EFFICIENCY FOR ACCESS

Supported by: UK ENGINEERS WITHOUT BORDERS

Efficiency for Access Design Challenge 2020-2021 Final Submission

Summary of the designs submitted by the participants

2020/2021

Funded by: UKaid from the British people, IKEA Foundation, energy saving trust

Contents

Abbreviations

AC……………………………………………………Alternating Current

ACB…………………………………………………Active Cool Box

DC……………………………………………………Direct Current

GHI…………………………………………………Global Hunger Index

LCD…………………………………………………Liquid Crystal Display

LED…………………………………………………Light Emitting Diode

LPG…………………………………………………Liquid Potroleum Gas

NTC…………………………………………………Negative Temperature Coefficient

SDG…………………………………………………Sustainable Development Goal

UV……………………………………………………Ultraviolet

Please refer to the below diagram for information on each Sustainable Development Goal:

Foreword

The Efficiency for Access Design Challenge is a global, multi-disciplinary competition that empowers teams of university students to help accelerate clean energy access. To provide sustainable energy for all, we urgently need to enhance the efficiency and affordability of high performing appliances. The Challenge invites teams of university students to create affordable and high-performing off-grid appliances and supportive technologies.

By bringing together and inspiring students, the competition aims to foster innovation in the off-grid appliances sector. It also seeks to help address barriers that limit market expansion in this area. Furthermore, the Challenge seeks to forge beneficial partnerships between universities, researchers, and industry partners at a global level. In this way, it will further strengthen academic capacity within the off-grid sector.

The Efficiency for Access Coalition and Engineers Without Borders UK are delighted to collaborate on the delivery of the Efficiency for Access Design Challenge. The Efficiency for Access Coalition is coordinated jointly by CLASP and Energy Saving Trust. The Challenge is funded by UK aid and the IKEA Foundation. To read more on the Efficiency for Access Design Challenge, please read this year's Challenge Brief.

In this second year of the competition, 94 students from 13 universities in Bangladesh, Kenya, Uganda, India and the UK submitted 23 projects and were supported by over 30 industry partners. These students have spent the year creating innovative designs for off-grid settings. The work presented in this document is licensed under Creative Commons license CC-BY 4.0.

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Summary Table

The table below summarises the projects that students submitted as part of the Efficiency for Access Design Challenge 2020–2021.

Team	University	Project Title	Theme	Full Reports	Team Members
2020-03	Independent University, Bangladesh	Solar Direct Drive Vaccine Refrigerator and Effective Cold Chain System	Healthcare	Full Report	Md. Sadik Abdal, Nafiul Alam, Md. Toufiqul Islam Bilash
2020-04	Makerere University	Dc Solar Powered Aquaponics System	Agriculture	Full Report	Ngure Brian, Cathy Zebia, Edmund Walusimbi, Nasasira Tony
2020-06	Makerere University	Solar Milk Pasteuriser	Agriculture	Full Report	Nkajja Marvin Peter, Musoke Joel Bendict, Nalule Patricia Kyolaba, Luyima Mark
2020-07	Makerere University	Solar Grain Dryer	Agriculture	Full Report	Patrick Segujja, Kirabo Hope Ibingira, Joshua Mwesigwa, Arnold Luwagga, Derrick Lubuuluwa Mpiima
2020-09	Harper Adams University	Solar Mill	Agriculture	Full Report	Andrew Craig, Alex Williams, Anita Woolf, Liam Campbell
2020-10	Gulu University	Point Of Use Solar UV Water Disinfection For Emergency Situations	Other	Full Report	Mayanja Andrew, Alicwamu Moses, Adong Peace, Tamale Raymond Kiggundu, Ogwal Moris
2020-12	TERI School of Advanced Studies	Solar Powered Hydroponic Fodder Unit	Agriculture	Full Report	Souryadeep Basak, Lavkesh Balchandani
2020-13	University of Nairobi	Machine Learning Based Smart Solar Power Management System	Power Management	Full Report	Alvin Chirchir, Lyn Nzioka, Ricky Muinde, Peris Karanga
2020-14	University of Nairobi	Solar Powered Brick (Matofali) Maker	Other	Full Report	Maurice Musembi, Denis Kipkorir, Charles Lengushuru, Elsie Baraza
2020-15	University of Nairobi	Electro-Adsorption Cooler Box	Refrigeration	Full Report	Ghariba Ali, Elizabeth Omae, Larry Koech
2020-16	Gulu University	Intelligent Solar Powered Irrigation Pump for Horticultural Production in Northern Uganda	Agriculture	Full Report	Okot Bonny, Okee Vincent, Okane Reagan, Odong George Rackara, Elias Muhoozi
2020-17	London South Bank University	Off-Grid Design to Improve Energy Efficiency in the Agriculture Sector in LMIC Communities	Agriculture	Full Report	Maanasa Malladi, Paige Haire

2020-18	University of Strathclyde	Off-Grid Fridge Technology Implementation Review	Refrigeration	Full Report	Gavin Kitching, Giacomo Di Biase, Ross Craig
2020-19	UCL	Design of a Vaccine Refrigeration Unit	Refrigeration	Full Report	Daniel Hetzel, Simran Nair, Kushma Thapa, Safia Whitwham
2020-20	UCL	Solar Powered Oxygen Concentrators in Sub-Saharan Africa	Healthcare	Full Report	Reid Ashby, Alice Chave, Salome Laviolette, Keyur Roula, George Young
2020-22	Loughborough University	Design and Build a Solar Battery Cooker for Use in SSA	Cooking	Full Report	Tommy Ross
2020-24	Jomo Kenyatta University of Agriculture and Technology	Small-Scale DC Solar Powered Food Dehydrator	Agriculture	Full Report	Vincent Mwalya, Peter Kasyoki, Brenda Nthenya
2020-25	Jomo Kenyatta University of Agriculture and Technology	Solar Powered Water Filtration and Purification System	Other	Full Report	Josephine Tariya, Mercy Minoo, Charles Karira
2020-28	University of Bath	Efficient Kettle for Off-Grid Kenya	Cooking	Full Report	Paul Lavender-Jones, Luke Peacock, Luke Evason, Nicole Wan, Cameron Everist
2020-30	University of Bath	Tanzanian Smallholder Solar Mill	Agriculture	Full Report	Fabian Brennan, Elinor Barnett, Antoine Michelot, Ella Nicolson, Rose Powell
2020-31	University of Bath	Refriger8	Refrigeration	Full Report	Sage, Thomas Santini, Ellie Bowers, James Bozeat, Laurie Davies
2020-33	Moi University	Design, Construction and Performance Evaluation of a Solar Powered Electric Cooker	Cooking	Full Report	Eugene Asamoah, Jasper Okino, Felix Bosire, Margaret Ayabei, Bernadette Dushengere
2020-34	Moi University	Evaporative Cooler for Storinggrin Fresh Fish	Refrigeration	Full Report	Elly Olomo, Vitumbiko Nundwe, Gloria Musongwa, Emmanuel Rotich, Nahashon Limo

Team 2020-03 - Solar Direct Drive Vaccine Refrigerator and Effective Cold Chain System

Md. Sadik Abdal, Nafiul Alam, Md. Toufiqul Islam Bilash

Theme – Healthcare

Proposal

Design and implementation of an effective solar direct drive vaccine refrigeration system.

