

## Million Cool Roofs Challenge

### Project Retrospective

August 2, 2021



*Photo by Jasón Sosa Gomez, Échale*

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

# 1. Narrative description of activities to date

See attached project retrospective for all supporting materials.

Our high-impact achievements include:

- Identifying multiple scalable funding pathways to install cool roofs
- Developing a partnership network across different sectors
- Creating and sharing context-relevant knowledge

## Financial sustainability

To extend the Boost Award, our team agreed to donate time (a commitment of \$400,000 and 5,000 hours). We also sought scalable ways to fund the use of cool roofs in both retrofits and new construction.

Since some cool roof products are certified waterproof, for new construction we used dual-purpose products to install a cool roof without changing the budget or construction plan. Future Échale construction (by end of 2022: 4,500 homes; 18,500 beneficiaries; 140,000 m<sup>2</sup>) will use dual-purpose membranes, and other partners may adopt this strategy.

For existing buildings, we tried two strategies to keep complexity and cost down. One was ‘coordinated construction’. In communities where partners were still constructing homes, they coordinated purchasing and installation of cool roof products.

The other was ‘self-construction’. For historical reasons, it is common in Mexico for low-income families to own land, and many will build or improve their homes when they can afford to. Recognizing this, the Federal Government has adopted strategies to support housing development through self-construction. To achieve project sustainability, we needed to support this construction mode.

We produced collateral for homeowners describing the benefits of cool roofs and explaining how to install and maintain them. This will be distributed through the Federal Government’s ‘Decide y Construye’ online platform, which has received 430,000+ page views from 90,000+ users since its January launch.

We also partnered with Cemex to distribute debit cards directly to 27 families in Totolapan, Morelos. The prepaid cards could only be spent at local stores on cool roof materials and tools. By enabling families to install cool roofs themselves, we could minimize costs and keep money circulating locally. Our vision for this pilot is to demonstrate a pathway whereby funders without experience in the built environment, e.g. financial institutions, can support self-construction of cool roof retrofits.

## Building partnerships

We identified institutions for priority outreach, including non-profits, government agencies, developers, academia, etc. We prepared collateral describing different partnership strategies and approached nearly 50 groups. Of these, we have formalized our project aims and/or identified actionable next steps with 17.

Our partnership strategy was very flexible: partners identified viable projects, and we supported them with free technical advice and recommendations for policy or implementation.

## Knowledge creation and sharing

We performed technical studies demonstrating the effectiveness of cool roofs and other passive strategies for different climate zones and building typologies. We also researched the social impacts of heat stress, e.g. on crime, worker and student productivity, agricultural productivity, etc. These were shared with our local partners, including in academia; some of our collaborations may extend this work.

Everything we’ve learned on this project is being disseminated freely across different platforms. We are also developing a practical implementation toolkit focused specifically on Mexico and the region. It is designed to complement existing toolkits from the GCCA.

## 2. Alignment to criteria

### 2.1 Criteria 1: Effectiveness

1. Please explain which community(s) you have been working with and how you have engaged with them.

We prioritized supporting bottom-of-the-pyramid families and primarily targeted painting residences. The impacted communities were typically very low income and included people of all ages and genders. These families cannot afford air conditioning and rely on passive strategies to ensure thermal comfort in their homes. (In some regions, indoor conditions are often too hot during the day, and families are accustomed to not being inside their homes much.) In addition, these families often live in overcrowded conditions. For example, in the community scheduled to move into new housing in Nacajuca, one family currently sleeps 16 people in a two-room house.

Our coordinated construction work focused efforts in the hot-humid south of the country, which has higher rates of poverty and also larger indigenous communities. We also carried out pilots (coordinated construction and self-construction) in the center of the country in communities that were displaced in the recent earthquakes and other natural disasters in the region. In the north of the country, the target communities include migrants from elsewhere in Latin America and Mexico.

