EFFICIENCY FOR ACCESS

UK ENGINEERS WITHOUT BORDERS

Efficiency for Access Design Challenge 2022-2023 Final Submission

Summary of designs submitted by participants 2022 -2023

Funded by:

UKaid from the British people

IKEA Foundation

energy saving trust

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Contents

Abbreviations

AC.....Alternating Current

AWG.....Atmospheric Water Generator

BLDC.....Brushless Direct Current

CO_2.....Carbon Dioxide

DC.....Direct Current

EUR.....Euro

GBP.....Great British Pound

GHG.....Greenhouse Gas

ICT.....Information and Communications Technologies

IoT.....Internet of Things

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

W.....Watt

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

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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 via the Transforming Energy Access programme, and the IKEA Foundation. To read more about the Challenge, please take a look at this year's Challenge Brief.

In this fourth year of the Challenge, over 100 students from 14 universities in Bangladesh, Kenya, Nepal, Nigeria, Senegal, Sweden, Uganda, the UK, and Zimbabwe have participated and were supported by more than 20 industry partners. The students have spent the year creating innovative designs for off-grid settings and the final submissions are summarised in this document.

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Summary Table

The table below summarises the projects that students submitted as part of the Efficiency for Access Design Challenge 2022–2023.

Team	University	Project Title	Theme	Full Reports	Video Submissions	Team Members
2022-04	Turkana University College, Kenya	Solar powered greenhouse	Agriculture	Full Report	Video Submission	Alex Tanui, Goldy Achieng, Madaraka Giyabe, Roy Rop
2022-05	Strathmore University, Kenya	Solar powered pressure cooker	Cooking	Full Report	Video Submission	Angela Achola, Angeline Njuguna, Collins Mugwanga, Stanley Mwangemi
2022-08	Turkana University College, Kenya	Water pumping using mechanical energy of running water	Water pump	Full Report	Video Submission	Kelvin Ndambuki, Kelvin Mutati, Kevin Kemboi, Sarah Jireh
2022-13	Independent University, Bangladesh, Bangladesh	Solar drying system for food processing	Agriculture	Full Report	Video Submission	Bushra Rahman, Md. Khalid Mahmud, Md. Mahmud Mohiuddin Sazzad, Tanjima Tahrin Khan
2022-17	Gulu University, Uganda	Thermal electric solar refrigeration system	Refrigeration	Full Report	Video Submission	Ignatius Ekwanait, Ivan Taiwan Engola, Musa Emuron, Priscilla Kisakye, Vanessa Fongwa
2022-18	University of Port Harcourt, Nigeria	Solar monitoring system for productive use	ICT	Full Report	Video Submission	Benneth Oyinna, Charles Adiman, Lois David
2022-20	Strathmore University, Kenya	Low-cost IoT irrigation system for limited water supply	Agriculture	Full Report	Video Submission	Joy Muntet, Vallary Shinaywa
2022-24	Independent University, Bangladesh, Bangladesh and Makerere University, Uganda	Solar powered automated grinder and anaerobic digestive chamber	Other	Full Report	Video Submission	Eazaz Ahamad, Mark Mutenga, Proscovia Adrabo Amviko, Adrabo, Siam Ibne Masud, Tarikul Islam Saikat
2022-25	University of Port Harcourt, Nigeria	Solar food dryer	Agriculture	Full Report	Video Submission	Elijah Aigbedion, Isaac Negedu, Paul Amadi
2022-27	University of Nairobi, Kenya	Air fryer	Cooking	Full Report	Video Submission	Calvin Gakunju, Jonathan Kaveke, Sherry Were
2022-28	Kathmandu University, Nepal	ICT for rural community heat grid system	ICT	Full Report	Video Submission	Madan Ghimire, Pratyoosh Dahal, Rajan Kandel,

EFFICIENCY FOR ACCESS

Team	University	Project Title	Theme	Full Reports	Video Submissions	Team Members
						Sadiksha Bhandari, Yogesh Niroula
2022-30	Lund University, Sweden	Water filtering system using sapwood	Water	Full Report	Video Submission	Alexandre Vacher, David Wenner
2022-31	University of Nairobi, Kenya	Automated hydroponic vertical farm	Agriculture	Full Report	Video Submission	Dalvin Onyango, Donatus Omondi Ochieng, Emmanuel Otieno, Nicole Ochieng
2022-32	Makerere University, Uganda	Borehole water treatment for hardwater	Water	Full Report	Video Submission	Aluma Simon Peter, Joel Ikabat, Karen Akiror, Maurice Massooto
2022-33	University of Nairobi, Kenya	Solar powered atmospheric water generator kiosk	Water	Full Report	Video Submission	Armstrong Koome, Festus Kipchirchir Kiprono, Richard Otieno, William Mwai
2022-35	Turkana University College, Kenya	Water desalination	Water	Full Report	Video Submission	Judith Eregae, Mwata Kiseu, Reuben Nyandieka, Shaban Omar
2022-36	African Institute for Mathematical Science, Senegal	Solar water filtering fountain	Water	Full Report	Video Submission	Amadou Ndiaye, Mamadou Faye, Mika Sall
2022-38	Aston University, United Kingdom	Solar powered ICT system	ICT	Full Report	Video Submission	Afsana Sharmin, Faiza Zubair Khan, Ihab Alzamer, Mansoor Mohammed, Palliyarallage De Almeida
2022-39	Aston University, United Kingdom	Solar water filters	Water	Full Report	Video Submission	Emmanuella Otekalu, Iyabo Ojetimi, Udochibata Ekwueme-Madu, Sphoorthy Sindhuvalli Mahadeva
2022-40	Aston University, United Kingdom	Atmospheric water generator	Water	Full Report	Video Submission	Bahareh Mardukhpour, Bhargav Gundameedi, Hamidreza, Bozorgasareh, Shima, Sheibani, Rahul Tholeti

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Team 2022-04 – Solar powered greenhouse

Alex Tanui, Goldy Achieng, Madaraka Giyabe, Roy Rop

Theme – Agriculture

Project Summary

Our project aims to promote sustainable agriculture practices and reduce the labour and water costs associated with traditional farming methods.

