EFFICIENCY FOR ACCESS

Supported by:

UK ENGINEERS WITHOUT BORDERS

Efficiency for Access Design Challenge

Challenge Brief 2022–2023

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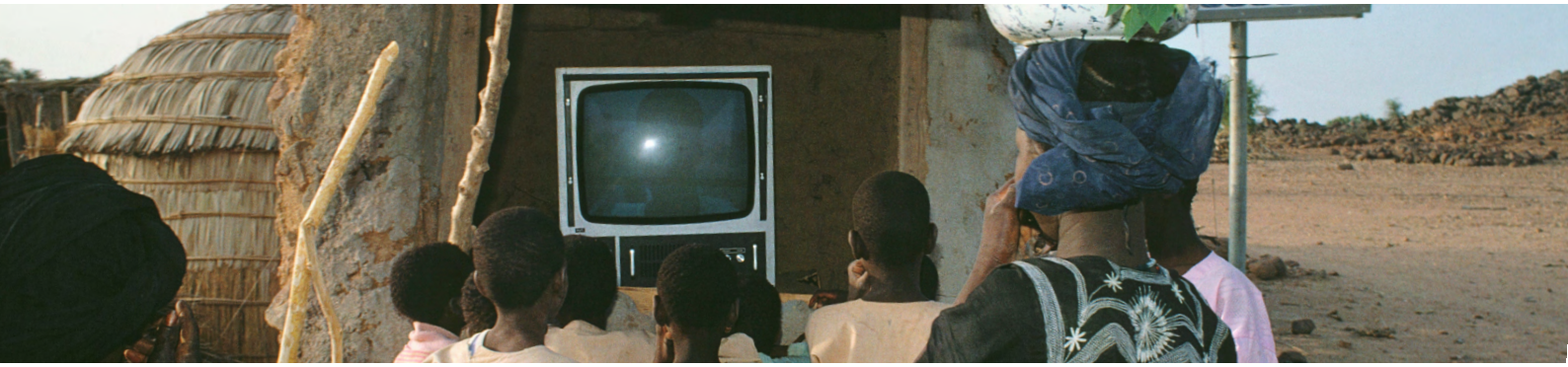


Overview

789 million people live without access to electricity, or access to electric appliances that boost productivity or provide cooling, refrigeration and communications. While an estimated 441 million people have gained access to energy since 2010 alone, a further 670 million people will still not have access to electricity by 2030. The world is also facing a climate emergency, plunge in biodiversity and cost of living crisis.

It is more important than ever to enhance access to modern energy services that are powered by renewable energy sources. We also need more innovators to create appliances that are truly accessible for those with access to solar home, and mini-grid systems. This means that we need to co-create and design products with, rather than for, the people who need them most. We must also consider the application of these products, and how they can play a critical role in addressing vast inequalities in energy access worldwide.

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 universal energy access, we urgently need to enhance the value, efficiency and affordability of high-performing appliances. The Challenge invites teams of university students to create affordable and high-performing off-grid appliances and enabling technologies.

Over the year, you have the opportunity to join students from around the world to design affordable and high-performing appliances and technologies for off- and weak-grid settings. The Efficiency for Access Design Challenge team is excited that you are part of the competition, and we are looking forward to the solutions you will submit.

This brief aims to enhance your understanding of clean energy access and solar appliances, helping you frame your project and design your solution.

The Challenge started in September 2019. Since its inception, over 300 students from 29 universities in Bangladesh, Benin, Cameroon, India, Kenya, Mozambique, Nigeria, Pakistan, Senegal, Sweden, Uganda, the UK, the USA and Zimbabwe participated. They were supported by over 50 industry partners. Details on the competition and more resources, including previous years' project submissions and a recording of the Grand Final, are available here.

Context

The UN Sustainable Development Goals (SDGs) recognise that access to affordable, reliable and modern energy services is crucial to poverty reduction and implementing sustainable agricultural practices.

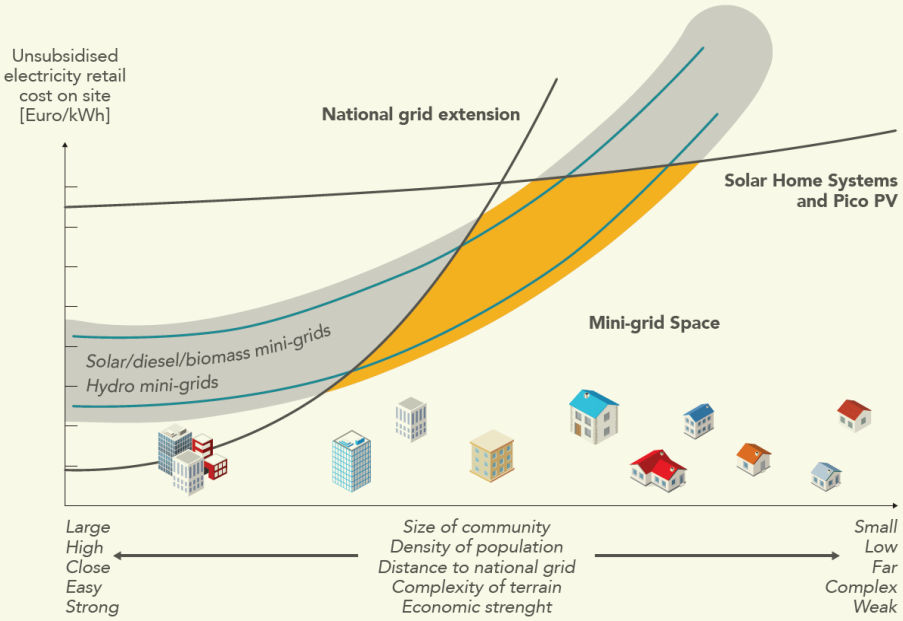
Distributed clean energy technologies such as off-grid solar home systems and standalone solar mini-grids help people and enterprises access life-changing modern energy for the first time. The improvement and expansion of existing grid infrastructure will also play an important role in accelerating energy access.

According to the International Energy Agency (IEA), off-grid solar home systems and solar mini-grids are the most economical ways to reach over 66% of those expected to gain energy access before 2030 in Africa. Solar photovoltaic (PV) is growing rapidly, despite growth in energy access stalling in recent years. Solar PV and wind have become the cheapest forms of new energy generation in most markets. As off-grid communities gain access to mobile phone networks, 'Pay-As-You-Go' (PAYGo) financing is helping households and businesses access affordable electricity flexibly. With PAYGo financing, customers usually pay an upfront deposit, with regular payments (often via SMS or mobile money), which enables them to buy a solar home system outright.

Solar home systems (SHSs) are standalone photovoltaic systems that offer a cost-effective way of supplying power to remote, off-grid households. A solar home system typically includes one or more photovoltaic modules consisting of solar cells, a battery to store energy and a charge controller, which distributes power, and protects the batteries and appliances from damage. Currently, a typical solar home system operates at a rated voltage of 12V direct current (DC) and provides electricity for low power appliances, such as LED light bulbs, radios and small TVs for about three to five hours a day.

A mini- or micro-grid can be defined as a set of electricity generators and energy storage systems interconnected to a distribution network that supplies electricity to a localised group of customers. They employ small-scale electricity generation ranging from 10 kilowatts (kW) to 10 megawatts (MW). Mini-grids are typically photovoltaic modules, micro-hydro and/or back-up generators, which serve a limited number of consumers via a distribution grid that can operate autonomously without being connected to a centralised grid, often referred to as a 'standalone'.

Opportunities for grid-extension, mini-grid and distributed renewable energy systems



Adapted from the EUEI PDF, Mini-grid Policy Toolkit, 2014.

This diagram shows the most economical way to achieve electrification in different settings. For dense, highly populated cities, grid extension remains the cheapest option, whereas for remote rural areas, solar home systems are much more viable. There is a sweet spot in between where mini-grids appear to be the preferable options to power communities, living in villages for example. Source: Integrated Electrification Pathways for Universal Access to Electricity: A Primer, Sustainable Energy for All (SEforAll), 2019.

Conventional appliances consume too much energy to be used affordably with off-grid energy systems such as solar home systems and mini-grids. The combined energy demand of inefficient appliances can overload these energy systems, which contributes to load shedding and power outages.

Affordable and high-performing appliances are essential to delivering modern energy services to underserved communities around the world at the lowest possible economic and environmental cost. These services, in turn, provide great potential for social development, and recently, potential to build resilience in the face of the COVID-19 pandemic (Efficiency for Access Coalition, 2021). These efficient appliances can also help reduce greenhouse gas emissions by replacing incumbent power generation systems and lower demand for future carbon-intensive energy supplies.

Families who gain energy access are reducing their reliance on or completely eliminating, dirty, expensive and dangerous prior fuel sources. This has a positive impact for their health, reducing their exposure to fine particulate matter (PM2.5) by as much as 50–80%; and for the environment, reducing their CO_2e[12] emissions by close to half a tonne per year (60 Decibels, 2020).

Just as super-efficient LED technology has unlocked modern lighting for tens of millions of households and microenterprises, **super-efficient appliances** promise to unlock life-changing modern energy services. These include cooking, cooling, power management or refrigeration. However, more technological advancements and market development are still needed to reach this goal.

LEARN MORE

Research Snapshot, Efficiency for Access Coalition, 2020

2021 Appliance Data Trends, Efficiency for Access Coalition, 2021

Scope of the competition

The Efficiency for Access Design Challenge is an opportunity for you to work at the forefront of energy access. You will be required to design affordable and high-performing appliances that can be used in an off-grid context, eg powered by a solar home system or a mini-grid.

