMS, INSPIRAFARMS.COM

1.4

Why Promising Cooling and Cooking Businesses Struggle to Scale

Despite technological improvements and experimentation with different delivery models, relatively few ventures have achieved large-scale commercial adoption. The barriers can be organised into four interrelated areas: customer economics, product and operating fit, value-chain integration, and enterprise economics.

Customer Economics and Affordability

The first challenge is developing a proposition that generates sufficient financial value for the customer. For a farmer or microenterprise, the expected increase in income or reduction in costs must justify the appliance price, financing cost, energy expenditure, maintenance requirements and operational risk.

Reducing the initial payment through credit, leasing, pay-as-you-go or pay-per-use arrangements can improve accessibility, but it does not remove the underlying affordability constraint. If the technology does not generate sufficient value, extending the repayment period may only delay default rather than resolve the problem.

Payment structures must also reflect the customer's cash flow. Agricultural income is often seasonal, while food-vendor revenues can vary daily according to demand, location and commodity prices. Financing products based on fixed monthly repayments may therefore be poorly suited to these businesses. More appropriate structures may include seasonal repayments, usage-based payments, revenue-linked financing or repayment schedules with initial grace periods.

Macroeconomic conditions can further weaken affordability. In Nigeria, high inflation, tight financial conditions, infrastructure gaps and regulatory uncertainty have increased the cost of doing business and constrained private investment. Currency depreciation also raises the local-currency cost of imported appliances and replacement parts, while reducing the real value of repayments collected over time.[6, 13, 14]

Product-Market Fit, Infrastructure and After-Sales Support

Technology performance under controlled conditions does not guarantee commercial value in the customer's operating environment. Cooling solutions require appropriate capacity, sufficient throughput, reliable energy and accessible maintenance. Cooking appliances must accommodate existing menus, cookware, preparation methods and service patterns.

Infrastructure reliability is particularly important. A cooking appliance cannot deliver consistent productivity gains if the electricity connection cannot support its power requirements. Similarly, a cold room may fail to preserve produce if power interruptions are frequent or if there is no backup system. Off-grid and solar-powered systems can address some of these problems, but they may have higher initial costs and require careful sizing to match demand.

After-sales support is equally important. Where technicians and spare parts are unavailable, even a minor fault can leave a productive asset out of operation for an extended period. For low-income customers, this represents both lost income and an ongoing repayment obligation. Consequently, training, warranties, maintenance arrangements, spare-parts availability and response times should be treated as part of the customer proposition rather than as secondary features.

Value-Chain Integration and Asset Utilisation

Cooling faces an additional value-chain constraint. Extending shelf life does not automatically increase income. Farmers must also be able to aggregate sufficient volumes, maintain quality after products leave storage, reach better buyers and negotiate prices that justify the cost of cooling.

A cold room may therefore perform well technically but remain commercially underutilised because production is seasonal, farmers are geographically dispersed, customers are unaware of the service or the facility is not connected to transport and offtake. UNEP and FAO emphasise that cold-chain development requires an end-to-end systems approach covering production, pre-cooling, storage, transport, distribution, energy and market access rather than isolated investment in refrigeration equipment.[1,2,4]

This has important implications for business-model design. Cooling companies may need partnerships with aggregators, cooperatives, logistics providers, processors, financial institutions and buyers. In some cases, the strongest proposition may be an integrated service that combines storage with market information, aggregation, transport or guaranteed offtake.

Enterprise Economics and Access to Appropriate Capital

The second side of commercial viability concerns the economics of the enterprise delivering the solution. Cooling and commercial cooking ventures often face high equipment and import costs, long asset-payback periods, limited working capital and expensive customer acquisition and servicing.

Demand is frequently fragmented across informal and geographically dispersed businesses. This raises the cost of identifying customers, assessing creditworthiness, installing equipment and providing after-sales services. Smaller suppliers may be unable to import equipment in bulk, establish extensive service networks or absorb significant customer defaults.

Available capital also does not always match enterprise needs. Shell Foundation's productive-use research found average minimum financing ticket sizes of approximately US$130,000 for grants, US$300,000 for debt and US$630,000 for equity. These thresholds can exclude smaller local companies seeking modest, flexible or rapidly disbursed financing. More broadly, research on productive-use energy solutions in Kenya, Nigeria and India identifies funding mismatches, high upfront costs and fragmented markets as persistent barriers to supplier growth.[6]

MINIMUM FINANCING TICKET SIZES (SHELL FOUNDATION PORTFOLIO DATA)

~US$130K
GRANT

~US$300K
DEBT

~US$630K
EQUITY

Most early-stage enterprises in this space operate well below these financing thresholds, leaving a 'missing middle' in blended finance — the critical gap this report addresses.

Results-based finance, subsidies and donor grants can help ventures demonstrate new technologies, stimulate early demand and reduce prices while markets develop. However, these instruments cannot substitute indefinitely for viable unit economics. A programme may end before a company reaches adequate scale, and a business that depends permanently on unpredictable subsidies remains vulnerable.

The relevant scaling question is therefore not whether subsidies should be used, but how catalytic funding can address specific and time-bound market failures. These may include supporting product adaptation, generating evidence, reducing the risk of entering a new market, building service networks, developing customer-finance partnerships or allowing companies to reach the volume at which procurement and servicing costs decline.

1.5

The Need for a Comparative Assessment

Existing research provides substantial evidence on the technical performance and potential benefits of individual cooling and clean cooking technologies. It also documents barriers such as affordability, limited awareness, unreliable infrastructure, weak distribution networks and limited access to finance.

However, fewer studies systematically compare how four critical factors interact:

1. The technology, including its cost, capacity, energy requirements and maintenance needs.
2. The customer segment, including income patterns, demand volumes, operating practices and willingness to pay.
3. The business model, including asset ownership, payment structure, risk allocation and revenue model.
4. The enabling environment, including energy infrastructure, value-chain organisation, policy support and access to capital.

A technology may be commercially viable for an aggregator but unaffordable for an individual farmer. A pay-per-use cold room may perform well in a densely concentrated horticultural hub but struggle in an area with dispersed production. An induction cooker may deliver strong savings for a high-volume restaurant connected to reliable electricity but offer limited value to a low-volume vendor who prepares dishes requiring prolonged or specialised cooking.

Assessing these factors separately can therefore produce misleading conclusions. The potential for scale depends on how well they align within a particular market and value chain.

1.6

Scope of the Report

This report examines sustainable cooling and commercial clean cooking business models in Kenya, Nigeria and India. These countries represent important markets for Shell Foundation's mission to raise incomes while reducing emissions among smallholder farmers, transporters and microentrepreneurs in Africa and Asia.[15]

They also provide a useful basis for comparison because they have different levels of energy access, cold-chain infrastructure, market maturity, policy development and access to finance. Previous market assessments have identified substantial potential demand for cold-chain infrastructure across all three countries, alongside country-specific gaps in infrastructure, financing, regulation and business-model development.[8,9]

The countries are also relevant to the Sustainable Innovation Seed Accelerator delivered by Shell Foundation and 500 Global, which supports early-stage climate-technology ventures operating in sectors including energy, agriculture and mobility.

The analysis focuses on productive and commercial applications rather than household adoption.

Cooling and Cooking Customers and Applications

SECTOR	CUSTOMERS	TECHNOLOGIES CONSIDERED
Sustainable Cooling	Smallholder farmers and farmer organisations; fishers; dairy cooperatives; aggregators and processors; produce vendors; food retailers; cold-chain and logistics providers.	Pre-cooling and milk chilling; modular cold rooms; standalone and display refrigerators and freezers; insulated storage; refrigerated transport.
Commercial Clean Cooking	Street-food vendors; market-based food businesses; restaurants and cafés; caterers; institutional kitchens; agricultural and food-processing enterprises.	Electric pressure cookers; induction cookers; other energy-efficient electric appliances; commercial LPG equipment where it is less polluting or more efficient than existing cooking practices.

The report provides a comparative, top-down assessment of specific cooling and commercial cooking configurations in the three countries. Each configuration is assessed using the supply-side and demand-side readiness framework presented in Section 4. The analysis considers customer value, affordability, technology fit, infrastructure requirements, asset utilisation, enterprise economics, access to finance and the wider enabling environment.

1.7

Research Question

The report is guided by the following overarching research question:

Which business models have the greatest potential to scale sustainable cooling and commercial clean cooking technologies in Kenya, Nigeria and India while delivering both commercial viability and measurable development impact?

To answer this question, the analysis considers four supporting questions:

Customer Value

Which technologies generate the strongest income, cost-saving, productivity or resilience benefits for different customer segments?