Some examples of our efforts include:

- Our initial pilot (coordinated construction, in Nacajuca, Tabasco – 65 homes) was carried out to support low-income families in the south.
- Another coordinated construction effort is planned for Ocuituco, Morelos (85 homes). This community houses families displaced in the 2017 earthquake.
- Our self-construction pilot in Totolapan, Morelos (27 homes) supports families displaced in the 2017 earthquake.
- Our self-construction pilot with the Univ. Autónoma de Ciudad Juárez will be carried out in a district of that city primarily housing internal migrants and migrants from Central and South America.
- Our work with TECHO supported the retrofit of emergency shelters constructed to house families in the aftermath of the 2017 earthquake.
- Current and future work done by non-profit partners Mejoremos, Habvita, GIZ, Habitat for Humanity, etc. supports low-income families in different parts of the country.
- Planned work with non-profit partner MSF will support migrants at the US border.

Échale, New Story, and many of our additional partners have long histories of working with these communities in different parts of Mexico. In some cases, our engagement strategy was to rely on these existing trusted connections to speak directly with community members. For example, because the Univ. Autónoma de Ciudad Juárez is highly regarded regionally and has previously worked with communities in the district where we have planned a self-construction pilot, ‘brigades’ of volunteers associated with the university will go door-to-door to speak with families.

Another strategy was to communicate with local leaders and support them to have conversations with the wider community. For example, in our self-construction pilot in Totolapan, Échale prepared community leaders with collateral describing the social, economic, and environmental benefits of cool roofs. The community leaders then promoted the project and identified a list of families interested to participate.

As part of our impact measurement strategy, we have also surveyed families about thermal comfort in their homes. See 2.1.3 and project retrospective for more detail.

2. How has the target community benefited from your project socially, economically (e.g. local employment, community relations) or in any other way?

We designed our project to ensure that local communities benefitted socially and economically from our participation. In addition, we sought to ensure that we shared knowledge from our project with individuals and a wide range of professionals and practitioners in the country.

A main aim of our project was to collect and share relevant knowledge with communities who could benefit. We did this through different channels and forms of media:

- During our initial coordinated construction pilot in Nacajuca, we filmed interviews with the workers who carried out the installations. We incorporated their advice and recommendations regarding the different products and training manuals into collateral disseminated to communities later.
- To support families participating in our self-construction pilots, we prepared collateral describing the benefits of cool roofs and how to install them. This was in part based on the interviews described above. It was disseminated through established connections to the communities.
- We also prepared collateral to be hosted by the Federal Government 'Decide y Construye' platform, which reaches 90,000+ users across their own website and multiple social media channels. Our contribution included a video and infographic describing the benefits of cool roofs and how to install them.
- We are currently preparing a standalone toolkit for homeowners and organizations which will host information about cool roofs that is regionally specific and focused on implementation. The toolkit will be freely available in English and Spanish. It is designed to complement existing toolkits prepared in part by the GCCA, which describe cool roofs generally but are neither implementation handbooks nor geographically specific. Our toolkit is being developed with advice from the GCCA and stakeholders in Mexico.

To support our community and partner outreach efforts, we wanted to better understand the social impacts of heat stress on communities. New Story carried out a literature review (see attachments) to research this question and found that improved thermal comfort:

- Increases economic productivity. (Beyond a critical temperature, productivity falls dramatically.)
- Decreases the likelihood of aggressive social behavior, including violent crime (like domestic violence), staging strikes or quitting jobs.
- Decreases rates of mental distress, including thoughts of suicide.

In an effort to ensure local communities benefitted economically from our participation in the Million Cool Roofs Challenge, nearly all (90%) of the Boost Award was spent within Mexico.

For our coordinated construction pilots in Nacajuca, Ocuilco, and elsewhere, about \$29,200 was used to buy cool roof materials from local suppliers. (Another \$6,700 was used to buy materials from a supplier in India.) Échale directly hired local workers to perform cool roof installations and other construction work and paid them about \$24,500. About \$11,500 was used to buy tools and \$3,300 was used to purchase sensors and other measurement equipment from suppliers in Mexico.

For our self-construction pilots, \$20,000 was set aside for direct awards to families to be spent on tools and materials at local hardware and home supply stores (see 2.2.2). In this way, funds benefitted both the recipients and local businesses downstream of them.

