Balancing the Present with the Future

The Key to Sustainable Microgrid Design

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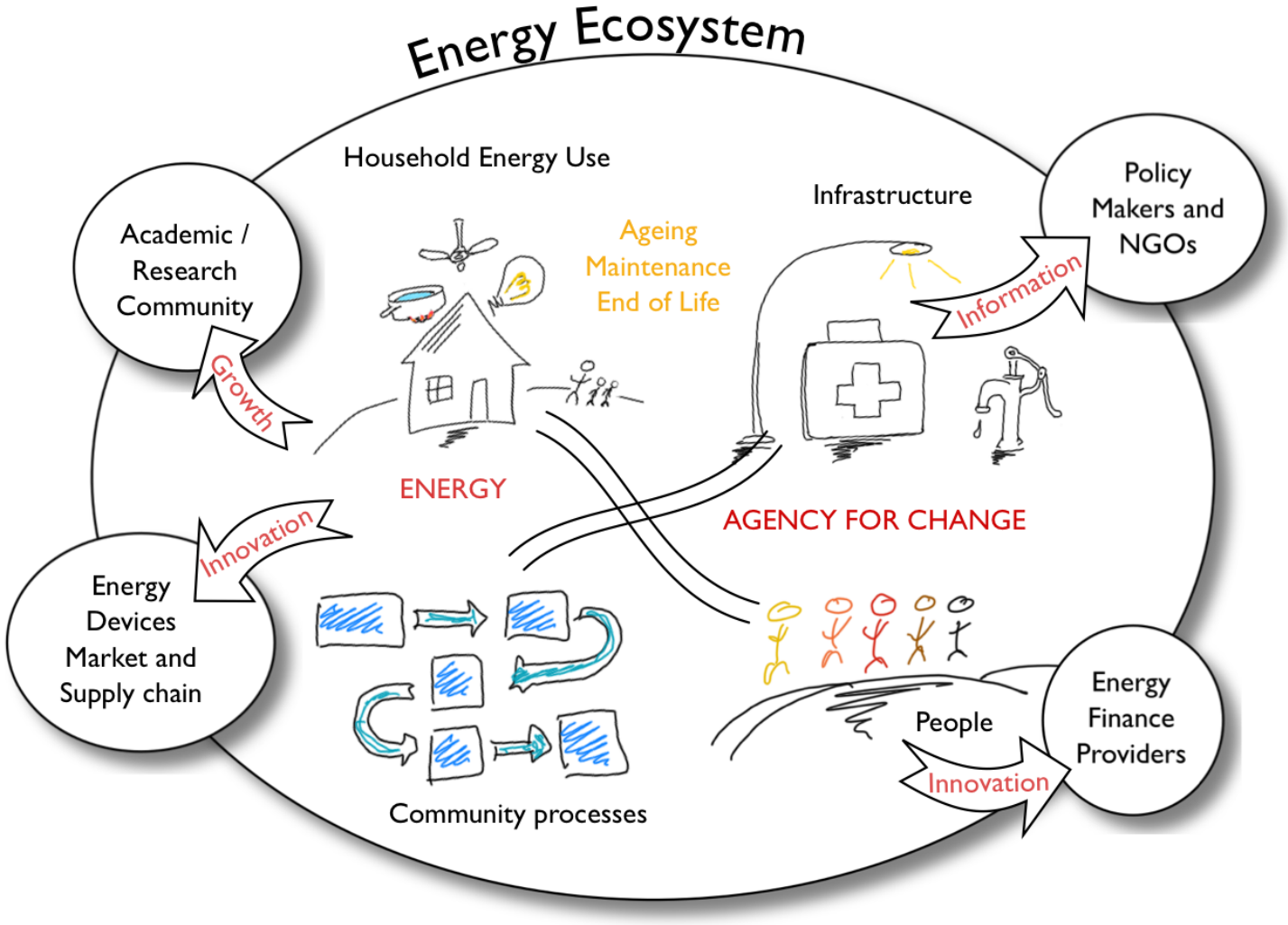
Humanitarian Engineering and Energy for Displacement

HEED: Re-thinking the Delivery of Energy Systems in the Displaced Context

- How and to what extent can refugee communities engage with the potential of current and emerging IoT solutions for distributed, off-grid, renewable micro-grid systems management?
- What principles and processes can be implemented that will deliver microgrid designs that respond to and respect the energy needs and aspirations of displaced people?
- How can we think differently about microgrid design to produce sustainable systems, leverage on the local economy of products and skills, and are future proof?