Affordability

Under what pricing, financing and payment structures can low-income customers adopt and continue using these technologies?

Business Viability

Which models provide suppliers with sufficient revenue, utilisation and margins to cover acquisition, financing, maintenance and servicing costs?

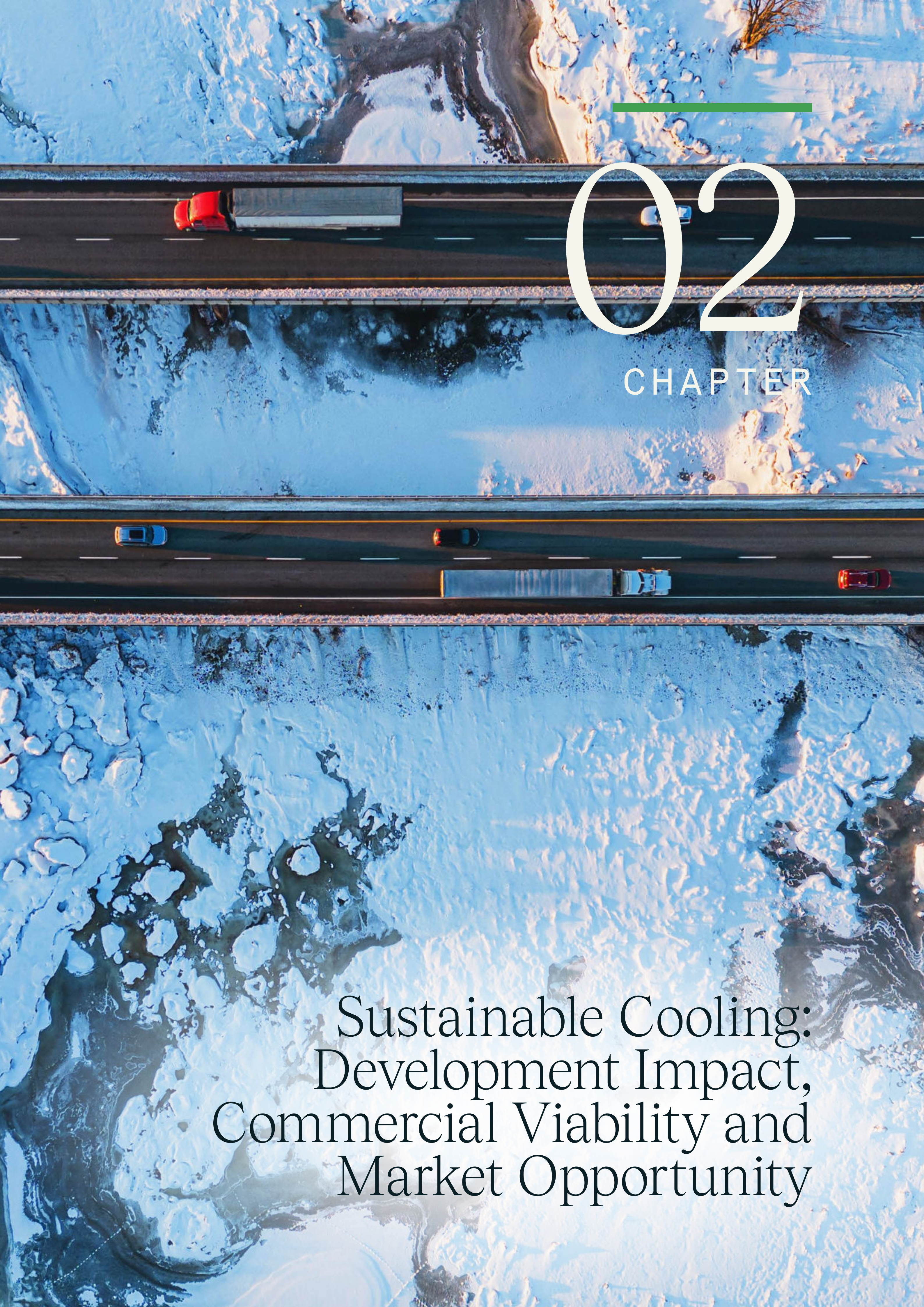
Enabling Conditions

What infrastructure, partnerships, policies and value-chain relationships are required for each model to succeed?

Scalability and Impact

Taken together, the answers to these four questions inform the assessment of which configurations can expand beyond pilots while continuing to serve low-income customers, reduce emissions and strengthen livelihoods.

This framing moves the analysis beyond identifying promising technologies. It focuses instead on the configurations in which technology, customer demand, business-model design, market infrastructure and capital are sufficiently aligned to support durable commercial scale and development impact.



02

CHAPTER

Sustainable Cooling: Development Impact, Commercial Viability and Market Opportunity

2.1

Why Sustainable Cooling Matters

The case for sustainable cooling begins with a widely documented development challenge. Across many agricultural value chains, inadequate temperature management leads to significant food loss, lowers product quality, constrains market access and reduces the incomes of producers, traders and food businesses. These challenges are particularly acute in emerging markets, where agricultural production is often fragmented, logistics infrastructure is underdeveloped and access to reliable electricity remains inconsistent.[1,2]

Sustainable cooling technologies can help address these constraints by reducing post-harvest losses, extending shelf life, preserving product quality and enabling producers to access higher-value markets. Beyond improving incomes, they can contribute to food security, strengthen resilience to climate-related shocks and reduce the emissions associated with food loss and waste. UNEP and FAO estimate that inadequate refrigeration contributes to the loss of approximately 526 million tonnes of food annually worldwide, representing around 12% of global food production. Sustainable cold chains therefore offer both economic and environmental benefits.[1,2]

However, cooling technologies do not automatically create value simply because they are installed. The commercial value generated by a refrigerator, cold room or refrigerated vehicle depends on several factors:

1. The perishability of the commodity being served
2. Where losses occur within the value chain
3. The volume and concentration of production
4. Distance to end markets
5. The ability to aggregate demand and achieve high utilisation
6. Whether the actor paying for cooling captures the value created by it

These conditions vary considerably across Kenya, Nigeria and India. As a result, cooling technologies that may be highly effective in one market or value chain can struggle to achieve commercial viability in another.

2.2

Why This Report Focuses on Productive Use Cooling

This report adopts a productive-use perspective, reflecting Shell Foundation's broader strategy of supporting clean energy solutions that directly raise or protect incomes among low-income customers.

Productive use of energy refers to energy consumed for agricultural, commercial or industrial activities that generate income. Within this framework, cooling is valuable because it can directly influence business performance.

For example:

- Farmers can reduce post-harvest losses and delay sales until prices improve
- Traders can reduce spoilage during transport and storage
- Retailers can stock more perishable products and reduce wastage
- Food businesses can expand inventory and increase sales

These outcomes generate measurable economic value that can be compared against the costs of acquiring, financing and operating cooling equipment.

This creates a clearer basis for assessing commercial viability than household refrigeration. Although household cooling may improve welfare and food security, the pathway between appliance ownership and income generation is indirect. In contrast, productive-use cooling generates value through identifiable commercial activities and revenue streams.

Previous Shell Foundation research highlights the significance of this market. Of 153 productive-use energy suppliers identified across Kenya, Nigeria and India, 49 supplied cooling products or services. Their customers included smallholder farmers, market traders, grocers, food vendors, restaurants and enterprises operating within horticulture, dairy, fish, meat and beverage value chains. As a result, this report focuses primarily on cooling used by:

- Smallholder farmers
- Farmer organisations and cooperatives
- Aggregators and traders
- Logistics providers
- Retailers
- Food-service businesses

2.3

Where Cooling Creates Value

Cooling applications span multiple sectors, including food systems, healthcare, industrial processes, transport and buildings. However, the greatest relevance for income generation lies within the food cold chain.

THE FOOD COLD CHAIN AND THIS REPORT'S FOCUS

Primary production storage → Transport refrigeration → Retail and commercial refrigeration → Household refrigeration → Industrial and process cooling

REPORT FOCUS

Drawing on UNEP, World Bank and industry frameworks, the food cold chain can be simplified into five segments:[16,17,18,19]

- Primary production storage
- Transport refrigeration
- Retail and commercial refrigeration
- Household refrigeration
- Industrial and process cooling

This report focuses on the first three commercially relevant segments:

- Primary production storage
- Transport refrigeration
- Retail and commercial refrigeration

Industrial processing and household refrigeration are excluded because their relationship with smallholder income generation is less direct.