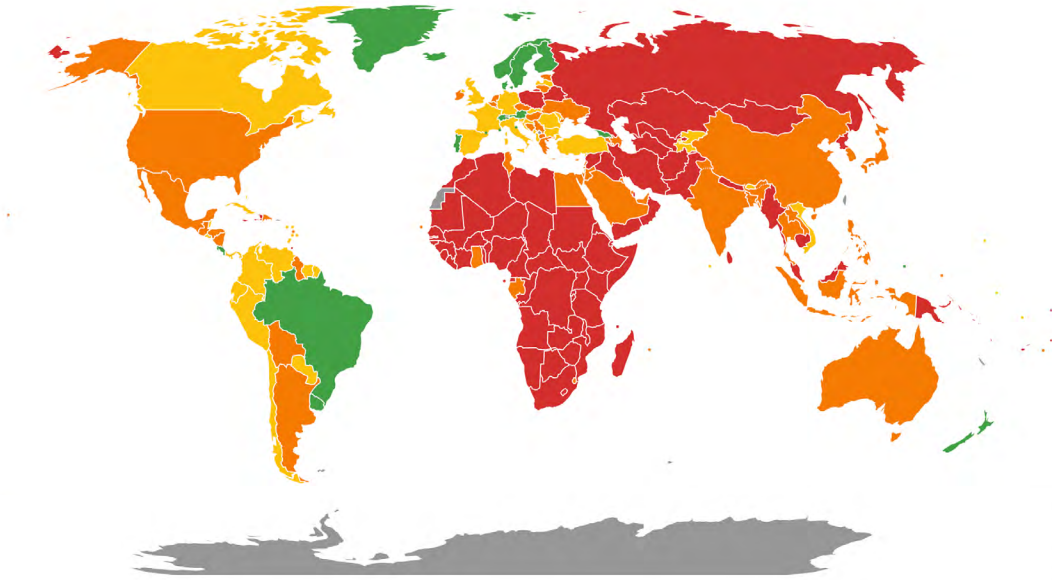
You will work on solutions for use in countries with the lowest rates of electrification and who critically need energy access. Focusing on Sustainable Development Goal 7 – Affordable and Clean Energy, please give special attention to communities with the lowest levels of energy access. Access to clean energy and other basic services is closely correlated with a country's position in the Sustainable Development Report rankings. For greater clarity, the Sustainable Development Report has interactive data visualisation tools for rankings against all SDGs as well as specifically against SDG 7.

We are interested in useful, affordable and efficient appliances that can help improve people's quality of life or increase business productivity. You must identify an opportunity for an appliance that can make a difference in people's lives. Your design should significantly improve on currently available solutions, and have the potential to scale.

You can choose one of the two tracks represented in the diagram on the following page. A business can be anything from a micro-enterprise, a small business employing no more than 10 people, or someone working for themselves, such as a smallholder farmer, a small retail shop or a bar, to a medium enterprise of 50-249 employees. It is possible that some of your designs could cover both tracks. In this case, please indicate the main track that your design applies to.

The focus is on energy consumption and the appliance's primary source of energy should be electricity (DC - Direct Current). The appliance should directly connect to a solar home system or a standalone DC mini-grid. You are not allowed to design an AC appliance, which connects to an inverter. Energy generation is also out of scope.

> The Sustainable Development Report, formerly the SDG Index and Dashboards, is a worldwide study that assesses each country's progress towards achieving the Sustainable Development Goals.



Visual representation of countries' performance on SDG7. The dashboard of the Sustainable Development Report allows us to explore the interactive maps and see each country's rating for SDG 7 as well as all other SDGs. Source: Sustainable Development Report 2022

- SDG achieved
- Challenges remain
- Significant challenges remain
- Major challenges remain
- Information unavailable

Choose one of these two tracks

Improving quality of life in homes

THE PROBLEM

Although access to energy is increasing in off-grid areas, **these homes are significantly different to on-grid homes**. Different in energy requirements, availability and usage. Affordable and efficient appliances powered by solar DC electricity can replace more expensive and polluting alternatives. They can also help improve people's quality of life, safety and health.

THE CHALLENGE

Design an affordable and efficient appliance, or an improvement to an existing appliance, that can help **improve quality of life in homes** based off-grid settings.

Increasing productivity of businesses

THE PROBLEM

Although access to energy is increasing in off-grid areas, people have limited access to affordable and efficient appliances powered by solar DC electricity. **Many income generating activities are still performed manually or with expensive and polluting fuels.**

THE CHALLENGE

Design an affordable and efficient appliance, or an improvement to an existing appliance that can help **increase productivity of businesses** based in off-grid settings.

The "Themes" sections below outline several themes, which you could explore when formulating your problem definition. Each theme contains examples of projects that illustrate what you could develop. These themes represent the main trends in the off-grid appliances industry, but do not feel limited to them. You are free to choose your own theme, as long as you can clearly demonstrate how you meet the marking criteria (see pages 32-33) and justify how your design embodies the four principles of global responsibility (see pages 8-11).

Global Responsibility

Typically, the engineering community still relies on unsustainable practices and materials, with limited consideration of the broader impact. This has to change. We all need to move away from outdated working methods and prioritising profit over people and planet.

In this Challenge, you are asked to ensure your design is guided by the **four principles of global responsibility**:

1. **PURPOSEFUL** (to consider all the impacts, from a project or product's inception to the end of its life. This should be at a global and local scale, for people and the planet);
2. **INCLUSIVE** (to ensure that diverse viewpoints and knowledge are included and respected in the process of addressing problems);
3. **RESPONSIBLE** (to meet the needs of all people within the limits of our planet);
4. **REGENERATIVE** (to actively restore and regenerate ecological systems, rather than just reducing impact).

Engineers Without Borders UK is working to reach a positive tipping point where global responsibility becomes integral to the way all engineering is taught and practiced. You can read more about the **need for global responsibility** and **watch and participate in webinars** about it and read **thought pieces**.

We invite you to spend six – seven hours learning deeply about this topic through **self-directed learning** available on the Engineers Without Borders UK and Forage website.

"This course may be one of the most eye-opening virtual experiences that I've taken part in. [It] is unique in the way that it tackles the ethics of our engineering work, which is rarely being discussed in standard courses [...]*."*

Participant, 2021

To gain a deeper understanding of this area, we would suggest that you review the Inclusivity webinars from, **year 2**, and **year 3** of the Challenge and the End User Perspective webinars from **year 1**, **year 2** and **year 3** of the Challenge.

To enable you to bring a globally responsible approach to your design, we encourage you to consider the four principles of global responsibility.

Applying these principles will require great creativity, we are excited to see how you get on.

LEARN MORE

Engineering for Sustainable Development: Delivering on the Sustainable Development Goals, UNESCO, 2021

1. PURPOSEFUL

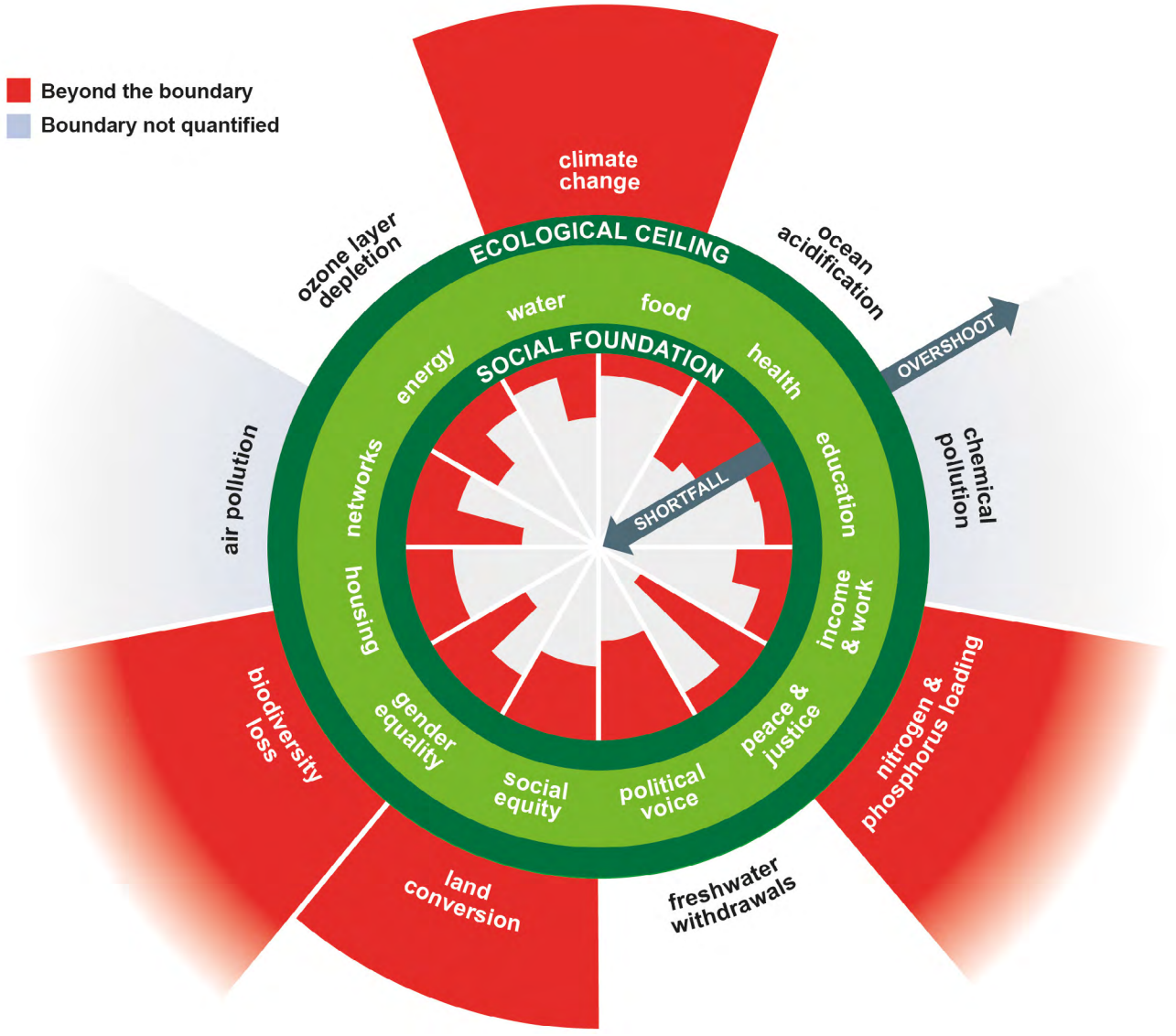
The responsibility of a designer is to design systems, products or projects with an adequate understanding of their effects, both positive and negative. Some starting points for these considerations are below:

- Decisions along every step of a supply chain carry wider impacts. For example, consider the materials used. Mining for materials like **cobalt in the Democratic Republic of the Congo** can drastically affect local communities and ecologies. Similarly, manufacturing can require high rates of water and energy use - consider the 'embodied carbon' impact of your design.
- Jobs are created in manufacturing that support local and global economies. However, a responsible supply chain also takes careful consideration of workers rights.
- An appliance puts a power draw on solar home system requirements, consider the strain on income or potential electrical risk, eg from electrical fires, the purchase of an appliance can create.
- E-waste can be compounded if companies do not create a clear plan for how to contribute to a circular economy where parts can be reused.

LEARN MORE

Doughnut Economics Action Lab has useful tools, research and stories to help understand and question the impact of projects. It highlights the transformations needed to meet the needs of all people within the means of the living planet.

We would recommend viewing the **'Unintended Consequences of the Sector's Growth'** and **'Product Lifecycle and Local Assembly'**



Source: kateraworth.com/doughnut

2. INCLUSIVE

Inclusivity requires the careful consideration of specific needs to ensure your design is suitable for all. Your design needs may vary greatly depending on how you consider how you ensure these needs are met. The diverse world in which we live is a composite of many cultures, values, and ways of interacting with one another. The dimensions of diversity include gender, religious beliefs, race, marital status, ethnicity, parental status, age, education, physical and mental ability, income, sexual orientation, occupation, language, geographic location, and many more components.

- We want you to hear from people who use appliances, understand their needs, and see those that buy appliances as one of your most critical stakeholder groups, not a group you see only as end-users; for example, we cannot rethink food supply unless the farmers and consumers of food are part of the debate.
- Engineers and designers alone cannot address the significant global challenges we face; we must work in collaboration with others.
- End-users as a group are not only considered at the end; they should form a core part of your thinking throughout. Ideally, appliances are designed to match the **aspirations of groups of people**, not in isolation to these.
- Ensure that you consider deeply how you will value people's perspectives in the design process, and how to value lived experience in the decisions you make that may impact people's lives. This empathetic approach is essential to ensure that people with lived experience of the issues that you are trying to solve, are not just passive recipients.
- Culture in relation to sustainable development plays an important role not only in promoting, but also enabling sustainable development. Culture is often recognised as the fourth pillar of sustainable development, together with economic prosperity, social justice and environmental sustainability.
- It is important to recognise that appliances need to integrate and work for different cultural practices (for example how you cook or what you make).

LEARN MORE

How can energy access programmes address the needs of people with disabilities?, Efficiency for Access Coalition, 2021

Why off-grid energy matters, 60 Decibels, 2020

Addressing the needs of people with disabilities in energy access, Efficiency for Access Coalition, 2021

The role of appliances in achieving gender equality and energy access for all, ENERGIA, 2020

The Transformative Benefits of Participatory Design, Sher Vogel, 2021

Design Thinking Defined, IDEO, year of publication unknown

Framework for Innovation, Design Council, 2019

Be aware that no design framework or process is 100% 'right'; you may find some useful when navigating the different stages of your project

3. RESPONSIBLE

This principle is about acting responsibly, focusing on meeting the needs of people, and ensuring the design of your project does not deteriorate our natural world.

- The latest landmark **IPCC** report states that humanity's role in driving climate change is undeniable, and the risk of a disorderly transition to a positive future is highlighted in the **2022 Global Risk Report** by the World Economic Forum.
- Our ecological emergencies are justice issues. High-income nations are responsible for **74% of global ecological damage** yet the impact of the damage will be strongest in low and middle income nations.
- We must recognise our responsibilities as designers. What we change must not limit people's rights to a better quality of life, which is why a transition to a better future must be just, and why we need to think through our responsibilities as designers carefully.
- **The UN Declaration on the Right to Development** states, "The right to development is an inalienable human right by virtue of which every human person and all peoples are entitled to participate in, contribute to, and enjoy economic, social, cultural and political development, in which all human rights and fundamental freedoms can be fully realised."
- Within this Challenge, exercise your ability to empathise and to deeply consider how ethical or responsible the decisions you make are. Critically reflect throughout on the impact your solution will or could have.
- In this challenge, this principle will challenge you to think about how your design interacts with ecological systems. Is there a loop here? Perhaps it is looking at a 'circular' approach, whereby you deeply consider material choices, or how the appliance will be disposed of or reused (and design for this).

LEARN MORE

Silver Bullet - are solar pumps a panacea for irrigation, farmer distress and discom losses?, Centre for Science and Environment, 2019

Submissions from **students** and **professionals** participating in the Engineers Without Borders UK's Designathon in 2022 on 'reshaping engineering' to make it more responsible

The **Engineers Without Borders UK reading list** has a list of good reads, watches and podcasts to listen to that relate to responsibility

4. REGENERATIVE

Restorative and regenerative approaches to design comprise a growing field that aims to meet the shortcomings of contemporary understanding and definitions of sustainability.

These approaches aim to design materials and products that actively restore ecological systems, rather than just reduce impact. You will need to adopt a holistic world-view, integrating the latest good practices, so that you design your project to help living systems (people and planet) to thrive and continually improve.

This approach focuses on seeing nature as a part of the design process, as a living system that interacts directly with the project. Regenerative approaches grow new capability and capacity in people whom the project affects, through processes where people are actively involved, rather than as only beneficiaries.

Regenerative agricultural practices are generally leading the development of this field of practice.

LEARN MORE

Leah Gibbons, is regenerative the new sustainability? Paper providing an overview of regenerative literature

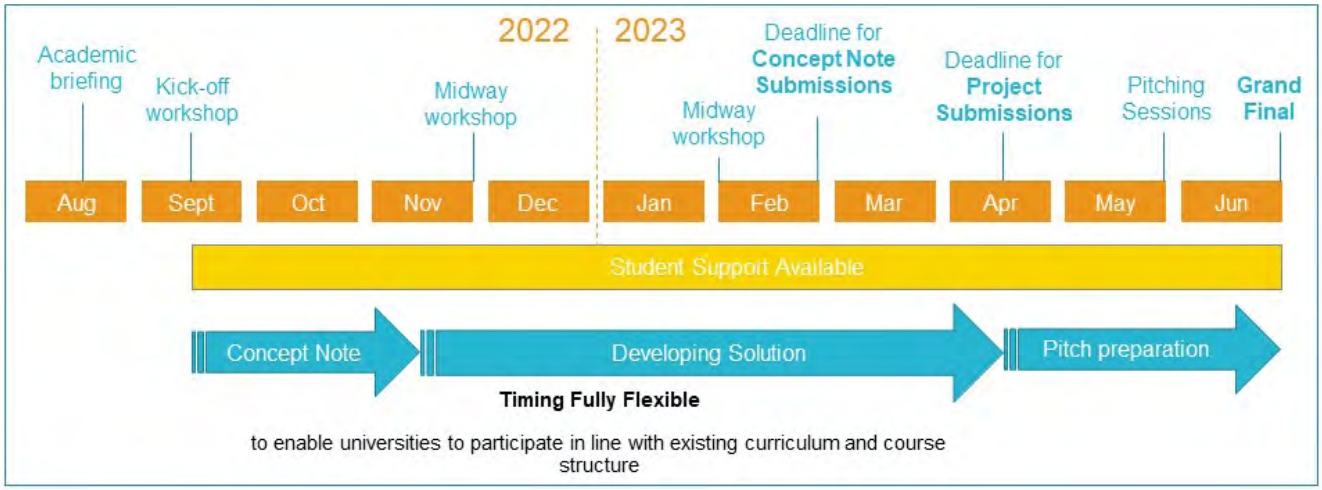
Worldviews - From Sustainability to Regeneration, a free online course by EdX

We Need a Better Theory of Change, Carol Sanford, 2022

When does it take place?

The Efficiency for Access Design Challenge 2022 –23 starts in September 2022 and ends with the Grand Final in June 2023. The timing of the Challenge is flexible, so universities can include the competition in existing curriculum and course structures. Universities decide whether to schedule the project to run over multiple terms or condense the participation period. We anticipate that students will receive credit for participation. The Efficiency for Access Design Challenge team is available to help universities embed the competition in existing curricula.