The design is a solar-powered greenhouse which uses a direct current to optimize plant growth conditions and reduce the environmental impact of traditional farming practices. The system consists of a custom-designed pump and tank, sensors, and a solar panel power system. The proposed project will be based in Naivasha, Kenya, a region heavily affected by climate change.

Innovation

The project involves designing and implementing innovative and sustainable farming practices that improve infrastructure and promote sustainable economic growth. A solar-powered greenhouse can provide consistent irrigation and chemical spraying capability while reducing the environmental impact of traditional agriculture practices. These greenhouses use solar panels to power a custom-designed pump and tank system, providing sustainable energy to the system. The use of sensors for monitoring temperature, humidity, and soil moisture levels provides optimal growth conditions for plants and reduces water usage.

Scalability

The technology is well-positioned to meet the growing demand for fresh produce, both now and in the future, as it enables year-round production. While development costs may be higher, scaling up the setup will be affordable and straightforward due to local farmers and other users' familiarity with the design.

Social Impact

The technology will help to combat food insecurity by promoting sustainable and efficient farming practices, leading to increased crop yields and reduced dependence on non-renewable resources. Local farmers will benefit from increased economic opportunities as their crop yields and profitability improves. The quality of life for local communities will improve due to increased access to fresh produce.

Sustainability

The use of solar panels eliminates the need for traditional electricity sources. Furthermore, the pump and tank system powers an efficient irrigation system that significantly reduces water usage, and an efficient spraying system that reduces chemical usage. The reduction in both water and chemical usage lowers the environmental impact of the operation.

Full Report

Video Submission

Team 2022-05 – Solar powered pressure cooker

Angela Achola, Angeline Njuguna, Collins Mugwanga, Stanley Mwangemi

Theme – Cooking

Project Summary

Our innovation is designed to enable 24/7 access to clean cooking for individuals who lack access to grid electricity. The PikaNaSolar is a solar-powered pressure cooker with an inbuilt battery, which aims to significantly improve people's lives while simultaneously promoting a cleaner and more sustainable environment.

Innovation

Unlike existing pressure cookers, this design includes an in-built battery that can store energy for round-the-clock cooking. The unique design allows it to consume less energy during use compared to jikos and gas cookers. The appliance can also be used off-grid, distinguishing it from traditional models.

Scalability

Partnering with existing manufacturing companies and distributors will reduce manufacturing costs. Two payment models are proposed where the customers can either purchase the product fully or use the "PAYGo" system where the customer pays an upfront amount and the rest in instalments over an agreed period.

Social Impact

Our pressure cooker design provides affordable and clean cooking to those without access to grid electricity and ensures no one is left behind. The appliance is powered entirely by renewable energy, which means that there are no ongoing costs and use of this method reduces the time used for cooking, freeing up valuable time for other activities.

Using solar power as an alternative to firewood and charcoal reduces air pollution and produces a cleaner environment. Cleaner air quality lessens the risk of respiratory illnesses and leads to improved overall health and wellbeing for everyone.

Sustainability

The product will have a positive environmental impact by reducing air pollution in comparison to traditional charcoal stoves and firewood. The appliance's use of solar energy eliminates the need to cut down trees for fuel and reduces greenhouse gas emissions.

Full Report

Video Submission

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Team 2022-08 – Water pumping using mechanical energy of running water

Kelvin Ndambuki, Kelvin Taabu, Kevin Kemboi, Sarah Jireh

Theme – Water Pump

Project Summary

Our design aims to make clean water available to communities by harnessing kinetic energy generated from running water to power a mechanical water pump. The system comprises a turbine that is linked to a pump via a gear box which helps to boost revolutions. By capturing the energy from the flowing water, the system can produce mechanical energy that powers the pump, thus reducing reliance on fossil fuels and minimizing environmental pollution. By drawing water from sources such as wells, rivers, or boreholes, this technology can make safe clean water available to communities in previously inaccessible areas.

Innovation

In contrast to existing alternatives, this system can dramatically lower the steep costs associated with fossil fuels. Once set up, there are no energy costs incurred and the system requires minimal maintenance. The technology offers a sustainable, cost-effective, and reliable solution that can improve access to water while reducing the reliance on non-renewable energy sources.

Scalability

Many mechanical water pumping systems are modular, meaning that they can be easily assembled or disassembled and scaled up or down as needed. This makes them flexible and adaptable to different contexts and levels of demand.

In areas where resources such as water sources and materials for construction are abundant, mechanical water pumping systems may be more scalable. The availability of local expertise in the design and maintenance of these systems can also contribute to scalability. Additionally, adequate financing and support from governments and NGOs can play a role in ensuring long-term scalability.

Social Impact

Mechanical water pumping systems can increase access to clean and safe water for drinking cooking and sanitation, reducing the incidence of waterborne illnesses and improving the overall health and well-being of individuals and communities.

These systems can also be used for irrigation, boosting agricultural productivity and enhancing food security. This, in turn, can create new economic opportunities for farmers and communities, driving sustainable economic growth and promoting employment opportunities.

Our design can reduce the amount of time and labour required to access water, particularly for women and children who are often responsible for collecting water in many communities. The introduction of a solar water pump can help to promote gender equality by freeing up time for education, income-generating activities, and other pursuits.