The Importance of the First Mile

Most food loss in emerging markets occurs before products reach consumers. The World Bank estimates that approximately 76% of food loss and waste in Sub-Saharan Africa and 69% in South and Southeast Asia **occurs during production, handling and storage.**[20]

WHERE FOOD LOSS ACTUALLY HAPPENS

76%	of food loss/waste occurs during production, handling and storage in Sub-Saharan Africa
69%	of food loss/waste occurs during production, handling and storage in South & Southeast Asia

This makes the first mile of agricultural value chains particularly important. At this stage, cooling technologies can:

- Remove field heat from harvested produce
- Preserve quality immediately after harvest
- Reduce spoilage during aggregation
- Preserve milk before collection
- Maintain the freshness of fish and meat

The potential development impact is therefore greatest where cooling addresses losses closest to production. Yet the first mile is also the most commercially challenging part of the value chain. Production is seasonal, farmers are geographically dispersed, transaction costs are high and utilisation rates can be difficult to maintain. A key insight emerges from this tension: the parts of the value chain where cooling delivers the greatest livelihood impact are not necessarily the parts where commercial scaling is easiest.

First-Mile vs. Commercial Cooling: Why the Distinction Matters

First-Mile Cooling

PRE-COOLING AT FARM GATE, MILK CHILLING, POST-HARVEST STORAGE

Designed to reduce loss and improve product quality before goods enter the supply chain. Its value is often shared across many actors — farmers, aggregators, buyers — which makes it harder for any single entity to capture the returns needed to repay a loan.

Commercial Cooling

COLD ROOMS, RETAIL REFRIGERATION, REFRIGERATED TRANSPORT

Operates closer to the point of sale, where revenue flows are more direct and more predictable.

This distinction shapes which financing structures work, and which business models can realistically scale.

2.4

Understanding Cooling's Impact Potential

Cooling creates value through two distinct pathways:

Impact Pathways for Cooling

IMPACT PATHWAY	VALUE CREATED OR PROTECTED	COSTS OR EMISSIONS INTRODUCED
Income and Livelihoods	Reduced spoilage; higher sales; preserved quality; better pricing opportunities.	Equipment, finance, energy, maintenance and servicing costs.
Climate	Avoided emissions from reduced food loss.	Electricity use; refrigerant leakage; fuel consumption during transportation.

Net impact depends on whether the value and emissions avoided exceed the costs and emissions introduced by the cooling system. First-mile technologies generally offer the strongest potential because they intervene before food and income are lost.

2.5

Technologies Across the Value Chain

The cooling technologies most relevant to productive-use applications can be grouped into five categories.

Cooling Technologies and Their Impact Potential

TECHNOLOGY	ROLE AND APPLICATION	IMPACT AND LIMITATIONS
Pre-Cooling	Removes field heat immediately after harvest.	It typically offers the highest development impact because it intervenes before significant deterioration occurs. However, it requires concentrated volumes and strong aggregation systems to achieve sufficient utilisation.
Chilling	Preserves dairy, horticulture, fish and beverages as they move through the supply chain.	It preserves quality while allowing products to move through the supply chain over longer periods. Chilling often generates strong economic returns where sufficient throughput exists.
Freezing	Freezing is most relevant for fish, meat and selected processed products.	While it allows substantially longer storage periods, it involves higher capital and energy costs, limiting its viability to specific customer segments and value chains.
Refrigerated Transport	Temperature-controlled transport connects production areas to markets.	The impact can be significant in countries where products travel long distances. However, capital intensity and uncertain utilisation frequently make third-party logistics models more viable than individual ownership.
Retail and Commercial Refrigeration	Display refrigerators and freezers support retailers and food-service businesses.	Although their contribution to system-wide food loss reduction is more modest, they often provide the clearest and most immediate commercial value proposition because business owners can directly observe increased sales and reduced wastage.

2.6

Business Models Emerging in Sustainable Cooling

Three business models currently dominate the sector.

MODEL 1

Individual Asset Ownership

Customers purchase equipment outright. This model works best where customers have sufficient capital and can clearly quantify the value created by cooling. It is most common among retailers, restaurants and larger enterprises. It is common for smaller assets like refrigerators and freezers.

MODEL 2

Shared Infrastructure and Pay-Per-Use Services

Shared or cooling-as-a-service models are more common for expensive assets. The supplier, cooperative or specialised operator retains ownership of the infrastructure, while users pay according to the quantity stored. Cold-room operators such as ColdHubs and Ecotutu in Nigeria, and providers such as Ecozen in India, use variants of this model.

Third-party logistics (3PL) is also categorized under this model. For instance, a specialist provider offers refrigerated storage or transport services. This model is particularly relevant for larger agricultural value chains where scale and route density justify dedicated logistics investments. Customers acquire equipment through loans or lease-to-own arrangements. This model improves affordability by spreading costs over time and aligning repayments with future income generation.

MODEL 3

Enterprise Sales, Leasing and Service Contracts

A third model involves larger systems supplied to cooperatives, aggregators, agribusinesses or logistics companies. Revenues may come from equipment sales, leasing, maintenance contracts or longer-term service agreements.

2.7

The Market Opportunity Differs by Country

Although cooling technologies are broadly similar across markets, commercial opportunities differ substantially because production systems differ.[21]

🇰🇪 Kenya

Kenya has the most perishability-intensive agricultural profile among the three markets.

- Horticulture represents a large share of agricultural production
- Dairy is economically significant
- Smallholder participation is high
- Export-oriented value chains already utilise cold chain infrastructure

The largest opportunity exists in extending cooling solutions beyond export chains and into domestic horticulture and dairy markets.

🇳🇬 Nigeria

Nigeria combines large production volumes with weak cold chain continuity. Agricultural products frequently travel hundreds of kilometres between production zones and urban consumption centres.

The principal challenge is not the absence of cooling assets alone but the absence of connected cold chains. Isolated cold storage facilities often fail to address losses occurring elsewhere during transport and distribution.

🇮🇳 India

India possesses the largest agricultural production base and the most developed cold chain ecosystem. The challenge is less about overall storage capacity and more about the uneven distribution of infrastructure. Large opportunities remain in:

- Farm-level aggregation
- Packhouses
- Pre-cooling facilities
- Temperature-controlled logistics for horticulture

The greatest opportunities therefore lie in closing first-mile gaps rather than expanding generic cold storage capacity.

2.8

Where the Opportunity for Commercial Scaling Exists

The evidence suggests that commercial scaling opportunities do not necessarily align with the areas of greatest technical impact. From a purely development perspective, first-mile pre-cooling and chilling offer the strongest potential to reduce losses, increase farmer incomes and lower emissions. However, these applications operate in fragmented and highly seasonal environments where utilisation is difficult to maintain and customer affordability remains a persistent challenge.

> Cooling alone rarely resolves the underlying market constraint.

Consequently, the most scalable opportunities are likely to emerge where three conditions are present simultaneously:

CONDITION 1

The User Directly Captures the Value Created

Cooling propositions are strongest when the customer paying for the solution can clearly observe and monetise the benefits. This favours:

- Aggregation services
- Logistics
- Market access
- Working-capital finance
- Quality assurance
- Offtake arrangements

By contrast, farmer-owned assets are less attractive where benefits are distributed across multiple actors in the supply chain.

CONDITION 2

Demand Can Be Aggregated

Utilisation is a critical determinant of commercial viability. The strongest opportunities are therefore likely to involve:

- Cooperatives
- Farmer producer organisations
- Aggregators
- Collection centres
- Wholesale markets
- Large institutional buyers

These entities can consolidate volumes, spread costs across multiple users and provide more predictable revenue streams for operators.

CONDITION 3

Cooling Is Integrated into a Wider Commercial Service

Cooling alone rarely resolves the underlying market constraint. The most promising businesses increasingly combine cooling with:

- Cooperatives
- Farmer producer organisations
- Aggregators
- Collection centres
- Wholesale markets
- Large institutional buyers

In these models, cooling becomes part of a broader value proposition rather than a standalone asset.

Implications by Market

🇰🇪 Kenya

The most attractive scaling opportunities lie in horticulture and dairy value chains through cooperative and aggregator-led models that combine chilling, aggregation and market access.

🇳🇬 Nigeria

The largest opportunities lie in integrated cold-chain platforms that combine storage, transport and coordination across long-distance supply chains, rather than isolated cooling assets.

