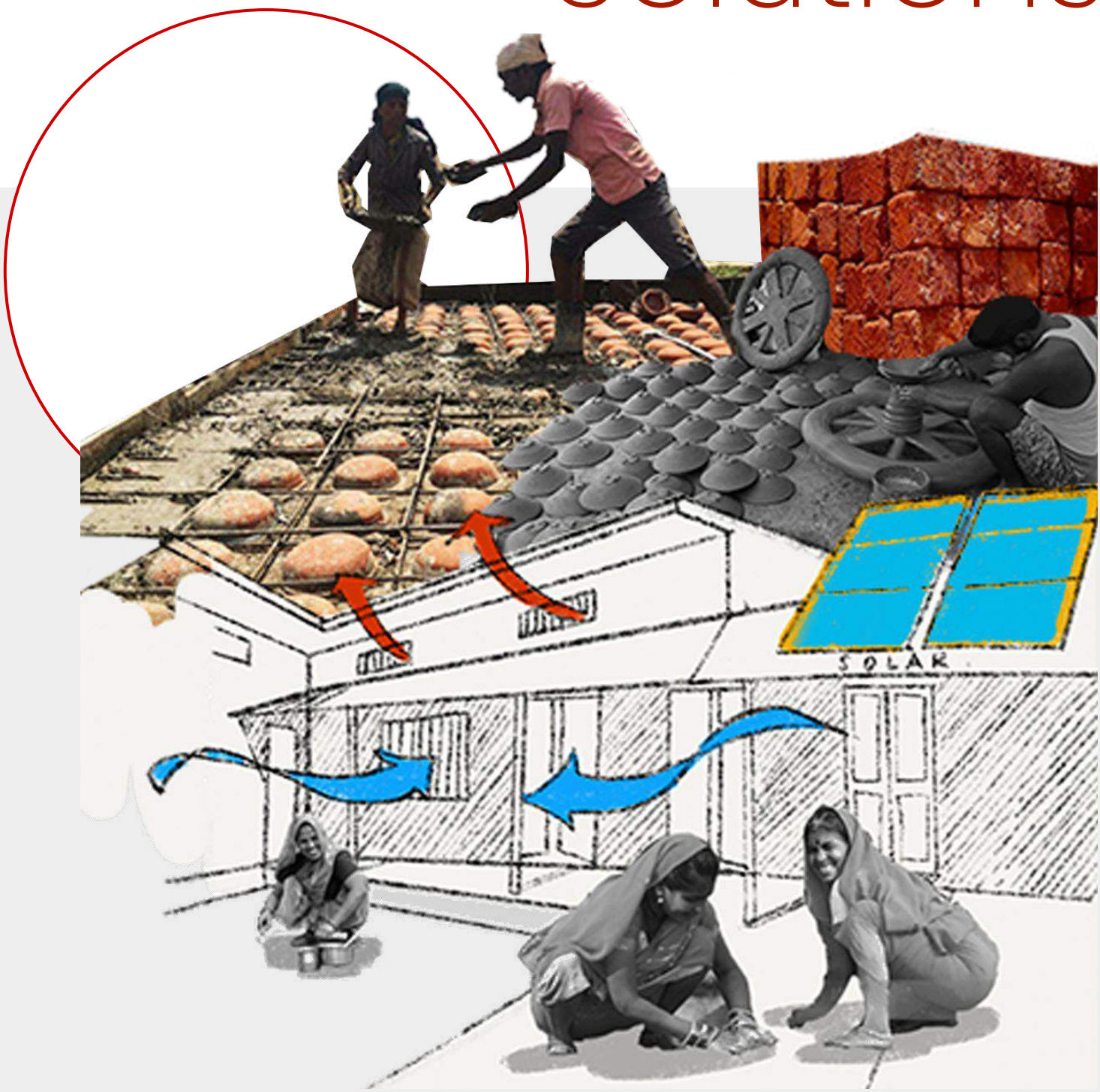
May 2022 | Built Environment | Selco Foundation

Cool Roofing Solutions



Passive integrated design strategies against heat stress

IKEA Foundation

SELCO FOUNDATION

CONTENTS

Global Context to Cooling and Built Environments

The agenda of climate change, in the last decade, has moved from being a footnote to a primary heading. The IPCC report states that climate-related risks to livelihoods, health, and human security are projected to increase as the planet warms by 1.5 degrees. (IPCC 2022)

A study conducted across households in eight countries stated that households spend between 35% and 42% more on electricity when they adopt air conditioning World Economic Forum 2020). As temperatures increase around the world, cooling is emerging as a new, basic need – even in countries that traditionally have not previously required such appliances. That puts an additional burden on families who might not be able to afford the most efficient appliances and could result in spending being diverted away from food or education towards cooling. Evidence from the ground through consultations for this report also point towards other indirect expenditures from the poor due to lack of appropriate, affordable and efficient cooling technologies. This has been in the form of loss of productive hours, loss of efficiency in livelihood, as well as long-term impacts on health and well-being.

