EFFICIENCY FOR ACCESS

UK ENGINEERS WITHOUT BORDERS

Efficiency for Access Design Challenge

Challenge Brief 2023–2024

Funded by:

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IKEA Foundation

energy saving trust

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Overview

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 to all, 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.

An estimated 425 million people have gained access to energy since 2010, but a further 660 million people are currently projected to still not have access to electricity by 2030. It is more important than ever to enhance access to modern appliances that are powered by renewable energy. 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.

> *"This [Challenge] is something worth doing, the Efficiency for Access Design Challenge was a summary of our entire degree, training and programme [...] This is where we [learned] exactly what we're supposed to do [...] It has given me a purpose as an engineer and shaped a path for my career. I now see myself somewhere in green energy."*
>
> **Mark Mutenga**
> student from Team 2022-24, Makerere University, Uganda

You will join students from around the world to design solar direct current (DC) appliances and supportive technologies. Once onboarded to the Challenge you and your team will submit a Concept Note, to give us an idea of the support you will need on your journey. You will receive feedback on your Concept Note, be paired with a mentor, and receive webinars and resources to help you design an appliance that will meet our four assessment criteria of:

- **Innovation**
- **Sustainability**
- **Social impact**
- **Scalability**

By 12 April, you will need to submit a **4,000-word report (maximum)** and **three-minute video** which you will receive in depth feedback on. You will have a final assessment in the form of a **pitch to a panel of experts in May**. Our Grand Final event is held in June, which will close out the Challenge year. The Efficiency for Access Design Challenge team is excited that you are joining the competition, and we are looking forward to the solutions you will submit.

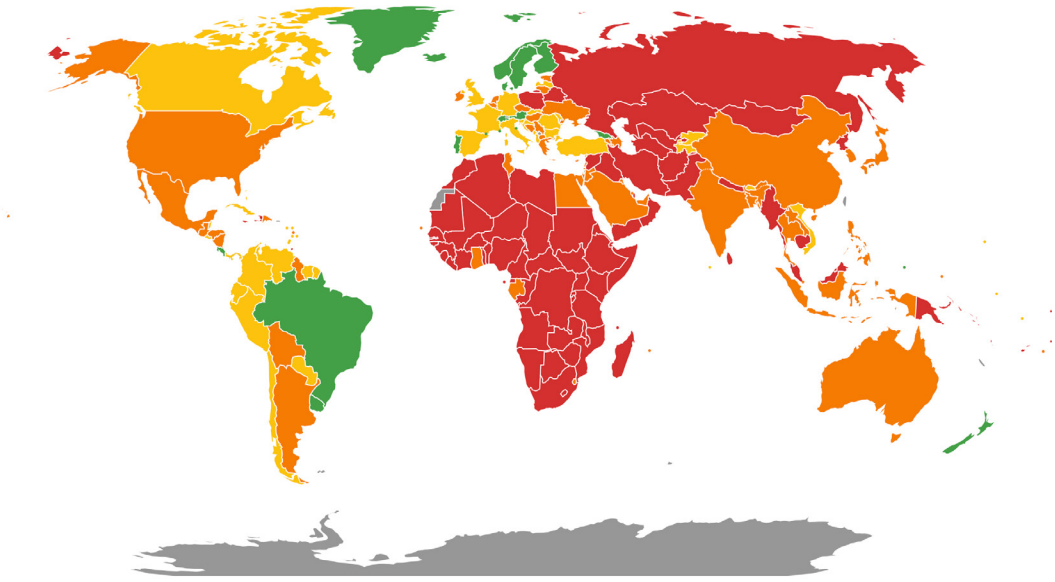
The Challenge started in September 2019. Since its beginning, over 400 students from over 30 universities in Bangladesh, Benin, Cameroon, India, Kenya, Mozambique, Nepal, Nigeria, Pakistan, Senegal, Sweden, Uganda, the UK, the USA and Zimbabwe have participated. They were supported by over 60 industry partners. Details on the competition and more resources, including previous years' project submissions and a recording of the most recent Grand Final, are available here.

This brief aims to give the reader everything they need to know about the Challenge and enhance their understanding of clean energy access and solar appliances, helping them to frame their project and design a solution.

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 solar DC appliances that can be used in an off-grid context, as part of a solar home system or a mini-grid.

You will work on solutions for use in countries with the lowest rates of electrification and that 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 report has interactive data visualisation tools that assess each country's progress towards achieving SDGs as well as specifically SDG 7.



Visual representation of countries' performance on SDG 7. 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 2023

"The Design Challenge isn't just about winning. It builds the participants' skills and opens them up to innovation on a global scale."