3. Please explain the impact your project has had in access to cooling, energy savings and reduction of urban heat island effect in your target communities.

#### Cooling access

Our target communities typically do not have access to air conditioning and instead rely on passive cooling strategies to keep comfortable. We surveyed community members and found that families suffered from difficulty sleeping, headaches, excessive sweating, difficulty concentrating, and dehydration due to excessive heat in the home. 95% of families have at least one family member who spends more than half their time in the home, and 92% of families described their homes as very hot during the day in the dry season. All families responded that they keep their windows open for at least part of the day to reduce temperatures and increase ventilation, but only half felt comfortable keeping any windows open at night due to safety concerns and mosquitoes.

To understand how well different passive strategies provide cooling, we performed desktop studies assessing the efficacy of several passive cooling methods, including cool roofs, in the 7 Mexican climate zones. The key findings from these assessments were:

1. Cool roofs were the most effective passive cooling measure in all climate zones, reducing temperatures felt by occupants both day and night by nearly 2°C throughout the house in the hottest months.
2. The most cost-effective, high-performing combination of measures was cool roofs + external shutters on windows + increased natural ventilation.

We carried out field measurements which validated the desktop results. (When Covid prevented Arup from travelling to the pilot site to install sensors as originally intended, we produced a 3D visualization tool with embedded instructions to enable Échale to carry out the instrumentation – see attachments.) We observed decreases in internal surface temperatures and air temperatures in buildings painted with cool roof products versus an otherwise identical control building with a red roof. (We also observed sharp, temporary increases in internal temperatures (+10°C) in rooms when sunlight entered through uncovered windows, validating our conclusion regarding the importance of external shutters.)

The findings from these studies have been compiled and made freely available to help communities and the organisations understand the benefits of cool roofs and optimize the passive performance of their buildings.

#### Energy savings

Because these families cannot afford mechanical cooling like air conditioning, we have not observed any decreases in energy consumption associated with our pilots. However, the use of cool roofs now may be sufficient to deter families from installing air conditioning even when they are affordable to them. We also note that in our collaborations with partners in the retail and healthcare sectors, they emphasize energy savings as the primary measure of impact. However, we don't have detailed information about their energy consumption.

#### Reduction in the urban heat island effect:

Our project has primarily targeted low-income people living in peri-urban and rural locations. Though these are less susceptible to the urban heat island effect, rising temperatures and heat stress are still major concerns (see survey results). Arup are planning to measure the neighborhood-scale cooling effects in our pilot communities by using satellite data collected before and after the installations.



#### 4. What impact has your project made on local, regional or national policy?

We implemented a major policy change internally: all new homes constructed by Échale in the future will use cool roof waterproofing materials. We identified candidate products from major suppliers, and Échale chose one to replace their current product. This change will reduce upfront and lifetime costs without altering construction plans. By the end of 2022, Échale expects to construct 4,500 homes with cool roofs, benefiting 18,500 people and covering 140,000 m<sup>2</sup> of roof area.

In our partner outreach, we have prioritized affecting policy as a strategy to achieve impact beyond the end of our project. We have worked with partners from different sectors and of different sizes in order to achieve more comprehensive development of a local market, identifying ways to emphasize the use of cool roofs in their current and future work.

As part of our partner outreach efforts, we prioritized certain public institutions with both regional and national footprints. In Mexico, there are several government-backed institutions supporting low-income people to access decent housing. By far the largest of these is Infonavit, which controls more than 70% of the market nationally. Infonavit offers a 'Green Mortgage' program, in which borrowers receive an additional credit to finance certain technologies that reduce energy consumption, water consumption, etc. Cool roofs are one of the approved technologies (nearly 300,000 have been financed since 2017 – 200,000 by developers and 100,000 by individual homeowners); so is air conditioning. Informed by our technical studies, we are discussing with Infonavit about prioritizing passive strategies, including cool roofs, in the program design.