KEY DATES



The Challenge begins in September: projects can start at any point from September 2022 onwards (depending on your university timelines). They should start with a **digital kick-off workshop** facilitated by the Efficiency for Access Design Challenge team.

Concept note

Your team should submit a concept note to CrowdSolve within a month of your kick-off workshop. The deadline to receive concept notes is **Wednesday, 15 February 2023**.

The deadline to submit the concept note is **Wednesday 15 February 2023**

The concept note should outline what your team plans to focus on and be no more than four A4 pages long. It will help the Efficiency for Access Design Challenge team understand how your team plans to approach the problem you want to work on, so that we can provide appropriate support. You will not be assessed on the concept note, and it will not be used to decide whether your team can participate in the competition. The concept note template will guide you when considering all the criteria needed for your design. When submitting the document, you will also sign up to the Challenge's terms and conditions. This concept note will also help the Efficiency for Access Design Challenge team identify a mentor from the solar appliance sector, who will support your team in developing your project.

Concept note feedback

Within one month, we will provide feedback on your concept note. You can use this feedback to reassess your assumptions and improve the design process.

Midway workshop

Halfway through the competition, the Efficiency for Access Design Challenge team will facilitate digital workshops to support you in the design process, and answer questions. Throughout the year, the Efficiency for Access Design Challenge team will provide support with regular check-ins to both universities and students. We will also help connect academics and industry partners. The team will organise a series of webinars for all universities, which will allow you to meet industry experts and learn more about off-grid appliances technologies.

Project submission

The deadline to submit your project is **Friday 14 April 2023**

Your team should submit your project – a 4,000-word (maximum) report and a three-minute video by **Friday, 14 April 2023**. Other supporting documentation can be attached to your submission, if deemed useful. These include posters or prototypes. Your team shall own the Intellectual Property of your work but will be required to give the Efficiency for Access Design Challenge team permission to use the research outcomes for a wider benefit. Agreeing to license your work under **Creative Commons license CC-BY 4.0 will achieve this**.

Feedback

You will receive feedback on your submission in **May 2023**. You can use this feedback to prepare for the pitching session.

Pitching to a judging panel

Before the Grand Final, your team will pitch your project to a judging panel in a digital session in **May 2023**.

Grand Final

The Grand Final will take place in **June 2023**

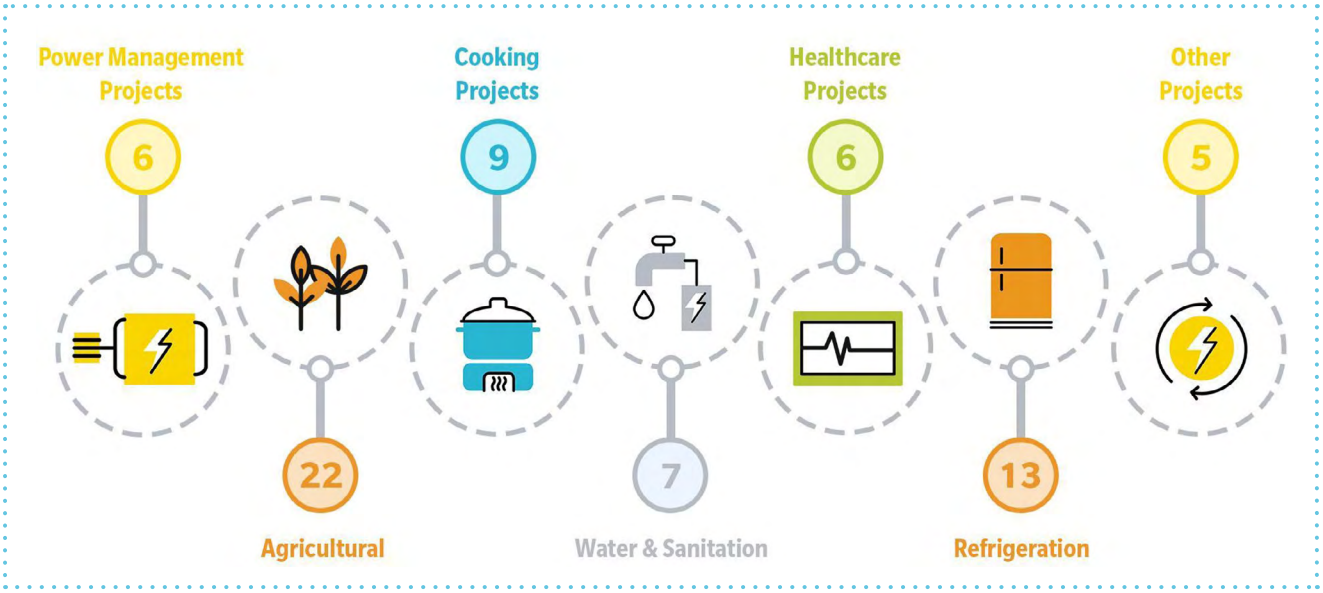
All students participating in the Efficiency for Access Design Challenge will be invited to the Grand Final, which will take place in **June 2023**. The Grand Final will showcase student teams' projects and prototypes and host an interactive panel discussion with experts in the sector. It will also include an awards ceremony that presents teams with gold, silver and bronze awards.

Themes

In the Challenge, you can focus on any appliance, as long as you clearly identify the purpose and need that your design addresses. In previous years, students from universities in Bangladesh, Benin, Cameroon, India, Kenya, Nigeria, Pakistan, Senegal, Sweden, Uganda, the UK, the USA, and Zimbabwe submitted 68 projects.

You can read the project summaries on **our website**. Please feel free to read through previous years' submissions and gather inspiration for your own design from the designs developed by your peers.

Previous years Efficiency for Access Design Challenge portfolio of projects



You can find further inspiration in the next pages of this Challenge Brief.

Agriculture

Over a quarter of global employment is in agriculture, but many farmers lack energy access. Smallholder farmers who engage in manual agriculture experience inconsistent, weather-dependent yields compared to farmers with access to energy and agricultural appliances. From incubating eggs to milling grain, solar-powered agricultural appliances can help improve productivity for farmers living in off-grid areas.

SPOTLIGHT ON: SOLAR MILLS

Communities without energy access often mill grains manually, a time-consuming task typically performed by women and children. For people with purchasing power, the only off-grid option is diesel-powered mills. This is a polluting and inefficient appliance that is unviable for sparsely populated and remote regions.

Milling requirements, preferences and demand vary geographically and seasonally, making the economic case for the technology a particularly challenging one. However, milling has arguably the potential to become the most important productive use technology. This is because off-grid communities need continual access to milling services and it is a uniquely gender-segregated household task. (Solar Milling: Market Requirements, Efficiency for Access Coalition, 2020).

Recently developed solar mills consume less energy compared to diesel mills. They can also help increase productivity, and help farmers earn more income.

Research suggests that improvements could include:

- enhanced, energy efficient motors for use in solar mills are affordable and durable, eg improved permanent magnet motors
- improved power electronics to improve efficiency
- adaptable machines that are able to accommodate a more diverse range of milled products.
- new applications relevant to specific local contexts

EXAMPLES

Solar Milling Pilot Highlights Important Consumer Voices, Efficiency for Access Coalition, 2019

How Agsol brings power to poor farmers, Borgen Project, 2017

There are nearly 500 million smallholder farmers worldwide. Efficiency for Access' research suggests that a **10% increase in agricultural productivity** for smallholder farmers in Sub-Saharan Africa could lead to a **7% reduction in poverty**. (**Efficiency for Access Coalition, 2021**)

In Africa, women in off-grid areas spend about 40 billion hours of unpaid time on agricultural processing each year, such as milling grains, maize and cassava. Automating this process could free up a significant amount of time for women and girls, which could be put towards other productive or educational activities, and support women's empowerment. (**Efficiency for Access Coalition, 2020**)

LEARN MORE

Milling: Solar Appliance Technology Brief, Efficiency for Access Coalition, 2021

Productive Use of Solar PV, energypedia, 2021

A New Approach to Testing Productive Use Appliances, VeraSol, 2022

Productive Use Report, A2EI, 2020

In certain contexts, **expensive and scarce fuel compromise** agricultural production and commercialisation of agricultural products. Irrigation systems, including solar water pumps, drip irrigation and water tanks, could help vulnerable farmers to overcome fuel-related challenges. (FAO, 2020)

SPOTLIGHT ON: SOLAR WATER PUMPS

Moving water using solar pumping systems offers a clean and simple alternative to diesel-driven pump sets. Solar water pumps are often used for farming in remote areas or where an alternative energy source is desired. If properly designed, they can result in significant long-term cost savings and increased agricultural productivity for farmers.