Project Summary

We are developing a smart vaccine refrigeration and storage system, which harnesses the power of the sun to create ice banks that help keep vaccines at an optimum temperature throughout the night and cloudy days when irradiance levels are low. We have achieved this by using solar direct drive technology, which replaces the need for traditional batteries.

Key design highlights

We have used two separate chambers in our design, with a partition between the vaccine chamber and the ice bank chamber. The two-chamber design has the following functions:

1. It separates the ice layer and the vaccines, providing more storage.
2. Each chamber can be accessed individually, which helps maintain low temperatures and prevents gases from escaping the vaccine chamber.
3. Separate chambers provide better thermal insulation for both the vaccines and the ice banks.
4. It allows for greater temperature control in the vaccine chamber.

Cost

Our final product will roughly cost around $500 USD. However, the costs of manufacturing and production can be reduced in future through economies of scale and linear production line methods.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design works to address the following SDGs:

- **SDG 3 (Good Health and Well-being):** by promoting greater health and greater security to the well-being of people in off-grid locations by giving them the means to be vaccinated.
- **SDG 7 (Affordable and Clean Energy):** by using solar energy as our main source of power and omitting the use of batteries to reduce both cost and environmental impact, particularly as batteries are very difficult to dispose of.
- **SDG 8 (Decent Work and Economic Growth):** By helping boost the immunity of people in rural off-grid areas, we allow for a safer work environment. We believe that this will increase morale and, in turn, boost the overall economic output of the region.

Social, environmental and economic considerations

The availability of vaccines in remote and off-grid locations will help marginalised people in these areas to live better lives with fewer health risks. A healthier population can mean a healthier economy. Healthier people can more effectively contribute to society, support one another, and build a more robust community.

The lack of a battery reduces the emissions and overall carbon footprint of our product, throughout its lifecycle.

[Link to the Full Report]

Team 2020-04 - DC Solar Powered Aquaponics System

Ngure Brian, Cathy Zebia, Edmund Walusimbi, Nasasira Tony

Theme – Agriculture

MAKERERE UNIVERSITY

Proposal

Our solar powered aquaponics system offers an off-grid solution that is energy efficient for farmers, uses less space to produce higher yields and is affordable. The pump is powered by a solar direct current (DC) unit to facilitate the recirculation of water in the system.

Project summary

Our solution not only builds on existing aquaponics technology, but also includes innovative improvements. Improvements in the use of off-grid renewable energy, and both lower cost and start-up cost by use of locally available and recycled materials. Aquaponics refers to the combined cultures of fish and plants in a symbiotic system where water is recirculated using pumps between fish tanks and growing beds for plants.

Key design highlights

The key features that make aquaponics attractive are that water is continually recirculated and the system does not use soil. Our solar powered aquaponics systems will offer an affordable off-grid solution that is energy efficient for farmers and uses less space while producing higher yields.

The solar DC unit will be used to power a pump that facilitates the recirculation of water in the system and an air blower to keep the water oxygenated. Our system uses a single DC water pump.

Cost

The major cost involved with running our system is the expense required to purchase fish feed. Since the system is solar powered, there are minimal costs to power it. The remaining cost to consider is maintenance, which the system owner can be trained on.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

With increased urban populations, there is a greater need for sustainable agricultural practices. However, it is still difficult for urban farming practices to challenge the conventional practice of transporting food grown in the countryside to cities. Nutrition is at the heart of SDG 2 and 3, which specifically focus on ending hunger, achieving food security, improving nutrition, and promoting good health and well-being. SDG 11 focuses on creating sustainable cities and communities. Improving food production within cities is a major way to move towards achieving this in Uganda.

Social, environmental and economic considerations

Our business model focuses on entry level and established urban and peri-urban farmers, which accounts for about 35% of Kampala city's food supply. Our secondary market will be urban households who do not have adequate space or reliable access to grid power.

The systems will be paid for in instalments by farmers, with 50% of the money being paid over agreed periods and payment plans, and the rest of the money paid through a percentage of the monthly produce sales made by our customers. This business model will help improve affordability and give customers time to receive returns on their investments.

Link to the concept note

Team 2020-06 - Solar Milk Pasteuriser

Nkajja Marvin Peter, Musoke Joel Bendict, Nalule Patricia Kyolaba, Luyima Mark

MAKERERE UNIVERSITY

Theme – Agriculture

Proposal

To minimise heavy post-harvest milk losses, our group proposed the design of a solar milk pasteuriser that efficiently utilises both solar heating and cooling to preserve milk.

Project summary

Preservation and processing of milk is still underdeveloped despite increasing milk production. This has led to heavy post-harvest milk losses. The current technology used to preserve milk in rural off-grid areas is expensive. The proposed solar milk pasteuriser efficiently utilises solar heating and cooling to preserve milk and make it safer for consumption. This milk can last up to 10 days when refrigerated.

Key design highlights

The solar milk pasteuriser utilises the batch pasteurisation method to heat milk to a temperature of 65°C, the milk is then kept at that temperature for 30 minutes and then cooled. This kills the bacteria that would lead to the quick spoilage of milk. The same system also cools the milk.

Cost

We expect that the solar milk pasteuriser would cost approximately $180 USD.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design works to address the following SDGs:

- **SDG 1(No Poverty)**
- **SDG 3 (Good Health and Well-being)**
- **SDG 5 (Gender Equality)**
- Most importantly, **SDG 7(Affordable and Clean Energy)**

Social, environmental and economic considerations

The solar milk pasteuriser will extend the shelf life of milk, reduce post-harvest losses and allow for the direct conversion of the milk to other by-products such as ghee, yoghurt, butter and cheese. The product will therefore be able to fetch extra income. Furthermore, solar energy is convenient in off-grid areas and is an energy alternative that reduces operational costs.

Link to the Full Report

Team 2020-07 – Solar Grain Dryer

Patrick Segujja, Kirabo Hope Ibingira, Joshua Mwesigwa, Arnold Luwagga, Derrick Lubuuluwa Mpiima

MAKERERE UNIVERSITY

Theme –Agriculture

Proposal

The design solution will help dry grain produce faster and more efficiently.

Project summary

Our design uses both solar thermal and solar PV to heat air that will dry grains in a drying chamber.