Joy Muntet
student from Team 2022-20, Strathmore University, Kenya

We are interested in useful, affordable and efficient appliances that can either

1. help improve people's quality of life in homes
2. or, increase business productivity

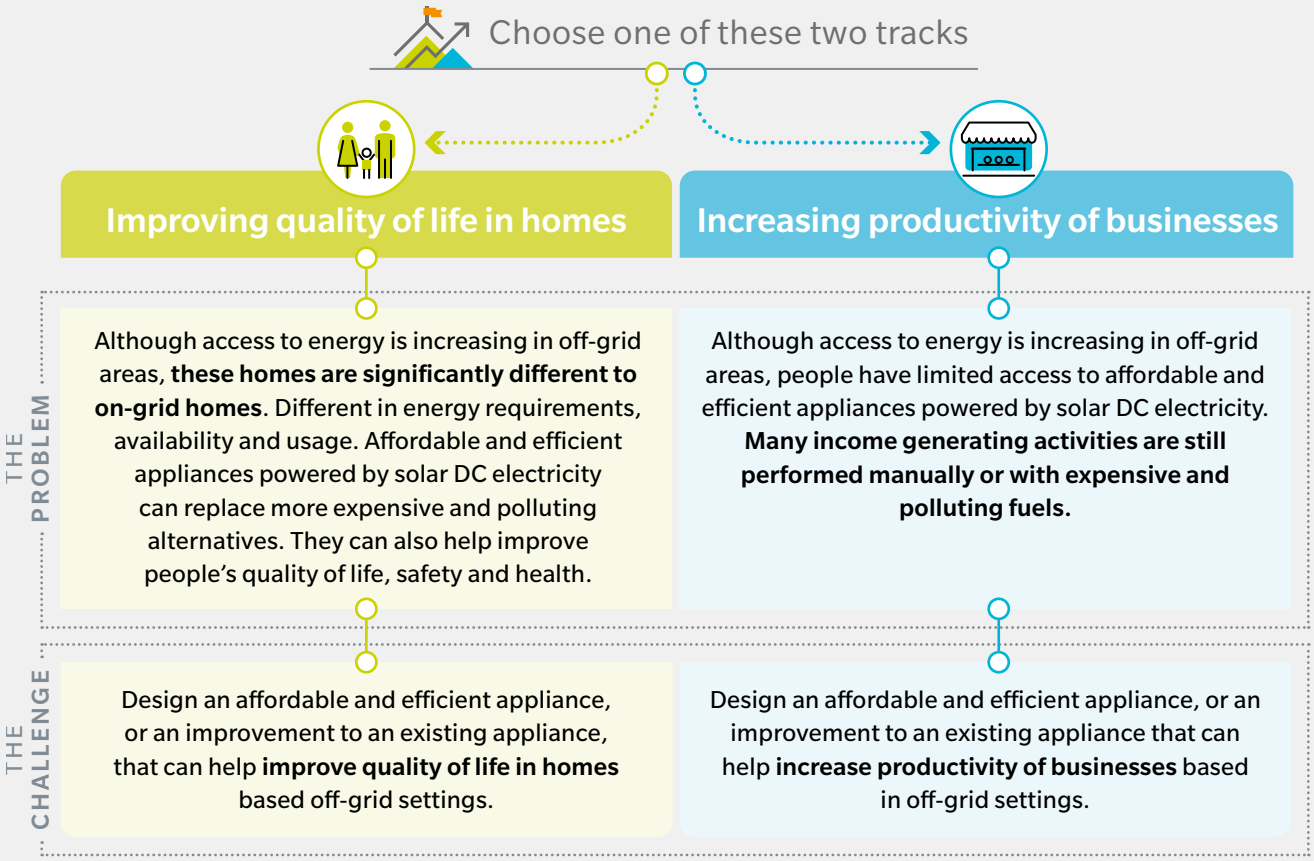
Please choose either of these two tracks, which are further illustrated in the diagram below.

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, to a medium enterprise of 50-249 employees. It is possible that some of your designs could cover both tracks.

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. The focus is on energy consumption and the appliance's primary source of energy must be electricity (DC - Direct Current). The appliance should directly connect to a solar home system or a standalone DC mini-grid. Designs using Alternating Current (AC) which connect to an inverter cannot be included. Energy generation is out of scope.

To reiterate, for your design to be eligible for the competition it must meet the following criteria:

1. Be a solar DC appliance that does not use an inverter and/or is not an energy generation device.
2. Be built for a community or context experiencing low levels of energy access.
3. Improve the quality of life of homes or increase the productivity of businesses.



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.

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 in Africa before 2030. This is because, while grid extension remains the cheapest option for dense, highly populated cities, the more remote and rural the area is the more expensive per capita it becomes to extend the grid to reach them, making solar home systems much more viable. There is a space in between, where mini-grids appear to be the preferable options to power communities, for example, those living in villages (Sustainable Energy for All (SEforAll), 2019).

Despite energy access dropping for the first time in decades last year, solar PV and wind have become the cheapest forms of new energy generation in most markets and are rapidly growing.

Conventional AC 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.

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.

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

LEARN MORE

Off-grid solar market trends report 2022: state of the sector, Efficiency for Access Coalition, 2022

Off-Grid Solar Market Trends Report 2022: Outlook, Efficiency for Access Coalition, 2022

Building Resilience in Low-Income Communities – The Role of Off-Grid Appliances, Efficiency for Access Coalition, 2023

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 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'.

A humanitarian context

A key principle that will be repeatedly underlined throughout your Challenge experience, is to understand and design for the end-user of your design. This will require you to design your appliance with a specific context in mind. However, while identifying a context can be relatively simple, in practice, designing for that particular context could be incredibly nuanced and complex.

Take a '**humanitarian context**' for example. This is a context in much need of support and innovation, and one you could consider designing for. **United Nations Office for the Coordination of Humanitarian Affairs** has projected that a record 339 million people will need humanitarian assistance and protection in 2023. Over one percent of the world's population, 103 million people, are displaced. This growing population in need of humanitarian need also need access to energy services that could be provided through solar appliances.

"94% of displaced people in camps do not have access to electricity", and energy access and proper infrastructure is often not considered to be a basic need (**UNITAR, 2022**).