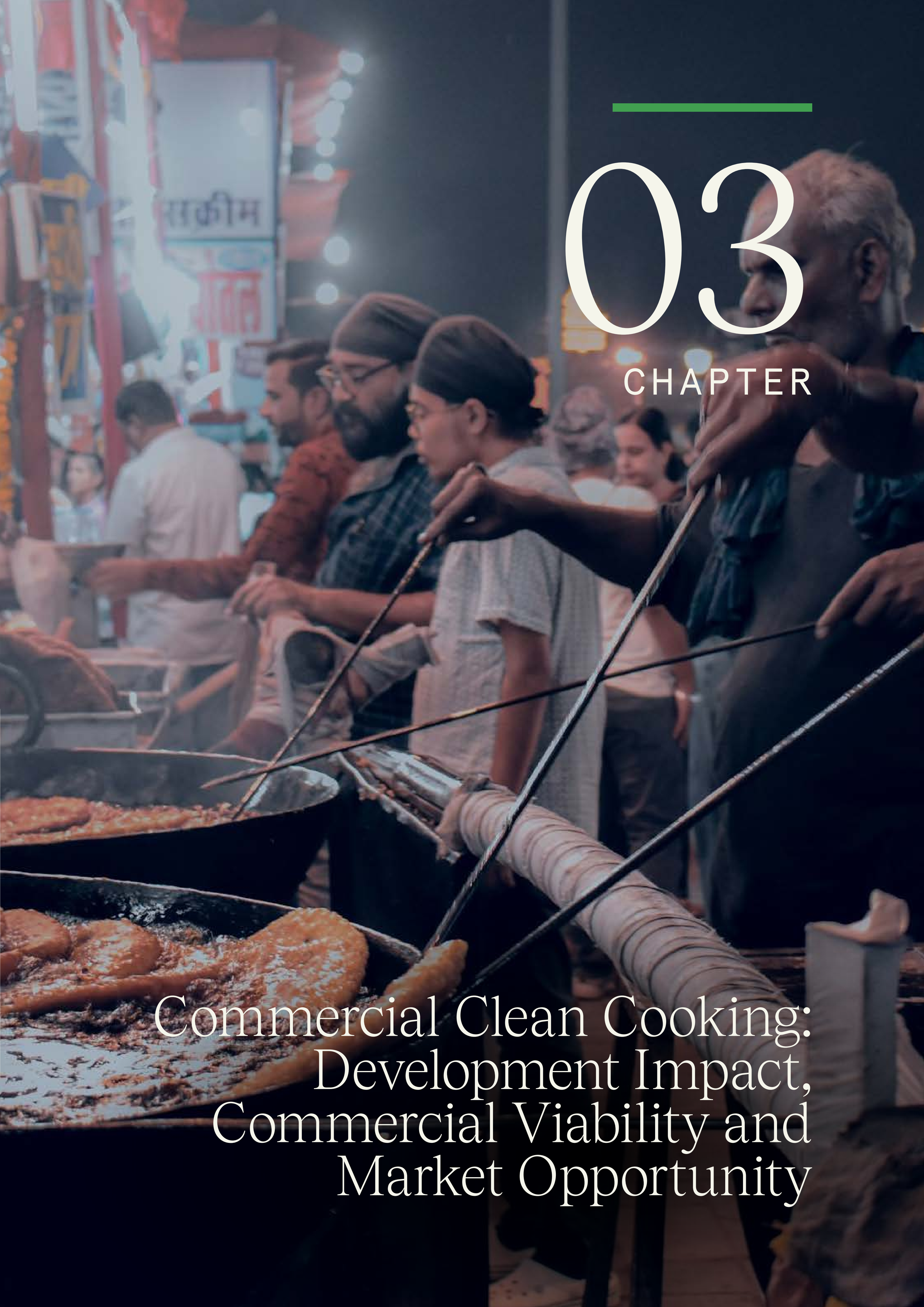
🇮🇳 India

The greatest commercial potential exists in first-mile horticulture infrastructure, including pre-cooling, packhouses and aggregation platforms linked to established market channels.

Conclusion

The most promising route to scale is not the sale of individual cooling technologies, but the development of business models that embed cooling within existing agricultural and commercial systems. Ventures that can connect into existing aggregated demand structures, and help build where it is missing, are best placed to scale. This means selecting anchors that already manage volume, manage member's payments and capture enough of the value of better quality. Ventures that combine this with complementary services like market linkages, grading are likely to achieve both the strongest commercial performance and the greatest development impact. Such models offer the clearest pathway for scaling sustainable cooling across Kenya, Nigeria and India.

> "The most promising route to scale is not the sale of individual cooling technologies, but the development of business models that embed cooling within existing agricultural and commercial systems.



03

CHAPTER

Commercial Clean Cooking: Development Impact, Commercial Viability and Market Opportunity

3.1

Reframing the Clean Cooking Narrative

The clean cooking agenda has traditionally been framed around household energy access. Much of the existing literature focuses on reducing household exposure to harmful smoke, lowering the time burden associated with fuel collection, reducing pressure on forests and mitigating greenhouse gas emissions.[22] These objectives remain important, particularly in countries where biomass continues to dominate household cooking.

> A stove or appliance is therefore not simply an energy device; it is a productive asset.

However, this narrative only partially captures cooking as an economic activity. For millions of food vendors, restaurants, caterers, institutional kitchens and small food processors across Africa and Asia, cooking is not primarily a household task but a productive activity that generates income. For these businesses, the choice of cooking technology affects operational efficiency, customer throughput, product quality, labour productivity and profitability. A stove or appliance is therefore not simply an energy device; it is a productive asset.

RETHINKING THE COOKING DEVICE

In a commercial context, a stove, burner or cooker is not a household appliance — it is the primary production tool of the business. A restaurant owner's induction stove is as essential to their operation as a contractor's drill or a farmer's irrigation pump.

This reframe matters for financing: productive assets can be underwritten against business revenue, not just household income. It opens the door to asset-finance structures that household-use narratives cannot access.

Commercial cooking requires a distinct analytical lens because businesses operate under different conditions from households. Their decisions are influenced by menu requirements, batch sizes, cookware, mobility, cooking duration, energy reliability and cash-flow considerations.[23] Consequently, technologies that perform well in household settings may not necessarily be the best option for commercial users.

This report focuses on commercial modern cooking, defined as the use of higher-performing cooking fuels and appliances by income-generating enterprises and institutions that provide food at scale. These technologies include:

Electric Cooking Technologies	Liquefied Petroleum Gas (LPG)	Ethanol and Other Alcohol Fuels	Biogas	High-Performing Advanced Biomass Systems

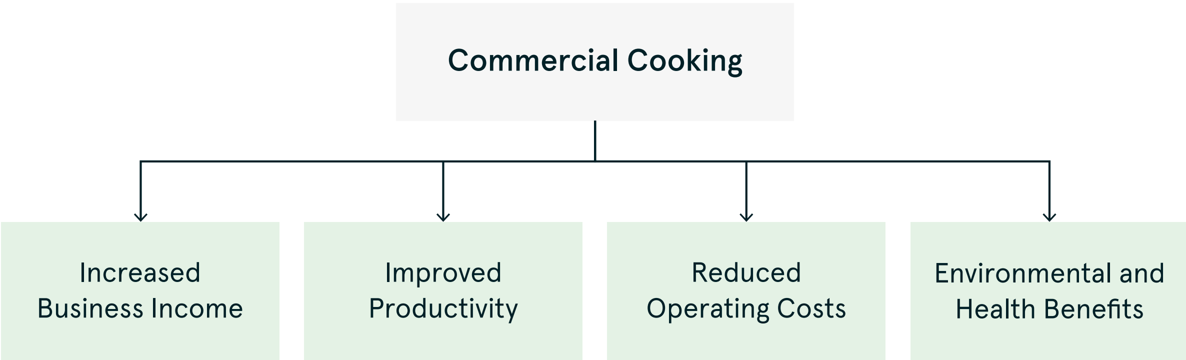
A central finding emerging from Kenya, Nigeria and India is that the strongest commercial opportunities are concentrated in food businesses where modern cooking technologies improve productivity, increase sales capacity and reduce operating costs. At the same time, different fuels continue to play important roles depending on mobility requirements, energy infrastructure, cookware needs and cooking intensity.[24]

PHOTO: INDIAN BIOGAS ASSOCIATION, BIOGAS-INDIA.COM

3.2

Where Commercial Cooking Creates Value

Commercial cooking creates value through four pathways:



The relative importance of each pathway varies by customer segment and application.