The role of passive cooling is often underestimated in optimising the need for cooling solutions. The Economist Intelligence Unit on the Power of Efficient Cooling (The Economist 2020) illustrated through extensive modelling on the financial and environmental costs of energy supply if electricity demand from space cooling is not reduced. It states that:

- Without the implementation of sustainable cooling solutions, countries aiming to meet net zero emissions in 2050 are likely to miss those targets by up to eight years.
- Efficient cooling can expedite the transition to net zero at a lower cost, as well as providing benefits for all stakeholders, including governments, consumers and the power sector itself, given the right incentives

However, in the context of the poor, turning towards passive technologies for cooling solutions also results in reduced recurring expenditures on energy bills, productivity loss, income loss and health burden. Cooling solutions available today primarily respond to a society where supply of energy is not a constraint.

Poorer populations are facing the impact of heat stress in multiple different ways and need cooling solutions today in order to adapt and overcome increasing challenges of food security, livelihood and health. If the existing cooling solutions are deployed in order to meet their urgent demands, it will not only result in future burden (due to unoptimised solutions), but also result in increased pressure on the planet due to increased emissions. There needs to be a greater understanding of the cooling needs, the factors that influence these needs and the role of passive and active cooling solutions to create a new spectrum of solutions.

Built Environment Approach

'Direct heat stress' cases account for about 10% and up to 90% account for 'indirect heat stress'. While direct heat stress affects people who are directly exposed to the sun during peak summer days, the striking fact about indirect heat stress is that it affects persons who remain indoors and are not directly exposed to the sun. These effects include circulatory overload, kidney failures, dehydration, etc. which causes hospitalisation and even deaths in some cases and yet they are almost never recorded as heat stroke effects.

Workspaces, houses, institutions characterised by heat trapping building materials, poorly ventilated spaces and those with an additional source of heat along with increasing external temperatures owing to climate change creates conditions for indirect heat stress. To cope with the extreme working and living conditions, the need and demand for active cooling techniques increase. And energy demand for the same is mostly met with expensive and unsustainable sources of energy. This reliance on energy sources increases the energy bills and thus exacerbates the financial condition of the people.

Broadly, the thermal quality of a habitat and the optimised use of the cooling source determines how much energy is needed to ensure the well-being of the household. Factors that broadly affect the space cooling needs are as following:

- **Climate, or the climatic zone** (dictating temperature, humidity, rainfall), can play a significant role in influencing the energy needs.

- **Roofing:** Roofing, in tropical habitats, constitutes 70% of the total heat gain. Most poorer habitats and institutions (in urban and rural geographies) use metal or asbestos sheet roofs which is a heat trapping material.

- **Activities:** Drudgery driven physical activities or use of active heat source as in forges, stoves etc also determines the heat stress and thus, the design of the intervention.

As mentioned earlier, poor households use their homes for livelihood activities and cooling solutions in this case also need to include:

- Interventions that reduce the physical drudgery and improving productivity
- Interventions that extract heat from the heat generating sources

