Accessing Sustainable Cooling in Off-Grid Rural Areas: The Nexus between Access to Energy and to Clean Cooling

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SUSTAINABLE ENERGY FOR ALL

Sustainable Cooling Is Critical for Off-Grid Rural Communities

Rural Communities Have Diverse Needs for Sustainable Cooling

Human Comfort and Safety

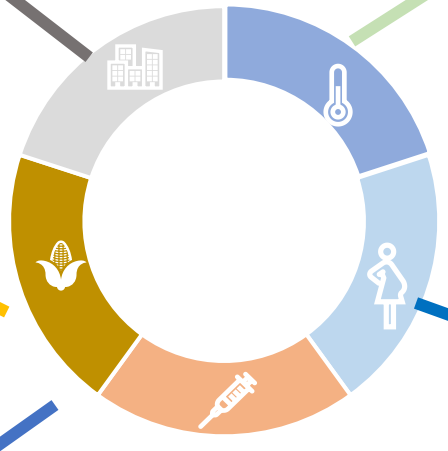
- In 2050, over 3 billion people will be rural inhabitants, including 1.58 billion living in the Critical 9* countries for access to sustainable cooling.
- The proportion of rural residents above 65 years of age will also increase to 22.7 percent by 2100 from 8.3 percent in 2015

Agriculture, Food Security and Nutrition

- 17 percent of total global food production was wasted in 2019, including from spoilage partly due to lack of cooling.
- A lack of access to cooling hinders the economic potential of farmers and exacerbates malnutrition

Health Care

- 1 billion people in low- and lower-middle-income countries are served by health care facilities without reliable electricity
- The COVID-19 pandemic exposed vast inequities in access to vaccine cold chains in rural areas.



Climate and Gender Inequities Exacerbate the Challenge

Climate Change

- Half the global population faced extreme heat for at least 30 days in 2023.
- In 2030, 60 percent of the global heat-stress-related loss of working time will be in agriculture.
- Africa's agriculture sector will suffer 89 percent of global productivity loss in the sector due to heat.

Gender

- Women and girls face specific challenges in accessing and benefiting from cooling services.
- Women represent up to 50 percent of agricultural workers, and post-harvest activities are often part of traditional women's household responsibilities.
- Women are more likely than men to experience moderate or severe food insecurity.

*The Critical 9 Countries are: Bangladesh, Brazil, China, India, Indonesia, Mozambique, Nigeria, Pakistan, and Sudan (SEforALL, 2018)

Defining the Nexus and Benefits of Action on Rural Cooling with Off-grid Electrification

COOLING ACCESS–ELECTRICITY ACCESS NEXUS	AGRICULTURE, FOOD SECURITY, AND NUTRITION	HUMAN SAFETY AND COMFORT	HEALTH CARE
Cooling (adaptation) benefits due to electricity access	Households or communities can store more nutritious food longer. Cold storage prolongs the life of the produce and products of farmers, fishermen, or herdsmen and enables them to reach markets further afield in better condition and obtain higher prices in new or existing markets. Food waste and methane emissions from decomposing food are avoided.	Ability to reliably power a fan or more powerful cooling appliances during a heat wave. Productivity improvement in the workplace and in classrooms.	Comfort cooling in rural health clinics. Cold chains preserve the efficacy of vaccines and other medical products.
Electricity access benefits due to cooling	The desire to power cooling appliances drives the demand for electricity access. Productive cooling services help pay for stand-alone off-grid power systems, for example, solar. Methane emissions from decomposing food are avoided.	Off-grid cooling appliances drive a demand for greater electricity access. Passive and efficient active off-grid cooling accelerate access to higher levels of household electricity services.	Improved efficiency and performance of cooling appliances frees up electricity to support expanded health care operations and services. This can also provide additional load, which may make some electricity access solutions more economic.

Defining the Nexus and Benefits of Action on Rural Cooling with Off-grid Electrification

Access to Cooling – A New Frontier for Expanding Access to Energy in Off-Grid Rural Areas

		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
TIER CRITERIA			Task lighting and phone charging	Task lighting, phone charging, television and fan	Tier 2 and any medium-power appliance	Tier 3 and any high-power appliance	Tier 4 and very high-power appliance
PEAK CAPACITY	Power capacity ratings (in W or daily wh)		Min 3 W	Min 50 W	Min 200 W	Min 800 W	Min 2 kW
			Min 12 Wh	Min 200 Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 W
AVAILABILITY	Hours per day		Min 4 hrs	Min 4 hrs	Min 8 hrs	Min 16 hrs	Min 23 hrs
	Hours per evening		Min 1 hr	Min 2 hr	Min 3 hr	Min 4 hrs	Min 4 hrs
FANS							
REFRIGERATORS							
REFRIGERATOR-FREEZERS							
AIR COOLERS							
ACS							

Note: AC = air conditioner; kWh = kilowatt-hour; MTF = Multi-Tier Framework; Wh = watt-hour.

