EFFICIENCY FOR ACCESS

Supported by: UK ENGINEERS WITHOUT BORDERS

Efficiency for Access Design Challenge 2021-2022 Final Submission

Summary of the designs submitted by the participants 2021 -2022

Funded by:

UKaid from the British people

IKEA Foundation

energy saving trust

Contents

Abbreviations

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

CFA…………………………………………………..West African franc

CO_2……………………………………………………Carbon Dioxide

DC……………………………………………………..Direct Current

EUR……………………………………………………Euro

GBP……………………………………………………Great British Pound

GHG………………………………………………….Greenhouse Gas

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

NGO…………………………………………………..Non-Governmental Organisation

PAYGo………………………………………………..Pay-As-You-Go

PV……………………………………………………..Photovoltaic

RFID…………………………………………………..Radio Frequency Identification

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

TEC…………………………………………………….Thermoelectric Cooling

UN……………………………………………………..United Nations

USD……………………………………………………United States Dollars

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 solar appliances and enabling technologies.

By bringing together and inspiring students, the competition aims to foster innovation in the solar appliance 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.

Efficiency for Access and Engineers Without Borders UK are delighted to collaborate on the delivery of the Efficiency for Access Design Challenge. Efficiency for Access 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 third year of the competition, 119 students from 19 universities in Bangladesh, Benin, Cameroon, Kenya, Nigeria, Pakistan, Senegal, Uganda, the UK, the USA, and Zimbabwe submitted 31 projects and were supported by over 40 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	Video Submissions	Team Members
2021-01	Gulu University, Uganda	Solar-powered washing machine	Water	Full Report	Video Submission	Ocen Zedekia Ezra Ojok, Ahereza Oscar, Olanya Olenge Tonny
2021-05	Gulu University, Uganda	Improved solar-assisted evaporative cooler	Agriculture	Full Report	Video Submission	Bridget Viola Adoch, Feddy Francis Otim, George Rackara Odong, Sam Odora Okello
2021-06	National University of Sciences and Technology (NUST), Pakistan	Solar-based dehydrating system for food preservation	Agriculture	Full Report	Video Submission	Zainab Sajjad, Iram Fatima Aulakh, Khurram Zia, Hadiya Rafique
2021-09	Aston University, United Kingdom	Smart solar- powered irrigation system	Agriculture	Full Report	Video Submission	Aisha Aden, Samay Massum, Augustine Anaka, Sami Lattrsh
2021-10	Aston University, United Kingdom	Atmospheric water generation with bios and filtration and UV purification system	Access to clean water	Full Report	Video Submission	Jack Benefer, Gopu Gopakumar Nair, Pathan Navedahmed, Toshif Mansuri, Simranpal Kandol
2021-11	Aston University, United Kingdom	Phone charging station	Power management	Full Report	Video Submission	Chigozirim Nnorom, Ayooluwa Folayan, Harshil Patel, Sanoj Babu
2021-12	Makerere University, Uganda and Swansea University, United Kingdom	Solar-powered milk cooling unit	Agriculture	Full Report	Video Submission	Harry Vine, Panagiotis Chatziangelakis, Simon Kalungi, Caleb Oguli
2021-13	Swansea University, United Kingdom	Hydrogen smart battery	Power management	Full Report	Video Submission	Nia Melding, Rachel De-Matei, Matthew Carrington, Alice Blaber
2021-14	Makerere University, Uganda and Swansea University, United Kingdom	Pasteurisation unit for milk cooling centres in Uganda	Agriculture	Full Report	Video Submission	Oluwafunmibi Ijaiyemakinde, Hannah Bayoudhi, Gladys Abiyo, Mark Ssentongo
2021-15	National University of Sciences and Technology (NUST), Pakistan	Evaluating the potential of smart, direct current microgrids	Power management	Full Report	Video Submission	Shoaib Ahmed, Tahreem Fatima, Ahmad Rizwan, Muhammad Abdur Rehman Wasti, Syed Ashhab Ur Rahman Iqbal Ahmed

Team	University	Project Title	Theme	Full Reports	Video Submissions	Team Members
2021-17	Harper Adams University, United Kingdom	Pay-As-You-Go solar milling solution	Agriculture	Full Report	Video Submission	Gareth Goodchild, John Morgan, Isabelle Bourassa, William Evans, Jack Yeomans
2021-18	UCL, United Kingdom	Space cooling system with grass filter	Space cooling	Full Report	Video Submission	Hannah O'brien, Eleanor Deansmith, Xinyu Xiang, Leo Rey-Coquais, Adeola Onanuga
2021-19	Midlands State University, Zimbabwe	Semi-automatic lawn mower	Landscaping	Full Report	Video Submission	Talent Chigwagwa, Morelife Zibaiwa, Anesu Dhinha, Courage Manzwei, Price Sanya
2021-21	University of Port Harcourt, Nigeria	Community-based smart potable water system	Access to clean water	Full Report	Video Submission	Ntami Echeng, Somina Afrogha, Alfred Ndorbele, Anthony Akpasoh, Favour Emmanuel
2021-22	University of Port Harcourt, Nigeria	Solar PV tech module potable cooler box	Refrigeration	Full Report	Video Submission	Abasiama Udomah, Ufuoma Omosohwofa, Nsikan Udomah, Ovie Jacob
2021-25	Jomo Kenyatta University of Agriculture and Technology, Kenya	Solar-powered mobile blood bank	Healthcare	Full Report	Video Submission	Sera Maina, Eric Muia
2021-26	Jomo Kenyatta University of Agriculture and Technology, Kenya	Solar baby incubator	Healthcare	Full Report	Video Submission	Margaret Kuria, Doris Mwimali, Winfred Mwendwa
2021-27	National University of Sciences and Technology, Zimbabwe	Solar-powered greenhouse system, with online web monitoring	Agriculture	Full Report	Video Submission	Volition Smthxilo Mashamba, Hazel Queen Makiseni, Andrew Kapasura, Makhosandile Makhiye Nyathi, Henry Melusi Phiri
2021-28	National University of Sciences and Technology, Zimbabwe	Solar-powered oxygen generator with solar batteries	Healthcare	Full Report	Video Submission	Gideon Mhlanga, Batsirai Nyabunze, Trymore Kanjera, Fanuel Magomo, Tinotenda G. Moyo
2021-31	City, University of London, United Kingdom and Independent University, Bangladesh, Bangladesh	Solar direct drive cold storage system for off-grid preservation of fish and perishable goods	Refrigeration	Full Report	Video Submission	Md. Sadik Abdal, Tashfiah Tahsin, Ali Ahmed, Nour Ben Gaied

Team	University	Project Title	Theme	Full Reports	Video Submissions	Team Members
2021-33	African Institute for Mathematical Science, Senegal	Intelligent solar dryers for food valorisation	Agriculture	Full Report	Video Submission	Waly Faye, Fatou Fall, Issiakou Worou Wouignanso, Kancou Dableny Fall, Binta Sow
2021-36	National University of Sciences, Technologies, Engineering and Mathematics, Benin	Study and design of a solar-powered electric oven	Cooking	Full Report	Video Submission	Adekambi Olachadé, Adigbe Vincent, Djossou Eudes, Gbossou Odilon, Migbe Isaï
2021-37	University of Bath, United Kingdom	Communal cooler	Refrigeration	Full Report	Video Submission	Ashwath Shanmugavel, Matthew Davies, Eva Vautrin, Dan Gooda,
2021-40	University of Bath, United Kingdom	Solar-powered toilet	Sanitation	Full Report	Video Submission	Grace Adeniyi, Alex Esslinger, Anastasis Adamopoulos, Nikolai Puumalainen,
2021-41	City, University of London, Unite Kingdom and Independent University, Bangladesh, Bangladesh	E-bikes: a micro-mobility vehicle for rural regions	Transport	Full Report	Video Submission	Fatima Shamim, Sadiqul Islam, Ushua Prashanth, Paloma Junco, Tauhidul Islam
2021-42	Lund University School of Industrial Design, Sweden	Off-grid solar light design	Lighting	Full Report	Video Submission	Zimeng Chen
2021-43	Makerere University, Uganda	Solar-powered IoT hydroponics system	Agriculture	Full Report	Video Submission	Ngure Brian, Cathy Zebia, Nasasira Tony
2021-44	National Advanced School of Engineering, University of Yaounde, Cameroon	Egg incubator	Agriculture	Full Report	Video Submission	Élodie Joséphine Atangana Nkolo, Cyrille Kenfack, Joyce Matekeng Kenfack, Pierre Toloko Bello, Blairio Giacomoni Yetgang Kengne
2021-46	Turkana University College, Kenya	Borehole hard water treatment in Lodwar	Access to clean water	Full Report	N/A	Joseph Wainaina, Simon Karan, Sharon Mwangi
2021-47	Turkana University College, Kenya	Advancing Thermal cell mosquito repellent	Healthcare	Full Report	N/A	Sheila Makokha, Andrew Ngetich, Elvis Odhiambo
2021-48	Duke University, United States of America	Energy efficient thermoelectric refrigerator for fruit and vegetable storage	Refrigeration	Full Report	Video Submission	Kristen Angell, Eric Jiang, Felicia Wang

Team 2021-01 –Solar-powered washing machine

Ocen Zedekia Ezra Ojok, Ahereza Oscar and Olanya Olenge Tonny

Theme – Water

Proposal

The design of a solar-powered washing machine for both domestic and commercial laundry.