EXAMPLE: DISPLACEMENT CAMP

While humanitarian contexts are very diverse, you could choose to narrow it down to consider a displacement setting. This will give you a slightly clearer picture of what and who you are designing for. Displaced people need access to modern electricity services like anyone. They run and rely on in-camp businesses, schools, hospitals, community spaces, water, and sanitation facilities, to name just a few. People need to work, study, move around at night, and to build resilient and thriving communities. Needless to say, demand for electricity services is high. Camps are often seen as a temporary solution by host governments, despite many large camps existing for decades. To compensate for the lack of grid access, expensive and environmentally harmful off-grid alternatives like diesel generators are often used to provide electricity in-camp.

While off-grid solar home systems and mini-grids are proving to hold widely held benefits in these settings, needs differ across different displacement contexts. Understand whether you are addressing a protracted situation in which the displaced people have been in this context for five or more years, or whether you are addressing an emergency situation, will have drastically different needs (**UNITAR, 2022**).

What innovation means, will vary across different situations. For example, clean cooking and solar lighting dominate humanitarian energy sector platforms and studies (**IRENA, 2019**). You may find that there may be much more room for innovation designing a refrigerator, fan, solar water pump, or television specifically for this context than if you designed a clean cooking solution or even designed the same technology for a different setting.

Last year, team **2022–38 from Aston University** addressed a need for innovative teaching methods following recent floods in Pakistan that caused devastating infrastructure damage. They won a silver award for their design of a solar-powered ICT system designed specifically for this context.

All design contexts are incredibly nuanced and will require an intimate knowledge of the situation, environment, and its people's needs to effectively design for it. Even within what may seem like a fairly narrow 'humanitarian' or 'displacement' context there are countless layers to unpeel and to consider. We would recommend giving yourself as much time to research your chosen context as thoroughly as you can. If you decide to proceed down a humanitarian route, we recommend viewing the resources in the Learn More section.

LEARN MORE

Efficiency for Access Design Challenge Webinar on Designing for Humanitarian Contexts, 2023

The State of the Humanitarian Energy Sector 2022, UNITAR, 2022

Energy Solutions for Displacement Settings, GIZ, 2021

User-Centered Design in Humanitarian Energy Projects, Energypedia, 2023

Renewables for Refugee Settlements, IRENA, 2019

Timeline

The Efficiency for Access Design Challenge 2023–2024 starts in September 2023 and ends with the Grand Final in June 2024. 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 – your educator will be able to inform you about this possibility. The Efficiency for Access Design Challenge team is available to help universities embed the competition in curricula.

KEY DATES

1. **SEPTEMBER** – Kick-off Workshops
2. **DECEMBER** – Midway Workshop
3. **FEBRUARY** – Deadline for Concept Note Submissions
4. **APRIL** – Deadline for Final Project Submissions
5. **MAY** – Pitching Sessions
6. **JUNE** – Grand Final

Projects can start at any point from September 2023 onwards (depending on your timelines) after all team members sign the Challenge terms and conditions. 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 **within a month of your kick-off workshop**. All concept notes must be submitted by our final deadline of **Wednesday, 14 February 2024**. We encourage early submissions in order to fully benefit from the support provided by the Efficiency for Access Design Challenge team.

The concept note should outline what the student team plans to focus on and be **no longer than four A4 pages**. It will help the Challenge team understand how you intend to approach your problem statement, so that we can provide appropriate support and ensure the design is within scope.

You will not be assessed on the concept note and it will not be used to decide whether you can participate in the competition. The concept note template will guide you to consider all the necessary design criteria. This concept note will also help the Challenge team to identify a mentor from the solar appliance sector, who will support the team throughout the design process. We encourage you to submit these as soon as possible rather than waiting to 'perfect' the document in order to get the support you require in time.

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

The final deadline to submit your concept note is **14 February 2024**

All students participating in the Challenge will have to **sign the terms and conditions** document

Online events

Halfway through the competition, the Challenge team will facilitate two midway workshops, and monthly drop-in sessions to support students in the design process and to answer any questions. The Challenge team will also organise a series of webinars and career conversation events, which will allow students to meet industry experts, familiarise themselves with the sector, and learn more about off-grid appliances and enabling technologies.

Project submission

Your team should submit a 4,000-word (maximum) report and a three-minute video by **Friday, 12 April 2024**.

You will receive feedback from reviewers on your submission in **May 2024** which you can use to prepare for the pitching session.

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.

You can view past submissions on our website here.

Pitching sessions

A judging panel, comprised of industry experts in the sector, will assess the student teams' projects during the pitching sessions in **May 2024**.

More details on your submission and pitching session can be found under the Assessment section on page 12.

Grand final

The last stage of the competition, the Grand Final, will be held online in **June 2024**. The Grand Final is a celebration of the year and a showcase some of the submissions. All students and universities participating in the Challenge as well as external professionals will be invited.

The Grand Final will also include a presentation of gold, silver, and bronze awards to winning teams.

"Using the Efficiency for Access Design Challenge as a complementary, flexible and tension-free learning tool, our students have gained valuable technical, soft and entrepreneurial skills.