Innovation Accelerates Performance & Affordability Of Cooling Technologies

Passive Technology	Active Technology									Passive Technology
Space Cooling									Application Cooling	
Heat Infiltration	**Ventilation**			**Cooling**						
Insulation, Wall, Shading	Fenestration	Exhaust (Room)	Exhaust (Spot)	Fans (Wind, Chill Effect]	Water Based Cooler	Radiant Cooling	AC/PCM Based or Ice Based)	AC (Cold storage or Cold room)	Freezer and Refrigerator	Portable Cooling Solutions

- Expanding access to this broad range of market ready off-grid cooling technologies is feasible and would dramatically improve quality of life and livelihood opportunities for these populations.
- Mapping the maturity of these solutions is needed to better understand the potential of these largely early-stage cooling technologies / companies.
- Transforming access to “Near to Market” and “Horizon” solutions is necessary to make mass impact.
- Concerted attention and resource allocation to innovation and scale-up of these technologies, business models and financing mechanisms is essential to unlock the potential of these solutions to improve access to both modern energy and cooling solutions for off-grid rural populations.

Advances in Technology Are Opening New Opportunities for Sustainable Off-Grid Cooling

Technology Advances are Improving the Ability to Access Cooling

Efficiency improvements are expanding availability

There have also been rapid improvements in the efficiency, performance, and cost of off-grid cooling appliances and equipment.

Taken together, these improvements to appliances dramatically increase the range of off-grid cooling services available, i.e. "ice batteries".

Passive solutions further reduce the need for active cooling technology, improving overall efficiency.

Increasing Affordability Underpins the Ability of Rural Residents to Take Advantage of Solutions

Human Comfort and Safety

- In a survey of off-grid customers in Bangladesh, 81 percent reported that fans had improved their quality of live and over 2hours more daily productive time.
- Estimates indicate that those making $3.20/day require 4 months to purchase a fan with cash by saving 10 percent of income.

Agriculture, Food Security and Nutrition

- Off-grid domestic and light commercial refrigerators / freezers approx. retail $900-1,000 = upto 200L while $1,200-3,500 for 200-400L units. Typically, unaffordable
- Walk-in cold rooms (WICR) have promise but must leverage demand aggregation and innovative business models as $20k–50k for 3 MT/20-foot units in SSA.
- GOGLA estimates only approx. 12% of farmers in Sub-Saharan Africa and 30% of Indian farmers can afford access to cold storage at current costs.

Health Care

- Solar direct drive (SDD) vaccine refrigerator is sole technology used by UICEF & WHO. Cost averages $682, while solar-battery powered refrigerators average $782.
- Annualized costs for SDD refrigerators approx. double conventional refrigerators (approx. 15% lower than generator powered refrigerators).

Innovative Business Models and Financing Mechanisms also Needed to Accelerate Access to Off-Grid Cooling

- **Strong overlap** between innovative **business models** <-> **financing mechanisms**
- Cooling solutions must learn from access to energy, etc.
- **Public-private partnership** and **market systems** approach is key
- **Public sector plays critical role**, establishing an **enabling environment** through key 'building blocks'; data and research, stakeholder awareness raising, capacity building, business and policy development and access to finance for sustainable clean energy rural cooling solutions.

- Direct Purchase
- Charitable Donation
- Asset Finance & Lease
- On Bill Financing
- Rent to Own
- Pay As You Go
- Cooling as a Service

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- Cooling as a Service
- Community Cooling Hub

- Public Procurement
- Charitable Donation
- Energy as a Service

Policies and Quality Assurance Play a Key Role in Enabling Access to Cooling

Challenges

- Policy ambition and cross-sectoral coordination is necessary for Governments to address off-grid cooling challenges.
- Institutional coordination among stakeholders is critical.
- Substandard, inefficient, and inappropriate equipment could be financially devastating and slow progress.

Opportunities

1. Integrate access to cooling into energy access, climate change, agricultural and health care policies, plans and programs.
2. Adopt regulations, standards, and quality assurance to channel incentives and financing to sustainable cooling solutions.
3. Implement institutional coordination at national and local levels, including ministries, civil society, and the private sector.

Conclusions & Recommendations
A Call to Action

Access to Cooling represents a new frontier for climate justice and adaptation, constituting a new basic need and essential aspect of energy access.

1. Residents of high-temperature rural off-grid areas lack access to cooling services; the impacts cut across nearly all SDGs, threatening livelihoods and even lives.
2. Passive cooling solutions need to be prioritized within an integrated approach.
3. Advances in off-grid electrification and further innovation of a diverse range of cooling appliances for off-grid use is opening game-changing opportunities.
4. Off-grid refrigeration for agricultural, dairy, fisheries and livestock produce as well as MSME retail are emerging applications needing growth support.
5. Policy ambition, cross-sectoral institutional coordination, and implementation of quality assurance frameworks are essential to increase adoption.
6. Efforts to boost cooling and electricity access sustainably must utilize renewable energy, efficient equipment, and minimize high GWP refrigerants.
7. Climate change will only worsen this situation, and off-grid sustainable cooling in rural areas offers both climate change adaptation and mitigation benefits.

Thank You!

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