Project Summary

Our solar-powered washing machine aims to reduce the time women spend on laundry. Domestic activities like laundry can lead to fatigue and take considerable time. Our washing machine will help reduce fatigue, and free up time for women to spend on other activities.

Key design highlights

The design uses a DC motor powered by a 12 volt (V) battery charged with 100 watts of solar PV, which initiates the circular motion of the machine. The frame is made of steel and with stainless steel bearing. In just 10 minutes, the machine can wash three kilogrammes (kg) of clothes. This machine will reduce washing time and water use.

Cost

The washing machine will cost USD811.

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

This appliance can be used for family laundry and as a community commercial laundry point due to its robust design and low operational and maintenance costs. Commercially, this would help create employment for the operators, and people who assemble the machine's parts. This potential supplementary family income for the owner can help tackle **SDG 1 (No Poverty).** Women are mostly responsible for carrying out domestic chores, including washing clothes. As the machine helps reduce the time women spend washing clothes, it contributes to both: **SDG 5 (Gender Equality)** and **SDG 10 (Reduced Inequality)**. Solar power offers a clean and reliable alternative to traditional power sources in Uganda. This washing machine would be a sustainable and efficient technology that contributes towards **SDG 7 (Affordable and Clean Energy)**.

Social, environmental and economic considerations

As the washing machine has a single water discharge point, it reduces the amount of water required to run the appliance. This could help mitigate the negative environmental impacts from discharging washing wastewater into streams. The materials chosen for use have at least three years of service life, which could help reduce the potential for e-waste. Economically, the machine could help increase family income through commercial laundry, improving livelihoods, and freeing up time for other income generating activities. The machine will also help improve social wellbeing of households by reducing women's workloads.

Full Report

Video Submission

Team 2021-05 –Improved solar-assisted evaporative cooler

Bridget Viola Adoch, Feddy Francis Otim, George Rackara Odong and Sam Odora Okello

Theme – Agriculture

Proposal

To design an affordable and efficient solar-assisted evaporative cooler appliance that uses off-grid solar energy. This project was inspired by the current loss of food between harvest and consumption.

Project Summary

The main challenge in the vegetable supply chain is the waste that occurs due to a lack of reliable cold storage. Often, produce is left to rot away and or discarded, resulting in significant losses for farmers and market vendors, and a lack of fresh fruit and vegetables for customers. This highlights the need for efficient and effective cold storage and transportation for harvested fruit and vegetables.

Key design highlights

The design has a solar panel and battery to power the unit, the sides are embedded with cooling fans and charcoal, and there is a DC pump which helps water circulation in the system.

Cost

The cost of a single unit is estimated to be USD548.25. The battery and solar panel are the most expensive components of the design.

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

- **SDG 1** Target 1: by improving incomes for vendors of highly perishable fruits and vegetables
- **SDG 2 (End Hunger)** Target 1: reducing the amount of food perishes due to a lack of high-quality storage technologies
- **SDG 7** Target 2: through promoting the use of clean and affordable solar energy, which has less environmental impacts compared to non-renewable energy forms
- **SDG 8 (Decent Work and Economic Growth)** Target 2: through improving people's income levels and creating employment
- **SDG 9 (Industry, Innovation, and Infrastructure)** Target 3: through improving on small scale businesses and promoting innovation among people

Social, environmental and economic considerations

- Improving the livelihoods of fruits and vegetable vendors by reducing waste
- Rather than refrigerants, which can have a high global warming potential, this design uses water to cool the refrigerator
- Using the cooler can help boost incomes by reducing food waste for sellers and farmers

Full Report

Video Submission

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Team 2021-06 – Solar-based dehydrating system for food preservation

Zainab Sajjad, Iram Fatima Aulakh, Khurram Zia and Hadiya Rafique

Theme – Agriculture

Proposal

Design and implementation of an efficient and temperature-controlled, solar-based product for dehydrating food.

Project Summary

To design a solar-powered food dehydration and preservation system, which is almost non-existent in Pakistan. This product has minimal operational costs compared to a conventional electric dehydrator and offers almost 80% more efficient drying compared to drying food in the open sun, which is the traditional practice. This will enable farmers to sell their yields at a higher price, thus helping to increase their household income, and it will also help avoid food waste by extending the shelf life of farmers' products.

Key design highlights

It uses three energy transfer mechanisms of conduction, convection, and radiation. To enhance the efficiency of the solar dryer, a combination of forced convection and the greenhouse effect is introduced into the system. A temperature-humidity control mechanism has been included in the system to achieve controlled and mechanised heating in the drying chamber. A heat recovery mechanism for water and air also accelerates the drying process, making the product more energy efficient.

Cost

We built the initial prototype for USD700/800, depending on the availability of components in the local market. Our optimised product would cost around USD500. The cost reduction would be achieved by mass production, and by selecting more affordable materials.

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

Our proposed design uses solar energy, which is clean and affordable. It plays a vital role in securing sustainable energy with lower carbon emissions thus improving air quality. The solar panels, installed to power the electrical components, provide a reliable power supply, which enhances the energy efficiency of the product. In this way, our project contributes to the UN's Sustainable Development Goals, in particular **SDG 7**. The design aims to help reduce food waste and provide income opportunities for people, particularly in areas where food dehydrating practices is very common, such as Khairpur, Pakistan. Hence, the goals of the project are also aligned with **SDG 2, SDG 8**, and **SDG 12.**

Social, environmental and economic considerations

The proposed design aims to enhance agricultural practices by maintaining the maximum quality and output of crops in an innovative way, as well as avoiding food losses. This could significantly help the farming community, which often experiences food losses, and assist farmers in extending the shelf life of their crops. In addition, farmers could earn higher profits from their products and support their families. The system would also use renewable solar energy and avoid carbon emissions.

Full Report

Video Submission

Team 2021-09 – Smart solar-powered irrigation system

Aisha Aden, Samay Massum, Augustine Anaka and Sami Lattrsh

Aston University
BIRMINGHAM UK

Theme – Agriculture

Proposal

A smart, solar-powered irrigation system that will enable farmers in Chad to use water more efficiently.

Project Summary

As Chad has one of the highest levels of hunger in the world, this project aims to improve the quality of the agricultural practices in the region. Furthermore, it aims to tackle climate change by using renewable energy and smart irrigation systems. This design uses solar power as the main source of electricity as well as using dripping irrigation and sprinklers irrigation accompanied by Bluetooth moisture sensors to detect the moisture in the soil to start irrigation.

Key design highlights

The system generation parts (photovoltaic (PV) panels and storage DC batteries) are assembled to supply the water suction (main submersible part of the DC pump) and irrigation system with the required power when needed, and supply the intelligent microcontroller with continuous power. Two networks of intelligent Bluetooth soil moisture sensors, which consist of three sensors connected to one out of three logics in the main microcontroller, which helps to monitor soil moisture continuously, maintain the sensor in case we use each sensor individually.

Cost

This design will approximately cost USD1,250. As the main part of this design, the solar panels will cost around USD511.50. Furthermore, the water pump and batteries are other components with higher costs.

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

This design aims to address more than seven Sustainable Development Goals. This design would enable Chad's smallholder farmers to manage water and power sustainably, which could help them save money. The project would help curb climate change impacts, which are already influencing economic and social stability. The proposed project will enable farmers to produce more food locally which will help tackle hunger in the region and reduce chronic diseases caused by the food scarcity in Chad. Levels of employment could increase as a result of implementing the proposed project which will enable us to tackle poverty in the region.

Social, environmental and economic considerations

This system will help relieve some of the issues related to food insecurity as the system increases agricultural productivity, including crop yields. As a result, this will increase autonomy for the people of Chad as they will have more stable food production, reducing dependency on food packages. As the system takes advantage of the country's abundant sources of solar energy, it does not rely on fossil fuels. The system is designed in a way to tackle social, environmental, and economic issues related to Chad. It also would not require additional operating costs other than the cost of installation.

Full Report

Video Submission

Team 2021-10 –Atmospheric water generation with bios, filtration and UV purification

Jack Benefer, Gopu Gopakumar Nair, Pathan Navedahmed, Toshif Mansuri and Simranpal Kandol

Theme – Access to clean water

Proposal

Utilise humidity in the air to create safe drinking water.

Project Summary

The design is a system that cools the air without a compressor to condense the water, filter, and sanitise it to ensure that it is safe for drinking. This is to help improve access to clean and potable water for rural, off-grid communities.

Key design highlights

The design uses a wrap-around heat pipe system to cool the air without the need for a compressor, which would require more power to run and involve more maintenance throughout its lifecycle. We will add a sustainable refrigerant that has also no ozone depletion factor and low global warming potential.

Cost

The entire unit will cost GBP2,186. This will be offset by a leasing plan of as little as GBP10/month. The system has an estimated lifespan of 25 years.