Key design highlights

Key parts of the solar grain dryer design are the airflow and heating system, which are responsible for air induction and the subsequent heating of air to pre-determined temperatures that vary by grain type. Another key element of the design is the drying chamber, where grains are placed, and heated air is driven through, to dry them.

Cost

The cost of the full design may prove high, but elements of the design can be stripped down depending on the buyer. Thus, the cost is variable.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design works to address the following SDGs:

- **SDG 2 (Zero Hunger):** By reducing the amount of food lost due to poor post-harvest treatment.
- **SDG 1 (No Poverty):** Our design also aims to reduce income loss incurred by farmers due to the lower prices on their poorly dried produce – particularly in rural areas.

Social, environmental and economic considerations

We considered the economic cost incurred by farmers due to poor post-harvest treatment.
Some social considerations include food security and the prevalence of hunger in communities.

Link to the Full Report

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Team 2020-09 - Solar Mill

Andrew Craig, Alex Williams, Anita Woolf, Liam Campbell

Harper Adams University

Theme – Agriculture

Proposal

While milling grain is already fundamental to the livelihoods of over 600 million people in Sub-Saharan Africa, improving the accessibility, affordability, and improvements to this practice would be a breakthrough. Historically, the cost of solar mills has been prohibitive in the marketplace. Our proposed innovative solution is to sell the solar mill to a mini-grid provider. The user will then pay a monthly service fee.

Project summary

The barriers to the adoption of solar mills are not technological, but rather arise from a failure to fully understand the needs of the intended users, primarily from a cost point of view. Secondly, the difficulties in providing lifecycle support for solar mills in extremely inaccessible locations is often not fully appreciated. This project proposal is made up of synthesised information from current advancements in technology, possibilities unique to a developing country, and thoughtful insights from engineers. The solution was tested against our final user profiles to ensure that the users' requirements and needs had been addressed appropriately throughout. Finally, the business case for the proposal has been rigorously tested to ensure that the product is marketable in a challenging sector.

Key design highlights

The needs of the solar mill user have, at every stage, been scoped, evaluated, and considered against the final proposed solution to ensure the efficacy of the project. The areas identified for design improvements of solar mills are as follows: maintenance support, a Pay as You Go system, Contactless Radio Frequency Identification (RFID) systems, improved energy efficiency, improved usability, reduced environmental impact, and improved prospects for scalability.

Cost

The unit price of the target solar mill is $1500 USD, and the delivered price is up to about $2000 USD.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design works to address the following SDGS:

- **SDG 2 (Zero Hunger):** Local access to mills enables food production at a lower cost.
- **SDG 7 (Affordable and Clean Energy):** The mills run using solar power, promoting clean and affordable energy.
- **SDG 8 (Decent Work and Economic Growth):** The mills foster job creation in the local area including job opportunities for onsite care, maintenance and operation.
- **SDG 10 (Reduced Inequalities):**A local environmentally friendly mill is more accessible; this allows villagers with disabilities to access it more easily. The reduction in milling cost compared to diesel mills can also help people with low levels of income.
- **SDG 13 (Climate Action):** Promotes and encourages local adoption solar powered technology while reducing the use of diesel-powered mills, which require fossil fuels.

Social, environmental and economic considerations

The social, environmental, and economic considerations have been presented above in the explanations on which SDGs are pursued.

[Link to the Full Report]

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Team 2020-10 - Point of Use Solar UV Water Disinfection For Emergency Situations

Mayanja Andrew, Alicwamu Moses, Adong Peace, Tamale Raymond Kiggundu, Ogwal Moris

Theme – Water purification

Proposal

Different methods used to disinfect water in Ugandan refugee settlements include boiling with charcoal or firewood and solar disinfection. These methods are both inefficient and unreliable due to high fuel costs and considerable time invested. Our design solution proposes a point of use disinfection systems that is low cost and uses solar energy, which can help boost disinfection rates in refugee settlements and off-grid communities in Uganda.

Project summary

The system consists of a raw water tank plus a bio-filtration unit where raw water is filtered at a flow rate of 10L/hour and then fed into the UV-C disinfection chamber. This allows for sufficient exposure to intensive radiation to enable the >4-log reduction of pathogens.

Key design highlights

The designed system uses solar powered, direct current (DC), ultraviolet light emitting diodes (UV-C LEDS) that expose pathogens to electromagnetic radiations of 100- 400nm, which are then absorbed by the proteins in DNA and RNA, damaging their structure.

Cost

The prototype components cost $284.5 USD. There are other expenses involved in conducting laboratory tests and shipping, as well as lower costs that will be highlighted in the report, amounting to $599 USD.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design pursues SDG 6 (Clean Water and Sanitation) and SDG 3 (Good Health and Well-Being) by ensuring access to safe clean affordable water in refugee settlements which consequently improves health through safe water.

Social, environmental and economic considerations

A social consideration made during this design process was to ensure the product can be operated by everyone with ease. The environmental impact was considered through the use of renewable energy (solar), by ensuring no air pollution was emitted by system, and by fitting a bio-filter to filter out pollutants.

Economic considerations were made during the design process to help ensure the materials for the design were locally available, the container materials and the bio-filter were affordable, and that the maintenance costs were low.

Link to the Full Report

Team 2020-12 - Solar Powered Hydroponic Fodder Unit

Souryadeep Basak, Lavkesh Balchandani

teri school of advanced studies

Theme – Agriculture

Proposal

We have designed a community level solar powered hydroponic fodder unit for off-grid regions. The fundamental principle behind the design is the maximum utilisation of under-utilised assets is already owned by these communities. A low-cost automated hydroponic fodder unit has been designed to help boost livestock productivity and a base income for people with low levels of income.

Project summary

The design uses the hydroponic method to grow green fodder in a short period of eight days, resulting in an almost six-fold mass increase during the same period. This method is soilless, requires up to 95% less water than conventional fodder production, and due to its vertical scalability, reduces stress on small land holdings as well.

Key design highlights

The design includes an Arduino based micro-controller, which regulates the watering cycle through nozzles. Temperature control within the unit is achieved through evaporative cooling. Green shade nets seem to be an effective facade material. A closed loop water circulation system ensures zero wastage and rainwater harvesting structures aim to minimise water inputs. Sensor based cooling ensures energy efficiency through proper selection of set-points.

Cost

The cost of a fodder unit with a daily output of 50 kg comes out to be around $100 USD without the power conditioning equipment. However, the price per unit falls exponentially with an increase in the capacity of the system, which encouraged us to propose a community fodder solution.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

By leveraging our commitment to SDG 7, primarily through 7.1 (Access to Affordable Energy) and 7.3 (Energy Efficiency), we simultaneously address nine other SDGs. SDG 1 (No Poverty) and SDG 2 (Zero Hunger) are at the heart of the design, which is inspired by the idea of progressive universalism. SDG 5 (Gender Equality) and SDG 10 (Reduced Inequalities) guide our social model of employment, which aims to rehabilitate marginalised populations. The model of local entrepreneurship and boosted revenues from livestock products breathes life into SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation and Infrastructure). Our commitment to SDG 13 (Climate Action) is realised through the GHG mitigation potential of hydroponic fodder, in comparison to traditional processes. This sustainable route of fodder production further addresses issues under SDG 12 (Responsible Production and Consumption) and SDG 15 (Life on Land).

