

VLIR-UOS Community Talk XL: From Research to Impact.

Solar Cookers For All (Sc4all)



Solar Cookers for All:

Introduction and Perspectives

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“Design, development and optimization of a solar cooker: Application at household scale in Lubumbashi (DR Congo)”

Functional Materials Engineering

Faculty of Industrial Engineering Technology (UHasselt)

Member of SC₄All team

Lecturer at the Department of Electrical Engineering

School of Industrial Engineering

University of Lubumbashi



Problems



1. Deforestation and energy access



- Access to sustainable energy sources is a significant challenge in many developing countries
- Over-exploitation of wood energy species
- Charcoal costs are 30-40% of household income

2. Health risks and inequality education



- Women and children are most affected by fuel collection and cooking
- WHO estimates 3.8 million premature deaths annually from household air pollution.

Solar Cookers for All (Sc4all) project: Objective



Université
de
Lubumbashi

Design and promote solar cookers tailored to the needs of households in Lubumbashi





Importance: A sustainable choice



Reduces Deforestation

Less reliance on firewood preserves forests



Combats Desertification

Preserves vegetation cover in vulnerable areas



Mitigates Climate Change

Lowers carbon emissions by reducing burning wood



Improves Air Quality

Reduces indoor smoke and respiratory illnesses by eliminating firewood smoke



Health impact: Cleaner air, healthier lives

Reduced Premature Deaths

Eliminates Indoor Smoke

Water Pasteurization

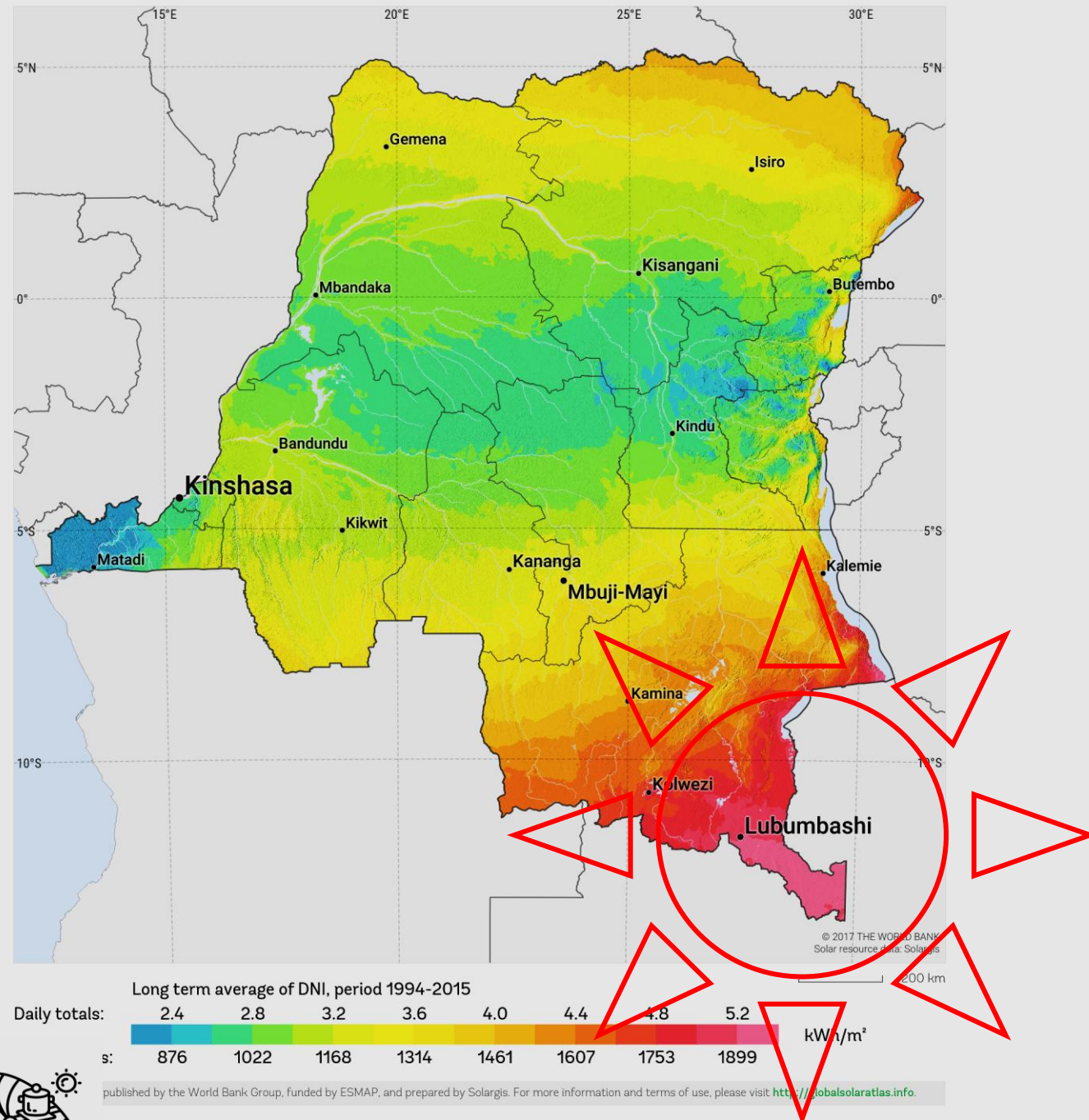
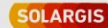