Research suggests that technological improvements could include:

- remote monitoring systems, including low-cost sensors and controllers that improve efficiency of irrigation using the right amount of water
- highly efficient motors – eg BLDC motors – Experts indicate that while appliances that use BLDC motors present a higher upfront cost, they are more energy efficient, serviceable and reliable than traditional AC motor appliances and, as a result, present a lower net system cost
- improved saline water tolerance and filtration to increase durability of the pump
- modularity and availability of spare parts

EXAMPLES

Solar Water Pump – Technology Road Map, Efficiency for Access Coalition, 2019

Solar Water Pumps: Solar Appliances Technology Brief, Efficiency for Access Coalition, 2021

2019 Buyer's Guide for Solar Water Pumps, Global LEAP Awards, 2019

LEARN MORE

Uses & Impacts of Solar Water Pumps, Efficiency for Access Coalition & 60 Decibels, 2021

The Benefits of Permanent Magnet Motors: Efficiency Opportunities in Off- and Weak-Grid Markets, Efficiency for Access Coalition, 2021

Solar Water Pump Test Method, Global LEAP, 2019

Solar Water Pump Outlook 2019: Global Trends and Market Opportunities, Efficiency for Access Coalition, 2019

Solar Water Pump Durability Research Memo, Efficiency for Access Coalition, 2019

Sustainable Expansion of Groundwater-Based Solar Water Pumping for Smallholder Farmers in Sub-Saharan Africa, Efficiency for Access Coalition, 2021

Cooking

The IEA reports that 2.5 billion people currently cook with polluting fuels such as kerosene, coal or biomass, in poorly ventilated areas. Of those 2.5 billion, around 2.5 million people die prematurely from illness attributable to household air pollution per year. Manufacturers in the off-grid appliance sector have designed super-efficient cook stoves, but cooking appliances could be more affordable, efficient and respectful of traditional cooking methods. Since 2010, 450 million people in India and China have gained clean cooking access due to clean energy policies and liquid petroleum gas programmes. However, progress is notoriously slow in addressing the scale of the issue and many initiatives have failed to reach scale. The COVID-19 pandemic is threatening this modest progress.

SPOTLIGHT ON: ELECTRIC PRESSURE COOKERS

The Electric Pressure Cooker (EPC) or multicooker is an appliance capable of steaming, boiling, pressure cooking, frying, and baking, while producing no smoke. Through a combination of insulation, pressure, and high temperatures, EPCs use about one-fifth of the energy of a hotplate to cook over 90% of foods.

EPCs have the enormous potential of being able to provide clean cooking to the 2.5 billion people who rely primarily on biomass or polluting fuels to cook their food. EPCs as an appliance, have a disproportionate potential to improve women's health and socioeconomic standing. By reducing exposure to indoor air pollution, the time and drudgery associated with collecting fuel, and improved nutrition from food cooked with an EPC – two-thirds of consumers noted their improved health, 50% report an improved quality of life, and 35% see a reduction in household fuel expenses. (Efficiency for Access, 2021)

Research suggests that challenges include:

- integrating EPCs into prevailing cooking habits
- technology uptake due to high upfront costs and lack of consumer financing
- underdeveloped EPC supply chains
- improvements to cooking time
- adapting EPCs to individual communities' way of life
- reliability issues including pressure sealing rings, component burn out and circuitry on button interface models

EXAMPLES

The desirability of clean cooking in off-grid households, A2EI, 2019

MECS' e-CookBooks, MECS, 2019

Exploring User Personas, MECS, 2019

Clean cooking in refugee camps and COVID-19: what lessons can we learn?, MECS, 2021

Household air pollution causes non-communicable diseases including stroke, ischaemic heart disease, chronic obstructive pulmonary disease (COPD) and lung cancer. (WHO, 2019)

LEARN MORE

Open Access Resources, EIStove, year of publication unknown

Overcoming the "Affordability Challenge" associated with the transition to electric cooking, MECS, 2021

Gender-Responsive Electric Cooking in Nepal, MECS, 2021

Solar electric cooking in Africa: Where will the transition happen first?, 2018

Electric Pressure Cookers: Solar Appliance Technology Brief, Efficiency for Access Coalition, 2021

Refrigeration

Refrigeration provides a wide range of benefits from improving health and productivity, to reducing domestic labour for women and children responsible for food preparation. It also enables income-generating activities through the cold storage of drinks, food, and other perishable items for later sale. Essential for a sustainable agricultural sector, modern cold chain technology is still often out of reach in some markets due to its prohibitive cost and high load requirements. Cold chains manage the temperature of perishable goods from farm or sea to table. This helps ensure quality and safety in the supply chain, reduce food loss, and enhance income generating opportunities.

Refrigeration is similarly vital in healthcare. This has been made abundantly clear throughout the COVID-19 pandemic, as the COVID vaccine rollout requires a robust cold chain to deliver vaccinations to communities. The World Health Organisation (WHO) estimates that up to **50% of vaccines are being wasted globally every year**. This level of waste is, in large part, due to inadequate cold chain systems and technologies. This does not only impact vaccine rollout, but also medicines such as **insulin, antibiotic liquids, chemotherapy drugs, and topical preparations**, for example, require strict temperature controls – typically between +2 and +8 °C. These requirements are particularly challenging for off-grid communities who need these treatments and preventative measures to survive, but may lack the energy requirements to store them.

Due to inadequate food storage and conservation, around 37% of food products are lost between harvest and consumption in Sub-Saharan Africa. (**SEforAll, 2021**)

The most abundant Hydrofluorocarbon (HFCs), HFC-134a, **has a greenhouse effect 3,790 times more powerful than CO_2 over a 20 year period**. If signatory countries implemented the Kigali Amendment to the Montreal Protocol, the world could avoid as much as 0.4°C of global warming by 2100, bringing us much closer to achieving our 1.5°C target. (**International Institute of Sustainable Development, 2019**)

SPOTLIGHT ON: REFRIGERATORS

Most current household refrigerating appliances sold in off-grid settings are conventional, low-price AC grid household refrigerators. These require inverters and/or charge controllers when used off-grid. Most refrigerators cost around five times the combined value of all other appliances in the typical solar home system and are uneconomical for users and system suppliers.

Research suggests that improvements could include:

- improving variable speed compressors and their controls
- highly efficient motors
- use of low global warming potential refrigerants
- modular cooling system designs for local assembly
- increasing cooling capacity and temperature lift at times of high ambient temperature and high humidity
- technologies that improve the energy efficiency or effectiveness of ice-making or its end use for cooling, storage and transport of foodstuff
- approaches that could lead to practical exploitation of Peltier or other solid-state cooling technologies

EXAMPLES

Innovator Series: Truck-Mounted, Solar Refrigerators to Enable Local Farmers in India to Reach New Markets, Efficiency for Access Coalition, 2022

Innovator Series Retrofitting Refrigerators to Create an Affordable, Energy Efficient Cooling Solutions, Efficiency for Access Coalition, 2022

Chill Challenge Teams, Engineers Without Borders USA, 2020

LEARN MORE

Refrigerators: Solar Appliance Technology Brief, Efficiency for Access Coalition, 2021

Phasing down HFCs in off-and weak-grid refrigeration, Efficiency for Access Coalition, 2021

Raising Ambitions for Off-grid Cooling Appliances, SEforAll, 2021

SPOTLIGHT ON: WALK IN COLD-STORAGE

In developing countries, 45% of food spoils mainly due to a lack of adequate cold storage. This results in at least a 15% loss of annual income for 470 million smallholder farmers (**Efficiency for Access Coalition, 2021**). As perishable food begins to deteriorate as soon as it is harvested, a robust cold chain system, fit with walk in cold-storage rooms, is required to keep produce fresh. This can be a challenge in off-grid settings – particularly when considering the size of the room that the off-grid power is required to cool.

Research suggests that improvements could include:

- greater unit autonomy
- reliable remote tracking and monitoring
- implementation of cooling as a service business models
- greater power system sizing
- use of efficient and affordable insulation materials

EXAMPLES

Off-Grid Cold Chain Challenge winners, Efficiency for Access Coalition, 2018

Walk-in cold room by **Cold Hubs** , year of publication unknown

Commercial cooling unit by **Fresh Box**, year of publication unknown

Solar cold storage room: Ecofrost by **Ecozen**, year of publication unknown

Innovator Series: Off-Grid Cold Rooms: A Game-Changing Development for Local Smallholder Farmers, Efficiency for Access Coalition, 2022

LEARN MORE

Walk-in Cold Rooms: Solar Appliance Technology Brief, Efficiency for Access Coalition, 2021

Off-Grid Refrigeration – Technology Roadmap, Efficiency for Access Coalition, 2019

2021 Appliance Data Trends, Efficiency for Access Coalition, 2021

Creating a More Resilient Food System Through Sustainable Refrigeration, Efficiency for Access Coalition, 2022

Chilling Prospects: Providing Sustainable Cooling for All, SEforAll and K-CEP, 2019

Space cooling

Beyond basic comfort and productivity, access to cooling solutions such fans can help enhance wellbeing and reduce mortality and morbidity during severe heat waves (Efficiency for Access Coalition, 2021). Fans are in high demand among off-grid consumers, but mainstream fans still consume as much as 10 times the amount of electricity compared to lighting in the same setting.

In countries that are most vulnerable to high temperatures, over one billion people face significant risks from extreme heat every year. (K-CEP, 2019)

On our current carbon emission trajectory, three billion people could be living in places as hot as the Sahara by 2070. (World Economic Forum, 2020)

Fans that use permanent magnet motors consume up to 42% less energy than those that use conventional motors.(Efficiency for Access Coalition, 2021)

LEARN MORE

Solar-powered fans can help support sustainable futures, Efficiency for Access Coalition, 2021

Fans: Solar Appliance Technology Brief, Efficiency for Access Coalition, 2021

Chilling Prospects: Providing Sustainable Cooling for All, SEforAll and K-CEP, 2019

Why cooling? K-CEP, year of publication unkown

SPOTLIGHT ON: FANS

Fans are a cost-effective cooling solution that can help save lives, improve productivity and quality of life. Evidence suggests that with each degree the temperature increases, a person's productivity can drop by up to 4%. Fans can also reduce exposure to pollution and disease carrying insects for people and their livestock.