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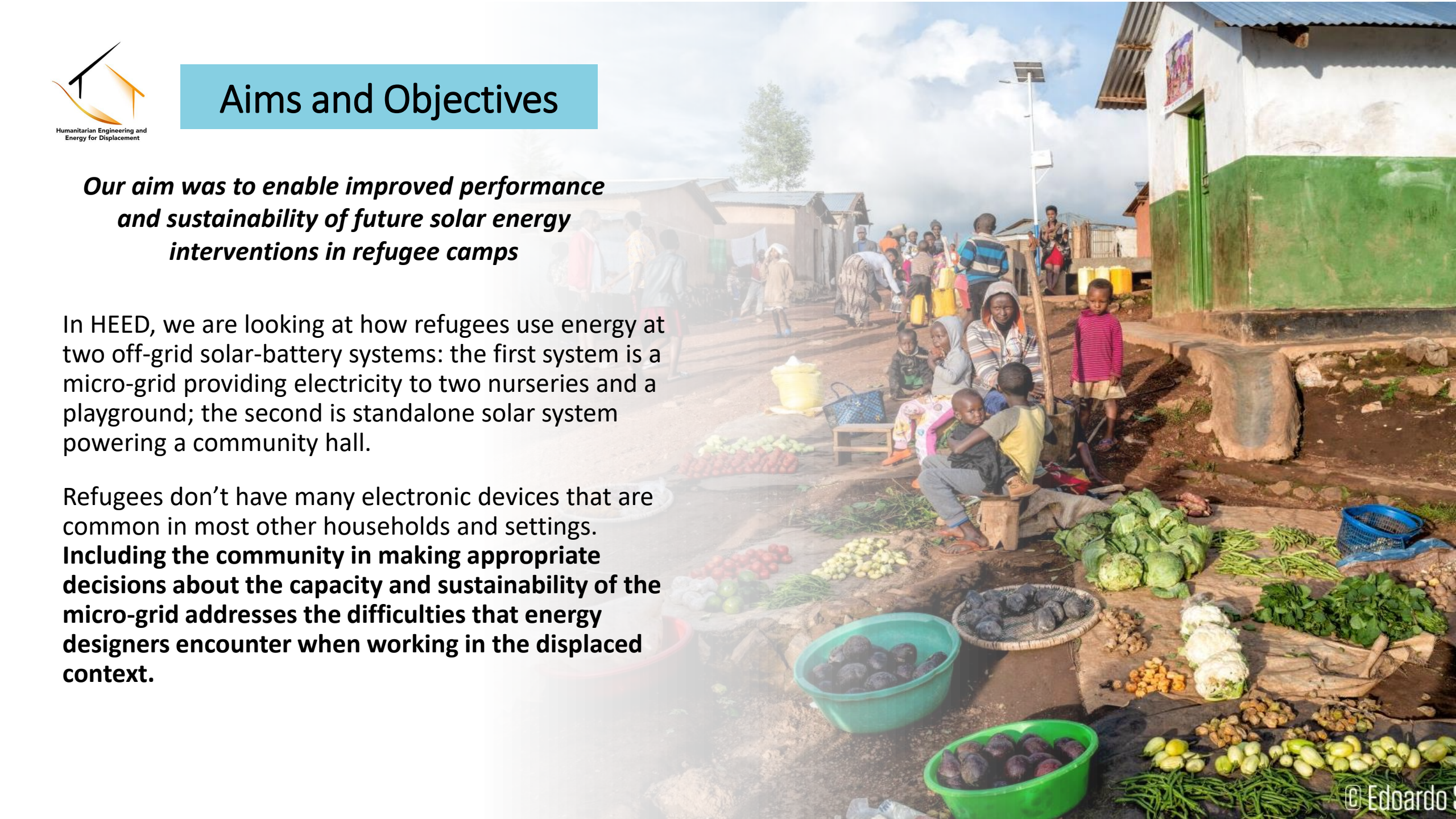
Aims and Objectives

Our aim was to enable improved performance and sustainability of future solar energy interventions in refugee camps

In HEED, we are looking at how refugees use energy at two off-grid solar-battery systems: the first system is a micro-grid providing electricity to two nurseries and a playground; the second is standalone solar system powering a community hall.

Refugees don't have many electronic devices that are common in most other households and settings. **Including the community in making appropriate decisions about the capacity and sustainability of the micro-grid addresses the difficulties that energy designers encounter when working in the displaced context.**