We have also worked with contacts in local government and in public academies. One collaboration, with the resilience office of the city of Juárez in northern Mexico, raised awareness about the advantages of cool roofs. In another collaboration, we are working with the leaders of the architecture program at Univ. Autónoma de Ciudad Juárez to support a self-construction pilot in a disadvantaged district in that city. A third collaboration, with the Univ. de Guadalajara, emphasizes knowledge sharing.

In some collaborations with public entities, our progress was affected by elections that took place midway through the project. These created uncertainty in government commitments to different sustainability and equitable housing initiatives.

In our outreach efforts, we emphasized that Mexico has a nonbinding performance and product testing standard for cool roofs (NMX-U-125-SCFI-2016) promulgated by the Ministry of Economy and developed in conjunction with industry.

## 2.2 Criteria 2: Project Viability

1. Please summarise the three key successes and three key challenges you have faced during this project.

### Successes

1. Partner outreach – we successfully onboarded organizations from different backgrounds and got them to make introductions to others, and now have collaborations with 17 NGOs and groups from retail, academia, finance, and government. Our success is due to our flexibility in structuring our collaboration around their goals and our ability to support them pro bono.
2. Identification of viable funding models – we recognized at project inception that we could fund the use of cool roofs in new construction by tapping into budgets for roof waterproofing and site labor. For existing buildings – where materials and labor are additional costs – we are piloting a self-construction model where we support communities with training and disburse funds for materials with managed debit cards. Our vision is to create an informed community who will choose cool roofs over air conditioning and to demonstrate a pathway whereby funders with no experience in the built environment, e.g. financial institutions, can support self-construction of cool roof retrofits.
3. Adaptability to Covid – our initial plan was to perform pilots of growing scale on Échale sites in Tabasco and use the learnings to approach potential partners. During lockdown, when suppliers indicated bulk orders would be delayed 6+ months, we instead performed technical studies remotely to support partner engagement. We began physical implementation when local conditions allowed.

### Challenges

1. Covid – site access constraints and building material shortages delayed construction and family move-ins. This postponed some impact measurement surveying beyond the competition end date.
2. Importation / customs – materials importation was complex and slow but eventually successful. Our first batch of sensor equipment was destroyed by customs; we purchased replacement kit from Mexican suppliers.
3. Outreach to developers – we made unsuccessful approaches to several medium-to-large regional developers, but we learned that their main drivers are cost, national policy, and market conformity.

2. Please describe both the project team and the partners involved in this project, explaining the role each has played in achieving the success of the project.

The core project team includes Échale, Arup, and New Story. Échale is a Mexican social housing constructor. Arup is an international engineering firm. New Story is a US-based housing innovation non-profit.

Échale and New Story have supported all field work, including purchasing, coordination, and implementation for pilots; impact measurement through surveys and building measurements; knowledge sharing from implementation; community engagement with families participating in pilots, and more. Échale have also prepared collateral (videos, photos, infographics, etc.). New Story have also prepared literature reviews on the social and economic consequences of heat stress. Arup have supported remotely with expert technical advice; project management; partner outreach; product specification; the development of a free implementation toolkit with regionally specific information; capacity building; knowledge sharing; and more.

In addition, we have onboarded other partners from the NGO, retail, academia, government, and finance sectors. Many of these collaborations are similar in that we are working with the partner to incorporate cool roofs on new or existing buildings they own, design, etc.

Two of our unique collaborations are with Cemex and with the Federal Government development office. Cemex have supported our self-construction pilot through their 'ConstruApoyo' funds disbursement program. This allows us to send money for cool roof materials directly to families and gives us many tools for governance of those funds (monitoring, clawbacks, etc.). The Federal Government development office have supported the dissemination of our cool roofs self-construction collateral through their 'Decide y Construye' online platform, which reaches 90,000+ users.



3. Please outline your approach to monitoring and evaluation and how this has helped you achieve success. What feedback mechanisms have you put in place to overcome challenges and improve performance in your project?

To ensure our project was achieving its aims, we carried out an impact measurement program that included both quantitative and qualitative monitoring, and also implemented procedures for project monitoring and oversight.