Social, environmental and economic considerations

Our design is a socio-technical solution for low income off-grid communities. This is a robust framework as it relies on the inherent gaps in the labour availability in these communities.

On the environmental front, the land sparing nature of our design helps in habitat conservation and secondary carbon dioxide mitigation. By foregoing the use of fertilisers, pesticides and huge quantities of water, a significant portion of the embedded energy in fodder can be reduced over time.

The economics of the system have been charted with respect to consumer payment models, hybrid models of operation and access to credit facilities.

Link to the Full Report

Team 2020-13 - Machine Learning Based Smart Solar Power Management System

Alvin Chirchir, Lyn Nzioka, Ricky Muinde, Peris Karanga

UNIVERSITY OF NAIROBI

Theme – Power management

Proposal

Our proposal is for a machine learning based residential solar power management system that will monitor, manage and optimise power consumption in a private home.

Project summary

The proposed system incorporates machine learning to enhance decision making based on how power is consumed in off grid solar power homes. The system can help ensure effective usage of the available solar energy increasing the reliability of the energy systems.

Key design highlights

The project incorporates a support vector machine and a supervised machine learning algorithm, which allows us to mimic many different scenarios in a residential setting. This gives us the ability to combine observations made of consumption rates of different loads in the house with other factors such as light intensity, time of day and human motion. This allows accurate decisions, tailored for different scenarios, to be made.

Cost

The cost of the prototype is relatively inexpensive, currently standing at $133.50 USD. We have had to strike a balance between features and the cost without compromising on either. We have also employed a system of upcycling and recycling of the batteries to further help reduce the cost.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Properly managed energy can help ensure that there is surplus of energy for income generating activities at home. This can help reduce rates of unemployment, many of whom have been affected by the COVID-19 pandemic – this in turn, works to address SDG 7. The power management system can be integrated into solar home systems for easier regulation even after the grid arrives in an area – which help to address SDG 11. SDG 12 is addressed by allowing the user to see their consumption and production rates and in turn, make informed changes into how they use the available energy, thus reducing wastage. Applying the cradle-to-cradle approach for the batteries and using models that are easily reparable, we aim to ensure that little to nothing is left to waste – helping to address SDG 13.

Social, environmental and economic considerations

Social: The project design is gender -inclusive, prevents the wastage of food as energy is consumed efficiently, and ensures sufficient and proper lighting to help school children and adults to increase their productivity.

Environmental: We aim to reduce e-waste by using upcycled lithium-ion batteries. While more is still to be done to ensure an efficient model, we believe this is a vital step as solar use increases. Through responsible power use, there is less wasted energy. Efficient systems will also have a longer shelf life, which reduces waste.

Economic: Efficient use of power ensures more energy for productive use. The payment model also ensures that the user is comfortable and able to pay without too much exertion. Benefits are likely to be seen over the long run as fuel costs continue to rise in Kenya.

Link to the Full Report

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Team 2020-14 - Solar Powered Brick (Matofali) Maker

Maurice Musembi, Denis Kipkorir, Charles Lengushuru, Elsie Baraza

UNIVERSITY OF NAIROBI

Theme – Infrastructure

Proposal

The proposed machine aims to provide communities with a means of generating income through brick making, for individual use or selling to construction companies.

Project summary

Our team has designed a solar powered brick maker, which utilises off-grid solar power to manufacture bricks.

Key design highlights

Our proposed energy efficient, solar powered, eco-friendly brick heating furnace aims to enhance the efficiency of the eco-friendly brick making processes. Our design provides both a cheaper and greener method of heating when compared to conventional mostly liquified petroleum gas (LPG) powered models. As the furnace can be used in off-grid settings, bricks can now be made on site and therefore help reduce the cost of transporting bricks to construction sites. We will use graphitic carbon fibre as our heating element as opposed to the filament heating element used in conventional systems, as graphitic carbon fibre is less power intensive and can provide the required furnace temperature without choking our solar modules.

Cost

The total estimated cost for the proposed design is about $600 USD.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design works to address the following SDGs:

- **SDG 1 (No Poverty):** The proposed Matofali Brick maker, if actualised, could enhance employment not only for users but also for designers, transporters and retailers. This can help reduce unemployment and, in turn, poverty.
- **SDG 7 (Affordable and Clean Energy):** Our Brick Maker uses solar energy as its primary energy source and therefore, its actualisation, could help increase the share of renewable power in the global energy mix.
- **SDG 8 (Decent Work and Economic Growth):** From the manufacturing process through to the final user of the machine, new employment opportunities are present.
- **SDG 9 (Industry, Innovation and Infrastructure**): The proposed Matofali Brick maker in itself is a project that encourages innovation. Through its development process the number of research and development workers could be increased.
- **SDG 11 (Sustainable Cities and Communities):** Our solar powered brick maker could help lower the cost of brick making, thereby reducing the overall costs of bricks.

Social, environmental and economic considerations

Our proposed solar powered furnace for eco-friendly brick making delivers a cheaper method of producing bricks, which can significantly reduce construction costs. This can help address challenges in the housing sector, even as the sector continues to grow. Thus, it can translate to improved living standards in the target community. Furthermore, the construction of the furnace is simple and most of the materials used are recyclable, which translates to minimal negative effects to the environment.

Link to the Full Report

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Team 2020-15 - Electroadsorption Cooler Box

Ghariba Ali, Elizabeth Omae, Larry Koech

UNIVERSITY OF NAIROBI

Theme – Refrigeration

Proposal

We are proposing a cooling unit that can be used by smallholder farmers in rural Kenya. The design is for an affordable, energy efficient and environmentally friendly device that can improve the storage of perishable farm produce at appropriate temperatures.

Project summary

We propose an electroadsorption cooler (EAC) to reduce food losses. The design is a hybrid of the adsorption and thermoelectric cooling cycles, which employs thermoelectric modules in the reactor beds, thus creating a highly efficient and environmentally friendly fridge.

Key design highlights

The EAC symbiotically combines adsorption cooling and thermoelectric cooling cycles.

The working principle of an EAC is similar to an adsorption cooler. The primary difference is that the heating of the desorber and cooling of the adsorber are accomplished by the thermoelectric device’s hot junction and cold junction, as opposed to using a heat transfer fluid. During the heating and cooling of the beds, small valves help ensure that no refrigerant flows in and out of the beds. A timed controller controls the opening and closing of the valves. The switching of the adsorber and desorber, to reverse their roles, is achieved by alternating the polarity of the direct current (DC) electrical input into the thermoelectric circuit.