Sustainability

Mechanical water pumping systems can be engineered to operate efficiently with minimal environmental impact, reducing carbon emissions and helping to mitigate climate change. In addition, these systems help communities to build resilience in the face of environmental challenges. By providing a reliable source of water during droughts or other weather events, mechanical water pumping systems can help to lessen the impacts of these challenges and support sustainable development.

Full Report

Video Submission

Team 2022-13 – Solar drying system for food processing

Bushra Rahman, Md. Khalid Mahmud, Md. Mahmud Mohiuddin Sazzad, Tanjima Tahrin Khan

Theme – Agriculture

Project Summary

Our design is a combined solar dryer and milling system aimed at reducing the drying time for spices, herbs and vegetables while maintaining the quality of the end product. The innovation is aimed at small-scale farmers in rural communities and off-grid areas.

Innovation

The mill uses a blending machine with a 48-volt BLDC motor, which is powered by a battery charged through a 400W solar panel. BLDC motors are more efficient and have longer lifespan than conventional ones.

The design of the solar collector is be optimized to maximize solar radiation absorption and heat transfer while incorporating fans or natural convection to improve air circulation inside the drying chamber for more effective moisture evaporation. The drying chamber is enclosed with a protective cover to address hygiene concerns.

Scalability

The business model considers that a team will be available in each district of Bangladesh for installation and maintenance services which will be enhance customer service and satisfaction.

The design will be tailored to consumers' preferences, making it affordable and user-friendly for farmers and others.

All materials will be sourced locally, minimising dependence on imports. The design will be customizable and made into a smaller, portable version. These design features will create a product that is affordable and accessible to all members of the community.

Social Impact

Our technology gives the dried spices an added value and increased income for small-scale farmers as it allows them to store the product and sell when prices are high.

Providing women with access to solar dryers can increase their productivity and income, leading to greater economic empowerment and gender equality.

Sustainability

This design contributes towards SDG 7 - Affordable and Clean Energy, SDG 1 - No Poverty, SDG 2 - Zero hunger, SDG 3 - Good Health and Wellbeing, SDG 8 - Good Jobs and Economic Growth, SDG 11 - Sustainable Cities and Communities, SDG 12 - Responsible Consumption and Production.

Full Report

Video Submission

Team 2022-17 –Thermal electric solar refrigeration system

Ignatius Ekwanait, Ivan Taiwan Engola, Musa Emuron, Priscilla Kisakye, Vanessa Fongwa

Theme – Refrigeration

Project Summary

Our design is a thermoelectric refrigerator aimed at solving the problem of food waste and financial loss due to spoiled produce.

Thermoelectric refrigeration is an innovative and eco-friendly method of refrigeration that uses the Peltier effect to create a temperature differential across a thermoelectric module. This temperature differential causes heat to move from one side of the module to the other, resulting in the cooling of one side and the heating of the other. Thermoelectric refrigeration units are an innovative and eco-friendly solution to the problem of refrigeration for rural farmers in developing countries.

Innovation

The proposed design for a thermal electric refrigerator replaces the liquid refrigerant, compressor, and condenser with a doped semi-conductor material, a heat sink, and a DC power source respectively. This design is estimated to require 85W of power compared to the 160-220W of a conventional refrigerator, resulting in significant energy savings. The system is powered by solar rechargeable batteries, making it cheaper to operate than hydro-electricity powered refrigeration systems. It can run 24/7, allowing for the preservation of goods during power shortages, and is also portable.

Scalability

The design takes into account the needs of farmers who rely on subsistence farming and often face losses due to spoilage of produce. Farmers need a storage entity to delay spoilage and prevent loss of perishable goods. The design aims to fulfil the needs of farmers who supply markets in bulk and market vendors who have no way to store perishable goods. Meat sellers who have no refrigeration options are also potential customers. The design is viable and can meet market needs, with flexible payment options available. The project could be expanded beyond the initial target area.

Social Impact

The design allows for the preservation of goods for longer periods of time. This ensures that high quality goods can reach their target market, generating better income for farmers and improving their livelihood. The solar-powered and affordable design makes it accessible to many people, including women, who often handle farm and market work, and can be most negatively affected by goods spoilage.

Sustainability

The proposed system design of the thermal electric refrigerator eliminates the use of harmful refrigerants, such as ammonia and chloro-fluoro-hydrocarbons that pollute the environment. It is powered by solar energy, which reduces carbon emissions and encourages sustainable energy use.

Full Report

Video Submission

Team 2022-18 – Solar monitoring system for productive use

Benneth Oyinna, Charles Adiman, Lois David

Theme – ICT

Project Summary

Our design is a standalone solar advanced metering/monitoring infrastructure for productive use. The innovation aims to provide the community with access to energy and a way to monitor and measure this energy in order to minimise cost and maximise efficiency. The project focuses on Igbo-Etche, a rural community in Rivers State in the South-South region of Nigeria.

Innovation

The design attempts to integrate multiple features in one stand-alone solar system, which sets it apart from existing alternatives. The standalone solar PV monitor features an interface that efficiently manages the allocation of energy to end-users. It incorporates load control mechanisms with alarms that signal when an end-user's consumption surpasses predetermined thresholds. This is an improvement over existing load monitoring platforms, which only offer basic visualizations of energy consumption and payment integrations.

Scalability

A standalone solar PV monitor that enables end-users to manage their energy use efficiently allows users to make informed decision. The product can be scaled to a premium energy monitoring platform with integrated payment systems for solar micro and mini-grids. The product is suitable for both rural and urban areas, with a software-as-a-service business model that reduces manufacturing costs, making it affordable for the masses. The technology is user-friendly, easy to integrate, and has a large market potential.