The purpose of our quantitative monitoring program was to measure building performance improvements from cool roofs, validate desktop analysis models of their effects, and compare different cool roof products. We carried out measurements during our pilot in Nacajuca. We installed temperature sensors in multiple locations on buildings painted with different products and collected ambient temperature and insolation data. We measured continuously for several weeks and observed surface and air temperature reductions in alignment with our predictions, corresponding to reductions in temperatures felt indoors of up to 2°C (4°F).

The purpose of our qualitative monitoring program was to measure community members' changes in behavior, perceptions, and health outcomes related to thermal comfort before and after their use of cool roofs. Using the New Story survey tool "Felix" we carried out intake surveys of families asking about window use, sleep habits, comfort, ability to focus, and more. We observed that temperature is the primary reason families report trouble sleeping. Construction delays from Covid have prevented family move-ins; we will carry out the follow-up surveys as soon as we can.

Our project monitoring / oversight strategy included weekly coordination calls between core partners and monthly reviews with Arup project and fund directors. We also arranged reviews of technical work as per standard Arup quality assurance procedures.

To manage our growing network of partners, we assigned each partner a primary contact. That person also worked to bring additional prospective partners into the project if possible. After initial conversations outlining the scope of a proposed collaboration, we held one-on-one calls as needed to ensure we offered partners whatever support they needed.

4. Please describe your communications strategy for this project and how it has contributed to its success.

Our communications strategy targeted two key audiences: possible additional partners, and families who might self-construct cool roofs.

To onboard partners, we prepared one-pagers, comprehensive slide decks, and writeups of our technical studies in both English and Spanish. We delivered these direct to our contacts by email and followed up with one-on-one calls. We identified additional contacts by word-of-mouth or introductions from existing contacts and through internal networks. We found that contacts were very receptive to our outreach and were willing to introduce us to others. We think this is in part because of how we approached them (i.e. individually or through an introduction, rather than through a mass communication). We also think our partners were receptive because a) they trusted our technical expertise and contextual knowledge, b) we were doing our work pro bono, and c) we were flexible in structuring our collaboration around their needs.

To communicate with families who might self-construct cool roofs, we conducted direct approaches to communities and also shared content on web platforms. We revisited communities previously constructed by Échale and worked with local leaders to generate interest in the project. We prepared collateral specifically for those community outreach efforts, distributed it, and staged trainings for interested families. We also worked with the development office of the Federal Government to prepare content for their 'Decide y Construye' platform, which offers tutorials, videos, and infographics related to self-construction and has 90,000+ users. We prepared a video and an infographic describing the benefits of cool roofs and demonstrating the installation process.

We prepared a video of our pilot installations in Nacajuca and interviewed the painters about their techniques and recommendations. We used these videos to improve the training collateral we produced and distributed to families (see 2.1.2).

5. Please describe how you used the project extension and extra grant funding to overcome the impact of Covid-19 on your project.

Our original project plan was to perform multiple demonstration pilots, then approach additional partners using knowledge gained from the trials and the power of their example. Covid prevented us from sourcing some of the materials we planned to use during our trials and generally threatened to lengthen our project schedule to the point that this approach was no longer viable.

We shifted to a plan that required demonstrating viability through context-relevant technical studies, bringing in additional partners, identifying their needs, proposing flexible collaborations, and achieving on-the-ground installations when local conditions allowed.

The extension was helpful because it allowed us to spend more time onboarding partners, identifying worthwhile collaborations, and organizing pilots to take place under safe conditions. It also gave us time to complete a pilot which had been partially underway when Covid stopped construction. The purpose of that pilot was to identify a preferred product for retrofit installations, and by completing it we were able to inform purchasing decisions made later in the project.

The extra funding was used to support a later series of pilots, including one in which we used the Cemex managed funds disbursement program called 'ConstruApoyo' to help deliver funds for materials and tools directly to families who would self-construct their cool roofs. This pilot was designed specifically to study the viability of a delivery model relying on external funds plus self-construction. We think this model has potential to be viable at scale.