Off-grid Solar System Research Questions

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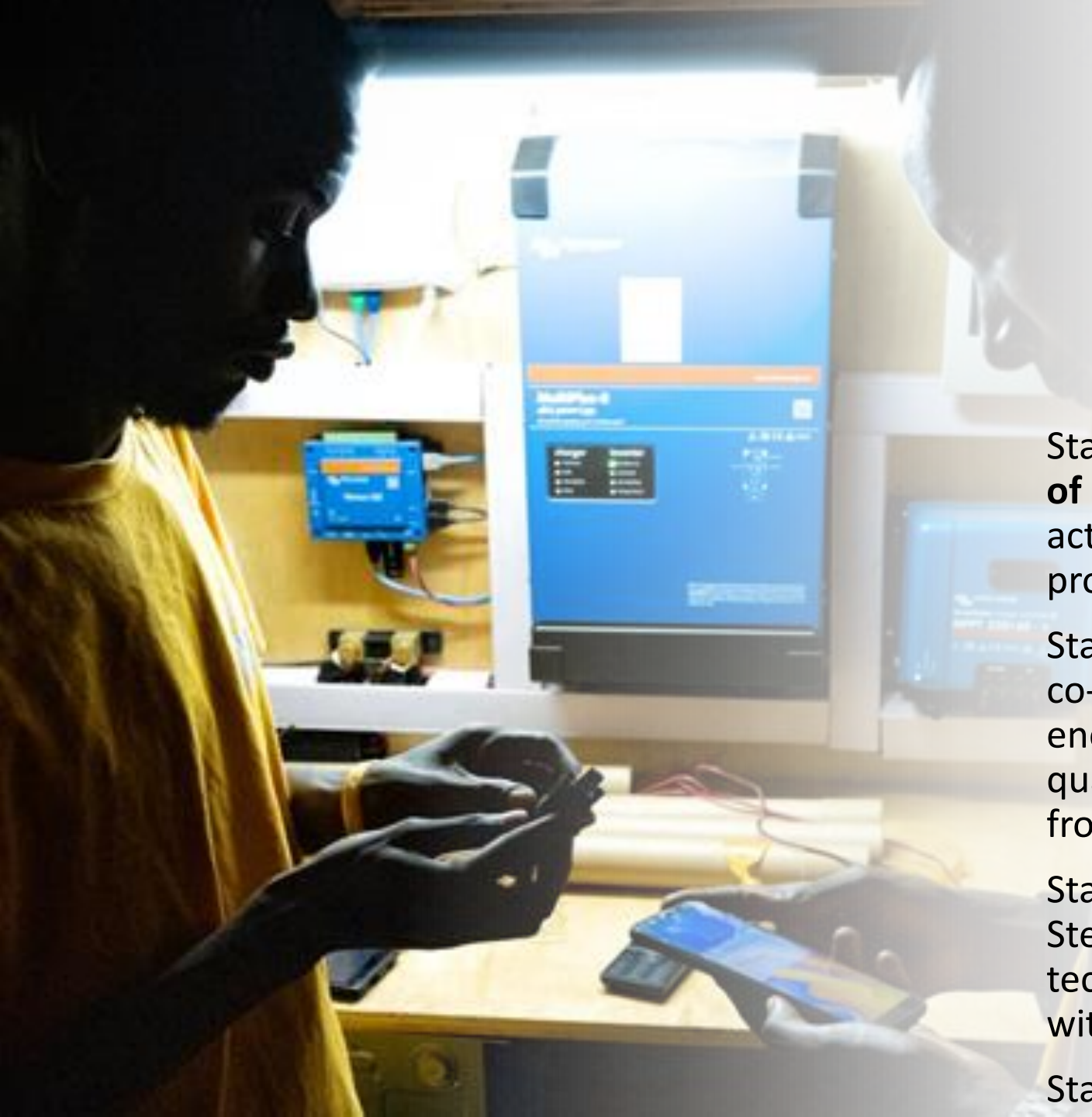
There were many specific questions that we wanted to address for off-grid solar system interventions

- Is the design performance of off-grid solar power systems co-designed with refugee communities realised in **real-life implementation**?
- What are the design, implementation and operational challenges that reduce the performance of energy systems deployed in refugee camps?

We set out to answer these questions through the design, implementation and monitoring of two different off-grid solar power systems deployed in refugee camps in Rwanda.



Stages of Design

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A 4-stage approach to the deployment of our solar energy interventions was adopted

Stage 1: **Project set up, mapping and baseline survey of current energy context in the camps.** A series of activities to better understand the availability, use and projected aspirations around energy in camps.

Stage 2: **Community Designathons.** These workshops co-emerged and validated with the communities, energy intervention designs informed by the quantitative and qualitative research data gathered from Stage 1.

Stage 3: **Energy system implementation.** Translate Stege 2 outputs into
technical specification, simulation, design, working with local suppliers, installation.

Stage 4: **Analysis, dissemination, and handover.**

Stage 1

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Context for micro-grid intervention

Kigeme refugee camp, is the second largest refugee camp in Rwanda with around 20,000 refugees.

From 202 household participants surveyed , no household had a grid connection and only 10 homes had a solar home system.

Energy for education and health were perceived to be the most important communal needs.

The most common item used in the home for lighting was a mobile phone.

Radios and phone chargers were the main devices used by the community; with adequate supply the next appliances they would like to use would be an iron and computer.