Social Impact

This design aims to provide access to clean and affordable energy, improve energy management for underserved communities and ultimately improve quality of life for users. It aims to reduce energy loss, tackle poverty and improve health. The design aims to eradicate inequality, discrimination, and exclusion by bringing the quality of life of rural communities in line with that of urban regions.

Sustainability

Inefficient and polluting systems would be avoided at all cost. No greenhouse gases would be emitted during use. The technology encourages efficient energy use, continuously reducing the environmental impacts of its users.

Full Report

Video Submission

Team 2022-20 – Low-cost IoT irrigation system for limited water supply

Joy Muntet, Vallary Shinaywa

Theme – Agriculture

Project Summary

Our design is a smart solar-powered Internet of Things (IoT) irrigation system which is cost-effective, efficient, and user-friendly. This innovative system leverages the power of IoT technology to sense the moisture level of the soil, and adjust the amount of water needed to irrigate a crop accordingly. The system utilizes green energy, with an efficient pumping system, and allows for remote communication for user maintenance.

Innovation

Unlike reliance on rainwater, or irrigation systems which operate without considering the soil conditions, the smart solar-powered IoT irrigation system provides a sustainable and efficient solution for irrigation that can help improve crop yields while reducing water consumption and energy costs.

Scalability

The smart solar-powered IoT irrigation system has the potential to increase crop yields and economic growth for low-income farmers and other users in need of irrigation solutions. One of the system's key benefits is its use of locally available materials, making it easily accessible and affordable for farmers. The system is also designed to be easily assembled by farmers.

Social Impact

The implementation of a smart solar-powered IoT irrigation system holds the potential to enhance crop yields and drive economic growth for low-income farmers and their communities. The technology has the capability to improve country's food security.

Sustainability

By employing an IoT irrigation system, both water efficiency and field health can be significantly improved, leading to higher crop yields for years to come. This irrigation system is powered by solar energy, unlike other grid-connected technologies that rely on non-renewable sources.

Full Report

Video Submission

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Team 2022-24 – Solar powered automated grinder and anaerobic digestive chamber

Eazaz Ahamad, Mark Mutenga, Proscovia Adrabo Amviko, Adrabo, Siam Ibne Masud, Tarikul Islam Saikat

Theme – Other

Project Summary

Our design is a solar power operated biodigester which produces biogas for cooking along with a nutrient-rich fertiliser for use on farmland. The system provides an eco-friendly and cost-effective alternative to fossil-fuel derived cooking fuels and fertilisers.

Innovation

Our system comprises a solar panel, charge controller, sensors, microcontrollers, a 24V 30Ah LiFePO4 battery, a compressor and two LCD displays connected to a grinding chamber, an anaerobic digestive chamber and a water scrubber.

The mechanical pre-treatment of the food waste is managed using a 500W BLDC motor which, compared to traditional DC motors, achieves an increased blending speed for the same energy input and helps to reduce the particle size of waste and reduces retention time. A small DC motor is next used to mix the blended waste. The two chambers for grinding and anaerobic digestion have blades connected to the motor's shaft. which is more efficient than traditional DC motors,

Microcontrollers, motor controllers and sensors are used for monitoring the gases in the chamber and adjusting the rotation of motors as and when needed.

The biogas generated in the anaerobic digestor chamber is compressed into the water scrubber for purification to achieve a high calorific cooking gas while the substrate inside the chamber will be used as crop fertilizer.

Scalability

The anaerobic digesters can be designed in various sizes to serve urban or rural communities and has the potential to be used by large livestock farms which may need to treat large volumes of manure, or the hospitality sector which generates vast amounts of food waste and also require regular provision of cooking gas. Government agencies and NGOs working in the waste sector can also use this technology.

Assembly of the three main parts can be carried out locally at the final location which ensures the cost is kept considerably low. An easy-to-read operating manual will be provided.

Social Impact

The fully functioning system can be manually operated by one person, thus reducing the need for large labour output. Communities will benefit by having access to cheaper cooking fuels. Farmers will be able to make use of a cheaper fertiliser that is also rich in soil nutrients therefore potentially improving future crops and livelihoods.

Sustainability

Reducing harmful emissions to the atmosphere (from food and agriculture waste degradation) provides better air quality for people and can prevent lung related diseases.

This design contributes towards SDG 7 - Affordable and Clean Energy, as well as, SDG 1 - No Poverty, SDG 3 - Good Health and Wellbeing, SDG 11 - Sustainable Cities and Communities, SDG 12 - Responsible Consumption and Production, and SDG 13 - Climate Action.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2022-25 – Solar food dryer

Elijah Aigbedion, Isaac Negedu, Paul Amadi

Theme – Agriculture

Project Summary

Our design is a solar dryer which offers a reliable and affordable energy alternative for drying food and is more sustainable when compared with traditional preservation methods like smoking. The dryer can typically be used to dry foods such as meat, fish, yam or plantain.

Innovation

Solar energy is collected by the solar panel and converted into electrical energy which is delivered to the charge controller. The produce to be dried is placed inside the drying chamber and exposed to the heated, humid air. The dryer uses an Arduino Uno Microcontroller to control the temperature sensor and maintain a consistent temperature. The drying process continues until the produce has reached the desired level of dryness. Inclusion of a battery for energy storage means the dryer can operate when solar irradiation is insufficient.

The main distinguishing factor between this product and already existing alternatives is its compliance with the zero emissions target. The dryer will help drain away the moisture in most perishable foods, to prevent the growth of fungi and bacteria.

Scalability

Our solar drying technology is suitable for use by households and commercially and the size can be developed according to the need, ranging from smaller sizes for individuals or families, through to medium sized for retail and larger size designs for wholesales commercial purposes.