The huge benefits and low cost of fans has made them one of the most commonly sold appliances in the world, with 290 million units sold in 2019 alone (Efficiency for Access, 2021). Fans – including table, pedestal and ceiling fans- are relatively simple to design and manufacture, comprising five main components: fan blades, a base, motor, finger guard, and motor housing. This has enabled cheap, generic products to enter and dominate the market. However, it is evident from just the last five years that there is still room for innovation in this relatively mature off-grid market. The average efficiency of fans tested increased by 49% between 2018 and 2019, and the price of the average fan dropped by 47% between 2016 and 2018. (Efficiency for Access, 2021)

Research suggests that improvements could include:

- improved motors for use in off-grid fans that both increase energy efficiency and are affordable and durable, eg BLDC motors
- enhanced blade designs that increase air delivery and lead to overall service improvement
- smart/interoperable functionalities that can improve the overall efficiency, affordability, performance, or user experience, eg occupancy sensors and remote based functions
- improved electronic controls for adjusting the speed of a motor, which can enhance its efficiency
- alternative approaches and designs for fans in space cooling enhancing its usability

EXAMPLES

Research and Development Fund – Project Spotlights, Cooling Call, Efficiency for Access Coalition, 2020

The socio-economic impact of super-efficient fans in Bangladesh, Efficiency for Access Coalition, 2019

Keeping rural Pakistan cool during a global pandemic (Harness Energy), Efficiency for Access Coalition, 2021

Power management

The high cost of batteries is a significant barrier to the uptake of appliances in off-grid settings. Distributors often oversize them to ensure a constant and consistent supply of electricity to large appliances like fridges. This then leads to an increase cost and reduction in efficiency. Improved power management can help reduce the size of batteries required, making larger appliances more affordable for people.

SPOTLIGHT ON: SOLAR HOME SYSTEMS AND MINI-GRIDS

Solar home systems and mini-grids have limited power supplies. They have to balance generation and storage through batteries and a limited number of appliances can be run at any one time. Smart scheduling and balancing ensure that people have the services needed and that systems are used as energy efficiently as possible.

Research suggests that improvements could include:

- systems that integrate different appliances or allow them to communicate with each other
- widgets that can be included in a range of equipment so that they can connect to each other
- cheaper connectivity and control components, eg embedded controllers
- general data communication for appliances and power supply modules
- smart batteries: collection and optimisation of data using machine learning to improve the overall system efficiency and performance
- innovative business model providing holistic services

Smart-grids, created through widespread installation of smart meters and sensors, are embedded with an information layer that allows communication between its various components. They utilise data collection, storage and analysis so that they can better respond to quick changes in energy demand or urgent situations. Paired with powerful data analytics, these smart-grid elements have helped improve the reliability, security, and efficiency of electricity transmission and distribution networks. (**IFC, 2020**)

EXAMPLES

Harnessing the power of water to provide cooling technology in developing countries, Sure Chill, 2020

'Core' modular battery, Aceleron Energy, 2021

LEARN MORE

A Comparison of Batteries for the MECS Project, MECS, 2020

The Future of Energy Storage, SILA Nanotechnologies, 2020

State of the Global Mini-grid Market Report, SEforAll, 2020

Sustainable solar e-waste and battery technology management (Uganda and Senegal), USAID, 2019

Information and communications technologies

Information and communications technologies (ICT) is a broad term that covers communication enabling technologies such as television, radio, mobile phones, and computers, as well as network hardware such as satellite systems and internet of things (IoT). ICT are essential to how we communicate and interact with each other and society. The COVID-19 pandemic made this increasingly clear, which led to further discussions in many countries on whether access to the internet is a human right.

Two technological pillars, digitisation and interconnection, are driving a digital transformation of all areas of life, complemented by related technologies. Smart devices or objects, connected to the Internet or one another, monitor, communicate and interpret information– the result is an IoT. Among other applications, networked sensors utilising IoT can be used to monitor the location, activities, and status of appliances, remote control devices, optimise performance through artificial intelligence (AI), and facilitate interoperability (Efficiency for Access, 2021).

ICT provides information and communication for businesses, education, entertainment, healthcare, social communities, and other purposes. Digital innovation brought by ICT also enables applications and services in a wide range of sectors including agriculture, healthcare or science.

In healthcare, the use of mobile health applications and of electronic health records can help enable the creation of new care models and provides the foundation to improve clinical management. Transformation processes include improved efficiency, productivity and quality of care.

Tractors have become a data-intensive product that can monitor soil conditions, send data to its proprietor and plant with precision. Precision agriculture has transformed farming thanks to big data analytics, which can help improve productivity by optimising the use of resources such as fertiliser, irrigation and farmers' time. (Villa-Henriksen, et al., 2020)

SPOTLIGHT ON: COMPUTERS

Access to ICT can help countries upskill their workforces and facilitate social mobility, helping individuals to compete in a global economy. Thus, ICT usage in schools is important to ensure that children can develop digital literacy, which will enable them to acquire general life and basic work skills. Where ICTs are absent in households, computers in schools are even more necessary. The integration of ICT in schools requires reliable energy access, so students can use devices like televisions, desktop/laptop/tablet computers and the Internet.

Only 7.7% of households in Africa and 6.9-22% across Asia had computers in 2019. Computers are expensive and consume significantly more energy than mobile phones, thus they have a very low penetration rate in off and weak-grid areas (Efficiency for Access, 2021). To reap the computer's benefits listed above, initiatives such as the One Laptop per Child, which distributed 2.4 million laptops to students and teacher, were developed to promote mobile learning. However, they have so far been broadly unsuccessful after low sales and criticisms around high costs and a lack of teacher support (Efficiency for Access, 2021).

ICT, like computers, can help improve access to education, employment opportunities, community activities and other services for people with disabilities. ICT is therefore critical in the pursuit of the Sustainable Development Goals such as reduced inequalities, quality education, and decent work and economic growth (Global Sustainable Development Report, 2019).

Research suggests that improvements could include:

- reduced power consumption of computer processors and monitors
- improved capacity of storage in batteries
- accurate load calculation and system sizing to existing and growing needs
- sustainable funding models for public good ICT technologies, such as in education and health
- training for users, such as teachers and healthcare professionals, in ICT use

EXAMPLES

Innovator Series: Improving Digital Education Throughout Madagascar, Efficiency for Access Coalition, 2022

Solar Power for PC Deployments: Enabling ICT Beyond the Grid, Intel Corporation, 2009

Solar computer, Niwa Solar, year of publication unknown

A study conducted by the UN on energy poor areas of Yemen found that in proposed solar systems for a large school of 11-15 classes, a computer would only introduce a 2% load on the system. (**UNDP, 2019**)

In developing countries mobile phones are still set to see high market growth. In Sub-Saharan Africa, market penetration is expected to grow from 45% in 2019 to 50% by 2025. (**Efficiency for Access, 2021**)

LEARN MORE

Interoperability: Solar Appliance Technology Brief, Efficiency for Access Coalition, 2021

Televisions: Solar Appliance Technology Brief, Efficiency for Access Coalition, 2021

The Connect White Paper: Defining A Universal Connector And Firmware For 12V SHS Kit And Appliance Interoperability, GOGLA, 2021

ICT Solar Appliance Technology Brief, Efficiency for Access Coalition, 2021

Healthcare

Safe and adequate environmental conditions in health care facilities are essential to protect and improve the health of patients, staff, visitors, and the wider community. These include the availability of water, sanitation, hygiene, energy and waste management, as well as personal protective equipment.

Reliable energy in health care facilities is essential for functional services. Intermittent electricity can create safety hazards and limit patient care. For example, sterilising equipment cannot be operated, lighting is inadequate to perform procedures, and electric powered tools for procedures cannot be used. Unreliable electricity also affects the use of information technology and communications to inform decision-making. According to the 2020 Off-Grid Appliance Market Survey Report, the highest scoring clinic infrastructure technologies are LED room lighting, energy storage and backup, ICT equipment, water purifiers and water pumps. The ongoing COVID-19 pandemic has magnified this issue. Innovation in the healthcare system is not only required in medical devices, but also the infrastructure of health care facilities. This may include reliable LED lighting, solar water pumps and purification systems for clean water access, ICT technology for medical staff, and medical waste and wastewater management systems.