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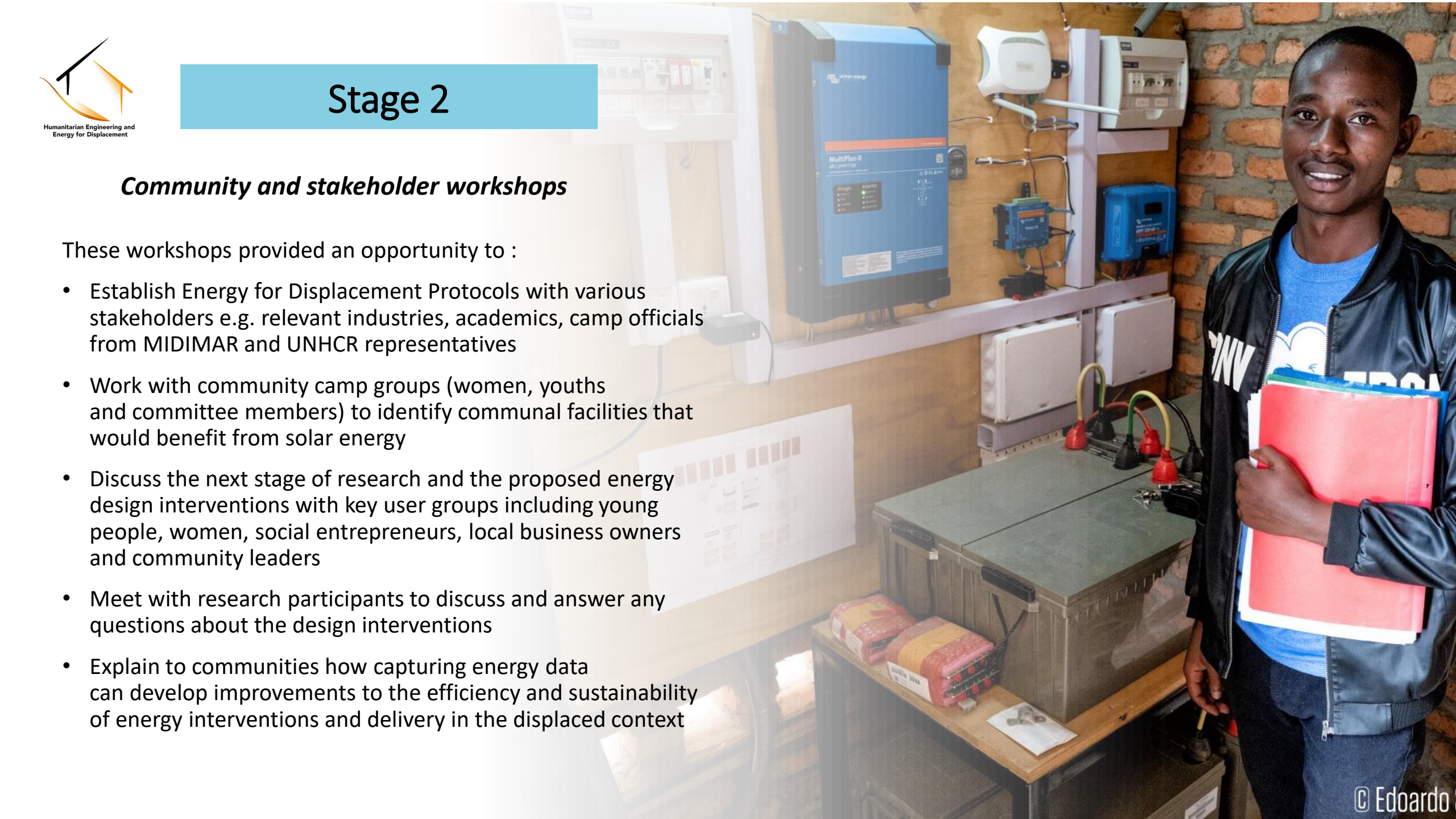
Stage 2

Community and stakeholder workshops

These workshops provided an opportunity to :

- Establish Energy for Displacement Protocols with various stakeholders e.g. relevant industries, academics, camp officials from MIDIMAR and UNHCR representatives
- Work with community camp groups (women, youths and committee members) to identify communal facilities that would benefit from solar energy
- Discuss the next stage of research and the proposed energy design interventions with key user groups including young people, women, social entrepreneurs, local business owners and community leaders
- Meet with research participants to discuss and answer any questions about the design interventions
- Explain to communities how capturing energy data can develop improvements to the efficiency and sustainability of energy interventions and delivery in the displaced context



Stage 3

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Design and implementation of a solar energy intervention