Lubumbashi: Ideal conditions

SOLAR RESOURCE MAP

DIRECT NORMAL IRRADIATION

DEMOCRATIC REPUBLIC OF THE CONGO



High Solar Irradiance



Over 200 sunny days per year

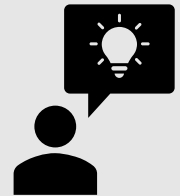


Growing environmental awareness

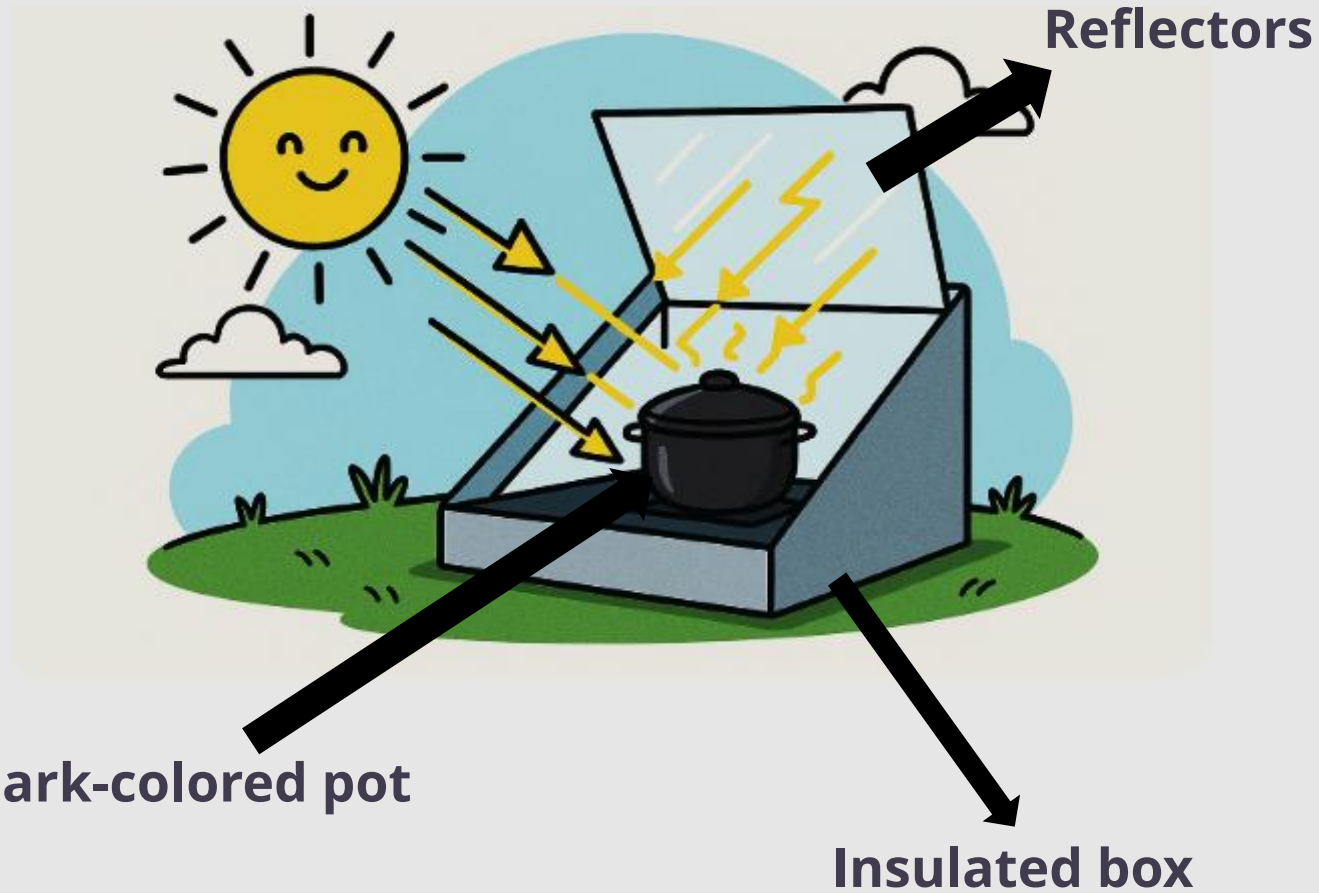


Local Materials

Solar cooking: A sustainable solution

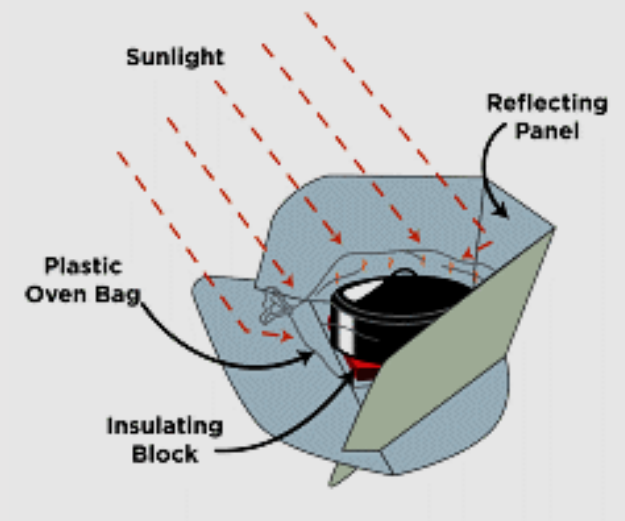


How solar cookers work ?