Research on environmental conditions in almost 130,000 healthcare facilities showed that 50% lack piped water, 33% lack improved sanitation, and 39% lack soap for hand washing. Furthermore, 39% of the above healthcare facilities lack adequate infectious waste disposal, 73% lack sterilisation equipment, and 59% lack reliable energy services. (**Science Direct, 2018**)

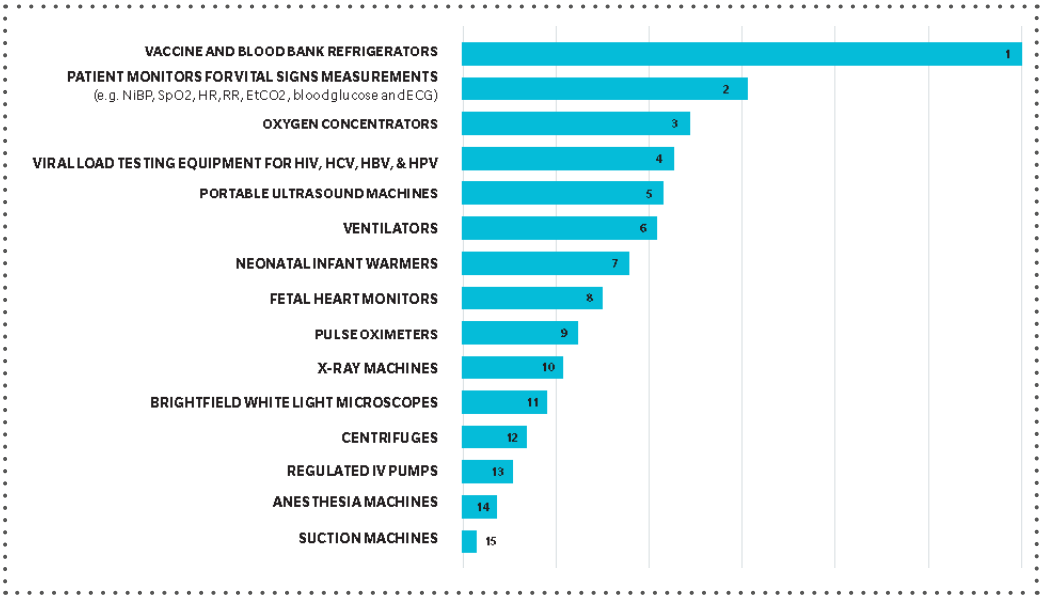
One in four health-care facilities in Sub-Saharan Africa has **no electricity** (**SEforALL, 2021**).

LEARN MORE

WHO, 2016

Achieving universal electrification of rural healthcare facilities in Sub-Saharan Africa with decentralised renewable energy technologies, Moner Girona et al., 2021

IMPORTANCE OF MEDICAL DEVICES FOR HEALTH SERVICE DELIVERY



This graphic illustrates the importance of medical devices for health service delivery. The 2020 survey included clinic infrastructure as well as medical devices required for provision of health services to provide a holistic perspective on clinic electrification needs. Source: 2020 Off-Grid Appliance Market Survey Report, Efficiency for Access Coalition, 2020.

SPOTLIGHT ON: VITAL SIGN MONITORING

Vital sign monitoring devices provide early warning to medical staff to provide more timely and effective intervention, and are essential in all kinds of medical scenarios. Vital sign monitoring devices are often seen as large stationary pieces of equipment used to measure vital signs when staff visit patients. However, with the proliferation of innovation in the wearable technology space, which is a device worn on the user's body, there is greater opportunity for this technology to be used in medical settings. Wearable monitoring devices allow for seamless ambulatory care, patient empowerment to monitor their own status, monitoring of several patients from a central location, and more dynamic clinic environments, such as in off-grid locations where electricity may be interrupted (National Library of Medicine, 2018).

Wearable vital sign monitoring devices can measure vital signs such as heart rate, oxygen concentration, temperature, respiratory rate, and blood pressure through several different methods. Wearable technologies include patches, arm bands, chest straps, clothing-based devices, and wristbands – wristbands being the most popular (Soon et al., 2020).

While the personal use of this technology is quite developed, its preparedness to support healthcare facilities with low levels of electrification is still quite nascent (GOGLA, 2020).

EXAMPLES

Neoguard by Neopenda

Solar baby incubator with vital sign monitoring a design by Team 2021-26, one of the teams participating in a previous year of the Efficiency for Access Design Challenge

E-mobility

The transport sector is responsible for approximately 23% of total energy-related CO_2 emissions. To reach global climate change mitigation targets, there will need to be radical transformative changes to the sector (IPCC, 2022). E-mobility, encompassing all modes of battery-powered transport, has long established itself as the future of land-based transport, and we are seeing growing awareness of this. Still, only 1% of road vehicles are electric (Efficiency for Access 2021). Beyond the wider adoption of non-motorised forms of transport, electric vehicles powered by low emission electricity are the most effective way to decarbonise our land-based transportation, despite growing concern around manufacturing requirements of the batteries (IPCC, 2022).

Battery powered vehicles convert stored chemical energy into electrical energy to power a motor, typically connected to a gear box that turns the vehicle's wheels. These systems can eliminate the need for an internal combustion engine (ICE), which releases large amounts of carbon dioxide and toxic particulate matter into the air (Efficiency for Access 2021). There are many co-benefits to these mitigation strategies in the transport sector including air quality improvements through the elimination of tail pipe emissions, which helps address SDG 3 (Good Health and Wellbeing), and SDG 11 (Sustainable Cities and Communities). Another common benefit of e-mobility is that it provides the means for rural communities to safely transport their produce, which helps provide fair incomes to producers, and improve food systems.

The cost and performance of e-mobility technology is heavily reliant on the battery market. The battery comprises nearly 40% of the cost of an electric vehicle and efficiency improvements are mostly derived from improved battery technology (Efficiency for Access 2021). A key consideration to keep in mind when a battery is so central to a design is the potential e-waste caused by the device – please consider how the battery will be disposed of at the end of its life.

In 2021 alone, well-to-wheel, electric vehicles allowed for a 40-million-ton net reduction in CO_2 equivalents. This is roughly equivalent to the emissions of the entire energy sector in Finland. The biggest savings were made in China, where almost 45% of the emission reductions come from the electrification of two/three-wheelers (IEA, 2022)

SPOTLIGHT ON: TWO/THREE WHEELERS

ICE motorcycles are often seen as a more climate-friendly and fuel-efficient form of transport. However, due to harmful nitrogen oxide, carbon monoxide and hydrocarbon emissions, motorcycle emissions are often worse than cars. This often leads to unsafe levels of air pollution in cities in low- and middle- income countries where two-wheelers are very common, such as Kampala in Uganda (IPCC, 2022). Greater prevalence of electric micro-mobility vehicles such as two/three-wheelers can help curb these emissions.

Motorcycles are the most electrified segment of road transportation today. Due to their light weight and short driving distances, micro-mobility vehicles require relatively small batteries and are therefore easy to electrify. In many regions, electrification already makes economic sense, with a sales share higher than 20% for electric two/three wheelers in 2021 (IEA, 2022). This dominance is projected to continue – in announced policy pledge scenarios, electric vehicles are expected to make up 35% of the global two/three wheeler stock and 65% of sales by 2030 (IEA, 2022).

Micro-mobility vehicles also provide great opportunities for productive use applications. For example, two/three-wheelers are already widely used for taxi services – it is estimated that the Sub-Sahara African motorcycle taxi market was worth USD 62 billion in 2019 (Efficiency for Access 2021). Electrification of these taxi services has great potential to increase the monetary savings of drivers while decreasing negative environmental impacts as the cost to own electric motorcycles is much lower than ICE ones. Additionally, with reliable rural transport, fresh food can be transported to market faster, safer and more cheaply – helping to strengthen food systems and address SDG 2 (Zero Hunger), in the process (Efficiency for Access 2021).

Research suggests that improvements can include:

- integration with other sectors such as cooling
- integration of open and interoperable software
- integration of hardware communication technologies in rural areas
- greater understanding of the end-user and their needs
- more reliable renewable energy charging services
- local and integrated recycling systems

EXAMPLES

Hamba from Mobility for Africa

Team 2021-41 Repurposed e-bikes from Year 3 of the Challenge

Team 013 Electric rickshaw from Year 1 of the Challenge

SPOTLIGHT ON: CHARGING-AS-A-SERVICE

Charging-as-a-service is a strong e-mobility related business model that includes battery swapping and renting.
Battery swapping entails a customer replacing their discharged battery with a fully charged one for a small fee. This reduces the upfront cost by about 40–50% of an e-bike as it allows customers to rent/purchase their system without a battery, and negates the need for fast-charging, which degrades batteries more quickly. When motors can be easily detached, such as on boats, battery rentals allow customers to rent motors and batteries together. For fisher people, for example, this model allows them to convert their boats into electric vehicles when they may need it and return them after a day's work. This can reduce the operational costs of vehicular based businesses.

EXAMPLES

The Electric Boda-Boda Taxi by Kenya's Stima Mobility

Jerr-E-Can Swappable Battery Pack by Powerhive

Remotely enabled electric outboard engines for rental by Asobo

LEARN MORE

E-mobility solar appliance technology brief, Efficiency for Access, 2021

Global EV outlook 2022, IEA, 2022

AR 6 Working Group 3: Mitigation of Climate Change, IPCC, 2022

Other technologies

SPOTLIGHT ON: IRONS

Bboxx has developed a DC-powered iron that aims to reduce ironing time while being efficient, durable, safe and affordable at price point of about USD20. The solution hopes to reduce traditional charcoal irons, which are unsafe, inefficient, expensive, and polluting. Irons help to reduce the burden placed on women and children who are typically responsible for the ironing process, enable people to work in professional attire and reduce the potential of health conditions like human myiasis, which is transmitted by insects that infest damp clothes hung up to dry.

SPOTLIGHT ON: WATER PURIFICATION SYSTEMS

To achieve SDG 6 (Clean Water and Sanitation for All) increased access to water purification and filtration systems is required. Off- and weak-grid communities are no exception to this. According to the IEA, currently 2.1 billion people drink contaminated water in the world. Pairing off-grid energy systems with filtration or purification appliances, such as the Off Grid Box, could be key in providing these people with safe drinking water.