Cost

The design has been estimated to cost $400 USD. The most expensive feature of the design is either the silica gel or activated charcoal used in the reactor beds.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design works to address the following SDGS:

- **SDG 1 (No Poverty):** Our design improves the livelihoods of small-scale farmers.
- **SDG 2 (Zero Hunger):** The proposed design reduces food loss during harvest which has the potential to provide food for the masses.
- **SDG 7 (Affordable and Clean Energy):** The design uses solar energy, a renewable power source.
- **SDG 12 (Responsible Production and Consumption):** The design can help lower food loss by saving up all harvested produce.
- **SDG 13 (Climate Action):** The design uses water as a refrigerant and thus has no harmful emissions.

Social, environmental and economic considerations

The proposed design is environmentally friendly because water is used as a refrigerant and there are therefore no harmful emissions in the environment. The design can help eventually boost the economy by improving the livelihoods lives of smallholder farmers. It helps ensures that most, if not all, of the harvested food reaches the market, thus, providing enough food for everyone, helping to reduce hunger as well as poverty.

Link to the Full Report

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Team 2020-16 - Intelligent Solar Powered Irrigation Pump for Horticultural Production in Northern Uganda

Okot Bonny, Okee Vincent, Okane Reagan, Odong George Rackara, Elias Muhoozi

Theme – Agriculture

Proposal

Our proposed design solution is comprised of a soil moisture sensor, water level sensor, pump and reservoir tank, microcontroller, and solar module.

Project summary

Water from a water source, such as a well, is pumped by a submersible pump to a reservoir tank, which is fitted with a water level sensor. With gravity, this water should flow to the field for irrigation. The flow is controlled by a valve which responds to a signal from a soil moisture sensor in the field. The main aim here is to increase production with the optimum amount of water, helping to boost farmers' incomes.

Key design highlights

Understanding crop water requirements is essential to designing other components of the system. A key part of the design was calculating the total dynamic head of the pump because it affects the pump's power requirements. Furthermore, the sensors had to be well-selected to suit their purpose.

Cost

The total cost of the project is estimated to be $600 USD. However, other significant expenses may be incurred through equipment import charges and maintenance costs.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design works to address the following SDGs:

- **SDG 2 (Zero Hunger):** Our design will help support year-round production of vegetables.
- **SDG 8 (Decent Work and Economic Growth):** This goal is addressed through the automation of the design.

Social, environmental and economic considerations

The social consideration made in this design was to increase food production. Environmental considerations were made when deciding to use clean energy to minimise the release of hazardous chemicals into irrigation water supplies. Finally, this project was made with economic considerations in mind, with the hope of increasing farmers' incomes.

Link to the Full Report

Team 2020-17 - Off-Grid Design to Improve Energy Efficiency for the Agriculture Sector in LMIC Communities

Maanasa Malladi, Paige Haire

Theme – Agriculture

Proposal

Our proposal is for a counter-top solar powered grain mill.

Project summary

The report summarises the primary research obtained from interviews with industry experts – an external mentor and LSBU professors – as well as the technical elements of the project, which comprise the design and development process undertaken to meet the project's aims and requirements. The report also discusses the evaluation criteria used for the concept selection, based on initial design sketches.

Key design highlights

Key design highlights include a small countertop-suitable size; a 150W power requirement for 18000rpm, making it more energy efficient compared to conventional medium sized grain mills on the market which require 750-1000W; The design utilises novel blade cutting technology; and the mill employs locally sourced materials.

Cost

The major costs of the grain mill include; The motor - £30 ($42.58 USD), other electrical components - £5 ($7.1 USD), and the casing and jug - £4 ($5.68 USD)

We have also decided to use a payback model system for customers to help make the device more affordable.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

The sustainable development goals have been considered at each design process listed below.

The manufacturing process:
We aim to use locally sourced materials for the outer casing of the mill, which can help reduce the overall cost of the device by lowering import fees. That said, certain elements of the design would still need to be imported and, as such, may incur a substantial carbon footprint. This is a trade-off, as these quality parts will require less frequent replacement.

Eco-friendly energy source:
The device will primarily use solar energy – a more eco-friendly option, when compared to the current standard diesel mills.

Waste disposal considerations:
The device will strive to use as many recyclable components as possible.

Social, environmental and economic considerations

In 2015, 27 of the 28 poorest countries were located in Sub-Saharan Africa. 25% of people in the region live on less than $1-$2 USD per day of which 50% to 80% is spent on food. Sub-Saharan African countries which produce high volumes of millets were researched. We discovered that Chad was the second hungriest country in 2018 according to the Global Hunger Index (GHI).

Link to the Full Report

EFFICIENCY FOR ACCESS

Team 2020-18 - Off-Grid Fridge Technology Implementation Review

Gavin Kitching, Giacomo Di Biase, Ross Craig

University of Strathclyde Glasgow

Theme – Refrigeration

Proposal

Our solution provides a framework by which to analyse the suitability of incorporating fridges into interconnected solar home systems.

Project summary

This solution provides analysis on the number of fridges, which can be accommodated based on current energy generation. Recommendations can then be made regarding the cable size used to make connections within the grid. Finally, the amount of storage required to support a certain load can be ascertained.

Key design highlights

The solution is both well-structured and documented. This allows it to be scaled for any input parameters and, in turn, to be implemented across many village contexts.

Cost

As this is a supporting methodology, there are no physical costs. If implemented, an employee(s) of the implementing organisation would be required to help scale this.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

With a methodology to extract key parameters and scale our proposed technology, the implementation of refrigerators can be accelerated. Refrigerators provide numerous benefits for the users, which touch upon multiple Sustainable Development Goals (SDG 8 (Decent Work and Economic Growth), in particular, is identified).

Social, environmental and economic considerations

Social considerations made:
Offering refrigeration technologies to members of Sub-Saharan African communities can help provide them with opportunities for social development. Caution must be taken to ensure that the analysis works within a reasonable margin of error to avoid incorrect assumptions based on numerical data that have real impacts on people's lives.

Economic considerations made:
This analysis provides the opportunity to offer villagers in Sub-Saharan Africa the chance to purchase a refrigerator, which based on the average income in these communities, will be a considerable investment. As such, the analysis focused on trying to find the cheapest solution while maintaining the quality of the recommendations being made.

Link to the Full Report

EFFICIENCY FOR ACCESS

Team 2020-19 - Design of a Vaccine Refrigeration Unit

Daniel Hetzel, Simran Nair, Kushma Thapa, Safia Whitwham

UCL

Theme – Refrigeration

Proposal

This proposal is for an active cool box (ACB), which aims to bridge the gap between cool boxes and vaccine refrigerators.