Livelihood and Productivity Benefits

The strongest commercial rationale for adopting modern cooking technologies comes from their potential to improve business performance. Income gains typically arise through three mechanisms:

How Commercial Clean Cooking Creates Livelihood Value

MECHANISM	HOW INCOME OR PRODUCTIVITY IMPROVES
Reduced Energy Expenditure	More efficient appliances can lower fuel consumption and reduce expenditure on charcoal, firewood, kerosene or LPG.
Productivity Improvements	Faster heat generation, more precise temperature control, automated cooking functions and parallel cooking can reduce cooking times. Where businesses face customer queues or production bottlenecks, these improvements can significantly increase output.
Higher Revenue	Businesses may be able to serve more customers, extend operating hours, offer additional menu items and improve product consistency.

The productive-use case is strongest where the technology removes a genuine operational constraint and enables the business to capture the resulting value. Not all enterprises benefit equally. For example:

- A low-volume vendor with spare production capacity may save time but generate little additional revenue
- A busy lunchtime restaurant may convert the same time saving directly into higher sales.

Commercial viability depends not simply on appliance performance, but on whether productivity gains translate into measurable economic value.

Climate, Health and Work Benefits

Commercial modern cooking can also generate broader social and environmental benefits.

Environmental Impact of Commercial Modern Cooking Solutions

TECHNOLOGY OR FUEL	CLIMATE IMPLICATIONS
Electric Cooking	Eliminates combustion emissions at the point of use.
LPG	Significantly reduces emissions relative to charcoal or firewood but remains a fossil fuel.
Ethanol and Biogas	Businesses may be able to serve more customers, extend operating hours, offer additional menu items and improve product consistency.
Advanced Biomass	Climate performance varies substantially depending on stove efficiency and fuel quality.

3.3

Commercial Cooking Applications

Commercial food enterprises differ in their energy needs, mobility and operating models. Commercial cooking is best understood through applications rather than technologies alone.

Applications of Commercial Cooking Technologies to Customer Segment

CUSTOMER SEGMENT	OPERATING CHARACTERISTICS	TECHNOLOGY AND BUSINESS-MODEL FIT
Mobile Vendors	Limited space, frequent movement, small batches and minimal infrastructure.	Portability, rapid startup and safe fuel storage are essential. LPG performs strongly; ethanol can work where distribution exists; advanced biomass remains relevant for high-heat cooking. Electric cooking is limited by access to reliable connections.
Fixed Kiosks, Cafés and Micro-Eateries	Fixed premises, repeated cooking cycles, consistent menus and concentrated peak demand.	Faster cooking, parallel processing, improved heat control and lower fuel costs can directly improve business performance. Studies from Kenya and India provide the strongest evidence of productivity and income gains in this segment.
Restaurants, Hotels and Caterers	Multiple cooking processes, several burners, high-temperature requirements and large cookware.	Hybrid kitchens are often most suitable. LPG can support high-heat cooking, while electric appliances perform specific tasks. Backup technologies may also be required.
Institutional Kitchens	Often has predictable meal volumes, centralised procurement, long-term contracts and large cooking loads.	Their scale can support commercial LPG, biogas, electric or high-performing biomass systems. Concentrated and predictable demand also allows them to act as anchor customers for suppliers.
Small Food Processor	Performs repetitive activities such as boiling, frying, drying, steaming and baking.	Technologies can improve consistency, process control and energy efficiency. The opportunity is strongest where the task can be easily matched to a specific technology.

The productive-use case is strongest where the technology removes a genuine operating constraint and the business directly captures the value created.

3.4

Technology Pathways and Their Commercial Potential

No single cooking technology is appropriate across all applications. Technologies should be assessed by their ability to perform the required cooking task at an acceptable cost.

Commercial Potential of Different Modern Cooking Technologies

TECHNOLOGY	STRENGTHS AND BEST-FIT APPLICATIONS	CONDITIONS AND LIMITATIONS
Electric Cooking: induction, infrared, hotplates, electric pressure cookers and multicookers	Among all technologies assessed, electric cooking currently has the strongest direct evidence of productive-use value. Benefits include high efficiency, faster cooking, precise temperature control, automation and reduced workplace pollution. Most attractive for fixed urban and peri-urban food businesses.	Requires reliable electricity, sufficient electrical capacity, safe wiring and appropriate cookware.
LPG	The most versatile commercial cooking fuel. It offers familiar cooking characteristics, high heat, portability and compatibility with existing cookware. Relevant for mobile vendors, restaurants, caterers and institutional kitchens.	Recurring fuel costs, refill logistics and price volatility can weaken affordability.
Ethanol	Occupies a niche between LPG and electric cooking.	Most viable where fuel distribution is established, quality is reliable and prices are competitive. Its commercial potential is market-specific.
Advanced Biomass	Relevant where biomass is abundant, electricity is unreliable, large pots are used and high temperatures are required.	It should not automatically be considered clean cooking. Performance depends heavily on stove design and fuel quality.
Biogas	Most relevant for institutions, cooperatives, farms and food-processing enterprises.	Requires readily available organic waste, predictable cooking loads and technical management capacity. It is generally less suited to individual micro-vendors.

3.5

Business Models Driving Adoption

Four business models currently dominate commercial cooking markets.

Direct Purchase

The customer purchases equipment outright and subsequently pays for energy separately. This model works best where businesses:

- Have available capital
- Trust the technology
- Can clearly evaluate expected returns

Financed Ownership

Equipment costs are spread over time through:

- Credit
- Lease-to-own arrangements
- PAYGO financing
- Staged-payment plans

These structures improve affordability by aligning repayments with future income generation.

Recurring Energy-Service Models

In these models, appliance adoption is linked to ongoing fuel supply relationships. Examples include:

- LPG refill programmes
- Ethanol dispensing systems
- Processed biomass supply
- Utility-supported electric cooking programmes

The value proposition combines equipment access with reliable energy provision.

Enterprise and Institutional Contracts

Larger customers often acquire systems through:

- Service agreements
- Leasing arrangements
- Installation contracts
- Long-term maintenance agreements

Such arrangements are particularly relevant for institutional kitchens and food-processing businesses.

3.6

How The Opportunities Differ Across Markets

Although similar technologies are available across Kenya, Nigeria and India, the commercial opportunity differs substantially because infrastructure[25], fuel markets and customer behaviour vary.

🇰🇪 Kenya

Kenya combines:

- A large urban food economy
- Extensive mobile money adoption
- Growing clean cooking networks
- Strong PAYGO capability

The strongest evidence currently exists for electric cooking among urban and peri-urban food businesses, particularly women-led enterprises. However, LPG, ethanol and advanced biomass continue to play important complementary roles.

🇳🇬 Nigeria

Nigeria presents the largest market opportunity in absolute terms but also the greatest infrastructure constraints. Key challenges include:

- Weak electricity reliability
- Regional variation in service quality
- High equipment costs

🇮🇳 India

India offers the strongest infrastructure foundation. Key advantages include:

- Universal electricity access
- Widespread LPG adoption
- Large informal food sector
- Increasing evidence of productive eCooking use cases

Rather than replacing LPG entirely, electric cooking is increasingly being adopted on a task-by-task basis, allowing vendors to optimise different cooking processes.

3.7

Where the Opportunity for Commercial Scaling Exists

The evidence suggests that commercial scale will not come from distributing a single cooking technology universally. Instead, scale will emerge where technology, business model and operating requirements are closely aligned.

Five conditions consistently underpin scalable opportunities.

CONDITION 1

The Technology Solves a Clear Business Problem

The strongest adoption drivers are:

- Faster cooking
- Higher throughput
- Reduced fuel expenditure
- Improved consistency

Businesses adopt technologies that improve profitability rather than technologies that simply provide environmental benefits.

CONDITION 2

The Application Comes Before the Technology

Commercial success depends on matching technologies to specific use cases. The critical variables are:

- Menu type
- Cooking task
- Cookware
- Batch size
- Mobility requirements
- Energy infrastructure

Market development should therefore begin with the customer's operational requirements rather than with the technology itself.

CONDITION 3

Fixed High-Throughput Food Businesses Represent the Strongest Entry Point

Across India and Kenya, fixed micro-enterprises provide the clearest evidence of commercial viability. These businesses typically have:

- Predictable demand
- Daily cooking volumes
- Fixed locations
- Sufficient cash flow to support repayment

Consequently, they represent the most attractive initial market for financed electric cooking solutions.

CONDITION 4

Hybrid Energy Models Will Dominate

Fuel stacking should be viewed as a rational commercial strategy rather than a failure of adoption. Businesses frequently combine:

- Electricity and LPG
- LPG and biomass
- Multiple appliance types

The most successful solutions are therefore likely to optimise specific cooking tasks rather than seek immediate full-fuel replacement.

"Fuel stacking should be viewed as a rational commercial strategy rather than a failure of adoption.