Social and Financially viable **Roofing solution**

Incorporation of roof based **NLV solutions**

Integrated of **solar DRE systems**

Wellbeing and Health

Energy Opex reduction

Aspirational

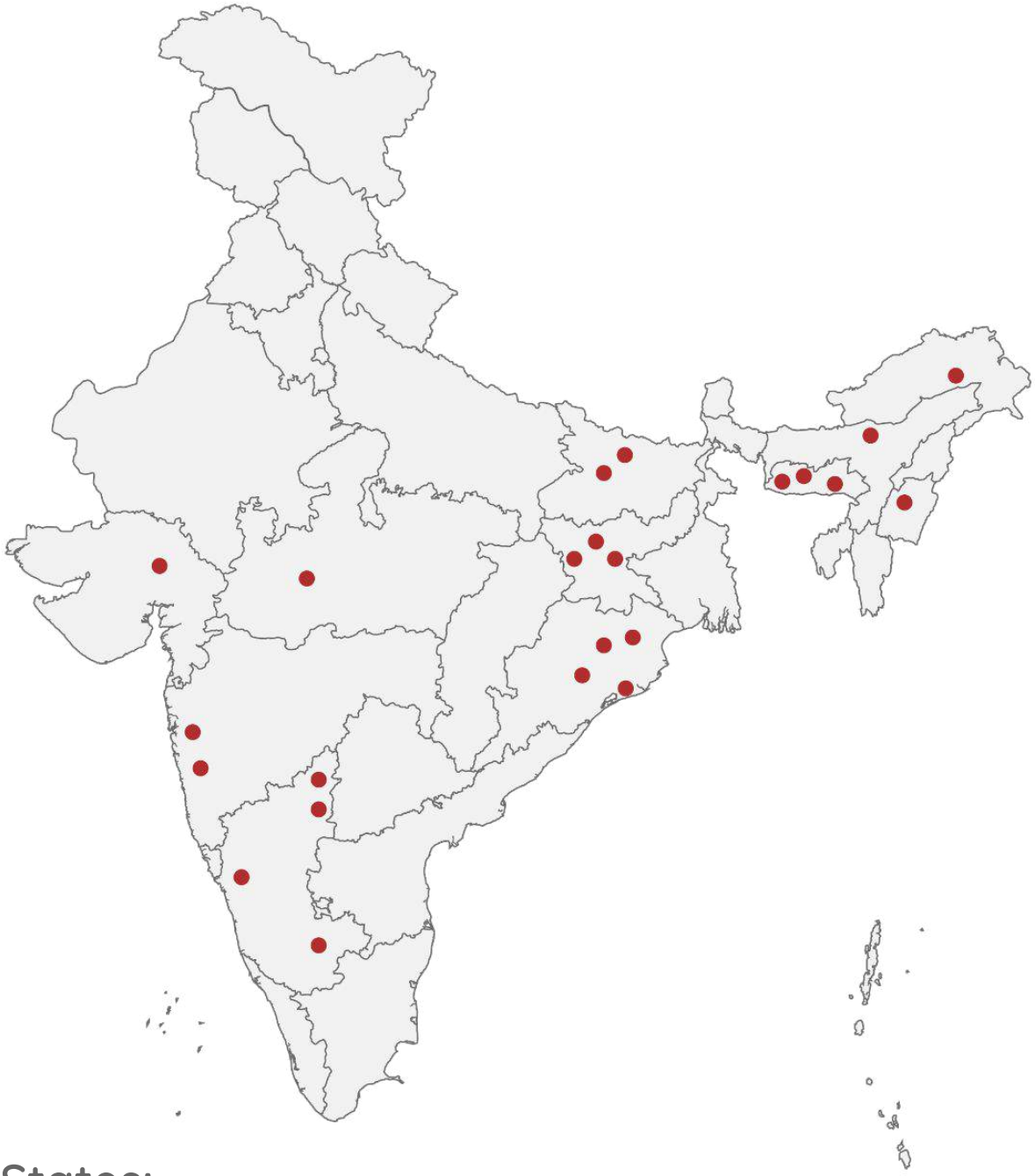
Simple interventions like careful selection of roofing materials, building technology, building layouts, increasing the building height, addition of roof fenestrations or openings, active cooling mechanisms using renewable energy solutions, etc. would be the ideal solutions in low resource settings.

Cool Pottery shed in Puri, Odisha for cyclone resilience

Solution Matrix for Cool Roofs

Solutions >	Roof slabs	Insulated roof panels	False ceilings	Insulation layers	Surface finishes
	Exterior	Exterior	Interior	Interior	Exterior
Sector Example	Modular roof systems Hollow clay blocks	Puf panel EPS sheets	PVC Gypsum board	Thermal wraps Eco panel	Tiles Cool roof paints
Housing	✓	✓	✓	✓	✓
Workspaces	✓	✓	✓	✓	✓
Animal Shelters	✓	✓		✓	✓
School & other education facilities	✓	✓	✓		✓
Healthcare Institutions	✓	✓	✓		✓

Project locations



States:

01: Assam
02: Karnataka
03: Arunachal Pradesh
04: Meghalaya
05: Jharkhand
06: Odisha
07: Gujarat
08: Maharashtra
09: Bihar
10: West Bengal
11: Madhya Pradesh
12: Manipur

Solutions.

Case Studies

Name - Rabia

Address - Amalapur, Bidar

Occupation - Tailoring

Technology - Passive cooling technology

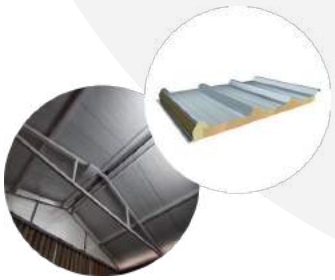
Monthly Income - INR 3,000 - INR 4,000

No. of Family Members - 8

Before

After

Insulated roof panel
Material - PUF Panel



Area of the house - 210 Sq. ft.