Students who have participated are more attuned to the problems around them and the resulting impact on individuals and communities. They now feel that they can take a more active role and can actually contribute to solving these issues. They have learned to:

- *work with others across borders and time zones*
- *share their ideas, value those of others, and collaborate constructively*
- *express themselves and be heard."*

Kinyua Wachira
Assistant Lecturer, University of Nairobi, Kenya

The deadline to submit your project is **12 April 2024**

The Grand Final will take place in **June 2024**

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 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. We held a short discussion on the mentoring opportunity at last year's Grand Final, you can watch the recording of that session here. During the discussion, the participants highlighted how the mentoring experience can be invaluable for providing insider information to the market they're approaching as well as exposure to communicating and working with professionals in the industry. Our mentor highlighted the mutually beneficial nature of a mentor relationship.

> *"I couldn't be happier with the entire competition and the team [I mentored]. I very much appreciate the memories this competition has placed into my life. What an amazing experience."*
>
> **Chris Woyewodzic**
> Mentor for Team 2022–24, CEO of Western Harmonics

Prototyping grants

Grants to support your team to develop a prototype will be available on application. This is a great opportunity to consolidate the project concepts developed by your team and elaborate on your ideas through 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 and external reviewers in visualising your design and how it can be improved. Your team's application for the prototype development grant will include a needs statement and a detailed budget signed off by your educator supervisor. If your application is successful, you will need to complete an impact report for the funds by September 2024. More details, templates, and deadlines on the application process will be available closer to the application window.

Get some inspiration from previous prototypes showcased in this **short video**.

Learning and networking opportunities

The Efficiency for Access Design Challenge team will deliver a programme of online workshops, live webinars, career conversations, and digital events to enhance your learning and networking opportunities.

This will include webinars to help you understand the off-grid context better and ensure that end-users are at the centre of your design. Previous years' recorded webinars are also available. These are essential to help you gain exposure to the solar appliance industry and learn key principles of design.

The career conversations are an opportunity for you to learn more about a career in the solar appliance sector, and build relationships with industry leaders. Previous career conversation recordings are also available.

You will also have access to a live digital library of reports, market surveys and research papers from Efficiency for Access and our partners. 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.

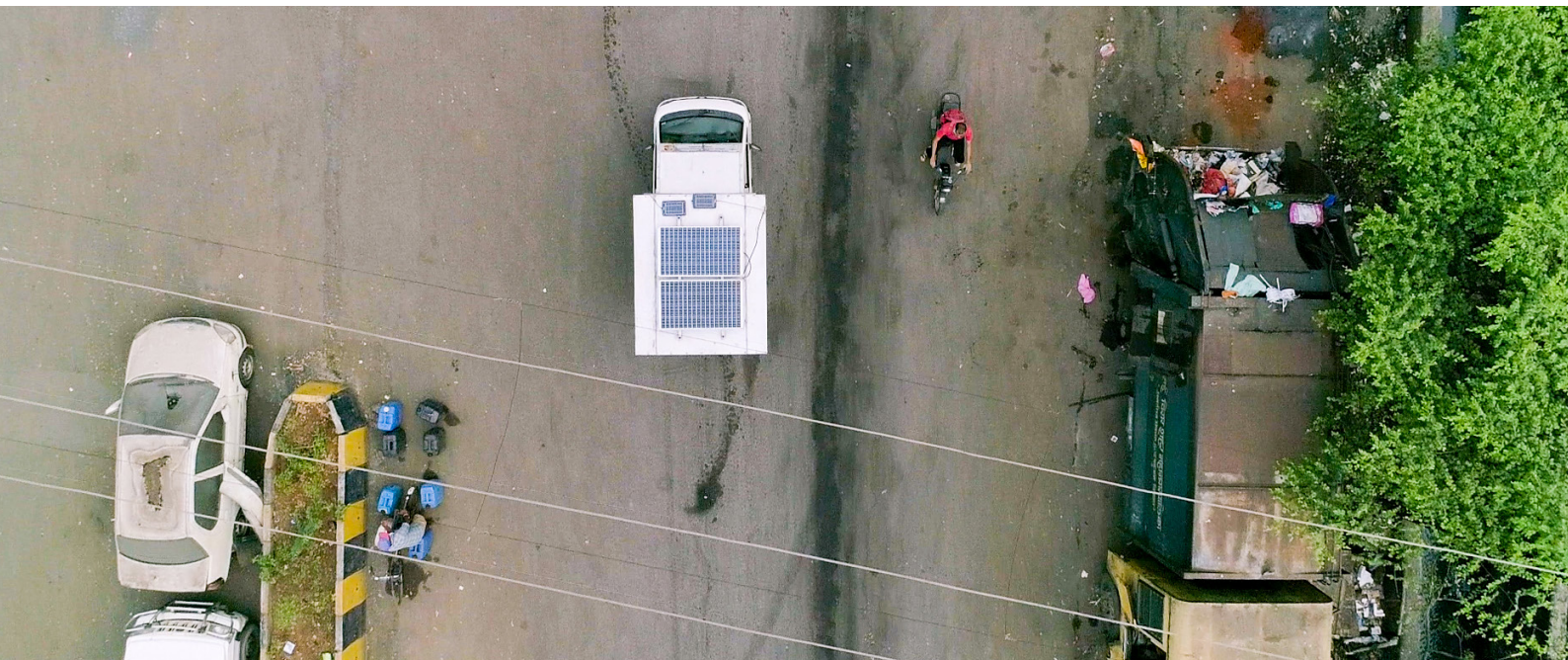
Remember to sign up to our newsletter here

CrowdSolve

CrowdSolve is an online collaborative space allowing you to connect with other students globally by following their project updates and engage with your industry mentors and reviewers. You can also interact on the forum spaces, and use the private chat function. It will act as your submission and feedback portal. The Efficiency for Access Design Challenge team will be posting important updates and event information on the CrowdSolve forum. Crowdsolve allows for private messaging, which you can use to get in contact with other participants or the Challenge Team. You will be encouraged to create a profile on CrowdSolve at the outset of the challenge, and you will need to create a project space on CrowdSolve for your team. Guidance on how to do this and use all other features will be available.