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

This design directly contributes towards **SDG 6 (Clean Water and Sanitation)** by providing clean and drinkable water and **SDG 7 (Affordable and Clean Energy)** by providing clean and affordable energy through the use of solar panels. It indirectly contributes to **SDGs 1 (No Poverty)**, **SDG 3 (Good Health and Well-being)**, **SDG 4 (Quality Education)**, and **SDG 5 (Gender Equality)** by helping people to lead healthier lives so they can work and go to school, as well as reducing the time women and children spend collecting drinking water, which is often unsafe for drinking.

Social, environmental and economic considerations

The project uses recyclable and affordable materials where possible. The project will enable businesses to sell water and can be scaled up to accommodate larger communities. It will also help create jobs for and enhance the skills of people who maintain and install the systems.

Full Report

Video Submission

Team 2021-11 – Phone charging station

Chigozirim Nnorom, Ayooluwa Folayan, Harshil Patel, Sanoj Babu

Theme – Power management

Proposal

Mobile phone charging station

Project Summary

People living in rural areas in Benin must make numerous trips to neighbouring towns to charge their phones, but the charge does not last. We have designed a mobile phone charging station that can be moved to different locations.

Key design highlights

The design has been developed so that the charging station incorporates a DC-DC booster converter and a battery management controller to ensure optimal energy absorption. The panel will require three – four hours of direct sunlight, and the battery charging station will be recharged to its full capacity. The product is mobile and can be used in different locations.

Cost

The designs' estimated cost is USD990.

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

Paying close attention to **SDG 5 (Gender Equality)** and **SDG 10 (Reduced Inequalities)** through disability inclusion, we designed our solution to be operated and used by all genders without discrimination or any form of exclusion. **SDG 7 (Affordable and Clean Energy)** and **SDG 13 (Climate Action)** are also embedded into the power systems of our design as we use renewable solar energy that reduce greenhouse gas emissions when used in lieu of market alternatives. **SDG 8 (Decent Work and Economic Growth)** is addressed through the employment opportunities that the manufacturing and use of our design could create.

Social, environmental and economic considerations

This solution is designed to help increase business productivity and improve quality of life at homes, as it can be adopted by low-income entrepreneurs in rural areas in Benin. It aims to enhance social relationships and could also support emergency response times, agricultural productivity, and transport services through improved access to communication for rural communities. We also intend to promote community ownership rather than just through an individual to improve engagement and accessibility, which helps open benefits to a wider number of people, and minimises inequalities

Full Report

Video Submission

Team 2021-12 – Solar-powered milk cooling unit

Harry Vine, Panagiotis Chatziangelakis, Simon Kalungi and Caleb Oguli

Swansea University
Prifysgol Abertawe

Theme – Agriculture

Proposal

Solar-powered cooling unit for smallholder dairy production in Uganda.

Project Summary

We aim to address the challenges faced by dairy farmers in Uganda by maintaining milk quality during the post-production and transport phase of the value chain. This helps rural farmers access cooling, reduce losses, and gain a stable income. It could also help create more jobs and foster the development of skills of local farmers. This is in line with the aims of the Dairy Development Authority in Uganda.

Key design highlights

Use of solar power, solid-state cooling solution (thermo-electric devices), low to no maintenance, and small form factor.

Cost

The design estimated cost is USD430.

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

We hope to address **SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic growth)** and **SDG 10 (Reduced Inequalities)** through our solar-powered milk cooling unit. SDGs 1 and 8 are addressed through the profit-making opportunities that our design creates by offering farmers greater yields. SDG 7 is addressed through the power system our design uses, as it uses renewable energy and helps to mitigate carbon emissions through traditional cooling systems. SDG 2 is addressed by reducing food waste, food that could otherwise go to hungry people. Finally, we address SDG 10 by ensuring our design considered, and was inclusive of, women – allowing for female members of households to lead the business.

Social, environmental and economic considerations

Dairy farming helps to alleviate poverty in rural areas and can help farmers earn higher incomes and enjoy improved living standards. The unit uses solar energy with no moving parts, making it a clean energy off-grid alternative - perfect for areas where access to cooling is limited. It is cheap and will be sold through savings and credit cooperative organisations (SACCOs) to enable multiple farmers in a community to have joint ownership and therefore increase community engagement.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2021-13 – Hydrogen smart battery

Nia Melding, Rachel De-Matei, Matthew Carrington, Alice Blaber

Swansea University Prifysgol Abertawe

Theme – Power management

Proposal

While villages with access to solar power in Sub-Saharan Africa have energy generally guaranteed throughout the day, it is intermittent. If people want to store energy for variable use, lead acid batteries are usually the only affordable option and provide an unreliable, inefficient, and short-term solution. This report proposes a hydrogen smart battery as an alternative to existing lead acid battery usage in Sub-Saharan Africa.

Project Summary

We envisage a hydrogen smart battery that is used as a mini-grid across a village to supply both electricity and cooking fuel efficiently and reliably. The project aimed to design a smart battery that decouples supply from demand, uses frugal and affordable technology, and improves quality of life through job creation and reliable access to energy. The system is simulated across a hypothetical village in Malawi and is accompanied by a business plan to present possible financing routes and options for scaling across other villages.

Key design highlights

Energy not being used from the solar system will be diverted to a water splitting device where it will split water into hydrogen and oxygen. The electrolysis process of this design is approximately 75% more efficient, with close to zero hydrogen loss through piping. The decoupling of energy supply and demand makes this system a smart battery. Additionally, the system uses gravity to aid the splitting of the water; the water flows down through the splitting device, negating the need for a pump and helping maintain energy.

Cost

The cost is USD4,700 for a 10-kilowatt system. We suggest the units are leased through congressional budget offices (CBOs) to reduce initial costs for communities, and to implement a PAYGo finance plan through phone payments. As the design is scaled larger and implemented in more villages, the costs are expected to decrease.

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

This design contributes to **SDGs 7 (Affordable and Clean Energy), 12 (Responsible Consumption and Production),** and **13 (Climate Action)** by increasing access to clean energy, and using equipment that has minimal environmental impact compared to existing battery alternatives. It would also provide jobs, community engagement, and ownership of the project through participatory methods, aligning with **SDG 11 (Sustainable Cities and Communities)**. It supports **SDGs 8 (Decent Work) and 9 (Industry, Innovation, and Infrastructure)** by creating job opportunities and building industry, innovation, and infrastructure.

Social, environmental and economic considerations

- This design helps foster job creation. The creation of businesses to support the maintenance, installation, training, and manufacturing of our batteries allows communities to improve their quality of life.
- Increased access to energy creates the potential for income generation and educational activities to continue after dark, increasing potential daily productivity.
- The design has minimal effects on climate change, as the operation of the smart battery emits no CO_2.
- An additional aspect that makes this smart battery unique is that it uses hydrogen as a cooking fuel. Nearly 98% of households in rural Malawi currently cook with firewood. Using hydrogen as fuel provides a familiar cooking technique through open flame while reducing the time required to collect firewood and possible health issues related to smoke inhalation.

Full Report

Video Submission

Team 2021-14 – Pasteurisation unit for milk collection centres in Uganda

Oluwafunmibi Ijaiyemakinde, Hannah Bayoudhi, Gladys Abiyo, Mark Ssentongo

Swansea University Prifysgol Abertawe

Theme – Agriculture

Proposal

This project proposes a solar-powered pasteuriser unit to be used by milk collection centres (MCCs) in Uganda.

Project Summary

Milk spoilage is a prominent issue within the milk supply chain in rural Uganda. This project combines modern pasteurisation techniques with solar energy, to offer a more environmentally and economically sustainable solution. We expect that it will have socio-economic benefits in the wider community.

Key design highlights

The system uses a combination of solar photovoltaic and solar thermal technology to power a continuous flow pasteuriser unit.

Cost

Total cost projection of the design is USD3,212. The unit will sell for USD4,000 at a 25% production cost profit margin.

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

The innovation in this design will allow small-scale rural farmers and MCCs to generate more income from their produce, hence enabling expansion in stocks and productivity. Solar power (clean energy) will be harnessed to run the pasteurisers and the excess electricity will be stored and used to fulfil the electrical needs of other local facilities. This not only reduces dependence on fossil fuels, but it also helps encourage the local community to move towards a greener source of electricity and support **SDG 13 (Climate Action)**. Lead-acid batteries will be considered because of the price, availability, and the ability to recycle the battery at the end of life in Uganda. This will support **SDG 11 (Sustainable Cities and Communities)**.

Social, environmental, and economic considerations

Since milk pasteurisation is an energy-intensive process, and on-grid electricity is currently unreliable or unavailable in some parts of rural Uganda, this design will mean that MCCs will not need to rely on diesel generators to run their business. The model will use solar energy to power the pasteuriser, which is abundant in Uganda. It will increase profit for the MCCs and create the opportunity to employ more people in the rural community. Lithium-ion batteries would be the optimum for the model, however lead-acid batteries will be considered instead because of the price, availability, and the ability to recycle the battery at the end of its life in Uganda.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2021-15 – Evaluating the potential of smart, direct current microgrids

Shoaib Ahmed, Tahreem Fatima, Ahmad Rizwan, Muhammad Abdur Rehman Wasti, Syed Ashhab Ur Rahman Iqbal Ahmed

Theme – Power management

Proposal

The project proposed a power management and optimisation concept for photovoltaic, smart, direct current (DC) micro-grids to improve their performance.