Recorded Temperature within the space:

Before	After
31°C	Δ 4°C reduction

"With the previous roof, we weren't able to use the room during the afternoons. It used to get too hot. With this new roof, it's much cooler inside and we're able to use the space throughout the day"

~ Rabia Begum

Project done in partnership with Samarasa

Cool Roofing Solutions

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Name: Hemalatha

Address: Amalapur, Bidar

Occupation: Tailoring

Technology: Passive cooling technology

Monthly Income: INR 3,000 - INR 5,000

No. of Family Members: 3

Before

After

False ceiling

Material - PPGI sheet + PVC False ceiling

Area of the house - 140 Sq. ft.

Recorded Temperature within the space:

Before	After
32°C	Δ 3°C reduction

"It used to get really hot and uncomfortable before. Now, with the installation of the ceiling, it's very comfortable. I can work better and my daughter can study better because of the better environment."

~ Hemalatha

Project done in partnership with Samarasa

Cool Roofing Solutions

Highest temperature recorded in Bidar in 2022 is 43°C

Name: Jasmin

Address: Valdodi, Bidar

Occupation: Cook

Technology: Passive cooling technology

Monthly Income: INR 8,000

No. of Family Members: 5

Before

After

Roof slab
Material - Hollow Clay Hourdi blocks

Area of the house - 200 Sq. ft.

Recorded Temperature within the space:

Before	After
31°C	Δ 5°C reduction

"Installing the hourdi blocks for our roof has made our house really cool. Before, under our tin sheet roof, it used to be very hot. Now, it's so cool and comfortable inside that we don't even need to switch on the fan."

~ Jasmin

Project done in partnership with Samarasa

Cool Roofing Solutions

SELCO FOUNDATION

Name: Jagdevi

Address: Chimkod, Bidar

Occupation: Agriculture Labour

Technology: Passive cooling technology

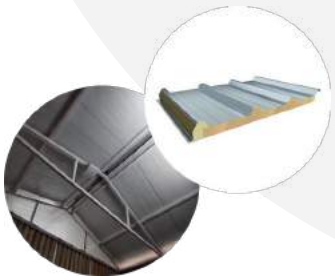
Monthly Income: INR 4,000 - INR 6,000

No. of Family Members: 5

Before

After

Insulated roof panel
Material - PUF Panel



Area of the house - 140 Sq. ft.

Recorded Temperature within the space:

Before	After
35°C	Δ 4°C reduction

"This roof has made it really comfortable in my house. During summers, it's cool inside and during winters, it's warm. This really helped when my daughter came back when she was pregnant. I was able to give her a place to stay comfortably."
~ Jagdevi

Project done in partnership with Samarasa

Cool Roofing Solutions

SELCO FOUNDATION

Name: Nirmala

Address: Mugad, Dharwad

Occupation: Roti making

Technology: Passive cooling technology

Monthly Income: INR 6,000 - INR 10,000

No. of Family Members: 3

Before

After

Roof slab
Material - Hollow Clay Hourdi blocks

Area of the house - 173 Sq. ft.

Recorded Temperature within the space:

Before	After
29°C	Δ 3°C reduction

"It used to get very hot and smokey before. Working was difficult due to this. Getting the roof replaced and adding more windows has made the space very comfortable. We can work for longer now."

~ Nirmala

Name: Vittala

Address: Mugad, Dharwad

Occupation: Roti making

Technology: Passive cooling technology

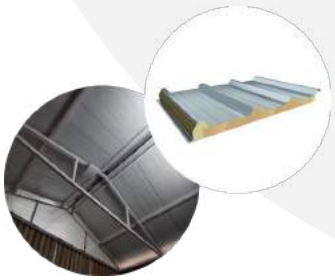
Monthly Income: INR 8,000

No. of Family Members: 4

Before

After

Insulated roof panel
Material - PUF panel



Area of the house - 257 Sq. ft.

Recorded Temperature within the space:

Before	After
30°C	Δ 3-5°C reduction

"The (cool) roof and the turbo ventilator has made my workspace very comfortable. I can work throughout the day. The skylight has made it bright and I don't need to switch on the lights during the day anymore."

~ Vittala

Name: Mahadevappa

Address: Garag, Dharwad

Occupation: Potter

Technology: Passive cooling technology

Monthly Income: INR 4,000 - INR 10,000

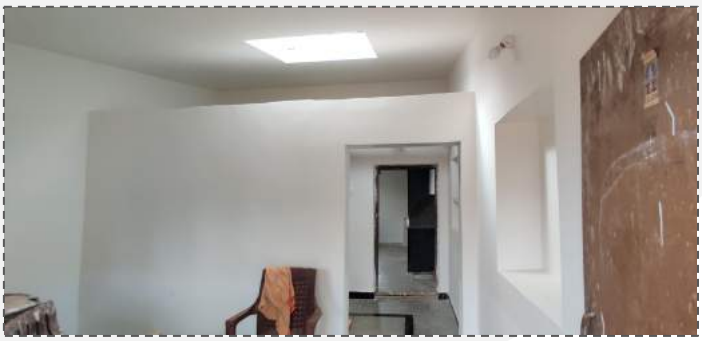
No. of Family Members: 5

Before

After

False ceiling

Material - PPGI sheet + Gypsum False ceiling



Area of the house - 600 Sq. ft.