CONDITION 5

Distribution, Finance and After-Sales Support Are Critical

Commercial success depends on more than appliance performance. Scaling requires:

- Affordable financing
- Compatible cookware
- Safe electrical connections
- User training
- Demonstrations
- Responsive after-sales service

Customer support must be considered part of the product rather than a supplementary activity.

Market-Specific Scaling Opportunities

🇰🇪 Kenya

The strongest evidence currently exists for electric cooking among urban and peri-urban food businesses, particularly women-led enterprises. However, LPG, ethanol and advanced biomass continue to play important complementary roles.

🇳🇬 Nigeria

The strongest opportunity lies in segmented approaches combining LPG, selective eCooking and higher-performing biomass solutions according to local infrastructure conditions. Institutional kitchens and food processors offer particularly attractive entry points where demand can be aggregated.

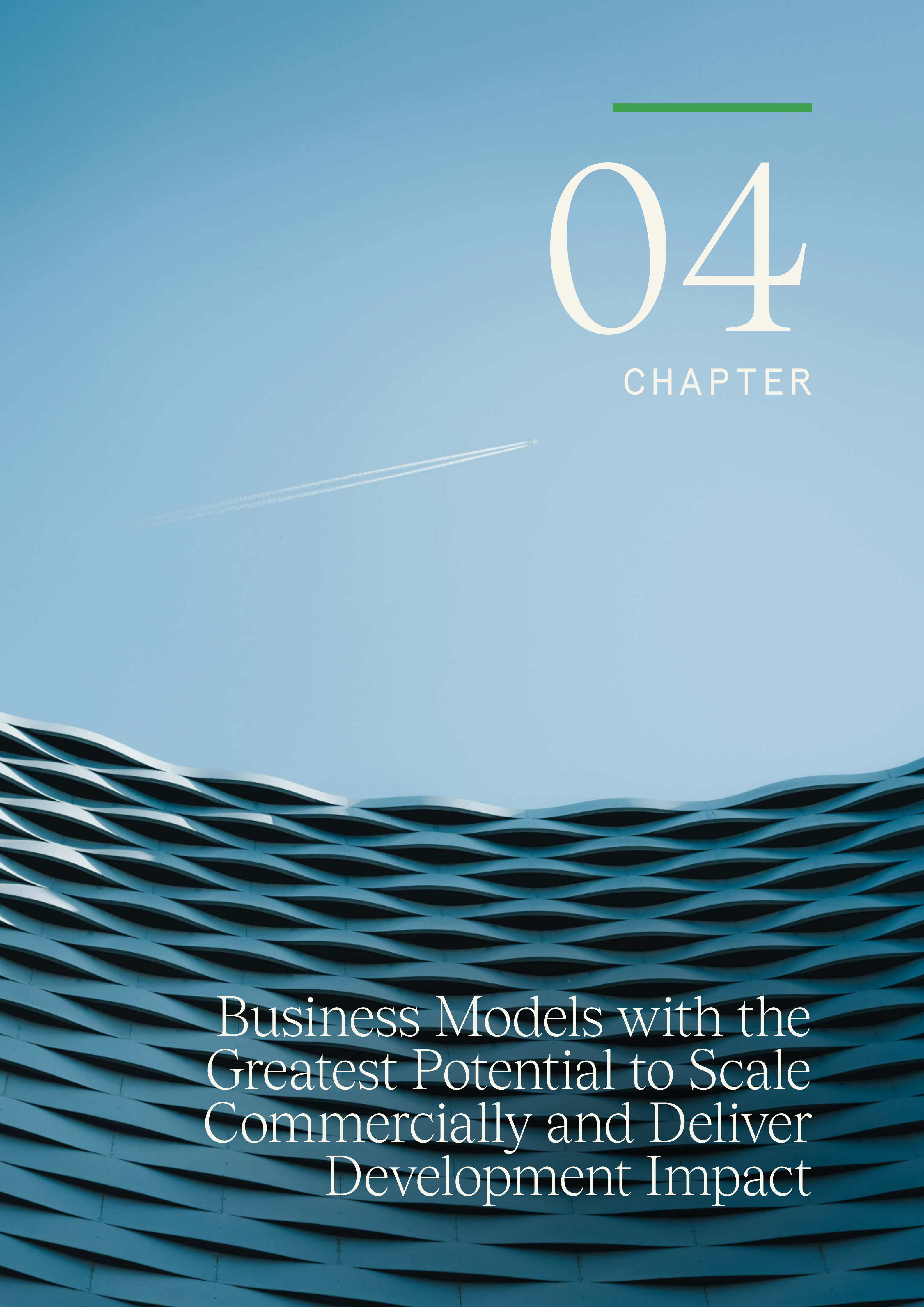
🇮🇳 India

The clearest path to scale lies in task-specific electrification among fixed food vendors and micro-enterprises. Rather than displacing LPG entirely, electric cooking technologies are most likely to scale as complementary productivity tools integrated into existing kitchens.

Conclusion

The commercial clean cooking opportunity is fundamentally a productivity opportunity. Technologies scale when they help businesses cook faster, serve more customers, reduce operating costs and improve profitability. Across Kenya, Nigeria and India, the strongest near-term opportunities are concentrated among fixed food businesses, institutional kitchens and food processing enterprises where demand is predictable, value creation is visible and the benefits of modern cooking technology can be readily monetised.

The businesses most likely to achieve scale will therefore be those that move beyond appliance sales and deliver integrated solutions combining technology, finance, training, energy access and after-sales support. These models offer the clearest route to both sustainable commercial growth and meaningful development impact.



04

CHAPTER

Business Models with the Greatest Potential to Scale Commercially and Deliver Development Impact

4.1

Moving Beyond Technologies to Business Model Configurations

The preceding chapters demonstrated that neither cooling nor clean cooking technologies scale automatically because they are technically effective. Technologies create impact only when they are embedded within a business model that aligns customer value, supplier economics, financing mechanisms and market conditions.

For example, a PAYGO refrigerator sold to a retailer, a solar cold room serving hundreds of farmers and a milk chiller operated by a dairy cooperative may all be described as cooling solutions, yet they have fundamentally different utilisation patterns, risk profiles and pathways to sustainability. Similarly, a PAYGO induction stove used by a food vendor, an LPG package supplied through recurring fuel sales and a commercial kitchen operating under an institutional service contract represent very different commercial propositions despite serving the same broad cooking market.

This report therefore focuses on **business model configurations** rather than technologies alone. A business model configuration consists of:

- The technology being deployed
- The productive-use application
- The customer or anchor buyer
- The ownership structure
- The financing and payment mechanism
- The market environment in which the model operates

This distinction is important because two common misconceptions frequently emerge in productive-use energy markets.

First, customer adoption does not necessarily indicate commercial sustainability. PAYGO, leasing and pay-per-use models may successfully increase access, but they do not automatically create viable unit economics for providers.

Second, solutions that are easiest to finance are not always those that generate the greatest development impact. A refrigerator for a retailer may be easier to sell than a farmgate cooling solution, even though upstream interventions often deliver larger benefits in terms of farmer incomes, food loss reduction and resilience. The objective of this chapter is therefore to identify the business model configurations that combine:

Commercial Scale Potential

A commercially scalable model is one where:

- Customers consistently capture sufficient value to pay for the solution
- Suppliers recover acquisition, financing, servicing and operating costs
- Replication is possible without permanent subsidy dependence

Development Impact

A high-impact model is one that:

- Raises or protects incomes for low-income customers rather than only intermediaries
- Improves resilience and working conditions
- Reduces emissions

The strongest opportunities occur where commercial viability and development impact reinforce one another.

4.2

The SS-DD Readiness Framework

To assess scalability across cooling and cooking markets, this report applies a Supply-Side and Demand-Side Readiness Framework (SS-DD Framework).

The framework recognises that promising technologies often fail to scale because either:

- Customers are unable or unwilling to pay
- Suppliers are unable to deliver sustainably
- The beneficiaries of a solution are not the same actors responsible for paying for it

The framework therefore evaluates complete business model configurations rather than individual technologies.

Supply-Side Readiness (SS)

Supply-side readiness assesses whether providers can deliver the full proposition at scale.

Key considerations include:

- Technology availability and suitability
- Distributor and installation capability
- Maintenance and repair infrastructure
- Access to energy and logistics networks
- Working-capital availability
- Growth financing

The central question is:

Can suppliers deliver and support the proposition while maintaining viable unit economics?

Demand-Side Readiness (DD)

Demand-side readiness assesses whether customers can adopt and sustain use of the solution.