Project Summary

Our project focuses on power monitoring and control for appliances for off-grid communities, which are connected to photovoltaic, DC micro-grids. The project aimed to increase the efficiency of and optimise the power consumption for these appliances to make solar energy more economically feasible and maximise its utility. This solution will also aim to curtail blackouts and power surges. We also developed a robust business model to commercialise our solution, and we will use the PAYGo revenue model.

Key design highlights

Each appliance is connected to a unique test bed, which comprises a microcontroller, temperature sensor, power measurement module, and an infrared (IR) transmitter, which are embedded on a printed circuit board (PCB). The testbed measures the ambient temperature and power consumption for each appliance and controls the appliance using an IR transmitter control. The measurements are transmitted wirelessly, using an MQ Telemetry Transport (MQTT) communication protocol to the master controller device, NVIDIA Jetson Nano, which solves the optimisation problem (i.e., model predictive control) and generates control signals for the smart control of appliances. The behaviour of the room is modelled using a fourth-order state-space equation, employing a resistor capacitor circuit analogy.

Cost

The design of each testbed costs USD14.32, which can be reduced significantly due to economies of scale.

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

Our project directly aligns with **SDG 5 (Gender Equality)**, as it aims to foster educational and income-earning opportunities for women through increased access to electricity and information. It addresses **SDG 7 (Affordable and Clean Energy)**, by reducing the costs associated with solar energy installation. With this project, we aim to support the development of domestic technology, as well as research and innovation, and facilitate sustainable infrastructure, which align with **SDG 9 (Industry, Innovation, and Infrastructure)**. Our project aims to accelerate the transition towards renewable energy alternatives, improve health standards, and promote income-earning opportunities for underserved communities, aligning with **SDG 11 (Sustainable Cities and Communities)**. Our project promotes low-carbon energy sources and reduces dependence on biomass fuels, contributing positively to the environment and addressing **SDG 13 (Climate Action**).

Social, environmental, and economic considerations

Intelligent renewable energy management (IREM) can promote access to renewable energy alternatives. Through collaboration with NGOs and outreach programmes, it can make a significant impact on society by facilitating access to affordable, solar energy systems. Affordable access to energy will also help to increase the productivity of businesses, improve quality of life, and collectively contribute to the socio-economic development of Pakistan. The PAYGo revenue model that we propose also benefits low-income households and growing businesses such as start-ups. Moreover, lithium-ion batteries can be reused, so cost savings associated with the solutions are significant.

Full Report

Video Submission

Team 2021-17 – Pay-As-You-Go solar milling solution

Gareth Goodchild, John Morgan, Isabelle Bourassa, William Evans, Jack Yeomans

Harper Adams University

Theme – Agriculture

Proposal

We are proposing an affordable, PAYGo, solar-powered grain milling service, designed to be connected to mini-grids in rural Rwanda.

Project Summary

Our solution is holistic, sustainable, and regenerative, and gives local communities the skills and tools to be self-sufficient in feeding themselves. The project provides a constant, reliable, and affordable milling service in the heart of rural villages. Our mills will also be powered by solar mini-grids and operated by trained locals. They will be manufactured and assembled by our local team of technicians at our warehouse headquarters, with routine maintenance and basic repairs conducted by the trained on-site operator. This supports knowledge transfer from the global North to global South and ensures that skills are developed and maintained in the communities which need them most.

Key design highlights

Mills will be repaired on-site by our trained operators, with replacement parts and mills provided as necessary to ensure continuous milling service. When mills reach their end-of-life, they will be returned to our hub. Usable parts will be reused to make new mills or repair current mills, and unusable parts will be recycled. Our non-ownership model, which has no upfront cost and only requires payment at the point of use, guarantees a continuous milling service, as we retain responsibility for maintenance and repair through our local team. This reduces both our footprint and costs as the mills will require fewer new components.

Cost

Inclusive of installation costs, the mill will cost USD990.71. The design cost has been minimised to make our milling service affordable for Rwandans living in rural villages.

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

Our solution helps to deliver 13 of the 17 UN SDGs (see report for a full list).

Some of the key SDGs our project addresses are: **SDG 7 (Affordable and Clean Energy)**: Our mills are 100% solar-powered, with electricity coming directly from solar mini-grids. Our affordable solution enables more people to use solar energy to mill grain instead of the polluting, diesel-powered alternative. Our service-based, no-upfront cost PAYGo model is designed with the poorest people in mind, giving them the option of cash payments or payments through our mini-grid partners' gateway. **SDG 12 (Responsible Consumption and Production)**: Our solution is inspired by circular design principles, using recycled and reused parts and materials with our service model dedicated to extending service life by careful maintenance and occasional repairs, facilitated by our modular design. Our design includes a converted used car alternator, and all other components and materials will be sourced as locally as possible. **SDG 13 (Climate Action)**: Our project aims to reduce supply chains, which aims to reduce the need for transport and its associated emissions. Recycling components and replacing diesel-powered mills with solar-powered mills also reduces energy use and emissions.

Social, environmental and economic considerations

These considerations are central to our design specification and are the basis of our solution. We aim to have a minimal environmental footprint while offering a significant positive social impact. View page 22 of our report for our impact summary table which breaks down these impacts and considerations.

Full Report

Video Submission

Team 2021-18 – Space cooling system with grass filter

Hannah O'brien, Eleanor Deansmith, Xinyu Xiang, Leo Rey-Coquais, Adeola Onanuga

Theme – Space cooling

Proposal

We are proposing a grass-based filter attached to fans, which will perform space cooling and air filtration.

Project Summary

This report determined that a lemongrass filter, attached to a floor fan, could be an attainable solution to improve the particulate matter within air and cool buildings. We identified Chad, Central African Republic, Burundi, and Tanzania as the countries most suited to our project, as these countries have limited access to grid electricity, and produce a significant amount of lemongrass.

Key design highlights

A grass-based filter will be attached to a fan to perform both space cooling and air filtration.

Cost

The final product can be sold on the market at a midrange price of USD34.30.

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

The design outcome of this project will work towards many of the Sustainable Development Goals, particularly **SDG 7 (Affordable and Clean Energy)** and the commitment to 'leave no one behind' (United Nations, 2022). This is because it provides an affordable and renewable cooling solution for low-income communities with limited access to electricity.

Social, environmental and economic considerations

Sub-Saharan Africa is a region that experiences extremely high temperatures, posing significant health risks to its inhabitants. In addition, studies show that the region is disproportionately impacted by vector-borne diseases, and urbanisation across the region is contributing to air pollution. Our system aims to address these issues by helping to create creating a more comfortable environment for people. The filter is made from a locally sourced grass, further supporting the environment, and potentially strengthening the local economy. Every effort has been made throughout the project to make this system affordable.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2021-19 – Semi-automatic lawnmower

Talent Chigwagwa, Morelife Zibaiwa, Anesu Dhinha, Courage Manzwei, Price Sanya

Theme – Landscaping, power management

Proposal

The proposed design is an off-grid grass cutting system for people who have no access to electricity and currently use more conventional methods of grass cutting, such as sickles and slashers.

Project Summary

Surveys have shown that the people most in need of solar-powered grass cutting machines live in rural areas, where there is little to no access to reliable electricity. The design aims to resolve the limitations that are evident in lawnmowers that are currently available on the market. The device is equipped with a state-of-the-art architecture that comprises a solar recharging unit with dense, metal lithium-ion batteries, making the design a zero-emission industrial tool. The device can also be recharged using solar energy, significantly reducing operational costs and making it more affordable for low-income users.

Key design highlights

- efficiency
- off-grid use
- high-performing
- endurance
- scalability
- safety
- affordability
- robustness

Cost

Readily available components in the local market have shown that manufacturing the proposed product is relatively cheap compared to existing products that are on the market.

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

The proposed design does not affect the soil where the grass is being cut. Furthermore, it provides ground cover or mulching, which traps moisture and reduces its loss. The twine also produces a finer cut than the existing alternatives. The design is environmentally friendly since there is no release of greenhouse gases, and it is less noisy than the current models.

The solar rechargeable lawnmower design is in line with the **SDG 7 (Affordable and Clean Energy)** which states the need to ensure access to affordable, reliable, sustainable, and modern energy for all. The core aspect driving this design is to develop an appliance that has a lower production-to-cost ratio hence affordable to low-income households while providing end-user satisfaction.

The remote-control system gives access to anyone to use the mower, and considers the disabled and the old age since little to no human effort is needed to operate the device. This is fundamental when it comes to global considerations as noted in the **SDG 5 (Gender Equality)** and **SDG 10 (Reduced Inequality)**.

Social, environmental and economic considerations

The design has low operating and maintenance costs, increasing the affordability of the product. There is no specialist technical knowledge required to operate the lawn mowers. It can also be controlled via a remote, which makes it easy to operate for end-users.

Full Report

Video Submission

Team 2021-21 – Semi-automated water vending machine

Ntami Echeng, Somina Afrogha, Alfred Ndorbele, Anthony Akpasoh, Favour Emmanuel

Theme – Access to clean water

Proposal

We aimed to provide African communities with a safe, clean, potable water supply. This design seeks to increase the efficiency of energy spent in pumping water and build a business model around water vending.