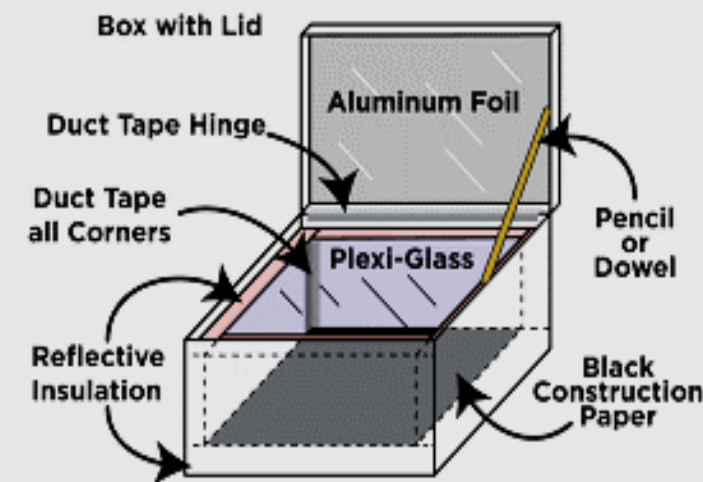


Types of solar cookers

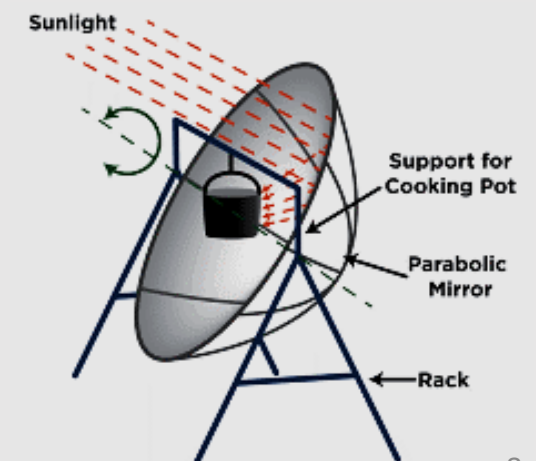
Panel cookers



Box cookers



Parabolic cookers

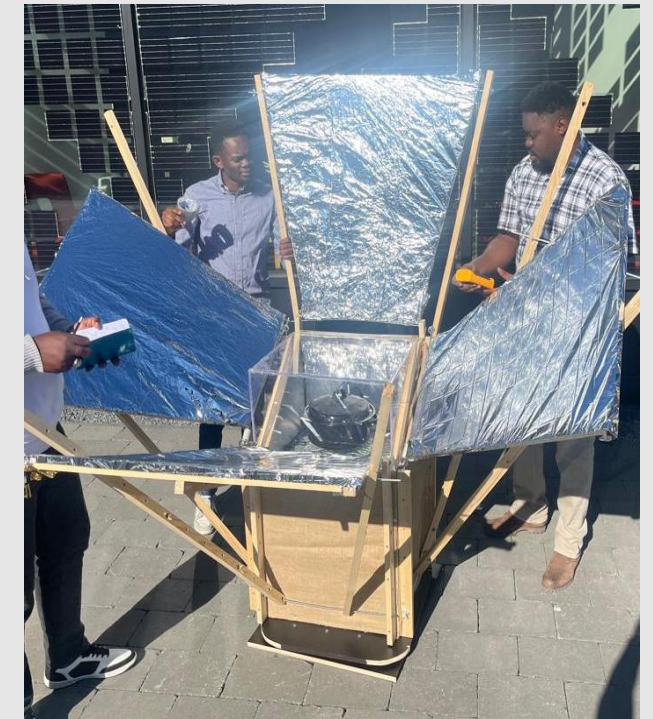


Sc4all project: What is already done?