Design simulations

Product specification

Call for suppliers

Supplier selection

Design revision

Installation

Testing

Commissioning

Community mobilisers training

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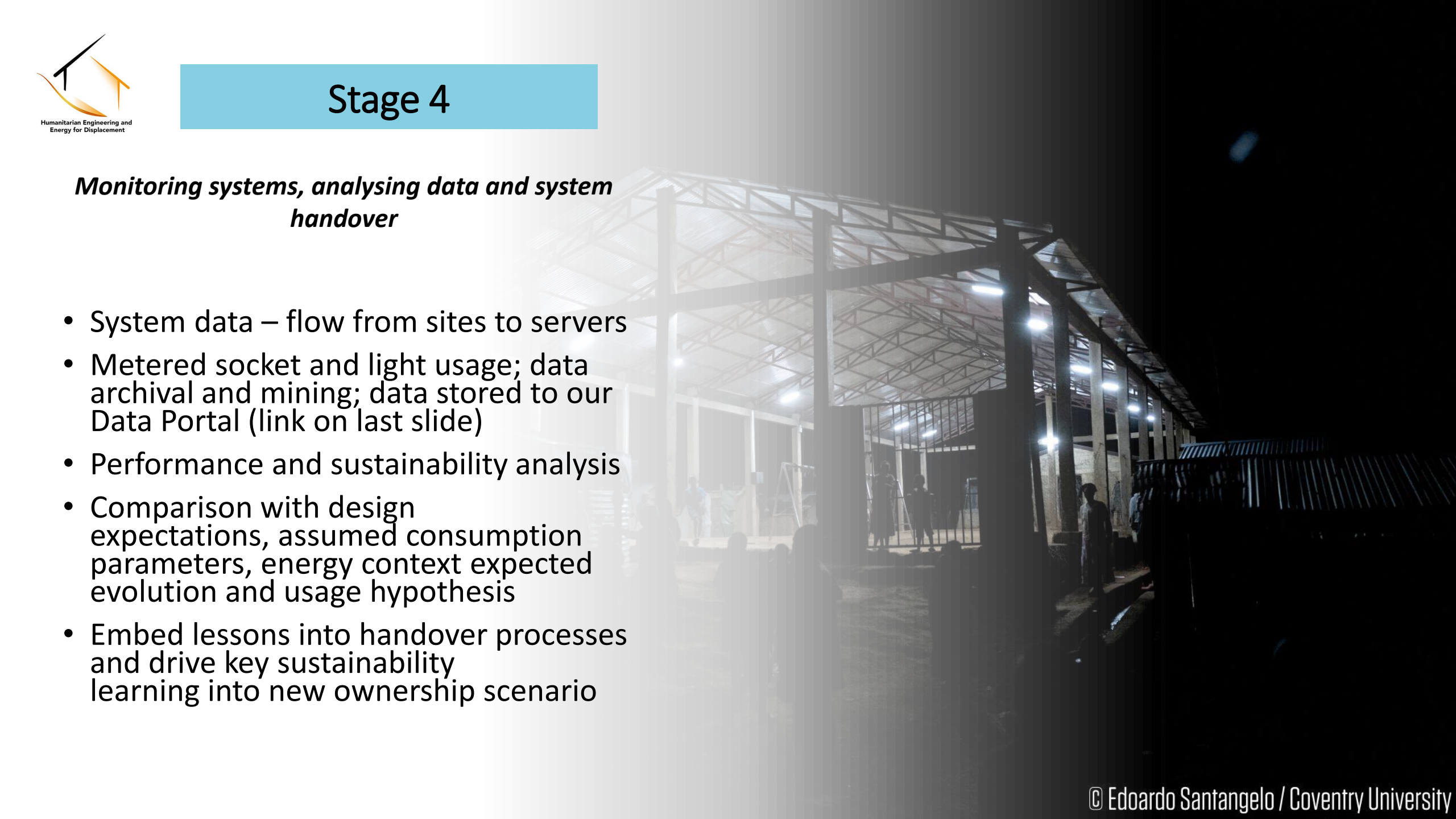
Stage 4

Monitoring systems, analysing data and system handover

- System data – flow from sites to servers
- Metered socket and light usage; data archival and mining; data stored to our Data Portal (link on last slide)
- Performance and sustainability analysis
- Comparison with design expectations, assumed consumption parameters, energy context expected evolution and usage hypothesis
- Embed lessons into handover processes and drive key sustainability learning into new ownership scenario



