# PASSIVE SOLAR HOUSING IN AFGHANISTAN: HARNESSING SOLAR ENERGY FOR GREENER SHELTER

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Solar verandas in Kabul

**LOCATION:** Afghanistan – Kabul, Bamyan, Wardak, Badakhshan

**CRISIS:** Conflict, economic instability, natural hazards, restrictive governance

**RESPONSE PERIOD:** 2003 - 2020
(with local partner continuation post-2021)

**PEOPLE REACHED:** 6,000+ households directly, 10,000+ self-replicated, 500+ artisans trained


**TARGET:**
Around 10,000 households through multiple projects

**BUDGET:**
Average €285 per unit (2021)

**IMPLEMENTING ACTORS:** NGO Geres, Rural Movement Organisation (RMO), local artisans

## OBJECTIVE

To improve living conditions by promoting **solar-based, energy-efficient housing** that reduces fuel use, curbs deforestation, lowers emissions, and improves health.

## CONTEXT

- Afghanistan faces extreme winters, hot summers, and recurrent droughts.
- Widespread deforestation (70% loss of eastern forestlands) and land degradation linked to unsustainable fuel use.
- Most households heat with wood, coal, or dung, leading to severe air pollution and health risks.
- Kabul ranked among the world's most polluted capitals in winter.
- Afghanistan has 300+ sunny days annually, offering untapped renewable energy potential.

## PROJECT APPROACH

- Attached south-facing **verandas ("gulkhona" or sun houses)** to homes, capturing solar heat in winter.
- R&D process tested and adapted designs for urban and rural contexts.
- Artisans trained; associations formed for bulk procurement and quality control.
- Demonstration units in health posts, mosques, and households encouraged adoption.
- Financial mechanisms included subsidies and microfinance options.
- Awareness campaigns targeted households, community leaders, and institutions.

## OUTCOMES

- ✓ Warmer, brighter, healthier homes; reduced smoke exposure.
- ✓ Lower household fuel expenditure and improved family economy.
- ✓ Additional warm, bright room for study, crafts, washing, and social activities.
- ✓ PSH embedded in local building practices in Kabul and Bamyan.
- ✓ Replication potential in Tajikistan, wider Central Asia, and the Andes.

## OUTPUTS

6,000+ subsidised Passive Solar Housing (PSH) units built.
10,000+ households self-replicated PSH design.
Over 500 artisans trained and engaged in construction.
500,000+ people reached by awareness campaigns.
Average cost per unit: €285.

## ENVIRONMENTAL INNOVATION & HIGHLIGHTS

- Up to 38% **reduction in fuel use** per household.
- Estimated 1.3 **tonnes $CO_2$ avoided annually** per unit.
- Reduced deforestation and preserved animal dung for agricultural fertilizer.
- Plastic sheeting reused/replaced with reeds in summer for shaded terraces.
- Catalysed adoption of broader energy efficiency practices (insulation, improved stoves).

## CHALLENGES

- Household financial capacity limited uptake.
- Technical requirements (south orientation, space) excluded some households.
- Donor awareness of energy efficiency in housing was low.
- Plastic sheeting short lifespan (average three years), limited recycling options.
- Political instability disrupted operations after 2021.

## LESSONS LEARNED

- Iterative R&D is critical for adaptation and uptake.
- Demonstration units drive awareness and replication.
- Behavioural change (energy management) complements technical solutions.
- Waste management must be integrated when plastic is used.
- Access to finance determines scalability.

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Winter in the outskirts of Kabul in 2020

## 1 | INTRODUCTION & CONTEXT

Afghanistan is a mountainous, landlocked country at the crossroads of Central and South Asia. Its geography is dominated by the Hindu Kush mountain range, and its dry continental climate is characterised by very hot summers, extremely cold winters, and limited rainfall. For decades, recurrent conflict has undermined development, leaving Afghanistan among the world's least developed countries. Poverty, unemployment, food insecurity, and widespread dependence on international aid remain persistent challenges.

Environmental stressors exacerbate these vulnerabilities. Afghanistan is highly exposed to the impacts of climate change, including severe droughts and floods. It also has severe land degradation linked to over extraction of natural resources. Deforestation is particularly acute: up to 70 per cent of eastern forestlands have disappeared in the past 25 years. Traditional fuel use — wood, bushes, and animal dung — further drives deforestation, reduces soil fertility, and contributes to both indoor and outdoor air pollution. In urban areas, widespread coal and wood burning makes Kabul one of the most polluted capitals in the world during winter.

Low thermal performance aggravates the crisis. Households, particularly women, children, older persons, and people with disabilities, spend long hours in cold, smoke-filled environments. Meanwhile, Afghanistan has abundant solar potential, with over 300 sunny days per year. This context made Passive Solar Housing (PSH) a critical innovation, providing an environmentally sustainable solution to energy poverty, deforestation, and household health risks.