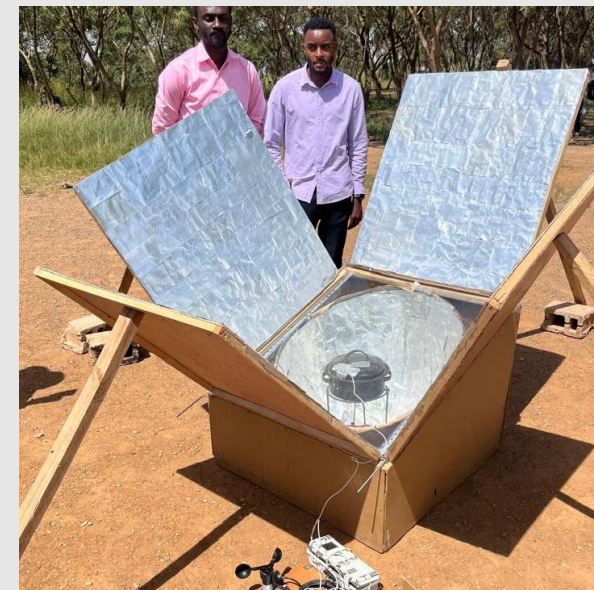
Oven Type



Hybrid Type



Parabola Type



Sc4all project: Cooking traditional meals



FOUFOU



In 30min



BEANS



In 3h



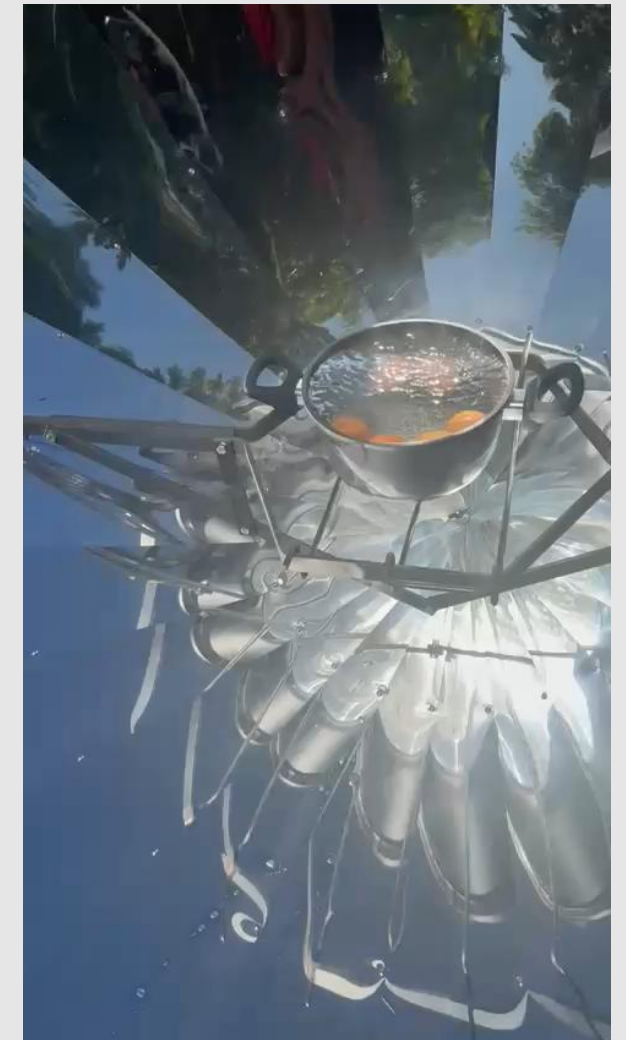
RICE



in 20min



Eggs



In less than 10 min

Using a solar cooker: A simple guide



Placement

Face the sun, adjust cooker periodically.



Preparation

Use dark, thin pots, cover food.



Cooking Times

Adjust based on sunlight intensity.