Recorded Temperature within the space:

Before	After
32°C	Δ 2°C reduction

"My workspace is more comfortable to work in now. It is cool and bright and I'm able to work for longer without getting very tired."

~ Mahadevappa

Highest temperature recorded in Dharwad in 2022 is 38°C

Name: Mahadevi

Address: Kelgeri, Dharwad

Occupation: Home based petty shop

Technology: Passive cooling technology

Monthly Income: INR 5,000 - INR 8,000

No. of Family Members: 4

Before

After

Surface finish

Material - White Tiles

Area of the house - 520 Sq. ft.

Recorded Temperature within the space:

Before	After
30°C	Δ 3-5°C reduction

"When I was first introduced to this roof white tiling, I was skeptical on it's benefits. Now, after it was completed, I have felt very comfortable inside the house. Days when it used to get very hot in the previous years are very comfortable and cool now."

~ Mahadevi

Name: Parava

Address: Nigadi, Dharwad

Occupation: Roti making

Monthly Income: INR 8,000 -10,000

Technology: Passive cooling technology

No. of Family Members: 2

Area of the house - 1000 Sq. ft.

After

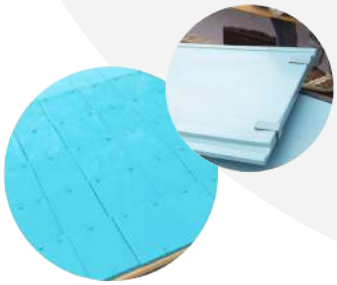
Δ 5°C reduction

Before

After

Roof slab

Material -Modroof



"After the upgradation of my workspace, I am very comfortable working the long hours to run my business. This has allowed me to diversify and open my own Khanavali (eatery) as an extension to my home."

~ Parava

Project done in partnership with SKDRDP

Cool Roofing Solutions

Name: Gonen

Address: Tanal apal, East Garo Hills, Meghalaya

Occupation: Farmer

Monthly Income: INR 7,000

Technology: Cyclone resilient roofing

No. of Family Members: 4

Area of the house - 370 Sq. ft.

Highest temperature recorded in East Garo Hills in 2022 is 36°C

Very high damage risk zone with wind speed upto 50 m/s

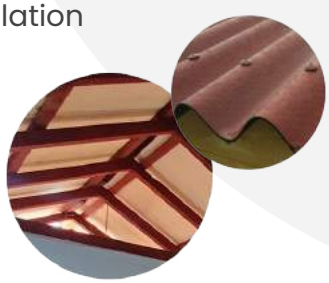
Before

Cyclone Resilient Solution

After

False ceiling + Insulation layer

Material -Onduline roofing with marine plywood panels, air gap for insulation



Project done in partnership with DC Office. EGH

Cool Roofing Solutions

SELCO FOUNDATION

Name: Tangsin

Address: Tanal apal, East Garo Hills, Meghalaya

Occupation: Farmer

Monthly Income: INR 7,000

Technology: Cyclone resilient roofing

No. of Family Members: 4

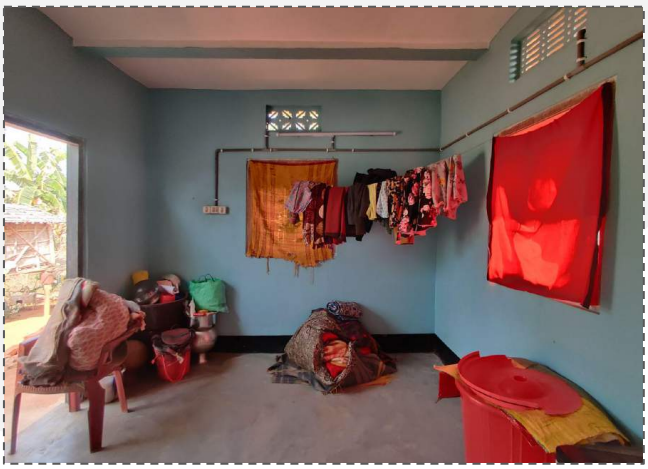
Area of the house - 370 Sq. ft.