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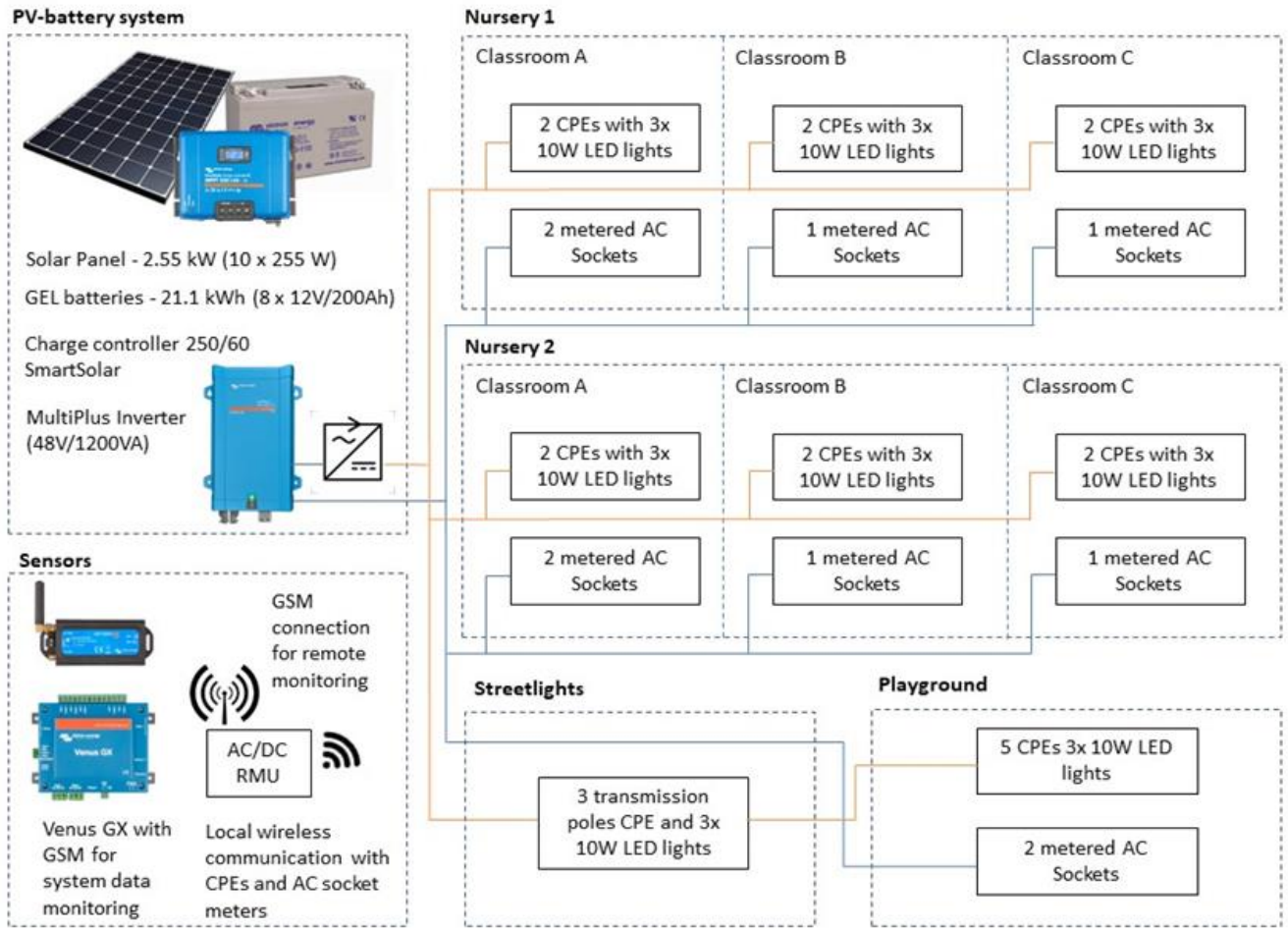
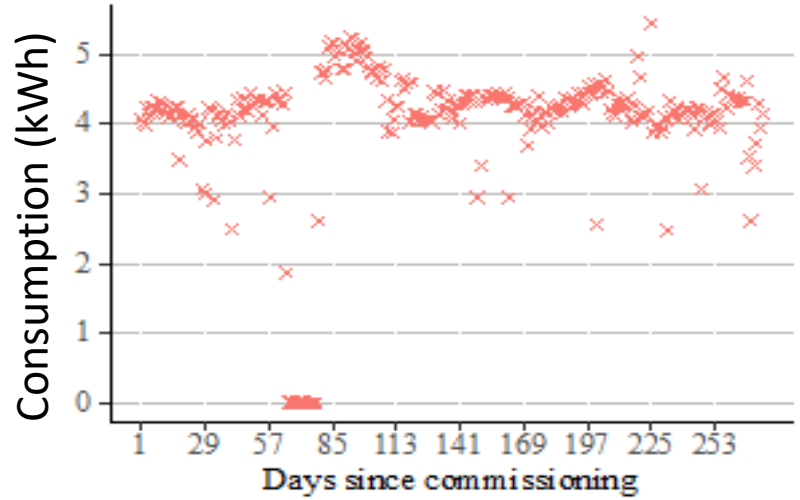
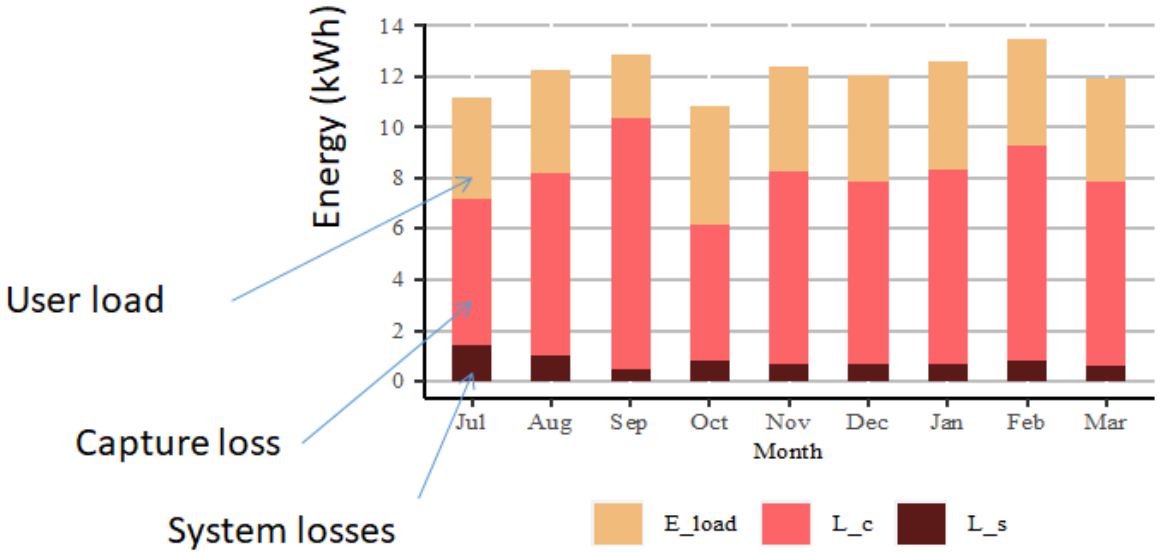
Microgrid System Overview