Key considerations include:

- Ability and willingness to pay
- Access to finance
- Product-market fit
- Customer trust
- Operating practices
- Demand concentration and aggregation

The central question is:

Does the customer capture enough value to support sustained adoption and payment?

Alignment and Unit Economics

A third dimension assesses the balance between demand and supply (i.e. does the market function effectively enough to allocate value and risk fairly).

Specifically:

- Who owns the asset?
- Who bears utilisation risk?
- Who captures the benefits?
- Who carries repayment risk?
- How are revenues gtenerated?

The central question becomes:

Does the model align the payer with the beneficiary while creating sufficient margin for both customer and provider?

Scale Readiness Outcomes

Analysis of these three dimensions generates four possible readiness positions.

<table>
<tr><th>POSITION</th><th>WHAT IT MEANS</th></tr>
<tr><td>Scale Ready</td><td>Supply and demand conditions are aligned. Customer value is proven, provider economics are viable and commercial capital can support expansion.</td></tr>
<tr><td>Demand Constrained</td><td>Products and suppliers exist, but customer adoption remains limited. Primary barriers typically include:
Affordability
Awareness
Financing
Product-market fit</td></tr>
<tr><td>Supply Constrained</td><td>Customer demand exists but providers face constraints relating to:
Infrastructure
Distribution
Maintenance
Working capital
Delivery capability</td></tr>
<tr><td>Pre-Scale</td><td>Both supply and demand remain insufficiently developed or validated. Market-building and learning remain more important than rapid expansion.</td></tr>
</table>

4.3

Country Readiness Overview

The three markets assessed in this report exhibit fundamentally different readiness profiles.

🇮🇳 India: Strongest Overall Readiness

India benefits from:

- Extensive energy infrastructure
- Mature LPG markets
- Cold-chain institutions
- Large supplier ecosystems
- Strong agricultural aggregation structures

However, gaps remain in first-mile cooling and among informal enterprises. Overall, India offers the strongest foundation for both productive cooling and commercial cooking scale.

🇰🇪 Kenya: Strong Customer and Financing Foundations

Kenya benefits from:

- Mobile money penetration
- PAYGO capability
- Active productive-use energy markets
- Expanding clean cooking ecosystems

Customer demand is generally stronger than supplier capacity, particularly for first-mile cooling. As a result, many opportunities are demand-ready but remain supply-constrained.

🇳🇬 Nigeria: High Need, Weaker Market Readiness

Nigeria presents the largest unmet need but also the greatest scaling challenges. Constraints include:

- Electricity reliability
- Long logistics corridors
- Limited service infrastructure
- Currency volatility
- Inflationary pressures

Consequently, scalable opportunities require greater coordination and stronger anchors than in Kenya or India.

4.4

Cooling Business Models: Which Are Most Likely to Scale?

Four configurations dominate current cooling markets.

Common Business Model Configurations

CONFIGURATION	STRUCTURE AND APPLICATIONS	COMMERCIAL LOGIC AND CONSTRAINTS	ASSESSMENT
Individual Ownership	Customers purchase assets directly or through credit, lease-to-own or PAYGO. Best suited to retail refrigeration; display refrigerators and small commercial freezers.	Users directly observe the business benefits, daily revenue can support repayment and asset use remains under their control. Impact is largely concentrated at the retailer level.	Near-scale and commercially attractive, but moderate development impact.
Cooperative and Aggregator Ownership	Cooperatives, farmer producer organisations, aggregators, dairy processors or off-takers own the infrastructure and recover costs through service charges or deductions from product sales. Suited to pre-cooling, milk chilling, shared cold storage and packhouses.	Because the anchor aggregates volume and controls market access, it can manage utilisation and payment more effectively than individual farmers.	One of the strongest routes to achieving both scale and development impact.
Cooling-as-a-Service	The provider retains ownership and customers pay based on use. This expands access to capital-intensive assets without requiring customers to purchase them.	Operator economics depend heavily on utilisation, concentrated volumes and seasonal demand. Insufficient use remains the main barrier.	Strong impact potential but commercially sensitive to utilisation.
Integrated Cold-Chain Services	Providers combine aggregation, storage, refrigerated transport and market linkage rather than selling access to one asset. Particularly relevant in Nigeria, where losses occur across several stages of the value chain.	Requires significant market building and reliable demand from an anchor customer.	Highest system-level impact but requires significant market-building and anchor demand.

4.5

Commercial Cooking Business Models: Which Are Most Likely to Scale?

Three configurations dominate commercial cooking markets.

Common Business Model Configurations in Commercial Cooking

CONFIGURATION	STRUCTURE AND APPLICATIONS	COMMERCIAL LOGIC AND CONSTRAINTS	ASSESSMENT
Direct and Financed Appliance Ownership	Businesses purchase equipment outright or through PAYGO, lease-to-own or credit.	Performs best where the appliance clearly improves productivity, businesses have regular cash flows and the benefits are directly observable. Evidence from Kenya and India suggests that fixed food businesses frequently meet these conditions.	One of the most commercially scalable configurations across all markets.
Integrated Appliance and Energy Models	Equipment access is combined with ongoing energy supply. Examples include LPG cylinder-and-refill models, ethanol distribution systems and utility-supported electric cooking programmes.	The recurring relationship can improve customer retention and provide suppliers with multiple revenue streams.	Particularly attractive where energy access, rather than equipment cost, is the main barrier.
Institutional and Enterprise Contracts	Suppliers serve schools, hospitals, caterers, food processors and restaurant groups.	Aggregated demand lowers customer acquisition costs and supports larger installations. Scale depends on procurement processes, reliable payment and clear maintenance arrangements.	High-impact and potentially scalable, but slower to develop than SME-focused models.

4.6

Which Business Models Show the Greatest Potential to Scale?

The analysis suggests that a relatively small number of configurations combine strong customer economics with meaningful development impact.

TIER 1

Strongest Commercial Scaling Opportunities

🇰🇪 Kenya: Financed Electric Cooking for Fixed Food Businesses

This is currently the clearest pathway to rapid scale. The model benefits from:

- Proven productivity gains
- Daily customer cash flows
- PAYGO infrastructure
- Mobile money adoption

Customer value and supplier economics are already sufficiently aligned to support replication.

🇮🇳 India: Financed Task-Specific eCooking

India presents perhaps the most developed opportunity for commercial eCooking. The strongest approach involves:

- Induction cooking
- Infrared cooking
- Electric pressure cooking deployed for specific tasks within existing kitchens

Rather than replacing LPG entirely, businesses combine technologies to optimise productivity.

🇮🇳 India: Anchor-Owned First-Mile Cooling

Among cooling opportunities, this configuration is closest to commercial maturity. Success occurs where:

- Commodity volumes are concentrated
- Farmer organisations are active
- Buyer demand is verified
- Maintenance arrangements are established

This model combines strong farmer impact with credible commercial economics.

🇰🇪 Kenya: Financed Refrigeration for Retailers and Food Businesses

Among cooling opportunities, this configuration is closest to commercial maturity. Success occurs where:

- Commodity volumes are concentrated
- Farmer organisations are active
- Buyer demand is verified
- Maintenance arrangements are established

While development impact is smaller than first-mile cooling, commercial scalability is considerably stronger.

TIER 2

Strongest Commercial Scaling Opportunities

These configurations have strong development potential but require additional system development before commercial replication can occur at scale. These include:

- Cooperative-owned first-mile cooling in Kenya
- Integrated cold-chain corridors in Nigeria
- Anchor-backed market cold rooms in Nigeria
- Institutional clean cooking systems across all three markets
- Pay-as-you-store cooling services in India

However, current infrastructure constraints prevent broad market deployment.

TIER 3

Selective Opportunities

These opportunities can be commercially viable but only within specific customer segments.The leading example is:

🇳🇬 Nigeria: Financed eCooking

The model can work for:

- Modern restaurants
- Caterers
- Food processors
- Operating in areas with reliable electricity

However, current infrastructure constraints prevent broad market deployment.

4.7

Building the Market for Higher Impact Models

The tiers above reflects current market conditions, not a fixed ranking of long-term potential. A real gap remains between the models that are easiest to scale today and those with the greatest potential to increase incomes. DFIs, foundations and other funders should seek to work across two time horizons: backing what is ready now and building what can scale in the future.

Cooling shows this split most clearly. Where a credible anchor already exists, as in organised dairy collection, first-mile cooling should be prioritised for investment because daily volumes, payment collection and access to buyers are more predictable. Where aggregation, offtake, transport or maintenance are weak, financing the asset should not be the first step. Funders should strengthen the market around it by supporting producer organisations, securing buyer relationships and building the transport and maintenance systems required to keep the asset in use.