Before

After

Roof slab

Material -Precast slab and height increase



Project done in partnership with DC Office. EGH

Cool Roofing Solutions

SELCO FOUNDATION

Name: Pilseng

Address: Tanal apal, East Garo Hills, Meghalaya

Occupation: Farmer

Monthly Income: INR 7,000

Technology: Cyclone resilient roofing

No. of Family Members: 5

Area of the house - 520 Sq. ft.

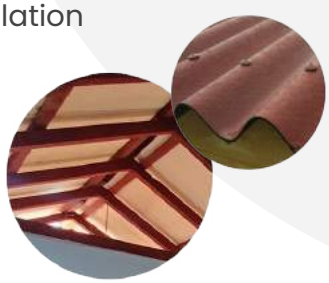
Before

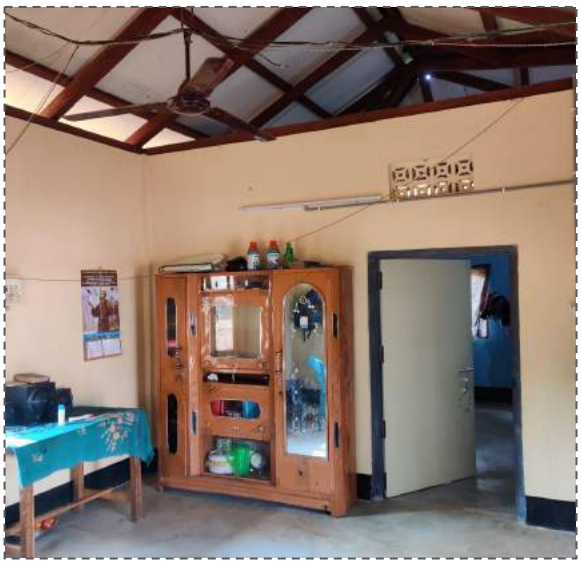
Cyclone Resilient Solution

After

False ceiling + Insulation layer

Material -Onduline roofing with marine plywood panels, air gap for insulation





Project done in partnership with DC Office. EGH

Cool Roofing Solutions

Highest temperature recorded in Ahmedabad in 2022 is 45.8°C

Name: Lakshmi

Address: Rajiv nagar, Ahmedabad

Space: Convenience store

Monthly Income: INR 5,000 - 8,000

Technology: Bamboo corrugated sheet roofing

Area of the house - 100 Sq. ft.

Insulated roof panel
Material -Bamboo corrugated sheet

Name: Ashramshaala

Address: Gadat, Navsari, Gujarat

Space: Residential school

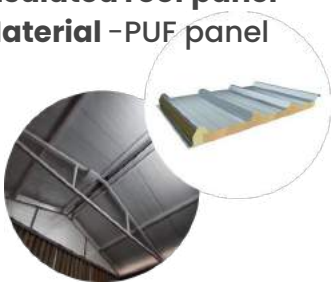
Technology: Passive cooling technology

Area of the house - 800 Sq. ft.

After

Δ 3°C reduction

Insulated roof panel
Material -PUF panel



Projects done in partnership with Mahila Housing Sewa Trust

Cool Roofing Solutions

SELCO FOUNDATION

Name: Shilpa
Address: Mandya
Space: Dairy Farm
Technology: Passive cooling technology
Area of the house - 750 Sq. ft.

After

Δ 4°C reduction

Before

After

Insulated roof panel
Material -Mangalore tile roofing and height increase

"With the new shed, my cows have a proper place to stay. They are more comfortable, safer and it has become easier to manage them."

Name: Alka

Address: Vangani

Space: House

Monthly Income: INR 6,000 - 8,000

Technology: Passive cooling technology

No. of Workers: 5

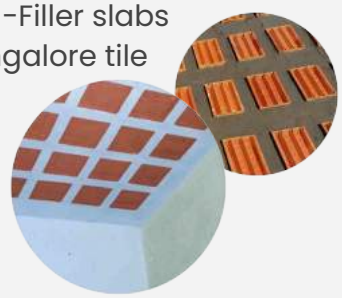
Area of the house - 437 Sq. ft.