Project Summary

Water is a requirement for many human activities. However, unfortunately only 21.69% of Nigerians have access to potable water supply, many of whom live in rural communities that also lack access to modern energy services and the internet. Our solution is a semi-automatic water vending machine. It will address the problem of sustainability by ensuring that water is paid for before dispensing and curbing waste by automatically dispensing water. Furthermore, internet connectivity would not be required since the system will be voucher-enabled rather than the common system of using the internet of things (IoT) to dispense water that has been paid for.

Key design highlights

The system improves the efficiency of the current manually operated system. It also has the potential to empower the rural community as vouchers would be sold by different vendors to make profits. No maintenance is required, and the system can work in areas with or without network connectivity.

Cost

The system is cheaper than existing vending machines as it does not incorporate IT infrastructure such as gateways, servers, and internet connectivity to solve payment-related issues, such as using a smart card and coin-based water vending system. We estimate a 40– 60% cost reduction in comparison to our competitors.

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

This design addresses:

- **SDG 5 (Gender Equality)**: as it allows easier water collection, a task typically carried out by women
- **SDG 7 (Affordable and Clean Energy)**: reliable energy efficient water system helping to increase access to clean energy
- **SDG 12 (Responsible Consumption and Production)**: sustainable consumption patterns

Social, environmental, and economic considerations

This design helps ease the burden of water collection, typically carried out by women and girls. Waste water streams are eliminated by automatic flow control, which curbs the concerns of water-logged areas becoming mosquito and other insect breeding zones. The design also proposes an efficient strategy to curb waste, consequently reducing operating costs and runs the water facility as a social enterprise. It also helps to improve livelihoods and enhance wellbeing in the community.

Full Report

Video Submission

Team 2021-22 – PV TEC module cooler box

Abasiama Udomah, Ufuoma Omosohwofa, Nsikan Udomah, Ovie Jacob

Theme – Refrigeration

Proposal

This proposal is for a photovoltaic (PV), thermoelectric cooling (TEC) module cooler box. It aims to address the challenge of energy access and food waste due to inefficient refrigeration systems.

Project Summary

The PV TEC module cooler box is a portable refrigeration system that will meet the needs of rural-off grid farmers and retailers who experience no or unreliable access to energy and refrigeration, which has resulted in agricultural and food waste. The system is cost-effective, environmentally friendly, and has no battery.

Key design highlights

The key highlight is the ice storage provision that replaces the need for battery storage in a PV TEC Cooling System.

Cost

The overall cost to develop our prototype was USD755 per unit, including manufacturing costs.

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

This design provides a clean energy solution **(SDG 7.3)**, reduces hunger by preserving food **(SDG 2.3)**, and helps tackle climate change **(SDG 13.1)**, as it will not create any greenhouse gas emissions. It reduces waste by recycling the used cooler box **(SDG 12.5)** and improves economic growth via innovation and technology upgrading **(SDG 8.2)**. It also promotes gender inclusion **(SDG 5)**.

Social, environmental, and economic considerations

Socially, this project will help reduce post-agricultural harvest losses encountered by farmers and enhance their livelihoods, as they will be able to preserve and sell any fresh produce.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2021-25 – Solar-powered mobile blood bank

Sera Maina, Eric Muia

Theme – Healthcare

Proposal

Our mobile blood bank design transports blood from major blood banks to remote hospitals while maintaining the integrity and quality of the blood.

Project Summary

There is a lack of proper infrastructure to transport blood to and store blood in remote areas, which results in more people losing lives when faced with life-threatening conditions. The proposed mobile blood bank will be able to transport blood over several hours whilst avoiding any blood spoilage.

Key design highlights

- a solar panel to harness the solar energy
- thermoelectric modules that provide the cooling needed
- fans to distribute cold air within the blood bank and blow heat away to the outside
- heat sinks to conduct heat outside the bank
- internal aluminium lining of the box
- polyurethane for insulation.

Cost

The most expensive components of the design are the lithium acid battery, solar panel, and charge controller which mean the cost is relatively high at USD1,150, inclusive of a profit margin.

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

SDG 7 (Affordable and Clean Energy): by using solar energy, which is a clean source of energy
SDG 3 (Good Health and Well-being): as the project provides blood to patients who need it
SDG 1 (Zero Poverty): as it helps to provide jobs and a source of income

Social, environmental, and economic considerations

The design uses clean energy and does not emit greenhouse gases, so it has a positive impact on the environment. Economically, the design will promote good health, which will help strengthen local workforces and local economies.

Full Report

Video Submission

Team 2021-26 – Solar baby incubator

Margaret Kuria, Doris Mwimali, Winfred Mwendwa

Theme – Healthcare

Proposal

Our design of a solar-powered baby incubator aims to reduce the infant mortality rate in Kenya by providing a technology that will help preterm infants to grow and thrive.

Project Summary

Our solar-powered incubator will use a parabolic trough reflector to heat water, which will be used to provide warmth to babies, at a lower price point compared to other electric incubators currently on the market. The incubator's maintenance and repair will simpler and less costly than competitors' incubators because the raw materials will be sourced locally. Our incubator will also be used in on-grid and off-grid hospitals.

Key design highlights

Our design uses solar power by way of a parabolic trough reflector (PTR). The design consists of two water tanks, one for cold and one for hot water, three PTRs, a twin incubator, and a heat chamber. The PTRs will concentrate the solar energy at one focal point in a pipe that uses water as a transmission fluid. The heated water will be stored in the hot water tank before it is pumped into the heat chamber, which holds a heat exchanger to help regulate the temperature in the baby incubators. The water will then be recycled back into the PTR for heating. Thermostats will further control the incubators' temperatures. After delivering heat to the heat exchanger, the water will be driven out of the incubator by gravity. The incubator will have a control panel to display the incubator temperature, and humidity levels and an alarm system in case of emergencies.

Cost

Our design will be more affordable compared to other market alternatives, as it will use locally available materials and manufacturing. We anticipate the design to be half the price of our current market competitors. The energy required for operation will also be free and maintenance costs will be kept low.

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

Our design aims to contribute towards: **SDG 3 (Good Health and Well-being)**. The design will help reduce the rate of neonatal mortality by providing a reliable medical resource, a solar baby incubator, that utilises solar energy. **SDG 7 (Affordable and Clean Energy)**: this design uses one of the cleanest forms of energy, solar energy. **SDG 8 (Decent Work and Economic Growth)**: the design will utilise locally available materials, thus creating a ready market for these materials in the area. **SDG 1 (No Poverty)**: the project will provide job opportunities for local people. **SDG 9 (Industry, Innovation, and Infrastructure)**: our project uses smart technology, locally available resources, and cheap labour from the local community. **SDG 13 (Climate Action)**: our project proposes the use of solar energy and water to operate baby incubators instead of mains electricity like the modern industry standard.

Social, environmental and economic considerations

This design will help to lower infant mortality rates in rural areas. This will help create healthy children, which hopefully translates into a healthy nation with the strength to work to improve its economy. The proposed design uses solar as an energy source, which is both renewable, free, and abundant in Kenya given its proximity to the equator. The design also uses a recycled water system to transfer heat, saving on the amount of water used. The materials being used are locally available and cheap, and design is simple meaning that local labour can be used for manufacturing.

Full Report

Video Submission

Team 2021-27 – Solar-powered automated greenhouse electronic system

Volition Smthxilo Mashamba, Hazel Queen Makiseni, Andrew Kapasura, Makhosandile Makhiye Nyathi, Henry Melusi Phiri

Theme – Agriculture

Proposal

This project is a solar-powered greenhouse control system with automatic regulatory algorithms to control growing conditions, together with an online web monitoring interface.

Project Summary

The project monitors temperature, humidity, and soil moisture content in an enclosed greenhouse environment. The system will trigger output devices via the programmed microcontroller to regulate temperature, humidity, or moisture content automatically when they exceed their optimal ranges. These values will be sent to a web interface, which displays current sensor values along with charted historical data.

Key design highlights

- Power system: The system will use solar power to generate energy, batteries will store the energy, and regulators will control the voltage.
- Hardware: The hardware will be connected to numerous parts of the microcontroller.
- Software: The hardware will be controlled and monitored by the code uploaded to the controller.
- Monitoring - The system will send input data from a sensor to an online web monitoring system.

Cost

The cost for this solution was outsourced after thorough research to create the most affordable, efficient, and reliable design.

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

The design will work towards **SDG 2 (Zero Hunger)** by improving food security, and **SDG 13 (Climate Action)** because it is an environmentally friendly solution.

Social, environmental and economic considerations

This project's design is environmentally conscious.

[Full Report]

[Video Submission]

Team 2021-28 – Solar-powered oxygen generator with built-in solar batteries

Gideon Mhlanga, Batsirai Nyabunze, Trymore Kanjera, Fanuel Magomo, Tinotenda G. Moyo

Theme – Healthcare

Proposal

We have designed a solar-powered oxygen generator with a back-up solar battery. The solar-powered oxygen generator uses the vacuum pressure swing adsorption concept to extract pure oxygen from the air.

Project Summary

By proposing affordable solar-powered oxygen generators, we are helping to address a shortage of medical oxygen in medical facilities across Zimbabwe. We aim for the oxygen generators to be used in rural areas and be affordable for low-income patients and medical facilities in Zimbabwe. The overall scope of the project is not limited to COVID-19 patients, but extends to everyone who may need oxygen services in Zimbabwean medical facilities.