## 2 | OVERALL OBJECTIVE

The overall objective of the PSH initiative was to improve Afghan households' living conditions by fostering the widespread adoption of energy-efficient housing technologies that reduce fuel consumption, mitigate environmental degradation, and improve indoor air quality. By introducing cost-effective, solar-based designs, the project aimed to combat poverty, reduce natural resource depletion, and strengthen resilience at the household and community level.

# 3 | IMPLEMENTATION DETAILS

The PSH concept was introduced in 2003 by Geres and Afghan partners, initially piloted in Bamyan Province. Over time it expanded to Kabul, Wardak, and Badakhshan provinces. The innovation centred on attaching a south or southwest-facing veranda — locally called a *gulkhona* or "sun house" — to existing homes. Constructed with simple, locally available materials such as wood or metal beams and plastic sheeting, the veranda concentrated solar radiation during the day and released heat slowly at night, thanks to the thermal mass of traditional adobe or brick walls.

The project followed an iterative research and development approach, adjusting designs to different house types and socio-economic contexts. Artisans (carpenters, blacksmiths, masons) were trained to build PSH, and artisan associations were established to support bulk procurement and quality assurance. Public demonstration units in health posts, mosques, and households showcased the innovation and encouraged replication.

Building a solar veranda in Behsud

Blue veranda in Kabul

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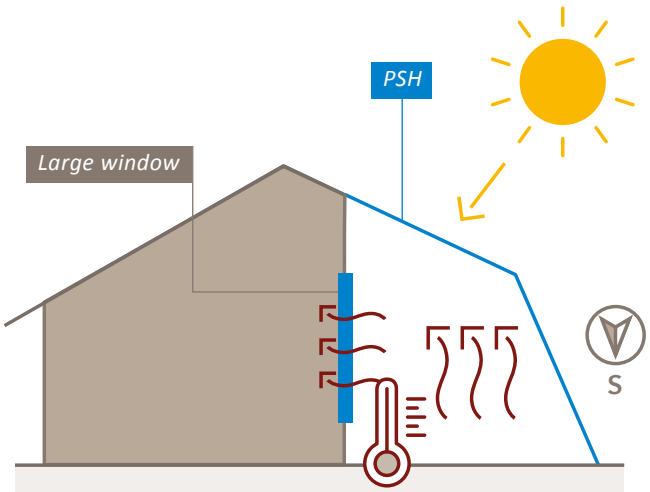
*SEADEP – Socio-Economic Assessment of Domestic Energy Practices: An in-depth field study examining socio-economic conditions, household energy use and practices, and the broader economic landscape. The tool supports the identification of tailored energy-saving solutions and assesses their potential impacts.*

*CVRA – Climate Vulnerability and Resilience Assessment: A participatory, community-level methodology used to map and understand a territory. The tool identifies strengths, weaknesses, and interconnections across spatial, social, demographic, cultural, economic, and environmental dimensions. Given the limited availability of climatological data, climate analysis was complemented by local knowledge, bio-indicators, and community perceptions.*

*PSH heating principle in winter*



Awareness campaigns targeted households, community leaders, and government stakeholders. These were critical to ensure that households were aware of how to look after the plastic sheeting - for example how to remove and properly store during the hot summer months - and how to adapt the verandas for the summer, for example covering with reeds for shading. Financial mechanisms, including subsidies and microfinance, supported household investment. Two participatory tools guided planning and assessment: the **Socio-Economic Assessment o f Domestic Energy Practices (SEADEP) and the Climate Vul nerability and Resilience Assessment (CVRA)**.

Both SEADEP and CVRA are participatory assessments of local situations with regards to project's objectives and all relevant stakeholders were consulted (households, craftsmen, retailers, local authorities, CSOs), either through individual survey or focus group discussions. Some women-only focus group discussions were organized to capture their specific perceptions given that women spend the most time at home and are in charge of most, if not all, households chores.

By 2020, over 6,000 households had directly received PSH units through various levels of subsidy, while at least 10,000 units were self-replicated by households. More than 500 artisans were trained, creating livelihoods and local capacity. The average cost of a PSH unit in Kabul was approximately €285 (2021).

## 4 | MAIN CHALLENGES

- The limited financial capacity of households constrained uptake despite strong interest.
- Access to credit and sustainable financing mechanisms was insufficient.
- Technical requirements—south orientation, unobstructed sunlight, sufficient space—excluded some households.
- Donor and institutional awareness of energy efficiency in housing was limited. For example, some actors underestimated PSH.
- Quality inconsistencies emerged in self-replicated units.
- Plastic sheeting has a short lifespan (average three years), and recycling options were very limited.
- Political instability, especially the Taliban takeover in 2021, disrupted operations and required handover to local partners.