After

Δ 5°C reduction

Insulated roof panel

Material -Filler slabs with Mangalore tile



Name: Punam

Address: Bhuiyan Toli, Ranchi

Occupation: Daily Wage Worker

Space: House

Monthly Income: INR 3,000

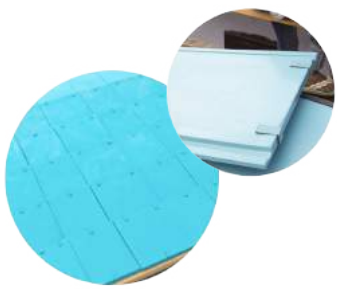
Technology: Passive cooling technology

No. of Workers: 4

Area of the house - 221 Sq. ft

Roof slab

Material -Modroof



1: Project done in partnership with Habitat for Humanity
2: Project done in partnership with Mahila Housing Sewa Trust

Name: Yellapur Maternity Clinic

Address: Yellapur

Space: Yellapur Maternity Clinic

Monthly Income: INR 7,000

Technology: Passive & Active cooling technology

After

24-26°C

Before

After

Roof slab + Air conditioner

Material -Brick Bat Coba Slab roof + Solar Air Conditioner with battery back up

Yellapur Labour rooms: A set temperature range (22.8°C-29.3°C) is required within the labour room for safe and comfortable delivery. To maintain this above temperature range, the installation of an energy-efficient Air Conditioner (AC) is done to cool the space during extreme heat situations.

Name: Rehana

Address: Amalapur. Bidar

Occupation: Tailoring

Technology: Passive cooling technology

Monthly Income: INR 20,000

No. of Workers: 9

Area of the space - 528 Sq. ft.

After

Δ 5°C reduction

Before

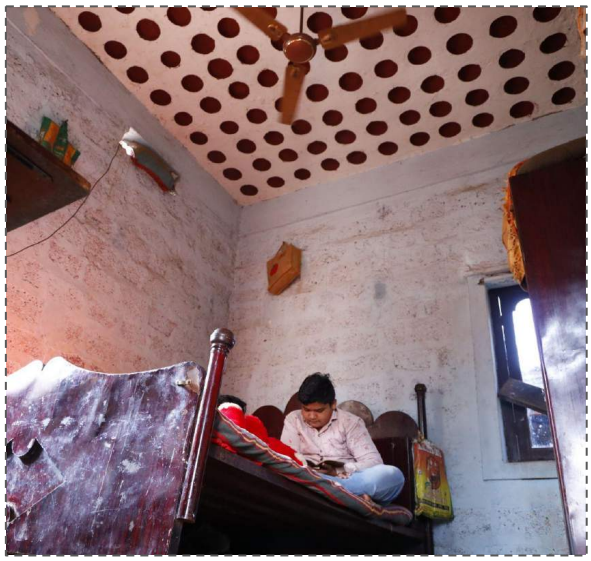
After

Roof slab

Material -Filler slab + Madras terrace

During COVID we were unable to live comfortably indoors which was very difficult for us before. Now it is nice and cool inside. We are able to open the windows also in the day. We are happy and comfortable enough even during the lockdown days.

~ Rehana



Project done in partnership with Samarasa

Cool Roofing Solutions

Name: Sangeetha

Address: Gadgi, Bidar

Occupation: Daily wage worker

Technology: Passive cooling technology

Monthly Income: INR 10,000

No. of Members: 4

Area of the space - 470 Sq. ft.

After

Δ 5°C reduction

Roof slab

Material -Madras terrace

After

Project done in partnership with Samarasa

Cool Roofing Solutions

SELCO FOUNDATION

Name: Bridge school

Address: Gillesugur

Space: Bridge school

Technology: Passive cooling technology

Area of the space - 752 Sq. ft.

After

Δ 3-5°C reduction

After

Roof slab

Material -Hollow Clay Hourdi blocks

Project done in partnership with INGRID

Cool Roofing Solutions

Name: Maternity ward

Address: Rairakhol, Sambalpur

Space: Maternity ward

Technology: Active cooling technology

After

24-26°C

Air conditioner

Material -Solar Air Conditioner with thermal back up

Name: Bhadoti PHC

Address: Bhadoti PHC, Rajasthan

Space: Primary health centre

Technology: Active cooling technology

Area of the house - 511 Sq. ft.

After

24-26°C

Air conditioner

Material -Solar Air Conditioner with thermal back up

Projects done in partnership with WISH Foundation

Name: Navrachit Slum school

Address: Prahladnagar, Ahmedabad

Space: Slum school for migrant children

Technology: Passive & Active cooling technology

Area of the space - 665 Sq. ft.