The solar dryer is a one-time purchase and will prove more cost effective than the food smoking process which requires a constant supply of charcoal or wood.

Social Impact

Drying food by means of solar energy eliminates health hazards inherent in smoke drying. This solar dryer has the ability to improve the food chain in terms of storage and distribution and improve the nutrition of households and communities as it enhances the access to preserved food for longer periods.

To accommodate customers' taste preferences, the innovation will include the use of seasonings and flavourings to recreate a smoke flavour which can be used while the food is being dried. Producing the flavourings will create a sub-industry alongside the solar dryer.

Sustainability

The solar dryer uses a clean and green energy source to dry the food. Dried food is lighter due to the water content being reduced in the drying process. The end product will be easier and cheaper to transport and will contribute to the reduction in transport related emissions.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2022-27 – Solar powered air fryer

Calvin Gakunju, Jonathan Kaveke, Sherry Were

Theme – Cooking

Project Summary

Our design is a solar powered air fryer which provides a healthier, more affordable and sustainable means of simulating deep fried foods for street fish vendors. In certain regions frying fish is the preferred method of preservation as it preserves the food for longer and ensures any harmful microorganisms are killed by high temperatures. Air fryers use minimal oil while retaining high temperatures.

Innovation

Our proposed design is to increase the insulation of the food chamber by lining the inner walls of the air fryer basket holder with glass wool. This innovation will improve the efficiency of the fryer by maintaining the temperature setting for the food and allow cooking to continue while using less energy. A solar battery is included with the fryer to enable storing of the charge meaning the appliance can be used on low solar days.

Scalability

The air fryer can be designed with low (800W) or high voltage (1200W) depending on the user's needs. Keeping the design simple with minimal functions allows us to focus efforts on the utility while keeping costs low. The proposed business model allows for buying the item outright or on hire-purchase.

As the cost of solar panels decrease and technology innovations are further developed, so the affordability of the air fryer will increase.

Social Impact

The use of solar power for energy instead of charcoal and firewood, along with less oil used during cooking will reduce running costs for users. Cheaper running costs and increased income for the vendors will contribute to their own financial wellbeing and impact on the wider community.

Reduced exposure to smoke from using fossil fuels in certain settings is alleviated, improving work productivity and lifestyles.

Sustainability

Reducing the dependence on fossil fuels like natural gas, firewood and charcoal, as an energy source, would help save on costs and limit harm to the environment.

The manufacture and maintenance of the appliance is projected to be easy and less costly since the materials needed for the proposed glass-wool insulation utilises widely available recyclable glass.

Full Report

Video Submission

Team 2022-28 – ICT for rural community heat grid system

Madan Ghimire, Pratyoosh Dahal, Rajan Kandel, Sadiksha Bhandari, Yogesh Niroula

Theme – ICT

Project Summary

Our design is a control system for a single powerplant network which uses solar energy to provide heat and hot water for community buildings in the Langtang Valley in Nepal. Temperatures here can dip to below freezing, especially on higher ground.

Innovation

The heating system comprises solar water heating collectors, heat exchangers, insulated storage tanks, pumps, and a series of controllers and sensors connected to radiators in the buildings. The use of a centralised heating system allows for a load-shift according to demand and load-shed when demand is greater than production.

Internet of Things (IoT) technology is integrated into the control system to improve the efficiency and effectiveness of the heating system. Sensors integrated through the system measure temperature, flow rate, and other variables that are important for optimising the system's performance.

Scalability

The installation of a heat grid system in Langtang Valley would provide a feasible pilot project for other regions to take up and replicating the concept would be easier in urban settings compared to Langtang.

The system could potentially be adapted for cooling instead of heating by replacing the fluids and replacing the heaters to refrigerators.

Social Impact

This project would provide an environmentally friendly heating option for residential buildings and local communities in the Langtang Valley region. As the area is a popular destination for hikers and mountaineers, providing warm and comfortable indoor environments would boost tourism which would in turn contribute to the economy of the surrounding villages.

The construction of the powerplant network would provide employment opportunities for local people and even further opportunities for those wanting to be trained in the operation and maintenance of the system.

Sustainability

This design aims to promote and utilise renewable sources of energy with high efficiency, thereby reducing the use of solid fuels which are a major contributor to climate change. Moreover, the central system uses less material than the individual household heating system, thereby reducing their manufacturing and disposal environmental impacts.

The project reduces the need for individual energy systems which would mean less pollutants released into the atmosphere and improved air quality for all.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2022-30 – Water filtering system using sapwood

Alexandre Vacher, David Wenner

LUNDS UNIVERSITET

Theme – Water

Project Summary

Our design is a solar-powered water filter system aimed at protecting against water-borne pathogens and improving the health of people who lack access to safe, clean water. The filtration technology is affordable, simple to maintain, uses locally sourced materials and has a prolonged lifespan compared with other filters.

The water filter system incorporates a water flow sensor, ceramic pre-filter, and xylem filtration, enabled by SMS, and powered by solar energy. The system provides a reliable, eco-friendly, and low-maintenance solution for clean water access.

Innovation

This design uses a wood-based material, xylem, the porous inner layer of wood, as a natural filter to purify water by trapping impurities and contaminants as it passes through the tiny pores. The filter uses a three-part system with a metal mesh, ceramic, and xylem to successively remove impurities from water.

The system has a solar-charged battery which powers a microcontroller, solenoid valve, water pump, water flow sensor, and other components. A controller also alerts for timely filter replacements.

Scalability

The business model will rely on using existing supply chains, manufacturing and local partners or other services to minimise cost and efficiency. Maintenance would be managed through a franchise model, whereby local entrepreneurs can maintain the water filter, or possibly for users themselves to purchase water filters from local stores. This will facilitate scalability as it allows for people to set up and operate at different locations.