Key design highlights

The design consists of two cylinders: one undergoing pressurisation and the other undergoing depressurisation. We also included zeolite granules in the system to improve the efficiency of the vacuum pressure swing adsorption process. In addition, we included two more cylinders with silica gel to dry the pressured air and a microcontroller to automate the opening and closing of pneumatic valves at certain time intervals.

Cost

The most significant expenses in our design are the solar panel and the solar battery. Our budget for a single unit was around USD998, but we are yet to implement the prototype of our design.

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

The design is solar-powered, addressing **SDG 7 (Affordable and Clean Energy)**. By using locally obtained resources, we will make the design affordable and less expensive for rural hospitals and to all individuals whatever their economic status – **SDG 3 (Good Health and Well-being)**. The use of solar energy has helped us contribute towards reducing greenhouse gas emissions – **SDG 13 (Climate Action)**. Our design is focused on fostering technological development in rural areas, particularly the medical field – **SDG 9 (Industry, Innovation, and Infrastructure)**. Our design is focusing on fostering economic inclusion for rural communities – **SDG 10 (Reduced Inequalities)**.

Social, environmental and economic considerations

The social, environmental, and economic considerations we have made in our design process are:

- the need to reduce greenhouse gas emissions
- introducing on-site oxygen generation within a medical facility to reduce costs involved in buying oxygen
- Helping to increase patients' chances for survival by making vital oxygen more affordable
- designing exceptional medical equipment using locally obtained resources without compromising on effectiveness and quality
- the financial crisis and Zimbabwe's economic situation.

Full Report

Video Submission

Team 2021-31 – Solar direct drive cold storage for preservation of fish and perishable goods

Md. Sadik Abdal, Tashfiah Tahsin, Ali Ahmed, Nour Ben Gaied

Theme – Space cooling

Proposal

The purpose of our design project was to create an effective cold storage system for both off- and weak- grid use in rural Bangladesh, and help local communities achieve economic prosperity.

Project Summary

Our project intends to harness the power of renewable solar energy and convert it into ice banks to keep the storage system cool during nights and cloudy days while limiting the use of external batteries. This will not only make the overall design lightweight, but also help drive down its price and make it more affordable for end-users.

Key design highlights

- the use of solar energy to power the unit
- the limited use of batteries, saving on cost and making the product lightweight
- multiple temperature settings to store different types of produce and perishable items
- a mobile design, which can be easily shipped and relocated to different areas at short notice
- locally sourced materials used to ensure that it can be manufactured in the native country
- user-friendly user interface and LCD display to monitor information such as temperature, humidity level, and weight
- Radio Frequency Identification (RFID) sensor to minimise the risk of theft

Cost

The project would cost us around USD1,000 to develop a single unit. However, the cost will come down drastically once we start mass producing the prototype due to economies of scale.

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

Through our Challenge project, we have addressed **SDGs 7, 8, 10, 12**, and **13** directly, making sure our project is not only sustainable, but also environmentally conscious and economically viable. The exclusion of batteries will also reduce servicing costs and the appliance's carbon footprint to address **SDG 7** by providing economic security to the end-user and **SDG 8**.

Social, environmental and economic considerations

We have incorporated economic stability, sustainability, and agility as crucial design considerations for the product's social impact. Based on the manufacturing costs, the cold storage unit will be reasonably priced. The goal is to reduce operational costs for local farmers while also assisting them to increase their incomes by eliminating unnecessary costs such as rent. As a result, the product's retail price will be lower than competitors on the market, and there may be an option to lease the unit with monthly payments.

Full Report

Video Submission

Team 2021-33 – Intelligent solar dryers for food valorisation

Waly Faye, Fatou Fall, Issiakou Worou Wouignanso, Kancou Dableny Fall, Binta Sow

Theme – Agriculture

Proposal

The purpose of our food dryer is to preserve or transform food products. Our objective is to support producers and farmers to preserve food, allow economic interest groups to train people on the drying process, and inform companies about the energy efficiency of dryers.

Project Summary

Our project consisted of developing a prototype of an intelligent solar dryer that could drying all agri-food products. This dryer will be designed with locally available materials and use solar energy. A photovoltaic solar panel, regulator, batteries, and fans with thermal radiators will be used to operate the regulator.

Key design highlights

Our design is simple, affordable, accessible, efficient, and functions without a network.

Cost

- base dryer cost: West African CFA franc (CFA) 800,000
- maintenance costs: CFA3,000 every 2 days, CFA4,5000/month
- Repair costs (broken glass, holes in the racks, damaged fan:
    - 3m² of reserve glass: CFA21,000
    - 6 spare racks: CFA20,000
    - 4 reserve fans: CFA28,000

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

Our design will address **SDG 13 (Climate Action)**, as it aims to avoid post-harvest losses and food waste, which can generate CO_2 emissions – through the methane (CH4) produced while food decomposes, and nitrogen dioxide (NO2) emitted by using fertilisers. It will also avoid the release of manure and slurry into the environment due to the degradation of tons of product, addressing **SDG 12 (Responsible Consumption and Production)**. Our project will also help to make food available throughout the year, addressing **SDG 2 (Zero Hunger)**.

Social, environmental and economic considerations

We are helping producers to preserve their primary products and sell food out of season. We hope to improve the living environment of rural populations by processing surplus product. If we manage to transform surplus product into consumable dried goods, it will also help to reduce hunger and alleviate poverty in remote areas. We also hope that the project will help improve social wellbeing, and make a positive impact on the environment by allowing people to fertilise soil with composted waste. In addition, the project aims to reducing greenhouse gas emissions through the energy-intensive conservation of fresh food products.

Full Report

Video Submission

Team 2021-36 – Study and design a solar-powered electric oven

Adekambi Olachadé, Adigbe Vincent, Djossou Eudes, Gbossou Odilon, Migbe Isaï

Theme – Cooking

Proposal

Our project aims to improve roasting by replacing firewood with solar heating in the preparation of cassava flour.

Project Summary

The project consists of the design of a solar-powered electric oven for cooking gari, a special cassava flour that is widely consumed in Benin. We have found that, despite efforts to improve the production of cassava flour, it is baked in ovens that use firewood. This artisanal production exposes the people preparing gari to extremely high temperatures. Our system proposes a closed oven using heating plates, which use energy from photovoltaic modules to cook gari and produce a high-quality product.

Key design highlights

Our solar gari cooker consists of the following items:

- solar resistors or solar heating plates
- the current production and supply system for the solar heating plates
- the cooking temperature regulation system
- a gari mixer system

Cost

A single unit cost of our design may cost approximately USD1,941.

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

The design help to reduce CO_2 emissions to 66.9 tonnes per batch of gari, which is what the traditional method can emit. This contributes to **SDGs 7 (Affordable and Clean Energy)** and **13 (Climate Action)**. The harmful pollution emitted in conventional gari preparation methods can also be avoided, which will contribute towards **SDG 3 (Good Health and Well-being)**.

Social, environmental and economic considerations

We aim to improve the health of those preparing cassava flour, reduce the harm to the environment caused by the emission from traditional gari preparation, reduce the cost of preparing gari by allowing producers to save on wood fire, and protect the environment by reducing the need for wood fire.

Full Report

Video Submission

Team 2021-37 – CoolMunal: a community cold storage solution

Ashwath Shanmugavel, Matthew Davies, Eva Vautrin, Dan Gooda,

Theme – Refrigeration

Proposal

CoolMunal is a shared cold storage unit created for 20 families. It has various advantages over an individual fridge. First, it is more affordable for Kenyans, as it is less expensive compared to the cheapest personal refrigerators, which cost USD182.The combination of solar panels and solar collectors also allows the cold storage unit to use minimal electrical input. Finally, the absorption cycle allows minimal maintenance, as there are no moving parts, which also extends the cold storage unit's lifetime to 10 years. The lifetime also extends to 15 years with some minor replacements, in comparison to eight years for a normal refrigerator.

Project Summary

Communal refrigerators are the only way that many low-income families in Kenya can access refrigeration. Accordingly, we designed community cold storage solution for 20 families, which aims to reduce food waste. It also helps to extend the shelf life of fresh fruit and vegetables, which can improve people's nutrition and diet. There are individual compartments, which are cooled using solar collectors to power an absorption cycle. Auxiliary electronics such as pumps and a fan are powered from the 12V.

Key design highlights

The refrigeration cycle is an absorption cycle rather than a common compression cycle. The refrigerant, ammonia, is heated using water warmed to 100°C inside the solar collectors. The refrigerant goes through an internal coil, and air is circulated using a fan. Each compartment is equipped with a removable basket and RFID technology that is used for locking. The refrigerator is comprised of aluminium, the exterior shell, a polyurethane foam of 120-millimetre thickness for insulation, and an internal polyvinyl chloride (PVC) plastic shell for the interior.

Cost

The total cost of a single unit is USD2,750, which includes raw materials, equipment, and manufacturing costs. The unit will be sold to a local, who will pay USD 50/month until the refrigerator is completely paid off. The end-user will, in parallel, rent each compartment to one family at a guided rate of USD5.00 per month.