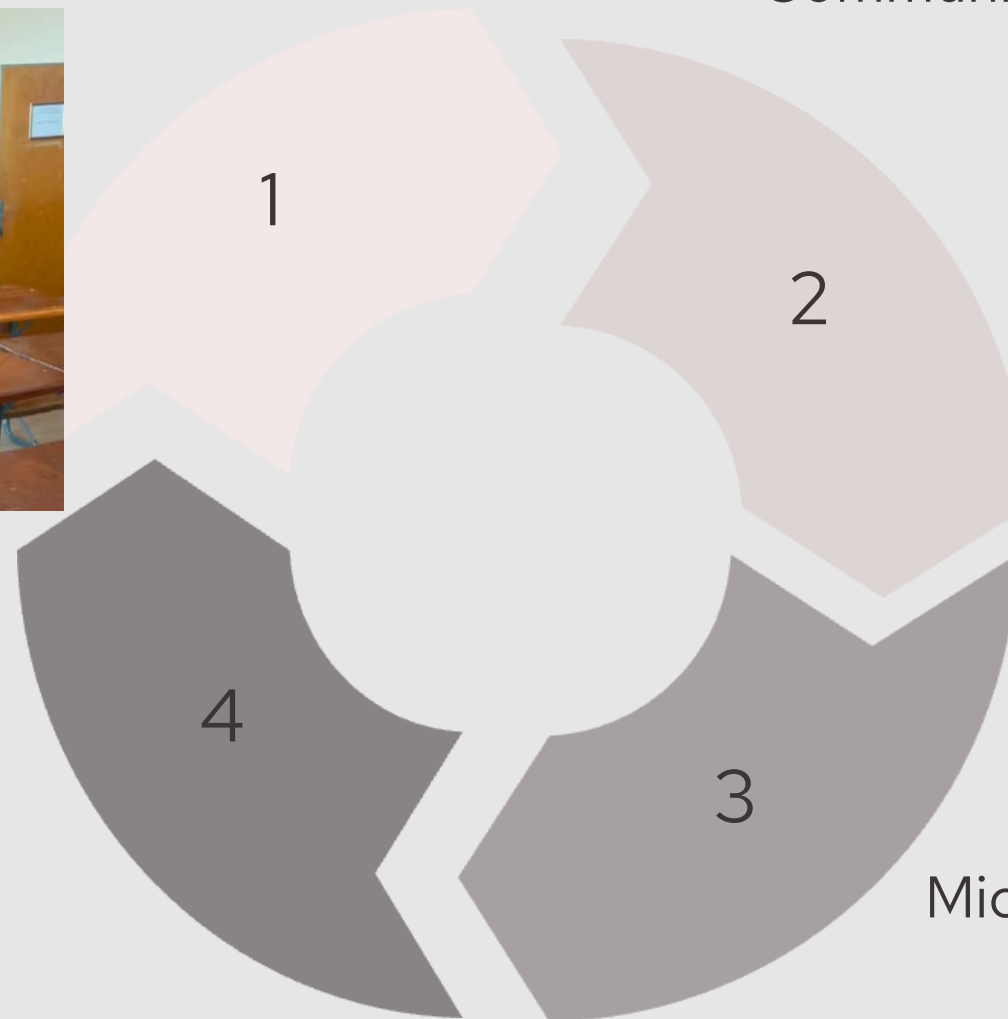




Implementation strategy

Local Partnerships

Community-Based

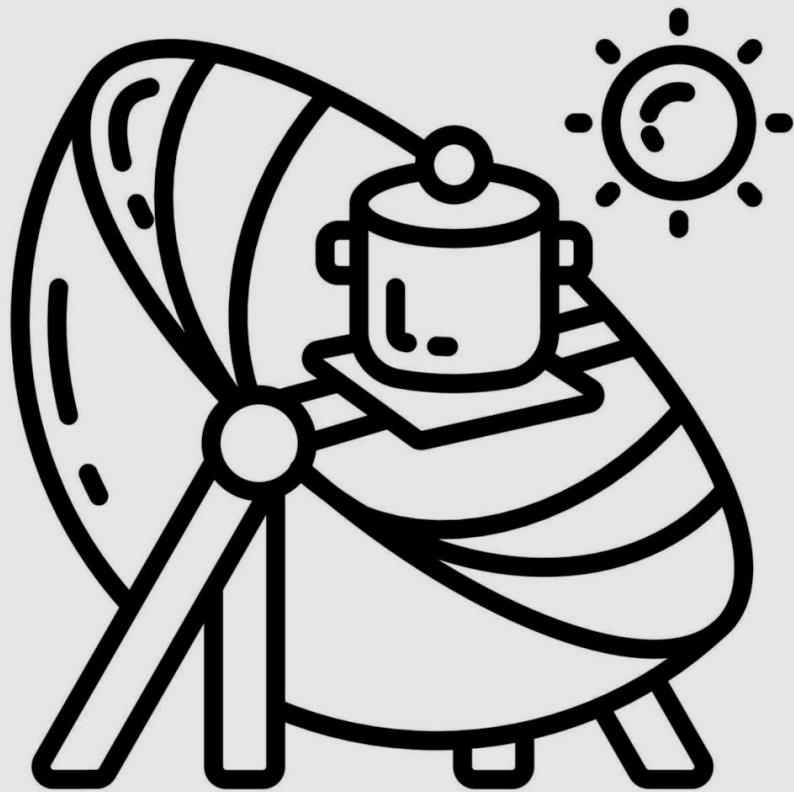


Education

Micro-Enterprise



Sc4all project: What remains to be done?



- Improving the reflectivity of materials
- Raising user awareness of its use
- Reduce the size of prototypes adapted to household sizes
- Ongoing collaboration with communities
- Share the benefits of solar cooking by scientific outputs

My PhD Thesis:

Design, development and optimization of a solar cooker: Application at household scale in Lubumbashi (DR Congo)

General background on the use of charcoal and firewood for transit to clean cooking systems

Design a solar cooker using recycle materials:

Characterise the materials to be used and their impact on the thermal performance of the cooker.

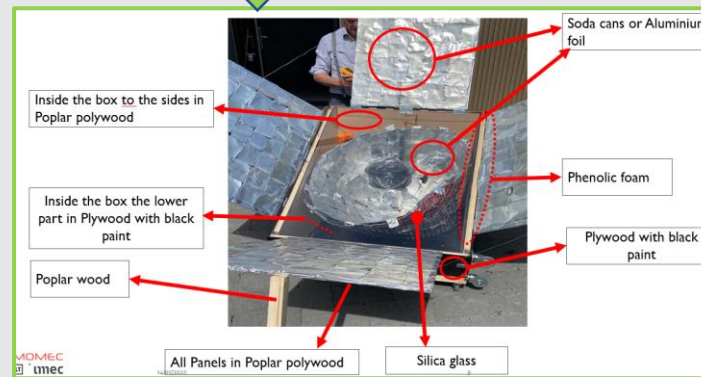
Study the properties of different types of coating to optimise the reflection of materials.

Simulation of solar cookers to optimise its thermal performance.

develop a solar cooker that can compete with the charcoal-based combustion system widely used in Lubumbashi.

Paper on *DESIGN AND PERFORMANCE EVALUATION OF LOCALLY BUILT SOLAR COOKERS FOR SUSTAINABLE COOKING IN LUBUMBASHI (DRC) (Under revision)*

Paper on *CHARCOAL AND FIREWOOD USE IN URBAN AREAS OF DEVELOPING COUNTRIES: DRIVERS, CONSEQUENCES, AND THE NEED FOR CLEAN COOKING SOLUTIONS (Published)*