Wireless SMS-based payments would enable the water filter to be installed practically anywhere. Customers will be able to access the system using various flexible payment models such as subscription or pay-as-you-go where a customer pays a sum of money upfront and then monthly incremental sums.

Social Impact

The pay-as-you-go system minimises waste and promotes water conservation as users are only paying for the water used.

Sustainability

This water filter system contributes towards several SDGs including SDG 7 - Affordable and Clean Energy – as it uses solar power to pump the water, SDG 3 - Good Health and Wellbeing - providing clean water to reduce illnesses caused by contaminated drinking water, SDG 6 - Clean Water and Sanitation - ensuring availability and sustainable management of water and sanitation for all, SDG 8 - Decent Work and Economic Growth - providing clean drinking water, which will improve productivity and livelihoods, and SDG 12 - Responsible Consumption and Production – using sustainable and locally sourced materials and local manufacturing.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2022-31 – Automated hydroponic vertical farm

Dalvin Onyango, Donatus Omondi Ochieng, Emmanuel Otieno, Nicole Ochieng

Theme – Agriculture

Project Summary

Our design is a low-cost automated vertical hydroponic unit which enables people without access to farmland to grow their own produce in a small space with minimal water consumption and supervision. The system also provides a diversification option to traditional farming.

Innovation

A simple automated watering system that allows for remote monitoring and control is incorporated into a vertical hydroponic unit. The system has the capacity to pump a water-nutrient mixture to 20 plants in $1m^3$. A battery is included to store energy for use at night or when solar energy is not available. Data such as the state of the pump or the battery charge level will be produced by the system and accessible online. The unit is easy to operate, and modular, allowing for the easy replacement of any damaged parts.

Scalability

The initial cost for a prototype is estimated to be US$150. The cost can be reduced by contracting custom PVC manufacturers for the tower parts and miniaturising the electronic components to a printed circuit board. A business model approach for low-income customers would be to work through “nyumba kumi” groups, a local model of community policy groups in Kenya. The groups are already in place and are proven to enable people to pool their resources and keep costs manageable for each member. This approach will also make it easier for the people to obtain loans from financing institutions.

Social Impact

The unit can be used in rural and urban settings, allowing people with no or limited access to farm land to cultivate their own produce. This increases food security, and creates an additional income generation opportunity if used to sell produce. The system will come equipped with a user manual and guidance on nutrient-to-water mixture ratios and recommendations for growing different types of produce.

Sustainability

Vertical hydroponic units help curb emissions, compared to traditional farming practices as it uses less land, reduces water consumption and wastage, and reduces produce wastage.

This design contributes towards SDG 7 - Affordable and Clean Energy, as well as, SDG 1 - No Poverty, SDG 2 - Zero hunger, SDG 3 - Good Health and Wellbeing, and SDG 12 - Responsible Consumption and Production.

Full Report

Video Submission

Team 2022-32 – Borehole water treatment for hardwater

Aluma Simon Peter, Joel Ikabat, Karen Akiror, Maurice Massooto

Theme – Water

Project Summary

Our design is a pre-filter water treatment system for boreholes that uses reverse osmosis technology and solar energy to improve access to clean, safe water for human consumption and agriculture. Implementing this system will remove pathogens from water, soften hard water and reduce manual labour used in pumping water.

The pre-filter is fitted and fastened to a borehole to treat water as it is pumped for immediate use or to storage tanks. The design can be used in residences, irrigation systems, and other water supply systems.

Innovation

This design modifies already existing, widely available hand pumps, to enable solar energy to automate the pumping of water and activate reverse osmosis technology to filter out harmful contaminants from the water. To increase access, this water could be pumped into a newly built or purchased reservoir and then dispensed from there.

A solar tracking system which is designed to follow the movement of the sun, can be incorporated into the system to optimise the amount of solar energy collected by solar panels.

Scalability

The pilot project focusses on Uganda, however the system can be rolled out wherever boreholes are in use around the world. The design's simplicity, small size, and use of readily available components make it easy to replicate in any part of the world. The affordability of installation and cost-effectiveness over the long term will encourage adoption and further promote its scalability.

Social Impact

Access to clean water will improve the overall health of the community. Removing pathogens from water will curb and prevent outbreak of epidemics such as cholera.

The technology will also improve agricultural production and encourage economic growth and food security. The design could pump water directly into homes and so would also free up time and improve livelihoods for women who may be expected to fetch water from springs and boreholes.

The increase in land use for agriculture and pollution due to human activity has had a toll on both the environment and human life. In order to ensure that clean and safe water is accessible, we have designed a technology that makes this possible using solar energy and reverse osmosis technology.

Sustainability

The use of solar energy to pump water rather than using fossil fuels reduces greenhouse gases emissions. Additionally, continuous use of safe irrigation water can help restore degraded saline soils through the leaching away of salts in the field.

Full Report

Video Submission

Team 2022-33 – Solar powered atmospheric water generator kiosk

Armstrong Koome, Festus Kipchirchir Kiprono, Richard Otieno, William Mwai

Theme – Water

Project Summary

Our design ins a solar-powered atmospheric water generator kiosk that extracts moisture from the air and converts it into clean potable water. The system is designed to meet the needs of communities who lack access to safe water sources and is designed to operate in remote locations, making it an ideal solution for communities that are not connected to municipal water systems.

Innovation

The kiosk is an all-in-one solution that combines the functions of an Atmospheric Water Generator (AWG), a water dispenser, and a water treatment system. It uses a closed-air system that requires no drilling, pumping, or treatment of contaminated water, making it a cost-effective, environmentally beneficial solution. The kiosk is equipped with a smart control system that optimizes the operation of the AWG based on real-time weather data which allows the system to operate at peak efficiency, reduces energy consumption and improves overall performance by maximizing water generation during favourable weather conditions and minimising energy consumption during less favourable conditions.