Project summary

The active cool box is a portable refrigeration solution, which aims to reduce issues within the cold chain. It has an appropriate temperature, making it a more reliable solution than the conventional cool box, and the small size means it can be set up at vaccination outreach centres for a number of days allowing it to reach more vulnerable members of the community.

Key design highlights

The key design highlight is the use of thermoelectric cooling technology within the active cool box.

Cost

The cost of the solution including profit is $450 USD, which can be offset by reduced vaccine wastage after only three uses.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

This design looks to directly affect SGD 3 (Good Health and Wellbeing), SDG 7 (Affordable and Clean Energy) by attempting to harness technology applicable to the nascent PV mini grid market, and SDG 10 (Reduced Inequalities) by ensuring everyone has access to these critical vaccinations.

Social, environmental and economic considerations

Socially, the ACB can help increase access to vaccinations. The ACB allows for an increase in the scope of outreach programmes, thereby reducing the distances that vaccine beneficiaries need to travel. This is particularly important for people with disabilities or women with small children. Increased vaccination rates can help improve the health of whole communities, particularly because a large number of health issues experienced by those in poverty are either preventable or treatable.

Link to the Full Report

Team 2020-20 - Solar Powered Oxygen Concentrators in Sub-Saharan Africa

Reid Ashby, Alice Chave, Salome Laviolette, Keyur Roula, George Young

Theme – Healthcare

Proposal

Our aim was to design a direct current (DC)-compatible concentrator, to match the performance of commercial alternating current (AC) models and to the design and implementation challenges present in Sub-Saharan Africa.

Project summary

Our project aimed to double the outflow of DC devices and look for alternative technical solutions to climatic, efficiency and usability challenges. Additionally, we built up a solid business model, including a field study, while carefully considering end users' needs.

Key design highlights

Our team chose to try out two DC compressors in parallel to help improve the performance of existing DC devices so that they match commercial AC ones. We also added a motor controller which enabled control of the motor speed, a reduction of the power demand and improvements to energy efficiency. All of this was successfully prototype-tested.

Our design recommendations are to add a pre-filter before the bacteria filter to tackle dust issue and maintenance, to add a two-stage evaporation cooling system to help deal with both humidity and temperature which hinder the concentrator's performance, and use a flow splitter to potentially allow for up to four babies to be connected to the same device.

Cost

This report recommends a hub-and-spoke distribution model with a fee-for-service style subscription rather than a financing to own model. County 'hub' hospitals would partner with smaller health care centres 'spokes' within a reachable radius. The revenue shared with the hub will be reinvested to further improve care services within the network.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design works towards the following SDGs:

- **SDG 3 (Good Health and Well-being):** through the innovation of an essential medical appliances which will expand oxygen accessibility across the region and raise the standard of care.
- **SDG 7 (Affordable and Clean Energy)**

Social, environmental and economic considerations

The business model incentivises the avoidance of expensive stock replacement while guarding against accelerated wear and tear on the concentrator. Lithium-ion batteries hold reuse potential, and Sub-Saharan Africa is considered a region that would benefit from a circular economy program.

The innovations in the design and implementation can help expand affordable access to oxygen therapy in resource-strained locations, dramatically improving survival rates from respiratory infections. The savings realised by health care centres can help reduce patients' out-of-pocket costs. Furthermore, local mechanics and electricians can be recruited and trained for technical staffing, hence empowering busy medical staff to focus solely on care and not worry about machine maintenance.

Link to the Full Report

EFFICIENCY FOR ACCESS

Team 2020-22 - Design and Build a Solar Battery Cooking for Use in SSA

Tommy Ross

Loughborough University

Theme – Cooking

Proposal

The proposed design is to use detailed modelling to identify suitable existing direct current (DC) appliances, then design and build an integrated prototype solution for a solar e-cooking system.

Project summary

Through detailed modelling, it has been identified that an electric cooking system with current DC appliances, powered by solar panels and a lithium iron phosphate battery, can be cost competitive. A prototype solution for an integrated unit has been designed to demonstrate this.

Key design highlights

A sample meal plan was used to estimate energy requirements in a way that was as representative as possible. Appliance testing was then carried out to further improve the model by identifying the combination of components that provided the minimum possible lifetime cost for a system. A prototype for an integrated unit was then designed (and is currently being assembled). A prototype water tank has also been designed and tested to explore alternative energy storage as a way of reducing system cost. Cooking experiments were conducted with the appliances to validate the model and identify where further work would add the most value.

Cost

The funding received as part of the challenge went towards prototyping. The most significant expenses were £150 GBP ($212.9 USD) for thermocouples and £46.26 GBP ($ 65.7 USD) for a thermometer to test the appliances and water tank.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

This design works to address the following SDG targets:

- **SDG 3 (Good Health and Well-being) target 3.9**: 4 million premature deaths each year are estimated to be caused by household air pollution linked to cooking with traditional stoves.
- **SDG 5 (Gender Equality) target 5.b**: Solar electric cooking could help remove the need for travelling to buy or collecting traditional fuels, which would empower women by freeing their time.
- **SDG 7 (Affordable and Clean Energy) target 7.1**: Solar electric cooking could provide reliable, safe cooking at a price that is competitive with traditional fuels.

Social, environmental and economic considerations

Based on an estimation that the cost of cooking with charcoal is $14.84 USD per month, the 890 million people (estimated to be 218.1 million households) in Sub-Saharan Africa who are currently without access to clean cooking solutions could represent a potential market of $3.24 billion USD a year if they were to transfer to electric cooking.

Life cycle assessment has not been conducted, however avoiding the burning of solid fuels for cooking would avoid 2% of global CO2 emissions and 58% of global black carbon emissions. Using a water tank as energy storage is also expected to reduce environmental impacts as it significantly reduces the size of battery required (therefore reducing all the environmental impacts associated with battery manufacturing).

Link to the Full Report

EFFICIENCY FOR ACCESS

Team 2020-24 - Small-Scale DC Solar Powered Food Dehydrator

Vincent Mwalya, Peter Kasyoki, Brenda Nthenya

Theme – Agriculture

Proposal

This proposal is for a small-scale direct current (DC) solar-powered food dehydrator meant for drying maize for storage to prevent harvest loss and ensure a continuous food supply.

Project summary

Post-harvest losses, such as those caused by aflatoxins, create a shortage in maize supply and ultimately, increase the price of flour. It is crucial to find all possible means to reduce these losses. One way to achieve this is to ensure proper drying of the maize before storage.

This project presents the design, construction, and performance evaluation of a small-scale DC solar powered food dehydrator, designed to dry maize with the use of locally available materials.

Key design highlights

The designed hydrator operates in a closed loop system. It also uses solar radiation for additional heat in the food chamber, and it can operate during the rainy seasons.