Simulation with COMSOL

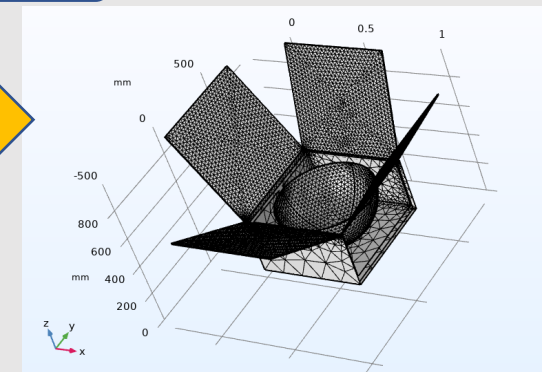
Already done

Existing systems

In progress

To be done

Solution	Reflexion	Self-adapting effect	Easy
TiO ₂ paint alone	85-95%	No	★★★★☆
TiO ₂ + Photochromic paint	70-90%	Yes (UV)	★★★★☆
TiO ₂ + Microbeads paint	80-90%	Yes (variable angle)	★★★★☆



Solar Cookers for All: Interdisciplinarity and Future Outlook

Present

March 2025 — now	Member Young Academy
Nov. 2024 — now	FWO Senior Postdoctoral Fellow, UHasselt/UGent/IMEC, BE
June 2024 — now	Young Scientist at the 73 rd Physics Lindau Nobel Laureate Meeting

Past

2021— 2024	FWO Junior Postdoctoral Fellow, UHasselt, BE
2020— 2021	Remote Research Consultant KAUST, KSA
2019—2020	Visiting PhD Fellow at KPV Lab, KAUST, KSA
2016— 2020	FWO PhD Fellow, obtained PhD in Natural Sciences, UHasselt, BE
2015—2016	Visiting Researcher at POD Group, Oxford University, UK
2015—2016	Joint PhD Researcher, UHasselt/IMEC, BE
2013— 2015	Master Bioelectronics and Nanotechnology, UHasselt, BE
2010— 2013	Bachelor Biomedical Sciences, UHasselt, BE



Biomedical Materials Scientist

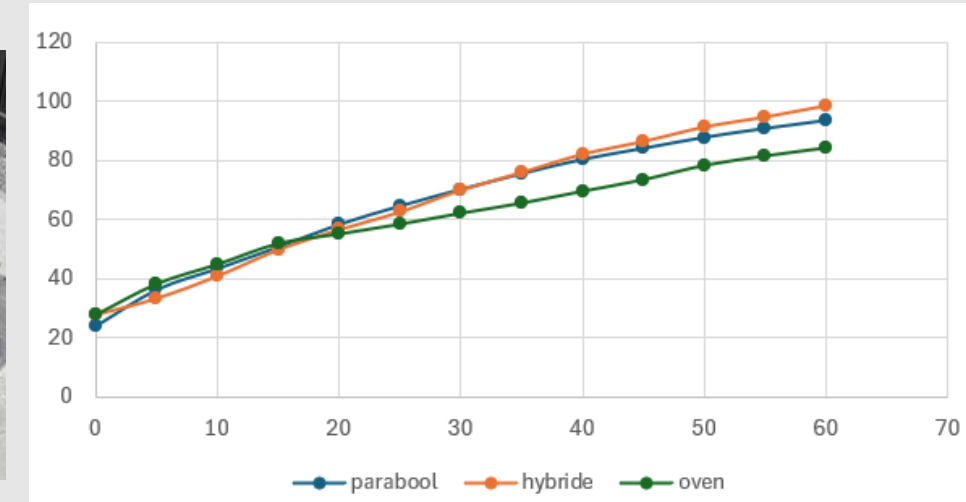
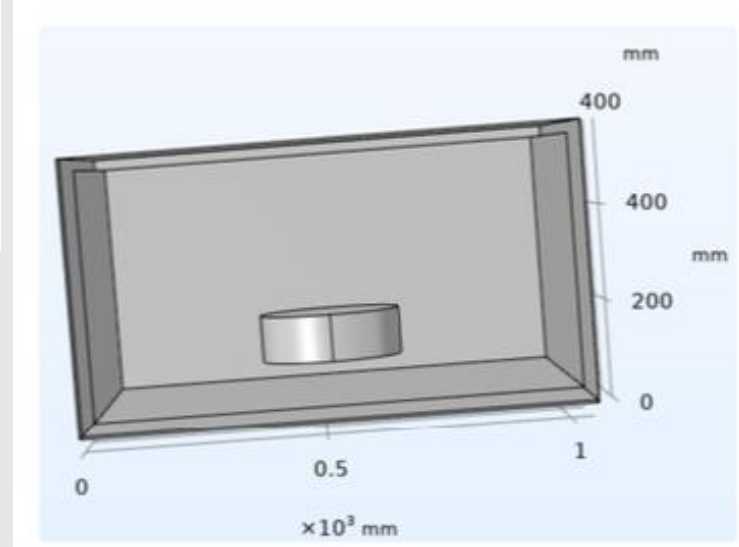
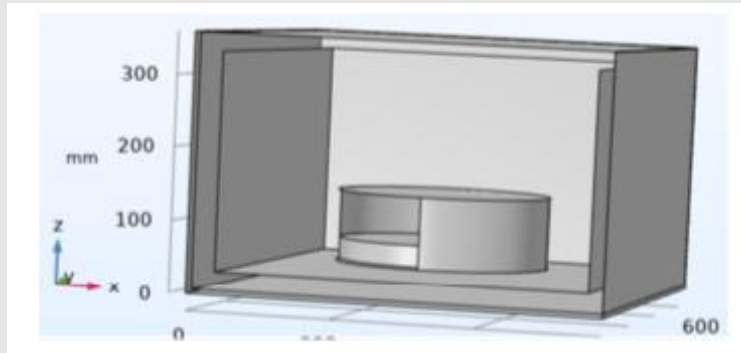
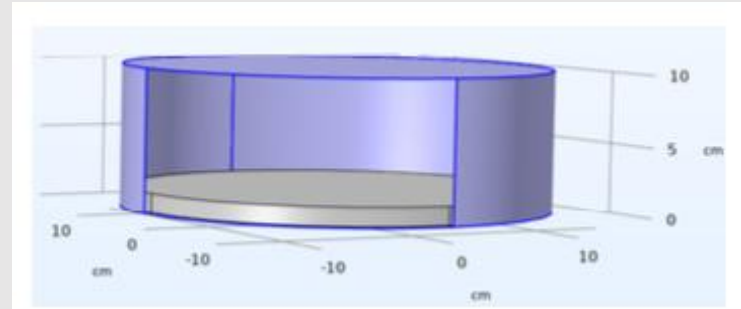
Interdisciplinary, fundamental research on hybrid
semiconductors for photovoltaics