On CrowdSolve you will need to:

- Set up a profile
- Create a project space
- Submit your concept note
- Keep up with Challenge updates
- Make your final submission



Assessment

Stages of assessment

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

First stage Your team should submit your final project – a 4,000-word (maximum) report and a three-minute video by **Friday, 12 April 2024**. Other supporting documentation eg posters or photographs can be included within the submission.

A reviewing panel, comprised of experts from the solar appliance sector, will review the submissions (both the report and video) and provide feedback to the teams in **May 2024**.

Second stage For your final assessment, your team will pitch your project to a judging panel in a digital session in **May 2024**. The pitching sessions will consist of a 10-minute presentation followed by 10 minutes of questions from the judges and five minutes of feedback. This pitch will form the majority of your combined score, used to determine your place in the competition.

The Grand Final

The Gold, Silver, and Bronze awardees of the competition, determined by the combined score of the final submission and pitch, will be announced at our Grand Final event in **June 2024**.

"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

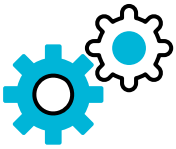
What are the Reviewing and Judging Panels looking for?

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 final submission and pitch. Each criteria 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?

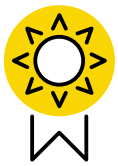
Judges will want to see that you have demonstrated and understood the technological context that you are targeting, and that you have gone through a well-informed design process to improve on solutions currently available to the end user.

- **What is the potential of your design to improve energy efficiency compared to existing DC and non-DC 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.

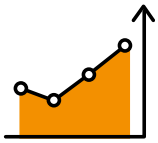
- **Is your design reducing the environmental impact throughout its lifecycle compared to existing alternatives?** Consider the whole product lifecycle: materials used, repairability and end of life.
- **How does your design contribute towards greenhouse gas emissions reduction compared to other technologies 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 SDG 7?** Affordable and clean energy?
- **How well have you demonstrated your understanding of 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.

Global responsibility

Engineering has played a significant role in shaping the world we live in. While it has contributed to improving the lives of people worldwide, engineering has also played a fundamental role in contributing to the unjust and unsustainable practices that dominate the world today. Globally responsible engineering is critical to ensure society balances the needs of all people with the needs of our planet and to actively address the challenge of our age.

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

1. **PURPOSEFUL** To shape outcomes to be equitable and ethical throughout engineering and the life cycle of any project.
2. **INCLUSIVE** To ensure that diverse viewpoints and knowledge are included and respected in the engineering process and outcomes.
3. **RESPONSIBLE** To meet the needs of all people within the limits of our planet. This should be at the heart of engineering.
4. **REGENERATIVE** To maximise the ability of all living systems, to achieve and maintain a healthier state and naturally co-evolve.

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 practised. Visit the **Engineers Without Borders UK website** to learn more about the need for global responsibility in engineering.

We invite you to explore the **Global Responsibility Competency Compass** which points practitioners towards the capabilities they will need to stay relevant and provides practical ways to develop themselves. It articulates 12 essential competencies that align with the four principles of global responsibility, along with an online learning library of relevant professional development and training available on the **Engineers Without Borders UK 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 of the Global Responsibility self-directed learning course, 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 described here.

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.

Within this Challenge you can design ways for operating, maintaining and improving living systems, to challenge established practices and behaviours that are unsustainable, unethical or unjust and works effectively with others to bring about positive change.