Micro-grid performance: Usage

- Power failure between 4th – 18th September 2019
- Capture losses around 6-10 kWh/day
- Performance ratio (delivered output to rated output) was around 33%
- Targeted performance ratio was 50%





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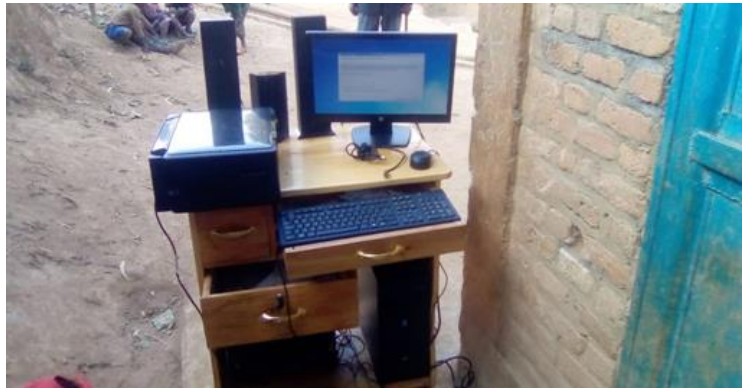
Micro-grid performance: Usage



- System usage was low from July 2019 – Mar 2020 (around 4.5 kWh/day)
- Design target was 5.75 kWh/day
- Socket loads during the day were limited to around 10-20 Watts
- Aug 2020 loads increased to 7.5 kWh/day supporting University students having to study remotely – this is higher than the designed load

Performance Gaps

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Where, Why and What Happens Next?

- Anticipated user loads and demand growth were not observed in the first 9 months.
- Accessibility issues for suppliers resulted in an increase in system faults and delays in deployment and maintenance
- Community access to facilities was limited

- Provide ongoing and repeat training for local technicians to improve fault reporting and maintenance.
- Ensure regular and scheduled permissions for suppliers to access sites
- Use low-cost and simple information technology to support fair sharing and access of community resource