Interdisciplinarity

Department Physics

Faculty of Industrial Engineering Technology



- COMSOL simulations for performance prediction of various (proto)types. Including coatings that are high-end industrial vs. those recycled and/or affordable: e.g., Al foil and soda cans.
- Comparison of solar cookers with PV panels

- Building and designing new prototypes.
- Creating mini-models for performance testing in Belgium (with also use of solar simulators).



Expanding collaborations in the future

Field Trip July 2025—UniLu and Ardhi Meet at Tanzania

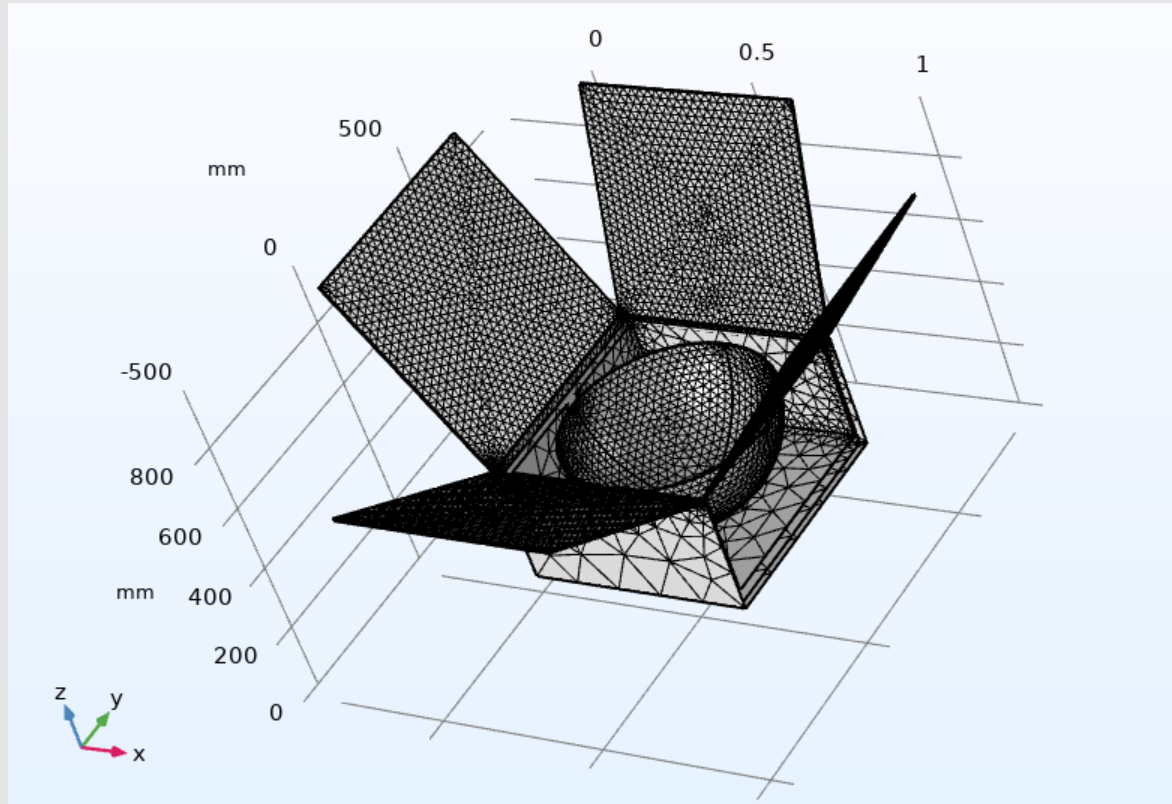
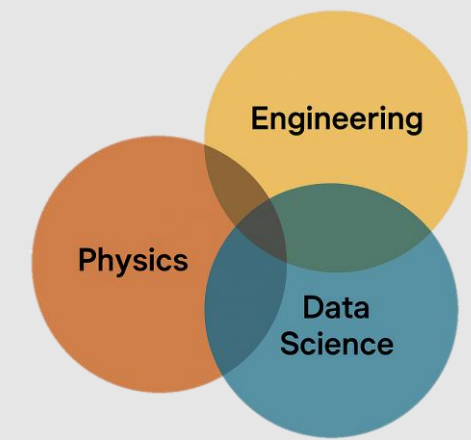


Building community beyond borders in Africa itself, sharing experience, expertise and exchange of key knowledge for more impact and efficiency.