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

Our team focused on the following goals: **SDG 1 (No Poverty)**: CoolMunal improves access to food. **SDG2 (Zero Hunger)**: The project helps reduce food waste and consequently improve people's access to food. **SDG 3 (Good Health and Well-being)**: the design permits a more varied diet, as it allows fresh produce such as fruit, vegetables, and dairy to be stored for longer. **SDG 7 (Affordable and Clean Energy)**: the design uses solar collectors and solar panels**. SDG 8 (Decent Work and Economic Growth)**: the project helps to improve the unit owner's livelihood and strengthen the local economy, as it is assembled locally**. SDG 9 (Industry, Innovation, and Infrastructure)**: the project uses an innovative design, as it is energy efficient and affordable for end-users.

Social, environmental and economic considerations

The use of an absorption system reduces the project's environmental footprint, as it extends the cooling unit's lifetime and requires less parts to be changed in comparison to compression refrigerators, which also use chlorofluorocarbons (CFCs). The refrigerator will be manufactured locally, fostering job creation in Sub-Saharan Africa, and boosting manufacturing in the region. The business model allows for a better and more even social platform and helps the underserved communities of Sub-Saharan Africa.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2021-40 – Solar-powered toilet

Grace Adeniyi, Alex Esslinger, Anastasis Adamopoulos, Nikolai Puumalainen,

UNIVERSITY OF BATH

Theme – Sanitation

Proposal

To design a solar-powered toilet that converts human waste into useful by-products: clean water and fertiliser.

Project Summary

There are more than two billion people in the world without access to proper sanitation. This increases the risk of open defecation and thus, the contamination of crops and water sources. Our project proposes a toilet with enhanced safety features and water to wash hands, improving water, sanitation, and hygiene.

Key design highlights

- The toilet flushing mechanism traps smells and reduces the amount of flushing water required. Waste is also converted into clean water and fertiliser.
- The modularity of the design adds flexibility when adding toilet stall units.
- The design includes safety features such as a locking system, mechanism to swing the door open when the stall is empty, and lighting.
- We also created accurate piping and modelled the flow through the system.
- We have an understanding of the sizing and requirements for a manually-turned Archimedes screw.
- The system considers the ergonomics of the user interface and the disability access features.
- There is a control system for flow rates. There are solar-powered heating components to accelerate the composting process.

Cost

The modular design helps to reduce manufacturing costs by using one processing unit for all waste. Components such as piping can be produced locally to minimise transportation costs – meaning that more complex components can be purchased. The valuable by-products of the system, water, and fertiliser, offset some of the production costs. A 50-person unit is anticipated to cost GBP2,100.

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

Open defecation affects personal safety and increases the risk of sexual exploitation, and a low-cost, solar powered toilet system has the capacity to transform the lives of Zimbabweans on both a micro and macro scale. By converting human waste into useful by-products like fertiliser and water for irrigation, the toilet will help to improve people's quality of life and enhance their productivity. This would benefit most Zimbabweans who rely on small farms for survival. At a macroscale, we could see a significant transformation of sanitation and hygiene contributing towards **SDG 3 (Good Health and Well-being)** and **SDG 6 (Clean Water and Sanitation)**. Reducing toxic chemicals that are present in soil due to improper waste management would help minimise the contamination of crops and drinking sources and prevent the transmission of diseases such as diarrhoea, which kill thousands of Zimbabweans every year. Finally, improved sanitation delivers up to USD9 in social and economic benefits for every dollar invested, **SDG 8** (**Decent Work and Economic Growth)**.

Social, environmental and economic considerations

Our modular design allows customisable layouts suitable for persons with disabilities, which increased mobility and otherwise, includes wide hallways and wheelchair accessibility. We will also work to develop an 'ambulant disabled' stall, which is less costly compared to a conventional wheelchair stall. Our closed-loop system prevents hazardous leaks, and our system does not use chemicals that are harmful to human or plant life. This, combined with our safety features, as well as the relatively low cost make the design a competitive solution.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2021-41 – E-bikes: a micro-mobility vehicle for rural regions

Fatima Shamim, Sadiqul Islam, Ushua Prashanth, Paloma Junco, Tauhidul Islam

Theme – Transport

Proposal

Our focus is to upgrade a conventional gasoline-powered motorcycle to an electric powered motorcycle to reduce the use of fuel.

Project Summary

Electric two-wheelers use a rechargeable battery technology to transform electrical energy into mechanical energy. This product could help develop e-transportation in rural off-grid locations.

Key design highlights

Our key design highlight is that our electric two-wheelers use clean energy, reducing dependence on polluting fuels, while providing great comfort and safety.

Cost

We estimate a cost of USD700 for a single working unit.

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

We hope to address:

- **SDG 7 (Affordable and Clean Energy)**: by working with affordable and clean energy
- **SDG 8 (Decent Work and Economic Growth)**: as our design will both help create jobs and allow people to work more effectively
- **SDG 10 (Reduced Inequalities)**: by being accessible for vulnerable groups in the region
- **SDG 11 (Sustainable Cities and Communities)**: because it allows for safe and sustainable long-distance mobility, which can connect rural communities, reducing congestion and emissions, and
- **SDG 12 (Responsible Consumption and Production)**: as it has the scientific and technological capacity to help move people towards more sustainable patterns of consumption.

Social, environmental and economic considerations

The design removes the need to produce new, high-quality two-wheelers, which carry large carbon costs. We also aim to rejuvenate existing bicycle chassis and extend their lifespan to accommodate higher mileage and connectivity.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

LUNDS UNIVERSITET

Team 2021-42 – Off-grid solar light design for Uganda rural area

Zimeng Chen

Theme – Lighting

Proposal

This project proposes signing an affordable home lighting system to make off-grid resources accessible to end-users. I decided to innovate on the way people interact with their appliance, by making the product easy to understand and affordable while saving energy.

Project Summary

There are 716 million people without electricity access and a further one billion people with an unreliable grid connection in Sub-Saharan Africa and the Asia-Pacific, the focal regions of this project. Our project aims to provide lighting to undeserved people through the creation of a highly efficient solar lantern using cheap recycled materials.

Key design highlights

The design is an innovative portable lighting design primarily built off the concept of a sun collector. A photovoltaic light design using a jerry can, commonly used for carrying water, as the framing structure. The design uses a moveable panel that can be directed at the sun and a pivoting light to angle the light for different uses.

Cost

The cost of an individual unit is broken down as:

- EUR5: Diffuser sheet/LED protection
- EUR3: LED
- EUR10: Solder paste
- EUR2: Metal Core Printed Circuit Board
- EUR2: Thermal transfer tape
- EUR5: Appropriate heat-sink
- EUR3: LED Flashlight Driver Circuit
- EUR3: Clickable switch for the LED dimming function
- EUR15: Polymer charger
- EUR20: Appropriate 10,000mAh Li-Poly battery
- EUR35: 5-Watt 6 Volt Solar Panel

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

This design aims to work towards **SDG 7 (Affordable and Clean Energy)** by providing clean and affordable energy to those without reliable energy access. Improved lighting can also have several other benefits including **SDGs 3 (Good Health and Well-being)**, **4 (Quality Education)**, SDG 5 (Gender Equality), and **8 (Decent Work and Economic Growth)**, by allowing people to stay safe and continue being productive after dark.

Social, environmental and economic considerations

The device will be affordable, as the parts will be readily available, and use standard industrial manufacturing components, making them easy to replace and cheap. The main parts of the products also use commonly recycled local materials. The device also replaces harmful and polluting kerosene lamps, improving social and environmental wellbeing. Furthermore, by utilising jerry cans as the product frame, energy and water can be collected simultaneously.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2021-43 – Solar powered IoT hydroponics system

Ngure Brian, Cathy Zebia, Nasasira Tony

Theme – Agriculture

Proposal

Our design builds on existing hydroponic technologies, but with innovative improvements to monitor and control the system remotely, use off-grid renewable energy, and lower operating and start-up costs.

Project Summary

The key feature that makes hydroponic systems desirable are the high yields, water recirculation, and its soil-less nature. Our affordable, solar-powered hydroponics systems will offer an off-grid solution that is energy efficient for farmers. We achieve this through the use of low voltage DC-powered submersible pumps that circulate water and a low voltage DC powered microcontroller for control and data acquisition. It will also use vertical farming, which requires less space to produce higher yields. The system also uses water more efficiently compared to traditional methods, and is reliable for all year-round production.

Key design highlights

Our design will be fully automated to ensure that the system parameters such as pH and macro-nutrients levels are optimised for yield. In the long term, our solution will improve yields and increase profits. Once implemented in our beachhead market, the design will reduce the distance that products must travel to market, and minimise the use of non-organic and soil degrading pesticides. As a result, the net GHG emissions for our target market, urban farmers, will be reduced significantly.

Cost

Our design is low-cost, as it is made from locally available and recyclable materials. The design also reduces costs associated with water usage in agricultural activities. It may also free up time and resources for women and children who are the main demographic involved in subsistence farming.

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

Nutrition, at the heart of **SDG 2 (Zero Hunger)** and **SDG 3 (Good Health and Well-being)**, is also at the heart of our design project. **SDG 11 (Sustainable Cities and Communities)** focuses on creating sustainable cities and communities; improving food production within cities, rather than important them rural areas is a major way to move towards achieving sustainability in city environments. In Uganda, improving urban farming practices using our solar-powered IoT hydroponics design has the potential to provide cheaper food for Ugandan urban populations and improve their livelihoods.