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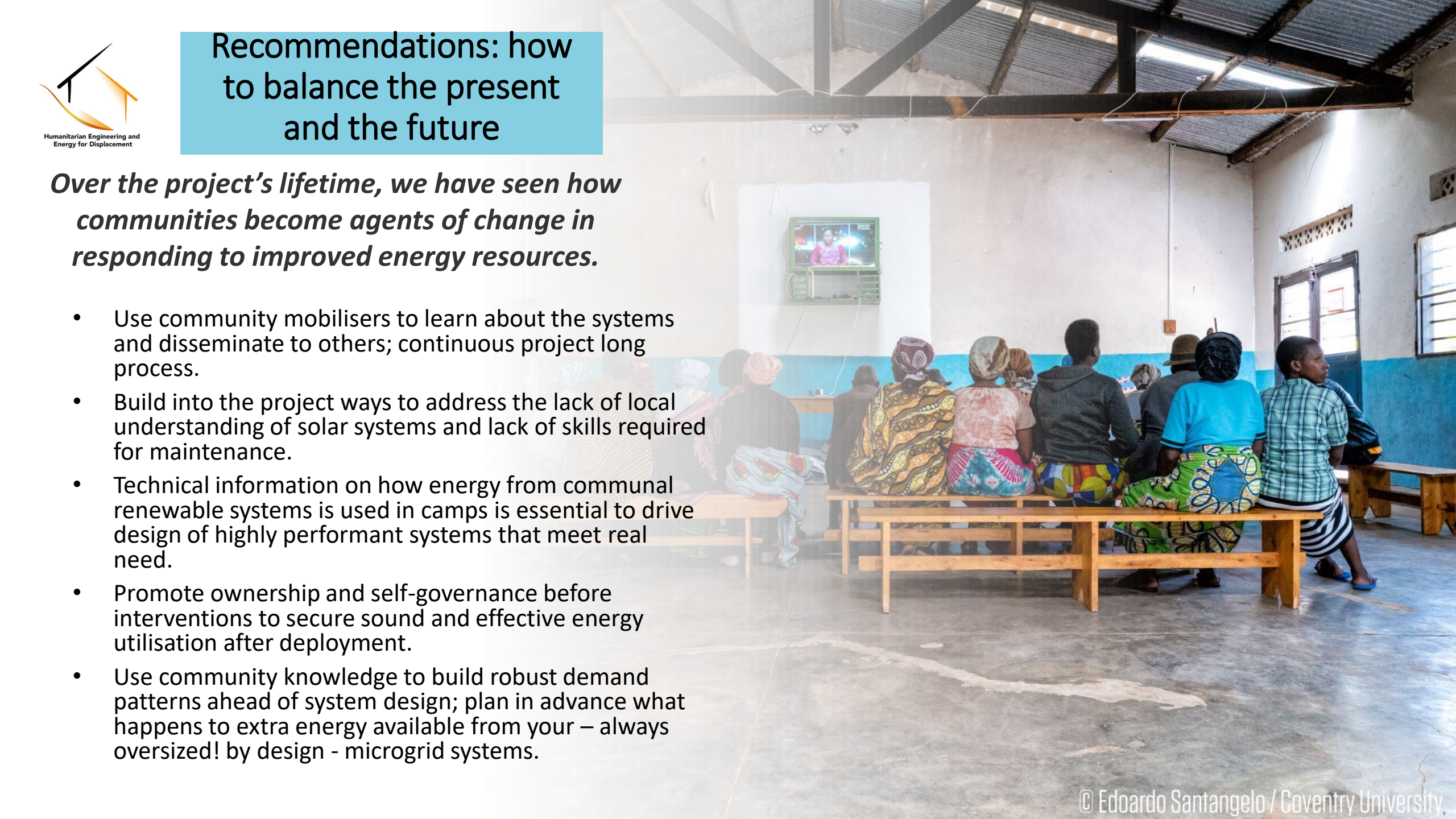
Recommendations: how to balance the present and the future

Over the project's lifetime, we have seen how communities become agents of change in responding to improved energy resources.

- Use community mobilisers to learn about the systems and disseminate to others; continuous project long process.
- Build into the project ways to address the lack of local understanding of solar systems and lack of skills required for maintenance.
- Technical information on how energy from communal renewable systems is used in camps is essential to drive design of highly performant systems that meet real need.
- Promote ownership and self-governance before interventions to secure sound and effective energy utilisation after deployment.
- Use community knowledge to build robust demand patterns ahead of system design; plan in advance what happens to extra energy available from your – always oversized! by design - microgrid systems.



Resources

HEED Renewable Energy Recommendations Tool (RERT)

https://heedproject.github.io/rert/

Data Portal

http://data-portal-heed.s3-website.eu-west-2.amazonaws.com/home

Website: **http://heed-refugee.coventry.ac.uk/**

Twitter: Energy4Displacement **@HEED_energy**

Email: **ad4480@coventry.ac.uk**

Blogs Posts from HEED team and partners

http://heed-refugee.coventry.ac.uk/reflections/

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HEED Digital Conference 4th November 2020

'Agency of Change: Energy in the Displaced Context'

Tickets: **https://www.eventbrite.co.uk/e/agency-of-change-energy-in-the-displaced-context-tickets-86929678007**

Newsletter: To sign up for HEED's newsletter email **ad4480@Coventry.ac.uk**

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