The trade-off is less pronounced in commercial cooking. Task-specific appliances can scale while directly improving business productivity and income. Market-building support should focus on the barriers that still limit replication, including customer finance, electrical upgrades and affordable sales and repair networks.

This has direct implications for how capital should be used. Different levels of market readiness require different forms of finance and support.

Implications for Financing and Market Support

SCALE-READY MODELS	DEMAND-CONSTRAINED MODELS	SUPPLY-CONSTRAINED MODELS	PRE-SCALE MODELS
Commercial debt in local currency; asset finance; supplier working capital; growth equity	PAYGO; consumer finance; credit products; demonstrations and customer activation	Blended finance; infrastructure investment; guarantees; service-network development	Grants; results-based financing; technical assistance; market validation

Commercial capital should support models where customer value, asset use and repayment are already visible. Grants and concessional finance should address clearly identified gaps and have a path towards reduced subsidy and commercial finance.

Progress should be measured through sustained use, customer reach and income gains, not equipment sales alone. A follow-on phase should estimate the income potential of each configuration and establish the level and form of support required to attract commercial lenders.

4.8

Conclusion: Where the Strongest Opportunities for Commercial Scale Exist

Across cooling and clean cooking, the strongest opportunities emerge when three conditions are present simultaneously:

1. The user paying for the solution captures the value created.

2. Demand is sufficiently concentrated to support efficient service delivery.

3. The supplier can recover acquisition, financing and servicing costs without permanent subsidy.

Applying these principles across the three markets leads to a clear conclusion.

For commercial cooking, the strongest near-term scaling opportunities are financed electric cooking solutions for fixed food businesses in Kenya and India, supported by appliance-service packages, customer finance and after-sales support.

For sustainable cooling, the most promising long-term opportunity lies in anchor-led first-mile cooling systems owned by cooperatives, aggregators and off-takers. Although these models require more market-building than downstream refrigeration, they offer the greatest potential to reduce food loss, increase producer incomes and strengthen agricultural resilience.

More broadly, the analysis suggests that neither technology nor financing mechanism should be viewed as the primary driver of scale. The businesses most likely to succeed will be those that align technology, finance, aggregation and service delivery within a commercially viable operating model. In practice, this means moving beyond standalone asset sales towards integrated solutions that embed cooling and cooking technologies within existing agricultural and food-market systems. These configurations offer the strongest prospect of achieving both sustainable commercial growth and meaningful development impact across Kenya, Nigeria and India.

> “Scale requires business-model innovation, not only technology innovation.

Endnotes

1. UNITED NATIONS ENVIRONMENT PROGRAMME. "SUSTAINABLE COLD CHAINS." UNEP, 1 OCT. 2025.
2. UNITED NATIONS ENVIRONMENT PROGRAMME AND FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. SUSTAINABLE FOOD COLD CHAINS: OPPORTUNITIES, CHALLENGES AND THE WAY FORWARD. UNEP, NAIROBI; FAO, ROME, 2022.
3. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. "AMID FOOD AND CLIMATE CRISES, INVESTING IN SUSTAINABLE FOOD COLD CHAINS CRUCIAL." FAO, 12 NOV. 2022.
4. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. "REDUCING FOOD LOSS AND WASTE THROUGH SUSTAINABLE FOOD COLD CHAINS." FAO, 23 MAY 2023.
5. SARIN, SHVETA. "THE OVERLOOKED PRODUCTIVITY REVOLUTION HAPPENING IN EAST AFRICA'S KITCHENS." SHELL FOUNDATION, 19 JUNE 2026.
6. TROOST, ANDRÉ, SAM DUBY, KELVIN KAMANDE, NICHOLA RICHARDS, AND NOKUTHULA MSIZA. PRODUCTIVE USE OF ENERGY SOLUTIONS FOR MICROENTERPRISES. SHELL FOUNDATION, FEB. 2025, P. 23.
7. INFOTRAK RESEARCH & CONSULTING LIMITED. FEASIBILITY STUDY REPORT FOR A SOLAR-POWERED REFRIGERATOR IN KENYA: DAIRY INDUSTRY. 11 NOV. 2024, PP. 13, 35-37.
8. EFFICIENCY FOR ACCESS COALITION. "KEY COLD CHAIN INFRASTRUCTURE MARKETS." EFFICIENCY FOR ACCESS. ACCESSED 2 SEPT. 2026.
9. CLASP. "KEY COLD CHAIN INFRASTRUCTURE MARKETS." CLASP, 20 MAR. 2023.
10. SHELL FOUNDATION. "FROM FLAME TO PLUG: WHAT INDIA'S MICRO-FOOD VENDORS TELL US ABOUT THE COMMERCIAL FUTURE OF CLEAN COOKING." SHELL FOUNDATION, 18 MAR. 2026.
11. SHELL FOUNDATION. COMMERCIAL ECOOKING: UNLOCKING PRODUCTIVITY FOR WOMEN-LED BUSINESSES IN KENYA AND TANZANIA. SHELL FOUNDATION, 2026.
12. MODERN ENERGY COOKING SERVICES. "FACTSHEETS-KENYA, MALAWI, TANZANIA." MECS. ACCESSED 2 SEPT. 2026.
13. WORLD BANK. MACRO POVERTY OUTLOOK: NIGERIA. WORLD BANK, APR. 2026, PP. 1-2.
14. WORLD BANK. "OFFICIAL EXCHANGE RATE (LCU PER US$, PERIOD AVERAGE)-NIGERIA." WORLD DEVELOPMENT INDICATORS. ACCESSED 2 SEPT. 2026.
15. NOTE: SHELL FOUNDATION'S MISSION IS TO RAISE INCOME FOR LOW-INCOME CUSTOMERS WHILE LOWERING EMISSIONS.
16. UNITED NATIONS ENVIRONMENT PROGRAMME. COLD CHAIN TECHNOLOGY BRIEF: REFRIGERATION IN FOOD PRODUCTION AND PROCESSING. UNEP, 2018.
17. UNITED NATIONS ENVIRONMENT PROGRAMME. COLD CHAIN TECHNOLOGY BRIEF: TRANSPORT REFRIGERATION. UNEP, 2018.
18. UNITED NATIONS ENVIRONMENT PROGRAMME. COLD CHAIN TECHNOLOGY BRIEF: COMMERCIAL, PROFESSIONAL AND DOMESTIC REFRIGERATION. UNEP, 2018.
19. UNITED NATIONS ENVIRONMENT PROGRAMME. COLD CHAIN TECHNOLOGY BRIEF: COLD STORAGE AND REFRIGERATED WAREHOUSE. UNEP, 2018.
20. WORLD BANK. COLD CHAINS IN DEVELOPING ECONOMIES. WORLD BANK, 2019.
21. NOTE: SEE ANNEX FOR BREAKDOWN OF CROP PRODUCTION VOLUMES BY MARKET AND SHARE OF FRESH FOOD AND VEGETABLES IN TOTAL PRODUCTION VOLUME.
22. INTERNATIONAL ENERGY AGENCY. A VISION FOR CLEAN COOKING ACCESS FOR ALL. IEA, 2023; WORLD HEALTH ORGANIZATION. "HOUSEHOLD AIR POLLUTION AND HEALTH." WHO, 16 DEC. 2025.
23. FINOVISTA. ELECTRIFYING INDIA'S STREET FOOD: INCOME, IMPACT AND THE PATH TO SCALABLE ECOOKING ADOPTION. SHELL FOUNDATION, NOV. 2025, PP. 3-16, 30-41; SHELL FOUNDATION. COMMERCIAL ECOOKING: EXAMINING THE IMPACTS OF INTRODUCING INDUCTION COOKSTOVES TO BUSINESSES IN KENYA AND TANZANIA. SHELL FOUNDATION, 2026, PP. 2-7.
24. FINOVISTA. ELECTRIFYING INDIA'S STREET FOOD: INCOME, IMPACT AND THE PATH TO SCALABLE ECOOKING ADOPTION. SHELL FOUNDATION, NOV. 2025, PP. 3-16, 30-41; SHELL FOUNDATION. COMMERCIAL ECOOKING: EXAMINING THE IMPACTS OF INTRODUCING INDUCTION COOKSTOVES TO BUSINESSES IN KENYA AND TANZANIA. SHELL FOUNDATION, 2026, PP. 2-7.
25. THIS WAS QUALIFIED USING HOUSEHOLD ACCESS TO ELECTRICITY FIGURES. THIS CAN BE FOUND IN THE ANNEX.