Scalability

Market research will be conducted to understand the target market's purchasing power, to develop payment models, and explore local partnerships and collaborations. Existing supply chains in the relevant areas will be assessed, and partnerships with local manufacturers and service providers will be established. Additional services such as maintenance, repair, and customer support can be provided by local partners. These strategies will ensure that the kiosk is well-positioned to meet its objectives and that it is also scalable.

Social Impact

Improved access to clean water will improve the overall health of communities by reducing the incidence of waterborne diseases. The kiosk will be accessible and affordable to all members of the community, regardless of their socio-economic status, gender, age, or ability, and will be located in areas where water access and quality are most limited. The kiosk has the potential to eliminate the need for bottled water or costly water treatment methods and reduce the need for people to travel long distances or pay high prices for clean water. The kiosk can stimulate economic growth and development while promoting sustainable energy practices.

Sustainability

The AWG kiosk can reduce environmental impact through its lifecycle by using renewable energy sources. Its closed-loop system recycles any unused water back into the atmosphere, which reduces water waste and ensures maximum efficiency in water production. As the system is powered by renewable energy, it can help to reduce reliance on fossil fuels. The project aligns with SDG 7 by providing access to clean and affordable energy, and can contribute to SDG 6, SDG 3, SDG 2, SDG 12, and SDG 13 by improving access to clean water, reducing waterborne diseases, improving food security and nutrition, and promoting sustainable consumption and production practices by reducing single-use plastic water bottles.

Full Report

Video Submission

Team 2022-35 – Water desalination

Judith Eregae, Mwata Kiseu, Reuben Nyandieka, Shaban Omar

Theme – Water

Project Summary

Our design is a solar powered water desalination facility which treats seawater using reverse osmosis technology to produce a dependable source of clean potable water. The facility will have the capacity to produce 100m^3 of drinkable water per day. In many regions of the world where freshwater is in short supply, desalination is a vital solution to the problem of water shortages.

Innovation

The desalination system uses pumps, filters, and reverse osmosis membranes and will include a pre-treatment process to remove large debris and sediment. Following the reverse osmosis process the purified water will be collected and stored in a clear well. Reverse osmosis technology is highly efficient, has low energy consumption, and is easy to operate.

The pre-treatment process will involve sand filtration, chemical dosing, and disinfection to keep the membranes clean. The purified water will undergo post-treatment processes such as remineralization and disinfection to ensure that it meets the required quality standards before distribution through a network of pipelines.

The system will be connected to solar panels and an energy storage system which will make the system self-sufficient and independent of an electricity grid.

Scalability

Solar-powered water desalination projects can be easily scaled up or down depending on the water demand, making them flexible and adaptable to changing conditions. Modest sized, portable desalination systems can be easily installed to supply a small community with up to 10,000 litres of water per day. Other desalination systems can be erected to accommodate large-scale use such as delivering water for industrial or agricultural needs. The flexibility and scalability of this modular design makes it simpler to adjust to shifting water demands.

Partnerships and collaborations with government, NGOs, and private sector will be needed to ensure affordability of a solar-powered water desalination plant.

Social Impact

By providing water for irrigation, aquaculture, and other agricultural activities, a solar-powered water desalination plant can increase economic potential. The operation and maintenance of the system will require a trained workforce that could boost local job opportunities. Solar-powered desalination can provide a reliable source of water, even during power outages or in areas with unreliable electricity supplies thus securing safe water for communities.

Sustainability

The resilience of local communities in climate change affected and natural disaster-prone areas can be significantly improved through use of a solar-powered water desalination plant.

This design contributes towards SDG 7 - Affordable and Clean Energy, as well as, SDG 3 - Good Health and Wellbeing, SDG 6 - Clean Water and Sanitation, SDG 9 - Industry Innovation and Infrastructure, SDG 14 - Life Below Water, and SDG 15 - Life on Land.

Full Report

Video Submission

Team 2022-36 – Solar water filter fountain

Amadou Ndiaye, Mamadou Faye, Mika Sall

Theme – Water

Project Summary

Our design is a solar-powered water filter system that increase access to clean safe drinking water in rural communities in Africa.

Innovation

Our system consists of a solar pump which serves to bring the water from any source to the filter network and to power the filtering system. A dual-level filter system first of all eliminates most of the residues contained in water and next, using a ceramic filter, eliminates bacteria to make the water completely potable. A tank with a capacity of 1,000 liters will store the filtered water. SMART technology will be incorporated to allow for monitoring of water quality produced over time.

Scalability

The system is mobile and can be installed in different communities. The business model will offer two payment options - cash payment and a PAYGo method, which will allow suppliers to set payment rates according to the customers' financial means. The operation and maintenance of the system is simple, meaning customers can do it themselves, thus ensuring customer loyalty. We will help our customers use and maintain their fountains by providing instructions and support. Potential partners will include municipalities, NGOs, youth associations, women's groups, and the state.

Social Impact

Providing access to clean water is essential for community development. This system will help reduce illnesses related to the lack of water portability and address inequalities.

Sustainability

The system emits no greenhouse gases and uses recycled materials, to reduce costs and environmental impact. This design contributes towards SDG 7 - Affordable and Clean Energy, as well as SDG 6 - Clean Water and Sanitation.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2022-38 – Solar powered ICT system

Afsana Sharmin, Faiza Zubair Khan, Ihab Alzamer, Mansoor Mohammed, Palliyarallage De Almeida

Aston University
BIRMINGHAM UK

Theme – ICT

Project Summary

Our design is a solar-powered portable ICT system which can be used in areas without access to grid electricity. The system is fully mobile and can be easily transported to various locations. The ICT system provides a sustainable and cost-effective access to technology and training opportunities for students and educators in rural and low-income communities and for displaced populations.