Social, environmental and economic considerations

With growing urban populations, there is a need for sustainable agricultural practices. As a result, the role of urban farmers is one that is becoming more and more essential in Uganda. However, urban farmers have trouble in challenging the conventional agricultural practices, which is to transport food grown in the countryside to cities. As it is, urban farming in Uganda is less economical with its small agricultural spaces and the number of inputs needed. In response, our solution increases net production for urban farmers while using fewer resources more efficiently.

Full Report

Video Submission

Team 2021-44 – Egg incubator

Élodie Joséphine Atangana Nkolo, Cyrille Kenfack, Joyce Matekeng Kenfack, Pierre Toloko Bello, Blairio Giacomoni Yetgang Kengne

Theme – Agriculture

Proposal

Our solution is an automatic egg incubator with precisely controlled humidity and temperature settings. Both egg candling, the process used to measure the development of the embryo within the egg, and returning are automated processes.

Project Summary

To help our country pursue greater economic growth, we decided to design an automatic, solar-powered egg incubator that would be accessible to local farmers and could compete with foreign products.

Key design highlights

The unit comprises three sections that respectively focus on pre-incubation, incubation, and protecting baby chicks. The device has an automatic returning mechanism – a system with a servo motor that will rotate the eggs five times per day between the first and eighteenth day. The device will also be easy to use and include a simple explanation of its functions. Finally, candling will be automated using an LED under each egg.

Cost

The cost for the prototype of a single unit was USD608 for the following materials: heat resistance, cockpit, Captor Dht22, battery, solar panel, LCD1602, MOC3021, BTA10, pipes, fans, and connections.

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

The urgency of sustainable development requires countries to move towards **SDG 7 (Affordable and Clean Energy)**. Other pressing SDGs include **SDGs 8 (Decent Work and Economic Growth)** and **SDG1 (No Poverty)**. The SDGs provide a great opportunity for Cameroon, where imports far outstrip exports, where poverty is high and development is slow, to rise to the challenge and make progress towards these goals. The design uses clean energy (**SDG 7 (Affordable and Clean Energy**), facilitates education, captured by **SDG 4 (Quality Education)**, increases incomes and reduces poverty, captured by **SDG 1 (No Poverty)**, by improving yields and reducing losses, will facilitate economic growth, captured by **SDG 8**), by using locally sourced materials, and by automating a traditionally woman borne task, will free up women's time to pursue other endeavours, captured by **SDG 5 (Gender Equality).**

Social, environmental and economic considerations

The social impact of our project is already being felt by our team, as we continue to learn programming in depth, the steps needed to execute a project, how to build a project, and teamwork. A wider consideration may be that when our project goes to scale, we will use raw materials from Cameroon in manufacturing. Buying these products locally will improve the lives of people whom we source from. Finally, we have made our product accessible to all farmers, through the easy to use and accessible training materials that we will provide.

Full Report

Video Submission

Team 2021-46 – Borehole hard water treatment

Joseph Wainaina, Simon Karan, Sharon Mwangi

Theme – Refrigeration

Proposal

Our proposal is a borehole water treatment for the Lodwar community, in Kenya, but it could also be used by industry or other regions that have high temperatures and abundant sunshine.

Project Summary

Our multi-component design of a borehole water treatment has used several different designs combined to improve the livelihoods and health of the Lodwar community and work towards the SDGs.

Key design highlights

The design involves pumping water from a borehole, well, river or lake using a DC solar-powered pump. The system also utilises a water purifier, softener, and cooling system to pump clean cold water from the source.

Cost

The maximum cost of a single unit is USD1,065. However, replacing some of the components and equipment with recycled materials could reduce its cost.

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

- **SDG 2 (Good Health and Well-being)**: by removing the bacteria in water that can cause disease
- **SDG 6 (Clean Water and Sanitation)**: by producing clean and safe water
- **SDG 7 (Affordable and Clean Energy)**: by substituting the fuels generally required to pump water with clean solar energy

Social, environmental and economic considerations

We have incorporated environmental considerations into the design of our appliance. Our design will use clean energy and natural to offset the use of fuels such as coal, which contribute to climate change.

Full Report

Video Submission – N/A

Team 2021-47 – Advancing Thermacell

Sheila Makokha, Andrew Ngetich, Elvis Odhiambo

Theme – Healthcare

Proposal

This design is a mosquito-repellent system. The value of our design comes from its ability to reduce rates of malaria by preventing mosquitos from breeding. Advancing Thermacell is affordable, and has a simple design that can be operated by anyone.

Project Summary

The main aim of Advancing Thermacell is to repel mosquitos from breeding zones to reduce mosquito populations, and deter mosquitos from entering general areas to prevent them from biting people. The design comprises a solar panel timer, resistor, capacitor, and other simple components. The device is solar-powered, and it emits harmless radiations that repel mosquitos.

Key design highlights

The design consists of:

- a timer: for oscillatory pulse generation
- a Piezzo buzzer: to produce a tone or sound
- an electric capacitor: to provide a local charge source that prevents the voltage from dipping and a bypass path that reduces the buzzing
- a flooded lead acid battery: to discharge a large amount of current in a short period of time

Cost

The device's upfront, maintenance, and running costs are low, as it is solar-powered. The components that comprise the Advancing Thermacell are also cheap.

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

- The design mostly contributes to **SDG 3 (Good Health and Well-being)** as it helps to reduce the spread of malaria, which affects a large number of people, especially children.
- It contributes to **SDG 7 (Affordable and Clean Energy)** as it uses a clean and efficient solar energy.
- The design also contributes towards **SDG 8 (Decent Work and Economic Growth)**, as manufacturing an innovative technology will boost job creation.

Social, environmental and economic considerations

The device is environmentally friendly, and no scent or smoke is produced while it is running. The device will help to reduce deaths and infection rates from malaria.

Full Report

Video Submission- N/A

Team 2021-48 – Energy efficient thermoelectric refrigerator for fruits & vegetables

Kristen Angell, Eric Jiang, Felicia Wang

Theme – Refrigeration

Proposal

This project proposes an energy efficient, cost-effective, DC-powered refrigeration unit for small businesses and families in Sub-Saharan Africa, which utilises thermoelectric cooling technology

Project Summary

Many countries in Sub-Saharan Africa struggle with food waste. A core cause of food losses is a lack of a reliable cold chain and refrigeration capabilities. By targeting distribution and market parts of the cold chain, new refrigeration technology in off-grid settings can promote economic growth and entrepreneurship, while improving sustainability and increasing access to food. Our team proposes an energy efficient, cost-effective, DC-powered thermoelectric refrigeration unit for small businesses and families to cool fruit and vegetables.

Key design highlights

The proposed solution is a solar-powered thermoelectric refrigerator with an internal capacity of 100 litres, which can cool up to -40°F below ambient temperature and maintain an 85% target humidity. For cooling, the thermoelectric fridge utilises two TEC1-12706 Peltier units in combination with two small fans and heatsinks to transport heat effectively and reduce emissions. To maximise energy efficiency, the exterior shell is insulated with 2.5” of affordable, environmentally friendly, blow-moulded Polyurethane foam. A temperature sensing unit is included to minimise current draw and ensure energy is only being used as needed. The refrigerator runs off a 12V DC source, and power is obtained via solar panels. An add-on that can be purchased is a simple cart and rechargeable battery, making the refrigerator mobile and transport produce easily.

Cost

The raw material cost for this fridge is USD114.54. To account for manufacturing, distribution, and labour costs, the team anticipates that the unit will retail for USD250.

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

Using solar-powered thermoelectric technology, our device contributes to **SDG 13 (Climate Action)** and **SDG 7 (Affordable and Clean Energy)**. Since our refrigerator reduces food waste, we support SDG 2 (Zero Hunger), and **SDG 12 (Responsible Consumption and Production)**. Our refrigerator extends the shelf life of fruit and vegetables, which promotes **SDG 3 (Good Health and Well-being)**. By implementing refrigeration, perishables can be sold in more locations by more stores. Thus, entrepreneurs can increase their selection of products and profits – **SDG 8 (Economic Growth)**. Since grocery shoppers are often mothers or wives, implementing fridges in more stores will reduce the time taken for women to feed their families. This extra time will empower them to pursue other activities, such as entrepreneurship and education, improving **SDG 5 (Gender Equality)**.

Social, environmental and economic considerations

The proposed design optimises sustainability by reducing food waste, by using Peltier plates, improved energy efficiency, and solar energy. Reducing food waste also helps to reduce the carbon footprint from production or distribution. Moreover, the Peltier effect is more sustainable than other, more polluting forms of cooling, Additionally, the insulation and temperature monitoring system maximise energy efficiency. Social impact is also maximised by targeting small business owners in rural areas. The proposed design uses DC power, which, combined with its size and portability, make it easy-to-use. The relative simplicity of the design, affordable insulation materials, and widespread applicability allow manufacturing costs to be minimised. This project also intends to use locally sourced labour/materials to minimise production costs and increase accessibility.

Full Report

Video Submission