SPOTLIGHT ON: ICE MAKERS

Ice can be used to store freshly caught fish, or cool drinks. Ice making can be done on a small scale to make a living, particularly in remote and hot areas. (Off-grid Refrigeration Technology Road Map, 2019)

SPOTLIGHT ON: EGG INCUBATION

In the face of climate change impacts, enhancing livestock production could significantly increase farmer resilience through the diversification of income. OVO-Solar has developed a stackable egg incubation unit that regulates temperature, humidity, and air exchange, and integrates IoT monitoring hardware.

LEARN MORE

Sustainable Energy and Livelihoods – A collection of 50 livelihood applications, SELCO Foundation Off- and Weak-Grid Solar Appliance Market: India, Efficiency for Access Coalition, 2020

2021 Appliance Data Trends, Efficiency for Access Coalition, 2021

Student Support

The Efficiency for Access Design Challenge team will provide a curated programme of support to students, including:

Mentoring

Efficiency for Access has an extensive network of contacts with specialists from the off-grid appliance sector. Each student team will be introduced to a relevant industry mentor, who will guide and support your team throughout the development of your project.

Prototyping grants

Grants to support your team in developing a prototype will be available on application. This is a great opportunity to consolidate the project concepts developed by your team and elaborate these ideas from the design process. Prototype development is optional and will not be used to assess your designs.

This opportunity can help bring your project one step closer to market. It will also assist you in visualising your own design and how it can be improved as well as helping others visualise your product. Your team's application for the prototype development grant will include a needs statement signed off by your academic supervisor and a detailed budget. If your application is successful, an impact report of the funds will need to be completed by September 2023. More details, templates, and deadlines on the application process will be available once the Challenge starts in September.

Resources

You will have access to a comprehensive digital library of reports, market surveys and research papers from Efficiency for Access. These resources will support your team in developing your concept note and solution. You will also have access to the VeraSol-Certified Products Database, which is an off-grid appliance data platform. Industry partners will deliver thematic webinars throughout the year and previous years' recorded webinars will also be available.

"The Efficiency for Access Design Challenge experience was an accelerated process of self-discovery for myself, helping me channel my energy into meaningful and impactful creations for communities in need. I hope they help many more like me to learn how to dream with their eyes open."

Souryadeep Basak
Team 2020–21,TERI School of Advanced Studies, India

teri school of advanced studies

Get some inspiration from previous years' students' prototypes showcased in this short video.

Remember to sign up to our newsletter here

"This one of a kind challenge has developed in me a sense of responsibility toward society. In short, [it provided me with] a farsightedness to judge a technology on the basis of its... impact on the society as well as the environment. This is what is missing from academia, which primarily focuses on innovation and novelty without considering the impact it creates. I learnt from this challenge that a novel solution is nothing if it is not sustainable, cost effective and easily adoptable by the consumers."

Iram Fatima Aulakh
Team 2021-18, NUST, Pakistan

NUST
NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY

"The competition came with twofold benefits to my students; the ability to understand energy access problems and the capacity to explicitly provide innovative solutions to the problems. I am sure the competition has added impetus to the hands-on experience promised by our MSc Energy Access and Renewable Energy Technology programme."

Ogheneruona Diemuodeke
Senior Lecturer,
University of Port Harcourt, Nigeria

Learning and networking opportunities

The Efficiency for Access Design Challenge team is developing a programme of online workshops (kick-off and midway workshops), live webinars, career conversations, and digital events to enhance learning and networking opportunities for you and your university departments. This will include sessions to help you understand the off-grid context better, and ensure that end-users are at the centre of your design.

The career conversations will also allow you to engage with industry experts. This will be an opportunity for you to learn more about the solar appliance sector, and build relationships with industry leaders.

The Efficiency for Access Design Challenge team will use the concept note you submit to assess the specific needs of your team and adapt the planned activities accordingly.

Online students' working space

Through the Efficiency for Access Design Challenge students' working space, hosted on CrowdSolve, you will be able to contact other students currently participating in the Challenge, as well as students that participated last year. This platform offers you an opportunity to ask questions, collaborate and share ideas with students from other universities in Europe, South Asia and Sub-Saharan Africa. You will be able to connect with students working like you to accelerate clean energy access to provide affordable and efficient high-performing, and inclusive appliances. This platform also allows you to interact with industry experts supporting you as reviewers and mentors, ask questions and receive feedback. This platform will be your space to showcase your designs.

Assessment

You will work in teams to deliver design and innovation projects that focus on affordable and high-performing solar appliances and enabling technologies.

Project submissions

Your team will need to submit your project submission by **14 April 2023**. It will consist of a 4,000-word (maximum) report and a three-minute video. Other supporting documentation eg posters or prototypes can be photographed or included within the submission, if deemed useful.

Your team will own the intellectual property of your work, but will be required to give the Efficiency for Access Design Challenge team permission to use the research outcomes for a wider benefit. This will be achieved by students agreeing to license their work under **Creative Commons license CC-BY 4.0**.

Stages of assessment

The project submissions will be evaluated in two stages and informed by the assessment framework on the next page.

First stage A reviewing panel, comprised of experts from the solar appliance sector, will review the submissions (both the report and the video) and provide feedback to the teams in **May 2023**.

Second stage A judging panel, comprised of funders, industry experts and investors in the sector, will assess the student teams' submissions during the pitching sessions in **May 2023**.

The Grand Final

The last stage of the competition, the Grand Final, will be held online in **June 2023**. All students and universities participating in the Efficiency for Access Design Challenge will be invited to the Grand Final. The Grand Final will include many opportunities for networking between students and specialists from the solar appliance sector, and the chance to showcase some of the submissions from the year.

The Grand Final will also include presentations from industry experts and an engaging panel discussion. In addition, many experts and investors from the sector will also be invited. The Grand Final will include an award ceremony to award teams with gold, silver, and bronze prizes.

"I continue to be blown away by the quality of submissions to the Efficiency for Access Design Challenge. The students are tackling complex global challenges with great creativity and understanding of the technical, human and business dimensions of bringing new appliances to market. A real source of inspiration and motivation for the wider sector."

Ellen Dobbs
Independent Climate Innovation and Energy Access Consultant

Assessment framework

What are the Reviewing and Judging Panels looking for?

The Assessment Framework on the next page provides guidance on what both the Reviewing Panel and Judging Panel will be looking for in your solution. It should be useful in helping you to structure your project submission. For your submission, regardless of the chosen technology, you should demonstrate how your design addresses a need people are experiencing. Your design must provide an improvement in terms of innovation compared to existing alternatives, ensure it is a sustainable and impactful solution and consider how to scale it up to market. All criteria are equally weighted and should all be addressed in your design. Each point is given a score of 1–5, 1 indicating poor potential, 3 as moderate and 5 as strong.

SCORING

1 2 3 4 5

Poor ‹····○ Moderate ○···› Strong

Innovation

How does your design compare and improve on solutions that are currently available to your target end-user?

Judges will want to see that you have demonstrated and understood the technological context that you are targeting, and that you have gone through a well-informed design process to improve on solutions currently available to the end user.

- What is the potential of your design to improve energy efficiency compared to existing alternatives? Consider how you define energy efficiency (energy used per service provided) and what the baseline is for comparison.
- What is the potential of your design to reduce production costs compared to existing alternatives? Consider materials used, price of components and cost of assembly.
- What is the potential of your design to improve usability compared to existing alternatives? Consider its ease of use, reliability and safety.

Sustainability

How does your design contribute to a positive impact on the environment?

Judges will want to see that you have understood the effects your solution could have, and how you demonstrate your solution is worthwhile and contributes to achieving the SDGs.

- Is your design reducing the environmental impact throughout its lifecycle compared to existing alternatives? Consider the whole product lifecycle: materials used, repairability and end of life.
- How does your design contribute towards greenhouse gas emissions reduction compared to other technologies that exist on the market? Consider the sustainability of your business model (including manufacturing, distribution and operating) and its scalability.
- How does your design contribute to the SDGs, in particular SDG7? Affordable and clean energy?
- How well have you demonstrated you understood the potential connections with all the 17 SDGs and its associated targets? Consider how the different areas of this assessment framework are contributing to this.

Social impact

What difference does your design make to people's lives?

Judges will want to see how you have researched the needs of the people whom your solution could benefit. They will want to understand why you think your design will improve peoples' lives, and how you have considered social inclusion and equality in your solution.

- How well have you considered who will be using the design? How well have you understood their needs?
- What is the likely potential of the design to improve quality of people's lives? How does your design improve the desirability of your target end-user? Consider what their livelihood was before and the improvement your design will bring to them.
- How well has your design considered the Sustainable Development Goals' commitment to 'Leave no one behind'? In particular, consider gender equality and disability inclusion.

Scalability

How feasible is it that your design could get to market at scale?

Judges will want to see that you have considered the business case. Including considering the market opportunity, including the market size, for your solution, and demonstrated how people will be able to access and afford this.

- How well have you considered the potential market for your product? Consider the target customer, size of market and customer value proposition.
- How well have you considered how people will be able to access and afford your product? Consider affordability, potential customer payment models and existing financial models.
- How well has your business model considered affordability, payment models, existing supply chains, manufacturing, distribution channels, local partners and services associated? Consider the pricing and costs strategies to make your business model commercially viable.

EFFICIENCY FOR ACCESS

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You will find more details and information on the Efficiency for Access Design Challenge web page.

You can access the Efficiency for Access Design Challenge student's working space on CrowdSolve.

To keep up to date with the Efficiency for Access Design Challenge sign up to the newsletter

Contact us

If you have any question about the Efficiency for Access Design Challenge, please contact Efficiency for Access Design Challenge team at

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