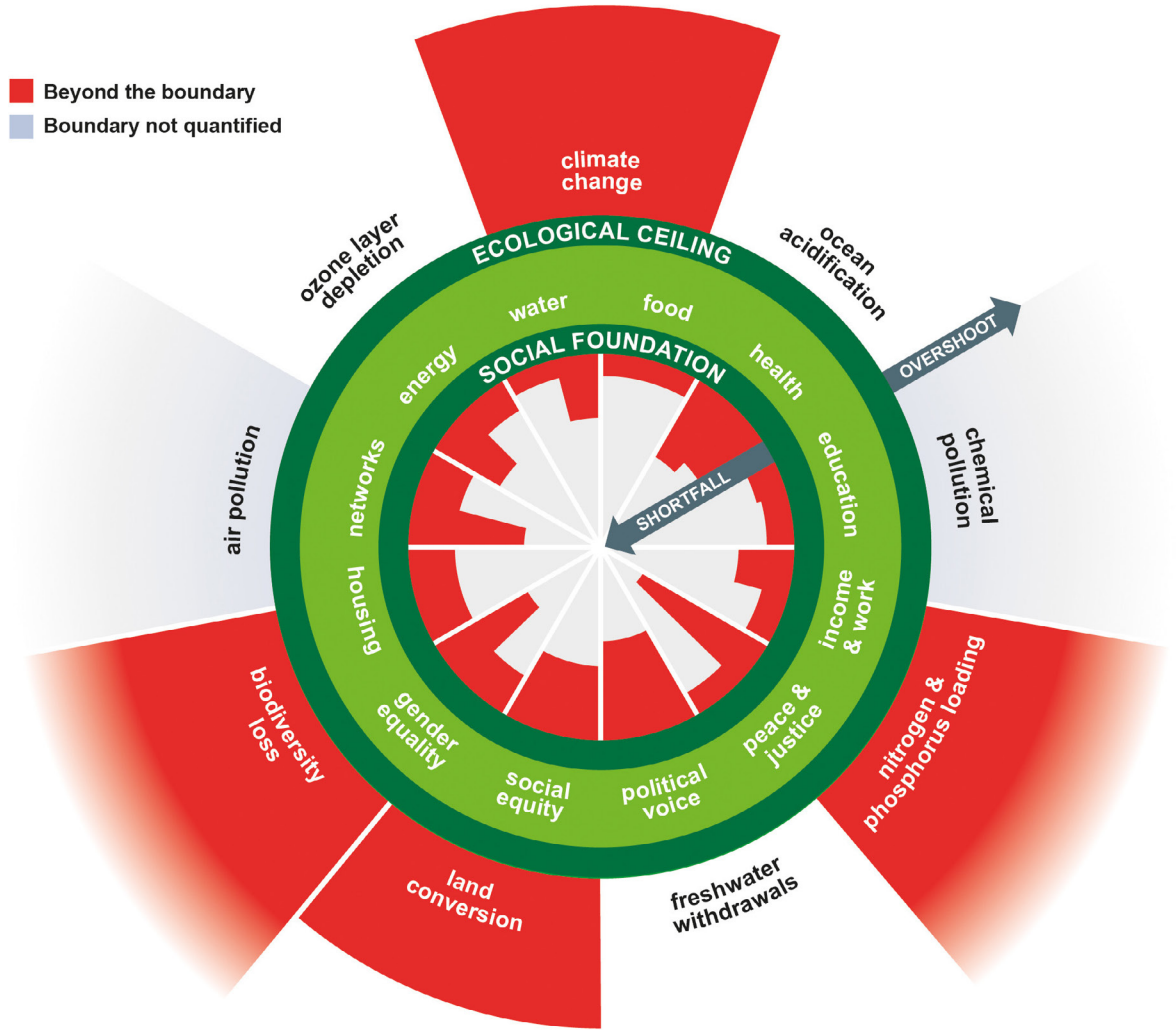
LEARN MORE

Doughnut Economics Action Lab works with changemakers worldwide, turning ideas into transformative action and learns from others through experiments in co-creating a new economy, 2020

'Unintended Consequences of the Sector's Growth' webinar and 'Product Lifecycle and Local Assembly' webinar

Examining Fiscal Environment for Increased Localisation of Solar Products, Efficiency for Access Coalition, 2023

Off- and Weak-Grid Appliances Impact Assessment Framework, Efficiency for Access Coalition, 2022



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 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.

- People who use your appliance will be one of your most critical stakeholder groups. We want you to seek out their opinions and involve them to fully understand their needs and aspirations, rather than view them purely as end users.
- Engineers and designers alone cannot address the significant global challenges we face; we must work in collaboration with others.
- 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).

Throughout the Challenge, consider the importance of inclusive approaches to design in shaping better project outcomes and cultural practices within engineering. As different perspectives and priorities are evident across society, value tensions exist across the design process that can result in unintended consequences.

LEARN MORE

Appliance Impacts Over Time, Efficiency for Access Coalition, 2023

Appliances for All: Assessing the Inclusivity of the Solar Lighting and Appliances Sector, Efficiency for Access Coalition, 2022

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

The Globally Responsible Virtual Experience Programme, EWB UK, 2021, is aimed at interrogating the role of engineering, learning about the principles of global responsibility, how to encourage participatory and inclusive outcomes in practice and critically reflecting on your role in ensuring a more safe and just future for all

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

Resilient Appliances for Resilient People and Planet, Efficiency for Access Coalition, 2023

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.

Regenerative Design 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.

"Within this Challenge, consider how your design interacts with social and ecological systems. Is there a loop here? What patterns and relationships between these living systems can you see? 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