Innovation

The ICT system will incorporate a solar panel to charge a computer, router, and projector on a movable table This design is cost-effective and utilises readily available materials, such as a standard solar panel. By eliminating the need for a power converter, energy consumption and energy loss during energy conversion are reduced, making this project a sustainable and efficient solution. Assembly is easy and can be installed in tent schools in areas affected by natural disasters such as the recent floods in Pakistan.

Scalability

The system is solar powered and can be used anywhere, however it highly depends on a quality internet connection. Thus, one of the main stakeholders is the government to ensure the adequate infrastructure is in place. Other key stakeholders are UN agencies and NGOs.

The procurement and assembly of the system will be carried out locally to reduce costs. While this system has a significant upfront investment, operating costs are minimal as it can function without reliance on the electricity grid. The project will be designed to scale cost-effectively, with features such as cloud-based infrastructure, open-source technology, and efficient use of resources.

Social Impact

The project ensures uninterrupted access to education for all children, despite the challenges posed by any natural disasters and contributes to improved educational outcomes, enhanced digital literacy, community development, and sustainable development. Access to technology and information will have a positive impact as education and training is necessary to help the community cope with floods and develop skills for everyday life after the event. By providing access to technology and education, this design aims to bridge the digital divide and help promote the development of these communities.

Sustainability

This design contributes towards SDG 7 - Affordable and Clean Energy, as well as, SDG 3 - Good Health and Wellbeing, SDG 4 - Quality Education, SDG 5 - Gender Equality, SDG 10 - Reduced Inequalities, SDG 17 - Partnerships for the Goals.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2022-39 – Solar water filters

Emmanuella Otekalu, Iyabo Ojetimi, Udochibata Ekwueme-Madu, Sphoorthy Sindhuvalli Mahadeva

Aston University BIRMINGHAM UK

Theme – Water

Project Summary

Our design is a solar water microfiltration system which will provide clean drinking water to households in the Bidar community in India who have to pay for water tankers and private companies to safe clean water. The innovation is designed to be sustainable, easy to maintain, and cost-effective.

Innovation

A water-based UV paint is used to coat the upper steel container's inner and exterior walls to absorb radiation and kill bacteria in the water. Ceramic filters remove particulate matter and bacteria while colloidal silver in the ceramic layer sterilises the water and removes further bacteria.

Scalability

The system can be adapted to meet the specific needs of different communities, including rural areas with similar conditions in Asia as and Africa. Reduced manufacturing costs and inexpensive materials for the filters like sand, ceramic, and plastic makes this a viable option for producers and consumers. A payment scheme could help a household to pay off the price for the system through a fixed amount over a certain period. Another option is sharing the system between two households and splitting the cost to improve affordability.

Social Impact

Our water-filtration system can have a profound impact on the social, economic, and environmental well-being of the Bidar community by improving access to clean water, increasing sustainability, boosting the local economy, and reducing the negative environmental impact associated with certain water treatments. Improved access to clean water not only enhances the hygiene and health outcomes by reducing waterborne diseases but also leads to an overall improvement in the quality of life by providing more time for other essential activities such as work and education.

Sustainability

This design contributes towards SDG 7 - Affordable and Clean Energy, as well as, SDG 1 - No Poverty, SDG 3 - Good Health and Wellbeing, SDG 6 - Clean Water and Sanitation, SDG 12 - Responsible Consumption and Production.

Full Report

Video Submission

EFFICIENCY FOR ACCESS

Team 2022-40 – Atmospheric water generator

Bahareh Mardukhpour, Bhargav Gundameedi, Hamidreza, Bozorgasareh, Shima, Sheibani, Rahul Tholeti

Aston University
BIRMINGHAM UK

Theme – Water

Project Summary

Our design is an atmospheric water generator which extracts water from the atmosphere to provide drinking water for 20 families. This system produces sustainable, cost-effective, and chemical-free drinking water.

Innovation

The appliance works by means of PV panels which absorb solar energy to run a chiller compressor. The cooling energy produced by the chiller enters a storage tank and changes the Phase Change Material inside it from a liquid to a solid phase. At night, a condenser uses the stored cold energy in the tank to condensate the water content in the air and produce pure water. Condensing at night is more energy- efficient compared to models which go through the process by day as night time temperatures are lower so less energy is needed to condense the water. The phase change material makes the appliance cheaper and more environmentally friendly in comparison to the other models which use electric batteries as the main energy storage unit.

Scalability

We propose a pay-per-use system for individuals and small organizations and a subscription or leasing model for larger communities and businesses. The appliance has a payback period of about two years with income generation of US$409 net.

The system is modular so if any part needs to be repaired, it can be easily separated from the main unit and sent for repair.

Social Impact

A consistent supply of clean water can improve health outcomes by lowering the prevalence of water-related illnesses and provide benefits for agriculture and other forms of economic activity. Atmospheric water generators can provide drinkable water to neglected areas and reduce water collection time and energy. This system can assist to equalise educational, career, and recreational prospects.

Sustainability

The utilisation of solar panels as a source of electricity generation reduces its carbon footprint. The appliance can eliminate the need for single-use plastic water bottles, which contribute significantly to the plastic waste problem. This design contributes towards SDG 7 - Affordable and Clean Energy, as well as, SDG 3 - Good Health and Wellbeing, SDG 6 - Clean Water and Sanitation, SDG 13 - Climate Action.

Full Report

Video Submission