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Children in a solar veranda in Kabul district

## 5 | CROSS-CUTTING ISSUES

The PSH initiative had a significant positive impact on women, who spend most of their time indoors, and benefited from improved thermal comfort, reduced smoke exposure, and additional bright space for domestic tasks and social activities. Children and older persons also gained from healthier living environments.

Community engagement was embedded through-out. Demonstration sites, public gatherings, and consultations with shura leaders built acceptance and trust. Women-only focus groups ensured that female perspectives informed design.

The project supported livelihoods by training over 500 artisans and establishing artisan associations, enabling long-term sustainability of PSH construction and maintenance.

## 6 | ENVIRONMENTAL INNOVATION & HIGHLIGHTS

The PSH model directly addressed Afghanistan's energy and environmental crisis by reducing reliance on unsustainable sources of fuel. Each unit saved up to 38 per cent of winter heating fuel, equivalent to 1.3 tonnes of $CO_2$ emissions avoided annually. Reduced fuelwood use helped curb deforestation and desertification, while reserving animal dung for use as fertilizer.

The seasonal adaptability of PSH—serving as a solar veranda in winter and a shaded terrace in summer—maximized year-round functionality. The model also served as an entry point for broader energy efficiency practices, encouraging households to consider insulation, airtightness, double-glazing, and improved stoves.

By integrating traditional Afghan building knowledge with simple, locally available materials, PSH demonstrated how low-cost innovations can align cultural appropriateness with climate adaptation and environmental sustainability.

## 7 | OUTCOMES & WIDER IMPACTS

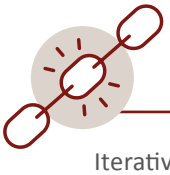
**Immediate outcomes** included warmer and brighter living spaces, reduced fue expenditure, improved air quality, and healthier households. Solar verandas provided flexible spaces for studying, washing, social gatherings, and vocational work during the winter months.

**Wider impacts** included contributions to climate change mitigation through reduced greenhouse gas emissions and resource use. In areas where PSH had been established for years, such as Kabul and Bamyan, the approach became embedded in local construction practices and was replicated without external support. Awareness campaigns reached more than 500,000 people, magnifying environmental and social benefits.

Replication potential extends beyond Afghanistan to similar climates, with adaptations already piloted in Tajikistan and potential applicability across Central Asia and the Andes.

Solar verandas in Kabul

# 8 | STRENGTHS, WEAKNESSES & LESSONS LEARNED



## STRENGTHS

Iterative R&D ensured strong contextual adaptation and high acceptance

Locally available, low-cost materials and traditional knowledge used effectively

Demonstration sites and campaigns promoted replication

Strong local capacity building: over 500 artisans trained

Significant fuel savings, better air quality, and lower GHG emissions

## WEAKNESSES

Limited financial capacity of households constrained scale-up

Quality inconsistencies in self-replicated units

Technical requirements (orientation, space) excluded some households

Plastic sheeting lifespan short, recycling options are limited

Limited donor interest in energy efficiency housing

## LESSONS LEARNED

Understanding local building practices and resources is critical before introducing new solutions.

Iterative R&D strengthens trust, quality, and user uptake.

Demonstration units are powerful tools for awareness and replication.

Behavioural change (e.g. energy management) is as important as technical tools.

Waste management must be integrated when using short-lived materials such as plastic sheeting.

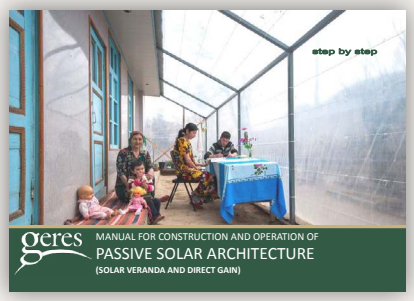
CASE STUDY


Wood frame veranda

## 9 | RECOMMENDATIONS: MOVING FORWARD

Future shelter programmes in Afghanistan and similar contexts should prioritise energy-efficient, climate-adapted housing solutions. Key recommendations include:

- ✓ Develop and disseminate practical construction guidelines to ensure quality and replicability.
- ✓ Promote a range of energy-saving products suitable for different income levels.
- ✓ Strengthen access to finance (subsidies, microfinance) to enable uptake among vulnerable households.
- ✓ Institutionalise energy efficiency in national housing standards.
- ✓ Establish waste management strategies and recycling systems for plastic components.
- ✓ Leverage opportunities for replication across Central Asia and other cold, sunny climates.




### FURTHER READING

Manual for Construction and Operation of Passive Solar Architecture, Geres

Passive Solar Houses in Afghanistan Final Evaluation, Geres

### FOR FURTHER INFORMATION CONTACT

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PRODUCED WITH THE FINANCIAL SUPPORT FROM:

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