Cost

The design is estimated to cost $420 USD.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design works toward the following SDGs and SDG targets:

- **SDG 2 (Zero Hunger) target 2.1**: Through the drying process, grain produce is preserved for long periods of time, thus helping to ensure a constant supply of produce and contributing towards the reduction hunger and access to food by all people.
- **SDG 2 (Zero Hunger) target 2.3**: By preserving food through drying, this design seeks to reduce harvest loss and, in turn, contribute towards increased agricultural productivity and income of small-scale farmers.
- **SDG 7 (Affordable and Clean Energy) target 2**: Our project will use solar energy, which is both clean and affordable. The design aims to be as energy efficient as possible, so that any additional harnessed energy can be put towards other productive uses.
- **SDG 10 (Reduced Inequalities) target 1:** By addressing the insufficient food security of small-scale farmers, this project aims to help integrate farmers into their communities.

Social, environmental and economic considerations

This product took economic considerations of the farmer into account by making sure the product can be used to dry foods other than maize.

Social inclusivity was observed during the design process by ensuring the design can be used by anyone intending to dry food products.

This design is environmentally friendly as no harmful substances are released during its operation.

Link to the Full Report

EFFICIENCY FOR ACCESS

Team 2020-25 - Solar Powered Water Filtration and Purification System

Josephine Tariya, Mercy Minoo, Charles Karira

Theme – Water Purification

Proposal

Our proposed design is for a water filtration and purification system powered by solar energy.

Project summary

Our idea uses an ultrafiltration membrane and ultraviolet (UV) light emitting diode (LED) to provide clean and safe drinking water to communities.

Key design highlights

Key design highlights are as follows:

- A sieve for pre-treatment to remove any large particles from the cloudy water.
- A pump at the bottom of the tank to pumps water at a sufficient pressure to the membrane.
- An ultrafiltration membrane that removes small particles and bacteria.
- A pipe fitted with an UV LED which purifies water by killing viruses.
- Additionally, we have a liquid crystal display (LCD) and buzzer for monitoring and notifying the user when maintenance is needed.

Cost

The total cost of the project is $300 USD, which includes miscellaneous costs, namely, transport and inflation costs. However, the filter and UV LED are the costliest components in the budget.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design works toward the following SDGs:

- **SDG 3 (Good Health and Well-being)**: Access to clean drinking water helps to promote good health by reducing the contraction of waterborne diseases.
- **SDG 6 (Clean Water and Sanitation):** Residents in rural areas can receive general sanitation improvements through improved access to clean water.
- **SDG 7 (Affordable and Clean Energy):** Solar energy, the energy source used to power the UV chamber purifier, is more affordable compared to alternating current (AC).
- **SDG 10 (Reduced Inequalities):** Providing access to clean water and affordable energy to the rural community promotes resource equality within a country. This design can help enhance access to clean water for urban and rural populations.

Social, environmental and economic considerations

The social, environmental and economic considerations of this design are as follows:

Social considerations – The design can help enable access to clean water, thus helping to reduce the occurrence of water borne diseases.

Economic considerations – The design incorporates a Pay As You Go model for payment.

Environmental considerations – The design provides an environmentally friendly alternative to boiling water with firewood/coal through the use of solar energy, a clean and renewable power source.

[Link to the Full Report]

EFFICIENCY FOR ACCESS

Team 2020-28 - Design of an Efficient Kettle for Off-Grid Kenya

Paul Lavender-Jones, Luke Peacock, Luke Evason, Nicole Wan, Cameron Everist

UNIVERSITY OF BATH

Theme – Cooking

Proposal

We have proposed a design for a dual-mode insulated kettle with an integrated filtration system.

Project summary

The aim of this design is to provide boiling water for cleaning, drinking and cooking, whilst also providing a means for sterilising water.

Key design highlights

By having a secondary mode that only heats the water to 70°C, the design can help save energy when the user does not require boiling water. Insulation not only increases efficiency, but also reduces the frequency of boiling by keeping water warm for longer. Opting to use an electrical appliance to boil water, rather than the traditional 3-stone fire, lowers carbon emissions through reduced biomass combustion, as well as offers health benefits from less exposure to fumes.

Cost

Bill of materials (BoM) cost is hard to calculate for certain, but when designing, the target was to aim for around $30 USD. Mass manufacturing of the kettle will be cheap but initial capital for machinery may be significant.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design addresses SDG 6, which focuses on providing clean water and sanitation for all, a problem that is particularly apparent in Sub-Saharan Africa. The kettle also directly helps SDG 7 (Affordable and Clean Energy) and SDG 5 (Gender Equality).

Social, environmental and economic considerations

The full lifecycle of the device has been considered in relation to the environment to reduce e-waste and the possibility of the device ending up in a landfill. Furthermore, all non-electronic materials are recyclable.

Marketing has also been considered to ensure we are contributing to SDG 5 (Gender Equality).

[Link to the Full Report]

EFFICIENCY FOR ACCESS

Team 2020-30 - Tanzanian Smallholder Solar Mill

Fabian Brennan, Elinor Barnett, Antoine Michelot, Ella Nicolson, Rose Powell

UNIVERSITY OF BATH

Theme – Agriculture

Proposal

Our proposal is for an automated flour production system powered by solar energy that uses modular sub-systems to integrate pre-processing stages in Tanzania.

Project summary

As Tanzania's staple crop, maize is key to life in rural communities. Currently, 90% of milled maize is produced by small-scale mills, the majority of which are powered by diesel generators. As Tanzania has experienced a high rollout of solar home systems and low grid coverage in maize producing regions, the country was identified as the primary market for the new machine. Additionally, with 96% of diesel mill customers being women and children, these were selected as the target user.

Key design highlights

The design is produced with three primary sub-systems; de-husking/shelling, cleaning, and milling. The final design has a throughput of 60kg/hr with a baseline efficiency of 25kg/kWh, with significant potential for improvement during testing. The different processes were designed to work as standalone machines and be assembled into one larger machine. A battery can also be specified.

Cost

To optimise the efficiency of the system, brushless direct current (DC) motors have been specified, this significantly contributed to the purchase cost. The battery also increases the estimated cost.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Using a solar mill can help women and children save time for other activities such as education or starting a small business. This helps tackle SDG 4 (Quality Education) and 5 (Gender Equality). Furthermore, the product's ergonomics were designed for women, which directly addresses target 5.3 to 'enhance use of enabling technology […] to promote the empowerment of women'.

The mill also helps contribute to work towards SDG 2 (Zero Hunger), specifically target 2.3, to 'double agricultural productivity and income of small-scale food producers, in particular women' by 2030.

The mill also promotes SDG 7 (Affordable and Clean Energy), encouraging people to use solar energy rather than diesel alternatives, which reduces the health risks associated with inhaling fumes. This directly addresses Target 7b to 'expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries.

Social, environmental and economic considerations

Social – The solar mill encourages clean energy practices and steers users away from diesel mills, which have detrimental effects on user's health and the environment. The company also aims to provide more opportunities for education by reducing the time spent on manual labour.