After

24-26°C

Before

After

Insulated roof panel + Air conditioner

Material -PUF panel + Solar Air Conditioner with thermal back up

Project done in partnership with Navrachit Trust and Mahila Housing Sewa Trust

Cool Roofing Solutions

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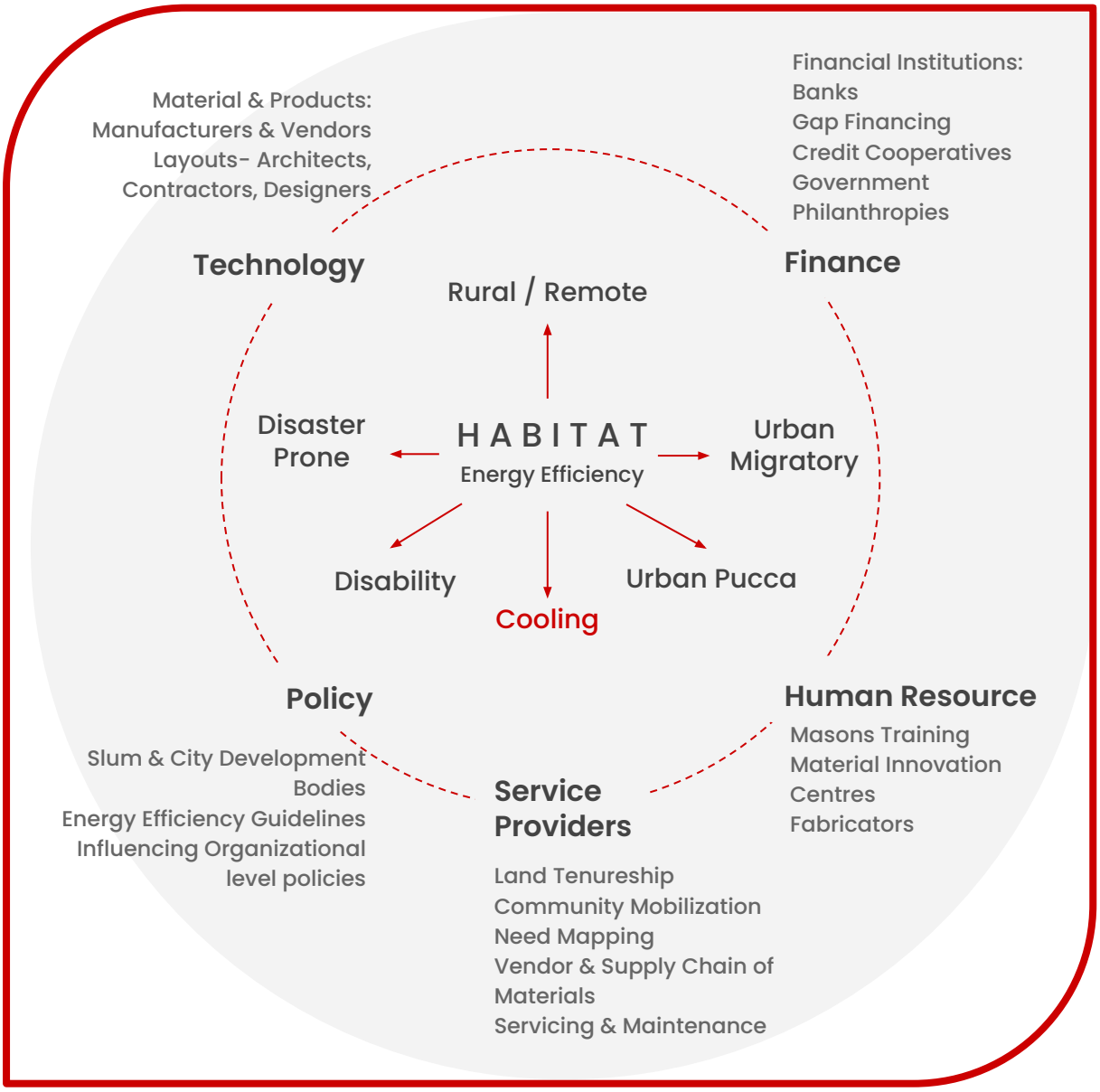

Ecosystem needed to Scale Cool Roofing

Creating an ecosystem to scale cool roofing solutions would create larger impacts among communities in heat stressed geographies. The ecosystem will introduce sustainable building materials and construction technologies that are productised and benchmarked with financial institutions like banks, credit cooperatives etc. Here conducive policies, subsidies will play a larger role in creating access to the technology. Capacitating and training personnel (masons, fabricators, carpenters, contractors, etc.) for green and cool jobs will also be critical. Creating awareness among communities on the benefits of these solutions towards their well being and health also becomes key in scaling such solutions.

As we are running out of time, to combat the 1.5 degree increase, all stakeholders must take urgent actions. The report presents various solutions ready to be scaled and replicated across geographies. Doing so will result in new trajectories of development for the poor, which builds ownership at the grassroot and innovates for local systems to be more resilient. It can be done, but the window to do it is small

Construction workers accommodation, Bangalore.
Project done in partnership with Labournet

www.selcofoundation.org | info@selcofoundation.org

690, 15th Cross Rd, Jeewan Griha Colony, 2nd Phase, J. P. Nagar, Bengaluru, Karnataka 560078