Future research direction

Academic year 2025–2026



WP1. Design and simulation

- Finalize design specifications based on Sc4All insights
- Acquire recycled materials and COMSOL modules
- Run thermal simulations and assess usability and safety

WP2. Field validation and optimization

- Build prototypes using drink carton aluminum
- Process data materials characterization
- Deploy prototypes in DR Congo and Tanzania; collect performance data
- Analyze results and user feedback data; refine simulation models

WP3. Knowledge exchange and capacity building

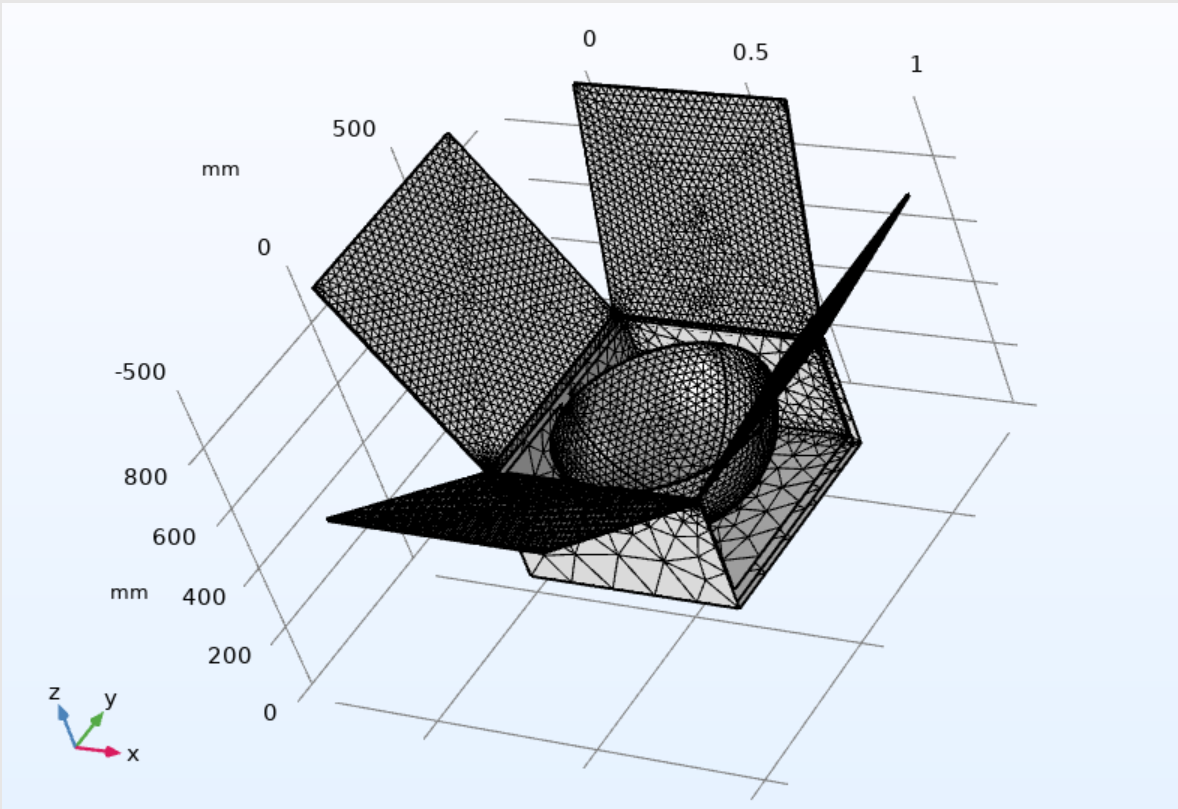
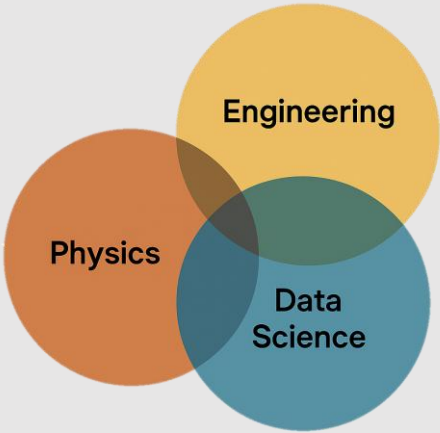
- Host African students in Belgium; Belgian student joins field testing
- Prepare capacity building report and outreach materials
- Outreach via workshops and community engagement

Pending project application: i.e., FWO Climate Prize (results by dec. 2025)



Future research direction

Academic year 2025-2026



Funding duration — 1 YEAR (i.e., 1 st January 2026 to 31 st December 2026)											
Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
WP 1: Finalize Specs & acquire materials											
	WP1: Simulation & usability testing										
			WP2: Prototype building								
					WP2: Field testing (DRC & Tanzania)						
	WP2: Process data materials charact.						WP2: Process & analyze performance data & user feedback				
				WP3: Student exchanges							
							WP3: Capacity report & outreach materials				
									WP3: Outreach & dissemination		
WP0: Management											

Hereafter, also looking to involve Social Sciences for successful integration via awareness capacity.



Thank you for your attention