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

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

Do Less, Better, IStructE, 2022

Blogs on shifting to a life-centric mindset, Roberta Iley, 2022

Blogs on regenerative design, Oliver Broadbent, 2023

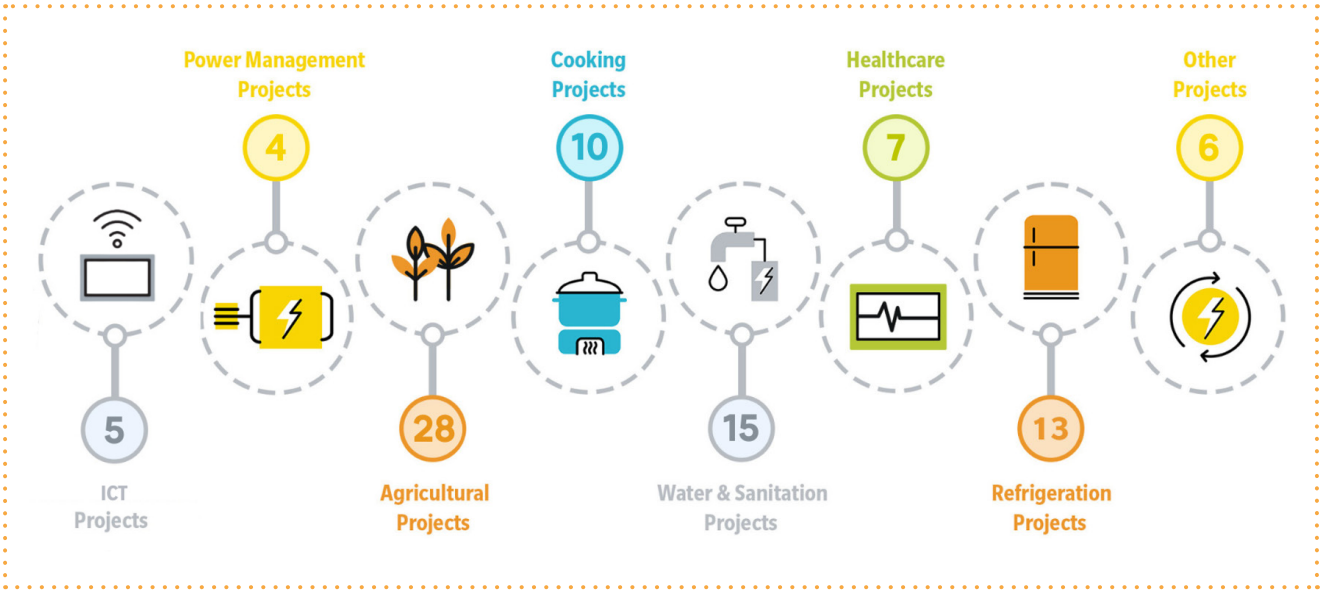
Engineering for Sustainable Development: Delivering on the Sustainable Development Goals, UNESCO, 2021

Themes

In the Challenge, you can focus on any appliance, as long as you clearly identify the purpose and need that your design addresses. The 88 projects submitted to the Challenge over previous years can be categorised into the broad technological themes illustrated in the graphic below.

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 Efficiency for Access Design Challenge portfolio of projects



The next section of this Brief is here to offer ideas of different technology themes to work on within the off-grid appliance space and expand your knowledge of the sector as a whole. Think of the following pages as a knowledge resource with links for further reading and not something intimidating.

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.

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)

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

Innovator Series – Agsol, 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

Productive Use of Solar PV, energypedia, 2021

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

Productive Use Report, A2EI, 2020

How Can Energy Access Practitioners Energise Regenerative Agriculture Settings?, Efficiency for Access Coalition, 2023

Evaluating Appliance Performance in the Field: Solar Water Pumps, Efficiency for Access Coalition, 2023

Evaluating Appliance Performance in the Field: Solar Milking Machines, Efficiency for Access Coalition, 2023

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.

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 labour 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 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 was made abundantly clear through the COVID-19 pandemic, as the COVID vaccine rollout required 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**, which require strict temperature controls – typically between +2 and +8 ºC. These requirements are particularly challenging for off-grid communities who need these treatments and preventative measures.

A key innovation to look out for in solar refrigeration is **solar direct drive refrigeration** that makes use of phase change materials like water packs to store energy as 'ice banks' – **bypassing the use of a battery and charge controller**. Another innovation is **solid-state refrigeration** that makes use of thermo-electric cooling and the Peltier effect to bypass the use of refrigerants and many moving parts. These are important steps forward in solar refrigeration and should be well understood when approaching this technology.

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 0.4ºC of global warming by 2100, bringing us much closer to achieving our 1.5ºC target. (**International Institute of Sustainable Development, 2019**)

LEARN MORE

2022 Buyer's Guide for Off-Grid Cold Chain Solutions, Efficiency for Access Coalition, 2023

Key Cold Chain Infrastructure Markets, Efficiency for Access Coalition, 2023

Uses and Impact of Off-Grid Refrigerators, Efficiency for Access Coalition, 2022

Challenges and Opportunities in the Cold Chain Sector, Efficiency for Access Coalition, 2022

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

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

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

Life Cycle Greenhouse Gas Emissions Assessment of Off- and Weak-Grid Refrigeration Technologies, Efficiency for Access Coalition, 2023

Evaluating Appliances Performance in the Field: Solar Refrigerators, Efficiency for Access Coalition, 2023

Innovator Series – Devidayal Solar: Truck mounted, solar-powered refrigerators to enable local farmers in India to reach new markets, Efficiency for Access Coalition, 2022

SPOTLIGHT ON: WALK IN COLD-STORAGE

In Sub-Saharan Africa, 37% 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
- use of phase changing materials

EXAMPLES

Walk-in cold room by Cold Hubs

Commercial cooling unit by Fresh Box

Solar cold storage room: Ecofrost by Ecozen

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

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

Innovator Series: Smart Villages Research Group, Efficiency for Access Coalition, 2022

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

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

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

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 increased 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

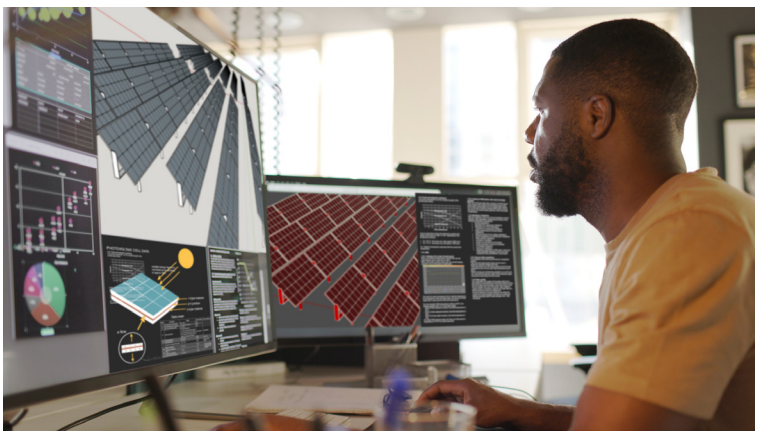
State of the Global Mini-grid Market Report, SEforAll, 2020

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.