Environmental – All materials for the manufactured parts are made from recyclable materials.

Economic – While it has a higher upfront cost compared top diesel mills, once the mill is paid off, in 3.35 years, it will be cheaper due to lower operating costs. The mill will also be available through a "lease to own" scheme, improving the affordability of the system.

[Link to the Full Report]

EFFICIENCY FOR ACCESS

Team 2020-31 - Refriger8

Sage, Thomas Santini, Ellie Bowers, James Bozeat, Laurie Davies

UNIVERSITY OF BATH

Theme – Refrigeration

Proposal

A communal refrigeration system for use in off-grid communities.

Project summary

Our design is a bank of drawers cooled by a compressor to extend the life of food stores, minimising post-harvest food losses in Sub-Saharan Africa. It bridges the gap between the current solutions of individual refrigeration units and larger cold rooms, for small and subsistence farming communities.

Key design highlights

- One of the key design features is a simple and easy-to-use ATM-style interface, which allows for opening and closing drawers and signing-up to the community refrigerator.
- An economical cooling system utilising a biomimetic structure, modelled on termite mounds.
- Increased security through sturdy and lockable cooling boxes
- Thermistors measure the internal temperature of the drawers and a microprocessor controls the compressor to keep the temperature within the 0–5-degree range.
- The coolant used is R123 (hydrofluorocarbon replacement), which has a minimal impact on the environment and on the health of the users, while still being as efficient as possible.

Cost

The user pays $3.50 USD per week via SMS to access the device, with no maintenance costs imposed. The business model consists of partnering with various organisations or investors to fund design iterations during pilot schemes. Our Average Product Unit Cost (APUC) is $429.75 USD.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design works to address the following SDGs:

- **SDG 7 (Affordable and Clean Energy):** Our design uses cost-effective manufacturing methods and materials to ensure affordability. The materials used are recyclable, which helps to increase the sustainability of the design.
- **SDG 2 (Zero Hunger)**: By providing an accessible refrigeration solution, our design hopes to make more food available to the users in off-grid and vulnerable areas in Sub-Saharan Africa. This refrigeration solution also helps to promote sustainable agriculture, which is stipulated in SDG 2.
- **SDG 4 (Quality Education):** Finally, less of the user's time is needed in the fields, allowing them to focus on other endeavours such as education.

Social, environmental and economic considerations

Social considerations include the acknowledgement of the need for a solution between the existing individual fridges and the larger cold rooms. The larger screen also allows for a large font size in consideration of users with potential eyesight problems.

Environmental concerns led the team to select a coolant that is environmentally friendly, while still working efficiently. This efficiency allows for less power to be drawn by the system.

Economic considerations resulted in a design that is affordable for users by using cost-effective materials and designs. Using passive cooling through biomimicry adds another cooling feature at a minimal cost. The materials can also be sourced locally, which further minimises transport costs.

Link to the Full Report

Team 2020-33 - Design, Construction and Performance Evaluation of a Solar Powered Electric Cooker

Eugene Asamoah, Jasper Okino, Felix Bosire, Margaret Ayabei, Bernadette Dushengere

Theme – Cooking

Proposal

Our proposal is to improve the livelihood of rural communities with clean cooking facilities.

Project summary

We aimed to design and construct a solar powered electric cooker, targeting rural communities to address health and environmental problems associated with the use of traditional cooking methods, such as firewood.

Key design highlights

Key design parts for this project are as follows:

- A direct current (DC) heating element with a power requirement of 50W, and a heated temperature of 140 degrees C.
- A generic digital thermostat temperature control switch sensor. The thermostat used is an incredibly low-cost, yet highly functional, thermostat controller. With this module, you can intelligently control power to most types of electrical devices, based on the temperature sensed by the included high accuracy negative temperature coefficient (NTC) temperature sensor.

Cost

The total cost for the design and construction amounted to $302 USD.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

- Our solar powered electric cooker could help reduce the incidence of illness caused by indoor air pollution as a result of using dirty traditional three-stone stoves.
- Our project could help improve access and knowledge to use clean cooking technologies in rural communities.
- The cooker could help reduce the 21 hours a week labour of collecting firewood traditionally borne by women and girls and/or remove costs of cooking fuel.
- It c could help reduce over-reliance on forest resources as a source of cooking fuel. This could help reduce deforestation and pressure put on forest resources. There are no emissions caused by the use of a solar cooker during cooking and is therefore safer for the environment.

Social, environmental and economic considerations

The use of solar powered electric cookers could help reduce pressure put on forests for the collection of firewood. This helps to prevent the greenhouse gas emissions associated with the use of firewood.

[Link to the Full Report]

EFFICIENCY FOR ACCESS

Team 2020-34 - Project Title: Evaporative Cooler for Storing Fresh Fish

Elly Olomo, Vitumbiko Nundwe, Gloria Musongwa, Emmanuel Rotich, Nahashon Limo

Moi University
Foundation of knowledge

Theme – Refrigeration

Proposal

Our proposal is to design an evaporative cooler to allow for the temporary storage of fresh fish.

Project summary

This project proposes the use of an evaporative cooler to store fresh fish while awaiting transit to market or purchase by industrial fish processors. The evaporative cooler provides low temperature storage and hence, longer shelf for life of fresh fish. This is a more affordable option for the majority of fishermen and traders who cannot use the available ice coolers and refrigerators, whether due to purchase cost, their scale of operation or the absence or high cost of electricity, among other factors.

Key design highlights

The major design options considered included:

- A higher storage volume of 50kg, providing enough storage space for two days' catch worth.
- A lower temperature target (less than 15 degrees C)
- Frame material (aluminium, mild steel, wood)
- Pad material (manufactured cellulosic pad material, saw dust, foam mattress material, cotton waste)
- Tank material (supply tank and sump) aluminium, mild steel and plastic

Cost

For most of the design, we used locally developed and cheap material. The significant costs associated with the design are the electric components like the solar panel and direct current (DC) battery.

How does your design help to work towards the Sustainable Development Goals (SDGs)?

Our design works to address the following SDGs:

- **SDG 7 (Affordable and Clean Energy):** Our evaporative cooler seeks to provide affordable technology and an energy efficient appliance.
- **SDG 1 (No Poverty):** Work towards SDG 7 will translate to economic empowerment, by providing productive activities and economic incentives to the local fishermen.
- **SDG 5 (Gender Equality):** It is also a technology designed with inclusive participation in mind.

Social, environmental and economic considerations

Our technology will achieve effective cooling temperatures. It will achieve this while being affordable, throughout its lifecycle, from initial purchase to use and maintenance. The evaporative cooler is also energy efficient and has a limited environmental impact. Furthermore, due to the nature of the technology, issues faced with conventional refrigerators, such as electrical resilience, survivability, and difficulty of transportation, do not arise.

Link to the Full Report