> Even 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)

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

Innovator Series: Innovex Uganda, Efficiency for Access Coalition, 2023

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

Team 2022-28 Solar powered ICT system from year 4 of the Challenge, 2023

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)

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 (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, 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-Saharan 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

Repurpose e-bikes design project, Challenge participating team 2021-41, 2022

Electric rickshaw design project, Challenge participating team 2019-13, 2020

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

The High Volume Transport Applied Research Programme, DT Global

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: WASHING MACHINES

There is a whole group of technologies that significantly benefit women and girls by facilitating tasks they are traditionally burdened with. Washing machines, a key technology in this group, work to free their time and energy to pursue other interests. Village Infrastructure Angels have developed an innovative solar washing machine and mentored team 2021-01 from Gulu University to develop their solar-powered washing machine.

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)

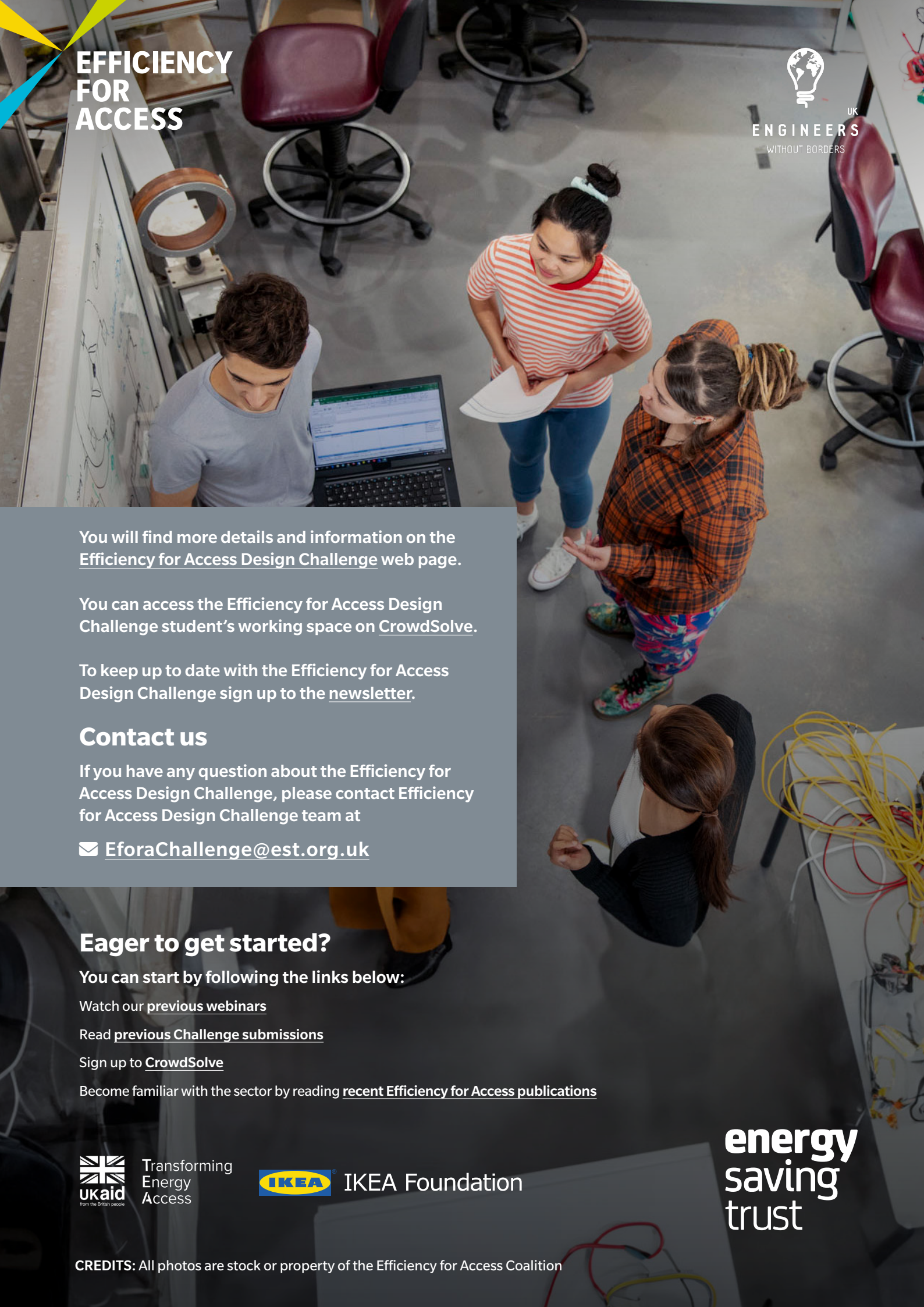
SPOTLIGHT ON: EGG INCUBATION

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



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